AIR Severe Thunderstorm and Flood Models – Updates and Advancements

Casualty Actuaries of Greater New York – Spring Meeting

Brandie Andrews, CCM

June 11, 2014

AIR WORLDWIDE®

AGENDA

- AIR's Commitment to Advancing Catastrophe Risk Modeling Technology
- 2014 Update to the AIR U.S. Severe Thunderstorm Model
- Release of the AIR U.S. Inland Flood Model

AIR's Focus on Advancing Catastrophe Risk Modeling Technology

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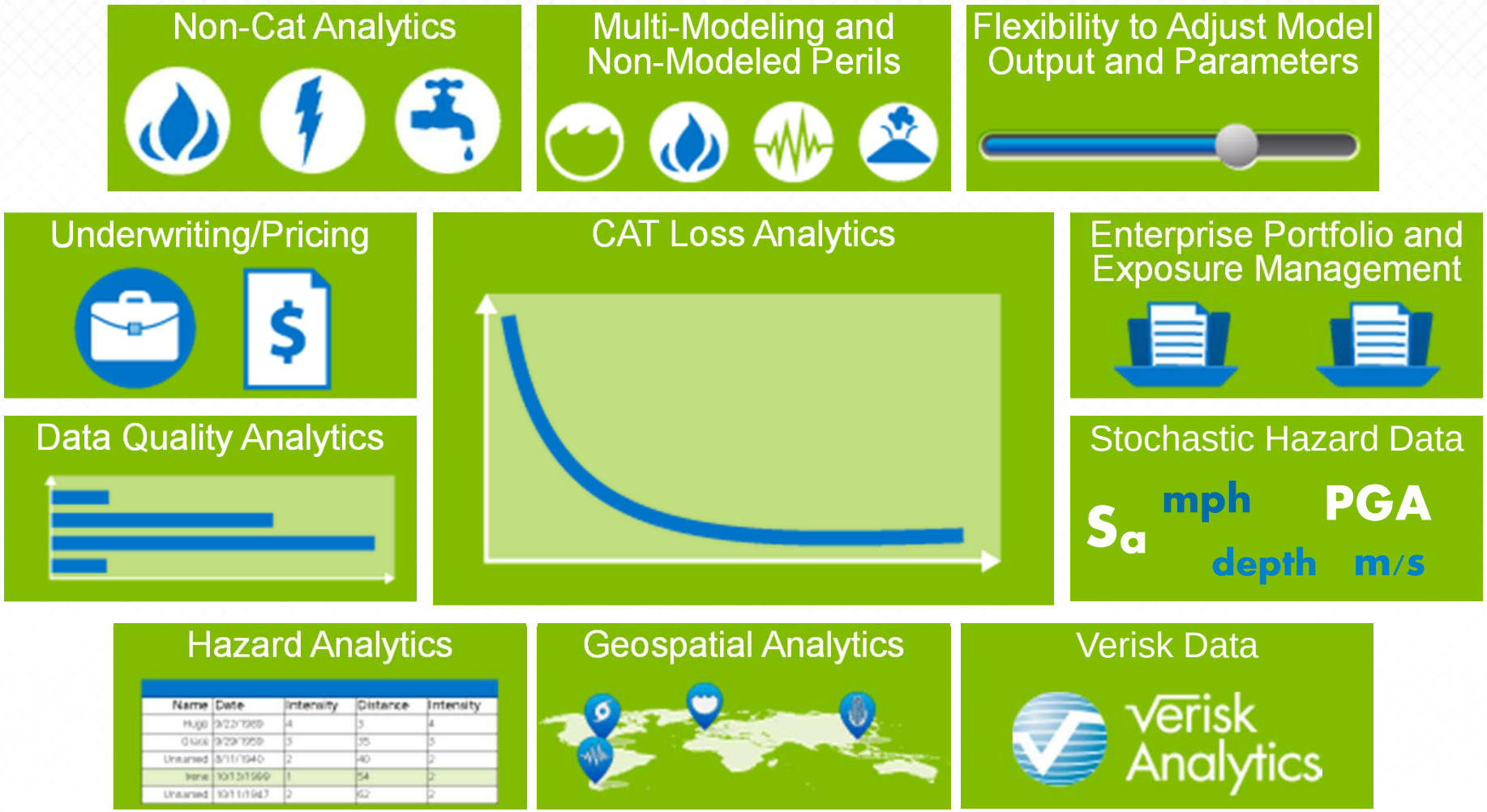
AIR Software Touchstone – End-to-End Solutions



Research and Modeling Roadmap for 2014

North America

U.S. Flood

U.S. Severe Thunderstorm

Canada Earthquake and Tsunami

U.S. Earthquake (minor updates to accommodate unified (U.S. and Canada) catalog

U.S. Crop Hail

Asia-Pacific

Thailand Flood Hazard

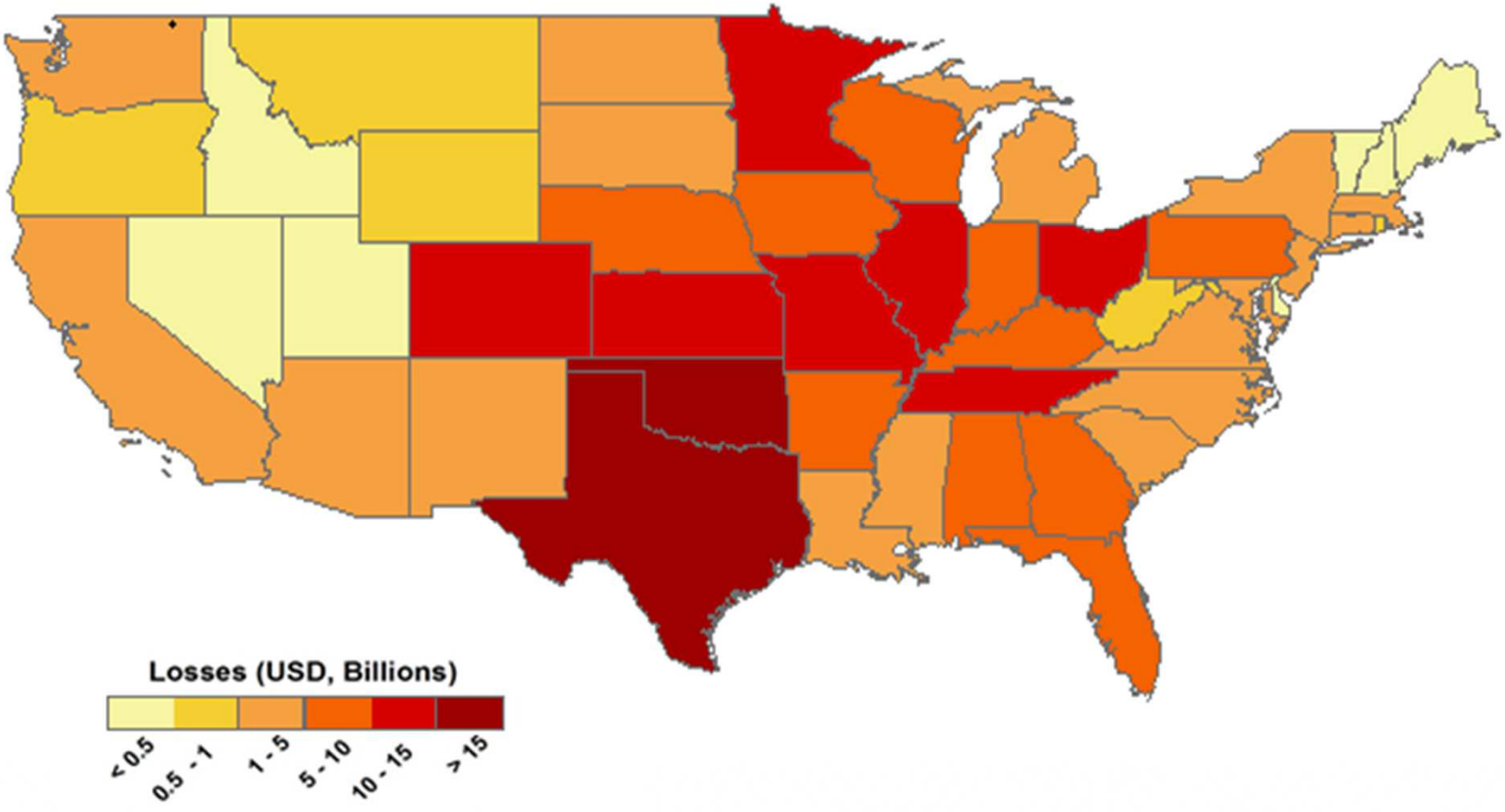
China Flood Hazard

China Crop (addition of forestry, new sub-perils)

2014 Update to the AIR U.S. Severe Thunderstorm Model – Hazard Overview

AIR

All 48 Contiguous States Are Affected by Severe Thunderstorms



PCS Losses, 1990-2013, Trended to 2013 Dollars

Severe Thunderstorms Consist of Multiple Sub-Perils and Multiple Modes of Damage

Straight-Line Wind

- Localized
- Highly variable
- 58+ mph

Hail

- Strong core
- Different concentrations of different diameters
- Integrated damage over time and diameter to produce estimate of Total Kinetic Energy (TKE)
- 1 inch+ in diameter

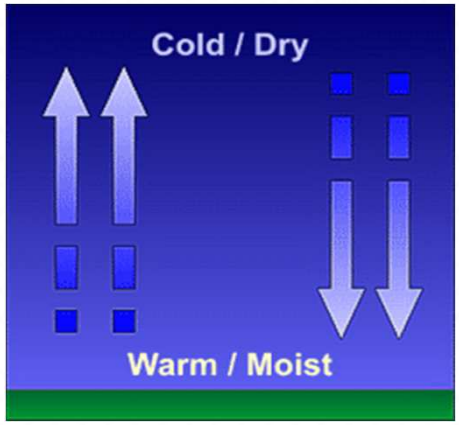
Tornado

- Strong, localized core
- Variable width and intensity over path
- Torsional and suctional damage
- Rated EF0-EF5

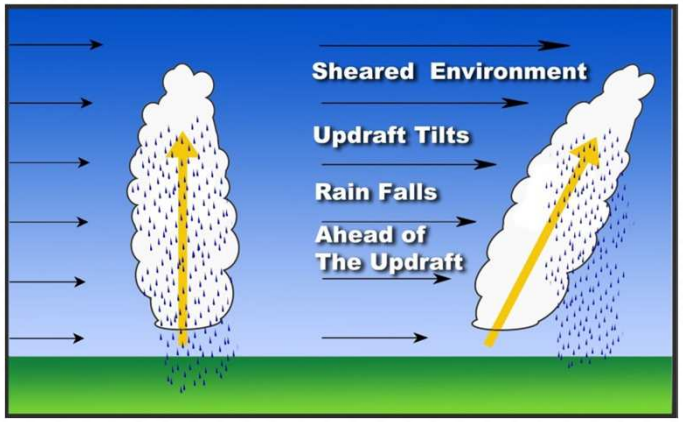
Severe Weather “Ingredients” Can Be Quantified by Composite Indices

Severe Thunderstorms Require:

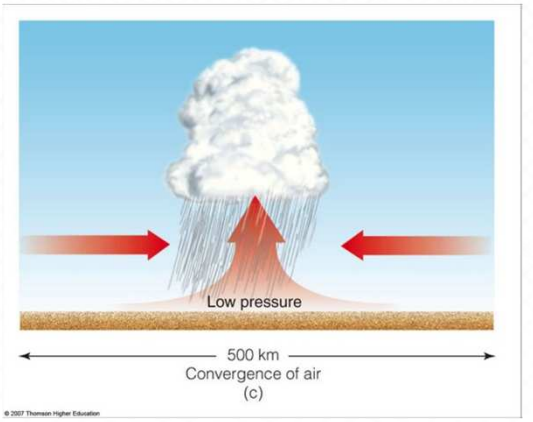
Instability (Moisture, CAPE)



Vertical Wind Shear



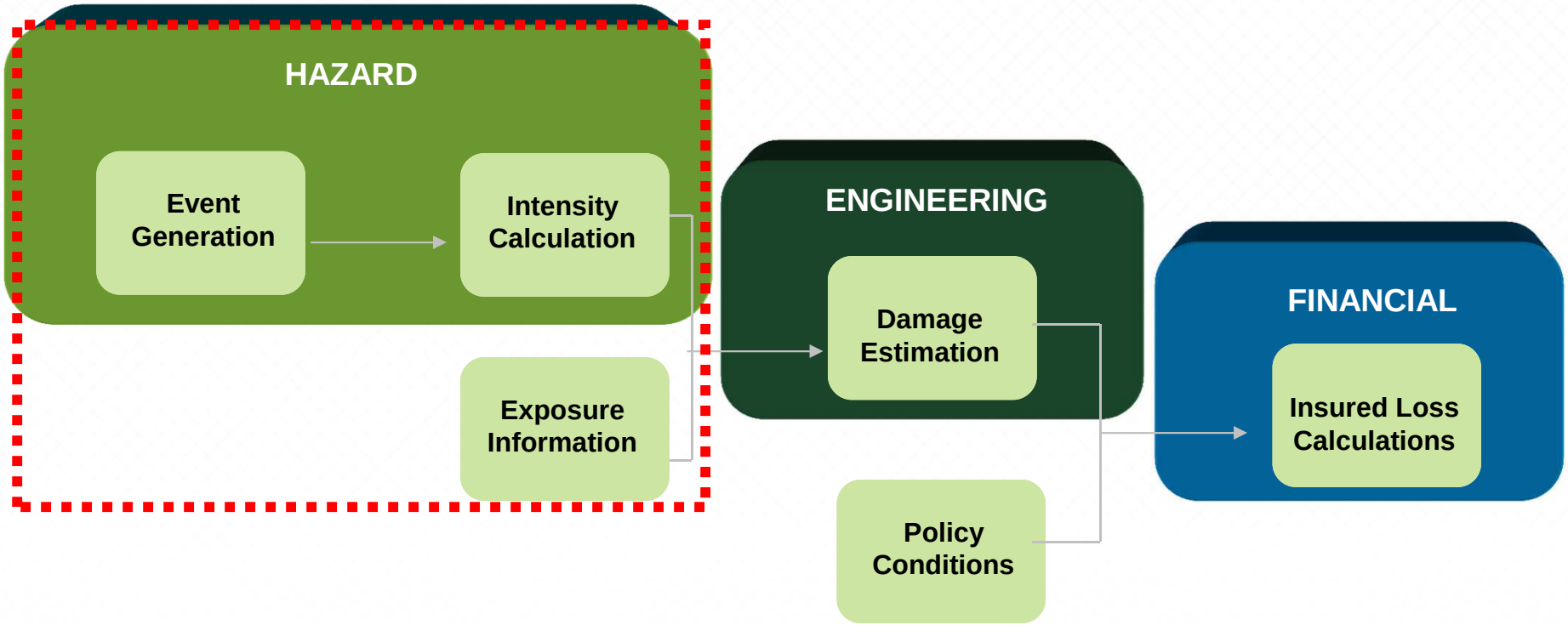
Lift



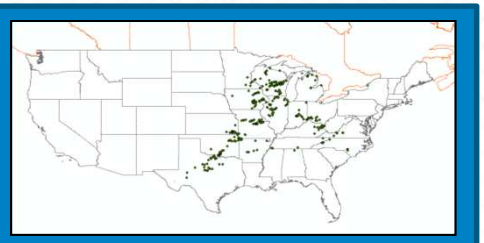
Often quantified using composite indices:

- Sig. Hail Parameter (SHiP) – Hail
- Sig. Tornado Parameter (STP) – Tornado
- Energy Helicity Index (EHI) – Wind

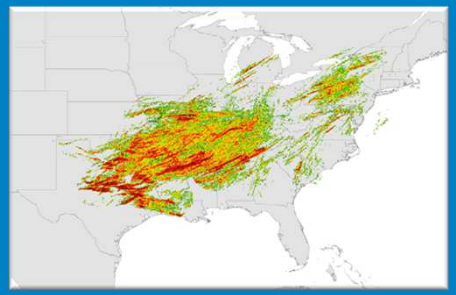
AIR U.S. Severe Thunderstorm Model Updates



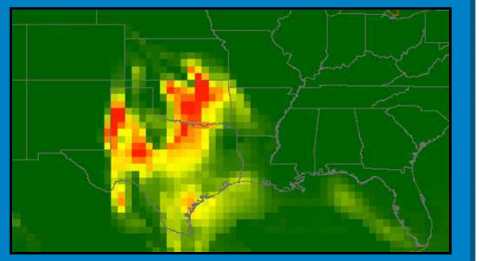
Updated Hazard Model Methodology Improves Simulated Event Frequencies and Physically Realistic Event Locations



SPC reports



High resolution radar data for improved swath dimensions



Index values allow for meteorologically plausible events that have not been observed in the historical record

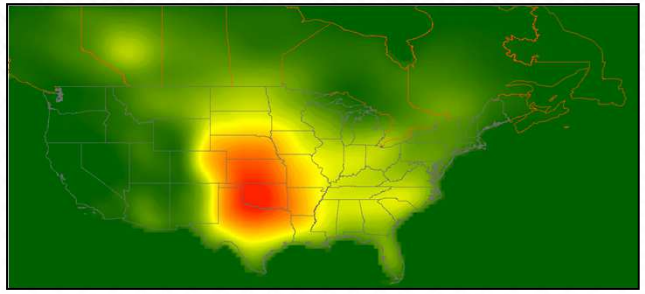
Statistical and meteorological smoothing

Augmentation

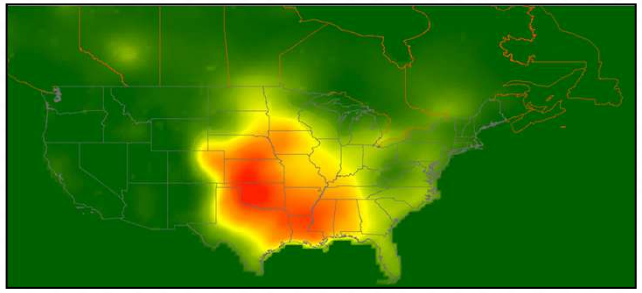
Debiasing

Clustering

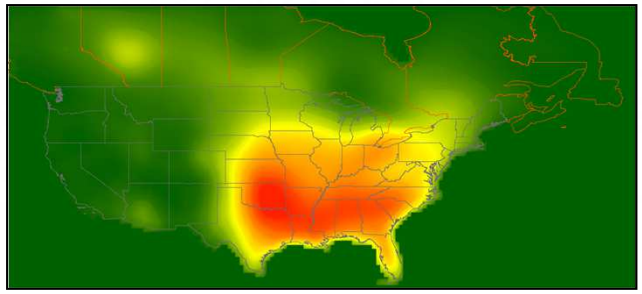
Realistic footprint sizes



Hail occurrences



Tornado occurrences



Wind occurrences

The Historical Record
Consists Mainly of Point-Wise, Eyewitness Accounts

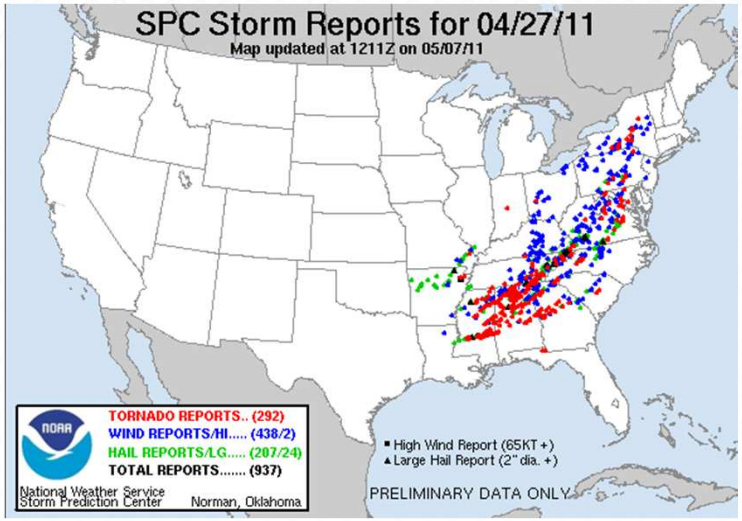
Eyewitness reports of severe weather

- Hail ≥ 1” in diameter
- Wind ≥ 58 mph
- Any Tornado

Point measurements

Maximum intensity achieved

- Largest hailstone diameter
- Highest 3-second gust
- Strongest tornado intensity along track (damage derived)



SKYWARN

Grouping Point Measurements into Larger Loss Events is a Key Challenge

PROPERTY CLAIM SERVICES

CATASTROPHE BULLETIN

CATASTROPHE SERIAL NO. 46

FINAL ESTIMATE OF INSURED PROPERTY DAMAGE

DATES: April 22, 2011 To April 28, 2011

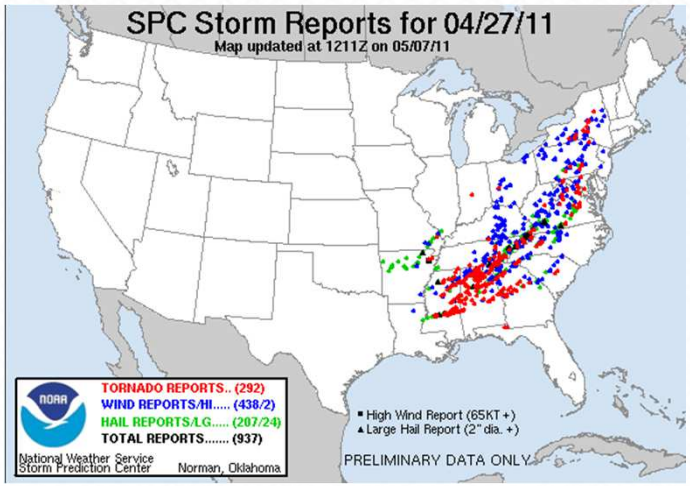
STATES: Alabama, Arkansas, Georgia, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Tennessee, Texas, Virginia

PERILS: Flooding, Hail, Tornadoes, Wind

STORM FAMILY: Wind and Thunderstorm Event

With further reference to our Catastrophe Bulletin No. 46 - 7 dated September 28, 2011, PCS has prepared the following final estimate of insured property damage:

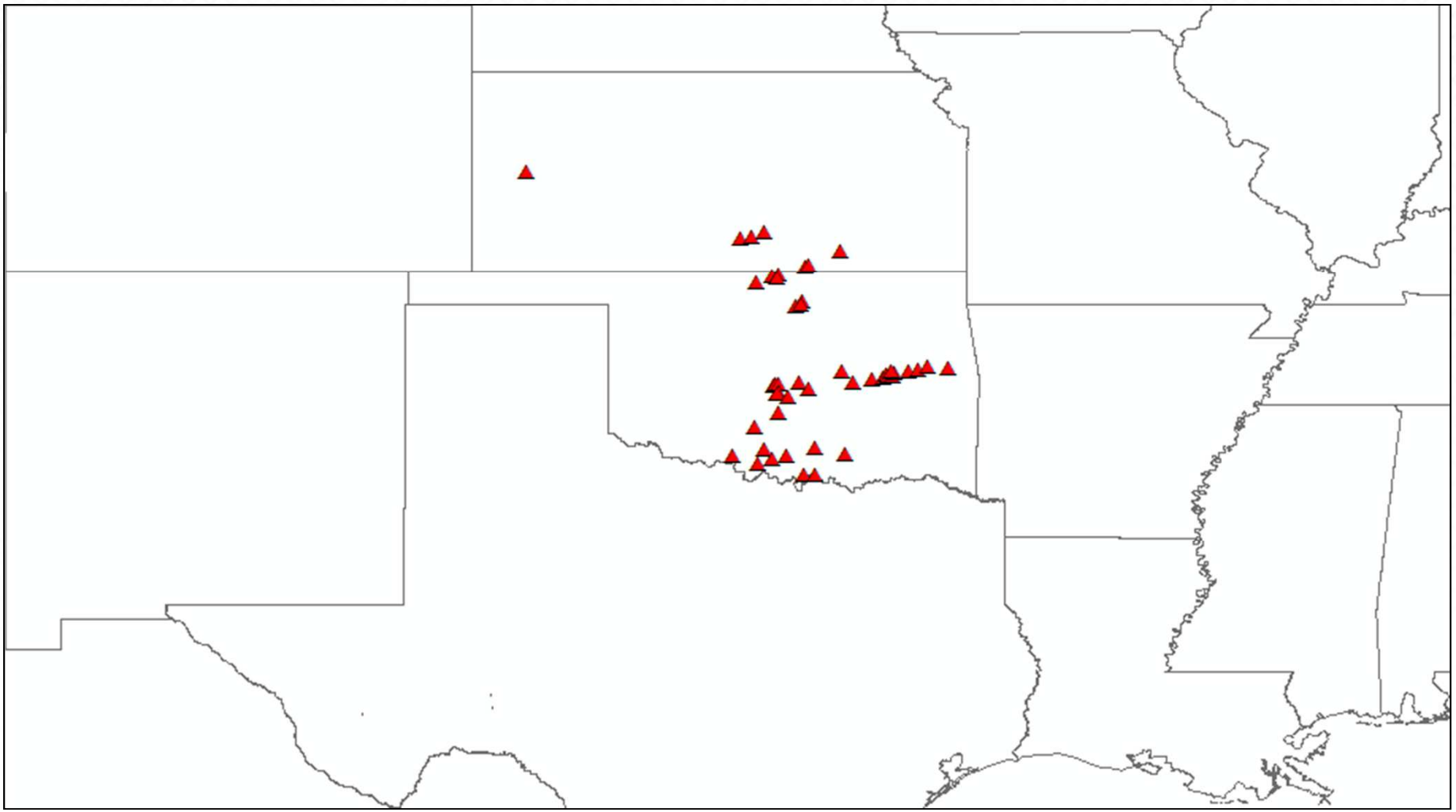
STATES:	Estimated Insurance Payment
Alabama	$2,925,000,000
Arkansas	$338,000,000
Georgia	$435,000,000



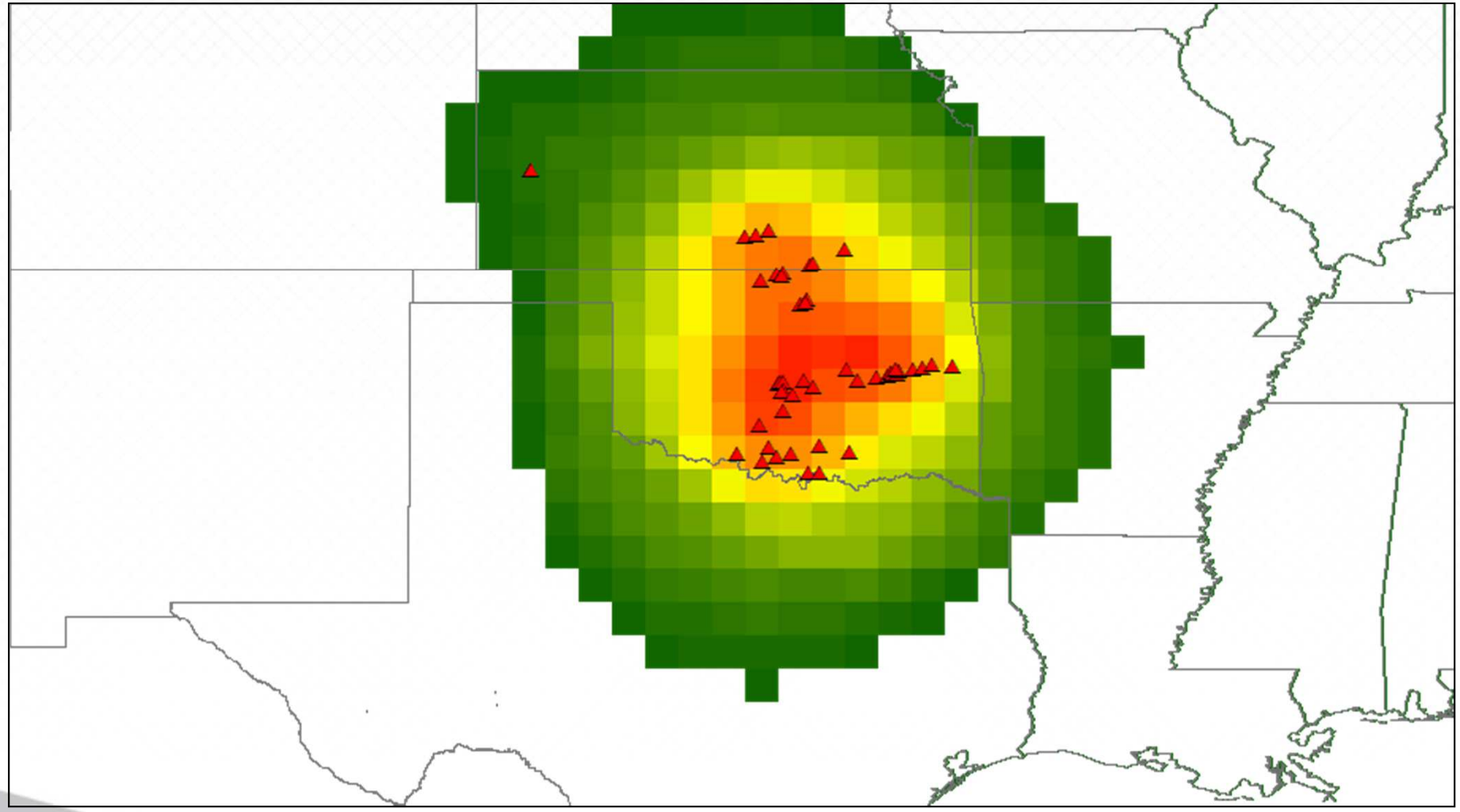
Need a way to go from point measurements to areas affected by severe weather

1. Radar data only
2. Radar and SPC reports
3. SPC reports only

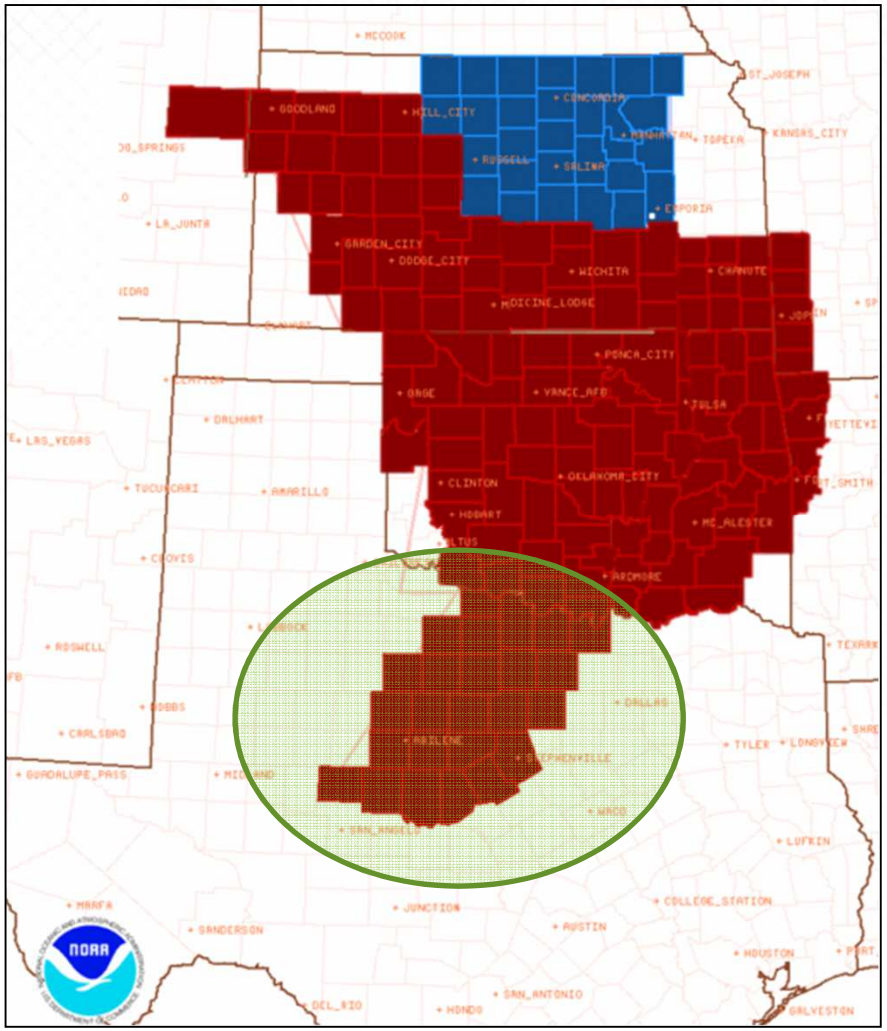
May 10, 2010, Case Study: Raw SPC Tornado Reports



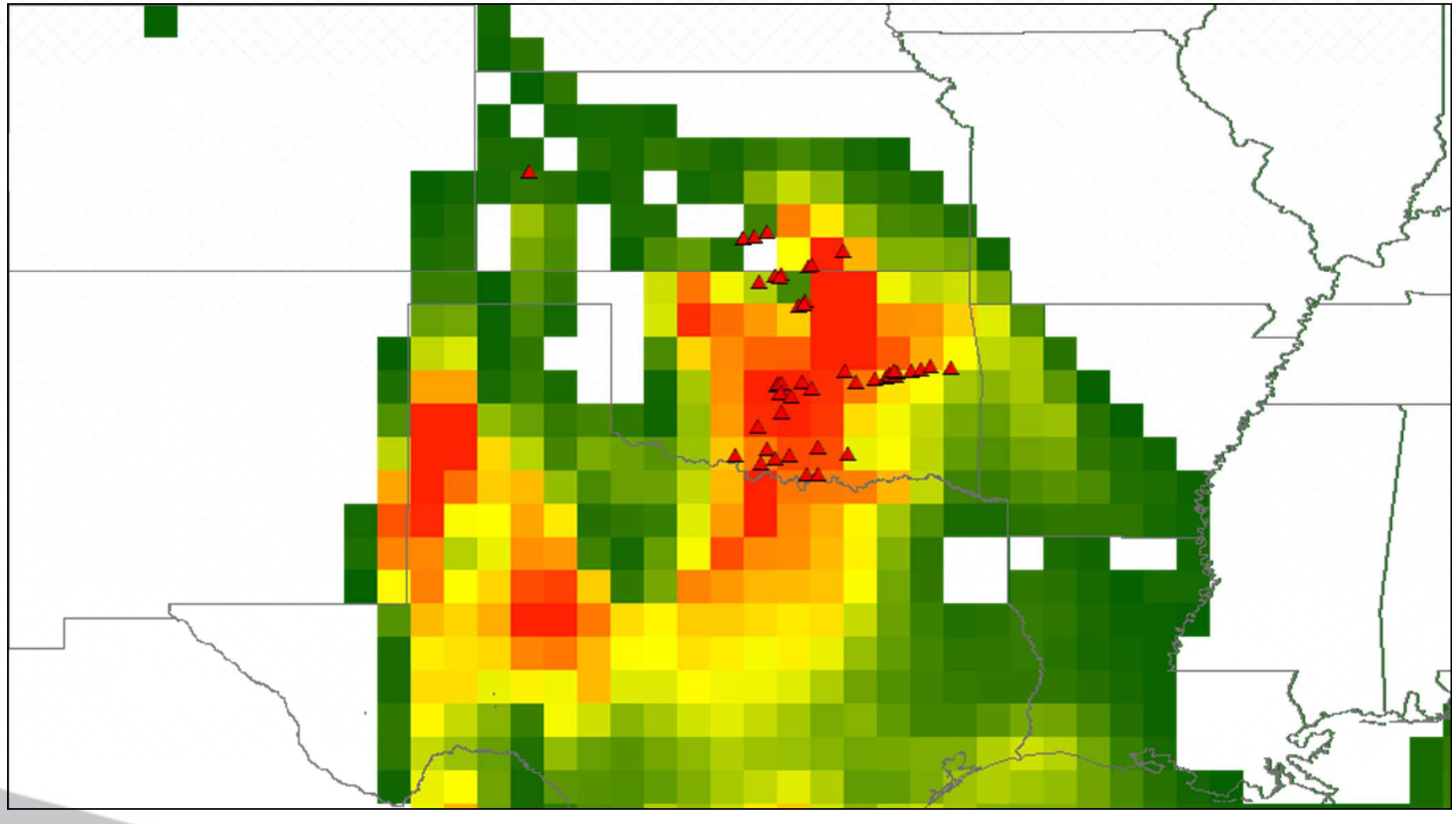
May 10, 2010, Case Study: Statistical Smoothing of SPC Tornado Reports



Tornado Watches on May 10
Showed the Potential for Activity In Texas

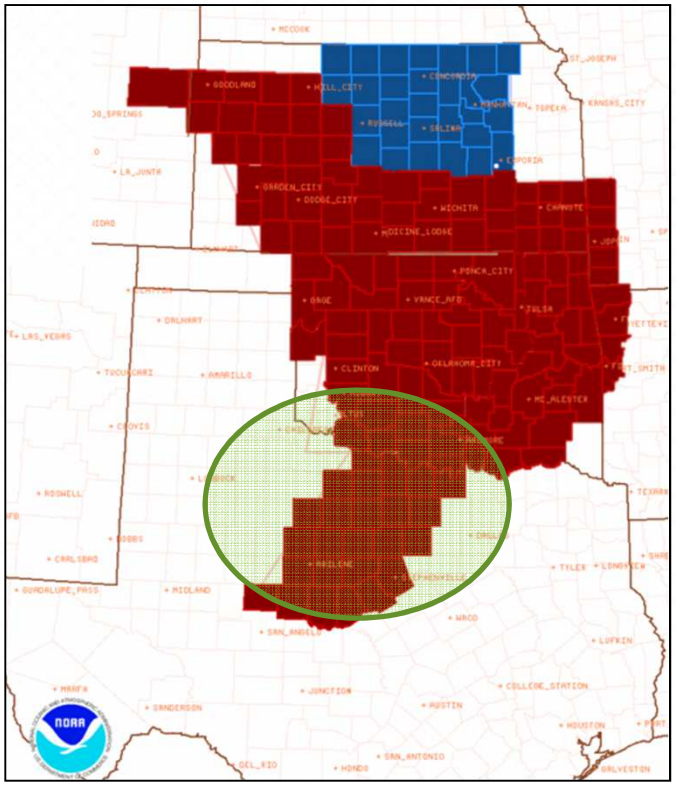


Meteorological Index Values on May 10 with SPC Reports

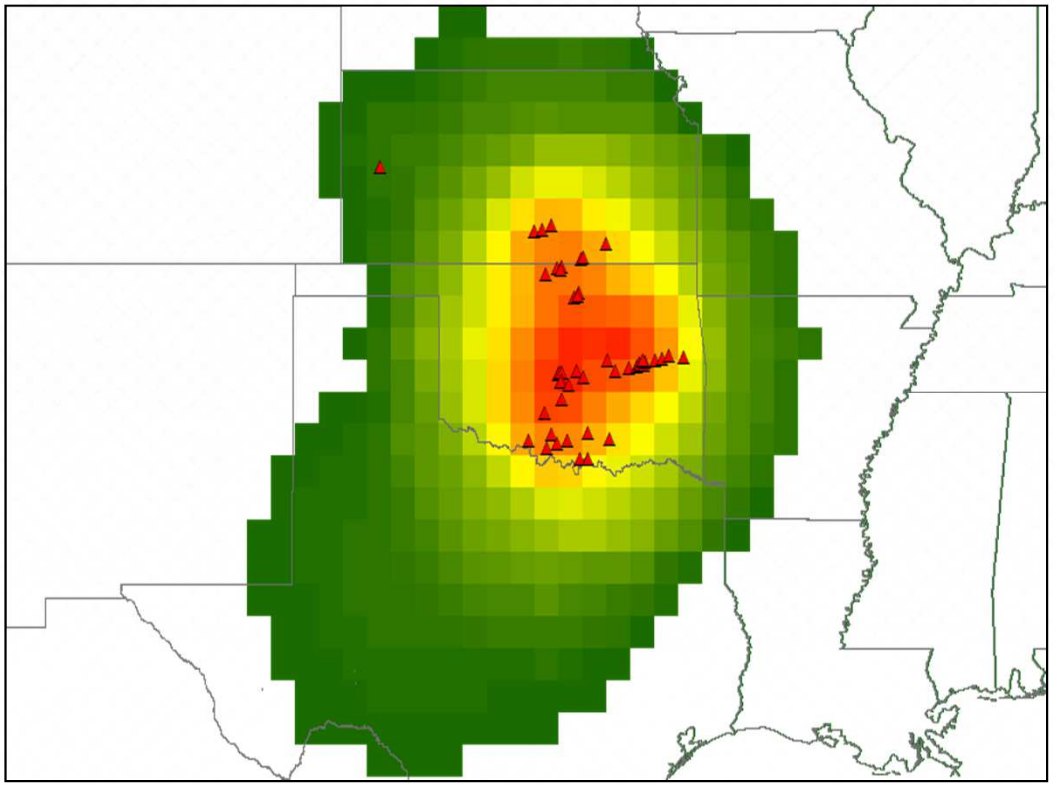


May 10, 2010 Case Study: Comparison of Smoothing Methods

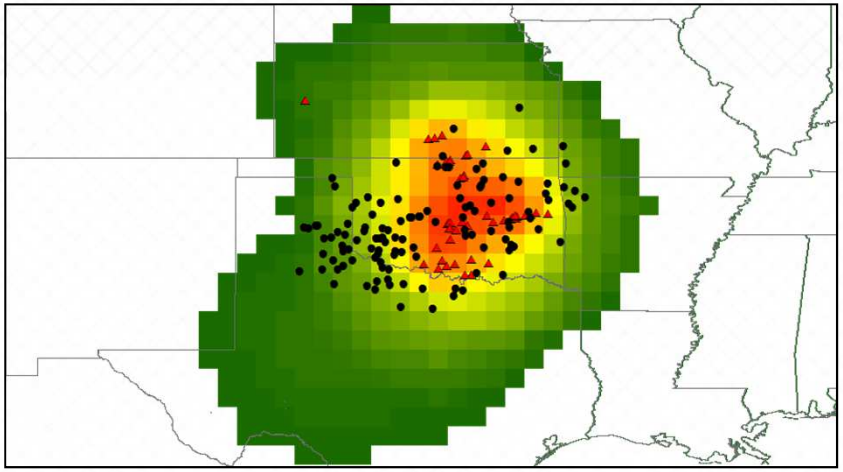
May 10 Tornado Watches Issued

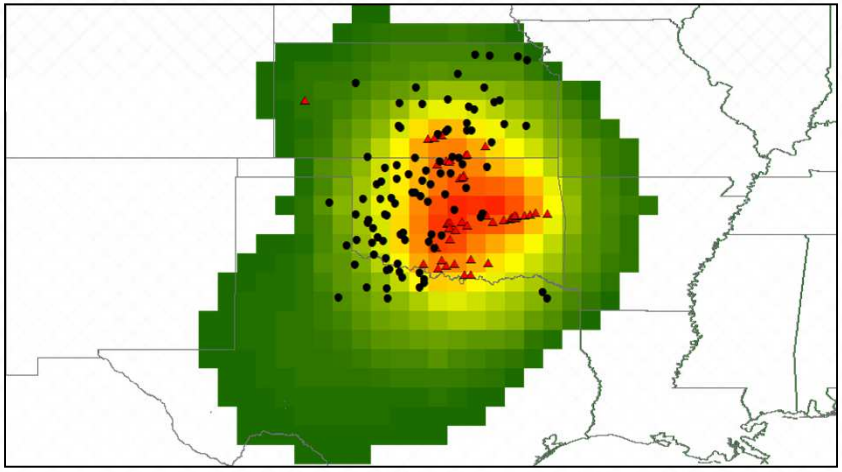


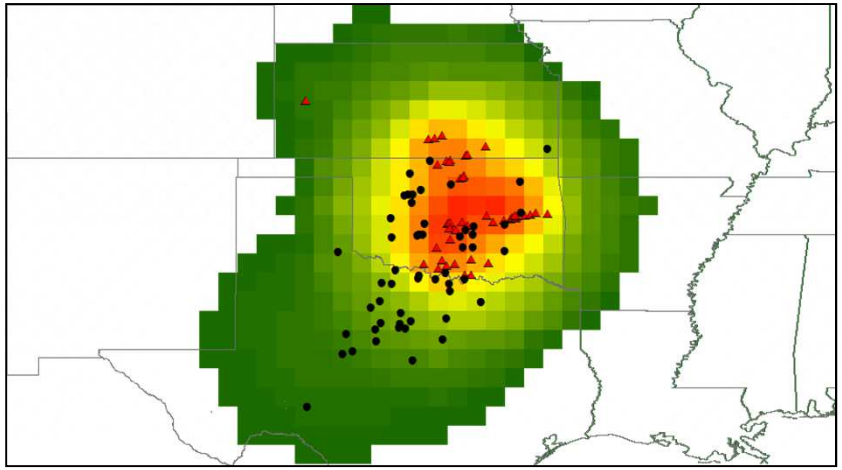
Hybrid Statistical-physical Model

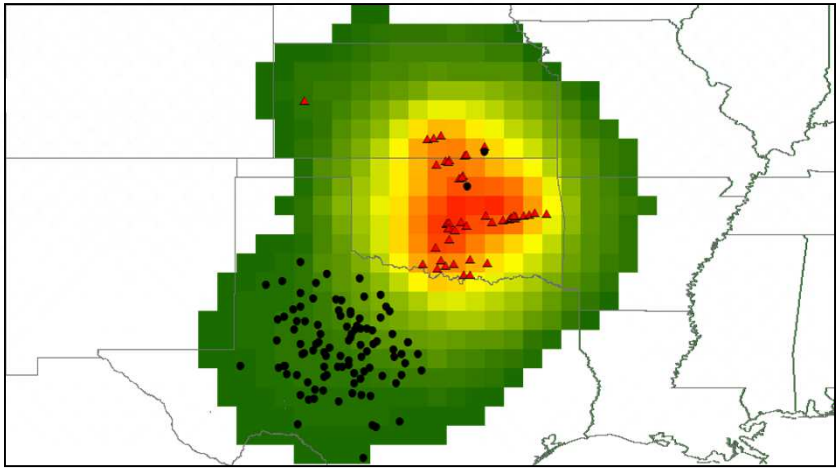


Four Stochastic Tornado Simulations Based on the May 10 “Seed” Date





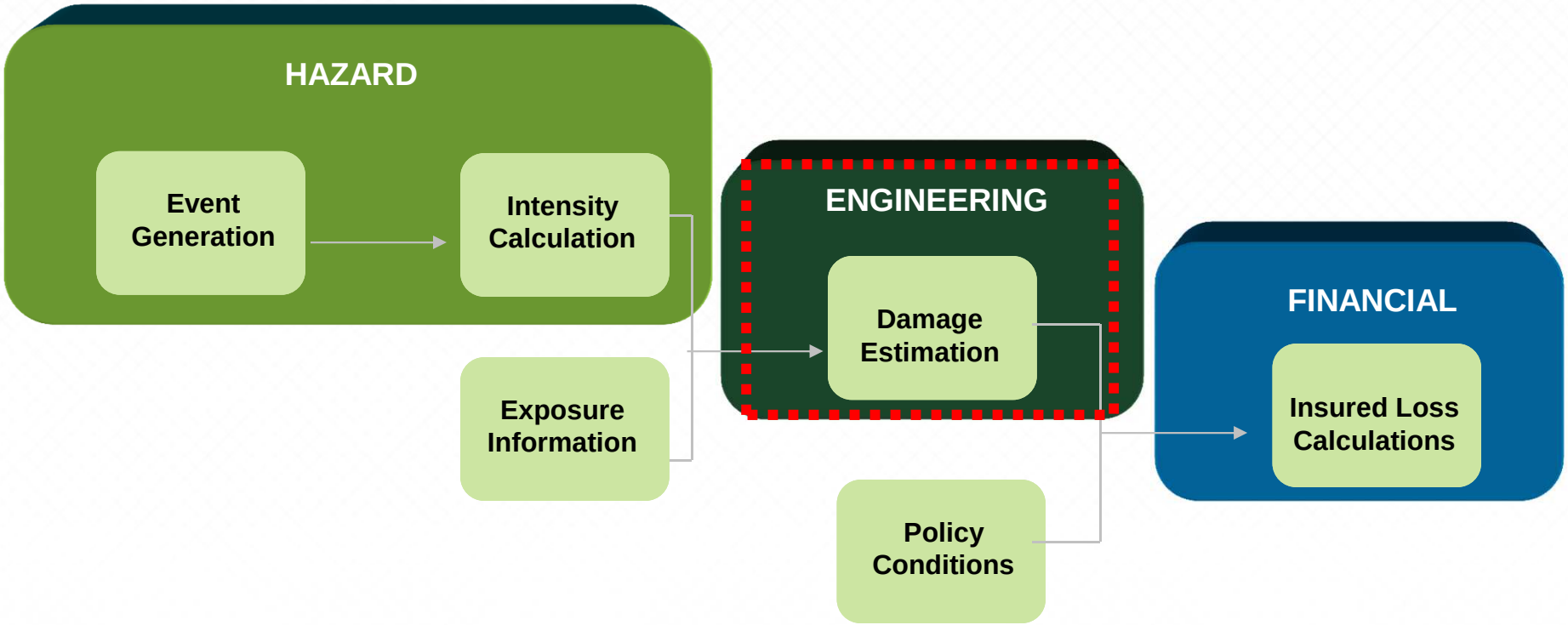




2014 Update to the AIR U.S. Severe Thunderstorm Model – Vulnerability Overview

AIR

AIR U.S. Severe Thunderstorm Model Updates



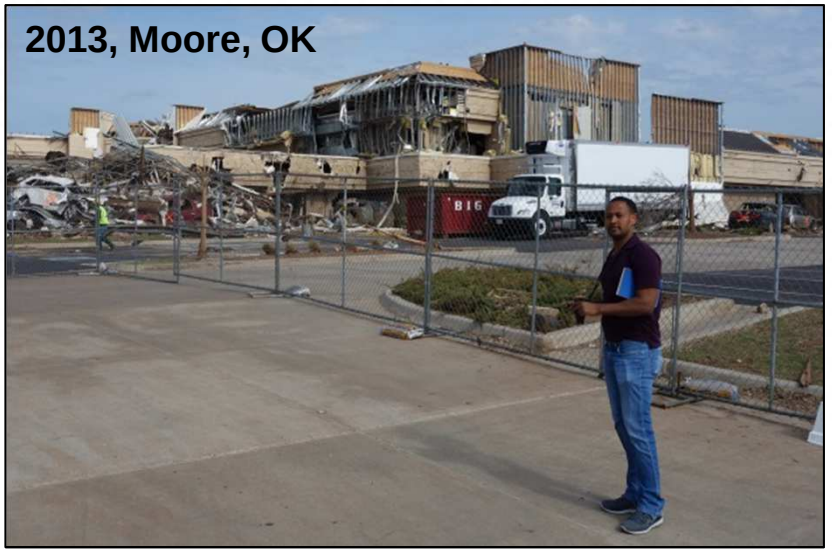
Key Considerations for Updating and Enhancing the Vulnerability Module

- New engineering research
  - Tornado wind field generation
  - Hail experiments and reports
- New data following recent major events
  - Damage surveys
  - Claims
- More features and flexibility
  - Secondary characteristics
  - Regional and temporal variation
  - Industrial facilities

March 2008, Atlanta, GA

Damage from an EF2 Tornado

AIR Engineers and Scientists Led Detailed Damage Surveys in 2008, 2011, and 2013



AIR Participated in RICOWI Damage Survey Following the 2011 Dallas/Fort Worth Hailstorm

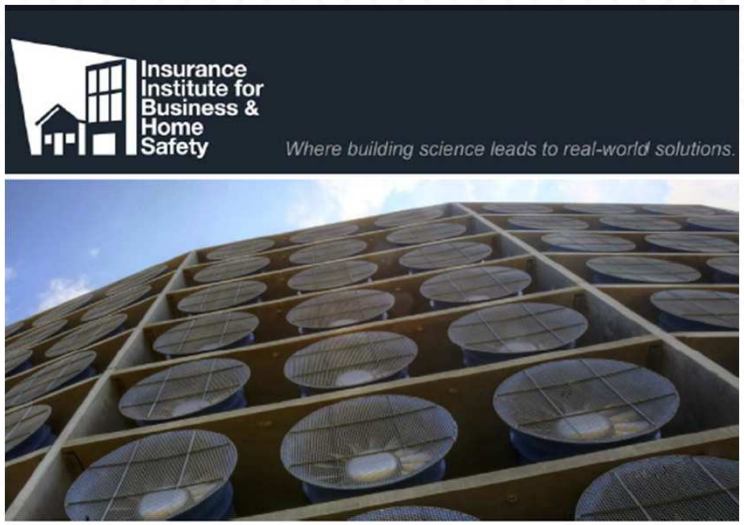
RICOWI, Inc.
Roofing Industry Committee on Weather Issues, Inc.

Leading the Roofing Industry through Innovative Collaboration

HAILSTORM INVESTIGATION
DALLAS / FORT WORTH, TX
MAY 24, 2011

- More than 100 sites visited
- Maximum hail size at the site was recorded based on observed damage
- Impact effects were measured using a damage scale from 0 to 5
- Roof types were recorded

Claims Analyses and Experiments From the IBHS Also Inform Hail Vulnerability

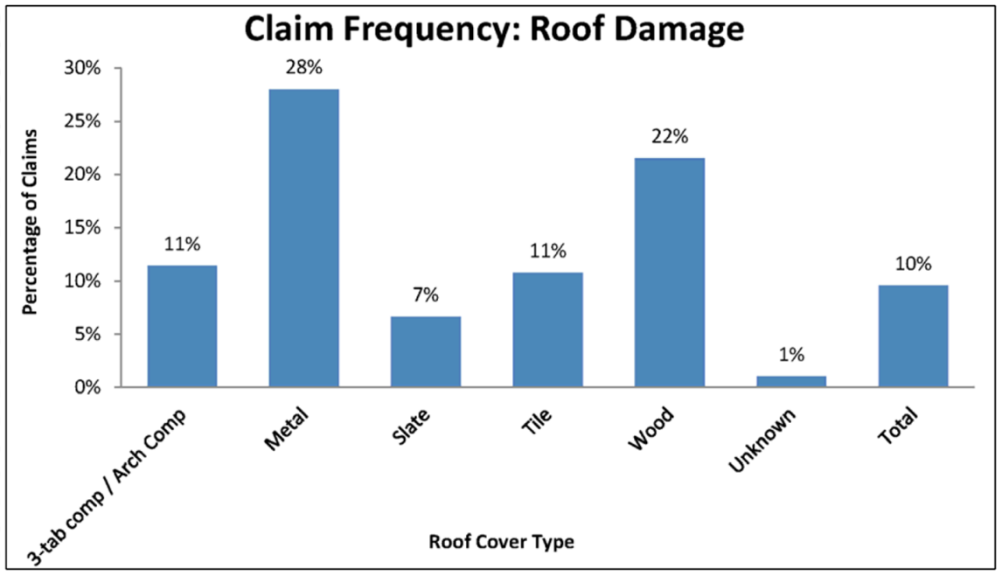


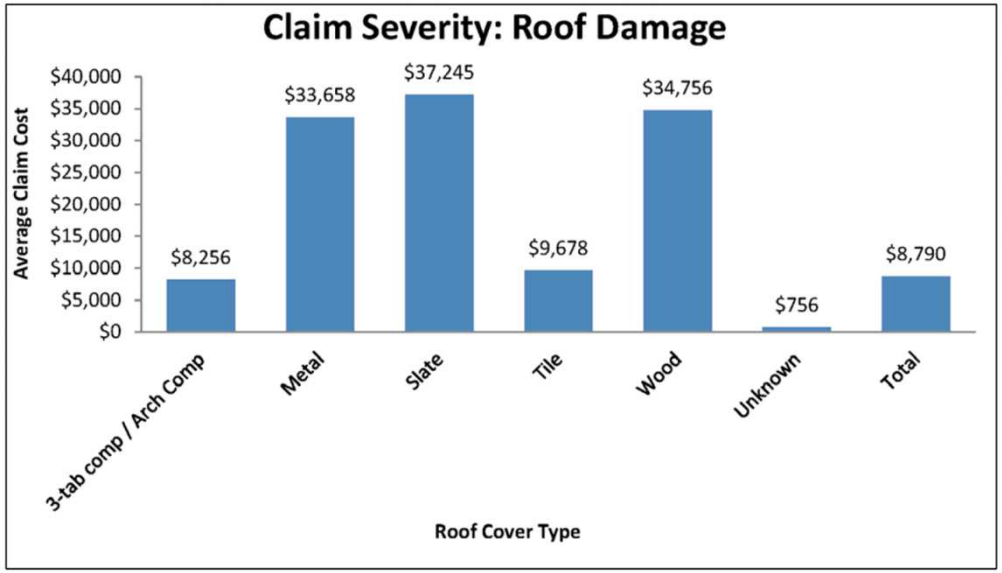
Claims Analysis Study of May 24, 2011 Hailstorms in Dallas-Fort Worth

Tanya M. Brown, PhD
South Carolina Wind & Hail Underwriting Association Research Engineer

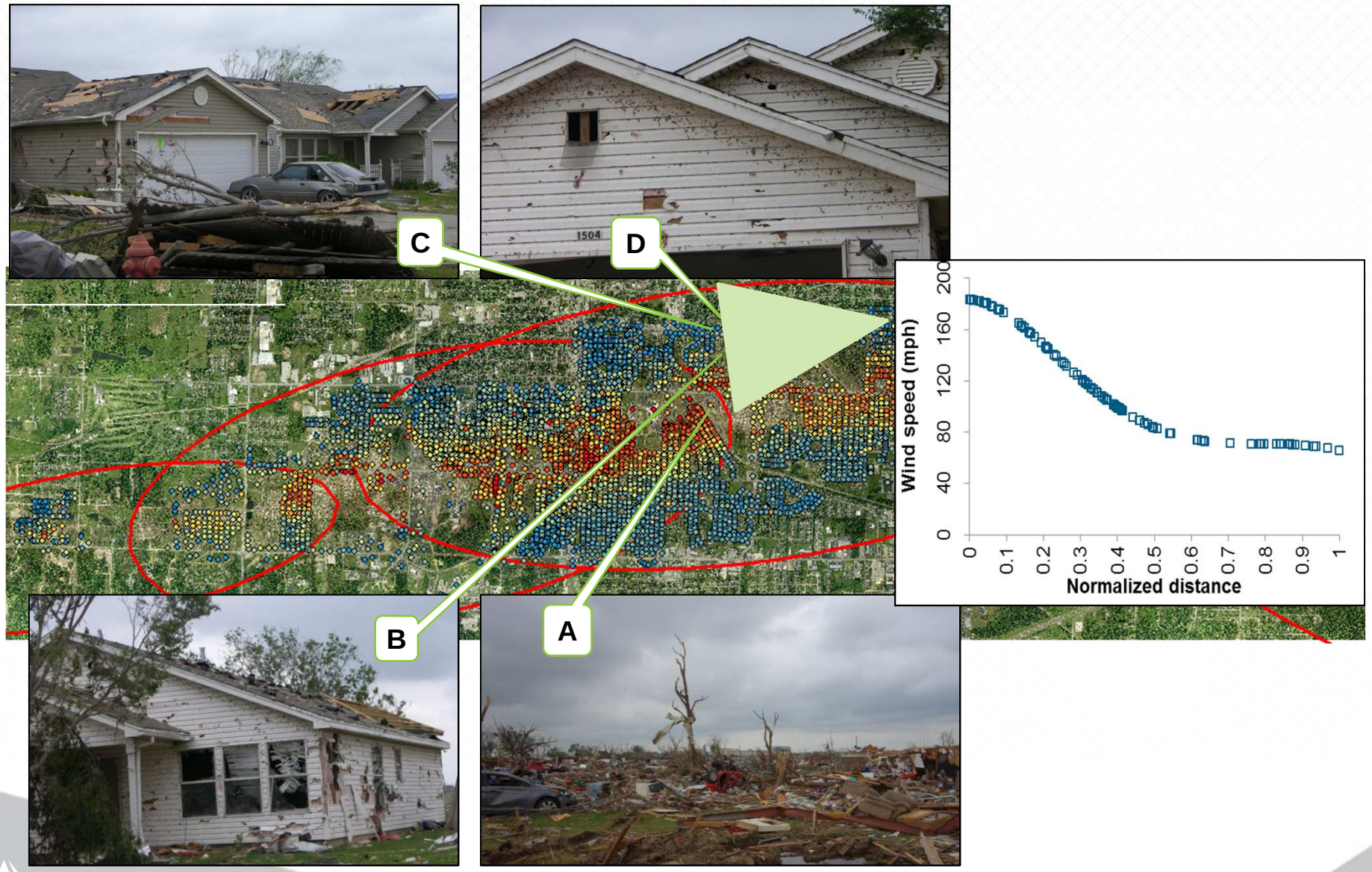
Hank Pogorzelski
Applied Statistician

Insurance Institute for Business & Home Safety
June 10, 2013
IBHS – RC02 – 2013

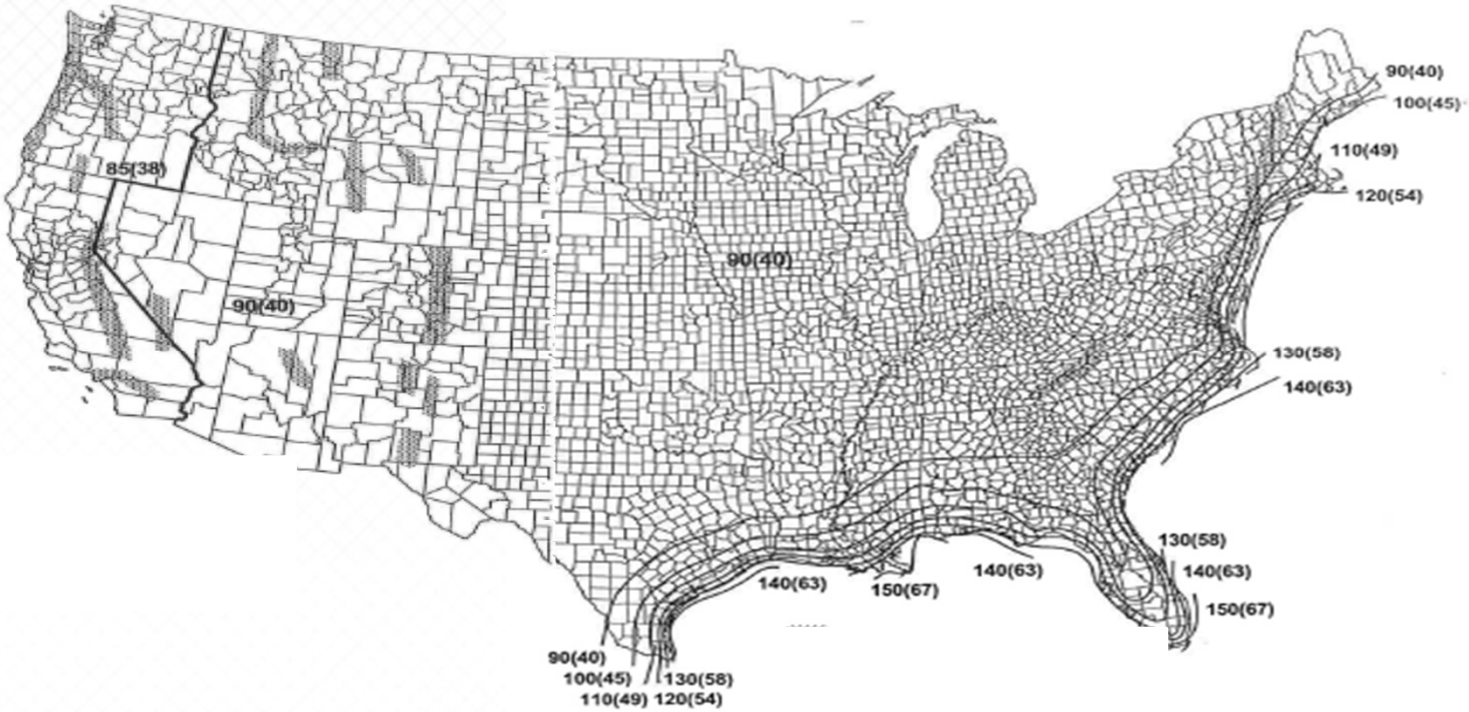




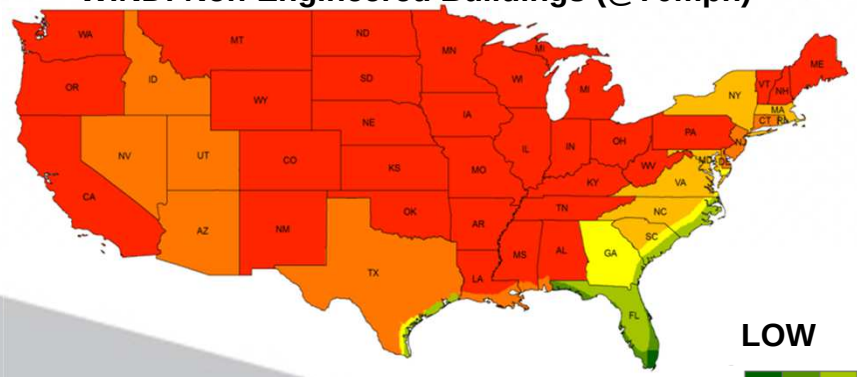
AIR Has Collaborated With Texas Tech to Formulate Tornado Profiles



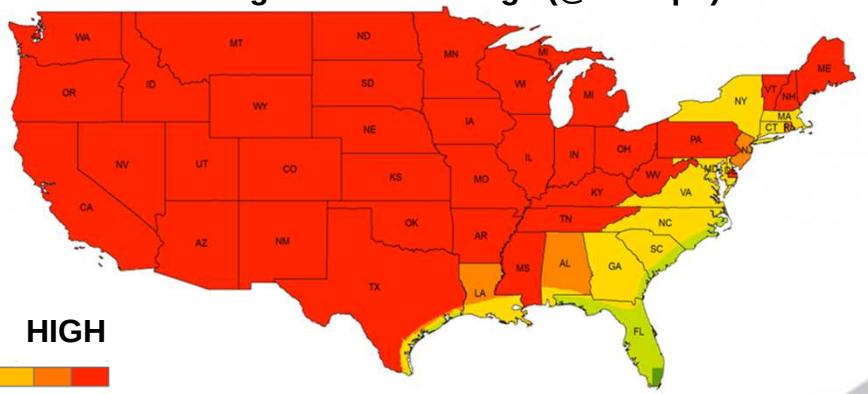
The Updated Model Explicitly Accounts for Regional and Temporal Changes in Wind Vulnerability



WIND: Non-Engineered Buildings (@70mph)



TORNADO: Engineered Buildings (@150mph)

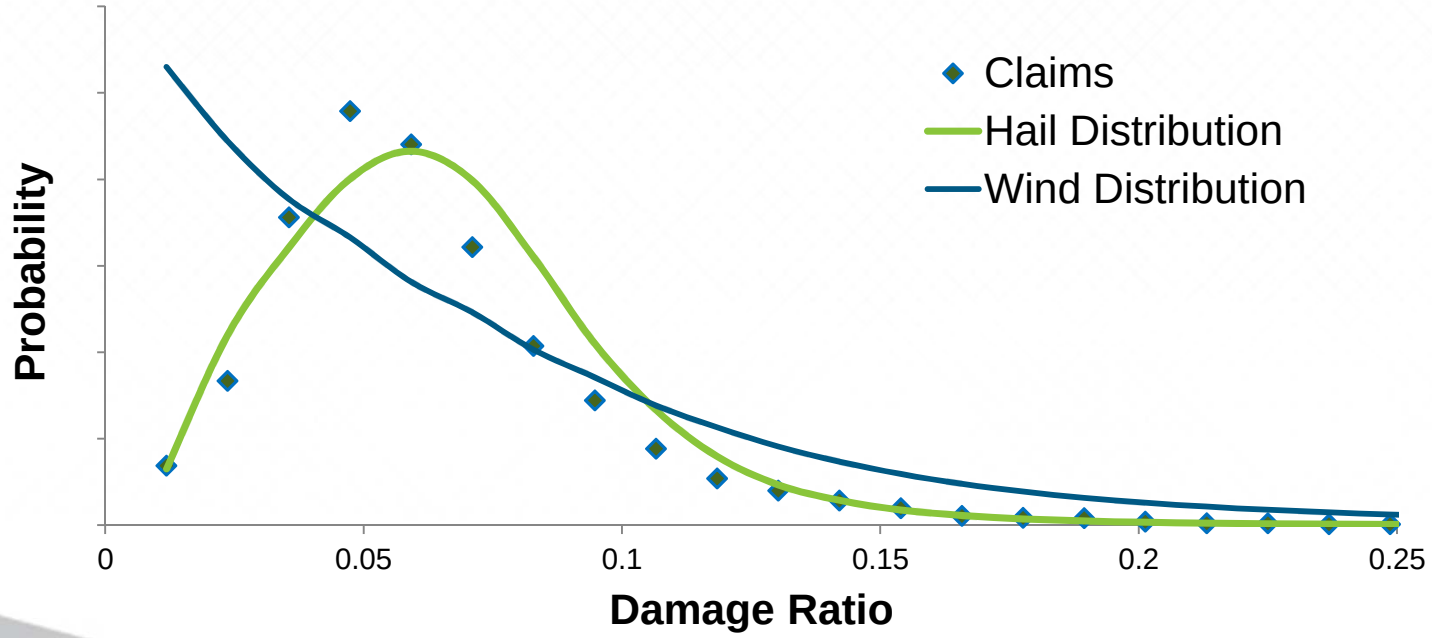


LOW **HIGH**

The Model Uses Peril-Specific Damage Distributions to Account for Uncertainty in Local Hazard and Damage

- Damage distributions differ by sub-peril and coverage
- For hail, we see a greater proportion of small claims and fewer large claims, as compared to wind

Distribution of damage at a given mean damage ratio:



Secondary Building Characteristics Can Be Accounted for Directly in the AIR Model

Sub-Peril: Hail

List of Hail Secondary Features for the Updated Model		
Existing Features in AIR's Hurricane Model	• Year Roof Built	
	• Wall Siding	
	• Glass Type	
	• Glass Percent	
	• Window Protection	
	• Roof Pitch	
	• Roof Covering	
	• Roof Attached Structures	
Newly Added Features ONLY for Hail	• Hail Impact Resistance Roof Coverings:	
	✓ Class A	Least resistant
	✓ Class B	
	✓ Class C	
	✓ Class D	Most resistant

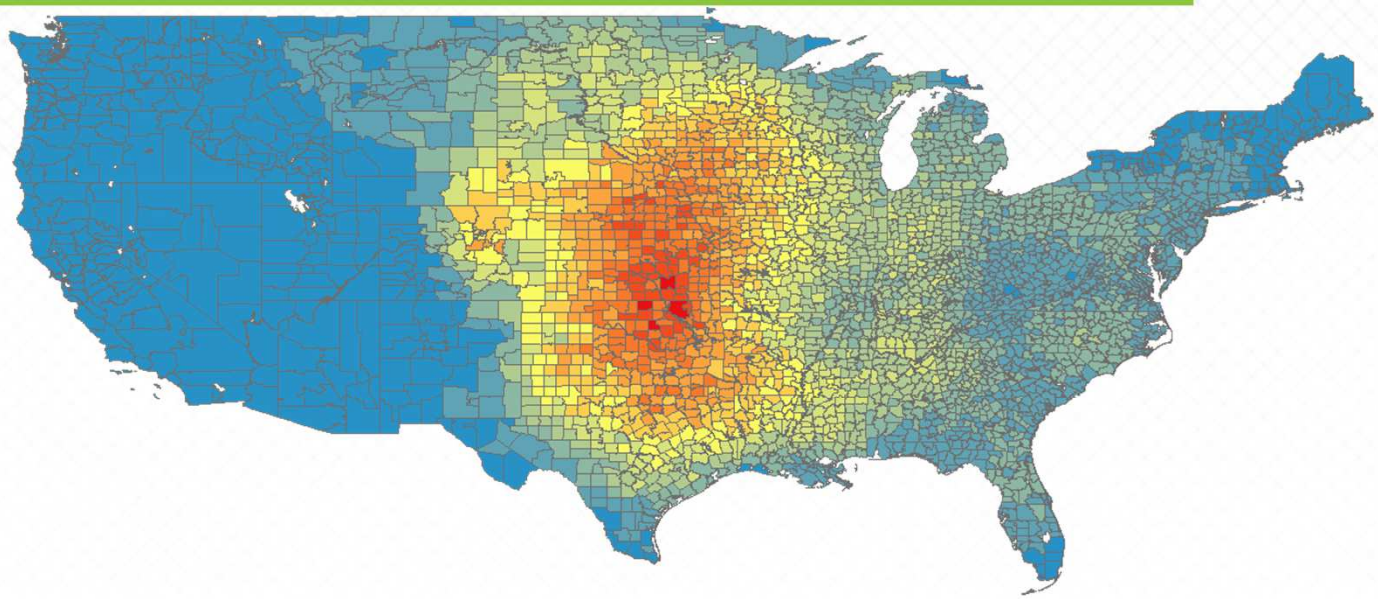
Secondary Building Characteristics Can Be Accounted for Directly in the AIR Model

Sub-Peril: Straight-Line Wind and Tornado

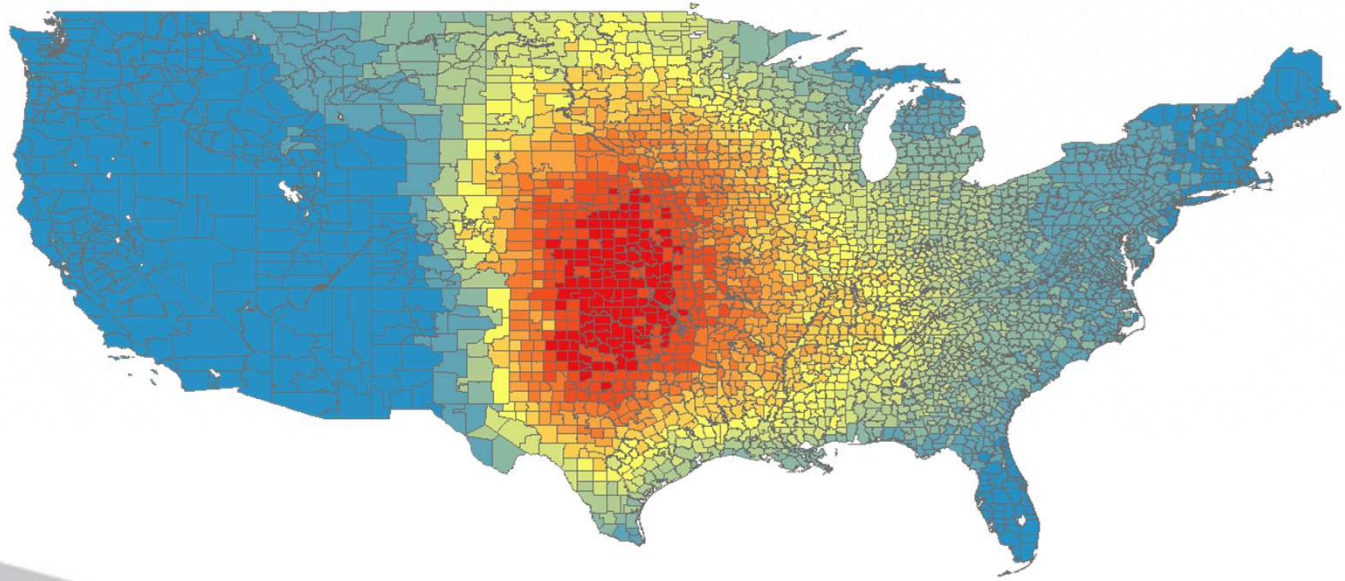
List of Straight Line Wind and Tornado Secondary Features for the Updated Model	
• Seal of Approval	• Roof Anchorage
• Floor of Interest	• Year Roof Built
• Building Condition	• Wall Type
• Tree Exposure	• Wall Siding
• Small Debris Source	• Glass Type
• Large Missile Source	• Glass Percent
• Terrain Roughness	• Window Protection
• Adjacent Building Height	• Exterior Doors
• Roof Geometry	• Building-Foundation Connection
• Roof Pitch	• Internal Partition Walls
• Roof Covering	• Wall Attached Structures
• Roof Deck	• Appurtenant Structures
• Roof Covering Attachment	• Roof Attached Structures
• Roof Deck Attachment	

The Overall View of Risk is Relatively Consistent Between the Models

Old Model



New Model



The Value of the Severe Thunderstorm Model to an Insurance Organization

Model output not limited by historical event and claim reporting bias

- The model captures a broad range of potential events across the entire country
- Simulated storms can occur where no historical storms have been reported

Account for severe thunderstorm loss volatility

- Historical loss is volatile, with active and inactive periods for a given location
- Events modeled include the range of low to high frequency, high to low severity catastrophes

The model includes physically realistic "tail" events

- Low frequency, high severity events not likely to be well-represented based on historical data alone

Enable users to evaluate scenarios for a variety of applications

- Underwriting
- Ratemaking
- Reinsurance structuring
- Portfolio management/ ERM

The Updated Model Has Been Thoroughly Peer-Reviewed by Leading Experts

The new model is "**realistic** and represent[s] the likely variability of intensity" and will "allow users to make **better decisions** about their exposure over a range of time horizons. AIR researchers have a **very good understanding** of the state of the scientific understanding and the uncertainties of the community's knowledge about severe thunderstorm hazards and have **utilized that knowledge in the models**."

- Dr. Harold Brooks, National Severe Storms Laboratory

"AIR Worldwide has developed a **comprehensive** Severe Thunderstorm Model for the United States." The model has "damage functions [that] are based on the **scientific relationship** between building damage and wind speed/hail impact energy." For hail, the model "includes both the vertical fall speed as well as the horizontal component of wind speed to calculate impact energy. This is **especially useful** when estimating the amount of damage to building exteriors such as siding and windows."

- Timothy Marshall, PE, Haag Engineering

The New AIR U.S. Inland Flood Model

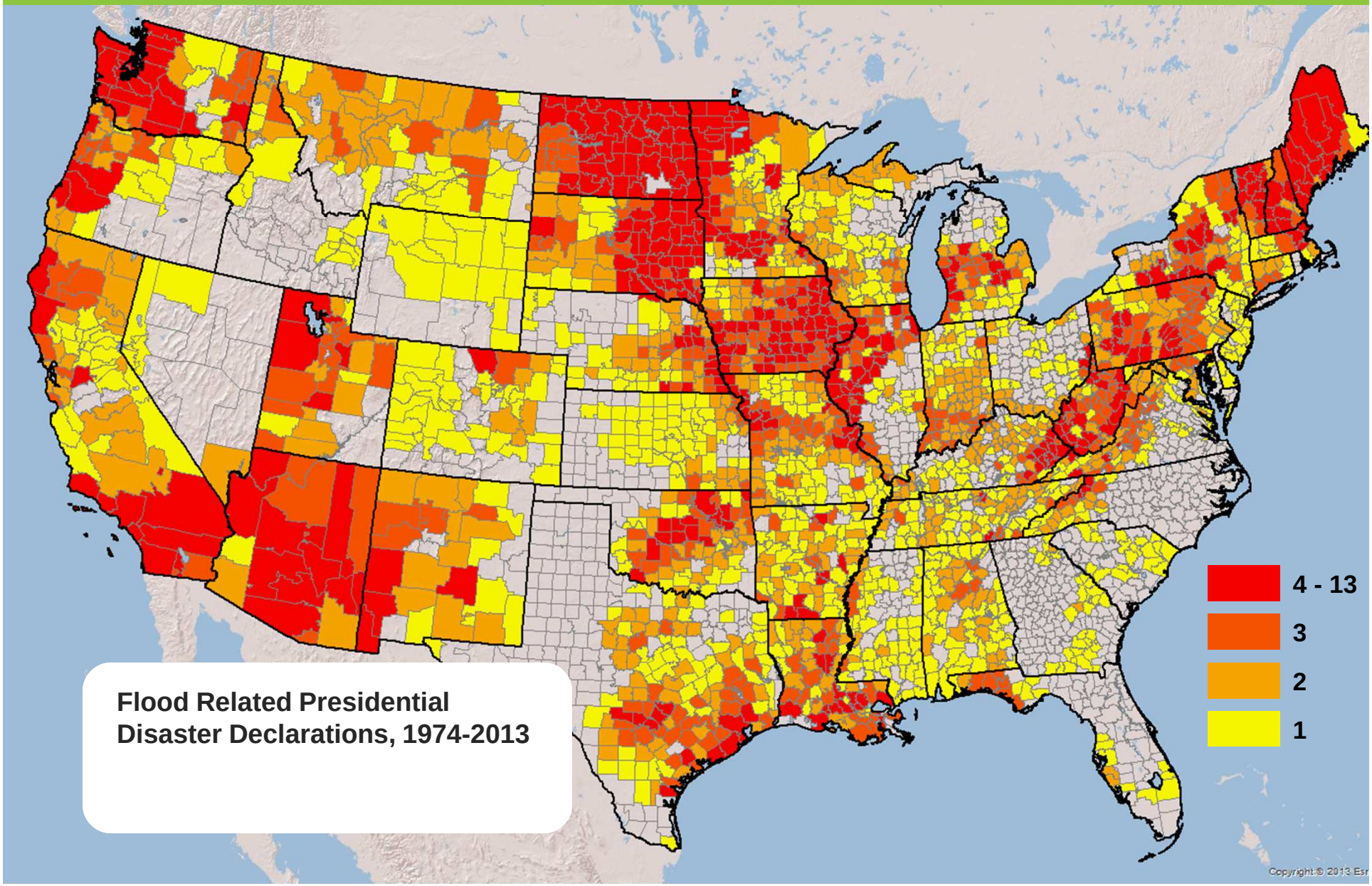
AIR

Overview of U.S. Private Flood Insurance Market

- What is already available in the U.S. for private flood insurance coverage?
  - Commercial flood policies
  - Auto
  - renters
  - Homeowners – sprinkler leakage, pipe breakage, sewage backup
  - Excess homeowners flood coverage (above maximum of building/ contents coverage provided by NFIP)
  - Florida – flood insurance endorsements

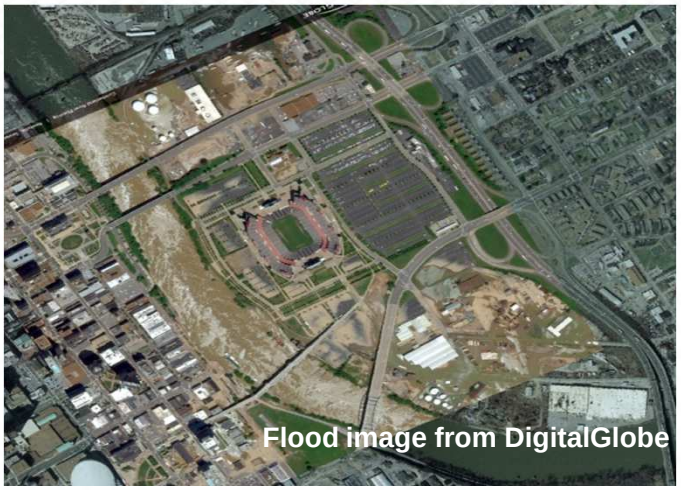
- Is the insurance industry ready to take on flood risk?
  - As federal subsidies for flood insurance are reduced and cost of government insurance increases, demand for private coverage could grow
  - Lawmakers want to reduce risk to NFIP support – Biggert-Waters Flood Insurance Reform Act of 2012
  - Florida, West Virginia advancing legislation to increase availability of private flood insurance

Why AIR Is Developing a U.S. Inland Flood Model - Flood Hazard Is a National Threat

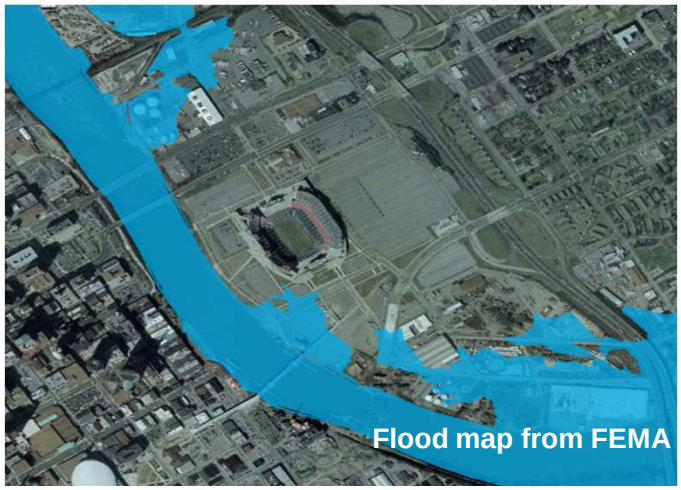


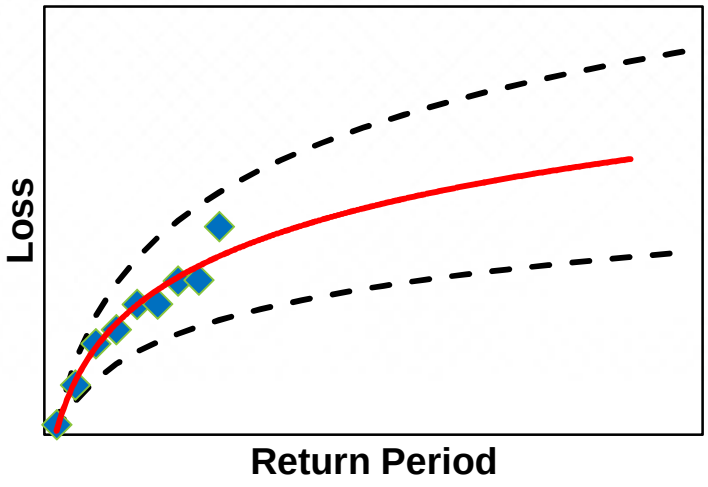
There Are Many Different Ways to Examine Flood Risk, But Not All Yield the Same Results

Historical Flood Footprints



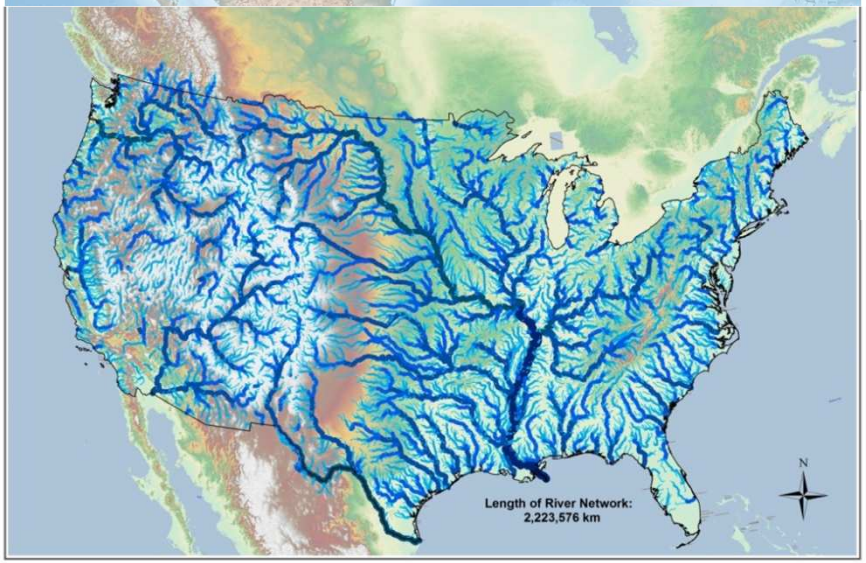
Return Period Flood Maps





Actuarial Models Based on Trended Losses

AIR Models Flood at a High Resolution



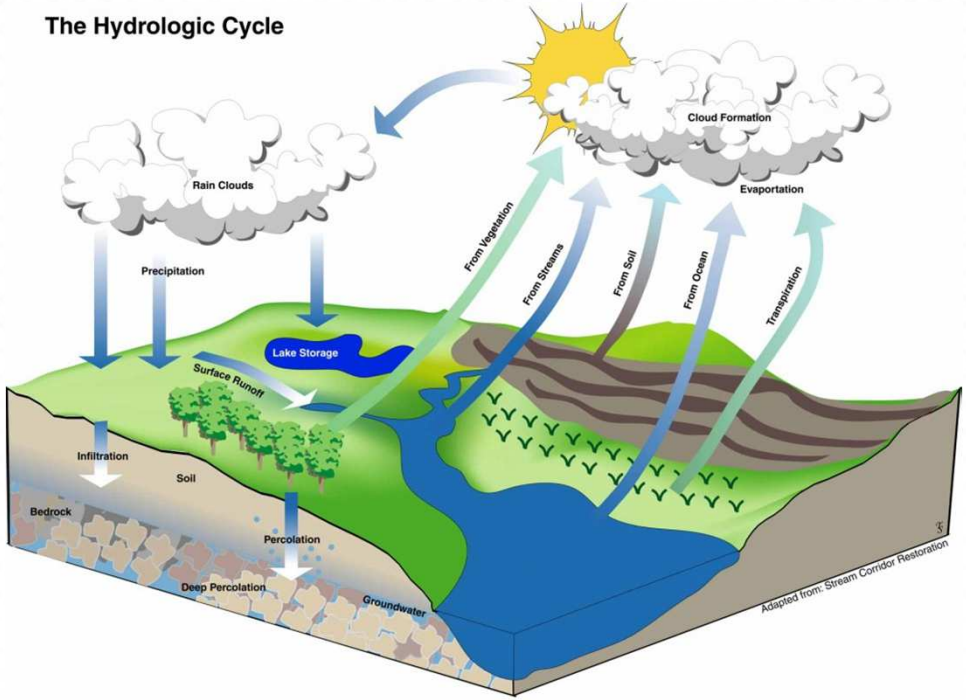
- 18 major river basins in the contiguous U.S.
- Every stream draining 10 km^2 or more
- Over 8 M km^2 of drainage area
- 2.2 M km of total streams
- About 9,000 river gauges used for calibration
- 20,000 lakes and reservoirs
- Over 4 M river cross-sections, roughly spaced every 500 m
- 30-m NED DTM* used for water surface elevation

**NED DTM – National Elevation Dataset - Digital Terrain Model*

The New AIR U.S. Inland Flood Model – Hazard & Vulnerability Overview

AIR

A Flood Hazard Model Contains Two Key Components

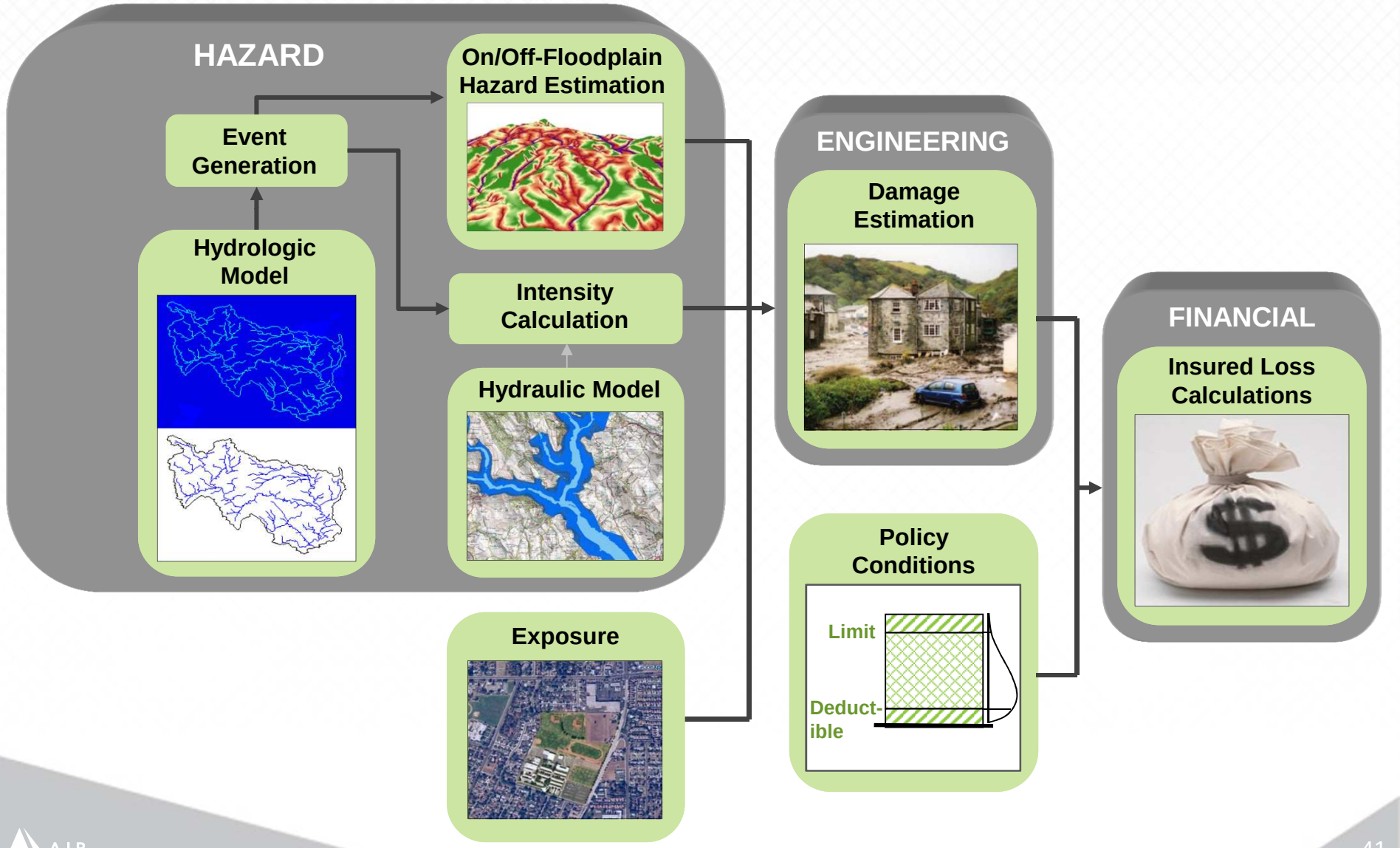


1. Hydrology
   - Precipitation
   - Runoff components
     - Storage in snow pack, soil, etc…
   - Flows in river

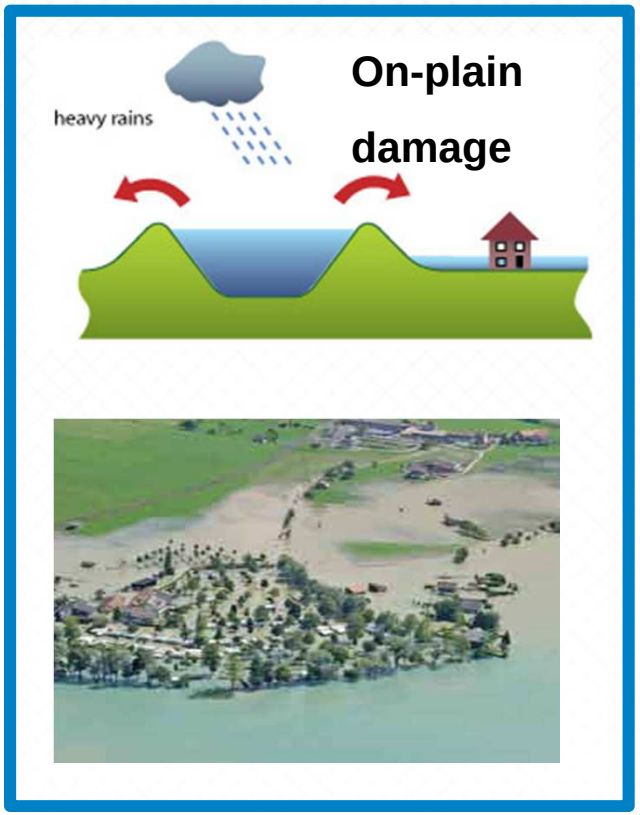
2. Hydraulics
   - Mechanics of flow
   - How water overflows banks
   - Mapping of flood zone

Illustration adopted from http://www.metrofieldguide.com/the-hydrologic-cycle/

AIR Uses a Similar Model Framework Across Many Different Perils



The AIR Inland Flood Model Includes Separate Hazard Modeling & Damage Functions for On- and Off-Floodplain Losses



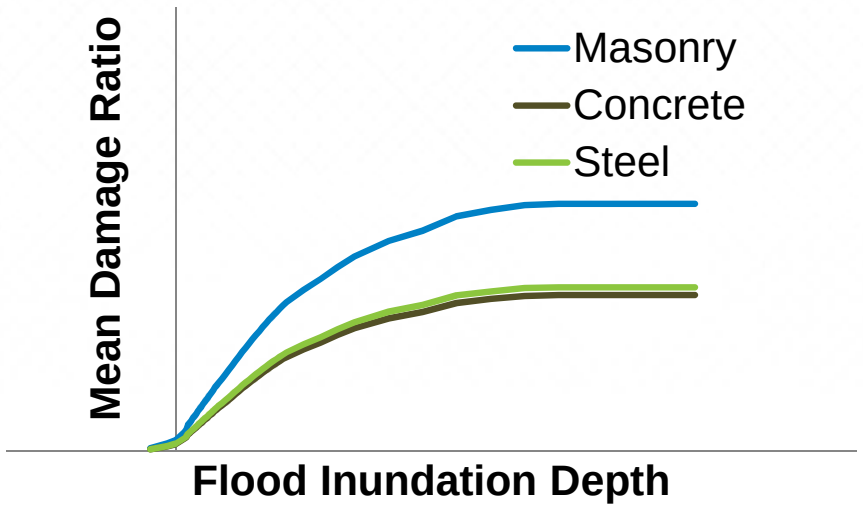
- River swells into adjoining floodplains
- Levee failure

- Heavy local downpour
- High urbanization resulting in quick ponding
- Flatter topography
- Poor drainage
- Distance from nearest stream

AIR Has Developed Damage Functions for a Variety of Construction and Occupancy Combinations

Flood damage estimation is based on extensive use of multiple data sources

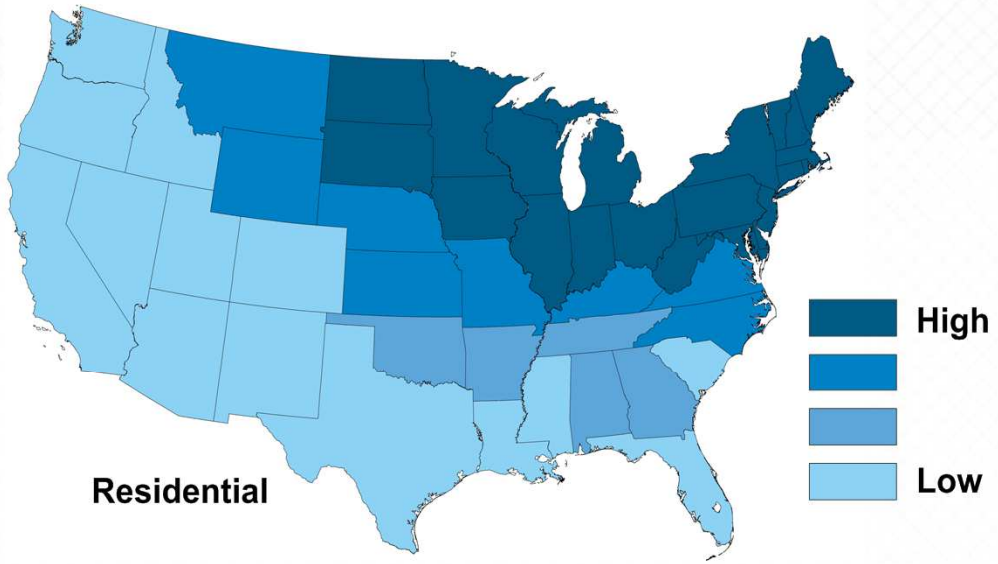
- Engineering analyses
  - Construction practices and building code design criteria in U.S.
  - Flood resistance of building components
  - Published engineering research
- Damage surveys
- Historical loss estimates
- Company claims data

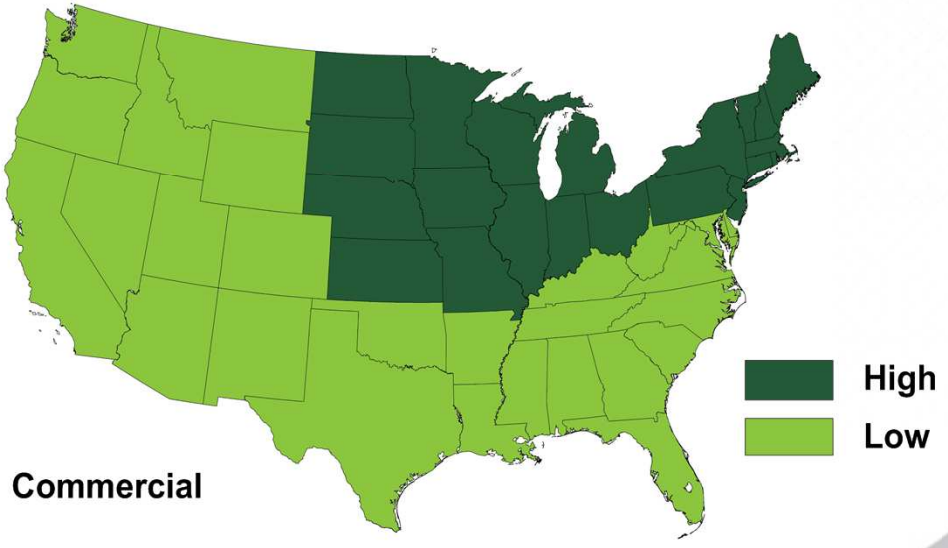


The AIR Inland Flood Model Accounts for Exposure Characteristics

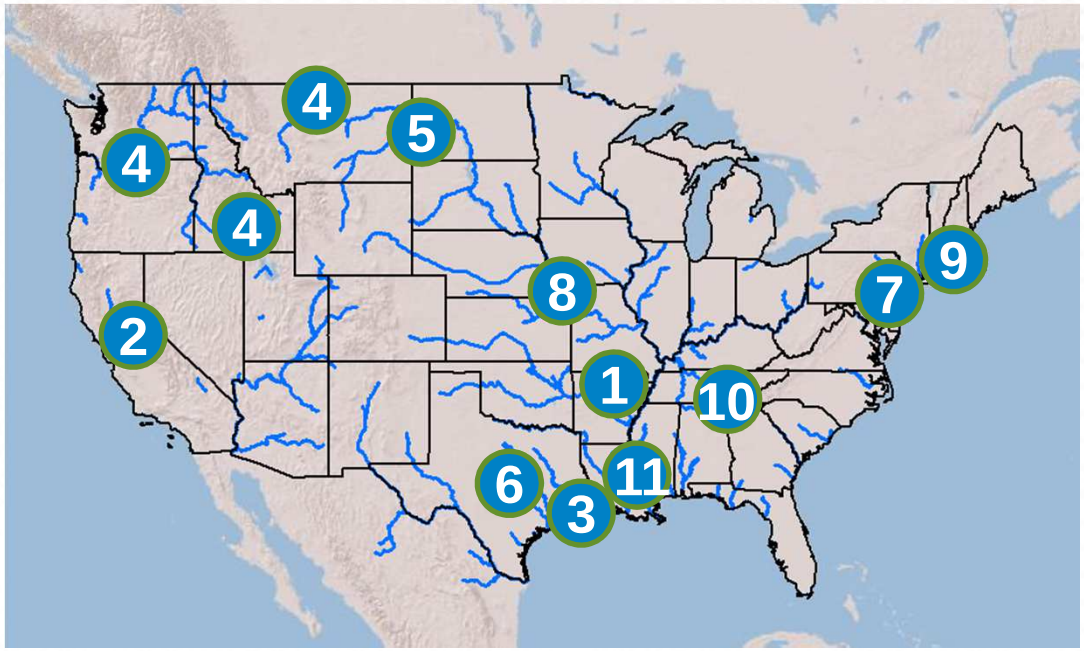
- Differentiate risk based on exposure characteristics
  - Primary characteristics include: age, construction, occupancy, and height (similar to other models)
- New data collection likely required for secondary risk characteristics
  - Secondary characteristics include:
    - Custom Elevation Modifiers
    - Foundation and Basement Modifiers
    - Floor of Interest
    - Contents and Equipment
- Consider the impact of custom flood defenses

What Areas of the Country Are Most Vulnerable to Flood Risk?
Relative Flood Vulnerability Across the U.S.





AIR Considers Major Historical Events for Validation



1) The Great Flood, 1993

2) California Flood, 1995

3) Gulf Coast Flooding,1995

4) Pacific Northwest, 1996–97

5) Red River Flood, 1997

6) Texas Flood, 1998

7) Northeast Flood, 2006

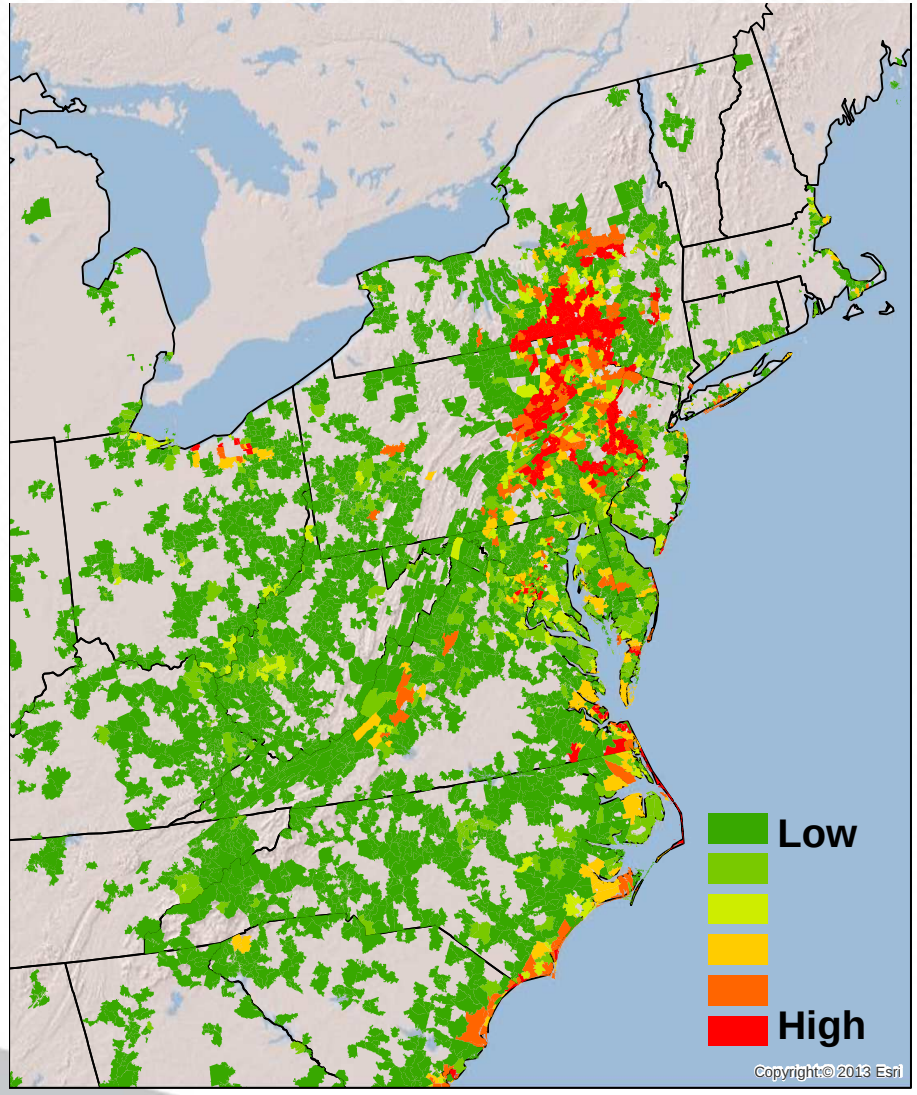
8) Midwest Flooding, 2008

9) Rhode Island Flooding, 2010

10) Tennessee Flooding, 2010

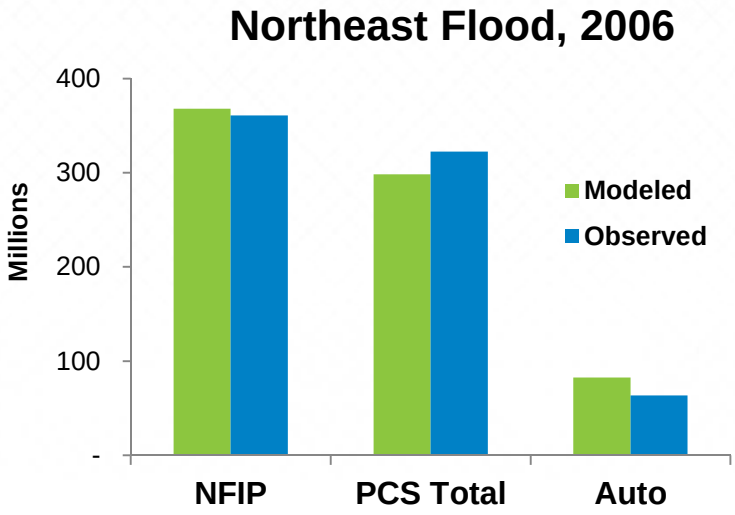
11) Lower Mississippi River Flood, 2011

Industry Exposure Database (IED) Enables AIR to Validate the Model at an Industry Level

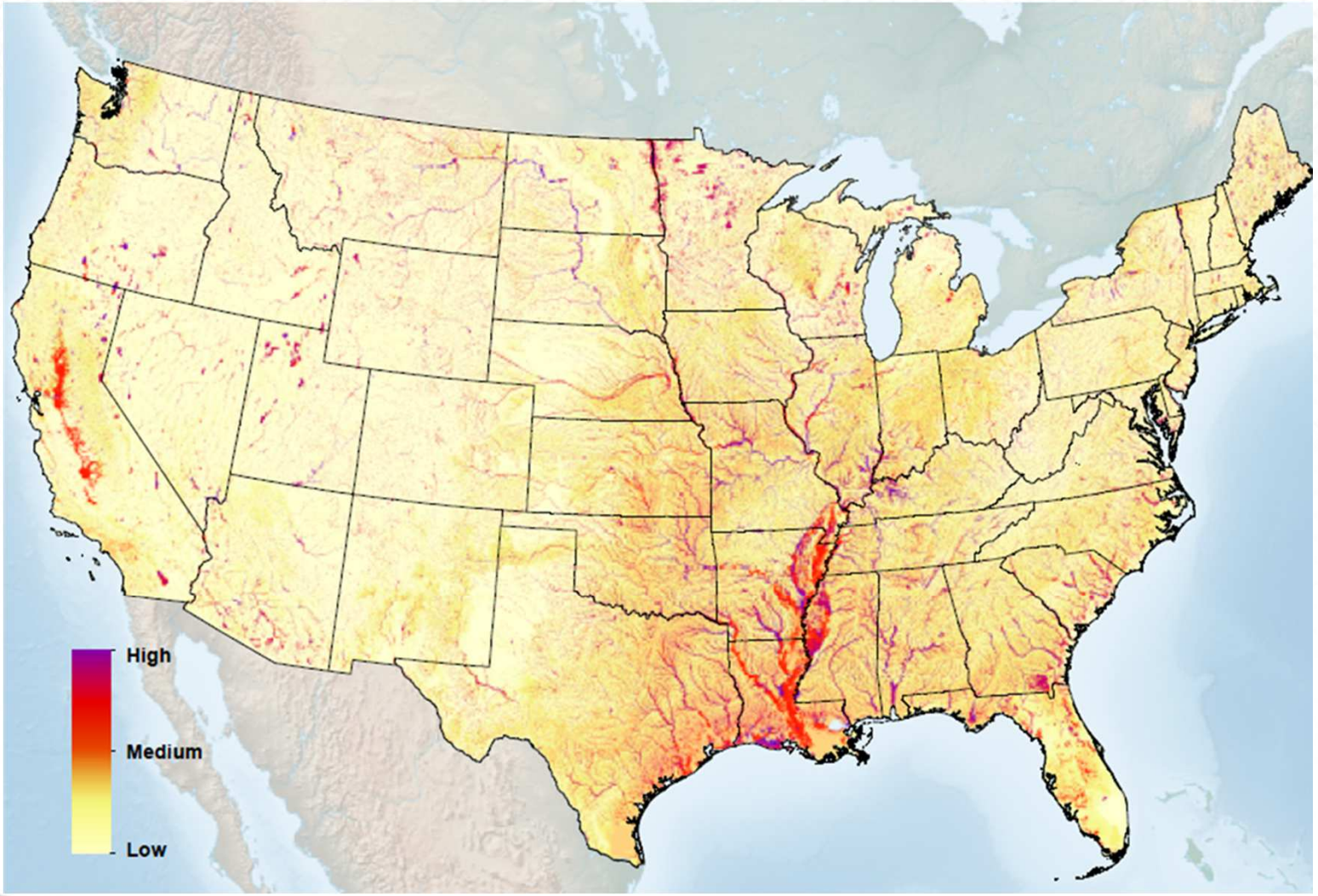


Data sources

- NFIP insured losses
- PCS® insured losses
- National Weather Service economic losses
- Claims data from Xactware®



AIR Inland Flood Risk Map Shows Flood Risk Is Distributed Throughout the Country

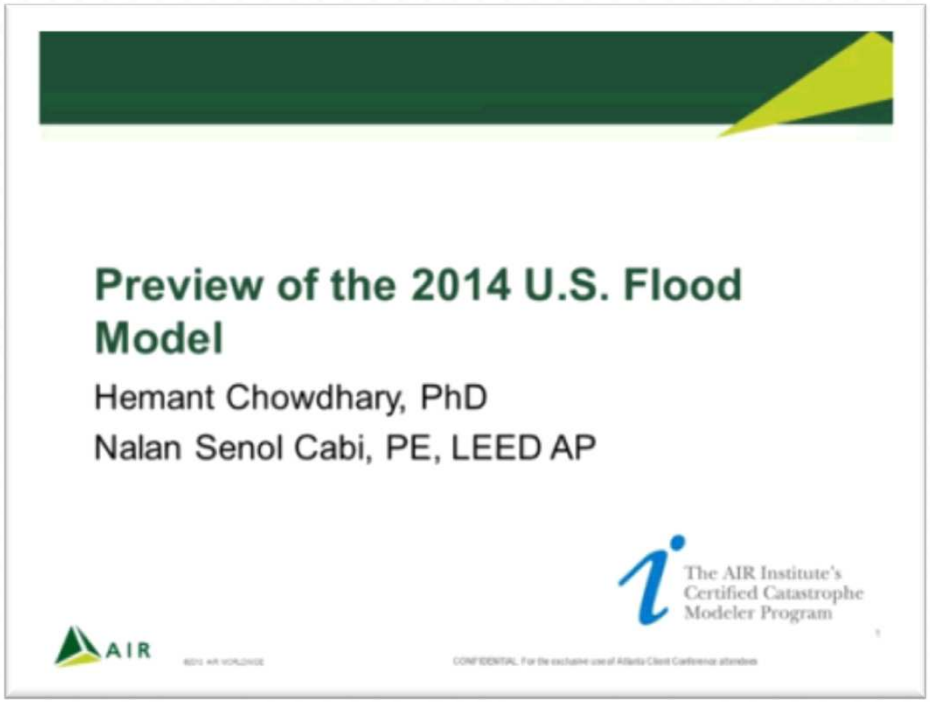


Summary of the New AIR U.S. Inland Flood Model

- Flood is a threat throughout the U.S.
- The AIR U.S. Inland Flood Model is the industry's first comprehensive model available and can be used for a variety of risk management applications
- AIR's U.S. flood model accounts for on- and off-floodplain losses to yield the most realistic view of risk
- Secondary modifiers, including custom flood protection features, allow users to correctly model exposures
- Create exceedance probability curves at either location or portfolio level
- The AIR Inland Flood Model for the U.S. will be released in 2014

AIR Webinar Replay: “Preview of the U.S. Flood Model”

In this recording, originally presented on May 2, 2013 at the AIR Client Conference in Atlanta, Georgia, Hemant Chowdhary, PhD, Senior Scientist in our Research Department and Nalan Senol Cabi, PE, LEED AP, a Hydraulic Engineer in the Research and Modeling Department, preview the 2014 AIR U.S. Flood Model.



http://www.air-worldwide.com/Publications/Presentations/private/Preview-of-the-2014-U-S--Flood-Model/

Note: Must be logged in to the AIR Client Portal to access webinar replay. Please contact an AIR Consultant if you require access.

Questions?