The Modeler's Mantra

This is the best available information, so it must be of value.
Everyone knows the limitations. Everyone understands the implications of these assumptions.
This is better than nothing.
No one has proven this is wrong.
There is no systematic error, on average. The systematic errors don't matter.
The systematic errors are accounted for in the post processing.
Normality is always a good first approximation. In the limit, it has to be normally distributed, at least approximately.
Everyone assumes it is normally distributed to start with.
Everyone makes approximations like that.
Everyone makes this approximation.
We have more advanced techniques to account for that.
The users demand this. The users will not listen to us unless we give them the level of detail they ask for.
We must keep the users on-board.
If we do not do this, the user will try and do it themselves.
There is a commercial need for this information, and it is better supplied by us than some cowboy.
Refusing to answer a question is answering the question.
Refusing to use a model is still using a model.
Even if you deny you have a subjective probability, you still have one. All probabilities are subjective.
The model just translates your uncertainty in the inputs to your rational uncertainty in the future.
Sure this model is not perfect, but it is not useless.
No model is perfect.
No model is useless if interpreted correctly. It is easy to criticise.
This model is based on fundamental physics.
The probabilities follow from the latest developments in Bayesian statistics.
Think of the damage a decision maker might do without these numbers.
Any rational user will agree.
Things will get better with time, we are making real progress.
You have to start somewhere. What else can we do? It might work, can you deny that?
What damage will it do?

I have taught real-world mathematical modelling courses for over a decade: I now urge students to pause, should they ever hear themselves utter one of these…

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What damage will it do?

Those in yellow I have heard uttered with respect to UKCIP08, et al.

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The Munich Re Programme: *Evaluating the Economics of Climate Risks and Opportunities in the Insurance Sector*

Climate Models and Their Information Content for the Insurance Industry

Leonard A Smith with Nicola Ranger

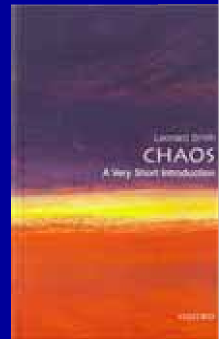
Grantham Research Institute, LSE

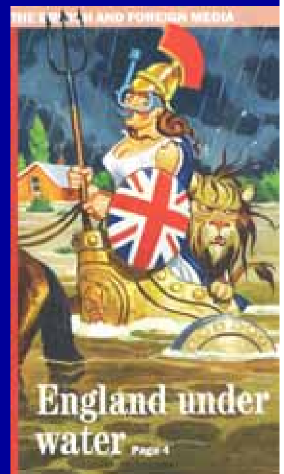
Centre for the Analysis of Time Series, LSE

& Pembroke College, Oxford

Dave Stainforth, Ana Lopez & Ed Tredger

www.lsecats.org





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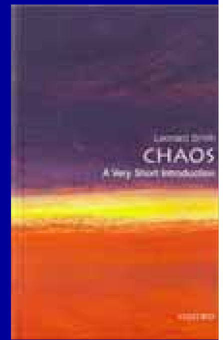
Climate Models and Their Information Content for the Insurance Industry

(When might UKCP Numbers add value to UKCP Science for the Insurance Industry?)



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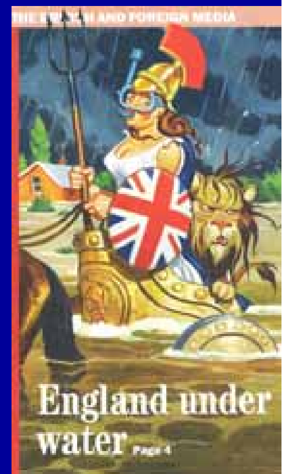

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Climate Models and Their Information Content for the Insurance Industry

(When might UKCP Numbers add value to UKCP Science for the Insurance Industry?)

?Expected Uncertainty -or- Big Surprise?

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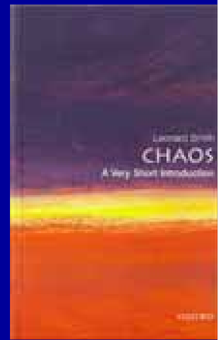

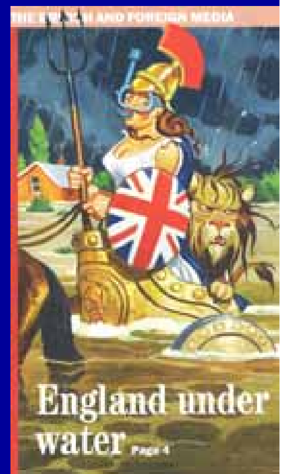

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Overview

- Decision Support requires specific questions
  - Typical questions: pub kitchens, Atlantic storms, UK floods, cables under the streets of London, Norwegian snow fall, castle location, subsidence coverage …
- When might UKCP (numbers) add value to decision making?
  - Value beyond the use of today's climate science (also a UKCP specialty)?
- Why "Better" and even "Best" model output does **not** imply relevance to the insurance sector!
  - A schematic picture for accessing of UKCP numbers are "fit for purpose"
  - Why ABI might ask for the probability of a big surprise, in each application!
- How do we make progress in applying climate science+models
  - Openness to communicate (today's) limitations. (and estimate next years).
  - Questions the ABI should expect answers to when using UKCP numbers in risk.

How did the Norman's account for twentieth century climate 1000 years ago?

When can we use numbers to inform decisions?

Given a decision relevant Probability Distribution we can apply the tools of Decision Theory 101

Can UKCP09 provide a decision-relevant PDF for most questions of interest to the insurance sector?

Is this an obvious “yes”?

If not, (a) how to get to yes/no? and (b) how would you proceed?

(a) Is information believed to be: Robust. Relevant. **And** Informative.

(b) When all the models are run and all the approximation are made:

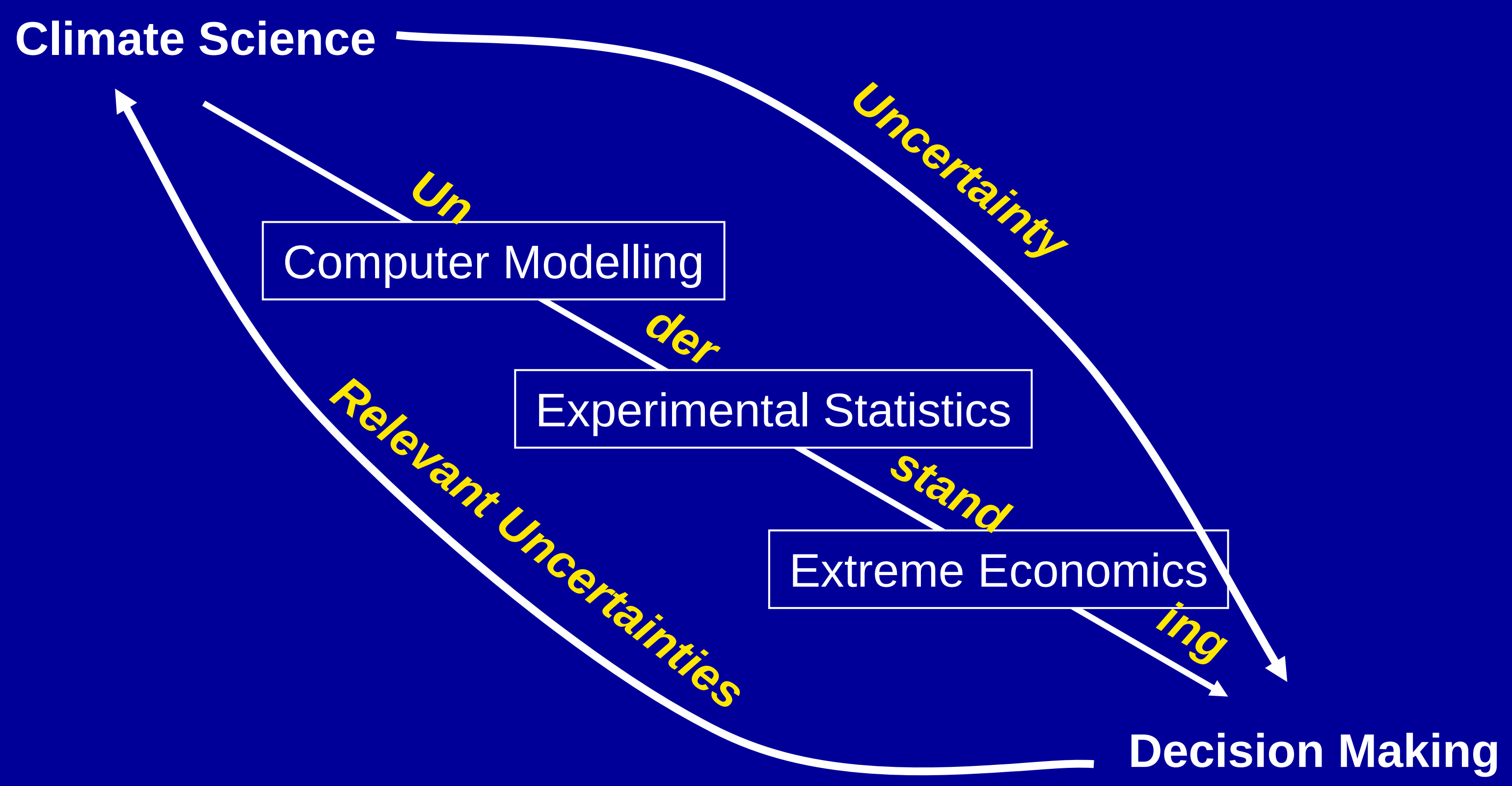
What is the probability of a “Big Surprise”?

Climate Science

Understanding

Decision Making

There is a long way between climate science and decision support!



My aim is to help you find the best questions to ask UKCP climate scientists, in order to find out how useful quantitative UKCP data is likely to be for you.

One has to rely more on the Models with climate forecasts, they are harder to use than Seasonal or Daily Forecasts, as you cannot see how they go wrong and learn how to use them.

I first ran into UKCIP thinking about rainfall (flooding, subsistence, …)

Change in precip over a three month period (June, July, Aug)

Projected Patterns of Precipitation Changes

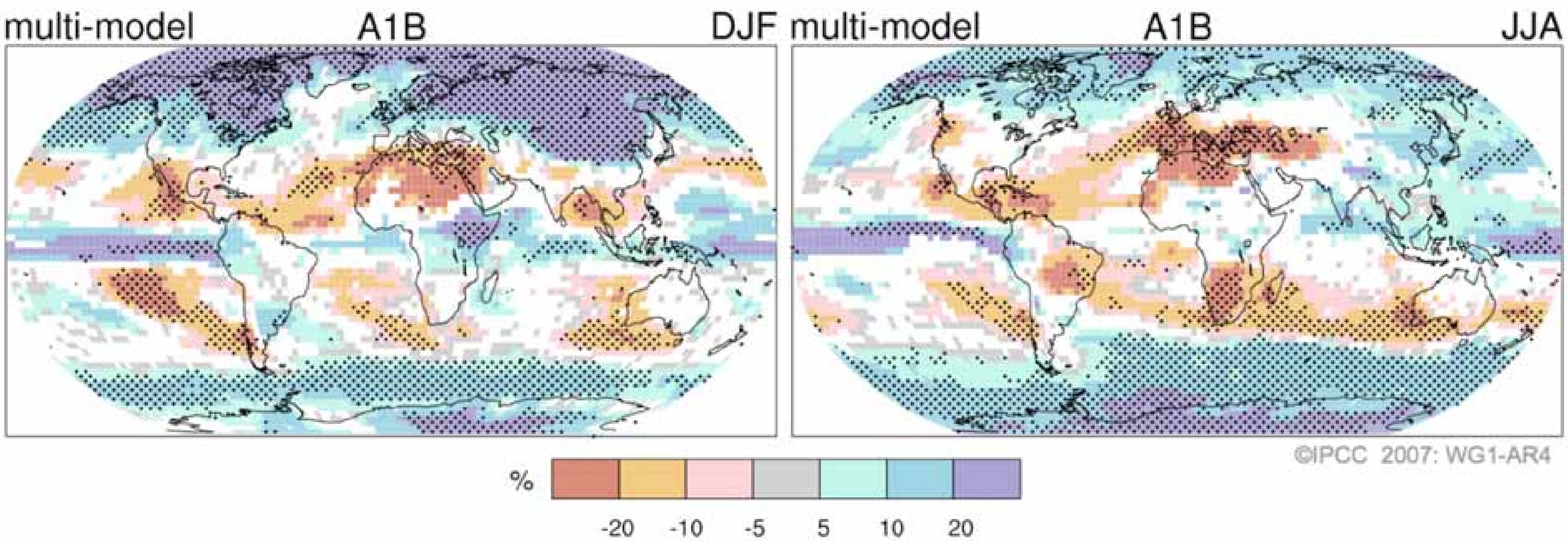
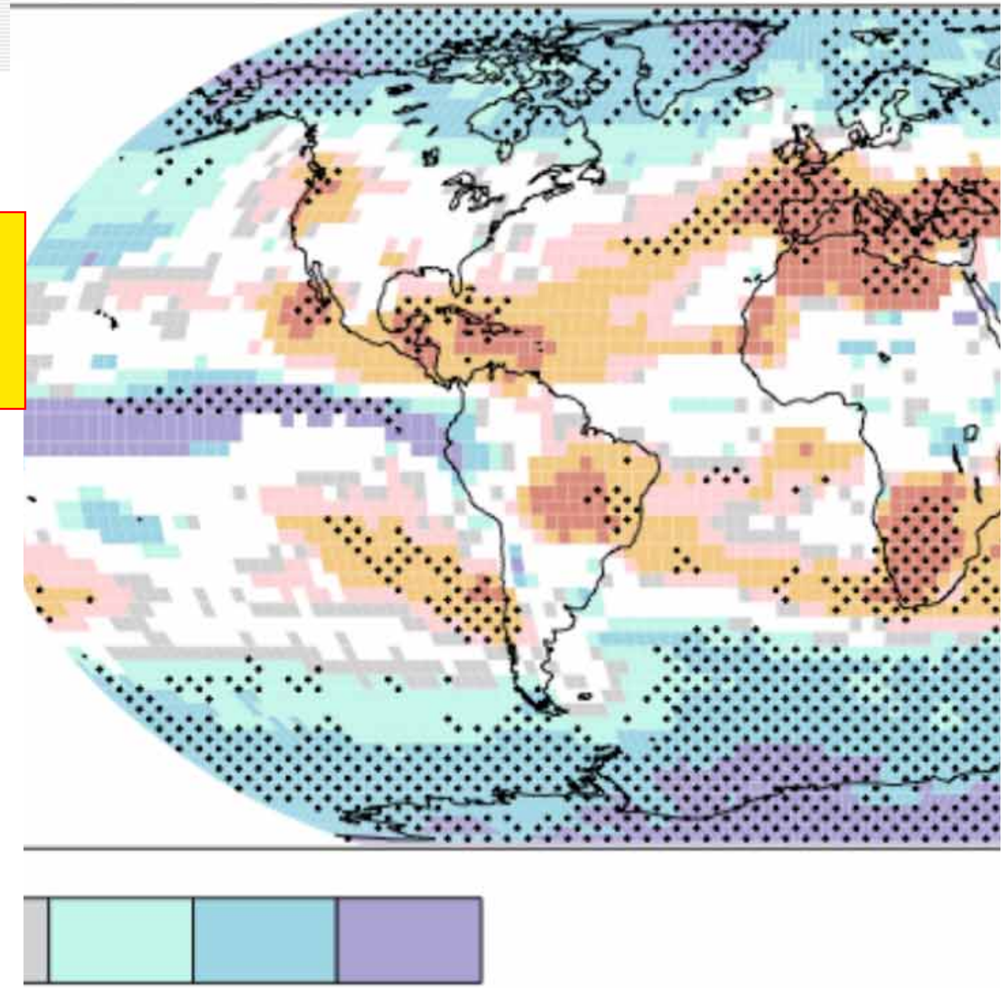


FIGURE SPM-6. Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. {Figure 10.9}

nulti-model A1B



UK Climate Impacts Programme

UKCIP08 will provide climate change scenarios for the UK :

- for 25 x 25 km grid squares, plus some aggregated results for administrative regions and river catchments

- The weather generator will allow future time daily (and sub-daily) time-series to be simulated, which will be of use to any user who is interested in daily weather variables, thresholds and sequences or extreme events.

events.
- relative to a baseline period of 1961–1990
- including extra information such as marine scenarios and changes to river flows

UKCIP02

-20

If the models disagree on whether summers will be wetter or drier, how exactly do we get useful daily information?

FIGURE SPM-7. Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. {Figure 10.9}

UK CLIMATE PROJECTIONS

Annex 3: Strengths and weaknesses of climate models

Relevant Skill: Large Storms in the UK

(b) Anticyclones and blocking

The inconsistency of the three diagnostics makes it difficult to make a clear statement about the ability of the perturbed physics ensemble to simulate anticyclones, but in general the HadCM3 ensemble is competitive with other climate models.

Climate modellers, quite naturally, compare their model with other modeller's models.

But being competitive is decision support irrelevant!

The ABI might ask instead if the model "fit for purpose" for a given decision/question?

Competitive, better, improving, even best are a distraction unless we expect robust, relevant, AND informative.

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http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_A3.pdf

Science might usefully avoid "Plausible Deniability"

Model-land phrases like "improved", "better", "best", "includes", "state-of-the-art", "comparable", "simulates", "skill" ….

…should be immediately qualified at every use, unless they imply:

Robust, Relevant and in context Informative

Robust: Thought to be unlikely to change significantly (PDF).
Relevant: **All** meteorological drivers have been considered.
Informative: predictions on space-time-impact scales of the user.

UK CLIMATE PROJECTIONS

What is UKCP09? | UKCP09 Guidance | Key findings | Published material | Customisable output | About UKCP09 | Down

Climate change projections

Annex 6 Future changes to storms & anticyclones affecting the UK

A6.1 Introduction

It has not been possible to produce probabilistic projections of changes in frequency, strength and location of future storms and anticyclones (often called blocking events) — collectively known as synoptic-scale (that is, weather system) variability. This is due to the reasons discussed in Chapter 3, Section 3.3, namely that large differences are found between projections from the Met Office perturbed physics ensemble and those from a multi-model ensemble of alternative climate models (see Figure A6.2). This implies that attempts to construct probabilistic projections would be too dominated by the contribution arising from structural model errors (see Section 3.2.8) to be considered robust. Furthermore, the required storm tracking statistics from other models are not available in any case, thus precluding the use of the UKCP09 methodology (described in Chapter 3) to produce PDFs for this metric. However, storms and blocking events are explicitly modelled in climate models, and the impacts of such synoptic-scale variability and potential changes are considered in the production of PDFs of mean and extreme climate shown elsewhere in this report. Each of the models used in the ensembles which underlie the PDFs, both the perturbed physics and the multi-model, simulate storms and blocking and their integrated impact on those mean and extreme conditions. In addition, the PDFs are constrained by the large-scale observed fields of climate which are partly determined by synoptic-scale variability. In short, the effects of synoptic-scale variability, including potential changes, are taken into account.

"Storms and Blocking events":

"explicitly modelled", "impacts…considered", models "simulate storms"

"In short, the effects … are taken into account"

Such phrases seem to imply we have reliable, decision relevant probabilities for future blocking and changes in the storm track. But they do not, really.

Are they meant to imply:

Relevant or Robust or Informative ***for a given real world Application!***

?Decision Relevant Probabilities?

Report from the Review of the Methodology used for the UKCP climate change projections

13 and 14 January 2009

The focus on UK-scale climate change information should not obscure the fact that the skill of the global climate model is of over-whelming importance. Errors in it, such as the limited current ability to represent European blocking, cannot be compensated by any downscaling or statistical procedures, however complex, and will be reflected in uncertainties on all scales.

http://ukclimateprojections.defra.gov.uk/images/stories/Other_images/UKCP09_Review.pdf

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Climate change projections

Box 1.4: Confidence in climate projections

There is a cascade of confidence in climate projections. There is very high confidence in the occurrence of global warming due to human emissions of greenhouse gases. There is moderate confidence in aspects of continental scale climate change projections. 25 km scale climate change information is indicative to the extent that it reflects the large-scale changes modified by local conditions. There is no climate change information in the 5 km data beyond that at 25 km. All that can be produced is a range of examples of local climates consistent with current larger-scale

the probabilities cannot represent uncertainties arising from deficiencies common to all models, such as a limited ability to represent European blocking. The fact that the UKCP09 projections are presented at a high resolution for the UK should not obscure this,

not obscure this, and users should understand that future improvements in global climate modelling may alter the projections, as common deficiencies are steadily resolved.

It is not clear to me how to use UKCP PDFs in a decision context for extreme events known not to be represented in those PDFs. The ABI might ask explicitly!

Read the Boxes!

http://ukclimateprojections.defra.gov.uk/content/view/1924/517/

UK CLIMATE PROJECTIONS

Large Storms in the UK

Annex 3: Strengths and weaknesses of climate models

Tropical cyclones which may re-curve into mid-latitudes and become intense storms cannot, [redacted], be simulated by the current generation of climate models. That is not to say however that such storms are likely to form a major component of the climate change signal.

Is this meant to imply we have robust evidence frequency will not change?

At present, such storms are relatively rare (although may have large consequences) and there is no robust evidence that their frequency will change in the future.

Nevertheless, without a number of relatively high-resolution climate model simulations, which will take many years if not decades to realise, it is almost impossible to make any reliable assessments of such phenomena.

This seems a clear, brave and valuable statement that UKCP and Met Office products can not quantitatively support reliable decisions on such storms which are clearly of interest to the Insurance Sector. Such words should be applauded!

http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_A3.pdf

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1 JULY 2008 SEAGER ET AL. 3261

Things we know cannot model: The 1930'sDust bowl

Would Advance Knowledge of 1930s SSTs Have Allowed Prediction of the Dust Bowl Drought?*

RICHARD SEAGER, YOCHANAN KUSHNIR, MINGFANG TING, MARK CANE, NAOMI NAIK, AND JENNIFER MILLER

Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York

This hypothetical drought prediction would have been of limited success because of differences in the modeled and observed patterns.

A clear statement of which meteorological drivers of insurance impacts are well captured in the present, and which are not, would be of significant value.

Wind storms, Heavy rain events, Dry spells….

Would UKCP information for this decade have been of use to the ABI in1999?

Report from the Review of the Methodology used for the UKCP climate change projections

13 and 14 January 2009

The focus on UK-scale climate change information should not obscure the fact that the skill of the global climate model is of over-whelming importance. Errors in it, such as the limited current ability to represent European blocking, cannot be compensated by any downscaling or statistical procedures, however complex, and will be reflected in uncertainties on all scales.

Regarding the User Guidance

. It should give very firm guidance as to the uses that should and should not be made of the data, with concrete examples where possible. In particular it should include

, and detailed discussion of how the projected probabilities should be interpreted, and what they can and cannot be used for. Examples of analyses using projection products based on more traditional

http://ukclimateprojections.defra.gov.uk/images/stories/Other_images/UKCP09_Review.pdf

UK CLIMATE PROJECTIONS

Annex 3: Strengths and weaknesses of climate models

You can ask for more than:

. Careful evaluation of such diagnostics from the RCM simulations and the weather generators is recommended in cases where such variability is important to the individual user.

UK CLIMATE PROJECTIONS

3 Construction of probabilistic climate projections

Adobe Acrobat

Acrobat has finished searching the document. The find item was not found.

OK

Discrepancy in future variables increases the uncertainty associated with the projections, and mitigates the risk of making overconfident projections.

Caution: There appears to be a curious belief that if probability distributions are "too wide" they will not cause harm.
Long tails may, of course, make some things appear uninsurable, cause over-engineering, …

What is a “Big Surprise”?

Suppose there is an ABI meeting in 2109 to discuss the IPCC AR21

We have 2100 hardware, and knowledge of the “emission scenario”

We can reproduce (shadow) climate change from 1900 till 2100 with good fidelity relevant to the insurance sector (using 2100 hardware)

We contrast our 2100 results with climate models available in 2009: What is the chance that events of high impact on the insurance sector happened? Things that we then understand, but which UKCP09 simply could not have foreseen using the model **structures** available on the hardware available in 2009?

In short:

What is the probability of a Big Surprise (in 2012? 2040? 2090?) for UKCP users?

How is “the ABI” to use UKCP numbers for quantitative decision support when Prob(BS) is not small?

(First note: climate scientists in 2009 can often say Prob(BS) is **not** small).

UK CLIMATE PROJECTIONS

Ask for Prob(Big Surprise)

Annex 3: Strengths and weaknesses of climate models

The role of atmospheric blocking under climate change is currently a major topic of research. Might current model errors severely limit the reliability of climate change projections (e.g. Palmer *et al*. 2008; Scaife *et al*. 2008)? Might large changes in blocking, that current models cannot simulate, cause large changes in the frequency of occurrence of summer heat waves for example? Of more practical interest than the diagnosis of blocking frequency is perhaps is the frequency of occurrence of blocking-like weather in the models used in UKCP09.

An answer "yes" would lead to "big surprises" (the questions are not answered) but what do climate scientists think the probability of a relevant big surprise is?

If scientists believe it is small (the insurance sector defines "small") then perhaps the PDFs will prove useful as they stand.

But if we agree that they are too large for the insurance sector to neglect them, then the quantitative model output is of little use in decision support.

And the good news is we know we do not know!

http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_A3.pdf

Schematic For Decision Relevance

- Clearly specify the Decision Question in terms of local environmental phenomena that Impact it ("hot dry periods")
- Determine the larger scale "meteorological" phenomena that impact the local. ("blocking")
- Identify all relevant drivers (known). ("mountains")

Pose necessary (NEVER SUFFICIENT) conditions for model output to quantitatively inform prior subjective science based reflections

- Are local phenomena of today realistically simulated in the model?
  - (If not: Are relevant larger scale (to allow "prefect prog")). If not: P(BS)>>0
- Are drivers represented? (to allow "laws-of-physics" "extrapolation")
- Are these conditions likely to hold given the end-of-run model-climate?

If one cannot clear these hurdles, the scientific value of the results does not make them of value to decision makers. They can be a detriment. And claiming they are the "Best Available Information" is both false and misleading.

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Quantitative Projections Demand Quantitative Guidance

For *each* question asked, the ABI should expect and get:

- clear statements of known shortcomings and likely implications in terms of impacts
  Quantify: “very high confidence”, “moderate confidence”, “indicative”
- reputation binding statements on what is believed to be robust
- quantitative subjective estimate of a relevant “big surprise” probability *from climate scientists for every projection!*

Even the best methodology available can accompany “the answer” with a statement of confidence in its expected relevance to the question asked. Prob(BS)

And also get a rough idea of how fast model output is likely to improve

What misuses of UKCP09 are officially deprecated?

I believe these actions would be inappropriate even if UKCP distributions were decision relevant PDFs.

But is it appropriate to use UKCP PDFs as such?

Some UKCIP worked examples suggest yes…

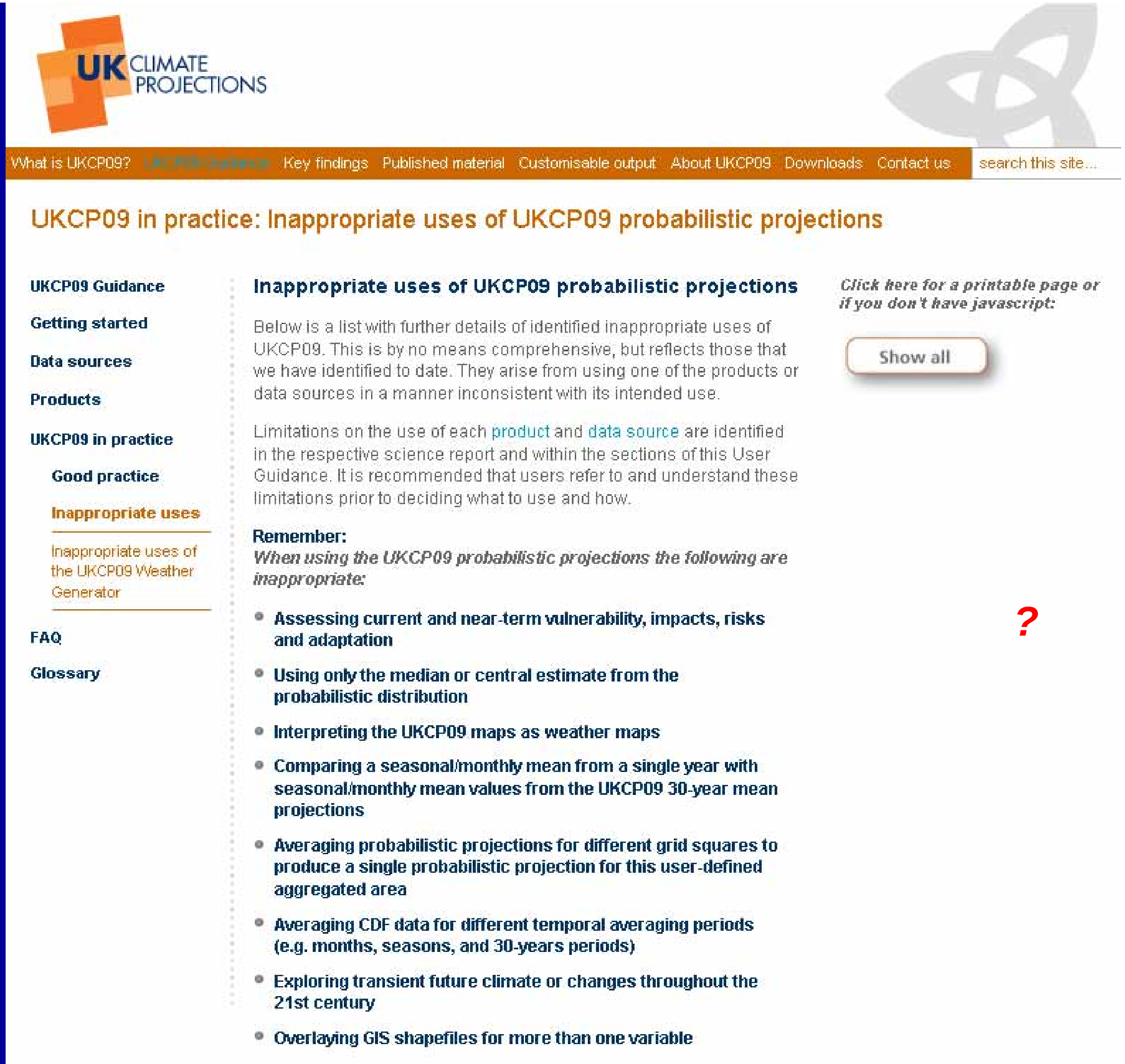
Can we use UKCP PDFs in these three insurance sector relevant cases?

Extreme wind frequencies (?robust realistic storm track?)

Extreme rain (informative: flooding)

Extended dry periods (informative: subsidence)

Prob(BS) < 10%: Yes or no?



http://ukclimateprojections.defra.gov.uk/content/view/1793/510/

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Extreme rain (informative: flooding)

Extended dry periods (informative: subsidence)

Prob(BS) < 10%: Yes or no?

UK CLIMATE PROJECTIONS

UKCP09 in practice: Inappropriate uses of UKCP09 probabilistic projections

- **UKCP09 Guidance**
- **Getting started**
- **Data sources**
- **Products**
- **UKCP09 in practice**
  - **Good practice**
  - **Inappropriate uses**
  - Inappropriate uses of the UKCP09 Weather Generator
- **FAQ**
- **Glossary**

Inappropriate uses of UKCP09 probabilistic projections

Below is a list with further details of identified inappropriate uses of UKCP09. This is by no means comprehensive, but reflects those that we have identified to date. They arise from using one of the products or data sources in a manner inconsistent with its intended use.

Limitations on the use of each product and data source are identified in the respective science report and within the sections of this User Guidance. It is recommended that users refer to and understand these limitations prior to deciding what to use and how.

Remember:
When using the UKCP09 probabilistic projections the following are inappropriate:

- **Assessing current and near-term vulnerability, impacts, risks and adaptation**
- **Using only the median or central estimate from the probabilistic distribution**
- **Interpreting the UKCP09 maps as weather maps**
- **Comparing a seasonal/monthly mean from a single year with seasonal/monthly mean values from the UKCP09 30-year mean projections**
- **Averaging probabilistic projections for different grid squares to produce a single probabilistic projection for this user-defined aggregated area**
- **Averaging CDF data for different temporal averaging periods (e.g. months, seasons, and 30-years periods)**
- **Exploring transient future climate or changes throughout the 21st century**
- **Overlaying GIS shapefiles for more than one variable**

Click here for a printable page or if you don't have javascript:

Show all

?Few businesses perform quantitative calculations more than a decade ahead; UKCP deprecates explicitly the use of probabilistic projections before the 2020s?

http://ukclimateprojections.defra.gov.uk/content/view/1793/510/

UK CLIMATE PROJECTIONS

UKCP09 in practice: Good practice

UKCP09 Guidance

Getting started

Data sources

Products

UKCP09 in practice

- Good practice
- *Table of worked examples*
- Inappropriate uses

FAQ

Glossary

Using UKCP09 to...

Keywords	Data source used	Organisation	Probability level	Emissions scenario
Provide guidance on how to prepare for climate change				
Defra, government, communication	• Probabilistic climate change projections (land)	Defra	10 to 90	Low, medium, high
Assess adaptation measures				
Built environment, adaptation	• Probabilistic climate change projections (land)	CIBSE/ARUP	10, 50, 90	Medium, high
Investigate impacts & implications for managment policies				
Impacts, management policies, coastal, habitats, visitors	• Probabilistic climate change projections (land) • Storm surge • Sea level rise	Pembrokeshire Coast National Park	10 to 90	Low, medium, high
Perform a local climate impacts profile (LCLIP)				
LCLIP, vulnerability, city council	• Weather Generator	Leeds City Council	N/A	Medium
Inform integrated land-use planning				
Under development	• Under development	Macaulay institute	Under development	Under development

impacts		Commission		
Inform strategic investment & adaptation policy (storm surge)				
Under development	• Under development	Risk Management Solutions	Under development	Under development
Inform strategic investment & adaptation policy (inland flooding)				
Adaptation, strategy, flood, model	• Probabilistic climate change projections (land)	Risk Management Solutions	10, 50, 90	Low, medium, high
Perform an impacts & opportunity analysis				
Under development	• Under development	South West Tourism / Environment Agency / SWCCIP	Under development	Under development
Inform resource management & planning				
Planning, water	• Observed climate information • Probabilistic climate change projections (land) • Weather Generator	Newcastle University	N/A	Low, medium, high
Perform an ecological assessment				
Salmon, water temperature, ecology	• Probabilistic climate change projections (land)	Environment Agency	10, 50, 90	Medium
Support change in management practice				
Forestry, practices	• Probabilistic climate change projections (land)	Forestry Commission	10, 50, 90	Low, medium, high
Investigate current policy				
Environment Agency, policy, flood management, 11-member RCM	• 11-member RCM	Environment Agency / Defra	N/A	medium plus 4 emission scenarios from IPCC

Support change in management practice				
Forestry, practices	• Probabilistic climate change projections (land)	Forestry Commission	10, 50, 90	Low, medium, high
Investigate current policy				
Environment Agency, policy, flood management, 11-member RCM	• 11-member RCM	Environment Agency / Defra	N/A	medium plus 4 emission scenarios from IPCC AR4
Undertake Robust decision-making				
Under development	• Under development	Exeter University	Under development	Under development
Extract wind data				
CIBSE, wind, thermal simulation modelling	• 11-member RCM	CIBSE	N/A	Low, medium, high
Perform a sustainability assessment				
Energy, sustainability	• Weather Generator	acclimatise	N/A	Medium
Update existing research				
Water resources	• Sampled data • Weather Generator	Anglian Water	10, 50, 90	Medium
Investigate impacts				
Snow cover, Snowdonia, Wales	• Weather Generator	Countryside Council for Wales	N/A	Medium

Are these just old unfair criticisms?

444 *Admiral Fitz-Roy* [March 28,

WEEKLY EVENING MEETING,

Friday, March 28, 1862.

JOHN PETER GASSIOT, Esq. F.R.S. Vice-President, in the Chair.

REAR-ADMIRAL FITZ-ROY, F.R.S.

An Explanation of the Meteorological Telegraphy, and its Basis, now under trial at the Board of Trade.

an idea of the kind of weather thought *probable* cannot be otherwise than acceptable, provided that he is in no way *bound* to act in accordance with any such views, against his own judgment.

No! (In fact I fall on Fitzroy's side of the "Storm warning" debate, as did Lloyd's).
The case against detailed 2007 "climate-proofing" differs in that:

(a) one can learn how to use storm warning, day after day.
(b) storm warning did in fact reflect the weather "thought probable."
(c) Fitzroy argued captains to be left entirely to their own judgement.

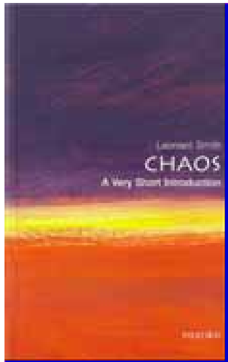
Advantages of unleashing the "Big Surprise"?

- Big Surprises arise when something our models cannot mimic turns out to have important implications for us.
- Climate science can (sometimes) warn us of where those who use naïve (if complicated) model-based probabilities will suffer from a Big Surprise.
  (Science can warn of "known unknowns" even when the magnitude is not known)
- Big Surprises invalidate (not update) the foundations of model-based probability forecasts. (Arguably "Bayes" does not apply)

(Failing to highlight model inadequacy can lead to likely credibility loss)

Including information on the Prob(BS) **in every case study** allows use of distribution of probabilities conditioned on the model (class) being perfect without believing in them

(or appearing to suggest others should act as if they do!)



Background

LA Smith(2002) *What might we learn from climate forecasts?* P. Nat. Acad. Sci (99)

LA Smith (2003) *Predictability Past Predictability Present. Predictability and Weather Forecasting* (ed. Tim Palmer, CUP).

LA Smith (2000) *Disentangling Uncertainty and Error*, in Nonlinear Dynamics and Statistics (ed A.Mees) Birkhauser.

Stainforth et al (2005) *Uncertainties in Prediction of Climate response*. Nature.

Stainforth et al (2007) *Uncertainty & Decision Support*. Phil Trans Roy. Soc. A,1098

LA Smith (2007) *A Very Short Introduction to Chaos*. OUP

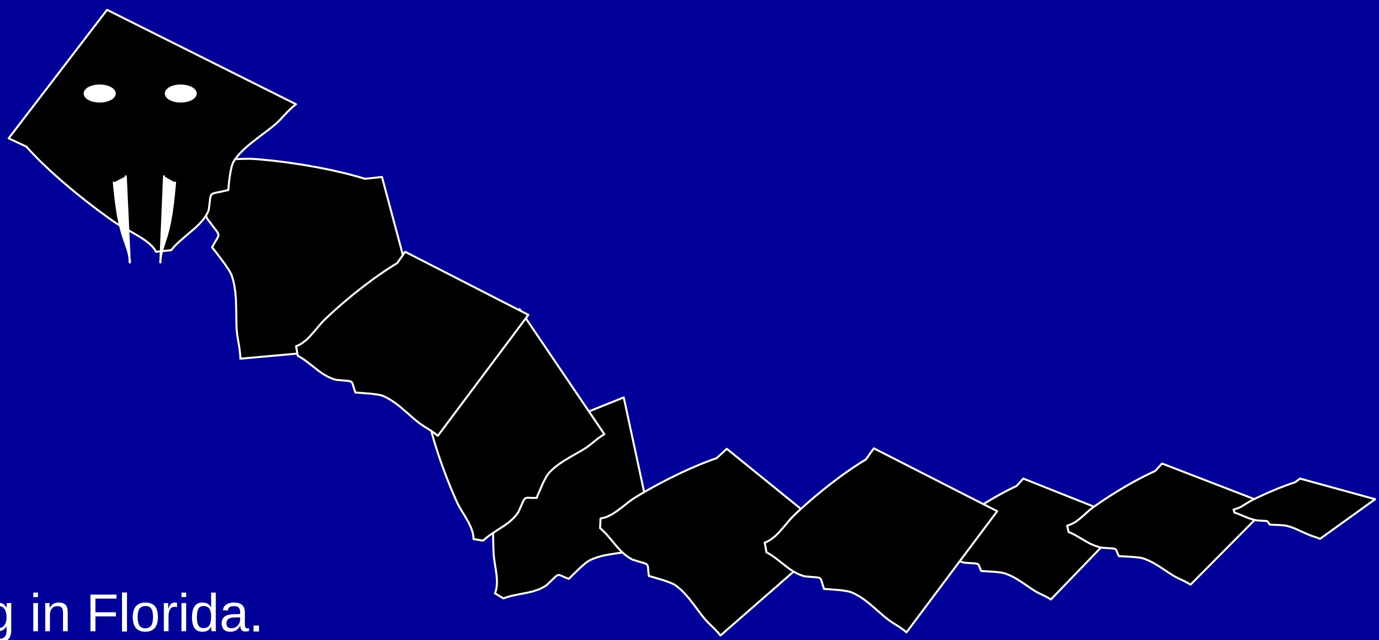
Nancy Cartwright (1983) *How the Laws of Physics Lie.* OUP

www.cccep.ac.uk

L.Smith@lse.ac.uk

When in doubt, distrusting the indications, or inferences from them (duly considered on purely scientific principles, and checked by experience), the words "*Uncertain*," or "*Doubtful*," may be used, without hesitation.

Fitzroy, 1862



We are walking in Florida.
You find you have just been bitten on the hand by a snake.
We did not see the snake.
If it was the deadly carbonblack snake, the bite will kill you in a painful way, unless you cut off your hand within 15 secs.
I have a hatchet.
You have 5 seconds left.
Did you cut off your hand?

How would a society learn to make such decisions?

Luckily with climate change we have more than 15 seconds.

Mitigation Decisions are often more simple than Adaptation Decisions

I am flying to the UK tomorrow.
If an engineer says my plane will fall out the say over the Atlantic tomorrow, I do not ask her "where exactly".
And I certainly do not plan to fly unless she can tell me!
I plan not to fly.

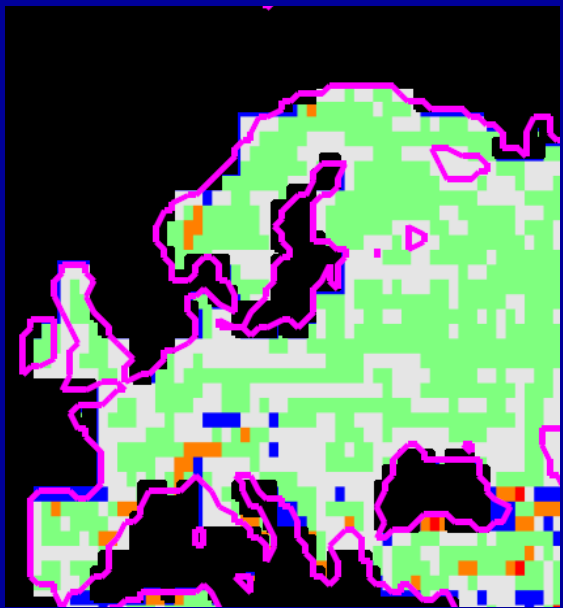
And if I must fly?
If she tell me that at a cost of twice my ticket, she can cut the probability from 10% to 1%,
or from 1% to 0.1%
or from 0.000000001% to 0.0000000001% ?

Do I care if she is not sure whether it is from 50 to 5, or if it is from 10 to 1?

No, as long as the chance is not vanishingly small already!
And there are huge costs (to me) associated with waiting:

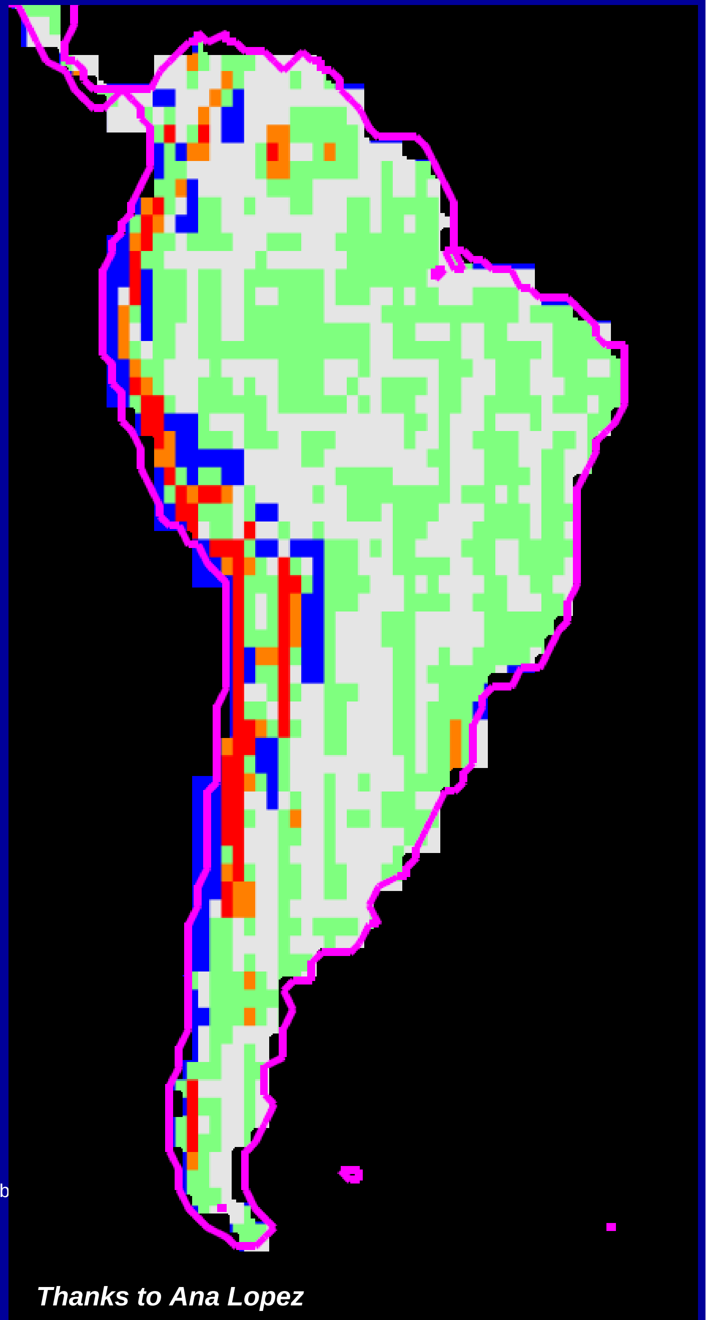
The Cost (to me) of doing something once my plane has taken off is much higher than doing something now.

Missing Mountain Ridges



Blue < -500m
Grey > -500m
Green > 250m
Orange > 500m
Red > 1 km

Observed minus HADCM3 Height



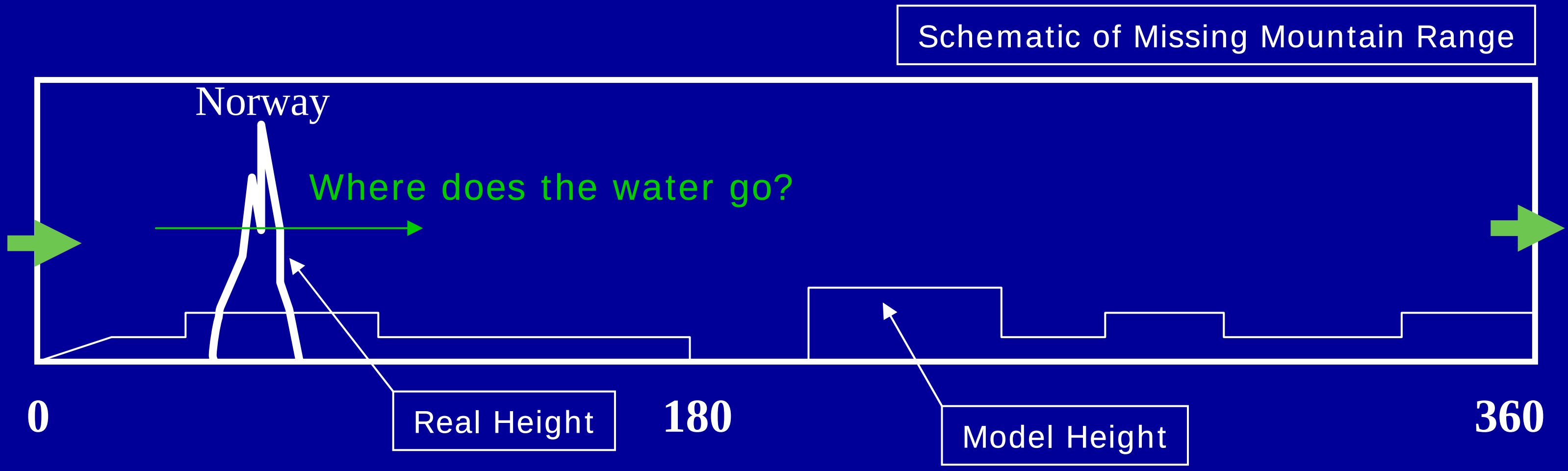
Orange and red lines correspond to walls which water vapour must go over or around, walls which are missing in this climate model.

(Walls > 500m and > 1km!)

Resulting changes in the downstream dynamics cannot be "fixed" statistically.

Continent outlines: National Geophysical Data Center,NOAA 88-MGG-02.via matlab
Hadcm3 model topography http://www.ipcc-data.org/sres/hadcm3_topo.html
1x1 topography: http://www.ngdc.noaa.gov/mgg/topo/globe.html.

Sciences knows more than we can Model



If important, this leads to nonlocal effects.
(and the effective creation of water!)

Not "how to downscale?" but "whether to downscale?"

1.4 Projections at a daily resolution over land

Changes in daily climate, such as the frequency of hot or very wet days, are likely to be more significant for many climate impacts than changes in monthly or seasonal averages. Whilst we are not able to project changes in storm tracks and anticyclones with confidence, we can project how the characteristics of daily time series could be affected by changes in the more basic aspects of future climate, such as monthly mean temperature and precipitation and other aspects of their distributions, which we have more confidence in projecting.

Our approach, therefore, is to provide a tool known as a weather generator, capable of providing plausible realisations of how future daily time series of several variables could look, consistent with changes in the characteristics of monthly-average climate sampled from the probability distributions. It does not provide a weather forecast for a particular day in the future; it gives statistically credible representations of what may occur given a particular future climate. Despite their limitations (for example, they assume that relationships between different variables remain unchanged in a future climate), we recognised the inevitability of (possibly different varieties of) weather generators being employed by many users, and the advantages for consistency between impacts studies that a single weather generator would bring. The UKCP09 weather generator was developed by the Universities of Newcastle and East Anglia, based on a previous version in use by the Environment Agency.

The UKCP09 Weather Generator provides synthetic daily time series of temperature (mean, maximum and minimum), precipitation, relative humidity, vapour pressure, potential evapotranspiration (PET) and sunshine (from which we also estimate diffuse and direct downward solar radiation) at a resolution of 5 km, for each of the three emission scenarios and each of the future 30-year time periods — 2020s, 2030s etc. It provides data over land but not for marine regions. The weather generator does not add any additional climate change information over that which is present in the 25 km probabilistic projections. However it does add local topographical information (e.g. hills, valleys) at the 5 km scale, as it is based on observed data which is representative of this scale. The Weather Generator is also able to construct synthetic hourly time series for precipitation, temperature, vapour pressure, relative humidity and sunshine for future time periods. This is a disaggregation of daily data and, again, does not provide any new climate change information at this level. The UK Climate Projections science report: Projections of future daily climate for the UK from the weather generator describes the weather generator in detail, with examples of its output, and also considers its limitations.

What does it mean to say you can provide "plausible realizations" or "statistically credible" hourly information on weather, after you have stated that the basic causes of many extremes of obvious interest (storms, blocking: flooding and heatwaves) are not included?

What is intended physically by the phrase "more basic aspects of future climate"? The rainfall in a month is the sum of the rain each day, the monthly average is not "more basic" in any sense.

Why might one think it better ("the advantages for consistency") for all users to see the same systematic errors?

This is not thought to be a good idea in the banking sector, for instance.
(Or by the IPCC for global modelling!)

UK CLIMATE PROJECTIONS

Annex 3: Strengths and weaknesses of climate models

Typical Errors suggest "Big Surprises" relevant to Insurance Sector Decisions

A3.4.2 Storm tracks and blocking

HadCM3 does simulate the main hemispheric pattern of storm tracks and some aspects of Atlantic-European blocking.

. The perturbations to HadCM3 do result in some spread in the position and intensity of the cyclone track between model versions, with ensemble members between 0 and 6 degrees too far south and

some having strengths as much as 20% too low. However, this spread is smaller than that seen in the CMIP3 multi-model ensemble, where the equivalent range is from 2 degrees too far north to14 degrees too far south, and range in intensity from 35% too low to 33% too high (Figure A3.6).

Centre for Climate Change Economics and Policy
The Munich Re Programme: Evaluating the Economics of Climate Risks and Opportunities in the Insurance Sector

Mat Collins, Simon Brown, Tim Hinton, and Tom Howard, Met Office Hadley Centre

1 JULY 2008 SEAGER ET AL. 3261

Things we know cannot model: The 1930'sDust bowl

Would Advance Knowledge of 1930s SSTs Have Allowed Prediction of the Dust Bowl Drought?*

RICHARD SEAGER, YOCHANAN KUSHNIR, MINGFANG TING, MARK CANE, NAOMI NAIK, AND JENNIFER MILLER

Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York

As noted earlier, the overestimate of intensity of the modeled Dust Bowl drought in the southern plains and northern Mexico is attributable to model error. Errors in the temperature simulations are consistent with being the result of errors in the precipitation simulation.

It is extremely valuable for scientists to be this blunt about model error!

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A
MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

A methodology for probabilistic predictions of regional climate change from perturbed physics ensembles

J.M Murphy, B.B.B Booth, M Collins, G.R Harris, D.M.H Sexton and M.J Webb

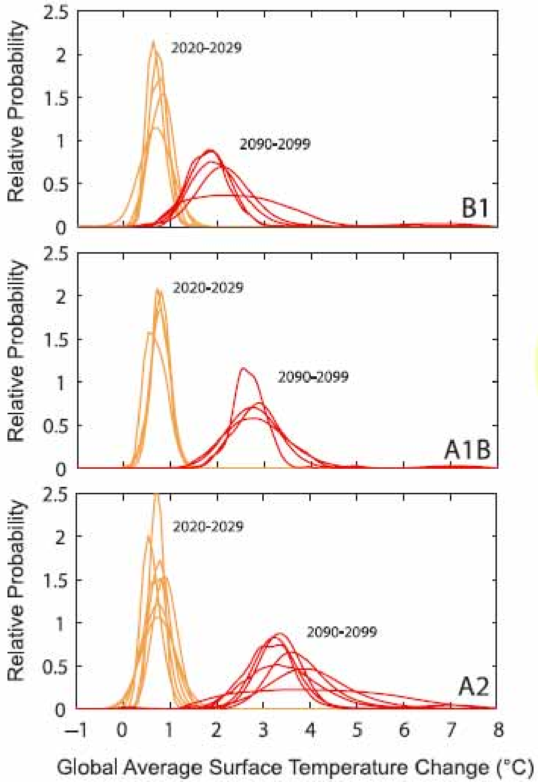
Phil. Trans. R. Soc. A 2007 **365**, 1993-2028
doi: 10.1098/rsta.2007.2077

In general, such biases could arise from either missing processes or common limitations such as insufficient resolution or the widespread adoption of a deficient parametrization scheme. They introduce an important general caveat on the confidence that can be placed in ensemble predictions (Smith 2002).

. We believe it is preferable to include a lower bound for the effects of structural modelling errors than to ignore them altogether, since this will reduce the risk of providing policy makers with over-confident climate predictions.

It is important to stress that our approach to the specification of discrepancy can only be expected to capture a subset of possible structural modelling errors and should be regarded as a lower bound. This is because models tend to share certain common systematic biases, which can be found in diverse elements of climate including multiannual means of basic quantities such as surface temperature, precipitation and pressure at mean sea level (e.g. Lambert & Boer 2001),

PROJECTIONS OF SURFACE TEMPERATURES



10

This risk of overconfidence is well known and well founded.

Global Climate Projections

The effects of uncertainty in the knowledge of Earth system processes can be partially quantified by constructing ensembles of models that sample different parametrizations of these processes. However, some processes may be missing from the set of available models, and alternative parametrizations of other processes may share common systematic biases. Such limitations imply that distributions of future climate responses from ensemble simulations are themselves subject to uncertainty (Smith, 2002), and would be wider were uncertainty due to structural model errors accounted for. 797

One would be exposed to significant losses/costs if distributions which are not decision-support relevant probabilities are interpreted as if they were.

UKCP distribution may provide insight into things that have not been "ruled out", but how exactly are we to use these distributions to assess risk, or support decisions in the Insurance sector, if the Prob(Big Surprise) is high?

Scientifically Relevant vs. Decision Support Relevant

Modellers sometimes understandably take offence when one complains that their model cannot do something that no model in the world can do:
In application, it would be useful to better distinguish a "best model in the world" from a "model that is fit for the purpose" at hand.

Science might usefully avoid "Plausible Deniability"

Model-land phrases like "improved", "better", "best", "includes", "state-of-the-art", "comparable", "simulates", "skill" ….

…should be immediately qualified at every use, unless they imply:

Robust, Relevant and in context Informative

Robust: Thought to be unlikely to change significantly (PDF).
Relevant: **All** meteorological drivers have been considered.
Informative: predictions on space-time-impact scales of the user.

Reference: Probability

Probability (objective and subjective)

Probability is a concept most of us deal with in everyday life. There are, however, two types of probability. That which most people are familiar with is objective probabilities (frequency of occurrence of an outcome based on observations). UKCP09 probabilities are not this type, but are subjective/Bayesian probability (strength of considered evidence).

In detail

Objective probability:
The expected frequency of occurrence of some outcome based on observations of a large number of independent trials carried out under the same conditions for which all outcomes are accounted for (e.g. rolling a pair of dice).

Subjective/Bayesian probability:
A measure of the degree to which a particular outcome is consistent with the information considered in the analysis (i.e. strength of the evidence).

Probabilistic climate projections fall under subjective probability as the probabilities are a measure of the degree to which a particular level of future climate change is consistent with the evidence considered. In the case of UKCP09, the evidence comes from historical climate observations, expert judgement and results of considering the outputs from a number of climate models, all with their associated uncertainties.

The methodology that generates the probabilities is based on large numbers (ensembles) of climate model simulations, but adjusted according to how well different simulations fit historical climate observations. As such, the probabilities provide information on the consistency of future climate outcomes with the evidence considered which can be used to support decisions related to impacts and adaptation options.

One important consequence of the definition of probability used in UKCP09 is that the probabilistic projections are themselves uncertain, because they are dependent on the evidence used, including how the methodology is formulated.

UK CLIMATE PROJECTIONS

Annex 3: Strengths and weaknesses of climate models

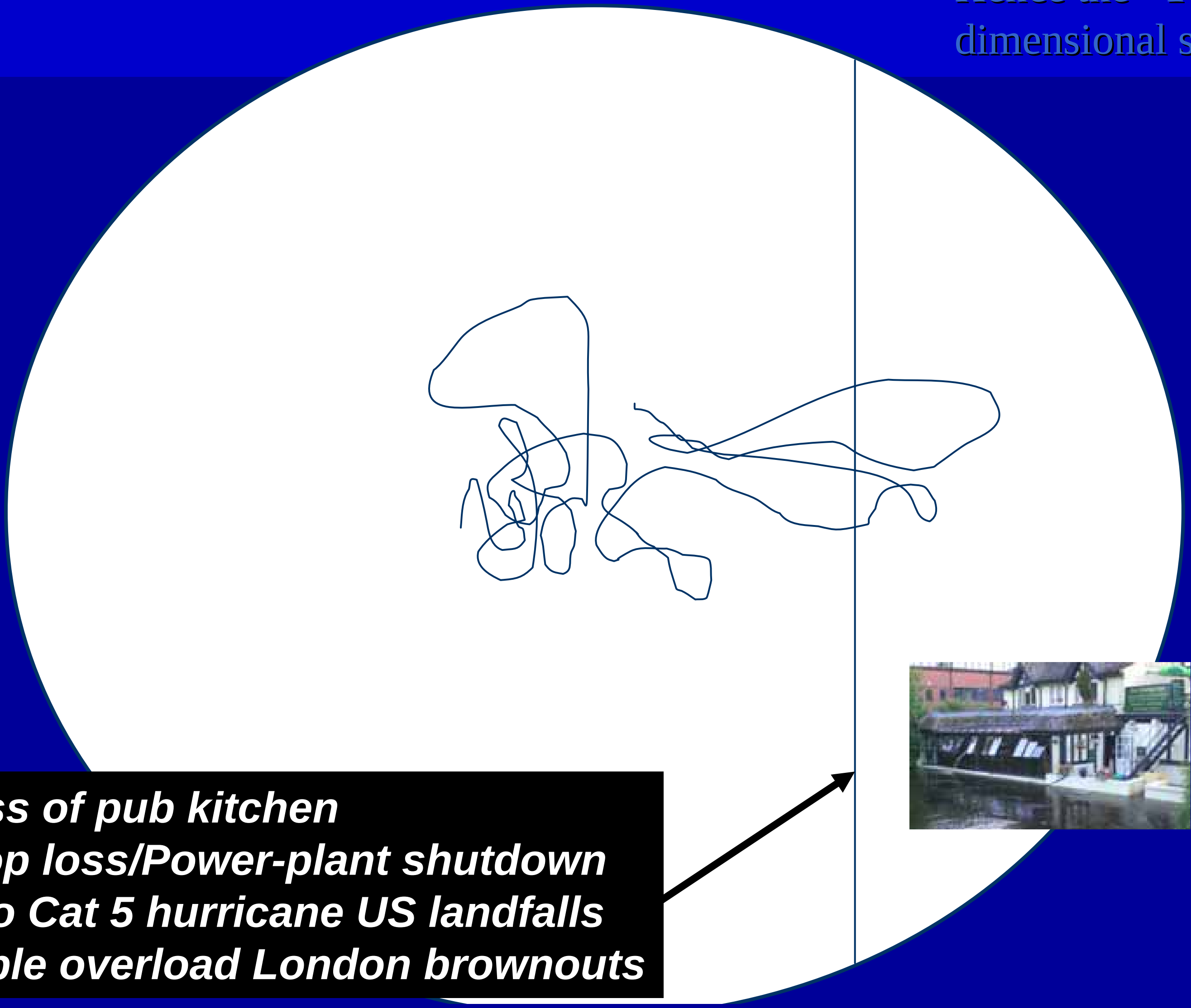
. Careful evaluation of such diagnostics from the RCM simulations and the weather generators is recommended in cases where such variability is important to the individual user. It should be noted that the

http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_A3.pdf

http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_A3.pdf

As they are nonlinear we have to evaluate them along trajectories. Crops, cables, wind energy and system failures depend on what and even when weather events unfold.

Hence the ~10^6x10^{21} dimensional space



This kind of information is not available from today's models, nor will it ever be visible in model mean values!

3 Construction of probabilistic climate projections

Adobe Acrobat

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OK

Discrepancy in future variables increases the uncertainty associated with the projections, and mitigates the risk of making overconfident projections.

3.2.8 Structural model errors (discrepancy)

What is discrepancy, and why is it important?

The discrepancy term, introduced in Section 3.2.7, is a measure of how informative the climate model is about the real world. Formally, it represents the mismatch we would find between the model and the real world if we could locate precisely the

UK Climate Projections science report: Climate change projections — Chapter 3

combination of model parameter settings giving the best overall simulation of climate that the model is capable of providing.

Centre for Climate Change Economics and Policy
The Munich Re Programme: Evaluating the Economics of Climate Risks and Opportunities in the Insurance Sector

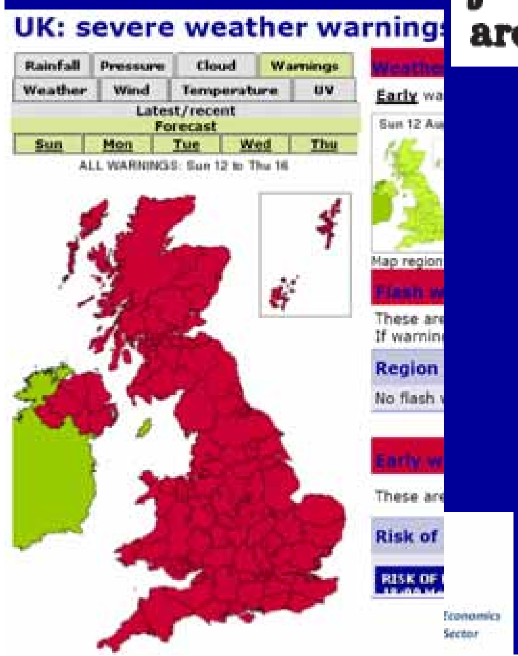
http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_V2.pdf

Objection has been taken to such forecasts, because they cannot be always exactly correct,—for all places in one district. It is, however, considered by most persons that general, comprehensive expressions, in aid of local observers, who can form independent judgments from the tables and *their own instruments*, respecting their immediate vicinity, *though not so well for distant places*, may be very useful, as well as interesting: while to an unprovided or otherwise uninformed person, an idea of the kind of weather thought *probable* cannot be otherwise than acceptable, provided that he is in no way *bound* to act in accordance with any such views, against his own judgment.

Like the storm signals, such notices should be merely *cautionary* —to denote anticipated disturbance *somewhere* over these islands,— without being in the least degree compulsory, or interfering arbitrarily with the movements of vessels or individuals.

Certain it is, that although our conclusions may be incorrect—our judgment erroneous—the laws of nature, and the signs afforded to man, are invariably true. Accurate interpretation is the real deficiency.

Fitzroy, 1862



Typical reply to a comment on blocking in GCMs:

"It would require half of all years to be blocked as badly as the worst year (for blocking) ever observed in order to wipe out the climate change signal."

The point is, of course, that if your decision is sensitive to impacts associated with blocking, then you care not at all about "cancelling the climate change signal" in the average values!

Your power station (or distribution grid) need only meltdown on one weekend, or your crop die on one day, …

Best available information need not be BAMO!
(Biggest available model output)

need to clearly state each models limits