Florida Hurricane (FCHLPM) Model Version 3.0 ELEMENTS Version 18.1

May 28, 2025



December 12, 2024

Chair, Florida Commission on Hurricane Loss Projection Methodology
Florida State Board of Administration
1801 Hermitage Boulevard, Suite 100
Tallahassee, FL 32308

Re: Certification of the Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0

Dear Commission Chair,

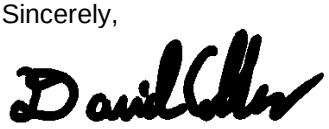
We are pleased to inform you that Impact Forecasting is ready for the Commission's review and certification of the Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 as implemented in the ELEMENTS Version 18.1 software.

As required by the Commission, enclosed are the disclosures, data, and analyses to reflect compliance with the General, Meteorological, Vulnerability, Actuarial, Statistical, and Computer/Information Standards set forth in the Hurricane Standards Report of Activities as of November 1, 2023. The Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 has been reviewed by professionals having credentials and/or experience in the areas of meteorology, statistics, structural engineering, actuarial science, and computer/information science, as documented in the signed Expert Certification Forms (G-1, G-2, G-3, G-4, G-5, G-6). We have also completed the Editorial Review Expert Certification (Form G-7).

Impact Forecasting is confident that its Florida Hurricane (FCHLPM) Model Version 3.0 is in compliance with the Commission's Standards and is ready to be reviewed by the Professional Team.

Four bound copies of the Impact Forecasting submission are provided herein. Please contact us with any questions on the enclosed.

Sincerely,



David Colbus

Associate Director
Impact Forecasting

Description of Trade Secret Information

Trade secret information that Impact Forecasting will make available to the Professional Team for review during the on-site visit and to the Commission during the closed portion of the Acceptability Meeting is described below and noted at the appropriate places throughout the submission:

- Form V-3: Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)
- Form V-5: Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)
- Form A-6: Logical Relationship to Hurricane Risk (Trade Secret Item)

Florida Commission on Hurricane Loss Projection Methodology Hurricane Model Identification

Name of Hurricane Model	Florida Hurricane (FCHLPM)
Hurricane Model Version Identification:	Version 3.0
Hurricane Model Platform Names and Identifications with Primary Hurricane Model Platform and Identification Listed First:	ELEMENTS Version 18.1
Name of Modeling Organization:	Impact Forecasting
Street Address:	200 East Randolph Street
City, State, ZIP Code:	Chicago, IL 60601
Mailing Address, if different from above:	Same as above
Contact Person:	David Colbus
Phone Number:	1-978-305-1995
Email Address:	David.Colbus@aon.com
Date:	May 28, 2025

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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 hurricane model developed by Impact Forecasting (IF) estimates loss costs and probable maximum losses to insured residential property caused by wind damage from hurricanes. Loss outputs are modeled for primary structure, appurtenant structure, contents, and time element coverages and are validated extensively using historical claims data. The methods used by Impact Forecasting in hurricane loss cost and probable maximum loss estimation are actuarially sound as demonstrated in Standard A-4.

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

Impact Forecasting employs standard methods and procedures to ensure agreement and correct correspondence of databases, data files, and computer source code. Source control software and error tracking systems are used to maintain accuracy.

C. All software, data, and flowcharts (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 Hurricane Standards.

All software, data, and flowcharts used to develop and validate the Impact Forecasting model, project loss outputs, and create forms comply with the Computer/Information Standards.

D. All meteorological forms, statistical Forms S-1, S-2, and S-6, and all actuarial forms with the exception of Form A-2 shall be produced through

an automated procedure or procedures as indicated in the form instructions.

Impact Forecasting uses automated procedures to generate submission forms when it is indicated to do so in the form instructions.

E. Vintage of data, code, scientific literature, and technical literature used shall be justifiable.

Impact Forecasting rigorously evaluates data, code, and scientific and technical literature on a continuous basis. When new data, code, and literature are made available, Impact Forecasting incorporates the most recent vintage of data or information when it is a sufficiently defensible improvement on older sources, and when it is demonstrably fit for use within the model's framework and development cycle.

G-1.1 Specify the hurricane model version identification. If the hurricane model is implemented on more than one platform, specify each hurricane model platform identifying the primary platform and the distinguishing aspects of each platform.

The hurricane model submitted for review is the Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0. The Impact Forecasting loss modeling platform associated with the model submission is ELEMENTS Version 18.1.

G-1.2 Provide a comprehensive summary of the hurricane model. This summary shall 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 shall be complete and shall not reference unpublished work.

The Impact Forecasting Florida Hurricane (FCHLPM) Model is designed to estimate insured losses from hurricanes. The model contains a robust event set that calculates and analyzes the wind hazard during the entire lifecycle of a hurricane, which allows for variations in hurricane intensity that are associated with varying ocean temperatures. Simulated events are based on historical and observational data sets including the National Hurricane Center (NHC) HURDAT2 database and represent a range of varying central pressures, maximum sustained wind speeds, translational velocities, heading angles, and radii of maximum winds (Rmax).

The model includes a set of damage functions that integrate a suite of programs developed over many years including Impact Forecasting's wind damage simulator. The damage functions relate wind hazard to chance of damage occurring and ground up loss, and they include modifiers for secondary risk characteristics to refine loss estimates. Modeled loss output is calculated using a probabilistic sampling method in a Monte Carlo simulation framework to account for damage uncertainty and the application of policy limits and deductibles. Each individual model component has been validated with appropriate observational data and modeled loss outputs have been validated with Florida hurricane claims data from multiple insurers.

The model consists of four components: hazard, exposure, vulnerability, and financial.

Hazard Component

The hazard component includes the model's stochastic and historical event sets. It describes the location, frequency, and intensity of the simulated events and incorporates a windfield model to calculate wind speeds within each event's footprint. A tropical cyclone simulation model is used to model the track and intensity parameters of each stochastic event. The model uses a Markov Chain approach to simulate the full track of both landfalling and bypassing tropical cyclone events from the point of initiation through to final dissipation. The model considers environmental conditions to ensure that simulated events reflect realistic track and physical properties as they progress through time and space. Impact Forecasting's windfield model is based on the Willoughby wind profile (Willoughby et al., 2006). Local terrain conditions are addressed using a terrain model that considers multiple wind speed directions. The final stochastic event set consists of simulated hurricane events that cause insured loss in Florida.

Impact Forecasting uses a genesis model to determine the number of tropical cyclones in each simulated year in the model. The number of events per year is modeled using a negative binomial distribution. Genesis parameters including location, date and time, initial forward speed, heading direction, and central pressure are assigned to each simulated event by randomly sampling historical data to preserve spatial and temporal patterns. To propagate the simulated events, the NHC historical data and associated environmental conditions are processed and assigned to a 5x5-degree grid across the model domain. Forward speed and track angle are modeled at six hourly time steps using multiple linear regression models developed based on the gridded data. Similarly, the intensity of an event in terms of its central pressure is modeled at each time step. Event intensity is modeled as a function of sea surface temperatures (SSTs) given that they are a key environmental variable for determining tropical cyclone intensity. The modeled intensity is constrained by the minimum central pressure a tropical cyclone can physically reach under certain environmental conditions.

Transitional decay of events as they travel on land and away from warm ocean water is associated with an increase in central pressure and "filling" of the event's central core. To model central pressure decay, Impact Forecasting uses the functional forms proposed by Vickery (2005). The model was developed for different coastal regions in the Atlantic Ocean,

Gulf of Mexico, and Caribbean Sea using the measured central pressure data from the HURDAT2 database. To model the size of an event, Impact Forecasting developed an Rmax model using data from the Atlantic Hurricane Database Re-analysis Project (e.g., Landsea et al., 2004a, 2004b, 2008, 2012, 2014; Hagen et al., 2012; Delgado et al., 2018), NOAA Report NWS 38 (Ho et al., 1987), and the Extended Best Track Dataset (Demuth et al., 2006). The model accounts for the range of possible Rmax values associated with observed storm tracks and intensities.

The Impact Forecasting windfield model is an important part of the hazard component. It adopts the model given by Willoughby et al. (2006) and considers the asymmetrical nature of hurricane winds to evaluate wind speed propagation. The model incorporates a dual-exponential wind profile in which the wind decreases exponentially outside the eye and has two decay lengths. The asymmetry in wind speeds was accounted for by adding a parameter which is a function of forward speed. To calculate wind speeds, central pressures from the intensity and the filling models were converted to their associated maximum sustained wind speeds (Vmax), accounting for both marine and on-land conditions. The model wind footprints are calculated on a regular 0.01 by 0.01. degree longitude/latitude grid. The windfield model was validated with station measurements and shows good agreement.

To estimate damage and loss, the 1-minute sustained wind speeds at a 10-meter elevation derived from the windfield model were converted to 3-second gust actual terrain wind speeds using a methodology derived from the Engineering Sciences Data Unit (ESDU, 2002a, 2002b). First, 1-minute sustained wind speeds were converted to open terrain 3-second gust wind speeds. Open terrain gust wind speeds were then converted to reflect their actual terrain conditions using the Impact Forecasting terrain model. The model leverages a modified ESDU approach that uses a 1-km by 1-km surface roughness (terrain) model and considers the local site as well as upstream terrain conditions. Because a given site may have different terrain roughness at different directions upstream, the Impact Forecasting terrain model considers eight wind speed directions.

The stochastic event set provided with the Impact Forecasting Florida Hurricane (FCHLPM) Model consists of nearly 56,000 unique Florida loss-causing events, selected from more than 2.6 million tropical cyclones simulated for the North Atlantic Ocean. The model includes both direct landfalls (either on Florida or its neighboring states) and by-passing hurricanes. Each

hurricane in the event set has a unique track with varying characteristics such as central pressure, maximum sustained wind speed, radius of maximum winds, forward speed, heading direction, and event frequency. The modeled events are validated against historical observations using goodness-of-fit tests. Impact Forecasting uses a direct Monte Carlo simulation approach to estimate hurricane loss costs and hurricane output ranges. The number of simulated years of hurricane events in the model is deemed adequate as the mean standard error in Florida county-level hurricane loss costs associated with the sampling is less than 2.5% of the loss cost estimate. A plot of 100 simulated hurricanes that make landfall in Southeast Florida is shown below in Figure 1.

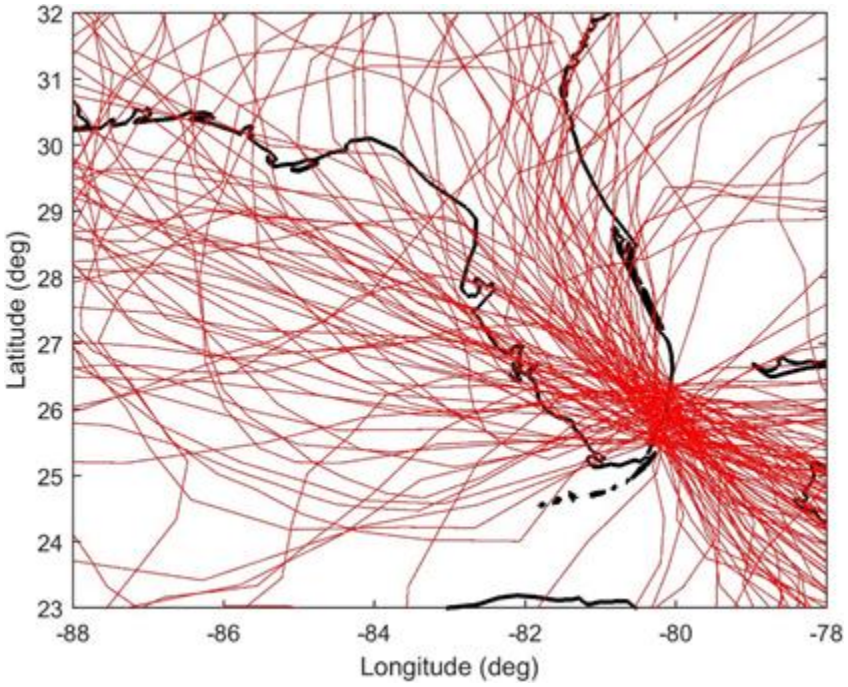


Figure 1: 100 landfalling hurricanes simulated for Southeast Florida

Exposure Component

Wind speeds from simulated events in the model are applied to exposure information for the goal of determining insured loss. Exposure information describes the portfolio of insurance

policies and associated risks that are to be analyzed. Exposure information includes information about the location of each risk, details that describe its physical attributes (such as construction type and number of stories), insured values covered by the policy, and any deductible and limit information for the policy.

The Impact Forecasting Florida Hurricane (FCHLPM) Model accepts exposure information that describes a range of personal and commercial residential risks. The model estimates loss to owners, manufactured homes, renters, condominium owners, and condominium association policies.

Reliable model output depends on exposure information that accurately describes each underlying risk. For risks with incomplete exposure information, the model offers a series of unknown default attributes.

Vulnerability Component

The vulnerability component of the Impact Forecasting Florida Hurricane (FCHLPM) Model relies on many years of building vulnerability assessment and wind engineering experience to produce thousands of vulnerability functions for different combinations of exposure variables (e.g., construction type, occupancy, year built, region, number of stories, and other property-specific characteristics) as well as thorough statistical processing of claims data from insurers. The vulnerability component has been validated using claims data for different areas in Florida considering building code requirements and compliance practices.

The vulnerability component is an integration of a suite of programs developed over more than 20 years at Impact Forecasting. The most important program among them is a building component-based wind damage simulator, developed and maintained by Impact Forecasting's vulnerability team. The wind damage simulator uses engineering principles and reliability methods to estimate load and capacity characteristics of various components of a building susceptible to wind damage.

The simulator is based on a Monte Carlo framework which performs statistical sampling for various wind loading conditions and resistance values on different structural components in order to estimate damage outcomes for each component. These component-based results are aggregated into overall building outcomes which represent the chance of loss occurring

as well as the mean and the standard deviation of the damage ratio. Component damage estimates are then combined with a restoration cost model to determine repair cost and time estimates. Finally, these estimates are represented as the proportion of the overall combined component replacement values of the buildings, also known as damage ratios.

For use in the Impact Forecasting ELEMENTS catastrophe modeling platform, damage ratio estimates from the wind damage simulator are sorted by discrete wind speed ranges. For each 3-second gust wind speed range, the mean and standard deviation of the damage ratio is determined from the simulations and a moment-based distribution is fitted to model the damage uncertainty. Separate mean damage ratios and distributions are implemented for building, appurtenant structure, contents, and time element coverages for different combinations of exposure variables. Damage functions consider the impact of the Florida building codes and regional vulnerability differences across Florida.

An objective statistical framework merges damage ratio functions calculated from the vulnerability simulator with empirical estimates of damage ratio functions derived from past claims such that the resulting damage functions for chance of loss and conditional damage are maximally-consistent with both Florida residential loss experience and engineering principles. For the empirical approach, a curated database of roughly 7 million exposures exposed to tropical storm-force or greater wind hazard and 600 thousand associated wind-loss claims are used to train the empirical model for chance of loss and conditional mean damage ratio distributions. The hazard linked to each exposure is developed and validated using a Bayesian maximum likelihood estimation approach to generate a wind footprint that best agrees with both HURDAT2 event parameters as well as wind gusts observed from surface stations. These observation-calibrated hazard estimates are also used to validate the vulnerability module, reducing regression dilution and other sources of statistical uncertainty.

Impact Forecasting's wind engineers have conducted numerous on-site damage surveys for past hurricane events to assist with the validation of damage modeling. This includes both recent hurricanes, such as Hurricane Irma (2017), Hurricane Michael (2018) and Hurricane Ian (2022), as well as hurricanes that occurred longer ago like Hurricane Wilma (2005) and Hurricane Katrina (2005). Complementary to learnings from on-site damage surveys, Impact

Forecasting vulnerability engineers have reviewed numerous hurricane claims data sets to further validate the vulnerability components.

Financial Component

The hurricane model's financial component applies the appropriate damage ratios to exposure replacement values to determine a risk's ground up loss while the occurrence of loss is also modeled. During the loss analysis, a Monte Carlo simulation is used to sample first, whether the loss occurs by comparing randomly sampled number with probability of loss occurrence (Chance of Loss) for given wind speed, and then, sample the damage distributions for a given level of wind speed to account for damage uncertainty. Building, appurtenant structure, contents, and time element losses are determined using sampling from beta distributions. The appropriate number of damage samples required to ensure loss stability is determined by Impact Forecasting model developers for different analysis types.

Individual coverage-level samples are propagated through the financial component for the application of policy deductibles and limits. In the final step, ground up loss samples net of policy conditions are assembled into gross loss statistics including average annual losses and annual return period probable maximum loss levels (PMLs). The financial component also incorporates a demand surge function to account for the increase in the cost of materials, services and labor due to spikes in demand following a catastrophe (Olsen & Porter, 2011a). The demand surge function is developed using linear regression analysis based on historical hurricane loss data and pricing information for the construction sector from Xactimate and XactContents (Xactware, 2020). As the developed function uses hurricane Ground Up losses from entire United States, an estimation of US loss from Florida market loss is performed before the demand surge function is applied.

Average annual losses and annual return period probable maximum loss level calculation are performed on Year Loss Table containing 300,000 years assigned to events and modeled loss perspectives.

G-1.3 Provide a flowchart that illustrates interactions among major hurricane model components.

A flowchart is provided below in Figure 2.

Impact Forecasting Florida Hurricane (FCHLPM) Version 3.0

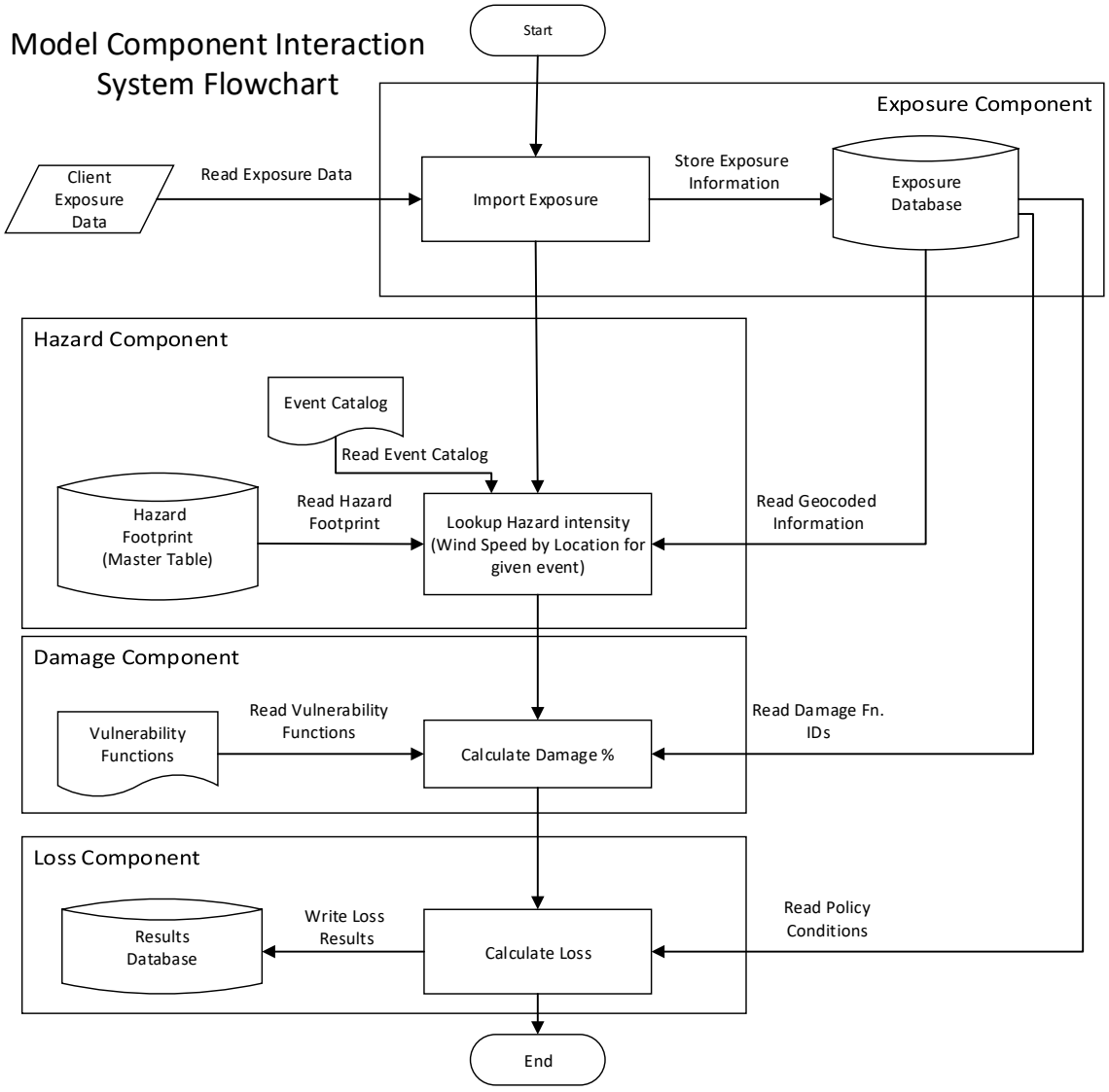


Figure 2: Interactions among major hurricane model components

G-1.4 Provide a diagram defining the network organization in which the hurricane model is designed and operates.

A diagram is provided below in Figure 3.

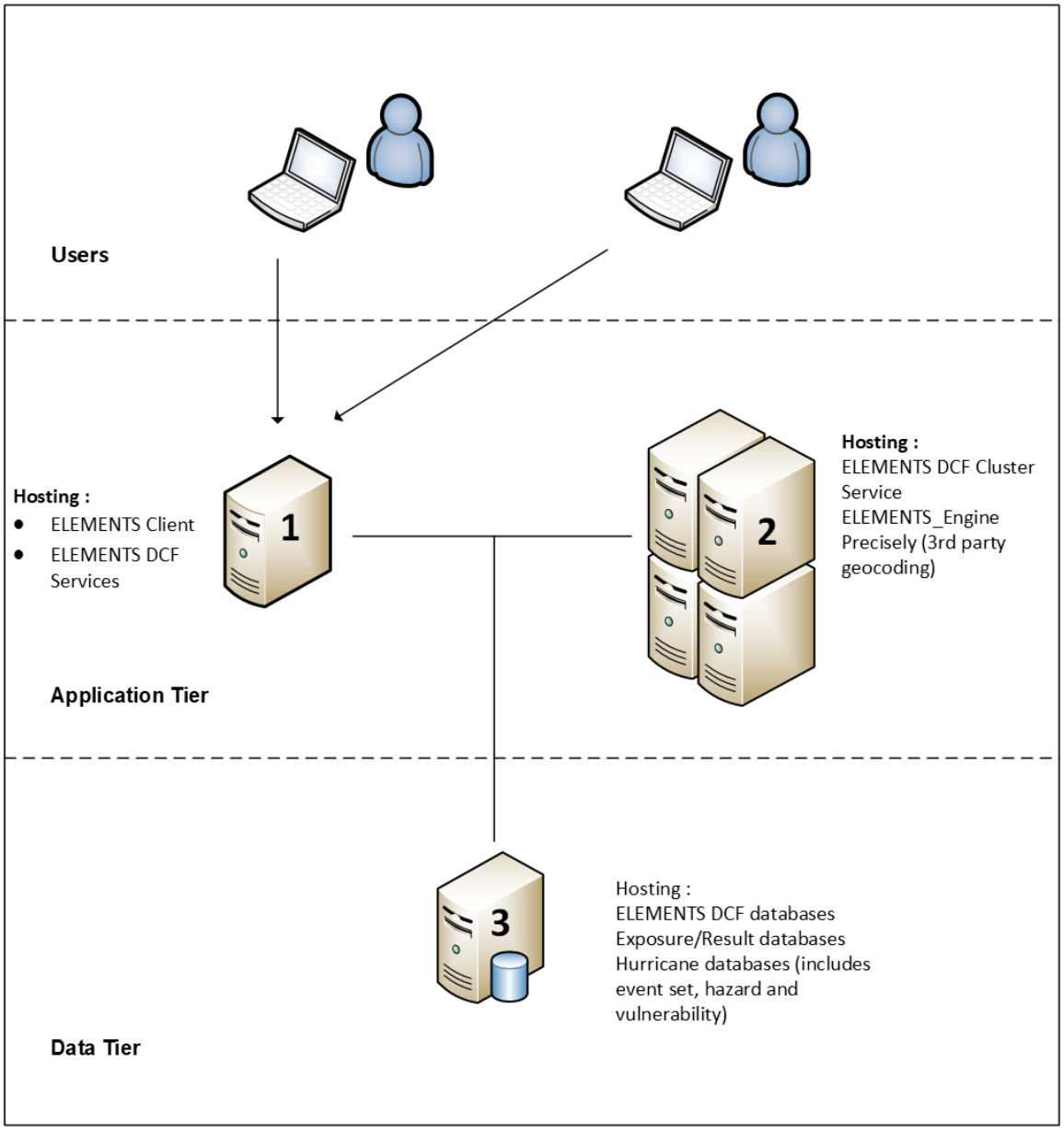


Figure 3: The network organization within which the Impact Forecasting Florida Hurricane (FCHLPM) Model is designed and operates

G-1.5 Provide detailed information on the hurricane model implementation on more than one platform, if applicable. In particular, submit Forms S-5, A-1, A-4, and A-8 from each platform including additional calculations showing no differences.

The Impact Forecasting Florida Hurricane Model (FCHLPM) is implemented only on the Impact Forecasting ELEMENTS Version 18.1 catastrophe modeling platform.

G-1.6 Provide a comprehensive list of complete references pertinent to the hurricane model under review by standards group using professional citation standards.

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G-1.7 Provide the following information related to changes in the hurricane model from the current 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,

Impact Forecasting Florida Hurricane (FCHLPM) Version 3.0

2. ***A list of all other changes, and***
3. ***The rationale for each change.***

Impact Forecasting's Florida Hurricane (FCHLPM) Model has been updated to incorporate new data and to implement additional features. Changes that affect the personal or commercial residential hurricane loss costs or hurricane probable maximum loss levels include updates to the model's hazard component, vulnerability component, and other changes including geocoding and software updates.

Hazard Component

The Florida Hurricane (FCHLPM) Model's v3.0 intensity model is updated with the latest sea surface temperature using Hadley Centre Sea Ice and Sea Surface Temperature Dataset (HadISST) downloaded in Dec. 2023 and updated through 2022. Additionally, the updated model incorporates HURDAT2 data as of October 1, 2023, covering the period between 1900-2022, including Hurricane Ian. Updates have been made to the genesis, track, intensity, radius of maximum winds, decay, and maximum sustained wind speed models to account for two additional years of observed North Atlantic tropical cyclones. Factors for the terrain model have been updated to be consistent with the National Land Cover Database 2021, as released in July 2023. For grid cells with sparse historical data, regression estimates of stochastic track and intensity parameter evolution is made more robust by incorporating observations from the 50 nearest HURDAT2 observations to the grid cell center by distance using the great circle approximation.

In addition to revised datasets for model training, empirical research by Uhlhorn et al. (2014) on observed asymmetry in North Atlantic tropical cyclones has been applied to update the asymmetry parameterization of the Willoughby model to show consistency with the wind field asymmetries observed by National Oceanic and Atmospheric Administration aircraft reconnaissance of North Atlantic hurricanes.

Historical scenarios have been revised to correspond more closely to the observed evolution of cyclone intensity in the hours shortly before and after landfall. Hourly updates from the National Hurricane Center for sixteen Florida-landfalling storms indicate that, on average, intensity at landfall is unchanged from the last six-hour intensity fix over water, consistent with Zhu et al. (2021). This observed behavior is used to assume that historical storms

landfall at an intensity equal to the last intensity provided by HURDAT2 before undergoing rapid decay. For the modeling of historical events only, an empirical scaling function derived from simulations of landfalls using the Impact Forecasting modified Willoughby wind field model is applied to improve the translation of historical Vmax values to their open-terrain equivalent during landfall.

ZIP code level hazard has been regenerated to account for updated postal code vintage and hazard. The Impact Forecasting model evaluates the ZIP code wind speeds using housing unit population-weighted averaging from the grid wind speeds. The housing unit population data is obtained from the latest U.S. census data corresponding to the year 2020.

Vulnerability Component

The building vulnerability curves for personal and commercial residential occupancies have been recalibrated based on additional insurance claims from hurricane seasons listed below.

- 2016 hurricane season: Matthew, Hermine
- 2017 hurricane season: Irma
- 2018 hurricane season: Michael
- 2022 hurricane season: Ian

The historical hazard footprints used for training and calibrating the vulnerability model have been fine-tuned using hundreds of station observations of maximum observed wind gusts provided by the National Hurricane Center. Using a Bayesian likelihood maximization framework, a posterior estimate of the wind footprint is developed that best agrees with both HURDAT2 event parameters as well as wind gusts observed from surface stations. The improved footprints reduce hazard uncertainty and result in the more accurate calibration of vulnerability functions to claims.

An improved statistical framework has been developed to improve the calibration and validation of vulnerability functions using empirical loss data. The vulnerability component of the hurricane model assesses ground-up losses prior to the application of financial conditions and the social dynamics of claims reporting. Thus, a novel statistical inference model is used to produce a ground-up claims dataset for validating chance of loss curves by

accounting for the truncation of losses incurred through claims reporting. Logistic regression modeling is applied to both generate a set of preliminary vulnerability functions using observed losses and to infer a set of damage functions that synthesize estimates from both component-based damage functions and empirical damage functions.

Geocoding and Software Changes

ZIP Codes have been updated using the August 2023 ZIP Code vintage from ZIP-Codes.com.

Following the update of the ZIP Code database, the method to assign a vulnerability tier to a ZIP Code crossing two Tier zones has been enhanced. The ZIP Code is now assigned to the Tier in which the ZIP Code housing unit population-weighted centroid falls into (previously assigned to the Tier where majority of the ZIP code area belongs).

The introduction of Chance of Loss includes the addition of chance of loss probabilities that correspond with each individual damage function. With the inclusion of this Chance of Loss probability, alongside the already in effect mean damage ratios and standard deviations, we can generate the mean damage ratio for each damage function. Secondary Modifiers are now applied to the Chance of Loss and damage ratios separately, where first the Chance of Loss for Secondary Modifiers is applied to the Chance of Loss of the primary damage function, and then the Secondary Modifier impact to structure damageability is accounted for after.

The process of loss calculation of Probable Maximum Loss (PML) has been upgraded in the Florida Hurricane (FCHLPM) Model such that it precisely follows the definition using years (in Occurrence Exceedance Probability curve and Annual Exceedance Probability Curve), replacing the approximate solution of the currently accepted model that uses event frequencies. From the original set of 2.6 million tracks generated from 200,000 years of simulated tropical cyclone activity, Stratified Random Sampling is applied to landfalling and by-passing Florida events to yield 56,000 unique and representative events, with each representative event selected based upon landfall intensity, Rmax, and landfall location. Assignation is then performed in two steps. First, for each of the 2.6 million events in the full set, a representative event from the 56,000 event set is assigned. Second, an event-to-year assignation is performed for those events. As a result, modeled events and years are

statistically representative of the original set without the need to model the computationally-expensive full event set. For consistency with other model solutions used by Aon, 200,000 years of modeled tropical cyclone activity are resampled into a 300,000 year set as follows: first, the 200,000 year set is inserted into 300,000 year set as is, then the remaining 100,000 years are randomly sampled from the 200,000 year set. This way, all events from hazard modelling are guaranteed to appear in 300,000 year set. The modeling software automatically assigns the event losses calculated from the 56,000 event set into a year table with stochastic years and aggregates (sum and maxima) per year. These annual aggregates are then used in calculation of return period levels of annual aggregate and annual occurrence curves.

All Other Changes

The Impact Forecasting Florida Hurricane (FCHLPM) Model's geographical scope is limited to Florida only. As a result, an estimation of US market loss had to be performed in order to be able to apply a demand surge factor to each event.

B. Percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 FHCF exposure data for:

1. ***All changes combined, and***
2. ***Each individual hurricane model component change.***

Table 1 shows the 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 for all changes combined, and each individual hurricane model component change.

Table 1: Percentage difference in average annual zero deductible statewide hurricane loss costs

Percentage difference					
Software	**Geocoding**	**Hazard**	**Vulnerability**	**Loss calculation method**	**Overall**
0.1%	0.1%	12.7%	6.3%	0.1%	20.1%

C. Color-coded map by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 FHCF exposure data for all hurricane model component changes combined.

Color-coded maps in Figure 4 through Figure 8 reflect the percentage differences in average annual zero deductible statewide hurricane loss costs by county based on the 2017 FHCF exposure data for the software, geocoding, hazard, vulnerability, and Event Loss to Year Loss calculation method model component changes.

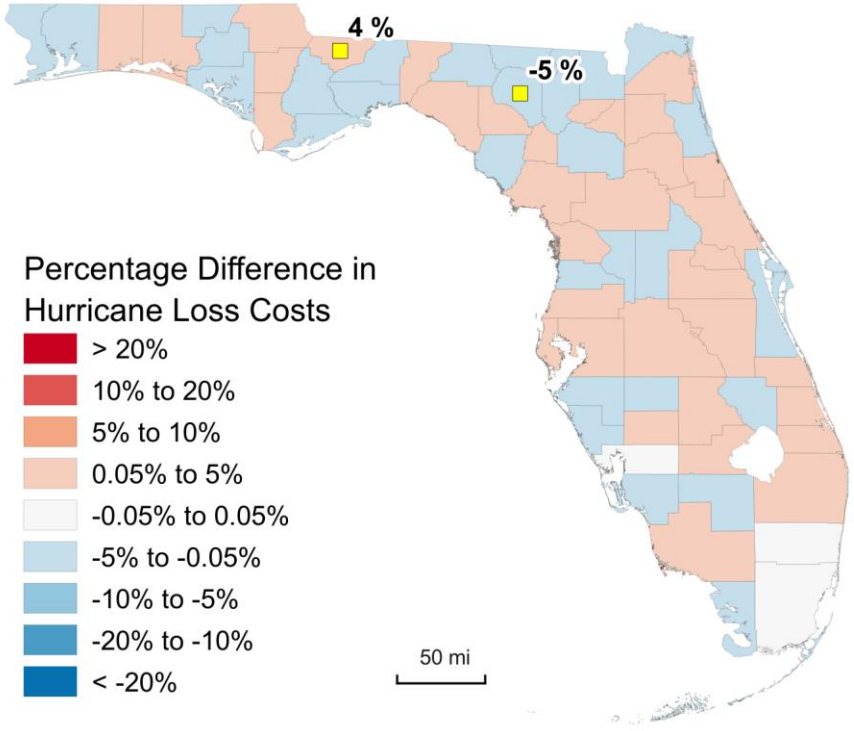


Figure 4: County-level map of percentage differences in average annual zero deductible hurricane loss costs due to the software component change. Yellow squares represent maximum and minimum values.

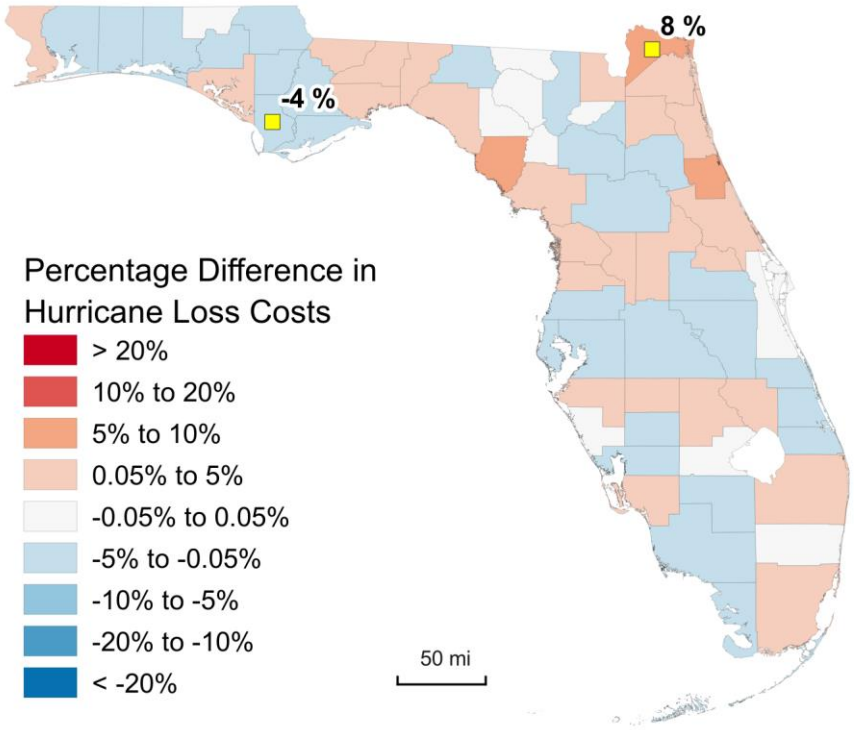


Figure 5: County-level map of percentage differences in average annual zero deductible hurricane loss costs due to the geocoding component change. Yellow squares represent maximum and minimum values.

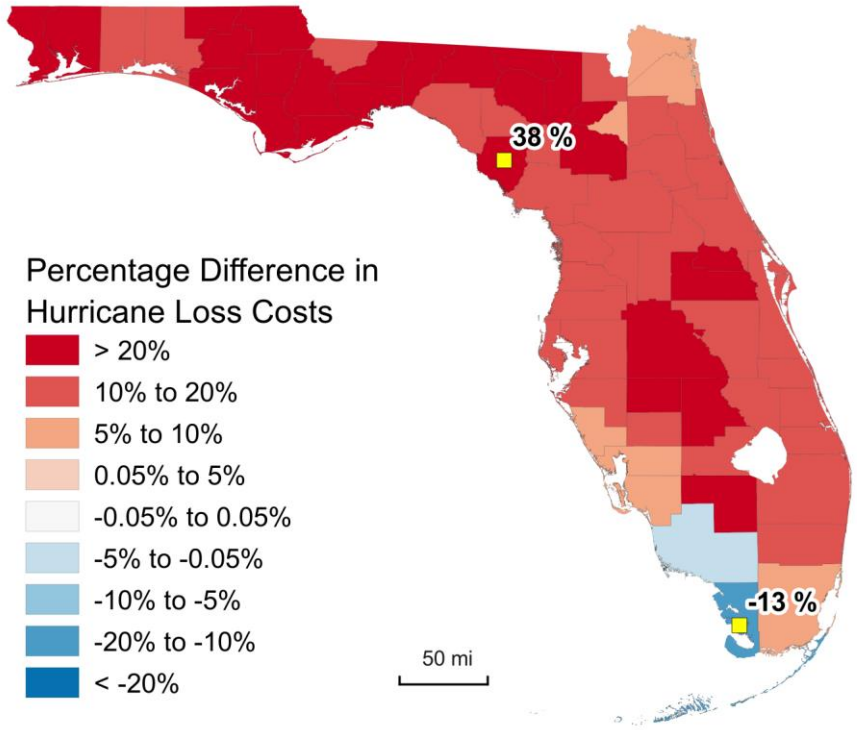


Figure 6: County-level map of percentage differences in average annual zero deductible hurricane loss costs due to the hazard component change. Yellow squares represent maximum and minimum values.

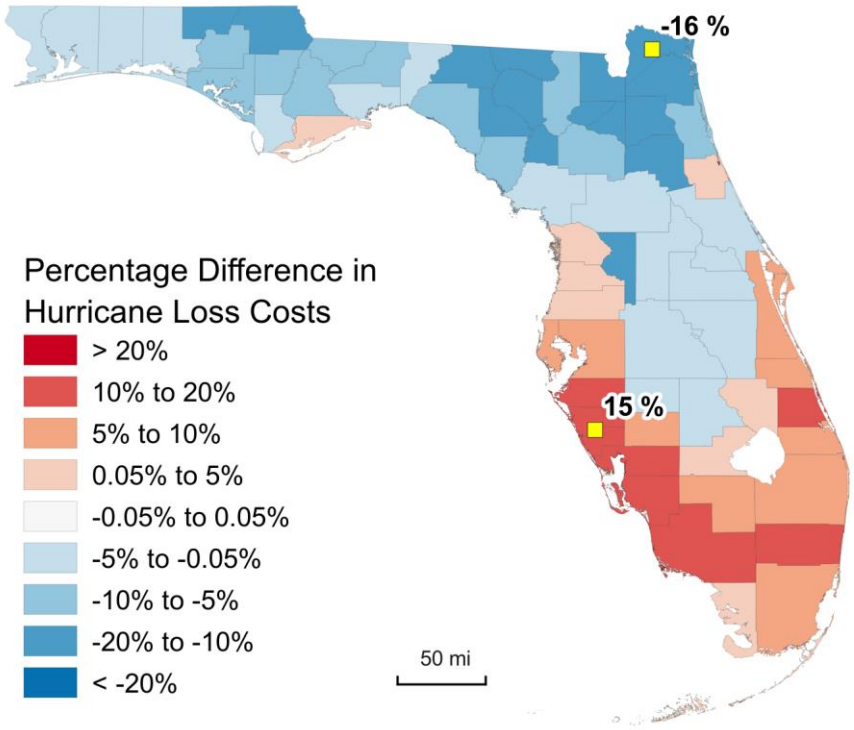


Figure 7: County-level map of percentage differences in average annual zero deductible hurricane loss costs due to the vulnerability component change. Yellow squares represent maximum and minimum values.

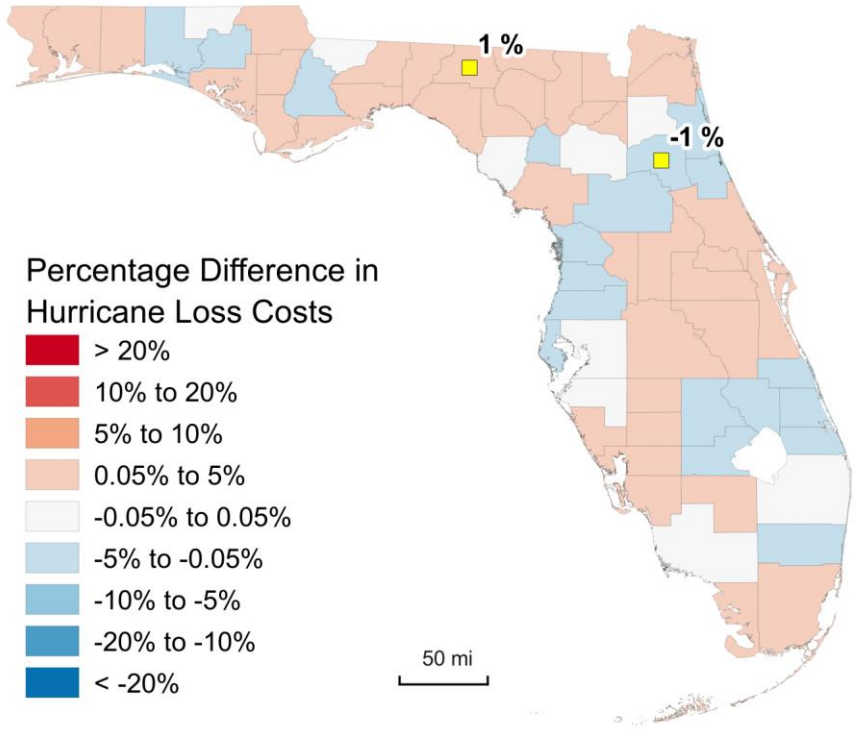


Figure 8: County-level map of percentage differences in average annual zero deductible hurricane loss costs due to the Event Loss to Year Loss calculation method component change. Yellow squares represent maximum and minimum values.

D. Color-coded map by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 FHCF exposure data for all hurricane model component changes combined.

Figure 9 contains a color-coded map by county, which reflects the percentage differences in average annual zero deductible statewide hurricane loss costs based on the 2017 FHCF exposure data for all hurricane model component changes combined.

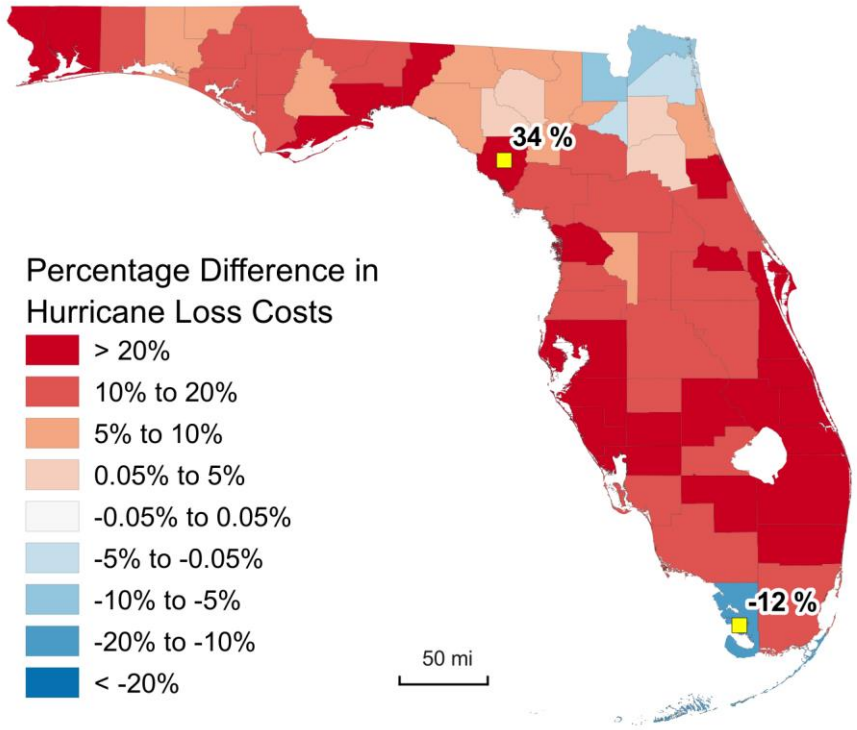


Figure 9: County-level map of the overall percentage differences in average annual zero deductible hurricane loss costs due to model component changes. Yellow squares represent maximum and minimum values.

G-1.8 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.

No interim updates to underlying data relied upon by the model are anticipated.

G-2 Qualifications of Modeling Organization Personnel and Consultants Engaged in Development and Implementation 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.

Impact Forecasting staff and consultants involved in the development of the hurricane model possess a wide range of multi-disciplinary skills in meteorology, structural engineering, actuarial science, statistics, computer science, and risk analysis. Model developers have advanced degrees and the majority hold PhDs in their fields of expertise. They are suitably qualified to develop, test, and evaluate hurricane loss projection methodologies.

Further information about the qualifications of individuals can be found in Disclosure G-2.2.

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 (current licensed professional engineer), statistics (advanced degree or equivalent experience), 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 Impact Forecasting Florida Hurricane (FCHLPM) Model and submission documentation have been thoroughly reviewed by individuals holding suitable qualifications within the professional disciplines listed above and are outlined in Disclosure G-2.2. These individuals have signed the Expert Certification Form G-1: General Hurricane Standards Expert

Certification through Form G-6: Computer/Information Hurricane Standards Expert Certification as applicable.

G-2.1 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.

Impact Forecasting LLC is a wholly owned subsidiary of Aon Benfield Inc. Aon Benfield Inc. is the reinsurance broking subsidiary of Aon plc, a publicly held global professional services firm providing risk, retirement, and health solutions. Impact Forecasting provides catastrophe modeling services to Aon Benfield Inc. and directly to insurers, reinsurers, and regulatory organizations.

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 are exercised. If more than one entity is involved in the development of the hurricane model, describe all involved.

The model was developed solely by Impact Forecasting LLC. Impact Forecasting holds the proprietary rights and controls to the model.

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 developed solely by Impact Forecasting LLC.

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

Impact Forecasting develops and maintains a global suite of catastrophe models and software tools to empower insurers, reinsurers, and regulatory organizations to quantify and manage the financial impact of natural catastrophes including hurricanes, earthquakes, and floods.

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.***

Impact Forecasting has never been involved in litigation related to its hurricane model.

G-2.2 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***

The credentials of individuals who contributed to development of the Impact Forecasting Florida Hurricane (FCHLPM) Model are listed below in Table 2. Contributors are either Impact Forecasting employees or Aon Benfield Inc. employees acting as consultants on the project. The table identifies the years of professional experience of each contributor as well as their tenure at either Impact Forecasting or Aon Benfield Inc. Individuals are listed more than once if they have contributed to more than one aspect of the hurricane model. Further details are provided for each contributor in Appendix B: Individuals Involved in the Impact Forecasting Florida Hurricane (FCHLPM) Model Acceptability Process.

Table 2: Credentials of individuals involved in the acceptability process and each aspect of the hurricane model

Standard	Name	Degree	Discipline	University	Status*	Prof. Exp. (Yrs)	Tenure at IF (Yrs)**
General, Meteorological, Statistical	Brian Penserini	Ph.D.	Earth Science	University of California, Santa Barbara	E	4	0.25
Actuarial	Chad Xu	M.S.	Actuarial Science	Temple University	C	3	3
General, Statistical, Vulnerability, Actuarial	Corbin Tucker	M.S.	Actuarial Science	University of Illinois at Urbana Champaign	E	6	3
General	David Colbus	M.A.	Climate and Society	Columbia University	E	7	3
Vulnerability	Karthik Yarasuri	M.S.	Civil Engineering	University of Florida	E	10	5
Statistical, Vulnerability	Kun Yang	Ph.D.	Civil Engineering	University of Delaware	E	7	1

Standard	Name	Degree	Discipline	University	Status*	Prof. Exp. (Yrs)	Tenure at IF (Yrs)**
Actuarial	Minchong Mao	M.S., FCAS, MAAA, CCRM P	Computer Science	University of Missouri-Columbia	C	23	6
Computer / Information	Pooja Maan	MBA	Finance	IBS Hyderabad (India)	E	16	3
Computer / Information	Purvish Patel	B.S.	Computer Science	Wayne State College	E	25	11
Statistical	Radek Solnicky	M.S.	Mathematical Statistics	Charles University	E	13	13
General, Meteorological, Statistical, Actuarial	Radovan Drinka	M.A.	Physics (with focus on Meteorology and Climatology)	Comenius University in Bratislava (Slovakia)	E	16	13
Computer / Information	Shruthi Srikantegowda	PGDIPL	Information Technology	Symbiosis International, Pune (India)	E	19	15

Standard	Name	Degree	Discipline	University	Status*	Prof. Exp. (Yrs)	Tenure at IF (Yrs)**
General, Meteorological, Statistical	Sri Harshitha Polamuri	Ph.D.	Civil Engineering	Clemson University	E	5	3
Computer / Information	Sushma Bhat	B.S.	Computer Science	University of Bombay (India)	E	26	17
General, Meteorological, Statistical, Vulnerability	Ted Amdur	Ph.D.	Earth and Planetary Sciences	Harvard University	E	7	1
Computer / Information	Venkatesh Ramaiah	M.S.	Computer Science	Birla Institute of Technology and Science, Pilani (India)	E	20	14
Vulnerability	Vipin Unnikrishnan	Ph.D.	Structural Engineering	Louisiana State University	E	10	8
Computer / Information	William Dong	Ph.D.	Civil Engineering	University of Nebraska-Lincoln	E	12	7

Standard	Name	Degree	Discipline	University	Status*	Prof. Exp. (Yrs)	Tenure at IF (Yrs)**
Meteorological	Xian He	Ph.D.	Civil Engineering	University of Illinois at Urbana-Champaign	E	7	6
Vulnerability	Yujin Liang	Ph.D.	Structural Engineering	University of Illinois at Chicago	E	32	19
Vulnerability	Zhuoxuan Wei	Ph.D.	Civil Engineering	Florida Institute of Technology	E	1	1

Note:

* E = Employee & C = Consultant

** For consultants (C), shows tenure at Aon Benfield Inc.

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

The new employees or consultants engaged in the development of the hurricane model or the acceptability process can be found in the following list:

- Brian Penserini
- Kun Yang
- Ted Amdur

Impact Forecasting Florida Hurricane (FCHLPM) Version 3.0

- Zhuoxuan Wei

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

A diagram to illustrate connections between all personnel related to hurricane model design, testing, execution, maintenance, and decision-making is provided below in Figure 10.

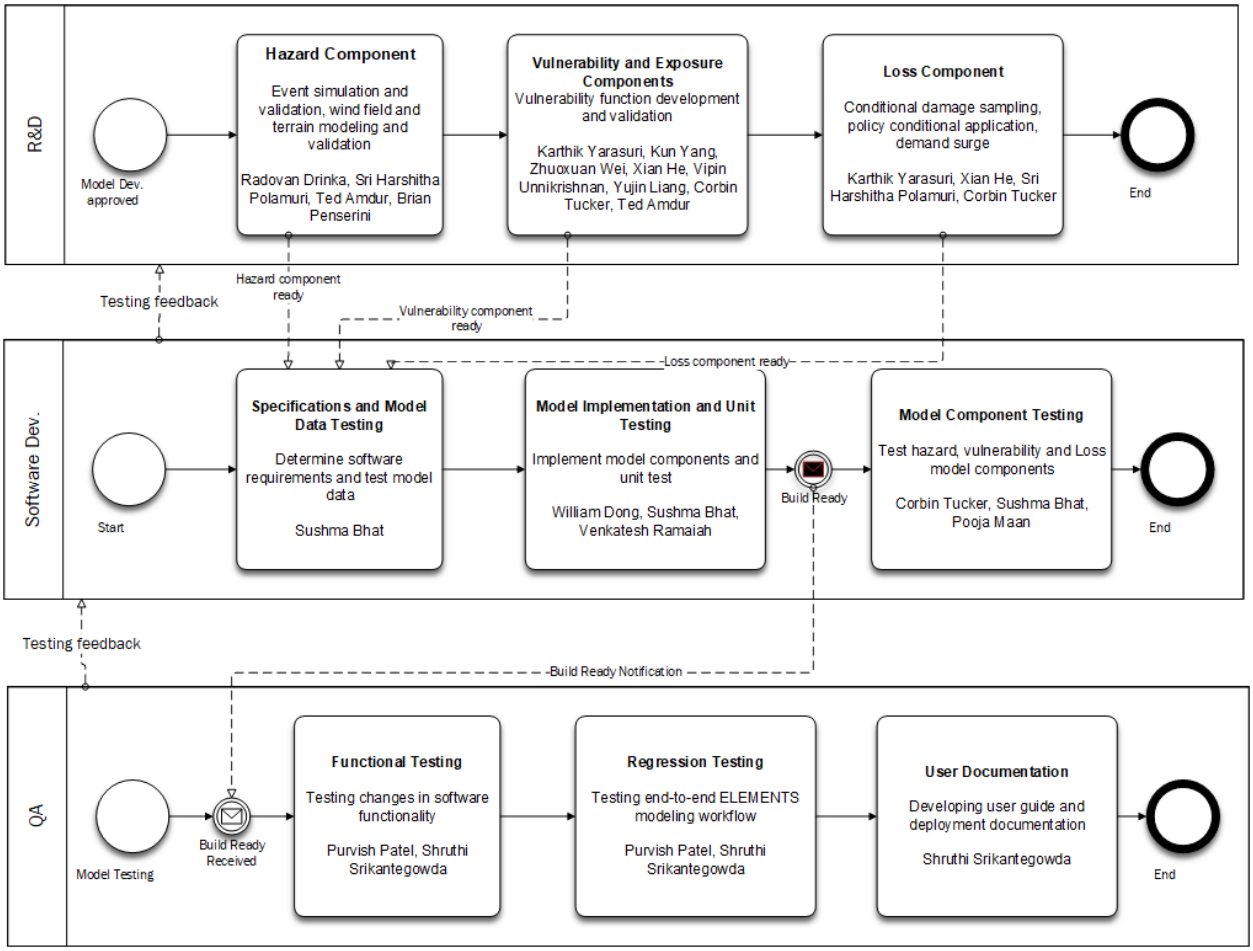


Figure 10: Business workflow diagram illustrating the connections between Impact Forecasting personnel

G-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***

The updated Florida Hurricane (FCHLPM) Model has not been peer-reviewed by external independent peer reviewers.

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

The updated Florida Hurricane (FCHLPM) Model has not been peer-reviewed by external independent peer reviewers.

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.

The updated Florida Hurricane (FCHLPM) Model has not been peer-reviewed by external independent peer reviewers.

G-2.4 ***Provide completed Form G-1. Provide a link to the location of the form in the submission appendix [Form G-1: General Hurricane Standards Expert Certification].***

G-2.5 ***Provide completed Form G-2. Provide a link to the location of the form in the submission appendix [Form G-2: Meteorological Hurricane Standards Expert Certification].***

G-2.6 ***Provide completed Form G-3. Provide a link to the location of the form in the submission appendix [Form G-3: Statistical Hurricane Standards Expert Certification].***

G-2.7 ***Provide completed Form G-4. Provide a link to the location of the form in the submission appendix [Form G-4: Vulnerability Hurricane Standards Expert Certification].***

G-2.8 ***Provide completed Form G-5. Provide a link to the location of the form in the submission appendix [Form G-5: Actuarial Hurricane Standards Expert Certification].***

G-2.9 ***Provide completed Form G-6. Provide a link to the location of the form in the submission appendix [Form G-6: Computer/Information Hurricane Standards Expert Certification].***

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.

The Impact Forecasting Florida Hurricane (FCHLPM) Model uses United States Postal Service ZIP Code data that is post processed by the third-party vendor Zip-Codes.com. Impact Forecasting's ZIP Code database is updated at least every 24 months; the vintage of the current iteration is August 2023.

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

ZIP Code centroids used in the Impact Forecasting hurricane model are based on population data.

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

ZIP Code boundary data is examined by Impact Forecasting for consistency and quality.

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, such as vulnerability tiers and ZIP Code Events (see Disclosure G-3.5) are recreated using the latest update of the ZIP Code data in the model.

E. Geocoding methodology shall be justified.

Impact Forecasting uses an industry-proven toolset for geo addressing from Precisely (formerly Pitney Bowes) to convert street addresses to location coordinates that are routinely quality-checked to ensure accuracy. The ELEMENTS platform uses their GeoAdressing API's

(Application programming interface) service to convert street address strings into location coordinates (in WGS 84 (World Geodetic System 1984) coordinate system).

G-3.1 Provide a description of the geographic information system (GIS) software and tools used for geocoding.

The Impact Forecasting Florida Hurricane (FCHLPM) Model uses geocoding API (Precisely) to convert street addresses to location coordinates after importing a portfolio into ELEMENTS.

When address information is available for a location, the Precisely geocoding service is triggered during portfolio import and converts the given information to latitude and longitude coordinates in the WGS 84 coordinate standard. Locations with provided coordinates pass directly to the model, which consumes the coordinates in the WGS 84 coordinate standard. After creating these coordinates, the location is assigned an ID that corresponds to the appropriate 1km x 1km cell in the model.

G-3.2 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 Impact Forecasting Florida Hurricane (FCHLPM) Model uses ZIP Code Boundary Data generated by ZIP-Codes.com. The above products are compiled using the August 2023 vintage of the United States Postal Service ZIP Code data. Vulnerability tiers and housing-unit-weighted wind speeds for each ZIP Code are calculated using the ZIP Code boundary data.

G-3.3 Describe in detail how invalid ZIP Codes are handled.

After importing a portfolio into ELEMENTS as described in Disclosure G-3.4, the status of the quality of the data can be found in a summary result which indicates how many exposures were mapped to the street address level, mapped to the ZIP Code level, or were found to be invalid. If a ZIP Code is found to be invalid and can't be found in the Impact Forecasting ZIP Code database, it will not be modeled. Users have the option to correct the data by changing the address/ZIP Code or setting coordinates and re-importing the portfolio.

G-3.4 Describe the data, methods, and process used in the hurricane model to convert among street addresses, geocode locations (latitude and longitude), and ZIP Codes.

There are four geocoding options when importing exposure data into ELEMENTS:

1 Use Most Precise Information Available

If both coordinate and address information are provided by the user, this option uses the higher precision. For example, if ZIP Code centroid coordinates are provided but address data is available and can be geocoded to street level, then the address data is used. If the coordinates provide more precise information, reverse geocoding is performed to find related administrative information (i.e., ZIP Code, state, etc.) which is used for reporting.

2 Use Address Information, Ignore Coordinates

This option uses the user-supplied address information (excluding coordinates) for geocoding with the internal geocoding engine. Locations where geocoding cannot be achieved with address information are excluded from analysis even if coordinates were provided.

3 Use Coordinates and only if not available use Address Information

This option uses the user-supplied coordinates regardless of precision. If coordinates are not present, the address data provided is used (as in option 2).

4 Use Coordinates for Hazard and Address Information for Reporting

The coordinates are used to find the appropriate hazard location and the supplied address information is used for reporting. Generally, administrative information is retained (e.g., ZIP Code, state) when an exact match is available. ZIP Codes entered by the user that do not match exactly to a known ZIP Code may be re-mapped to known ZIP Codes. This avoids the reverse geocoding process performed when attempting to use the Use Most Precise Information Available option (option 1 above) and administrative information is generally retained. If coordinates are not present for a given location, the address information is used (as in option 2). If address information is not present for a given location, the coordinate information is used (as in option 3).

ELEMENTS has the option to validate the address information provided by the user using a third-party geocoder (Precisely) if available.

G-3.5 List and provide a brief description of each hurricane model ZIP Code-based database (e.g., ZIP Code centroids)

A list of ZIP Code-based databases used in the Impact Forecasting Florida Hurricane (FCHLPM) Model, along with a brief description of each, is given below.

ZIP Code

ZIP Code boundaries and point ZIP Codes used in the Impact Forecasting model are acquired from Zip-Codes.com. Zip-Codes.com uses algorithms that strictly interpret monthly data feeds from the U.S. Postal Service to construct polygons for postal ZIP Codes. All ZIP Code-level maps displayed in this submission are created based on this ZIP Code boundary product.

ZIP Code Events

Housing unit population-weighted wind speed data is calculated for ZIP Codes affected by events. Using the 2020 U.S. Census population data, number of housing units is assigned to each model grid cell and the average housing unit population-weighted wind speed is calculated for each event and ZIP Code. Those ZIP Codes that have a housing-unit-weighted centroid outside of the event footprint will not be included for that event.

Vulnerability Tiers

Each ZIP Code is assigned to a vulnerability tier (Tier 1 to Tier 3) based on the Florida Building Code (see Disclosure V-1.9). Tier 1 is the zone with the highest design wind speeds and Tier 3 is the zone with the lowest design wind speeds. Tier assignments are updated accordingly when a new ZIP Code boundary shapefile is acquired. If a ZIP Code falls within two tier zones it is assigned to the Tier in which the ZIP Code housing unit population-weighted centroid falls into (previously assigned to the Tier where majority of the ZIP code area belongs).

G-3.6 Describe the process for updating hurricane model ZIP Code-based databases.

Impact Forecasting updates its ZIP Code databases at least every 24 months. The update process is as follows:

1 Acquire the ZIP Code boundary and point ZIP Code data from ZIP-Codes.com.

2 ZIP Code boundary data are compared with previous vintages for accuracy and appropriateness.

3 If the data pass the above inspection, the new version is deployed into the Impact Forecasting hurricane model.

4 Using the new ZIP Code data and wind zones of the Florida Building Code, a vulnerability tier is assigned to each ZIP Code.

5 Additional ZIP Code databases described in Disclosure G-3.5 (ZIP Code Events) are prepared using the new ZIP Code data and U.S. Census data.

G-4 Independence of Hurricane Model Components

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

The meteorological, vulnerability, and actuarial components of the Impact Forecasting Florida Hurricane (FCHLPM) Model are theoretically sound and developed independently. Each component is validated individually without consideration of possible biases in other components.

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 that the submission has been personally reviewed and is editorially correct.

The Impact Forecasting submission has been compiled, edited, and reviewed by a person with experience in authoring and reviewing technical documents for consistency, grammar, and editorial accuracy. The signatory for Form G-7: Editorial Hurricane Standards Expert Certification (also referred to here as the Editor), David Colbus, has experience in authoring, reviewing, and editing technical documentation, as well as experience understanding the FCHLPM Hurricane Standards and Acceptability Process. Further details on the qualifications and experience of the Editor may be found in Appendix B: Individuals Involved in the Impact Forecasting Florida Hurricane (FCHLPM) Model Acceptability Process.

G-5.1 *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.*

Impact Forecasting used the web-based collaboration platform, Microsoft SharePoint, to manage document control of the submission. In addition to facilitating clear version histories, SharePoint has a “check out” feature which is used by the Editor to ensure that (1) only authorized changes are made to the submission document, (2) all required formatting and links are maintained, and (3) ultimately, the paper and electronic versions of the submission document and all associated files are identical in content.

To compile the initial version of the submission document, submission authors and contributors first produced a separate draft of each Standards section within an organized folder structure on SharePoint. Track Changes and Comments were used to facilitate collaboration and discussion among Standard collaborators. Once the draft of each Standards section was completed and reviewed by the section owner (signatory who certifies

the corresponding Expert Certification form), the Editor locked each draft document for editing and incorporated its content into a master document template.

From this point forward, in order to maintain a clear and consistent version history and ensure that no changes that weren't expressly authorized by the section owners would be made to the final document, only the Editor was permitted to make changes to the draft submission. At this stage, the Editor performed a comprehensive editorial review of the draft document using Track Changes and made notes using Comments of any areas that appeared to need clarification or additional information from the section owners.

Further edits were completed on a rolling basis while the Editor maintained a comprehensive version history of each subsequent draft version. To request a change to any submission content (Standards, Disclosures, or Forms), the section owner or collaborator downloaded the most recent version of the master document, made edits using Track Changes, clearly labeled the file name of their version, and submitted it to the Editor for inclusion. The Editor incorporated the requested changes to the master document (while noting in the version history what changes were made) and requested review from the section owner. A final deadline was established for content changes by section owners, after which point the Editor made a final review of the completed submission document for consistency, grammar, and editorial accuracy.

Finally, to prepare for printing, the submission document was converted to PDF (Portable Document Format). The PDF was reviewed by the Editor for proper bookmark functionality. Upon receipt of the printed copies, the document was personally reviewed by the Editor to ensure print quality and readability.

G-5.2 Describe the process used by the signatories on Expert Certification Forms G-1 through G-6 to ensure that the information contained under each group of hurricane standards is accurate and complete.

Each signatory on Expert Certification Form G-1: General Hurricane Standards Expert Certification through Form G-6: Computer/Information Hurricane Standards Expert Certification was responsible for the final review of their section, in addition to preliminary reviews throughout the submission production process. Additional key contributors may submit requested changes to the master document (see Disclosure G-5.1), but the section

owner must ultimately approve them. Upon inclusion of any changes to the working submission draft, the signatory must re-approve the updated version. Prior to submission of the final document, each signatory gives a final review and communicates to the Editor that they have signed off.

G-5.3 Provide completed Form G-7. Provide a link to the location of the form in the submission appendix [Form G-7: Editorial Hurricane Standards Expert Certification]

M-1 Model Base Hurricane Set

A. The Model Base Hurricane Set shall be one of the following: (1) Reference Hurricane Set, (2) Model Adjusted Hurricane Set, or (3) Model Climate-Adjusted Hurricane Set, and shall be justifiable.

Model Base Hurricane Set used by Impact Forecasting is (2) Model Adjusted Hurricane Set developed using the process described in Disclosure M-1.1 and M-1.2. The Model Adjusted Hurricane Set is in full agreement with the HURDAT2 dataset that underpins the Reference Hurricane Set, but with the classification of four events not contained within the Reference Hurricane Set as by-passing hurricanes due to their generation of minimum damaging windspeeds on Florida in our model.

B. A climate-adjusted hurricane model shall use one of the hurricane sets listed in A as its Model Base Hurricane Set and shall be justifiable.

Impact Forecasting Model does not account for climate change.

C. Annual frequencies used in the hurricane model validation shall be based upon the Model Base Hurricane Set.

Impact Forecasting used the Model Base Hurricane Set to validate the landfall and by-passing hurricane frequencies.

M-1.1 Identify the basis for the Model Base Hurricane Set as listed in Hurricane Standard M-1.A.

Impact Forecasting used the Model Base Hurricane Set (Landsea & Franklin, 2013) from the official HURDAT2 database, downloaded on October 27, 2023 (April 2023 Vintage). All storms that occurred within the period 1900 to 2022 were used to develop and implement landfall and by-passing hurricane frequencies.

M-1.2 Describe the process used to develop the Model Base Hurricane Set. Specify:

Impact Forecasting developed all storms in HURDAT2 database within period 1900-2022. Additional hurricane and environmental variables not available in HURDAT2 are obtained from external data sources as outlined in M-1.2b.

a. The HURDAT2 release date used,

Impact Forecasting used the official HURDAT2 database as available on October 27, 2023.

b. Additional data, databases, and modifications, excluding climate change, used, if relevant, and

To supplement the HURDAT2 track and intensity data, Impact Forecasting integrated data from several additional datasets to develop the Model Base Hurricane Set:

1 The National Environmental Satellite, Data, and Information Service (NESDIS) Extended Best Track (EBTRK) dataset, as available on January 5, 2024, for radius of maximum winds data (Demuth et al., 2006);

2 The HURDAT Reanalysis Project dataset (February 2024) (e.g., Landsea et al., 2004a, 2004b, 2008, 2012, 2014; Hagen et al., 2012; Delgado et al., 2018), for radius of maximum winds data;

3 NOAA Report NWS 38 (Ho et al., 1987).

4 The Hadley Centre Sea Ice and Sea Surface Temperature dataset (HadISST) (Rayner et al., 2003), as available on December 20, 2023, for sea surface temperature data used in the central pressure model;

5 The National Land Cover Database NLCD 2021, released July 2023 (Dewitz, 2023);

6 ZIP Code Information from Zip-Codes.com (August 2023);

7 U.S. Census (2020) Data;

8 For claims-based calibration and validation, wind gust observations and other data reported in National Hurricane Center Tropical Cyclone Reports (TCR) (e.g., Beven et al., 2019; Bucci et al., 2023; Cangialosi et al., 2018 ; Pasch et al., 2004, 2006; Paschet al., 2006).

9 For validation of hurricane intensity evolution at landfall, National Hurricane Center Intermediate Advisories for position and intensity are used for: CHARLEY2004, FRANCES2004, IVAN2004, JEANNE2004, DENNIS2005, KATRINA2005, RITA 2005, WILMA2005, MATTHEW2016, IRMA2017, MICHAEL2017, ISAIAS2020, SALLY2020, ETA2020, ELSA2021, IAN2022, downloaded from National Hurricane Center archives November 2023 (National Hurricane Center, 2023).

c. Additional data, databases, and modifications related to climate change used, if relevant.

Impact Forecasting Florida Hurricane (FCHLPM) Model does not account for climate change.

M-1.3 Justify the Model Base Hurricane Set based upon current scientific literature and current technical literature.

Impact Forecasting uses the most recent vintage of HURDAT2 data, scientific and technical literature to develop the Model Base Hurricane Set. The HURDAT2 dataset is regularly updated to ensure data quality and contains the National Hurricane Center's official assessments of tropical cyclone histories in the Atlantic (Landsea and Franklin, 2013) and is consistent with Form M-1: Annual Occurrence Rates of the 2023 ROA.

M-1.4 Provide completed Form M-1(s). Provide a link to the location of the form(s) in the submission appendix [Form M-1: Annual Occurrence Rates].

M-1.5 Describe the process for incorporating the Model Base Hurricane Set consistently into Forms M-1, S-1, and A-2.

An automated script is used to confirm that Form M-1: Annual Occurrence Rates is consistent with Form S-1: Probability and Frequency of Florida Landfalling Hurricanes per Year and Form A-2: Model Base Hurricane Set Statewide Hurricane Losses.

M-2 Hurricane Parameters (Inputs)

Methods for depicting all modeled hurricane parameters shall be based on information documented in current scientific literature and current technical literature.

All hurricane parameters and characteristics are modeled using methods proposed in scientific and technical literature. The methods are implemented and validated by Impact Forecasting scientists using historical data. A complete list of references is provided in Disclosure G-1.6, some of which are referred to below in Disclosure M-2.4

M-2.1 Provide details of modifications to the meteorological component of the hurricane model since the current accepted hurricane model.

Track and intensity model

In the currently accepted model, for cells with insufficient data, the regression coefficients for track and intensity models were copied from adjacent cells. This procedure has now been updated and the coefficients for those cells are fitted using a weighted regression approach, utilizing the nearest 50 observation points available. The weights assigned to the data are calculated using bi-square approach which is a function of the distance from observation point to the location of interest.

Stratified Random Sampling procedure

The stratified random sampling procedure is same as the currently accepted model but extra gates are added in Mexico, Canada and Caribbean (Puerto Rico, Haiti, Dominican Republic, Jamaica and Cuba)

Event stop criteria

In the currently accepted model, events were capped at 100 steps (25 days), causing some of them to terminate at high windspeeds close to the coast. To address this, the maximum limit of the track is increased to 250 steps. If the event lasts for 25 days, it is kept active until it turns to Tropical storm (17≤Vmax≤33m/s).

Revision of storm motion-based asymmetry parameterization

The existing storm motion-based asymmetry representation scheme was based upon NWS Technical Report 23 (1979) and NWS Technical Report 48 (1992). Since the release of these reports, radiosonde data from hundreds of aircraft missions into North Atlantic hurricanes have been analyzed to produce an improved empirical model for storm-motion induced asymmetry (Uhlhorn et al., 2014). From spatial observations of 128 flights into 35 hurricanes in the North Atlantic between 1998 and 2011, Uhlhorn et al. fit a wavenumber-1 wind speed asymmetry model to observed surface winds. The study resulted in two notable findings. First, the amplitude and phase of the asymmetry was found to be independent of radial distance, thus the revised asymmetry model contains no radial dependence. Second, it was found that the relationship between storm motion with asymmetry magnitude and phase differed from assumptions made in prior asymmetry models, including those cited and used by the Impact Forecasting hazard model. Adopting the conclusions of Uhlhorn et al. 2014, the revised Impact Forecasting model superimposes a wavenumber-1 windfield upon the symmetrical wind field determined through the Willoughby model. The amplitude of asymmetry is linearly dependent upon storm motion, following the empirical linear dependence estimated by Uhlhorn et al. Likewise, the phase of asymmetry is also made to be linearly dependent upon storm motion following the empirical linear dependence estimated by Uhlhorn et al. In practice, we find that the mean amplitude of added surface windfield asymmetry is roughly 5 m/s, while the phase of surface windfield asymmetry varies from 21 degrees right-of-center for the 10th percentile of landfalling Florida storms to 52 degrees right-of-center for the 90th percentile of landfalling Florida storms.

Interpolation of event properties at landfall for historic events

The interpolation of event properties at landfall for historic events have been improved in two ways. First, the interpolation of event parameters between six-hourly fixes from HURDAT2 has been improved using a detailed analysis of the current literature and NHC advisories for recent Florida-landfalling hurricane events. The interpolation scheme of the prior submission linearly interpolated between six-hourly data points. If the points straddled landfall, however, that implicitly led to some weakening of the storm prior to landfall due to decay-induced intensity declines being observed at the post-landfall six-hourly data point. This assumption has been revised, however, in consideration of hourly updates from the National Hurricane

Center for sixteen Florida-landfalling storms between 2004 and 2022. These high-resolution intensity updates indicate that, on average, intensity at landfall is unchanged from the last six-hour intensity fix over water, consistent with Zhu et al. (2021). This observed behavior is used to create the improved interpolation assumption that historical storms landfall at an intensity equal to the last intensity provided by HURDAT2 before undergoing decay after landfall occurs. This is modeled by keeping intensity constant until landfall, then performing a linear interpolation from that intensity value to the next inland intensity value in HURDAT2 in the time the storm is over land.

Second, the conversion of HURDAT2 reported Vmax to open-terrain equivalent is improved. The parameterization of the wind field model used in the model under review is premised upon the hurricane Vmax being an open-terrain equivalent sustained wind. Nevertheless, reports of Vmax in HURDAT2, derived initially from NHC estimates of Vmax, are agnostic to the terrain under which the Vmax occurs (Franklin 2002 Public Correspondence). Thus, a determination of whether Vmax occurred over open terrain or open water must be made when modeling historical wind footprints of historic events. For the modeling of historical events only, an empirical scaling function derived from simulations of landfalls using the Impact Forecasting modified Willoughby wind field model is applied to improve the translation of HURDAT2 reported Vmax to open-terrain equivalent during landfall. The landfalling parameters of 16 Florida hurricane landfalls from 2004 to 2022 are randomly resampled to generate 80,000 synthetic landfalling Florida hurricanes at various stages of the eyewall passing over land. The wind fields of these synthetic hurricanes are sampled to determine whether the NHC reported Vmax for the storm at that time would have corresponded to an open terrain or open water value. From these synthetic landfalls, a calibration curve is derived to predict the effective open-terrain Vmax of a historic storm as a function of the percentage of eyewall that is over land.

Revision of intensity for Hurricane Ian (2022)

From the National Hurricane Center Tropical Cyclone Report for Ian, a set of 105 station observations of maximum wind gusts were selected that were in the path of significant winds and do not show instrumental failure. Objective comparison between these observations and a modified Willoughby wind field model indicate that Vmax decayed rapidly after landfall, with a most likely Vmax upon landfall in mainland Florida 7 m/s lower than provided in

HURDAT2. This revised estimate of Vmax used for the model-adjusted historical set is consistent with the published expectation that U.S. landfalling major hurricanes have a standard error of 9.8 kts as of 2010 (Landsea and Franklin, 2013).

M-2.2 Identify the hurricane parameters (e.g., central pressure, radius of maximum winds, rainfall) that are used in the hurricane model.

The following hurricane parameters are used in the model:

1 Latitude
2 Longitude
3 Translational/forward speed
4 Heading angle/direction
5 Central pressure
6 Maximum sustained wind speed
7 Radius of maximum winds
8 Inland decay rate
9 Radial wind profile parameters
10 Empirical regression coefficients for angle of wind field asymmetry
11 Empirical regression coefficients for magnitude of wind field asymmetry
12 Inflow angle

M-2.3 Describe the dependencies among parameters 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.

The maximum sustained wind speed (Vmax) and radius of maximum winds (Rmax) are determined once the hurricane track has been simulated. Vmax and Rmax are then used to model the windfield. The various dependencies are:

- Vmax is a function of the central pressure deficit (difference between central pressure and far-field pressure) and storm eye latitude.
- Rmax is a function of the central pressure deficit and storm eye latitude.

- The shape parameters are used to define the shape of the hurricane windfield (Willoughby et al., 2006) and are functions of Vmax and storm eye latitude.
- Besides the shape parameters, the open terrain wind speed at any location is dependent on Vmax, translational speed, heading direction, storm eye latitude, and distance of the location from the storm eye. The actual wind speed is also affected by the terrain conditions at and upstream of the site.
- The asymmetry factor, which results in higher wind speed towards the right of the storm compared to the left with respect to the storm forward motion, is proportional to the translational speed.

M-2.4 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.

The methods used to model each hurricane parameter are described below.

Storm Formation Count and Genesis Parameters

The Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 uses a Markov Chain approach to model the entire track of each hurricane on a 6-hour time step from initiation to dissipation, limited to 250 time steps. The number of tropical cyclones generated each year is modeled using a negative binomial distribution (Vickery et al., 2000). The genesis location of the hurricane along with its genesis date and time, initial forward speed, heading angle, and central pressure are modeled by random draws from historical genesis data (Vickery et al., 2000, 2009c). If central pressure data is not available, a regression equation is used to estimate the central pressure value from maximum sustained wind speed and latitude. The hurricane parameters at subsequent time steps are determined using regression models.

Translational/Forward Speed and Heading Angle/Direction

The hurricane translational speed and heading angle at every 6-hour time step are modeled as separate regression models with the forward speed, heading direction, latitude, and longitude from up to two previous time steps as predictors. The regression coefficients are derived for different 5x5-degree cells across the North Atlantic Ocean (Vickery et al., 2000, 2009c). When a modeled storm enters a given cell, the corresponding set of coefficients is

used in the regression model. The residuals from the regression are modeled as a normal distribution in each cell to address the randomness of hurricane movement.

Central Pressure

Central pressure is modeled in the form of relative intensity (Darling, 1991) using a multiple linear regression model. For each time step, the central pressure in a given 5x5-degree cell is modeled as a function of the relative intensities from the previous three time steps and the current and previous sea surface temperatures (Vickery et al., 2000; Rayner et al., 2003). A normally distributed random error term is used to model the residuals that result from the regression. Relative intensity values are taken between 0 and 1 to constrain the minimum central pressures a hurricane can physically reach under certain environmental conditions.

Maximum Sustained Wind Speed

The modeled central pressure is converted to maximum 1-minute sustained wind speed for windfield construction. The maximum sustained wind speed is estimated using a regression equation with central pressure deficit and latitude as predictors (Knaff & Zehr, 2007). A normally distributed random error term is included in the equation to model regression residuals. The maximum sustained wind speed is modeled differently for marine and land roughness conditions, based on the respective HURDAT2 data.

Radius of Maximum Winds

Radius of maximum winds is an important parameter that describes the size of a hurricane. It is modeled as a random variable which follows a lognormal distribution. The mean of the variable is described as a function of central pressure deficit and latitude (Vickery & Wadhera, 2008). The variation relative to the mean is determined from historical data through regression analysis. The historical data is obtained from the HURDAT Re-analysis Project (e.g., Landsea et al., 2004a, 2004b, 2008, 2012, 2014; Hagen et al., 2012; Delgado et al., 2018), NOAA Technical Report NWS 38 (Ho et al., 1987), and the Extended Best Track Dataset (Demuth et al., 2006).

Inland Decay Rate

Once a hurricane makes landfall, its central pressure starts to increase. The increase of hurricane central pressure is modeled as an exponential function with hurricane central pressure deficit at landfall and travel time after landfall as predictors. The speed of central pressure increase is described using the inland decay rate. The inland decay rate is modeled as a Gaussian distribution. The mean of the distribution is formulated as a function of the hurricane forward speed, radius of maximum winds, and its central pressure deficit at landfall (Vickery, 2005). The variation around the mean is determined using a linear regression on the historical data. The inland decay rate is modeled differently for seven regions that may influence Florida landfalls – the U.S. Gulf Coast, the Florida Peninsula Coast, the Mid-Atlantic Coast, the New England Coast, the Mexican Coast, the Caribbean Islands, and the remaining coasts in the Caribbean.

Wind Profile Parameters

Wind profile parameters are used in the Willoughby model (Willoughby et al., 2006) to structure the hurricane windfield. Impact Forecasting uses the dual-exponential formulation to generate the wind profile. The wind profile parameters include the exponent n for the power law inside the eye, the exponential decay length X1 in the outer vortex, and the proportion A of the two exponentials in the profile. These parameters are modeled as deterministic variables given hurricane maximum sustained wind speed and latitude as inputs. Wind field asymmetry is modeled by the deterministic, empirical linear function of wavenumber-1 amplitude and phase, as provided by Uhlhorn et al. (2014).

Inflow Angle

Inflow angle describes the difference of the actual wind direction inside a hurricane with respect to the tangential direction due to air inflow towards the hurricane center. This parameter is important for an improved estimation of hurricane losses since both terrain effects and structure responses to winds are sensitive to wind directions. The inflow angle is modeled as a constant supported by recent studies (e.g., Powell et al., 2009; Zhang & Uhlhorn, 2012).

M-2.5 Describe if and how any hurricane parameters are treated differently in the Model Base Hurricane Set and the stochastic storm set and provide rationale.

Functionally, all hurricane parameters are treated the same in the historical and stochastic storm sets. The stochastic events are modeled using data and formulas utilized to create historical storms. Because the stochastic event generation process can explicitly sample open terrain-equivalent Vmax, while the historical Vmax provided in HURDAT2 is agnostic to the surface roughness where Vmax occurs, some inference of the open terrain-equivalent Vmax from reported Vmax is necessary for historical storms, i.e. when landfalling storm wind fields are parameterized using an over-water Vmax. The conversion of HURDAT2 Vmax to open-terrain equivalent, using a peak factor conversion equation provided by ESDU (2002b), is done to minimize to all-possible extent any difference in the handling of Model Base Hurricane Set wind field simulation and those produced from the stochastic storm set.

M-2.6 Describe any evolution of the functional representation of hurricane parameters during an individual storm life cycle.

Hurricane central pressure and maximum sustained wind speed are modeled separately before and after landfall. Before landfall, the intensity model is used to model hurricane central pressure. The central pressure values can increase or decrease, dependent upon certain environmental conditions used to predict central pressure. Once the storm makes landfall, the decay model is used to describe the decay/filling of hurricane central pressure. Given a decay rate, the central pressure can only increase until the storm fully dissipates or exits land. The method of calculating maximum sustained wind speed also evolves as a hurricane moves between sea and land, accounting for changes in surface roughness that are implicitly considered in the Vmax values reported in HURDAT2.

M-2.7 If the modeling organization has accounted for climate change in the hurricane model development (other than a change to the Model Base Hurricane Set), justify its use in modeling Florida hurricane rates from current scientific literature and current technical literature. Describe the analysis and its impacts on Florida hurricane rates.

The hazard statistics generated by the stochastic model are reflective of the hurricane climatology observed in the Model Base Hurricane Set. No explicit consideration of climate change is included in model development.

M-2.8 ***Provide plots of distance along the coast of Florida and adjacent states (x-axis) versus modeled annual landfall occurrence rates (y-axis) in two intensity bands (Saffir-Simpson categories 1 2 and 3-5). Any set of coastal segments may be used for this purpose, as long as they are not greater than 100 miles in length. If the modeling organization has a current accepted hurricane model, provide the current accepted hurricane model's rates on the same axes. Also provide on the same axes the modeled annual landfall occurrence rates computed directly from the Model Base Hurricane Set. For a climate-adjusted hurricane model that uses either the Reference Hurricane Set or a Model Adjusted Hurricane Set for the Model Base Hurricane Set, a modeling organization shall provide two plots, one completed with climate-adjusted modeled rates and one completed without climate-adjusted modeled rates.***

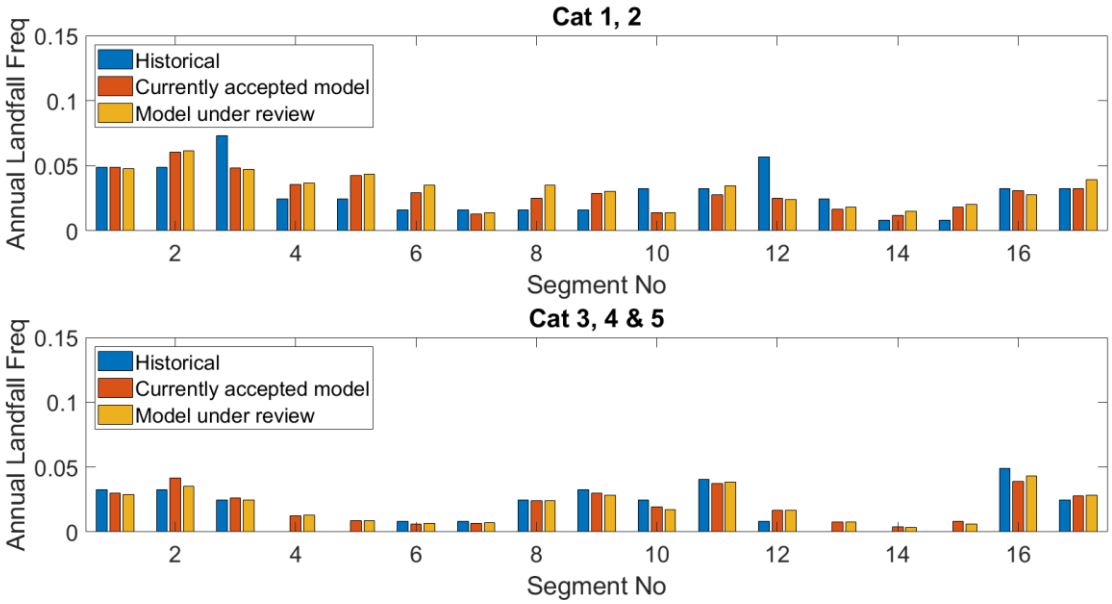


Figure 11: Comparisons between modeled and measured annual landfall occurrence rates for Florida coastal segments

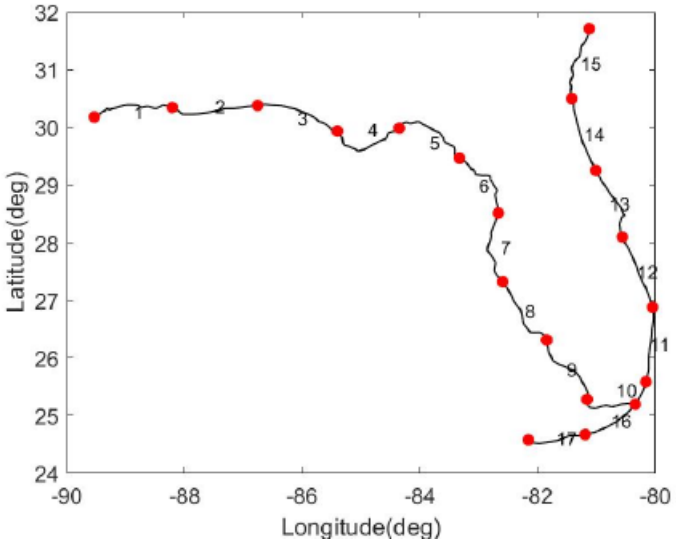


Figure 12: Coastal segments of Florida used for calculating annual occurrence rates

M-3 Hurricane Probability Distributions

A. Modeled probability distributions of hurricane parameters shall be consistent with the Model Base Hurricane Set. Any differences shall be justifiable.

The probability distributions of hurricane parameters and characteristics are modeled using historical data. Validation including statistical tests is performed to ensure that the modeled statistics agree well with the observations contained in the Base Hurricane Set. Details of the statistical tests can be found in Disclosure S-1.5.

B. Modeled hurricane landfall frequency distributions shall reflect the Model Base Hurricane 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). Any differences shall be justifiable.

The modeled hurricane frequencies at landfall match the observed frequencies obtained from the Base Hurricane Storm Set for different hurricane categories (1 to 5 based on the Saffir-Simpson Hurricane Wind Scale) and different geographic regions (coastal segments), including Northwest Florida, Southwest Florida, Southeast Florida, Northeast Florida, Alabama/Mississippi, and Georgia. The comparisons between modeled and observed hurricane frequencies are provided in Form M-1: Annual Occurrence Rates.

C. The hurricane model shall use maximum one-minute sustained 10-meter windspeed when defining hurricane landfall intensity. This applies both to the Model Base Hurricane 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 landfall intensity of each hurricane found in either the Base Hurricane Storm Set or the model simulations is defined using maximum 1-minute sustained wind speed. The classification of hurricane categories uses wind speeds in statute miles per hour and follows the Saffir-Simpson Hurricane Wind Scale given in the table above.

M-3.1 Provide a brief rationale for the probability distributions used for assigning all hurricane parameters, including any assumptions that go into the use or interpretation of the distributions.

Probability distributions used to model all hurricane parameters and a brief rationale for the choice of each distribution are summarized in Table 3.

Table 3: Assumptions underlying the probability distributions described in Form S-3

Stochastic Hurricane Parameter	Functional Form of Distribution	Assumptions in the use or interpretation of results
Annual number of storms	Negative binomial	Stationarity of storm genesis processes with time. Independence of genesis events.

Stochastic Hurricane Parameter	Functional Form of Distribution	Assumptions in the use or interpretation of results
Storm genesis parameters	Random Sampling	Genesis is spatially uncorrelated within hurricane season.
Translational speed and heading	Empirical (regression model with residuals fitted to normal distribution)	Perturbations to track and intensity from predictive variables not represented in the regression model can be represented by a Gaussian error term.
Central pressure	Empirical (regression model with residuals fitted to normal distribution)	Perturbations to central pressure from predictive variables not represented in the regression model can be represented by a Gaussian error term.
Maximum sustained wind speed	Normal (with mean modeled as a function of central pressure deficit and latitude)	Perturbations to maximum sustained wind from predictive variables not represented in the regression model can be represented by a Gaussian error term.
Radius of maximum winds	Lognormal (with mean modeled as a function of central pressure deficit and latitude)	The logarithm of perturbations to Rmax from predictive variables not represented in the regression model can be represented by a Gaussian error term.

Stochastic Hurricane Parameter	Functional Form of Distribution	Assumptions in the use or interpretation of results
Inland decay rate	Normal (with mean modeled as a function of central pressure deficit, forward speed and radius of maximum winds at landfall)	Uncertainty in the rate of inland decay for individual storm events, after accounting for central pressure deficit, forward speed, Rmax, and region of landfall, is Guassian.

M-3.2 Describe and justify any changes made to the Model Base Hurricane Set in the hurricane model under review that are not reflected in changes to the distributions in Form S-3. Describe the methodology used to make such changes.

Changes made to the Model Base Hurricane Set in the Impact Forecasting model that are not reflected in changes to the distributions in Form S-3: Distributions of Stochastic Hurricane Parameters are described in further detail in Disclosure M-2.1.

Track and Intensity Models:

In the currently accepted model, for cells with insufficient data, the regression coefficients for track and intensity models were copied from adjacent cells. This procedure has now been updated and the coefficients for those cells are fitted utilizing the nearest observation points available. We find from examination of cells using the new methodology that the sampled points lie closer on average to the center of the grid cell than points in neighboring grid cells.

Stratified Random Sampling procedure

The stratified random sampling procedure is same as the currently accepted model but extra gates are added in Mexico, Canada and Caribbean (Puerto Rico, Haiti, Dominican Republic,

Jamaica and Cuba), a change that has no significant consequences for sampling of events that bypass or make landfall in Florida.

Event stop criteria

In the currently accepted model, events were capped at 100 steps (25 days), causing some of them to terminate at high windspeeds close to the coast. To address this, the maximum limit of the track is increased to 250 steps, solving observed abrupt and artificial termination of an event.

Revision of storm motion-based asymmetry parameterization

The existing storm motion-based asymmetry representation scheme was based upon NWS Technical Report 23 (1979) and NWS Technical Report 48 (1992). Since the release of these reports, radiosonde data from hundreds of aircraft missions into North Atlantic hurricanes have been analyzed to produce an improved empirical model for storm-motion induced asymmetry (Uhlhorn et al., 2014). From spatial observations of 128 flights into 35 hurricanes in the North Atlantic between 1998 and 2011, Uhlhorn et al. fit a wavenumber-1 wind speed asymmetry model to observed surface winds. The inclusion of this dataset allows for a better empirical characterization of storm asymmetry than was available in the technical reports used in the prior submission.

Interpolation of event properties at landfall for historic events

The interpolation of event properties at landfall for historic events have been improved in two ways. First, the interpolation of event parameters between six-hourly fixes from HURDAT2 has been improved using a detailed analysis of the current literature and NHC advisories for recent Florida-landfalling hurricane events. The improved interpolation scheme for historical events is justified by better reflecting both the experience of hourly-resolution intensity estimation provided by the National Hurricane Center for sixteen Florida-landfalling storms between 2004 and 2022, as well as by published research on near-landfall intensity variablility by Zhu et al. (2021).

Second, the conversion of HURDAT2 reported Vmax to open-terrain equivalent is improved. In prior submissions, HURDAT2 reported Vmax was assumed to be an open terrain estimate

solely based upon the storm center fix was onshore. The revised scaling incorporates both stochastic modeling and information on the distribution of the winds in a storm's eyewall to make a more nuanced determination of whether HURDAT2 Vmax reflects an open terrain value.

Revision of intensity for Hurricane Ian (2022)

The revision of landfall intensity for Hurricane Ian (2022) is justified by the known uncertainty in HURDAT2 values, even for recent U.S.-landfalling events (Landsea and Franklin, 2010). When event parameters are calibrated using the National Hurricane Center Tropical Cyclone Report for Ian, using a set of 105 station observations of maximum wind gusts that were in the path of significant winds and do not show instrumental failure, objective comparison between these observations and a modified Willoughby wind field model indicate that Vmax decayed rapidly after landfall, with a most likely Vmax upon landfall in mainland Florida 7 m/s lower than provided in HURDAT2, an estimated change consistent with the remarkably rapid decrease in aircraft reconnaissance observations of hurricane intensity in the hours before landfall (Bucci et al., 2023).

M-4 Hurricane Windfield Structure

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

Windfields generated by the Impact Forecasting Florida Hurricane (FCHLPM) Model are consistent with observed historical storms affecting Florida. Comparisons of the model-generated winds to the observed historical hurricane winds show good agreement. The comparisons are provided in Disclosure M-4.9.

B. *The land use and land cover (LULC) database shall be consistent with National Land Cover Database (NLCD) 2016 or later. Use of alternate datasets shall be justified.*

The land use and land cover database used in the Impact Forecasting model is National Land Cover Database (NLCD) 2021.

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.*

The land use and land cover data are converted into surface roughness coefficients using methodologies available in published literature (Hansen, 1993; ESDU, 2002a, 2002b). The data is transformed to the coordinate system that is consistent with the Impact Forecasting model to ensure its implementation with the proper geographic information system data.

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

The effects of the vertical variation of winds for multi-story buildings are considered in the vulnerability curves.

M-4.1 Provide a tangential windspeed (y-axis) versus radius (x-axis) plot of the average or default symmetric wind profile used in the hurricane model. Justify the choice of this wind profile. If the windfield represents a modification from the current accepted hurricane model, plot the previous and modified wind profiles on the same figure using consistent axes. Describe variations between the previous and modified wind profiles with references to historical storms.

The Impact Forecasting Florida Hurricane (FCHLPM) Model wind profile is based on the wind profile model provided in Willoughby et al. (2006). This model was developed by analyzing flight-level winds for several hundred historical storms. Reasonable agreement is obtained between the model-generated winds and actual measurements as shown in Disclosure M-4.9. This windfield is not modified from that used in the current accepted hurricane model.

Figure 13 shows the symmetric wind profile for the hurricane parameter values given below. The values are the averages of the parameters from historical landfalling hurricanes that are provided in Form A-2: Model Base Hurricane Set Statewide Hurricane Losses.

- Vmax = 105 mph
- Rmax = 25 miles
- Latitude = 28° N

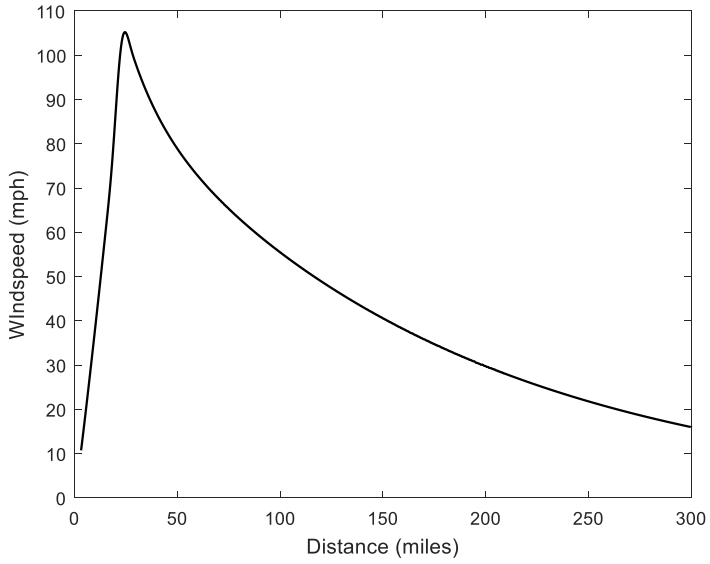


Figure 13 Radial profile of symmetrical wind speed used in the Impact Forecasting Florida Hurricane (FCHLPM) Model with Vmax of 105 mph, Rmax of 25 miles, and Latitude of 28N

M-4.2 Describe the general process for calculating hurricane surface winds.

At 5-minute intervals interpolated from six-hourly fixes of hurricane track and intensity information, the model provided in Willoughby et al. (2006) is used to generate a two-dimensional, axisymmetric spatial field of winds. The Willoughby model is designed to be valid for simulating the hurricane vortex at the 700 hPa geopotential height. This wind field is then translated to surface winds by accounting for the radially-dependent vertical profile of hurricane winds observed by Franklin et al. (2003), as well as the boundary layer effects parameterized by ESDU (2002b). Once the Willoughby wind field is translated to surface winds, a wavenumber-1 asymmetry field based upon research by Uhlhorn et al. (2014) is superimposed to account for storm-motion induced asymmetry.

M-4.3 Describe how the vertical variation of winds is accounted for in the hurricane model where applicable.

The hurricane winds are generated at a height of 10 m. The effect of vertical variation of wind speed on hurricane damage is accounted for in the vulnerability curves. The same methodology is adopted for historical and stochastic storms.

M-4.4 Describe the relevance of the formulation of gust factor(s) used in the hurricane model.

The gust factors in the Impact Forecasting Florida Hurricane (FCHLPM) Model are formulated using the methodology given in published literature (ESDU, 2002a, 2002b; Vickery & Skerlj, 2005). These gust factors are developed for a height of 10 m and vary as a function of surface roughness.

M-4.5 Identify all non-meteorological variables (e.g., surface roughness, topography) that affect windspeed estimation.

Surface roughness at and upstream of a given site affects the wind speed at the site. In general, wind speeds are lower for rougher surfaces. Topographic effects are not considered in the wind speed estimation.

M-4.6 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.

The Impact Forecasting Florida Hurricane (FCHLPM) Model uses NLCD 2021 for land use and land cover data, which complies with Standard M-4. The database for NLCD 2021 was released in July 2023 and includes terrain data for the continental U.S.

M-4.7 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 Impact Forecasting team uses the land use and land cover data provided in NLCD 2021 to develop the roughness coefficients. The data in NLCD 2021 are provided at a resolution of 30 m. These data are assigned appropriate surface roughness lengths based on the values

provided in published literature (Hansen, 1993; ESDU, 2002a). The surface roughness lengths are then averaged for each 1 km model grid cell.

The surface roughness lengths are converted to roughness coefficients using the ESDU methodology. The roughness coefficient considers the direction of the wind and the terrain conditions at and upstream of the site. Eight roughness coefficients corresponding to eight wind directions are assessed for each 1 km grid cell.

M-4.8 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.

The model-generated windfields were compared with historical hurricane windfields and were found to be in good agreement. Tropical cyclone reports published by the NHC, as well as anemometer records provided by the Automated Surface Observing System (ASOS) program, were used as observations to validate the model output. These measurements were standardized for height, averaging time, etc. Exhibits in Disclosure M-4.9 (Figure 14 through Figure 21) show the comparisons of model-generated, 3-second gusts at a height of 10m to standardized station measurements for various hurricanes.

ASOS is one of the major climatological observing networks in the United States and is operated jointly by the National Weather Service, the Federal Aviation Administration, and the Department of Defense. Further, NOAA provides tropical cyclone reports, which have measurements in addition to those provided by ASOS, through NHC (one of its divisions). The data obtained from the above sources are well documented, standardized, and have undergone quality checks. Thus, these datasets are reliable sources for windfield validation.

M-4.9 Describe how the hurricane model 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).

Hurricane Charley (2004), Hurricane Wilma (2005), Hurricane Irma (2017), and Hurricane Michael (2018) have different values of Vmax, Rmax, translational speed, heading angle, and

other parameters. This diversity is well-captured and reflected in the Impact Forecasting Florida Hurricane (FCHLPM) Model wind speed estimation, as indicated by the good agreement between model-generated winds and observed winds for these hurricanes. Model-generated winds for Hurricane Michael are typically greater than observed winds, however this may be the result of sampling bias. After converting reported gusts in the National Hurricane Center Tropical Cyclone Report for Michael to equivalent 3-second gusts at a height of 10m, 13 of the 19 stations with surface observations of hurricane-force max gusts from Florida or Florida waters had an incomplete record, often due to station failure. Thus, it is reasonable to expect that the extreme winds of Michael produced a systematic under-sampling of the true wind field during and after landfall.

Hurricane Irma (2017) is characterized by a swath of hurricane-force wind gusts observed across the Florida peninsula as the cyclone traversed the state from south to north. The large Rmax recorded for Irma during and after landfall is reflected in the modeled windfield, and is substantially larger than modeled for Charley (2004) and Michael (2018). Nevertheless, surface observations of maximum wind gusts for Hurricane Irma (2017) along the East Coast of Florida during the event suggest that a secondary maxima of winds may have occurred there and is not well-captured by the Willoughby model used.

The figures below (Figure 14 through Figure 21) show comparisons of model-generated winds to station measurements for the above-mentioned hurricanes in both map view and as a scatterplot. NHC Tropical Cyclone Reports were used to identify failed stations. ASOS stations that were not included in the Tropical Cyclone Report but stopped recording within 2 hours of recording a maximum gust were also designated as failed. Note that where observed gust values are at an elevation different than 10 m, a power law conversion to 10 m equivalent wind gust using accepted boundary layer parameterization (ESDU 2002a,b) is applied.

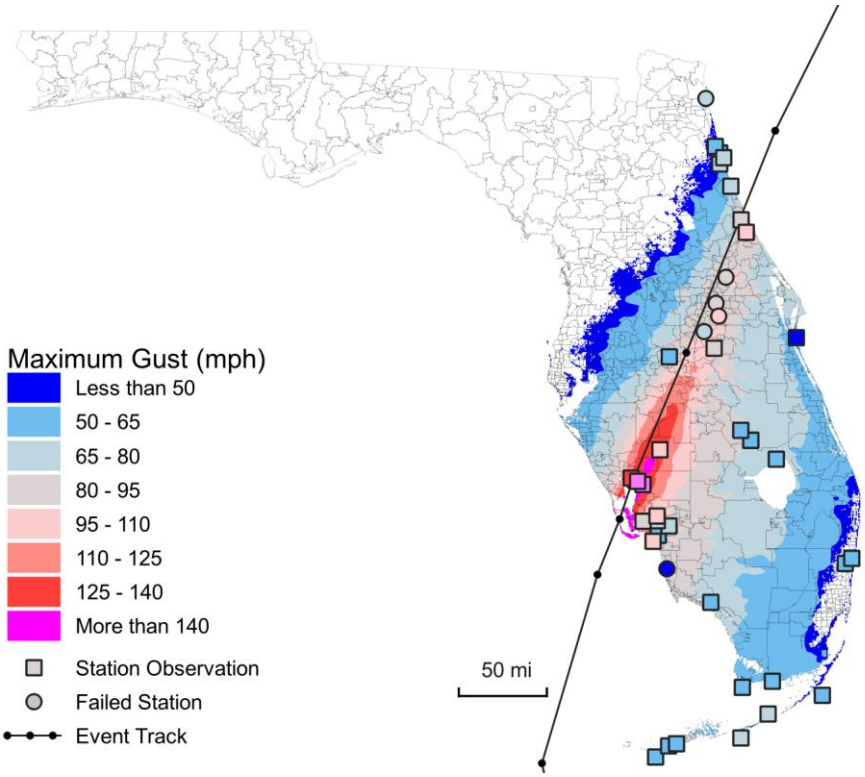


Figure 14: Observed (squares) versus modeled wind speeds for Hurricane Charley (2004). Stations that failed during the hurricane (circles) display the maximum gust prior to failure. Values below 45 mph are not plotted.

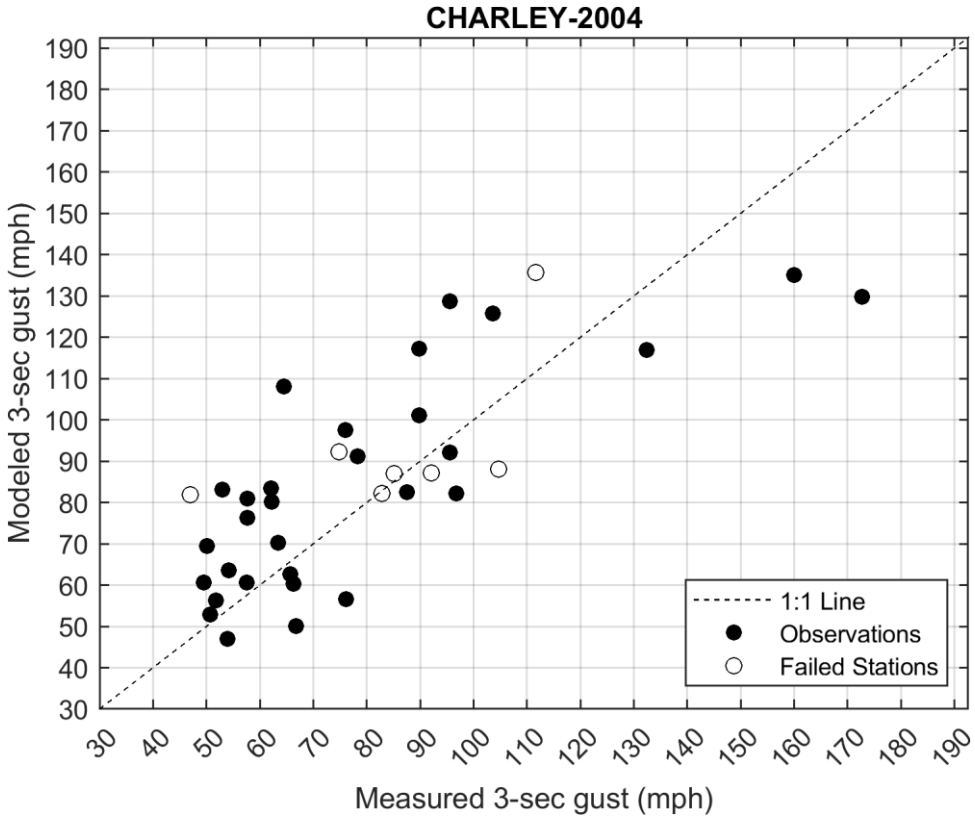


Figure 15: Observed versus modeled wind speeds for stations within the wind footprint of Hurricane Charley (2004). Stations that failed during the hurricane (circles) display the maximum observed gust prior to failure. Values below 45 mph are not plotted.

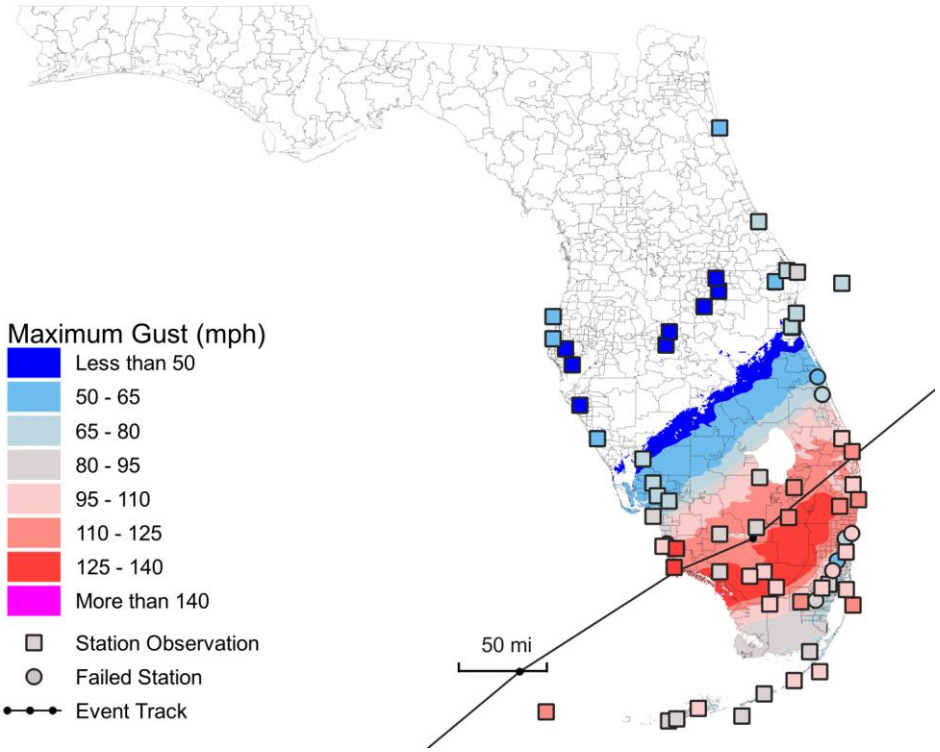


Figure 16: Observed (squares) versus modeled wind speeds for Hurricane Wilma (2005). Stations that failed during the hurricane (circles) display the maximum gust prior to failure. Values below 45 mph are not plotted.

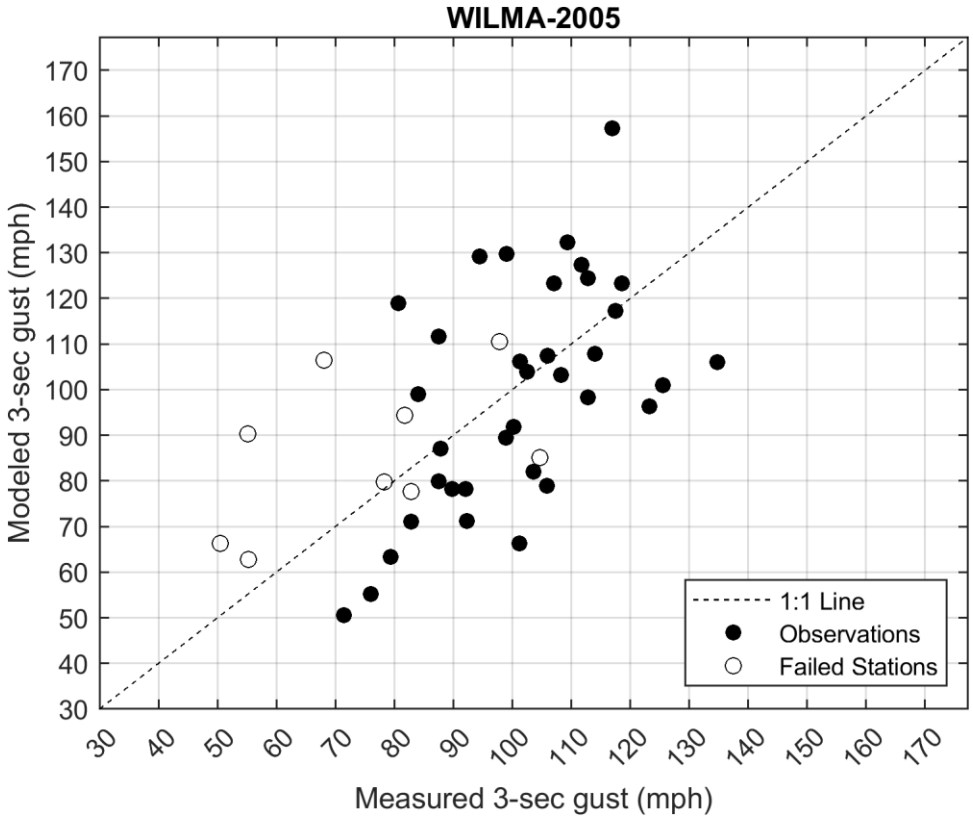


Figure 17: Observed versus modeled wind speeds for stations within the wind footprint of Hurricane Wilma (2005). Stations that failed during the hurricane (circles) display the maximum observed gust prior to failure. Values below 45 mph are not plotted.

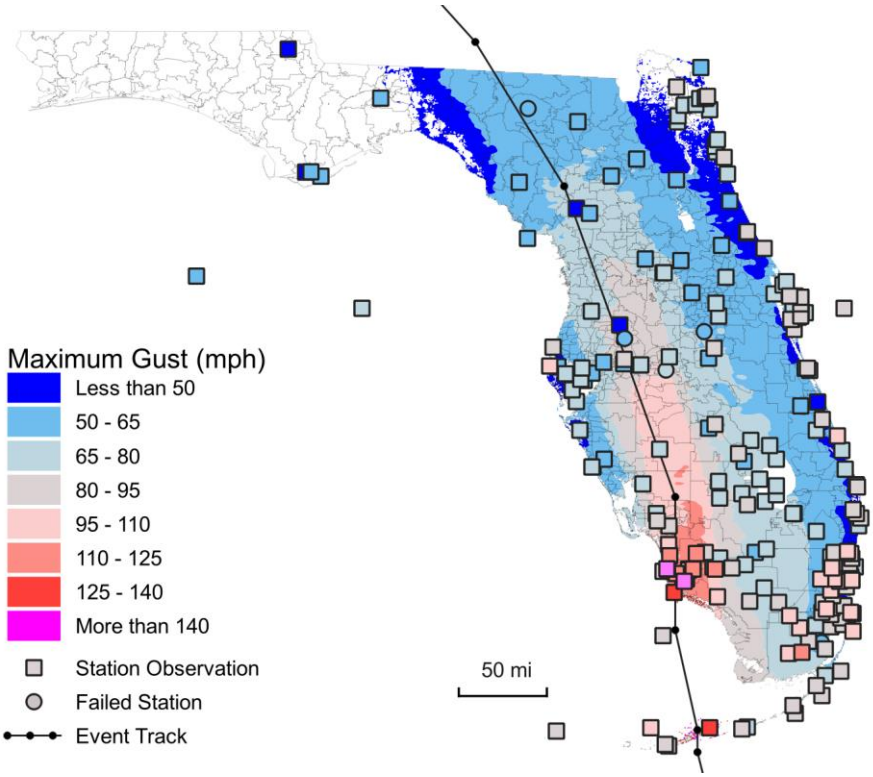


Figure 18: Observed (squares) versus modeled wind speeds for Hurricane Irma (2017). Stations that failed during the hurricane (circles) display the maximum gust prior to failure. Values below 45 mph are not plotted.

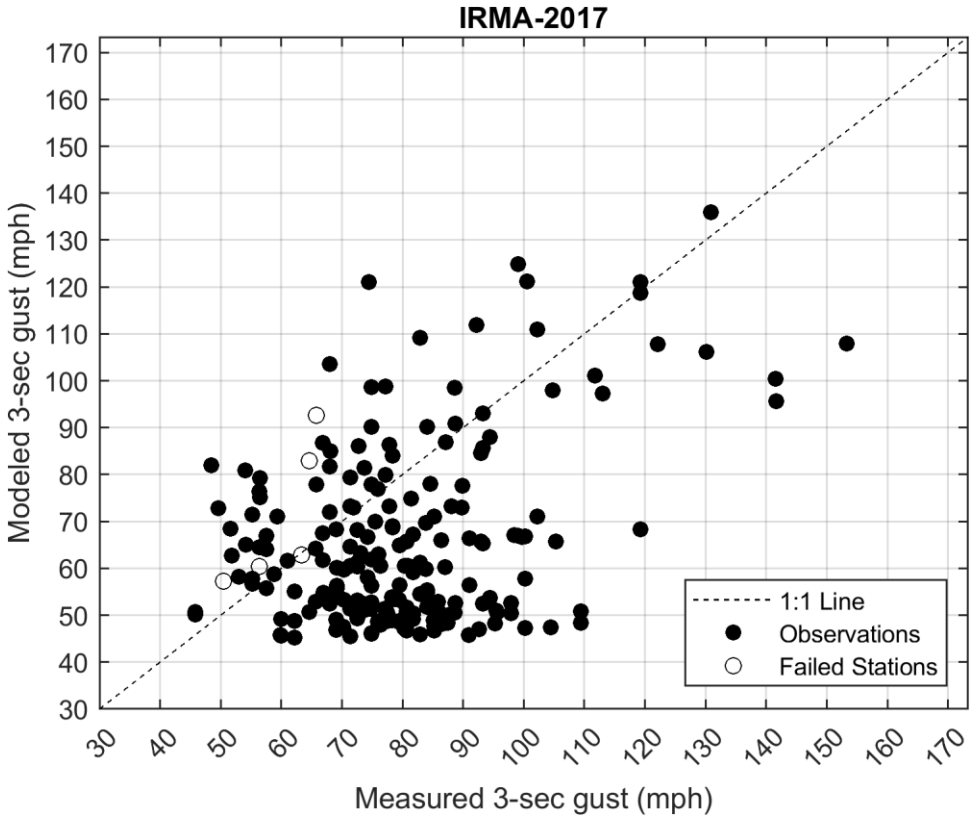


Figure 19: Observed versus modeled wind speeds for stations within the wind footprint of Hurricane Irma (2017). Stations that failed during the hurricane (circles) display the maximum observed gust prior to failure. Values below 45 mph are not plotted.

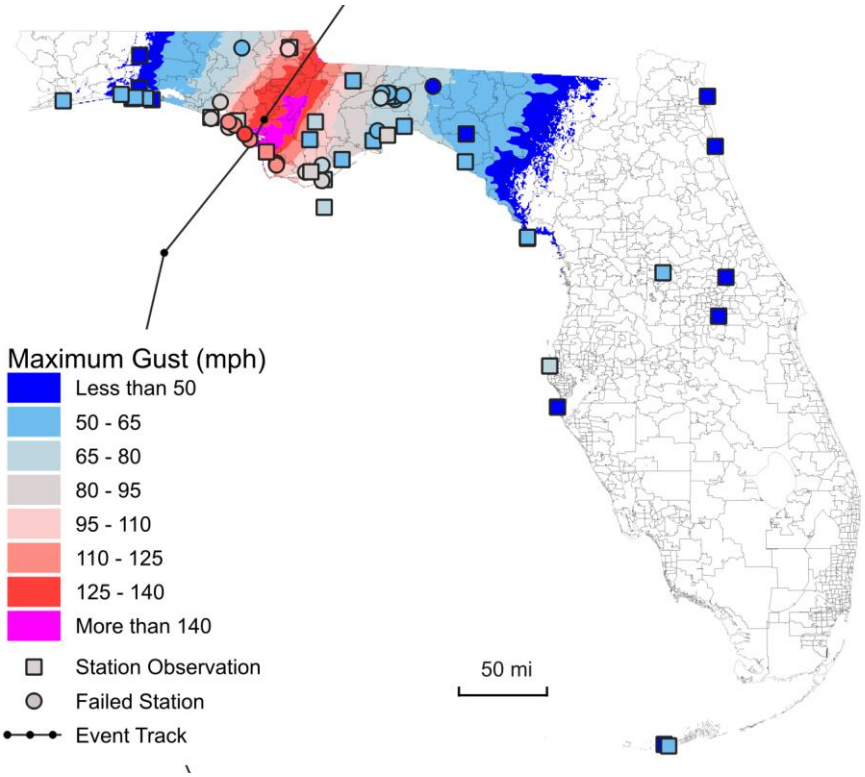


Figure 20: Figure 14: Observed (squares) versus modeled wind speeds for Hurricane Michael (2018). Stations that failed during the hurricane (circles) display the maximum gust prior to failure. Values below 45 mph are not plotted.

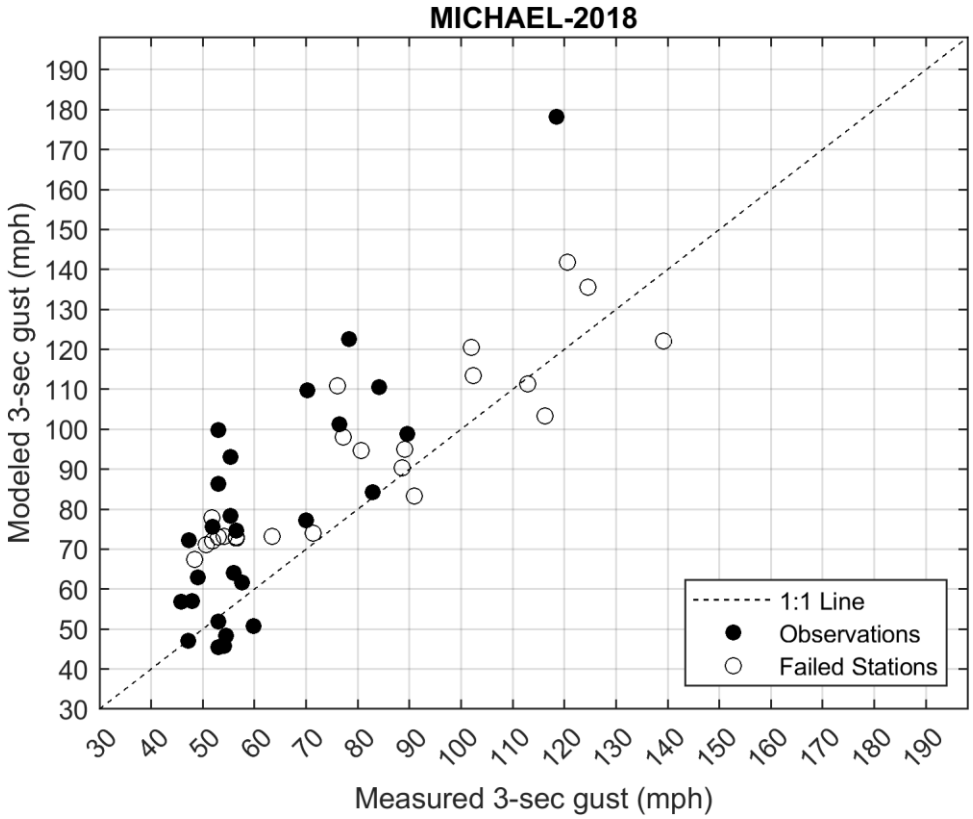


Figure 21: Observed versus modeled wind speeds for stations within the wind footprint of Hurricane Michael (2018). Stations that failed during the hurricane (circles) display the maximum observed gust prior to failure. Values below 45 mph are not plotted.

M-4.10 Describe any variations in the treatment of the hurricane model windfield for stochastic versus Model Base Hurricane Set storms and justify this variation.

The windfield is modeled in the same manner for historical and stochastic storms. The input to the windfield model (Vmax, Rmax, forward speed, etc.) for historical hurricanes is obtained from HURDAT2, Extended Best Track, and other published literature. For stochastic hurricanes, these input parameters are modeled based on the values of historical storms.

M-4.11 Provide completed Form M-2. Provide a link to the location of the form in the submission appendix.

Form M-2 provides contour maps of maximum one-minute sustained wind at 0.01x0.01-degree resolution, and is provided in the submission appendix: [Form M-2: Map of Maximum Winds].

M-4.12 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 winds to surface winds, including the treatment of the inherent uncertainties in the conversion factors with respect to location of the site compared to the radius of maximum winds over time. Justify the variation in the surface winds conversion factors as a function of hurricane intensity and distance from the hurricane center.

The hurricane model requires the conversion of wind speed between gradient level, as calculated spatially through the modified Willoughby model (Willoughby et al., 2006), and the surface level. This is accomplished by using conversion factors obtained from the equation provided in Franklin et al. (2003) and ESDU (2002a, 2002b). Franklin et al. have derived the equation by analyzing data obtained from dropsonde wind measurements. These consist of 630 hurricane profiles obtained from NOAA and Air Force Reserve Command (AFRC) Hurricane Hunter aircraft.

The conversion factor formula is a function of the wind speed, the Coriolis parameter, and the distance from the center of the storm. For the conversion from gradient to surface wind speeds, lower and higher wind speeds are associated with lower and higher values of conversion factors, respectively. The conversion factor varies by distance from the center of the storm, with a lower factor for locations between the eye and eyewall compared to locations outside the eyewall. Other inherent uncertainties of the conversion factor are not modeled, though the uncertainties in wind speed, Rmax, etc., are carried over to the conversion factor.

M-4.13 Describe how the windspeeds generated in the windfield model are converted from sustained to gust and identify the averaging time.

Windspeeds generated by the Willoughby model and translated to the surface are initially in the form of one-minute sustained wind independent of any local terrain effects. Three components of the terrain model are relevant in converting these sustained winds to three-second maximum gust, the averaging time used by the vulnerability module to assess the hazard to exposures.

1 The calculation of how fetch factor, which accounts for the effect of upwind terrain upon sustained wind, differs for wind gusts.

2 The scaling of 1-minute sustained winds to a 3-second gust independent of terrain effects, denoted as the gust factor, found to be 1.27 based upon conversions provided by ESDU (2002b).

3 The dependence of gust factor upon local surface roughness.

These three components are calculated such that the one-minute sustained wind, when multiplied by the output of these three components, yields the local estimate of three-second maximum gust.

M-5 Hurricane Intensity Change Methodologies

A. The hurricane intensity change methodology used by the hurricane model shall be consistent with current state-of-the-science.

The hurricane intensity change methodology used by the Impact Forecasting Florida Hurricane (FCHLPM) Model are developed using historical data based on a methodology published in recent scientific literature (Vickery et al., 2000, Vickery, 2005). Details of the model along with the validation analysis that was performed are described in Disclosures M-5.1, M-5.2, and M-5.3 below.

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 Impact Forecasting Florida Hurricane (FCHLPM) Model uses roughness coefficients to capture the effect of terrain on wind speed, including wind speed transition due to terrain changes from over-water to over-land and whether the fetch is on-shore or off-shore. The roughness coefficients are developed based on the methodology provided in ESDU (2002a, 2002b). The ESDU method is one of the most comprehensive and scientific approaches in the field.

C. Intensity change of hurricanes that pass from over land to over water shall be consistent with current state-of-the-science.

The hurricane intensity change from land to ocean used by the Impact Forecasting Florida Hurricane (FCHLPM) Model are developed using historical data based on a methodology published in scientific literature (Vickery et al., 2000). Details of the model are described in Disclosure M-5.2.

M-5.1 Describe and justify the functional form of hurricane decay rates for hurricanes moving onshore.

Hurricane central pressure decay after landfall is modeled using an exponential function adopted from Vickery (2005):

$$\Delta P(t) = \Delta p_0 exp(-\alpha t) \quad (1)$$

where $\Delta P(t)$ is the central pressure deficit at time t after landfall, Δp_0 is the central pressure deficit at landfall, and α is the inland decay rate. α is modeled differently for different geographic regions based on the following empirical relation:

$$\alpha = a_0 + a_1(\Delta p_0 V_{T0}/R_{max0}) + \varepsilon_\alpha \quad (2)$$

where V_{T0} and R_{max0} are the translational speed and radius of maximum winds, respectively, at the time of landfall, a_0 and a_1 are the regression coefficients, and ε_a is the random error term. a_0, a_1, and ε_α are estimated using least-squares regressions on historical data for different geographic regions. These regions, differentiated by inland decay rates of landfalling hurricanes, are the U.S. Gulf Coast, the Florida Peninsula Coast, the Mid-Atlantic Coast, the New England Coast, the Mexican Coast, the Caribbean Islands, and the remaining coasts in the Caribbean.

Using an exponential function to model hurricane central pressure decay is also documented in other literature, such as Schwerdt et al. (1979), Ho et al. (1987), and Vickery and Twisdale (1995). The Impact Forecasting model inland decay rate is a function of Δp_0, V_{T0}, and R_{max0} as suggested by Vickery (2005). It is found in Vickery (2005) that the inland decay rate of a hurricane tends to increase with the increase of the central pressure deficit and forward speed at landfall and decrease as the radius of maximum winds at landfall increases.

M-5.2 Describe and justify the functional form of hurricane intensity change for hurricanes moving offshore.

Hurricane central pressure after moving from land back into the ocean is modeled in the form of relative intensity (Darling, 1991) using a multiple linear regression model, as described in

Disclosure M-2.4. For each time step, the central pressure in a given 5x5-degree cell is modeled as a function of the relative intensities from the previous time steps and the current and previous sea surface temperatures (Vickery et al., 2000; Rayner et al., 2003).

$$ln\,(It+1) = c0 + c1ln\,(It) + c2ln\,(It-1\,) + c3ln(\,It-2\,) + c4SSTt+1 + c5\,(SSTt+1 - SSTt\,) + \varepsilon l \quad (3)$$

where $It+1$, It, $It-1$, and $It-2$ are the relative intensities at t+1, t, t-1, and t-2 time steps, respectively, $SSTt+1$, $SSTt$ is sea surface temperature at t+1 and t time steps, respectively, $c0$, $c1$, ... $c5$ are the regression coefficients, and εl is the random error term. Sea surface temperature features prominently as a predictor of offshore-moving intensification changes as a known key environmental variable in influencing tropical cyclone intensity, as documented in DeMaria & Kaplan (1994).

Since the central pressure immediately after the storm moves from over land to over water is not available, Impact Forecasting modeled it as a function of sea surface temperature and central pressure from previous time step as shown the in the following equation.

$$\Delta Pt+1 = ce0 + ce1\,\Delta Pt + ce2\,SSTt+1 + \varepsilon e \quad (4)$$

where $\Delta Pt+1$ and ΔPt is the central pressure deficit at t+1 and t time steps. $ce0$, $ce1$, and $ce2$ are the regression coefficients, and εe is the random error term.

M-5.3 Provide a graphical representation of the modeled and observed temporal decay rates of wind or central pressure for Florida hurricanes.

A graphical comparison between the modeled and measured maximum sustained wind speeds after landfall for eight Florida hurricanes since 1900 is given in Figure 22. The maximum sustained wind speeds are modeled using the Impact Forecasting inland decay model given hurricane central pressure, forward speed, and radius of maximum winds at landfall. The hurricanes compared are Lake Okeechobee (1928), Labor Day (1935), Unnamed #13 (1944), Dora (1964), Frances (2004), Jeanne (2004), Hermine (2016), and Michael (2018). Good agreement is observed across all storms as modeled hurricane intensities decrease after landfall at similar rates when compared to historical observations.

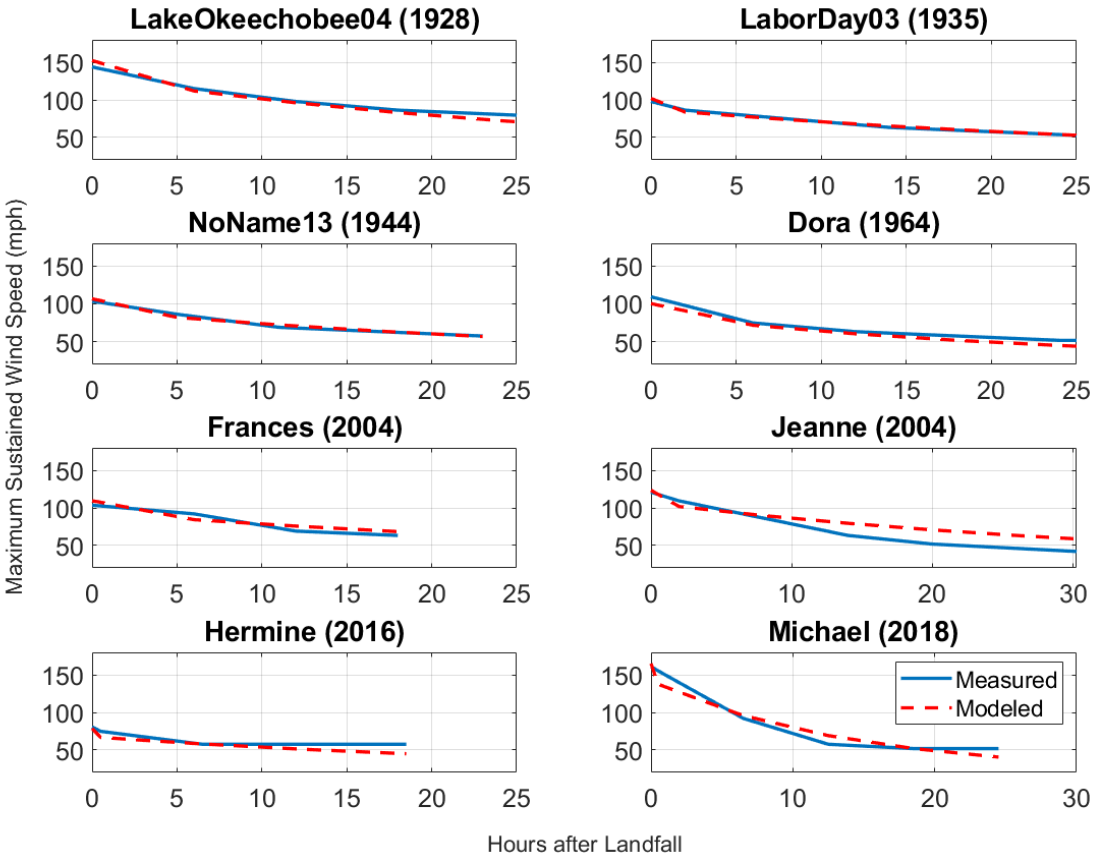


Figure 22: Comparisons between modeled and measured maximum sustained wind speeds after landfall for historical Florida hurricanes

M-5.4 Describe any changes in hurricane parameters, other than intensity, resulting from the transition from over water to over land.

Hurricane intensity (i.e., central pressure and maximum sustained wind speed) changes as the storm transitions from over-water to over-land. Some hurricane parameters, such as radius of maximum winds and wind profile parameters, which are dependent on hurricane intensity, also change accordingly. No other parameters change before and after hurricane landfall.

M-5.5 Describe the representation in the hurricane model of passage over non-continental United States (U.S.) land masses on hurricanes affecting Florida.

As described in Disclosure M-5.1, decay models were developed separately for non-continental U.S. land masses, including the Mexican Coast, the Caribbean Islands, and the remaining coasts in the Caribbean. Hurricanes that make landfall on these land masses are modeled using their respective decay functions. Central pressure decay due to the Caribbean Islands (e.g., Cuba) has the greatest effect on intensities of hurricanes that impact Florida. This approach is developed to accurately model Florida-impacting tropical cyclones if they pass non-continental U.S. land masses.

M-5.6 Describe any differences in the treatment of decay rates in the hurricane model for stochastic hurricanes compared to historical hurricanes affecting Florida.

The decay rates for stochastic and historical hurricanes are treated the same, as the decay rates used to model stochastic events are developed using the exact decay rates observed from historical storms.

M-6 Logical Relationships of Hurricane Characteristics

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

The magnitude of asymmetry increases with an increase in translation speed, all other factors held constant, as described in Disclosure M-6.1.

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

The mean wind speed decreases with increasing surface roughness, all other factors held constant, as described in Disclosures M-4.4, M-4.5, M-4.6, and M-4.7.

M-6.1 Describe how the asymmetric structure of hurricanes is represented in the hurricane model.

The Impact Forecasting Florida Hurricane (FCHLPM) Model includes an asymmetry factor that is added to the baseline symmetrical hurricane windfield to account for the asymmetric structure of hurricanes. The asymmetry factor is a function of the translational speed, and the angle between the storm heading direction and the location vector relative to the eye of the storm. The resulting asymmetrical hurricane has higher wind speeds on the right side compared to the left of the storm's forward motion, with the magnitude of asymmetry increasing as translational speed increases and maximum winds become increasingly displaced to the right of storm motion, as found by Uhlhorn et al. (2014).

M-6.2 Provide completed Form M-3. Provide a link to the location of the form in the submission appendix [Form M-3: Radius of Maximum Winds and Radii of Standard Wind Thresholds].

M-6.3 Explain the radii ranges for each central pressure band in Form M-3 in the context of available hurricane observations. Justify the appropriateness of the databases used in the radii validations.

The quartiles of outer radii for 73 mph and 40 mph wind thresholds reported in Form M-3: Radius of Maximum Winds and Radii of Standard Wind Thresholds are compared below in Table 4 with the quartiles computed using historical observations in HURDAT2. In HURDAT2, the maximum radial extents (wind radii) of 34-knot (39-mph), 50-knot (58-mph), and 64-knot (74-mph) winds in four quadrants are documented. These wind radii values are reported at every timestep for all storms after 2003. The outer radii in HURDAT2 are assumed as the maxima of wind radii across all quadrants. Since the number of intense storms that have impacted Florida is limited, the values in Form M-3: Radius of Maximum Winds and Radii of Standard Wind Thresholds are compared directly with all observations in HURDAT2 between the latitudes of 24N and 31N to augment a lack of data. The outer radii for the 110-mph wind threshold are not included in the comparison because such data is not available in HURDAT2.

It can be seen in Table 4 that the modeled (Form M-3: Radius of Maximum Winds and Radii of Standard Wind Thresholds) quartiles of outer radii for hurricane force winds (i.e., greater than 73 mph) have general agreement with the observed values (HURDAT2). Bootstrapped resampling of the HURDAT2 record, for the purposes of estimating uncertainty due to limited sample size, is performed to generate 95% confidence intervals for the HURDAT2 wind radii that are also included. This uncertainty estimate is overly constrained for bins with small sample sizes, however, due to only observed variability being sampled through bootstrapping, rather than true population variability.

Due to the adoption of an updated windfield asymmetry scheme that does not show decay in windfield asymmetry with distance from center, unlike the prior scheme, the distance to outer radii in the quadrant with strongest winds generally increases for events in the current submission. The modeled outer radii for tropical storm or gale force winds (i.e., greater than

40 mph), however, tend to be slightly lower than the values reported in HURDAT2. This is likely due to the significant uncertainty in wind radii estimates, particularly for tropical storm force winds, in HURDAT2 (Landsea and Franklin, 2013).

Table 4: Comparison of modeled and observed quartiles of outer radii for hurricane force winds, with 95% confidence interval for HURDAT2 observations

Central Pressure (mb)	Outer Radii (>73 mph) (mi)						Outer Radii (>40 mph) (mi)					
	Model			HURDAT2			Model			HURDAT2		
	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q
980 ≤ cp < 990	37	46	54	NA	12 [NA, 17]	26 [23, 29]	159	168	177	115 [115, 127]	173 [150, 184]	230 [207, 253]
970 ≤ cp < 980	44	53	62	23 [17, 23]	29 [29, 35]	40 [35, 46]	163	172	181	115 [101, 121]	138 [138, 153]	199 [173, 207]
960 ≤ cp < 970	57	65	73	35 [29, 35]	46 [46, 52]	69 [58, 75]	171	179	188	138 [138, 150]	184 [167, 201]	207 [207, 221]
950 ≤ cp < 960	65	72	79	46 [40, 58]	63 [58, 69]	81 [81, 92]	171	178	186	173 [161, 196]	207 [201, 219]	259 [230, 276]
940 ≤ cp < 950	70	76	82	42 [35, 56]	58 [58, 58]	69 [58, 86]	168	175	183	161 [150, 173]	201 [173, 207]	230 [207, 253]

Central Pressure (mb)	Outer Radii (>73 mph) (mi)						Outer Radii (>40 mph) (mi)					
	Model			HURDAT2			Model			HURDAT2		
	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q
930 ≤ cp < 940	71	75	81	52 [46, 58]	60 [58, 69]	86 [69, 98]	160	167	174	173 [173, 196]	207 [196, 207]	250 [207, 288]
920 ≤ cp < 930	69	74	79	47 [40, 73]	69 [46, 92]	91 [54, 104]	151	158	166	152 [127, 207]	207 [150, 230]	230 [183, 276]
910 ≤ cp < 920	67	73	79	40 [40, 48]	46 [40, 81]	81 [46, 104]	142	150	160	138 [127, 161]	150 [130, 207]	207 [141, 230]
900 ≤ cp < 910	64	70	76	95 [86, 104]	104 [86, 104]	104 [86, 104]	132	142	152	196 [184, 230]	219 [184, 230]	230 [184, 230]
cp < 900	59	63	69	69 [69, 69]	69 [69, 69]	69 [69, 69]	120	126	137	184 [184, 184]	184 [184, 184]	184 [184, 184]

M-6.4 Describe the dependencies among characteristics (i.e., model output) in the windfield component and how they are represented by the hurricane model.

The maximum wind gust reported at every grid cell for an event is a function of the maximum sustained wind speed (Vmax), the radius of maximum winds (Rmax), the translational velocity (Vt), storm heading, and the coordinates of the event center fix. Additionally, the upwind surface roughness of each grid cell is used to account for terrain effects on

maximum wind gusts. A set of constant parameters for radial wind profile, asymmetric wind field, and inflow angle are also used to generate local maximum wind gust. The various dependencies are:

- Local maximum wind gust, not accounting for terrain, is a function of event center coordinates, translational velocity, Vmax, Rmax, storm heading, and wind field parameters.
- Terrain factor correction for terrain effects is a function of local and upwind surface roughness, as determined using the National Land Cover Database, as well as the local wind direction of maximum wind gust. In turn, the local wind direction is a function of event center coordinates, Rmax, and the inflow angle parameter.

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 literature and current technical literature.

Hurricane parameters and characteristics are modeled using regression equations and probability distributions fit to historical data. These equations and distributions are developed and validated based on methods documented in current scientific and technical literature. A complete list of references is provided in Disclosure G-1.6 and some are referred to in Disclosure S-1.1 below.

B. Modeled results shall reflect statistical agreement with historical data or the Model Base Hurricane Set using current scientific and statistical methods for the academic disciplines appropriate for the various hurricane model components. Any differences shall be justifiable.

Modeled results and historical observations are made sure to be consistent across all aspects of the model. This is achieved by performing statistical tests in all stages of model development. Good agreement is observed between modeled and measured statistics of various hurricane parameters and characteristics in different geographic regions. Examples are given below in Disclosure S-1.5.

S-1.1 Describe the nature and results of the tests performed to validate the windspeeds generated.

Extensive comparisons have been performed between the model-generated winds and station measurements obtained from the Automated Surface Observing System (ASOS) database and Tropical Cyclone Reports (NHC, 2021b). Reporting stations are distributed throughout Florida and provide wind speed and direction measurements at different time steps throughout the duration of the storm. Comparisons between maximum modeled winds and station measurements for Hurricanes Charley (2004), Wilma (2005), Irma (2017), and Michael (2018) are shown in Standard M-4 (Figure 14 through Figure 21) and reproduced

below (Figure 23). Comparison statistics for these four events, as well as for all events within the Base Hurricane Storm Set, are provided in Table 5. Only stations within the modeled footprint and with maximum 3-second gusts greater than 45 mph were considered in the comparison statistics calculations.

Comparison statistics in Table 5 reveal a consistent positive relationship between modeled and observed windspeeds. While modeled windspeeds for individual events experience varying degrees of both positive and negative bias, mean bias error across all events is relatively small (-1.18 mph, Table 5). For purposes of developing, calibrating, and validating the vulnerability module of this submission, the residuals of observed wind speeds from past events are incorporated to produce hazard footprints that more accurately reflect the idiosyncrasies of individual historical events and thus better predict observed losses, as further described in Standard V-1.

Table 5: Validation tests for Hurricanes Charley (2004), Wilma (2005), Irma (2017), and Michael (2018), and all events within the Base Hurricane Storm Set with more than one ASOS-measured gust greater than 45 mph. Values in parentheses are calculated with failed stations excluded.

Hurricane	Number of Observations	Correlation Coefficient	Mean Bias Error (mph)	Root Mean Square Deviation (mph)
Charley (2004)	38 (31)	0.77 (0.78)	6.73 (6.44)	19.68 (19.92)
Wilma (2005)	44 (35)	0.55 (0.56)	0.66 (-2.00)	20.29 (20.26)
Irma (2017)	203 (198)	0.37 (0.38)	-13.76 (-14.38)	24.76 (24.96)
Michael (2018)	50 (26)	0.81 (0.83)	14.49 (16.70)	21.52 (24.83)

All Events	735 (664)	0.56 (0.54)	-1.18 (-2.52)	19.71 (19.56)

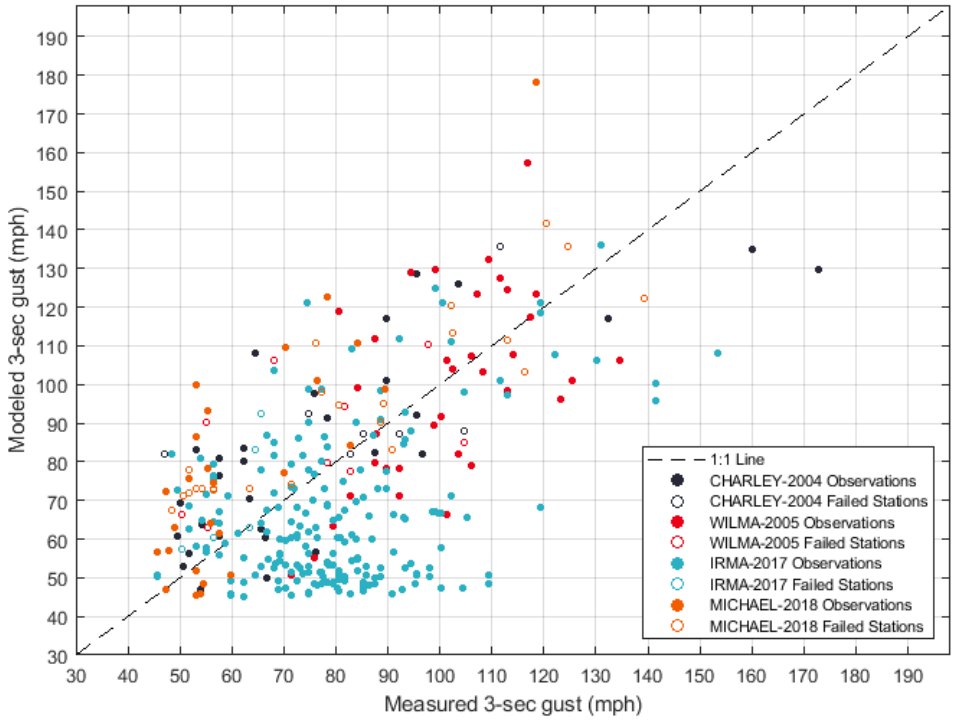


Figure 23: Observed versus modeled wind speeds (maximum 3-second gusts at 10m) for stations within the wind footprints of Hurricane Charley (2004), Wilma (2005), Irma (2017), and Michael (2018). Stations designated to have failed during each hurricane (circles) display the maximum observed gust derived from the incomplete station record. Values below 45 mph are not plotted.

S-1.2 Provide the dates of hurricane loss of the insurance company hurricane claims data used for validation and verification of the hurricane model.

Impact Forecasting used claims data from the following hurricanes to validate the hurricane model:

- Hurricane Charley (2004)
- Hurricane Frances (2004)
- Hurricane Ivan (2004)
- Hurricane Jeanne (2004)
- Hurricane Dennis (2005)
- Hurricane Katrina (2005)
- Hurricane Rita (2005)
- Hurricane Wilma (2005)
- Hurricane Hermine (2016)
- Hurricane Matthew (2016)
- Hurricane Irma (2017)
- Hurricane Michael (2018)
- Hurricane Eta (2020)
- Hurricane Isaias (2020)
- Hurricane Sally (2020)
- Hurricane Zeta (2020)
- Hurricane Ian (2022)

S-1.3 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.

The uncertainty in hurricane loss costs and probable maximum loss levels has been studied and presented in Form-S6 of the 2021 FCHLPM submission The parameters studied included central pressure, radius of maximum winds, translational speed, windfield model shape parameter, far field pressure, and inland decay rate. Far field pressure and radius of maximum winds are found to have the greatest contributions to modeling uncertainty for

Category 1 and 3 and for Category 5 hurricanes, respectively. The contributions from central pressure and inland decay rate are also significant, while the contributions from translational speed and the windfield model shape parameter are relatively low.

S-1.4 Justify any differences between the historical and modeled results using current scientific and statistical methods in the appropriate disciplines.

The agreement between historical and modeled results is justified using appropriate statistical methods including goodness-of-fit tests from scientific and technical literature. Specifically, a detailed statistical analysis was undertaken to determine the effect of changes to the age of building stock over time.

The vulnerability module implicitly accounts for the age of exposures through the 'year built' variable that represents the joint effects of building code modifications and building age. An older building, controlling for all other characteristics, exhibits greater vulnerability to hurricane wind hazard (Alduse et al., 2022). Because the vulnerability module is conditioned upon the ages of exposures in 2025, damage estimates using these curves will be overestimated for events that occurred in the distant past when buildings were far newer.

A multilinear regression experiment was conducted to assess the overestimate in historical storms expected when building an accurate vulnerability module for contemporary exposure ages. Figure 24 shows the expected overestimate of modeled claims losses. While recent events show little change, events in 2004 – 2005 are associated with 5 – 16% overestimate in losses. Because the overall claims dataset used in this submission features a large number of losses from these 2004 - 2005 events, the overall overestimate in the entire claims dataset is estimated to be 9%, in line with the observations from our claims analysis and lending confidence in the accuracy of our modeled losses, showing a 6% overestimate in unscaled modeled to observed claims ratio in Disclosure S-5.1.

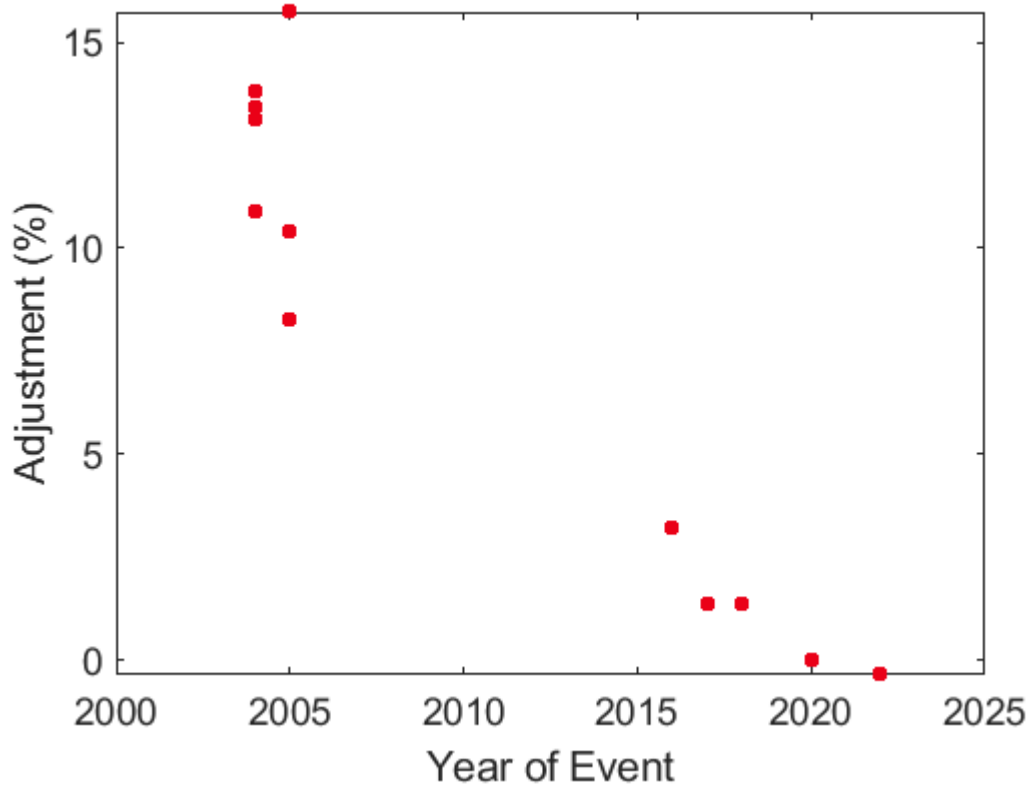


Figure 24 Expected increase in total modeled gross losses for events in claims dataset when the age of building stock is reflective of 2025 age distribution rather than building stock at time of event.

S-1.5 Provide graphical comparisons of modeled and historical data and goodness-of-fit tests. Examples to include are hurricane frequencies, tracks, intensities, and physical damage.

Graphical comparisons of modeled and observed data and goodness-of-fit tests are presented below.

Landfall Frequency

The comparison between modeled and measured frequencies of Florida landfalling hurricanes per year is provided in Figure 25. The p-value from a two-sample Pearson's chi-squared test performed on the data is 0.20. It indicates reasonable agreement between modeled and measured counts of landfalling hurricanes in Florida every year at the 5% level of significance.

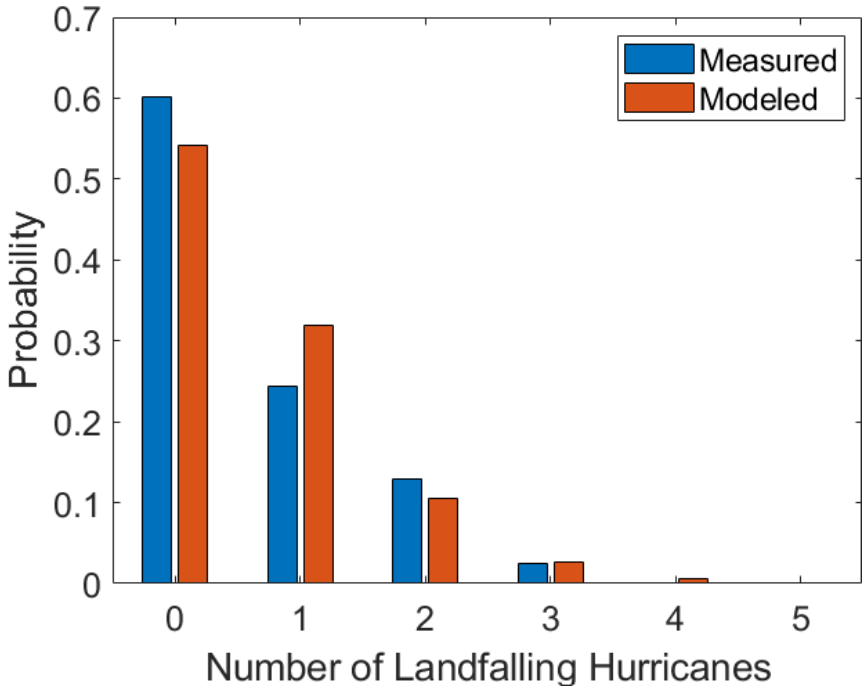
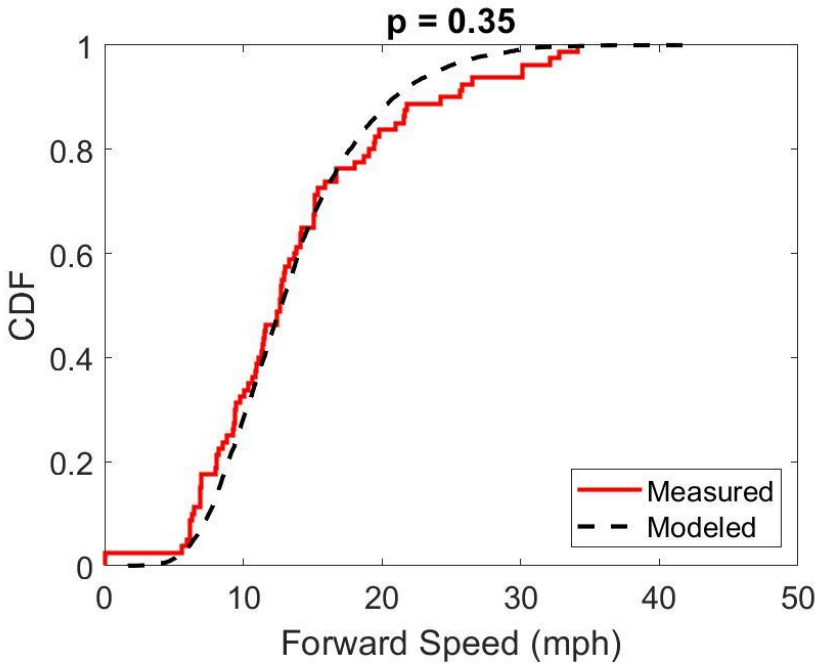


Figure 25: Comparison of modeled and observed frequencies of Florida landfalling hurricanes per year

Forward Speed and Heading Angle (track)

The CDFs of modeled and measured hurricane forward speeds and heading angles at landfall on Florida are compared in Figure 26. The goodness-of-fit is verified using Kolmogorov-Smirnov tests. The p-values associated with the tests are 0.35 and 0.16 for forward speed and heading angle, respectively. The p-values show good agreement between modeled and measured hurricane track parameters at landfall in Florida at the 5% level of significance.


p = 0.35
CDF
Forward Speed (mph)
Measured
Modeled
0
0.2
0.4
0.6
0.8
1
0
10
20
30
40
50

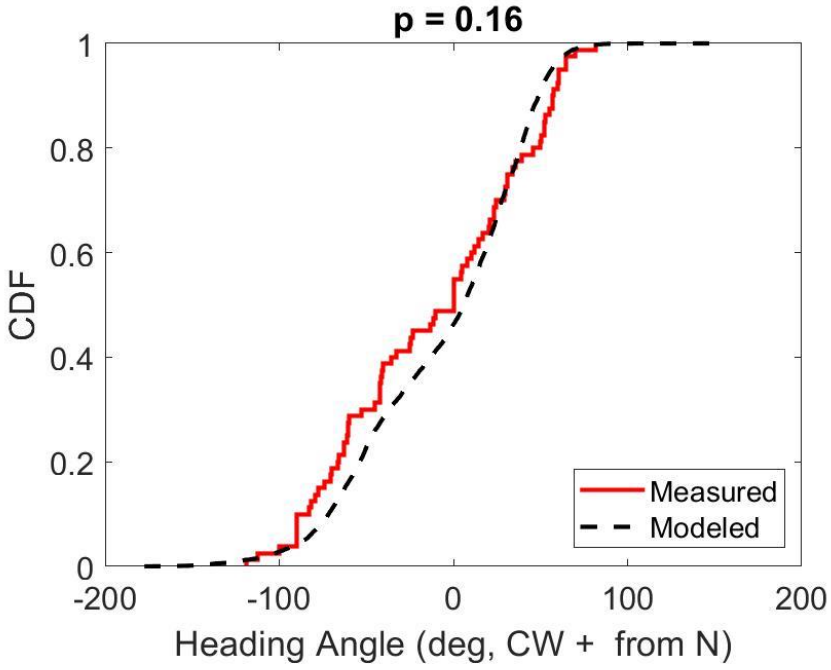

p = 0.16
CDF
Heading Angle (deg, CW + from N)
Measured
Modeled
0
0.2
0.4
0.6
0.8
1
-200
-100
0
100
200

Figure 26: Comparisons of modeled and measured hurricane (top) forward speeds and (bottom) heading angles at Florida landfall

Central Pressure and Maximum Sustained Wind Speed (intensity)

The CDFs of modeled and measured hurricane central pressures at landfall on Florida are compared in Figure 27. The goodness-of-fit for central pressures is verified using Kolmogorov-Smirnov test. The p-values associated with the KS-test for central pressure is 0.16, showing good agreement between modeled and measured hurricane intensities at landfall in Florida at the 5% level of significance.

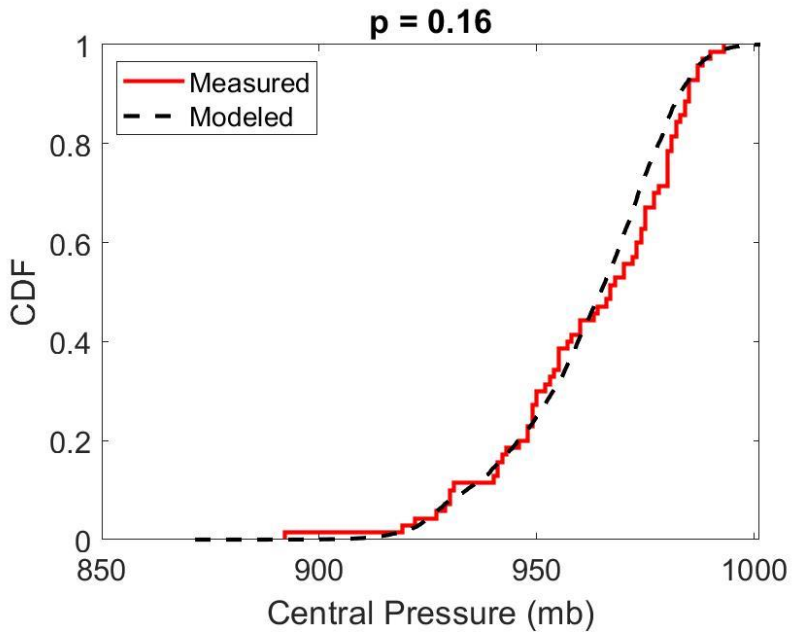


Figure 27: Comparison of modeled and observed CDFs of Central Pressure at landfall in Florida.

The CDFs and bar charts of modeled and measured hurricane maximum sustained wind speeds at landfall on Florida are compared in Figure 28. The p-value from the Pearson's chi-squared test performed on the data is 0.94. It indicates reasonable agreement between modeled and measured hurricane sizes at landfall in Florida at the 5% level of significance.

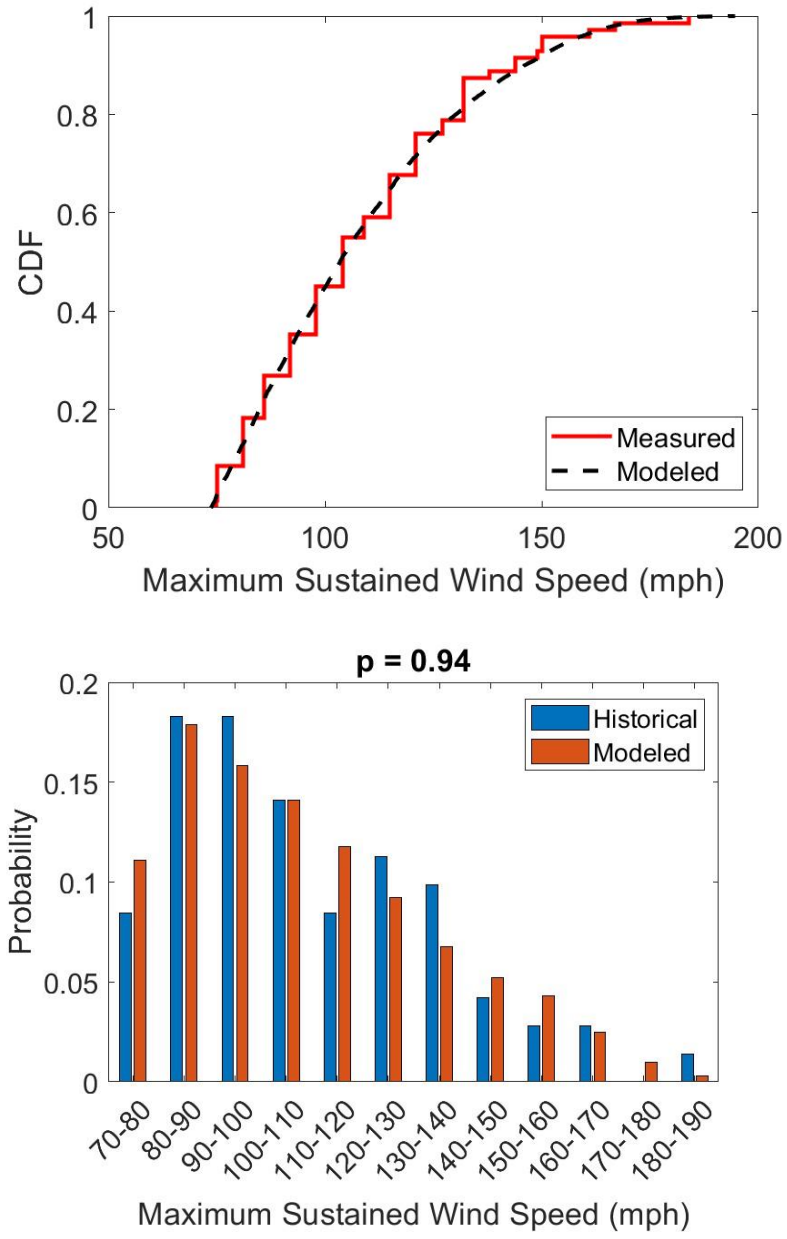
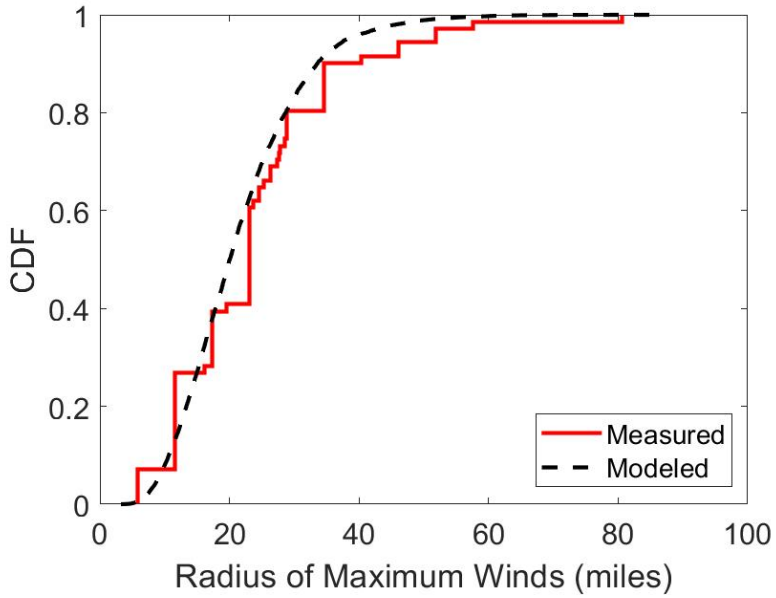


Figure 28: Comparisons of modeled and measured hurricane maximum sustained wind speeds at Florida landfall

Radius of Maximum Winds (size)

Impact Forecasting Florida Hurricane (FCHLPM) Version 3.0

The comparison of CDFs and bar charts between modeled and measured hurricane radii of maximum winds at landfall on Florida is provided in Figure 29. The p-value from the Pearson's chi-squared test performed on the data is 0.60. It indicates reasonable agreement between modeled and measured hurricane sizes at landfall in Florida at the 5% level of significance.



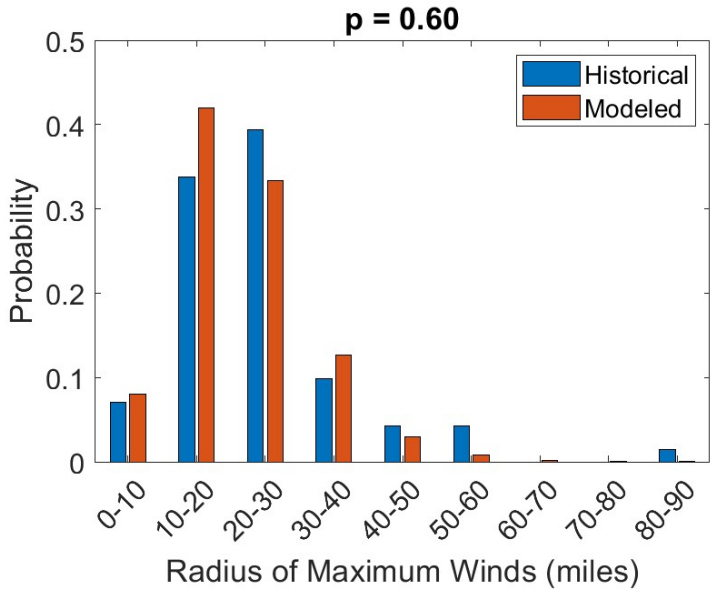


Figure 29: Comparison of modeled and observed hurricane radii of maximum winds at Florida landfall

Damage Ratio (physical damage)

A comparison between modeled and claims gross damage ratios as a function of wind speed is presented in Figure 30. The damage ratios were calculated for residential single-family, masonry construction exposures using data from historical claims and exposures, for a total dataset of 4.8 million exposures used for validation. At each 5 m/s hazard bin, event-level block bootstrapping of the claims data is performed to estimate the distribution of claims data sample means, which is assumed to be normal by the central limit theorem. Using a two-tailed Z-test, we find that the damage ratios from the model and claims agree well (Table 6). p-values greater than 0.05 for seven of eight hazard bins with significant claims numbers (hazard between 25 and 65 m/s) is consistent with the difference between modeled and claims mean damage ratios not being statistically significant globally at the 5% level of significance.

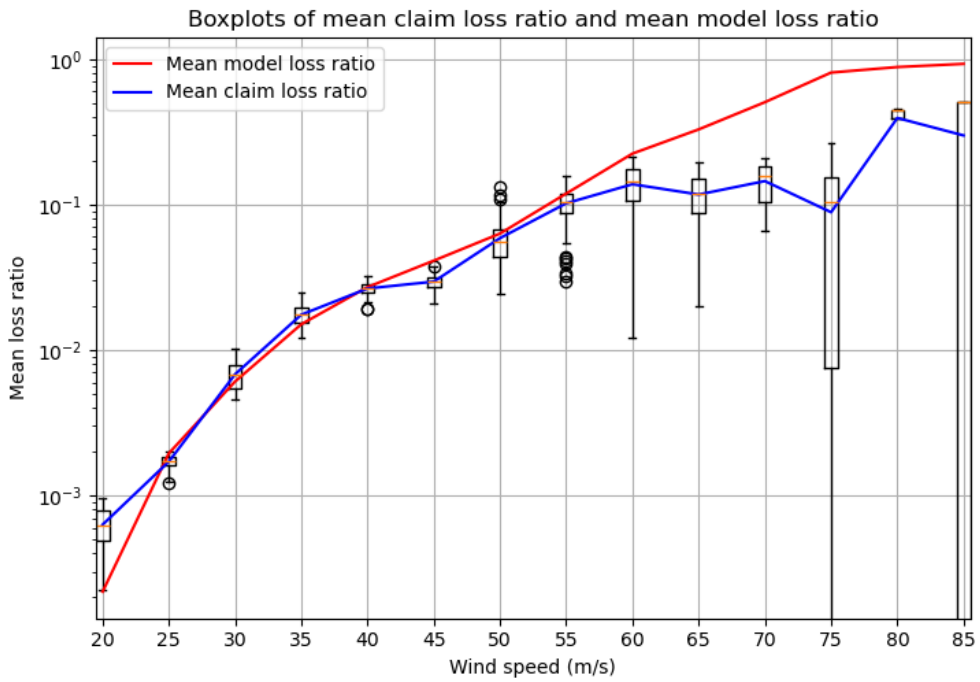


Figure 30: Comparison of modeled and claims damage ratios from historical hurricanes

Table 6 Modeled Claims DR, Observed Claims DR, and p-value from two-tailed Z-Test for ResSF Masonry Exposures

Hazard Bin (m/s)	Modeled Claims DR	Observed Claims DR	p-value
20 - 25	0.00022	0.00063	0.02
25 - 30	0.00195	0.00171	0.19
30 - 35	0.00609	0.00681	0.62
35 - 40	0.01501	0.01750	0.40

Hazard Bin (m/s)	Modeled Claims DR	Observed Claims DR	p-value
40 - 45	0.02707	0.02648	0.81
45 - 50	0.04114	0.02953	0.00
50 - 55	0.06313	0.05876	0.83
55 - 60	0.11892	0.10202	0.52
60 - 65	0.22363	0.13794	0.08
65 - 70	0.32818	0.11722	0.00
70 - 75	0.50512	0.14495	0.00
75 - 80	0.80777	0.08857	0.00
80 - 85	0.88129	0.39365	0.00
85 - 90	0.92687	0.29864	0.01

S-1.6 Provide completed Form S-1(s). Provide a link to the location of the form(s) in the submission appendix [Form S-1: Probability and Frequency of Florida Landfalling Hurricanes per Year].

S-1.7 Provide completed Form S-2. Provide a link to the location of the form in the submission appendix [Form S-2: Examples of Hurricane Loss Exceedance Estimates].

S-1.8 Provide completed Form S-3. 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 in the submission appendix [Form S-3: Distributions of Stochastic Hurricane Parameters].

The probability distributions used to model different hurricane parameters are discussed below. Exhibits and results from the goodness-of-fit tests performed at landfall can be found in Disclosure S-1.5.

For each parameter, the choice of goodness-of-fit test at landfall is made in careful consideration of two limitations inherent to HURDAT2 as a validation data set: 1. The relatively small number of observed landfalls that violates assumptions that sample sizes are large from the chi-squared test and other categorical goodness-of-fit tests and 2. The coarse, discrete estimates of parameters such as Vmax (5 kt. reported bins) and Rmax (5 n mi. reported bins) that violates assumptions of a continuous domain for nonparametric tests such as the KS-test.

In consideration of the above limitations, the following heuristic is applied in determining the appropriate test: If the underlying data is binned, chi-squared testing is used. Landfall count, Rmax, and Vmax fall in this category and are validated by chi-squared test. For these tests, in cases where parameter bins do not contain enough observations to satisfy chi-squared test requirements for sample counts, neighboring bins are combined until the resulting bin contains at least 5 observations. If the data are continuous, or HURDAT2 reports values with

integer resolution, then KS-testing, with a small jitter applied to validation data, is applied. Forward speed, theta, and Cp fall in this category and are validated by KS-test.

Annual Number of Storms

The number of storms generated each year is modeled using a negative binomial distribution (Vickery et al., 2000). The negative binomial distribution is found to outperform the Poisson distribution in estimating the annual count of storms given its flexibility in modeling datasets with unequal mean and variance. The same behavior is observed in their p-values from statistical tests. The parameters of the distribution are estimated using the maximum likelihood method. The goodness-of-fit is verified using a Pearson's chi-squared test. The p-value associated with the test is 0.11 which indicates that the fitted distribution has reasonable agreement with the historical data at the 5% level of significance.

Storm Genesis Parameters

Impact Forecasting simulates hurricanes from their initial geneses. The genesis parameters of each hurricane are randomly sampled from historical genesis data (Vickery et al., 2000). These parameters include genesis location (latitude and longitude), date and time, initial forward speed, heading angle, and central pressure. These parameters are sampled from the historical data to preserve the historical genesis pattern both spatially and temporally.

Translational/Forward Speed and Heading Angle/Direction

Hurricane translational speed and heading angle are modeled using separate regression models with residuals fitted to normal distributions. The regression coefficients are determined using the least-squares method at a 5x5-degree cell resolution covering the North Atlantic Ocean. The hurricane translational speed and heading angle at every time step are modeled as functions of their values from previous time steps. (Vickery et al., 2000). The resultant forward speeds and heading angles follow empirical distributions derived for different geographic regions. Impact Forecasting performed Kolmogorov-Smirnov goodness-of-fit tests using data from smaller cells with a size of 2x2 degrees to better ensure that the modeled results agree with the observations. The map of the 2x2-degree cells used is given in Figure 31. The p-values from the tests range from 0.09 to 1.00 for forward speed and 0.05 to 1.00 for heading angle across all cells close to Florida. The cumulative distribution

functions (CDFs) of forward speeds and heading angles from one cell centered at 29°N and 85°W in southeast Florida are presented in Figure 32. This cell has p-values of 0.42 and 0.57 for translational speed and heading angle, respectively.

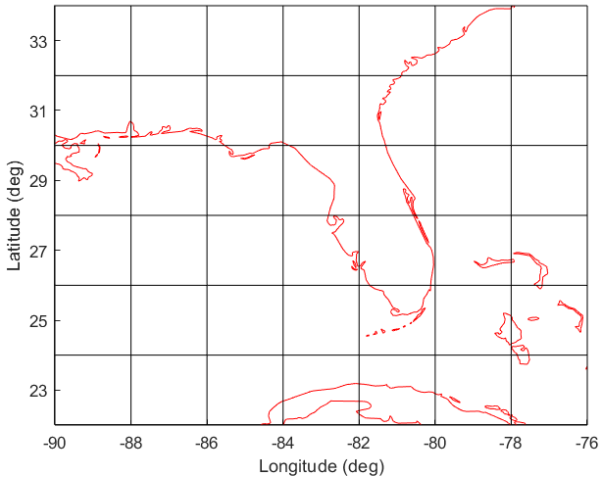


Figure 31: 2x2-degree cells used in model validation

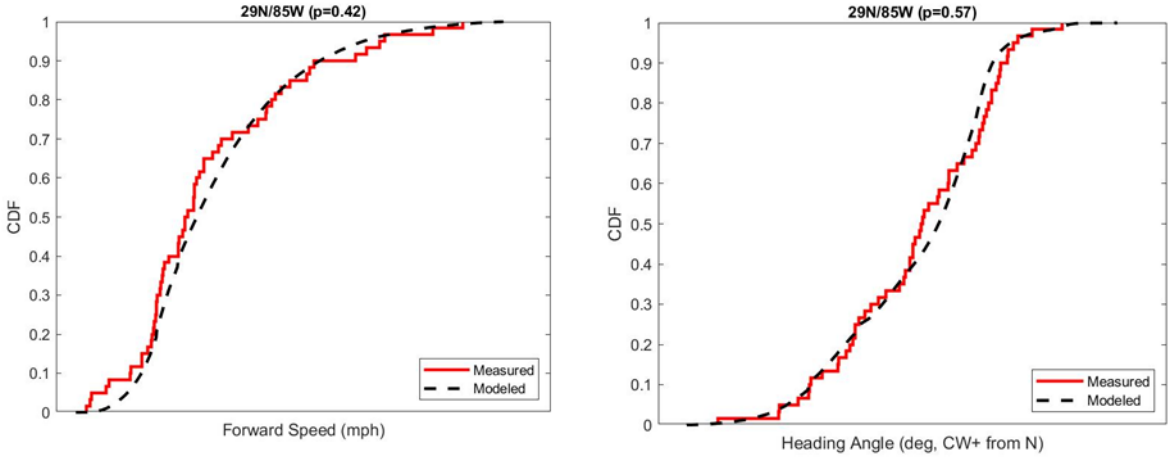


Figure 32: Comparisons of modeled and observed CDFs of (a) forward speeds and (b) heading angles from a 2x2-degree cell centered at 29°N/85°W in southeast Florida

Central Pressure

Hurricane central pressure is modeled using a regression equation and a Gaussian distribution to describe residuals for each of the 5x5-degree cells. The central pressure modeled at any given time step depends on the relative intensities (Darling, 1991) and sea surface temperatures at current and previous time steps (Vickery et al., 2000). Sea surface temperature is regarded as one of the key environmental variables that control tropical cyclone intensity (DeMaria & Kaplan, 1993). The modeled central pressures follow empirical distributions. The goodness-of-fit is confirmed using Kolmogorov-Smirnov tests on data from the 2x2-degree cells – the same cells used for forward speed and heading angle validations (see Figure 31 above). The p-values from the tests range from 0.06 to 0.97, which shows good agreement between modeled and measured central pressures at the 5% level of significance. A comparison between modeled and observed CDFs of central pressures from the same cell discussed above is presented in Figure 33. The p-value from the Kolmogorov-Smirnov test for this cell is 0.86.

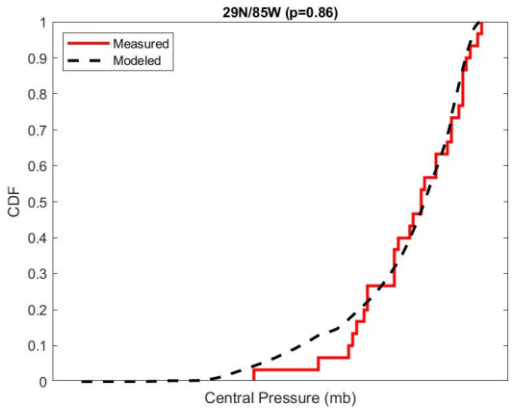


Figure 33: Comparison of modeled and observed CDFs of central pressures from a 2x2-degree cell centered at 29°N/85°W in southeast Florida

Maximum Sustained Wind Speed

To construct the hurricane windfield for each event, the central pressure discussed above is converted to the maximum sustained wind speed. It is modeled as a normal random variable with a mean described as a function of central pressure deficit and latitude (Knaff & Zehr, 2007) and a standard deviation determined using a least-squares regression. Impact

Forecasting conducted a Pearson Chi-squared goodness-of-fit test to ensure that the modeled maximum sustained wind speeds at landfall matches the historical measurements. The p-value of 0.94 from the test for Florida overall shows that the modeled distribution agrees well with the historical data at the 5% level of significance (see Disclosure S-1.5).

Radius of Maximum Winds

The radius of maximum winds describes the size of a storm and is modeled as a random variable that follows a lognormal distribution. Its mean depends on central pressure deficit and latitude, and its variance relative to the mean is estimated using a least-squares regression (Vickery & Wadhera, 2008). To verify the goodness-of-fit, Impact Forecasting performed a Pearson Chi-squared test on the modeled and measured radii of maximum winds at landfall. The test result shows the distribution modeled has reasonable agreement with the historical observation given a p-value of 0.60 at the 5% level of significance (see Disclosure S-1.5).

Inland Decay Rate

How fast the central pressure of a storm increases after landfall is determined using the inland decay rate. The inland decay rate is modeled differently for different regions including the U.S. Gulf Coast, the Florida Peninsula Coast, the Mid-Atlantic Coast, and the Caribbean Islands, among others. For each region, the inland decay rate is modeled as a Gaussian distribution with its mean described as a function of central pressure deficit, forward speed, and radius of maximum winds at landfall, and its standard deviation modeled using a least-squares regression (Vickery, 2005). The modeled inland decay rates are validated using the decay rates from historical storms. The decay rates are found to be consistent with the decay rates observed from historical events (see Disclosure M-5.3).

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.

Impact Forecasting assessed the sensitivity of model outputs with respect to the simultaneous variation of input variables using current scientific and statistical methods. Specifically, a detailed sensitivity analysis of loss costs was performed in Form S-6 for the 2021 FCHLPM submission of the Impact Forecasting Atlantic Tropical Cyclone - Wind Model Version 2.0 ELEMENTS Version 17.0. Additionally, results of a temporal sensitivity analysis of modeled wind speeds are presented in Disclosure S-2.1 of that submission. Analogous sensitivity analyses for the model under review have been performed on the provided dataset of hypothetical Category 1, 3, and 5 hurricanes ("FormS6Input23.xlsx"). We find that sensitivity remains consistent with the findings of the 2021 submission, with only small absolute changes in sensitivities.

S-2.1 Identify the most sensitive aspect of the hurricane model and the basis for making this determination.

Modeled loss costs are most sensitive to far field pressure (FFP), inland decay rate (α), radius of maximum winds (Rmax), and central pressure (Cp). Sensitivity analysis, as described in Form S-6 of the 2021 Impact Forecasting Submission, includes six model input variables: central pressure (Cp), radius of maximum winds (Rmax), translational velocity (VT), far field pressure (FFP), inland decay rate (α), and windfield shape parameter (X1). Updated standardized regression coefficients (SRCs) for expected hurricane loss costs are shown in Figure 34. The results show that FFP, Cp, and Rmax have the most influence on the magnitude of the loss cost for Category 1 and Category 3 hurricanes. For Category 5 hurricanes, Rmax becomes the greatest contributor to the change in loss costs, followed by α, FFP, and Cp. The shape parameter (X1) and translational velocity (VT) have the least influence on the loss costs for all hurricane intensities.

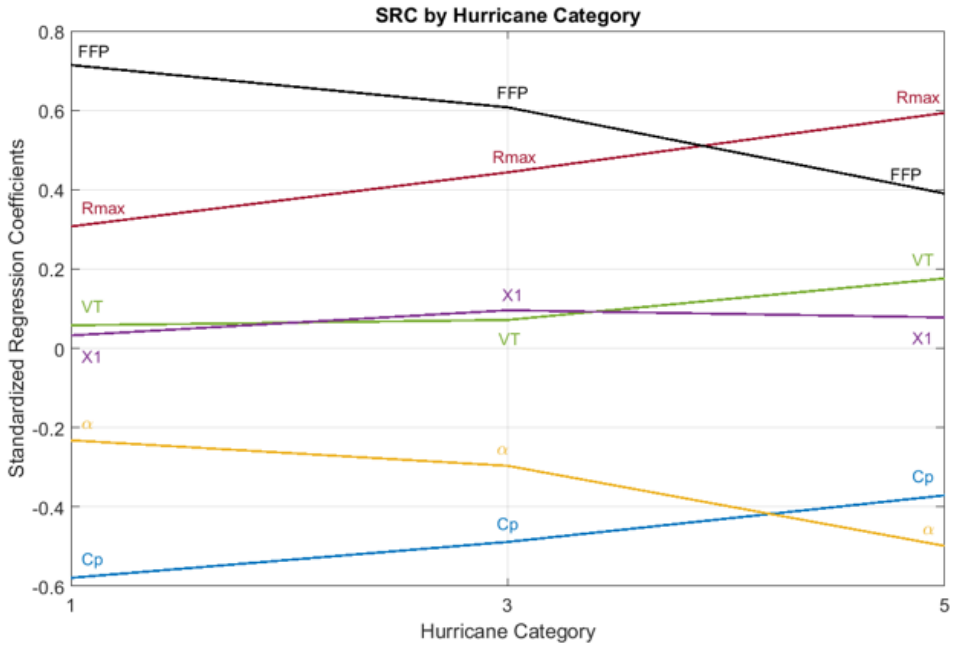


Figure 34 Standardized Regression Coefficients (SRC) for Expected Hurricane Hurricane Loss Costs for all Input Variables for All Hurricane Categories: Result from Current Submission.

Temporal sensitivity analyses of loss costs were not performed since loss costs depend on the peak gust wind speed and not the temporal variation of the wind speed. Instead, the temporal sensitivity of modeled wind speeds was studied using the hypothetical storms of Form S-6. Figure 35, Figure 36, and Figure 37 show time series of SRCs for hourly wind speeds at the landfall point of hypothetical Category 1, 3, and 5 hurricanes, respectively. At hour 0, before landfall, the modeled wind speeds at the landfall point (denoted by the coordinates (9, 0)) are most sensitive to Rmax for all hurricane intensities. As time post-landfall increases, the influence of X1 becomes the most impactful, followed by VT. In later time periods (after hour 4), SRCs for Cp, FFP and Rmax have relatively similar absolute values, which diminish over time. Overall, trends and relativities of SRCs for Category 1, 3, and 5 hurricanes are consistent with the findings of the 2021 submission, with only small absolute changes in sensitivities.

The temporal sensitivity results described above are location-dependent and could vary significantly depending on the selected grid point.

Impact Forecasting Florida Hurricane (FCHLPM) Version 3.0

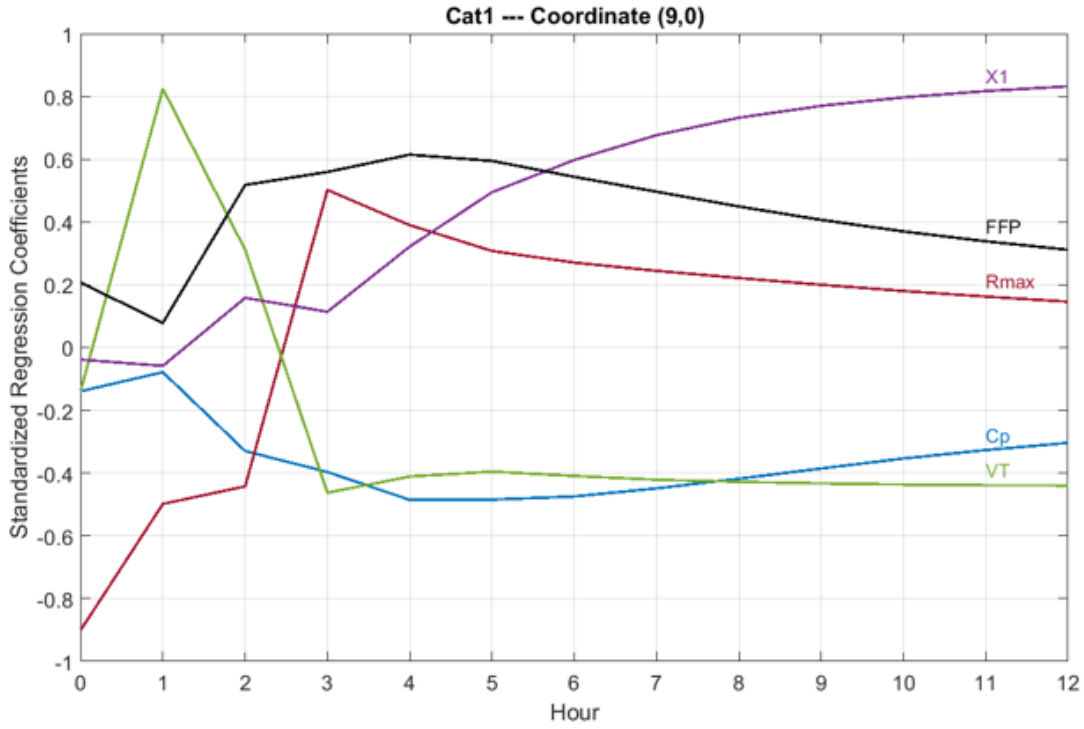


Figure 35: Time series of SRC of wind speed at grid coordinate (9, 0) for hypothetical Category 1 hurricanes with input variables listed in the worksheet "SA all Variables" in "FormS6Input23.xlsx".

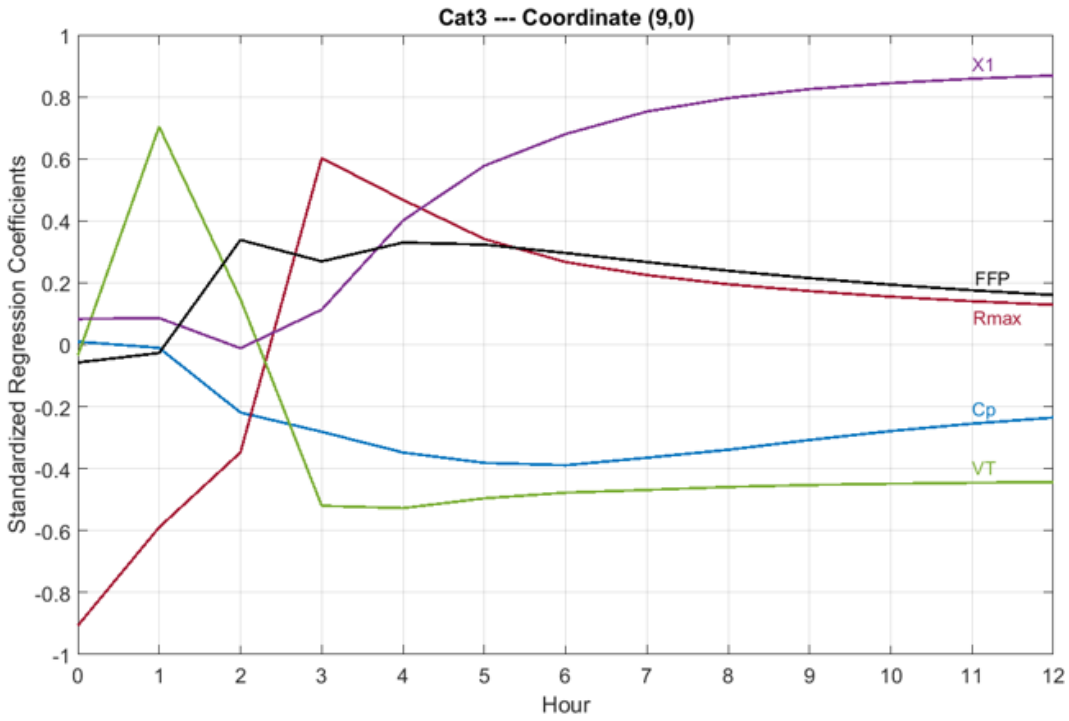


Figure 36: Time series of SRCs of wind speed at grid coordinate (9, 0) for hypothetical Category 3 hurricanes with input variables listed in the worksheet "SA all Variables" in "FormS6Input23.xlsx".

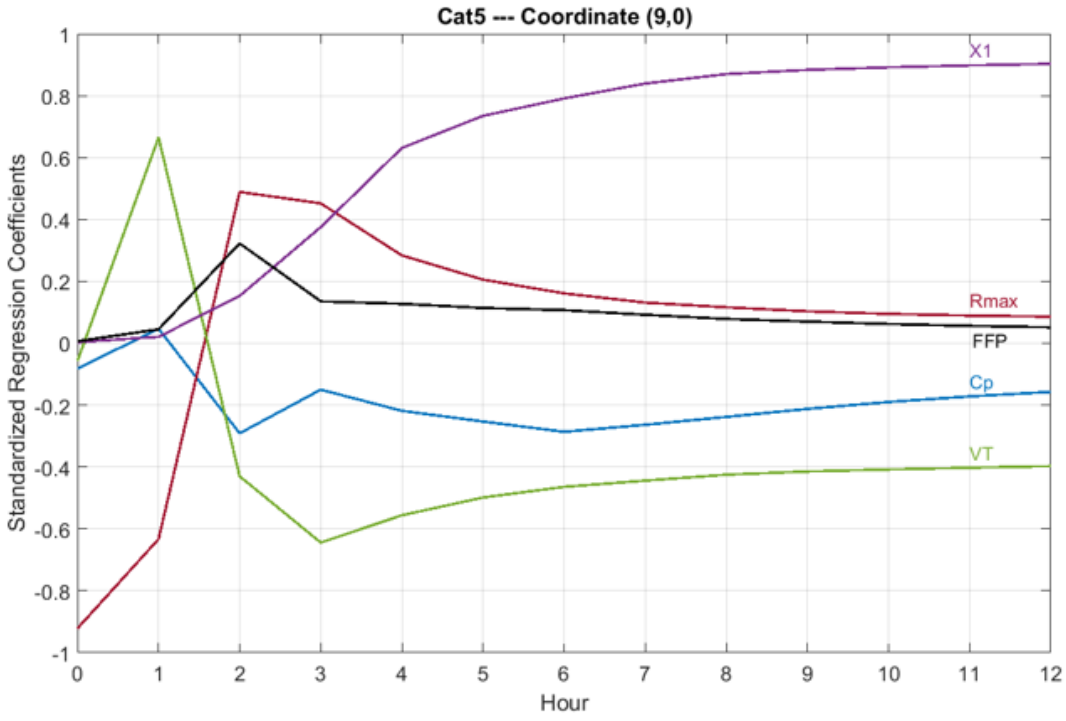


Figure 37: Time series of SRCs of wind speed at grid coordinate (9, 0) for hypothetical Category 5 hurricanes with input variables listed in worksheet "SA all variables" in "FormS6Input23.xlsx."

S-2.2 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.

Impact Forecasting has identified no other input variables that impact the magnitude of the output when input variables varied simultaneously.

S-2.3 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.

Output results are sensitive to exact landfall location and storm heading relative to exposure concentration. The areas with high or low wind risk are determined by their locations with respect to the storm track, which is largely defined by its landfall location and heading direction after landfall. Properties exposed to high wind speed tend to suffer more damage than properties that are located in low wind speed regions. Surface roughness and the parameterization of local gust factor can also have a significant impact on hurricane model output.

S-2.4 Describe and justify action or inaction as a result of the sensitivity analyses performed.

The results of the sensitivity analysis have been carefully reviewed and were found to be reasonable. No action was taken.

S-2.5 For a new modeling organization only, provide completed Form S-6. Provide a link to the location of the form in the submission appendix.

A new Form S-6 is not completed for the current submission, as Impact Forecasting is not a new modeling organization.

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.

Impact Forecasting assessed the uncertainty of model outputs with respect to the simultaneous variation of input variables using current scientific and statistical methods. Specifically, a detailed uncertainty analysis was performed in Form S-6 for the 2021 FCHLPM submission of the Impact Forecasting Atlantic Tropical Cyclone - Wind Model Version 2.0 ELEMENTS Version 17.0. Additionally, results of a temporal uncertainty analysis of modeled wind speeds are presented in Disclosure S-3.1 of that submission. Analogous uncertainty analyses for the model under review have been performed on the provided dataset of hypothetical Category 1, 3, and 5 hurricanes ("FormS6Input23.xlsx"). We find that sources of uncertainty remain consistent with the findings of the 2021 submission, with only small absolute changes in the degree of uncertainty associated with each examined input variable.

S-3.1 *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.*

The far field pressure (FFP) has the greatest expected percentage reduction (EPR) in the variance of hurricane loss costs for Category 1 and Category 3 storms. For Category 5 hurricanes, Rmax has the greatest EPR. This determination is based on the uncertainty analyses described in Form S-6 of the 2021 Impact Forecasting Submission, and updated in the figures shown below.

Uncertainty analysis of loss costs includes six model input variables: central pressure (Cp), radius of maximum winds (Rmax), translational velocity (VT), far field pressure (FFP), inland decay rate (α), and windfield shape parameter (X1). The uncertainty analysis for loss costs

was conducted based on the guidelines from the Commission. The expected percentage reduction (EPR) in the variance of loss cost was computed for all six model parameters for hypothetical Category 1, 3, and 5 hurricanes, as shown in Figure 38.

The results show that FFP contributes most to the uncertainty in loss costs for Category 1 and 3 hurricanes. For Category 1 hurricanes, Cp makes the second largest contribution to uncertainty followed by Rmax. For Category 3 hurricanes, Rmax makes the second largest contribution followed by Cp and inland decay rate (α). For Category 5 hurricanes, Rmax is the largest contributor to uncertainty in loss costs when compared to the other parameters. The inland decay rate (α) makes the second largest contribution followed by Cp and FFP. The contribution of Rmax and α to the uncertainty of loss costs increases as storm intensity increases, while the contributions of FFP and Cp decrease as storm intensity increases. The shape parameter (X1) and translational velocity (VT) make very little contribution to the uncertainty in hurricane loss costs across all hurricane categories. These trends are consistent with the results of uncertainty analyses performed for the 2021 FCHLPM submission.

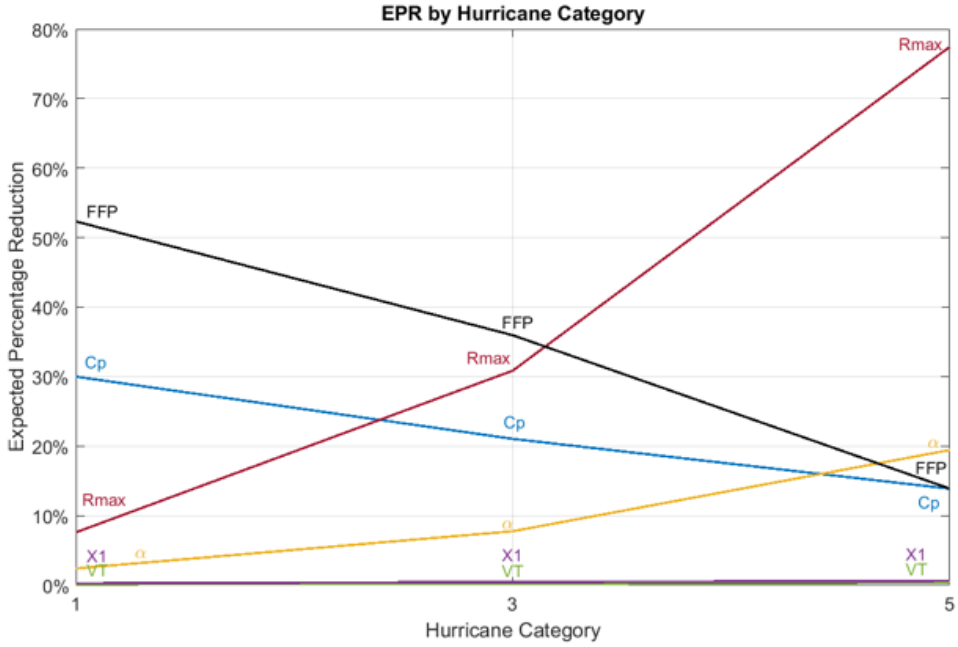


Figure 38 Expected Percentage Reduction (EPR) for Expected Hurricane Loss Costs for All Input Variables for All Hurricane Categories: Results from Current Submission.

Figure 39, Figure 40, and Figure 41 show time series of EPR in the variance of the modeled hourly wind speeds at the landfall point (denoted by the coordinates (9, 0)) of hypothetical Category 1, 3, and 5 hurricanes, respectively. At hour 0, which is before landfall, the largest contribution to the uncertainty in the modeled wind speed is Rmax for all hurricane categories. The EPR of Rmax decreases as time increases. At hour 1, VT has the largest EPR for Category 1 hurricanes and the second largest EPR for Category 3 and Category 5 hurricanes. The EPR of VT decreases slightly at later hours but remains the second largest contributor at hour 12 for all hurricane categories. Across all categories of hurricanes, the contribution of X1 to the uncertainty in modeled wind speeds increases as time increases. FFP and Cp have some influence on the uncertainty of modeled wind speeds at early hours, especially for Category 1 hurricanes, however their contribution diminishes as time increases. Overall, trends and relativities of EPR for Category 1, 3, and 5 hurricanes are consistent with the findings of the 2021 submission, with only small absolute changes in EPR.

The temporal uncertainty analysis results described above are location-specific and could vary significantly depending on the selected grid point.

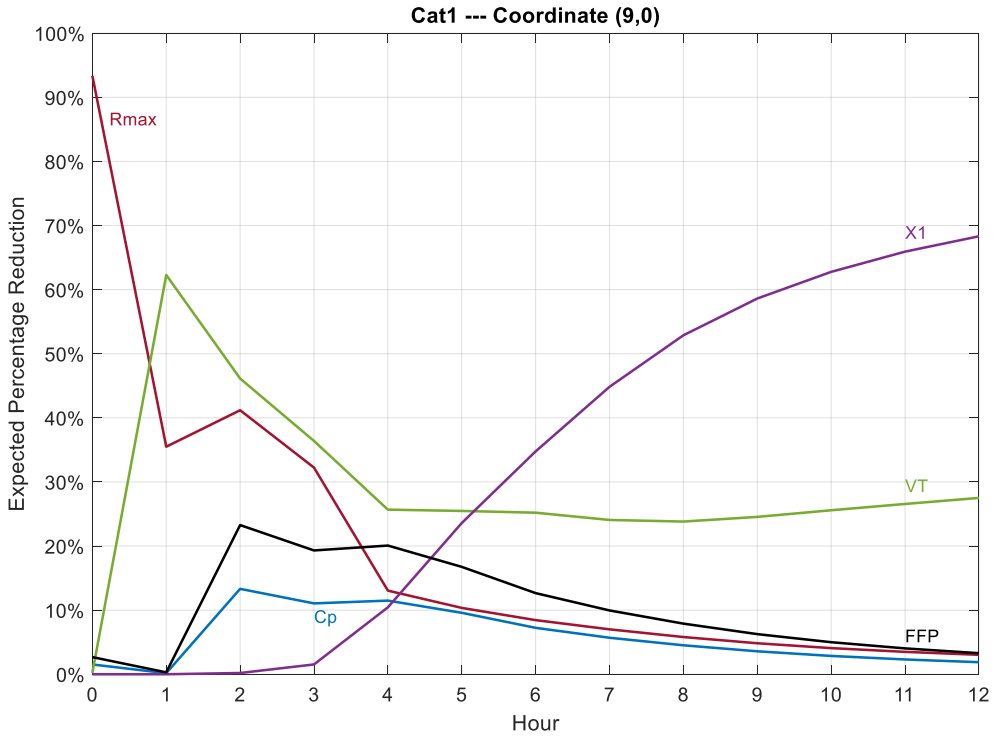


Figure 39: Time series of EPR in the variance of wind speed at grid coordinate (9, 0) for hypothetical Category 1 hurricanes with input variables listed in the worksheets of "FormS6Input23.xlsx."

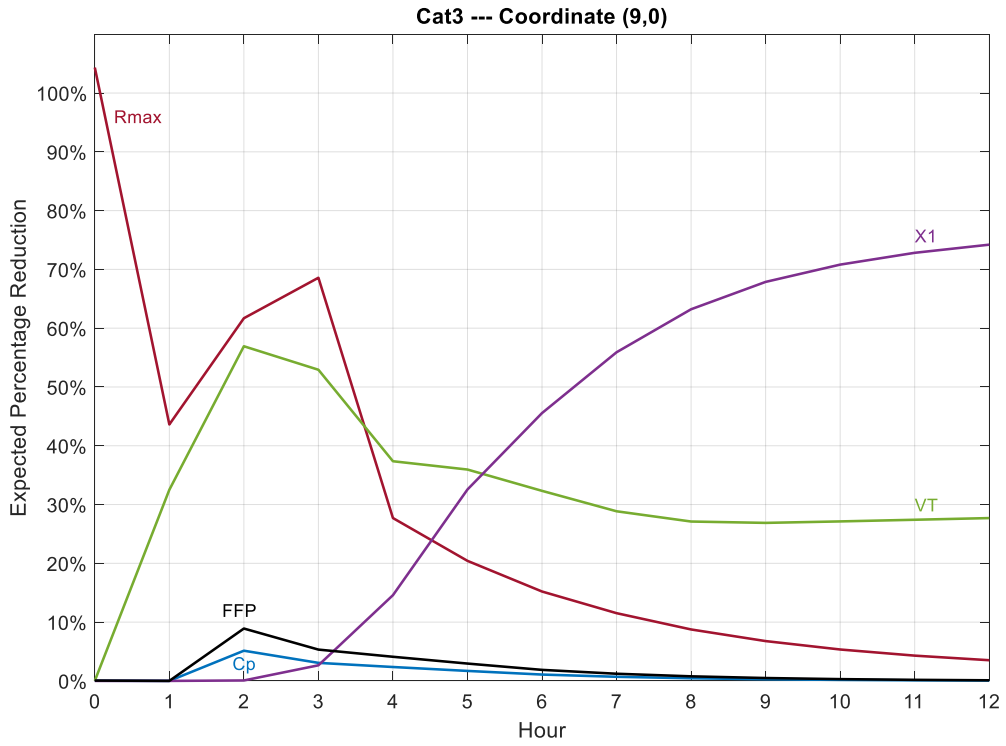


Figure 40: Time series of EPR in the variance of wind speed at grid coordinate (9, 0) for hypothetical Category 3 hurricanes with input variables listed in the worksheets of "FormS6Input23.xlsx."

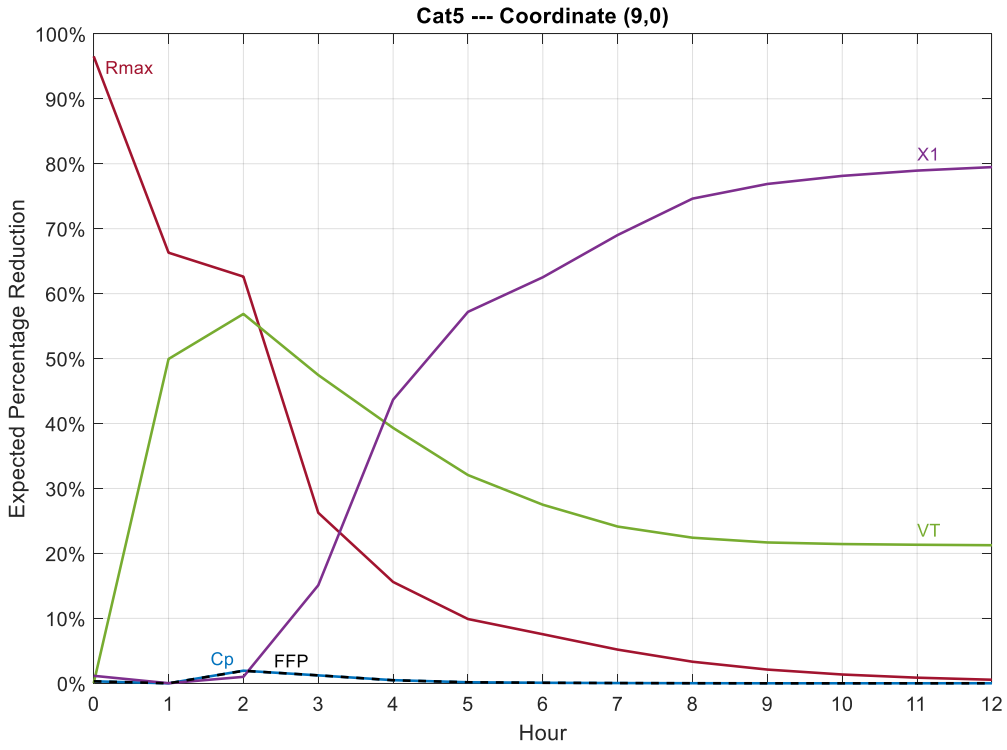


Figure 41: Time series of EPR in the variance of wind speed at grid coordinate (9, 0) for hypothetical Category 5 hurricanes with input variables listed in the worksheets of "FormS6Input23.xlsx."

S-3.2 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.

The landfall location and storm heading relative to exposure concentration also have a significant impact on the uncertainties in output results. The areas with high or low wind risk are determined by their locations with respect to the storm track, which is largely defined by its landfall location and heading direction after landfall. Properties exposed to high wind speed tend to suffer more damage than properties that are located in low wind speed regions. Surface roughness and local gust factor scaling of sustained winds can also contribute to the uncertainties in hurricane model output.

S-3.3 Describe and justify action or inaction as a result of the uncertainty analyses performed.

The results of the uncertainty analyses have been thoroughly reviewed and were found to be reasonable. No action was taken as a result of the analyses performed.

S-3.4 Form S-6, if disclosed under Hurricane Standard S-2, will be used in the verification of Hurricane Standard S-3.

Form S-6 is not disclosed for the current submission, as Impact Forecasting is not a new modeling organization.

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 Impact Forecasting Florida Hurricane (FCHLPM) Model stochastic event set is constructed using 200,000 years' worth of synthetic hurricanes resampled to generate a 300,000 year set. As described in Disclosure S-4.1, the standard error in hurricane loss cost is lower than 2.5% of the estimated loss cost value for every county in Florida.

S-4.1 *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 process of loss calculation of Probable Maximum Loss (PML) has been upgraded in the Florida Hurricane (FCHLPM) Model such that it precisely follows the definition using years (in Occurrence Exceedance Probability curve and Annual Exceedance Probability Curve), replacing the approximate solution of the currently accepted model that uses event frequencies. From the original set of 2.6 million tracks generated from 200,000 years of simulated tropical cyclone activity, Stratified Random Sampling is applied to landfalling and by-passing Florida events to yield 56,000 unique and representative events, with each representative event selected based upon landfall intensity, Rmax, and landfall location. Assignation is then performed in two steps. First, for each of the 2.6 million events in the full set, a representative event from the 56,000 event set is assigned. Second, an event-to-year assignation is performed for those events. As a result, modeled events and years are statistically representative of the original set without the need to model the computationally expensive full event set. For consistency with other model solutions used by Aon, 200,000 years of modeled tropical cyclone activity are resampled into a 300,000 year set as follows: first, the 200,000 year set is inserted into 300,000 year set as is, then the remaining 100,000 years are randomly sampled from the 200,000 year set. This way, all events from

hazard modelling are guaranteed to appear in 300,000 year set. The modeling software automatically assigns the event losses calculated from the 56,000 event set into a year table with stochastic years and aggregates (sum and maxima) per year. These annual aggregates are then used in calculation of return period levels of annual aggregate and annual occurrence curves.

The efficacy of the stratified random sampling scheme is contingent upon the variance in event losses between strata being large compared to the variance for events within a strata, a result that is demonstrated by the diversity of modeled loss in Form-A2 of the model under review, where scenarios belonging to events of different category, Rmax, and location of landfall, and thus strata, showing significant difference in losses.

Impact Forecasting uses a direct Monte Carlo simulation approach to estimate individual hurricane loss costs and hurricane output ranges. In a sensitivity analysis during model development, the sample size was increased gradually and the corresponding standard errors in hurricane loss costs at county level were calculated. With 200,000 years of simulation, the maximum standard error at county level becomes smaller than 2.5% of the loss cost estimate for every county in Florida. The full 300,000 year event set, including the addition of 100,000 resampled years to the simulated 200,000 years, is done in a manner that preserves the variance of the 200,000 year approach validated by sensitivity analysis.

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 Hurricane Irma (2017), Hurricane Michael (2018), and Hurricane Ian (2022) to the extent data from Hurricane Ian are available.

The Impact Forecasting Florida Hurricane (FCHLPM) Model reasonably replicates incurred hurricane losses for 18 historical events from 2004 through 2022 for six insurance companies without significant bias, as shown in Figure 42. This is the case for both personal and six residential lines and by county, coverage type, and construction class. Individual claims were provided mostly at the location-coverage level along with their contemporaneous exposure. Modeled losses are gross of all insurance and include demand surge. The loss data includes loss data from Hurricane Irma (2017), Hurricane Michael (2018), and Hurricane Ian (2022).

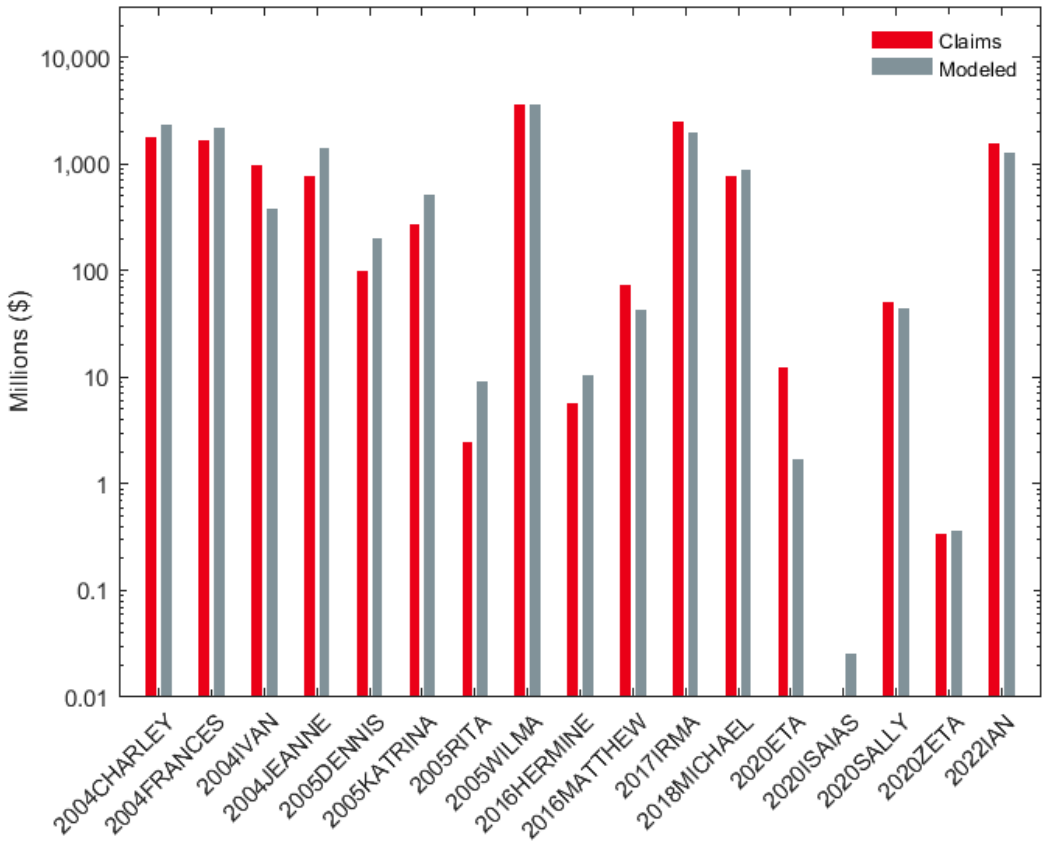


Figure 42: Modeled vs. claims by hurricane event, summed across all client portfolios

S-5.1 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 2017 and 2018 hurricane seasons, and for Hurricane Ian (2022) to the extent data from Hurricane Ian are available.

Table 7 compares the Impact Forecasting modeled gross losses with actual claims by event and company for 17 hurricane events occurring from 2004 through 2022. Only claims associated with modeled damaging hazard are compiled, with claims reported outside the

hazard footprint of the event excluded. The losses in the table have been scaled to protect clients' data privacy.

Most of the claims were provided at the location coverage level along with exposure in place at the time the hurricane occurred. These data along with other sources were used to calibrate and validate damage functions by estimating the mean and standard deviation of damage ratios using modeled hazard footprints derived from the hazard module of the Impact Forecasting Florida Hurricane (FCHLPM) Model. This exposure data included:

- 99.5% of data having coordinates or addresses that were geocoded using the ELEMENTS geocoder that licenses Precisely software
- Primary building characteristics such as construction, occupancy, year built, and number of stories
- Secondary building characteristics that may affect damageability (for example, roof age, connections, covering, sheathing, and type as well as building size, window protection, and presence of garage)
- Insurance terms like deductible, limits, and policy fraction at coverage, location, and policy levels

Finally, at the validation stage, overall modeled losses are compared against claims after accounting for the age of building stock at time of event occurrence, as described in Disclosure S-1.4, which leads to an expectation that accurately-modeled losses will be 9% greater than claims over the entire set of portfolios modeled.

Table 7: Modeled loss vs. claims by event and company

Hurricane	Company	Modeled Loss ($)	Claims ($)	Modeled/Claims
Charley (2004)	A	1,113,523,374	423,304,292	2.63
	B	1,236,076,264	1,392,613,366	0.89
	Total	2,349,599,638	1,815,917,658	1.29
Frances (2004)	A	1,543,565,763	905,386,527	1.70
	B	701,195,507	807,543,193	0.87
	Total	2,244,761,270	1,712,929,719	1.31
Ivan (2004)	A	205,214,155	672,334,425	0.31
	B	181,482,162	319,355,592	0.57
	Total	386,696,317	991,690,017	0.39
Jeanne (2004)	A	672,772,720	400,523,697	1.68
	B	780,875,289	376,466,933	2.07
	Total	1,453,648,010	776,990,630	1.87

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Hurricane	Company	Modeled Loss ($)	Claims ($)	Modeled/Claims
Dennis (2005)	A	128,338,913	75,646,855	1.70
	B	74,379,950	24,977,664	2.98
	C	3,545,087	1,001,867	3.54
	Total	206,263,949	101,626,387	2.03
Katrina (2005)	A	434,048,318	202,848,276	2.14
	B	81,951,182	63,578,027	1.29
	C	16,576,585	11,965,355	1.39
	Total	532,576,085	278,391,658	1.91
Rita (2005)	A	9,416,456	2,497,819	3.77
	Total	9,416,456	2,497,819	3.77
Wilma (2005)	A	2,186,417,542	2,304,789,963	0.95
	B	1,263,659,245	1,232,829,208	1.03
	C	172,550,739	154,837,638	1.11
	Total	3,622,627,526	3,692,456,809	0.98
Hermine (2016)	A	1,376,546	443,365	3.10
	B	8,281,919	4,704,577	1.76
	D	49,027	4,338	11.30
	E	882,498	648,822	1.36
	Total	10,589,991	5,801,101	1.83
Matthew (2016)	A	13,035,021	17,852,487	0.73
	B	21,917,372	38,779,171	0.57
	D	4,047,250	6,989,087	0.58
	E	4,555,278	10,498,512	0.43
	Total	43,554,922	74,119,257	0.59
Irma (2017)	A	586,067,406	1,221,893,788	0.48
	B	411,696,147	200,214,940	2.06
	C	547,701,465	668,882,648	0.82
	D	122,035,636	53,074,812	2.30
	E	171,518,668	193,582,265	0.89
	F	150,576,660	221,698,646	0.68
	Total	1,989,595,983	2,559,347,098	0.78
Michael (2018)	A	102,664,613	126,471,868	0.81
	B	232,994,630	189,709,438	1.23
	C	472,966,887	379,407,387	1.25
	D	1,519,910	1,328,741	1.14
	E	83,817,618	89,071,023	0.94
	Total	893,963,657	785,988,457	1.14
Eta (2020)	C	1,744,980	12,600,412	0.14
	Total	1,744,980	12,600,412	0.14
Isaias (2020)	C	26,096	-	-
	Total	26,096	-	-
Sally (2020)	C	45,185,641	51,484,390	0.88
	Total	45,185,641	51,484,390	0.88

Hurricane	Company	Modeled Loss ($)	Claims ($)	Modeled/Claims
Zeta (2020)	C	368,011	349,476	1.05
	Total	368,011	349,476	1.05
Ian (2022)	A	1,313,074,398	1,566,754,748	0.84
	Total	1,313,074,398	1,566,754,748	0.84
Total		**15,103,692,931**	**14,428,945,635**	**1.05**

S-5.2 Provide completed Form S-4. Provide a link to the location of the form in the submission appendix [Form S-4: Validation Comparisons].

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 historical and modeled annual average statewide hurricane loss costs based on the 2023 FHCF personal and commercial residential zero deductible exposure data are $4.21 and $5.14 billion, respectively. Such difference exists due to different sample sizes of historical and stochastic storm sets and various uncertainties within. As shown in Form S-5: Average Annual Zero Deductible Statewide Hurricane Loss Costs, the difference is not statistically significant.

S-6.1 *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.*

Validation tests were performed throughout the model development process to ensure the accuracy of projected hurricane losses. The validation tests included:

1 The modeled hurricane loss cost for the state of Florida was compared with the historical loss cost produced by the hurricanes in the Base Hurricane Storm Set. The loss difference is shown to be statistically insignificant based on the confidence interval constructed on the loss cost data (see Form S-5: Average Annual Zero Deductible Statewide Hurricane Loss Costs).

2 The loss estimates using actual insurance company exposures for recent historical hurricanes were validated against claims data for different occupancy, construction, and coverage types, and for different geographic regions. The validation results are generally favorable (see Form S-4: Validation Comparisons).

3 The probable maximum loss (PML) levels generated using stochastic events were used to estimate the return periods of historical hurricane losses. The return period of each historical event loss based on the PML curve was found to be reasonable.

4 The accuracy of track and intensity modeling is of utmost importance to loss estimations. As demonstrated in Standard S-1 and Form M-1: Annual Occurrence Rates, the simulated event tracks and intensities were validated against HURDAT2 data at both the 2x2-degree cell level close to Florida and at the time of Florida landfall. Goodness-of-fit tests were performed along with visual inspections. The parameters validated were hurricane landfall frequency by

category, forward speed, heading angle, central pressure, maximum sustained wind speed, and radius of maximum winds. The validation of storm inland decay rates is described provided in Disclosure M-5.1.

5 In Form M-2: Map of Maximum Winds return period wind maps from the stochastic storm set are justified in terms of wind speed patterns using both the peak wind speed maps from historical hurricanes as well as publicly available information such as the design wind speed maps in the building code. The consistency and smoothness of loss cost distributions in Florida were also verified (see Form A-1, as provided in "IF_2023_FCHLPM_Submission_Form_A1_A-F.pdf").

6 The Impact Forecasting model is constructed using 200,000 years' worth of synthetic hurricanes resampled to generate a 300,000 year set. The 300,000 years of simulation are found to be adequate to produce a standard error in loss cost lower than 2.5% of the estimated loss cost value for every county in Florida (see Standard S-4).

S-6.2 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 approaches taken to produce hurricane loss costs for historical and stochastic events are the same.

S-6.3 Provide completed Form S-5. Provide a link to the location of the form in the submission appendix [Form S-5: Average Annual Zero Deductible Statewide Hurricane Loss Costs].

V-1 Development of Building Hurricane Vulnerability Functions

A. *Development of the building hurricane vulnerability functions shall be based on a combination of available insurance company hurricane claims data and rational engineering analysis supported by laboratory testing, field testing, or post-event site investigations.*

The development of the building hurricane vulnerability functions incorporates sound engineering principles and historical insurance claims data together with supporting information from public domain research and post-event reconnaissance. The model methodology is detailed in Disclosures V-1.5, V-2.3, and V-3.3. The development of the suite of vulnerability functions was supported by insured wind claims data totaling $14.4 billion and underlying exposures. These data are described in Disclosure V-1.3.

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

The vulnerability functions for the Impact Forecasting Florida Hurricane (FCHLPM) Model are developed based on sound engineering principles incorporating empirical loss experience, component-based methodology and peer-reviewed research publications. The engineering-based vulnerability functions are developed using a component-based vulnerability approach in which the entire building is divided into several components (e.g., main wind force resisting system, exterior systems, and interior systems) based on specific details of building features. The uncertainties in both loading and resistance for each component are accounted for using appropriate probabilistic distributions. The catalog of vulnerability functions is constructed by experts in wind and structural engineering using information from published research, guidance from ASCE 7, the historical experience provided by insurance claims data, and post-event reconnaissance.

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

The residential building stock classifications are based on a review of construction inventories using information from the U.S. Census, tax appraiser's data, public domain reference information such as the Federal Emergency Management Agency (FEMA), Florida Hurricane Catastrophe Fund (FHCF), and post-event reconnaissance surveys. In addition, the residential building stock classification was compared with exposure data from historical claims. These resources were used to compile standard structure types for personal and commercial residential buildings. Impact Forecasting and Aon, over more than 20 years, have supported various clients in terms of modeling their loss exposures and portfolios.

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 development and application of building hurricane vulnerability functions.

The Impact Forecasting exposure module classifies structures by their primary and secondary risk characteristics. Primary risk characteristics include the following parameters: (a) Occupancy type, (b) Construction type, (c) Number of stories, (d) Year-built, and (e) Tier (vulnerability region). Building code is accounted for with the tier and year-built parameters. A vulnerability function is assigned to each risk based on the primary risk characteristics when importing exposure data into the exposure database. The inclusion of various secondary risk characteristics will modify the vulnerability function. Primary characteristics are further explained in Disclosure V-1.8.

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

Vulnerability functions for personal residential, commercial residential, and manufactured homes are derived separately and are included in the model. The vulnerability functions for appurtenant structures are modeled separately using the same vulnerability functions as for primary buildings. The Impact Forecasting Florida Hurricane (FCHLPM) Model has the capability of choosing different vulnerability functions for appurtenant structures and primary structures based on the building characteristics (e.g., construction type, year-built, number of stories, etc.) of the primary building.

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

The Impact Forecasting Florida Hurricane (FCHLPM) Model begins to estimate damage when the 1-minute sustained wind speed at 10-meter height is greater than 35.2 mph under open terrain conditions (3-second peak wind speed at 10-meter height is greater than 20 m/s). This is consistent with fundamental engineering principles and has been validated using claims data from historical events.

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 used in the Impact Forecasting Florida Hurricane (FCHLPM) Model account for damage to buildings from windspeed and wind pressure, water infiltration, and missile impacts associated with hurricanes. The damage due to flood (including hurricane storm surge and wave action) is not explicitly included in the Impact Forecasting Florida Hurricane (FCHLPM) Model.

V-1.1 Provide details of modifications to the building vulnerability component of the hurricane model since the current accepted hurricane model.

The most important modification made to the building vulnerability component of the hurricane model since the current accepted model is the explicit modeling of Chance of Loss, which Impact Forecasting defines as the probability of ground up loss occurring, conditional upon hazard and primary building characteristics. Claims observations for hurricane wind losses in Florida suggest that the distribution of damage ratios is bipartite and best described as the superposition of a continuous loss distribution with a point mass of zero loss, thus necessitating the inclusion of Chance of Loss. The updated Impact Forecasting vulnerability module first applies Monte Carlo sampling of a loss probability using the damage function's Chance of Loss, followed by the Monte Carlo sampling of the

damage ratio conditional upon loss occurring, to represent the bipartite distribution of losses. The following steps are taken to develop, calibrate, and validate these damage curves: Chance of Loss, conditional mean damage ratio and conditional standard deviation.

- The vulnerability component-based simulator of the hurricane model assesses ground-up damage ratios given wind speed and number of simulations. The simulator is enhanced to store chance of loss, conditional mean damage ratio and standard deviation.
- The vulnerability component of the hurricane model assesses ground-up losses prior to the application of financial conditions and the social dynamics of claims reporting. Thus, the inference of ground-up claims rate using a peer-reviewed statistical estimator is applied to ensure that the empirical data used to calibrate damage curves accounts for the truncation of losses incurred through claims reporting.
- Historical wind footprints are improved using Bayesian maximum likelihood estimation to generate a wind footprint that best agrees with both HURDAT2 event parameters as well as wind gusts observed from surface stations.
- Historical claims data, as inferred through statistical estimation to reflect ground-up losses, are used to determine the distribution of damage estimates, with engineering principles applied to constrain chance of loss at regions of low and high hazard where data quality or availability are lacking.
- The damage curves associated with each damage function are validated using the bootstrap resampling of historical loss events to estimate a confidence interval consistent with loss experience. The damage estimates are then checked against these confidence intervals.

V-1.2 Provide a flowchart documenting the process by which the building hurricane vulnerability functions are developed and implemented.

The building vulnerability function development process is shown in Figure 43.

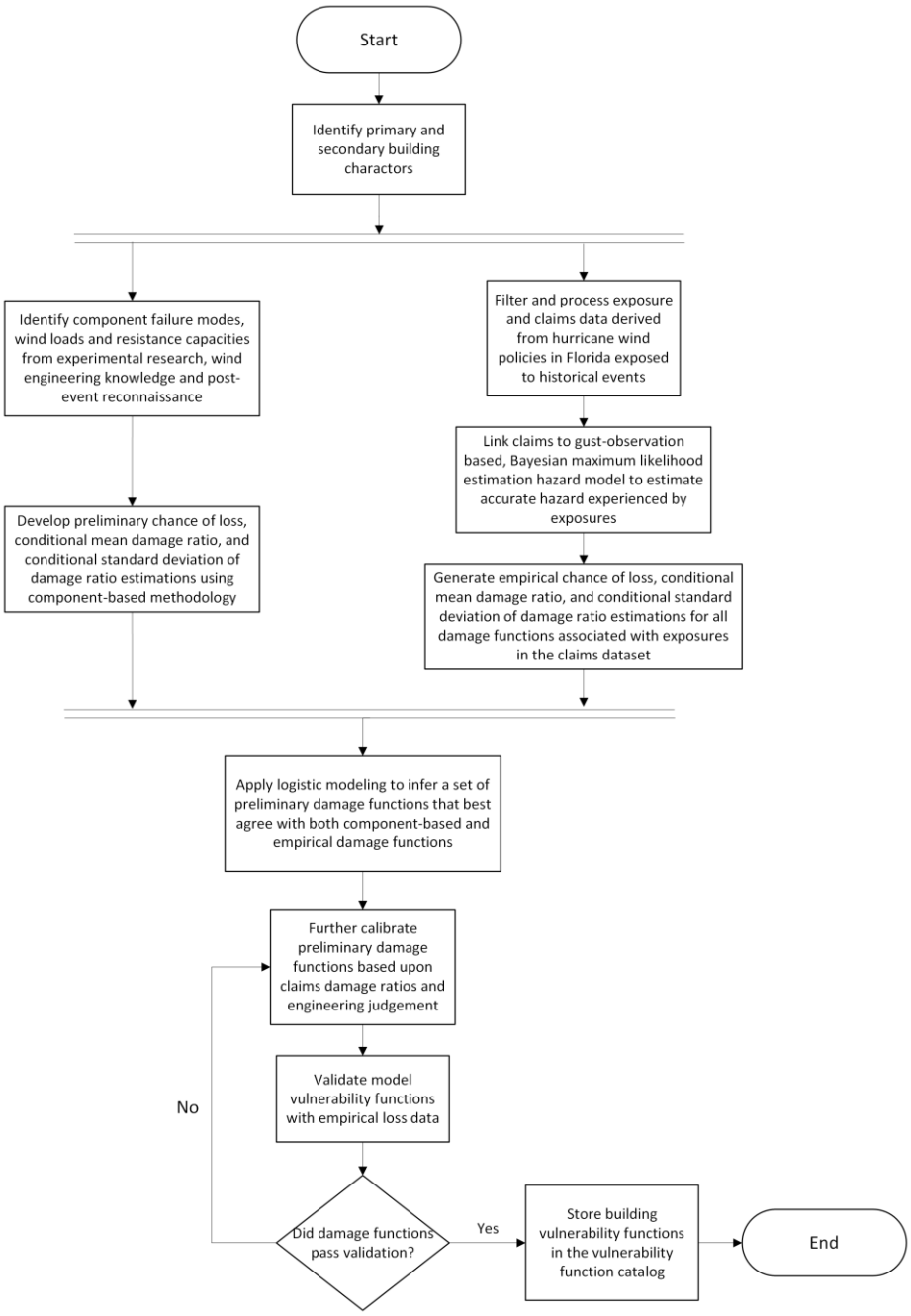


Figure 43: Development process for building hurricane vulnerability functions

V-1.3 Describe the nature and extent of insurance company hurricane claims data used to develop the building hurricane vulnerability functions. Describe in detail the breakdown of data into 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.

Impact Forecasting was provided with detailed insurance exposure and claims data, including data at the coverage level. The amount of exposure provided at the street address level was greater than 99 percent. The claims data was inclusive of 17 historical events for six insurers in an amount totaling $14.4 billion.

The exposure amount and number of policies used to develop building hurricane vulnerability functions are shown in Table 8. The list of historical events for which claims data was available is provided in Table 9.

Table 8: Number of policies and exposure value by policy type

Policy Type	Number of Policies	Exposure Value ($)
Personal Residential	7,132,796	2,286,624,464,747
Manufactured Homes	642,742	46,247,485,026
Commercial Residential	53,466	144,279,180,449

Table 9: Historical hurricane events for which claims data was available

Year	Hurricane	Number of Clients per Event and Line of Business			Claims per Event and Line of Business ($)			
		Personal Residential	Commercial Residential	Manufactured Homes	Personal Residential	Commercial Residential	Manufactured Homes	Total
2004	Charley	2	2	2	1,545,376,567	102,820,056	74,010,208	1,722,206,831
2004	Frances	2	2	2	1,332,735,397	344,682,930	59,913,582	1,737,331,909
2004	Ivan	2	2	2	701,218,378	374,202,862	7,947,127	1,083,368,366
2004	Jeanne	2	2	2	649,772,938	108,252,327	34,721,800	792,747,065
2005	Dennis	3	1	2	78,813,137	20,659,893	2,336,292	101,809,322
2005	Katrina	3	2	2	225,142,614	21,947,905	9,524,253	256,614,772
2005	Rita	1	1	1	4,332,156	171,441	550,623	5,054,221
2005	Wilma	3	2	2	2,879,825,056	580,748,751	159,018,841	3,619,592,647
2016	Hermine	3	1	2	8,594,634	11,097	674,884	9,280,616
2016	Matthew	3	1	2	67,399,078	2,088,669	12,392,722	81,880,469
2017	Irma	5	1	3	2,276,744,214	51,791,727	118,021,035	2,446,556,976
2018	Michael	1	0	0	21,912,439	-	-	21,912,439
2020	Eta	1	0	0	54,706,201	-	-	54,706,201
2020	Isaias	1	0	0	378,765	-	-	378,765

Year	Hurricane	Number of Clients per Event and Line of Business			Claims per Event and Line of Business ($)			
		Personal Residential	Commercial Residential	Manufactured Homes	Personal Residential	Commercial Residential	Manufactured Homes	Total
2020	Sally	1	1	1	1,464,769,473	43,632,473	269,303,589	1,777,705,535
2020	Zeta	2	2	2	1,545,376,567	102,820,056	74,010,208	1,722,206,831
2022	Ian	2	2	2	1,332,735,397	344,682,930	59,913,582	1,737,331,909
					11,993,453,106	**1,652,381,735**	**791,551,262**	**14,437,386,103**

V-1.4 Describe any new insurance company hurricane claims data received and reviewed since the current accepted hurricane model. Indicate whether the new data, if any, have been incorporated in the hurricane model under review.

Since the previous submission, Impact Forecasting obtained new claims data in personal residential, commercial residential, and manufactured homes for storms Hermine (2016), Matthew (2016), Irma (2017), and Michael (2018), which were included in the previous submission.

In addition to these updates, the new event of Ian (2022) were included with the addition of new client data.

V-1.5 Describe the assumptions, data (other than insurance company hurricane claims data), methods, and processes used for the development of the building hurricane vulnerability functions.

The vulnerability functions for the Impact Forecasting Florida Hurricane (FCHLPM) Model are developed based on sound engineering principles incorporating empirical loss experience, component-based methodology and peer-reviewed research publications. Impact Forecasting analyzes the various sub-assemblies, assigns damage levels, and aggregates the constituent parts into the impact on the entire building. The components include the following structural systems: main wind force resisting system (such as rafters, sheathing, framing, roof-to-wall connections, wall-to-floor connection, anchoring to the foundation), exterior systems (such as roof covering, exterior walls, windows, and garage doors, cladding) and interior systems (such as interior framing, flooring, ceiling). The conceptual framework is supported in engineering publications, including Cope (2004), Pinelli et al. (2004), Apirakvorapinit and Daneshvaran (2009a, 2009b), Barbato et al. (2013), Huang et al. (2015), and Unnikrishnan and Barbato (2016). Using the component-based methodology, Impact Forecasting established a preliminary set of engineering-derived vulnerability functions including chance of loss, conditional mean damage ratio and conditional standard deviation. The preliminary vulnerability functions were compared with loss experience using information from lessons learned on Impact Forecasting damage surveys and supporting information from sources including the Insurance Institute for Business and Home Safety (IBHS) (IBHS, 2004, 2019).

Separately, an empirical vulnerability model is developed using a multilinear logistic regression model with physically-grounded constraints. A curated database of roughly 7 million exposures exposed to tropical storm-force or greater wind hazard and 600 thousand associated wind-loss claims are used to train the model. The empirical model is sensitive to the following predictors: (a) Occupancy type, (b) Construction type, (c) Number of stories, (d) Year-built, (e) Tier (vulnerability region),and (f) building age at time of hazard, as well the highly nonlinear relationship between hazard and expected loss behavior. The hazard linked to each exposure is developed and validated using a Bayesian maximum likelihood estimation approach to generate a wind footprint that best agrees with both HURDAT2 event parameters as well as wind gusts observed from surface stations. The model is constrained such that losses are zero for hazard values insufficient to cause damage and total for hazard

values approaching 150 m/s, and estimates Chance of Loss, conditional mean damage ratio, and standard deviation of conditional damage ratio, for all structure types with observed claims. Additionally, to produce an empirical dataset that supports the estimation of ground-up vulnerability functions, a statistical estimator is applied to account for the left-truncation of claims data for losses that occur below policy deductibles.

Final vulnerability functions are determined by synthesizing the component-based and empirical damage functions using an objective, logistic regression framework. Where loss observations are sparse or data quality is poor, more weight is placed upon the component-based vulnerability estimates. For damage functions with no corresponding observed claims in the loss dataset, the vulnerability function is wholly engineering-based. For lower hazard ranges where loss experience is well-developed, the empirical vulnerability curves are assigned greater weight.

Finally, the primary vulnerability functions were validated using claims losses from historical events (refer to Disclosure S-1.5 under damage ratios).

V-1.6 Describe the basis, development, modeling, and treatment of uncertainties associated with the building hurricane vulnerability functions.

The uncertainties associated with the building hurricane vulnerability functions were initially modeled based on a Monte Carlo framework which performs statistical sampling for various wind loading conditions on different structural components. These component-based results are aggregated into overall building outcomes which represent both the conditional mean and the standard deviation of the damage ratios, as well as chance of loss. The modeled uncertainties, or the standard deviation and chance of loss, were then calibrated or validated using the claims data.

V-1.7 Summarize post-event site investigations, including the sources, and provide a brief description of the resulting use of these data in the development of building hurricane vulnerability functions.

Impact Forecasting structural engineers, wind engineers, and research team members have traveled to various locations with high or moderate damage to perform post-event reconnaissance. The post-event reconnaissance provides site inspections that are used to

compare actual observed damage with expected model results across various locations in the wind field.

Impact Forecasting experience includes post-event reconnaissance for Hurricane Katrina (2005), Hurricane Rita (2005), Hurricane Wilma (2005), and Hurricane Sandy (2012). Recent post-event reconnaissance includes Hurricane Matthew (2016), Hurricane Irma (2017), Hurricane Michael (2018), and Hurricane Ian (2022).

V-1.8 Provide the total number of building hurricane vulnerability functions available for use in the hurricane model for personal and commercial residential classifications. 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.

There are 15,372 building vulnerability functions in the Impact Forecasting Florida Hurricane (FCHLPM) Model for personal and commercial residential classifications based on the following primary building characteristics: (a) Occupancy type, (b) Construction type, (c) Number of stories, (d) Year-built, and (e) Tier (vulnerability region).

The categories and descriptions of the available occupancy type, construction type, number of stories, year-built, and tier options are described in Table 10.

Table 10: Categories of vulnerability functions in the Impact Forecasting Florida Hurricane (FCHLPM) Model

Category	Option	Description
Occupancy Type	Residential Single Family	Occupancy classes provide differentiation based on building function, building design, and insured policy categorization.
	Residential Multiple Families	
	Residential Renter	
	Residential Condo Unit Owner	
	Commercial Apartment Condo Association	
	Unknown Residential Occupancy Type	
Construction Type	General Masonry	Construction classifications provide differentiation based on building material, function and wind load resistance.
	Unreinforced Masonry	
	Reinforced Masonry	
	Manufactured Home with Tied Down	
	Manufactured Home Double Wide	
	Manufactured Home without Tied Down	
	Manufactured Home with Tie-Down Unknown	
	Wood Frame	
	Masonry Veneer	

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Category	Option	Description
	Reinforced Concrete	
	Reinforced Concrete - Tilt-Up	
	Steel Frame	
	Light Metal Building	
	Unknown Construction Type	
Number of Stories	Unknown	The number of story classifications provides differentiation based on height, construction quality, and wind load resistance.
	1	
	2	
	3	
	4 to 10	
	11 to 20	
	> 20	
Year Built (non-Mobile Home)	Unknown	Year-built classifications provide differentiation based on changes to building codes over time and their impact on wind load resistance.
	Pre-1995	
	1995 to 2001	
	2002 to 2011	
	Post-2011	
	Unknown	

Category	Option	Description
Year Built (Mobile Home)	Pre-1976	Year-built classifications provide differentiation based on changes to building codes and their impact on wind load resistance.
	1976 to 1993	
	1994 to 1998	
	1999 to 2007	
	Post-2007	
Tier	1. Broward County, Miami-Dade County, and the Florida Keys	Tier classification provides differentiation based on varied wind load resistance requirements for different geographies
	2. Areas where the ultimate design wind speed is 140 mph or greater, areas within 1 mile of the coastal mean high-water line, which are not in Tier 1	
	3. The remaining areas of Florida	

V-1.9 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.

The building vulnerability functions for Florida vary both spatially and temporally to represent the regional variation in construction practices and building code adoption and enforcement over time. The vulnerability tiers are derived following the design guidelines in minimum design wind speeds, High-Velocity Hazard Zones (HVHZ), and Wind-Borne Debris Region (WBDR) in the Florida Building Codes, which represent distinct spatial regions in Florida with varied requirements in the design load and provisions to protect the building from damage. Tier 1 refers to the county areas of Broward and Miami-Dade, as well as the Florida Keys. Tier 2 refers to the designated areas where the ultimate design wind speed is 140 mph or greater,

areas within 1 mile of the coastal mean high-water line, which are not in Tier 1. Tier 3 covers the remaining areas of Florida.

The year built is used to temporally vary the vulnerability of risks that are in the same spatial region but were built in different periods with different building code requirements, which is grouped into year-built bands that represent distinct points in time when meaningful building code changes occurred that would impact the structural performance of a risk in a hurricane event.

V-1.10 Describe the relationship between building structure and appurtenant structure hurricane vulnerability functions and their consistency with insurance company hurricane claims data.

Building coverage represents the primary personal residential or commercial residential domiciles. Appurtenant structure coverage includes additional structures, such as detached garages, guest houses, equipment sheds, pool enclosures, and gazebos. Loss determination for the appurtenant structure coverage is processed separately from building, contents, and time element coverages. Appurtenant structures are modeled using the same vulnerability functions as the primary building structures.

Figure 44 shows the observed and modeled mean damage ratios (MDR) between buildings and appurtenant structures. This figure demonstrates that the MDRs between the building and appurtenant structure coverages are comparable.

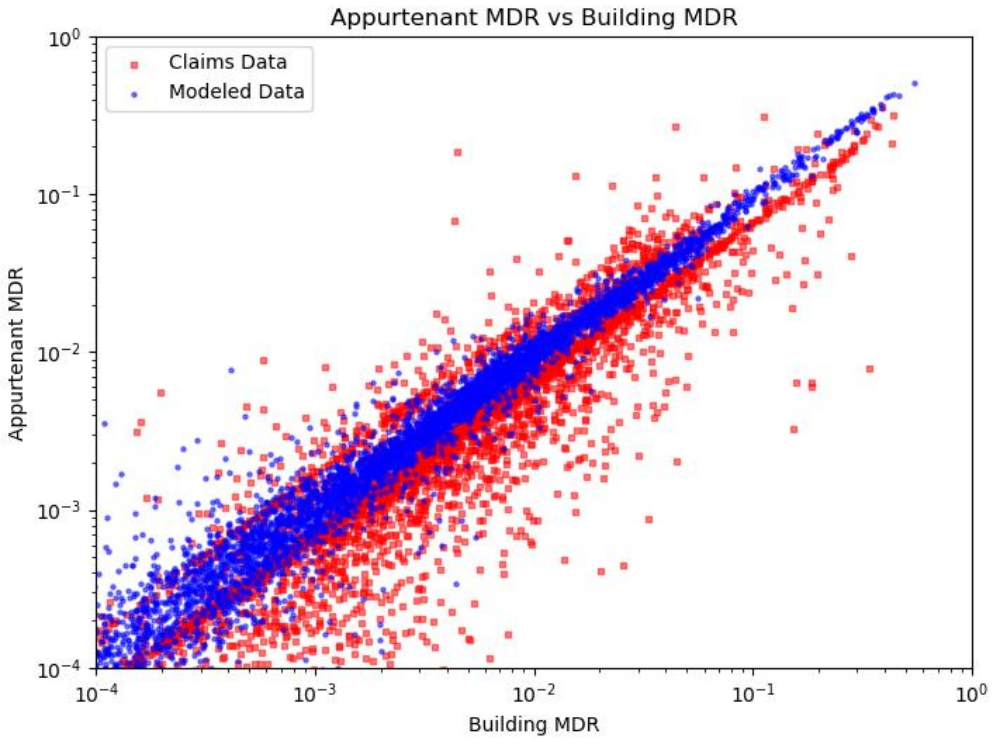


Figure 44: Observed and modeled relationship between building and appurtenant structure mean damage ratios (MDR)

V-1.11 ***Describe the assumptions, data (including available insurance company hurricane claims data), methods, and processes used to develop building hurricane vulnerability functions when***

A. ***residential construction types are unknown, or***

B. ***one or more primary building characteristics are unknown, or***

C. ***one or more secondary characteristics are known, or***

D. ***building input characteristics are conflicting.***

The suite of vulnerability functions is developed for various characteristic parameters including (a) Occupancy type, (b) Construction type, (c) Number of stories, (d) Year-built, and (e) Tier (vulnerability region). In cases where one or more of the parameters are blank or unknown, derived vulnerability functions are assigned. These additional vulnerability functions are derived from the existing set based on a weighted average methodology calibrated using claims data, when available, to create composite vulnerability functions. In cases where building input characteristics are conflicting, credibility is given to the construction class over the other building characteristics. The vulnerability functions for the unrealistic building characteristic combinations are mapped to the realistic ones.

During the import of exposure information, the Impact Forecasting exposure module assigns vulnerability function identification codes based on each risk's primary and secondary characteristics. No adjustments are made when secondary risk characteristics are not provided. The Impact Forecasting exposure module relies on the user to provide realistic building characteristics.

V-1.12 Identify the one-minute average sustained windspeed and the windspeed reference height at which the hurricane model begins to estimate damage.

Impact Forecasting Florida Hurricane (FCHLPM) Model uses a 3-sec gust wind speed to estimate the damage. The damage is beginning to be estimated when the 10-meter 3-sec gust wind speed is greater than 20 m/s, which corresponds to a one-minute average sustained wind speed of 35.2 mph under open terrain conditions.

V-1.13 Describe how the duration of windspeeds at a particular location over the life of a hurricane is considered.

The model does not explicitly consider the duration of wind speed at a particular location over the life of a hurricane. The building vulnerability functions were developed based on the maximum wind speed (3-second gust) experienced at a location. However, the building vulnerability functions were calibrated using insurance claims data where the reported losses may implicitly include damage caused by the duration of wind speed. The damage and insured losses may occur due to fatigue under repeated loading. Thus, the hurricane duration effects are implicitly accounted for in the development of building vulnerability functions.

V-1.14 Describe how the hurricane model addresses wind-borne missile impact damage and water infiltration.

Wind-borne debris is accounted for in the component-based vulnerability methodology used in the initial development of preliminary vulnerability functions. The wind-borne debris impacts are incorporated using a debris generation model, a dedicated debris trajectory model, and a debris impact model.

A debris generation model provides the number and type of wind-borne debris that can affect the structure under consideration. The results of the debris generation model derived according to the geometry of the source building (i.e., density and relative position of debris sources for the target building), are taken as input for the debris trajectory model (Holmes, 2004; Baker, 2007; Lin et al., 2007; Apirakvorapinit & Daneshvaran, 2009a, 2009b).

The debris trajectory model is used to assess if and at what impact velocity a given wind-borne missile hits the building. The debris trajectory is modeled using a two-dimensional Gaussian distribution (Yau, 2011).

Finally, the debris impact model uses the horizontal component of the wind-borne debris velocity (obtained from the debris trajectory model) and data related to the wind-borne debris size and mass (obtained from the debris generation model) to compute the impact of linear momentum of the wind-borne debris. The linear momentum of the wind-borne debris orthogonal to the impacted surface is compared to the resistance of the openings. Additionally, wind-borne debris damage and water infiltration are implicitly accounted for in the historical claims data used in the calibration and validation processes.

V-1.15 Provide completed Form V-1. Provide a link to the location of the form in the submission appendix[Form V-1: One Hypothetical Event].

V-2 Development of Contents Hurricane Vulnerability Functions

A. *Development of the contents hurricane vulnerability functions shall be based on a combination of available insurance company hurricane claims data and rational engineering analysis supported by laboratory testing, field testing, or post-event site investigations.*

The contents vulnerability functions are developed as a function of building damage based on rational engineering analysis and judgment, published peer-reviewed research, and post-event reconnaissance. These functions are further calibrated and validated using claims data from multiple historical events. The claims data are further described in Disclosure V-1.3.

B. *The relationship between the hurricane model building and contents hurricane vulnerability functions shall be consistent with, and supported by, the relationship observed in insurance company hurricane claims data.*

The contents vulnerability curves are derived as a function of conditional building damage ratios, and they were calibrated and validated using historical insurance claims data with coverage level detail.

V-2.1 *Provide details of modifications to the contents vulnerability component of the hurricane model since the current accepted hurricane model.*

There is one modification to the content vulnerability component of the hurricane model since the currently accepted hurricane model. The contents vulnerability curves are now functions of conditional building damage ratios (previously a function of building damage ratios) due to the introduction of chance of loss to building damage ratios.

V-2.2 *Provide a flowchart documenting the process by which the contents hurricane vulnerability functions are developed and implemented.*

The contents vulnerability function development process is shown in Figure 45.

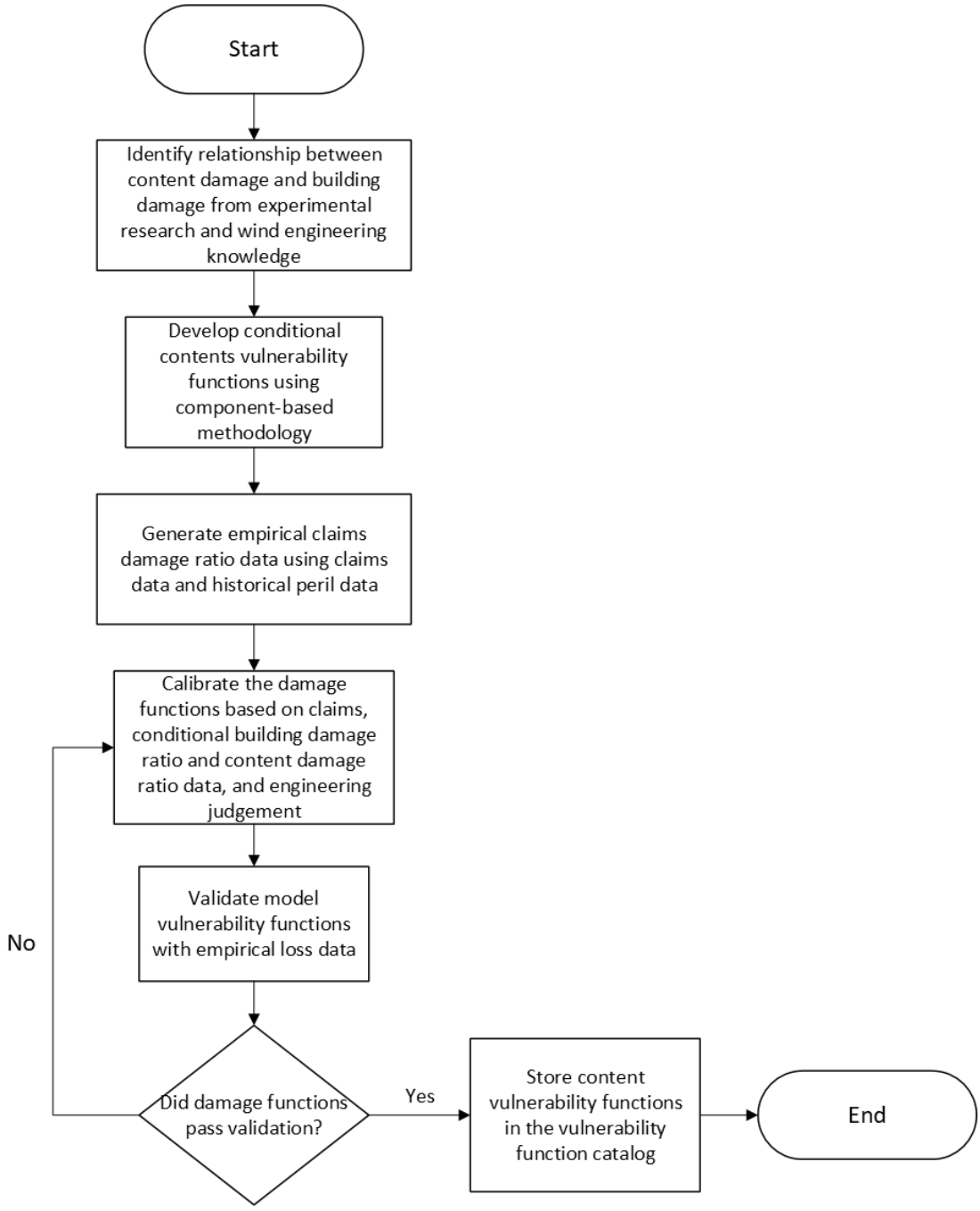


Figure 45: Development process for contents hurricane vulnerability functions

V-2.3 Describe the assumptions, data, methods, and processes used to develop the contents hurricane vulnerability functions.

The preliminary contents vulnerability functions were developed based on engineering analysis and judgment, using the Impact Forecasting damage simulator. These functions provide content loss behavior as a function of the conditional building damage ratio. The contents vulnerability functions were then calibrated and validated by detailed coverage-level insurance claims.

V-2.4 Describe the basis, development, modeling, and treatment of uncertainties associated with the contents hurricane vulnerability functions.

The uncertainties associated with the contents hurricane vulnerability functions were initially modeled based on a Monte Carlo framework which performs statistical sampling for various wind loading conditions on different structural components. The content vulnerability curves include both mean damage ratios and standard deviations for a given building damage ratio. The modeled uncertainties, or the standard deviation, were then calibrated or validated using the claims data.

V-2.5 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.

For every building vulnerability function, there is a corresponding contents vulnerability function. The total number of contents hurricane vulnerability functions is 2,352. Different buildings to contents damage relationships are used for condo association and other occupancies and for low-rise buildings (≤ 3 stories) and mid/high-rise buildings (> 3 stories).

V-2.6 Describe the relationship between building and contents hurricane vulnerability functions.

The contents vulnerability is a function of the building damage ratio, as contents damage depends on the extent of building structure damage. The contents damage ratio changes monotonically with the building damage ratio. However, the relationship between content damage and building damage is not linear. The contents damage is minimal at lower levels of building damage since the building envelope elements are still intact. As the level of building damage increases, the contents become more vulnerable, and the contents damage ratio increases. In general, the contents damage is relatively small compared to building damage until the building envelope is breached.

V-2.7 Describe how the impact of water infiltration is accounted for in the contents vulnerability functions.

The impacts of water infiltration are implicitly accounted for in the historical claims data used in the calibration and validation processes.

V-3 Development of Time Element Hurricane Vulnerability Functions

A. Development of the time element hurricane vulnerability functions shall be based on a combination of available insurance company hurricane claims data and rational engineering analysis supported by laboratory testing, field testing, or post-event site investigations.

The time element vulnerability functions were developed as a function of conditional building damage based on engineering analysis and judgment, published peer-reviewed research, and post-event reconnaissance. The time element vulnerability functions were initially developed using a component-based model to establish the amount of time required for restoration. These functions were further calibrated and validated using claims data from multiple historical events.

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 insurance company hurricane claims data.

The time element vulnerability functions were calibrated and validated using historical insurance claims data with coverage level detail.

C. Time element hurricane vulnerability function development shall consider the estimated time required to repair or replace the property.

The preliminary time element vulnerability functions were developed using a component-based methodology that incorporates the estimation of expected restoration times (Program Evaluation and Review Technique/Critical Path Method). The time element vulnerability functions describe loss behavior as a function of the conditional building damage ratios. The vulnerability functions were calibrated and validated using historical insurance claims data.

D. Time element hurricane vulnerability functions shall include time element hurricane losses associated with damage to the infrastructure caused by a hurricane.

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Time element vulnerability functions were derived using the information on the restoration of building function due to damage from wind loading to the structure. The vulnerability functions were calibrated and validated using historical insurance claims data, which implicitly covers losses associated with damage to the infrastructure.

V-3.1 Provide details of modifications to the time element vulnerability component of the hurricane model since the current accepted hurricane model.

There is one modification to the time element vulnerability component of the hurricane model since the currently accepted hurricane model. The time element vulnerability curves are now functions of conditional building damage ratios (previously a function of building damage ratios) due to the introduction of chance of loss to building damage ratios.

V-3.2 Provide a flowchart documenting the process by which the time element hurricane vulnerability functions are developed.

The time element vulnerability function development process is shown in Figure 46.

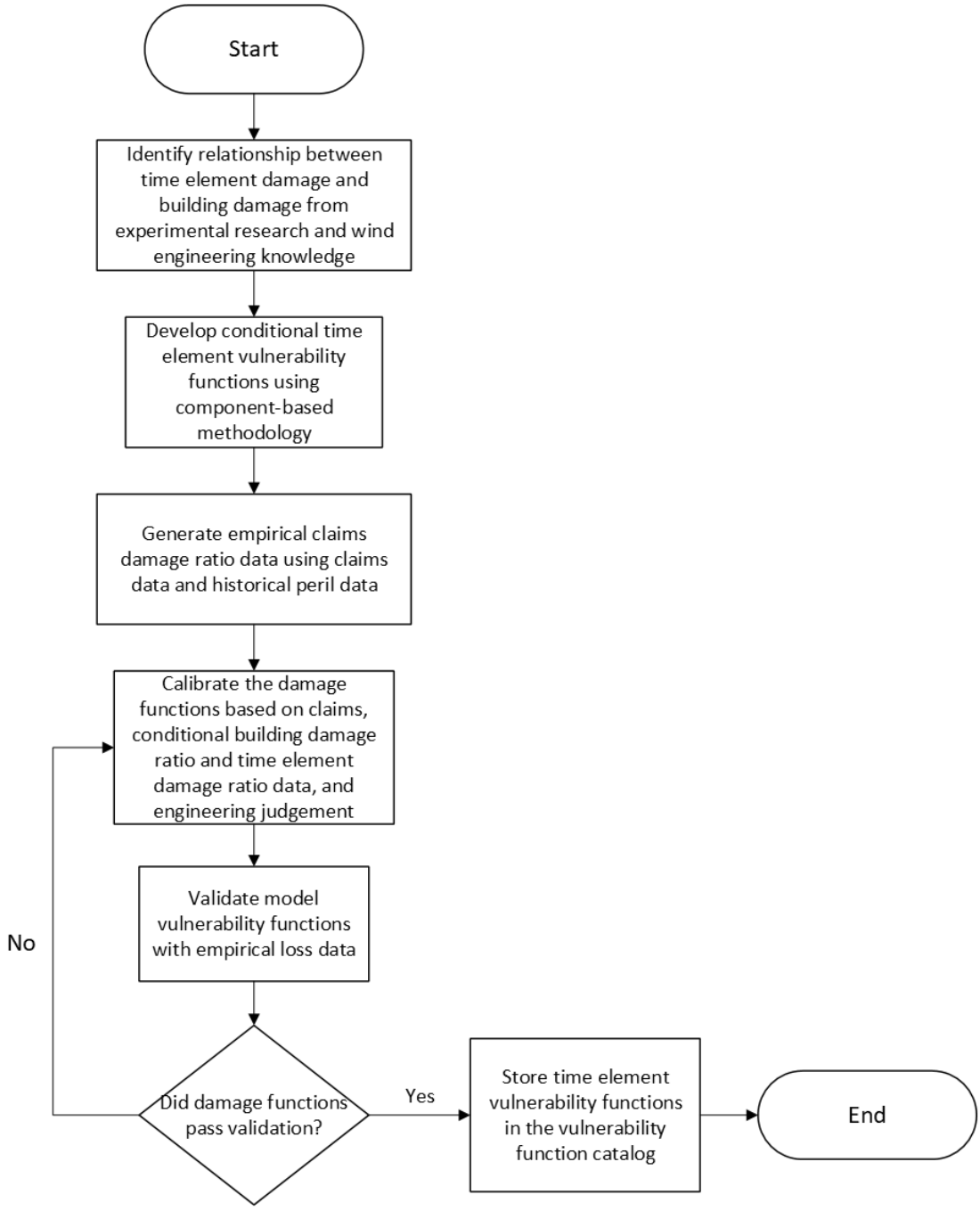


Figure 46: Development process for time element hurricane vulnerability functions

V-3.3 Describe the assumptions, data, methods, and processes used to develop the time element hurricane vulnerability functions.

The preliminary time element vulnerability functions were developed using a component-based model combined with a restoration process modeling using the estimation of expected restoration times (Program Evaluation and Review Technique/Critical Path Method) to determine time element losses (Seal, 2001). The cost and daily output data for each repair activity were obtained from RSMeans (Waier, 1995; Gordian, 2023). The time element vulnerability functions describe loss behavior as a function of the conditional building damage ratio. The vulnerability functions were calibrated and validated using insurance claims data.

V-3.4 Describe the basis, development, modeling, and treatment of uncertainties associated with the time element hurricane vulnerability functions.

The uncertainties associated with the time element hurricane vulnerability functions were initially modeled based on a Monte Carlo framework which performs statistical sampling for various wind loading conditions on different structural components. The time element vulnerability curves include both mean damage ratios and standard deviations for a given building damage ratio. The modeled uncertainties, or the standard deviation, were then calibrated or validated using the claims data.

V-3.5 Describe how time element hurricane vulnerability functions take into consideration damage to local and regional infrastructure.

The time element vulnerability functions do not explicitly distinguish between direct loss (i.e., losses related to building repair time) and indirect loss (e.g., losses caused by infrastructure service disruption under hurricane wind, storm surge, or flood). However, since insurance claims data from historical events were used to calibrate the time element vulnerability functions, the effects of local and regional infrastructure disruptions are implicitly accounted for within the time element vulnerability functions to the extent that such losses are included in the claims.

V-3.6 Describe the relationship between building structure and time element hurricane vulnerability functions.

The time element vulnerability functions reflect the time required to repair or reconstruct the damaged building to full function. Time element vulnerability is a function of the building damage ratio. At low building damage levels, the repair of the damaged building components is relatively fast and not significant enough to force the occupants to leave the dwelling. However, as the building damage level increases, the repair time also increases significantly. Infrastructure disruptions also contribute to the time element losses and are incorporated implicitly through calibration of the time element vulnerability functions with insurance claims data from historical hurricane events.

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 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 include:

- ***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 are theoretically sound and consistent with fundamental engineering principles. The secondary risk characteristics (secondary modifiers) are used to account for the effects of hurricane mitigation measures. These were developed through wind engineering analysis and then calibrated based on post-disaster damage survey reports, insurance claims data, and engineering judgment.

The impact of mitigation measures and secondary characteristics on a building's expected vulnerability and its associated uncertainty distribution is captured in the Impact Forecasting Florida Hurricane (FCHLPM) Model by secondary risk characteristics that increase or decrease the primary building vulnerability functions. The primary building vulnerability

functions are those developed for the distinct combinations of primary building characteristics described in Standard V-1. The secondary characteristics considered in the model include roof shape and strength, roof covering type and age, roof-to-wall connection, wall-to-floor-to-foundation connections, and opening strength and protection for windows, skylights, doors, and garage doors. Secondary risk characteristics and their descriptions are given in Disclosure V-4.4.

B. The modeling organization shall justify all hurricane mitigation measures and secondary characteristics considered by the hurricane model.

Key hurricane mitigation measures and secondary characteristics were identified based on structural engineering expertise and post-event reconnaissance of historical hurricane damage. The secondary risk characteristics were developed through wind engineering analysis and calibrated based on post-event damage survey reports and engineering judgment. Some limited insurance claims data were also used to calibrate and validate the secondary risk characteristics. The mitigation measures and secondary risk characteristics and their impacts on the building performance given hurricane hazards are well-documented.

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.

The application of hurricane mitigation measures, both individually and in combination, is reasonable. The effect of each hurricane mitigation measure was estimated separately based on wind and structural engineering analysis, post-event building performance survey reports, engineering judgment, and limited insurance claims data. If several mitigation measures are present, the effects of multiple mitigation measures are combined systematically, as described in Disclosure V-4.6.

D. Treatment of individual and combined secondary characteristics that affect the performance of the building and the damage to contents shall be justified.

The impact of an individual secondary characteristic on building structure performance is derived using wind and structural engineering analysis as well as engineering judgment. The secondary characteristics and mitigation measures are explicitly considered in estimating the building structure damage and accounted for when estimating the contents damage ratio, since the contents damage ratio is a function of the building structure damage ratio. The treatment of individual and combined secondary characteristics and the resulting building and contents vulnerability functions are in good agreement with insurance claims data.

V-4.1 Provide details of modifications to hurricane mitigation measures and secondary characteristics in the hurricane model since the current accepted hurricane model.

The modifications to hurricane mitigation measures and secondary characteristics in the hurricane model since the currently accepted hurricane model includes the application of secondary modifiers to chance of loss, conditional mean damage ratio and standard deviation (previously only applicable to mean damage ratio and standard deviation).

V-4.2 Describe the procedures used to calculate the impact of hurricane mitigation measures and secondary characteristics, including software, its identification, and current version. Describe whether or not such procedures have been modified since the current accepted hurricane model.

The impact of mitigation measures and secondary characteristics are calculated based on how these affects (improve or degrade) the wind performance of the structure. In general, the mitigation measures are accounted for by increasing the resistance (or, conversely, reducing it due to a lack of mitigation measures) of the mitigated components. The effect of wind loads acting on the components is incorporated by modifying the load profile of the corresponding components and re-computing the physical damage.

The mitigation measures and secondary characteristics are broadly categorized into two groups based on how these measures impact the loading and resistance of the components: (1) impacting the wind loads experienced by the structure, or (2) influencing the component resistance. In the former group, the modifications are made to the wind load acting on the component by using modified pressure profiles (e.g., using a different pressure profile for a

hip roof or gable roof), while in the latter group, the modifications are made to the resistance of the corresponding components (e.g., using different resistance values for a different roof deck nailing pattern or a different roof cover).

The methodology to calculate the effect of secondary modifiers for given hazards has been revised to include chance of loss along with conditional mean damage ratio and standard deviation (As mentioned in Disclosure V-4.1).

Secondary Modifiers are now applied to the Chance of Loss and damage ratios separately, where the Secondary Modifiers are applied to the Chance of Loss and the Secondary Modifier impact to conditional mean damage is accounted for after (As mentioned in Disclosure G-1.7 under software changes).

V-4.3 Provide completed Form V-2. Provide a link to the location of the form in the submission appendix [Form V-2: Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage].

Form V-2 in Excel format is provided in the file “IF2023FormV2.xlsx” at the link provided to the FCHLPM.

V-4.4 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.

Table 11: Secondary risk characteristics and their descriptions

Secondary Characteristic	Options	In Form V-2	Description
Roof age	Unknown roof age	Yes	The strength of the roofing system components reduces over time and the roofs become more vulnerable to wind loads. Newer roofs are generally better
	Roof age 0-5 years		
	Roof age 5-10 years		
	Roof age >10 years		

			designed for wind resistance and meet stricter building code requirements. Thus, newer roofs generally perform better than older roofs.
Roof-to-wall connections	Unknown connection		The type of roof-to-wall connection affects how well wind loads transfer to the walls. The failure of roof-to-wall connections will lead to the loss of roof and expose the interior building to rain and wind.
	No strap and no toenail		
	Only toenail	Yes	
	100% straps	Yes	
	100% clips	Yes	
Roof covering	Unknown roof covering		The material used to cover the roof affects the roof uplift capacity and debris impact resistance.
	Shingles (90 mph)	Yes	
	Tiles		
	Rated shingles (150 mph)	Yes	
	Rated shingles w/ secondary water barrier		
	Metal roof covering	Yes	
	Membrane	Yes	
Roof sheathing	Unknown roof sheathing		

	Roof sheathing (6d @ 6"/12")	Yes	The roof sheathing material and nailing pattern affects the vulnerability of building roofs. The damage of roof sheathing will increase the vulnerability of roof covers and expose the interior building to wind and rain.
	Roof sheathing (8d @ 6"/12")	Yes	
	Roof sheathing (8d @ 6"/6")		
	Metal deck		
	Concrete deck		
Roof type	Unknown roof type		The roof shape affects the intensity of the wind load a roof is likely to experience and the resulting uplift forces.
	Hip roof type	Yes	
	Flat roof type		
	Unbraced gable roof type	Yes	
	Braced gable roof type	Yes	
Floor size	Unknown building	Yes	The total floor area of a building. In general, larger buildings are more resistant to wind forces.
	Big building (>=5000 ft2)		
	Average building (2000-5000 ft2)		
	Small building (<2000 ft2)		
Window protection	Unknown window protection		Poor window protections will increase the vulnerability of buildings under high winds. If a window is breached, the
	No window protection	Yes	
	Ordinary non-impact	Yes	

	Basic impact	Yes	internal pressure of a building will increase, and the building envelope is more likely to be damaged. The damage to the building envelope will expose the interior building to wind and rain.
	Hurricane impact	Yes	
Garage doors	Garage door unknown	Yes	The braced garage door has stronger resistance to wind pressure.
	Garage door braced	Yes	
	Garage door unbraced		
	No garage		
Wall-to-floor connections	Unknown connection		The type of wall-to-floor connection affects how well wind loads transfer from the walls to the floor.
	Toenails	Yes	
	Ties or clips	Yes	
	Straps	Yes	
Wall-to-foundation connections	Unknown connection		The type of wall-to-foundation connection affects how well wind loads transfer from the wall system to the ground. A stronger connection prevents the building envelope from sliding or overturning.
	Regular anchors or large spacing	Yes	
	Large anchors or closer spacing	Yes	
	Straps	Yes	

Other opening protection	Unknown opening protection		Other openings include entry door, sliding door, and skylights. If an opening is breached, the internal pressure of a building will increase, and the building envelope is more likely to be damaged. The damage to the building envelope will expose the interior of the building to wind and rain.
	No opening protection	Yes	
	Ordinary non-impact		
	Basic impact shutters	Yes	
	Hurricane impact	Yes	

V-4.5 Describe how hurricane mitigation measures and secondary characteristics are implemented in the hurricane model. Identify any assumptions.

The set of secondary characteristics available for model users to select is provided in Table 11. The hurricane mitigation and secondary characteristics values vary by primary vulnerability function and wind speed. These can increase, reduce, or maintain the primary building vulnerability functions. The secondary characteristics are used to adjust the behavior of the underlying building based on conditions provided in the exposure data. The change in building damage ratio affects the contents vulnerability as well since the content vulnerability is derived and modeled as a function of building vulnerability. In the absence of any mitigation or secondary risk characteristics, the model uses the primary vulnerability curve without any modification.

V-4.6 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.

The effects of multiple hurricane mitigation measures and secondary characteristics are combined with a multiplicative methodology. Limits (both lower and upper bounds) are implemented to control the maximum change when many secondary characteristics are simultaneously applied. The impacts of multiple hurricane mitigation measures and secondary characteristics were calibrated and validated through structural engineering analyses and post-event reconnaissance.

V-4.7 Describe how building and contents damage are affected by performance of hurricane mitigation measures and secondary characteristics. Identify any assumptions.

The hurricane mitigation measures and secondary characteristics can increase, decrease, or maintain the primary building vulnerability functions depending on the secondary characteristics used. The magnitude of increase or decrease in building damage ratios for each modifier option varies by wind speed. When multiple mitigation measures are present, their combined impact on the building damage ratio will be capped (upper and lower bound) in the model. The contents damage ratio changes monotonically to the building damage ratio. No additional assumptions were made.

V-4.8 Describe how roof age and roof covering type are incorporated in the hurricane model.

The impact of roof age and roof covering are calculated based on how these affects (improve or degrade) the wind performance of the structure. The strength of the roofing system components reduces over time and the roofs become more vulnerable to wind loads. Thus, newer roofs generally perform better than older roofs. Similarly, for roof covering the material used to cover the roof affects the roof uplift capacity and debris impact resistance. These adjusted damage functions are used in the elements framework to generate the losses for different roof age and roof covering options. Table 11 lists all the roof age and roof covering options supported in Impact Forecasting vulnerability model.

V-4.9 Describe how hurricane mitigation measures and secondary characteristics affect the uncertainty of the vulnerability. Identify any assumptions.

The vulnerability functions for buildings with secondary characteristics were developed using the same load and resistance model as buildings with unknown secondary characteristics (primary vulnerability functions). The output of the damage simulator provides the conditional mean and the standard deviation of damage ratios, and chance of loss at each wind speed using a Monte Carlo method. When secondary characteristics and mitigation measures are considered, the conditional mean and standard deviation, as well as chance of loss of the vulnerability function change to reflect the combined vulnerability due to the chosen secondary characteristics. No additional assumptions were made.

V-4.10 Provide completed Form V-3 if not considered as Trade Secret. Provide a link to the location of the form in the submission appendix[Form V-3: Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)].

Form V-3 is considered to be trade secret material and will be provided to the Professional Team for review during the on-site visit and to the Commission during the closed portion of the Acceptability Meeting.

V-4.11 Provide completed Form V-4. Provide a link to the location of the form in the submission appendix [Form V-4: Differences in Hurricane Mitigation Measures and Secondary Characteristics].

Form V-4 in Excel format is provided in the file “IF2023FormV4.xlsx” at the link provided to the FCHLPM.

V-4.12 Provide completed Form V-5 if not considered as Trade Secret. Provide a link to the location of the form in the submission appendix [Form V-5: Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)].

Form V-5 is considered to be trade secret material and will be provided to the Professional Team for review during the on-site visit and to the Commission during the closed portion of the Acceptability Meeting.

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.*

Any adjustments, edits, inclusions, or deletions made to insurance company or other input data are based upon 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.*

Model input data is provided by the user for each hurricane model analysis. The Impact Forecasting model performs validation tasks during exposure data import and includes any anomalies in the import log file to help users ensure data integrity. All modifications, adjustments, assumptions, inputs and input file identification, and defaults necessary to use the hurricane model are actuarially sound and are included with the hurricane model output report and in the Impact Forecasting documentation. Treatment of missing values required to run the hurricane model is actuarially sound.

A-1.1 *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 Impact Forecasting Florida Hurricane (FCHLPM) Model does not make assumptions regarding insurance-to-value. The insured value and insurance limits are provided as separate inputs by the user. Users may enter different values for insurance limit and replacement value to reflect certain policy terms such as underinsurance or guaranteed

replacement cost. No adjustments are made to these values within the model. As such, no sample calculation has been provided.

A-1.2 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.

The Impact Forecasting Florida Hurricane (FCHLPM) Model does not make assumptions of depreciation and does not reduce insured hurricane losses on account of depreciation. Users have the option to code the actual cash values instead of the replacement cost values into the hurricane model input file. Depreciation assumptions can be made by the user in the exposure data prior to running the Impact Forecasting model. As such, no sample calculation has been provided.

A-1.3 Describe the methods and input data used to distinguish among policy form types (e.g., homeowners, dwelling property, manufactured homes, tenants, condo unit owners) and their deductibles and coverage limits.

The Impact Forecasting Florida Hurricane (FCHLPM) Model distinguishes various personal and commercial residential policy form types based on occupancy type and construction class as coded in input data. Manufactured homes are identified by construction type (i.e., mobile home tied down, mobile home not tied down, mobile home unknown tie down state, mobile home double wide). Other policy form types are distinguished by occupancy type (i.e., residential single family, residential multi-family, residential renter, residential condominium unit owner, commercial apartment condominium association). For any policy form type, losses can be estimated based on vulnerability characteristics coded in the exposure and by coverage (i.e., building, appurtenant structure, contents, time element). Impact Forecasting Florida Hurricane (FCHLPM) Model input data includes coverage limit fields for building, contents, and additional living expense/business interruption separately. The Impact Forecasting Florida Hurricane Model input data also includes fields for deductibles (in dollar amount or as a percentage of a coverage). The deductible can be coded to be applied at policy level, location level, or coverage level, as described in the Hurricane Model Input Form Input in Appendix C: Hurricane Model Input Form.

A-1.4 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 shall be clearly labeled and defined.

The Impact Forecasting Florida Hurricane (FCHLPM) Model has a data import and mapping feature. The data import and mapping feature enable users to convert flat files of peril-specific policy data into portfolios which can be used by the model to analyze exposures and produce results in the form of PML curves or other loss reports.

Multiple import formats are supported for importing exposure information into the Impact Forecasting exposure database. The ELEMENTS Input Data Format document (see Disclosure CI-2.1) describes input field names and data types that are supported during import, including the fields which are required in order to generate loss estimates.

The Impact Forecasting model supports 3 different types of input file formats to import exposure:

- Two File Format: This is a simplified input file format using just one file and an additional optional file called SecondaryModifiers which carry the secondary modifier values for all perils.
- Four File Format (Formerly known as Three-File Format): This format contains a nearly complete set of features in three input files with partially normalized data, and an additional optional file called SecondaryModifiers. This is easier to create and edit manually compared to the ENF format, but perhaps not as easy to create from an existing normalized database. The file containing treaty information may be omitted if no treaties exist for a portfolio.
- ELEMENTS Normal Format (ENF): This format contains multiple files with fully normalized input data. Some files may be excluded if no information from them is needed for that portfolio (such as if the portfolio does not have treaties or sub-policies).

The input form(s) used by the hurricane model are provided in Appendix C: Hurricane Model Input Form.

- Location data fields are provided in Table 49.

Impact Forecasting Florida Hurricane (FCHLPM) Version 3.0

- Policy data fields are provided in Table 50.
- Treaty data fields (optional) are provided in Table 51.
- SecondaryModifiers data fields (optional) are provided in Table 52.
- Screenshots of a sample data file and import options are provided in Figure 91, Figure 92, Figure 93, Figure 94, and Figure 95.

The process for the user to generate the model output produced by such input is shown in Figure 47.

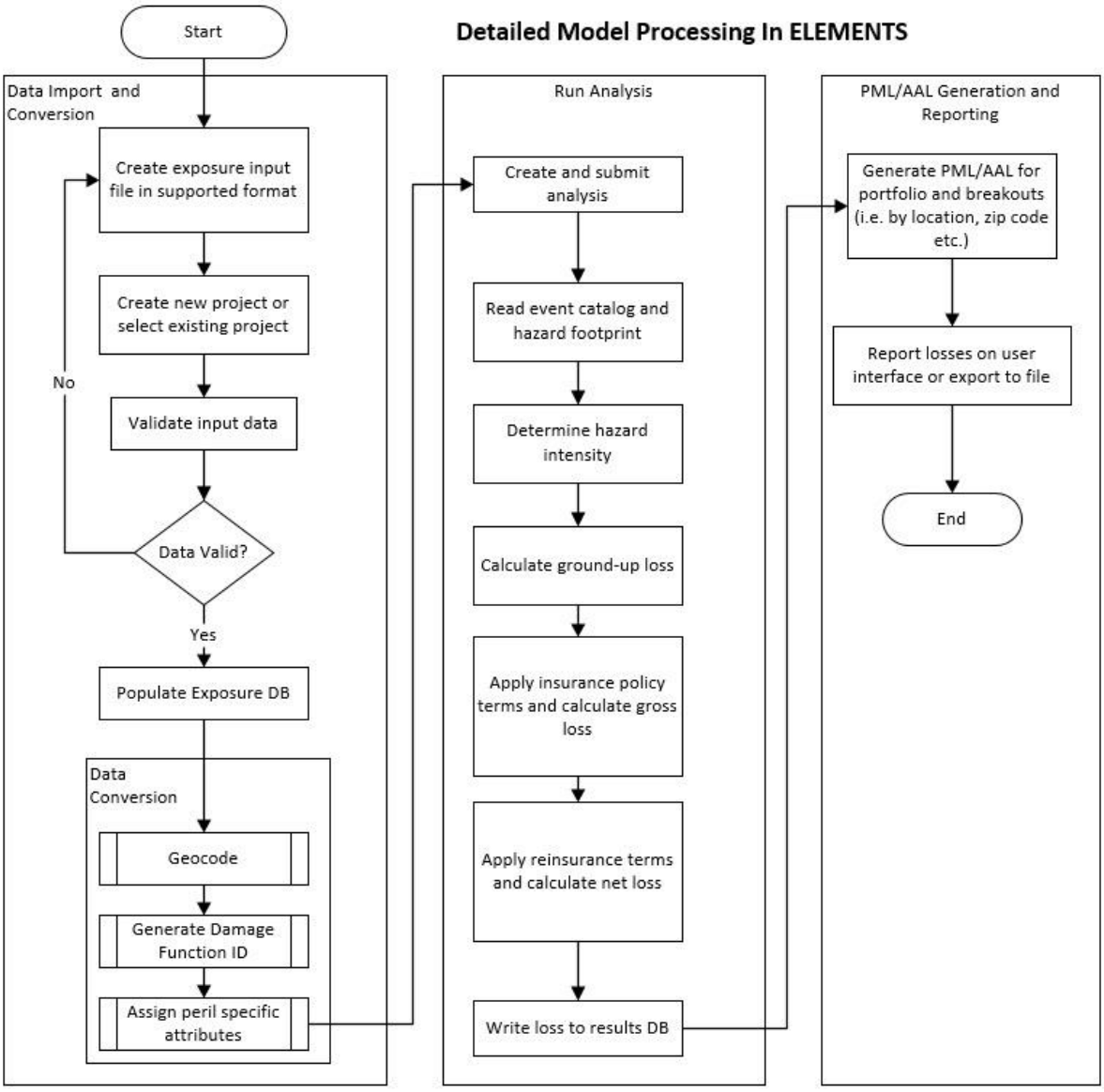


Figure 47: User workflow to create hurricane model output

A-1.5 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 in Florida. 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 shall be clearly labeled, highlighted, and defined.

Analysis options for Florida rate making are specified by Florida Statute FS 627.0628. The following Impact Forecasting Florida Hurricane (FCHLPM) Model options are required for Florida personal lines ratemaking model runs (Table 12).

A-1.6 Provide the specific set of options acceptable for use in preparing a Florida insurance rate filing.

All options available and options acceptable for a Florida rate filing have been included in Table 12.

Table 12: Required Impact Forecasting Florida Hurricane (FCHLPM) Model v3.0 analysis settings for Florida ratemaking

Option	For All Available Settings	For Florida Rate Filing	Note
ELEMENTS Version	18.1.0.0	18.1.0.0	Version of ELEMENTS platform
Region	United States	United States	Region selection
Peril	Tropical Cyclone/Tropical Cyclone Scenario	Tropical Cyclone	Peril selection
Model Suite	Impact Forecasting	Impact Forecasting	Model suite selection

Option	For All Available Settings	For Florida Rate Filing	Note
Peril Type	Florida Hurricane (FCHLPM) v3.0	Florida Hurricane (FCHLPM) v3.0	Peril type selection
Tropical Cyclone Damage	Wind Only	Wind Only	Peril option selection
Loss Cases	With/Without Demand Surge	With Demand Surge	Demand surge option provides losses that include increased cost of labor and material following major catastrophe.
Include Damage Uncertainty	Yes/No	Yes	This option allows the user to run damage calculation with a defined number of samples to account for damage uncertainty.
Custom Damage Samples	Yes/No	No	This option allows the user to change the default number of samples suggested for given model.
Custom Event selection	Yes/No	No	This option enables the user to generate losses for selected events out of the full event catalog.
Custom Damage Function	Yes/No	No	This option allows the user to overwrite the default damage function with custom vulnerability curve.

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Option	For All Available Settings	For Florida Rate Filing	Note
Parameter Adjustment	Yes/No	No	This option allows the user to adjust ground up losses based on given criteria.
Use location-based seed	Yes/No	Yes	Use of location-based seed ensures result repeatability (the same location will always generate the same losses irrespective of order of record in given portfolio).
View (when viewing output report)	Long Term/Near Term View	Long Term View	Provides the user an option to view the Long Term or Near Term view of the risk.

The hurricane model output report is provided Appendix D: Hurricane Model Output Form.

Screenshots of analysis settings and report viewing options referred to in Table 12 are provided in Figure 97, Figure 98, and Figure 99.

Example screenshots of the hurricane model output (results) are provided in Figure 100 and Figure 101.

A-1.7 Describe actions performed to ensure the validity of insurer or other input data used for hurricane model inputs or for validation/verification.

The Impact Forecasting model performs validation tasks during exposure data import. Below is a list of assumptions for treatment of data during import.

Insurance to Value

The model does not make assumptions regarding insurance to value. The insured value and insurance limits are provided as separate inputs. No adjustments are made to these values within the model. Users may enter different values for insurance limit and replacement value to reflect certain policy terms such as underinsurance or guaranteed replacement cost.

Missing values of building characteristics

If building characteristics are missing, the model defaults to an unknown value. Unknown values are based on the weighted average of known characteristic(s) (see Disclosure V-1.11). If policy conditions are missing, the model does not make additional assumptions.

Appurtenant structures

Limits and values of appurtenant structures for each location are user inputs. The model does not make assumptions regarding the value of appurtenant structures.

Contents

Contents limits and values are part of the user input. No assumptions are made within the model.

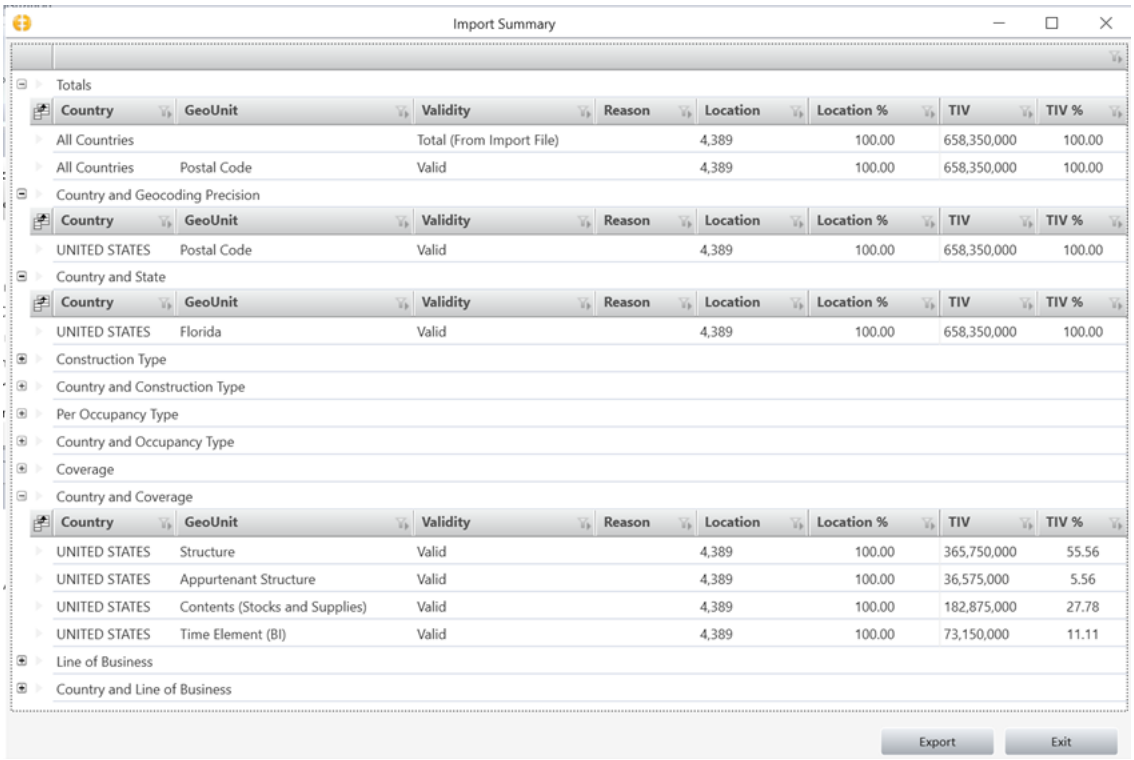
Time Element coverage

Time element coverage limits and values are part of the user input. No assumptions are made within the model.

Geocoding

As discussed in Disclosure G-3.4, there are four ways to geocode portfolio data within the Impact Forecasting model. If both address and longitude/latitude information are available, users are given an option to select how geocoding should be performed. If the policy's address is incorrect, ZIP Code centroid geocoding is performed for the policy. If a location does not geocode (for example, if a ZIP Code is invalid), the location is excluded from the analysis. All locations that are not included in the analysis are recorded in a log file.

The portfolio Import Summary (Figure 48) and portfolio Import Log (Figure 49) are available upon completion of data import. It is recommended that the logs and exposure summary be reviewed prior to running the model in order to ensure data integrity prior to analysis. Upon review, the user may correct any errors and re-import the data. Invalid locations are omitted from the import.



Country	GeoUnit	Validity	Reason	Location	Location %	TIV	TIV %
All Countries		Total (From Import File)		4,389	100.00	658,350,000	100.00
All Countries	Postal Code	Valid		4,389	100.00	658,350,000	100.00

Country	GeoUnit	Validity	Reason	Location	Location %	TIV	TIV %
UNITED STATES	Postal Code	Valid		4,389	100.00	658,350,000	100.00

Country	GeoUnit	Validity	Reason	Location	Location %	TIV	TIV %
UNITED STATES	Florida	Valid		4,389	100.00	658,350,000	100.00

Country	GeoUnit	Validity	Reason	Location	Location %	TIV	TIV %
UNITED STATES	Structure	Valid		4,389	100.00	365,750,000	55.56
UNITED STATES	Appurtenant Structure	Valid		4,389	100.00	36,575,000	5.56
UNITED STATES	Contents (Stocks and Supplies)	Valid		4,389	100.00	182,875,000	27.78
UNITED STATES	Time Element (BI)	Valid		4,389	100.00	73,150,000	11.11

Figure 48: Sample portfolio Import summary

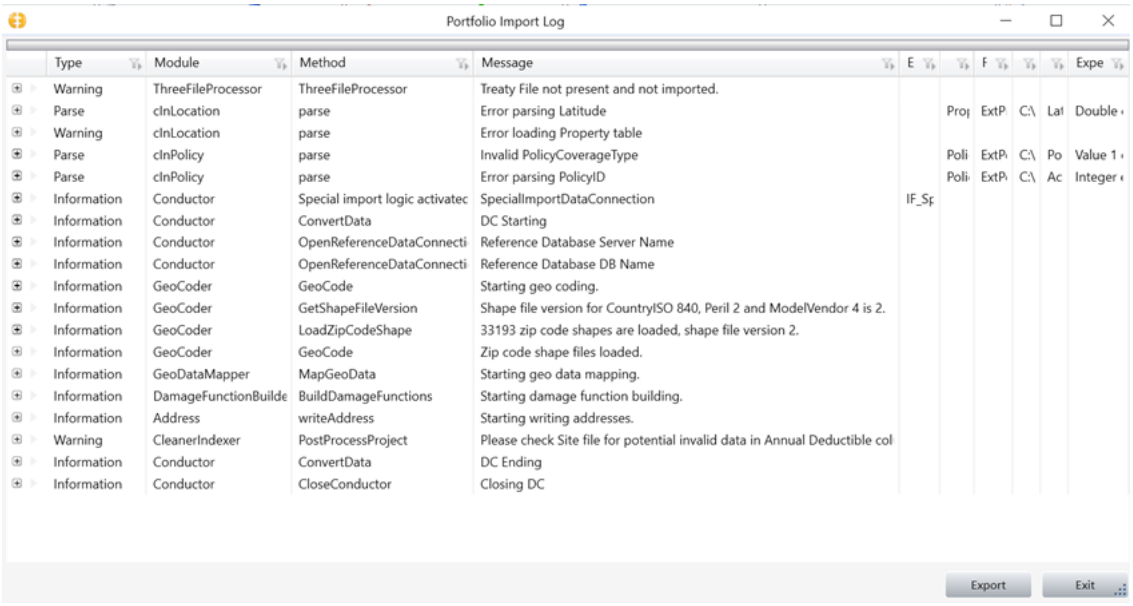


Figure 49: Sample portfolio Import log

A-1.8 Disclose if changing the order of the hurricane model input exposure data produces different hurricane model output or results.

The order of hurricane model input exposure data does not affect the hurricane model output or results.

A-1.9 Disclose if removing or adding policies from the hurricane model input file affects the hurricane model output or results for the remaining policies.

Adding or removing policies from the hurricane model input file does not affect the output or results for the remaining policies.

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 and hurricane probable maximum loss levels reflect all insured wind-related damages from storms classified as landfalling or by-passing hurricanes that produce minimum damaging wind speeds or greater on land in Florida, as described in Disclosure A-2.1.

B. The modeling organization shall have a documented procedure for distinguishing wind-related hurricane losses from other peril losses.

Impact Forecasting has a documented procedure for distinguishing wind losses from other peril losses. As shown in Figure 97, the Impact Forecasting Florida Hurricane (FCHLPM) Model only provides users the option to model wind-only losses. Storm surge losses are excluded from any Florida hurricane analysis by the Impact Forecasting Florida Hurricane (FCHLPM) Model.

A-2.1 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.

The calculation of hurricane loss costs and hurricane probable maximum loss levels for Florida include damage from landfalling and by-passing hurricanes. Damage is included in the calculation of hurricane loss costs and probable maximum losses from the time when the hurricane first reaches damaging wind speeds on land in Florida.

A-2.2 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.

The Impact Forecasting Florida Hurricane (FCHLPM) Model only provides users the option to model wind-only losses. Storm surge losses are excluded from any Florida hurricane analysis by the Impact Forecasting Florida Hurricane (FCHLPM) Model.

A-3 Hurricane Coverages

A. *The methods used in the calculation of building hurricane loss costs, including the effect of law and ordinance coverage, shall be actuarially sound.*

The methods used in the development of building hurricane loss costs are actuarially sound. The vulnerability functions are developed based on well-established structural and wind engineering science in literature and calibrated and validated by analyzing historical hurricane claims data. Impact Forecasting model has three distinct sets of damage functions to account for 0%, 25% and 50% law and ordinance coverage for Florida residential buildings.

In addition, Aon is a major sponsor of the Insurance Institute for Business and Home Safety (IBHS) and serves on the IBHS Research Advisory Board. Aon and Impact Forecasting personnel have participated in several post-hurricane site surveys. The knowledge acquired during these independent studies have been used to enhance the calibration and validation of the vulnerability functions.

B. *The methods used in the calculation of appurtenant structure hurricane loss costs shall be actuarially sound.*

The methods used in the calculation of appurtenant structure hurricane loss costs are actuarially sound. The Impact Forecasting Florida Hurricane (FCHLPM) Model calculates appurtenant structure hurricane loss costs separately from building, contents, and time element hurricane loss costs. The methods used in the calculation of appurtenant structure hurricane loss costs are similar to the methods used for the calculation of building hurricane loss costs.

C. *The methods used in the calculation of contents hurricane loss costs shall be actuarially sound.*

The methods used in the development of contents hurricane loss costs are actuarially sound. The Impact Forecasting Florida Hurricane (FCHLPM) Model calculates contents loss cost

separately from building, appurtenant structure, and time element hurricane loss costs. The model has been validated against actual loss data.

D. The methods used in the calculation of time element hurricane loss costs shall be actuarially sound.

The methods used in the development of time element hurricane loss costs are actuarially sound. The Impact Forecasting Florida Hurricane (FCHLPM) Model calculates time element losses based on the estimated time to repair the structure, which is determined based on the estimated damage to the structure. Time element damage functions have been calibrated and validated against actual hurricane event time element coverage losses.

A-3.1 Describe the methods used in the hurricane model to calculate hurricane loss costs for building coverage associated with personal and commercial residential properties.

Hurricane loss cost for building coverage is calculated through the following steps:

1 Based on the latitude/longitude, year built, number of stories, construction and occupancy types, secondary modifiers (garage doors, floor size, window protection, roof type, age, connections, covering, and sheathing, other opening protection, wall-to-floor connections and wall-to-foundation connections), and tier (vulnerability region), a vulnerability function is assigned to the exposure.

2 Wind speed is determined for each simulated event and location. Based on the wind speed a probability of loss occurrence (chance of loss) is assigned and sampled random number is compared to said probability to determine whether loss occurred. If so, a damage ratio for that exposure is generated by sampling from distribution defined by mean damage ratio and standard deviation. A Monte Carlo simulation approach, sampling separately from probability of loss occurrence and damage ratio distributions, is used to produce the damage samples at the coverage level.

3 Ground up loss is calculated based on the damage ratio and exposure for building coverage.

4 Gross loss is calculated after applying limits, deductibles, coinsurance, etc., at the coverage, location, and policy levels.

5 Average Annual Loss (AAL) is the sum product of event rate and event loss across all simulated events.

6 Loss cost is the average annual loss per $1,000 of insured value (loss is divided by the insured value, then multiplied by 1,000).

A-3.2 Describe the methods used in the hurricane model to calculate hurricane loss costs for appurtenant structure coverage associated with personal and commercial residential properties.

The Impact Forecasting Florida Hurricane (FCHLPM) Model estimates hurricane losses for appurtenant structure coverage associated with personal and commercial residential properties using the same method as for building coverage, as described in Disclosure A-3.1, but using the input appurtenant structure coverage values. The Impact Forecasting model can assign a different vulnerability function for appurtenant structures if the appurtenant structure is separately coded with different characteristics in the input file.

A-3.3 Describe the methods used in the hurricane model to calculate hurricane loss costs for contents coverage associated with personal and commercial residential properties.

Hurricane loss cost for contents coverage is calculated through the following steps:

1 Based on the latitude/longitude, year built, number of stories, construction and occupancy types, secondary modifiers (garage doors, floor size, window protection, roof type, age, connections, covering, and sheathing, other opening protection, wall-to-floor connections and wall-to-foundation connections), and tier (vulnerability region), a vulnerability functions for building and contents are assigned to the exposure.

2 Wind speed is determined for each simulated event and location. Based on the wind speed a probability of building loss occurrence (chance of loss) is assigned and sampled random number is compared to said probability to determine whether building loss occurred. If so, based on the contents vulnerability function conditional on building damage ratios, a damage ratio is generated by sampling from distribution defined by mean damage ratio and standard deviation. A Monte Carlo simulation approach, sampling separately from probability of building loss occurrence, from building damage ratio distributions and contents damage ratio distributions dependent on building damage ratios, is used to produce the damage samples at the coverage level.

3 Ground up loss is calculated based on the damage ratio and exposure for contents coverage.

4 Gross loss is calculated after applying limits, deductibles, coinsurance, etc., at the coverage, location, and policy levels.

5 Average Annual Loss (AAL) is the sum product of event rate and event loss across all simulated events.

6 Loss cost is the average annual loss per $1,000 of insured value (loss is divided by the insured value, then multiplied by 1,000).

A-3.4 Describe the methods used in the hurricane model to calculate hurricane loss costs for time element coverage associated with personal and commercial residential properties.

Hurricane loss cost for time element coverage is calculated through the following steps:

1 Based on the latitude/longitude, year built, number of stories, construction and occupancy types, secondary modifiers (garage doors, floor size, window protection, roof type, age, connections, covering, and sheathing, other opening protection, wall-to-floor connections and wall-to-foundation connections), and tier (vulnerability region), a vulnerability functions for building and time element are assigned to the exposure.

2 Wind speed is determined for each simulated event and location. Based on the wind speed a probability of building loss occurrence (chance of loss) is assigned and sampled random number is compared to said probability to determine whether building loss occurred. If so, based on the time element vulnerability function conditional on building damage ratios, a damage ratio is generated by sampling from distribution defined by mean damage ratio and standard deviation. A Monte Carlo simulation approach, sampling separately from probability of building loss occurrence, from building damage ratio distributions and time element damage ratio distributions dependent on building damage ratios, is used to produce the damage samples at the coverage level.

3 Ground up loss is calculated based on the damage ratio and exposure for time element coverage.

4 Gross loss is calculated after applying limits, deductibles, coinsurance, etc., at the coverage, location, and policy levels.

5 Average Annual Loss (AAL) is the sum product of event rate and event loss across all simulated events.

6 Loss cost is the average annual loss per $1,000 of insured value (loss is divided by the insured value, then multiplied by 1,000).

A-3.5 Describe the methods used in the hurricane model to account for law and ordinance coverage associated with personal residential properties.

Impact Forecasting Florida Hurricane (FCHLPM) model uses vulnerability functions to account for law and ordinance coverage for personal residential properties. The Impact Forecasting component-based vulnerability simulator captures the Florida building code requirements for roof and window replacement along with the increased replacement costs of different components. These additional costs are capped at the law and ordinance coverage limit.

Three sets of building damage functions were developed using vulnerability simulator and implemented into the model for Florida residential buildings to represent 0%, 25%, or 50% law and ordinance coverage.

The historical claims data is assumed to have a required 25% law and ordinance coverage by default and is used to calibrate the vulnerability functions representing 25% law and ordinance coverage option.

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.

Hurricane losses and probable maximum loss levels generated by the Impact Forecasting Florida Hurricane (FCHLPM) Model do not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margins.

B. Hurricane loss cost projections and hurricane probable maximum loss levels shall not make a prospective provision for economic inflation.

The Impact Forecasting Florida Hurricane (FCHLPM) Model does not make a prospective provision for economic inflation.

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 Impact Forecasting Florida Hurricane (FCHLPM) Model only provides users the option to model wind-only losses. Storm surge losses are excluded from any Florida hurricane analysis by the Impact Forecasting Florida Hurricane (FCHLPM) Model.

D. Hurricane loss cost projections and hurricane probable maximum loss levels shall be capable of being calculated from exposures at a geocode (latitude and longitude) level of resolution.

The Impact Forecasting Florida Hurricane (FCHLPM) Model is capable of calculating hurricane loss cost projections and hurricane probable maximum loss levels based on exposures at a geocode (latitude-longitude) 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 Impact Forecasting model's calculation of hurricane loss costs and probable maximum loss levels. The demand surge function is developed based on analysis of the pricing information for the construction sector from Xactimate and XactContents (Olsen & Porter, 2011a; Xactware, 2020) before and after hurricanes occurred between 1990 and 2021. The methods and assumptions underlying the demand surge factors are actuarially sound and described in Disclosure A-4.3.

A-4.1 Describe the method(s) used to estimate annual hurricane loss costs and hurricane probable maximum loss levels and the treatment of associated uncertainties. Identify any source documents used and any relevant research results.

Method to calculate Annual Average loss and hurricane probable maximum loss levels relies on a loss table that represents 300,000 years of hurricane activity together with loss estimates for each stochastic event. After aggregation per year, new table contains a complete distribution of annual losses (sum of losses of all events in given year) and annual loss maxima (maximum of losses in given year) for hurricanes affecting Florida.

Following are the methods used to calculate loss distribution characteristics from such data:

Annual Average Loss $$AAL = \frac{1}{300{,}000}\sum_{n=1}^{300{,}000} L_n$$

Standard Deviation $$StD = \sqrt{\frac{\sum_{n=1}^{300{,}00}(L_n - AAL)^2}{300{,}000}},$$

(5)

Where $n \in \{1, 2, 3, \ldots, 300000\}$ is index of stochastic year and L_n is annual loss for given year.

Occurrence PML calculation

- Sort annual loss maxima from largest to lowest and assign 1/300000 as probability of occurrence of each annual loss maxima

- Calculate cumulative probability for all losses and its inverse value represents return period
- If a certain return period level does not exist in the event loss table, linear interpolation is used to determine the loss level for that return period.

Aggregate Exceedance Probability PML calculation

- Sort annual loss from largest to lowest and assign 1/300000 as probability of occurrence of each annual loss
- Calculate cumulative probability for all losses and its inverse value represents return period
- If a certain return period level does not exist in the event loss table, linear interpolation is used to determine the loss level for that return period.

The table with 300,000 years of hurricane activity and associated losses originates in 2,571,436 stochastic tropical cyclones generated in North Atlantic basin simulated in 200,000 years. Such large number of footprints used for loss calculation would lead to very long model run-times, hence only reduced number of stochastic events are used in the model runs. This reduced selection of stochastic events is decided using maximum wind speed (V_max), radius of maximum (R_max) winds and decay rate (α) in 32 gates along Unites States coast to guarantee that each parameters distribution remains relatively unchanged, but with lower number of events. After this reduction (143,131 events US wide out of which 55,956 affect Florida) one can use the linking table of events from original set and 'loss representatives' in model's reduced set to construct a complete table with all the events in their respective stochastic years and their proxy-losses.

Although the model simulates 200,000 years of activity, the table lists 300,000 years to align with Impact Forecasting's many global models. These additional 100,000 years do not significantly impact the resulting PMLs and loss averages, as the additional 100,000 years are sampled randomly from existing stochastic years until the 300,000 years are complete.

Loss estimation in the model is based on the assessment of hazard intensities at each of the exposure sites. The site losses are determined for all possible hazard events that may occur in the site's specific region from the reduced stochastic event set. The loss analysis method estimates losses to building, appurtenant structure, contents, and time element coverage for each simulated event by using pre-developed damage functions. The model outputs different

perspectives of hurricane losses, including ground up loss, gross loss (net of deductibles and policy limits), and net loss (net of reinsurance recoveries).

The uncertainty captured in the model is coming from the probability of loss occurrence (Chance of Loss) and uncertainty of damage ratio for given hazard at a site. In the model run, Monte Carlo simulation approach is taken, where for given event and site, a hazard value is taken from precalculated hazard files, based on the hazard the probability of loss occurrence is obtained from vulnerability file, random number is sampled and compared to that probability do decide whether loss occurs or not. If so, another random number is used to sample from beta distribution of damage ratios taken from the vulnerability file, which is applied on insured values to obtain ground-up loss and with policy conditions also other loss perspectives. Losses are then aggregated to the desired output level and sample average is calculated for each event. As described above, event mean proxy-losses obtained by estimates on reduced event set are then used to populate 300,000 years of hurricane activity, which then lead to calculation of annual hurricane loss costs and hurricane probable maximum loss levels.

A-4.2 Identify all possible resolutions available for the reported hurricane output ranges. Identify the finest level of resolution (i.e., the most granular level) for which hurricane loss costs and hurricane probable maximum loss levels can be provided.

In the Impact Forecasting Florida Hurricane (FCHLPM) Model, hurricane loss costs and hurricane probable maximum loss can be produced at the location or site level. Hurricane loss costs and hurricane probable maximum loss levels can then be calculated at any geographic level, such as ZIP Code, county, state, etc.

A-4.3 Describe how the hurricane model incorporates demand surge in the calculation of hurricane loss costs and hurricane probable maximum loss levels.

Demand surge factors are calculated for each simulated event and are applied uniformly to each risk which experiences loss for that event. For each event, the demand surge factor is a function of the storm's estimated US industry-wide loss before consideration of demand

surge. The method to estimate US industry-wide loss from Florida industry loss is provided at the end of the Disclosure.

The building and contents demand surge factors following a historical hurricane were estimated based on the pricing information for the construction sector from Xactimate (for building materials) and XactContents (for contents). Xactimate and XactContents are computer software developed and distributed by Xactware Solutions, Inc (Olsen & Porter, 2011a; Xactware, 2020). Xactware collects pricing data on building repairs, contents replacement, and cleaning costs for more than 470 cities in the United States, Canada, United Kingdom, and Ireland. The removal and replacement cost for each repair line item is the sum of the labor, material, and equipment costs. The sets of the repair line-items typically performed in reconstruction after hurricanes and the amount for each item were determined based on expert judgment.

The approach to estimate the building and contents demand surge is to examine the peak surge of total construction cost of one basket of repair line-items following historical hurricanes. From the history of the total construction cost, Impact Forecasting researchers projected what the cost would have been in the period following the hurricane had no hurricane occurred. Any gap between the predicted total construction cost and the actual cost, adjusted by the normal Consumer Price Index inflation, was assumed to be caused by demand surge. In total, the impact of 21 US landfalling hurricanes from 1990 to 2021 were considered. From these observations of structural and contents demand surge, the functional relationship between the demand surge and industry-wide loss was generalized.

The time element demand surge was implicitly considered in the above procedure. Higher building and contents demand surge implies a more severe mismatch between the demand for reconstruction work and the supply of repair materials and labor. This mismatch can translate into longer delays in completing the repair work, which in turn leads to a higher time element surge. From the analysis of the 21 historical hurricanes, it was found that the peak demand surge for structure and contents does not always occur immediately after the landfall of a hurricane. It could occur several months after a hurricane impacts that region.

The function for estimating demand surge depends on United States industry-wide Ground Up loss, and since the model under review contains only Florida, it was necessary to employ a method that would estimate United States industry loss using Florida industry loss as an

input. To do this, Impact Forecasting used the United States Hurricane model (Version 3.0) to calculate ratios between United States industry loss and Florida industry loss for all Florida-landfalling events. In this process, each Florida-landfalling event produced two values: a Florida-only loss and a loss for the whole of the United States. These values were then converted to a ratio. Once these ratios were obtained, they were split into groups based on landfalling category at their respective landfalling gates, of which there are 32. The outcome of this process was that for each hurricane category at each of the 32 landfall gates, a distinct ratio was produced (totaling 160 distinct ratios). Once these ratios were obtained, the model under review was run against the same exposure, and for each event making landfall in Florida the estimated United States Ground Up loss was derived from the Florida Ground Up loss by applying the aforementioned ratios, which are determined based on each event's landfall gate and category at landfall. As the function for estimating demand surge depends on the United States industry-wide Ground Up loss, the resulting estimated United States loss is then used to create the demand surge function for that event.

An exception to this process is required for events that bypass Florida in the model under review. For these events in the model under review, for their given landfall gate and category, the United States Hurricane model's event that produces the most similar Florida-only loss is chosen as a proxy, and that event's United States ground up loss is used instead of applying the aforementioned ratios (as the ratios would be largely influenced by the loss levels achieved by landfalling events of that given category and landfall gate).

A-4.4 Provide citations to published papers, if any, or modeling-organization studies that were used to develop how the hurricane model estimates demand surge.

The following references were used to guide the development of the demand surge model:

Ahmadi, N., & Shahandashti, S. M. (2018). Role of predisaster construction market conditions in influencing postdisaster demand surge. Natural Hazards Review, 19(3), 04018010.

Döhrmann, D., Gürtler, M., & Hibbeln, M. (2017). Insured loss inflation: How natural catastrophes affect reconstruction costs. Journal of Risk and Insurance, 84(3), 851-879.

EM-DAT Database (2020). Retrieved from https://www.emdat.be/. Accessed 30 July 2020.

Hallegatte, S. (2008). An adaptive regional input-output model and its application to the assessment of the economic cost of Katrina. Risk Analysis: An International Journal, 28(3), 779-799.

Hallegatte, S., Boissonnade, A., Schlumberger, M. E., & Muir-Wood, R. (2008). Demand surge and worker migrations in disaster aftermaths: application to Florida in 2004 and 2005. Journal of Regional Science. Retrieved from http://www2.centre-ired.fr/IMG/pdf/Migration_Final.pdf

Olsen, A. H., & Porter, K. A. (2011a). What we know about demand surge: Brief summary. Natural Hazards Review, 12(2), 62-71.

Olsen, A. H., & Porter, K. A. (2011b). On the contribution of reconstruction labor wages and material prices to demand surge. Report No. SESM-11-1, Dept. of Civil, Environmental, and Architectural Engineering, Univ. of Colorado at Boulder, Boulder, CO.

Property Claim Services (2020). Catastrophe Bulletins. Retrieved from https://pcs.iso.com/pcs/app/start.do. Accessed 30 July 2020.

Rachel Personius (2020). Construction Cost: The Impacts of Hurricanes Harvey and Irma. Retrieved from https://www.fgould.com/americas/articles/construction-cost-the-impacts-of-hurricanes/. Accessed 30 July 2020.

Rick Lloyd (2020). The Cost Impact of Hurricane Harvey on The Texas Construction Market. Retrieved from https://www.mgac.com/blog/the-cost-impact-of-hurricane-harvey-on-the-texas-construction-market/. Accessed 30 July 2020.

Significant Flood Events (2020). Retrieved from https://www.fema.gov/significant-flood-events. Accessed 30 July 2020.

Smith, A. B., & Katz, R. W. (2013). US billion-dollar weather and climate disasters: data sources, trends, accuracy and biases. Natural Hazards, 67(2), 387-410.

Trish Hopkinson (November, 2017). Hurricanes drive demand surge in reconstruction costs. Retrieved from https://www.verisk.com/insurance/visualize/hurricanes-drive-demand-surge-in-reconstruction-costs/. Accessed 30 July 2020.

Xactware (2020). Xactware's pricing data. Retrieved from https://www.xactware.com/en-us/resources/pricing-data-services/overview/#. Accessed 30 July 2020.

Impact Forecasting (2024). United States Hurricane Version 3.0 Methodology. (Internal model documentation)

A-4.5 Describe how economic inflation has been applied to past insurance experience to develop and validate hurricane loss costs and hurricane probable maximum loss levels.

When past insurance experience was used to develop and validate hurricane loss costs and hurricane probable maximum losses, Impact Forecasting did not apply economic inflation to the data. The in-force exposure at the time of the event was used to generate the modeled losses. Modeled losses were then compared to actual claims. Both exposure and losses are in original dollars without adjustment for inflation.

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 in the development of mathematical distributions to reflect the effects of deductibles and policy limits are actuarially sound. Deductible methodology is discussed in Disclosure A-5.1.

B. *The relationship among the modeled deductible hurricane loss costs shall be reasonable.*

The relationship among the modeled deductible hurricane loss costs is reasonable. When other variables are held constant, loss costs decrease as deductibles increase.

C. *Deductible hurricane loss costs shall be calculated in accordance with s.627.701(5)(a), F.S.*

The Impact Forecasting Florida Hurricane (FCHLPM) Model is capable of handling annual deductibles. It complies with s. 627.701(5)(a), F.S.

The statute requires the hurricane deductible to be applied on an annual basis. If there are multiple hurricanes during the calendar year, the deductible after the first hurricane is the greater of the remaining amount of the hurricane deductible or the amount of all other perils deductible.

A-5.1 *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.*

Expected loss at each location is estimated using the probability density function of the damage ratio. Damage ratio is defined as ground up loss divided by replacement value.

$$E(L)= \int_{ded}^{ded+lim}(x-ded)*f(x)dx + lim*(1-F(lim+ded)) \quad (6)$$

Where:

- ded = deductible
- lim = limit
- x = ground up loss, $x \geq 0$
- $f(x)$ = probability density function of ground up loss
- $E(L)$= expected gross loss net of deductible and limit
- $F(x)$ = cumulative distribution function of ground up loss

Percentage deductibles are converted to dollar deductibles during import.

The calculation of gross loss given above is based on well-established actuarial methodology. The method is discussed in Impact Forecasting's Financial Model documentation (Impact Forecasting, 2023).

A-5.2 Describe if and how the hurricane model treats policy exclusions and loss settlement provisions.

Regarding policy exclusions, if the user removes a coverage amount from the input file, such as wind exclusion policies, the model would not generate losses for the excluded coverage. Loss settlement and other exclusions that are not explicitly reflected in the exposure data cannot be quantified by the model. However, loss settlement and other exclusions may be implicitly included in the model results to the extent that the claims data used to calibrate the model reflected these conditions.

A-5.3 Describe how the hurricane model treats annual hurricane deductibles.

If a model user codes the annual deductible in the import file, the hurricane model will conduct the following computations during analysis. The model keeps track of the deductible applied to each location for each event during each simulated year. For the first hurricane event in a year, the hurricane annual deductible is applied, and the remaining deductible is calculated and stored. The deductible that will apply to the next event during the same simulated year is the greater of the remaining hurricane deductible and the all other perils deductible. The remaining deductible is then recalculated and stored along with each event for each location. After the hurricane deductible is exhausted, the all other perils deductible will be applied for that policy for the remainder of the year.

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 methods, data, and assumptions used in the estimation of probable maximum loss levels 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 generated by the Impact Forecasting model do not show an illogical relation to risk, and do not exhibit a significant change when the underlying risk does not change significantly.

C. Hurricane loss costs produced by the hurricane model shall be positive and non-zero for all valid Florida ZIP Codes.

Loss costs produced by the model are positive and non-zero for all valid Florida ZIP Codes, as shown in Form A-1, as provided in Excel format in the file "IF2023FormA1.xlsx" and "IF2023FormA3.pdf".

D. Hurricane loss costs cannot increase as the quality of construction type, materials, and workmanship increases, all other factors held constant.

Hurricane loss costs do not increase as the quality of construction type, materials, and workmanship increases, all other factors held constant. Hurricane loss cost maps for various construction types are provided in Form A-6: Logical Relationships to Hurricane Risk (Trade Secret Item), which will be available for review by the Professional Team.

E. Hurricane loss costs cannot increase as the presence of fixtures or construction techniques designed for hazard mitigation increases, all other factors held constant.

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Hurricane loss costs do not increase as the presence of fixtures or construction techniques designed for hazard mitigation increases, all other factors held constant. Hurricane loss cost sensitivity tests performed in Form A-6: Logical Relationships to Hurricane Risk (Trade Secret Item) will be available for review by the Professional Team.

F. Hurricane loss costs cannot increase as the wind resistant design provisions increase, all other factors held constant.

Hurricane loss costs do not increase as the wind resistant design provisions increase, all other factors held constant. Hurricane loss cost sensitivity tests performed in Form A-6: Logical Relationships to Hurricane Risk (Trade Secret Item) will be available for review by the Professional Team.

G. Hurricane loss costs cannot increase as building code enforcement increases, all other factors held constant

Hurricane loss costs do not increase as building code enforcement increases, all other factors held constant. Hurricane loss cost sensitivity tests performed Form A-6: Logical Relationships to Hurricane Risk (Trade Secret Item) will be available for review by the Professional Team.

H. Hurricane loss costs shall decrease as deductibles increase, all other factors held constant.

Hurricane loss costs decrease as deductibles increase, all other factors held constant. Hurricane loss cost sensitivity tests performed in Form A-6: Logical Relationships to Hurricane Risk (Trade Secret Item) will be available for review by the Professional Team.

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 relationship of hurricane loss costs for individual coverages is consistent with the coverages provided. Hurricane loss cost sensitivity tests performed in Form A-6: Logical

Relationships to Hurricane Risk (Trade Secret Item) will be available for review by the Professional Team.

J. Hurricane output ranges shall be logical for the type of risk being modeled and apparent deviations shall be justified.

Hurricane output ranges are logical for the type of risk being modeled. There are no deviations other than those counterintuitive relationships as a result of the characteristics of the underlying data, as discussed in Disclosure A-6.8.

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,

Hurricane output ranges produced by the Impact Forecasting Florida Hurricane (FCHLPM) Model reflect lower hurricane loss costs for masonry construction versus frame construction, all other factors held constant.

2. personal residential risk exposure versus manufactured home risk exposure,

Hurricane output ranges produced by the Impact Forecasting Florida Hurricane (FCHLPM) Model reflect lower hurricane loss costs for personal residential risk exposure versus manufactured home risk exposure.

3. inland counties versus coastal counties,

Hurricane output ranges produced by the Impact Forecasting Florida Hurricane (FCHLPM) Model in general reflect lower hurricane loss costs for inland counties versus coastal counties.

4. northern counties versus southern counties, and

Hurricane output ranges produced by the Impact Forecasting Florida Hurricane (FCHLPM) Model in general reflect lower hurricane loss costs for northern counties versus southern counties.

5. newer construction versus older construction.

Hurricane output ranges produced by the Impact Forecasting Florida Hurricane (FCHLPM) Model reflect lower hurricane loss costs for newer construction versus older construction, all other factors held constant.

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.

Disclosures V-1.2 and V-1.3 discuss how historical loss information has been used in the development of the Impact Forecasting vulnerability functions. Disclosures V-1.2 and V-1.3 also discuss that construction characteristics, lines of business, policy terms, insured value/limits, deductibles and sublimits, etc., were supplied by insurance companies to Impact Forecasting along with the claim information. Data mapping schemes were provided by insurance companies as well. Impact Forecasting scientists thoroughly reviewed the exposure, claims data, and data assumptions. Additional communications and clarifications were carried out with the data providers in case there were ambiguities and anomalies.

A-6.1 Provide details of modifications to the financial component of the hurricane model since the current accepted hurricane model.

Currently accepted model uses event losses and event frequencies to estimate the PML curves for OEP and AEP. Events frequencies may not be the same, because a reduction of events in stochastic event set was performed, to reduce the number of events that need to be processed while statistical parameters at landfall - maximum wind, radius to maximum winds and decay factor - show very similar distributions. As a result, some events with similar characteristics may be removed and only one representative event will remain in the set. That event frequency, however, needs to be adjusted up, to account for all similar events that were removed. Event frequencies are then used for estimating OEP and this method assumes Poisson distribution of losses. AEP exceedance curve is then estimated using Fast Fourier Transform (FFT) method proposed by Heckman and Meyers (1983). This method was adopted in currently accepted model.

In the model under review, we too use a reduction of the event set by securing similar distribution of maximum wind, radius to maximum winds and decay factor to the original events set. In the new approach, calculated losses of reduced event set are assigned to events of the original stochastic event set (using the knowledge of which event from reduced event set represent which events of the original set) and with that are assigned within stochastic years. The forms a complete table of event losses with stochastic years characteristic for 200,000 years of hurricane activity.

The method adopted in the model uses 300,000 years to align with Impact Forecasting's global models. Years of original 200,000 years of modelled hurricane activity are randomly sampled into an additional 100,000 years, to produce the 300,000-year event set.

The process above provides long table with loss estimates in 300,000 stochastic years and necessary parameters are calculated using per-year loss aggregates (summation for AEP and maxima for OEP) as described in Disclosure A-4.1.

A-6.2 Provide completed Form A-1. Provide a link to the location of the form in the submission appendix. [Form A-1: Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code].

A-6.3 Provide completed Form A-2. Provide a link to the location of the form in the submission appendix [Form A-2: Model Base Hurricane Set Statewide Hurricane Losses].

A-6.4 Provide completed Form A-3. Provide a link to the location of the form in the submission appendix [Form A-3: Hurricane Losses].

A-6.5 Provide completed Form A-4. Provide a link to the location of the form in the submission appendix [Form A-4: Hurricane Output Ranges].

A-6.6 Provide completed Form A-5 using the 2017 FHCF exposure data. Provide a link to the location of the form in the submission appendix [Form A-5: Percentage Change in Hurricane Output Ranges].

A-6.7 Provide completed Form A-6 if not considered as Trade Secret. Provide a link to the location of the form in the submission appendix [Form A-6: Logical Relationships to Hurricane Risk (Trade Secret Item)]

A-6.8 Explain any assumptions, deviations, and differences from the prescribed exposure information in Form A-6. Explain how the treatment of unknown is handled in each sensitivity exhibit.

When preparing the exposure file as specified in the file “NotionalInput23.xlsx”, Impact Forecasting coded any “unknown” value with an equivalent “unknown” code for the risk characteristics in the Impact Forecasting model. Deductibles prescribed in “NotionalInput23.xlsx” were mapped to the annual deductible data field. The 'all other perils deductible' field used by the Impact Forecasting was defaulted to zero. There were no additional assumptions and deviations.

A-6.9 Provide completed Form A-8. Provide a link to the location of the form in the submission appendix [Form A-8: Hurricane Probable Maximum Loss for Florida].

A-6.10 Describe the calculation of uncertainty intervals.

The uncertainty intervals for annual occurrence PML represent the 10th and 90th percentiles of the simulated losses at each return period. To generate Form A-8: Hurricane Probable Maximum Loss for Florida, 100 samples were used and each event was simulated 100 times. For each sample, event losses are taken, assigned to 300,000 years table and AEP curves are calculated (as described in Disclosure A-4.1). This process generates 100 PML curves, which is then used to calculate 10th and 90th percentiles for each Return Period.

The uncertainty interval measures the variations of loss due to sampling at each return period. The sampling in the model workflow represents random draws from hazard distributions to establish sample hazard value, probability of loss (Chance of Loss) for given hazard and vulnerability uncertainty.

A-6.11 Describe how the hurricane model produces hurricane probable maximum loss levels.

The methodology used by the Impact Forecasting Florida Hurricane (FCHLPM) Model to estimate hurricane probable maximum loss levels has been discussed in Disclosure A-4.1.

A-6.12 Provide citations to published scientific literature and technical literature, if any, or modeling-organization studies that were used to estimate hurricane probable maximum loss levels.

Homer, D., & Li, M. (2017, June). Notes on using property catastrophe model results. In Casualty Actuarial Society E-Forum (Vol. 2). Retrieved from https://www.casact.org/community/affiliates/camar/0517/CatNotes.pdf

Impact Forecasting (2020). ELEMENTS Computational & Financial Model. (Internal documentation).

Impact Forecasting (2024). United States Hurricane Version 3.0 Methodology. (Internal model documentation)

Heckman, P. E., & Meyers, G. G. (1983). The calculation of aggregate loss distributions from claim severity and claim count distributions. In Proceedings of the Casualty Actuarial Society (Vol. 70, No. 133-134, pp. 49-66). Casualty Actuarial Society.

Meyers, G. (2006, March). The report of the research working party on correlations and dependencies among all risk sources. Part 3: The common shock model for correlated insurance. The Casualty Actuarial Society Forum, Winter 2006 Edition (p. 231-254).

Kuzak, D., & Larsen, T. (2005). Use of catastrophe models in insurance rate making. Catastrophe modeling: A new approach to managing risk, Chap. 5 (Springer, New York), 97–118.

A-6.13 Describe how the hurricane probable maximum loss levels produced by the hurricane model include the effects of personal and commercial residential insurance coverage.

The hurricane probable maximum loss levels produced by the Impact Forecasting Florida Hurricane (FCHLPM) Model include the effects of personal and commercial residential insurance coverage based on the input provided by users. Personal and commercial residential PMLs can be calculated separately or combined.

A-6.14 Explain any differences between the values provided in Form A-8, Part A and those provided in Form S-2 using the 2017 FHCF exposure data.

The difference between Annual Aggregate result in Part A.2 in Form A-8: Hurricane Probable Maximum Loss for Florida and the in Form S-2: Examples of Hurricane Loss Exceedance Estimates (2017 FHCF Dataset) is caused by using different number of samples. For obtaining meaningfully robust data to provide 10th and 90th percentiles in Form A-8: Hurricane Probable Maximum Loss for Florida, we run the analysis with 100 samples whereas the default model setting used in Form S-2: Examples of Hurricane Loss Exceedance Estimates uses 5 samples.

A-6.15 Explain any differences between the values provided in Form A-8, Part B and those provided in Form S-2 using the 2023 FHCF exposure data.

The difference between Annual Aggregate result in Part B.2 in Form A-8: Hurricane Probable Maximum Loss for Florida and the in Form S-2: Examples of Hurricane Loss Exceedance Estimates (2023 FHCF Dataset) is caused by using different number of samples. For obtaining meaningfully robust data to provide 10th and 90th percentiles in Form A-8: Hurricane Probable Maximum Loss for Florida, we run the analysis with 100 samples whereas the default model setting used in Form S-2: Examples of Hurricane Loss Exceedance Estimates uses 5 samples.

A-6.16 The difference between Annual Aggregate result in Part B.2 in Form A-8: Hurricane Probable Maximum Loss for Florida and the in Form S-2: Examples of Hurricane Loss Exceedance Estimates (2023 FHCF Dataset) is caused by using different number of samples. For obtaining meaningfully robust data to provide 10th and 90th percentiles in Form A-8: Hurricane Probable Maximum Loss for Florida, we run the analysis with 100 samples whereas the default model setting used in Form S-2: Examples of Hurricane Loss Exceedance Estimates uses 5 samples.Provide an explanation for all hurricane loss costs that are not consistent with the requirements of this standard.

Hurricane loss costs are consistent with the requirements of Standard A-6.

A-6.17 Provide an explanation of the differences in hurricane output ranges between the current accepted hurricane model and the hurricane model under review.

The results in the Actuarial Forms show some differences compared to the currently accepted hurricane model and are a consequence of changes in hazard and vulnerability components of the model.

Generally, the spatial pattern of Hurricane Loss Cost change in Form A-5: Percentage Change in Hurricane Output Ranges of Frame/Masonry Owners and Manufactured Home is consistent with the hazard change impact demonstrated in Disclosure G-1.7. The hazard

change in the model led to a decrease in loss in the South, and an increase in the rest of the State with local maxima in Panhandle and central inland part of the State. The pattern is observed in Owners lines and Manufactured Homes. South remains decreasing, following hazard changes also for Condos and Frame/Masonry Renters. Vulnerability changes, as described in Disclosure G-1.7 also significantly contributed to observed changes with enhanced process for claims analysis, estimation of claims under the deductible and introduction of modeling of probability of loss occurrence (Chance of Loss).

A-6.18 Identify the assumptions used to account for the effects of coinsurance on commercial residential hurricane loss costs.

Coinsurance is an input field used by the model to calculate gross loss. The model supports coinsurance at the coverage level as well as at the policy level. Users can code coinsurance in two different fields in the input file: Coverage Fraction (for each coverage) or Policy Fraction (for each policy). The Impact Forecasting Florida Hurricane (FCHLPM) Model accounts for the effects of coinsurance by multiplying losses by the coverage or policy fraction to estimate the gross losses.

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 correspondence including emails, presentation materials, and unformatted text files.

Impact Forecasting maintains the following three sets of documentation related to hurricane model development and implementation:

- Model development documentation created by the Research and Development (R&D) team detailing all components, formulas, and test data for the hurricane model;
- Technical notes produced by the Software Team based on model methodology described in the R&D document. The technical notes describe architectural and design strategies to implement the hurricane model in the ELEMENTS platform; and
- High-level documentation created for end users which describes the components of the hurricane model and their usage in the ELEMENTS platform.

All documents are maintained in Azure DevOps and are version controlled.

B. All documentation, code, and scripts shall be located in central repositories controlled by repository software. Repository software shall support track changes, versioning, and collaborative editing.

Impact Forecasting maintains a document repository in Azure DevOps where all documents are stored and versioned. These documents describe major components of the hurricane model as well as interactions between components of the model using sequence diagrams, flowcharts, and other graphical descriptions where applicable. A list of such documents is provided in Disclosure CI-2.1.

C. All computer software relevant to the hurricane model shall be consistently documented and dated.

Documents describing model requirements, system architecture, design strategy, implementation details, and the user interface are produced by the R&D and Software teams,

where applicable. In addition, a document related to testing plans and test results is produced by the QA (Quality Assurance) Team.

D. ***The following shall be maintained: (1) a table of all changes in the hurricane model from the current accepted hurricane model to the initial submission this year, and (2) a table of all substantive changes since this year's initial submission.***

Impact Forecasting maintains a table of all substantive changes after the prior submission. Any changes to the accepted model will be tracked for affected components.

E. ***Documentation shall be created separately from the source code.***

The Impact Forecasting Software team produces requirements, architecture, and design documents separate from the source code. These documents are used by the QA Team to prepare test cases and perform tests. R&D team also creates model requirements document which is used by Software team to create requirement documents for implementing changes in ELEMENTS application.

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.***

A list of externally acquired software and data assets is created and maintained by the Impact Forecasting team and will be available for review by the Professional Team.

CI-1.1 ***Provide a description of the software engineering methodologies (e.g., Scrum, Agile, Waterfall, Hybrid) utilized for the software lifecycle.***

The Software team has adopted Scrum methodology (based on Agile Software Development) for ELEMENTS software development lifecycle. The team follows a 4-week sprint cycle to

complete work items from Product Backlog to develop and test features required for model development that are planned to be integrated into a version of ELEMENTS application.

CI-1.2 Document compliance with external international, national, or organizational standards and certifications, where applicable to the Computer/Information Hurricane Standards.

The standards followed for Computer/Information Hurricane Standards are:

- Flowchart based on symbols defined in ISO 5807-1985 (E) and ISO/IEC 19510

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.

Impact Forecasting maintains a set of documentation containing the requirements for each component and its features. These documents are modified and tracked when the model changes. Documents listed in Disclosure CI-2.1 will be available for review by the Professional Team.

CI-2.1 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.

Impact Forecasting maintains documentation for major software components along with a database schema, technical notes, a user guide, an installation guide, and a deployment guide for successful deployment and usage of the models on the ELEMENTS platform.

Impact Forecasting produces various types of internal (i.e., used only by IF) and external (i.e., client-facing) documents at different phases of the model development process. Documentation produced and maintained by the Impact Forecasting Software Team includes:

- Software Development Process: Describes the ELEMENTS software development process including various phases of development and delivery (e.g., requirements gathering, architecting, designing, implementation, testing, deployment, and support)
- Feature Requirement Specification: Captures requirements for new features or enhancements to existing ones
- Architecture/Design Document: Describes overall architecture and design of the system
- Technical Notes: Describes each major feature in detail along with dataflow diagrams and flowcharts when applicable

- Test Plans and Test Cases: Captures test cases for each feature and test plans for each iteration of internal and external releases
- Database Schema: Describes database schema for Exposure, Results and Model databases
- Product Release Notes (Internal and External): Documents the addition of new features and the enhancement of existing features for every internal and external release
- ELEMENTS User Guide: Contains operational instructions for end users of the ELEMENTS platform
- Input Data Format: Describes each exposure field and indicates the supported format to successfully import exposure data to ELEMENTS
- ELEMENTS Installation and Deployment Guide: Provides guidance on server configuration and product setup for IT administrators
- Additional Tools User Guide: Consists of a user guide for administration tools for managing product setup and configuration by IT administrator
- Coding Standard: Details coding standards to be followed when developing applications

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.

Impact Forecasting develops and maintains documents which describe the database schema and relationships between data, including flowcharts to show the flow of information and links between data from various components of the software system. This includes schema of the Exposure/Results database and Model database. Interaction between software components and sub-components is captured in architecture and design documentation, including the interactions between hazard and vulnerability modules. A separate document describing interactions between multiple Impact Forecasting groups and team members is maintained using a diagram.

B. All flowcharts (e.g., software, data, and system models) in the submission or in other relevant documentation shall be based on (1) a referenced industry standard (e.g., UML, BPMN, SysML), or (2) a comparable internally developed standard which is separately documented.

All flowcharts developed and maintained by Impact Forecasting follow industry standards based on ISO (International Organization for Standardization) 5807, Unified Modeling Language (UML) and Business Process Model and Notation (BPMN). Figure 50 is an example of the detailed modeling process in ELEMENTS using Impact Forecasting's Flowchart Standards.

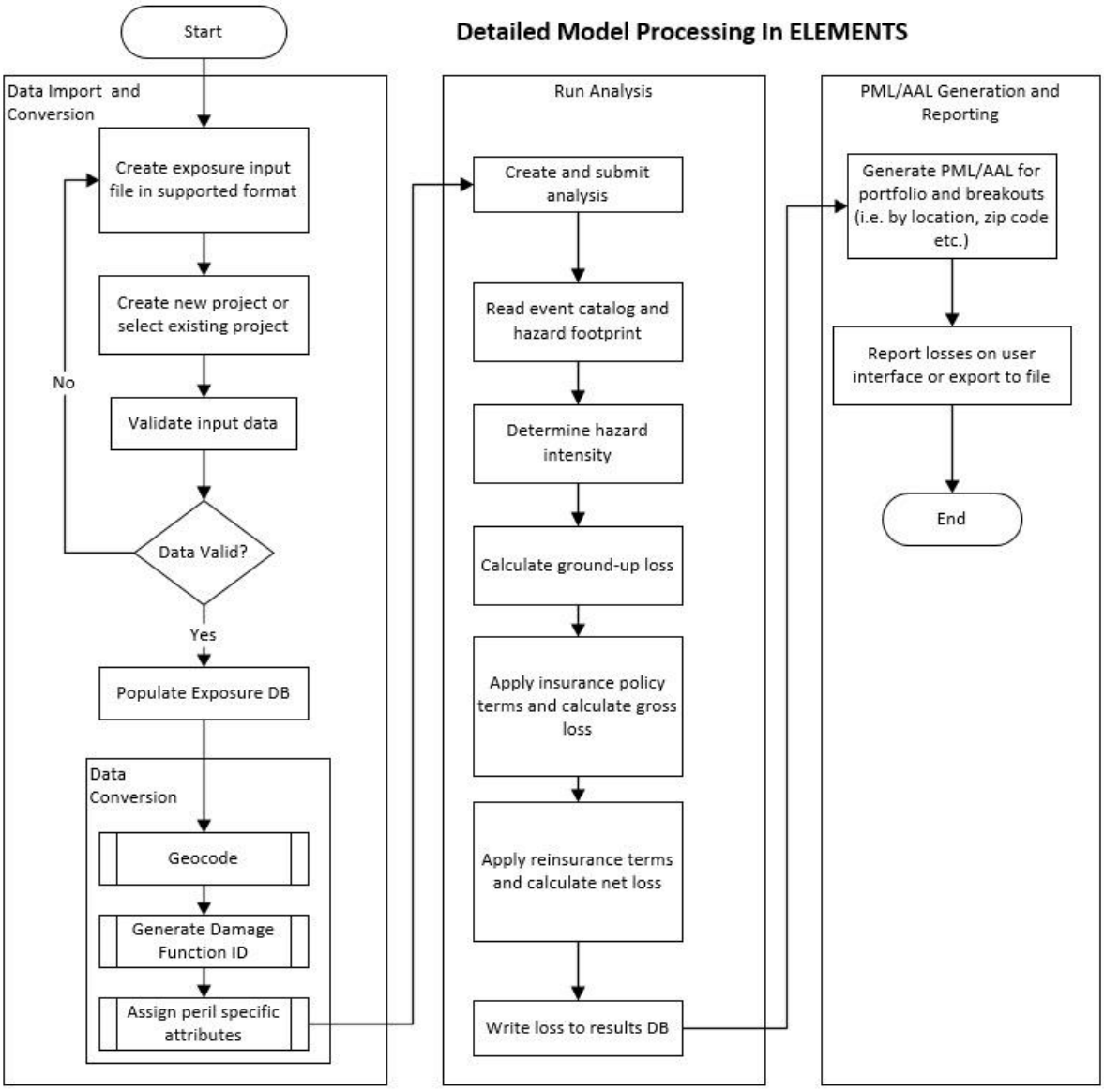


Figure 50: Example of modeling process flowchart

CI-4 Hurricane Model Implementation

A. A complete procedure of coding guidelines consistent with accepted practices shall be maintained. Coding guidelines shall be referenced for each programming language used in the hurricane model or submission document.

Impact Forecasting maintains coding guidelines and a handbook of good coding practice. Developers are encouraged to follow documented best practices to ensure a robust product.

B. Network organization documentation shall be maintained.

Impact Forecasting maintains a network organization diagram involving all the servers and hardware components involved in running the hurricane model on the ELEMENTS platform.

C. A complete procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components shall be maintained.

All model files and databases provided by the R&D group are stored and backed up regularly. The Software team compares production-ready files and databases with original copies using MD5 Hash comparison.

D. All components shall be traceable, through explicit component identification in the hurricane model representations (e.g., requirements, flowcharts) down to the implementation level.

Descriptions of all static components and interactions between components are documented at various levels of detail using flowcharts and other depictions. This documentation can be used to track implementation details in actual code.

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.

Impact Forecasting maintains a list of all components affecting hurricane loss cost and probable maximum loss calculations along with implementation details, such as number of lines of code and number of lines of comments for each component and sub-component.

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.

All components including Classes and Methods are sufficiently commented in the code as per industry guidelines. All Classes are commented with each class's purpose and linkage to other Classes. All methods are commented with Input and Output parameters along with inner workings of the method, exceptions, and logic. An important line of code is commented in detail with linkage to work items in the source control system (Azure DevOps) when applicable.

G. The following documentation shall be maintained for all components or data modified by items identified in Hurricane Standard G-1, Disclosure 7 and Audit 4:

6. A list of all equations and formulas used in documentation of the hurricane model with definitions of all terms and variables, and
7. A cross-referenced list of implementation source code terms and variable names corresponding to items within G.1 above.

A list of all components referred to in Standard G-1 and used in software implementation is maintained and tracked. A cross-referenced list of equations and variables used in implementation is documented and maintained.

H. Hurricane model code and data shall be accompanied by documented review plans, testing plans, and if needed, update plans through regularly

scheduled intervals. The vintage of the hurricane model code and data shall be justified.

Hurricane model code has been stored and maintained in an Azure DevOps source control system. Changes to the Hurricane model methodology has been documented as a part of new requirements. A plan was prepared to implement and test new requirements and a schedule was prepared to introduce changes. Hurricane model code has been updated based on the change in requirements and changes to the code have been tracked using a source control system. Both during, and upon completion of, coding, new and updated functionalities have been tested to match outcome with expected results. Code is stored with a time stamp in the source control system and the difference between new and old code can be compared upon request. Vintage of data used in modeling can be accessed upon request.

CI-4.1 Specify the hardware, operating system, and essential software required to use the hurricane model on a given platform.

Table 13 shows various hardware and software components along with configuration and supported versions of the Impact Forecasting Florida Hurricane (FCHLPM) Model on the ELEMENTS platform.

Table 13: Hardware and software requirements for the Impact Forecasting Florida Hurricane (FCHLPM) Model on the ELEMENTS Version 18.1 platform

Component	Configuration or Supported Versions	Remarks
Operating system (Server)	Microsoft Windows 2016 R2 or higher	
Operating system (Client)	Microsoft Windows 7 Enterprise or Microsoft Windows 10 - 64 bit	

Component	Configuration or Supported Versions	Remarks
CPU Speed (Minimum)	2.0 GHz of higher	
RAM (Minimum)	4 GB per core	JobManager - min. 4 cores AnalysisServer - min. 12 cores Exposure/Results/Model database server - min. 12 cores
Hard disk space	Minimum 300 GB (base - no models), max. 3.5TB (base + all models)	
SQL Server Database	Minimum 64 GB (base - no models), recommended 64 GB per instance	Recommend hosting exposure/result and model databases on separate servers.
SQL Native Client	SQL Server Native Client version 11	Impact Forecasting also has installation files which use MSOLEDBSQL
SQL Server Management Object (SMO)	SQL Server 2012 SMO	
.Net Framework	Ver. 4.8	
Visual Studio	Visual Studio 2017 or higher	

Component	Configuration or Supported Versions	Remarks
Precisely Geocoding engine	Spectrum 2019 with May 2022 dataset	
Infragistics Windows Presentation Foundation (WPF) controls	Ver. 14.2, 20.1	
Spreadsheet Gear controls	Ver. 7.4.4	
Message Passing Interface (MPI) Fastest Fourier Transform in the West (FFTW) Wrappers	Ver. 9.0.21022.8	Used to implement FFT (Fast Fourier Transform) methodology

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.

Any change in a model component is usually performed by engineers from the Research & Development group. These changes are documented and developed by engineers in their choice of language or other product (e.g., FORTRAN, Python, R, Excel, MATLAB) depending on the complexity of the change. These components are then peer reviewed and approved. Test portfolios, including approved client books, are then run with approved changes. Results and documentation of changes are shared with the Software Team. The Software Team independently implements these changes in the production-ready software following industry standard processes. At the end, the QA Team performs various tests in which results (hazard and losses) are compared with original runs performed by model development engineers and, upon successful comparison, changes are approved and released in the final product.

B. Component Testing

1. Testing software shall be used to assist in documenting and analyzing all components.

The Impact Forecasting Software team uses Azure DevOps Unit testing framework to perform unit tests on all components when applicable. All unit test cases are documented and stored in Azure DevOps repository.

2. Unit tests shall be performed and documented for each updated component.

Unit tests for all components are performed where applicable. For all eligible components and sub-components, an input, along with the expected output, is defined and tests are run

to match expected results. Only upon passing the unit tests is the code allowed to be checked in as a part of the final build.

In addition to the unit tests, automated tests, which go through sets of sub-components and check the correctness of the results, are also performed.

3. Regression tests shall be performed and documented on incremental builds.

Sets of regression tests are documented and performed with each iteration of internal and production releases. New regression tests are added with newly added features to complete the coverage of all cases.

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.

End-to-end tests involving all hurricane model components are performed regularly by the QA team with each internal and production release. Multiple test cases are created to make sure all possible interactions among sub-components and components are covered.

C. Data Testing

1. Testing software shall be used to assist in documenting and analyzing all databases and data files accessed by components.

2. Integrity, consistency, and correctness checks shall be performed and documented on all databases and data files accessed by the components.

Specific test cases are developed for components which access model data from a database or files and are compared against expected results. These tests are run periodically with every internal and production release cycle. The Unified Function Test (UFT) suite by MicroFocus is used to automate test cases in addition to manual testing to verify communications between various components. The combination of log files, intermediate files, and SQL databases are also used to verify data flow and inter-component communication. Microsoft Excel and Word are used to document the testing process and its outcome.

CI-5.1 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 Impact Forecasting Florida Hurricane (FCHLPM) Model will produce the same loss cost and probable maximum loss levels when fed with the same set of input data multiple times. The model will use the same seed for a given location based on its latitude and longitude. This will also ensure that the same result is produced even when the ordering of locations changes in the input file. Loss repeatability is tested as part of the regular testing suite.

CI-5.2 Provide an overview of the component testing procedures.

Hurricane model component testing consists of the following types of tests:

Hazard Component Testing

Once implemented in the ELEMENTS software, the hazard intensity values (3-second peak gust windspeed) for strategically selected locations and for selected events are extracted from the ELEMENTS analysis and compared with the hazard intensity from model development.

Vulnerability Component Testing

A unit test for selected damage functions to check for boundary conditions and interpolation is performed and compared with manual calculations. A portfolio is prepared to cover all possible combinations of damage functions and is analyzed against a selected hazard value and compared with manual calculations.

Aggregation Testing

A full analysis (hazard and loss) is performed on the test portfolio and the results are compared with baseline numbers to ensure hazard and vulnerability components are working together as expected and are providing expected results.

Regression Testing

Test portfolios and approved client portfolios are run with every internal and release build to ensure consistency in results. Automation tests are run with every release build to ensure end-to-end product integrity.

Performance Testing

With every release build, a performance test is run to ensure runtime is consistent with expectations based on the new or modified features.

CI-5.3 Provide a description of verification approaches used for externally acquired data, software, and models.

Data and software received from external sources go through quality checks before they are deemed usable by the group. These checks are described in Table 14.

In addition, Impact Forecasting also performs the following data checks on externally acquired data sources when possible:

1 Creation of a Hash of the received data which is verified against data copied to the destination
2 Check data accuracy against other available sources
3 Compare current version with previous version in the case of an upgrade

Table 14: Impact Forecasting verification approaches for externally-acquired data and software

Externally-Acquired Data	Verification Approach
Atlantic Hurricane Database (HURDAT2)	Verified by spot checks against the online version at the time of verification. Also validated by visually comparing the HURDAT2 data with historical storm tracks/intensities provided by NOAA (National Oceanic and Atmospheric Administration).

Externally-Acquired Data	Verification Approach
Tropical Cyclone Extended Best Track Dataset	Verified by spot checks against the latest version as well as comparing with HURDAT2 for parameters that are in both datasets.
HURDAT Reanalysis Data	Verified by spot checks against the online version at the time of verification. The data were also compared with that available in the NOAA Report NWS (National Weather Service) 38 - Hurricane Climatology for the Atlantic and Gulf Coasts of the United States.
Hadley Centre Sea Ice and Sea Surface Temperature Dataset (HadISST)	Verified by comparing the SST plots with the latest version available as well as other data sources, such as the Extended Reconstructed Sea Surface Temperature (ERSST), for consistency.
National Land Cover Database (NLCD 2021)	The data were plotted across the U.S. and compared with the plot found on the source website. Spot checks at various locations have also been done.
National Hurricane Center Intermediate Advisories	For CHARLEY2004, FRANCES2004, IVAN2004, JEANNE2004, DENNIS2005, KATRINA2005, RITA 2005, WILMA2005, MATTHEW2016, IRMA2017, MICHAEL2017, ISAIAS2020, SALLY2020, ETA2020, ELSA2021, IAN2022: Verified by spot checks with published advisory values on the NHC website and NHC Tropical Cyclone Reports for the respective storms, updated as of time of verification
Postal Code Information from Zip-Codes.com	ZIP Code boundaries are examined for consistency and quality, and are compared with previous vintages for accuracy and appropriateness.

Externally-Acquired Data	Verification Approach
U.S. Census (2020) Data	Verified by spot checks against the online version at the time of verification.
Precisely Geocoding Engine	Sets of addresses are passed to the geocoder engine, and the retrieved coordinates are compared with other sources, such as Google Maps. Various combinations of address components (street, city, state, county) are tested for validity of the address and the returned coordinate values.

CI-6 Human-Computer Interaction

A. Interfaces shall be implemented as consistent with accepted principles and practices of Human-Computer Interaction (HCI), Interaction Design, and User Experience (UX) engineering.

The user interface is designed using accepted principles and practices of HCI, and considers various human factors to implement requirements making the interface intuitive and easy to use for end users. The user interface is designed to minimize common user errors and to streamline workflows. Catastrophe modeling domain specific vocabulary is used on user interface to communicate tasks and workflow effectively. The UX design is finalized using industry standard software packages and UX engineering principles prior to coding.

B. Interface options used in the hurricane model shall be unique, explicit, and distinctly emphasized.

The option to run a FCHLPM approved model is uniquely emphasized on user interface by having “FCHLPM” as a part of the model’s name along with model version.

C. For a Florida insurance rate filing, interface options shall be limited to those options found acceptable by the Commission.

An option to run the FCHLPM approved model rate filing is available in the interface. When this option is selected, all other options are set to approved default values, limiting users only to options found acceptable by the Commission.

CI-6.1 Identify procedures used to design, implement, and evaluate interface options.

- Clearly defined description of available analysis options.
- Define default values for all applicable options when submitting analysis for filing using FCHLPM approved model.
- Provide option (default) to run FCHLPM approved model for rate filing purpose.

- Set all options to approved default value and lock options (not allowing users to change values) when model is used for rate filing using FCHLPM approved model.

CI-7 Hurricane Model Maintenance and Revision

A. A clearly written policy shall be implemented for review, maintenance, and revision of the hurricane model and network organization, including verification and validation of revised components, databases, and data files.

Impact Forecasting created policies and processes to be followed when changing model components in any form. This includes the production of a business case which includes the driving factor(s) that necessitate the change and the objective and impact of the change.

Detailed documentation also includes the proposed solution by R&D, the methodology, and the impact of changes on model results. New proposed changes are peer reviewed and upon approval, this information is passed on to the Software Team for implementation along with relevant modified components.

The Software team follows the process to perform quality checks of components received from R&D. New methodology is documented by software engineers and architecture and design documents are revised accordingly. Once new changes are implemented in the software, software engineers and the QA Team follow the process to test new changes. The type of tests performed to check the quality of the model change depends on the nature of the change which was made.

B. A revision to any portion of the hurricane model that results in a change in any Florida personal and commercial residential hurricane loss cost or hurricane probable maximum loss level shall result in a new hurricane model version identification.

Impact Forecasting maintains one version identifier for the hurricane model and separate version identifier for the ELEMENTS platform. As the Impact Forecasting Florida Hurricane (FCHLPM) Model periodically changes to reflect new learning and advancement in understanding of the model components, new versions are assigned for internal and external releases.

C. 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.

Impact Forecasting will maintain a list of hurricane model changes after the initial submission. A unique version identifier will be assigned according to the versioning scheme established by Impact Forecasting (see Disclosure CI-7.2).

CI-7.1 Identify procedures used to review and maintain code, data, and documentation.

New development in the ELEMENTS platform and hurricane model components starts with creating a requirement specification for approved changes. Once a requirement specification and scope of the project is finalized, the project is assigned to R&D and/or the Software Team depending on the nature of the changes.

Based on the requirements and scope, functional specifications with technical details are prepared. Once the functional specifications are finalized, the QA team starts creating test cases and the software team prepares architecture, design and/or technical documentation depending on the complexity of the change. Upon finalization of architecture and design changes, the Software team creates a new branch in Azure DevOps, implements the changes, and performs unit testing when appropriate. After completion of implementation, new changes are merged into the main branch and an internal product release gets built which is then submitted for testing by the QA team. The QA team performs tests based on the created test cases for the given changes to make sure the new changes are performing as expected. New changes are then tested along with rest of the existing components as a part of the regression test. Once approved by QA, new features are considered ready for release. A description of new features is added into Release Notes for the next release and the User Guide and Deployment Guide (see Disclosure CI-2.1) are updated appropriately.

Figure 51 shows the high-level model implementation and release process.

Model implementation in ELEMENTS and deployment process

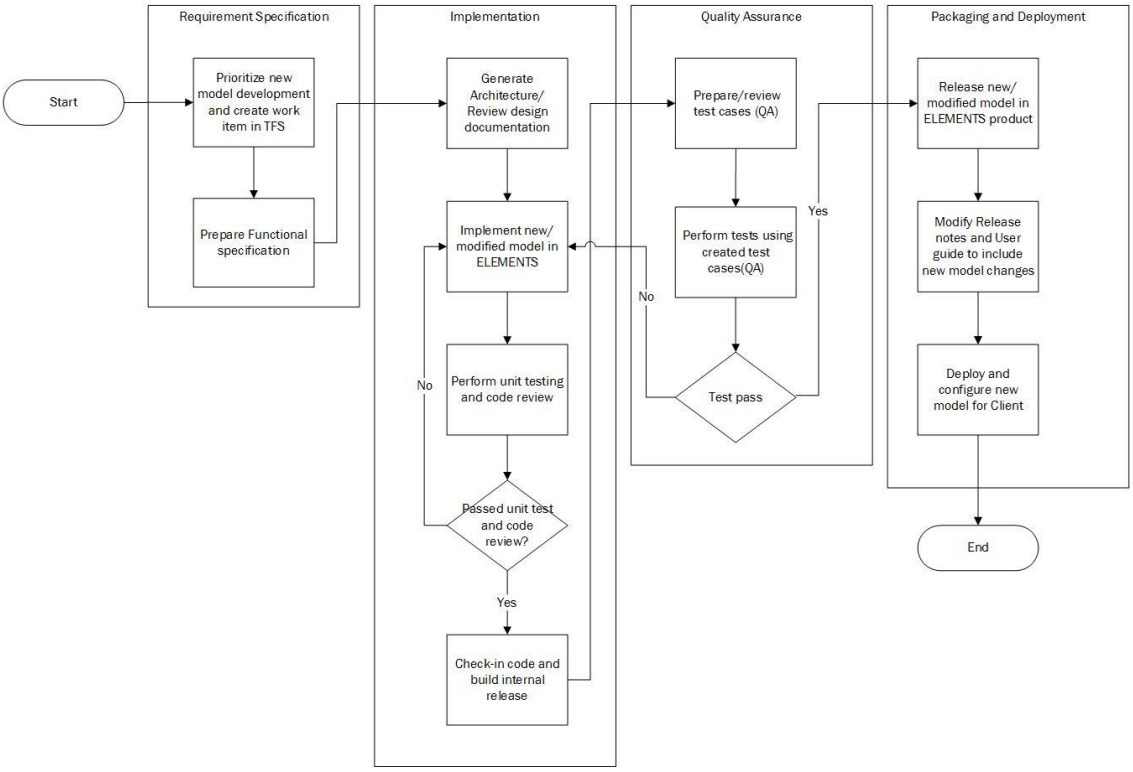


Figure 51: Model implementation in ELEMENTS software and deployment process

CI-7.2 Describe the rules underlying the hurricane model and code revision identification systems.

The Impact Forecasting Florida Hurricane (FCHLPM) Model is deployed on the Impact Forecasting ELEMENTS platform. Any changes in model components or the ELEMENTS platform which result in a change in loss results are carefully managed by providing version identification to the hurricane model and platform independently. Figure 52 shows an example of the version progression of the ELEMENTS platform and an example model independently.



Figure 52: Example of models hosted on the ELEMENTS platform

Impact Forecasting uses the following versioning scheme for the ELEMENTS platform and models.

- [Major Release].[Minor Release].[Beta]

All major releases of the model or platform follow a whole number format (e.g., Ver. 1.0, Ver. 2.0, etc.). Minor releases which may include patches receive a minor release number (e.g., Ver. 10.1, Ver. 12.2, etc.). If Impact Forecasting is releasing a beta model or platform to clients, “b” will be added at the end of the beta version (i.e., Ver. 2.0.1b).

CI-7.3 Provide all accepted and functionally equivalent model version number and platform identifications for the current accepted hurricane model and the previous accepted hurricane model, if applicable.

The current accepted hurricane model is the Impact Forecasting Atlantic Tropical Cyclone – Wind (FCHLPM) Model Version 2.0 on the ELEMENTS Version 17.0 platform.

The previous accepted hurricane model is the Impact Forecasting Florida Hurricane Model Version 1.0, on ELEMENTS Version 15.0.

Table 15: Accepted Impact Forecasting Hurricane Models

Hurricane Model	Version Number	Platform	Platform Number	Acceptance Date
Impact Forecasting Florida Hurricane Model	1.0	ELEMENTS	15.0	June 10, 2021
Impact Forecasting Atlantic Tropical Cyclone – Wind (FCHLPM)	2.0	ELEMENTS	17.0	June 20, 2023

Impact Forecasting Florida Hurricane (FCHLPM) Version 3.0

CI-8 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.

Impact Forecasting documents and follows security processes to secure access to the code, data, and documentation as prescribed by company's policy and industry standard.

CI-8.1 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.

Secured Computer Access

Office Security:

- Aon facilities employ 24-hour security staff and building access monitoring.
- Only employees with authorized electronic badges may enter Aon facilities.
- Only authorized employees of Aon may enter areas of the building designated for Aon employees.
- All Aon floors feature doors that close and lock automatically.

Data Center Access:

- Data center access is restricted to only administrators.
- Access to servers is monitored 24 hours per day, 7 days per week.
- Data center access requires specific security badges and biometric scans.

Secured Hurricane Model

Firewall and Network Security:

- Cisco Next-Gen Firewalls are used for controlling traffic in and out of the network.
- Intrusion detection systems (IDS) and intrusion protection systems (IPS) software are used to detect and prevent network intrusions.
- Proxy servers are used to filter user traffic to only approved external web sites.

User Account Access:

- Authorized Aon user accounts are required for network access. Former employees' user accounts are immediately closed following their last day of employment.
- Access to files and folders on all servers is regulated by Windows permissions. Permissions are set on a server-by-server, folder-by-folder, or file-by-file basis as appropriate. Access to SQL instances is set on a user-by-user basis.
- Access to the Aon network from outside the firewall is granted using a VPN gateway. VPN access is tied to a user's Windows account and is controlled by Aon IT and Security.
- All company personnel are required to pass a background check upon employment.
- All employees require an authorized user account to log in to any workstation or server. Passwords must adhere to strict, industry-standard requirements.
- User accounts are managed by the Aon's UAM (User Access Management) teams.
- Server and workstation accounts are locked out after 5 unsuccessful logins.
- All servers are located in a secured data center, which requires electronic badge access and biometric hand scans. Datacenter access is restricted to administrators only.
- Windows updates and patches are administered by the IT department and run monthly. The distribution of updates is controlled by Group Policy at the domain level.

Anti-virus:

- All servers and workstations are installed with Symantec Hosted Endpoint antivirus software.
- Virus definitions are updated daily.

- Updates to the antivirus software are managed by Aon IT department via a web-based management console.

Secured Documentation, Software, and Data

Code:

- Only developers have access to Impact Forecasting code.
- Microsoft Team Foundation Server is used for version control, and only specified developers have access to the necessary Collections, Projects, and Solutions.
- Only administrators have physical access to the Azure DevOps server.
- Azure DevOps server(s) are backed-up to tape on a weekly basis. Backup tapes are stored offsite.

Data Security:

- All confidential data can be sent via SFTP (Secure File Transfer Protocol) with PGP encryption.
- All confidential data must be stored in our physically secured datacenter.
- File shares and SQL servers are not accessible outside the Aon network.
- Both remote access (RDP) and file access are restricted to only authorized users.
- File servers containing client and/or sensitive data must have Symantec Endpoint Protection antivirus software installed, be encrypted with BitLocker, and be backed up nightly via ShadowProtect.
- Data access is regulated to authorized users only. This includes access to the Team Foundation Server for version control, file shares and SQL Server databases.
- All servers are backed up using StorageCraft ShadowProtect, with full backups monthly and incremental backups nightly. Tape backups are made monthly and shipped off-site to Iron Mountain, a third-party storage company.
- All old hard drives are wiped clean by an administrator when they are no longer needed. Non-solid state drives (SSD) are wiped using Darik's Boot and Nuke (DBAN), and SSD drives are wiped using SecureErase.

Documentation:

- SharePoint is used to manage and version control documentation.
- Users are granted permissions to SharePoint sites on an as needed basis.
- Access to SharePoint is managed by the SharePoint administrators.
- Windows authentication is used for managing, granting, and denying access.

Security of code, data, and documentation for each client organization is governed by strict licensing, mutually acceptable requirements under which they cannot reverse engineer or modify any of the binaries provided to them under the terms and conditions of the license, and secure installations involving both parties' IT departments.

CI-8.2 Identify certifications, if any, and external standards compliance relevant to cyber security.

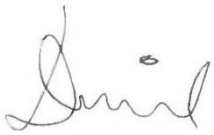
ELEMENTS is a standalone Windows based application. All security standards are provided by Aon or client IT teams.

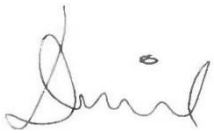
Appendix A: Forms

Form G-1: General Hurricane Standards Expert Certification

I hereby certify that I have reviewed the current submission of Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 for compliance with the 2023 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology, and hereby certify that:

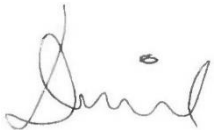
1. ***The hurricane model meets the General Hurricane Standards (G-1–G-5),***
2. ***The disclosures and forms related to the General Hurricane Standards are editorially and technically accurate, reliable, unbiased, and complete,***
3. ***My review was completed in accordance with the professional standards 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 to bias or prejudice my opinion.***

Radovan Drinka	M.S. Physics .
Name	***Professional Credentials (Area of Expertise)***
	.
Signature (initial submission)	***Date***
	.
Signature (response to deficiencies, if any)	***Date***
	
	December 11, 2024 .
Signature (revisions to submission, if any)	***Date***



January 14, 2025 .

Signature (revisions to submission, if any) ***Date***



May 28, 2025 .

Signature (final submission) ***Date***

An updated signature and form are required following any modification of the hurricane model and any revision of the initial 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***

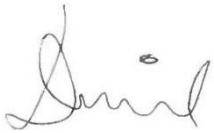
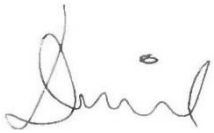
Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

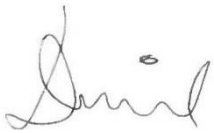
Include Form G-1 in a submission appendix.

Form G-2: Meteorological Hurricane Standards Expert Certification

I hereby certify that I have reviewed the current submission of Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 for compliance with the 2023 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology, and hereby certify that:

1. ***The hurricane model meets the Meteorological Hurricane Standards (M-1–M-6),***
2. ***The disclosures and forms related to the Meteorological Hurricane Standards 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. ***In expressing my opinion, I have not been influenced by any other party to bias or prejudice my opinion.***

Radovan Drinka	M.S. Physics .
Name	***Professional Credentials***
	***(Area of Expertise)***
	November 4, 2024 .
Signature (initial submission)	***Date***
	January 14, 2025 .
Signature (response to deficiencies, if any)	***Date***
	.
Signature (revisions to submission, if any)	***Date***



May 28, 2025 .

Signature (final submission) ***Date***

An updated signature and form are required following any modification of the hurricane model and any revision of the initial 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***

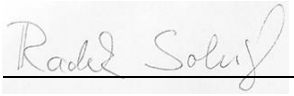
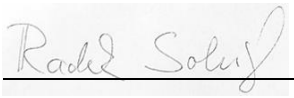
Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

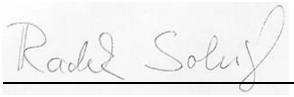
Include Form G-2 in a submission appendix.

Form G-3: Statistical Hurricane Standards Expert Certification

I hereby certify that I have reviewed the current submission of Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 for compliance with the 2023 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology, and hereby certify that:

1. ***The hurricane model meets the Statistical Hurricane Standards (S-1–S-6),***
2. ***The disclosures and forms related to the Statistical Hurricane Standards 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. ***In expressing my opinion, I have not been influenced by any other party to bias or prejudice my opinion.***

Radek Solnicky	M.S., Mathematical Statistics .
Name	***Professional Credentials (Area of Expertise)***
	.
Signature (initial submission)	***Date***
	.
Signature (response to deficiencies, if any)	***Date***
	December 09, 2024 .
Signature (revisions to submission, if any)	***Date***
	January 14, 2025 .
Signature (revisions to submission, if any)	***Date***



May 28, 2025 .

Signature (final submission) ***Date***

An updated signature and form are required following any modification of the hurricane model and any revision of the initial 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 in a submission appendix.

Form G-4: Vulnerability Hurricane Standards Expert Certification

I hereby certify that I have reviewed the current submission of Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 for compliance with the 2023 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology, and hereby certify that:

1. ***The hurricane model meets the Vulnerability Hurricane Standards (V-1–V-4),***
2. ***The disclosures and forms related to the Vulnerability Hurricane Standards 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. ***In expressing my opinion, I have not been influenced by any other party to bias or prejudice my opinion.***

Yujin Liang	Ph.D., Structural Engineering; P.E.
Name	***Professional Credentials (Area of Expertise)***
	State: Minnesota .
	Expiration Date: 06/30/2026 .
	Structural .
	Professional License Type:
	November 4, 2024 .
Signature (initial submission)	***Date***
	.
Signature (response to deficiencies, if any)	***Date***
	January 14, 2025 .
Signature (revisions to submission, if any)	***Date***



May 28, 2025 .

Signature (final submission) ***Date***

An updated signature and form are required following any modification of the hurricane model and any revision of the initial 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 in a submission appendix.

Form G-5: Actuarial Hurricane Standards Expert Certification

I hereby certify that I have reviewed the current submission of Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 for compliance with the 2023 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology, and hereby certify that:

1. ***The hurricane model meets the Actuarial Hurricane Standards (A-1–A-6),***
2. ***The disclosures and forms related to the Actuarial Hurricane Standards 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. ***In expressing my opinion, I have not been influenced by any other party to bias or prejudice my opinion.***

Minchong Mao	FCAS, MAAA .
Name	***Professional Credentials (Area of Expertise)***
_____	_____ .
Signature (initial submission)	***Date***
_____	_____ .
Signature (response to deficiencies, if any)	***Date***
	
_____	December 11, 2024 .
Signature (revisions to submission, if any)	***Date***
	
_____	January 14, 2025 .
Signature (revisions to submission, if any)	***Date***



May 28, 2025 .

Signature (final submission) ***Date***

An updated signature and form are required following any modification of the hurricane model and any revision of the initial 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***

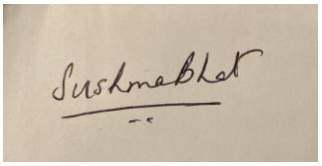
Note: A facsimile or any properly reproduced signature will be acceptable to meet this requirement.

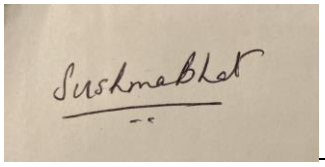
Include Form G-5 in a submission appendix.

Form G-6: Computer/Information Hurricane Standards Expert Certification

I hereby certify that I have reviewed the current submission of Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 for compliance with the 2023 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology, and hereby certify that:

1. ***The hurricane model meets the Computer/Information Hurricane Standards (CI-1–CI-8),***
2. ***The disclosures and forms related to the Computer/Information Hurricane Standards 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. ***In expressing my opinion, I have not been influenced by any other party to bias or prejudice my opinion.***

Sushma Bhat	B.S., Computer Science .
Name	***Professional Credentials***
	***(Area of Expertise)***
Signature (initial submission)	November 4, 2024 . ***Date***
Signature (response to deficiencies, if any)	. ***Date***
Signature (revisions to submission, if any)	. ***Date***



May 28, 2025 .

Signature (final submission) ***Date***

An updated signature and form are required following any modification of the hurricane model and any revision of the initial 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 in a submission appendix.

Form G-7: Editorial Hurricane Standards Expert Certification

I hereby certify that I have reviewed the current submission of Impact Forecasting Florida Hurricane (FCHLPM) Model Version 3.0 for compliance with the 2023 Hurricane Standards adopted by the Florida Commission on Hurricane Loss Projection Methodology, and hereby certify that:

1. ***The hurricane model submission is in compliance with the acceptability process Notification Requirements and General Hurricane Standard G-5,***
2. ***The disclosures and forms related to each hurricane standards group 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 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 to bias or prejudice my opinion.***

David Colbus	M.A. Climate and Society .
Name	***Professional Credentials (Area of Expertise)***
	.
Signature (initial submission)	***Date***
	.
Signature (response to deficiencies, if any)	***Date***
David Colbus	December 12, 2024 .
Signature (revisions to submission, if any)	***Date***



January 14, 2025 .

Signature (revisions to submission, if any) ***Date***



May 28, 2025 .

Signature (final submission) ***Date***

An updated signature and form are required following any modification of the hurricane model and any revision of the initial 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 in a submission appendix.

Form M-1: Annual Occurrence Rates

A. ***One or more automated programs or scripts shall be used to generate and arrange the data in Form M-1.***

A MATLAB script is used to generate and arrange the data and to create the bar graphs automatically.

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 1. List the annual occurrence rate per hurricane category. Annual occurrence rates shall be rounded to three decimal places.***

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 Florida. For the by-passing hurricanes included in the table only, the intensity entered is the maximum windspeed at closest approach to Florida as a hurricane, not the windspeed over Florida.

The annual occurrences for hurricane landfall is provided in Table 16.

C. ***For a climate-adjusted hurricane model that uses either the Reference Hurricane Set or a Model Adjusted Hurricane Set for the Model Base Hurricane Set, a modeling organization shall provide two Form M-1s, one completed with climate-adjusted modeled rates and one completed without climate-adjusted modeled rates.***

The Impact Forecasting Florida Hurricane (FCHLPM) Model does not account for climate change.

D. Describe hurricane model variations from the Reference Hurricane Set frequencies.

The modeled hurricane frequencies agree well with the historical observations for each region and each category defined by the Saffir-Simpson Hurricane Wind Scale. The variations are attributed to the limited historical data available for certain regions and/or categories.

E. Provide vertical bar graphs depicting distributions of hurricane frequencies by category by region of Florida (Figure 1), 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.

The bar graphs are given in Figure 53 below.

F. List all hurricanes added, removed, or modified from the current accepted hurricane model.

The following hurricanes from 2021 and 2022 have been added to the currently accepted hurricane model version of the Base Hurricane Storm Set.

- Elsa 2021
- Ian 2022 (also revised from HURDAT2 parameters, as described in Standard M-2.1)
- Nicole 2022

The following hurricanes have been modified as by-passing events due to their current generation of losses.

- Ethel 1960
- Camille 1969
- Sally 2020

Additionally, the following hurricanes have been modified to increase from a Category 1 to a Category 2 storm in alignment with the updates in the HURDAT2 data.

- Inez 1966
- Gladys 1968

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 in a submission appendix.***

Form M-1 is provided below (Table 16) as well as in the file “IF2023FormM1.xlsx” at the link provided to the FCHLPM.

Figure 1 **State of Florida and Neighboring States by Region**

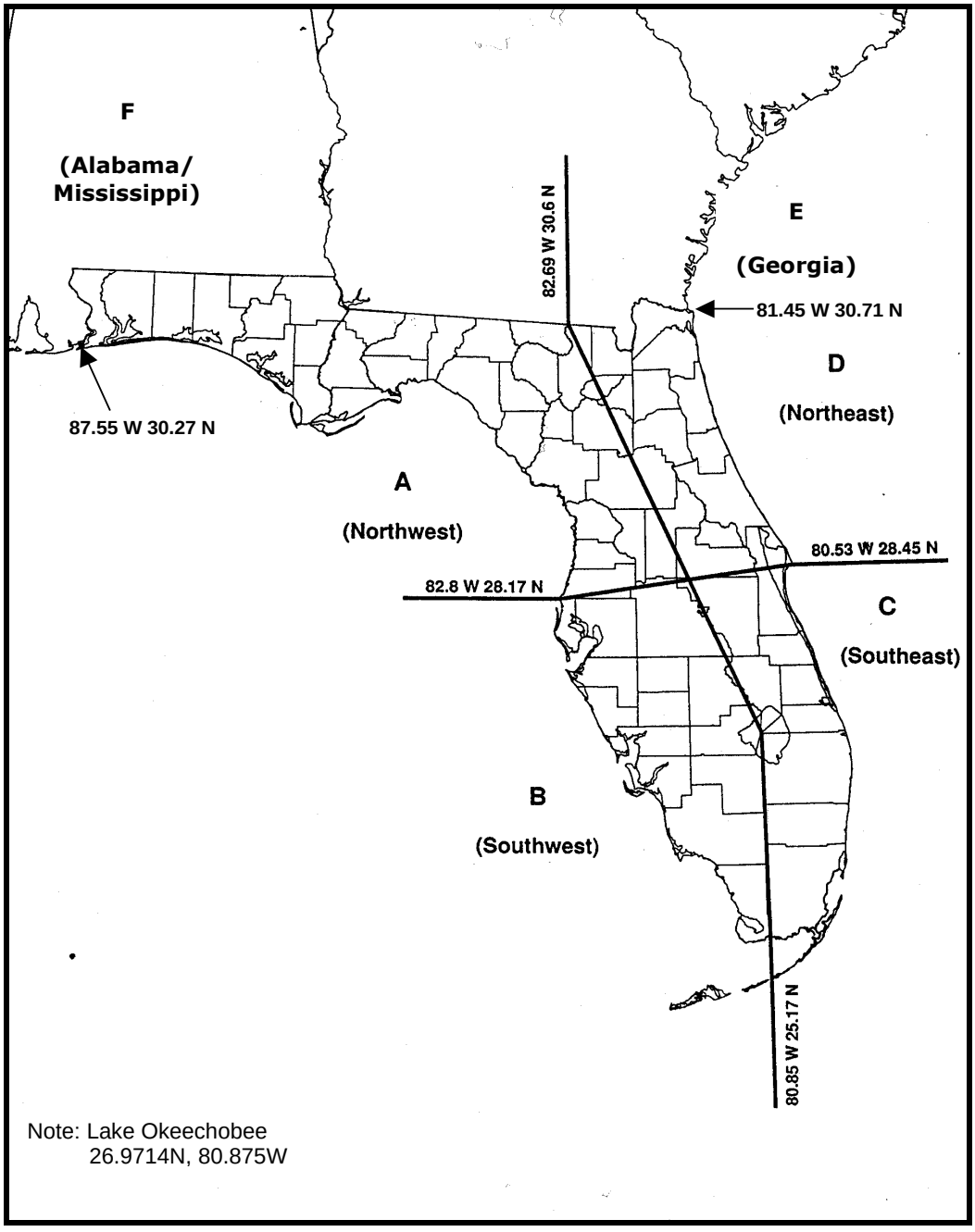


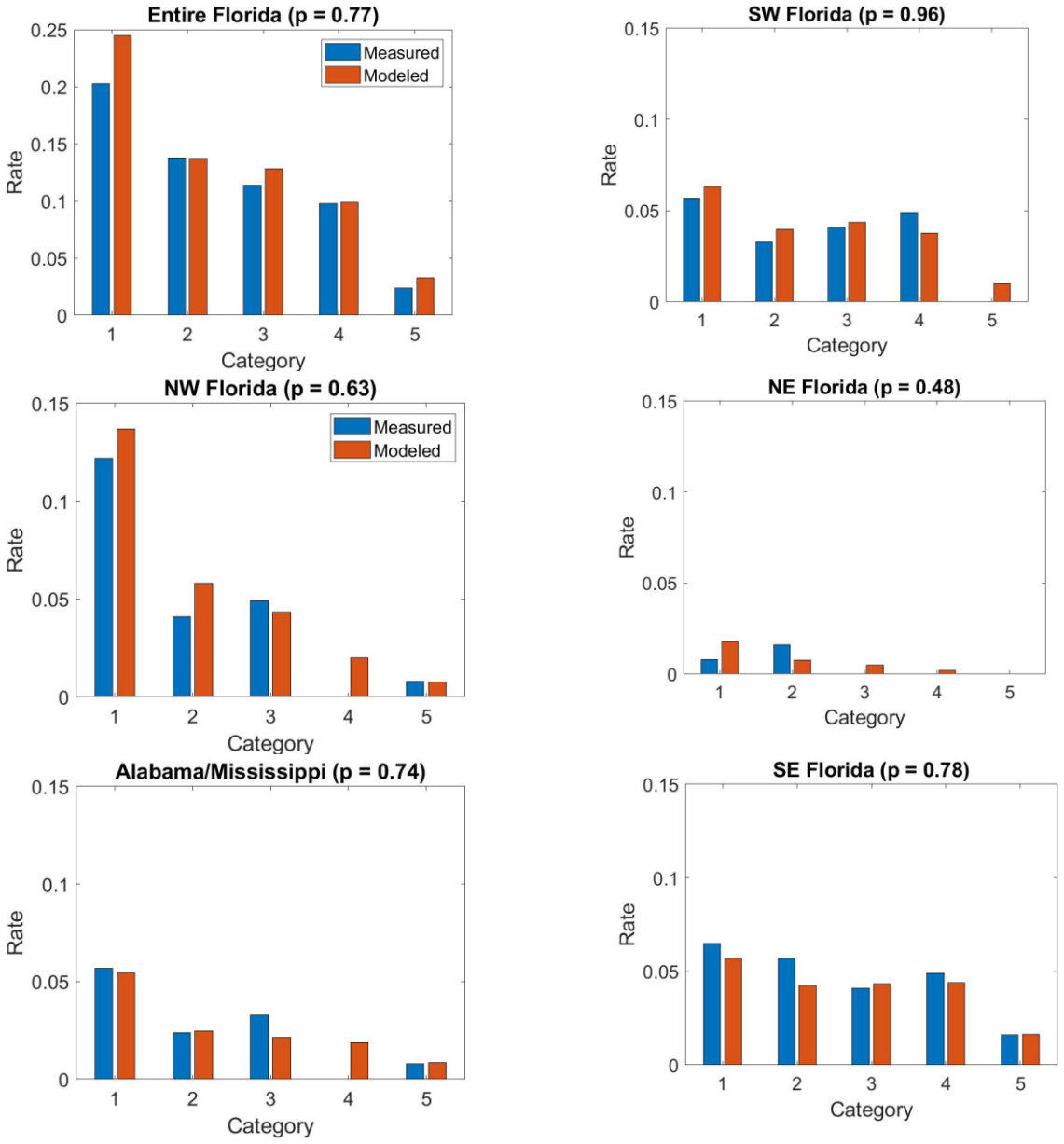
Table 16: Annual Occurrence Rates

	Entire State					Region A – NW Florida				
	Reference Hurricane Set		Model Base Hurricane Set		Modeled	Reference Hurricane Set		Model Base Hurricane Set		Modeled
Category	Nbr	Rate	Nbr	Rate	Rate	Nbr	Rate	Nbr	Rate	Rate
1	25	0.203	25	0.203	0.245	15	0.122	15	0.122	0.137
2	17	0.138	17	0.138	0.137	5	0.041	5	0.041	0.058
3	14	0.114	14	0.114	0.128	6	0.049	6	0.049	0.043
4	12	0.098	12	0.098	0.099	0	0.000	0	0.000	0.020
5	3	0.024	3	0.024	0.033	1	0.008	1	0.008	0.008

	Region B – SW Florida					Region C – SE Florida				
	Reference Hurricane Set		Model Base Hurricane Set		Modeled	Reference Hurricane Set		Model Base Hurricane Set		Modeled
Category	Nbr	Rate	Nbr	Rate	Rate	Nbr	Rate	Nbr	Rate	Rate
1	7	0.057	7	0.057	0.063	8	0.065	8	0.065	0.057
2	4	0.033	4	0.033	0.040	7	0.057	7	0.057	0.042
3	5	0.041	5	0.041	0.044	5	0.041	5	0.041	0.043
4	6	0.049	6	0.049	0.038	6	0.049	6	0.049	0.044
5	0	0.000	0	0.000	0.010	2	0.016	2	0.016	0.016

	Region D – NE Florida					Florida By-Passing Hurricanes				
	Reference Hurricane Set		Model Base Hurricane Set		Modeled	Reference Hurricane Set		Model Base Hurricane Set		Modeled
Category	Nbr	Rate	Nbr	Rate	Rate	Nbr	Rate	Nbr	Rate	Rate
1	1	0.008	1	0.008	0.018	5	0.041	10	0.081	0.052
2	2	0.016	2	0.016	0.008	3	0.024	5	0.041	0.038
3	0	0.000	0	0.000	0.005	7	0.057	8	0.065	0.039
4	0	0.000	0	0.000	0.002	0	0.000	2	0.016	0.038
5	0	0.000	0	0.000	0	0	0.000	1	0.008	0.014

	Region E – Georgia					Region F – Alabama/Mississippi				
	Reference Hurricane Set		Model Base Hurricane Set		Modeled	Reference Hurricane Set		Model Base Hurricane Set		Modeled
Category	Nbr	Rate	Nbr	Rate	Rate	Nbr	Rate	Nbr	Rate	Rate
1	0	0.000	0	0.000	0.019	7	0.057	7	0.057	0.055
2	2	0.016	2	0.016	0.008	3	0.024	3	0.024	0.025
3	0	0.000	0	0.000	0.007	4	0.033	4	0.033	0.021
4	0	0.000	0	0.000	0.002	0	0.000	0	0.000	0.019
5	0	0.000	0	0.000	0.000	1	0.008	1	0.008	0.008


Entire Florida (p = 0.77)
Measured
Modeled
Rate
Category
SW Florida (p = 0.96)
NW Florida (p = 0.63)
NE Florida (p = 0.48)
Alabama/Mississippi (p = 0.74)
SE Florida (p = 0.78)

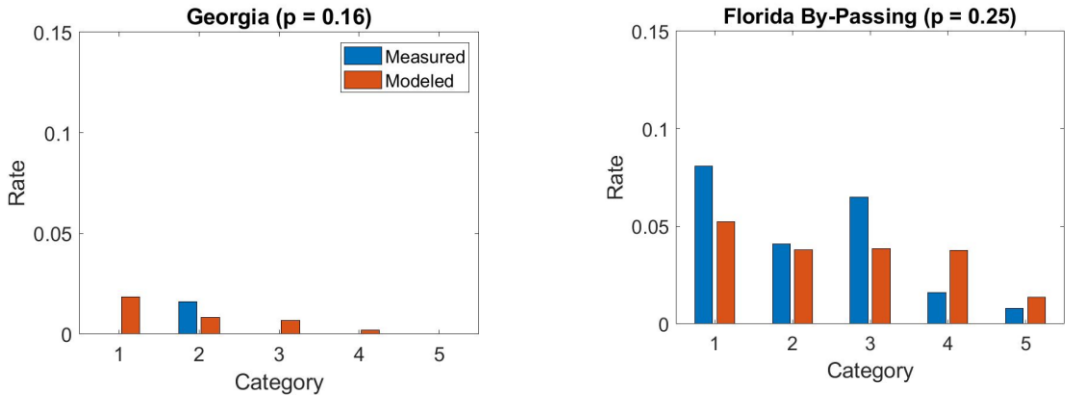


Figure 53: Comparison of historical and modeled hurricane occurrence rates by region and category, using Figure 1 from the Hurricane Standards Report of Activities as of November 1, 2023

Form M-2: Map of Maximum Winds

A. ***One or more automated programs or scripts shall be used to generate and arrange the data in Form M-2.***

Maximum windspeeds for the modeled versions of the Model Base Hurricane Set, as well as 100-year and 250-year return periods from the stochastic storm set, were compiled in a single table at 0.1x0.1-degree resolution using an automated Matlab script. Figure 54 to Figure 56 in Form M-2 were then generated from this data table in QGIS 3.34.8 using a predefined map template, a custom processing model, and a Python script to ensure consistent data formatting and automate image output.

B. ***Provide color-coded contour plots on a map with ZIP Code boundaries of the maximum winds for the modeled version of the Model Base Hurricane Set. Plot the position and value of the maximum windspeed on the contour map.***

A contour plot of the maximum winds for the modeled version of the Model Base Hurricane Set is provided in Figure 54. The position and value of the maximum windspeed is plotted on the contour map.

C. ***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. Plot the position and value of the maximum windspeed on each contour map.***

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

Use the following eight isotach values and interval color-coding for all maps:

1.	***Minimum damaging***	***Blue***
2.	***50 mph***	***Medium Blue***

3.	***65 mph***	***Light Blue***
4.	***80 mph***	***Grey***
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.

Color-coded contour plots of the maximum winds for a 100-year and 250-year return period from the stochastic storm set are provided in Figure 55 - Figure 56, respectively. The position and value of the maximum windspeed is plotted on each contour map.

D. Include Form M-2 in a submission appendix.

Form M-2 is included as an appendix to the submission.

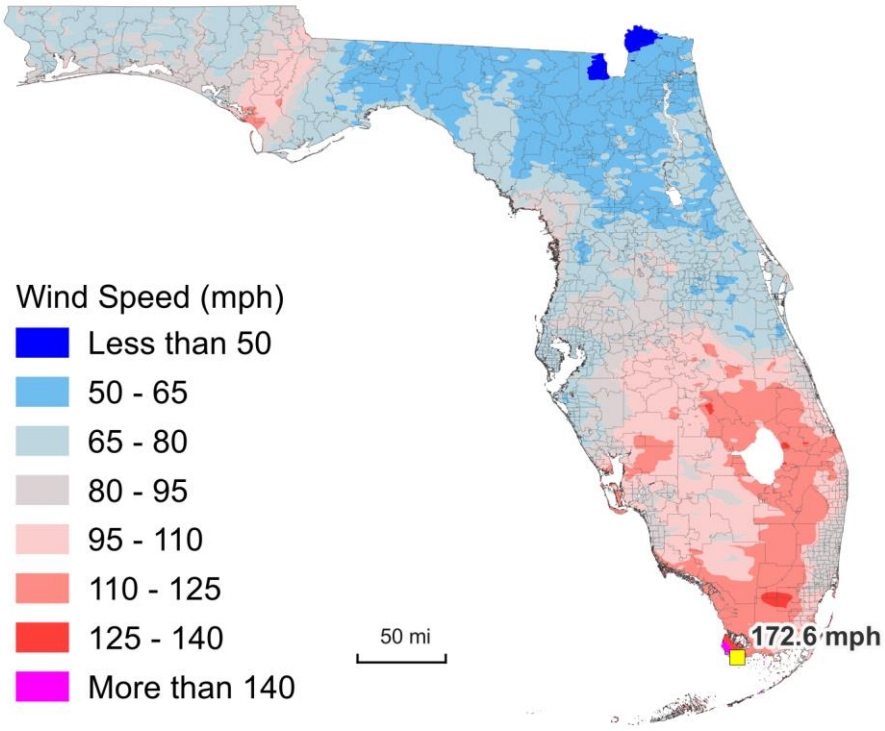


Figure 54: Maximum, 1-minute sustained wind speeds for the modeled historical storm set. Yellow square indicates the position of the maximum value.

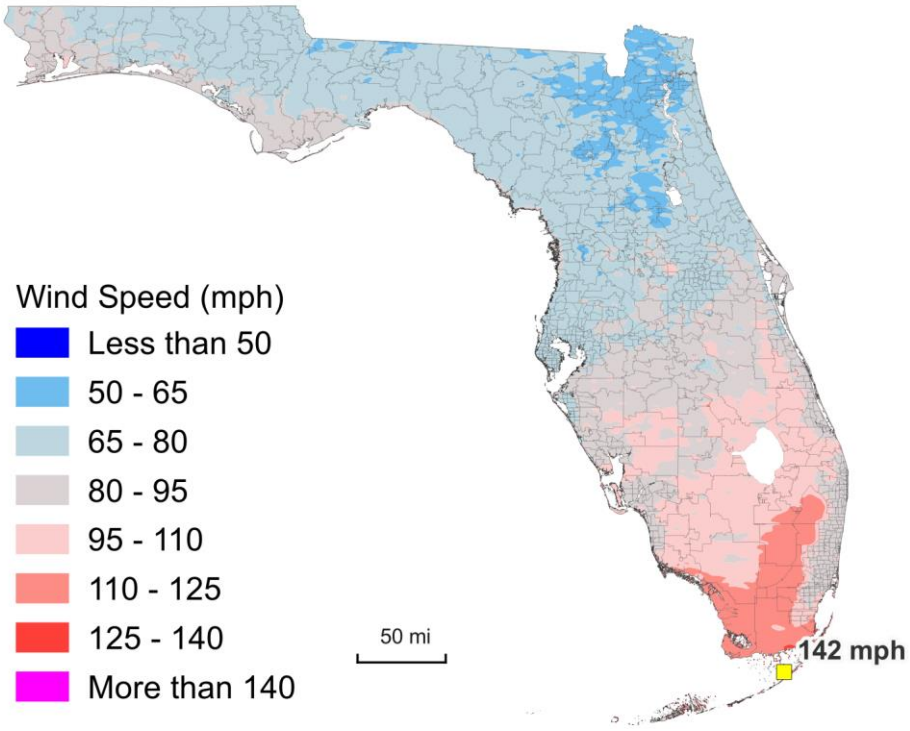


Figure 55: Maximum, 1-minute sustained wind speeds for a 100-year return period from the stochastic storm set. Yellow square indicates the position of the maximum value.

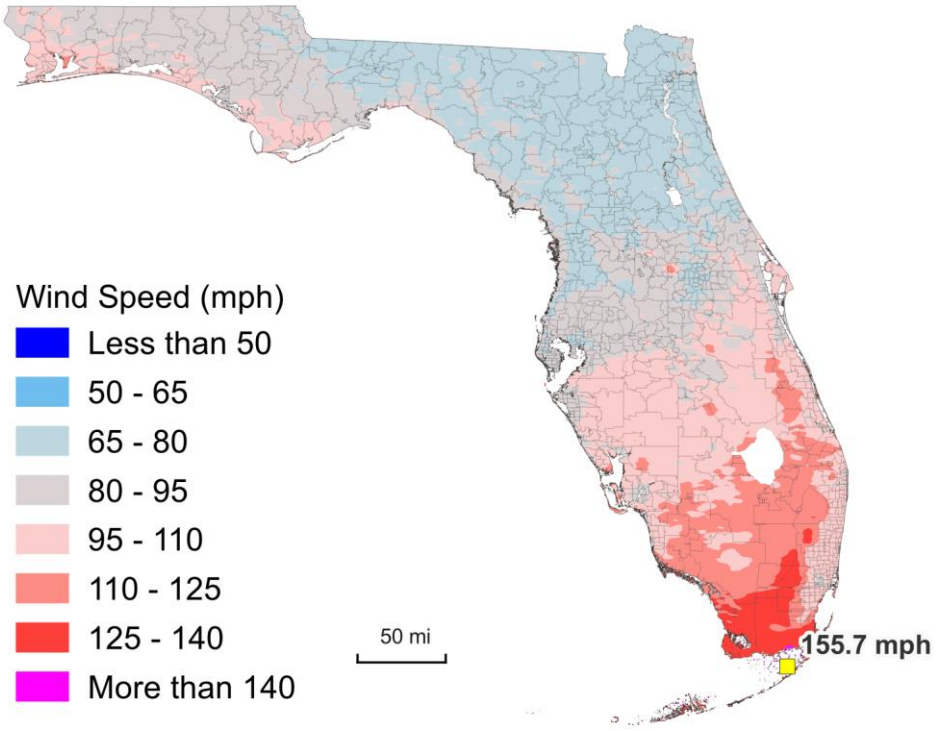


Figure 56: Maximum, 1-minute sustained wind speeds for a 250-year return period from the stochastic storm set. Yellow square indicates the position of the maximum value.

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

A. ***One or more automated programs or scripts shall be used to generate and arrange the data in Form M-3.***

Two MATLAB scripts are used to generate and arrange the data and to create the graphs automatically.

B. ***For the central pressure (CP) ranges in the table below, provide the first quartile (1Q), second quartile (2Q), and third quartile (3Q) in the stochastic storm set of the following quantities: radii to maximum wind (Rmax), the category 3 (110 mph) wind radii, the category 1 (73 mph) wind radii, and the gale force (40 mph) wind radii. If a value is unavailable, then populate the table with "NA."***

The first quartile (1Q), second quartile (2Q), and third quartile (3Q) values in the stochastic storm set for Rmax, category 3 wind radii, category 1 wind radii, and gale force wind radii are provided in the table below (Table 17). Values that are unavailable are populated with "NA."

C. ***Specify any truncations applied to Rmax distributions in the hurricane model, and if and how these truncations vary with other variables.***

In the Impact Forecasting Florida Hurricane (FCHLPM) Model, the upper and lower bounds of Rmax are set to 150 km (93 miles) and 5 km (3 miles), respectively. These upper and lower limits do not vary with other variables.

D. ***Provide a box and whiskers plot of the data from the table with central pressure on the x-axis and Rmax on the y-axis.***

A box plot of central pressure (x-axis) versus Rmax (y-axis) (Figure 57) is presented below.

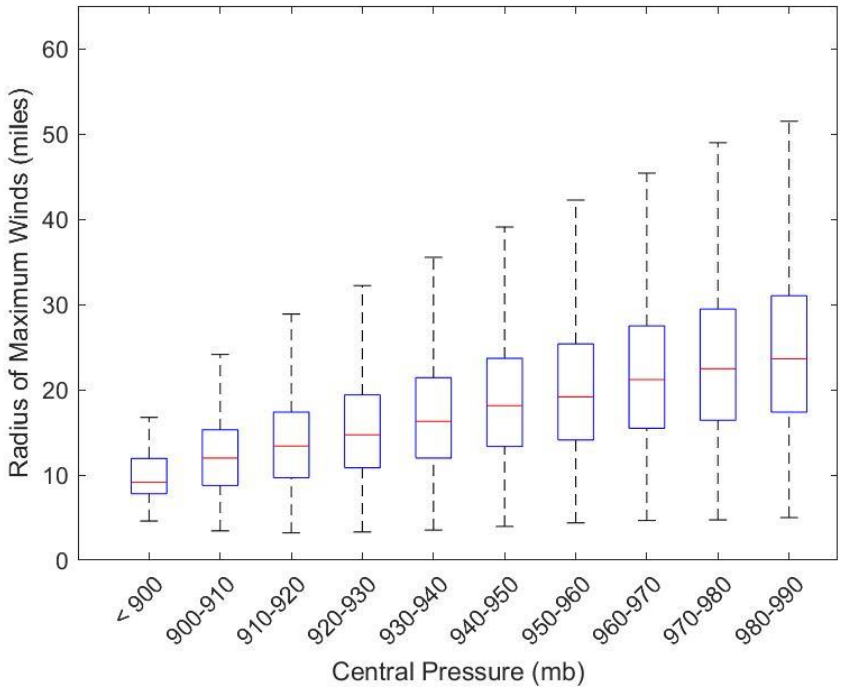


Figure 57: Box plot of central pressure versus radius of maximum winds (Rmax)

E. ***If central pressure is not modeled, describe how the hurricane model intensities were mapped to the central pressure ranges listed in the table.***

Impact Forecasting models intensities of events in terms of central pressure.

F. ***Provide this form in Excel using the format given in the file named "2023FormM3.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 in a submission appendix.***

Form M-3 is provided in the appendix as well as in the file "IF2023FormM3.xlsx" at the link provided to the FCHLPM.

Table 17 Ranges of Rmax and radii of standard wind thresholds used in the hurricane model stochastic storm set

Central Pressure (mb)	Rmax (mi)			Outer Radii (>110 mph) (mi)			Outer Radii (>73 mph) (mi)			Outer Radii (>40 mph) (mi)		
	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q	1Q	2Q	3Q
980 ≤ cp < 990	17	24	31	NA	NA	NA	37	46	54	159	168	177
970 ≤ cp < 980	16	22	29	NA	NA	23	44	53	62	163	172	181
960 ≤ cp < 970	15	21	27	17	24	31	57	65	73	171	179	188
950 ≤ cp < 960	14	19	25	22	28	35	65	72	79	171	178	186
940 ≤ cp < 950	13	18	24	27	32	38	70	76	82	168	175	183
930 ≤ cp < 940	12	16	21	29	34	39	71	75	81	160	167	174
920 ≤ cp < 930	11	15	19	31	35	40	69	74	79	151	158	166
910 ≤ cp < 920	10	13	17	32	36	41	67	73	79	142	150	160
900 ≤ cp < 910	9	12	15	33	36	40	64	70	76	132	142	152
cp < 900	8	9	12	31	34	36	59	63	69	120	126	137

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.***

A MATLAB script is used to automatically generate and arrange the data used in Form S-1 (Table 18).

B. ***Complete the table below for the modeled probabilities and frequencies of the number of landfalling Florida hurricanes per year. Values derived from the Reference Hurricane Set (as given in Form A-2) have been provided.***

Probabilities shall be rounded to three decimal places.

Model Base Hurricane Set frequency values shall be multiplied by a factor that is the number of years in the Reference Hurricane Set divided by the number of years in the Model Base Hurricane Set.

For a climate-adjusted hurricane model that uses either the Reference Hurricane Set or a Model Adjusted Hurricane Set for the Model Base Hurricane Set, a modeling organization shall provide two Form S-1s, one completed with climate-adjusted modeled probabilities and frequencies, and one completed without climate-adjusted modeled probabilities and frequencies.

C. ***Include Form S-1 in a submission appendix.***

Table 18: Probability and Frequency of Florida Landfalling Hurricanes per Year

Number of Hurricanes Per Year	Reference Hurricane Set Probability	Model Base Hurricane Set Probability	Modeled Probability	Reference Hurricane Set Frequency	Model Base Hurricane Set Frequency	Modeled Frequency
0	0.593	0.602	0.541	73	74	67
1	0.244	0.244	0.319	30	30	39
2	0.138	0.130	0.106	17	16	13
3	0.025	0.024	0.027	3	3	3
4	0.000	0.000	0.006	0	0	1
5	0.000	0.000	0.001	0	0	0
6	0.000	0.000	0	0	0	0
7	0.000	0.000	0	0	0	0
8	0.000	0.000	0	0	0	0
9	0.000	0.000	0	0	0	0
10 or more	0.000	0.000	0	0	0	0

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.***

An automated script is used to generate and arrange the data in Form S-2 (Table 19 and Table 20).

B. ***Provide estimates of the annual aggregate combined personal and commercial residential insured hurricane losses for various probability levels using the notional risk dataset specified in Form A-1, the 2017 FHCF exposure data, and the 2023 FHCF exposure data.***

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.

Annual aggregate estimates and distribution characteristics for three data sets are provided in Table 19 and Table 20.

C. ***Include Form S-2 in a submission appendix.***

Part A

Table 19: Examples of hurricane loss exceedance estimates

Return Period (Years)	Annual Probability of Exceedance	Estimated Hurricane Loss Notional Risk Dataset	Estimated Personal and Commercial Residential Hurricane Loss 2017 FHCF Dataset	Estimated Personal and Commercial Residential Hurricane Loss 2023 FHCF Dataset
Top Event	NA	104,485,888	288,302,780,826	382,130,937,052
10000	0.01%	85,126,143	203,687,083,025	279,842,541,818

Return Period (Years)	Annual Probability of Exceedance	Estimated Hurricane Loss Notional Risk Dataset	Estimated Personal and Commercial Residential Hurricane Loss 2017 FHCF Dataset	Estimated Personal and Commercial Residential Hurricane Loss 2023 FHCF Dataset
5000	0.02%	73,065,090	174,684,889,270	237,623,668,359
2000	0.05%	58,807,259	145,253,326,804	196,442,993,384
1000	0.10%	50,863,684	120,017,605,065	163,060,341,912
500	0.20%	43,154,000	97,418,300,992	132,921,489,014
250	0.40%	34,083,715	77,216,998,306	104,469,464,409
100	1.00%	24,210,220	53,305,141,888	72,148,917,512
50	2.00%	17,353,589	37,330,915,480	50,817,810,903
20	5.00%	9,598,433	19,623,643,301	26,856,089,976
10	10.00%	5,227,995	10,274,136,180	14,002,428,077
5	20.00%	2,080,857	3,885,560,644	5,322,997,053

Part B

Table 20: Average annual loss for the hurricane loss exceedance distribution

	Estimated Hurricane Loss Notional Risk Dataset	Estimated Personal and Commercial Residential Hurricane Loss 2017 FHCF Dataset	Estimated Personal and Commercial Residential Hurricane Loss 2023 FHCF Dataset
Mean (Total Average Annual Hurricane Loss)	1,841,082	3,767,967,138	5,143,074,753
Median	52,976	52,186,014	72,909,087
Standard Deviation	4,895,133	10,905,556,620	14,814,088,891
Interquartile Range	1,328,288	2,344,071,997	3,246,388,920
Sample Size	300,000	300,000	300,000

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.***

B. ***Provide a summary of the justification for each functional form selected for each general classification and for the goodness-of-fit tests used.***

Year Range Used for Fitting refers to the year range of data upon which the hurricane model distribution parameters are estimated.

Year Range Used for Validation refers to the year range of data upon which the goodness-of-fit statistics are based.

C. ***Include Form S-3 in a submission appendix.***

Table 21: Distributions of stochastic hurricane parameters

Stochastic Hurricane Parameter (Function or Variable)	Functional Form of Distribution	Data Sources	Year Range Used		Justification for Functional Form and Parameter Estimates
			For Filing	For Validation	
Annual number of storms	Negative binomial	HURDAT2	1900-2022	1900-2022	Negative binomial distribution fits historical data well which is supported by standard statistical tests. It works better than Poisson distribution and is validated through chi-squared test.

Stochastic Hurricane Parameter (Function or Variable)	Functional Form of Distribution	Data Sources	Year Range Used		Justification for Functional Form and Parameter Estimates
			For Filing	For Validation	
Storm genesis parameters	Equal-weighted random sampling	HURDAT2	1900-2022	1900-2022	Storm genesis parameters (e.g., initial location, forward speed, etc.) are sampled randomly from historical data to preserve spatial and temporal patterns of historical genesis, perfectly fitting storm genesis statistics by construction.
Translational speed and heading angle	Empirical (regression models with residuals fitted to normal distributions)	HURDAT2	1900-2022	1900-2022	Both translational speed and heading angle are modeled using a Markov Chain approach. The approach is based on the published work of Vickery et al. (2000). The resultant empirical distributions match historical data well, as validated through KS test for Florida-landfalling storms.
Central pressure	Empirical (regression model with residuals fitted to normal distribution)	HURDAT2, HadISST	1900-2022	1900-2022	Central pressure is modeled as a function of sea surface temperature. Sea surface temperature has been found to have a positive correlation with hurricane intensity. The modeling method is adopted from Vickery et al. (2000). The resultant

Stochastic Hurricane Parameter (Function or Variable)	Functional Form of Distribution	Data Sources	Year Range Used		Justification for Functional Form and Parameter Estimates
			For Filing	For Validation	
					empirical distribution agrees with historical data, as validated through KS test for Florida-landfalling storms.
Maximum sustained wind speed	Normal (with mean modeled as a function of central pressure deficit and latitude)	HURDAT2	1900-2022	1900-2022	The model is based on the functional form proposed by Knaff and Zehr (2007). It is fitted to historical data and describes the data well, as validated through chi-squared test for Florida-landfalling storms.
Radius of maximum winds	Lognormal (with mean modeled as a function of central pressure deficit and latitude)	HURDAT2, HURDAT Reanalysis, NWS 38, Extended Best Track	1900-2022	1900-2022	Radius of maximum winds is modeled using an empirical equation documented in Vickery and Wadhera (2008). The coefficients in the equation are estimated using a multi-linear regression. The model fits historical data well, as validated through chi-squared test for Florida-landfalling storms.

Stochastic Hurricane Parameter (Function or Variable)	Functional Form of Distribution	Data Sources	Year Range Used		Justification for Functional Form and Parameter Estimates
			For Filing	For Validation	
Inland decay rate	Normal (with mean modeled as a function of central pressure deficit, forward speed and radius of maximum winds at landfall)	HURDAT2, HURDAT Reanalysis, NWS 38, Extended Best Track	1900-2022	1900-2022	It has been found in the literature that hurricane inland decay rate tends to increase with the increase of hurricane intensity and forward speed and the decrease of hurricane radius of maximum winds at landfall. The three parameters are used in the model development as suggested by Vickery (2005). Modeled intensity decay for Florida landfalling events agrees visually with observation, as validated in Vickery (2005).

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.

Comparisons shall include hurricane losses from Hurricane Irma (2017), Hurricane Michael (2018), and Hurricane Ian (2022) to the extent data from Hurricane Ian are available.

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 relevant commercial residential classifications.***

C. ***Provide scatter plots 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 in a submission appendix.***

Rather than using a specific published hurricane windfield directly, the winds underlying the modeled hurricane loss cost calculations shall be produced by the hurricane model being evaluated and shall be the same hurricane parameters as used in completing Form A-2.

Validation comparisons, including scatter plots, for personal residential (Part A) and commercial residential (Part B) exposures are provided below. All percentages in the following exhibits are rounded to three decimal places. By construction of the exposure and claims dataset, "total exposure" encompasses the insured value of all exposures in the area affected by the hurricane covered by a hurricane wind policy.

For events for which residential loss experience data is available and sufficient surface observations are available to produce a calibrated hazard footprint, the vulnerability module is calibrated using a calibrated hurricane wind field, as described in Disclosure V-1.1. This includes calibrated footprints for Hurricane Charley (2004), Hurricane Irma (2017), and Hurricane Ian (2022). A version of Form S-4 providing validation using these calibrated footprints is provided following the submitted response for Form S-4.

Form S-4 Validation Comparisons

Part A: Personal Residential

Personal Residential Example 1

Hurricane = Charley (2004)
Exposure = Personal Residential

Table 22: Hurricane Charley (2004) modeled loss vs. claims by coverage type for personal residential

Coverage	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Building and Appurtenant Structure	1.054	1.802	0.748
Contents	0.193	0.216	0.023
Time Element	0.361	0.329	-0.032
Total	**0.706**	**1.145**	**0.440**

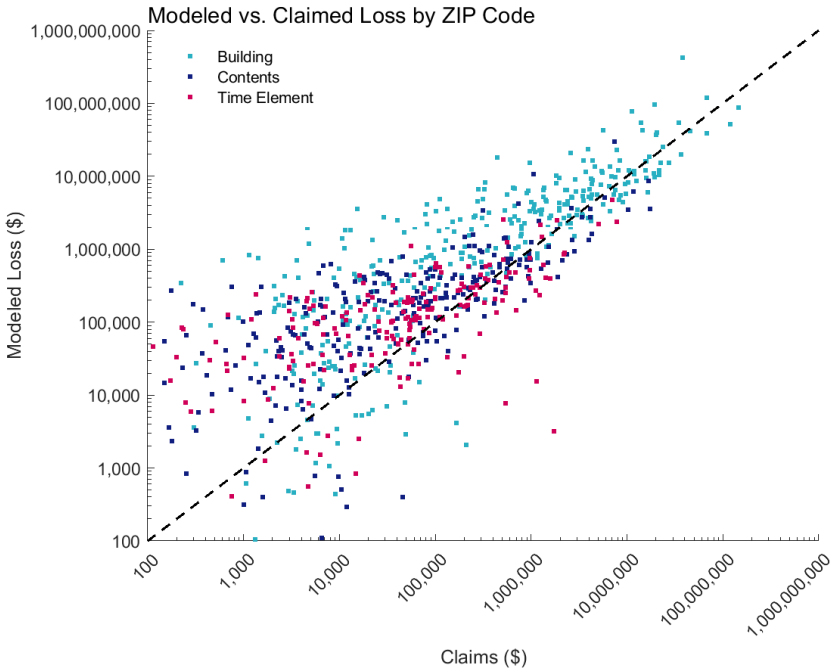


Figure 58: Hurricane Charley (2004) modeled loss vs. claims by construction type (ZIP Code resolution) for personal residential

Personal Residential Example 2

Hurricane = Ian (2022)
Exposure = Personal Residential

Table 23: Hurricane Ian (2022) modeled loss vs. claims by coverage type for personal residential

Coverage	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Building and Appurtenant Structure	0.849	0.737	-0.112
Contents	0.220	0.088	-0.132
Time Element	0.380	0.142	-0.238
Total	**0.698**	**0.573**	**-0.125**

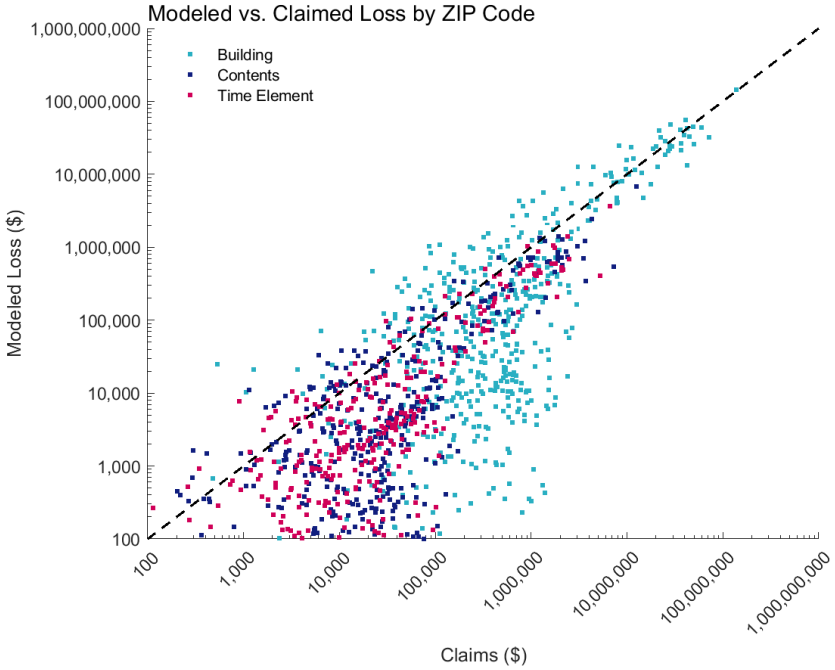


Figure 59: Hurricane Ian (2022) modeled loss vs. claims by coverage type (ZIP Code resolution) for personal residential

Personal Residential Example 3

Hurricane = Irma (2017)
Exposure = Personal Residential

Table 24: Hurricane Irma (2017) modeled loss vs. claims by construction type for personal residential

Construction	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Wood Frame	0.494	0.319	-0.175
Masonry	0.621	0.221	-0.400
Other *	0.610	0.186	-0.424
Total	**0.598**	**0.237**	**-0.361**

* Other includes unknown, reinforced concrete, steel, wind resistive, and very wind resistive. Wind resistive is defined as a building that is designed to undergo small amount of damage, even in higher wind speeds. Examples include rigid structures like bridges and transportation systems. Very wind resistive represents structures that are similar to wind resistive but perform even better.



Figure 60: Hurricane Irma (2017) modeled loss vs. claims by company (ZIP Code resolution) for personal residential

Personal Residential Example 4

Hurricane = Michael (2018)
Exposure = Personal Residential

Table 25: Hurricane Michael (2018) modeled loss vs. claims by construction type for personal residential

Construction	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Wood Frame	2.512	1.259	-1.252
Masonry	2.730	1.226	-1.504
Other *	2.618	0.303	-2.315
Total	**2.553**	**1.245**	**-1.308**

* Other includes unknown, reinforced concrete, steel, wind resistive, and very wind resistive. Wind resistive is defined as a building that is designed to undergo small amount of damage, even in higher wind speeds. Examples include rigid structures like bridges and transportation systems. Very wind resistive represents structures that are similar to wind resistive but perform even better.

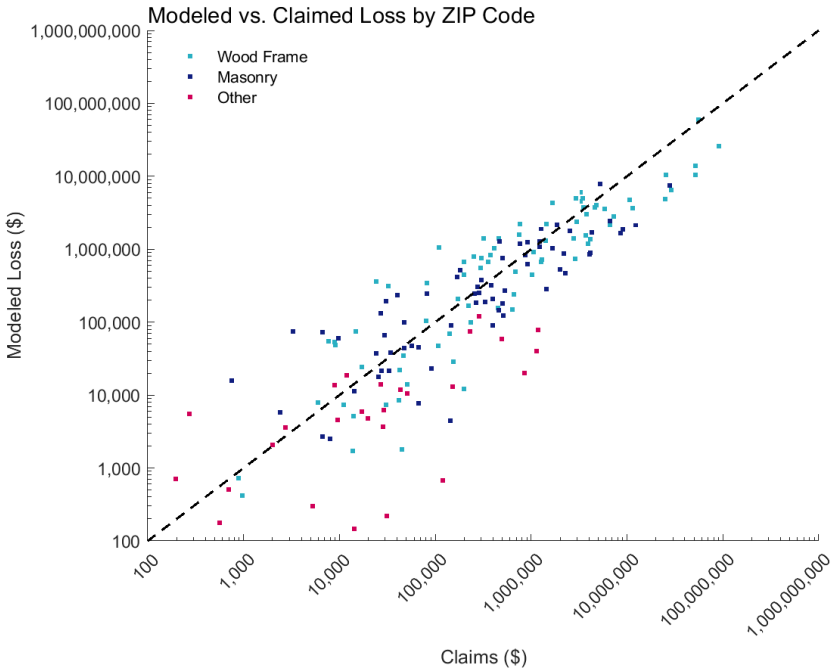


Figure 61: Hurricane Michael (2018) modeled loss vs. claims by construction type (ZIP Code resolution) for personal residential

Part B: Commercial Residential

Commercial residential exposure in the Impact Forecasting Florida Hurricane (FCHLPM) Model is defined by the commercial apartment condominium association occupancy type.

Commercial Residential Example 1

Hurricane = Irma (2017)
Exposure = Commercial Residential

Table 26: Hurricane Irma (2017) modeled loss vs. claims by construction type for commercial residential

Construction	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Wood Frame	0.282	0.331	0.048
Masonry	0.521	0.218	-0.303
Other *	0.199	0.052	-0.147
Total	**0.378**	**0.151**	**-0.228**

* Other includes unknown, reinforced concrete, steel, wind resistive, and very wind resistive. Wind resistive is defined as a building that is designed to undergo small amount of damage, even in higher wind speeds. Examples include rigid structures like bridges and transportation systems. Very wind resistive represents structures that are similar to wind resistive but perform even better.

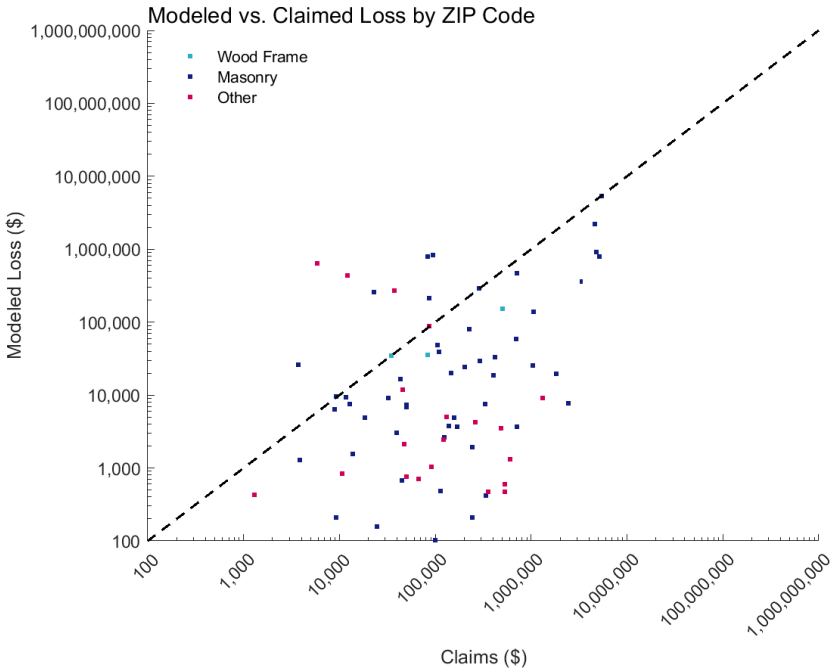


Figure 62: Hurricane Irma (2017) modeled loss vs. claims by construction type (ZIP Code resolution) for commercial residential

Form S-4 validation comparisons applying hazard footprints used for vulnerability calibration and validation

Part A: Personal Residential

Personal Residential Example 1

Hurricane = Charley (2004)
Exposure = Personal Residential

Coverage	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Building and Appurtenant Structure	1.090	1.550	0.460
Contents	0.198	0.189	-0.009
Time Element	0.357	0.272	-0.086
Total	**0.726**	**0.981**	**0.255**

Figure 63 Hurricane Charley (2004) modeled loss vs. claims by coverage type for personal residential



Figure 64: Hurricane Charley (2004) modeled loss vs. claims by construction type (ZIP Code resolution) for personal residential

Personal Residential Example 2

Hurricane = Ian (2022)
Exposure = Personal Residential

Table 27: Hurricane Ian (2022) modeled loss vs. claims by coverage type for personal residential

Coverage	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Building and Appurtenant Structure	1.035	0.844	-0.190
Contents	0.254	0.138	-0.116
Time Element	0.463	0.223	-0.240
Total	**0.840**	**0.661**	**-0.179**

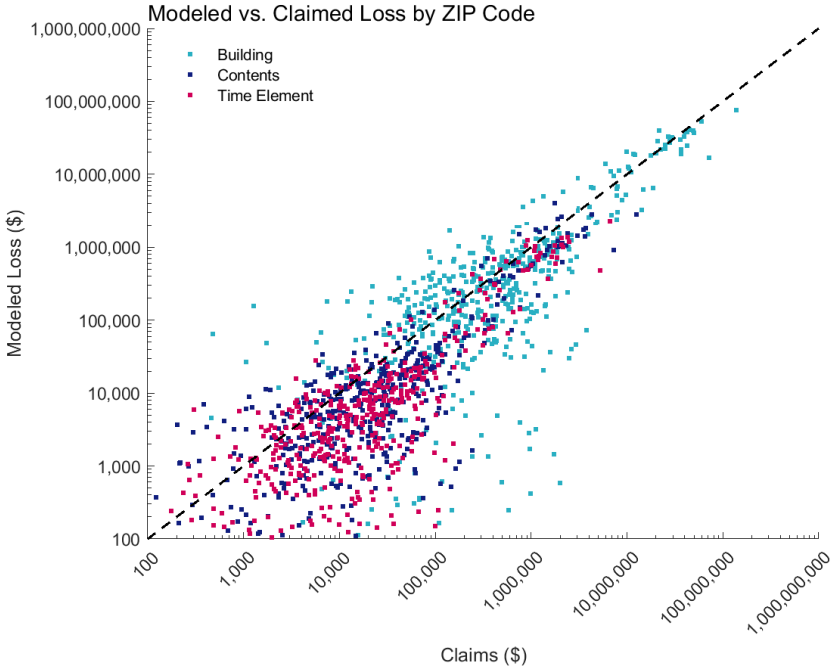


Figure 65: Hurricane Ian (2022) modeled loss vs. claims by coverage type (ZIP Code resolution) for personal residential

Personal Residential Example 3

Hurricane = Irma (2017)
Exposure = Personal Residential

Table 28: Hurricane Irma (2017) modeled loss vs. claims by construction type for personal residential

Construction	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Wood Frame	0.422	0.435	0.013
Masonry	0.609	0.433	-0.176
Other *	0.584	0.408	-0.176
Total	**0.569**	**0.432**	**-0.137**

* Other includes unknown, reinforced concrete, steel, wind resistive, and very wind resistive. Wind resistive is defined as a building that is designed to undergo small amount of damage, even in higher wind speeds. Examples include rigid structures like bridges and transportation systems. Very wind resistive represents structures that are similar to wind resistive but perform even better.

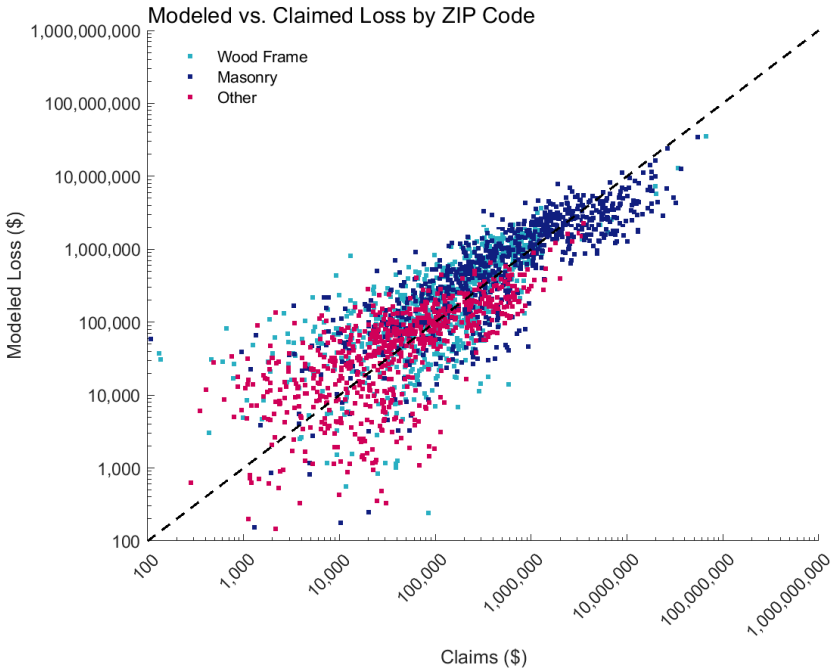


Figure 66: Hurricane Irma (2017) modeled loss vs. claims by company (ZIP Code resolution) for personal residential

Part B: Commercial Residential

Commercial residential exposure in the Impact Forecasting Florida Hurricane (FCHLPM) Model is defined by the commercial apartment condominium association occupancy type.

Commercial Residential Example 1

Hurricane = Irma (2017)
Exposure = Commercial Residential

Table 29: Hurricane Irma (2017) modeled loss vs. claims by construction type for commercial residential

Construction	Company Actual Hurricane Loss / Exposure (%)	Modeled Hurricane Loss / Exposure (%)	Difference (%pt)
Wood Frame	0.281	0.384	0.103
Masonry	0.522	0.802	0.280
Other *	0.211	0.288	0.077
Total	**0.384**	**0.574**	**0.189**

* Other includes unknown, reinforced concrete, steel, wind resistive, and very wind resistive. Wind resistive is defined as a building that is designed to undergo small amount of damage, even in higher wind speeds. Examples include rigid structures like bridges and transportation systems. Very wind resistive represents structures that are similar to wind resistive but perform even better.

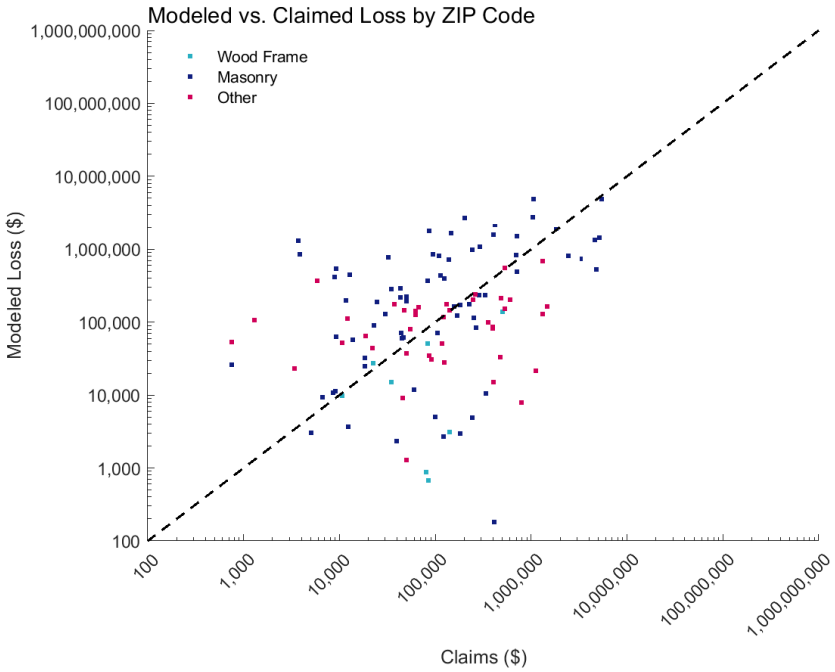


Figure 67: Hurricane Irma (2017) modeled loss vs. claims by construction type (ZIP Code resolution) for commercial residential

Form S-5: Average Annual Zero Deductible Statewide Hurricane Loss Costs

Part A – 2017 FHCF Exposure Data

A. ***Provide the average annual zero deductible statewide personal and commercial residential hurricane loss costs produced using the Model Base Hurricane Set.***

For the row related to the Current Accepted Hurricane Model and the two rows related to the Second Previous Accepted Hurricane Model, the table is to be completed with the same data as previously given in Form S-5 under the 2021 Hurricane Standards.

The average annual zero deductible statewide personal and commercial residential hurricane loss costs on 2017 FHCF Exposure Data are provided in Table 30.

Table 30: Average Annual Zero Deductible Statewide Personal and Commercial Residential Hurricane Loss Costs on 2017 FHCF Exposure Data ($ billions)

Time Period	Reference Hurricane Set (Previously Historical)	Model Base Hurricane Set	Produced by Hurricane Model
Current Submission	NA	$3.10	$3.77
Current Accepted Hurricane Model* (2021 Hurricane Standards)	$2.84	NA	$3.14
Second Previous Accepted Hurricane Model* (2019 Hurricane Standards)	$2.81	NA	$3.37
Percent Change Current Submission/ Second Previous Accepted Hurricane Model*	10.4%	NA	11.8%

***Enter N/A if no current or previous accepted hurricane model**

B. Provide a comparison with the statewide personal and commercial residential hurricane loss costs produced by the hurricane model.

As shown in Table 30, the statewide average annual hurricane loss cost produced using the 2017 FHCF personal and commercial residential zero deductible exposure data and the list of historical hurricanes in the Model Base Hurricane Set is $3.10 billion. The statewide average annual hurricane loss cost produced by the Florida Hurricane (FCHLPM) Model using the same exposure data is $3.77 billion.

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

The 95% confidence interval on the statewide average annual loss cost produced using the list of historical hurricanes in the Model Base Hurricane Set is $1.77 billion to $4.44 billion. Since the modeled personal and commercial residential hurricane loss cost ($3.77 billion) is within the range, the difference between the historical and modeled hurricane loss costs is not statistically significant.

Part B – 2023 FHCF Exposure Data

D. Provide the average annual zero deductible statewide personal and commercial residential hurricane loss costs produced using the Model Base Hurricane Set.

The average annual zero deductible statewide personal and commercial residential hurricane loss cost on 2023 FHCF Exposure Data is provided in Table 31.

Table 31: Average Annual Zero Deductible Statewide Personal and Commercial Residential Hurricane Loss Costs on 2023 FHCF Exposure Data ($ billions)

Time Period	Model Base Hurricane Set	Produced by Hurricane Model
Current Submission	$4.21	$5.14

E. Provide a comparison with the statewide personal and commercial residential hurricane loss costs produced by the hurricane model.

As shown in Table 31, the statewide average annual hurricane loss cost produced using the 2023 FHCF personal and commercial residential zero deductible exposure data and the list of historical hurricanes in the Model Base Hurricane Set is $4.21 billion. The statewide average annual hurricane loss cost produced by the Florida Hurricane (FCHLPM) Model using the same exposure data is $5.14 billion.

F. Provide the 95% confidence interval on the differences between the means of the Model Base Hurricane Set and modeled personal and commercial residential hurricane loss costs.

The 95% confidence interval on the statewide average annual loss cost produced using the list of historical hurricanes in the Model Base Hurricane Set is $2.40 billion to $6.01 billion. Since the modeled personal and commercial residential hurricane loss cost ($5.14 billion) is within the range, the difference between the historical and modeled hurricane loss costs is not statistically significant.

G. Include Form S-5 in a submission appendix.

Form S-5 has been provided in the Appendix.

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 "FormV1Input23.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 loss ratios summarized by windspeed (mph) and construction type.***

The windspeeds provided are one-minute sustained 10-meter windspeeds. The sample personal and commercial residential exposure data provided consists 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 windspeed.

For completing Part A, Estimated Damage for each individual windspeed range is the sum of ground up hurricane loss to all structures in the ZIP Codes subjected to that individual windspeed range, excluding demand surge and flood (including hurricane storm surge). Subject Exposure is all exposures in the ZIP Codes subjected to that individual windspeed 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 windspeed 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 is to be placed at the population centroid of the ZIP Codes. Do not include appurtenant structure, contents, or time element coverages in the building damage ratios. Do not include building, appurtenant structure, or time element coverages in the contents damage ratios. Do not include building, appurtenant structure, or contents coverages in the time element loss ratios.

Reference Frame Structure	Reference Masonry Structure
One story Unbraced gable end roof American Society for Testing and Materials (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	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

No skylight covers Constructed in 1995	
Reference Manufactured Home Structure	Reference Concrete Structure
Tie downs Single unit Manufactured in 1980	Twenty stories 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. List assumptions necessary to complete Form V-1 (e.g., regarding structural characteristics, duration, or surface roughness). Provide the rationale and a detailed description of how the assumptions are implemented.

The structures used in completing this form are identical to those in the above table.

Impact Forecasting assumes that the wind speeds provided in the file named "FormV1Input23.xlsx" are open terrain one-minute sustained wind speeds at 10 m above the ground. As the Impact Forecasting vulnerability module requires three-second gust wind speeds to calculate wind damage for a property, the given wind speeds were converted into actual terrain three-second gust wind speeds. For each ZIP Code, a population-weighted mean roughness coefficient and gust factor were used to convert the open terrain sustained windspeed to actual terrain gust windspeed. More details regarding the development and use of roughness coefficients and gust factors are provided in Standard M-2 and Standard M-4.

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.

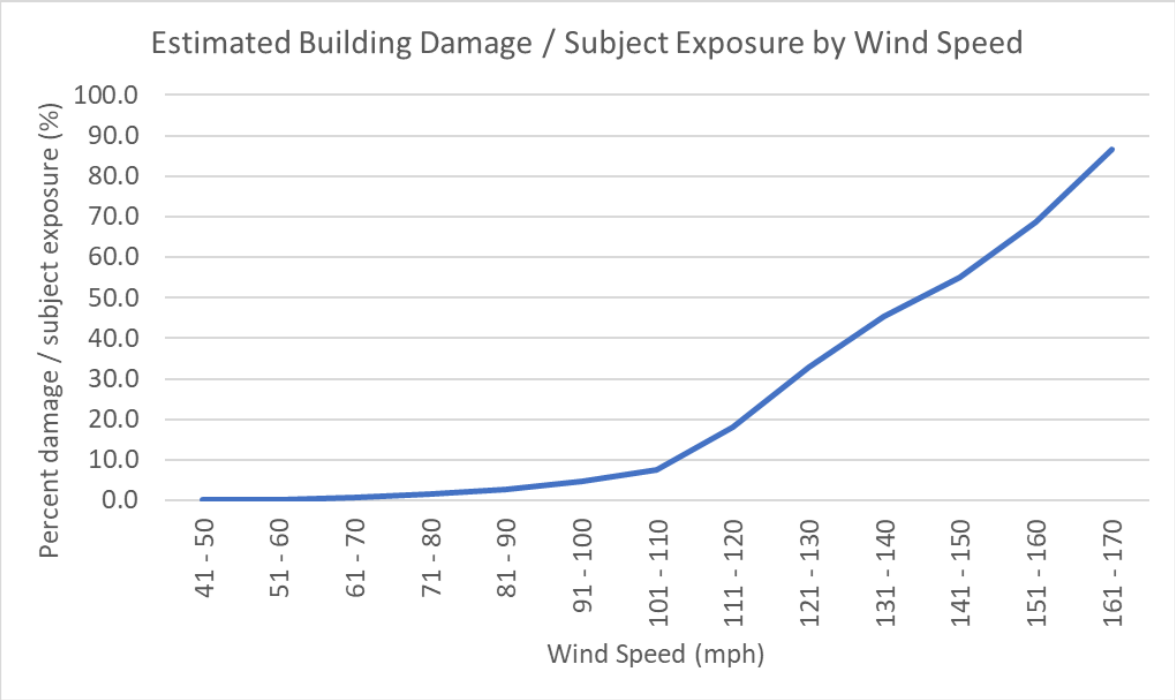


Figure 68: Estimated damage/subject exposure versus wind speed for building exposure

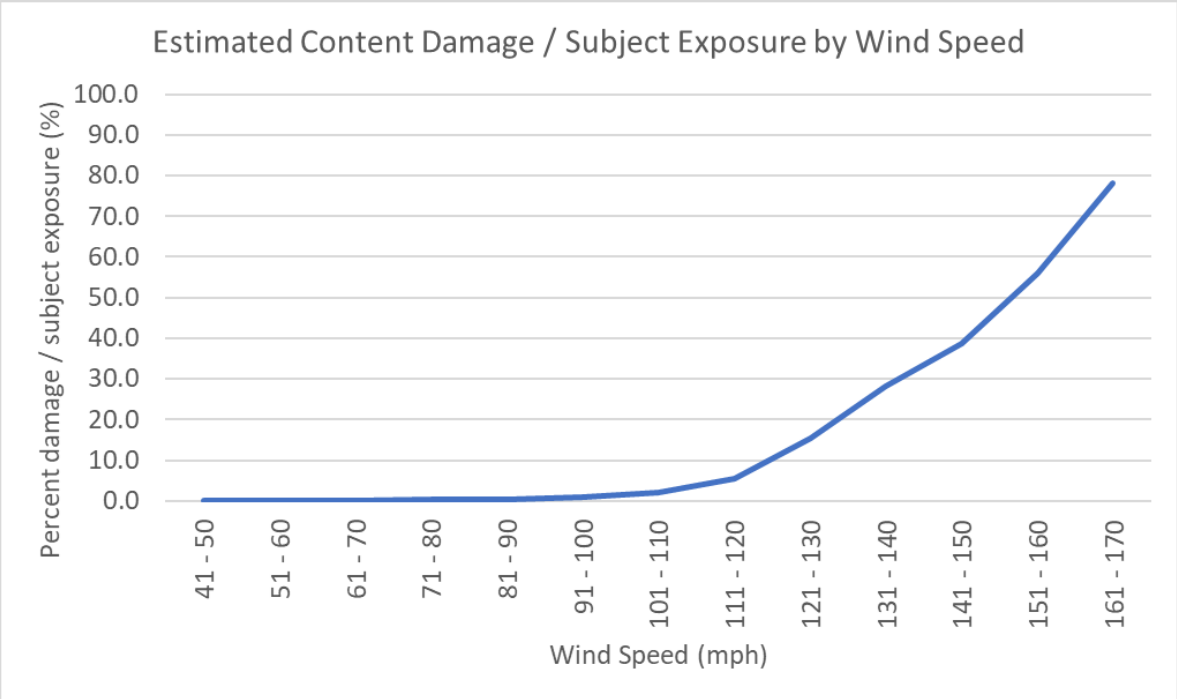


Figure 69: Estimated damage/subject exposure versus wind speed for contents exposure

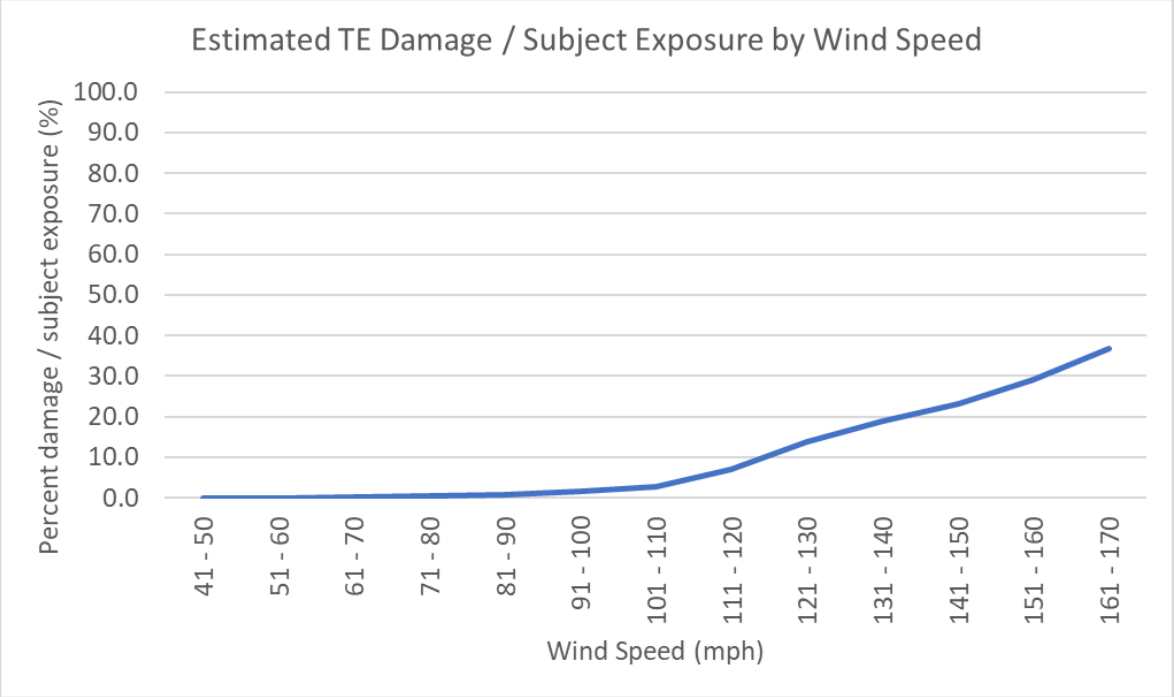


Figure 70: Estimated damage/subject exposure versus wind speed for time element exposure

D. Include Form V-1 in a submission appendix.

Part A

Table 32: Damage ratios summarized by windspeed

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	0.13	0.02	0.03
61 - 70	0.71	0.10	0.19

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
71 - 80	1.67	0.29	0.49
81 - 90	2.70	0.46	0.83
91 - 100	4.61	1.03	1.59
101 - 110	7.66	1.97	2.78
111 - 120	17.96	5.58	7.06
121 - 130	32.93	15.47	13.73
131 - 140	45.29	28.22	19.01
141 - 150	55.02	38.60	23.24
151 - 160	68.64	55.96	29.11
161 - 170	86.57	78.28	36.91

Part B

Table 33: Damage ratios summarized by construction type

Construction Type	Estimated Building Damage/ Subject Building Exposure	Estimated Contents Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
Wood Frame	24.73	20.19	10.30
Masonry	23.61	18.95	9.83
Manufactured Home	29.86	24.91	12.68
Concrete	10.73	2.82	4.42

Form V-2: Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage

A. Explain how the hurricane vulnerability functions for the two reference structures are developed. Demonstrate that the hurricane vulnerability function for each reference structure is related to one of the hurricane model's standard building structure vulnerability functions for frame and masonry constructions.

The hurricane vulnerability functions for the two reference structures are the combination of the primary vulnerability functions of the frame and masonry structures and associated secondary modifiers. The primary vulnerability functions and the secondary modifiers are developed based on sound engineering principles and are calibrated and validated using claims data from multiple historical events and peer-reviewed research publications, as described in Standards V-1 and V-4 .

B. Place the reference building at the population centroid for ZIP Code 33921 in Lee County.

The reference buildings are placed at the centroid of the zip code 33921 in Lee County.

C. Provide the change in the zero deductible personal residential reference building damage ratio (not hurricane loss cost) for each individual hurricane mitigation measure and secondary characteristic listed in Form V-2, 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.

Form V-2 is provided in Table 34 below.

D. List assumptions necessary to complete Form V-2, including those for membrane and metal roof covering, roof age, duration, and surface roughness. Provide the rationale and a detailed description of how the assumptions are implemented.

The wind speeds provided in Form V-2 are assumed as open terrain with one-minute sustained winds at 10 m above the ground. As the Impact Forecasting vulnerability module requires three-second gust wind speeds to calculate wind damage for a property, the given wind speeds were converted into actual terrain three-second gust wind speeds. More details regarding the development and use of roughness coefficients and gust factors are provided in Standard M-2 and Standard M-4.

E. Provide an explanation for cells filled with "0" or blank cells.

There are cells filled with "0" in Form V_2, including roof-membrane-covering, wall-to-floor-to-foundation strength and at 160 mph wind speeds.

The capacity of the roof membrane to withstand wind loads is assumed to be similar to that of ASTM D7158 Class D shingles. Therefore, using a Membrane as a roof covering does not improve the overall vulnerability of the building.

The wall-to-floor-to-foundation failure mode, which is rare, was analyzed using the Impact Forecasting wind damage simulator. The use of strong wall-to-floor-to-foundation connections does not significantly change the vulnerability curves from the simulator. Also, it is understood from the literature that wall-to-floor-to-foundation failures in the event of a hurricane are rare and almost always caused by storm surges and not wind. Therefore, individual upgrades to this component do not receive credits.

The reference building is a weak structure and therefore a single mitigation measure does not improve the performance of the building at high wind speeds of 160 mph.

F. 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 in a submission appendix.

Form V-2 in Excel format is provided in the file "IF2023FormV2.xlsx" at the link provided to the FCHLPM.

Reference Frame Building	Reference Masonry Building
One story	One story
Unbraced gable end roof	Unbraced gable end roof
ASTM D3161 Class D or ASTM D7158 Class D shingles	ASTM D3161 Class D or ASTM D7158 Class D shingles
½” plywood deck	½” plywood deck
6d nails deck to roof members	6d nails deck to roof members
Toe nail truss to wall anchor	Weak truss to wall connection
Wood framed exterior walls	Masonry exterior walls
5/8” diameter anchors at 48” centers for wall-floor-foundation connections	No vertical wall reinforcing
No shutters	No shutters
Standard glass windows	Standard glass windows
No door covers	No door covers
No skylight covers	No skylight covers
Constructed in 1995	Constructed in 1995
Mitigated Frame Building	**Mitigated Masonry Building**
ASTM D7158 Class H shingles	ASTM D7158 Class H shingles
8d nails deck to roof members	8d nails deck to roof members

Truss straps at roof Structural wood panel shutters	Truss straps at roof Structural wood panel shutters

Table 34: Hurricane Mitigation Measures, Range of Changes in Hurricane Damage

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS		PERCENTAGE CHANGES IN DAMAGE ((REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO) / REFERENCE DAMAGE RATIO) * 100									
		FRAME BUILDING					MASONRY BUILDING				
		WINDSPEED (MPH)*					WINDSPEED (MPH)*				
		60	85	110	135	160	60	85	110	135	160
	REFERENCE BUILDING	—	—	—	—	—	—	—	—	—	—
ROOF CONFIGUR-	BRACED GABLE ENDS	9.693	10.688	9.307	6.937	0.000	10.651	11.877	9.460	6.482	0.000
	HIP ROOF	19.384	25.219	20.836	10.679	0.000	19.931	24.968	19.337	10.999	0.000
ROOF COVERING	METAL	16.370	15.658	11.286	5.185	0.000	16.825	15.246	11.471	5.837	0.000
	ASTM D7158 CLASS H SHINGLES	20.986	18.754	13.547	7.070	0.000	21.621	18.812	13.844	7.048	0.000
	MEMBRANE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Roof Sheathing	NAILING OF DECK 8d	7.796	8.300	8.337	7.231	0.000	8.766	9.299	7.834	6.665	0.000
ROOF-WALL STRENGTH	CLIPS	13.559	15.955	16.528	12.822	0.000	14.165	16.298	16.631	13.229	0.730
	STRAPS	21.573	26.150	28.303	22.070	1.777	21.908	26.128	28.314	22.306	6.892
WALL-FLOOR	TIES OR CLIPS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	STRAPS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WALL-FOUNDATION	LARGER ANCHORS OR CLOSER SPACING	0.000	0.000	0.000	0.000	0.000	—	—	—	—	—
	STRAPS	0.000	0.000	0.000	0.000	0.000	—	—	—	—	—

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS			PERCENTAGE CHANGES IN DAMAGE ((REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO) / REFERENCE DAMAGE RATIO) * 100									
			FRAME BUILDING					MASONRY BUILDING				
			WINDSPEED (MPH)*					WINDSPEED (MPH)*				
			60	85	110	135	160	60	85	110	135	160
	VERTICAL REINFORCING		—	—	—	—	—	11.124	7.483	6.811	5.978	0.000
OPENING PROTECTION	WINDOW SHUTTERS	STRUCTURAL WOOD PANEL	3.688	5.668	8.345	7.066	0.000	4.313	6.220	7.848	6.809	0.000
		METAL	10.976	16.425	21.086	16.738	0.067	11.594	16.924	21.673	16.756	5.303
	DOOR AND SKYLIGHT COVERS		4.503	8.372	9.871	8.488	0.000	5.691	9.332	10.046	8.296	0.000
WINDOW, DOOR, SKYLIGHT STRENGTH	WINDOWS	IMPACT RATED	12.741	19.187	24.012	19.097	2.328	13.250	19.726	23.884	19.305	7.428
	ENTRY DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	6.212	9.472	12.283	9.433	0.000	6.166	9.740	12.378	9.511	0.225
	GARAGE DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	1.833	5.523	6.161	2.305	0.000	2.434	6.320	6.445	2.900	0.000
	SLIDING GLASS DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	6.212	9.472	12.283	9.433	0.000	6.166	9.740	12.378	9.511	0.225
	SKYLIGHT	IMPACT RATED	6.212	9.472	12.283	9.433	0.000	6.166	9.740	12.378	9.511	0.225

HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION	PERCENTAGE CHANGES IN DAMAGE ((REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO) / REFERENCE DAMAGE RATIO) * 100									
	FRAME BUILDING WINDSPEED (MPH)*					MASONRY BUILDING WINDSPEED (MPH)*				
	60	85	110	135	160	60	85	110	135	160
MITIGATED BUILDING	43.229	49.142	47.354	37.658	14.919	43.466	49.464	47.289	37.626	19.159

*Windspeeds are one-minute sustained 10-meter.

Form V-3: Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)

Form V-3 is considered to be trade secret material and will be provided to the Professional Team for review during the on-site visit and to the Commission during the closed portion of the Acceptability Meeting.

Form V-4: Differences in Hurricane Mitigation Measures and Secondary Characteristics

A. Provide the differences between the values reported in Form V-2 relative to the equivalent data compiled from the current accepted hurricane model.

Form V-4 is provided in Table 35 below.

B. List assumptions necessary to complete Form V-4, including those for membrane and metal roof covering, roof age, duration, and surface roughness.

There are no additional assumptions applied.

C. Provide a summary description of the differences.

The differences shown in Form V-4 are mainly contributed by modifications as described in Disclosures V-1.1 and V-4.1. The differences are stemmed from the recalibration of the primary vulnerability functions and the adjustments of the secondary modifiers to include chance of loss.

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 in a submission appendix.

Form V-4 in Excel format is provided in the file “IF2023FormV4.xlsx” at the link provided to the FCHLPM.

Table 35: Differences for hurricane mitigation measures and secondary characteristics

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS		DIFFERENCES FROM FORM V-2 RELATIVE TO CURRENT ACCEPTED HURRICANE MODEL									
		FRAME BUILDING					MASONRY BUILDING				
		WINDSPEED (MPH)*					WINDSPEED (MPH)*				
		60	85	110	135	160	60	85	110	135	160
	REFERENCE BUILDING	—	—	—	—	—	—	—	—	—	—
ROOF CONFIGUR-ATION	BRACED GABLE ENDS	0.060	-1.459	-0.152	0.618	0.000	1.019	-0.265	0.001	0.163	0.000
	HIP ROOF	0.964	-0.629	2.367	-0.147	0.000	1.499	-0.862	0.868	0.174	0.000
ROOF COVERING	METAL	-2.877	-3.274	-3.054	-1.449	0.000	-2.430	-3.537	-2.869	-0.796	0.000
	ASTM D7158 CLASS H SHINGLES	-2.586	-3.753	-2.595	-1.376	0.000	-1.947	-3.639	-2.297	-1.397	0.000
	MEMBRANE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Roof Sheathing	NAILING OF DECK 8d	0.432	-0.739	0.041	0.859	0.000	1.395	0.250	-0.462	0.294	0.000
ROOF-WALL STRENGTH	CLIPS	0.484	-0.235	-0.364	0.595	0.000	1.068	-0.085	-0.262	1.004	0.730
	STRAPS	0.923	-0.866	-0.263	0.417	1.777	1.232	-1.138	-0.252	0.656	6.403
WALL-FLOOR CONNECT.	TIES OR CLIPS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	STRAPS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS			DIFFERENCES FROM FORM V-2 RELATIVE TO CURRENT ACCEPTED HURRICANE MODEL									
			FRAME BUILDING					MASONRY BUILDING				
			WINDSPEED (MPH)*					WINDSPEED (MPH)*				
			60	85	110	135	160	60	85	110	135	160
WALL-FOUNDATION STRENGTH	LARGER ANCHORS OR CLOSER SPACING		0.000	0.000	0.000	0.000	0.000	—	—	—	—	—
	STRAPS		0.000	0.000	0.000	0.000	0.000	—	—	—	—	—
	VERTICAL REINFORCING		—	—	—	—	—	11.124	7.483	1.909	-3.826	0.000
OPENING PROTECTION	WINDOW SHUTTERS	STRUCTURAL WOOD PANEL	-0.6	-0.497	0.161	0.231	0	0.016	-0.024	-0.336	-0.026	0
		METAL	0.344	-0.749	1.566	0.372	0.067	0.948	-0.549	2.153	0.39	5.303
	DOOR AND SKYLIGHT COVERS		-0.4	-1.083	-0.64	0.2	0	0.779	-0.351	-0.464	0.009	0
WINDOW, DOOR, SKYLIGHT STRENGTH	WINDOWS	IMPACT RATED	0.281	-0.577	0.588	-0.376	2.328	0.768	-0.324	0.46	-0.167	4.543
	ENTRY DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0.483	-0.552	-0.217	0.007	0	0.432	-0.399	-0.122	0.085	0.225
	GARAGE DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	-0.416	-0.408	-0.033	-0.233	0	0.182	0.363	0.251	0.362	0
	SLIDING GLASS DOORS	MEETS WIND-BORNE DEBRIS REQUIREMENTS	0.483	-0.552	-0.217	0.007	0	0.432	-0.399	-0.122	0.085	0.225

INDIVIDUAL HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS			DIFFERENCES FROM FORM V-2 RELATIVE TO CURRENT ACCEPTED HURRICANE MODEL									
			FRAME BUILDING					MASONRY BUILDING				
			WINDSPEED (MPH)*					WINDSPEED (MPH)*				
			60	85	110	135	160	60	85	110	135	160
	SKYLIGHT	IMPACT RATED	0.483	-0.552	-0.217	0.007	0	0.432	-0.399	-0.122	0.085	0.225

HURRICANE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION	DIFFERENCES FROM FORM V-2 RELATIVE TO CURRENT ACCEPTED HURRICANE MODEL									
	FRAME BUILDING					MASONRY BUILDING				
	WINDSPEED (MPH)*					WINDSPEED (MPH)*				
	60	85	110	135	160	60	85	110	135	160
MITIGATED BUILDING	-2.628	-2.219	-2.196	-0.361	3.997	-2.415	-2.027	-2.261	-0.391	4.095

*Windspeeds are one-minute sustained 10-meter.

Form V-5: Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item)

Form V-5 is considered to be trade secret material and will be provided to the Professional Team for review during the on-site visit and to the Commission during the closed portion of the Acceptability Meeting.

Form A-1: Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code

A. One or more automated programs or scripts shall be used to generate and arrange the data in Form A-1.

An automated script is used to generate and arrange the data in Form A-1. Figure 71, Figure 72, and Figure 73 in Form A-1 were generated from the data within this table in QGIS 3.34.8 using a Python script and predefined map template. These scripts and associated formatting files will be available for review during the in-person audit.

B. Provide three maps, color-coded by ZIP Code (with a minimum of seven value ranges), displaying zero deductible personal residential hurricane loss costs per $1,000 of exposure for frame owners, masonry owners, and manufactured homes.

Three maps, color-coded by ZIP Code, displaying zero deductible personal residential hurricane loss costs per $1,000 of exposure appear in Figure 71 (frame owners), Figure 72 (masonry owners), and Figure 73 (manufactured homes) below.

C. Provide, in the format given in the file named "2023FormA1.xlsx," in both Excel and PDF format, the underlying hurricane loss cost data, rounded to three decimal places, used for B. above. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name.

The required information is contained in the files IF2023FormA1.xlsx and IF2023FormA1.pdf.

D. Create exposure sets for the exhibits by modeling the frame owners, masonry owners, and manufactured homes from Notional Set 3, described in the file "NotionalInput23.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 (Figure 12) 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.

No assumptions, deviations and differences were necessary from the prescribed exposure information.

E. Describe how Law and Ordinance is included in the hurricane loss cost data.

Law and ordinance coverage was default to 25% for personal residential properties (excluding Mobile Home) for this form. This assumption is incorporated into vulnerability curves.

F. List assumptions necessary to complete Form A-1. Provide the rationale and a detailed description of how the assumptions are implemented.

No additional assumptions were made for this form.

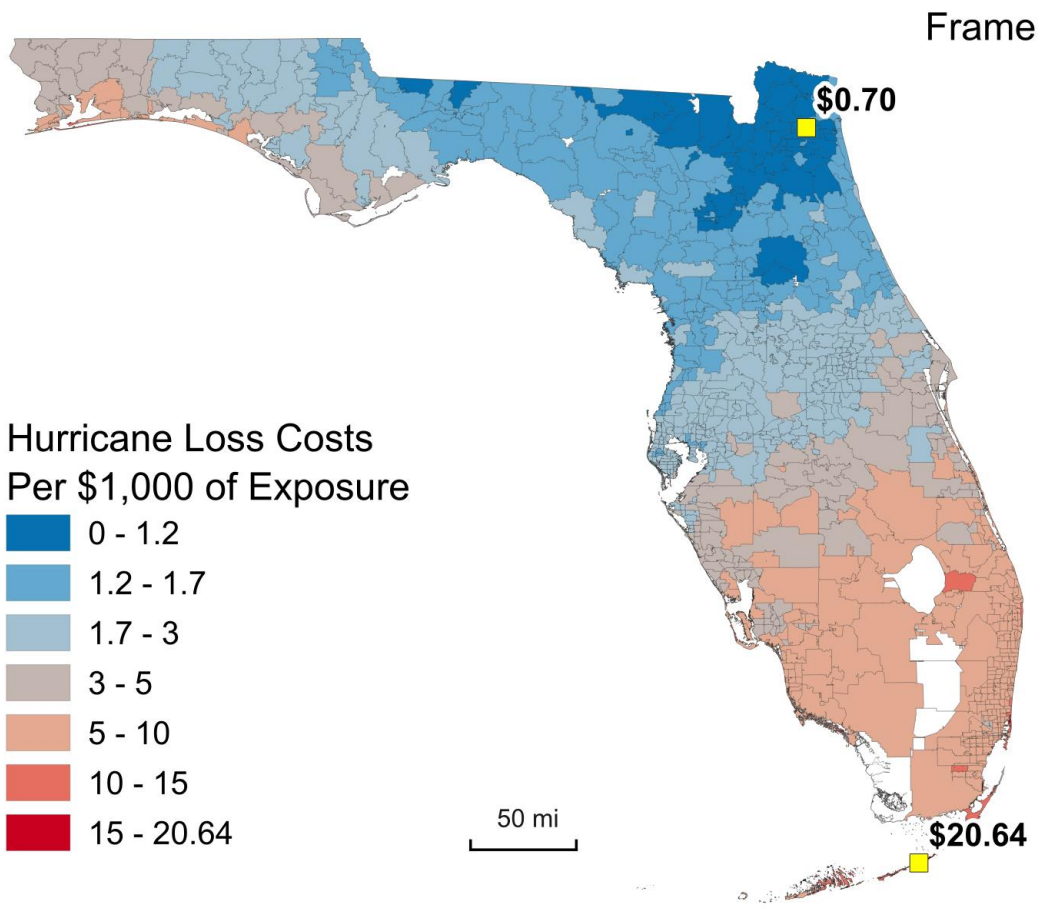


Figure 71: Zero deductible hurricane loss costs per $1,000 of exposure for frame owners. Yellow squares denote minimum and maximum values. No data shown for areas without ZIP code designation.

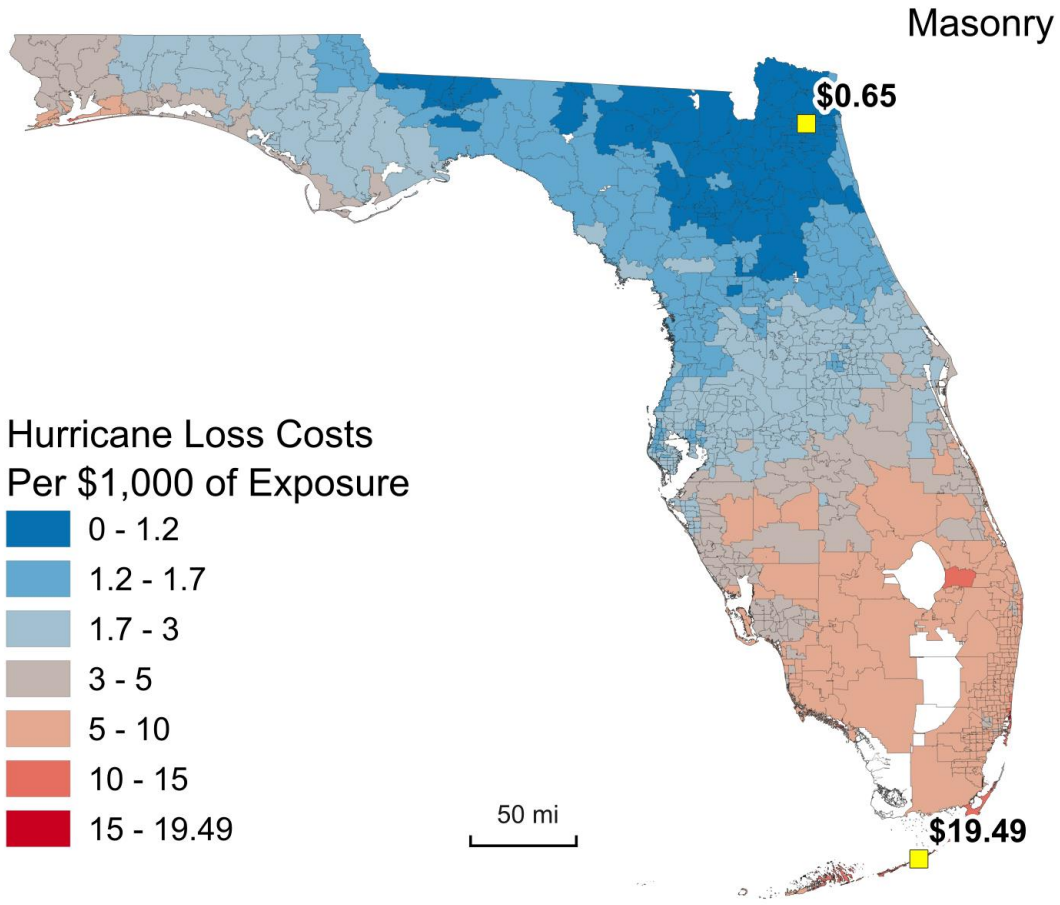


Figure 72: Zero deductible hurricane loss costs per $1,000 of exposure for masonry owners. Yellow squares denote minimum and maximum values. No data shown for areas without ZIP code designation.

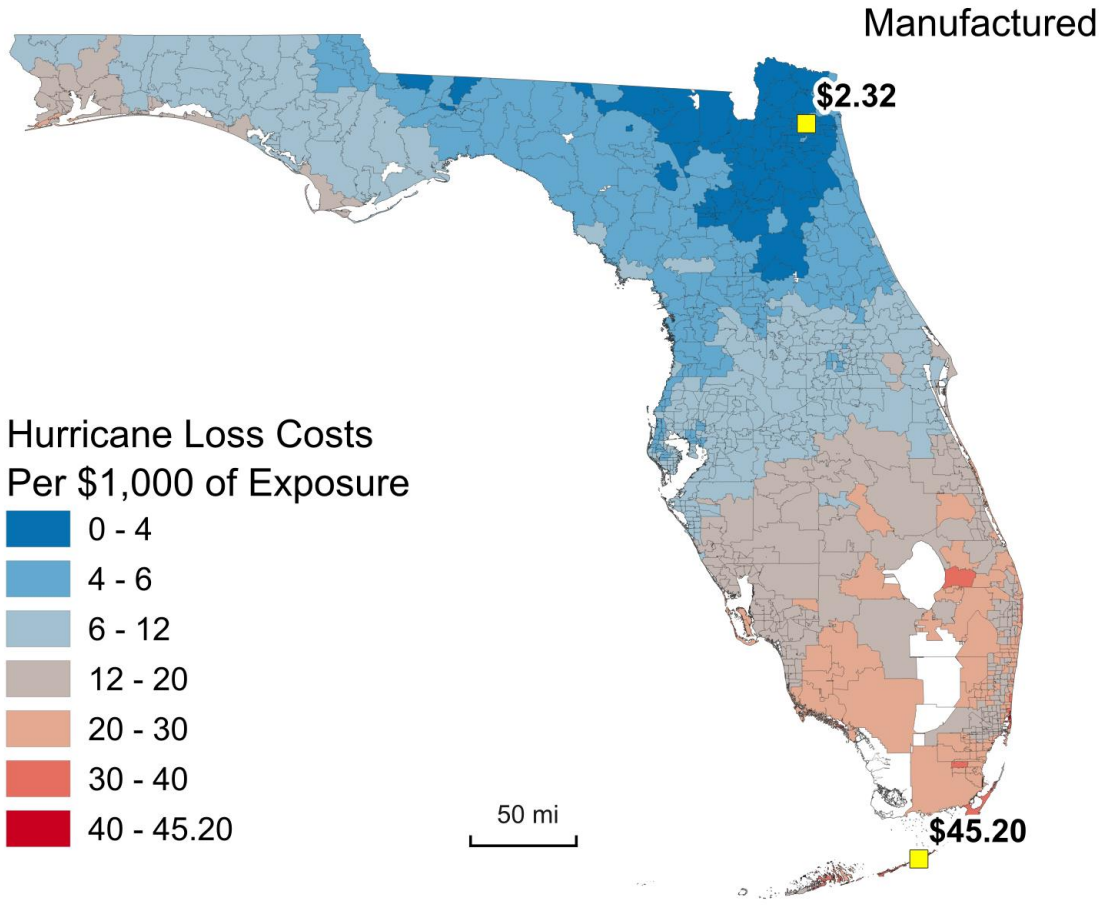


Figure 73: Zero deductible hurricane loss costs per $1,000 of exposure for manufactured homes. Yellow squares denote minimum and maximum values. No data shown for areas without ZIP code designation.

Form A-2: Model Base Hurricane Set Statewide Hurricane Losses

A. ***Provide the total insured hurricane loss assuming zero deductible policies for individual historical hurricanes using the 2017 FHCF exposure data and the 2023 FHCF exposure data. The list of hurricanes in this form shall include all Florida and by-passing hurricanes in the Model Base Hurricane Set.***

The table below contains the hurricanes from the Reference Hurricane Set. The modeling organization shall populate the table with its Model Base Hurricane Set. Each hurricane from the Reference Hurricane Set has been assigned an ID number. Additional hurricanes included in the Model Base Hurricane Set, if any, shall be added to the table in order of year and assigned an intermediate ID number within the bounding ID numbers. For hurricanes resulting in zero loss, the table entry shall be left blank.

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 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.

The average annual zero deductible statewide personal and commercial residential hurricane loss costs on 2017 FHCF Exposure Data are provided in Table 30. Required modeled loss information is given in Table 36.

B. ***List assumptions necessary to complete Form A-2. Provide the rationale and a detailed description of how the assumptions are implemented.***

Additional four by-passing hurricanes which cause loss in the model have been added to this form. Their corresponding ID numbers in Table 36 are 1, 137, 142 and 146.

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 in a submission appendix.

Form A-2 is provided in Excel format in the file "IF2023FormA2.xlsx" at the link provided to the FCHLPM and appears in Table 36 below.

Table 36: Base hurricane storm set statewide hurricane losses using the 2017 and 2023 FHCF zero deductible exposure data

ID	Hurricane Landfall/ Closest Approach Date	Year	Name	Region as defined in Figure 3-Category	Personal and Commercial Residential Insured Hurricane Losses ($) 2017 FHCF Exposure Data	Personal and Commercial Residential Insured Hurricane Losses ($) 2023 FHCF Exposure Data
1	9/6/1900	1900	NoName01-1900	ByP-1	230,062	394,091
5	8/15/1901	1901	NoName04-1901	F-1/ByP-1	14,912,682	20,049,883
10	9/11/1903	1903	NoName03-1903	C-1/A-1	5,006,244,868	6,646,386,707
15	10/17/1904	1904	NoName04-1904	C-1	350,428,391	462,833,287
20	6/17/1906	1906	NoName02-1906	B-1/C-1	553,063,917	724,561,410
25	9/27/1906	1906	NoName06-1906	F-2/ByP-2	91,636,907	129,967,823
30	10/18/1906	1906	NoName08-1906	B-3/C-3	5,600,694,203	7,424,919,343
35	10/11/1909	1909	NoName11-1909	B-3	418,568,898	567,554,597
40	10/18/1910	1910	NoName05-1910	B-2	11,114,771,981	15,354,495,863

ID	Hurricane Landfall/ Closest Approach Date	Year	Name	Region as defined in Figure 3-Category	Personal and Commercial Residential Insured Hurricane Losses ($) 2017 FHCF Exposure Data	Personal and Commercial Residential Insured Hurricane Losses ($) 2023 FHCF Exposure Data
45	8/11/1911	1911	NoName02-1911	A-1	222,580,249	314,049,511
50	9/14/1912	1912	NoName04-1912	F-1/ByP-1	47,126,534	68,915,111
55	8/1/1915	1915	NoName01-1915	D-1	140,016,884	196,995,431
60	9/4/1915	1915	NoName04-1915	A-1	204,585,611	288,962,454
65	7/5/1916	1916	NoName02-1916	F-3/ByP-3	154,182,527	223,198,235
70	10/18/1916	1916	NoName14-1916	A-2	1,070,707,532	1,526,989,117
75	9/29/1917	1917	NoName04-1917	A-3	2,740,364,494	4,069,067,847
80	9/10/1919	1919	NoName02-1919	B-4	102,618,563	158,854,294
85	10/25/1921	1921	TampaBay06-1921	B-3	13,041,693,132	18,105,124,402
90	9/15/1924	1924	NoName05-1924	A-1	33,860,224	46,485,807
95	10/21/1924	1924	NoName10-1924	B-1	1,319,587,658	1,747,871,033
100	7/28/1926	1926	NoName01-1926	D-2	1,834,584,299	2,573,515,833
105	9/18/1926	1926	GreatMiami07-1926	C-4/A-3	29,470,163,830	39,595,865,822
110	10/21/1926	1926	NoName10-1926	ByP-3	414,039,857	555,619,582
115	8/8/1928	1928	NoName01-1928	C-2	1,163,892,803	1,577,519,379

ID	Hurricane Landfall/ Closest Approach Date	Year	Name	Region as defined in Figure 3-Category	Personal and Commercial Residential Insured Hurricane Losses ($) 2017 FHCF Exposure Data	Personal and Commercial Residential Insured Hurricane Losses ($) 2023 FHCF Exposure Data
120	9/17/1928	1928	LakeOkeechobee04-1928	C-4	54,608,173,177	74,305,378,061
125	9/28/1929	1929	NoName02-1929	C-3/A-1	2,492,812,297	3,425,876,760
130	9/1/1932	1932	NoName03-1932	F-1/ByP-1	156,300,081	215,448,510
135	7/30/1933	1933	NoName05-1933	C-1	427,590,080	572,597,994
137	9/1/1933	1933	NoName08-1933	ByP-3	1,637,224	2,410,682
140	9/4/1933	1933	NoName11-1933	C-3	7,056,844,323	9,615,954,038
142	10/5/1933	1933	NoName17-1933	ByP-2	9,952,387	13,831,165
145	9/3/1935	1935	LaborDay03-1935	C-5/A-2	11,296,313,411	15,601,750,812
146	9/29/1935	1935	NoName05-1935	ByP-4	53,018,827	73,731,108
150	11/4/1935	1935	NoName07-1935	C-2	2,073,869,507	2,689,289,997
155	7/31/1936	1936	NoName05-1936	A-2	736,704,258	1,049,601,371
160	8/11/1939	1939	NoName02-1939	C-1/A-1	839,706,240	1,167,517,872
165	10/6/1941	1941	NoName05-1941	C-2/A-1	2,679,351,345	3,564,738,483
170	10/19/1944	1944	NoName13-1944	B-3	13,638,185,615	18,810,005,273
175	6/24/1945	1945	NoName01-1945	A-1	791,212,015	1,119,678,924

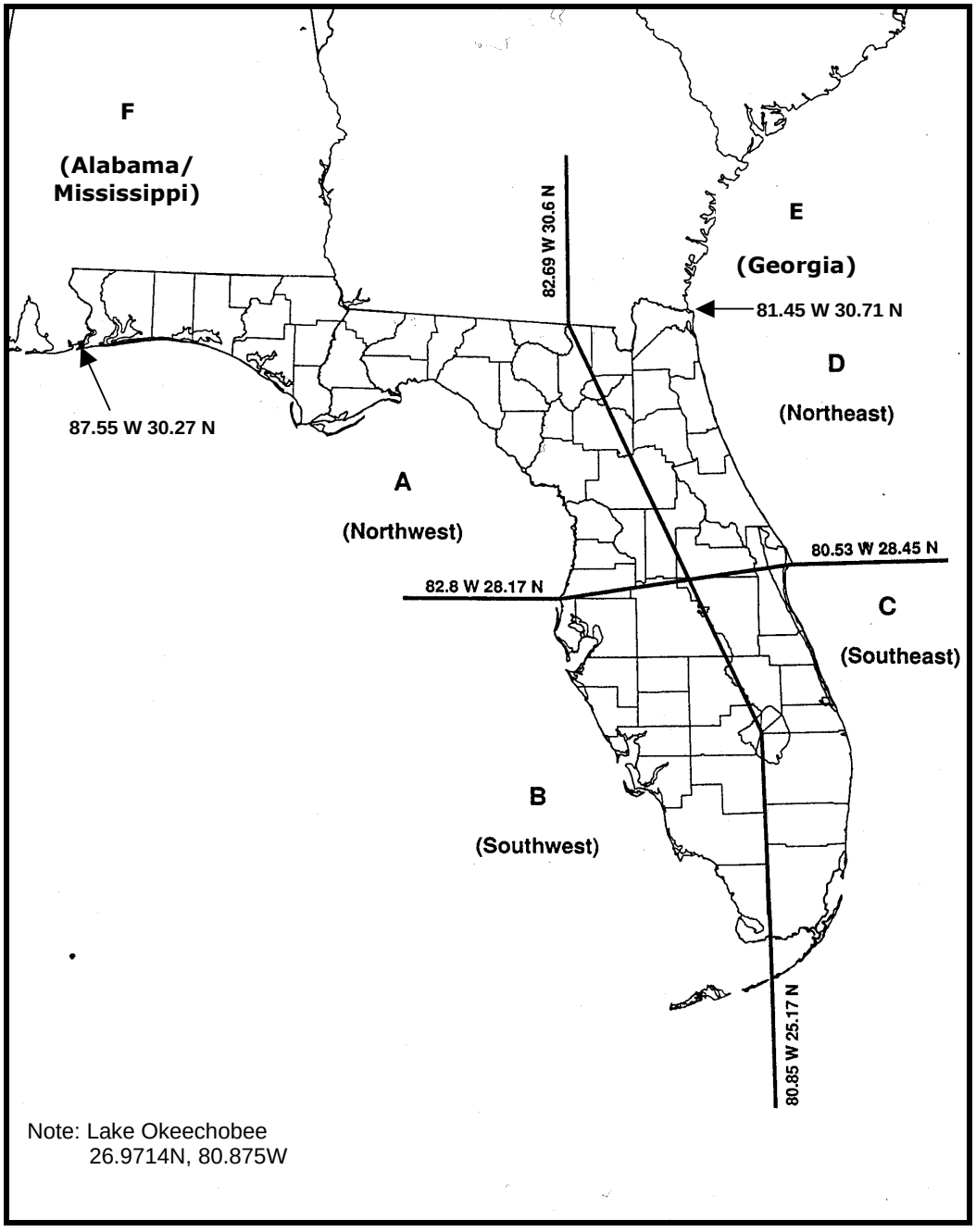
ID	Hurricane Landfall/ Closest Approach Date	Year	Name	Region as defined in Figure 3-Category	Personal and Commercial Residential Insured Hurricane Losses ($) 2017 FHCF Exposure Data	Personal and Commercial Residential Insured Hurricane Losses ($) 2023 FHCF Exposure Data
180	9/15/1945	1945	NoName09-1945	C-4	9,665,161,754	13,081,869,865
185	10/8/1946	1946	NoName06-1946	B-1	3,889,135,573	5,434,447,618
190	9/17/1947	1947	NoName04-1947	C-4	20,563,454,520	26,735,923,308
195	10/12/1947	1947	NoName09-1947	B-1/E-2	2,344,863,149	3,063,049,242
200	9/22/1948	1948	NoName08-1948	B-4	3,322,323,314	4,439,622,851
205	10/5/1948	1948	NoName09-1948	B-2	2,916,594,450	3,849,144,054
210	8/26/1949	1949	NoName02-1949	C-4	20,104,097,548	26,911,496,957
215	8/31/1950	1950	Baker-1950	F-1/ByP-1	90,216,784	126,742,369
220	9/5/1950	1950	Easy-1950	A-3	3,324,981,582	4,690,318,242
225	10/18/1950	1950	King-1950	C-4	10,010,055,427	13,187,266,674
230	9/26/1953	1953	Florence-1953	A-1	368,965,925	562,150,164
235	10/9/1953	1953	Hazel-1953	B-1	1,262,526,080	1,682,099,959
240	9/25/1956	1956	Flossy-1956	A-1	524,488,415	779,147,016
245	9/10/1960	1960	Donna-1960	B-4	14,758,333,734	20,379,359,020
250	9/15/1960	1960	Ethel-1960	F-1/ByP-1	104,865	133,314

ID	Hurricane Landfall/ Closest Approach Date	Year	Name	Region as defined in Figure 3-Category	Personal and Commercial Residential Insured Hurricane Losses ($) 2017 FHCF Exposure Data	Personal and Commercial Residential Insured Hurricane Losses ($) 2023 FHCF Exposure Data
255	8/27/1964	1964	Cleo-1964	C-2	6,236,465,496	8,132,581,553
260	9/10/1964	1964	Dora-1964	D-2	757,740,988	1,103,522,069
265	10/14/1964	1964	Isbell-1964	B-2	5,371,885,823	7,003,621,661
270	9/8/1965	1965	Betsy-1965	C-3	1,390,295,156	1,865,066,457
275	6/9/1966	1966	Alma-1966	A-1/ByP-3	1,254,006,357	1,731,816,873
280	10/4/1966	1966	Inez-1966	C-2	191,496,194	270,148,389
285	10/19/1968	1968	Gladys-1968	A-2	1,386,995,408	1,975,093,951
290	8/18/1969	1969	Camille-1969	F-5/ByP-5	438,673	564,940
295	6/19/1972	1972	Agnes-1972	A-1	31,433,841	43,194,490
300	9/23/1975	1975	Eloise-1975	A-3	727,968,359	1,204,987,261
305	9/4/1979	1979	David-1979	C-2/E-2	4,180,423,282	5,684,538,748
310	9/13/1979	1979	Frederic-1979	F-3/ByP-4	391,512,371	557,939,971
315	9/2/1985	1985	Elena-1985	F-3/ByP-3	258,021,551	373,916,330
320	11/21/1985	1985	Kate-1985	A-2	227,587,187	311,154,674

ID	Hurricane Landfall/ Closest Approach Date	Year	Name	Region as defined in Figure 3-Category	Personal and Commercial Residential Insured Hurricane Losses ($) 2017 FHCF Exposure Data	Personal and Commercial Residential Insured Hurricane Losses ($) 2023 FHCF Exposure Data
325	10/12/1987	1987	Floyd-1987	B-1	50,186,217	67,701,103
330	8/24/1992	1992	Andrew-1992	C-5	16,037,233,988	21,292,628,593
335	8/3/1995	1995	Erin-1995	C-1/A-1	3,056,377,852	4,204,885,851
340	10/4/1995	1995	Opal-1995	A-3	2,753,332,821	4,035,885,418
345	7/19/1997	1997	Danny-1997	F-1/ByP-1	23,889,183	33,666,770
350	9/3/1998	1998	Earl-1998	A-1	625,590,708	896,763,810
355	9/25/1998	1998	Georges-1998	B-2/F-2	350,033,136	519,385,570
360	10/15/1999	1999	Irene-1999	B-1	2,215,474,577	2,920,315,165
365	8/13/2004	2004	Charley-2004	B-4	11,123,078,749	15,011,475,283
370	9/5/2004	2004	Frances-2004	C-2	7,864,176,786	10,737,792,710
375	9/16/2004	2004	Ivan-2004	F-3/ByP-3	755,496,706	1,089,614,866
380	9/26/2004	2004	Jeanne-2004	C-3	10,855,793,544	14,777,207,501
385	7/10/2005	2005	Dennis-2005	A-3	1,384,224,478	1,989,685,713
390	8/25/2005	2005	Katrina-2005	C-1	321,572,226	412,912,338
395	9/20/2005	2005	Rita-2005	ByP-2	24,475,335	38,709,378

ID	Hurricane Landfall/ Closest Approach Date	Year	Name	Region as defined in Figure 3-Category	Personal and Commercial Residential Insured Hurricane Losses ($) 2017 FHCF Exposure Data	Personal and Commercial Residential Insured Hurricane Losses ($) 2023 FHCF Exposure Data
400	10/24/2005	2005	Wilma-2005	B-3	13,803,748,658	18,092,429,889
405	9/2/2016	2016	Hermine-2016	A-1	72,384,616	102,014,849
410	10/7/2016	2016	Matthew-2016	ByP-3	662,397,695	908,143,727
415	9/10/2017	2017	Irma-2017	B-4	5,881,544,364	8,275,689,691
420	10/8/2017	2017	Nate-2017	F-1/ByP-1	156,505	221,011
425	10/10/2018	2018	Michael-2018	A-5	1,225,066,488	1,717,005,306
430	9/4/2019	2019	Dorian-2019	ByP-2	2,070,976	2,724,036
435	9/16/2020	2020	Sally-2020	F-2/ByP-2	688,232,933	986,522,097
440	10/28/2020	2020	Zeta-2020	ByP-3	2,172,111	2,889,413
445	11/11/2020	2020	Eta-2020	ByP-1	36,543,370	48,313,118
450	7/7/2021	2021	Elsa-2021	ByP-1	12,313,567	16,167,335
455	9/28/2022	2022	Ian-2022	B-4	12,741,629,086	17,182,611,612
460	11/10/2022	2022	Nicole-2022	C-1	1,635,834,393	2,261,075,844
			Total		**381,728,831,761**	**517,413,363,929**

Figure 1 **State of Florida and Neighboring States by Region**



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.***

Figure 74, Figure 76, Figure 78 and Figure 80 in Form A-3 were generated from the data within sheet “Part A-2017 FHCF Exposure Data’ in the file ‘lF2023FormA3.xlsx’, and Figure 75, Figure 77, Figure 79, and Figure 81 from the data within sheet “Part B-2023 FHCF Exposure Data’ in the file ‘lF2023FormA3.xlsx’, in QGIS 3.34.8 using a predefined map template.

Automated scripts were used to generate Form A-3.

B. ***Provide the percentage of personal and commercial residential zero deductible hurricane total loss, rounded to four decimal places, and the modeled loss from Hurricane Matthew (2016), Hurricane Irma (2017), Hurricane Michael (2018), and Hurricane Ian (2022) for each affected ZIP Code.***

For Part A, use the 2017 FHCF exposure data, and for Part B, use the 2023 FHCF exposure data.

Rather than using directly a specified published windfield, the winds underlying the hurricane loss cost calculations shall be produced by the hurricane model under review and shall be the same hurricane parameters as used in completing Form A-2.

The same hurricane parameters were used to analyze Form A-3 and corresponding hurricanes in Form A-2: Model Base Hurricane Set Statewide Hurricane Losses.

C. ***Provide maps color-coded by ZIP Code depicting the percentage of total personal and commercial residential hurricane loss from each hurricane:***

Hurricane Matthew (2016), Hurricane Irma (2017), Hurricane Michael (2018), and Hurricane Ian (2022), using the following interval coding.

Red	***> 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	***> 0% to 0.1%***
Grey	***0%***

Eight maps, color-coded by ZIP Code depicting the percentage of total personal and commercial residential hurricane loss from Hurricanes Matthew (2016), Irma (2017), Michael (2018), and Ian (2022) using both the 2017 and 2023 FHCF exposure datasets, are presented in Figure 74 - Figure 81.

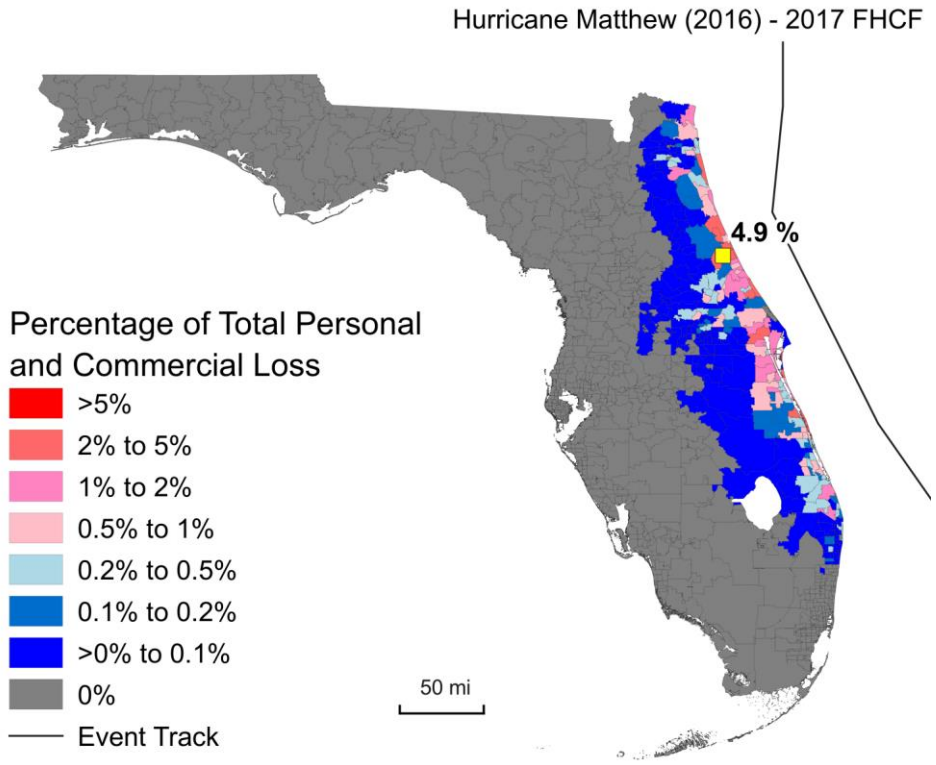


Figure 74: Percentage of total residential hurricane losses from Hurricane Matthew (2016) by ZIP Code using 2017 FHCF Exposure Data. Yellow square denotes the maximum value.

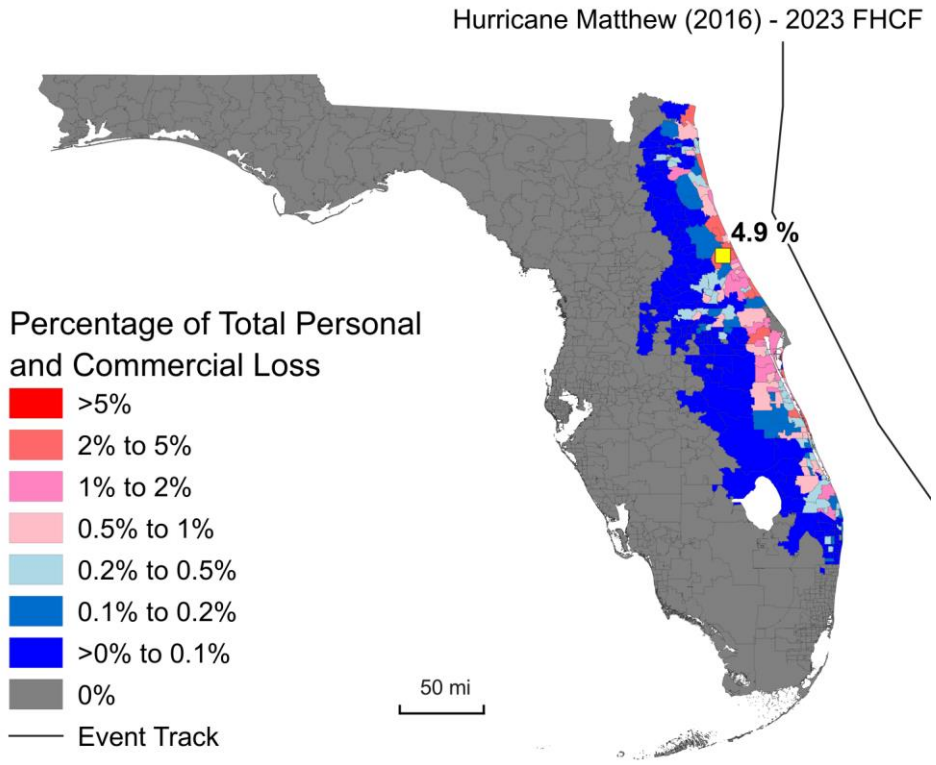


Figure 75: Percentage of total residential hurricane losses from Hurricane Matthew (2016) by ZIP Code using 2023 FHCF Exposure Data. Yellow square denotes the maximum value.

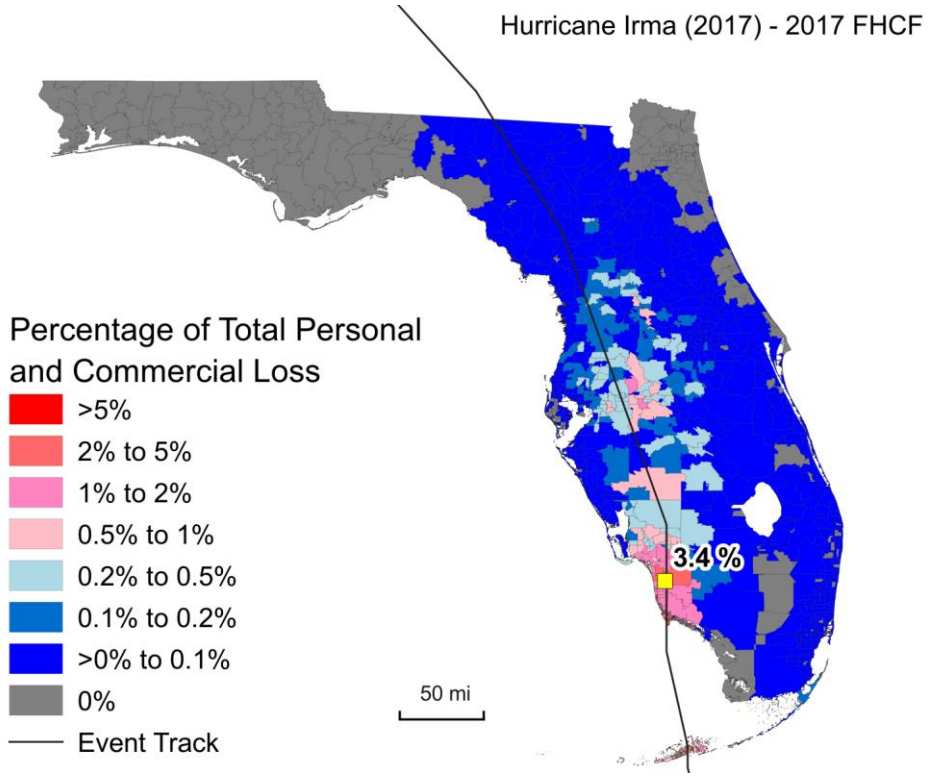


Figure 76: Percentage of total residential hurricane losses from Hurricane Irma (2017) by ZIP Code using 2017 FHCF Exposure Data. Yellow square denotes the maximum value.

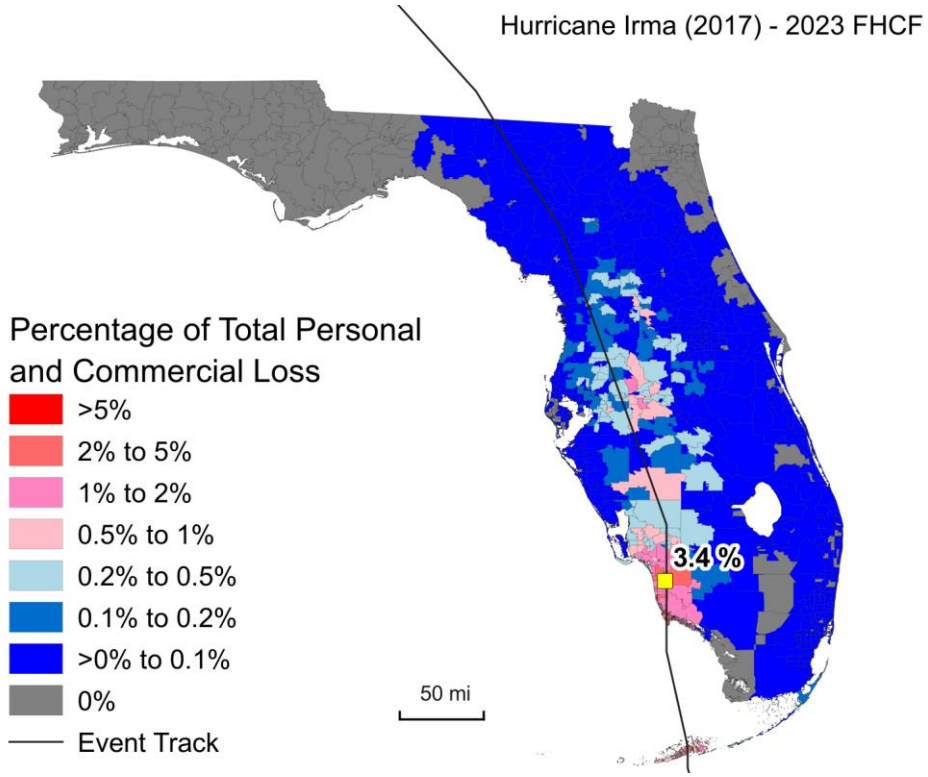


Figure 77: Percentage of total residential hurricane losses from Hurricane Irma (2017) by ZIP Code using 2023 FHCF Exposure Data. Yellow square denotes the maximum value.

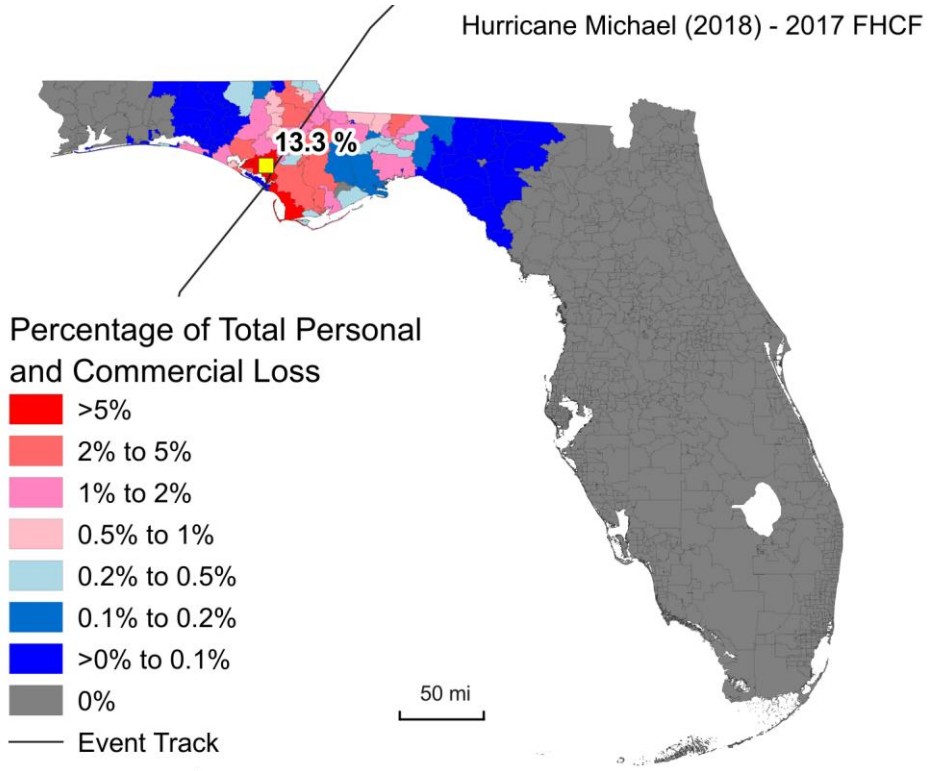


Figure 78: Percentage of total residential hurricane losses from Hurricane Michael (2018) by ZIP Code using 2017 FHCF Exposure Data. Yellow square denotes the maximum value.

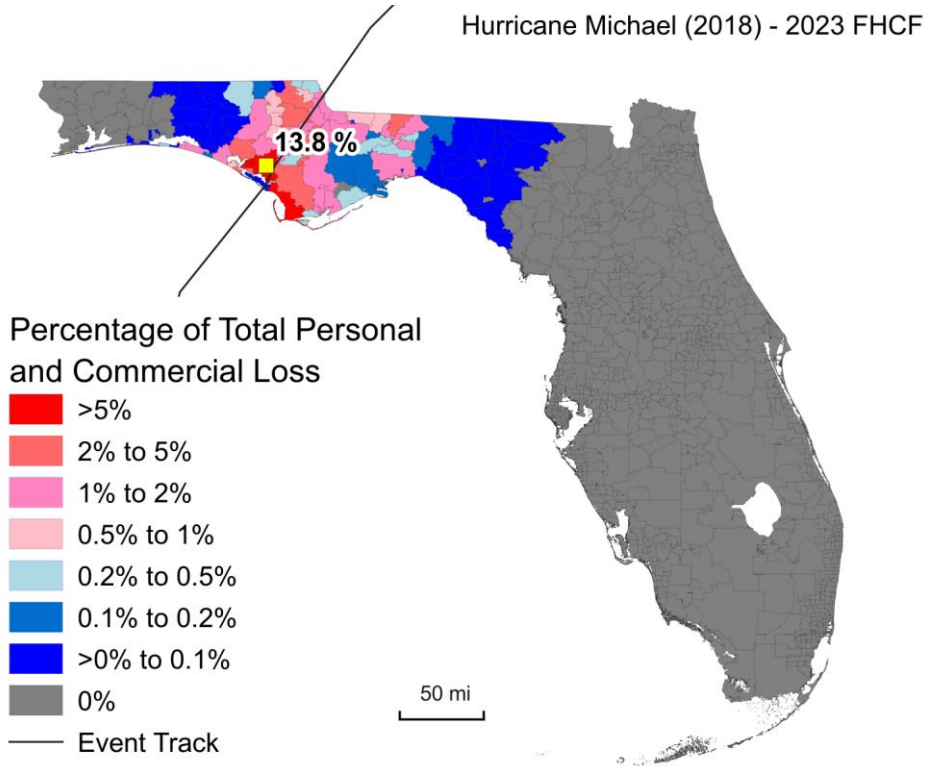


Figure 79: Percentage of total residential hurricane losses from Hurricane Michael (2018) by ZIP Code using 2023 FHCF Exposure Data. Yellow square denotes the maximum value.

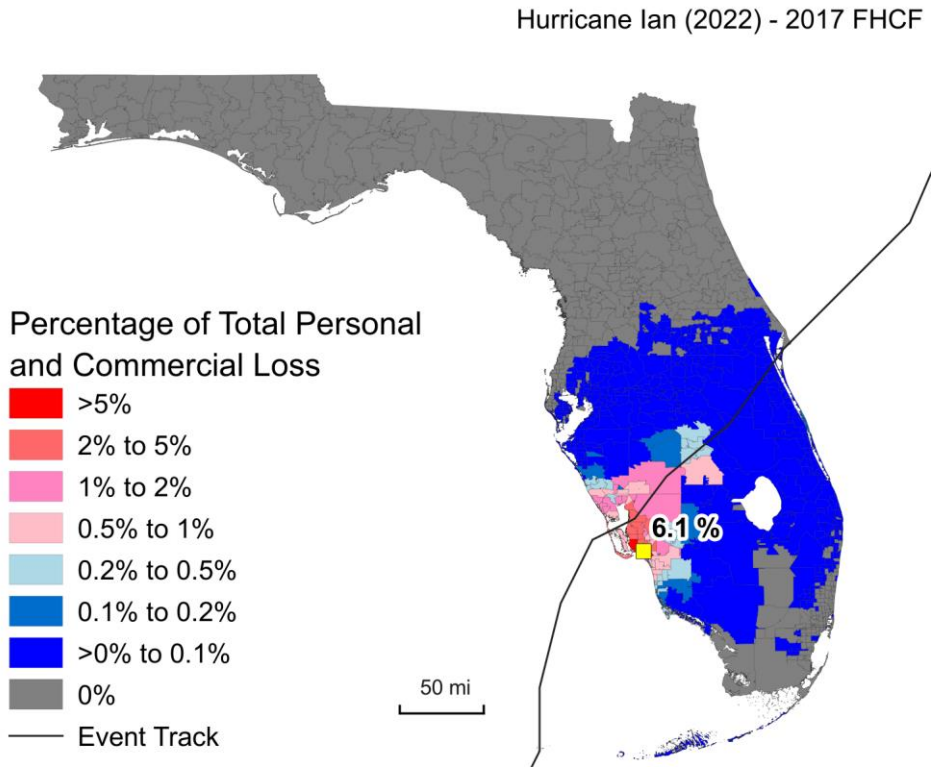


Figure 80: Percentage of total residential hurricane losses from Hurricane Ian (2022) by ZIP Code using 2017 FHCF Exposure Data. Yellow square denotes the maximum value.

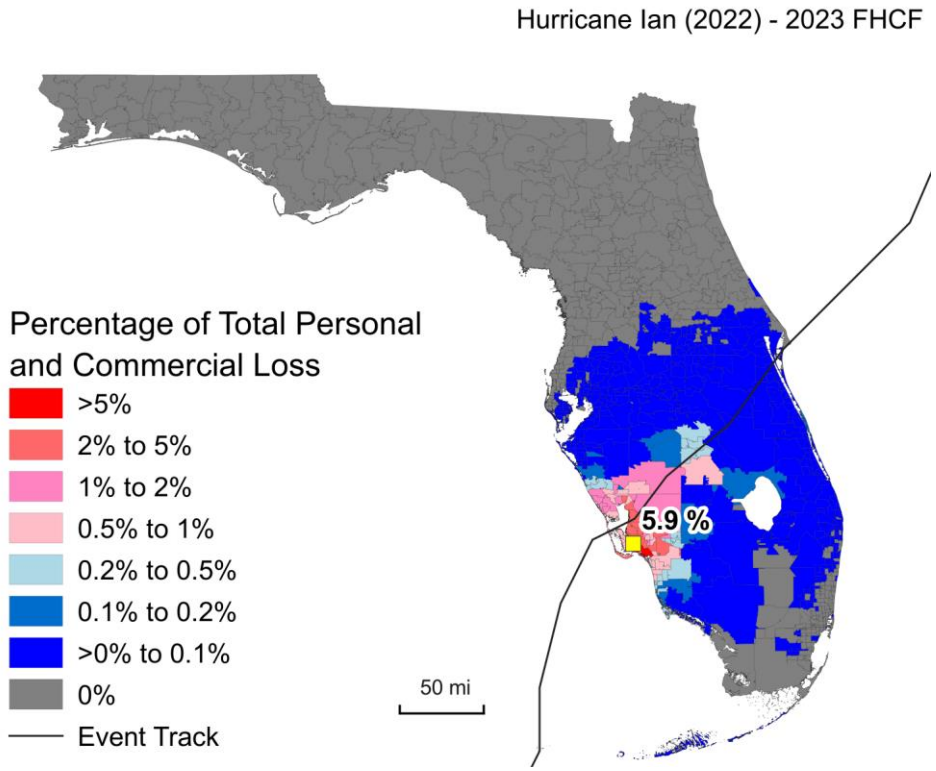


Figure 81: Percentage of total residential hurricane losses from Hurricane Ian (2022) by ZIP Code using 2023 FHCF Exposure Data. Yellow square denotes the maximum value.

D. Plot the relevant storm track on each map.

The relevant storm track has been plotted on each map Figure 74 - Figure 81.

E. Provide this form in both Excel and PDF format. The file name shall include the abbreviated name of the modeling organization, the hurricane standards year, and the form name.

Form A-3 is provided in Excel format in the file “IF2023FormA3.xlsx” and the file ""“IF2023FormA3.pdf".

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 "2023FormA4.xlsx."***

An automated script is used to generate and arrange the data in 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 in a submission appendix.***

This form is provided under the name IF2023FormA4.xlsx and is also provided in submission appendix.

C. ***Provide hurricane loss costs, rounded to three decimal places, by county (Figure 13). 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 ranges shall show the highest hurricane loss cost, the lowest hurricane loss cost, and the weighted average hurricane loss cost.***

The aggregate personal and commercial residential exposure data is to be developed from the 2017 FHCF exposure data for Part A, and from the 2023 FHCF exposure data for Part B, except for insured values and deductibles information. Insured values are to be based on the hurricane output range specifications given below. Deductible amounts of 0% and as specified in the hurricane output range specifications are to 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).

Form A-4, Hurricane Output Ranges, is provided in Excel format in the file "IF2023FormA4.xlsx" at the link provided to the FCHLPM and appears below in Table 37 (Part A with zero deductible), Table 38 (Part A with specified deductible), Table 39 (Part B with zero deductible) and Table 40 (Part B with specified deductible). The specified deductible loss costs have been calculated with the assumption of no all perils deductible in order to clearly show the relationship between the annual deductible and zero deductible only.

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 of those ZIP Codes where this occurs.

There are no instances of hurricane loss costs for a ZIP Code for which there is no exposure.

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 of the ZIP Codes where this occurs.

There are no instances of no hurricane loss costs for a ZIP Code for which there is some exposure.

F. NA shall be used in cells to signify no exposure.

NA is used in the cells of Form A-4 for which there is no exposure in the FHCF 2017 Exposure Data and FHCF 2023 Exposure Data.

G. 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 $300 per day per policy shall be used.

Per diem is not used in producing hurricane loss costs for Coverage D (Time Element) in the personal residential hurricane output ranges.

H. Describe how Law and Ordinance is included in the hurricane output ranges.

Law and ordinance coverage was default to 25% for personal residential properties (excluding Mobile Home) for this form.

I. List assumptions necessary to complete Form A-4. Provide the rationale for assumptions and a detailed description of how the assumptions are implemented.

No additional assumptions were made for this form.

Table 37: Hurricane loss costs per $1,000 of Part A exposure for 0% deductibles

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Alachua	LOW	0.145	0.125	0.989	0.008	0.007	0.028	0.031	0.126
	AVERAGE	0.996	1.059	1.681	0.122	0.112	0.152	0.136	0.776
	HIGH	1.699	1.606	4.901	0.198	0.173	0.207	0.180	1.129
Baker	LOW	0.161	0.144	1.044	0.011	0.048	NA	NA	0.736
	AVERAGE	0.877	0.879	1.383	0.144	0.113	NA	NA	0.736
	HIGH	1.166	1.071	3.953	0.168	0.148	NA	NA	0.736
Bay	LOW	0.507	0.521	3.146	0.054	0.053	0.132	0.144	0.720
	AVERAGE	2.725	2.715	5.241	0.472	0.445	0.706	0.556	2.411
	HIGH	5.195	4.900	14.940	1.469	1.322	1.106	1.004	4.133
Bradford	LOW	0.140	0.167	1.033	0.073	0.063	NA	NA	NA
	AVERAGE	1.006	1.005	1.482	0.150	0.125	NA	NA	NA
	HIGH	1.424	1.307	4.927	0.187	0.162	NA	NA	NA
Brevard	LOW	0.517	0.484	3.524	0.041	0.033	0.088	0.083	0.440

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	3.276	2.803	6.775	0.502	0.469	0.520	0.544	2.581
	HIGH	7.415	7.017	22.854	1.808	1.588	1.455	1.329	6.003
Broward	LOW	1.233	1.123	7.541	0.094	0.086	0.271	0.184	0.657
	AVERAGE	6.023	5.486	12.319	0.940	0.953	1.055	1.004	4.577
	HIGH	13.253	12.451	26.449	3.916	3.550	2.950	2.665	10.348
Calhoun	LOW	0.402	0.372	2.511	0.038	0.182	NA	NA	NA
	AVERAGE	1.893	1.846	3.361	0.321	0.307	NA	NA	NA
	HIGH	2.728	2.523	8.994	0.377	0.332	NA	NA	NA
Charlotte	LOW	0.750	0.698	4.800	0.080	0.048	0.200	0.125	0.689
	AVERAGE	4.124	3.377	7.578	0.650	0.561	0.719	0.564	2.910
	HIGH	6.333	5.931	21.084	1.219	1.074	1.105	1.024	5.050
Citrus	LOW	0.220	0.181	1.510	0.015	0.010	0.064	0.117	0.214
	AVERAGE	1.604	1.268	2.430	0.204	0.177	0.271	0.226	1.348
	HIGH	2.247	2.066	8.336	0.330	0.287	0.327	0.302	1.778

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Clay	LOW	0.135	0.121	0.933	0.008	0.008	0.026	0.030	0.119
	AVERAGE	0.875	0.947	1.507	0.128	0.111	0.132	0.119	0.669
	HIGH	1.646	1.511	4.401	0.185	0.157	0.180	0.164	1.035
Collier	LOW	1.045	0.983	7.011	0.078	0.066	0.165	0.145	0.795
	AVERAGE	5.322	4.192	12.734	0.743	0.708	0.876	0.756	3.456
	HIGH	11.903	10.860	35.289	3.216	2.785	2.478	2.240	9.490
Columbia	LOW	0.186	0.142	0.942	0.011	0.012	0.177	0.135	0.729
	AVERAGE	1.061	1.048	1.573	0.148	0.134	0.180	0.159	0.729
	HIGH	1.380	1.267	4.725	0.191	0.166	0.183	0.161	0.729
DeSoto	LOW	0.963	0.883	4.388	0.468	0.064	0.491	0.471	2.853
	AVERAGE	4.654	4.148	8.060	0.838	0.656	0.761	0.678	3.669
	HIGH	7.431	6.983	20.057	1.101	1.000	0.879	0.928	4.606
Dixie	LOW	0.236	0.203	1.505	0.083	0.028	0.160	0.139	1.405

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.791	1.299	2.325	0.196	0.170	0.409	0.363	2.032
	HIGH	5.043	4.807	17.224	0.210	0.182	0.643	0.546	4.160
Duval	LOW	0.120	0.122	0.907	0.006	0.005	0.017	0.016	0.117
	AVERAGE	0.931	0.961	1.602	0.126	0.111	0.133	0.122	0.692
	HIGH	1.424	1.340	4.682	0.224	0.211	0.245	0.194	1.205
Escambia	LOW	0.718	0.674	4.645	0.077	0.091	0.252	0.209	1.086
	AVERAGE	4.517	4.540	8.636	0.963	0.949	1.090	1.039	4.116
	HIGH	7.534	7.081	21.625	2.102	1.895	1.577	1.435	5.877
Flagler	LOW	0.180	0.167	1.538	0.013	0.012	0.053	0.091	0.407
	AVERAGE	1.270	1.019	2.461	0.156	0.136	0.243	0.176	0.858
	HIGH	2.261	2.127	7.716	0.375	0.333	0.356	0.314	1.857
Franklin	LOW	0.578	0.528	3.750	0.296	0.387	0.263	0.334	1.692
	AVERAGE	3.048	3.170	5.974	0.590	0.587	0.449	0.485	2.006
	HIGH	4.209	3.984	13.193	0.893	0.796	0.722	0.655	3.357

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Gadsden	LOW	0.201	0.154	1.334	0.016	0.014	NA	NA	0.702
	AVERAGE	1.144	1.141	1.903	0.188	0.166	NA	NA	0.970
	HIGH	1.660	1.526	5.749	0.253	0.176	NA	NA	1.062
Gilchrist	LOW	0.239	0.221	1.674	0.018	0.111	NA	NA	NA
	AVERAGE	1.312	1.327	2.188	0.202	0.194	NA	NA	NA
	HIGH	1.848	1.702	6.219	0.267	0.245	NA	NA	NA
Glades	LOW	3.881	1.259	7.730	0.137	0.608	NA	NA	4.574
	AVERAGE	6.176	5.048	10.747	1.072	0.967	NA	NA	5.031
	HIGH	6.763	6.341	22.584	1.212	1.075	NA	NA	5.554
Gulf	LOW	0.514	0.694	4.049	0.105	0.396	0.180	0.125	1.757
	AVERAGE	2.956	3.267	5.696	0.748	0.725	0.562	0.438	2.668
	HIGH	4.136	3.821	13.086	0.926	0.811	0.762	0.678	3.395
Hamilton	LOW	0.155	0.168	1.075	0.090	0.070	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.117	1.077	1.602	0.162	0.140	NA	NA	NA
	HIGH	1.434	1.337	5.011	0.215	0.149	NA	NA	NA
Hardee	LOW	0.848	0.699	5.893	0.414	0.373	0.911	NA	4.025
	AVERAGE	4.568	3.960	8.050	0.775	0.655	0.911	NA	4.025
	HIGH	6.109	5.709	20.124	1.100	0.968	0.911	NA	4.025
Hendry	LOW	1.212	1.129	5.070	0.122	0.086	0.635	0.519	4.331
	AVERAGE	5.646	4.869	10.364	1.015	0.787	0.946	0.821	4.514
	HIGH	8.977	8.562	29.293	1.861	0.997	1.043	0.950	4.866
Hernando	LOW	0.221	0.191	1.510	0.013	0.011	0.202	0.039	0.868
	AVERAGE	1.514	1.263	2.375	0.187	0.167	0.254	0.225	1.278
	HIGH	2.200	2.011	7.404	0.336	0.287	0.326	0.286	1.790
Highlands	LOW	0.626	0.433	3.037	0.050	0.034	0.213	0.090	0.853
	AVERAGE	3.746	3.275	6.437	0.561	0.497	0.600	0.533	2.988
	HIGH	6.714	6.340	23.507	1.234	1.103	0.827	0.739	4.961

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Hillsborough	LOW	0.237	0.231	1.881	0.014	0.014	0.048	0.036	0.226
	AVERAGE	1.737	1.790	4.341	0.239	0.232	0.276	0.273	1.552
	HIGH	4.383	7.825	15.003	0.577	0.679	0.551	0.505	2.783
Holmes	LOW	0.453	0.436	2.914	0.048	0.205	NA	NA	1.761
	AVERAGE	2.087	2.075	3.834	0.420	0.381	NA	NA	1.761
	HIGH	2.767	2.610	9.232	0.530	0.456	NA	NA	1.761
Indian River	LOW	0.907	0.806	5.828	0.072	0.057	0.220	0.164	0.808
	AVERAGE	4.566	3.371	9.359	0.872	0.667	0.844	0.814	3.766
	HIGH	8.055	7.612	22.882	1.934	1.724	1.587	1.417	6.496
Jackson	LOW	0.271	0.275	1.847	0.104	0.025	NA	NA	1.020
	AVERAGE	1.625	1.624	2.853	0.288	0.244	NA	NA	1.519
	HIGH	2.202	2.124	7.753	0.414	0.372	NA	NA	1.900
Jefferson	LOW	0.208	0.186	1.180	0.070	0.083	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.175	1.137	1.934	0.181	0.161	NA	NA	NA
	HIGH	1.686	1.573	5.560	0.225	0.198	NA	NA	NA
Lafayette	LOW	0.212	0.195	1.483	0.215	0.094	NA	NA	NA
	AVERAGE	1.327	1.242	2.087	0.215	0.170	NA	NA	NA
	HIGH	1.697	1.574	5.388	0.215	0.189	NA	NA	NA
Lake	LOW	0.199	0.177	1.571	0.017	0.011	0.053	0.045	0.215
	AVERAGE	1.646	1.495	3.031	0.224	0.188	0.294	0.249	1.401
	HIGH	3.347	3.107	11.612	0.552	0.470	0.427	0.381	2.034
Lee	LOW	0.759	0.720	5.020	0.059	0.044	0.126	0.109	0.600
	AVERAGE	4.806	3.364	9.611	0.536	0.538	0.805	0.615	2.999
	HIGH	11.560	10.904	28.981	2.788	2.287	2.459	2.239	9.099
Leon	LOW	0.163	0.142	1.091	0.010	0.007	0.031	0.036	0.172
	AVERAGE	1.152	1.123	1.888	0.150	0.123	0.149	0.146	0.785
	HIGH	1.477	1.368	5.236	0.211	0.187	0.204	0.206	1.150

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Levy	LOW	0.233	0.203	1.294	0.081	0.086	0.193	0.247	1.171
	AVERAGE	1.432	1.286	2.176	0.201	0.183	0.320	0.294	1.353
	HIGH	2.424	2.297	8.190	0.366	0.327	0.371	0.330	2.024
Liberty	LOW	0.341	0.381	2.030	0.168	0.286	NA	NA	NA
	AVERAGE	1.661	1.669	2.993	0.277	0.286	NA	NA	NA
	HIGH	1.992	1.855	6.989	0.324	0.286	NA	NA	NA
Madison	LOW	0.178	0.192	1.187	0.009	0.013	NA	NA	NA
	AVERAGE	1.185	1.143	1.863	0.162	0.149	NA	NA	NA
	HIGH	1.499	1.393	5.169	0.207	0.185	NA	NA	NA
Manatee	LOW	0.405	0.389	3.030	0.038	0.024	0.083	0.074	0.418
	AVERAGE	2.837	2.266	5.362	0.375	0.361	0.489	0.436	1.782
	HIGH	5.709	5.422	19.089	1.041	0.938	0.862	0.777	4.027
Marion	LOW	0.180	0.141	1.097	0.013	0.009	0.032	0.029	0.152

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.300	1.043	2.050	0.162	0.135	0.205	0.157	0.918
	HIGH	2.333	2.167	7.157	0.280	0.243	0.248	0.260	1.420
Martin	LOW	1.122	0.888	6.317	0.103	0.088	0.225	0.253	1.160
	AVERAGE	5.789	4.651	13.399	0.897	0.959	1.242	0.918	4.346
	HIGH	8.852	8.434	27.123	2.267	2.026	1.789	1.600	7.092
Miami-Dade	LOW	1.011	0.811	7.023	0.083	0.059	0.197	0.165	0.548
	AVERAGE	6.067	5.472	15.227	1.042	1.175	1.145	1.096	4.505
	HIGH	17.345	16.492	27.409	6.132	5.522	4.311	3.955	13.019
Monroe	LOW	1.590	1.523	9.458	0.197	0.435	0.360	0.659	1.476
	AVERAGE	8.875	9.814	24.679	2.462	2.731	1.350	2.179	7.521
	HIGH	21.306	20.168	47.747	5.822	7.739	3.591	5.332	15.517
Nassau	LOW	0.145	0.129	1.110	0.010	0.009	0.028	0.036	0.233
	AVERAGE	0.962	0.981	1.704	0.134	0.124	0.189	0.178	0.848
	HIGH	1.521	1.421	5.404	0.244	0.206	0.221	0.200	1.268

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Okaloosa	LOW	0.401	0.454	3.183	0.046	0.059	0.109	0.197	0.605
	AVERAGE	3.571	3.484	5.628	0.752	0.707	0.844	0.796	3.343
	HIGH	6.552	6.204	19.458	1.703	1.556	1.327	1.206	5.150
Okeechobee	LOW	1.151	1.020	7.150	0.432	0.366	0.236	0.526	2.928
	AVERAGE	5.245	4.533	9.957	0.928	0.785	0.798	0.889	4.280
	HIGH	6.055	5.659	20.389	1.071	0.950	1.002	0.929	5.016
Orange	LOW	0.250	0.231	1.679	0.016	0.011	0.033	0.038	0.188
	AVERAGE	1.588	1.680	3.477	0.206	0.194	0.252	0.235	1.293
	HIGH	4.139	3.872	14.241	0.719	0.643	0.372	0.375	2.480
Osceola	LOW	0.279	0.256	2.273	0.021	0.012	0.055	0.048	0.254
	AVERAGE	1.787	1.873	4.520	0.224	0.228	0.295	0.258	1.305
	HIGH	5.035	4.753	16.807	0.856	0.533	0.472	0.403	4.105
Palm Beach	LOW	1.086	0.991	6.881	0.088	0.074	0.189	0.161	0.834

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	5.914	4.903	12.033	0.972	0.941	1.086	0.970	4.098
	HIGH	13.978	13.225	30.456	4.358	3.891	3.135	2.854	10.871
Pasco	LOW	0.237	0.217	1.685	0.015	0.017	0.044	0.037	0.290
	AVERAGE	1.473	1.474	2.998	0.195	0.192	0.252	0.227	1.401
	HIGH	2.861	2.375	10.148	0.399	0.338	0.367	0.339	1.977
Pinellas	LOW	0.265	0.230	1.899	0.021	0.015	0.052	0.039	0.195
	AVERAGE	2.033	1.833	3.160	0.280	0.267	0.330	0.304	1.552
	HIGH	3.977	3.746	10.637	0.724	0.645	0.689	0.627	3.269
Polk	LOW	0.297	0.276	2.211	0.018	0.017	0.070	0.050	0.271
	AVERAGE	2.283	2.052	4.373	0.295	0.289	0.321	0.311	1.500
	HIGH	5.278	4.967	17.704	0.877	0.787	0.820	0.749	3.688
Putnam	LOW	0.175	0.139	1.071	0.081	0.077	0.158	0.069	0.166
	AVERAGE	1.257	1.192	1.935	0.179	0.154	0.214	0.165	0.924
	HIGH	1.761	1.622	6.231	0.255	0.215	0.254	0.222	1.377

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
St. Johns	LOW	0.157	0.147	1.265	0.010	0.008	0.021	0.017	0.126
	AVERAGE	0.913	1.028	1.886	0.162	0.141	0.203	0.200	0.992
	HIGH	1.944	1.796	6.344	0.302	0.259	0.289	0.260	1.594
St. Lucie	LOW	0.921	0.861	6.041	0.070	0.056	0.245	0.134	0.751
	AVERAGE	4.913	3.513	10.058	0.720	0.634	0.962	0.959	3.796
	HIGH	10.427	9.822	30.595	2.797	2.508	2.172	1.995	8.151
Santa Rosa	LOW	0.817	0.791	5.034	0.091	0.089	0.247	0.240	0.949
	AVERAGE	4.270	4.272	8.816	1.064	1.046	1.594	1.444	3.954
	HIGH	10.945	10.360	28.777	3.554	3.208	2.567	2.320	8.448
Sarasota	LOW	0.472	0.444	3.255	0.033	0.029	0.090	0.078	0.451
	AVERAGE	3.251	2.738	6.675	0.448	0.404	0.518	0.459	2.198
	HIGH	4.932	4.655	16.007	0.864	0.748	0.789	0.721	3.859
Seminole	LOW	0.261	0.240	2.058	0.017	0.011	0.037	0.033	0.246

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.861	1.792	3.657	0.238	0.216	0.262	0.241	1.367
	HIGH	3.266	3.031	11.277	0.529	0.465	0.460	0.323	2.017
Sumter	LOW	0.221	0.174	1.454	0.011	0.010	0.151	0.124	0.174
	AVERAGE	0.935	0.772	3.045	0.107	0.082	0.224	0.180	0.924
	HIGH	2.889	2.666	10.064	0.428	0.378	0.250	0.226	1.936
Suwannee	LOW	0.205	0.185	1.195	0.012	0.060	NA	NA	0.175
	AVERAGE	1.153	1.105	1.707	0.158	0.145	NA	NA	0.907
	HIGH	1.501	1.415	5.199	0.213	0.184	NA	NA	1.190
Taylor	LOW	0.201	0.211	1.390	0.021	0.088	0.054	0.123	0.767
	AVERAGE	1.324	1.269	1.962	0.187	0.169	0.189	0.157	0.927
	HIGH	1.792	1.674	5.766	0.244	0.223	0.247	0.191	1.420
Union	LOW	0.176	0.161	1.116	0.012	0.055	NA	NA	NA
	AVERAGE	1.011	1.033	1.595	0.143	0.140	NA	NA	NA
	HIGH	1.432	1.308	5.006	0.180	0.151	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Volusia	LOW	0.227	0.203	1.687	0.015	0.013	0.037	0.036	0.238
	AVERAGE	1.791	1.512	2.756	0.210	0.209	0.330	0.334	1.390
	HIGH	3.649	3.401	9.006	0.673	0.589	0.603	0.553	2.910
Wakulla	LOW	0.216	0.209	1.668	0.020	0.018	0.188	0.321	0.873
	AVERAGE	1.341	1.422	2.401	0.218	0.235	0.313	0.401	1.221
	HIGH	2.835	2.694	9.595	0.511	0.440	0.472	0.417	2.271
Walton	LOW	0.508	0.452	3.304	0.052	0.086	0.212	0.238	1.012
	AVERAGE	2.989	2.774	5.493	0.567	0.548	0.881	0.744	3.140
	HIGH	5.450	5.101	16.075	1.428	1.272	1.090	0.991	4.303
Washington	LOW	0.459	0.439	3.037	0.224	0.045	0.462	NA	1.321
	AVERAGE	2.061	2.108	3.829	0.441	0.390	0.462	NA	1.490
	HIGH	3.327	3.191	10.609	0.764	0.678	0.462	NA	1.842
Statewide	LOW	0.120	0.121	0.907	0.006	0.005	0.017	0.016	0.117

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	2.342	2.998	4.741	0.335	0.508	0.444	0.690	2.829
	HIGH	21.306	20.168	47.747	6.132	7.739	4.311	5.332	15.517

Table 38: Hurricane loss costs per $1,000 of Part A exposure for specified deductibles

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Alachua	LOW	0.110	0.090	0.831	0.001	0.001	0.019	0.022	0.098
	AVERAGE	0.794	0.832	1.464	0.075	0.066	0.093	0.077	0.604
	HIGH	1.366	1.284	4.381	0.131	0.111	0.124	0.101	0.877
Baker	LOW	0.126	0.111	0.881	0.002	0.020	NA	NA	0.559
	AVERAGE	0.695	0.686	1.194	0.093	0.066	NA	NA	0.559
	HIGH	0.925	0.841	3.507	0.111	0.094	NA	NA	0.559
Bay	LOW	0.421	0.430	2.832	0.022	0.023	0.093	0.103	0.615
	AVERAGE	2.335	2.308	4.793	0.358	0.331	0.535	0.409	1.994
	HIGH	4.527	4.274	13.751	1.228	1.096	0.866	0.770	3.488
Bradford	LOW	0.105	0.133	0.874	0.040	0.032	NA	NA	NA
	AVERAGE	0.802	0.790	1.287	0.097	0.077	NA	NA	NA
	HIGH	1.130	1.027	4.391	0.120	0.099	NA	NA	NA
Brevard	LOW	0.416	0.385	3.210	0.012	0.008	0.060	0.055	0.351

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	2.759	2.349	6.204	0.361	0.329	0.348	0.364	2.106
	HIGH	6.470	6.113	20.904	1.460	1.260	1.096	0.976	5.077
Broward	LOW	1.024	0.922	6.971	0.031	0.026	0.204	0.118	0.570
	AVERAGE	5.208	4.720	11.318	0.701	0.703	0.737	0.688	3.814
	HIGH	11.798	11.088	24.191	3.261	2.941	2.387	2.115	8.908
Calhoun	LOW	0.329	0.303	2.236	0.015	0.112	NA	NA	NA
	AVERAGE	1.574	1.522	3.032	0.230	0.215	NA	NA	NA
	HIGH	2.293	2.106	8.211	0.281	0.241	NA	NA	NA
Charlotte	LOW	0.609	0.559	4.384	0.028	0.012	0.151	0.084	0.556
	AVERAGE	3.511	2.832	6.965	0.468	0.389	0.480	0.361	2.376
	HIGH	5.501	5.141	19.419	0.936	0.813	0.779	0.703	4.261
Citrus	LOW	0.172	0.135	1.304	0.004	0.002	0.049	0.055	0.174
	AVERAGE	1.296	1.008	2.157	0.135	0.110	0.163	0.128	1.047
	HIGH	1.840	1.678	7.603	0.225	0.189	0.199	0.178	1.411

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Clay	LOW	0.101	0.087	0.790	0.001	0.001	0.018	0.022	0.095
	AVERAGE	0.698	0.746	1.311	0.081	0.067	0.084	0.072	0.521
	HIGH	1.331	1.209	3.936	0.124	0.100	0.107	0.093	0.808
Collier	LOW	0.857	0.798	6.455	0.023	0.017	0.112	0.092	0.634
	AVERAGE	4.590	3.566	11.768	0.541	0.501	0.609	0.505	2.845
	HIGH	10.633	9.668	32.693	2.686	2.294	1.939	1.717	8.178
Columbia	LOW	0.145	0.106	0.791	0.002	0.002	0.101	0.085	0.574
	AVERAGE	0.842	0.822	1.358	0.093	0.081	0.104	0.088	0.574
	HIGH	1.101	0.999	4.202	0.125	0.104	0.108	0.089	0.574
DeSoto	LOW	0.785	0.708	3.988	0.300	0.018	0.252	0.269	2.392
	AVERAGE	3.950	3.494	7.395	0.613	0.457	0.521	0.433	3.001
	HIGH	6.478	6.071	18.479	0.835	0.742	0.644	0.619	3.813
Dixie	LOW	0.186	0.156	1.284	0.040	0.006	0.110	0.091	1.139

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.459	1.030	2.053	0.128	0.106	0.288	0.244	1.653
	HIGH	4.258	4.045	15.914	0.138	0.114	0.465	0.374	3.410
Duval	LOW	0.092	0.089	0.775	0.001	0.000	0.010	0.008	0.091
	AVERAGE	0.744	0.758	1.404	0.081	0.068	0.085	0.073	0.542
	HIGH	1.157	1.081	4.236	0.155	0.142	0.143	0.112	0.954
Escambia	LOW	0.595	0.552	4.269	0.033	0.039	0.190	0.150	0.933
	AVERAGE	3.918	3.931	7.926	0.758	0.740	0.826	0.789	3.471
	HIGH	6.605	6.210	19.785	1.737	1.564	1.236	1.100	4.985
Flagler	LOW	0.134	0.122	1.333	0.003	0.002	0.039	0.046	0.341
	AVERAGE	1.030	0.812	2.210	0.100	0.082	0.151	0.109	0.677
	HIGH	1.874	1.753	7.047	0.268	0.230	0.233	0.190	1.496
Franklin	LOW	0.465	0.419	3.410	0.186	0.257	0.150	0.195	1.380
	AVERAGE	2.570	2.656	5.516	0.433	0.429	0.314	0.317	1.637
	HIGH	3.590	3.384	12.235	0.698	0.610	0.493	0.431	2.752

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Gadsden	LOW	0.157	0.113	1.155	0.004	0.003	NA	NA	0.570
	AVERAGE	0.922	0.910	1.681	0.126	0.107	NA	NA	0.761
	HIGH	1.356	1.234	5.200	0.172	0.115	NA	NA	0.830
Gilchrist	LOW	0.184	0.167	1.428	0.004	0.058	NA	NA	NA
	AVERAGE	1.053	1.048	1.912	0.130	0.120	NA	NA	NA
	HIGH	1.488	1.357	5.575	0.180	0.161	NA	NA	NA
Glades	LOW	3.221	1.022	7.100	0.054	0.387	NA	NA	3.844
	AVERAGE	5.271	4.271	9.887	0.788	0.687	NA	NA	4.185
	HIGH	5.791	5.405	20.771	0.902	0.777	NA	NA	4.591
Gulf	LOW	0.402	0.582	3.630	0.054	0.268	0.133	0.081	1.396
	AVERAGE	2.510	2.752	5.213	0.578	0.554	0.407	0.310	2.197
	HIGH	3.521	3.237	12.107	0.732	0.627	0.541	0.465	2.802
Hamilton	LOW	0.119	0.131	0.905	0.049	0.034	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	0.887	0.842	1.385	0.103	0.085	NA	NA	NA
	HIGH	1.136	1.051	4.465	0.144	0.092	NA	NA	NA
Hardee	LOW	0.687	0.541	5.292	0.263	0.227	0.605	NA	3.320
	AVERAGE	3.868	3.322	7.322	0.558	0.455	0.605	NA	3.320
	HIGH	5.264	4.897	18.502	0.832	0.713	0.605	NA	3.320
Hendry	LOW	0.993	0.913	4.619	0.047	0.026	0.338	0.300	3.451
	AVERAGE	4.810	4.108	9.534	0.743	0.551	0.619	0.527	3.706
	HIGH	7.849	7.470	27.066	1.456	0.721	0.704	0.618	3.991
Hernando	LOW	0.167	0.142	1.300	0.003	0.002	0.121	0.029	0.697
	AVERAGE	1.230	1.013	2.115	0.123	0.105	0.157	0.130	1.009
	HIGH	1.814	1.641	6.743	0.234	0.191	0.201	0.166	1.434
Highlands	LOW	0.501	0.324	2.659	0.014	0.006	0.166	0.059	0.704
	AVERAGE	3.122	2.696	5.833	0.392	0.334	0.387	0.328	2.415
	HIGH	5.746	5.410	21.598	0.927	0.809	0.538	0.457	4.124

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Hillsborough	LOW	0.185	0.181	1.633	0.003	0.002	0.033	0.019	0.186
	AVERAGE	1.437	1.468	3.935	0.160	0.150	0.182	0.169	1.241
	HIGH	3.732	6.877	13.780	0.424	0.491	0.367	0.326	2.284
Holmes	LOW	0.373	0.357	2.633	0.020	0.131	NA	NA	1.427
	AVERAGE	1.770	1.749	3.493	0.311	0.275	NA	NA	1.427
	HIGH	2.365	2.227	8.459	0.399	0.334	NA	NA	1.427
Indian River	LOW	0.743	0.652	5.341	0.026	0.018	0.163	0.113	0.652
	AVERAGE	3.882	2.844	8.578	0.658	0.482	0.583	0.556	3.109
	HIGH	7.042	6.645	20.963	1.554	1.367	1.200	1.044	5.501
Jackson	LOW	0.210	0.218	1.629	0.056	0.009	NA	NA	0.838
	AVERAGE	1.350	1.341	2.572	0.206	0.169	NA	NA	1.245
	HIGH	1.849	1.783	7.077	0.308	0.270	NA	NA	1.553
Jefferson	LOW	0.162	0.142	1.001	0.032	0.041	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	0.942	0.901	1.696	0.118	0.100	NA	NA	NA
	HIGH	1.367	1.268	4.996	0.152	0.129	NA	NA	NA
Lafayette	LOW	0.163	0.148	1.257	0.139	0.046	NA	NA	NA
	AVERAGE	1.061	0.978	1.821	0.139	0.104	NA	NA	NA
	HIGH	1.357	1.249	4.822	0.139	0.118	NA	NA	NA
Lake	LOW	0.151	0.130	1.352	0.004	0.002	0.036	0.029	0.178
	AVERAGE	1.343	1.206	2.703	0.143	0.115	0.181	0.147	1.113
	HIGH	2.798	2.579	10.575	0.397	0.323	0.261	0.223	1.638
Lee	LOW	0.614	0.575	4.592	0.017	0.010	0.085	0.070	0.472
	AVERAGE	4.128	2.824	8.852	0.373	0.367	0.556	0.407	2.458
	HIGH	10.291	9.719	26.644	2.342	1.874	1.959	1.746	7.851
Leon	LOW	0.123	0.102	0.929	0.002	0.001	0.021	0.025	0.141
	AVERAGE	0.923	0.889	1.660	0.096	0.074	0.095	0.086	0.619
	HIGH	1.184	1.088	4.707	0.143	0.122	0.127	0.123	0.893

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Levy	LOW	0.183	0.156	1.105	0.038	0.037	0.104	0.164	0.900
	AVERAGE	1.155	1.021	1.909	0.130	0.114	0.203	0.179	1.053
	HIGH	1.983	1.871	7.466	0.249	0.215	0.227	0.191	1.613
Liberty	LOW	0.271	0.312	1.782	0.102	0.194	NA	NA	NA
	AVERAGE	1.370	1.365	2.683	0.189	0.194	NA	NA	NA
	HIGH	1.640	1.518	6.349	0.229	0.194	NA	NA	NA
Madison	LOW	0.139	0.152	1.004	0.002	0.002	NA	NA	NA
	AVERAGE	0.944	0.899	1.625	0.104	0.091	NA	NA	NA
	HIGH	1.199	1.104	4.629	0.134	0.115	NA	NA	NA
Manatee	LOW	0.322	0.307	2.764	0.011	0.005	0.055	0.048	0.347
	AVERAGE	2.403	1.894	4.910	0.262	0.245	0.332	0.283	1.458
	HIGH	4.920	4.662	17.546	0.785	0.691	0.608	0.527	3.393
Marion	LOW	0.136	0.104	0.929	0.003	0.001	0.022	0.019	0.119

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.041	0.823	1.803	0.104	0.081	0.123	0.091	0.719
	HIGH	1.907	1.759	6.455	0.189	0.157	0.147	0.148	1.120
Martin	LOW	0.950	0.722	5.791	0.043	0.031	0.172	0.184	0.956
	AVERAGE	4.981	3.976	12.258	0.673	0.719	0.902	0.627	3.617
	HIGH	7.763	7.397	24.810	1.847	1.634	1.371	1.194	6.026
Miami-Dade	LOW	0.830	0.648	6.487	0.029	0.015	0.139	0.106	0.477
	AVERAGE	5.266	4.722	14.073	0.793	0.895	0.829	0.791	3.771
	HIGH	15.438	14.723	25.354	5.188	4.655	3.622	3.276	11.277
Monroe	LOW	1.340	1.276	8.849	0.096	0.247	0.270	0.412	1.249
	AVERAGE	7.948	8.804	22.934	2.068	2.297	0.990	1.688	6.497
	HIGH	19.508	18.496	44.500	5.120	6.889	3.014	4.620	13.792
Nassau	LOW	0.110	0.092	0.939	0.002	0.001	0.017	0.024	0.193
	AVERAGE	0.771	0.777	1.493	0.085	0.074	0.119	0.103	0.668
	HIGH	1.230	1.142	4.865	0.168	0.134	0.130	0.112	0.998

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Okaloosa	LOW	0.311	0.363	2.857	0.014	0.023	0.077	0.137	0.509
	AVERAGE	3.085	3.002	5.146	0.588	0.546	0.636	0.595	2.805
	HIGH	5.748	5.444	17.861	1.403	1.275	1.035	0.919	4.372
Okeechobee	LOW	0.950	0.824	6.535	0.253	0.207	0.175	0.335	2.377
	AVERAGE	4.440	3.795	9.126	0.676	0.550	0.555	0.578	3.523
	HIGH	5.156	4.788	18.708	0.797	0.683	0.673	0.602	4.140
Orange	LOW	0.191	0.172	1.450	0.003	0.001	0.020	0.022	0.148
	AVERAGE	1.297	1.359	3.114	0.133	0.121	0.161	0.141	1.023
	HIGH	3.504	3.264	13.025	0.530	0.461	0.235	0.222	1.991
Osceola	LOW	0.211	0.188	1.976	0.004	0.001	0.034	0.031	0.196
	AVERAGE	1.467	1.523	4.061	0.142	0.140	0.194	0.162	1.040
	HIGH	4.268	4.013	15.388	0.631	0.372	0.344	0.280	3.370
Palm Beach	LOW	0.899	0.812	6.331	0.029	0.022	0.128	0.105	0.670

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	5.103	4.201	11.028	0.734	0.701	0.767	0.665	3.400
	HIGH	12.347	11.708	27.870	3.634	3.230	2.547	2.281	9.322
Pasco	LOW	0.181	0.168	1.512	0.002	0.003	0.028	0.025	0.232
	AVERAGE	1.211	1.198	2.685	0.124	0.121	0.163	0.135	1.104
	HIGH	2.373	1.958	9.241	0.281	0.227	0.231	0.200	1.589
Pinellas	LOW	0.210	0.176	1.711	0.005	0.002	0.037	0.025	0.171
	AVERAGE	1.696	1.511	2.880	0.194	0.181	0.214	0.188	1.246
	HIGH	3.423	3.211	9.728	0.549	0.477	0.477	0.418	2.724
Polk	LOW	0.227	0.203	1.920	0.003	0.003	0.048	0.031	0.214
	AVERAGE	1.875	1.667	3.924	0.192	0.184	0.205	0.187	1.191
	HIGH	4.490	4.203	16.219	0.638	0.557	0.540	0.477	3.038
Putnam	LOW	0.136	0.102	0.908	0.040	0.039	0.108	0.032	0.136
	AVERAGE	1.009	0.945	1.702	0.118	0.096	0.131	0.094	0.718
	HIGH	1.427	1.304	5.622	0.173	0.138	0.151	0.123	1.082

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
St. Johns	LOW	0.119	0.109	1.086	0.002	0.001	0.012	0.009	0.097
	AVERAGE	0.739	0.824	1.677	0.105	0.087	0.130	0.121	0.784
	HIGH	1.601	1.467	5.777	0.212	0.173	0.179	0.153	1.280
St. Lucie	LOW	0.754	0.701	5.531	0.023	0.016	0.185	0.088	0.610
	AVERAGE	4.185	2.964	9.224	0.523	0.448	0.685	0.681	3.138
	HIGH	9.182	8.657	27.980	2.297	2.044	1.700	1.532	6.941
Santa Rosa	LOW	0.683	0.660	4.631	0.039	0.039	0.173	0.163	0.809
	AVERAGE	3.715	3.708	8.100	0.846	0.825	1.279	1.136	3.352
	HIGH	9.677	9.176	26.327	3.007	2.700	2.113	1.877	7.256
Sarasota	LOW	0.379	0.352	2.961	0.008	0.006	0.062	0.050	0.361
	AVERAGE	2.753	2.291	6.135	0.315	0.274	0.342	0.293	1.782
	HIGH	4.254	3.998	14.749	0.646	0.540	0.542	0.471	3.221
Seminole	LOW	0.197	0.177	1.789	0.003	0.001	0.023	0.019	0.193

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.524	1.455	3.287	0.158	0.137	0.165	0.142	1.085
	HIGH	2.735	2.520	10.285	0.380	0.322	0.291	0.190	1.619
Sumter	LOW	0.176	0.131	1.244	0.002	0.002	0.094	0.071	0.141
	AVERAGE	0.758	0.615	2.712	0.062	0.045	0.139	0.114	0.735
	HIGH	2.389	2.187	9.134	0.298	0.250	0.146	0.126	1.527
Suwannee	LOW	0.161	0.142	1.008	0.002	0.026	NA	NA	0.143
	AVERAGE	0.917	0.867	1.478	0.099	0.087	NA	NA	0.695
	HIGH	1.193	1.119	4.640	0.140	0.116	NA	NA	0.918
Taylor	LOW	0.151	0.162	1.180	0.006	0.044	0.040	0.071	0.594
	AVERAGE	1.058	1.000	1.723	0.121	0.104	0.128	0.099	0.737
	HIGH	1.439	1.335	5.220	0.167	0.143	0.142	0.120	1.107
Union	LOW	0.139	0.123	0.944	0.002	0.021	NA	NA	NA
	AVERAGE	0.804	0.812	1.381	0.089	0.084	NA	NA	NA
	HIGH	1.146	1.036	4.469	0.116	0.091	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Volusia	LOW	0.172	0.150	1.463	0.003	0.002	0.024	0.023	0.195
	AVERAGE	1.467	1.227	2.473	0.140	0.135	0.212	0.214	1.113
	HIGH	3.101	2.874	8.227	0.508	0.433	0.412	0.365	2.394
Wakulla	LOW	0.162	0.155	1.432	0.006	0.004	0.103	0.169	0.705
	AVERAGE	1.088	1.142	2.125	0.143	0.151	0.197	0.237	0.963
	HIGH	2.352	2.226	8.834	0.368	0.304	0.298	0.252	1.808
Walton	LOW	0.414	0.364	2.991	0.021	0.040	0.154	0.172	0.850
	AVERAGE	2.597	2.390	5.028	0.435	0.412	0.675	0.559	2.657
	HIGH	4.765	4.454	14.750	1.179	1.039	0.836	0.739	3.639
Washington	LOW	0.375	0.357	2.743	0.146	0.018	0.351	NA	1.108
	AVERAGE	1.751	1.776	3.486	0.333	0.288	0.351	NA	1.236
	HIGH	2.880	2.762	9.722	0.615	0.535	0.351	NA	1.505
Statewide	LOW	0.092	0.087	0.775	0.001	0.000	0.010	0.008	0.091

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.976	2.528	4.303	0.237	0.364	0.305	0.469	2.326
	HIGH	19.508	18.496	44.500	5.188	6.889	3.622	4.620	13.792

Table 39: Hurricane loss costs per $1,000 of Part B exposure for 0% deductibles

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Alachua	LOW	0.138	0.125	0.330	0.008	0.007	0.020	0.025	0.140
	AVERAGE	0.909	1.015	1.496	0.111	0.092	0.150	0.135	0.850
	HIGH	1.699	1.606	5.370	0.201	0.173	0.207	0.180	1.129
Baker	LOW	0.148	0.125	0.322	0.011	0.010	NA	NA	0.822
	AVERAGE	0.777	0.754	1.210	0.131	0.112	NA	NA	0.822
	HIGH	1.167	1.071	4.363	0.169	0.148	NA	NA	0.822
Bay	LOW	0.421	0.460	1.606	0.044	0.048	0.098	0.113	0.407
	AVERAGE	2.340	2.607	4.200	0.462	0.393	0.598	0.510	2.062
	HIGH	5.195	4.900	13.889	1.469	1.322	1.106	1.004	4.133
Bradford	LOW	0.158	0.139	0.354	0.011	0.010	NA	NA	0.853
	AVERAGE	0.921	0.981	1.326	0.129	0.111	NA	NA	0.958
	HIGH	1.424	1.307	4.835	0.187	0.162	NA	NA	1.062
Brevard	LOW	0.509	0.484	1.558	0.036	0.032	0.088	0.081	0.335

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	3.138	2.521	6.517	0.446	0.402	0.507	0.508	2.263
	HIGH	7.415	7.017	23.992	1.808	1.588	1.455	1.329	6.003
Broward	LOW	1.221	1.123	3.652	0.096	0.078	0.191	0.180	0.657
	AVERAGE	5.468	5.234	10.869	0.853	0.780	1.044	0.981	4.433
	HIGH	13.253	12.451	27.708	3.916	3.550	2.950	2.665	10.348
Calhoun	LOW	0.315	0.362	1.149	0.149	0.247	NA	NA	NA
	AVERAGE	1.738	1.817	2.896	0.331	0.319	NA	NA	NA
	HIGH	2.730	2.523	8.225	0.377	0.365	NA	NA	NA
Charlotte	LOW	0.749	0.698	2.313	0.052	0.039	0.121	0.114	0.644
	AVERAGE	3.758	2.935	6.948	0.531	0.464	0.635	0.526	2.660
	HIGH	6.333	5.931	20.326	1.219	1.074	1.105	1.024	5.176
Citrus	LOW	0.213	0.174	0.507	0.013	0.010	0.064	0.040	0.669
	AVERAGE	1.447	1.154	2.062	0.191	0.148	0.269	0.223	1.412
	HIGH	2.472	2.066	8.523	0.330	0.287	0.327	0.302	1.778

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Clay	LOW	0.135	0.121	0.341	0.006	0.007	0.020	0.022	0.134
	AVERAGE	0.794	0.905	1.397	0.116	0.108	0.127	0.115	0.590
	HIGH	1.646	1.511	4.818	0.185	0.157	0.180	0.164	0.929
Collier	LOW	1.045	0.983	3.483	0.073	0.067	0.165	0.145	0.503
	AVERAGE	4.726	3.602	10.823	0.754	0.568	0.776	0.725	3.670
	HIGH	11.903	11.212	34.237	3.216	2.785	2.478	2.240	9.108
Columbia	LOW	0.168	0.142	0.280	0.010	0.010	0.176	0.159	NA
	AVERAGE	0.966	1.020	1.443	0.139	0.120	0.180	0.160	NA
	HIGH	1.380	1.267	5.236	0.191	0.166	0.183	0.161	NA
DeSoto	LOW	0.963	0.883	2.877	0.083	0.064	0.491	0.183	2.528
	AVERAGE	4.422	3.719	8.799	0.732	0.626	0.724	0.667	3.336
	HIGH	7.431	6.015	21.029	1.101	1.000	0.997	0.928	4.822
Dixie	LOW	0.223	0.171	0.514	0.015	0.009	0.121	0.248	1.300

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.569	1.255	1.759	0.183	0.151	0.407	0.323	2.165
	HIGH	5.043	4.807	15.658	0.384	0.182	0.643	0.546	4.160
Duval	LOW	0.120	0.113	0.317	0.006	0.005	0.017	0.015	0.110
	AVERAGE	0.841	0.927	1.247	0.099	0.097	0.127	0.120	0.700
	HIGH	1.431	1.340	4.817	0.240	0.211	0.223	0.194	1.158
Escambia	LOW	0.703	0.674	2.340	0.076	0.094	0.190	0.169	0.581
	AVERAGE	4.131	4.266	7.285	0.894	0.892	0.934	0.967	4.093
	HIGH	7.534	7.081	21.625	2.117	5.949	1.577	1.723	5.877
Flagler	LOW	0.180	0.167	0.534	0.012	0.009	0.100	0.032	0.223
	AVERAGE	0.994	0.879	2.125	0.140	0.112	0.234	0.173	1.119
	HIGH	2.261	2.127	6.983	0.378	0.333	0.356	0.314	1.857
Franklin	LOW	0.567	0.528	1.691	0.058	0.335	0.328	0.260	1.637
	AVERAGE	2.672	2.986	4.471	0.542	0.497	0.423	0.499	1.726
	HIGH	4.209	3.984	12.175	0.893	0.796	0.722	0.655	1.730

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Gadsden	LOW	0.169	0.153	0.513	0.012	0.013	0.187	0.173	NA
	AVERAGE	1.061	1.103	1.945	0.179	0.150	0.187	0.173	NA
	HIGH	1.660	1.526	5.749	0.253	0.176	0.187	0.173	NA
Gilchrist	LOW	0.207	0.191	0.580	0.018	0.012	NA	0.143	NA
	AVERAGE	1.074	1.250	1.722	0.183	0.158	NA	0.143	NA
	HIGH	1.848	1.702	6.387	0.267	0.245	NA	0.143	NA
Glades	LOW	1.191	1.259	3.709	0.137	0.123	NA	NA	NA
	AVERAGE	5.664	4.728	11.463	0.955	0.707	NA	NA	NA
	HIGH	6.763	6.341	24.285	1.212	1.075	NA	NA	NA
Gulf	LOW	0.514	0.561	1.972	0.052	0.061	0.180	0.125	1.204
	AVERAGE	2.250	2.934	3.847	0.568	0.563	0.489	0.436	1.961
	HIGH	4.136	3.821	13.086	0.926	0.811	0.762	0.678	2.258
Hamilton	LOW	0.155	0.168	0.369	0.011	0.072	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.035	1.048	1.400	0.141	0.131	NA	NA	NA
	HIGH	1.434	1.337	5.499	0.170	0.178	NA	NA	NA
Hardee	LOW	0.888	0.657	2.628	0.080	0.053	0.911	NA	NA
	AVERAGE	4.456	3.630	8.807	0.634	0.553	0.911	NA	NA
	HIGH	6.109	5.709	20.945	1.100	0.968	0.911	NA	NA
Hendry	LOW	1.206	1.129	3.845	0.092	0.079	0.639	0.162	NA
	AVERAGE	5.142	3.433	9.488	0.886	0.673	0.962	0.783	NA
	HIGH	8.977	8.562	30.804	1.117	1.195	1.047	0.950	NA
Hernando	LOW	0.193	0.172	0.515	0.013	0.011	0.038	0.039	0.996
	AVERAGE	1.396	1.159	2.217	0.173	0.140	0.255	0.218	1.477
	HIGH	2.200	2.011	6.706	0.338	0.287	0.326	0.286	1.790
Highlands	LOW	0.581	0.433	1.543	0.044	0.028	0.137	0.081	0.484
	AVERAGE	3.604	3.056	7.385	0.530	0.445	0.549	0.518	2.999
	HIGH	6.714	6.340	24.910	1.071	1.103	0.829	0.739	4.250

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Hillsborough	LOW	0.229	0.221	0.655	0.014	0.011	0.043	0.035	0.174
	AVERAGE	1.502	1.610	3.733	0.222	0.175	0.258	0.254	1.459
	HIGH	3.711	7.825	12.583	0.577	0.524	0.551	0.505	2.508
Holmes	LOW	0.390	0.436	1.501	0.042	0.253	NA	NA	1.397
	AVERAGE	1.957	2.039	3.506	0.359	0.356	NA	NA	1.397
	HIGH	2.767	2.610	9.232	0.530	0.456	NA	NA	1.397
Indian River	LOW	0.880	0.806	2.808	0.077	0.057	0.200	0.122	1.468
	AVERAGE	4.402	2.919	7.875	0.731	0.598	0.818	0.778	4.113
	HIGH	8.055	7.612	18.877	1.934	1.724	1.587	1.417	6.496
Jackson	LOW	0.290	0.275	0.830	0.020	0.024	NA	NA	0.446
	AVERAGE	1.533	1.594	2.721	0.252	0.219	NA	NA	0.869
	HIGH	2.202	2.124	7.135	0.414	0.338	NA	NA	1.292
Jefferson	LOW	0.174	0.186	0.508	0.012	0.111	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.018	1.096	1.583	0.170	0.161	NA	NA	NA
	HIGH	1.686	1.573	6.146	0.225	0.198	NA	NA	NA
Lafayette	LOW	0.188	0.195	0.516	0.115	0.127	NA	NA	NA
	AVERAGE	1.228	1.221	1.645	0.195	0.169	NA	NA	NA
	HIGH	1.697	1.415	5.910	0.216	0.189	NA	NA	NA
Lake	LOW	0.199	0.177	0.571	0.012	0.011	0.052	0.030	0.255
	AVERAGE	1.491	1.281	3.409	0.199	0.177	0.270	0.226	1.497
	HIGH	3.347	3.107	12.518	0.552	0.470	0.374	0.381	2.123
Lee	LOW	0.745	0.674	2.311	0.049	0.043	0.126	0.107	0.496
	AVERAGE	4.103	2.916	8.723	0.520	0.444	0.725	0.589	2.999
	HIGH	11.560	10.904	24.252	3.250	2.886	2.459	2.239	9.099
Leon	LOW	0.163	0.157	0.435	0.010	0.008	0.029	0.028	0.163
	AVERAGE	1.100	1.092	1.908	0.118	0.098	0.145	0.143	0.700
	HIGH	1.477	1.368	5.258	0.213	0.187	0.228	0.206	1.138

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Levy	LOW	0.193	0.174	0.496	0.016	0.013	0.238	0.247	0.223
	AVERAGE	1.240	1.208	1.654	0.185	0.143	0.322	0.277	1.681
	HIGH	2.424	2.297	7.363	0.366	0.242	0.371	0.330	2.024
Liberty	LOW	0.339	0.381	0.848	0.024	0.201	NA	NA	NA
	AVERAGE	1.534	1.642	2.323	0.267	0.272	NA	NA	NA
	HIGH	1.992	1.855	7.583	0.324	0.286	NA	NA	NA
Madison	LOW	0.175	0.159	0.386	0.012	0.015	NA	NA	NA
	AVERAGE	1.088	1.100	1.534	0.154	0.131	NA	NA	NA
	HIGH	1.499	1.393	5.672	0.207	0.185	NA	NA	NA
Manatee	LOW	0.405	0.376	1.272	0.028	0.026	0.083	0.074	0.443
	AVERAGE	2.303	1.924	5.270	0.352	0.299	0.431	0.399	2.137
	HIGH	5.709	5.422	19.089	1.041	0.938	0.864	0.777	4.027
Marion	LOW	0.178	0.141	0.354	0.008	0.008	0.029	0.024	0.176

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.197	0.865	2.091	0.144	0.120	0.197	0.136	1.024
	HIGH	2.333	2.167	7.820	0.280	0.243	0.248	0.260	1.356
Martin	LOW	0.962	0.888	3.067	0.068	0.061	0.215	0.148	0.927
	AVERAGE	5.554	4.295	12.708	0.917	0.844	1.180	0.877	4.287
	HIGH	8.852	8.434	25.313	2.280	2.026	1.789	1.600	7.092
Miami-Dade	LOW	1.011	0.811	3.350	0.068	0.057	0.168	0.150	0.524
	AVERAGE	5.570	5.156	13.519	0.829	0.755	1.074	0.997	4.383
	HIGH	15.266	16.492	27.409	6.132	5.522	4.311	3.955	13.019
Monroe	LOW	1.577	1.523	5.506	0.197	0.144	0.360	0.230	0.890
	AVERAGE	8.081	8.539	24.825	1.750	2.438	1.384	2.163	6.446
	HIGH	21.306	20.168	45.644	5.075	5.188	4.026	5.332	15.144
Nassau	LOW	0.145	0.129	0.361	0.008	0.009	0.028	0.025	0.189
	AVERAGE	0.769	0.836	1.320	0.108	0.116	0.181	0.163	0.909
	HIGH	1.522	1.421	5.404	0.244	0.209	0.221	0.200	1.268

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Okaloosa	LOW	0.399	0.370	1.527	0.045	0.047	0.100	0.139	0.841
	AVERAGE	3.183	3.411	4.364	0.666	0.651	0.783	0.743	3.449
	HIGH	6.552	6.204	17.896	1.703	1.556	1.327	1.206	4.391
Okeechobee	LOW	1.099	0.858	3.360	0.105	0.076	0.236	0.526	2.813
	AVERAGE	4.932	4.212	11.313	0.867	0.737	0.764	0.825	4.317
	HIGH	6.055	5.659	21.871	1.071	0.950	1.002	0.929	4.757
Orange	LOW	0.250	0.228	0.719	0.011	0.011	0.036	0.028	0.148
	AVERAGE	1.407	1.545	3.619	0.196	0.156	0.232	0.225	1.194
	HIGH	4.139	3.872	14.241	0.717	0.643	0.663	0.390	2.480
Osceola	LOW	0.278	0.256	0.823	0.015	0.012	0.042	0.037	0.260
	AVERAGE	1.361	1.541	4.963	0.192	0.190	0.257	0.228	1.111
	HIGH	5.035	4.753	18.057	0.856	0.768	0.542	0.403	2.191
Palm Beach	LOW	1.064	0.991	3.471	0.088	0.072	0.179	0.158	0.645

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	5.640	4.541	10.715	0.858	0.841	1.028	0.935	4.501
	HIGH	13.978	13.225	26.371	4.358	3.891	3.135	2.854	10.871
Pasco	LOW	0.237	0.217	0.599	0.012	0.011	0.037	0.030	0.210
	AVERAGE	1.183	1.305	2.777	0.185	0.172	0.218	0.215	1.220
	HIGH	2.861	2.356	9.430	0.381	0.338	0.367	0.339	1.977
Pinellas	LOW	0.261	0.249	0.702	0.015	0.015	0.043	0.036	0.117
	AVERAGE	1.964	1.787	3.223	0.257	0.238	0.314	0.297	1.545
	HIGH	3.977	3.746	9.202	0.724	0.645	0.690	0.627	3.269
Polk	LOW	0.292	0.253	0.828	0.016	0.015	0.049	0.048	0.275
	AVERAGE	1.867	1.698	4.833	0.265	0.235	0.251	0.287	1.491
	HIGH	5.278	4.967	16.759	0.877	0.787	0.820	0.749	3.295
Putnam	LOW	0.151	0.139	0.387	0.012	0.011	0.054	0.108	0.820
	AVERAGE	1.183	1.146	2.078	0.177	0.145	0.211	0.176	1.070
	HIGH	1.761	1.622	6.752	0.255	0.215	0.254	0.222	1.286

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
St. Johns	LOW	0.156	0.147	0.445	0.008	0.006	0.023	0.017	0.137
	AVERAGE	0.697	0.892	1.617	0.105	0.107	0.188	0.193	0.921
	HIGH	1.944	1.796	6.344	0.303	0.259	0.291	0.260	1.594
St. Lucie	LOW	0.916	0.826	2.843	0.074	0.058	0.216	0.134	0.751
	AVERAGE	4.678	2.883	9.532	0.689	0.536	0.900	0.893	4.064
	HIGH	10.427	9.822	20.823	2.798	2.508	2.174	1.995	8.151
Santa Rosa	LOW	0.805	0.757	2.627	0.067	0.071	0.245	0.271	1.257
	AVERAGE	3.644	3.933	7.398	0.838	0.823	1.568	1.393	4.910
	HIGH	10.945	10.360	22.912	3.554	3.208	2.567	2.320	8.448
Sarasota	LOW	0.472	0.444	1.397	0.035	0.027	0.076	0.072	0.296
	AVERAGE	2.942	2.400	6.567	0.399	0.337	0.496	0.435	2.337
	HIGH	4.932	4.655	14.928	0.864	0.748	0.789	0.721	3.859
Seminole	LOW	0.254	0.240	0.769	0.017	0.011	0.033	0.033	0.192

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.756	1.698	3.645	0.226	0.187	0.260	0.232	1.255
	HIGH	3.266	3.031	12.088	0.529	0.465	0.369	0.416	2.017
Sumter	LOW	0.190	0.174	0.629	0.011	0.010	0.061	0.049	0.654
	AVERAGE	0.828	0.623	3.124	0.092	0.086	0.220	0.179	1.099
	HIGH	2.889	2.666	10.064	0.384	0.378	0.250	0.312	1.964
Suwannee	LOW	0.176	0.164	0.405	0.009	0.010	0.047	NA	1.012
	AVERAGE	1.055	1.069	1.466	0.136	0.128	0.047	NA	1.012
	HIGH	1.501	1.415	5.531	0.213	0.185	0.047	NA	1.012
Taylor	LOW	0.201	0.211	0.476	0.014	0.092	0.041	0.116	0.736
	AVERAGE	1.233	1.244	1.390	0.170	0.160	0.185	0.143	0.747
	HIGH	1.792	1.674	5.995	0.259	0.193	0.208	0.166	0.767
Union	LOW	0.176	0.161	0.353	0.012	0.006	NA	NA	NA
	AVERAGE	0.885	1.012	1.358	0.141	0.128	NA	NA	NA
	HIGH	1.432	1.308	4.970	0.182	0.151	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Volusia	LOW	0.207	0.185	0.597	0.011	0.010	0.040	0.027	0.207
	AVERAGE	1.690	1.336	2.687	0.193	0.192	0.322	0.320	1.459
	HIGH	3.660	3.401	9.006	0.673	0.589	0.607	0.553	2.910
Wakulla	LOW	0.216	0.209	0.655	0.015	0.018	0.049	0.225	0.873
	AVERAGE	1.097	1.333	2.142	0.174	0.194	0.201	0.371	1.116
	HIGH	2.835	2.694	8.474	0.511	0.440	0.468	0.417	2.011
Walton	LOW	0.412	0.392	1.373	0.037	0.065	0.176	0.150	0.699
	AVERAGE	2.279	2.178	4.251	0.539	0.349	0.700	0.658	3.509
	HIGH	5.453	5.101	16.651	1.434	1.272	1.090	0.991	4.303
Washington	LOW	0.396	0.362	1.540	0.049	0.206	NA	NA	1.842
	AVERAGE	1.891	2.062	3.221	0.409	0.392	NA	NA	1.842
	HIGH	3.327	3.191	11.229	0.764	0.678	NA	NA	1.842
Statewide	LOW	0.120	0.113	0.280	0.006	0.005	0.017	0.015	0.110

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	2.037	2.702	4.409	0.349	0.436	0.427	0.664	3.180
	HIGH	21.306	20.168	45.644	6.132	5.949	4.311	5.332	15.144

Table 40: Hurricane loss costs per $1,000 of Part B exposure for specified deductibles

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Alachua	LOW	0.102	0.090	0.291	0.001	0.001	0.012	0.016	0.114
	AVERAGE	0.724	0.796	1.305	0.068	0.053	0.091	0.076	0.663
	HIGH	1.366	1.284	4.794	0.133	0.111	0.126	0.108	0.877
Baker	LOW	0.113	0.092	0.283	0.002	0.002	NA	NA	0.620
	AVERAGE	0.617	0.588	1.047	0.083	0.066	NA	NA	0.620
	HIGH	0.928	0.841	3.869	0.112	0.094	NA	NA	0.620
Bay	LOW	0.335	0.375	1.489	0.017	0.019	0.067	0.075	0.357
	AVERAGE	2.004	2.215	3.851	0.350	0.291	0.450	0.377	1.718
	HIGH	4.527	4.274	12.774	1.228	1.096	0.866	0.770	3.488
Bradford	LOW	0.124	0.101	0.315	0.002	0.002	NA	NA	0.651
	AVERAGE	0.734	0.770	1.154	0.081	0.065	NA	NA	0.730
	HIGH	1.130	1.027	4.315	0.120	0.099	NA	NA	0.808
Brevard	LOW	0.410	0.385	1.427	0.009	0.007	0.060	0.054	0.294

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	2.636	2.107	5.970	0.315	0.276	0.340	0.338	1.844
	HIGH	6.470	6.113	21.933	1.460	1.260	1.096	0.976	5.077
Broward	LOW	1.014	0.922	3.361	0.031	0.022	0.131	0.118	0.570
	AVERAGE	4.713	4.486	9.993	0.626	0.563	0.730	0.672	3.696
	HIGH	11.798	11.088	25.323	3.261	2.941	2.387	2.115	8.908
Calhoun	LOW	0.243	0.292	1.057	0.084	0.167	NA	NA	NA
	AVERAGE	1.445	1.498	2.616	0.237	0.224	NA	NA	NA
	HIGH	2.299	2.106	7.503	0.281	0.260	NA	NA	NA
Charlotte	LOW	0.609	0.559	2.122	0.014	0.008	0.083	0.076	0.513
	AVERAGE	3.191	2.456	6.387	0.374	0.313	0.423	0.336	2.164
	HIGH	5.501	5.141	18.714	0.936	0.813	0.779	0.703	4.349
Citrus	LOW	0.162	0.127	0.451	0.002	0.002	0.049	0.027	0.528
	AVERAGE	1.169	0.917	1.833	0.125	0.090	0.162	0.126	1.101
	HIGH	2.039	1.678	7.728	0.225	0.189	0.200	0.178	1.411

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Clay	LOW	0.101	0.087	0.302	0.001	0.001	0.013	0.014	0.107
	AVERAGE	0.634	0.712	1.217	0.072	0.065	0.082	0.070	0.458
	HIGH	1.331	1.209	4.309	0.124	0.100	0.107	0.093	0.720
Collier	LOW	0.857	0.798	3.219	0.021	0.018	0.112	0.092	0.436
	AVERAGE	4.065	3.054	10.004	0.547	0.393	0.540	0.483	3.035
	HIGH	10.633	10.007	31.730	2.688	2.294	1.939	1.717	7.833
Columbia	LOW	0.129	0.106	0.246	0.002	0.002	0.101	0.086	NA
	AVERAGE	0.767	0.798	1.253	0.086	0.070	0.105	0.087	NA
	HIGH	1.103	0.999	4.662	0.125	0.104	0.108	0.089	NA
DeSoto	LOW	0.785	0.708	2.633	0.029	0.018	0.252	0.134	2.098
	AVERAGE	3.749	3.124	8.072	0.524	0.432	0.479	0.423	2.690
	HIGH	6.478	5.128	19.355	0.835	0.742	0.683	0.619	4.014
Dixie	LOW	0.174	0.124	0.458	0.003	0.001	0.075	0.161	1.039

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.272	0.992	1.553	0.117	0.093	0.287	0.215	1.784
	HIGH	4.258	4.045	14.459	0.261	0.114	0.466	0.374	3.410
Duval	LOW	0.092	0.083	0.280	0.001	0.000	0.010	0.008	0.087
	AVERAGE	0.671	0.730	1.093	0.061	0.059	0.081	0.072	0.547
	HIGH	1.166	1.081	4.322	0.168	0.142	0.137	0.113	0.919
Escambia	LOW	0.582	0.552	2.163	0.031	0.040	0.133	0.111	0.507
	AVERAGE	3.584	3.690	6.694	0.700	0.695	0.706	0.737	3.467
	HIGH	6.605	6.210	19.785	1.754	5.112	1.236	1.357	4.985
Flagler	LOW	0.134	0.122	0.478	0.002	0.001	0.054	0.020	0.181
	AVERAGE	0.803	0.699	1.908	0.087	0.065	0.146	0.108	0.887
	HIGH	1.874	1.753	6.371	0.271	0.232	0.235	0.197	1.496
Franklin	LOW	0.456	0.419	1.555	0.022	0.219	0.208	0.160	1.336
	AVERAGE	2.243	2.493	4.119	0.396	0.351	0.300	0.327	1.423
	HIGH	3.590	3.384	11.280	0.698	0.610	0.493	0.431	1.426

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Gadsden	LOW	0.127	0.110	0.463	0.003	0.003	0.107	0.098	NA
	AVERAGE	0.854	0.878	1.718	0.119	0.095	0.107	0.098	NA
	HIGH	1.356	1.234	5.200	0.172	0.115	0.107	0.098	NA
Gilchrist	LOW	0.153	0.137	0.516	0.004	0.002	NA	0.078	NA
	AVERAGE	0.860	0.984	1.507	0.117	0.092	NA	0.078	NA
	HIGH	1.488	1.357	5.725	0.180	0.161	NA	0.078	NA
Glades	LOW	0.978	1.022	3.417	0.054	0.045	NA	NA	NA
	AVERAGE	4.819	3.983	10.534	0.693	0.483	NA	NA	NA
	HIGH	5.791	5.405	22.326	0.902	0.777	NA	NA	NA
Gulf	LOW	0.402	0.452	1.816	0.021	0.027	0.133	0.081	1.033
	AVERAGE	1.904	2.466	3.522	0.428	0.422	0.354	0.308	1.628
	HIGH	3.521	3.237	12.107	0.732	0.627	0.541	0.465	1.888
Hamilton	LOW	0.119	0.131	0.326	0.002	0.034	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	0.822	0.819	1.214	0.087	0.077	NA	NA	NA
	HIGH	1.136	1.051	4.901	0.109	0.111	NA	NA	NA
Hardee	LOW	0.724	0.503	2.406	0.028	0.013	0.605	NA	NA
	AVERAGE	3.768	3.039	8.019	0.442	0.368	0.605	NA	NA
	HIGH	5.264	4.897	19.274	0.832	0.713	0.605	NA	NA
Hendry	LOW	0.990	0.913	3.542	0.029	0.022	0.347	0.103	NA
	AVERAGE	4.372	2.881	8.728	0.638	0.459	0.638	0.493	NA
	HIGH	7.849	7.470	28.428	0.831	0.876	0.711	0.618	NA
Hernando	LOW	0.147	0.128	0.457	0.002	0.002	0.027	0.029	0.812
	AVERAGE	1.134	0.929	1.977	0.110	0.084	0.156	0.126	1.172
	HIGH	1.814	1.641	6.057	0.237	0.191	0.201	0.166	1.434
Highlands	LOW	0.470	0.324	1.399	0.012	0.005	0.103	0.054	0.384
	AVERAGE	3.000	2.509	6.704	0.367	0.290	0.351	0.318	2.417
	HIGH	5.746	5.410	22.895	0.796	0.809	0.541	0.457	3.479

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Hillsborough	LOW	0.177	0.171	0.590	0.003	0.001	0.025	0.022	0.147
	AVERAGE	1.241	1.319	3.385	0.146	0.108	0.170	0.158	1.155
	HIGH	3.126	6.877	11.518	0.425	0.378	0.367	0.326	2.036
Holmes	LOW	0.306	0.357	1.395	0.014	0.167	NA	NA	1.150
	AVERAGE	1.659	1.717	3.196	0.261	0.255	NA	NA	1.150
	HIGH	2.368	2.227	8.459	0.399	0.334	NA	NA	1.150
Indian River	LOW	0.722	0.652	2.577	0.027	0.018	0.149	0.080	1.226
	AVERAGE	3.730	2.455	7.219	0.540	0.426	0.563	0.526	3.411
	HIGH	7.042	6.645	17.310	1.558	1.367	1.200	1.044	5.501
Jackson	LOW	0.231	0.218	0.760	0.006	0.008	NA	NA	0.378
	AVERAGE	1.273	1.315	2.455	0.176	0.148	NA	NA	0.728
	HIGH	1.849	1.783	6.510	0.308	0.243	NA	NA	1.077
Jefferson	LOW	0.129	0.142	0.457	0.002	0.062	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	0.816	0.867	1.391	0.110	0.100	NA	NA	NA
	HIGH	1.367	1.268	5.533	0.152	0.129	NA	NA	NA
Lafayette	LOW	0.139	0.148	0.459	0.064	0.072	NA	NA	NA
	AVERAGE	0.983	0.960	1.439	0.124	0.103	NA	NA	NA
	HIGH	1.357	1.116	5.288	0.141	0.118	NA	NA	NA
Lake	LOW	0.151	0.130	0.512	0.002	0.002	0.036	0.017	0.200
	AVERAGE	1.216	1.033	3.049	0.126	0.109	0.168	0.134	1.179
	HIGH	2.798	2.579	11.409	0.397	0.323	0.246	0.223	1.684
Lee	LOW	0.602	0.535	2.123	0.012	0.010	0.085	0.070	0.430
	AVERAGE	3.502	2.441	8.038	0.360	0.298	0.500	0.389	2.455
	HIGH	10.291	9.719	22.307	2.710	2.390	1.959	1.746	7.851
Leon	LOW	0.123	0.115	0.389	0.002	0.001	0.018	0.018	0.133
	AVERAGE	0.881	0.864	1.680	0.072	0.057	0.092	0.085	0.547
	HIGH	1.184	1.088	4.712	0.146	0.122	0.144	0.123	0.889

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Levy	LOW	0.144	0.127	0.443	0.004	0.002	0.143	0.164	0.185
	AVERAGE	1.000	0.957	1.453	0.119	0.082	0.208	0.173	1.350
	HIGH	1.984	1.871	6.641	0.249	0.154	0.227	0.191	1.613
Liberty	LOW	0.271	0.312	0.774	0.007	0.121	NA	NA	NA
	AVERAGE	1.266	1.341	2.084	0.185	0.182	NA	NA	NA
	HIGH	1.640	1.518	6.878	0.229	0.194	NA	NA	NA
Madison	LOW	0.135	0.120	0.343	0.003	0.005	NA	NA	NA
	AVERAGE	0.867	0.864	1.340	0.098	0.077	NA	NA	NA
	HIGH	1.199	1.104	5.082	0.134	0.115	NA	NA	NA
Manatee	LOW	0.322	0.294	1.161	0.007	0.006	0.055	0.048	0.353
	AVERAGE	1.944	1.604	4.827	0.241	0.196	0.293	0.258	1.745
	HIGH	4.920	4.662	17.546	0.785	0.691	0.611	0.527	3.393
Marion	LOW	0.135	0.104	0.312	0.001	0.001	0.020	0.015	0.144

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	0.958	0.683	1.842	0.091	0.072	0.119	0.080	0.800
	HIGH	1.907	1.759	7.053	0.189	0.157	0.147	0.148	1.061
Martin	LOW	0.796	0.722	2.822	0.022	0.018	0.149	0.100	0.758
	AVERAGE	4.764	3.660	11.633	0.689	0.624	0.849	0.593	3.573
	HIGH	7.763	7.397	23.132	1.862	1.634	1.371	1.194	6.026
Miami-Dade	LOW	0.830	0.648	3.079	0.019	0.014	0.115	0.103	0.455
	AVERAGE	4.820	4.434	12.507	0.614	0.553	0.782	0.718	3.669
	HIGH	13.643	14.723	25.354	5.188	4.655	3.622	3.276	11.277
Monroe	LOW	1.330	1.276	5.160	0.096	0.059	0.270	0.146	0.775
	AVERAGE	7.219	7.626	23.072	1.427	2.039	1.028	1.673	5.544
	HIGH	19.508	18.496	42.523	4.418	4.533	3.396	4.620	13.428
Nassau	LOW	0.108	0.092	0.321	0.001	0.001	0.017	0.014	0.150
	AVERAGE	0.616	0.660	1.156	0.066	0.070	0.113	0.095	0.708
	HIGH	1.232	1.142	4.865	0.168	0.144	0.130	0.112	0.998

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Okaloosa	LOW	0.311	0.282	1.405	0.016	0.016	0.069	0.094	0.720
	AVERAGE	2.748	2.939	4.001	0.516	0.500	0.587	0.558	2.894
	HIGH	5.748	5.444	16.398	1.403	1.275	1.035	0.919	3.709
Okeechobee	LOW	0.899	0.712	3.083	0.039	0.022	0.175	0.286	2.263
	AVERAGE	4.163	3.518	10.359	0.623	0.509	0.537	0.527	3.484
	HIGH	5.156	4.788	20.056	0.797	0.683	0.673	0.602	3.899
Orange	LOW	0.191	0.169	0.646	0.001	0.001	0.022	0.015	0.129
	AVERAGE	1.149	1.249	3.249	0.126	0.096	0.149	0.136	0.943
	HIGH	3.504	3.264	13.025	0.530	0.461	0.441	0.230	1.991
Osceola	LOW	0.211	0.188	0.738	0.002	0.001	0.027	0.022	0.205
	AVERAGE	1.115	1.252	4.467	0.121	0.116	0.171	0.144	0.880
	HIGH	4.268	4.013	16.537	0.631	0.551	0.349	0.280	1.747
Palm Beach	LOW	0.884	0.812	3.199	0.029	0.021	0.122	0.100	0.563

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	4.846	3.875	9.827	0.637	0.618	0.719	0.637	3.748
	HIGH	12.347	11.708	24.077	3.634	3.230	2.549	2.281	9.322
Pasco	LOW	0.179	0.168	0.539	0.002	0.002	0.023	0.017	0.166
	AVERAGE	0.970	1.060	2.493	0.120	0.108	0.142	0.128	0.972
	HIGH	2.373	1.933	8.574	0.266	0.227	0.231	0.200	1.589
Pinellas	LOW	0.206	0.195	0.633	0.003	0.002	0.028	0.023	0.102
	AVERAGE	1.635	1.471	2.937	0.176	0.158	0.202	0.184	1.245
	HIGH	3.423	3.211	8.423	0.549	0.477	0.480	0.418	2.724
Polk	LOW	0.223	0.189	0.746	0.002	0.002	0.031	0.029	0.210
	AVERAGE	1.532	1.377	4.353	0.172	0.146	0.163	0.173	1.183
	HIGH	4.490	4.203	15.346	0.638	0.557	0.540	0.477	2.670
Putnam	LOW	0.112	0.102	0.345	0.002	0.002	0.040	0.057	0.667
	AVERAGE	0.950	0.908	1.832	0.116	0.090	0.128	0.100	0.837
	HIGH	1.427	1.304	6.092	0.174	0.138	0.151	0.122	1.013

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
St. Johns	LOW	0.118	0.109	0.398	0.001	0.001	0.014	0.009	0.106
	AVERAGE	0.564	0.714	1.435	0.065	0.064	0.120	0.116	0.728
	HIGH	1.601	1.467	5.777	0.214	0.173	0.182	0.155	1.280
St. Lucie	LOW	0.751	0.669	2.611	0.025	0.016	0.163	0.087	0.610
	AVERAGE	3.973	2.425	8.743	0.499	0.372	0.633	0.626	3.361
	HIGH	9.182	8.657	19.087	2.301	2.044	1.704	1.532	6.941
Santa Rosa	LOW	0.674	0.625	2.431	0.027	0.027	0.171	0.194	1.062
	AVERAGE	3.168	3.410	6.809	0.653	0.637	1.256	1.099	4.185
	HIGH	9.677	9.176	20.929	3.007	2.700	2.113	1.877	7.256
Sarasota	LOW	0.379	0.352	1.273	0.008	0.005	0.052	0.047	0.258
	AVERAGE	2.485	2.003	6.036	0.277	0.224	0.328	0.277	1.895
	HIGH	4.254	3.998	13.754	0.646	0.540	0.542	0.472	3.215
Seminole	LOW	0.194	0.177	0.694	0.003	0.001	0.020	0.019	0.147

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.436	1.376	3.283	0.148	0.115	0.164	0.137	1.002
	HIGH	2.735	2.520	11.035	0.380	0.322	0.255	0.252	1.619
Sumter	LOW	0.145	0.131	0.561	0.002	0.002	0.047	0.035	0.518
	AVERAGE	0.672	0.498	2.790	0.053	0.048	0.137	0.113	0.872
	HIGH	2.389	2.187	9.134	0.265	0.250	0.147	0.178	1.563
Suwannee	LOW	0.132	0.123	0.361	0.001	0.002	0.036	NA	0.766
	AVERAGE	0.839	0.838	1.275	0.083	0.075	0.036	NA	0.766
	HIGH	1.193	1.119	4.925	0.140	0.116	0.036	NA	0.766
Taylor	LOW	0.151	0.162	0.423	0.003	0.045	0.028	0.064	0.563
	AVERAGE	0.985	0.979	1.221	0.107	0.098	0.126	0.089	0.574
	HIGH	1.439	1.335	5.376	0.175	0.123	0.135	0.115	0.594
Union	LOW	0.139	0.123	0.313	0.002	0.000	NA	NA	NA
	AVERAGE	0.704	0.794	1.179	0.089	0.076	NA	NA	NA
	HIGH	1.146	1.036	4.418	0.119	0.091	NA	NA	NA

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
Volusia	LOW	0.157	0.137	0.535	0.001	0.001	0.027	0.015	0.163
	AVERAGE	1.382	1.082	2.417	0.127	0.123	0.206	0.206	1.173
	HIGH	3.115	2.874	8.227	0.508	0.435	0.417	0.365	2.394
Wakulla	LOW	0.162	0.155	0.591	0.003	0.004	0.035	0.117	0.705
	AVERAGE	0.889	1.071	1.896	0.109	0.122	0.136	0.216	0.871
	HIGH	2.352	2.226	7.688	0.368	0.304	0.297	0.252	1.552
Walton	LOW	0.327	0.304	1.268	0.012	0.027	0.132	0.106	0.614
	AVERAGE	1.986	1.880	3.901	0.413	0.252	0.532	0.495	2.968
	HIGH	4.779	4.454	15.300	1.193	1.039	0.837	0.739	3.639
Washington	LOW	0.314	0.282	1.428	0.021	0.131	NA	NA	1.505
	AVERAGE	1.606	1.736	2.943	0.307	0.288	NA	NA	1.505
	HIGH	2.880	2.762	10.290	0.615	0.535	NA	NA	1.505
Statewide	LOW	0.092	0.083	0.246	0.001	0.000	0.010	0.008	0.087

County	Hurricane Loss Costs	Frame Owners	Masonry Owners	Manufactured Homes	Frame Renters	Masonry Renters	Frame Condo Unit	Masonry Condo Unit	Commercial Residential
	AVERAGE	1.715	2.272	4.002	0.247	0.306	0.293	0.450	2.628
	HIGH	19.508	18.496	42.523	5.188	5.112	3.622	4.620	13.428

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.***

An automated script is used to generate and arrange the data in Form A-5.

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 all tables and maps in Form A-5 in a submission appendix.***

This form is provided under the name IF2023FormA5.xlsx and is also provided in submission appendix.

C. ***Provide summaries of the percentage change in average hurricane loss cost output range data compiled in Form A-4, Part A, relative to the equivalent data compiled from the current accepted hurricane model, in the format shown below and in the file named "2023FormA5.xlsx."***

For the percentage change in hurricane output range, provide the summary:

- ***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.***

Table 41: Percentage Change in Hurricane loss costs per $1,000 of exposure for 0% deductibles

Percentage Change in $0 Deductible Hurricane Output Ranges (2017 FHCF Exposure Data)								
Region	**Frame Owners**	**Masonry Owners**	**Manufactured Homes**	**Frame Renters**	**Masonry Renters**	**Frame Condo Unit**	**Masonry Condo Unit**	**Commercial Residential**
Coastal	11.1%	24.7%	-8.5%	-40.2%	-40.5%	-0.1%	9.1%	17.4%
Inland	9.6%	24.3%	-14.2%	-43.6%	-42.5%	10.0%	19.1%	3.1%
North	13.3%	19.2%	-7.0%	-33.3%	-32.2%	5.4%	20.1%	4.9%
Central	11.0%	27.2%	-13.4%	-41.4%	-39.7%	8.9%	18.6%	14.2%
South	6.0%	23.5%	-6.8%	-45.7%	-41.4%	-7.4%	7.3%	17.7%
Statewide	10.8%	24.6%	-10.6%	-41.0%	-40.7%	1.3%	9.3%	16.8%

Table 42: Percentage Change in Hurricane loss costs per $1,000 of exposure for specified deductibles

Percentage Change in Specified Deductible Hurricane Output Ranges (2017 FHCF Exposure Data)								
Region	**Frame Owners**	**Masonry Owners**	**Manufactured Homes**	**Frame Renters**	**Masonry Renters**	**Frame Condo Unit**	**Masonry Condo Unit**	**Commercial Residential**
Coastal	21.6%	36.2%	-3.1%	-39.4%	-42.1%	31.6%	39.1%	34.0%
Inland	23.1%	40.8%	-7.7%	-43.0%	-43.5%	98.6%	114.9%	22.2%
North	25.5%	36.0%	0.3%	-28.9%	-28.3%	37.0%	51.7%	21.9%
Central	24.0%	43.8%	-6.9%	-40.2%	-39.9%	79.4%	83.2%	34.6%
South	12.6%	33.5%	-2.8%	-47.3%	-43.5%	13.7%	33.9%	33.6%
Statewide	21.9%	36.8%	-4.8%	-40.2%	-42.2%	38.3%	40.3%	33.6%

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 current 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 grey. The larger the percentage change in the county, the more intense the color-shade.

The maps are provided in Figure 82 through Figure 89.

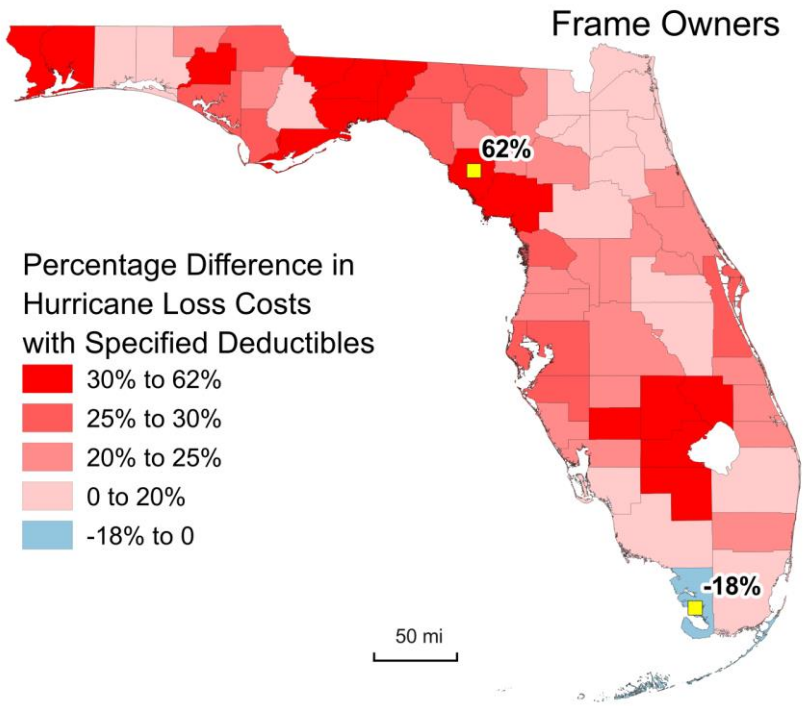


Figure 82: Frame Owners Percentage Change With Specified Deductibles

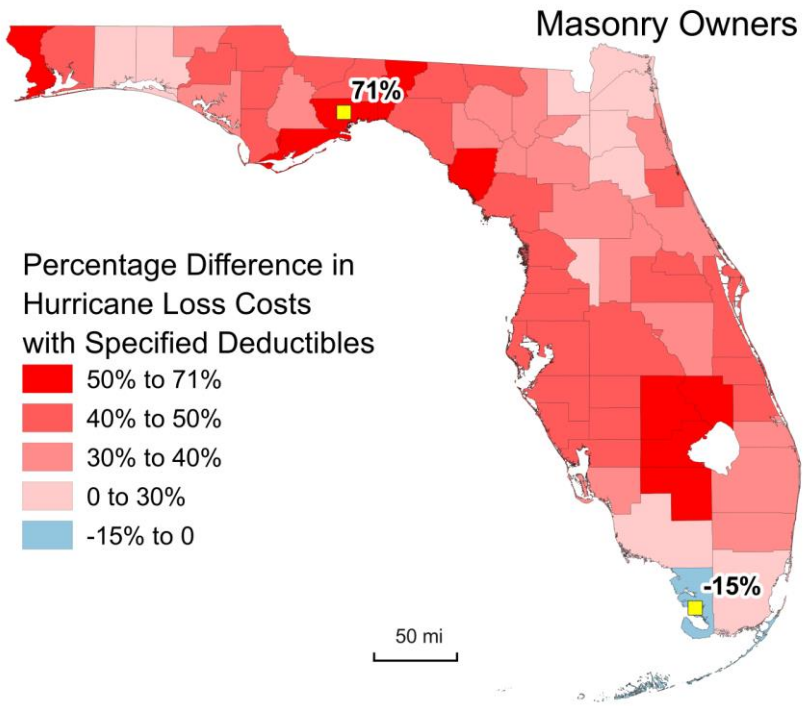


Figure 83: Masonry Owners Percentage Change With Specified Deductibles

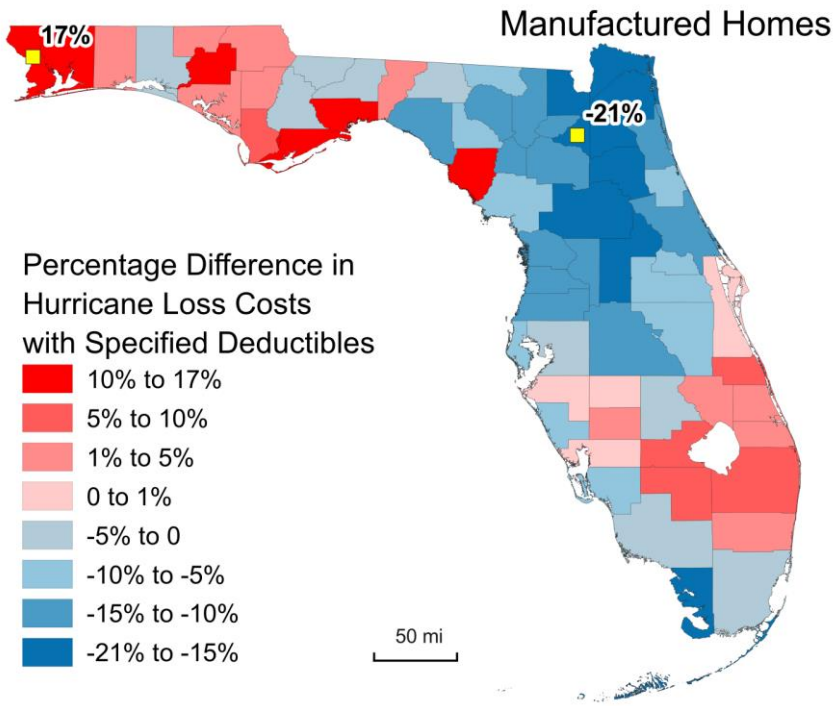


Figure 84: Manufactured Homes Percentage Change With Specified Deductibles

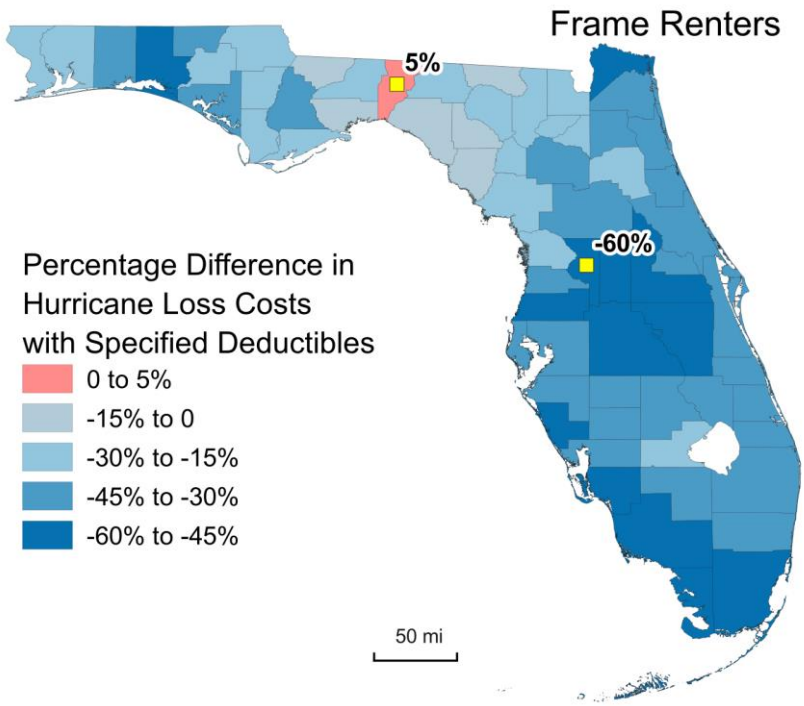


Figure 85: Frame Renters Percentage Change With Specified Deductibles

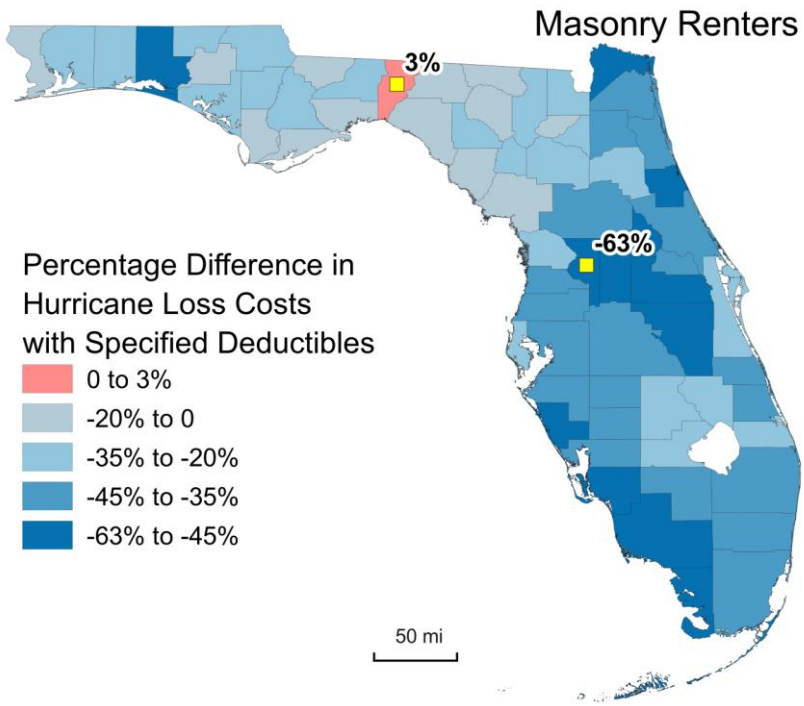


Figure 86: Masonry Renters Percentage Change With Specified Deductibles

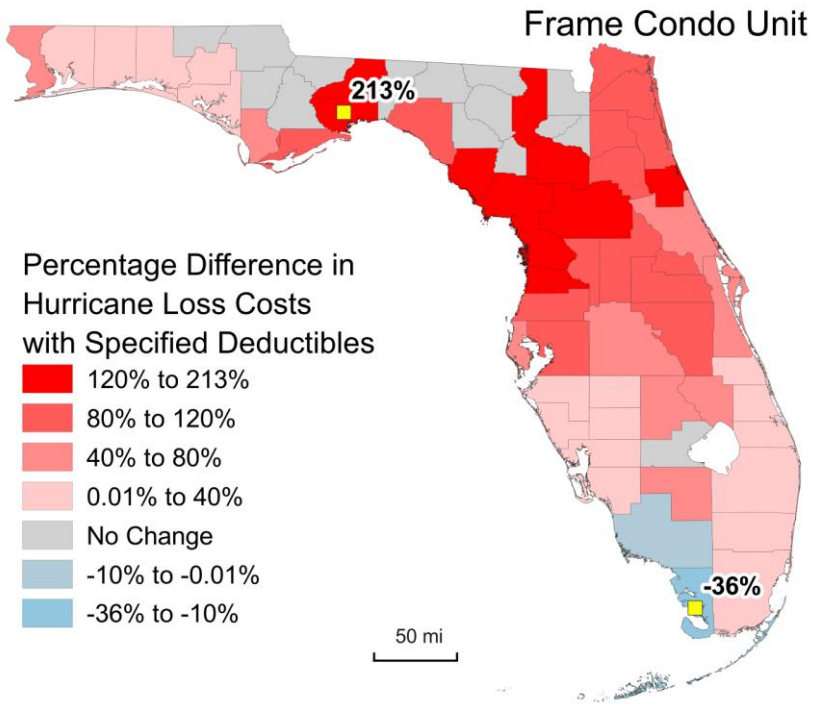


Figure 87: Frame Condo Unit Percentage Change With Specified Deductibles

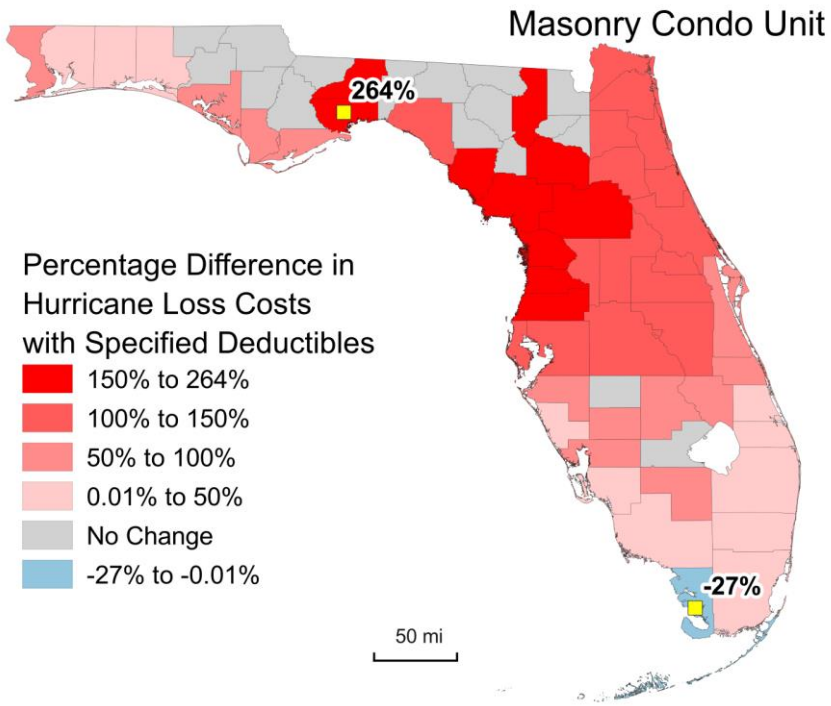


Figure 88: Masonry Condo Unit Percentage Change With Specified Deductibles

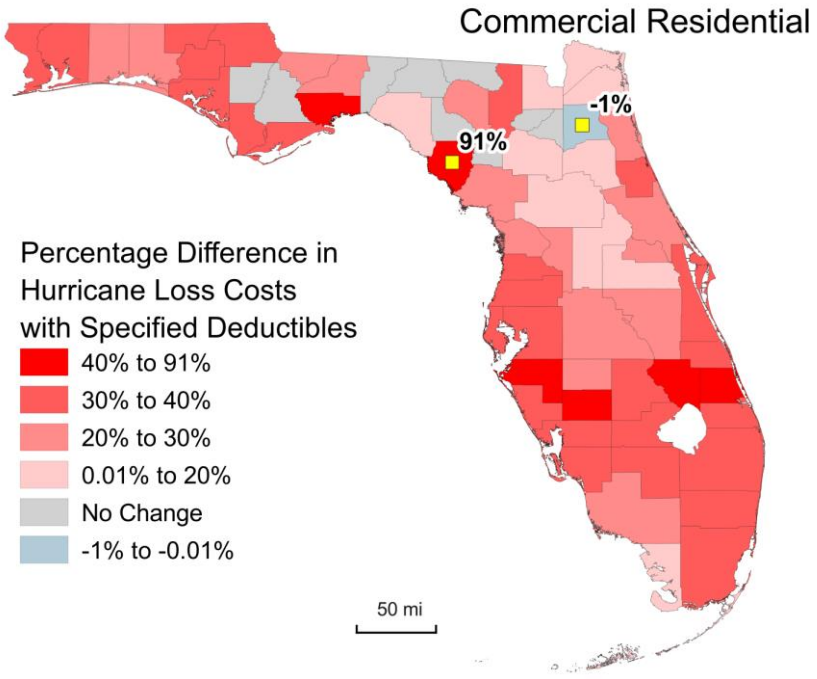


Figure 89: Commercial Residential Percentage Change With Specified Deductibles

Figure 14 **State of Florida by North/Central/South Regions**

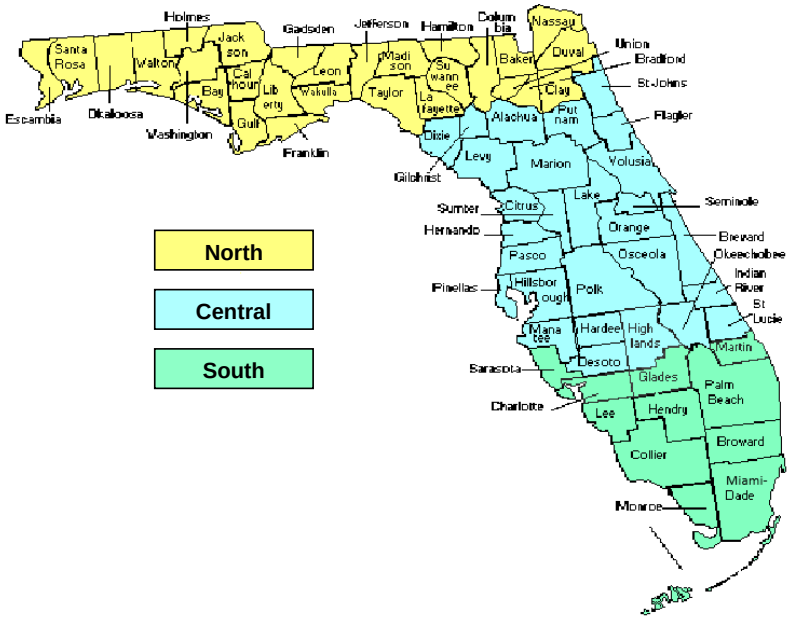
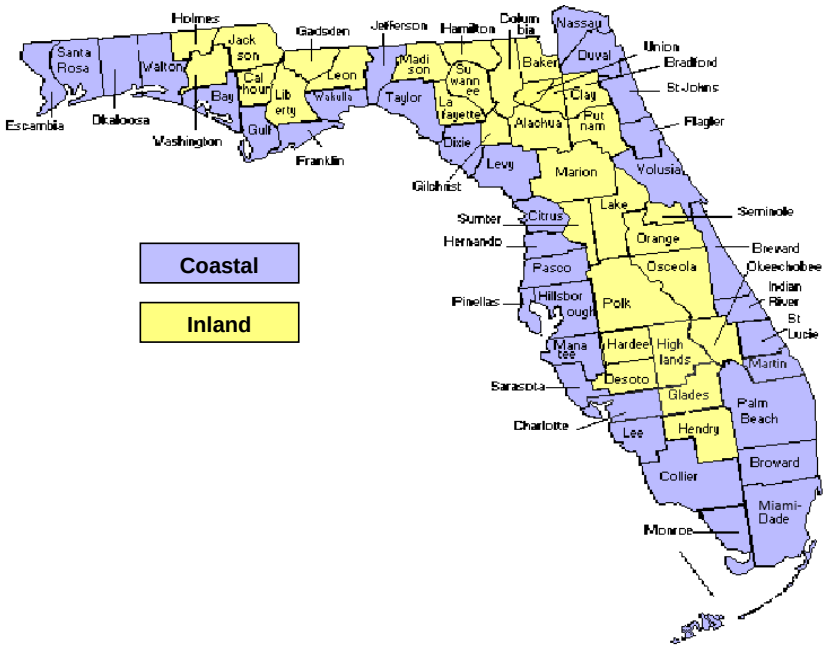


Figure 15 **State of Florida by Coastal/Inland Counties**



Form A-6: Logical Relationships to Hurricane Risk (Trade Secret Item)

Form A-6 is considered to be a trade secret item and will be provided to the Professional Team during the on-site review and the closed portion of the Commission meeting.

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.

An automated script is used to generate and arrange the data in Form A-8.

B. Provide a detailed explanation of how the Expected Annual Hurricane Losses and Return Periods are calculated.

Expected Annual Hurricane Loss calculation is performed on loss table produced by the model under review which lists event losses with assigned stochastic years as explained in Standard A-4.1. Each event having a loss within the given range is multiplied by its annual rate of occurrence. The products are summed across the range and the result is the Expected Annual Hurricane Loss for the range. The Return Period for each range is calculated as the return period of the event loss (reciprocal of the probability of a hurricane loss equaling or exceeding this loss) which is closest to the Average Hurricane Loss for the range. Return Periods are rounded to the nearest whole integer year. Initially, the events within given interval are identified, then summed up and divided by 300,000 years. The Return Period for each range is calculated as the return period of the event annual maximum loss (reciprocal of the probability of a hurricane annual maximum loss equaling or exceeding this loss) which is closest to the Average Hurricane Loss for the range. Return Periods are rounded to the nearest whole integer year. In Return Period assignment we assume it is more meaningful to use return periods for Probable Maximum Loss (return periods of annual maxima) since we are comparing it to annual hurricane loss within certain range which is event averaged loss and not annual loss.

C. Complete Part A using the 2017 FHCF exposure data and Part B using the 2023 FHCF exposure data.

Part A and Part B have been completed in Table 43 to Table 48

D. For the Expected Annual Hurricane Losses column in Part A.1 and Part B.1, provide personal and commercial residential, zero deductible statewide hurricane loss costs.

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 shall 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 shall 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 shall 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 shall be lower than the return period for an average hurricane loss of $5,455 million associated with the $5,001-$6,000 million range.

Part A.1 is provided in Table 43 and Part B.1 in Table 44

E. ***Provide a graphical comparison of the hurricane model under review Residential Return Periods hurricane loss curve to the current 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 hurricane model under review and a dotted line representing the current accepted hurricane model.

A graphical comparison of the current hurricane model Residential Return Periods hurricane loss curve to the currently accepted hurricane model Residential Return Periods hurricane loss curve can be seen in Figure 90.

F. Provide the expected hurricane loss and 10% (lower bound) and 90% (upper bound) hurricane loss levels for each of the Personal and Commercial Residential Return Periods given in Part A.2 and Part B.2, Annual Aggregate, and Part A.3 and Part B.3, Annual Occurrence. Describe how the uncertainty in hurricane vulnerability functions has been propagated to the uncertainty in portfolio loss and how it relates to the 10% and 90% hurricane loss levels.

Lower and upper bounds of hurricane loss and annual aggregate loss are provided in Table 44 and Table 45 for Parts A.2 and A.3 and in Table 47 and Table 48 for Parts B.2 and B.3.

The uncertainty intervals for annual occurrence PML represent the 10th and 90th percentiles of the simulated losses at each return period. To generate Form A-8, 100 seed samples were used and each event was simulated 100 times. The uncertainty interval measures either the variations of maximum event loss per year due to sampling in case of Part A.3 and B.3, or the variations in annual loss due to sampling in case of Part A.2 and B.2 at each return period. The Return period loss and uncertainty interval in Part B A.2, A.3. B.2 and B.3 were calculated by linear interpolation and weighted average of the closest events annual aggregated loss above and below each PML return period into prescribed.

G. List assumptions necessary to complete Form A-8. Provide the rationale for assumptions and a detailed description of how the assumptions are implemented.

No additional assumptions were made for this form. The analysis of the model under review was performed using 100 samples instead of standard 5 samples to be able to obtain reliable estimates of 10% and 90% required event loss estimates.

H. 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 in a submission appendix.

Form A-8 is provided in Excel format in the file "IF2023FormA8.xlsx" at the link provided to the FCHLPM and appears below.

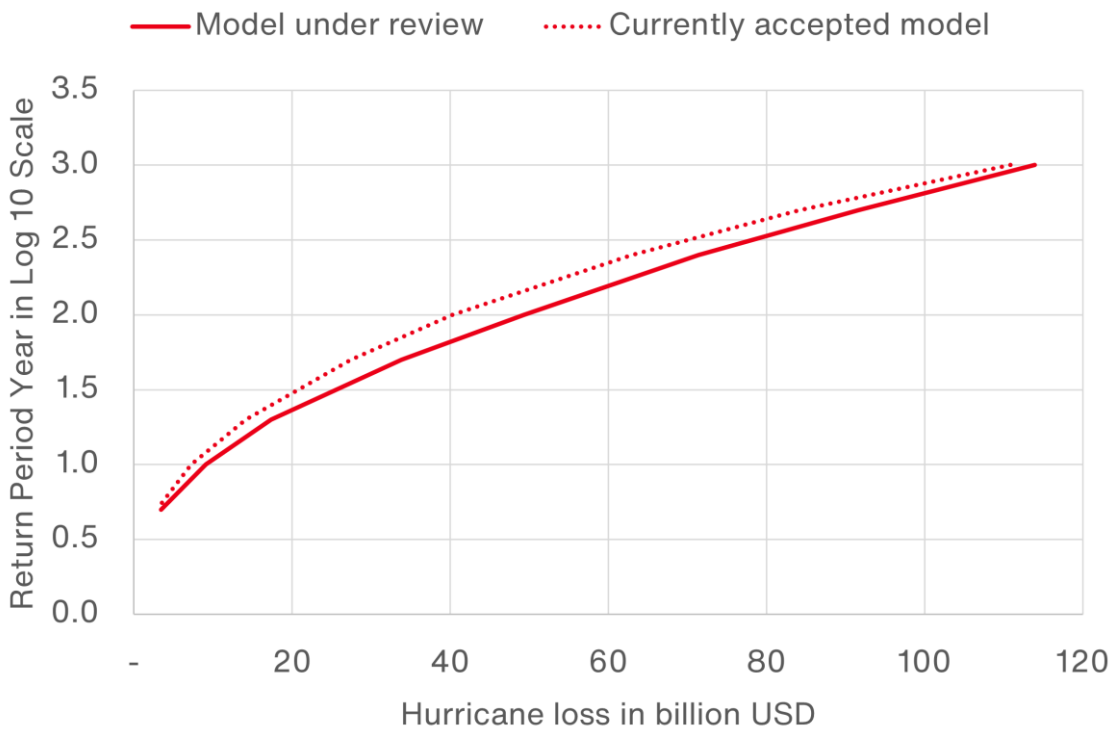


Figure 90: Graphical Comparison of Residential Return Periods hurricane loss curves for the current hurricane model and the currently accepted hurricane model.

Table 43: Part A.1: Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida (2017 FHCF Exposure Data)

HURRICANE LOSS RANGE (MILLIONS)			TOTAL HURRICANE LOSS	AVERAGE HURRICANE LOSS (MILLIONS)	NUMBER OF HURRICANES	EXPECTED ANNUAL HURRICANE LOSSES	RETURN PERIOD (YEARS)
$ -	to	$500	15,882,023	107	148,871	53	2
$501	to	$1,000	23,144,945	725	31,938	77	3
$1,001	to	$1,500	23,570,649	1,229	19,186	79	3
$1,501	to	$2,000	22,222,652	1,746	12,731	74	4
$2,001	to	$2,500	20,623,955	2,238	9,214	69	4
$2,501	to	$3,000	20,530,232	2,749	7,468	68	5
$3,001	to	$3,500	18,422,795	3,247	5,674	61	5
$3,501	to	$4,000	20,241,812	3,739	5,413	67	5
$4,001	to	$4,500	20,120,355	4,265	4,718	67	6
$4,501	to	$5,000	22,668,004	4,747	4,775	76	6
$5,001	to	$6,000	36,751,844	5,494	6,689	123	7
$6,001	to	$7,000	36,184,184	6,503	5,564	121	8
$7,001	to	$8,000	32,090,996	7,472	4,295	107	8
$8,001	to	$9,000	32,505,064	8,527	3,812	108	9
$9,001	to	$10,000	28,458,178	9,480	3,002	95	10
$10,001	to	$11,000	30,915,256	10,462	2,955	103	11

HURRICANE LOSS RANGE (MILLIONS)			TOTAL HURRICANE LOSS	AVERAGE HURRICANE LOSS (MILLIONS)	NUMBER OF HURRICANES	EXPECTED ANNUAL HURRICANE LOSSES	RETURN PERIOD (YEARS)
$11,001	to	$12,000	26,423,807	11,509	2,296	88	13
$12,001	to	$13,000	24,428,079	12,579	1,942	81	14
$13,001	to	$14,000	27,463,890	13,483	2,037	92	15
$14,001	to	$15,000	20,860,826	14,507	1,438	70	16
$15,001	to	$16,000	21,650,877	15,454	1,401	72	18
$16,001	to	$17,000	17,593,598	16,443	1,070	59	19
$17,001	to	$18,000	18,378,349	17,453	1,053	61	20
$18,001	to	$19,000	15,503,375	18,523	837	52	21
$19,001	to	$20,000	20,064,265	19,499	1,029	67	23
$20,001	to	$21,000	17,281,984	20,428	846	58	24
$21,001	to	$22,000	12,908,373	21,478	601	43	26
$22,001	to	$23,000	14,049,462	22,479	625	47	27
$23,001	to	$24,000	15,217,643	23,484	648	51	29
$24,001	to	$25,000	14,037,057	24,497	573	47	30
$25,001	to	$26,000	12,155,910	25,538	476	41	32
$26,001	to	$27,000	12,645,634	26,511	477	42	34
$27,001	to	$28,000	12,395,250	27,545	450	41	35
$28,001	to	$29,000	12,179,967	28,458	428	41	38

HURRICANE LOSS RANGE (MILLIONS)			TOTAL HURRICANE LOSS	AVERAGE HURRICANE LOSS (MILLIONS)	NUMBER OF HURRICANES	EXPECTED ANNUAL HURRICANE LOSSES	RETURN PERIOD (YEARS)
$29,001	to	$30,000	10,147,037	29,497	344	34	39
$30,001	to	$35,000	56,731,414	32,307	1,756	189	45
$35,001	to	$40,000	47,132,767	37,318	1,263	157	59
$40,001	to	$45,000	41,624,101	42,648	976	139	74
$45,001	to	$50,000	31,256,382	47,574	657	104	93
$50,001	to	$55,000	28,636,550	52,352	547	95	115
$55,001	to	$60,000	25,762,045	57,122	451	86	142
$60,001	to	$65,000	21,030,898	62,406	337	70	172
$65,001	to	$70,000	18,908,600	67,290	281	63	212
$70,001	to	$75,000	16,184,977	72,254	224	54	256
$75,001	to	$80,000	11,932,377	77,483	154	40	303
$80,001	to	$90,000	21,746,011	84,287	258	72	389
$90,001	to	$100,000	18,645,398	94,169	198	62	550
$100,001	to	$Maximum	60,852,029	133,155	457	203	1734
Total			1,130,161,874	3,737	302,435	3,767	

Table 44: Part A.2: Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida – Annual Aggregate (2017 FHCF Exposure Data)

Return Period (Years)	Expected Hurricane Loss Level	10% Loss Level	90% Loss Level
Top Event	284,733,465,003	277,836,997,630	291,114,105,873
1,000	120,437,076,161	116,354,573,124	124,910,164,802
500	97,531,830,735	92,952,252,396	101,945,503,289
250	76,929,547,462	73,294,066,970	80,813,270,454
100	53,180,920,395	50,070,559,560	56,500,190,511
50	37,426,337,268	34,814,449,254	40,239,692,594
20	19,561,563,236	17,613,731,454	21,611,567,250
10	10,273,591,393	8,835,565,161	11,834,513,336
5	3,872,756,423	3,002,879,427	4,843,934,167

Table 45: Part A.3: Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida – Annual Occurrence (2017 FHCF Exposure Data)

Return Period (Years)	Expected Hurricane Loss Level	10% Loss Level	90% Loss Level
Top Event	284,733,465,003	277,836,997,630	291,114,105,873
1,000	113,883,049,609	109,967,629,267	117,755,910,813
500	91,587,808,637	88,607,335,698	94,962,090,730
250	71,409,014,236	68,409,079,229	74,603,502,061
100	49,315,001,702	46,631,877,648	51,921,142,141
50	33,823,275,207	31,734,311,778	36,003,909,717
20	17,339,015,161	15,768,225,344	18,984,634,851
10	9,091,949,845	7,944,216,378	10,319,795,164
5	3,441,786,195	2,713,261,841	4,229,970,865

Table 46: Part B.1: Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida (2023 FHCF Exposure Data)

HURRICANE LOSS RANGE (MILLIONS)			TOTAL HURRICANE LOSS	AVERAGE HURRICANE LOSS (MILLIONS)	NUMBER OF HURRICANES	EXPECTED ANNUAL HURRICANE LOSSES	RETURN PERIOD (YEARS)
$ -	to	$500	ff	108	136,527	49	2
$501	to	$1,000	20,713,705	733	28,253	69	3
$1,001	to	$1,500	24,562,301	1,225	20,046	82	3
$1,501	to	$2,000	23,645,748	1,728	13,682	79	3
$2,001	to	$2,500	22,799,153	2,254	10,113	76	4
$2,501	to	$3,000	22,067,429	2,743	8,044	74	4
$3,001	to	$3,500	20,660,289	3,245	6,366	69	4
$3,501	to	$4,000	19,904,419	3,747	5,312	66	4
$4,001	to	$4,500	19,441,356	4,246	4,579	65	5
$4,501	to	$5,000	20,199,560	4,764	4,240	67	5
$5,001	to	$6,000	38,850,281	5,495	7,070	130	5
$6,001	to	$7,000	44,102,703	6,455	6,832	147	6
$7,001	to	$8,000	36,362,669	7,502	4,847	121	7
$8,001	to	$9,000	36,183,098	8,476	4,269	121	7
$9,001	to	$10,000	38,064,793	9,492	4,010	127	8
$10,001	to	$11,000	28,650,878	10,506	2,727	96	9

HURRICANE LOSS RANGE (MILLIONS)			TOTAL HURRICANE LOSS	AVERAGE HURRICANE LOSS (MILLIONS)	NUMBER OF HURRICANES	EXPECTED ANNUAL HURRICANE LOSSES	RETURN PERIOD (YEARS)
$11,001	to	$12,000	32,323,701	11,487	2,814	108	9
$12,001	to	$13,000	33,143,882	12,465	2,659	110	10
$13,001	to	$14,000	29,283,385	13,482	2,172	98	11
$14,001	to	$15,000	29,633,779	14,505	2,043	99	12
$15,001	to	$16,000	24,496,119	15,494	1,581	82	12
$16,001	to	$17,000	26,026,788	16,525	1,575	87	13
$17,001	to	$18,000	26,460,564	17,500	1,512	88	14
$18,001	to	$19,000	27,091,954	18,468	1,467	90	15
$19,001	to	$20,000	22,432,576	19,422	1,155	75	16
$20,001	to	$21,000	18,118,696	20,543	882	60	17
$21,001	to	$22,000	24,848,850	21,477	1,157	83	18
$22,001	to	$23,000	16,610,743	22,508	738	55	19
$23,001	to	$24,000	18,149,645	23,540	771	60	20
$24,001	to	$25,000	16,418,437	24,432	672	55	21
$25,001	to	$26,000	20,476,659	25,468	804	68	22
$26,001	to	$27,000	16,989,229	26,504	641	57	23
$27,001	to	$28,000	18,430,950	27,386	673	61	24
$28,001	to	$29,000	13,667,038	28,414	481	46	25

HURRICANE LOSS RANGE (MILLIONS)			TOTAL HURRICANE LOSS	AVERAGE HURRICANE LOSS (MILLIONS)	NUMBER OF HURRICANES	EXPECTED ANNUAL HURRICANE LOSSES	RETURN PERIOD (YEARS)
$29,001	to	$30,000	12,241,040	29,496	415	41	26
$30,001	to	$35,000	70,413,991	32,270	2,182	235	29
$35,001	to	$40,000	60,791,881	37,341	1,628	203	36
$40,001	to	$45,000	63,598,968	42,484	1,497	212	43
$45,001	to	$50,000	49,672,644	47,488	1,046	166	53
$50,001	to	$55,000	42,050,200	52,301	804	140	63
$55,001	to	$60,000	40,376,444	57,516	702	135	73
$60,001	to	$65,000	34,125,524	62,159	549	114	87
$65,001	to	$70,000	33,878,614	67,353	503	113	103
$70,001	to	$75,000	27,286,258	72,377	377	91	120
$75,001	to	$80,000	27,490,294	77,437	355	92	140
$80,001	to	$90,000	41,267,612	84,913	486	138	174
$90,001	to	$100,000	36,273,358	94,462	384	121	236
$100,001	to	$Maximum	157,694,957	142,068	1,110	526	730
Total			1,542,783,585	5,096	302,752	5,143	

Table 47: Part B.2: Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida – Annual Aggregate (2023 FHCF Exposure Data)

Return Period (Years)	Expected Hurricane Loss Level	10% Loss Level	90% Loss Level
Top Event	377,225,243,042	368,740,799,295	385,116,849,899
1,000	162,749,646,267	156,744,649,970	169,194,994,358
500	132,688,835,157	126,956,480,234	139,145,595,287
250	104,294,749,747	98,901,445,162	109,758,061,916
100	71,989,152,207	67,676,339,690	76,550,383,401
50	50,853,828,093	47,166,940,446	54,739,640,161
20	26,673,711,381	23,936,673,028	29,551,849,615
10	14,078,149,767	12,108,556,176	16,173,552,707
5	5,332,538,046	4,155,886,641	6,664,878,755

Table 48: Part B.3: Personal and Commercial Residential Hurricane Probable Maximum Loss for Florida – Annual Occurrence (2023 FHCF Exposure Data)

Return Period (Years)	Expected Hurricane Loss Level	10% Loss Level	90% Loss Level
Top Event	377,225,243,042	368,740,799,295	385,116,849,899
1,000	153,232,148,462	148,125,440,511	158,436,897,833
500	123,779,754,318	119,034,566,854	128,390,117,878
250	96,840,118,484	92,588,256,287	100,908,997,382
100	66,620,551,707	63,000,418,219	70,060,847,458
50	46,355,436,295	43,361,652,966	49,249,299,821
20	23,736,045,393	21,616,897,623	25,994,012,197
10	12,364,661,365	10,863,451,741	13,990,796,805
5	4,747,255,265	3,772,671,366	5,813,467,250

Appendix B: Individuals Involved in the Impact Forecasting Florida Hurricane (FCHLPM) Model Acceptability Process

Ted Amdur, Ph.D., Earth and Planetary Sciences, Harvard University

Ted Amdur is a Senior Scientist for Impact Forecasting, working within the US Hurricane Model development team. He focuses upon researching and implementing improvements to the modeling of hurricane climatology and wind fields, as well as development of statistical models for wind hazard and wind vulnerability modules. Prior to joining Impact Forecasting, Dr. Amdur completed a Ph.D. in Earth and Planetary Sciences at Harvard University, publishing original research in paleoclimatology focusing upon the development of novel statistical tests and Bayesian hierarchical models for improved climate reconstruction.

Dr. Amdur's contributions to the Impact Forecasting Florida Hurricane Model include the development, production, and review of changes to the wind model that affect general, statistical, and vulnerability standards.

Sushma Bhat, B.S., Computer Technology, University of Mumbai, India

Ms. Bhat is a Director and a solution architect for Impact Forecasting's software development team. Her experience includes involvement at all stages of software development life cycle for catastrophe modeling, customer deployments and operations. She has hands-on experience with C#, MS SQL Server, and user interface design.

Ms. Bhat's contribution to Impact Forecasting's Florida Hurricane Model includes deployment of ELEMENTS and conforming to application standards and procedures, coding guidelines, and software documentation, as well as acting as the Computer / Information Signatory.

David Colbus, M.A., Climate and Society, Columbia University

David Colbus is an Associate Director for Impact Forecasting, operating within a Program Management team. He operates within the Program Management team, focusing on Impact Forecasting's models related to America's weather and climate, and his responsibilities include achieving strategic initiatives and satisfying regulatory requirements. Prior to joining Impact Forecasting, Mr. Colbus was responsible for client relationships and expert

catastrophe risk analysis as a Catastrophe Risk Consultant at Verisk. Mr. Colbus holds a Master of Arts in Climate and Society from Columbia University.

Mr. Colbus' contributions to the Impact Forecasting Florida Hurricane Model include project management, production, and review of the submission document as the editorial signatory, and review and generation of general standards as the general signatory.

William Dong, Ph.D., Civil Engineering, University of Nebraska - Lincoln

Dr. Dong is Associate Director and Tech Lead within Impact Forecasting's software development team. Since joining Impact Forecasting in 2017, Dr. Dong has led development of ELEMENTS, Impact Forecasting's catastrophe loss modeling platform, as well as overseen development of IF's Automated Event Response service for North Atlantic hurricane. Dr. Dong has a Ph.D. in Civil Engineering from the University of Nebraska and prior to joining Impact Forecasting was involved in software development for multiple government grant projects from Illinois Transportation Department and Environmental Protection Agency.

Dr. Dong's contribution to Impact Forecasting's Florida Hurricane Model includes implementing the annual deductible feature and zip code mapping into ELEMENTS, deployment of ELEMENTS and conforming to application standards and procedures, coding guidelines, and software documentation.

Radovan Drinka, M.S., Physics, Comenius University in Bratislava, Slovakia

Radovan Drinka is a Director – Analytics and Impact Forecasting's Global Head of Tropical Cyclone Model Development. He leads development for Impact Forecasting's tropical cyclone models, including the U.S. Hurricane model and Impact Forecasting's Asia and Pacific typhoon models, and has previously worked on model development for European Windstorm, Southwest Pacific Tropical Cyclone, Vietnam Typhoon, Japan Typhoon, and bespoke vulnerability damage functions. Mr. Drinka holds a Master of Science in Physics, focusing on Meteorology and Climatology, from Comenius University in Bratislava, Slovakia

Mr. Drinka has led development of Impact Forecasting's Florida Hurricane Model, contributing widely to the overall model development.

Xian He, Ph.D., Civil Engineering, University of Illinois at Urbana-Champaign

Dr. He, Associate Director, earned a Ph.D. in Civil Engineering with additional coursework in Mathematics and Statistics. Dr. He has published several research papers on hazard mitigation planning for interdependent infrastructure systems with a focus on hurricane hazards. Dr. He's Ph.D. research is related to developing a mathematical model that simulates the damage and recovery of interdependent infrastructure systems under hazard events and proposing risk-informed decision frameworks to support strategic pre-disaster risk mitigation and post-disaster recovery planning. She has completed extensive coursework in mathematics, probability and statistics, and risk analysis.

Dr. He's contributions to the Impact Forecasting Florida Hurricane Model include validating the vulnerability model, performing statistical analysis, developing demand surge function and peer review of the financial model.

Yujin Liang, Ph.D., P.E., Structural Engineering, University of Illinois at Chicago

Dr. Liang is a Director at Impact Forecasting and holds a Ph.D. in structural engineering from the University of Illinois at Chicago. He is a licensed Professional Engineer (Minnesota). Dr. Liang's research contributions within Impact Forecasting include developing advanced models to improve vulnerability and hazard assessments of insurance interests for various natural perils. He is experienced in the design and construction of hydroelectric dams and power plants and has published multiple research articles on the evaluation of structural damage. His work has achieved an ASCE Best Paper Award.

Dr. Liang contributes to the development of the Impact Forecasting Florida Hurricane Model's wind vulnerability functions and assists with reviews of the meteorological component of the model.

Minchong Mao, M.S., FCAS, MAAA, CCRMP, Computer Science, University of Missouri

Minchong Mao is a Senior Managing Director at Aon Reinsurance Solutions. She is a Fellow of the Casualty Actuarial Society (FCAS, 2007) and a member of American Academy of Actuaries (MAAA, 2005). At Aon, Ms. Mao advises clients in catastrophe actuarial services, such as rate making and rate filing strategy, ASOP 38 compliance, reinsurance cost allocation and profitability. Ms. Mao is responsible for Aon's homeowner ROE study and residual market study. Ms. Mao is a consulting actuary for the Impact Forecasting Florida

Hurricane Model. Before joining Aon in 2018, Ms. Mao worked at State Farm Insurance Company for 18 years where she was responsible for the use of catastrophe models in pricing, underwriting, claims, enterprise risk managements, and rating agency reporting. Ms. Mao has a wealth of experience in the securitization of insurance risk and the use of catastrophe model outputs for pricing, risk selection and capital modeling.

In January 2015, Ms. Mao was appointed by Florida CFO Jeff Atwater to serve on the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) as the industry actuary. For over three years Ms. Mao represented the property insurance industry on the FCHLPM to review and accept hurricane models for use in ratemaking in the State of Florida. From 2010 to 2013, Ms. Mao was a member of an advisory group to the Insurance Bureau of Canada (IBC) and Office of the Superintendent of Financial Institutions (OSFI) to provide expert opinions on insurance and economic impact of major earthquakes in Canada. From 2011 to 2013, Ms. Mao was a member of an advisory group for IBC and OSFI to revise OSFI Guideline B-9 (Earthquake Exposure Management Sound Practice Guideline for insurance companies). Ms. Mao is a member of the CAS Climate Change Committee and member of AAA Extreme Event Risk Committee. In 2017, Ms. Mao contributed to AAA's Flood Monograph. In 2018, she was one of the main authors for AAA's catastrophe modeling monograph. Ms. Mao was one of the recipients of Casualty Actuarial Society's Above and Beyond Achievement Award in 2019 to recognize her leadership and contributions to establish the Certified Catastrophe Risk Management Professional (CCRMP) designation for CAS Institute. Ms. Mao has a bachelor's degree in Biochemical Engineering from Beijing University of Chemical Technology, a master's degree in Chemistry from Eastern Illinois University and a master's degree in Computer Science from University of Missouri - Columbia.

Ms. Mao's actuarial contributions to Impact Forecasting Florida Hurricane Model include advising and reviewing how insurance terms are applied in the financial model, reviewing actuarial forms to ensure results are reasonable and consistent, developing contents for the actuarial standards of the submission document and performing ASOP 38 compliance tasks.

Brian Penserini, Ph.D., Earth Science, University of California, Santa Barbara

Dr. Penserini is a Senior Scientist at Impact Forecasting. He joined Impact Forecasting in July 2024 and operates within the Research & Development team. Dr. Penserini holds a Ph.D. in Earth Science from the University of California, Santa Barbara, where his research used numerical and statistical modeling methods to simulate and constrain the rates of fluvial erosion in the Himalayas. He has published multiple first-author works in peer-reviewed journals, based on his Master's research at the University of Oregon and Ph.D. research at the University of California, Santa Barbara. Prior to joining Impact Forecasting, Dr. Penserini was also responsible for deliverable preparation on a variety of environmental remediation projects as an environmental consultant.

Dr. Penserini's contributions to the Impact Forecasting Florida Hurricane Model include: developing GIS workflows for creating map figures for general, meteorological, and actuarial disclosures and forms, peer review and editing of the submission, and documenting workflows.

Sri Harshitha Polamuri, Ph.D., Civil Engineering, Clemson University

Dr. Polamuri is a Senior Scientist at Impact Forecasting. She holds a Ph.D in Civil Engineering from Clemson University. Her Ph.D. research focused on stochastic typhoon model development for Western Pacific basin and investigating the impact of climate change on typhoon wind hazard. Dr. Polamuri holds a B.Tech degree in Civil Engineering and M.Tech degree in Structural Engineering from Jawaharlal Nehru Technological University , Hyderabad, India.

Dr. Polamuri contribution to the Impact Forecasting Florida Hurricane Model include stochastic hurricane model development and validation.

Venkatesh Ramaiah, M.S., Computer Science, Birla Institute of Technology and Science, Pilani, India

Mr. Ramaiah has 15 years of software development experience building enterprise applications using Microsoft technologies. He has supported the development of Impact Forecasting's ELEMENTS catastrophe modeling platform since joining Impact Forecasting.

Mr. Ramaiah's contribution to the Impact Forecasting's Florida Hurricane Model involves implementing model components into the ELEMENTS modeling platform.

Shruthi Srikantegowda, Post-Graduate Diploma, Information Technology, Symbiosis University, Pune, India

Ms. Srikantegowda holds the title of Principal Consultant I and leads many quality assurance tasks to ensure appropriate implementation of Impact Forecasting models within the ELEMENTS modeling platform. Ms. Srikantegowda holds a post-graduate diploma in information technology from Symbiosis University, Pune, India, and an engineering degree in electronics and communications from the Visvesvaraya Technical University, Belgaum Karnataka, India.

Ms. Srikantegowda's contributions to the Impact Forecasting Florida Hurricane Model includes testing and validating model data and software functionality using automation scripts, as well as documenting and maintaining traceability matrixes.

Radek Solnicky, M.S., Mathematical Statistics, Charles University, Prague, Czechia

Mr. Solnicky, Senior Scientist, earned a M.S. in Probability, Mathematical Statistics and Econometrics from Charles University. Mr. Solnicky's work within Impact Forecasting includes the development of advanced event set generation methodologies for flood models, spatial and extreme value analyses of hydrological data, and implementation of uncertainty linked to exposure and vulnerability data into the model. He also supervises statistical aspects of catastrophe model testing and implementation into ELEMENTS, the firm's catastrophe modelling software platform.

Mr. Solnicky's contribution to the Impact Forecasting Florida Hurricane Model includes the peer review of key statistical work as well as ensuring compliance with the statistical standards as the statistical signatory.

Corbin Tucker, M.S., Actuarial Science, University of Illinois at Urbana Champaign

Corbin Tucker is a Reinsurance Analytics Senior Analyst for Impact Forecasting. He operates within the Research & Development team by working on the development of IF's catastrophe

models. Mr. Tucker has a M.S. in Actuarial Science from the University of Illinois at Urbana-Champaign.

Mr. Tucker's contribution to the Impact Forecasting Florida Hurricane Model includes analyzing claims data, as well as generation and QA of statistical forms.

Vipin Unnikrishnan, Ph.D., Structural Engineering, Louisiana State University, Baton Rouge

Dr. Unnikrishnan is a Principal Research Consultant at Impact Forecasting. His research and contributions within Impact Forecasting include development of advanced vulnerability models for perils such as wind, flood, and storm surge. Before joining Impact Forecasting, he was working as a post-doctoral fellow at the NIST Center of Excellence for Risk-Based Community Resilience Planning at Colorado State University. Dr. Unnikrishnan completed his doctoral studies in structural engineering at Louisiana State University and has published multiple research articles on the performance-based risk assessment of buildings and critical infrastructure in peer reviewed journals.

Dr. Unnikrishnan's contribution to the Impact Forecasting Florida Hurricane Model includes the development and peer review of key vulnerability components.

Zhuoxuan Wei, Ph.D., Civil Engineering, Florida Institute of Technology

Zhuoxuan works as a vulnerability senior scientist within Impact Forecasting US Hurricane team. His expertise is developing damage functions for hurricane catastrophe model.

Dr. Wei's contributions to the Impact Forecasting Florida Hurricane Model include development and calibration of damage functions, and producing vulnerability standard and forms of submission document.

Chad Xu, M.S., Actuarial Science, Temple University

Mr. Xu is a Catastrophe Actuarial Analyst at Aon Reinsurance Solutions. Mr. Xu joined Aon in June 2021. At Aon, Mr. Xu assists Minchong Mao in catastrophe actuarial client services, Aon's homeowner ROE study, inflation study and residual market study. Mr. Xu has practical experience with multiple programming languages and automated app development. Before joining Aon, Mr. Xu published two research papers on political economic and actuarial

product pricing/hedging topics. Mr. Xu earned a Bachelor of Science degree majoring Applied Mathematics in China, a Master of Science degree majoring Finance from Dayton University and a Master of Science degree majoring Actuarial Science from Temple University.

Mr. Xu's contributions to the Impact Forecasting Florida Hurricane Model include generation and QA of actuarial and statistical forms, as well as assisting Minchong Mao in conducting due diligence on reasonableness and consistency in actuarial results.

Kun Yang, Ph.D. Civil Engineering, University of Delaware

Kun Yang works as an Associated Director at Impact Forecasting. His role is focused on the vulnerability component of the US Hurricane model. His major responsibilities include damage function development and calibration, building code investigation, updates of secondary features, insurance claim analysis, overall model validation, and so on. Before joining Impact Forecasting, he worked as a senior engineer for close to six years at Verisk and focused on the vulnerability development of their atmospheric peril models.

Dr. Yang's contributions to the Impact Forecasting Florida Hurricane Model include the overall model calibration and peer review of vulnerability related documentations.

Karthik Yarasuri, M.S., Department of Civil Engineering, University of Florida

Mr. Yarasuri received a Bachelor of Technology degree in civil engineering from Jawaharlal Nehru Technological University, Hyderabad, India, in 2014. Later in 2014 he joined the doctoral program in civil engineering at the University of Florida under the guidance of Dr. Kurtis R. Gurley. His primary research focused on determining the vulnerability of residential buildings in Florida to hurricane winds. He received a Master of Science degree in civil engineering in 2016 from the University of Florida. Mr. Yarasuri joined the Impact Forecasting team as a senior scientist to develop a U.S. hurricane vulnerability model for the Florida Commission on Loss Projection Methodology.

Mr. Yarasuri's contribution to the Impact Forecasting Florida Hurricane Model includes the development and calibration of vulnerability function.

Appendix C: Hurricane Model Input Form

Location Information

Table 49: Impact Forecasting Florida Hurricane (FCHLPM) Model input fields for location information

Field Name	Description
PropertyID	Identifies a specific site/location and should be unique
BuildingID	Identifies a specific building within a site
BuildingName	This field is for user reference and not used in modeling
BuildingNumber	For U.S. locations, BuildingNumber is prepended to the StreetName when passed to the geocoding engine
StreetName	The street on which the property is located
City	The name of the city (used only for street-level geocoding of U.S. locations)
PostalCode	ZIP Code or postal code of the location
District	The name of the district (not used for U.S. locations)
StateAbbreviation	2-character state abbreviation
State	The name of the U.S. state (used only for street-level geocoding of U.S. locations)
TerritoryCode	The country in which the property is located. Use ISO 2-character country IDs or 3-digit ISO country number
NumOfStories	The number of stories in the building.
YearBuilt	Year of construction

Field Name	Description
OccupiedFloors	Field not currently used
BuildingType	The construction class of the building
OccupancyType	The occupancy class of the building
BuildingScheme	The classification scheme for BuildingType.
OccupancyScheme	The classification scheme for OccupancyType.
PropertyName	The name of the property, for user reference
PropertyNum	The number of the property, for user reference
GarageDoor	Type of garage door
FloorSize	Square footage area of building
RoofCover	Type of roof covering
RoofType	Roof type (geometry)
RoofConnections	Type of roof connection
RoofAge	Age of the roof
WindowProtection	Type of window protection
RoofSheathing	Type of roof sheathing
CoverageType1	Building coverage
CoverageSumInsured1	Replacement value of Building coverage
CoverageLimit1	The limit value assigned to the Building
CoverageDeductible1	The deductible value assigned to the Building

Field Name	Description
CoverageFraction1	This is a fraction that is applied to the Building loss after all insurance terms and before it is aggregated to the account level, currently not used
AggregationKey1	An integer to group similar user-defined coverages together at the Property Coverage level on the Building coverage
CoverageType2	Contents coverage
CoverageSumInsured2	Replacement value of Contents coverage
CoverageLimit2	The limit value assigned to the Contents
CoverageDeductible2	The deductible value assigned to the Contents
CoverageFraction2	This is a fraction that is applied to the Contents loss after all insurance terms and before it is aggregated to the account level, currently not used
AggregationKey2	An integer to group similar user defined coverages together at the Property Coverage level on the Contents coverage
CoverageType3	Time Element coverage
CoverageSumInsured3	The value of Time Element coverage.
CoverageLimit3	The limit for Time Element coverage
CoverageDeductible3	The deductible for Time Element coverage. This can be Additional Living Expenses (Residential) or Business Interruption (Commercial)
CoverageFraction3	This is a fraction that is applied to the Time Element loss after all insurance terms and before it is aggregated to the account level, currently not used

Field Name	Description
AggregationKey3	An integer to group similar user defined coverages together at the Property Coverage level on the Time Element coverage
CoverageType4	User-specified coverage type
CoverageSumInsured4	Replacement value of coverage type selected
CoverageLimit4	The limit value assigned to the coverage type selected
CoverageDeductible4	The deductible value assigned to the coverage type selected
CoverageFraction4	This is a fraction that is applied to the coverage loss after all insurance terms and before it is aggregated to the account level, currently not used
AggregationKey4	An integer to group similar user defined coverages together at the coverage type selected
LocationNum	This field is for user reference
LocationName	This field is for user reference
LocationLimit	This is the limit at the site/location level. Usually expressed as an amount but can also be expressed as a fraction of the underlying TIV
LocationDeductible	This is an all other perils (AOP) (occurrence-based) deductible value at the site/location level. Usually expressed as an amount but can also be expressed as a fraction of the underlying TIV or loss
LocationAnnualDeductible	This is an annual deductible value at the site/location level. Usually expressed as an amount but can also be expressed as a fraction of the underlying TIV or loss
LocationDeductibleFractionBasis	1 – Deductible applies to total underlying value 2 – Deductible applies to structure coverage only

Field Name	Description
LocationDeductibleType	1 – Additional 2 – Net (default chosen by ELEMENTS) 3 – Loss based deductible
CombinedLimit	Combined limit at the site/location level. Applies before other site/location level limits
CombinedDeductible	Combined deductible at the site/location level. Applies before other site/location level deductibles
SiteFraction	Site level loss fraction paid by the insurer
AccountID	Unique identifier for the account
Latitude	The latitude of the location in decimal degrees
Longitude	The longitude of the location in decimal degrees
Matchcode	Indicates what the given latitude/longitude represents (exact coordinates of location, centroid of ZIP Code, etc.)
CrestaZone	Used in some models for geocoding
GridCellID	An internal geocode used for R&D and in a few of the non-U.S. models where geocoding is difficult. It is a geolocation value defined by the hazard modelers
Municipality	Used in some non-U.S. models for Geocoding
County	Used in some non-U.S. models for Geocoding
Group1	User-defined name of group
Group2	User-defined name of group

Field Name	Description
Group3	User-defined name of group
Group4	User-defined name of group
Group5	User-defined name of group
RoofTypeScheme	Field not currently used
FloorArea	This is the floor area used by the parameter adjustment feature
BasementScheme	The classification scheme for basement characteristics
BasementClass	Used with basement scheme to describe the basement characteristics
CustomElevation	User-defined elevation of the location, expressed in feet (not used for modeling, only reporting)
FirstFloorAdjustment	Height of the building above ground specified in meters

Policy Information

Table 50: Impact Forecasting Florida Hurricane (FCHLPM) Model input fields for policy information

Field Name	Description
AccountID	Unique identifier for the account
PolicyID	Unique identification number for the policy
PolicyNum	This field is for user reference
PolicyNote1	This field is for user reference
PolicyNote2	This field is for user reference

Field Name	Description
Attachment	The value of the lower bound of the layer. For step policies, this is the lesser boundary of the step. It is expressed in monetary amounts rather than fractions
Layer	The thickness of the layer. This can be expressed either in monetary amounts or as a fraction of the underlying TIV
Deductible	The deductible for standard policies. If expressed as a fraction, it will be the fraction of the TIV
MinimumDeductible	Minimum deductible amount paid by insured
MaximumDeductible	Maximum deductible amount paid by insured
DeductibleFractionBasis	1 – Deductible applies to total underlying value 2 – Deductible applies to structure coverage only
BlanketLimit	This is the maximum payout on the policy layer. If expressed as a fraction, it will be the fraction of the layer or fraction of the TIV if no layer is defined
DeductibleTypeCode	1 – Additional 2 – Net 11 – Step entered based on B losses 12 – Step entered based on B+C losses 13 – Step entered based on either B or C losses 14 – Step entered based on B and/or C losses (not supported) 15 – Step entered based on C losses

Field Name	Description
LocationDeductibleMax	1 – No 2 – Yes
PolicyType	1 – Standard policy 3 – California Earthquake Authority (CEA) 4 – PDTE (Physical Damage & Time Element) 11 – Fixed payment step policy 12 – Loss value step policy
LineOfBusiness	An identifier for the line of business
PolicyFraction	This fraction is used where the cedant is only participating in a part of the defined layer structure. It is applied after the policy deductible but before policy layer, blanket limit and policy attachment
PolicyCoverageLimit	This is the maximum payout on the policy coverage
PolicyCoverageDeductible	The deductible that applies to the policy coverage
PolicyCoverageFraction	Fraction that applies to policy coverage
PolicyCoverageCoverage	0 – Structure 1 – Appurtenant structure 2 – Contents 3 – Not currently used 4 – Time Element

Field Name	Description
	5 – Not currently used 6 – Injury 7 – Death 8 – Death & Injury
PolicyCoverageType	1 – Additional 2 – Net
CedantName	Name of the cedant
SubPolicyType1	0 – Sublimit 1 – Policy restriction (currently not supported)
SubPolicyDeductible1	The value of the lower bound of the sub-limit.
SubPolicyDeductibleType1	0,1 – Additional 2 – Net 3 – Minimum 4 – Maximum
SubPolicyLimit1	This is the maximum payout on the sub-limit
SubPolicyGroupName1	Name of the sub-policy group
SubPolicyType2	0 – Sublimit 1 – Policy restriction (currently not supported)
SubPolicyDeductible2	The value of the lower bound of the sub-limit

Field Name	Description
SubPolicyDeductibleType2	0,1 – Additional 2 – Net 3 – Minimum 4 – Maximum
SubPolicyLimit2	This is the maximum payout on the sub-limit
SubPolicyGroupName2	Name of the sub-policy group
SubPolicyType3	0 – Sublimit 1 – Policy restriction (currently not supported)
SubPolicyDeductible3	The value of the lower bound of the sub-limit
SubPolicyDeductibleType3	0,1 – Additional 2 – Net 3 – Minimum 4 – Maximum
SubPolicyLimit3	This is the maximum payout on the sub-limit
SubPolicyGroupName3	Name of the sub-policy group
SubPolicyType4	0 – Sublimit 1 – Policy restriction (currently not supported)
SubPolicyDeductible4	The value of the lower bound of the sub-limit

Field Name	Description
SubPolicyDeductibleType4	0,1 – Additional 2 – Net 3 – Minimum 4 – Maximum
SubPolicyLimit4	This is the maximum payout on the sub-limit
SubPolicyGroupName4	Name of the sub-policy group
SubPolicyType5	0 – Sublimit 1 – Policy restriction (currently not supported)
SubPolicyDeductible5	The value of the lower bound of the sub-limit
SubPolicyDeductibleType5	0,1 – Additional 2 – Net 3 – Minimum 4 – Maximum
SubPolicyLimit5	This is the maximum payout on the sub-limit
SubPolicyGroupName5	Name of the sub-policy group
Payment	The payment for a fixed payment step policy

Treaty Information

Table 51: Impact Forecasting Florida Hurricane (FCHLPM) Model input fields for treaty information

Field Name	Description
TreatyID	This is the unique identifier for each treaty
TreatyRiskID	This is the unique identifier for each treaty record
TreatyName	This field is used to enter the treaty name
TreatyDescription	This field is used to enter the treaty description
TreatyType	1 – Facultative 2 – Working Excess 3 – Surplus Share 4 – Quota Share
TreatyLevel	Indicates level at which the treaty is applied: 2 – Site 3 – Account 4 – Policy
ConnectionID	The SiteID, AccountID, PolicyID or LOBID that the treaty applies to (depends on TreatyLevel)
LOB	Field used to enter LOB that the treaty applies to, multiple LOBs can be separated by a “;”
Attachment	The lower bound of loss above which the treaty is active
OccurenceLimit	This is occurrence limit of the treaty
TotalLimit	This is the maximum payout on the reinsurance layer
PercentPlaced	Indicates percentage of recovery from the treaty

Field Name	Description
Inuring Order	This is the inuring priority of the reinsurance

Please note that quota share and working excess treaties only apply if selected in the analysis setting window in the UI.

Table 52: Impact Forecasting Florida Hurricane (FCHLPM) Model input fields for secondary modifier information

Field Name	Description
Property ID	Unique identifier ID
SecondaryModifierGroup	Secondary modifier group ID for the group names
Value	Secondary modifier value IDs for the respective secondary modifier group.

Sample Input Data File and Import Options Screenshots

PropertyID	BuildingID	BuildingNa	BuildingNu	StreetNam	City	PostalCod	district	StateAbbr	state	TerritoryC	NumOfSto	yearbuilt	occupiedFloor	BuildingTy	OccupancyType	BuildingSc	Occupanc	User1
1	1	XXX1	0			78070		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	1
2	2	XXX2	0			78070		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	1
3	3	XXX3	0			78070		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	23
4	4	XXX1	0			78070		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	1
5	5	XXX2	0			78070		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	1
6	6	XXX3	0			72543		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	23
7	7	XXX1	0			52157		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	1
8	8	XXX2	0			60439		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	1
9	9	XXX3	0			32801		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	23
10	10	XXX3	0			32508		0		US	0	1/1/9999	0	WD	RESSF	IFUW	IFUW	23

Figure 91: Screenshot of sample hurricane model input file (part 1 of 5)

User2	User3	User4	User5	PropertyN	PropertyN	YearRetro	GarageDo	FloorSize	RoofCover	RoofType	RoofConn	RoofAge	WindowPr	RoofSheat	coverageT	CoverageSumInsur	CoverageLim
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	11132000	11132
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	11132000	11132
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	256000000	256000
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	11132000	11132
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	11132000	11132
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	256000000	256000
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	11132000	11132
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	11132000	11132
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	256000000	256000
u2	u3	u4	u5	pname1	pnum1	0	0	0	0	0	0	0	0	0	0	256000000	256000

Figure 92: Screenshot of sample hurricane model input file (part 2 of 5)

CoverageI	Coveragef	Aggregatic	coverageT	CoverageSumInsured	CoverageLimit2	CoverageI	Coveragef	Aggregatic	coverageT	CoverageSumInsured3	CoverageLimit3	CoverageI	Coveragef	Aggre
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	

Figure 93: Screenshot of sample hurricane model input file (part 3 of 5)

CoverageI	Coveragef	Aggregatic	coverageT	CoverageSumInsured	CoverageLimit2	CoverageI	Coveragef	Aggregatic	coverageT	CoverageSumInsured3	CoverageLimit3	CoverageI	Coveragef	Aggregatic
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	1
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	1
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	1
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	1
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	1
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	1
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	1
0	1	1	2	11132000	11132000	0	1	1	4	11132000	11132000	0	1	1
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	1
0	1	1	2	256000000	256000000	0	1	1	4	256000000	256000000	0	1	1

Figure 94: Screenshot of sample hurricane model input file (part 4 of 5)

Latitude	Longitude	MatchCod	DamageFu	CrestaZon	CrestaZon	GridCellID	Municipal	County	CDFStubPr	CDFStubSc	Group1	Group2	Group3	Group4	Group5	RoofTypeS	CoverageT	Coverage
29.8598	-98.3884	1	0			0			0	0							0	0
29.8598	-98.3884	1	0			0			0	0							0	0
29.8598	-98.3884	1	0			0			0	0							0	0
29.8598	-98.3884	1	0			0			0	0							0	0
29.8598	-98.3884	1	0			0			0	0							0	0
35.49079	-91.9753	1	0			0			0	0							0	0
43.04257	-91.1791	1	0			0			0	0							0	0
41.67543	-88.0008	1	0			0			0	0							0	0
28.5417	-81.3757	1	0			0			0	0							0	0
26.16388	-81.7733	1	0			0			0	0							0	0

Figure 95: Screenshot of sample hurricane model input file (part 5 of 5)

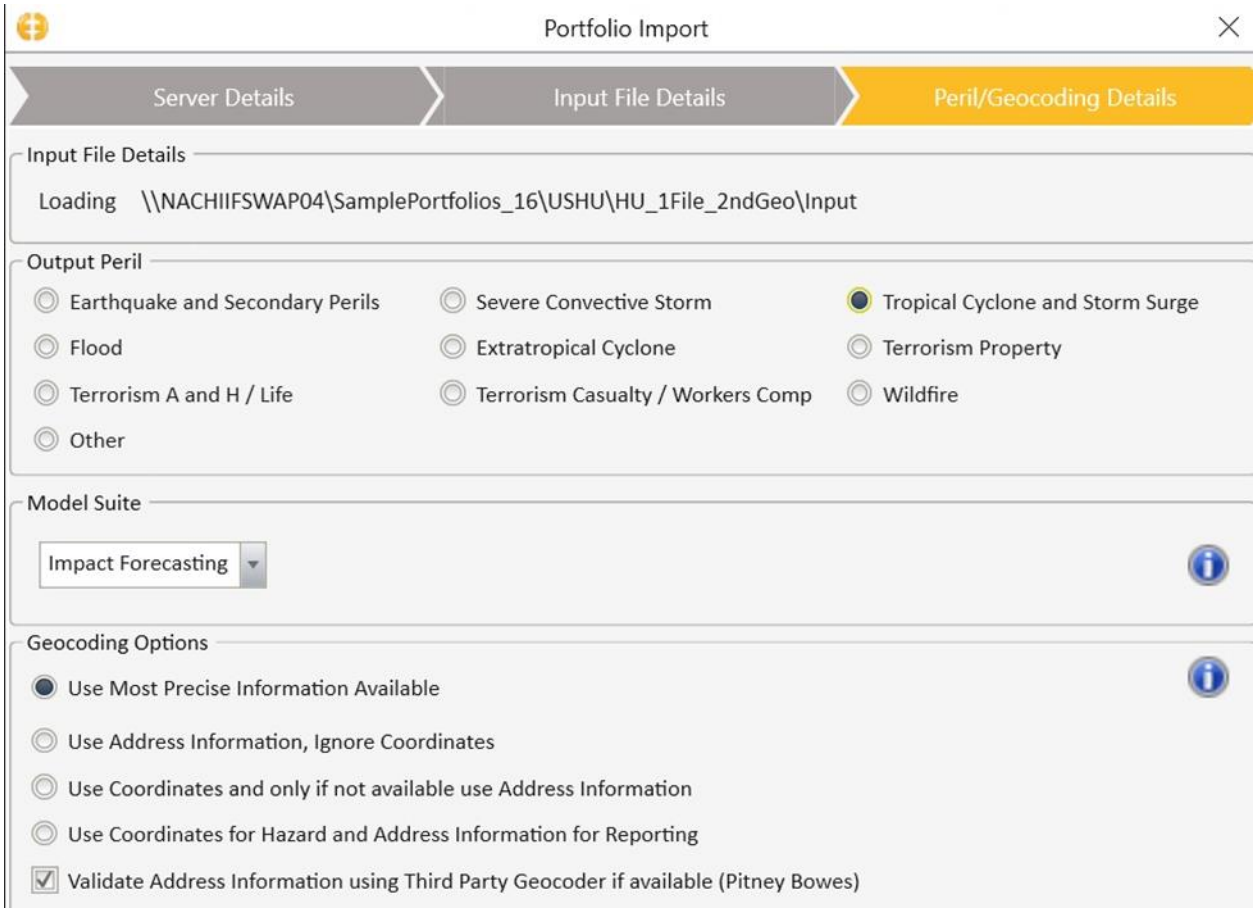


Figure 96: Screenshot of ELEMENTS input file import options

Appendix D: Hurricane Model Output Form

Analysis Settings

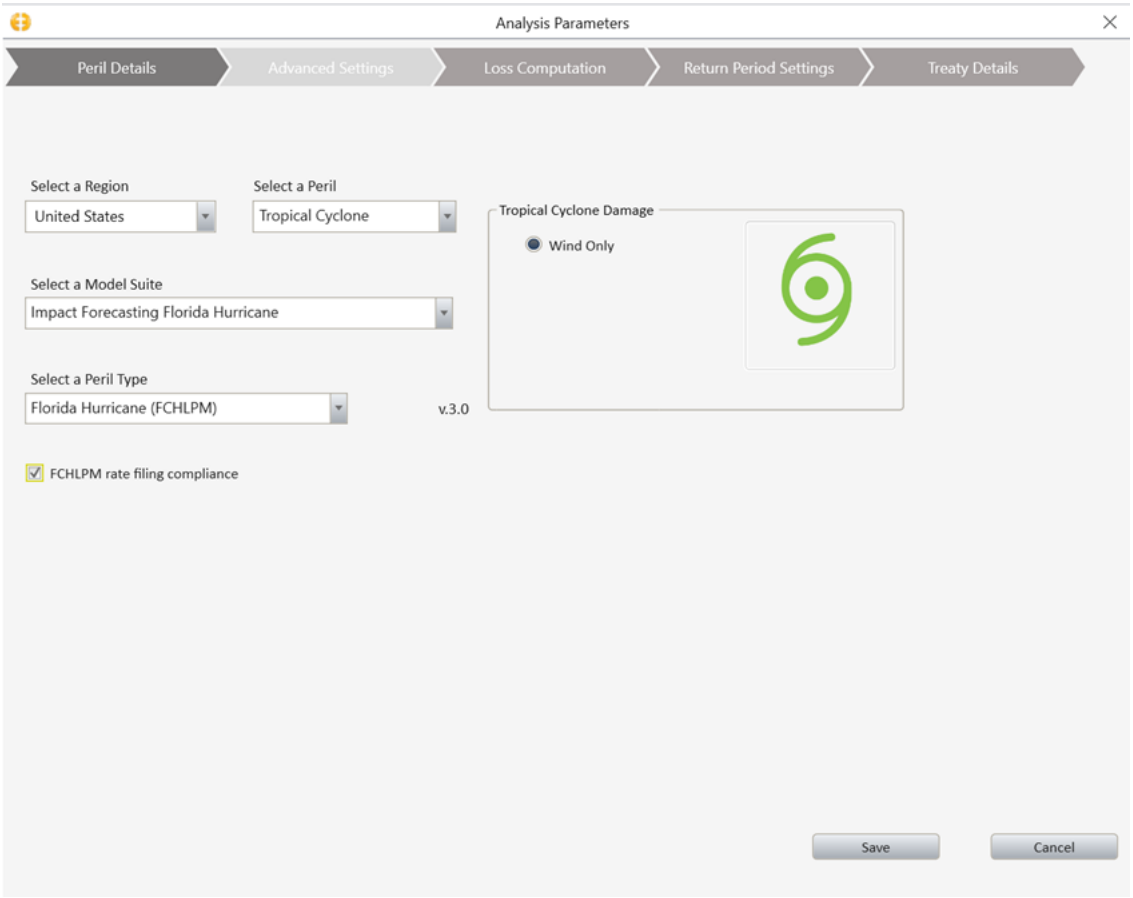


Figure 97: Screenshot of hurricane model analysis settings required for Florida ratemaking (part 1 of 3)

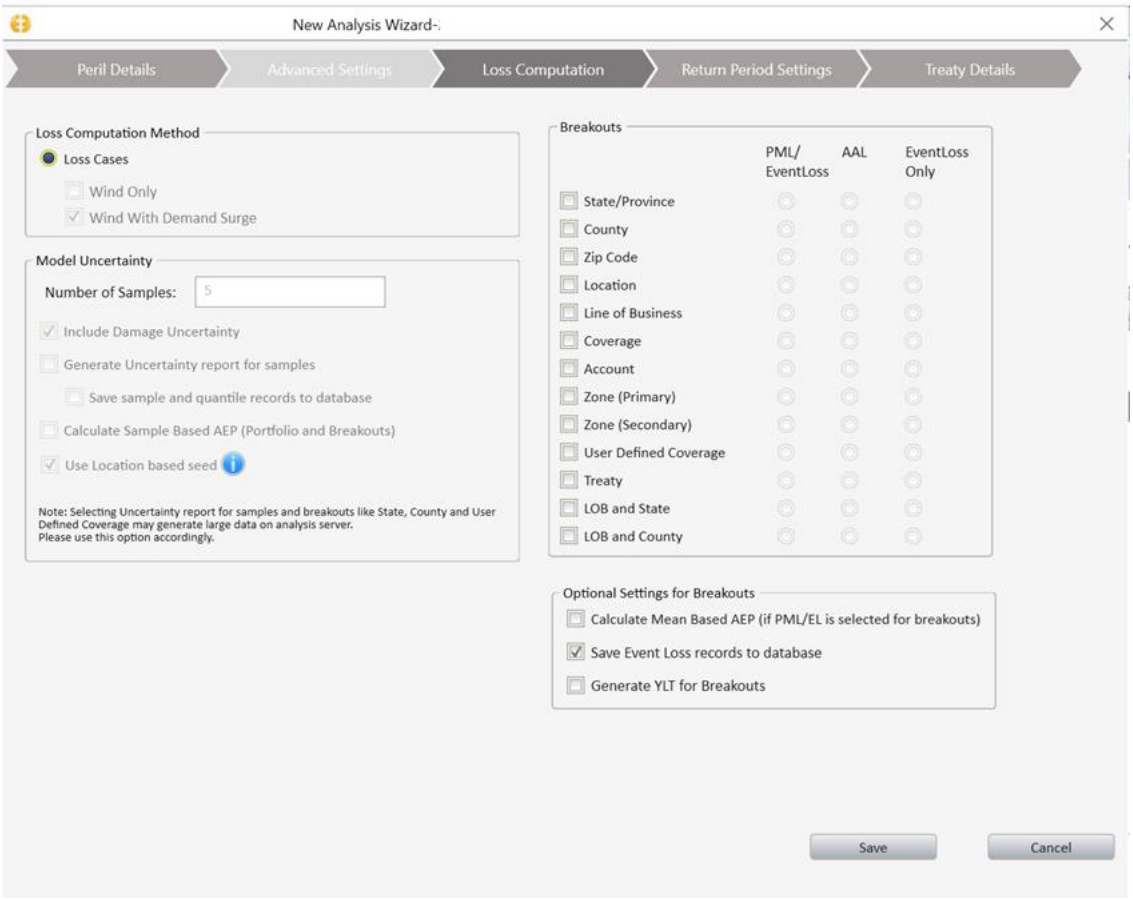


Figure 98: Screenshot of hurricane model analysis settings required for Florida ratemaking (part 2 of 3)

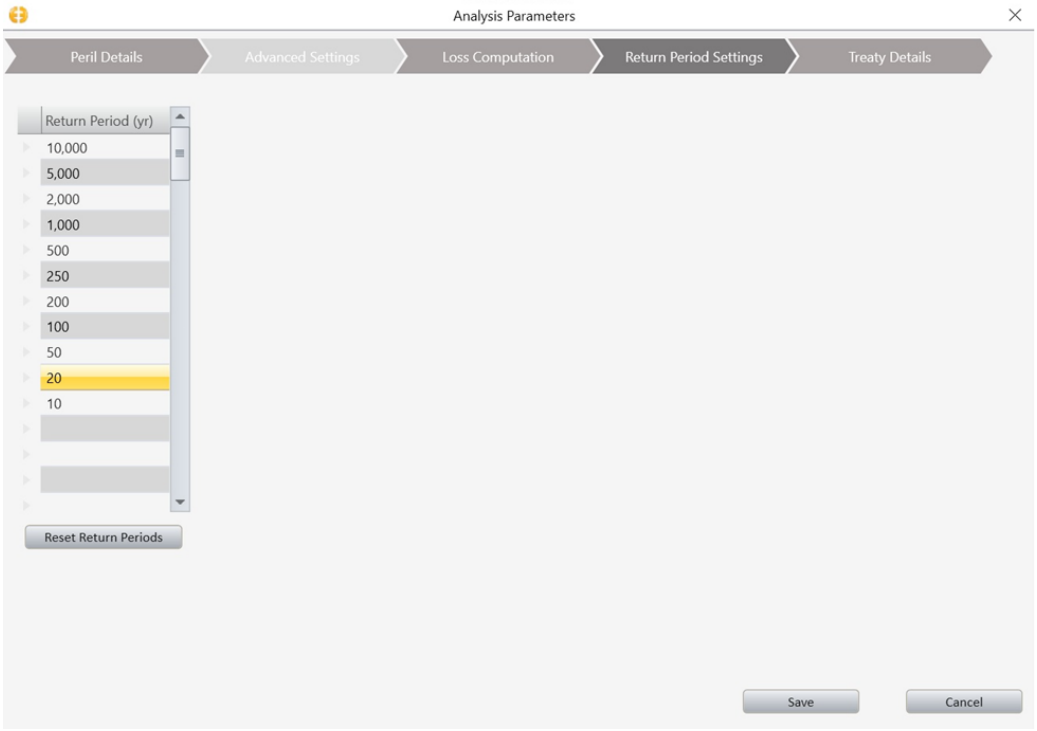


Figure 99: Screenshot of hurricane model analysis settings required for Florida ratemaking (part 3 of 3)

Output Report

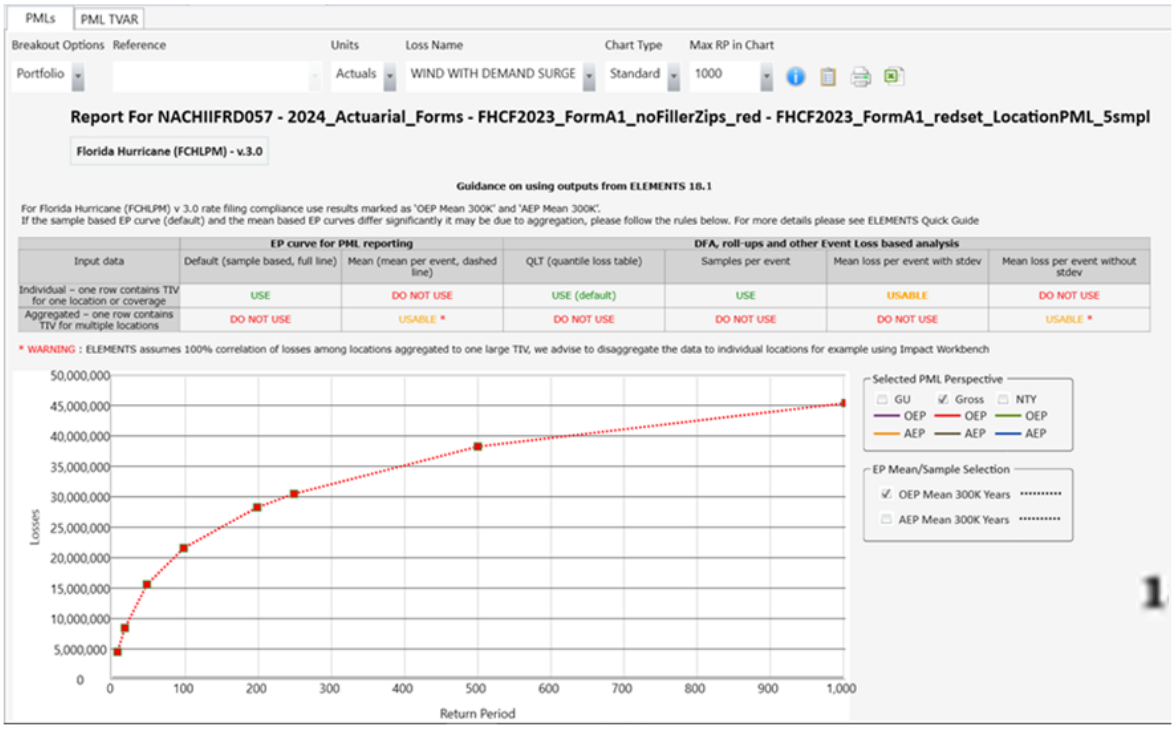


Figure 100: Screenshot of hurricane model output report (part 1 of 2)

AEP Mean 300K Years

Return Period	Ground Up - Mean	Gross - Mean	Net of Treaty - Mean
10,000	85,126,143	78,252,000	78,252,000
5,000	73,065,090	68,297,351	68,297,351
2,000	58,807,259	56,225,469	56,225,469
1,000	50,863,684	48,459,548	48,459,548
500	43,154,000	41,642,792	41,642,792
250	34,083,715	33,224,668	33,224,668
200	31,654,113	30,882,405	30,882,405
100	24,210,220	23,803,156	23,803,156
50	17,353,589	17,139,263	17,139,263
20	9,598,433	9,537,597	9,537,597
10	5,227,995	5,211,288	5,211,288
AAL	1,841,082	1,820,233	1,820,233
STDDEV	4,895,133	4,769,012	4,769,012

* Table values in Actuals

OEP Mean 300K Years

Return Period	Ground Up - Mean	Gross - Mean	Net of Treaty - Mean
10,000	78,736,229	74,821,403	74,821,403
5,000	67,544,262	63,429,077	63,429,077
2,000	55,581,269	52,712,055	52,712,055
1,000	48,045,075	45,391,001	45,391,001
500	39,555,917	38,247,116	38,247,116
250	31,460,798	30,486,276	30,486,276
200	29,070,772	28,264,449	28,264,449
100	22,022,560	21,571,015	21,571,015
50	15,820,541	15,596,435	15,596,435
20	8,536,195	8,467,287	8,467,287
10	4,554,577	4,542,016	4,542,016
AAL	1,841,082	1,820,233	1,820,233
STDDEV	4,895,133	4,769,012	4,769,012

Figure 101: Screenshot of hurricane model output report (occurrence exceedance probability, below, and aggregate exceedance probability, above) (part 2 of 2)

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Appendix E: Glossary of Acronyms

AAL	Average annual loss
AEP	Aggregate exceedance probability
AFRC	Air Force Reserve Command
AOP	All other perils
API	Application programming interface
ARe	Associate in Reinsurance
ARM	Associate in Risk Management
ASCE	American Society of Civil Engineers
ASOS	Automated Surface Observing System
ASTM	American Society for Testing and Materials
BA	Bachelor of Arts
BE	Bachelor of Engineering
BPMN	Business Process Model and Notation
BS	Bachelor of Science
CCRMP	Certified Catastrophe Risk Management Professional
CDF	Cumulative distribution function
Cp	Central pressure

CF	Conversion factor for converting the modeled gradient winds to surface winds
CPU	Central processing unit
CSPA	Certified Specialist in Predictive Analytics
DB	Database
DBAN	Darik's Boot and Nuke
EBTRK	Extended Best Track dataset
ENF	ELEMENTS Normalized Format
EP	Exceedance probability
ESDU	Engineering Sciences Data Unit
FBC	Florida Building Code
FCAS	Fellow of the Casualty Actuarial Society
FCHLPM	Florida Commission on Hurricane Loss Projection Methodology
FEMA	Federal Emergency Management Agency
FFP	Far field pressure
FFT	Fast Fourier Transform
FHCF	Florida Hurricane Catastrophe Fund
FFTW	Fastest Fourier Transform in the West
GB	Gigabyte

HCI	Human-Computer Interaction
HadISST	Hadley Centre Sea Ice and Sea Surface Temperature Dataset
HURDAT	HURricane DATabase
HVHZ	High-Velocity Hurricane Zone
IBHS	Insurance Institute for Business and Home Safety
IDS	Intrusion detection systems (IDS)
IPS	Intrusion prevention systems (IPS)
IF	Impact Forecasting
ISCM	International Society of Catastrophe Managers
ISO	International Organization for Standardization
IT	Information Technology
km	Kilometers
L&O	Law and Ordinance
LLC	Limited liability company
m	Meters
m/s	Meters per second
MA	Master of arts
MAAA	Member of the American Academy of Actuaries
mb	Millibar

MBA	Master of Business Administration
MDR	Mean damage ratio
mph	Miles per hour
MPI	Message Passing Interface
MS	Master of Science
NESDIS	National Environmental Satellite, Data, and Information Service
NEP	Non-exceedance probability
NHC	National Hurricane Center
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OEP	Occurrence exceedance probability
PE	Professional Engineer
PhD	Doctor of Philosophy
PML	Probable maximum loss level
QA	Quality Assurance
R&D	Research and Development
RAM	Random access memory
RDP	Remote Desktop Access

Rmax	Radius of maximum winds
RP	Return period
SFTP	Secure File Transfer Protocol
SMO	SQL Server Management Object
sq ft	Square feet
SQL	Structured Query Language
SRC	Standardized Regression Coefficients
SSD	Solid state drive
SST	Sea surface temperature
TCR	National Hurricane Center Tropical Cyclone Reports
TFS	Microsoft Team Foundation Server
UAM	User Access Management
UFT	Unified Function Test
UML	Unified Modeling Language
UX	User Experience
Vmax	Maximum sustained wind speed
VPN	Virtual private network
VT	Translational velocity (forward speed)
WBDR	Wind-Borne Debris Region

WPF	Windows Presentation Foundation
WSP	Hurricane model windfield shape parameter
X1	Windfield shape parameter

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Contact Us

IFsupport@aon.com

www.aon.com

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