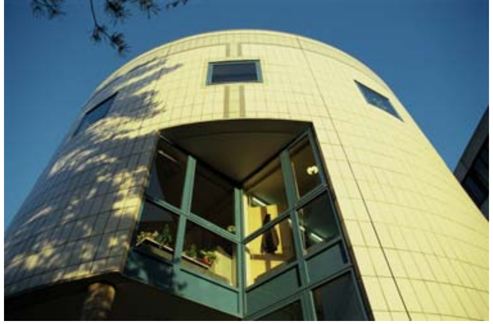


Clare Goodess
Climatic Research Unit
UEA, Norwich

- Techniques for the construction of probabilistic high-resolution climate scenarios

- Discussion on the use of information on probabilities and extremes in climate impacts analysis

UEA NORWICH

http://www.cru.uea.ac.uk

CRU

UEA contributions to Task 1a (analysing uncertainties in high-resolution climate scenarios) and 1c (communicating climate uncertainties to designers and decision-makers)

Clare Goodess, Craig Wallace, Phil Jones, Colin Harpham

Task 1a

- First point location daily probabilistic scenarios of extremes for UK
- Based on state-of-art European RCMs
- Demonstration that weather generator can be linked with RCM output in a probabilistic framework

Task 1c

- Discussions at CRANIUM, IF, ShF meetings
- Briefing note and key questions
- Outputs will be available from web site
- Royal Meteorological Society presentation
- Two journal papers
- Preparing way for ENSEMBLES, UKCIPnext and SKCC

But limited response from BKCC

- Pressures to finalise individual projects
- Not enough ‘context’ provided
- Too ‘new’ an issue
- Need to be more ‘persuasive’
- Challenge for planned SKCC workshop

UK probabilistic scenario community

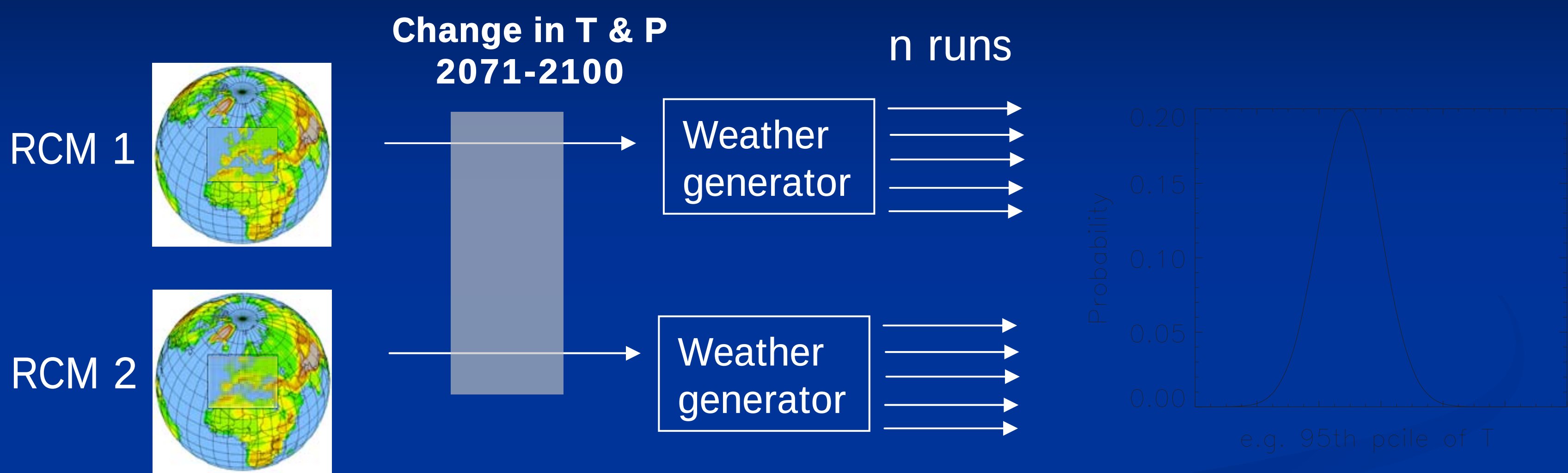
- CRU (CRANIUM & ENSEMBLES, Ekstrom)
- Tyndall HQ (Dessai)
- Newcastle (CRANIUM, Fowler…)
- UKCIPnext (steering group, wgen group)
- Hadley Centre (Murphy, Jenkins…..)
- Tyndall Oxford (New…)
- ENSEMBLES (Murphy, Rougier, Palmer….)
- Climate*prediction*.net (Allen, Stainforth….)
- NERC workshop, June 2006

CRANIUM should provide good foundation for SKCC

- e.g., integration of results in *Built Environment* special issue
  - ‘Scenarios and decision making under uncertainty’, Goodess, Wallace, Jones, Betts, Best, Hall, Kilsby
  - Draft (6000 words) – end June
  - ShF – synthesis – clear and simple message

The sources of uncertainty in climate scenarios will be outlined, and the need for a move to probabilistic scenarios explained. **Examples of probabilistic scenarios of extremes, based on the UEA CRANIUM work**, will be presented. **Uncertainties in scenarios of extremes with high temporal resolution and long return periods are illustrated using CRANIUM work undertaken by the University of Newcastle**. Additional sources of uncertainty exist for urban area scenarios - **uncertainties in future anthropogenic heat sources and their implications for urban areas are discussed**, based on Hadley Centre BETWIXT work. Decision-making under these uncertainties requires the development of novel methods, such as the **imprecise probability and information gap methods being developed by Newcastle. Examples of the application** of these methods to built environment problems will be presented.

1: Incorporating RCM uncertainty: the CRANIUM methodology



The CRU weather generator:

- developed for BETWIXT (Watts *et al.*, 2004)
- produces stochastic daily time series
- mean and s.d. constrained

1: Incorporating RCM uncertainty: the CRANIUM methodology

PRUDENCE simulations

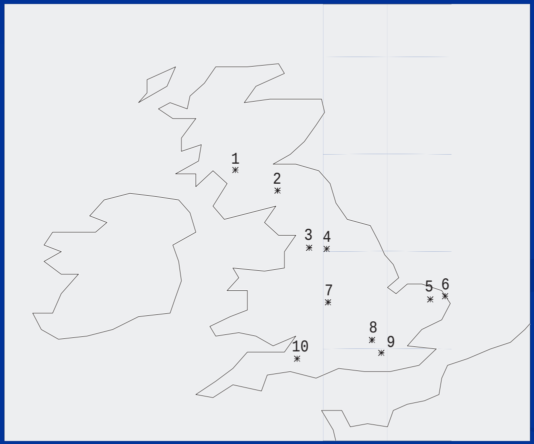
Control 1961-1990	Future Scen A2 2071-2100	Future Scen B2 2071-2100
HIRHAM (x2)	HIRHAM (x2)	HIRHAM
HadRM3P	HadRM3P	HadRM3P
CHRM	CHRM	RCAO (x2)
CLM	CLM	PROMES
REMO	REMO	RegCM
RCAO (x2)	RCAO (x2)	Arpege (x2)
PROMES	PROMES	
RegCM	RegCM	
RACMO	RACMO	
Arpege (x2)	Arpege (x2)	

1: Incorporating RCM uncertainty: the CRANIUM methodology

Which climate extremes are we interested in?

Heatwave duration
Number of hot days
Number of cold days
Fraction of rainfall from intense events..

→



→

Station	Lat	Lon
1: Paisley	55.85	-4.43
2: Eskdalemuir	55.32	-3.20
3: Ringway	53.85	-2.28
4: Bradford	53.82	-1.77
5: Coltishall	52.77	1.35
6: Hemsby	52.68	1.68
7: Elmdon	52.45	-1.73
8: Heathrow	51.48	-0.45
9: Gatwick	51.15	-0.18
10: Yeovilton	51.00	-2.63

2: Example changes in UK extremes by 2071-2100

The number of hot days:

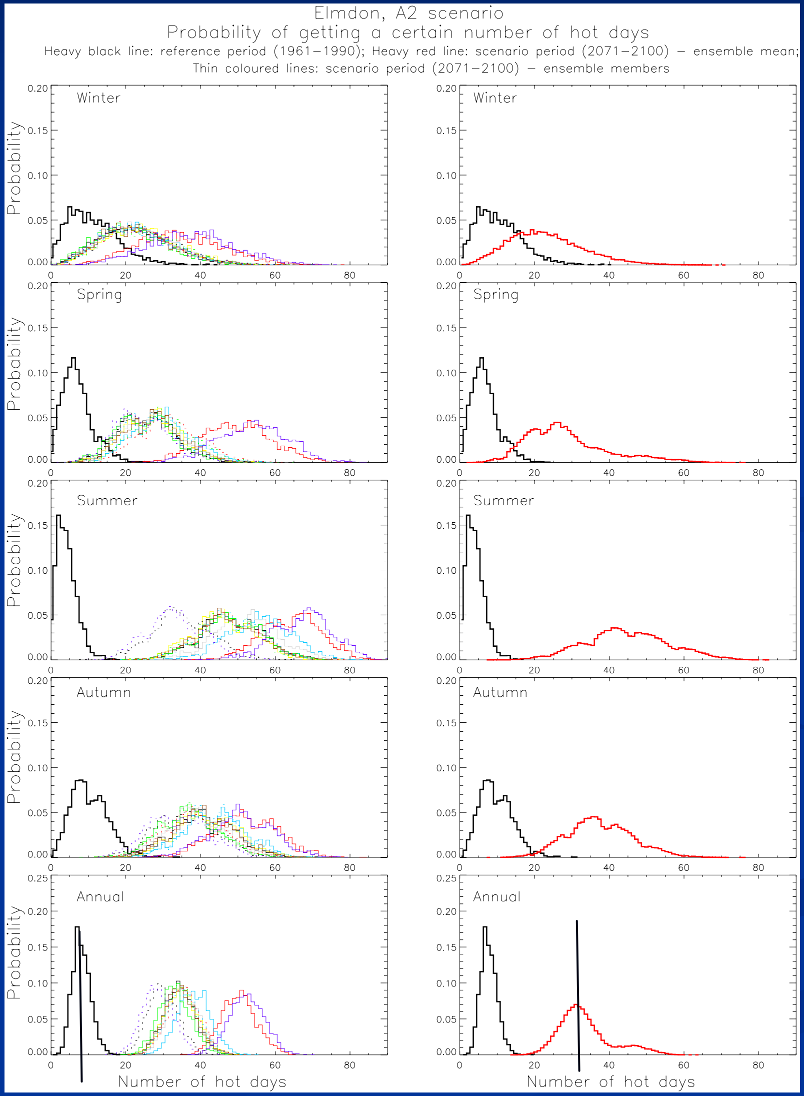
*"The number of days in a year or season (within the future climate) where Tmax exceeds the **95th percentile** of the year/season daily Tmax population within **a reference climate**"*

Reference climate?

BETWIXT project conducted a suite of weather generator simulations using *observed station* data as constraining parameters (rather than *future* changes) to obtain a number of years of control daily weather.

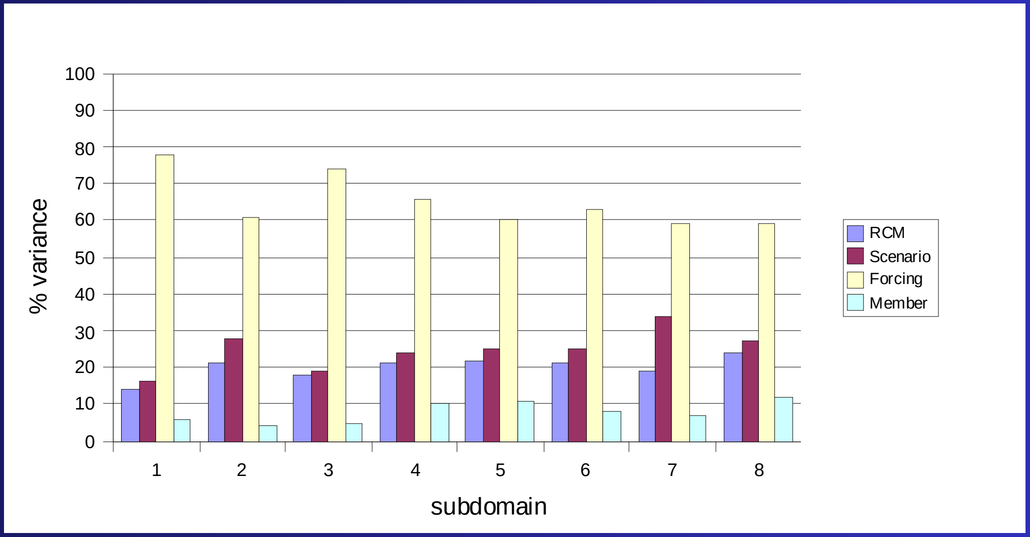
2: Example changes in UK extremes by 2071-2100

Elmdon: under A2 scenario forcing

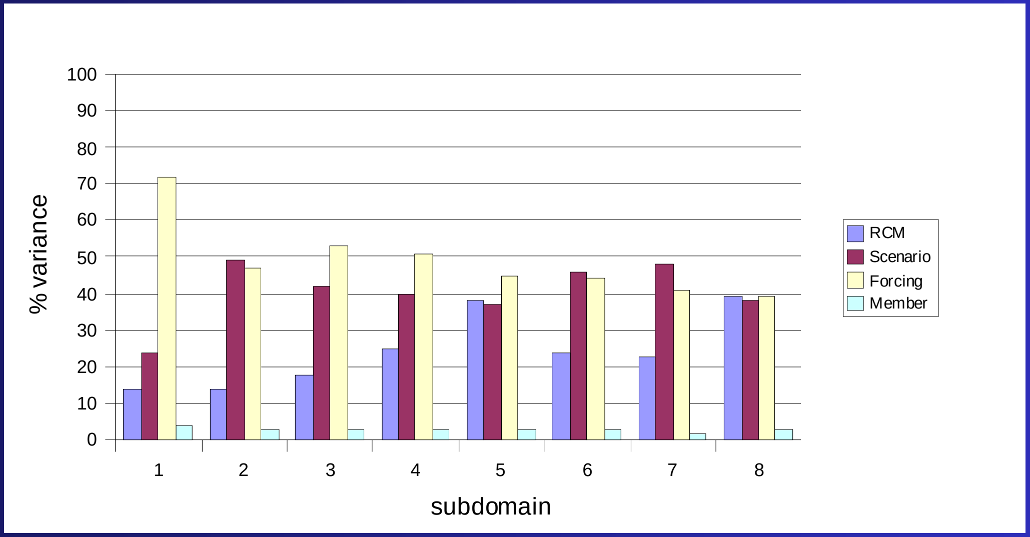


1961-1990: 7 hot days

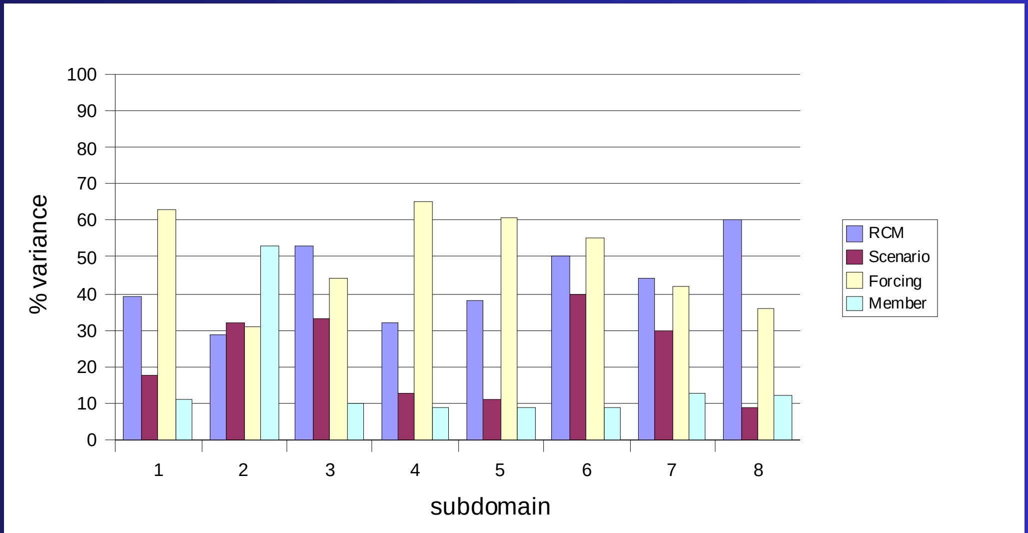
2071-2100: 31 hot days...



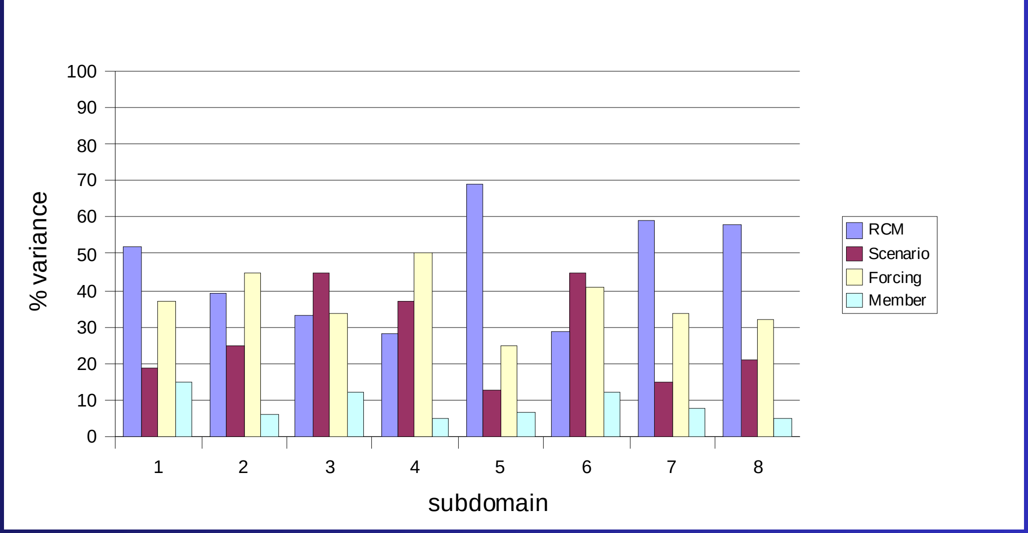
DJF Temperature



JJA Temperature



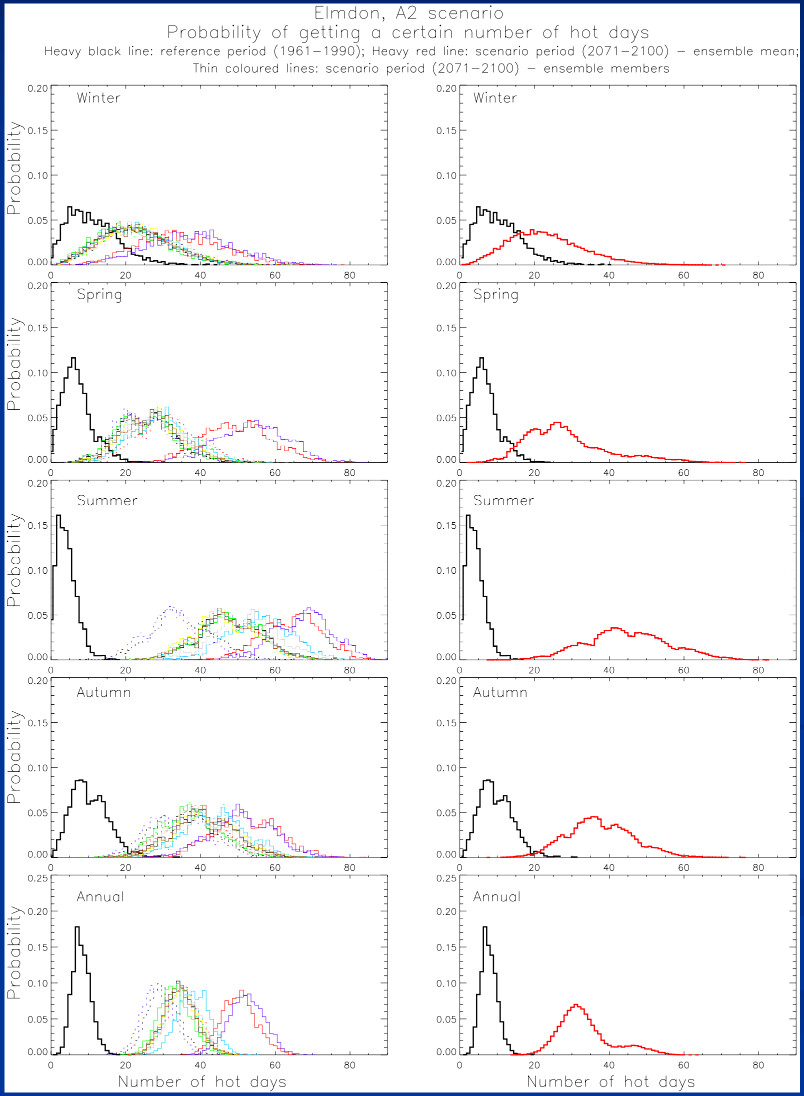
DJF Precipitation



JJA Precipitation

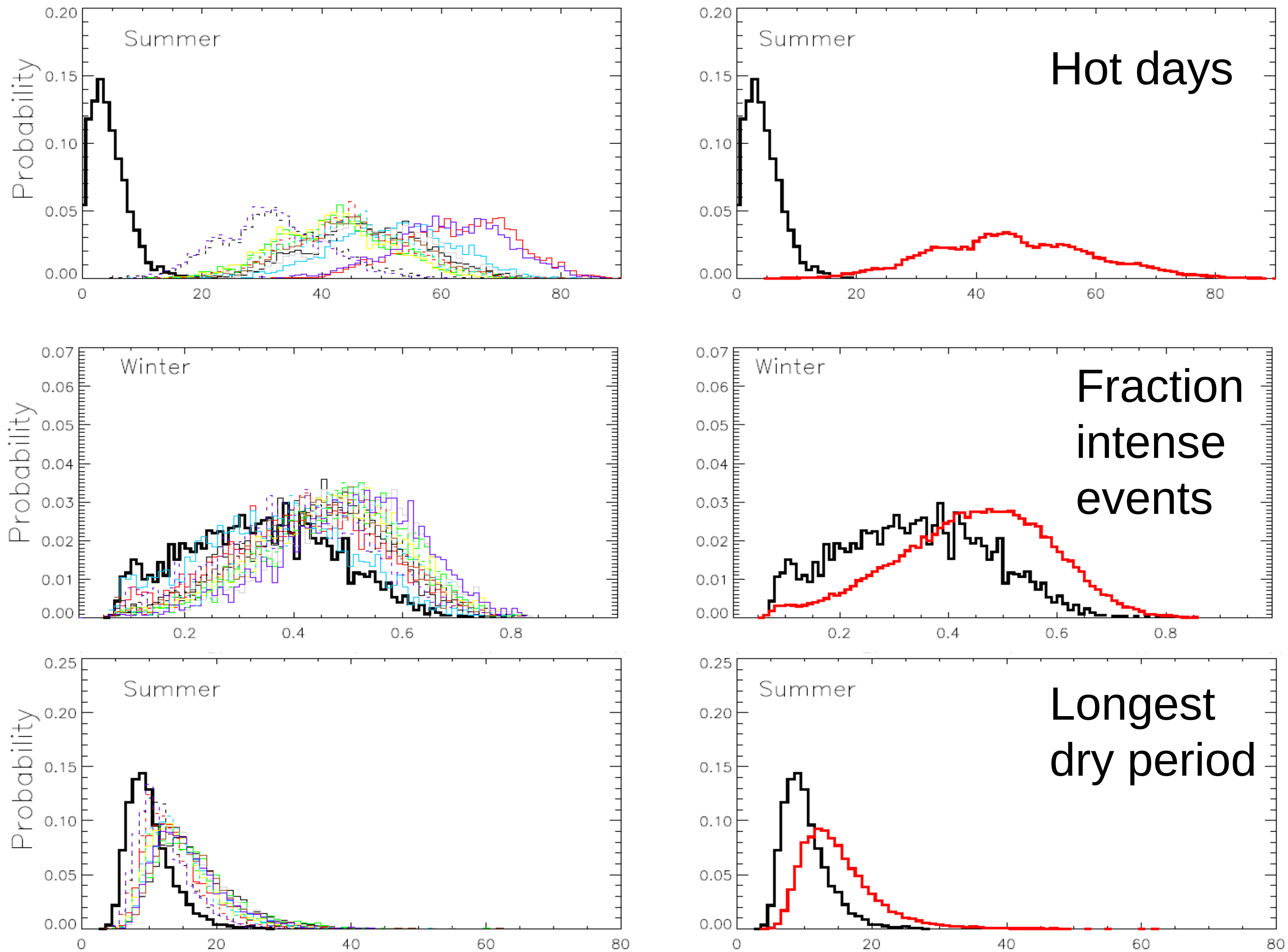
2: Example changes in UK extremes by 2071-2100

Elmdon: under A2 scenario forcing



EPSRC
Engineering and Physical Sciences Research Council

Probabilistic scenarios for Ringway (Manchester) 2080s, Medium-high emissions scenario



UK Climate Impacts Programme

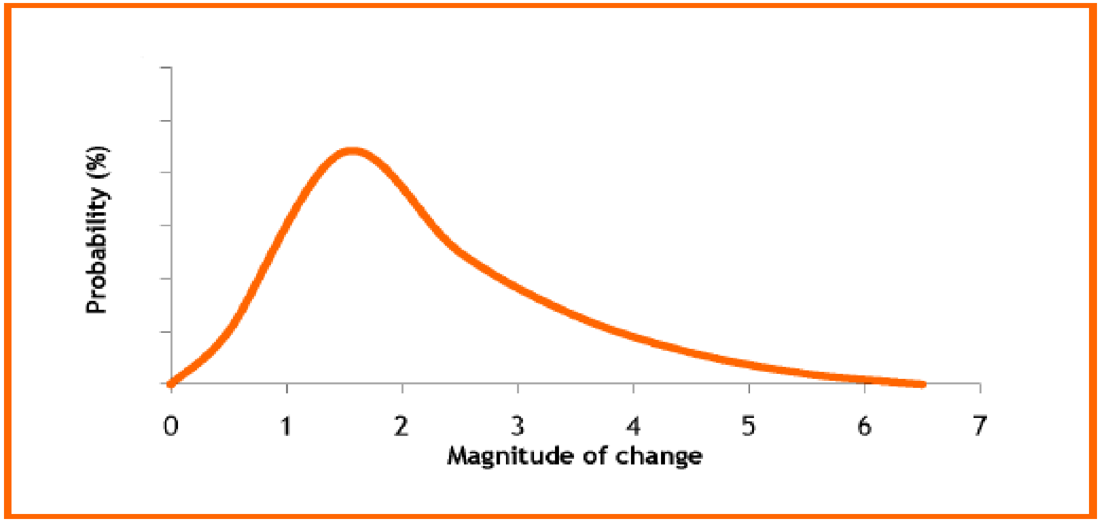
Web site for UEA CRANIUM results

- Tables of figures, e.g.,
- Non-technical background information, including assumptions etc.
- Descriptive summary of results
- Briefing note and questions
- Powerpoint presentations
- *Alternative forms of presentation.....*

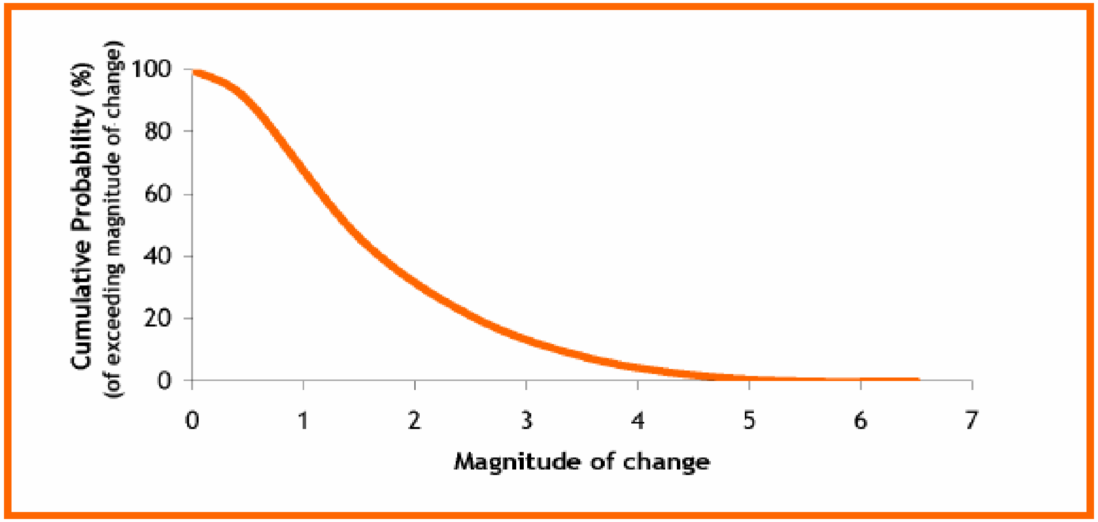
There are several ways in which this information can be delivered in terms of what is provided and what format is used. Please consider the following seven methods, thinking in particular about how you currently, or plan to, make use of climate change information.

In each case, the climate change information you would receive is coloured orange and / or contained within an orange frame

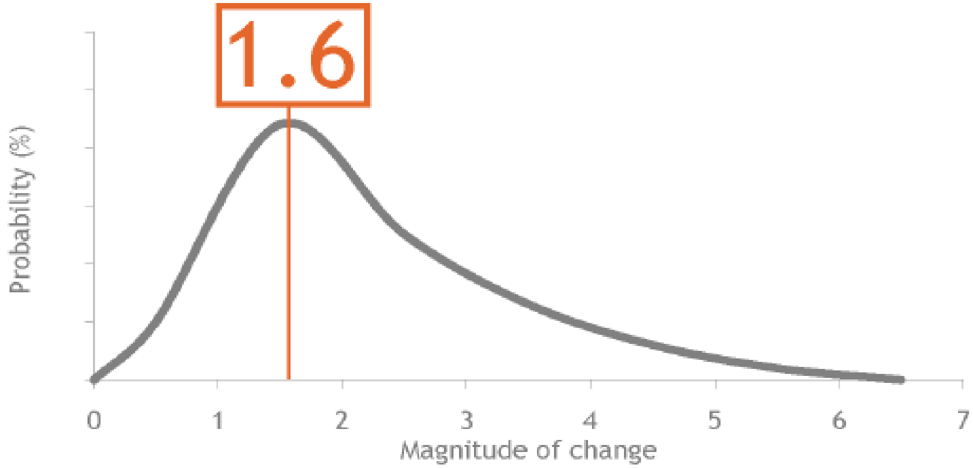
(a) As a pre-prepared graph presenting the results as a probability distribution function (pdf)



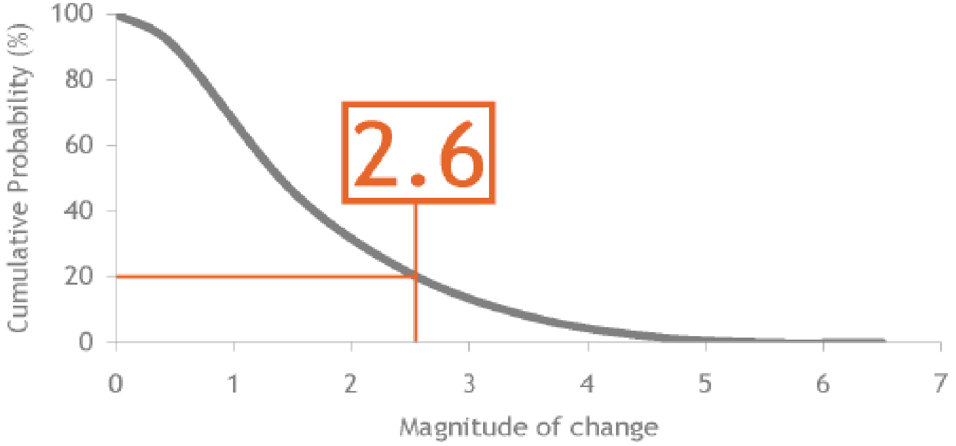
(b) As a pre-prepared graph presenting the results as a cumulative distribution function (cdf)



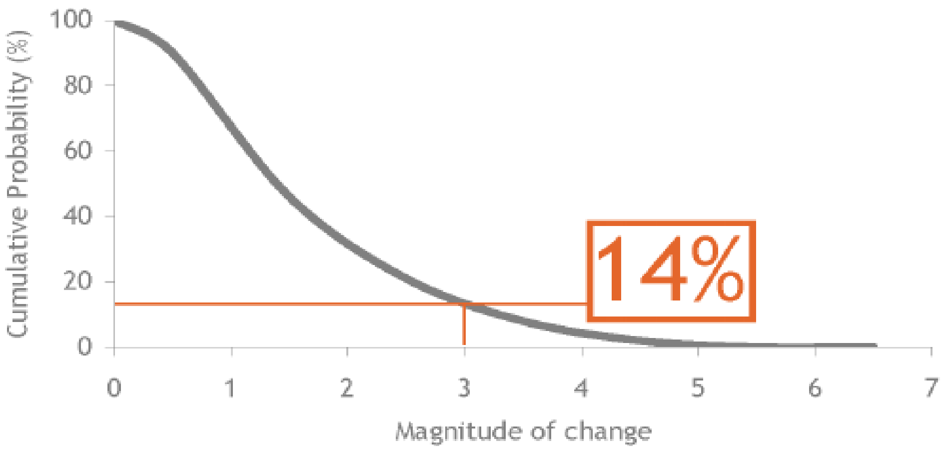
(c) As a single value to represent an average change. This could be the mean, median or modal average (as below), or other values.



(d) As a single value to represent a change that occurs with a specified probability (e.g. 5%, 67%, 90%, etc). The example below shows the change associated with 20% probability (also called the 80th percentile)



(e) As a single value to represent the probability associated with a specified threshold. The example below shows the probability associated with a change greater than 3.0



(g) As a spreadsheet containing the underlying probabilities and change classes

Change classes	Probability
0-1	10
1-2	44
2-3	25
3-4	13
4-5	6
5-6	2
6-7	0

2.1 Which of these methods would best meet your needs?
(Please tick one or more boxes)

	For every 25km grid square	For pre-defined aggregated areas
(a) Pre-prepared pdf graph	☐	☐
(b) Pre-prepared cdf graph	☐	☐
(c) Single average value	☐	☐
(d) Other representative single value (i.e. percentiles)	☐	☐
If so, which ones? ________		
(e) Single value associated with a threshold being exceeded	☐	☐
(f) Map showing a single value	☐	☐
(g) Spreadsheet containing the underlying probabilities	☐	☐

Other suggestions:

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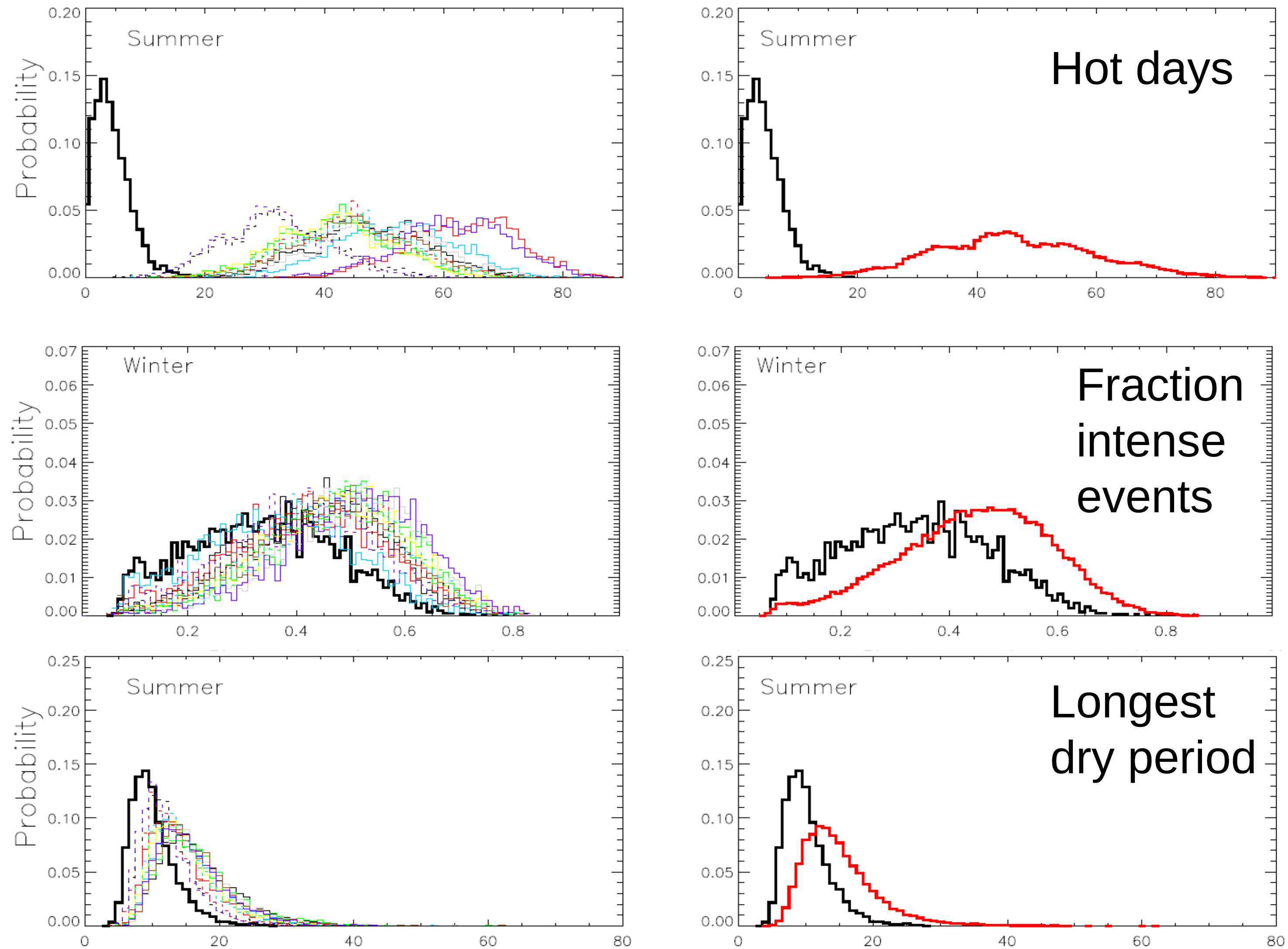
Engineering and Physical Sciences Research Council

Probabilistic scenarios for Ringway (Manchester) 2080s, Medium-high emissions scenario

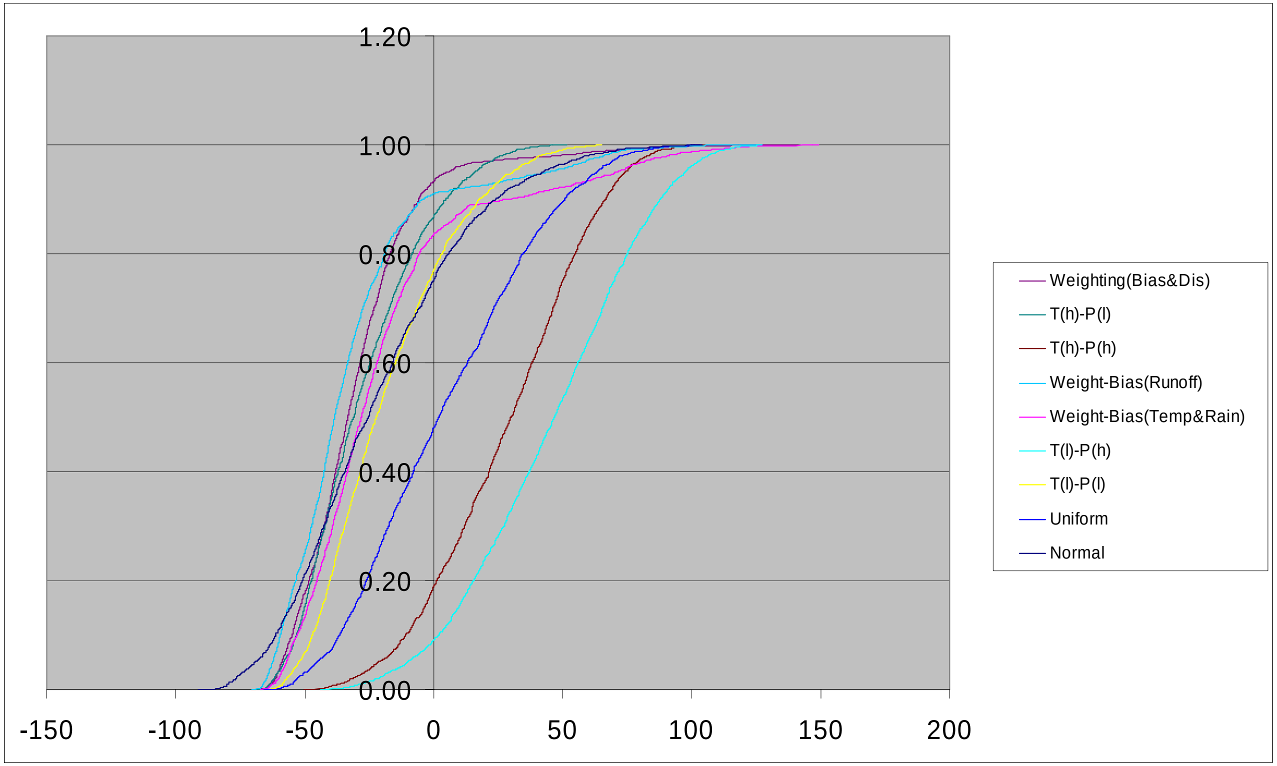


UK Climate Impacts Programme

Further development….

- Weighting?
- Ensemble ‘averaging’
- Monte Carlo sampling – RCM PDFs
  - ENSEMBLES D2B.6, D3.2.1, D1.2 http://www.ensembles-eu.org/
  - Dessai, 2005 http://www.uea.ac.uk/~e120782/thesis.pdf
  - Dessai et al., 2005, *JGR*
  - Ali-Reza Massah Bavani work on Iranian runoff

Effect of prior distribution and weighting method on winter runoff distributions for Zayandeh Rud river, Iran



Based on 7 GCM A2 scenarios

1. What uncertainties should be represented in climate scenarios for impacts assessments?

- what uncertainties can we reasonably expect to be represented in climate scenarios for impacts assessments?

- and what underlying assumptions will still have to be made?

- what guidance can we provide to help users take account of uncertainty?

- how explicit do we need to be about the nature of the various uncertainties and how they are (or are not represented)?

- will emissions scenario uncertainty have to be handled separately?

2. Are PDFs the most appropriate way of representing the uncertainties? What are the alternatives (e.g., probability bounds, two- or three-dimensional response surfaces)? What if users want maps?

3. Are industry approaches to climate variability sufficiently advanced to cope with new probabilistic information on climate change? Are there any examples of industry using (or preparing to use) probabilistic information on climate change?

4. How might industry make use of new probabilistic information:

- what are the advantages and disadvantages, compared with non-probabilistic scenarios?
- how important is synthetic time-series data?
- can climate change impacts be described in probabilistic terms?
- how does this information fit with current decision-making processes (and attitudes to risk) and what changes to these processes will be needed?
- how will users access the information? How can it be presented most usefully to different audiences – eg., for impacts users, for decision-makers, for less technical users?
- what communications/visualisation challenges and opportunities will all this bring?