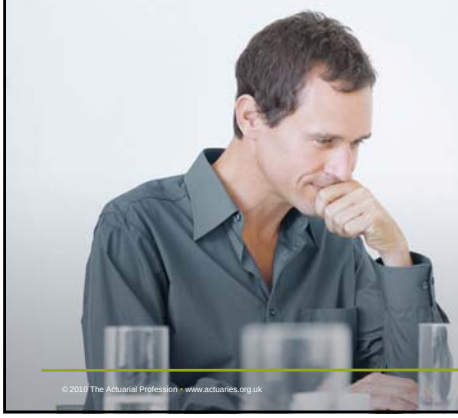
The Actuarial Profession
making financial sense of the future

The latest issues surrounding catastrophe modelling
Trevor Maynard



Value of seasonal hurricane forecasting

29 March 2011

Agenda

- Weather matters
- Forecasting – current capabilities
- Insurance considerations
- What might the future hold?

Weather matters

Some facts and stats

x 7

- 1960 - 1990 number of natural catastrophes doubled…
  …. **insured losses increased nearly seven times**.
- Due (in part) to increased population in risky areas…
  …but also due to an increase in the level of risk.
- 2005 was the worst year ever for property insurers
  - USD 95 bn dollars relates to the US hurricanes alone
  - the Lloyd's incurred claims of USD 6 bn to help people hit by Hurricanes Katrina, Rita, and Wilma.

Table 12
The 40 most costly insurance losses 1970–2009

Insured loss[10] (in USD m, indexed to 2009)	Victims[11]	Date (start)	Event	Country
71 163	1836	25.08.2005	Hurricane Katrina: floods, dams burst, damage to oil rigs	US, Gulf of Mexico, Bahamas, North Atlantic
24479	43	23.08.1992	Hurricane Andrew: floods	US, Bahamas
22767	2982	11.09.2001	Terror attack on WTC, Pentagon and other buildings	US
20276	61	17.01.1994	Northridge earthquake (M 6.6)	US
19940	136	06.09.2008	Hurricane Ike: floods, offshore damage	US, Caribbean, Gulf of Mexico et al
14642	124	02.09.2004	Hurricane Ivan: damage to oil rigs	US, Caribbean: Barbados et al
13807	35	19.10.2005	Hurricane Wilma: floods	US, Mexico, Jamaica, Haiti et al
11089	34	20.09.2005	Hurricane Rita: floods, damage to oil rigs	US, Gulf of Mexico, Cuba
9148	24	11.08.2004	Hurricane Charley: floods	US, Cuba, Jamaica et al
8899	51	27.09.1991	Typhoon Mireille/No 19	Japan
7916	71	15.09.1989	Hurricane Hugo	US, Puerto Rico et al
7672	95	25.01.1990	Winter storm Daria	France, UK, Belgium, NL et al
7475	110	25.12.1999	Winter storm Lothar	Switzerland, UK, France et al
6300	54	18.01.2007	Winter storm Kyrill: floods	Germany, UK, NL, Belgium et al
5857	22	15.10.1987	Storm and floods in Europe	France, UK, Netherlands et al
5848	38	26.08.2004	Hurricane Frances	US, Bahamas
5242	64	25.02.1990	Winter storm Vivian	Europe
5206	26	22.09.1999	Typhoon Bart/No 18	Japan
4649	600	20.09.1998	Hurricane Georges: floods	US, Caribbean
4369	41	05.06.2001	Tropical storm Allison: floods	US
4321	3034	13.09.2004	Hurricane Jeanne: floods, landslides	US, Caribbean: Haiti et al
4074	45	06.09.2004	Typhoon Songda/No 18	Japan, South Korea
3988	135	26.08.2008	Hurricane Gustav: floods, offshore damage	US, Caribbean: Gulf of Mexico et al
3740	45	02.05.2003	Thunderstorms, tornadoes, hail	US
3637	70	10.09.1999	Hurricane Floyd: floods	US, Bahamas, Colombia
3631	167	06.07.1988	Explosion on platform Piper Alpha	UK
3530	59	01.10.1995	Hurricane Opal: floods	US, Mexico, Gulf of Mexico
3482	6425	17.01.1995	Great Hanshin earthquake (M 7.2) in Kobe	Japan
3372	25	24.01.2009	Winter storm Klaus	France, Spain
3093	46	27.12.1999	Winter storm Martin	Spain, France, Switzerland
2917	246	10.03.1993	Blizzard, tornadoes, floods	US, Canada, Mexico, Cuba
2755	38	06.08.2002	Severe floods	UK, Spain, Germany, Austria et al
2680	26	20.10.1991	Forest fires which spread to urban areas, drought	US
2667	–	06.04.2001	Hail, floods and tornadoes	US
2575	4	25.06.2007	Heavy rainfall, floods	UK
2540	30	18.09.2003	Hurricane Isabel	US, Canada
2488	39	05.09.1996	Hurricane Fran	US
2454	20	03.12.1999	Winter storm Anatol	Denmark, Sweden, UK et al
2448	4	11.09.1992	Hurricane Iniki	US, North Pacific Ocean
2361	–	29.08.1979	Hurricane Frederic	US

Chile EQ

New Zealand EQ

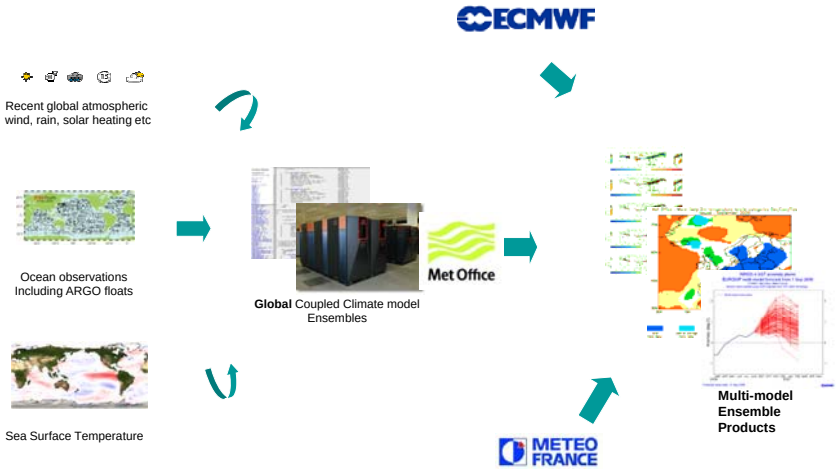
Winter Storm Xynthia

2010 update:
Source Munich RE

© Lloyd's 12 Source: Swiss Re, sigma catastrophe database

Forecasting
Current capabilities

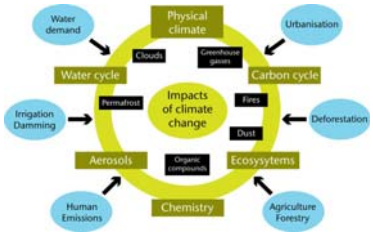
How is forecasting carried out?



 See Vitart et al 2007

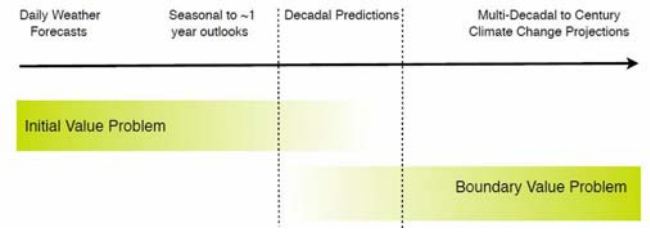
How is forecasting carried out?

- WMO: 11 "Global Producing centres"
- Limiting factor - Computing power
  - **Resolution** (2x horizontal needs 8x power)
  - **Complexity** (e.g. currently models don't include the stratosphere; needed for EUWS)
  - **Size of ensemble** (GloSea4 has 42)
  - **Number of hindcasts/calibration**
  - **Forecast initialisation**



Certainty and the role of chaos

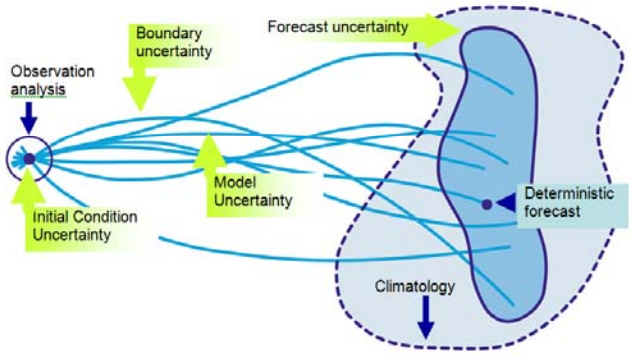
- Boundaries (fixed for daily forecasts):
  - Ocean/land surface temperature
  - Atmospheric constituents and radiative properties
  - Solar irradiance



http://en.wikipedia.org/wiki/File:Lorenz_attractor_yb.svg

Certainty and the role of chaos

- Chaos =>
  - cannot forecast with certainty
  - ranges may still be predictable – and useful
  - ensembles/ multi-model ensembles



How are long range forecasts possible?

- Oceans store heat which leads to system memory
  - Top 3 meters hold more than entire atmosphere
  - Additional solar heating at tropics flows to poles
  - 50% of this is moved (slowly) by the oceans
- Other features with memory
  - Land and surface vegetation
  - Snow and ice
  - Aerosols
  - All persist and evolve; influencing climate over months/weeks/years
- Natural modes and cycles
  - Coupled ocean/atmospheric effects
  - e.g Day/Night, Seasons, El-Nino

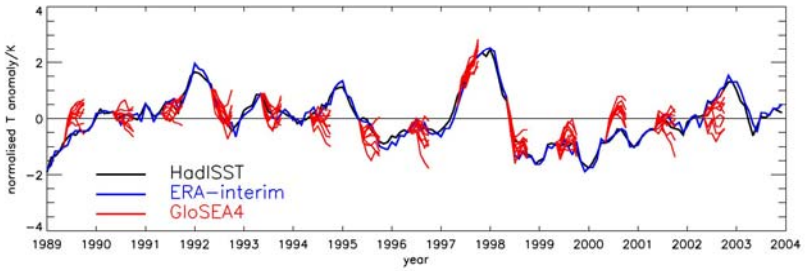
How are long range forecasts possible?

- El-nino – globally important
  - Atlantic tropical cyclones
  - Australia – bush fires (El-Nino) / flooding (La- Nina)
  - European winters (El-Nino => moderate)
- Understanding physical characteristics =>
  - Hierarchy of predictable phenomena
  - More skill than traditional statistical forecasts
  - Allow for complex, non-linear interactions

Measuring skill – how good are the forecasts?

- Anomaly correlation coefficients (ACC)
- Root mean square error
- Ignorance
- Weather roulette – equivalent interest rates
- Brier skill score

http://en.wikipedia.org/wiki/File:Roulette_-_detail.jpg



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What can be done well at present?

- Pacific SSTs – 6 months ahead
(ACC = 0.86)
- Atlantic TC basin frequency from 1/6
(ACC = 0.81, compared to statistical forecasts ACC=0.39)
- Atlantic TC basin frequency from 1/11
(ACC=0.4)
- Average TC basin frequency over 5 years
(ACC=0.75 compared to ACC=0.4 for 5 year running mean)
- *All* are more skilful than climateology
- Many become *more* skilful in years with a significant event

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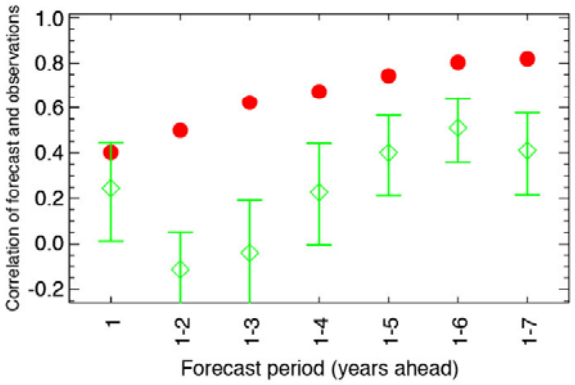
Atlantic tropical cyclones – beyond seasonal

- Using Met office model DePreSys…
  - = ACC for model
  - = 5 year running mean
- Recent increase in activity not just caused by natural variation
  - GHGs - manmade
  - Aerosols - manmade
  - Solar/ Volcano



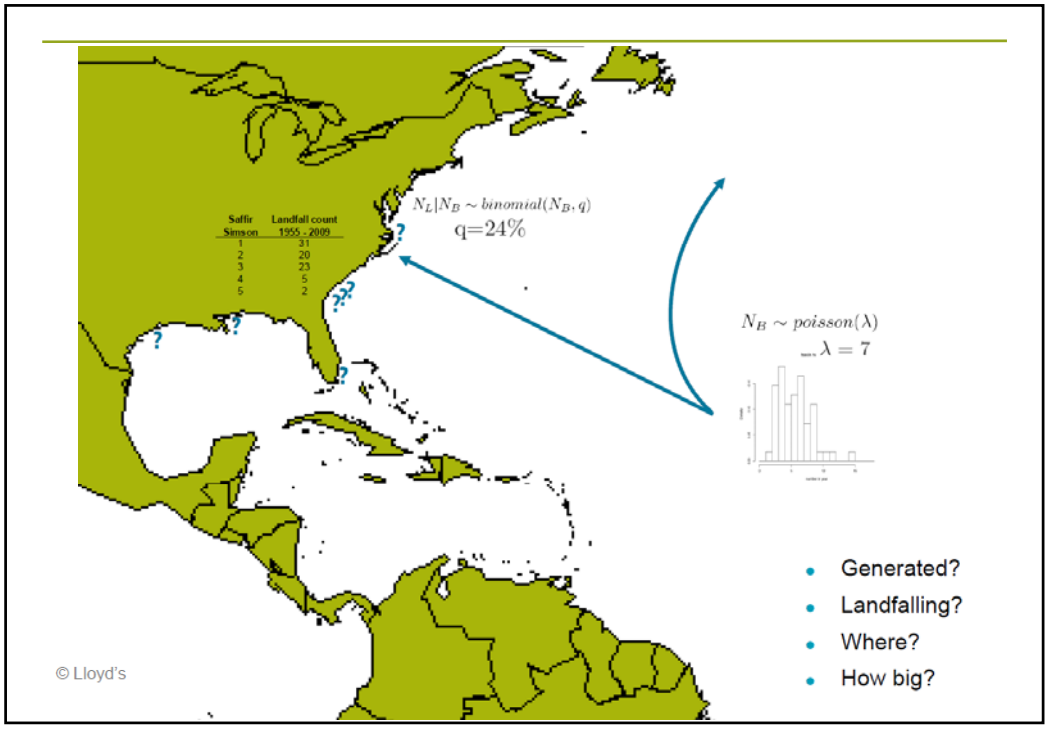
Insurance considerations

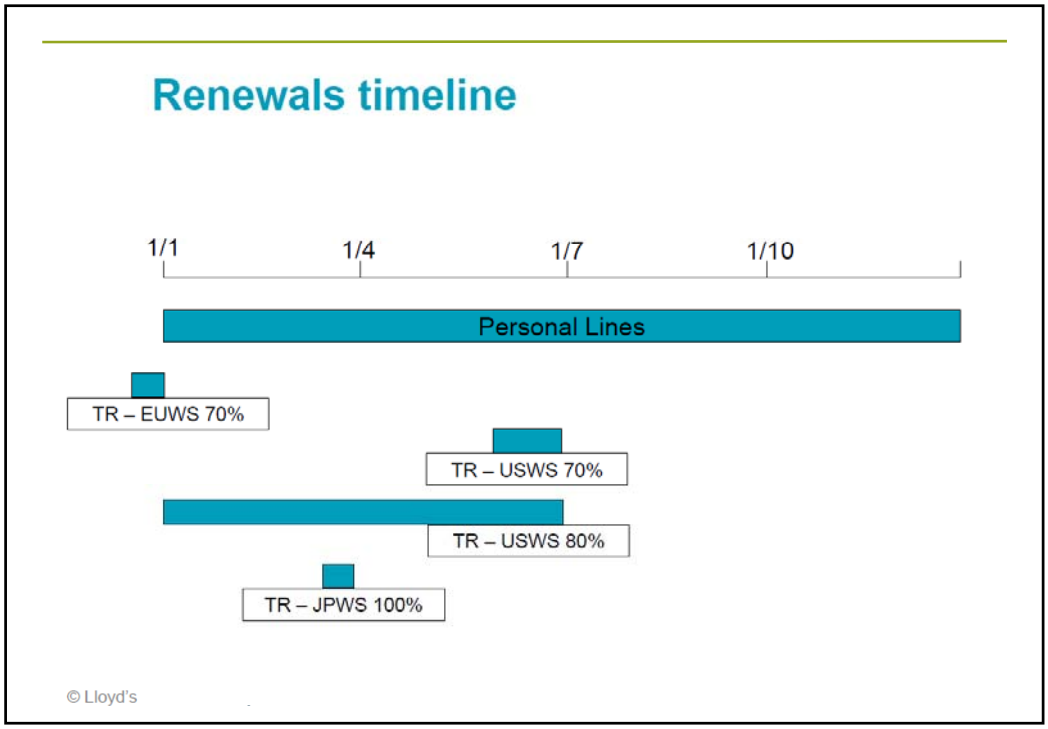
The "near term" view

- Catastrophe modelling companies have offered conditional models
- Variety of names:
  - "Near term"
  - Warm SST conditioned
  - "Medium term"
- Typically a 5 year average
- Variety of procedures
  - Expert elicitation
  - Internal view
  - Weighted Ensemble Average

Behavioural issues

- Lloyd's convened working group of: UWs Cat modellers Brokers Research Scientists.
- Hurricane Andrew tipping point …
  … step changes as belief grows.
- Financial crisis "now is not the time for new ideas"…
  … OR "now is the time to inject more science"?
- General agreement: "*we should not use a long term average – when a better short term forecast is available.*"
- Relationship based market – early adopters don't always gain…
  …but we can scale line size etc.
- People "feel" forecasts should have value….
  …but "you only need one [catastrophe]"
- Key driver "will the market judge you well?"


Saffir Simpson
Landfall count 1955 - 2009
1 31
2 20
3 23
4 5
5 2
$N_L|N_B \sim binomial(N_B, q)$
q=24%
$N_B \sim poisson(\lambda)$
$\lambda = 7$
Generated?
Landfalling?
Where?
How big?
© Lloyd's


Renewals timeline
1/1
1/4
1/7
1/10
Personal Lines
TR – EUWS 70%
TR – USWS 70%
TR – USWS 80%
TR – JPWS 100%
© Lloyd's

User focussed forecasting

- E.g. landfalling hurricanes – where? How big?
- Produce psuedo "storms" that fit with (open) cat models?
- "Skill" scores
  … based on end-user utility
  … insurers would value education on this
- Extremes are key (but often hardest to model)
- Communicate uncertainty
  - Resolving local scale – only if it is really skilful – there is a big danger in "spurious accuracy"
  - Mindful of disturbing features – e.g. volcanoes

Mid season "optimisation"

- Pre-season preparation
- Mid year hedging products – for customers
- Portfolio rebalancing for insurers

Multi-year considerations

- These remarks in context….
  …. typical strategy 3 years
- Pre-purchase materials? Resilience vs Optimal
- Inform building codes/ design standards
- Pre-decade preparation
- Tele-connections – changes in dependency in year
- Value of Climate Change Adaptation
- Social issues – impact of climate and man made issues (political unrest etc)

Social and other issues

- There is a lack of symmetry between positive and negative outcomes.
  - Can't expose capital too far
  - Simple modelling suggests differential pricing could be *less* profitable; but may need less capital?
- Is more volatile pricing desirable?
- Formulaic use of forecasts – leads to systemic risk?
- Danger of too-accurate forecasts?

What might the future hold?

How good will forecasts be in 5-10 years?

- IPCC process is leading to rapid advancement
- Continued collaboration between governments essential
- Deeper understanding of physical processes
- Higher resolution
- Understanding teleconnections
- Focus on insurance relevant issues – e.g. landfalling storms

In summary…

- Weather matters
- Forecasting becoming ever more sophisticated
- Physical processes and memory => skill
- But…
  … significant residual uncertainty
- Many behavioural factors will affect uptake amongst insurers

Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.