Future Weather in the Context of Climate Services and Climate Modelling

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Deltas in Times of Climate Change II

DP 1.1 Future Weather: a new instrument for policymakers and risk analysts

Wednesday 24th September 2014

Outline

- Climate Services
- The UK experience
  - UK Climate Projections 2009 (UKCP09)
- Future Weather – a new approach

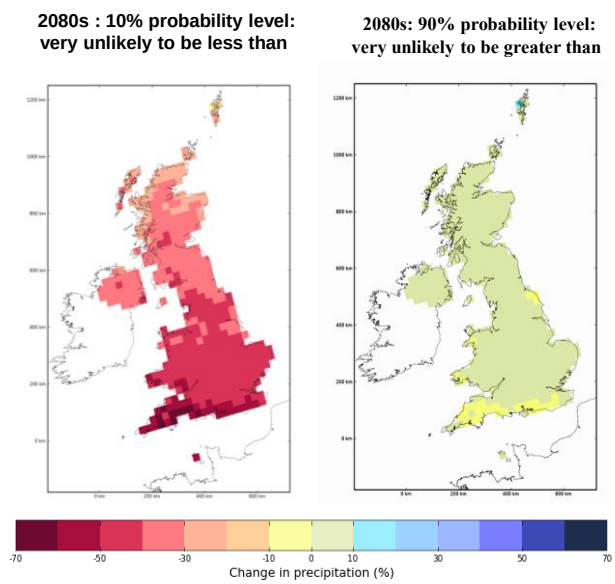
Climate Services

Examples of predictions: UK Climate Projections 2009:
Change in Mean **Summer** Precipitation in Medium (A1B) scenario

"The UK Climate Projections (UKCP09) provide climate information designed to help those needing to plan how they will adapt to a changing climate. The data is focussed on the UK,"

"UKCP09 provides **future climate projections** for land and marine regions."

"They **assign probabilities** to different future climate outcomes. "
http://ukclimateprojections.defra.gov.uk



Examples of predictions: UK Climate Projections 2009:
Change in Mean **Winter** Precipitation in Medium (A1B) scenario

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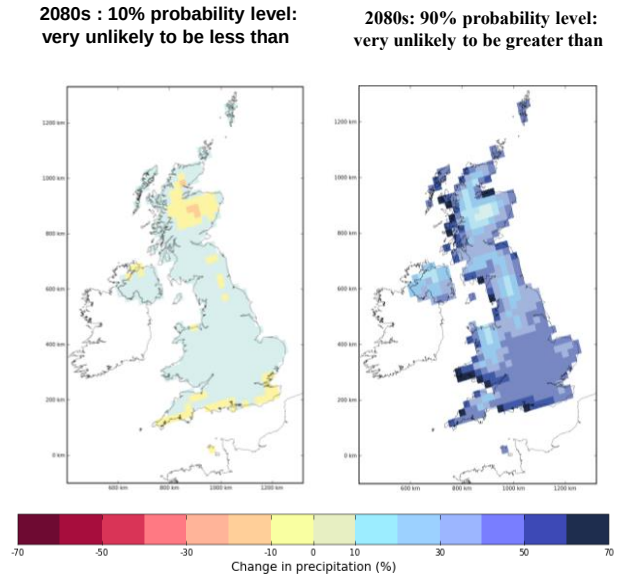
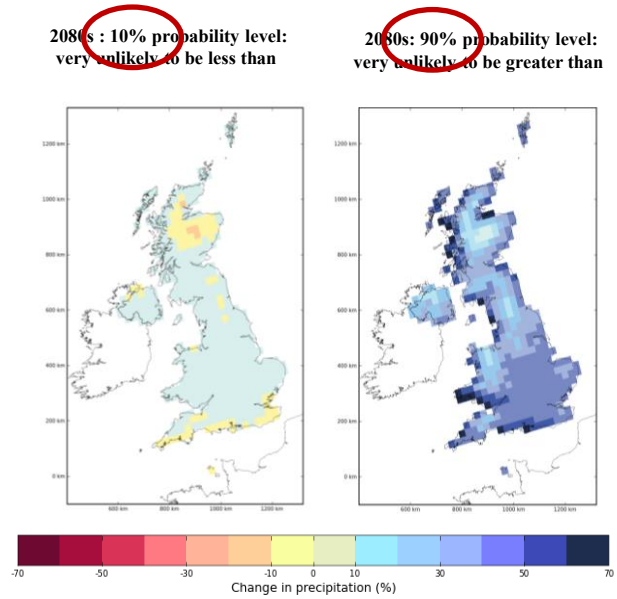


What is climate?
UK Climate Projections 2009

UK Climate Projections:
Mean Winter Precipitation

December / January / February average.

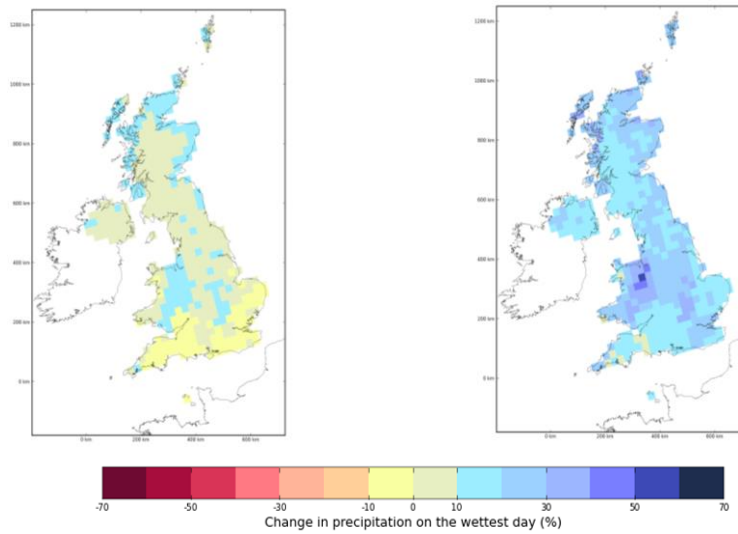
Taken over 30 years.



Examples of predictions: UK Climate Projections 2009:
Change in Wettest Day in Summer in Medium (A1B) scenario

2080s : 67% probability level: unlikely to be greater than

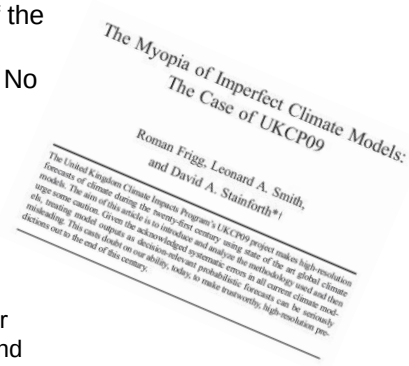
2080s: 90% probability level: very unlikely to be greater than



But UKCP09 is controversial

- Disagreement about the robustness of the approach.
  Are the probabilities reliable? Answer: No
  Are they approximately reliable? My answer: No.

- Even if the probabilities were reliable i.e. robust to anticipatable changes in models and understanding:
  - They don't provide joint probabilities for multiple variables which can be user and threshold specific.
  - They can't be linked to past experience – recent events with which decision makers have experience.


The Myopia of Imperfect Climate Models:
The Case of UKCP09

Roman Frigg, Leonard A. Smith,
and David A. Stainforth*†

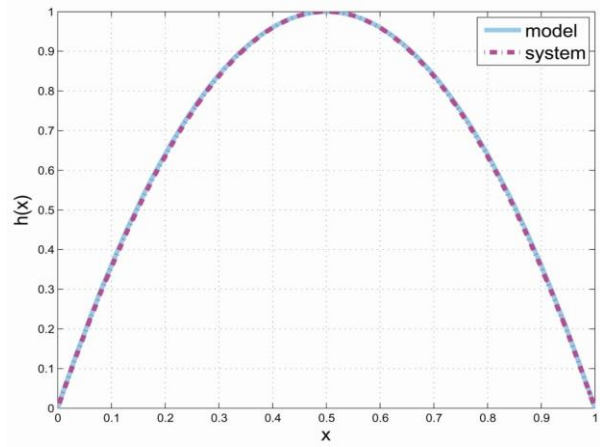
Future Weather

- A new approach to the use of models to provide guidance to decision makers in the context of climate change

Barriers to climate prediction at regional and local scales

- Nonlinearity; sensitivity to initial conditions at the finest scales. {chaos, the butterfly effect).
- Sensitivity to model error at the finest scales.
  (the hawkmoth effect).
- Lack of understanding of long timescale feedbacks for the whole climate system and for the local scales of interest.
- No possibility of verification

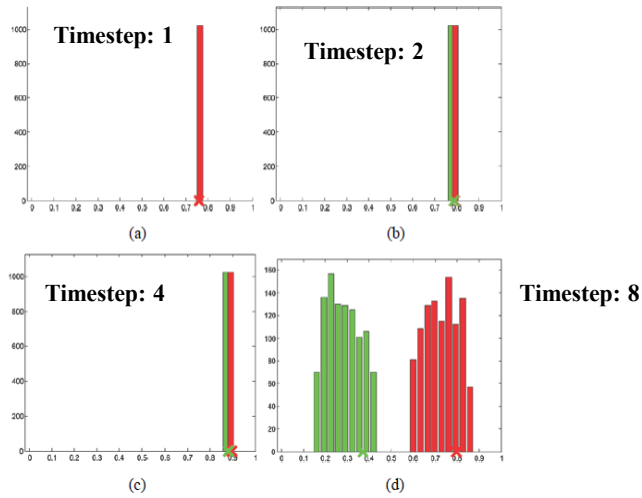
The Logistic Map and the Hawkmoth Effect



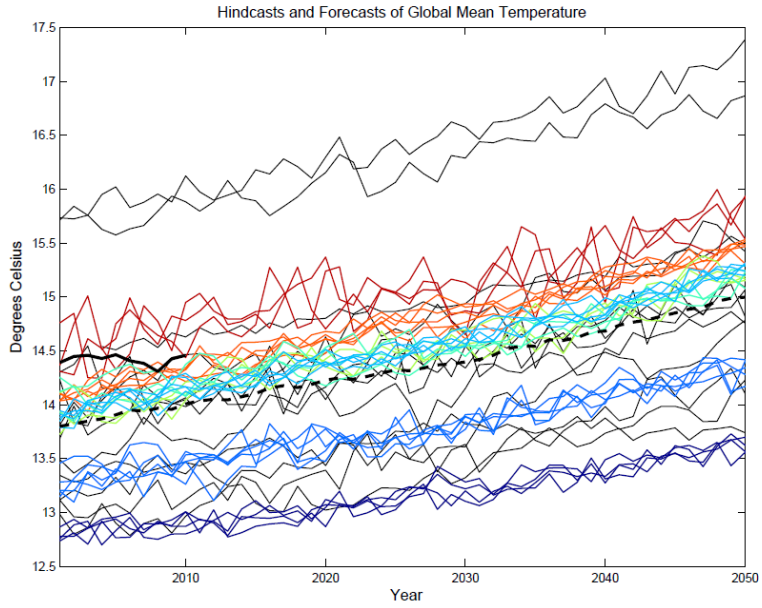
Model: $N_{t+1} = 4\,N_t(1- N_t)$ *System:* $N_{t+1} = 4N_t(1-N_t)\left[(1-\varepsilon)+\frac{4}{5}\varepsilon(N_t^{\,2}-N_t-1)\right]$

Laplace's Demon and Climate Change, Frigg et al., 2013

A Good Looking Model, Not A Good Forecasting System



Laplace's Demon and Climate Change, Frigg et al., 2013



Acknowledgement: Ana Lopez

Future Weather

- Future weather cuts through these barriers by not trying to make predictions.
  No statements about what **will** happen.
  No **probabilities** for future behaviour.

- Instead it is a about **plausible possibilities** containing all the detail needed to assess the impact on infrastructure and support adaptation decisions.

- Method:
  Use weather models to simulate parallels to previously experienced events to show how similar events may have a different character/intensity/impact in a future climate.

Future Weather – Isn't it just dynamical downscaling? A: No

- Full resolution weather models.
- Large scale boundary conditions need not be taken from Atmosphere/Ocean Global Circulation Models (AOGCMs) . They can (they should) be constructed to span a range of possible futures based on physical understanding.
- Particular types of events could be driven using the techniques of data assimilation.



Future Weather – Connections with Events Experience

- By focusing on changes in types of events which have been previously experienced they can be connected with response strategies which have or haven't worked in the past. [Complex, integral response strategies across a number of societal actors.]

  They facilitate the use of the expertise which decision makers already have.
- Some similarity with the attribution experiments which are a central part of climate science, except:
  - The models are weather models not high resolution climate models.
  - They are used to look forward to changes in character and intensity rather than back to what might have been.
  - There is no attempt at providing probabilities of event occurrence.

Future Weather – Credible Possibilities

- Credible possibilities not probabilistic prediction.
- Making a real connection with experience to enable.

- We argue that this is better than using model based predictions with current models since the relationship between such models and reality at the scales of interest to decision makers is unknown.
- Like so many aspects of climate science it requires investment.
  Investment in the model simulation time.
  Investment in the expertise to construct future weather.

Questions?

"Tales of Future Weather", W. Hazeleger, B.J.J.M. van den Hurk, E. Min, G.J. van Oldenborgh, X. Wang, A.C. Petersen, D.A. Stainforth, E. Vasileiadou, L.A. Smith – in review.