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How should Actuaries make use of Catastrophe Models?

Catastrophe Modelling Working Party

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How should Actuaries make use of Catastrophe Models?

1. **Background**
2. **Issues for actuaries using Catastrophe Models**
3. **2006 Hurricane Season**

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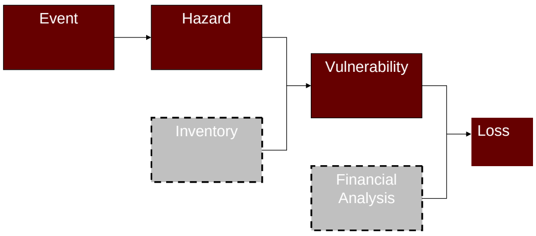
Background: Components of Catastrophe Models



Background: History of Catastrophe Models

- 1987 AIR Established
- 1988 RMS Established
- 1992 Hurricane Andrew
- 1993 Bermuda "Class of 93"
- 1994 Northridge Earthquake
- 1994 EQECAT established
- 1999 Anatol/Lothar/Martin
- 2001 WTC
- 2002 Third wave of Bermuda start-ups
- 2004 Charley, Frances, Ivan, Jeanne
- 2005 Katrina (Rita & Wilma)

Background: Uses of Catastrophe Models

- Aggregate modelling (including RDS)
- Pricing
- Planning/Forecasting
- Reserving – assessment of events
- Capital allocation and assessment – internal
- Capital allocation and assessment – external
- Reinsurance buying

Issues for Actuaries

- Frequency
- Severity: Demand Surge
- Exposure data
- Unmodelled Elements

We will focus frequency/demand surge on US Hurricanes (Hurricane Season officially starts in 16 days time)

Issues for Actuaries: Frequency

- Short term - ENSO (El Niño)
- Medium term - Atlantic Multidecadal Oscillation
- Long term - Climate Change

Issues for Actuaries: Frequency
Short Term: El Niño Southern Oscillation (ENSO)

- El Niño (boy child) was originally used for warm waters that would in some years form off the coast of Ecuador and Peru near Christmas
- Now used to describe a general and wider phenomenon of unusally warm waters in tropical Eastern and Central pacific
- La Niña years are years with cooler than normal waters
- Normal conditions are called neutral years
- El Niño years also are associated with changes in sea level atmospheric pressure – Southern Oscillation
- Currently 2006 neutral. 80% chance of April-June remaining neutral

Issues for Actuaries: Frequency
Short Term: El Niño Southern Oscillation

- Primary effect of El Nino Southern Oscillation on Hurricane Formation is due to wind shear
- Vertical wind shear is change in wind pattern with height. Hurricane formation requires low wind shear
- In El Nino years, vertical wind shear is increased (as changes to wind patterns reinforce existing patterns)
- La Nina reduces wind shear and increases hurricane formation

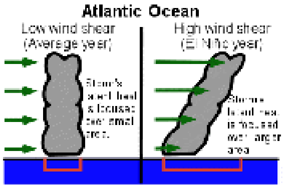
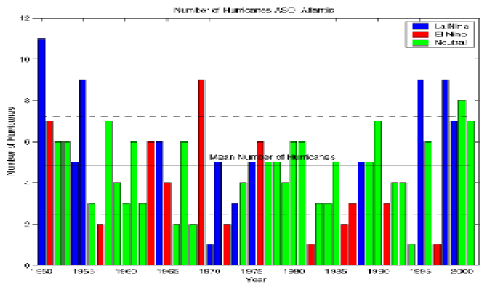


Image from the University of Illinois WW2010 Project

Issues for Actuaries: Frequency
Short Term: El Niño Southern Oscillation

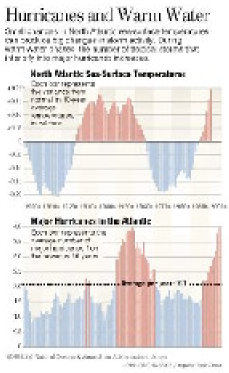


Source: International Research Institute for Climate and Society

http://iri.columbia.edu/climate/ENSO/globalimpact/TC/Atlantic/no_hurricane.html

Issues for Actuaries: Frequency
Medium Term: Atlantic Multidecadal Oscillation

- Ongoing series of long-duration changes in the Sea Surface Temperature (SST) of the North Atlantic
- Cool and warm phases that may last for 15-40 years at a time – have been occuring for last 1000 years
- A difference of about 1°F (0.6°C) between extremes.
- Frequency of weak storms not strongly correlated with AMO
- Number of tropical storms maturing into major hurricanes much greater in warm phase
- Latest warm phase since 1995



Source: Wikipedia

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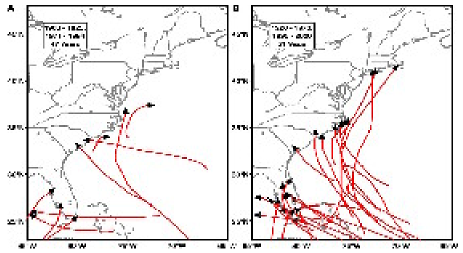
Issues for Actuaries: Frequency
Medium Term: US East Coast Hurricanes



Cold Phases

Warm Phase

Source: S. B. Goldenberg et al., Science 293, 474 -479 (2001).
Published by AAAS

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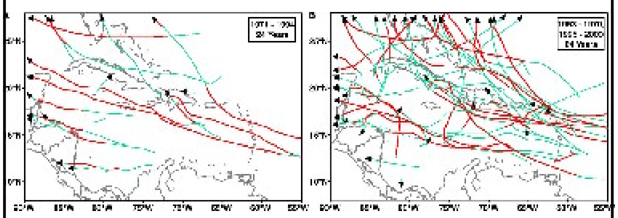
Issues for Actuaries: Frequency
Medium Term: Caribbean Hurricanes



Cold Phases

Warm Phases

Source: S. B. Goldenberg et al., Science 293, 474 -479 (2001).
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Issues for Actuaries: Frequency Long Term: Climate Change

- Evidence of gradual rise in tropical Sea Surface Temperatures (SST)
- http://climatechange.pbwiki.com/

Issues for Actuaries: Severity

- Traditional actuarial risk assessment approach based on historical observed losses not reliable
- Models start from historical basis but make allowances for:
  - Seismology, meteorology and hydrodynamics
  - Population movements
  - Structural and geotechnical engineering
- Severity allowance in models

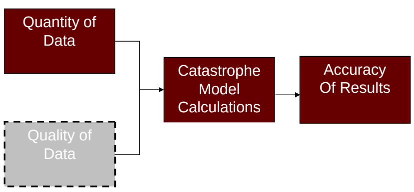
Issues for Actuaries: Severity - Demand Surge

- Sudden increase in construction costs following a catastrophe
- Causes:
  - Increased demand for construction materials and labour outstrips supply
  - Infrastructure damage and fuel prices may also add to accommodation and transport costs
  - Labour force itself may have been evacuated
  - Local building supplies / construction business also destroyed

Issues for Actuaries: Severity - Demand Surge

- Complexity in estimation:
  - Timing
  - Location
  - Correlations
    - Impact is affected by size of loss
    - More than one event in region
- Separate parameters for demand surge
  - Form of catastrophe models being amended – “loss amplification”
  - User input percentage increase in costs of repair/rebuild to enable testing of sensitivities

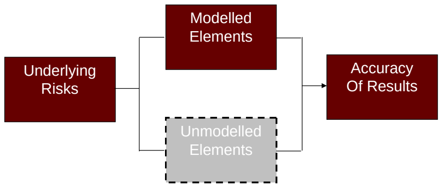
Issues for Actuaries: Exposure Data



Issues for Actuaries: Exposure Data

- Questionnaire on exposure data
- Some initial findings:
  - Wide variety in the quality and the effort spent collecting data
  - Quality of modelling depends on extent of data …. but exposure data better in countries where there are modelled perils
  - Size of datasets can be an issue
  - Need to consider how exposure will move over period
  - Location - level of granularity can greatly affect modelled losses
  - Sum Insured often underreported, this is commonly due to underestimate of inflation

Issues for Actuaries: Unmodelled Elements



Issues for Actuaries: Unmodelled Elements

- Unmodelled contracts in modelled classes (e.g. missing data)
- Unmodelled component of modelled contracts (e.g. missing locations in multi-location contract)
- Unmodelled classes with estimated percentage shares of industry loss (e.g. Retro, ILW)
- Unmodelled classes with PML estimation (e.g. Marine)
- Unmodelled unconsidered classes, where natural catastrophe exposure is not considered (FI)
- Unmodelled elements of a modelled loss (e.g. Storm surge)
- Unmodelled perils/territories (e.g. China earthquake)

Issues for Actuaries: Conclusions

- Understand the assumptions being made on your behalf
- Understand the data going into the model
- Catastrophe modelling is still a developing science
- Communicate: Catastrophe modelling team; Model providers; Underwriters; Management
- The catastrophe model is tools not the answer

2006 Hurricane Season: Predictions

- TROPICAL STORM RISK
- Saunders & Lea - UCL
- Prediction: 5th May 2006 (1995-2005 average)
- Named Tropical Storms: 14.6 (10.3)
- Hurricanes: 7.9 (6.2)
- Intense Hurricanes: 3.6 (2.7)
- US Landfalling Hurricanes: 2.1 (1.5)

2006 Hurricane Season: Predictions

- TROPICAL METEOROLOGY
- Klotzbach and Gray– Colorado State
- Prediction: 4th April 2006 (2005 actual)
- Named Tropical Storms: 17 (28)
- Hurricanes: 9 (15)
- Intense Hurricanes: 5 (7)
- Prob. of Cat 3-5 Landfalling in US: 81% (4)

2006 Hurricane Season: Storm Names

Alberto	**Beryl**	**Chris**	**Debby**
Ernesto	**Florence**	**Gordon**	**Helene**
Isaac	**Joyce**	**Kirk**	**Leslie**
Michael	**Nadine**	**Oscar**	Patty
Rafael	Sandy	Tony	Valerie
William			

2006 Hurricane Season: Useful links

FREQUENCY PREDICTIONS

- http://tsr.mssl.ucl.ac.uk/ (next forecast due early June)
- http://tropical.atmos.colostate.edu/ (next forecast due May 31st)
- http://www.nhc.noaa.gov/ (initial forecast due May 22nd)

HURRICANE TRACKERS

- http://forecast.mssl.ucl.ac.uk/shadow/tracker/dynamic/main.html
- http://hurricane.accuweather.com/hurricane/index.asp
- http://www.nhc.noaa.gov/

MODELLING FIRMS

- http://www.rms.com/ (new models due on May 19th)
- http://www.air-worldwide.com
- http://www.eqecat.com/

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