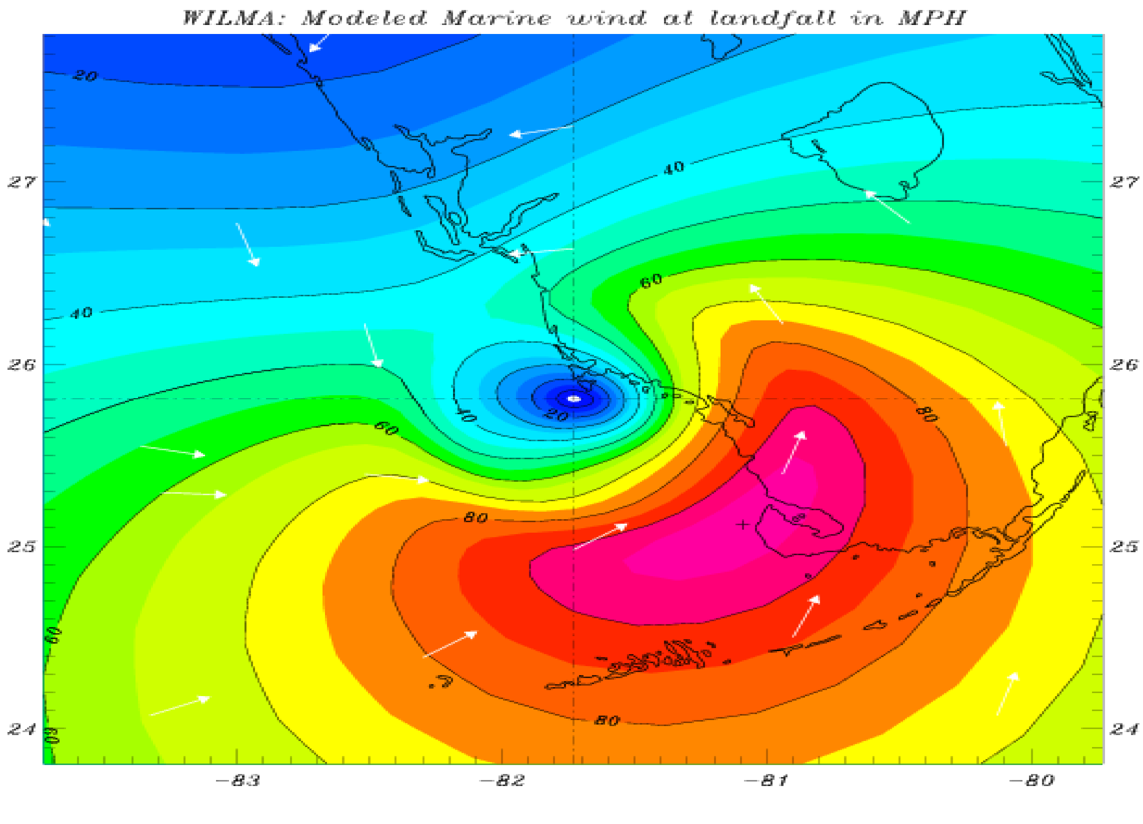
FLORIDA
PUBLIC HURRICANE LOSS MODEL 8.1

Submitted in compliance with the 2019 Standards of the
Florida Commission on Hurricane Loss Projection Methodology
Submitted on May 24, 2021



Hurricane Model Identification

Name of Hurricane Model: Florida Public Hurricane Loss Model

Hurricane Model Version Identification: V8.1

Hurricane Model Platform Names and Identifications with Primary Hurricane Model Platform and Identification Designated:

Interim Hurricane Model Update Version Identification:

Interim Data Update Designation:

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Date: May 24, 2021

May 24, 2021
Chair, Florida Commission on Hurricane Loss Projection Methodology
c/o Donna Sirmons
Florida State Board of Administration
1801 Hermitage Boulevard, Suite 100
Tallahassee, FL 32308

Dear Commission Chairman:

I am pleased to inform you that the revised version of 8.1 of Florida Public Hurricane Loss Model is ready for review by the Commission. The FPHLM model has been reviewed by professionals having credentials and/or experience in the areas of meteorology, engineering, actuarial science, statistics and computer science; for compliance with the Standards, as documented by the expert certification forms G1-G7.

Enclosed are 7 bound copies of our submission, which includes the summary statement of compliance with the standards, and the forms.

Please contact me if you have any questions regarding this submission.

Sincerely,

S. Hamid

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Statement of Compliance and Trade Secret Disclosure Items

The Florida Public Hurricane Loss Model 8.1 is intended to comply with each Standard of the 2019 Report of Activities released by the Florida Commission on Hurricane Loss Projection Methodology. The required disclosures, forms, and analysis are contained herein.

The source code for the loss model will be available for review by the Professional Team.

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GENERAL STANDARDS

G-1 Scope of the Hurricane Model and Its Implementation

A. The hurricane model shall project loss costs and probable maximum loss levels for damage to insured residential property from hurricane events.

The Florida Public Hurricane Loss Model estimates loss costs and probable maximum loss levels from hurricane events for personal lines and commercial lines of residential property. The losses are estimated for building, appurtenant structure, contents, and additional living expense (ALE).

B. A documented process shall be maintained to assure continual agreement and correct correspondence of databases, data files, and computer source code to slides, technical papers, and modeling organization documents.

The FPHLM group members follow the process specified in the flowchart of Figure 1 in order to assure continual agreement and correct correspondence of databases, data files, and computer source code to slides, technical papers, and FPHLM documents.

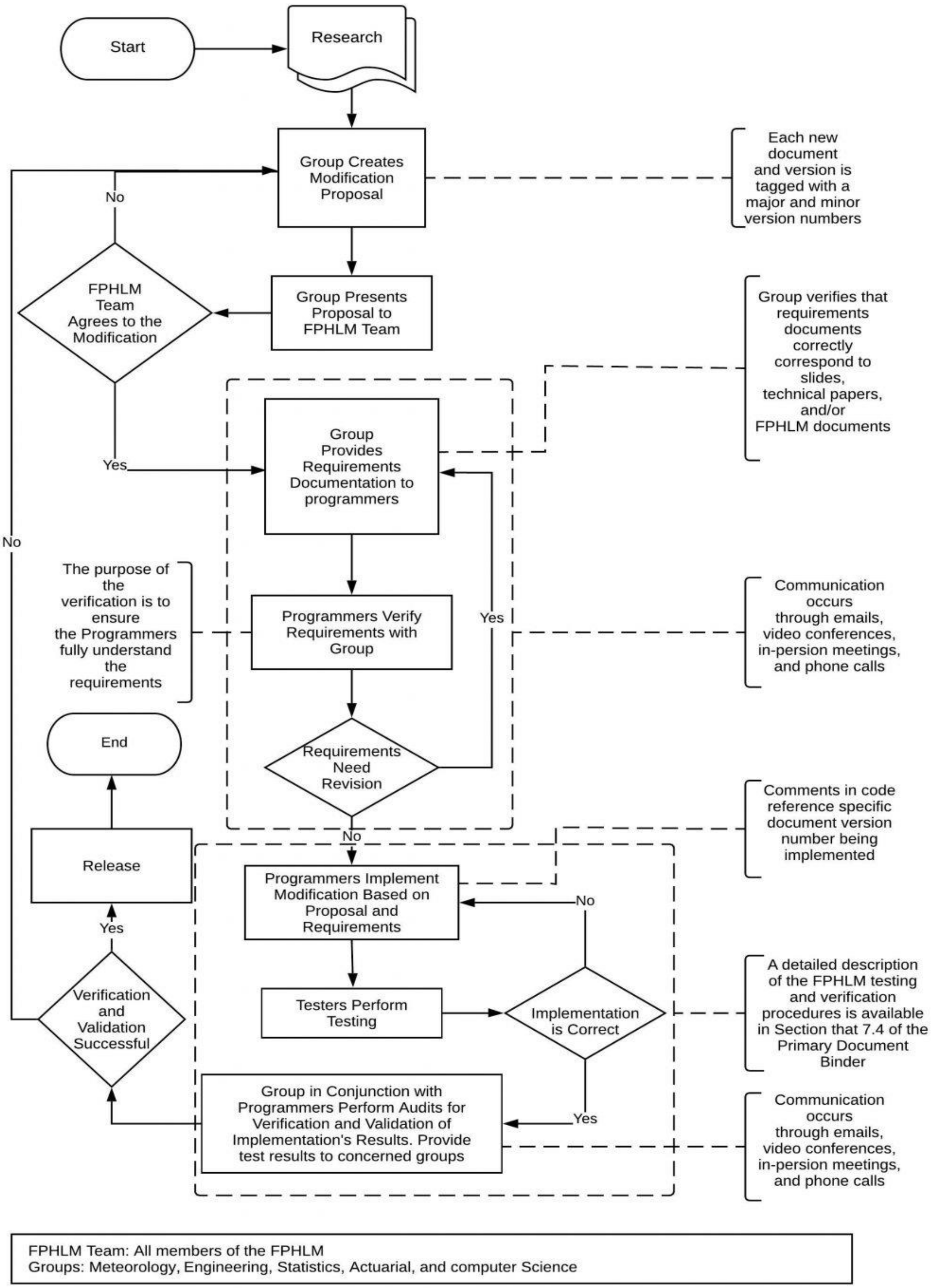

Figure 1. Process to assure continual agreement and correct correspondence

C. All software and data (1) located within the hurricane model, (2) used to validate the hurricane model, (3) used to project modeled hurricane loss costs and hurricane probable maximum loss levels, and (4) used to create forms required by the Commission in the Hurricane Standards Report of Activities shall fall within the scope of the Computer/Information Standards and shall be located in centralized, model-level file areas.

All software and data used to validate the model, project insured loss cost and PML, and create forms required by the Commission are centrally maintained in the model hardware infrastructure and easily accessible by appropriate team members, and comply with the Computer/Information Standards.

D. A subset of the forms shall be produced through an automated procedure or procedures as indicated in the form instructions.

As instructed by the forms, a subset of the forms is produced through an automated procedure.

Disclosures

1. Specify the hurricane model version identification. If the hurricane model submitted for review is implemented on more than one platform, specify each hurricane model platform identifying is the primary platform and the distinguishing aspects of each. Demonstrate how these platforms produce the same hurricane model output results, i.e., are otherwise functionally equivalent as provided for in subsection J. Review and Acceptance Criteria for Functionally Equivalent Hurricane Model Platforms, Item 2, under section VI. Review by the Commission in the chapter "Process for Determining the Acceptability of a Computer Simulation Hurricane Model."

The model name is Florida Public Hurricane Loss Model (FPHLM). The current version identification is V8.1.

2. Provide a comprehensive summary of the hurricane model. This summary should include a technical description of the hurricane model, including each major component of the hurricane model used to project loss costs and probable maximum loss levels for damage to insured residential property from hurricane events causing damage in Florida. Describe the theoretical basis of the hurricane model and include a description of the methodology, particularly the wind components, the vulnerability components, and the insured loss components used in the hurricane model. The description should be complete and must not reference unpublished work.

The model is a very complex set of computer programs. The programs simulate probable future hurricane activity, including where and when hurricanes form, their tracks and intensities, their wind fields and sizes; how they decay and how they are affected by the terrain along the tracks after landfall; how the winds interact with different types of residential structures; how much they can damage roofs, windows, doors, interior, and contents, etc.; how much it will cost to rebuild the damaged parts; and how much of the loss will be paid by insurers. The model consists of three major components: wind hazard (meteorology), vulnerability (engineering), and insured loss cost (actuarial). It has over a dozen subcomponents. The major components are developed independently before being integrated. The computer platform is designed to accommodate future subcomponents or enhancements. Following is the description of each of the major components and the computer platform.

Meteorology Component

Hurricane Track and Intensity

The storm track model generates storm tracks and intensities on the basis of historical storm conditions and motions. The initial seeds for the storms are derived from the HURDAT database. For historical landfalling storms in Florida and neighboring states, the initial positions, date of year, intensities, and motions are taken from the track fix 36 hours prior to first landfall. For historical storms that do not make landfall but come within 62 sm (100 km) of the coast, the initial conditions are taken from the track fix 36 hours prior to the point at which the storm first comes within 62 sm of the coast (threat zone) and has a central pressure below 1005 mb. Small, uniform random error terms are added to the initial position, the storm motion change, and the storm intensity change. The initial conditions derived from HURDAT are recycled as necessary to generate thousands of years of stochastic tracks. After the storm is initiated, the subsequent motion and intensity changes are sampled from empirically derived probability distribution functions over the model domain (Figure 2).

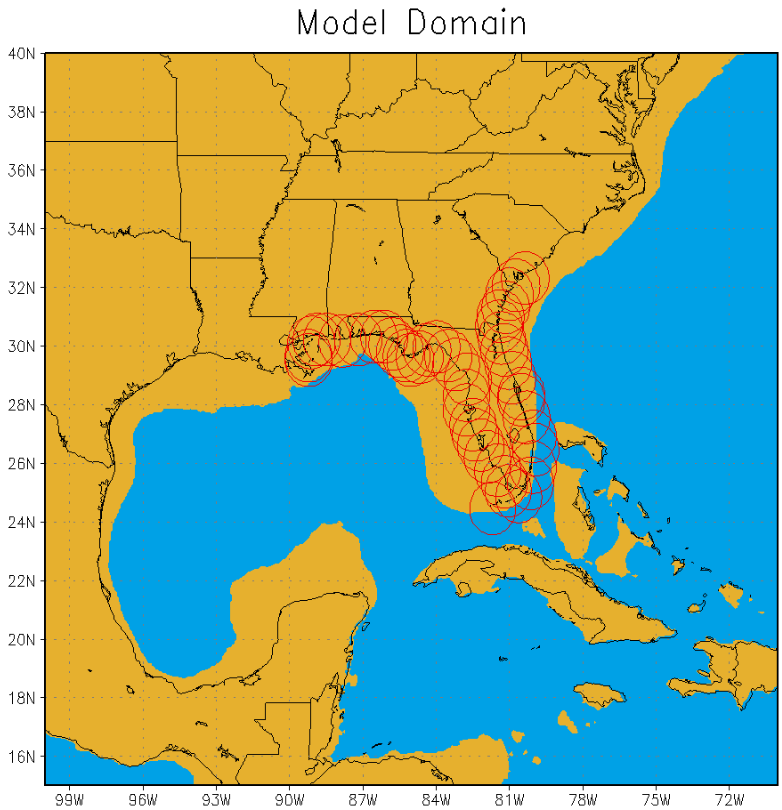

Figure 2. Florida Public Hurricane Loss Model domain. Circles represent the threat zone. Blue color indicates water depth exceeding 656 ft (200 m)

The time evolution of the stochastic storm tracks and intensity are governed by the following equations:

$$\Delta x = \frac{c\cos(\theta)\,\Delta t}{\cos(y)}$$

$$\Delta y = c\sin(\theta)\Delta t$$

$$\Delta p = w\Delta t$$

where (x, y) are the longitude and latitude of the storm, (c, θ) are the storm speed and heading (in conventional mathematical sense), p is central pressure, w is the rate of change in p, and Δt is the time step. The time step of the model is currently one hour. The change in storm speed and direction $(\delta c, \delta\theta)$ are sampled at every 24-hour interval from a probability distribution function (PDF). The intensity change after the initial 24 hours of track evolution is sampled every six hours to capture the more detailed evolution over the continental shelf (shallow water). From the 24-hour change in speed and heading angle, we determine the speed and heading angle at each one-hour time step by assuming the storm undergoes a constant acceleration that gives the 24-hour sampled change in velocity. For changes in pressure, we first sample from a PDF of relative intensity changes, δr, for the six-hour period and then determine the corresponding rate of pressure change, w. The relative intensity is a function of the climatological sea surface temperatures and the upper tropospheric 100 mb temperatures. The PDFs of the changes $(\delta c, \delta\theta, \delta r)$ depend on spatial location, as well as the current storm motion and intensity. These PDFs are of the form

$$PDF(\delta a) = A\ (\ \delta a, a, x, y\ )$$

where a is either c, θ, or r and are implemented as discrete bins that are represented by multi-dimensional matrices (arrays), $A(l,m,i,j)$. The indices (i,j) are the storm location bins. The model domain (100W to 70W, 15N to 40N) is divided into 0.5-degree boxes. The index m represents the bin interval that a falls into. That is, the range of all possible values of a are divided into discrete bins, the number of which depends on the variable, and the index m represents the particular bin a is in at the current time step. As with a, the range of all possible values of the change in a are also discretely binned. Given a set of indices (m,i,j), which represent the current storm location and state, the quantity $A(l,m,i,j)$ represents the probability that the change in a, δa , will fall into the l'th bin. When A is randomly sampled, one of the bins represented by the l index, e.g. l', is chosen. The change of a is then assigned the midpoint value of the bin associated with l'. A uniform random error term equal to the width of bin l' is added to δa, so that δa may assume any value within the bin l'.

The PDFs described above were generated by parsing the HURDAT database and computing for each track the storm motion and relative intensity changes at every 24- and 6-hour interval, respectively, and then binning them. Once the counts are tallied, they are then normalized to obtain the distribution function. For intensity reports for which pressure is not available, a wind pressure relation developed by Landsea et al. (2004) is used. In cases where there is no pressure report for a track fix in the historical data but there are two pressure reports within a 24-hour period that includes the track fix, the pressures are derived by linear interpolation. Otherwise the pressure is derived by using the wind-pressure relation. Extra-tropical systems, lows, waves, and depressions are excluded. Intensity changes over land are also excluded from the PDFs. To ensure a sufficient density of counts to represent the PDFs for each grid box, counts from nearest neighbor boxes, ranging up to 2 to 5 grid units away (both north-south and east-west direction), are aggregated. Thus, the effective size of the boxes may range from 1.5 to 5.5 degrees but are generally a fixed size for a particular variable. The sizes of the bins were determined by finding a compromise between large bin sizes, which ensure a robust number of counts in each bin to define the PDF, and small bin sizes, which can better represent the detail of the distribution of storm motion characteristics. Detailed examinations of the distributions, as well as sensitivity tests, were done. Bin sizes need not be of equal width, and a nonlinear mapping function is used to provide unequal-sized bins. For example, most storm motion tends to be persistent, with small changes in direction and speed. Thus, to capture this detail, the bins are more fine-grained at lower speed and direction changes.

For intensity change PDFs, boxes which are centered over shallow water (defined to be less than 656 ft deep, see Figure 2) are not aggregated with boxes over deeper waters. Deeper waters may have significantly higher ocean heat content, which can lead to more rapid intensification [see, for example, Shay et al. (2000); DeMaria et al. (2005); Wada and Usui (2007)].

In Figure 3 we show a sample of tracks generated by the stochastic track and intensity model.

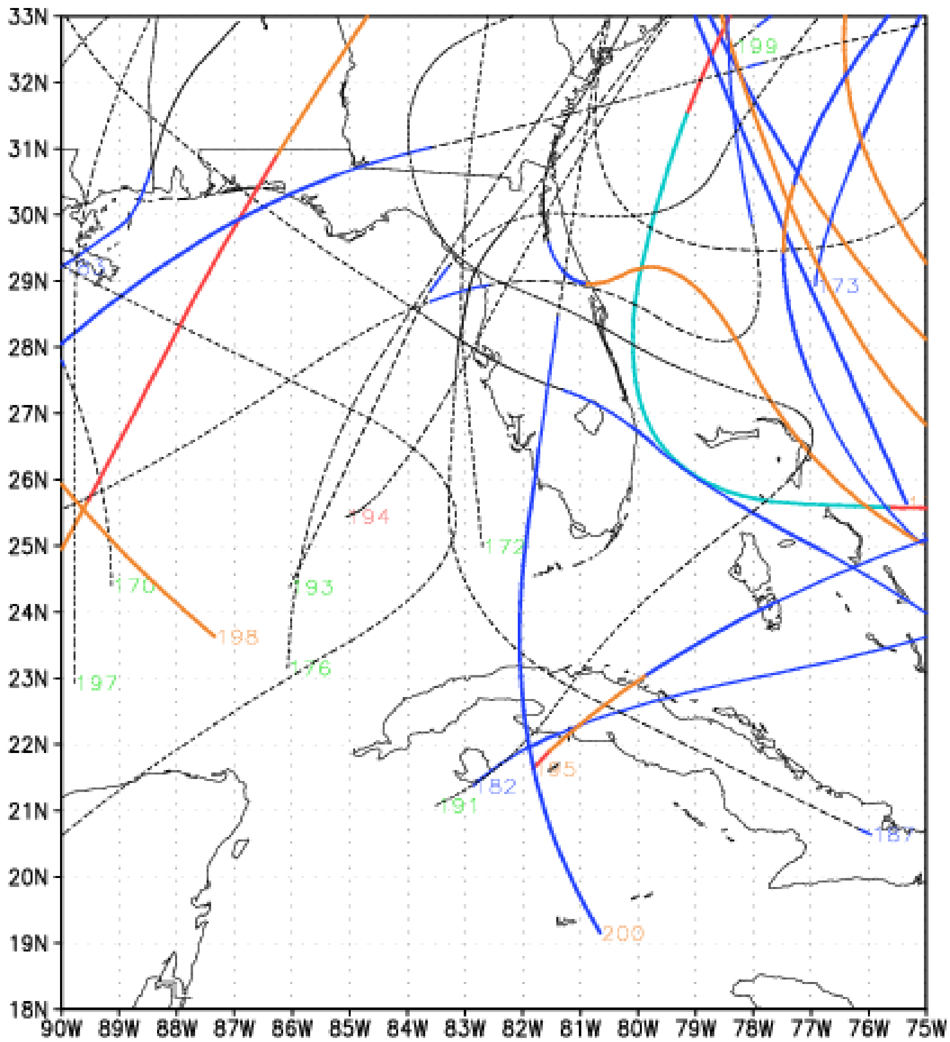

Figure 3. Examples of simulated hurricane tracks. Numbers refer to the stochastic track number, and colors represent storm intensity based on central pressure. Dashed lines represent tropical storm strength winds, and Cat 1-5 winds are represented by black, blue, orange, red, and turquoise, respectively.

When a storm is started, the parameters for radius of maximum winds and *Holland B* are computed and appropriate error terms are added as described below. The *Holland B* term is modeled as follows:

$$B = 1.74425 - 0.007915\, Lat + \ 0.0000084\, DelP^2 - 0.005024 Rmax$$

where *Lat* is the current latitude (degrees) of the storm center, *DelP* is the central pressure difference (mb), and *Rmax* is the radius of maximum winds (km). The random error term for the *Holland B* is modeled using a Gaussian distribution with a standard deviation of 0.286. Figure 4 shows a comparison between the Willoughby and Rahn (2004) B dataset (see Standard M-2.1) and the modeled results (scaled to equal the 116 measured occurrences in the observed dataset). The modeled results with the error term have a mean of about 1.38 and are consistent with the observed results. The figure indicates excellent agreement between model and observations.

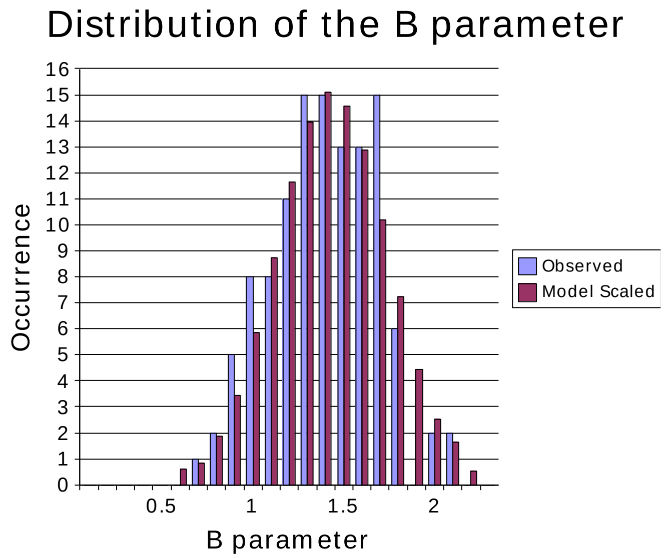

Figure 4. Comparison between the modeled and observed Willoughby and Rahn (2004) B dataset.

We developed an *Rmax* model using a landfall *Rmax* database, which includes more than 100 measurements for storms up to 2012. We have opted to model the *Rmax* at landfall rather than the entire basin for a variety of reasons. One is that the distribution of landfall *Rmax* may be different than that over open water. An analysis of the landfall *Rmax* database and the 1988–2007 DeMaria extended best track data shows that there appears to be a difference in the dependence of *Rmax* on central pressure (*Pmin*) between the two datasets (Demuth et al., 2006). The landfall dataset provides a larger set of independent measurements, more than 100 storms compared to about 31 storms affecting the Florida threat area region in the best track data. Since landfall *Rmax* is most relevant for loss cost estimation and has a larger independent sample size, we have chosen to model the landfall dataset.

We modeled the distribution of *Rmax* using a gamma distribution. Using the maximum likelihood estimation method, we found the estimated parameters for the gamma distribution, $\hat{k} = 4.76$ and $\hat{\theta} = 5.41$. With these estimated values, we show a plot of the observed and expected distribution in Figure 5. The *Rmax* values are binned in 5 sm intervals, with the *x*-axis showing the end value of the interval.

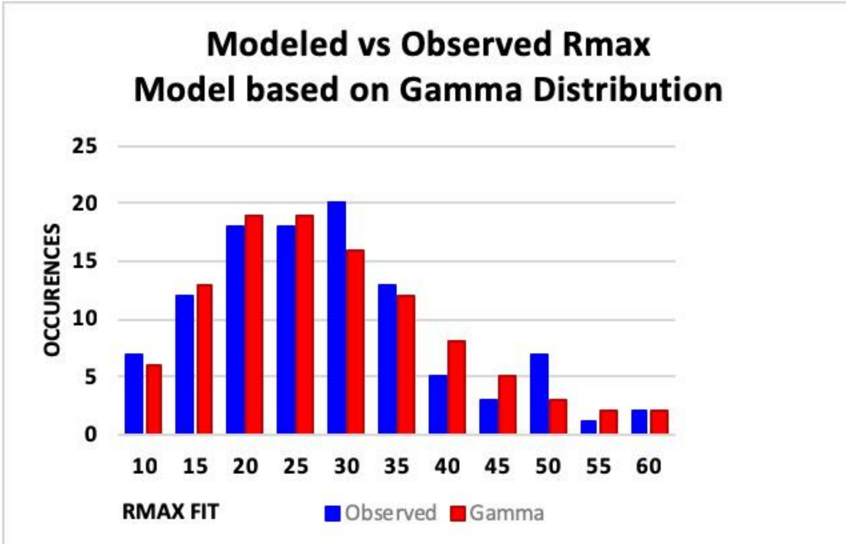

Figure 5. Observed and expected distribution for Rmax. The x-axis is the radius in statute miles, and the y-axis is the frequency of occurrence.

An examination of the *Rmax* database shows that intense storms, essentially Category 5 storms, have rather small radii. Thermodynamic considerations (Willoughby, 1998) also suggest that smaller radii are more likely for these storms. Thus, we model Category 5 (*DelP*>90 mb, where *DelP*=1013-*Pmin* and *Pmin* is the central pressure of the storm) storms using a gamma distribution, but with a smaller value of the θ parameter, which yields a smaller mean *Rmax* as well as smaller variance. We have found that for Category 1–4 (*DelP*<80 mb) storms there is essentially no discernable dependence of *Rmax* on central pressure. This is further verified by looking at the mean and variance of *Rmax* in each 10 mb interval. Thus, we model Category 1–4 storms with a single set of parameters. For a gamma distribution, the mean is given by $k\theta$, and variance is $k\theta^2$. For Category 5 storms, we adjust θ such that the mean is equal to the mean of the three Category 5 storms in the database: 1935 No Name, 1969 Camille, and 1992 Andrew. In 2018 Hurricane Michael made landfall in North Florida as a Category 5 storm. Currently the landfall intensity and radius maximum winds of this storm are under review, and we expect that a future update of the Category 5 Rmax mean will be warranted. An intermediate zone between *DelP*=80 mb and *DelP*=90 mb is established where the mean of the distribution is linearly interpolated between the Category 1–4 value and the Category 5 value. As the θ value is reduced, the variance is likewise reduced. Since there are insufficient observations to determine what the variance should be for Category 5 storms, we rely on the assumption that variance is appropriately described by the rescaled θ, via $k\theta^2$.

A simple method is used to generate the gamma-distributed values. A uniformly distributed variable, a product of the random number generator that is intrinsic to the FORTRAN compiler, is mapped onto the range of *Rmax* values via the inverse cumulative gamma distribution function. For computational efficiency, a lookup table is used for the inverse cumulative gamma distribution function, with interpolation between table values. Figure 6 shows a test using 100,000 samples of *Rmax* for Category 1–4 storms, binned in 1 sm intervals and compared with the expected values.

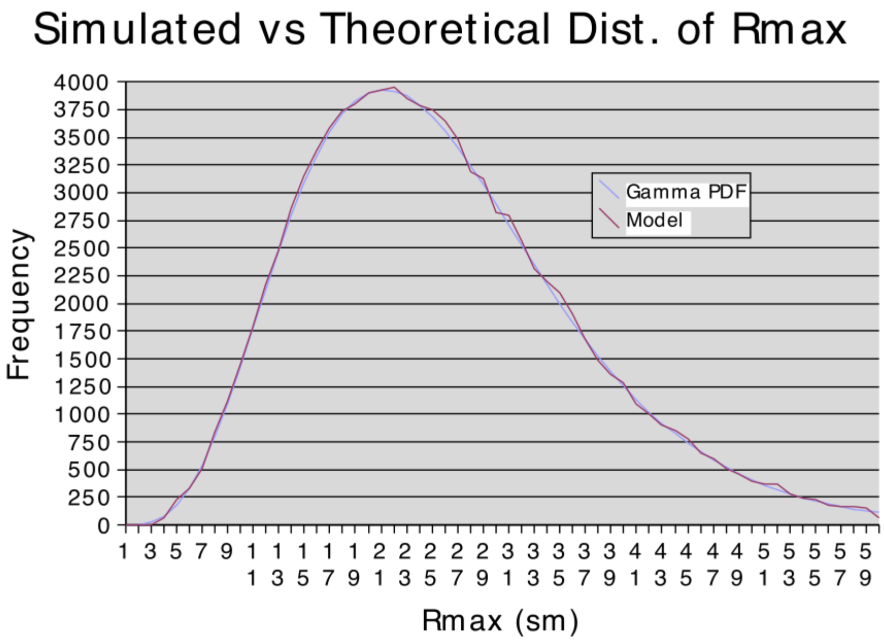

Figure 6. Comparison of 100,000 Rmax values sampled from the gamma distribution for Category 1-4 storms to the expected values.

For Category 5 and intermediate Category 4–5 storms, we use the property that the gamma cumulative distribution function is a function of $(k,x/\theta)$. Thus, by rescaling θ, we can use the same function (lookup table), but just rescale x (*Rmax*). The rescaled *Rmax* will still have a gamma distribution but with different mean and variance.

The storms in the stochastic model will undergo central pressure changes during the storm life cycle. When a storm is generated, an appropriate *Rmax* is sampled for the storm. To ensure the appropriate mean values of *Rmax* as pressure changes, the *Rmax* is rescaled every time step as necessary. As long as the storm has *DelP* < 80 mb, there is in effect no rescaling. In the stochastic storm generator, we limit the range of *Rmax* from 4 sm to 120 sm.

Storm landfall and decay over land are determined by comparing the storm location *(x,y)* with a 0.6 sm resolution land-sea mask. This land mask is obtained from the U.S. Geological Survey (USGS) land use cover data, and inland bodies of water have been reclassified as land to avoid spurious landfalls. Landfall occurs every time the storm moves from an ocean point to a land point as determined by this land mask. During landfall, the central pressure is modeled by a filling model described in Vickery (2005) and is no longer sampled from the intensity change PDFs. The Vickery (2005) model basically uses an exponentially decaying, in time, function of the central pressure difference with the decay coefficients varying by region on the basis of historical data. The pressure filling model also takes into account the speed and size of the storm. When the storm exits to sea, the land-filling model is turned off and sampling of the intensity change PDFs begins again. A storm is dissipated when its central pressure exceeds 1011 mb.

Wind Field Model

Once a simulated hurricane moves to within a threshold distance of a Florida ZIP Code, the wind field model is turned on. The model is based on the slab boundary layer concept originally conceived by Ooyama (1969) and implemented by Shapiro (1983). Similar models based on this concept have been developed by Thompson and Cardone (1996), Vickery et al. (1995), and Vickery et al. (2000a). The model is initialized by a boundary layer vortex in gradient balance. Gradient balance represents a circular flow caused by balance of forces on the flow whereby the inward directed pressure gradient force is balanced by outward directed Coriolis and centripetal accelerations. The coordinate system translates with the hurricane vortex moving at velocity *c*. The vortex translation is assumed to equal the geostrophic flow associated with the large-scale pressure gradient. In cylindrical coordinates that translate with the moving vortex, equations for a slab hurricane boundary layer under a prescribed pressure gradient are

$$u\frac{\partial u}{\partial r} - \frac{v^2}{r} - fv + \frac{v}{r}\frac{\partial u}{\partial \phi} + \frac{\partial p}{\partial r} - K\left(\nabla^2 u - \frac{u}{r^2} - \frac{2}{r^2}\frac{\partial u}{\partial \phi}\right) + F(c,u) = 0 = \frac{\partial u}{\partial t}$$

$$u\left(\frac{\partial v}{\partial r} + \frac{v}{r}\right) + fu + \frac{v}{r}\frac{\partial v}{\partial \phi} - K\left(\nabla^2 v - \frac{v}{r^2} + \frac{2}{r^2}\frac{\partial u}{\partial \phi}\right) + F(c,v) = 0 = \frac{\partial v}{\partial t}$$

where *u* and *v* are the respective radial and tangential wind components relative to the moving storm; *p* is the sea level pressure, which varies with radius (*r*); *f* is the Coriolis parameter, which varies with latitude; ϕ is the azimuthal coordinate; *K* is the eddy diffusion coefficient; and *F*(*c*,*u*), *F*(*c*,*v*) are frictional drag terms. All terms are assumed to be representative of means through the boundary layer. The motion of the vortex is determined by the modeled storm track. The symmetric pressure field *p*(*r*) is specified by the Holland (1980) pressure profile with the central pressure specified according to the intensity modeling in concert with the storm track. The model for the *Holland B* pressure profile and the radius of maximum wind are described above. The wind field is solved on a polar grid with a 0.1 *R*/*Rmax* resolution. The input *Rmax* is adjusted to remove a bias caused by a tendency of the wind field solution to place *Rmax* one grid point radially outward from the input value.

The marine surface winds from the slab model are adjusted to land surface winds using a surface friction model. The FPHLM includes the ability to model losses at the "street level." To incorporate this feature, the treatment of land surface friction in the model has been enhanced to provide surface winds at high resolution and to take advantage of recent developments in hurricane boundary layer theory. The 10-minute winds from the slab model are interpolated to a 1 km (0.62 sm) fixed grid covering the entire state of Florida at every time step to obtain a wind swath for each storm. Surface friction is modeled using an effective roughness model (Axe, 2004) based on the Source Area Model of Schmidt and Oke (1990) that takes into account upstream surface roughness elements. The surface roughness elements are derived from the Multi-Resolution Land Characteristics Consortium (MRLC) National Land Classification Database (NLCD) 2011 land cover/land use dataset (Jin et al., 2013) and the Statewide 2004-2011 Florida Water Management District land use classification data (available from the Florida Department of Environmental

Protection). The effective roughness elements are computed for eight incoming wind directions on a grid of approximately 90 m (295 ft) resolution covering the entire state of Florida.

For modeling losses at the ZIP Code level, the effective roughness elements are aggregated over the ZIP Code by a weighted summation of the roughness elements according to population density determined from census block data. The methodology for converting marine winds to actual terrain winds is based on Powell et al. (2003) and Vickery et al. (2009). This method assumes that wind at the top of the marine boundary layer is similar to the wind at the top of the boundary layer over land, and a modified log-wind profile is then used to determine the wind near the land surface. The winds are computed at various height levels that are needed for the vulnerability functions for residential and commercial residential structures.

The effect of the sea-land transition of hurricane winds coming onshore is modeled by modifying the terrain conversion methodology of Vickery et al. (2009). This modification is based on the concept of an internal boundary layer (IBL) (Arya, 1988) that develops as wind transitions from smooth to rough surface conditions. Winds above the IBL are assumed to be in equilibrium with marine roughness. In the equilibrium layer (EL), defined to be one-tenth of the IBL, the winds are assumed to be in equilibrium with the local effective roughness. Between the EL and IBL the winds are assumed to be in equilibrium with vertically varying step-wise changes in roughness associated with upstream surface conditions. This concept of multiple equilibrium layers is similar in philosophy to the method prescribed by the Engineering Sciences Data Unit (ESDU). The coastal transition function produces wind transitions that are very close to the ESDU and modified ESDU values reported in Vickery et al. (2009).

Vulnerability Component: Personal Residential Model

The engineering component performs several tasks: (1) it estimates the physical damage to exterior components of typical buildings, including roof cover, roof decking, walls, and openings; (2) it assesses the interior and utilities damage and contents damage due to water penetration through exterior damage and defects to interior walls, ceiling, doors, etc.; (3) it combines the exterior and interior damage to estimate the building and content vulnerabilities; (4) it estimates additional living expenses; and (5) it estimates the appurtenant structure vulnerability (Pinelli et al., 2003a, 2003b, 2004a, 2004b, 2005a, 2005b, 2006, 2007a, 2007b, 2008a, 2008b, 2009a, 2010a, 2011a, 2011b, 2012; Cope et al., 2003a, 2003b, 2004b, 2005; Gurley et al., 2003; Cope, 2004; Torkian at al., 2011, 2014; Pita et al., 2012, 2016).

Exposure Study

Personal residential single-family home buildings (PRB), either site built (Figure 7) or manufactured (Figure 8), are categorized into typical generic groups with similar structural characteristics, layout, and materials within each group. These buildings can suffer substantial external structural damage (in addition to envelope and interior damage), including collapse under hurricane winds. The approach to assessing damage for each of these building types is to model the building as a whole so that interactions among components can be accounted for. The models are intended to represent the majority of the PRB's in Florida.

An extensive survey of the Florida building stock was carried out to develop a manageable number of building models that represent the majority of the Florida residential building stock. The modelers analyzed several sources of data for building stock information. One source was the Florida Hurricane Catastrophe Fund (FHCF) exposure database. Another source was the Florida counties' property tax appraisers' databases. Although the database contents and format vary county to county, many of these databases contain the structural information needed to define common structural types. Each of the 67 counties were contacted to acquire their tax appraiser database, producing new information from 33 counties. This collection of new data coupled with the existing data from an additional 18 counties yielded a total of 51 counties. These 51 counties account for approximately 97% of Florida's population. The residential buildings in each county database were divided into single-family residential buildings and mobile homes.

County property tax appraiser (CPTA) databases contain large quantities of building information, and it was necessary to extract those characteristics related to the vulnerability of buildings to wind. The available building characteristics vary from county to county and include some combination of the following: exterior wall material, interior wall material, roof shape, roof cover, floor covering, foundation, opening protection, year built, number of stories, area per floor, area per unit, and geometry of the building. The parameters important for modeling are roof cover, roof shape, exterior wall material, number of stories, year built, and building area. For each of these categories, the authors extracted statistical information. The dependency between critical building characteristics was also investigated. For example, it was found that roof shape and area of the building are strongly dependent on the year built. The survey statistics were calculated for different eras to account for the correlation between various factors and year built.

Figure 7. Typical single-family homes (Google Earth).

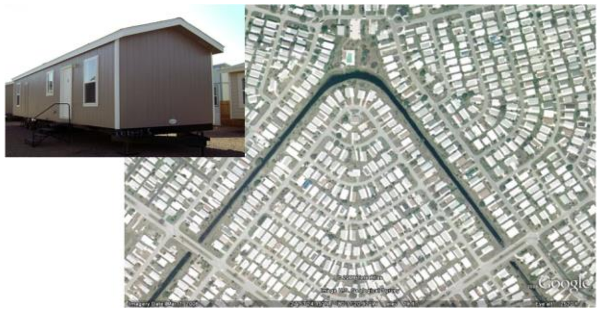

Figure 8. Manufactured homes (Google Earth).

The modelers divided Florida into four regions: North, Central, South, and the Keys. Geography and the statistics from the Florida Hurricane Catastrophe Fund (FHCF) provided guidance for defining regions that would have a similar building mix. For example, North Florida has primarily wood frame houses while South Florida primarily has masonry houses. Figure 9 shows the regions. Each county for which data were available is shaded. Databases representing the 2014 tax roll are shaded in green. Databases collected prior to 2014 are shaded in yellow (Michalski, 2016).

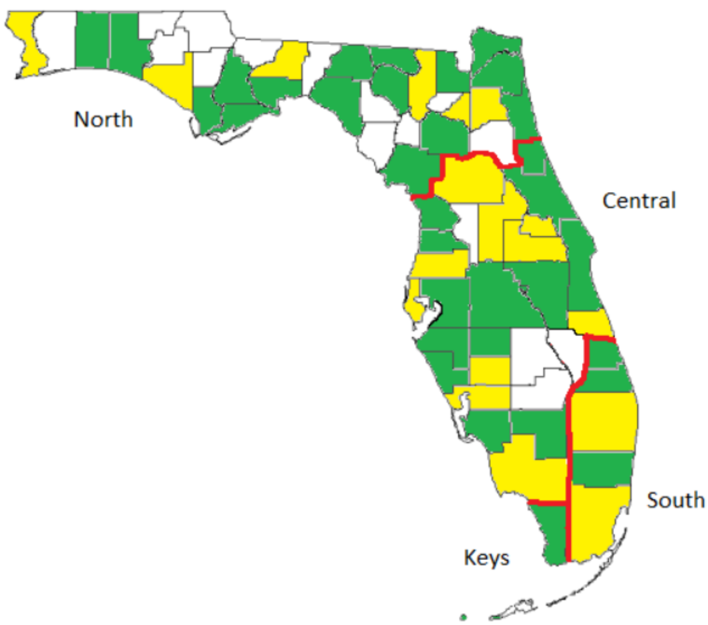

Figure 9. Regional Classification of Florida with the corresponding sample counties (shaded).

Structural types are delineated by a combination of four characteristics: number of stories (either one or two), roof cover (either shingle, tile, or metal), roof shape (either gable or hip), and exterior wall material (either concrete blocks or timber). Statistics were computed for each structural type in every sampled county. Weighted average techniques were used to extrapolate the results to the remaining counties in each region.

Building Models

Site-Built Home Models

In addition to a classification of building by structural types (wood or masonry walls, hip or gable roof), it was also necessary to classify the buildings by relative strength to reflect changes in construction practice over many years. The vulnerability team has developed strong, medium, and weak strength models for each site-built structural type to represent relative quality of original construction as well as post-construction mitigation. The weak and medium models have additional variants that reflect historical building practices, roof retrofits, and reroofing of existing structures as mandated by the newer building standards. The strong model has two variants to delineate code requirements that are regionally dependent. One strong variant reflects inland and wind-borne debris region (WBDR) construction, and another (stronger) variant reflects construction in the high velocity hurricane zone (HVHZ).

Both the WBDR and the HVHZ are defined in the Florida Building Code (FBC, 2020):

a) WIND-BORNE DEBRIS REGION: Areas within hurricane-prone regions located:
b) Within 1 mile (1.61 km) of the coastal mean high water line where the ultimate design wind speed Vult is 130 mph (58 m/s) or greater; or
c) In areas where the ultimate design wind speed Vult is 140 mph (63 m/s) or greater.
d) HIGH VELOCITY HURRICANE ZONE: Broward and Miami-Dade counties

Since the definition of WBDR is linked to the most current wind map in the FBC, its boundaries are not static, and can evolve with changes in the wind speed maps adopted by the FBC. In particular, it was revised in the 2007 and 2010 editions of the FBC, effective March 2009 and 2012 respectively. The FPHLM has implemented the pre-2007, the pre-2010, and the post 2010 boundaries of the WBDR. Consequently, a building might be assigned to a different WBDR depending on its year built (pre or post 2012).

The three strength categories are based on the same model framework, in which strength is represented by the capacities assigned to the modeled building components. For example, the strong models differ from the weak models by stronger assigned capacities for roof-to-wall (r2w) and stud to sill connections, garage pressure capacity, cracking capacity of masonry walls, gable end walls, decking and shingle capacities. The medium models differ from the weak models by increasing the strength of the roof-to-wall connections (toe nails vs. clips), roof decking capacity (nailing schedule), and masonry wall strength (un-reinforced vs. reinforced).

Any given strong, medium, or weak model may be altered by additional mitigation or retrofit measures individually or in combination. For example, from the base weak model, additional models were derived to represent historical building practices and mitigation techniques. The modified weak W10 model accounts for the use of tongue-and-groove plank decking in pre-1960s buildings. These buildings tend to exhibit higher deck strength capacities than the buildings with the plywood decking implemented in the base weak model, referred to as W00 (Shanmugam et al., 2009).

A modified medium model M10 was adopted that reflects the use of oriented strand board (OSB) decking with staples in the 1980s and pre-Andrew 1990s. This was considered an adequate alternative to nailed plywood at the time. It was, however, weaker in terms of wind resistance and was assigned a weaker deck attachment capacity than the standard medium model.

Additionally, retrofitted weak W01 and medium M01 models were derived from the base weak and medium models. They represent the case in which a structure has been reroofed and the decking re-nailed according to current code requirements. On the basis of the average lifespan of a roof, reroofing would be required periodically throughout the structure's lifetime and would result in an increase in the deck attachment capacity and shingle ratings to meet current building code requirements. The deck attachment capacities of these models were therefore upgraded to produce the retrofitted weak W01 and medium M01 cases. The roof cover was also upgraded to rated shingles (Pinelli et al., 2012).

The base, retrofitted and modified versions of the weak and medium models were developed in order to provide a fine model resolution of quality of construction for homes constructed prior to 1994 and a portion of the homes prior to 2002. Weak and medium models represent approximately 80% of the existing single-family residential inventory in Florida, and are described in Table 1.

Two basic variations of the strong model represent construction quality for the remaining approximately 20% of the single-family residential inventory. The base strong model, S00, represents modern construction in locations inland, as well as the WBDR that is not overlapping the HVHZ. The base strong model, S02, is the S00 variant with single straps and metal roof on a strong deck, for inland and WBDR. The difference in strong models between inland, S00 or S02, and WBDR, S00-OP or S02-OP, is due to the presence of metal shutters in WBDR. This base strong model incorporates modern requirements for nailing schedules, roof to wall connection products, masonry reinforcing, and roof shingle products and installation methods. The second strong model, S01, has upgrades to the capacity for roof cover, roof decking and roof to wall connections to reflect additional code requirements for HVHZ construction. The strong models are described in Table 2.

All models may be run without opening protection, with plywood opening protection, or with metal panel shutter opening protection installed, with increasing protection respectively.

The distribution of the weak, medium and strong model variations with respect to year built will be presented later in Table 7 and in the discussion of the models' distribution in time.

	Weak			Medium		
	W00 (base)	**W01 (retrofitted*)**	**W10 (modified**)**	**M00 (base)**	**M01 (retrofitted*)**	**M10 (modified***)**
Roof to wall	Weak	Weak	Weak	Medium	Medium	Medium
Stud to sill	Weak	Weak	Weak	Medium	Medium	Medium
Roof cover	Weak	Strong	Weak	Weak	Strong	Weak
Roof deck	Weak	Strong	Strong	Medium	Strong	Weak
Wall	Weak	Weak	Weak	Medium	Medium	Medium
Gable end	Weak	Weak	Weak	Weak	Weak	Weak
Garage	Weak	Weak	Weak	Weak	Weak	Weak

*retrofitted refers to re-roof and re-nailed decking, occurring post-1993 for HVHZ and Monroe, and post-2001 for everywhere else. No other retrofits are included.
**modified weak (W10) refers to the base weak model with stronger decking to reflect the use of plank decking
***modified medium (M10) refers to the base medium model with weak decking to reflect the use of staples and/or OSB

Table 1. Weak and Medium Models

	S00 or S02 Strong - inland	**S00-OP or S02-OP Strong - WBDR**	**S01 Strong - HVHZ**
Roof to wall	Strong	Strong	Upgraded Strong
Stud to sill	Strong	Strong	Strong
Roof cover	Strong	Strong	Upgraded Strong
Roof deck	Strong	Strong	Upgraded Strong
Wall	Strong	Strong	Strong
Gable end	Strong	Strong	Strong
Garage	Strong	Strong	Strong
Shutters	no shutters	metal	metal

Table 2. Strong Models

Manufactured Homes Model

On the basis of the exposure study, it was decided to model four manufactured home (MH) types: (1) pre-1994—fully tied down, (2) pre-1994—not tied down, (3) post-1994—Housing and Urban Development (HUD) Zone II, and (4) post-1994—HUD Zone III. The partially tied-down homes are assumed to have a vulnerability that is an average of the vulnerabilities of fully tied-down and not tied-down homes. Because little information is available regarding the distribution of manufactured home types by size or geometry, it is assumed that all model types are single-wide manufactured homes. The modeled single-wide manufactured homes are 56 ft x 13 ft, have gable roofs, eight windows, a front entrance door, and a sliding-glass back door.

Damage Matrices

Exterior Damage

The model accounts for a number of construction factors that influence the vulnerability of single-family dwellings, including classification (site-built or manufactured home), size, roof shape, location, age, and a variety of construction details and mitigation measures. The effects of mitigation measures such as code revisions and post-construction upgrades to the wind resistance of homes (e.g., new roof cover on an older home, shutter protection against debris impact, braced garage door, re-nailed roof decking, etc.) are accounted for both individually and in combination by selecting the desired statistical descriptors of the capacities of the various components. Thus the comparative vulnerability of older homes as built, older homes with combinations of mitigation measures, and homes constructed to the new code requirements can be estimated.

The vulnerability model uses a component-based Monte Carlo simulation to determine the external vulnerability at various wind speeds for the different building models. The approach accounts for the resistance capacity of the various building components, the wind-load effects from different directions, and associated uncertainties of capacity and loads to predict exterior damage at various wind speeds. The simulation relates probabilistic strength capacities of building components to a series of three-second peak gust wind speeds through a detailed wind and structural engineering analysis that includes effects of wind-borne debris. Damage to the structure occurs when the loads from wind or flying debris are greater than the components' capacity to resist them. The vulnerability of a structure at various wind speeds is estimated by quantifying the amount of damage to the modeled components. Damage to a given component may influence the loads on other components, e.g., a change in roof loading from internal pressurization due to a damaged opening. These influences are accounted for through an iterative process of loading, damage assessment, load redistribution, and reloading until convergence is reached.

The damage estimations are affected by uncertainties regarding the behavior and strength of the various components and the load effects produced by hurricane winds. Field and laboratory data that better define these uncertain behaviors can thus be directly included in the model by refining the statistical descriptors of the capacities, load paths, and applied wind loads.

The output of the Monte Carlo simulation model is an estimate of physical damage to structural and exterior components of the modeled home. The results are presented in the form of a damage matrix, where each row presents the output of an individual simulation. The 15 rows of this matrix (Table 3) correspond to damage to 14 components, and the internal pressure of the building upon completion of that simulation (column 11). A separate matrix is created for each peak three-second gust wind speed between 50 and 250 mph in 5 mph increments (50, 55, …, 250 mph) and for each wind angle between 0 and 315 degrees in 45-degree increments. A description of the values in each of the nine columns of the manufactured home damage matrix is given in Table 4. Note that internal pressure is not included as an output from the manufactured home model (Table 4). Changes in internal pressure due to breach are accounted for and utilized to quantify damage, but the final internal pressure value is not needed as an output.

Col#	Description of Value	Min Value	Max Value
1	% failed roof sheathing	0	100
2	% failed roof cover	0	100
3	% failed roof to wall connections	0	100
4	# of failed walls	0	4
5	# of failed windows	0	15
6	# of failed doors	0	2
7	y or n failed garage	0 = no	1 = yes
8	y or n envelope breached	0 = no	1 = yes
9	# of windows broken by debris impact	0	15
10	% of gable end panels broken	0	100
11	internal pressure	Not defined	Not defined
12	% failed wall panels – front	0	100
13	% failed wall panels – back	0	100
14	% failed wall panels – side	0	100
15	% failed wall panels – side	0	100

Table 3. Description of values given in the damage matrices for site-built homes

Col #	Description of Value	Min Value	Max Value
1	# of failed windows (out of 8 for single wide)	0	8
2	# of broken windows that were broken by impact load case	0	8
3	# of failed doors (front and back = 2 total)	0	2
4	% of roof sheathing failed	0	100
5	% of roof cover failed	0	100
6	% of wall sheathing failed	0	100
7	# of failed roof to wall connections (out of 58)	0	58
8	sliding (0 = no sliding, 1 = minor sliding, 2 = major sliding)	0	2
9	overturning (0 = not overturned, 1 = overturned)	0	1

Table 4. Description of values given in the damage matrices for manufactured homes.

Interior and Utilities Damage

Once the external damage has been calculated for a given Monte Carlo simulation, the internal, utilities, and contents damages to the building are then extrapolated from the external damage. For the interior and utilities of a home, there is no explicit means by which to compute damage. Damage to the interior and utilities occurs when the building envelope is breached, allowing wind and rain to enter. Damage to roof sheathing, roof cover, walls, windows, doors, and gable ends present the greatest opportunities for interior damage. For manufactured homes, sliding and overturning are additional factors.

Interior damage equations were derived as functions of each of the external components. These equations are developed primarily on the basis of experience and engineering judgment. Observations of homes damaged during the 2004 hurricane season helped to validate these predictions. The interior equations are derived by estimating typical percentages of damage to each interior component, given a percentage of damage to an external component. The interior damage as a function of each modeled component is the same for both site-built and manufactured homes.

To compute the total interior damage for each model simulation, all values in the damage matrices are converted to percentages of component damage. The interior equations are applied to each component, one at a time. The total interior damage for each simulation is the maximum interior damage value produced by these equations. The maximum value is used instead of a summation to avoid the possibility of counting the same interior damage more than once. That is, once water intrusion from one breach of the envelope has thoroughly damaged any part of the interior, further water intrusion from other sources will not increase the cost of the damage of that part.

Utilities damage is estimated on the basis of interior damage. A coefficient is defined for each utility (electrical, plumbing, and mechanical), which multiplies the interior equations defined for each component. As in the case of interior damage, the maximum value is retained as the total damage. The utilities coefficients are based on engineering judgment. In both site-built and manufactured homes, it is assumed that electrical damage occurs at half the rate of interior damage (0.5). Plumbing damage is set to 0.35 of interior damage for site-built homes and for manufactured homes. Mechanical damage is set to 0.4 of interior damage for site-built homes and for manufactured homes.

Contents Damage

As with the interior and utilities, the contents of the home are not modeled by Monte Carlo simulations. Contents damage is assumed to be a function of the interior damage caused by each failed component that causes a breach of the building envelope. The functions are based on engineering judgment and are validated using actual claims data.

Additional Living Expenses

Additional Living Expense (ALE) coverage covers only expenses actually paid by the insured. This coverage pays only the increase in living expenses that results directly from the covered damage and having to live away from the insured location. The value of an ALE claim is dependent on the time required to repair a damaged home and the surrounding utilities and infrastructure.

The equations and methods used for manufactured and residential homes are identical. However, it seems logical to reduce the manufactured home ALE predictions because typically a faster repair or replacement time may be expected for these home types. Therefore, an ALE multiplier factor of 0.75 was introduced into the manufactured home model.

Vulnerability Matrices

The estimates of total building damage result in the formulation of vulnerability matrices for each modeled building type. The flowchart in **Figure 53** of disclosure 2 of Standard V-1 summarizes the procedure used to convert the Monte Carlo simulations of physical external damage into a vulnerability matrix. For each Monte Carlo model, 2000 simulations are performed for each of 8 different wind angles and 41 different wind speeds. This is 2000 x 8 x 41 = 656,000 simulations of external damage per model, which are then expanded to cover interior, utilities, and contents damage, plus ALE, as explained above.

Knowing the components of a home and the typical square footage, the cost of repairing all damaged components is estimated using cost estimation resources [e.g., RSMeans Residential Cost Data (RSMeans, 2008a) and RSMeans Square Foot Costs (RSMeans, 2008b) and Construction Estimating Institute (Langedyk & Ticola, 2002)] and expert advice. These resources provide cost data from actual jobs based on estimates and represent typical conditions. Unmodeled nonstructural interior, plumbing, mechanical, and electrical utilities make up a significant portion of repair costs for a home.

Replacement cost ratios provide a link between modeled physical damage and the corresponding monetary losses. They can be defined as the cost of replacing a damaged component or assembly of a home divided by the cost of constructing a completely new home of the same type. The sum of the replacement cost ratios for all the components of a home is greater than 100% because the replacement costs include the additional costs of removal, repair, and remodeling.

An explicit procedure is used to convert physical damage of the modeled components to monetary damage. Since the replacement ratio of each modeled component is known, the monetary damage resulting from damage to a component expressed as a percentage of the home's value can be obtained by multiplying the damaged percentage of the component by the component's replacement ratio. For example, if 30% of the roof cover is damaged, and for this particular home type the replacement ratio of roof cover is 14%, the value of the home lost as a result of the damaged roof cover would be 0.30 x 0.14 = 4.2%. If the value of this home were $150,000, the cost to replace 30% of the roof would be $150,000 x 0.042 = $6,300. In addition, the costs will be adjusted as necessary because of certain requirements of the Florida building code that might result in an increase of the repair costs (for example, the code might require replacement of the entire roof if 30% or more is damaged).

After the simulation results have been translated into damage ratios, they are then transformed into vulnerability matrices. A total of 4356 matrices for site-built homes is created for different combinations of wall type (frame or masonry), region (North, Central, or South), subregion (high wind velocity zone, wind-borne debris region, or other), roof shape (gable or hip), roof cover (tile or shingle), window protection (shuttered or not shuttered), number of stories (one or two), and strength (base weak W00, modified weak W10, retrofitted weak W01, base medium M00, modified medium M10, retrofitted medium M01, or strong (base S00, stronger S01 for HVHZ, S02 with single straps and metal roof on a strong deck).

The cells of a vulnerability matrix for a particular structural type represent the probability of a given damage ratio occurring at a given wind speed. The columns of the matrix represent three-second gust wind speeds at 10 m, from 50 mph to 250 mph in 5 mph bands. The rows of the matrix correspond to damage ratios (DR) in 2% increments up to 20%, and then in 4% increments up to 100%. If a damage ratio is DR= 15.3%, it is assigned to the interval 14%<DR<16% with a midpoint DR=15%. After all the simulations have been counted, the total number of instances in each damage interval is divided by the total number of simulations per wind speed to determine the percentage of simulations at any damage state occurring at each speed. These percentages are the conditional probabilities of occurrence of a level of damage, given a certain wind speed. A partial example of a vulnerability matrix is shown in Table 5.

Damage\Wind Speed (mph)	**47.5 to 52.5**	**52.5 to 57.5**	**57.5 to 62.5**	**62.5 to 67.5**	**67.5 to 72.5**
0% to 2%	1	0.99238	0.91788	0.77312	0.61025
2% to 4%	0	0.00725	0.0806	0.21937	0.36138
4% to 6%	0	0.00037	0.001395	0.007135	0.0235
6% to 8%	0	0	0.000125	0.000375	0.0025
8% to 10%	0	0	0	0	0.000375
10% to 12%	0	0	0	0	0.000375
12% to 14%	0	0	0	0	0.000625
14% to 16%	0	0	0	0	0.0005
16% to 18%	0	0	0	0	0.000125
18% to 20%	0	0	0	0	0.00012
20% to 24%	0	0	0	0	0.00025
24% to 28%	0	0	0	0	0

Table 5. Partial example of vulnerability matrix.

An important plot derived from the vulnerability matrix is the vulnerability curve. The vulnerability curve for any structural type is the plot of the mean damage ratio vs. wind speed. The model can also generate fragility curves (the probability of exceedance of any given damage level as a function of the wind speed) for each vulnerability matrix, although these curves are not used in the model.

Similar vulnerability matrices and vulnerability curves are developed for contents and ALE, one for each structural type. The whole process is also applied to manufactured homes.

Weighted Vulnerability Matrices

Building vulnerability matrices were created for every combination of region (Keys, South, Central, and North), construction type (masonry, wood, or other), roof shape (gable or hip), roof cover (tile or shingle or metal), number of stories (one or two), shutters (with or without), and subregion (inland, wind-borne debris region, or high velocity hurricane zone). However, in general, there is little information available in an insurance portfolio file regarding the structural characteristics and the wind resistance of the insured property. Instead, insurance companies rely on the Insurance Services Office's (ISO) fire resistance classification. Portfolio files have information on ZIP Code and year built. The ISO classification is used to determine if the home is constructed of masonry, timber, or other. The ZIP Code is used to define the region and subregion. The year the home was built is used to assist in defining the strength to be assigned to the home.

Region, subregion, construction type, and year built are determined from the insurance files. This leaves the roof shape, roof cover, and shutter options undefined. From the exposure study of 51 Florida counties (Michalski, 2016), the distribution of number of stories, roof shapes, and roof cover by age per region can be extrapolated. For each age group, we define a weighted matrix for each construction type in each county belonging to a region and subregion. The weighted matrices are the sum of the corresponding vulnerability model matrices weighted on the basis of their statistical distribution. For example, consider a masonry home built in the wind-borne debris region of central Florida in 1990. The exposure study indicates that 66% of such homes have gable roofs, 85% have shingle roof cover, and 20% have window shutters. Weight factors can be computed for each model matrix based on these statistics. For example, the Central Florida, gable, tile, no shutters, masonry matrix would have a weight factor of 66% (masonry percent gable) x 15% (percent tile) x 80% (percent without shutters) = 7.9%; this is the percentage of that home type that would be expected in this region, for that year built. Each model matrix is multiplied by its weight factor, and the results are summed. The final result is a weighted matrix that is a combination of all the model matrices and can be applied to an insurance policy if only the ZIP Code, year built, and ISO classification are known. As a result, for each county in each subregion (inland, wind-borne debris region, and high velocity hurricane zone) of each region (Keys, South, Central, and North), there will be sets of weighted matrices (masonry, wood, and others) for weak, medium, and strong structures.

Age-Weighted Matrices

The year built or year of last upgrade of a structure in a portfolio might not be available when performing a portfolio analysis to estimate hurricane losses in a certain region. In that case, it becomes necessary to assume a certain distribution of ages in the region to develop an average vulnerability by combining weak, medium, and strong.

The tax appraisers' databases include effective year of construction and thus provide guidance as to how to weigh the combined weak, medium, and strong model results when year built information is not available in other portfolio files. In each region, the data were analyzed to provide the age statistics. These statistics were used to weigh the average of weak, medium, and strong vulnerabilities in each region. The results are shown in Figure 10 for the wind-borne debris zone in the Central region. The different weighted vulnerability curves are shown for the weak, medium, and strong models, superimposed with the age-weighted vulnerability curve.

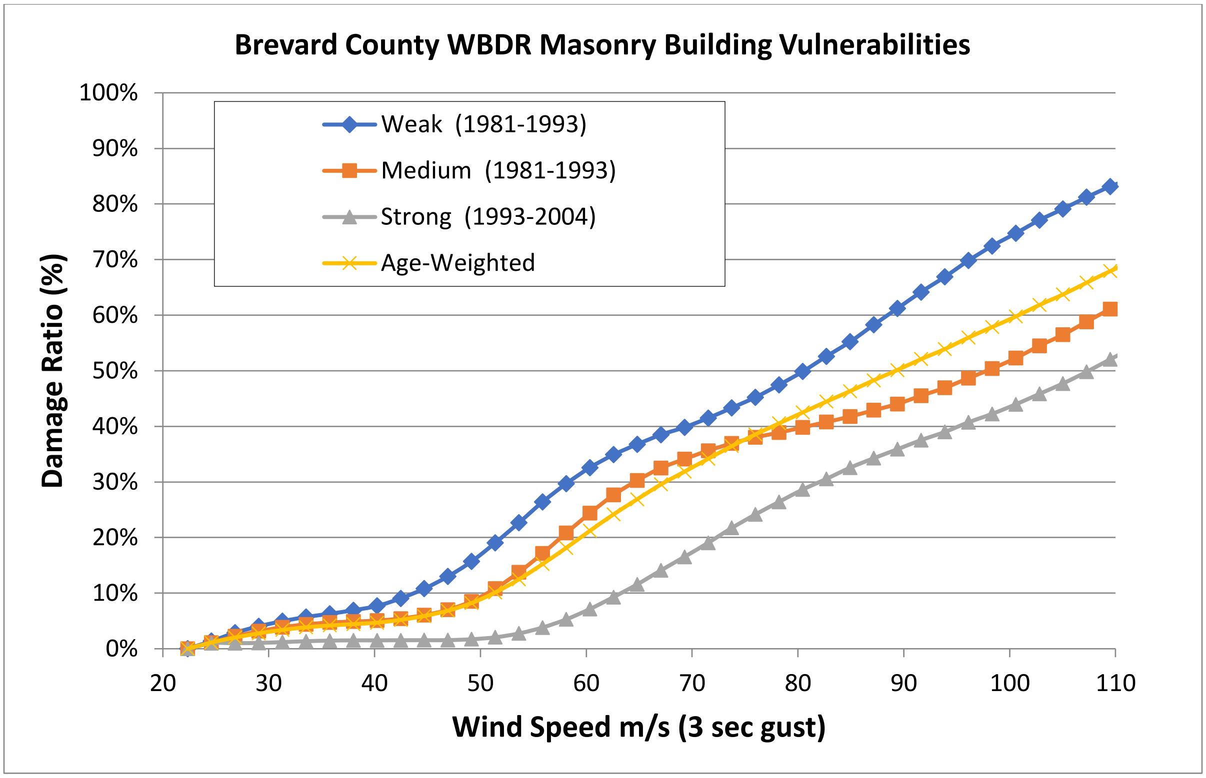

Figure 10. Weighted masonry structure vulnerabilities in a central wind-borne debris region.

Mapping of Insurance Policies to Vulnerability Matrices

The mapping of existing portfolio policies to available vulnerability matrices can be challenging. Disclosure 10 of Standard V-1 describes that process.

Models' Distribution in Time

Over time the codes used for construction in Florida have evolved to reduce wind damage vulnerability. However, the assignment of a building strength (its relative vulnerability to wind damage) based on its year of construction is not a straightforward task. The appropriate relationship between age and strength is a function of location within Florida, code in place in that location, and code enforcement policy (also regional). Disclosure 8 of Standard V-1 describes that process.

Appurtenant Structures

Appurtenant structures are not attached to the dwelling or main residence of the home but are located on the insured property. These types of structures could include detached garages, guesthouses, pool houses, sheds, gazebos, patio covers, patio decks, swimming pools, spas, etc. Insurance claims data reveal no obvious relationship between building damage and appurtenant structure claims. The variability of the structures covered by an appurtenant structure policy may be responsible for this result.

Since the appurtenant structures damage is not derived from the building damage, only one vulnerability matrix is developed for appurtenant structures. To model appurtenant structure damage, three equations were developed. Each determines the appurtenant structure insured damage ratio as a function of wind speed. One equation predicts damage for structures highly susceptible to wind damage, the second predicts damage for structures moderately susceptible to wind damage, and the third predicts damage for structures that are affected only slightly by wind. Because a typical insurance portfolio file gives no indication of the type of appurtenant structure covered under a particular policy, a distribution of the three types (slightly vulnerable, moderately vulnerable, and highly vulnerable) must be assumed and is validated against the claim data.

Vulnerability Component: Commercial Residential Model

Given the hurricane hazard defined by the atmospheric component, the engineering component performs several tasks: (1) it estimates the physical damage to exterior components of typical buildings or apartment units; (2) it assesses the interior and utilities damage and contents damage due to water penetration through exterior damage and defects to interior walls, ceiling, doors, etc.; (3) it combines the exterior and interior damage to estimate the building vulnerabilities; (4) estimate the content vulnerabilities; (5) it estimates the time related expenses; and (6) it estimates appurtenant structure vulnerability (Pita et al., 2008, 2009a, 2009b, 2009c, 2010, 2011a, 2011b, 2011c, 2012a, 2012b, 2013, 2014; Pinelli et al., 2009b, 2010b, 2012, 2013a, 2013b; Weekes et al., 2009, 2014; Johnson et al., 2018).

Exposure Study

Most low-rise commercial residential buildings (CR-LR) (Figure 11) can be categorized into a few generic groups having similar structural characteristics, layout, and materials, although they may differ somewhat in dimensions. These buildings can suffer substantial external structural damage, in addition to envelope and interior damage, from hurricane winds. The modeling approach to assessing damage for these building types is the same as that for assessing damage for personal residential buildings, modeling the building as a whole.

However, commercial residential mid- and high-rise buildings (MHR) (Figure 12) are very different from low-rise buildings and single-family homes. The mid-/high-rise buildings are engineered structures, which suffer few structural failures during a windstorm but are subject to water ingress from cladding and opening failures. These buildings, which come in many different types, shapes, height, and geometries, consist of steel, reinforced concrete, timber, masonry, or a combination of different structural materials.

It is not realistic to perform damage simulations on a reduced collection of ‘base’ buildings, as is done for single-family residential and low-rise commercial residential buildings, because that will necessarily leave out a majority of existing mid- and high-rise typologies. For instance, for steel frame structures alone there are a wide variety of possible building shapes and configurations. These different shapes lead to very different wind-loading scenarios and therefore different vulnerabilities. Equally important, the number of MHR is at least an order of magnitude smaller than the number of PRB or CR-LR. It is therefore not feasible to average the losses over a very large number of buildings and compensate small differences between buildings, as in the case of PRB. On the contrary, the analyst is faced with a relatively small number of buildings, each of which is different from the other.

As a result, the FPHLM has adopted a modular approach to model mid- and high-rise buildings. Rather than considering a structure as a whole, the model treats the building as a collection of apartment units. The base modules are typical apartment units, divided as corner and middle units. Thus, buildings with any number of stories and any number of units per floor can be modeled by aggregating the corresponding apartment units vulnerabilities and accounting for correlation of damage among units (e.g., water ingress through an envelope breach in a fifth-floor unit creates problems for lower units with no failures).

To summarize, in the case of CR-LR (low rise buildings), typical models of the whole structure that are representative of the vast majority of this building population in Florida were defined. In the case of MHR (mid-high rise buildings), typical models of individual units that are representative of the vast majority of units in Florida were defined.

An extensive survey of the commercial residential Florida building stock was carried out to generate a manageable number of these building and apartment models to represent the majority of the Florida residential building stock. The modelers analyzed Florida counties' property tax appraisers' (CPTA) databases for building stock information. Although the database contents and format vary from county to county, many of the databases contain the structural information needed to define the most common structural types. Information from 40 counties was collected for commercial residential buildings (Michalski, 2016). The modelers extracted information on several building characteristics for classification, including roof cover, roof shape, exterior wall material, number of stories, year built, building area, foundation type, floor plan, shape, and opening protection.

Figure 11. Typical low-rise buildings (LR).

Figure 12. Examples of mid- and high-rise buildings (MHR).

Commercial Residential Building Survey

In the case of the commercial residential buildings, the CPTAs classify the buildings either as condominiums or as multifamily residential (MFR) based only on the type of ownership. Condo buildings are such that each unit or apartment has a different owner. The condo unit can then be occupied by the owner or by a renter. The CPTAs do not record if the condo unit is rented or owned. Condo owners' expenses include the maintenance and use of the common areas and common facilities because the condo owner actually owns a percentage of the entire facility. The condo buildings relevant to this survey are all classified by the CPTAs as residential. Commercial office condo buildings are out of the scope of the survey.

A MFR building has a single owner who rents the units to tenants. The CPTAs classify MFR buildings with fewer than 10 units (duplex, triplex, and quadruplex) as residential buildings; MFR buildings with 10 units or more are classified as commercial buildings. Both residential and commercial MFR buildings were considered in this survey. MFR buildings are interchangeably referred to as apartment buildings by CPTAs. Residential MFR buildings (fewer than 10 units) account for approximately 70% of the MFR building stock, and the remaining 30% are commercial MFR buildings (10 units or more).

The commercial-residential buildings, regardless of whether they are condos or MFR buildings, were divided in two categories: low-rise (one–three stories) and mid-high rise (four stories and more). Low-rise buildings have three stories or fewer. The survey shows these buildings, which represent the majority of the building stock, have different characteristics than taller buildings. Unanwa (1997) uses a similar definition in his study. The mid- and high-rise buildings tend to be more heterogeneous and necessitate a different treatment in the vulnerability model. Owned as well as rented apartment units are included in this survey; the CPTAs do not distinguish between the two.

Appraisers have confirmed that MFR buildings tend to have fewer stories than condo buildings and the majority of MFR buildings are duplexes, triplexes, and quadruplexes. Also, the proportion of MFR buildings that can be classified as mid-/high-rise is negligible according to available information and consultation with CPTAs.

Building Models

Distinctly different construction characteristics and modes of damage in high winds led to the development of separate models for low-rise commercial residential construction (CR-LR) and mid-/high-rise commercial residential construction (MHR).

Low-Rise Commercial Residential Models

The CR-LR model was developed to represent typical apartment and town-house style structures of three stories or fewer (Figure 11). The model framework is based on the single-family, site-built residential model, which uses a probabilistic description of wind loads and exterior and structural component capacities to project physical damage as a function of wind speed. The components in the CR-LR damage model include roof cover, roof sheathing, roof-to-wall connections, wall type, wall sheathing, windows, entry doors, sliding-glass doors, soffits, and gable end truss integrity.

Given the large array of sizes and geometries for low-rise commercial residential structures, the program is developed to provide flexibility in choosing a building layout and dimensioning details (footprint, overhang length, roof slope, roof shape, etc.). The changes in construction practice over decades in Florida also necessitate flexibility when choosing construction quality with regard to hurricane wind resistance. The model allows the selection of building components with a variety of strength options to represent a range from low to high wind resistance (braced or unbraced gable ends, old or new roof cover, sheathing nailing schedules, etc.).

A standard (default) model was developed based on the building exposure study that quantified average square footage per story, units per story, and other descriptors. Default settings were also developed to represent weak, medium, and strong construction practice. Any given strong, medium, or weak model may be altered by additional mitigation or retrofit measures individually or in combination. For example, reroofing an older apartment can be represented by increasing the probabilistic descriptor of capacity for the roof cover.

Outputs (damage matrices) have been produced for each combination of the following: building height (one, two, or three stories), wall type (timber or masonry), roof shape (hip or gable), strength (weak, medium, or strong), and window protection (no protection or with metal shutters).

Mid-/High-Rise Commercial Residential Models

The mid-/high-rise model uses the Monte Carlo simulation concept, but it differs from the low-rise model in significant ways. There is a high level of variability among mid-/high-rise buildings because of the combination of the number of stories, the number of units per floor, intentionally unique geometries, and the materials used for the exterior. This makes the application of a "standard" or default model unfeasible. Because of the construction methods and materials used in these structures, damage to the superstructure and exterior surfaces of the buildings tends to be relatively minor. The majority of damage accumulation in mid-/high-rise structures is due to water penetration and failure of openings. The model reflects this by focusing on the failure of windows and doors, the ingress of rain water, and the proliferation of water from the source of the ingress to adjacent living units. The structure in whole is not modeled. Rather, individual units are modeled in isolation. That is, the vulnerability of a single unit is explicitly modeled, and damage is assessed to openings as a function of wind speed.

Two different mid-/high-rise classifications are modeled for this study: "closed building" and "open building." Closed buildings are characterized by the location of the unit entry doors at the interior of the building. The sliding-glass doors and windows are all facing the exterior of the building. For the open building model there is exterior corridor access to each unit entry door on one side of the building, and the patio areas are situated on the opposite side of the building (Figure 13). The type of building chosen can increase or decrease the vulnerability of a selected unit because of the exposure of the exterior openings. Middle units in a closed or open building have one or two exterior walls, respectively.

There are three main differences between the low-rise and mid-/high-rise models: (1) the use of a modular (i.e., per unit rather than per building) approach, (2) the exterior components being analyzed for failure, and (3) the use of two basic floor plans. Location of unit within the plan view of the building, unit square footage, and number of available openings are some of the important factors that separate one unit from another.

Corner units are subjected to higher wind pressures that are present along the edges of the building, compared to the middle units, which are located within lower pressure zones at the center of the wall area (Figure 13). Increased square footage typically results in an increase in exterior wall frontage and the number of openings vulnerable to damage.

The MHR model uses the same analysis and output technique as the CR-LR model. The difference is the number of failure types modeled. The MHR model analyzes only the damage to the openings, which include the windows, sliding doors, and entry doors. Each of the components can fail due to pressure or debris impact.

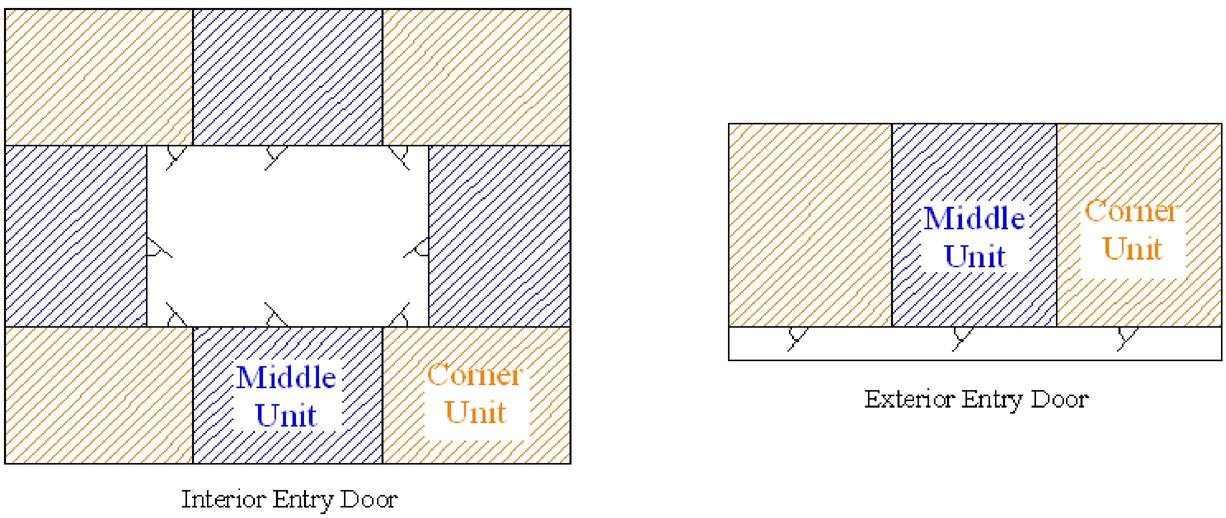

Figure 13. Apartment types according to layout (left: closed building with interior entry door; right: open building with exterior entry door).

Damage Matrices for Exterior Damage

The vulnerability model uses a Monte Carlo simulation based on a component approach to determine the external vulnerability (as shown in ???) at various wind speeds of buildings in the case of CR-LR, or apartment units in the case of MHR. For the case of CR-LR, the procedure is identical to the one described for single-family residential (PRB). In the case of MHR, the simulations address only wind pressure and debris impact on the openings.

The damage assessment is conducted over a range of wind speeds and wind directions, and results are stored in a damage matrix. Probabilistic damage assessment is conducted by first creating an individual building realization by mapping each component according to typical construction practice. Random capacity values are assigned to the various components on the basis of a probability distribution for each component type. This realization is subjected to a peak three-second gust wind speed from a particular direction. Directional loads are calculated using randomized pressure coefficients based on directional modifications to ASCE 7 as well as wind tunnel data (NIST Aerodynamic Database - http://fris2.nist.gov/winddata), and a comparison of resulting surface and internal loads to component capacities is conducted. Damage occurs when the assigned capacity of a component is exceeded by its loading. Once the openings have been checked for failure due to pressure, the damage due to the impact of windborne debris is also evaluated. Damaged components are removed, and a series of checks are performed to determine if lost components will redistribute loading to adjacent components or change the overall loading. For example, loss of a roof-to-wall connection places additional load on adjacent connections, whereas an envelope breach will potentially alter internal loading—changing the overall loading on most components. Iterative convergence is used to produce the final damage state for that building realization. The results of this single simulation are documented on the basis of the final iteration, another realization of that building is constructed by assigning new random capacities to each component, and the process repeats for the same three-second gust, same wind direction, and newly randomized pressure coefficients based on the number of desired simulations the user would like to run. The process is repeated for eight wind directions and a series of three-second wind speeds between 50 and 250 mph in 5 mph increments.

The output of the Monte Carlo simulation model is an estimate of physical damage to structural and exterior components. The results are in the form of a four-dimensional damage matrix. Each row of the matrix lists the results of one simulation. The amount of damage to each of the modeled components for a simulation is listed in 75 columns. The third dimension represents the peak three-second gust wind speed between 50 and 250 mph in 5 mph increments, and the fourth dimension represents the eight angles between 0 and 315 degrees in 45-degree increments. Table 6 delineates the damage matrix contents for the case of the CR-LR. A description of each of the nine columns of the MHR damage matrix is given in Table 7.

Column #	Timber Models	Masonry Models
Col 1	Percent roof cover (shingles or tiles) failed	
Col 2	Percent field roof sheathing lost (field roof sheathing is all but overhang)	
Col 3	Percent edge (overhang) roof sheathing failed	
Col 4	Percent roof-to-wall connections failed	
Col 5	Collapse of gable end trusses (0 = no, 1 to 20) starting from side 1	
Col 6	Collapse of gable end trusses (0 = no, 1 to 20) starting from side 2	
Col 7-8	Percent gable end wall covering failed (side 1 and 2, positive for windward, negative for leeward)	
Col 9-10	Percent gable end sheathing failed (side 1 and 2, positive for windward, negative for leeward)	
Col 11- 14	Percent wall covering failed – 1st floor (walls 1-4, positive for windward, negative for Leeward)	Shear Damage Ratio for Masonry Walls- 1st Floor (walls 1-4, positive for windward, negative for leeward)
Col 15-18	Percent wall sheathing failed – 1st floor (walls 1-4, positive for windward, negative for leeward)	Bending Damage Ratio for Masonry Walls- 1st Floor (walls 1-4, positive for windward, negative for leeward)
Col 19-22	Number of windows failed from wind pressure – 1st floor - (walls 1-4, positive for windward, negative for leeward)	
Col 23-26	Number of windows failed from wind Debris– 1st floor - (walls 1-4)	
Col 27	Number of sliding glass doors failed from wind pressure – 1st floor (+ for windward - for leeward)	
Col 28	Number of sliding glass doors failed from debris impact – 1st floor	
Col 29	Number of entry doors failed from wind pressure – 1st floor (+ for windward - for leeward)	
Col 30	Number of entry doors failed from debris impact – 1st floor	
Col 31-50	Repeat Col 11 - Col 30 for 2nd Floor	
Col 51-70	Repeat Col 11 - Col 30 for 3nd Floor	
Col 71	Garage Door Damage (positive for windward, negative for leeward)	
Col 72-75	Percent Soffit Damage (walls 1-4)	

Table 6. Description of damage matrices for CR-LR.

Commercial and Single Family Residential	
Column #	**Inner and Outer Stair Models**
Col 1	Number of Windows failed from wind pressure
Col 2	Number of Entry Doors failed from wind pressure
Col 3	Number of Sliding failed from wind pressure
Col 4	Number of Windows failed from debris impact
Col 5	Number of Entry Doors failed from debris impact
Col 6	Number of Sliding failed from debris impact
Col 7	Number of Windows breached from debris impact
Col 8	Number of Entry Doors breach from debris impact
Col 9	Number of Sliding breach from debris impact

Table 7. Description of the damage matrices for MHR apartments.

Interior and ContentsDamage

Following standard actuarial and insurance practice, interior (which include utilities) is anything inside the building, which is attached to the building and cannot be moved. On the other hand, contents is anything inside the building, which is not attached to the building and can be moved. The FPHLM uses a novel components-based approach to assess interior and contents damage, which takes into account the physical mechanisms of hurricane-induced interior damage from rainwater ingress. The method incorporates the results of large and full-scale tests to quantify (1) the rainwater impact and run-off on the building envelope, (2) the water ingress, and (3) its propagation and distribution from component to component in the interior of the building (Baheru et al., 2014 & 2015; Raji et al., 2020). It combines the test results with estimates of water resistance characteristics of the building interior, and with cost analyses. The approach starts from the defects and damage to the building envelope (Weekes et al., 2009), described in the previous section. The model then estimates the amount of wind-driven rain that enters through the breaches and defects in the building envelope. It models its propagation among ceilings, partitions, flooring, and contents, and converts the resulting moisture contents of the components into interior damage. More details are provided in standard V-1 and in (Pita, 2012; Pita et al., 2012a; Silva de Abreu, 2019; Pinelli et al., 2019; Silva de Abreu et al., 2020).

The method combines existing building defects and estimated building envelope damage with the impinging rain to predict the amount of water that will enter a building. This physically based approach models the main contributor to interior and contents damage, addresses the uncertainty in the interior and contents damage source, and documents the individual water ingress contribution of each external component to the total water intrusion. It also documents the contribution of each interior component (ceiling, partition, flooring, cabinets, utilities) and of category of contents (water absorbent or not, appliances) to the overall interior and contents damage in function of their wetness.

The exterior building components that the model considers include roof cover, roof sheathing, wall cover, wall sheathing, gable cover, gable sheathing, windows, doors, and sliding doors. In the case of MHR units, only windows, doors, and sliding doors are considered. For a given wind speed, the model first estimates breach areas of each component from the exterior damage array. The area of existing defects in envelope components is estimated based on surveys (Mullens et al., 2006) and engineering experience.

The interior building components that the model considers include ceiling, partitions, flooring, cabinets, and utilities. The categories of contents that the model considers include, water-absorbent or non-water-absorbent, either in the apartment units or in the common areas, and the appliances in the apartment units. This approach for both low-rise and mid/high-rise buildings estimates the amount of water that enters through the breaches and defects of each component of the envelope, for a given accumulated wind-driven rain associated with the maximum wind speed. The total amount of rainwater ingress is calculated by adding the contribution of all the external components for a given wind speed, and by estimating the water which percolates from story to story. In the end, the total amount of water accumulated within each internal components (i.e. their moisture contents) and the different contents categories result in a certain amount of interior and contents damage.

Time Related Expenses

Time Related Expenses refer to loss of rent for owners of apartment buildings, which are mainly low-rise commercial residential buildings. As in the case of interior and utilities damage, the Time Related Expenses are assumed to be a function of the amount of water that penetrates into the building, and they are therefore proportional to interior damage. The function is based on engineering judgment and should be validated using claims data, which is almost non-existent.

Vulnerability Matrices for Low-Rise Buildings

Unweighted Vulnerability Matrices of CR-LR

Given a particular building type, the Monte Carlo simulation-generated damage array that expresses the exterior damage in the envelope is loaded. For a particular wind speed and wind direction, each component physical damage is normalized to a percentage value. For instance, the number of damaged doors, windows, and sliding doors is divided by the total number of the corresponding openings; collapsed trusses are divided over the total number of trusses, etc. The cost of the damage is then assessed.

Interior damage is estimated by (1) simulating the amount of wind-driven rain that enters through the breaches and defects in the building envelope, (2) propagating the water among the interior components and the contents, and from floor to floor, and (3) converting the accumulated amount of water in the interior components and contents into interior and contents damage.

Replacement cost ratios provide the link between modeled physical damage and the corresponding monetary losses. They can be defined as the cost of replacing a damaged component or assembly of a building divided by the cost of constructing a completely new building of the same type. An explicit procedure is used to convert physical damage of the modeled components to monetary damage. The procedure is almost identical to the one already described for single-family residential buildings. The damage ratio (DR) as a function of wind speed for the exterior, and interior is calculated by adding the corresponding costs of damaged exterior plus damaged interior divided over the overall building cost that is contingent upon the type and size of the building.

Derivation of the probability distribution functions of damage at each wind speed interval is the final step of the process. For each wind speed interval, the probability of damage given that wind speed interval (i.e., the cells of the vulnerability matrices) is computed as the summation of specific damage ratios for all wind directions divided by the total number of simulations at that particular wind speed interval.

Weighted Vulnerability Matrices of CR-LR

In the case of CR-LR, vulnerability matrices were created for every combination of construction type (masonry, timber, or other), roof shape (gable or hip), roof cover (tile or shingle or metal), shutters (with or without), number of stories (one, two, or three), and subregion (inland, wind-borne debris region, and high velocity zone). However, in general, there is little information available in an insurance portfolio file regarding the structural characteristics and the wind resistance of the insured property. Instead, insurance companies rely on the ISO fire resistance classification. Portfolio files have information on ZIP Code and year built. The ISO classification is used to determine if the home is constructed of masonry, timber, or other. The ZIP Code is used to define the subregion. The year built is used to assist in defining whether a building should be considered weak, medium, or strong.

From the insurance files, sub-region, construction type, and year built are determined. This leaves the roof shape, roof cover, number of stories, and shutter options undefined. From the exposure study of 21 Florida counties, the distribution of these parameters can be extrapolated. For each age group, we define a weighted matrix for each construction type in each sub-region. The procedure is identical to the one already described for single-family buildings.

Age-Weighted Matrices of CR-LR

The year built or year of last upgrade of a structure in a portfolio may not be available when performing a portfolio analysis to estimate hurricane losses in a certain region. In that case, it becomes necessary to assume a certain distribution of ages in the region to develop an average vulnerability by combining weak, medium, and strong. Here again, the procedure is identical to the one described for single-family residential buildings.

Mapping of Insurance Policies to Vulnerability Matrices for CR-LR

The mapping of the low-rise vulnerability matrices to the insurance policies in any given portfolio is also very similar to the process already reported for single-family buildings.

CR-LR models' Distribution in Time

The low-rise building models' distribution in time is similar to that of the single-family buildings.

Vulnerability of Mid-/High-Rise Buildings

MHR opening vulnerabilities

In the case of MHR, a process similar to the one described above is followed to derive exterior vulnerability and breach curves for different openings of typical apartment units. These curves are derived for the cases of open and closed buildings, for corner and middle units, at different exposure for debris impact (which is a function of height), with different opening protections (with or without impact-resistant glass; with or without metal shutters). Each vulnerability curve for openings of corner or middle apartment units (window, door, or slider) gives the number or fraction of opening damaged as a function of wind speed. Each breach curve for openings of corner or middle apartment units (window, door, or slider) gives the breach area in ft2 of opening damaged as a function of wind speed.

MHR building vulnerability

Unlike the single-family home loss model that aggregates interior and exterior damage inside the vulnerability module, the mid-/high-rise building model performs the aggregation outside that module, because of the interior damage propagation. The modular approach produces independent assessments of exterior damage for each unit while also considering the interior water damage that can spread from unit to unit and trigger damage far from its source. Therefore, interior damage has two stages: the first stage occurs as a direct result of the exterior damage in the unit, and the second occurs as a consequence of propagation between units. The separate modeling of exterior and interior damage also facilitates dealing with the insurance issue of different insurance coverage for apartment and condo buildings.

Figure 53 in disclosure 2 of the V-1 standard summarizes the process for damage estimation for MHR. For each policy in the portfolio, the program reads the building information and assigns a wind speed profile based on its location (i.e., surrounding terrain). The algorithm calculates the number of corner and middle units per floor and loads the corresponding opening vulnerability and breach curves. The vulnerability curves, combined with the wind speed value at every story, yield the number of openings of each kind damaged at each story. The expected exterior damage ratio for each kind of opening is defined as the number of the damaged openings divided by the total number of opening at each story.

For the interior damage estimation the process is similar. Interior damage is estimated by (1) simulating the amount of wind-driven rain that enters through the breaches and defects of the opening, and from the roof or from the upper floor, (2) propagating the water from floor to floor, and (3) converting the accumulated amount of water per story into an interior damage ratio. The final product of the interior damage assessment is the expected interior damage ratio. Disclosures 1 and 13, in standard V-1 provide more details.

Once the algorithm has computed expected exterior and interior damage ratios, it multiplies them by the exterior and interior insured values expressed as a percentage of the total insured building value. These percentages vary for condos and apartment buildings. The resulting values of external and internal damage add up to the total expected damage value.

Time-Related Expenses

Time-related expenses are coverage for loss of income due to the building damage. The value of a claim is obviously dependent on the time it takes to repair a damaged building as well as the surrounding utilities and infrastructure. This coverage applies only to apartment buildings, where the loss of income is the loss of rent. The time-related expenses are modeled as directly proportional to the interior vulnerability.

Appurtenant Structures

For commercial residential structures, appurtenant structures might include a clubhouse or administration building, which are treated like additional buildings. For other structures such as pools, etc., the appurtenant structures model developed for residential buildings is applicable.

Actuarial Component

The actuarial component consists of a set of algorithms. The process involves a series of steps: rigorous check of the input data; selection and use of the relevant output produced by the meteorology component; selection and use of the appropriate vulnerability matrices for building structure, contents, appurtenant structure, and additional living expenses; running the actuarial algorithm to produce expected losses; aggregating the losses in a variety of manners to produce a set of expected annual hurricane wind losses; and producing probable maximum losses for various return periods. The expected losses can be reported by construction type (e.g., masonry, frame, manufactured homes), by county or ZIP Code, by policy form (e.g., HO-3, HO-4, etc.), by rating territory, and combinations thereof.

Expected annual losses are estimated for individual policies in the portfolio. They are estimated for building structure, appurtenant structure, contents, and ALE on the basis of their exposures and by using the respective vulnerability matrices or vulnerability curves for the construction types. For each policy, losses are estimated for all the hurricanes in the stochastic set by using appropriate damage matrices and policy exposure data. The losses are then summed over all hurricanes and divided by the number of years in the simulation to get the annual expected loss. These are aggregated at the ZIP Code, county, territory, or portfolio level and then divided by the respective level of aggregated exposure to get the loss costs. This is a computationally demanding method. Each portfolio must be run through the entire stochastic set of hurricanes.

The distribution of losses is driven by both the distribution of damage ratios generated by the engineering component and by the distribution of wind speeds generated by the meteorology component. The meteorology component provides, for each lat-long grid, the associated probabilities for a common set of wind speeds. Thus, locations are essentially differentiated by their probability distribution of wind speeds. The meteorology component uses up to 56,000 year simulations to generate a stochastic set of storms. The storms are hurricane events at landfall or when bypassing closely. Each simulated storm has a track and a set of modeled windfields at successive time intervals. The windfields generate the one-minute maximum sustained wind speeds for the storm at various locations (lat-long grid) along its track. These one-minute maximum sustained winds are then converted to three-second peak gust winds and corrected for terrain roughness by using the gust wind model and the terrain roughness model.
For each lat-long grid, an accounting is then made of all the simulated storms that pass through it. On the basis of the number of pass-through storms and their peak wind speeds, a distribution of the wind speed is then generated for the grid. On the basis of this distribution, probabilities are generated for each 5-mph interval of wind speeds, starting at 20 mph. These 5-mph bins constitute the column headings of the damage matrices generated by the engineering component.

The engineering group has produced vulnerability matrices for personal residential buildings and vulnerability curves for commercial residential buildings.

Vulnerability matrices are provided for personal residential building structure, contents, appurtenant structures and additional living expenses for a variety of residential construction types and for different policy types. The construction types are masonry, frame, mobile home, and other. The vulnerability matrices are also developed for weak, medium, and strong construction as proxy by year built.

Within each broad construction category, the vulnerability matrices are specific to the roof types and number of stories, etc. Since the policy data do not provide this level of specificity, weighted matrices are used instead, where the weights are the proportion of different roof types in given region as determined by a survey of the building blocks and exposure data. The vulnerability matrices are used as input in the actuarial model.

The starting point for the computations of personal residential losses is the vulnerability matrix with its set of damage intervals and associated probabilities. Appropriate vulnerability matrices are applied separately for building structure, content, appurtenant structure, and ALE. Once the matrix is selected, for a given wind speed, for each of the midpoint of the damage intervals, the ground up loss is computed, the appropriate deductibles and limits are applied, and the loss net of deductible is calculated. More specifically, for each damage outcome the damage ratio is multiplied by insured value to get dollar damages, the deductible is deducted, and net of deductible loss is estimated. Percentage deductibles are converted into dollar amounts. Both the replacement cost and actual cash value are generally assumed to equal the coverage limit. Furthermore, if there are multiple hurricanes in a year in the stochastic set, the wind deductibles are applied to the first hurricane, and any remaining amount is then applied to the second hurricane. If none remains then the general peril deductible can be applied.

The net of deductible loss is multiplied by the probability in the corresponding cell to get the expected loss for the given damage ratio. The results are then averaged across the possible damages for the given wind speed. The expected losses are then adjusted by the appropriate expected demand surge factor.

In the case of low-rise commercial residential structures, the expected damage ratios (EDR) are derived from the vulnerability curves for the maximum wind in the given storms. The EDRs are multiplied by the respective coverage limits to produce the expected ground up building damage value (EDV^B), and expected ground up content damage value (EDV^C) for the storm. The deductible is then applied to these damage values on a pro-rata basis to generate the net of deductible expected losses. The process is repeated across all the storms in the stochastic set to produce the average loss for the policy. The expected losses are then adjusted by the appropriate expected demand surge factor.

In the case of mid-high rise commercial residential buildings, the vulnerability component produces, for a given storm (or given vertical maximum wind profile) and across all the floors in the building, the total expected cost of damage to the openings (TECDO) and the expected interior damage ratio (EIDR). The EIDR is then multiplied by the fraction of the coverage limit corresponding to the value of the interior and added to the TECDO to produce the expected building damage value (EDV^B). The expected content damage value (EDV^C) is produced by multiplying a fraction of the EIDR by the content coverage limit. The deductible is then applied on a pro-rata basis to generate the expected loss for the storms. The process is repeated across all storms to produce the average loss for the policy. The expected losses are then adjusted by the appropriate expected demand surge factor.

For commercial residential policies, if there are multiple risks (multiple structures) within the policy, the default is to apply the deductible at the risk level. The percentage deductible is applied to each risk based on their individual limit. If information is so available, then deductible is applied at the policy level.

The demand surge factors are estimated by a separate model and applied appropriately to each hurricane in the stochastic set. The surge factors for structures are a function of the size of statewide storm losses and are produced separately for the different regions in Florida. The surge factors for content and ALE are functionally related to the surge factor for structure. To estimate the impact of demand surge on the settlement cost of structural claims following a hurricane, data from 1992 to 2007 on a quarterly construction cost index produced by Marshall & Swift/Boeckh are used. The approach to estimating structural demand surge was to examine the index for specific regions impacted by one or more hurricanes since 1992. From the history of the index we projected what the index would have been in the period following the storm had no storm occurred. Any gap between the predicted and actual index was assumed to be due to demand surge. In total ten storm–region combinations are examined. From these ten observations of structural demand surge the functional relationship is generalized.

After the losses are adjusted for demand surge, they are summed across all structures of the type in the grid and also across the grids to get expected aggregate portfolio loss. The model can process any combination of policy type, construction type, deductibles, coverage limits, etc. The model output reports include separate loss estimates for structure, content, appurtenant structure, and ALE. These losses are also reported by construction type (e.g., masonry, frame, manufactured homes), by county or ZIP Code, by policy form (e.g., HO-3, HO-4, etc.), by rating territory, and combinations thereof.

Another function of the actuarial algorithms is to produce estimates of the probable maximum loss for various return periods. The PML is produced non-parametrically using order statistics of simulated annual losses. Suppose the model produces N years of simulated annual losses. The annual losses L are ordered in increasing order so that $L(1) \leq L(2) \leq . . . \leq L(N)$. For a return period of Y years, let $p = 1-1/Y$. The corresponding PML for the return period Y is the p^{th} quantile of the ordered losses. Let $k = (N)*p$. If k is an integer, then the estimate of the PML is the kth order statistic, L(k), of the simulated losses. If k is not an integer, then let k* = the smallest integer greater than k, and the estimate of the p^{th} quantile is given by L(k*).

Computer System Architecture

The FPHLM is a large-scale system that is designed to store, retrieve, and process a large amount of historical and simulated hurricane data. In addition, intensive computation is supported for hurricane damage assessment and insured loss projection. To achieve system robustness and flexibility, a three-tier architecture is adopted and deployed in our system. It aims to solve a number of recurring design and development problems and make the application development work easier

and more efficient. The computer system architecture consists of three layers: the user interface layer, the application logic layer, and the database layer.
The interface layer offers the user a friendly and convenient user interface to communicate with the system. To offer greater convenience to the users, the system is prototyped on the web so that the users can access the system with existing web-browser software.

The application logic layer activates model logic based on the functionality presented to the user, processes data, and controls the information flow. This is the middle tier in the computer system architecture. It aims to bridge the gap between the user interface and the underlying database and to hide technical details from the users.

The database layer is responsible for data modeling to store, index, manage, and model information for the application. Data needed by the application logic layer are retrieved from the database, and the computational results produced by the application logic layer are stored back to the database.

Software, Hardware, and Program Structure

The user-facing part of the system consists of a web-based application that is hosted on a Tomcat web application server. The backend server environment is Linux and the server-side scripts that support the model's functionality are written in Bash, Java Server Pages (JSP) and JavaBeans. Backend probabilistic calculations are coded in C++ using the IMSL library and called through Java Native Interface (JNI). The system uses a PostgreSQL database that runs on a Linux server. Server-side software requirements are the IMSL library CNL 5.0, JDBC 3, JNI 1.3.1, and JDK 1.6. The end-user workstation requirements are minimal. Any current version of Internet Explorer, Firefox, Chrome, or Safari running on a currently supported version of Windows, Mac or Linux should deliver optimal user experience. Typically, the manufacturer's minimal set of hardware features for the current version of the web browser and operating system combination is sufficient for an optimal operation of the application.

Translation from Model Structure to Program Structure

The FPHLM uses a component-based approach in converting from model to program structure. The model is divided into the following components or modules: Storm Forecast Module, Wind Field Module, Damage Estimation Module, and Loss Estimation Module. Each of these modules fulfills its individual functionality and communicates with other modules via well-defined interfaces. The architecture and program flow of each module are defined in its corresponding use case document following software engineering specifications. Each model element is translated into subroutines, functions, or class methods on a one-to-one basis. Changes to the models are strictly reflected in the software code.

3. Provide a flowchart that illustrates interactions among major hurricane model components.

See below.

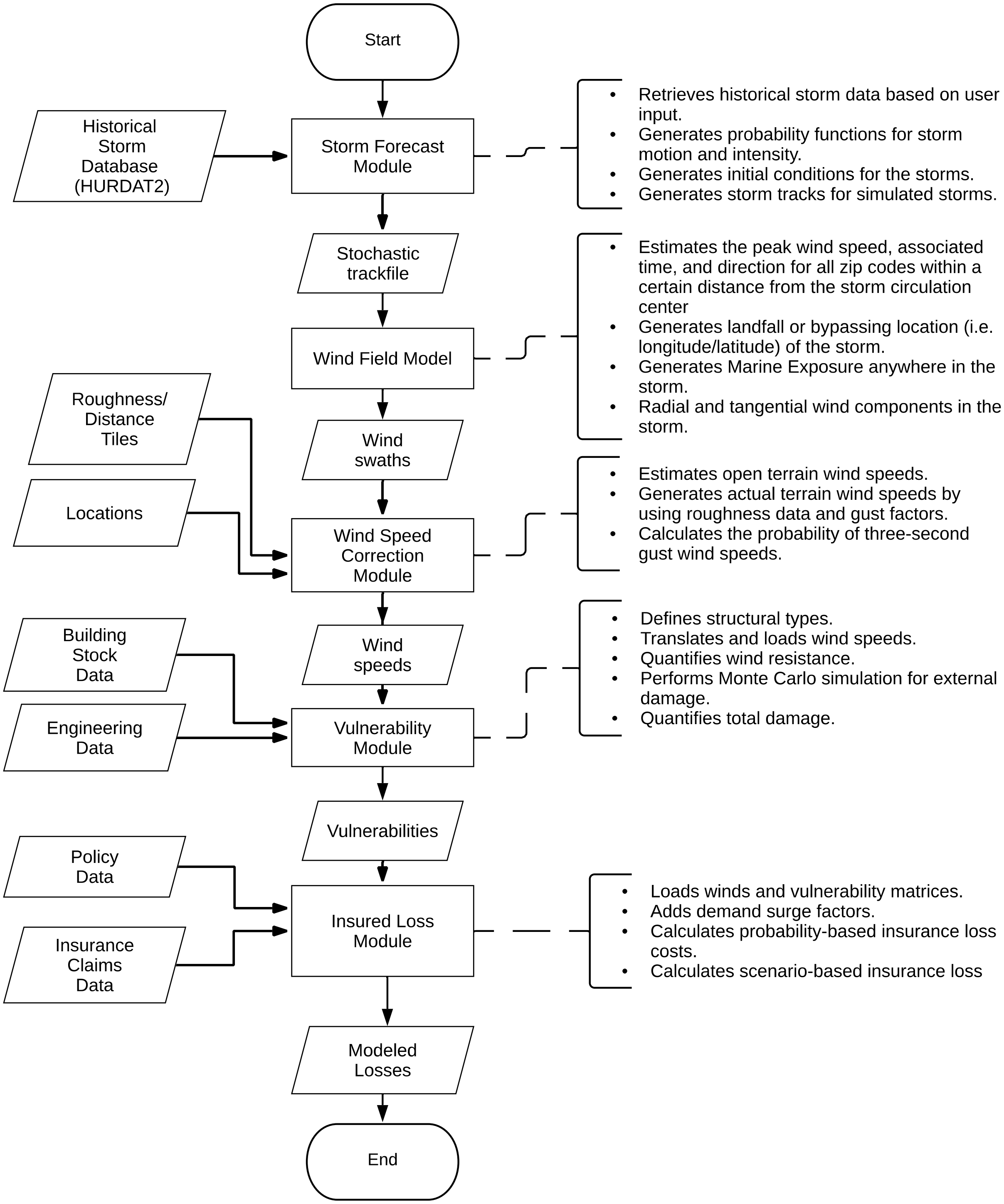

Figure 14. Flow diagram of the computer model.

4. Provide a diagram defining the network organization in which the hurricane model is designed and operates.

Our model is designed and operates on a computing cluster of 62 servers that are interconnected by routers V17, V2000, and V2064 as shown in Figure 15, marked by red squares. The hardware configurations of each server are listed in Table 8 shown below. This includes their hostname, the router immediately connected to the server, the allocated network bandwidth, the model and main frequency of CPU, the number of threads, memory size, and the Operating System (OS) installed on the server, and server's usage. Note that all the servers use different versions of Enterprise Linux (EL), specifically, CentOS/SL, as the OS.

Hostname	Router	Network Bandwidth	CPU	#Threads	Memory	OS	Usage
alex-a	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
alex-b	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
alex-c	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
alex-d	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
betsy	V17	10G	Opteron 6380	64	512G	EL6	compute server
camille	V17	10G	Opteron 6380	64	512G	EL6	compute server
carla	V17	10G	Opteron 6380	64	512G	EL6	compute server
david	V17	10G	Xeon L7555 1.87GHz	64	512G	EL6	compute server
donna	V17	10G	Opteron 6380	64	512G	EL6	compute server
dora	V17	10G	Opteron 6380	64	512G	EL6	compute server
earl-a	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
earl-b	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
earl-c	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server

Hostname	Router	Network Bandwidth	CPU	#Threads	Memory	OS	Usage
earl-d	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
easy	V17	10G	Opteron 6380	64	512G	EL6	compute server
eloise-a	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
eloise-b	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
eloise-c	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
eloise-d	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
fabian-a	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL8	compute server
fabian-b	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
fabian-c	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
fabian-d	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
floyd	V17	10G	Xeon X5650 2.67GHz	24	96G	EL5	compute server
frances-a	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
frances-b	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
frances-c	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
frances-d	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
gaston-a	V17	10G	Xeon E5-2680 2.5GHz	56	256G	EL6	compute server
gaston-b	V17	10G	Xeon E5-2680 2.5GHz	72	192G	EL6	compute server

Hostname	Router	Network Bandwidth	CPU	#Threads	Memory	OS	Usage
irma	V17	10G	Xeon Gold 6126 2.6GHz	48	128G	EL7	compute server
ivan-a	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
ivan-b	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
ivan-c	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
ivan-d	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
jeanne-a	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
jeanne-b	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
jeanne-c	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
jeanne-d	V17	10G	Xeon E5-2680 2.5GHz	48	256G	EL6	compute server
king	V17	10G	Xeon E5-2690 2.6GHz	56	512G	EL7	compute server
runway	V17	10G	Xeon Silver 4116 2.1GHz	48	128G	EL7	compute server
sandy	V17	10G	Opteron 6380	64	512G	EL6	compute server
wilma	V17	10G	Xeon Silver 4208 2.1GHz	16	48G	EL8	storage server
wilma-backup	V17	1G	Xeon Silver 4208 2.1GHz	16	48G	EL8	backup storage server
cleo-a	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
cleo-b	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
cleo-c	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server

Hostname	Router	Network Bandwidth	CPU	#Threads	Memory	OS	Usage
cleo-d	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
hugo-a	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
hugo-b	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
hugo-c	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
hugo-d	V2000	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
agnes-a	V2064	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
agnes-b	V2064	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
agnes-c	V2064	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
agnes-d	V2064	10G	Xeon E5-2680 2.5GHz	48	256G	EL7	compute server
charley	V2064	10G	Opteron 6320	16	128G	EL6	storage server
charley-backup	V2064	1G	Opteron 6320	16	128G	EL6	backup storage server
mitch	V2064	10G	Opteron 6212	16	128G	EL8	storage server
mitch-backup	V2064	1G	Opteron 6212	16	128G	EL8	backup storage server
opal	V2064	10G	Xeon X5650 2.67GHz	12	96G	EL5	compute server
stan	V2064	10G	Xeon X5650 2.67GHz	24	96G	EL5	compute server

Table 8. Hardware Configuration of Servers

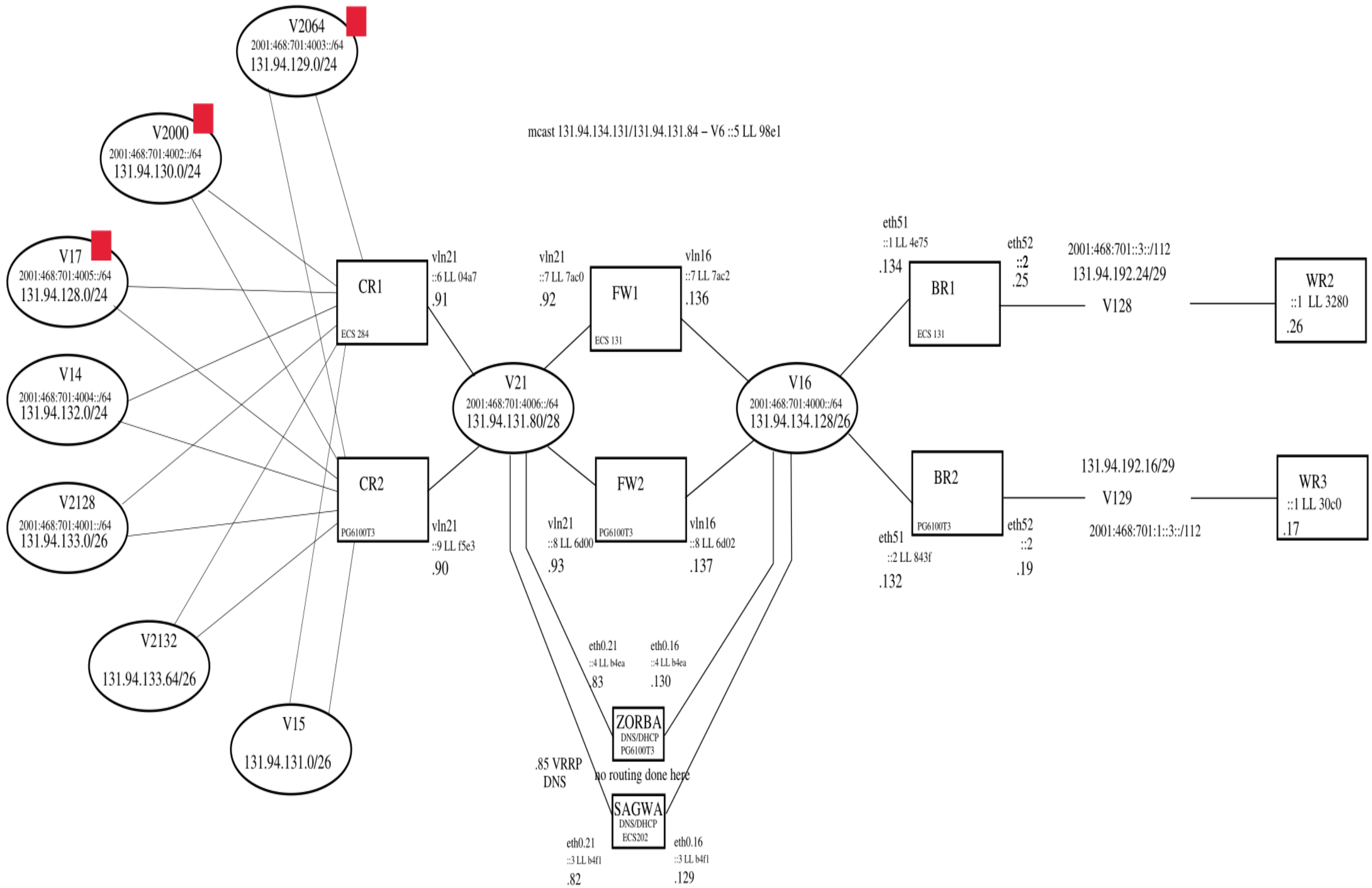

Figure 15. Network Diagrams for Logical Layer

5. Provide detailed information on the hurricane model implementation on more than one platform, if applicable.

All the hurricane model implementation is based on Linux CentOS/SL operating system.

6. Provide a comprehensive list of complete references pertinent to the hurricane model by standard grouping using professional citation standards.

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Relevant Web Sites

Applied Insurance Research, Inc. (AIR) page.
http://www.airboston.com_public/html/rmansoft.asp

Applied Research Associates, Inc. (ARA) page.
http://www.ara.com/risk_and_reliability_analysis.htm

ARIS Reference.
http://www.idsscheer.com/international/english/products/aris_design_platform/50324

Carpet water damage. https://www.scrt.org/scrt-free-reports/17-carpet-moisture-mold-study/file

CIMOSA Reference. http://cimosa.cnt.pl

EQECAT home page. http://www.eqecat.com/

FEMA hurricanes page. http://www.fema.gov/hazards/hurricanes

Florida Water Management District Land Use Data, Statewide 2004-2011, as compiled by the Florida State Department of Environmental Protection:
http://www.dep.state.fl.us/gis/datadir.htm

Actual data is at
http://publicfiles.dep.state.fl.us/otis/gis/data/STATEWIDE_LANDUSE_2004_2011.zip

Furniture water damage. http://furniture-restoration-blog.com/water-damaged-furniture/

Global Ecosystems Database (GED). http://www.ngdc.noaa.gov/seg/fliers/se- 2006.shtml

HAZUS Home. http://www.hazus.org/

HAZUS Overview. http://www.nibs.org/hazusweb/verview/overview.php

HAZUS manuals page, http://www.fema.gov/hazus/li_manuals.shtm

HURDAT data. http://www.aoml.noaa.gov/hrd/hurdat/Data Storm.html

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Java Native Interface.
https://docs.oracle.com/javase/8/docs/technotes/guides/jni/spec/jniTOC.html

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https://docs.oracle.com/cd/E13222_01/wls/docs81/jsp/intro.html

Matsinc catalog. http://matsinc.com/documents /_commercial-flooring-catalogs-brochures/Mats-Inc-Carpet-Matting-Brochure.pdf

National Hurricane Center. http://www.nhc.noaa.gov/

NIST Aerodynamic Database - http://fris2.nist.gov/winddata

NOAA Coastal Services Center. http:www.csc.noaa.gov

NOAA EL Nino Page. http://www.elnino.noaa.gov/

NOAA LA Nina Page. http://www.elnino.noaa.gov/lanina.html

PHRLM Manual. http://www.cis.fiu.edu/hurricaneloss

RAMS: Regional Atmospheric Modeling System. http://rams.atmos.colostate.edu/

R.L. Walko, C.J. Tremback, "RAMS: regional atmospheric modeling system, version 4.3/4.4 - Introduction to RAMS 4.3/4.4." http://www.atmet.com/html/docs/rams/ug44-rams-intro.pdf

RMS home page. http://www.rms.com

The JDBC API Universal Data Access for the Enterprise. http://java.sun.com/products/jdbc/overview.html

The Interactive Data Language. https://www.harrisgeospatial.com/Software-Technology/IDL
Track of hurricane Andrew (1992) (Source from NOVA). http://www.pbs.org/newshour/science/hurricane/facts.html

Tropical cyclone heat potential: http://www.aoml.noaa.gov/phod/cyclone/data/

7. Provide the following information related to changes in the hurricane model from the previously-accepted hurricane model to the initial submission this year.

A. Hurricane Model changes:

1. A summary description of changes that affect the personal or commercial residential hurricane loss costs or hurricane probable maximum loss levels,

Meteorological Component

- We updated to a recent version of HURDAT2 (4/28/2020) which includes storms up through the 2019 season.

- We updated the ZIP Code database to the April 2020 ZIP Code boundaries as per Standard G-3. The update of the ZIP Code database resulted in the update of the following ZIP Code-based databases: (1) population-weighted centroids of each ZIP Code, (2) population-weighted roughness for each ZIP Code, (3) distance to coast of each ZIP Code, (4) list of 2001 FBC WBDR ZIP Codes and list of 2007 FBC WBDR ZIP Codes and list of 2010 FBC WBDR ZIP Codes, and (5) classification of coastal/inland for each ZIP Code.

Vulnerability Component

<u>Changes in wind borne debris map</u>

The FPHLM added the wind borne debris (WBDR) map issued in the original 2001 edition of the FBC to its list of WBDR maps. The WBDR map is assigned according to the effective date of activation of the code revision:

a) for YB from 03-01-02 to 02-28-09**,** the 2001 map applies

b) for YB from 03-01-09 to 03-14-12 the 2007 map applies

c) for YB from 03-15-12 to now the 2010 map applies

Figure 16 shows the 3 WBDR maps translated into zip code boundaries, for FPHLM implementation

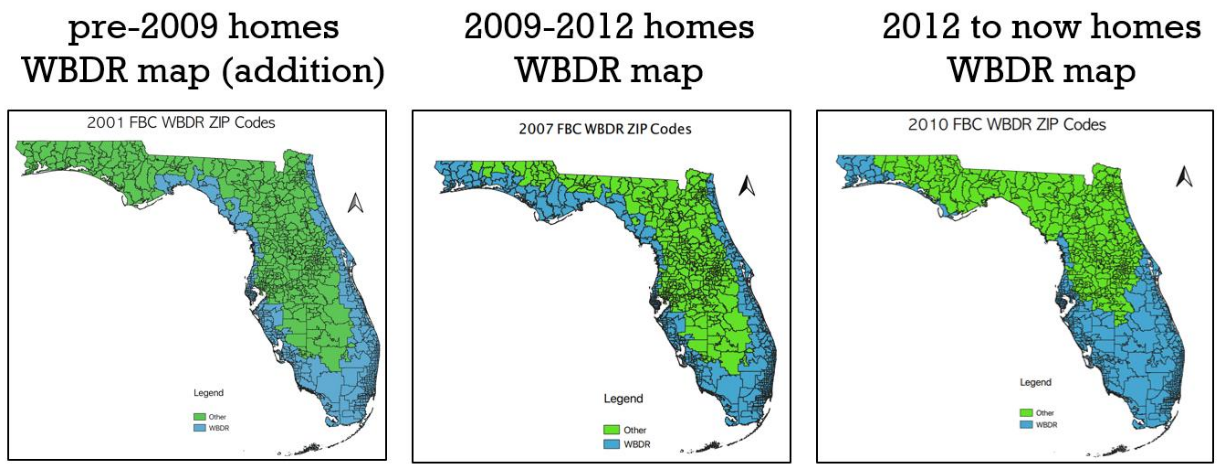


Figure 16: WBDR maps

Personal residential model

There are no changes to report.

Commercial residential low-rise model

a) The CR-LR model has new interior and contents damage models, which computes the rainwater induced damage to each interior component and contents.

b) The new interior damage model lead to a revised cost analyses of the low-rise models.

c) The model generates separate contents vulnerability curves for an overall building, an apartment building, and a condominium association building. In the past, it did not differentiate between the three.

d) The model has updated the formula to compute time-related expenses for apartment buildings.

Commercial residential mid/high-rise model

The engineering team implemented several improvements to the MHR model.

d) The FPHLM has an improved interface between Personal Residential portfolios with condo units (owners or rentals) and the MHR model. The model now can:

- Differentiation for condo unit insured building interior loss between the case of a renter and an owner.
- Differentiation for condo unit insured contents loss between the case of a renter and an owner.

- Assignment of missing information like total # of stories based on insurance stats

- Computation of condo loss depending on whether the location of the condo in the building is known or not

e) The FPHLM runs the model for both open and closed layouts and calculate the weighted average of the losses from both runs.

f) The model makes-up for missing data on building geometry (# of stories, building area, # of units per story) in a way consistent with the information available in the portfolio (insured value of the building and location).

g) The model benefits from an updated cost analysis; and,

h) The model now computes the insured losses differently for apartment buildings (AB) and condo associations (CA). In the past CR-MHR were assumed to be CA by default.

Changes in Treatment of Apartment Building vs Condominium Association in commercial residential model

a) The model has separate equations to transform the building damage into insured losses for either apartment building (AB) or condominium association (CA).

b) In the past CR-LR policies were assumed to be apartment buildings by default. Now, the model processes the CR-LR policies as both AB and CA, and produces a weighted average of the two. The statistical distribution of AB and CA within the insurance portfolios, for each county, defines the weights.

2. A list of all other changes, and

None

3. The rationale for each change.

Meteorological Component

i) Change made to update to a recent version of HURDAT2 (4/28/2020) as per Standard M-1.

j) Updated centroid locations as per Standard G-3.

Vulnerability Component

The rationale for each change is as follows:

<u>WBDR update</u>

The inclusion of the 2001 map in the FPHLM library of WBDR regions insures that the historical record of WBDR is complete.

<u>Commercial residential low-rise model</u>

a) new interior damage and contents models

The rationale behind the new interior and contents damage models due to rainwater ingress was to develop a physics-based and component-based model to replace the empirical approach of V7.0. It includes improvements or changes in:

- Water ingress: A series of large and full-scale tests at the Wall of Wind (WoW) (Raji, 2018; Raji et al., 2019; Raji et al., 2020) provided data on water ingress distribution among interior components. V8.1 integrates these test results into the new model.

- Water percolation of: V8.1 uses a more realistic approach for water percolation, where each interior component an contents category has its own water absorption limit and when that limit is reached, the excess volume percolates to other components.

- Damage evaluation: V8.1 evaluates the damage of each interior component based on their moisture contents after absorbing the water ingress. The model takes into account the interaction between interior components and contents, regarding water absorption.

b) Commercial residential low-rise model updated cost analyses:

The component approach for the new interior damage model necessitated an update of the cost structure of the CR-LR model, which extended to the exterior components as well.

c) Separate contents vulnerability curves for overall building, apartment building, and condominium association building:

CR-LR V7.0 did not explicitly model contents vulnerability. Instead, contents vulnerabilities were a function of interior vulnerabilities. The new approach models the contents damage due to water ingress, and explicitly produces contents vulnerability matrices and curves. It also differentiates among whole building contents, AB contents, and CA contents. There is a need to consider these different contents vulnerabilities due to the different type of insurance coverage for contents. See more details in disclosure 1 of Standard V-2.

d) Updated formula to compute time-related expenses for apartment buildings:

The previous model had time-related expenses based on interior vulnerabilities. The new model has lower interior vulnerability when compared to V7.0 and due to that, time-related expenses never reach 100% of its value. So, rather than basing time-related expenses on interior damage, we base it on the building damage and in this case we always exhaust the time-related expenses at high wind speed values.

Commercial residential mid/high-rise model

a) Improved interface between Personal Residential portfolios with condo units (owners or rentals) and the MHR model includes:

- Differentiation for condo unit insured building interior loss between the case of a renter (no insured interior loss) and an owner (possible insured interior loss). In the case of a rental unit, the building interior loss is covered by the building owner policy, not the condo unit renter policy. In the case of an owner unit, the building interior loss is covered by the condo unit owner policy.

- Differentiation for condo unit insured contents loss between the case of a renter (appliances not included) and an owner (appliances included).

  In the case of a rental unit, the contents insured loss does not include appliances, which belong to the building owner. In the case of an owner unit, the contents insured loss includes appliances, which belong to the condo unit owner.

- Assignment of missing information like total # of stories based on insurance stats

  A condo unit damage depends on its possible location in the building. If the location is not known, the model takes an average of the losses at each story. Therefore the number of stories is needed, and is assigned based on statistics.

- Computation of condo loss depending on whether the location of the condo in the building is known or not. That allows the program to make use of the information if available.

b) Calculation of the weighted average of the open and close layout losses:

There are two layout types of MHR buildings: closed buildings and open buildings whose units are accessed internally and externally respectively. In Version V7.0, the layout type of the building is selected based on location of the building (costal or inland) and number of stories of the building when the layout type is unknown. It lead to a bias because for each building the model calculates the damage one time based on the selected layout type. The new version calculate the weighted average of the losses of the two layout types to eliminate the bias.

c) Making-up of missing data on building geometry (# of stories, building area, # of units per story) in a way consistent with the information available in the portfolio (insured value of the building and location):

The building geometry (# of stories, building area, # of units per story) is required for the damage estimation, but some data might not be available in the portfolio. In version V7.0 the assignment of the missing data did not take always into account the insured value and location of the building.

V8.1 takes into account the insured value and location when assigning missing data.   these based on statistics. This process ensures that all the decisions regarding the geometry of the building are related to its insured value, and that there is no disconnect between the insurance data and the assumed geometric parameters for the building.

d) Updated cost analysis

In MHR model V7.0, the cost of damage to the openings equals the cost of each opening multiplied by the number of damaged openings. Consequently, the damage cost estimation is not linked to value of building. MHR model V8.1 calculates exterior damage to the openings but transforms it into expected exterior damage ratios thanks to new exterior cost coefficients, which link the insured damage to the insured value.

e) Computation of the insured losses differently for apartment buildings (AB) and condo associations (CA):

Insurance policies for apartment building and condo association cover different components, but Version V7.0 did not differentiate the two types of policies. Although, the vast majority of MHR buildings are CA, the option exists in V8.1 for MHR AB.

<u>Change in Treatment of Apt vs Condo Association in Commercial residential low-rise model</u>

a) Option to compute the insured losses for either apartment building (AB) or condominium association (CA):

CR-LR V7.0 did not differentiate between AB and CA. Due to the difference in coverage of AB and CA policies, there was a need to address this. See more details in disclosure 1 of Standard V-1.

b) Weighted average of AB and CA losses.

A large percentage of policies does not specify if they are AB or CA policies. A statistical analysis of the policies for which the type of residency is specified, showed that for CR-LR buildings, there is no correlation between number of stories and type of residency. Therefore, the model cannot assume automatically that all CR-LR buildings are AB. Instead, the model processes the CR-LR policies as both AB and CA, and produces a weighted average of the two. The statistical distribution of AB and CA within the insurance portfolios, for each county, defines the weights.

B. Percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.zip" for:

1. All changes combined, and

The impact of all model changes combined is -11.6%.

2. Each individual hurricane model component change.

The statewide impacts for Personal and Commercial Residential combined on $0 deductible loss costs were:

- -2.8%% due to updated HURDAT
- +0.01% due to roughness changes associated with updated Zip Code centroids
- +0.11% due to change in the WBDR.

The statewide impacts for Commercial Residential on $0 deductible loss costs were:

- -18.8% due to changes in the Commercial Residential vulnerability
- -30.3% due to changes in the weighting of low-rise Commercial Residential losses between types of insured (Apartment vs. Condominium) when that attribute is unknown, as it is for the Cat Fund.

C. Color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund's aggregate personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.zip" for each hurricane model component change.

See Figure 17 to Figure 21.

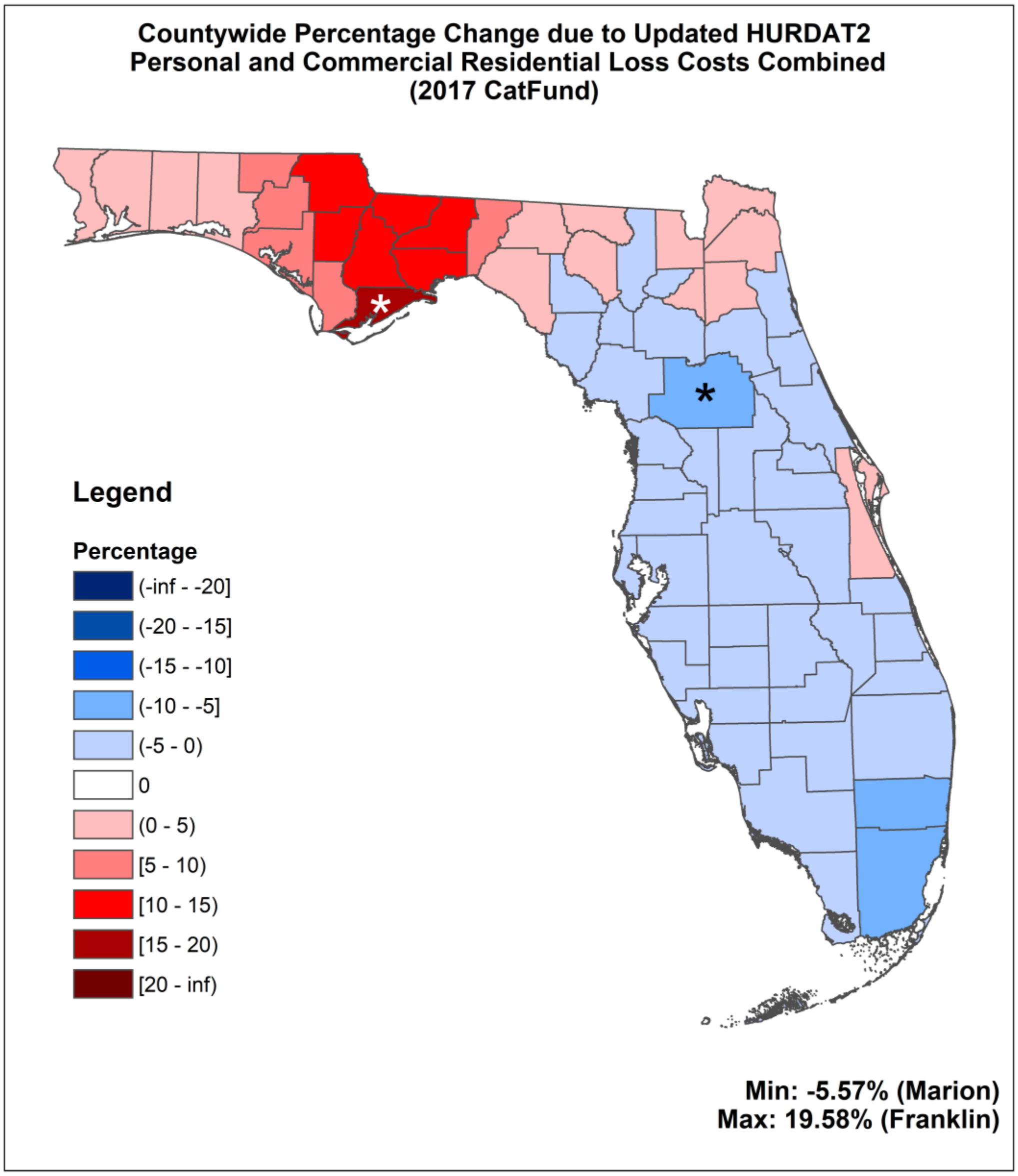


Figure 17. County wide percentage change due to updated HURDAT.

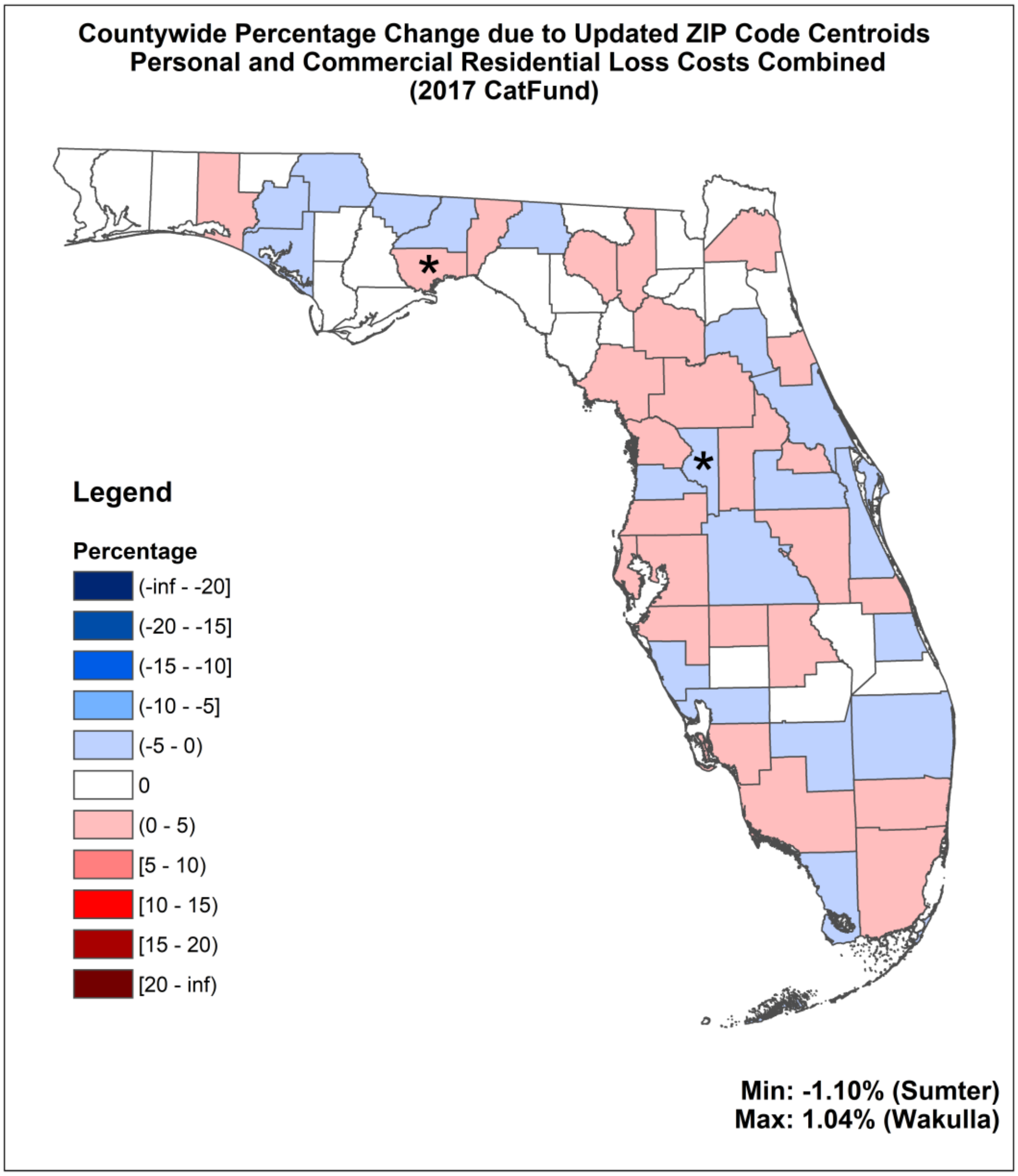


Figure 18. County wide percentage change due to updated Zip Code centroids.

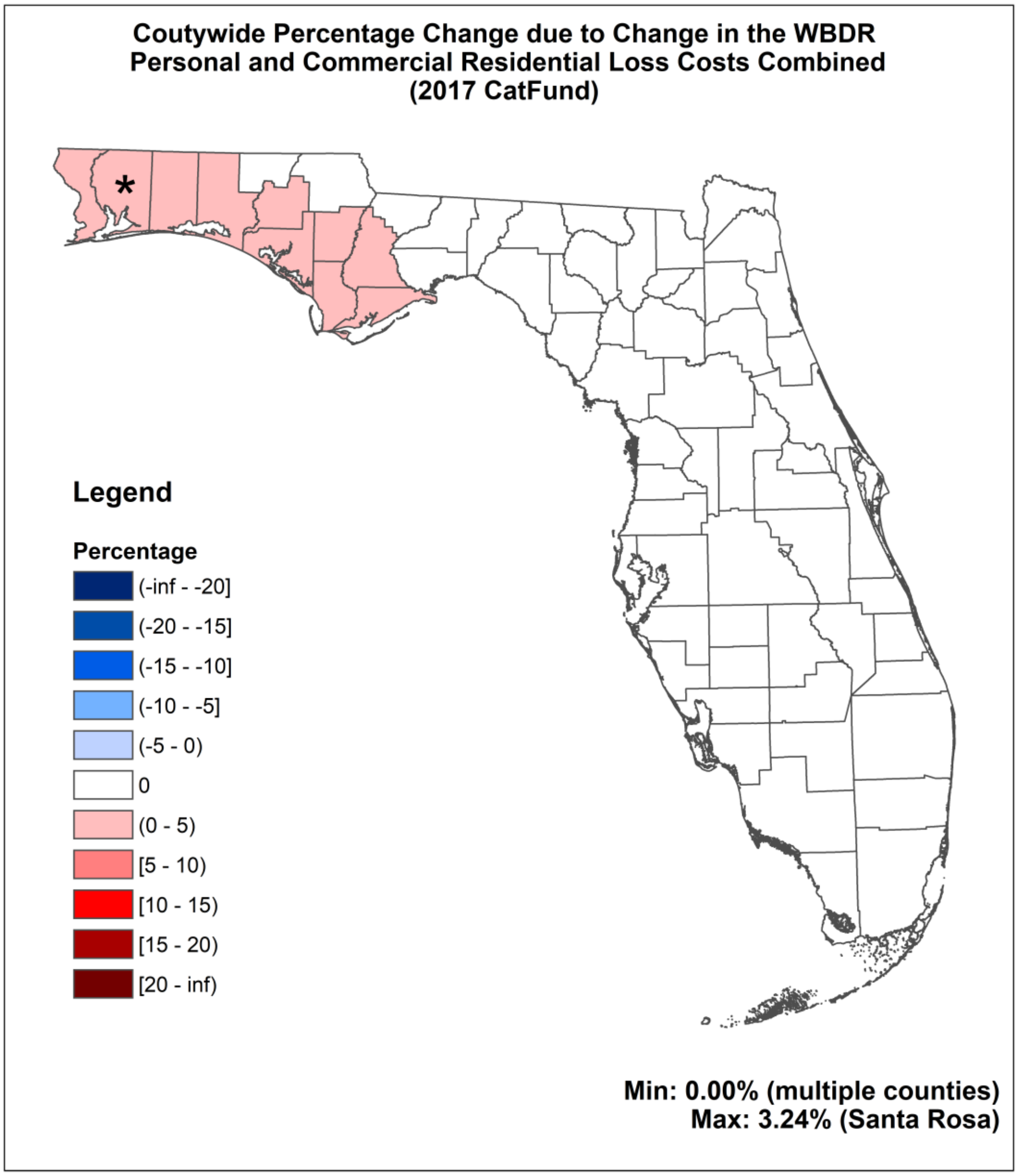


Figure 19. County wide percentage change due to change in WBDR

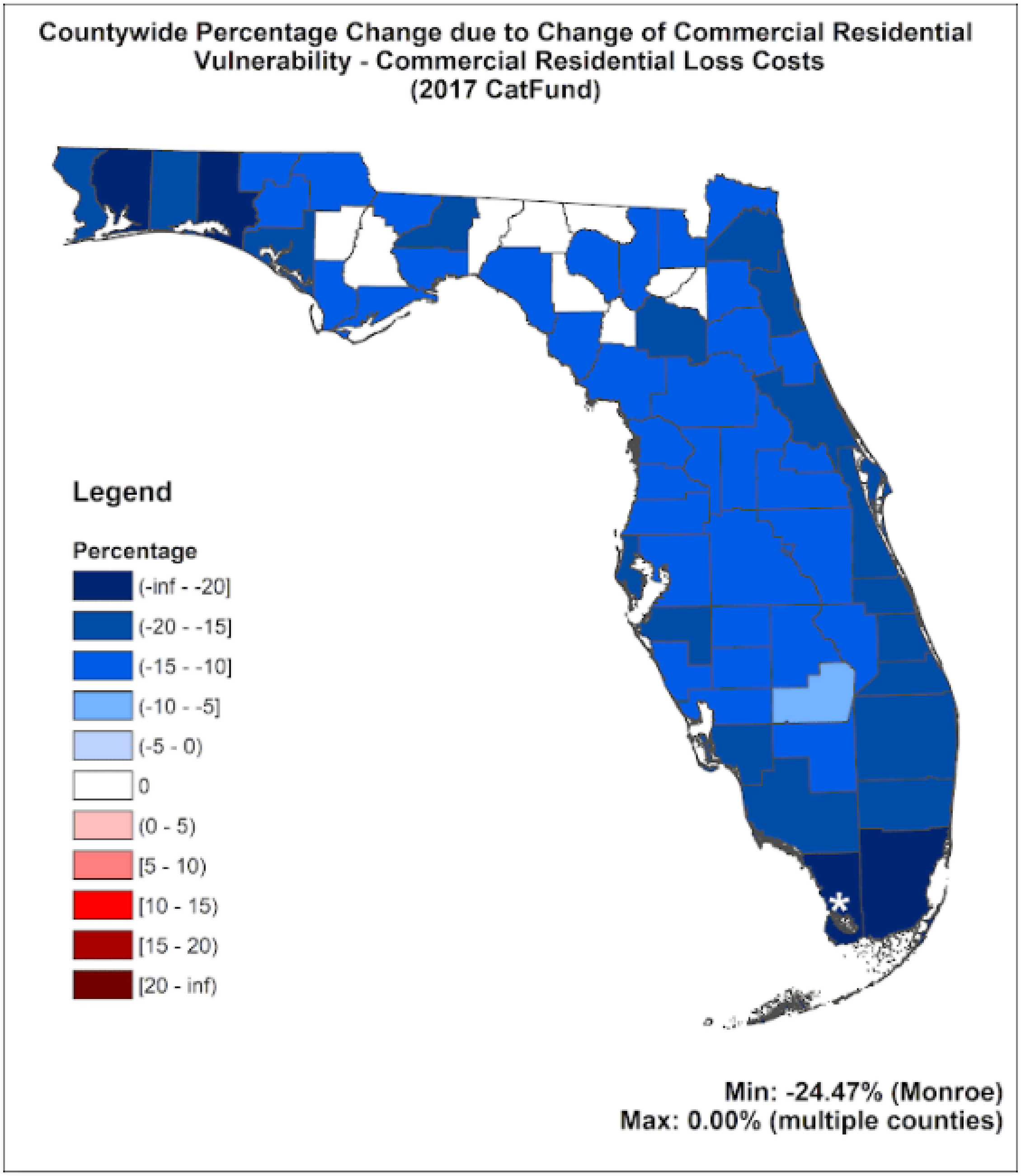


Figure 20. County wide percentage change due to Commercial Residential vulnerability

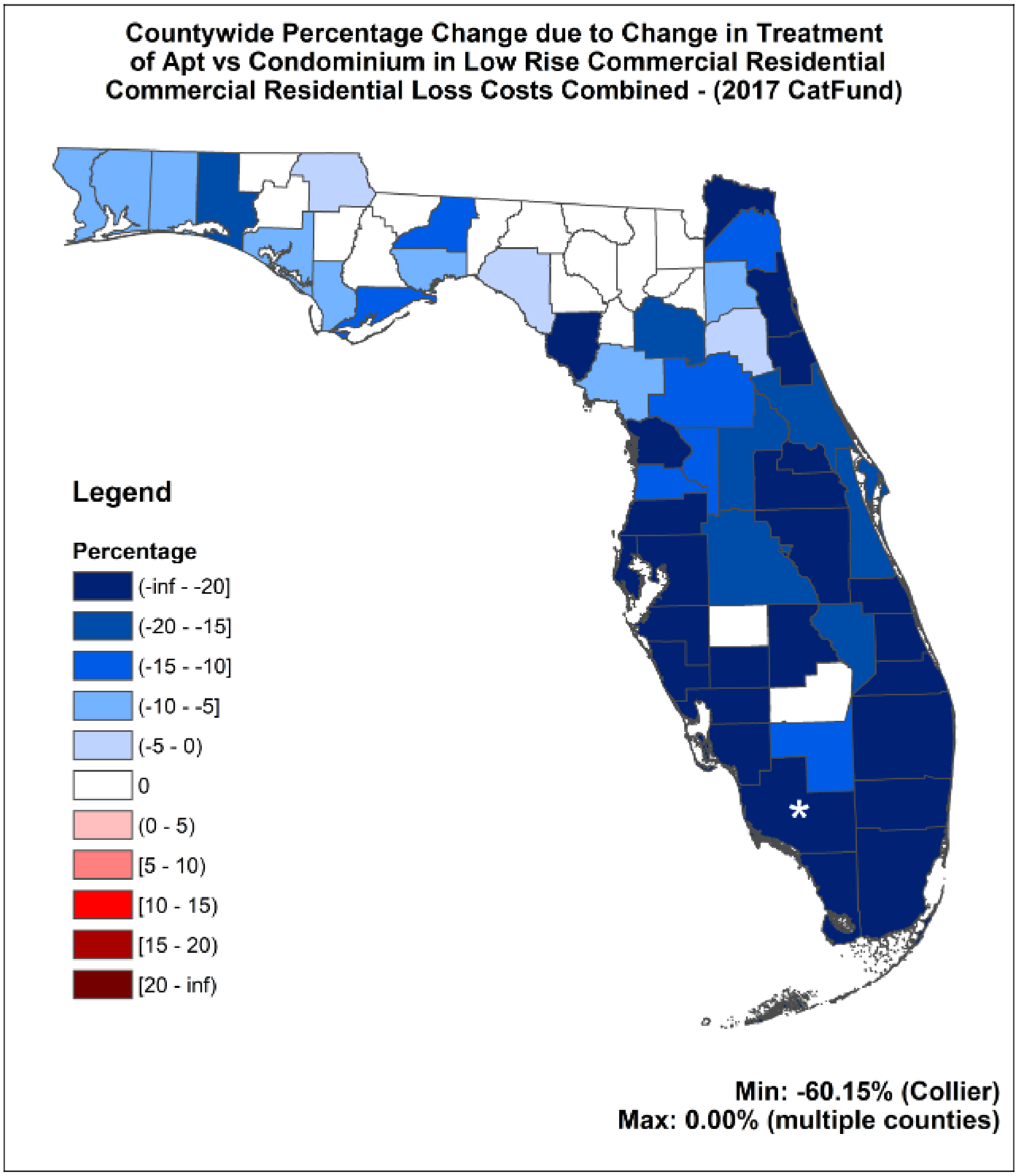


Figure 21. County wide percentage change due to change in treatment of apartment vs condo association in low rise Commercial Residential

D. Color-coded map by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund's aggregate personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.zip" for all hurricane model components changed.

See Figure 22**Error! Reference source not found.**.

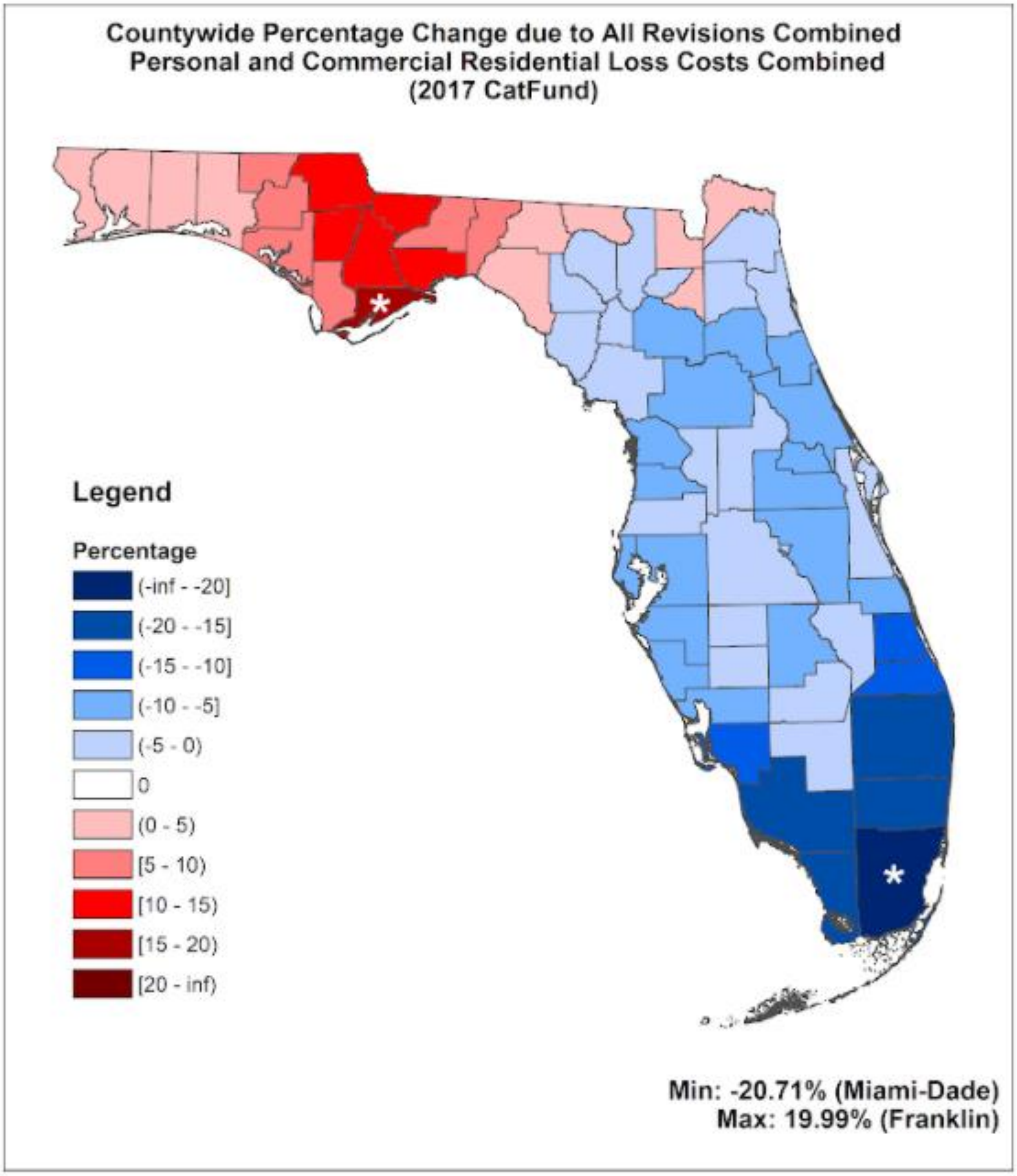


Figure 22. County wide percentage change due to all revisions combined

8. Provide a list and description of any potential interim updates to underlying data relied upon by the hurricane model. State whether the time interval for the update has a possibility of occurring during the period of time the hurricane model could be found acceptable by the Commission under the review cycle in this Hurricane Standards Report of Activities.

The FPHLM currently does not anticipate any interim updates.

G-2 Qualifications of Modeling Organization Personnel and Consultants Engaged in Development of the Hurricane Model

A. Hurricane model construction, testing, and evaluation shall be performed by modeling organization personnel or consultants who possess the necessary skills, formal education, and experience to develop the relevant components for hurricane loss projection methodologies.

The model was developed, tested, and evaluated by a multi-disciplinary team of professors and experts in the fields of meteorology, wind and structural engineering, computer science, statistics, finance, economics, and actuarial science. The experts work primarily at Florida International University, Florida Institute of Technology, Florida State University, University of Florida, Hurricane Research Division of NOAA, and University of Miami.

B. The hurricane model and hurricane model submission documentation shall be reviewed by modeling organization personnel or consultants in the following professional disciplines with requisite experience: structural/wind engineering (licensed Professional Engineer in civil engineering with a current license), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society or Society of Actuaries), meteorology (advanced degree), and computer/information science (advanced degree or equivalent experience and certifications). These individuals shall certify Expert Certification Forms G-1 through G-6, as applicable.

The model has been reviewed by modeler personnel and consultants in the required professional disciplines. These individuals abide by the standards of professional conduct as adopted by their profession.

Disclosures

1. Modeling Organization Background

A. Describe the ownership structure of the modeling organization engaged in the development of the hurricane model. Describe affiliations with other companies and the nature of the relationship, if any. Indicate if the modeling organization has changed its name and explain the circumstances.

The model was developed independently by a multi-disciplinary team of professors and experts. The lead university is the Florida International University. The model was commissioned by the Florida Office of Insurance Regulation.

B. If the hurricane model is developed by an entity other than the modeling organization, describe its organizational structure and indicate how proprietary rights and control over the hurricane model and its components is are exercised. If more than one entity is involved in the development of the hurricane model, describe all involved.

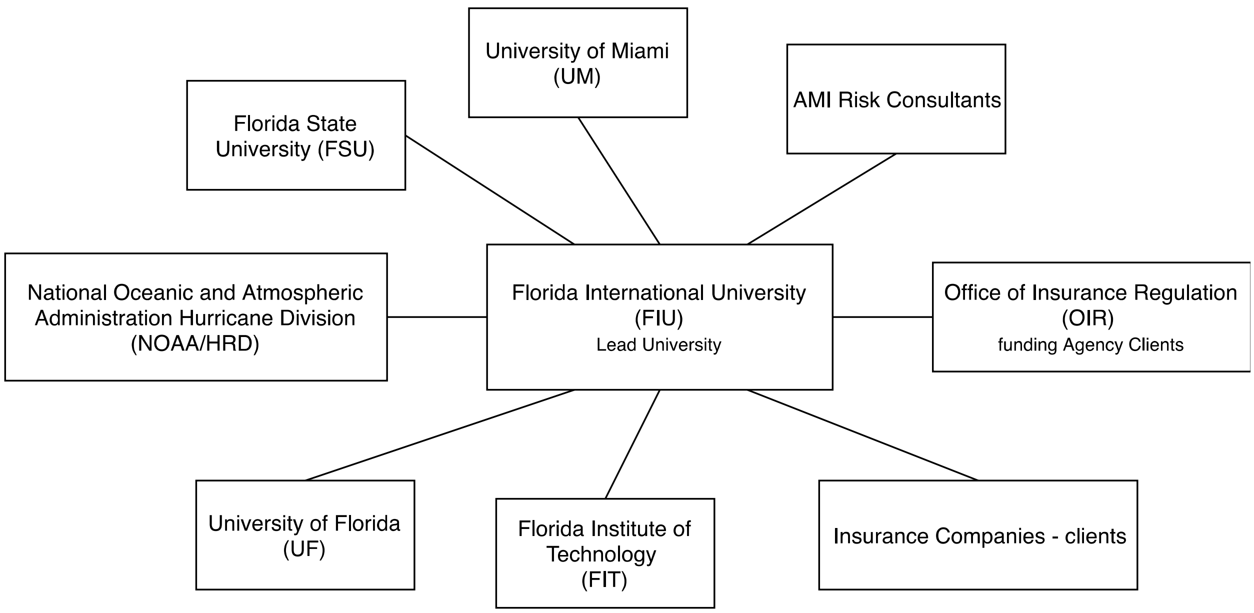


Figure 23. Organizational structure

The Florida Office of Insurance Regulation (OIR) contracted and funded Florida International University to develop the Florida Public Hurricane Loss Model. The model is based at the Laboratory for Insurance, Financial and Economic Research, which is part of the International Hurricane Research Center at Florida International University. The OIR did not influence the development of the model. The model was developed independently by a team of professors, experts, and graduate students working primarily at Florida International University, Florida Institute of Technology, Florida State University, University of Florida, Hurricane Research Division of NOAA, University of Miami, and AMI Risk Consultants. The copyright for the model belongs to OIR.

C. If the hurricane model is developed by an entity other than the modeling organization, describe the funding source for the development of the hurricane model.

The model was funded by the state legislature at the request of the Florida Office of Insurance Regulation.

D. Describe any services other than hurricane modeling provided by the modeling organization.

No other services beside hurricane modeling is provided by modeling organization.

Until 2008 the modeler provided services to only one major client, the FL-OIR. Effective January 2009 the modeler is providing services to the firms and organizations in the insurance and reinsurance industries. It has expanded the infrastructure and computational capacity to handle the added load.

The first version of the model was completed in May 2005 and was based on the knowledge and the limited data available prior to the 2004–2005 hurricane seasons. It was not used for purposes of estimating loss costs for insurance company exposures. Essentially, it was an internal model that was never implemented.

The next version of the model was developed upon the acquisition of a limited amount of meteorological, engineering, and insurance claim data from the 2004–2005 hurricane events and was implemented in March 2006. This version was used to process the insurance company data on behalf of the Florida Office of Insurance Regulation.

In summer 2007 a revised and updated version of the model, 2.6, was accepted by the Florida Commission on Hurricane Loss Projection Methodology and put to immediate use. Another revised and updated version, 3.0, was accepted by the Commission in June 2008. The next updated version of the model was 3.1, which was accepted by the Commission in June 2009. This was followed by version of the model was 4.1, which was accepted by the Commission in August 2011, the version 5.0 accepted in July 2013, and the version 6.1 accepted in July 2015. The next version of the model is 6.2, which was accepted by the Commission in May 2017. The latest version 7.0 was implemented in Summer 2019.

E. Indicate if the modeling organization has ever been involved directly in litigation or challenged by a governmental authority where the credibility of one of its U.S. hurricane model versions for projection of hurricane loss costs or hurricane probable maximum loss levels was disputed. Describe the nature of each case and its conclusion.

None.

2. Professional Credentials

A. Provide in a tabular format (a) the highest degree obtained (discipline and university), (b) employment or consultant status and tenure in years, and (c) relevant experience and responsibilities of individuals currently involved in the acceptability process or in any of the following aspects of the hurricane model:

1. Meteorology

2. Statistics

3. Vulnerability

4. Actuarial Science

5. Computer/Information Science

See below.

Key Personnel	Degree/ Discipline	University	Employment Status	Tenure	Experience
Meteorology					
Dr. Steve Cocke	Ph.D. Physics	Univ. Texas Austin	Scholar/Scientist FSU, Dept of Meteorology	24	Meteorology track, intensity, roughness models
Dr. Dongwook Shin	Ph.D. Meteorology	Florida State University	FSU/COAPS, Associate Research Scientist	19	Meteorology
Dr. Bachir Annane	Ph.D. Meteorology, M.S. Mathematics	Florida State University	Meteorologist, Univ. of Miami	26	Meteorology
Neal Dorst	B.S. Meteorology	Florida State University	Meteorologist, HRD/NOAA	37	Meteorology
Statistics					
Dr. B. M. Golam Kibria	Ph.D. Statistics	University of Western Ontario	Professor of Statistics, FIU	20	Distribution Theory, Ridge regression, Statistical Inference, Sensitivity Analysis
Dr. Wensong Wu	Ph.D. Statistics	University of South Carolina	Associate Professor, Statistics, FIU	9	Bayesian decision theory and computation, model selection and model averaging in risk analysis

Key Personnel	Degree/ Discipline	University	Employment Status	Tenure	Experience
Engineering					
Dr. Jean-Paul Pinelli	Ph.D. Civil Engineering	Georgia Tech	Professor, CE Florida Institute of Technology	25	Wind engineering, vulnerability functions
Dr. Kurt Gurley	Ph.D. Civil Engineering	University of Notre Dame	Associate Professor, CE University of Florida	21	Wind engineering, simulations
Roberto Vicente Silva de Abreu	B.S. Civil Engineering	Florida Institute of Technology	M. S.. Candidate in Civil Engineering, Florida Institute of Technology	3	Wind and structural engineering
Nima Aghli	M.S. Computer Science	Florida Institute of Technology	Ph.D. Candidate in Computer Science, Florida Institute of Technology	1	Software and database development
Karthik Yarasuri	B.S. Civil Engineering	Jawaharlal Nehru Technological University	Ph.D. Candidate in Civil Engineering, University of Florida	6	Wind engineering, simulations
Zhuoxuan Wei	M.S. Civil Engineering	Florida Institute of Technology	Ph.D. Candidate in Civil Engineering, Florida Institute of Technology	2	Wind and structural engineering
Daphne Otarola	B.S. Civil Engineering	Florida Institute of Technology	M.S. Candidate in Civil Engineering, Florida Institute of Technology	2	Database development
Christian Bedwell	B.S. Civil Engineering	Florida Institute of Technology	Ph.D. Candidate in Civil Engineering, University of Florida	0.5	Wind engineering, simulations
Actuarial/Finance					
Dr. Shahid Hamid Project Manager, PI	Ph.D. Economics (Financial), CFA	University of Maryland	Professor of Finance Florida International University	32	Insurance and finance
Gail Flannery	FCAS, Actuary	CAS	VP, AMI Risk Consultants	35	Reviewer, demand surge, actuarial analysis
Aguedo Ingco	FCAS, Actuary	CAS	President, AMI Risk Consultants	45	Reviewer, demand surge
Computer Science					
Dr. Shu-Ching Chen	Ph.D. Electrical and Computer Engineering	Purdue University	Professor of Computer Science, FIU	20	Software and database development
Dr. Mei-ling Shyu	Ph.D. Electrical and Computer Engineering	Purdue University	Professor of Electrical and Computer Engineering, University of Miami	20	Software quality assurance
Raul Garcia	M.S. Computer Science	Georgia Institute of Technology	Research Specialist II, FIU	10	Software and database development

Key Personnel	Degree/ Discipline	University	Employment Status	Tenure	Experience
Diana Machado	M.S. Computer Science	Georgia Institute of Technology	Research Specialist II, FIU	9	Software and database development
Yudong Tao	B.S. Microelectronics	Fudan University	Ph.D. Candidate in Electrical and Computer Engineering, UM	5	Software and database development
Maria Presa Reyes	M.S. Computer Science	Florida International University	Ph.D. student in Computer Science, FIU	5	Software and database development
Tianyi Wang	M.S. Computer Science	Florida International University	Ph.D. student in Computer Science, FIU	3	Software and database development
Daniel Martinez	High School	Florida International University	Student assistant in the DMIS lab, FIU	3	Information management systems
Anchen Sun	M.S. in Electrical and Computing Engineering	University of Miami	Ph.D. Candidate in Electrical and Computer Engineering, UM	1	Software and database development

Table 9. Professional credentials

B. Identify any new employees or consultants (since the previous submission) engaged in the development of the hurricane model or the acceptability process.

Nima Aghli, Christian Bedwell, Daphne Otarola, Zhuoxuan Wei, Anchen Sun.

C. Provide visual business workflow documentation connecting all personnel related to hurricane model design, testing, execution, maintenance, and decision-making.

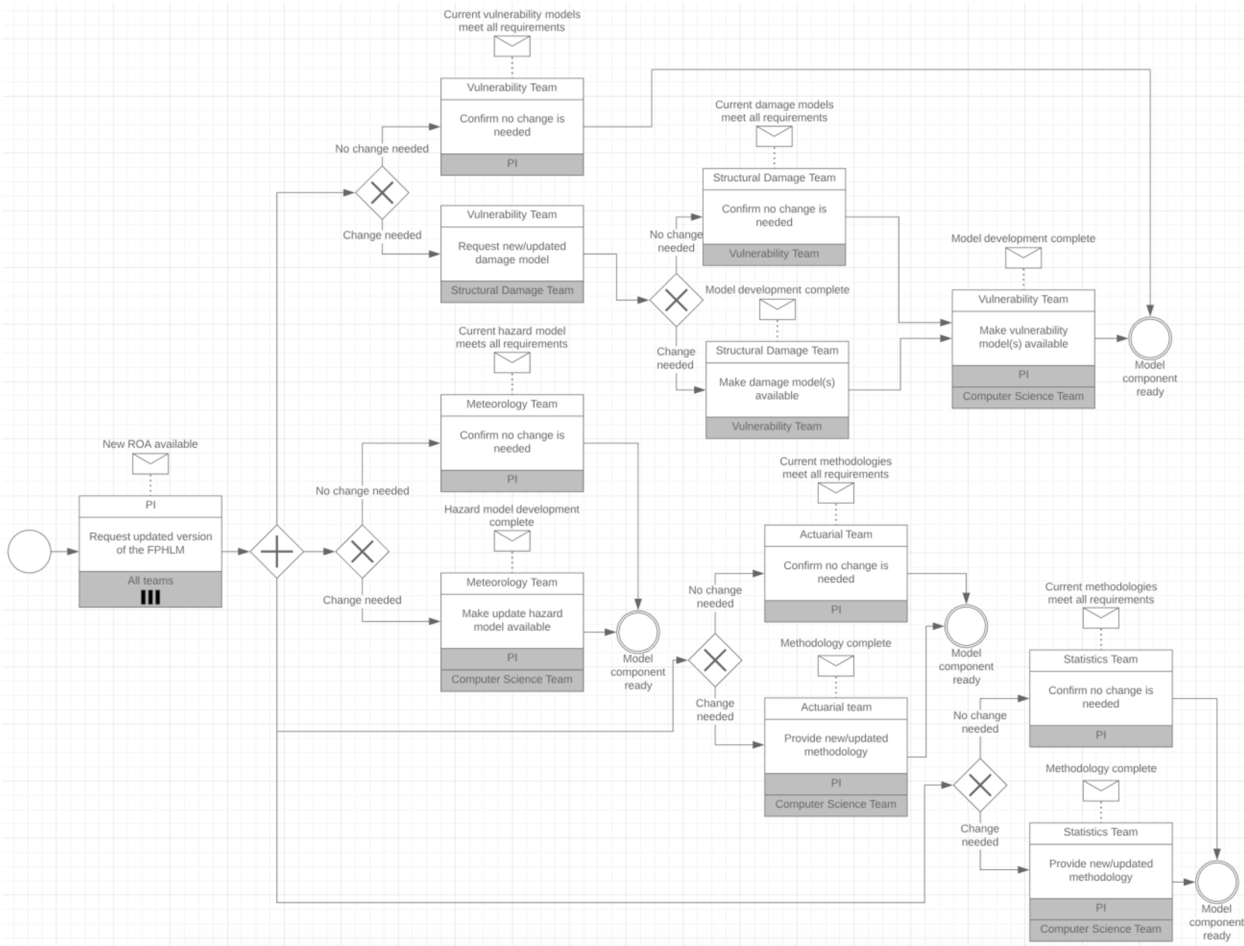


Figure 24. Florida Public Hurricane Loss Model workflow – Part 1

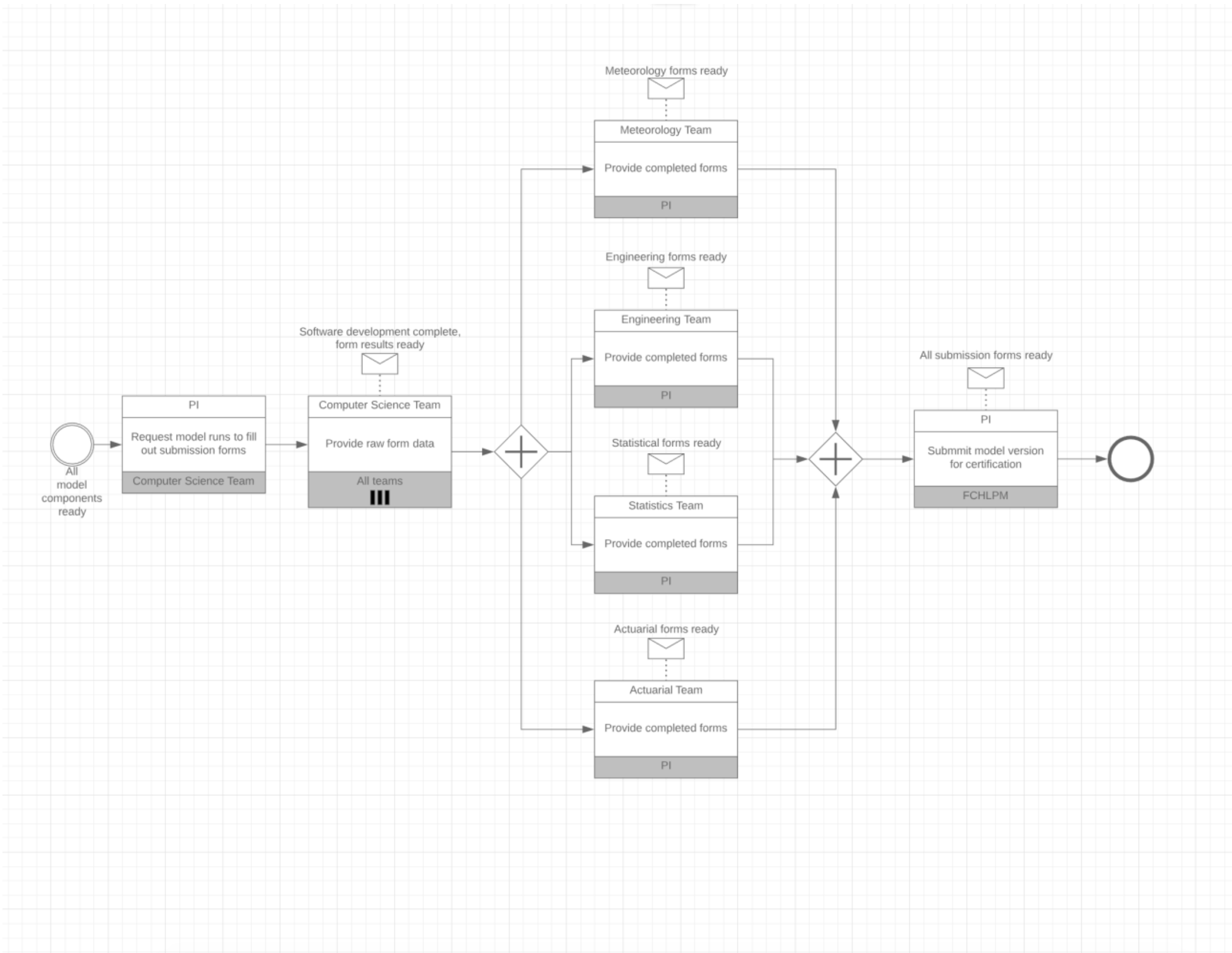


Figure 24. Florida Public Hurricane Loss Model workflow – Part 2

3. Independent Peer Review

A. Provide reviewer names and dates of external independent peer reviews that have been performed on the following components as currently functioning in the hurricane model:

1. Meteorology

2. Statistics

3. Vulnerability

4. Actuarial Science

5. Computer/Information Science

Dr. Gary Barnes, Professor of Meteorology at University of Hawaii, performed the external review of the meteorology component in February 2007. The current version was reviewed by modeler personnel.

Gail Flannery, FCAS, and Aguedo Ingco, FCAS, actuaries and vice president and president, respectively, of AMI Risk Consultants in Miami, performed the external review of the actuarial component and submission in October 2020. Gail Flannery was also involved in the development of the demand surge model and the commercial residential model.

The vulnerability, statistical, and computer science components were reviewed by modeler personnel.

B. Provide documentation of independent peer reviews directly relevant to the modeling organization's responses to the current hurricane standards, disclosures, or forms. Identify any unresolved or outstanding issues as a result of these reviews.

The written independent review of the wind component by Dr. Gary Barnes is presented in Appendix A. No unresolved outstanding issues remain after the review.

Gail Flannery, FCAS, performed the independent review of the actuarial component. She attended many meetings with the model team and helped in the understanding of the requirements of the actuarial standards, disclosures, and forms. She was provided with all relevant forms and supporting documents. She conducted independent analysis of the A forms and asked questions and provided feedback and suggestions; her questions were addressed, and the feedback and suggestions were acted upon so that no unresolved outstanding issues remain. She prepared the submission document for the actuarial standards. A letter from Gail Flannery can be found in Appendix A. See also Form G-5.

C. Describe the nature of any on-going or functional relationship the modeling organization has with any of the persons performing the independent peer reviews.

Dr. Gary Barnes, Professor of Meteorology at University of Hawaii, performed the external review of the version 2.6 meteorology component of the model, particularly the wind field model. He has no on-going or functional relationship to FIU or the modeling organization, other than as an independent reviewer. He did not take part in the development or testing of the model. His role in the model has been confined to being an independent external reviewer.

4. Provide a completed Form G-1, General Standards Expert Certification. Provide a link to the location of the form here.

See Form G-1.

5. Provide a completed Form G-2, Meteorological Standards Expert Certification. Provide a link to the location of the form here.

See Form G-2.

6. Provide a completed Form G-3, Statistical Standards Expert Certification. Provide a link to the location of the form here.

See Form G-3.

7. Provide a completed Form G-4, Vulnerability Standards Expert Certification. Provide a link to the location of the form here.

See Form G-4.

8. Provide a completed Form G-5, Actuarial Standards Expert Certification. Provide a link to the location of the form here.

See Form G-5.

9. Provide a completed Form G-6, Computer/Information Standards Expert Certification. Provide a link to the location of the here.

See Form G-6.

G-3 Insured Exposure Location

A. ZIP Codes used in the hurricane model shall not differ from the United States Postal Service publication date by more than 24 months at the date of submission of the hurricane model. ZIP Code information shall originate from the United States Postal Service.

Our model uses ZIP Code data exclusively from a third-party developer, which bases its information on the ZIP Code definitions issued by the United States Postal Service. The version we used has a USPS vintage of April 2020. The ZIP Code data have been changed in the current release of the model from the last submission.

B. ZIP Code centroids, when used in the hurricane model, shall be based on population data.

ZIP Code centroids used in the model are population centroids.

C. ZIP Code information purchased by the modeling organization shall be verified by the modeling organization for accuracy and appropriateness.

The ZIP Code information is checked for consistency by experts developing our model. Maps showing the ZIP Code boundaries and the associated centroids will be provided to the professional team during the on-site visit.

D. If any hurricane model components are dependent on ZIP Code databases, a logical process shall be maintained for ensuring these components are consistent with the recent ZIP Code database updates.

All ZIP Code-dependent components are recreated using the latest update of the ZIP code data in the model.

E. Geocoding methodology shall be justified.

The FPHLM uses an enterprise class geocoding engine for converting street addresses to latitude-longitude values.

Disclosures

1. List the current ZIP Code databases used by the hurricane model and the hurricane model components to which they relate. Provide the effective (official United States Postal Service) dates corresponding to the ZIP Code databases.

The FPHLM uses 5-digit ZIP Codes distributed by zip-codes.com. The 5-digit ZIP Codes product constitutes a geographic data set that contains the boundaries for each 5-digit ZIP Code in the United States assigned by the U.S. Postal Service.
The ZIP Code data are updated monthly. The release we used in this submission has a vintage of 2020.04 (April 2020).

The ZIP Code data are used in the Wind Speed Correction and Insured Loss modules of the model. The Wind Speed Correction Module converts the output from the wind model from marine exposure to actual or open terrain exposure and includes calculation of gust factors.

2. Describe in detail how invalid ZIP Codes are handled.

For historical loss costs where street addresses are not available, we use contemporaneous ZIP Codes and associated population-based centroids to locate the exposure. The Wind Speed Correction module subsequently determines the current (2020) ZIP Code that contains the historical centroid, and the exposure is then modeled on the basis of the 2020 ZIP code centroid location. If a policy has a ZIP Code that cannot be found in the contemporaneous database of ZIP Codes, it is not modeled.

3. Describe the data, methods, and process used in the hurricane model to convert among street addresses, geocode locations (latitude-longitude), and ZIP Codes.

The FPHLM uses the REST API of the ArcGIS Server with the StreetMap Premium for ArcGIS locators to geocode street addresses. A request is sent to the server containing the given street address, city, state, and ZIP Code. The server processes the request and sends a response containing the status, the location, and the standardized address. The location and address fields of the response are empty when the status is unmatched.

When the status is matched, the coordinates (longitude, latitude) are assigned to the policy and the ZIP Code is updated if necessary. When the status is unmatched, but the ZIP Code is given, the policy is assigned the coordinates of the population-weighted centroid of the ZIP Code. Finally, if the status is unmatched and a correct ZIP Code is not given, the policy is dropped.

4. List and provide a brief description of each hurricane model ZIP Code-based database (e.g., ZIP Code centroids).

Population-based ZIP Code centroids and roughness. This database provides the ZIP Code centroid location and corresponding population-weighted roughness and distance to coast for each incoming wind direction octant.

Wind-borne Debris Region (WBDR) ZIP Codes. This database provides three lists of Florida ZIP Codes: one containing the ZIP Codes that fall within the WBDR specified by the 2001 Florida Building Code (FBC), another containing the ZIP Codes falling within the 2007 FBC WBDR definition, and a third containing the ZIP Codes falling within the 2010 FBC WBDR definition.

Classification of coastal/inland for each ZIP Code. This database provides the list of ZIP Codes that are classified as coastal.

5. Describe the process for updating hurricane model ZIP Code-based databases.

The updated ZIP Code data, compliant with Standard G-3.A., is received from the vendor and checked and verified for accuracy and appropriateness. The ZIP Code data include a plain text list of all Florida ZIP Codes and GIS layers for the ZIP Code boundaries. These vendor data are used to calculate various datasets for use in the model:

1. Population-weighted centroids of each ZIP Code.
2. Population-weighted roughness for each ZIP code.
3. Distance to coast of each ZIP Code.
4. Lists of ZIP Codes within the Wind-Borne Debris Region (WBDR). One list based on the 2001 FBC's definition, another based on the 2007 FBC's definition, and a third based on the 2010 FBC's definition.
5. Classification of coastal/inland for each ZIP Code.

The GIS ZIP Code layers obtained from the vendor, in combination with U.S. Census block data and the effective roughness model gridded data (See Standard G-1, Disclosure 2), are used to compute the population-based centroids and population-weighted effective roughness for each ZIP Code. Once the centroids are calculated, the distance to coast for each centroid, in each of eight possible upstream wind directions, is then computed.

Each of the three lists of WBDR ZIP Codes is created by overlaying the map defining the WBDR over the ZIP Code boundaries map from the vendor and selecting the intersection. The list of coastal ZIP Codes is similarly derived from the boundaries map by selecting the ZIP Codes that have some portion of their boundary along the coastline.

These new data sets are formatted to be read directly by model code. Items (1) through (4) are formatted as files and transferred to dedicated directories for each version on the model's server platform where software links are used to ensure that the appropriate model components always read the correct version of the files. A copy of item (1) is also formatted as a database table as it is item (5), and both are used during the pre-processing applied to data to be used as input to the model. These tables are part of a dedicated database that is used as a template for the creation of new processing databases in order to ensure that the data pre-processing code uses the correct version of the ZIP Code datasets.

G-4 Independence of Hurricane Model Components

The meteorological, vulnerability, and actuarial components of the hurricane model shall each be theoretically sound without compensation for potential bias from the other two components.

The meteorology, vulnerability, and actuarial components of the model are theoretically sound and were developed and validated independently before being integrated. The model components were tested individually.

G-5 Editorial Compliance

The submission and any revisions provided to the Commission throughout the review process shall be reviewed and edited by a person or persons with experience in reviewing technical documents who shall certify on Form G-7, Editorial Review Expert Certification, that the submission has been personally reviewed and is editorially correct.

The current submission document has been reviewed and edited by persons who are qualified to perform such tasks. Future revisions and related documentation will likewise be reviewed and edited by the qualified individual listed in Form G-7.

Disclosures

1. Describe the process used for document control of the submission. Describe the process used to ensure that the paper and electronic versions of specific files are identical in content.

All submission document revisions are passed to the Editor prior to inclusion in the document. The editor is responsible for the electronic version of the document and the technical software issues. Several Microsoft Word tools are utilized to automate the process of formatting and editing the document. For example, we used Source Manager for APA-style bibliographies, consistent formatting via styles for standards, forms and disclosures, cross-references to cite figures and tables, and multi-level lists to ensure consistent numbering. In addition, Microsoft Word's track changes tool is used to keep track of modifications to the document since the initial submission. An export filter to PDF format is used to export the document directly to PDF format, which subsequently is printed directly to paper via a printer. The PDF and printed document should be identical barring unforeseen bugs in the PDF export plug-in or PDF printing software.

2. Describe the process used by the signatories on Expert Certification Forms G-1 through G-6 to ensure that the information contained under each set of hurricane standards is accurate and complete.

Each signatory was responsible for doing a final review of the standards related to their expertise prior to submission to verify the accuracy and completeness of the information in the submission document. A technical editor performs a thorough edit of the document. All signatories were required to proof-read a PDF version of the document to ensure accuracy and completeness. On-site meetings were held to perform a thorough review of the final version of the document.

3. Provide a completed Form G-7, Editorial Review Expert Certification. Provide a link to the location of the form here.

See Form G-7.

METEOROLOGICAL STANDARDS

M-1 Base Hurricane Storm Set

A. The Base Hurricane Storm Set is the National Hurricane Center HURDAT2 as of July 1, 2019 (or later), incorporating the period 1900-2018. Annual frequencies used in both hurricane model calibration and hurricane model validation shall be based upon the Base Hurricane Storm Set. Complete additional season increments based on updates to HURDAT2 approved by the Tropical Prediction Center/National Hurricane Center are acceptable modifications to these data. Peer reviewed atmospheric science literature may be used to justify modifications to the Base Hurricane Storm Set.

Validation of the FPHLM is based on the 1900–2019 period of historical record as provided in the April 28, 2020 version of HURDAT released by the National Hurricane Center.

B. Any trends, weighting, or partitioning shall be justified and consistent with current scientific and technical literature. Calibration and validation shall encompass the complete Base Hurricane Storm Set as well as any partitions.

Validation and comparison of the FPHLM encompasses the complete Base Hurricane Storm Set provided in HURDAT. We conduct no trending, weighting, or partitioning of the Base Hurricane Set.

Disclosures

1. Specify the Base Hurricane Storm Set release date and the time period used to develop and implement landfall and by-passing hurricane frequencies into the hurricane model.

The National Hurricane Center HURDAT file from April 28, 2020 for the period 1900–2019 is used to establish the official hurricane base set used by our model. All HURDAT storm tracks that have made landfall in Florida or bypassed Florida but passed close enough to produce damaging winds are documented in our archives.

2. If the modeling organization has made any modifications to the Base Hurricane Storm Set related to hurricane landfall frequency and characteristics, provide justification for such modifications.

For stochastic hurricane loss modeling, the HURDAT database indicated in Disclosure 1 is used, unmodified, to develop the probability distribution functions for track and intensity changes and to determine storm frequency.

To model historical losses, we developed a Historical Base Set. This base set is based on the latest HURDAT but includes additional data, such as central pressure and *Rmax*, that may not be available in HURDAT but is needed by the wind model.

3. If the hurricane model incorporates short-term, long-term, or other systematic modification of the historical data leading to differences between modeled climatology and that in the Base Hurricane Storm Set, describe how this is incorporated.

The FPHLM incorporates no short-term, long-term, or other systematic modifications of the climate record. Storm frequencies are based on historical occurrences derived from HURDAT and thus implicitly contain any long- or short-term variations that are contained in the historical record. No attempt is made to explicitly model long- or short-term variations.

4. Provide a completed Form M-1, Annual Occurrence Rates. Provide a link to the location of the form here.

See Form M-1.

M-2 Hurricane Parameters and Characteristics

Methods for depicting all modeled hurricane parameters and characteristics, including but not limited to windspeed, radial distributions of wind and pressure, minimum central pressure, radius of maximum winds, landfall frequency, tracks, spatial and time variant windfields, and conversion factors, shall be based on information documented in current scientific and technical literature.

All methods used to depict storm characteristics are based on methods described in the peer-reviewed scientific literature. Our scientists developed datasets using data from published reports, the HURDAT database, archives, observations, and analyses from NOAA's Hurricane Research Division, The Florida State University, Florida International University, and the Florida Coastal Monitoring Program.

Disclosures

1. Identify the hurricane parameters (e.g., central pressure, radius of maximum winds) that are used in the hurricane model.

Hurricane parameters used in the model include storm track (translation speed and direction of the storm), radius of maximum wind (*Rmax*), Holland surface pressure profile parameter (*B*), the minimum central sea level pressure (*Pmin*), the damage threshold distance, and the pressure decay as a function of time after landfall.

The storm initial position and motion are modeled using the HURDAT database. For pressure decay we use the Vickery (2005) decay model. Vickery developed the model on the basis of pressure observations in HURDAT and NWS-38, together with *Rmax* and storm motion data as described in the publication. The radius of maximum winds at landfall is modeled by fitting a gamma distribution to a comprehensive set of historical data published in NWS-38 by Ho et al. (1987) and supplemented by the extended best track data of DeMaria, NOAA HRD research flight data, and NOAA-AOML-HRD H*Wind analyses (Powell & Houston, 1996; Powell et al., 1996; Powell & Houston, 1998; Powell et al., 1998).

Additional research was used to construct a historical landfall *Rmax-Pmin* database using existing literature (Ho et al., 1987), extended best track data, HRD Hurricane field program data, and the H*Wind wind analysis archive (Demuth et al., 2006). We developed an *Rmax* model using the revised landfall *Rmax* database, which includes more than 100 measurements for hurricanes up to 2012. We have opted to model the *Rmax* at landfall rather than the entire basin for a variety of reasons. One is that the distribution of landfall *Rmax* may be different than that over open water. An analysis of the landfall *Rmax* database and the 1988–2007 extended best track data shows that there appears to be a difference in the dependence of *Rmax* on central pressure (*Pmin*) between the two datasets (Demuth et al., 2006). The landfall dataset provides a larger set of independent measurements (more than 100 storms compared to about 31 storms affecting the Florida threat area region in the best track data). Since landfall *Rmax* is most relevant for loss cost estimation and has a larger independent sample size, we have chosen to model the landfall dataset.

Research results by Willoughby and Rahn (2004) based on the NOAA-AOML-HRD annual hurricane field program and Air Force reconnaissance flight-level observations are used to create a model for the "*Holland B*" parameter. Ongoing research on the relationship between horizontal surface wind distributions (based on Stepped Frequency Microwave Radiometer observations) to flight level distributions (Powell et al., 2009) is used to correct the flight-level *Rmax* to a surface *Rmax* when developing a relationship for the *Holland B* term. We multiply the flight-level *Rmax* from the Willoughby and Rahn (2004) dataset by 0.815 to estimate the surface *Rmax* (based on SFMR, flight-level maxima pair data). This adjustment keeps the Holland pressure profile parameter consistent with a surface *Rmax* and because of the negative term in the equation produces a larger value of *B* than if a flight-level value of *Rmax* were used. This is consistent with the concept of a stronger radial pressure gradient for the mean boundary layer slab than at flight level (due to the warm core of the storm), which agrees with GPS dropsonde wind profile observations showing boundary layer winds that are stronger than those at the 10,000 ft flight level, which is the level for most of the *B* data in Willoughby and Rahn (2004). The *B* adjustment for a surface *Rmax* produces an overall stronger surface wind field than if *B* were not adjusted. In addition, surface pressures from the "best track" information on HURDAT are used to associate a particular flight-level pressure profile *B* with a surface pressure.

The NOAA-AOML-HRD H*Wind analysis archive was used to develop a relationship between *Rmax* and the extent of damaging winds to make sure that the model would only consider land locations that have potential for damaging winds. HRD wind modeling research initiated by Ooyama (1969) and extended by Shapiro (1983) has been used to develop the HRD wind field model. This model is based on the concept of a slab boundary layer model, a concept pioneered at NOAA-AOML-HRD and now in use by other modelers for risk applications (Thompson & Cardone, 1996; Vickery & Twisdale, 1995; Vickery et al., 2000b). The HURDAT historical database is used to develop the track and intensity model. Historical data used for computing the potential intensity is based on the National Centers for Environmental Prediction (NCEP) sea surface temperature archives and the NCEP reanalysis for determining the upper tropospheric outflow temperatures. Use cases describing the various model functions and their research bases are available with the model documentation.

2. Describe the dependencies among variables in the windfield component and how they are represented in the hurricane model, including the mathematical dependence of modeled windfield as a function of distance and direction from the center position.

B depends linearly on latitude and *Rmax*, and quadratically on *DelP*. The gradient wind for the slab boundary layer depends on *Pmin* (through *DelP*) and *B*; the mean slab planetary boundary layer (PBL) wind depends on the gradient wind, the drag coefficient (which depends on wind speed), the air density, the gradients of the tangential and radial components of the wind, and the Coriolis parameter (which also depends on latitude). The wind field model solves the equations of motion on a polar grid with a 0.1 *R/Rmax* radial grid resolution. The input *Rmax* is reduced by 10% to correct a small bias in *Rmax* caused by a tendency of the wind field solution to place *Rmax* radially outward by one grid point. The wind field model terms and dependencies are further described in Powell et al. (2005).

3. Identify whether hurricane parameters are modeled as random variables, functions, or fixed values for the stochastic storm set. Provide rationale for the choice of parameter representations.

Initial storm positions and motion changes derived from HURDAT are modified by the addition of small uniform random error terms. Subsequent storm motion change and intensity are obtained by sampling from empirically derived PDFs as described in Section G-1.2. The random error term for the B parameter is a normal distribution with zero mean and a standard deviation derived from observed reconnaissance aircraft pressure profile fits for B (Willoughby & Rahn, 2004). The radius of maximum winds is sampled from a gamma distribution based on landfall *Rmax* data and is described in more detail below and in Standard G-1.2.

Since *Rmax* is nonnegative and skewed, we model the distribution using a gamma distribution. Using the maximum likelihood estimators, we found the parameters for the gamma distribution to be k=4.76, θ=5.41. A discussion of the goodness of fit for *Rmax* is found in Standard S-1.

An examination of the *Rmax* database shows that intense storms, essentially Category 5 storms, have rather small radii. Thermodynamic considerations (Willoughby, 1998) also suggest that smaller radii are more likely for these storms. Thus, we model Category 5 (*DelP*>90 mb, where *DelP*=1013-*Pmin* and *Pmin* is the central pressure of the storm) storms using a gamma distribution, but with a smaller value of the θ parameter, which yields a smaller mean *Rmax* as well as smaller variance. We have found that for Category 1–4 (*DelP*<80 mb) storms there is essentially no discernable dependence of *Rmax* on central pressure. This is further verified by looking at the mean and variance of *Rmax* in each 10 mb interval. Thus, we model Category 1–4 storms with a single set of parameters. For a gamma distribution, the mean is given by $k\theta$, and variance is $k\theta^2$. For Category 5 storms, we adjust θ such that the mean is equal to the mean of the three Category 5 storms in the database: 1935 No Name, 1969 Camille, and 1992 Andrew. An intermediate zone between *DelP*=80 mb and *DelP*=90 mb is established where the mean of the distribution is linearly interpolated between the Category 1–4 value and the Category 5 value. As the θ value is reduced, the variance is likewise reduced. Since there are insufficient observations to determine what the variance should be for Category 5 storms, we rely on the assumption that variance is appropriately described by the rescaled θ, via $k\theta^2$.

A simple method is used to generate the gamma-distributed values. A uniformly distributed variable is mapped onto the range of *Rmax* values via the inverse cumulative gamma distribution function. For computational efficiency, a lookup table is used for the inverse cumulative gamma distribution function.

For Category 5 and intermediate Category 4–5 storms, we use the property that the gamma cumulative distribution function is a function of (k,x/θ). Thus, by rescaling θ, we can use the same function (lookup table), but just rescale x (*Rmax*). The rescaled *Rmax* will then still have a gamma distribution but with different mean and variance.

The storms in the stochastic model will undergo central pressure changes during the storm life cycle. When a storm is generated, an appropriate *Rmax* is sampled for the storm. To ensure the appropriate mean values of *Rmax* as pressure changes, the *Rmax* is rescaled every time step as necessary. As long as the storm has *DelP* < 80 mb, there is in effect no rescaling. In the stochastic storm generator, we limit the range of *Rmax* from 4 sm to 120 sm. The wind field solution, after including the translation speed, results in values of *Rmax* that are outside this range less than 2% of the time.

4. Describe if and how any hurricane parameters are treated differently in the historical and stochastic storm sets and provide rationale.

All historical storm sets consist of input files containing information derived from HURDAT or other observation sources as described in Standard M-1. All stochastic input storm tracks are modeled.

5. State whether the hurricane model simulates surface winds directly or requires conversion between some other reference level or layer and the surface. Describe the source(s) of conversion factors and the rationale for their use. Describe the process for converting the modeled vortex winds to surface winds including the treatment of the inherent uncertainties in the conversion factor with respect to location of the site compared to the radius of maximum winds over time. Justify the variation in the surface winds conversion factor as a function of hurricane intensity and distance from the hurricane center.

The mean boundary layer winds computed by the model are adjusted to the surface using results from Powell et al. (2003), which estimated a mean surface wind factor of 77.5% on the basis of over 300 GPS sonde wind profile observations in hurricanes. The surface wind factor is based on the ratio of the surface wind speed at 10 m to the mean wind speed for the 0–500 m layer (mean boundary layer wind speed or MBL) published in Powell et al. (2003). This ratio is far more relevant to a slab boundary layer model than using data based on higher, reconnaissance aircraft flight levels. The depth of the slab boundary layer model is assigned a value of 450 m, which is the level of the maximum mean wind speed from GPS sonde wind profiles published in Powell et al. (2003). The uncertainty of the surface wind factor is ~8%, based on the standard deviation of the measurements, but no attempt is made to model this uncertainty. No radial distance from center or intensity dependent variation of reduction factor is used at this time because of a lack of dependency on these quantities based on examination of GPS dropsonde data (Figure 25).

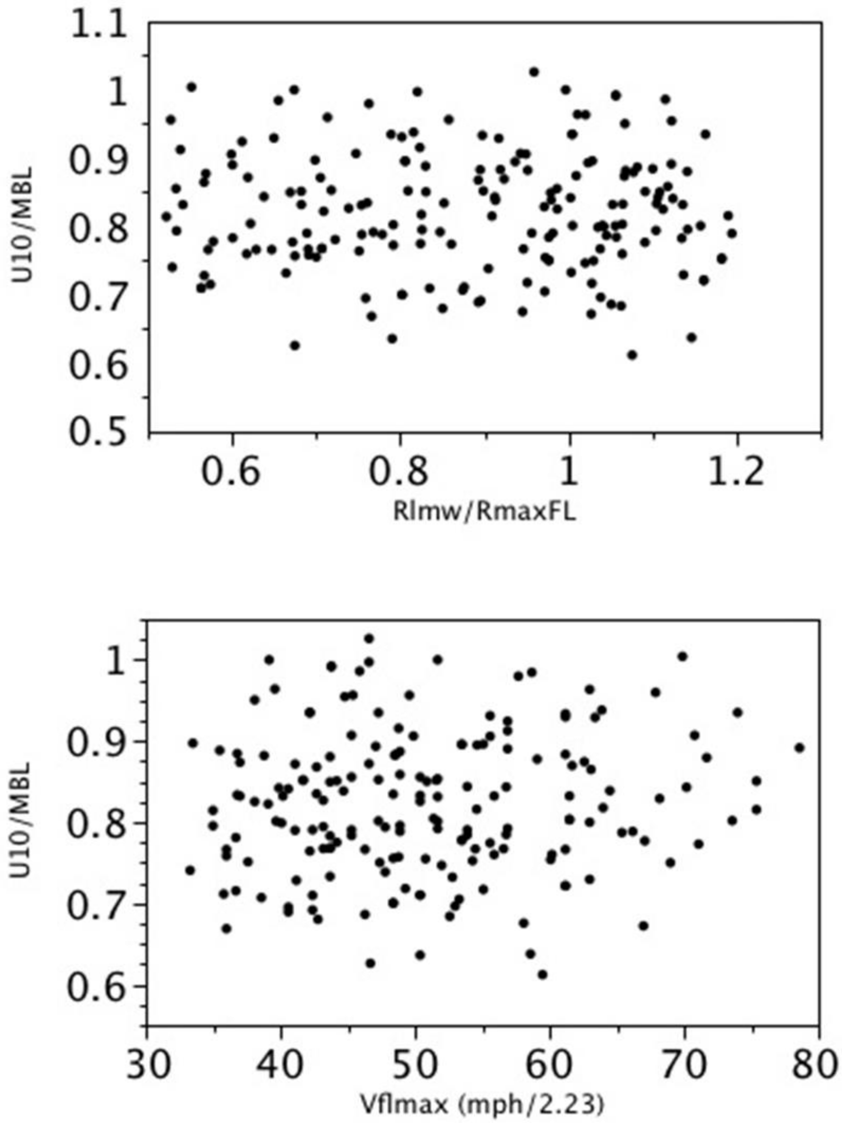


Figure 25. Analysis of 742 GPS dropsonde profiles launched from 2-4 km with flight-level winds at launch greater than hurricane force and with measured surface winds. Upper figure: Dependence of the ratio of 10 m wind speed (U10) to the mean boundary layer wind speed (MBL) on the scaled radius (ratio of radius of last measured wind (Rlmw) to the radius of maximum wind at flight level (RmaxFL). Lower figure: Surface wind factor (U10/MBL) dependence on maximum flight level wind speed (Vflmax, in units of miles per hour / 2.23).

6. Describe how the windspeeds generated in the windfield model are converted from sustained to gust and identify the averaging time.

Wind speeds from the HRD slab boundary layer wind field model are assumed to represent ten-minute averages. A sustained wind is computed by applying a gust factor to account for the highest one-minute wind speed over the ten-minute period. A peak three-second gust is also computed. Gust factors depend on wind speed and the upstream fetch roughness, which in turn depends on wind direction at a particular location. Gust factor calculations were developed using research in the Engineering Sciences Data Unit (ESDU) series papers as summarized and applied to tropical cyclones by Vickery and Skerlj (2005).

7. Describe the historical data used as the basis for the hurricane model's hurricane tracks. Discuss the appropriateness of the hurricane model stochastic hurricane tracks with reference to the historical hurricane data.

The hurricane tracks are modeled as a Markov process. Initial storm conditions are derived from HURDAT. Small uniform random perturbations are added to the historical initial conditions, including initial storm location, change in motion, and intensity.

Storm motion is determined by sampling empirical distributions, based on HURDAT, of change in speed and change in direction, as well as change in relative intensity. These functions are also spatially dependent, binned in variable box sizes (typically 2.5 degrees), and enlarged as necessary to ensure sufficient density of storms for the distribution.

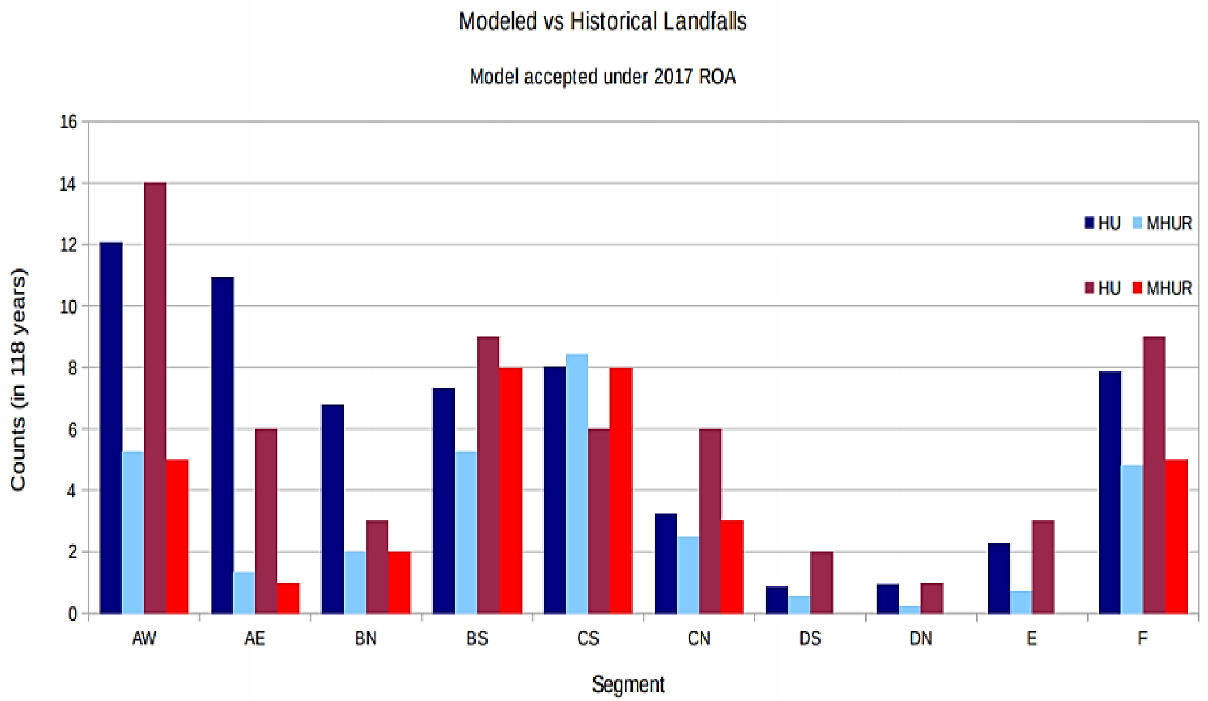
The model has been validated by examining key hurricane statistics relative to HURDAT at roughly 30 sm milepost locations along the Gulf and Atlantic coasts. The parameters examined include average central pressure deficit, average heading angle and speed, and total occurrence by Saffir-Simpson category.

8. If the historical data are partitioned or modified, describe how the hurricane parameters are affected.

The FPHLM does not partition or modify the historical data.

9. Describe how the coastline is segmented (or partitioned) in determining the parameters for hurricane annual landfall occurrence rates used in the hurricane model. Provide plots of the annual landfall occurrence rates obtained directly from the Base Hurricane StormSet for two intensity bands (Saffir-Simpson categories 1-2 and 3-5) as functions of coastal segments along Florida and adjacent states. Plot on the same axes the modeled annual landfall occurrence rates over the Base Hurricane Storm Set period. If the modeling organization has a previously-accepted hurricane model, also plot on these axes the previously-accepted hurricane model annual landfall occurrence rates.

The model does not use coastline segmentation to determine parameters for hurricane landfall occurrence rates. The figure below shows modeled and historical landfall frequencies by coastal segments. The segments are based on the regions defined in Form M-1 (see Figure 3 of the 2019 ROA). Each Florida region (A-D) was divided into two segments, either in the E-W or N-S direction. Region A was divided into AW and AE along the 85W longitiude. Regions B, C and D were divided into BS, BN, CS, CN, DS and DN along 26.5N, 26.7N and 29.5N latitudes, respectively. Region E is the Georgia coast, and Region F is the Alabama/Mississippi coast.



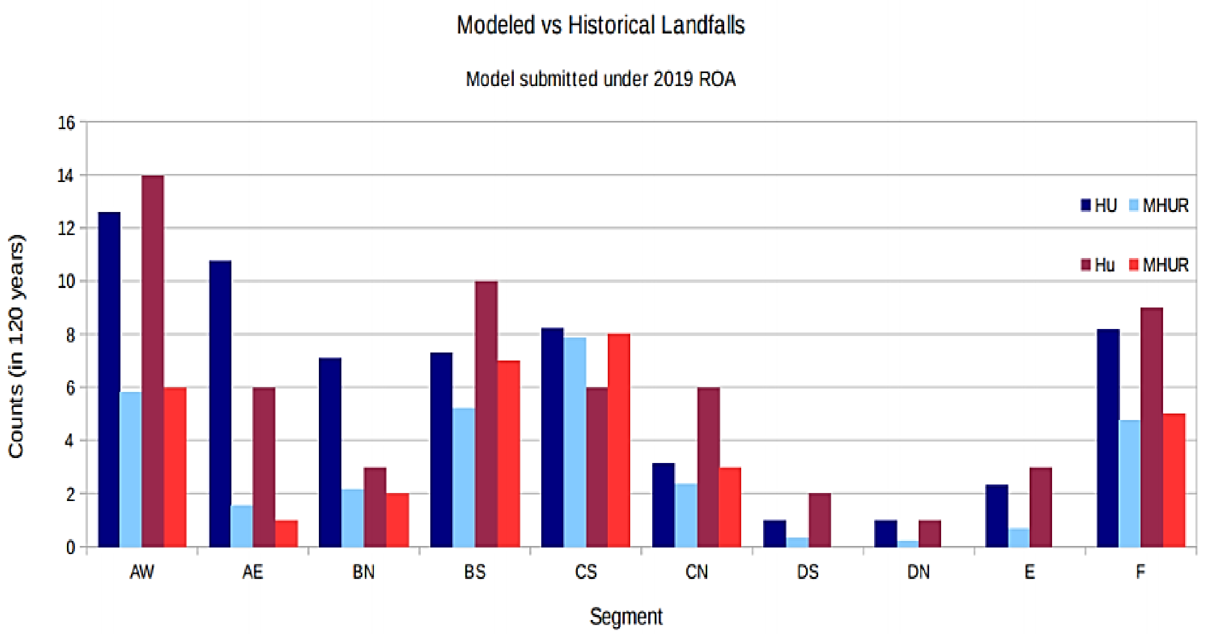


Figure 26. Modeled and historical landfalls by coastal segment for the model accepted under the 2017 Standards (top) and the model submitted under the 2019 Standards (bottom). Modeled frequencies are blue, and corresponding historical frequencies are red. HU denotes category 1-2 hurricanes and MHUR denotes category 3-5 hurricanes.

10. Describe any evolution of the functional representation of hurricane parameters during an individual storm life cycle.

Upon landfall, the evolution of the central pressure changes from sampling a PDF to a decay model described in Vickery (2005). When the storm exits back over water, the pressure is again modeled via the PDF. After landfall, the slab boundary layer surface drag coefficient changes from a functional marine form to a constant based on a mean aerodynamic roughness length of 0.2 m. The slab boundary layer height increases from 450 m to 1 km after the center makes landfall and decreases back to 450 m if the center exits land to go back to sea.

M-3 Hurricane Probability Distributions

A. Modeled probability distributions of hurricane parameters and characteristics shall be consistent with historical hurricanes in the Atlantic basin.

Hurricane motion (track) is modeled based on historical geographic probability distributions of hurricane translation velocity and velocity change, initial intensity, intensity change, and potential intensity. Modeled probability distributions for hurricane intensity, forward speed, *Rmax*, and storm heading are consistent with historical hurricanes in the Atlantic basin.

B. Modeled hurricane landfall frequency distributions shall reflect the Base Hurricane Storm Set used for category 1 to 5 hurricanes and shall be consistent with those observed for each coastal segment of Florida and neighboring states (Alabama, Georgia, and Mississippi).

As shown in Form M-1 and the accompanying plots, our model reflects reasonably the 1900–2019 Base Hurricane Set for hurricanes of Saffir-Simpson Categories 1–5 in each coastal region of Florida, as well as in the neighboring states. In addition, a finer scale coastal milepost study of model parameters (occurrence rate, storm translation speed, storm heading, and *Pmin*) was conducted during the development of the model.

C. Hurricane models shall use maximum one-minute sustained 10-meter windspeed when defining hurricane landfall intensity. This applies both to the Base Hurricane Storm Set used to develop landfall frequency distributions as a function of coastal location and to the modeled winds in each hurricane which causes damage. The associated maximum one- minute sustained 10-meter windspeed shall be within the range of windspeeds (in statute miles per hour) categorized by the Saffir- Simpson Hurricane Wind Scale.

Saffir-Simpson Hurricane Wind Scale:

Category	Winds (mph)	Damage
1	74 – 95	Minimal
2	96 – 110	Moderate
3	111 – 129	Extensive
4	130 – 156	Extreme
5	157 or higher	Catastrophic

The HRD wind field model simulates landfall intensity according to the maximum one-minute sustained wind for the 10 m level for both stochastic simulations and the Base Hurricane Set. The

Saffir-Simpson damage potential scale is used to further categorize the intensity at landfall, and the range of simulated wind speeds (in miles per hour) is within the range defined in the scale.

Disclosures

1. Provide a complete list of the assumptions used in creating the hurricane characteristics databases.

The *Holland B* database is based on flight-level pressure profiles corresponding to constant pressure surfaces at 700 mb and below. Because of a lack of surface pressure field data, an assumption is made that the *Holland B* at the surface is equivalent to a *B* determined from information collected at flight level. The surface pressure profile uses *Pmin*, *DelP*, and *Rmax* at the surface. It would be ideal to have a *B* dataset also corresponding to the surface, but such data are not available. The best available data on *B* are flight-level data from Willoughby and Rahn (2004). Willoughby and Rahn (2004) reveal that during major hurricanes most flights flew at 3 km (700 mb). Few lower-level data are available for mature hurricanes, so their plot (Figure 3) of *B* vs. flight level does not provide data about average vertical structure. In lieu of lower-level data, we model *B* using flight data supplied by Willoughby, but with *Rmax* adjusted to a surface *Rmax*, and with surface *DelP* added from NHC best track data for each flight. Since we are modeling hurricane winds during landfall, our *Rmax* model applies only to landfall and is not designed to model the life cycle of *Rmax* as a function of intensity.

2. Provide a brief rationale for the probability distributions used for all hurricane parameters and characteristics.

Form S-3 provides a list of probability distributions used to model hurricane parameters. Further discussion and rationale for these functions are provided in Standard M-2, Disclosure 1 and Standard S-1, Disclosure 1. Some of the details pertaining to data sources used are described below.

Monthly geographic distributions of climatological sea surface temperatures (Reynolds et al., 2002) and upper tropospheric outflow temperatures (Kanamitsu et al., 2002) are used to determine physically realistic potential intensities that help to bound the modeled intensity. Terrain elevation and bathymetry data were obtained from the United States Geological Survey. The radius of maximum wind at landfall is modeled from a comprehensive set of historical data published in NWS-38 by Ho et al. (1987) but supplemented by the extended best track data of DeMaria (Pennington et al., 2000), the HURDAT Reanalysis Project (Landsea et al, 2004), NOAA HRD research flight data, and NOAA-HRD H*Wind analyses (Powell et al., 1996, 1998). The development of the *Rmax* frequency distribution fit and its comparison to historical hurricane data are discussed in M-2.1, M-2.3 and in Standard S-1. Comparisons of the modeled radius of maximum wind to the observed data are shown in Form M-3.

M-4 Hurricane Windfield Structure

A. Windfields generated by the hurricane model shall be consistent with observed historical storms affecting Florida.

As described in Statistical Standards S-1, Disclosure 2, comparisons of FPHLM to gridded H*Wind fields indicate that the FPHLM wind fields are consistent with observed historical wind fields from Florida landfalling hurricanes.

B. The land use and land cover (LULC) database shall be consistent with National Land Cover Database (NLCD) 2011 or later. Use of alternate datasets shall be justified.

We use the MRLC NLCD 2011 land use dataset as well as the Statewide 2004-2011 Land Use/Land Cover dataset developed and maintained by the Florida Water Management Districts (WMD) and compiled and distributed by the Florida Department of Environmental Protection. The NLCD dataset became available in Spring 2014 and provides detailed (30 m) land use characteristics circa 2011. The datasets of the individual water management districts were combined in the statewide WMD dataset to form a unified dataset. The WMD data are based on 2004-2011 imagery.

C. The translation of land use and land cover or other source information into a surface roughness distribution shall be consistent with current state-of-the-science and shall be implemented with appropriate geographic-information-system data.

Land friction is modeled according to the currently accepted, state-of-the-science principles of surface layer similarity theory as described in the disciplines of micrometeorology, atmospheric turbulence, and wind engineering. The geographic distribution of surface roughness is determined by careful studies of aerial photography and satellite remote sensing measurements used to create land use-land cover classification systems. We have developed a roughness dataset at 90 meter resolution covering the state of Florida to enable modeling losses at the "street level." For modeling losses at the ZIP Code level, we use population-weighted roughness.

All street level locations (at 90 m resolution) and population-weighted ZIP Code centroids are assigned roughness values as a function of upstream fetch for each wind direction octant. After landfall, the surface drag coefficient used in the hurricane PBL slab model changes from a marine value to a fixed value associated with a roughness of 0.2 m.

D. With respect to multi-story buildings, the hurricane model shall account for the effects of the vertical variation of winds.

The modeled wind fields take into account vertical variation through the terrain conversion methodology based on Vickery et al. (2009). The coastal transition function also takes into account variation of wind with height.

Disclosures

1. Provide a rotational windspeed (y-axis) versus radius (x-axis) plot of the average or default symmetric wind profile used in the hurricane model and justify the choice of this wind profile. If the windfield represents a modification from the previously-accepted hurricane model, plot the old and new profiles on the same figure using consistent inputs. Describe variations between the old and new profiles with references to historical storms.

See Figure 27. The *Holland B* profile has been compared extensively to historical data (Holland, 1980; Willoughby & Rahn, 2004) and found to be a reasonable fit.

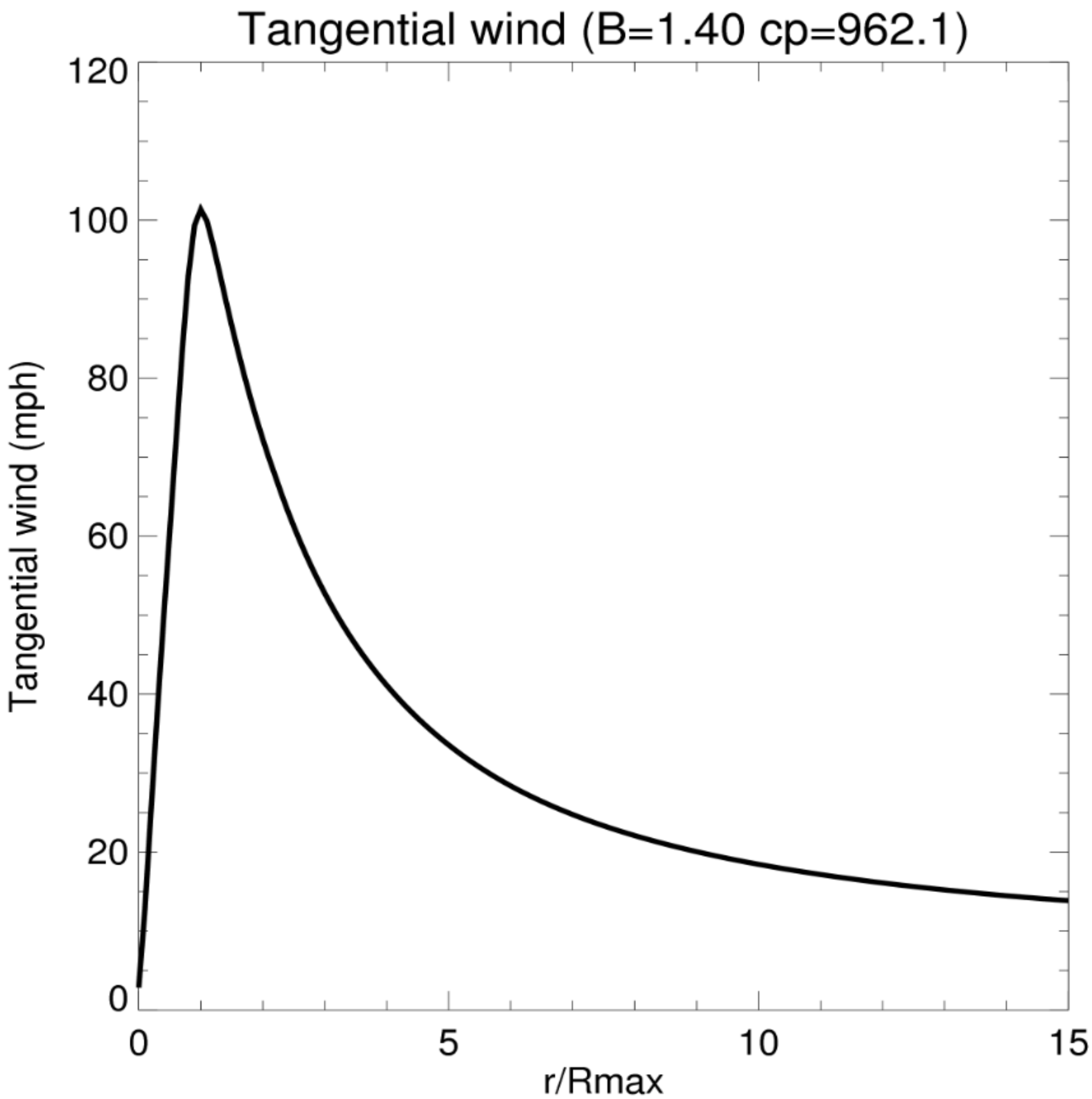


Figure 27. Axisymmetric rotational wind speed (mph) vs. scaled radius for B = 1.40 , DelP = 50.9 mb.

The wind field model has not been modified since the previous submission.

2. Describe how the vertical variation of winds is accounted for in the hurricane model where applicable. Document and justify any difference in the methodology for treating historical and stochastic storm sets.

Vertical variation of wind is accounted for in the terrain conversion methodology described in Vickery et al. (2009). This methodology is a modification of the log wind profile and has been validated against dropsonde data. The coastal transition function, which is based on the above methodology, also incorporates variation with height so that the impact of a larger marine fetch on taller structures in coastal regions can be modeled. The treatment of vertical variation of winds is the same for both historical and stochastic storm sets.

3. Describe the relevance of the formulation of gust factor(s) used in the hurricane model.

The gust factors used in the model were developed from hurricane wind speed data and the Engineering Sciences Data Unit methods as described in Vickery and Skerlj (2005).

4. Identify all non-meteorological variables (e.g., surface roughness, topography) that affect windspeed estimation.

Upstream aerodynamic surface roughness within a fixed 45-degree sector extending upstream has an effect on the determination of wind speed for a given street location (latitude and longitude) or ZIP Code centroid and is a significant variable that affects estimation of surface wind speeds. The upstream sectors are defined according to the Tropical Cyclone Winds at Landfall Project (Powell et al., 2004), which characterized upstream wind exposure for each of eight wind direction sectors at over 200 coastal automated weather stations (Figure 28). In additional, a coastal transition function is employed to account for the smooth marine fetch near coastal regions.

Figure 28. Upstream fetch wind exposure photograph for Chatham, MA (left, looking north), and Panama City, FL (right, looking northeast). After Powell et al. (2004).

5. Provide the collection and publication dates of the land use and land cover data used in the hurricane model and justify their timeliness for Florida.

We use the 2011 Multi-Resolution Land Characteristics Consortium (MRLC) National Land Cover Database released on March 31, 2014. This is a high-resolution (30 m) land cover dataset that covers not only Florida, but the entire United States, and roughly depicts land characteristics circa 2011 [see Jin et al. (2013) for more details]. We also use the Statewide 2004-2011 Florida Water Management District Land Use/Land Cover dataset based on 2004-2011 imagery. This dataset was published by the Florida Department of Environmental Protection on March 8, 2013.

6. Describe the methodology used to convert land use and land cover information into a spatial distribution of roughness coefficients in Florida and neighboring states.

The land cover classifications provided by the MRLC Land Cover Database and the WMD land use/land cover data are first mapped to roughness values using a lookup table based on HAZUS (FEMA, 2003) that associates a representative roughness for the land use category on the basis of peer-reviewed literature. An algorithm was developed to merge the datasets based on how well each dataset classified the land surface with respect to surface roughness. An effective roughness model (Axe, 2004) is then used to incorporate upstream roughness elements to provide a more realistic roughness on a 90 m (295 ft) grid covering Florida.

7. Demonstrate the consistency of the spatial distribution of model-generated winds with observed windfields for hurricanes affecting Florida. Describe and justify the appropriateness of the databases used in the windfield validations.

As shown below in Disclosure 10 and in Statistical Standard 1, Disclosure 2, the spatial distribution of model-generated winds is consistent with observed wind fields for hurricanes affecting Florida. The observations are from the H*Wind surface analyses produced by NOAA's Hurricane Research Division. These analyses are described in detail in Standard S-1, Disclosure 2. The H*wind analyses are highly regarded in the scientific community and have been cited in over 400 peer-reviewed publications.

8. Describe how the hurricane model's windfield is consistent with the inherent differences in windfields for such diverse hurricanes as Hurricane Charley (2004), Hurricane Wilma (2005), Hurricane Irma (2017), and Hurricane Michael (2018).

The model can represent a wide variety of storms through variation of parameters for radius of maximum winds, central pressure deficit, and *Holland B*. Snapshots of model wind fields at landfall are compared to NOAA-AOML-HRD H*Wind analyses below (for further details see Disclosure 2 for Standard S-1). In these cases, rather than tuning the model to best fit the observations by varying the *Holland B* parameter, we derived the input B from the H*Wind analyses. Hurricane Charley, a small, fast moving 2004 hurricane (Figure 29), was modeled quite well; the motion asymmetry and extent of strong winds in the core of the storm were captured, but the peak wind (near 150 mph) was underestimated by the model. Wilma made landfall in Florida in 2005 as a very large hurricane (Figure 30). The FPHLM captures the location of maximum winds in the core of the storm and represents the left-right motion asymmetry, but tends to produce too broad of a wind field. Figure 31 shows the modeled wind field for Irma (2017) and Michael (2018). Both of these storms used a modeled radius of 14 sm. The modeled maximum intensity of Irma at the time shown was 134 mph compared to 129 mph from NOAA's HWRF hybrid DA system based on observations. For Michael, the maximum modeled intensity was 148 mph, in agreement with the analyzed maximum intensity of 148 mph.

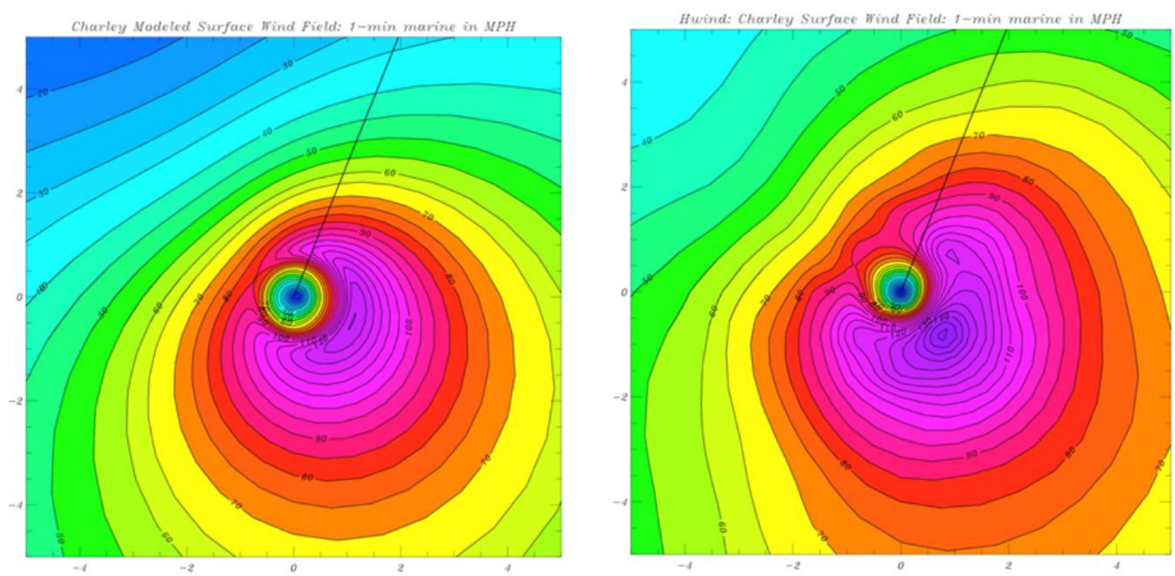


Figure 29. Comparison of modeled (left) and observed (H*Wind, right) landfall wind fields of Hurricane Charley (2004). Line segment indicates storm heading. Horizontal coordinates are in units of *R/Rmax* and winds units of miles per hour. All wind fields are for marine exposure.

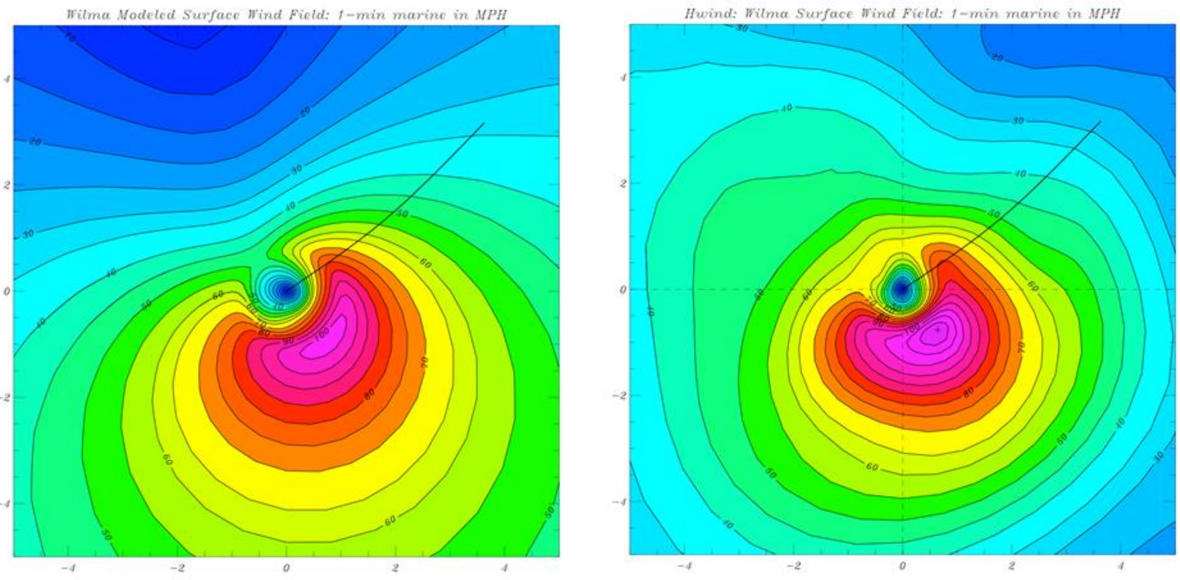


Figure 30. As in Figure 29, but for Hurricane Wilma of 2005.

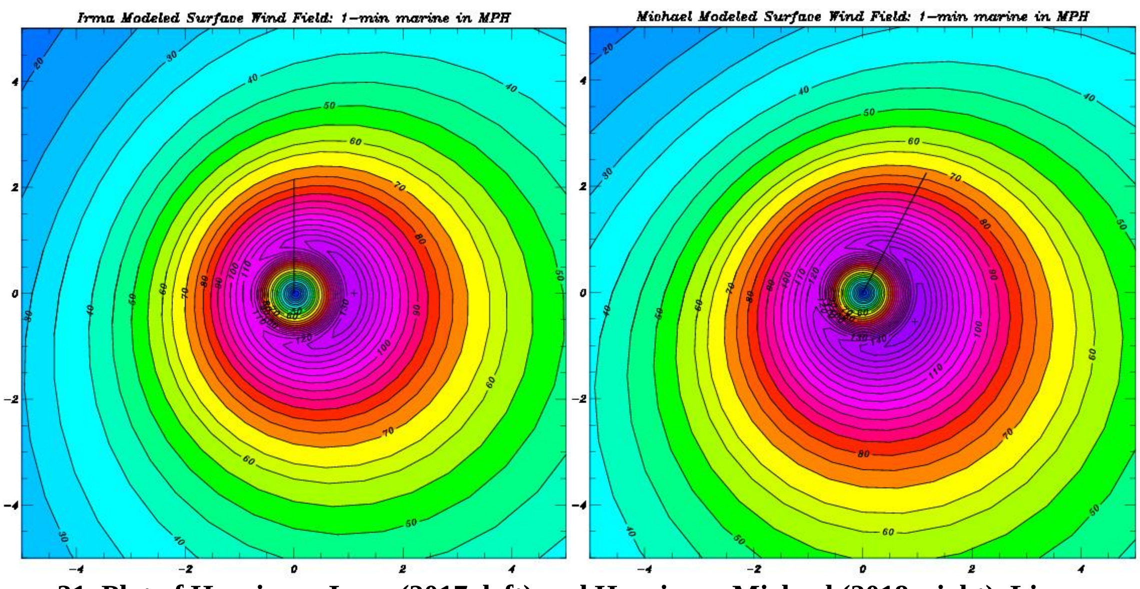


Figure 31. Plot of Hurricane Irma (2017, left) and Hurricane Michael (2018, right). Line segment indicates storm heading. Horizontal coordinates are in units of *R/Rmax* and winds units of miles per hour. All wind fields are for marine exposure.

9. Describe any variations in the treatment of the hurricane model windfield for stochastic versus historical storms and justify this variation.

All historical storm sets consist of input files containing information derived from HURDAT or other observation sources as described in Standard M-1. All stochastic input storm tracks are modeled. The wind field is modeled from the stochastic or historical input files in the same manner.

10. Provide a completed Form M-2, Maps of Maximum Winds. Explain the differences between the spatial distributions of maximum winds for open terrain and actual terrain for historical storms. Provide a link to the location of the form here.

See Form M-2.

The open terrain winds are based on the assumption that the wind is in equilibrium with open terrain roughness (0.03 m). The actual terrain winds are assumed to be in equilibrium with the local (effective) roughness near the surface, but near coastal regions the winds aloft may be more in equilibrium with marine roughness. The spatial distributions of open and actual terrain wind can be quite different because of the coastal transition and the fact that surface roughness in general has a large impact on the wind field. Spatial variations of roughness on the order of a few miles can cause large differences in the wind on that spatial scale.

M-5 Hurricane Landfall and Over-Land Weakening Methodologies

A. The hurricane over-land weakening rate methodology used by the hurricane model shall be consistent with historical records and with current state-of-the-science.

Overland weakening rates are based on a pressure decay model developed from historical data as described by a paper published in peer-reviewed atmospheric science literature (Vickery, 2005).

B. The transition of winds from over-water to over-land within the hurricane model shall be consistent with current state-of-the-science.

The transition of winds from over-water to over-land is consistent with the current state of the science through the use of a pressure decay model (Vickery, 2005), a terrain conversion model from marine to actual roughness, and a coastal transition function (Vickery et al., 2009).

Disclosures

1. Describe and justify the functional form of hurricane decay rates used by the hurricane model.

The hurricane decay rate function acts to decrease the *DelP* with time after landfall. The functional form is an exponential in time since landfall and is based on historical data (Vickery, 2005).

2. Provide a graphical representation of the modeled decay rates for Florida hurricanes over time compared to wind observations.

The degradation of the wind field of a landfalling hurricane is associated with the filling of the central sea level pressure and the associated weakening of the surface pressure gradient; also the hurricane is over land, where the flow is subject to friction while flowing across obstacles in the form of roughness elements. Maximum wind degradation is shown according to how the maximum sustained surface wind (at the location containing the maximum winds in the storm) changes with time after landfall. At landfall the marine exposure wind is assumed to be representative of the maximum winds occurring onshore. After landfall the open terrain wind is chosen to represent the maximum envelope of sustained winds over land. The NOAA-HRD H*Wind system is used to analyze the maximum winds at a sequence of times following landfalls of Hurricanes Katrina, Charley, Frances, Jeanne, and Wilma. H*Wind uses all available wind observations. The landfall wind field is used as a background field for times after landfall and compared to the available observations at a sequence of times after landfall. An empirical decay is applied to the background field based on the comparisons to the observations. These data are then objectively analyzed to determine the wind field at each time. The model maximum sustained winds are compared to the maximum winds from the H*Wind analyses for the same times and roughness exposures. In general, points after landfall are given for open terrain exposure. At times, even though the storm center is over land, the maximum wind speed may remain over water. For example, in the Hurricane Frances plot (Figure 32), the first four pairs of points represent marine exposure, the next three open terrain, and the final three marine exposure again, while all Hurricane Wilma point pairs (Figure 33) represent marine exposure. The plots indicate that the public wind field model realistically simulates decay of the maximum wind speed during the landfall process, as well as subsequent strengthening after exit.

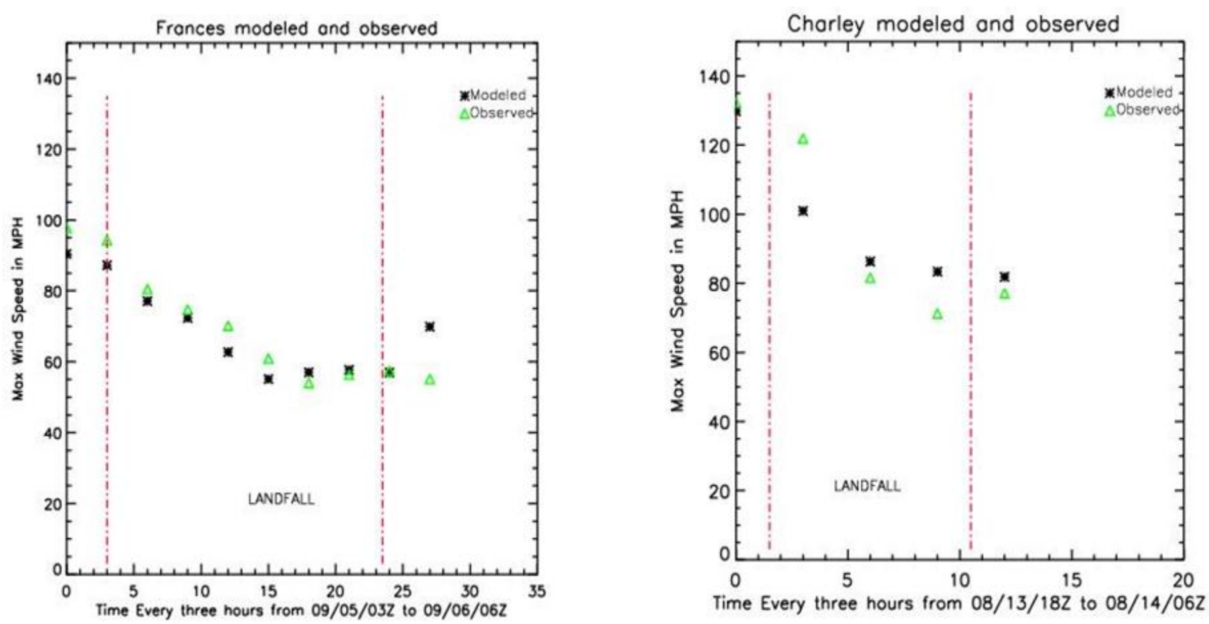


Figure 32. Observed (green) and modeled (black) maximum sustained surface winds as a function of time for 2004 Hurricanes Frances (left) and Charley (right). Landfall is represented by the vertical dash-dot red line at the left and time of exit as the red line on the right. For Hurricane Frances (left) the first four pairs of points represent marine exposure, the next three open terrain, and the final three pairs represent marine exposure. For Hurricane Charley (right) all pairs represent open terrain.

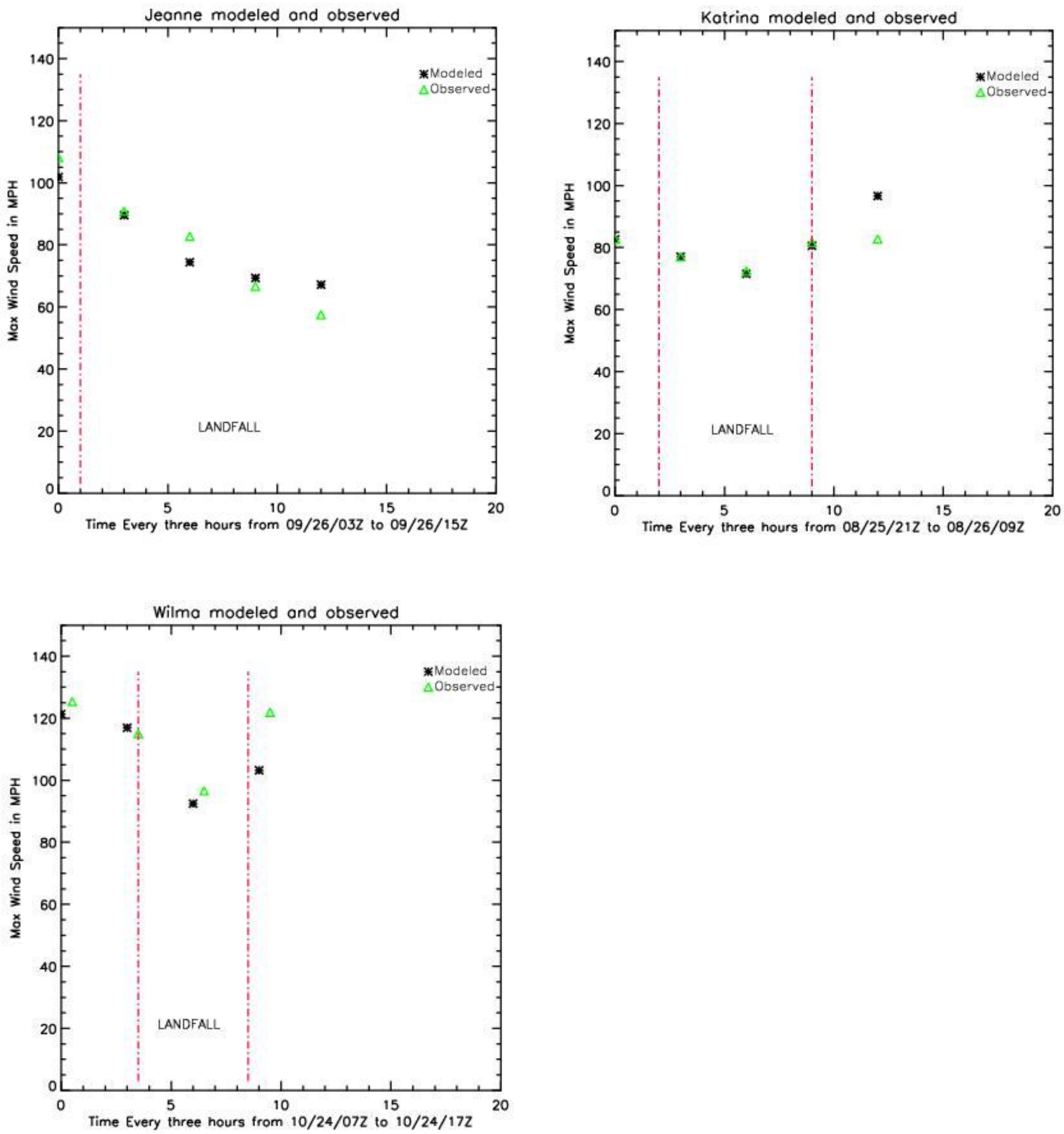


Figure 33. Observed (green) and modeled (black) maximum sustained surface winds as a function of time for Hurricanes Jeanne (2004, top left, open terrain), Katrina (2005 in South Florida, top right, open terrain), and Wilma (2005, lower left, marine exposure). Landfall is represented by the vertical dash-dot red line at the left and time of exit as the red line on the right.

3. Describe the transition from over-water to over-land boundary layer simulated in the hurricane model.

After landfall, the slab boundary layer, surface drag coefficient changes from a functional marine form to a constant based on a mean aerodynamic roughness length of 0.2 m. The slab boundary layer height increases from 450 m to 1 km after the center makes landfall and decreases back to 450 m if the center exits land to go back to sea. To determine surface winds, an effective roughness model is used along with a coastal transition function. The coastal transition function is based on the concept of a growing internal boundary layer (Arya, 1988) for the sea-to-land transition. Within the equilibrium layer, assumed to be one tenth of the internal boundary layer (IBL) height in depth, the wind is assumed to be in equilibrium with the local effective roughness. Above the IBL the wind is assumed to be in equilibrium with marine roughness. Between the equilibrium layer and the IBL we assume that the wind is in equilibrium with vertically varying, stepwise increments of roughness that decay linearly from the local roughness to marine roughness. This is similar in concept to the methodology described in ESDU, and the modeled transition is very close to the ESDU values reported in Vickery et al. (2009).

4. Describe any changes in hurricane parameters, other than intensity, resulting from the transition from over-water to over-land.

See Standard M-2, Disclosure 10. The *Holland B* parameter has a weak dependence on pressure and will undergo slight change. The radius of maximum winds has an implicit dependence on pressure through the scale and shape parameters of the gamma distribution (see M-2, Disclosure 3), and thus strong storms making landfall could undergo some expansion.

5. Describe the representation in the hurricane model of passage over non-continental U.S. land masses on hurricanes affecting Florida.

Noncontinental U. S. land masses are identified by a land-ocean mask that keeps track of whether the storm center is over the land or ocean. Storms that pass over noncontinental U.S. land masses (e.g., Cuba) undergo decay, just as storms do crossing continental land masses (e.g., mainland U. S.) using a pressure-filling model (Vickery, 2005).

6. Describe any differences in the treatment of decay rates in the hurricane model for stochastic hurricanes compared to historical hurricanes affecting Florida.

In the FPHLM model, decay is defined as the change in minimum sea level pressure (*Pmin*) with time after landfall. The input file for the wind field model consists of a hurricane track file that contains storm position, *Pmin*, *Rmax*, and *Holland B* at 1 h frequency. The wind field model is exactly the same for scenario (historical) or stochastic events. When running the model in scenario mode for historical hurricanes affecting Florida, we use a set of historical hurricane tracks as input to the model. When the model is run in stochastic mode, the input hurricane tracks are provided by the track and intensity model. The track and intensity model uses the Vickery (2005) pressure decay after landfall. When a hurricane exits land, the *Pmin* over water is determined on the basis of the Markov process as described in Disclosure G-1.2.

For historical hurricane tracks the landfall pressure is determined from HURDAT or from the Ho et al. (1987) report. If post-landfall pressure data are available in HURDAT, we interpolate pressure values over land. If post-landfall pressure data are not available, we apply the Vickery (2005) pressure decay model to the landfall pressure. After the storm exits land, the pressure is based on HURDAT data. Therefore, decay rates for historical hurricanes are based on HURDAT data if available, or the Vickery decay rate model applied to the HURDAT or Ho et al. (1987) landfall *Pmin*, and decay rates for stochastic hurricanes are based on Vickery (2005).

M-6 Logical Relationships of Hurricane Characteristics

A. The magnitude of asymmetry shall increase as the translation speed increases, all other factors held constant.

With all other factors held constant, the wind field asymmetry increases with translation speed. The storm translation speed causes a major right-left (looking in the direction the storm is moving) asymmetry in the wind field, which in turn causes an asymmetry in surface friction since the surface stress is wind-speed dependent. The magnitude of the asymmetry increases as the translation speed increases; there is no asymmetry for a stationary storm except for possible land friction effects if a storm becomes stationary while a large percentage of its circulation is over both land and water.

B. The mean windspeed shall decrease with increasing surface roughness (friction), all other factors held constant.

With all other factors held constant, the mean wind speed decreases with increasing surface roughness. However, the gust factor, which is used to estimate the peak one-minute wind and the peak three-second gust over the time period corresponding to the model mean wind increases as a function of turbulence intensity, which increases with surface roughness (Paulsen et al., 2003; Masters, 2004; Powell et al., 2004). For roughness values representative of ZIP Codes in Florida, with residential roughness values on the order of 0.2–0.3 m, the roughness effect on decreasing the mean wind speed overwhelms the enhanced turbulence intensity effect that increases the gust factor.

Disclosures

1. Describe how the asymmetric structure of hurricanes is represented in the hurricane model.

The asymmetry of the wind field is determined by the storm translation motion (right-left asymmetry) and the associated asymmetric surface friction. A set of form factors for the wind field also contributes to the asymmetry, and the proximity of the storm to land introduces an additional asymmetry because of the effect of land roughness elements on the flow. Azimuthal variation is introduced through the use of two form factors [see Appendix of Powell et al. (2005) for more detail]. The form factors multiply the radial and tangential profiles and provide a "factorized" ansatz for both the radial and tangential storm–relative wind components. Each form factor contains three constant coefficients that are variationally determined in such a way that the ansatz constructed satisfies (as far as its numerical degrees of freedom permit) the scaled momentum equations for the storm-relative polar wind components.

2. Discuss the impact of surface roughness on mean windspeeds.

As discussed in Standard G-1.2, the surface roughness is estimated using an effective roughness model that takes into account the upstream surface elements (fetch). The effect of this roughness on the mean wind is based on a modified log wind profile (Vickery et al., 2009) as indicated in Standard G-1.2. As a result, the mean windspeed decreases monotonically as the surface roughness increases. For example, a wind speed at 10 meter reference height of 100 mph over open ocean (z_0=0.001) would be reduced to about 50 mph in an area of high roughness (z_0=1), typical of forested areas.

3. Provide a completed Form M-3, Radius of Maximum Winds and Radii of Standard Wind Thresholds. Provide a link to the location of the form here.

See Form M-3.

4. Discuss the radii values for each wind threshold in Form M-3, Radius of Maximum Winds and Radii of Standard Wind Thresholds, with reference to available hurricane observations such as those in HURDAT2. Justify the appropriateness of the databases used in the radii validations.

We have validated the modeled wind field against H*Wind observations as described and justified in Standard S-1, Disclosure 2. In addition, we have compared the modeled radii with those in the HURDAT2 database, released February 17, 2016. We discuss this comparison in more detail below.

The HURDAT2 database has limited observations for some storms at three standard radii: 64 kt (73 mph), 50 kt (58 mph) and 34 kt (40 mph). There are no observations of 110 mph winds in HURDAT2. For the FPHLM wind model, the winds are often not computed or stored for winds below the damage threshold (50 mph 3-sec gust). Thus our comparison was limited to 64 kt ("R64" - 73 mph) and 50 kt ("R50" - 58 mph) radii. As described in Form M-3, the reported radii in Form M-3 for the model are limited to landfall values in Florida and neighboring states, and are within +/- 0.5 mb of the pressure threshold. In HURDAT2, there are too few storms that meet these criteria, so we relaxed the criteria to include all storms in the database, and within +/- 5 mb of the pressure threshold. For many storms there are multiple observations, and therefore the whole set of observations cannot be considered independent measurements. For pressures below 930 mb, there were only 6 storms that had reported radii, and thus too few to determine appropriate quantile values. In Form M-3 Supplemental (Table 34), we show the reported HURDAT2 outer radii thresholds for R64 (73 mph) and R50 (58 mph) in comparison with the modeled values which were obtained as described in Form M-3.

The comparison between the HURDAT2 and FPHLM wind model radii quantiles shows reasonable agreement, especially given the limitations of the comparison due to sparse data and relaxed criteria for the observations. In addition, NHC considers outer radii quality (as reported in HURDAT2) to be poor because of data sparseness, and therefore does not validate wind radii forecasts. Observed radii quantiles are sensitive to small sample size as well.

Form M-1: Annual Occurrence Rates

See Appendix K.

Form M-2: Maps of Maximum Winds

A. Provide color-coded contour plots on maps with ZIP Code boundaries of the maximum winds for the modeled version of the Base Hurricane Storm Set for land use set for open terrain and for land use set for actual terrain. Plot the position and values of the maximum windspeeds on each contour map.

B. Provide color-coded contour plots on maps with ZIP Code boundaries of the maximum winds for a 100-year and a 250-year return period from the stochastic storm set for land use set for open terrain and for land use set for actual terrain. Plot the position and values of the maximum windspeeds on each contour map.

Actual terrain is the roughness distribution used in the standard version of the hurricane model as defined by the modeling organization. For the open terrain maps, the modeling organization shall apply a uniform roughness length of 0.03 meters at all land points, but keep the open-water points the same as the standard version of the hurricane model.

Maximum winds in these maps are defined as the maximum one-minute sustained winds over the terrain as modeled and recorded at each location.

The same color scheme and increments shall be used for all maps.

Use the following eight isotach values and interval color coding:

(1)	***Minimum damaging***	***Blue***
(2)	***50 mph***	***Medium Blue***
(3)	***65 mph***	***Light Blue***
(4)	***80 mph***	***White***
(5)	***95 mph***	***Light Red***
(6)	***110 mph***	***Medium Red***
(7)	***125 mph***	***Red***
(8)	***140 mph***	***Magenta***

Contouring in addition to these isotach values may be included.

C. Include Form M-2, Maps of Maximum Winds, in a submission appendix.

See Appendix L.

Form M-3: Radius of Maximum Winds and Radii of Standard Wind Thresholds

See Appendix M.

STATISTICAL STANDARDS

S-1 Modeled Results and Goodness-of-Fit

A. The use of historical data in developing the hurricane model shall be supported by rigorous methods published in current scientific and technical literature.

The historical data for the period 1900-2019 were modeled using scientifically accepted methods that have been published in accepted scientific literature.

B. Modeled and historical results shall reflect statistical agreement using current scientific and statistical methods for the academic disciplines appropriate for the various hurricane model components or characteristics.

Modeled and historical results are in agreement as indicated by appropriate statistical and scientific tests. Some of these tests will be discussed below.

Disclosures

1. Provide a completed Form S-3, Distributions of Stochastic Hurricane Parameters. Identify the form of the probability distributions used for each function or variable, if applicable. Identify statistical techniques used for estimation and the specific goodness-of-fit tests applied along with the corresponding p-values. Describe whether the fitted distributions provide a reasonable agreement with the historical data. Provide a link to the location of the form here.

Form S-3 at the end of this section identifies the form of the probability distribution used for each variable with a brief justification for the fit. Some of the methods and distributions are described in greater details below.

Historical initial conditions are used to provide the seed for storm genesis in the model. Small uniform random error terms are added to the historical starting positions, intensities and changes in storm motion. Subsequent storm motion and intensity are determined by randomly sampling empirical probability distribution functions derived from the HURDAT historical record.

Figure 34 shows the occurrence rate of both modeled and historical land-falling hurricanes in Florida. The figure shows a high level of agreement between historical and modeled occurrences. We also conducted a chi-square test to test whether the historical and modeled landfall occurrence rates were equal. The historical number of years with 0, 1, 2, and 3 or more hurricanes per year (4 bins each with 5 or more occurrences giving 3 degrees of freedom) were compared to the corresponding modeled number of years resulting in a chi-squared test statistic of 1.564 and a *p*-

value of approximately 0.668 indicating that there was no significant difference between the two. A comparison of landfalls by region and intensity is given in Form M-1. The modeled results are consistent with the historical record, especially given the large uncertainty in the historical observations.

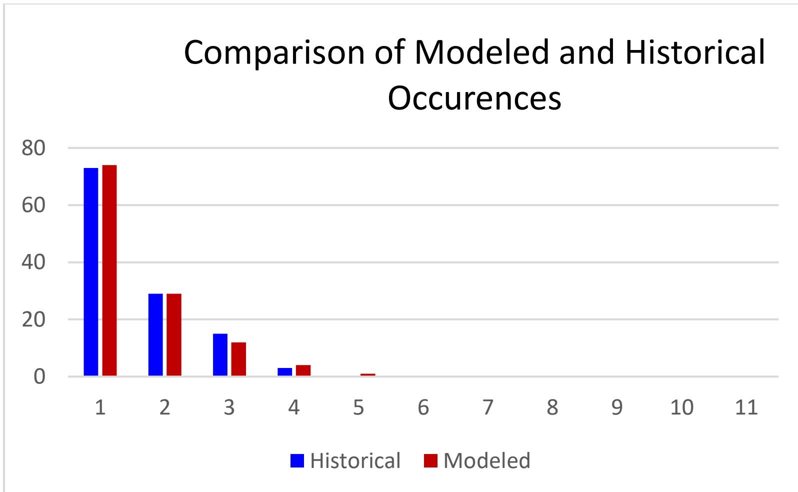


Figure 34. Comparison of modeled vs. historical occurrences.

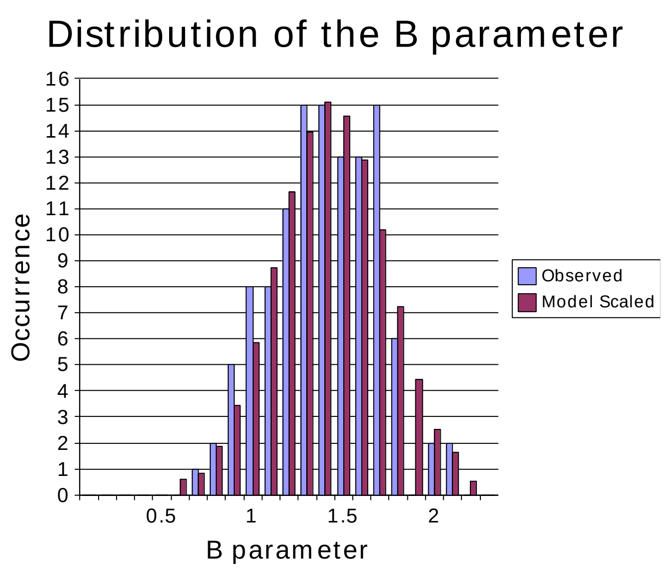


Figure 35. Comparison between the modeled and observed Willoughby and Rahn (2004) B data set.

The random error term for the *Holland B* is modeled using a Gaussian distribution with a standard deviation of 0.286. Figure 35 shows a comparison between the Willoughby and Rahn (2004) *B* data set (see Standard M-2.1) and the modeled results (scaled to equal the 116 measured occurrences in the observed data set). The modeled results with the error term have a mean of about 1.38 and are consistent with the observed results. The figure indicates a high level of agreement, and the chi-square goodness-of-fit test gives a *p*-value about 0.57, using 8 degrees of freedom (re-binning to 11 bins and two estimated parameters). A KS goodness-of-fit yields a *p*-value of 0.845 (ks=0.057).

We developed an *Rmax* model using 106 measurements from the revised landfall *Rmax* database which includes observations for storms up to 2012. We have opted to model the *Rmax* at landfall rather than the entire basin for a variety of reasons. One is that the distribution of landfall *Rmax* may be different from the *Rmax* distribution over open water. An analysis of the landfall *Rmax* database and the 1988-2007 DeMaria Extended Best Track data show that there appears to be a difference in the dependence of *Rmax* on central pressure (*Pmin*) between the two data sets. The landfall data set provides a larger set of independent measurements, which is more than 100 storms compared to about 31 storms affecting the Florida threat area region in the Best Track Data. Since landfall *Rmax* is most relevant for loss cost estimation, and has a larger independent sample size, we have chosen to model the landfall data set. Future studies will examine how the Extended Best Track Data can be used to supplement the landfall data set.

Based on the skewness of Rmax and the fact that it is nonnegative, we sought to model the distribution using a gamma distribution. Using the maximum likelihood estimation method, we found the estimated shape and scale parameters for the gamma distribution are 4.76 and 5.41 respectively. Using these estimated values, we plotted the observed and expected distribution in Figure 36. The Rmax values are binned in 5 sm intervals, with the x-axis showing the end value of the interval.

Plot of Observed *Rmax* vs. Gamma Distribution

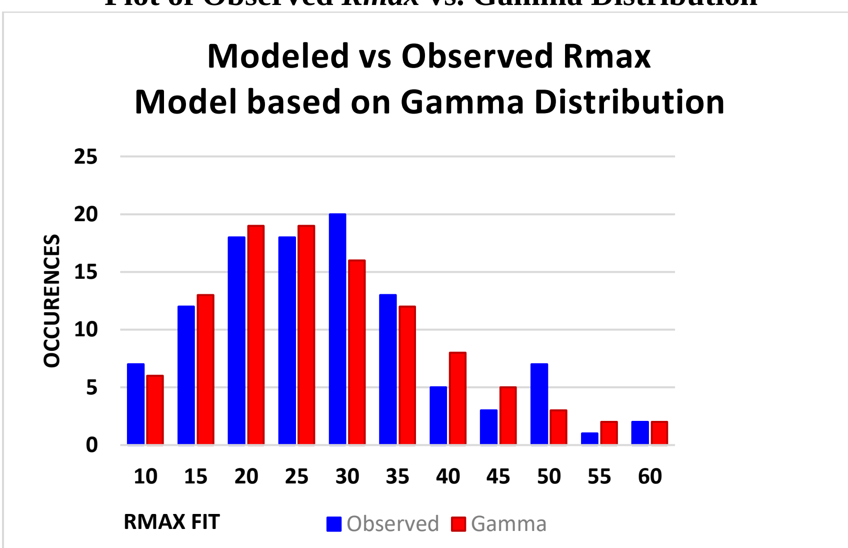


Figure 36. Observed and expected distribution using a gamma distribution.

The gamma distribution showed a reasonable fit. A chi-square goodness of fit test shows A chi-square goodness-of-fit test yields a *p*-value of 0.59 with 6 degrees of freedom (re-binning to 9 bins to ensure more than 5 expected occurrences per bin and 2 estimated parameters.) The KS goodness-of-fit yields a *p*-value of 0.8327 (ks= 0.0605).

2. Describe the nature and results of the tests performed to validate the windspeeds generated.

We compared the cumulative effect of a series of modeled and observed wind fields by comparing the peak winds observed at a particular ZIP Code during the entire storm life-cycle. We also compared our modeled wind fields to those that have been constructed from all available observations which are freely available on the NOAA AOML-HRD web site. A subsequent section describes the process for recording the peak modeled and observed wind speeds (wind swaths) from which the validation statistics are generated. Our validation is based on nine hurricanes that passed by or made landfall in Florida. These hurricanes were well-observed. We will have the ability to add new storms and quickly conduct new validation studies as our validation set grows and we make enhancements to the model. In order to run the Loss Model in "scenario" mode for doing validation studies, we had to construct detailed storm track histories for recent storms affecting Florida using the HURDAT, *Rmax* and *Holland B* databases. The validation suite included 1992 Hurricane Andrew and the following 2004 and 2005 storms: Charley, Frances, Jeanne, Ivan, Dennis, Katrina, Rita, and Wilma. The validations make use of the Hurricane Research Division's Surface Wind Analysis System (H*Wind).

H*Wind

The HRD approach to hurricane wind analysis employed in H*Wind evolved from a series of peer-reviewed, scientific publications analyzing landfalls of major hurricanes including Frederic of 1979, Alicia of 1983, Hugo of 1989, and Andrew of 1992 (Powell et al., 1991; Powell et al., 1996; Powell et al., 1998). In Powell et al. (1991) which described Hurricane Hugo's landfall, a concept was developed for conducting a real-time analysis of hurricane wind fields. The system was first used in real-time during Hurricane Emily in 1993 (Burpee et al., 1994). Since 1994, HRD wind analyses have been conducted on a research basis to create real time hurricane wind field guidance for forecasters at the National Hurricane Center. During hurricane landfall episodes from 1995-2005, HRD scientists have conducted research side by side with hurricane specialists at NHC analyzing wind observations on a regular 3 or 6 hour schedule consistent with NHC's warning and forecast cycle.

An HRD wind analysis requires the input of all available surface weather observations (e.g., ships, buoys, coastal platforms, surface aviation reports, reconnaissance aircraft data adjusted to the surface, etc.). Observational data are downloaded on a regular schedule and then processed to fit the analysis framework. This includes the data sent by NOAA P3 and G4 research aircraft during the HRD hurricane field program, including the Step Frequency Microwave Radiometer measurements of surface winds and U.S. Air Force Reserves (AFRES) C-130 reconnaissance aircraft, remotely sensed winds from the polar orbiting SSM/I and ERS, the QuikScat platform and TRMM microwave imager satellites, and GOES cloud drift winds derived from tracking low level near-infrared cloud imagery from geostationary satellites. These data are composited relative to the storm over a 4-6 hour period. All data are quality controlled and processed to conform to a common framework for height (10 m or 33 feet), exposure (marine or open terrain over land), and averaging period (maximum sustained 1minute wind speed) using accepted methods from micrometeorology and wind engineering (Powell et al., 1996). This framework is consistent with that used by the National Hurricane Center (NHC) and is readily converted to wind load frameworks used in building codes.

Based on a qualitative examination of various observing platforms and methods used to standardize observations, Powell et al. (2005) suggest that the uncertainty of the maximum wind from a given analysis ranges from 10-20% depending on the observing platform. In general the uncertainty of a given H*Wind analysis is of the order of 10% for analysis of Hurricanes Ivan, Frances, Jeanne, and Katrina, all of which incorporated more accurate surface wind measurements from the Stepped Frequency Microwave Radiometer (SFMR) aboard the NOAA research aircraft. The SFMR data used for those analyses was post-processed during the fall of 2005 using the latest geophysical model function relating wind speed to sea surface foam emissivity. Hurricanes Charley, Dennis, Rita, Wilma, and Andrew did not have the benefit of SFMR measurements but relied on adjusting Air Force reconnaissance observations at the 3 km altitude to the surface with empirical reduction methods. The method used was based on how SFMR measurements compared to flight level winds and depended on storm relative azimuth. Preliminary results suggest that this method has an uncertainty of 15%.

We created wind swaths for both the modeled and observed winds. We also computed the maximum winds at ZIP Codes for both the observed and modeled winds; from that we derived the mean and root-mean-square error (see Table 10 and Table 11).

Wind Swaths

For each storm in the validation set, the peak sustained surface wind speed is recorded at each ZIP Code in Florida for the duration of the storm event. Observed wind fields from H*Wind and modeled wind fields from the public model are moved along the exact same tracks, which are the observed high-resolution storm tracks assembled from reconnaissance aircraft and radar data. For each storm, the recorded peak of the observed and modeled wind speed is saved at each grid point and each ZIP Code, and the resulting ZIP Code comparison pairs provide the basis for the model validation statistics. The peak grid point values are color contoured and mapped as graphics showing the “swath” of maximum winds swept out by the storm passage. Wind swaths are sometimes confused with wind fields. The winds depicted in a wind swath do not have time continuity, cannot depict a circulation, and therefore cannot be described as a wind field. A wind field represents a vector field that represents a representative instance of the surface wind circulation.

Wind swaths were constructed for both the modeled and observed winds. Maximum marine exposure winds were compared at all ZIP Codes for both the observed and modeled winds (Figure 37) from which we derived the mean and root-mean-square error statistics shown in Table 10 and Table 11. This type of comparison provides an unvarnished assessment of model performance.

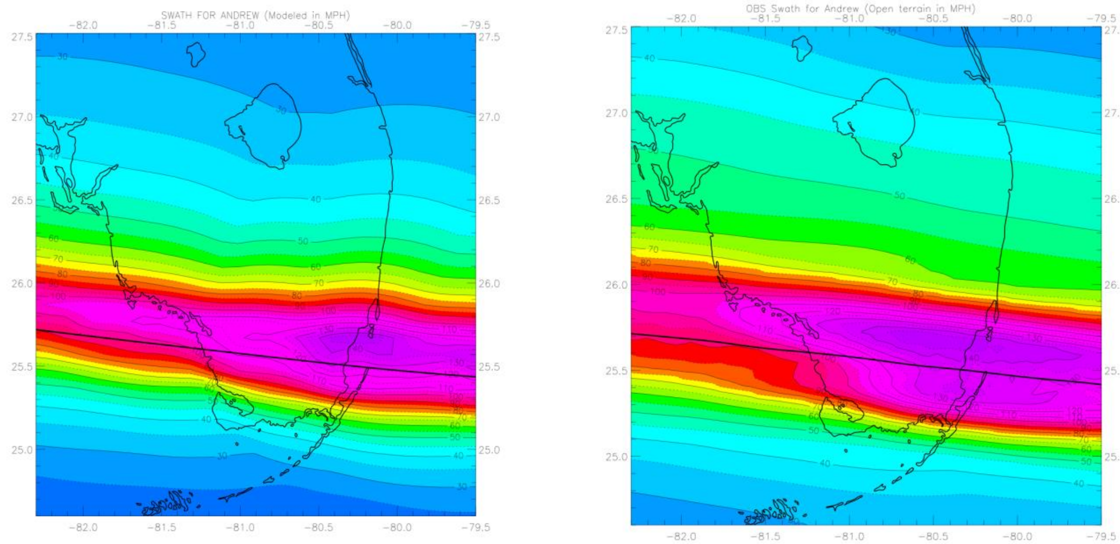


Figure 37. Comparison of modeled (left) and observed (right) swaths of maximum sustained marine surface winds for Hurricane Andrew of 1992 in South Florida. The Hurricane Andrew observed swath is based on adjusting flight-level winds with the SFMR-based wind reduction method.

Storms	Year	56-74 Model Threshold	75-112 Model Thresh.	>112mph Model Thresh.	>56mph Model Thresh.	56-74 H*Wind Thresh.	75-112 H*Wind Thresh.	>112mph H*Wind Thresh.	>56mph H*Wind Thresh.
Andrew	1992	5.25 92	13.86 107	2.73 100	7.49 299	10.26 139	12.47 54	0.66 88	7.68 281
Charley	2004	12.96 112	21.36 244	-7.36 13	17.80 369	8.58 122	-3.09 63	-8.91 17	3.47 202
Frances	2004	3.99 693	-0.99 96	None	3.38 789	-0.59 372	-4.48 96	None	-1.38 468
Ivan	2004	-6.95 20	-3.35 38	None	-4.59 58	-5.76 22	-3.73 41	None	-4.44 63
Jeanne	2004	6.78 250	3.95 190	None	5.56 440	2.67 225	-3.87 121	None	0.38 346
Dennis	2005	2.45 15	6.98 46	None	5.87 61	5.22 29	7.57 29	-4.37 3	5.87 61
Dennis Keys	2005	None	None	None	None	-12.65 5	None	None	-12.65 5
Katrina	2005	-11.43 77	-2.42 100	None	-6.34 177	-8.93 93	-11.57 149	None	-10.55 242
Rita	2005	6.28 5	14.54 3	None	9.38 8	12.01 5	None	None	12.01 5
Wilma	2005	0.44 133	-9.99 394	None	-7.35 527	6.54 87	-13.35 396	None	-9.77 483

Table 10. Validation Table based on ZIP Code wind swath comparison of the Public wind field model to H*Wind. Mean errors (bias) of model for the set of validation wind swaths. Errors (upper number in each cell) are computed as Modeled – Observed (Obs) at ZIP Codes were modeled winds were within wind thresholds (model threshold) or where observed winds were within respective wind speed threshold (H*Wind threshold). Number of ZIP Codes for the comparisons is indicated as the lower number in each cell.

Storms	Year	56-74 Model Threshold	75-112 Model Thresh.	>112mph Model Thresh.	>56mph Model Thresh.	56-74 H*Wind Thresh.	75-112 H*Wind Thresh.	>112mph H*Wind Thresh.	>56mph H*Wind Thresh.
Andrew	1992	6.11	15.75	7.024	10.81	12.19	14.26	5.82	11.10
Charley	2004	19.84	26.59	10.08	24.30	16.65	8.60	11.69	14.21
Frances	2004	8.08	11.20	None	8.52	4.99	10.20	None	6.41
Ivan	2004	7.07	5.20	None	5.91	6.11	5.51	None	5.72
Jeanne	2004	10.14	9.65	None	9.93	10.88	6.16	None	9.50
Dennis	2005	3.06	9.19	None	8.12	6.15	9.93	4.59	8.12
Dennis Keys	2005	None	None	None	None	12.67	None	None	12.67
Katrina	2005	14.66	8.25	None	11.49	12.50	17.97	None	16.09
Rita	2005	6.4992	14.54	None	10.28	12.41	None	None	12.41
Wilma	2005	14.73	14.05	None	14.22	12.51	14.83	None	14.44
RMS N	All	10.18 1397	14.87 1218	6.26 113	12.37 2728	9.75 1099	12.79 949	6.71 108	11.19 2156

Table 11. Validation Table based on ZIP Code wind swath comparison of the Public wind field model to H*Wind. Root mean square (RMS) wind speed errors (mph) of model for the set of validation wind swaths. Errors are based on Modeled – Observed (Obs) at ZIP Codes where modeled winds were within wind thresholds (model threshold) or where observed winds were within respective wind speed threshold (H*Wind threshold).

Comparison of model and H*Wind sustained marine exposure wind speeds at ZIP Codes receiving model wind speeds over the given thresholds (Table 10) indicates a positive bias. For ZIP Codes where model wind speeds exceeded 56 mph, the bias is +3.3 mph ; negative bias was apparent in Hurricanes Ivan, Katrina, and Wilma. At other wind speed thresholds, low bias is evident for winds > 112 mph in Hurricane Charley, and winds of 75-112 mph in Hurricanes Frances, Ivan, Katrina, and Wilma. For winds of 56-74 mph, low bias is noted in Hurricanes Ivan, and Katrina. Errors for Hurricane Andrew are relatively high, but the lack of observations for Hurricane Andrew makes it difficult to determine if it was a Cat 4 or Cat 5 hurricane during its landfall in South Florida. Hurricane Rita in the Keys also shows relatively high bias, but observations indicate that there were fluctuations in intensity over a short period of time during its passage past the Keys. Model errors for Hurricane Charley are also relatively high, likely due to the model producing a wind field that was too broad. When model winds are compared to H*Wind at ZIP Codes exceeding H*Wind and sustained wind speed thresholds of 56 mph are considered, the mean bias is -2.2 mph. However, bias at other wind speed thresholds is larger, primarily caused by large model - H*Wind differences in Hurricanes Andrew, Charley, and Rita.

When swaths are evaluated at ZIP Codes, a positive wind speed bias of ~3 mph is indicated. However, the model can also under-predict swaths for individual cases. While bias correction is an accepted practice for numerical weather prediction, there is no evidence that the model has a consistent bias. The swath bias is probably associated with limitations in specifying the radial pressure profile after landfall. The tendency for the Holland pressure profile parameter to produce too broad an area of strong winds near the eyewall is the most likely cause of bias. Therefore, we have decided to forgo any corrective measures at this point.

Our validation set is unique in that the values of storm position, motion, *Rmax* and *Pmin* are observed, and *B* is determined independently from the H*Wind field. In other words, it is impossible to fine-tune our results. Although additional validation storms are desired, we believe the positive bias for locations with winds > 56 mph is a characteristic of models that use the *Holland B* pressure profile parameter, which tends to produce model fields that are too broad outside the radius of maximum winds. Our validation method provides an objective means of assessing model performance by evaluating the portion of the wind field that contains damaging winds.

The root mean square (RMS) error (Table 11) provides a better estimate of model uncertainty. For ZIP Codes in which model winds were 56-74 mph, the RMS error is +/- 10 mph (~ 15%), for 75-112 mph the error is +/- 15 mph (~16%), and for winds > 112 mph the error is +/- 6 mph (~ 5%). In general, for winds > 56 mph, the RMS error is +/- 12 mph or ~ 13%. RMS errors are similar for ZIP Codes in which H*Wind wind speeds fell into the respective thresholds.

Summary of wind swath validation

Validation of the winds from the wind model against the H*WIND analyses was prepared by considering winds that would be strong enough to be associated with damage. Threshold-based comparisons could miss places where the observed winds were greater than the model and the model was below the threshold. Conversely, observed winds over the same thresholds can be compared to the co-located model grid points but would miss places where the observed winds were below the threshold. It is important to evaluate the errors both ways to see if a consistent bias is evident. According to our validation statistics, albeit for a relatively small number of cases, wind swath ZIP Code comparisons show evidence of a 3 mph positive bias, but it is not consistent for all storms. The bias is likely related to the limitations of the *Holland B* pressure profile specification. The model uncertainty, as estimated by the RMS error, is on the order of 15%.

3. Provide the dates of hurricane loss of the insurance claims data used for validation and verification of the hurricane model.

The following hurricane data from different insurance companies are used to validate the model:

Andrew	1992
Erin	1995
Charley	2004
Frances	2004
Jeanne	2004
Dennis	2005
Wilma	2005
Katrina	2005

4. Provide an assessment of uncertainty in hurricane probable maximum loss levels and hurricane loss costs for hurricane output ranges using confidence intervals or other scientific characterizations of uncertainty.

While the model does not automatically produce confidence intervals for the output ranges, the data do allow for the calculation of confidence intervals. We calculated the mean and the standard deviation of the losses for each county, and it was found that the standard errors were within 2.5% of the means for all counties. We also calculated the coefficient of variation (CV) for all counties and drew a histogram which is provided in Figure 38. The range of the CVs was between 2.70 and 4.77. Finally, we computed 95% confidence intervals for the average loss for each county. Some of these intervals are reproduced in Table 13.

As far as uncertainties for probable maximum loss, we use thewell known result from nonparametric statistics (see Section 3.2 of Practical Nonparametric Statistics by WJ Conover) that for any $1 \leq j \leq N$, the probability that

$$P(PML_p < X_{(j)}) = \sum_{i=1}^{j-1} \frac{N!}{i!(N-i)!} p^i (1-p)^{N-i}$$

Here PMLp refers to the probable maximum loss corresponding to the pth percentile (return period $\frac{1}{1-p}$)

The above implies that for some $r < s \leq N$,

$$
\begin{aligned}
& p(X_{(r)} < PML_p < X_{(s)}) \\
& = p(PML_p < X_{(s)}) - p(PML_p < X_{(r)}) \\
& = \sum_{i=1}^{s-1} \binom{N}{i} p^i (1-p)^{N-i} - \sum_{i=1}^{r-1} \binom{N}{i} p^i (1-p)^{N-i} \\
& = \sum_{i=r}^{s-1} \binom{N}{i} p^i (1-p)^{N-i} \approx 0.95
\end{aligned}
$$

Hence to construct an exact (1- α)100% confidence interval for PML_p, we need to find r and s with r <s (done through a numerical search) such that

$$
\sum_{i=r}^{s-1} \frac{N!}{i!(N-i)!} p^i (1-p)^{N-i} \approx 1-\alpha.
$$

If the solution from the computer search is not unique, the pair of r and s that minimizes s-r will be selected to give the narrowest interval.

However for large samples, the approximate 95% confidence interval of PML_p is given by (X_r, X_s) , using a binomial approximation. The large sample approximation assumes normality to obtain r and s as

$$
r = Np - 1.96\sqrt{Np(1-p)}
$$
$$
s = Np + 1.96\sqrt{Np(1-p)}
$$

Since for our modeled losses, we use 60,000 simulation years, we can easily use the binomial approximation and compute confidence intervals Probable Maximum Loss. Applying the approximation to the PML values for the 2017 Cat Fund Exposure data in Form S-2, we obtain confidence intervals for the PML values as shown in Table 12**Error! Reference source not found.**.

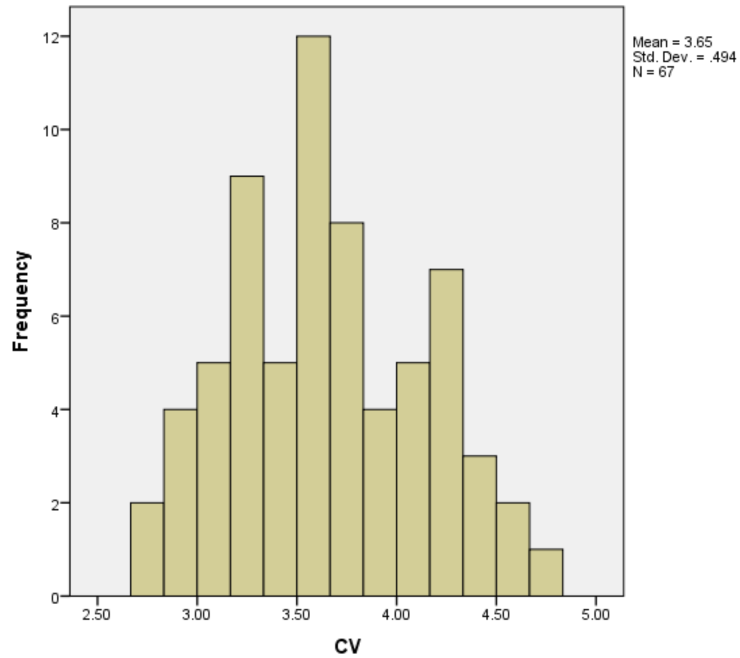


Figure 38. Histogram of CVs for all counties combined.

Return Period (Years)	Probability of Exceedance	Estimated PML	Lower Confidence Limit for PML	Upper Confidence Limit for PML
Top Event	NA	$119,237,000,000		
10000	0.01%	$93,291,739,325	$88,693,045,656	$111,193,878,661
5000	0.02%	$86,869,919,101	$83,635,117,432	$93,812,635,855
2000	0.05%	$78,004,236,041	$74,427,607,387	$83,412,757,545
1000	0.10%	$70,647,520,577	$67,663,335,486	$73,588,788,692
500	0.20%	$63,521,179,702	$61,797,029,498	$65,595,705,450
250	0.40%	$56,633,100,453	$55,467,410,468	$58,094,018,763
100	1.00%	$45,514,761,856	$44,696,851,086	$46,496,065,947
50	2.00%	$36,585,950,091	$35,979,016,789	$37,327,032,834
20	5.00%	$25,185,952,473	$24,751,613,874	$25,660,797,871
10	10.00%	$16,249,000,028	$15,931,878,725	$16,559,655,984
5	20.00%	$6,444,427,186	$6,183,483,018	$6,696,215,553

Table 12. Confidence Intervals for PML values for 2017 Cat Fund Exposure Data

county	average_loss	stdev_loss	LCL	UCL
Alachua	$12,232,448.85	$48,453,116.11	$11,844,743.00	$12,620,155.00
Brevard	$144,120,059.90	$522,431,178.20	$139,939,740.00	$148,300,380.00
Broward	$391,920,360.40	$1,163,600,174.00	$382,609,620.00	$401,231,101.00
Duval	$41,400,422.60	$175,708,600.10	$39,994,461.00	$42,806,384.00
Escambia	$43,492,917.22	$147,768,628.40	$42,310,522.00	$44,675,313.00
Gulf	$2,142,601.64	$7,196,505.43	$2,085,017.60	$2,200,185.70
Hamilton	$248,960.35	$1,188,115.58	$239,453.45	$258,467.26
Hillsborough	$199,034,324.80	$644,011,075.70	$193,881,163.00	$204,187,487.00
Jackson	$2,191,172.76	$7,990,519.00	$2,127,235.30	$2,255,110.20
Jefferson	$529,013.97	$2,367,004.59	$510,073.99	$547,953.95
Lee	$205,643,294.10	$557,652,929.50	$201,181,141.00	$210,105,447.00
Leon	$14,604,538.95	$59,776,850.78	$14,126,225.00	$15,082,853.00
Madison	$467,424.58	$2,176,378.64	$450,009.92	$484,839.23
Miami-Dade	$385,378,693.40	$1,157,759,127.00	$376,114,691.00	$394,642,696.00
Monroe	$47,938,201.05	$143,970,718.90	$46,786,195.00	$49,090,207.00
Nassau	$5,965,135.62	$24,948,583.15	$5,765,505.40	$6,164,765.90
Okeechobee	$8,113,271.98	$26,997,882.75	$7,897,243.90	$8,329,300.00
Osceola	$41,326,454.57	$142,062,503.30	$40,189,718.00	$42,463,191.00
Palm Beach	$550,604,092.00	$1,680,222,126.00	$537,159,515.00	$564,048,669.00
Sarasota	$123,296,359.60	$366,492,916.40	$120,363,806.00	$126,228,914.00

Table 13. 95% Confidence intervals for mean loss for selected counties (based on 60,000) year simulation.

LCL: 95% Lower Confidence Limit for the Average Loss
UCL: 95% Upper Confidence Limit for the Average Loss

5. Justify any differences between the historical and modeled results using current scientific and statistical methods in the appropriate disciplines.

The various statistical tests as well as other validation tests presented here and elsewhere indicate that any differences between modeled results and historical observations are not statistically significant given the large known uncertainties in the historical record.

6. Provide graphical comparisons of modeled and historical data and goodness-of-fit tests. Examples to include are hurricane frequencies, tracks, intensities, and physical damage.

For hurricane frequencies as a function of intensity by region, see Form M-1 plots. The histogram in Figure 34 compares the modeled and historical annual landfall distribution by number of events per year. The agreement between the two distributions is quite close and the histogram shows a good fit. The chi-square goodness-of-fit test gives a *p*-value of approximately 0.668 as described in S-1.1. Plots and goodness-of-fit tests for the radius of maximum wind and the Holland pressure profile parameter are shown in Disclosure 1 of this standard. Plots and statistical comparisons of historical and modeled losses are shown in Standard S-5, Form S-4 and Form S-5.

7. Provide a completed Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year. Provide a link to the location of the form here.

Please see completed Form S-1 at the end of this section.

8. Provide a completed Form S-2, Examples of Hurricane Loss Exceedance Estimates. Provide a link to the location of the form here.

Please see completed Form S-2 at the end of this section.

S-2 Sensitivity Analysis for Hurricane Model Output

The modeling organization shall have assessed the sensitivity of temporal and spatial outputs with respect to the simultaneous variation of input variables using current scientific and statistical methods in the appropriate disciplines and shall have taken appropriate action.

We have performed sensitivity analysis on the temporal and spatial outputs of the model using currently accepted scientific and statistical methods. We examined the effects of five input variables on the expected loss cost. The input variables were as follows:

CP = central pressure (in millibars)
Rmax = radius of maximum winds (in statute miles)
VT = translational velocity (forward speed in miles per hour)
Holland B = pressure profile parameter and
FFP = far field pressure

The effects of the above input variables on the expected loss cost were examined using the methods described by Iman et al. (2000a).

Disclosures

1. Identify the most sensitive aspect of the hurricane model and the basis for making this determination.

Figure 39 provides the graph of the standardized regression coefficients of the expected loss cost as a function of the input variables for Category 1, 3 and 5 hurricanes. From the graph, we observe that the sensitivity of expected loss cost depends on the category of the hurricanes. For a Category 1 hurricane, expected loss cost is most sensitive to Holland B. For a Category 3 hurricane, expected loss cost is most sensitive to Holland Band, and finally for a Category 5 hurricane, expected loss cost is most sensitive to *Rmax*.

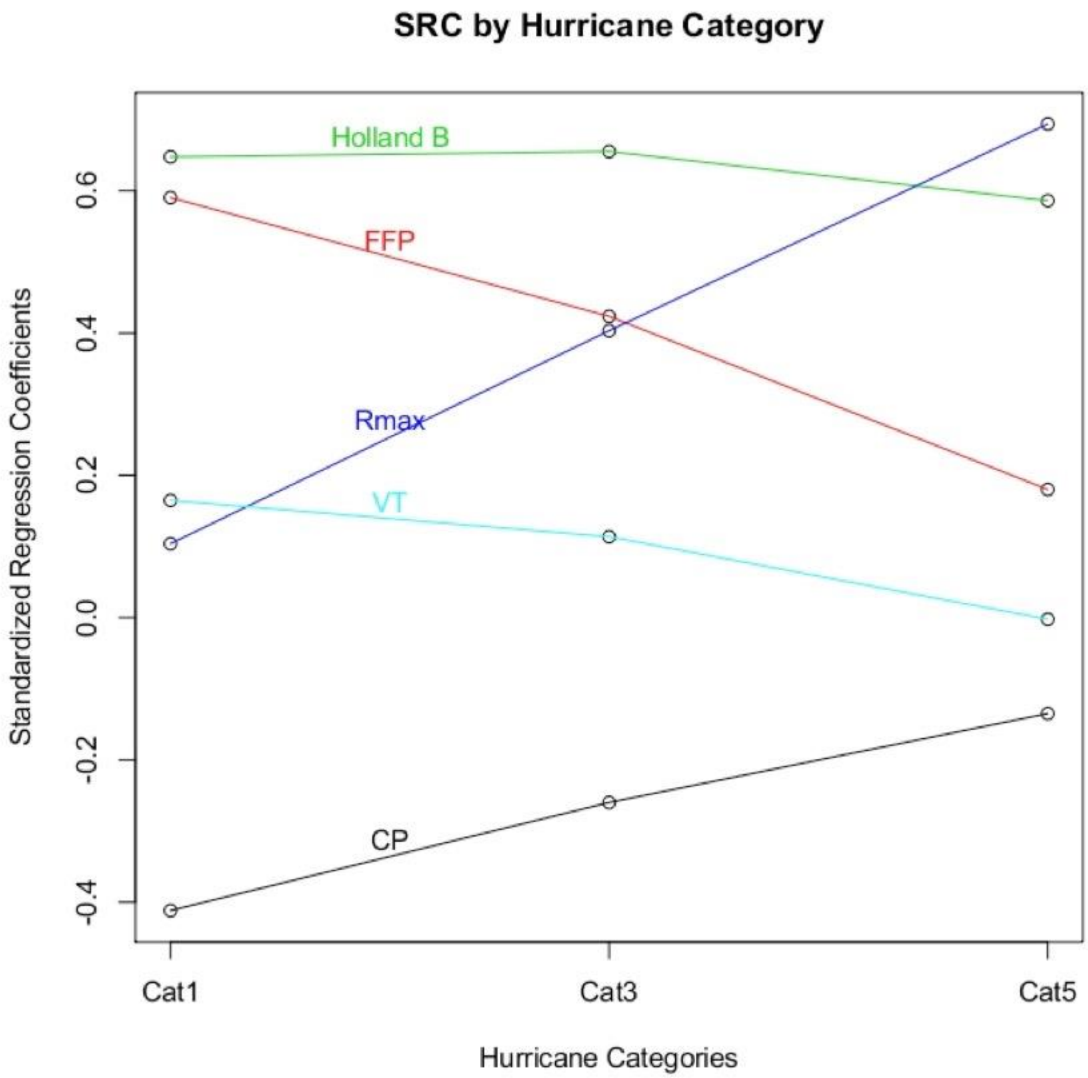


Figure 39. SRCs for Expected Loss Cost for all Input Variables for all Hurricane Categories.

2. Identify other input variables that impact the magnitude of the output when the input variables are varied simultaneously. Describe the degree to which these sensitivities affect output results and illustrate with an example.

As mentioned in disclosure 1; the input variables that impact the magnitude of the output when varied simultaneously depend on the category of the hurricanes. For a Category 1 hurricane, FFP and CP are the other two variables (in addition to Holland B) which have an impact on loss costs. For a Category 3 hurricane, expected loss cost the other variables are FFP and Rmax and finally for a Category 5 hurricane, these are Holland B, CP and FFP. The expected loss cost is least sensitive to Rmax for Category 1, while the expected loss cost is least sensitive to VT for Categories 3 and 5.

3. Describe how other aspects of the hurricane model may have a significant impact on the sensitivities in output results and the basis for making this determination.

Validation studies (described in Standard S-1.2) indicated that air density, boundary layer height, fraction of the boundary layer depth over which the turbulent stresses act, the drag coefficient, the averaging time chosen to represent the boundary layer slab winds, and the conversion of the 0-500 m layer mean wind to 10 m surface wind could all have a significant impact on the output. These quantities were evaluated during the validation process, resulting in the selection of physically consistent values. For example, the values chosen for air density, marine boundary layer height and reduction factor from the mean boundary layer to the surface are representative of near surface GPS dropsonde measurements in hurricanes. Model wind speeds (and therefore, output results) are very sensitive to surface roughness, which in turn depend on land use/land cover determined from satellite remote sensing. The assignment of roughness to mean land use / land cover classifications as well as the upstream filtering or weighting factor was applied to integrate the upstream roughness elements within a 45 degree sector to windward of the corresponding ZIP Code.

4. Describe and justify action or inaction as a result of the sensitivity analyses performed.

No actions were taken in light of the aforementioned sensitivity experiments.

5. Provide a completed Form S-6, Hypothetical Events for Sensitivity and Uncertainty Analysis. (Requirement for hurricane models submitted by modeling organizations which have not previously provided the Commission with this analysis. For hurricane models previously-found acceptable, the Commission will determine, at the meeting to review modeling organization submissions, if an existing modeling organization will be required to provide Form S-6, Hypothetical Events for Sensitivity and Uncertainty Analysis, prior to the Professional Team on-site review). If applicable, provide a link to the location of the form here.

Please see the completed Form S-6 at the end of this section.

S-3 Uncertainty Analysis for Hurricane Model Output

The modeling organization shall have performed an uncertainty analysis on the temporal and spatial outputs of the hurricane model using current scientific and statistical methods in the appropriate disciplines and shall have taken appropriate action. The analysis shall identify and quantify the extent that input variables impact the uncertainty in hurricane model output as the input variables are simultaneously varied.

We have performed uncertainty analysis on the temporal and spatial outputs of the model using currently accepted scientific and statistical methods. We examined the effects of five input variables on the expected loss cost. The input variables were as follows:

CP = central pressure (in millibars)
R*max* = radius of maximum winds (in statute miles)
VT = translational velocity (forward speed in miles per hour)
Holland B = pressure profile parameter and
FFP = far field pressure

The effects of the above input variables on the expected loss cost were examined using the methods described by Iman et al. (2000b).

Disclosures

1. Identify the major contributors to the uncertainty in hurricane model outputs and the basis for making this determination. Provide a full discussion of the degree to which these uncertainties affect output results and illustrate with an example.

Figure 40 gives the expected percentage reductions in the variance of expected loss costs for Category 1, 3 and 5 hurricanes as a function of the input variables. As with the sensitivity analysis, the category of the hurricane determines which variables contributes most to the uncertainty of the expected loss costs. For a Category 1 hurricane, the major contributor to the uncertainty in expected loss cost is the Holland B parameter followed by *FFP* and then *CP*. For a Category 3 hurricane, the major contributor to the uncertainty in loss costs is Holland B followed by *Rmax* and then *FFP* and finally for a Category 5 hurricane, the major contributor to the uncertainty of expected loss costs is *Rmax* followed by Holland B and then *FFP* and *CP*. The variable *VT* has negligible effect on the uncertainty in expected loss costs.

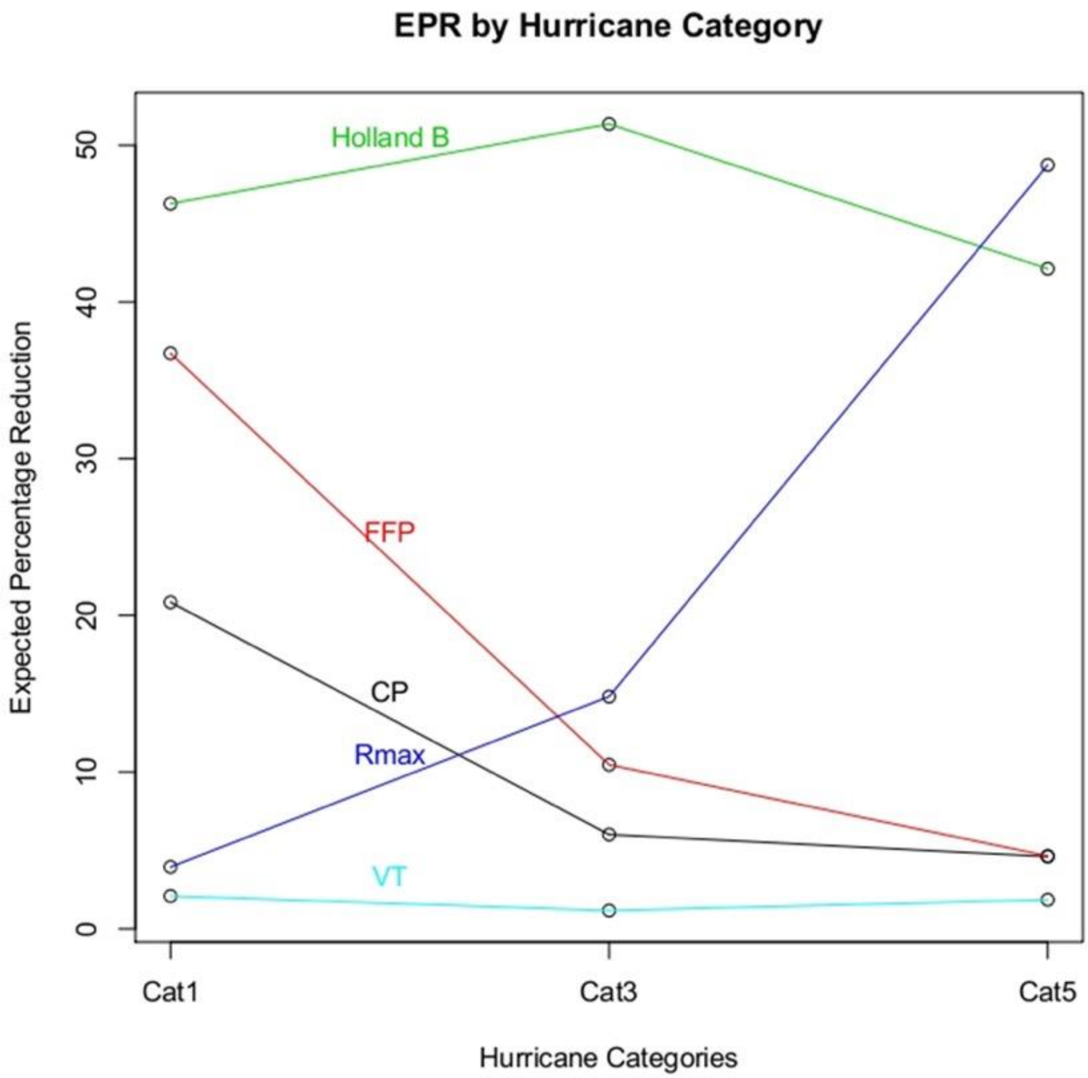


Figure 40. EPRs for Expected Loss Cost for all Input Variables for all Hurricane Categories.

2. Describe how other aspects of the hurricane model may have a significant impact on the uncertainties in output results and the basis for making this determination.

Limitations in the HURDAT record contribute to the uncertainty of modeled tracks and pressures. Surface pressure measurements are not always available in HURDAT and estimating surface pressures by pressure-wind relationships is also fraught with uncertainty since well-observed hurricanes can demonstrate a large variation in maximum wind speeds for a given minimum surface pressure. The HURDAT record prior to the advent of satellites in the mid-1960s could have missed or incorrectly classified many hurricanes that affected Florida in the early 20th century. Even today, there is still considerable uncertainty in the assessment of hurricane intensity. Recent research results based on SFMR measurements (Powell et al., 2009) indicate that some Saffir-

Simpson 1-3 Category hurricanes may be rated too highly while the Category 4 and 5 storms are probably rated accurately.

Uncertainty in surface roughness has a significant impact on wind uncertainty which in turn leads to a significant impact on losses.

3. Describe and justify action or inaction as a result of the uncertainty analyses performed.

No actions were taken in light of the aforementioned uncertainty analysis.

4. Form S-6, Hypothetical Events for Sensitivity and Uncertainty Analysis, if disclosed under Standard S-2, Sensitivity Analysis for Hurricane Model Output, will be used in the verification of Standard S-3, Uncertainty Analysis for Hurricane Model Output.

Please see the completed Form S-6 at the end of this section.

S-4 County Level Aggregation

At the county level of aggregation, the contribution to the error in hurricane loss cost estimates attributable to the sampling process shall be negligible.

The error in the county level loss costs induced by the sampling process can be quantified by computing standard errors for the county level hurricane loss costs. These loss costs have been computed for all counties in the state of Florida using 60,000 years of simulation. The results indicate that the standard errors are less than 2.5% of the average loss cost estimates for all counties.

Disclosure

1. Describe the sampling plan used to obtain the average annual hurricane loss costs and hurricane output ranges. For a direct Monte Carlo simulation, indicate steps taken to determine sample size. For an importance sampling design or other sampling scheme, describe the underpinnings of the design and how it achieves the required performance.

The number of simulation years was determined through the following process:

The average loss cost, $\overline{X}_Y$, and standard deviation S_Y, were determined for each county Y using an initial run of an 12,000 year simulation. Then the maximum error of the estimate will be 2.5% of the estimated mean loss cost, if the number of simulation years for county Y is:

$$N_Y = \left(\frac{s_Y}{0.025\overline{X}_Y} \right)^2$$

Based on the initial 12,000 year simulation runs, the minimum number of years required is N_Y = 35,786 for Hamilton County, which had the highest number of years required of all the counties. Therefore, we have decided to use 60,000 (500x120) years of simulation for our final results. For the 60000-year simulation runs, we found that the standard errors are less than 2.5% of the average loss costs for each county.

S-5 Replication of Known Hurricane Losses

The hurricane model shall estimate incurred hurricane losses in an unbiased manner on a sufficient body of past hurricane events from more than one company, including the most current data available to the modeling organization. This standard applies separately to personal residential and, to the extent data are available, to commercial residential. Personal residential hurricane loss experience may be used to replicate structure-only and contents-only hurricane losses. The replications shall be produced on an objective body of hurricane loss data by county or an appropriate level of geographic detail and shall include hurricane loss data from both 2004 and 2005.

Table 14 compares the modeled and actual total losses by hurricane and company for personal residential coverage. Moreover, Figure 41**Error! Reference source not found.** indicates reasonable agreement between the observed and modeled losses. This was also supported by the various statistical tests described below.

Disclosures

1. Describe the nature and results of the analyses performed to validate the hurricane loss projections generated for personal and commercial residential hurricane losses separately. Include analyses for the 2004 and 2005 hurricane seasons.

For model validation purposes, the actual and modeled losses for some selected companies and hurricanes are provided in Table 14.

Company Name	Event	Total Exposure	Total Actual Loss	Total Modeled Loss
A	Charley	$14,572,357,458.00	$274,702,333.00	$198,179,821.24
A	Frances	$9,613,407,332.00	$224,656,954.00	$141,512,861.20
B	Charley	$7,155,996,653.00	$110,471,361.00	$124,314,188.01
B	Frances	$1,847,430,290.00	$20,201,407.00	$61,499,099.10
C	Charley	$26,484,786,918.00	$526,544,555.00	$327,684,436.13
C	Dennis	$8,766,524,714.00	$20,384,468.00	$65,229,611.00
C	Frances	$17,568,485,865.00	$392,510,598.00	$272,473,719.65
C	Jeanne	$37,580,088,130.00	$177,552,030.00	$401,860,360.63
C	Katrina	$4,036,128,039.00	$19,712,702.00	$79,866,587.34
C	Wilma	$29,468,018,254.00	$340,628,254.00	$541,045,903.86
D	Charley	$1,377,700,566.00	$63,889,029.00	$22,307,062.19
D	Frances	$4,309,535,304.00	$122,776,727.00	$74,013,396.26
E	Charley	$35,580,184.00	$952,353.00	$662,609.32
E	Frances	$316,894,463.00	$10,007,410.00	$4,196,319.79
E	Charley	$2,498,971,217.00	$113,313,510.00	$47,126,067.73
E	Frances	$3,639,401,631.00	$78,377,163.00	$61,040,427.97

Company Name	Event	Total Exposure	Total Actual Loss	Total Modeled Loss
E	Jeanne	$4,307,858,204.00	$40,245,030.00	$71,503,863.12
F	Charley	$1,386,793,895.00	$32,316,645.00	$20,223,743.32
G	Charley	$587,526,292.00	$3,884,930.00	$6,619,029.79
G	Frances	$189,912,832.00	$2,918,642.00	$3,728,694.10
G	Katrina	$135,143,330.00	$464,971.00	$856,310.90
G	Wilma	$767,025,160.00	$6,120,435.00	$9,196,840.61
H	Charley	$844,602,098.00	$78,535,467.00	$51,410,383.28
H	Dennis	$28,266,337.00	$928,111.00	$2,142,032.00
H	Frances	$665,429,117.00	$59,229,372.00	$23,774,605.19
H	Jeanne	$1,854,530,377.00	$74,983,526.00	$54,175,725.15
H	Katrina	$6,903,619.00	$330,018.00	$234,367.52
H	Wilma	$727,865,863.00	$47,056,668.00	$18,751,067.87
I	Charley	$2,506,896,464.00	$62,086,256.00	$50,651,809.24
I	Frances	$74,702,419.00	$43,799,401.00	$7,138,363.35
J	Jeanne	$6,169,965,775.00	$84,545,829.00	$91,148,684.95
K	Charley	$932,092,266.00	$79,751,698.00	$56,841,903.52
K	Jeanne	$2,558,106,618.00	$81,552,694.00	$96,489,457.17
L	Charley	$41,558,803.00	$4,511,656.00	$2,566,483.69
L	Charley	$166,263,166.00	$8,645,559.00	$3,224,177.82
L	Frances	$34,908,100.00	$4,009,884.00	$1,428,840.54
L	Frances	$368,182,344.00	$11,489,176.00	$5,768,227.28
L	Jeanne	$78,735,391.00	$3,590,284.00	$3,298,610.46
L	Jeanne	$347,104,726.00	$4,812,837.00	$6,103,225.29
M	Charley	$1,517,072,812.00	$15,135,021.00	$22,381,833.66
M	Frances	$804,861,107.00	$9,399,468.00	$16,515,698.21
M	Jeanne	$2,272,770,727.00	$9,048,905.00	$27,652,669.65
N	Charley	$9,598,109,599.00	$250,201,871.00	$156,015,706.62
N	Frances	$7,762,557,563.00	$185,676,998.00	$157,821,509.41
N	Jeanne	$15,460,363,846.00	$127,752,952.00	$208,162,427.87
N	Katrina	$464,541,580.00	$1,498,112.00	$4,180,305.35
N	Wilma	$12,018,207,196.00	$156,638,501.00	$168,764,383.52
O	Charley	$475,100,767.00	$2,015,902.00	$3,090,495.42
O	Frances	$1,086,978,976.00	$2,659,551.00	$4,892,736.50
O	Jeanne	$905,676,619.00	$29,144,703.00	$36,525,360.04
O	Jeanne	$1,436,506,385.00	$2,059,383.00	$6,222,450.28
P	Jeanne	$3,434,049,257.00	$31,066,792.00	$52,352,494.70
Q	Andrew	$30,391,564,010.00	$2,984,373,067.00	$2,158,821,822.04
Q	Charley	$427,213,972.00	$23,395,988.00	$16,295,310.88
Q	Charley	$51,283,638,860.00	$1,037,108,745.00	$600,860,774.82
Q	Dennis	$8,527,804,503.00	$30,098,559.00	$63,280,716.00
Q	Erin	$3,193,215,496.00	$50,519,119.00	$61,294,920.22
Q	Frances	$482,335,774.00	$18,467,176.00	$7,891,813.22
Q	Frances	$36,447,006,477.00	$614,006,549.00	$420,848,614.43
Q	Katrina	$19,097,289,225.00	$54,163,254.00	$102,739,366.78
Q	Wilma	$76,663,257,400.00	$1,185,407,656.00	$731,098,284.25

Company Name	Event	Total Exposure	Total Actual Loss	Total Modeled Loss
R	Jeanne	$1,178,562,197.00	$3,125,588.00	$14,858,205.44
S	Charley	$9,721,434,560.00	$111,013,524.00	$215,906,252.91
S	Frances	$12,631,336,130.00	$94,272,660.00	$385,052,388.40
T	Charley	$2,685,932,544.00	$54,207,520.00	$41,602,464.36
T	Frances	$3,554,743,715.00	$121,893,725.00	$52,487,004.56

Table 14. Total Actual vs. Total Modeled Losses- Personal Residential

Figure 41**Error! Reference source not found.** provides a comparison of total actual losses vs. total modeled losses for different hurricanes. The comparison indicates a reasonable agreement between the actual and modeled losses. The correlation between actual and modeled losses is found to be 0.970, which shows a strong positive linear relationship between actual and modeled losses. We tested whether the difference in paired mean values equals zero using the paired t test ($t = 1.43$, $df = 65$, p-value = 0.158) and Wilcoxon signed rank test (V= 1249, p-value = 0.361). Based on these tests, we failed to reject the null hypothesis of equality of paired means and concluded that there is insufficient evidence to suggest a difference between actual and modeled losses. We also observed from Table 14 that about 52% of the actual losses are more than the corresponding modeled losses, and 48% of the modeled losses are more than the corresponding actual losses. This shows that our modeling process is not biased. Following Lin (1989), the bias correction factor (measure of accuracy) is obtained as 0.944, and the sample concordance correlation coefficient is found to be 0.916, which again shows a strong agreement between actual and modeled losses.

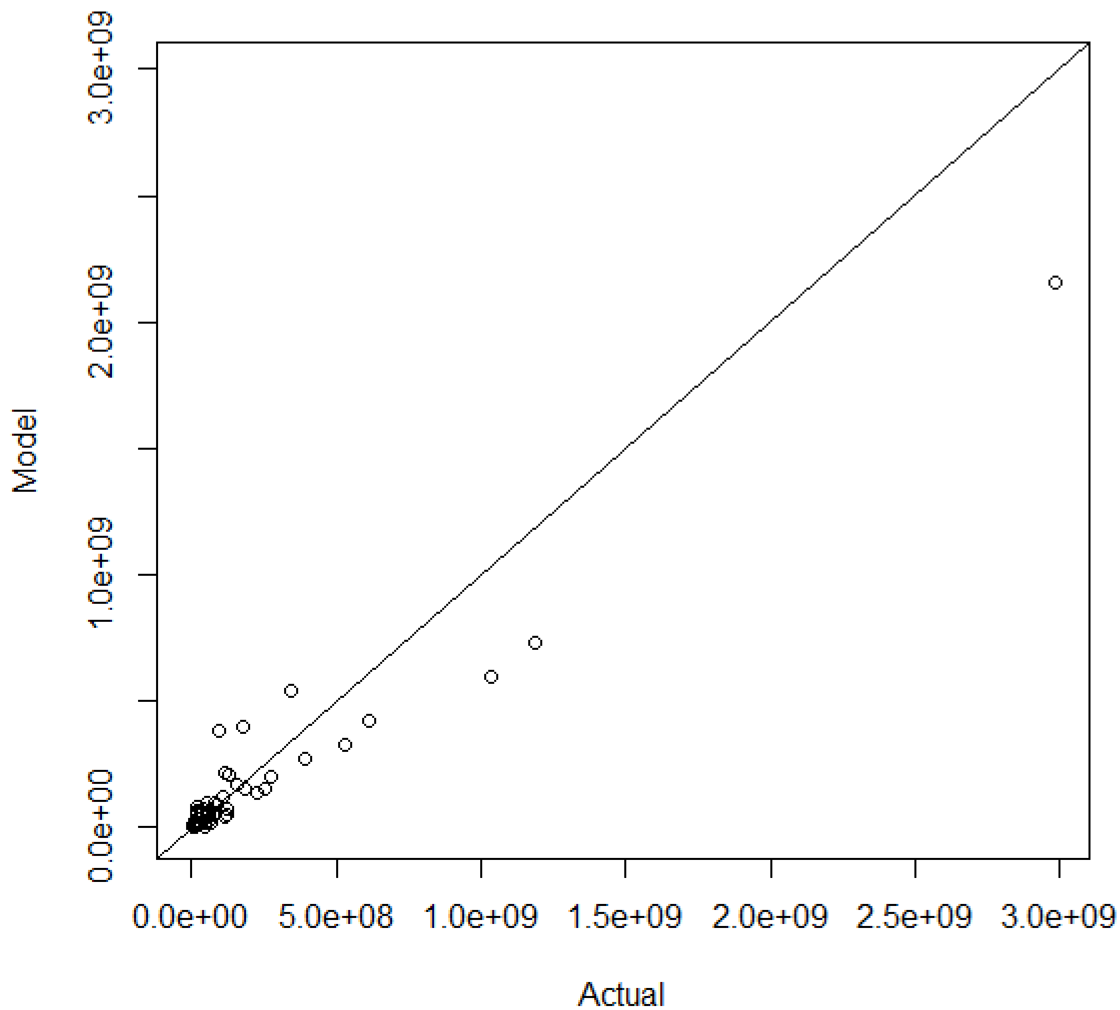


Figure 41. Scatter plot between total actual losses vs. total modeled losses – Personal Residential.

Due to the lack of a sufficient body of claims data for commercial losses, extensive statistical tests were not conducted to validate the model losses. A tabular comparison of the modeled vs. actual commercial insured loss costs is presented in Table 15**Error! Reference source not found.** and Figure 42**Error! Reference source not found.** in for illustration purposes only:

Company Name	Event	Total Exposure	Total Actual Loss	Total Modeled Loss
D	Charley	$ 2,344,572,547.00	$ 64,378,393.00	$24,647,035.62
D	Jeanne	$ 4,866,082,786.00	$ 34,826,257.00	$54,103,285.22
D	Katrina	$ 6,489,785,877.00	$ 11,846,697.00	$37,245,827.16

Company Name	Event	Total Exposure		Total Actual Loss		Total Modeled Loss
D	Wilma	$	20,489,475,103.00	$	318,671,056.00	$193,314,843.34
Q	Frances	$	863,784,392.00	$	42,238,244.00	$3,618,159.06
Q	Jeanne	$	1,021,385,625.00	$	8,446,718.00	$6,916,834.79
Q	Katrina	$	224,012,300.00	$	2,178,110.00	$317,809.98
Q	Wilma	$	2,423,163,266.00	$	62,492,371.00	$11,390,366.57

Table 15. Comparison of Total vs. Actual Losses - Commercial Residential

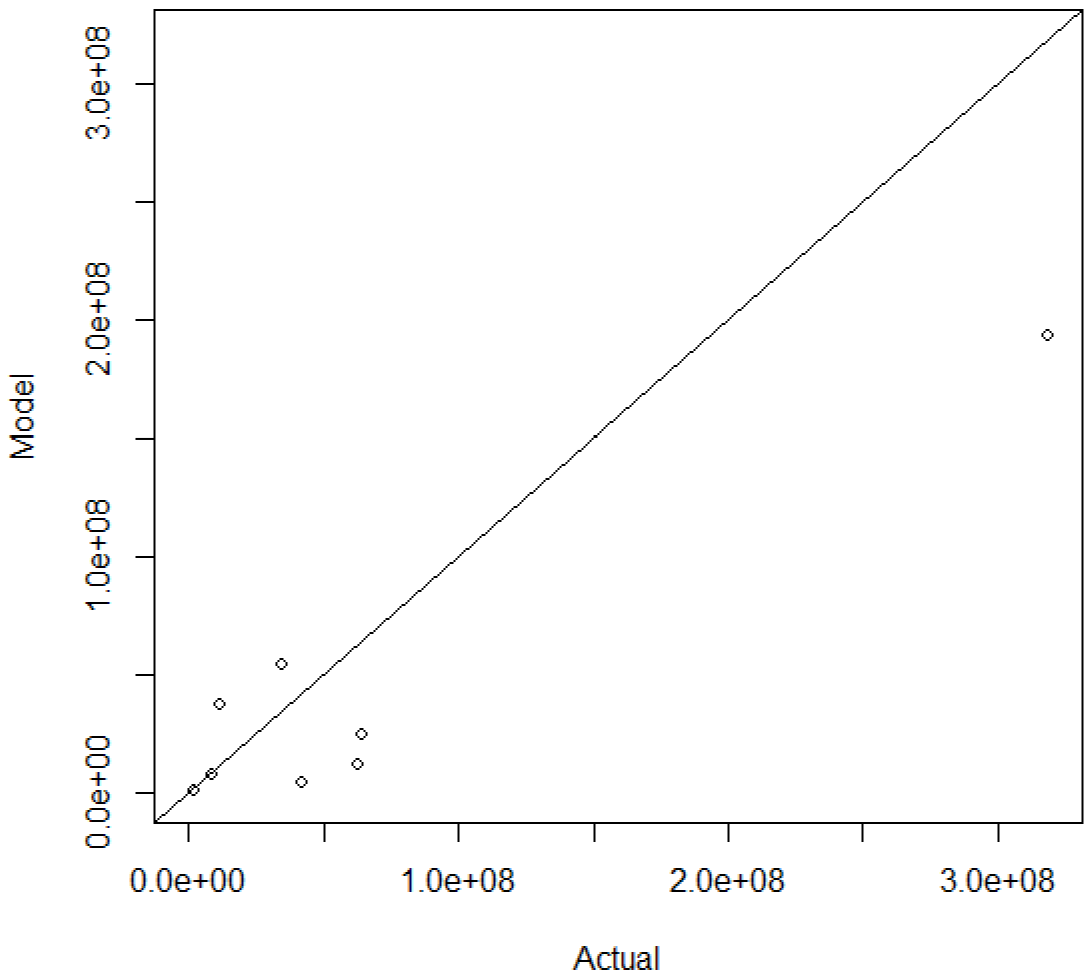


Figure 42. Scatter plot between total actual losses vs. total modeled losses – Commercial Residential.

2. Provide a completed Form S-4, Validation Comparisons. Provide a link to the location of the form here.

Please see the completed Form S-4 at the end of this section.

S-6 Comparison of Projected Hurricane Loss Costs

The difference, due to uncertainty, between historical and modeled annual average statewide hurricane loss costs shall be reasonable, given the body of data, by established statistical expectations and norms.

The difference, due to uncertainty, between historical and modeled annual average statewide loss costs is reasonable as shown in the following description.

Disclosures

1. Describe the nature and results of the tests performed to validate the expected hurricane loss projections generated. If a set of simulated hurricanes or simulation trials was used to determine these hurricane loss projections, specify the convergence tests that were used and the results. Specify the number of hurricanes or trials that were used.

Loss costs are generated using a simulated number of hurricanes. The number of years used in the simulations was calculated as described in Standard S-4, and was found to be 60,000. The standard errors are within 2.5% of the means for all counties. From Form S-5 we found that the 95% confidence interval on the difference between the mean of the losses from the historical and modeled contains 0, indicating that there is no statistically significant difference. In addition, as shown in Standard S-5, modeled loss costs have also been validated against insurance company data and are in reasonable agreement with the same.

2. Identify and justify differences, if any, in how the hurricane model produces hurricane loss costs for specific historical events versus hurricane loss costs for events in the stochastic hurricane set.

The historical and stochastic storm loss costs are treated the same.

3. Provide a completed Form S-5, Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled. Provide a link to the location of the form here.

Please see the completed Form S-5 at the end of this section.

Form S-1: Probability and Frequency of Florida Landfalling Hurricanes per Year

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year.

Automated scripts and programs were used to generate Form S-1.

B. Complete the table below showing the probability and modeled frequency of landfalling Florida hurricanes per year. Modeled probability shall be rounded to four three decimal places. The historical probabilities and frequencies below have been derived from the Base Hurricane Storm Set for the 119 year period 1900-2018 (as given in Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses). Exclusion of hurricanes that caused zero modeled Florida damage or additional Florida hurricane landfalls included in the modeling organization Base Hurricane Storm Set as identified in their response to Standard M-1, Base Hurricane Storm Set, shall be used to adjust the historical probabilities and frequencies provided.

C. If the data are partitioned or modified, provide the historical probabilities and frequencies for the applicable partition (and its complement) or modification as well as the modeled probabilities and frequencies in additional copies of Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year.

D. Include Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year, in a submission appendix.

See Appendix N. Please note that this form is based on the 1900-2019 (120 years) Base Set.

Form S-2: Examples of Hurricane Loss Exceedance Estimates

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form S-2, Examples of Hurricane Loss Exceedance Estimates.

Automated scripts and programs were used to generate Form S-2.

B. Provide estimates of the annual aggregate combined personal and commercial insured hurricane losses for various probability levels using the notional risk dataset specified in Form A-1, Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code, and using the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data provided in the file named "hlpm2017c.zip." Provide the total average annual hurricane loss for the hurricane loss exceedance distribution. If the modeling methodology does not allow the hurricane model to produce a viable answer for certain return periods, state so and why.

C. Include Form S-2, Examples of Hurricane Loss Exceedance Estimates , in a submission appendix.

See Appendix O.

Form S-3: Distributions of Stochastic Hurricane Parameters

A. Provide the probability distribution functional form used for each stochastic hurricane parameter in the hurricane model. Provide a summary of the justification for each functional form selected for each general classification.

B. Include Form S-3, Distributions of Stochastic Hurricane Parameters, in a submission appendix.

See Appendix P.

Form S-4: Validation Comparisons

A. Provide four validation comparisons of actual personal residential exposures and hurricane loss to modeled exposures and hurricane loss. Provide these comparisons by line of insurance, construction type, policy coverage, county or other level of similar detail in addition to total hurricane losses. Include hurricane loss as a percentage of total exposure. Total exposure represents the total amount of insured values (all coverages combined) in the area affected by the hurricane. This would include exposures for policies that did not have a hurricane loss. If this is not available, use exposures for only those policies that had a hurricane loss. Specify which was used. Also, specify the name of the hurricane event compared.

B. Provide a validation comparison of actual commercial residential exposures and hurricane loss to modeled exposures and hurricane loss. Use and provide a definition of the hurricane model's relevant commercial residential classifications.

C. Provide scatter plot(s) of modeled versus historical hurricane losses for each of the required validation comparisons. (Plot the historical hurricane losses on the x-axis and the modeled hurricane losses on the y-axis.)

D. Include Form S-4, Validation Comparisons, in a submission appendix.

Rather than using a specific published hurricane windfield directly, the winds underlying the modeled hurricane loss cost calculations must be produced by the hurricane model being evaluated and should be the same hurricane parameters as used in completing Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses.

See Appendix Q.

Form S-5: Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled

A. Provide the average annual zero deductible statewide personal and commercial residential hurricane loss costs produced using the list of hurricanes in the Base Hurricane Storm Set as defined in Standard M-1, Base Hurricane Storm Set, based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.zip."

Average Annual Zero Deductible Statewide Personal and Commercial Residential Hurricane Loss Costs

Time Period	Historical Hurricanes	Produced by Hurricane Model
Current Submission	$5,132.56	$4,427.87
Previously-Accepted Hurricane Model* (2017 Standards)	$5,792.95	$5,037.05
Percent Change Current Submission/ Previously Accepted Hurricane Model*	-11.40	-12.09
Second Previously-Accepted Hurricane Model* (2015 Standards)	NA**	NA**
Percent Change Current Submission/ Second Previously-Accepted Hurricane Model*	NA**	NA**

*NA if no previously-accepted hurricane model.
**The second previously-accepted hurricane model did not produce loss costs based on 2017 FHCF exposure data

B. Provide a comparison with the statewide personal and commercial residential hurricane loss costs produced by the hurricane model on an average industry basis.

The loss cost produced by the hurricane model on an average industry basis is 4.4 billion dollars and the corresponding historical average loss is 5.1 billion dollars.

C. Provide the 95% confidence interval on the differences between the means of the historical and modeled personal and commercial residential hurricane loss costs.

The 95% confidence interval on the difference between the mean of the historical and the mean of the modeled losses is between -1.09 and 2.50 billion dollars. Since the interval contains 0, we are

95% confident that there is no significant difference between the historical and the modeled hurricane losses.

D. If the data are partitioned or modified, provide the average annual zero deductible statewide personal and commercial residential hurricane loss costs for the applicable partition (and its complement) or modification, as well as the modeled average annual zero deductible statewide personal and commercial residential hurricane loss costs in additional copies of Form S-5, Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled.

Not applicable.

E. Include Form S-5, Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled, in a submission appendix.

See

Appendix R.

Form S-6: Hypothetical Events for Sensitivity and Uncertainty Analysis

We have provided the output in ASCII files based on running a series of hurricanes as provided in the Excel file “FormS6Input19.xlsx.” The output files consist of wind speeds (in miles per hour for one minute sustained 10 meter winds) at hourly intervals over a 21×40 grid for the 500 combinations of initial conditions specified in the Excel file for the following model inputs:

- *CP* = central pressure (in millibars)
- *Rmax* = radius of maximum winds (in statute miles)
- *VT* = translational velocity (forward speed in miles per hour)
- Holland *B* = pressure profile parameter for other input used by the modeler ($0 \le p \le 1$)
- *FFP* = far field pressure (in millibars)

The value of *CP*, *Rmax*, *VT*, *FFP* and Quantile are used as direct inputs. Quantiles from 0 to 1 have been provided in the Excel input file. For the FPHLM (V4.1) model, we used the first quantile input for the Holland *B* parameter.

On a CD, we have provided an ASCII file and a PDF file named FPHLM09Expected Loss Costs. This file gives aggregate and expected loss costs for each input vector for each category of hurricane and contains 3x100=300 rows.

We have also provided, on a CD, the results in an ASCII file and a PDF file named FPHLM09Loss Cost Contour, which contains 3 x 682 = 2,046 rows. This file gives the mean loss cost at each of the 682 land based vertices over all 100 input vectors for each hurricane category.

Distribution of Loss Costs

Figure 43 provides the comparison of CDFs of the Expected Loss Costs for all Hurricane Categories.

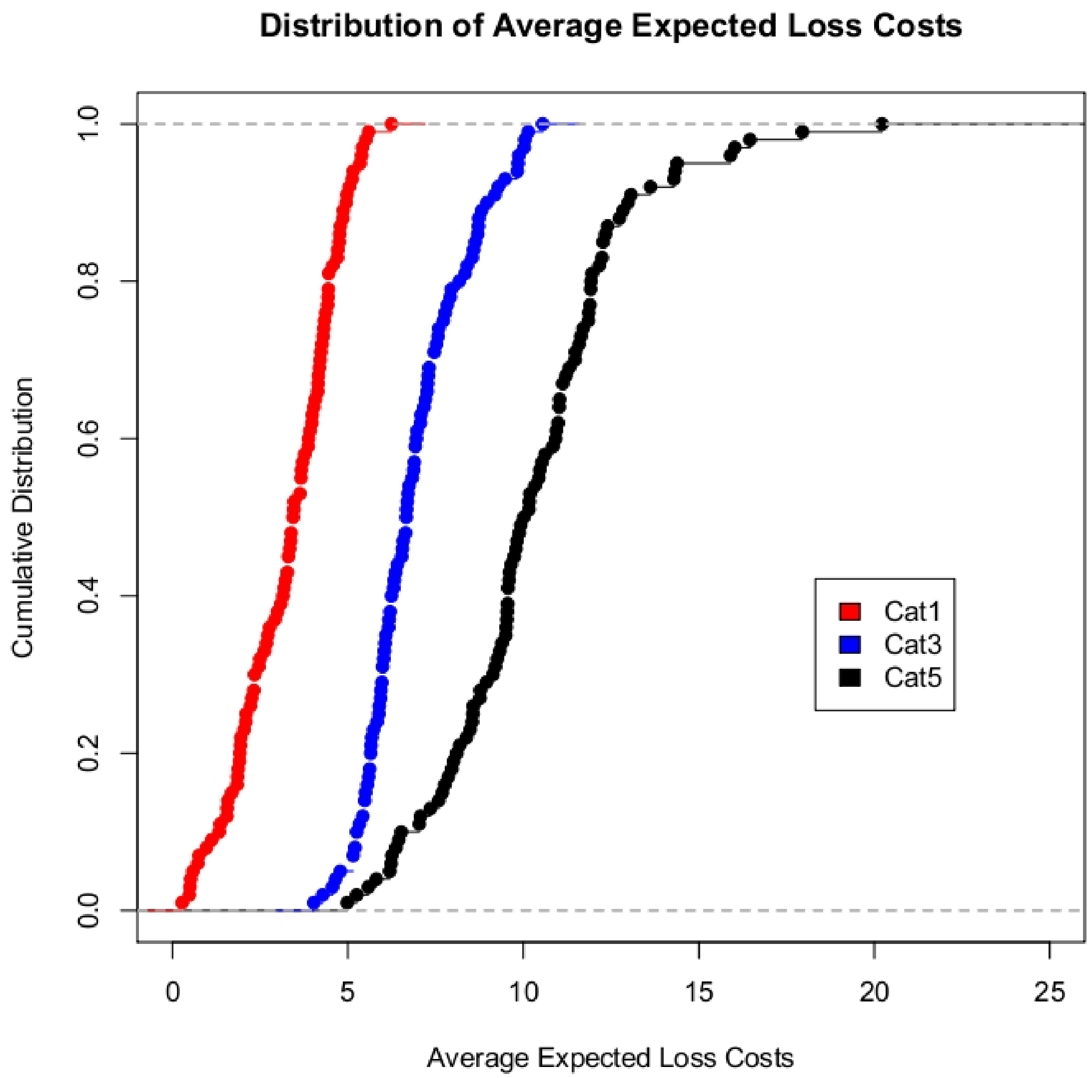


Figure 43. Comparison of CDFs of Loss Costs for all Hurricane Categories.

Figure 44 – Figure 46 show contours of the mean loss cost for Category 1, 3 and 5 hurricanes, respectively for each land based grid point. The mean percentage loss costs are found to be about between 1.14 %-8.3% for Category 1, between 3.64%-24.6% for Category 3 and between 2.57%-41.84% for Category 5 hurricanes. The largest losses occur shortly after landfall to the right of the hurricane path.

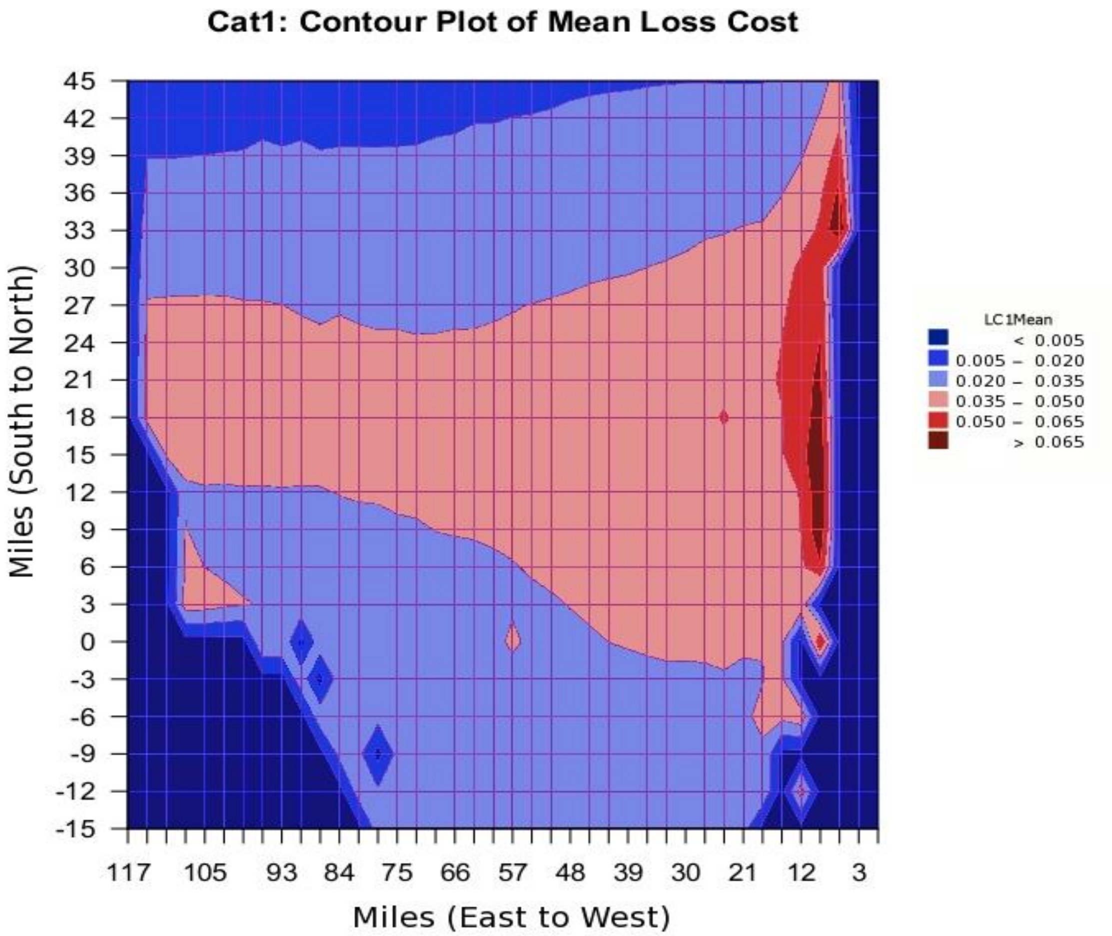


Figure 44. Contour Plot of Loss Cost for a Category 1 Hurricane.

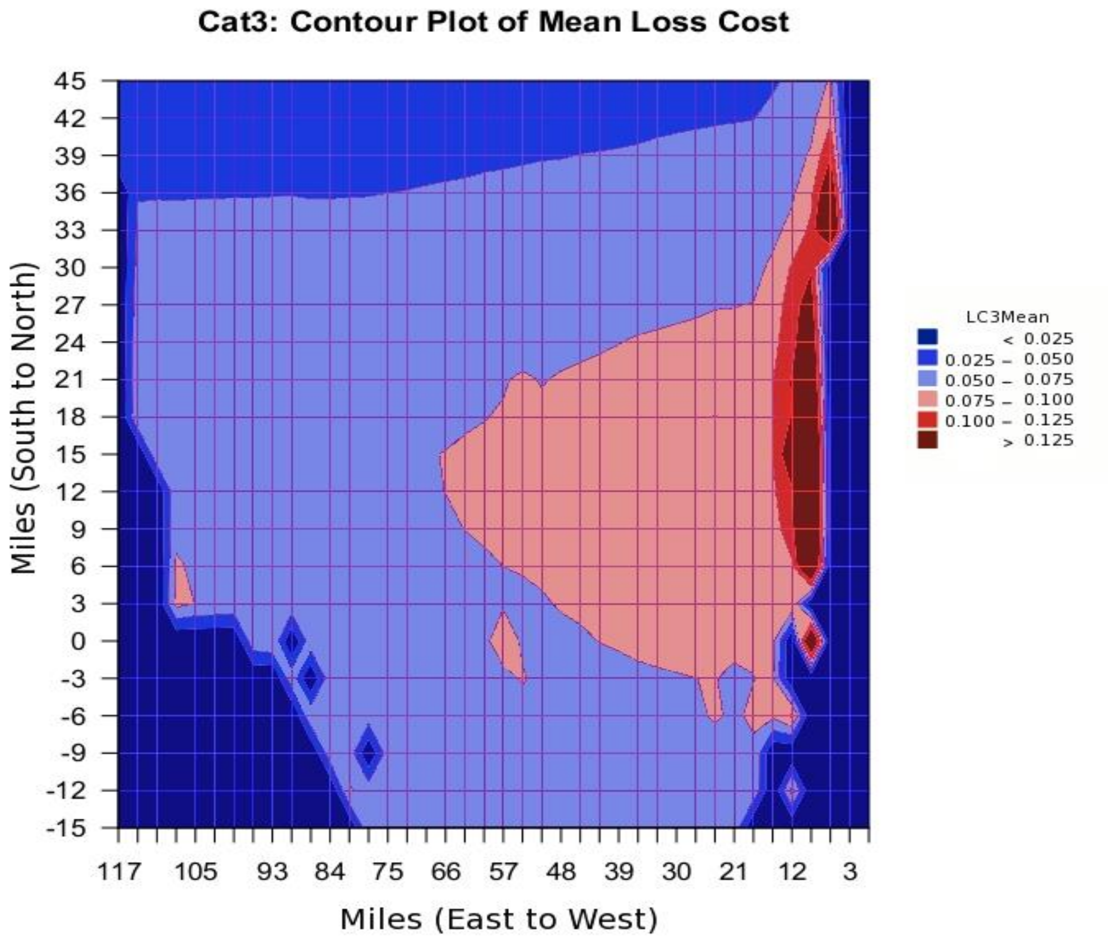


Figure 45. Contour Plot of Loss Cost for a Category 3 Hurricane.

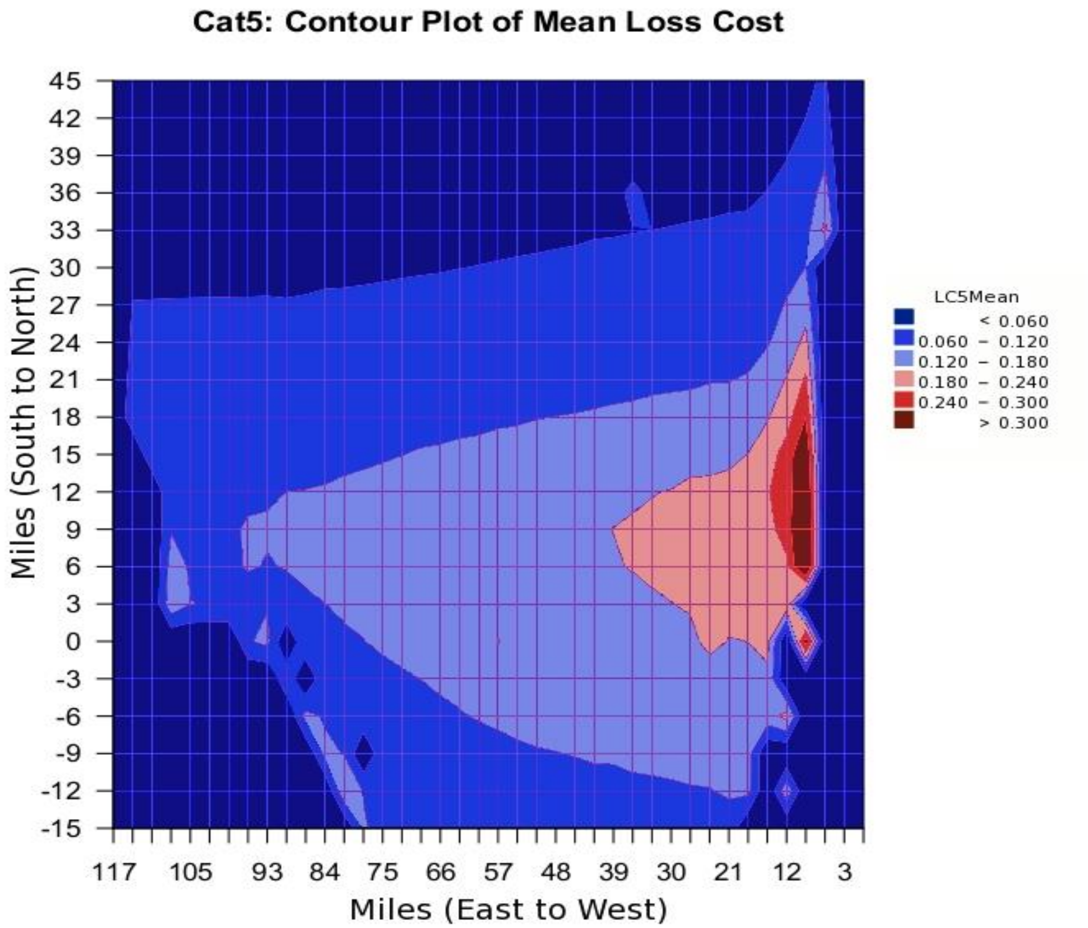


Figure 46. Contour Plot of Loss Cost for a Category 5 Hurricane.

Sensitivity and Uncertainty Analysis for Expected Loss Costs

Sensitivity analysis for the expected loss costs was conducted through the use of the standardized regression coefficients of the expected loss cost as a function of the input variables for Category, 1, 3 and 5 hurricanes. We used the methods described by Iman et al. (2000a, 2000b). The values of standardized regression coefficients are summarized in the table below.

Category	CP	Rmax	VT	Holland B	FFP
1	-0.4118	0.1039	0.1648	0.6477	0.5905
3	-0.2599	0.4033	0.1137	0.6552	0.4236
5	-0.1349	0.6939	-0.0022	0.5862	0.1801

Figure 47 gives the graph of the standardized regression coefficients for all input variables for Category 1, 3 and 5 hurricanes. From the graph, we observed that the sensitivity of expected loss cost depends on the category of the hurricanes. For a Category 1 hurricane, expected loss cost is most sensitive to Holland B parameter followed by FFP, CP and VT. For a Category 3 hurricane, expected loss cost is most sensitive to Holland B followed by FFP, *Rmax* and CP and finally for a Category 5 hurricane, expected loss cost is most sensitive to *Rmax*, followed by Holland B, CP and FFP. The expected loss cost is least sensitive to *Rmax* for Category 1 while the expected loss cost is least sensitive to VT for Categories 3 and 5.

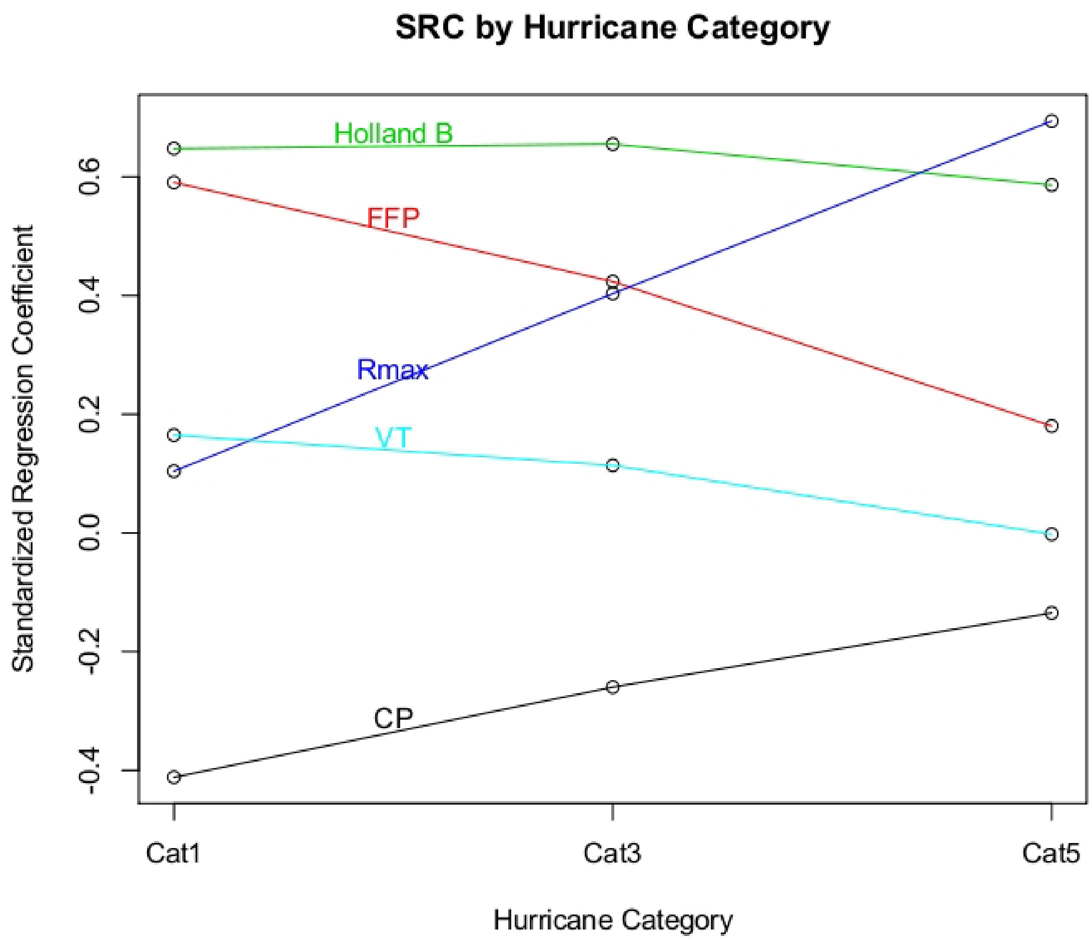


Figure 47. SRCs for expected loss cost for all input variables for all hurricane categories.

Uncertainty analysis for the expected loss costs was conducted through the use of the expected percentage reduction (EPR) in the variance of the expected loss cost as a function of the input variables for Category, 1, 3 and 5 hurricanes. We used the methods described by Iman et al. (2000a, 2000b). The values of EPR's are summarized in the table below.

Category	CP	Rmax	VT	Holland B	FFP
1	20.8398%	3.9463%	2.0921%	46.2717%	36.7245%
3	6.0155%	14.8201%	1.1625%	51.3594%	10.4668%
5	4.6087%	48.7428%	1.8529%	42.1176%	4.6455%

Figure 48 gives the expected percentage reductions in the variance of expected loss cost for Category 1, 3 and 5 Hurricanes for all input variables. As with the sensitivity analysis, the category of the hurricane determines which variable contributes most to the uncertainty of the expected loss cost. For a Category 1 hurricane, the major contributor to the uncertainty in loss cost is the Holland B parameter, followed by FFP, then CP. For a Category 3 hurricane, the major contributor to the uncertainty in loss cost is Holland B, followed by *Rmax*, then FFP. For a Category 5 hurricane, the major contributor to the uncertainty of expected loss cost is *Rmax*, followed by Holland B, then FFP, and finally CP. The variable VT has negligible effect on the uncertainty in expected loss costs.

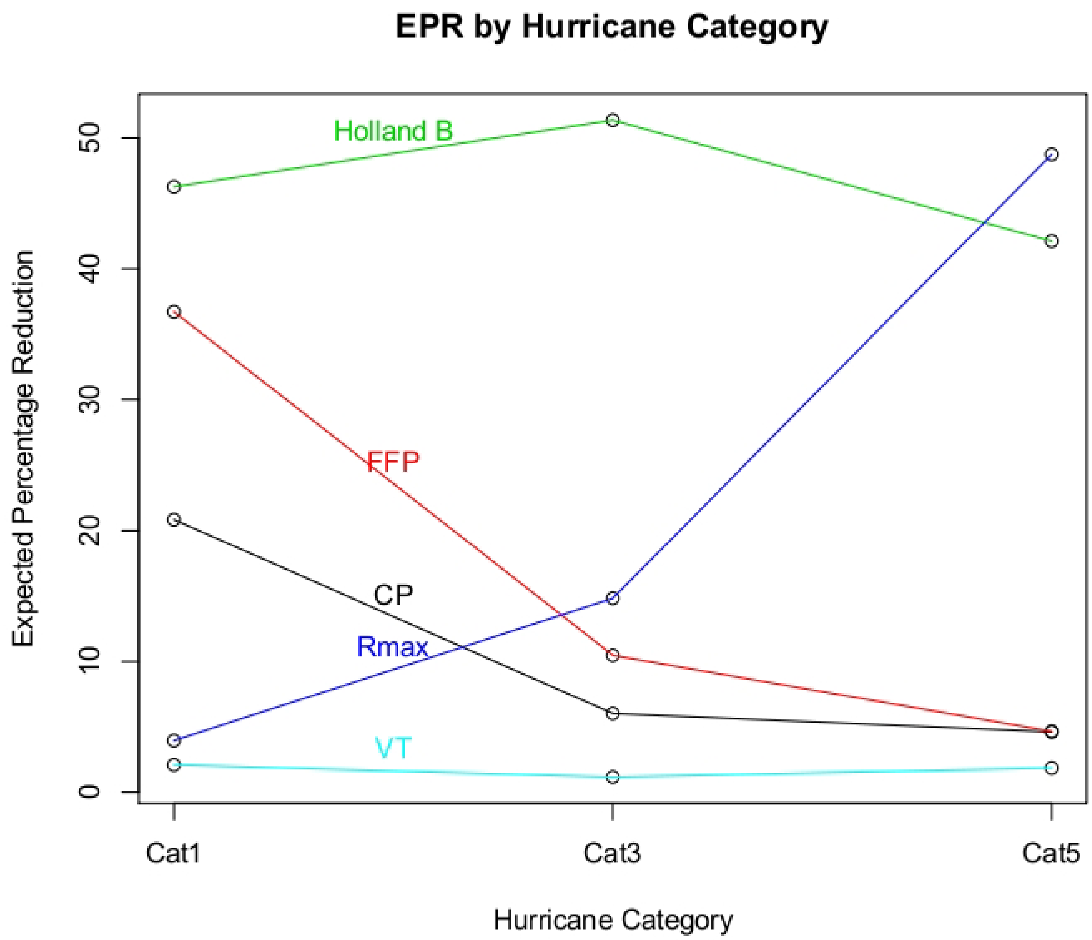


Figure 48. EPRs for Expected Loss Cost for all Input Variables for all Hurricane Categories.

VULNERABILITY STANDARDS

V-1 Derivation of Building Hurricane Vulnerability Functions

A. Development of the building hurricane vulnerability functions shall be based on at least one of the following: (1) insurance claims data, (2) laboratory or field testing, (3) rational structural analysis, and (4) post- event site investigations. Any development of the building hurricane vulnerability functions based on rational structural analysis, post-event site investigations, and laboratory or field testing shall be supported by historical data.

A component approach combines engineering modeling, simulations, engineering judgment, and insurance claim data to produce the vulnerabilities results. The determination of external damage to buildings results from structural calculations, tests, and Monte Carlo simulations. The wind loads and strength of the building components in the simulations result from laboratory and in-situ tests, manufacturer's data, expert opinion based on post-hurricane site inspections of actual damage, and codes and standards. The internal damage in the personal residential model is extrapolated from the external damage on the basis of expert opinion and site inspections of areas impacted by recent hurricanes. The internal damage in the commercial residential model results from water ingress calculations, tests, and Monte Carlo simulations. The water ingress and water absorption capacities of the building interior components in the simulations result from laboratory tests, manufacturer's data, expert opinion based on post-hurricane site inspections of actual damage, and codes and standards. The vulnerability results are calibrated and validated against insurance claim data.

B. The derivation of the building hurricane vulnerability functions and their associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles.

The method used in the derivation is based on extrapolating the results of Monte Carlo simulations of physical exterior damage through simple equations based on engineering judgment, expert opinion, and claims data. Uncertainties at each stage are accounted for by distributing the damage according to reasonable probability distributions and are validated with claims data.

The Monte Carlo component models take into account many variations in structural characteristics, and the result clearly filters through the cost estimation model. There are also different and clearly defined costing considerations applied to each structural type. These adjustments come directly from resources developed exclusively for defining repair costs to structures and therefore are theoretically sound.

C. Residential building stock classification shall be representative of Florida construction for personal and commercial residential buildings.

A detailed exposure study was carried out to define the most prevalent construction types and characteristics in the Florida residential building stock for different regions. The corresponding engineering models were built for each of the identified common structural types. In the case of the residential model and the low-rise commercial residential model, the models include differing wall types (wood and masonry) of varying strengths (e.g., reinforced or not, various roof to wall connection types), differing roof shapes (hip and gable end), various strengths of roof-to-wall connections (toe nails, clips, straps), varying window types and sizes, opening protection systems, varying garage door pressure capacities, and one and two story houses and one-to-three story commercial residential buildings.

Models of varying combinations of the above characteristics (e.g., wood frame, gable end, no window shutters) were created for four different regions in Florida. In all cases, the probabilistic capacities of the various components were determined by a variety of sources, including testing, test results in the literature, in-field data collection (post-hurricane damage evaluations), manufacturer's specifications and manufacturer's test data, and expert opinion.

In the case of the mid-/high-rise commercial residential model (buildings with more than three stories), the models include different apartment units corresponding to different building layouts (interior or exterior entry door), different locations within the floor plan (corner or middle units), different heights (subject to different probabilities of missile impact and wind speed), and different openings (windows, doors, sliders) with different protection options (none or impact resistant).

D. Building height/number of stories, primary construction material, year of construction, location, building code, and other construction characteristics, as applicable, shall be used in the derivation and application of building hurricane vulnerability functions.

The structural models include options that allow the representation of building code revisions. Three models were derived for each structural type: weak construction, medium construction, and strong construction. For example, each model for wood frame and gable roof homes has weak, medium, and strong versions. The assignment of a given strength level is based on the assumed age of the home being modeled and the available information on construction practice in that region of the state in that era of construction. Florida Building Code requirements that apply to the repair of existing homes are also taken into consideration when computing the repair costs of a structure. Separate models were also developed for manufactured housing constructed based on pre- and post-1994 HUD regulations and for different wind zones.

In addition to the various models that reflect construction type, region of Florida, and era of construction, each model has numerous additional strength features that can be adjusted before simulations are conducted to represent various combinations of mitigation features. For example, a weak constructed home in central Florida with masonry walls (no reinforcing) may have been recently re-roofed with renailed roof decking and modern code-approved shingles. The simulation model is capable of reflecting this combination of weak original construction and new, strong roof sheathing and roof cover mitigation.

E. Hurricane vulnerability functions shall be separately derived for commercial residential building structures, personal residential building structures, manufactured homes, and appurtenant structures.

Hurricane vulnerability functions are independently derived for commercial residential building structures, personal residential building structures, manufactured homes, and appurtenant structures.

F. The minimum windspeed that generates damage shall be consistent with fundamental engineering principles.

The minimum one-minute average sustained wind speed at which some damage is observed is 38 mph (3-second gust 50 mph) for appurtenant structures. Site-built and manufactured homes have a very small probability of some very minor damage at 42 mph (3-second gust 55 mph). This probability becomes more significant at 46 mph (3-second gust 60 mph) and increases with higher wind speed. Simulations are run for 3-second gusts from 50 mph to 250 mph in 5 mph increments.

G. Building hurricane vulnerability functions shall include damage as attributable to windspeed and wind pressure, water infiltration, and missile impact associated with hurricanes. Building hurricane vulnerability functions shall not include explicit damage to the building due to flood (including hurricane storm surge and wave action).

The vulnerability functions do not explicitly include damage due to flood, storm surge, or wave action. The vulnerability functions for all models (site-built residential, manufactured homes, low-rise commercial residential, and mid-/high-rise commercial residential) include damage due to wind pressure, missile impact and water infiltration.

Disclosures

1. Describe any modifications to the building vulnerability component in the hurricane model since the previously-accepted hurricane model.

There has been modifications in the commercial residential low-rise model and in the commercial residential mid/high-rise model. Standard G-1, disclosure 7, details the rationale for these changes.

<u>COMMERCIAL RESIDENTIAL LOW-RISE MODEL MODIFICATIONS</u>

a) New interior and contents damage model

The CR-LR model V8.1 has a new component-based interior damage model. Although the contents vulnerability model belongs to standard V-2, it is partially described here, because interior and content are intrinsically linked to each other in the same vulnerability model.

Interior and contents description.

The new methodology divides the interior of the building into 6 compartments, and within each compartment, it divides the interior components of the building into ceiling, partitions, flooring, cabinets, and utilities (electrical, plumbing and mechanical components), in addition to contents, which is part of the interior percolation mechanism, although as a separate component.

The contents can include various types of components located inside a building. It can be appliances and electronics, which would not absorb a high amount of water, all the way to couches and rugs, which have high water absorption capacity. The FPHLM model divides the contents into three categories: water absorbent contents (WA) (e.g. mattresses); non-water absorbent contents (NA) (e.g. electronics); and, appliances (AP). In addition, the model distinguishes between contents in the apartment units, and contents in the common areas (CA), which includes only water absorbent contents (WA-CA) and non-water absorbent contents (NA-CA). The reason for keeping appliances in a different category is that although they are physically located inside each apartment unit, in the case of a commercial residential apartment building they belong to the building owner and not to the renter of the apartment. As such, the building contents insurance policy will cover the appliances together with the building contents in the common areas. In the case of a condominium association, the contents insurance policy will cover only the contents in the common areas. Hence, the need to estimate separately the damage to contents in the common areas.

Water absorption capacities of interior components and contents.

Ceilings and partitions are made of gypsum. Gypsum boards typically used for partitions and ceilings in commercial residential buildings are regular non-water-resistant boards, technically referred to as regular gypsum wallboard (panel A for ½” thickness and panel C for thickness of ¼”) or type X gypsum board (panel B for 5/8” thickness) (ASTM C473-17, 2017; ASTM C1396, 2014). Typically, these regular boards are not tested for water resistance. Only the water-resistant boards, technically referred to as gypsum sheathing (panel D) and water-resistant gypsum backing board (panel E) are tested for water resistance, according to ASTM C473 (2017) and ASTM C1396 (2014). The water resistance – core (WRC) and the water resistance – surface (WRS) define the water resistance of such boards. WRC is the gain in weight of the wet board as a percentage of the original dry weight. For core treated and surface treated gypsum boards (D and E panels), for instance the ones used in wall gypsum sheathing, ASTM C473 (2017) tests show that after being submerged for two hours, they can only absorb 5.5% and 4% of their weight, respectively, with a coefficient of variation (cov) close to 20%. In addition, ASTM C1396 (2014) specifies that their WRC cannot exceed 10%. For non-water-resistant boards, manufacturers recommend a value close to 50% (National Gypsum, 2008). Consequently, the model treats the WRC of the gypsum board as a stochastic variable with a Gaussian probability distribution function (pdf) with a mean value of 50% and a cov of 20% (based on the ASTM C473 test results) for regular non-water-resistant gypsum boards, which are used for interior partitions and ceiling. For these regular boards, the run-off is 64% of the impinging water based on test results from the Wall of Wind also (Raji et al., 2020). The maximum water absorption capacity (WAC) of the panels is the WRC multiplied by the estimated dry weight of the panels.

For carpet flooring, the mean water absorption capacity is 20 oz/ft^2 of the floor area based on manufacturer catalogs and engineering judgment to account for both carpet surface and cushion backing water absorption (Matsinc, 2014). The maximum water absorption capacity (WAC) of a carpet floor is the value of absorption multiplied by the floor area.

The amount of water absorption by contents is the sum of the absorption from many water absorbent contents in a building. Overall, engineering judgment informed by data from manufacturer catalogs for various types of contents resulted in a total amount of water that all the contents can absorb at around 40.2 in^3/ft^2 for all the models in the FPHLM.

Water propagation mechanism

For each combination of wind speed and direction, the program loops over 2000 simulations. Disclosure 13 explains how, for each simulation, the program computes the rainwater ingress through defects and breaches of the external components of the roof and wall envelope (Pita et al., 2012; Johnson et al., 2018).

As the hurricane rotates around the building, the method keeps track of the rainwater ingress, and distributes it among ceiling, partitions, and flooring, and the contents, within each of the compartments, for each of the possible wind octant directions (from -180^o to +180^o, in 45^o increments, with 0^o being the direction of maximum wind speed). The results of large-scale and full-scale tests, carried on at the Wall of Wind (Raji et al., 2020), which are direction dependent, govern the distribution of the rainwater ingress among the different components. As the water accumulates within each internal component and contents, it propagates to other adjacent components and contents, and percolates from floor to floor if the components or contents exceed their maximum absorption capacity (Silva de Abreu, 2019).

The excess water is the accumulated volume of water in a component or contents minus its water absorption capacity (WAC). The green arrows in Figure 49 summarize the rainwater ingress vertical propagation. Starting with the roof at the top floor, the water ingresses through the defects and breaches of the roof cover and roof sheathing, and distributes among the 6 compartment ceilings. The model calculates the excess water from the ceiling, and distributes it randomly among partitions, contents, and flooring. The model assumes a Gaussian distributions, with a coefficient of variation of 0.2, and with mean values of 40% of the excess water from the ceiling going to the partitions and 40% to the contents, with the balance going to the flooring.

The blue arrows in Figure 49 summarize the rainwater ingress horizontal propagation. The water enters through the building vertical defects and breaches, and propagates to partitions, floors, and contents. 36% of the water that impinges on the partitions is absorbed by the partitions, up to their WAC, and the remaining 64% runs-off to the contents and flooring.

Out of all the water that reaches the contents, 37.5% goes to WA, 27.5% to NA, 15% to AP, 10% to WA-CA, and 10% to NA-CA. Engineering judgment based on the distribution of contents described in (USACE, 2006), and analyses of typical residential layouts, lead to these proportions. The common area contents gets less water due to its central position in the building (usually less exposed to water ingress).

The excess water from partitions and contents percolates to the flooring (see orange arrows in Figure 49). The percolation of excess water from the flooring depends on the flooring type. For each simulation, the model randomly selects either carpet floor or tile floor. For a tile floor, the model assumes no absorption and all the water that reaches the floor is excess water. In the case of a 1-story building that excess leaks out of the structure, but for a multi-story building, 20% of that excess percolates to the ceiling below through cracks and small openings on the floor and the remaining 80% leaks out. For the case of carpet floor, when the floor gets saturated, and there is excess water, the excess leaks out of the structure for a 1-story building, but for a multi-story, 70% percolates to the ceiling below and 30% leaks out of the building. Different propagation and percolation schemes can easily be implemented.

The method keeps track of the accumulation of water from each wind direction, into each interior component, and contents, within each compartment.

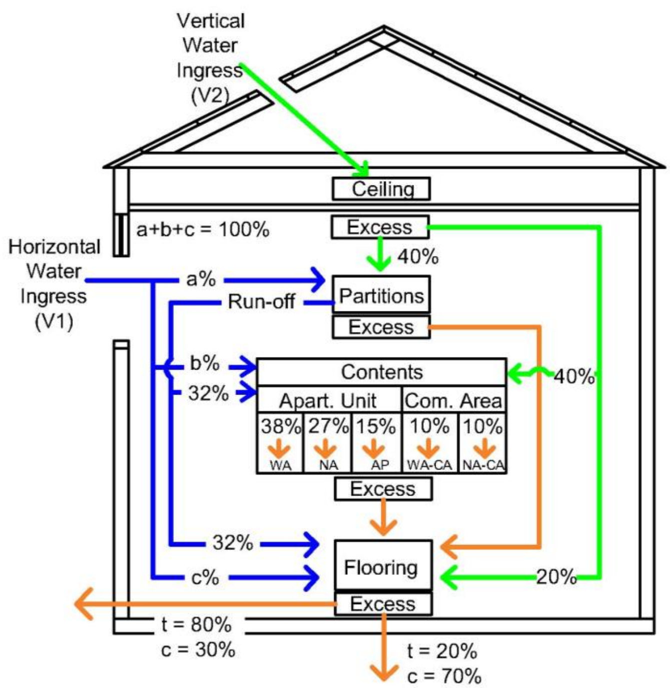


Figure 49. Monte Carlo simulation procedure to predict building damage.

Damage evaluation

The damage of each interior component depends on its moisture content (MC). MC is the gain in weight of the wet board as a percentage of its final wet weight. For the gypsum boards (partitions and ceiling), damage can start with a MC of 5%, and a moisture content of 17% or more represents 100% damage (Lewis, 2020). The timing of any restoration effort plays an important role, and gypsum manufacturers advise that partitions and ceiling boards can be dried and restored only if the water is removed from them no later than 48 hours after getting wet (Gypsum Association, 2015). After that, the water will cause mold and the component needs to be replaced. For flooring, the 100% damage threshold value is an MC of 14% (Berry et al., 2020).

A polynomial equation relates the damage to MC for interior components (see Equation 1). Figure 50 is a plot of Equation 1 for the gypsum boards and carpet. Manufacturer catalogs and expert opinion, plus the need to achieve the threshold values listed above, inform the values of multiplier α and exponent β. The concave upwards shape of the curves reflects the fact that at very low levels of MC, the components can be dried and saved if remedial action occurs rapidly.

$$Int\_Damage = \alpha \times (MC)^{\beta} \qquad (1)$$

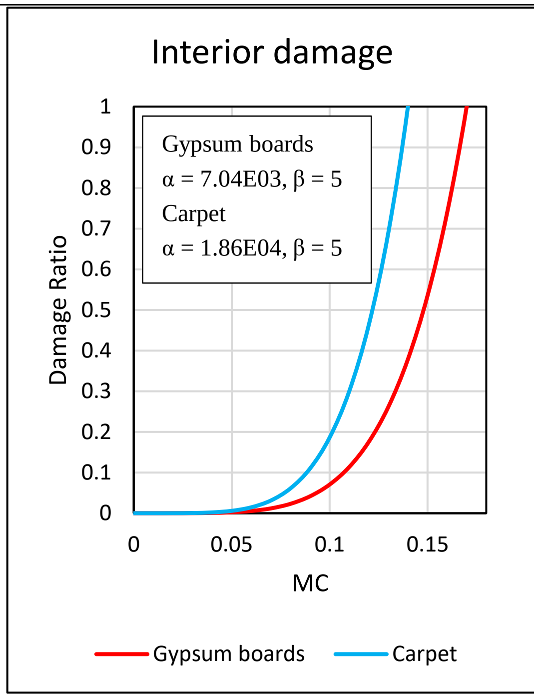


Figure 50. Damage evaluation curves for interior

The damage to cabinets and electrical components is a weighted average of the damage to the components that support them. For cabinets, the damage is a weighted average of 60% of the flooring damage and 40% of the partitions damage. Similarly, electrical and mechanical utilities damage is a weighted average of 40% of the ceilings damage and 60% for the partitions damage. The model assumes that mechanical and plumbing components suffer similar damage and their damage is based on an average of external wall and roof damage, to reflect the fact that their damage is more a result of wind damage than rain penetration.

b) Updated cost analysis

After the model has computed the physical damage of each interior component and contents, it converts these physical damage ratios into monetary damage cost ratios by multiplying the physical damage ratio of each component by its cost participation factor with respect to the total building value. The cost participation factors for interior components were added to the cost analysis, and the ones for exterior components were updated with the help of an experienced contractor and RSMeans (2015). The cost update resulted in more realistic cost proportions of each component with respect to the building value. The sum of the damages of each interior component results in the total monetary damage ratio of the interior of the building. The combination of interior and exterior damage proceeds as in previous versions of the model, without further changes. See Figure 53 for more details on these processes.

c) Differentiation between apartment buildings and condo associations.

Strictly speaking, this section belongs to the actuarial model, but it is included here for the sake of completeness. V8.1 of the CR model transforms building damage into insured losses for either apartment building (AB) or condominium association (CA). In the case of an apartment building, all the building damage is covered by the insurance policy, and the insured value is a proxy for the building value. In the case of condominium association building, only the building external damage and the interior damage to the common areas and utilities is covered by the insurance policy, and the insured value is a fraction of the building value. The coefficient ξ represents the portion of the total interior covered by a CA policy. The coefficient ρ is the ratio between the overall building value and the insured value in a CA insurance policy. These coefficients were derived from a cost analysis of the difference between AB and CA in terms of covered building components, using (RSMeans, 2015). These coefficients vary based on the number of stories of the building. For a 1-story building, ξ is 0.43 and ρ is 1.32. For a 2-story building, ξ is 0.41 and ρ is 1.49. For a 3-story building, ξ is 0.43 and ρ is 1.55. To determine these factors, the team took into account the interior components covered by CA policies, such that ξ equals 0.43 means that the value of the interior covered by a CA policy represents 43% of the total cost of the interior.

The resulting Equations 2 and 3 convert the overall building damage ratio into building damage for both AB and CA, respectively.

$$Bldg_{loss_{AB}} = BDR * Bldg\_limit \quad (2)$$

$$Bldg_{loss_{CA}} = (BDR - (1 - \xi) * IDR) * \rho * CA\_limit \quad (3)$$

Where:

$Bldg_{lossAB}$ = Apartment building damage

$Bldg_{lossCA}$ = Condominium association damage

Bldg_limit = Building insured limit; CA_limit = Condo association insured limit

BDR = Building damage ratio = building damage over building value

IDR = Interior damage ratio = interior damage over building value

ξ = % of interior corresponding to common areas

ρ = Building Value/Condominium Association Value

COMMERCIAL RESIDENTIAL MID/HIGH-RISE MODEL MODIFICATIONS

The engineering team implemented several improvements to the MHR model.

a) Improved interface between personal residential portfolios with condo units (owners or rentals) and the MHR model.

Identification of condo owners and condo rental policies

Insurance portfolios can be either personal residential (PR) portfolio or commercial residential (CR) portfolio. PR portfolios can include condo units, which in turn might correspond to the case of renter or owner. PR owner policy covers the interior of the condo unit, while PR renter policy does not. Condo unit policies in mid/high-rise buildings are processed through the MHR model. V8.1 of the MHR model assigns a flag to a policy, which lets the model know if the policy is a PR condo unit, either owner or rental, or if it is a CR policy, either apartment building or condo association. The value of the building, contents and ALE/TE will be assigned based on the flags.

Assignment of missing total # of stories based on insurance stats

In the cases of condo units, if the total number of stories of the building is unknown, the model V8.1 will assign the total number of stories based on location (i.e. county) and whether or not it is a rental (insurance code HO-4) or owner policy (insurance code HO-6), based on insurance portfolio statistics. These statistics result from the aggregation of insurance portfolios from the FPLHM clients. Because HO-4 renters' policies overwhelmingly include single family homes or town-houses, the average number of stories for renters is either 1 or 2, therefore in that case they will be processed by the PR model. But for condo units owners HO-6 policies, the mean number of building number of stories varies with the county, with Miami-Dade having the tallest number at 15. When the total number of stories of the building, which houses the unit, is greater than 3, the MHR model processes the policy.

Computation of condo loss depending on whether the location of the condo within the building is known or not.

If the story of the condo unit (s_condo) is available, V8.1 of the model will output expected unit damage value for building, contents ($EUBV^{C}$) and ALE ($EUBV^{ALE}$) for the unit at that specific story "s_condo", based on the expected interior damage ratio at that story. If the story of the condo unit is unknown, the model will output the expected damage value based on an average of the expected interior damage over all the stories

b) Treatment of open and closed layouts.

If the type of layout is unknown, the FPHLM analyses the policy twice, for open and closed layouts, and calculates the weighted average of the losses. The weights are based on population statistics and depend on the location (coastal vs. inland) and number of stories.

c) Treatment of missing data on building geometry (# of stories, building area, # of units per story).

The model handles missing data on building geometry (# of stories, building area, # of units per story) in a way consistent with the information available in the portfolio (insured value of the building and location).

Total number of stories.

If the number of stories is not available, the model will assign the number of stories based on population statistics, which take into account the building value and the residency type (apartment building or condominium building). These statistics come from the aggregated insurance portfolios of the FPHLM clients.

Total building area.

When missing, the model V8.1 calculates total building area as the building value divided by the unit cost per square foot. A cost analysis using (RSMeans, 2015) produced the unit cost per square foot as a function of the number of stories.

Number of apartments per story

The number of apartments per story is defined as the division of total number of units (#Units) by the number of stories. #Units equals total building area divided by average apartment area, if #Units is unknown. The average apartment area is not requested in the current input specification. It is defined as 1125 square feet.

d) Updated damage cost analysis

The model benefits from an updated damage cost analysis, for both exterior and interior damage, which takes into account the differences between apartment and condominium buildings.

Interior Cost Coefficients

Insurance policies for apartment buildings and condo associations cover different components so the apartment building insured value and condo association insured value will be different for the same building. The new MHR model V8.1 derives interior cost coefficients (K_I) with different Building Values in the denominator, which reflect the actual cost distribution of apartment buildings, or condo association policies. The interior cost coefficients used to estimate interior damage value for AB and CA are, respectively:

$$K_{I_{AB}} = \frac{Value\ of\ building\ interior}{Value\ of\ building} \qquad (4)$$

$$K_{I_{CA}} = \frac{Value\ of\ building\ interior\ Common\ Areas}{condo\ association\ value} \qquad (5)$$

The purpose of KI is to estimate the actual Interior Value from the Insured Value, as:

$$Interior\ Value = K_I * Insured\ Value \qquad (6)$$

Exterior Cost Coefficients

In MHR model V7.0, the cost of damage to the openings equals the cost of each opening multiplied by the number of damaged openings. Opening damage curves are used to estimate the number of damaged openings, as a function of the wind speed at each story. The damage cost estimation is not linked to the insured value of the building.

Model V8.1 uses exterior cost coefficients and exterior damage ratios to calculate the exterior damage value.

The equation for the external cost coefficients are:

$$K_{EW} = \frac{cost\ of\ exterior\ windows}{Insured\ value} \quad (7a)$$

$$K_{ED} = \frac{cost\ of\ doors}{Insured\ value} \quad (7b)$$

$$K_{ES} = \frac{cost\ of\ sliders}{Insured\ value} \quad (7c)$$

Where:

- K_{EW}, K_{ED}, K_{ES} are the exterior cost coefficient for windows, doors, and sliders.
- The Insured Value in the denominator is either the value of the building for apartment building or the condo association value for condominium building.

Opening damage curves are used to calculate the number of damaged opening, as in V7.0. But these numbers are transformed into expected exterior damage ratios as follows:

$$EEDR_W(s) = \left(\sum_{j=M,C} a_j \cdot \frac{V_W^j(s, W_o(s))}{\#Windows^j}\right) / \sum_{j=M,C} a_j \quad (8)$$

$$EEDR_D(s) = \left(\sum_{j=M,C} a_j \cdot V_D^j\big(s, W_o(s)\big)\right) / \sum_{j=M,C} a_j \quad (9)$$

$$EEDR_S(s) = \left(\sum_{j=M,C} a_j \cdot V_S^j\big(s, W_o(s)\big)\right) / \sum_{j=M,C} a_j \quad (10)$$

where,

- $EEDR_W(s)$, $EEDR_D(s)$, and $EEDR_S(s)$ are expected exterior damage ratios of windows, doors, and sliders at story “s”.
- a_j is the number of middle or corner apartment units. j can be M for middle units, or C for corner units.
- $\#Windows^j$ is the number of windows in the middle or corner units.
- V_W^j, V_D^j, V_S^j are opening damage curves for windows, doors, and sliders. The opening damage curves give the relationship between the maximum wind speed and the number of damaged openings at story “s”.
- $W_o(s)$ is the wind speed at a specific story "s".

The cost of damage to the openings equals exterior damage ratio multiplied by the value of openings. The value of openings is the product of the exterior cost coefficient and the insured value. Expected damage value including exterior and interior damage values per story is:

$$EDV^B(s) = (K_{EW} \cdot EEDR_W(s) + K_{ED} \cdot EEDR_D(s) + K_{ES} \cdot EEDR_S(s) + K_I \cdot EIDR(s)) \cdot \frac{BV}{S} \quad (11)$$

where,

- $EDV^B(s)$ is expected damage value for a specific story s.
- $K_{EW} \cdot \frac{BV}{S}, K_{ED} \cdot \frac{BV}{S}, K_{ES} \cdot \frac{BV}{S}$ are the value of windows, doors, and sliders per story. BV is the insured building value for apartment building, and condo association value for condominium building. S is total number of stories.
- $EIDR(s)$ is expected interior damage ratio for a specific story s.

The equations insure a link between both the exterior and interior damage values and the building value.

2. Provide a flowchart documenting the process by which the building hurricane vulnerability functions are derived and implemented.

The flow chart in Figure 51 summarizes the procedure used in the Monte Carlo simulations to predict the external damage to the different structural types for the case of residential buildings and commercial residential buildings. The random variables include wind speed, pressure coefficients, and the resistances of the various building components (roof cover, roof sheathing, openings, walls, connections).

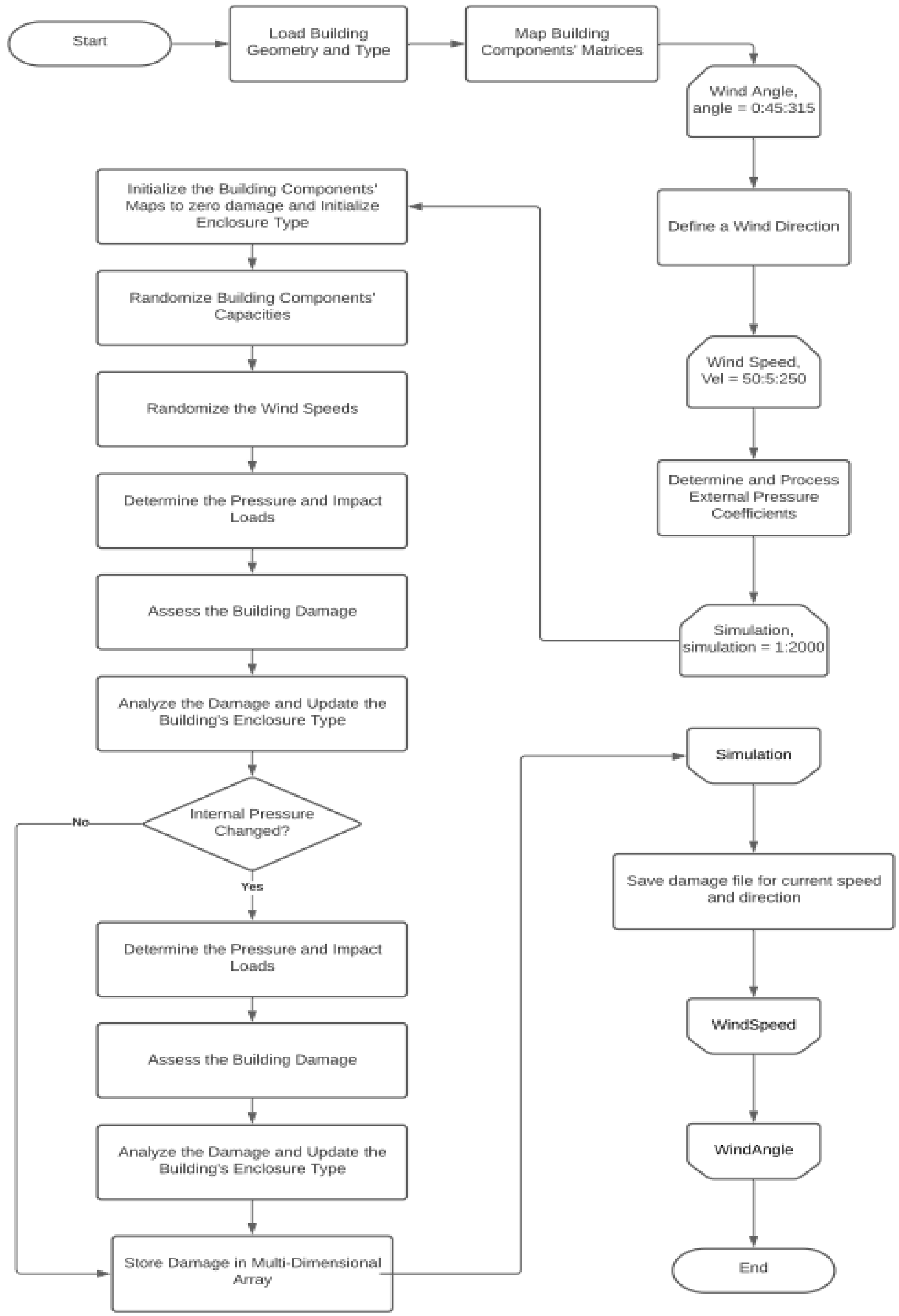
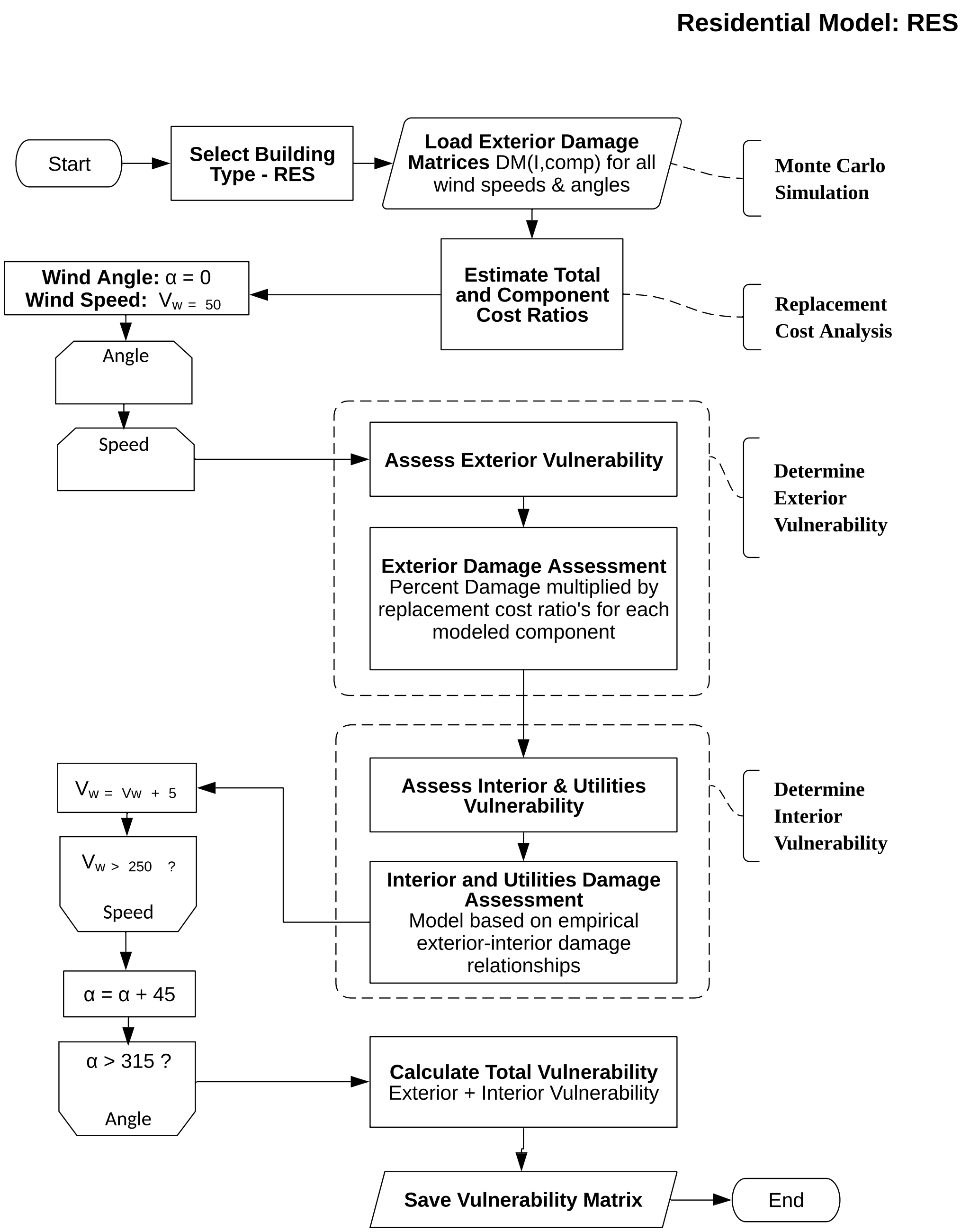


Figure 51. Monte Carlo simulation procedure to predict building damage.

The flow charts in Figure 52 summarize the procedure used to convert the results of the Monte Carlo simulations of physical external damage into vulnerability matrices for the cases of the personal residential model (left) and commercial residential model (right).



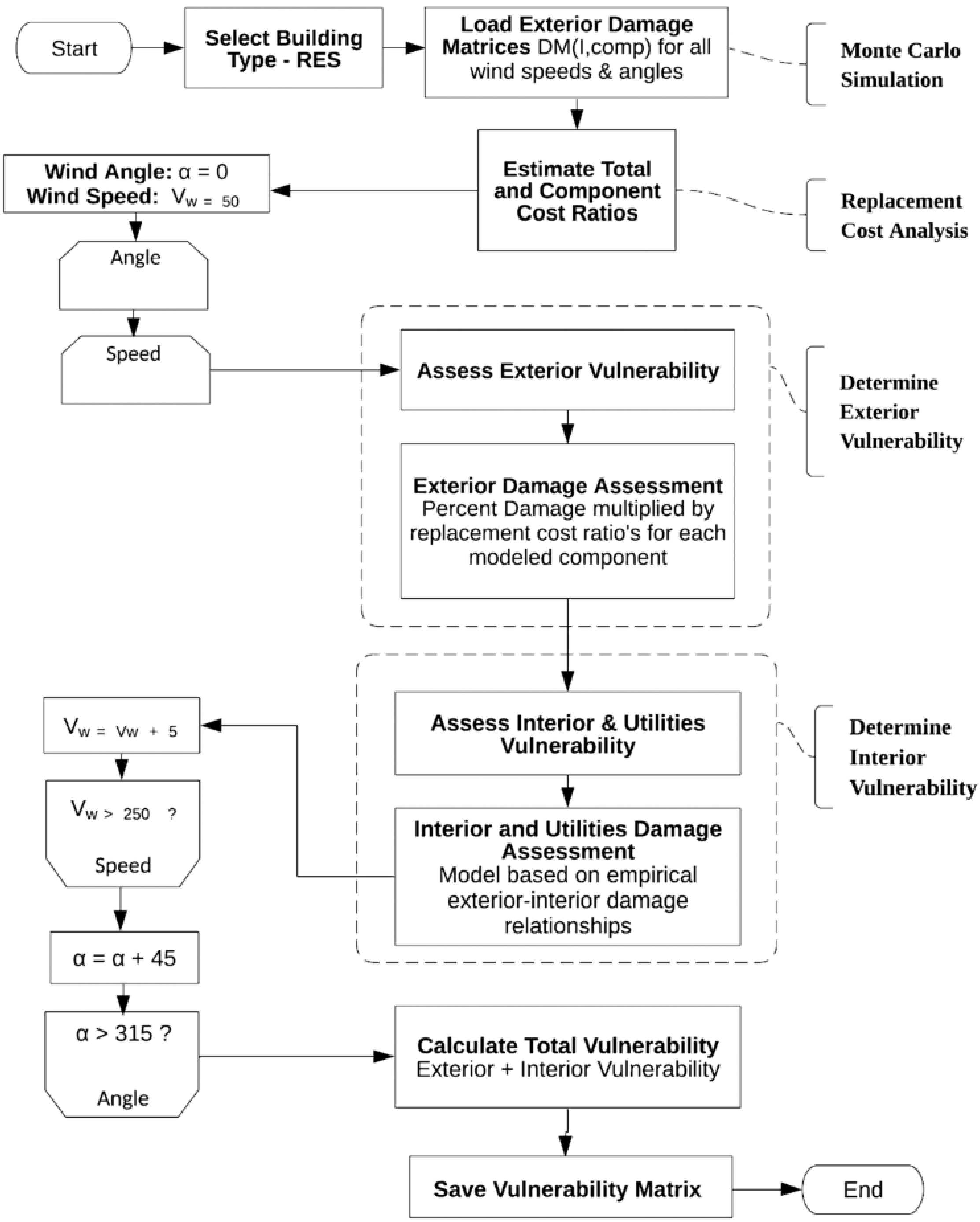


Figure 52. Procedure to create PR building vulnerability matrix.

The flow chart in Figure 53 summarizes the procedure to convert the results of the Monte Carlo simulations of physical external damage into vulnerability matrices for the case of commercial residential model.

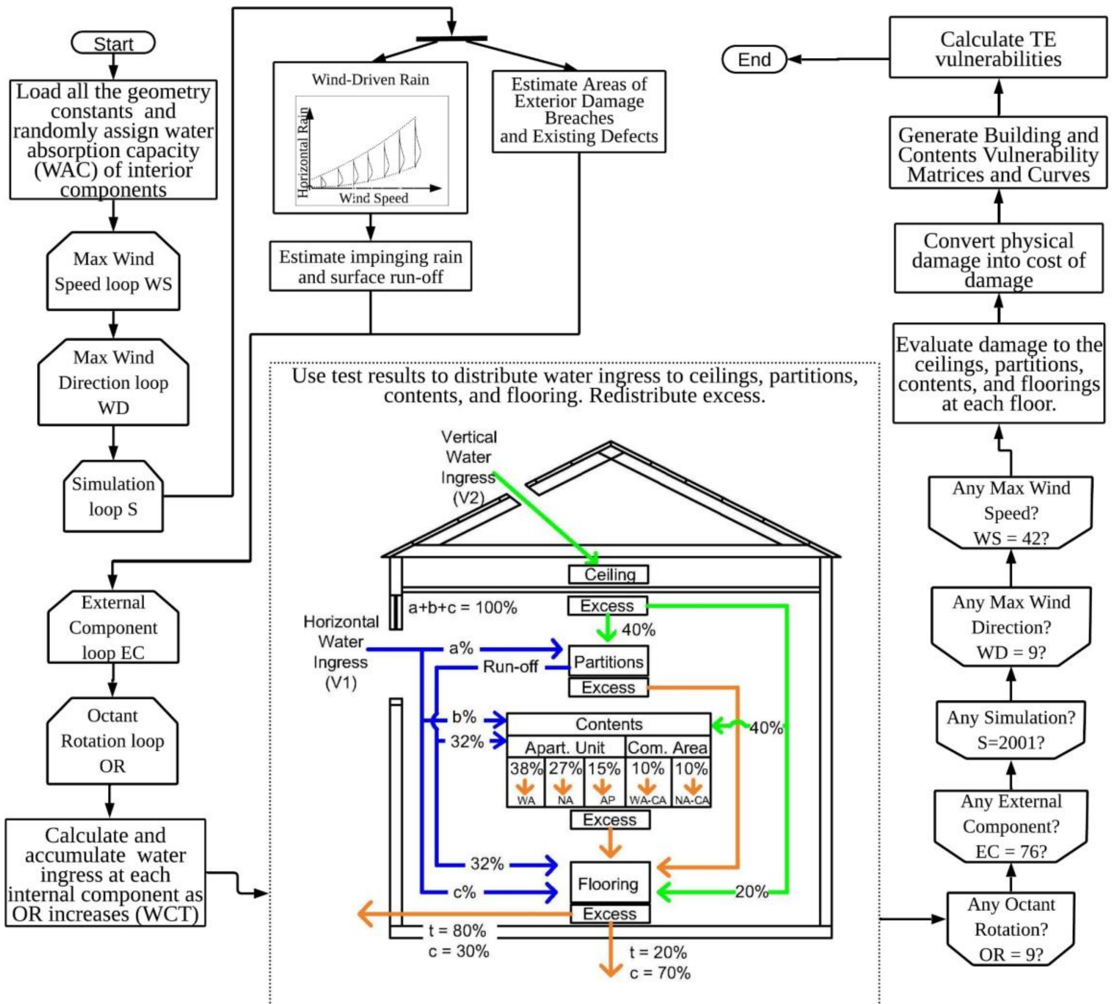
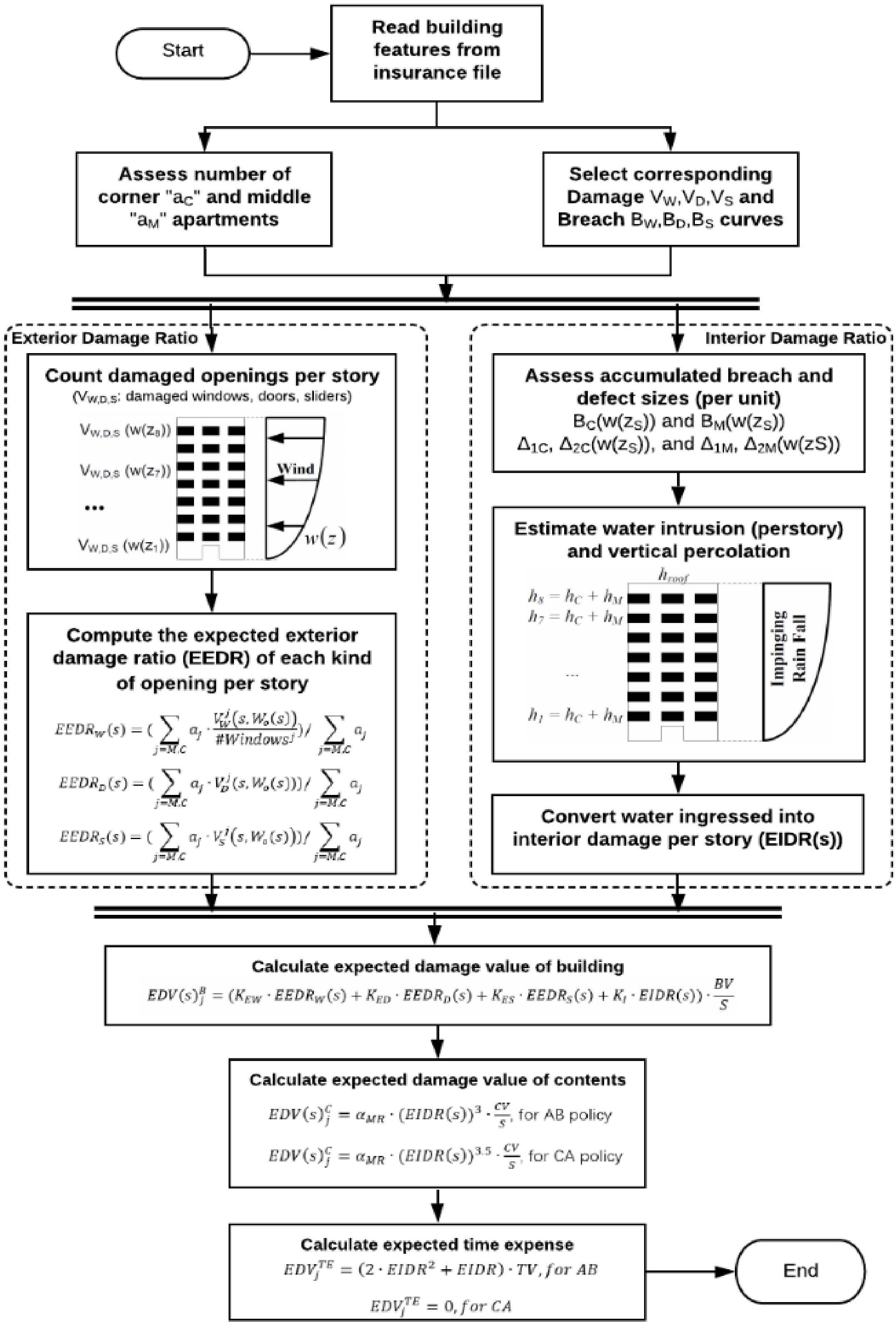


Figure 53. Procedure to create CR-LR building and contents vulnerability matrices.

The flowcharts in Figure 51 and Figure 52 are also partially applicable to the apartment facades of the mid-/high-rise commercial residential model (MHR), in which building components modeled include windows, entry doors, and balcony (sliding-glass) doors. In the case of MHR, a process similar to the one described above is followed to derive exterior vulnerability and breach curves for different openings of typical apartment units. These curves are derived for the cases of open and closed buildings, for corner and middle units, with different opening protections (with or without impact-resistant glass, with or without metal shutters). Each vulnerability curve for openings of corner or middle apartment units (window, door, or slider) gives the number or fraction of openings damaged as a function of wind speed. Each breach curve for openings of corner or middle apartment units (window, door, or slider) gives the breach area in ft2 of opening damaged as a function of wind speed.

The flow chart in Figure 54 summarizes the procedure to convert the apartment unit opening vulnerability and breach curves into an overall estimate of building vulnerability. Disclosure 1 provides details for the different equations in the flow chart.



$$EEDR_W(s) = \left(\sum_{j=M,C} a_j \cdot \frac{V_W^j(s, W_o(s))}{\#Windows^j}\right) / \sum_{j=M,C} a_j$$

$$EEDR_D(s) = \left(\sum_{j=M,C} a_j \cdot V_D^j(s, W_o(s))\right) / \sum_{j=M,C} a_j$$

$$EEDR_S(s) = \left(\sum_{j=M,C} a_j \cdot V_S^j(s, W_o(s))\right) / \sum_{j=M,C} a_j$$

$$EDV(s)_j^B = (K_{EW} \cdot EEDR_W(s) + K_{ED} \cdot EEDR_D(s) + K_{ES} \cdot EEDR_S(s) + K_I \cdot EIDR(s)) \cdot \frac{BV}{S}$$

$$EDV(s)_j^C = \alpha_{MR} \cdot (EIDR(s))^3 \cdot \frac{CV}{S}, \text{ for AB policy}$$

$$EDV(s)_j^C = \alpha_{MR} \cdot (EIDR(s))^{3.5} \cdot \frac{CV}{S}, \text{ for CA policy}$$

$$EDV_j^{TE} = (2 \cdot EIDR^2 + EIDR) \cdot TV, for\ AB$$

$$EDV_j^{TE} = 0, for\ CA$$

Figure 54. Exterior and interior damage assessment for MHR.

3. Describe the nature and extent of actual insurance claims data used to develop the building hurricane vulnerability functions. Describe in detail what is included, such as, number of policies, number of insurers, dates of hurricane loss, amount of hurricane loss, and amount of dollar exposure, separated into personal residential, commercial residential, and manufactured homes.

Pre-2004 Personal Residential Claims Data

At the request of the Florida Department of Financial Services (FDFS), four insurance companies provided insurance claims data for several hurricanes that impacted Florida prior to 2004, including Andrew. The companies provided the following two types of files:

1. Sample files with 10% of the exposure selected at random, plus the claims on this 10% exposure since 1996

2. Hurricane files with premium files for all hurricane claims since 1996, plus all the corresponding claims data since 1996

Because of a confidentiality agreement, these companies will be referred to as Company A, B, C, or D. These companies represent between 75% and 85% of the insured exposure in the state and approximately 70% of the claims. Most of the data provided come from minor hurricanes and tropical storms that impacted Florida between 1994 and 2002.

Company A provided the only significant data for storms prior to 2004, in particular for Hurricane Andrew, as shown in Table 16. Wind speed estimates are also available, so validation efforts were primarily concentrated on the use of these data. Attempts were made to make use of additional data from Hurricane Opal and other storms. However, the amount of processed data available was too small to be statistically significant for validation.

	Hurricane Andrew	**Hurricane Georges**	**Hurricane Opal**	**Tropical Storm Irene**	**Tropical Storm Earl**	**Hurricane Erin**
Company A						
Masonry	78636	266	1973	3638	59	11460
Timber	1603	1078	9166	776	89	11878
Manufactured	1775	0	256	184	16	690

Table 16. Summary of processed claims data (number of claims provided).

Note: Only building, contents, and appurtenant structure claims were provided by Company A (ALE was not provided).

2004 Personal Residential Claims Data

Claims data for the 2004 hurricane season from a series of insurance companies were also used to validate the FPHLM. Although 21 companies submitted data for a total of almost 675,000 claims, only two main companies are detailed here. These two companies (referred to as Company 1 and Company 2) represent 386,000 claims, mainly for site-built homes. These claims are divided between Hurricanes Charley, Frances, and Jeanne for central Florida, and Hurricane Ivan for the Panhandle. The validation consists of a series of comparisons between the actual claims data and the FPHLM results. The claims files were provided by the insurance companies. Table 17, Table 18, and Table 19 show the number of policies provided by the two companies for the four different hurricanes in 2004. As expected, there are more masonry claims in central Florida and more timber claims in the Panhandle. The claims data for Ivan was not used in the validation process because it was contaminated by storm surge damage.

Company	Hurricane	Construction	Year Built	Number of Claims
Company 1	Charley	Masonry	yb<1970	5026
Company 1	Charley	Masonry	1970<=yb<1984	8216
Company 1	Charley	Masonry	1984<=yb<1994	11850
Company 1	Charley	Masonry	yb>=1994	8110
Company 1	Charley	Frame	yb<1970	956
Company 1	Charley	Frame	1970<=yb<1984	1232
Company 1	Charley	Frame	1984<=yb<1994	3044
Company 1	Charley	Frame	yb>=1994	677
Company 1	Charley	Manufactured	yb<1994	2966
Company 1	Charley	Manufactured	yb>=1994	212
Company 1	Frances	Masonry	yb<1970	5009
Company 1	Frances	Masonry	1970<=yb<1984	6989
Company 1	Frances	Masonry	1984<=yb<1994	7903
Company 1	Frances	Masonry	yb>=1994	4384
Company 1	Frances	Frame	yb<1970	902
Company 1	Frances	Frame	1970<=yb<1984	2081
Company 1	Frances	Frame	1984<=yb<1994	5648
Company 1	Frances	Frame	yb>=1994	721
Company 1	Frances	Manufactured	yb<1994	3186
Company 1	Frances	Manufactured	yb>=1994	222
Company 1	Ivan	Masonry	yb<1970	2029
Company 1	Ivan	Masonry	1970<=yb<1984	2099
Company 1	Ivan	Masonry	1984<=yb<1994	1719
Company 1	Ivan	Masonry	yb>=1994	1769
Company 1	Ivan	Frame	yb<1970	3048
Company 1	Ivan	Frame	1970<=yb<1984	3956
Company 1	Ivan	Frame	1984<=yb<1994	4829
Company 1	Ivan	Frame	yb>=1994	3890
Company 1	Ivan	Manufactured	yb<1994	634
Company 1	Ivan	Manufactured	yb>=1994	79
Company 1	Jeanne	Masonry	yb<1970	3601
Company 1	Jeanne	Masonry	1970<=yb<1984	5274
Company 1	Jeanne	Masonry	1984<=yb<1994	5698
Company 1	Jeanne	Masonry	yb>=1994	4999
Company 1	Jeanne	Frame	yb<1970	825
Company 1	Jeanne	Frame	1970<=yb<1984	1386
Company 1	Jeanne	Frame	1984<=yb<1994	3430
Company 1	Jeanne	Frame	yb>=1994	674
Company 1	Jeanne	Manufactured	yb<1994	2717
Company 1	Jeanne	Manufactured	yb>=1994	177

Table 17. Company 1: Claim number for each year-build category

Company	Hurricane	Construction	Year Built	Number of Claims
Company 2	Charley	Masonry	yb<1970	8677
Company 2	Charley	Masonry	1970<=yb<1984	15085
Company 2	Charley	Masonry	1984<=yb<1994	18324
Company 2	Charley	Masonry	yb>=1994	6376
Company 2	Charley	Frame	yb<1970	1920
Company 2	Charley	Frame	1970<=yb<1984	1782
Company 2	Charley	Frame	1984<=yb<1994	3786
Company 2	Charley	Frame	yb>=1994	443
Company 2	Charley	Manufactured	yb<1994	1843
Company 2	Charley	Manufactured	yb>=1994	159
Company 2	Frances	Masonry	yb<1970	8276
Company 2	Frances	Masonry	1970<=yb<1984	11978
Company 2	Frances	Masonry	1984<=yb<1994	11394
Company 2	Frances	Masonry	yb>=1994	3224
Company 2	Frances	Frame	yb<1970	1453
Company 2	Frances	Frame	1970<=yb<1984	3202
Company 2	Frances	Frame	1984<=yb<1994	7731
Company 2	Frances	Frame	yb>=1994	601
Company 2	Frances	Manufactured	yb<1994	1590
Company 2	Frances	Manufactured	yb>=1994	131
Company 2	Ivan	Masonry	yb<1970	1399
Company 2	Ivan	Masonry	1970<=yb<1984	746
Company 2	Ivan	Masonry	1984<=yb<1994	449
Company 2	Ivan	Masonry	yb>=1994	275
Company 2	Ivan	Frame	yb<1970	4004
Company 2	Ivan	Frame	1970<=yb<1984	5546
Company 2	Ivan	Frame	1984<=yb<1994	4637
Company 2	Ivan	Frame	yb>=1994	2229
Company 2	Ivan	Manufactured	yb<1994	171
Company 2	Ivan	Manufactured	yb>=1994	41
Company 2	Jeanne	Masonry	yb<1970	6907
Company 2	Jeanne	Masonry	1970<=yb<1984	10767
Company 2	Jeanne	Masonry	1984<=yb<1994	9629
Company 2	Jeanne	Masonry	yb>=1994	4176
Company 2	Jeanne	Frame	yb<1970	1555
Company 2	Jeanne	Frame	1970<=yb<1984	2087
Company 2	Jeanne	Frame	1984<=yb<1994	4561
Company 2	Jeanne	Frame	yb>=1994	484
Company 2	Jeanne	Manufactured	yb<1994	1401
Company 2	Jeanne	Manufactured	yb>=1994	128

Table 18. Company 2: Claim number for each year-built category.

Company	Hurricane	Construction	Number of Claims
Company 1	Charley	Masonry	33202
Company 1	Charley	Frame	5909
Company 1	Charley	Manufactured	3178
Company 1	Charley	Other	260
Company 1	Frances	Masonry	24285
Company 1	Frances	Frame	9352
Company 1	Frances	Manufactured	3408
Company 1	Frances	Other	566
Company 1	Ivan	Masonry	7616
Company 1	Ivan	Frame	15723
Company 1	Ivan	Manufactured	713
Company 1	Ivan	Other	100
Company 1	Jeanne	Masonry	19572
Company 1	Jeanne	Frame	6315
Company 1	Jeanne	Manufactured	2894
Company 1	Jeanne	Other	331
Company 2	Charley	Masonry	48462
Company 2	Charley	Frame	7931
Company 2	Charley	Manufactured	2002
Company 2	Charley	Other	582
Company 2	Frances	Masonry	34872
Company 2	Frances	Frame	12987
Company 2	Frances	Manufactured	1721
Company 2	Frances	Other	1134
Company 2	Ivan	Masonry	2869
Company 2	Ivan	Frame	16416
Company 2	Ivan	Manufactured	212
Company 2	Ivan	Other	87
Company 2	Jeanne	Masonry	31479
Company 2	Jeanne	Frame	8687
Company 2	Jeanne	Manufactured	1529
Company 2	Jeanne	Other	1167

Table 19. Company 1 and Company 2: Claim numbers combined.

The claims are divided by the type of coverage for structure and contents. Company 1 has two types of coverage, replacement cost and actual cash value, but does not specify whether both structure and contents have the same coverage for each claim.

For Company 2, there are six types of coverage, as shown below.

ACV S/ACV C   Structure Actual-Cash-Value, Contents Actual-Cash-Value
ACV S/RC C   Structure Actual-Cash-Value, Contents Replacement-Cost
RC S/ACV C   Structure Replacement-Cost, Contents Actual-Cash-Value
RC S/RC C   Structure Replacement-Cost, Contents Replacement-Cost
SV S/RC C   Structure Stated-Value, Contents Replacement-Cost

SV S/SV C	Structure Stated-Value, Contents Stated-Value

Table 20 and Table 21 summarize the distribution of claims in both companies.

Coverage	Premium Policy Count		Claim Policy Count	
A	44020	1%	2759	2%
R	3706219	99%	163692	98%
Total	3750240		166451	

Table 20. Distribution of coverage for Company 1.

Coverage	Premium Policy Count		Claim Policy Count	
ACV S/ACV C	13173	3%	3496	3%
ACV S/RC C	44805	10%	12150	9%
RC S/ACV C	162122	35%	41484	30%
RC S/RC C	232688	51%	77146	57%
SV S/RC C	235	0%	69	0%
SV S/SV C	6019	1%	1717	1%
Total	459042	100%	136062	100%

Table 21. Distribution of coverage for Company 2.

There are 29,372 claims with $0 losses (i.e., Loss structure + Loss app + Loss contents + Loss ALE = 0), though they are listed in the claim file of Company 2. They probably correspond to claims whose losses were lower than the deductible.

2004 Personal Residential Claims Data

Claims data for the 2004 hurricane season from a series of insurance companies were also used to validate the FPHLM. Four insurance companies provided claims data for the 2004 hurricane season. They will be referred to as companies PR2 to 5-2004. Company PR5-2004 has only manufactured homes. See Table PR04a to q. The claims data for Ivan was not used in the validation process because it was contaminated by storm surge damage.

Table 22. 2004 Personal Residential Claims Data

PR04a. Distribution of claims per hurricane for PR-2004 Companies.

	PR2-2004	PR3-2004	PR4-2004	PR5-2004
Charley	12641	34149	289	8030
Frances	12731	27866	200	7,301
Ivan	6202	21424	31	817
Jeanne	11547	19975	248	10,390

PR04b. Distribution of claims per coverage for PR-2004 Companies.

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
A	0	155	0	0
R	43121	103414	768	26,538

PR04c. Distribution of claims per construction type for PR-2004 Companies.

Exterior Wall	PR2-2004	PR3-2004	PR4-2004	PR5-2004
Frame	10760	23471	198	0
Manuf. Homes	0	0	0	26,538
Masonry	31673	79911	569	0
Other	688	32	1	0

PR04d. Distribution of claims per story for PR-2004 Companies.

Stories	PR2-2004	PR3-2004	PR4-2004	PR5-2004
1	0	0	0	26,538
2	0	0	0	0
Unknown	43121	103,414	768	0

PR04e. Distribution of claims per era for PR-2004 Companies.

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	1785	7854	125	0
1960-1970	3983	12033	102	0
1971-1980	8312	19,772	145	0
1981-1993	18621	46,525	276	0
1994-2001	5545	14,436	91	0
2002-present	4875	2,785	29	0
MH pre-1994	0	0	0	22172
MH 1994-present	0	0	0	4366

PR04f. Distribution of claims per era for PR-2004 Companies, for hurricane Charley, and construction types Frame and Manufactured Homes.

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	119	535	20	0
1960-1970	80	190	2	0
1971-1980	212	471	3	0
1981-1993	956	2752	31	0
1994-2001	128	247	8	0
2002-present	237	29	1	0
MH pre-1994	0	0	0	6665
MH 1994-present	0	0	0	1365

PR04g. Distribution of claims per era for PR-2004 Companies, for hurricane Charley, and construction type Masonry

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	409	1870	32	0
1960-1970	972	3051	37	0
1971-1980	1909	5478	46	0
1981-1993	4674	13668	64	0
1994-2001	1580	4877	34	0
2002-present	1271	968	10	0

PR04h. Distribution of claims per era for PR-2004 Companies, for hurricane Charley, and construction type Other

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	0	0	0	0
1960-1970	5	0	0	0
1971-1980	35	0	0	0
1981-1993	35	8	0	0
1994-2001	3	1	0	0
2002-present	16	0	0	0

PR04i. Distribution of claims per era for PR-2004 Companies, for hurricane Frances, and construction type Frame and Manufactured Homes

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	110	419	7	0
1960-1970	96	218	4	0
1971-1980	555	922	6	0
1981-1993	2845	5689	24	0
1994-2001	265	311	8	0
2002-present-	358	30	3	0
MH pre-1994	0	0	0	6145
MH 1994-present	0	0	0	1156

PR04j. Distribution of claims per era for PR-2004 Companies, for hurricane Frances, and construction type Masonry

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	348	1433	15	0
1960-1970	1043	3181	27	0
1971-1980	1906	4770	34	0
1981-1993	3129	8165	56	0
1994-2001	954	2206	15	0
2002-present	864	511	1	0

PR04k. Distribution of claims per era for PR-2004 Companies, for hurricane Frances, and construction type Other

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	0	0	0	0
1960-1970	8	0	0	0
1971-1980	50	2	0	0
1981-1993	114	4	0	0
1994-2001	5	3	0	0
2002-present	81	0	0	0

PR04l. Distribution of claims per era for PR-2004 Companies, for hurricane Ivan, and construction type Frame and Manufactured Homes

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	140	914	4	0
1960-1970	117	538	2	0
1971-1980	174	759	2	0
1981-1993	626	3292	4	0
1994-2001	302	1636	0	0
2002-present-	273	223	0	0
MH pre-1994	0	0	0	620
MH 1994-present	0	0	0	197

PR04m. Distribution of claims per era for PR-2004 Companies, for hurricane Ivan, and construction type Masonry

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	151	1,207	4	0
1960-1970	624	2,557	4	0
1971-1980	1279	3,573	3	0
1981-1993	1320	4,087	6	0
1994-2001	676	2,251	2	0
2002-present	467	378	0	0

PR04n. Distribution of claims per era for PR-2004 Companies, for hurricane Ivan, and construction type Other

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	1	0	0	0
1960-1970	0	0	0	0
1971-1980	12	1	0	0
1981-1993	23	2	0	0
1994-2001	3	3	0	0
2002-present	13	1	0	0

PR04o. Distribution of claims per era for PR-2004 Companies, for hurricane Jeanne, and construction type Frame and Manufactured Homes

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	137	376	16	0
1960-1970	81	166	2	0
1971-1980	399	493	9	0
1981-1993	1983	2939	30	0
1994-2001	276	296	10	0
2002-present-	290	24	2	0
MH pre-1994	0	0	0	8742
MH 1994-present	0	0	0	1648

PR04p. Distribution of claims per era for PR-2004 Companies, for hurricane Jeanne, and construction type Masonry

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	369	1,100	26	0
1960-1970	951	2,132	24	0
1971-1980	1716	3,303	42	0
1981-1993	2795	5,915	61	0
1994-2001	1340	2,604	14	0
2002-present	926	619	12	0

PR04q. Distribution of claims per era for PR-2004 Companies, for hurricane Jeanne, and construction type Other

Year Built	PR2-2004	PR3-2004	PR4-2004	PR5-2004
pre1960	1	0	0	0
1960-1970	5	0	0	0
1971-1980	65	0	0	0
1981-1993	121	4	0	0
1994-2001	13	1	0	0
2002-present	79	2	0	0

2005 Personal Residential Claims Data

Claims data for the 2005 hurricane season from a series of insurance companies were also used to validate the FPHLM. Five insurance companies provided claims data for the 2005 hurricane season. They will be referred to as companies PR1 to 5-2005. Company PR5-2005 has only manufactured homes. See Table PR05a to q. The data for hurricane Rita was not used given the small number of claims.

Table 23. 2005 Personal Residential Claims Data

PR05a. Distribution of claims per hurricane for PR-2005 Companies.

	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
Dennis	3968	1251	3,467	9	232
Katrina	5382	201	2,379	30	78
Rita	56	34	0	1	4
Wilma	62677	9247	21328	264	5,302

PR05b. Distribution of claims per coverage for PR-2005 Companies.

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
A	5990	10733	43	304	0
R	66093	0	27,131	0	5616

PR05c. Distribution of claims per construction type for PR-2005 Companies.

Exterior Wall	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
Frame	6920	1629	2,881	44	0
Manuf. Homes	1402	0	0	0	5616
Masonry	60475	8538	24,292	258	0
Other	3286	566	1	2	0

PR05d. Distribution of claims per story for PR-2005 Companies.

Stories	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
1	664	0	0	0	0
2	146	0	0	0	0
Unknown	71273	10733	27,174	304	0

PR05e. Distribution of claims per era for PR-2005 Companies.

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	6204	233	2,526	47	0
1960-1970	10865	770	3,715	58	0
1971-1980	18922	2441	7172	69	0
1981-1993	26412	4498	10202	98	0
1994-2001	7172	1571	2,908	28	0
2002-present	1106	1220	649	4	0
MH pre-1994	1274	0	0	0	4227
MH 1994-present	128	0	0	0	1389

PR05f. Distribution of claims per era for PR-2005 Companies, for hurricane Dennis, and construction type Frame.

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	242	26	106	1	0
1960-1970	541	26	73	1	0
1971-1980	815	33	128	2	0
1981-1993	1046	112	452	0	0
1994-2001	573	77	422	0	0
2002-present	66	45	59	0	0
MH pre-1994	36	0	0	0	162
MH 1994-present	18	0	0	0	70

PR05g. Distribution of claims per era for PR-2005 Companies, for hurricane Dennis, and construction type Masonry

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	93	21	150	1	0
1960-1970	175	110	324	1	0
1971-1980	140	237	537	2	0
1981-1993	124	255	535	1	0
1994-2001	70	218	562	0	0
2002-present-	12	89	118	0	0

PR05h. Distribution of claims per era for PR-2005 Companies, for hurricane Dennis, and construction type Other

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	0	0	0	0	0
1960-1970	0	0	0	0	0
1971-1980	6	0	0	0	0
1981-1993	11	1	0	0	0
1994-2001	0	0	1	0	0
2002-present	0	1	0	0	0

PR05i. Distribution of claims per era for PR-2005 Companies, for hurricane Katrina, and construction type Frame

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	60	1	25	0	0
1960-1970	40	1	8	0	0
1971-1980	43	3	10	0	0
1981-1993	91	9	52	0	0
1994-2001	44	3	20	0	0
2002-present	8	4	6	0	0
MH pre-1994	45	0	0	0	68
MH 1994-present	1	0	0	0	10

PR05j. Distribution of claims per era for PR-2005 Companies, for hurricane Katrina, and construction type Masonry

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	969	10	410	12	0
1960-1970	1137	26	456	10	0
1971-1980	1428	48	583	4	0
1981-1993	1297	53	727	4	0
1994-2001	133	27	74	0	0
2002-present	23	12	8	0	0

PR05k. Distribution of claims per era for PR-2005 Companies, for hurricane Katrina, and construction type Other

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	1	0	0	0	0
1960-1970	14	0	0	0	0
1971-1980	31	1	0	0	0
1981-1993	13	2	0	0	0
1994-2001	4	0	0	0	0
2002-present	0	1	0	0	0

PR05l. Distribution of claims per era for PR-2005 Companies, for hurricane Rita, and construction type Frame

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	0	0	0	0	0
1960-1970	1	0	0	0	0
1971-1980	1	2	0	0	0
1981-1993	0	1	0	1	0
1994-2001	0	0	0	0	0
2002-present	0	2	0	0	0
MH pre-1994	1	0	0	0	4
MH 1994-present	0	0	0	0	0

PR05m. Distribution of claims per era for PR-2005 Companies, for hurricane Rita, and construction type Masonry

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	6	1	0	0	0
1960-1970	13	2	0	0	0
1971-1980	14	7	0	0	0
1981-1993	17	7	0	0	0
1994-2001	2	10	0	0	0
2002-present	0	1	0	0	0

PR05n. Distribution of claims per era for PR-2005 Companies, for hurricane Rita, and construction type Other

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	0	0	0	0	0
1960-1970	0	0	0	0	0
1971-1980	1	0	0	0	0
1981-1993	0	1	0	0	0
1994-2001	0	0	0	0	0
2002-present	0	0	0	0	0

PR05o. Distribution of claims per era for PR-2005 Companies, for hurricane Wilma, and construction type Frame

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	323	32	99	2	0
1960-1970	151	51	47	1	0
1971-1980	546	213	212	7	0
1981-1993	2136	786	1084	25	0
1994-2001	164	114	70	4	0
2002-present	29	88	8	0	0
MH pre-1994	1192	0	0	0	3993
MH 1994-present	109	0	0	0	1309

PR05p. Distribution of claims per era for PR-2005 Companies, for hurricane Wilma, and construction type Masonry

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	4484	142	1736	31	0
1960-1970	8567	542	2,807	45	0
1971-1980	14288	1721	5702	54	0
1981-1993	20430	3079	7352	65	0
1994-2001	6089	1103	1759	24	0
2002-present-	964	817	450	4	0

PR05q. Distribution of claims per era for PR-2005 Companies, for hurricane Wilma, and construction type Other

Year Built	PR1-2005	PR2-2005	PR3-2005	PR4-2005	PR5-2005
pre1960	26	0	0	0	0
1960-1970	226	12	0	0	0
1971-1980	1609	176	0	0	0
1981-1993	1247	192	0	2	0
1994-2001	93	19	0	0	0
2002-present-	4	160	0	0	0

Commercial Residential Claims Data

Claims data from the 2004 and the 2005 hurricane seasons for commercial residential from four insurance companies (referred to as companies CR1 to 4) were used to validate the commercial residential module of the FPHLM. The details are given below for low rise commercial and for mid/high rise commercial in Tables CR04-LRa to q, CR05-LRa to n, CR04-MRa to q, and CR05-MRa to k. The vast majority of the claims are for low-rise 1 and 2 story buildings.

The policies for company CR2 included commercial line accounts (CLA) for condominium association, apartment building, and homeowners association policies, and the policies for company CR3 included high risk accounts (HRA) in coastal areas.

2004 Low Rise Commercial Residential Claims Data

It is clear from Tables CR04-LRa to q that the vast majority of LR 2004 claims data consists of masonry one and two story tall pre-1994 buildings.

Table 24. 2004 Low Rise Commercial Residential Claims Data

CR04-LRa. Distribution of claims per hurricane for CR LR 2004 companies.

	CR1-LR04	CR2-LR04	CR3-LR04
Charley	575	11	182
Frances	691	78	808
Ivan	166	0	0
Jeanne	285	12	280

CR04-LRb. Distribution of claims per coverage for CR LR 2004 companies.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
A	0	0	0
R	1717	0	0
Not Provided	0	101	1270

CR04-LRc. Distribution of claims per construction type for CR LR 2004 companies.

Exterior Wall	CR1-LR04	CR2-LR04	CR3-LR04
Frame	405	28	240
Masonry	1204	73	1030
Other	108	0	0

CR04-LRd. Distribution of claims per story for CR LR 2004 companies.

Stories	CR1-LR04	CR2-LR04	CR3-LR04
1	806	24	441
2	789	69	677
3	122	8	152

CR04-LRe. Distribution of claims per era for CR LR 2004 companies.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	69	1	273
1960-1970	155	28	279
1971-1980	452	31	389
1981-1993	987	41	286
1994-2001	51	0	34
2002-present	3	0	9

CR04-LRf. Distribution of claims per era for CR LR 2004 companies, for hurricane Charley, and construction type Frame.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	12	0	20
1960-1970	1	0	11
1971-1980	6	7	19
1981-1993	50	4	20
1994-2001	2	0	2
2002-present	0	0	0

CR04-LRg. Distribution of claims per era for CR LR 2004 companies, for hurricane Charley, and construction type Masonry.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	10	0	12
1960-1970	33	0	17
1971-1980	153	0	45
1981-1993	290	0	26
1994-2001	9	0	10
2002-present	0	0	0

CR04-LRh. Distribution of claims per era for CR LR 2004 companies, for hurricane Charley, and construction type Other.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	3	0	0
1981-1993	6	0	0
1994-2001	0	0	0
2002-present	0	0	0

CR04-LRi. Distribution of claims per era for CR LR 2004 companies, for hurricane Frances, and construction type Frame.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	8	1	58
1960-1970	3	0	11
1971-1980	6	3	22
1981-1993	119	7	33
1994-2001	12	0	3
2002-present	0	0	0

CR04-LRj. Distribution of claims per era for CR LR 2004 companies, for hurricane Frances, and construction type Masonry.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	11	0	111
1960-1970	69	25	169
1971-1980	152	17	214
1981-1993	206	25	165
1994-2001	11	0	16
2002-present	2	0	6

CR04-LRk. Distribution of claims per era for CR LR 2004 companies, for hurricane Frances, and construction type Other.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	6	0	0
1981-1993	85	0	0
1994-2001	1	0	0
2002-present	0	0	0

CR04-LRl. Distribution of claims per era for CR LR 2004 companies, for hurricane Ivan, and construction type Frame.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	5	0	0
1960-1970	11	0	0
1971-1980	49	0	0
1981-1993	66	0	0
1994-2001	6	0	0
2002-present-	0	0	0

CR04-LRm. Distribution of claims per era for CR LR 2004 companies, for hurricane Ivan, and construction type Masonry.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	5	0	0
1960-1970	9	0	0
1971-1980	9	0	0
1981-1993	5	0	0
1994-2001	0	0	0
2002-present-	0	0	0

CR04-LRn. Distribution of claims per era for CR LR 2004 companies, for hurricane Ivan, and construction type Other.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	0	0	0
1981-1993	1	0	0
1994-2001	0	0	0
2002-present-	0	0	0

CR04-LRo. Distribution of claims per era for CR LR 2004 companies, for hurricane Jeanne, and construction type Frame.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	12	0	47
1960-1970	1	0	69
1971-1980	2	1	85
1981-1993	32	5	34
1994-2001	2	0	1
2002-present-	0	0	3

CR04-LRp. Distribution of claims per era for CR LR 2004 companies, for hurricane Jeanne, and construction type Masonry.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	6	0	47
1960-1970	28	3	69
1971-1980	64	3	85
1981-1993	124	0	34
1994-2001	7	0	1
2002-present-	1	0	3

CR04-LRq. Distribution of claims per era for CR LR 2004 companies, for hurricane Jeanne, and construction type Other.

Year Built	CR1-LR04	CR2-LR04	CR3-LR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	2	0	0
1981-1993	3	0	0
1994-2001	0	0	0
2002-present-	0	0	0

2005 Low Rise Commercial Residential Claims Data

It is clear from Tables CR05-LRa to n that the vast majority of LR 2005 claims data consists of masonry one and two story tall pre-1994 buildings for hurricane Wilma.

Table 25. 2005 Low Rise Commercial Residential Claims Data

CR05-LRa. Distribution of claims per hurricane for CR LR 2005 companies.

	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
Dennis	22	0	0	0
Katrina	68	81	186	0
Wilma	1117	1356	2080	410

CR05-LRb. Distribution of claims per coverage for CR LR 2005 companies.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
A	0	0	0	0
R	1207	0	0	0
Not Provided	0	1437	2266	410

CR05-LRc. Distribution of claims per construction type for CR LR 2005 companies.

Exterior Wall	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
Frame	180	168	102	47
Masonry	933	1269	2164	363
Other	94	0	0	0

CR05-LRd. Distribution of claims per story for CR LR 2005 companies.

Stories	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
1	645	458	955	180
2	498	863	1111	221
3	64	116	200	9

CR05-LRe. Distribution of claims per era for CR LR 2005 companies.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	3	112	644	0
1960-1970	98	229	743	0
1971-1980	279	501	559	6
1981-1993	811	578	270	119
1994-2001	16	17	35	196
2002-present	0	0	15	89

CR05-LRf. Distribution of claims per era for CR LR 2005 companies, for hurricane Dennis, and construction type Frame.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	2	0	0	0
1981-1993	12	0	0	0
1994-2001	7	0	0	0
2002-present-	0	0	0	0

CR05-LRg. Distribution of claims per era for CR LR 2005 companies, for hurricane Dennis, and construction type Masonry.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	1	0	0	0
1981-1993	0	0	0	0
1994-2001	0	0	0	0
2002-present-	0	0	0	0

CR05-LRh. Distribution of claims per era for CR LR 2005 companies, for hurricane Dennis, and construction type Other.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	0	0	0	0
1981-1993	0	0	0	0
1994-2001	0	0	0	0
2002-present	0	0	0	0

CR05-LRi. Distribution of claims per era for CR LR 2005 companies, for hurricane Katrina, and construction type Frame.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	0	0	2	0
1960-1970	0	0	0	0
1971-1980	1	0	1	0
1981-1993	2	6	1	0
1994-2001	0	0	0	0
2002-present	0	0	0	0

CR05-LRj. Distribution of claims per era for CR LR 2005 companies, for hurricane Katrina, and construction type Masonry.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	0	13	62	0
1960-1970	3	9	61	0
1971-1980	4	29	29	0
1981-1993	54	23	23	0
1994-2001	0	1	5	0
2002-present	0	0	2	0

CR05-LRk. Distribution of claims per era for CR LR 2005 companies, for hurricane Katrina, and construction type Other.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	0	0	0	0
1981-1993	4	0	0	0
1994-2001	0	0	0	0
2002-present	0	0	0	0

CR05-LRl. Distribution of claims per era for CR LR 2005 companies, for hurricane Wilma, and construction type Frame.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	2	4	46	0
1960-1970	93	0	20	0
1971-1980	248	11	12	0
1981-1993	525	147	19	9
1994-2001	4	0	1	29
2002-present	0	0	0	9

CR05-LRm. Distribution of claims per era for CR LR 2005 companies, for hurricane Wilma, and construction type Masonry.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	1	95	534	0
1960-1970	93	220	662	0
1971-1980	248	461	517	6
1981-1993	525	402	227	110
1994-2001	4	16	29	167
2002-present	0	0	13	80

CR05-LRn. Distribution of claims per era for CR LR 2005 companies, for hurricane Wilma, and construction type Other.

Year Built	CR1-LR05	CR2-LR05	CR3-LR05	CR4-LR05
pre1960	0	0	0	0
1960-1970	1	0	0	0
1971-1980	21	0	0	0
1981-1993	64	0	0	0
1994-2001	4	0	0	0
2002-present	0	0	0	0

2004 Mid/High Rise Commercial Residential Claims Data

It is clear from Tables CR04-MRa to n that the number of MHR 2004 claims is very small. It consists mainly of masonry or other four to eleven story tall pre-1994 buildings.

Table 26. 2004 Mid/High Rise Commercial Residential Claims Data

CR04-MRa. Distribution of claims per hurricane for CR MHR 2004 companies.

	CR1-MHR04	CR2-MHR04	CR3-MHR04
Charley	23	4	34
Frances	21	5	56
Jeanne	4	0	15

CR04-MRb. Distribution of claims per coverage for CR MHR 2004 companies.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
A	0	0	0
R	48	0	0
Not Provided	0	9	105

CR04-MRc. Distribution of claims per construction type for CR MHR 2004 companies.

Exterior Wall	CR1-MHR04	CR2-MHR04	CR3-MHR04
Frame	2	0	2
Masonry	34	9	103
Other	12	0	0

CR04-MRd. Distribution of claims per story for CR MHR 2004 companies.

Stories	CR1-MHR04	CR2-MHR04	CR3-MHR04
4	11	1	23
5	14	7	28
6	5	0	8
7	6	0	15
8	2	1	7
9	2	0	4
10	8	0	2
11	0	0	2
12	0	0	1
13	0	0	1
15	0	0	1
26	0	0	1
36	0	0	1
42	0	0	1

CR04-MRe. Distribution of claims per era for CR MHR 2004 companies.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	1	0	4
1960-1970	1	1	8
1971-1980	21	4	35
1981-1993	25	4	50
1994-2001	0	0	7
2002-present	0	0	1

CR04-MRf. Distribution of claims per era for CR MHR 2004 companies, for hurricane Charley, and construction type Frame.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	0	0	0
1981-1993	0	0	0
1994-2001	0	0	0
2002-present	0	0	0

CR04-MRg. Distribution of claims per era for CR MHR 2004 companies, for hurricane Charley, and construction type Masonry.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	0
1960-1970	0	0	2
1971-1980	10	4	9
1981-1993	10	0	20
1994-2001	0	0	3
2002-present	0	0	0

CR04-MRh. Distribution of claims per era for CR MHR 2004 companies, for hurricane Charley, and construction type Other.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	1	0	0
1981-1993	2	0	0
1994-2001	0	0	0
2002-present	0	0	0

CR04-MRi. Distribution of claims per era for CR MHR 2004 companies, for hurricane Frances, and construction type Frame.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	1
1960-1970	0	0	0
1971-1980	0	0	0
1981-1993	2	0	0
1994-2001	0	0	0
2002-present	0	0	0

CR04-MRj. Distribution of claims per era for CR MHR 2004 companies, for hurricane Frances, and construction type Masonry.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	1	0	3
1960-1970	0	1	3
1971-1980	9	0	23
1981-1993	3	4	22
1994-2001	0	0	3
2002-present	0	0	1

CR04-MRk. Distribution of claims per era for CR MHR 2004 companies, for hurricane Frances, and construction type Other.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	1	0	0
1981-1993	5	0	0
1994-2001	0	0	0
2002-present	0	0	0

CR04-MRl. Distribution of claims per era for CR MHR 2004 companies, for hurricane Jeanne, and construction type Frame.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	0
1960-1970	0	0	0
1971-1980	0	0	0
1981-1993	0	0	1
1994-2001	0	0	0
2002-present	0	0	0

CR04-MRm. Distribution of claims per era for CR MHR 2004 companies, for hurricane Jeanne, and construction type Masonry.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	0
1960-1970	0	0	3
1971-1980	0	0	3
1981-1993	1	0	7
1994-2001	0	0	1
2002-present	0	0	0

CR04-MRn. Distribution of claims per era for CR MHR 2004 companies, for hurricane Jeanne, and construction type Other.

Year Built	CR1-MHR04	CR2-MHR04	CR3-MHR04
pre1960	0	0	0
1960-1970	1	0	0
1971-1980	0	0	0
1981-1993	2	0	0
1994-2001	0	0	0
2002-present	0	0	0

2005 Mid/High Rise Commercial Residential Claims Data

It is clear from Tables CR05-MRa to k that the number of MHR 2005 claims is very small. It consists mainly of masonry four to ten story tall pre-1994 buildings for hurricane Wilma.

Table 27. 2005 Mid/High Rise Commercial Residential Claims Data

CR05-MRa. Distribution of claims per hurricane for CR MHR 2005 companies.

	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
Katrina	0	0	10	0
Wilma	125	118		42

CR05-MRb. Distribution of claims per coverage for CR MHR 2005 companies.

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
A	0	0	0	0
R	126	0	0	0
Not Provided	0	118	127	42

CR05-MRc. Distribution of claims per construction type for CR MHR 2005 companies.

Exterior Wall	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
Frame	0	0	1	0
Masonry	107	118	127	42
Other	19	0	0	0

CR05-MRd. Distribution of claims per story for CR MHR 2005 companies.

Stories	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
4	64	70	54	40
5	17	37	29	0
6	8	3	12	0
7	13	2	6	0
8	9	1	7	0
9	4	4	3	0
10	11	1	3	0
11	0	0	1	0
14	0	0	2	0
15	0	0	2	0
16	0	0	2	0
17	0	0	0	2
18	0	0	1	0
19	0	0	1	0
22	0	0	1	0
23	0	0	1	0
29	0	0	1	0
31	0	0	1	0

CR05-MRe. Distribution of claims per era for CR MHR 2005 companies.

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
pre1960	1	0	8	0
1960-1970	1	6	42	0
1971-1980	52	52	38	0
1981-1993	65	60	34	28
1994-2001	7	0	3	12
2002-present	0	0	2	2

CR05-MRf. Distribution of claims per era for CR MHR 2005 companies, for hurricane Katrina, and construction type Frame.

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	0	0	0	0
1981-1993	0	0	0	0
1994-2001	0	0	0	0
2002-present	0	0	0	0

CR05-MRg. Distribution of claims per era for CR MHR 2005 companies, for hurricane Katrina, and construction type Masonry.

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
pre1960	0	0	1	0
1960-1970	0	0	4	0
1971-1980	0	0	3	0
1981-1993	0	0	1	0
1994-2001	0	0	1	0
2002-present	0	0	0	0

CR05-MRh. Distribution of claims per era for CR MHR 2005 companies, for hurricane Katrina, and construction type Other

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	0	0	0	0
1981-1993	0	0	0	0
1994-2001	0	0	0	0
2002-present	0	0	0	0

CR05-MRi. Distribution of claims per era for CR MHR 2005 companies, for hurricane Wilma, and construction type Frame

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	0	0	0	0
1981-1993	0	0	1	0
1994-2001	0	0	0	0
2002-present	0	0	0	0

CR05-MRj. Distribution of claims per era for CR MHR 2005 companies, for hurricane Wilma, and construction type Masonry

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
pre1960	1	0	7	0
1960-1970	1	6	38	0
1971-1980	40	52	35	0
1981-1993	57	60	32	28
1994-2001	7	0	2	12
2002-present	0	0	2	2

CR05-MRk. Distribution of claims per era for CR MHR 2005 companies, for hurricane Wilma, and construction type Other

Year Built	CR1-MHR05	CR2-MHR05	CR3-MHR05	CR4-MHR05
pre1960	0	0	0	0
1960-1970	0	0	0	0
1971-1980	11	0	0	0
1981-1993	8	0	0	0
1994-2001	0	0	0	0
2002-present	0	0	0	0

4. Describe any new insurance claims datasets collected since the previously-accepted hurricane model.

No new wind insurance claims datasets were collected since the previously-accepted hurricane model.

5. Describe the assumptions, data (including insurance claims data), methods, and processes used for the development of the building hurricane vulnerability functions.

A detailed discussion of the assumptions, data (including insurance claim data), methods, and processes used for the development of the building vulnerability functions is contained within Standard G.1 and other disclosure items in Standard V.1.

6. Summarize post-event site investigations, including the sources, and provide a brief description of the resulting use of these data in the development or validation of building hurricane vulnerability functions.

The documentation and statistical analysis of damage caused by landfalling hurricanes has been conducted by a variety of stakeholders, including home builder trade associations (NAHB Research Center, 1993, 1996, 1999; Crandell, 1998), practicing engineers (Keith & Rose, 1994), government agencies (Oliver & Hanson, 1994; FEMA, 1992, 2006), and academic researchers (Kareem, 1985, 1986; Gurley, 2006; Gurley et al., 2006). Some of these studies provide a broad overview of structural performance (FEMA and NAHB reports). Others focus on a particular building component such as roofing (Croft et al., 2006; Meloy et al., 2007) or address a specific building type such as wood frame residential construction (van de Lindt et al., 2007). All such available public access literature regarding the performance of residential infrastructure in hurricane winds was reviewed and used as guidance for the development of the vulnerability model. Those studies that provide statistical assessments of damage to specific building components (Gurley, 2006; Gurley et al., 2006; Gurley and Masters, 2011; Meloy et al., 2007) were used as a means of validating the physical damage estimates of the model. Studies that are more qualitative in nature (e.g., FEMA reports) were used to provide guidance regarding the potential failure modes that were important to replicate in the model. For example, the common observation of gable end failures resulted in a gable end failure component in the model.

Several damage surveys were done in 2004. Damage from Hurricane Charley was reported across the state, and the most severe damage occurred where the eye made landfall near the cities of Punta Gorda and Port Charlotte. A team that consisted of approximately 30 members from UF, FIU, Clemson, and FIT, under the leadership of the Insurance Institute for Business & Home Safety (IBHS), surveyed the extent of the structural damage to homes and manufactured homes in these cities. For several days following the storm the team conducted a detailed statistical survey of damage in the impacted areas. Results of this survey can be found on the IBHS website http://www.ibhs.org/. Other information regarding the damage of Charley and other storms can be found at the Florida Tech Wind and Hurricane Impact Research Laboratory website, http://www.fit.edu/research/whirl/.

Damage from Hurricane Frances was surveyed in areas from Cocoa Beach to Stuart in eastern Florida. Although damage from Hurricane Frances was not as severe as that from Hurricane Charley, the same extensive survey conducted in Punta Gorda and Port Charlotte was also conducted in the impacted areas. Great efforts were made to monitor the strength and resulting damage from the storm as part of the Florida Coastal Monitoring Program. Towers were set up to record wind speeds along the coast in locations where the storm was forecasted to make landfall. Sensors to record the wind-induced pressure were deployed on the roofs of several homes. Following the storm, members of the same team that surveyed damage from Charley photographed and recorded damage throughout the area. Areas of Fort Pierce appeared to be hardest hit and damage was severe to many homes in some areas.

Similar efforts to monitor the winds and survey the damage were made for Hurricane Jeanne. Towers and pressure sensors were again deployed at various locations near where landfall was forecasted. After the storm, members of the team surveyed areas from Stuart to Cocoa Beach. These surveys consisted primarily of cataloging and photographing various observations of damage in the impacted areas, as was done with Hurricane Frances. Damage from Hurricane Jeanne in many locations was very similar to what was seen from Hurricane Frances. In many cases damage to structures that was initially caused by Frances was compounded by Hurricane Jeanne. Fatigue of structures from the winds of two hurricanes within three weeks most likely played a role in the most severe cases of damage in the areas such as Vero Beach and Fort Pierce. In some areas most of the weak trees and components of homes (shingles, screened porches, fences, etc.) were already damaged by Hurricane Frances, so when Hurricane Jeanne hit little or no further damage was seen. It is very difficult to tell what damage was caused by Hurricane Jeanne and what was caused by Hurricane Frances.

Additionally, engineers working on the physical damage model performed a detailed residential damage study after the 2004 hurricane season to assess the performance of housing built to the Florida Building Code and the Standard Building Code (Gurley, 2006; Gurley et al., 2006; Gurley and Masters, 2011). The data were collected as a part of a study conducted by UF and sponsored by the Florida Building Commission. Site-built single-family homes constructed after Hurricane Andrew-related changes to the standard building code went into effect were targeted for a detailed investigation of damage as a result of the 2004 hurricane season. This study provided a quantitative statistical comparison of the relative performance of homes built between 1994 and 2001 with the performance of those built after the 2001 Florida Building Code replaced the Standard Building Code. This evaluation was accomplished through a systematic survey of homes built from 1994 to

2004 in the areas that experienced the highest wind speeds from the 2004 storms (Charlotte, St. Lucie, Escambia, and Santa Rosa counties). Close to 200 homes were surveyed in these regions to define correlations between damage, age, and construction type. These relationships are referenced to maximum three-second gust wind speed via wind swath maps. An expanded and more detailed version of the conference publication (Gurley, 2006; Gurley et al., 2006) has appeared in the ASCE journal Natural Hazards Review (Gurley and Masters, 2011). The data from this study were used to modify the residential component capacities as this model evolved. Another source of field data is the aerial imagery collected by NOAA after Hurricane Katrina. These images provided a quantification of shingle damage relative to estimated wind speed and were used to validate the roof cover damage output from the physical damage model.

More recently, damage from hurricane Irma was surveyed in Florida, especially in the land-falling areas of the Florida Keys and South-West Florida (Pinelli et al., 2018). Following the storm, several team including FPHLM engineers and students deployed in the affected areas. Around 1000 properties were surveyed (Kijewski-Correa et al., 2018). In most mainland areas, the observations catalogued minor to moderate property damage, consistent with the moderate wind speeds of the hurricane during its passage across mainland Florida. While in the Keys, subjected to higher winds, 25% of the observed damage was severe or collapse. All things being equal, the actual peak 3-s gust wind speeds recorded in Hurricane Irma produced wind loads ranging from 24% to 97% of prescribed design wind loads of the specific FL areas. Although most, if not all, structures built or retrofitted to the current FBC performed well, older non-retrofitted structures exhibited substantial wind damage, especially in the roof cover. This is consistent with the vulnerability models of the FPHLM for different building strengths.

Damage from Hurricane Michael was documented by StEER (Structural Extreme Events Reconnaissance) (Roueche et al. 2019). Several FPHLM members participated in the damage documentation. Consistent with the findings of Irma, most structures built or retrofitted to the current FBC performed well, older non-retrofitted structures exhibited substantial wind damage, especially in the roof cover. This is consistent with the vulnerability models of the FPHLM for different building strengths.

7. Describe the categories of the different building hurricane vulnerability functions. Specifically, include descriptions of the building types and characteristics, building height, number of stories, regions within the state of Florida, year of construction, and occupancy types for which a unique building hurricane vulnerability function is used. Provide the total number of building hurricane vulnerability functions available for use in the hurricane model for personal and commercial residential classifications.

Vulnerability functions were derived for manufactured and site-built homes, for low-rise commercial residential buildings (one to three stories), and for apartment units of mid-/high-rise commercial residential buildings (four stories and higher).

A total of 4356 un-weighted vulnerability matrices were developed for site-built homes for building. The matrices correspond to different combinations of wall type (frame or masonry), region (north, central, south), subregion (high velocity hurricane zone, wind-borne debris region, inland), roof type (gable or hip), roof cover (metal, tile or shingle), window protection (shuttered or not shuttered), number of stories (one or two), and strength (weak, modified weak, retrofitted weak; medium, modified medium, retrofitted medium; strong for inland and WBDR, strong for HVHZ—see Table 1 and Table 2 in the General Standards).

These 4356 building un-weighted matrices were then combined to produce 5226 weighted matrices, and 291 age weighted matrices for site-built homes for building, for each county.

A total of 648 un-weighted vulnerability matrices were developed for low-rise, commercial residential buildings for building. They correspond to different combinations of wall type (frame or masonry), sub-region (high velocity hurricane zone, wind-borne debris region, inland), roof shape (gable or hip), roof cover (metal, tile or shingle), window protection (shuttered or not shuttered), number of stories (one, two, or three), and strength (weak, medium, or strong).

These 648 matrices were then combined to produce 144 weighted curves for low-rise, commercial residential buildings for building.

180 opening vulnerability curves and 180 associated breach curves were developed for openings of apartment units of mid-/high-rise commercial residential buildings. They correspond to different combinations of building layout (open or closed), unit floor location (corner or middle unit), impact debris zone (high density impact for stories 1 to 3, medium density impact for stories 4 to 7, and low density impact for stories 8 and higher), balconies (with or without sliders) and opening protection (none, impact resistant glass, or shutters).

4 un-weighted vulnerability matrices were developed for manufactured homes for building. They correspond to four manufactured home types: (1) pre-1994—fully tied down, (2) pre-1994—not tied down, (3) post-1994—Housing and Urban Development (HUD) Zone II, and (4) post-1994—HUD Zone III. The partially tied-down homes are assumed to have a vulnerability that is an average of the vulnerabilities of fully tied-down and not tied-down homes. Because little information is available regarding the distribution of manufactured home types by size or geometry, it is assumed that all model types are single-wide manufactured homes. The modeled single-wide manufactured homes are 56 ft x 13 ft, have gable roofs, eight windows, a front entrance door, and a sliding-glass back door. The un-weighted matrices are combined into 6 weighted matrices for building, for pre-1994 (4 regions: North, Central, South, Key) and post-1994 (2 zones: II and III) manufactured homes.

8. Describe the process by which local construction practices and statewide and county building code adoption and enforcement are considered in the development of the building hurricane vulnerability functions.

In addition to a classification of building by structural types (wood or masonry walls, hip or gable roof), the buildings are classified by relative strength. Residential construction methods have evolved in Florida as experience with severe winds drives the need to reduce vulnerability.

To address this, the vulnerability team has developed strong, medium, and weak models for each site-built home and low-rise, commercial residential building structural type to represent relative quality of original construction as well as post-construction mitigation. In each region of Florida, local construction and building code criteria are reflected in the mix of weak, medium, and strong buildings.

In the case of site-built single-family homes, the models are further refined with a modified weak to reflect pre-1960s decking practices, a retrofitted weak to model weak (older) buildings that have been reroofed and decking re-nailed, a modified medium to reflect loss of quality in the construction process in the high velocity hurricane zone before Andrew, a retrofitted medium to model medium buildings that have been reroofed and decking re-nailed, a strong model to reflect modern code requirements for inland structures and those in the WBDR but outside the HVHZ, and a strong model to reflect modern code requirements for structures within the HVHZ . A discussion of these models are provided in the Standard G-1 in the section describing the building models, and Table 1 and Table 2 (also in G-1) provide an overview of the relative strength among the models stratified by the exterior components included in the models. These additions to the model inventory were prompted by detailed interviews with several experts on the evolution of construction practice (common practice, codes and enforcement) in Florida. Details of this interview process and its outcomes are addressed in the next section, and in the "Models' Distribution in Time" section in Standard G-1. Regional differences in codes and enforcement are accounted for as described in the next section.

On the basis of the exposure study, it was also decided to model four manufactured home (MH) types. These types include pre-1994—fully tied down, pre-1994—not tied down, post-1994—HUD Zone II, and post-1994—HUD Zone III, where 1994 delineates older, much weaker styles of manufactured home construction than the post-1994 homes that meet minimum federal construction standards established by HUD.

Models' Distribution in Time: Regionally Varying Construction Practice

Over time the codes used for construction in Florida have evolved to reduce wind damage vulnerability. The weak W00, modified weak W10, retrofitted weak W01, medium M00, modified medium M10, retrofitted medium M01, and strong models represent this evolution in time of relative quality of construction in Florida. Each model is representative of the prevalent building type for a certain historical period. However, the assignment of a building strength (its relative vulnerability to wind damage) based on its year of construction is not a straightforward task. The appropriate relationship between age and strength is a function of location within Florida, code in place in that location, and code enforcement policy (also regional). It is therefore important to define the cut-off date between the different periods since the overall aggregate losses in any region are determined as a mixture of homes of various strengths (ages). The cut-off dates are based on both the evolution of the building code and the prevailing local builder/community code enforcement standards in each era.

Given the importance of these issues in the estimation of wind damage vulnerability, a brief history of codes and enforcement is presented next.

Construction practice in South Florida recognized the importance of truss-to-wall connection as early as the 1950s, when it became common to use clips rather than toe nails. The clips were not as strong as modern straps, but they were an improvement over nails. North Florida has fewer historical occurrences of severe hurricane impact, resulting in weaker construction in general than in the south within the same given era. The use of clips became relatively standard statewide by the mid-1980s. The use of improved shingle products and resistant garage doors became more common after Hurricane Andrew. The issue of code enforcement has also evolved over time. The State of Florida took an active role in uniform enforcement only recently. Prior to Hurricane Andrew, a given county may have built to standards that were worse than or exceeded the code in place at the time. Following consultation with building code development experts, which included the director of the Miami-Dade building department, the president of an engineering consulting firm and consultant to the South Florida Building Code, the consensus was that the issue was not only the contents of the code, but also enforcement of the code.

In an attempt to standardize construction, some cities and counties in Florida adopted building codes, some of the earliest being Clearwater, which adopted a draft of the Standard Building Code (SBC) in 1945 (Cox, 1962); Daytona Beach in 1946 (The Morning Journal, 1946); Bradenton and Manatee counties by 1950; Sarasota County in 1956 (Sarasota Journal, 1956), and Riviera Beach in Palm Beach County in 1957 (The Palm Beach Post, 1957). Miami-Dade and Broward counties adopted the South Florida Building Code (SFBC, 1957) in 1957 and 1961, respectively. The SFBC, one of the most stringent codes in the United States, had some wind provisions since its inception. SBC made wind-load provisions mandatory in 1986. Modern wind design started in 1972 and improved considerably for low-rise construction in 1982 (Mehta, 2010). In addition, Florida's construction boom of the 1970s led the state authorities to promote a statewide uniformity of building standards. The first attempt was Chapter 553, "Building Construction Standards," of the Florida Statutes (F.S.), which was enacted in 1974 and required all counties to adopt a code by January 1st, 1975. The statute selected four allowable minimum codes as the pool from which jurisdictions needed to adopt their official building codes, namely: (1) SBC (Southern Building Code Congress International, 1975), (2) the SFBC (South Florida Building Code, 1957), (3) the One and Two Family Dwelling Code, (CABO) (ICC, 1992) and (4) the EPCOT code (enforced in Walt Disney World and based on the SBC, SFBC, and Uniform Building Code) (Reedy Creek Improvement District, 2002). However, the responsibility for the administration and enforcement was left to the discretion of 400 local jurisdictions as diverse as local governments, local school boards, and state agencies (Governor's Report, 1996). The State allowed the jurisdictions to choose any code from the four allowed codes and granted them the authority to amend the code according to their needs, as long as the amendments resulted in more stringent requirements and the power to enforce it.

Problems in the Building Code System

After 1975, there were two main codes in use in Florida before the 1990s: the SFBC in Miami-Dade and Broward counties and the SBC in most of the rest of the state. Although the SFBC was the most stringent code in Florida, this was uncorrelated with compliance and enforcement from many builders, design professionals, and inspectors. To a lesser extent, some of the code stringency was eroded for almost three decades (Getter, 1992; Fronstin & Holtmann, 1994). Some measures that watered down the code included the allowance of power-driven staples instead of nails for roof decking, thinner roofing-felt, 63 mph resisting shingles, and waferboards (pressed wood) as a replacement for plywood for roof decking. A study by Florida A&M University published in 1987 also highlighted deficiencies in code compliance and enforcement in the rest of Florida. Furthermore, the local amendments created a state of confusion, making it difficult for engineers, architects, and contractors to identify the locally administered codes and their jurisdictions (Shingle, 2007; Barnes et al., 1991). The aftermath of Hurricane Andrew confirmed the concerns reported above. Post-storm damage surveys revealed innumerable violations to the SFBC (the absence of corner columns, vertical reinforcement, and gypsum board used as wall sheathing to name a few) that produced catastrophic failures of buildings (Khan & Suaris, 1993; Siddiq Khan & Associates, 1993). Clearly there were serious shortcomings in the compliance and enforcement process.

For later hurricanes like Opal and Erin in 1995, the rebuild process was also delayed because of the intricacies of the jurisdictional, enforcement, and compliance issues of the codes, exacerbating losses. An expeditious and unambiguous system would have eased proper compliance and enforcement and therefore would have drastically reduced losses (Governor's Report, 1996).

Post-Andrew Building Code Development Enforcement

The South Florida Building Code

Three to four months after Hurricane Andrew, South Florida began to reform the code and the code enforcement system. Engineers became directly involved in the design of residential structures. OSB decking and staples were banned. Wind-rated shingles were required. In 1994 the whole SFBC was reformed and adopted the ASCE 7 wind provisions.

The Florida Building Code

After Hurricane Andrew, local and state agencies were unsure about how to guarantee building safety. Concerns arose that a diminution of insurance availability would occur, which threatened the continuity of economic growth. In response, Governor Lawton Chiles established a Building Codes Study Commission in 1996 to review the current system of codes. The Governor's Commission found that the existing system had led to a "patchwork of technical and administrative processes." Its recommendations led to the formation of the Florida Building Commission in 1998, which was responsible for creating a unified Florida Building Code (Governor's Report, 1996).

For the new unified Florida Building Code (FBC), the Commission selected the SBC, developed in Alabama from 1940 to 1945 (Ratay, 2009), as the base code because 64 out of 67 counties were already using the 1973 and the 1997 versions of the code with amendments (Shingle, 2007). The SFBC was later included as an additional base code in 1999 to meet South Florida's special requirements. The Building Commission worked to reach a consensus among all stakeholders, and the first version of a unified FBC was made effective on March 1, 2002 (Blair, 2009). Studies indicate that the losses due to hurricanes have decreased since the enactment of the FBC (Gurley et al., 2006, Gurley & Masters, 2011).

Application of the Building Code History

The history above clearly indicates that a completely accurate accounting of all building practices in every region of Florida going back many decades is not possible, given the limited policy information of age and location. To accommodate the history of residential building construction practice in Florida, buildings were classified into different eras. The classifications shown in Table 28 were adopted for characterizing the regions by age and model. The strength descriptions within

Table 28 are provided at the bottom of Table 28 in terms of the nomenclature used in Table 1 and Table 2 of Standard G-1. The specific building eras and classifications per region are based on the evolution of the building codes in Florida and the opinions of the experts consulted.

	Pre-1960	1960-1970	1971-1980	1981-1993	1994-2001	2002-pres.
HVHZ	⅔ modified Weak, ⅓ Medium	⅔ Weak, ⅓ Medium	½ Weak, ½ modified Medium	⅔ Weak, ⅓ modified Medium	Modified Strong	Modified Strong
Keys	½ modified Weak, ½ Medium	Medium	Medium	Medium	⅓ Medium ⅔ Strong OP	Strong OP
WBDR	modified Weak	⅔ Weak, ⅓ Medium	⅓ Weak, ⅔ Medium	⅓ Weak, ⅔ Medium	½ Medium, ½ Strong OP	Strong OP
Inland	modified Weak	⅔ Weak, ⅓ Medium	½ Weak, ½ Medium	½ Weak, ½ Medium	½ Medium, ½ Strong	Strong
Table 28. Nomenclature with respect to Table 1 and Table 2 of Standard G-1. Strong: S00 Strong OP: S00-OP Modified Strong: S01 Medium: M00 Modified Medium: M10 Weak: W00 Modified Weak: W10						

Table 28. Age classification of the models per region.

Note: HVHZ is high velocity hurricane zone; WBDR is wind-borne debris region. The boundaries of the WBDR vary depending on the year built, and the edition of the FBC which applies, as explained in Standard G-1, in the description of the site-built models.

Analysis of changes to the Florida Building Code

The Florida Building Code (FBC) typically updates on a three year cycle. In conjunction with the release of an updated Code, the Florida Building Commission creates an 'Analysis of Changes' document for every subcode in the FBC (Accessibility, Building, Energy, Existing Building, Fuel Gas, Mechanical, Plumbing, Residential, Test Protocols for High-Velocity Hurricane Zones). These documents are arranged such that the comparable provision in the previous code can be identified for comparison, and a brief description of the change is provided. These 'Analysis of Changes' documents provide a convenient means to determine whether any of the hundreds of changes in the next generation FBC warrant investigation with respect to vulnerability model development (e.g. new or modified vulnerability functions).

The subcodes potentially relevant to the vulnerability model are the FBC-Residential and FBC-Test Protocols for High-Velocity Hurricane Zones (see vulnerability references: Florida Building Commission). Each change is evaluated by the vulnerability team to determine if it meets the following criteria: 1) the change indicates a clear improvement in wind resistance of building components, 2) The components affected by the change fall within the granularity of the model, and 3) data are available that would allow a quantitative implementation of that change within the model.

This analysis revealed that no model modifications are warranted in response to FBC changes in the 2014 and 2017 versions of the FBC.

Looking forward, the 2020 FBC (to be enforced in December 2020) has a potentially significant change in the adoption by reference of ASCE 7-16 “Minimum Design Loads and Associated Criteria for Buildings and Other Structures.” ASCE 7-16 includes some changes to the representation of design wind loads on low rise structures which may result in more wind resistant residential construction. Currently, the FPHLM engineers are developing model changes to be tested and completed for the 2022 model certification cycle. The likely outcome will be an additional variant of the current strong model series.

9. Describe the relationship between building structure and appurtenant structure hurricane vulnerability functions and their consistency with insurance claims data.

Appurtenant structures are not attached to the dwelling or main residence of the home, but are located on the insured property. These types of structures could include detached garages, guesthouses, pool houses, sheds, gazebos, patio covers, patio decks, swimming pools, spas, etc. Insurance claims data reveal no obvious relationship between building damage and appurtenant structure claims. The variability of the structures covered by an appurtenant structure policy may be responsible for this result. Consequently, building structures and appurtenant structures vulnerability functions were developed independently from each other.

Figure 55 and Figure 56 compare the masonry and timber building structure and appurtenant structure hurricane vulnerability curves, while Figure 57 compares the appurtenant structure hurricane vulnerability curve with insurance claims data from one company for the case of hurricanes Charley, Ivan, and Wilma. Notice that in each case the claim data includes many claims with insured appurtenant losses above the appurtenant limit (i.e. app damage ratios above 100%). For Charley, 0.5% of the claims had an app ratio between 100% and 1151%. For Ivan, 1% of the claims had an app ratio between 100% and 621%. For Wilma, 5% of the claims had an app ratio between 100% and 458%. It is not clear why the insurance company would pay more than 100% of the limit, but this happens for all the insurance companies. Figure 57 a) shows the comparison with all the claim data included. Figure 57 b) shows the comparison with the claim data above 100% excluded. Since the FPHLM does not model losses above 100%, the second plot is a better comparison. The FPHLM modelers have observed that there is no clear trend in the claim losses, and this is true across all the insurance companies, with appurtenant losses varying widely between companies and between hurricanes.

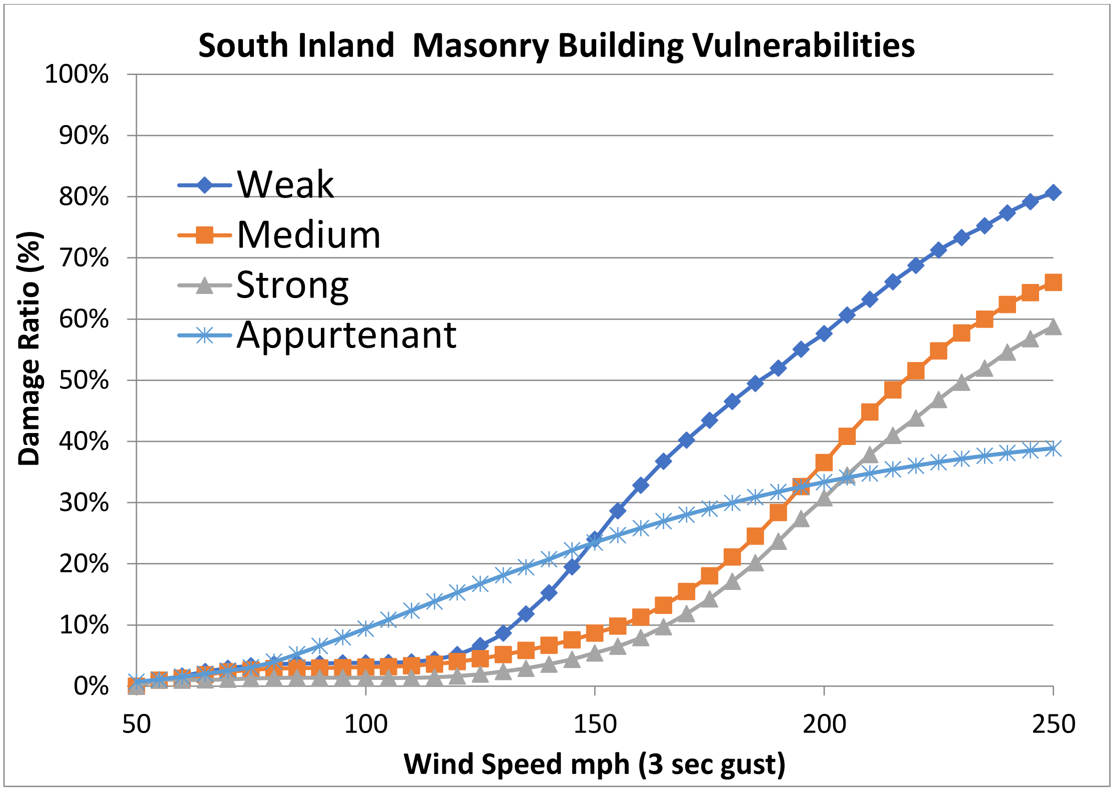


Figure 55. Masonry building structure and appurtenant structure hurricane vulnerability functions

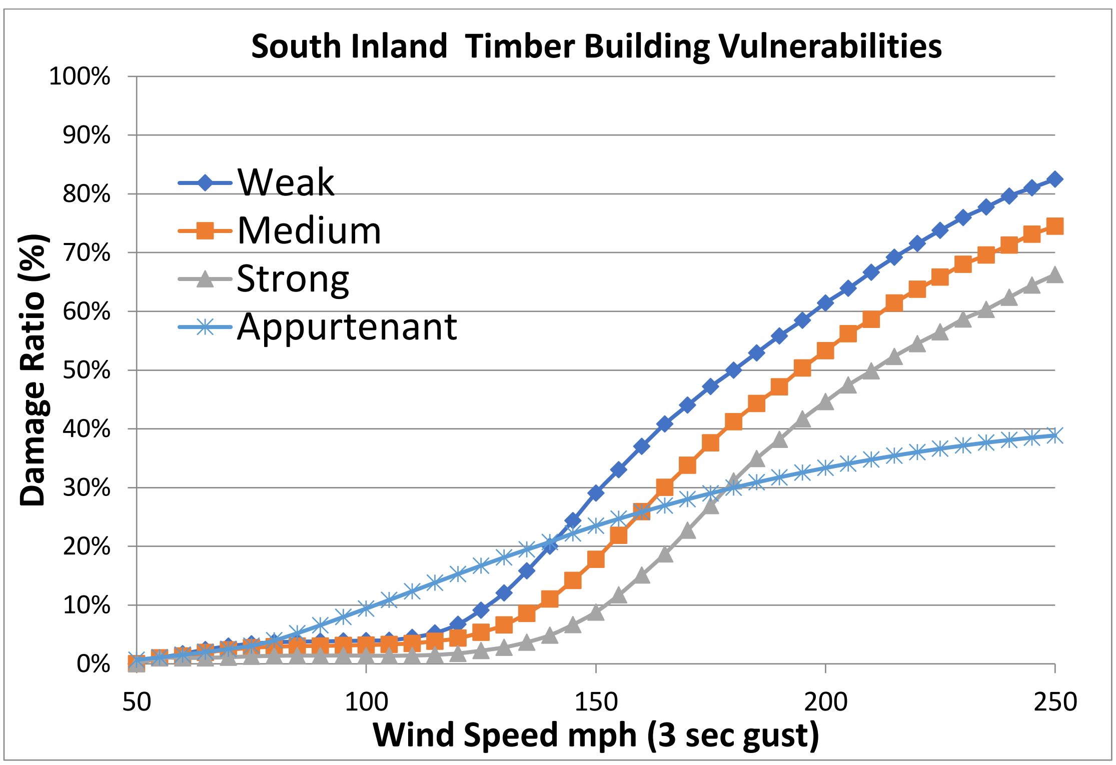
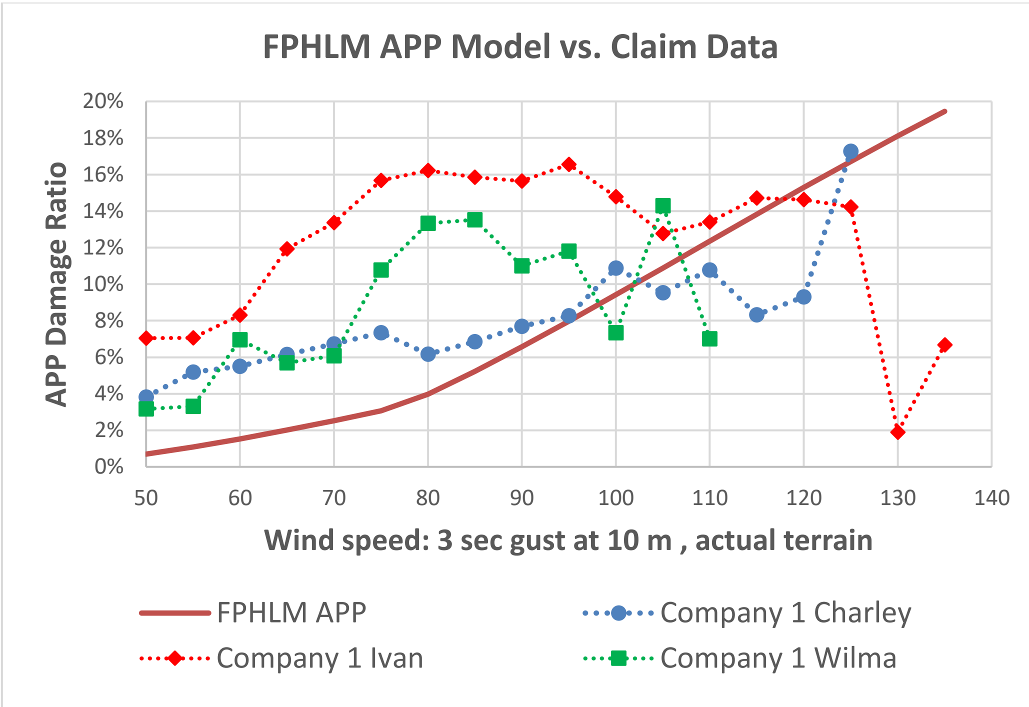


Figure 56. Timber building structure and appurtenant structure hurricane vulnerability functions

a)


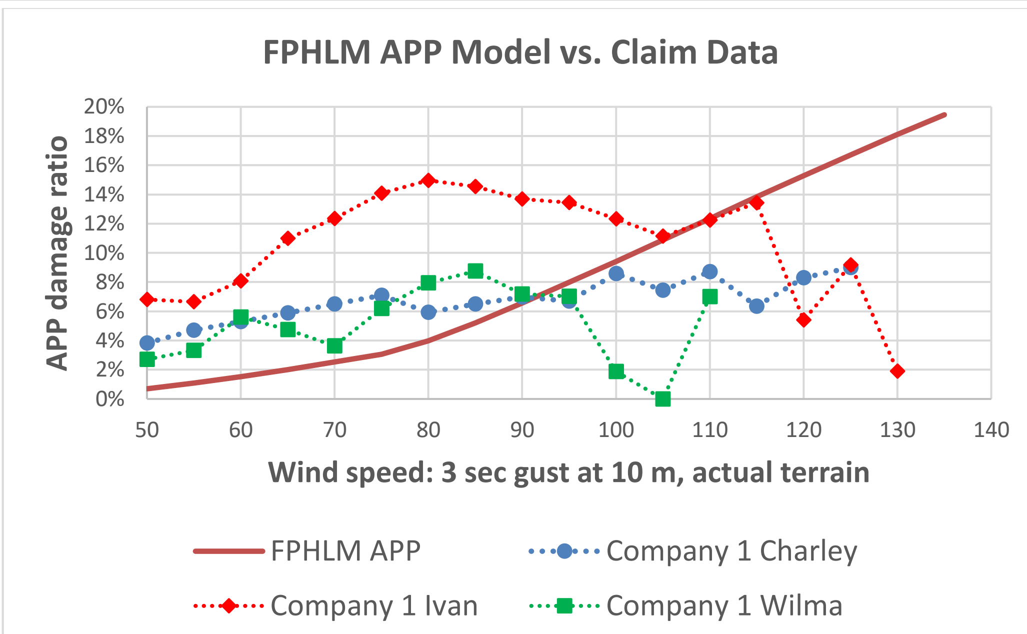
b)


Figure 57. Appurtenant structure hurricane vulnerability function vs. insurance claims data – a) all claim data included; b) claim data above 100% excluded

10. Describe the assumptions, data (including insurance claims data), methods, and processes used to develop building hurricane vulnerability functions when:

a. unknown residential construction types are unknown, or

b. or for when someone or more primary building characteristics are unknown, or

c. one or more secondary characteristics are known, or

d. building input characteristics are conflicting.

The FPHLM processes insurance portfolios from many different insurance companies. Since there is no universal way to classify building characteristics, each company assigns different names or classifications to the building variables. In many cases most of the building structural information in a portfolio is unknown since, in general, detailed records of building characteristics are missing. In a minority of cases, parameters are known, but they do not match any value in the library of the FPHLM. In this case these parameters are classified as "other." For example, the FPHLM models only timber or masonry residential single-family homes. A steel structure would be classified as other.

This makes the mapping of existing portfolio policies to available vulnerability matrices challenging. The engineering team designed a mapping tool to read a policy and assign building characteristics, if unknown or other, on the basis of building population statistics and year built, where the year built serves as a proxy for the strength of the building. The process is summarized in Table 29. Once all the unknown parameters in the policy have been defined, an unweighted vulnerability matrix based on the corresponding combination of parameters can then be assigned. If the number of unknown parameters exceeds a certain threshold defined by the actuarial team, a weighted matrix or age-weighted matrix is used instead. If the building input characteristics are conflicting, the policy is flagged, and the insurer is contacted to attempt to resolve the conflict. If the conflict is not resolved, the rules of the FPHLM will prevail. For example, if a building with a year built of 2000 has toe-nail roof to wall connections, either the year built or the connection is incorrect. If the insurer cannot resolve the conflict, the FPHLM will resolve based on the additional information available.

In the few cases in which a policy in a portfolio has a combination of parameters that would result in a vulnerability matrix different than any of the existing matrices in the library of the FPHLM, the program assigns to the policy a so-called "other" weighted matrix (see Table 29 below). The "other" matrices are an average of timber and masonry matrices.

Data in Insurance Portfolio	Year Built	Exterior Wall	No. of Story	Roof Shape	Roof Cover	Opening Protection	Vulnerability Matrix
Case 1	known	known	known	known	known	known	Use unweighted vulnerability matrix
Case 2	known	known or unknown	Any combination of the four parameters is either unknown or other				Use weighted matrix or replace all unknown and others based on stats and use unweighted vulnerability matrix
Case 3	known	other	Any combination of the four parameters is either unknown or other				Use the “other” weighted matrix
Case 4	unknown	known	Any combination of the four parameters is either unknown or other				Use age weighted matrix or replace all unknown and others based on stats and use unweighted vulnerability matrix
Case 5	unknown	other	Any combination of the four parameters is either unknown or other				Use age weighted matrices for “other”

Table 29. Age classification of the models per region

11. Identify the one-minute average sustained windspeed and the windspeed reference height at which the hurricane model begins to estimate damage.

The wind speeds used in the damage model are three-second gusts at 10 m. The lowest three-second gust is 50 mph. The minimum one-minute sustained wind is approximately 40 mph.

12. Describe how the duration of windspeeds at a particular location over the life of a hurricane is considered.

Duration of the storm is not explicitly modeled. The damage accumulation procedures assume sufficient duration of peak loads to account for duration dependent failures.

13. Describe how the hurricane model addresses wind-borne missile impact damage and water infiltration.

Treatment of wind borne missile impact damage

Windborne debris is considered as a source of potential damage to building openings (windows and doors). Based on post-storm damage investigations (e.g. Gurley and Masters, 2011), the model assumes that damaged roof cover from adjacent buildings is the dominant source of windborne debris. The vulnerability of an opening to windborne debris damage is modeled as a function of the density of the surrounding buildings (e.g. open vs. suburban terrain), wind speed and direction, building age (roof cover strength), height of the opening relative to building height, and opening protection (glass type and / or shutters). If an opening fails as a result of windborne debris impact, the internal pressure and associated building component loads are adjusted and failure checks are repeated. The breached opening is recorded in the damage matrix for use in costing as well as wind driven rain water ingress calculations.

For a given structural type and assigned peak 3-second wind speed (v_{wind}), the probability of damage to an opening ($PD(v_{wind})$) as:

$$P_D(v_{wind}) = 1 - e^{-N_A * A(v_{wind}) * B(v_{wind}) * C * D(v_{wind})} \quad (12)$$

where:

N_A is the total number of available missile objects in the area upwind of the structure being analyzed. For example, the total number of shingles on the neighboring upwind house.

$A(v_{wind})$ is the fraction of potential missile objects that are in the air at a given 3-second gust wind speed (v_{wind}). For example, the percentage of the shingles on the upwind neighboring roof that were damaged and available for flight.

$B(v_{wind})$ is probability of the missile hitting the structure. A free shingle upwind of the structure may or may not strike the subject building. A trajectory model is used to determine this parameter.

C is the fraction of the total area of a particular opening (window, entry door or sliding door) to area of the impact wall in which it exists. If a shingle does strike the building, C is the probability that it struck the subject opening.

$D(v_{wind})$ is the probability that the impacting missile has enough momentum to damage the component impacted.

Each of the above parameters is considered in more detail below.

NA is the total number of potential missiles that are upwind of the target structure. It is assumed that surrounding buildings are similar to that of the target building and therefore have approximately the same roof cover. The total number of potential missiles is dependent on the exposure category of the area and the wind direction. The particular exposure category chosen by the user determines the location of the surrounding buildings. There are eight building surrounding the structure in “Urban” and “Suburban” exposures while there are only four buildings cornering the target building in “Open” exposures. Distances from the surrounding buildings to the subject building also changes from urban to suburban to open. NA is evaluated for each of 8 directions (Figure 58). For wind directions that are perpendicular or parallel to ridgeline of the buildings, it is assumed that NA is equal to the number of shingles from the adjacent building. For wind directions diagonal to the ridgeline of the building it is assumed that there is full contributions from the building diagonal to ridgeline and a partial contribution from the adjacent structures (25% contribution).

$A(v_{wind})$ is the percentage of the number of potential missiles (NA) that are assumed to become airborne and become actual missiles in the wind field upwind of the subject building. Roof cover is assumed to become airborne if it is damaged in the wind field. Thus $A(v_{wind})$ is determined by assuming the neighboring structures are of the same age as the subject with respect to the capacity of the roof cover. The vulnerability of the roof cover at the speed v_{wind} being evaluated is used to populate $A(v_{wind})$. A matrix of mean percent roof cover damage for various roof cover strengths was created and used as the input for the $A(v_{wind})$ variable. The appropriate $A(v_{wind})$ for a given simulation is selected via table lookup and randomized for implementation. In this manner, homes with older and weaker roof cover are assumed to be subjected to a higher $A(v_{wind})$ value than homes with newer and stronger roof cover. This is consistent with post-storm investigation studies that have identified a correlation between roof cover age and vulnerability (e.g. Gurley and Masters, 2011; Liu and Pogorzelski et al., 2010).

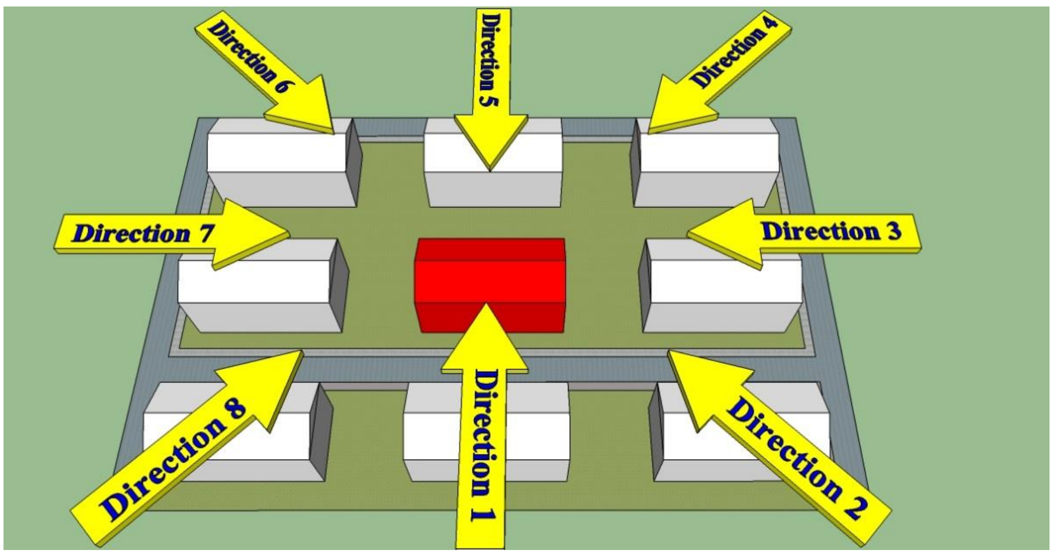


Figure 58. Evaluating NA for eight approach directions

$B(v_{wind})$ is probability of a airborne missile hitting the subject building. Referring to Figure 58, for a given direction, any airborne shingles that approach the subject building may fall short of, fly over, or strike the building. This is a function of the missile object, distance (sparse or dense neighborhoods), and wind speed and turbulence. A stochastic flight trajectory model (Laboy et al., 2013) is employed in a Monte Carlo framework (100,000 simulations). Inputs to this model include the flight object parameters (e.g. shingles), distance from source to target (dense or sparse neighborhoods), local wind turbulence (suburban or open terrain), and wind speed. A series of curves were developed to determine the mean probability of available debris striking the subject building (stratified by floor) as a function of the above mentioned variables, and are stored in a library to access for a given vulnerability simulation.

C is the fraction of the total area of a particular opening category (window, entry door or sliding door) to area of the impacted wall in which it exists. Now that the probability of a floor being hit has been determined ($B(v_{wind})$), the probability of the debris hitting the opening of interest is assessed. This is the area of the opening divided by the total wall area of the floor. The C value for a 4ft by 4ft window on a wall with dimensions 10ft by 40ft is equal to .04. Based on this value, if a projectile was to strike this wall, there is 4% chance of it hitting the window being evaluated.

$D(v_{wind})$ is the probability that a window impacted by debris will be damaged. It is a function of the missile object, impact velocity, angle of incidence, and material being impacted. The missile object is roof cover (shingles). The impact velocity and angle of incidence is captured by the flight trajectory model used to determine parameter B. The material being impacted is either standard annealed or impact resistant glass. A recent experimental study evaluated the momentum threshold required for shingles to break unprotected residential window glass. The study concluded that the wind speed necessary to remove and transport shingles a sufficient distance to the target convey sufficient momentum to break annealed glass (Masters et al., 2010). This is incorporated in the current model by assigning a value of 1.0 (100%) to the D parameter. That is, shingles will break standard glass if impact occurs.

Mitigation of damage from debris impact can be achieved via impact resistant glazing products (i.e. impact resistant glass) and / or exterior impact protection (plywood or metal shutters). This is implemented by reducing the probability of missile impact rather than adjusting the impact damage capacity (B is adjusted rather than D). The effect is combinatorial, such that impact resistant glass with shutters is less vulnerable than standard glass with shutters.

The implementation of the above components results in a probability of debris damage value as a function of wind speed, direction, building density / terrain, height of the opening on the building face, and window protection. A random number draw from a uniform distribution then determines the occurrence of damage for each opening on the subject building.

Treatment of water infiltration in the commercial residential model

The modelers developed a novel approach to assess interior damage. The method complements the component approach described above to compute the damage to the building envelope (Weekes et al., 2009). The method is summarized in Figure 53 of disclosure 2. The model estimates the amount of wind-driven rain that enters through the breaches and defects (also referred to as pre-existing deficiencies) in the building envelope and converts it to interior damage. The approach is described below.

The building envelope components that the model considers for low rise buildings are roof cover, roof sheathing, wall cover, wall sheathing, gable cover, gable sheathing, windows, entry doors and sliding doors. For an initial wind speed, the model starts loading the exterior damage array, expressed as breach areas of each component for thousands of simulation runs. It has been demonstrated that in buildings subjected to hurricane winds, the interior damage may start well before there are any breaches in the envelope (Mullens et al., 2006). The interior damage at this early stage is non-negligible and is caused by the building's existing defects that may be hidden or not, such as cracks, poorly caulked electrical outlets and ventilation ducts, inadequately sealed windows and doors, soffits, baseboards, door thresholds, etc. (Lstiburek, 2005). An estimated area of existing defects or deficiencies in envelope components is accounted for.

The quantification of existing defects is based on the surveys published in Mullens et al. (2006) and the American Society of Heating, Refrigerating and Air-Conditioning (ASHRAE) Handbook (2001) for estimating the infiltration area. To capture the quality of the construction, the model applies defect densities depending on the building's strength, which is related to the year built. Thus, strong buildings will have fewer defects than medium and weak buildings.

Recent studies have shown that water ingress via wind driven rain cannot be attributed exclusively to envelope breach, installation, or product defects. Properly manufactured, installed, and caulked fenestration may nonetheless offer leakage paths in extreme wind conditions, the severity of which is highly dependent on the specific product (Salzano et al., 2010). As this line of research matures, its findings will be incorporated within the above framework.

In order to estimate water intrusion into the buildings, a study was performed to estimate the likely accumulated wind driven impinging rain on a structure during a hurricane event. This study used a simulation model that is composed of a simplified wind model and the R-CLIPER rain rate model developed at NOAA HRD (Lonfat et al., 2007) and is used operationally at NHC. The simplified wind model is based on Holland (1980) and includes parameters for the pressure profile ("B"), Rmax, translation speed and central pressure. Additionally, the Vickery (2005) pressure filling model was used to decay the storms. Storm parameters are sampled from distributions relevant to Florida. The R-CLIPER model determines the vertically free-falling rain rates at each time step of the simulation. The R-CLIPER rain rate is essentially an azimuthally averaged rain rate that varies as a function of radius and maximum intensity of the storm. A detailed presentation of this study is given in Pita et al. (2012a) and Pita (2012).

The study simulates the duration of the event from the time a location enters the storm affected area (within 450 km of the storm center) until exit. The number of storm simulations was 100,000 and for each simulation, 91 locations were selected to record the accumulated wind driven rain ("WDR") and maximum three-second wind gust at 10 m. Each location was specified to be a multiple of 10 km away from the storm closest approach to center (from 450 km to the left of the storm to 450 km to the right of the storm, in steps of 10 km. A direct hit is at 0 km). The time step of the model was 0.1 hr. In addition to the total wind driven rain during the event, separate accumulations were recorded starting at the time that a location experiences the peak wind of the storm event ("WDR2"). The wind driven rain accumulated prior to the maximum peak gust ("WDR1") is computed as the difference: WDR1=WDR-WDR2. The resulting accumulations are then distributions of wind driven rain as a function of the peak three-second wind gust for 10 meter height.

Since WDR1 and WDR2 are not uniformly distributed through time (with higher concentration around the max wind speed), not all surfaces of a building will be subject to equal shares of wind driven rain as the storm rotates around the building. To account for this, we developed a directionality scheme where, during the rain simulation process, we record and calculate the WDR1 and WDR2 values while the wind direction falls into successive 45° octants.

The distribution of the wind driven rain at a particular location as a function of time is illustrated in Figure 59. αm is the fraction of WDR1 (i.e. the fraction of the area under the curve) while the wind direction is in a particular octant "m" (where m = 1, 2 … i represents the possible total number of changes in the wind direction prior to the occurrence of max wind speed). Similarly, βn represents the fraction of WDR2 while the wind direction is in a particular octant "n" (where n= 1,2,3….j represents the possible total number of changes in the wind direction after the occurrence of max wind speed). The vulnerability model assumes the peak wind to occur at the center angle of the sector or octant (at time t_{wmax} in Figure 59). For the sake of consistency with the damage model, in the rain study, the sectors are defined so that the peak wind occurs at the center of the sector which contains the max wind.

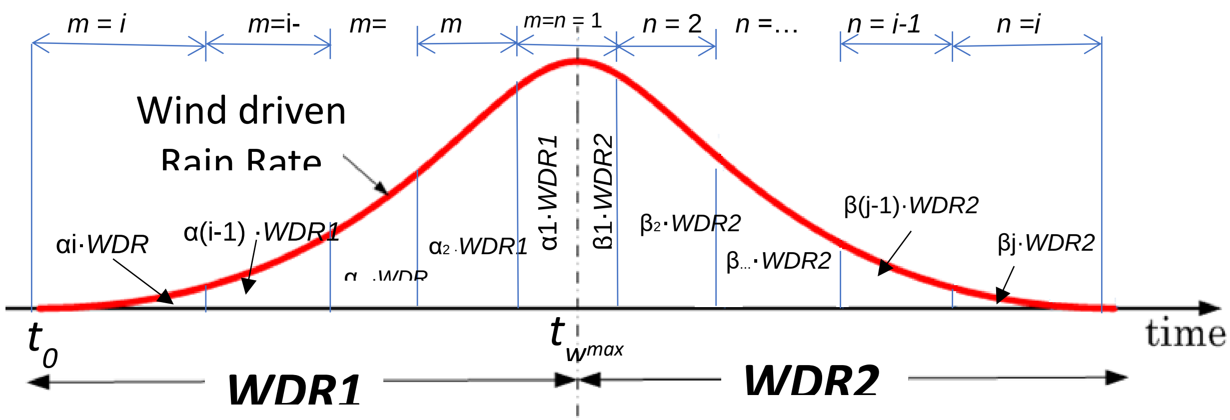


Figure 59. Wind driven rain rate as a function of storm duration

The overall volume of free stream wind driven rain (WDR) expected at a particular location can be reduced to the following equation:

$$WDR = \sum_{m=1}^{i} \alpha_m * WDR_1 + \sum_{n=1}^{j} \beta_n * WDR_2 \ (13)$$

where α_m is the fraction of WDR1 for a given wind direction octant and i is the total number of wind direction changes between the initial start of the storm (t_0) and the time of max wind speed (t_{wmax}). Consequently, $\sum_{m=1}^{i} \alpha_m = 1$ and m = 1 represents the wind direction octant at t_{wmax}, and m=i represents the wind direction at the beginning of the storm, t_0. If i=1 it means that the wind has blown in the same octant from t_0 to t_{wmax}.

Similarly, β_n is the fraction of WDR2 for a given wind direction octant and j is the total number of wind direction changes from the time of max wind speed to the end of the storm. Consequently, $\sum_{n=1}^{j} \beta_n = 1$ and n = 1 represents the wind direction at the time of maximum wind velocity (t_{wmax}), while n= j represents the wind direction at the end of the storm t_{max}.

Water intrusion model for low-rise CR building

The FPHLM interior damage model performs Monte Carlo simulations to estimate the total volume of water that penetrates through a building envelope on a component by component basis, through either defects in the component or breaches. Each simulation corresponds to a given wind direction octant (from 0° to 315° in 45° increments) and a given maximum wind speed (from 50 to 250 mph, in 5 mph increments). Each component is evaluated for both the directly impinging and the surface runoff rain. The total volume of water V_($_{totCi}$) for each component C_i can therefore be expressed by the general equation.

$$V_{tot_{Ci}} = V_{IR_{Ci}} + V_{SR_{Ci}} = RAF \cdot WDR \cdot A_{o_{Ci}} + SRC \cdot WDR \cdot A_{SR_{Ci}} \quad (14)$$

where:

$V_{IR_{Ci}}$ is the volume of wind driven impinging water penetrating through the component Ci

$V_{SR_{Ci}}$ is he volume of surface run-off water penetrating through the component Ci

RAF is the rain admittance factor, which transforms the wind driven rain in impinging rain

SRC is the surface runoff coefficient, which transforms the wind driven rain in surface run-off

A_{oCi} is the open area of the component Ci, either through defect and/or breach

A_{SRCi} is the reference surface runoff area or upstream area of the defect or breach collecting water, for component Ci, which is a function of the wind direction;

WDR is the wind driven rain, either WDR1 or WDR2 (before or after the occurrence of the maximum wind speed), sampled for each maximum wind speed from the full distribution of wind driven rain from the simulation.

The rain admittance factor (RAF) is the fraction of the approaching wind driven rain that strikes the building. It accounts for the effect of a large portion of the rain moving around the structure with the wind rather than striking the building surface and is dependent on the building shape. Both RAF and SRC are independent of the wind speed, but both are a function of the wind direction with respect to the building. The values of RAF and SRC are the result of an extensive testing program carried on at the Wall of Wind at FIU (Baheru et al., 2014a, 2014b).

For any given simulation, the link between the rain study and the vulnerability model is the maximum wind speed w_{max}. As the storm rotates before and after the occurrence of the maximum wind speed, it subjects any given defect or breach on a particular surface to all the fractions of impinging rain corresponding to the different wind directions (or octants) from the storm rotation.

Consequently, before t_{wmax} (i.e. before the occurrence of w_{max} and the occurrence of any breach in the model for that simulation), the total value of impinging rain penetrating through a component defect area A_{d_Ci} is the sum of the corresponding fractions of impinging rain over the wind direction octants θ_m, as the storm rotates from its start to t_{wmax}.

$$V_{IR1_{Ci}} = \left[\sum_{m=1}^{4} RAF_{\theta m} * \overline{a_m}(w_{max})\right] * WDR_1 * A_{d\_Ci} \quad (15)$$

where:

$\overline{a_m}(w_{max})$ is the mean fraction of WDR1 for the the wind direction octants θm. It is a function of wmax.

$RAF_{\theta m}$ is the rain admittance factor for the the wind direction octant θm, which transforms the free field horizonal rain into impinging rain.

Similarly, the total value of surface run-off water penetrating through a defect is the sum of the corresponding fractions of surface run-off water over the wind direction octants θ_m, as the storm rotates from its start to t_{wmax}. The total quantity WDR1 can be factored out of the summation, since it is independent of the angle.

$$V_{SR1_{Ci}} = \left[\sum_{m=1}^{4} SRC_{\theta m} * \overline{a_m}(V_{max}) \; * A_{SR\,Ci_{\theta m}}\right] * \; WDR_1 \; (16)$$

where:

$SRC_{\theta m}$ is the surface run-off coefficient for a wind direction octant θ_m, which transforms the free field horizonal rain into run-off water.

For each damage simulation, θ_1 is the wind direction or octant at t_{wmax}, θ_2 is the previous octant in the rotation (45 degrees), and so on.

After t_{wmax} (i.e. after the occurrence of w_{max} and the occurrence of some breaches in the model for that simulation), the total amount of impinging rain penetrating through the breach and the remaining defects of componnet C_i is the sum of the corresponding fractions of impinging rain over the wind direction octants θ_n, as the storm rotates from t_{wmax} to its end.

$$V_{IR2_{Ci}} = \left[\sum_{n=1}^{5} RAF_{\theta n} * \overline{\beta_n}(w_{max})\right] * \; WDR_2 * A_{oCi} \; (17)$$

where:
$\overline{\beta_n}(w_{max})$ is the mean fraction of WDR_2 for the the wind direction octants θ_n. It is a function of w_{max}. $RAF_{\theta n}$ is the RAF value for a wind direction octant θ_n.

Similarly, the total value of surface run-off penetrating through a component breach and its remaining defects is the sum of the corresponding fractions of surface run-off water over the wind direction octants θ_n, as the storm rotates from t_{wmax} to its end. The total quantity *WDR2* can be factored out of the sumation, since it is independent of the angle.

$$V_{SR2_{Ci}} = \left[\sum_{n=1}^{5} SRC_{\theta n} * \overline{\beta_n(w_{max})} \; * A_{SR\,Ci_{\theta n}}\right] * \; WDR_2 \; (18)$$

where $SRC_{\theta n}$ is the SRC value for a wind direction octant θ_n. For each damage simulation, θ_1 is the wind direction or octant at t_{wmax}, θ_2 is the next octant in the rotation (45 degrees), and so on.

Over the entire duration of the storm, the total amount of water penetrating through a component will be:

$$V_{tot_{Ci}} = V_{IR_{Ci}} + V_{R_{Ci}} = V_{IR1_{Ci}} + V_{SR1_{Ci}} + V_{IR2_{Ci}} + V_{SR2_{Ci}} \; (19)$$

These volumes of water are then distributed among interior components and contents as described in disclosure 1 of this standard (V-1).

Water intrusion model for mid/high-rise CR buildings

There is no data available on RAF and SRC for mid/high-rise buildings at this point. Therefore the water intrusion model has not changed and is the same as the previous version of the FPHLM. The product of the areas of the breaches and defects by the impinging rain conveys the amount of water that enters the building. The water penetration at each story is computed as follows.

Water penetration through components defects or pre-existing deficiencies:

$$h_{C_i}^{d} = \frac{f_{sim} \cdot f_{Run} \cdot RAF\left[WDR_1 \underbrace{\left(d_{C_i} A_{C_i}\right)}_{\text{Total Defects Area}} + WDR_2 \underbrace{\left(d_{C_i} A_{C_i} S_{C_i}\right)}_{\text{Post-breach Defects Area}} \right]}{A_b} \qquad (20)$$

Water penetration through breaches:

$$h_{C_i}^{b} = \frac{f_{sim} \cdot f_{Run} \cdot RAF\left[WDR_2 \cdot A_{C_i}^{B} \right]}{A_b} \qquad (21)$$

where:

h^{d}_{Ci}: height of water that accumulates due to defects in component *i*, in inches

h^{b}_{Ci}: height of water that accumulates due to envelope breaches in component *i*, in inches

f_{sim}: adjustment factor which takes into account that defects and breaches will progressively change from windward to leeward or vice-versa as the storm rotates

f_{Run}: adjustment factor for the water that runs-off the external surfaces of the building and ingress through the defects and breaches and into the building

RAF: rain admittance factor

d_{Ci}: defects percentage

A_{Ci}: area of component *i*

A^{B}_{Ci}: breach area of component *i*

A_b: floor area

WDR_1 : mean value of the accumulated wind driven rain prior to maximum wind speed

WDR_2 : mean value of the accumulated wind driven rain after the occurrence of maximum wind speed

S_{Ci} : survival factor for component $i = 1 - A^{B}_{\mathrm{Ci}} / A_{Ci}$

Rain admittance factor, RAF

Straube and Burnett (2000) and Blocken and Carmeliet (2010) suggest values for RAF between 0.5 and 1.0 for mid-/high-rise buildings. Accordingly, the FPHLM adopted a value of 0.6 for mid/high-rise buildings, except for the last story where a value of 1.0 was adopted.

Water percolation for CR-LR

The water percolation for CR-LR has changed and it is not a fixed value anymore. The new interior damage model is a component-based model and the percolation of water is directly dependent on the water absorption capacity of each interior component and contents. See the complete description in disclosure 1 of this Standard (V-1) and Figure 49.

Water percolation for MHR CR

In multi-story mid/high-rise buildings, a portion of the rainwater ingress percolates downward from story to story. The interior damage model assumes the percolation ρ to be 10% of the rainwater ingress at each story for mid/high rise building (concrete slabs). These values of percolation are based on engineering judgment, supported by calibration of the model with the insurance claims data, and thus can be updated when new research becomes available.

Figure 60 illustrates the percolation mechanism for rainwater ingress at a given story from pre-existing deficiencies and breaches in any component C_i. Upper story "j" gets rain from the pre-existing deficiencies and the breached openings, which is converted into the heights of water ingress, $h^d_{C_j}$ and $h^b_{C_j}$, respectively. A fraction of these water heights percolates down as $\rho h^d_{C_j}$ and $\rho h^b_{C_j}$. Rain also enters in the second story "k" through pre-existing deficiencies and the openings as $h^d_{C_k}$ and $h^b_{C_k}$, respectively.

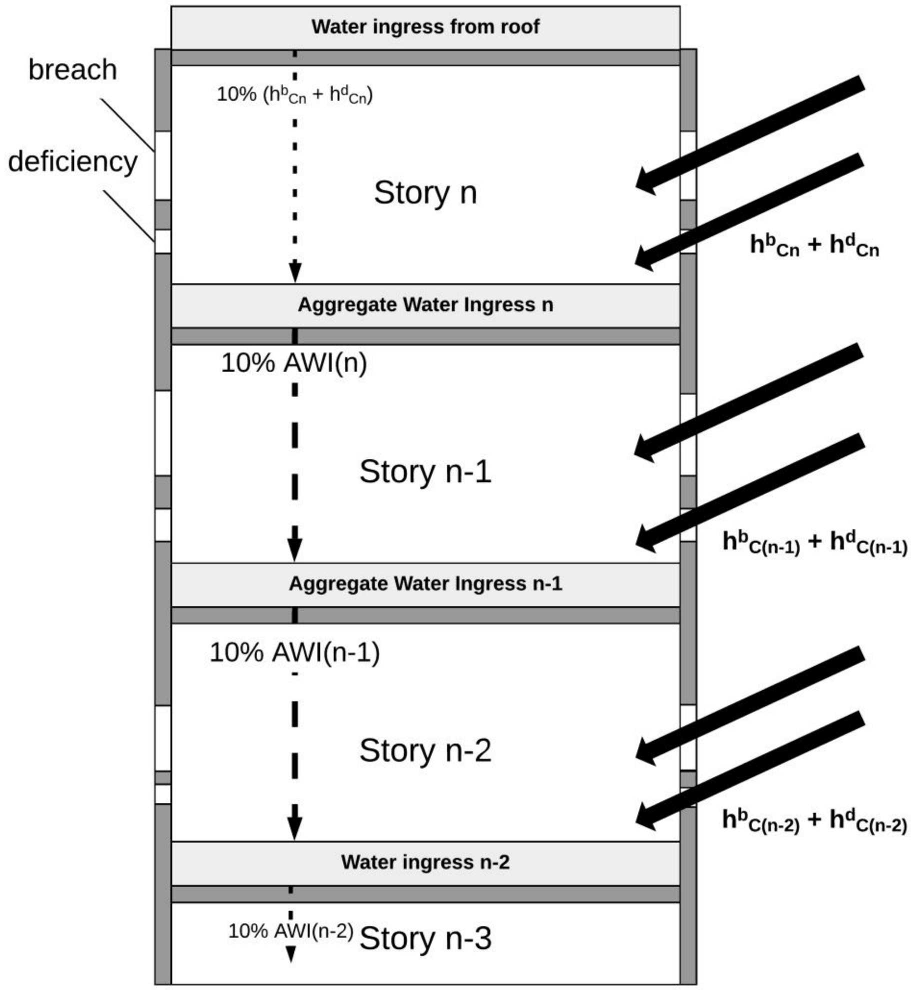


Figure 60. Diagram of water intrusion through breaches, deficiencies and percolation in a MHR building

The total amount of water in story *k* of Figure 60 is:

$$h_k = \sum_C \left\lfloor \rho\left(h^b_{C_j} + h^d_{C_j}\right) + \left(h^b_{C_k} + h^d_{C_k}\right) \right\rfloor \qquad (22)$$

Likewise, the total water height at the third-to-last story "*l*" of an n-story building is:

$$h_l = \sum_C \left\lfloor \rho^2\left(h^b_{C_j} + h^d_{C_j}\right) + \rho\left(h^b_{C_k} + h^d_{C_k}\right) + \left(h^b_{C_l} + h^d_{C_l}\right) \right\rfloor \qquad (23)$$

Thus, in mid/high-rise building, a story gets the percolated water from the story above by adding a $\rho h^d_{C_2}$ or $\rho h^b_{C_2}$ to the water coming from deficiencies and breaches respectively. The amount of water percolating downward is not subtracted from the total amount of water at the story where it originated. It is assumed that even if water percolates downward, it still has the potential to produce damage before leaking downward.

In conclusion, this approach for MHR CR estimates the amount of water that enters through each opening of the envelope. The total amount of water is calculated by adding the contributions of all fenestration components for a given wind speed, including percolation. The final step maps water inside the building to interior damage with a bilinear relationship, where total interior damage is achieved for a certain threshold of height of accumulated water (currently set at 1 inch).

Treatment of water infiltration in the personal residential model

The overall building damage is the sum of external damage plus interior damage plus utilities damage. In the PR model, the interior damage is extrapolated from the external damage, and the utilities damage is proportional to the interior damage, based on heuristics derived from engineering judgment validated with claims data. This model implicitly includes water infiltration at moderate to high wind speeds.

In damage surveys of past hurricanes (Gurley, 2006), it was observed that a number of houses that were not damaged on the outside did experience losses from water penetration. The heuristic interior damage model was adjusted to address these observations. In order to model rain induced damage, even in the absence of external damage at low wind speeds, a leak internal damage model was developed, which is independent of external damage at low wind speeds, while at higher wind speeds, the relationship between internal and external damage was maintained.

The leak model creates a smooth transition between interior damage at low wind speed (governed by leaks) and interior damage at high wind speed (governed by water penetration through breaches) by means of a polynomial equation coupled with an exponential decay function. The shape of the polynomial model was defined based on engineering judgment and calibrated and validated based on damage observed during the 2004 hurricane season, and the corresponding claims data (Artiles, 2006; Johnson, 2011). The model was first implemented in V3.1 of the FPHLM.

14. Provide a completed Form V-1, One Hypothetical Event. Provide a link to the location of the form here.

See Form V-1.

The model computes the damage based on actual terrain three-second gust winds at 10 m, that are obtained from the given open terrain one-minute sustained winds, and the losses are aggregated twice: once among the ZIP Codes with the same actual terrain three-second gust wind and once among the ZIP Codes with the same open terrain one-minute sustained wind. Because all the ZIP Codes do not have the same roughness, identical open terrain one-minute sustained winds result in different actual terrain three-second gust winds. Occasional bumps in the one-minute sustained winds plot are due to this process of conversion and re-aggregation. The modelers do confirm that the structures used in completing the form are identical to those in the table provided in the Standard.

The resulting damage ratios vs. wind speed for the personal residential reference structures in Form V-1 (i.e. timber, masonry, and manufactured home) and the engineered commercial residential reference structure correspond to widely different types of structures. Therefore, it is informative to report them separately, which is done in the last two tables of Part A of the form.

V-2 Derivation of Contents Hurricane Vulnerability Functions

A. Development of the contents hurricane vulnerability functions shall be based on at least one of the following: (1) insurance claims data, (2) tests, (3) rational analysis, and (4) post-event site investigations. Any development of the contents hurricane vulnerability functions based on rational engineering analysis, post-event site investigations, and tests shall be supported by historical data.

A component approach combines engineering modeling, simulations, engineering judgment, and insurance claim data to produce the vulnerabilities results. The contents damage in the personal residential model is extrapolated from the external damage on the basis of expert opinion and post-events site inspections of areas impacted by recent hurricanes. The contents damage in the commercial residential model results from water ingress calculations, tests, and Monte Carlo simulations. The water ingress and water absorption capacities of the building contents components in the simulations result from laboratory tests, manufacturer's data, and expert opinion based on post-hurricane site inspections of actual damage. The vulnerability results are calibrated and validated against insurance claim data.B. The relationship between the hurricane model building and contents hurricane vulnerability functions shall be consistent with, and supported by, the relationship observed in historical data.

B. The relationship between the modeled structure and the contents hurricane vulnerability functions is reasonable, on the basis of the relationship between historical structure and contents hurricane losses.

The relationship between the modeled structure and the contents hurricane vulnerability functions is reasonable, on the basis of the relationship between historical structure and contents hurricane losses.

Disclosures

1. Describe any modifications to the contents vulnerability component in the hurricane model since the previously-accepted hurricane model.

There has been modifications in the commercial residential low-rise model and in the commercial residential mid/high-rise model contents vulnerability models. Standard G-1, disclosure 7, details the rationale for these changes. This section describes these changes.

<u>COMMERCIAL RESIDENTIAL LOW-RISE MODEL</u>

a) New contents damage model.

The contents vulnerability model in V8.1 of the FPHLM divides the contents in categories based on water absorption capacity and location. It is integrated in the interior damage model. As such, it is partially described in disclosure 1 of Standard V-1.

The high variability in contents and the lack of data on its possible water resistance characteristics, prevent the use of moisture contents (MC) as a metric for contents damage. Instead, the damage of each contents category depends on a height of water *h*, such that:

$$h = WCT/A \qquad (1)$$

Where, in each of the 6 building compartments:

- WCT = the total amount of water accumulated in WA or WA-CA contents, or, the total amount of water going through NA or NA-CA contents or appliances AP,

- A = the area of the building compartment

A polynomial equation relates the contents physical damage ratio to h for contents (see Equation 2). Figure 61 is a representation of Equation 2 for each category of contents. Manufacturer catalogs and expert opinion inform the values of multiplier γ and exponent δ. The concave upwards shape of the curves reflects the fact that at very low levels of h, the contents can be dried and saved if remedial action occurs rapidly.

$$Cont\_Damage\_Ratio = \gamma \times (h)^{\delta} \qquad (2)$$

An USACE report (USACE, 2006) informed the contents description, distribution, and value in typical residences, which in turn led to the quantification of cost participation factors for each contents' category. The contents cost analysis showed that the cost participation factor for WA is 43% of the total contents cost, for NA it is 45%, for AP 4%, for WA-CA 3%, and for NA-CA 5%. To get the total contents monetary damage ratio, the model performs a weighted average of the physical damage ratios of each of the five individual contents categories where the weights are the cost participation factors.

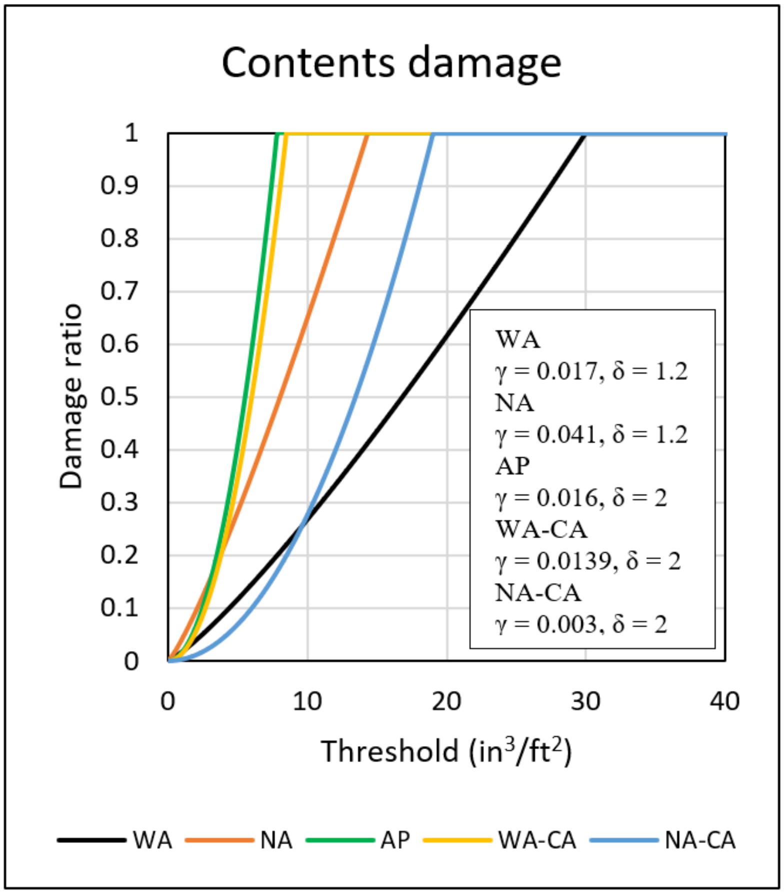


Figure 61. Damage evaluation curves for contents

b) Differentiation between apartment buildings and condo associations.

The V8.1 model has the option to produce contents vulnerability functions for all the contents in the building, for contents covered by an apartment building (AB) policy (common areas contents and appliances in condo units), and for contents covered by a condominium association (CA) policy (common areas contents). The overall building contents vulnerability curves include all the contents categories in the entire building. To produce vulnerability curves for AB contents, the model considers only the contents in the AP, WA-CA, and NA-CA categories. In the case of CA contents, the model only considers WA-CA and NA-CA.

COMMERCIAL RESIDENTIAL MID/HIGH-RISE MODEL

V8.1 of the FPHLM includes several improvements to the MHR contents model.

a) Improved interface between personal residential portfolios with condo units (owners or rentals) and the MHR model.

The FPHLM has improved the interface between personal residential portfolios with condo units (owners or rentals) and the MHR model. For a condo unit insured contents loss, the model now can differentiate between the case of a renter (appliances not included) and an owner (appliances included).

The expected unit damage value of contents ($EUDV^C$) for a PR owner or renter policy is defined as a function of the expected interior damage ratio (EIDR) of the building, as shown below.

$$EUDV_j^C = \alpha_{MR} \cdot EIDR \cdot UCV, for\ PR\ owner \qquad (3)$$

$$EUDV_j^C = \alpha_{MR} \cdot (\ EIDR - (EIDR^3 - EIDR^{3.5})) \cdot UCV, for\ PR\ renter \qquad (4)$$

Where:

- $EUDV_j^C$ is the expected unit damage value of contents in risk j.
- α_{MR} is the contents coefficient as proportion of interior damage, which is currently set to 1.
- UCV represents the condo unit insured contents coverage limit, which acts as a proxy for the contents value.
- $(EIDR^3 - EIDR^{3.5})$ is the damage ratio of the appliances. This is an empirical equation adopted by similitude with equations (5) and (6) below.

Note: if the story of the apartment unit is known, *EIDR* will be replaced by expected interior damage ratio of the story (*EIDR*(s)) where the apartment unit is located.

b) Differentiation between apartment building and condo association building policies

The model computes the contents insured damages differently for apartment building policies (AB), which include contents in common areas and appliances, and for condo association policies (CA), which include contents in common areas only.

The expected damage value of contents per story ($EDV(s)^C$) for the AB policy or the CA policy is defined as a function of expected interior damage ratio per story (*EIDR*(s)) based on engineering judgement, as shown in equations (5) and (6).

$$EDV(s)_j^C = \alpha_{MR} \cdot EIDR(s)^3 \cdot \frac{CV}{S}, for\ AB\ policy \qquad (5)$$

$$EDV(s)_j^C = \alpha_{MR} \cdot EIDR(s)^{3.5} \cdot \frac{CV}{S}, for\ CA\ policy \qquad (6)$$

Where:

c) EDV_j^C is the expected damage value of contents in risk j
d) $EIDR(s)$ is the expected interior damage ratio of story s
e) CV is insured contents value
f) S is the number of story of the building

The difference between equations (5) and (6) is the damage to the appliances.

2. Provide a flowchart documenting the process by which the contents hurricane vulnerability functions are derived and implemented.

Personal Residential model

Contents include anything in the home that is not attached to the structure itself. Like the interior and utilities, the contents of the home are not modeled in the exterior damage Monte Carlo simulations. Contents damage is modeled as a function of the interior damage caused by each exterior component failure that causes a breach of the building envelope. The function is based on engineering judgment and validated using claims data. The resulting computation of contents vulnerability functions is a 3 stage process as described in Figure 62, and discussed in disclosure 3 below.

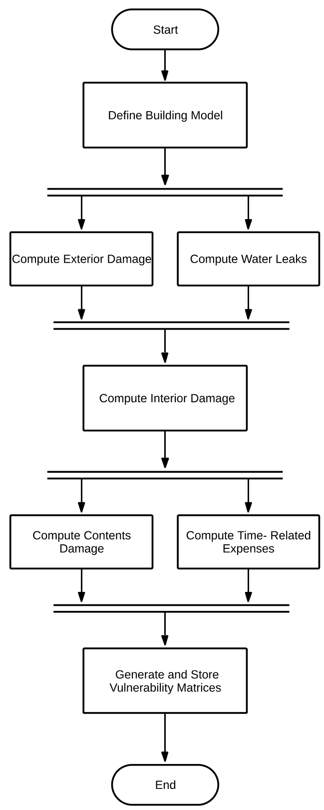


Figure 62. Derivation of contents and additional living expenses vulnerabilities for PR.

Commercial Residential model

Commercial residential low-rise model

In V8.1 of the CR-LR model, the contents damage model is integrated as part of the interior damage model and it is part of the propagation and percolation of water inside the building. See

Figure 53 in disclosure 2 of Standard V-1 where a detailed flowchart shows the integrated interior and contents damage model. Figure 63 below shows the process of computing contents vulnerability for CR-LR.

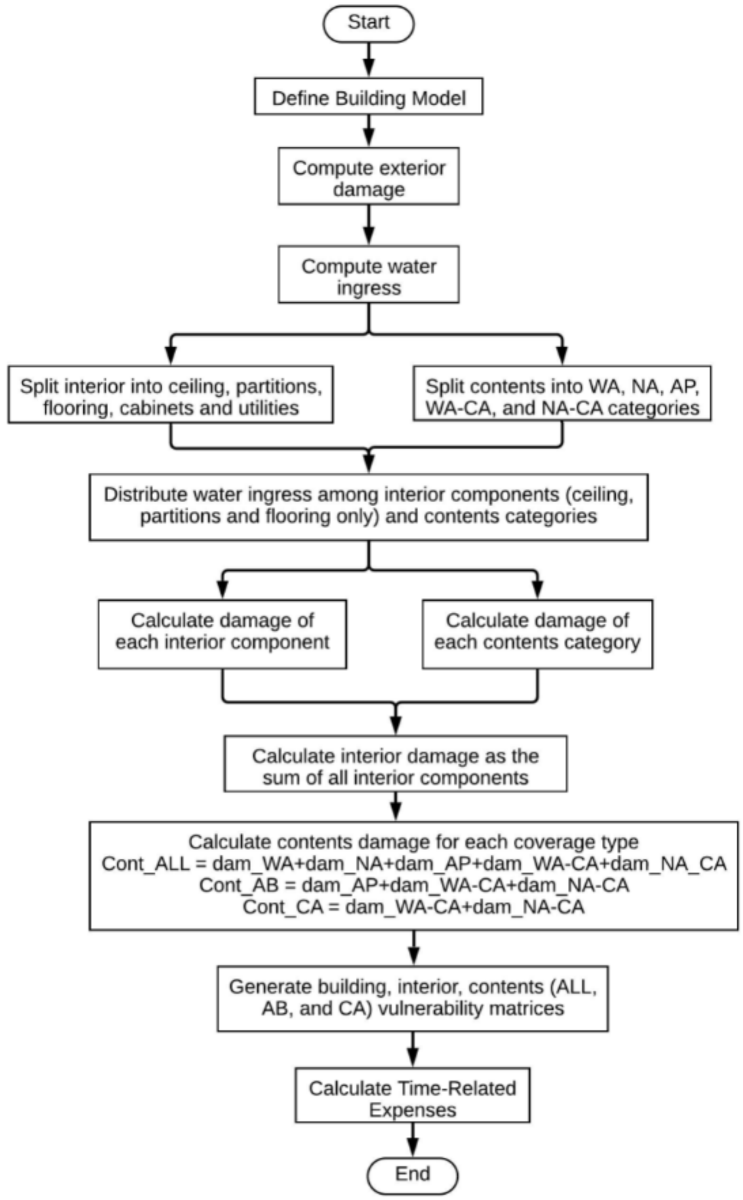


Figure 63. Derivation of contents and additional living expenses vulnerabilities for CR-LR.

<u>Commercial residential mid/high-rise model</u>

The MHR model treat AB policies, CA policies, PR condo unit owner policies, and PR condo unit renter policies separately. The damage ratio of contents is a function of expected interior damage ratio (EIDR). Figure 54 in disclosure 2, of standard V-1, describes the process to calculate *EIDR*.

3. Describe the assumptions, data (including insurance claims data), methods, and processes used to develop and validate the contents hurricane vulnerability functions.

Personal Residential model

For each building model, the first stage in the development of contents vulnerability functions corresponds to the external damage assessment through Monte Carlo simulations as discussed in standards G-1 and V-1. In the personal residential model, this is complemented by an empirical estimate of water penetration from wind driven rain due to exterior breaches or leakage paths in undamaged structures (see disclosure 13 of standard V-1). The second stage corresponds to the computation of internal damage. Damage to the interior occurs when the building envelope is breached, allowing wind and rain to ingress. Damage to roof sheathing, roof cover, walls, windows, doors, and gable ends present the possible sources of water ingress. Interior damage equations are derived as heuristic functions of each of these components failure. These relationships are developed primarily on the basis of experience and engineering judgment. Observations of homes damaged during the 2004 hurricane season (Gurley, 2006) helped to validate the predictions. In the third stage in the damage estimation, the model extrapolates the damage to contents from the interior damage, based on a heuristic function. This empirical function is based on engineering judgment and was validated against claims data for Hurricanes Andrew, Charley, and Frances, among others, as reported in disclosure 3 of Standard V-1.

Commercial Residential model

<u>Commercial residential low-rise model</u>

Contents damage in the new CR-LR V8.1 is a component-based model and it is part of the interior damage mechanism. See more details in disclosure 1 of Standards V-1 and v-2. The contents damage vulnerability functions correspond to different combinations of wall type (frame or masonry), sub-region (high velocity hurricane zone, wind-borne debris region, inland), roof shape (gable or hip), roof cover (metal, tile or shingle), window protection (shuttered or not shuttered), number of stories (one, two, or three), and strength (weak, medium, or strong).

The contents claim data for CR-LR represents claims for either apartment building policies or condo association policies. The new contents damage model, which considers different categories of contents allow for a better differentiation of insured contents damage between AB and CA. The results were validated against the contents claim data from 12 portfolios from 2 insurance companies for hurricanes Charley, Frances, Jeanne, Katrina, and Wilma. They are described in disclosure 3 of Standard V-1.

<u>Commercial residential mid/high-rise model</u>

Based on engineering judgment, contents damage ratio per story in mid/high-rise buildings is a function of the expected interior damage ratio per story for the building. Damage value of the contents per story equals the damage ratio of contents multiplied by the value of insured contents, which is then accumulated among stories. See disclosure 1, standard V-2 for details. The results were validated against the contents claim data from 10 portfolios from 2 insurance companies for hurricanes Charley, Frances, Jeanne, Katrina, and Wilma. They are described in disclosure 3 of Standard V-1.

4. Provide the total number of contents hurricane vulnerability functions. Describe whether different contents hurricane vulnerability functions are used for personal residential, commercial residential, manufactured homes, unit location for condo owners and apartment renters, and various building classes.

Contents vulnerability functions were derived for personal residential buildings (manufactured and site-built homes), and for low-rise commercial residential buildings (one to three stories).

A total of 4,356 un-weighted contents vulnerability matrices were developed for site-built homes. The matrices correspond to different combinations of wall type (frame or masonry), region (north, central, south), subregion (high velocity hurricane zone, wind-borne debris region, inland), roof type (gable or hip), roof cover (metal, tile or shingle), window protection (shuttered or not shuttered), number of stories (one or two), and strength (weak, modified weak, retrofitted weak; medium, modified medium, retrofitted medium; strong for inland and WBDR, strong for HVHZ—see Table 1 and Table 2 in the General Standards).

These 4,356 contents un-weighted matrices were then combined to produce 5,226 contents weighted matrices, and 291 contents age weighted matrices for site-built homes for building, for each county. Many of the matrices are repeated because many of the counties use the same regional statistics for the weighting.

A total of 1,944 un-weighted contents vulnerability matrices were developed for low-rise commercial residential buildings, 648 for all building contents, 648 for apartment buildings (AB) and 648 for condo association buildings (CA). They correspond to different combinations of wall type (frame or masonry), sub-region (high velocity hurricane zone, wind-borne debris region, inland), roof shape (gable or hip), roof cover (metal, tile or shingle), window protection (shuttered or not shuttered), number of stories (one, two, or three), and strength (weak, medium, or strong).

These 1,944 matrices were then combined to produce 432 contents weighted curves for low-rise, commercial residential buildings for building.

4 un-weighted contents vulnerability matrices were developed for manufactured homes for building. They correspond to four manufactured home types: (1) pre-1994—fully tied down, (2) pre-1994—not tied down, (3) post-1994—Housing and Urban Development (HUD) Zone II, and (4) post-1994—HUD Zone III. The partially tied-down homes are assumed to have a vulnerability that is an average of the vulnerabilities of fully tied-down and not tied-down homes. The un-weighted matrices are combined into 6 weighted matrices for building, for pre-1994 (4 regions: North, Central, South, Key) and post-1994 (2 zones: II and III) manufactured homes.

The contents vulnerability functions used for condo unit owners and apartment unit renters are the contents vulnerability functions for ether personal or commercial residential buildings.

5. Describe the relationship between building structure and contents hurricane vulnerability functions.

Personal residential model

The contents vulnerability is a function of the interior damage, which is a main contributor to the building vulnerability. Consequently, the relationship between contents vulnerability and structure vulnerability follows the relationship between overall building structure vulnerability and interior vulnerability.

Commercial residential model

Commercial residential low-rise model

The contents categories are components of the integrated interior and contents damage portion of the model. Therefore, the water absorption capacities of the contents have an influence on the distribution of water to the interior components, and vice-versa. The interior damage is a main contributor to the building vulnerability. Consequently, the relationship between contents vulnerability and structure vulnerability follows the relationship between overall building structure vulnerability and interior vulnerability. The damage to the contents will depend on the damage to the building envelope, and subsequent rainwater ingress and distribution to interior components and contents.

Commercial residential mid/high-rise model

The MHR model does not yield the vulnerability curves of the building structure and contents, but combines the vulnerability module and the actuarial module. The output of the MHR model are the damage values of building structure and contents. The damage ratio of contents is defined as a function of the damage ratio of the interior of the building. See disclosure 1, standard V-2 for details.

V-3 Derivation of Time Element Hurricane Vulnerability Functions

A. Development of the time element hurricane vulnerability functions shall be based on at least one of the following: (1) insurance claims data, (2) tests, (3) rational engineering analysis, and (4) post-event site investigations. Any development of the time element hurricane vulnerability functions based on rational engineering analysis, post-event site investigations, and tests shall be supported by historical data.

The time element hurricane vulnerability functions in the personal and commercial residential models are extrapolated from the building and interior damage on the basis of rational engineering analysis and post-events site inspections of areas impacted by recent hurricanes. The vulnerability results are calibrated and validated against insurance claim data when available.

B. The relationship between the hurricane model building and time element hurricane vulnerability functions shall be consistent with, and supported by, the relationship observed in historical data

The relationship between the modeled building and the time element hurricane vulnerability functions is consistent with the relationship observed in historical data.

For personal residential risks the hurricane vulnerability functions for time element expenses have been calibrated using historical claim data on additional living expense.

For commercial residential risks the relationship between model time element hurricane vulnerability functions is reasonable. Since no historical loss data were available for calibration, the relationship combines engineering and actuarial judgment.

C. Time element hurricane vulnerability function derivations shall consider the estimated time required to repair or replace the property.

Time element hurricane vulnerability function derivations consider the estimated time required to repair or replace the property.

D. Time element hurricane vulnerability functions used by the hurricane model shall include time element hurricane losses associated with wind, missile impact, flood (including hurricane storm surge), and damage to the infrastructure caused by a hurricane.

The time element hurricane vulnerability functions produced by the model include time element hurricane losses arising from wind, missile impact, flood (including hurricane storm surge), and damage to the infrastructure. The model does not distinguish explicitly between direct and indirect loss. For personal residential risks the time element vulnerability functions were calibrated against claim data that include both types of losses. For commercial residential risks the recognition of expenses due to indirect loss is based on judgment since no historical loss data were available for calibration.

Disclosures

1. Describe any modifications to the time element vulnerability component in the hurricane model since the previously-accepted hurricane model.

There has been modifications in the commercial residential low-rise model and in the commercial residential mid/high-rise model. Standard G-1, disclosure 7, details the rationale for these changes. This section describes these changes.

<u>Commercial residential low-rise model</u>

The model has an updated formula to compute time-related expenses for apartment buildings. The time-related expenses equation used in the previous model, V7.0, was a function of interior damage ratio (IDR). However, in the new model, the interior damage vulnerabilities are lower and the original equation from V7.0 equation would never reach 100% of time-related expenses. Therefore, the model it now a function of building damage ratio (*BDR*). The new equation for time element (*TE*) losses, equation (1), is a heuristic function of building damage ratio (*BDR*), which insures that the TE reach 100% at high wind speed.

$$TE = 2 * BDR^2 + 0.5 * BDR \ \leq 1.0 \qquad (1)$$

No portion of the policy hurricane deductible applies to the *TE* loss. A building damage of approximately 60% results in a *TE* loss equal to the *TE* coverage Limit. From an underwriting perspective, it is necessary to exhaust *TE* coverage limits in order to avoid any disincentive to rapid repairs.

In the case of condominium association policies no time element coverage is assumed, so it is not modeled.

<u>Commercial residential mid/high-rise model</u>

The previous version of the MHR model considered only the case of condominium association buildings, for which there are no time related losses. The new model includes the case of apartment buildings, and compute the time related expenses as a function of expected interior damage ratio of the building (*EIDR*). See equation (2).

$$EDV_j^{TE} = (2 \cdot EIDR^2 + EIDR) \cdot TV \leq TV \qquad (2)$$

Where:

- $\boldsymbol{EDV_j^{TE}}$ is the expected value of time related expenses in risk j.
- $\boldsymbol{TV}$ is the time element coverage value.

2. Provide a flowchart documenting the process by which the time element hurricane vulnerability functions are derived and implemented.

Personal residential model

Additional living expenses are a function of the interior damage caused by each exterior component failure that causes a breach of the building envelope. The function is based on engineering judgment and validated using claims data. Figure 62 of disclosure 2 of Standard V-2 describes the a 3 stage process for the computation of additional living expenses vulnerability functions.

Commercial Residential

Time element expenses in the CR-LR model are a function of the overall building damage. **Figure 53** of disclosure 2 in Standard V-1 and Figure 63 of disclosure 2 in Standard V-2 describes the process.

Time element expenses in the CR-MHR model are a function of the interior building damage. Figure 54 of disclosure 2 in Standard V-1 describes the process.

3. Describe the assumptions, data, methods, and processes used to develop and validate the time element hurricane vulnerability functions.

Personal Residential

Additional Living Expense (ALE) is coverage for additional expenses that arise when an individual must live away from the damaged home. ALE coverage comprises expenses actually paid by the insured. This coverage does not pay all living expenses, only the increase in living expense that results from the covered damage. The value of an ALE claim is dependent on the time needed to repair a damaged home as well as the utilities and infrastructure. Time element or Additional Living Expenses (ALE) are modeled as a function of interior damage. All the losses are based on a combination of engineering principles, empirical equations, and engineering judgment. The equations and methods used for manufactured and residential homes are identical. However, it seems logical to reduce the manufactured home ALE predictions because typically a faster repair or replacement time may be expected for these home types. Therefore, an ALE multiplier factor of 0.75 was introduced into the manufactured home model.

Commercial Residential

Owners of apartment buildings may purchase Time Element coverage in addition to wind coverage on the structure and contents. For commercial properties Time Element is an optional coverage and is therefore not purchased by all insured. It is generally a relatively expensive coverage. Some insurance carriers may not even offer Time Element coverage on commercial properties. The coverage will reimburse the owner of the building for business income lost or extra expenses incurred after a hurricane. Both "business income" and "extra expense" are subject to specific definitions and limitations within the coverage form.

See the details in disclosure 1 of this Standard (V-3) for both CR-LR and MHR.

Validation

The 2004 hurricane insurance provided a wealth of claim data, used to validate and calibrate the FPHLPM (Artiles, 2006; Pinelli et al., 2006). First, the consistency and validity of the data itself was investigated (see standard A-1), and the associated wind speed data was sought from NOAA. The results from the model were then compared to the claim data for hurricanes Charley and Frances. The comparisons were done for the different structural types, for different age categories, and for different insurance companies. They included comparisons of aggregated losses and of vulnerability curves. The comparisons took into account the fact that the actual wind data that caused the damage was not always available, and there was some unknowns regarding the true nature of coverage of many insurance policies. Based on these comparisons, the engineering team recalibrated the engineering model to produce a more accurate and credible predictive capability.

In subsequent years, for every new version of the FPHLM, and as new claim data became available, comparisons of aggregated losses between actual claim data and FPHLM output were performed to validate and calibrate the model. Disclosure 3 of Standard V-1 describes all the claim data.

4. Describe how time element hurricane vulnerability functions take into consideration the damage (including damage due to flood (including hurricane storm surge) and wind) to local and regional infrastructure.

Time element losses for personal residential and commercial residential buildings are based on empirical functions relating those losses to the damage to the interior of the building or the whole building. The model does not distinguish explicitly between direct and indirect losses to the structure, since the vulnerability functions do not explicitly consider the degree of flood or storm surge damage to the infrastructure. For personal residential losses there is potentially some influence of such damage injected through the validation process, since the functions are calibrated against claims data that include both types of losses. For commercial residential losses, however, there were no historical time element losses available for validation.

5. Describe the relationship between building structure and time element hurricane vulnerability functions.

The time element vulnerability is a function of the building damage, so they are directly related.

V-4 Hurricane Mitigation Measures and Secondary Characteristics

A. Modeling of hurricane mitigation measures to improve a building's hurricane wind resistance, the corresponding effects on hurricane vulnerability, and their associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles. These measures shall include fixtures or construction techniques that affect the performance of the building and the damage to contents and shall consider:

• Roof strength

• Roof covering performance

• Roof-to-wall strength

• Wall-to-floor-to-foundation strength

• Opening protection

• Window, door, and skylight strength.

Modeling of mitigation measures to improve a building's hurricane wind resistance, the corresponding effects on hurricane vulnerability, and their associated uncertainties is theoretically sound and consistent with fundamental engineering principles. The effect of hurricane mitigation measures in hurricane vulnerability uncertainty is illustrated in Figure 64 through Figure 70. The following structures were modeled:

Reference case as defined by the Commission

Mitigated case as defined by the Commission

Reference plus one mitigation at a time

B. The modeling organization shall justify all hurricane mitigation measures and secondary characteristics considered by the hurricane model.

The hurricane mitigation measures and secondary characteristics include hip roof, gable bracing, rated shingles, metal roof, stronger sheathing capacity, stronger roof-to-wall connections, stronger wall-to-sill connections, masonry reinforced walls, multiple opening protection options, and wind/missile resistant glass. Each of these has an impact on the building vulnerability depending on the combination of measures implemented.

C. Application of hurricane mitigation measures that affect the performance of the building and the damage to contents shall be justified as to the impact on reducing damage whether done individually or in combination.

For the reference cases the interior damage is governed by the sheathing loss at low to moderate wind speeds. The application of mitigation measures is justified as shown in Figure 71 through Figure 74.

D. Treatment of individual and combined secondary characteristics that affect the performance of the building and the damage to contents shall be justified.

The application of individual and combined secondary characteristics is justified as shown in Figure 71 through Figure 74.

Disclosures

1. Describe any modifications to hurricane mitigation measures and secondary characteristics in the hurricane model since the previously-accepted hurricane model.

None to be reported.

2. Describe the software used to calculate the impact of hurricane mitigation measures and secondary characteristics, its identification, and current version. Describe whether or not such software has been modified since the previously-accepted hurricane model.

The FPHLM team does not use special software to calculate the impact of hurricane mitigations. The team uses the latest version of the FPHLM V8.1. The modifications of the model are reported in Standard G-1, disclosure 7.

3. Provide a completed Form V-2, Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage. Provide a link to the location of the form here.

See Form V-2. Notice that there are no entries for the Wall-Foundation Strength rows for timber structures because the model does not have the capability to model wall-to-foundation anchors or straps for timber structures. The model does account for wall-to-sill plate connections, but not the sill plate-to-foundation connections. There are no field data to indicate that this is a significant failure mode. The connection to the foundation can be weak and is reflected in the wall-to-sill capacity (toe-nails, clips, straps).

4. Provide a description of the hurricane mitigation measures and secondary characteristics used by the hurricane model, whether or not they are listed in Form V-2, Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage.

The hurricane mitigation measures and secondary characteristics include hip roof, gable bracing, rated shingles, metal roof, stronger sheathing capacity, stronger roof-to-wall connections, stronger wall-to-sill connections, masonry reinforced walls, multiple opening protection options, and wind/missile resistant glass.

5. Describe how hurricane mitigation measures and secondary characteristics are implemented in the hurricane model. Identify any assumptions.

The various hurricane mitigation measures and secondary characteristics delineated in Form V-2 and Form V-3 are implemented in the model by varying the capacity model parameters (mean and coefficient of variation) to reflect the strength of a given component. For example, the reference model roof covering is represented by a random value for each shingle, with the specific capacity values for a given Monte Carlo simulation randomly assigned on the basis of a specified probability density function, mean, and coefficient of variation assigned to shingles. If the strong roof cover mitigation option is chosen, a different mean reflecting higher capacity, is used to randomly assign capacities to the shingles. This same approach is used for every component for which a hurricane mitigation measure or secondary characteristic is modeled. One or any combination of hurricane mitigation measures and secondary characteristics may be selected prior to running the Monte Carlo simulation. The stronger resistances of the mitigated components are directly reflected in the randomly assigned capacities of those components. In the case of membrane, the mitigation is modeled through a reduction of the interior damage due to loss of roof cover and subsequent water penetration.

6. Describe how the effects of multiple hurricane mitigation measures and secondary characteristics are combined in the hurricane model and the process used to ensure that multiple hurricane mitigation measures and secondary characteristics are correctly combined.

Each hurricane mitigation measure and secondary characteristic (e.g., sheathing, roof cover, membrane, roof-to-wall connections) is modeled and accounted for independently, allowing any combination to be chosen. As reflected in the results in Figure 71 through Figure 74, it is assumed that the effect of mitigating one component can change the vulnerability but not the capacity of other components via the influence that mitigation has on loading or load sharing. It is also assumed that any given mitigation does not necessarily produce improved overall performance for all wind speeds. An example is the influence of the roof sheathing strength on the vulnerability of roof-to-wall connections, caused by the influence of intact strong roof sheathing on the uplift acting on weak roof-to-wall connections. Another example is the influence of opening vulnerability on the performance of other components (walls, sheathing, and roof-to-wall connections), as the change in internal pressure resulting from opening failure changes the loading on these other components.

In summary, hurricane mitigation measures and secondary characteristics may be selected individually or in combination, but the effects of a given mitigation on other components and on overall building vulnerability, should not be and are not isolated in the model.

7. Describe how building and contents damage are affected by performance of hurricane mitigation measures and secondary characteristics. Identify any assumptions.

Bracing the gable end, using rated shingles, using a membrane, or using a metal roof alone does not provide any benefit when all other components remain weak, as required by Form V-2. For example, regardless of the type of roof cover used, if the home loses its weak sheathing panels, there will be little benefit in mitigating the roof cover or gable end alone. Combining mitigation measures, however, does indeed reduce the vulnerability of the home, as demonstrated in the bottom section of Form V-2.

The hip roof has a greater impact in reducing the losses, especially in the case of frame structures. Because the base frame structure is inherently weaker, there is comparatively a higher gain with the hip timber structure than with the hip masonry structure. For example, a weak home with a hip roof is not vulnerable to gable end collapse.

Improving the roof sheathing capacity (8d nails) alone reduces the damage at wind speeds up to 100 mph and 120 mph sustained winds for wood and masonry structures, respectively, but at higher wind speeds the mitigation becomes counter-effective (Figure 71 through Figure 74). The behavior of the damage curve with mitigated sheathing after 100 (wood) and 120 (masonry) mph sustained winds is due to the still very weak roof-to-wall connections. Loss of sheathing reduces the uplift on the roof-to-wall connections. Thus, the stronger deck results in higher loads on the connections, which the connections are not prepared to absorb. This effect was recently experimentally identified through destructive testing of real structures with toe-nail connections and strong decking attachment (Shanmugam et al., 2009).

Clips and straps are very effective for frame structures, less so for masonry structures. The model emphasizes interior damage due to loss of sheathing, roof cover, or gable end, which are all independent of the roof-to-wall connection strength. If the strength of the plywood deck and roof cover is not increased, increasing the roof-to-wall connections alone will do little good at low to moderate wind speeds. At higher wind speeds, the integrity of the box system in the frame structure is improved by the stronger roof-to-wall connection, hence the more pronounced benefit for the frame structure than for masonry. The observed negative values in Form V-2 corresponding to the clip or straps mitigation are from round off of smaller values within the uncertainty scatter of the model and indicate zero change.

Clips and straps for wall-to-sill plate connections are very effective at high wind speeds for frame structures because they improve the integrity of the box system. Similarly, the reinforcing of the walls for masonry structures is more effective at high wind speeds when unreinforced walls become vulnerable.

Opening protections are effective, and more so at higher wind speeds. This follows logically, as the internal pressurization caused by an opening breach is critical to the failure of other components only at higher wind speeds.

A mitigated structure with a combination of individual hurricane mitigation measures and secondary characteristics (as per standards definition) shows improved performance over the base structure and each of the individual hurricane mitigation measures and secondary characteristics.

The nonzero damage between 40 and 60 mph sustained winds, the convergence of the base, and all mitigation cases in this wind speed range reflect the incorporation of non-exterior damage-related losses in the model. Water penetration through windows and doors is possible even without window or door breach (Salzano et al., 2010). This portion of the model is not dependent upon mitigations, thus the convergence of curves in Figure 71 through Figure 74 in that wind speed range.

8. Describe how hurricane mitigation measures and secondary characteristics affect the uncertainty of the vulnerability. Identify any assumptions.

Both the mean damage ratio and its associated uncertainty (expressed as standard deviation) differ between the reference and mitigated structures. Figure 64 through Figure 67 show the mean vulnerability curves together with the mean +/- one standard deviation for reference case and the mitigated case, for both masonry and timber.

To better contrast the reference and mitigated structure damage ratios, Figure 68 shows the percent change in the mean damage ratio from the reference to the mitigated structure for both masonry and timber. As expected, there is a reduction in mean damage in the mitigated structure relative to the reference structure. The magnitude of the reduction varies with wind speed, but the mitigated structure consistently has a lower damage ratio. Figure 69 shows the percent change of the standard deviation of the damage ratio from the reference to the mitigated structure for both masonry and timber. The percent change fluctuates negatively and positively over the range of wind speeds. At lower wind speeds it is expected that the standard deviation of the damage ratio of the mitigated structure should be lower. However, at higher wind speeds this expectation is not valid. The relative contribution of individual building components (some mitigated and others not) to the damage ratio change as a function of wind speed, and interact in a highly nonlinear manner. Figure 70 shows Figure 68 and Figure 69 in ratio to present the percent change in the coefficient of variation (COV), and reflects the reduced damage and reduced uncertainty of the mitigated structure at lower wind speeds.

Overall Figure 64 through Figure 70 demonstrate that the mitigated structure has a lower mean damage ratio over the full range of wind speeds, while the associated uncertainty is lower at low wind speeds and variable at higher wind speeds where significant physical damage to a combination of many mitigated and unmitigated components accumulates.

9. Provide a completed Form V-3, Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret

Item). If not considered as Trade Secret, provide a link to the location of the form here.

See Form V-3.

10. Provide a completed Form V-4, Differences in Hurricane Mitigation Measures and Secondary Characteristics. Provide a link to the location of the form here.

See Form V-4. Notice that there are no entries for the Wall-Foundation Strength rows for timber structures because the model does not have the capability to model wall-to-foundation anchors or straps for timber structures. The model does account for wall-to-sill plate connections, but not the sill plate-to-foundation connections. There are no field data to indicate that this is a significant failure mode. The connection to the foundation can be weak and is reflected in the wall-to-sill capacity (toe-nails, clips, straps).

11. Provide a completed Form V-5, Percentage Change in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs. Provide a link to the location of the form here.

See Form V-5. Notice that there are no entries for the Wall-Foundation Strength rows for timber structures because the model does not have the capability to model wall-to-foundation anchors or straps for timber structures. The model does account for wall-to-sill plate connections, but not the sill plate-to-foundation connections. There are no field data to indicate that this is a significant failure mode. The connection to the foundation can be weak and is reflected in the wall-to-sill capacity (toe-nails, clips, straps).

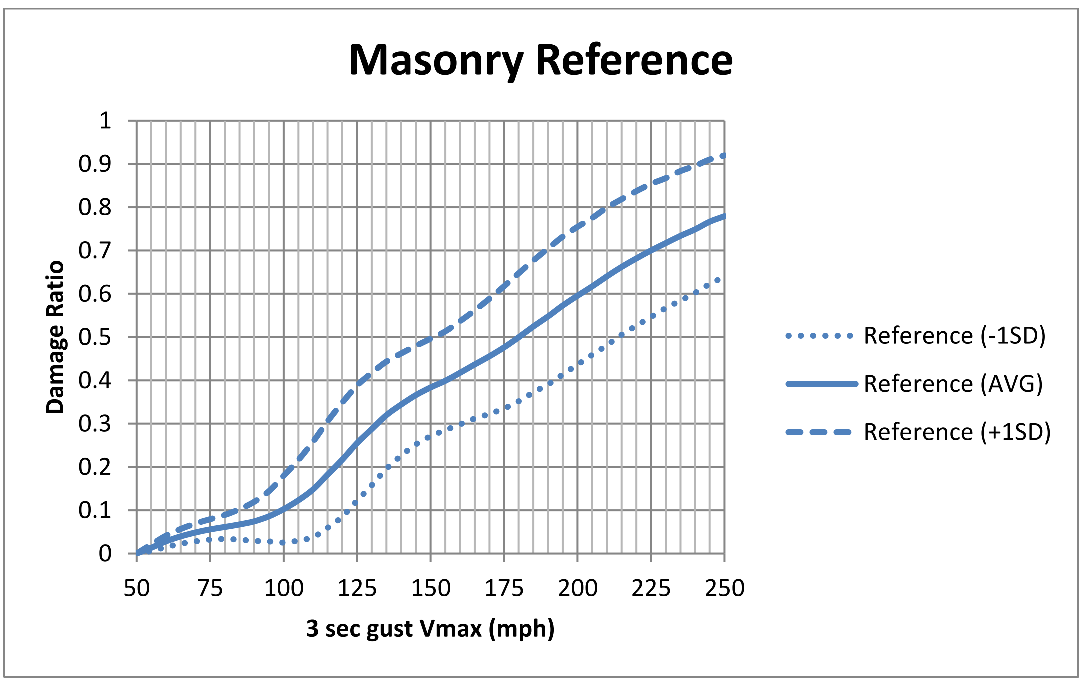


Figure 64. Masonry reference case vulnerability curves

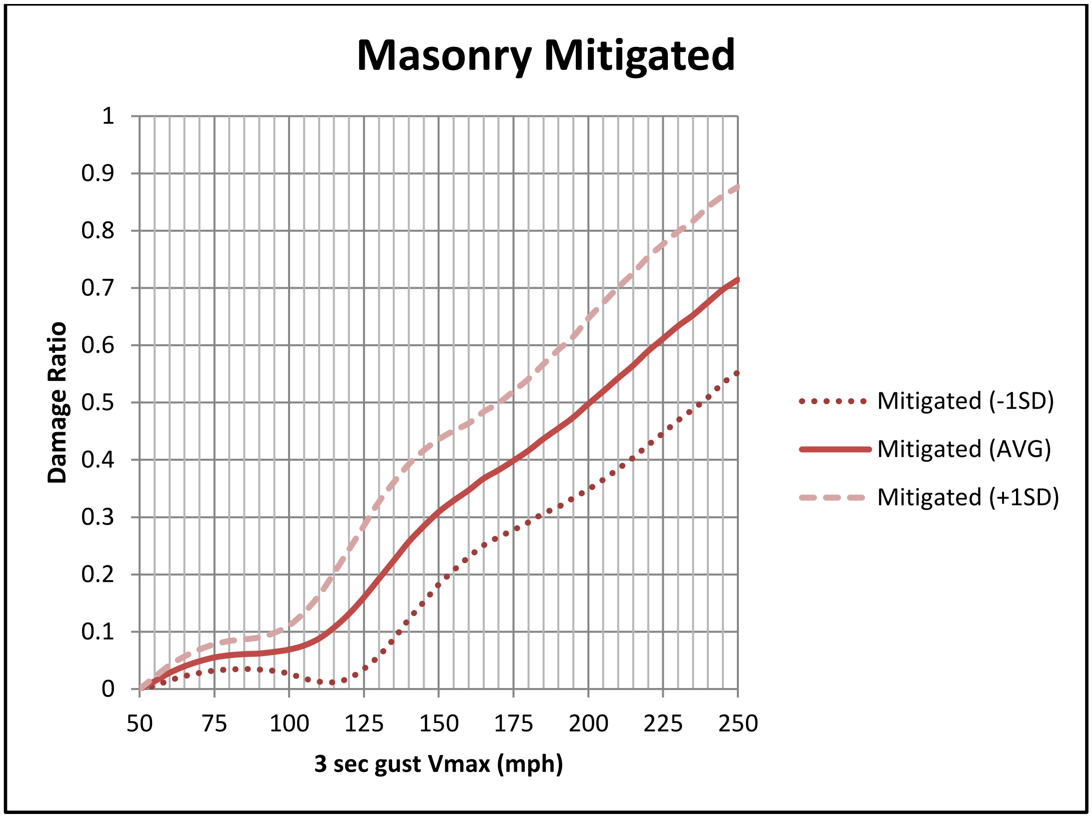


Figure 65. Masonry mitigated case vulnerability curves

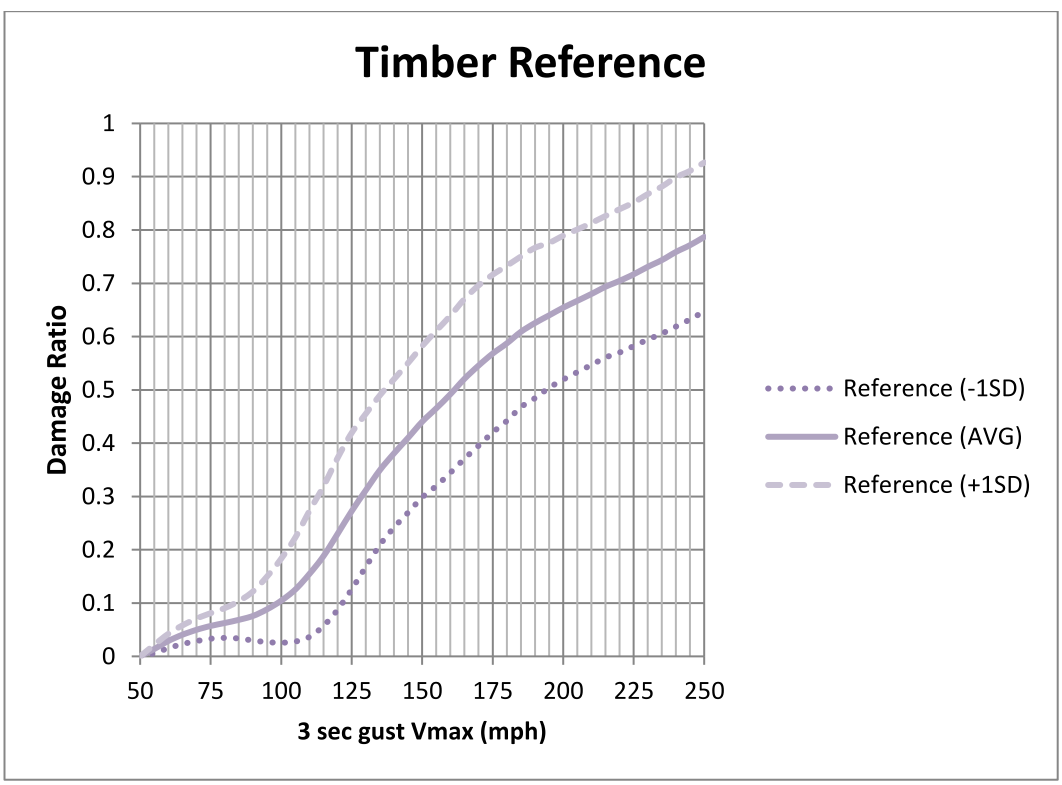


Figure 66. Timber reference case vulnerability curves

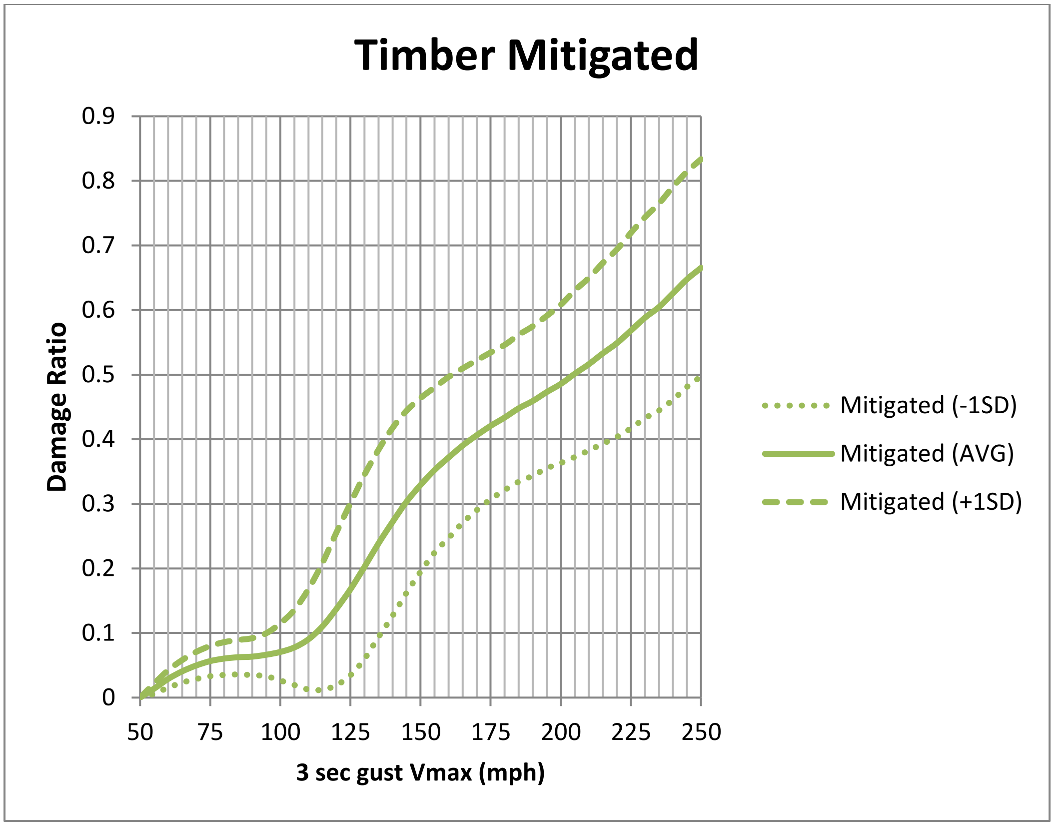


Figure 67. Timber mitigated case vulnerability curves

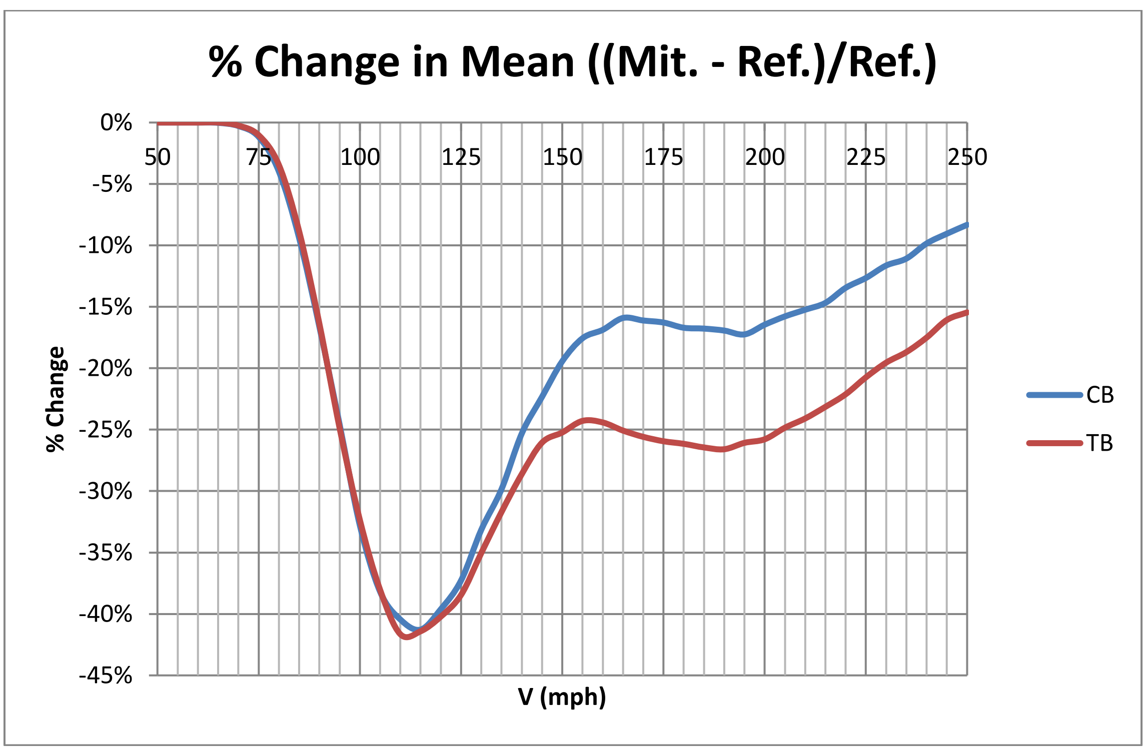


Figure 68. Percent change of mean damage ratio from reference to mitigated structure (blue: masonry, red: timber)

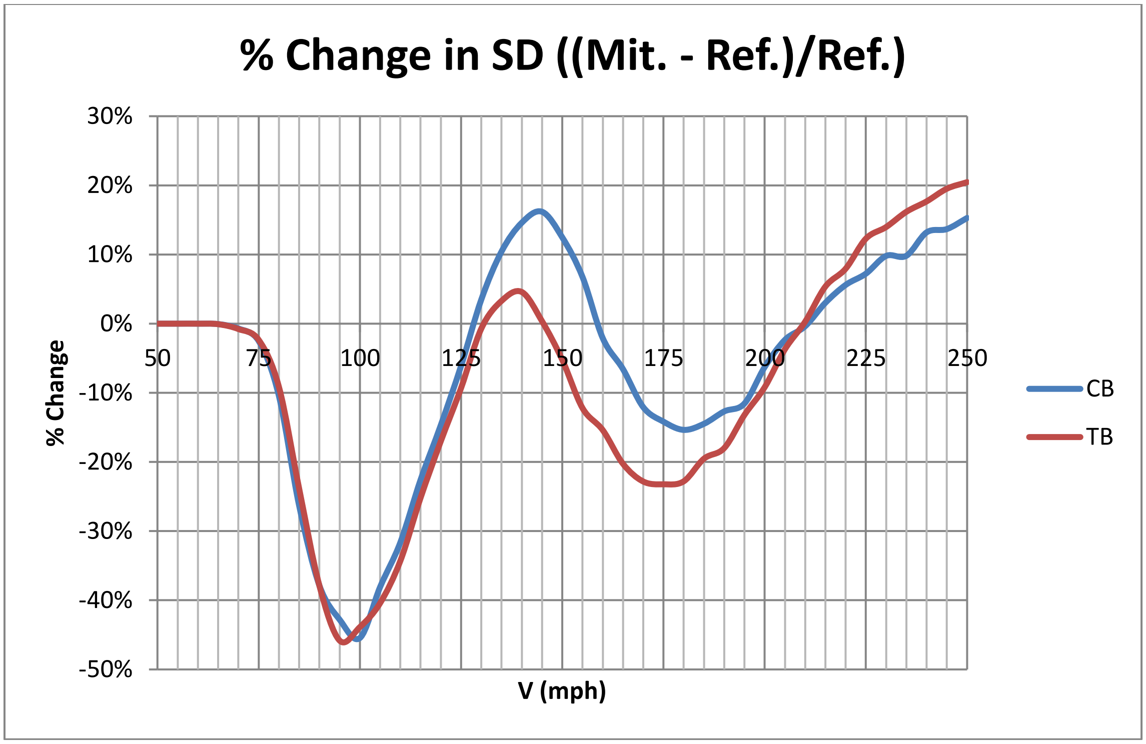


Figure 69. Percent change of standard deviation of the damage ratio from reference to mitigated structure (blue: masonry, red: timber)

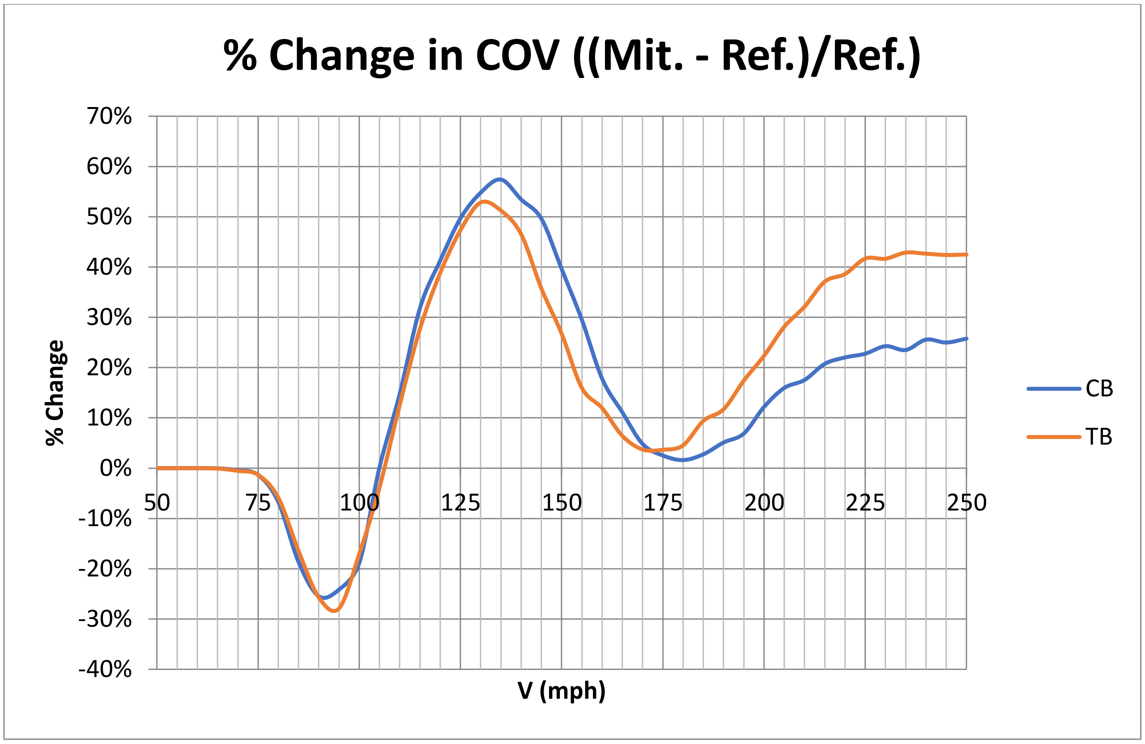


Figure 70. Relative change in coefficient of variation (COV) between mitigated and reference cases

Form V-1: One Hypothetical Event

A. Windspeeds for 96 ZIP Codes and sample personal and commercial residential exposure data are provided in the file named "FormV1Input19.xlsx." The windspeeds and ZIP Codes represent a hypothetical hurricane track. Model the sample personal and commercial residential exposure data provided in the file against these windspeeds at the specified ZIP Codes and provide the building and contents damage ratios and time element summarized by windspeed (mph) and construction type.

The wind speeds provided are one-minute sustained 10-meter wind speeds. The sample personal and commercial residential exposure data provided consist of four structures (one of each construction type: wood frame, masonry, manufactured home, and concrete) individually placed at the population centroid of each of the ZIP Codes provided. Each ZIP Code is subjected to a specific wind speed.

For completing Part A, Estimated Damage for each individual wind speed range is the sum of ground up hurricane loss to all structures in the ZIP Codes subjected to that individual wind speed range, excluding demand surge and flood (including hurricane storm surge). Subject Exposure is all exposures in the ZIP Codes subjected to that individual wind speed range.

For completing Part B, Estimated Damage is the sum of the ground up hurricane loss to all structures of a specific type (wood frame, masonry, manufactured home, or concrete) in all of the wind speed ranges, excluding demand surge and flood (including hurricane storm surge). Subject Exposure is all exposures of that specific construction type in all of the ZIP Codes.

One reference structure for each of the construction types shall be placed at the population center of the ZIP Codes. Do not include appurtenant structures, contents or time element coverages in the contents damage ratios. Do not include building, appurtent structure, or contents coverages in the time element loss ratios.

Reference Frame Structure:	Reference Masonry Structure:
One story Unbraced gable end roof ASTM D3161 Class D or ASTM D7158 Class D shingles ½" plywood deck 6d nails, deck to roof members Toe nail truss to wall anchor Wood framed exterior walls 5/8" diameter anchors at 48" centers for wall/floor/foundation connections No shutters Standard glass windows No door covers No skylight covers Constructed in 1995	One story Unbraced gable end roof ASTM D3161 Class D or ASTM D7158 Class D shingles ½" plywood deck 6d nails, deck to roof members Weak truss to wall connection Masonry exterior walls No vertical wall reinforcing No shutters Standard glass windows No door covers No skylight covers Constructed in 1995
Reference Manufactured Home Structure:	**Reference Concrete Structure:**
Tie downs Single unit Manufactured in 1980	Twenty story Eight apartment units per story No shutters Standard glass windows Constructed in 1980

B. Confirm that the structures used in completing the form are identical to those in the above table for the reference structures. If additional assumptions are necessary to complete this form (for example, regarding structural characteristics, duration, or surface roughness), provide the reasons why the assumptions were necessary as well as a detailed description of how they were included.

The modelers do confirm that the structures used in completing the form are identical to those in the table provided in the standard.

The engineered commercial residential reference structure is assumed to be a condominium association, and as such it does not have time element losses.

The insured value for the condo association of the 20 story concrete structure with 8 apartments per story was changed from $100,000 to $15,000,000 since this is a more realistic insured value for a condo association for a building of these characteristics. The change was necessary since the building area is computed as the insured value divided by the unit cost per ft^2. Keeping the insured value at $100,000 will produce an unrealistically small area, and therefore illogical damage. The adjustment in the insured value of the 20 story concrete structure then provides more realistic damage ratios.

The combined damage ratio is computed by (PR building damage + MHR building damage) / (PR building exposure + MHR building exposure). Some of the MHR damage ratios (MHR building damage / MHR building exposure) are smaller than the corresponding PR damage ratios (PR building damage / PR building exposure). When the exposure of the MHR policies increase to $15 million, the MHR damage ratio has an increasing weight in the new combined ratio and thus the combined damage ratio become closer to the MHR damage ratio, which is essentially smaller than PR damage ratio.

C. Provide separate plots of the Estimated Damage/Subject Exposure (y-axis) versus Windspeed (x-axis) for the Building, Contents, and Time Element data in Part A .

See Appendix S.

D. Include Form V-1, One Hypothetical Event, in a submission appendix.

See Appendix S.

Form V-2: Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage

A. Provide the change in the zero deductible personal residential reference building damage rate ratio (not hurricane loss cost) for each individual hurricane mitigation measure and secondary characteristic listed in Form V-2, Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage, as well as for the combination of the four hurricane mitigation measures and secondary characteristics provided for the Mitigated Frame Building and the Mitigated Masonry Building below.

See Appendix T.

B. If additional assumptions are necessary to complete this form (for example, regarding duration or surface roughness), provide the rationale for the assumptions as well as a detailed description of how they are included.

Not applicable.

C. Provide this form in Excel format without truncation. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form V-2, Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage, in a submission appendix.

Reference Frame Building: *One story* *Unbraced gable end roof* *ASTM D3161 Class D or* *ASTM D7158 Class D shingles* *½" plywood deck* *6d nails, deck to roof members* *Toe nail truss to wall anchor* *Wood framed exterior walls* *5/8" diameter anchors at 48" centers for wall/floor/foundation connections* *No shutters* *Standard glass windows* *No door covers* *No skylight covers* *Constructed in 1995*	***Reference Masonry Building:*** *One story* *Unbraced gable end roof* *ASTM D3161 Class D or* *ASTM D7158 Class D shingles* *½" plywood deck* *6d nails, deck to roof members* *Weak truss to wall connections* *Masonry exterior walls* *No vertical wall reinforcing* *No shutters* *Standard glass windows* *No door covers* *No skylight covers* *Constructed in 1995*
Mitigated Frame Building: *ASTM D7158 Class H shingles* *8d nails, deck to roof members* *Truss straps at roof* *Structural wood panel Shutters*	***Mitigated Masonry Building:*** *ASTM D7158 Class H shingles* *8d nails, deck to roof members* *Truss straps at roof* *Structural wood panel Shutters*

Place the reference building at the population centroid for ZIP Code 33921 in Lee County.

See Appendix T.

Form V-3: Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)

A. Provide the mean damage ratio (without including any insurance considerations) to the reference building for each individual hurricane mitigation measure and secondary characteristic listed in Form V-3, Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), as well as the percent damage for the combination of the four hurricane mitigation measures and secondary characteristics provided for the Mitigated Frame Building and the Mitigated Masonry Building below.

See Form V-3 below. Notice that for the 60 mph column all the vulnerabilities coincide at 6%. This is because at these low wind speeds, no significant damage is activated to trigger any significant difference between the different cases.

B. Provide the zero deductible personal residential hurricane loss cost rounded to three decimal places, for the reference building and for each individual hurricane mitigation measure and secondary characteristic listed in Form V-3, Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), as well as the hurricane loss cost for the combination of the four hurricane mitigation measures and secondary characteristics provided for the Mitigated Frame Building and the Mitigated Masonry Building below.

See Form V-3 below.

C. If additional assumptions are necessary to complete this form (for example, regarding duration or surface roughness), provide the rationale for the assumptions as well as a detailed description of how they are included.

Not applicable.

D. Provide a graphical representation of the hurricane vulnerability curves for the reference building and the fully mitigated building.

See Figure 71 to Figure 74.

E. If not considered as Trade Secret, provide this form in Excel format without truncation. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form V-3, Hurricane Mitigation Measures and Secondary Characteristics, Mean

Damage Ratios and Hurricane Loss Costs (Trade Secret Item), in a submission appendix.

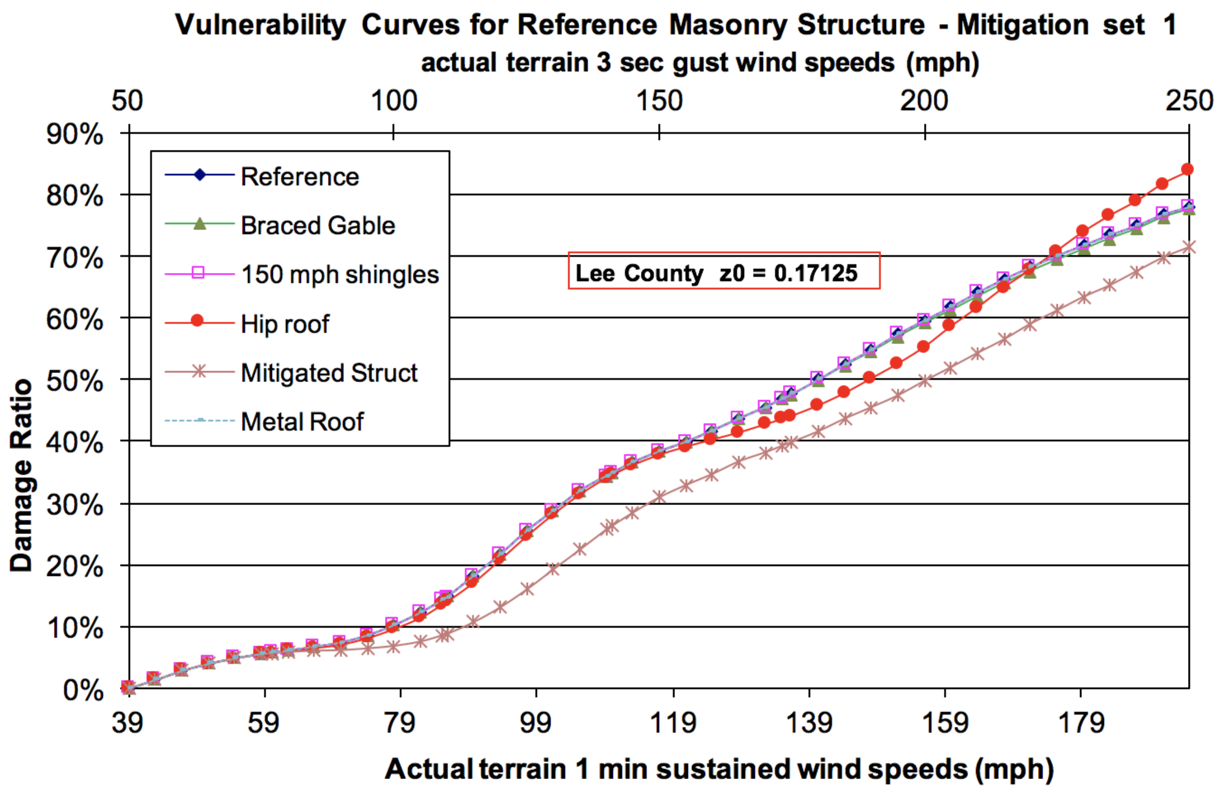
<u>Reference Frame Structure</u>: **One story** **Unbraced gable end roof** **ASTM D3161 Class D or** **ASTM D7158 Class D shingles** **½" plywood deck** **6d nails, deck to roof members** **Toe nail truss to wall anchor** **Wood framed exterior walls** **5/8" diameter anchors at 48" centers for wall/floor/foundation connections** **No shutters** **Standard glass windows** **No door covers** **No skylight covers** **Constructed in 1995**	**<u>Reference Masonry Structure</u>:** **One story** **Unbraced gable end roof** **ASTM D3161 Class D or** **ASTM D7158 Class D shingles** **½" plywood deck** **6d nails, deck to roof members** **Weak truss to wall connections** **Masonry exterior walls** **No vertical wall reinforcing** **No shutters** **Standard glass windows** **No door covers** **No skylight covers** **Constructed in 1995**
<u>Mitigated Frame Structure</u>: **ASTM D7158 Class H shingles** **8d nails, deck to roof members** **Truss straps at roof** **Structural wood panel Shutters**	**<u>Mitigated Masonry Structure</u>:** **ASTM D7158 Class H shingles** **8d nails, deck to roof members** **Truss straps at roof** **Structural wood panel Shutters**

Place the reference building at the population centroid for ZIP Code 33921 in Lee County.

See Figure 71 through Figure 74. Because there are too many vulnerability curves to plot in one figure, for the sake of clarity, the mitigations were divided in four sets for both masonry and frame structures. In each figure, there are two horizontal axes: the upper axis represents the actual terrain three-second gusty winds; the lower axis represents the actual terrain one-minute sustained winds. The conversion between three-second gust and one-minute sustained winds depends on the roughness of the terrain. Therefore, on each plot, the value of the roughness parameter for Lee County is indicated. Finally, please note that, as explained in the previous section, mitigating the roof shingles alone, or the metal roof alone, or the membrane alone without mitigating the roof deck (upgrading nail size and or spacing) or the roof-to-wall connections does not improve the overall vulnerability of the structure. Consequently, in Figure 71 through Figure 74, the curves for the base case and the rated shingle, metal roof, and membrane cases are superimposed on each other. This result is dependent on the base case weak sheathing connection and should not be interpreted to imply that reroofing is not an effective mitigation. Reroofing is only ineffective for the case of a very weak roof deck. The combination of re-nailing the decking and reroofing (now required practice) is an effective mitigation.

Form V-3: Mitigation Measures – Mean Damage Ratio (1 min)

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS			MEAN DAMAGE RATIO										HURRICANE LOSS COSTS	
			FRAME BUILDING					MASONRY BUILDING					FRAME BUILDING	MASONRY BUILDING
			WIND SPEED (MPH)*					WIND SPEED (MPH)*					ACROSS ALL WINDSPEEDS	
			60	85	110	135	160	60	85	110	135	160		
	REFERENCE BUILDING		6%	15%	39%	56%	67%	6%	14%	35%	47%	62%	$14.797	$14.277
ROOF STRENGTH	BRACED GABLE ENDS		6%	15%	39%	56%	66%	6%	14%	35%	47%	61%	$14.797	$14.277
ROOF STRENGTH	HIP ROOF		6%	14%	37%	50%	64%	6%	13%	34%	44%	59%	$14.211	$13.747
ROOF COVERING	METAL		6%	15%	39%	56%	67%	6%	14%	35%	47%	62%	$14.794	$14.274
ROOF COVERING	ASTM D7158 CLASS H SHINGLES		6%	15%	39%	56%	67%	6%	14%	35%	47%	62%	$14.794	$14.274
ROOF COVERING	MEMBRANE		6%	15%	39%	56%	67%	6%	14%	35%	47%	62%	$14.797	$14.277
ROOF COVERING	NAILING OF DECK 8d		6%	9%	38%	60%	67%	6%	9%	30%	48%	63%	$12.136	$11.460
ROOF-WALL STRENGTH	CLIPS		6%	15%	37%	48%	59%	6%	14%	35%	43%	54%	$14.721	$14.275
ROOF-WALL STRENGTH	STRAPS		6%	15%	37%	46%	51%	6%	14%	35%	43%	53%	$14.709	$14.274
WALL-FLOOR STRENGTH	TIES OR CLIPS		6%	15%	38%	54%	65%	-	-	-	-		$14.729	-
WALL-FLOOR STRENGTH	STRAPS		6%	15%	37%	53%	64%	-	-	-	-		$14.709	-
WALL FOUNDATION STRENGTH	LARGER ANCHORS OR CLOSER SPACING		-	-	-	-	-	-	-	-	-	-	-	-
WALL FOUNDATION STRENGTH	STRAPS		-	-	-	-	-	-	-	-	-	-	-	-
WALL FOUNDATION STRENGTH	VERTICAL REINFORCING		-	-	-	-	-	6%	14%	35%	42%	48%	-	$14.252
OPENING PROTECTION	WINDOW SHUTTERS	STRUCT WOOD	6%	14%	36%	55%	67%	6%	14%	32%	46%	61%	$14.509	$14.000
OPENING PROTECTION	WINDOW SHUTTERS	METAL	6%	14%	35%	54%	66%	6%	14%	31%	44%	61%	$14.331	$13.835
OPENING PROTECTION	DOOR AND SKYLIGHT COVERS		6%	15%	38%	56%	66%	6%	14%	35%	46%	61%	$14.761	$14.245
WINDOW DOOR, SKYLIGHT STRENGTH		IMPACT RATED	6%	14%	34%	50%	63%	6%	14%	30%	41%	58%	$14.285	$13.793
WINDOW DOOR, SKYLIGHT STRENGTH	ENTRY DOORS	MEETS WINDBORNE DEBRIS REQUIREMENTS	6%	15%	39%	56%	66%	6%	14%	35%	46%	61%	$14.785	$14.266
WINDOW DOOR, SKYLIGHT STRENGTH	GARAGE DOORS	MEETS WINDBORNE DEBRIS REQUIREMENTS	6%	12%	37%	56%	67%	6%	12%	33%	47%	62%	$13.689	$13.194
WINDOW DOOR, SKYLIGHT STRENGTH	SLIDING GLASS DOORS	MEETS WINDBORNE DEBRIS REQUIREMENTS	6%	15%	38%	55%	66%	6%	14%	35%	46%	61%	$14.750	$14.235
HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION			MEAN DAMAGE RATIO											
			FRAME BUILDING					MASONRY BUILDING					FRAME BUILDING	MASONRY BUILDING
			WIND SPEED (MPH)					WIND SPEED (MPH)					ACROSS ALL WINDSPEEDS	
			60	85	110	135	160	60	85	110	135	160		
MITIGATED BUILDING			6%	9%	28%	42%	50%	6%	9%	26%	39%	52%	$11.549	$11.216



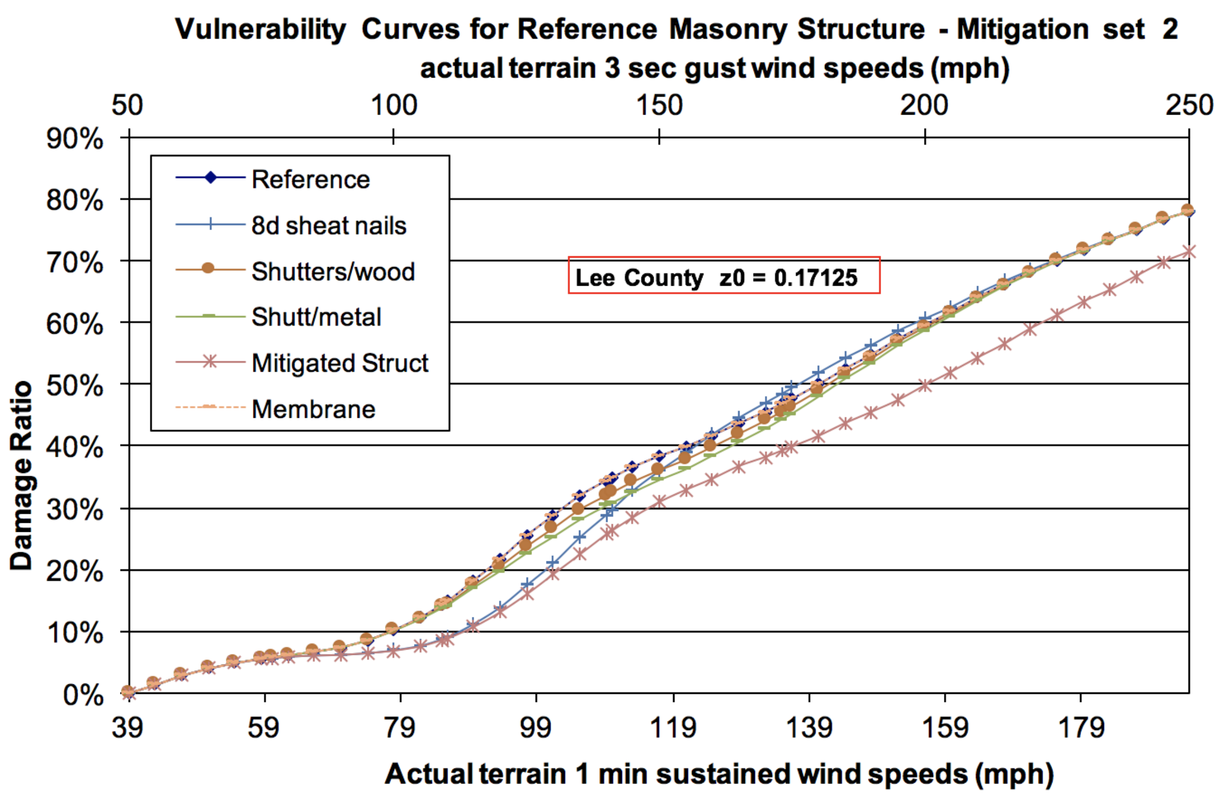
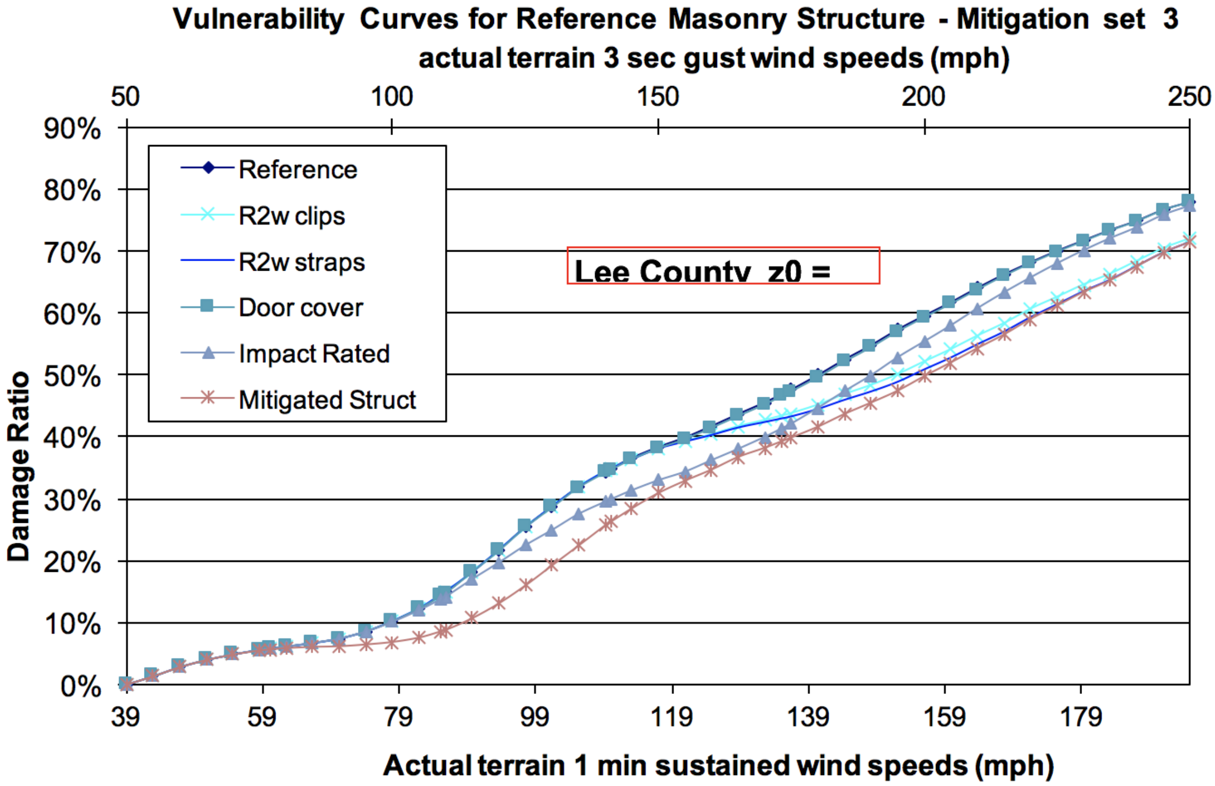


Figure 71. Mitigation measures for masonry homes.



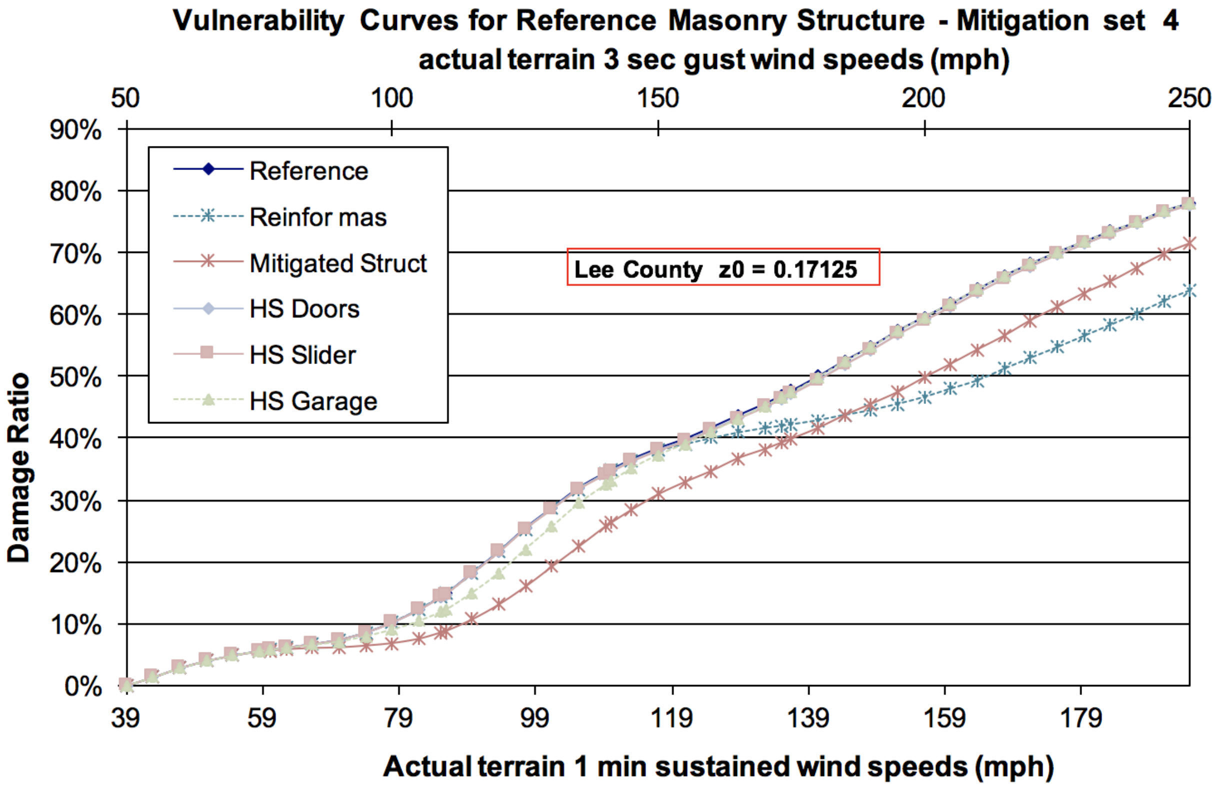
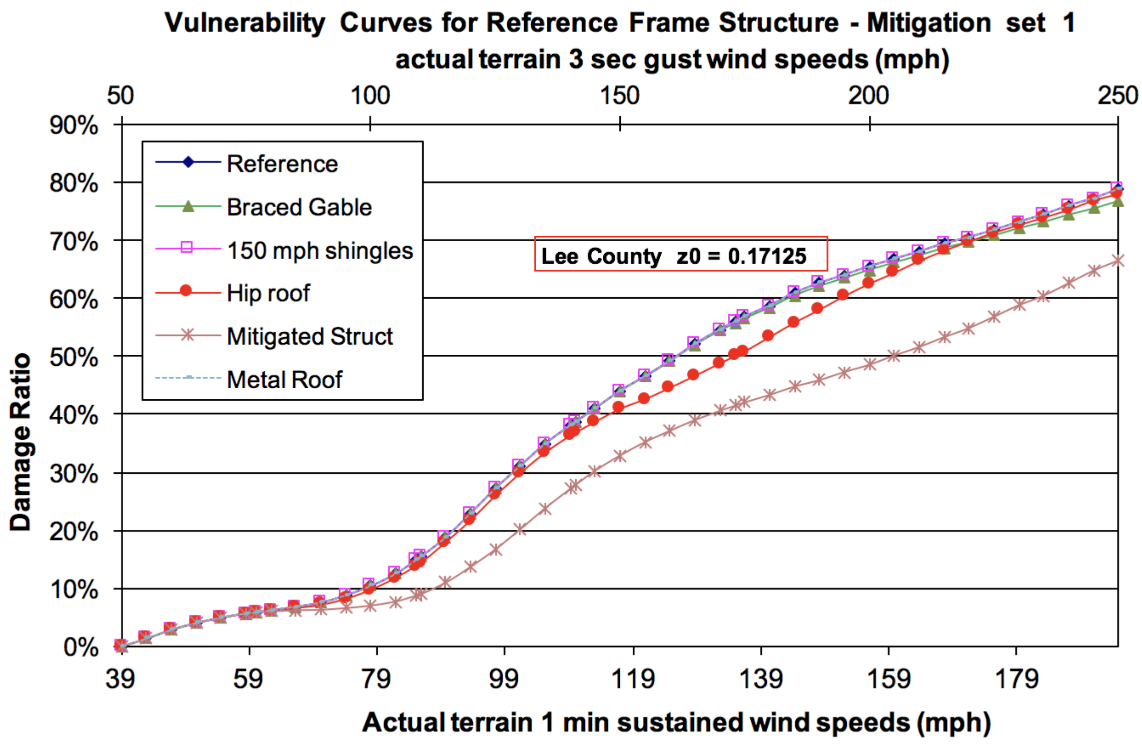


Figure 72. Mitigation measures for masonry homes.



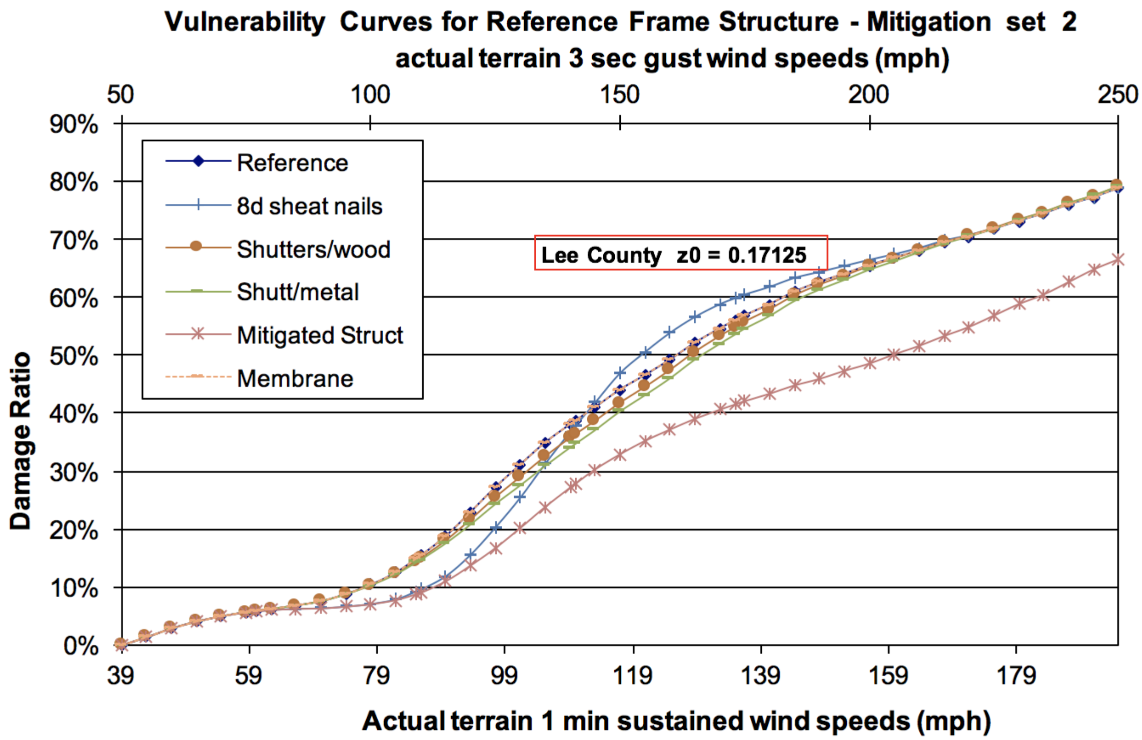
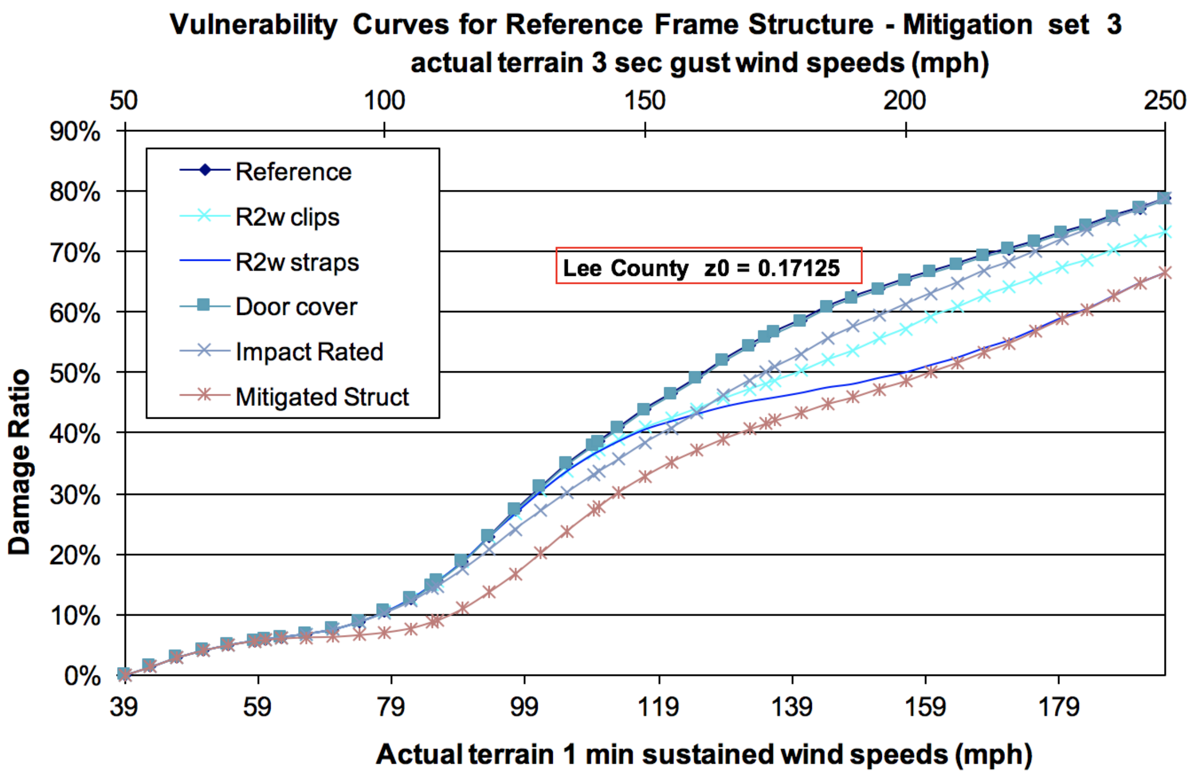


Figure 73. Mitigation measures for frame homes.



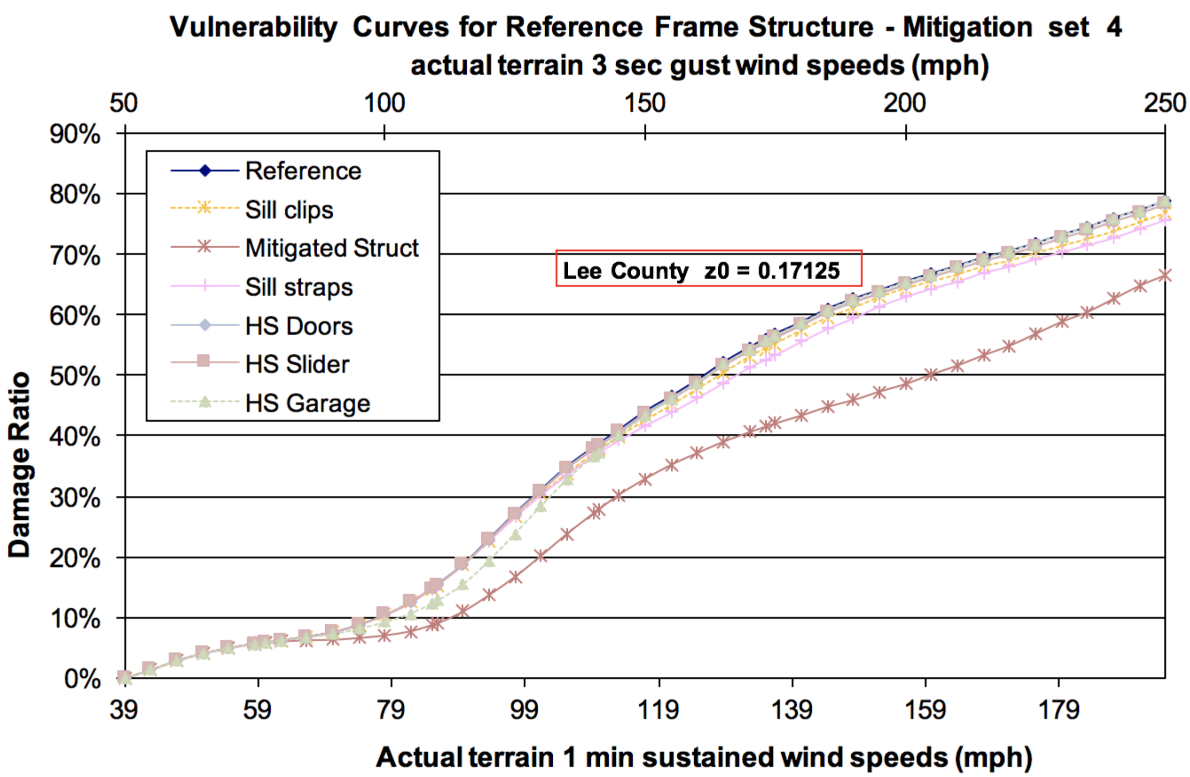


Figure 74. Mitigation measures for frame homes.

Form V-4: Differences in Hurricane Mitigation Measures and Secondary Characteristics

A. Provide the differences between the values reported in Form V-2, Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage, relative to the equivalent data compiled from the previously-accepted hurricane model.

See Appendix U.

B. Provide a list and describe any assumptions made to complete this form.

The list and assumptions governing this form are the same than the ones described in disclosures 4 and 5 of Standard V-4.

C. Provide a summary description of the differences.

Form V-4 shows no differences. No changes were made to the reference or mitigated structure models relative to the previous submission.

D. Provide this form in Excel format without truncation. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form V-4, Differences in Hurricane Mitigation Measures and Secondary Characteristics, in a submission appendix.

See Appendix U.

Form V-5: Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)

A. Provide the differences between the values reported in Form V-3, Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), relative to the equivalent data compiled from the previously-accepted hurricane model.

See Form V-5 below.

B. Provide a list and describe any assumptions made to complete this form.

The list and assumptions governing this form are the same than the ones described in disclosures 4 and 5 of Standard V-4.

C. Provide a summary description of the differences.

Form V-5 shows no differences for the mean damage ratios. No changes were made to the reference or mitigated structure models relative to the previous submission. Please refer to the summary description of Form V-4 for justification.

The form shows minor differences for the loss cost ratios, of the order of 6.8% to 7.6%. Theses minor changes are due to changes in the hazard model.

D. If not considered as Trade Secret, provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form V-5, Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), in a submission appendix.

Form V-5: Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS			DIFFERENCES FROM FORM V-3 RELATIVE TO PREVIOUSLY-ACCEPTED HURRICANE MODEL											
			MEAN DAMAGE RATIO										HURRICANE LOSS COSTS	
			FRAME BUILDING					MASONRY BUILDING					FRAME BUILDING	MASONRY BUILDING
			WINDSPEED (MPH)*					WINDSPEED (MPH)*					ACROSS ALL WINDSPEEDS*	
			60	85	110	135	160	60	85	110	135	160		
	REFERENCE BUILDING		0	0	0	0	0	0	0	0	0	0	$1.043	$0.964
ROOF CONFIGUR-ATION	BRACED GABLE ENDS		0	0	0	0	0	0	0	0	0	0	$1.043	$0.964
	HIP ROOF		0	0	0	0	0	0	0	0	0	0	$0.990	$0.934
ROOF COVERING	METAL		0	0	0	0	0	0	0	0	0	0	$1.043	$0.964
	ASTM D7158 CLASS H SHINGLES		0	0	0	0	0	0	0	0	0	0	$1.043	$0.964
	MEMBRANE		0	0	0	0	0	0	0	0	0	0	$1.043	$0.964
	NAILING OF DECK	8d	0	0	0	0	0	0	0	0	0	0	$0.907	$0.771
ROOF-WALL STRENGTH	CLIPS		0	0	0	0	0	0	0	0	0	0	$1.010	$0.960
	STRAPS		0	0	0	0	0	0	0	0	0	0	$1.004	$0.959
WALL-FLOOR STRENGTH	TIES OR CLIPS		0	0	0	0	0	0	0	0	0	0	$1.021	
	STRAPS		0	0	0	0	0	0	0	0	0	0	$1.013	
WALL-FOUNDATION STRENGTH	LARGER ANCHORS OR CLOSER SPACING		–	–	–	–	–	—	—	—	—	—	-----	—
	STRAPS		-	-	-	-	-	—	—	—	—	—	-----	—
	VERTICAL REINFORCING		—	—	—	—	—	0	0	0	0	0	—	$0.954
OPENING PROTECTION	WINDOW SHUTTERS	STRUCTURAL WOOD PANEL	0	0	0	0	0	0	0	0	0	0	$0.995	$0.916
		METAL	0	0	0	0	0	0	0	0	0	0	$0.963	$0.885
	DOOR AND SKYLIGHT COVERS		0	0	0	0	0	0	0	0	0	0	$1.038	$0.959
WINDOW, DOOR, SKYLIGHT STRENGTH	WINDOWS	IMPACT RATED	0	0	0	0	0	0	0	0	0	0	$0.944	$0.869
	ENTRY DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0	0	0	0	0	0	0	0	0	0	$1.040	$0.961
	GARAGE DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0	0	0	0	0	0	0	0	0	0	$0.965	$0.883
	SLIDING GLASS DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0	0	0	0	0	0	0	0	0	0	$1.036	$0.957

HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION	PERCENTAGE CHANGE FROM FORM V-3 RELATIVE TO PREVIOUSLY-ACCEPTED HURRICANE MODEL											
	MEAN DAMAGE RATIO										HURRICANE LOSS COSTS	
	FRAME BUILDING					MASONRY BUILDING					FRAME BUILDING	MASONRY BUILDING
	WINDSPEED (MPH)*					WINDSPEED (MPH)*					ACROSS ALL WINDSPEEDS*	
	60	85	110	135	160	60	85	110	135	160		
MITIGATED BUILDING	0	0	0	0	0	0	0	0	0	0	$0.736	$0.705

*Windspeeds are one-minute sustained 10-meter.

ACTUARIAL STANDARDS

A-1 Hurricane Model Input Data and Output Reports

A. Adjustments, edits, inclusions, or deletions to insurance company or other input data used by the modeling organization shall be based upon generally accepted actuarial, underwriting, and statistical procedures.

All modifications to the input data are consistent with generally accepted actuarial, underwriting and statistical procedures.

B. All modifications, adjustments, assumptions, inputs and input file identification, and defaults necessary to use the hurricane model shall be actuarially sound and shall be included with the hurricane model output report. Treatment of missing values for user inputs required to run the hurricane model shall be actuarially sound and described with the hurricane model output report.

The hurricane model output report identifies and summarizes the input file that was used. Any changes to the original input file, including the treatment of missing values are included in the output report as well.

Disclosures

1. Identify insurance-to-value assumptions and describe the methods and assumptions used to determine the property value and associated hurricane losses. Provide a sample calculation for determining the property value.

The model assumes that the insured value is the value of the property except in rare cases when the insurance company provides a separate property value that is higher than the insured value.

Sample calculation of property value:

Insured values as reported on the input file:

Structure	$300,000
Appurtenant Structures	$30,000
Contents	$150,000
Time Element	$15,000

Property values as calculated by the model:

Structure = Structure Insured Value =	$300,000
Appurtenant Structures = Appurtenant Structures Insured Value =	$30,000
Contents = Contents Insured Value =	$150,000

Time Element = Time Element Insured Value = $15,000.

2. Identify depreciation assumptions and describe the methods and assumptions used to reduce insured hurricane losses on account of depreciation. Provide a sample calculation for determining the amount of depreciation and the actual cash value (ACV) hurricane losses.

For both replacement cost and ACV policies, the value of structures and contents is generally assumed to equal the insured limit. In the rare case where data on property value are available from the insurance company and that value exceeds the limit, the value provided is used to estimate the ground-up damages.

Depreciation is considered in the model, but not explicitly. The damage ratios were calibrated to insured losses that contained a mix of replacement cost and ACV policies, but primarily replacement cost. Consequently, there is an implicit allowance for depreciation (of an unknown degree) built into the modeled losses.

Sample calculation of depreciation and ACV loss:

Modeled Loss = $2,000

Depreciation = $0

ACV Loss = Modeled Loss - $0 Depreciation = $2,000.

3. Describe the methods used to distinguish among policy form types (e.g., homeowners, dwelling property, manufactured homes, tenants, condo unit owners).

The input record provided by the company includes a "policy form" code. If there is any ambiguity, the company is contacted for clarification.

4. Provide a copy of the input form(s) used by the hurricane model with the hurricane model options available for selection by the user for the Florida hurricane model under review. Describe the process followed by the user to generate the hurricane model output produced from the input form. Include the hurricane model name, version identification, and platform identification on the input form. All items included in the input form submitted to the Commission shall be clearly labeled and defined.

Florida Public Hurricane Loss Model: Version 8.1 Platform NA
Input Data File Format Specifications

Personal Residential Policies

Input files containing personal residential policies to be processed through version 8.1 of the Florida Public Hurricane Loss Model should adhere to the format specifications contained in this document.

Observe the following when preparing the input file:

(a) Provide one policy per line in a comma-separated values file (.csv).
(b) Do not use comma within the fields' values (e.g., as thousand separators or within addresses).
(c) Include the name of each field in the first line of the file.
(d) For fields that require a code, enter the code that most closely represents the data value.
(e) Only include policies with wind and/or flood coverage.

Each policy should contain a total of 43 attributes. Always provide all 43 attributes.

Attributes 1-25 are the minimum required attributes. Attributes 26-43 are secondary modifiers. Attributes 39-43 apply only to policies that include flood coverage. Follow the instructions for each attribute for information that is unknown or not applicable to a policy.

1. Policy Coverage Type

The type of coverage for each policy. Encode the data to one of the following:

This policy includes coverage for:	Code
Wind, but not for flood	1
Primary flood only	2
Excess flood only	3
Both wind and primary flood	4

2. Policy ID

A unique identifier for this policy in the data file. An alphanumeric text.

3. Type of Insured

Encode the data to one of the following:

Value	Code
Owner	1
Tenant	2
Other or Unknown	6

4. ZIP Code	The ZIP Code where this building is located. A 5-digit number.
5. Latitude	The latitude where this building is located. Format: YY.YYYYY. If not known, enter UNKNOWN.
6. Longitude	The longitude where this building is located. Format: XX.XXXXX. If not known, enter UNKNOWN.
7. County	The name of the county where the building is located.
8. Address	The street address of the building.
9. City	The name of the city where the building is located.
10. Year Built	The year in which the building was built. A 4-digit number or UNKNOWN.
11. Insured Property Type	The type of the property covered by the policy. Encode the data to one of the following:

Value	Code
Stand-alone single family residence, townhouse or rowhouse	1
Unit in a multi-story building	2
Other	3
Unknown	4

12. Construction Type	The construction type of the building. Encode the data to one of the following:

Value	Code
Frame, Timber, Wood	1
Masonry	2
Manufactured home – not tied-down	3
Manufactured home – partially tied-down	4
Manufactured home – tied-down	5
Manufactured home – tie-down unknown	6
Other	7
Unknown	8

13. Building or Unit Value	The dollar amount value of the insured building or unit. If not known, enter UNKNOWN.
14. Building Coverage	The building coverage amount in dollars. Enter 0 if none.
15. App. Coverage	The appurtenant structure coverage amount in dollars. Enter 0 if none.
16. Contents Coverage	The contents coverage amount in dollars. Enter 0 if none.
17. ALE Coverage	The additional living expenses (ALE) coverage amount in dollars. Enter 0 if none.
18. Deductible	The deductible amount for perils other than hurricane and flood. Dollar amount (convert percentages to dollar amounts).
19. Hurricane Deductible	The hurricane deductible amount in dollars (convert percentages to dollar amounts).

20. Hurricane Deductible Type

The type of hurricane deductible. For flood-only policies enter 0. For policies covering wind, encode the data to one of the following:

Value	Code
Per calendar year	1
Per occurrence	2

21. Settlement Option

The settlement option on the building. Encode the data to one of the following:

Value	Code
Replacement Cost	R
Actual Cash Value	A

22. Law and Ordinance

Encode the data to one of the following:

Value	Code
Coverage is not included	0
Coverage is included	1
Coverage does not apply	NA

23. Form

Policy form (HO-1, HO-2, HO-3, HO-5, HO-8, HO-4, HO-6, DP-1, DP-2, DP-3, etc.).

24. Program Code

Use one uppercase letter to represent each company program.

25. Territory Code

Use the territory codes reflected in your rate manual.

26. Year Retrofitted

The 4-digit year when the building was retrofitted (brought up to code).
If only the year of roof replacement is known, enter the 4-digit year when the roof was replaced followed by R (i.e. if the roof was replaced in 1999, enter 1999R).
If not retrofitted enter NA. If not known enter UNKNOWN.

27. Number of Stories

Number of stories in the building (e.g., 1, 2, 3, etc.) or UNKNOWN.

28. Sliders

Indicates whether the building/unit has sliders. Encode the data to one of the following:

Value	Code
No Sliders	0
Sliders	1
Unknown	2

29. Roof Shape

Encode the data to one of the following:

Value	Code
Gable	1
Hip	2
Other	3
Unknown	4

Note: Gambrel should be considered as gable and mansard as hip

30. Roof Cover

Encode the data to one of the following:

Value	Code
Shingles	1
Tiles	2
Metal	3
Other FBC* Compliant	4
Other Non-FBC Compliant	5
Unknown	6

*FBC = Florida Building Code

31. Roof Membrane

Encode the data to one of the following:

Value	Code
Regular Underlayment	1
Secondary Water Resistance	2
Other*	3
Unknown	4

*Example of other include foam joints

32. Soffit

Encode the data to one of the following:

Value	Code
None	0
Vinyl	1
Plywood	3
Other	4
Unknown	5

33. Roof-to-Wall Connection

Encode the data to one of the following:

Value	Code
Toe Nails	1
Clips	2
Straps	3
Other	4
Unknown	5

34. Deck Attachment

Encode the data to one of the following:

Value	Code
Planks	1
Sheathing with 6d@6/12”	2
Sheathing with 8d@6/12”	3
Sheathing with 8d@6/6”	4
Other *	5
Unknown	6

*Example of other include reinforced concrete deck attachment

35. Garage Door

Encode the data to one of the following:

Value	Code
No garage door	0
Unbraced	1
Braced	2
Unknown	3

36. Opening Protection

If at least one glazed opening is not protected, enter as no protection.
If there is more than one type of opening protection, use the most predominant type code. If the only known information is that the policy qualifies for a Basic or Hurricane windstorm loss reduction credit, use code 2.

Value	Code
No Protection	0
Plywood	1
Metal	2
Impact Resistant Glass	3
Laminated Glass	
Other*	4
Unknown	5

*Example of other include fabric

37. Location of Unit

The story in which the unit is located (e.g., 1, 2, 3, etc.) or UNKNOWN. Only applicable to units in a multi-family building; e.g., condo or rental units. Enter "NA" for all other policy types.

38. Building or Unit Area

The total square feet of the insured unit or of all floors of the insured building. If not known, enter UNKNOWN.

THE FOLLOWING FIVE FIELDS APPLY ONLY TO POLICIES THAT INCLUDE FLOOD COVERAGE.

For wind-only policies, follow the instructions for each attribute.

39. Elevation

Encode the data to one of the following:

Value	Code
Slab on-grade	1
Crawlspace – open	2
Crawlspace – closed	3
Elevated	4
Unknown or wind-only policy	5

40. First Floor Elevation

The elevation (ft.) of the first floor of the building with respect to ground elevation. If not known or for wind-only policy, enter UNKNOWN.

41. Elevated or Protected Utility

As a mitigation measure, indicate whether the utilities are elevated or protected.

Value	Code
No	0
Protected or elevated by 1 foot	1
Protected or elevated by 2 feet	2
Protected or elevated by 3 feet	3
Unknown or wind-only policy	4

42. Floodproofing

As a mitigation measure, indicate whether the building is floodproofed.

Value	Code
No	0
Wet floodproofed by 1 foot	1
Wet floodproofed by 2 feet	2
Wet floodproofed by 3 feet	3
Dry floodproofed by 1 foot	4
Dry floodproofed by 2 feet	5
Dry floodproofed by 3 feet	6
Unknown or wind-only policy	7

43. Flood Deductible

The flood deductible amount in dollars (convert percentages to dollar amounts). For wind-only policy enter 0.

Example of data file:

PolicyCoverageType,PolicyID,TypeOfInsured,ZIPCode,Latitude,Longitude,County,Address,City,YearBuilt,
InsuredPropertyType,ConstructionType,BuildingOrUnitValue,BuildingCoverage,AppCoverage,
ContentsCoverage,ALECoverage,Deductible,HurricaneDeductible,HurricaneDeductibleType,SettlementOption,
LawAndOrdinance,Form,ProgramCode,TerritoryCode,YearRetrofitted,NumberOfStories,Sliders,RoofShape,
RoofCover,RoofMembrane,Soffit,RoofToWallConnection,DeckAttachment,GarageDoor,OpeningProtection,
LocationOfUnit,BuildingOrUnitArea,Elevation,FirstFloorElevation,ElevatedOrProtectedUtility,FloodProofing,
FloodDeductible
1,ABC100,1,33143,28.04747,-80.66522,Miami-Dade,123 Main Street,Miami,1981,1,2,100000,50000,0,20000,
8000,1000,1000,2,R,1,HO-6,A,35,NA,1,2,4,6,3,1,5,5,3,5,UNKNOWN,1245,5,UNKNOWN,4,7,0

Florida Public Hurricane Loss Model: Version8.1Platform NA
Input Data File Format Specifications

Commercial Residential Policies

Input files containing commercial residential policies to be processed through version 8.1 of the Florida Public Hurricane Loss Model should adhere to the format specifications contained in this document.

Observe the following when preparing the input file:

(f) Provide one policy per line in a comma-separated values file (.csv). For a policy with multiple buildings and/or locations, each building for each location must be recorded in a separate line.
(g) Do not use comma within the fields' values (e.g., as thousand separators or within addresses).
(h) Include the name of each field in the first line of the file.
(i) For fields that require a code, enter the code that most closely represents the data value.
(j) Only include policies with wind and/or flood coverage.

Each policy should contain a total of 46 attributes. Always provide all 46 attributes. Attributes 42-46 apply only to policies that include flood coverage. Follow the instructions for each attribute for information that is unknown or not applicable to a policy.

1. Policy Coverage Type — The type of coverage for each policy. Encode the data to one of the following:

This policy includes coverage for:	Code
Wind but not for flood	1
Primary flood only	2
Excess flood only	3
Both wind and primary flood	4

2. Policy ID — A unique identifier for this policy in the data file. An alphanumeric text.
3. Location ID — A unique identifier for the location of the insured building. An alphanumeric text.
4. Building ID — A unique identifier for the building. An alphanumeric text.
5. Type of Insured — Encode the data to one of the following:

Value	Code
Condominium Association	1
Apartment Complex	2
Homeowner Association	3
Continuing Care Retirement Community	4
Manufactured Housing Park	5
Other or Unknown	6

6. ZIP Code — The ZIP Code where this building is located. A 5-digit number.
7. Latitude — The latitude where this building is located. Format: YY.YYYYY. If not known, enter UNKNOWN.
8. Longitude — The longitude where this building is located. Format: XX.XXXXX. If not known, enter UNKNOWN.
9. County — The name of the county where the building is located.
10. Address — The street address of the building.
11. City — The name of the city where the building is located.
12. Year Built — The year in which the building was built. A 4-digit number or UNKNOWN.
13. Year Retrofitted — The 4-digit year when the building was retrofitted (brought up to code).
    If only the year of roof replacement is known, enter the 4-digit year when the roof was replaced followed by R (i.e. if the roof was replaced in 1999, enter 1999R).
    If not retrofitted enter NA. If not known enter UNKNOWN.

14. Building Use

Encode the data to one of the following:

Value	Code
Residential	1
Pool	2
Detached Garage	3
Club House	4
Administration Building	5
Other	6
Unknown	7

15. Construction Type

The construction type of the building. Encode the data to one of the following:

Value	Code
Frame, Timber, Wood	1
Masonry	2
Manufactured home – not tied-down	3
Manufactured home – partially tied-down	4
Manufactured home – tied-down	5
Manufactured home – tie down unknown	6
Other	7
Unknown	8

16. Number of Stories

Number of stories in the building (e.g., 1, 2, 3, etc.) or UNKNOWN.

17. Sliders

Indicates whether the building has sliders. Encode the data to one of the following:

Value	Code
No Sliders	0
Sliders	1
Unknown	2

18. Roof Shape

Encode the data to one of the following:

Value	Code
Gable	1
Hip	2
Other	3
Unknown	4

Note: Gambrel should be considered as gable and mansard as hip

19. Roof Cover

Encode the data to one of the following:

Value	Code
Shingles	1
Tiles	2
Metal	3
Other FBC Compliant	4
Other Non-FBC Compliant	5
Unknown	6

20. Roof Membrane

Encode the data to one of the following:

Value	Code
Regular Underlayment	1
Secondary Water Resistance	2
Other*	3
Unknown	4

*Example of other includes foam joints

21. Soffit

Encode the data to one of the following:

Value	Code
None	0
Vinyl	1
Plywood	3
Other	4
Unknown	5

22. Roof-to-Wall Connection

Encode the data to one of the following:

Value	Code
Toe Nails	1
Clips	2
Straps	3
Other	4
Unknown	5

23. Deck Attachment

Encode the data to one of the following:

Value	Code
Planks	1
Sheathing with 6d@6/12”	2
Sheathing with 8d@6/12”	3
Sheathing with 8d@6/6”	4
Other *	5
Unknown	6

*Example of other includes reinforced concrete deck attachment

24. Garage Door

Encode the data to one of the following:

Value	Code
No garage door	0
Unbraced	1
Braced	2
Unknown	3

25. Opening Protection

If at least one glazed opening is not protected, enter as no protection.
If there is more than one type of opening protection, use the most predominant type code. If the only known information is that the policy qualifies for a Basic or Hurricane windstorm loss reduction credit, use code 2.

Value	Code
No Protection	0
Plywood	1
Metal	2
Impact Resistant Glass	3
Laminated Glass	4
Other*	5
Unknown	6

*Example of other includes fabric

26. Building Layout

Encode the data to one of the following:

Value	Code
Open (Access to units through external balcony)	1
Closed (Access to units through the interior)	2
Unknown	3

27. Total Units — The number of units in the building (e.g., 1, 2, 3, etc.) or UNKNOWN.

28. Units per Story — The number of units per story (e.g., 1, 2, 3, etc.) or UNKNOWN.

29. Building Area — The total square feet for all floors of the insured building or UNKNOWN.

30. Building Value — The dollar amount value of the insured building. If not known, enter UNKNOWN.

31. Building Coverage — The building coverage amount in dollars. Enter 0 if none.

32. Contents Coverage — The contents coverage amount in dollars. Enter 0 if none.

33. ALE/Time Element Coverage — The coverage amount in dollars for Loss of Rents or other time element coverage. Enter 0 if none.

34. Deductible — The deductible amount in dollars for perils other than hurricane and flood (convert percentages to dollar amounts).

35. Hurricane Deductible — The hurricane deductible amount in dollars (convert percentages to dollar amounts).

36. Hurricane Deductible Type

The type of hurricane deductible. For flood-only policies enter 0. For policies covering wind, encode the data to one of the following:

Value	Code
Per calendar year	1
Per occurrence	2

37. Coinsurance

Coinsurance percentage (e.g., for 80% enter 80). Enter 0 if none.

38. Settlement Option

The settlement option on the building. Encode the data to one of the following:

Value	Code
Replacement Cost	R
Actual Cash Value	A

39. Form

Policy Form. If company offers different base forms of coverage, enter company code; otherwise, enter 0.

40. Program Code

Use one uppercase letter to represent each company program.

41. Territory Code

Use the territory codes reflected in your rate manual.

<u>THE FOLLOWING FIVE FIELDS APPLY ONLY TO POLICIES THAT INCLUDE FLOOD COVERAGE.</u>

For wind-only policies, follow the instructions for each attribute.

42. Elevation

Encode the data to one of the following:

Value	Code
Slab on-grade	1
Crawlspace – open	2
Crawlspace – closed	3
Elevated	4
Unknown or wind-only policy	5

43. First Floor Elevation

The elevation (ft.) of the first floor of the building with respect to ground elevation. If not known or for wind-only policy, enter UNKNOWN.

44. Elevated or Protected Utility

As a mitigation measure, indicate whether the utilities are elevated or protected.

Value	Code
No	0
Protected or elevated by 1 foot	1
Protected or elevated by 2 feet	2
Protected or elevated by 3 feet	3
Unknown or wind-only policy	4

45. Floodproofing

As a mitigation measure, indicate whether the building is floodproofed.

Value	Code
No	0
Wet floodproofed by 1 foot	1
Wet floodproofed by 2 feet	2
Wet floodproofed by 3 feet	3
Dry floodproofed by 1 foot	4
Dry floodproofed by 2 feet	5
Dry floodproofed by 3 feet	6
Unknown or wind-only policy	7

46. Flood Deductible

The flood deductible amount in dollars (convert percentages to dollar amounts). For wind-only policy enter 0.

Example of data file:

PolicyCoverageType,PolicyID,LocationID,BuildingID,TypeOfInsured,ZIPCode,Latitude,Longitude,County,
Address,City,YearBuilt,YearRetrofitted,BuilidingUse,ConstructionType,NumberOfStories,Sliders,RoofShape,
RoofCover,RoofMembrane,Soffit,RoofToWallConnection,DeckAttachment,GarageDoor,OpeningProtection,
BuildingLayout,TotalUnits,UnitsPerStory,BuildingArea,BuildingValue,BuildingCoverage,ContentsCoverage,
TimeElementCoverage,Deductible,HurricaneDeductible,HurricaneDeductibleType,Coinsurance,
SettlementOption,Form,ProgramCode,TerritoryCode,Elevation,FirstFloorElevation,ElevatedOrProtectedUtility,
Floodproofing,FloodDeductible
1,ABC100,1,1,1,33143,28.04747,-80.66522, Miami-Dade,123 Main Street,Miami,1981,NA, 1,2,1,2,1,2,4,5,2,2,3,
5,3,10,10,UNKNOWN,UNKNOWN,1000000,500000,0,8000,50000,2,80,R ,0,A,35, 5,UNKNOWN,4,7,0

5. Disclose, in a hurricane model output report, the specific inputs required to use the hurricane model and the options of the hurricane model selected for use in a residential property insurance rate filing. Include the hurricane model name, version identification, and platform identification on the hurricane model output report. All items included in the hurricane model output report submitted to the Commission shall be clearly labeled and defined.

A hurricane model output report follows.

Output Report for OIR Data Processing

Florida Public Hurricane Loss Model: Release 8.1 Platform NA

OIR Data Processing Results: <Company Name: OIR Filing Number>

Report Content:
- Original Number of the policies in data set
- Process steps to formalize the data set
- Numbers of policies which are excluded due to certain reason, e.g. invalid ZIP Codes, invalid format, etc.
- Numbers of: Construction Types, Territory Codes, Policy Forms, Program Codes, etc.

- Coverage limits for building, appurtenant structure, content, additional living expense
- Distribution of deductibles
- Number of records that change values for different types of roof shape, roof cover, roof membrane, roof to wall connection, nailing of deck, garage door, opening protection, due to missing or illogical values
-Number of records for a county whose name is changed due to inconsistencies with the zip codes

- Number of policies to generate the estimated losses
- Number of files in the report

The results are aggregated by different combinations of counties, ZIP Codes, policy forms, program codes, and territory codes as applicable.

In case if there are:
- more than 1 construction type
- more than 1 policy form
- more than 1 program code
- more than 1 territory code

There will be 40 files in the report for personal residential policies with names as below:

<CompanyName>_PERSONAL_Loss_ConstType.xls
<CompanyName>_PERSONAL_Loss_County.xls
<CompanyName>_PERSONAL_Loss_PolicyForm.xls
<CompanyName>_PERSONAL_Loss_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_Zipcode.xls
<CompanyName>_PERSONAL_Loss_ConstType_PolicyForm.xls
<CompanyName>_PERSONAL_Loss_ConstType_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_ConstType_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_County_ConstType.xls
<CompanyName>_PERSONAL_Loss_County_PolicyForm.xls
<CompanyName>_PERSONAL_Loss_Zipcode_ConstType.xls

<CompanyName>_PERSONAL_Loss_County_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_Zipcode_PolicyForm.xls
<CompanyName>_PERSONAL_Loss_PolicyForm_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_PolicyForm_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_TerritoryCode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_Zipcode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_Zipcode_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_ConstType_PolicyForm_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_ConstType_PolicyForm_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_ConstType_TerritoryCode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_ConstType_PolicyForm.xls
<CompanyName>_PERSONAL_Loss_County_ConstType_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_ConstType_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_County_PolicyForm_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_PolicyForm_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_County_TerritoryCode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_Zipcode_ConstType_PolicyForm.xls
<CompanyName>_PERSONAL_Loss_Zipcode_ConstType_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_Zipcode_PolicyForm_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_ConstType_PolicyForm_TerritoryCode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_ConstType_PolicyForm_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_ConstType_PolicyForm_TerritoryCode.xls
<CompanyName>_PERSONAL_Loss_County_ConstType_TerritoryCode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_PolicyForm_TerritoryCode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_Zipcode_ConstType_PolicyForm_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_PolicyForm_TerritoryCode_ProgramCode.xls
<CompanyName>_PERSONAL_Loss_County_ConstType_PolicyForm_TerritoryCode_ProgramCode.xls

There will be 9 files in the report for commercial residential policies with names as below:

< CompanyName>_COMMERCIAL_Loss_ConstType.xls
<CompanyName>_COMMERCIAL_Loss_County.xls
<CompanyName>_COMMERCIAL_Loss_TerritoryCode.xls
<CompanyName>_COMMERCIAL_Loss_Zipcode.xls
<CompanyName>_COMMERCIAL_Loss_ConstType_TerritoryCode.xls
<CompanyName>_COMMERCIAL_Loss_County_ConstType.xls
<CompanyName>_COMMERCIAL_Loss_Zipcode_ConstType.xls
<CompanyName>_COMMERCIAL_Loss_County_TerritoryCode.xls
<CompanyName>_COMMERCIAL_Loss_County_ConstType_TerritoryCode.xls

There will be 9 files in the report for combined personal and commercial residential policies with names as below:

< CompanyName>_Loss_ConstType.xls
<CompanyName>_Loss_County.xls
<CompanyName>_Loss_TerritoryCode.xls
<CompanyName>_Loss_Zipcode.xls
<CompanyName>_Loss_ConstType_TerritoryCode.xls
<CompanyName>_Loss_County_ConstType.xls
<CompanyName>_Loss_ZIPcode_ConstType.xls
<CompanyName>_Loss_County_TerritoryCode.xls
<CompanyName>_Loss_County_ConstType_TerritoryCode.xls

Table 30. Output report for OIR data processing.

6. Describe actions performed to ensure the validity of insurer or other input data used for hurricane model inputs or for validation/verification.

Each line of data submitted for input is screened to ensure the number of fields, their order and the basic structure of the data matches the input specifications. Any mismatch causes the screening process stop and the line in question is reported to the FPHLM user for resolution. The correction typically requires manual intervention by the user after communicating with the organization that provided the data.

After the initial screening a series of functions is run to further check each data attribute and prepare it for processing through the model. Those checks are outlined in the table below.

Data Attribute	Pre-processing Steps
Policy ID	Not used in processing. Included in Model Output.
Model ID	Numeric ID assigned by model.
Residency Type	Replace empty, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description.
Zip Code	Replace empty and NULL values with the value Unknown. Remove the last five characters (dash and four digits) from ZIP 5+4 values. Exposures without a valid ZIP Code are not modeled.
Year Built	Replace empty and NULL values with the value Unknown. Set to Unknown values smaller than 1800 or larger than the current year. Impute Unknown values using county statistics.
Construction Type	Remove any character that is not a digit. Replace empty and NULL values with the value Unknown. Replace numeric codes with corresponding description. Replace out-of-range numeric codes with the value Other.
Structure, App. Structures, Contents, and TE Coverages	Remove any character that is not a digit or a dot. Replace with 0 any value that is not a correct representation of a real number. Exposures with 0 total coverage are not modeled.
Deductible	Remove any character that is not a digit, a dot, or a percent sign. Replace with 0 any value that is not a correct representation of a real number. Replace with the corresponding dollar value any value that is expressed as a percentage of the exposure (values between 0 and 1). Report zero and high (> 10%) deductible policies.
Nature of Coverage	Replace empty, N/A, and NULL values with the value Unknown.
County	Remove any character that is not a lowercase or uppercase letter, a dot, a whitespace, or a dash. Ensure that the first letter of every word in the county name is capitalizes and the rest are not. Replace empty, N/A, and NULL values with the value Unknown. Correct county name spelling. Ensure correct assignment based on ZIP Code.
Address	Remove any character that is not a lowercase or uppercase letter, a digit, a dot, or a whitespace. Replace empty, N/A, and NULL values with the value Unknown.

Data Attribute	**Pre-processing Steps**
Longitude and Latitude	Remove any character that is not a digit, a dot, or a dash. Replace empty and NULL values with the value 0. Assign location of ZIP Code centroid if Unknown and ZIP Code information is available. Exposures without a location are not modeled.
City	Remove any character that is not a lowercase or uppercase letter, a dot, or a dash. Replace empty, N/A, and NULL values with the value Unknown.
Form	Replace empty, N/A, and NULL values with the value Unknown.
Program	Unused during processing. Included in model output. Replace empty, N/A, and NULL values with the value Unknown.
Territory	Unused during processing. Included in model output. Replace empty, N/A, and NULL values with the value Unknown.
Year Retrofitted	Replace empty, N/A, and NULL values with the value Unknown.
Number of Stories	Replace with the value Unknown any value that is not an integer number between 1 and 99. Ensure Manufactured policies have one story. Ensure Frame buildings have at most three stories. Ensure non-unit PR policies have one or two stories. Ensure the number of stories is at least the location of unit for unit policies. Impute Unknown values using county statistics.
Location of Unit	Replace with the value Unknown any value that is not either an integer number between 1 and 99, Unknown, or NA.
Sliders	Replace empty, N/A, and NULL values with the value Unknown. Replace numeric codes with corresponding description. Replace Unknown values with default.
Units per Story	Remove any character that is not a digit. Replace empty and NULL values with the value Unknown.
Total Units	Remove any character that is not a digit. Replace empty and NULL values with the value Unknown. Ensure values agree with units per story and number of units when available. Impute Unknown values using county statistics.
Area of Property	Remove any character that is not a digit or a dot. Replace empty and NULL values with the value Unknown.
Roof Shape	Replace empty, N/A, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description. Impute Unknown values using county statistics.
Roof Cover	Replace empty, N/A, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description. Impute Unknown values using county statistics.
Roof Membrane	Replace empty, N/A, NULL, or out-of-range values with the value Unknown. Replace numeric codes with corresponding description.
Soffit	Replace empty, N/A, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description.
Building Layout	Remove any character that is not a digit. Replace empty and NULL values with the value Unknown. Replace numeric codes with corresponding description

Data Attribute	Pre-processing Steps
Roof-to-Wall Connection	Replace empty, N/A, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description.
Deck Attachment	Replace empty, N/A, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description.
Garage Door	Replace empty, N/A, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description.
Opening Protection	Replace empty, N/A, NULL, and out-of-range values with the value Unknown. Replace numeric codes with corresponding description. Impute Unknown values using county statistics.

Table 31. Input Data Pre-processing

7. Disclose if changing the order of the hurricane model input exposure data produces different hurricane model output or results.

If one or more attributes are known and unknown attributes are assigned based on survey statistics, changing the order of the input exposure data may produce a different model output. Whenever assignment of attributes is performed, reprocessing the same input exposure, even with no change in order, may produce a different output.

8. Disclose if removing and adding policies from the hurricane model input file affects the hurricane model output or results for the remaining policies.

If one or more attributes is unknown and unknown attributes are assigned based on survey statistics, adding policies to or removing policies from the input exposure data may produce a different model output. If the policies added or removed have known attributes and are not part of the block receiving assignments, those policies themselves will have no impact on results for the remaining policies. However, as noted above, whenever assignment is involved, reprocessing the same input exposure, even with no additions to or deletions from that exposure, may produce a different output.

A-2 Hurricane Events Resulting in Modeled Hurricane Losses

A. Modeled hurricane loss costs and hurricane probable maximum loss levels shall reflect all insured wind related damages from hurricanes that produce minimum damaging windspeeds or greater on land in Florida.

Modeled hurricane losses are produced for hurricanes producing damaging windspeeds on land in Florida.

B. The modeling organization shall have a documented procedure for distinguishing wind-related hurricane losses from other peril losses.

The procedure for distinguishing wind-related hurricane losses from other peril losses is documented.

Disclosures

1. Describe how damage from hurricane model generated storms (landfalling and by-passing hurricanes) is excluded or included in the calculation of hurricane loss costs and hurricane probable maximum loss levels for Florida.

Damages are computed for all Florida land-falling and certain by-passing storms in the stochastic set that attain hurricane level wind speeds. The following by-passing hurricanes are included:

-Non-landfalling hurricanes with point of closest approach in region A, B, C, D, E or F and open terrain winds greater than 30 mph in at least one Florida ZIP Code.

-Landfalling hurricanes in regions E or F with open terrain winds greater than 30 mph in at least one Florida ZIP Code.

2. Describe how damage resulting from concurrent or preceding flood (including hurricane storm surge) is treated in the calculation of hurricane loss costs and hurricane probable maximum loss levels for Florida.

Damage from concurrent or preceding flood or storm surge is not considered in the calculation of hurricane loss costs and hurricane probable maximum loss. The hurricane model assumes that wind is the only cause of loss from each hurricane.

A-3 Hurricane Coverages

A. The methods used in the calculation of building hurricane loss costs shall be actuarially sound.

The model's calculation of building loss costs is actuarially sound.

B. The methods used in the calculation of appurtenant structure hurricane loss costs shall be actuarially sound.

The model's calculation of appurtenant structure loss costs is actuarially sound.

C. The methods used in the calculation of contents hurricane loss costs shall be actuarially sound.

The model's calculation of contents loss costs is actuarially sound.

D. The methods used in the calculation of time element hurricane loss costs shall be actuarially sound.

The model's calculation of time element loss costs is actuarially sound.

Disclosures

1. Describe the methods used in the hurricane model to calculate hurricane loss costs for building coverage associated with personal and commercial residential properties.

Personal Residential Buildings

The model includes a set of vulnerability matrices for personal residential buildings. The matrices specify the probability of damage of a given magnitude at various wind speeds. For each building in the policy portfolio the applicable matrix for that building is used to determine the expected percent damage at a given wind speed. This determination is made storm by storm for every storm in the stochastic set. The resulting damages, adjusted for policy limits, deductibles and demand surge, are aggregated across all storms to calculate the loss cost per $1,000 of exposure.

Commercial Residential Buildings

For low-rise commercial residential buildings (three stories or fewer) the model includes a set of vulnerability curves. The curves specify the expected damage rate by wind speed, for the entire building. The resulting building damage is then treated differently for apartment buildings (AB) and condominium buildings insured by an association (CA). See Standard V-1 disclosure 1. In the event the exposure does not identify the type of insured (i.e. AB or CA), a weighted average of the modeled loss for AB and CA is assumed. The weights vary by county and are based on insurance company statistics compiled from stress testing portfolios that were processed by the model on behalf of the Florida OIR.

For mid-/high-rise commercial residential buildings (over three stories), the model estimates exterior damage to the building by aggregating expected damage per story and interior damage as a function of the volume of water intrusion resulting from breached openings on each story.

Similar to the approach applied to personal residential buildings, expected damages for commercial residential buildings are determined for each storm, adjusted for policy provisions and demand surge, and aggregated to calculate the loss cost per $1,000 of exposure.

2. Describe the methods used in the hurricane model to calculate hurricane loss costs for appurtenant structure coverage associated with personal and commercial residential properties.

Expected damages for both personal residential and commercial residential appurtenant structures are determined by policy for each storm in the stochastic set, adjusted for policy provisions and demand surge, and aggregated across all storms to calculate the loss cost per $1,000 of exposure. Expected damages are determined as follows:

Personal Residential Appurtenant Structures

Since the appurtenant structures damage is not derived from the building damage, only one vulnerability matrix is applied for appurtenant structures. The typical insurance portfolio gives no indication of the type of appurtenant structure covered under a particular policy. Therefore, a distribution of the three types (slightly vulnerable, moderately vulnerable, and highly vulnerable) was assumed in developing this matrix, and the result was then validated against claim data.

Commercial Residential Appurtenant Structures

For commercial residential exposures, appurtenant structures might include a clubhouse or administration building. These are modeled like additional buildings. For other structures such as pools, the appurtenant structures vulnerability matrix developed for residential buildings is applied.

3. Describe the methods used in the hurricane model to calculate hurricane loss costs for contents coverage associated with personal and commercial residential properties.

Expected damages for both personal residential and commercial residential contents coverage are determined for each storm in the stochastic set, adjusted for policy provisions and demand surge, and aggregated across all storms to calculate the loss cost per $1,000 of exposure. Expected damages are determined as follows:

Personal Residential Contents

Contents losses are a function of the internal damage. The model applies empirical functions that are based on engineering judgment and were validated against claim data for Hurricanes Andrew, Charley, and Frances. Figure 75 shows masonry claims data from Hurricane Andrew, the cubic polynomial trend fit, and the model curve for the High Velocity Hurricane Zone (HVHZ), which consists of Miami-Dade and Broward counties. Notice that in this case the fit between model and data is reasonable where the density of data is higher. A resulting set of vulnerability matrices are applied to determine expected percent contents damage for a given wind speed.

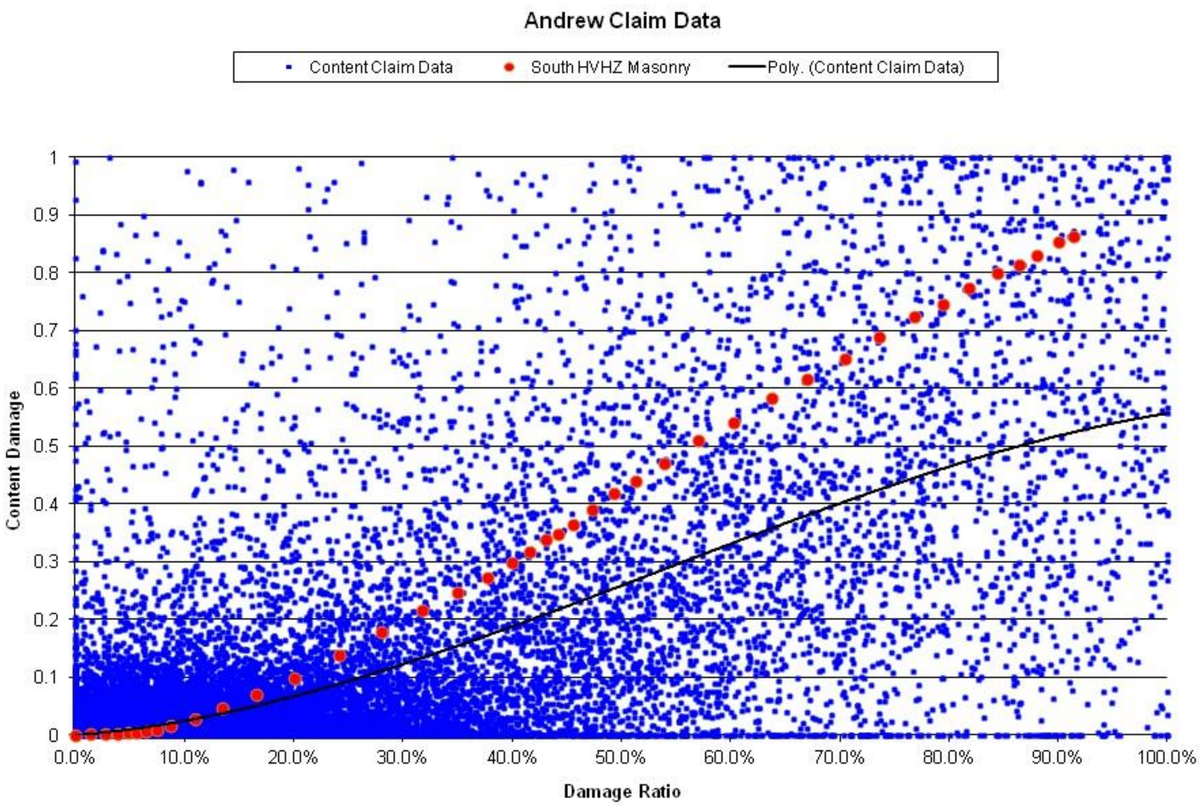


Figure 75. Modeled vs. actual relationship between structure and content damage ratios for Hurricane Andrew.

Commercial Residential Contents

Contents damage in low-rise buildings (three stories or fewer) is the result of a component-based approach. See Standard V-1 disclosure 1 and Standard V-2 disclosure 1. The model produces different vulnerability curves for apartment buildings and condominium associations, which reflect the differences in coverage. The resulting set of vulnerability curves vary by subregion and number of stories and specify expected percent damage by wind speed.

Contents damage in mid-/high-rise buildings (over three stories) is also determined as a proportion of total estimated interior damage to the building. The interior damage is estimated by determining the expected number of openings (windows, doors, sliding-glass doors) per story to be breached, and the resulting volume of water intrusion in each story.

The assumptions underlying contents damage development are based on engineering judgment.

4. Describe the methods used in the hurricane model to calculate hurricane loss costs for time element coverage associated with personal and commercial residential properties.

Expected damages for both personal residential and commercial residential time element coverage are determined for each storm in the stochastic set, adjusted for policy provisions and demand surge, and aggregated across all storms to calculate the loss cost per $1,000 of exposure. Expected damages are determined as follows:

Personal Residential Time Element

Personal residential time element expenses are based on an empirical function relating those expenses to the interior damage to the structure. The model does not distinguish explicitly between direct and indirect loss to the structure, but the function is calibrated against claim data that include both types of losses. Vulnerability matrices are applied to determine the expected percent loss fora given wind speed.

Commercial Residential Time Element

The time element expenses associated with low-rise buildings (three stories or fewer) are modeled using functions that relate those expenses to overall damage to the building. The resulting set of vulnerability curves specify expected percent expense by wind speed.

Time element expenses in mid-/high-rise buildings (over three stories) are not modeled for the case of condominium associations (which is the default adopted in this submission). Time element expenses in mid-/high-rise buildings (over three stories) for the case of apartment buildings are modeled using functions that relate those expenses to interior damage to the building.

See Standard V-3, disclosure 1.

5. Describe the methods used in the hurricane model to account for law and ordinance coverage associated with personal residential properties.

A provision for Law and Ordinance coverage is embedded in the vulnerability matrices. This provision can be removed whenever Law and Ordinance coverage is not included in a policy.

To exclude Law and Ordinance a reduction factor is applied to the modeled structure loss for each storm in the stochastic set. The factor depends on the characteristics of the exposure (such as construction type and year-built) and on the wind speed of the storm in question at that policy's location.

A-4 Modeled Hurricane Loss Cost and Hurricane Probable Maximum Loss Level Considerations

A. Hurricane loss cost projections and hurricane probable maximum loss levels shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin.

The model does not include expenses, risk load, investment income, premium reserves, taxes, assessments or profit margin in the calculation of loss costs and probable maximum loss levels.

B. Hurricane loss cost projections and hurricane probable maximum loss levels shall not make a prospective provision for economic inflation.

The model does not make a prospective provision for economic inflation in the calculation of loss costs and probable maximum loss levels.

C. Hurricane loss cost projections and hurricane probable maximum loss levels shall not include any explicit provision for direct flood losses (including those from hurricane storm surge).

The model does not include any explicit provision for direct flood losses including those from hurricane storm surge in the calculation of loss costs and probable maximum loss levels.

D. Hurricane loss cost projections and hurricane probable maximum loss levels shall be capable of being calculated from exposures at a geocode (latitude-longitude) level of resolution.

The model allows for loss cost and probable maximum loss calculations at the geocode level of resolution.

E. Demand surge shall be included in the hurricane model's calculation of hurricane loss costs and hurricane probable maximum loss levels using relevant data and actuarially sound methods and assumptions.

Demand surge is included in the model's calculation of loss costs and probable maximum loss levels. Demand surge is based on and analysis of Marshall & Swift/Boeckh construction cost indices before and after hurricanes occurring between 1992 and 2007. The methods and assumptions underlying the demand surge factors are actuarially sound.

Disclosures

1. Describe the method(s) used to estimate annual hurricane loss costs and hurricane probable maximum loss levels and their uncertainties. Identify any source documents used and any relevant research results.

To estimate annual loss costs and probable maximum loss levels, losses are estimated for individual policies in the portfolio for each hurricane in a stochastic set of storms. Losses are estimated separately for structure, appurtenant structure, contents, and time element coverage.

The meteorological component of the model generates the stochastic set of hurricanes and derives an expected three-second gust wind speed, by latitude and longitude, for each hurricane in that set of storms.

The engineering component of the model consists of a set of vulnerability matrices for personal residential exposures and a set of vulnerability curves for low-rise commercial residential exposures. The matrices specify the probability of damage of a given magnitude at various wind speeds. The curves specify the expected damage rate by wind speed. For mid-rise and high-rise commercial residential exposures, the model estimates exterior damage by aggregating expected damage per story and interior damage as a function of the volume of water intrusion resulting from breached openings on each story.

The estimated damages are reduced by applicable deductibles and increased to allow for the impact of demand surge on claim costs.

The modeled insured losses can then be summed across all properties in a ZIP Code or across all ZIP Codes in a county to obtain expected aggregate loss. The losses can also be aggregated by policy form, construction type, rating territories, etc.

Finally, modeled losses are divided by the number of years in the simulation and by the total amount of insurance to estimate annual loss costs.

To estimate Probable maximum loss on an "annual aggregate" basis modeled losses for storms occurring in the same year of the simulation are summed to produce annual storm losses. Probable maximum loss levels are calculated from the ordered set of annual losses as described in Standard A-6, Disclosure # 10.

To estimate Probable maximum loss on an "annual occurrence" basis the ordered set consists of the largest loss in each year of the simulation.

The uncertainty intervals are determined based on the ordered set of annual losses as described in Form A-8, Item E.

The following sources were used in the research:

Hogg, R. V., & Klugman, S. (1984). Loss Distributions. New York: Wiley.

Klugman, S., Panjer, H., & Willmot, G. (1998). Loss Models: From Data to Decisions. New York: Wiley.
Wilkinson, M. E. (1982). Estimating Probable Maximum Loss with Order Statistics. Casualty Actuarial Society, LXIX, pp. 195-209.

2. Identify the highest level of resolution for which hurricane loss costs and hurricane probable maximum loss levels can be provided. Identify all possible resolutions available for the reported hurricane output ranges.

Losses are calculated at the policy/coverage level for each storm in the stochastic set.

Losses can be summarized across any policy characteristic provided in the exposures. Therefore, loss costs and probable maximum loss levels can be aggregated by characteristics such as policy form, coverage, construction, deductible, latitude-longitude, ZIP Code, county, rating territory, roof shape, or whatever is provided for input.

For the reported output ranges, the resolutions available are defined by the policy characteristics provided in the exposures, namely, policy form, ZIP Code, construction and deductible. ZIP Codes can be aggregated to the county, region, or statewide level.

3. Describe how the hurricane model incorporates demand surge in the calculation of hurricane loss costs and hurricane probable maximum loss levels.

Demand surge factors by coverage are calculated for each storm in the stochastic set and are applied to the estimated losses for that storm. For each storm, demand surge is assumed to be a function of coverage, region, and the storm's estimated statewide losses before consideration of demand surge.

General Form of the Demand Surge Functions

The functions applied to determine the demand surge for each storm are of the form

Structure: Surge Factor = c + p1 x ln (statewide storm losses) + p2,

where c is a constant,
p1 is a constant for all regions except Monroe County,
p2 varies by region, and
"statewide storm losses" are the estimated losses, before demand surge, for the storm under consideration.

Appurtenant Structures: Surge Factor = Structure Factor.

Contents: Surge Factor = [(Structure Factor – 1) x 30%] + 1.

Additional Living Expenses: Surge Factor = 1.5 x Structure Factor - .5.

Development of the Demand Surge Function for Structure

To estimate the impact of demand surge on the settlement cost of structural claims following a hurricane we used a quarterly construction cost index produced by Marshall & Swift/Boeckh. We considered the history of the index from first quarter 1992 through second quarter 2007. There is an index for each of 52 ZIP Codes in Florida representing 42 counties. We grouped the indices to produce a set of regional indices, weighting each ZIP Code index with population.

The approach to estimating structural demand surge was to examine the index for specific regions impacted by one or more hurricanes since 1992. From the history of the index, we projected what the index would have been in the period following the storm had no storm occurred. Any gap between the predicted and actual index was assumed to be due to demand surge. In total we examined ten storm–region combinations. From these ten observations of structural demand surge, we generalized to the functional relationship shown above.

Monroe County was treated as an exception. There were no storms of any severity striking Monroe during the period of our observations. We believe, though, that the location of and limited access to the Keys will result in an unusually high surge in reconstruction costs after a storm, particularly since the Overseas Highway could be damaged by storm surge or seriously blocked by debris. We have therefore judgmentally selected demand surge parameters for Monroe in excess of those indicated for the remainder of South Florida.

Development of the Contents Demand Surge Function

The approach to determining the contents demand surge function was to relate any surge in consumer prices in Southeast Florida following hurricanes Katrina and Wilma to the estimated structure demand surge following those storms. We used a sub-index of the Miami-Ft. Lauderdale Consumer Price Index for this purpose and compared the projected and actual indices after the storms. Since the surge in consumer prices was roughly 30% of the surge in construction costs, we selected that percentage as the relationship between structure and contents demand surge.

Development of Time Element (TE) Demand Surge Function

To estimate TE demand surge we first examined the relationship between structure losses and TE losses in the validation dataset. This dataset includes losses from three storms (Andrew, Charley, and Frances) and eleven insurance companies. We then compared the predicted increase in TE losses associated with various increases in structure losses. That generalized relationship is the TE demand surge function shown above.

TE demand surge is related to structure demand surge in the following sense: structure surge is caused by an inability of the local construction industry to meet the sudden demand for materials and labor following a storm. A high surge in construction costs suggests a more serious mismatch between the demand for repairs and the supply of materials and labor. This mismatch translates into longer delays in the completion of repairs and rebuilding, which in turn implies a higher surge in TE costs.

Because the model's TE surge is determined as a function of structure surge, Monroe County TE surge factors are higher than those for the remainder of South Florida. We believe this is reasonable because of the unusual delays in repair and rebuilding that are likely to occur following a major storm in the Keys, especially if there is damage to US 1 or to bridges connecting the islands.

Treatment of Demand Surge for Storms Impacting both the Florida Panhandle and Alabama

The Northwest region is segregated from the remainder of the North to allow for demand surge that is a function of combined Florida–Alabama losses from storms impacting both states. The Northwest region consists of all Panhandle counties west of Leon and Wakulla. The definition of this region was selected by considering which counties experienced losses from Hurricanes Ivan, Frederic, and Elena, i.e., from storms that impacted both states. Not all counties in the Northwest region experienced losses from these three specific storms, but losses in neighboring counties suggest that that they are nevertheless at risk for inclusion in a combined Florida–Alabama event.

Demand surge factors for the Northwest region are determined as an upward adjustment to the factors for the Northeast–North Central region. The purpose of this adjustment is to correct for an understatement of the model's demand surge that occurs when only the Florida losses from a combined Florida–Alabama event are used to determine the level of demand surge from a storm.

4. Provide citations to published papers, if any, or modeling-organization studies that were used to develop how the hurricane model estimates demand surge.

No published papers or modeling organization studies were used in the demand surge development.

5. Describe how economic inflation has been applied to past insurance experience to develop and validate hurricane loss costs and hurricane probable maximum loss levels.

No adjustments for economic inflation were applied to past insurance experience in the development or validation of loss costs and probable maximum loss levels.

A-5 Hurricane Policy Conditions

A. The methods used in the development of mathematical distributions to reflect the effects of deductibles and policy limits shall be actuarially sound.

The methods used by the model to reflect the impact of deductibles and policy limits are actuarially sound.

B. The relationship among the modeled deductible hurricane loss costs shall be reasonable.

The model produces deductible loss costs with reasonable relationships among the various deductibles.

C. Deductible hurricane loss costs shall be calculated in accordance with s. 627.701(5)(a), F.S.

The model calculates deductible loss costs in compliance with this statute as described in Disclosure #4 below.

Disclosures

1. Describe the methods used in the hurricane model to treat deductibles (both flat and percentage), policy limits, and insurance-to-value criteria when projecting hurricane loss costs and hurricane probable maximum loss levels. Discuss data or documentation used to validate the method used by the hurricane model.

In practice insurance companies often allocate deductibles to structure, content, AP, and ALE on a pro-rata loss basis. Thus, if for example, structure and content damages before deductible are $20,000 and $6,000 respectively, and the deductible is $3,000, then (20,000/26,000)(3,000) = $2,308 is allocated to structure and (6,000/26,000)(3,000) = $692 is allocated to contents. This means that the various damages have to be considered and deductibles applied simultaneously. The deductibles must be allocated among the different losses and the truncation applied to each loss separately on a pro-rata basis.

For the pro-rata deductible method to work optimally, the functional relationships between structure damage and others should be estimated, and for each interval or class of structural damage, the corresponding mean and variance of the C, AP, and ALE damages should be specified. The conditional probabilities for C, AP, and ALE will then be the same as those for structural damage. An independent content matrix is somewhat problematic and may create biases in estimates of net of deductible losses. For structures we are likely to have damage ratio ranges or intervals of 0 to 2%, 2% to 4%, 4% to 6%, etc. For each interval (and its midpoint), ideally we may want to use the mean and variance of the corresponding damage ratios for contents, AP, and ALE. In practice, since the damage matrix for different types of losses are not directly related, we need to use the mean of the content, or AP, or ALE damage vector conditional on windspeeds since the windspeed is the only common frame of reference to the various types of damages.

$$\text{Expected Structure Loss} = E(L_s) = \sum_{D_S}^{L+D_S} (DM_i - D_s)\, p_S(x_i w) + \sum LM_S\, p_S(x_i w)$$

$$\text{Expected Content Loss} = E(L_C) = \sum_{C_S}^{L+C_S} (f(X_i) - D_c)\, p_C(x_i w) + \sum LM_C\, p_C(x_i w)$$

$$\text{Expected Appurtenant Loss} = E(L_{AP}) = \sum (g(X_i) - D_{AP})\, p_S(x_i w) + \sum LM_{AP}\, p_S(x_i w)$$

$$\text{Expected ALE Loss} = E(L_{ALE}) = \sum (h(X_i) - D_{ALE})\, p_S(x_i w) + \sum LM_{ALE}\, p_S(x_i w)$$

$$\text{Expected Loss} = E(L) = E(L_S) + E(L_C) + E(L_{AP}) + E(L_{ALE})$$

where each of the losses net of deductible is $\geqslant 0$ and where the deductibles DS, DC, DAP, DALE are applied on a pro-rata basis to the respective damages as follows:

$D_S = [DM_S / (DM_S + C + AP + ALE)] * D$
$D_C = [C / (DM_S + C + AP + ALE)] * D$
$D_{AP} = [AP / (DM_S + C + AP + ALE)] * D$
$D_{ALE} = [ALE / (DM_S + C + AP + ALE)] * D$

For this method to work, ideally, the joint probabilities of the losses must be estimated and used. In practice such joint probabilities are hard to estimate and validate. Thus, the engineering component should ideally provide for each structural damage interval, and given a wind speed, the mean and variance of damage ratio for content, AP, and ALE. The model uses the mean C, AP, and ALE for the given wind speed to determine the allocation of deductible to the various coverages.

This method is based on Hogg and Klugman (1984). Modeled losses net of deductible were validated against insurance company losses for Hurricanes Andrew, Charley, and Frances.

Personal Residential

In the damage matrices, each wind speed interval is associated with a distribution of possible damage ratios. Each damage ratio is multiplied by insured value to determine dollar damages, the deductible is deducted, and net of deductible loss is estimated.

Commercial Residential

The deductible is deducted from expected loss for each building.

Personal and Commercial Residential

The deductible is allocated to coverage by first calculating expected losses for each coverage, assuming zero deductible, and then allocating the deductible to coverage based on those losses.

Percentage deductibles are converted into dollar amounts.

Both the replacement cost and property value are assumed to equal the coverage limit unless the property value is provided as an input.

2. Describe whether, and if so how, the hurricane model treats policy exclusions and loss settlement provisions.

The model does not adjust losses for policy exclusions or loss settlement provisions.

3. Describe how the hurricane model treats annual deductibles.

If there are multiple Hurricanes in a year in the stochastic set, the wind deductibles are applied to the first hurricane, and any remaining amount is then applied to the second hurricane. If none of the wind deductible remains, then the general peril deductible is applied. This is the case for both personal and commercial residential policies.

A-6 Hurricane Loss Outputs and Logical Relationships to Risk

A. The methods, data, and assumptions used in the estimation of hurricane loss costs and hurricane probable maximum loss levels shall be actuarially sound.

The probable maximum loss levels estimated by the model are actuarially sound.

B. Hurricane loss costs shall not exhibit an illogical relation to risk, nor shall hurricane loss costs exhibit a significant change when the underlying risk does not change significantly.

Loss costs produced by the model exhibit a logical relation to risk and do not change significantly when the underlying risk is unchanged.

C. Hurricane loss costs produced by the hurricane model shall be positive and non-zero for all valid Florida ZIP Codes.

The model's loss costs are positive and non-zero for all valid Florida ZIP Codes.

D. Hurricane loss costs cannot increase as the quality of construction type, materials and workmanship increases, all other factors held constant.

The model produces loss costs that do not increase as the quality of construction increases, all other factors held constant.

E. Hurricane loss costs cannot increase as the presence of fixtures or construction techniques designed for hazard mitigation increases, all other factors held constant.

The model's loss costs do not increase in the presence of hazard mitigation features, all other factors held constant.

F. Hurricane loss costs cannot increase as the wind resistant design provisions increase, all other factors held constant.

The model's loss costs do not increase in the presence of wind resistant design provisions, all other factors held constant.

G. Hurricane loss costs cannot increase as building code enforcement increases, all other factors held constant.

The model produces loss costs that do not increase as building code enforcement increases, all other factors held constant.

H. Hurricane loss costs shall decrease as deductibles increase, all other factors held constant.

The model's loss costs decrease as deductibles increase, all other factors held constant.

I. The relationship of hurricane loss costs for individual coverages, (e.g., building, appurtenant structure, contents, and time element) shall be consistent with the coverages provided.

The relationships between modeled loss costs by coverage are consistent with the coverage provided.

J. Hurricane output ranges shall be logical for the type of risk being modeled and apparent deviations shall be justified.

Output ranges are logical by risk type. Apparent deviations are justified in Disclosure #17 below.

K. All other factors held constant, hurricane output ranges produced by the hurricane model shall in general reflect lower hurricane loss costs for:

1. masonry construction versus frame construction,

All other factors held constant, the output ranges reflect lower loss costs for masonry versus frame construction.

2. personal residential risk exposure versus manufactured home risk exposure,

All other factors held constant, the output ranges reflect lower loss costs for site-built versus manufactured home exposures.

3. inland counties versus coastal counties, and

All other factors held constant, the output ranges reflect lower loss costs for inland versus coastal counties.

4. northern counties versus southern counties, and

All other factors held constant, the output ranges reflect lower loss costs for northern versus southern counties.

5. newer construction versus older construction.

All other factors held constant, the output ranges reflect lower loss costs for newer construction versus older construction.

L. For hurricane loss cost and hurricane probable maximum loss level estimates derived from and validated with historical insured hurricane losses, the assumptions in the derivations concerning (1) construction characteristics, (2) policy provisions, (3) coinsurance, and (4) contractual provisions shall be appropriate based on the type of risk being modeled.

In the derivation of loss costs and probable maximum loss levels the model's assumptions concerning construction characteristics, policy provisions, coinsurance and contractual provisions are appropriate based on the type of risk modeled.

Disclosures

1. Provide a completed Form A-1, Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code. Provide a link to the location of the form here.

See Form A-1.

2. Provide a completed Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses. Provide a link to the location of the form here.

See Form A-2.

3. Provide a completed Form A-3, Hurricane Losses. Provide a link to the location of the form here.

See Form A-3.

4. Provide a completed Form A-4, Hurricane Output Ranges. Provide a link to the location of the form here.

See Form A-4.

5. Provide a completed Form A-5, Percentage Change in Hurricane Output Ranges. Provide a link to the location of the form here.

See Form A-5.

6. Provide a completed Form A-6, Logical Relationship to Hurricane Risk (Trade Secret Item), if not considered as Trade Secret. Provide a link to the location of the form here.

See Form A-6.

7. Provide a completed Form A-7, Percentage Change in Logical Relationship to Hurricane Risk. Provide a link to the location of the form here.

See Form A-7.

8. Explain any assumptions, deviations, and differences from the prescribed exposure information in Form A-6, Logical Relationship to Hurricane Risk (Trade Secret Item), and Form A-7, Percentage Change in Logical Relationship to Hurricane Risk. In particular, explain how the treatment of unknown is handled in each sensitivity exhibit.

Notional Set 1- Deductible Sensitivity

Weighted vulnerability matrices were used to address the unknown attributes for Personal Residential. Weights vary by county and year built.

Number of stories 3 was changed to 2 for Condo Frame and Masonry.

Unknown opening protection for Commercial Residential was assigned a value based on the county and year built. Other "unknown" attributes do not impact the loss cost in the Mid-/High-rise model.

Layout was set to "Closed" for all Commercial Residential policies.

Notional Set 2 - Construction Sensitivity

Weighted vulnerability matrices were used to address the unknown attributes for Personal Residential. Weights vary by county and year built.

Number of stories 3 was changed to 2 for Condo Frame and Masonry.

Unknown opening protection for Commercial Residential was assigned a value based on the county and year built. Other "unknown" attributes do not impact the loss cost in the

Mid-/High-rise model.

Layout was set to "Closed" for all Commercial Residential policies.

Notional Set 3 - Policy Form Sensitivity

Weighted vulnerability matrices were used to address the unknown attributes for Personal Residential. Weights vary by county and year built.

Notional Set 4 - Coverage Sensitivity

Number of stories 3 was changed to 2 for Condo Frame and Masonry.

Unknown opening protection for Commercial Residential was assigned a value based on the county and year built. Other "unknown" attributes do not impact the loss cost in the

Mid-/High-rise model.

Layout was set to "Closed" for all Commercial Residential policies.

Notional Set 5 - Year Built Sensitivity

Roof shape was assigned to "gable" for Personal Residential policies.

Roof cover was assigned to "shingle" for Personal Residential policies.

Opening protection was assigned to "none" for Personal Residential policies.

Roof deck attachment and roof wall anchorage were assigned in combinations based on the

Personal Residential model's definition of weak, medium and strong vulnerability matrices. Those matrices were then combined in varying proportions depending on the model's eras (i.e. Year Built) and the policy location (i.e. HVHZ, Keys, WBDR, Inland).

Number of stories 3 was changed to 2 for Condo Frame and Masonry.

Unknown opening protection for Commercial Residential was assigned a value based on the county and year built. Other "unknown" attributes do not impact the loss cost in the

Mid-/High-rise model.

Layout was set to "Closed" for all Commercial Residential policies.

Notional Set 6 - Building Strength Sensitivity

For Personal Residential policies with only deck attachment and roof-to-wall unknown: Roof-to-wall was assigned based on statistics and Deck Attachment was assigned based on the year built, location and strength. Other Personal Residential assignments were:

Opening protection was assigned based on year-built.

Roof covering was assigned based year-built and exterior wall.

Roof shape was assigned based on year-built.

Number of stories 3 was changed to 2 for Condo Frame and Masonry.

Unknown opening protection for Commercial Residential was assigned based on the county and year built. Other “unknown” attributes do not impact the loss cost in the Mid-/High-rise model.

Notional Set 7 - Number of Stories Sensitivity

Roof shape was assigned “gable” for Personal Residential policies.

Roof cover was assigned “shingle/unrated” for Personal Residential policies.

Roof to deck connection was assigned “8d12” for Personal Residential policies.

Opening protection was assigned “none” for Personal Residential policies.

Unknown opening protection for Commercial Residential was assigned a value based on the county and year built. Other “unknown” attributes do not impact the loss cost in the Mid-/High-rise model.

9. Provide a completed Form A-8, Hurricane Probable Maximum Loss for Florida. Provide a link to the location of the form here.

See Form A-8.

10. Describe how the hurricane model produces hurricane probable maximum loss levels.

Probable Maximum Loss on an Annual Aggregate Basis

Probable maximum loss is produced non-parametrically using order statistics of simulated annual losses.

The model produces N simulated annual losses, represented by $X_1, X_2, \ldots, X_N$. The data are ordered so that $X_{(1)} \leq X_{(2)} \leq . . . \leq X_{(N)}$.

For a return period of Y years, let p = 1-1/Y. The corresponding PML for the return period Y is the pth quantile of the ordered losses.

Let k = (N)*p. If k is an integer, then the estimate of the PML is the kth order statistic, $X_{(k)}$, of the simulated losses. If k is not an integer, then let k* = the smallest integer greater than k, and the estimate of the pth quantile is given by $X_{(k*)}$.

Probable Maximum Loss on an Annual Occurrence Basis

Probable maximum loss on an annual occurrence basis is determined similarly to probable maximum loss on an annual aggregate basis. The set of N losses, $X_1, X_2, \ldots, X_N$, consists of the largest event loss in each simulated year, ordered from smallest to largest.

11. Provide citations to published papers, if any, or modeling-organization studies that were used to estimate hurricane probable maximum loss levels.

Wilkinson, M. E. (1982). Estimating Probable Maximum Loss with Order Statistics. *Casualty Actuarial Society*, *LXIX*, pp. 195-209.

12. Describe how the hurricane probable maximum loss levels produced by the hurricane model include the effects of personal and commercial residential insurance coverage.

The model can produce probable maximum loss levels separately for personal and commercial residential exposures or on a combined basis. To produce the probable maximum loss on a combined basis, modeled losses for both personal and commercial exposures are aggregated for each storm in the simulation before the years are ordered. Because modeled losses are used as the basis for the probable maximum loss level, the effects of policy limits, deductibles, etc. are reflected in the probable maximum loss estimates.

13. Explain any differences between the values provided on Form A-8, Hurricane Probable Maximum Loss for Florida, and those provided on Form S-2, Examples of Hurricane Loss Exceedance Estimates.

The values on Form A-8 and Form S-2 are the same.

14. Provide an explanation for all anomalies in the hurricane loss costs that are not consistent with the requirements of this standard.

Form A-4: In Form A-4 the county weighted average loss cost for masonry sometimes exceeds frame because the masonry weights are greater in ZIP Codes with higher loss costs.
Form A-6**:** There are anomalies in the Coverage, Year-Built and Building Strength tests in Form A-6. The anomalies are the result of the following model assumptions:

- At lower windspeeds the % damage for Building coverage under Condo Frame and Masonry is greater than 10% of the % damage for the primary Contents coverage.

- For Personal Residential policies the model's year-built eras assume the same vulnerability for 1980 **and 1989, except in the HVHZ. In the HVHZ the vulnerability is higher for 1989 vs. 1980.**

- For Personal Residential policies the model's year-built eras assume no difference in vulnerability between 1998, 2004 and 2019 in the HVHZ.

- The model assumes no difference in vulnerability between 1972, 1989 and 1992 Manufactured Homes. The model assumes no difference in vulnerability between 2004 and 2019 Manufactured Homes. The model's Manufactured Home vulnerabilities do not vary based on tie-down or other secondary attributes such as roof shape and roof covering.

- The model assumes no difference in vulnerability between the 1980, 1989 and 1998 Commercial Residential construction, except in the HVHZ where metal shutters were required after 1994.

15. Provide an explanation of the differences in hurricane output ranges between the previously-accepted hurricane model and the current hurricane model.

As described in Standard G-1, there were updates and changes to the model.

The statewide impacts for Personal and Commercial Residential combined on $0 deductible loss costs were:

g) -2.8% due to updated HURDAT
h) +0.01% due to roughness changes associated with updated Zip Code centroids
i) +0.11% due to change in the WBDR.

Other Commercial Residential impacts were:

j) -18.8%due to changes in the Commercial Residential vulnerability
k) -30.3% due to changes in the weighting of low-rise Commercial Residential losses between types of insured (Apartment vs. Condominium) when that attribute is unknown, as it is for the Cat Fund.

Other Personal Residential impacts were:

l) -3.1% due to additional exposures which, due to their age, now qualify for lower retrofitted vulnerabilities. Although not a result of a model change or update, this feature of the model impacts loss costs.

The overall changes for $0 deductible loss costs were:

Personal Residential: -5.6%
Commercial Residential: -45.5%.

16. Identify the assumptions used to account for the effects of coinsurance on commercial residential hurricane loss costs.

The model assumes properties are insured to value and makes no adjustment to losses for coinsurance penalties.

Form A-1: Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code

A. Provide three maps, color-coded by ZIP Code (with a minimum of six value ranges), displaying zero deductible personal residential hurricane loss costs per $1,000 of exposure for frame owners, masonry owners, and manufactured homes.

B. Create exposure sets for these exhibits by modeling all of the buildings from Notional Set 3 described in the file "NotionalInput19.xlsx" geocoded to each ZIP Code centroid in the state, as provided in the hurricane model. Provide the predominant County name and the Federal Information Processing Standards (FIPS) code associated with each ZIP Code centroid. Refer to the Notional Hurricane Policy Specifications below for additional modeling information. Explain any assumptions, deviations, and differences from the prescribed exposure information.

C. Provide, in the format given in the file named "2019FormA1.xlsx" in both Excel and PDF format, the underlying hurricane loss cost data, rounded to three decimal places, used for A. above. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name.

See Appendix B.

Notional Hurricane Policy Specifications

Policy Type	Assumptions
Owners	**Coverage A = Building** • Replacement Cost included subject to Coverage A limit • Law and Ordinance included **Coverage B = Appurtenant Structure** • Replacement Cost included subject to Coverage B limit • Law and Ordinance included **Coverage C = Contents** m) Replacement Cost included subject to Coverage C limit **Coverage D = Time Element** n) Time limit = 12 months o) Per diem = $150.00/day per policy, if used **Hurricane loss costs per $1,000 shall be related to the Coverage A limit**

Manufactured Homes	**Coverage A = Building** • Replacement Cost included subject to Coverage A limit **Coverage B = Appurtenant Structure** • Replacement Cost included subject to Coverage B limit **Coverage C = Contents** • Replacement Cost included subject to Coverage C limit **Coverage D = Time Element** • Time limit = 12 months • Per diem = $150.00/day per policy, if used **Hurricane loss costs per $1,000 shall be related to the Coverage A limit**

Form A-2: Base Hurricane Storm Set Statewide Hurricane Losses

A. Provide the total insured hurricane loss and the dollar contribution to the average annual hurricane loss assuming zero deductible policies for individual historical hurricanes using the Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.zip." The list of hurricanes in this form shall include all Florida and by-passing hurricanes in the modeling organization Base Hurricane Storm Set, as defined in Standard M-1, Base Hurricane Storm Set.

The table below contains the minimum number of hurricanes from HURDAT2 to be included in the Base Hurricane Storm Set, based on the 119-year period 1900-2018. As defined, a by-passing hurricane (ByP) is a hurricane which does not make landfall on Florida, but produces minimum damaging windspeeds or greater on land in Florida. For the by-passing hurricanes included in the table only, the hurricane intensity entered is the maximum windspeed at closest approach to Florida as a hurricane, not the windspeed over Florida. Each hurricane has been assigned an ID number. As defined in Standard M-1, Base Hurricane Storm Set, the Base Hurricane Storm Set for the modeling organization may exclude hurricanes that had zero modeled impact, or it may include additional hurricanes when there is clear justification for the additions. For hurricanes in the table below resulting in zero hurricane loss, the table entry shall be left blank. Additional hurricanes included in the hurricane model Base Hurricane Storm Set shall be added to the table below in order of year and assigned an intermediate ID number as the hurricane falls within the bounding ID numbers.

B. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a detailed description of how they are included.

C. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses, in a submission appendix.

See Appendix C.

Note: Total dollar contributions should agree with the total average annual zero deductible statewide hurricane loss costs provided in Form S-5, Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled.

Form A-3: Hurricane Losses

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form A-3, Hurricane Losses.

Automated scripts and programs were used to generate Form A-3.

B. Provide the percentage of residential zero deductible hurricane losses, rounded to four decimal places, and the monetary contribution from Hurricane Hermine (2016), Hurricane Matthew (2016), Hurricane Irma (2017), and Hurricane Michael (2018), and Hurricane Jeanne (2004) for each affected ZIP Code, .Include all ZIP Codes where hurricane losses are equal to or greater than $500,000.

Use the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data provided in the file named "hlpm2017c.zip."

Rather than using directly a specified published windfield, the winds underlying the hurricane loss cost calculations must be produced by the hurricane model being evaluated and should be the same hurricane parameters as used in completing Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses.

C. Provide maps color-coded by ZIP Code depicting the percentage of total residential hurricane losses from each hurricane: Hurricane Hermine (2016), Hurricane Matthew (2016), Hurricane Irma (2017), and Hurricane Michael (2018), using the following interval coding:

Red	***Over 5%***
Light Red	***2% to 5%***
Pink	***1% to 2%***
Light Pink	***0.5% to 1%***
Light Blue	***0.2% to 0.5%***
Medium Blue	***0.1% to 0.2%***
Blue	***Below 0.1%***

D. Plot the relevant storm track on each map.

E. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form A-3, Hurricane Losses, in a submission appendix.

See Appendix D.

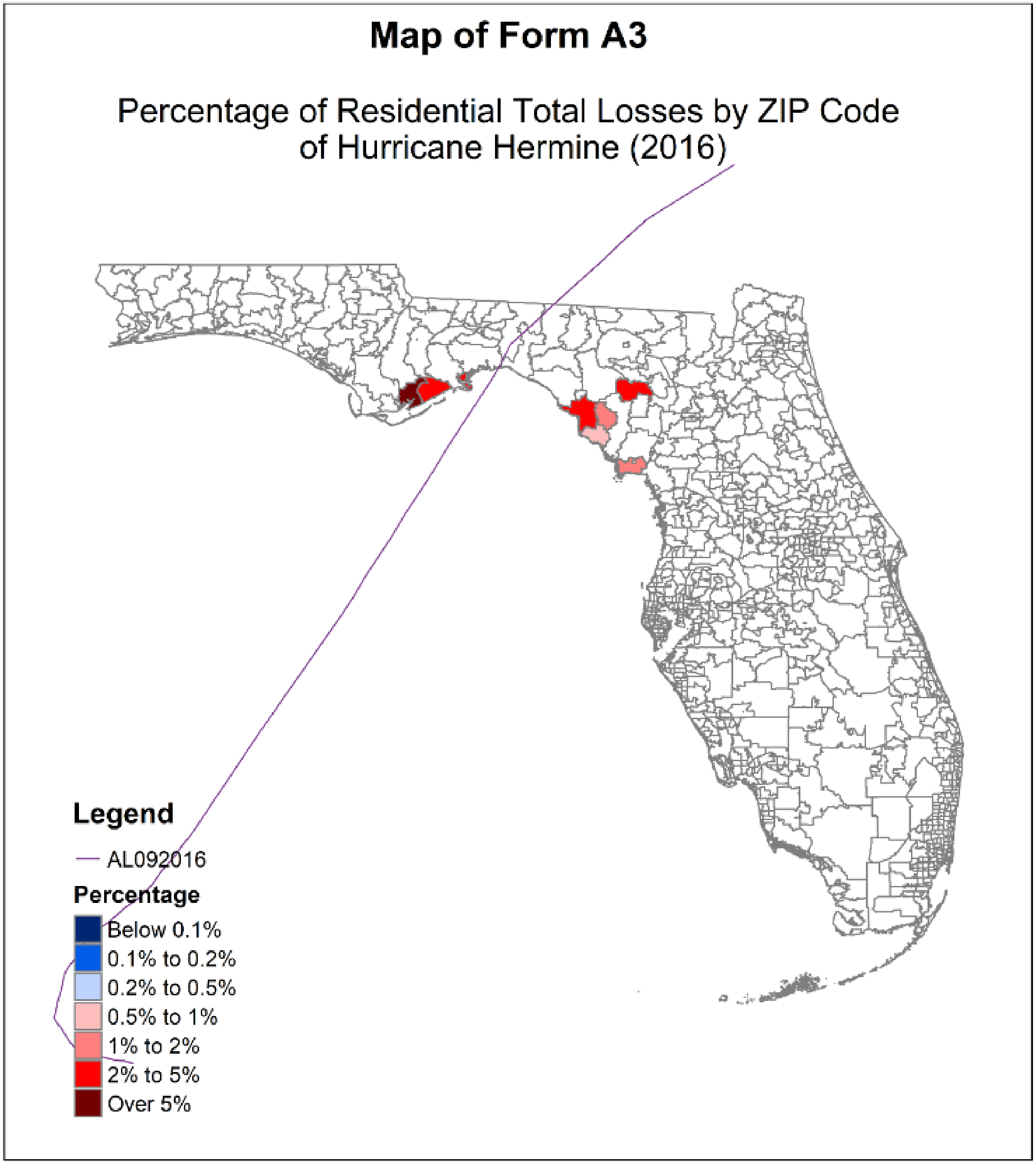


Figure 76. Percentage of residential total losses by ZIP code of Hurricane Hermine (2016).

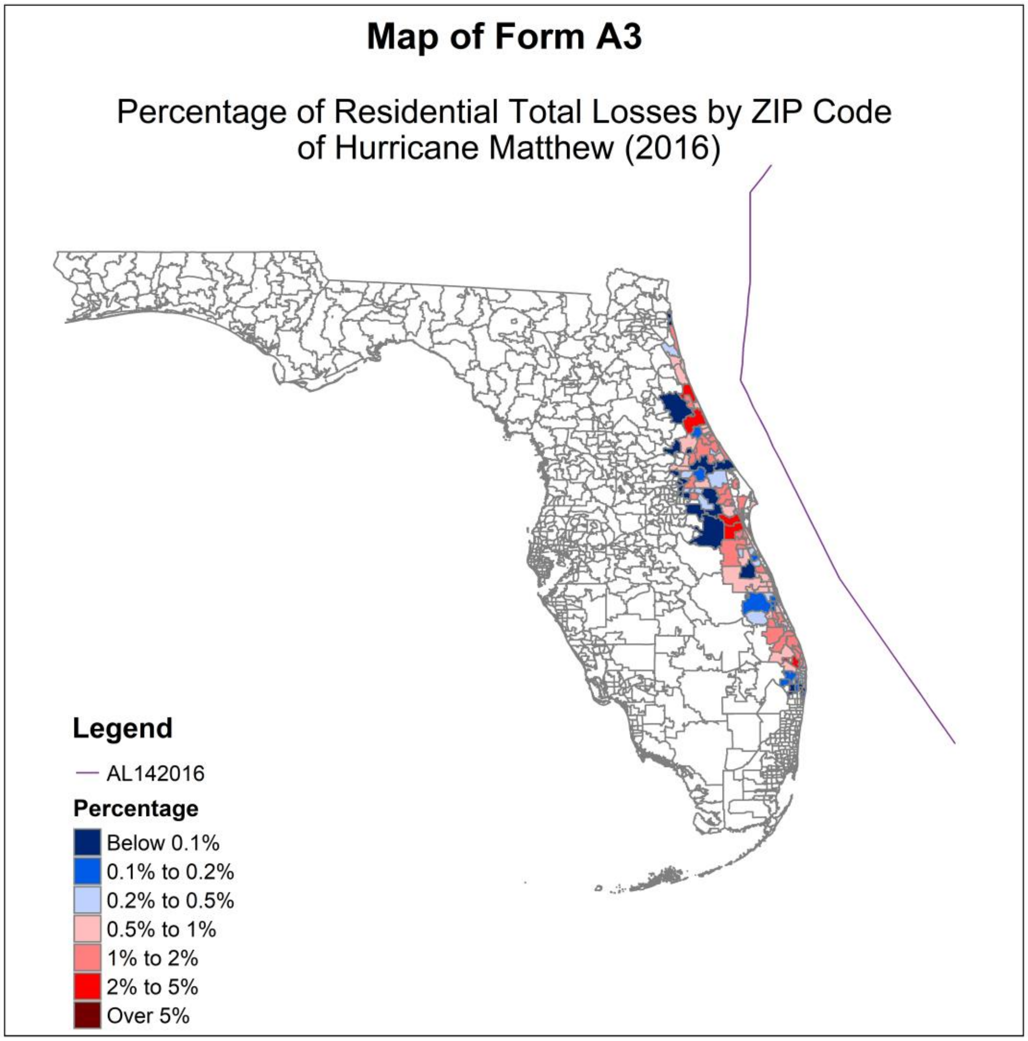


Figure 77. Percentage of residential total losses by ZIP code of Hurricane Matthew (2016).

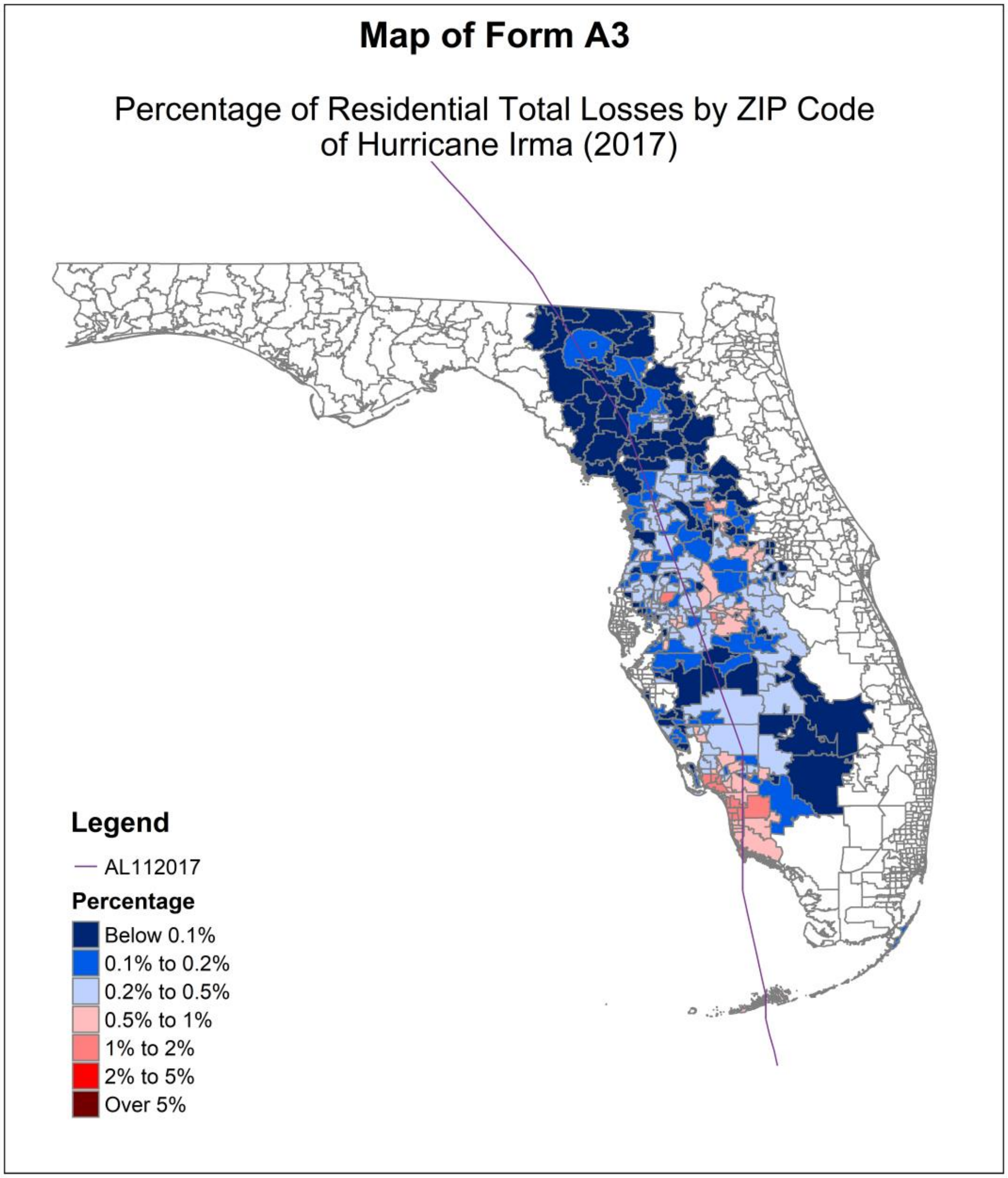


Figure 78. Percentage of residential total losses by ZIP code of Hurricane Irma (2017).

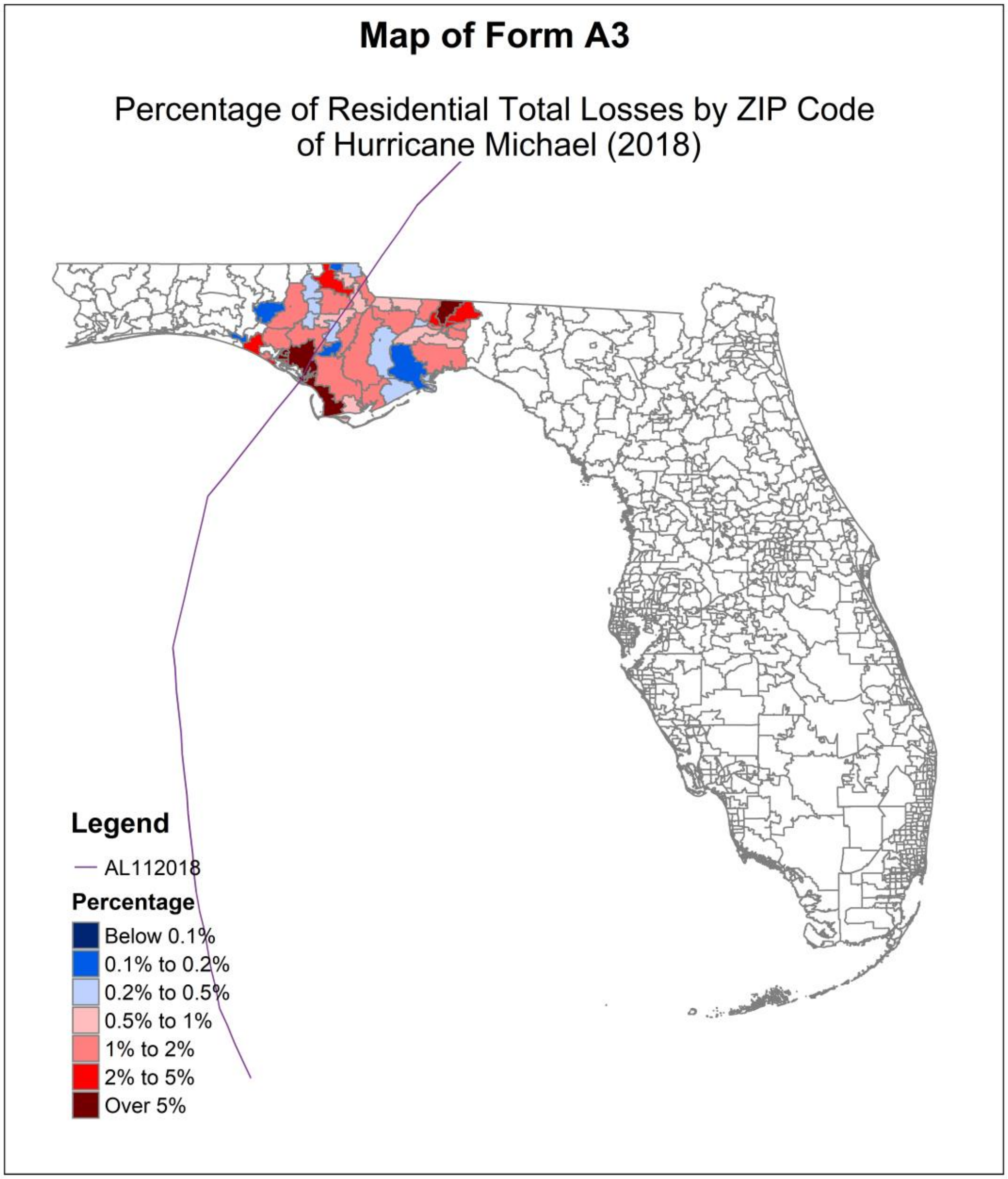


Figure 79. Percentage of residential total losses by ZIP code of Hurricane Michael (2018).

Form A-4: Hurricane Output Ranges

A. One or more automated programs or scripts shall be used to generate the personal and commercial residential hurricane output ranges in the format shown in the file named "2019FormA4.xlsx."

Automated scripts and programs were used to generate Form A-4.

B. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form A-4, Hurricane Output Ranges, in a submission appendix.

C. Provide hurricane loss costs, rounded to three decimal places, by county. Within each county, hurricane loss costs shall be shown separately per $1,000 of exposure for frame owners, masonry owners, frame renters, masonry renters, frame condo unit owners, masonry condo unit owners, manufactured homes, and commercial residential. For each of these categories using ZIP Code centroids, the hurricane output range shall show the highest hurricane loss cost, the lowest hurricane loss cost, and the weighted average hurricane loss cost. The aggregate residential exposure data for this form shall be developed from the information in the file named "hlpm2017c.zip," except for insured values and deductibles information. Insured values shall be based on the hurricane output range specifications given below. Deductible amounts of 0% and as specified in the hurricane output range specifications given below shall be assumed to be uniformly applied to all risks. When calculating the weighted average hurricane loss costs, weight the hurricane loss costs by the total insured value calculated above. Include the statewide range of hurricane loss costs (i.e., low, high, and weighted average).

D. If a modeling organization has hurricane loss costs for a ZIP Code for which there is no exposure, give the hurricane loss costs zero weight (i.e., assume the exposure in that ZIP Code is zero). Provide a list in the submission document of those ZIP Codes where this occurs.

E. If a modeling organization does not have hurricane loss costs for a ZIP Code for which there is some exposure, do not assume such hurricane loss costs are zero, but use only the exposures for which there are hurricane loss costs in calculating the weighted average hurricane loss costs. Provide a list in the submission document of the ZIP Codes where this occurs.

F. NA shall be used in cells to signify no exposure.

G. All hurricane loss costs that are not consistent with the requirements of Standard A-6, Hurricane Loss Outputs and Logical Relationships to Risk, and have been explained in Disclosure A-6.14 shall be shaded.

H. Indicate if per diem is used in producing hurricane loss costs for Coverage D (Time Element) in the personal residential hurricane output ranges. If a per diem rate is used, a rate of $150.00 per day per policy shall be used.

See Appendix E.

Form A-5: Percentage Change in Hurricane Output Ranges

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form A-5, Percentage Change in Hurricane Output Ranges.

Automated scripts and programs were used to generate Form A-5.

B. Provide summaries of the percentage change in average hurricane loss cost output range data compiled in Form A-4, Hurricane Output Ranges, relative to the equivalent data compiled from the previously-accepted hurricane model in the format shown in the file named "2019FormA5.xlsx."

For the change in hurricane output range exhibit, provide the summary by:

- ***Statewide (overall percentage change),***
- ***By region, as defined in Figure 14 – North, Central and South, and***
- ***By county, as defined in Figure 15 – Coastal and Inland.***

C. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include all tables in Form A-5, Percentage Change in Hurricane Output Ranges, in a submission appendix.

D. Provide color-coded maps by county reflecting the percentage changes in the average hurricane loss costs with specified deductibles for frame owners, masonry owners, frame renters, masonry renters, frame condo unit owners, masonry condo unit owners, manufactured homes, and commercial residential from the hurricane output ranges from the previously-accepted hurricane model.

Counties with a negative percentage change (reduction in hurricane loss costs) shall be indicated with shades of blue, counties with a positive percentage change (increase in hurricane loss costs) shall be indicated with shades of red, and counties with no percentage change shall be white. The larger the percentage change in the county, the more intense the color-shade.

See Appendix F.

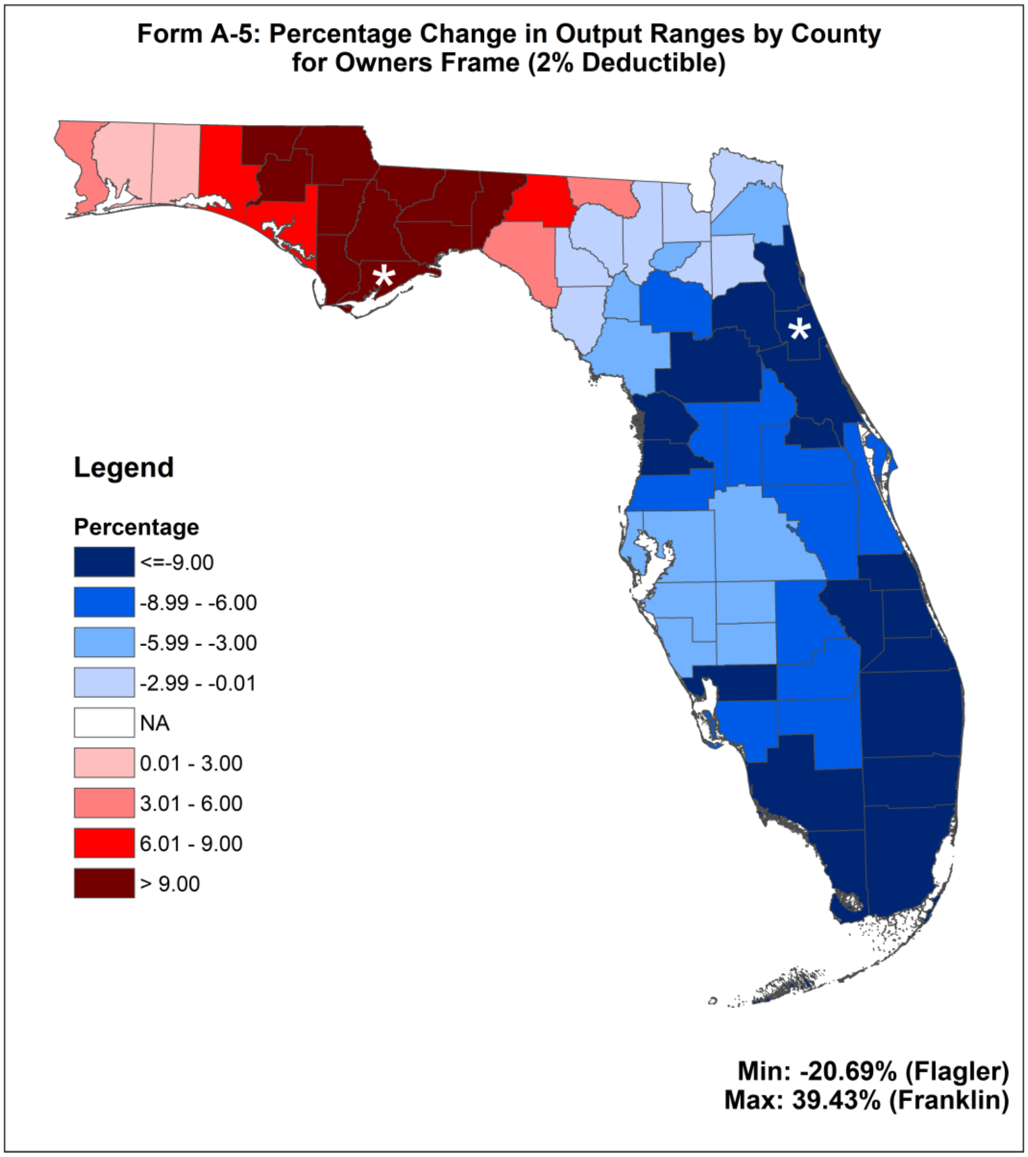


Figure 80. Percentage change in output ranges by county for owners frame (2% deductible).

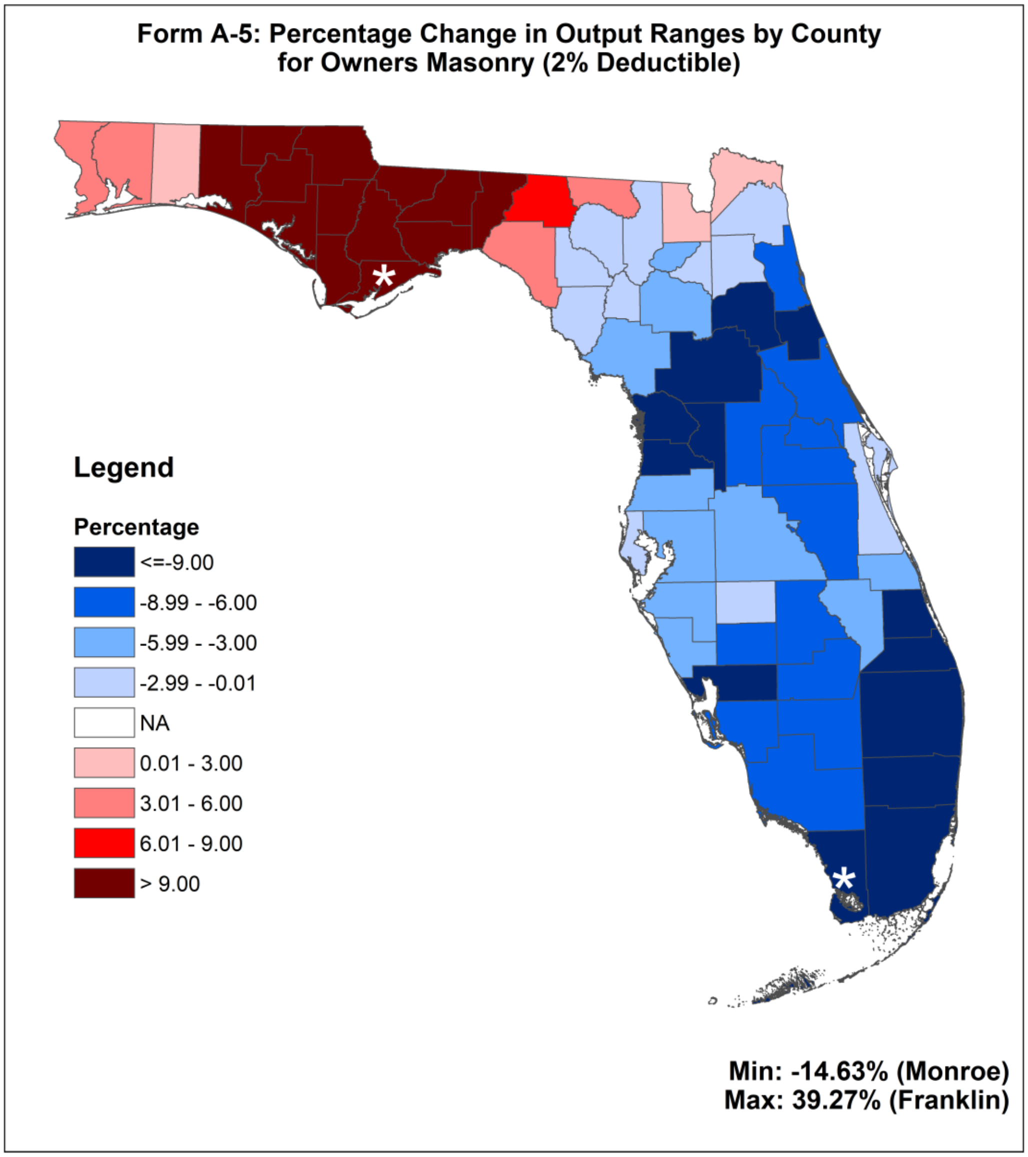


Figure 81. Percentage change in output ranges by county for owners masonry (2% deductible).

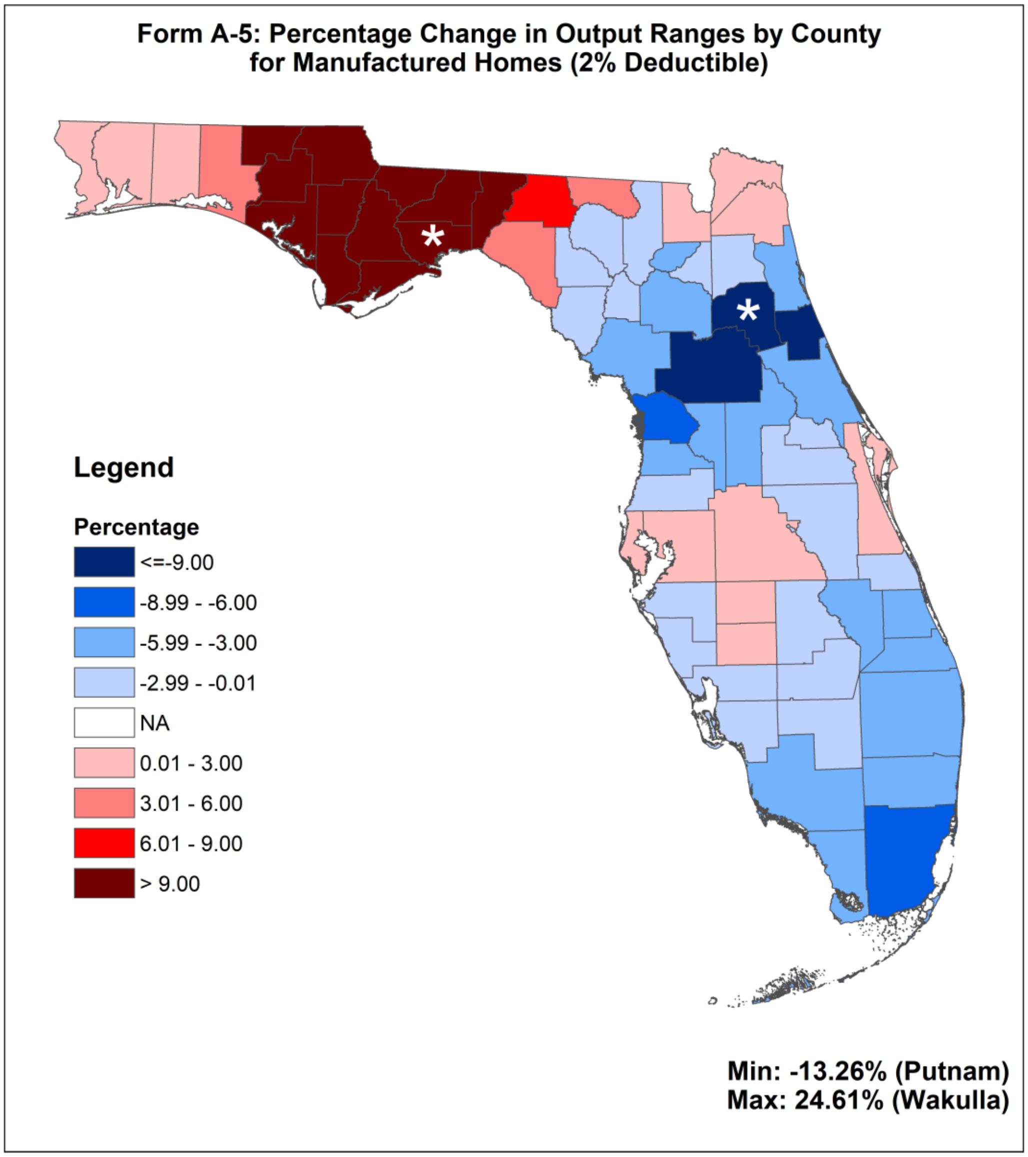


Figure 82. Percentage change in output ranges by county for mobile homes (2% deductible).

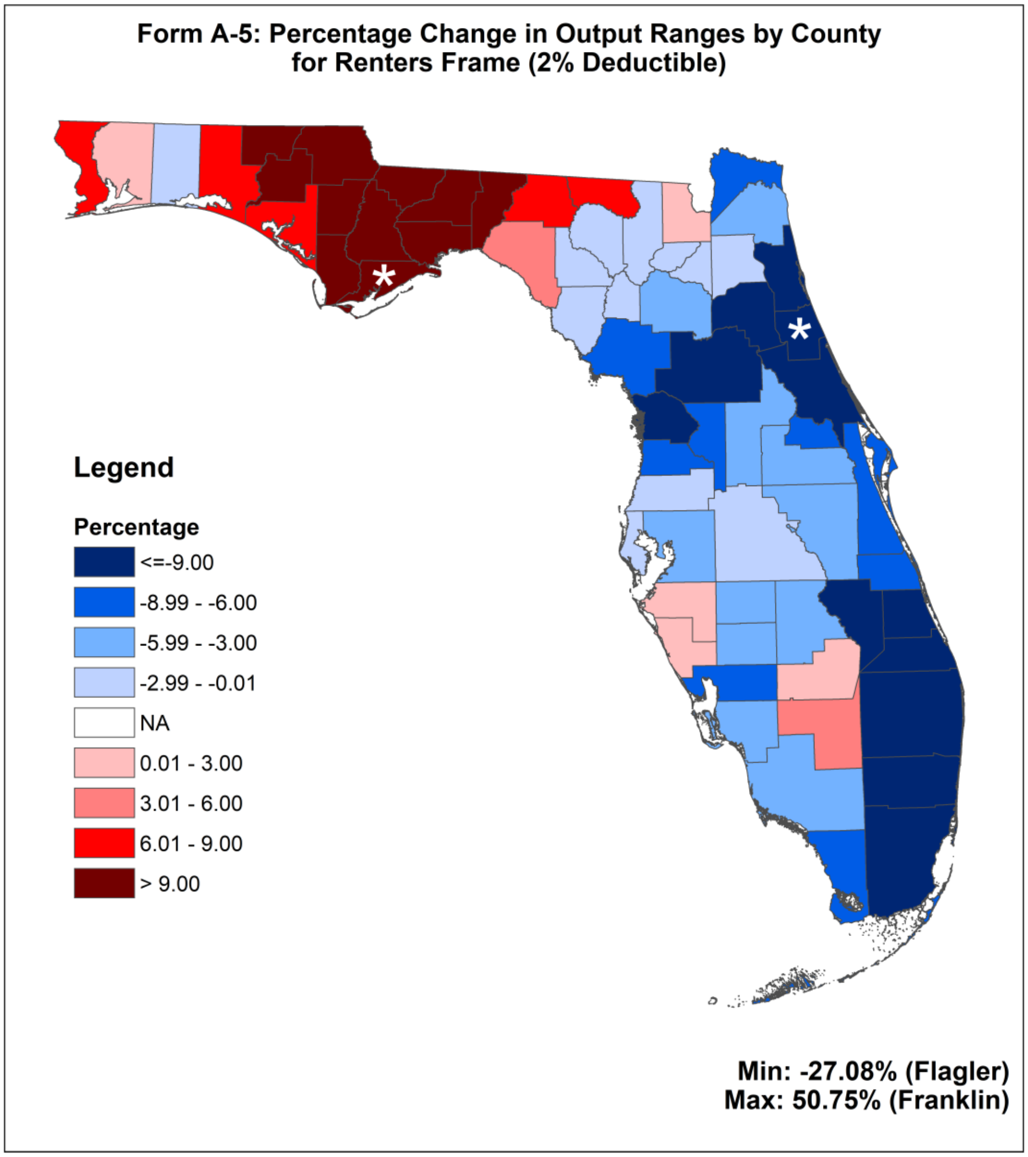


Figure 83. Percentage change in output ranges by county for renters frame (2% deductible).

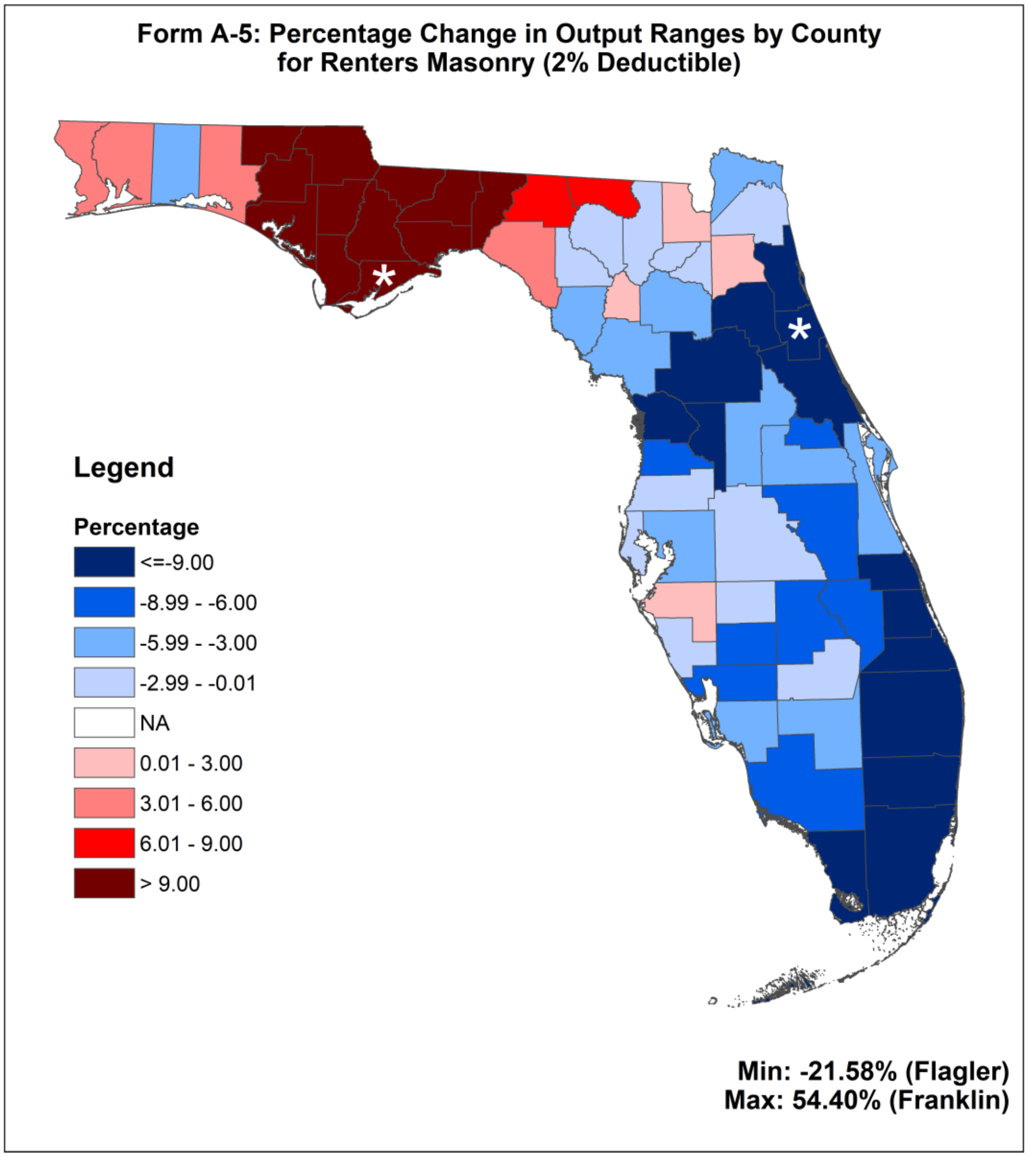


Figure 84. Percentage change in output ranges by county for renters masonry (2% deductible).

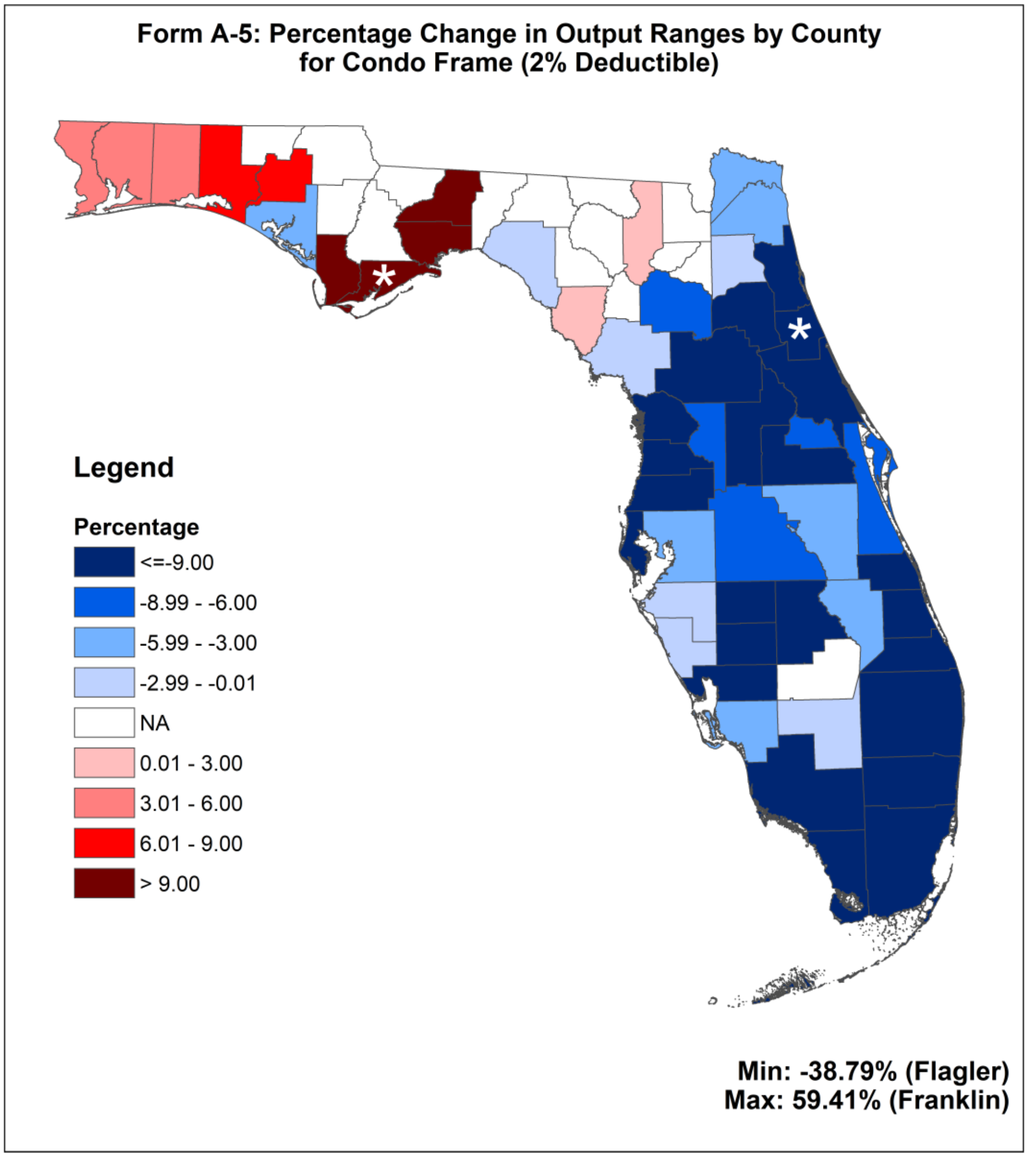


Figure 85. Percentage change in output ranges by county for condo frame (2% deductible).

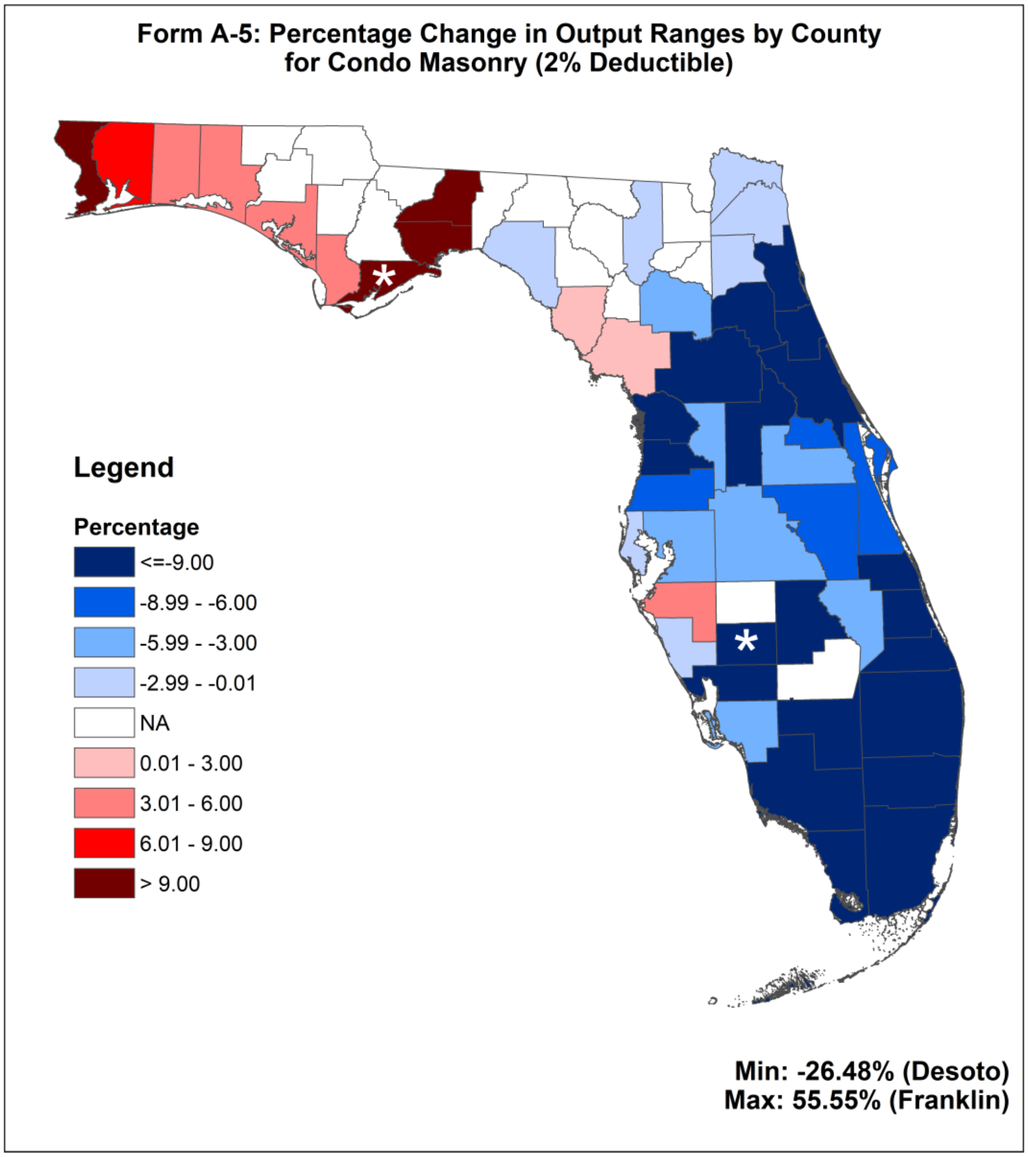


Figure 86. Percentage change in output ranges by county for condo masonry (2% deductible).

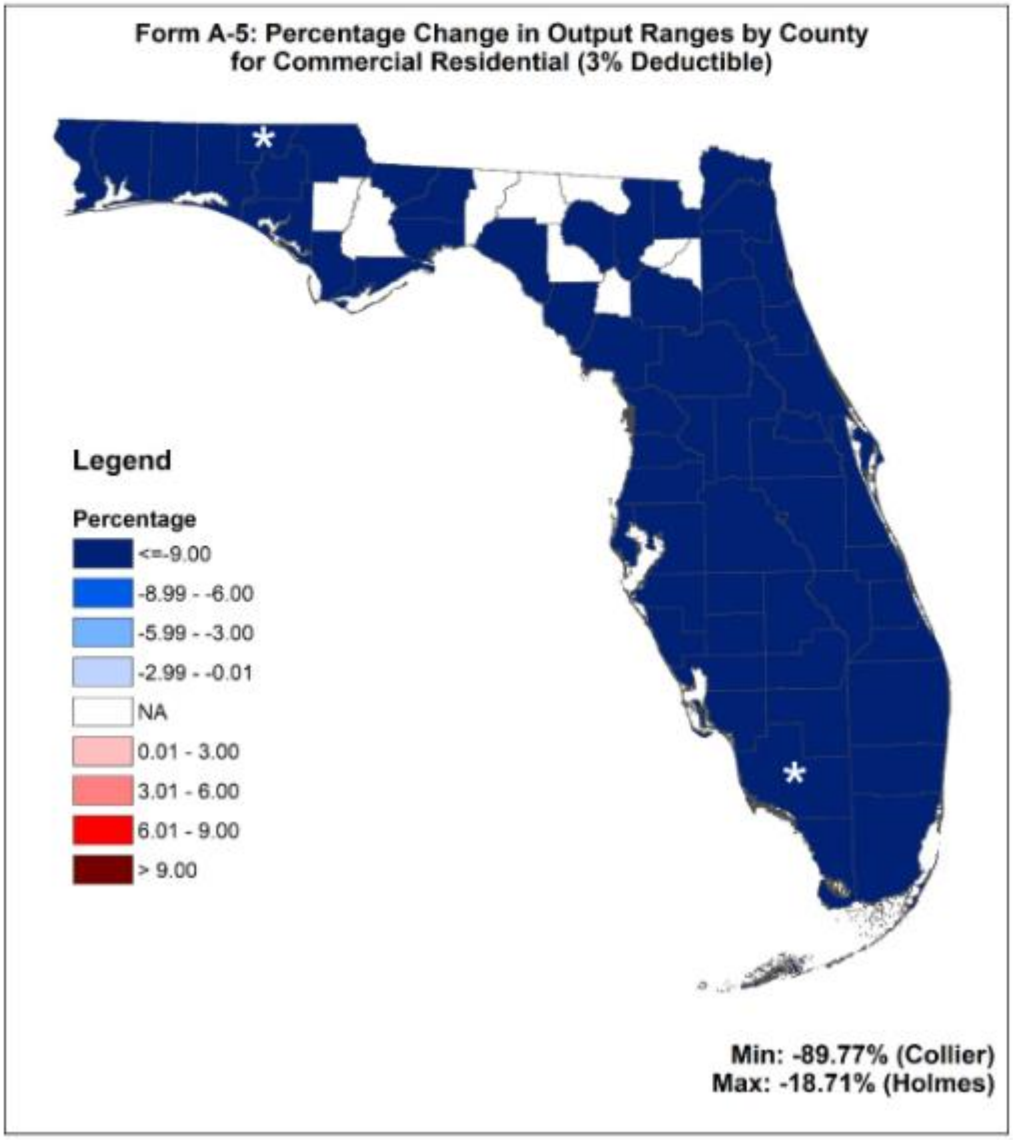


Figure 87. Percentage change in output ranges by county for commercial residential (3% deductible).

Form A-6: Logical Relationship to Hurricane Risk (Trade Secret Item)

A. One or more automated programs or scripts shall be used to generate the exhibits in Form A6, Logical Relationship to Hurricane Risk (Trade Secret Item).

Automated scripts and programs were used to generate Form A-6.

B. Provide the logical relationship to hurricane risk exhibits in the format shown in the file named "2019FormA6.xlsx."

C. Create exposure sets for each exhibit by modeling all of the coverages from the appropriate Notional Set listed below at each of the locations in Location Grid A as described in the file "NotionalInput19.xlsx." Refer to the Notional Hurricane Policy Specifications below for additional modeling information.

Exhibit	Notional Set
Deductible Sensitivity	**Set 1**
Policy Form Sensitivity	**Set 2**
Construction Sensitivity	**Set 3**
Coverage Sensitivity	**Set 4**
Year Built Sensitivity	**Set 5**
Building Strength Sensitivity	**Set 6**
Number of Stories Sensitivity	**Set 7**

D. Hurricane models shall treat points in Location Grid A as coordinates that would result from a geocoding process. Hurricane models shall treat points by simulating hurricane loss at exact location or by using the nearest modeled parcel/street/cell in the hurricane model. Report results for each of the points in Location Grid A individually, unless specified.

Hurricane loss costs per $1,000 of exposure shall be rounded to three decimal places.

E. All hurricane loss costs that are not consistent with the requirements of Standard A-6, Hurricane Loss Outputs and Logical Relationships to Risk, and have been explained in Disclosure A-6.14 shall be shaded.

F. Provide graphical summaries to demonstrate the sensitivities for each Notional Set.

G. Create an exposure set and report hurricane loss costs results for strong owners frame buildings (Notional Set 6) for each of the points in "Location Grid

B" as described in the file "NotionalInput19.xlsx." Provide a color-coded contour map of the hurricane loss costs. Provide a scatter plot of the hurricane loss costs (y-axis) against distance to closest coast (x- axis).

See Appendix G.

Notional Hurricane Policy Specifications

Policy Type	Assumptions
Owners	**Coverage A = Building** • Replacement Cost included subject to Coverage A limit • Law and Ordinance included **Coverage B = Appurtenant Structure** • Replacement Cost included subject to Coverage B limit • Law and Ordinance included **Coverage C = Contents** p) Replacement Cost included subject to Coverage C limit **Coverage D = Time Element** q) Time limit = 12 months r) Per diem = $150.00/day per policy, if used ❖ Hurricane loss costs per $1,000 shall be related to the Coverage A limit ❖ Hurricane loss costs for the various specified deductibles shall be determined based on annual deductibles ❖ All-other perils deductible = $500
Renters	**Coverage C = Contents** • Replacement Cost included subject to Coverage C limit **Coverage D = Time Element** • Time limit = 12 months • Per diem = $150.00/day per policy, if used. ❖ Hurricane loss costs per $1,000 shall be related to the Coverage C limit ❖ Hurricane loss costs for the various specified deductibles shall be determined based on annual deductibles ❖ All-other perils deductible = $500
Condo Unit Owners	**Coverage A = Building** • Replacement Cost included subject to Coverage A limit **Coverage C = Contents** • Replacement Cost included subject to Coverage C limit **Coverage D = Time Element** • Time limit = 12 months • Per diem = $150.00/day per policy, if used.

- ❖ Hurricane loss costs per $1,000 shall be related to the Coverage C limit
- ❖ Hurricane loss costs for the various specified deductibles shall be determined based on annual deductibles
- ❖ All-other perils deductible = $500

Manufactured Homes

Coverage A = Building
- Replacement Cost included subject to Coverage A limit

Coverage B = Appurtenant Structure
- Replacement Cost included subject to Coverage B limit

Coverage C = Contents
- Replacement Cost included subject to Coverage C limit

Coverage D = Time Element
- Time limit = 12 months
- Per diem = $150.00/day per policy, if used

- ❖ Hurricane loss costs per $1,000 shall be related to the Coverage A limit
- ❖ Hurricane loss costs for the various specified deductibles shall be determined based on annual deductibles
- ❖ All-other perils deductible = $500

Commercial Residential

Coverage A = Building
- Replacement Cost included subject to Coverage A limit

Coverage C = Contents
- Replacement Cost included subject to Coverage C limit

Coverage D = Time Element
- Time limit = 12 months
- Per diem = $150.00/day per policy, if used.

- ❖ Hurricane loss costs per $1,000 shall be related to the Coverage A limit
- ❖ Hurricane loss costs for the various specified deductibles shall be determined based on annual deductibles
- ❖ All-other perils deductible = $5,000

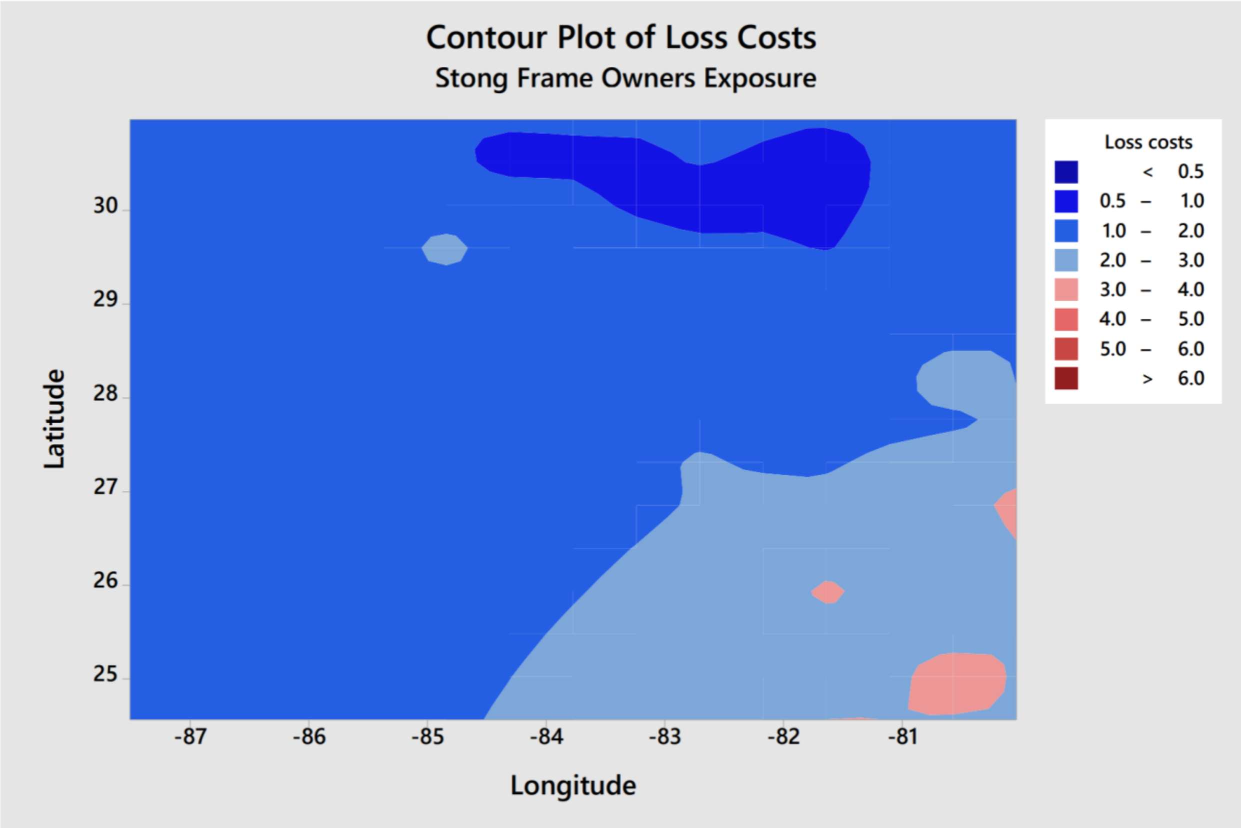


Figure 88. Contour Plot of Loss Costs - Strong Frame Owners Exposure.

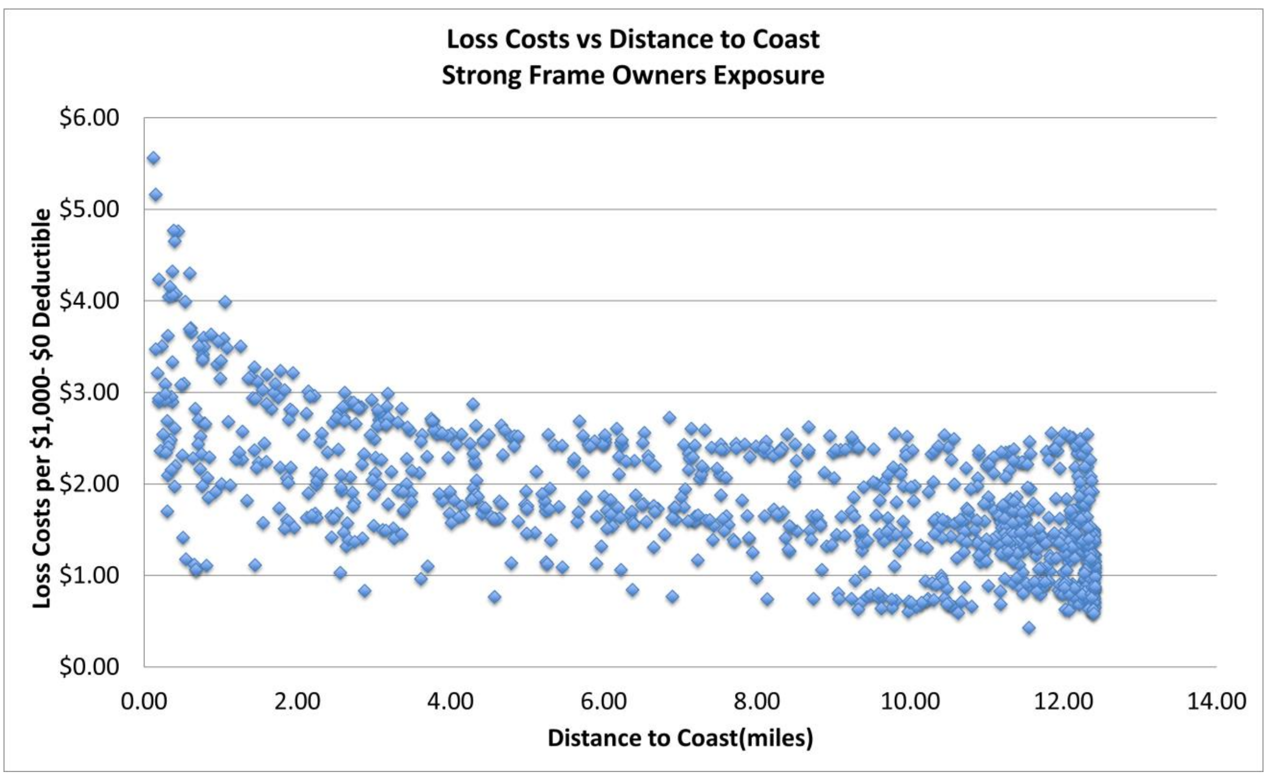


Figure 89. Loss Costs vs. Distance to the Coast Strong Owners Frame Exposures.

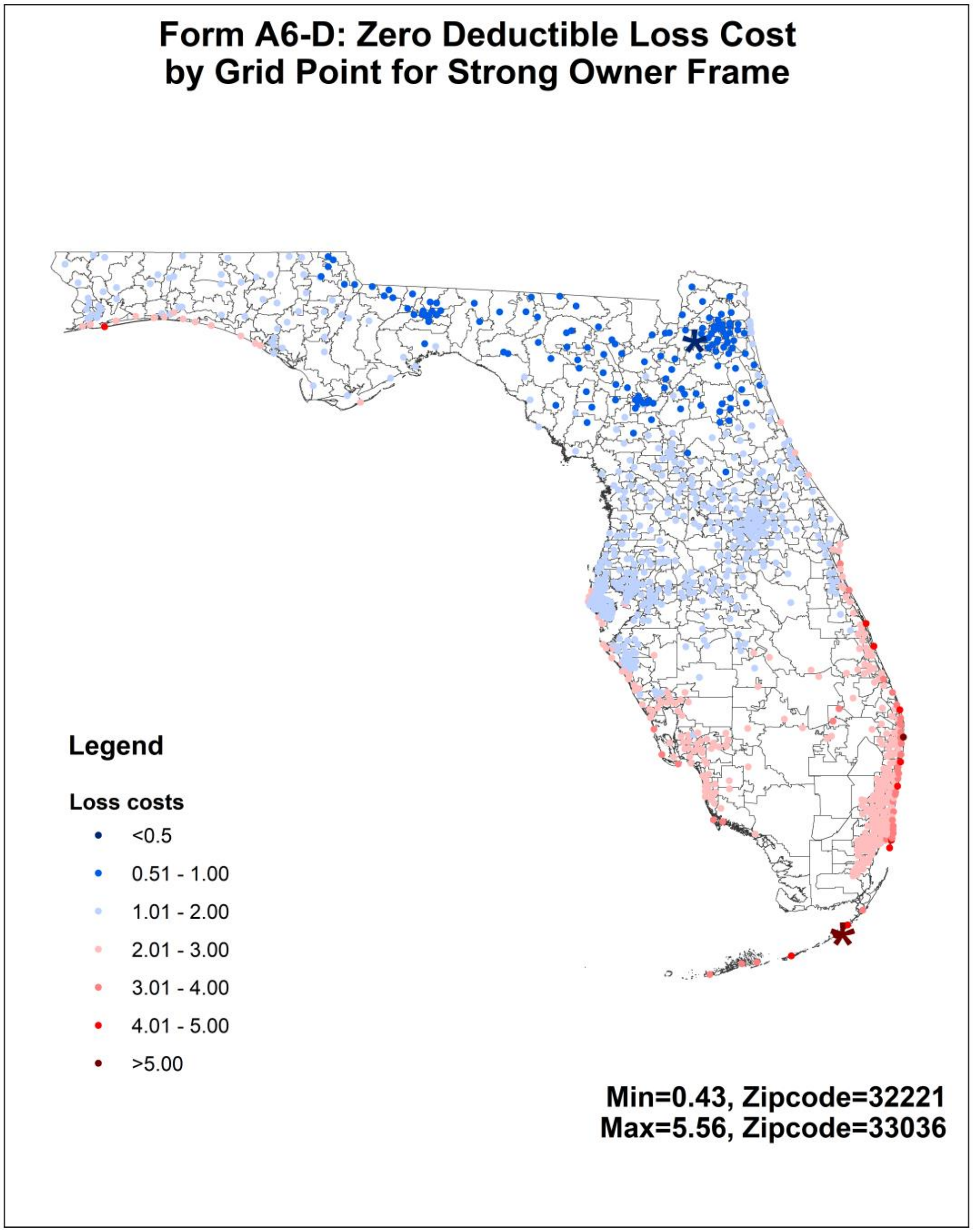


Figure 90. Zero Deductible Loss Costs by Grid Point for Strong Owner Frame.

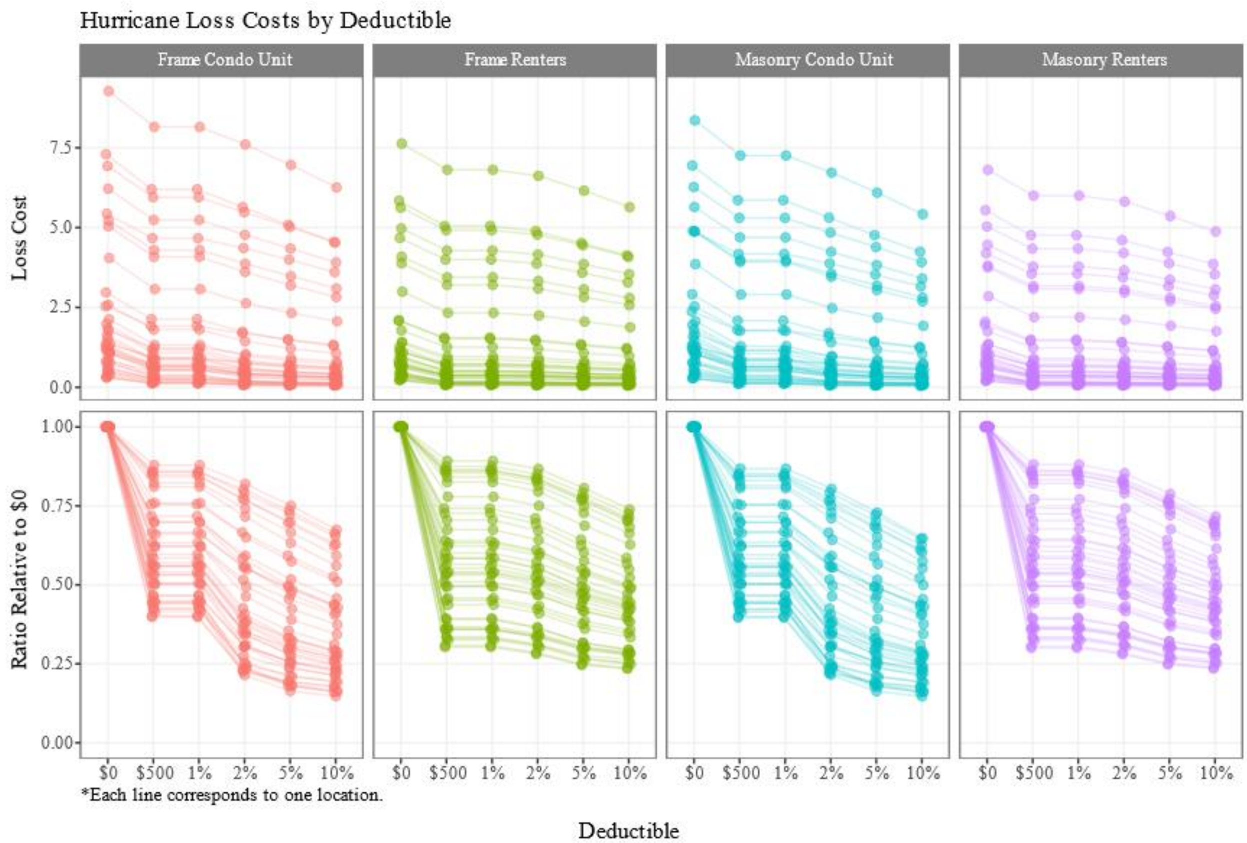


Figure 91. Hurricane Loss Costs by Deductible.

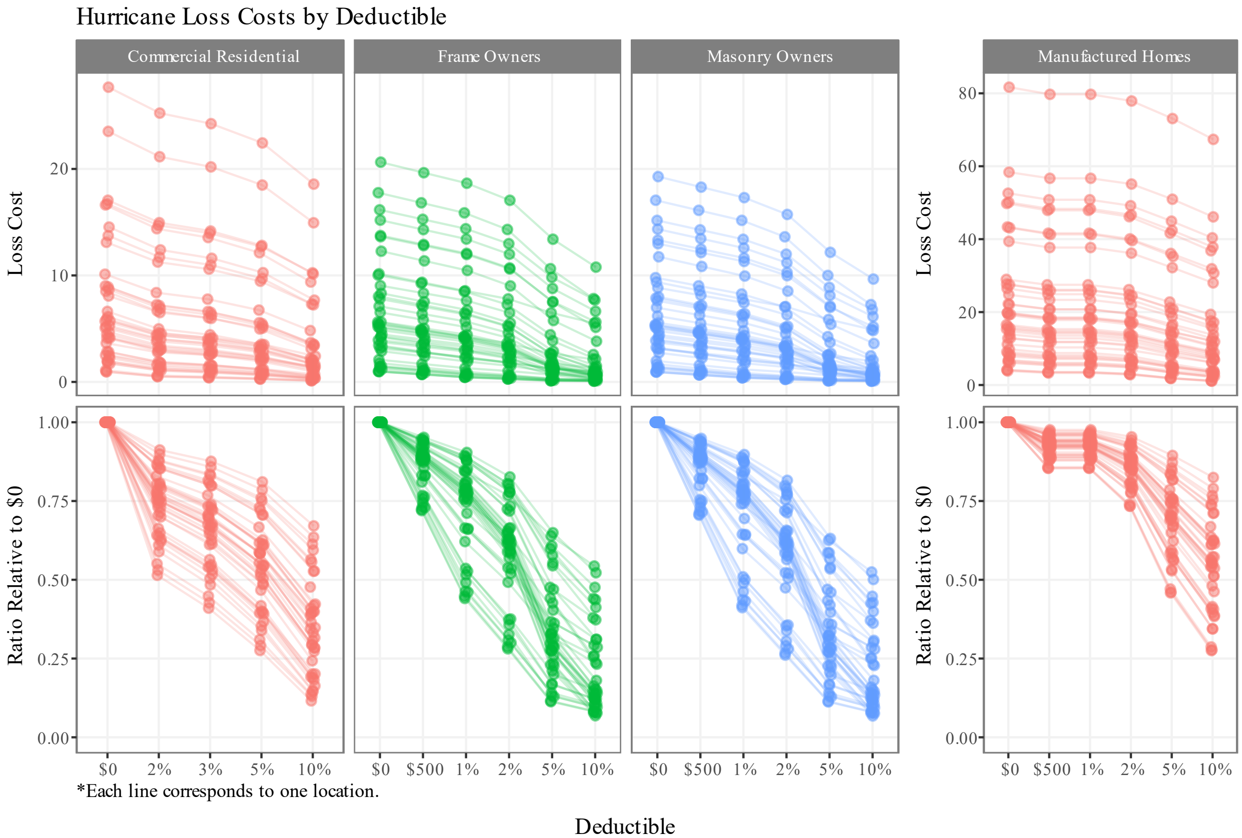


Figure 92. Hurricane Loss Costs by Deductible.

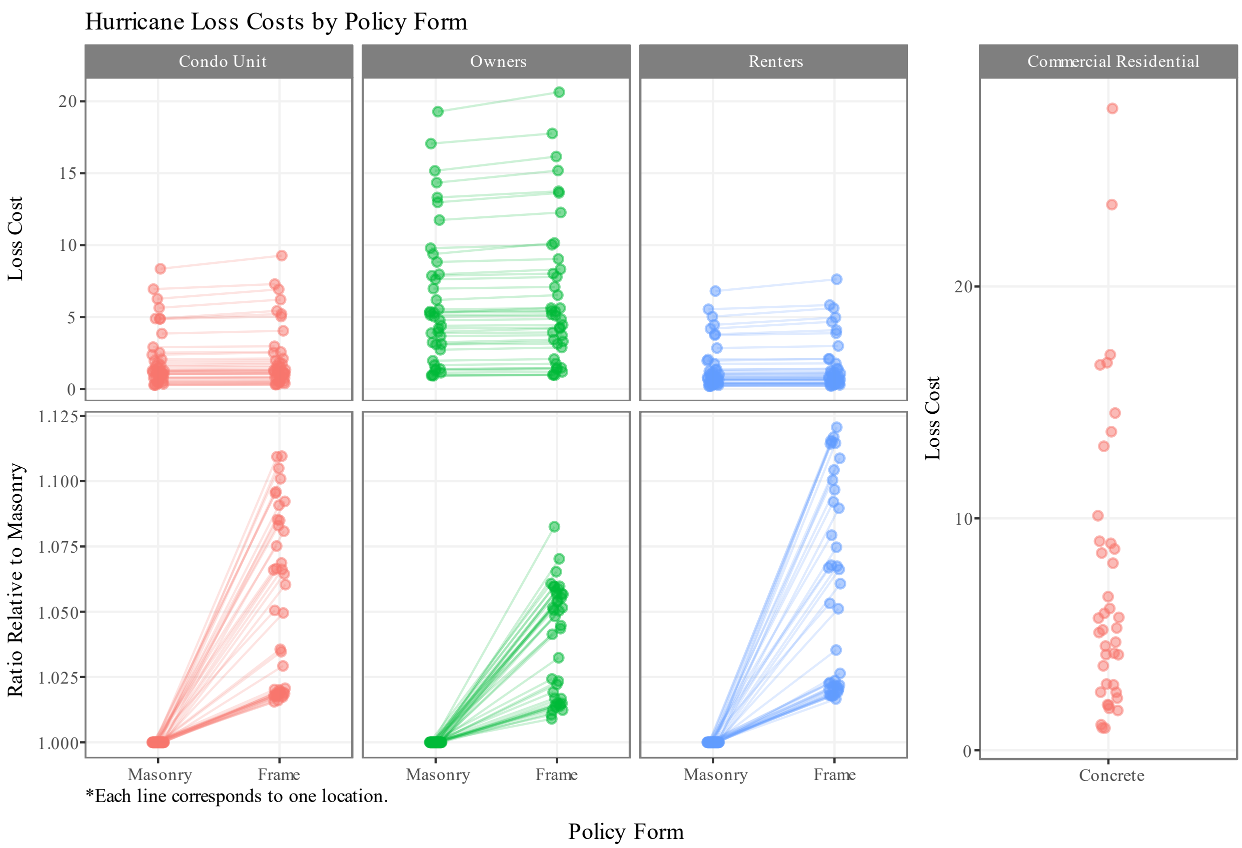


Figure 93, Hurricane Loss Costs by Policy Form.

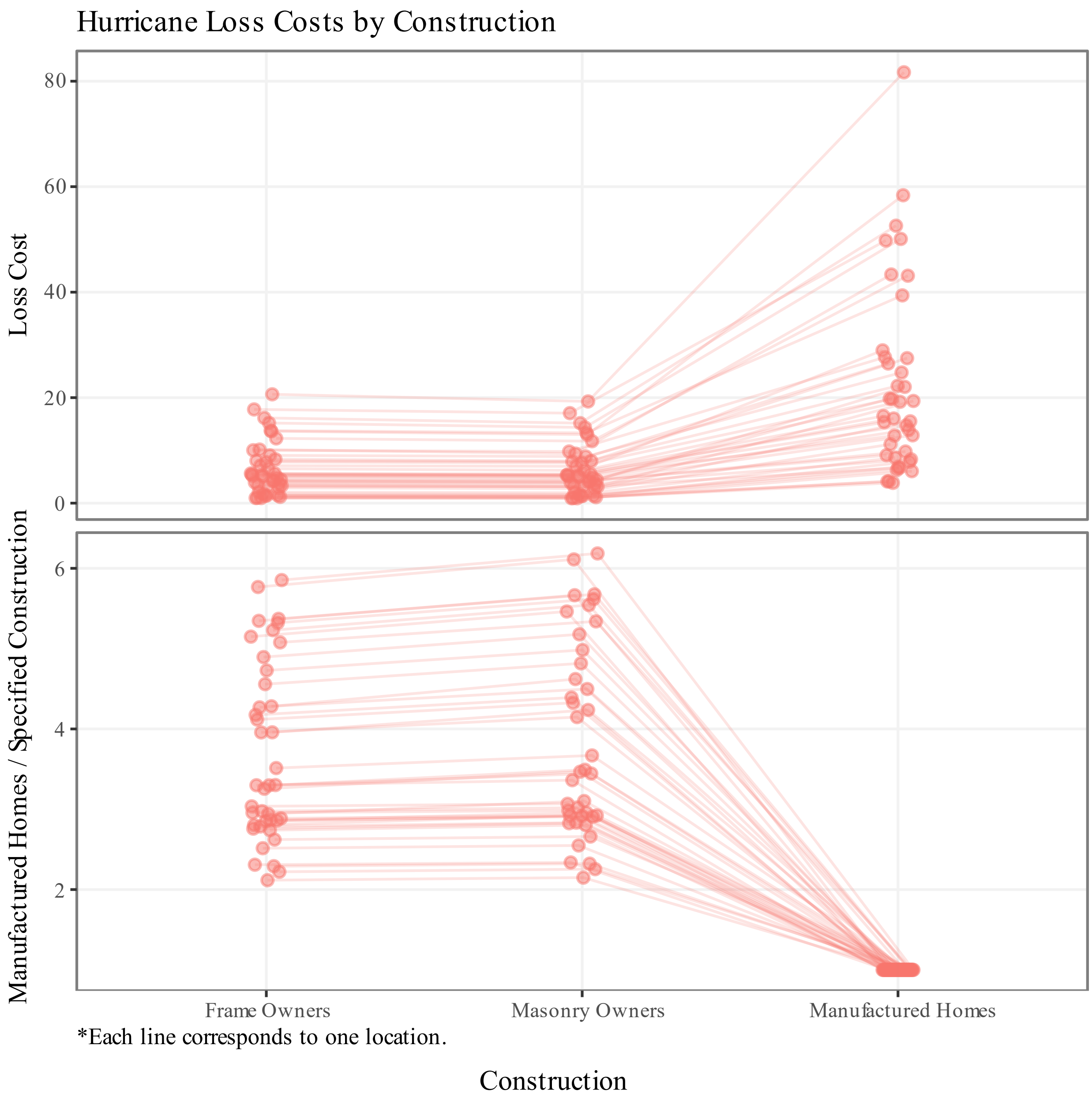


Figure 94. Hurricane Loss Costs by Construction.

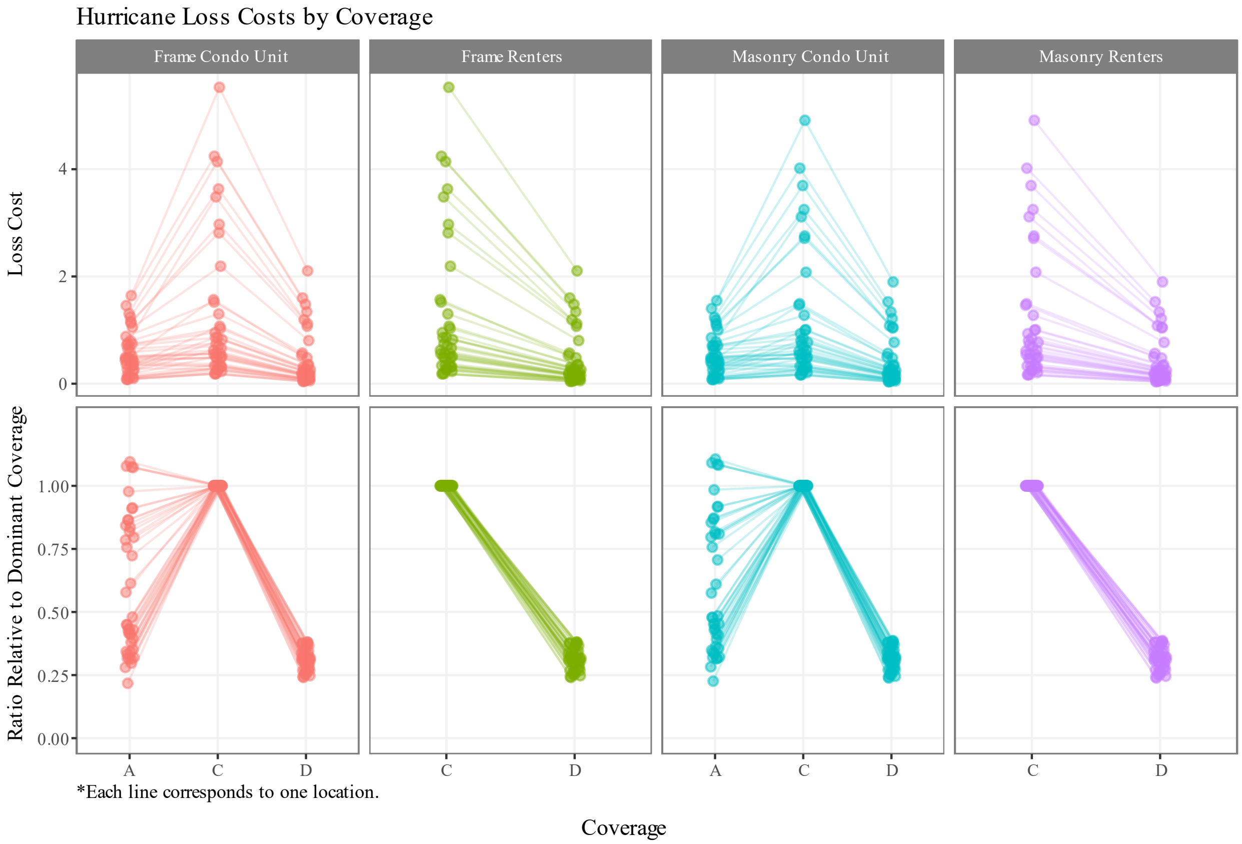


Figure 95. Hurricane Loss Costs by Coverage.

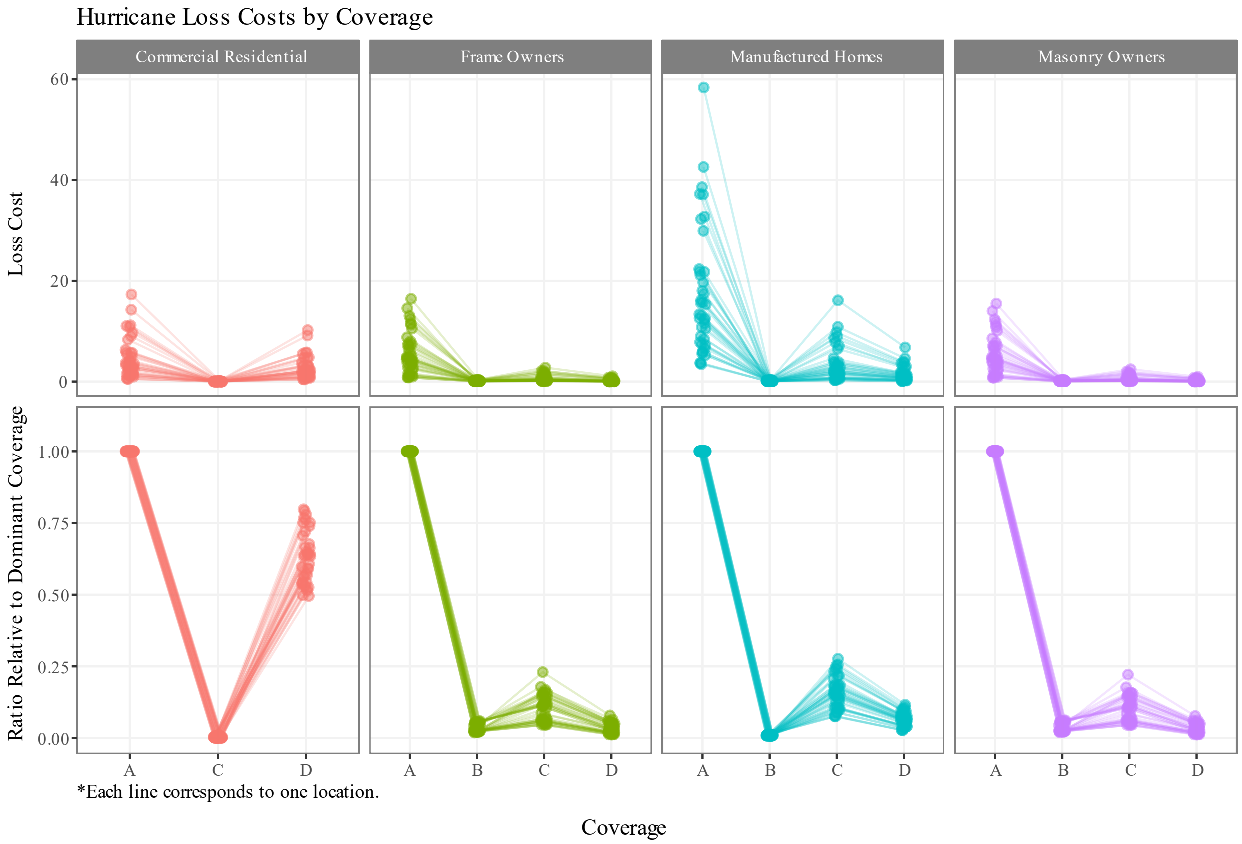


Figure 96. Hurricane Loss Costs by Coverage.

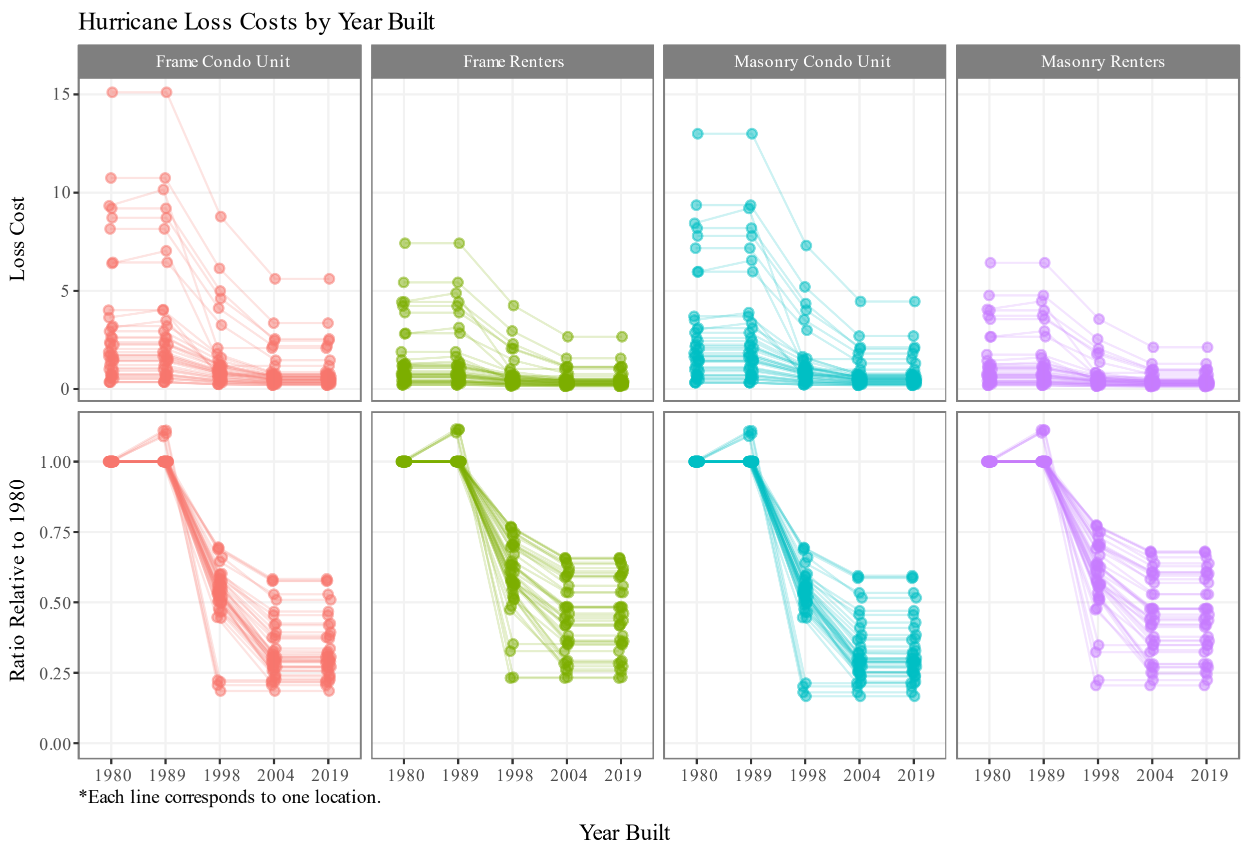


Figure 97. Hurricane Loss Costs by Year Built.

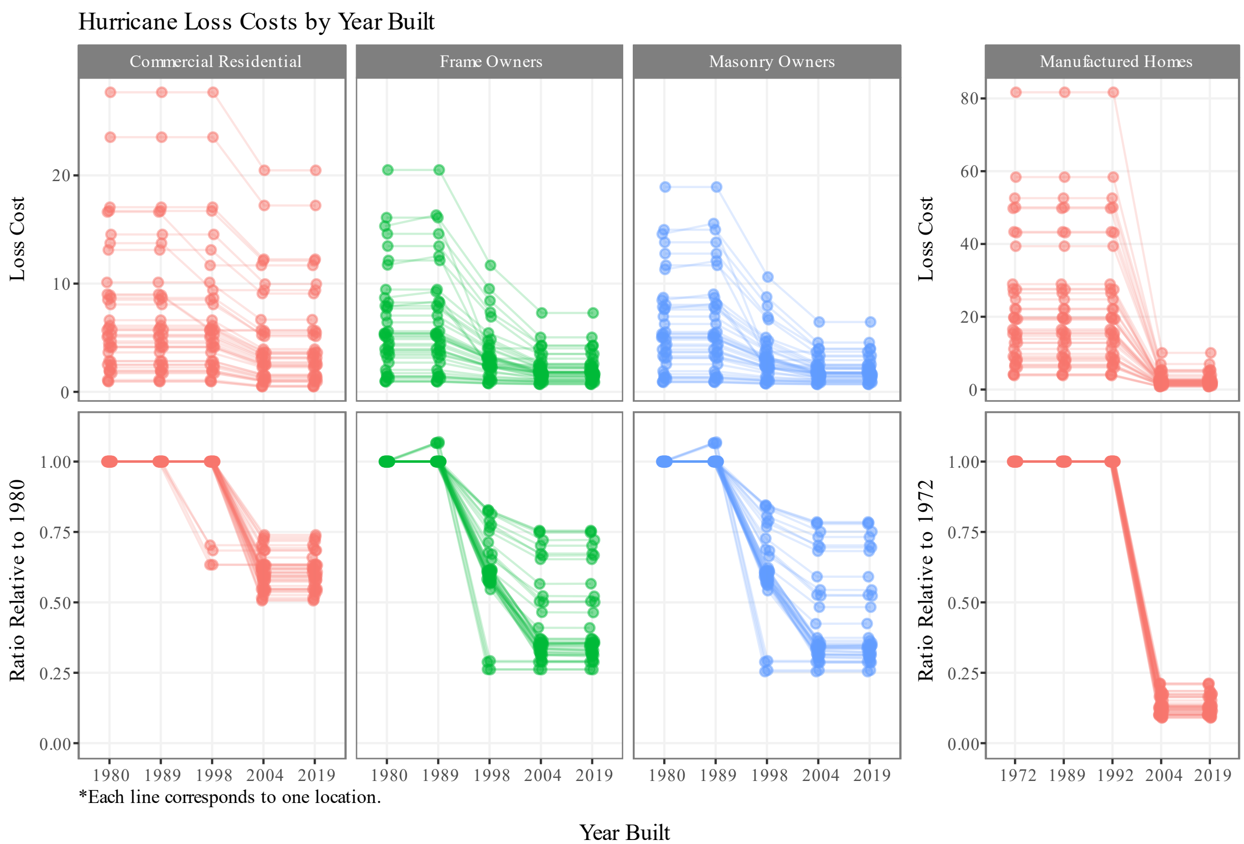


Figure 98. Hurricane Loss Costs by Year Built.

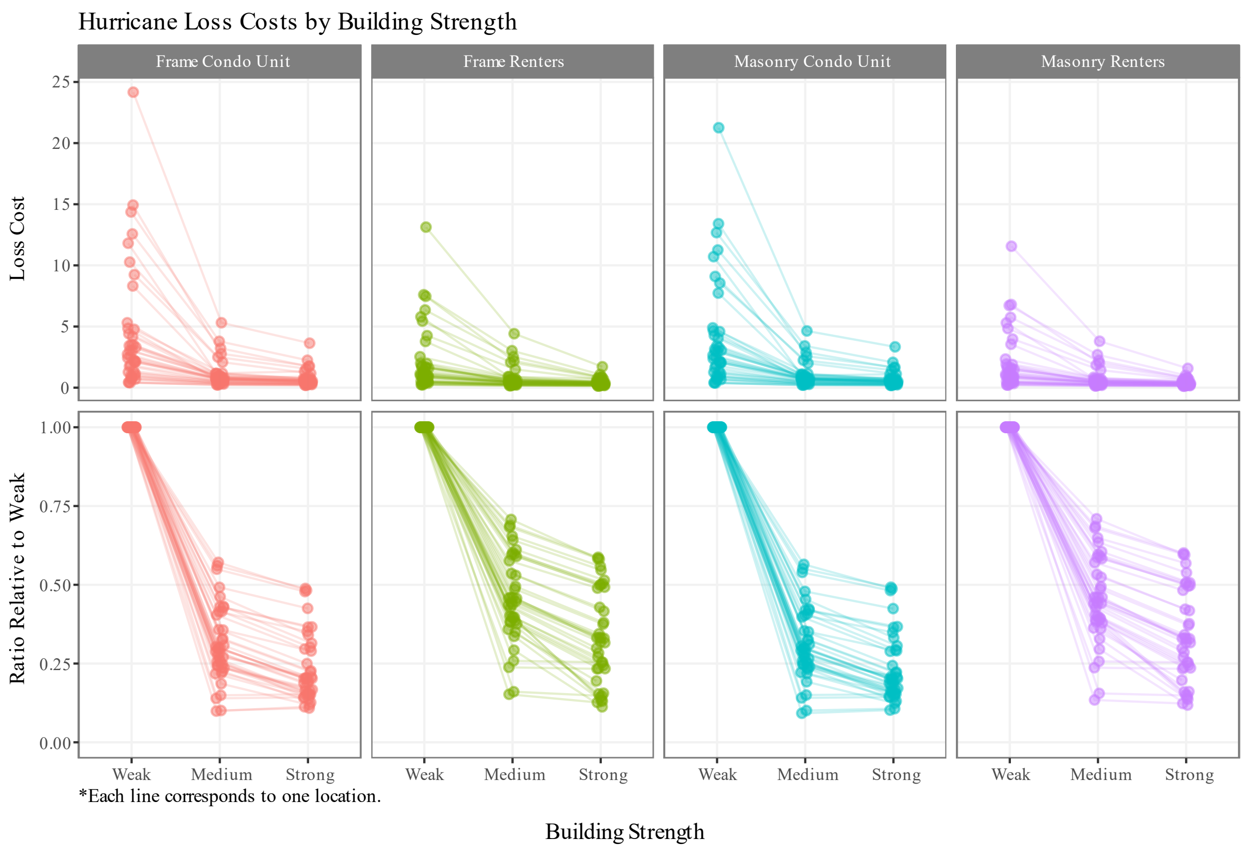


Figure 99. Hurricane Loss Costs by Building Strength.

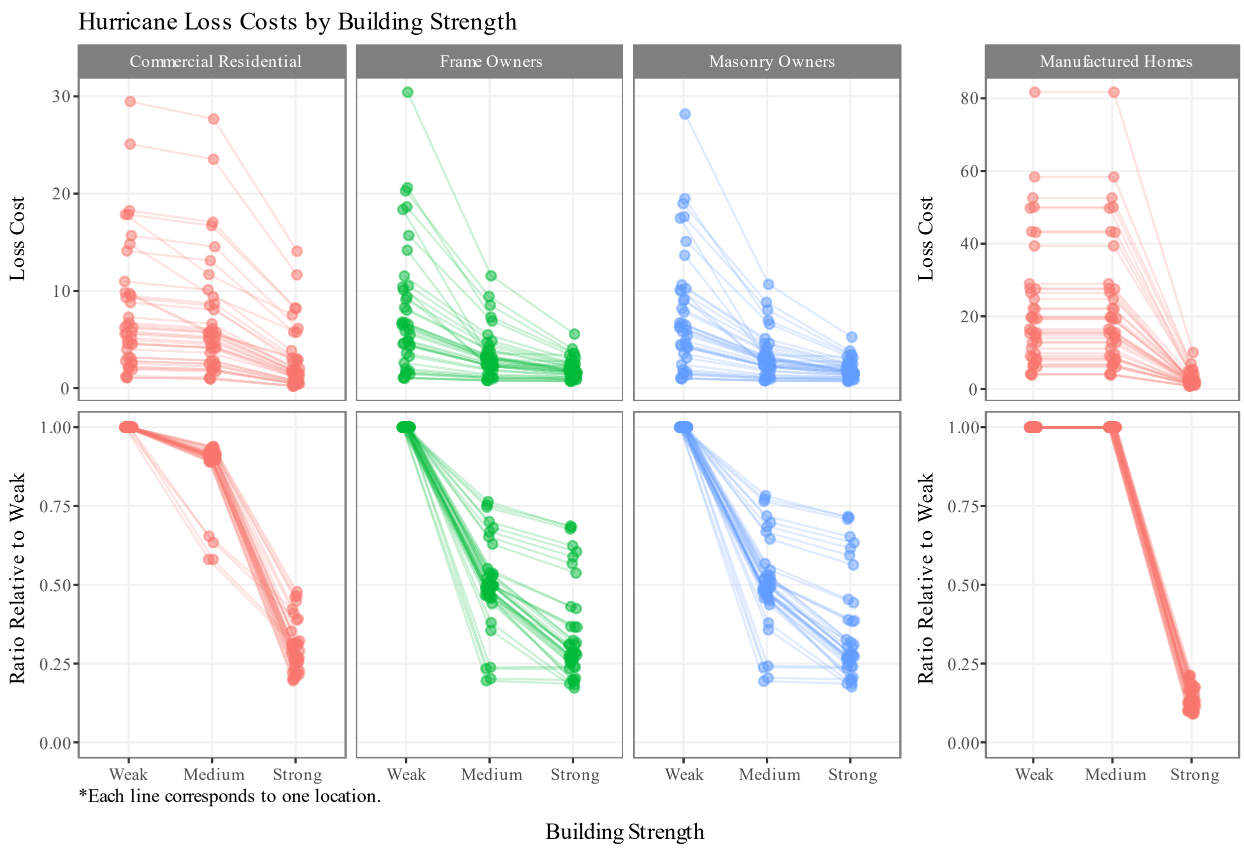


Figure 100. Hurricane Loss Costs by Building Strength.

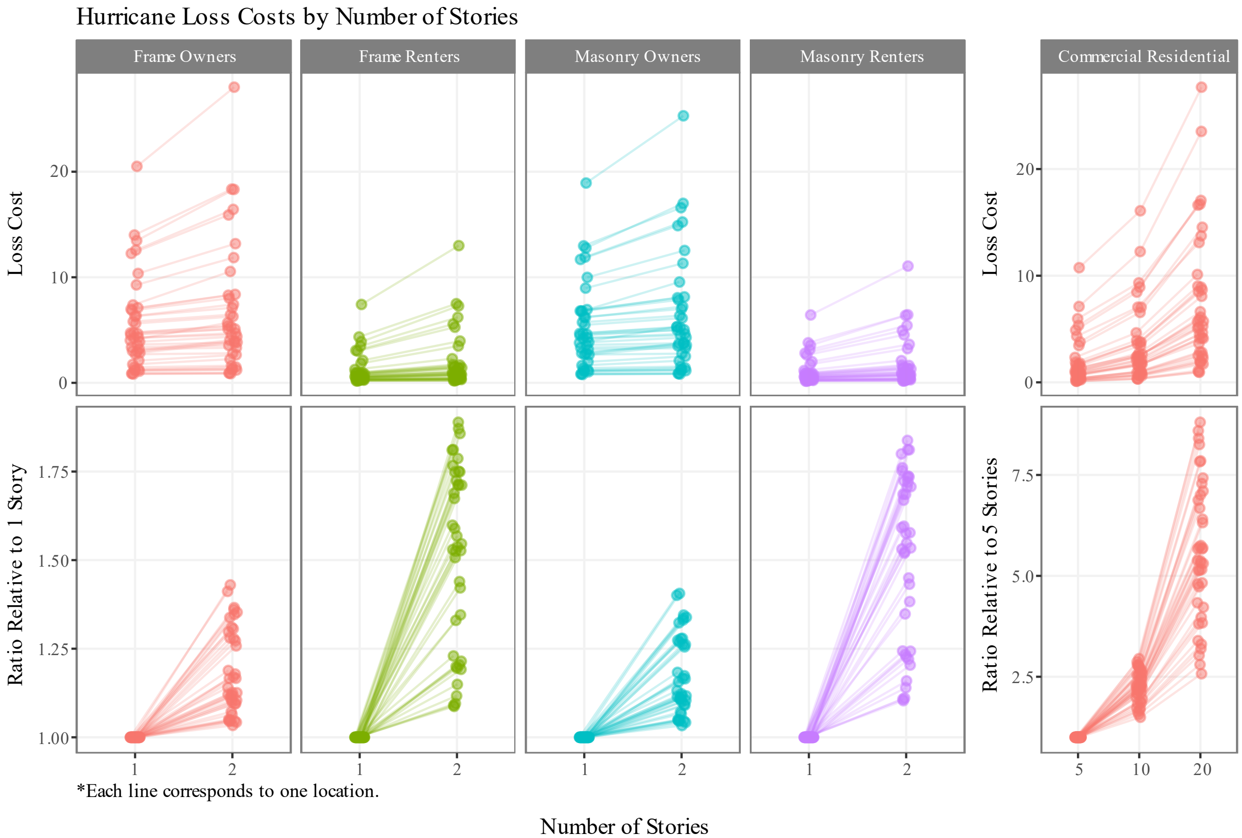


Figure 101. Hurricane Loss Costs by Number of Stories.

Form A-7: Percentage Change in Logical Relationship to Hurricane Risk

A. One or more automated programs or scripts shall be used to generate the exhibits in Form A7, Percentage Change in Logical Relationship to Hurricane Risk.

Automated scripts and programs were used to generate Form A-7.

B. Provide summaries of the percentage change in logical relationship to hurricane risk exhibits from the previously-accepted hurricane model in the format shown in the file named "2019FormA7.xlsx."

C. Create exposure sets for each exhibit by modeling all of the coverages from the appropriate Notional Set listed below at each of the locations in "Location Grid B" as described in the file "NotionalInput19.xlsx." Refer to the Notional Hurricane Policy Specifications provided in Form A-6, Logical Relationship to Hurricane Risk (Trade Secret Item), for additional modeling information.

Exhibit	Notional Set
Deductible Sensitivity	**Set 1**
Policy Form Sensitivity	**Set 2**
Construction Sensitivity	**Set 3**
Coverage Sensitivity	**Set 4**
Year Built Sensitivity	**Set 5**
Building Strength Sensitivity	**Set 6**
Number of Stories Sensitivity	**Set 7**

D. Hurricane models shall treat points in Location Grid B as coordinates that would result from a geocoding process. Hurricane models shall treat points by simulating hurricane loss at exact location or by using the nearest modeled parcel/street/cell in the hurricane model.

Provide the results statewide (overall percentage change) and by the regions defined in Form A-5, Percentage Change in Hurricane Output Ranges.

E. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include all exhibits in Form A-7, Percentage Change in Logical Relationship to Hurricane Risk, in a submission appendix.

See Appendix H.

Form A-8: Hurricane Probable Maximum Loss for Florida

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form A-8, Hurricane Probable Maximum Loss for Florida.

Automated scripts and programs were used to generate Form A-8.

B. Provide a detailed explanation of how the Expected Annual Hurricane Losses and Return Periods are calculated.

For each range of losses:

Expected Annual Hurricane Losses = Total Loss / Number of years in the simulation,

Where:
Total Loss = Sum of losses for all simulated years with aggregate storm losses in the range.
Return Period = 1 / Probability of exceeding the average loss in the range,

Where:
Average Loss = Total Loss / Number of years with aggregate storm losses in the range,

And

Probability of exceeding the average loss in the range = (Number of years with aggregate storm losses > Average Loss) / Number of years in the simulation.

C. Complete Part A showing the personal and commercial residential hurricane probable maximum loss for Florida. For the Expected Annual Hurricane Losses column, provide personal and commercial residential, zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.zip."

In the column, Return Period (Years), provide the return period associated with the average hurricane loss within the ranges indicated on a cumulative basis.

For example, if the average hurricane loss is $4,705 million for the range $4,501 - $5,000 million, provide the return period associated with a hurricane loss that is $4,705 million or greater.

For each hurricane loss range in millions ($1,001-$1,500, $1,501-$2,000, $2,001-$2,500) the average hurricane loss within that range should be identified and then the return period associated with that hurricane loss calculated. The return period is then the reciprocal of the probability of the hurricane loss equaling or exceeding this average hurricane loss size.

The probability of equaling or exceeding the average of each range should be smaller as the ranges increase (and the average hurricane losses within the ranges increase). Therefore, the return period associated with each range and average hurricane loss within that range should be larger as the ranges increase. Return periods shall be based on cumulative probabilities.

A return period for an average hurricane loss of $4,705 million within the $4,501-$5,000 million range should be lower than the return period for an average hurricane loss of $5,455 million associated with a $5,001- $6,000 million range.

D. Provide a graphical comparison of the current hurricane model Residential Return Periods hurricane loss curve to the previously-accepted hurricane model Residential Return Periods hurricane loss curve. Residential Return Period (Years) shall be shown on the y-axis on a log- 10 scale with Hurricane Losses in Billions shown on the x-axis. The legend shall indicate the corresponding hurricane model with a solid line representing the current year and a dotted line representing the previously-accepted hurricane model.

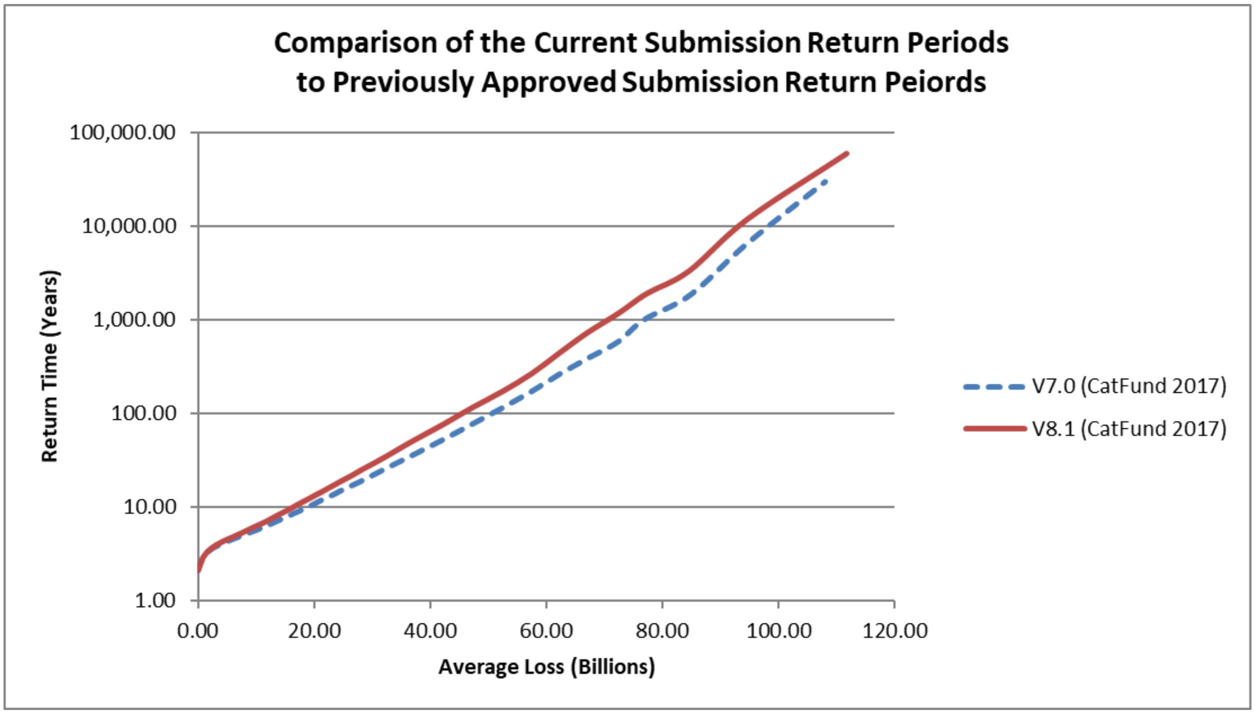


Figure 102. Comparison of return periods.

E. Provide the estimated hurricane loss and uncertainty interval for each of the Personal and Commercial Residential Return Periods given in Part B, Annual Aggregate, and Part C, Annual Occurrence. Describe how the uncertainty intervals are derived. Also, provide in Parts B and C, the Conditional Tail Expectation, the expected value of hurricane losses greater than the Estimated Hurricane Loss Level.

The uncertainty intervals (except for the top event) are approximate 95% confidence intervals.

Let $X_1, X_2, \ldots, X_N$ be the ordered set of annual losses produced by the simulation with $X_{(1)} \leq X_{(2)} \leq \ldots \leq X_{(N)}$. (Or alternatively for part C the ordered set of the largest loss from each year of the simulation.)

Since the sample is large enough to assume a normal approximation for the p^{th} quantile of the ordered set, an approximate 95% confidence interval for the PML is given by $(X_{(r)}, X_{(s)})$, where

$$r = Np - 1.96\sqrt{Np(1-p)}$$

$$s = Np + 1.96\sqrt{Np(1-p)}$$

and N and p are defined as

N = number of years in the simulation

and

p = 1 – 1 / return period.

If r and/or s are not integers, let r* be the smallest integer greater than r and let s* be the smallest integer greater than or equal to s. The 95% approximate confidence interval is given by $(X_{(r^*)}, X_{(s^*)})$

The top event itself is estimated by the highest order statistics, $X_{(N)}$. It is not possible to compute a confidence interval for the top event using the above method.

F. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form A-8, Hurricane Probable Maximum Loss for Florida, in a submission appendix.

See Appendix I.

COMPUTER/INFORMATION STANDARDS

CI-1 Hurricane Model Documentation

A. Hurricane model functionality and technical descriptions shall be documented formally in an archival format separate from the use of letters, slides, and unformatted text files.

The Florida Public Hurricane Loss Model (FPHLM) formally documents the model functionality and technical descriptions in the primary document repository, an archival format separate from the use of letters, slides, and unformatted text files. The primary document repository uses standard software practices to formally describe the model's requirements and complete software design and implementation specifications. All documentation related to the model is maintained in the project's primary document repository, a central location that is easily accessible.

B. A primary document repository shall be maintained, containing or referencing a complete set of documentation specifying the hurricane model structure, detailed software description, and functionality. Documentation shall be indicative of current model development and software engineering practices.

The FPHLM maintains a primary document repository to satisfy the aforementioned requirements. In addition, the FPHLM maintains a user manual, designed for the end user, which provides a high-level introduction and a step-by-step guide to the entire system. All the documents are available for inspection on the project's primary document repository. Current software engineering best practices are used to render all the documents more readable, self-contained, consistent, and easy to understand. Every component of the system is documented with standard use case, class, data flow, sequence diagrams, etc. The diagrams describe in detail the structure, logic flow, information exchange among submodules, etc. of each component and increase the visibility of the system. The diagrams describing the component functionality and structure also make each component of the system reusable and easily maintainable.

C. All computer software (i.e., user interface, scientific, engineering, actuarial, data preparation, and validation) relevant to the hurricane model shall be consistently documented and dated.

The primary document repository contains all of the required documentation organized in chapters and sections linked to one another on the basis of their mutual relationships. Thus, the entire document can be viewed as a hierarchical referencing scheme in which each module is linked to its sub-module, which ultimately refers to the corresponding codes.

D. The following shall be maintained: (1) a table of all changes in the hurricane model from the previously-accepted hurricane model to the initial submission this year, and (2) a table of all substantive changes since this year's initial submission.

These tables are maintained and documented and will be available for review.

E. Documentation shall be created separately from the source code.

The aforementioned primary document repository, created and maintained according to the requirements specified in this standard, is separate from source code and source code documentation.

F. A list of all externally acquired currently used hurricane model-specific software and data assets shall be maintained. The list shall include (1) asset name, (2) asset version number, (3) asset acquisition date, (4) asset acquisition source, (5) asset acquisition mode (e.g., lease, purchase, open source), and (6) length of time asset has been in use by the modeling organization.

We created and maintain a list of all the externally acquired currently used hurricane model-specific software and data assets. The list will be available for review.

CI-2 Hurricane Model Requirements

A complete set of requirements for each software component as well as for each database or data file accessed by a component, shall be maintained. Requirements shall be updated whenever changes are made to the hurricane model.

The FPHLM is divided into several major modules, each of them providing one or more inputs to other modules. Requirements of each of the modules, including input/output formats, are precisely documented. In addition to maintaining a detailed documentation of each module of the system using standard software practices, several other documents are maintained as part of a large-scale project management requirement, including a quality assurance document, a system hardware and software specification document, a training document, a model maintenance document, a testing document, a user manual, etc. Moreover, detailed documentation has been developed for the database consisting of the schema and information about each table. Additionally, information about the format for each data file (in the form of an Excel or text file) accessed by different programs is documented. Whenever changes are made to a model, the corresponding requirements documentation is updated to reflect such changes.

Disclosure

1. Provide a description of the hurricane model and platform(s) documentation for interface, human factors, functionality, system documentation, data, human and material resources, security, and quality assurance.

The user interface, functionality requirements, and material resources of each of the modules are described in the relevant module documentation using formal modeling languages and representations. Database schema, table formats, security, software and hardware specifications, and training plans are separately documented for the whole system in the primary document repository. A separate software testing and quality assurance document describes the system quality, performance, and stability concerns. Additionally, a user manual and a human resource management document are maintained.

CI-3 Hurricane Model Organization and Component Design

A. The following shall be maintained and documented: (1) detailed control and data flowcharts and interface specifications for each software component, (2) schema definitions for each database and data file, (3) flowcharts illustrating hurricane model-related flow of information and its processing by modeling organization personnel or consultants, (4) network organization, and (5) system model representations associated with (1)- (4) above. Documentation shall be to the level of components that make significant contributions to the hurricane model output.

Interface specifications for each of the software modules are included in the module's documentation. Diagrams are presented at various levels of the model documentation. High-level flowcharts are used to illustrate the flow of the whole system and the interactions among modules. More detailed diagrams are used in module-level descriptions.

The database schema is documented in the primary document repository. A detailed schema representation of the active database is documented with additional information such as database maintenance, tuning, data loading methodologies, etc. to provide a complete picture of the database maintained for the project.

Business process diagrams are used to illustrate the flow of model-related information and its processing by modeling organization personnel and consultants. Additionally. The organization of the network is documented in the primary document repository.

B. All flowcharts (e.g., software, data, and system models) shall be based on (1) a referenced industry standard (e.g., Unified Modeling Language (UML), Business Process Model and Notation (BPMN), Systems Modeling Language (SysML)), or (2) a comparable internally-developed standard which is separately documented.

Diagrams documenting the Florida Public Hurricane Loss Model are created according to standards International Organization for Standards (ISO) 5807, Business Process Model and Notation (BPMN) 2, and Unified Modeling Language (UML) 2.

Data flowcharts, program flowcharts, system flowcharts, program network charts, and system resources charts are created according to ISO 5807. Flowcharts illustrating model-related flow of information and its processing by team members follow BPMN 2. Other diagrams for both behavioral and structural object-oriented design documentation such as use case and class diagrams follow UML 2.

CI-4 Hurricane Model Implementation

A. A complete procedure of coding guidelines consistent with accepted software engineering practices shall be maintained.

The FPHLM has developed and followed a set of coding guidelines that is consistent with accepted software engineering practices. These guidelines include policies for coding style, version control, code revision history maintenance, etc. Developers involved in the system development adhere to the instructions in these documents.

B. Network organization documentation shall be maintained.

The organization of the network is documented in the primary document repository.

C. A complete procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components shall be maintained.

The FPHLM uses a PostgreSQL database to store, pre-process, and post-process model input and output data. The procedures for creating and using these databases is formalized in the form of stored procedures, which are documented in-line and in the primary document repository. Data files are generated by different modules and used as data interfaces between modules. Several data verification steps are undertaken to ensure their correctness. These steps are formalized in the form of Linux shell scripts and documented as part of the primary document repository.

D. All components shall be traceable, through explicit component identification in the hurricane model representations (e.g., flowcharts) down to the code level.

Traceability, from requirements to the code level and vice versa, is maintained throughout the system documentation.

E. A table of all software components affecting hurricane loss costs and hurricane probable maximum loss levels shall be maintained with the following table columns: (1) component name, (2) number of lines of code, minus blank and comment lines, and (3) number of explanatory comment lines.

The FPHLM primary document repository includes a table of all software components affecting hurricane loss costs and hurricane probable maximum loss levels with the required columns.

F. Each component shall be sufficiently and consistently commented so that a software engineer unfamiliar with the code shall be able to comprehend the component logic at a reasonable level of abstraction.

Computer code comments are consistently used throughout all of the model's codebase to ease the understanding of its logic. These code-level comments include a summary of important changes, names of developers involved in each modification, function headers, and in-line comments to explain potentially ambiguous software code.

G. The following documentation shall be maintained for all components or data modified by items identified in Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7 and Audit 6:

1. A list of all equations and formulas used in documentation of the hurricane model with definitions of all terms and variables, and

2. A cross-referenced list of implementation source code terms and variable names corresponding to items within G.1 above.

Tables mapping the equations and formulas used in the model's documentation to the source code terms and variable names are provided in the glossaries to the model's documentation, thus combining G.1 and G.2 into a single table. These tables enhance the model's documentation and include the equations and formulas for each module (not just the modified ones from the prior year's submission).

Disclosure

1. Specify the hardware, operating system, and essential software required to use the hurricane model on a given platform.

The user-facing part of the system consists of a web-based application that is hosted on a Tomcat web application server. The backend server environment is Linux and the server-side scripts that support the model's functionality are written in Bash, Java Server Pages (JSP) and JavaBeans. Backend probabilistic calculations are coded in C++ using the IMSL library and called through Java Native Interface (JNI). The system uses a PostgreSQL database that runs on a Linux server. Server-side software requirements are the IMSL library CNL 5.0, JDBC 3, JNI 1.3.1, and JDK 1.6. The end-user workstation requirements are minimal. Any current version of Internet Explorer, Firefox, Chrome, or Safari running on a currently supported version of Windows, Mac or Linux should deliver optimal user experience. Typically, the manufacturer's minimal set of hardware features for the current version of the web browser and operating system combination is sufficient for an optimal operation of the application.

CI-5 Hurricane Model Verification

A. General

For each component, procedures shall be maintained for verification, such as code inspections, reviews, calculation crosschecks, and walkthroughs, sufficient to demonstrate code correctness. Verification procedures shall include tests performed by modeling organization personnel other than the original component developers.

The FPHLM software verification is done in three stages:

1. Code inspection and verification by the code developer.

2. Inspection of the input and validation of the output by the system modeler.

3. Review and extensive testing of the code by modeler personnel who are not part of the original component development.

The first level of verification includes code-level debugging, walking through the code to ensure a proper flow, inspection of internal variables through intermediate output printing and error logging, use of exception handling mechanisms, calculation crosschecks, and verification of the output against sample calculations provided by the system modeler.

In the second level of the verification, the modeler is provided with sample inputs and corresponding outputs. The modeler then conducts black-box testing to verify the results against his or her model. Finally, each component is rigorously tested by modeler personnel not responsible for original component development.

B. Component Testing

1. Testing software shall be used to assist in documenting and analyzing all components.

Component testing and data testing are done in the third level of verification. The system is rigorously checked for the correctness, precision, robustness, and stability of the whole system. Calculations are performed outside the system and compared against the system-generated results to ensure the system correctness. Extreme and unexpected inputs are given to the system to check the robustness. Wide series of test cases are developed to check the stability and the consistency of the system.

2. Unit tests shall be performed and documented for each component.

Unit testing is done at the first and third levels of verification. The developer tests all the units as the unit is developed and modified. Then all the units are tested again by the external testing team. Both black-box and white-box tests are performed and documented in a separate testing document.

3. Regression tests shall be performed and documented on incremental builds.

Regression testing is performed for each module. In this kind of testing methodology, the modules that have undergone some changes and revisions are retested to ensure that the changes have not affected the entire system in any undesired manner.

4. Integration tests shall be performed and documented to ensure the correctness of all hurricane model components. Sufficient testing shall be performed to ensure that all components have been executed at least once.

Integration testing is performed at all three levels of verification. Integration testing is performed by running each major module as a complete package. It is ensured that all components have been executed at least once during the testing procedure. All the test cases executed are described in the software testing and verification documentation.

C. Data Testing

1. Testing software shall be used to assist in documenting and analyzing all databases and data files accessed by components.

The FPHLM uses a PostgreSQL database to store the required data. Data integrity and consistency are maintained by the Relational Database Management System itself. Moreover, different queries are issued and PL/SQL is implemented to check the database. PostgreSQL has a very robust loader, which is used to load the data into the database. The loader maintains a log that depicts if the loading procedure has taken place properly and completely without any discrepancy. Data files are manually tested using commercial data manipulation software such as Microsoft Excel and Microsoft Access.

2. Integrity, consistency, and correctness checks shall be performed and documented on all databases and data files accessed by the components.

All the tests are well documented in a separate testing document.

Disclosures

1. State whether any two executions of the hurricane model with no changes in input data, parameters, code, and seeds of random number generators produce the same hurricane loss costs and hurricane probable maximum loss levels.

The model produces the same loss costs and probable maximum loss levels if it is executed more than once with no changes in input data, parameters, code, and seeds of random number generators.

2. Provide an overview of the component testing procedures.

The FPHLM software testing and verification is done in three stages.

[A] Code inspection and the verification by the code developer.

The code developer performs a sufficient amount of testing on the code and does not deliver the code until he or she is satisfied with the correctness and robustness of the code.
The first level of verification includes code-level debugging, walking through the code to ensure proper flow, inspection of internal variables through intermediate output printing and error logging, use of exception handling mechanisms, calculation crosschecks, and verification of the output against sample calculations provided by the system modeler.

[B] Verification of results by the person who developed the system model.

Once the first level of testing is done, the developer sends the sample inputs and the generated results back to the modeler. Then the system modeler double-checks the results against his or her model. The code is not used in the production environment unless approved by the modeler.

[C] Review and extensive testing of the code by modeler personnel other than the original component developers.

The system is rigorously checked by modeler personnel (testers) other than the original component developers for the correctness, precision, robustness, and stability of the whole system. Calculations are performed outside the system and compared against the system generated results to ensure the system correctness. Extreme and unexpected inputs are given to the system to check the robustness. Wide series of test cases are developed to check the stability and the consistency of the system. Unit testing, regression testing, and aggregation testing (both white-box and black-box) are performed and documented.

Any flaw in the code is reported to the developer, and the bug-corrected code is again sent to the tester. The tester then performs unit testing again on the modified units. Additionally, regression testing is performed to determine if the modification affects any other parts of the code.

3. Provide a description of verification approaches used for externally acquired data, software, and models.

The verification approaches used for externally acquired data, software, and models are documented in the primary document repository.

CI-6 Hurricane Model Maintenance and Revision

A. A clearly written policy shall be implemented for review, maintenance, and revision of the hurricane, including verification and validation of revised components, databases, and data files.

The FPHLM is periodically enhanced to reflect the state of the art in hurricane loss modeling, historical event information, and the distribution of the population in the state of Florida. The primary document repository contains a clear policy for model revision and network organization

B. A revision to any portion of the hurricane model that results in a change in any Florida residential hurricane loss cost or hurricane probable maximum loss level shall result in a new hurricane model version identification.

Whenever a revision results in a change in any Florida residential hurricane loss cost or probable maximum loss level, a new model version identification will be assigned to the revision. Verification and validation of the revised units are repeated according to the above-mentioned "software verification procedures" document.

C. Tracking software shall be used to identify and describe all errors, as well as modifications to code, data, and documentation.

The FPHLM uses Subversion to identify and describe all errors, as well as modifications to code, data, and documentation.

D. A list of all hurricane model versions since the initial submission for this year shall be maintained. Each hurricane model description shall have a unique version identification and a list of additions, deletions, and changes that define that version.

A list of all model versions since the initial submission is maintained as part of the model's documentation. Each model revision has a unique version number and a list of additions, deletions, and changes that define that version. The unique model version will consist of the scheme "V[major].[minor]." The terms "[major]" and "[minor]" are positive integers that correspond to substantial and minor changes in the model, respectively. A minor change in the model would cause the minor number to be incremented by one, and similarly, a major change in the model would cause the major number to be incremented by one with the minor reset to zero. The rules that prompt changes in the major and minor numbers are described in Disclosure 2.

Disclosures

1. Identify procedures used to review and maintain code, data, and documentation.

The FPHLM's software development team employs version control software for all software development. In particular, the FPHLM uses Subversion, an accepted and effective system for managing simultaneous development of files. Subversion maintains a record of the changes to each file and allows the user to revert to a previous version, merge versions, and track changes. This software is able to record the information for each file, the date of each change, the author of each change, the file version, and the comparison of the file before and after the changes.

2. Describe the rules underlying the hurricane model and code revision identification systems.

The model identification system consists of the scheme "V[major].[minor]." The terms "[major]" and "[minor]" are positive integers that correspond to major and minor changes in the model, respectively. A minor change causes the minor number to be incremented by one, and similarly, a major change causes the major number to be incremented by one with the minor number reset to zero. The rules that prompt major or minor changes in the model are the following:

Any of the following events will trigger a change in the major number:

a) Major updates in any of the main modules of the FPHLM: major modification of the Storm Forecast Module,Wind Field Model, Wind Speed Correction Module, Vulnerability Module, or Insured Loss Module.

b) Addition or removal of options affecting how input data is processed by the model.

c) Addition or removal of attributes in the model's input data specification.

Any of the following events will trigger a change in the minor number:

a) Minor changes to the Storm Forecast Module, Wind Field Model, Wind Speed Correction Module, Vulnerability Module, or Insured Loss Module: minor updates such as a change in the Holland B parameter or any change to correct deficiencies that do not result in a new algorithm for the component.

b) Updates to correct errors in the computer code: modifications in the code to correct deficiencies or errors such as a code bug in the computer program.

c) Changes in the probability distribution functions using updated or corrected historical data, such as the updates of the HURDAT2 database: each year the model updates its

HURDAT database with the latest HURDAT2 data released by the National Hurricane Center, which is used as the input in the Storm Generation Model.

d) Updates of the ZIP Code list: every two years the ZIP Codes used in the model must be updated according to information originating from the United States Postal Service.

e) Updates in the validation of the vulnerability matrices: the incorporation of new data, such as updated winds and insurance data, may trigger a tune-up of the vulnerability matrices used in the Insurance Loss Model.

f) Modification to the set of valid values for any of the attributes in the model's input data specification.

If any change results in a change in loss costs estimates or probable maximum loss level, there will be at least a change in the minor revision number.

CI-7 Hurricane Model Security

Security procedures shall be implemented and fully documented for (1) secure access to individual computers where the software components or data can be created or modified, (2) secure operation of the hurricane model by clients, if relevant, to ensure that the correct software operation cannot be compromised, (3) anti-virus software installation for all machines where all components and data are being accessed, and (4) secure access to documentation, software, and data in the event of a catastrophe.

The FPHLM maintains and enforces a set of security procedures to protect data and documents from deliberate or accidental changes. These procedures include both physical and electronic measures. A set of policies identifies different security issues and addresses each of them. All of the security measures are properly documented in the primary document repository.

Disclosure

1. Describe methods used to ensure the security and integrity of the code, data, and documentation. These methods include the security aspects of each platform and its associated hardware, software, and firmware.

Electronic measures include the use of different authorization levels, special network security enforcements, and regular backups. Each developer is given a separate username and password and assigned a level of authorization so that even a developer cannot change another developer's code. The users of the system are given usernames and passwords so that unauthorized users cannot use the system. External users are not allowed direct access to any of the data sources of the system. The network is extensively monitored for any unauthorized actions using standard industry practices. Since the system runs on a Linux sever environment, which is maintained up to date, minimal virus attacks are expected.

Any sensitive or confidential data (insurance data, for example) are kept on an unshared disk on a system that has user access control and requires a login. Screen locks are enforced whenever the machine is left unattended. In addition, for system security and reliability purposes, we also deploy a development environment besides the production environment. Modifications to the code and data are done in the development environment and tested by in-house developers. The final production code and data can only be checked into the production environment by the authorized personnel. The models resulting from the FPHLM project can only be used by the authorized users. Authorized user accounts are created by the project manager. Regular backups of the server are taken and stored in two ways: physically and electronically. Backups are performed daily and are kept for six weeks. Nightly backups of all Linux data disks and selected Windows data disks (at user requests) are performed over the network onto LT02 and LT03 tapes. The tape drives have built-in diagnostics and verification to ensure that the data is written correctly to the tapes. This ensures that if the tape is written successfully, it will be readable, provided no physical damage occurred to the tape. A copy of each backup is placed in a secure and hurricane-protected building.

Additionally, the application server and the database server are physically secured in a secure server room with alarm systems. In case of disasters, we have implemented a set of preparation procedures and recovery plans as outlined in "FIU SCIS Hurricane Preparation Procedures."

APPENDICES

Appendix A – Expert Review Letters

Florida International University
Florida Public Hurricane Loss Model 8.1
May 24, 2021

Assessment of the meteorological portion of the State of Florida Public Hurricane Model

February 15, 2007
Gary M. Barnes
Professor, Department of Meteorology
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa

Introduction

My review of the State of Florida Public Hurricane Model is based on a three day visit to Florida International University in December, and an examination of the submission draft provided to me in February. I have had full access to the meteorological portion of the model, access to the draft for the Florida commission, and access to prior submittals to the commission from several other groups in order to establish a sense of what is desired by the commission. I am pleased to report that the issues that I have raised have received their attention and I believe that the model meets all the standards set forth by the commission. Ultimately this model, when linked to engineering and actuarial components, will provide objective guidance for the estimation of wind losses from hurricanes for the state of Florida. It does not address losses from other aspects of a tropical cyclone such as storm surge, or fresh water flooding. I now offer specific comments on each of the six meteorological standards established by the commission to ascertain this model's suitability.

M-1 Official Hurricane Set

The consortium of scientists working on the Public model have adopted HURDAT (1900- 2006) to determine landfall frequency and intensity at landfall. The NWS report by Ho et al. (1987), DeMaria's extension of the best track, H*Wind analyses (Powell & Houston, 1996, 1998; Powell et al. 1996, 1998) and NOAA Hurricane Research Division aircraft data are used to estimate the radius of maximum winds (RMW) at landfall. The strength of HURDAT is that it is the most complete and accessible historical record for hurricanes making landfall or passing closely by Florida. HURDAT weaknesses include the abbreviated record and questionable intensity estimates for those hurricanes early in the record, especially those that remain offshore. Evidence for the shortness of record is the impact of the last few hurricane seasons on landfall return frequency. The meteorological team has scrutinized the base set developed by the commission and made a number of adjustments to the dataset based on refereed literature and the HURDAT record. I have looked at several of these adjustments in detail and find the corrections to be an improvement over the initial base set.

M-2 Hurricane Characteristics

The model has two main components. The track portion of the model produces a storm with either an initial location or genesis point and an intensity that is derived from an empirical distribution derived from HURDAT (2006). Storm motion and intensity is then initialized by using a Monte Carlo approach, drawing from probability density functions (PDFs) based on the historical dataset to create a life for a bogus hurricane. Examination of the PDFs reveals that they are faithful to the observed patterns for storms nearing Florida, and the evolution of any particular hurricane appears realistic.

The second component of the meteorological model is the wind field generated for a given hurricane, which only comes into play when the hurricane comes close enough to place high winds over any given ZIP Code of Florida. To generate a wind field the minimum sea-level pressure (MSLP) found in the eye, the RMW at landfall, and a distant environmental pressure (1013 mb) are entered into the Holland (1980) B model for the axisymmetric pressure distribution around the hurricane. The behavior of the RMW is based on a variety of sources that include Ho et al. (1987), DeMaria's extension of the best track data, H*wind analyses, and aircraft reconnaissance radial wind profiles. The B coefficient is based on the extensive aircraft dataset acquired in reconnaissance and research flights over the last few decades. RMW and B use a random or error term to introduce variety into the model. The Holland pressure field is used to produce a gradient wind at the top of the boundary layer. The winds in the boundary layer are estimated following the work proposed by Ooyama (1969) and later utilized by Shapiro (1983) which includes friction and advection effects. These boundary layer winds are reduced to surface winds (10 m) using reduction factors based on the work of Powell et al. (2003). Maximum sustained winds and 3 second gusts are estimated using the guidance of Vickery and Skerlj (2005). Once the hurricane winds come ashore there are further adjustments to the wind to account for local roughness as well as the roughness of the terrain found upstream of the location under scrutiny. The pressure decay of the hurricane is modeled to fit the observations presented by Vickery (2005).

Gradient balance has been demonstrated to be an accurate representation for vortex scale winds above the boundary layer by Willoughby (1990) and is a fine initial condition. The slab boundary layer concept of Ooyama and Shapiro has been shown to produce wind fields much like observed once storm translation and surface friction come into play. The reduction to 10 m altitude is based on Powell et al. (2003); they use the state of the art Global Positioning System sondes to compare surface and boundary layer winds.

Perhaps the most questionable part of the wind portion of the model is the reliance on the estimates of the RMW at landfall. The scatter in RMW for a given MSLP is large; larger RMWs coupled with the B parameter control the size of the annulus of the damaging winds. The typical length of an aircraft leg from the eye is about 150 km so the choice of the B parameter is based on a small radial distance in the majority of hurricanes. The collection of quality wind observations over land in hurricanes remains a daunting task; therefore the actual response of the hurricane winds to variations in roughness is less certain. Applying roughness as a function of ZIP Code is a coarse approximation to reality. However, this is the approach chosen by the commission, and given the data limitations, a reasonable course to take.

M-3 Landfall Intensity

The model uses one minute winds at 10 m elevation to determine intensity at landfall and categorizes each hurricane according to the Saffir-Simpson classification. The model considers any hurricane that makes landfall or comes close enough to place high winds over Florida. Multiple landfalls are accounted for, and decay over land between these landfalls is also estimated. Maximum wind speeds for each category of the Saffir-Simpson scheme are reasonable as is the worst possible hurricane the model generates. Simulations are conducted for a hypothetical 60,000 years. Any real climate change would alter results, but maybe not as much as have an actual record of order of 1,000 years to base the PDFs on.

M-4 Hurricane Probabilities

Form M-1 demonstrates that the model is simulating the landfalls very well for the entire state, region A (NW Florida) and region B (SW Florida). There are subsections of the state where the historical and the simulated landfalls have a discrepancy. In region C (SE Florida) the observations show an unrealistic bias toward Category 3 storms. This is likely due to an overestimate of intensity for the hurricanes prior to the advent of aircraft sampling or advanced satellite techniques. The historical distribution for region C also does not fit any accepted distributions that we typically see for atmospheric phenomena. This discrepancy is probably due to the shortness of the historical record. I note that other models also have difficulty with this portion of the coast. I believe the modeled distribution, based on tens of thousands of years, is more defensible than the purported standard. Regions D (NE Florida) and E (Georgia) have virtually no distribution to simulate, again pointing to a very short historical record. There is no documented physical reason why these two regions have escaped landfall events. Perhaps a preferred shape of the Bermuda High may bias the situation, but this remains speculative.

M-5 Land Friction and Weakening

Land use and land cover are based on high resolution satellite imagery. Roughness for a particular location is then based on HAZUS tables that assign a roughness to a particular land use. There are newer assessments from other groups but the techniques were not consistently applied throughout the state, nor are the updated HAZUS maps for 2000 available yet. Winds at a particular location are a function of the roughness at that point and conditions upwind. A pressure decay model based on the work of Vickery (2005) produces weakening winds that are reasonable approximations of the observed decay rates of several hurricanes that made landfall in Florida in 2004 and 2005.

The maps (Form M-2) of the 100 year return period maximum sustained winds shows the following trends: (1) a reduction in the sustained winds from south to north, (2) a reduction of winds from coastal to inland ZIP Codes, and (3) the highest winds in the Keys and along the SE and SW coasts. The plotting thresholds requested by the commission partially obfuscate the gradients in wind speed, but Form M-2 produced with finer contours highlights the above trends clearly. The open terrain maps look logical; the actual terrain maps are perhaps overly sensitive to the local roughness. Convective scale motions, which cannot be resolved in this type of model, would probably be responsible for making the winds closer to the open terrain results.

M-6 Logical Relationships of Hurricane Characteristics

The RMW is a crucial but poorly measured variable. Making RMW a function of intensity and latitude explains only a small portion of the variance (~20%). Examination of aircraft reconnaissance radial profiles shows that RMW is highly variable. Currently there are no other schemes available to explain more of the variance. Form M-3 reflects the large range of RMW. Note that only the more intense hurricanes (MSLP < 940 mb) show a trend, and only with the upper part of the range. Even open ocean studies of the RMW show such large scatter.

Tests done during my visits show that wind speed decreases as a function of roughness, all other variables being held constant. The evolution of the wind field as a hurricane comes ashore is logical.

Summary

The consortium that has assembled the meteorological portion of the Public Model for Hurricane Wind Losses for the State of Florida is using the HURDAT with corrections based on other refereed literature. These data yield a series of probability density functions that describe frequency, location, and intensity at landfall. Once a hurricane reaches close enough to the coast the gradient winds are estimated using the equations by Holland (1980), then a sophisticated wind model (Ooyama 1969, Shapiro 1983) is applied to calculate the boundary layer winds. Reduction of this wind to a surface value is based on recent boundary layer theory and observations. Here the consortium has exploited other sources of data (e.g., NOAA/AOML/HRD aircraft wind profiles and GPS sondes) to produce a surface wind field. As the wind field transitions from marine to land exposure changes in roughness are taken into account. Form M-1 (frequency and category at landfall as a function of coastal segment) and Form M-2 (100 year return maximum sustained winds for Florida) highlight the good performance of the model.

I suspect that the differences between the historical record and the simulation are largely due to the shortness and uncertainty of the record. If the consortium had the luxury of 1000 years of observations agreement between the record and the simulation would be improved. I believe that the meteorological portion of the model is meeting all the standards established by the commission. Tests of the model against H*Wind analyses and the production of wind speed swaths go beyond the typical quality controls of prior models and demonstrate that this model is worthy of consideration by the commission

AMI Risk Consultants, Inc.
Actuarial & Risk Management Consulting Services

1336 SW 146th Ct, Miami, Florida 33184, USA Tel No: (305)273-1589 Fax No:(305)330-5427 www.amirisk.com

March 11, 2021
Dr. Shahid Hamid
Chair and Professor of Finance,
Department of Finance, College of Business
Florida International University
11200 SW 8th Street
Miami, FL 33199

Re: Florida Public Hurricane Loss Model
Version 8.1
Independent Actuarial Review

Dear Dr. Hamid:

AMI Risk Consultants, Inc. was engaged by the International Hurricane Research Center ("IHRC") at Florida International University ("FIU") to review the actuarial components of its hurricane model, ***Florida Public Hurricane Loss Model, Version 8.1.*** I am a Fellow of the Casualty Actuarial Society, a Member of the American Academy of Actuaries, and have more than twenty-five years of actuarial experience in the property/casualty insurance industry. I am an employee of the actuarial consulting firm AMI Risk Consultants, Inc.

It is my understanding that between Versions 7.0 and 8.1 there were changes to the Florida Public Hurricane Loss Model ("FPHLM"). Those changes included:

- Updates to HURDAT
- Updates to ZIP Code centroids
- Updates to the WBDR.

In addition there were revisions to the vulnerability component for Commercial Residential exposures and a change in the treatment of Low-rise Commercial Residential exposures in cases where the Type of Insured (Apartment or Condominium Association) is unknown.

My review is based the IHRC's November 2020 model submission to the Commission. I revisited each of the Actuarial Standards, and have the following comments:

Standard A-1: I reviewed the data input and output record formats for Personal and Commercial Residential policies. The input records have been expanded so that both hurricane/wind and flood exposures can be collected. The output record has not changed. The new input formats were originally planned for the V7.0 submission, but were withdrawn because submission of the new Flood Model had been postponed.

Standard A-2: Although Version 8.1 incorporates a new set of stochastic storms, the criteria for inclusion/exclusion of storms in the calculation of loss costs and PML have not changed, and the computer code categorizing each storm is also unchanged.

Standard A-3: The approach to estimating loss costs by coverage has not changed in this version of the model for Personal Residential. The vulnerability component of both the Low-rise and Mid-/High-rise Commercial Residential models have been revised as described in Standard G-1.7. Those changes, coupled with the treatment of missing identification of Apartment vs. Condominium Association, produced a large reduction in loss costs for this submission. The reduction is exaggerated here because none of the Cat Fund exposures specify Apartment or Condominium Association. For an insurance company portfolio the loss cost reduction in general should not be as extreme.

Standard A-4: The treatment of the items detailed in this standard, such as expenses, inflation, storm surge, geocoding, and demand surge has not changed with this version of the model. Please note that our attempt to obtain an update of the Marshall-Swift indices that underlie the demand surge factors was unsuccessful. The company that now publishes those indices quoted a fee far in excess of what the model's budget could bear.

Standard A-5: The methods used by the model to reflect the impact of deductibles and policy limits on losses have not changed since the prior submission.

Standard A-6: I tested the loss costs for compliance with this standard. I examined Forms A-1, A-2, A-3, A-4, and A-8 for reasonability, and compared the results to the prior submission where applicable. I examined loss cost changes by county, separating the impacts of each component that changed.

I tested loss costs at the Zip Code level in instances where compliance could not be verified from the weighted averages in Form A-4.

I identified the instances in Form A-6 that appeared to deviate from the standard, determined the reason for each, and documented those reasons in Standard A-6. Graphs were prepared to satisfy the new requirement that the Form A-6 tests be represented graphically.

<u>Conclusion:</u>

My conclusion is that the Florida Public Hurricane Model V8.1 reflects reasonable actuarial assumptions, and meets the Commission's Standards A-1 through A-6.

If you have any questions about my review, I would be happy to discuss them.

Sincerely,

Gail Flannery

Gail Flannery, FCAS, MAAA
Consulting Actuary

AMI Risk Consultants, Inc.

Appendix B - Form A-1: Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code

Florida International University
Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021

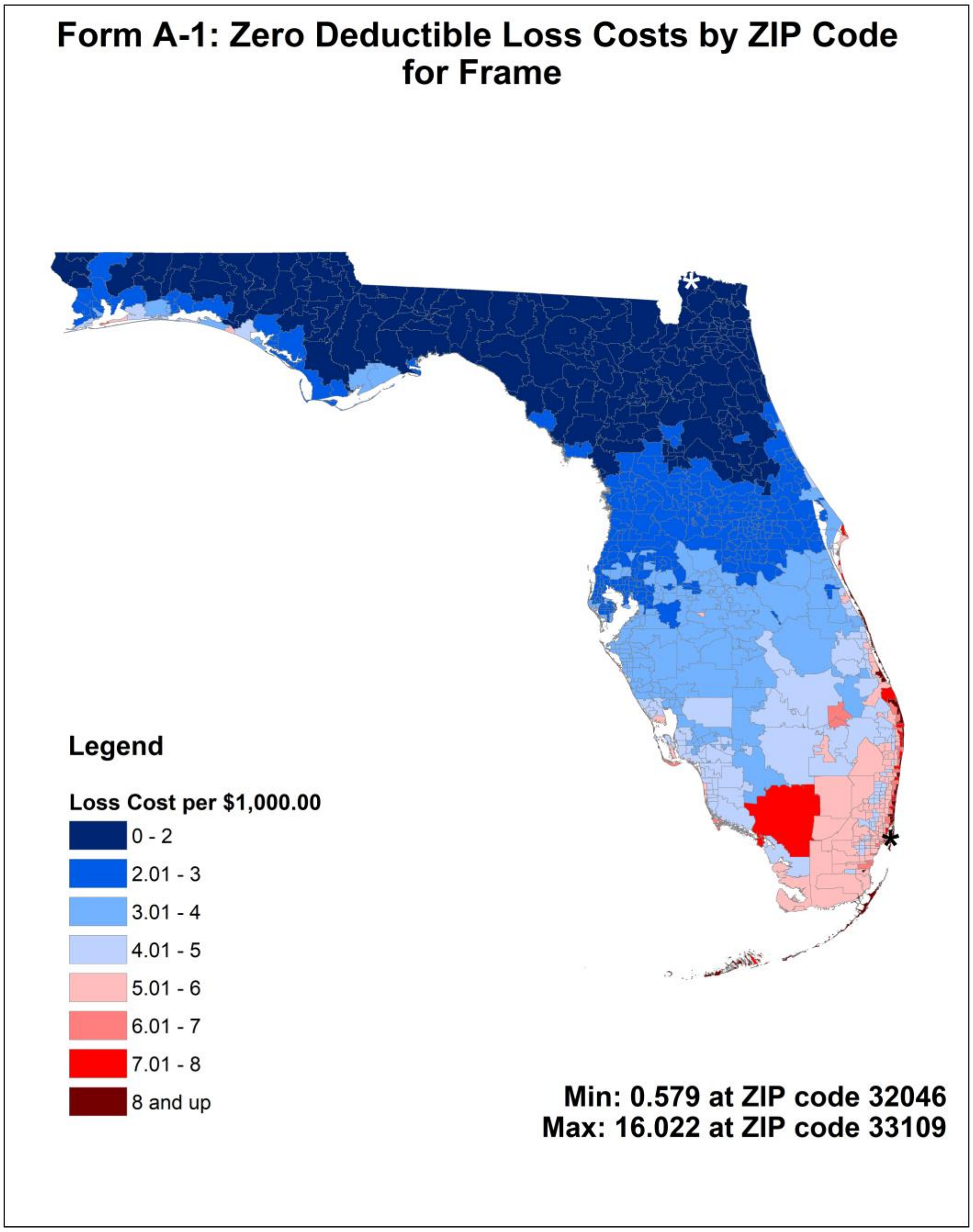


Figure 103. Zero deductible loss costs by ZIP code for frame.

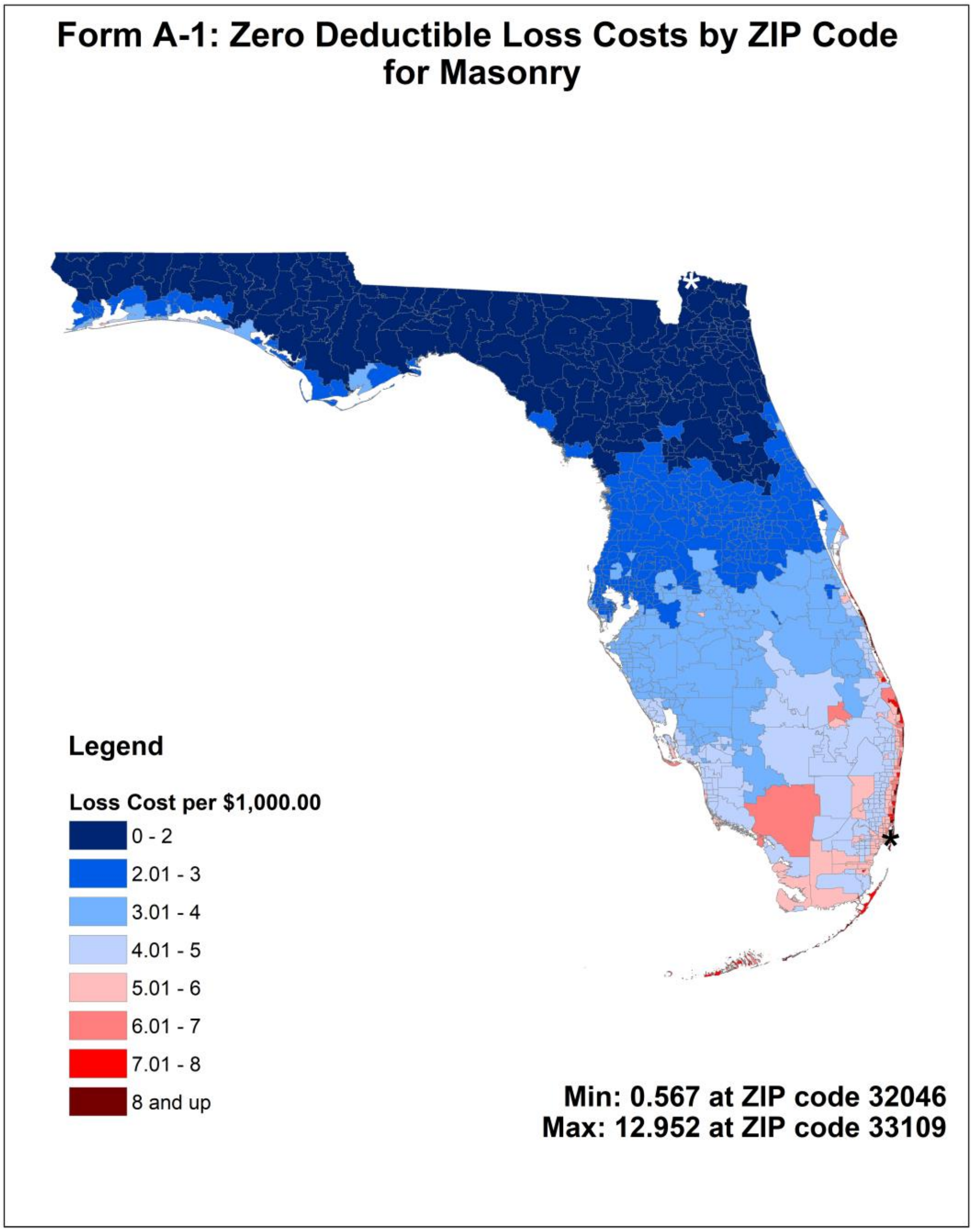


Figure 104. Zero deductible loss costs by ZIP code for masonry.

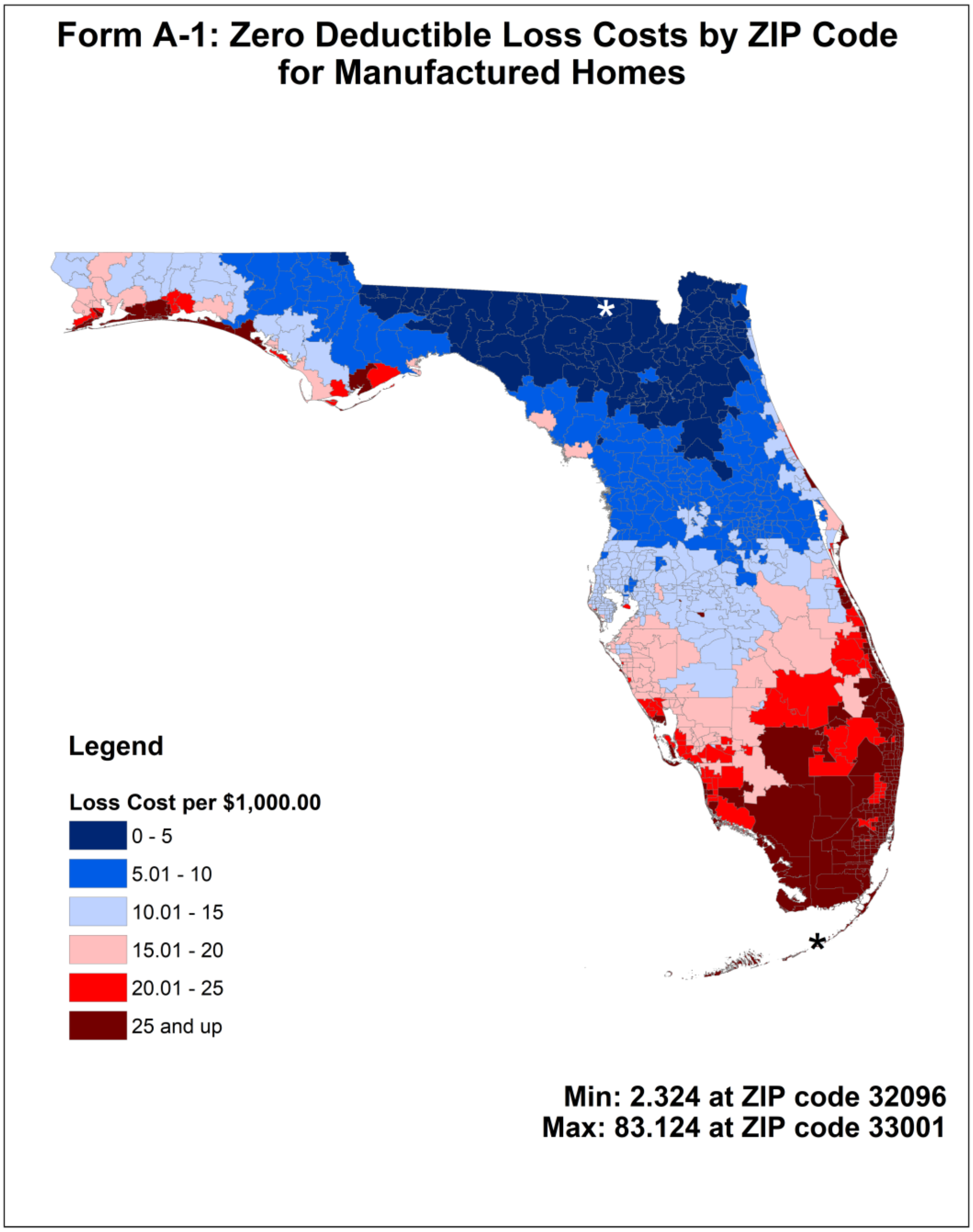


Figure 105. Zero deductible loss costs by ZIP code for manufactured home.

Appendix C – Form A-2: Base Hurricane Storm Set Statewide Hurricane Losses

Florida International University
Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021

Form A-2: Base Hurricane Storm Set Statewide Hurricane Losses
Modeling Organization: Florida International University
Model Name & Version Number: Florida Public Hurricane Loss Model 8.1 Platform NA
Model Release Date: May 24, 2021

ID	Hurricane Landfall/Closest Approach Date	Year	Name	Region as defined in Figure 3 - Category	Personal and Commercial Residential Insured Hurricane Losses ($)	Dollar Contribution
005	08/15/1901	1901	NoName04-1901	F-1	336,095,334	2,800,794
010	09/11/1903	1903	NoName03-1903	C-1/A-1	9,267,788,876	77,231,574
015	10/17/1904	1904	NoName04-1904	C-1	2,955,366,551	24,628,055
020	06/17/1906	1906	NoName02-1906	B-1	2,996,293,926	24,969,116
025	09/27/1906	1906	NoName06-1906	ByP-2/F-2	846,550,677	7,054,589
030	10/18/1906	1906	NoName08-1906	B-3	14,605,373,331	121,711,444
035	10/11/1909	1909	NoName11-1909	B-3	740,302,972	6,169,191
040	10/18/1910	1910	NoName05-1910	B-2	29,967,643,930	249,730,366
045	08/11/1911	1911	NoName02-1911	A-1	384,655,758	3,205,465
050	09/14/1912	1912	NoName04-1912	F-1/ByP-1	17,574,925	146,458
055	08/01/1915	1915	NoName01-1915	D-1	890,591,742	7,421,598
060	09/04/1915	1915	NoName04-1915	A-1	448,630,407	3,738,587
065	07/05/1916	1916	NoName02-1916	F-3/ByP-2	539,670,687	4,497,256
070	10/18/1916	1916	NoName14-1916	A-2	1,160,044,098	9,667,034
075	09/29/1917	1917	NoName04-1917	A-3	1,778,905,825	14,824,215
080	09/10/1919	1919	NoName02-1919	ByP-4	147,617,843	1,230,149
085	10/25/1921	1921	TampaBay06-1921	B-3	20,750,476,292	172,920,636
090	09/15/1924	1924	NoName05-1924	A-1	47,231,291	393,594
095	10/21/1924	1924	NoName10-1924	B-1	6,656,060,709	55,467,173
100	07/28/1926	1926	NoName01-1926	D-2	3,975,039,615	33,125,330
105	09/18/1926	1926	GreatMiami07-1926	C-4/A-3	34,601,021,423	288,341,845
110	10/21/1926	1926	NoName10-1926	ByP-3	2,661,103,894	22,175,866
115	08/08/1928	1928	NoName01-1928	C-2	4,368,720,620	36,406,005

ID	Hurricane Landfall/Closest Approach Date	Year	Name	Region as defined in Figure 3 - Category	Personal and Commercial Residential Insured Hurricane Losses ($)	Dollar Contribution
120	09/17/1928	1928	LakeOkeechobee04-1928	C-4	44,176,420,309	368,136,836
125	09/28/1929	1929	NoName02-1929	C-3/A-1	12,098,927,102	100,824,393
130	09/01/1932	1932	NoName03-1932	F-1/ByP-1	1,544,589,420	12,871,578
135	07/30/1933	1933	NoName05-1933	C-1	1,091,332,577	9,094,438
140	09/04/1933	1933	NoName11-1933	C-3	11,896,215,357	99,135,128
145	09/03/1935	1935	LaborDay03-1935	B-5/A-2	19,100,563,167	159,171,360
150	11/04/1935	1935	NoName07-1935	C-2	6,231,531,739	51,929,431
155	07/31/1936	1936	NoName05-1936	A-2	2,004,065,114	16,700,543
160	08/11/1939	1939	NoName02-1939	C-1/A-1	3,437,076,190	28,642,302
165	10/06/1941	1941	NoName05-1941	C-2/A-1	8,210,915,451	68,424,295
170	10/19/1944	1944	NoName13-1944	B-2	27,262,424,108	227,186,868
175	06/24/1945	1945	NoName01-1945	A-1	6,603,260,884	55,027,174
180	09/15/1945	1945	NoName09-1945	C-4	16,577,246,393	138,143,720
185	10/08/1946	1946	NoName06-1946	B-1	14,389,547,479	119,912,896
190	09/17/1947	1947	NoName04-1947	C-4	23,520,490,493	196,004,087
195	10/12/1947	1947	NoName09-1947	B-1/E-2	7,282,244,700	60,685,373
200	09/22/1948	1948	NoName08-1948	B-3	12,279,682,391	102,330,687
205	10/05/1948	1948	NoName09-1948	B-2	6,439,324,789	53,661,040
210	08/26/1949	1949	NoName02-1949	C-4	30,422,993,709	253,524,948
215	08/31/1950	1950	Baker-1950	F-1/ByP-1	589,520,765	4,912,673
220	09/05/1950	1950	Easy-1950	A-3	10,032,791,494	83,606,596
225	10/18/1950	1950	King-1950	C-4	16,133,393,857	134,444,949
230	09/26/1953	1953	Florence-1953	A-1	506,518,363	4,220,986
235	10/09/1953	1953	Hazel-1953	B-1	3,226,126,125	26,884,384
240	09/25/1956	1956	Flossy-1956	A-1	773,631,396	6,446,928
245	09/10/1960	1960	Donna-1960	B-4	23,209,966,087	193,416,384
250	09/15/1960	1960	Ethel-1960	F-1	205	2

ID	Hurricane Landfall/Closest Approach Date	Year	Name	Region as defined in Figure 3 - Category	Personal and Commercial Residential Insured Hurricane Losses ($)	Dollar Contribution
255	08/27/1964	1964	Cleo-1964	C-2	16,664,234,141	138,868,618
260	09/10/1964	1964	Dora-1964	D-2	3,913,125,223	32,609,377
265	10/14/1964	1964	Isbell-1964	B-2	7,472,291,177	62,269,093
270	09/08/1965	1965	Betsy-1965	C-3	4,154,923,605	34,624,363
275	06/09/1966	1966	Alma-1966	A-2	12,802,667,150	106,688,893
280	10/04/1966	1966	Inez-1966	B-1	245,700,981	2,047,508
285	10/19/1968	1968	Gladys-1968	A-1	5,239,628,971	43,663,575
290	08/18/1969	1969	Camille-1969	F-5	0	0
295	06/19/1972	1972	Agnes-1972	A-1	103,527,273	862,727
300	09/23/1975	1975	Eloise-1975	A-3	1,146,364,205	9,553,035
305	09/04/1979	1979	David-1979	C-2/E-2	8,739,690,369	72,830,753
310	09/13/1979	1979	Frederic-1979	ByP-3/F-3	1,106,663,760	9,222,198
315	09/02/1985	1985	Elena-1985	F-3/ByP-3	190,623,088	1,588,526
320	11/21/1985	1985	Kate-1985	A-2	473,560,621	3,946,339
325	10/12/1987	1987	Floyd-1987	B-1	205,676,653	1,713,972
330	08/24/1992	1992	Andrew-1992	C-5	15,110,522,287	125,921,019
335	08/03/1995	1995	Erin-1995	C-1/A-2	5,216,485,949	43,470,716
340	10/04/1995	1995	Opal-1995	A-3	2,899,696,687	24,164,139
345	07/19/1997	1997	Danny-1997	ByP-1/F-1	62,366,270	519,719
350	09/03/1998	1998	Earl-1998	A-1	11,451,367	95,428
355	09/25/1998	1998	Georges-1998	B-2/F-2	560,563,860	4,671,366
360	10/15/1999	1999	Irene-1999	B-1	4,707,429,632	39,228,580
365	08/13/2004	2004	Charley-2004	B-4	7,739,656,660	64,497,139
370	09/05/2004	2004	Frances-2004	C-2	11,792,940,545	98,274,505
375	09/16/2004	2004	Ivan-2004	F-3/ByP-3	669,992,667	5,583,272
380	09/26/2004	2004	Jeanne-2004	C-3	13,715,706,719	114,297,556
385	07/10/2005	2005	Dennis-2005	A-3	949,231,812	7,910,265

ID	Hurricane Landfall/Closest Approach Date	Year	Name	Region as defined in Figure 3 - Category	Personal and Commercial Residential Insured Hurricane Losses ($)	Dollar Contribution
390	08/25/2005	2005	Katrina-2005	C-1	3,627,177,655	30,226,480
395	09/20/2005	2005	Rita-2005	ByP-2	96,387,061	803,226
400	10/24/2005	2005	Wilma-2005	B-3	16,205,159,000	135,042,992
401	09/10/2008	2008	Ike-2008	ByP-1	406,701	3,389
405	09/02/2016	2016	Hermine-2016	A-1	137,104,899	1,142,541
410	10/07/2016	2016	Matthew-2016	ByP-3	4,615,828,432	38,465,237
415	09/10/2017	2017	Irma-2017	B-4	15,345,741,603	127,881,180
420	10/08/2017	2017	Nate-2017	F-1	N/A	N/A
425	10/10/2018	2018	Michael-2018	A-5	858,617,594	7,155,147
Total					**615,964,705,006**	**5,133,039,208**

Appendix D – Form A-3: Hurricane Losses

Florida International University
Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021 Form A-3: Hurricane Losses
Modeling Organization: Florida International University
Model Name & Version Number: Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32008	2,333,287	2.9268%	0	0.0000%	4,763,237	0.0312%	0	0.0000%
32024	0	0.0000%	0	0.0000%	21,484,845	0.1406%	0	0.0000%
32025	0	0.0000%	0	0.0000%	15,374,348	0.1006%	0	0.0000%
32038	0	0.0000%	0	0.0000%	8,910,420	0.0583%	0	0.0000%
32044	0	0.0000%	0	0.0000%	730,698	0.0048%	0	0.0000%
32052	0	0.0000%	0	0.0000%	4,277,477	0.0280%	0	0.0000%
32053	0	0.0000%	0	0.0000%	2,550,852	0.0167%	0	0.0000%
32054	0	0.0000%	0	0.0000%	4,283,905	0.0280%	0	0.0000%
32055	0	0.0000%	0	0.0000%	11,399,203	0.0746%	0	0.0000%
32059	0	0.0000%	0	0.0000%	1,590,443	0.0104%	0	0.0000%
32060	0	0.0000%	0	0.0000%	16,921,118	0.1107%	0	0.0000%
32062	0	0.0000%	0	0.0000%	2,109,895	0.0138%	0	0.0000%
32064	0	0.0000%	0	0.0000%	7,206,371	0.0472%	0	0.0000%
32066	0	0.0000%	0	0.0000%	3,069,576	0.0201%	0	0.0000%
32071	0	0.0000%	0	0.0000%	2,953,880	0.0193%	0	0.0000%
32080	0	0.0000%	36,817,873	0.7997%	0	0.0000%	0	0.0000%

ZIP Code	Hurricane Hermine (2016) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Hermine (2016) Percent of Losses (%)	Hurricane Matthew (2016) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Matthew (2016) Percent of Losses (%)	Hurricane Irma (2017) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Irma (2017) Percent of Losses (%)	Hurricane Michael (2018) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Michael (2018) Percent of Losses (%)
32082	0	0.0000%	70,042,048	1.5213%	0	0.0000%	0	0.0000%
32084	0	0.0000%	24,627,742	0.5349%	0	0.0000%	0	0.0000%
32086	0	0.0000%	25,204,311	0.5474%	0	0.0000%	0	0.0000%
32094	0	0.0000%	0	0.0000%	3,001,344	0.0196%	0	0.0000%
32095	0	0.0000%	13,022,508	0.2828%	0	0.0000%	0	0.0000%
32096	0	0.0000%	0	0.0000%	1,513,171	0.0099%	0	0.0000%
32110	0	0.0000%	3,000,598	0.0652%	0	0.0000%	0	0.0000%
32113	0	0.0000%	0	0.0000%	6,101,608	0.0399%	0	0.0000%
32114	0	0.0000%	31,294,592	0.6797%	0	0.0000%	0	0.0000%
32117	0	0.0000%	36,627,861	0.7955%	0	0.0000%	0	0.0000%
32118	0	0.0000%	49,823,989	1.0822%	0	0.0000%	0	0.0000%
32119	0	0.0000%	48,565,111	1.0548%	0	0.0000%	0	0.0000%
32124	0	0.0000%	6,305,896	0.1370%	0	0.0000%	0	0.0000%
32127	0	0.0000%	80,017,452	1.7379%	0	0.0000%	0	0.0000%
32128	0	0.0000%	50,802,988	1.1034%	0	0.0000%	0	0.0000%
32129	0	0.0000%	40,322,851	0.8758%	0	0.0000%	0	0.0000%
32132	0	0.0000%	18,634,816	0.4047%	0	0.0000%	0	0.0000%
32136	0	0.0000%	26,289,938	0.5710%	0	0.0000%	0	0.0000%
32137	0	0.0000%	101,340,215	2.2011%	0	0.0000%	0	0.0000%
32141	0	0.0000%	44,743,145	0.9718%	0	0.0000%	0	0.0000%
32159	0	0.0000%	0	0.0000%	87,706,845	0.5739%	0	0.0000%
32162	0	0.0000%	0	0.0000%	153,941,711	1.0074%	0	0.0000%
32163	0	0.0000%	0	0.0000%	57,059,501	0.3734%	0	0.0000%
32164	0	0.0000%	56,922,731	1.2363%	0	0.0000%	0	0.0000%

ZIP Code	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32168	0	0.0000%	66,489,733	1.4441%	0	0.0000%	0	0.0000%
32169	0	0.0000%	61,975,973	1.3461%	0	0.0000%	0	0.0000%
32174	0	0.0000%	129,386,088	2.8102%	0	0.0000%	0	0.0000%
32176	0	0.0000%	67,404,886	1.4640%	0	0.0000%	0	0.0000%
32179	0	0.0000%	0	0.0000%	6,558,043	0.0429%	0	0.0000%
32195	0	0.0000%	0	0.0000%	4,653,521	0.0305%	0	0.0000%
32233	0	0.0000%	603,370	0.0131%	0	0.0000%	0	0.0000%
32250	0	0.0000%	2,482,490	0.0539%	0	0.0000%	0	0.0000%
32266	0	0.0000%	7,531,927	0.1636%	0	0.0000%	0	0.0000%
32301	0	0.0000%	0	0.0000%	0	0.0000%	15,400,475	1.7936%
32303	0	0.0000%	0	0.0000%	0	0.0000%	32,826,794	3.8232%
32304	0	0.0000%	0	0.0000%	0	0.0000%	9,811,126	1.1427%
32305	0	0.0000%	0	0.0000%	0	0.0000%	7,189,205	0.8373%
32308	0	0.0000%	0	0.0000%	0	0.0000%	20,411,430	2.3772%
32309	0	0.0000%	0	0.0000%	0	0.0000%	36,124,851	4.2073%
32310	0	0.0000%	0	0.0000%	0	0.0000%	6,752,389	0.7864%
32311	0	0.0000%	0	0.0000%	0	0.0000%	16,094,040	1.8744%
32312	0	0.0000%	0	0.0000%	0	0.0000%	48,028,888	5.5937%
32317	0	0.0000%	0	0.0000%	0	0.0000%	13,814,709	1.6089%
32320	0	0.0000%	0	0.0000%	0	0.0000%	5,725,141	0.6668%
32321	0	0.0000%	0	0.0000%	0	0.0000%	10,311,937	1.2010%
32322	1,739,214	2.1816%	0	0.0000%	0	0.0000%	2,577,886	0.3002%
32324	0	0.0000%	0	0.0000%	0	0.0000%	7,912,813	0.9216%
32327	0	0.0000%	0	0.0000%	0	0.0000%	15,523,951	1.8080%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32328	5,065,437	6.3539%	0	0.0000%	0	0.0000%	10,337,695	1.2040%
32332	0	0.0000%	0	0.0000%	0	0.0000%	988,285	0.1151%
32333	0	0.0000%	0	0.0000%	0	0.0000%	11,598,029	1.3508%
32334	0	0.0000%	0	0.0000%	0	0.0000%	1,764,350	0.2055%
32340	0	0.0000%	0	0.0000%	6,551,984	0.0429%	0	0.0000%
32343	0	0.0000%	0	0.0000%	0	0.0000%	1,936,159	0.2255%
32346	2,334,707	2.9286%	0	0.0000%	0	0.0000%	2,615,224	0.3046%
32350	0	0.0000%	0	0.0000%	971,677	0.0064%	0	0.0000%
32351	0	0.0000%	0	0.0000%	0	0.0000%	14,655,763	1.7069%
32352	0	0.0000%	0	0.0000%	0	0.0000%	5,095,045	0.5934%
32358	0	0.0000%	0	0.0000%	0	0.0000%	1,623,725	0.1891%
32359	1,647,444	2.0665%	0	0.0000%	0	0.0000%	0	0.0000%
32401	0	0.0000%	0	0.0000%	0	0.0000%	39,926,846	4.6501%
32404	0	0.0000%	0	0.0000%	0	0.0000%	106,945,968	12.4556%
32405	0	0.0000%	0	0.0000%	0	0.0000%	50,469,463	5.8780%
32407	0	0.0000%	0	0.0000%	0	0.0000%	13,022,081	1.5166%
32408	0	0.0000%	0	0.0000%	0	0.0000%	34,409,450	4.0075%
32409	0	0.0000%	0	0.0000%	0	0.0000%	10,697,366	1.2459%
32410	0	0.0000%	0	0.0000%	0	0.0000%	2,966,640	0.3455%
32413	0	0.0000%	0	0.0000%	0	0.0000%	26,225,482	3.0544%
32420	0	0.0000%	0	0.0000%	0	0.0000%	3,778,956	0.4401%
32421	0	0.0000%	0	0.0000%	0	0.0000%	8,155,356	0.9498%
32423	0	0.0000%	0	0.0000%	0	0.0000%	1,828,391	0.2129%
32424	0	0.0000%	0	0.0000%	0	0.0000%	14,784,967	1.7220%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32428	0	0.0000%	0	0.0000%	0	0.0000%	9,372,973	1.0916%
32430	0	0.0000%	0	0.0000%	0	0.0000%	2,164,892	0.2521%
32431	0	0.0000%	0	0.0000%	0	0.0000%	3,460,832	0.4031%
32438	0	0.0000%	0	0.0000%	0	0.0000%	2,938,162	0.3422%
32442	0	0.0000%	0	0.0000%	0	0.0000%	8,060,382	0.9388%
32443	0	0.0000%	0	0.0000%	0	0.0000%	5,082,141	0.5919%
32444	0	0.0000%	0	0.0000%	0	0.0000%	44,098,608	5.1360%
32445	0	0.0000%	0	0.0000%	0	0.0000%	1,491,703	0.1737%
32446	0	0.0000%	0	0.0000%	0	0.0000%	17,494,450	2.0375%
32448	0	0.0000%	0	0.0000%	0	0.0000%	9,118,040	1.0619%
32449	0	0.0000%	0	0.0000%	0	0.0000%	984,346	0.1146%
32456	0	0.0000%	0	0.0000%	0	0.0000%	102,863,391	11.9801%
32460	0	0.0000%	0	0.0000%	0	0.0000%	10,755,794	1.2527%
32462	0	0.0000%	0	0.0000%	0	0.0000%	1,094,893	0.1275%
32465	0	0.0000%	0	0.0000%	0	0.0000%	14,881,552	1.7332%
32466	0	0.0000%	0	0.0000%	0	0.0000%	9,776,634	1.1386%
32601	0	0.0000%	0	0.0000%	17,343,199	0.1135%	0	0.0000%
32603	0	0.0000%	0	0.0000%	3,081,868	0.0202%	0	0.0000%
32605	0	0.0000%	0	0.0000%	37,057,907	0.2425%	0	0.0000%
32606	0	0.0000%	0	0.0000%	32,746,864	0.2143%	0	0.0000%
32607	0	0.0000%	0	0.0000%	30,580,847	0.2001%	0	0.0000%
32608	0	0.0000%	0	0.0000%	46,545,478	0.3046%	0	0.0000%
32609	0	0.0000%	0	0.0000%	9,879,859	0.0647%	0	0.0000%
32615	0	0.0000%	0	0.0000%	19,470,549	0.1274%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32617	0	0.0000%	0	0.0000%	5,916,874	0.0387%	0	0.0000%
32618	0	0.0000%	0	0.0000%	9,266,687	0.0606%	0	0.0000%
32619	0	0.0000%	0	0.0000%	3,426,860	0.0224%	0	0.0000%
32621	0	0.0000%	0	0.0000%	4,019,859	0.0263%	0	0.0000%
32622	0	0.0000%	0	0.0000%	1,007,394	0.0066%	0	0.0000%
32625	1,558,647	1.9551%	0	0.0000%	1,305,850	0.0085%	0	0.0000%
32626	0	0.0000%	0	0.0000%	6,379,960	0.0417%	0	0.0000%
32628	1,031,117	1.2934%	0	0.0000%	1,065,013	0.0070%	0	0.0000%
32631	0	0.0000%	0	0.0000%	512,693	0.0034%	0	0.0000%
32640	0	0.0000%	0	0.0000%	4,946,868	0.0324%	0	0.0000%
32641	0	0.0000%	0	0.0000%	6,293,827	0.0412%	0	0.0000%
32643	0	0.0000%	0	0.0000%	14,180,825	0.0928%	0	0.0000%
32653	509,507	0.6391%	0	0.0000%	21,109,904	0.1381%	0	0.0000%
32664	0	0.0000%	0	0.0000%	1,740,955	0.0114%	0	0.0000%
32667	0	0.0000%	0	0.0000%	5,990,284	0.0392%	0	0.0000%
32668	0	0.0000%	0	0.0000%	8,172,847	0.0535%	0	0.0000%
32669	0	0.0000%	0	0.0000%	21,289,969	0.1393%	0	0.0000%
32680	0	0.0000%	0	0.0000%	4,240,390	0.0277%	0	0.0000%
32686	0	0.0000%	0	0.0000%	9,875,883	0.0646%	0	0.0000%
32693	0	0.0000%	0	0.0000%	8,855,744	0.0580%	0	0.0000%
32694	0	0.0000%	0	0.0000%	864,012	0.0057%	0	0.0000%
32696	0	0.0000%	0	0.0000%	12,887,834	0.0843%	0	0.0000%
32707	0	0.0000%	1,129,164	0.0245%	0	0.0000%	0	0.0000%
32708	0	0.0000%	1,488,907	0.0323%	0	0.0000%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32709	0	0.0000%	1,842,864	0.0400%	0	0.0000%	0	0.0000%
32720	0	0.0000%	599,198	0.0130%	0	0.0000%	0	0.0000%
32724	0	0.0000%	27,695,737	0.6015%	0	0.0000%	0	0.0000%
32725	0	0.0000%	36,043,102	0.7828%	0	0.0000%	0	0.0000%
32726	0	0.0000%	0	0.0000%	14,674,003	0.0960%	0	0.0000%
32732	0	0.0000%	8,163,043	0.1773%	0	0.0000%	0	0.0000%
32735	0	0.0000%	0	0.0000%	5,802,915	0.0380%	0	0.0000%
32738	0	0.0000%	47,887,398	1.0401%	0	0.0000%	0	0.0000%
32744	0	0.0000%	2,519,265	0.0547%	0	0.0000%	0	0.0000%
32746	0	0.0000%	2,121,105	0.0461%	0	0.0000%	0	0.0000%
32754	0	0.0000%	20,770,613	0.4511%	0	0.0000%	0	0.0000%
32757	0	0.0000%	0	0.0000%	27,291,835	0.1786%	0	0.0000%
32759	0	0.0000%	4,357,086	0.0946%	0	0.0000%	0	0.0000%
32764	0	0.0000%	3,324,306	0.0722%	0	0.0000%	0	0.0000%
32765	0	0.0000%	56,604,954	1.2294%	0	0.0000%	0	0.0000%
32766	0	0.0000%	24,171,070	0.5250%	0	0.0000%	0	0.0000%
32771	0	0.0000%	40,940,080	0.8892%	0	0.0000%	0	0.0000%
32773	0	0.0000%	15,237,888	0.3310%	0	0.0000%	0	0.0000%
32778	0	0.0000%	0	0.0000%	26,234,793	0.1717%	0	0.0000%
32780	0	0.0000%	85,857,650	1.8648%	0	0.0000%	0	0.0000%
32784	0	0.0000%	0	0.0000%	7,009,343	0.0459%	0	0.0000%
32792	0	0.0000%	2,141,734	0.0465%	0	0.0000%	0	0.0000%
32796	0	0.0000%	47,048,196	1.0219%	0	0.0000%	0	0.0000%
32807	0	0.0000%	1,011,408	0.0220%	0	0.0000%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32808	0	0.0000%	0	0.0000%	2,039,778	0.0133%	0	0.0000%
32811	0	0.0000%	0	0.0000%	1,721,278	0.0113%	0	0.0000%
32817	0	0.0000%	21,242,323	0.4614%	0	0.0000%	0	0.0000%
32818	0	0.0000%	0	0.0000%	631,944	0.0041%	0	0.0000%
32819	0	0.0000%	0	0.0000%	34,153,186	0.2235%	0	0.0000%
32820	0	0.0000%	9,658,948	0.2098%	0	0.0000%	0	0.0000%
32821	0	0.0000%	0	0.0000%	9,362,555	0.0613%	0	0.0000%
32824	0	0.0000%	0	0.0000%	1,632,120	0.0107%	0	0.0000%
32825	0	0.0000%	1,097,921	0.0238%	0	0.0000%	0	0.0000%
32826	0	0.0000%	13,069,140	0.2839%	0	0.0000%	0	0.0000%
32828	0	0.0000%	50,623,934	1.0995%	0	0.0000%	0	0.0000%
32832	0	0.0000%	2,413,226	0.0524%	0	0.0000%	0	0.0000%
32833	0	0.0000%	11,383,708	0.2472%	0	0.0000%	0	0.0000%
32835	0	0.0000%	0	0.0000%	4,346,838	0.0284%	0	0.0000%
32836	0	0.0000%	0	0.0000%	49,411,364	0.3233%	0	0.0000%
32837	0	0.0000%	0	0.0000%	37,762,785	0.2471%	0	0.0000%
32901	0	0.0000%	31,247,186	0.6787%	0	0.0000%	0	0.0000%
32903	0	0.0000%	57,280,080	1.2441%	0	0.0000%	0	0.0000%
32904	0	0.0000%	54,448,564	1.1826%	0	0.0000%	0	0.0000%
32905	0	0.0000%	33,718,174	0.7323%	0	0.0000%	0	0.0000%
32907	0	0.0000%	64,710,975	1.4055%	0	0.0000%	0	0.0000%
32908	0	0.0000%	14,148,246	0.3073%	0	0.0000%	0	0.0000%
32909	0	0.0000%	44,026,198	0.9562%	0	0.0000%	0	0.0000%
32920	0	0.0000%	30,166,984	0.6552%	0	0.0000%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
32922	0	0.0000%	13,564,241	0.2946%	0	0.0000%	0	0.0000%
32926	0	0.0000%	39,842,395	0.8654%	0	0.0000%	0	0.0000%
32927	0	0.0000%	54,266,819	1.1787%	0	0.0000%	0	0.0000%
32931	0	0.0000%	72,194,137	1.5680%	0	0.0000%	0	0.0000%
32934	0	0.0000%	47,006,813	1.0210%	0	0.0000%	0	0.0000%
32935	0	0.0000%	75,611,393	1.6423%	0	0.0000%	0	0.0000%
32937	0	0.0000%	101,177,606	2.1975%	0	0.0000%	0	0.0000%
32940	0	0.0000%	117,351,897	2.5488%	0	0.0000%	0	0.0000%
32948	0	0.0000%	3,627,220	0.0788%	0	0.0000%	0	0.0000%
32949	0	0.0000%	7,187,530	0.1561%	0	0.0000%	0	0.0000%
32950	0	0.0000%	11,505,976	0.2499%	0	0.0000%	0	0.0000%
32951	0	0.0000%	51,274,185	1.1137%	664,051	0.0043%	0	0.0000%
32952	0	0.0000%	88,983,693	1.9327%	0	0.0000%	0	0.0000%
32953	0	0.0000%	70,731,625	1.5363%	0	0.0000%	0	0.0000%
32955	0	0.0000%	95,793,350	2.0806%	0	0.0000%	0	0.0000%
32958	0	0.0000%	55,991,255	1.2161%	0	0.0000%	0	0.0000%
32960	0	0.0000%	32,389,439	0.7035%	0	0.0000%	0	0.0000%
32962	0	0.0000%	39,345,787	0.8546%	0	0.0000%	0	0.0000%
32963	0	0.0000%	117,639,196	2.5551%	0	0.0000%	0	0.0000%
32966	0	0.0000%	24,142,013	0.5244%	0	0.0000%	0	0.0000%
32967	0	0.0000%	39,943,934	0.8676%	0	0.0000%	0	0.0000%
32968	0	0.0000%	29,329,794	0.6370%	0	0.0000%	0	0.0000%
32976	0	0.0000%	13,792,299	0.2996%	0	0.0000%	0	0.0000%
33001	0	0.0000%	0	0.0000%	1,541,395	0.0101%	0	0.0000%

ZIP Code	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33036	0	0.0000%	0	0.0000%	19,659,828	0.1286%	0	0.0000%
33037	0	0.0000%	0	0.0000%	23,408,173	0.1532%	0	0.0000%
33040	0	0.0000%	0	0.0000%	138,194,293	0.9043%	0	0.0000%
33042	0	0.0000%	0	0.0000%	117,461,963	0.7686%	0	0.0000%
33043	0	0.0000%	0	0.0000%	96,082,327	0.6287%	0	0.0000%
33050	0	0.0000%	0	0.0000%	67,582,014	0.4422%	0	0.0000%
33051	0	0.0000%	0	0.0000%	18,429,065	0.1206%	0	0.0000%
33052	0	0.0000%	0	0.0000%	1,397,120	0.0091%	0	0.0000%
33070	0	0.0000%	0	0.0000%	12,725,942	0.0833%	0	0.0000%
33109	0	0.0000%	0	0.0000%	3,292,984	0.0215%	0	0.0000%
33401	0	0.0000%	20,157,805	0.4378%	0	0.0000%	0	0.0000%
33403	0	0.0000%	7,232,361	0.1571%	0	0.0000%	0	0.0000%
33404	0	0.0000%	25,171,648	0.5467%	0	0.0000%	0	0.0000%
33405	0	0.0000%	9,811,333	0.2131%	0	0.0000%	0	0.0000%
33406	0	0.0000%	13,418,027	0.2914%	0	0.0000%	0	0.0000%
33407	0	0.0000%	16,901,251	0.3671%	0	0.0000%	0	0.0000%
33408	0	0.0000%	44,136,988	0.9586%	0	0.0000%	0	0.0000%
33409	0	0.0000%	14,099,442	0.3062%	0	0.0000%	0	0.0000%
33410	0	0.0000%	62,685,329	1.3615%	0	0.0000%	0	0.0000%
33411	0	0.0000%	8,503,948	0.1847%	0	0.0000%	0	0.0000%
33412	0	0.0000%	25,933,082	0.5633%	0	0.0000%	0	0.0000%
33413	0	0.0000%	10,611,672	0.2305%	0	0.0000%	0	0.0000%
33414	0	0.0000%	5,328,988	0.1157%	0	0.0000%	0	0.0000%
33415	0	0.0000%	7,153,704	0.1554%	0	0.0000%	0	0.0000%

ZIP Code	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33417	0	0.0000%	20,304,047	0.4410%	0	0.0000%	0	0.0000%
33418	0	0.0000%	111,860,129	2.4296%	0	0.0000%	0	0.0000%
33426	0	0.0000%	1,500,518	0.0326%	0	0.0000%	0	0.0000%
33435	0	0.0000%	6,416,614	0.1394%	0	0.0000%	0	0.0000%
33440	0	0.0000%	0	0.0000%	8,557,677	0.0560%	0	0.0000%
33455	0	0.0000%	62,880,889	1.3657%	0	0.0000%	0	0.0000%
33458	0	0.0000%	80,026,476	1.7381%	0	0.0000%	0	0.0000%
33460	0	0.0000%	11,030,189	0.2396%	0	0.0000%	0	0.0000%
33461	0	0.0000%	4,292,880	0.0932%	0	0.0000%	0	0.0000%
33462	0	0.0000%	3,199,686	0.0695%	0	0.0000%	0	0.0000%
33463	0	0.0000%	5,388,168	0.1170%	0	0.0000%	0	0.0000%
33467	0	0.0000%	4,194,867	0.0911%	0	0.0000%	0	0.0000%
33469	0	0.0000%	48,803,013	1.0600%	0	0.0000%	0	0.0000%
33471	0	0.0000%	0	0.0000%	5,811,666	0.0380%	0	0.0000%
33472	0	0.0000%	791,855	0.0172%	0	0.0000%	0	0.0000%
33477	0	0.0000%	51,802,263	1.1251%	0	0.0000%	0	0.0000%
33478	0	0.0000%	25,961,571	0.5639%	0	0.0000%	0	0.0000%
33480	0	0.0000%	104,956,524	2.2796%	0	0.0000%	0	0.0000%
33510	0	0.0000%	0	0.0000%	69,556,507	0.4552%	0	0.0000%
33511	0	0.0000%	0	0.0000%	123,183,241	0.8061%	0	0.0000%
33513	0	0.0000%	0	0.0000%	25,517,334	0.1670%	0	0.0000%
33514	0	0.0000%	0	0.0000%	2,676,823	0.0175%	0	0.0000%
33521	0	0.0000%	0	0.0000%	1,158,889	0.0076%	0	0.0000%
33523	0	0.0000%	0	0.0000%	34,570,318	0.2262%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33525	0	0.0000%	0	0.0000%	45,310,874	0.2965%	0	0.0000%
33527	0	0.0000%	0	0.0000%	32,574,272	0.2132%	0	0.0000%
33534	0	0.0000%	0	0.0000%	13,209,100	0.0864%	0	0.0000%
33538	0	0.0000%	0	0.0000%	13,193,813	0.0863%	0	0.0000%
33540	0	0.0000%	0	0.0000%	21,823,869	0.1428%	0	0.0000%
33541	0	0.0000%	0	0.0000%	48,096,888	0.3147%	0	0.0000%
33542	0	0.0000%	0	0.0000%	65,975,559	0.4317%	0	0.0000%
33543	0	0.0000%	0	0.0000%	69,267,440	0.4533%	0	0.0000%
33544	0	0.0000%	0	0.0000%	52,185,502	0.3415%	0	0.0000%
33545	0	0.0000%	0	0.0000%	27,501,476	0.1800%	0	0.0000%
33547	0	0.0000%	0	0.0000%	58,587,054	0.3834%	0	0.0000%
33548	0	0.0000%	0	0.0000%	25,254,621	0.1653%	0	0.0000%
33549	0	0.0000%	0	0.0000%	49,303,429	0.3226%	0	0.0000%
33556	0	0.0000%	0	0.0000%	50,988,008	0.3337%	0	0.0000%
33558	0	0.0000%	0	0.0000%	54,493,959	0.3566%	0	0.0000%
33559	0	0.0000%	0	0.0000%	30,965,964	0.2026%	0	0.0000%
33563	0	0.0000%	0	0.0000%	39,640,234	0.2594%	0	0.0000%
33565	0	0.0000%	0	0.0000%	47,468,201	0.3106%	0	0.0000%
33566	0	0.0000%	0	0.0000%	56,476,856	0.3696%	0	0.0000%
33567	0	0.0000%	0	0.0000%	21,739,724	0.1423%	0	0.0000%
33569	0	0.0000%	0	0.0000%	64,349,199	0.4211%	0	0.0000%
33570	0	0.0000%	0	0.0000%	19,348,828	0.1266%	0	0.0000%
33572	0	0.0000%	0	0.0000%	46,135,862	0.3019%	0	0.0000%
33573	0	0.0000%	0	0.0000%	85,598,593	0.5601%	0	0.0000%

ZIP Code	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33576	0	0.0000%	0	0.0000%	13,430,009	0.0879%	0	0.0000%
33578	0	0.0000%	0	0.0000%	68,532,308	0.4485%	0	0.0000%
33579	0	0.0000%	0	0.0000%	46,778,769	0.3061%	0	0.0000%
33584	0	0.0000%	0	0.0000%	53,979,676	0.3532%	0	0.0000%
33585	0	0.0000%	0	0.0000%	2,696,331	0.0176%	0	0.0000%
33592	0	0.0000%	0	0.0000%	20,057,661	0.1313%	0	0.0000%
33594	0	0.0000%	0	0.0000%	89,964,097	0.5887%	0	0.0000%
33596	0	0.0000%	0	0.0000%	107,440,774	0.7031%	0	0.0000%
33597	0	0.0000%	0	0.0000%	15,683,512	0.1026%	0	0.0000%
33598	0	0.0000%	0	0.0000%	20,998,429	0.1374%	0	0.0000%
33602	0	0.0000%	0	0.0000%	21,163,493	0.1385%	0	0.0000%
33603	0	0.0000%	0	0.0000%	23,498,096	0.1538%	0	0.0000%
33604	0	0.0000%	0	0.0000%	35,826,976	0.2344%	0	0.0000%
33605	0	0.0000%	0	0.0000%	12,292,983	0.0804%	0	0.0000%
33606	0	0.0000%	0	0.0000%	42,733,135	0.2796%	0	0.0000%
33607	0	0.0000%	0	0.0000%	14,078,129	0.0921%	0	0.0000%
33609	0	0.0000%	0	0.0000%	22,324,848	0.1461%	0	0.0000%
33610	0	0.0000%	0	0.0000%	35,975,829	0.2354%	0	0.0000%
33611	0	0.0000%	0	0.0000%	28,056,606	0.1836%	0	0.0000%
33612	0	0.0000%	0	0.0000%	43,391,098	0.2839%	0	0.0000%
33613	0	0.0000%	0	0.0000%	50,077,340	0.3277%	0	0.0000%
33614	0	0.0000%	0	0.0000%	26,643,225	0.1743%	0	0.0000%
33615	0	0.0000%	0	0.0000%	1,786,840	0.0117%	0	0.0000%
33616	0	0.0000%	0	0.0000%	13,212,863	0.0865%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33617	0	0.0000%	0	0.0000%	74,562,488	0.4879%	0	0.0000%
33618	0	0.0000%	0	0.0000%	59,609,695	0.3901%	0	0.0000%
33619	0	0.0000%	0	0.0000%	35,215,623	0.2304%	0	0.0000%
33624	0	0.0000%	0	0.0000%	45,591,030	0.2983%	0	0.0000%
33625	0	0.0000%	0	0.0000%	17,655,694	0.1155%	0	0.0000%
33626	0	0.0000%	0	0.0000%	1,398,197	0.0091%	0	0.0000%
33629	0	0.0000%	0	0.0000%	62,833,423	0.4112%	0	0.0000%
33634	0	0.0000%	0	0.0000%	10,762,706	0.0704%	0	0.0000%
33637	0	0.0000%	0	0.0000%	20,832,149	0.1363%	0	0.0000%
33647	0	0.0000%	0	0.0000%	171,103,996	1.1197%	0	0.0000%
33706	0	0.0000%	0	0.0000%	0	0.0000%	0	0.0000%
33708	5,359,336	6.7225%	0	0.0000%	0	0.0000%	0	0.0000%
33767	19,957,887	25.0343%	0	0.0000%	0	0.0000%	0	0.0000%
33772	0	0.0000%	0	0.0000%	0	0.0000%	0	0.0000%
33774	0	0.0000%	0	0.0000%	0	0.0000%	0	0.0000%
33776	0	0.0000%	0	0.0000%	0	0.0000%	0	0.0000%
33785	0	0.0000%	0	0.0000%	0	0.0000%	0	0.0000%
33801	0	0.0000%	0	0.0000%	77,281,342	0.5057%	0	0.0000%
33802	0	0.0000%	0	0.0000%	979,151	0.0064%	0	0.0000%
33803	0	0.0000%	0	0.0000%	142,248,585	0.9308%	0	0.0000%
33805	0	0.0000%	0	0.0000%	53,939,479	0.3530%	0	0.0000%
33809	0	0.0000%	0	0.0000%	114,764,996	0.7510%	0	0.0000%
33810	0	0.0000%	0	0.0000%	137,268,331	0.8983%	0	0.0000%
33811	0	0.0000%	0	0.0000%	67,396,399	0.4410%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33812	0	0.0000%	0	0.0000%	42,078,838	0.2754%	0	0.0000%
33813	0	0.0000%	0	0.0000%	160,674,468	1.0514%	0	0.0000%
33815	0	0.0000%	0	0.0000%	18,869,632	0.1235%	0	0.0000%
33823	0	0.0000%	0	0.0000%	73,761,958	0.4827%	0	0.0000%
33825	0	0.0000%	0	0.0000%	49,698,516	0.3252%	0	0.0000%
33827	0	0.0000%	0	0.0000%	7,808,624	0.0511%	0	0.0000%
33830	0	0.0000%	0	0.0000%	81,263,626	0.5318%	0	0.0000%
33834	0	0.0000%	0	0.0000%	10,114,595	0.0662%	0	0.0000%
33835	0	0.0000%	0	0.0000%	1,289,575	0.0084%	0	0.0000%
33837	0	0.0000%	0	0.0000%	44,010,735	0.2880%	0	0.0000%
33838	0	0.0000%	0	0.0000%	6,361,116	0.0416%	0	0.0000%
33839	0	0.0000%	0	0.0000%	6,801,320	0.0445%	0	0.0000%
33841	0	0.0000%	0	0.0000%	21,023,327	0.1376%	0	0.0000%
33843	0	0.0000%	0	0.0000%	17,817,675	0.1166%	0	0.0000%
33844	0	0.0000%	0	0.0000%	55,912,637	0.3659%	0	0.0000%
33846	0	0.0000%	0	0.0000%	508,315	0.0033%	0	0.0000%
33847	0	0.0000%	0	0.0000%	1,405,748	0.0092%	0	0.0000%
33849	0	0.0000%	0	0.0000%	1,541,279	0.0101%	0	0.0000%
33850	0	0.0000%	0	0.0000%	18,111,629	0.1185%	0	0.0000%
33851	0	0.0000%	0	0.0000%	1,538,714	0.0101%	0	0.0000%
33852	0	0.0000%	0	0.0000%	67,541,324	0.4420%	0	0.0000%
33853	0	0.0000%	0	0.0000%	19,561,033	0.1280%	0	0.0000%
33854	0	0.0000%	0	0.0000%	634,252	0.0042%	0	0.0000%
33855	0	0.0000%	0	0.0000%	1,874,239	0.0123%	0	0.0000%

ZIP Code	Hurricane Hermine (2016) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Hermine (2016) Percent of Losses (%)	Hurricane Matthew (2016) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Matthew (2016) Percent of Losses (%)	Hurricane Irma (2017) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Irma (2017) Percent of Losses (%)	Hurricane Michael (2018) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Michael (2018) Percent of Losses (%)
33857	0	0.0000%	0	0.0000%	2,213,777	0.0145%	0	0.0000%
33859	0	0.0000%	0	0.0000%	20,025,173	0.1310%	0	0.0000%
33860	0	0.0000%	0	0.0000%	57,896,289	0.3789%	0	0.0000%
33865	0	0.0000%	0	0.0000%	2,242,716	0.0147%	0	0.0000%
33868	0	0.0000%	0	0.0000%	24,719,719	0.1618%	0	0.0000%
33870	0	0.0000%	0	0.0000%	47,237,032	0.3091%	0	0.0000%
33872	0	0.0000%	0	0.0000%	40,519,048	0.2651%	0	0.0000%
33873	0	0.0000%	0	0.0000%	29,592,246	0.1936%	0	0.0000%
33875	0	0.0000%	0	0.0000%	33,666,915	0.2203%	0	0.0000%
33876	0	0.0000%	0	0.0000%	13,474,448	0.0882%	0	0.0000%
33877	0	0.0000%	0	0.0000%	504,852	0.0033%	0	0.0000%
33880	0	0.0000%	0	0.0000%	85,325,958	0.5584%	0	0.0000%
33881	0	0.0000%	0	0.0000%	79,935,176	0.5231%	0	0.0000%
33884	0	0.0000%	0	0.0000%	101,464,682	0.6640%	0	0.0000%
33890	0	0.0000%	0	0.0000%	14,703,770	0.0962%	0	0.0000%
33896	0	0.0000%	0	0.0000%	21,559,200	0.1411%	0	0.0000%
33897	0	0.0000%	0	0.0000%	27,875,485	0.1824%	0	0.0000%
33898	0	0.0000%	0	0.0000%	33,612,079	0.2200%	0	0.0000%
33901	0	0.0000%	0	0.0000%	62,329,207	0.4079%	0	0.0000%
33903	0	0.0000%	0	0.0000%	102,985,374	0.6739%	0	0.0000%
33904	0	0.0000%	0	0.0000%	168,614,130	1.1034%	0	0.0000%
33905	0	0.0000%	0	0.0000%	97,463,465	0.6378%	0	0.0000%
33907	0	0.0000%	0	0.0000%	74,130,901	0.4851%	0	0.0000%
33908	0	0.0000%	0	0.0000%	206,616,786	1.3521%	0	0.0000%

ZIP Code	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33909	0	0.0000%	0	0.0000%	55,704,430	0.3645%	0	0.0000%
33912	0	0.0000%	0	0.0000%	130,455,408	0.8537%	0	0.0000%
33913	0	0.0000%	0	0.0000%	116,693,011	0.7636%	0	0.0000%
33914	0	0.0000%	0	0.0000%	153,763,071	1.0062%	0	0.0000%
33916	0	0.0000%	0	0.0000%	28,644,922	0.1874%	0	0.0000%
33917	0	0.0000%	0	0.0000%	109,805,633	0.7185%	0	0.0000%
33919	0	0.0000%	0	0.0000%	194,538,607	1.2730%	0	0.0000%
33920	0	0.0000%	0	0.0000%	28,122,250	0.1840%	0	0.0000%
33921	0	0.0000%	0	0.0000%	29,174,259	0.1909%	0	0.0000%
33922	0	0.0000%	0	0.0000%	11,372,289	0.0744%	0	0.0000%
33924	0	0.0000%	0	0.0000%	11,872,747	0.0777%	0	0.0000%
33928	0	0.0000%	0	0.0000%	134,699,737	0.8814%	0	0.0000%
33930	0	0.0000%	0	0.0000%	1,353,960	0.0089%	0	0.0000%
33931	0	0.0000%	0	0.0000%	84,996,907	0.5562%	0	0.0000%
33935	0	0.0000%	0	0.0000%	36,963,375	0.2419%	0	0.0000%
33936	0	0.0000%	0	0.0000%	89,756,779	0.5873%	0	0.0000%
33946	0	0.0000%	0	0.0000%	14,147,938	0.0926%	0	0.0000%
33947	0	0.0000%	0	0.0000%	20,162,692	0.1319%	0	0.0000%
33948	0	0.0000%	0	0.0000%	50,004,484	0.3272%	0	0.0000%
33950	0	0.0000%	0	0.0000%	118,366,060	0.7746%	0	0.0000%
33952	0	0.0000%	0	0.0000%	91,523,885	0.5989%	0	0.0000%
33953	0	0.0000%	0	0.0000%	14,116,623	0.0924%	0	0.0000%
33954	0	0.0000%	0	0.0000%	31,758,044	0.2078%	0	0.0000%
33955	0	0.0000%	0	0.0000%	41,389,217	0.2708%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
33956	0	0.0000%	0	0.0000%	15,313,007	0.1002%	0	0.0000%
33957	0	0.0000%	0	0.0000%	66,507,033	0.4352%	0	0.0000%
33960	0	0.0000%	0	0.0000%	1,723,688	0.0113%	0	0.0000%
33966	0	0.0000%	0	0.0000%	45,394,487	0.2971%	0	0.0000%
33967	0	0.0000%	0	0.0000%	84,766,388	0.5547%	0	0.0000%
33971	0	0.0000%	0	0.0000%	44,942,034	0.2941%	0	0.0000%
33972	0	0.0000%	0	0.0000%	42,308,400	0.2769%	0	0.0000%
33973	0	0.0000%	0	0.0000%	10,047,734	0.0658%	0	0.0000%
33974	0	0.0000%	0	0.0000%	28,412,022	0.1859%	0	0.0000%
33976	0	0.0000%	0	0.0000%	21,959,955	0.1437%	0	0.0000%
33980	0	0.0000%	0	0.0000%	31,640,415	0.2070%	0	0.0000%
33981	0	0.0000%	0	0.0000%	19,406,400	0.1270%	0	0.0000%
33982	0	0.0000%	0	0.0000%	37,034,479	0.2423%	0	0.0000%
33983	0	0.0000%	0	0.0000%	63,069,221	0.4127%	0	0.0000%
33990	0	0.0000%	0	0.0000%	93,623,430	0.6127%	0	0.0000%
33991	0	0.0000%	0	0.0000%	59,136,448	0.3870%	0	0.0000%
33993	0	0.0000%	0	0.0000%	50,904,879	0.3331%	0	0.0000%
34102	0	0.0000%	0	0.0000%	165,720,172	1.0844%	0	0.0000%
34103	0	0.0000%	0	0.0000%	133,378,545	0.8728%	0	0.0000%
34104	0	0.0000%	0	0.0000%	107,531,746	0.7037%	0	0.0000%
34105	0	0.0000%	0	0.0000%	147,166,446	0.9630%	0	0.0000%
34108	0	0.0000%	0	0.0000%	254,233,949	1.6637%	0	0.0000%
34109	0	0.0000%	0	0.0000%	175,483,413	1.1483%	0	0.0000%
34110	0	0.0000%	0	0.0000%	234,871,951	1.5370%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
34112	0	0.0000%	0	0.0000%	202,047,835	1.3222%	0	0.0000%
34113	0	0.0000%	0	0.0000%	138,202,861	0.9044%	0	0.0000%
34114	0	0.0000%	0	0.0000%	84,456,780	0.5527%	0	0.0000%
34116	0	0.0000%	0	0.0000%	89,808,782	0.5877%	0	0.0000%
34117	0	0.0000%	0	0.0000%	77,860,786	0.5095%	0	0.0000%
34119	0	0.0000%	0	0.0000%	242,082,682	1.5841%	0	0.0000%
34120	0	0.0000%	0	0.0000%	192,770,204	1.2614%	0	0.0000%
34134	0	0.0000%	0	0.0000%	250,063,719	1.6364%	0	0.0000%
34135	0	0.0000%	0	0.0000%	259,475,779	1.6980%	0	0.0000%
34138	0	0.0000%	0	0.0000%	1,296,019	0.0085%	0	0.0000%
34139	0	0.0000%	0	0.0000%	3,833,167	0.0251%	0	0.0000%
34140	0	0.0000%	0	0.0000%	2,795,946	0.0183%	0	0.0000%
34142	0	0.0000%	0	0.0000%	17,248,150	0.1129%	0	0.0000%
34145	3,113,772	3.9058%	0	0.0000%	230,626,571	1.5092%	0	0.0000%
34202	11,283,375	14.1534%	0	0.0000%	47,635,816	0.3117%	0	0.0000%
34211	0	0.0000%	0	0.0000%	14,432,774	0.0944%	0	0.0000%
34212	0	0.0000%	0	0.0000%	30,149,583	0.1973%	0	0.0000%
34215	0	0.0000%	0	0.0000%	0	0.0000%	0	0.0000%
34216	20,818,519	26.1138%	0	0.0000%	0	0.0000%	0	0.0000%
34217	0	0.0000%	0	0.0000%	0	0.0000%	0	0.0000%
34219	0	0.0000%	0	0.0000%	28,232,747	0.1847%	0	0.0000%
34223	0	0.0000%	0	0.0000%	35,512,804	0.2324%	0	0.0000%
34224	0	0.0000%	0	0.0000%	22,287,510	0.1458%	0	0.0000%
34228	1,900,475	2.3839%	0	0.0000%	21,515,500	0.1408%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
34229	0	0.0000%	0	0.0000%	16,666,951	0.1091%	0	0.0000%
34231	0	0.0000%	0	0.0000%	5,993,127	0.0392%	0	0.0000%
34236	0	0.0000%	0	0.0000%	2,864,920	0.0187%	0	0.0000%
34239	0	0.0000%	0	0.0000%	824,618	0.0054%	0	0.0000%
34242	0	0.0000%	0	0.0000%	1,908,839	0.0125%	0	0.0000%
34251	0	0.0000%	0	0.0000%	13,621,280	0.0891%	0	0.0000%
34266	0	0.0000%	0	0.0000%	64,362,225	0.4212%	0	0.0000%
34269	0	0.0000%	0	0.0000%	19,194,078	0.1256%	0	0.0000%
34275	0	0.0000%	0	0.0000%	27,640,426	0.1809%	0	0.0000%
34285	0	0.0000%	0	0.0000%	19,995,355	0.1308%	0	0.0000%
34286	0	0.0000%	0	0.0000%	32,795,212	0.2146%	0	0.0000%
34287	0	0.0000%	0	0.0000%	30,137,789	0.1972%	0	0.0000%
34288	0	0.0000%	0	0.0000%	22,777,573	0.1491%	0	0.0000%
34289	0	0.0000%	0	0.0000%	4,446,748	0.0291%	0	0.0000%
34291	0	0.0000%	0	0.0000%	9,197,889	0.0602%	0	0.0000%
34292	0	0.0000%	0	0.0000%	3,061,439	0.0200%	0	0.0000%
34293	0	0.0000%	0	0.0000%	5,073,174	0.0332%	0	0.0000%
34420	0	0.0000%	0	0.0000%	25,818,715	0.1690%	0	0.0000%
34428	0	0.0000%	0	0.0000%	20,660,875	0.1352%	0	0.0000%
34429	0	0.0000%	0	0.0000%	29,448,966	0.1927%	0	0.0000%
34431	0	0.0000%	0	0.0000%	25,092,307	0.1642%	0	0.0000%
34432	0	0.0000%	0	0.0000%	37,827,072	0.2475%	0	0.0000%
34433	0	0.0000%	0	0.0000%	16,075,935	0.1052%	0	0.0000%
34434	0	0.0000%	0	0.0000%	21,413,943	0.1401%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
34436	0	0.0000%	0	0.0000%	25,005,806	0.1636%	0	0.0000%
34442	0	0.0000%	0	0.0000%	57,119,252	0.3738%	0	0.0000%
34446	0	0.0000%	0	0.0000%	53,396,549	0.3494%	0	0.0000%
34448	0	0.0000%	0	0.0000%	23,918,964	0.1565%	0	0.0000%
34449	0	0.0000%	0	0.0000%	2,882,267	0.0189%	0	0.0000%
34450	0	0.0000%	0	0.0000%	38,692,139	0.2532%	0	0.0000%
34452	0	0.0000%	0	0.0000%	33,323,969	0.2181%	0	0.0000%
34453	0	0.0000%	0	0.0000%	29,326,478	0.1919%	0	0.0000%
34461	0	0.0000%	0	0.0000%	34,345,966	0.2248%	0	0.0000%
34465	0	0.0000%	0	0.0000%	61,242,956	0.4008%	0	0.0000%
34470	0	0.0000%	0	0.0000%	30,336,195	0.1985%	0	0.0000%
34471	0	0.0000%	0	0.0000%	74,098,364	0.4849%	0	0.0000%
34472	0	0.0000%	0	0.0000%	43,617,324	0.2854%	0	0.0000%
34473	0	0.0000%	0	0.0000%	38,488,179	0.2519%	0	0.0000%
34474	0	0.0000%	0	0.0000%	26,680,309	0.1746%	0	0.0000%
34475	0	0.0000%	0	0.0000%	11,344,996	0.0742%	0	0.0000%
34476	0	0.0000%	0	0.0000%	72,693,865	0.4757%	0	0.0000%
34479	0	0.0000%	0	0.0000%	25,420,329	0.1663%	0	0.0000%
34480	0	0.0000%	0	0.0000%	46,137,749	0.3019%	0	0.0000%
34481	0	0.0000%	0	0.0000%	57,822,922	0.3784%	0	0.0000%
34482	0	0.0000%	0	0.0000%	48,367,233	0.3165%	0	0.0000%
34484	0	0.0000%	0	0.0000%	10,309,219	0.0675%	0	0.0000%
34488	0	0.0000%	0	0.0000%	6,343,943	0.0415%	0	0.0000%
34491	0	0.0000%	0	0.0000%	62,817,954	0.4111%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
34498	0	0.0000%	0	0.0000%	961,425	0.0063%	0	0.0000%
34601	0	0.0000%	0	0.0000%	42,694,761	0.2794%	0	0.0000%
34602	0	0.0000%	0	0.0000%	18,271,495	0.1196%	0	0.0000%
34604	0	0.0000%	0	0.0000%	18,720,663	0.1225%	0	0.0000%
34606	0	0.0000%	0	0.0000%	68,101,786	0.4456%	0	0.0000%
34607	0	0.0000%	0	0.0000%	27,739,396	0.1815%	0	0.0000%
34608	0	0.0000%	0	0.0000%	79,349,778	0.5192%	0	0.0000%
34609	0	0.0000%	0	0.0000%	97,727,494	0.6395%	0	0.0000%
34610	0	0.0000%	0	0.0000%	20,216,589	0.1323%	0	0.0000%
34613	0	0.0000%	0	0.0000%	47,655,605	0.3118%	0	0.0000%
34614	0	0.0000%	0	0.0000%	11,757,207	0.0769%	0	0.0000%
34637	0	0.0000%	0	0.0000%	13,496,541	0.0883%	0	0.0000%
34638	0	0.0000%	0	0.0000%	38,163,837	0.2497%	0	0.0000%
34639	0	0.0000%	0	0.0000%	70,509,529	0.4614%	0	0.0000%
34652	0	0.0000%	0	0.0000%	17,565,569	0.1149%	0	0.0000%
34653	0	0.0000%	0	0.0000%	17,380,437	0.1137%	0	0.0000%
34654	0	0.0000%	0	0.0000%	24,584,589	0.1609%	0	0.0000%
34655	0	0.0000%	0	0.0000%	44,330,199	0.2901%	0	0.0000%
34667	0	0.0000%	0	0.0000%	49,228,032	0.3221%	0	0.0000%
34668	0	0.0000%	0	0.0000%	37,135,989	0.2430%	0	0.0000%
34669	0	0.0000%	0	0.0000%	14,465,047	0.0947%	0	0.0000%
34688	0	0.0000%	0	0.0000%	1,123,630	0.0074%	0	0.0000%
34705	0	0.0000%	0	0.0000%	2,008,443	0.0131%	0	0.0000%
34711	0	0.0000%	0	0.0000%	121,787,422	0.7970%	0	0.0000%

ZIP Code	Hurricane Hermine (2016) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Hermine (2016) Percent of Losses (%)	Hurricane Matthew (2016) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Matthew (2016) Percent of Losses (%)	Hurricane Irma (2017) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Irma (2017) Percent of Losses (%)	Hurricane Michael (2018) Personal & Commercial Residential Monetary Contribution ($)	Hurricane Michael (2018) Percent of Losses (%)
34714	0	0.0000%	0	0.0000%	23,038,495	0.1508%	0	0.0000%
34715	0	0.0000%	0	0.0000%	23,370,601	0.1529%	0	0.0000%
34731	0	0.0000%	0	0.0000%	21,590,780	0.1413%	0	0.0000%
34734	0	0.0000%	0	0.0000%	4,667,809	0.0305%	0	0.0000%
34736	0	0.0000%	0	0.0000%	33,729,202	0.2207%	0	0.0000%
34737	0	0.0000%	0	0.0000%	9,219,012	0.0603%	0	0.0000%
34741	0	0.0000%	0	0.0000%	3,626,573	0.0237%	0	0.0000%
34743	0	0.0000%	0	0.0000%	925,549	0.0061%	0	0.0000%
34744	0	0.0000%	0	0.0000%	36,336,325	0.2378%	0	0.0000%
34746	0	0.0000%	0	0.0000%	52,377,217	0.3427%	0	0.0000%
34747	0	0.0000%	0	0.0000%	50,824,462	0.3326%	0	0.0000%
34748	0	0.0000%	0	0.0000%	78,253,670	0.5121%	0	0.0000%
34753	0	0.0000%	0	0.0000%	6,581,062	0.0431%	0	0.0000%
34756	0	0.0000%	0	0.0000%	7,831,880	0.0513%	0	0.0000%
34758	0	0.0000%	0	0.0000%	34,989,636	0.2290%	0	0.0000%
34759	0	0.0000%	0	0.0000%	36,283,329	0.2374%	0	0.0000%
34760	0	0.0000%	0	0.0000%	995,082	0.0065%	0	0.0000%
34761	0	0.0000%	0	0.0000%	33,428,642	0.2187%	0	0.0000%
34762	0	0.0000%	0	0.0000%	1,346,765	0.0088%	0	0.0000%
34773	0	0.0000%	2,676,511	0.0581%	0	0.0000%	0	0.0000%
34785	0	0.0000%	0	0.0000%	23,260,542	0.1522%	0	0.0000%
34786	0	0.0000%	0	0.0000%	114,546,326	0.7496%	0	0.0000%
34787	0	0.0000%	0	0.0000%	76,846,234	0.5029%	0	0.0000%
34788	0	0.0000%	0	0.0000%	26,201,697	0.1715%	0	0.0000%

	Hurricane Hermine (2016)		Hurricane Matthew (2016)		Hurricane Irma (2017)		Hurricane Michael (2018)	
ZIP Code	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)	Personal & Commercial Residential Monetary Contribution ($)	Percent of Losses (%)
34797	0	0.0000%	0	0.0000%	3,823,405	0.0250%	0	0.0000%
34945	0	0.0000%	5,300,691	0.1151%	0	0.0000%	0	0.0000%
34946	0	0.0000%	4,773,255	0.1037%	0	0.0000%	0	0.0000%
34947	0	0.0000%	5,643,371	0.1226%	0	0.0000%	0	0.0000%
34949	0	0.0000%	26,822,116	0.5826%	0	0.0000%	0	0.0000%
34950	0	0.0000%	7,861,229	0.1707%	0	0.0000%	0	0.0000%
34951	0	0.0000%	20,225,666	0.4393%	0	0.0000%	0	0.0000%
34952	0	0.0000%	56,881,281	1.2354%	0	0.0000%	0	0.0000%
34953	0	0.0000%	67,988,294	1.4767%	0	0.0000%	0	0.0000%
34957	0	0.0000%	45,990,104	0.9989%	0	0.0000%	0	0.0000%
34974	0	0.0000%	0	0.0000%	583,620	0.0038%	0	0.0000%
34981	0	0.0000%	4,745,394	0.1031%	0	0.0000%	0	0.0000%
34982	0	0.0000%	27,090,437	0.5884%	0	0.0000%	0	0.0000%
34983	0	0.0000%	56,298,524	1.2228%	0	0.0000%	0	0.0000%
34984	0	0.0000%	20,293,129	0.4408%	0	0.0000%	0	0.0000%
34986	0	0.0000%	44,526,501	0.9671%	0	0.0000%	0	0.0000%
34987	78,652,723		12,964,069	0.2816%	0	0.0000%	0	0.0000%
34990	2,333,287	2.9268%	61,520,905	1.3362%	0	0.0000%	0	0.0000%
34994	0	0.0000%	22,792,487	0.4950%	0	0.0000%	0	0.0000%
34996	0	0.0000%	42,303,653	0.9188%	0	0.0000%	0	0.0000%
34997	0	0.0000%	75,417,878	1.6380%	0	0.0000%	0	0.0000%
	0	0.0000%	4,599,834,867		15,268,340,711		855,969,669	

Appendix E – Form A-4: Hurricane Output Ranges

Florida International University
Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021

Form A-4 Hurricane Output Ranges
Hurricane Loss Costs per $1000 for 0% Deductible
Modeling Organization: Florida International University
Model Name & Version Number: Florida Public Hurricane Loss Model 8.1 Platform NA
Model Release Date: May 24, 2021

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Alachua	LOW	0.758	0.888	0.887	0.176	0.166	0.237	0.226	0.083
	AVERAGE	0.925	0.967	2.474	0.191	0.181	0.272	0.258	1.480
	HIGH	1.184	1.157	4.900	0.264	0.233	0.284	0.303	1.670
Baker	LOW	0.641	0.651	1.200	0.147	0.128	NA	NA	1.282
	AVERAGE	0.687	0.691	1.627	0.152	0.141	NA	NA	1.282
	HIGH	0.749	0.701	1.888	0.160	0.145	NA	NA	1.282
Bay	LOW	1.325	1.448	3.570	0.377	0.297	0.486	0.487	0.792
	AVERAGE	2.546	2.649	8.957	0.634	0.556	1.321	0.890	4.962
	HIGH	3.464	3.904	23.095	1.008	0.812	1.706	0.978	6.301
Bradford	LOW	0.724	0.721	1.652	0.161	0.133	NA	NA	NA
	AVERAGE	0.859	0.865	2.080	0.199	0.174	NA	NA	NA
	HIGH	1.127	1.154	2.584	0.294	0.301	NA	NA	NA
Brevard	LOW	2.443	1.930	2.227	0.319	0.250	0.482	0.428	2.306
	AVERAGE	3.866	3.855	13.620	0.656	0.724	1.037	1.332	4.663
	HIGH	10.403	8.532	31.138	4.038	2.318	3.944	3.790	8.539
Broward	LOW	2.334	2.321	2.562	0.527	0.506	0.649	0.659	0.222
	AVERAGE	5.754	4.768	19.573	0.916	0.935	1.554	1.711	5.121
	HIGH	13.872	12.396	37.530	3.545	2.650	4.856	3.515	9.169

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Calhoun	LOW	1.149	1.135	3.321	0.208	0.266	NA	NA	NA
	AVERAGE	1.279	1.278	3.494	0.242	0.267	NA	NA	NA
	HIGH	1.393	1.519	3.615	0.315	0.280	NA	NA	NA
Charlotte	LOW	3.252	3.134	2.052	0.425	0.455	0.592	0.709	0.639
	AVERAGE	4.047	3.692	8.329	0.544	0.517	1.046	0.793	2.939
	HIGH	5.050	4.806	27.104	0.755	0.848	1.371	1.250	3.931
Citrus	LOW	2.032	1.900	3.714	0.243	0.254	0.448	0.330	2.033
	AVERAGE	2.353	2.099	4.620	0.284	0.274	0.515	0.500	2.288
	HIGH	2.881	2.668	6.153	0.436	0.320	0.561	0.614	2.724
Clay	LOW	0.712	0.749	0.815	0.142	0.141	0.191	0.176	1.347
	AVERAGE	0.801	0.821	2.024	0.169	0.163	0.221	0.204	1.417
	HIGH	0.993	0.998	3.777	0.216	0.208	0.262	0.249	2.038
Collier	LOW	2.496	2.538	5.409	0.513	0.489	0.565	0.557	1.434
	AVERAGE	4.879	4.182	13.379	0.694	0.674	1.215	1.211	2.111
	HIGH	10.753	9.452	43.487	2.310	2.152	3.123	2.767	3.277
Columbia	LOW	0.643	0.607	0.923	0.104	0.145	0.252	0.237	2.375
	AVERAGE	0.829	0.828	1.836	0.181	0.168	0.259	0.241	2.375
	HIGH	0.910	0.886	2.024	0.247	0.189	0.269	0.252	2.375
De Soto	LOW	3.724	3.686	7.492	0.510	0.482	0.783	0.744	2.845
	AVERAGE	3.899	3.754	7.709	0.542	0.496	0.833	0.837	3.077
	HIGH	6.209	5.186	16.600	0.597	0.744	0.842	0.838	3.092

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Dixie	LOW	1.096	1.034	3.055	0.232	0.238	0.266	0.251	1.463
	AVERAGE	1.256	1.075	3.370	0.248	0.251	0.413	0.360	1.867
	HIGH	2.518	2.078	12.271	0.253	0.373	0.522	0.494	2.536
Duval	LOW	0.618	0.616	0.726	0.132	0.128	0.176	0.162	1.130
	AVERAGE	0.824	0.818	2.002	0.180	0.171	0.232	0.257	1.408
	HIGH	1.642	1.677	10.599	0.447	0.572	0.473	0.425	2.648
Escambia	LOW	1.685	1.752	4.796	0.419	0.393	0.508	0.443	3.440
	AVERAGE	2.744	2.813	9.641	0.745	0.710	1.121	1.043	5.637
	HIGH	4.169	4.427	31.469	1.319	1.054	1.498	1.463	6.535
Flagler	LOW	1.583	1.459	2.850	0.221	0.213	0.267	0.260	1.476
	AVERAGE	2.184	1.787	5.418	0.311	0.277	0.592	0.442	1.883
	HIGH	5.044	3.601	8.303	0.819	0.743	1.138	0.859	2.959
Franklin	LOW	2.555	3.094	10.655	1.035	0.763	0.577	0.544	5.413
	AVERAGE	2.999	3.258	13.950	1.128	0.889	0.750	0.797	5.413
	HIGH	3.233	3.533	18.189	1.215	1.015	1.513	1.089	5.413
Gadsden	LOW	0.710	0.739	1.849	0.189	0.166	NA	NA	1.469
	AVERAGE	0.880	0.893	2.371	0.211	0.190	NA	NA	1.669
	HIGH	1.300	1.279	4.572	0.290	0.208	NA	NA	2.429
Gilchrist	LOW	0.936	0.916	2.349	0.190	0.183	NA	NA	NA
	AVERAGE	1.030	1.027	2.811	0.234	0.224	NA	NA	NA
	HIGH	1.066	1.077	3.060	0.240	0.240	NA	NA	NA
Glades	LOW	3.902	2.343	8.193	0.716	0.569	NA	NA	5.255

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	5.098	4.218	11.592	0.716	0.569	NA	NA	5.255
	HIGH	5.125	4.262	11.717	0.716	0.569	NA	NA	5.255
Gulf	LOW	1.519	1.654	4.664	0.335	0.472	0.579	0.493	3.721
	AVERAGE	1.986	2.214	7.183	0.643	0.594	0.579	0.493	3.721
	HIGH	2.067	2.346	11.827	0.684	0.626	0.579	0.493	3.721
Hamilton	LOW	0.579	0.573	1.171	0.129	0.103	NA	NA	NA
	AVERAGE	0.656	0.659	1.325	0.152	0.143	NA	NA	NA
	HIGH	0.712	0.708	1.403	0.161	0.151	NA	NA	NA
Hardee	LOW	3.565	3.438	6.753	0.429	0.450	1.133	NA	4.592
	AVERAGE	3.638	3.516	7.190	0.469	0.482	1.133	NA	4.592
	HIGH	3.854	3.538	7.639	0.614	0.573	1.133	NA	4.592
Hendry	LOW	3.837	2.807	6.190	0.494	0.467	0.841	0.796	4.364
	AVERAGE	4.377	4.182	11.084	0.722	0.677	1.169	1.189	5.219
	HIGH	5.407	5.124	12.925	0.887	0.976	1.215	1.294	5.593
Hernando	LOW	1.992	1.580	1.298	0.269	0.258	0.533	0.331	2.339
	AVERAGE	2.396	2.206	6.127	0.292	0.285	0.585	0.575	2.676
	HIGH	2.790	3.025	8.315	0.463	0.358	0.630	0.766	3.115
Highlands	LOW	2.937	1.778	1.977	0.410	0.393	0.725	0.697	2.775
	AVERAGE	3.584	3.417	9.005	0.481	0.450	0.764	0.795	3.009
	HIGH	4.940	4.788	12.668	0.862	0.699	0.835	0.938	3.876
Hillsborough	LOW	1.877	1.585	1.675	0.305	0.312	0.404	0.396	1.762
	AVERAGE	2.565	2.818	7.451	0.363	0.360	0.591	0.600	2.409

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	HIGH	3.920	6.027	16.274	0.616	0.648	0.947	0.735	3.270
Holmes	LOW	1.222	1.057	3.825	0.305	0.288	NA	NA	2.704
	AVERAGE	1.402	1.427	3.860	0.320	0.309	NA	NA	2.704
	HIGH	1.403	1.429	3.936	0.328	0.314	NA	NA	2.704
Indian River	LOW	2.994	2.328	2.812	0.348	0.342	0.883	0.723	3.477
	AVERAGE	5.823	4.668	13.347	1.661	1.107	2.157	2.149	5.153
	HIGH	10.963	7.827	24.337	3.319	2.432	4.587	3.118	7.693
Jackson	LOW	0.979	0.994	2.153	0.220	0.204	NA	NA	1.832
	AVERAGE	1.159	1.166	3.141	0.270	0.249	NA	NA	2.460
	HIGH	1.409	1.438	3.933	0.341	0.395	NA	NA	2.607
Jefferson	LOW	0.756	0.655	1.647	0.171	0.142	NA	NA	NA
	AVERAGE	0.766	0.759	1.872	0.177	0.166	NA	NA	NA
	HIGH	0.865	0.837	2.816	0.179	0.169	NA	NA	NA
Lafayette	LOW	0.860	0.854	0.814	0.204	0.170	NA	NA	NA
	AVERAGE	0.861	0.854	2.019	0.204	0.170	NA	NA	NA
	HIGH	0.861	0.892	2.020	0.204	0.170	NA	NA	NA
Lake	LOW	1.704	1.631	3.134	0.191	0.180	0.359	0.346	1.926
	AVERAGE	2.173	2.022	5.434	0.275	0.263	0.508	0.469	2.323
	HIGH	2.982	4.024	9.176	0.384	0.338	0.549	0.532	3.315
Lee	LOW	2.179	2.113	2.211	0.391	0.380	0.593	0.577	2.827
	AVERAGE	4.978	3.568	13.693	0.560	0.531	1.140	0.922	3.438
	HIGH	8.478	8.309	39.569	1.826	1.600	2.850	2.345	6.909

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Leon	LOW	0.827	0.815	0.932	0.168	0.150	0.213	0.201	0.065
	AVERAGE	0.891	0.895	2.704	0.191	0.177	0.243	0.242	1.479
	HIGH	1.159	1.038	5.153	0.231	0.243	0.294	0.283	1.637
Levy	LOW	1.021	0.948	2.695	0.250	0.222	0.839	0.775	2.292
	AVERAGE	1.350	1.211	3.326	0.294	0.277	0.839	0.775	3.614
	HIGH	2.441	2.416	10.162	0.738	0.772	0.839	0.775	4.452
Liberty	LOW	1.074	1.052	2.902	0.256	0.271	NA	NA	NA
	AVERAGE	1.175	1.192	3.258	0.256	0.271	NA	NA	NA
	HIGH	1.179	1.197	3.613	0.258	0.271	NA	NA	NA
Madison	LOW	0.611	0.597	1.385	0.114	0.118	NA	NA	NA
	AVERAGE	0.718	0.708	1.717	0.154	0.142	NA	NA	NA
	HIGH	0.748	0.729	1.990	0.165	0.168	NA	NA	NA
Manatee	LOW	2.488	2.132	1.790	0.378	0.373	0.483	0.502	1.369
	AVERAGE	3.671	3.045	9.969	0.496	0.513	1.166	1.307	3.057
	HIGH	10.011	8.460	34.309	1.891	1.658	2.782	2.575	7.125
Marion	LOW	1.677	0.934	1.034	0.213	0.190	0.286	0.337	1.155
	AVERAGE	2.004	1.738	3.810	0.243	0.230	0.393	0.423	1.916
	HIGH	3.360	2.964	6.330	0.366	0.368	0.646	0.487	2.647
Martin	LOW	4.074	3.429	12.478	0.609	0.577	1.385	1.249	4.573
	AVERAGE	6.594	5.656	26.343	1.443	1.336	2.787	1.996	6.103
	HIGH	9.596	10.504	39.564	2.770	2.863	3.431	2.859	8.535

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Miami-Dade	LOW	2.503	2.396	2.636	0.448	0.481	0.658	0.630	0.286
	AVERAGE	5.989	5.067	19.704	1.445	1.336	2.643	2.432	6.048
	HIGH	14.588	10.578	40.454	9.596	5.086	7.575	5.997	10.462
Monroe	LOW	7.503	6.790	55.749	2.392	1.312	3.085	2.095	9.875
	AVERAGE	8.801	8.421	66.188	3.437	1.918	4.235	2.686	12.085
	HIGH	13.550	10.878	82.185	6.754	3.419	6.643	4.001	16.995
Nassau	LOW	0.549	0.546	1.075	0.115	0.105	0.315	0.307	1.518
	AVERAGE	0.906	0.889	1.927	0.213	0.198	0.315	0.307	1.518
	HIGH	1.040	1.075	3.480	0.239	0.223	0.315	0.307	1.518
Okaloosa	LOW	1.456	1.502	2.431	0.373	0.346	0.406	0.728	2.602
	AVERAGE	3.180	3.216	6.900	0.954	0.883	1.488	1.355	5.865
	HIGH	5.526	5.719	30.318	2.061	1.852	1.973	1.480	8.312
Okeechobee	LOW	4.035	2.907	9.487	0.635	0.536	0.570	0.849	3.651
	AVERAGE	4.508	4.156	13.133	0.656	0.608	0.655	0.927	4.434
	HIGH	5.511	4.484	18.212	0.667	0.663	0.877	0.928	4.434
Orange	LOW	1.337	1.294	1.323	0.214	0.234	0.332	0.334	0.157
	AVERAGE	2.097	2.310	5.275	0.286	0.280	0.461	0.470	1.938
	HIGH	3.719	2.966	8.743	0.380	0.325	0.710	0.739	2.397
Osceola	LOW	1.855	1.815	4.930	0.280	0.286	0.416	0.402	1.260
	AVERAGE	2.086	2.305	6.459	0.299	0.301	0.518	0.462	2.102
	HIGH	4.234	3.597	9.864	0.828	0.473	0.606	0.571	3.052

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Palm Beach	LOW	2.789	2.574	2.757	0.575	0.561	0.684	0.666	3.166
	AVERAGE	6.856	5.661	21.090	1.556	1.244	2.422	2.205	5.647
	HIGH	13.435	11.402	46.530	5.378	3.754	6.723	4.954	9.942
Pasco	LOW	1.688	1.633	1.659	0.283	0.292	0.405	0.410	1.443
	AVERAGE	2.194	2.438	6.212	0.320	0.335	0.530	0.577	2.288
	HIGH	4.512	3.539	11.180	0.444	0.468	0.730	0.697	2.521
Pinellas	LOW	1.557	1.458	5.528	0.326	0.336	0.429	0.487	1.237
	AVERAGE	3.306	3.544	10.088	0.429	0.455	0.833	0.854	2.796
	HIGH	5.236	5.869	19.336	1.330	1.020	1.543	1.278	3.984
Polk	LOW	1.515	1.549	1.704	0.255	0.243	0.348	0.335	2.010
	AVERAGE	2.847	2.741	7.235	0.357	0.370	0.532	0.586	2.684
	HIGH	6.218	5.656	22.837	0.945	1.134	0.885	0.951	3.946
Putnam	LOW	0.896	0.878	2.017	0.196	0.183	0.240	0.227	1.862
	AVERAGE	1.036	1.019	3.020	0.230	0.211	0.309	0.279	1.926
	HIGH	1.236	1.204	4.397	0.279	0.251	0.369	0.345	2.383
St. Johns	LOW	0.722	0.731	1.516	0.151	0.139	0.194	0.183	0.739
	AVERAGE	1.091	1.247	3.445	0.302	0.272	0.459	0.448	1.922
	HIGH	1.899	1.805	10.811	0.555	0.434	0.658	0.555	2.610
St. Lucie	LOW	3.867	2.160	2.394	0.501	0.403	0.585	0.568	2.567
	AVERAGE	4.952	3.332	17.183	0.700	0.656	2.049	2.048	5.479
	HIGH	10.908	8.787	44.917	3.133	2.358	4.138	2.883	7.303
Santa Rosa	LOW	1.819	1.789	6.808	0.476	0.443	0.593	0.610	3.157

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	3.066	2.908	11.085	1.063	1.029	2.022	1.503	6.974
	HIGH	6.373	5.845	24.452	2.864	2.233	2.951	1.682	9.661
Sarasota	LOW	1.875	1.825	1.913	0.402	0.406	0.509	0.494	1.821
	AVERAGE	4.000	3.582	13.509	0.560	0.529	0.987	0.969	3.021
	HIGH	6.107	6.094	21.392	1.177	1.046	1.686	1.653	4.012
Seminole	LOW	1.253	1.545	3.786	0.253	0.215	0.332	0.322	0.240
	AVERAGE	2.210	2.239	5.463	0.274	0.267	0.456	0.458	1.878
	HIGH	2.548	2.693	7.500	0.337	0.349	0.512	0.555	2.222
Sumter	LOW	1.236	1.200	2.221	0.222	0.211	0.360	0.349	2.056
	AVERAGE	1.405	1.366	5.400	0.241	0.233	0.433	0.370	2.129
	HIGH	3.006	2.745	6.621	0.393	0.340	0.515	0.510	2.802
Suwannee	LOW	0.694	0.687	1.522	0.150	0.117	NA	NA	1.280
	AVERAGE	0.763	0.756	1.691	0.167	0.150	NA	NA	1.654
	HIGH	0.894	0.876	2.082	0.215	0.217	NA	NA	1.756
Taylor	LOW	0.896	0.901	2.104	0.202	0.179	0.214	0.305	2.263
	AVERAGE	0.966	0.929	2.976	0.208	0.185	0.314	0.305	2.263
	HIGH	1.239	1.321	5.237	0.228	0.277	0.322	0.305	2.263
Union	LOW	0.842	0.842	0.925	0.184	0.176	NA	NA	NA
	AVERAGE	0.848	0.848	1.788	0.188	0.183	NA	NA	NA
	HIGH	0.988	0.939	2.490	0.243	0.199	NA	NA	NA
Volusia	LOW	1.062	1.363	1.196	0.214	0.214	0.319	0.319	0.018
	AVERAGE	2.707	2.491	5.869	0.385	0.380	0.857	1.058	3.382

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	HIGH	5.354	5.274	25.178	1.075	0.978	1.668	1.258	4.918
Wakulla	LOW	0.921	0.951	1.795	0.208	0.200	0.297	0.822	1.656
	AVERAGE	1.084	1.117	3.225	0.240	0.297	0.533	0.822	2.422
	HIGH	2.078	2.595	11.842	0.562	0.596	0.666	0.822	4.174
Walton	LOW	1.580	1.524	1.641	0.338	0.311	0.500	0.805	1.610
	AVERAGE	2.732	2.579	7.406	0.789	0.693	1.609	1.153	5.981
	HIGH	3.980	3.639	28.272	1.551	1.254	1.996	1.292	8.084
Washington	LOW	1.349	1.386	3.463	0.340	0.318	0.356	NA	2.492
	AVERAGE	1.370	1.415	3.600	0.345	0.328	0.356	NA	2.492
	HIGH	1.805	1.704	6.560	0.436	0.443	0.356	NA	2.492
Statewide	LOW	0.549	0.546	0.726	0.104	0.103	0.176	0.162	0.018
	AVERAGE	2.415	3.531	7.564	0.465	0.665	0.857	1.478	4.284
	HIGH	14.588	12.396	82.185	9.596	5.086	7.575	5.997	16.995

Hurricane Loss Costs per $1,000 with Specified Deductibles
Florida International University
Florida Public Hurricane Loss Model Version 8.1 Platform NA
May 24, 2021

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Alachua	LOW	0.093	0.175	0.184	0.035	0.031	0.033	0.030	0.000
	AVERAGE	0.186	0.217	1.527	0.039	0.037	0.042	0.038	0.124
	HIGH	0.327	0.331	3.650	0.067	0.056	0.045	0.061	0.163
Baker	LOW	0.113	0.121	0.569	0.031	0.024	NA	NA	0.150
	AVERAGE	0.124	0.127	0.939	0.032	0.029	NA	NA	0.150
	HIGH	0.171	0.129	1.151	0.034	0.031	NA	NA	0.150
Bay	LOW	0.304	0.393	2.344	0.082	0.065	0.084	0.080	0.135
	AVERAGE	1.017	1.117	7.208	0.263	0.204	0.681	0.322	1.774
	HIGH	1.697	2.082	20.592	0.566	0.402	1.017	0.401	2.601
Bradford	LOW	0.142	0.141	0.936	0.034	0.025	NA	NA	NA
	AVERAGE	0.182	0.188	1.249	0.046	0.037	NA	NA	NA
	HIGH	0.254	0.274	1.667	0.082	0.097	NA	NA	NA
Brevard	LOW	1.093	0.491	0.751	0.081	0.047	0.074	0.064	0.338
	AVERAGE	2.113	2.116	11.631	0.319	0.374	0.417	0.599	1.502
	HIGH	7.625	5.864	28.344	3.339	1.713	2.895	2.548	4.098
Broward	LOW	0.587	0.577	0.755	0.143	0.142	0.102	0.109	0.001
	AVERAGE	3.364	2.506	17.024	0.473	0.478	0.705	0.802	1.604
	HIGH	10.552	9.344	34.375	2.889	2.014	3.636	2.401	4.271

Calhoun	LOW	0.265	0.257	2.212	0.038	0.058	NA	NA	NA
	AVERAGE	0.333	0.337	2.337	0.051	0.063	NA	NA	NA
	HIGH	0.370	0.467	2.400	0.084	0.064	NA	NA	NA
Charlotte	LOW	1.429	1.322	0.540	0.097	0.119	0.088	0.107	0.040
	AVERAGE	2.012	1.762	6.350	0.167	0.153	0.285	0.150	0.195
	HIGH	2.739	2.583	24.186	0.313	0.396	0.492	0.390	0.464
Citrus	LOW	0.833	0.730	2.460	0.050	0.055	0.058	0.044	0.141
	AVERAGE	1.066	0.893	3.289	0.064	0.062	0.077	0.069	0.236
	HIGH	1.425	1.257	4.643	0.154	0.082	0.099	0.126	0.354
Clay	LOW	0.115	0.128	0.170	0.027	0.028	0.026	0.023	0.146
	AVERAGE	0.150	0.167	1.203	0.035	0.034	0.032	0.029	0.162
	HIGH	0.231	0.231	2.669	0.048	0.046	0.041	0.036	0.302
Collier	LOW	0.703	0.786	3.428	0.134	0.137	0.083	0.083	0.036
	AVERAGE	2.566	2.015	11.013	0.255	0.244	0.375	0.366	0.248
	HIGH	7.584	6.584	40.204	1.648	1.485	1.823	1.464	0.805
Columbia	LOW	0.126	0.103	0.366	0.018	0.028	0.038	0.035	0.164
	AVERAGE	0.165	0.166	1.034	0.039	0.035	0.039	0.035	0.164
	HIGH	0.230	0.196	1.188	0.069	0.043	0.041	0.036	0.164
De Soto	LOW	1.779	1.814	5.592	0.127	0.137	0.123	0.109	0.165
	AVERAGE	1.946	1.833	5.788	0.164	0.145	0.164	0.152	0.167
	HIGH	3.967	2.936	14.158	0.187	0.318	0.171	0.152	0.201
Dixie	LOW	0.257	0.214	2.054	0.049	0.060	0.037	0.034	0.050
	AVERAGE	0.352	0.249	2.302	0.060	0.063	0.073	0.060	0.087
	HIGH	1.058	0.669	10.314	0.064	0.093	0.101	0.093	0.148

Duval	LOW	0.075	0.071	0.148	0.025	0.025	0.024	0.021	0.089
	AVERAGE	0.184	0.195	1.254	0.044	0.042	0.040	0.049	0.159
	HIGH	0.631	0.664	9.045	0.201	0.329	0.150	0.120	0.653
Escambia	LOW	0.554	0.330	3.478	0.137	0.096	0.082	0.067	0.584
	AVERAGE	1.179	1.223	7.855	0.345	0.320	0.488	0.424	2.106
	HIGH	2.282	2.660	28.730	0.819	0.587	0.792	0.798	2.706
Flagler	LOW	0.587	0.497	1.833	0.047	0.045	0.036	0.035	0.079
	AVERAGE	0.987	0.701	4.087	0.104	0.081	0.161	0.096	0.166
	HIGH	3.220	1.967	6.819	0.485	0.409	0.541	0.292	0.488
Franklin	LOW	1.120	1.540	8.786	0.643	0.388	0.127	0.114	1.874
	AVERAGE	1.434	1.690	11.958	0.709	0.494	0.278	0.289	1.874
	HIGH	1.641	1.881	15.966	0.777	0.615	0.879	0.476	1.874
Gadsden	LOW	0.098	0.120	1.075	0.041	0.035	NA	NA	0.186
	AVERAGE	0.193	0.202	1.503	0.049	0.042	NA	NA	0.237
	HIGH	0.374	0.370	3.362	0.067	0.047	NA	NA	0.526
Gilchrist	LOW	0.194	0.181	1.440	0.037	0.035	NA	NA	NA
	AVERAGE	0.218	0.219	1.808	0.051	0.054	NA	NA	NA
	HIGH	0.227	0.236	2.006	0.053	0.062	NA	NA	NA
Glades	LOW	1.965	0.799	6.263	0.255	0.148	NA	NA	1.289
	AVERAGE	2.753	2.065	9.304	0.255	0.148	NA	NA	1.289
	HIGH	2.771	2.095	9.415	0.255	0.148	NA	NA	1.289
Gulf	LOW	0.408	0.514	3.302	0.077	0.185	0.126	0.083	0.786
	AVERAGE	0.610	0.807	5.594	0.277	0.246	0.126	0.083	0.786

	HIGH	0.645	0.876	9.821	0.304	0.262	0.126	0.083	0.786
Hamilton	LOW	0.111	0.108	0.612	0.027	0.019	NA	NA	NA
	AVERAGE	0.135	0.137	0.713	0.035	0.034	NA	NA	NA
	HIGH	0.157	0.156	0.756	0.038	0.036	NA	NA	NA
Hardee	LOW	1.747	1.647	4.969	0.104	0.100	0.297	NA	1.134
	AVERAGE	1.788	1.716	5.350	0.124	0.142	0.297	NA	1.134
	HIGH	1.949	1.746	5.736	0.216	0.197	0.297	NA	1.134
Hendry	LOW	1.841	1.083	4.326	0.124	0.122	0.131	0.111	0.869
	AVERAGE	2.241	2.109	8.879	0.293	0.276	0.340	0.388	1.347
	HIGH	3.011	2.815	10.586	0.416	0.496	0.369	0.461	1.557
Hernando	LOW	0.755	0.453	0.312	0.058	0.052	0.072	0.044	0.257
	AVERAGE	1.061	0.931	4.635	0.067	0.063	0.093	0.094	0.406
	HIGH	1.286	1.456	6.581	0.171	0.090	0.112	0.173	0.693
Highlands	LOW	1.284	0.382	0.527	0.096	0.086	0.104	0.099	0.197
	AVERAGE	1.731	1.606	7.030	0.139	0.121	0.131	0.150	0.258
	HIGH	2.703	2.563	10.321	0.390	0.277	0.180	0.233	0.503
Hillsborough	LOW	0.549	0.346	0.456	0.065	0.062	0.057	0.056	0.069
	AVERAGE	1.111	1.317	5.758	0.095	0.094	0.107	0.104	0.183
	HIGH	2.170	3.955	14.052	0.267	0.295	0.287	0.157	0.465
Holmes	LOW	0.314	0.204	2.614	0.068	0.062	NA	NA	0.500
	AVERAGE	0.389	0.411	2.649	0.078	0.077	NA	NA	0.500
	HIGH	0.389	0.413	2.723	0.084	0.080	NA	NA	0.500
Indian River	LOW	1.381	0.875	1.080	0.080	0.071	0.232	0.139	0.565

	AVERAGE	3.628	2.659	11.240	1.188	0.680	1.320	1.239	1.758
	HIGH	8.119	5.258	21.794	2.684	1.810	3.472	2.028	3.698
Jackson	LOW	0.234	0.243	1.278	0.046	0.039	NA	NA	0.223
	AVERAGE	0.297	0.304	2.079	0.067	0.061	NA	NA	0.449
	HIGH	0.406	0.438	2.701	0.096	0.152	NA	NA	0.506
Jefferson	LOW	0.153	0.092	0.933	0.035	0.029	NA	NA	NA
	AVERAGE	0.160	0.156	1.132	0.041	0.038	NA	NA	NA
	HIGH	0.209	0.177	1.937	0.041	0.040	NA	NA	NA
Lafayette	LOW	0.187	0.184	0.174	0.048	0.033	NA	NA	NA
	AVERAGE	0.187	0.185	1.208	0.048	0.033	NA	NA	NA
	HIGH	0.202	0.230	1.209	0.048	0.033	NA	NA	NA
Lake	LOW	0.548	0.644	1.963	0.040	0.035	0.049	0.047	0.174
	AVERAGE	0.928	0.798	4.007	0.060	0.057	0.073	0.065	0.251
	HIGH	1.501	2.355	7.341	0.113	0.084	0.087	0.086	0.627
Lee	LOW	0.516	0.602	0.580	0.082	0.082	0.088	0.084	0.071
	AVERAGE	2.686	1.599	11.349	0.178	0.154	0.358	0.213	0.310
	HIGH	5.510	5.383	36.222	1.201	0.974	1.643	1.180	2.073
Leon	LOW	0.159	0.151	0.210	0.033	0.028	0.029	0.027	0.000
	AVERAGE	0.199	0.201	1.789	0.041	0.038	0.037	0.038	0.163
	HIGH	0.365	0.262	3.955	0.054	0.068	0.057	0.059	0.228
Levy	LOW	0.226	0.224	1.621	0.055	0.046	0.337	0.299	0.416
	AVERAGE	0.370	0.285	2.191	0.080	0.075	0.337	0.299	0.928
	HIGH	0.995	0.988	8.323	0.365	0.409	0.337	0.299	1.298

Liberty	LOW	0.284	0.271	1.850	0.053	0.066	NA	NA	NA
	AVERAGE	0.284	0.301	2.161	0.053	0.066	NA	NA	NA
	HIGH	0.285	0.302	2.550	0.055	0.066	NA	NA	NA
Madison	LOW	0.120	0.101	0.758	0.021	0.022	NA	NA	NA
	AVERAGE	0.156	0.151	1.033	0.034	0.030	NA	NA	NA
	HIGH	0.168	0.161	1.258	0.037	0.044	NA	NA	NA
Manatee	LOW	0.986	0.676	0.466	0.084	0.086	0.071	0.075	0.047
	AVERAGE	1.866	1.406	8.099	0.172	0.188	0.485	0.558	0.458
	HIGH	7.000	5.711	31.270	1.332	1.095	1.706	1.427	2.539
Marion	LOW	0.608	0.161	0.225	0.044	0.034	0.038	0.044	0.132
	AVERAGE	0.874	0.675	2.610	0.054	0.049	0.052	0.063	0.201
	HIGH	1.902	1.559	4.849	0.111	0.119	0.137	0.069	0.469
Martin	LOW	2.062	1.508	10.225	0.223	0.199	0.545	0.406	0.949
	AVERAGE	4.095	3.327	23.607	0.951	0.831	1.803	1.041	2.168
	HIGH	6.740	7.581	36.404	2.149	2.181	2.356	1.750	4.119
Miami-Dade	LOW	0.702	0.635	0.852	0.098	0.113	0.113	0.102	0.011
	AVERAGE	3.577	2.769	17.269	0.958	0.835	1.734	1.483	2.352
	HIGH	11.339	7.432	37.277	8.481	4.221	6.121	4.620	5.723
Monroe	LOW	5.027	4.144	52.651	1.799	0.767	2.025	1.030	5.064
	AVERAGE	6.149	5.617	62.728	2.775	1.290	3.084	1.558	7.296
	HIGH	10.536	7.770	78.375	5.846	2.681	5.361	2.698	11.684
Nassau	LOW	0.096	0.098	0.286	0.022	0.020	0.063	0.059	0.121
	AVERAGE	0.204	0.210	1.222	0.055	0.052	0.063	0.059	0.121
	HIGH	0.255	0.283	2.492	0.067	0.061	0.063	0.059	0.121

Okaloosa	LOW	0.368	0.401	0.812	0.097	0.088	0.062	0.214	0.343
	AVERAGE	1.566	1.617	5.366	0.532	0.472	0.810	0.672	2.222
	HIGH	3.515	3.758	27.487	1.497	1.297	1.216	0.780	3.921
Okeechobee	LOW	2.027	1.138	7.410	0.232	0.172	0.084	0.127	0.477
	AVERAGE	2.332	2.060	10.760	0.234	0.209	0.111	0.148	0.790
	HIGH	3.231	2.284	15.606	0.239	0.237	0.183	0.149	0.791
Orange	LOW	0.283	0.257	0.316	0.040	0.046	0.045	0.045	0.001
	AVERAGE	0.832	1.005	3.849	0.063	0.062	0.066	0.070	0.147
	HIGH	2.182	1.520	6.969	0.118	0.085	0.150	0.163	0.253
Osceola	LOW	0.536	0.457	3.457	0.056	0.062	0.058	0.055	0.088
	AVERAGE	0.771	0.942	4.837	0.065	0.067	0.083	0.068	0.166
	HIGH	2.524	1.794	7.993	0.402	0.170	0.120	0.095	0.656
Palm Beach	LOW	0.802	0.644	0.814	0.173	0.171	0.114	0.113	0.258
	AVERAGE	4.199	3.217	18.393	1.028	0.728	1.412	1.175	1.684
	HIGH	9.987	8.355	43.123	4.542	2.935	5.229	3.483	4.712
Pasco	LOW	0.435	0.399	0.458	0.056	0.057	0.056	0.057	0.071
	AVERAGE	0.843	1.040	4.646	0.073	0.084	0.081	0.093	0.170
	HIGH	2.723	1.960	9.264	0.152	0.173	0.161	0.159	0.237
Pinellas	LOW	0.360	0.305	4.013	0.072	0.077	0.062	0.068	0.097
	AVERAGE	1.646	1.864	8.263	0.137	0.153	0.234	0.229	0.399
	HIGH	3.208	3.593	16.949	0.843	0.562	0.683	0.472	0.856
Polk	LOW	0.429	0.329	0.447	0.051	0.047	0.047	0.045	0.150
	AVERAGE	1.299	1.224	5.512	0.086	0.094	0.080	0.096	0.312

	HIGH	3.661	3.267	20.154	0.444	0.603	0.212	0.249	0.843
Putnam	LOW	0.188	0.181	1.171	0.041	0.036	0.033	0.031	0.265
	AVERAGE	0.248	0.240	2.007	0.053	0.048	0.051	0.043	0.279
	HIGH	0.324	0.306	3.183	0.073	0.059	0.062	0.054	0.411
St. Johns	LOW	0.102	0.097	0.715	0.030	0.027	0.026	0.024	0.034
	AVERAGE	0.284	0.344	2.437	0.106	0.084	0.141	0.118	0.250
	HIGH	0.725	0.644	9.160	0.289	0.174	0.248	0.159	0.512
St. Lucie	LOW	1.890	0.536	0.757	0.150	0.087	0.093	0.089	0.149
	AVERAGE	2.743	1.484	14.784	0.307	0.284	1.183	1.164	1.879
	HIGH	7.987	6.002	41.614	2.510	1.740	3.090	1.860	3.108
Santa Rosa	LOW	0.551	0.530	5.221	0.148	0.121	0.123	0.118	0.527
	AVERAGE	1.449	1.314	9.209	0.622	0.603	1.278	0.800	3.142
	HIGH	4.228	3.712	21.859	2.208	1.620	2.082	0.941	5.251
Sarasota	LOW	0.455	0.421	0.512	0.096	0.094	0.073	0.070	0.070
	AVERAGE	2.072	1.762	11.358	0.205	0.183	0.295	0.284	0.363
	HIGH	3.767	3.804	18.761	0.719	0.586	0.829	0.754	0.935
Seminole	LOW	0.258	0.466	2.523	0.053	0.040	0.045	0.043	0.013
	AVERAGE	0.958	0.983	4.032	0.061	0.059	0.066	0.066	0.156
	HIGH	1.226	1.346	5.874	0.096	0.110	0.075	0.095	0.242
Sumter	LOW	0.253	0.230	1.146	0.042	0.039	0.049	0.048	0.200
	AVERAGE	0.389	0.355	3.943	0.049	0.047	0.059	0.050	0.207
	HIGH	1.462	1.355	5.057	0.115	0.090	0.069	0.067	0.409
Suwannee	LOW	0.129	0.125	0.840	0.029	0.020	NA	NA	0.149

	AVERAGE	0.149	0.144	0.957	0.036	0.031	NA	NA	0.243
	HIGH	0.185	0.180	1.274	0.056	0.059	NA	NA	0.265
Taylor	LOW	0.208	0.212	1.321	0.043	0.038	0.029	0.045	0.341
	AVERAGE	0.229	0.224	2.037	0.048	0.040	0.047	0.045	0.341
	HIGH	0.304	0.356	3.945	0.061	0.058	0.048	0.045	0.341
Union	LOW	0.161	0.156	0.194	0.038	0.037	NA	NA	NA
	AVERAGE	0.163	0.164	0.974	0.040	0.039	NA	NA	NA
	HIGH	0.246	0.208	1.567	0.066	0.045	NA	NA	NA
Volusia	LOW	0.207	0.379	0.278	0.043	0.043	0.045	0.043	0.000
	AVERAGE	1.335	1.190	4.472	0.143	0.142	0.323	0.433	0.868
	HIGH	3.298	3.304	22.651	0.690	0.588	0.906	0.565	1.736
Wakulla	LOW	0.167	0.192	0.922	0.044	0.043	0.046	0.340	0.184
	AVERAGE	0.251	0.291	2.215	0.060	0.098	0.153	0.340	0.500
	HIGH	0.775	1.230	10.018	0.242	0.279	0.213	0.340	1.231
Walton	LOW	0.442	0.420	0.452	0.079	0.067	0.081	0.248	0.302
	AVERAGE	1.086	0.962	5.831	0.383	0.319	0.911	0.519	2.332
	HIGH	2.071	1.761	25.498	1.020	0.763	1.239	0.626	3.890
Washington	LOW	0.352	0.385	2.286	0.087	0.087	0.052	NA	0.412
	AVERAGE	0.360	0.396	2.398	0.092	0.092	0.052	NA	0.412
	HIGH	0.634	0.559	5.052	0.147	0.168	0.052	NA	0.412
Statewide	LOW	0.075	0.071	0.148	0.018	0.019	0.024	0.021	0.000
	AVERAGE	1.110	1.774	5.966	0.196	0.318	0.337	0.684	1.210
	HIGH	11.339	9.344	78.375	8.481	4.221	6.121	4.620	11.684

Appendix F – Form A-5: Percentage Change in Hurricane Output Ranges

Florida International University
Florida Public Hurricane Loss Model Version 8.1 Platform NA
May 24, 2021

Percentage Change in $0 Deductible Hurricane Output Ranges

Region	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Coastal	-4.0%	-6.4%	-1.6%	-4.2%	-7.9%	-6.2%	-7.7%	-45.9%
Inland	-3.4%	-4.1%	-1.4%	-1.9%	-2.8%	-4.0%	-4.2%	-34.7%
North	3.1%	3.4%	5.6%	2.7%	2.9%	2.9%	4.3%	-24.5%
Central	-5.3%	-3.5%	-1.8%	-3.9%	-3.4%	-5.7%	-4.1%	-41.4%
South	-8.7%	-7.9%	-2.8%	-7.6%	-9.4%	-9.4%	-8.7%	-46.7%
Statewide	-3.9%	-6.1%	-1.6%	-3.8%	-7.4%	-5.9%	-7.6%	-45.5%

Percentage Change in Specified Deductible Hurricane Output Ranges

Region	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Coastal	-7.3%	-9.1%	-1.7%	-6.7%	-11.4%	-9.4%	-11.1%	-68.1%
Inland	-7.2%	-6.5%	-1.5%	-3.7%	-4.6%	-8.3%	-8.2%	-75.6%
North	3.7%	4.5%	6.6%	2.6%	2.4%	2.9%	5.8%	-47.1%
Central	-9.1%	-5.3%	-1.9%	-7.5%	-6.0%	-10.9%	-7.2%	-73.0%
South	-11.7%	-10.9%	-2.9%	-9.6%	-12.6%	-12.6%	-12.1%	-67.8%
Statewide	-7.3%	-8.8%	-1.6%	-6.4%	-11.1%	-9.4%	-11.1%	-68.2%

Appendix G – Form A-6: Logical Relationship to Hurricane Risk (Trade Secret Item)

Florida International University
Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021

Exposure Exceptions:

Notional Set 1 - Deductible Sensitivity

Unknown opening protection for Commercial Residential assigned a value based on the county and year built.
Layout was set to "Closed" for all Commercial Residential policies.
Number of stories 3 was changed to 2 for Condo Frame and Masonry.
For all personal residential policies, Territory code was assigned to "33".

Notional Set 2 - Construction Sensitivity

Unknown opening protection for Commercial Residential assigned a value based on the county and year built.
Layout was set to "Closed" for all Commercial Residential policies.
Number of stories 3 was changed to 2 for Condo Frame and Masonry.
For all personal residential policies, Territory code was assigned to "33".

Notional Set 4 - Coverage Sensitivity

Unknown opening protection for Commercial Residential assigned a value based on the county and year built.
Layout was set to "Closed" for all Commercial Residential policies.
Number of stories 3 was changed to 2 for Condo Frame and Masonry.
For all personal residential policies, Territory code was assigned to "33".

Notional Set 5 - Year Built Sensitivity

Unknown opening protection for Commercial Residential assigned a value based on the county and year built.
Layout was set to "Closed" for all Commercial Residential policies.
Roof shape was assigned "gable".
Roof cover was assigned "shingle".
Opening protection was assigned "none".
Number of stories 3 was changed to 2 for Condo Frame and Masonry.
For all personal residential policies, Territory code was assigned to "33".

Notional Set 6 - Building Strength Sensitivity

For policies with only deck attachment and roof-to-wall unknown:
Roof-to-wall was assigned based on statistics.
Deck attachment was assigned based on the year built, location and strength.
Number of stories 3 was changed to 2 for Condo Frame and Masonry.
For all personal residential policies, Territory code was assigned to "33".

Notional Set 8 - Number of Stories Sensitivity

For all personal residential policies:
Roof shape was assigned "gable".
Roof cover was assigned "shingle/unrated".
Roof to deck connection was assigned "8d12".
Opening protection was assigned "none".
Territory code was assigned "33".

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	$500	1%	2%	5%	10%	$0	$500	1%	2%	5%	10%
Frame Owners	1	BAY	5.625	4.936	4.249	3.640	2.676	2.133	1.000	0.877	0.755	0.647	0.476	0.379
	2	BREVARD	5.441	4.854	4.269	3.411	1.616	0.798	1.000	0.892	0.785	0.627	0.297	0.147
	3	BREVARD	5.188	4.609	4.032	3.192	1.442	0.662	1.000	0.888	0.777	0.615	0.278	0.128
	4	BROWARD	10.029	9.261	8.496	7.266	4.431	2.569	1.000	0.924	0.847	0.725	0.442	0.256
	5	BROWARD	17.766	16.820	15.876	14.317	10.635	7.823	1.000	0.947	0.894	0.806	0.599	0.440
	6	CITRUS	3.932	3.462	2.993	2.314	0.906	0.305	1.000	0.880	0.761	0.588	0.230	0.078
	7	CLAY	0.984	0.712	0.441	0.283	0.114	0.082	1.000	0.723	0.448	0.287	0.116	0.083
	8	COLLIER	8.026	7.246	6.467	5.261	2.628	1.306	1.000	0.903	0.806	0.655	0.327	0.163
	9	COLUMBIA	1.008	0.725	0.444	0.283	0.114	0.082	1.000	0.720	0.441	0.281	0.113	0.082
	10	DIXIE	3.434	2.856	2.281	1.848	1.259	1.005	1.000	0.832	0.664	0.538	0.367	0.293
	11	DUVAL	2.087	1.691	1.296	1.027	0.685	0.542	1.000	0.810	0.621	0.492	0.328	0.260
	12	FRANKLIN	10.154	9.354	8.555	7.796	6.491	5.519	1.000	0.921	0.842	0.768	0.639	0.544
	13	GLADES	7.098	6.393	5.690	4.606	2.224	0.984	1.000	0.901	0.802	0.649	0.313	0.139
	14	HAMILTON	0.971	0.710	0.450	0.299	0.137	0.100	1.000	0.731	0.463	0.308	0.141	0.103
	15	HERNANDO	5.391	4.796	4.203	3.324	1.479	0.660	1.000	0.890	0.780	0.617	0.274	0.122
	16	HILLSBOROUGH	5.095	4.556	4.018	3.190	1.400	0.539	1.000	0.894	0.789	0.626	0.275	0.106
	17	HOLMES	1.763	1.353	0.945	0.658	0.299	0.213	1.000	0.768	0.536	0.373	0.170	0.121
	18	INDIAN RIVER	16.159	15.271	14.384	12.981	9.822	7.692	1.000	0.945	0.890	0.803	0.608	0.476
	19	JACKSON	1.379	1.028	0.677	0.450	0.184	0.131	1.000	0.745	0.491	0.326	0.133	0.095
	20	LEE	7.794	7.060	6.327	5.167	2.584	1.198	1.000	0.906	0.812	0.663	0.332	0.154
	21	LEON	1.449	1.097	0.747	0.517	0.242	0.175	1.000	0.757	0.516	0.357	0.167	0.121
	22	MARION	3.146	2.746	2.348	1.790	0.664	0.216	1.000	0.873	0.746	0.569	0.211	0.069
	23	MARTIN	6.528	5.838	5.151	4.117	1.922	0.889	1.000	0.894	0.789	0.631	0.294	0.136
	24	MARTIN	15.191	14.302	13.416	11.995	8.781	6.634	1.000	0.942	0.883	0.790	0.578	0.437
	25	MIAMI-DADE	9.041	8.336	7.632	6.493	3.856	2.145	1.000	0.922	0.844	0.718	0.427	0.237
	26	MIAMI-DADE	13.747	12.908	12.071	10.702	7.486	5.128	1.000	0.939	0.878	0.778	0.545	0.373
	27	MONROE	13.634	12.798	11.964	10.606	7.539	5.622	1.000	0.939	0.878	0.778	0.553	0.412
	28	MONROE	20.636	19.646	18.657	17.056	13.400	10.780	1.000	0.952	0.904	0.826	0.649	0.522
	29	OKALOOSA	4.215	3.605	2.997	2.483	1.701	1.309	1.000	0.855	0.711	0.589	0.404	0.311
	30	OSCEOLA	4.271	3.767	3.264	2.529	1.001	0.338	1.000	0.882	0.764	0.592	0.234	0.079
	31	OSCEOLA	5.626	5.028	4.433	3.541	1.625	0.689	1.000	0.894	0.788	0.629	0.289	0.122
	32	PALM BEACH	8.326	7.537	6.750	5.535	2.877	1.502	1.000	0.905	0.811	0.665	0.346	0.180
	33	PALM BEACH	12.275	11.369	10.465	9.016	5.764	3.819	1.000	0.926	0.853	0.735	0.470	0.311
	34	PINELLAS	4.865	4.315	3.768	2.957	1.259	0.522	1.000	0.887	0.775	0.608	0.259	0.107
	35	SAINT JOHNS	1.475	1.126	0.778	0.554	0.294	0.219	1.000	0.763	0.527	0.376	0.199	0.148
	36	SANTA ROSA	2.889	2.397	1.907	1.502	0.909	0.671	1.000	0.830	0.660	0.520	0.315	0.232
	37	SEMINOLE	3.741	3.284	2.828	2.181	0.849	0.287	1.000	0.878	0.756	0.583	0.227	0.077
	38	TAYLOR	1.193	0.871	0.550	0.358	0.154	0.114	1.000	0.730	0.461	0.300	0.129	0.096
	39	VOLUSIA	4.453	3.957	3.462	2.751	1.277	0.623	1.000	0.889	0.777	0.618	0.287	0.140
	40	WAKULLA	3.309	2.750	2.193	1.772	1.198	0.945	1.000	0.831	0.663	0.535	0.362	0.286

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	$500	1%	2%	5%	10%	$0	$500	1%	2%	5%	10%
Masonry Owners	1	BAY	5.303	4.615	3.928	3.365	2.490	1.967	1.000	0.870	0.741	0.635	0.469	0.371
	2	BREVARD	5.384	4.797	4.212	3.357	1.572	0.765	1.000	0.891	0.782	0.624	0.292	0.142
	3	BREVARD	5.142	4.563	3.986	3.149	1.408	0.639	1.000	0.887	0.775	0.612	0.274	0.124
	4	BROWARD	9.791	9.024	8.260	7.042	4.254	2.452	1.000	0.922	0.844	0.719	0.434	0.250
	5	BROWARD	17.061	16.115	15.172	13.626	9.999	7.260	1.000	0.945	0.889	0.799	0.586	0.426
	6	CITRUS	3.885	3.414	2.945	2.272	0.881	0.297	1.000	0.879	0.758	0.585	0.227	0.077
	7	CLAY	0.936	0.663	0.392	0.250	0.107	0.076	1.000	0.709	0.419	0.267	0.115	0.081
	8	COLLIER	7.874	7.095	6.317	5.121	2.532	1.255	1.000	0.901	0.802	0.650	0.321	0.159
	9	COLUMBIA	0.959	0.676	0.395	0.250	0.108	0.077	1.000	0.705	0.412	0.261	0.112	0.080
	10	DIXIE	3.241	2.664	2.088	1.692	1.171	0.925	1.000	0.822	0.644	0.522	0.361	0.285
	11	DUVAL	1.969	1.574	1.179	0.934	0.636	0.497	1.000	0.799	0.599	0.474	0.323	0.252
	12	FRANKLIN	9.380	8.581	7.783	7.074	5.865	4.922	1.000	0.915	0.830	0.754	0.625	0.525
	13	GLADES	6.981	6.276	5.572	4.498	2.151	0.950	1.000	0.899	0.798	0.644	0.308	0.136
	14	HAMILTON	0.926	0.665	0.405	0.269	0.130	0.094	1.000	0.718	0.437	0.290	0.140	0.102
	15	HERNANDO	5.315	4.720	4.127	3.254	1.432	0.635	1.000	0.888	0.776	0.612	0.269	0.120
	16	HILLSBOROUGH	5.027	4.488	3.950	3.128	1.360	0.524	1.000	0.893	0.786	0.622	0.271	0.104
	17	HOLMES	1.666	1.257	0.849	0.590	0.281	0.199	1.000	0.754	0.509	0.354	0.168	0.120
	18	INDIAN RIVER	15.169	14.280	13.394	12.000	8.877	6.789	1.000	0.941	0.883	0.791	0.585	0.448
	19	JACKSON	1.305	0.953	0.603	0.399	0.172	0.122	1.000	0.731	0.462	0.305	0.132	0.094
	20	LEE	7.624	6.891	6.159	5.011	2.481	1.153	1.000	0.904	0.808	0.657	0.325	0.151
	21	LEON	1.375	1.023	0.673	0.465	0.227	0.163	1.000	0.744	0.489	0.338	0.165	0.118
	22	MARION	3.100	2.700	2.301	1.749	0.641	0.210	1.000	0.871	0.742	0.564	0.207	0.068
	23	MARTIN	6.193	5.505	4.819	3.819	1.756	0.849	1.000	0.889	0.778	0.617	0.284	0.137
	24	MARTIN	14.347	13.461	12.576	11.192	8.123	6.136	1.000	0.938	0.877	0.780	0.566	0.428
	25	MIAMI-DADE	8.834	8.129	7.426	6.297	3.705	2.050	1.000	0.920	0.841	0.713	0.419	0.232
	26	MIAMI-DADE	13.316	12.478	11.641	10.284	7.118	4.824	1.000	0.937	0.874	0.772	0.535	0.362
	27	MONROE	12.980	12.146	11.313	9.975	6.999	5.182	1.000	0.936	0.872	0.769	0.539	0.399
	28	MONROE	19.282	18.293	17.305	15.727	12.169	9.658	1.000	0.949	0.897	0.816	0.631	0.501
	29	OKALOOSA	3.977	3.368	2.761	2.286	1.578	1.203	1.000	0.847	0.694	0.575	0.397	0.302
	30	OSCEOLA	4.213	3.708	3.205	2.477	0.971	0.330	1.000	0.880	0.761	0.588	0.230	0.078
	31	OSCEOLA	5.545	4.948	4.352	3.467	1.576	0.667	1.000	0.892	0.785	0.625	0.284	0.120
	32	PALM BEACH	7.979	7.191	6.406	5.221	2.687	1.441	1.000	0.901	0.803	0.654	0.337	0.181
	33	PALM BEACH	11.750	10.845	9.943	8.527	5.409	3.614	1.000	0.923	0.846	0.726	0.460	0.308
	34	PINELLAS	4.784	4.235	3.688	2.884	1.215	0.504	1.000	0.885	0.771	0.603	0.254	0.105
	35	SAINT JOHNS	1.398	1.048	0.700	0.498	0.276	0.204	1.000	0.750	0.501	0.356	0.197	0.146
	36	SANTA ROSA	2.734	2.242	1.753	1.380	0.850	0.623	1.000	0.820	0.641	0.505	0.311	0.228
	37	SEMINOLE	3.686	3.229	2.773	2.132	0.822	0.280	1.000	0.876	0.752	0.578	0.223	0.076
	38	TAYLOR	1.135	0.812	0.491	0.318	0.146	0.107	1.000	0.716	0.432	0.281	0.129	0.094
	39	VOLUSIA	4.399	3.902	3.408	2.700	1.237	0.594	1.000	0.887	0.775	0.614	0.281	0.135
	40	WAKULLA	3.132	2.573	2.016	1.631	1.121	0.877	1.000	0.822	0.644	0.521	0.358	0.280

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	$500	1%	2%	5%	10%	$0	$500	1%	2%	5%	10%
Manufactured Homes	1	BAY	28.967	27.490	27.490	26.155	22.761	19.369	1.000	0.949	0.949	0.903	0.786	0.669
	2	BREVARD	16.519	15.330	15.330	14.276	11.664	9.317	1.000	0.928	0.928	0.864	0.706	0.564
	3	BREVARD	15.342	14.169	14.169	13.135	10.577	8.300	1.000	0.924	0.924	0.856	0.689	0.541
	4	BROWARD	27.668	26.122	26.122	24.724	21.160	17.605	1.000	0.944	0.944	0.894	0.765	0.636
	5	BROWARD	49.794	47.897	47.897	46.159	41.649	36.813	1.000	0.962	0.962	0.927	0.836	0.739
	6	CITRUS	9.081	8.131	8.131	7.306	5.311	3.708	1.000	0.895	0.895	0.805	0.585	0.408
	7	CLAY	4.110	3.526	3.526	3.043	1.935	1.179	1.000	0.858	0.858	0.740	0.471	0.287
	8	COLLIER	26.475	24.895	24.895	23.463	19.810	16.197	1.000	0.940	0.940	0.886	0.748	0.612
	9	COLUMBIA	4.148	3.543	3.543	3.042	1.901	1.142	1.000	0.854	0.854	0.733	0.458	0.275
	10	DIXIE	19.805	18.560	18.560	17.453	14.690	12.126	1.000	0.937	0.937	0.881	0.742	0.612
	11	DUVAL	11.157	10.304	10.304	9.565	7.770	6.231	1.000	0.924	0.924	0.857	0.696	0.559
	12	FRANKLIN	43.347	41.635	41.635	40.080	36.080	31.884	1.000	0.961	0.961	0.925	0.832	0.736
	13	GLADES	19.776	18.352	18.352	17.083	13.896	10.921	1.000	0.928	0.928	0.864	0.703	0.552
	14	HAMILTON	3.842	3.283	3.283	2.822	1.771	1.066	1.000	0.854	0.854	0.734	0.461	0.277
	15	HERNANDO	16.044	14.839	14.839	13.768	11.096	8.686	1.000	0.925	0.925	0.858	0.692	0.541
	16	HILLSBOROUGH	12.814	11.726	11.726	10.753	8.318	6.164	1.000	0.915	0.915	0.839	0.649	0.481
	17	HOLMES	8.630	7.750	7.750	6.985	5.120	3.580	1.000	0.898	0.898	0.809	0.593	0.415
	18	INDIAN RIVER	52.597	50.809	50.809	49.176	44.941	40.364	1.000	0.966	0.966	0.935	0.854	0.767
	19	JACKSON	6.286	5.532	5.532	4.887	3.350	2.167	1.000	0.880	0.880	0.777	0.533	0.345
	20	LEE	22.235	20.754	20.754	19.413	16.004	12.742	1.000	0.933	0.933	0.873	0.720	0.573
	21	LEON	6.849	6.095	6.095	5.448	3.907	2.708	1.000	0.890	0.890	0.795	0.570	0.395
	22	MARION	6.660	5.852	5.852	5.161	3.520	2.291	1.000	0.879	0.879	0.775	0.529	0.344
	23	MARTIN	19.210	17.814	17.814	16.567	13.446	10.593	1.000	0.927	0.927	0.862	0.700	0.551
	24	MARTIN	50.094	48.307	48.307	46.668	42.410	37.825	1.000	0.964	0.964	0.932	0.847	0.755
	25	MIAMI-DADE	24.766	23.346	23.346	22.056	18.754	15.448	1.000	0.943	0.943	0.891	0.757	0.624
	26	MIAMI-DADE	39.389	37.699	37.699	36.158	32.189	28.013	1.000	0.957	0.957	0.918	0.817	0.711
	27	MONROE	58.376	56.688	56.688	55.115	50.950	46.110	1.000	0.971	0.971	0.944	0.873	0.790
	28	MONROE	81.685	79.722	79.722	77.901	73.082	67.366	1.000	0.976	0.976	0.954	0.895	0.825
	29	OKALOOSA	22.043	20.736	20.736	19.560	16.592	13.726	1.000	0.941	0.941	0.887	0.753	0.623
	30	OSCEOLA	9.785	8.766	8.766	7.877	5.721	3.976	1.000	0.896	0.896	0.805	0.585	0.406
	31	OSCEOLA	14.753	13.546	13.546	12.484	9.863	7.555	1.000	0.918	0.918	0.846	0.669	0.512
	32	PALM BEACH	27.486	25.889	25.889	24.450	20.793	17.201	1.000	0.942	0.942	0.890	0.756	0.626
	33	PALM BEACH	43.120	41.287	41.287	39.605	35.256	30.689	1.000	0.957	0.957	0.918	0.818	0.712
	34	PINELLAS	13.916	12.804	12.804	11.813	9.340	7.117	1.000	0.920	0.920	0.849	0.671	0.511
	35	SAINT JOHNS	7.852	7.099	7.099	6.451	4.893	3.632	1.000	0.904	0.904	0.822	0.623	0.463
	36	SANTA ROSA	15.517	14.463	14.463	13.519	11.143	8.882	1.000	0.932	0.932	0.871	0.718	0.572
	37	SEMINOLE	8.310	7.386	7.386	6.592	4.687	3.187	1.000	0.889	0.889	0.793	0.564	0.384
	38	TAYLOR	6.058	5.364	5.364	4.778	3.396	2.344	1.000	0.885	0.885	0.789	0.561	0.387
	39	VOLUSIA	12.856	11.850	11.850	10.969	8.802	6.904	1.000	0.922	0.922	0.853	0.685	0.537
	40	WAKULLA	19.371	18.165	18.165	17.093	14.413	11.904	1.000	0.938	0.938	0.882	0.744	0.615

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	$500	1%	2%	5%	10%	$0	$500	1%	2%	5%	10%
Frame Renters	1	BAY	2.096	1.555	1.555	1.489	1.349	1.226	1.000	0.742	0.742	0.711	0.644	0.585
	2	BREVARD	0.822	0.454	0.454	0.432	0.388	0.356	1.000	0.553	0.553	0.525	0.472	0.433
	3	BREVARD	0.729	0.372	0.372	0.352	0.315	0.290	1.000	0.510	0.510	0.483	0.432	0.398
	4	BROWARD	2.092	1.521	1.521	1.452	1.308	1.189	1.000	0.727	0.727	0.694	0.625	0.568
	5	BROWARD	5.841	5.050	5.050	4.891	4.517	4.130	1.000	0.865	0.865	0.837	0.773	0.707
	6	CITRUS	0.428	0.154	0.154	0.144	0.128	0.120	1.000	0.359	0.359	0.337	0.299	0.281
	7	CLAY	0.228	0.070	0.070	0.065	0.057	0.054	1.000	0.308	0.308	0.286	0.250	0.237
	8	COLLIER	1.265	0.738	0.738	0.700	0.626	0.573	1.000	0.583	0.583	0.554	0.495	0.453
	9	COLUMBIA	0.234	0.071	0.071	0.066	0.058	0.055	1.000	0.303	0.303	0.281	0.246	0.234
	10	DIXIE	1.133	0.725	0.725	0.691	0.623	0.568	1.000	0.640	0.640	0.610	0.550	0.501
	11	DUVAL	0.658	0.395	0.395	0.377	0.339	0.310	1.000	0.601	0.601	0.572	0.515	0.471
	12	FRANKLIN	4.676	3.999	3.999	3.876	3.587	3.284	1.000	0.855	0.855	0.829	0.767	0.702
	13	GLADES	0.983	0.522	0.522	0.494	0.439	0.403	1.000	0.531	0.531	0.502	0.446	0.410
	14	HAMILTON	0.236	0.085	0.085	0.079	0.070	0.066	1.000	0.358	0.358	0.335	0.296	0.278
	15	HERNANDO	0.738	0.366	0.366	0.346	0.310	0.285	1.000	0.496	0.496	0.469	0.419	0.387
	16	HILLSBOROUGH	0.621	0.280	0.280	0.263	0.233	0.216	1.000	0.451	0.451	0.424	0.376	0.348
	17	HOLMES	0.445	0.175	0.175	0.163	0.141	0.131	1.000	0.394	0.394	0.365	0.317	0.294
	18	INDIAN RIVER	5.622	4.918	4.918	4.780	4.447	4.080	1.000	0.875	0.875	0.850	0.791	0.726
	19	JACKSON	0.332	0.112	0.112	0.103	0.089	0.084	1.000	0.336	0.336	0.310	0.268	0.253
	20	LEE	1.141	0.645	0.645	0.611	0.544	0.498	1.000	0.565	0.565	0.535	0.477	0.436
	21	LEON	0.366	0.143	0.143	0.133	0.116	0.108	1.000	0.390	0.390	0.363	0.317	0.295
	22	MARION	0.334	0.111	0.111	0.104	0.093	0.088	1.000	0.331	0.331	0.310	0.277	0.262
	23	MARTIN	0.936	0.503	0.503	0.477	0.427	0.393	1.000	0.537	0.537	0.509	0.456	0.419
	24	MARTIN	4.973	4.283	4.283	4.157	3.859	3.540	1.000	0.861	0.861	0.836	0.776	0.712
	25	MIAMI-DADE	1.783	1.258	1.258	1.198	1.075	0.978	1.000	0.705	0.705	0.672	0.603	0.548
	26	MIAMI-DADE	3.884	3.205	3.205	3.089	2.825	2.573	1.000	0.825	0.825	0.795	0.727	0.662
	27	MONROE	4.091	3.444	3.444	3.331	3.068	2.797	1.000	0.842	0.842	0.814	0.750	0.684
	28	MONROE	7.631	6.811	6.811	6.620	6.155	5.639	1.000	0.892	0.892	0.867	0.807	0.739
	29	OKALOOSA	1.426	0.962	0.962	0.916	0.820	0.745	1.000	0.675	0.675	0.642	0.575	0.522
	30	OSCEOLA	0.467	0.172	0.172	0.161	0.142	0.134	1.000	0.367	0.367	0.344	0.304	0.286
	31	OSCEOLA	0.737	0.365	0.365	0.344	0.307	0.283	1.000	0.495	0.495	0.467	0.416	0.383
	32	PALM BEACH	1.384	0.861	0.861	0.820	0.738	0.675	1.000	0.622	0.622	0.593	0.533	0.487
	33	PALM BEACH	2.995	2.333	2.333	2.248	2.059	1.880	1.000	0.779	0.779	0.751	0.687	0.628
	34	PINELLAS	0.629	0.288	0.288	0.272	0.242	0.224	1.000	0.458	0.458	0.432	0.385	0.357
	35	SAINT JOHNS	0.392	0.171	0.171	0.161	0.142	0.131	1.000	0.437	0.437	0.410	0.361	0.334
	36	SANTA ROSA	0.873	0.511	0.511	0.482	0.425	0.387	1.000	0.585	0.585	0.552	0.487	0.443
	37	SEMINOLE	0.409	0.147	0.147	0.138	0.123	0.116	1.000	0.360	0.360	0.338	0.301	0.283
	38	TAYLOR	0.288	0.094	0.094	0.087	0.076	0.072	1.000	0.326	0.326	0.303	0.264	0.250
	39	VOLUSIA	0.660	0.357	0.357	0.339	0.306	0.281	1.000	0.540	0.540	0.514	0.463	0.425
	40	WAKULLA	1.083	0.685	0.685	0.652	0.585	0.533	1.000	0.632	0.632	0.602	0.540	0.492

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	$500	1%	2%	5%	10%	$0	$500	1%	2%	5%	10%
Masonry Renters	1	BAY	1.964	1.459	1.459	1.397	1.263	1.143	1.000	0.743	0.743	0.711	0.643	0.582
	2	BREVARD	0.804	0.443	0.443	0.421	0.378	0.346	1.000	0.552	0.552	0.524	0.470	0.430
	3	BREVARD	0.714	0.365	0.365	0.345	0.309	0.283	1.000	0.510	0.510	0.483	0.432	0.397
	4	BROWARD	2.055	1.491	1.491	1.422	1.277	1.160	1.000	0.725	0.725	0.692	0.621	0.564
	5	BROWARD	5.546	4.763	4.763	4.605	4.236	3.860	1.000	0.859	0.859	0.830	0.764	0.696
	6	CITRUS	0.418	0.150	0.150	0.141	0.125	0.117	1.000	0.359	0.359	0.337	0.298	0.280
	7	CLAY	0.205	0.063	0.063	0.058	0.051	0.049	1.000	0.306	0.306	0.285	0.251	0.238
	8	COLLIER	1.243	0.725	0.725	0.688	0.614	0.560	1.000	0.583	0.583	0.553	0.494	0.451
	9	COLUMBIA	0.209	0.063	0.063	0.059	0.052	0.049	1.000	0.300	0.300	0.280	0.248	0.235
	10	DIXIE	1.061	0.685	0.685	0.654	0.589	0.536	1.000	0.645	0.645	0.616	0.555	0.505
	11	DUVAL	0.610	0.369	0.369	0.352	0.317	0.289	1.000	0.606	0.606	0.577	0.520	0.474
	12	FRANKLIN	4.194	3.556	3.556	3.439	3.163	2.877	1.000	0.848	0.848	0.820	0.754	0.686
	13	GLADES	0.966	0.514	0.514	0.485	0.430	0.394	1.000	0.532	0.532	0.502	0.445	0.408
	14	HAMILTON	0.215	0.078	0.078	0.073	0.065	0.061	1.000	0.363	0.363	0.341	0.303	0.283
	15	HERNANDO	0.722	0.358	0.358	0.339	0.302	0.278	1.000	0.496	0.496	0.469	0.418	0.385
	16	HILLSBOROUGH	0.610	0.276	0.276	0.259	0.229	0.212	1.000	0.452	0.452	0.425	0.376	0.347
	17	HOLMES	0.408	0.161	0.161	0.150	0.131	0.121	1.000	0.396	0.396	0.369	0.321	0.298
	18	INDIAN RIVER	5.034	4.340	4.340	4.206	3.883	3.537	1.000	0.862	0.862	0.836	0.771	0.703
	19	JACKSON	0.301	0.101	0.101	0.093	0.081	0.076	1.000	0.335	0.335	0.311	0.271	0.254
	20	LEE	1.121	0.633	0.633	0.599	0.532	0.486	1.000	0.565	0.565	0.534	0.475	0.434
	21	LEON	0.334	0.131	0.131	0.122	0.107	0.099	1.000	0.392	0.392	0.366	0.321	0.298
	22	MARION	0.327	0.108	0.108	0.102	0.090	0.085	1.000	0.331	0.331	0.311	0.277	0.262
	23	MARTIN	0.916	0.492	0.492	0.466	0.417	0.382	1.000	0.537	0.537	0.509	0.455	0.417
	24	MARTIN	4.462	3.783	3.783	3.660	3.371	3.069	1.000	0.848	0.848	0.820	0.756	0.688
	25	MIAMI-DADE	1.754	1.235	1.235	1.175	1.052	0.955	1.000	0.704	0.704	0.670	0.599	0.544
	26	MIAMI-DADE	3.751	3.080	3.080	2.964	2.702	2.455	1.000	0.821	0.821	0.790	0.720	0.654
	27	MONROE	3.807	3.169	3.169	3.059	2.801	2.539	1.000	0.833	0.833	0.804	0.736	0.667
	28	MONROE	6.810	6.001	6.001	5.815	5.365	4.877	1.000	0.881	0.881	0.854	0.788	0.716
	29	OKALOOSA	1.336	0.905	0.905	0.861	0.770	0.697	1.000	0.677	0.677	0.644	0.576	0.522
	30	OSCEOLA	0.458	0.168	0.168	0.158	0.139	0.131	1.000	0.368	0.368	0.344	0.304	0.286
	31	OSCEOLA	0.723	0.358	0.358	0.338	0.300	0.276	1.000	0.495	0.495	0.467	0.415	0.382
	32	PALM BEACH	1.357	0.844	0.844	0.803	0.721	0.658	1.000	0.622	0.622	0.592	0.531	0.485
	33	PALM BEACH	2.849	2.198	2.198	2.114	1.927	1.752	1.000	0.771	0.771	0.742	0.676	0.615
	34	PINELLAS	0.617	0.283	0.283	0.267	0.237	0.219	1.000	0.459	0.459	0.433	0.385	0.356
	35	SAINT JOHNS	0.360	0.159	0.159	0.150	0.133	0.122	1.000	0.442	0.442	0.416	0.368	0.340
	36	SANTA ROSA	0.819	0.483	0.483	0.456	0.403	0.366	1.000	0.590	0.590	0.557	0.492	0.447
	37	SEMINOLE	0.400	0.144	0.144	0.136	0.120	0.113	1.000	0.361	0.361	0.339	0.301	0.283
	38	TAYLOR	0.260	0.085	0.085	0.079	0.070	0.065	1.000	0.325	0.325	0.303	0.268	0.252
	39	VOLUSIA	0.643	0.346	0.346	0.329	0.296	0.271	1.000	0.538	0.538	0.512	0.460	0.421
	40	WAKULLA	1.021	0.654	0.654	0.623	0.560	0.509	1.000	0.640	0.640	0.610	0.549	0.498

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	$500	1%	2%	5%	10%	$0	$500	1%	2%	5%	10%
Frame Condo Unit	1	BAY	2.535	1.915	1.915	1.690	1.502	1.333	1.000	0.756	0.756	0.667	0.593	0.526
	2	BREVARD	1.312	0.748	0.748	0.520	0.436	0.385	1.000	0.570	0.570	0.397	0.332	0.293
	3	BREVARD	1.199	0.648	0.648	0.427	0.353	0.312	1.000	0.540	0.540	0.356	0.295	0.260
	4	BROWARD	2.972	2.133	2.133	1.738	1.478	1.296	1.000	0.718	0.718	0.585	0.497	0.436
	5	BROWARD	7.298	6.200	6.200	5.643	5.087	4.555	1.000	0.850	0.850	0.773	0.697	0.624
	6	CITRUS	0.791	0.352	0.352	0.186	0.142	0.127	1.000	0.445	0.445	0.235	0.180	0.161
	7	CLAY	0.311	0.125	0.125	0.071	0.060	0.056	1.000	0.402	0.402	0.229	0.194	0.179
	8	COLLIER	1.986	1.185	1.185	0.845	0.705	0.620	1.000	0.597	0.597	0.426	0.355	0.312
	9	COLUMBIA	0.318	0.127	0.127	0.072	0.061	0.056	1.000	0.399	0.399	0.225	0.191	0.177
	10	DIXIE	1.406	0.936	0.936	0.783	0.692	0.615	1.000	0.666	0.666	0.557	0.492	0.438
	11	DUVAL	0.825	0.523	0.523	0.426	0.375	0.335	1.000	0.633	0.633	0.516	0.455	0.406
	12	FRANKLIN	5.433	4.668	4.668	4.359	3.996	3.605	1.000	0.859	0.859	0.802	0.736	0.664
	13	GLADES	1.629	0.913	0.913	0.611	0.493	0.434	1.000	0.560	0.560	0.375	0.303	0.266
	14	HAMILTON	0.318	0.140	0.140	0.087	0.075	0.068	1.000	0.439	0.439	0.275	0.236	0.215
	15	HERNANDO	1.228	0.651	0.651	0.422	0.347	0.307	1.000	0.531	0.531	0.344	0.283	0.250
	16	HILLSBOROUGH	1.088	0.549	0.549	0.331	0.261	0.231	1.000	0.504	0.504	0.304	0.240	0.212
	17	HOLMES	0.591	0.276	0.276	0.181	0.152	0.137	1.000	0.468	0.468	0.307	0.257	0.232
	18	INDIAN RIVER	6.929	5.950	5.950	5.480	5.018	4.527	1.000	0.859	0.859	0.791	0.724	0.653
	19	JACKSON	0.447	0.189	0.189	0.113	0.095	0.087	1.000	0.424	0.424	0.254	0.213	0.194
	20	LEE	1.847	1.080	1.080	0.752	0.613	0.538	1.000	0.585	0.585	0.407	0.332	0.291
	21	LEON	0.486	0.226	0.226	0.148	0.125	0.113	1.000	0.465	0.465	0.304	0.257	0.232
	22	MARION	0.625	0.266	0.266	0.134	0.102	0.092	1.000	0.426	0.426	0.214	0.164	0.147
	23	MARTIN	1.527	0.853	0.853	0.579	0.477	0.422	1.000	0.558	0.558	0.379	0.313	0.276
	24	MARTIN	6.216	5.239	5.239	4.774	4.344	3.910	1.000	0.843	0.843	0.768	0.699	0.629
	25	MIAMI-DADE	2.581	1.806	1.806	1.440	1.213	1.064	1.000	0.700	0.700	0.558	0.470	0.412
	26	MIAMI-DADE	5.041	4.085	4.085	3.612	3.192	2.827	1.000	0.810	0.810	0.716	0.633	0.561
	27	MONROE	5.221	4.295	4.295	3.870	3.481	3.096	1.000	0.823	0.823	0.741	0.667	0.593
	28	MONROE	9.275	8.153	8.153	7.604	6.961	6.259	1.000	0.879	0.879	0.820	0.751	0.675
	29	OKALOOSA	1.761	1.229	1.229	1.043	0.911	0.805	1.000	0.698	0.698	0.592	0.517	0.457
	30	OSCEOLA	0.862	0.388	0.388	0.206	0.158	0.142	1.000	0.450	0.450	0.239	0.183	0.164
	31	OSCEOLA	1.251	0.666	0.666	0.429	0.344	0.304	1.000	0.532	0.532	0.343	0.275	0.243
	32	PALM BEACH	2.129	1.326	1.326	0.986	0.830	0.731	1.000	0.623	0.623	0.463	0.390	0.343
	33	PALM BEACH	4.048	3.073	3.073	2.632	2.325	2.065	1.000	0.759	0.759	0.650	0.574	0.510
	34	PINELLAS	1.073	0.542	0.542	0.332	0.271	0.240	1.000	0.506	0.506	0.310	0.252	0.224
	35	SAINT JOHNS	0.513	0.257	0.257	0.180	0.154	0.138	1.000	0.501	0.501	0.350	0.300	0.269
	36	SANTA ROSA	1.107	0.688	0.688	0.547	0.469	0.414	1.000	0.621	0.621	0.495	0.424	0.374
	37	SEMINOLE	0.754	0.335	0.335	0.177	0.136	0.122	1.000	0.444	0.444	0.235	0.181	0.162
	38	TAYLOR	0.387	0.161	0.161	0.096	0.081	0.074	1.000	0.416	0.416	0.247	0.210	0.192
	39	VOLUSIA	1.062	0.594	0.594	0.409	0.343	0.304	1.000	0.560	0.560	0.385	0.323	0.286
	40	WAKULLA	1.346	0.889	0.889	0.740	0.650	0.576	1.000	0.661	0.661	0.549	0.483	0.428

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	$500	1%	2%	5%	10%	$0	$500	1%	2%	5%	10%
Masonry Condo Unit	1	BAY	2.378	1.796	1.796	1.583	1.404	1.241	1.000	0.755	0.755	0.666	0.590	0.522
	2	BREVARD	1.289	0.731	0.731	0.509	0.423	0.373	1.000	0.567	0.567	0.395	0.328	0.289
	3	BREVARD	1.181	0.635	0.635	0.420	0.345	0.304	1.000	0.538	0.538	0.356	0.292	0.258
	4	BROWARD	2.913	2.085	2.085	1.697	1.440	1.260	1.000	0.716	0.716	0.583	0.494	0.432
	5	BROWARD	6.947	5.860	5.860	5.314	4.766	4.245	1.000	0.844	0.844	0.765	0.686	0.611
	6	CITRUS	0.777	0.344	0.344	0.183	0.139	0.124	1.000	0.443	0.443	0.235	0.178	0.159
	7	CLAY	0.284	0.113	0.113	0.064	0.054	0.050	1.000	0.400	0.400	0.224	0.192	0.177
	8	COLLIER	1.949	1.160	1.160	0.829	0.689	0.605	1.000	0.595	0.595	0.425	0.353	0.310
	9	COLUMBIA	0.290	0.115	0.115	0.064	0.055	0.051	1.000	0.397	0.397	0.220	0.189	0.175
	10	DIXIE	1.318	0.881	0.881	0.738	0.652	0.578	1.000	0.669	0.669	0.560	0.495	0.439
	11	DUVAL	0.768	0.487	0.487	0.397	0.350	0.311	1.000	0.635	0.635	0.517	0.456	0.405
	12	FRANKLIN	4.898	4.174	4.174	3.880	3.532	3.158	1.000	0.852	0.852	0.792	0.721	0.645
	13	GLADES	1.601	0.894	0.894	0.600	0.483	0.424	1.000	0.559	0.559	0.375	0.302	0.265
	14	HAMILTON	0.293	0.129	0.129	0.081	0.070	0.063	1.000	0.441	0.441	0.275	0.238	0.217
	15	HERNANDO	1.205	0.637	0.637	0.414	0.338	0.298	1.000	0.528	0.528	0.343	0.281	0.248
	16	HILLSBOROUGH	1.071	0.539	0.539	0.326	0.256	0.227	1.000	0.503	0.503	0.305	0.239	0.211
	17	HOLMES	0.546	0.255	0.255	0.167	0.141	0.127	1.000	0.468	0.468	0.306	0.258	0.233
	18	INDIAN RIVER	6.271	5.303	5.303	4.843	4.390	3.918	1.000	0.846	0.846	0.772	0.700	0.625
	19	JACKSON	0.410	0.173	0.173	0.103	0.087	0.079	1.000	0.422	0.422	0.250	0.212	0.193
	20	LEE	1.811	1.055	1.055	0.735	0.599	0.525	1.000	0.583	0.583	0.406	0.331	0.290
	21	LEON	0.448	0.208	0.208	0.136	0.115	0.104	1.000	0.465	0.465	0.303	0.258	0.232
	22	MARION	0.613	0.260	0.260	0.132	0.100	0.090	1.000	0.424	0.424	0.215	0.163	0.147
	23	MARTIN	1.475	0.822	0.822	0.559	0.466	0.411	1.000	0.557	0.557	0.379	0.316	0.279
	24	MARTIN	5.646	4.694	4.694	4.243	3.828	3.409	1.000	0.831	0.831	0.751	0.678	0.604
	25	MIAMI-DADE	2.533	1.767	1.767	1.409	1.184	1.036	1.000	0.698	0.698	0.556	0.468	0.409
	26	MIAMI-DADE	4.872	3.927	3.927	3.462	3.047	2.689	1.000	0.806	0.806	0.711	0.625	0.552
	27	MONROE	4.885	3.977	3.977	3.564	3.184	2.808	1.000	0.814	0.814	0.729	0.652	0.575
	28	MONROE	8.359	7.257	7.257	6.721	6.095	5.417	1.000	0.868	0.868	0.804	0.729	0.648
	29	OKALOOSA	1.652	1.153	1.153	0.977	0.853	0.752	1.000	0.698	0.698	0.592	0.516	0.455
	30	OSCEOLA	0.847	0.379	0.379	0.203	0.155	0.138	1.000	0.448	0.448	0.240	0.183	0.163
	31	OSCEOLA	1.230	0.652	0.652	0.421	0.337	0.296	1.000	0.530	0.530	0.343	0.274	0.241
	32	PALM BEACH	2.068	1.287	1.287	0.960	0.811	0.713	1.000	0.622	0.622	0.464	0.392	0.345
	33	PALM BEACH	3.857	2.905	2.905	2.478	2.182	1.927	1.000	0.753	0.753	0.643	0.566	0.500
	34	PINELLAS	1.053	0.530	0.530	0.326	0.265	0.235	1.000	0.504	0.504	0.310	0.251	0.223
	35	SAINT JOHNS	0.475	0.239	0.239	0.167	0.144	0.129	1.000	0.502	0.502	0.352	0.303	0.271
	36	SANTA ROSA	1.040	0.648	0.648	0.517	0.443	0.391	1.000	0.623	0.623	0.497	0.426	0.376
	37	SEMINOLE	0.741	0.328	0.328	0.174	0.134	0.120	1.000	0.442	0.442	0.236	0.180	0.161
	38	TAYLOR	0.355	0.147	0.147	0.086	0.074	0.068	1.000	0.415	0.415	0.244	0.209	0.191
	39	VOLUSIA	1.041	0.578	0.578	0.398	0.331	0.292	1.000	0.556	0.556	0.382	0.318	0.281
	40	WAKULLA	1.270	0.844	0.844	0.704	0.619	0.548	1.000	0.665	0.665	0.554	0.488	0.432

Construction / Policy	Location	County	Hurricane Loss Cost at different Deductibles						Ratios relative $0					
			$0	2%	3%	5%	10%		$0	2%	3%	5%	10%	
	1	BAY	10.115	8.386	7.774	6.746	4.824		1.000	0.829	0.769	0.667	0.477	
	2	BREVARD	5.698	4.413	4.004	3.349	2.204		1.000	0.774	0.703	0.588	0.387	
	3	BREVARD	5.075	3.827	3.430	2.808	1.750		1.000	0.754	0.676	0.553	0.345	
	4	BROWARD	9.015	7.248	6.615	5.564	3.688		1.000	0.804	0.734	0.617	0.409	
	5	BROWARD	16.620	14.390	13.558	12.134	9.381		1.000	0.866	0.816	0.730	0.564	
	6	CITRUS	2.505	1.605	1.353	0.988	0.480		1.000	0.641	0.540	0.394	0.192	
	7	CLAY	1.100	0.606	0.493	0.341	0.150		1.000	0.551	0.448	0.310	0.136	
	8	COLLIER	8.506	6.676	6.029	4.970	3.106		1.000	0.785	0.709	0.584	0.365	
	9	COLUMBIA	0.971	0.500	0.398	0.268	0.112		1.000	0.514	0.410	0.276	0.116	
	10	DIXIE	5.192	4.008	3.628	3.032	2.041		1.000	0.772	0.699	0.584	0.393	
	11	DUVAL	3.641	2.784	2.529	2.128	1.440		1.000	0.765	0.695	0.585	0.396	
	12	FRANKLIN	13.111	11.256	10.590	9.455	7.300		1.000	0.859	0.808	0.721	0.557	
	13	GLADES	5.906	4.386	3.883	3.078	1.730		1.000	0.743	0.657	0.521	0.293	
	14	HAMILTON	0.955	0.507	0.408	0.278	0.125		1.000	0.531	0.427	0.291	0.130	
	15	HERNANDO	4.495	3.282	2.903	2.299	1.323		1.000	0.730	0.646	0.512	0.294	
	16	HILLSBOROUGH	4.126	2.907	2.523	1.927	1.002		1.000	0.705	0.611	0.467	0.243	
	17	HOLMES	2.856	1.893	1.611	1.193	0.573		1.000	0.663	0.564	0.418	0.201	
	18	INDIAN RIVER	16.712	14.708	13.967	12.704	10.248		1.000	0.880	0.836	0.760	0.613	
	19	JACKSON	1.964	1.198	0.990	0.694	0.291		1.000	0.610	0.504	0.353	0.148	
Commercial Residential	20	LEE	6.624	4.983	4.428	3.537	2.038		1.000	0.752	0.669	0.534	0.308	
	21	LEON	1.939	1.237	1.051	0.775	0.366		1.000	0.638	0.542	0.400	0.189	
	22	MARION	1.807	1.064	0.874	0.613	0.263		1.000	0.589	0.484	0.339	0.145	
	23	MARTIN	6.114	4.610	4.120	3.346	2.030		1.000	0.754	0.674	0.547	0.332	
	24	MARTIN	17.059	14.955	14.171	12.815	10.137		1.000	0.877	0.831	0.751	0.594	
	25	MIAMI-DADE	8.924	7.170	6.536	5.478	3.561		1.000	0.803	0.732	0.614	0.399	
	26	MIAMI-DADE	13.737	11.726	10.983	9.705	7.240		1.000	0.854	0.800	0.707	0.527	
	27	MONROE	23.530	21.148	20.193	18.487	14.944		1.000	0.899	0.858	0.786	0.635	
	28	MONROE	27.679	25.245	24.251	22.442	18.572		1.000	0.912	0.876	0.811	0.671	
	29	OKALOOSA	8.069	6.509	5.963	5.052	3.375		1.000	0.807	0.739	0.626	0.418	
	30	OSCEOLA	2.819	1.830	1.545	1.122	0.514		1.000	0.649	0.548	0.398	0.182	
	31	OSCEOLA	4.186	2.988	2.617	2.042	1.141		1.000	0.714	0.625	0.488	0.273	
	32	PALM BEACH	8.680	6.909	6.294	5.278	3.464		1.000	0.796	0.725	0.608	0.399	
	33	PALM BEACH	14.543	12.399	11.610	10.260	7.677		1.000	0.853	0.798	0.705	0.528	
	34	PINELLAS	4.664	3.404	2.995	2.354	1.324		1.000	0.730	0.642	0.505	0.284	
	35	SAINT JOHNS	2.498	1.747	1.534	1.211	0.709		1.000	0.699	0.614	0.485	0.284	
	36	SANTA ROSA	5.273	4.010	3.574	2.866	1.666		1.000	0.761	0.678	0.544	0.316	
	37	SEMINOLE	2.250	1.399	1.163	0.827	0.368		1.000	0.622	0.517	0.368	0.163	
	38	TAYLOR	1.715	1.078	0.910	0.673	0.345		1.000	0.629	0.531	0.392	0.201	
	39	VOLUSIA	4.120	3.074	2.750	2.246	1.435		1.000	0.746	0.667	0.545	0.348	
	40	WAKULLA	5.730	4.519	4.129	3.506	2.422		1.000	0.789	0.721	0.612	0.423	

Policy Form	Location	County	Hurricane Loss Cost per Construction Type		Frame / Masonry
			Masonry	Frame	
Owners	1	BAY	5.303	5.625	1.061
	2	BREVARD	5.384	5.441	1.011
	3	BREVARD	5.142	5.188	1.009
	4	BROWARD	9.791	10.029	1.024
	5	BROWARD	17.061	17.766	1.041
	6	CITRUS	3.885	3.932	1.012
	7	CLAY	0.936	0.984	1.052
	8	COLLIER	7.874	8.026	1.019
	9	COLUMBIA	0.959	1.008	1.051
	10	DIXIE	3.241	3.434	1.060
	11	DUVAL	1.969	2.087	1.060
	12	FRANKLIN	9.380	10.154	1.083
	13	GLADES	6.981	7.098	1.017
	14	HAMILTON	0.926	0.971	1.048
	15	HERNANDO	5.315	5.391	1.014
	16	HILLSBOROUGH	5.027	5.095	1.014
	17	HOLMES	1.666	1.763	1.058
	18	INDIAN RIVER	15.169	16.159	1.065
	19	JACKSON	1.305	1.379	1.057
	20	LEE	7.624	7.794	1.022
	21	LEON	1.375	1.449	1.054
	22	MARION	3.100	3.146	1.015
	23	MARTIN	6.193	6.528	1.054
	24	MARTIN	14.347	15.191	1.059
	25	MIAMI-DADE	8.834	9.041	1.023
	26	MIAMI-DADE	13.316	13.747	1.032
	27	MONROE	12.980	13.634	1.050
	28	MONROE	19.282	20.636	1.070
	29	OKALOOSA	3.977	4.215	1.060
	30	OSCEOLA	4.213	4.271	1.014
	31	OSCEOLA	5.545	5.626	1.015
	32	PALM BEACH	7.979	8.326	1.044
	33	PALM BEACH	11.750	12.275	1.045
	34	PINELLAS	4.784	4.865	1.017
	35	SAINT JOHNS	1.398	1.475	1.055
	36	SANTA ROSA	2.734	2.889	1.057
	37	SEMINOLE	3.686	3.741	1.015
	38	TAYLOR	1.135	1.193	1.052
	39	VOLUSIA	4.399	4.453	1.012
	40	WAKULLA	3.132	3.309	1.057

Policy Form	Location	County	Hurricane Loss Cost per Construction Type		Frame / Masonry
			Masonry	Frame	
Renters	1	BAY	1.964	2.096	1.067
	2	BREVARD	0.804	0.822	1.023
	3	BREVARD	0.714	0.729	1.020
	4	BROWARD	2.055	2.092	1.018
	5	BROWARD	5.546	5.841	1.053
	6	CITRUS	0.418	0.428	1.023
	7	CLAY	0.205	0.228	1.114
	8	COLLIER	1.243	1.265	1.018
	9	COLUMBIA	0.209	0.234	1.116
	10	DIXIE	1.061	1.133	1.068
	11	DUVAL	0.610	0.658	1.079
	12	FRANKLIN	4.194	4.676	1.115
	13	GLADES	0.966	0.983	1.018
	14	HAMILTON	0.215	0.236	1.100
	15	HERNANDO	0.722	0.738	1.021
	16	HILLSBOROUGH	0.610	0.621	1.018
	17	HOLMES	0.408	0.445	1.092
	18	INDIAN RIVER	5.034	5.622	1.117
	19	JACKSON	0.301	0.332	1.104
	20	LEE	1.121	1.141	1.018
	21	LEON	0.334	0.366	1.097
	22	MARION	0.327	0.334	1.024
	23	MARTIN	0.916	0.936	1.022
	24	MARTIN	4.462	4.973	1.115
	25	MIAMI-DADE	1.754	1.783	1.017
	26	MIAMI-DADE	3.751	3.884	1.035
	27	MONROE	3.807	4.091	1.075
	28	MONROE	6.810	7.631	1.121
	29	OKALOOSA	1.336	1.426	1.067
	30	OSCEOLA	0.458	0.467	1.021
	31	OSCEOLA	0.723	0.737	1.019
	32	PALM BEACH	1.357	1.384	1.020
	33	PALM BEACH	2.849	2.995	1.051
	34	PINELLAS	0.617	0.629	1.021
	35	SAINT JOHNS	0.360	0.392	1.090
	36	SANTA ROSA	0.819	0.873	1.066
	37	SEMINOLE	0.400	0.409	1.022
	38	TAYLOR	0.260	0.288	1.109
	39	VOLUSIA	0.643	0.660	1.026
	40	WAKULLA	1.021	1.083	1.061

Policy Form	Location	County	Hurricane Loss Cost per Construction Type		Frame / Masonry
			Masonry	Frame	
Condo Unit	1	BAY	2.378	2.535	1.066
	2	BREVARD	1.289	1.312	1.018
	3	BREVARD	1.181	1.199	1.016
	4	BROWARD	2.913	2.972	1.020
	5	BROWARD	6.947	7.298	1.051
	6	CITRUS	0.777	0.791	1.018
	7	CLAY	0.284	0.311	1.095
	8	COLLIER	1.949	1.986	1.019
	9	COLUMBIA	0.290	0.318	1.096
	10	DIXIE	1.318	1.406	1.067
	11	DUVAL	0.768	0.825	1.075
	12	FRANKLIN	4.898	5.433	1.109
	13	GLADES	1.601	1.629	1.018
	14	HAMILTON	0.293	0.318	1.085
	15	HERNANDO	1.205	1.228	1.018
	16	HILLSBOROUGH	1.071	1.088	1.016
	17	HOLMES	0.546	0.591	1.083
	18	INDIAN RIVER	6.271	6.929	1.105
	19	JACKSON	0.410	0.447	1.091
	20	LEE	1.811	1.847	1.020
	21	LEON	0.448	0.486	1.085
	22	MARION	0.613	0.625	1.020
	23	MARTIN	1.475	1.527	1.036
	24	MARTIN	5.646	6.216	1.101
	25	MIAMI-DADE	2.533	2.581	1.019
	26	MIAMI-DADE	4.872	5.041	1.035
	27	MONROE	4.885	5.221	1.069
	28	MONROE	8.359	9.275	1.110
	29	OKALOOSA	1.652	1.761	1.066
	30	OSCEOLA	0.847	0.862	1.018
	31	OSCEOLA	1.230	1.251	1.017
	32	PALM BEACH	2.068	2.129	1.029
	33	PALM BEACH	3.857	4.048	1.050
	34	PINELLAS	1.053	1.073	1.019
	35	SAINT JOHNS	0.475	0.513	1.081
	36	SANTA ROSA	1.040	1.107	1.064
	37	SEMINOLE	0.741	0.754	1.019
	38	TAYLOR	0.355	0.387	1.092
	39	VOLUSIA	1.041	1.062	1.021
	40	WAKULLA	1.270	1.346	1.060

Policy Form	Location	County	Hurricane Loss Cost per Construction Type
			Concrete
Commercial Residential	1	BAY	10.115
	2	BREVARD	5.698
	3	BREVARD	5.075
	4	BROWARD	9.015
	5	BROWARD	16.620
	6	CITRUS	2.505
	7	CLAY	1.100
	8	COLLIER	8.506
	9	COLUMBIA	0.971
	10	DIXIE	5.192
	11	DUVAL	3.641
	12	FRANKLIN	13.111
	13	GLADES	5.906
	14	HAMILTON	0.955
	15	HERNANDO	4.495
	16	HILLSBOROUGH	4.126
	17	HOLMES	2.856
	18	INDIAN RIVER	16.712
	19	JACKSON	1.964
	20	LEE	6.624
	21	LEON	1.939
	22	MARION	1.807
	23	MARTIN	6.114
	24	MARTIN	17.059
	25	MIAMI-DADE	8.924
	26	MIAMI-DADE	13.737
	27	MONROE	23.530
	28	MONROE	27.679
	29	OKALOOSA	8.069
	30	OSCEOLA	2.819
	31	OSCEOLA	4.186
	32	PALM BEACH	8.680
	33	PALM BEACH	14.543
	34	PINELLAS	4.664
	35	SAINT JOHNS	2.498
	36	SANTA ROSA	5.273
	37	SEMINOLE	2.250
	38	TAYLOR	1.715
	39	VOLUSIA	4.120
	40	WAKULLA	5.730

Location	County	Hurricane Loss Cost per Construction			Manufactured Homes / Frame Owners	Manufactured Homes / Masonry Owners
		Frame Owners	Masonry Owners	Manufactured Homes		
1	BAY	5.625	5.303	28.967	5.149	5.462
2	BREVARD	5.441	5.384	16.519	3.036	3.068
3	BREVARD	5.188	5.142	15.342	2.957	2.984
4	BROWARD	10.029	9.791	27.668	2.759	2.826
5	BROWARD	17.766	17.061	49.794	2.803	2.919
6	CITRUS	3.932	3.885	9.081	2.309	2.338
7	CLAY	0.984	0.936	4.110	4.176	4.391
8	COLLIER	8.026	7.874	26.475	3.299	3.362
9	COLUMBIA	1.008	0.959	4.148	4.117	4.325
10	DIXIE	3.434	3.241	19.805	5.767	6.111
11	DUVAL	2.087	1.969	11.157	5.346	5.665
12	FRANKLIN	10.154	9.380	43.347	4.269	4.621
13	GLADES	7.098	6.981	19.776	2.786	2.833
14	HAMILTON	0.971	0.926	3.842	3.957	4.148
15	HERNANDO	5.391	5.315	16.044	2.976	3.019
16	HILLSBOROUGH	5.095	5.027	12.814	2.515	2.549
17	HOLMES	1.763	1.666	8.630	4.895	5.178
18	INDIAN RIVER	16.159	15.169	52.597	3.255	3.467
19	JACKSON	1.379	1.305	6.286	4.558	4.817
20	LEE	7.794	7.624	22.235	2.853	2.916
21	LEON	1.449	1.375	6.849	4.729	4.983
22	MARION	3.146	3.100	6.660	2.117	2.149
23	MARTIN	6.528	6.193	19.210	2.943	3.102
24	MARTIN	15.191	14.347	50.094	3.298	3.492
25	MIAMI-DADE	9.041	8.834	24.766	2.739	2.804
26	MIAMI-DADE	13.747	13.316	39.389	2.865	2.958
27	MONROE	13.634	12.980	58.376	4.282	4.497
28	MONROE	20.636	19.282	81.685	3.958	4.236
29	OKALOOSA	4.215	3.977	22.043	5.230	5.542
30	OSCEOLA	4.271	4.213	9.785	2.291	2.323
31	OSCEOLA	5.626	5.545	14.753	2.622	2.660
32	PALM BEACH	8.326	7.979	27.486	3.301	3.445
33	PALM BEACH	12.275	11.750	43.120	3.513	3.670
34	PINELLAS	4.865	4.784	13.916	2.861	2.909
35	SAINT JOHNS	1.475	1.398	7.852	5.322	5.617
36	SANTA ROSA	2.889	2.734	15.517	5.371	5.677
37	SEMINOLE	3.741	3.686	8.310	2.221	2.254
38	TAYLOR	1.193	1.135	6.058	5.078	5.339
39	VOLUSIA	4.453	4.399	12.856	2.887	2.922
40	WAKULLA	3.309	3.132	19.371	5.854	6.185

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Frame Owners	1	BAY	4.394	0.184	0.783	0.264	1.000	0.042	0.178	0.060
	2	BREVARD	4.905	0.125	0.312	0.098	1.000	0.026	0.064	0.020
	3	BREVARD	4.703	0.120	0.279	0.085	1.000	0.026	0.059	0.018
	4	BROWARD	8.795	0.188	0.761	0.286	1.000	0.021	0.086	0.032
	5	BROWARD	14.567	0.278	2.121	0.800	1.000	0.019	0.146	0.055
	6	CITRUS	3.634	0.085	0.169	0.045	1.000	0.023	0.046	0.012
	7	CLAY	0.826	0.045	0.092	0.022	1.000	0.054	0.111	0.027
	8	COLLIER	7.207	0.186	0.477	0.156	1.000	0.026	0.066	0.022
	9	COLUMBIA	0.845	0.046	0.094	0.023	1.000	0.054	0.111	0.027
	10	DIXIE	2.729	0.138	0.430	0.137	1.000	0.051	0.157	0.050
	11	DUVAL	1.672	0.085	0.251	0.078	1.000	0.051	0.150	0.047
	12	FRANKLIN	7.573	0.243	1.742	0.596	1.000	0.032	0.230	0.079
	13	GLADES	6.453	0.153	0.373	0.119	1.000	0.024	0.058	0.018
	14	HAMILTON	0.811	0.042	0.094	0.024	1.000	0.052	0.116	0.030
	15	HERNANDO	4.896	0.125	0.283	0.086	1.000	0.026	0.058	0.018
	16	HILLSBOROUGH	4.676	0.109	0.239	0.071	1.000	0.023	0.051	0.015
	17	HOLMES	1.460	0.080	0.176	0.047	1.000	0.055	0.120	0.032
	18	INDIAN RIVER	13.069	0.279	2.071	0.740	1.000	0.021	0.158	0.057
	19	JACKSON	1.150	0.063	0.133	0.033	1.000	0.055	0.115	0.029
	20	LEE	7.057	0.166	0.431	0.140	1.000	0.024	0.061	0.020
	21	LEON	1.201	0.065	0.145	0.038	1.000	0.054	0.120	0.032
	22	MARION	2.912	0.067	0.133	0.034	1.000	0.023	0.046	0.012
	23	MARTIN	5.911	0.149	0.354	0.114	1.000	0.025	0.060	0.019
	24	MARTIN	12.433	0.271	1.816	0.670	1.000	0.022	0.146	0.054
	25	MIAMI-DADE	7.977	0.172	0.650	0.241	1.000	0.022	0.082	0.030
	26	MIAMI-DADE	11.573	0.232	1.407	0.535	1.000	0.020	0.122	0.046
	27	MONROE	11.296	0.292	1.486	0.560	1.000	0.026	0.132	0.050
	28	MONROE	16.432	0.388	2.764	1.052	1.000	0.024	0.168	0.064
	29	OKALOOSA	3.350	0.152	0.536	0.177	1.000	0.045	0.160	0.053
	30	OSCEOLA	3.946	0.091	0.184	0.050	1.000	0.023	0.047	0.013
	31	OSCEOLA	5.137	0.121	0.282	0.086	1.000	0.024	0.055	0.017
	32	PALM BEACH	7.445	0.189	0.515	0.177	1.000	0.025	0.069	0.024
	33	PALM BEACH	10.524	0.254	1.095	0.402	1.000	0.024	0.104	0.038
	34	PINELLAS	4.436	0.114	0.243	0.072	1.000	0.026	0.055	0.016
	35	SAINT JOHNS	1.210	0.069	0.153	0.043	1.000	0.057	0.127	0.035
	36	SANTA ROSA	2.335	0.117	0.332	0.105	1.000	0.050	0.142	0.045
	37	SEMINOLE	3.457	0.080	0.161	0.043	1.000	0.023	0.047	0.013
	38	TAYLOR	0.991	0.058	0.116	0.029	1.000	0.059	0.117	0.029
	39	VOLUSIA	4.022	0.101	0.253	0.078	1.000	0.025	0.063	0.019
	40	WAKULLA	2.633	0.135	0.411	0.130	1.000	0.051	0.156	0.050

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Masonry Owners	1	BAY	4.137	0.184	0.732	0.250	1.000	0.044	0.177	0.060
	2	BREVARD	4.857	0.125	0.305	0.097	1.000	0.026	0.063	0.020
	3	BREVARD	4.664	0.120	0.273	0.084	1.000	0.026	0.059	0.018
	4	BROWARD	8.576	0.188	0.745	0.282	1.000	0.022	0.087	0.033
	5	BROWARD	14.009	0.278	2.009	0.764	1.000	0.020	0.143	0.055
	6	CITRUS	3.591	0.085	0.165	0.044	1.000	0.024	0.046	0.012
	7	CLAY	0.789	0.045	0.082	0.020	1.000	0.057	0.104	0.025
	8	COLLIER	7.067	0.186	0.467	0.154	1.000	0.026	0.066	0.022
	9	COLUMBIA	0.809	0.046	0.085	0.020	1.000	0.056	0.105	0.025
	10	DIXIE	2.572	0.138	0.401	0.129	1.000	0.054	0.156	0.050
	11	DUVAL	1.579	0.085	0.232	0.073	1.000	0.054	0.147	0.046
	12	FRANKLIN	7.040	0.243	1.557	0.540	1.000	0.035	0.221	0.077
	13	GLADES	6.344	0.153	0.365	0.118	1.000	0.024	0.058	0.019
	14	HAMILTON	0.777	0.042	0.086	0.022	1.000	0.054	0.111	0.028
	15	HERNANDO	4.828	0.125	0.277	0.085	1.000	0.026	0.057	0.018
	16	HILLSBOROUGH	4.614	0.109	0.234	0.070	1.000	0.024	0.051	0.015
	17	HOLMES	1.383	0.080	0.161	0.043	1.000	0.058	0.116	0.031
	18	INDIAN RIVER	12.373	0.279	1.848	0.669	1.000	0.023	0.149	0.054
	19	JACKSON	1.091	0.063	0.120	0.030	1.000	0.058	0.110	0.028
	20	LEE	6.898	0.166	0.422	0.139	1.000	0.024	0.061	0.020
	21	LEON	1.143	0.065	0.132	0.035	1.000	0.057	0.115	0.031
	22	MARION	2.869	0.067	0.130	0.034	1.000	0.023	0.045	0.012
	23	MARTIN	5.586	0.149	0.345	0.113	1.000	0.027	0.062	0.020
	24	MARTIN	11.845	0.271	1.624	0.607	1.000	0.023	0.137	0.051
	25	MIAMI-DADE	7.785	0.172	0.638	0.239	1.000	0.022	0.082	0.031
	26	MIAMI-DADE	11.208	0.232	1.355	0.520	1.000	0.021	0.121	0.046
	27	MONROE	10.785	0.292	1.377	0.526	1.000	0.027	0.128	0.049
	28	MONROE	15.489	0.388	2.456	0.949	1.000	0.025	0.159	0.061
	29	OKALOOSA	3.157	0.152	0.500	0.168	1.000	0.048	0.158	0.053
	30	OSCEOLA	3.893	0.091	0.179	0.049	1.000	0.023	0.046	0.013
	31	OSCEOLA	5.063	0.121	0.276	0.086	1.000	0.024	0.055	0.017
	32	PALM BEACH	7.111	0.189	0.503	0.175	1.000	0.027	0.071	0.025
	33	PALM BEACH	10.071	0.254	1.039	0.385	1.000	0.025	0.103	0.038
	34	PINELLAS	4.363	0.114	0.238	0.071	1.000	0.026	0.054	0.016
	35	SAINT JOHNS	1.149	0.069	0.140	0.040	1.000	0.060	0.122	0.034
	36	SANTA ROSA	2.207	0.117	0.310	0.100	1.000	0.053	0.140	0.045
	37	SEMINOLE	3.406	0.080	0.157	0.043	1.000	0.023	0.046	0.012
	38	TAYLOR	0.946	0.058	0.104	0.026	1.000	0.062	0.110	0.027
	39	VOLUSIA	3.976	0.101	0.246	0.076	1.000	0.025	0.062	0.019
	40	WAKULLA	2.487	0.135	0.386	0.124	1.000	0.054	0.155	0.050

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Manufactured Homes	1	BAY	22.344	0.184	4.620	1.819	1.000	0.008	0.207	0.081
	2	BREVARD	13.389	0.125	2.124	0.880	1.000	0.009	0.159	0.066
	3	BREVARD	12.568	0.120	1.875	0.779	1.000	0.010	0.149	0.062
	4	BROWARD	21.834	0.188	3.949	1.698	1.000	0.009	0.181	0.078
	5	BROWARD	37.247	0.278	8.646	3.623	1.000	0.007	0.232	0.097
	6	CITRUS	7.833	0.085	0.828	0.335	1.000	0.011	0.106	0.043
	7	CLAY	3.677	0.045	0.284	0.104	1.000	0.012	0.077	0.028
	8	COLLIER	21.109	0.186	3.651	1.528	1.000	0.009	0.173	0.072
	9	COLUMBIA	3.722	0.046	0.280	0.101	1.000	0.012	0.075	0.027
	10	DIXIE	15.661	0.138	2.869	1.136	1.000	0.009	0.183	0.073
	11	DUVAL	9.020	0.085	1.466	0.585	1.000	0.009	0.163	0.065
	12	FRANKLIN	32.268	0.243	7.804	3.031	1.000	0.008	0.242	0.094
	13	GLADES	16.181	0.153	2.423	1.019	1.000	0.009	0.150	0.063
	14	HAMILTON	3.445	0.042	0.261	0.094	1.000	0.012	0.076	0.027
	15	HERNANDO	13.151	0.125	1.957	0.811	1.000	0.010	0.149	0.062
	16	HILLSBOROUGH	10.795	0.109	1.348	0.562	1.000	0.010	0.125	0.052
	17	HOLMES	7.428	0.080	0.807	0.315	1.000	0.011	0.109	0.042
	18	INDIAN RIVER	38.600	0.279	9.786	3.933	1.000	0.007	0.254	0.102
	19	JACKSON	5.540	0.063	0.496	0.187	1.000	0.011	0.090	0.034
	20	LEE	18.040	0.166	2.838	1.191	1.000	0.009	0.157	0.066
	21	LEON	5.921	0.065	0.623	0.241	1.000	0.011	0.105	0.041
	22	MARION	5.868	0.067	0.520	0.204	1.000	0.011	0.089	0.035
	23	MARTIN	15.713	0.149	2.342	1.006	1.000	0.009	0.149	0.064
	24	MARTIN	37.128	0.271	8.962	3.733	1.000	0.007	0.241	0.101
	25	MIAMI-DADE	19.677	0.172	3.438	1.479	1.000	0.009	0.175	0.075
	26	MIAMI-DADE	29.919	0.232	6.495	2.743	1.000	0.008	0.217	0.092
	27	MONROE	42.601	0.292	10.877	4.606	1.000	0.007	0.255	0.108
	28	MONROE	58.377	0.388	16.141	6.778	1.000	0.007	0.277	0.116
	29	OKALOOSA	17.403	0.152	3.210	1.277	1.000	0.009	0.184	0.073
	30	OSCEOLA	8.460	0.091	0.876	0.358	1.000	0.011	0.104	0.042
	31	OSCEOLA	12.244	0.121	1.686	0.702	1.000	0.010	0.138	0.057
	32	PALM BEACH	21.778	0.189	3.860	1.659	1.000	0.009	0.177	0.076
	33	PALM BEACH	32.743	0.254	7.113	3.011	1.000	0.008	0.217	0.092
	34	PINELLAS	11.569	0.114	1.578	0.656	1.000	0.010	0.136	0.057
	35	SAINT JOHNS	6.613	0.069	0.837	0.333	1.000	0.010	0.127	0.050
	36	SANTA ROSA	12.564	0.117	2.024	0.812	1.000	0.009	0.161	0.065
	37	SEMINOLE	7.234	0.080	0.710	0.286	1.000	0.011	0.098	0.040
	38	TAYLOR	5.245	0.058	0.545	0.210	1.000	0.011	0.104	0.040
	39	VOLUSIA	10.527	0.101	1.582	0.646	1.000	0.010	0.150	0.061
	40	WAKULLA	15.302	0.135	2.821	1.113	1.000	0.009	0.184	0.073

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Frame Renters	1	BAY	0.000	0.000	1.567	0.529			1.000	0.337
	2	BREVARD	0.000	0.000	0.625	0.197			1.000	0.315
	3	BREVARD	0.000	0.000	0.558	0.171			1.000	0.306
	4	BROWARD	0.000	0.000	1.521	0.571			1.000	0.375
	5	BROWARD	0.000	0.000	4.242	1.599			1.000	0.377
	6	CITRUS	0.000	0.000	0.337	0.090			1.000	0.268
	7	CLAY	0.000	0.000	0.183	0.045			1.000	0.244
	8	COLLIER	0.000	0.000	0.953	0.312			1.000	0.327
	9	COLUMBIA	0.000	0.000	0.188	0.045			1.000	0.241
	10	DIXIE	0.000	0.000	0.860	0.273			1.000	0.318
	11	DUVAL	0.000	0.000	0.502	0.156			1.000	0.312
	12	FRANKLIN	0.000	0.000	3.484	1.192			1.000	0.342
	13	GLADES	0.000	0.000	0.746	0.237			1.000	0.318
	14	HAMILTON	0.000	0.000	0.189	0.048			1.000	0.254
	15	HERNANDO	0.000	0.000	0.566	0.172			1.000	0.303
	16	HILLSBOROUGH	0.000	0.000	0.478	0.142			1.000	0.297
	17	HOLMES	0.000	0.000	0.351	0.094			1.000	0.268
	18	INDIAN RIVER	0.000	0.000	4.141	1.481			1.000	0.358
	19	JACKSON	0.000	0.000	0.266	0.067			1.000	0.251
	20	LEE	0.000	0.000	0.861	0.280			1.000	0.325
	21	LEON	0.000	0.000	0.289	0.077			1.000	0.265
	22	MARION	0.000	0.000	0.266	0.068			1.000	0.257
	23	MARTIN	0.000	0.000	0.707	0.229			1.000	0.323
	24	MARTIN	0.000	0.000	3.632	1.341			1.000	0.369
	25	MIAMI-DADE	0.000	0.000	1.301	0.483			1.000	0.371
	26	MIAMI-DADE	0.000	0.000	2.813	1.071			1.000	0.381
	27	MONROE	0.000	0.000	2.971	1.120			1.000	0.377
	28	MONROE	0.000	0.000	5.528	2.104			1.000	0.381
	29	OKALOOSA	0.000	0.000	1.071	0.355			1.000	0.331
	30	OSCEOLA	0.000	0.000	0.367	0.100			1.000	0.273
	31	OSCEOLA	0.000	0.000	0.564	0.173			1.000	0.306
	32	PALM BEACH	0.000	0.000	1.030	0.355			1.000	0.344
	33	PALM BEACH	0.000	0.000	2.191	0.804			1.000	0.367
	34	PINELLAS	0.000	0.000	0.486	0.143			1.000	0.295
	35	SAINT JOHNS	0.000	0.000	0.307	0.086			1.000	0.280
	36	SANTA ROSA	0.000	0.000	0.664	0.210			1.000	0.316
	37	SEMINOLE	0.000	0.000	0.322	0.086			1.000	0.268
	38	TAYLOR	0.000	0.000	0.231	0.057			1.000	0.248
	39	VOLUSIA	0.000	0.000	0.505	0.155			1.000	0.307
	40	WAKULLA	0.000	0.000	0.822	0.261			1.000	0.317

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Masonry Renters	1	BAY	0.000	0.000	1.464	0.500			1.000	0.342
	2	BREVARD	0.000	0.000	0.610	0.194			1.000	0.318
	3	BREVARD	0.000	0.000	0.546	0.169			1.000	0.309
	4	BROWARD	0.000	0.000	1.491	0.565			1.000	0.379
	5	BROWARD	0.000	0.000	4.019	1.527			1.000	0.380
	6	CITRUS	0.000	0.000	0.329	0.089			1.000	0.270
	7	CLAY	0.000	0.000	0.165	0.040			1.000	0.242
	8	COLLIER	0.000	0.000	0.934	0.309			1.000	0.331
	9	COLUMBIA	0.000	0.000	0.169	0.040			1.000	0.239
	10	DIXIE	0.000	0.000	0.803	0.258			1.000	0.321
	11	DUVAL	0.000	0.000	0.464	0.146			1.000	0.316
	12	FRANKLIN	0.000	0.000	3.113	1.081			1.000	0.347
	13	GLADES	0.000	0.000	0.731	0.235			1.000	0.322
	14	HAMILTON	0.000	0.000	0.172	0.043			1.000	0.252
	15	HERNANDO	0.000	0.000	0.553	0.169			1.000	0.306
	16	HILLSBOROUGH	0.000	0.000	0.469	0.141			1.000	0.301
	17	HOLMES	0.000	0.000	0.321	0.086			1.000	0.269
	18	INDIAN RIVER	0.000	0.000	3.695	1.338			1.000	0.362
	19	JACKSON	0.000	0.000	0.241	0.060			1.000	0.250
	20	LEE	0.000	0.000	0.843	0.278			1.000	0.329
	21	LEON	0.000	0.000	0.263	0.070			1.000	0.267
	22	MARION	0.000	0.000	0.259	0.067			1.000	0.259
	23	MARTIN	0.000	0.000	0.690	0.226			1.000	0.327
	24	MARTIN	0.000	0.000	3.247	1.214			1.000	0.374
	25	MIAMI-DADE	0.000	0.000	1.276	0.478			1.000	0.375
	26	MIAMI-DADE	0.000	0.000	2.711	1.040			1.000	0.384
	27	MONROE	0.000	0.000	2.754	1.053			1.000	0.382
	28	MONROE	0.000	0.000	4.911	1.899			1.000	0.387
	29	OKALOOSA	0.000	0.000	0.999	0.337			1.000	0.337
	30	OSCEOLA	0.000	0.000	0.359	0.099			1.000	0.275
	31	OSCEOLA	0.000	0.000	0.552	0.171			1.000	0.310
	32	PALM BEACH	0.000	0.000	1.007	0.350			1.000	0.348
	33	PALM BEACH	0.000	0.000	2.078	0.771			1.000	0.371
	34	PINELLAS	0.000	0.000	0.475	0.141			1.000	0.298
	35	SAINT JOHNS	0.000	0.000	0.281	0.079			1.000	0.282
	36	SANTA ROSA	0.000	0.000	0.620	0.199			1.000	0.321
	37	SEMINOLE	0.000	0.000	0.315	0.085			1.000	0.270
	38	TAYLOR	0.000	0.000	0.209	0.051			1.000	0.246
	39	VOLUSIA	0.000	0.000	0.491	0.152			1.000	0.310
	40	WAKULLA	0.000	0.000	0.773	0.248			1.000	0.321

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Frame Condo Unit	1	BAY	0.439	0.000	1.567	0.529	0.280		1.000	0.337
	2	BREVARD	0.490	0.000	0.625	0.197	0.785		1.000	0.315
	3	BREVARD	0.470	0.000	0.558	0.171	0.843		1.000	0.306
	4	BROWARD	0.879	0.000	1.521	0.571	0.578		1.000	0.375
	5	BROWARD	1.457	0.000	4.242	1.599	0.343		1.000	0.377
	6	CITRUS	0.363	0.000	0.337	0.090	1.078		1.000	0.268
	7	CLAY	0.083	0.000	0.183	0.045	0.450		1.000	0.244
	8	COLLIER	0.721	0.000	0.953	0.312	0.756		1.000	0.327
	9	COLUMBIA	0.085	0.000	0.188	0.045	0.449		1.000	0.241
	10	DIXIE	0.273	0.000	0.860	0.273	0.317		1.000	0.318
	11	DUVAL	0.167	0.000	0.502	0.156	0.333		1.000	0.312
	12	FRANKLIN	0.757	0.000	3.484	1.192	0.217		1.000	0.342
	13	GLADES	0.645	0.000	0.746	0.237	0.865		1.000	0.318
	14	HAMILTON	0.081	0.000	0.189	0.048	0.430		1.000	0.254
	15	HERNANDO	0.490	0.000	0.566	0.172	0.864		1.000	0.303
	16	HILLSBOROUGH	0.468	0.000	0.478	0.142	0.977		1.000	0.297
	17	HOLMES	0.146	0.000	0.351	0.094	0.416		1.000	0.268
	18	INDIAN RIVER	1.307	0.000	4.141	1.481	0.316		1.000	0.358
	19	JACKSON	0.115	0.000	0.266	0.067	0.433		1.000	0.251
	20	LEE	0.706	0.000	0.861	0.280	0.819		1.000	0.325
	21	LEON	0.120	0.000	0.289	0.077	0.415		1.000	0.265
	22	MARION	0.291	0.000	0.266	0.068	1.095		1.000	0.257
	23	MARTIN	0.591	0.000	0.707	0.229	0.836		1.000	0.323
	24	MARTIN	1.243	0.000	3.632	1.341	0.342		1.000	0.369
	25	MIAMI-DADE	0.798	0.000	1.301	0.483	0.613		1.000	0.371
	26	MIAMI-DADE	1.157	0.000	2.813	1.071	0.411		1.000	0.381
	27	MONROE	1.130	0.000	2.971	1.120	0.380		1.000	0.377
	28	MONROE	1.643	0.000	5.528	2.104	0.297		1.000	0.381
	29	OKALOOSA	0.335	0.000	1.071	0.355	0.313		1.000	0.331
	30	OSCEOLA	0.395	0.000	0.367	0.100	1.075		1.000	0.273
	31	OSCEOLA	0.514	0.000	0.564	0.173	0.910		1.000	0.306
	32	PALM BEACH	0.744	0.000	1.030	0.355	0.723		1.000	0.344
	33	PALM BEACH	1.052	0.000	2.191	0.804	0.480		1.000	0.367
	34	PINELLAS	0.444	0.000	0.486	0.143	0.913		1.000	0.295
	35	SAINT JOHNS	0.121	0.000	0.307	0.086	0.395		1.000	0.280
	36	SANTA ROSA	0.234	0.000	0.664	0.210	0.352		1.000	0.316
	37	SEMINOLE	0.346	0.000	0.322	0.086	1.073		1.000	0.268
	38	TAYLOR	0.099	0.000	0.231	0.057	0.429		1.000	0.248
	39	VOLUSIA	0.402	0.000	0.505	0.155	0.796		1.000	0.307
	40	WAKULLA	0.263	0.000	0.822	0.261	0.320		1.000	0.317

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Masonry Condo Unit	1	BAY	0.414	0.000	1.464	0.500	0.283		1.000	0.342
	2	BREVARD	0.486	0.000	0.610	0.194	0.797		1.000	0.318
	3	BREVARD	0.466	0.000	0.546	0.169	0.855		1.000	0.309
	4	BROWARD	0.858	0.000	1.491	0.565	0.575		1.000	0.379
	5	BROWARD	1.401	0.000	4.019	1.527	0.349		1.000	0.380
	6	CITRUS	0.359	0.000	0.329	0.089	1.091		1.000	0.270
	7	CLAY	0.079	0.000	0.165	0.040	0.479		1.000	0.242
	8	COLLIER	0.707	0.000	0.934	0.309	0.757		1.000	0.331
	9	COLUMBIA	0.081	0.000	0.169	0.040	0.478		1.000	0.239
	10	DIXIE	0.257	0.000	0.803	0.258	0.320		1.000	0.321
	11	DUVAL	0.158	0.000	0.464	0.146	0.341		1.000	0.316
	12	FRANKLIN	0.704	0.000	3.113	1.081	0.226		1.000	0.347
	13	GLADES	0.634	0.000	0.731	0.235	0.868		1.000	0.322
	14	HAMILTON	0.078	0.000	0.172	0.043	0.452		1.000	0.252
	15	HERNANDO	0.483	0.000	0.553	0.169	0.873		1.000	0.306
	16	HILLSBOROUGH	0.461	0.000	0.469	0.141	0.984		1.000	0.301
	17	HOLMES	0.138	0.000	0.321	0.086	0.431		1.000	0.269
	18	INDIAN RIVER	1.237	0.000	3.695	1.338	0.335		1.000	0.362
	19	JACKSON	0.109	0.000	0.241	0.060	0.454		1.000	0.250
	20	LEE	0.690	0.000	0.843	0.278	0.818		1.000	0.329
	21	LEON	0.114	0.000	0.263	0.070	0.434		1.000	0.267
	22	MARION	0.287	0.000	0.259	0.067	1.106		1.000	0.259
	23	MARTIN	0.559	0.000	0.690	0.226	0.809		1.000	0.327
	24	MARTIN	1.185	0.000	3.247	1.214	0.365		1.000	0.374
	25	MIAMI-DADE	0.778	0.000	1.276	0.478	0.610		1.000	0.375
	26	MIAMI-DADE	1.121	0.000	2.711	1.040	0.413		1.000	0.384
	27	MONROE	1.078	0.000	2.754	1.053	0.392		1.000	0.382
	28	MONROE	1.549	0.000	4.911	1.899	0.315		1.000	0.387
	29	OKALOOSA	0.316	0.000	0.999	0.337	0.316		1.000	0.337
	30	OSCEOLA	0.389	0.000	0.359	0.099	1.085		1.000	0.275
	31	OSCEOLA	0.506	0.000	0.552	0.171	0.917		1.000	0.310
	32	PALM BEACH	0.711	0.000	1.007	0.350	0.706		1.000	0.348
	33	PALM BEACH	1.007	0.000	2.078	0.771	0.485		1.000	0.371
	34	PINELLAS	0.436	0.000	0.475	0.141	0.918		1.000	0.298
	35	SAINT JOHNS	0.115	0.000	0.281	0.079	0.409		1.000	0.282
	36	SANTA ROSA	0.221	0.000	0.620	0.199	0.356		1.000	0.321
	37	SEMINOLE	0.341	0.000	0.315	0.085	1.082		1.000	0.270
	38	TAYLOR	0.095	0.000	0.209	0.051	0.453		1.000	0.246
	39	VOLUSIA	0.398	0.000	0.491	0.152	0.809		1.000	0.310
	40	WAKULLA	0.249	0.000	0.773	0.248	0.322		1.000	0.321

Construction / Policy	Location	County	Hurricane Loss Cost per Coverage				Ratios Relative to Dominant Coverage			
			Coverage A	Coverage B	Coverage C	Coverage D	Coverage A	Coverage B	Coverage C	Coverage D
Commercial Residential	1	BAY	6.317	0.000	0.024	3.774	1.000		0.004	0.597
	2	BREVARD	3.707	0.000	0.009	1.982	1.000		0.002	0.535
	3	BREVARD	3.287	0.000	0.006	1.782	1.000		0.002	0.542
	4	BROWARD	5.836	0.000	0.013	3.167	1.000		0.002	0.543
	5	BROWARD	11.046	0.000	0.074	5.500	1.000		0.007	0.498
	6	CITRUS	1.468	0.000	0.001	1.036	1.000		0.001	0.706
	7	CLAY	0.628	0.000	0.000	0.472	1.000		0.000	0.752
	8	COLLIER	5.436	0.000	0.009	3.061	1.000		0.002	0.563
	9	COLUMBIA	0.540	0.000	0.000	0.431	1.000		0.000	0.798
	10	DIXIE	3.169	0.000	0.010	2.013	1.000		0.003	0.635
	11	DUVAL	2.056	0.000	0.005	1.580	1.000		0.003	0.768
	12	FRANKLIN	8.339	0.000	0.061	4.712	1.000		0.007	0.565
	13	GLADES	3.856	0.000	0.004	2.046	1.000		0.001	0.531
	14	HAMILTON	0.533	0.000	0.000	0.422	1.000		0.001	0.792
	15	HERNANDO	2.740	0.000	0.004	1.751	1.000		0.001	0.639
	16	HILLSBOROUGH	2.476	0.000	0.002	1.648	1.000		0.001	0.666
	17	HOLMES	1.660	0.000	0.001	1.195	1.000		0.001	0.720
	18	INDIAN RIVER	10.849	0.000	0.102	5.761	1.000		0.009	0.531
	19	JACKSON	1.115	0.000	0.000	0.849	1.000		0.000	0.761
	20	LEE	4.202	0.000	0.005	2.416	1.000		0.001	0.575
	21	LEON	1.089	0.000	0.001	0.849	1.000		0.001	0.779
	22	MARION	1.094	0.000	0.001	0.712	1.000		0.001	0.650
	23	MARTIN	3.960	0.000	0.005	2.148	1.000		0.001	0.543
	24	MARTIN	11.183	0.000	0.089	5.787	1.000		0.008	0.518
	25	MIAMI-DADE	5.682	0.000	0.012	3.230	1.000		0.002	0.569
	26	MIAMI-DADE	9.047	0.000	0.043	4.647	1.000		0.005	0.514
	27	MONROE	14.266	0.000	0.116	9.148	1.000		0.008	0.641
	28	MONROE	17.294	0.000	0.156	10.229	1.000		0.009	0.591
	29	OKALOOSA	4.912	0.000	0.012	3.145	1.000		0.002	0.640
	30	OSCEOLA	1.714	0.000	0.001	1.104	1.000		0.001	0.644
	31	OSCEOLA	2.628	0.000	0.003	1.555	1.000		0.001	0.592
	32	PALM BEACH	5.682	0.000	0.012	2.986	1.000		0.002	0.526
	33	PALM BEACH	9.692	0.000	0.049	4.802	1.000		0.005	0.495
	34	PINELLAS	2.899	0.000	0.004	1.761	1.000		0.001	0.608
	35	SAINT JOHNS	1.489	0.000	0.002	1.007	1.000		0.001	0.677
	36	SANTA ROSA	3.030	0.000	0.004	2.240	1.000		0.001	0.739
	37	SEMINOLE	1.352	0.000	0.001	0.897	1.000		0.001	0.663
	38	TAYLOR	0.979	0.000	0.001	0.736	1.000		0.001	0.752
	39	VOLUSIA	2.507	0.000	0.005	1.608	1.000		0.002	0.641
	40	WAKULLA	3.500	0.000	0.011	2.220	1.000		0.003	0.634

Construction / Policy	Location	County	Hurricane Loss Cost per Year Built					Ratios Relative to 1980 Year Built				
			Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019	Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019
Frame Owners	1	BAY	5.334	5.334	3.106	2.186	2.184	1.000	1.000	0.582	0.410	0.409
	2	BREVARD	5.422	5.422	3.296	1.854	1.854	1.000	1.000	0.608	0.342	0.342
	3	BREVARD	5.172	5.172	3.172	1.806	1.806	1.000	1.000	0.613	0.349	0.349
	4	BROWARD	8.691	9.261	2.504	2.504	2.504	1.000	1.066	0.288	0.288	0.288
	5	BROWARD	15.312	16.331	4.014	4.014	4.014	1.000	1.067	0.262	0.262	0.262
	6	CITRUS	3.960	3.960	2.391	1.410	1.410	1.000	1.000	0.604	0.356	0.356
	7	CLAY	0.972	0.972	0.799	0.726	0.726	1.000	1.000	0.823	0.748	0.748
	8	COLLIER	7.943	7.943	4.724	2.582	2.582	1.000	1.000	0.595	0.325	0.325
	9	COLUMBIA	0.996	0.996	0.825	0.752	0.752	1.000	1.000	0.828	0.755	0.755
	10	DIXIE	3.553	3.553	2.402	1.789	1.790	1.000	1.000	0.676	0.503	0.504
	11	DUVAL	2.031	2.031	1.448	1.149	1.150	1.000	1.000	0.713	0.566	0.566
	12	FRANKLIN	9.454	9.454	5.441	3.503	3.503	1.000	1.000	0.575	0.371	0.371
	13	GLADES	7.047	7.047	4.041	2.276	2.236	1.000	1.000	0.573	0.323	0.317
	14	HAMILTON	0.925	0.925	0.764	0.695	0.695	1.000	1.000	0.826	0.752	0.752
	15	HERNANDO	5.413	5.413	3.313	1.874	1.874	1.000	1.000	0.612	0.346	0.346
	16	HILLSBOROUGH	5.057	5.057	2.972	1.698	1.669	1.000	1.000	0.588	0.336	0.330
	17	HOLMES	1.730	1.730	1.300	1.130	1.130	1.000	1.000	0.752	0.653	0.653
	18	INDIAN RIVER	16.097	16.097	9.519	5.036	5.036	1.000	1.000	0.591	0.313	0.313
	19	JACKSON	1.363	1.363	1.075	0.956	0.956	1.000	1.000	0.789	0.701	0.701
	20	LEE	7.705	7.705	4.364	2.416	2.373	1.000	1.000	0.566	0.314	0.308
	21	LEON	1.426	1.426	1.093	0.960	0.960	1.000	1.000	0.766	0.673	0.673
	22	MARION	3.147	3.147	1.936	1.165	1.165	1.000	1.000	0.615	0.370	0.370
	23	MARTIN	6.421	6.421	3.886	2.149	2.149	1.000	1.000	0.605	0.335	0.335
	24	MARTIN	14.601	14.601	8.411	4.245	4.245	1.000	1.000	0.576	0.291	0.291
	25	MIAMI-DADE	7.870	8.377	2.299	2.299	2.299	1.000	1.064	0.292	0.292	0.292
	26	MIAMI-DADE	11.730	12.548	3.066	3.066	3.066	1.000	1.070	0.261	0.261	0.261
	27	MONROE	13.469	13.469	7.350	4.290	4.290	1.000	1.000	0.546	0.319	0.319
	28	MONROE	20.504	20.504	11.693	7.288	7.288	1.000	1.000	0.570	0.355	0.355
	29	OKALOOSA	3.865	3.865	2.369	1.796	1.793	1.000	1.000	0.613	0.465	0.464
	30	OSCEOLA	4.266	4.266	2.577	1.519	1.519	1.000	1.000	0.604	0.356	0.356
	31	OSCEOLA	5.602	5.602	3.267	1.871	1.840	1.000	1.000	0.583	0.334	0.328
	32	PALM BEACH	8.248	8.248	4.845	2.580	2.580	1.000	1.000	0.587	0.313	0.313
	33	PALM BEACH	12.140	12.140	6.930	3.498	3.498	1.000	1.000	0.571	0.288	0.288
	34	PINELLAS	4.870	4.870	3.010	1.720	1.720	1.000	1.000	0.618	0.353	0.353
	35	SAINT JOHNS	1.452	1.452	1.125	0.967	0.969	1.000	1.000	0.775	0.666	0.667
	36	SANTA ROSA	2.699	2.699	1.760	1.411	1.407	1.000	1.000	0.652	0.523	0.521
	37	SEMINOLE	3.739	3.739	2.278	1.357	1.357	1.000	1.000	0.609	0.363	0.363
	38	TAYLOR	1.219	1.219	0.991	0.878	0.879	1.000	1.000	0.814	0.721	0.722
	39	VOLUSIA	4.429	4.429	2.722	1.551	1.575	1.000	1.000	0.615	0.350	0.356
	40	WAKULLA	3.374	3.374	2.265	1.688	1.690	1.000	1.000	0.671	0.500	0.501

Construction / Policy	Location	County	Hurricane Loss Cost per Year Built					Ratios Relative to 1980 Year Built				
			Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019	Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019
Masonry Owners	1	BAY	5.005	5.005	2.956	2.123	2.125	1.000	1.000	0.591	0.424	0.425
	2	BREVARD	5.356	5.356	3.237	1.793	1.793	1.000	1.000	0.604	0.335	0.335
	3	BREVARD	5.119	5.119	3.120	1.749	1.749	1.000	1.000	0.610	0.342	0.342
	4	BROWARD	8.468	9.020	2.442	2.442	2.442	1.000	1.065	0.288	0.288	0.288
	5	BROWARD	14.585	15.550	3.707	3.707	3.707	1.000	1.066	0.254	0.254	0.254
	6	CITRUS	3.915	3.915	2.350	1.368	1.368	1.000	1.000	0.600	0.349	0.349
	7	CLAY	0.923	0.923	0.775	0.718	0.718	1.000	1.000	0.840	0.778	0.778
	8	COLLIER	7.849	7.849	4.638	2.490	2.490	1.000	1.000	0.591	0.317	0.317
	9	COLUMBIA	0.946	0.946	0.800	0.743	0.743	1.000	1.000	0.845	0.785	0.785
	10	DIXIE	3.311	3.311	2.278	1.743	1.742	1.000	1.000	0.688	0.527	0.526
	11	DUVAL	1.908	1.908	1.387	1.128	1.128	1.000	1.000	0.727	0.591	0.591
	12	FRANKLIN	8.709	8.709	5.026	3.258	3.258	1.000	1.000	0.577	0.374	0.374
	13	GLADES	6.958	6.958	3.965	2.195	2.163	1.000	1.000	0.570	0.316	0.311
	14	HAMILTON	0.879	0.879	0.741	0.687	0.687	1.000	1.000	0.843	0.782	0.782
	15	HERNANDO	5.356	5.356	3.258	1.813	1.813	1.000	1.000	0.608	0.339	0.339
	16	HILLSBOROUGH	4.998	4.998	2.918	1.641	1.617	1.000	1.000	0.584	0.328	0.323
	17	HOLMES	1.633	1.633	1.252	1.114	1.114	1.000	1.000	0.767	0.682	0.682
	18	INDIAN RIVER	14.978	14.978	8.765	4.554	4.554	1.000	1.000	0.585	0.304	0.304
	19	JACKSON	1.289	1.289	1.038	0.943	0.943	1.000	1.000	0.806	0.732	0.732
	20	LEE	7.602	7.602	4.279	2.327	2.292	1.000	1.000	0.563	0.306	0.301
	21	LEON	1.349	1.349	1.055	0.947	0.947	1.000	1.000	0.782	0.702	0.702
	22	MARION	3.112	3.112	1.904	1.133	1.133	1.000	1.000	0.612	0.364	0.364
	23	MARTIN	6.268	6.268	3.797	2.105	2.105	1.000	1.000	0.606	0.336	0.336
	24	MARTIN	13.818	13.818	7.935	3.959	3.959	1.000	1.000	0.574	0.286	0.286
	25	MIAMI-DADE	7.673	8.165	2.243	2.243	2.243	1.000	1.064	0.292	0.292	0.292
	26	MIAMI-DADE	11.317	12.098	2.931	2.931	2.931	1.000	1.069	0.259	0.259	0.259
	27	MONROE	12.772	12.772	6.918	3.991	3.991	1.000	1.000	0.542	0.313	0.313
	28	MONROE	18.926	18.926	10.609	6.451	6.451	1.000	1.000	0.561	0.341	0.341
	29	OKALOOSA	3.643	3.643	2.269	1.760	1.760	1.000	1.000	0.623	0.483	0.483
	30	OSCEOLA	4.218	4.218	2.533	1.473	1.473	1.000	1.000	0.600	0.349	0.349
	31	OSCEOLA	5.532	5.532	3.207	1.809	1.784	1.000	1.000	0.580	0.327	0.322
	32	PALM BEACH	8.039	8.039	4.728	2.520	2.520	1.000	1.000	0.588	0.313	0.313
	33	PALM BEACH	11.689	11.689	6.670	3.351	3.351	1.000	1.000	0.571	0.287	0.287
	34	PINELLAS	4.828	4.828	2.963	1.665	1.665	1.000	1.000	0.614	0.345	0.345
	35	SAINT JOHNS	1.374	1.374	1.086	0.955	0.955	1.000	1.000	0.790	0.695	0.695
	36	SANTA ROSA	2.546	2.546	1.688	1.386	1.385	1.000	1.000	0.663	0.544	0.544
	37	SEMINOLE	3.697	3.697	2.239	1.318	1.318	1.000	1.000	0.606	0.356	0.356
	38	TAYLOR	1.155	1.155	0.959	0.868	0.868	1.000	1.000	0.830	0.751	0.751
	39	VOLUSIA	4.374	4.374	2.674	1.501	1.521	1.000	1.000	0.611	0.343	0.348
	40	WAKULLA	3.157	3.157	2.158	1.653	1.652	1.000	1.000	0.683	0.524	0.523

Construction / Policy	Location	County	Hurricane Loss Cost per Year Built					Ratios Relative to 1972 Year Built				
			Year Built 1989	Year Built 1972	Year Built 1992	Year Built 2004	Year Built 2019	Year Built 1989	Year Built 1972	Year Built 1992	Year Built 2004	Year Built 2019
Manufactured Homes	1	BAY	28.967	28.967	28.967	2.937	2.937	1.000	1.000	1.000	0.101	0.101
	2	BREVARD	16.519	16.519	16.519	2.035	2.035	1.000	1.000	1.000	0.123	0.123
	3	BREVARD	15.342	15.342	15.342	1.970	1.970	1.000	1.000	1.000	0.128	0.128
	4	BROWARD	27.668	27.668	27.668	2.699	2.699	1.000	1.000	1.000	0.098	0.098
	5	BROWARD	49.794	49.794	49.794	5.016	5.016	1.000	1.000	1.000	0.101	0.101
	6	CITRUS	9.081	9.081	9.081	1.498	1.498	1.000	1.000	1.000	0.165	0.165
	7	CLAY	4.110	4.110	4.110	0.854	0.854	1.000	1.000	1.000	0.208	0.208
	8	COLLIER	26.475	26.475	26.475	2.704	2.704	1.000	1.000	1.000	0.102	0.102
	9	COLUMBIA	4.148	4.148	4.148	0.879	0.879	1.000	1.000	1.000	0.212	0.212
	10	DIXIE	19.805	19.805	19.805	2.361	2.361	1.000	1.000	1.000	0.119	0.119
	11	DUVAL	11.157	11.157	11.157	1.453	1.453	1.000	1.000	1.000	0.130	0.130
	12	FRANKLIN	43.347	43.347	43.347	4.812	4.812	1.000	1.000	1.000	0.111	0.111
	13	GLADES	19.776	19.776	19.776	2.439	2.439	1.000	1.000	1.000	0.123	0.123
	14	HAMILTON	3.842	3.842	3.842	0.813	0.813	1.000	1.000	1.000	0.212	0.212
	15	HERNANDO	16.044	16.044	16.044	2.051	2.051	1.000	1.000	1.000	0.128	0.128
	16	HILLSBOROUGH	12.814	12.814	12.814	1.813	1.813	1.000	1.000	1.000	0.141	0.141
	17	HOLMES	8.630	8.630	8.630	1.405	1.405	1.000	1.000	1.000	0.163	0.163
	18	INDIAN RIVER	52.597	52.597	52.597	7.009	7.009	1.000	1.000	1.000	0.133	0.133
	19	JACKSON	6.286	6.286	6.286	1.163	1.163	1.000	1.000	1.000	0.185	0.185
	20	LEE	22.235	22.235	22.235	2.481	2.481	1.000	1.000	1.000	0.112	0.112
	21	LEON	6.849	6.849	6.849	1.171	1.171	1.000	1.000	1.000	0.171	0.171
	22	MARION	6.660	6.660	6.660	1.234	1.234	1.000	1.000	1.000	0.185	0.185
	23	MARTIN	19.210	19.210	19.210	2.272	2.272	1.000	1.000	1.000	0.118	0.118
	24	MARTIN	50.094	50.094	50.094	5.300	5.300	1.000	1.000	1.000	0.106	0.106
	25	MIAMI-DADE	24.766	24.766	24.766	2.473	2.473	1.000	1.000	1.000	0.100	0.100
	26	MIAMI-DADE	39.389	39.389	39.389	3.525	3.525	1.000	1.000	1.000	0.089	0.089
	27	MONROE	58.376	58.376	58.376	5.378	5.378	1.000	1.000	1.000	0.092	0.092
	28	MONROE	81.685	81.685	81.685	10.075	10.075	1.000	1.000	1.000	0.123	0.123
	29	OKALOOSA	22.043	22.043	22.043	2.341	2.341	1.000	1.000	1.000	0.106	0.106
	30	OSCEOLA	9.785	9.785	9.785	1.614	1.614	1.000	1.000	1.000	0.165	0.165
	31	OSCEOLA	14.753	14.753	14.753	1.999	1.999	1.000	1.000	1.000	0.136	0.136
	32	PALM BEACH	27.486	27.486	27.486	2.745	2.745	1.000	1.000	1.000	0.100	0.100
	33	PALM BEACH	43.120	43.120	43.120	3.983	3.983	1.000	1.000	1.000	0.092	0.092
	34	PINELLAS	13.916	13.916	13.916	1.801	1.801	1.000	1.000	1.000	0.129	0.129
	35	SAINT JOHNS	7.852	7.852	7.852	1.191	1.191	1.000	1.000	1.000	0.152	0.152
	36	SANTA ROSA	15.517	15.517	15.517	1.828	1.828	1.000	1.000	1.000	0.118	0.118
	37	SEMINOLE	8.310	8.310	8.310	1.441	1.441	1.000	1.000	1.000	0.173	0.173
	38	TAYLOR	6.058	6.058	6.058	1.063	1.063	1.000	1.000	1.000	0.175	0.175
	39	VOLUSIA	12.856	12.856	12.856	1.703	1.703	1.000	1.000	1.000	0.132	0.132
	40	WAKULLA	19.371	19.371	19.371	2.208	2.208	1.000	1.000	1.000	0.114	0.114

Construction / Policy	Location	County	Hurricane Loss Cost per Year Built					Ratios Relative to 1980 Year Built				
			Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019	Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019
Frame Renters	1	BAY	1.898	1.898	0.899	0.536	0.536	1.000	1.000	0.474	0.283	0.283
	2	BREVARD	0.787	0.787	0.480	0.349	0.349	1.000	1.000	0.610	0.444	0.444
	3	BREVARD	0.699	0.699	0.443	0.337	0.337	1.000	1.000	0.634	0.482	0.482
	4	BROWARD	1.484	1.655	0.485	0.485	0.485	1.000	1.115	0.327	0.327	0.327
	5	BROWARD	4.432	4.886	1.025	1.025	1.025	1.000	1.103	0.231	0.231	0.231
	6	CITRUS	0.433	0.433	0.301	0.255	0.255	1.000	1.000	0.695	0.589	0.589
	7	CLAY	0.221	0.221	0.170	0.145	0.145	1.000	1.000	0.766	0.656	0.656
	8	COLLIER	1.185	1.185	0.691	0.495	0.495	1.000	1.000	0.583	0.417	0.417
	9	COLUMBIA	0.227	0.227	0.175	0.150	0.150	1.000	1.000	0.769	0.659	0.659
	10	DIXIE	1.179	1.179	0.674	0.430	0.430	1.000	1.000	0.572	0.365	0.365
	11	DUVAL	0.610	0.610	0.369	0.255	0.255	1.000	1.000	0.604	0.418	0.418
	12	FRANKLIN	4.227	4.227	2.060	1.107	1.107	1.000	1.000	0.487	0.262	0.262
	13	GLADES	0.929	0.929	0.537	0.420	0.420	1.000	1.000	0.578	0.453	0.453
	14	HAMILTON	0.212	0.212	0.162	0.138	0.138	1.000	1.000	0.766	0.653	0.653
	15	HERNANDO	0.733	0.733	0.465	0.354	0.354	1.000	1.000	0.635	0.483	0.483
	16	HILLSBOROUGH	0.586	0.586	0.379	0.314	0.314	1.000	1.000	0.647	0.536	0.536
	17	HOLMES	0.422	0.422	0.297	0.250	0.250	1.000	1.000	0.703	0.594	0.594
	18	INDIAN RIVER	5.432	5.432	2.957	1.567	1.567	1.000	1.000	0.544	0.288	0.288
	19	JACKSON	0.320	0.320	0.239	0.205	0.205	1.000	1.000	0.748	0.641	0.641
	20	LEE	1.069	1.069	0.595	0.453	0.453	1.000	1.000	0.557	0.424	0.424
	21	LEON	0.347	0.347	0.245	0.206	0.206	1.000	1.000	0.707	0.594	0.594
	22	MARION	0.327	0.327	0.241	0.207	0.207	1.000	1.000	0.738	0.635	0.635
	23	MARTIN	0.837	0.837	0.529	0.406	0.406	1.000	1.000	0.632	0.485	0.485
	24	MARTIN	4.433	4.433	2.302	1.131	1.131	1.000	1.000	0.519	0.255	0.255
	25	MIAMI-DADE	1.270	1.413	0.447	0.447	0.447	1.000	1.113	0.352	0.352	0.352
	26	MIAMI-DADE	2.812	3.134	0.658	0.658	0.658	1.000	1.115	0.234	0.234	0.234
	27	MONROE	3.892	3.892	2.057	1.140	1.140	1.000	1.000	0.529	0.293	0.293
	28	MONROE	7.423	7.423	4.251	2.665	2.665	1.000	1.000	0.573	0.359	0.359
	29	OKALOOSA	1.206	1.206	0.614	0.421	0.421	1.000	1.000	0.509	0.349	0.349
	30	OSCEOLA	0.455	0.455	0.321	0.274	0.274	1.000	1.000	0.705	0.603	0.603
	31	OSCEOLA	0.709	0.709	0.430	0.342	0.342	1.000	1.000	0.606	0.482	0.482
	32	PALM BEACH	1.296	1.296	0.729	0.495	0.495	1.000	1.000	0.562	0.382	0.382
	33	PALM BEACH	2.838	2.838	1.452	0.775	0.775	1.000	1.000	0.512	0.273	0.273
	34	PINELLAS	0.606	0.606	0.406	0.324	0.324	1.000	1.000	0.670	0.535	0.535
	35	SAINT JOHNS	0.373	0.373	0.260	0.208	0.208	1.000	1.000	0.696	0.559	0.559
	36	SANTA ROSA	0.757	0.757	0.430	0.329	0.329	1.000	1.000	0.568	0.435	0.435
	37	SEMINOLE	0.397	0.397	0.284	0.242	0.242	1.000	1.000	0.714	0.610	0.610
	38	TAYLOR	0.297	0.297	0.222	0.184	0.184	1.000	1.000	0.747	0.621	0.621
	39	VOLUSIA	0.632	0.632	0.395	0.291	0.291	1.000	1.000	0.626	0.460	0.460
	40	WAKULLA	1.092	1.092	0.616	0.395	0.395	1.000	1.000	0.564	0.362	0.362

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			Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019	Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019
Masonry Renters	1	BAY	1.755	1.755	0.832	0.494	0.494	1.000	1.000	0.474	0.282	0.282
	2	BREVARD	0.764	0.764	0.466	0.336	0.336	1.000	1.000	0.610	0.440	0.440
	3	BREVARD	0.681	0.681	0.431	0.325	0.325	1.000	1.000	0.633	0.477	0.477
	4	BROWARD	1.440	1.602	0.465	0.465	0.465	1.000	1.113	0.323	0.323	0.323
	5	BROWARD	4.055	4.470	0.831	0.831	0.831	1.000	1.102	0.205	0.205	0.205
	6	CITRUS	0.422	0.422	0.291	0.246	0.246	1.000	1.000	0.690	0.582	0.582
	7	CLAY	0.198	0.198	0.152	0.134	0.134	1.000	1.000	0.771	0.679	0.679
	8	COLLIER	1.157	1.157	0.675	0.477	0.477	1.000	1.000	0.583	0.412	0.412
	9	COLUMBIA	0.203	0.203	0.157	0.138	0.138	1.000	1.000	0.775	0.681	0.681
	10	DIXIE	1.078	1.078	0.616	0.394	0.394	1.000	1.000	0.571	0.366	0.366
	11	DUVAL	0.560	0.560	0.339	0.236	0.236	1.000	1.000	0.605	0.422	0.422
	12	FRANKLIN	3.734	3.734	1.786	0.936	0.936	1.000	1.000	0.478	0.251	0.251
	13	GLADES	0.907	0.907	0.523	0.406	0.406	1.000	1.000	0.577	0.447	0.447
	14	HAMILTON	0.189	0.189	0.146	0.128	0.128	1.000	1.000	0.771	0.676	0.676
	15	HERNANDO	0.714	0.714	0.453	0.341	0.341	1.000	1.000	0.634	0.478	0.478
	16	HILLSBOROUGH	0.573	0.573	0.368	0.303	0.303	1.000	1.000	0.642	0.529	0.529
	17	HOLMES	0.383	0.383	0.269	0.232	0.232	1.000	1.000	0.702	0.606	0.606
	18	INDIAN RIVER	4.769	4.769	2.542	1.292	1.292	1.000	1.000	0.533	0.271	0.271
	19	JACKSON	0.288	0.288	0.216	0.190	0.190	1.000	1.000	0.750	0.660	0.660
	20	LEE	1.042	1.042	0.580	0.437	0.437	1.000	1.000	0.557	0.419	0.419
	21	LEON	0.314	0.314	0.222	0.191	0.191	1.000	1.000	0.707	0.608	0.608
	22	MARION	0.318	0.318	0.233	0.200	0.200	1.000	1.000	0.732	0.628	0.628
	23	MARTIN	0.817	0.817	0.515	0.391	0.391	1.000	1.000	0.630	0.479	0.479
	24	MARTIN	4.005	4.005	2.059	0.984	0.984	1.000	1.000	0.514	0.246	0.246
	25	MIAMI-DADE	1.233	1.370	0.429	0.429	0.429	1.000	1.111	0.348	0.348	0.348
	26	MIAMI-DADE	2.656	2.953	0.595	0.595	0.595	1.000	1.112	0.224	0.224	0.224
	27	MONROE	3.558	3.558	1.852	0.999	0.999	1.000	1.000	0.520	0.281	0.281
	28	MONROE	6.429	6.429	3.560	2.125	2.125	1.000	1.000	0.554	0.330	0.330
	29	OKALOOSA	1.125	1.125	0.571	0.393	0.393	1.000	1.000	0.507	0.349	0.349
	30	OSCEOLA	0.445	0.445	0.311	0.264	0.264	1.000	1.000	0.699	0.595	0.595
	31	OSCEOLA	0.692	0.692	0.418	0.330	0.330	1.000	1.000	0.604	0.476	0.476
	32	PALM BEACH	1.263	1.263	0.712	0.477	0.477	1.000	1.000	0.564	0.378	0.378
	33	PALM BEACH	2.666	2.666	1.364	0.716	0.716	1.000	1.000	0.512	0.269	0.269
	34	PINELLAS	0.591	0.591	0.394	0.312	0.312	1.000	1.000	0.667	0.529	0.529
	35	SAINT JOHNS	0.340	0.340	0.237	0.193	0.193	1.000	1.000	0.697	0.569	0.569
	36	SANTA ROSA	0.703	0.703	0.396	0.307	0.307	1.000	1.000	0.563	0.436	0.436
	37	SEMINOLE	0.388	0.388	0.275	0.234	0.234	1.000	1.000	0.708	0.602	0.602
	38	TAYLOR	0.268	0.268	0.201	0.171	0.171	1.000	1.000	0.750	0.638	0.638
	39	VOLUSIA	0.613	0.613	0.383	0.280	0.280	1.000	1.000	0.626	0.456	0.456
	40	WAKULLA	1.010	1.010	0.570	0.366	0.366	1.000	1.000	0.565	0.363	0.363

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Frame Condo Unit	1	BAY	4.015	4.015	1.794	0.868	0.867	1.000	1.000	0.447	0.216	0.216
	2	BREVARD	1.883	1.883	0.998	0.540	0.540	1.000	1.000	0.530	0.287	0.287
	3	BREVARD	1.674	1.674	0.902	0.510	0.510	1.000	1.000	0.539	0.305	0.305
	4	BROWARD	3.644	4.044	0.750	0.750	0.750	1.000	1.110	0.206	0.206	0.206
	5	BROWARD	9.327	10.155	2.085	2.085	2.085	1.000	1.089	0.224	0.224	0.224
	6	CITRUS	1.009	1.009	0.565	0.379	0.379	1.000	1.000	0.560	0.375	0.375
	7	CLAY	0.360	0.360	0.247	0.207	0.207	1.000	1.000	0.688	0.575	0.575
	8	COLLIER	2.940	2.940	1.482	0.757	0.757	1.000	1.000	0.504	0.258	0.258
	9	COLUMBIA	0.366	0.366	0.254	0.213	0.213	1.000	1.000	0.696	0.583	0.583
	10	DIXIE	2.379	2.379	1.271	0.690	0.690	1.000	1.000	0.534	0.290	0.290
	11	DUVAL	1.214	1.214	0.666	0.387	0.387	1.000	1.000	0.548	0.319	0.319
	12	FRANKLIN	8.153	8.153	4.117	2.199	2.199	1.000	1.000	0.505	0.270	0.270
	13	GLADES	2.305	2.305	1.099	0.633	0.629	1.000	1.000	0.477	0.275	0.273
	14	HAMILTON	0.342	0.342	0.237	0.197	0.197	1.000	1.000	0.692	0.577	0.577
	15	HERNANDO	1.751	1.751	0.946	0.537	0.537	1.000	1.000	0.540	0.306	0.306
	16	HILLSBOROUGH	1.421	1.421	0.735	0.465	0.462	1.000	1.000	0.517	0.327	0.325
	17	HOLMES	0.761	0.761	0.445	0.346	0.346	1.000	1.000	0.585	0.454	0.454
	18	INDIAN RIVER	10.743	10.743	6.144	3.358	3.358	1.000	1.000	0.572	0.313	0.313
	19	JACKSON	0.539	0.539	0.348	0.285	0.285	1.000	1.000	0.645	0.528	0.528
	20	LEE	2.657	2.657	1.238	0.683	0.679	1.000	1.000	0.466	0.257	0.256
	21	LEON	0.616	0.616	0.369	0.288	0.288	1.000	1.000	0.600	0.467	0.467
	22	MARION	0.737	0.737	0.441	0.309	0.309	1.000	1.000	0.598	0.419	0.419
	23	MARTIN	2.046	2.046	1.087	0.608	0.608	1.000	1.000	0.531	0.297	0.297
	24	MARTIN	9.198	9.198	4.991	2.471	2.471	1.000	1.000	0.543	0.269	0.269
	25	MIAMI-DADE	3.137	3.484	0.684	0.684	0.684	1.000	1.111	0.218	0.218	0.218
	26	MIAMI-DADE	6.396	7.037	1.185	1.185	1.185	1.000	1.100	0.185	0.185	0.185
	27	MONROE	8.721	8.721	4.608	2.551	2.551	1.000	1.000	0.528	0.293	0.293
	28	MONROE	15.107	15.107	8.777	5.612	5.612	1.000	1.000	0.581	0.371	0.371
	29	OKALOOSA	2.597	2.597	1.154	0.614	0.614	1.000	1.000	0.444	0.237	0.236
	30	OSCEOLA	1.065	1.065	0.599	0.407	0.407	1.000	1.000	0.563	0.382	0.382
	31	OSCEOLA	1.724	1.724	0.860	0.514	0.510	1.000	1.000	0.499	0.298	0.296
	32	PALM BEACH	3.203	3.203	1.596	0.773	0.773	1.000	1.000	0.498	0.241	0.241
	33	PALM BEACH	6.447	6.447	3.259	1.466	1.466	1.000	1.000	0.505	0.227	0.227
	34	PINELLAS	1.439	1.439	0.801	0.483	0.483	1.000	1.000	0.557	0.336	0.336
	35	SAINT JOHNS	0.693	0.693	0.417	0.294	0.294	1.000	1.000	0.602	0.425	0.425
	36	SANTA ROSA	1.587	1.587	0.741	0.459	0.459	1.000	1.000	0.467	0.289	0.289
	37	SEMINOLE	0.917	0.917	0.527	0.361	0.361	1.000	1.000	0.575	0.394	0.394
	38	TAYLOR	0.511	0.511	0.338	0.260	0.260	1.000	1.000	0.660	0.509	0.509
	39	VOLUSIA	1.482	1.482	0.807	0.452	0.454	1.000	1.000	0.545	0.305	0.306
	40	WAKULLA	2.256	2.256	1.172	0.611	0.611	1.000	1.000	0.519	0.271	0.271

Construction / Policy	Location	County	Hurricane Loss Cost per Year Built					Ratios Relative to 1980 Year Built				
			Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019	Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019
Masonry Condo Unit	1	BAY	3.703	3.703	1.652	0.792	0.792	1.000	1.000	0.446	0.214	0.214
	2	BREVARD	1.829	1.829	0.967	0.517	0.517	1.000	1.000	0.529	0.282	0.282
	3	BREVARD	1.637	1.637	0.880	0.491	0.491	1.000	1.000	0.538	0.300	0.300
	4	BROWARD	3.512	3.890	0.708	0.708	0.708	1.000	1.108	0.201	0.201	0.201
	5	BROWARD	8.439	9.197	1.522	1.522	1.522	1.000	1.090	0.180	0.180	0.180
	6	CITRUS	0.997	0.997	0.553	0.365	0.365	1.000	1.000	0.554	0.366	0.366
	7	CLAY	0.334	0.334	0.229	0.195	0.195	1.000	1.000	0.686	0.586	0.586
	8	COLLIER	2.868	2.868	1.445	0.726	0.726	1.000	1.000	0.504	0.253	0.253
	9	COLUMBIA	0.339	0.339	0.235	0.202	0.202	1.000	1.000	0.695	0.595	0.595
	10	DIXIE	2.175	2.175	1.157	0.627	0.627	1.000	1.000	0.532	0.288	0.288
	11	DUVAL	1.122	1.122	0.615	0.360	0.360	1.000	1.000	0.548	0.321	0.321
	12	FRANKLIN	7.171	7.171	3.529	1.811	1.811	1.000	1.000	0.492	0.252	0.252
	13	GLADES	2.266	2.266	1.077	0.608	0.605	1.000	1.000	0.475	0.268	0.267
	14	HAMILTON	0.317	0.317	0.219	0.186	0.186	1.000	1.000	0.692	0.589	0.589
	15	HERNANDO	1.710	1.710	0.921	0.515	0.515	1.000	1.000	0.539	0.301	0.301
	16	HILLSBOROUGH	1.405	1.405	0.721	0.448	0.446	1.000	1.000	0.513	0.319	0.317
	17	HOLMES	0.717	0.717	0.416	0.327	0.327	1.000	1.000	0.580	0.456	0.456
	18	INDIAN RIVER	9.363	9.363	5.201	2.699	2.699	1.000	1.000	0.556	0.288	0.288
	19	JACKSON	0.504	0.504	0.323	0.269	0.269	1.000	1.000	0.640	0.534	0.534
	20	LEE	2.603	2.603	1.211	0.657	0.653	1.000	1.000	0.465	0.252	0.251
	21	LEON	0.578	0.578	0.344	0.272	0.272	1.000	1.000	0.595	0.470	0.470
	22	MARION	0.728	0.728	0.430	0.298	0.298	1.000	1.000	0.591	0.409	0.409
	23	MARTIN	2.002	2.002	1.063	0.588	0.588	1.000	1.000	0.531	0.294	0.294
	24	MARTIN	8.193	8.193	4.352	2.045	2.045	1.000	1.000	0.531	0.250	0.250
	25	MIAMI-DADE	3.037	3.369	0.646	0.646	0.646	1.000	1.109	0.213	0.213	0.213
	26	MIAMI-DADE	5.961	6.552	0.993	0.993	0.993	1.000	1.099	0.167	0.167	0.167
	27	MONROE	7.794	7.794	4.014	2.124	2.124	1.000	1.000	0.515	0.272	0.272
	28	MONROE	12.998	12.998	7.305	4.458	4.458	1.000	1.000	0.562	0.343	0.343
	29	OKALOOSA	2.440	2.440	1.086	0.577	0.577	1.000	1.000	0.445	0.237	0.237
	30	OSCEOLA	1.055	1.055	0.586	0.392	0.392	1.000	1.000	0.556	0.372	0.372
	31	OSCEOLA	1.694	1.694	0.841	0.495	0.492	1.000	1.000	0.497	0.292	0.290
	32	PALM BEACH	3.099	3.099	1.549	0.743	0.743	1.000	1.000	0.500	0.240	0.240
	33	PALM BEACH	5.977	5.977	2.997	1.305	1.305	1.000	1.000	0.501	0.218	0.218
	34	PINELLAS	1.415	1.415	0.783	0.465	0.465	1.000	1.000	0.553	0.328	0.328
	35	SAINT JOHNS	0.649	0.649	0.390	0.278	0.278	1.000	1.000	0.601	0.428	0.428
	36	SANTA ROSA	1.507	1.507	0.700	0.433	0.433	1.000	1.000	0.465	0.288	0.288
	37	SEMINOLE	0.906	0.906	0.515	0.348	0.348	1.000	1.000	0.569	0.384	0.384
	38	TAYLOR	0.476	0.476	0.314	0.246	0.246	1.000	1.000	0.659	0.516	0.516
	39	VOLUSIA	1.435	1.435	0.780	0.431	0.433	1.000	1.000	0.544	0.300	0.302
	40	WAKULLA	2.083	2.083	1.082	0.567	0.566	1.000	1.000	0.520	0.272	0.272

Construction / Policy	Location	County	Hurricane Loss Cost per Year Built					Ratios Relative to 1980 Year Built				
			Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019	Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019
Commercial Residential	1	BAY	10.115	10.115	10.115	6.668	6.668	1.000	1.000	1.000	0.659	0.659
	2	BREVARD	5.698	5.698	5.698	3.538	3.538	1.000	1.000	1.000	0.621	0.621
	3	BREVARD	5.075	5.075	5.075	3.070	3.070	1.000	1.000	1.000	0.605	0.605
	4	BROWARD	9.015	9.015	5.711	5.711	5.711	1.000	1.000	0.634	0.634	0.634
	5	BROWARD	16.620	16.620	11.682	11.682	11.682	1.000	1.000	0.703	0.703	0.703
	6	CITRUS	2.505	2.505	2.505	1.369	1.369	1.000	1.000	1.000	0.546	0.546
	7	CLAY	1.100	1.100	1.100	0.567	0.567	1.000	1.000	1.000	0.515	0.515
	8	COLLIER	8.506	8.506	8.506	5.246	5.246	1.000	1.000	1.000	0.617	0.617
	9	COLUMBIA	0.971	0.971	0.971	0.491	0.491	1.000	1.000	1.000	0.506	0.506
	10	DIXIE	5.192	5.192	5.192	3.203	3.203	1.000	1.000	1.000	0.617	0.617
	11	DUVAL	3.641	3.641	3.641	2.266	2.266	1.000	1.000	1.000	0.622	0.622
	12	FRANKLIN	13.111	13.111	13.111	9.081	9.081	1.000	1.000	1.000	0.693	0.693
	13	GLADES	5.906	5.906	5.906	3.492	3.492	1.000	1.000	1.000	0.591	0.591
	14	HAMILTON	0.955	0.955	0.955	0.487	0.487	1.000	1.000	1.000	0.510	0.510
	15	HERNANDO	4.495	4.495	4.495	2.630	2.630	1.000	1.000	1.000	0.585	0.585
	16	HILLSBOROUGH	4.126	4.126	4.126	2.365	2.365	1.000	1.000	1.000	0.573	0.573
	17	HOLMES	2.856	2.856	2.856	1.594	1.594	1.000	1.000	1.000	0.558	0.558
	18	INDIAN RIVER	16.712	16.712	16.712	12.113	12.113	1.000	1.000	1.000	0.725	0.725
	19	JACKSON	1.964	1.964	1.964	1.054	1.054	1.000	1.000	1.000	0.537	0.537
	20	LEE	6.624	6.624	6.624	3.942	3.942	1.000	1.000	1.000	0.595	0.595
	21	LEON	1.939	1.939	1.939	1.055	1.055	1.000	1.000	1.000	0.544	0.544
	22	MARION	1.807	1.807	1.807	0.950	0.950	1.000	1.000	1.000	0.526	0.526
	23	MARTIN	6.114	6.114	6.114	3.701	3.701	1.000	1.000	1.000	0.605	0.605
	24	MARTIN	17.059	17.059	17.059	12.252	12.252	1.000	1.000	1.000	0.718	0.718
	25	MIAMI-DADE	8.924	8.924	5.654	5.654	5.654	1.000	1.000	0.634	0.634	0.634
	26	MIAMI-DADE	13.737	13.737	9.396	9.396	9.396	1.000	1.000	0.684	0.684	0.684
	27	MONROE	23.530	23.530	23.530	17.221	17.221	1.000	1.000	1.000	0.732	0.732
	28	MONROE	27.679	27.679	27.679	20.469	20.469	1.000	1.000	1.000	0.740	0.740
	29	OKALOOSA	8.069	8.069	8.069	5.128	5.128	1.000	1.000	1.000	0.636	0.636
	30	OSCEOLA	2.819	2.819	2.819	1.544	1.544	1.000	1.000	1.000	0.548	0.548
	31	OSCEOLA	4.186	4.186	4.186	2.415	2.415	1.000	1.000	1.000	0.577	0.577
	32	PALM BEACH	8.680	8.680	8.680	5.459	5.459	1.000	1.000	1.000	0.629	0.629
	33	PALM BEACH	14.543	14.543	14.543	9.961	9.961	1.000	1.000	1.000	0.685	0.685
	34	PINELLAS	4.664	4.664	4.664	2.755	2.755	1.000	1.000	1.000	0.591	0.591
	35	SAINT JOHNS	2.498	2.498	2.498	1.449	1.449	1.000	1.000	1.000	0.580	0.580
	36	SANTA ROSA	5.273	5.273	5.273	3.148	3.148	1.000	1.000	1.000	0.597	0.597
	37	SEMINOLE	2.250	2.250	2.250	1.214	1.214	1.000	1.000	1.000	0.540	0.540
	38	TAYLOR	1.715	1.715	1.715	0.940	0.940	1.000	1.000	1.000	0.548	0.548
	39	VOLUSIA	4.120	4.120	4.120	2.504	2.504	1.000	1.000	1.000	0.608	0.608
	40	WAKULLA	5.730	5.730	5.730	3.622	3.622	1.000	1.000	1.000	0.632	0.632

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Frame Owners	1	BAY	6.642	3.108	2.065	1.000	0.468	0.311
	2	BREVARD	6.790	3.300	1.819	1.000	0.486	0.268
	3	BREVARD	6.441	3.175	1.781	1.000	0.493	0.277
	4	BROWARD	10.400	2.427	2.434	1.000	0.233	0.234
	5	BROWARD	18.369	3.590	3.414	1.000	0.195	0.186
	6	CITRUS	4.548	2.365	1.404	1.000	0.520	0.309
	7	CLAY	1.071	0.800	0.726	1.000	0.746	0.677
	8	COLLIER	10.098	4.692	2.532	1.000	0.465	0.251
	9	COLUMBIA	1.094	0.825	0.751	1.000	0.754	0.687
	10	DIXIE	4.628	2.333	1.702	1.000	0.504	0.368
	11	DUVAL	2.596	1.432	1.118	1.000	0.552	0.431
	12	FRANKLIN	11.531	5.495	2.952	1.000	0.477	0.256
	13	GLADES	8.287	4.034	2.253	1.000	0.487	0.272
	14	HAMILTON	1.017	0.777	0.694	1.000	0.764	0.683
	15	HERNANDO	6.736	3.280	1.847	1.000	0.487	0.274
	16	HILLSBOROUGH	5.867	2.969	1.688	1.000	0.506	0.288
	17	HOLMES	1.988	1.297	1.127	1.000	0.652	0.567
	18	INDIAN RIVER	20.285	9.437	4.045	1.000	0.465	0.199
	19	JACKSON	1.531	1.072	0.955	1.000	0.700	0.624
	20	LEE	9.099	4.339	2.385	1.000	0.477	0.262
	21	LEON	1.627	1.087	0.958	1.000	0.668	0.589
	22	MARION	3.587	1.928	1.161	1.000	0.537	0.324
	23	MARTIN	8.016	3.857	2.121	1.000	0.481	0.265
	24	MARTIN	18.647	8.522	3.587	1.000	0.457	0.192
	25	MIAMI-DADE	9.390	2.233	2.244	1.000	0.238	0.239
	26	MIAMI-DADE	14.183	2.862	2.808	1.000	0.202	0.198
	27	MONROE	20.614	7.306	3.554	1.000	0.354	0.172
	28	MONROE	30.433	11.550	5.561	1.000	0.380	0.183
	29	OKALOOSA	4.789	2.394	1.754	1.000	0.500	0.366
	30	OSCEOLA	4.897	2.570	1.513	1.000	0.525	0.309
	31	OSCEOLA	6.540	3.266	1.854	1.000	0.499	0.284
	32	PALM BEACH	10.522	4.844	2.514	1.000	0.460	0.239
	33	PALM BEACH	15.696	6.911	3.193	1.000	0.440	0.203
	34	PINELLAS	6.012	2.994	1.704	1.000	0.498	0.283
	35	SAINT JOHNS	1.789	1.126	0.962	1.000	0.629	0.537
	36	SANTA ROSA	3.289	1.764	1.396	1.000	0.536	0.424
	37	SEMINOLE	4.280	2.269	1.352	1.000	0.530	0.316
	38	TAYLOR	1.447	0.985	0.876	1.000	0.681	0.605
	39	VOLUSIA	5.498	2.726	1.522	1.000	0.496	0.277
	40	WAKULLA	4.441	2.207	1.623	1.000	0.497	0.366

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Masonry Owners	1	BAY	6.220	2.970	2.029	1.000	0.478	0.326
	2	BREVARD	6.705	3.242	1.762	1.000	0.483	0.263
	3	BREVARD	6.372	3.122	1.726	1.000	0.490	0.271
	4	BROWARD	10.125	2.405	2.383	1.000	0.237	0.235
	5	BROWARD	17.481	3.388	3.254	1.000	0.194	0.186
	6	CITRUS	4.498	2.325	1.361	1.000	0.517	0.303
	7	CLAY	1.014	0.775	0.718	1.000	0.765	0.708
	8	COLLIER	9.974	4.565	2.445	1.000	0.458	0.245
	9	COLUMBIA	1.036	0.800	0.743	1.000	0.772	0.717
	10	DIXIE	4.308	2.238	1.675	1.000	0.520	0.389
	11	DUVAL	2.432	1.380	1.104	1.000	0.567	0.454
	12	FRANKLIN	10.624	5.106	2.854	1.000	0.481	0.269
	13	GLADES	8.181	3.933	2.173	1.000	0.481	0.266
	14	HAMILTON	0.963	0.754	0.687	1.000	0.783	0.713
	15	HERNANDO	6.664	3.234	1.789	1.000	0.485	0.268
	16	HILLSBOROUGH	5.800	2.919	1.630	1.000	0.503	0.281
	17	HOLMES	1.875	1.253	1.112	1.000	0.668	0.593
	18	INDIAN RIVER	18.980	8.828	3.832	1.000	0.465	0.202
	19	JACKSON	1.444	1.038	0.943	1.000	0.718	0.653
	20	LEE	8.974	4.203	2.298	1.000	0.468	0.256
	21	LEON	1.535	1.052	0.946	1.000	0.685	0.616
	22	MARION	3.548	1.891	1.128	1.000	0.533	0.318
	23	MARTIN	7.825	3.681	2.081	1.000	0.470	0.266
	24	MARTIN	17.632	8.040	3.465	1.000	0.456	0.196
	25	MIAMI-DADE	9.149	2.214	2.197	1.000	0.242	0.240
	26	MIAMI-DADE	13.660	2.792	2.727	1.000	0.204	0.200
	27	MONROE	19.489	6.962	3.430	1.000	0.357	0.176
	28	MONROE	28.192	10.675	5.253	1.000	0.379	0.186
	29	OKALOOSA	4.508	2.297	1.727	1.000	0.510	0.383
	30	OSCEOLA	4.843	2.521	1.467	1.000	0.521	0.303
	31	OSCEOLA	6.457	3.201	1.792	1.000	0.496	0.278
	32	PALM BEACH	10.245	4.605	2.463	1.000	0.449	0.240
	33	PALM BEACH	15.090	6.585	3.112	1.000	0.436	0.206
	34	PINELLAS	5.960	2.919	1.650	1.000	0.490	0.277
	35	SAINT JOHNS	1.688	1.089	0.950	1.000	0.645	0.563
	36	SANTA ROSA	3.102	1.695	1.374	1.000	0.546	0.443
	37	SEMINOLE	4.233	2.225	1.312	1.000	0.526	0.310
	38	TAYLOR	1.367	0.954	0.866	1.000	0.698	0.633
	39	VOLUSIA	5.430	2.680	1.476	1.000	0.494	0.272
	40	WAKULLA	4.147	2.122	1.600	1.000	0.512	0.386

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Manufactured Homes	1	BAY	28.967	28.967	2.937	1.000	1.000	0.101
	2	BREVARD	16.519	16.519	2.035	1.000	1.000	0.123
	3	BREVARD	15.342	15.342	1.970	1.000	1.000	0.128
	4	BROWARD	27.668	27.668	2.699	1.000	1.000	0.098
	5	BROWARD	49.794	49.794	5.016	1.000	1.000	0.101
	6	CITRUS	9.081	9.081	1.498	1.000	1.000	0.165
	7	CLAY	4.110	4.110	0.854	1.000	1.000	0.208
	8	COLLIER	26.475	26.475	2.704	1.000	1.000	0.102
	9	COLUMBIA	4.148	4.148	0.879	1.000	1.000	0.212
	10	DIXIE	19.805	19.805	2.361	1.000	1.000	0.119
	11	DUVAL	11.157	11.157	1.453	1.000	1.000	0.130
	12	FRANKLIN	43.347	43.347	4.812	1.000	1.000	0.111
	13	GLADES	19.776	19.776	2.439	1.000	1.000	0.123
	14	HAMILTON	3.842	3.842	0.813	1.000	1.000	0.212
	15	HERNANDO	16.044	16.044	2.051	1.000	1.000	0.128
	16	HILLSBOROUGH	12.814	12.814	1.813	1.000	1.000	0.141
	17	HOLMES	8.630	8.630	1.405	1.000	1.000	0.163
	18	INDIAN RIVER	52.597	52.597	7.009	1.000	1.000	0.133
	19	JACKSON	6.286	6.286	1.163	1.000	1.000	0.185
	20	LEE	22.235	22.235	2.481	1.000	1.000	0.112
	21	LEON	6.849	6.849	1.171	1.000	1.000	0.171
	22	MARION	6.660	6.660	1.234	1.000	1.000	0.185
	23	MARTIN	19.210	19.210	2.272	1.000	1.000	0.118
	24	MARTIN	50.094	50.094	5.300	1.000	1.000	0.106
	25	MIAMI-DADE	24.766	24.766	2.473	1.000	1.000	0.100
	26	MIAMI-DADE	39.389	39.389	3.525	1.000	1.000	0.089
	27	MONROE	58.376	58.376	5.378	1.000	1.000	0.092
	28	MONROE	81.685	81.685	10.075	1.000	1.000	0.123
	29	OKALOOSA	22.043	22.043	2.341	1.000	1.000	0.106
	30	OSCEOLA	9.785	9.785	1.614	1.000	1.000	0.165
	31	OSCEOLA	14.753	14.753	1.999	1.000	1.000	0.136
	32	PALM BEACH	27.486	27.486	2.745	1.000	1.000	0.100
	33	PALM BEACH	43.120	43.120	3.983	1.000	1.000	0.092
	34	PINELLAS	13.916	13.916	1.801	1.000	1.000	0.129
	35	SAINT JOHNS	7.852	7.852	1.191	1.000	1.000	0.152
	36	SANTA ROSA	15.517	15.517	1.828	1.000	1.000	0.118
	37	SEMINOLE	8.310	8.310	1.441	1.000	1.000	0.173
	38	TAYLOR	6.058	6.058	1.063	1.000	1.000	0.175
	39	VOLUSIA	12.856	12.856	1.703	1.000	1.000	0.132
	40	WAKULLA	19.371	19.371	2.208	1.000	1.000	0.114

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Frame Renters	1	BAY	2.533	0.909	0.493	1.000	0.359	0.195
	2	BREVARD	1.139	0.497	0.340	1.000	0.436	0.299
	3	BREVARD	0.999	0.457	0.331	1.000	0.458	0.331
	4	BROWARD	1.996	0.475	0.466	1.000	0.238	0.233
	5	BROWARD	5.795	0.882	0.734	1.000	0.152	0.127
	6	CITRUS	0.519	0.299	0.254	1.000	0.576	0.489
	7	CLAY	0.249	0.170	0.145	1.000	0.683	0.583
	8	COLLIER	1.781	0.714	0.482	1.000	0.401	0.271
	9	COLUMBIA	0.254	0.175	0.149	1.000	0.688	0.587
	10	DIXIE	1.699	0.650	0.398	1.000	0.383	0.234
	11	DUVAL	0.865	0.370	0.245	1.000	0.428	0.284
	12	FRANKLIN	5.440	2.076	0.834	1.000	0.382	0.153
	13	GLADES	1.204	0.553	0.415	1.000	0.460	0.345
	14	HAMILTON	0.237	0.168	0.138	1.000	0.707	0.581
	15	HERNANDO	1.044	0.465	0.347	1.000	0.445	0.332
	16	HILLSBOROUGH	0.729	0.391	0.312	1.000	0.536	0.428
	17	HOLMES	0.501	0.298	0.250	1.000	0.595	0.499
	18	INDIAN RIVER	7.599	3.026	1.082	1.000	0.398	0.142
	19	JACKSON	0.366	0.240	0.205	1.000	0.655	0.559
	20	LEE	1.400	0.613	0.445	1.000	0.438	0.318
	21	LEON	0.409	0.246	0.205	1.000	0.602	0.501
	22	MARION	0.379	0.243	0.207	1.000	0.642	0.546
	23	MARTIN	1.206	0.554	0.400	1.000	0.460	0.331
	24	MARTIN	6.354	2.523	0.848	1.000	0.397	0.133
	25	MIAMI-DADE	1.700	0.439	0.432	1.000	0.258	0.254
	26	MIAMI-DADE	3.778	0.607	0.557	1.000	0.161	0.147
	27	MONROE	7.471	2.184	0.841	1.000	0.292	0.113
	28	MONROE	13.129	4.415	1.712	1.000	0.336	0.130
	29	OKALOOSA	1.605	0.637	0.408	1.000	0.397	0.254
	30	OSCEOLA	0.543	0.324	0.274	1.000	0.596	0.504
	31	OSCEOLA	0.901	0.438	0.338	1.000	0.487	0.375
	32	PALM BEACH	1.962	0.755	0.478	1.000	0.385	0.244
	33	PALM BEACH	4.255	1.491	0.663	1.000	0.350	0.156
	34	PINELLAS	0.841	0.416	0.320	1.000	0.495	0.380
	35	SAINT JOHNS	0.497	0.263	0.207	1.000	0.530	0.416
	36	SANTA ROSA	0.983	0.440	0.325	1.000	0.447	0.330
	37	SEMINOLE	0.470	0.287	0.242	1.000	0.611	0.514
	38	TAYLOR	0.373	0.220	0.184	1.000	0.590	0.492
	39	VOLUSIA	0.896	0.409	0.283	1.000	0.457	0.316
	40	WAKULLA	1.601	0.601	0.374	1.000	0.376	0.234

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Masonry Renters	1	BAY	2.341	0.850	0.462	1.000	0.363	0.197
	2	BREVARD	1.102	0.485	0.329	1.000	0.440	0.298
	3	BREVARD	0.969	0.446	0.320	1.000	0.460	0.330
	4	BROWARD	1.926	0.456	0.450	1.000	0.237	0.233
	5	BROWARD	5.298	0.712	0.652	1.000	0.134	0.123
	6	CITRUS	0.507	0.289	0.245	1.000	0.570	0.483
	7	CLAY	0.225	0.153	0.134	1.000	0.680	0.597
	8	COLLIER	1.727	0.700	0.466	1.000	0.405	0.270
	9	COLUMBIA	0.229	0.157	0.138	1.000	0.686	0.601
	10	DIXIE	1.558	0.606	0.371	1.000	0.389	0.238
	11	DUVAL	0.798	0.341	0.228	1.000	0.428	0.286
	12	FRANKLIN	4.832	1.848	0.772	1.000	0.382	0.160
	13	GLADES	1.174	0.540	0.401	1.000	0.460	0.341
	14	HAMILTON	0.214	0.152	0.127	1.000	0.709	0.595
	15	HERNANDO	1.013	0.453	0.335	1.000	0.447	0.331
	16	HILLSBOROUGH	0.713	0.380	0.301	1.000	0.533	0.422
	17	HOLMES	0.460	0.270	0.232	1.000	0.587	0.503
	18	INDIAN RIVER	6.720	2.696	1.012	1.000	0.401	0.151
	19	JACKSON	0.333	0.216	0.189	1.000	0.649	0.568
	20	LEE	1.361	0.599	0.430	1.000	0.440	0.316
	21	LEON	0.374	0.223	0.190	1.000	0.596	0.508
	22	MARION	0.370	0.235	0.199	1.000	0.635	0.538
	23	MARTIN	1.175	0.541	0.386	1.000	0.460	0.329
	24	MARTIN	5.749	2.222	0.808	1.000	0.387	0.141
	25	MIAMI-DADE	1.643	0.422	0.417	1.000	0.257	0.254
	26	MIAMI-DADE	3.548	0.551	0.526	1.000	0.155	0.148
	27	MONROE	6.800	2.010	0.804	1.000	0.296	0.118
	28	MONROE	11.567	3.798	1.578	1.000	0.328	0.136
	29	OKALOOSA	1.502	0.593	0.381	1.000	0.395	0.254
	30	OSCEOLA	0.532	0.314	0.264	1.000	0.590	0.496
	31	OSCEOLA	0.878	0.427	0.326	1.000	0.487	0.371
	32	PALM BEACH	1.896	0.741	0.463	1.000	0.391	0.244
	33	PALM BEACH	3.975	1.433	0.639	1.000	0.360	0.161
	34	PINELLAS	0.820	0.405	0.309	1.000	0.494	0.377
	35	SAINT JOHNS	0.459	0.240	0.192	1.000	0.524	0.418
	36	SANTA ROSA	0.920	0.406	0.302	1.000	0.441	0.329
	37	SEMINOLE	0.460	0.278	0.233	1.000	0.605	0.507
	38	TAYLOR	0.341	0.199	0.170	1.000	0.583	0.498
	39	VOLUSIA	0.865	0.398	0.273	1.000	0.460	0.316
	40	WAKULLA	1.481	0.562	0.350	1.000	0.379	0.236

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Frame Condo Unit	1	BAY	5.308	1.156	0.751	1.000	0.218	0.142
	2	BREVARD	2.740	0.789	0.513	1.000	0.288	0.187
	3	BREVARD	2.434	0.739	0.493	1.000	0.304	0.203
	4	BROWARD	4.844	0.675	0.692	1.000	0.139	0.143
	5	BROWARD	11.811	1.170	1.331	1.000	0.099	0.113
	6	CITRUS	1.267	0.512	0.375	1.000	0.404	0.296
	7	CLAY	0.431	0.237	0.206	1.000	0.550	0.478
	8	COLLIER	4.409	1.129	0.720	1.000	0.256	0.163
	9	COLUMBIA	0.436	0.244	0.213	1.000	0.560	0.488
	10	DIXIE	3.435	0.837	0.604	1.000	0.244	0.176
	11	DUVAL	1.755	0.486	0.359	1.000	0.277	0.205
	12	FRANKLIN	10.270	2.497	1.560	1.000	0.243	0.152
	13	GLADES	3.044	0.914	0.616	1.000	0.300	0.202
	14	HAMILTON	0.408	0.233	0.197	1.000	0.571	0.482
	15	HERNANDO	2.543	0.757	0.517	1.000	0.298	0.203
	16	HILLSBOROUGH	1.837	0.657	0.459	1.000	0.358	0.250
	17	HOLMES	0.977	0.405	0.343	1.000	0.415	0.352
	18	INDIAN RIVER	14.370	3.790	2.244	1.000	0.264	0.156
	19	JACKSON	0.668	0.329	0.284	1.000	0.492	0.425
	20	LEE	3.521	0.999	0.661	1.000	0.284	0.188
	21	LEON	0.781	0.336	0.286	1.000	0.430	0.366
	22	MARION	0.902	0.417	0.307	1.000	0.462	0.340
	23	MARTIN	3.007	0.897	0.590	1.000	0.299	0.196
	24	MARTIN	12.571	3.222	1.736	1.000	0.256	0.138
	25	MIAMI-DADE	4.179	0.624	0.637	1.000	0.149	0.153
	26	MIAMI-DADE	8.318	0.839	0.903	1.000	0.101	0.109
	27	MONROE	14.932	2.776	1.768	1.000	0.186	0.118
	28	MONROE	24.165	5.310	3.639	1.000	0.220	0.151
	29	OKALOOSA	3.501	0.829	0.577	1.000	0.237	0.165
	30	OSCEOLA	1.338	0.556	0.404	1.000	0.415	0.302
	31	OSCEOLA	2.243	0.731	0.502	1.000	0.326	0.224
	32	PALM BEACH	4.771	1.183	0.725	1.000	0.248	0.152
	33	PALM BEACH	9.238	2.082	1.168	1.000	0.225	0.126
	34	PINELLAS	2.079	0.683	0.471	1.000	0.329	0.227
	35	SAINT JOHNS	0.998	0.356	0.289	1.000	0.356	0.290
	36	SANTA ROSA	2.151	0.582	0.446	1.000	0.271	0.207
	37	SEMINOLE	1.140	0.492	0.358	1.000	0.431	0.314
	38	TAYLOR	0.704	0.302	0.258	1.000	0.428	0.366
	39	VOLUSIA	2.119	0.651	0.429	1.000	0.307	0.202
	40	WAKULLA	3.304	0.778	0.553	1.000	0.236	0.167

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Masonry Condo Unit	1	BAY	4.894	1.086	0.712	1.000	0.222	0.146
	2	BREVARD	2.651	0.772	0.496	1.000	0.291	0.187
	3	BREVARD	2.372	0.724	0.477	1.000	0.305	0.201
	4	BROWARD	4.648	0.655	0.668	1.000	0.141	0.144
	5	BROWARD	10.713	0.987	1.094	1.000	0.092	0.102
	6	CITRUS	1.254	0.499	0.362	1.000	0.398	0.289
	7	CLAY	0.405	0.218	0.195	1.000	0.539	0.482
	8	COLLIER	4.276	1.103	0.696	1.000	0.258	0.163
	9	COLUMBIA	0.408	0.225	0.201	1.000	0.551	0.492
	10	DIXIE	3.152	0.785	0.571	1.000	0.249	0.181
	11	DUVAL	1.626	0.454	0.340	1.000	0.279	0.209
	12	FRANKLIN	9.095	2.242	1.441	1.000	0.246	0.158
	13	GLADES	2.987	0.891	0.594	1.000	0.298	0.199
	14	HAMILTON	0.381	0.215	0.186	1.000	0.565	0.487
	15	HERNANDO	2.476	0.741	0.499	1.000	0.299	0.202
	16	HILLSBOROUGH	1.816	0.642	0.442	1.000	0.354	0.244
	17	HOLMES	0.930	0.374	0.325	1.000	0.403	0.349
	18	INDIAN RIVER	12.679	3.416	2.070	1.000	0.269	0.163
	19	JACKSON	0.633	0.303	0.268	1.000	0.479	0.424
	20	LEE	3.439	0.973	0.638	1.000	0.283	0.185
	21	LEON	0.740	0.311	0.270	1.000	0.420	0.365
	22	MARION	0.894	0.406	0.296	1.000	0.454	0.332
	23	MARTIN	2.930	0.867	0.573	1.000	0.296	0.195
	24	MARTIN	11.260	2.888	1.626	1.000	0.256	0.144
	25	MIAMI-DADE	4.032	0.605	0.615	1.000	0.150	0.152
	26	MIAMI-DADE	7.734	0.779	0.825	1.000	0.101	0.107
	27	MONROE	13.410	2.577	1.663	1.000	0.192	0.124
	28	MONROE	21.259	4.637	3.338	1.000	0.218	0.157
	29	OKALOOSA	3.287	0.778	0.548	1.000	0.237	0.167
	30	OSCEOLA	1.329	0.541	0.390	1.000	0.407	0.293
	31	OSCEOLA	2.200	0.714	0.485	1.000	0.325	0.220
	32	PALM BEACH	4.584	1.146	0.704	1.000	0.250	0.154
	33	PALM BEACH	8.552	1.994	1.118	1.000	0.233	0.131
	34	PINELLAS	2.043	0.665	0.455	1.000	0.326	0.223
	35	SAINT JOHNS	0.942	0.331	0.274	1.000	0.351	0.291
	36	SANTA ROSA	2.046	0.544	0.422	1.000	0.266	0.206
	37	SEMINOLE	1.129	0.479	0.346	1.000	0.424	0.306
	38	TAYLOR	0.664	0.279	0.244	1.000	0.419	0.367
	39	VOLUSIA	2.047	0.636	0.414	1.000	0.311	0.202
	40	WAKULLA	3.052	0.732	0.525	1.000	0.240	0.172

Construction / Policy	Location	County	Hurricane Loss Cost by Building Strength			Ratios Relative to Weak		
			Weak	Medium	Strong	Weak	Medium	Strong
Commercial Residential	1	BAY	10.974	10.115	3.871	1.000	0.922	0.353
	2	BREVARD	6.237	5.698	1.890	1.000	0.914	0.303
	3	BREVARD	5.575	5.075	1.577	1.000	0.910	0.283
	4	BROWARD	9.839	5.711	3.100	1.000	0.580	0.315
	5	BROWARD	17.848	11.682	7.539	1.000	0.655	0.422
	6	CITRUS	2.789	2.505	0.620	1.000	0.898	0.222
	7	CLAY	1.233	1.100	0.248	1.000	0.892	0.201
	8	COLLIER	9.320	8.506	2.724	1.000	0.913	0.292
	9	COLUMBIA	1.091	0.971	0.213	1.000	0.890	0.195
	10	DIXIE	5.688	5.192	1.738	1.000	0.913	0.306
	11	DUVAL	3.984	3.641	1.243	1.000	0.914	0.312
	12	FRANKLIN	14.115	13.111	5.788	1.000	0.929	0.410
	13	GLADES	6.510	5.906	1.710	1.000	0.907	0.263
	14	HAMILTON	1.072	0.955	0.215	1.000	0.891	0.200
	15	HERNANDO	4.961	4.495	1.293	1.000	0.906	0.261
	16	HILLSBOROUGH	4.566	4.126	1.116	1.000	0.904	0.244
	17	HOLMES	3.172	2.856	0.730	1.000	0.901	0.230
	18	INDIAN RIVER	17.855	16.712	8.252	1.000	0.936	0.462
	19	JACKSON	2.192	1.964	0.463	1.000	0.896	0.211
	20	LEE	7.294	6.624	1.951	1.000	0.908	0.268
	21	LEON	2.160	1.939	0.477	1.000	0.898	0.221
	22	MARION	2.021	1.807	0.417	1.000	0.894	0.206
	23	MARTIN	6.716	6.114	1.882	1.000	0.910	0.280
	24	MARTIN	18.255	17.059	8.180	1.000	0.935	0.448
	25	MIAMI-DADE	9.740	5.654	3.053	1.000	0.580	0.313
	26	MIAMI-DADE	14.817	9.396	5.757	1.000	0.634	0.389
	27	MONROE	25.094	23.530	11.659	1.000	0.938	0.465
	28	MONROE	29.471	27.679	14.079	1.000	0.939	0.478
	29	OKALOOSA	8.802	8.069	2.791	1.000	0.917	0.317
	30	OSCEOLA	3.138	2.819	0.693	1.000	0.898	0.221
	31	OSCEOLA	4.629	4.186	1.160	1.000	0.904	0.251
	32	PALM BEACH	9.484	8.680	2.933	1.000	0.915	0.309
	33	PALM BEACH	15.683	14.543	6.142	1.000	0.927	0.392
	34	PINELLAS	5.141	4.664	1.358	1.000	0.907	0.264
	35	SAINT JOHNS	2.760	2.498	0.713	1.000	0.905	0.258
	36	SANTA ROSA	5.804	5.273	1.557	1.000	0.908	0.268
	37	SEMINOLE	2.509	2.250	0.541	1.000	0.897	0.216
	38	TAYLOR	1.909	1.715	0.435	1.000	0.898	0.228
	39	VOLUSIA	4.524	4.120	1.315	1.000	0.911	0.291
	40	WAKULLA	6.256	5.730	2.014	1.000	0.916	0.322

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
Frame Owners	1	BAY	4.026	5.684	1.000	1.412
	2	BREVARD	4.739	5.406	1.000	1.141
	3	BREVARD	4.538	5.088	1.000	1.121
	4	BROWARD	6.982	8.298	1.000	1.188
	5	BROWARD	12.255	15.902	1.000	1.298
	6	CITRUS	3.372	3.541	1.000	1.050
	7	CLAY	0.872	0.914	1.000	1.047
	8	COLLIER	6.866	8.007	1.000	1.166
	9	COLUMBIA	0.897	0.938	1.000	1.045
	10	DIXIE	3.015	4.034	1.000	1.338
	11	DUVAL	1.748	2.238	1.000	1.280
	12	FRANKLIN	7.378	10.550	1.000	1.430
	13	GLADES	5.807	6.456	1.000	1.112
	14	HAMILTON	0.833	0.872	1.000	1.048
	15	HERNANDO	4.751	5.322	1.000	1.120
	16	HILLSBOROUGH	4.246	4.553	1.000	1.072
	17	HOLMES	1.471	1.624	1.000	1.104
	18	INDIAN RIVER	14.003	18.349	1.000	1.310
	19	JACKSON	1.195	1.272	1.000	1.064
	20	LEE	6.311	7.109	1.000	1.126
	21	LEON	1.226	1.347	1.000	1.098
	22	MARION	2.708	2.798	1.000	1.033
	23	MARTIN	5.623	6.286	1.000	1.118
	24	MARTIN	12.578	16.429	1.000	1.306
	25	MIAMI-DADE	6.351	7.432	1.000	1.170
	26	MIAMI-DADE	9.277	11.861	1.000	1.279
	27	MONROE	13.469	18.321	1.000	1.360
	28	MONROE	20.504	28.006	1.000	1.366

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
	29	OKALOOSA	2.941	3.960	1.000	1.347
	30	OSCEOLA	3.635	3.803	1.000	1.046
	31	OSCEOLA	4.664	5.107	1.000	1.095
	32	PALM BEACH	7.110	8.380	1.000	1.179
	33	PALM BEACH	10.362	13.183	1.000	1.272
	34	PINELLAS	4.300	4.709	1.000	1.095
	35	SAINT JOHNS	1.284	1.497	1.000	1.166
	36	SANTA ROSA	2.109	2.653	1.000	1.258
	37	SEMINOLE	3.198	3.334	1.000	1.042
	38	TAYLOR	1.105	1.220	1.000	1.105
	39	VOLUSIA	3.894	4.384	1.000	1.126
	40	WAKULLA	2.841	3.843	1.000	1.353

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
Masonry Owners	1	BAY	3.790	5.308	1.000	1.401
	2	BREVARD	4.682	5.299	1.000	1.132
	3	BREVARD	4.492	5.005	1.000	1.114
	4	BROWARD	6.811	8.058	1.000	1.183
	5	BROWARD	11.689	14.889	1.000	1.274
	6	CITRUS	3.332	3.498	1.000	1.050
	7	CLAY	0.832	0.872	1.000	1.049
	8	COLLIER	6.786	7.850	1.000	1.157
	9	COLUMBIA	0.857	0.896	1.000	1.046
	10	DIXIE	2.813	3.722	1.000	1.323
	11	DUVAL	1.646	2.089	1.000	1.269
	12	FRANKLIN	6.794	9.552	1.000	1.406
	13	GLADES	5.734	6.359	1.000	1.109
	14	HAMILTON	0.795	0.833	1.000	1.048
	15	HERNANDO	4.702	5.233	1.000	1.113
	16	HILLSBOROUGH	4.195	4.494	1.000	1.071
	17	HOLMES	1.391	1.540	1.000	1.107
	18	INDIAN RIVER	12.977	16.588	1.000	1.278
	19	JACKSON	1.133	1.208	1.000	1.066
	20	LEE	6.230	6.995	1.000	1.123
	21	LEON	1.163	1.280	1.000	1.101
	22	MARION	2.676	2.765	1.000	1.033
	23	MARTIN	5.490	6.130	1.000	1.117
	24	MARTIN	11.911	15.236	1.000	1.279
	25	MIAMI-DADE	6.197	7.228	1.000	1.166
	26	MIAMI-DADE	8.973	11.321	1.000	1.262
	27	MONROE	12.772	17.001	1.000	1.331
	28	MONROE	18.926	25.295	1.000	1.337
	29	OKALOOSA	2.778	3.737	1.000	1.345
	30	OSCEOLA	3.593	3.757	1.000	1.046
	31	OSCEOLA	4.606	5.032	1.000	1.092
	32	PALM BEACH	6.936	8.141	1.000	1.174
	33	PALM BEACH	9.989	12.538	1.000	1.255

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
	34	PINELLAS	4.261	4.647	1.000	1.091
	35	SAINT JOHNS	1.217	1.418	1.000	1.165
	36	SANTA ROSA	1.990	2.511	1.000	1.262
	37	SEMINOLE	3.161	3.293	1.000	1.042
	38	TAYLOR	1.050	1.159	1.000	1.104
	39	VOLUSIA	3.847	4.297	1.000	1.117
	40	WAKULLA	2.662	3.564	1.000	1.339

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
Frame Renters	1	BAY	1.262	2.285	1.000	1.811
	2	BREVARD	0.610	0.976	1.000	1.598
	3	BREVARD	0.549	0.840	1.000	1.530
	4	BROWARD	0.973	1.719	1.000	1.767
	5	BROWARD	3.068	5.560	1.000	1.812
	6	CITRUS	0.347	0.426	1.000	1.230
	7	CLAY	0.194	0.211	1.000	1.090
	8	COLLIER	0.888	1.499	1.000	1.689
	9	COLUMBIA	0.200	0.217	1.000	1.087
	10	DIXIE	0.919	1.538	1.000	1.674
	11	DUVAL	0.483	0.767	1.000	1.589
	12	FRANKLIN	3.014	5.269	1.000	1.748
	13	GLADES	0.654	0.985	1.000	1.507
	14	HAMILTON	0.186	0.203	1.000	1.095
	15	HERNANDO	0.577	0.880	1.000	1.525
	16	HILLSBOROUGH	0.444	0.591	1.000	1.330
	17	HOLMES	0.343	0.411	1.000	1.200
	18	INDIAN RIVER	4.348	7.498	1.000	1.725
	19	JACKSON	0.273	0.305	1.000	1.117
	20	LEE	0.737	1.156	1.000	1.568
	21	LEON	0.284	0.340	1.000	1.195
	22	MARION	0.274	0.315	1.000	1.149
	23	MARTIN	0.652	1.003	1.000	1.537
	24	MARTIN	3.473	6.205	1.000	1.787
	25	MIAMI-DADE	0.841	1.440	1.000	1.713
	26	MIAMI-DADE	1.845	3.485	1.000	1.889
	27	MONROE	3.892	7.282	1.000	1.871
	28	MONROE	7.423	12.995	1.000	1.751
	29	OKALOOSA	0.807	1.381	1.000	1.712
	30	OSCEOLA	0.367	0.443	1.000	1.205
	31	OSCEOLA	0.517	0.745	1.000	1.439
	32	PALM BEACH	0.963	1.684	1.000	1.749
	33	PALM BEACH	2.130	3.956	1.000	1.857

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
	34	PINELLAS	0.488	0.694	1.000	1.422
	35	SAINT JOHNS	0.311	0.418	1.000	1.345
	36	SANTA ROSA	0.531	0.811	1.000	1.527
	37	SEMINOLE	0.325	0.387	1.000	1.192
	38	TAYLOR	0.259	0.314	1.000	1.215
	39	VOLUSIA	0.500	0.773	1.000	1.546
	40	WAKULLA	0.837	1.433	1.000	1.712

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
Masonry Renters	1	BAY	1.169	2.105	1.000	1.800
	2	BREVARD	0.596	0.948	1.000	1.592
	3	BREVARD	0.537	0.823	1.000	1.531
	4	BROWARD	0.954	1.672	1.000	1.752
	5	BROWARD	2.812	4.952	1.000	1.761
	6	CITRUS	0.337	0.419	1.000	1.244
	7	CLAY	0.171	0.189	1.000	1.108
	8	COLLIER	0.872	1.471	1.000	1.686
	9	COLUMBIA	0.176	0.194	1.000	1.103
	10	DIXIE	0.837	1.398	1.000	1.669
	11	DUVAL	0.441	0.704	1.000	1.596
	12	FRANKLIN	2.637	4.543	1.000	1.723
	13	GLADES	0.641	0.973	1.000	1.519
	14	HAMILTON	0.164	0.182	1.000	1.111
	15	HERNANDO	0.564	0.859	1.000	1.523
	16	HILLSBOROUGH	0.433	0.584	1.000	1.348
	17	HOLMES	0.306	0.377	1.000	1.234
	18	INDIAN RIVER	3.793	6.393	1.000	1.686
	19	JACKSON	0.242	0.276	1.000	1.140
	20	LEE	0.724	1.140	1.000	1.575
	21	LEON	0.253	0.310	1.000	1.227
	22	MARION	0.266	0.308	1.000	1.159
	23	MARTIN	0.639	0.989	1.000	1.548
	24	MARTIN	3.133	5.434	1.000	1.734
	25	MIAMI-DADE	0.824	1.406	1.000	1.706
	26	MIAMI-DADE	1.763	3.241	1.000	1.838
	27	MONROE	3.558	6.446	1.000	1.812
	28	MONROE	6.429	11.060	1.000	1.720
	29	OKALOOSA	0.749	1.301	1.000	1.737
	30	OSCEOLA	0.357	0.436	1.000	1.220
	31	OSCEOLA	0.506	0.734	1.000	1.450
	32	PALM BEACH	0.947	1.643	1.000	1.735
	33	PALM BEACH	2.012	3.644	1.000	1.811

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories		Ratios Relative to 1 Story	
			1 Story	2 Story	1 Story	2 Story
	34	PINELLAS	0.476	0.682	1.000	1.432
	35	SAINT JOHNS	0.280	0.387	1.000	1.383
	36	SANTA ROSA	0.486	0.766	1.000	1.577
	37	SEMINOLE	0.316	0.380	1.000	1.204
	38	TAYLOR	0.231	0.287	1.000	1.243
	39	VOLUSIA	0.487	0.747	1.000	1.534
	40	WAKULLA	0.774	1.321	1.000	1.707

Construction / Policy	Location	County / City	Hurricane Loss Cost by Number of Stories			Ratios Relative to 5 Story		
			5 Story	10 Story	20 Story	5 Story	10 Story	20 Story
Commercial Residential	1	BAY	2.335	4.642	10.115	1.000	1.988	4.333
	2	BREVARD	1.058	2.374	5.698	1.000	2.243	5.384
	3	BREVARD	0.895	2.059	5.075	1.000	2.300	5.669
	4	BROWARD	1.879	3.938	9.015	1.000	2.096	4.798
	5	BROWARD	4.896	8.459	16.620	1.000	1.728	3.395
	6	CITRUS	0.364	0.927	2.505	1.000	2.544	6.876
	7	CLAY	0.128	0.367	1.100	1.000	2.870	8.596
	8	COLLIER	1.657	3.614	8.506	1.000	2.181	5.134
	9	COLUMBIA	0.116	0.323	0.971	1.000	2.796	8.408
	10	DIXIE	1.362	2.507	5.192	1.000	1.840	3.811
	11	DUVAL	0.769	1.599	3.641	1.000	2.079	4.733
	12	FRANKLIN	4.327	7.046	13.111	1.000	1.628	3.030
	13	GLADES	1.034	2.390	5.906	1.000	2.312	5.713
	14	HAMILTON	0.116	0.323	0.955	1.000	2.787	8.255
	15	HERNANDO	0.874	1.891	4.495	1.000	2.162	5.140
	16	HILLSBOROUGH	0.618	1.563	4.126	1.000	2.529	6.678
	17	HOLMES	0.365	1.007	2.856	1.000	2.759	7.830
	18	INDIAN RIVER	5.966	9.333	16.712	1.000	1.564	2.801
	19	JACKSON	0.223	0.657	1.964	1.000	2.948	8.806
	20	LEE	1.232	2.748	6.624	1.000	2.230	5.375
	21	LEON	0.277	0.711	1.939	1.000	2.570	7.006
	22	MARION	0.230	0.628	1.807	1.000	2.729	7.849
	23	MARTIN	1.063	2.470	6.114	1.000	2.323	5.751
	24	MARTIN	5.339	8.927	17.059	1.000	1.672	3.195
	25	MIAMI-DADE	1.676	3.748	8.924	1.000	2.236	5.324
	26	MIAMI-DADE	3.454	6.555	13.737	1.000	1.898	3.977
	27	MONROE	7.114	12.264	23.530	1.000	1.724	3.307
	28	MONROE	10.752	16.087	27.679	1.000	1.496	2.574
	29	OKALOOSA	1.565	3.431	8.069	1.000	2.193	5.157
	30	OSCEOLA	0.387	1.022	2.819	1.000	2.642	7.287
	31	OSCEOLA	0.738	1.689	4.186	1.000	2.287	5.669
	32	PALM BEACH	1.799	3.778	8.680	1.000	2.100	4.826
	33	PALM BEACH	3.793	7.042	14.543	1.000	1.857	3.834

	34	PINELLAS	0.728	1.800	4.664	1.000	2.471	6.404
	35	SAINT JOHNS	0.395	0.967	2.498	1.000	2.445	6.319
	36	SANTA ROSA	0.926	2.144	5.273	1.000	2.315	5.693
	37	SEMINOLE	0.303	0.805	2.250	1.000	2.657	7.425
	38	TAYLOR	0.242	0.622	1.715	1.000	2.574	7.101
	39	VOLUSIA	0.776	1.726	4.120	1.000	2.223	5.307
	40	WAKULLA	1.357	2.647	5.730	1.000	1.950	4.222

Appendix H – Form A-7: Percentage Change in Logical Relationship to Hurricane Risk

Florida International University
Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost					
		$0	**$500**	**1%**	**2%**	**5%**	**10%**
Frame Owners	Coastal	-2.6%	-2.7%	-2.8%	-2.9%	-3.1%	-3.1%
	Inland	-1.1%	-1.2%	-1.4%	-1.4%	-0.9%	0.9%
	North	11.4%	13.2%	16.0%	18.0%	20.2%	19.9%
	Central	-1.7%	-1.8%	-1.8%	-1.9%	-1.9%	-1.8%
	South	-4.6%	-4.7%	-4.8%	-5.0%	-5.5%	-5.8%
	Statewide	-2.4%	-2.5%	-2.6%	-2.7%	-2.9%	-2.8%
Masonry Owners	Coastal	-2.6%	-2.7%	-2.8%	-2.8%	-3.1%	-3.0%
	Inland	-1.1%	-1.3%	-1.5%	-1.5%	-0.9%	0.8%
	North	11.8%	13.8%	17.1%	19.3%	21.5%	21.5%
	Central	-1.7%	-1.8%	-1.8%	-1.9%	-1.8%	-1.7%
	South	-4.6%	-4.7%	-4.8%	-5.0%	-5.5%	-5.8%
	Statewide	-2.4%	-2.5%	-2.6%	-2.7%	-2.9%	-2.8%
Manufactured Homes	Coastal	-3.0%	-3.1%	-3.1%	-3.1%	-3.3%	-3.4%
	Inland	-0.1%	-0.1%	-0.1%	-0.1%	0.1%	0.6%
	North	5.2%	5.4%	5.4%	5.5%	6.0%	6.5%
	Central	-1.7%	-1.7%	-1.7%	-1.7%	-1.8%	-1.7%
	South	-4.8%	-4.9%	-4.9%	-5.0%	-5.1%	-5.3%
	Statewide	-2.6%	-2.7%	-2.7%	-2.7%	-2.9%	-3.0%
Frame Renters	Coastal	-2.6%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%
	Inland	0.5%	1.2%	1.2%	1.2%	1.2%	1.1%
	North	15.5%	19.5%	19.5%	19.5%	19.6%	19.4%
	Central	-1.8%	-1.9%	-1.9%	-1.9%	-1.9%	-1.9%
	South	-5.5%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
	Statewide	-2.3%	-2.4%	-2.4%	-2.4%	-2.4%	-2.5%
Masonry Renters	Coastal	-2.6%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%
	Inland	0.4%	1.2%	1.2%	1.2%	1.2%	1.1%
	North	15.8%	19.8%	19.8%	19.9%	19.8%	19.7%
	Central	-1.7%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%
	South	-5.5%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
	Statewide	-2.3%	-2.4%	-2.4%	-2.5%	-2.5%	-2.5%
Frame Condo Unit	Coastal	-2.6%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%
	Inland	-0.2%	0.4%	0.4%	1.4%	1.8%	1.8%
	North	14.2%	18.9%	18.9%	21.1%	21.4%	21.3%
	Central	-1.7%	-1.8%	-1.8%	-1.9%	-2.0%	-2.0%
	South	-5.2%	-5.6%	-5.6%	-5.9%	-5.9%	-5.9%
	Statewide	-2.3%	-2.4%	-2.4%	-2.5%	-2.5%	-2.5%
Masonry Condo Unit	Coastal	-2.6%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%
	Inland	-0.3%	0.4%	0.4%	1.4%	1.7%	1.7%
	North	14.5%	19.3%	19.3%	21.6%	21.8%	21.7%
	Central	-1.7%	-1.7%	-1.7%	-1.8%	-1.8%	-1.8%
	South	-5.2%	-5.6%	-5.6%	-5.9%	-5.9%	-5.9%
	Statewide	-2.3%	-2.4%	-2.4%	-2.5%	-2.5%	-2.5%
Construction / Policy	**Region**	**Percent Change in Loss Cost**					

		$0	2%	3%	5%	10%	
Commercial Residential	Coastal	26.5%	53.1%	66.9%	99.7%	229.3%	
	Inland	29.5%	86.4%	120.1%	218.1%	904.4%	
	North	38.1%	73.4%	90.7%	131.4%	292.9%	
	Central	28.1%	68.7%	90.3%	144.0%	359.0%	
	South	23.9%	47.3%	59.7%	89.2%	207.3%	
	Statewide	26.8%	55.6%	70.3%	105.2%	240.4%	

Policy Form	Region	Percentage Change in Hurricane Loss Cost	
		Masonry	Frame
Owners	Coastal	-2.6%	-2.6%
	Inland	-1.1%	-1.1%
	North	11.8%	11.4%
	Central	-1.7%	-1.7%
	South	-4.6%	-4.6%
	Statewide	-2.4%	-2.4%
Renters	Coastal	-2.5%	-2.5%
	Inland	0.4%	0.5%
	North	15.3%	15.0%
	Central	-1.7%	-1.7%
	South	-5.4%	-5.5%
	Statewide	-2.2%	-2.2%
Condo Unit	Coastal	-2.6%	-2.6%
	Inland	-0.3%	-0.2%
	North	14.5%	14.2%
	Central	-1.7%	-1.7%
	South	-5.2%	-5.2%
	Statewide	-2.3%	-2.3%

Policy Form	Region	Percentage Change in Hurricane Loss Cost	
		Concrete	
Commercial Residential	Coastal	26.5%	
	Inland	29.5%	
	North	38.1%	
	Central	28.1%	
	South	23.9%	
	Statewide	26.8%	

Region	Percentage Change in Hurricane Loss Cost		
	Frame Owners	**Masonry Owners**	**Manufactured Homes**
Coastal	-2.6%	-2.6%	-3.0%
Inland	-1.1%	-1.1%	-0.1%
North	11.4%	11.8%	5.2%
Central	-1.7%	-1.7%	-1.7%
South	-4.6%	-4.6%	-4.8%
Statewide	-2.4%	-2.4%	-2.6%

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost			
		Coverage A	Coverage B	Coverage C	Coverage D
Frame Owners	Coastal	-2.6%	-2.6%	-2.4%	-2.7%
	Inland	-1.2%	-0.3%	0.4%	0.6%
	North	11.0%	4.1%	14.4%	16.9%
	Central	-1.7%	-1.6%	-1.7%	-1.8%
	South	-4.5%	-4.3%	-5.4%	-5.7%
	Statewide	-2.4%	-2.2%	-2.1%	-2.5%
Masonry Owners	Coastal	-2.6%	-2.6%	-2.5%	-2.8%
	Inland	-1.3%	-0.3%	0.4%	0.6%
	North	11.5%	4.1%	14.7%	17.3%
	Central	-1.7%	-1.6%	-1.6%	-1.8%
	South	-4.5%	-4.3%	-5.3%	-5.7%
	Statewide	-2.4%	-2.2%	-2.2%	-2.5%
Manufactured Homes	Coastal	-2.9%	-2.6%	-3.3%	-3.5%
	Inland	-0.3%	-0.3%	0.8%	0.7%
	North	4.9%	4.1%	6.5%	6.5%
	Central	-1.7%	-1.6%	-1.5%	-1.6%
	South	-4.7%	-4.3%	-5.3%	-5.4%
	Statewide	-2.5%	-2.2%	-2.9%	-3.1%
Frame Renters	Coastal	NA	NA	-2.4%	-2.7%
	Inland	NA	NA	0.4%	0.6%
	North	NA	NA	14.4%	16.9%
	Central	NA	NA	-1.7%	-1.8%
	South	NA	NA	-5.4%	-5.7%
	Statewide	NA	NA	-2.1%	-2.5%
Masonry Renters	Coastal	NA	NA	-2.5%	-2.8%
	Inland	NA	NA	0.4%	0.6%
	North	NA	NA	14.7%	17.3%
	Central	NA	NA	-1.6%	-1.8%
	South	NA	NA	-5.3%	-5.7%
	Statewide	NA	NA	-2.2%	-2.5%
Frame Condo Unit	Coastal	-2.6%	NA	-2.4%	-2.7%
	Inland	-1.2%	NA	0.4%	0.6%
	North	11.0%	NA	14.4%	16.9%
	Central	-1.7%	NA	-1.7%	-1.8%
	South	-4.5%	NA	-5.4%	-5.7%
	Statewide	-2.4%	NA	-2.1%	-2.5%

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost			
		Coverage A	Coverage B	Coverage C	Coverage D
Masonry Condo Unit	Coastal	-2.6%	NA	-2.5%	-2.8%
	Inland	-1.3%	NA	0.4%	0.6%
	North	11.5%	NA	14.7%	17.3%
	Central	-1.7%	NA	-1.6%	-1.8%
	South	-4.5%	NA	-5.3%	-5.7%
	Statewide	-2.4%	NA	-2.2%	-2.5%
Commercial Residential	Coastal	34.9%	NA	-93.4%	NA
	Inland	38.5%	NA	-98.6%	NA
	North	47.6%	NA	-94.0%	NA
	Central	36.8%	NA	-96.5%	NA
	South	32.1%	NA	-92.7%	NA
	Statewide	35.3%	NA	-94.0%	NA

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost				
		Year Built 1980	**Year Built 1989**	**Year Built 1998**	**Year Built 2004**	**Year Built 2019**
Frame Owners	Coastal	-2.5%	-2.6%	-2.3%	-2.4%	-2.4%
	Inland	-1.1%	-1.1%	-1.0%	-0.5%	-0.5%
	North	10.3%	10.3%	4.1%	3.6%	3.5%
	Central	-1.7%	-1.7%	-1.6%	-1.5%	-1.5%
	South	-4.4%	-4.5%	-3.8%	-4.0%	-4.0%
	Statewide	-2.3%	-2.4%	-2.0%	-2.0%	-2.1%
Masonry Owners	Coastal	-2.5%	-2.6%	-2.2%	-2.4%	-2.4%
	Inland	-1.2%	-1.2%	-1.0%	-0.5%	-0.5%
	North	10.7%	10.7%	4.3%	3.4%	3.5%
	Central	-1.7%	-1.7%	-1.6%	-1.5%	-1.5%
	South	-4.4%	-4.5%	-3.7%	-3.9%	-3.9%
	Statewide	-2.3%	-2.4%	-2.0%	-2.0%	-2.0%

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost				
		Year Built 1989	**Year Built 1972**	**Year Built 1992**	**Year Built 2004**	**Year Built 2019**
Manufactured Homes	Coastal	-3.0%	-3.0%	-3.0%	-2.5%	-2.5%
	Inland	-0.1%	-0.1%	-0.1%	-0.3%	-0.3%
	North	5.2%	5.2%	5.2%	3.8%	3.8%
	Central	-1.7%	-1.7%	-1.7%	-1.6%	-1.6%
	South	-4.8%	-4.8%	-4.8%	-4.1%	-4.1%
	Statewide	-2.6%	-2.6%	-2.6%	-2.1%	-2.1%

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost				
		Year Built 1980	Year Built 1989	Year Built 1998	Year Built 2004	Year Built 2019
Frame Renters	Coastal	-2.2%	-2.4%	-2.5%	-2.7%	-2.7%
	Inland	0.4%	0.4%	-0.2%	-0.5%	-0.5%
	North	14.0%	14.0%	4.8%	4.2%	4.2%
	Central	-1.8%	-1.8%	-1.9%	-1.9%	-1.9%
	South	-5.2%	-5.3%	-4.4%	-4.4%	-4.4%
	Statewide	-1.9%	-2.1%	-2.1%	-2.3%	-2.3%
Masonry Renters	Coastal	-2.2%	-2.4%	-2.4%	-2.6%	-2.6%
	Inland	0.3%	0.3%	-0.3%	-0.5%	-0.5%
	North	14.2%	14.2%	4.8%	4.1%	4.1%
	Central	-1.7%	-1.7%	-1.8%	-1.9%	-1.9%
	South	-5.1%	-5.2%	-4.3%	-4.3%	-4.3%
	Statewide	-1.9%	-2.1%	-2.0%	-2.2%	-2.2%
Frame Condo Unit	Coastal	-2.4%	-2.6%	-2.4%	-2.9%	-2.9%
	Inland	0.2%	0.2%	-0.3%	-0.4%	-0.4%
	North	14.8%	14.8%	5.3%	4.6%	4.6%
	Central	-1.6%	-1.6%	-1.7%	-2.0%	-2.0%
	South	-5.2%	-5.3%	-4.3%	-4.6%	-4.6%
	Statewide	-2.1%	-2.3%	-2.1%	-2.5%	-2.5%
Masonry Condo Unit	Coastal	-2.4%	-2.5%	-2.3%	-2.8%	-2.8%
	Inland	0.1%	0.1%	-0.3%	-0.4%	-0.4%
	North	15.0%	15.0%	5.3%	4.4%	4.4%
	Central	-1.6%	-1.6%	-1.7%	-1.9%	-1.9%
	South	-5.1%	-5.2%	-4.2%	-4.4%	-4.4%
	Statewide	-2.1%	-2.2%	-2.0%	-2.4%	-2.4%
Commercial Residential	Coastal	26.5%	26.5%	26.0%	22.9%	22.9%
	Inland	29.5%	29.5%	29.5%	26.0%	26.0%
	North	38.1%	38.1%	38.1%	34.8%	34.8%
	Central	28.1%	28.1%	28.1%	24.6%	24.6%
	South	23.9%	23.9%	22.8%	20.4%	20.4%
	Statewide	26.8%	26.8%	26.5%	23.2%	23.2%

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost		
		Weak	Medium	Strong
Frame Owners	Coastal	-2.9%	-2.2%	-2.3%
	Inland	-1.1%	-1.0%	-0.5%
	North	5.6%	4.9%	3.5%
	Central	-1.7%	-1.6%	-1.5%
	South	-4.5%	-3.8%	-3.8%
	Statewide	-2.7%	-1.9%	-1.9%
Masonry Owners	Coastal	-2.9%	-2.1%	-2.3%
	Inland	-1.2%	-1.0%	-0.5%
	North	5.9%	5.0%	3.4%
	Central	-1.7%	-1.6%	-1.4%
	South	-4.4%	-3.7%	-3.8%
	Statewide	-2.6%	-1.9%	-1.9%
Manufactured Homes	Coastal	-3.0%	-3.0%	-2.5%
	Inland	-0.1%	-0.1%	-0.3%
	North	5.2%	5.2%	3.8%
	Central	-1.7%	-1.7%	-1.6%
	South	-4.8%	-4.8%	-4.1%
	Statewide	-2.6%	-2.6%	-2.1%
Frame Renters	Coastal	-3.3%	-2.3%	-2.5%
	Inland	0.4%	-0.2%	-0.5%
	North	5.8%	5.5%	3.9%
	Central	-1.6%	-1.8%	-1.8%
	South	-5.2%	-4.3%	-4.1%
	Statewide	-2.9%	-2.0%	-2.1%
Masonry Renters	Coastal	-3.3%	-2.2%	-2.5%
	Inland	0.3%	-0.3%	-0.6%
	North	5.8%	5.5%	3.9%
	Central	-1.6%	-1.8%	-1.8%
	South	-5.2%	-4.2%	-4.1%
	Statewide	-2.9%	-1.9%	-2.1%
Frame Condo Unit	Coastal	-3.3%	-2.3%	-2.6%
	Inland	0.1%	-0.6%	-0.5%
	North	6.2%	5.3%	4.2%
	Central	-1.6%	-1.8%	-1.8%
	South	-5.1%	-4.1%	-4.3%
	Statewide	-2.9%	-2.0%	-2.2%
Masonry Condo Unit	Coastal	-3.3%	-2.2%	-2.6%
	Inland	0.0%	-0.6%	-0.5%
	North	6.2%	5.4%	4.1%
	Central	-1.6%	-1.7%	-1.8%
	South	-5.1%	-4.0%	-4.2%
	Statewide	-2.9%	-1.9%	-2.2%

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost		
		Weak	**Medium**	**Strong**
Commercial Residential	Coastal	26.9%	26.0%	20.2%
	Inland	30.0%	29.5%	22.8%
	North	38.5%	38.1%	32.3%
	Central	28.6%	28.1%	21.7%
	South	24.4%	22.8%	17.8%
	Statewide	27.3%	26.5%	20.4%

Form A-7: Percentage Change in Logical Relationship to Hurricane Risk – Number of Stories Appendix H
Florida International University
Florida Public Hurricane Loss Model Version 8.1 Platform NA
May 24, 2021

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost		
		1 Story	**2 Story**	
Frame Owners	Coastal	-2.9%	-3.1%	
	Inland	-1.2%	-1.1%	
	North	4.4%	4.5%	
	Central	-1.7%	-1.7%	
	South	-4.3%	-4.5%	
	Statewide	-2.6%	-2.8%	
Masonry Owners	Coastal	-2.9%	-3.0%	
	Inland	-1.3%	-1.1%	
	North	4.9%	5.3%	
	Central	-1.7%	-1.6%	
	South	-4.3%	-4.5%	
	Statewide	-2.6%	-2.7%	
Frame Renters	Coastal	-3.2%	-3.4%	
	Inland	0.0%	0.5%	
	North	5.2%	5.9%	
	Central	-1.8%	-1.7%	
	South	-5.0%	-5.2%	
	Statewide	-2.8%	-3.0%	
Masonry Renters	Coastal	-3.1%	-3.3%	
	Inland	-0.1%	0.4%	
	North	5.2%	5.9%	
	Central	-1.7%	-1.6%	
	South	-4.9%	-5.2%	
	Statewide	-2.8%	-3.0%	

Construction / Policy	Region	Percentage Change in Hurricane Loss Cost		
		5 Story	**10 Story**	**20 Story**
Commercial Residential	Coastal	-4.0%	-4.6%	26.5%
	Inland	-0.7%	-1.9%	29.5%
	North	5.9%	4.6%	38.1%
	Central	-2.3%	-3.1%	28.1%
	South	-6.0%	-6.6%	23.9%
	Statewide	-3.8%	-4.4%	26.8%

Appendix I – Form A-8: Hurricane Probable Maximum Loss for Florida

Florida International University
Florida Public Hurricane Loss Model 8.1 Platform NA
May 24, 2021

Form A-8: Hurricane Probable Maximum Loss for Florida

Part A - Personal and Commercial Residential Probable Maximum Loss for Florida

Modeling Organization: Florida International University
Hurricane Model Name & Version Number: Florida Public Hurricane Loss Model 8.1 Platform NA
Hurricane Model Platform & Version Number: NA
Hurricane Model Release Date: May 24, 2021

Range Start (Millions)	Range End (Millions)	Total Loss (Millions)	Average Loss per Year (Millions)	Number of Hurricanes	Expected Annual Hurricane Losses (Millions)	Return Period (Years)
0	500	1,233,400.90	33.32	10,394	20.56	2.12
501	1000	2,065,913.72	727.95	4,115	34.43	2.79
1001	1500	2,408,919.37	1,233.45	3,091	40.15	3.14
1501	2000	2,209,327.18	1,738.26	2,072	36.82	3.42
2001	2500	2,012,353.69	2,235.95	1,522	33.54	3.64
2501	3000	2,074,543.20	2,729.66	1,253	34.58	3.84
3001	3500	1,977,335.31	3,236.23	1,067	32.96	4.02
3501	4000	2,105,837.91	3,753.72	992	35.10	4.18
4001	4500	2,117,325.23	4,243.14	866	35.29	4.34
4501	5000	2,020,403.04	4,742.73	769	33.67	4.49
5001	6000	4,534,165.81	5,495.96	1,508	75.57	4.71
6001	7000	4,900,763.36	6,499.69	1,397	81.68	5.02
7001	8000	5,479,265.95	7,485.34	1,373	91.32	5.35
8001	9000	6,142,690.40	8,484.38	1,435	102.38	5.73
9001	10000	6,426,227.99	9,478.21	1,331	107.10	6.13
10001	11000	6,221,337.51	10,509.02	1,137	103.69	6.56
11001	12000	6,899,663.42	11,499.44	1,206	114.99	7.00
12001	13000	7,726,356.16	12,502.19	1,238	128.77	7.55
13001	14000	7,168,187.05	13,499.41	1,081	119.47	8.15
14001	15000	7,465,264.00	14,495.66	1,033	124.42	8.77
15001	16000	7,318,697.44	15,505.71	936	121.98	9.44
16001	17000	7,834,903.01	16,494.53	998	130.58	10.20
17001	18000	7,182,398.29	17,475.42	807	119.71	11.04
18001	19000	7,283,956.63	18,487.20	820	121.40	11.91
19001	20000	6,787,069.91	19,503.07	704	113.12	12.84
20001	21000	6,718,161.33	20,482.20	675	111.97	13.87
21001	22000	6,927,397.32	21,513.66	660	115.46	14.97
22001	23000	5,848,725.16	22,495.10	548	97.48	16.19
23001	24000	6,645,109.09	23,480.95	586	110.75	17.49
24001	25000	6,049,018.28	24,489.95	539	100.82	18.92
25001	26000	5,861,701.38	25,485.66	476	97.70	20.43
26001	27000	5,644,894.08	26,501.85	448	94.08	22.06
27001	28000	5,581,554.63	27,495.34	438	93.03	23.98
28001	29000	5,095,687.40	28,467.53	394	84.93	25.95
29001	30000	4,623,820.56	29,451.09	360	77.06	27.95
30001	35000	22,416,166.07	32,346.56	1,650	373.60	35.09

Range Start (Millions)	Range End (Millions)	Total Loss (Millions)	Average Loss per Year (Millions)	Number of Hurricanes	Expected Annual Hurricane Losses (Millions)	Return Period (Years)
35001	40000	17,114,297.09	37,286.05	1,136	285.24	52.77
40001	45000	12,047,288.56	42,271.19	741	200.79	77.62
45001	50000	10,535,779.58	47,245.65	619	175.60	116.96
50001	55000	6,818,609.96	52,450.85	352	113.64	174.42
55001	60000	6,150,135.43	57,477.90	304	102.50	270.27
60001	65000	4,106,858.71	62,225.13	188	68.45	447.76
65001	70000	2,879,890.78	66,974.20	123	48.00	731.71
70001	75000	1,667,372.69	72,494.46	68	27.79	1,200.00
75001	80000	1,005,097.61	77,315.20	40	16.75	1,935.48
80001	90000	1,436,040.25	84,472.96	51	23.93	3,333.33
90001	100000	567,480.65	94,580.11	17	9.46	12,000.00
100001	Maximum	334,917.36	111,639.12	9	5.58	60,000.00
Total		265,672,310.45		53,567		

Form A-8: Hurricane Probable Maximum Loss for Florida

Part B - Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida (Annual Aggregate)

Modeling Organization: Florida International University
Hurricane Model Name & Version Number: Florida Public Hurricane Loss Model 8.1 Platform NA
Hurricane Model Platform & Version Number: NA
Hurricane Model Release Date: May 24, 2021

Return Period (Years)	Estimated Loss Level (Billion)	Uncertainty Interval (Billion)			Conditional Tail Expectation (Billion)
Top Event	$119.24		-		-
1000	$70.65	$67.66	-	$73.59	$81.17
500	$63.52	$61.80	-	$65.60	$73.78
250	$56.63	$55.47	-	$58.09	$66.77
100	$45.51	$44.70	-	$46.50	$56.83
50	$36.59	$35.98	-	$37.33	$48.67
20	$25.19	$24.75	-	$25.66	$37.54
10	$16.25	$15.93	-	$16.56	$28.88
5	$6.44	$6.18	-	$6.70	$19.90

Form A-8: Hurricane Probable Maximum Loss for Florida

Part C - Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida (Annual Occurrence)

Modeling Organization: Florida International University
Hurricane Model Name & Version Number: Florida Public Hurricane Loss Model 8.1 Platform NA
Hurricane Model Platform & Version Number: NA
Hurricane Model Release Date: May 24, 2021

Return Period (Years)	Estimated Loss Level (Billion)	Uncertainty Interval (Billion)			Conditional Tail Expectation (Billion)
Top Event	$97.39		-		-
1000	$56.07	$54.48	-	$59.51	$64.01
500	$51.04	$49.83	-	$52.43	$58.59
250	$45.59	$44.34	-	$46.60	$53.35
100	$37.68	$37.01	-	$38.47	$46.01
50	$31.07	$30.57	-	$31.69	$40.07
20	$22.30	$22.00	-	$22.72	$31.72
10	$15.60	$15.39	-	$15.86	$25.15
5	$8.85	$8.67	-	$9.00	$18.51

Appendix J – Form G1 – Form G7

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Form G-1: General Standards Expert Certification

Purpose: This form identifies the signatory or signatories who have reviewed the current submission for compliance with the General Standards (G-1 – G-5) in accordance with the stated provisions.

I hereby certify that I have reviewed the current submission of FPHLM Florida Public Hurricane Loss Model (Name of Hurricane Model) Version ~~8.0~~ 8.1 for compliance with the 2019 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology and hereby certify that:

1. The hurricane model meets the General Standards (G-1 – G-5);
2. The disclosures and forms related to the General Standards section are editorially and technically accurate, reliable, unbiased, and complete;
3. My review was completed in accordance with the professional standards and code of ethical conduct for my profession;
4. My review involved ensuring the consistency of the content in all sections of the submission; and
5. In expressing my opinion I have not been influenced by any other party in order to bias or prejudice my opinion.

SHAHID S. HAMID
Name

PhD in Economics (Financial)
Professional Credentials (Area of Expertise)

S. Hamid
Signature (original submission)

10/31/2020
Date

S. Hamid
Signature (response to deficiencies, if any)

1/29/2021
Date

S. Hamid
Signature (revisions to submission, if any)

3/14/2021
Date

Signature (final submission)

Date

An updated signature and form are required following any modification of the hurricane model and any revision of the original submission. If a signatory differs from the original signatory, provide the printed name and professional credentials for any new signatories. Additional signature lines shall be added as necessary with the following format:

Signature (revisions to submission)

Date

Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

Include Form G-1, General Standards Expert Certification, in a submission appendix.

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Form G-2

Form G-2: Meteorological Standards Expert Certification

Purpose: This form identifies the signatory or signatories who have reviewed the current submission for compliance with the Meteorological Standards (M-1 – M-6) in accordance with the stated provisions.

I hereby certify that I have reviewed the current submission of FPHLM (Name of Hurricane Model) Version 8.0/8.1 for compliance with the 2019 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology and hereby certify that:

1. The hurricane model meets the Meteorological Standards (M-1 – M-6);
2. The disclosures and forms related to the Meteorological Standards section are editorially and technically accurate, reliable, unbiased, and complete;
3. My review was completed in accordance with the professional standards and code of ethical conduct for my profession; and
4. In expressing my opinion I have not been influenced by any other party in order to bias or prejudice my opinion.

Steven Cocke	PhD Physics
Name	Professional Credentials (Area of Expertise)
	October 28, 2020
Signature (original submission)	Date
	January 28, 2021
Signature (response to deficiencies, if any)	Date
Signature (revisions to submission, if any)	Date
Signature (final submission)	Date

An updated signature and form are required following any modification of the hurricane model and any revision of the original submission. If a signatory differs from the original signatory, provide the printed name and professional credentials for any new signatories. Additional signature lines shall be added as necessary with the following format:

Signature (revisions to submission)	Date

Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

Include Form G-2, Meteorological Standards Expert Certification, in a submission appendix.

110

Form G-3: Statistical Standards Expert Certification

Purpose: This form identifies the signatory or signatories who have reviewed the current submission for compliance with the Statistical Standards (S-1 – S-6) in accordance with the stated provisions.

I hereby certify that I have reviewed the current submission of FPHLM (Name of Hurricane Model) Version 8.0 / 8.1 for compliance with the 2019 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology and hereby certify that:

1. The hurricane model meets the Statistical Standards (S-1 – S-6);
2. The disclosures and forms related to the Statistical Standards section are editorially and technically accurate, reliable, unbiased, and complete;
3. My review was completed in accordance with the professional standards and code of ethical conduct for my profession; and
4. In expressing my opinion I have not been influenced by any other party in order to bias or prejudice my opinion.

Wensong Wu	PhD Statistics
Name	Professional Credentials (Area of Expertise)
Wensong Wu	October, 28, 2020
Signature (original submission)	Date
Signature (response to deficiencies, if any)	Date
Wensong Wu	March 14, 2021
Signature (revisions to submission, if any)	Date
Signature (final submission)	Date

An updated signature and form are required following any modification of the hurricane model and any revision of the original submission. If a signatory differs from the original signatory, provide the printed name and professional credentials for any new signatories. Additional signature lines shall be added as necessary with the following format:

Signature (revisions to submission)	Date

Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

Include Form G-3, Statistical Standards Expert Certification, in a submission appendix.

Form G-4

Form G-4: Vulnerability Standards Expert Certification

Purpose: This form identifies the signatory or signatories who have reviewed the current submission for compliance with the Vulnerability Standards (V-1 – V-4) in accordance with the stated provisions.

I hereby certify that I have reviewed the current submission of Florida Public Hurricane Loss Model
(Name of Hurricane Model)
Version 8.0/8.1 for compliance with the 2019 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology and hereby certify that:

1. The hurricane model meets the Vulnerability Standards (V-1 – V-4);
2. The disclosures and forms related to the Vulnerability Standards section are editorially and technically accurate, reliable, unbiased, and complete;
3. My review was completed in accordance with the professional standards and code of ethical conduct for my profession; and
4. In expressing my opinion I have not been influenced by any other party in order to bias or prejudice my opinion.

Jean-Paul Pinelli	PhD, P.E, Structural/Wind Engineer
Name	Professional Credentials (Area of Expertise)
	10/31/2020
Signature (original submission)	Date
	1/25/21
Signature (response to deficiencies, if any)	Date
	3/14/21
Signature (revisions to submission, if any)	Date
Signature (final submission)	Date

An updated signature and form are required following any modification of the hurricane model and any revision of the original submission. If a signatory differs from the original signatory, provide the printed name and professional credentials for any new signatories. Additional signature lines shall be added as necessary with the following format:

Signature (revisions to submission)	Date

Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

Include Form G-4, Vulnerability Standards Expert Certification, in a submission appendix.

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Form G-5

Form G-5: Actuarial Standards Expert Certification

Purpose: This form identifies the signatory or signatories who have reviewed the current submission for compliance with the Actuarial Standards (A-1 – A-6) in accordance with the stated provisions.

I hereby certify that I have reviewed the current submission of Florida Public Hurricane Loss Model (Name of Hurricane Model) Version 8.0/8.1 for compliance with the 2019 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology and hereby certify that:

1. The hurricane model meets the Actuarial Standards (A-1 – A-6);
2. The disclosures and forms related to the Actuarial Standards section are editorially and technically accurate, reliable, unbiased, and complete;
3. My review was completed in accordance with the Actuarial Standards of Practice and Code of Conduct; and
4. In expressing my opinion I have not been influenced by any other party in order to bias or prejudice my opinion.

Gail Flannery	FCAS, MAAA
Name	Professional Credentials (Area of Expertise)
	October 26, 2020
Signature (original submission)	Date
	January 25, 2021
Signature (response to deficiencies, if any)	Date
	March 12, 2021
Signature (revisions to submission, if any)	Date
Signature (final submission)	Date

An updated signature and form are required following any modification of the hurricane model and any revision of the original submission. If a signatory differs from the original signatory, provide the printed name and professional credentials for any new signatories. Additional signature lines shall be added as necessary with the following format:

Signature (revisions to submission)	Date

Form G-6

Form G-6: Computer/Information Standards Expert Certification

Purpose: This form identifies the signatory or signatories who have reviewed the current submission for compliance with the Computer/Information Standards (CI-1 – CI-7) in accordance with the stated provisions.

I hereby certify that I have reviewed the current submission of Florida Public Hurricane Loss Model
(Name of Hurricane Model)

Version 8.0/8.1 for compliance with the 2019 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology and hereby certify that:

1. The hurricane model meets the Computer/Information Standards (CI-1 – CI-7);
2. The disclosures and forms related to the Computer/Information Standards section are editorially and technically accurate, reliable, unbiased, and complete;
3. My review was completed in accordance with the professional standards and code of ethical conduct for my profession; and
4. In expressing my opinion I have not been influenced by any other party in order to bias or prejudice my opinion.

Shu-Ching Chen Name	Ph.D. in Electrical and Computer Engineering MS in Computer Science Professional Credentials (Area of Expertise)
[signature] Signature (original submission)	10/26/2020 Date
Signature (response to deficiencies, if any)	Date
[signature] Signature (revisions to submission, if any)	3/10/2021 Date
Signature (final submission)	Date

An updated signature and form are required following any modification of the hurricane model and any revision of the original submission. If a signatory differs from the original signatory, provide the printed name and professional credentials for any new signatories. Additional signature lines shall be added as necessary with the following format:

Signature (revisions to submission)	Date

Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

Include Form G-6, Computer/Information Standards Expert Certification, in a submission appendix.

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Form G-7: Editorial Review Expert Certification

Purpose: This form identifies the signatory or signatories who have reviewed the current submission for compliance with the Notification Requirements and General Standard G-5, Editorial Compliance, in accordance with the stated provisions.

I hereby certify that I have reviewed the current submission of FPHLM (Name of Hurricane Model) Version 8.0 for compliance with the "Process for Determining the Acceptability of a Computer Simulation Hurricane Model" adopted by the Florida Commission on Hurricane Loss Projection Methodology in its *Hurricane Standards Report of Activities as of November 1, 2019*, and hereby certify that:

1. The hurricane model submission is in compliance with the Notification Requirements and General Standard G-5, Editorial Compliance;
2. The disclosures and forms related to each hurricane standards section are editorially accurate and contain complete information and any changes that have been made to the submission during the review process have been reviewed for completeness, grammatical correctness, and typographical errors;
3. There are no incomplete responses, charts or graphs, inaccurate citations, or extraneous text or references;
4. The current version of the hurricane model submission has been reviewed for grammatical correctness, typographical errors, completeness, the exclusion of extraneous data/information and is otherwise acceptable for publication; and
5. In expressing my opinion I have not been influenced by any other party in order to bias or prejudice my opinion.

Daniel Martinez	High School Graduate
Name	Professional Credentials (Area of Expertise)
Daniel Martinez	October 30, 2020
Signature (original submission)	Date
Daniel Martinez	January 29, 2021
Signature (response to deficiencies, if any)	Date
Daniel Martinez	March 14, 2021
Signature (revisions to submission, if any)	Date
Signature (final submission)	Date

An updated signature and form are required following any modification of the hurricane model and any revision of the original submission. If a signatory differs from the original signatory, provide the printed name and professional credentials for any new signatories. Additional signature lines shall be added as necessary with the following format:

Signature (revisions to submission)	Date

Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

Include Form G-7, Editorial Review Expert Certification, in a submission appendix.

Appendix K – Form M-1: Annual Occurrence Rates

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form M-1, Annual Occurrence Rates.

Automated scripts and programs were used to generate Form M-1.

B. Provide a table of annual occurrence rates for hurricane landfall from the dataset defined by marine exposure that the hurricane model generates by hurricane category (defined by maximum windspeed at hurricane landfall in the Saffir-Simpson Hurricane Wind Scale) for the entire state of Florida and additional regions as defined in Figure 3. List the annual occurrence rate per hurricane category. Annual occurrence rates shall be rounded to three decimal places.

The historical frequencies below have been derived from the Base Hurricane Storm Set as defined in Standard M-1, Base Hurricane Storm Set. If the modeling organization Base Hurricane Storm Set differs from that defined in Standard M-1, Base Hurricane Storm Set, (for example, using a different historical period), the historical rates in the table shall be edited to reflect this difference (see below). As defined, a by-passing hurricane (ByP) is a hurricane which does not make landfall on Florida, but produces minimum damaging windspeeds or greater on land in Florida. For the by-passing hurricanes included in the table only, the intensity entered is the maximum windspeed at closest approach to Florida, not the windspeed over Florida.

The table of annual occurrence rates are shown in Table 32. A report detailing how the counts were determined will be available for review.

C. Describe hurricane model variations from the historical frequencies.

The modeled frequencies are consistent with the historical record, to the extent that we may consider the historical record reliable. Statewide, the model produces 76.07 Florida landfalls (67.62 storms) in 120 years, compared to 75 landfalls (68 storms) historically. For major (Category 3–5) storms, the model produces 25.5 landfalls, compared to about 27 landfalls historically.

On a regional basis, the model is also consistent with the historical record. In Part D below we show bar charts for each region. The bar charts show reasonable agreement between the modeled and historical frequencies. Goodness of fit tests have been performed and indicate that the model results are consistent with the historical record. These tests will be available for review.

D. Provide vertical bar graphs depicting distributions of hurricane frequencies by category by region of Florida (Figure 3), for the neighboring states of Alabama/Mississippi and Georgia, and for by-passing hurricanes. For the neighboring states, statistics based on the closest coastal segment to the state boundaries used in the hurricane model are adequate.

Vertical bar charts are shown in the figure below. These charts show the number of hurricanes in a 120-year period.

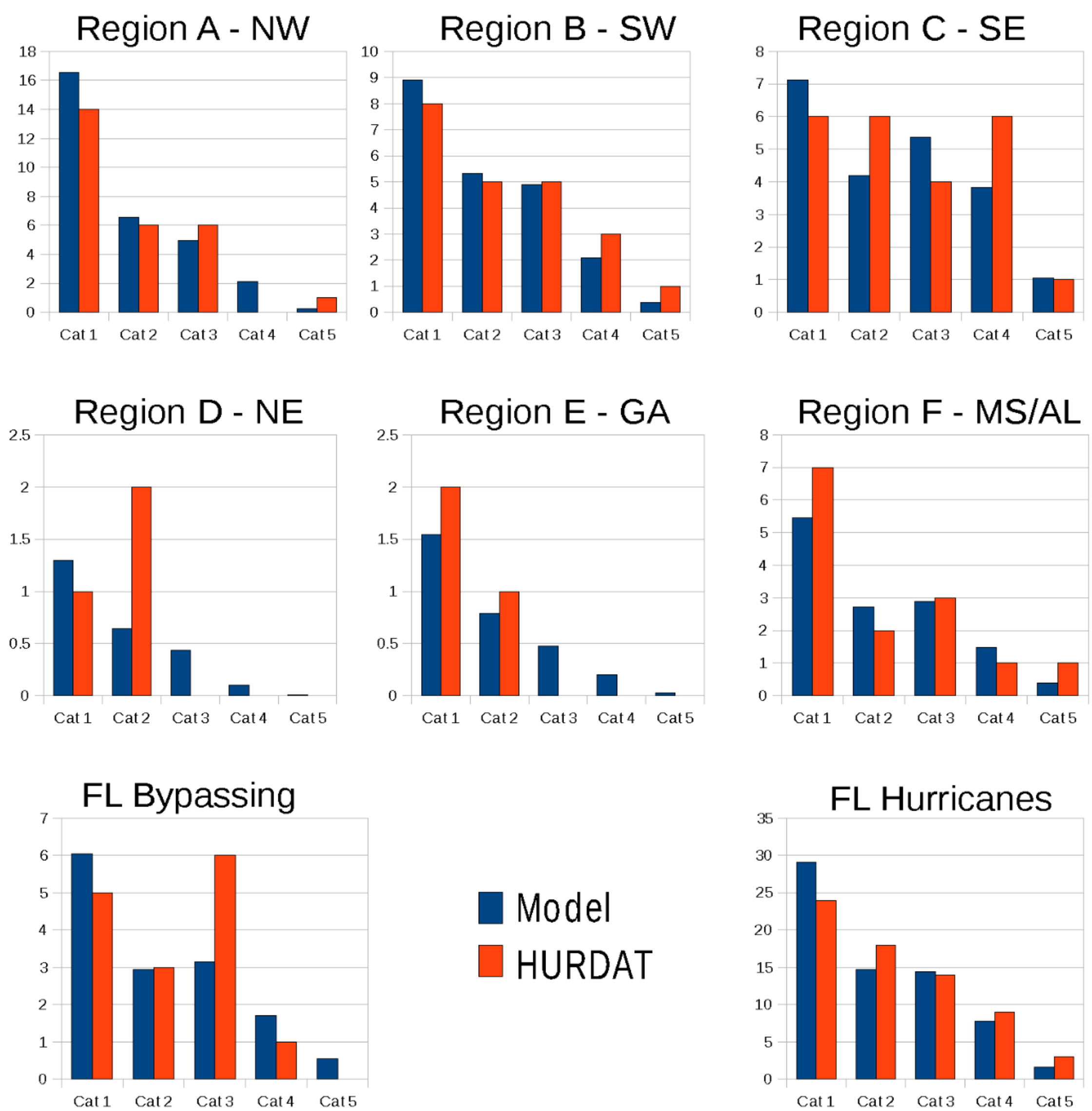

Figure 106. Form M-1 comparison of modeled and historical landfalling hurricane frequency (storms occurring in 120 years) for Regions A–F, FL bypassing storms, and FL state-wide hurricanes.

E. If the data are partitioned or modified, provide the historical annual occurrence rates for the applicable partition (and its complement) or modification as well as the modeled annual occurrence rates in additional copies of Form M-1, Annual Occurrence Rates.

Not Applicable.

F. List all hurricanes added, removed, or modified from the previously-accepted hurricane model version of the Base Hurricane Storm Set.

The HRD base set of storms used in the FPHLM has been updated to include new and revised storms from the HURDAT2 database as of April 28, 2020. One new storm was added, Hurricane Michael (2018), which was a Category 5 storm hitting near Mexico Beach, Florida. Four storms were revised due to the ongoing HURDAT Reanalysis Project: Cleo (1964), Dora (1964), Isbell (1964) and Betsy (1965). All of these storms had numerous adjustments to the track and intensity. A summary of the significant changes to these storms is provided below:

Cleo (1964) - First Florida landfall intensity increased from 90 kt to 95 kt. Slight change in landfall location.

Dora (1964) - Florida landfall pressure changed from 961 mb to 966 mb. Landfall intensity unchanged at 95 kt.

Isbell (1964) - Florida landfall intensity change from 110 kt (Category 3) to 90 kt (Category 2). Central pressure changed from 964 mb to 970 mb. Slight change in landfall location.

Betsy (1965) - Florida Keys landfall intensity reduced from 110 kt to 100 kt. Slight change in landfall location.

G. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form M-1, Annual Occurrence Rates, in a submission appendix.

The form is provided in Excel format. See Table 33.

Form M-1. Modeled Annual Occurrence Rates

	Entire State				Region A – NW Florida			
	Historical		Modeled		Historical		Modeled	
Category	Number	Rate	Number	Rate	Number	Rate	Number	Rate
1	24	0.200	29.078	0.242	14	0.117	16.550	0.138
2	18	0.150	14.710	0.123	6	0.050	6.542	0.055
3	14	0.117	14.426	0.120	6	0.050	4.976	0.041
4	9	0.075	7.776	0.065	0	0.000	2.134	0.018
5	3	0.025	1.630	0.014	1	0.008	0.246	0.002
	Region B – SW Florida				**Region C – SE Florida**			
	Historical		**Modeled**		**Historical**		**Modeled**	
Category	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**
1	8	0.067	8.912	0.074	6	0.050	7.114	0.059
2	5	0.042	5.312	0.044	6	0.050	4.194	0.035
3	5	0.042	4.878	0.041	4	0.033	5.376	0.045
4	3	0.025	2.094	0.017	6	0.050	3.824	0.032
5	1	0.008	0.372	0.003	1	0.008	1.060	0.009
	Region D – NE Florida				**Florida By-Passing Hurricanes**			
	Historical		**Modeled**		**Historical**		**Modeled**	
Category	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**
1	1	0.008	1.298	0.011	5	0.042	6.050	0.050
2	2	0.017	0.644	0.005	3	0.025	2.932	0.024
3	0	0.000	0.434	0.004	6	0.050	3.150	0.026
4	0	0.000	0.104	0.001	1	0.008	1.698	0.014
5	0	0.000	0.006	0.000	0	0.000	0.546	0.005
	Region E – Georgia				**Region F – Alabama/Mississippi**			
	Historical		**Modeled**		**Historical**		**Modeled**	
Category	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**
1	2	0.017	1.544	0.013	7	0.058	5.462	0.046
2	1	0.008	0.788	0.007	2	0.017	2.712	0.023
3	0	0.000	0.474	0.004	3	0.025	2.888	0.024
4	0	0.000	0.200	0.002	1	0.008	1.484	0.012
5	0	0.000	0.028	0.000	1	0.008	0.384	0.003

Table 32. Form M-1 Modeled Annual Occurrence Rate

Appendix L – Form M-2: Maps of Maximum Winds

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Map of Form M2-A

Maximum Winds for the Modeled Version of the
Base Hurricane Set (Actual Terrain)

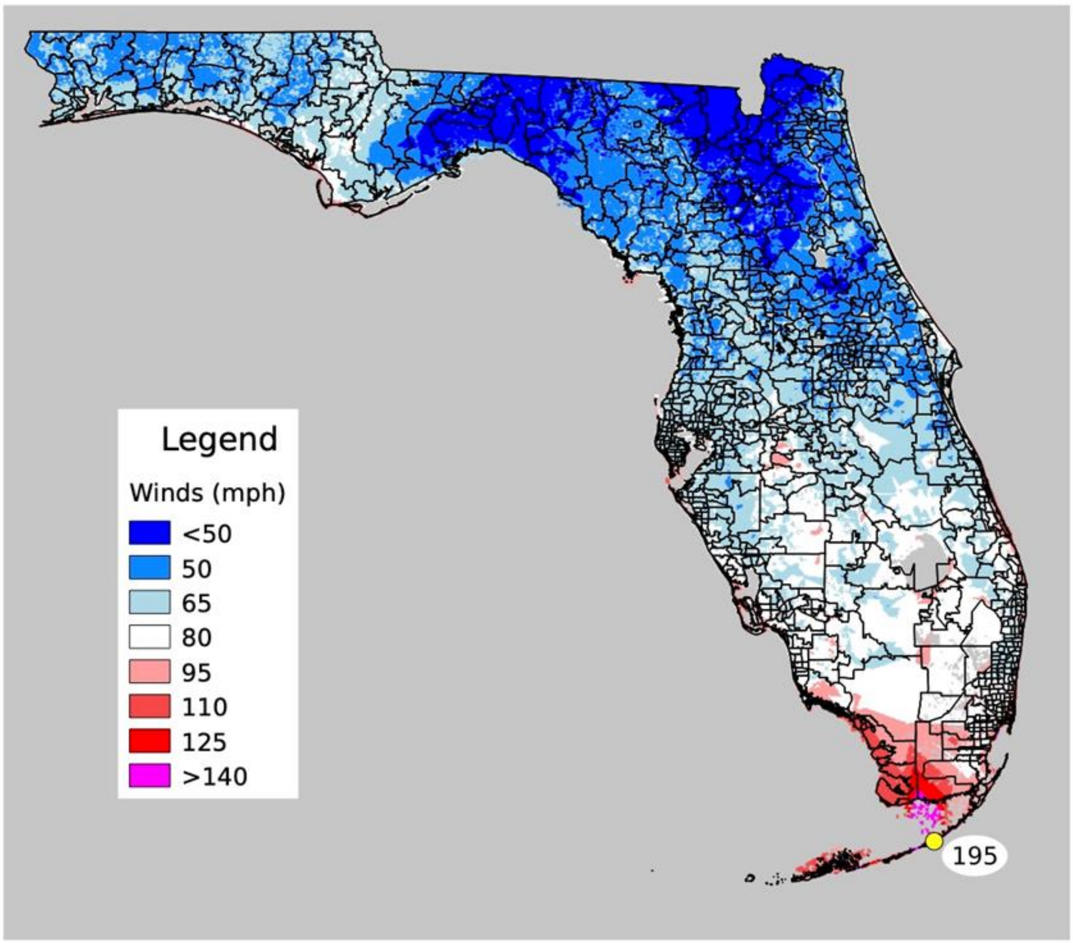

Figure 107. Maximum winds for the modeled version of the base hurricane storm set (actual terrain)

Map of Form M2-A

Maximum Winds for the Modeled Version of the Base Hurricane Set (Open Terrain)

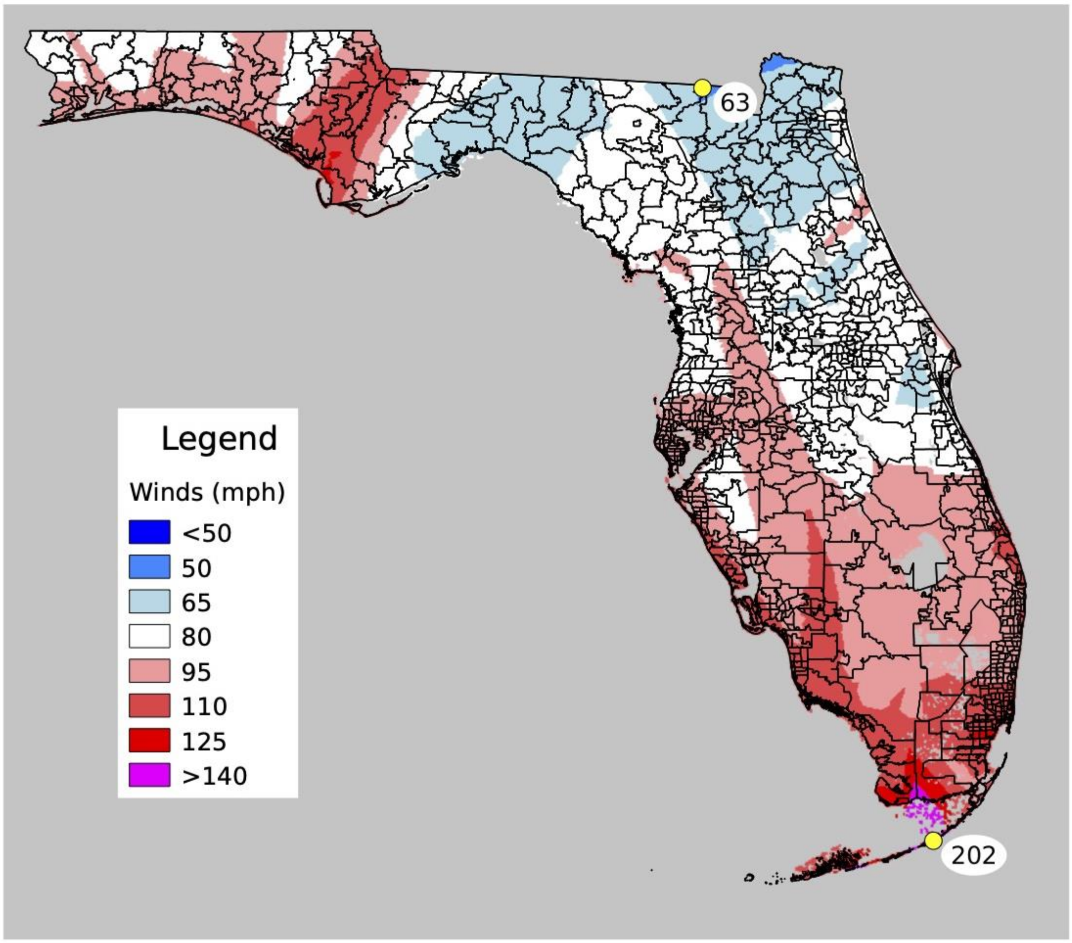

Figure 108. Maximum winds for the modeled version of the base hurricane storm set (open terrain)

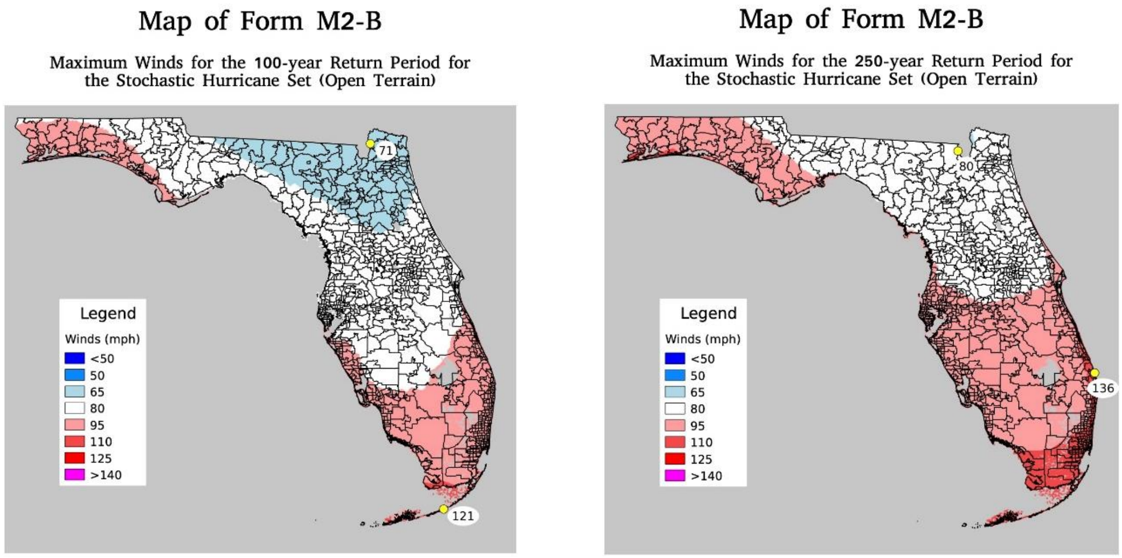

Figure 109. 100- and 250-year return period wind speeds for open terrain wind exposure.

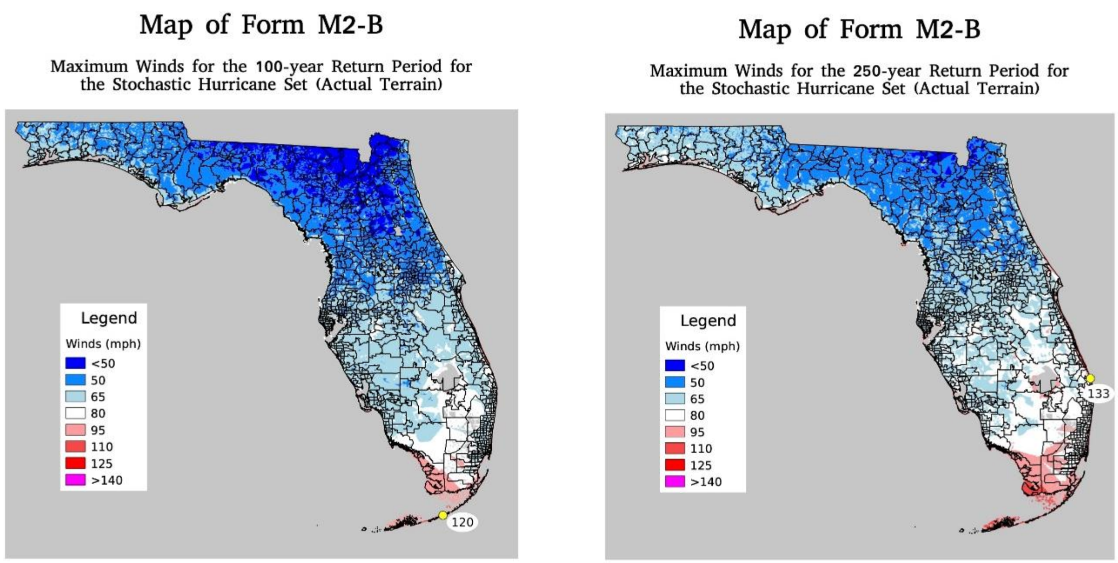

Figure 110. 100- and 250-year return period wind speeds for actual terrain wind exposure. Note that winds below 50 mph were not saved for this calculation, and thus the minimum wind cannot be determined.

Appendix M – Form M-3: Radius of Maximum Winds and Radii of Standard Wind Thresholds

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form M-3, Radius of Maximum Winds and Radii of Standard Wind Thresholds.

Automated scripts and programs were used to generate Form M-3.

B. For the central pressures in the table below, provide the first quartile (1Q), median (2Q), and third quartile (3Q) values for (1) the radius of maximum winds (Rmax) used by the hurricane model to create the stochastic storm set, and the first quartile (1Q), median (2Q), and third quartile (3Q) values for the outer radii of (2) Category 3 winds (>110 mph), (3) Category 1 winds (>73 mph), and (4) gale force winds (>40 mph).

See Table 33.

C. Describe the procedure used to complete this form.

From the entire set of stochastic track files, 10 sets of track files were extracted; each set was selected on the basis of the central pressure at landfall being within +/- 0.5 mb of the pressure as listed in Form M-3. The input *Rmax* parameter can vary slightly from *Rmax* determined from the gridded wind field because of the effects of translation speed on the wind field and interpolation truncation over the 0.1 R/ *Rmax* model grid.

D. Identify other variables that influence Rmax.

For our input values of *Rmax* that determine the initial boundary layer mean vortex, we sample *Rmax* from a gamma distribution, which only explicitly depends on central pressure. For *Rmax* determined from the wind field, the translation speed (which is added after the steady state boundary layer model solution is obtained) may also influence *Rmax*.

E. Specify any truncations applied to Rmax distributions in the hurricane model, and if and how these truncations vary with other variables.

The *Rmax* input parameter is truncated to be in the range of 4 to 120 sm.

F. Provide a box plot and histogram of Central Pressure (x-axis) versus Rmax (y-axis) to demonstrate relative populations and continuity of sampled hurricanes in the stochastic storm set.

A scatter plot with histograms and box plot is shown below.

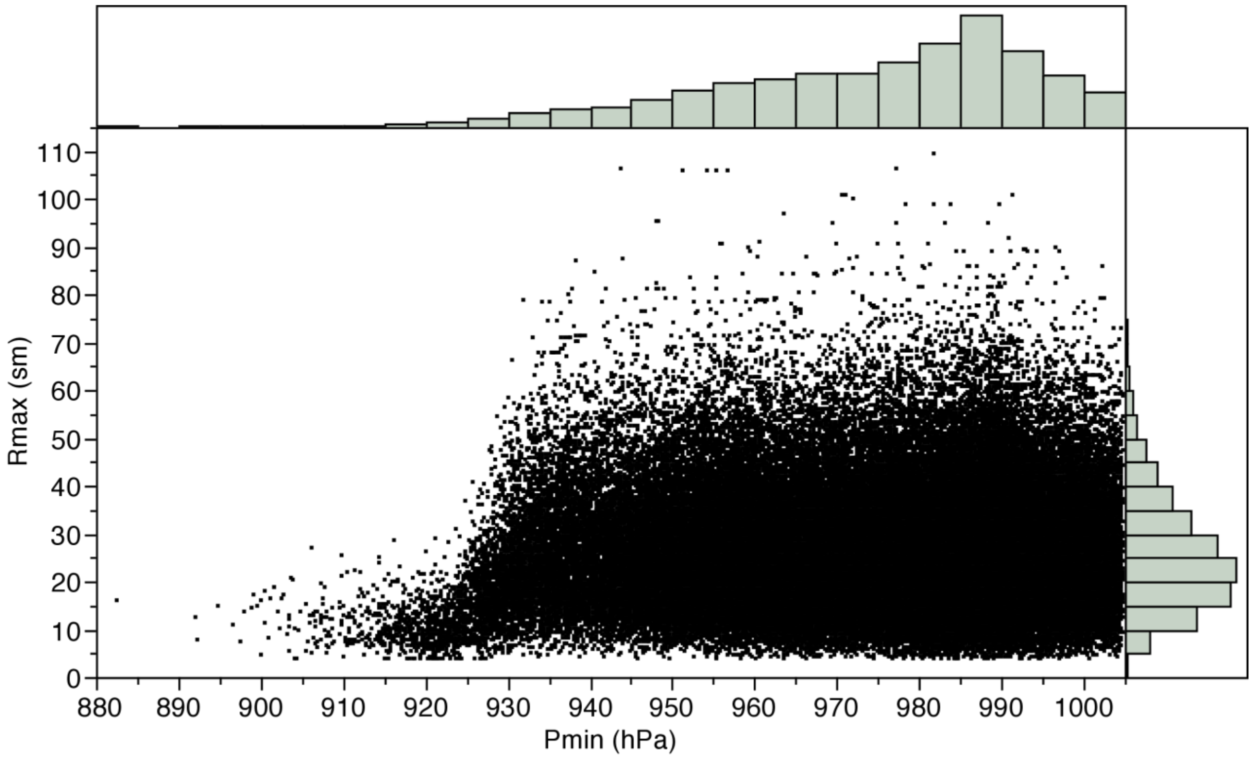

Figure 111. Representative scatter plot of the model input radius of maximum wind (y axis) versus minimum sea-level air pressure at landfall (mb). Relative histograms for each quantity are also shown.

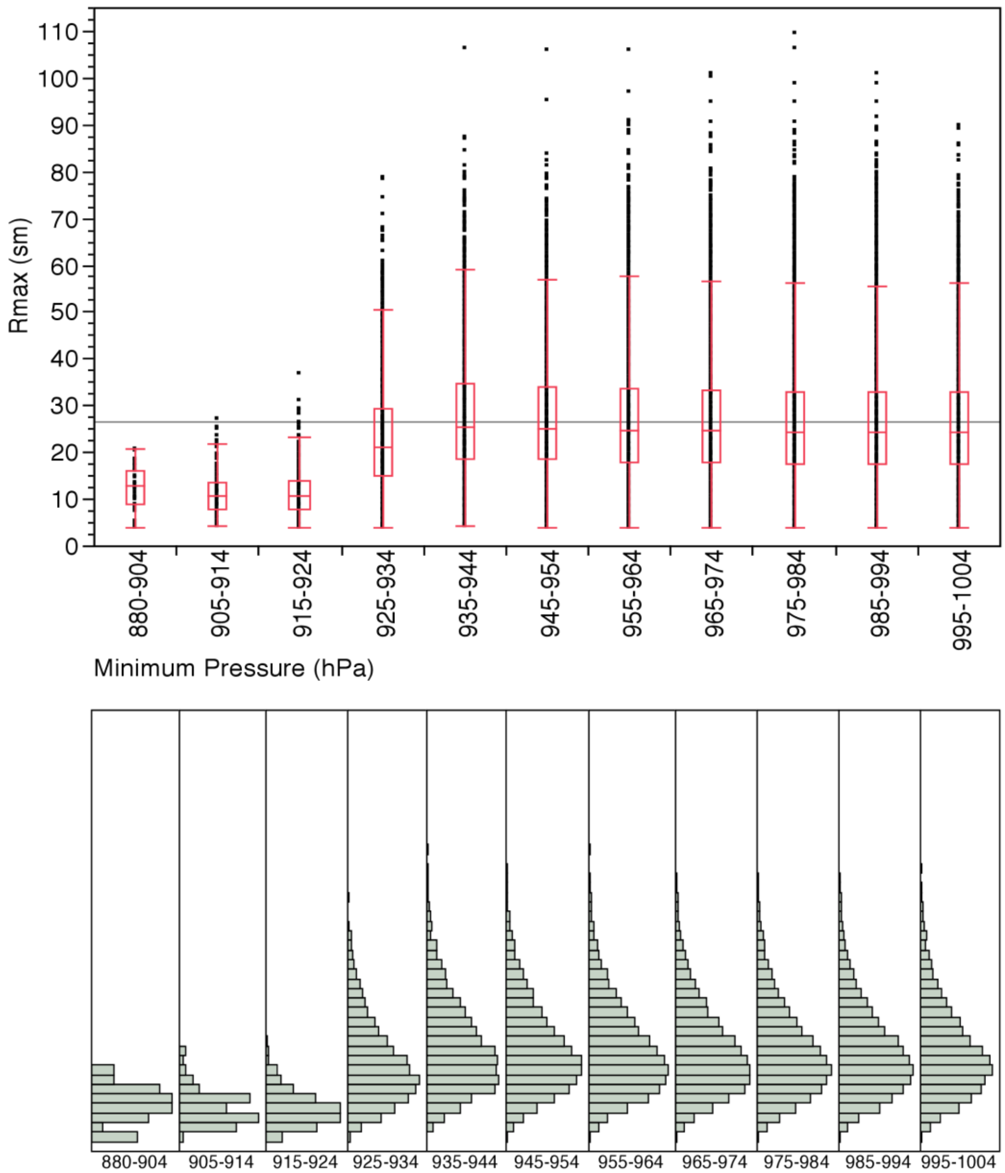

Figure 112. One way box plot (top) of *Rmax* (continuous) response across 10 mb *Pmin* groups. Boxes (and whiskers) are in red; standard deviations are in blue. Histograms (bottom) for each *Pmin* group.

G. Provide this form in Excel using the format given in the file named "2019FormM3.xlsx." The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name. Also include Form M-3, Radius of Maximum Winds and Radii of Standard Wind Thresholds, in a submission appendix.

The form is provided in Excel format. See Table 33.

Central Pressure (mb)	Rmax (sm)			Outer Radii (>110 mph) (sm)			Outer Radii (>73 mph) (sm)			Outer Radii (>40 mph) (sm)		
	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q
990	18	25	34	NA	NA	NA	17	22	30	50	66	87
980	18	25	34	10	14	18	25	32	42	66	87	114
970	18	24	33	14	19	25	32	42	54	80	107	139
960	18	25	34	18	23	30	40	51	66	94	125	165
950	18	24	33	22	28	36	45	59	75	102	137	181
940	18	24	33	26	33	42	50	66	85	111	151	201
930	15	21	28	26	34	43	49	64	83	106	145	194
920	7	9	12	13	18	25	23	31	44	49	70	101
910	6	9	12	14	19	26	24	33	46	50	73	99
900	6	8	13	14	20	28	23	34	52	49	71	106

Table 33. Form M-3: Radius of Maximum Winds and Radii of Standard Wind Thresholds

Central Pressure (mb)	**HURDAT2**						**Model**					
	Outer Radii (>73 mph) (sm)			**Outer Radii (>58 mph) (sm)**			**Outer Radii (> 73 mph) (sm)**			**Outer Radii (>58 mph) (sm)**		
	1Q	**2Q**	**3Q**	**1Q**	**2Q**	**3Q**	**1Q**	**2Q**	**3Q**	**1Q**	**2Q**	**3Q**
990	17	23	29	32	46	69	17	22	30	35	46	60
980	20	23	35	43	58	78	25	32	42	47	63	80
970	23	33	43	50	72	118	32	42	54	59	77	99
960	32	43	65	62	89	118	40	51	66	69	91	119
950	36	52	72	65	89	116	45	59	75	76	101	132
940	40	52	70	72	89	114	50	66	85	83	111	147
930	43	52	72	76	89	116	49	64	83	79	107	142

Table 34. Comparison of HURDAT2 and FPHLM outer radii

Appendix N – Form S-1: Probability and Frequency of Florida Landfalling Hurricanes per Year

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Complete the table below showing the probability and modeled frequency of landfalling Florida hurricanes per year. Modeled probability shall be rounded to three decimal places. The historical probabilities and frequencies below have been derived from the Base Hurricane Storm Set for the 118 year period 1901-2018 (as given in Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses (2017 FHCF Exposure Data)). Exclusion of hurricanes that caused zero modeled Florida damage or additional Florida hurricane landfalls included in the modeling organization Base Hurricane Storm Set as identified in their response to Standard M-1, Base Hurricane Storm Set, should be used to adjust the historical probabilities and frequencies provided.

If the data are partitioned or modified, provide the historical probabilities and frequencies for the applicable partition (and its complement) or modification as well as the modeled probabilities and frequencies in additional copies of Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year.

Hurricane Model Results
Probability and Frequency of Florida Landfalling Hurricanes per Year

Number of Hurricanes Per Year	Historical Probability	Modeled Probability	Historical Frequency	Modeled Frequency
0	0.608	0.618	73	74
1	0.242	0.246	29	29
2	0.125	0.100	15	12
3	0.025	0.031	3	4
4	0.000	0.006	0	1
5	0.000	0.000	0	0
6	0.000	0.000	0	0
7	0.000	0.000	0	0
8	0.000	0.000	0	0
9	0.000	0.000	0	0
10 or more	0.000	0.000	0	0

Note: Historical and modeled frequencies are the number of occurrences in a 120 year period.

Appendix O – Form S-2 : Examples of Hurricane Loss Exceedance Estimates (2017 FHCF Exposure Data)

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Provide estimates of the annual aggregate combined personal and commercial insured hurricane losses for various probability levels using the notional risk dataset specified in Form A-1, Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code, and using the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data provided in the file named "hlpm2017c.zip." Provide the total average annual hurricane loss for the hurricane loss exceedance distribution. If the modeling methodology does not allow the hurricane model to produce a viable answer for certain return periods, state so and why.

Part A

Return Period (Years)	Probability of Exceedance	Estimated Loss Notional Risk Data Set	Estimated Personal and Commercial Residential Loss FHCF Data Set
Top Event	NA	$73,643,080	$119,237,371,481
10000	0.01%	$57,024,462	$93,291,739,325
5000	0.02%	$53,210,261	$86,869,919,101
2000	0.05%	$47,374,273	$78,004,236,041
1000	0.10%	$42,835,570	$70,647,520,577
500	0.20%	$38,117,738	$63,521,179,702
250	0.40%	$32,351,329	$56,633,100,453
100	1.00%	$25,667,407	$45,514,761,856
50	2.00%	$20,174,958	$36,585,950,091
20	5.00%	$13,207,489	$25,185,952,473
10	10.00%	$8,064,712	$16,249,000,028
5	20.00%	$2,954,258	$6,444,427,186

Part B

Mean (Total Average Annual Loss)	$2,321,192	$4,427,871,840
Median	$60	$73,973
Standard Deviation	$5,285,782	$9,635,244,706
Interquartile Range	$1,737,523	$3,185,123,392
Sample Size	60000	60000

Appendix P – Form S-3: Distributions of Stochastic Hurricane Parameters

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Provide the probability distribution functional form used for each stochastic hurricane parameter in the model. Provide a summary of the justification for each functional form selected for each general classification.

Stochastic Hurricane Parameter (Function or Variable)	**Functional Form of Distribution**	**Data Source**	**Year Range Used**	**Justification for Functional Form**
Holland B Error term	Normal	Willoughby and Rahn (2004)	1977-2000	The Gaussian Distribution provided a good fit for the error term. See Standard S-1, Disclosure 1.
Rmax	Gamma	Ho et al. (1987) , supplemented by the extended best track data of DeMaria (Penington 2000), NOAA HRD research flight data, and NOAA-HRD H*Wind analyses (Powell et al. 1996, 1998).	1901-2012	Rmax is skewed, nonnegative and does not have a long tail. So the gamma distribution was tried and found to be a good fit. We limit the range of Rmax to the interval (4, 120). See Standard S-1, Disclosure 1.
Pressure decay Term	Normal	Vickery (2005)	1926 - 2004	From Vickery (2005)
Storm initial location perturbation	Uniform	N/A	N/A	Plausible variations in initial storm locations are assumed to be uniform
Storm initial motion perturbation	Uniform	N/A	N/A	Plausible variations in initial storm motion are assumed to be uniform
Storm change in motion and intensity distributions	Empirical	HURDAT	1900-2019	Sampling from historical data See Standard G-1, Disclosure 2 for details

Appendix Q – Form S-4: Validation Comparisons

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Personal Residential:

Coverage	Company Actual Loss/Exposure	Modeled Loss/Exposure	Difference
Building	0.00764	0.00927	-0.00163
Contents	0.00007	0.00247	-0.00240
Appurtenant	0.00107	0.01042	-0.00935
ALE	0.00025	0.00174	-0.00149
Total	0.00424	0.00650	-0.00226

Comparison #1: Hurricane Charley and Company O by Coverage

Company	Event	Company Actual Loss/Exposure	Modeled Loss/Exposure	Difference
J	Jeanne	0.01370	0.01477	-0.00107
N	Wilma	0.01303	0.01404	-0.00101
B	Charley	0.01544	0.01737	-0.00193
O	Frances	0.00245	0.00450	-0.00205
O	Charley	0.00424	0.00650	-0.00226

Comparison #2: Different Companies by Different Hurricanes

Company	Event	Company Actual Loss/Exposure	Modeled Loss/Exposure	Difference
O	Frances	0.00245	0.00450	-0.00205
O	Charley	0.00424	0.00650	-0.00226
O	Jeanne	0.00143	0.00433	-0.00290

Comparison #3: Company O by Hurricane Frances, Charley, Jeanne

Construction	Company	Company Actual Loss/Exposure	Modeled Loss/Exposure	Difference
Frame	B	0.01363	0.01695	-0.00332
Masonry	B	0.01584	0.01687	-0.00103
Manufactured	Q	0.05476	0.03724	0.01752
Other	A	0.01803	0.01450	0.00353

Comparison #4: Construction Type for Hurricane Charley

County	Company Actual Loss/Exposure	Modeled Loss/Exposure	Difference
Lee	0.000019	0.000025	-0.000007
Sarasota	0.000122	0.000259	-0.000137
Collier	0.000031	0.000080	-0.000050
Madison	0.000865	0.000931	-0.000066
Manatee	0.000257	0.000456	-0.000199

Comparison #5: County wise for Company A and Hurricane Frances

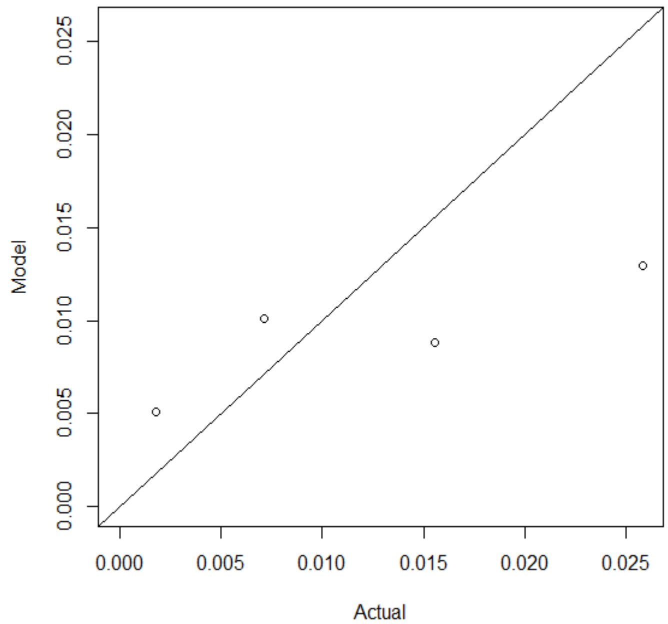

Figure 113. Scatter plot for comparison # 1.

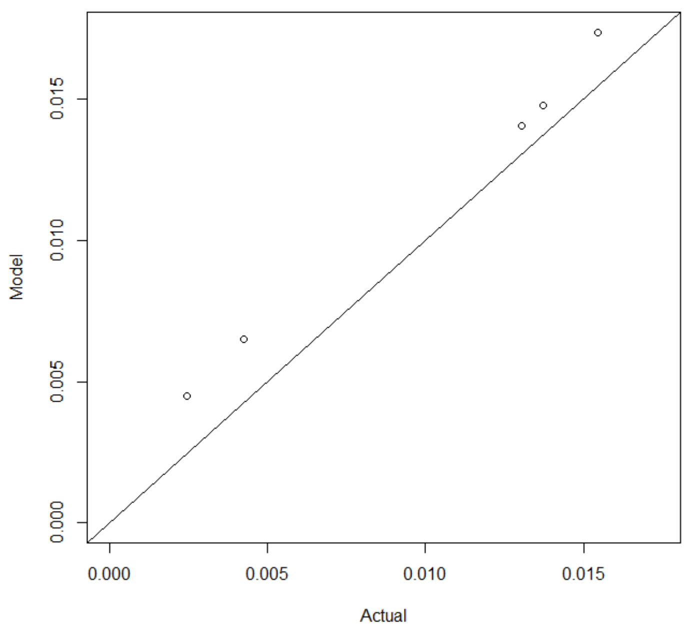

Figure 114. Scatter plot for comparison # 2.

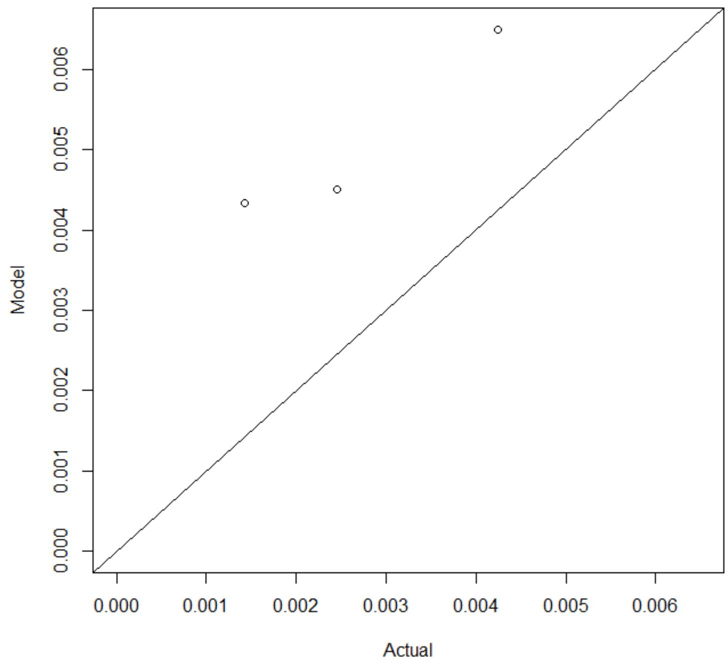

Figure 115 Scatter plot for comparison # 3.

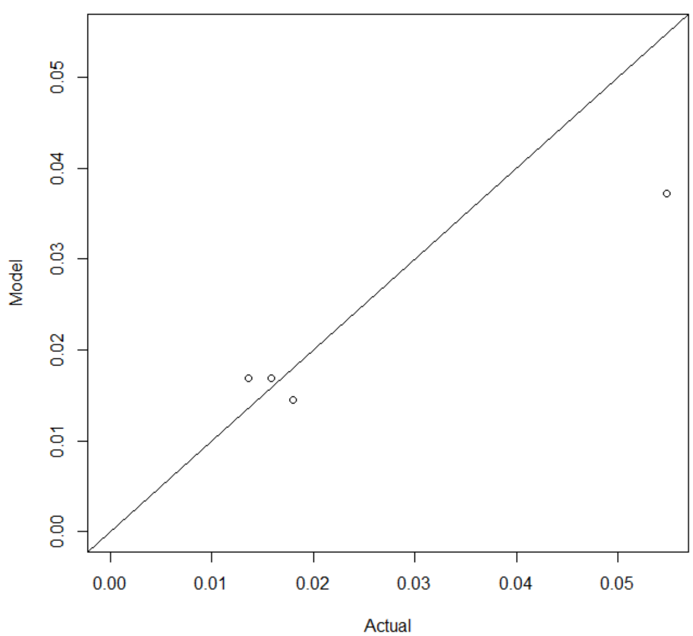

Figure 116. Scatter plot for comparison # 4.

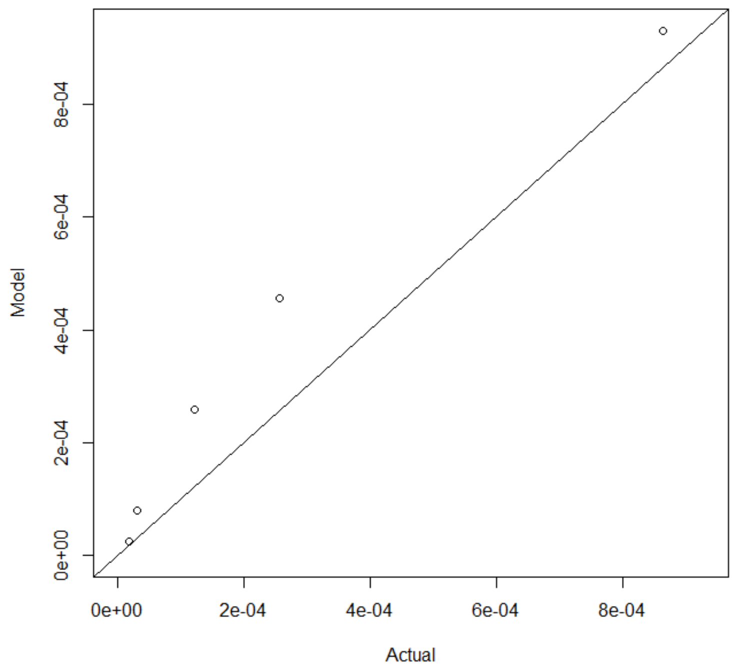

Figure 117. Scatter plot for comparison # 5.

Commercial Residential:

Company	Event	Company Actual Loss/Exposure	Modeled Loss/Exposure	Difference
D	Jeanne	0.00716	0.01112	-0.00396
D	Katrina	0.00183	0.00574	-0.00391
D	Wilma	0.01555	0.00943	0.00612
Q	Wilma	0.02579	0.00470	0.02109

Comparison # 1: Company D and Q by Hurricane Jeanne, Katrina, and Wilma

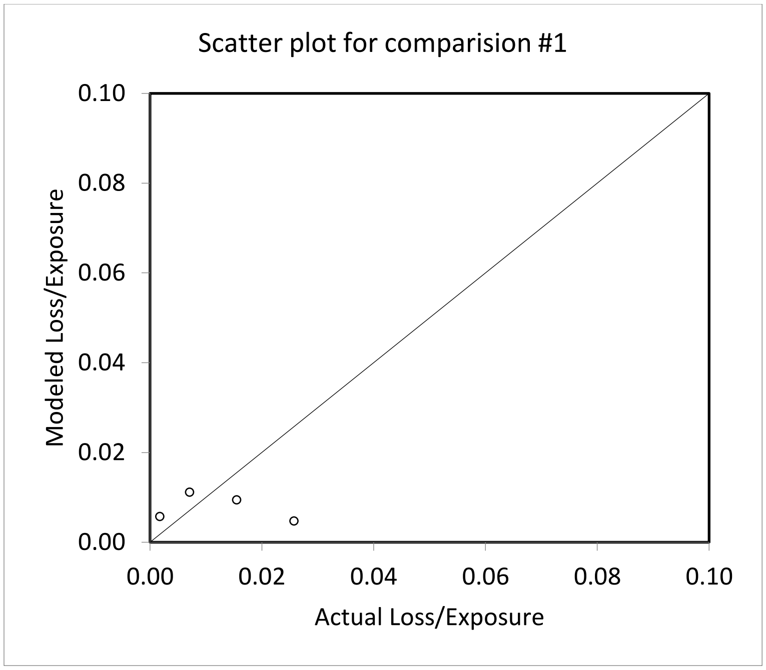

Figure 118. Scatter plot for comparison #1

Appendix R – Form S-5: Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Average Annual Zero Deductible Statewide Personal and Commercial Residential Hurricane Loss Costs

Time Period	Historical Hurricanes	Produced by Hurricane Model
Current Submission	$5,133.04	$4,427.87
Previously-Accepted Hurricane Model* (2017 Standards)	$5,792.95	$5,037.05
Percent Change Current Submission/ Previously-Accepted Hurricane Model*	-11.39	-12.09
Second Previously-Accepted Hurricane Model* (2015 Standards)	NA**	NA**
Percent Change Current Submission/ Second Previously-Accepted Hurricane Model*	NA**	NA**

**NA if no previously-accepted hurricane model*

*****The second previously-accepted hurricane model did not produce loss costs based on 2017 FHCF exposure data*** **Appendix S – Form V-1: One Hypothetical Event**

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Part A

All reference structures combined.

Windspeed (mph, one-minute sustained 10-meter)	Estimated Building Damage/ Subject Building Exposure	Estimated Contents Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
41 – 50	0.01%	0.00%	0.00%
51 – 60	0.09%	0.08%	0.04%
61 – 70	0.76%	0.23%	0.16%
71 – 80	2.42%	0.38%	0.36%
81 – 90	7.52%	1.01%	1.25%
91 – 100	16.94%	4.28%	5.30%
101 – 110	24.48%	7.96%	8.77%
111 – 120	35.07%	14.81%	14.31%
121 – 130	41.76%	27.37%	24.82%
131 – 140	42.67%	29.63%	26.76%
141 – 150	44.75%	37.63%	33.89%
151 – 160	45.10%	40.20%	36.20%
161 – 170	45.74%	47.39%	43.37%

Only personal residential reference structures combined (Timber + Masonry + MH).

Windspeed (mph, one-minute sustained 10-meter)	Estimated Building Damage/ Subject Building Exposure	Estimated Contents Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
41 – 50	0.00%	0.00%	0.00%
51 – 60	0.87%	0.10%	0.04%
61 – 70	2.58%	0.31%	0.16%
71 – 80	3.86%	0.51%	0.36%
81 – 90	6.18%	1.31%	1.25%
91 – 100	12.38%	5.20%	5.30%
101 – 110	17.43%	8.75%	8.77%
111 – 120	25.41%	14.59%	14.31%
121 – 130	40.76%	27.12%	24.82%
131 – 140	43.52%	29.43%	26.76%
141 – 150	53.41%	38.45%	33.89%
151 – 160	56.27%	41.60%	36.20%
161 – 170	64.00%	50.71%	43.37%

Only commercial residential reference structures (Concrete).

Windspeed (mph, one-minute sustained 10-meter)	Estimated Building Damage/ Subject Building Exposure	Estimated Contents Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
41 – 50	0.01%	0.00%	N/A
51 – 60	0.07%	0.00%	N/A
61 – 70	0.72%	0.00%	N/A
71 – 80	2.39%	0.00%	N/A
81 – 90	7.54%	0.10%	N/A
91 – 100	17.03%	1.54%	N/A
101 – 110	24.62%	5.58%	N/A
111 – 120	35.27%	15.49%	N/A
121 – 130	41.78%	28.13%	N/A
131 – 140	42.66%	30.22%	N/A
141 – 150	44.58%	35.18%	N/A
151 – 160	44.58%	36.00%	N/A
161 – 170	45.38%	37.42%	N/A

Part B

Construction Type	Estimated Building Damage/ Subject Building Exposure	Estimated Contents Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
Wood Frame	13.99%	10.17%	8.43%
Masonry	12.66%	8.30%	6.94%
Manufactured Home	36.57%	24.48%	22.57%
Concrete	18.40%	11.97%	N/A

The structures used in completing the form are identical to those in the table provided.

The engineered commercial residential reference structure is assumed to be a condominium association, and as such it does not have time element losses.

Part C

All reference structures combined.

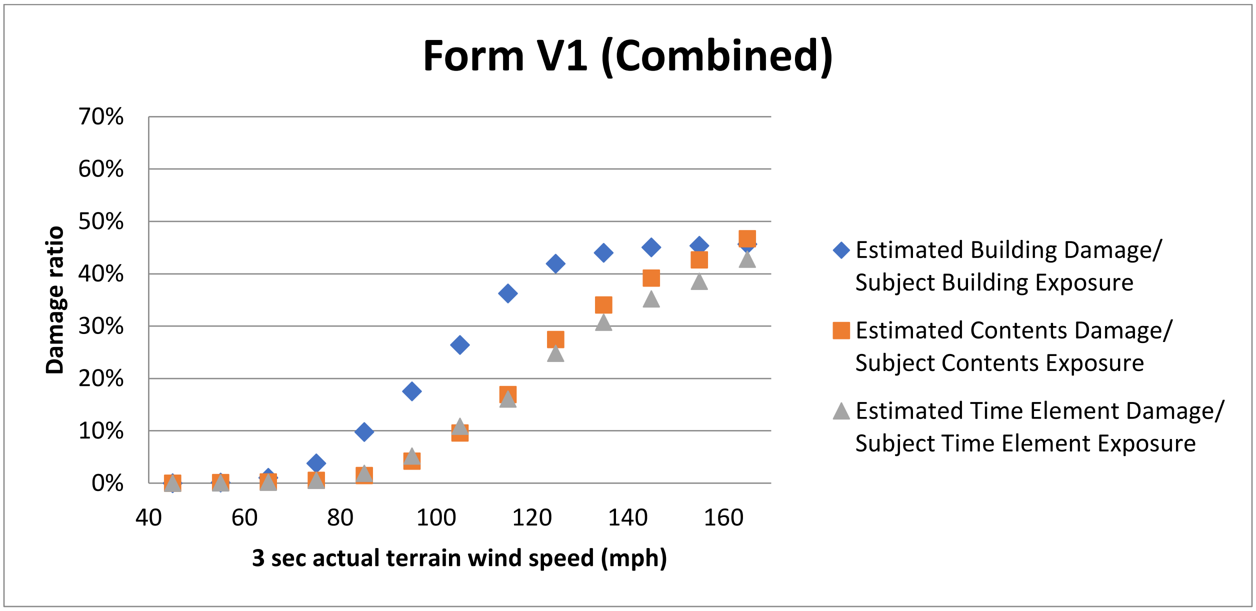

Figure 119. Building and contents damage, and TE expenses vs. 3 sec actual terrain wind speed.

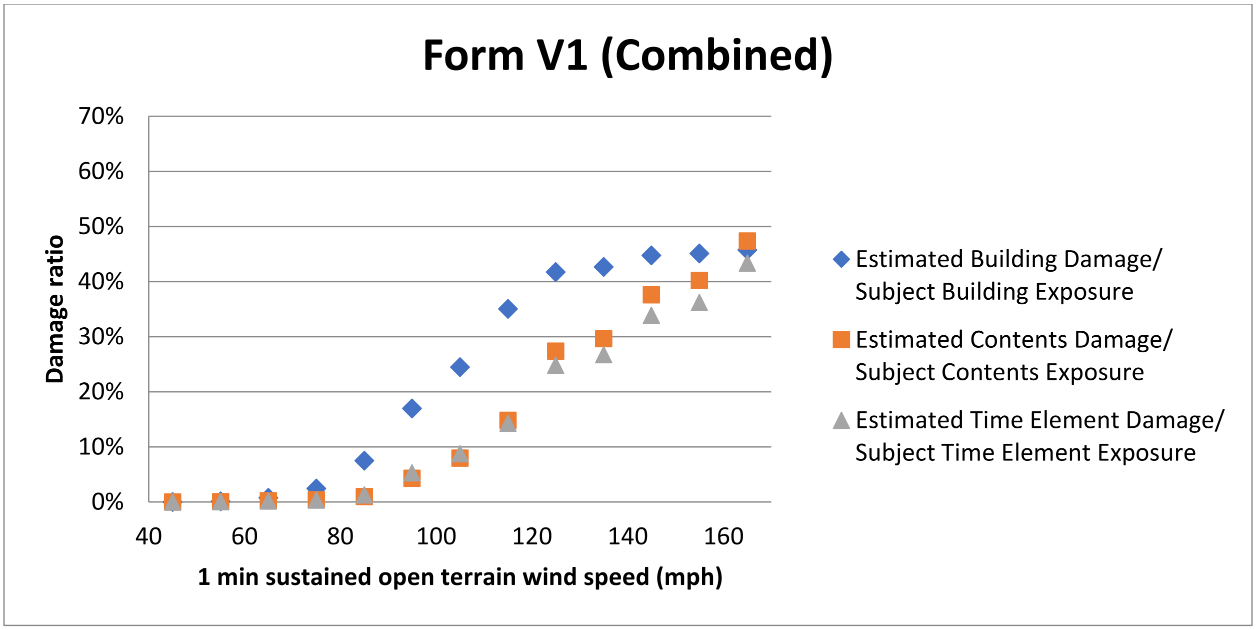

Figure 120. Building and contents damage, and TE expenses vs. 1 minute sustained wind speed.

Only personal residential reference structures combined (Timber + Masonry + MH).

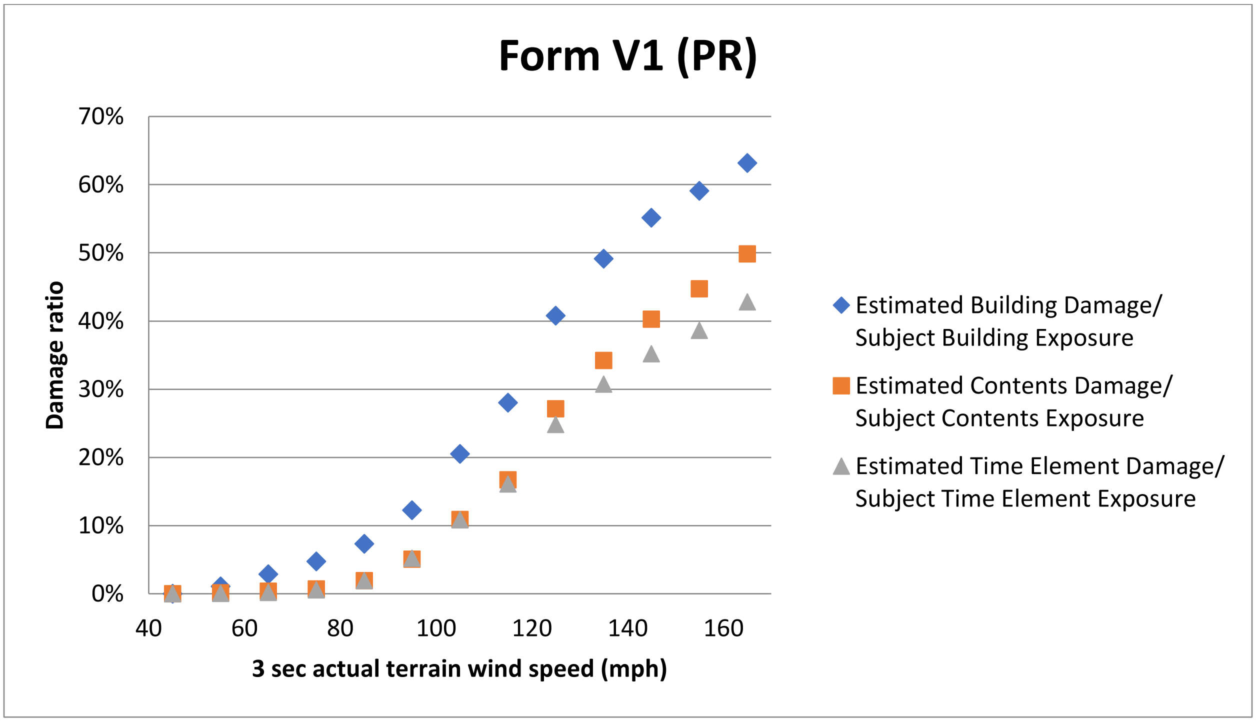

Figure 121. Building and contents damage, and TE expenses vs. 3 sec actual terrain wind speed.

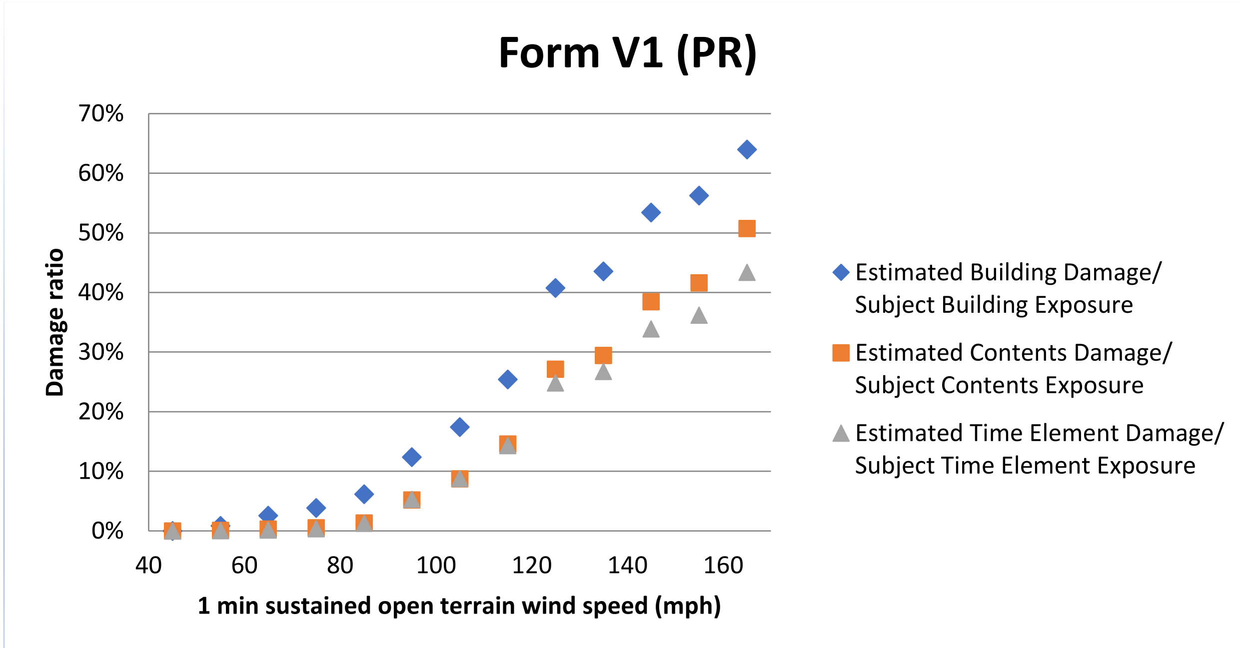

Figure 122. Building and contents damage, and TE expenses vs. 1 minute sustained wind speed.

Only commercial residential reference structures (Concrete).

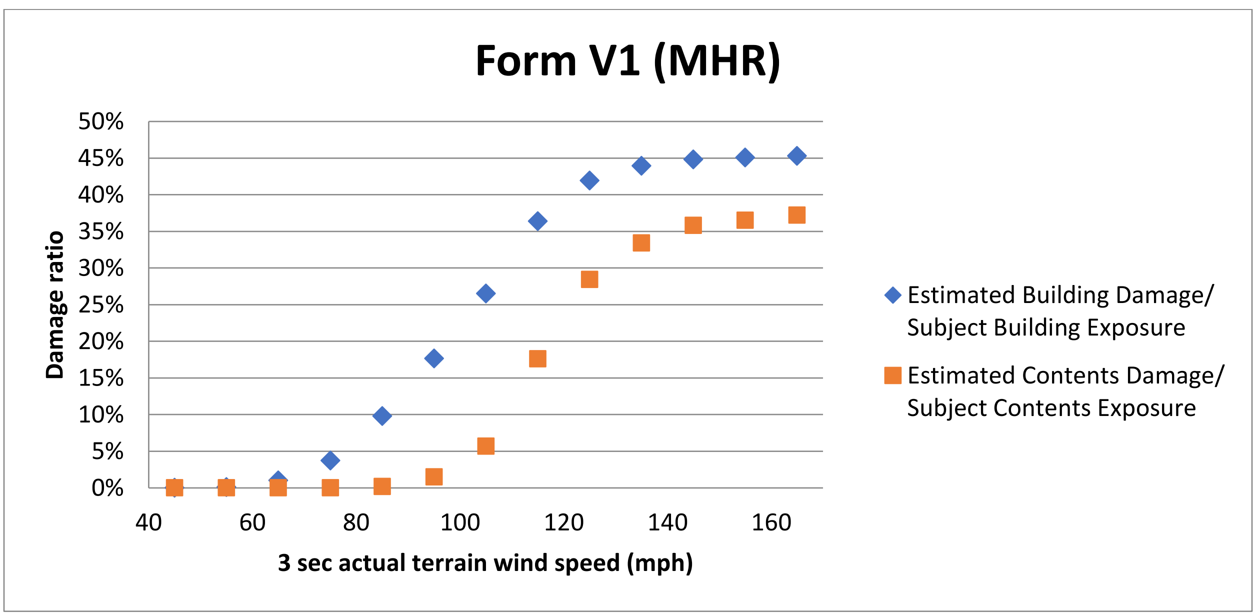

Figure 123. Building and contents damage vs. 3 sec actual terrain wind speed.

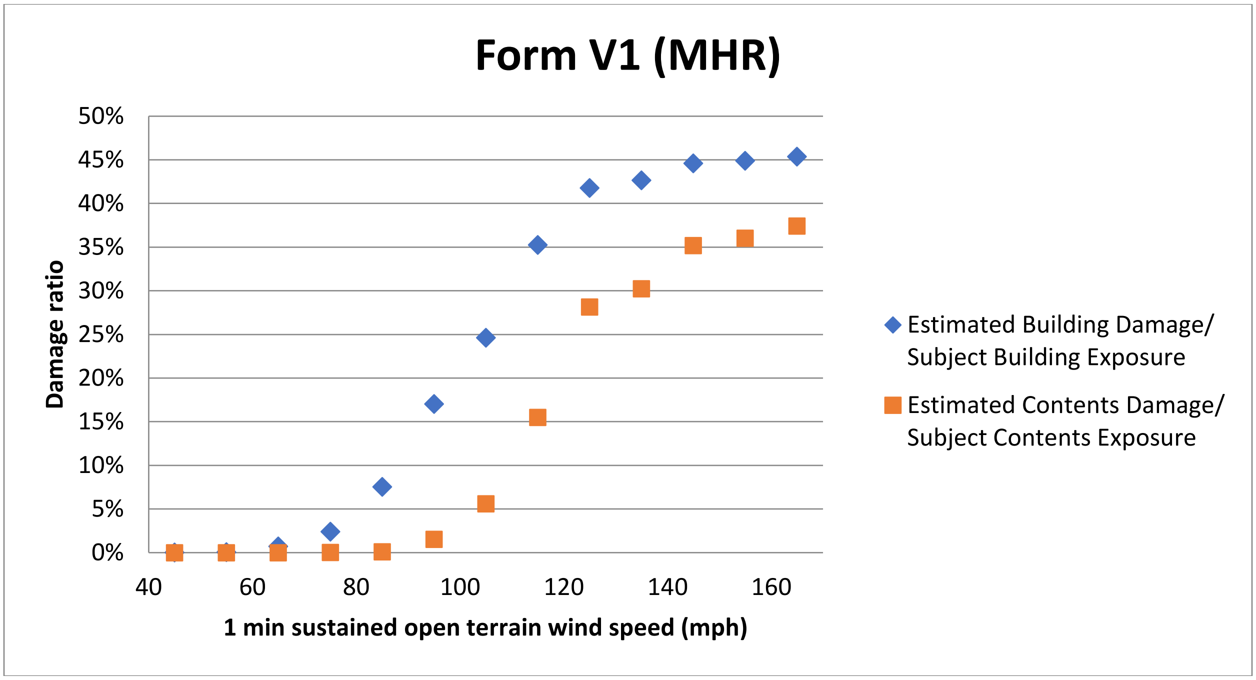

Figure 124. Building and contents damage vs. 1 minute sustained wind speed.

Appendix T – Form V-2: Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Form V-2: Mitigation Measures – Range of Changes in Damage (1 min)

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS			PERCENTAGE CHANGES IN DAMAGE (REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATE)/(REFERENCE DAMAGE RATIO)*100									
			FRAME BUILDING					MASONRY BUILDING				
			WIND SPEED (MPH)*					WIND SPEED (MPH)*				
			60	85	110	135	160	60	85	110	135	160
	REFERENCE BUILDING		-	-	-	-	-	-	-	-	-	-
ROOF STRENGTH	BRACED GABLE ENDS		0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
ROOF STRENGTH	HIP ROOF		1%	7%	5%	11%	4%	1%	6%	1%	7%	5%
ROOF COVERING	METAL		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ROOF COVERING	ASTM D7158 CLASS H SHINGLES		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ROOF COVERING	MEMBRANE		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ROOF COVERING	NAILING OF DECK 8d		2%	38%	2%	-7%	-1%	2%	39%	15%	-4%	-1%
ROOF-WALL STRENGTH	CLIPS		0%	0%	4%	14%	11%	0%	-1%	0%	7%	12%
ROOF-WALL STRENGTH	STRAPS		0%	0%	5%	19%	23%	0%	-1%	0%	8%	15%
WALL-FLOOR STRENGTH	TIES OR CLIPS		0%	0%	3%	3%	2%	-	-	-	-	-
WALL-FLOOR STRENGTH	STRAPS		0%	0%	4%	6%	4%	-	-	-	-	-
WALL FOUNDATION STRENGTH	LARGER ANCHORS OR CLOSER SPACING		-	-	-	-	-	-	-	-	-	-
WALL FOUNDATION STRENGTH	STRAPS		-	-	-	-	-	-	-	-	-	-
WALL FOUNDATION STRENGTH	VERTICAL REINFORCING		-	-	-	-	-	0%	-1%	0%	10%	22%
OPENING PROTECTION	WINDOW SHUTTERS	STRUCT WOOD	0%	3%	6%	2%	0%	0%	2%	7%	3%	0%
OPENING PROTECTION	WINDOW SHUTTERS	METAL	0%	4%	10%	4%	1%	0%	4%	12%	5%	1%
OPENING PROTECTION	DOOR AND SKYLIGHT COVERS		0%	0%	1%	1%	0%	0%	0%	1%	1%	1%
OPENING PROTECTION	WINDOWS	IMPACT RATED	0%	4%	13%	10%	5%	0%	4%	14%	12%	6%
OPENING PROTECTION	ENTRY DOORS	MEETS WINDBORNE DEBRIS REQUIREMENTS	0%	0%	0%	1%	1%	0%	0%	0%	1%	1%
OPENING PROTECTION	GARAGE DOORS	MEETS WINDBORNE DEBRIS REQUIREMENTS	0%	17%	4%	1%	0%	0%	17%	5%	1%	0%
OPENING PROTECTION	SLIDING GLASS DOORS	MEETS WINDBORNE DEBRIS REQUIREMENTS	0%	0%	1%	1%	1%	0%	0%	1%	1%	1%

HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION	PERCENTAGE CHANGES IN DAMAGE (REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO)/(REFERENCE DAMAGE RATIO)*100									
	FRAME BUILDING					MASONRY BUILDING				
	WIND SPEED (MPH)					WIND SPEED (MPH)				
	60	85	110	135	160	60	85	110	135	160
MITIGATED BUILDING	2%	41%	28%	26%	25%	2%	40%	25%	16%	16%

*Windspeeds are one-minute sustained 10-meter

Appendix U – Form V-4: Differences in Hurricane Mitigation Measures and Secondary Characteristics

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Form V-4: Differences in Hurricane Mitigation Measures and Secondary Characteristics

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS			PERCENTAGE CHANGE FROM FORM V-2 RELATIVE TO PREVIOUSLY-ACCEPTED HURRICANE MODEL									
			FRAME BUILDING					MASONRY BUILDING				
			WINDSPEED (MPH)*					WINDSPEED (MPH)*				
			60	85	110	135	160	60	85	110	135	160
	REFERENCE BUILDING		—	—	—	—	—	—	—	—	—	—
ROOF CONFIGURATION	BRACED GABLE ENDS		0	0	0	0	0	0	0	0	0	0
	HIP ROOF		0	0	0	0	0	0	0	0	0	0
ROOF COVERING	METAL		0	0	0	0	0	0	0	0	0	0
	ASTM D7158 CLASS H SHINGLES		0	0	0	0	0	0	0	0	0	0
	MEMBRANE		0	0	0	0	0	0	0	0	0	0
	NAILING OF DECK	8d	0	0	0	0	0	0	0	0	0	0
ROOF-WALL STRENGTH	CLIPS		0	0	0	0	0	0	0		0	0
	STRAPS		0	0	0	0	0	0	0	0	0	0
WALL-FLOOR STRENGTH	TIES OR CLIPS		0	0	0	0	0	0	0	0	0	0
	STRAPS		0	0	0	0	0	0	0	0	0	0
WALL-FOUNDATION STRENGTH	LARGER ANCHORS OR CLOSER SPACING							—	—	—	—	—
	STRAPS							—	—	—	—	—
	VERTICAL REINFORCING		—	—	—	—	—	0	0	0	0	0
OPENING PROTECTION	WINDOW SHUTTERS	STRUCTURAL WOOD PANEL	0	0	0	0	0	0	0	0	0	0
		METAL	0	0	0	0	0	0	0	0	0	0
	DOOR AND SKYLIGHT COVERS		0	0	0	0	0	0	0	0	0	0
WINDOW, DOOR, SKYLIGHT STRENGTH	WINDOWS	IMPACT RATED	0	0	0	0	0	0	0	0	0	0
	ENTRY DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0	0	0	0	0	0	0	0	0	0
	GARAGE DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0	0	0	0	0	0	0	0	0	0
	SLIDING GLASS DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0	0	0	0	0	0	0	0	0	0

HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION	PERCENTAGE CHANGE FROM FORM V-2 RELATIVE TO PREVIOUSLY-ACCEPTED HURRICANE MODEL									
	FRAME BUILDING					MASONRY BUILDING				
	WINDSPEED (MPH)*					WINDSPEED (MPH)*				
	60	85	110	135	160	60	85	110	135	160
MITIGATED BUILDING	0	0	0	0	0	0	0	0	0	0

*Windspeeds are one-minute sustained 10-meter.

Appendix V – List of Acronyms

Florida International University
Florida Public Hurricane Loss Model 8.0
May 24, 2021

Acronym	Full Name
ACV	Actual Cash Value
ACV S/ACV C	Structure Actual-Cash-Value, Contents Actual-Cash-Value
ACV S/RC C	Structure Actual-Cash-Value, Contents Replacement-Cost
AFRES	Air Force Reserves
ALE	Additional Living expenses
AOML	Atlantic Oceanographic and Meteorological Laboratory
AP	Appurtenant
APA	American Psychological Association
ASCE	American Society of Civil Engineers
ASHARE	American Society of Heating, Refrigeration and Air Conditioning
BR	Border Router
CDFs	Cumulative Distribution Functions
CDO	Cost of Damage to Openings
CR-LR	Commercial Low-rise Model
CNL	C Numerical Library
COV	Coefficient of Variation
CP	Central Pressure
CPTA	County Property Tax Appraiser
CR	Commercial Residential
CR#	Core Router #
CVS	Concurrent Versions System
DA	Damage Array
DR	Damage Ratio
EDR	Expected Damage Ratio
EDV	Expected Damage Value
EIDR	Expected Interior Damage Ratio
EL	Equilibrium Layer
EPR	Expected Percentage Reduction
ERS	European Remote Sensing
ESDU	Engineering Sciences Data Unit
FBC	Florida Building Commission
FDFS	Florida Department of Financial Services
FEMA	Federal Emergency Management Agency
FFP	Far Field Pressure
FHCF	Florida Hurricane Catastrophe Fund
FPHLM	Florida Public Hurricane Loss Model
FW	Firewall
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
HRA	High Risk Accounts
HRD	Hurricane Research Division
HUD	Housing and Urban Development
HURDAT	Hurricane Database
HVHZ	High Velocity Hurricane Zone
IBHS	Insurance Institute for Business and Home Safety
IBL	Internal Boundary Layer
ID	Interior Damage Ratio
IMSL	International Mathematical and Statistical Library
ISO	Insurance Services Office

Acronym	Full Name
JDBC	Java Database Connectivity
JNI	Java Native Interface
JSP	Java Server Pages
LR	Low-rise Commercial Residential Building
M00	Base Medium Model
M01	Retrofitted Medium Model (Re-roof and Re-nailed decking)
M10	Modified Medium Model. Weaker Decking Connection
MBL	Mean Boundary Layer
MFR	Multi-Family Residential Building
MH	Manufactured Home
MHR	Mid and High-rise Building
MPH	Miles Per Hour
MRLC	Multi-resolution Land Characteristics Consortium
NAHB	National Association of Home Builders
NCEP	National Centers for Environmental Prediction
NHC	National Hurricane Center
NLCD	National Land Classification Database
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OIR	Florida Office of Insurance Regulation
OSB	Oriented Strand Board
PBL	Planetary Boundary Layer
PDF	Probability Density Function
Pmin	Minimum Central Pressure
PML	Probable Maximum Loss
PR	Personal Residential
PRB	Personal Residential Single-Family Home Buildings
R2W	Roof to Wall Connections
R-CLIPER	Tropical Cyclone Rainfall Climatology and Persistence Model
RC S/ACV C	Structure Replacement-Cost, Contents Actual-Cash-Value
RC S/RC C	Structure Replacement-Cost, Contents Replacement-Cost
RES	Residential Building Model
Rmax	Radius to Maximum Winds
S00	Base Strong Model Inland
S00-OP	Base Strong Model with Metal Shutters
S02	Strong Inland Model with Metal Roof
S02-OP	Strong Inland Model with Metal Roof and Metal Shutters
S01	Modified Strong Model for HVHZ
SAGWA and ZORBA	Name of DNS / DHCP servers
SBC	Standard Building Code
SFBC	South Florida Building Code
SFMR	Stepped Frequency Microwave Radiometer
SQL	Structured Query Language
SSM/I	Special Sensor Microwave Imager
SV S/RC C	Structure Stated-Value, Contents Replacement-Cost
SV S/SV C	Structure Stated-Value, Contents Stated-Value
TE	Time Element
TECDO	Total Expected Cost of Damage to Openings
TRMM	Tropical Rainfall Measuring Mission
UML	Unified Modeling Language
USGC	United States Geological Survey

Acronym	Full Name
USPS	United States Postal Service
V#	Router
VT	Translational Velocity
W00	Base Weak Model
W01	Retrofitted Weak Model (Re-roof and Re-nailed Decking)
W10	Modified Weak Model. Stronger Decking Connection
WBDR	Wind-borne Debris Region
WDR	Wind Driven Rain
WDR1	Wind Driven Rain variable #1
WDR2	Wind Driven Rain variable #2
WSC	Wind Speed Correction
WMD	Water Management District
WR	Wireless Router