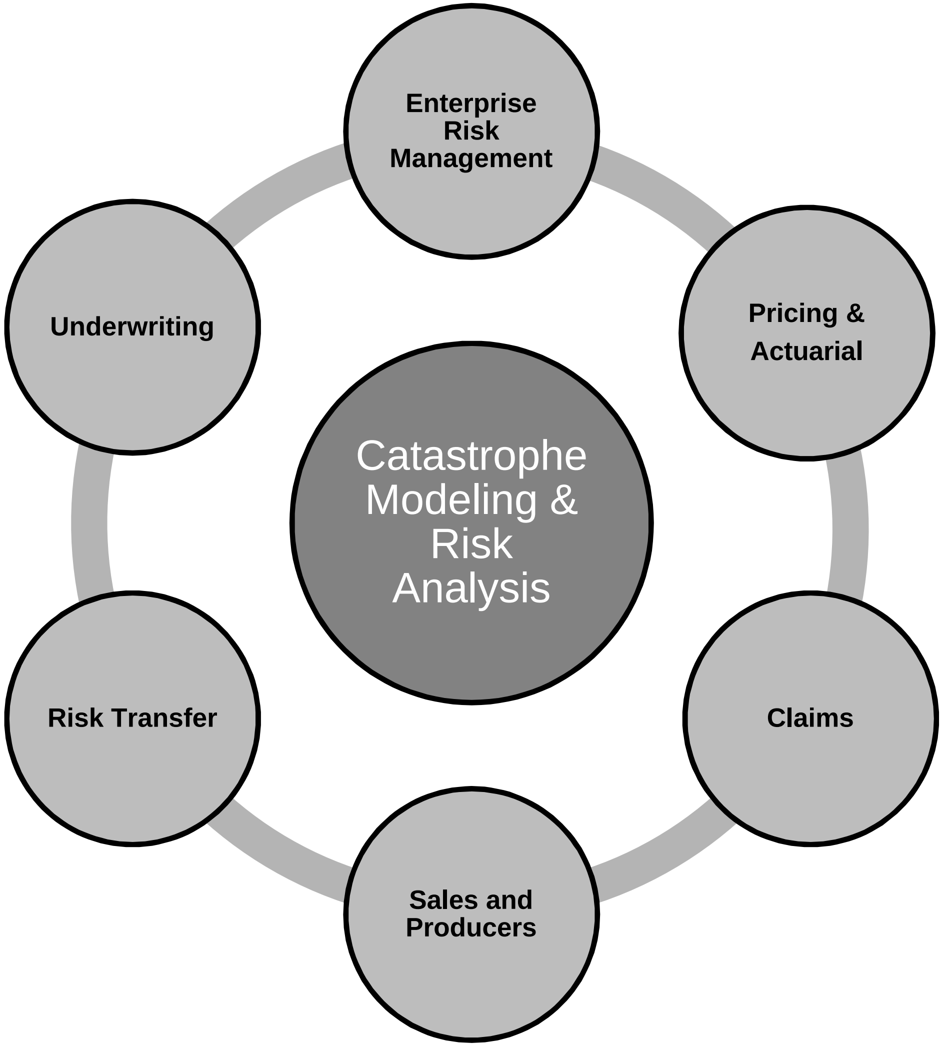
Integrating Catastrophe Risk Models into the Business of Insurance

DENNIS FASKING, FCAS, MAAA

Many Key Operating Areas Can Use Catastrophe R Metrics



Why Should Catastrophe Information Be Integrated Other Facets of Insurer Operations?

- Catastrophe risk is the greatest threat to both earnings (the income statement) and solvency (the balance sheet) of nearly all property insurers
- Therefore, nearly every decision at the macro (strategy) and micro (risk acceptance) levels is better informed with catastrophe impact information
- Catastrophe models provide numerous outputs which can be adapted to support decisions in every functional area
- All stakeholders now know this and apply pressure to properly use model results in risk management
  - Executives and Boards
  - Regulators
  - Investors
  - Ratings Agencies
  - Partners and Vendors
- Competitors also apply pressure to adopt state-of-the-art solutions
- Integration of catastrophe risk management separates winners from losers in 21st century

Why are Models the Best Platform for Obtaining and Inte Results into Decisions?

- Using models as the framework allows a common language of and set of facts about catastrophe risk among functional areas
  - Facilitating communication and decision-making
- Models allow plugging of gaps in historical data and human experience
  - What are the opportunities and risks in places we don't write business now?
  - What if that historical event re-occurred or similar but worse event occurred with today's exposures?
- Models operate in real-time with current (or hypothetical) exposure data, informing today's decisions based on current information
- Models allow easy sensitivity testing of actions and consequences
- Models produce a wide range of stochastic based outputs for reporting to a range of stakeholders with diverse interests and various "must-haves"

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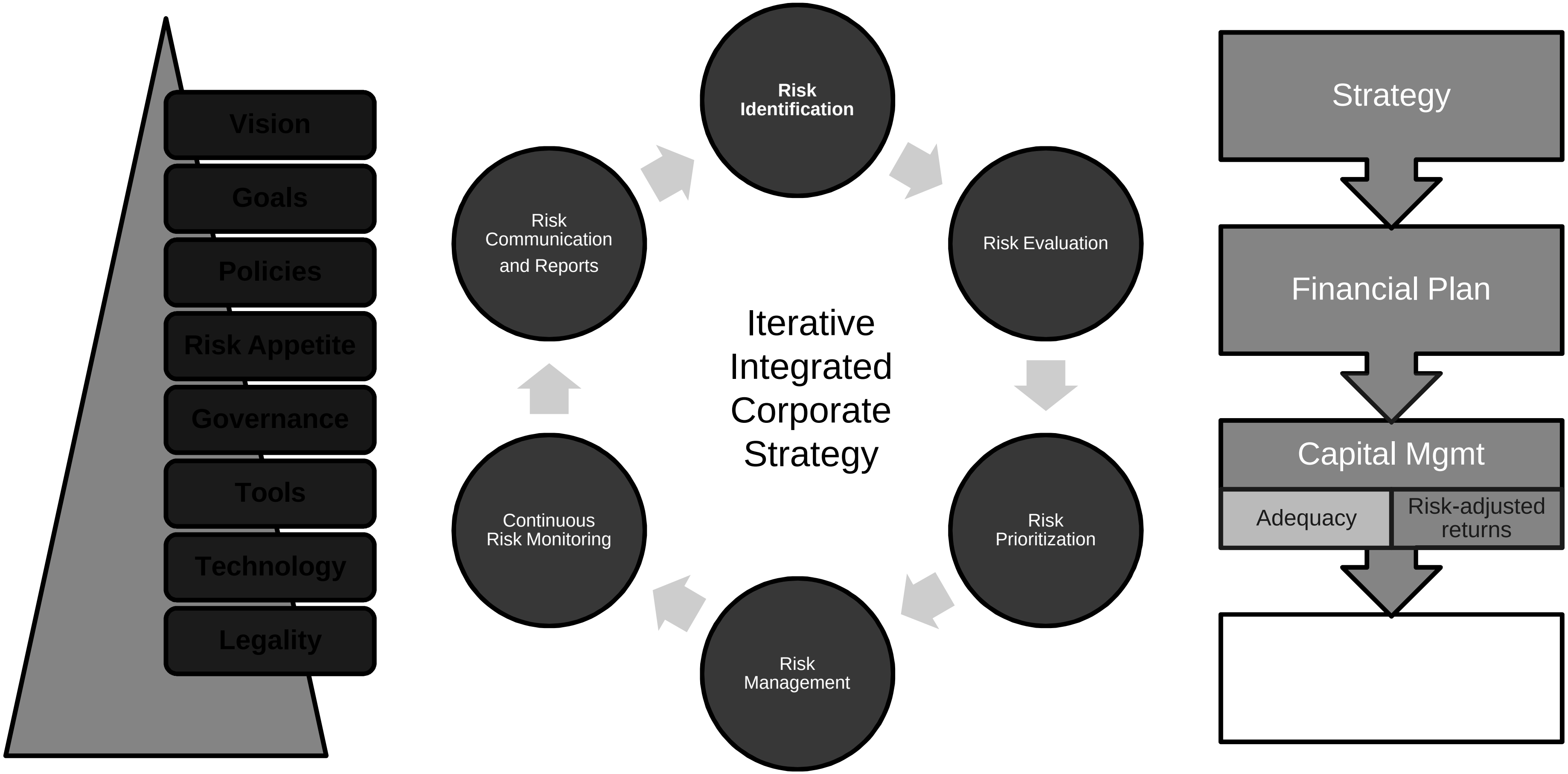
What is ERM and Why Does it Require Model Results?



Catastrophe Risk: Single greatest threat to solvency, management freedom, and ratings; highly correlated with other risks.

ERM Requires a Quantitative High-Level Definition Preferences

- Often stated in a probability of ruin framework, such as:

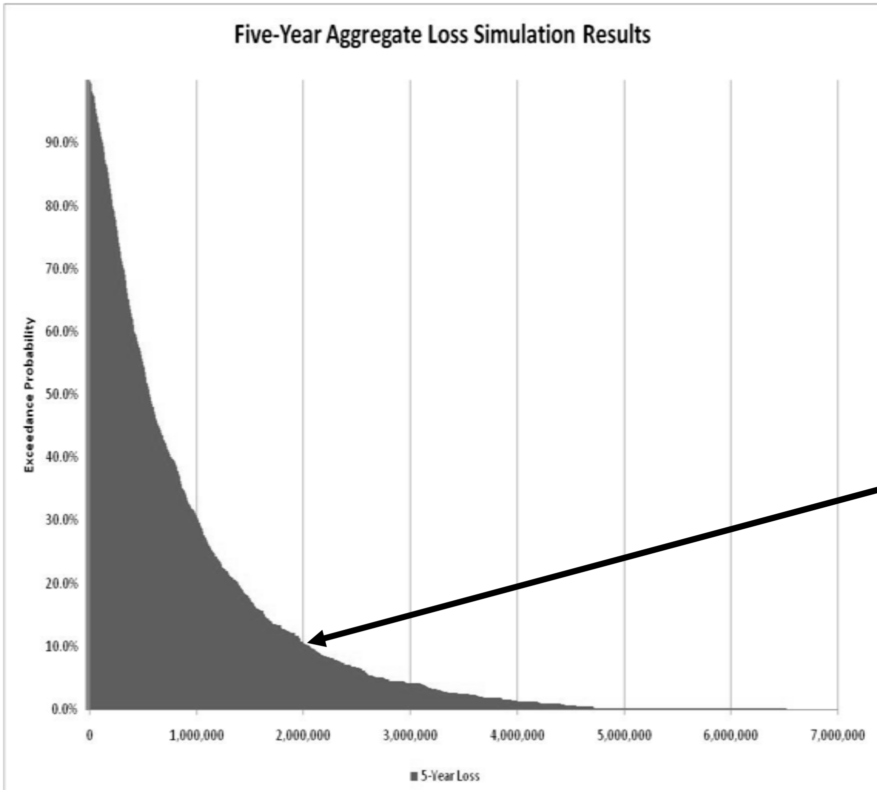
$$\mathbf{Pr\ (L_N > k \cdot S) < p}$$

- This equation encompasses key decision-making parameters
  - Loss distribution – L is assembled using models for catastrophe risk
  - Time horizon – aggregate losses over N years
  - Existing capitalization – net worth of S under some valuation framework
    - Could be GAAP, IFRS, Statutory US
  - Risk tolerance – desire to risk only k% of net worth over horizon
  - Risk appetite – willing to take a p% chance of exceeding tolerance to achieve desired returns
- Long scholarly history of studying similar metrics
- Embedded in current and future insurer capital adequacy standards

Managing all Enterprise Risks Together Means Conside
Correlations Among Cat and Other Risks

- It's reasonable to expect significant positive correlations among catastrophe risk metrics and those used for other risks in the "map"
  - Regulatory risk
    - Suppression of price increases passing through higher reinsurance costs
    - Restrictions on non-renewals, withdrawal plans
    - Scrutiny of claims handling and new rules (post-event mediation programs)
    - Additional, frequent reporting of claims counts and losses
  - Operational risk
    - Tremendous stress on claims adjusters, diversion of resources reducing quality of claims handling in other lines (e.g. auto)
    - Additional expenses and overhead for catastrophe response
    - Diversion of actuarial and financial resources for reporting and regulatory relations
  - Financial risks
    - Massive cash flow needs to pay claims and bridge delay in reinsurance recoveries, need to sell assets at suboptimal times
    - Collectability of reinsurance for event losses
  - Reputation risk: consumer-slanted publicity of any coverage disputes

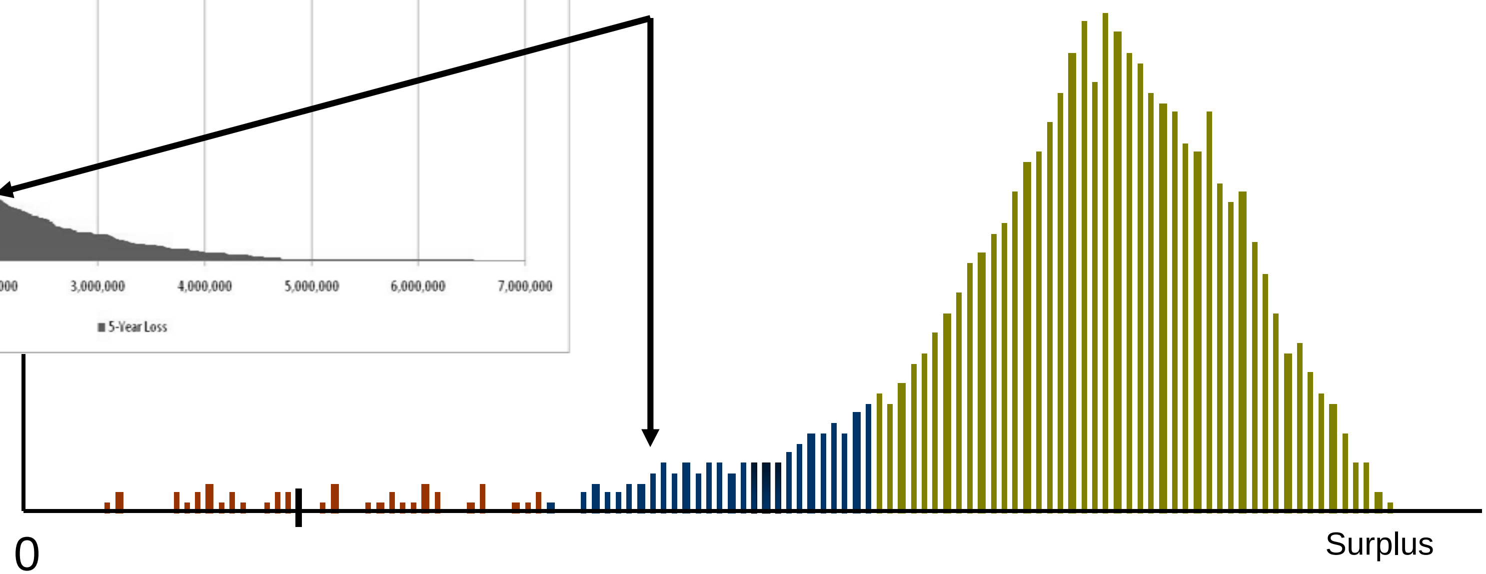
Determining the Probability of Tail Loss That Triggers A Ratings Downgrade



Rating Downgrade = .6% Probability of a 10% Loss of Surplus

k = 10%

p = .006



ERM and Catastrophe Risk are Closely Scrutinized by Rating Agencies and Boards

- **A.M. Best, Fitch, and Standard & Poor's** all have ratcheted up their focus on ERM practices
  - Particular focus on catastrophe risk in ERM since 2005
- Current required catastrophe reporting involves
  - Loss Threshold values at various EP levels, both occurrence and aggregate (N=1)
  - Tail Value at Risk at various EP levels
  - Stress Testing for first event and second event losses in specific event scenarios
  - Questions about data quality, modeling assumptions and processes

Indicated CAT Risk Exposure	2006 Per Occurrence Gross Losses (I)				2006 Per Occurrence Pre-Tax Net Losses (II)			
Loss Return Period (Annual Probability)	(01) Probable Maximum Loss (PML) ($000s)	(02) % of 2006 Group PHS	(03) TVAR or TCE* ($000s)	(04) % of 2006 Group PHS	(05) PML (Including Reinstatement Costs ($000)	(06) % of 2006 Group PHS	(07) TVAR or TCE* (Excluding Reinstatement Costs ($000s)	(08) % of 2006 Group PHS
1. 50 Years (2.0%)								
2. 100 Years (1.0%)								
3. 250 Years (0.4%)								
4. 500 Years (0.2%)								
5. 1,000 Years (0.1%)								

*TVAR (Tail Value at Risk) or TCE (Tail Conditional Expectation)

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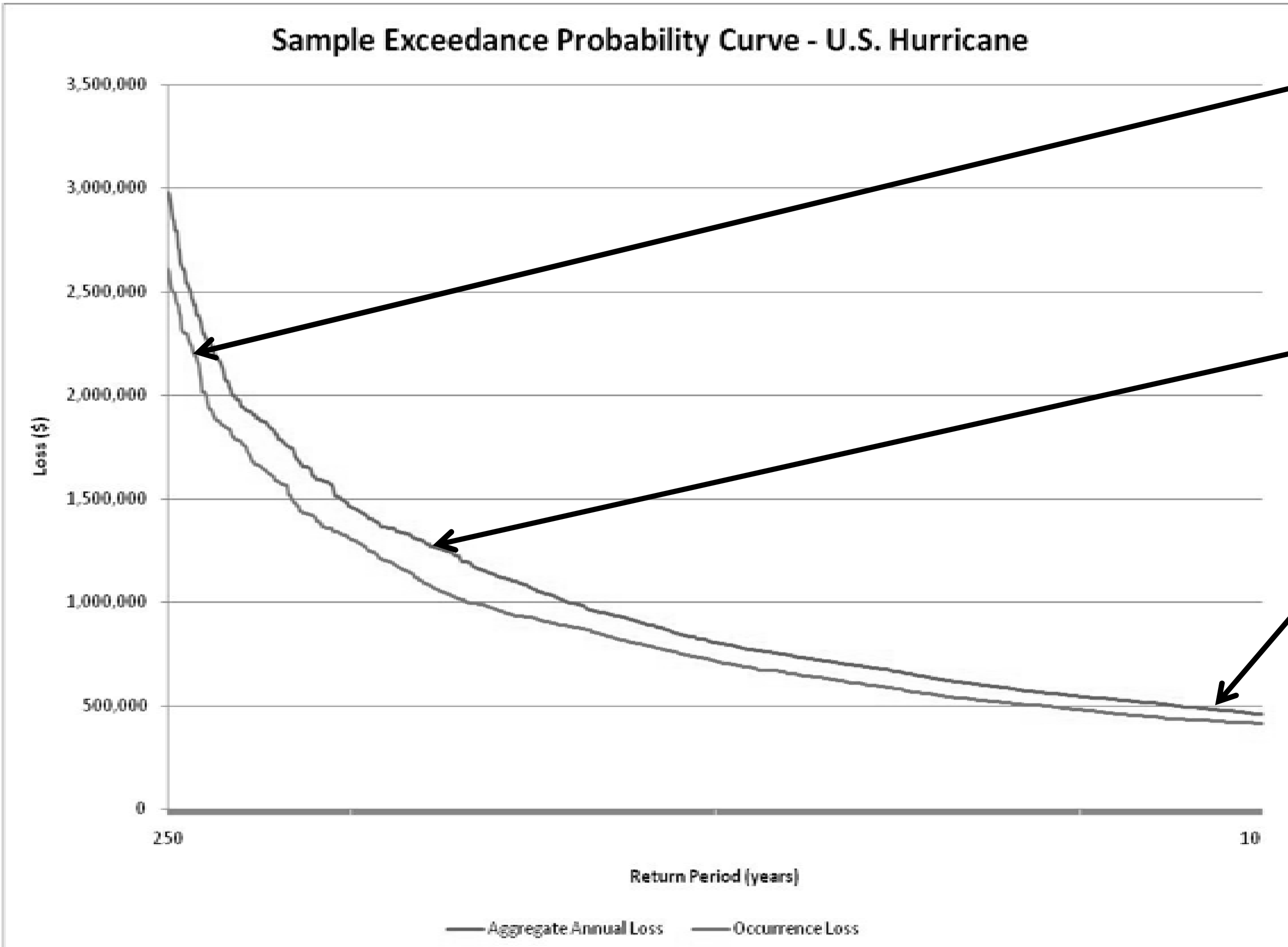
Catastrophe Risk Transfer Decisions Have Several Elements

- Main goal: modify EP curve net of transfer so that enterprise-wide risk appetite and tolerance goals are achieved
  - But trade-offs in ERM among catastrophe and other risks (credit, liquidity) may ensue
  - Traditional reinsurance most common mechanism, but capital markets increasingly important
  - Other management actions, such as deductibles and other coverage limitations transfer risk to the insured
- Quantity of transfer often heavily influenced by model results
  - Occurrence (XOL) retention, top limit, and coinsurance
  - Aggregate (XOL) retention, limits
  - Per-risk and facultative retentions and limits on large single risks
  - Participation in state funds determined indirectly by models (FHCF)
- Price per unit (rate on line) determined by supply and demand for capital
  - But often depends on "technical prices" derived using model results

Can Analyze Occurrence and Aggregate EP Curves to Understand Risk Transfer Needs



Coverage for severe events ("the big one") based on maximums at selected return periods

Reinstatement and drop-down provisions selected based on probability of multiple covered events

Retentions also selected based on how often the enterprise can "take a hit" and for how much

Can Employ Benchmarking Market Against Technical P… Test for Consistency

- Technical pricing may assume that the risk load in the layer is proportional to volatility of layer losses as represented by standard deviation – a metric in common use

$$P_T = E[L_i] + R \cdot SD[L_i]$$

- Assume occurrence cat program of $2M xs $500M, with two pro-rata reinstatements, in three layers (a sample answer to previous exercise)

Modeled annual loss statistics compiled and compared to market quotes for each layer

Solve for multiplier equal to "how many standard deviations" are being charged in excess of expected losses [R]

Multipliers should smoothly increase by layer as risk of loss relative to expectations increases – if not, question pricing

			Annual Modeled Losses		Market	Implied	Technical
Layer	Attachment	Limit	Average	Std. Dev.	Rate-on-Line	Price	Multiplier
Retention	0	500,000	125,564	199,296			
First Reins.	500,000	500,000	25,546	106,083	20.0%	100,000	0.70
Second Reins.	1,000,000	500,000	10,846	69,427	17.0%	85,000	1.07
Third Reins.	1,500,000	1,000,000	8,274	81,002	9.0%	90,000	1.01
Excess	2,500,000	n/a	4,002	81,379			

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Direct Insurance Premiums are Determined by Many Co Interdependent Base Rates and Differentials

- Base Rates
  - Set to provide sufficient overall revenue to insure entire portfolio
  - In regulated environments, include provisions for specific cost components
    - Normal losses (non-catastrophe)
    - Catastrophe retained losses
    - Catastrophe risk transfer (e.g. reinsurance) costs
    - Overhead expenses
    - All grossed up by percentages for producer commissions, taxes, and profit
- Rating Factors
  - Set to equitably distribute premiums among risks of different loss potential
    - Geographic location (territory, building code and mitigation zones)
    - Property attributes (construction, occupancy, mitigation features)
    - Coverage modifiers (deductibles, coinsurance, limits)
    - Marketing preferences (multi-policy discount)
- Rating factors are interdependent and nearly all affected by catastrophe risk – so modeled "risk load" should be part of the classification basis

Typical Rating Algorithm and Base Premium Form
Modeled Losses Enter in Several Places

Expected loss costs – modeled cat , non-modeled cat, and non-cat

Risk transfer costs, including reinsured cat losses

$$P = \frac{E[L_{MC} + L_{NMC} + L_{N}] + K + F}{1 - (c + t + p)}$$

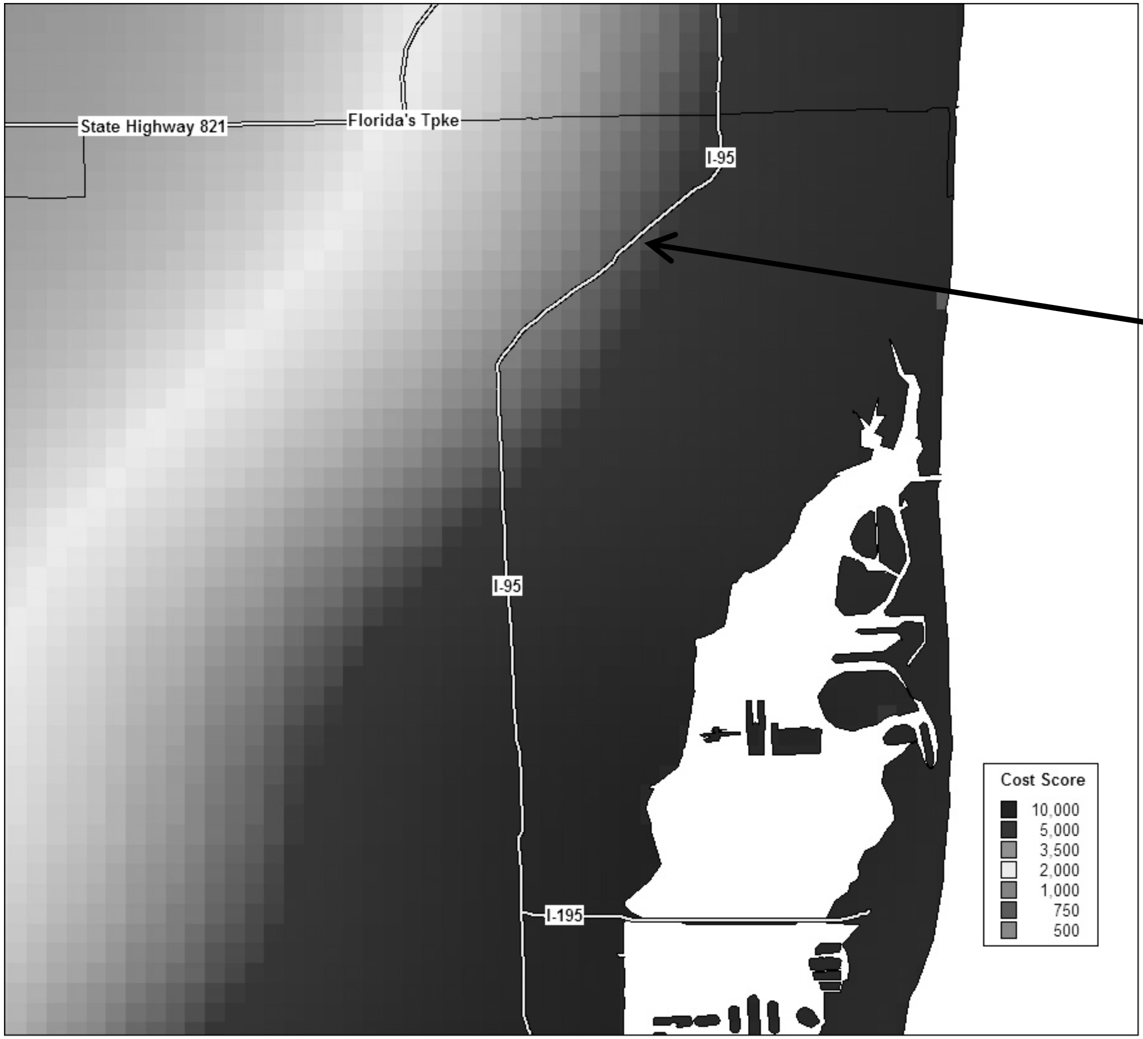
Variable expenses (percent of premium)

Fixed overhead expenses (not a percent of premium)

	Then: Base Premium [**P**]
x	Construction Type factor
x	Territory factor
x	Amount of Insurance factor
x	Deductible factor
x	Mitigation discount
x	Building Code Zone discount
x	Multi-Policy discount
+	Policy Fees
=	Final Premium

- Allocation of base premiums (via rating factors) should be based on relative loss potential – including catastrophe losses from models
- Relative loss potential should be measured using both expected losses and a measure of risk (volatility)

Example: Territory Definitions for Rating Fact



1. Generate granular grid-level model results from a hypothetical portfolio of typical risks
2. "Eyeball" results looking for contours in loss costs and alignment with natural boundaries useful to producers and underwriters
3. Select and publish definitions for rating policies and analysis of rating factors

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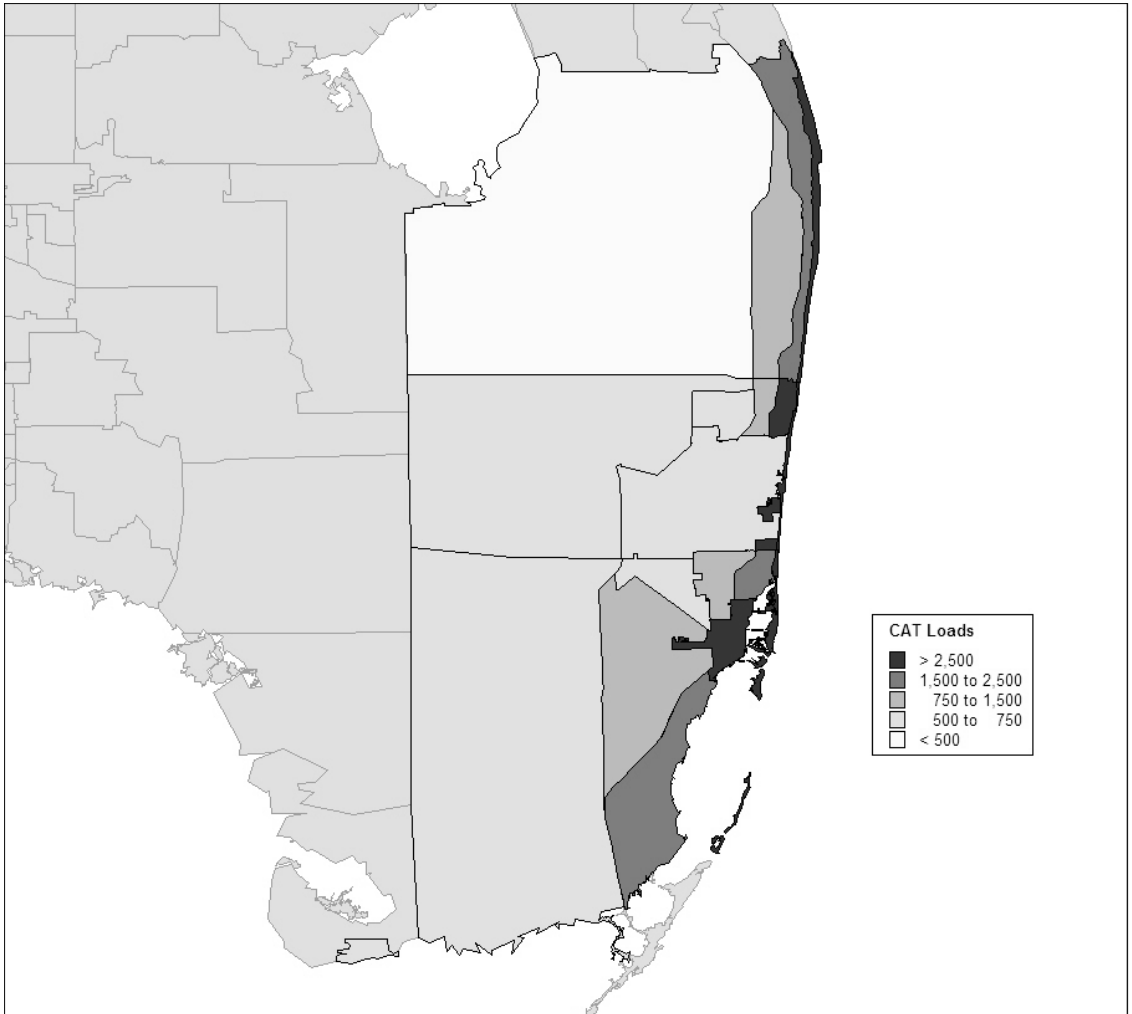
Example: Territory Rating Factor Analysis Using Definitions Informed by Models



1. Assemble modeled loss statistics for selected territory boundaries from a similar hypothetical portfolio of standard risks
2. Use both averages (expected losses) and volatility (e.g. 10% of 100-year PML) to build a "cat load" mimicking risk transfer costs for territory
3. Create equitable rating factors using standard balanced actuarial analysis

Example: Hurricane Deductible Factors Based on Losses

Territory	County	2% Hurricane Deductible AAL	PML	Cat Load	5% Hurricane Deductible AAL	PML	Cat Load	Ratio of AALs	Ratio of Cat Loads
1	Broward	1,136	29,399	4,127	932	24,388	3,413	0.821	0.827
2	Broward	818	18,134	2,662	653	13,453	2,022	0.799	0.759
3	Broward	218	4,017	626	161	2,104	375	0.740	0.599
4	Broward	450	9,077	1,373	344	5,347	888	0.764	0.646
5	Broward	216	3,695	591	160	1,855	349	0.744	0.590
6	Broward	209	3,925	608	152	2,117	368	0.730	0.605
7	Miami-Dade	980	24,392	3,461	798	19,658	2,798	0.815	0.809
8	Miami-Dade	871	21,233	3,031	707	16,546	2,390	0.812	0.789
9	Miami-Dade	819	20,368	2,891	661	15,527	2,240	0.807	0.775
10	Miami-Dade	255	4,783	741	188	2,320	424	0.739	0.572
11	Miami-Dade	626	14,112	2,062	483	9,737	1,474	0.772	0.715
12	Miami-Dade	427	9,091	1,352	327	5,301	866	0.765	0.640
13	Miami-Dade	237	4,740	719	171	2,347	410	0.724	0.570
14	Palm Beach	765	17,405	2,536	602	12,699	1,894	0.787	0.747
15	Palm Beach	683	15,577	2,267	533	10,742	1,625	0.780	0.717
16	Palm Beach	283	5,388	831	210	2,881	504	0.744	0.606
17	Palm Beach	166	2,892	461	124	1,665	294	0.748	0.638
							Average	0.770	0.683
							Std Dev	0.032	0.089

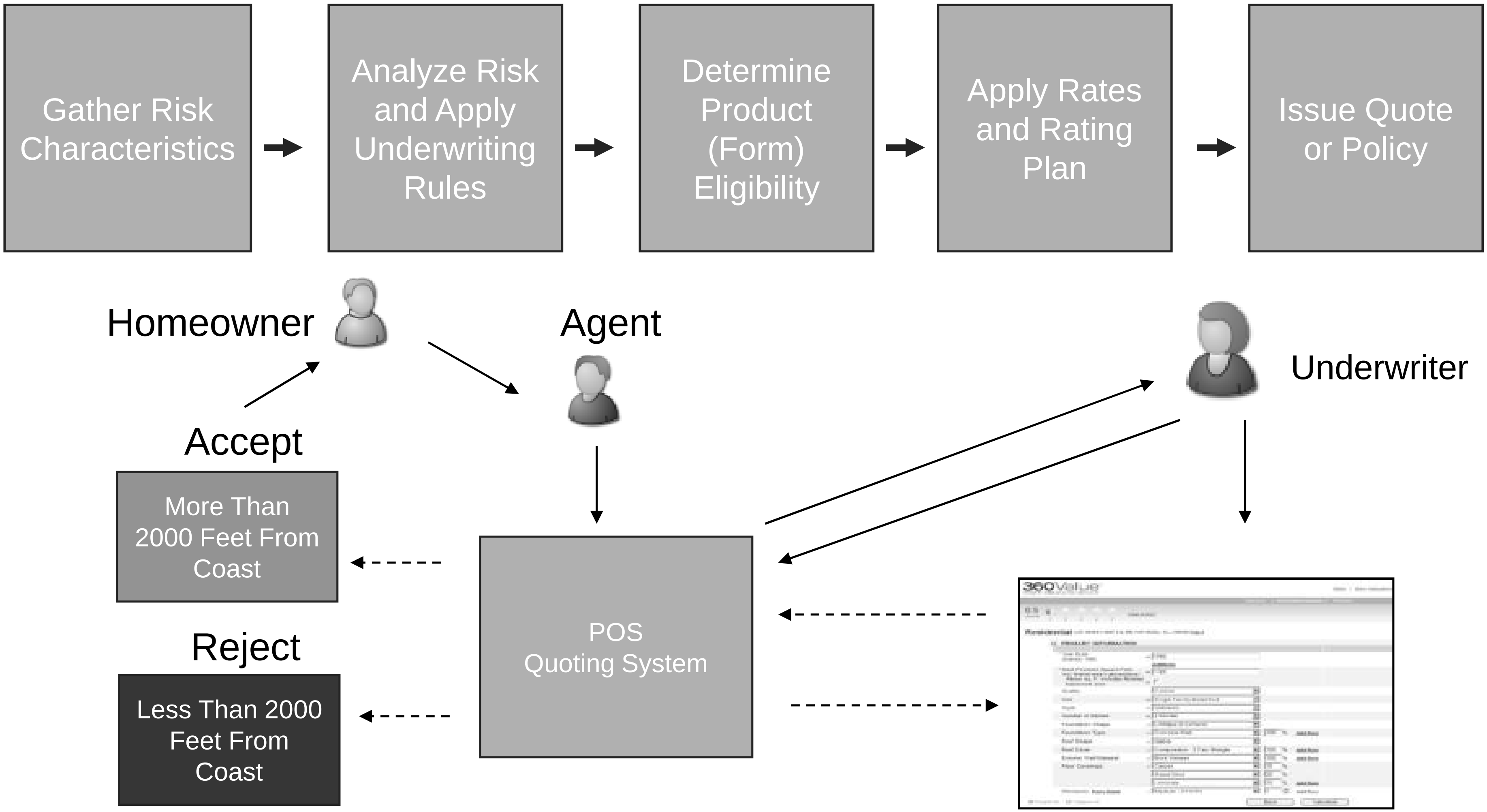
Model indicates a 5% deductible is worth an average 23% credit based only on AAL

But when volatility included, average credit increases to 32%, and varies more by territory (SDev increases)

The Role of Models in Underwriting Workflow

- The use of model results improves not only analysis “in batch” but individual policy-level decision making in a catastrophe-exposed environment
- Embedding cat modeling into production environments is a proactive approach to enterprise risk management
- Models facilitate a common language among quantitative analysts and line managers - and communication leads to better decisions, both on a strategic and a transactional basis

Simplified Personal Lines Underwriting Workflow i Catastrophe-Exposed Area



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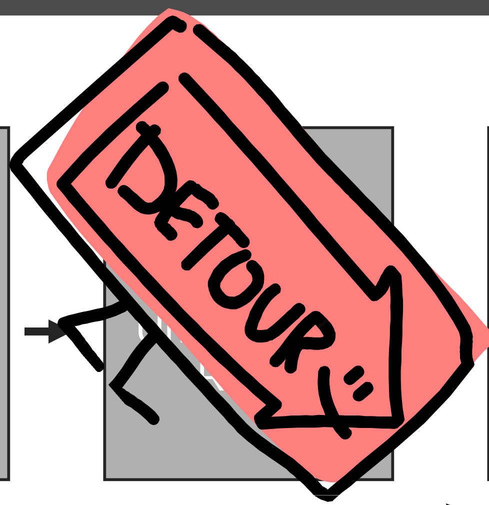
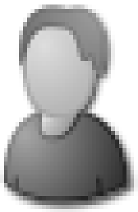
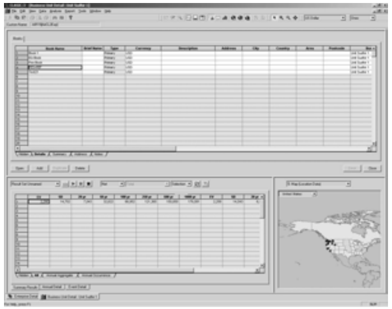
CONFIDENTIAL

Catastrophe Risk Assessment for Residential Properties Can Become A Cumbersome Process

Gather Risk Characteristics → [illegible] → Determine Product (Form) Eligibility → Apply Rates and Rating Plan → Issue Quote or Policy





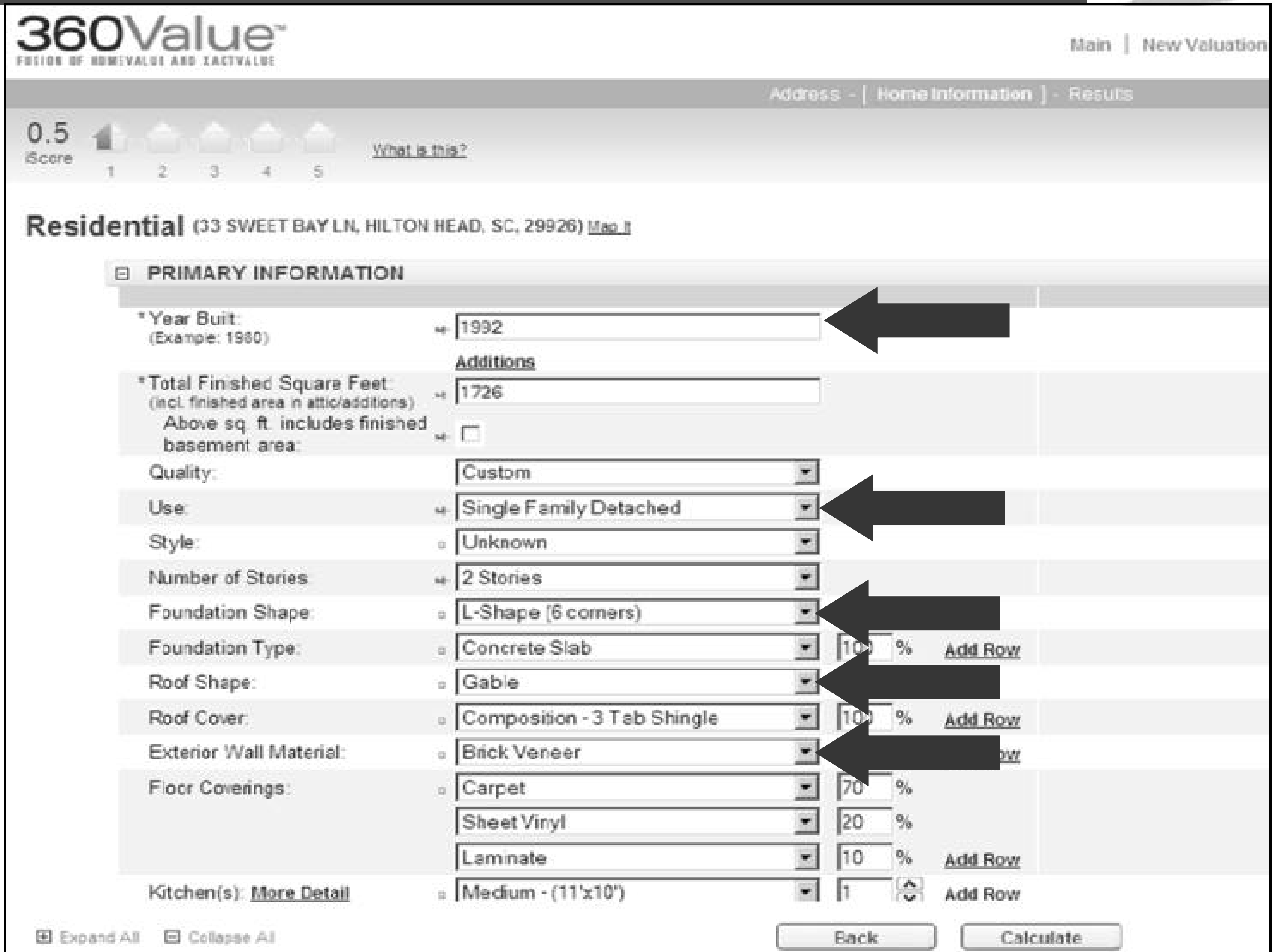


Catastrophe Modeling Analyst

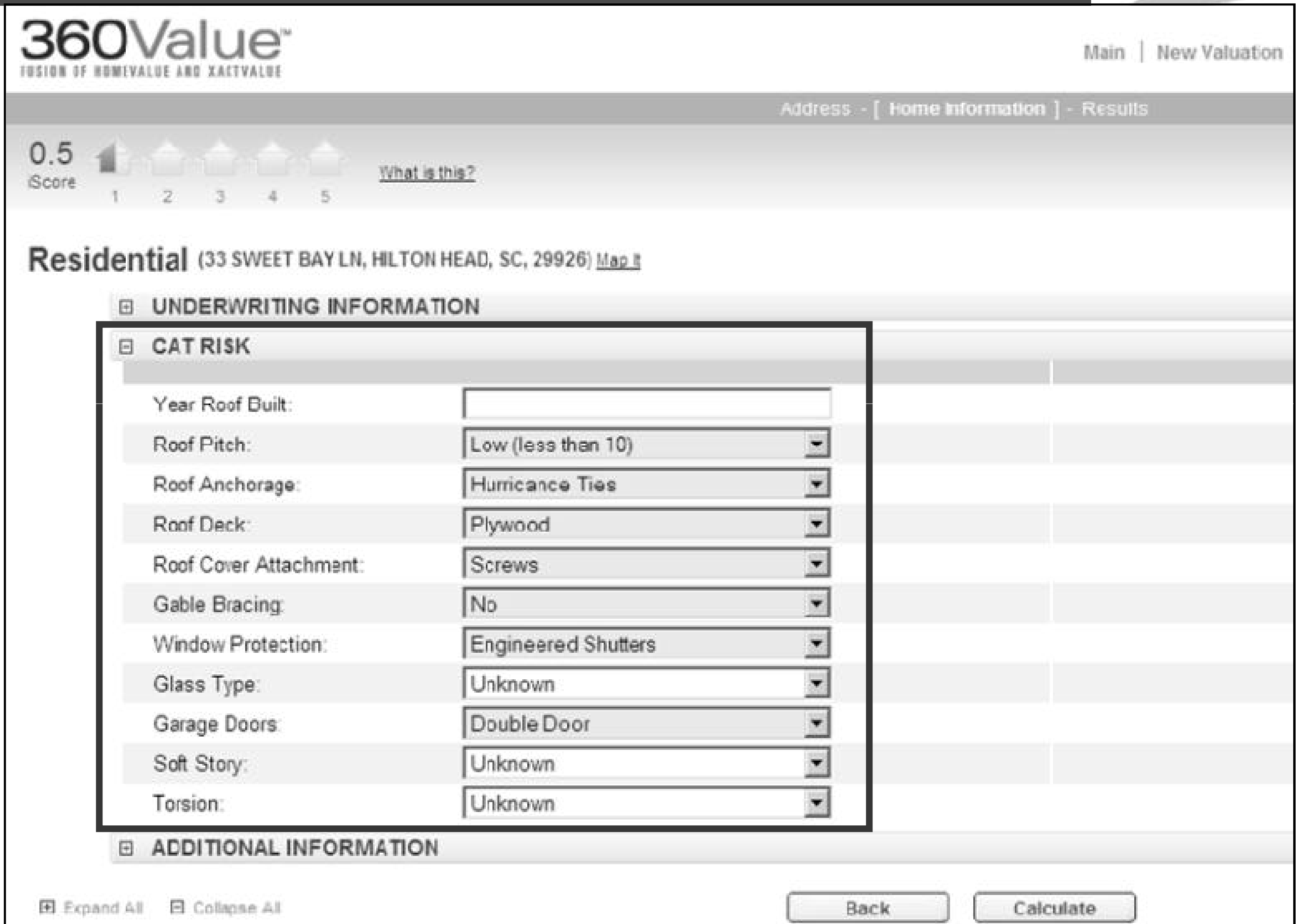
Point of Sale: The Best Place for Obtaining Risk D

- Point-of-sale data is collected before the decision to bind
- Data entry step is the only prospective opportunity to ensure data quality at the individual risk level
  - Validation of location and related risk factors
  - Establishment of replacement value estimate
  - Validation of property attributes and enforcement of underwriting guidelines
  - Data completeness
- Retrospective "cleaning" of data records at the time of cat model input is difficult!
- Many point-of-sale data elements are critical to cat loss analysis
  - Address used to geo-code risk location and all "lookups" for rating and underwriting (e.g. rating territory, fire protection class, wind mitigation zone)
  - Replacement Value defines exposure basis for modeling each coverage and bounds limits and deductibles
  - Construction and Surroundings data influences damage functions and secondary modifiers used by model

Point-of-Sale Example: Compile Key Property Characteristics



Capture Catastrophe Risk Features



Estimate Replacement Cost

Main | New Valuation | Risk Reports | Search | User

Address - Home Information - [Results]

Residential

RESULTS FOR (v.1)

⊟ PRIMARY INFORMATION

Name:	**Jim Wray**
Street:	**33 SWEET BAY LN**
City, State ZIP Code:	**HILTON HEAD, SC 29926**
Date Entered:	01/28/2008
Date Calculated:	01/28/2008
Entered By:	mgannon

⊞ HOME INFORMATION

⊟ COST BREAKDOWN

Appliances	$2,417.83
Electrical	$10,234.93
Exterior Finish	$43,887.72
Floor Covering	$10,656.56
Foundation	$10,926.68
Heating/AC	$11,408.93
Interior Finish	$53,956.89
Plumbing	$9,266.63
Roofing	$3,810.90
Rough Framing	$25,649.15
Specialty Systems	$2,627.66
Windows	$8,062.94

⊟ ESTIMATED REPLACEMENT COST

Calculated Value: **$250,930.00** ($225,837.00 - $276,023.00)

⊟ CATASTROPHE RISK ANALYSIS

PERIL	AVERAGE ANNUAL LOSS - GROSS	
Hurricane	$438	$1.75/$1000

(Replacement cost includes all applicable permits, fees, overhead, profit, and sales tax)

What To Do With the Results of Point-of-Sale Capt Underwriting Decision-Making?

- Apply "Go/No-Go" guidelines at a level of granularity
  - Average Annual Loss per unit of Rated Premium or Insured Value above a pre-set limit by territory, line of business, or construction class
- "Score" the risk for a multiple-tier product
  - Underwriting flexibility, coverage options, and rating plan vary by tier
- Identify candidates for individual risk rating under consent-to-rate
  - Target risks for excess & surplus (E&S) market
- Apply more complex metrics involving marginal impact on existing portfolio
  - Approximate the incremental change in EP value or TVaR from the addition of the prospective risk
  - Requires link to existing analysis engine for current portfolio

Using Aggregated Point-of-Sale Data in Periodic Re and Strategic Planning

- Regular integrated reporting of aggregates for
  - Risk distributions (e.g. by construction type)
  - Replacement values and insured limits
  - Catastrophe expected losses and EP values
- Review and adjust target metrics based on known capital requirements, market share goals, and other corporate strategy
  - Total insured value and premium
  - Probable maximum loss at given EP levels
  - Risk count of certain types
- Feed results of reporting into ratemaking process so that rate changes may be used to realign costs and benefits
- Feed results into reinsurance planning to structure optimal mix of programs
  - Excess of loss with consideration of multiple events
  - Proportional and per-risk

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Incorporating Hazard Analysis Into the Underwriting Process

- Catastrophe hazard reports
  - Earthquake - nearest faults, liquefaction potential, soil type
  - Hurricane - distance to coast, elevation, Florida Windstorm Mitigation Zones
  - Severe thunderstorm - storm frequency rating
  - Flood - FEMA defined zone
  - Terrorism - distance to nearest target

- Ability to integrate with key ISO data
  - PPC™ (Public Protection Codes)
  - Claims/Loss histories (A-Plus™)
  - BCEGS™ (Building Code Effectiveness)

Hazard Report Print

Please scroll to desired hazard profile(s) below.

Address: 610 SCHOONER RD CHARLESTON SC 29412

Latitude: 32.1601
Longitude: -79.0530

Hurricane Profile

RISK
(Percentage Loss)

0% 5 10 15 20 25 30 35 40 45 100%

100-year Loss Level:
250-year Loss Level:
Average Annual Loss: 0.3%

RELATIVE RISK
(Percentile)

0% 10 20 30 40 50 60 70 80 90 100%

within County:
within State:

HAZARD INFORMATION

Storm Surge Potential: Yes
Distance to Coast: 1 - 2 miles
Elevation: Less than 5 feet above mean sea level
Terrain/Land Use: Suburban

NEAREST HISTORICAL HURRICANES

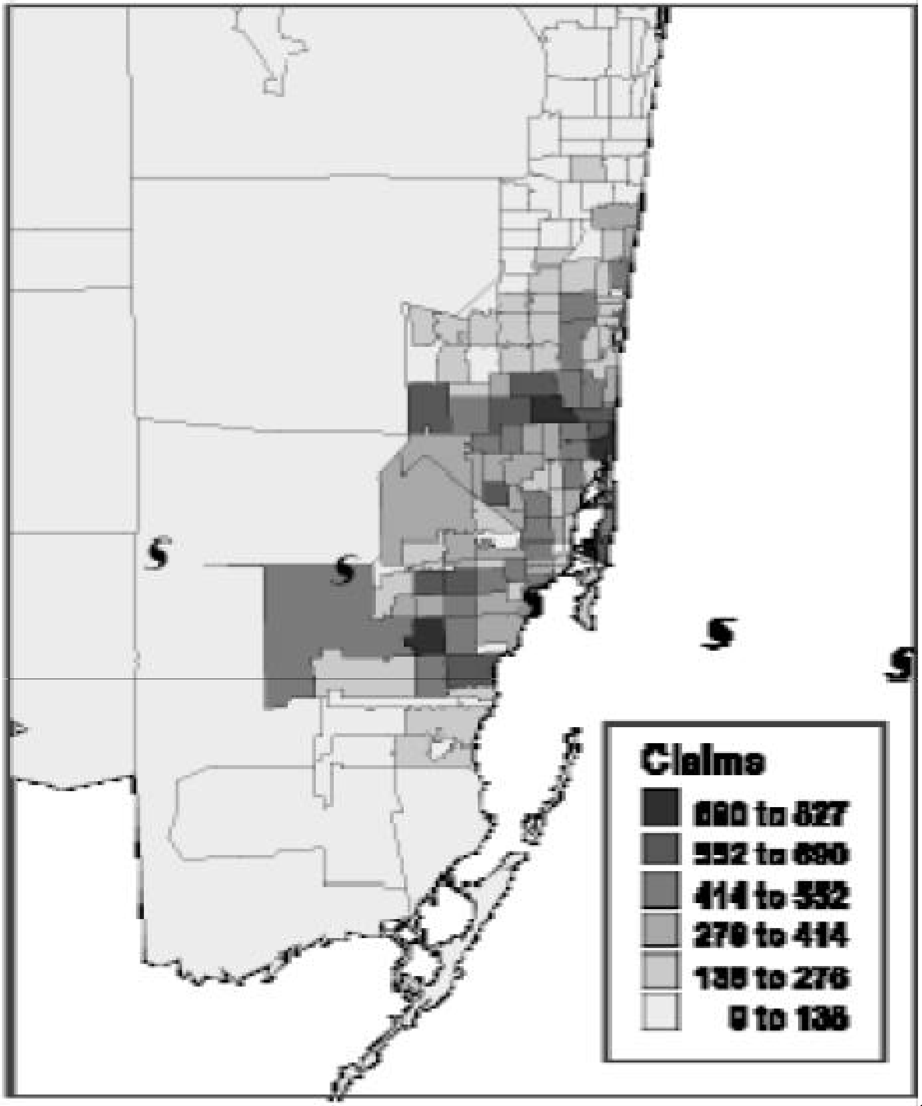
Name	Date of Landfall	Intensity at Landfall (Saffir-Simpson)	Distance of Track to Property (mi)	Intensity Closest to Property (Saffir-Simpson)
HUGO	September 22, 1989	4	3	4
GRACIE	September 29, 1959	3	35	3
Unnamed	August 11, 1940	2	40	2
IRENE	October 13, 1999	1	64	2
Unnamed	October 11, 1947	2	52	2

Advance Planning for “The Next Big One”

- Model deterministic events for each population center at risk
  - Stochastic or Historical catalog selections
  - “What if” event ___ happened again, but we weren’t so lucky?
    - Andrew – but 20 miles north through downtown Miami!
    - Northridge – but in downtown Los Angeles!
  - Claim Count output in addition to losses
- Use results for multiple planning decisions
  - Outsourcing – advance commitments needed; deployment
  - Locating claims centers and standard staging areas

Example: Real-T

- Use ALERT™ sce event sets to estir results at granula
  - Full or Select Sc Like Event scena
- Use claim count a results to identify areas
  - Severe likely los: risks requiring sp expertise
  - Large numbers c claims in small o access areas
- Activate, mobilize and deploy resou



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Example: Post-Event Activities

- Proactive communication and reporting to stakeholders
  - Ranges of estimated event losses and claim counts by ZIP code or county
  - Impact to reinsurance program and cat bonds (satisfy notice requirements by layer)
  - Gross and Net impact to earnings and balance sheet
  - Regulatory reports
- Work with Finance and Treasury to liquidate securities as necessary to ensure cash flow to pay gross claims expected and probable from event

ALERT™ All Selected Scenarios Loss Results for Sample Insurer – Hurricane Ike

Loss Perspective	Expected	Minimum	Maximum	90th Pctile	10th Pctile
Ground-Up	86,931,861	71,095,452	108,812,806	100,028,589	72,881,624
Gross of Reinsurance	67,329,093	54,396,588	85,576,676	78,153,641	55,876,331
Ceded - First Layer	24,982,719	24,396,588	25,000,000	25,000,000	25,000,000
Ceded - Second Layer	12,210,943	0	25,000,000	23,153,641	876,331
Ceded - Third Layer	135,431	0	5,576,676	0	0

Conclusions: Putting It All Together

- Consider the catastrophe science, technology, and reporting that model vendors provide as a suite of essential tools for making pricing, costing, and production decisions in any hazard risk-bearing organization
  - As opposed to a sterile package of abstract models and software constructed and delivered in a vacuum
  - As opposed to being utilized by managements within isolated or loosely aligned operation silos
- Model vendor employees seek to learn how clients are using vendor’s expertise and tools to solve real business problems – it makes the full integration of the modeling structure and operations make more sense