

# GUY CARPENTER

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## Catastrophe Modeling

A Look at Two Decades of Modeling and Lessons Learned

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# Catastrophe Modeling 20 Year Retrospective

- Cat management before models
- Models emerge in late 1980's
- How are they built?
- Widely used by late 1990's
- What's all the recent fuss? – the wind blew
- Lessons learned by industry & modelers

# Cat Management before Models

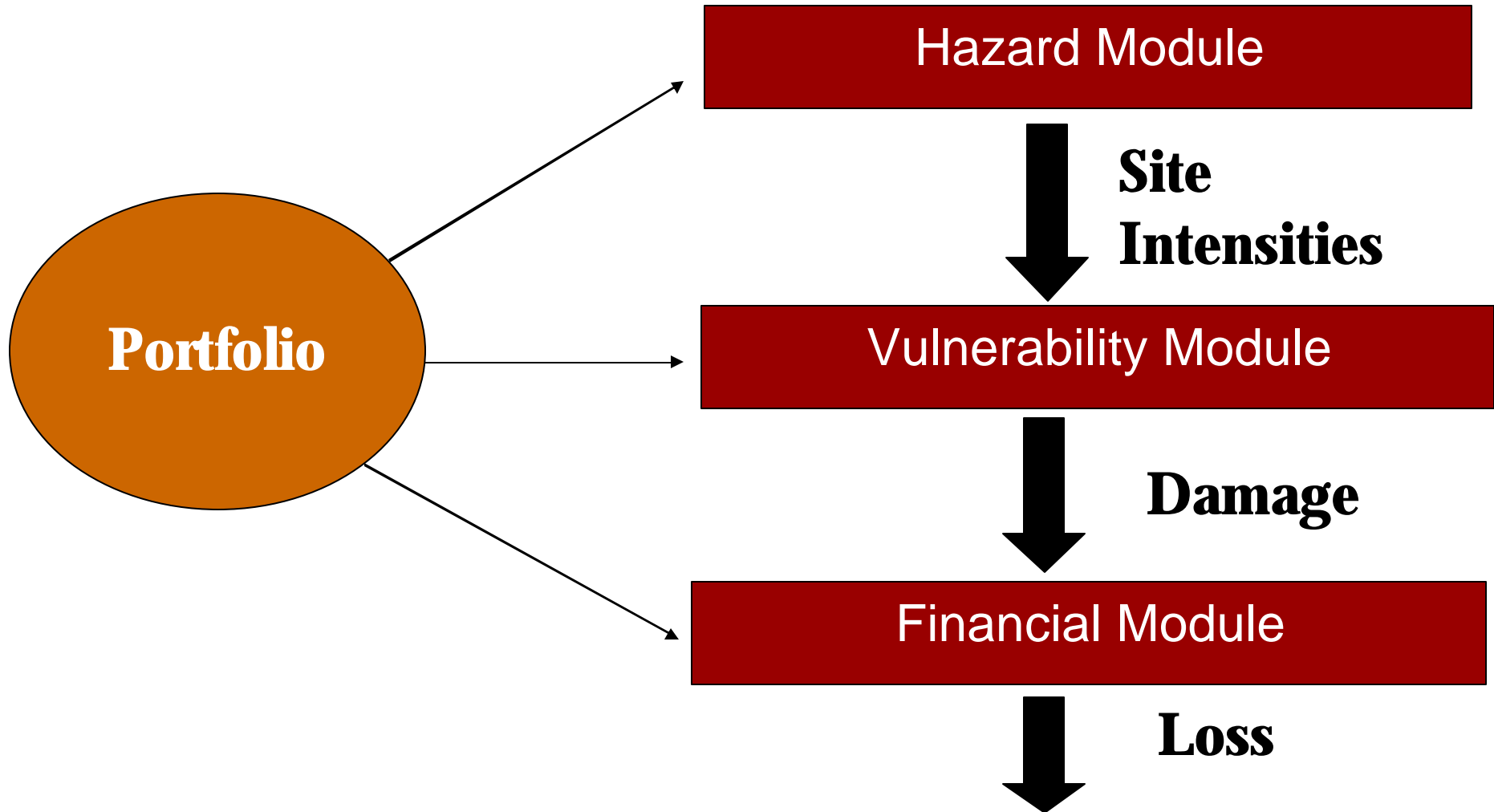
- Exposure management – collecting data
- Aggregate management – monitoring accumulations
- PML Management – apply damage factors to high risk areas
- National Hurricane Research Services (NHRS)
- California Earthquake Authority and Zonal Management

# Catastrophe Models

## The foundation

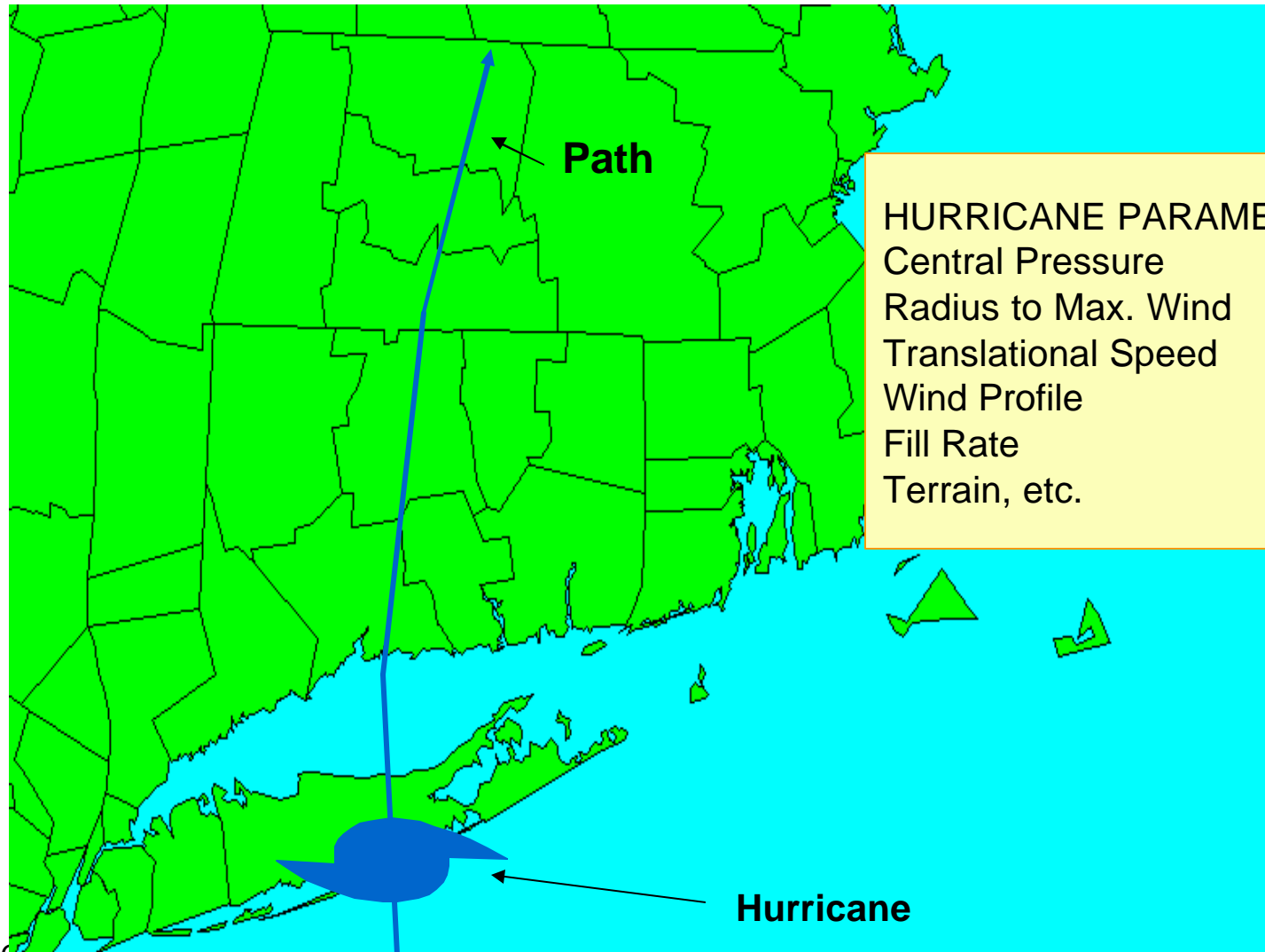
- 3 widely used models
  - RMS (Risk Management Solutions)
  - AIR (Applied Insurance Research)
  - EQECAT
- Cat management techniques coupled with scientific and engineering research
  - Expert opinion solicited
    - Meteorologists & seismologists
    - Structural engineers
    - Mathematicians
    - Insurance experts
  - 100+ years of historical record
  - Post event surveys & claims data from Andrew (1992) and Northridge (1994)
- Models are similar but not equal

# Components of a Cat Model

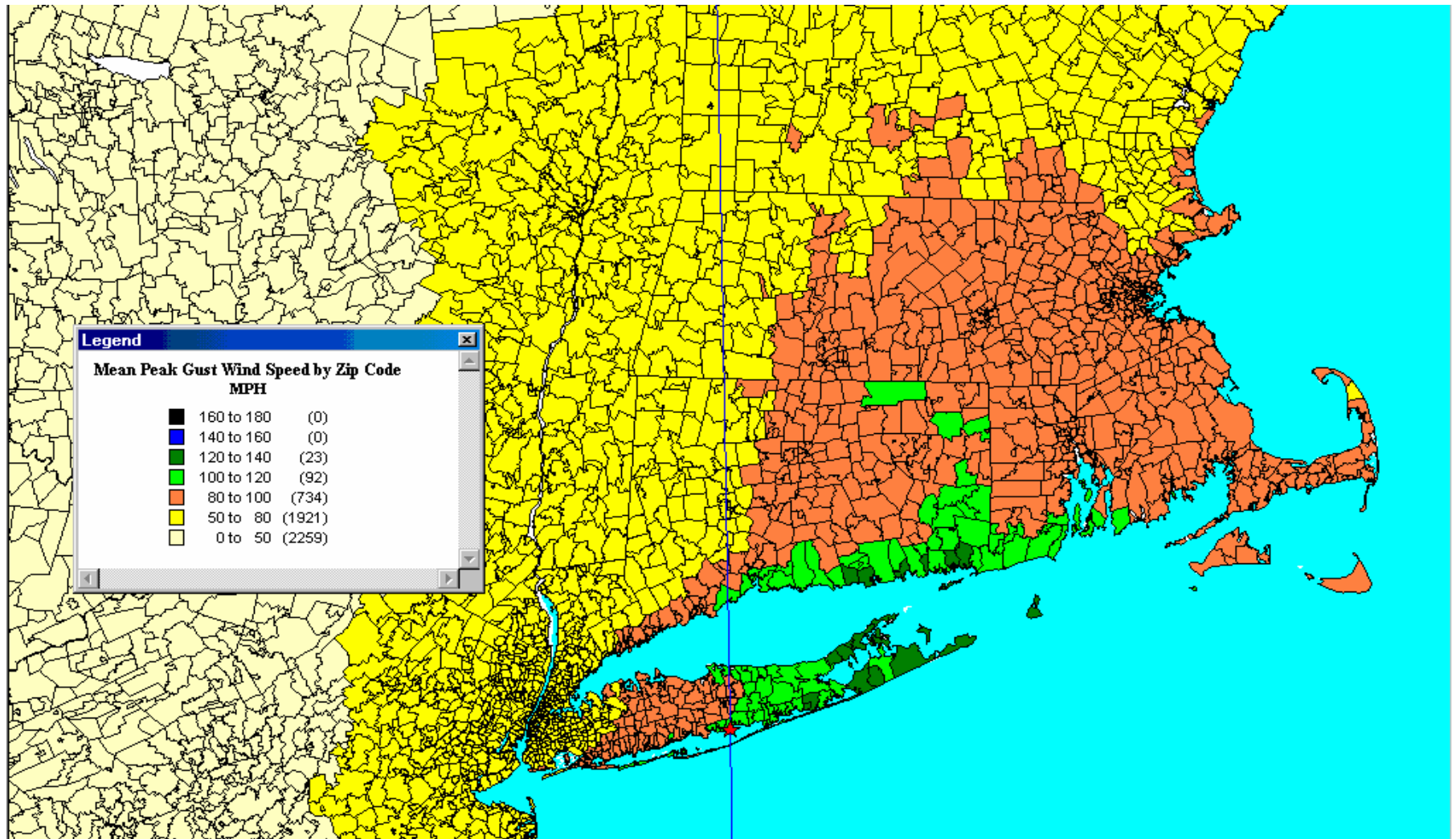


# Components of a Cat Model

## Step 1: Define the hazard - Hurricane Example

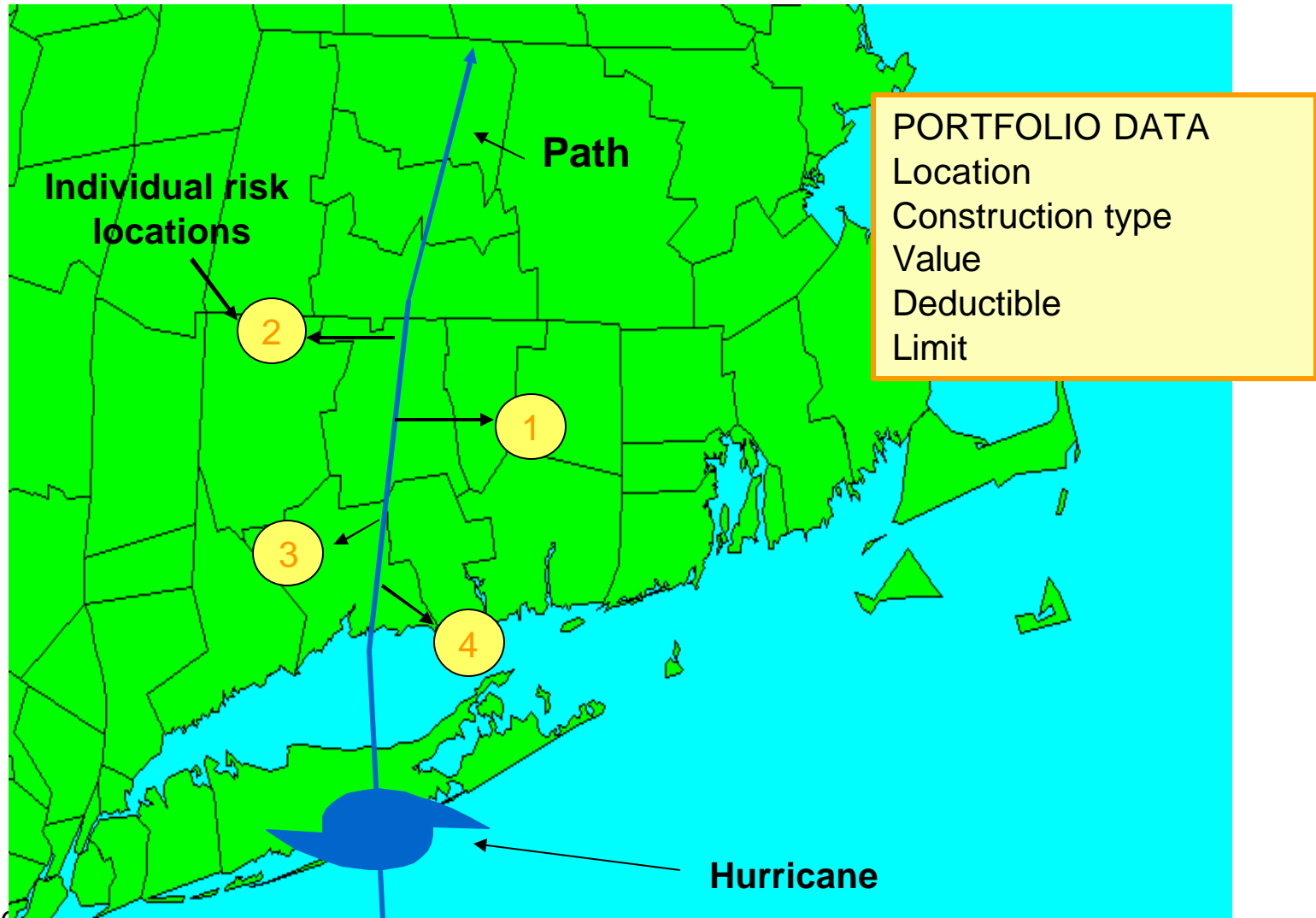


# 1938 Hurricane - Wind Speed



# Components of a Cat Model

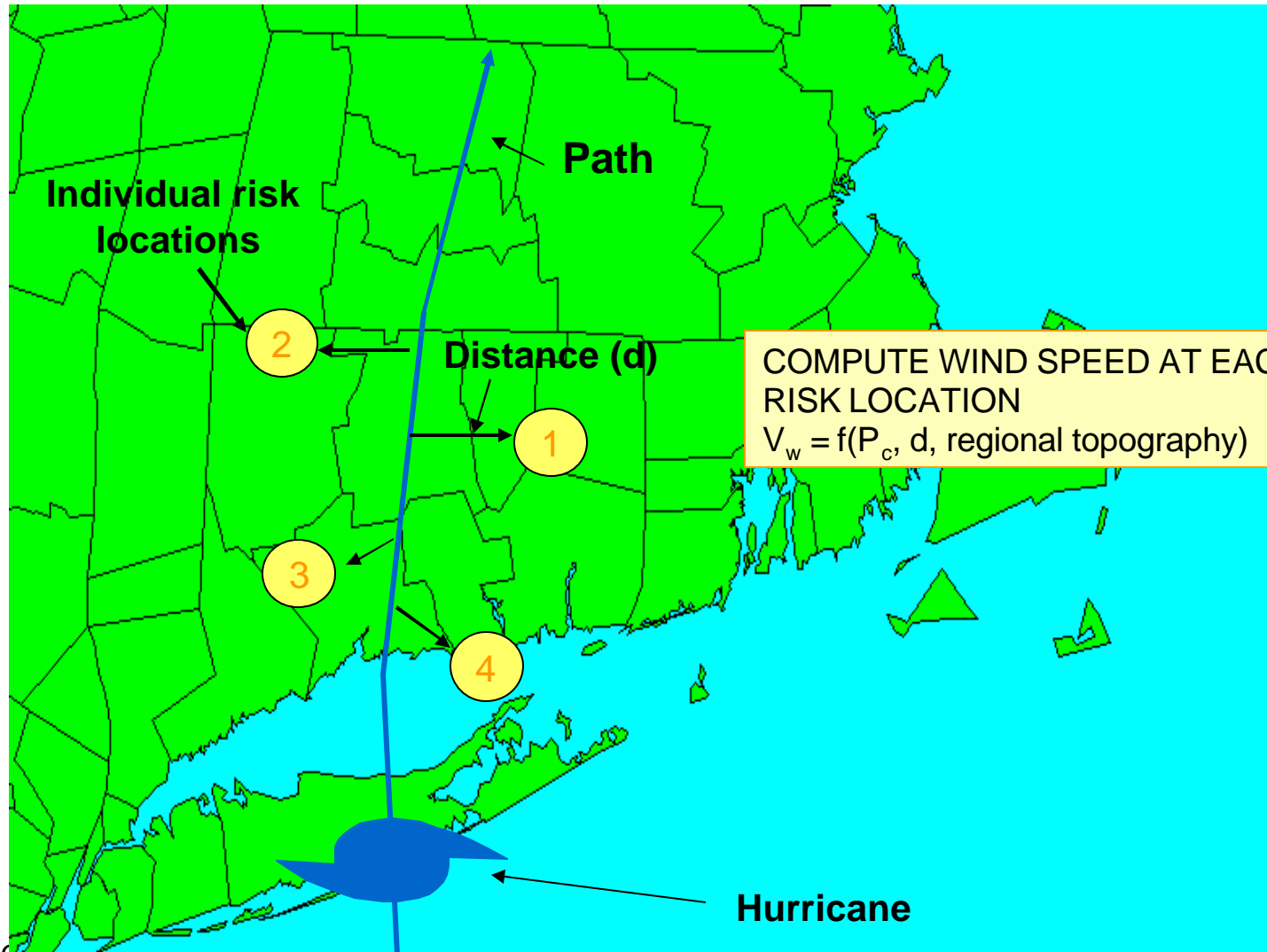
## Step 2 - Define the insured assets





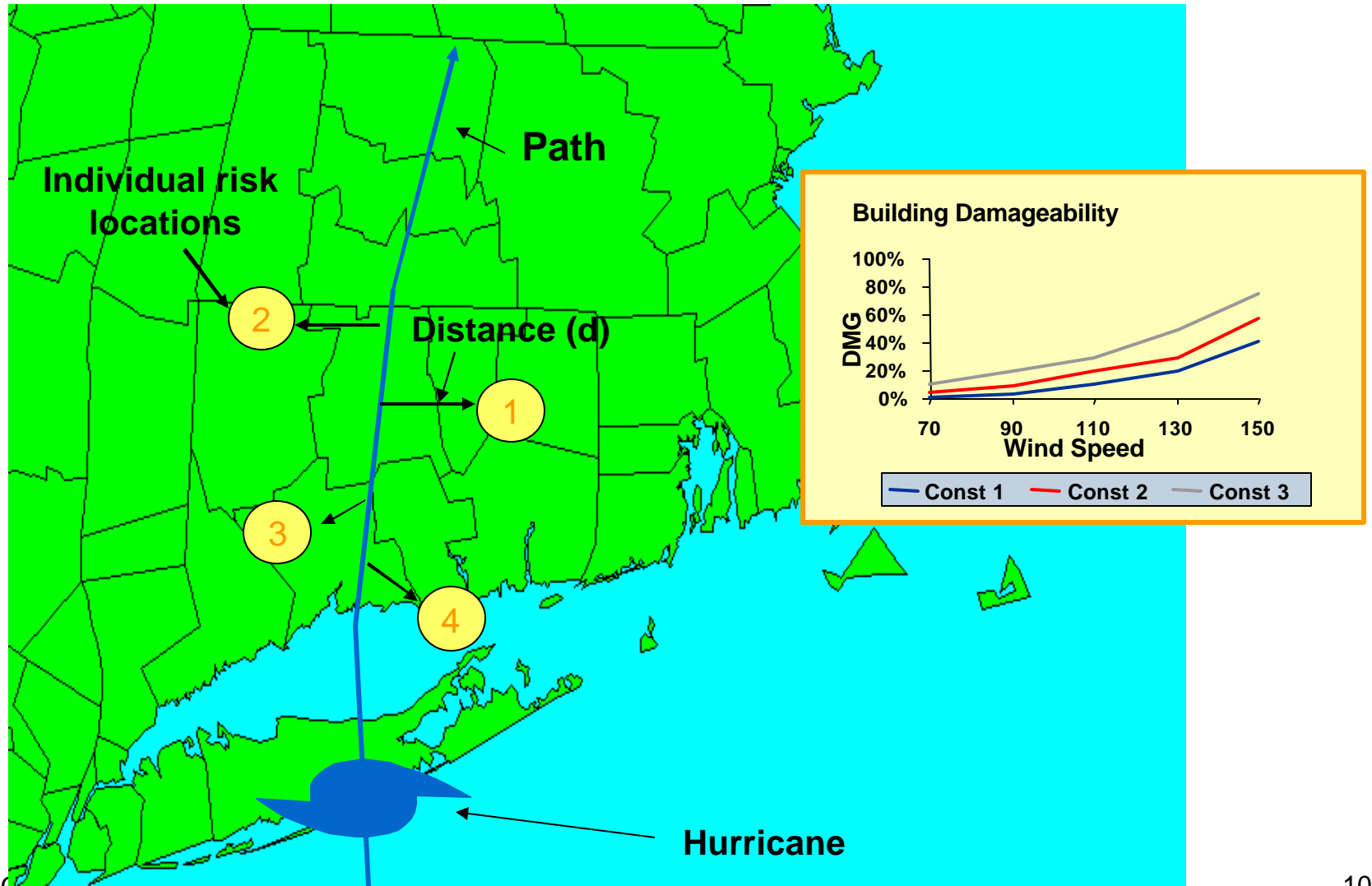
# Components of a Cat Model

## Step 3 - Calculate windspeed at site



# Components of a Cat Model

## Step 4 - Calculate site damage

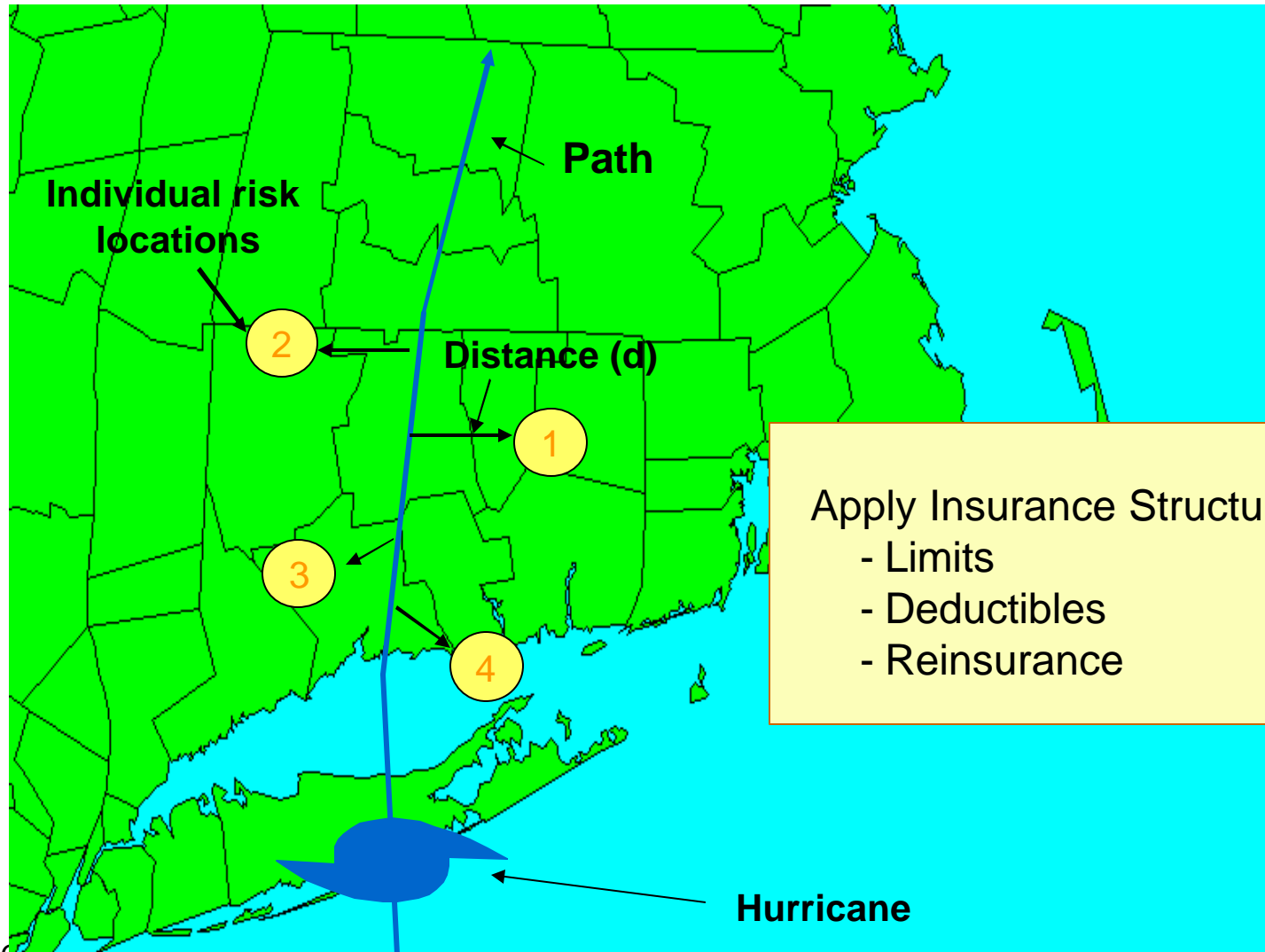


# Vulnerability Module - Structural Uncertainty



# Components of a Cat Model

## Step 5 - Calculate Insured loss



Apply Insurance Structures

- Limits
- Deductibles
- Reinsurance

# Sources of Uncertainty in Cat Models

- Accuracy of Exposure Data
- Hazard
  - Limited historical data
  - Pre 1950's data unreliable
  - Lack of understanding of hurricane and earthquake behavior
- Engineering
  - Prior to 2004 limited claims data
  - Unreliable data quality for old records
  - Lack of understanding of structural behavior under severe loads
- More reliable – still imprecise

# Industry use of Cat Models

- Primary carriers, reinsurers, brokers, rating agencies, Departments of Insurance, investors
- Could models be misused? Yes
  - “Garbage in, Garbage out”; own the data first
  - Using one model promotes model bias
  - Managing to a single loss output (i.e. 250 Year Return Period)
  - Lack of consideration for non modeled risk
  - Balance with other cat management practices
- Were models validated by events like Andrew and Northridge? No
  - Not widely used
  - Model use less sophisticated
  - Lack of claims data detail

and then the wind blew

Charley

Frances

Ivan

Jeanne

Katrina

Rita

Wilma

- 7 of the top 11 cats in US history
- \$78B in industry loss
- Costliest / deadliest
- Lowest central pressure
- Most FL landfalling storms in a season

# Modeled Loss vs. Actual Claims Observations

- Modeled loss not equal to paid loss
- Modelers use industry databases
  - PL more in line
  - CL loss estimates diverge the most
- Specific company analyses diverge even more than IED
  - Industry exposure database reflective of marketplace?
  - Data quality of inputted exposure called into question
- Frequency of events unexpected



# Modeled Loss vs. Actual Claims

## Factors contributing to divergence

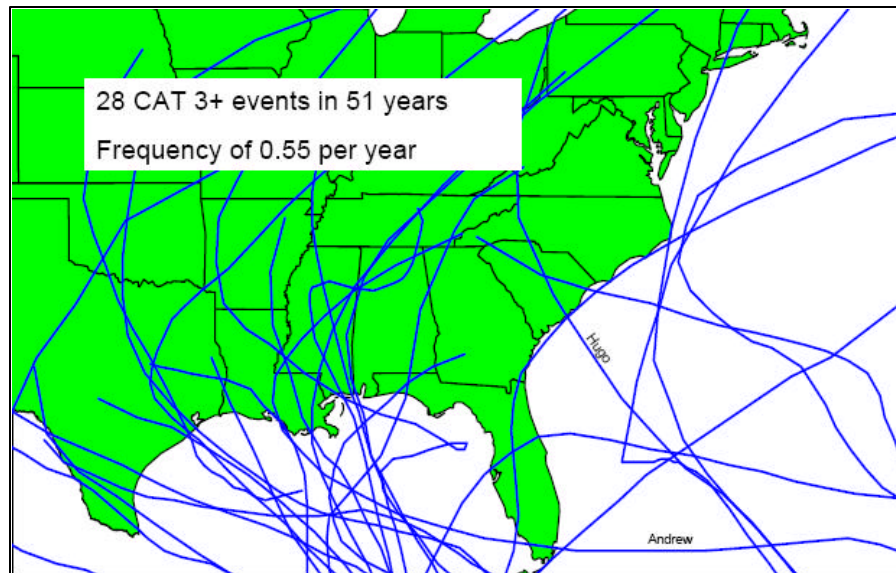
- Models need recalibration
  - Vulnerability module
  - Demand Surge and Storm Surge model
- Non modeled loss
  - Inland flood
  - Contingent BI
  - Mold
  - Tree Damage
  - Power Outage
  - Ordinance of Law
  - Loss Adjustment Expense
  - Looting / Rioting / Malicious Mischief
  - Backup of Sewers and Drains
- Data Quality

# Climate Factors that Influence Hurricane Activity

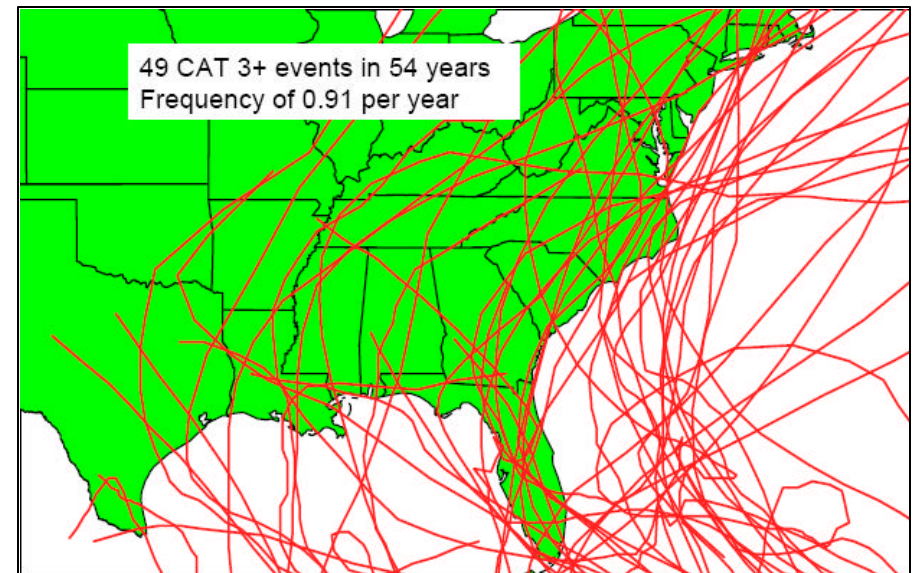
- Increased activity is national news
- Expert consensus next 5 to 10 years more activity
- Weather theorists debate causes:
  - North Atlantic Oscillation (NAO)
  - Quasi-Biennial Oscillation (QBO)
  - El Nino / Southern Oscillation (ENSO)
  - Atlantic Multi-Decadal Oscillation (AMO)
  - Global Warming (controversial and ongoing)

# Frequency of Major U.S. Landfalling Hurricanes by AMO Phase

## Cool Phase



## Warm Phase



Conversely Dr Kerry Emanuel stated at last weeks' RMS conference:  
*"AMO likely a statistical artifact of projecting a de-trended, nonlinear, forced temperature change on rotated EOF"*

# Industry Reaction

- Modelers acknowledge fixes needed
- Industry response - “Throw out the models”
- RMS, AIR and EQE report plans for new versions
- All vendors make some changes:
  - Vulnerability
  - Updates to Long term catalog to reflect more severe events
  - Demand Surge & Storm Surge
  - New model to reflect short term climate trends
- Jan 1 reinsurance renewals negotiations
  - more focus on exposure data / data quality
  - current model output ‘loaded’
- Regulators/rating agencies want more detail from defunct models!

# Risk Management Solutions

## RiskLink Version 6.0

- Updates to US Hurricane include:
  - Event catalog to include more severe events
  - Vulnerability – Importance of Building Characteristics ‘reordered’
  - Storm Surge & Demand Surge models
  - Frequency and Severity
    - New modeling platform based on Mid Term view of increased Frequency and Severity
    - Continue to represent long term view (100+ years) as a alternative view but recommends use of Mid Term view for risk management decisions
- Updates to Eastern US and Canada EQ Model
  - Reduced frequency rates for NE events
  - Reduced severity for NM events
  - Changes in vulnerability for Eastern Canada
  - Updates to Hazard Maps

# Applied Insurance Research

## AIR Clasic/2 Version 8.0

- Updates to US Hurricane include:
  - Event catalog to include more severe events
  - Vulnerability – new occupancies and recalibration of some construction
  - Storm Surge & Demand Surge models
  - Frequency and Severity
    - Continue to represent long term view (100+ years)
    - Continue to offer weather forecasting model (1 year view)
    - Offering new near term view (5 – 10 years) to reflect increased hurricane activity but recommends the continued use of the existing Long Term view as their modeling platform.
- CA Wildfire
- Update to Extratropical Cyclone for Europe
- Update to Mexico and South America Earthquake models including new model for Peru
- New China Earthquake model

- Updates to US Hurricane:
  - Event catalog to include 2004 and 2005 storms
  - Frequency and Severity
    - Continue to represent long term view (100+ years) and recommend it's use as their modeling platform
    - New modeling platform based on Short Term view of increased Frequency and Severity – Event By Event output only
- Upcoming new tools (release details to follow)
  - Off Shore Energy Model
  - River Flood model

# RMS Changes in Model Results v5.0 versus v6.0 Mid Term View

- HU Changes based on revisions to Vulnerability, Demand Surge, and increased activity rates

□	PL	AAL	+75%
	100 Yr RP		+40%
□	CL	AAL	+120%
	100 Yr RP		+85%

Expect greater increases for Excess and Surplus books

- Eastern US & Canada EQ Changes based on revisions to hazard and vulnerability
  - NE decrease
  - NM decrease
  - Canada subject to construction mappings



# AIR Changes in Model Results v7.0 versus v8.0

- Change to Demand Surge 100 Yr RP Loss by 5-7%
- Changes based on revisions to Vulnerability
  - PL AAL +6%
  - 100 Yr RP +2%
  - CL AAL +14%
  - 100 Yr RP +24%
- Changes based on increased activity rates
  - PL AAL +36%
  - 100 Yr RP +26%
  - CL AAL +37%
  - 100 Yr RP +20%

# Impact of Recent Hurricanes and Model Change on Industry

- 2004 harder on FL primary carriers
- 2005 affected reinsurers
  - Bermuda markets lost 25% of capital
- Investors want more detailed model output
- Rating agencies require more capital per dollar
- 1<sup>st</sup> quarter 2006 premium writings down
- Need stronger statement to regulators and legislators to de-mystify needs for rate increases
- Can FL writers withstand another active year?
- Will coastal property become uninsurable?

# Where will Catastrophe Modeling go from here?

- Models continue to diverge in science and application
- Industry must understand differences / manage use of tools more carefully
- Can and should risk management / pricing be based off of tools that yield 100% increases in metrics?
- Should vendors get a pass?
- Earthquake and other major drivers of cat