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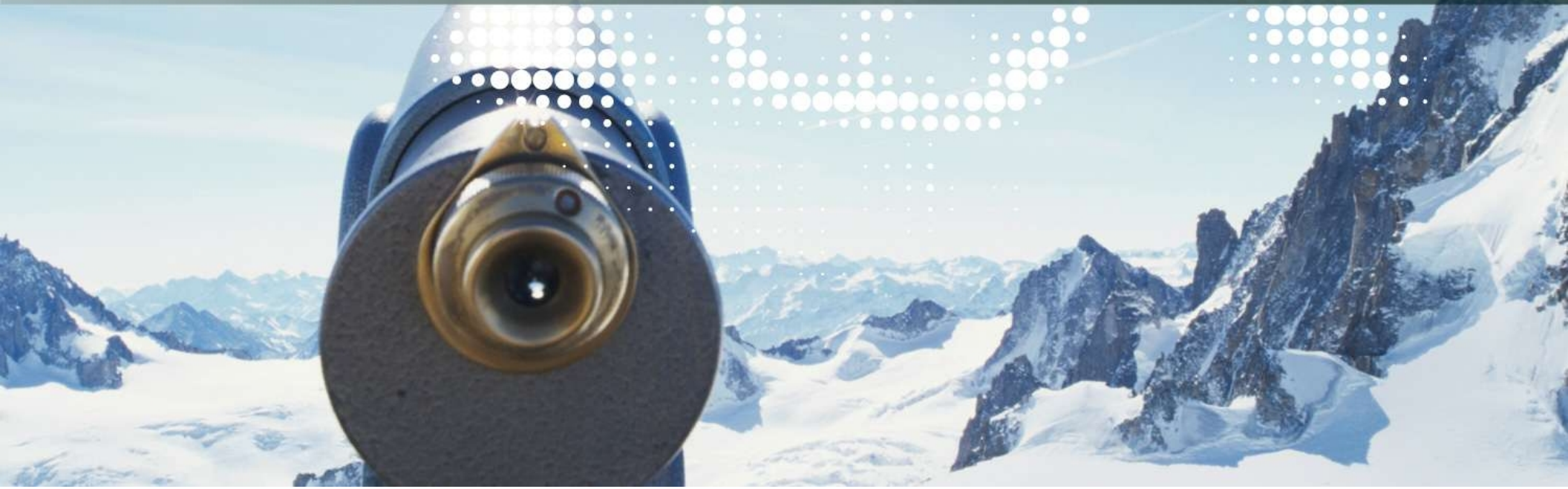
Cat Modeling & Pricing

Seminar on Reinsurance - Philadelphia

June 6, 2011



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What is Catastrophe Modeling?

- Catastrophe modeling is the process of using computer-assisted calculations to estimate losses that could be sustained by a portfolio of properties due to a catastrophic event such as a hurricane or earthquake.
- Modeled Nat Cat perils include
  - Hurricane (incl. storm surge)
  - Earthquake (incl. fire following and EQSL)
  - Tornado/Hail (including straight line winds)
  - Winterstorm
  - Flood
  - Brushfire

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Why Are Catastrophe Models Run?

- Management of Exposures
  - Control writings in regions
  - Scenario testing
  - Capital Costs
  - Probability of Ruin
  - Reinsurance Buying
  - Rating Agency Needs
- Ratemaking
  - Primary
  - Reinsurance

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Choices of Models

- Main Vendors
  - RMS
  - AIR
  - EQE
- Broker Models
- Company Proprietary Models

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How Cat Models Work

- Exposures – Models start with the exposure distribution (geography, construction, occupancy, etc.).
- Hazard – Stochastic events are simulated against the exposures. Each event has an associated probability.
- Vulnerability – This is the amount of damage expected to result from an event based on the exposure characteristics and event intensity.
- Financial Perspectives – Finally, varying perspectives of the loss are generated (application of primary insurance conditions and facultative and treaty reinsurance).

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Terminology - Perils

- Storm Surge (SS) – Quickly rising ocean water levels associated with windstorms that can cause widespread flooding. Measured as the difference between the predicted astronomical tide and the actual height of the tide when it arrives. Caused by the lower barometric pressure associated with tropical or extra-tropical cyclones, and the action of the wind in piling up the surface of the water. The amount of surge depends on a storm's strength, the path it is following, and the contours of the ocean and bay bottoms as well as the land that will be flooded.
- Tornado/Hail (TH) – Non hurricane wind events

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Terminology - Perils

- Earthquake Shake (EQ) – A sudden or abrupt movement along a fault or other pre-existing zone of weakness in response to accumulated stresses.
- Fire Following Earthquake (FFEQ) – Hazard presented by fires which commonly occur following an earthquake, typically due to the rupture of natural gas lines or other structures carrying combustible materials.
- Earthquake Sprinkler Leakage (EQSL) – Direct damage to the building or contents caused by the leakage or discharge of water or other substances from an automatic sprinkler system due to earthquake or volcanic action.

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Terminology - Perils

- Demand surge/Loss amplification (DS) – Post event inflation.
  - Shortages of labor and materials cause prices to rise.
  - Supply/demand imbalances delay repairs resulting in structural deterioration.
  - Faced with the magnitude of the disaster and under pressure from politicians, insurers are encouraged to settle claims generously and to expand the terms of coverage beyond those strictly defined in contracts.

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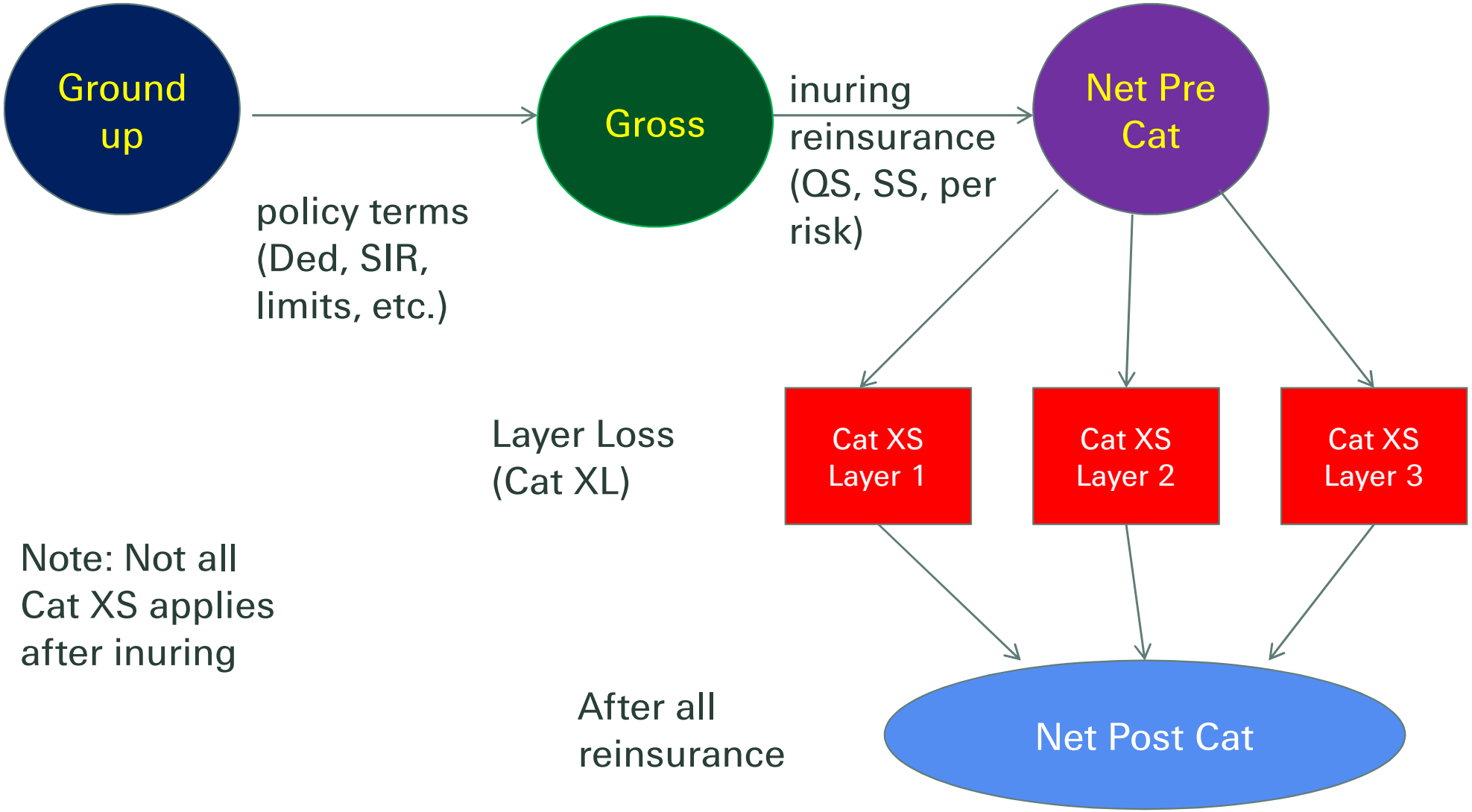
Terminology - Financial Perspectives



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Terminology – Model Results

- Exceedance Probability (EP) - Also known as "exceeding probability" or "EP", it is the probability of exceeding specified loss thresholds.
- EP curve defines the probability of various levels of potential loss for a defined structure or portfolio of assets at risk of loss from natural hazards.
- By combining probabilities of occurrence with the loss levels of all potential events, the probability of exceeding certain loss levels in a given year (return period loss) can be calculated.

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Terminology - Model Results

PDF	Occurrence Loss
0.01%	**172,952**
0.01%	**153,691**
0.01%	143,571
0.01%	135,451
0.01%	**124,701**
0.01%	119,579
0.01%	114,923
0.01%	110,707
0.01%	106,891
0.01%	**103,167**
0.01%	100,001
.....	.....

Return Period	Exceedance Probability		
	Eqiv Prob.	Occurrence OEP	Aggregate AEP
10,000	0.01%	**172,952**	178,140
5,000	0.02%	**153,691**	159,838
2,000	0.05%	124,701	130,936
1,000	0.10%	103,167	109,357
500	0.20%	**83,644**	90,336
250	0.40%	63,882	70,270
100	1.00%	43,887	50,470
50	2.00%	31,353	37,623
25	4.00%	20,941	26,176
20	5.00%	**18,429**	25,800
10	10.00%	9,506	15,002
5	20.00%	5,666	10,211
2	50.00%	1,554	3,123

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Terminology - Model Results

- Expected Annual Loss (Average Annual Loss or Pure Premium) – Sum of all modeled event losses divided by the number of years modeled. This is the annual premium required to cover the loss exposure over time.
- The expected annual loss cost rate load is a good index of relative risk between programs and accounts. Loss cost rate loads can be developed by dividing the expected annual loss by the sums insured per hundred.

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Terminology - RMS

- Secondary Uncertainty - While primary uncertainty measures uncertainty in the likelihood that a particular event occurs, secondary uncertainty incorporates the distribution of potential loss amounts for the event. In other words, it recognizes that when an event occurs, there is a range of possible loss values. The inclusion of secondary uncertainty produces smoother EP curves with longer tails; a longer tail on the curve indicates a positive probability that losses exceed a maximum event.

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Terminology - RMS

- Risk Management Solutions (RMS) – Founded at Stanford University in 1988, this company developed RiskLink.
- RiskLink (RL) – RMS catastrophe modeling tool with models for Hurricane, EQ, FFEQ, EQSL, TH, Brushfire, Winterstorm, and Terrorism.
- Aggregate Loss Module (ALM) – Version of RiskLink that works with aggregate input data, and is designed to support treaty reinsurance underwriting and other applications when detailed exposure data is not available.

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Terminology - RMS

- Detailed Loss Module (DLM) - Version of RiskLink that works with detailed input data, and is designed to support underwriting situations when detailed exposure data is available.
- Exposure Data Model (EDM) – The RMS database structure for capturing information about property exposures such as location, values, and insurance terms, for use in risk modeling.
- Results Data Model (RDM) – The RMS database structure for capturing loss estimates and other output data generated by RMS catastrophe modeling products. Includes by event losses for all financial perspectives and perils analyzed.

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Agenda

- Cat Terminology & Model Basics
- Cat Exposure Data
- Model Differences & Selection
- Model Adjustments
- Experience Rating
- Summary

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Common Data Formats

- EDM – detailed data in RiskLink format
- UNICEDE file – aggregated data in AIR format
- UNICEDE/2 file – aggregated data in AIR format
- UNICEDE/px (UPX)– detailed data in AIR format
- Raw detailed data
  - Format into model(s) you want to use
  - Format differs by client
  - Other formats start as raw data

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What is in an EDM?

- Exposure data contained in multiple files in EDM
  - Primary location details - address, construction, occupancy, year built, number of stories, values by coverage
  - Secondary characteristics - Characteristics of a structure (other than the primary details) that can be specified to differentiate vulnerability, such as year of upgrade, soft story, setbacks and overhangs, torsion, and cladding.
  - Geocoding information - Latitude/Longitude, may be entered or generated by RiskLink based on address information.
  - Primary policy conditions (deductibles, limits...)
  - Portfolios - A grouping of policies for purposes of risk analysis and risk management. User can create portfolios based on policy information such as line of business or geographic region.
  - Reinsurance - facultative, per risk, quota share, surplus share, and cat.

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UNICEDE File

- Includes state, county, and total values by line of business for homeowners, mobile homes, commercial and auto.

```
*AIR-UNICEDE-PUBLIC-1.000
*REF = Applied Insurance Research, Inc., Boston, MA
*SOURCE_DATE = 20000609 : Sep 06, 2000
*SOURCE_COMPANY = ABC Ins Co
*SOURCE_CONTACT =
*SOURCE_ADDR_1 =
*SOURCE_ADDR_2 =
*SOURCE_ADDR_3 =
*SOURCE_ADDR_4 =
*SOURCE_ADDR_5 =
*SOURCE_PHONE =
*SOURCE_FAX =
*CEDING_COMPANY = ABC Ins Co
*CEDING_CO_STD_ID = AMBEST-100000
*CESSION_YEAR = 2000
*DATA_YEAR = 2000
*DATA_UNITS = 1000.0
*DATA_CURRENCY = USD: US Dollars
*DATA_FOR = SI: Sums Insured
*DATA_QUALITY = 1: EXCELLENT All data submitted directly by eding company.
*DATA_LEVEL = 3: State & County only
*DATA_LINE_TYPE = 1: Basic, HO,MH,CM,AU,TT
*AREA_TAG_TYPE = 1: FIPS Codes
04-001,       15392,        1186,        1630,        3138,        21346
04-003,       45338,        4962,       18210,        6520,        75031
04-005,      282155,        6788,       17088,       27745,       333777
04-007,      250758,       12140,       24758,       19086,       306742
04-009,        7298,         644,        1285,        1492,        10719
04-011,         301,         145,           0,         344,          789
04-012,       19357,         976,        2519,        2204,        25056
04-013,    18100519,      172332,     1338772,     1552286,     21163909
04-015,      369086,       16773,       33416,       30435,       449710
04-017,      147418,        5963,       13019,       13284,       179684
04-019,     2770707,       48887,      213678,      250426,      3283698
04-021,      522162,       59062,       45614,       57508,       684346
04-023,       68814,         566,        2016,       12642,        84037
```

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UNICEDE/2 File

- Includes peril, line of business, coverages, average deductible, risk count, value and premium

UNICEDE/px

- Primary Data Exchange Format used by primary insurers to transfer detailed exposure formatted for use in AIR's detailed model (CLASIC/2).
- Format used for all types of property insurance including commercial, residential, single-location, multi-location and excess insurance.

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Raw Data – Basic Data

- Address – state, county, city, zip code, and street address
- Occupancy
- Construction
- Values by coverage - building, contents, time element
- Limits
- Deductibles
- Peril specific deductibles and/or sub-limits
- Year built
- Number of stories
- Not required, but good to have - secondary characteristics

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Raw Data – Data Prep

- Format
  - One row of data per risk if reported by coverage
  - Is it consistent with per risk definition of risk?
- Data complete?
  - Missing lines of business?
  - Missing states?
  - Missing perils?

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Raw Data – Address

- Formatting - state, county, city, zip code, street address
  - Minimum of two address fields required
  - Reasonable (state codes vs. name/wrong column)
  - Check for billing vs. location address information
- Why important?
  - As in real estate – location, location, location
  - Street level most important for earthquake and hurricane storm surge
- Assumptions
  - Generally cannot make assumptions

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Raw Data – Occupancy

- Formatting
  - Map client codes/description
  - Default unknown or not reported
- Why important?
  - Single most important risk characteristic for damage calculation
- Assumptions
  - Personal lines easily defaulted to either single or multiple family
  - Commercial damageability differs greatly by occupancy
  - May overstate or understate damage

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Raw Data – Construction

- Formatting
  - Map client codes/description
  - Default unknown or not reported
- Why important?
  - Important characteristic for damage calculation
  - Very important for mobile homes
- Assumptions
  - If all or many risks reported as unknown, underwriting judgment used to assume most likely assumption
  - May overstate or understate damage

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Raw Data – Values

- Formatting
  - Many clients report limits by coverage not values
  - BOP risks generally reported without time element
- Why important?
  - Starting point for damage calculation
- Assumptions
  - Damage will be understated if limits are run as values and ITV is less than 100%
  - Use ITV by line of business to convert limits to values if only limits are reported
  - Often default time element value for BOP as % of building and/or contents values

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Raw Data – Limits

- Formatting
  - Correctly apply at coverage, site, or policy level as applicable
- Why important?
  - Used to calculate insured loss from damage
- Assumptions
  - Improperly applied limits can result in understated or overstated insured loss

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Raw Data – Deductibles

- Formatting
  - Correctly apply at coverage, site, or policy level as applicable
  - May be dollar amounts or percentages
- Why important?
  - Used to calculate insured loss from damage
- Assumptions
  - Improperly applied deductibles will result in understated or overstated insured loss

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Raw Data – Peril Specific Conditions

- Formatting
  - CA mini policy structure
  - Confirm whether or not wind deductibles and limits apply to tornado/hail as well as hurricane
- Why important?
  - Used to calculate insured loss from damage
- Assumptions
  - Missing or improperly applied limits/deductibles will result in understated or overstated insured loss

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Raw Data – Year Built

- Formatting
  - Reported for all risks?
  - Format reported year built to “01/01/YYYY”
  - If unknown, appears as 12/31/9999
- Why important?
  - Important characteristic for damage calculation
  - Vulnerability curves reflect building codes in force when built
- Assumptions
  - Generally difficult to make assumptions if data is not provided

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Raw Data – Number of Stories

- Formatting
  - Reported for all risks?
  - Reasonable against construction?
- Why important?
  - Affects damage calculation
- Assumptions
  - Generally difficult to make assumptions

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Raw Data – Secondary Characteristics

- Formatting
  - Reported for all risks?
  - Reported only for better than average?
- Why important?
  - Affects damage calculation
- Assumptions
  - Generally difficult to make assumptions
  - Use with caution

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Agenda

- Cat Terminology & Model Basics
- Cat Exposure Data
- Model Differences & Selection
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- Experience Rating
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Model Differences

- Models differ because of the different methodologies utilized as well as different views on perils and vulnerability.
- Source of differences
  - Geocoding
  - Hazard
  - Vulnerability
  - Application of insurance

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Choice of Models

- Models differ because of the different methodologies utilized as well as different views on perils and vulnerability.
- Options can include
  - Use one model exclusively
  - Use one model by “territory”
  - Use multiple models for each account

Choice of Models – Option # 1
Use One Model Exclusively

- Benefits
  - Simplify process for each deal
  - Consistency of rating
  - Lower cost of license
  - Accumulation easier
  - Running one model for each deal involves less time
- Drawbacks
  - Can't see differences by deal and in general
  - Conversion of data to your model format

Choice of Models – Option # 2
Use One Model by "Territory"

- Detailed review of each Model By “Territory”
- Territory examples (EU wind, CA EQ, FL wind)
- Select adjustment factors for the chosen model
- Benefits
  - Simplify process for each deal
  - Consistency of rating
  - Accumulation easier
  - Running one model involves less time
- Drawbacks
  - Can’t see differences by deal
  - Conversion of data to your model format

Choice of Models – Option #2

Use One Model By "Territory" – a fictitious example

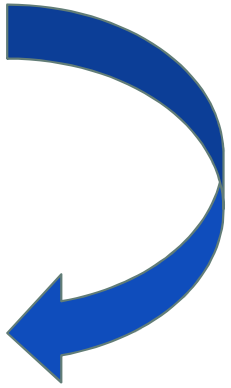
Weights

Zone	CT	RMS	EQE
CA EQ	70%	0%	30%
Japan EQ	50%	0%	50%
FL WS	0%	100%	0%
Euro Wind	20%	40%	40%

This reinsurer happened to like the RMS shape for FL WS, but wanted an 20% adjustment to frequency

Factors

Zone	CT	RMS	EQE
CA EQ	80%	150%	130%
Japan EQ	80%	120%	125%
FL WS	90%	120%	50%
Euro Wind	150%	80%	110%



average relativity to desired blend

Choice of Models – Option #3
Use Multiple Models

- Benefits
  - Can see differences by deal and in general
- Drawbacks
  - Consistency of rating?
  - Conversion of data to each model format
  - Simplify process for each deal
  - High cost of licenses
  - Accumulation difficult
  - Running one model for each deal is time consuming

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Model Adjustment – Climate Prediction

Despite impressive science, the individual season predictions, the last several years was off the mark.

	Named Storms			Hurricanes			Major Hurricanes		
Season	Actual	Forecast	Variance	Actual	Forecast	Variance	Actual	Forecast	Variance
2005	27	12-15	100.0%	15	7-9	87.5%	7	3-5	75.0%
2006	10	13-17	-33.3%	5	8-10	-44.4%	2	4-6	-60.0%
2007	15	13-17	0.0%	6	7-10	-29.4%	2	3-5	-50.0%
2008	16	12-16	-12.5%	8	6-9	6.7%	5	2-5	42.9%
2009	9	9-14	-21.7%	3	4-7	-45.5%	2	1-3	0.0%
2010	19	14-23	2.7%	12	8-14	9.1%	5	3-7	0.0%
Average	16.0	15.1	5.9%	8.2	8.4	-2.7%	3.8	3.8	1.3%
1950-2005	10			6			3		
1995-2010	15			8			4		

However, actual and forecast are both above average in total relative to long term averages, but consistent with the last 16 years

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Nat Cat Costing – Adjustments

- Growth
  - exposures are typically "yesterday's" exposures
  - need to adjust to prospective treaty period
  - occasionally need to adjust for less "organic" changes
- ALAE – reflective of cat specific ALAE missing from model
- Pools and Fair Plans – reflect treaty wording
- Historical miss – compare actual hurricane losses to modeled return period losses or modeled footprint
- Data Quality – blanket load for non-corrected elements

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Nat Cat Costing – Adjustments

- If not included in Model results
  - Storm Surge
  - Post event demand surge – cost of labor and materials rises after major event
  - Pre event demand surge – prior event in general area already lead to increases in costs
  - EQ Fire Following
  - EQ Sprinkler Leakage
- "Unmodeled" Exposures

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Nat Cat Costing – "Unmodeled" Perils

- Tornado/Hail
- Winter Storm
- Wildfire
- Flood
- Terrorism
- Fire Following
- Other

Nat Cat Costing – Tornado/Hail

Tornado Hail

- National writers may not to include all TH exposures
- Models are improving, but not quite there yet
- Significant exposure
  - Frequency: TX
  - Severity: 5 of top 20 US all time (untrended)

- Methodology
  - Experience and exposure rate
  - Compare to peer companies with more data
  - Determine use of longer term or shorter term averages
  - Weight methods
  - Percentile Matching with model

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Nat Cat Costing – "Unmodeled" Perils

Winter storm

- Not insignificant peril in some areas, esp. low layers
  - Several 1B+ industry events or cluster of events in last 20 years
  - separating occurrences in a cluster?????
  - Possible Understatement of PCS data
- Methodology
  - Degree considered in models
  - Evaluate past event return period(s)
  - Adjust loss for today's exposure
  - Fit curve to events
  - Aggregate Cover?????

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Nat Cat Costing – "Unmodeled" Perils

Wildfire

- Not just CA
- Oakland Fires: 1.7B untrended
- Austin "It Could Happen Tomorrow"
- 2003, 2007 Fires: multiple occurrences?
- Development of land should increase freq/severity
- Two main loss drivers
  - Brush clearance – mandated by code
  - Roof type (wood shake vs. tiled)
- Methodology
  - Degree considered in models
  - Evaluate past event return period(s), if possible
  - Incorporate Risk management, esp. changes
  - No loss history - not necessarily no exposure

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Nat Cat Costing – "Unmodeled" Perils

Flood

- Less frequent
- Development of land should increase frequency
- Methodology
  - Degree considered in models
  - Evaluate past event return period(s),if possible
  - No loss history – not necessarily no exposure

Terrorism

- Modeled by vendor model? Scope?
- Adjustments needed
  - Take-up rate – current/future
  - Post TRIA extension issues
  - Other – depends on data

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Nat Cat Costing – "Unmodeled" Perils

Other Perils

- Expected the unexpected
- Examples: Blackout caused unexpected losses
- Methodology
  - Blanket load
  - Exclusions, Named Perils in contract
  - Develop default loads/methodology for an **complete** list of perils

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Agenda

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Experience Rating Overview

- Similar to normal experience rating from earlier sessions today
- Main Difference – Need to adjust for volume (150 houses will give 50% more loss than 100 houses)
- May need to adjust for geographical, policies changes, etc. (wind deductible)
- Adjustments in examples herein assume organic growth of the same general exposures (overly simplistic for many carriers)
- Important for low layer catastrophe layers, aggregate XS and pro rata

Experience Rating Example

Experience Approach #1
Excess Cat Load Analysis - longer term

Year	Trended Exposure	Trended & Dev Loss	Vol Adj Loss	
1990	1,000	500	2,500	
1994	1,600	1,000	3,125	
1997	2,000	6,000	15,000	=5,000*6,000/2,000
1998	2,350	-	-	
1999	2,550	-	-	
2000	2,750	-	-	
2001	3,000	3,000	5,000	
2002	3,100	-	-	
2003	3,250	-	-	
2004	3,400	2,000	2,941	
2005	3,550	-	-	
2006	3,700	-	-	
2007	3,950	3,500	4,430	
2008	4,230	5,000	5,910	
2009	4,410	3,000	3,401	
2010	4,850	2,500	2,577	
2011	5,000			Projected

Average (90-10)	2,137	
Industry 40 yr Avg XS Wind	80,000	
Industry 21 yr Avg XS Wind	100,000	
Long term/Short Term	80%	
Selected adjustment	90%	(partially wighting in old years)
Selected Experience Load	1710	=1,158*90%

Trended exposure = Earned House Years, Onlevel EP, Onlevel TIV,

Analyst chose to rely 50/50 on 21 years and extrapolated 40 year experience

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Experience Rating Example

Experience Approach #2
Excess Cat Load Analysis - Shorter Term

Year	Trended Exposure	Trended & Dev Loss	Vol Adj Loss	Weight
1990	1,000	500	2,500	25%
1994	1,600	1,000	3,125	25%
1997	2,000	6,000	15,000	25%
1998	2,350	-	-	25%
1999	2,550	-	-	25%
2000	2,750	-	-	25%
2001	3,000	3,000	5,000	50%
2002	3,100	-	-	50%
2003	3,250	-	-	50%
2004	3,400	2,000	2,941	50%
2005	3,550	-	-	50%
2006	3,700	-	-	100%
2007	3,950	3,500	4,430	100%
2008	4,230	5,000	5,910	100%
2009	4,410	3,000	3,401	100%
2010	4,850	2,500	2,577	100%
2011	5,000			Projected
Average (90-10)			2,137	
Weighted Avg			2,483	
Selected Experience Load			2,483	

Analyst chose to rely more heavily on recent experience due to changes at company and/or weather patterns

Experience Rating Example

Experience Approach #3
Excess Cat Load Analysis - 10 Year

Year	Trended Exposure	Trended & Dev Loss	Vol Adj Loss	Weight
1990	1,000	500	2,500	
1994	1,600	1,000	3,125	
1997	2,000	6,000	15,000	
1998	2,350	-	-	
1999	2,550	-	-	
2000	2,750	-	-	
2001	3,000	3,000	5,000	100%
2002	3,100	-	-	100%
2003	3,250	-	-	100%
2004	3,400	2,000	2,941	100%
2005	3,550	-	-	100%
2006	3,700	-	-	100%
2007	3,950	3,500	4,430	100%
2008	4,230	5,000	5,910	100%
2009	4,410	3,000	3,401	100%
2010	4,850	2,500	2,577	100%
2011	5,000			Projected

Average (90-10)	2,137
Weighted Avg	2,426
Selected Experience Load	2,426

Analyst chose to rely on 10 year experience as older years less reliable due to lack of faith in adjustments, changes in company, weather.

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Experience Rating Fitting

Experience Approach Alternative
Percentile Matching

Percentile	Unadjusted Vendor	Adjusted Vendor	Smoothed Experience
20%	400	300	100
25%	600	500	300
30%	1,000	700	500
35%	1,300	1,000	1,000
40%	1,600	1,200	1,500
45%	2,000	1,500	1,700
50%	2,500	2,000	2,000
55%	3,000	2,500	2,300
60%	3,500	3,000	2,500
65%	4,500	3,500	3,200
70%	5,500	4,000	3,800
75%	6,500	5,000	4,800
80%	7,500	6,000	6,200
85%	10,000	7,000	7,500
90%	13,000	9,000	9,000
95%	18,000	13,000	13,000

Used a vendor models shape of curve as reasonable, but used experience as basis for adjustment

First, fit curve to experience he trusted then adjusted vendor model

Swiss Re

Agenda

- Cat Terminology & Model Basics
- Cat Exposure Data
- Model Differences & Selection
- Model Adjustments
- Experience Rating
- Summary

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Summary

- Data – Garbage in, garbage out
- Data – understand assumptions used in populating
- Models – understand limitations and biases
- Experience Rating – a powerful tool
- Actuaries can provide valuable insight and judgment
- Expect the "unexpected"
- Use Judgment – **Don't be a fool to the tool**

Swiss Re

Wrap Up

Q & A