The Actuarial Profession
making financial sense of the future

Catastrophe Modelling Working Party
33rd Annual GIRO Convention

Catastrophe Modelling Working Party

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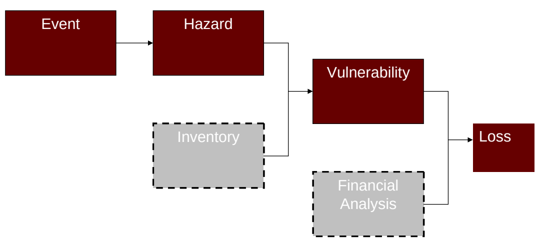
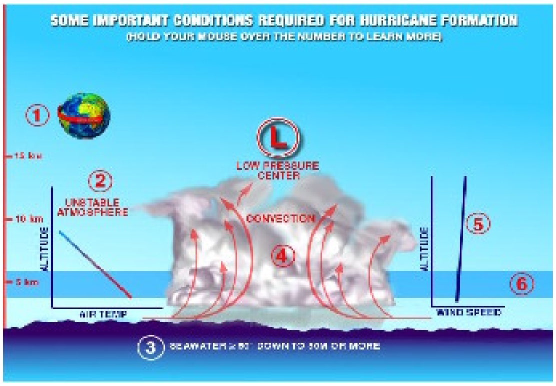
Components of Catastrophe Models



Uses of Catastrophe Models

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



Graphic: Source – NOAA (www.hurricanewaves.org)

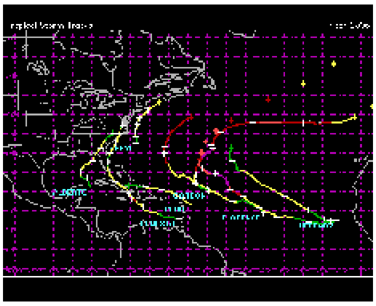
Atlantic Hurricanes : 2005 Season Records

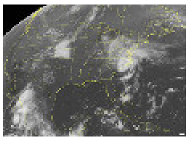
- The highest number of named storms – 27 (21 – 1933)
- The highest number of hurricanes – 15 (12 – 1969)
- The joint (with 1950) highest number of major hurricanes – 7
- The highest number of category 5 hurricanes – 4 Emily, Katrina, Rita, Wilma. (2 - 1960 and 1961)
- The highest number of intense hurricanes to make US Landfall – 4. (3: 1893, 1909, 1933, 1954 and 2004)
- The lowest pressure ever measured in the Atlantic basin – 882 mb Wilma. (888 mb Hurricane Gilbert in 1988)
- The highest damages both in aggregate and from a single storm – Katrina
- The most Easterly and Northerly tropical cyclone. Vince formed near Madeira and also became the first ever tropical storm to strike the Iberian peninsular

Atlantic Hurricanes: 2005 Season Summary

Graphic: Source – NASA

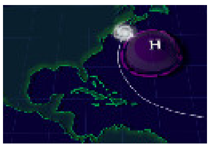
2006 Atlantic Season

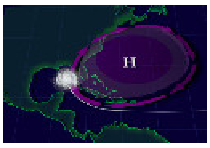


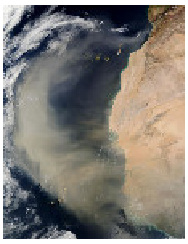


Graphic: Sources – weather.unisys.com, bbc.co.uk & NASA

2005 Season versus 2006 Season

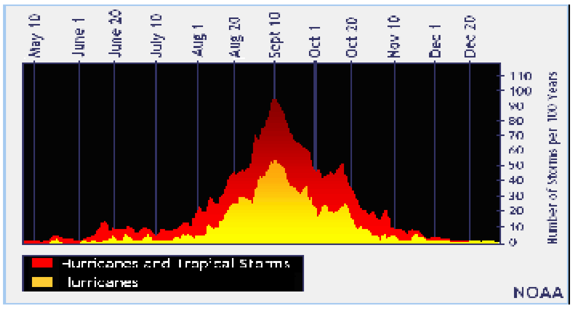






Graphic: Source – NOAA & www.climatescience.gov

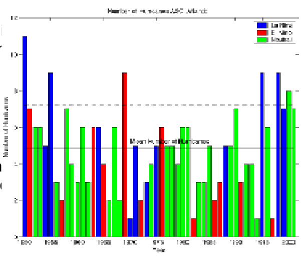
Atlantic Hurricane Season



Graphic: Source – NOAA

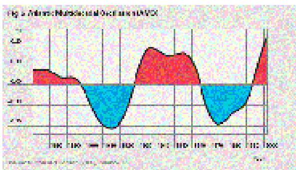
Frequency: Short Term - El Niño (ENSO)

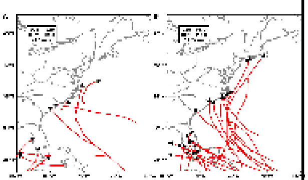
- El Niño Southern Oscillation
- El Niño (Boy child) originally described warm waters that formed some years off the coast of Ecuador and Peru near Christmas
- La Niña years are years with cooler than normal waters.
- Now recognised as a complex coupled oceanic (EN) and atmospheric (SO) phenomenon with wide ranging effects on world climate
- El Niño years associated with high vertical wind shear and lower hurricane formation in Atlantic
- Opposite in Pacific Basin



Graphic: Source - International Research Institute for Climate and Society

Frequency: Medium Term - AMO

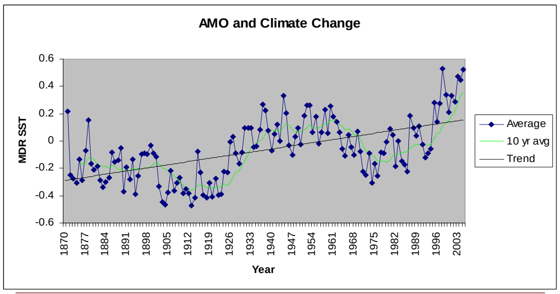




- Atlantic Multidecadal Oscillation
- Ongoing series of long-duration changes in the Sea Surface Temperature (SST) of the North Atlantic
- Cool and warm phases that may last for 15-40 years at a time – have been occuring for last 1000 years
- A difference of about 1°F (0.6°C) between extremes
- Cold phase 1970-1994
- Latest warm phase since 1995

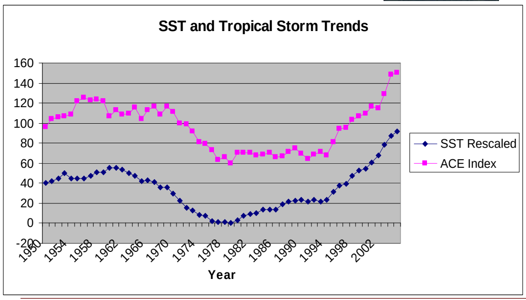
Graphic: Source: S. B. Goldenberg et al., Science 293, 474 -479 (2001). Published by AAAS

Frequency: Long Term – Climate Change



Graphic: Source – Working Party's own analysis

Frequency: Long Term – Climate Change



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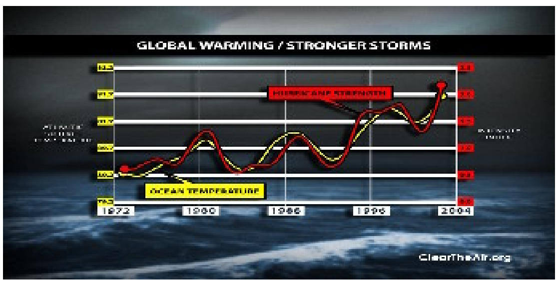
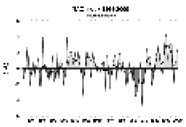
Frequency: Long Term – Climate Change



Graphic: Source – ClearTheAir.org following Emanuel (2005)

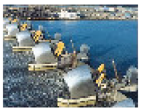
Uncertainties (Windstorm Frequency)

- Atlantic Hurricanes:
  - Data and research on landfalling hurricanes much sparser – but appears related to position of Bermuda High
  - ENSO: 1965 (Betsy), 1992 (Andrew), 2004 and 2005 were all either El Niño or neutral
  - AMO – latest reseach cast doubts on AMO theory and proferred an anthropological explanation
  - Role of climate change VERY controversial
- European Winter Storms (Extra tropical cyclones)
  - Influenced by North Atlantic Oscillation
  - High NAO index means anomalously strong high pressure centre in Azores or anomalously deep Icelandic low
  - High NAO leads to a wetter and windier North European storm season
  - NAO related to Bermuda High



Graphic: Source: http://www.cgd.ucar.edu/cas/jhurrell/publications.html

Uncertainties (Other Events)



- Storm surge
  - Uncertainty of climate change on sea levels (http://flood.firetree.net/)
  - Risk of UK East Coast windstorm coupled with London storm surge
  - Thames Barrier failure
- Seismic events - earthquakes
  - Two different models for time dependent estimation:
    Clustering (e.g. aftershocks)
    Seismic gap (stress build-up and release)
  - Some faults have few recorded major events – e.g. New Madrid 1811/1812

Severity & Demand Surge

- Models start from historical basis but implicitly or explicitly allow for:
  - Changed views on seismology, meteorology and hydrodynamics
  - Population trends and housing density changes
  - Updates on structural and geotechnical engineering
- Demand Surge
  - Following a catastrophe increased demand for construction material and labour, outstrips reduced supply
  - Mega/Super Catastrophes – infrastructure damage, cascading losses, social breakdown, policy coverage leakage, regulatory intervention amplify the effect
  - Complex to estimate: correlated with prior events and with size of loss
  - Dates from Edwardian times – San Francisco 1906 and …

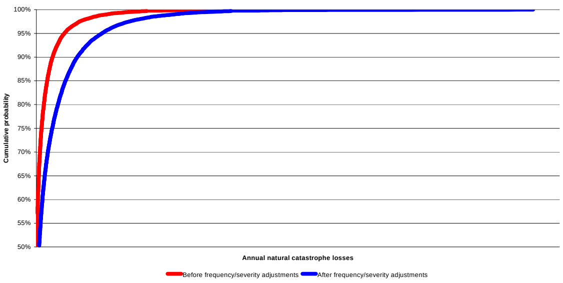
Demand Surge – nothing new!

Writ to John Pecche, the Mayor, Thomas de Lodelowe, the Recorder, and the Sheriffs:

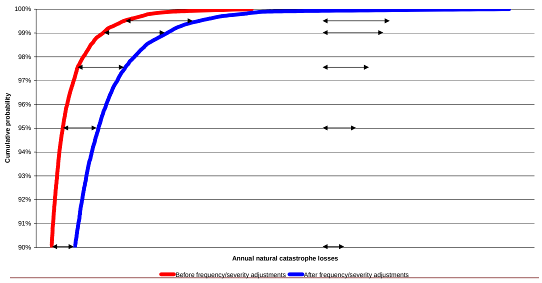
“to make proclamation forbidding tilers enhancing the price of tiles by pretext of the damage done by the recent tempest, and demanding higher wages for themselves and their servants”

Witness the King at Westminster, 28 March, 36 Edward III.
A.D. 1362

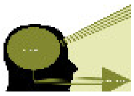
Frequency/Severity change impact



Frequency/Severity change impact

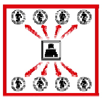


Other Issues



- Data (based on Interviews):
  - Huge amounts of data, very variable quality
  - Quality varies by peril and territory (e.g. quality of location data)
  - Quality varies by party doing the modelling
- Mathematical Approximations
  - Need to understand approximations made in model
- Model Structure
  - Detailed versus aggregate models
- Unmodelled elements
  - Unmodelled contracts in modelled classes
  - Unmodelled component of modelled contracts
  - Unmodelled classes
  - Unmodelled elements of a modelled loss - flood
  - Unmodelled perils/territories

Communication



- Catastrophe modelling teams: completeness and quality of data; assumptions where data incomplete
- Catastrophe model providers: inherent assumptions (e.g. for frequency and severity issues); modelling methodologies used; mathematical approximations
- Underwriters: reasonability checks; how the catastrophe modelling output interacts with other underwriting considerations
- Users of actuarial output based on catastrophe models: communicate the uncertainty involved; the assumptions made in modelling; additional assumptions the actuary has made in using the modelled outputs

Conclusions

- **C**OMMUNICATE **–** with your model providers, with the modelling team, with underwriters, with management
- **A**SSUMPTIONS **–** understand and communicate the assumptions being made on your behalf as well as those you are making
- **T**OOL **–** Catastrophe models are a useful tool (and a developing one) they are not the answer
- **S**CIENCE **–** understand the science