
June 2011

# RMS Version 2011
# Atlantic Hurricane Models Update

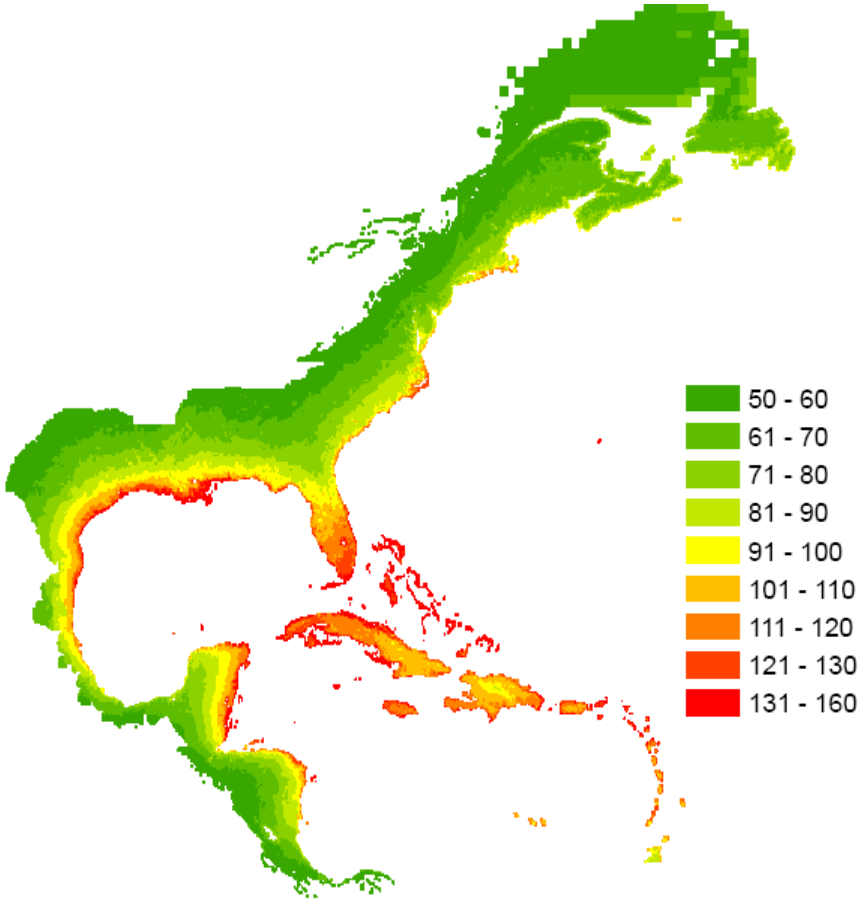
Michael Kistler

Nat Cat & Portfolio Solutions

# Overview of Model Upgrade

# The Atlantic Basin Hurricane Models of 2011

- Major upgrade to event set and wind and surge modeling bringing in new data and research since 2003 and some recalibration of vulnerabilities
- Link all country models with the same event set
  - Improve workflows for multi-region writers by removing windstorm converter between US and CB models
  - Regional modeling capabilities implemented
- Adding new countries:
  - Canada
  - Mexico
  - Central America: Belize, Costa Rica, Guatemala, Honduras, and Panama
  - Bermuda added to the Caribbean




**100 Year Wind Hazard – 3s Peak Gust**

# Key Elements of the v11 Atlantic Hurricane Model

- **Unprecedented increase in quality and quantity of data informing release**

  10x more wind observations than used in current model, additional claims data

- **Super computing power** enables extra insights using numerical modeling, completely new storm surge modeling approach

- **Increased transparency into key uncertainties**
  - Surge losses under wind policies
  - Vulnerability uncertainty

- **Stamp of approval**

Database of more than 20,000 windspeed observations, including ground level and flight level data is the "most complete possible" – Bob Hart

# Collaborations, Publications and Reviews

- Three year RMS R&D project involving 20+ incld six PhDs
- RMS worked with leading experts in Hurricane modeling
  - Dave Nolan - Associate Professor at University of Miami
    - 10+ years experience in numerical simulations

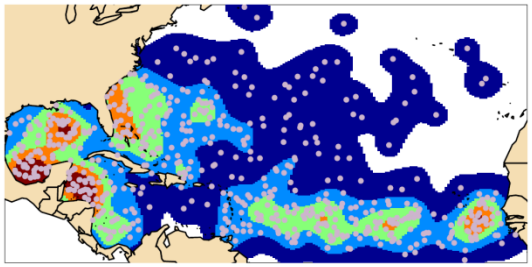
**Peer-reviewed publication on inland filling: "Using Mesoscale Simulations to Train Statistical Models of Tropical Cyclone Intensity over Land" ,** Colette, A., Leith N., Daniel, V., Bellone, E, Nolan D.S. *Monthly Weather Review* Vol. 138, No. 6. (June 2010)

- Bob Hart (Associate Professor, FSU):
  - Reviewer for overall hazard model

"Considerable new research and datasets have been incorporated into the new model, leading to an improvement on the regionalization of the risk. The most significant improvements appear to be in modeling inland wind threat, the threat to New England from both pure hurricanes and transitioning hurricanes, as well as improved representation of surface roughness across over-water and urban areas. " – Bob Hart, PhD

# Building the Track Set

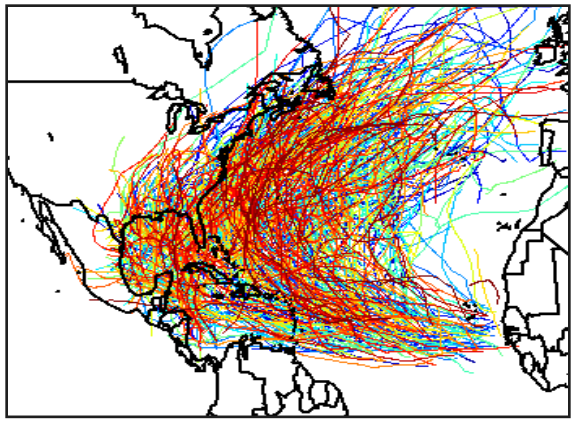
1. Genesis – where storms start



2. Where the hurricanes go after genesis

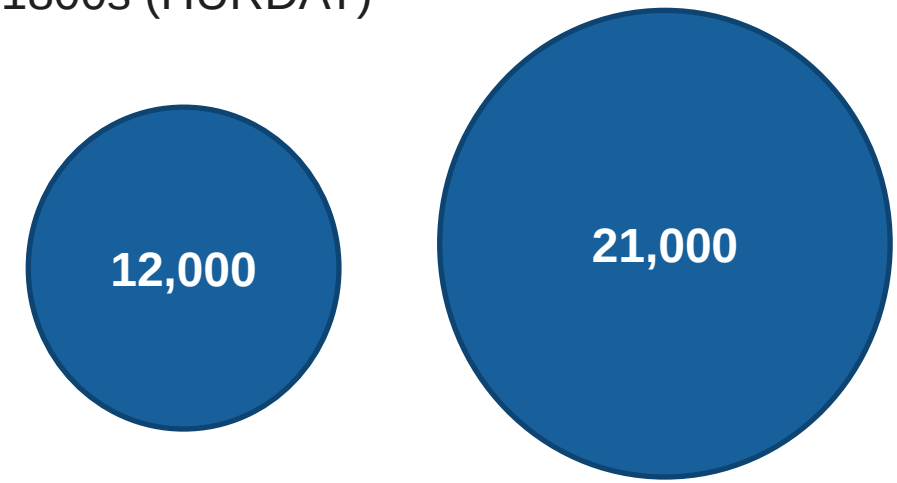

3. Storm parameters over the course of the track
   - Pressure, Vmax, Rmax

**Landfall Rates**
**Correlation Across the Basin**

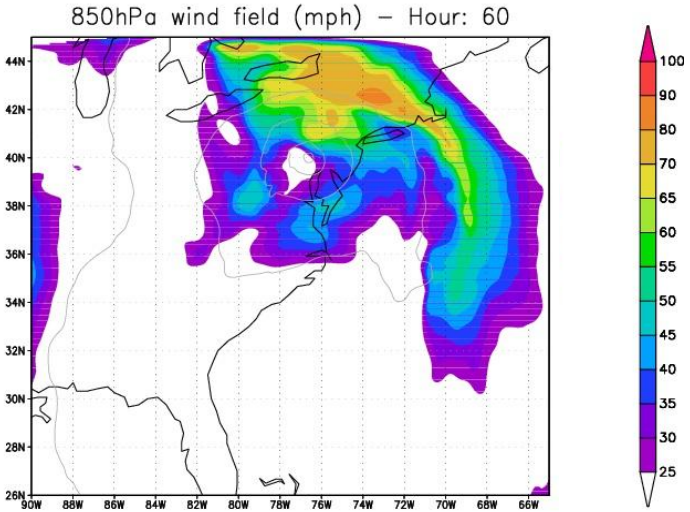


# Revolution in Understanding Windfields

- More data PLUS advances in computer power
  - Approximately 10x more wind and surge data used to inform hazard module
- Last RMS hazard model update 2003
- More hurricanes in the last decade, plus more knowledge of history back to mid-1800s (HURDAT)



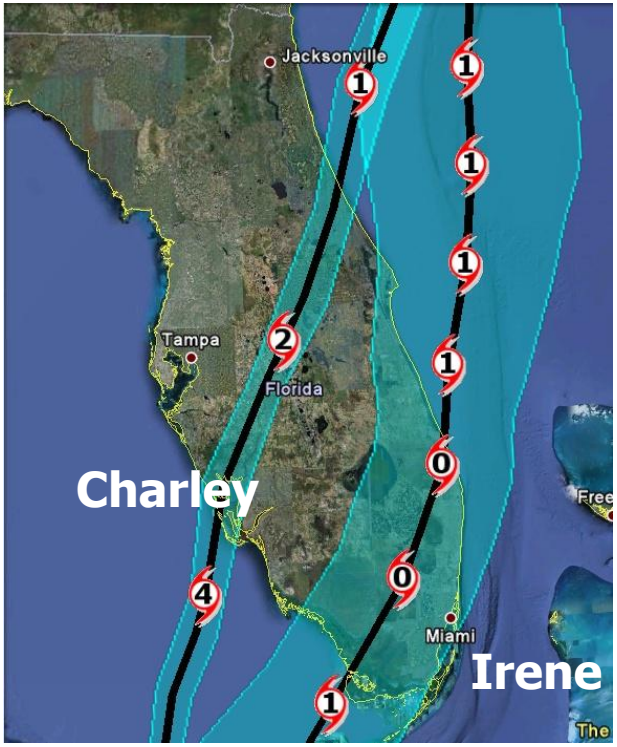

- Largest ever numerical modeling study of hurricane behavior adds more insight



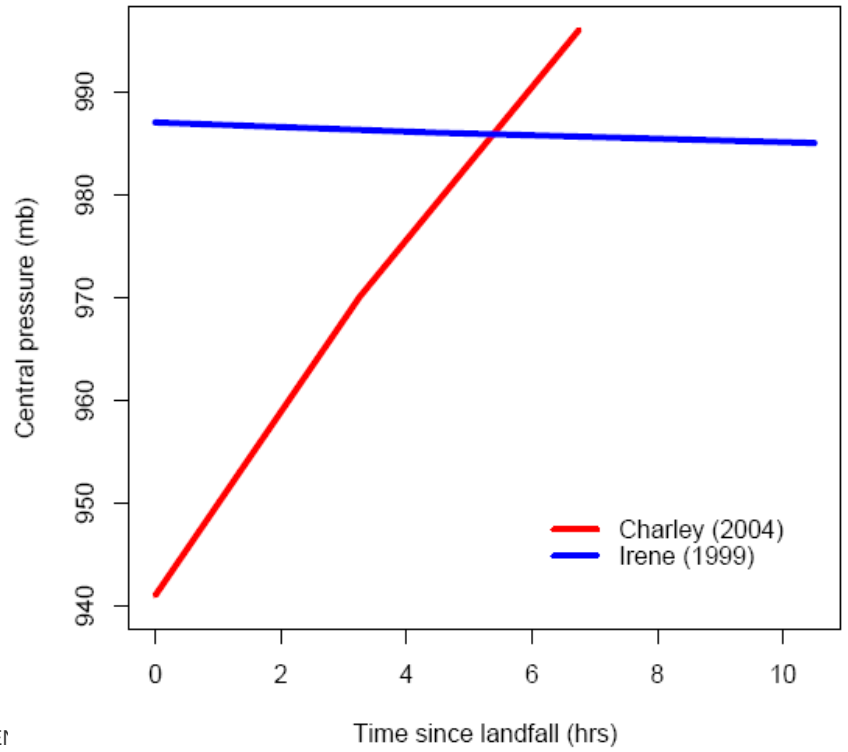

Database of more than 20,000 windspeed observations, including ground level and flight level data is the "most complete possible" – Bob Hart

# Increased Information on Inland Risk

- "Inland filling" characterizes how the eye of the storm "fills" after landfall and the pressure increases as hurricanes are removed from their primary energy source
- Not all storms fill in the same way - but detailed multi-parameter data limited to last 20 yrs
  - Limited information to guide the simulations of a hurricane's decay after it makes landfall



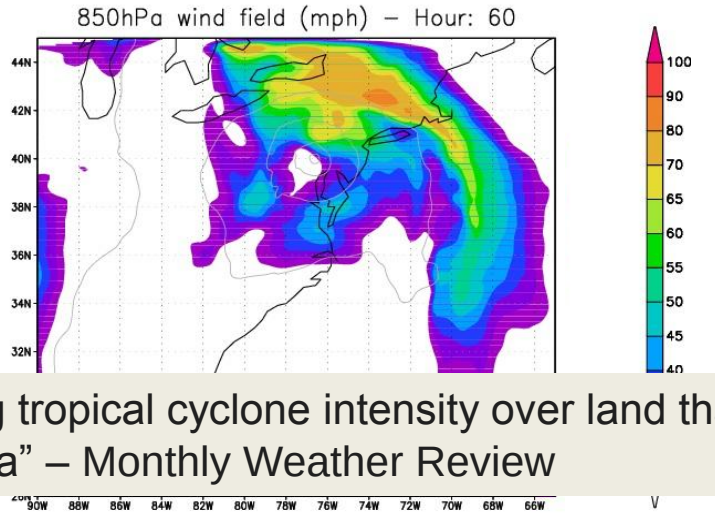

**Pressure time series from landfall**



# Bringing New Modeling Methods to Fill the Gaps

- RMS conducted largest ever numerical modelling study of hurricane behavior at and post landfall
  - Increases the number of storms by approx 40X compared to historical record
- Used in combination with available data to produce a new model of inland filling
- Peer reviewed methodology

Using Mesoscale Simulations to Train Statistical Models of Tropical Cyclone Intensity over Land *Monthly Weather Review* **Vol. 138, No. 6.** (June 2010)

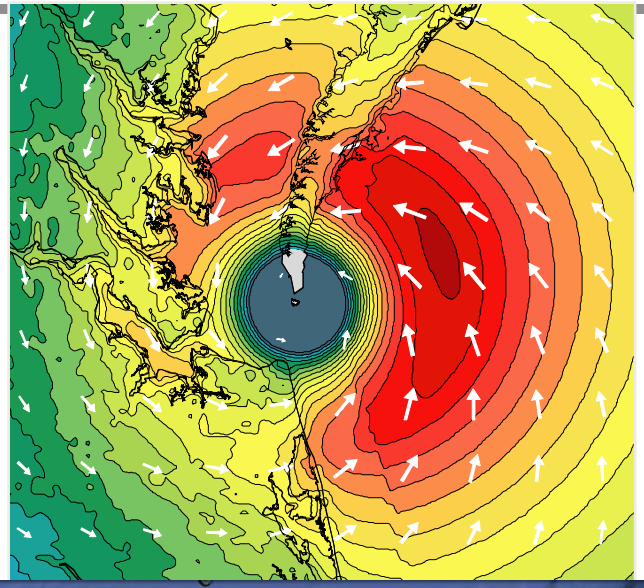


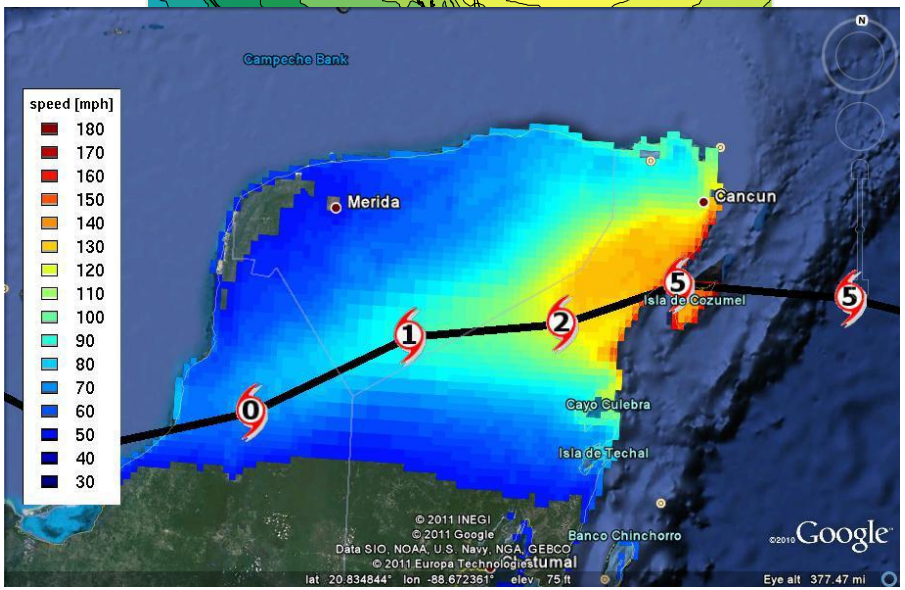

"These [RMS] models have more skill at predicting tropical cyclone intensity over land than similar models trained exclusively on historical data" – Monthly Weather Review

"incorporation of an improved inland decay model that models much more correctly the rate of decay inland" – Bob Hart

# Modeling Wind Speed at a Location

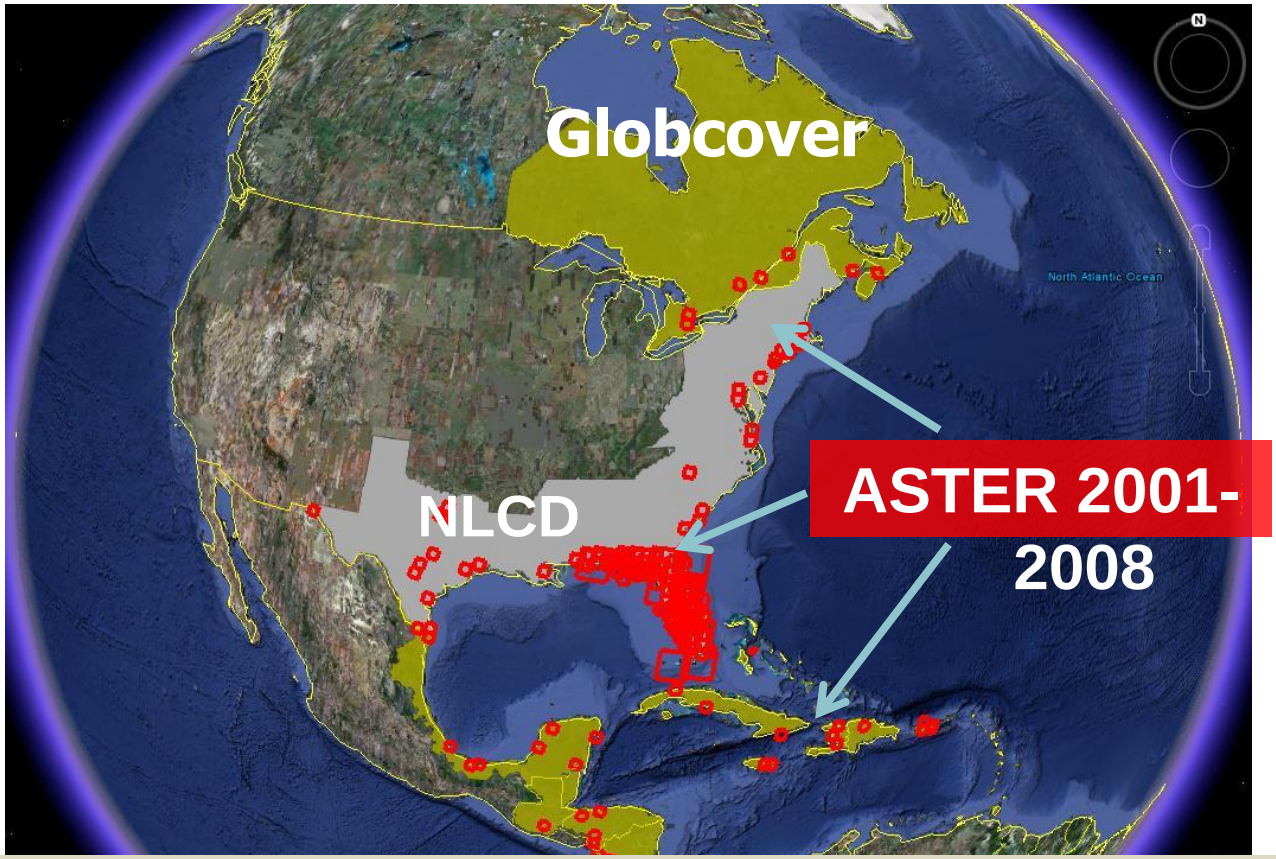
- To calculate wind speeds for specific locations, the windfield model must consider:
  - Direction of approaching winds
  - Terrain/roughness upwind
  - Topography
  - Weakening/filling of storm during and after landfall
- Time-stepping directional windfield
  - Upwind roughness sampled 80 km in eight directions
  - Each hurricane windfield modeled at 5-minute intervals
  - Highest wind speed stored at each location over the passage of a storm





# Surface Roughness: More Realistic Modeling

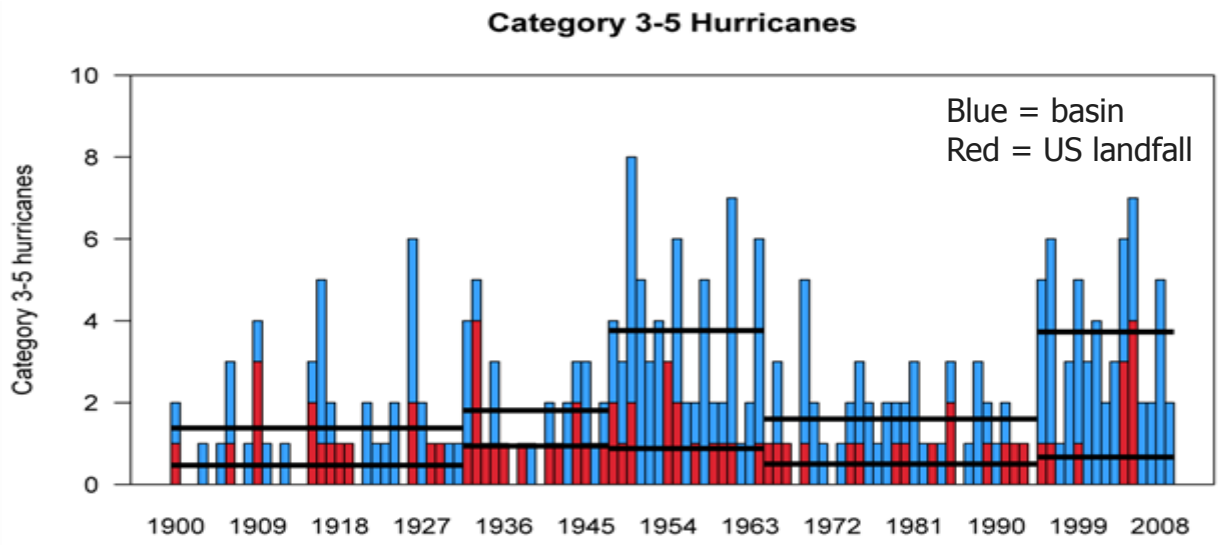
- Winds encounter friction as they approach a location
- ASTER = high-res satellite data, used for Florida and metro areas (up to 15 meters)
- National Land Cover Data (NLCD) – free but lower resolution (30 meter resolution)
- Globcover – outside the U.S. global land cover 300 meters




"The new version of NAHU has an improved roughness model that leads to several important improvements in realistic modeling of the details of the wind risk across a surface with varying roughness.
Specifically, the use of ASTER imagery in Florida and all U.S. metropolitan regions has lead to a more realistic and consistent surface roughness database." – Bob Hart

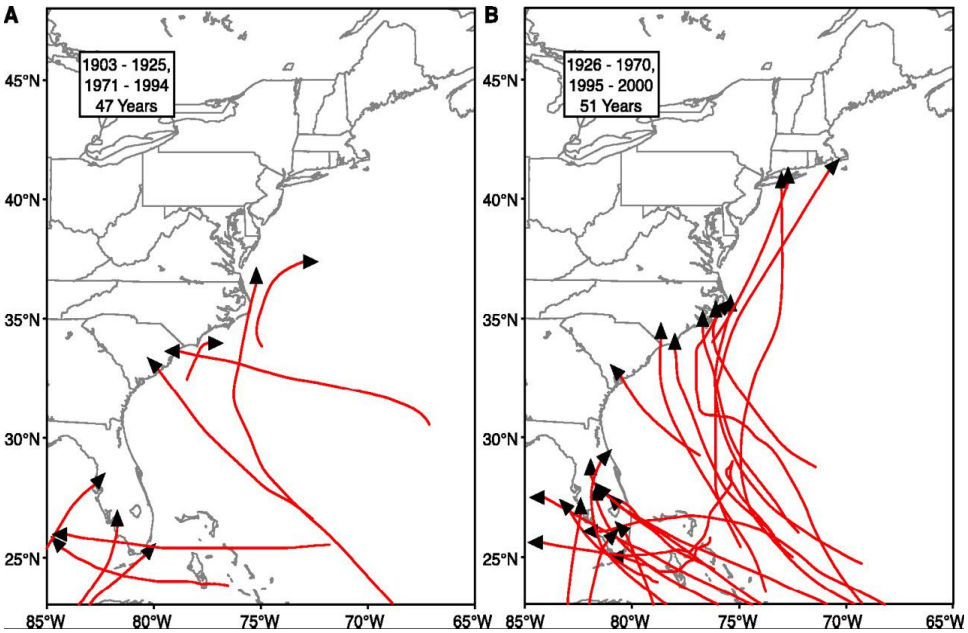
# Medium-Term Rates Forecast – Higher SSTs = Higher Expected Activity Levels

- Scientific consensus continues that we are currently in a period of elevated activity compared to the long term average of history
  - And that the Atlantic Basin exhibits phases of higher and lower activity throughout history
- Using the average of long-term historical activity will overestimate frequency during periods of lower activity and underestimate frequency during periods of higher activity
- RMS introduced “medium term rates” in 2006 to reflect expected activity levels over the subsequent 5 years
  - Annual volatility is high due to short-scale variations in steering patterns etc.

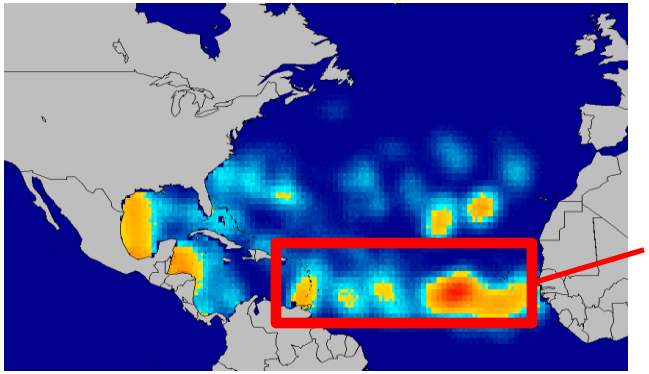


# Regional Changes in Hurricane Activity

- Changes in SSTs change geographical patterns of activity as well as the overall activity rates
- This shift has been seen in the observations: post-1995 storms tend to form further to the east, e.g. hurricane Julia in 2010 set the record for the most intense storm the furthest east in the Atlantic Basin.
- For v11 we are using a new hurricane track-generation model with the warmed SSTs to compared to historical SSTs, to determine impact on regional distribution of landfalls
- Atlantic Florida is particularly vulnerable to MDR-origin storms, though not as much as the Caribbean.

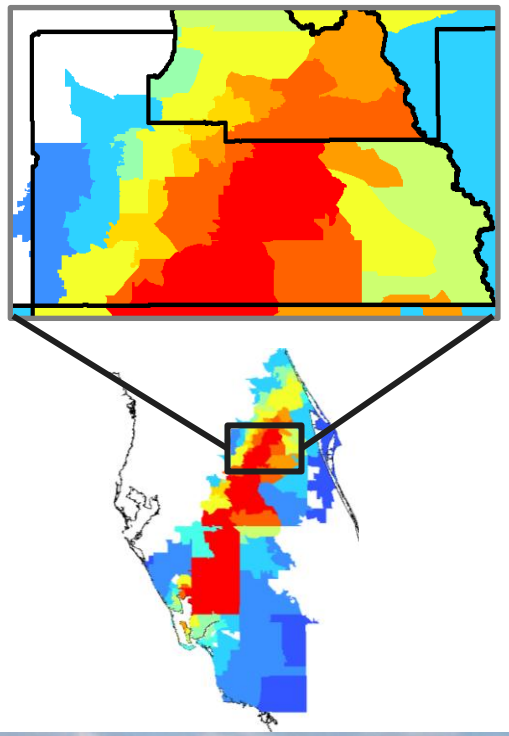



Tracks of major US east coast landfalling hurricanes in cold phases (left panel) and warm phases (right panel) of the AMO.

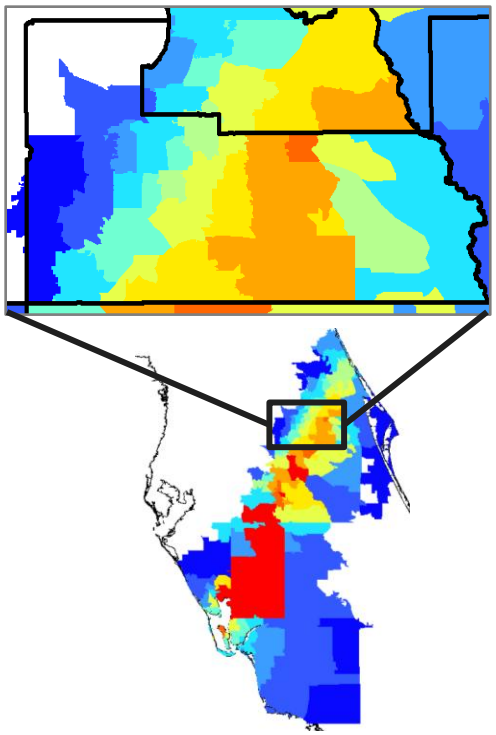


# Charley Wind Speed Return Periods: Orange Co., FL

**RiskLink 10.0**



**RiskLink 11.0**

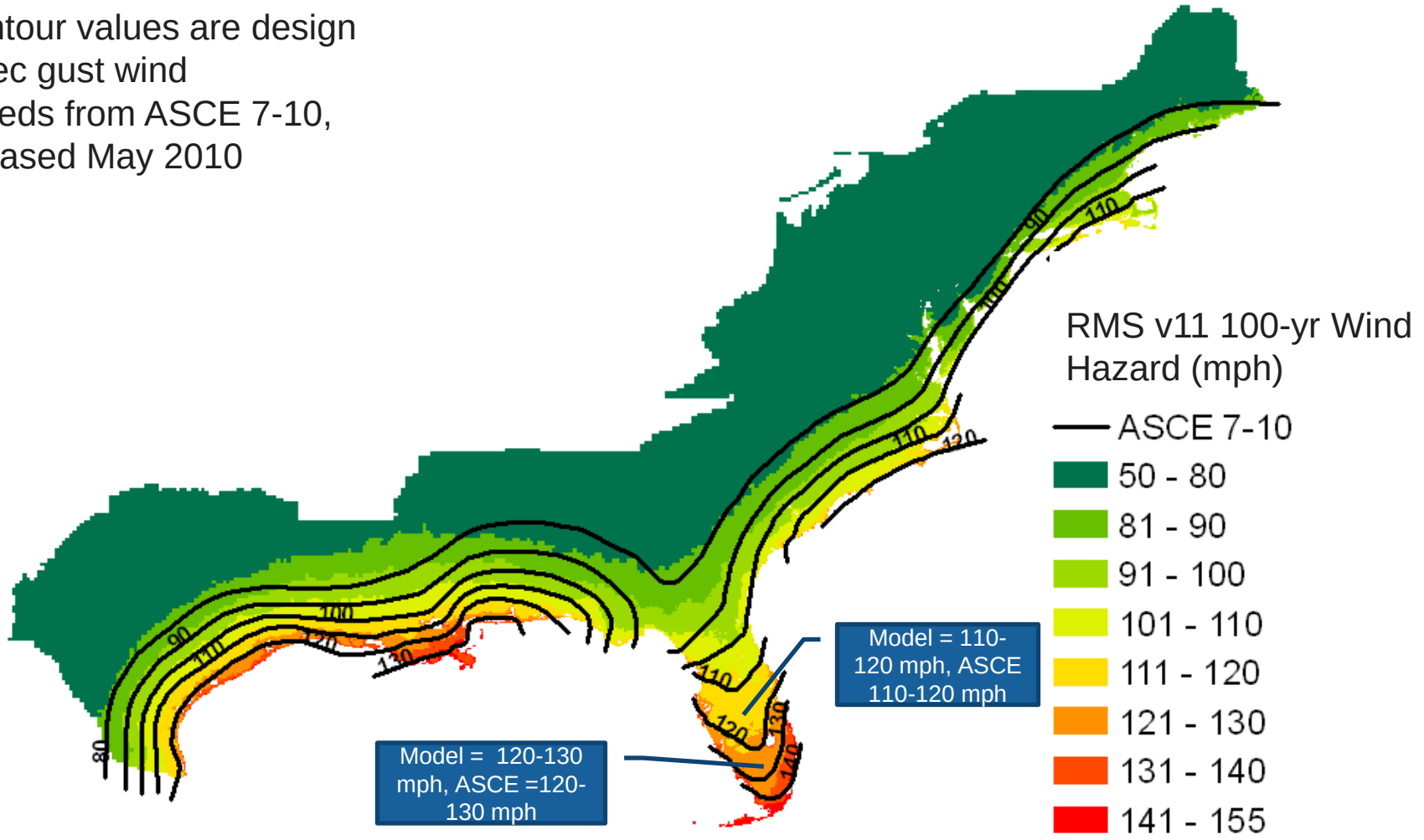


**Return Period (years)**

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 100
- 101 - 150
- 151 - 200
- 201 - 500
- >500

# Comparison of v11 100-yr Wind Hazard with ASCE 100-yr Hazard Map Published May 2010

Contour values are design 3-sec gust wind speeds from ASCE 7-10, released May 2010

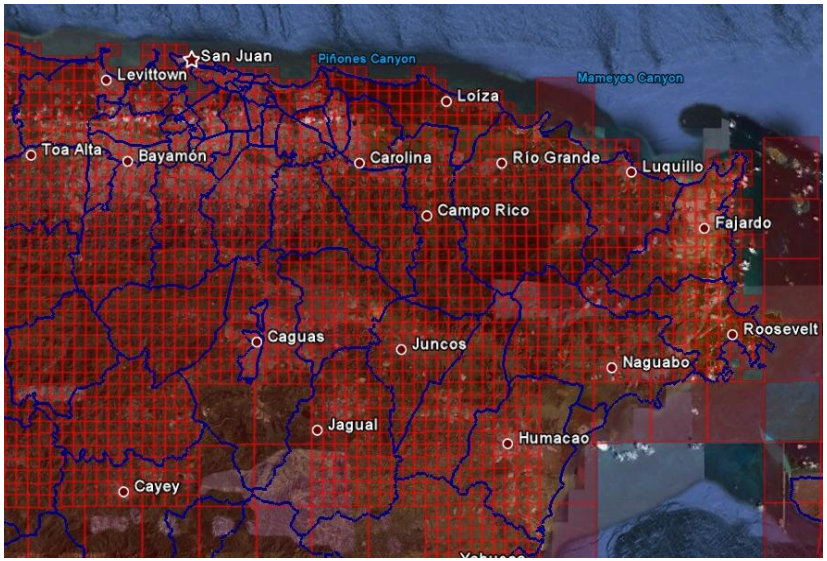



100-yr Wind Hazard 3-sec peak gusts using “open terrain”

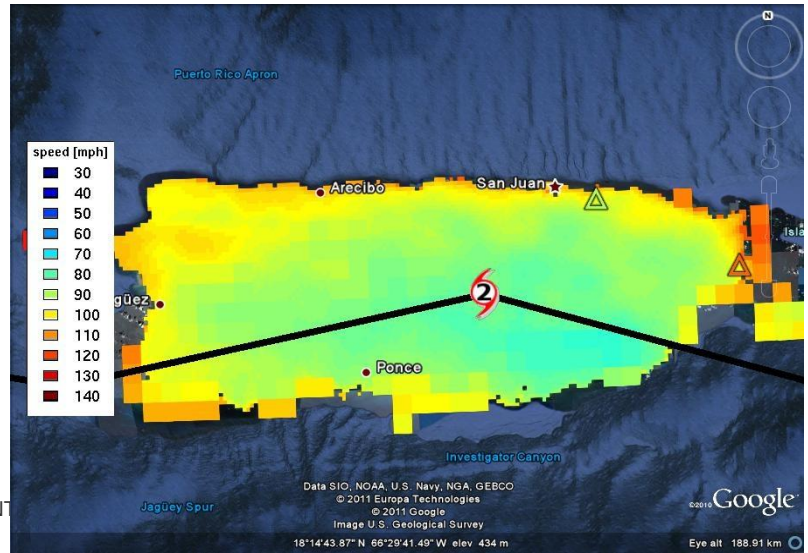
# Caribbean Hurricane Model Advances

- More detailed Variable Resolution Grid (VRG)
- Updates to wind hazard module, including inland filling and site coefficients
- Vulnerability enhancements
- Updates to Loss Amplification
- Implementation of new storm surge model for Bahamas, Caymans, and Turks and Caicos
- New MTR forecast – impacts CB relative to v10 significantly
- Addition of Bermuda

**Example of Wind VRG (red boundaries) and ZIP Code (blue boundary) in North East Puerto Rico**




**Footprint of Hurricane Georges 1998 over Puerto-Rico**

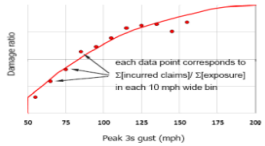


# Vulnerability

# Understanding Development Process for Vulnerability

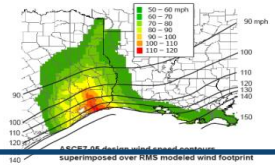
- Each region's vulnerability curves are built with data specific to that region
- In building vulnerability curve development various information sources used including:
  - Claims data
  - Historical reconstructions of industry losses
  - Building code comparisons
  - Input from engineering consultants on construction quality
  - Third-party engineering reports
  - Post-event reconnaissance observations
  - Engineering analytical models
- The weight assigned to each of these sources of information varies by region and is dictated by the amount and type of data that is available.

**Detailed Claims Data**

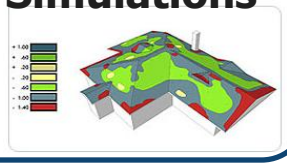



**Bldg envelope failure mode**

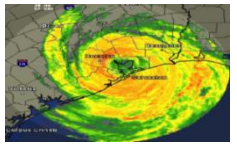
**Building Codes**



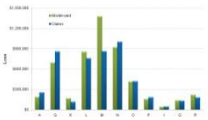

**Bldg Element Simulations**



**Historical PCS/Claims**



**Model review process**



# External Vulnerability Review

- Tom Smith, TLSmith Consulting
  - Internationally recognized expert on wind performance of buildings
  - Extensive field experience examining damage post-landfall for 15 hurricanes

- Quote from Tom Smith:

**“Based on my experience and discussion with other design professionals, the inclusion of the new coastal region is appropriate because of the greater attention that is generally given to design and construction near the coast.”**

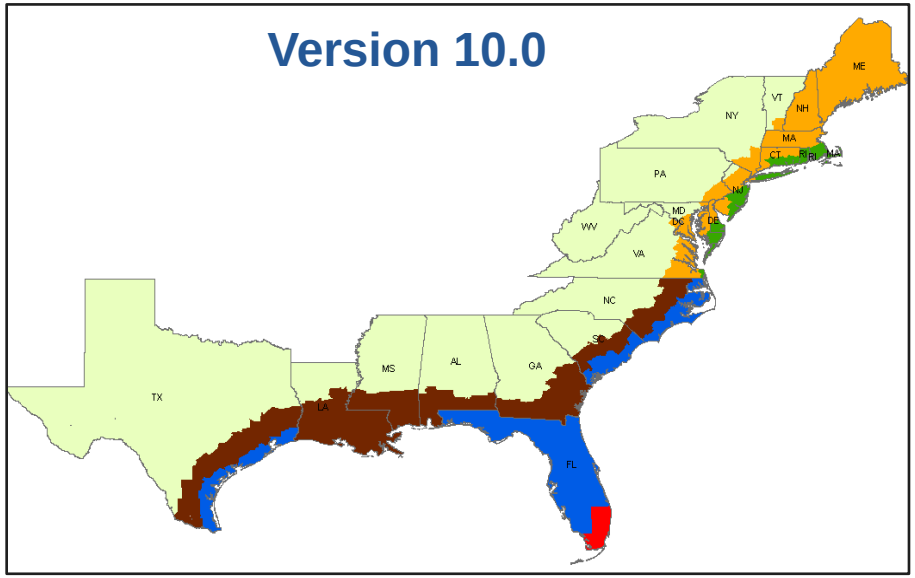
# Lessons Learned from Hurricane Ike
# Texas and Gulf Regions Vulnerability Development

- A large proportion of the losses occurred in Harris County, which experienced wind speeds between 60 and 90 mph
- RMS has collected more than $2 billion in location-level Hurricane Ike claims for TX and LA
- Building envelopes, and roof systems in particular, failed at wind speeds lower than engineering principles and building codes predicted
- Systematic undervaluation of properties – by as much as 40-50% for MFD occupancies in some client portfolios

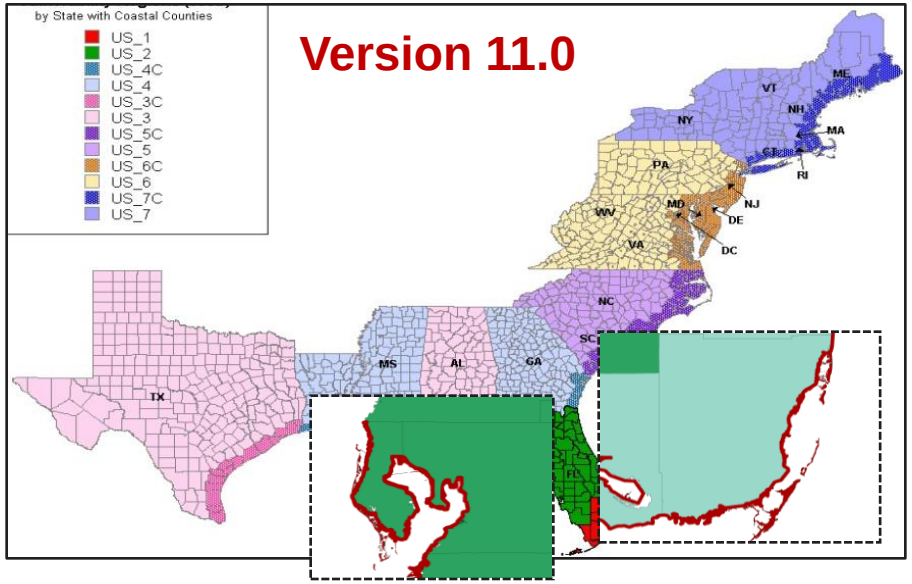
**Modeled Peak 3s Gust = 91 mph**
**~20% Roof Destroyed**

# Vulnerability Function Development

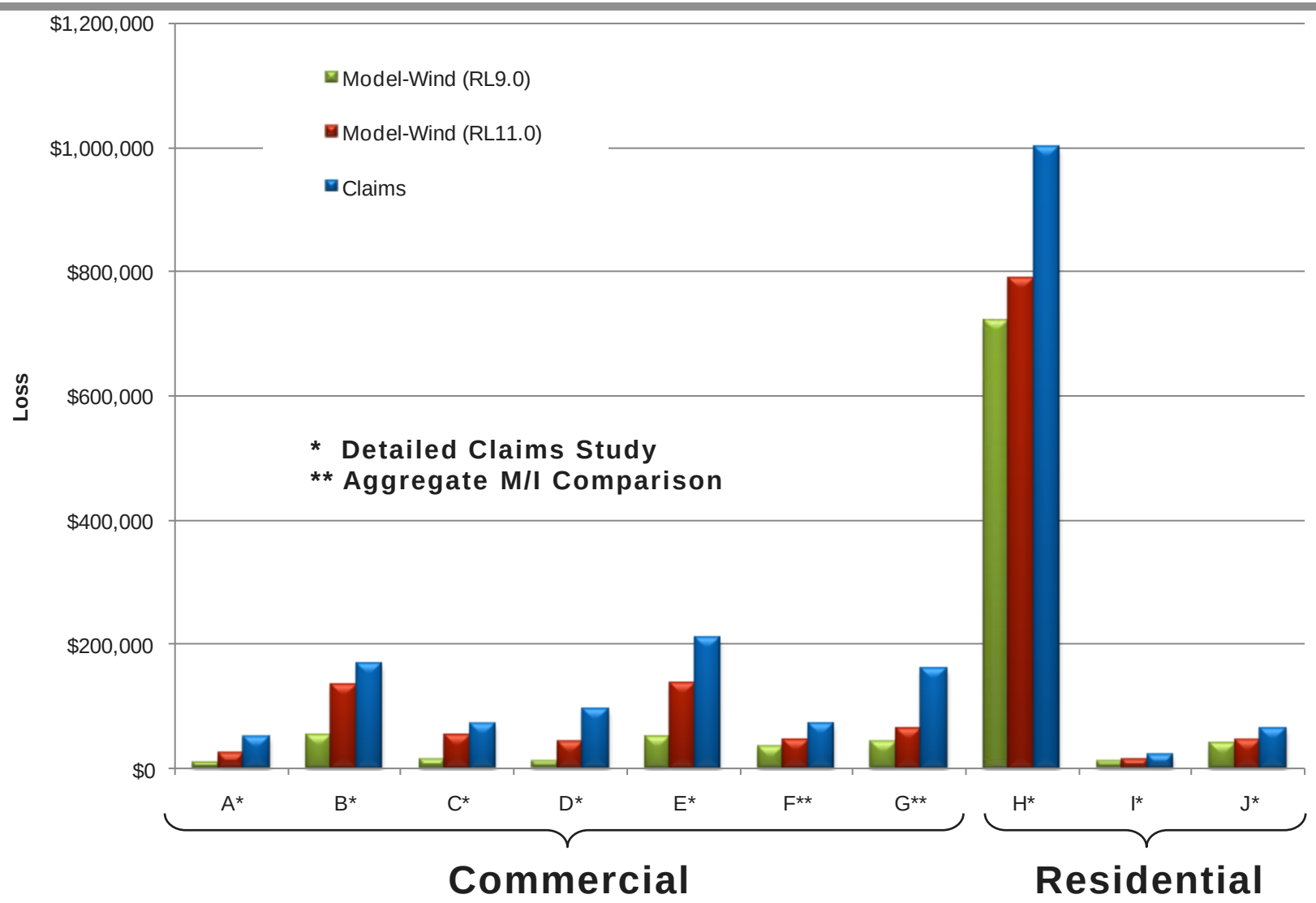
- **RiskLink 10.0** vulnerability regions
  - Six regions (or, eight since Alabama uses the year modifier files to scale the vulnerability functions down) based on information about building codes and design wind speeds, building performance in past hurricanes and general construction practices



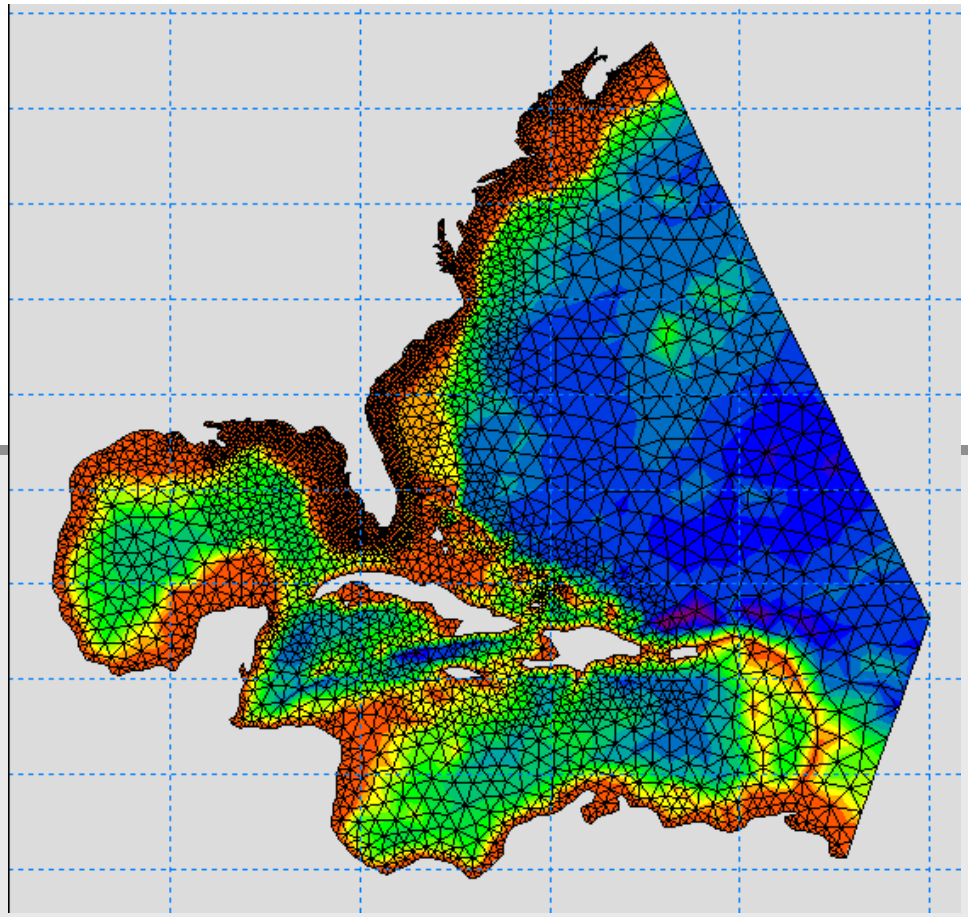

- **RiskLink 11.0** vulnerability regions
  - Fourteen regions, as shown below based on information used in the Version 6.0 development
  - Further refined using information provided by consultants and historical loss recreations and claims analyses



# Model & Incurred Losses for IKE – Wind Only v9 and v11




**Losses and claims normalized by a common factor such that maximum claims = $1M**

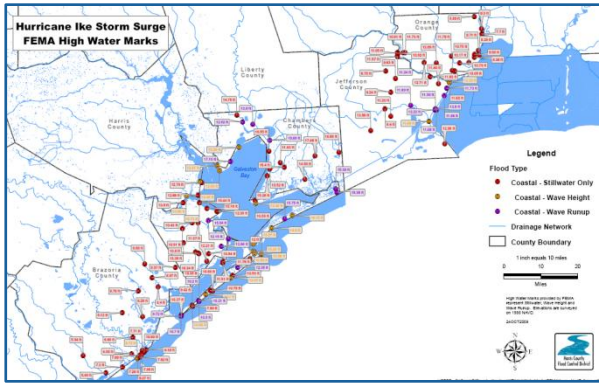


# Storm Surge Modeling

Geographic domain of the v11 surge model including the North Atlantic, the Gulf of Mexico and the Caribbean

# Why Did We Develop a New Surge Model?

- Surge is a product of the wind and pressure over the lifetime of the storm, not just the landfall characteristics
  - Storm surge models have traditionally been ‘parametric’
  - takes the attributes of a storm at landfall (e.g. Cat size, forward speed) and creates a surge footprint
  - Misses storms that change in intensity before landfall
    - Katrina was a Category 3 at landfall, but had a Category 5 storm surge
- Statistical models have problems representing the surge along complex coastlines.
- From recent storms we have learned that the current model doesn’t produce flooding far enough inland
- More full featured two peril hurricane model (wind and/or surge)
- Include waves in the Offshore Platform model
- Increases in computer power allow use of numerical models that solve these problems

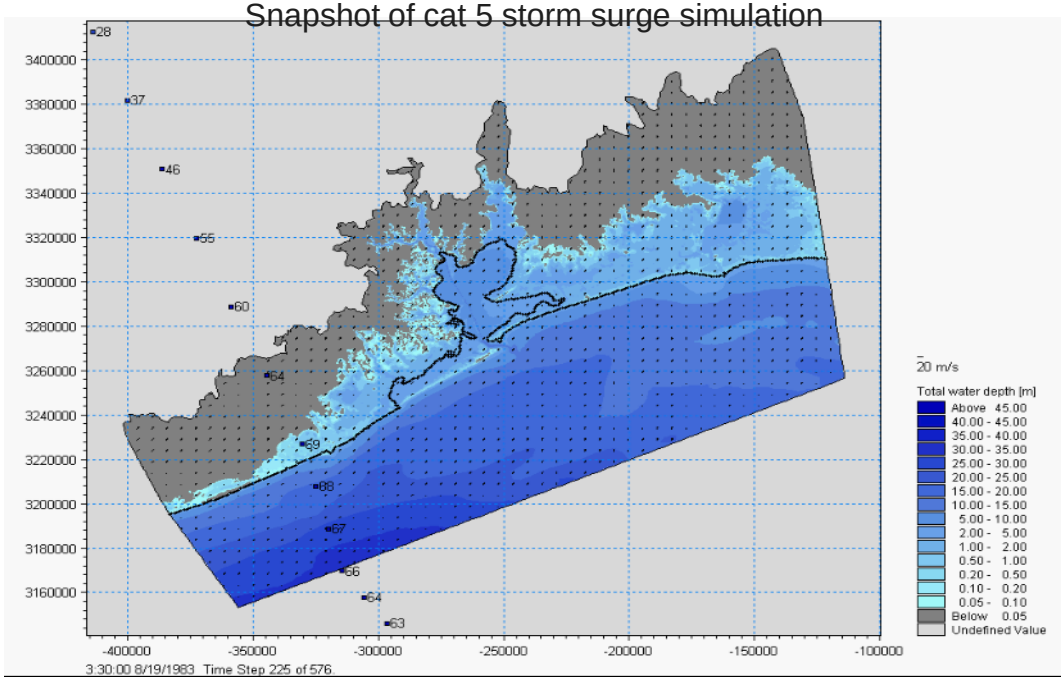


# Entire Lifecycle Storm Surge Modeling

- New solution is a numerical storm surge model dynamically linked with the windstorm model throughout entire lifecycle
  - Better captures the surge build up at sea e.g. Ike and Katrina and penetrates further inland than current model
  - The high resolution of numerical modeling allows for detailed representations of water flow over terrain and topography

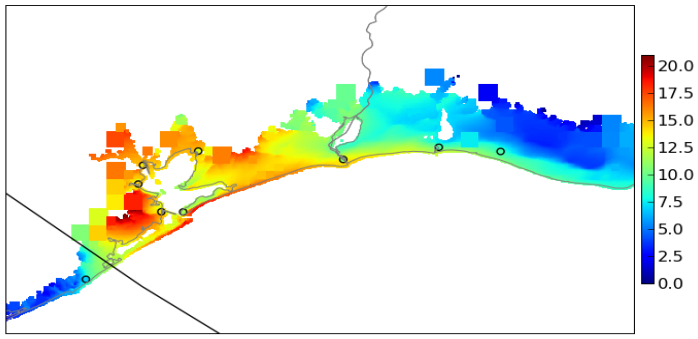
- Partnered with the Danish Hydrological Institute to use their MIKE FM Hydrodynamic Model
- One of only two models certified for FEMA Surge modeling
- Triangular mesh: well suited to model complex coastlines

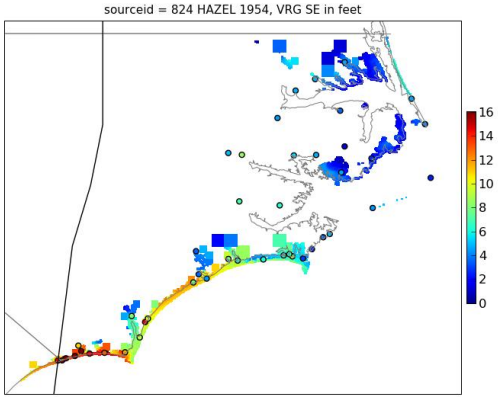
Snapshot of cat 5 storm surge simulation

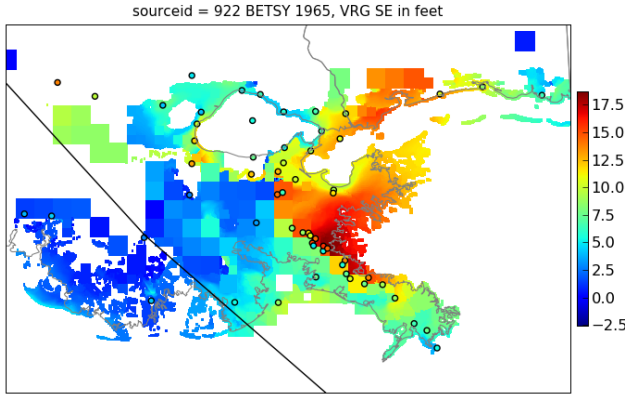


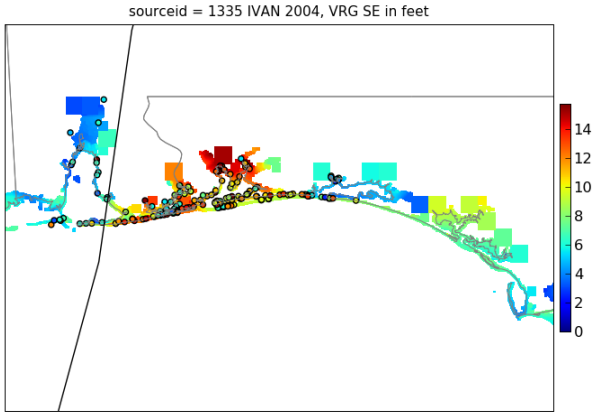

"MIKE 21 system has been used worldwide over the last 20 years for over 400 studies, including those in the United States"

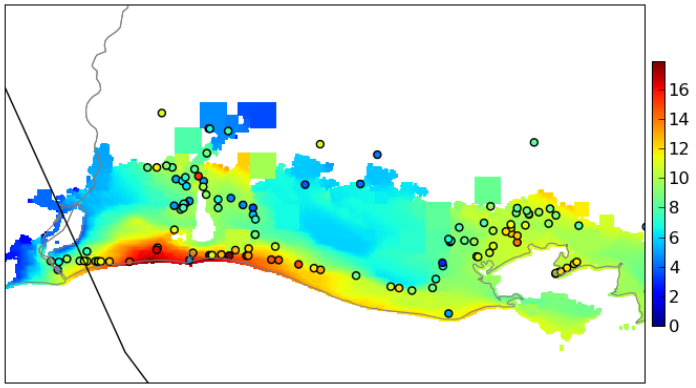
# Observations From 31 Storms Reviewed

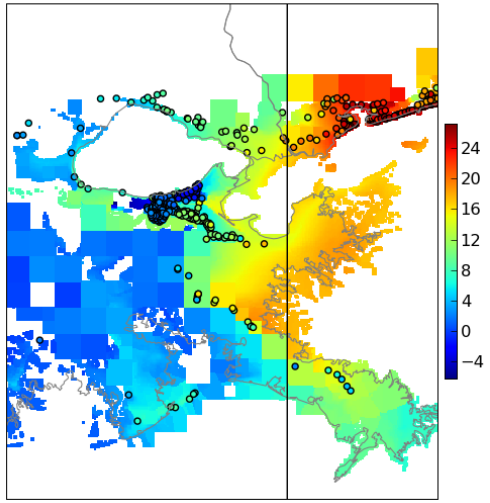


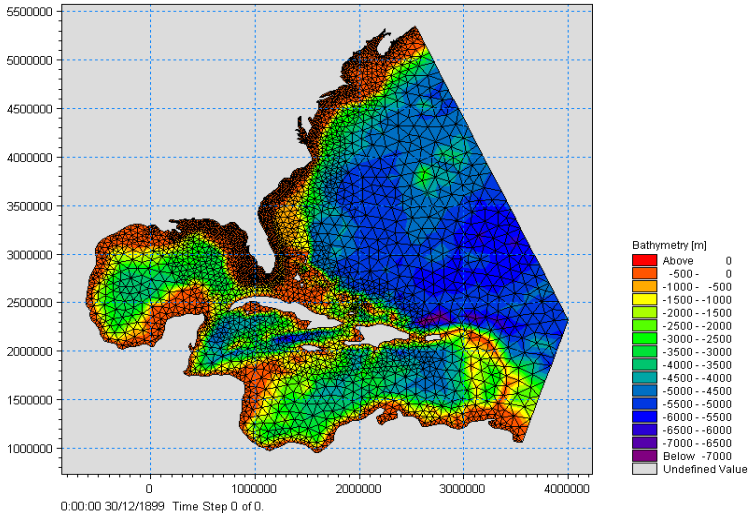



# RiskLink 11.0 – New Storm Surge Model

- Vulnerability enhancements in version 11.0
  - Surge can be run separately
  - Extensive Base Flood Elevation determination process
  - More refined geographic assignment of NFIP take-up rates; users can over-ride NFIP take-up rate assumptions
  - Ability to specify proportion of surge loss to include in loss analysis by line of business

Regional Mesh




# Version 11.0 Hurricane Models: Remarks on Market Impact

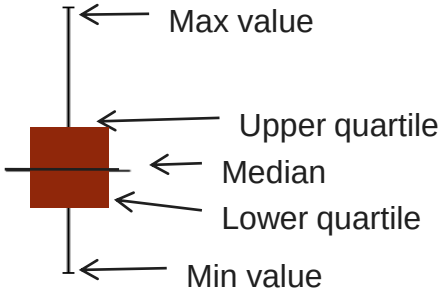
# One year of change guidance

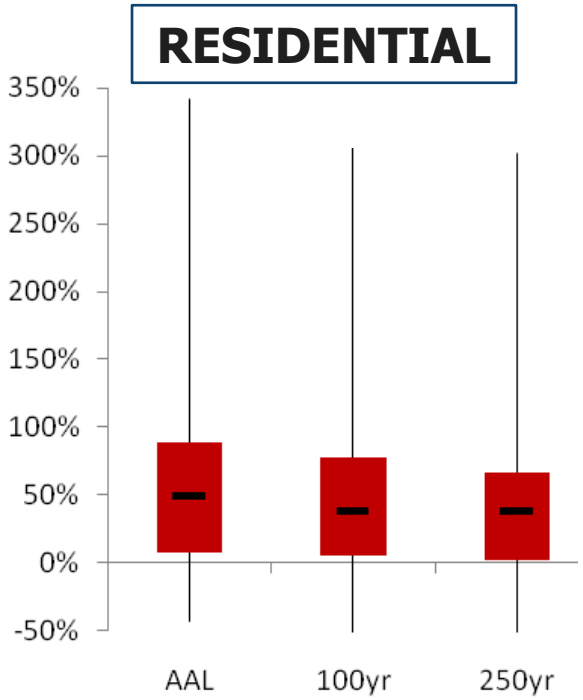
| | | |
|---|---|---|
| Spring 2010 | Client meetings, conferences | Released methodological changes, preliminary view on hazard change |
| September 2010 | Industry Briefing #1 | Summarized new information and methodologies during change |
| October 2010 | Industry Briefing #2 | First directional loss guidance, US Wind |
| November 2010 | Industry Briefing #3 | Quantitative guidance, US Wind, started outreach to rating agencies, submitted Florida Commission documentation |
| February 2011 | Industry Briefing #4 | Further details for US Wind, quantitative guidance for Storm Surge, IED change guidance |
| March 2011 | Client Specific Guidance | Change impact reports |
| April-May 2011 | Validation papers, rating agency followup, FCHLPM audit | Successfully completed methodological review by Florida Commission, distributed US wind validation white paper for Florida |

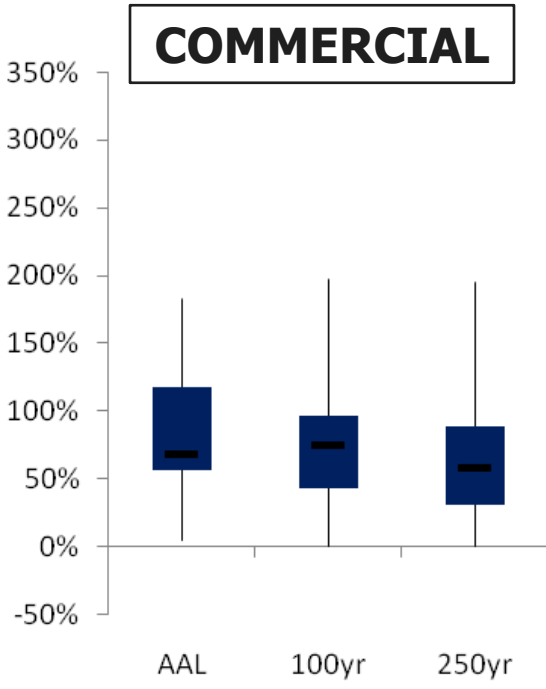
**130+ change impact analyses, 30 deep dives for insurers, reinsurers, brokers**

# Client Portfolio Results: Key differentiators

- Client portfolio loss metrics may, and often do, differ dramatically from an All-Lines, nationwide IED view on change in loss metrics
- During the change management process, RMS has documented three important differentiators that can cause individual client portfolios to diverge dramatically from IED results (in either direction)
  - **Occupancy** and construction class: e.g. education (ATC 25) not included in the zipcode-level exposure in the windstorm IED
  - **Financial structure:** RMS IED uses an industry average policy structure by LOB. Policies with multiple layers and attachment points of more complex E+S business can be higher or lower than that indicated by an IED
  - **Geographic concentration** of risk can differ significantly from IED All Lines exposure, e.g. FL



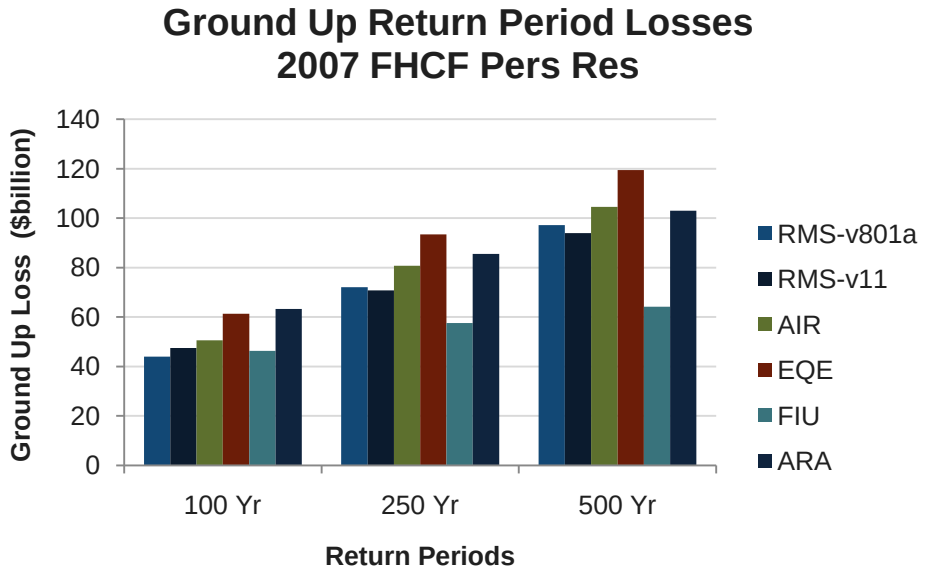



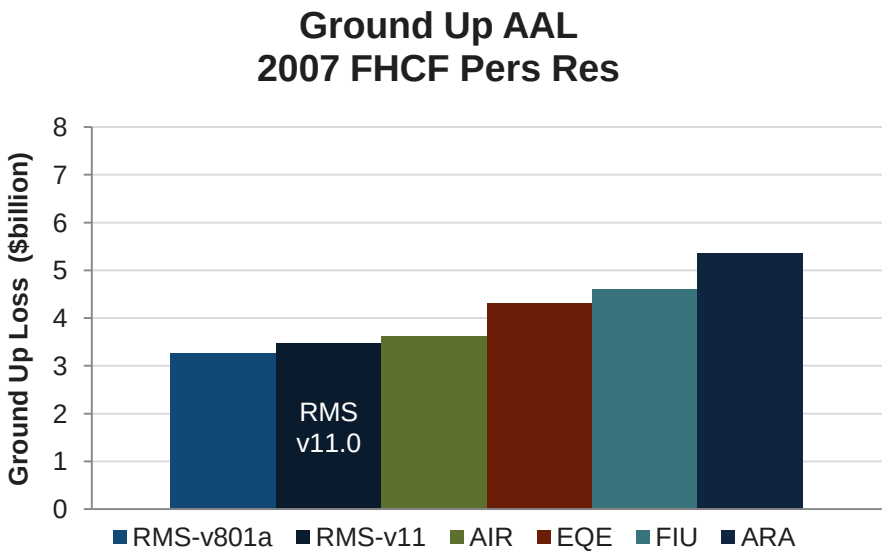
# Regular interaction with rating agencies

- Interactions to date
  - Model change presentations for large group audiences (30+ people)
  - Discussions on expectations, how will v11 results be handled?
- Reaction and expectations: Pragmatic
  - AMB: “Model change alone does not change ratings”
  - SRQs not required to have v11 results immediately after release
- Few downgrades expected due to model change
- Scrutiny will be proportional to the company’s cat exposure
- AMB Webinar last week: model output increases have not driven any downgrade of rating to vendor model clients

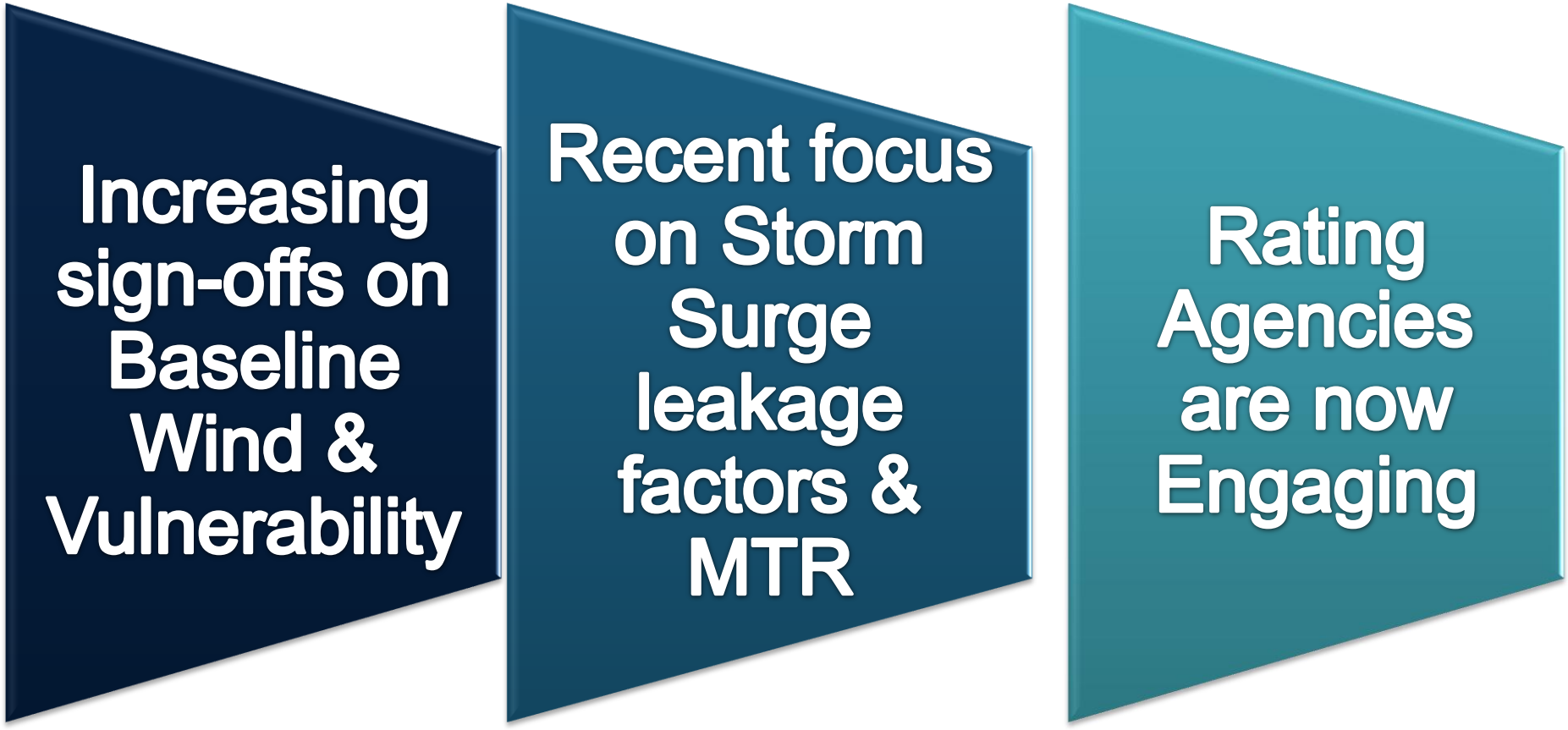
# RMS Version 11.0 Hurricane Model FCHLPM Status

- RMS submitted required documentation to Florida Commission in November, 2010
- FCHLPM "Pro-team" on-site audit completed in April, with recommendation to approve methodology based upon very thorough review process
- Final Commission public hearing tomorrow, June 2, 2011



# The Adoption Process - Where Do We Stand?




**RMS 11.0 model change is gaining influence on the upcoming mid-year U.S. property catastrophe reinsurance renewals….ultimate impact is likely to play out over a longer period of time…..VJ Dowling**

# Thank you