EQECAT
AN ABS GROUP COMPANY

Presentation on Catastrophe Modeling:
Buckeye Actuarial Continuing Education

Columbus OH
April 10, 2012

George G. Freimarck
201-315-8502
gfreimarck@eqecat.com

Setting Rational Expectations About Risk

Agenda

- EQECAT: Cat Model Stewardship
- Cat Model Overview
  - Hurricane
  - Earthquake
  - Tornado Hail
- Methodology
- RQE™

A Brief History of EQECAT

EQECAT Transformation

1981
EQE International Forms

1987
EQE Develops EQ Model for Engineering Support

1992
EQE Develops 1st EQ FF Model

1994
Forms as JV Between EQE and GC
Develops 1st EQ Sprinkler Leakage Model

1998
Wholly-Owned by EQE
Develops 3D EQ Fault Model/ Spectral Parameters
Develops Time Dependency EQ Model
Conducts Analytics for 1st Securitization
Develops NE Asymetrical Storm Methodology
Helps in Formation of CEA

2000
Professional Service Provider of Year – Review
EQE International Acquired by ABS Group
Develops Eurowind – Historical SS Temperatures

2001
Develops Euroflood
Releases WORLDCATenterprise platform

2003
Professional Service Provider of Year - Review
Develops T&H and Winterstorm Models
Upgrades Eurowind – Measured Wind Speeds
Terrorism Model for NCCI Rate Support
Introduces Dynamic Financial 150,000 Year Model

2006
Develops Gulf of Mexico Offshore Model

2009
New warm AMO HU Freq.
1st to use soils based attenuation
1st to adopt UCERF 1.0
Develops eCAT ILS Model

EQECAT
AN ABS GROUP COMPANY

Cat Model Stewardship

- *Responsible* implementation
  - timely updates and releases
  - empirical/claims based loss modeling
  - manage model change
- *State of the Art Tools*
  - transparent results
- *Client's* ownership of process
  - understand model and own results

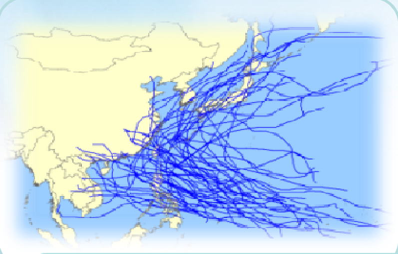
EQECAT AN ABS GROUP COMPANY

Cat Modeling: Why it matters

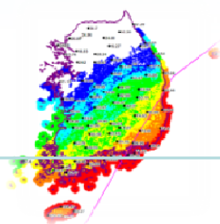
- Enterprise Risk Management
- What decisions do we make?
  - Risk of ruin
  - Pricing
  - Capital decisions
  - Communicating risk to stake holders
  - Reinsurance purchasing decisions
  - Setting expectations about risk

Modeling Methodology

Hazard Definition

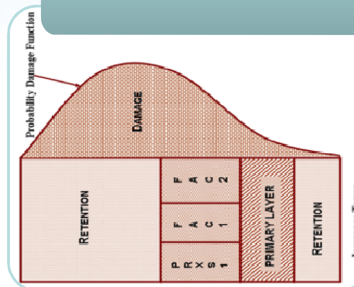


Propagation of Hazard to Site



Estimation of Damage

Estimation of Loss



- **Hurricane**
  - ➢Storm Tracks
- **Earthquake**
  - ➢Magnitudes
  - ➢Frequencies

- **Hurricane**
  - ➢Surface Wind Speed
  - ➢Local Wind Gust
- **Earthquake**
  - ➢Attenuation functions
  - ➢Soil Maps

- **Vulnerability functions**
  - ➢Occupancy
  - ➢Building age
  - ➢Number of stories
  - ➢Construction material

- **Loss calculation**
  - ➢Ground-up Loss
  - ➢Apply financial terms
  - ➢Validated with historical loss data

EQECAT AN ABS GROUP COMPANY


EQECAT
AN ABS GROUP COMPANY
North Atlantic Hurricane

2004 – 2011: Major updates to EQECAT's North Atlantic Hurricane Model

2004
- Wind Field
- LULC

2005
- Clustering of events
- Gradient to sustained conversion and air density parameter
- Vulnerability curves for Residential Structures

2006
- Near Term Model
- Storm Parameters
- Storm Surge & Riverine Flood

2007
- Updated the Vulnerability for building based on claims data from Hurricanes Rita and Katrina
- Improved Demand Surge model outside of Florida
- Improved reporting features (TVAR/ EBE)
- Released the offshore energy model

2008
- Updated windspeeds for 1938 New England Hurricane
- Inland decay rate functions updated
- Profile factor updated
- Mobile Home Vulnerability Updated
- Demand Surge Function updated

2009
- Improved method of sampling from the hurricane frequency & severity distribution

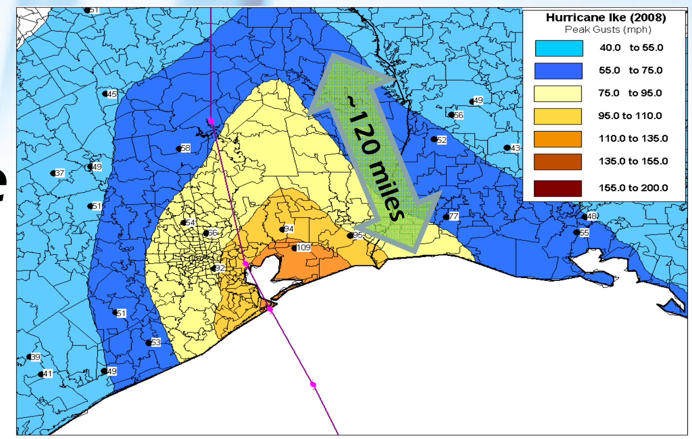
2010-11
- Time Stepping
- FLCHLPM changes
- High rise vulnerability

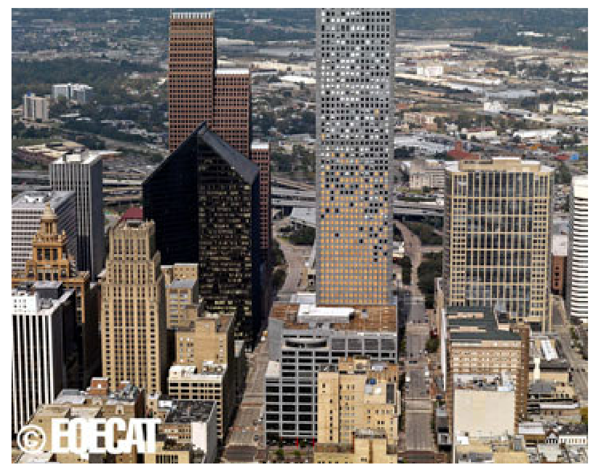
✓ Original Release – 1995
✓ EQECAT is a pioneer in creating basin wide, correlated models: released first in 2003
✓ Certified by the FCHLPM annually, since the inception of the certification process in 1997

EQECAT AN ABS GROUP COMPANY

Hurricane Ike was not a surprise

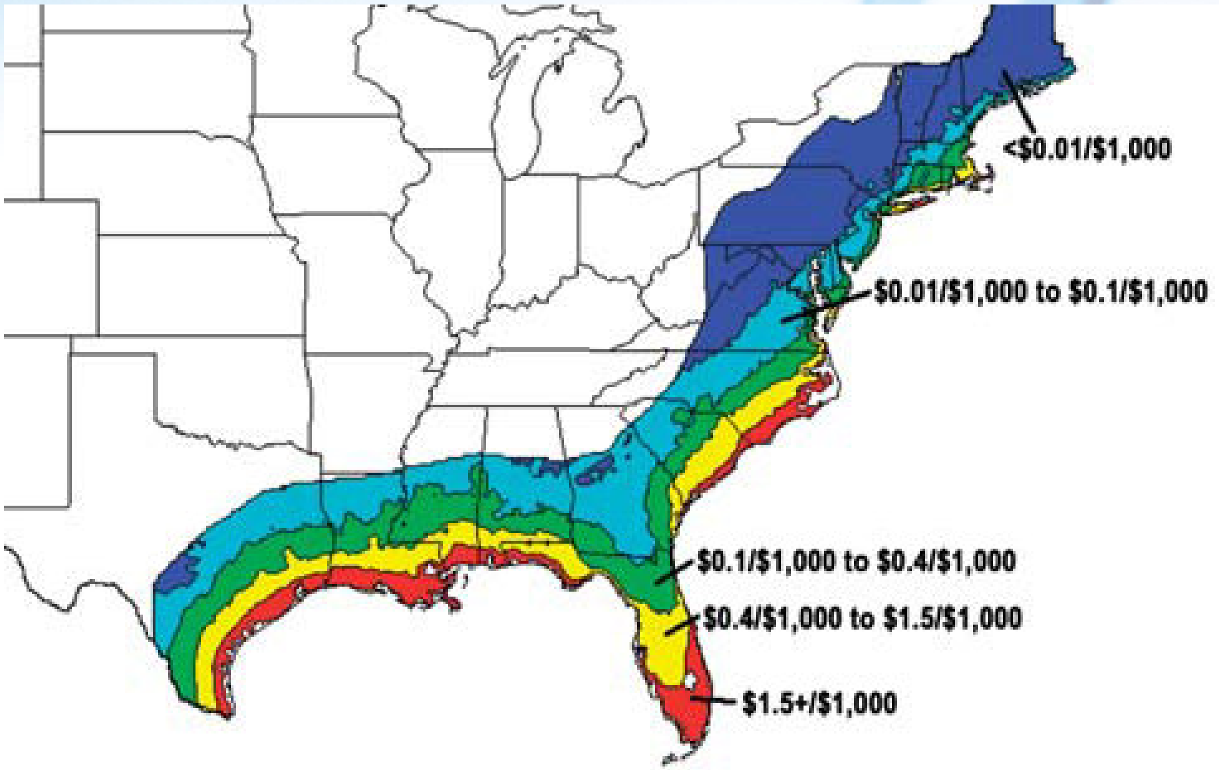
- EQECAT's robust stochastic storm set had events similar to hurricane Ike
  - EQECAT's insured loss estimate on Sept 13, 2008: $8 B to $18 B
  - Revised insured loss estimate on Sept 18, 2008: $8 B to $12 B
  - EQECAT's model loss estimate: $10 B (Texas & Louisiana)
  - PCS industry loss estimate (including losses in the Midwest): $12.5 B





EQECAT
AN ABS GROUP COMPANY

EQECAT 2004 Windfield

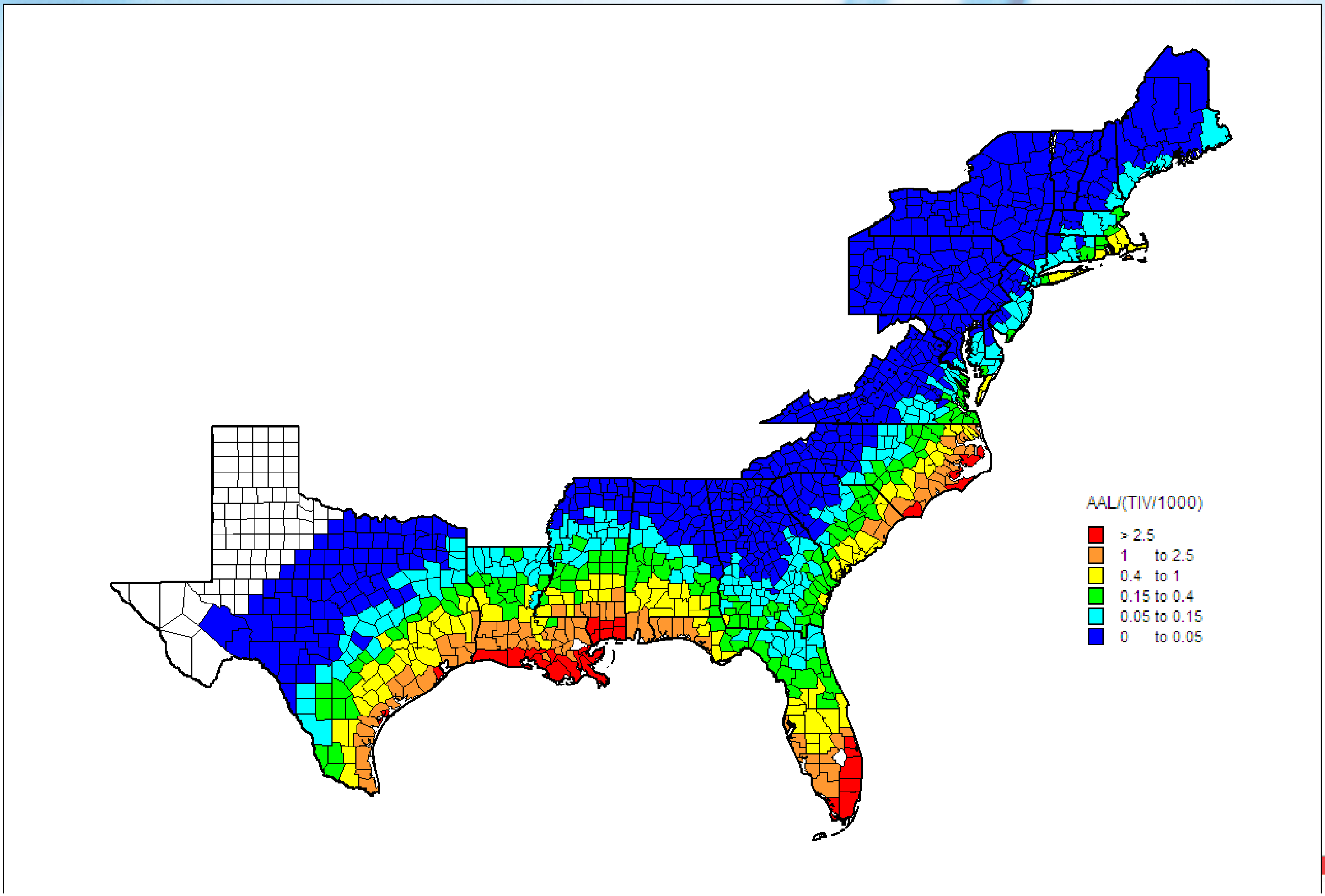


Ground up loss in WORLDCATenterprise™ version 3.6

EQECAT
AN ABS GROUP COMPANY

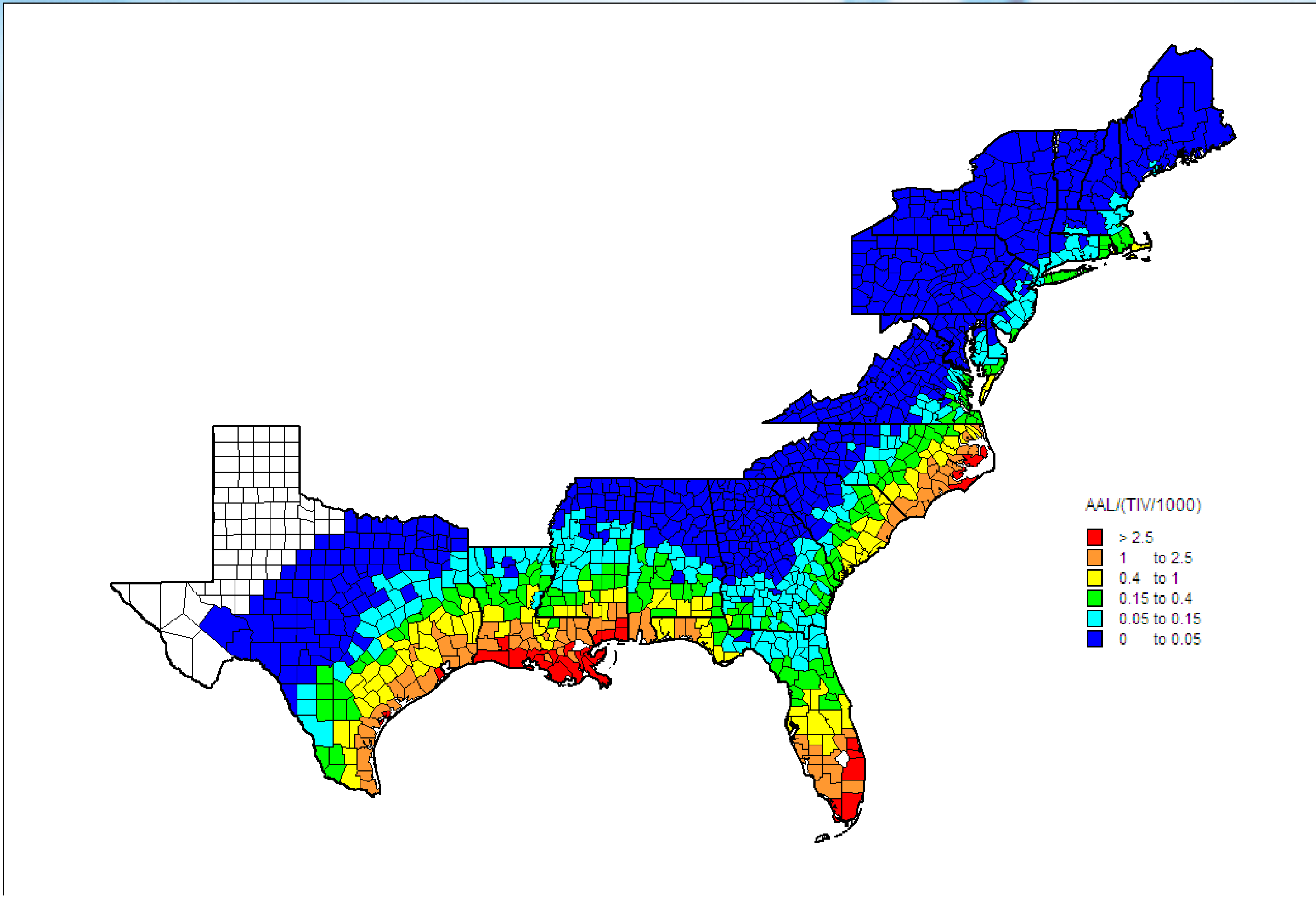
All US, Industry Loss Cost, v3.15

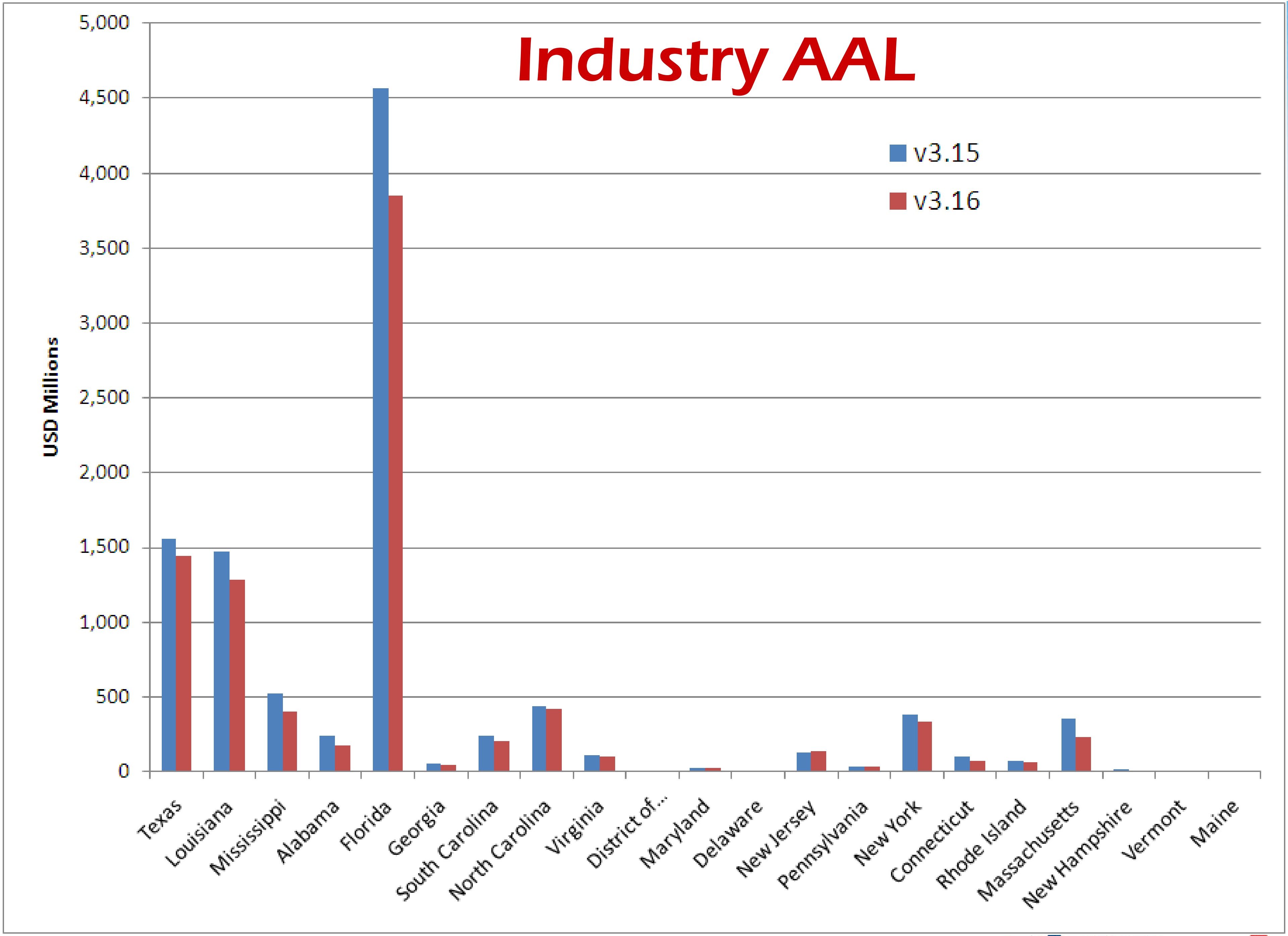
Released 2009



All US, Industry Loss Cost, v3.16

Released 2011





AN ABS GROUP COMPANY

Comparing Exceedance Probability for different Wce Versions

V 3.7 (2005) to V 3.15 (2010)

- Overall percent change in OEP between versions :
  - 100 year return period is from10% to -20%
  - 250 year return period is from17% to -22%
  - 500 year return period is from 22% to -26%

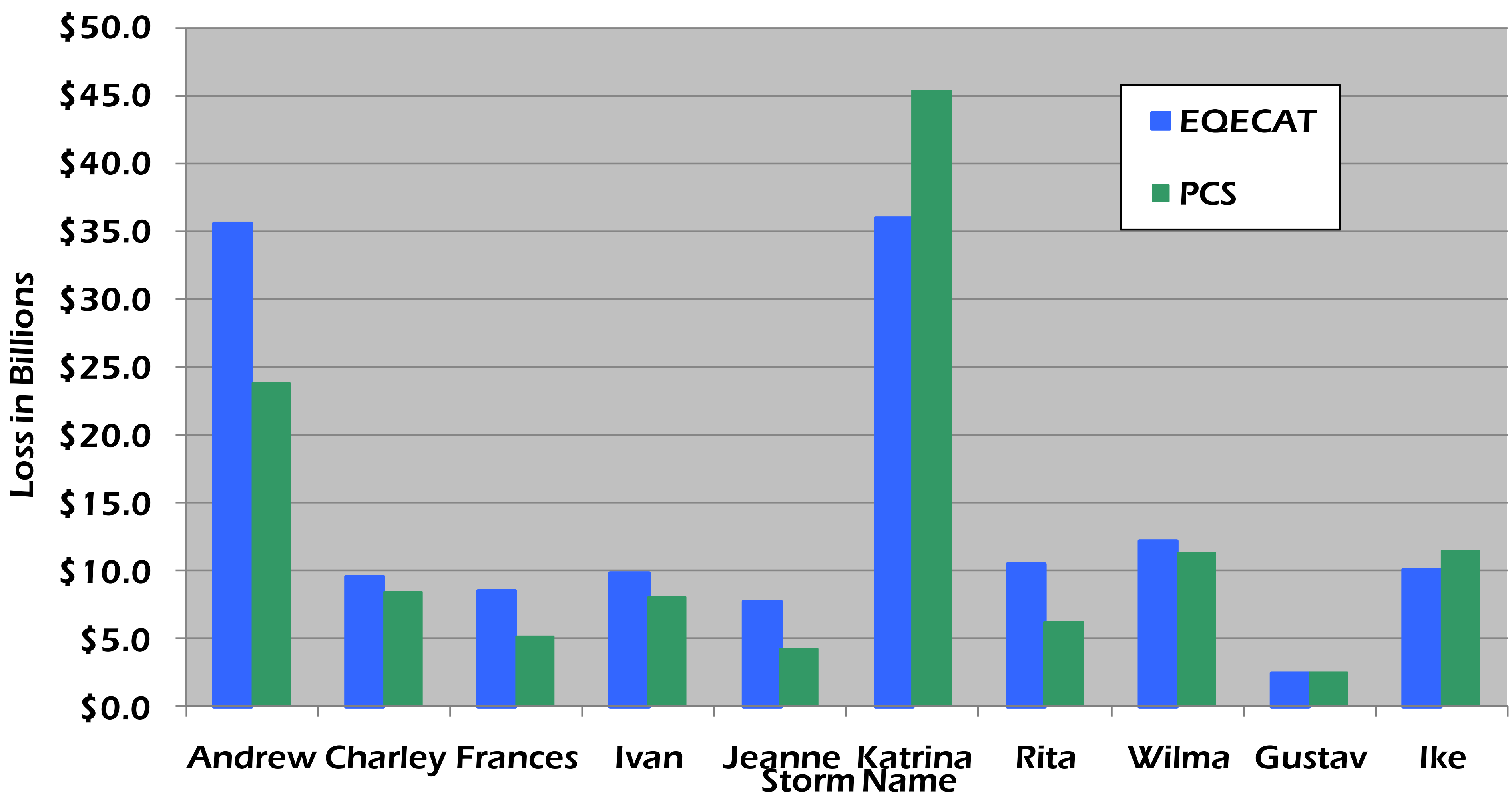
- Overall percent change in AEP between versions :
  - 100 year return period is from13% to -17%
  - 250 year return period is from17% to -19%
  - 500 year return period is from 21% to -18%

EQECAT AN ABS GROUP COMPANY

NA HU: Additional Components

- Demand Surge, or Post-Catastrophe Inflation
- Alterative Frequency and Severity assumption
  - Long term is based on HURDAT
  - Near term is based upon a warm Atlantic Multi-decadal Oscillation (AMO) time series
- Storm Surge and Flooding
  - Calculates results for wind only, or wind plus hurricane flooding
  - Hurricane Flooding damage estimation is done via a detailed storm surge analysis, and an analysis of the incremental damages due to rainfall and associated flooding
- Landfall Series Report
  - Provides a deterministic snap shot of expected loss (by storm intensity) for 310 gates

Industry Loss Estimates: EQECAT vs PCS



PCS estimates are adjusted to 2008 dollars, reflecting inflation but not exposure increase

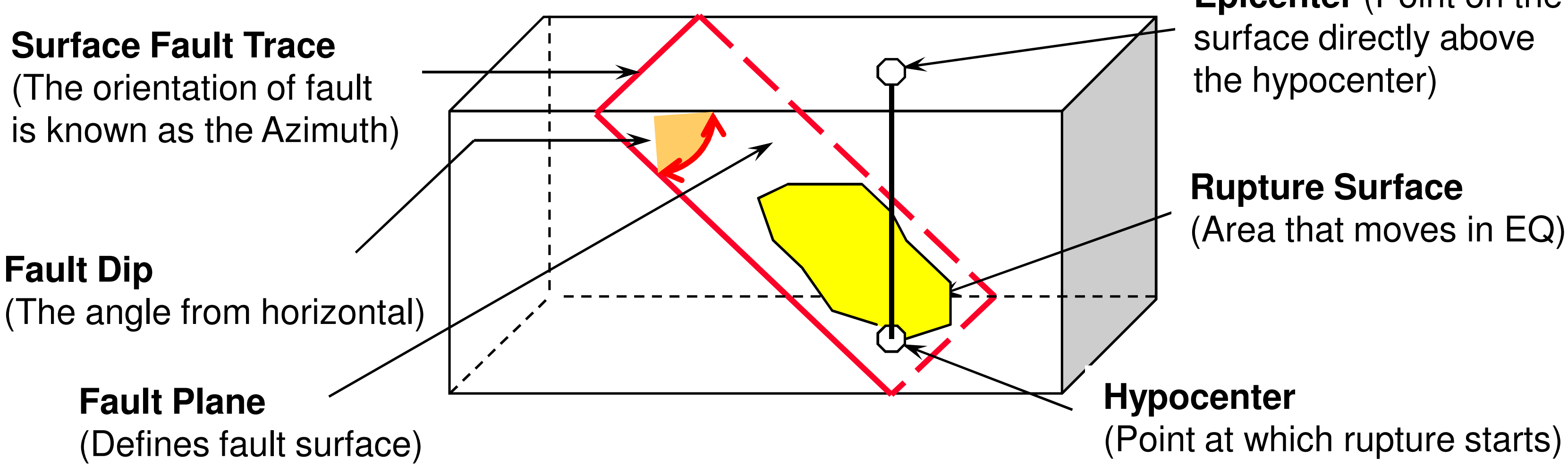
EQECAT AN ABS GROUP COMPANY

EQECAT
AN ABS GROUP COMPANY

EQECAT:
US Quake Components

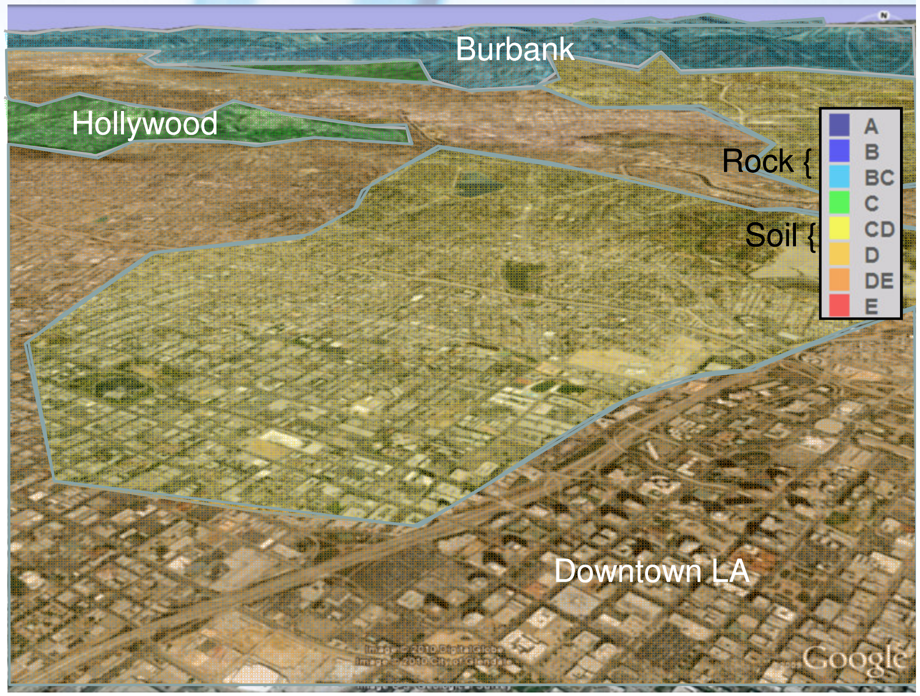
Fault Parameters

- 3-D geometry (length, width, and dip)
- Type and depth of faulting
- Minimum, maximum & characteristic magnitudes
- Recurrence rate or geologic slip rate
- Time-dependent probability



Innovations: Soil-Based Attenuation

- Captures the exposure
  - more people are located on soil
- Models are better constrained
  - more recordings are located on soil

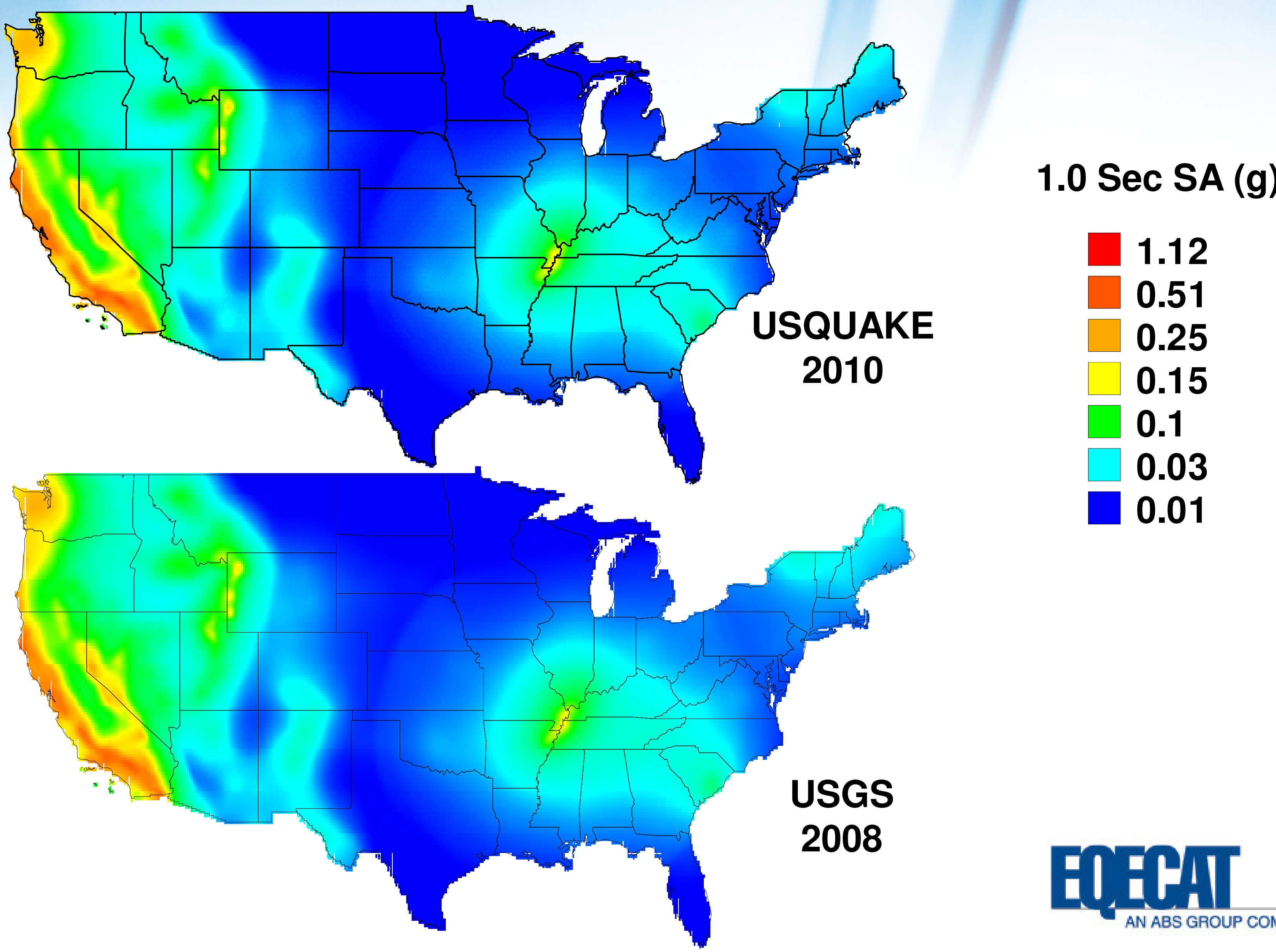


- Smaller amplification factors (1.0 vs. 2.0)
  - Less uncertainty in losses
- Modest changes for future releases

EQECAT AN ABS GROUP COMPANY

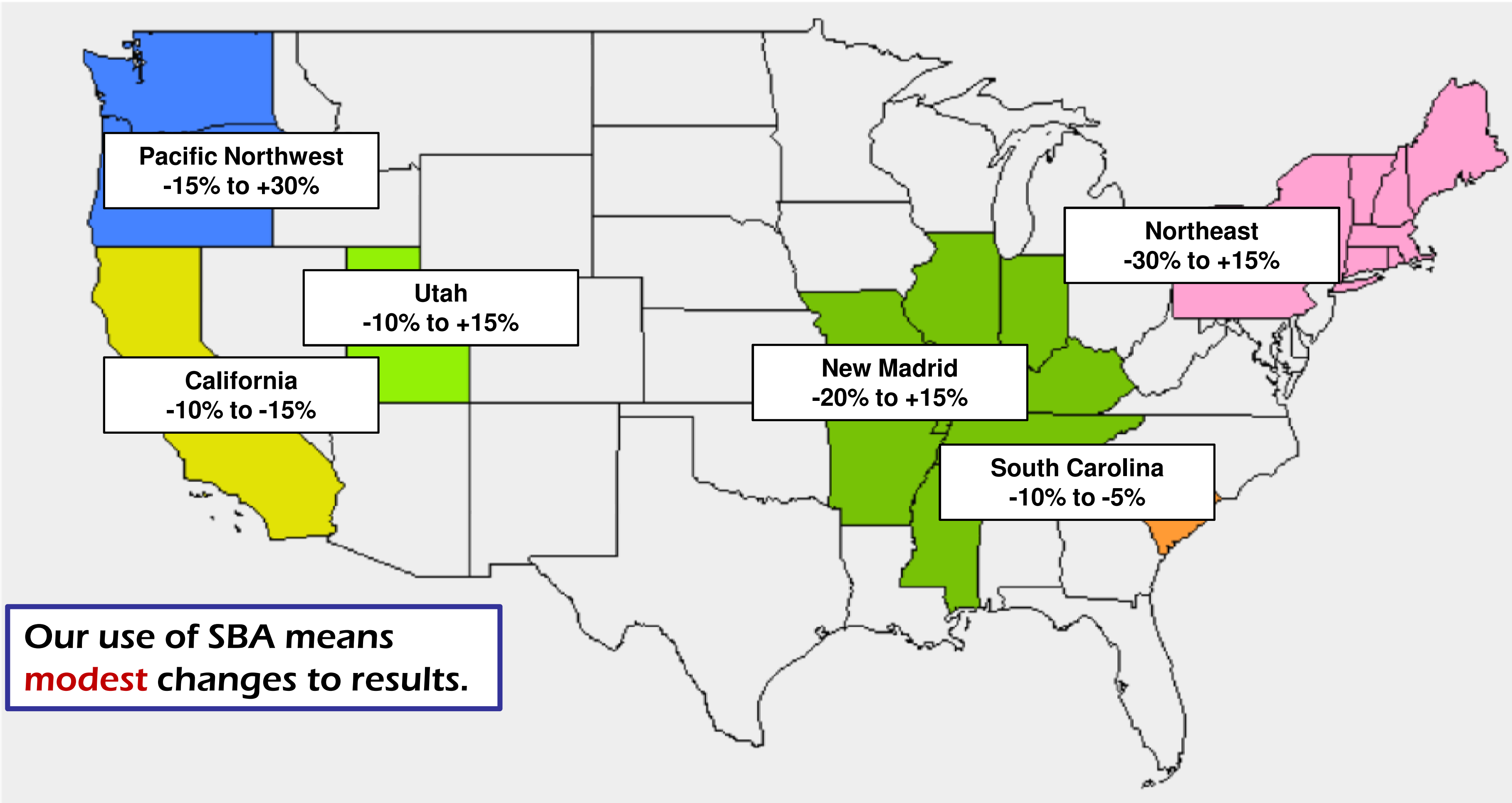
Hazard Maps Match within 2%

United States 475-Year Hazard



EQECAT
AN ABS GROUP COMPANY

New Results by Region: Market Portfolio



Our use of SBA means **modest** changes to results.

Ratio between losses from new model and WCe 3.13, for the market portfolio. Return periods range from 100 to1000 years.

EQECAT AN ABS GROUP COMPANY

Principled Science: Rigorous Peer-Review

- Modeler for California EQ Authority
  - Requires "state of art" certification thru peer review
- Hazard Model: Reviewed by USGS scientists
  - *including Dr. Ned Field, primary author of UCERF*
- *Vulnerability and damage modules reviewed by PEER*

Pacific Earthquake Engineering Research Center (PEER)

Cal UCLA BRUINS UCI USC UCSD W UCDAVIS

EQECAT
AN ABS GROUP COMPANY

EQECAT
AN ABS GROUP COMPANY

Severe Convective Storms in the US

Modeling Severe Convective Storm

- 2011 was a record year for SCS insured losses
- Aggregate losses exceeded $20 Billion
  - 6 events had losses > $1 Billion (2 were $5+ B)
  - 1990-2010 annual average loss (US $5.11 billion)[1]
  - 551 deaths attributed to Tornado (3rd highest since 1925)[2]
- The losses of 2011 are part of a trend

http://www.aon.com/attachments/reinsurance/201106_us_april_may_severe_weather_outbreaks_recap.pdf
http://www.spc.noaa.gov/wcm/#2011

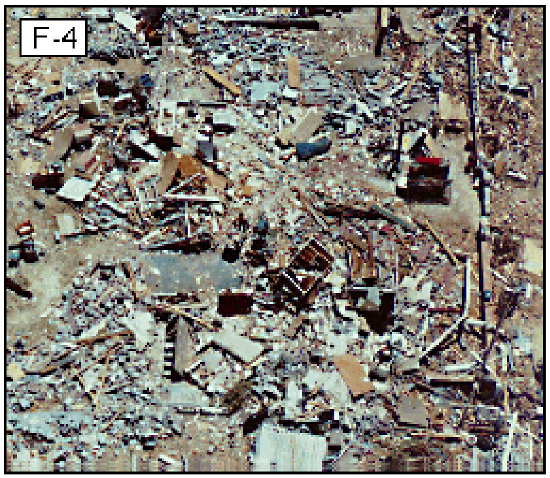
EQECAT AN ABS GROUP COMPANY

Damage Classification

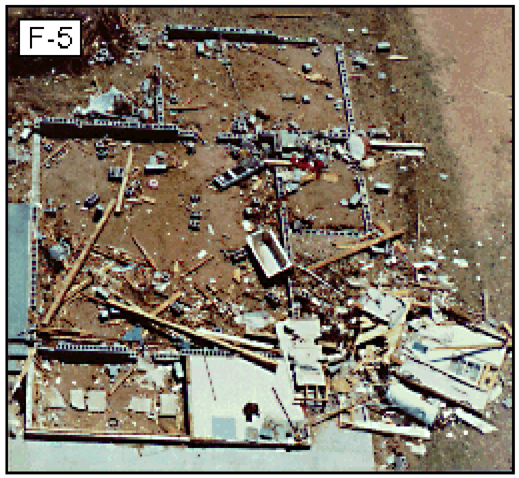
100 mph

150 mph

170 mph

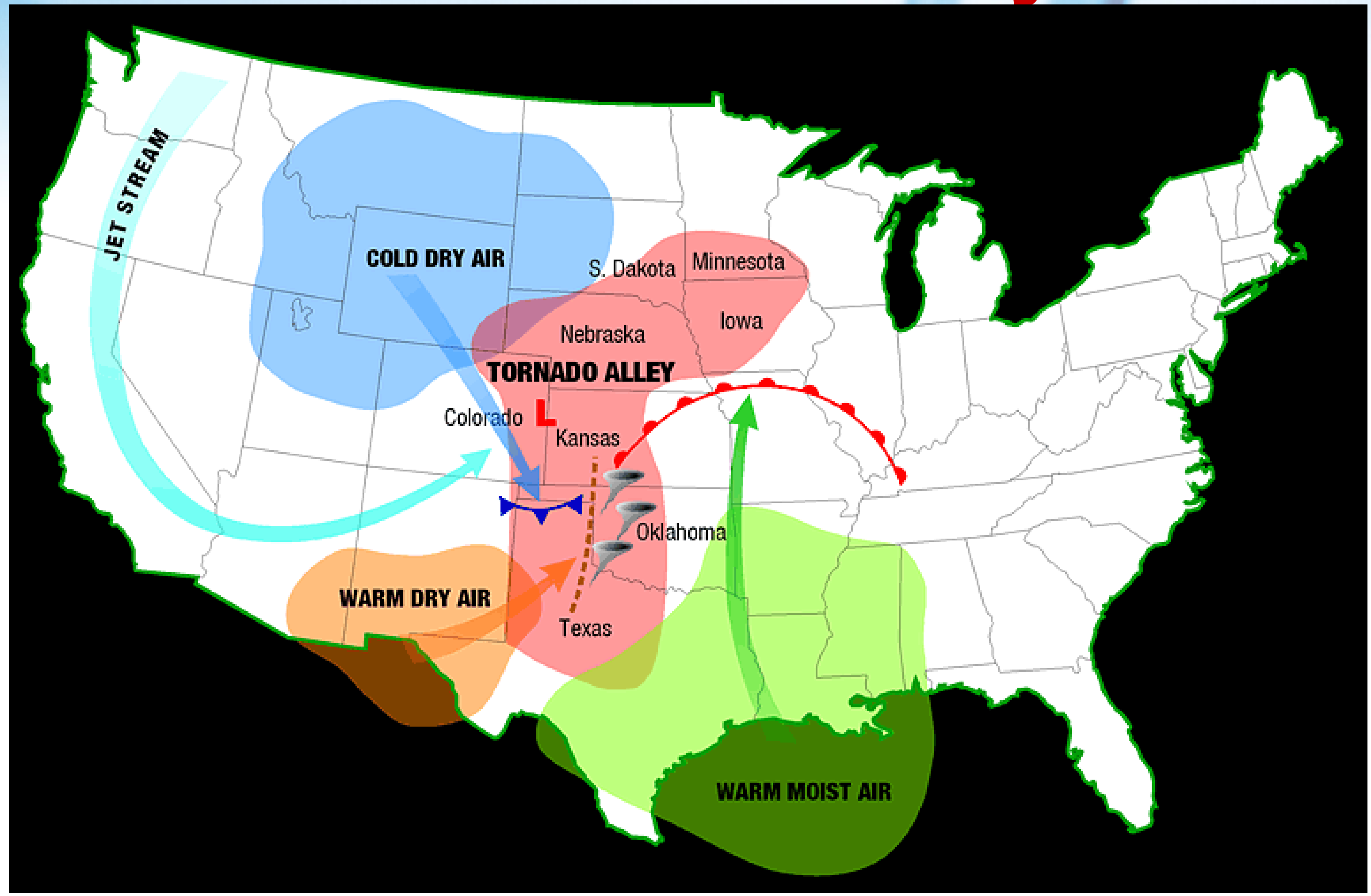


220 mph



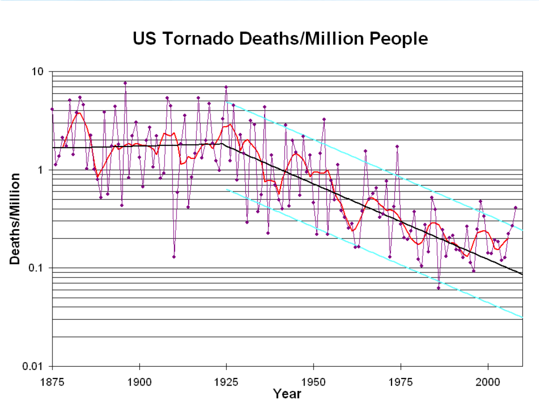
300 mph

Tornado Event Weather Systems



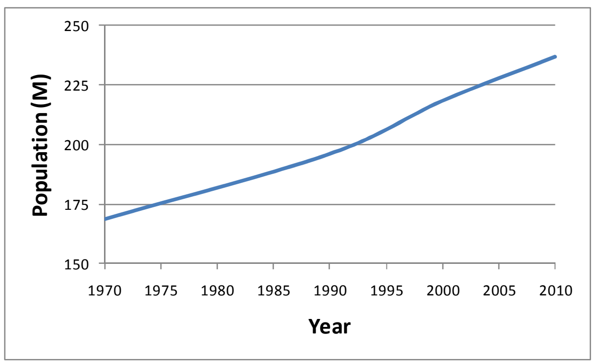
Source: NOAA/NWS

Trends

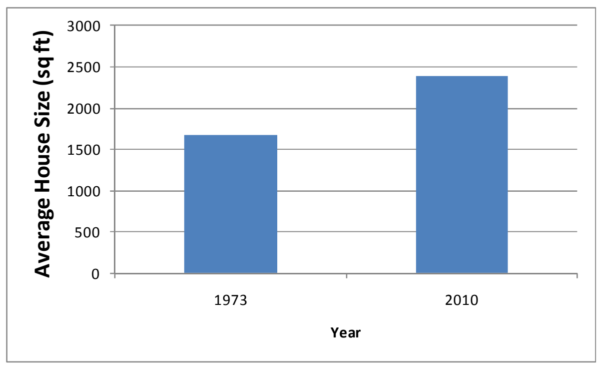


http://www.norman.noaa.gov/2009/03/us-annual-tornado-death-tolls-1875-present/

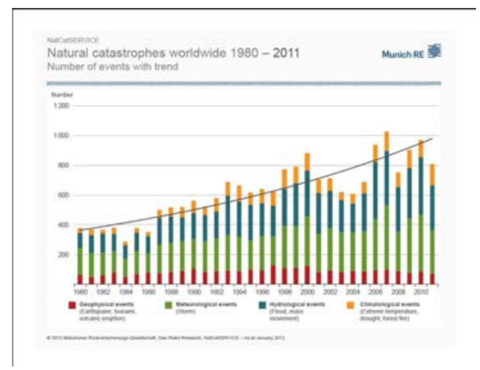
Downward trend in fatalities, corresponding to better warning system



*



=



More targets (population in Tornado states)

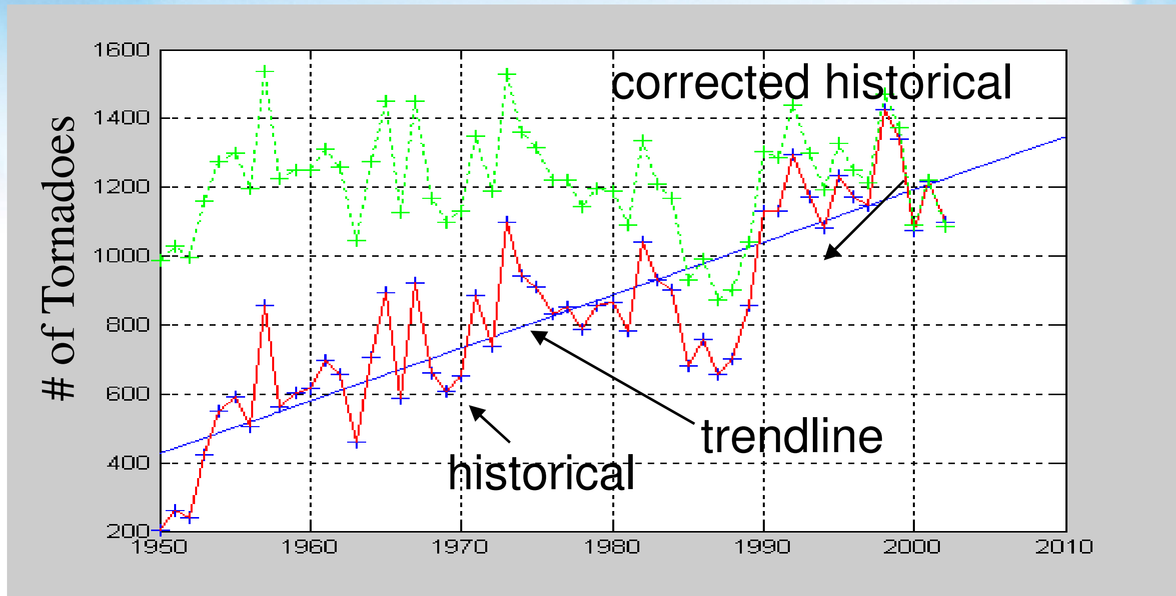
Bigger targets (house size)

http://www.munichre.com/app_pages/www/@res/pdf/media_relations/press_releases/2012/2012_01_04_munich_re_natural-catastrophes-2011_en.pdf?2

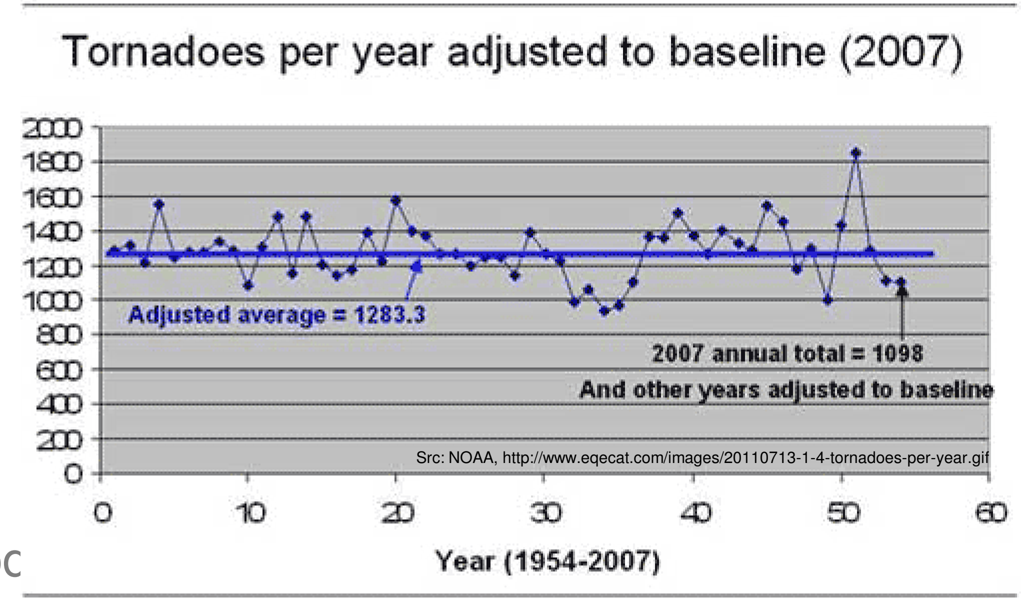
More losses

EQECAT
AN ABS GROUP COMPANY

Tornado Frequency



- •Adjusted trend based on better observation technology (Doppler Radar)
- •Exposure growth leads to more observation
- •Increased perception of Tornado risk

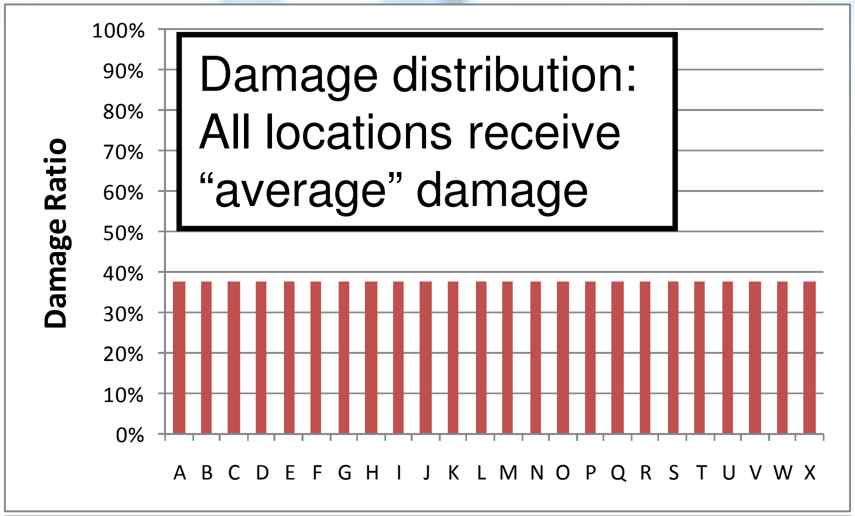


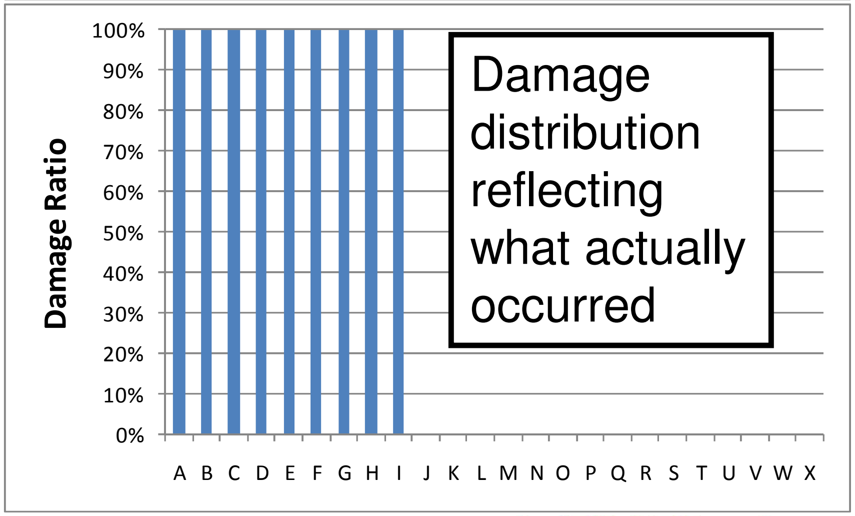
Moc

EQECAT AN ABS GROUP COMPANY

Robust Modeling for Tornado

- Proper calculation of insured loss requires modeling small events
- Tornado damage footprints do not look like those from other perils (EQ, Hurricane)
- Loss estimation (net of deductibles, limits) is very sensitive to how damage is modeled
- Creating event footprints that look like real events is very important





EQECAT AN ABS GROUP COMPANY

Modeling SCS

- 800,000 + events
- Tornado: 1x10 kilometer grid
  - Not uniformly distributed within the grid
  - Varies to look like a tornado
- Individual tornado touchdowns are one or more grid (some real tornado touchdowns are 100 kilometers or more, we want ours to look real)
- Event is comprised of one or more touchdowns, with hundreds of touchdowns very possible (an event can stretch up to 5 days)
- Hail grids are 3 km by 3 km. Damage varies within a grid
- Hail occurrences are a part of the overall "SCS" event which includes tornadoes and straight winds

EQECAT
AN ABS GROUP COMPANY

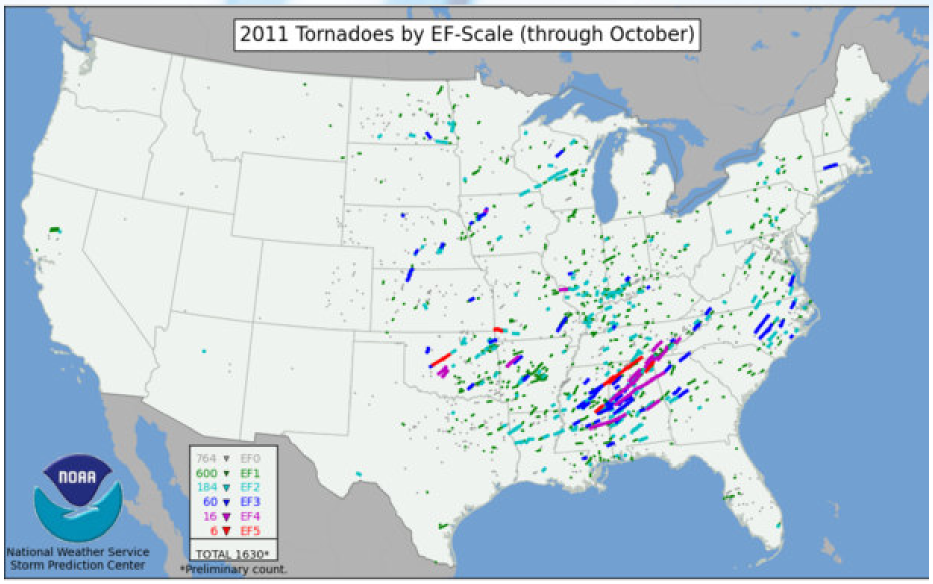
Claims Data and PCS Industry Data

- **Model Validation:**
  - Overall PCS Industry Loss
    - Expected annual loss
    - High frequency (<15 years) portion of the exceedance curve
  - 20+ years of claims data from 3 major insurers
    - Portfolio specific expected annual loss
    - Regional (State) Expected annual loss
    - High frequency (<15 years) portion of the exceedance curve

EQECAT AN ABS GROUP COMPANY

2011 – What happened

	2011	Maximum Observed
Tornado Days	179	211 (2000)
Tornadoes	1700	1817 (2004)
Most in single day	200 (27 Apr)	Was 128 (1974)
Fatalities	551 (3rd)	~700 (1925)
Longest Track	132 miles(AL-TN)	235 miles (LA-MS, 1953)
# EF4-EF5	22 (4th)	36 (1974)
# EF5	6 (2nd)	7 (1974)



2011:

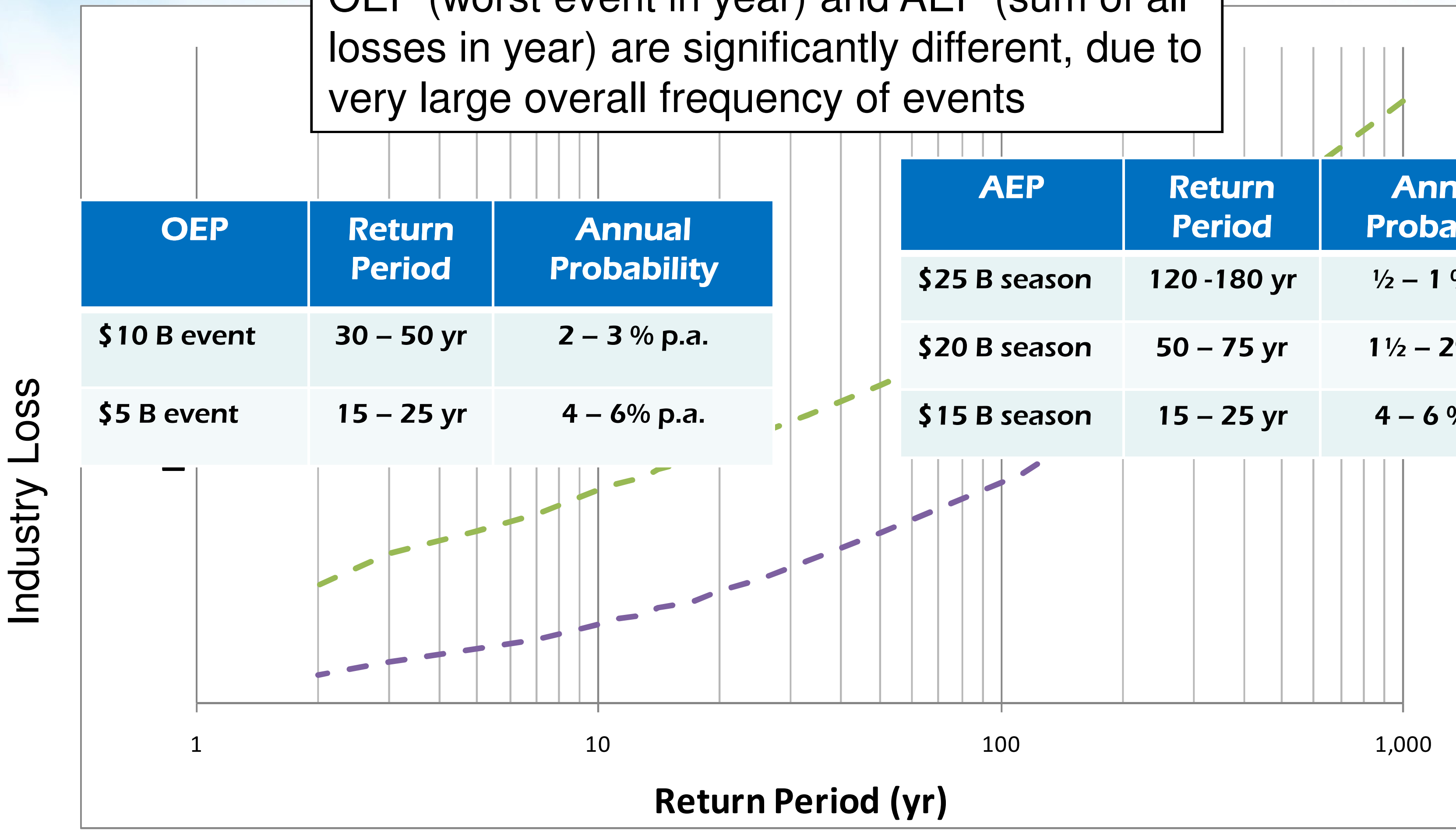
- Aggregate Loss exceeded $20 Billion
- 6 events had losses > $1 Billion (2 were $5+ B)

http://www.spc.noaa.gov/wcm/2011-jan-oct_sm.png

EQECAT AN ABS GROUP COMPANY

"Modeled Market" Loss Curves

OEP (worst event in year) and AEP (sum of all losses in year) are significantly different, due to very large overall frequency of events



OEP	Return Period	Annual Probability
$10 B event	30 – 50 yr	2 – 3 % p.a.
$5 B event	15 – 25 yr	4 – 6% p.a.

AEP	Return Period	Annual Probability
$25 B season	120 -180 yr	½ – 1 % p.a.
$20 B season	50 – 75 yr	1 ½ – 2% p.a.
$15 B season	15 – 25 yr	4 – 6 % p.a.

2011 was an exceptional year, with several very large events

EQECAT AN ABS GROUP COMPANY

Methodology

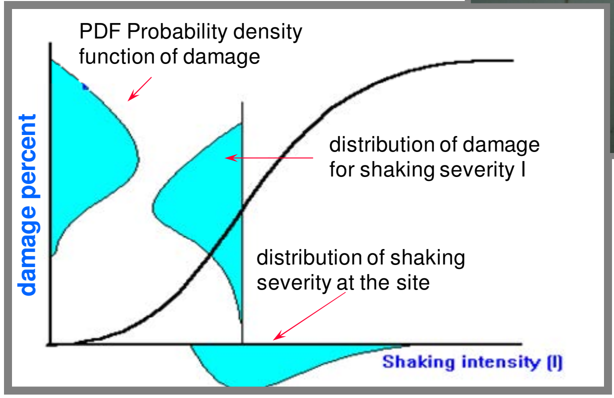
Treatment of Uncertainty

and

The Importance of Correlation

Understanding and Modeling of Uncertainty: Sources of Uncertainty

- Catastrophe modeling is all about uncertainty:
  - Uncertainty in **Time** (frequency of occurrence)
  - Uncertainty in **Space** (location of event)
  - Uncertainty in event **Intensity** (magnitude, SSI, ...)
  - Uncertainty in **Spatial Distribution** of hazard (soil failure in EQ, tornadoes in hurricanes)



EQECAT
AN ABS GROUP COMPANY

Why Correlation is important

- **Extreme events**
- **The "tail of the curve" is where correlation has a large impact**
- **Correlation not accounted for can result in unpleasant surprises**
  - **Like hazard and vulnerability, correlation modeling affects model performance**
  - **Overestimation and underestimation both problematic**

First Generation Correlation Modeling (1G)

- Assume a reasonable but simple rule for correlation (i.e. 80/20)
- But ignores wealth of empirical data we have on this problem
- Provides a transparent means for adding portfolios (aggregation of risks)
- Calculation methods straight-forward
- Tail results will be highly influenced by the rule chosen

but not robust….

EQECAT
AN ABS GROUP COMPANY

Second Generation Correlation Modeling (2G)

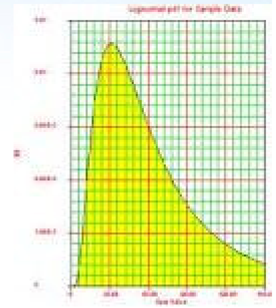
- Allow for model differing correlations between different components of the loss distribution calculation:
  - Occupancy
  - Location
  - Structural Characteristics
- Base characterization of correlation on study of loss data (empirical –varies by peril and region)
- Apply differing correlation relationships to different aspects of the loss calculation

EQECAT's Stochastic Risk Atlas (SRA) -Product of 2G-

- 150,000 years' simulation
  - 300,000 in October 2012
- Loss calculations with full uncertainty
  - All uncertainty is Primary, never Secondary
  - OEP, AEP
- Correlation of Events and Years
- Clustering
- Time Dependency

EQECAT
AN ABS GROUP COMPANY

Event Loss Table (ELT)



- Every event in the stochastic set contains
  - Event characteristics (location, intensity)
  - Annual Frequency
- Risk Analysis produces an Event Loss Table with a characterization of the loss at every event

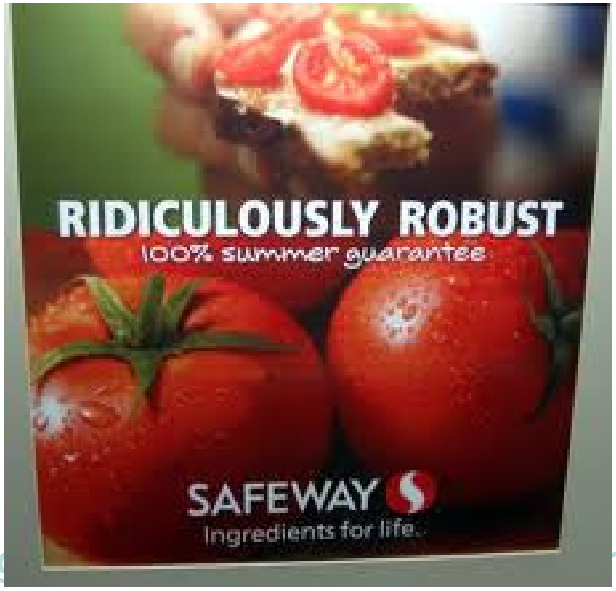
Event ID	Milepost	SSI	Latitude	Longitude	Max Wind	Rmax	Trans Speed	Min bp	Direction	Frequency	Loss Mean	Loss Std
1	36	1	24.22	-97.87	88	29	22	984	SW	5.23E-05	11.21	22.41
2	34	1	24.18	-97.88	84	23	14	986	W	5.32E-05	2.70	5.41
3	34	1	24.18	-97.88	82	46	27	989	W	8.15E-05	2.50	5.01
4	38	2	24.26	-97.86	100	75	18	970	WNW	5.32E-05	132.48	81.02
5	31	3	24.12	-97.895	120	24	12	955	WSW	5.32E-05	554.35	371.75
6	34	2	24.18	-97.88	98	39	20	975	W	8.15E-05	58.74	35.32
7	36	4	24.11	-97.87	140	30	16	930	WNW	5.32E-05	5149.32	6765.71

- Loss statistics (Average Annual Loss, exceedance probabilities) are produced from ELT

EQECAT AN ABS GROUP COMPANY

Second Generation Correlation Modeling (2G)

- Provides more robust modeling of phenomena
- Represents complex distributions more precisely
- Complexity and directionality of calculations precludes aggregation / disaggregation outside of the model

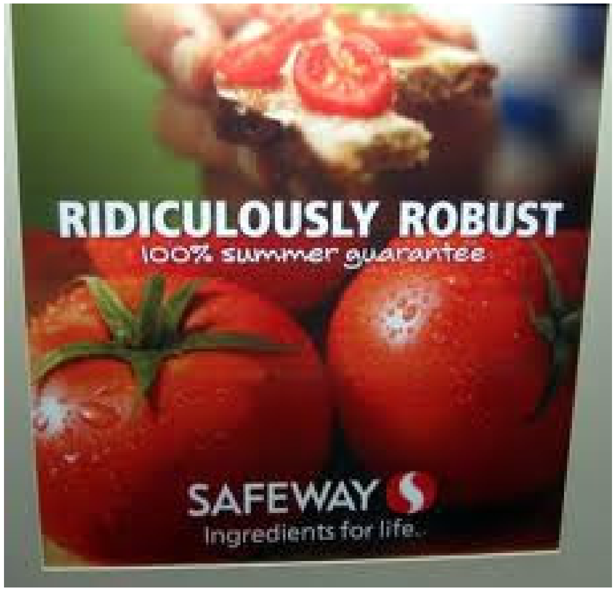


but not easy…

EQECAT AN ABS GROUP COMPANY

Third Generation Correlation Modeling (3G)

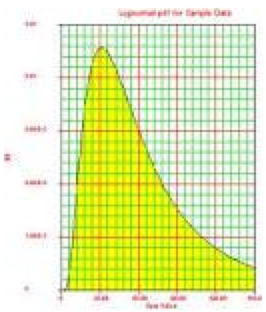
- Will employ the robustness of 2G approach
- And the ease of use of 1G approach



Year Loss Table (YLT)
-Product of 3G-

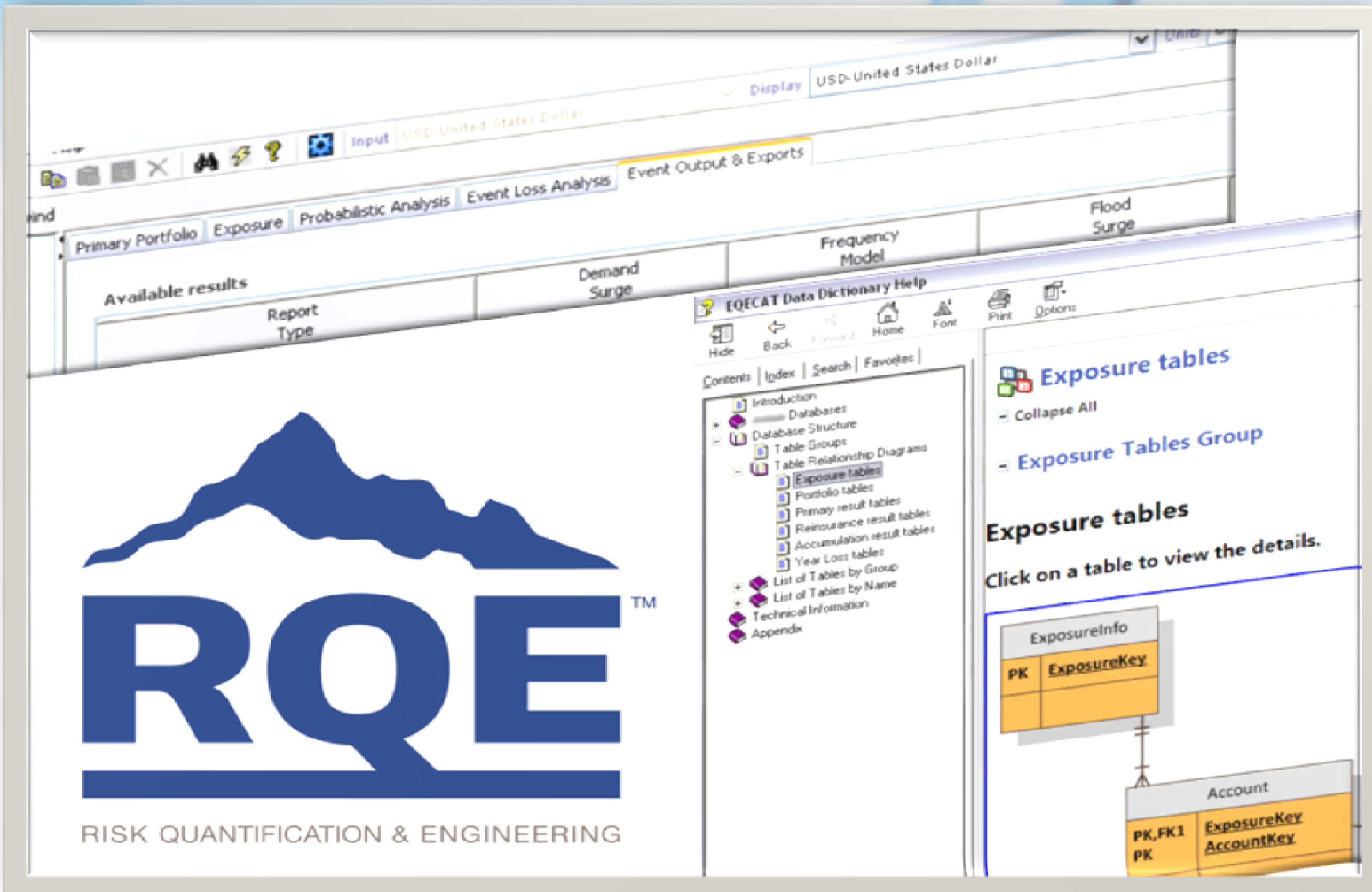
- Natural Catastrophes can occur multiple times in a year
- Robust modeling for risk analysis requires the translation of event frequencies into loss probabilities
- Robust Modeling requires inclusion of natural and modeling uncertainty in model results, especially intra-event correlation

Sim Yr	Peril Model	Event ID	DOY	Loss
1	US EQ	1	194	12.8
3	US HU	39	118	181.4
3	US HU	23507	241	7732.1
4	US HU	485	299	133.3
5	US SCS	423042	23	3.0
9	US HU	18501	291	86.2



EQECAT AN ABS GROUP COMPANY

Introducing: RQE™
(Risk Quantification & Engineering)



EQECAT
AN ABS GROUP COMPANY

RQE™ : The Future of Cat Modeling

October 2012:

- Robust Treatment of Uncertainty
- Four Principal Report Types
- Diverse Reporting Levels and Perspectives
- Comprehensive Portfolio Aggregation Tool
- Comprehensive Data Import
- Easy Workflow Integration
- Interactive Exposure Management
- Extensive Global Coverage

EQECAT
AN ABS GROUP COMPANY

Summary

- Cat Models critical to ERM
  - Quantifying Risk
  - Cat Model Stewardship
- Hurricane
  - Consistent update, model change management
- Earthquake
  - Innovations and model change management
- Convective Storm
  - Unlike big HU, EQ events
  - 2011 exceptional, but not extraordinary
- Uncertainty and Correlation
  - Importance capture range
  - 1G, 2G
  - 3G: Robust, Portable
- RQE™
  - The Future of Cat Modeling

EQECAT AN ABS GROUP COMPANY

RQE™ Release Events:

Toronto, Chicago, Minneapolis, New York

June-July 2012

Register: www.eqecat.com

Thank You!

Notable Losses (if they occurred today …)

- Historic Hurricane
  - 1926 Cat 4, Broward $70 Billion insured+
  - 1947 Cat 4, Palm Beach $60+ Billion
  - 1900 Cat 4, Houston $55+ Billion
  - 1915 Cat 4, Houston $50+ Billion
- Historic Earthquake
  - 1811-1812 sequence, New Madrid $110+ Billion
  - 1906 San Francisco $50+ Billion

EQECAT
AN ABS GROUP COMPANY