The Actuarial Profession
making financial sense of the future

ICA Modelling Seminar

Parameter Uncertainty

Peter Tavner, Gavin Hill, Trevor Maynard

Agenda

- Introduction
- Catastrophe Modelling
- Specific areas of uncertainty

Introduction

Uncertainty: the problem

- We have been asked to calculate remote scenarios
- We have:
  - limited data
  - some theory
  - some tools
  - our actuarial judgement
  - ..and lots of ‘expert opinion’
- In the context of a 99.5% CI, we can never say with certainty that the ICA number is ‘correct’
- …but how far out are we?

The response so far?

The response so far?

- Many ICAs do not fully acknowledge the issue of uncertainty. Why not?
  - Insufficient awareness of tools and methods
  - Insufficient data in first place => guesstimates
  - Difficult to sell internally
  - Other priorities
  - Likely to increase the number!
- Are actuaries in danger of over-promising?

Drivers of Uncertainty

- Parameter Uncertainty
  - Specific to our data sample
  - Beyond the data
- Model error
- Convergence error, process error

Parameter uncertainty

- Parameter estimate is based on population sample
- It will always be an estimate, hence uncertain
- Different estimation methods will give different answers e.g.
  - Maximum likelihood
  - Method of moments
- But you do need some data in first place! ☺

Identifying Parameter Uncertainty

- Keeping it simple: back test the results
- Conventional statistical methods
  - Confidence intervals
  - Goodness of fit tests
  - Asymptotic distribution of ML estimator
- Bayesian approach

Note: explicitly incorporating parameter uncertainty can materially impact distributions

Parameter Uncertainty (2)

- Beyond the data: is the past a reliable guide to the future?
  - Regulatory/legal changes e.g. Ogden
  - Latent claims

- Very difficult to capture explicitly
- Sensitivity test the results

Other sources

- Model Error
  - The best fit may not be the true underlying
  - Over-parameterisation can be an issue

- Convergence
  - 10,000 sims may be insufficient
  - Problem worse with risk measures that look further into tail
  - Technical solutions available: stratified/importance sampling

What the guidance says

- FSA sector briefing (Nov 2005):

  "important that firms recognise the issue"

  "that uncertainty is adequately communicated"

  "not appropriate to ignore this risk"

- Lloyd's:

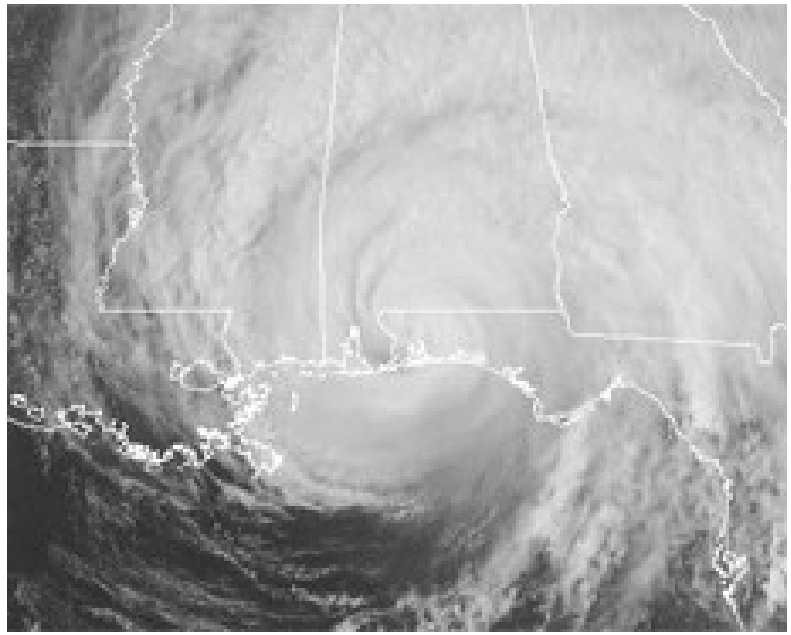
  "Adopt prudent assumptions to compensate for known shortcomings including parameter uncertainty"

The bigger picture

- ICAS is not just about the number, it is also the framework
  - Remember the ICA process is intended as a tool to inform management
  - Use statistical methods (and judgement) to *identify* risk areas and weaknesses
  - Communication important : better to flag areas of uncertainty than do nothing
  - Keep the ICA strictly ‘best estimate’? Discuss

Catastrophe modelling

- Parameter Uncertainty



Types of uncertainty

- Aleatory
  - inherent randomness
  - cannot be reduced by collation of additional data
- Epistemic
  - lack of information/understanding
  - can be reduced

- Useful concepts

Epistemic sources

- Hazard data is scarce!
  - a few hundred years at most
  - of very low probability events
- Limited scientific knowledge
- Cross disciplinary nature
  - Actuaries
  - Structural Engineers
  - Climate Scientists/ Seismologists

(more) epistemic sources

- Exposure data
  - often poor – lack of GIS data
  - but important
    - E.g soil type can vary within small area but
    - crucial for earthquake damage
  - Insured values often uncertain

- Damage functions
  - Based on laboratory models
  - Models within models!

GIS = Geographic Information Systems = geographically referenced data

General Comments

- Knowledge wave; modelling wave (lag) –
  - Find out what's known
  - Ask your modelling company their view
- Modelling Co's are "silent" on this
- Some of the parameter uncertainty is built in
  - secondary uncertainty
  - damageability factors
- Understand the choices they have made on your behalf
  - E.g. RMS near term view/ AIR long baseline

FCHLPM scenarios

Event ID	SSI	Central Pressure (mb)	Radius of Max Winds (mi.)	Forward Speed (mph)	Landfall Latitude	Landfall Longitude	Landfall Location
1	5	913.5	8	15	30.3	-81.4	Jacksonville
2	4	930.7	10	15	30.3	-81.4	Jacksonville
3	3	956.4	12	15	30.3	-81.4	Jacksonville
4	2	973.5	15	15	30.3	-81.4	Jacksonville
….							
30	1	982.1	15	15	30.1	-85.8	Panama City

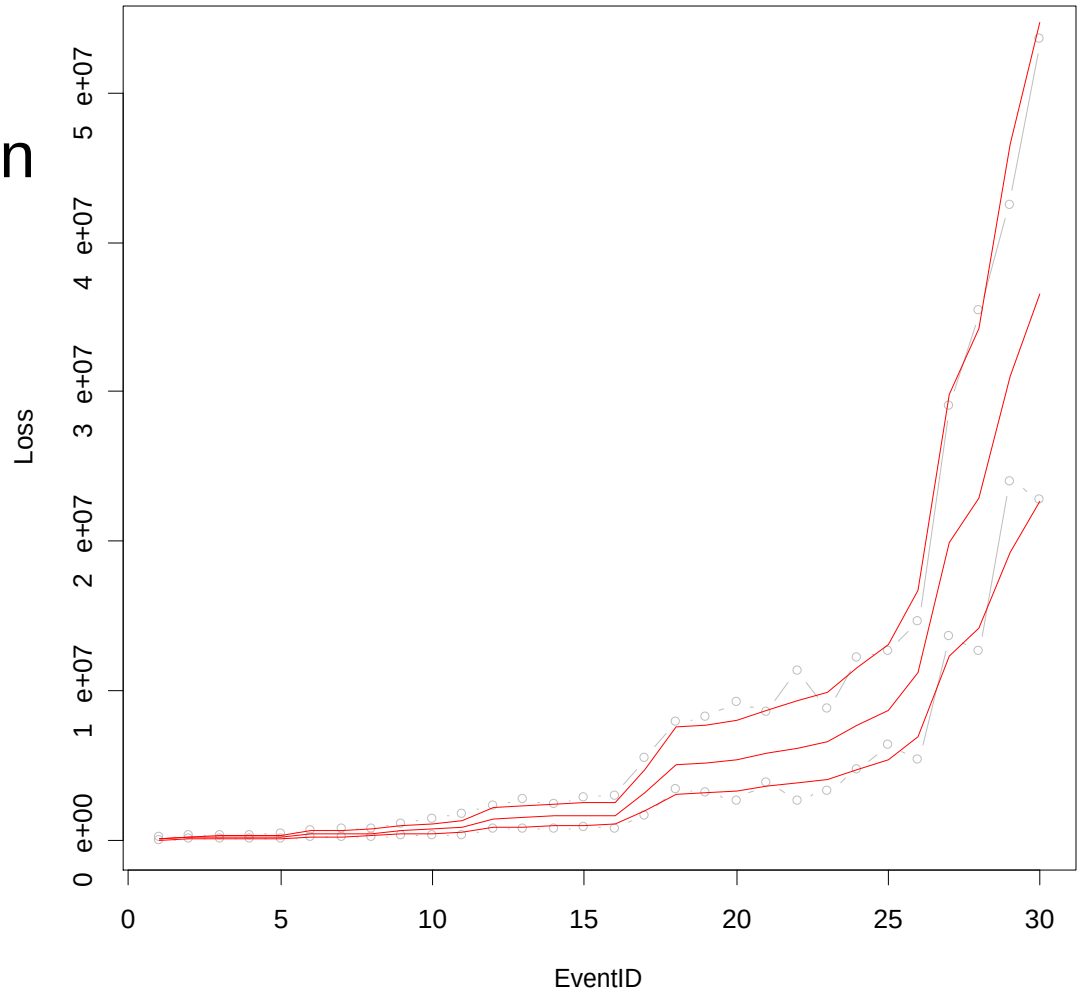
- For certification
- 4 model companies complete returns
- Public results

FCHLPM scenarios - results

AIR	ARA	Eqecat	RMS
5,387,021	13,579,563	14,619,000	11,244,471
3,369,452	8,774,355	8,397,000	5,964,194
736,047	1,742,091	2,433,000	1,652,508
208,825	379,178	629,000	498,050
…….			
32,330	57,075	209,000	115,176

FCHLPM scenarios - results

- Average range 62% to 150% of mean
- Is your ICA result that uncertain?
- Different models give very different results
- The science is not exact!!!



Parameter risk can be huge.

- Ground up losses
- 3 models + Wharton School
- 99.5%ile
  - $0bn, or
  - $3bn!!
- Why?
  - No data

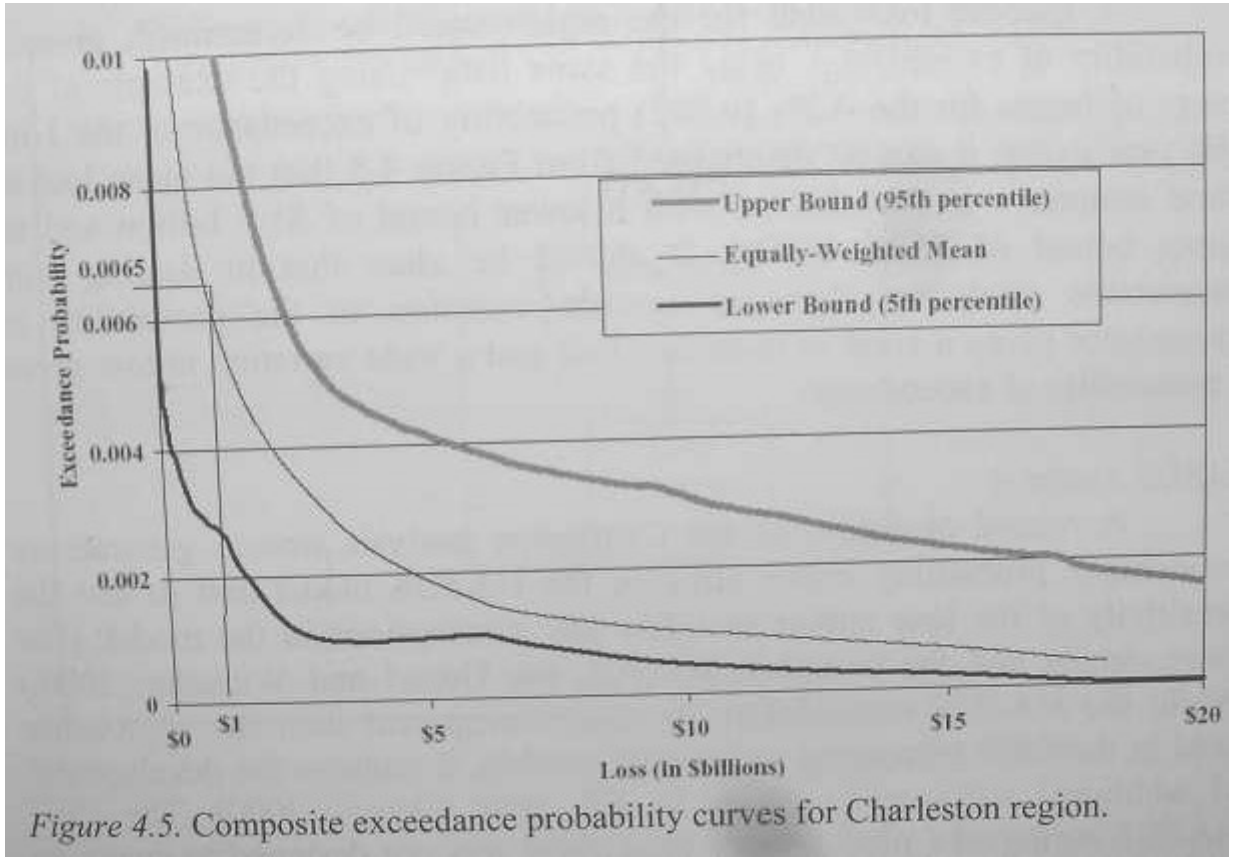


Figure 4.5. Composite exceedance probability curves for Charleston region.

Source: Grossi and Kunreuther. Catastrophe Modelling, Springer 0-387-23082-3

“ A little knowledge is a dangerous thing; drink deep, or taste not the Pierian Spring: there shallow draughts intoxicate the brain, and drinking deeply sobers us again”

Alexander Pope – an essay on Criticism 1709

Catastrophe modelling

- Climate change

"Climate change poses risks to a large number of general insurers….it became apparent that some ***firms may rely too much*** *on the output of their catastrophe models without proper consideration of the inputs….it is imperative that firms address this issue Urgently"*

FSA Financial Risk Outlook 2006

http://www.fsa.gov.uk/pubs/plan/financial_risk_outlook_2006.pdf

*"….it is **not acceptable to wait** until the effects of the trend are well understood before commenting on the possible implications… consider scientific evidence on climate change with regards to parameter setting"*

Lloyds ICA guidance 2006

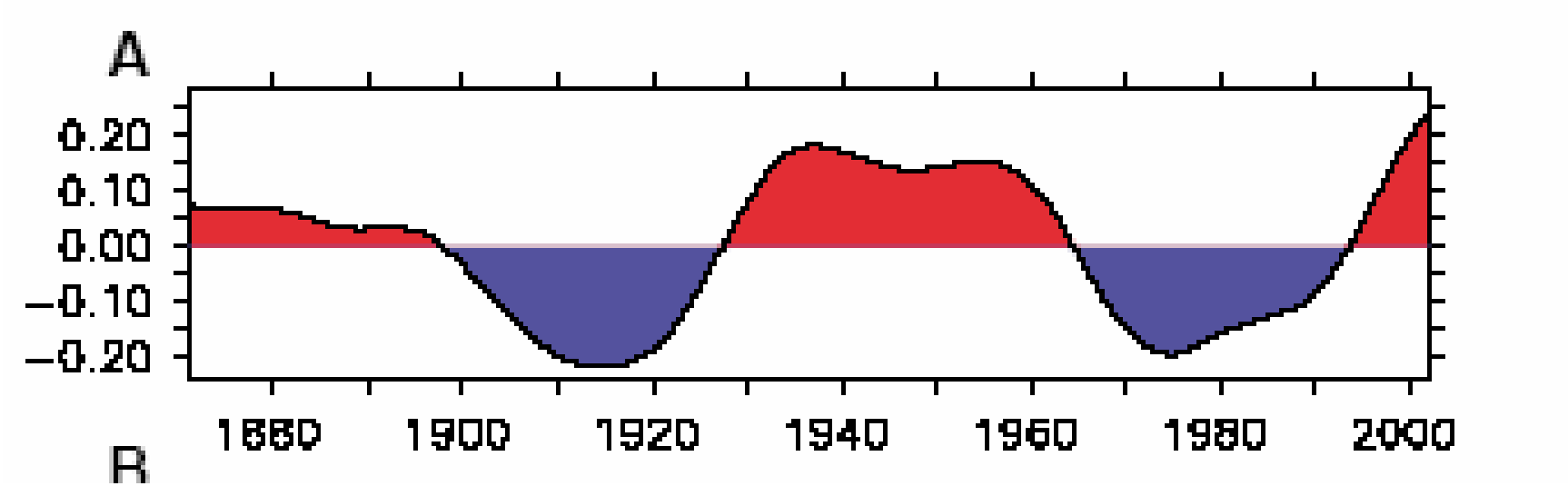
http://www.lloyds.com/

Why wait?

There is no justifiable reason any more:

- Climate change is happening
- Even the (sane) sceptics agree
- There is sufficient information to do something

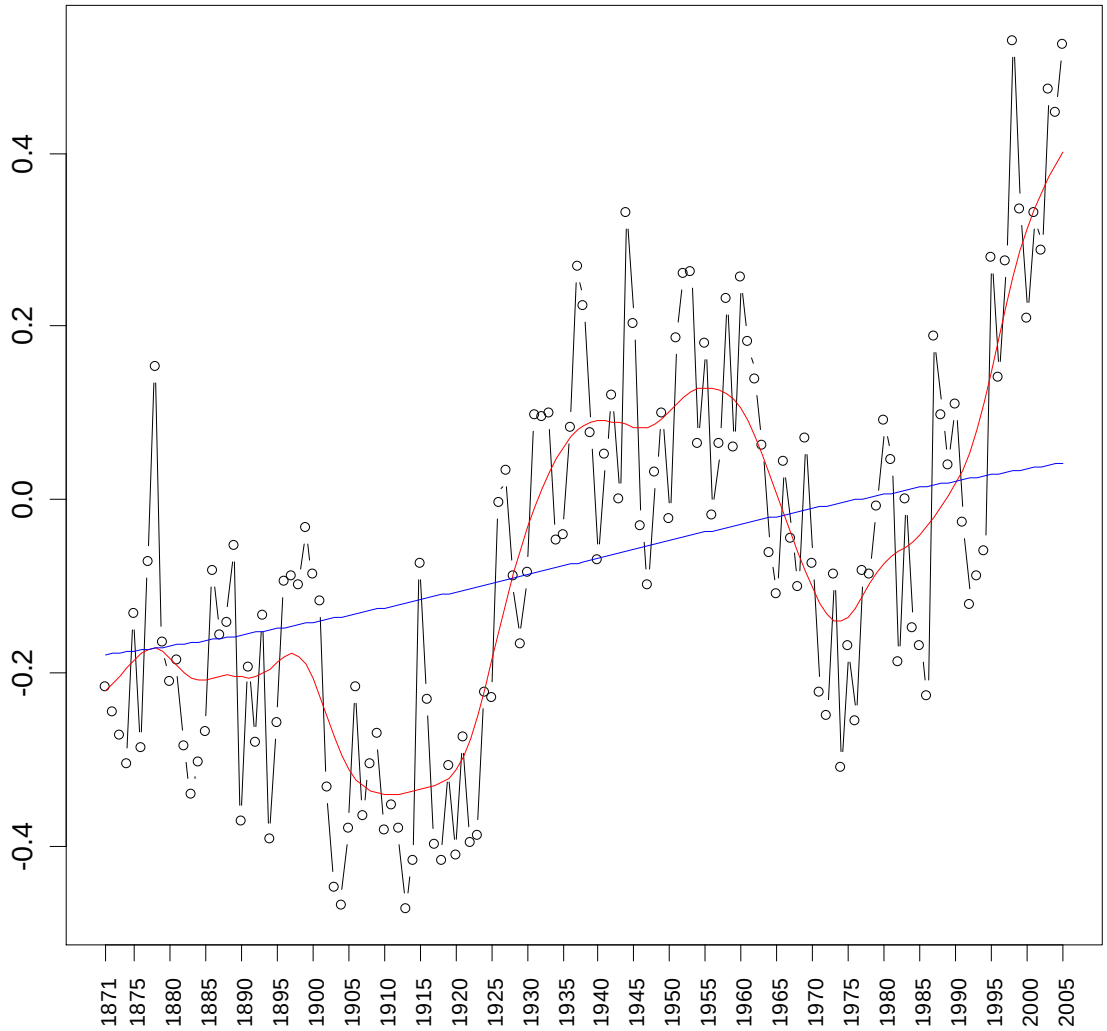
The AMO



or is it?…….

Source: Atlantic Ocean Forcing of North American and European Summer Climate
Rowan T. Sutton and Daniel L. R. Hodson*

The AMO


0.4
0.2
0.0
-0.2
-0.4
1871
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1915
1920
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1945
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1955
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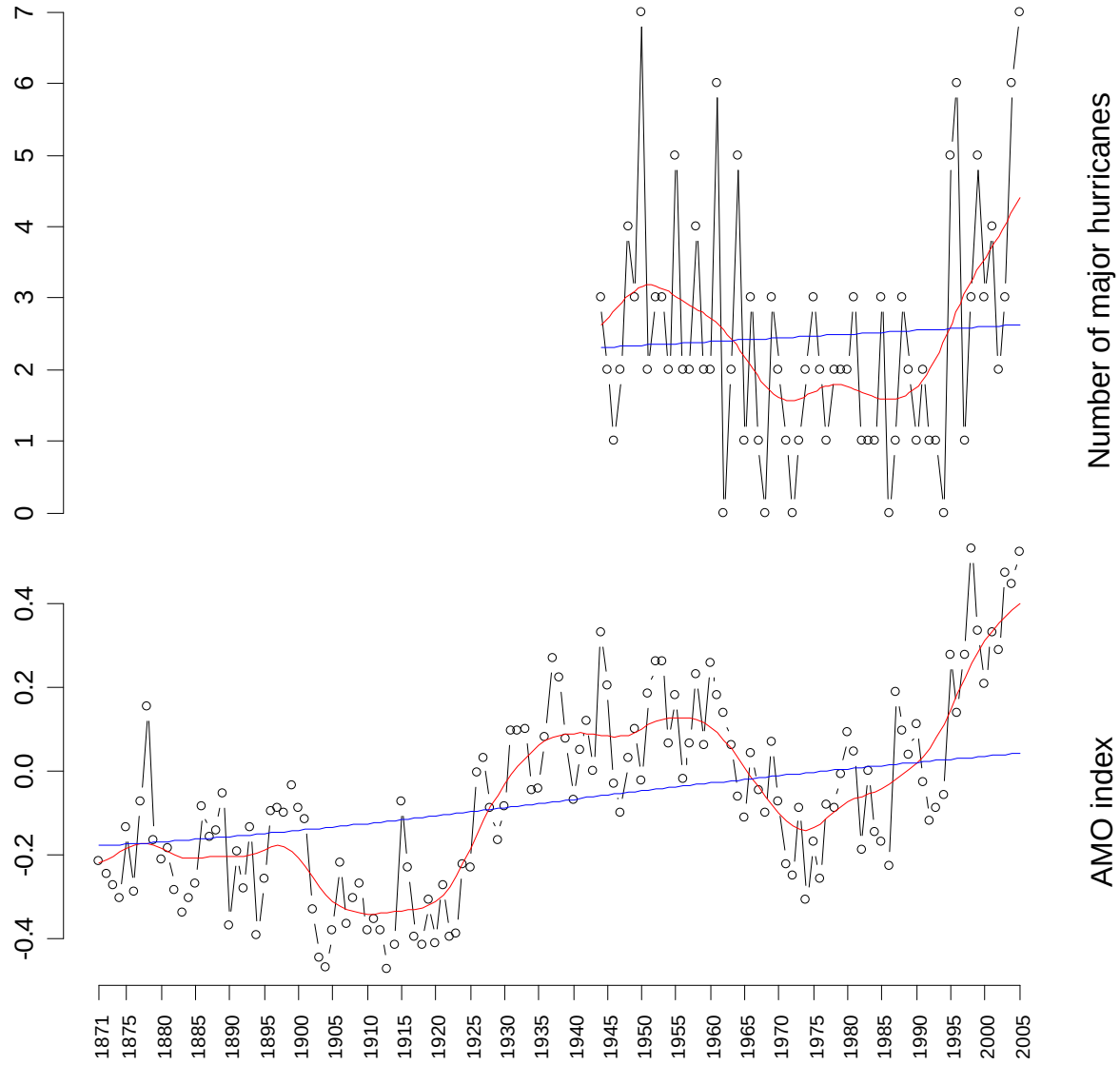
2000
2005

Means

- cycle 2.46
- high mode 3.18
- low mode 1.91



Simple model

- Hurricane formation rate 3.18/2.46-1 = 29% above average (could say 4/2.46)
- Assume constant landfall proportion (25%)
  - From NHC data
  - debatable
  - probably higher in hot phase
- Assume poisson landfall process, X_t
- Assume capital proportionate to 95%ile of X_t

=> Required Capital increases by 20%

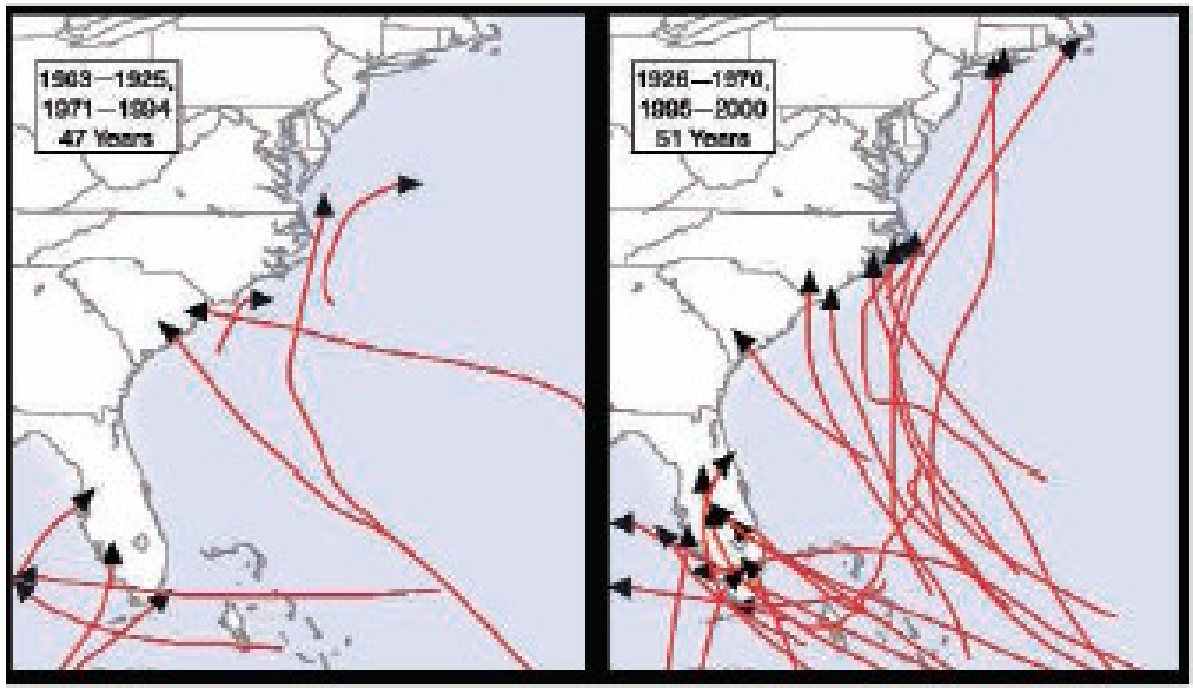
Intense Hurricane Risk

“we don’t know the right answer….”

- Correct
- But zero is definitely the *wrong* answer
- Uncertainty = risk…
  - Volatility has increased
  - Price (& capital requirement) goes up

The data is out there

climatechange.pbwiki.com/DataSources



Specific areas of uncertainty

Areas we will cover

- Sensitivity testing
- Data considerations
- Insurance risk
- Credit risk
- Operational risk
- Market risk
- Stress and scenario tests

Sensitivity testing

How does parameter uncertainty apply here?

- Identification of key parameters
- What is the impact of changing key parameters
- Correlation levels
- Communication – separating theory and practical implementation

Data considerations

Are there different / new data considerations in the ICA environment, compared to reserving?

- Data outliers
- What is the impact of one year of extra data?

Insurance risk

Observations

- Best practice splits underwriting risk, reserve risk and reinsurance risk
- Underwriting risk can be further split between claims risks and pricing risks
- Claims risks can be further split between attritional losses, large losses and catastrophic losses

Insurance risk

Reserve risk

- Allowing ultimate reserve uncertainty to emerge
  - Need to allow for relevant reinsurance?
- When is bootstrapping paid claims a reasonable approach to estimating reserve risk?

Insurance risk

Underwriting risk

- Separating underlying attritional loss ratio volatility from pricing volatility
- What is a ‘1 in 200’ level of catastrophe?
- What is the uncertainty surrounding this?
- What is a ‘1 in 200’ level of large loss?
  - What is a ‘1 in 200’ motor large loss?

Insurance risk

Long tailed lines of business / liability business

- What is the appropriate amount of uncertainty to allow for when considering long tailed liability account reserves, eg Asbestos
- What allowance should be made for future latent claims?

Credit risk

Which things need consideration?

- Investment credit risk
- Counterparty credit risk
  - Where does materiality let us stop?
  - Allowance for reinsurance credit risk ‘to ultimate’
  - Ripple effects - Increased risk following major insurance event (increase in probability and exposure)
- How to treat ‘binary’ events

Operational risk

- ‘Most operational risks eventually manifest themselves within historic (claims) data – our parameterisation includes Op risk implicitly’
  - Is this a reasonable claim?
- Use of risk registers to populate stress test models of Op risk
- Defined benefit pension scheme ICA requirement
- Is a simple percentage loading for Op risk reasonable?
- Avoiding double counting / excessive prudence

Market risk

- Valuation basis
- Allowance for discounting
- Parameter uncertainty
- Market consistency
- Use of an ESG versus self derived models
- Investment policy – designed for which basis?
- Materiality

Stress and scenario tests

- Typical use – stress tests to derive capital requirement, scenario tests for testing
- Ensuring consistency between probabilities for different stress tests
- Evaluation of expected and maximum costs for stress tested events
- What is a reasonable objective when using stress tests
- Use of model output to inform stress/scenario tests
- Aggregation of stress test results