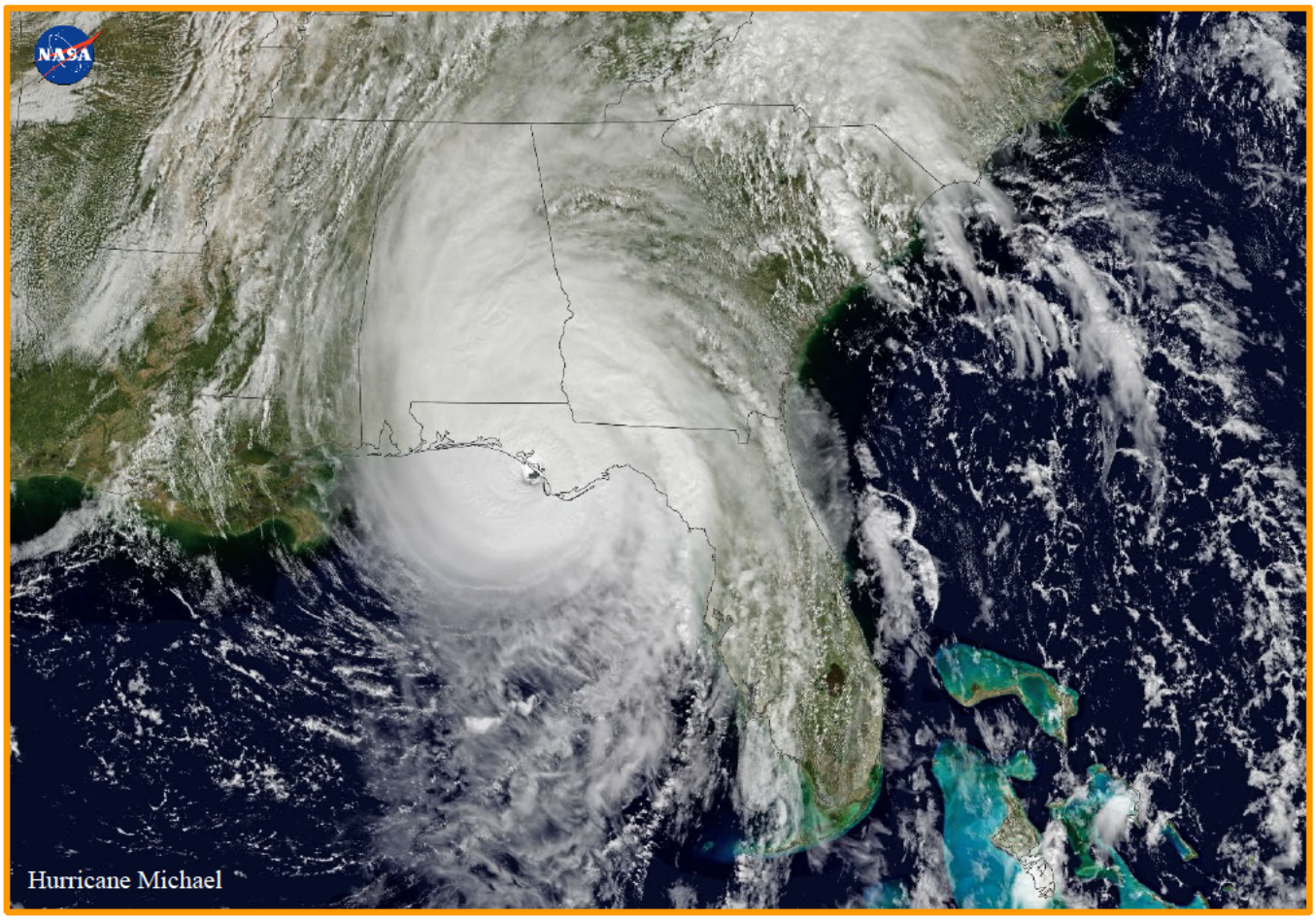
Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report

2019 Hurricane Standards



Florida International University

Remote Review

March 29 – 31, 2021

On March 29–31, 2021, the Professional Team conducted a remote review of the Florida International University (FIU), Florida Public Hurricane Loss Model Version 8.1. The following individuals participated in the remote review.

FIU

Roberto Vicente Silva de Abreu, Ph.D. Candidate, Wind Engineering, Florida Institute of Technology
Bachir Annane, Ph.D., Senior Research Associate III, CIMAS/HRD
Christian Bedwell, Graduate Student, Civil Engineering, University of Florida
Shu-Ching Chen, Ph.D., Professor, Director, Distributed Multimedia Information Systems Laboratory, School of Computing and Information Sciences, College of Engineering and Computing, Florida International University
Steve Cocke, Ph.D., Scholar/Scientist, Department of Meteorology and COAPS, Florida State University
Erik Coltey, Student, Florida Institute of Technology
Gail Flannery, FCAS, MAAA, Consulting Actuary, AMI Risk Consultants, Inc., Miami, Florida
Kurt Gurley, Ph.D., Professor, Department of Civil and Coastal Engineering, College of Engineering, University of Florida
Shahid Hamid, Ph.D., CFA, Professor and Chairman Department of Finance, College of Business, Florida International University
Golam Kibria, Ph.D., Professor, Mathematics and Statistics, College of Arts and Sciences, Florida International University
Daniel Martinez, Accounting Student, Florida International University
Jean-Paul Pinelli, Ph.D., P.E., Professor, Civil Engineering Department, Florida Institute of Technology
Maria Presa Reyes, Ph.D. Candidate, Computer Science, Florida International University
Dongwook Shin, Ph.D., Associate Research Scientist, Florida State University
Mei-Ling Shyu, Professor, Electrical and Computer Engineering, College of Engineering, University of Miami
Anchen Sun, Ph.D. Student, Electrical and Computer Engineering, University of Miami
Yudong Tao, Ph.D. Candidate, Electrical and Computer Engineering, College of Engineering, University of Miami
Tianyi Wang, Ph.D. Candidate, Computer Science, Florida International University
Zhuoxuan Wei, Ph.D. Candidate, Florida Institute of Technology
Wensong Wu, Ph.D., Associate Professor, Statistics, Florida International University

Professional Team

Paul Fishwick, Ph.D., Computer and Information Scientist
Tim Hall, Ph.D., Meteorologist
Mark Johnson, Ph.D., Statistician, Team Leader
Stu Mathewson, FCAS, MAAA, Actuary
Greg McLellan, P.E., Structural Engineer
Donna Sirmons, Staff

Due to the COVID-19 pandemic and State Board of Administration travel restrictions, the Professional Team conducted the review remotely rather than on-site. The remote review

followed the on-site review process as detailed in the Report of Activities and the remote review procedures adopted by the Commission at their December 10, 2020 meeting.

The Professional Team began the review with an opening briefing and introductions were made. FIU provided an overview of updates to the model.

- Update to April 2020 HURDAT2
- Primary ZIP Code database and its associated databases updated to April 2020
- Incorporation of the windborne debris map issued in the 2001 edition of the Florida Building Code
- Commercial residential low-rise model updates including 1) new interior and contents damage models computing rainwater induced damage, 2) revised cost analyses, 3) revised to generate separate vulnerability curves for overall building, apartment building, and condominium association building, and 4) formula computing time-related expenses for apartment buildings updated
- Commercial residential mid/high-rise model updates including 1) improved interface between personal residential portfolios with condo units and the mid/high-rise, 2) running the model for both open and closed layouts and calculating the weighted average from both runs, 3) missing data on building geometry filled using available portfolio information, 4) updated cost analysis, and 5) insured losses computed differently for apartment building and condo associations
- Differentiation in treatment of apartment building versus condo association exposures

The audit continued with a review of each standards section. FIU provided further details on the error in generating Form A-1 and the error in commercial residential losses in several actuarial, statistical, and vulnerability forms due to changes made to the mid/high-rise buildings model not being implemented properly when producing the forms (see the March 15, 2021 notification from FIU included at the end of the report).

During the Commission meeting to review the model for acceptability under the 2019 Hurricane Standards, FIU is to present the following information as specified on page 61 of the *Hurricane Standards Report of Activities as of November 1, 2019*:

1. Detailed information and discussion of Forms V-3 and V-5
2. Detailed information and discussion of relativities in Form A-6.

Report on Deficiencies

The Professional Team reviewed the following deficiencies cited by the Commission at the January 12, 2021 meeting. The deficiencies were eliminated by the established time frame, and the modifications have been verified.

1. G-1.D, page 20: Incomplete. No response given to Part D.

2. M-2, Disclosure 9, page 137: Incomplete. Provide plots of annual landfall rates as required in the disclosure.
3. Form M-1: Non-responsive. The Excel spreadsheet version of Form M-1 is not correct.

4. Form M-1, page 542, Form A-2, pages 414-417, and Form S-1, page 553: Incorrect. Reconcile the landfall counts in Forms M-1 and S-1 with landfalls listed in Form A-2 as required.

5. Form M-3: Non-responsive. The Excel spreadsheet version of Form M-3 is unpopulated.

6. V-2.B, page 268: Non-responsive. No response given to Part B.

Professional Team Pre-Visit Letter

The Professional Team's pre-visit letter questions are provided in the report under the corresponding standards. Following is the pre-visit letter preamble.

The purpose of the pre-visit letter is to outline specific issues unique to the modeler's submission, and to identify lines of inquiry to be followed during the remote on-site review to allow adequate preparation by the modeler. Aside from due diligence with respect to the full submission, various questions that the Professional Team is certain to ask the modeler during the remote on-site review are provided in this letter. This letter does not preclude the Professional Team from asking for additional information during the remote on-site review that is not given below or discussed during an upcoming conference call that will be held if requested by the modeler. One goal of the potential conference call is to address modeler questions related to this letter or other matters pertaining to the remote on-site review. The overall intent is to expedite the remote on-site review and to avoid last minute preparations that could have been undertaken earlier.

The Professional Team will also be considering material in response to deficiencies designated by the Florida Commission on Hurricane Loss Projection Methodology (Commission) during the January 12, 2021 meeting.

It is important that all material prepared for presentation during the remote on-site review be provided to the Professional Team and presented using a medium that is readable by all members of the Professional Team simultaneously.

The remote on-site schedule is tentatively planned to proceed in the following sequence: (1) presentation of new or extensively updated material related to the model; (2) section by section review commencing within each section with pre-visit letter responses; (3) responses to new or significantly changed hurricane standards in the 2019 *Hurricane Standards Report of Activities*, and (4) responses to the audit items for each hurricane standard in the 2019 *Hurricane Standards Report of Activities*.

If changes have been made in any part of the model or the modeling process from the descriptions provided in the original November 1, 2020 submission, provide the Professional Team with a complete and detailed description of those changes, the reasons for the changes (e.g., an error was discovered), and all revised forms where any output changed. For each revised form, provide an additional form with cell-by-cell differences between the revised and originally submitted values.

Refer to the On-Site Review chapter of the *Hurricane Standards Report of Activities as of November 1, 2019* as amended by the Commission on December 10, 2020 for more details on materials to be presented and provided to the Professional Team. Particular attention should be paid to the requirements under Presentation of Materials. These requirements are reproduced at the conclusion of this letter.

The pre-visit questions are grouped by hurricane standards sections.

Editorial Items

Editorial items were noted by the Professional Team in the pre-visit letter for correction prior to the start of the virtual review in order to facilitate efficiency during the review and to avoid last minute edits. Additional editorial items were also noted during the review. The Professional Team reviewed the following corrections to be included in the revised submission to be provided to the Commission no later than 10 days prior to the meeting to review the model for acceptability. Page numbers below correspond to the March 14, 2021 submission document.

1. Page 9: Extraneous “data” word in the List of Figures title removed.
2. G-1.B, page 19: Figure 1 replaced with complete annotations.
3. G-1, Disclosure 2, page 26: Revised to acknowledge the addition of Hurricane Michael as a Category 5 storm.
4. G-1, Disclosure 6, page 76: Florida Building Code references added.
5. G-1, Disclosure 6, page 80: Khanduri reference corrected.
6. G-1, Disclosure 6, page 88: RSMeans reference extraneous comma after “34th,” removed.
7. G-1, Disclosure 6, page 93: USACE reference “struc-tures” corrected.
8. G-2, Disclosure 2, page 121: Anchen Sun Ph.D. reference corrected.
9. M-2, Disclosure 1, page 135: “Recent” removed from statement on research results.
10. M-2, Disclosure 9, page 139: Mis-spelling and extraneous period in the disclosure wording, “Strom” and “rates” corrected.
11. M-2, Disclosure 10, page 141: Extraneous comma between “slab boundary layer” and “surface drag coefficient” corrected.
12. M-4, Disclosure 1, page 145: Figure 27 replaced.
13. M-5, Disclosure 2, page 152: Caption for Figure 31 corrected.
14. S-1, Disclosure 4, page 170: Extraneous “we use the” in second paragraph removed.
15. S-1, Disclosure 4, page 171: Repeated square root symbols removed, numbers in Table 13 formatted, column heading repeated on page break.
16. S-5, Disclosure 1, pages 183-185: Table 14 and Figure 41 corrected.

17. V-1, Disclosure 2, pages 215-218: Figures 51, 52 and 53 revised.
18. V-1, Disclosure 9, page 258: Figure 56(a) legend corrected.
19. V-3, Disclosure 1, page 283: Equation 1 revised to match the implementation.
20. Form A-3, page 359: Figure 76 revised.
21. Appendix C, pages 439-447: Form A-2 revised.
22. Appendix I, pages 657-659: Form A-8 revised.
23. Appendix M, page 688: Form M-3 mi in Table 33 changed to sm for consistency.
24. Appendix P, page 695: Form S-3 revised to correct year range of data used for the pressure decay term.
25. Appendix V: List of Acronyms updated.

GENERAL STANDARDS – Mark Johnson, Leader

G-1 Scope of the Hurricane Model and Its Implementation*

*(*Significant Revision)*

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

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

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

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

Audit

1. Automated procedures used to create forms will be reviewed.

2. All primary technical papers that describe the underlying hurricane model theory and implementation (where applicable) should be available for review in hard copy or electronic form. Modeling-organization-specific publications cited must be available for review in hard copy or electronic form.

3. Compliance with the process prescribed in Standard G-1.B in all stages of the modeling process will be reviewed.

4. Items specified in Standard G-1.C will be reviewed as part of the Computer/Information Standards.

5. Maps, databases, and data files relevant to the modeling organization's submission will be reviewed.

6. The following information related to changes in the hurricane model, since the initial submission for each subsequent revision of the submission, will be reviewed.
   A. Hurricane model changes:
      1. A summary description of changes that affect, or are believed to affect, the personal or commercial residential hurricane loss costs or hurricane probable maximum loss levels,
      2. A list of all other changes, and
      3. The rationale for each change.

B. Percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named *"hlpm2017c.zip"* for:
   1. All changes combined, and
   2. Each individual hurricane model component and subcomponent change.

C. For any modifications to Form A-4, Hurricane Output Ranges, since the initial submission, a newly completed Form A-5, Percentage Change in Hurricane Output Ranges:
   1. With the initial submission as the baseline for computing the percentage changes, and
   2. With any intermediate revisions as the baseline for computing the percentage changes.

D. Color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named *"hlpm2017c.zip"* for each hurricane model component change:
   1. Between the previously-accepted hurricane model and the revised hurricane model,
   2. Between the initial submission and the revised submission, and
   3. Between any intermediate revisions and the revised submission.

Pre-Visit Letter

1. G-1.B, page 19: Provide documentation of the process beyond Figure 1, if available.

2. G-1, Disclosure 2, Rmax, pages 25-30 and M-2, Disclosure 3, page 134: Discuss the impact of an additional category-5 landfall (Hurricane Michael 2018) on the category-5 Rmax model component, given that there are only three other category-5 landfalls used to estimate the Gamma-distribution's theta parameter.

3. G-1, Disclosure 4, page 63: Explain how the various "compute" servers fit into Figure 15 and define the other entities in the figure (e.g., FW1, BR1, WR2, among other boxes).

Verified: YES

Professional Team Comments:

Reviewed the flowchart of the process to assure continual agreement and correct correspondence of databases, data files, and code with presentation slides, technical papers, and model documentation.

Reviewed the network diagram and hardware configuration of servers.

Discussed the impact on the Rmax model if Hurricane Michael (2018) was included.

Discussed the updates to the ZIP Code-based databases after updating the ZIP Code database to the April 2020 ZIP Code boundaries.

Reviewed impacts of the various model updates on loss costs.

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

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

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

Audit

1. The professional vitae of personnel and consultants engaged in the development of the hurricane model and responsible for the current hurricane model and the submission will be reviewed. Background information on the professional credentials and the requisite experience of individuals providing testimonial letters in the submission will be reviewed.

2. Forms G-1, General Standards Expert Certification; G-2, Meteorological Standards Expert Certification; G-3, Statistical Standards Expert Certification; G-4, Vulnerability Standards Expert Certification; G-5, Actuarial Standards Expert Certification; G-6, Computer/ Information Standards Expert Certification, and all independent peer reviews of the hurricane model under consideration will be reviewed. Signatories on the individual forms will be required to provide a description of their review process.

3. Incidents where modeling organization personnel or consultants have been found to have failed to abide by the standards of professional conduct adopted by their profession will be discussed.

4. For each individual listed under Disclosure 2.A, specific information as to any consulting activities and any relationship with an insurer, reinsurer, trade association, governmental entity, consumer group, or other advocacy group within the previous four years will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed resumes of new personnel:

- Nima Aghli, Ph.D. in Computer Science, Florida Institute of Technology, Melbourne, FL; M.S. in Computer Science, Florida Institute of Technology, Melbourne, FL; B.S. in Computer Engineering, Azad University, Tabriz, Iran
- Christian Bedwell, B.S. in Civil Engineering, University of Florida, Gainesville, FL
- Daphne Otarola, M.S. Candidate in Structural Engineering, Florida Institute of Technology, Melbourne, FL; B.S. in Civil Engineering, Florida Institute of Technology, Melbourne, FL
- Anchen Sun, Ph.D. Candidate in Electrical and Computer Engineering, University of Miami, Coral Gables, FL; M.S. in Electrical and Computer Engineering, University of Miami, Coral Gables, FL; B.S. in Marine Science and Computer Science, University of Miami, Coral Gables, FL
- Zhuoxuan Wei, Ph.D. Candidate in Civil Engineering, Florida Institute of Technology, Melbourne, FL; M.S. in Civil Engineering, Florida Institute of Technology, Melbourne, FL; B.S. in Engineering Management, Sichuan University, Chengdu, China

Discussed that the model experts' catastrophe modeling work occurs through their home institutions.

Discusssed that there were no departures of personnel attributable to violations of professional standards.

G-3 Insured Exposure Location*

*(*Significant Revision)*

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.

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

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

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.

E. Geocoding methodology shall be justified.

Audit

1. Geographic displays for all ZIP Codes will be reviewed.
2. Geographic comparisons of previous to current locations of ZIP Code centroids will be reviewed.
3. Third party vendor information, if applicable, and a complete description of the process used to validate ZIP Code information will be reviewed.
4. The treatment of ZIP Code centroids over water or other uninhabitable terrain will be reviewed.
5. Examples of geocoding for complete and incomplete street addresses will be reviewed.
6. Examples of latitude-longitude to ZIP Code conversions will be reviewed.
7. Hurricane model ZIP Code-based databases will be reviewed.

Pre-Visit Letter

4. G-3.D, page 124: Provide the list of out-of-date ZIP Codes and the list of new ZIP Codes.

Verified: YES

Professional Team Comments:

Reviewed the list of out-of-date ZIP Codes. Discussed that no new ZIP Codes were added from the previously-accepted model.

Reviewed geographic displays of ZIP Code boundaries and centroids.

Reviewed comparisons of ZIP Code centroid locations from the previously-accepted model.

Discussed the process for validating ZIP Code data from ZIP-Codes.com.

Discussed the process for coastal or inland classification for ZIP Codes.

G-4 Independence of Hurricane Model Components

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

Audit

1. The hurricane model components will be reviewed for adequately portraying hurricane phenomena and effects (damage, hurricane loss costs, and hurricane probable maximum loss levels). Attention will be paid to an assessment of (1) the theoretical soundness of each component, (2) the basis of the integration of each component into the hurricane model, and (3) consistency between the results of one component and another.

2. All changes in the hurricane model since the previous submission that might impact the independence of the hurricane model components will be reviewed.

Verified: YES

Professional Team Comments:

There was no evidence to suggest one component of the model was deliberately adjusted to compensate for another component.

G-5 Editorial Compliance

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

Audit

1. An assessment that the person who has reviewed the submission has experience in reviewing technical documentation and that such person is familiar with the submission requirements as set forth in the *Hurricane Standards Report of Activities as of November 1, 2019* will be made.

2. Attestation that the submission has been reviewed for grammatical correctness, typographical accuracy, completeness, and no inclusion of extraneous data or materials will be assessed.

3. Confirmation that the submission has been reviewed by the signatories on the Expert Certification Forms G-1 through G-6 for accuracy and completeness will be assessed.

4. The modification history for submission documentation will be reviewed.

5. A flowchart defining the process for form creation will be reviewed.

6. Form G-7, Editorial Review Expert Certification, will be reviewed.

Verified: YES

Professional Team Comments:

Discussed with the Editorial Review signatory the documentation process for compiling and reviewing the submission document, including review by each section signatory.

Editorial items noted in the pre-visit letter and during the review by the Professional Team were satisfactorily addressed. The Professional Team has reviewed the submission per Audit item 3, but cannot guarantee that there are no remaining editorial issues. The modeler is responsible for eliminating editorial errors.

METEOROLOGICAL STANDARDS – Tim Hall, Leader

M-1 Base Hurricane Storm Set*

*(*Significant Revision)*

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

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

Audit

1. The modeling organization Base Hurricane Storm Set will be reviewed.

2. A flowchart illustrating how changes in the HURDAT2 database are used in the calculation of hurricane landfall distribution will be reviewed.

3. Changes to the modeling organization Base Hurricane Storm Set from the previously-accepted hurricane model will be reviewed. Any modification by the modeling organization to the information contained in HURDAT2 will be reviewed.

4. Reasoning and justification underlying any short-term, long-term, or other systematic variations in annual hurricane frequencies incorporated in the hurricane model will be reviewed.

5. Modeled probabilities will be compared with observed hurricane frequency using methods documented in current scientific and technical literature. The goodness-of-fit of modeled to historical statewide and regional hurricane frequencies as provided in Form M-1, Annual Occurrence Rates, will be reviewed.

6. Form M-1, Annual Occurrence Rates, will be reviewed for consistency with Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year.

7. Comparisons of modeled probabilities and characteristics from the complete historical record will be reviewed. Modeled probabilities from any subset, trend, or fitted function will be reviewed, compared, and justified against the complete HURDAT2 database. In the case of partitioning, modeled probabilities from the partition and its complement will be reviewed and compared with the complete HURDAT2 database.

Pre-Visit Letter

8. Form M-1, page 541 and Form A-2, page 415: Explain why Hurricane Isbell (1964) in Form A-2 was not updated to reflect the change given in Form M-1.F, page 541.

9. Form M-1, page 542: Explain why the changes, compared to the previously-accepted model, are minor with the exceptions of:
   a. Region D, NE Florida. Generally, the Modeled Number changed minimally (second digit) except for Category 3, for which the Modeled Number dropped from 0.65 to 0.434, even though the only change in the region was a lack of new storms. This decrease is large relative to other cells in the same circumstances.
   b. Region A, NW Florida. There was only one Category 5 historical event added, yet there were relatively larger increases in Modeled Numbers for Categories 2, 3, and 4.

Verified: YES

Professional Team Comments:

Discussed that the Base Hurricane Storm Set is based on HURDAT2 years 1900-2019 as of April 28, 2020.

Reviewed the track and intensity changes due to HURDAT2 reanalysis of Hurricanes Cleo (1964), Dora (1964), Isbell (1964), and Betsy (1965).

Discussed that the landfall region and intensity was not updated in the original submission Form A-2 or the revised March 14, 2021 submission. Reviewed the correct version of Form A-2 that is now included in the final revised version of the model submission.

Reviewed the flowchart for processing changes in HURDAT2 data in model storm simulations.

Reviewed the processing and implementation of changes in HURDAT2 to update the model's representation of storm track parameters. Reviewed relevant code documentation.

Reviewed the model's stochastic storm formation generator.

Reviewed the landfall rate changes in Regions A and D from the previously-accepted model.

Reviewed the annual occurrence rates in Form M-1 compared to Form S-1.

M-2 Hurricane Parameters and Characteristics

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

Audit

1. All hurricane parameters used in the hurricane model will be reviewed.
2. Graphical depictions of hurricane parameters as used in the hurricane model will be reviewed. Descriptions and justification of the following will be reviewed:
    a. The dataset basis for the fitted distributions, the methods used, and any smoothing techniques employed,
    b. The modeled dependencies among correlated parameters in the windfield component and how they are represented, and
    c. The asymmetric structure of hurricanes.
3. The treatment of the inherent uncertainty in the conversion factor used to convert the modeled vortex winds to surface winds will be reviewed and compared with current scientific and technical literature. Treatment of conversion factor uncertainty at a fixed time and location within the windfield for a given hurricane intensity will be reviewed.
4. Scientific literature cited in Standard G-1, Scope of the Hurricane Model and Its Implementation, may be reviewed to determine applicability.
5. All external data sources that affect model-generated windfields will be identified, and their appropriateness will be reviewed.
6. Description of and justification for the value(s) of the far-field pressure used in the hurricane model will be reviewed.

Verified: YES

Professional Team Comments:

Discussed that the Rmax distribution has not changed from the previously-accepted model.

Discussed that Hurricane Michael (2018) intensity is under further investigation by NOAA, and an adjustment in intensity to a Cat 5 would increase the Cat 5 Rmax mean by approximately 0.1 to 1.1 statute miles.

Reviewed comparison of historical to modeled annual landfall occurrence rates by category and region.

Reviewed the model domain for storm track propagation and intensity.

Discussed that the data used to fit the Holland-B parameter has not changed since the previously-accepted model.

Reviewed sources of data for SST and tropopause storm outflow temperature. Discussed the role of these data in calculating maximum potential intensity in the relative intensity simulations.

Documentation reviewed:

Axe, L.M. (2004). *Hurricane surface wind model for risk assessment*. MS Thesis, Florida State University, Department of Meteorology.

M-3 Hurricane Probability Distributions

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

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

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

Saffir-Simpson Hurricane Wind Scale:

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

Audit

1. Demonstration of the quality of fit extending beyond the Florida border will be reviewed by showing results for appropriate coastal segments in Alabama, Georgia, and Mississippi.

2. The method and supporting material for selecting stochastic storm tracks will be reviewed.

3. The method and supporting material for selecting storm track strike intervals will be reviewed. If strike locations are on a discrete set, the hurricane landfall points for major metropolitan areas in Florida will be reviewed.

4. Any modeling-organization-specific research performed to develop the functions used for simulating hurricane model variables or to develop databases will be reviewed.

5. Form S-3, Distributions of Stochastic Hurricane Parameters, will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed landfall rates for Category 1-2 and Category 3-4 hurricanes as functions of distance along the Florida coast and adjacent states. Reviewed comparisons of these rates to historical landfalls.

Reviewed distributions and their fits for Rmax and the Holland-B parameter.

Reviewed the probability distributions and data sources provided in Form S-3.

M-4 Hurricane Windfield Structure

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

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

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.

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

Audit

1. Any modeling-organization-specific research performed to develop the windfield functions used in the hurricane model will be reviewed. The databases used will be reviewed.

2. Any modeling-organization-specific research performed to derive the roughness distributions for Florida and neighboring states will be reviewed.

3. The spatial distribution of surface roughness used in the hurricane model will be reviewed.

4. The previous and current hurricane parameters used in calculating the hurricane loss costs for the LaborDay03 (1935) and NoName09 (1945) hurricane landfalls will be reviewed. Justification for the choices used will be reviewed. The resulting spatial distribution of winds will be reviewed with Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses.

5. For windfields not previously reviewed, detailed comparisons of the hurricane model windfield with Hurricane Charley (2004), Hurricane Wilma (2005), Hurricane Irma (2017), and Hurricane Michael (2018) will be reviewed.

6. Representation of vertical variation of winds in the hurricane model, where applicable, will be reviewed.

7. Form M-2, Maps of Maximum Winds, will be reviewed.

Pre-Visit Letter

5. M-4, Disclosure 6, page 144: Provide detail on "based on how well each dataset classified the land surface with respect to surface roughness." Against what criteria were the dataset classifications evaluated?

6. M-4, Disclosure 8, page 146: Provide observed landfall windfields for Hurricane Irma (2017) and Hurricane Michael (2018).

Verified: YES

Professional Team Comments:

Reviewed the criteria used for comparison of surface roughness databases. Discussed cases where the Multi-resolution Land Characteristics Consortium (MRLC) National Land Cover Database (NLCD) 2011 data provides a better description and other cases where the Florida Water Management District data provides a more detailed description of the land use.

Discussed that satellite imagery and other GIS databases are used to determine which land use dataset provides the better characteristics for estimating roughness.

Discussed that the land use datasets are merged using an algorithm, and a lookup table is used to select a roughness value for each land use type.

Reviewed maps of roughness values for the Miami area.

Reviewed the wind conversion methodology from gradient to surface level.

Reviewed plot of mean windspeeds as a function of roughness.

Reviewed surface roughness map for Hurricane Dennis (2005).

Reviewed comparisons of observed 10-meter surface windfields to modeled marine windfields for Hurricane Irma (2017) and Hurricane Michael (2018). Reviewed modeled terrain windfield for Hurricane Michael (2018).

Discussed issues with observational estimates of windfields over land, as generated by the H-WRF system.

M-5 Hurricane Landfall and Over-Land Weakening Methodologies

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

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

Audit

1. The variation in over-land decay rates used in the hurricane model will be reviewed.

2. Comparisons of the hurricane model weakening rates to weakening rates for historical Florida hurricanes will be reviewed.

3. The detailed transition of winds from over-water to over-land (i.e., hurricane landfall, boundary layer) will be reviewed. The region within 5 miles of the coast will be emphasized. Color-coded snapshot maps of roughness length and spatial distribution of over-land and over-water windspeeds for Hurricane Andrew (1992), Hurricane Jeanne (2004), and Hurricane Irma (2017) at the closest time after landfall will be reviewed.

Verified: YES

Professional Team Comments:

Discussed the multi-level boundary layer adjustments equilibration with surface roughness as storms make landfall and begin to attenuate over land.

Discussed that the boundary-layer vertical variation of windspeed provides input to the vulnerability model.

Reviewed the attenuating effects of surface roughness on simulated winds for Hurricane Dennis (2005).

M-6 Logical Relationships of Hurricane Characteristics

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

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

Audit

1. Form M-2, Maps of Maximum Winds, will be reviewed with a focus on the comparison between actual terrain and open terrain.

2. Form M-3, Radius of Maximum Winds and Radii of Standard Wind Thresholds, and the modeling organization sensitivity analyses will be reviewed.

3. Justification for the relationship between central pressure and radius of maximum winds will be reviewed. The relationships among intensity, Rmax, and their changes will be reviewed.

4. Justification for the variation of the asymmetry with the translation speed will be reviewed.

5. Methods (including any software) used in verifying these logical relationships will be reviewed.

6. Time-based contour animations (capable of being paused) of windfield distributions demonstrating scientifically-reasonable windfield characteristics and logical relationships will be reviewed.

Pre-Visit Letter

7. M-6, Disclosure 2, page 154: Provide detail on the modeling of surface roughness and its impact on modeled windspeed.

Verified: YES

Professional Team Comments:

Reviewed the modeling of surface roughness and its impact on windspeed.

Reviewed the inverse relationship between surface windspeed and roughness length for simulations of Hurricane Dennis (2005).

Reviewed asymmetry in simulated windfields due to storm translation.

STATISTICAL STANDARDS – Mark Johnson, Leader

S-1 Modeled Results and Goodness-of-Fit*

*(*Significant Revision)*

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

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

Audit

1. Forms S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year; S-2, Examples of Hurricane Loss Exceedance Estimates; and S-3, Distributions of Stochastic Hurricane Parameters, will be reviewed. Justification for the distributions selected, including for example, citations to published literature or analyses of specific historical data, will be reviewed. Justification for the goodness-of-fit tests used will also be reviewed.

2. The modeling organization characterization of uncertainty for windspeed, damage estimates, annual hurricane loss, hurricane probable maximum loss levels, and hurricane loss costs will be reviewed.

Pre-Visit Letter

10. S-1, Disclosure 2, pages 165-166: Describe the computation of +3.3 mph bias. Is the 3 mph bias significant?

11. S-1, Disclosure 2, page 166: Provide a reference on biases in other risk models.

Verified: YES

Professional Team Comments:

Discussed that the +3.3 mph bias is the average bias across 2,728 ZIP Codes for all nine storms used in the validation. Reviewed the threshold of 56 mph for inclusion in the bias calculation. Discussed that this bias is not of practical significance.

Discussed that the statement related to biases in other risk models in the original submission was based on Dr. Mark Powell's expert opinion, and reviewed that it was removed from the revised March 14, 2021 submission.

Reviewed Forms S-1, S-2, S-3, S-4, and S-5.

Reviewed goodness-of-fit tests for landfall frequency, Holland-B parameter, and Rmax distributions.

Reviewed comparisons of the historical and modeled distributions.

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.

Audit

1. The modeling organization's sensitivity analysis will be reviewed in detail. Statistical techniques used to perform sensitivity analysis will be reviewed. The results of the sensitivity analysis displayed in graphical format (e.g., color-coded contour plots with temporal animation) will be reviewed.

2. Form S-6, Hypothetical Events for Sensitivity and Uncertainty Analysis, will be reviewed, if applicable.

Verified: YES

Professional Team Comments:

Discussed that no changes were made in model methodology from the previously-accepted model, and that no new sensitivity analyses were performed.

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.

Audit

1. The modeling organization uncertainty analysis will be reviewed in detail. Statistical techniques used to perform uncertainty analysis will be reviewed. The results of the uncertainty analysis displayed in graphical format (e.g., color-coded contour plots with temporal animation) will be reviewed.

2. Form S-6, Hypothetical Events for Sensitivity and Uncertainty Analysis, will be reviewed, if applicable.

Verified: YES

Professional Team Comments:

Discussed that no changes were made in model methodology from the previously-accepted model, and that no new uncertainty analyses were performed.

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.

Audit

1. A graph assessing the accuracy associated with a low impact area such as Nassau County will be reviewed. If the contribution error in an area such as Nassau County is small, the expectation is that the error in other areas would be small as well. The contribution of simulation uncertainty via confidence intervals will be reviewed.

Pre-Visit Letter

12. S-4, Disclosure 1, page 178: Provide the individual county standard errors.

Verified: YES

Professional Team Comments:

Reviewed the sorted standard errors as a percentage of hurricane loss cost estimates by county.

S-5 Replication of Known Hurricane Losses

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

Audit

1. The following information for each insurer and hurricane will be reviewed:
    a. The validity of the hurricane model assessed by comparing projected hurricane losses produced by the hurricane model to actual observed hurricane losses incurred by insurers at both the state and county level,
    b. The version of the hurricane model used to calculate modeled hurricane losses for each hurricane provided,
    c. A general description of the data and its source,
    d. A disclosure of any material mismatch of exposure and hurricane loss data problems, or other material consideration,
    e. The date of the exposures used for modeling and the date of the hurricane,
    f. An explanation of differences in the actual and modeled hurricane parameters,
    g. A listing of the departures, if any, in the windfield applied to a particular hurricane for the purpose of validation and the windfield used in the hurricane model under consideration,
    h. The type of coverage applied in each hurricane to address:
        1. Personal versus commercial
        2. Residential structures
        3. Manufactured homes
        4. Commercial residential
        5. Condominiums
        6. Structures only
        7. Contents only
        8. Time element,
    i. The treatment of demand surge or loss adjustment expenses in the actual hurricane losses or the modeled hurricane losses, and
    j. The treatment of flood losses (including hurricane storm surge losses) in the actual hurricane losses or the modeled hurricane losses.

2. The following documentation will be reviewed:
    a. Publicly available documentation referenced in the submission in hard copy or electronic form,

b. The data sources excluded from validation and the reasons for excluding the data from review by the Commission (if any),
c. An analysis that identifies and explains anomalies observed in the validation data, and
d. User input data for each insurer and hurricane detailing specific assumptions made with regard to exposed property.

3. The confidence intervals used to gauge the comparison between historical and modeled hurricane losses will be reviewed.

4. Form S-4, Validation Comparisons, will be reviewed.

5. The results of one hurricane event for more than one insurance company and the results from one insurance company for more than one hurricane event will be reviewed to the extent data are available.

Pre-Visit Letter

13. S-5, Disclosure 1, pages 179-181: Explain why the updates to modeled loss changed results for Hurricane Erin (1995), Hurricane Dennis (2005), and Hurricane Katrina (2005) and no other events.

Verified: YES

Professional Team Comments:

Discussed an error discovered resulting in losses not being computed for vulnerability matrices with missing or unknown year-built. Discussed the changes implemented to prevent the error from recurring.

Reviewed the validation process user manual for completing Form S-4.

Reviewed the modeled loss changes related to the windborne debris regions as proxies for coastal regions.

Reviewed the changes in the coastal and inland classifications of counties in the Panhandle related to the incorporation of the windborne debris region map from the 2001 edition of the Florida Building Code.

Reviewed Form S-4.

Reviewed revised table of personal residential actual and modeled losses for select companies and hurricanes and the associated revised scatter plot.

Discussed the use of concordance correlation as a measure of model-observation agreement.

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.

Audit

1. Form S-5, Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled, will be reviewed for consistency with Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7.

2. Justification for the following will be reviewed:
    a. Meteorological parameters,
    b. The effect of by-passing hurricanes,
    c. The effect of actual hurricanes that had two landfalls impacting Florida,
    d. The departures, if any, from the windfield, vulnerability functions, or insurance functions applied to the actual hurricanes for the purposes of this test and those used in the hurricane model under consideration, and
    e. Exposure assumptions.

Verified: YES

Professional Team Comments:

Reviewed Form S-5.

VULNERABILITY STANDARDS – Greg McLellan, Leader

V-1 Derivation of Building Hurricane Vulnerability Functions*

*(*Significant Revision)*

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

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

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

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

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

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

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).

Audit

1. Modifications to the building vulnerability component in the hurricane model since the previously-accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impacts on the building vulnerability component. Comparisons with the previously-accepted hurricane model will be reviewed.

2. Historical data in the original form will be reviewed with explanations for any changes made and descriptions of how missing or incorrect data were handled. When historical data are used to develop building hurricane vulnerability functions, the goodness-of-fit of the data will be reviewed. Complete reports detailing loading conditions and damage states for any laboratory or field testing data used will be reviewed. When rational structural analysis is used to develop building hurricane vulnerability functions, such analyses will be reviewed for a variety of different building construction classes. Laboratory or field tests and original post-event site investigation reports will be reviewed.

3. All papers, reports, and studies used in the continual development of the building hurricane vulnerability functions must be available for review in hard copy or electronic form.

4. Multiple samples of building hurricane vulnerability functions for commercial residential building structures, personal residential building structures, manufactured homes, and appurtenant structures will be reviewed. The magnitude of logical changes among these items for a given windspeed and validation materials will be reviewed.

5. Justification for the construction classes and characteristics used will be reviewed.

6. Validation of the building hurricane vulnerability functions and associated uncertainties will be reviewed.

7. Documentation and justification for the effects on the building hurricane vulnerability functions due to local and regional construction practices, and statewide and county building codes and their enforcement will be reviewed. If year of construction or geographical location of building is used as a surrogate for building code and code enforcement, complete supporting information for the number of year of construction groups used as well as the year-bands or geographical region(s) of construction that separate particular groups will be reviewed.

8. Validation material for the disclosed minimum windspeed will be reviewed. The computer code showing the inclusion of the minimum windspeed at which damage occurs will be reviewed.

9. How the claim practices of insurance companies are accounted for when claims data for those insurance companies are used to develop or to verify building hurricane vulnerability functions will be reviewed. Examples include the level of damage the insurer considers a loss to be a total loss, claim practices of insurers with respect to concurrent causation, the impact of public adjusting, or the impact of the legal environment.

10. The percentage of damage at or above which the hurricane model assumes a total structure loss will be reviewed.

11. The treatment of law and ordinance in building hurricane vulnerability functions will be reviewed.

12. A plot comparing building structure and appurtenant structure hurricane vulnerability functions will be reviewed.

13. A plot comparing appurtenant structure hurricane vulnerability functions with insurance claims data will be reviewed.

14. Form V-1, One Hypothetical Event, and the process for completing the form with respect to building damage will be reviewed.

Pre-Visit Letter

14. V-1, Disclosure 1, pages 200-209: Provide a comprehensive presentation detailing the updates made to the vulnerability components, including the methodology, data used, assumptions made, and results.

15. V-1, Disclosure 1, pages 200-209: Provide plots of the impacts on building, contents, and time element vulnerability functions relative to the same vulnerability functions in the previously-accepted model.

16. V-1, Disclosure 1, page 205: Regarding Equations 2 and 3,
    a. Explain and justify the use of "building insured limit" as opposed to "building replacement value" or "building value" used to calculate ρ.
    b. Define CA_limit in Equation 3.
    c. Explain how and where *IDR* is calculated for input to Equation 3.

17. V-1, Disclosure 2, page 210: Regarding Figure 50,
    a. Explain what is meant by "Randomize the Wind Speeds" on the left, when on the right it says "Define a wind speed."
    b. Explain what happens if the response to "Internal Pressure Changed?" is always "Yes" as a consequence of the steps "Randomize Building Components' Capacities" and "Randomize the Wind Speeds."

18. V-1, Disclosure 4, page 242: Describe in detail claims data for more recent hurricanes.

19. V-1, Disclosure 8, page 249: Justify the last column in Table 28 holding for all constructions in Florida from 2002 to present.

20. V-1, Disclosure 9, page 253: Explain the differences in Figure 56(a) with Figure 56(b), and why the red data point at 135 mph windspeed in (a) does not appear in (b), even though the damage ratio was only slightly over 6%. Explain how this exhibit is supportive of the model.

22. Form V-1, page 569: Explain the changes in Part B from the previously-accepted model.

Verified: YES

Professional Team Comments:

Discussed that the windborne debris map issued in the 2001 Florida Building Code (FBC) is assigned for the year-built range March 1, 2002 to February 28, 2009; the 2007 FBC windborne debris map is assigned for the year-built range March 1, 2009 to March 14, 2012; and the 2010 FBC windborne debris map is assigned for the year-built range March 15, 2012 to present.

Reviewed the new commercial residential low-rise interior and contents damage model to compute rainwater-induced damage to each interior component and contents and the changes from the previously-accepted model.

Reviewed the flowchart for implementation of the commercial residential low-rise interior and contents damage model.

Reviewed the rain propagation tests conducted at the Wall of Wind facility at Florida International University.

Reviewed the methodology for the updated cost participation factors for each exterior and interior building component. Reviewed examples of cost participation factors for exterior wall, roof sheathing, utilities, and interior partitions, ceilings, flooring, cabinets, electronics, and appliances.

Reviewed the calculations for determining the total building damage ratio.

Discussed that the new interior and contents damage model captures water intrusion at lower windspeeds.

Reviewed the differentiation in calculating losses between apartment buildings and condo associations.

Reviewed comparisons of building vulnerability functions for different building and construction types for the current model to the previously-accepted model.

Reviewed the changes to the mid/high-rise commercial residential model, including 1) differentiation for condo unit building interior and contents losses between condo-unit owner and condo-unit renter, and 2) calculation of condo loss if building location is known or unknown.

Discussed that the commercial residential mid/high-rise model calculates the weighted average of building expected loss for open and closed layout types based on the layout distribution table.

Discussed that missing data for total number of stories is assigned based on building value, location, and residency type.

Reviewed the process for assigning building area and number of units per story when the data are unknown.

Reviewed the updated calculation for exterior cost coefficients to ensure consistency between exterior damage and insured building value.

Reviewed the updated calculations for interior cost coefficients for apartment buildings and condo associations. Discussed that building insured limit is a proxy for building replacement value or building value since claims data usually provide only the insured limits.

Reviewed the changes in Form V-1 from the previously-accepted model.

Discussed that no new claims datasets have been received since the previously-accepted model and that the Office of Insurance Regulation has issued a claims data call for Hurricanes Irma (2017) and Michael (2018).

Discussed that claims data above 100% were excluded from the plot in Figure 57b.

Reviewed the flowchart for the procedure to convert the Monte Carlo simulations of external building damage into vulnerability matrices. Discussed the treatment of windspeed as a random variable.

Discussed that the vulnerability team evaluates the 3-year updates to the FBC to identify changes that warrant an update to the model. Criteria for a model update are 1) a FBC change item that indicates a clear improvement in wind resistance of building components, 2) the affected components fall within the granularity of the model and its intent to represent the aggregate, and 3) data are available that would allow a quantitative implementation of that change within the model.

Discussed that the vulnerability team is currently investigating the implications of the change in the 2020 FBC to adopt by reference ASCE 7-16 which includes changes to design wind loads on low-rise buildings.

Discussed the procedure for modeling older year-built homes with new roofs on a 20-year cycle.

Discussed the procedure for capturing total roof replacement when 25% of the roof covering is damaged and that the model default is to include law and ordinance costs in the modeled losses.

Documentation reviewed:

- Silva de Abreu, R.V., Pinelli, J.-P., Raji, F., Zisis, I. (2020). Testing and Modeling of Hurricane Wind-Driven Rainwater Ingress, Propagation, and Subsequent Interior Damage in Residential Buildings. Journal of Wind Engineering & Industrial Aerodynamics, Volume 207, December 2020, 104427, ISSN 0167-6105, https://doi.org/10.1016/j.jweia.2020.104427.
- Raji, F., Zisis, I., Pinelli, J.-P. (2020). Experimental Investigation of Wind-Driven Rain Propagation in a Building Interior. ASCE Journal of Structural Engineering.

V-2 Derivation of Contents Hurricane Vulnerability Functions*

*(*Significant Revision)*

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

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

Audit

1. Modifications to the contents vulnerability component in the hurricane model since the previously-accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impact on the contents vulnerability component. Comparisons with the previously-accepted hurricane model will be reviewed.
2. Multiple samples of contents hurricane vulnerability functions will be reviewed.
3. To the extent that historical data are used to develop mathematical depictions of contents hurricane vulnerability functions, the goodness-of-fit of the data to fitted models will be reviewed.
4. Justification for changes from the previously-accepted hurricane model in the relativities between hurricane vulnerability functions for building and the corresponding hurricane vulnerability functions for contents will be reviewed.
5. Justification and documentation for the dependence of contents hurricane vulnerability functions on construction or occupancy type will be reviewed.
6. Documentation and justification of the method of derivation and underlying data or assumptions related to contents hurricane vulnerability functions will be reviewed.
7. Form V-1, One Hypothetical Event, and the process for completing the form with respect to contents damage will be reviewed.

Verified: YES

Professional Team Comments:

Discussed that the commercial residential low-rise model now generates separate contents vulnerability curves for the overall building, an apartment building, and a condo association building.

Reviewed comparisons of contents vulnerability functions for different building and construction types for the current model to the previously-accepted model.

V-3 Derivation of Time Element Hurricane Vulnerability Functions*

*(*Significant Revision)*

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

B. The relationship between the hurricane model building and time element hurricane vulnerability functions shall be consistent with, and supported by, the relationship observed in historical data.

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

D. Time element hurricane vulnerability functions used by the hurricane model shall include time element hurricane losses associated with wind, missile impact, flood (including hurricane storm surge), and damage to the infrastructure caused by a hurricane.

Audit

1. Modifications to the time element vulnerability component in the hurricane model since the previously-accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impact on the time element vulnerability component. Comparisons with the previously-accepted hurricane model will be reviewed.

2. Multiple samples of time element hurricane vulnerability functions will be reviewed.

3. Documentation and justification of the method of derivation and underlying data or assumptions related to time element hurricane vulnerability functions will be reviewed.

4. Justification for changes from the previously-accepted hurricane model in the relativities between hurricane vulnerability functions for building and the corresponding hurricane vulnerability functions for time element will be reviewed.

5. To the extent that historical data are used to develop mathematical depictions of time element hurricane vulnerability functions, the goodness-of-fit of the data to fitted models will be reviewed.

6. Form V-1, One Hypothetical Event, and the process for completing the form with respect to time element loss will be reviewed.

Pre-Visit Letter

21. V-3, Disclosure 1, page 278: Explain equation (1).

Verified: YES

Professional Team Comments:

Reviewed the updated calculation for time-element expenses for apartment buildings in the commercial residential low-rise model and implementation in the code.

Discussed that time-element losses are capped at 100%.

Reviewed comparisons of time-element vulnerability functions for different building and construction types for the current model to the previously-accepted model.

V-4 Hurricane Mitigation Measures and Secondary Characteristics*

*(*Significant Revision)*

A. Modeling of hurricane mitigation measures to improve a building's hurricane wind resistance, the corresponding effects on hurricane vulnerability, and their associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles. These measures shall include fixtures or construction techniques that affect the performance of the building and the damage to contents and shall consider:

- ***Roof strength***
- ***Roof covering performance***
- ***Roof-to-wall strength***
- ***Wall-to-floor-to-foundation strength***
- ***Opening protection***
- ***Window, door, and skylight strength.***

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

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.

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

Audit

1. Modifications to hurricane mitigation measures and secondary characteristics in the hurricane model since the previously-accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications, and their impacts on the vulnerability component. Comparisons with the previously-accepted hurricane model will be reviewed.

2. Procedures, including software, used to calculate the impact of hurricane mitigation measures and secondary characteristics will be reviewed.

3. Form V-2, Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage; Form V-3, Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item); Form V-4, Differences in Hurricane Mitigation Measures and Secondary Characteristics; and Form V-5, Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), will be reviewed.

4. Implementation of individual hurricane mitigation measures and secondary characteristics will be reviewed as well as the effect of individual hurricane mitigation measures and secondary characteristics on damage. Any variation in the change over the range of windspeeds for individual hurricane mitigation measures and secondary characteristics will be reviewed. Historical data, technical literature, analysis or judgment based on fundamental engineering principles used to support the assumptions and implementation of the hurricane mitigation measures and secondary characteristics will be reviewed.

5. The treatment of roof age will be reviewed.

6. Implementation of multiple hurricane mitigation measures and secondary characteristics will be reviewed. The combined effects of these hurricane mitigation measures and secondary characteristics on damage will be reviewed. Any variation in the change over the range of windspeeds for multiple hurricane mitigation measures and secondary characteristics will be reviewed.

7. Hurricane mitigation measures and secondary characteristics used by the hurricane model, whether or not referenced in Form V-2, Hurricane Mitigation Measures, Range of Changes in Damage, and Form V-3, Hurricane Mitigation Measures, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), will be reviewed for theoretical soundness and reasonability.

Verified: YES

Professional Team Comments:

Reviewed Forms V-2, V-3, V-4, and V-5.

Discussed the model differences between impact-rated windows and shutter-protected windows.

ACTUARIAL STANDARDS – Stu Mathewson, Leader

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.

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.

Audit

1. Quality assurance procedures, including methods to assure accuracy of insurance or other input data, will be reviewed. Compliance with this standard will be readily demonstrated through documented rules and procedures.

2. All hurricane model inputs and assumptions will be reviewed to determine that the hurricane model output report appropriately discloses all modifications, adjustments, assumptions, and defaults used to produce the hurricane loss costs and hurricane probable maximum loss levels.

Pre-Visit Letter

23. A-1, Disclosure 4, pages 308-319: Explain the changes in the input form.

Verified: YES

Professional Team Comments:

Discussed the changes in the model input form.

Discussed the input data pre-processing steps provided in Table 31.

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.

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

Audit

1. The hurricane model will be reviewed to evaluate whether the determination of hurricane losses in the hurricane model is consistent with this standard.

2. The hurricane model will be reviewed to determine that by-passing hurricanes and their effects are considered in a manner that is consistent with this standard.

3. The hurricane model will be reviewed to determine whether and how the hurricane model takes into account any damage resulting directly and solely from flood (including hurricane storm surge).

4. The documented procedure for distinguishing wind-related hurricane losses from other peril losses will be reviewed.

Pre-Visit Letter

24. A-2.B, page 325: Provide a copy of the documented procedure.

Verified: YES

Professional Team Comments:

Reviewed the documented procedure for distinguishing wind losses from other peril losses.

A-3 Hurricane Coverages

A. The methods used in the calculation of building hurricane loss costs shall be actuarially sound.

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

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

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

Audit

1. The methods used to produce building, appurtenant structure, contents and time element hurricane loss costs will be reviewed.

2. The treatment of law and ordinance coverage will be reviewed, including the statutory required 25% and 50% coverage options for personal residential policies.

3. The treatment of loss assessment coverage for condo unit owners will be reviewed, including the statutory required $2,000 coverage option.

Pre-Visit Letter

25. A-3, Disclosures 1-4, pages 326-329: Show a calculation of loss costs and probable maximum loss levels for the minimum Frame Owners loss costs in Form A-1 (i.e., ZIP Code 32046 in Nassau County).

26. A-3, Disclosure 4, page 329: Explain how the model handles the statutory 25% and 50% coverages. Explain how the model accounts for loss assessment coverage of $2,000 for condos. (Audit items 2 and 3)

Verified: YES

Professional Team Comments:

Discussed with the Actuarial Standards signatory how she attested the model results to be actuarially sound.

Reviewed a calculation of frame-owners loss costs in Form A-1 and probable maximum loss levels for ZIP Code 32046 in Nassau County.

Discussed that law and ordinance coverage is embedded in the damage ratios and that a set of factors were created to remove the provision if the exposure input record indicates the coverage is not included. Discussed that there is no differentiation between the 25% and 50% options.

Discussed that loss assessment coverage is not explicitly considered in the model.

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.

B. Hurricane loss cost projections and hurricane probable maximum loss levels shall 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).

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

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.

Audit

1. How the hurricane model handles expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, economic inflation, and any criteria other than direct property insurance claim payments will be reviewed.

2. The method of determining hurricane probable maximum loss levels will be reviewed.

3. The uncertainty in the estimated annual hurricane loss costs and hurricane probable maximum loss levels will be reviewed.

4. The data and methods used to incorporate individual aspects of demand surge on personal and commercial residential hurricane losses, inclusive of the effects from building material costs, labor costs, contents costs, and repair time will be reviewed.

5. How the hurricane model accounts for economic inflation associated with past insurance experience will be reviewed.

6. The treatment of flood losses (including hurricane storm surge) in the determination of modeled hurricane losses will be reviewed.

7. All referenced literature will be reviewed, in hard copy or electronic form, to determine applicability.

Pre-Visit Letter

27. A-4, Disclosure 1, page 332: Provide, in Excel, tables of 1,000 years descending from the Top Event corresponding to Form A-8. For each year, show the value of each hurricane separately.

Verified: YES

Professional Team Comments:

Reviewed the top 1,000 years of hurricanes sorted by aggregate loss corresponding to Form A-8.

Reviewed the demand surge model documentation.

Reviewed implementation of demand surge factors.

A-5 Hurricane Policy Conditions*

*(*Significant Revision)*

A. The methods used in the development of mathematical distributions to reflect the effects of deductibles and policy limits shall be actuarially sound.

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

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

Audit

1. The process used to determine the accuracy of the insurance-to-value criteria in data used to develop and validate the hurricane model results will be reviewed.

2. To the extent that insurance claims data are used to develop mathematical depictions of deductibles, policy limits, policy exclusions, and loss settlement provisions, the goodness-of-fit of the data to fitted models will be reviewed.

3. To the extent that insurance claims data are used to validate the hurricane model results, the treatment of the effects of deductibles, policy limits, policy exclusions, loss settlement provisions, and coinsurance in the data will be reviewed.

4. Treatment of annual deductibles will be reviewed.

5. Justification for the changes from the previously-accepted hurricane model in the relativities among corresponding deductible amounts for the same coverage will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the implementation of annual hurricane deductibles.

A-6 Hurricane Loss Outputs and Logical Relationships to Risk*

*(*Significant Revision)*

A. The methods, data, and assumptions used in the estimation of hurricane loss costs and hurricane probable maximum loss levels shall be 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.

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

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

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

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

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

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

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.

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

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,***
2. ***personal residential risk exposure versus manufactured home risk exposure,***
3. ***inland counties versus coastal counties,***
4. ***northern counties versus southern counties, and***
5. ***newer construction versus older construction.***

A-6 Hurricane Loss Outputs and Logical Relationships to Risk* (Continued) *(*Significant Revision)*

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.

Audit

1. The data and methods used for hurricane probable maximum loss levels for Form A-8, Hurricane Probable Maximum Loss for Florida, will be reviewed. The hurricane associated with the Top Events will be reviewed.

2. The frequency distribution and the individual event severity distribution, or information about the formulation of events, underlying Form A-8, Hurricane Probable Maximum Loss for Florida, will be reviewed.

3. All referenced literature will be reviewed, in hard copy or electronic form, to determine applicability.

4. Graphical representations of hurricane loss costs by ZIP Code and county will be reviewed.

5. Color-coded maps depicting the effects of land friction on hurricane loss costs by ZIP Code will be reviewed.

6. The procedures used by the modeling organization to verify the individual hurricane loss cost relationships will be reviewed. Methods (including any software) used in verifying Standard A-6, Hurricane Loss Outputs and Logical Relationships to Risk, will be reviewed. Forms A-1, Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code; A-2, Base Hurricane Storm Set Statewide Hurricane Losses; A-3, Hurricane Losses; A-6, Logical Relationship to Hurricane Risk (Trade Secret Item); and A-7, Percentage Change in Logical Relationship to Hurricane Risk, will be reviewed to assess coverage relationships.

7. The hurricane loss cost relationships among deductible, policy form, construction type, coverage, year of construction, building strength, number of stories, territory, and region will be reviewed.

8. Forms A-4, Hurricane Output Ranges, and A-5, Percentage Change in Hurricane Output Ranges, will be reviewed, including geographical representations of the data where applicable.

9. Justification for all changes in hurricane loss costs from the previously-accepted hurricane model will be reviewed.

10. Form A-4, Hurricane Output Ranges, will be reviewed to ensure appropriate relativities among deductibles, coverages, and construction types.

11. Apparent anomalies in the hurricane output ranges and their justification will be reviewed.

Pre-Visit Letter

28. A-6, Disclosure 15, page 346: Explain the changes for Personal Residential and Commercial Residential coverages and the weighting used to arrive at the overall decrease of 11.35%.

29. Form A-1: Explain the large changes in ZIP Codes 32192 and 33421.

30. Form A-1: Explain why there are no new ZIP Codes in the current Form A-1 relative to the previously-accepted model Form A-1.

31. Form A-1: Explain the increase in loss costs for Manufactured Homes relative to the decreases in Frame Owners and Masonry Owners.

32. Form A-1: Explain the apparent inconsistency in Frame Owners and Masonry Owners between Form A-1 and Figure 22 (page 113).

33. Form A-1, pages 409-411: Reconcile the changes in Form A-1 from the previously-accepted model with Standard A-6 Disclosure 15 (page 346), which shows a personal residential decrease of 5.6%.

34. Form A-2, page 414-417: Explain the changes from the previously-accepted model for hurricanes Ike (2008), Georges (1998) and Betsy (1965).

35. Form A-3, Figure 75, page 352: Explain why there is no damage shown near the storm track.

36. Form A-4, 0% Deductible, pages 445-454: Explain the reversal in loss costs where Frame is less than Masonry:
    Owners: Gulf Average, Pasco Average, St. Johns Average,
    Renters: Brevard Average, Calhoun Average, Wakulla Average, and
    Condo Unit: Okeechobee Average, Volusia Average, Wakulla Average.

37. Form A-4, page 458: With Form A-1 having only one ZIP Code for Glades County (33471), explain Form A-4 showing different loss costs for Low, Average, and High for all construction/policy combinations.

38. Form A-4, page 459: Explain the values given for Lafayette County Low, Average, and High for Frame Owners, Masonry Owners, and Manufactured Homes.

39. Form A-5, Figures 79 and 80, pages 359 and 360: Reconcile the figures for Frame and Masonry Owners for Miami-Dade and Broward Counties showing greater than 9% decreases, compared to the large increases for Average loss costs in Form A-4.

40. Form A-7, page 515: Reconcile the statewide changes shown in Form A-7 with Standard A-6 Disclosure 15 (page 346), which shows a personal residential decrease of 5.6%.

41. Form A-8.A, page 528: Explain the large decreases in Number of Hurricanes for ranges starting at $75,000 million, compared to the previously-accepted model.

42. Form A-8, pages 528-529: Provide details on the calculation of the uncertainty intervals.

Verified: YES

Professional Team Comments:

Reviewed the exposure weighting for the personal residential and commercial residential loss costs.

Discussed that the increases in Form A-1 for ZIP Codes 32192, 33421, and 32079 are due to ZIP Code changes.

Discussed that the ZIP Code data update did not include any new ZIP Codes to the previously-accepted model.

Discussed the changes in Form A-1 from the previously-accepted model, including changes introduced to the Form A-1 notional input exposure file and model changes.

Discussed that the changes in Form A-2 from the previously-accepted model for Hurricanes Ike (2008), Georges (1998), and Betsy (1965) were due mainly to the changes in the commercial residential low-rise and mid/high-rise models.

Reviewed map of Form A-3 losses by ZIP Code with a revised Rmax and track for Hurricane Hermine (2016).

Discussed the loss costs in Form A-4 where frame loss costs are less than masonry loss costs and the underlying reasons for the results.

Discussed loss costs in Form A-4 for Lafayette County.

Discussed that the statewide changes in Form A-7 reflect the impact of HURDAT2 updates and additional exposures now qualifying for lower retrofitted vulnerabilities due to their age.

Reviewed revised Form A-8. Discussed the methodology for calculating the uncertainty intervals. Reviewed the frequency and severity distributions.

Discussed the reasons for the errors in completing the uncertainty intervals in Form A-8.

Reviewed Form A-6 and the reasonableness checks of the loss costs performed by the modeler.

Reviewed Form A-5 maps of changes in loss costs by county from the previously-accepted model.

Reviewed map of the effect of surface roughness changes from the previously-accepted model on loss costs by ZIP Code.

COMPUTER/INFORMATION STANDARDS – Paul Fishwick, Leader

CI-1 Hurricane Model Documentation

A. Hurricane model functionality and technical descriptions shall be documented formally in an archival format separate from the use of letters, slides, and unformatted text files.

B. A primary document repository shall be maintained, containing or referencing a complete set of documentation specifying the hurricane model structure, detailed software description, and functionality. Documentation shall be indicative of current model development and software engineering practices.

C. All computer software (i.e., user interface, scientific, engineering, actuarial, data preparation, and validation) relevant to the hurricane model shall be consistently documented and dated.

D. The following shall be maintained: (1) a table of all changes in the hurricane model from the previously-accepted hurricane model to the initial submission this year, and (2) a table of all substantive changes since this year's initial submission.

E. Documentation shall be created separately from the source code.

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.

Audit

1. The primary document repository, in either electronic or physical form, and its maintenance process will be reviewed. The repository should contain or reference full documentation of the software.

2. All documentation should be easily accessible from a central location in order to be reviewed.

3. Complete user documentation, including all recent updates, will be reviewed.

4. Modeling organization personnel, or their designated proxies, responsible for each aspect of the software (i.e., user interface, quality assurance, engineering, actuarial, verification) should be present when the Computer/Information Standards are being reviewed. Internal users of the software will be interviewed.

5. Verification that documentation is created separately from, and is maintained consistently with, the source code will be reviewed.

6. The list of all externally acquired hurricane model-specific software and data assets will be reviewed.

7. The tables specified in CI-1.D that contain the items listed in Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7 will be reviewed. The tables should contain the item number in the first column. The remaining five columns should contain specific document or file references for affected components or data relating to the following Computer/Information Standards: CI-2, Hurricane Model Requirements; CI-3, Hurricane Model Organization and Component Design; CI-4, Hurricane Model Implementation; CI-5, Hurricane Model Verification; and CI-6, Hurricane Model Maintenance and Revision.

8. Tracing of the hurricane model changes specified in Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7 and Audit 6 through all Computer/Information Standards will be reviewed.

Pre-Visit Letter

43. CI-1.B, page 387: Relate the primary binder table of contents with the response to Standard G-1 Disclosure 7 (pages 101-113) by demonstrating individual table item compliance with Computer/Information Standards CI-1 through CI-7.

44. CI-1.D, page 388: Provide the table required by Standard CI-1 Audit Item 7.

45. CI-1.F, page 388: Provide the list of all externally-acquired hurricane model-specific software and data assets as described and required by Standard CI-1 Audit Item 6.

Verified: YES

Professional Team Comments:

Reviewed the User Manual for the Form S-4 validation process.

Reviewed the table relating items in the model changes table to the Computer/Information Standards.

Reviewed the table of changes as required by CI-1.D.

Reviewed the list of externally-acquired hurricane model-specific software and data sources.

Reviewed the development process for model change documentation.

Discussed the use of Source Versioning System (SVN) for storing code, data files, and documentation.

Discussed that team communications are handled via email, an instant messaging application, and Zoom meetings.

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.

Audit

1. Maintenance and documentation of a complete set of requirements for each software component, database, and data file accessed by a component will be reviewed.

Pre-Visit Letter

46. CI-2, page 389: Provide requirements documentation that specifically relates to each model change identified in Standard G-1 Disclosure 7 (pages 101-113).

Verified: YES

Professional Team Comments:

Reviewed software requirements documentation of model changes.

Reviewed revised software requirements documenting the changes from version 8.0 to version 8.1.

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.

B. All flowcharts (e.g., software, data, and system models) shall be based on (1) a referenced industry standard (e.g., Unified Modeling Language (UML), Business Process Model and Notation (BPMN), Systems Modeling Language (SysML)), or (2) a comparable internally-developed standard which is separately documented.

Audit

1. The following will be reviewed:
    a. Detailed control and data flowcharts, completely and sufficiently labeled for each component,
    b. Interface specifications for all components in the hurricane model,
    c. Documentation for schemas for all data files, along with field type definitions,
    d. Each network flowchart including components, sub-component flowcharts, arcs, and labels,
    e. Flowcharts illustrating hurricane model-related information flow among modeling organization personnel or consultants (e.g., BPMN, UML, SysML, or equivalent technique including a modeling organization internal standard), and
    f. If the hurricane model is implemented on more than one platform, the detailed control and data flowcharts, component interface specifications, schema documentation for all data files, and detailed network flowcharts for each platform.

2. A hurricane model component custodian, or designated proxy, should be available for the review of each component.

3. The flowchart reference guide or industry standard reference will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed control and data flowcharts and verified the compliance of the flowcharts with ISO Standard 5807.

Reviewed the model flow diagram.

Reviewed the flowchart of the process to assure continual agreement and correct correspondence of databases, data files, and code to presentation slides, technical papers, and model documentation.

Reviewed the flowchart for processing changes in HURDAT2 data.

Reviewed the flowchart for implementation of the commercial residential low-rise interior and contents damage model.

CI-4 Hurricane Model Implementation*

*(*Significant Revision)*

A. A complete procedure of coding guidelines consistent with accepted software engineering practices shall be maintained.

B. Network organization documentation shall be maintained.

C. A complete procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components shall be maintained.

D. All components shall be traceable, through explicit component identification in the hurricane model representations (e.g., flowcharts) down to the code level.

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.

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.

G. The following documentation shall be maintained for all components or data modified by items identified in Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7 and Audit 6:

1. A list of all equations and formulas used in documentation of the hurricane model with definitions of all terms and variables, and

2. A cross-referenced list of implementation source code terms and variable names corresponding to items within G.1 above.

Audit

1. The interfaces and the coupling assumptions will be reviewed.

2. The documented coding guidelines, including procedures for ensuring readable identifiers for variables, constants, and components, and confirmation that these guidelines are uniformly implemented will be reviewed.

3. The procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components will be reviewed.

4. The traceability among components at all levels of representation will be reviewed.

5. The following information will be reviewed for each component, either in a header comment block, source control database, or the documentation:
    a. Component name,
    b. Date created,
    c. Dates modified, modification rationale, and by whom,
    d. Purpose or function of the component, and
    e. Input and output parameter definitions.

6. The table of all software components as specified in CI-4.E will be reviewed.

7. Hurricane model components and the method of mapping to elements in the computer program will be reviewed.

8. Comments within components will be reviewed for sufficiency, consistency, and explanatory quality.

9. Unique aspects within various platforms with regard to the use of hardware, operating system, and essential software will be reviewed.

10. Network organization implementation will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the coding guidelines.

Reviewed the modeler's plan for ongoing continuous improvement and quality control for code within the model so that the code is consistent with all CI Standards.

Discussed the importance of variable naming convention.

Reviewed examples of comments in the code. Discussed the significance of having sufficient explanatory and quality comments.

Reviewed implementation of coastal transition of winds.

Reviewed implementation of HURDAT2 changes in calculating landfall distributions.

Reviewed code to generate PDFs for the storm track model.

Reviewed the network diagram and hardware configuration of servers.

Reviewed terms and variables associated with time-element losses.

Reviewed implementation of time-element losses.

Reviewed implementation of demand surge factors.

Reviewed terms and variables associated with annual hurricane deductibles.

Reviewed implementation of annual hurricane deductibles.

Discussed that automated scripts were created to generate and arrange the data for Forms M-1, M-3, S-1, S-2, A-3, A-4, A-5, A-6, A-7, and A-8.

Discussed the reasons for the error in completing Form A-1. Discussed that a post-processing script was written to automate the process and prevent the error from recurring. Discussed that the User Manual was updated to reflect the newly implemented post-processing methodology.

Discussed the reasons for the error in implementing two of the changes to the commercial residential model in producing the submission forms and how the error was discovered. Discussed that the modeler, in an effort to prevent this type of error from recurring, will improve communication between the engineering and computer teams to ensure that all model changes are properly understood.

Discussed the various programming languages used by the modeler.

Reviewed the table of all software components that contains the number of lines of code by project.

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.

B. Component Testing

1. ***Testing software shall be used to assist in documenting and analyzing all components.***

2. ***Unit tests shall be performed and documented for each component.***

3. ***Regression tests shall be performed and documented on incremental builds.***

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.***

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.***

Audit

1. The components will be reviewed for containment of sufficient logical assertions, exception-handling mechanisms, and flag-triggered output statements to test the correct values for key variables that might be subject to modification.

2. The testing software used by the modeling organization will be reviewed.

3. The component (unit, regression, integration) and data test processes and documentation will be reviewed including compliance with independence of the verification procedures.

4. Fully time-stamped, documented cross-checking procedures and results for verifying equations, including tester identification, will be reviewed. Examples include mathematical calculations versus source code implementation or the use of multiple implementations using different languages.

5. Flowcharts defining the processes used for manual and automatic verification will be reviewed.

6. Verification approaches used for externally acquired data, software, and models will be reviewed.

Pre-Visit Letter

47. CI-5, pages 393-395: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1 Disclosure 7 (pages 101-113).

Verified: YES

Professional Team Comments:

Reviewed the verification procedures for the model changes.

Reviewed the input data pre-processing steps.

Reviewed the series of logical tests performed on the loss cost relationships in Form A-6.

Discussed the testing software used for unit testing. Reviewed an example of a unit test and the test results.

CI-6 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.

B. A revision to any portion of the hurricane model that results in a change in any Florida residential hurricane loss cost or hurricane probable maximum loss level shall result in a new hurricane model version identification.

C. Tracking software shall be used to identify and describe all errors, as well as modifications to code, data, and documentation.

D. A list of all hurricane model versions since the initial submission for this year shall be maintained. Each hurricane model description shall have a unique version identification and a list of additions, deletions, and changes that define that version.

Audit

1. All policies and procedures used to review and maintain the code, data, and documentation will be reviewed. For each component in the system decomposition, the installation date under configuration control, the current version identification, and the date of the most recent change(s) will be reviewed.
2. The policy for hurricane model revision and management will be reviewed.
3. Portions of the code, not necessarily related to recent changes in the hurricane model, will be reviewed.
4. The tracking software will be reviewed and checked for the ability to track date and time.
5. The list of all hurricane model revisions as specified in CI-6.D will be reviewed.

Pre-Visit Letter

48. CI-6.D, page 396: Provide the model version history over the past 5 years, leading up to the version identified in the submission.

Verified: YES

Professional Team Comments:

Reviewed the model version history.

Reviewed the model maintenance and revision documentation. Discussed the rules that trigger a change in the major version number and the minor version number.

CI-7 Hurricane Model Security

Security procedures shall be implemented and fully documented for (1) secure access to individual computers where the software components or data can be created or modified, (2) secure operation of the hurricane model by clients, if relevant, to ensure that the correct software operation cannot be compromised, (3) anti-virus software installation for all machines where all components and data are being accessed, and (4) secure access to documentation, software, and data in the event of a catastrophe.

Audit

1. The written policy for all security procedures and methods used to ensure the security of code, data, and documentation will be reviewed.

2. Documented security procedures for access, client hurricane model use, anti-virus software installation, and off-site procedures in the event of a catastrophe will be reviewed.

3. Security aspects of each platform will be reviewed.

4. Network security documentation and network integrity assurance procedures will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the security policies. Discussed that there have been no recent updates to the security procedures.

Discussed that there have been no security breaches.

Florida Public Hurricane Loss Model V8.0
Report on errors in initial submission
March 2021

1. Report on Form A-1 error

There was an error in generating Form A1. The loss costs presented were for structure loss rather than total loss. Form A-1 consists of one table with zip code-level hurricane lost costs grouped by three columns of the corresponding loss based on the policy's construction type.

Hurricane loss costs per $1,000 are computed during post-processing from the losses generated by the model. The data in these files are then copied to the form template to produce a single final document. However, during the copying process, the column with Structured Loss Cost values were copied over Form A-1 rather than the expected Total Loss Cost. The problem was limited to selecting the correct column for the computed total hurricane loss costs per $1000 since the values themselves are correct. Maps showing these results were affected as they are created from selecting the same hurricane loss cost data used for Form A-1.

To correct this mistake, we have updated the post-processing steps using an automatic script to select the correct column value, enter the information into the form, and generate the map without user intervention. To prevent this from happening in the future, we have added instructions on using the newly implemented post-processing method to create this form and its associated maps.

Revised form A1 and the associated maps are being submitted.

2. Report on CR-MHR Model Change Implementation Misinterpretation

The engineering team made a number of changes to the Mid-/high-rise buildings (MHR) model. Two of the changes were not implemented in producing the forms. More specifically, of the changes in MHR model listed in G1.7 on pages 102-103 of the November 20201 submission document, the following two were not implemented:
Part (a) bullet point #3: Assignment of missing information like total # of stories based on insurance stats.
Part (c) The model makes-up for missing data on building geometry (# of stories, building area, # of units per story) in a way consistent with the information available in the portfolio (insured value of the building and location).

When we implemented the programming steps of a new component to process commercial residential mid-/high-rise (CR-MHR) policies following the engineering team's documentation, a step in the documented process was misinterpreted, which impacted the commercial residential policies' losses. We have identified the issue and modified the implementation accordingly. All forms impacted by the error have been re-generated. More specifically, the CR losses in forms A2-A8, S2, S4, S5, and V1 were updated and are being submitted.