Effective dissemination of uncertain forecasts

Liz Stephens,

UUEM Workshop, January 10th 2013

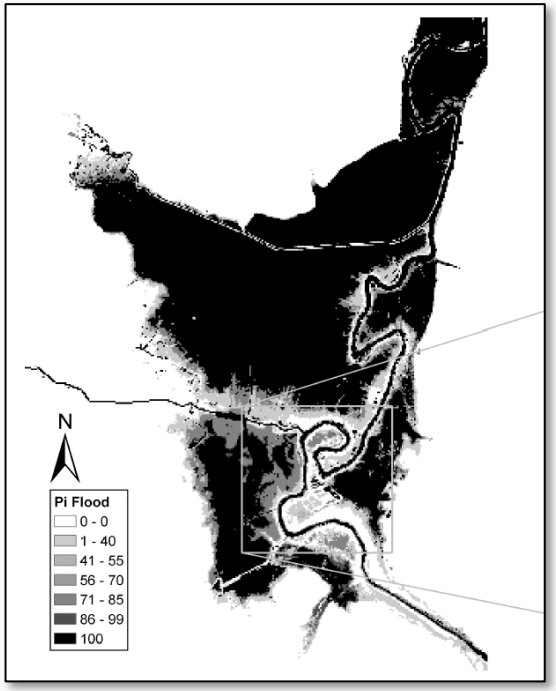
@liz_stephens

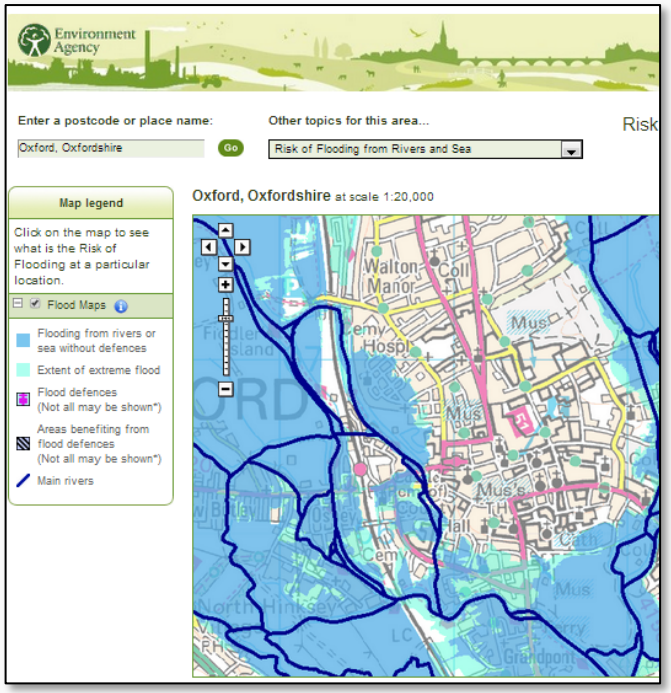
University of Reading

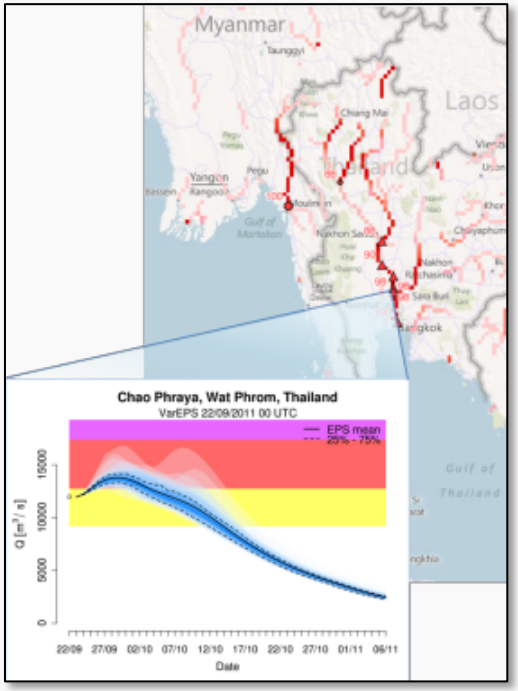
The Leverhulme Trust

Brief biography…

- Geographer / hydrologist
- PhD in modelling flood risk (U. Bristol)
- Worked on communication of uncertainty (PhD internship with Met Office)
- Moved into interdisciplinary work on usability of forecasts, with anthropologists and physicists (U. Oxford)
- Recently started a Leverhulme fellowship looking at usability of global flood forecasts for humanitarian response (U. Reading)







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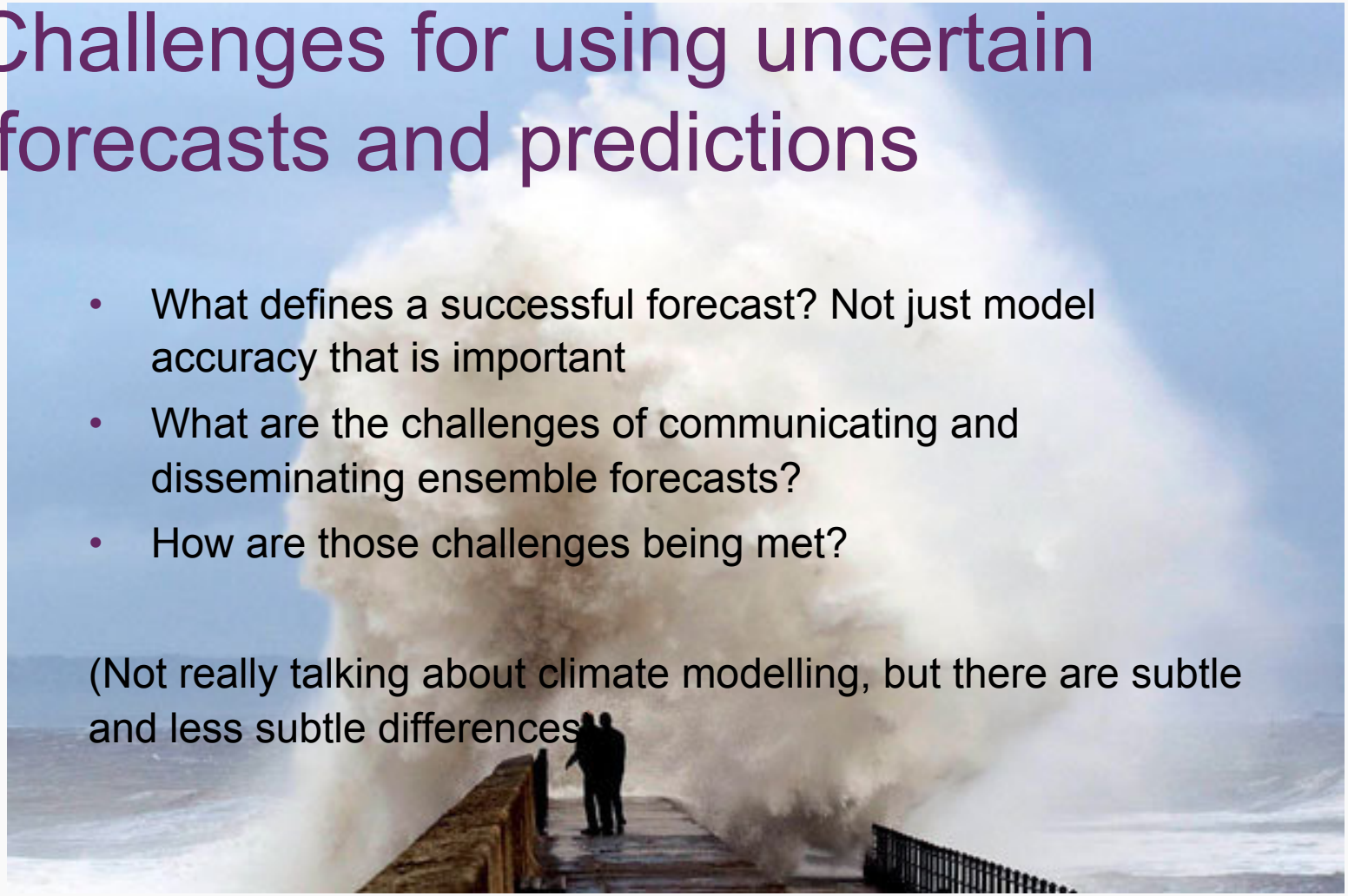
Challenges for using uncertain forecasts and predictions



- What defines a successful forecast? Not just model accuracy that is important
- What are the challenges of communicating and disseminating ensemble forecasts?
- How are those challenges being met?

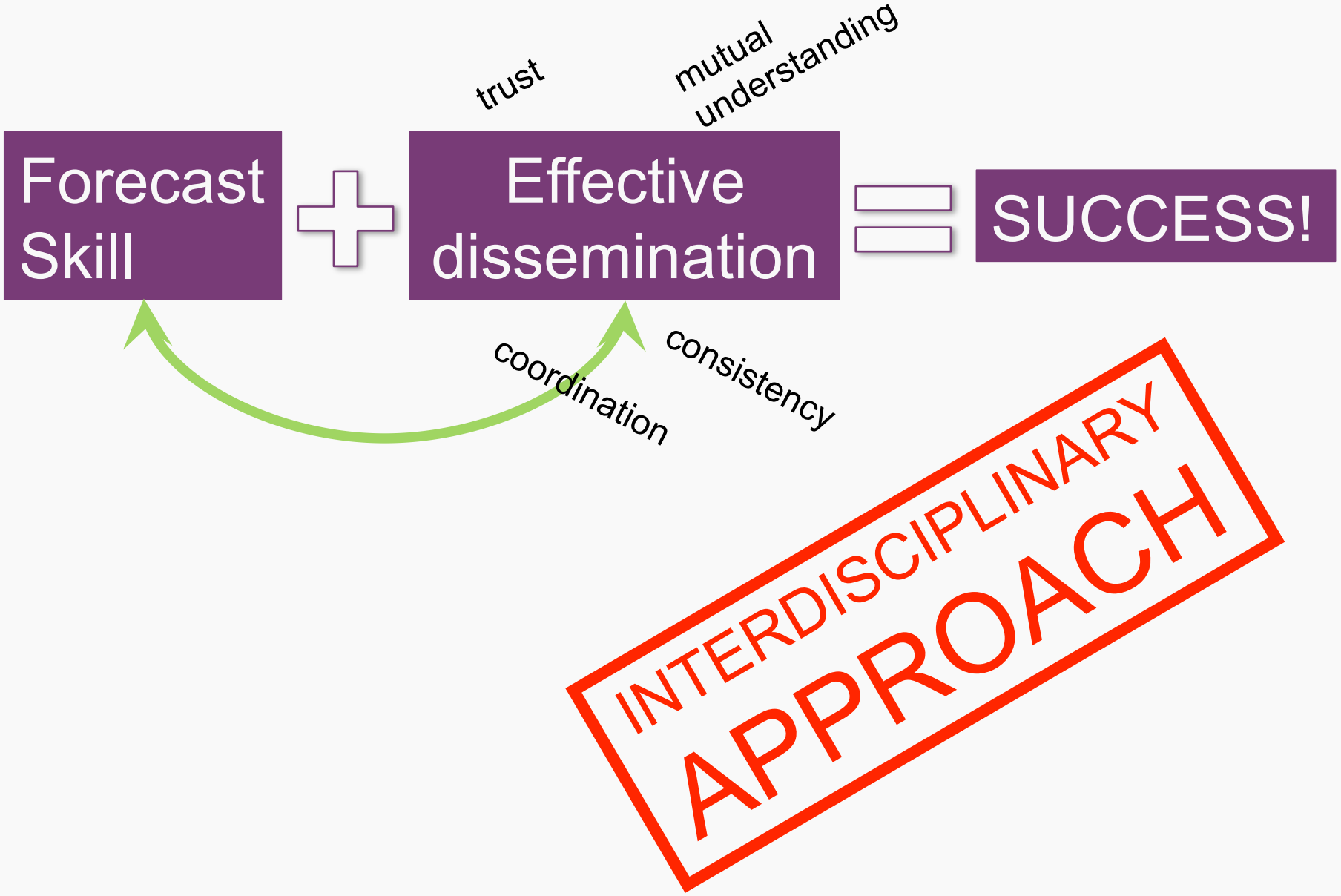
(Not really talking about climate modelling, but there are subtle and less subtle differences)

So how do you make [issue] a good forecast?

[Definition of forecast I use for this talk, defining things is very important!]

OBVIOUSLY

You can't have an early warning system without a warning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trust
mutual understanding
Forecast Skill
Effective dissemination
SUCCESS!
coordination
consistency
INTERDISCIPLINARY
APPROACH

An extreme event: Hurricane Sandy

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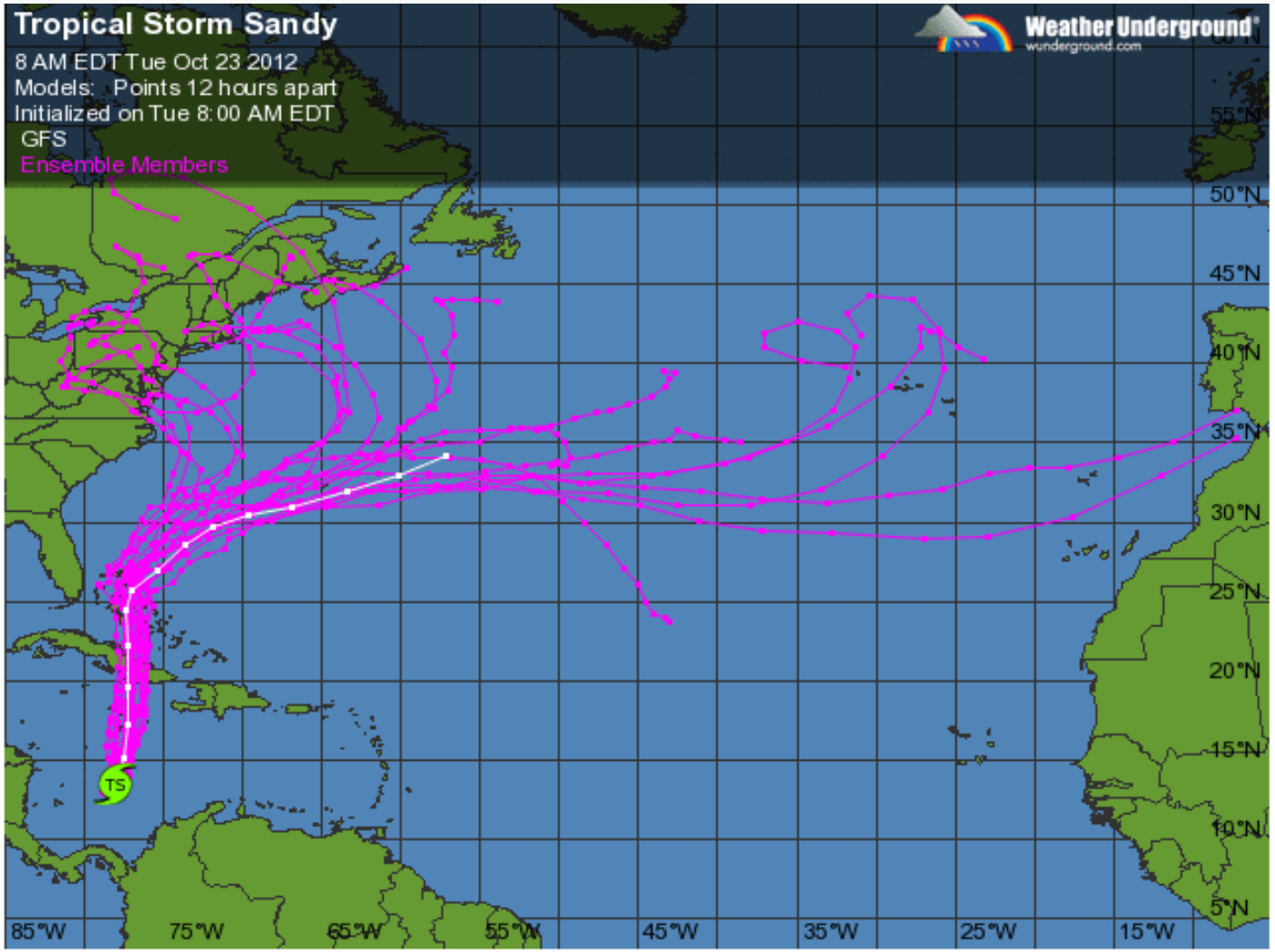

Figure 2. The Tuesday morning 06Z (2 am EDT) run of the GFS model was done 20 times at lower resolution with slightly varying initial conditions of temperature, pressure, and moisture to generate an ensemble of forecast tracks for Sandy (pink lines). These forecasts show substantial uncertainty in Sandy's path after Friday, with the majority of the forecasts taking Sandy to the northeast, out to sea, but a substantial number predicting a landfall in the Northeast or mid-Atlantic states of the U.S. The white line shows the official GFS forecast, run at higher resolution.

“Hazards, risks, advice, how far should we go?” – EMS2013 Plenary Discussion

- Reflected concern and frustration that forecasts were not being acted upon

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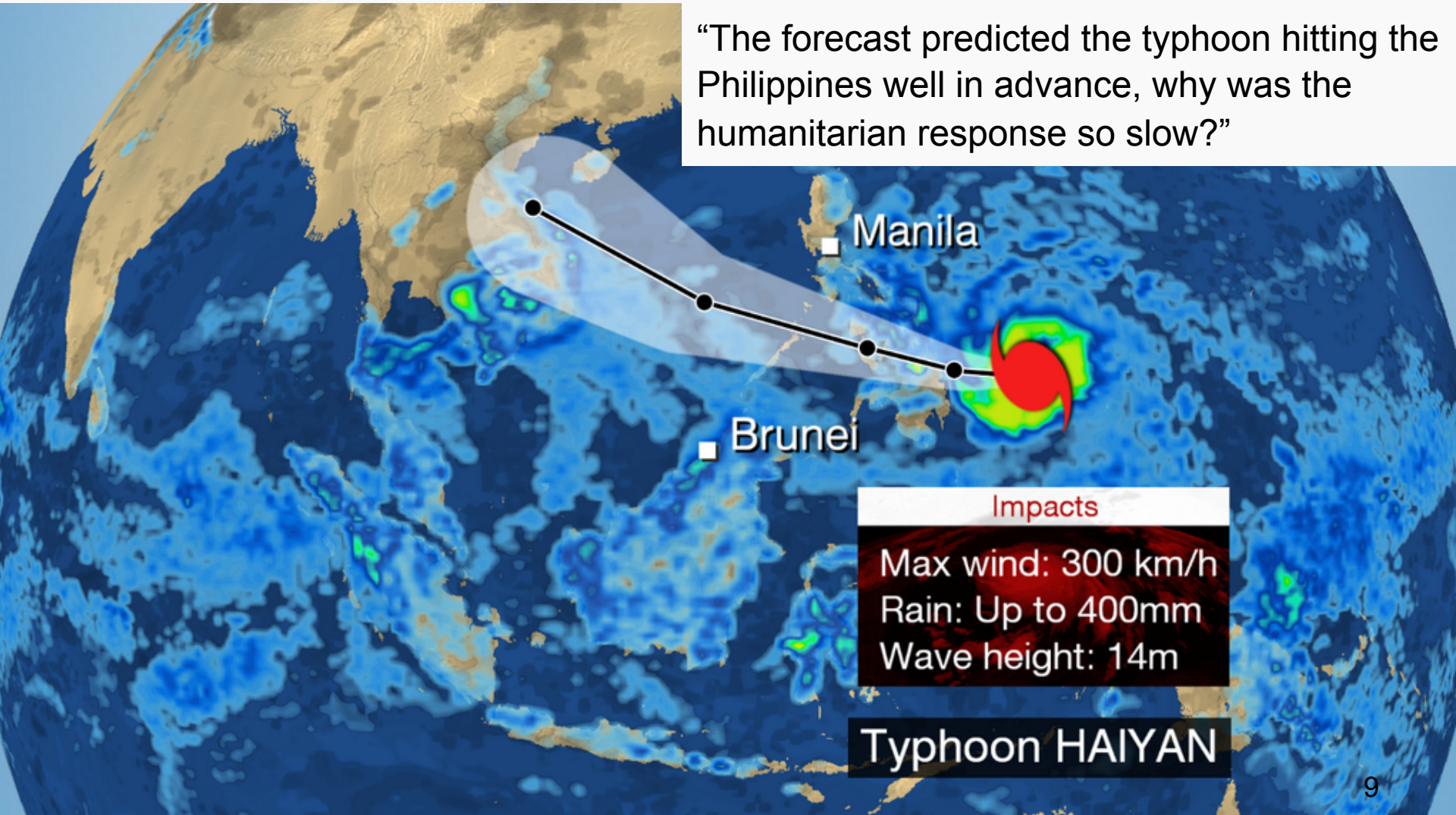
Typhoon Haiyan

"The forecast predicted the typhoon hitting the Philippines well in advance, why was the humanitarian response so slow?"



Snow in UK

"Why do people still drive when snow is forecast?"

Evacuation

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Japan typhoon: Rescuers search debris for missing

Aerial footage shows search teams combing Izu Oshima island

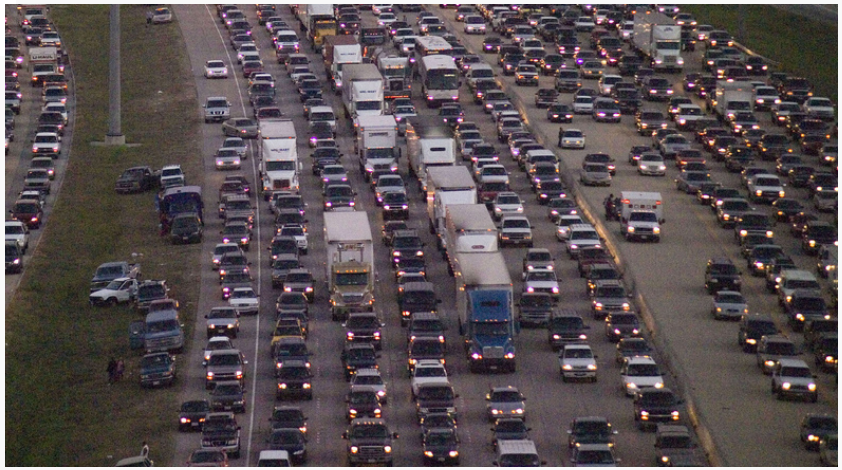
Rescuers in Japan worked overnight and into Thursday looking for survivors of Typhoon Wipha, which has killed at least 18 people.

"I'd like to offer an apology because some people could have been saved if the town had issued an evacuation advisory or order," the mayor of the island, Masafumi Kawashima, said.

He said that he had not issued an evacuation advisory at the time because he feared that doing so "in the middle of heavy rains in the dark could lead to a secondary disaster".

"But in retrospect, I think that was naive," he said.

Related Stories



Clip: Ignoring advice to evacuate

Weather Forecasts Are For wimps: Why Water Resource Managers Do Not Use Climate Forecasts

(Rayner et al. 2005)

Priorities for water resources industry in US:

1) Water coming out of tap
2) Clean water
3) Cheap

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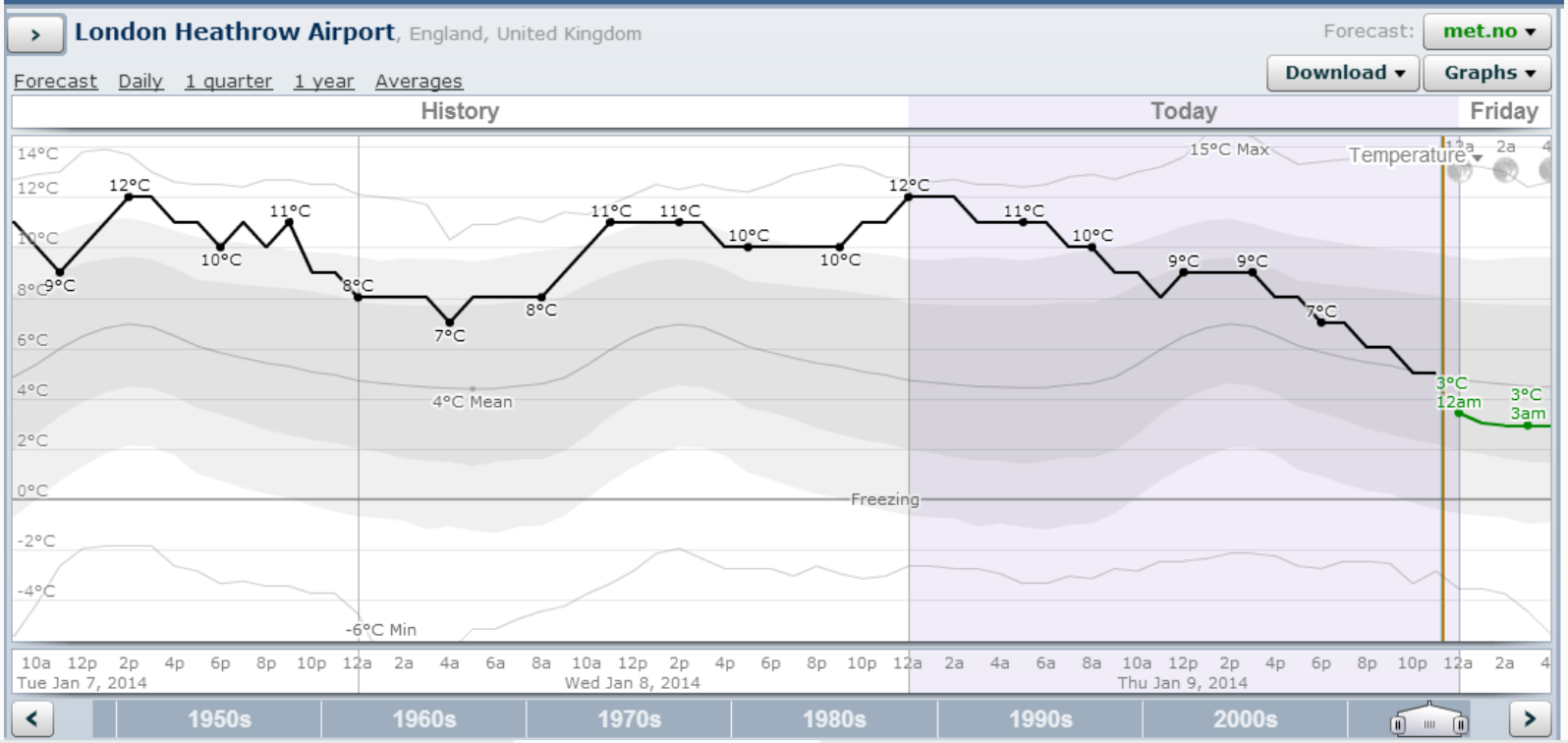
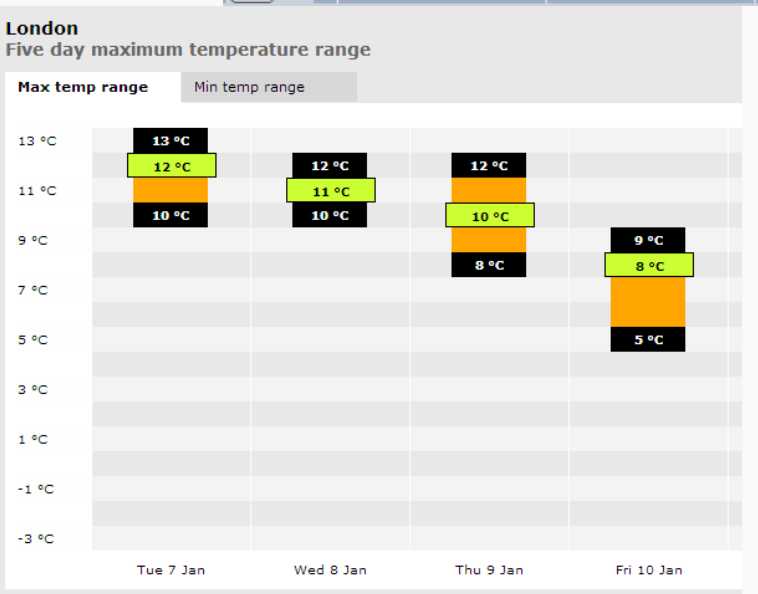
Let’s start with communication:

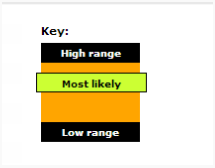
What is currently out there?
Is it being understood?

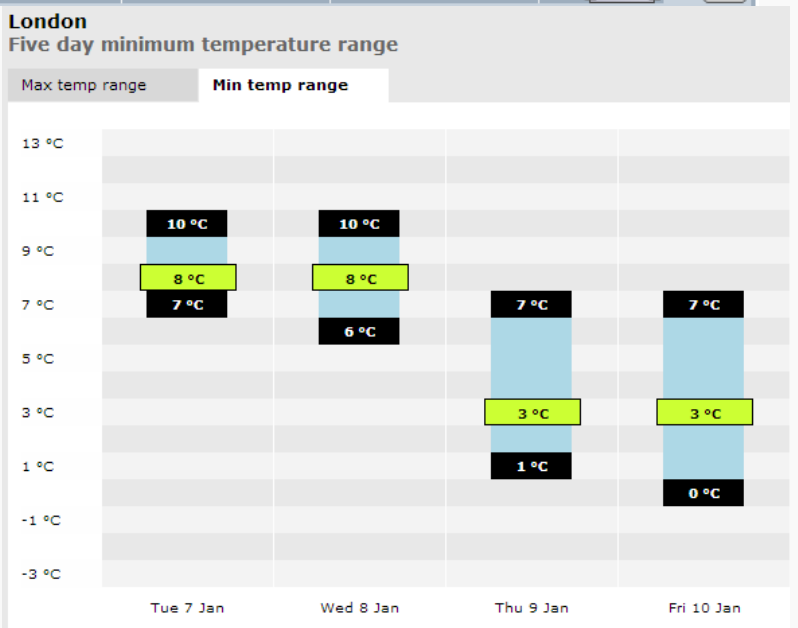




Issued at: 1400 on Tue 7 Jan 2014

Select the 'Max temp range' or 'Min temp range' tab to view the range and 'most likely' daily maximum minimum temperature expected respectively.





Issued at: 1400 on Tue 7 Jan 2014

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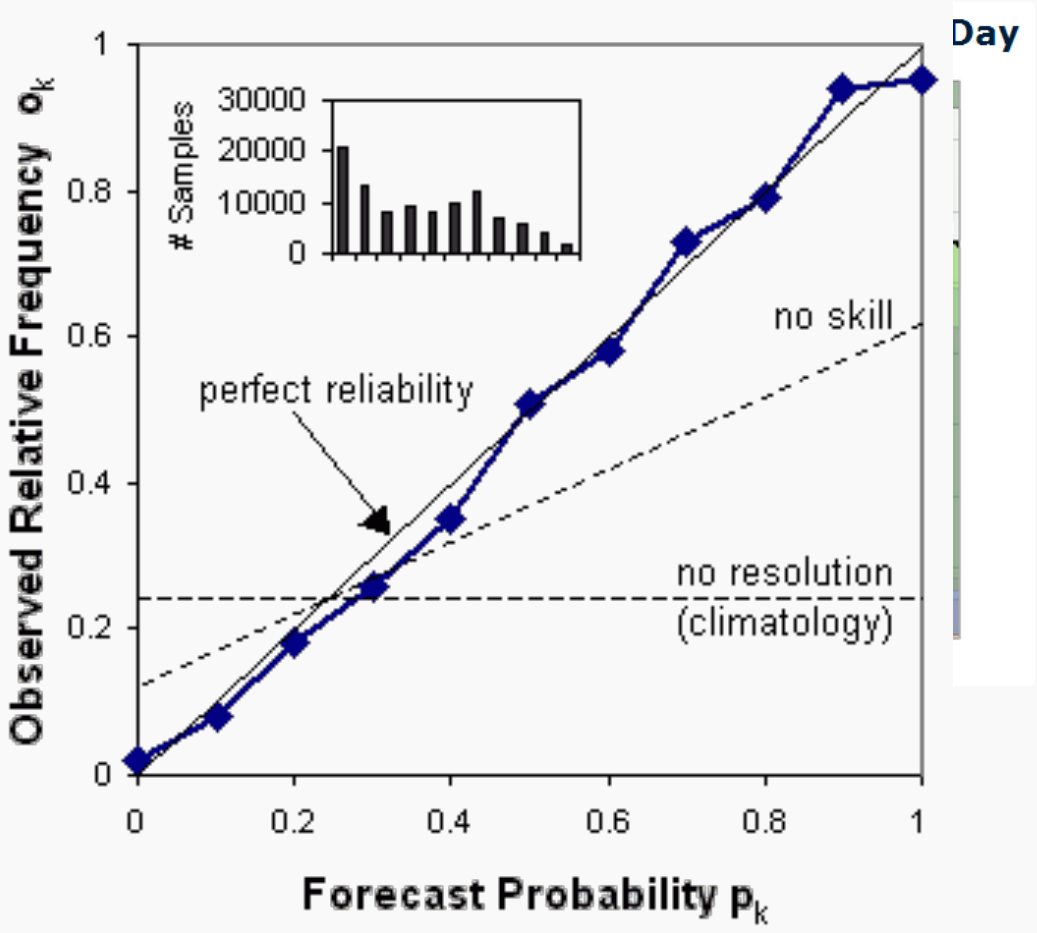
Is this useful information?

Met Office Android App



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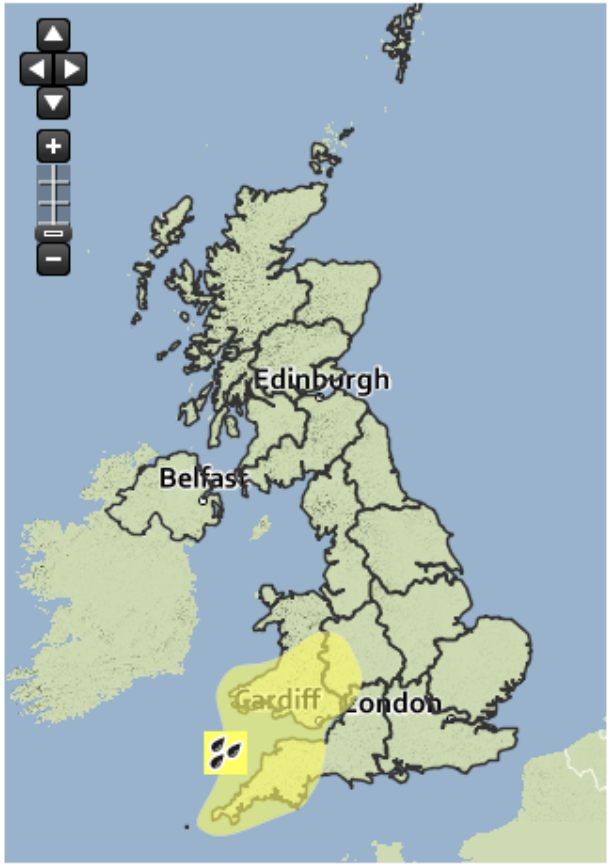
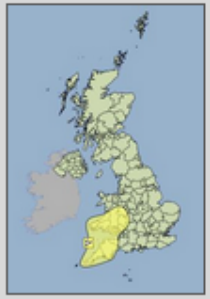
Warnings overview: United Kingdom

Issued on Wed 8 Jan

Wed 8 Jan



Wed 8 Jan	Thu 9 Jan	Fri 10 Jan	Sat 11 Jan	Sun 12 Jan
				

Use the small maps above to select the weather warnings over the next five days. Click on your chosen region below for more details of current warnings in force.

United Kingdom	North West England
Orkney & Shetland	North East England
Highlands & Eilean Siar	Yorkshire & Humber
Grampian	West Midlands
Strathclyde	East Midlands
Central, Tayside & Fife	East of England
SW Scotland, Lothian Borders	South West England
Northern Ireland	London & South East England
Wales	

Key: Be aware; Be prepared; Take action; Rain; Wind; Snow; Ice; Fog

The Met Office has responsibility for providing weather warnings for the UK.

Coloured regions on the map show where severe weather warnings have been issued. When issued, the public are advised to take extra care. Further information and advice can be found on the: Severe weather impact links page.

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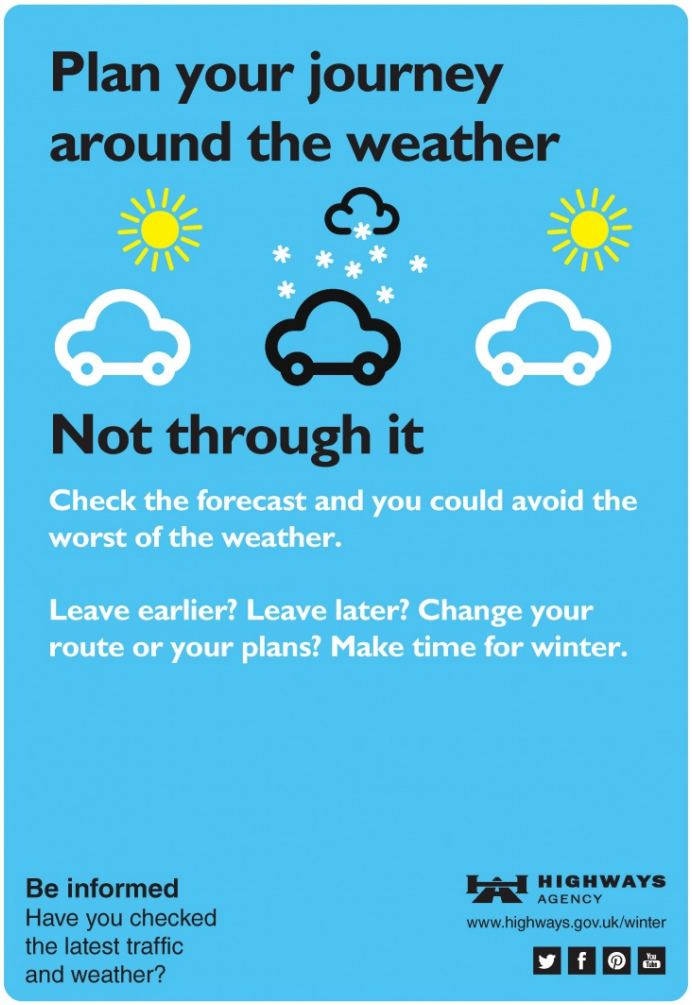
Communication:

The public



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Communication of ensemble forecasts

What prohibits organisations from presenting information from an ensemble forecast?

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Communicating complex ensemble forecasts is too difficult
(Is there one good way of presenting them?)

I use Google weather and Foreca and both have used % probability of rain for as long as I can remember. I much prefer that concept than a "likely", "most likely " prediction that means different things to different people.Very clear and easy to understand. Let's have more of it!

- alimac, berkshire, 10/11/2011 14:12

Report abuse Click to rate **Rating** 7

We've used this system for many years. Unless the forecasters predict something 100 per cent, thay are never wrong! Seems to work well for them.

- William, Atlanta, Georgia, USA, 10/11/2011 0:18

Report abuse Click to rate **Rating** 31

Probabilities will be seen as a get-out clause
(Meteorologists are just covering their backs)

People won't understand what the probability refers to
(reference class errors such as this)

I can only speak of the U.S weather forecasters when I make this comment. When a forecaster uses percentages like 20% chance of rain, what that really means is that there is going to be rain but it will be over 20 percent of the area and which area that gets that rain, not even the forecaster knows but someone will be seeing rain. Ambiguous I know.

- Elizabeth , London, England by way of Chicago, 10/11/2011 13:36

Current BBC website - sunny intervals. Info above >5% chance of precipitation. So why am I looking at rain?

- bebe, high wycombe, England, 10/11/2011 12:15

Report abuse Click to rate **Rating** 14

People won't be able to make use of the extra information (Is it just converted to a binary prediction?)

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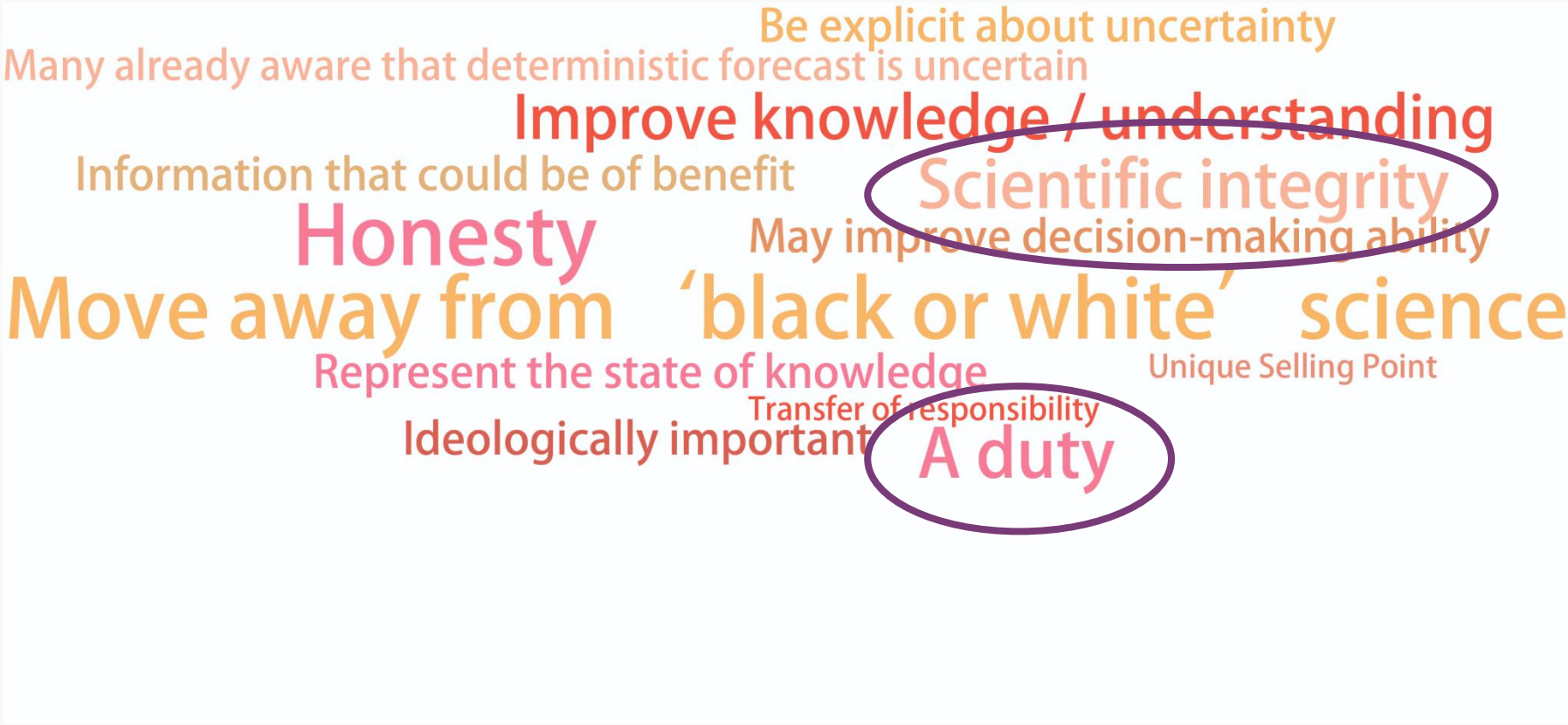
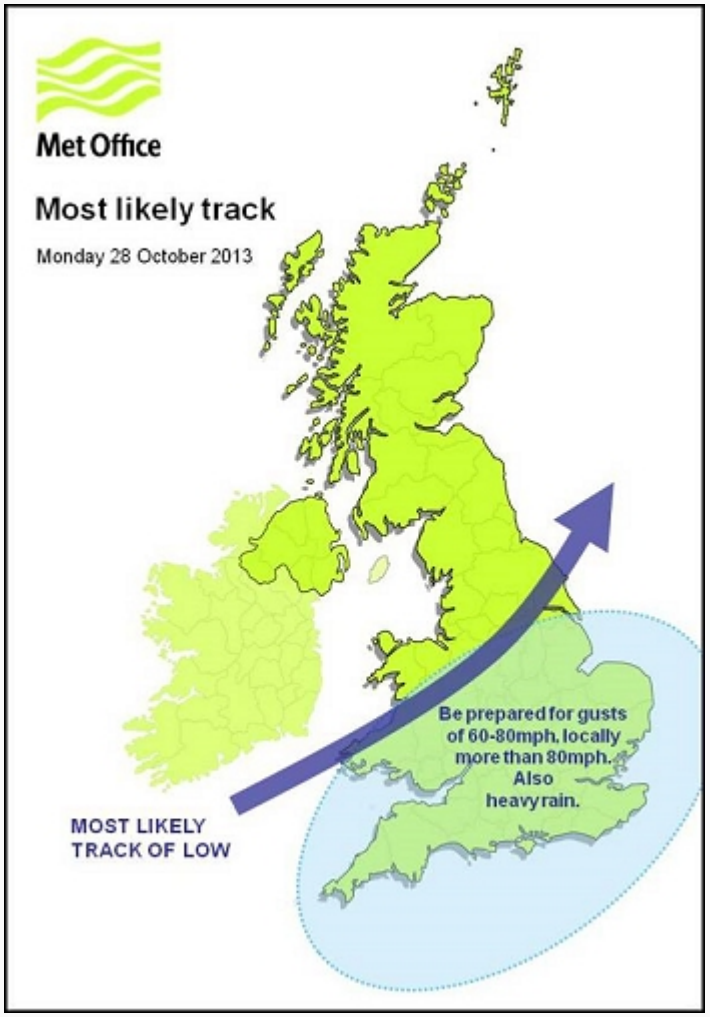


Why do meteorologists want to present uncertainty to the public?

Communication



"Why doesn't the BBC present uncertainty in its forecasts?"

Met Office Weather Game

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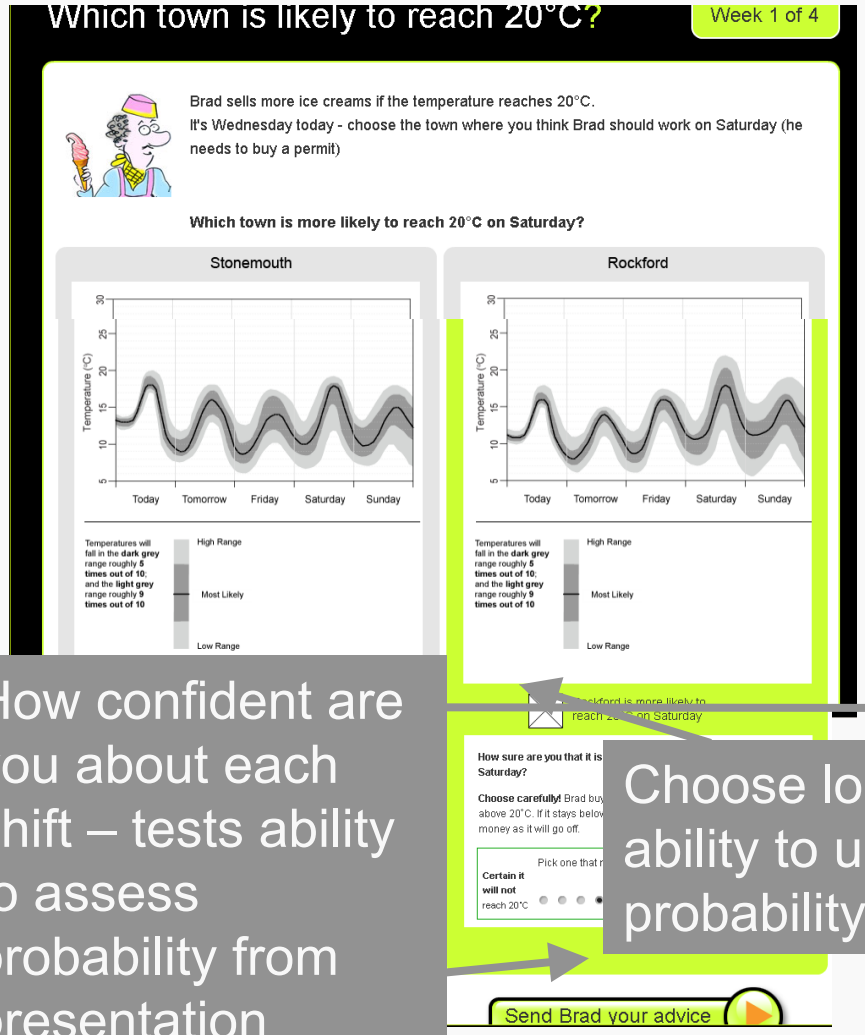

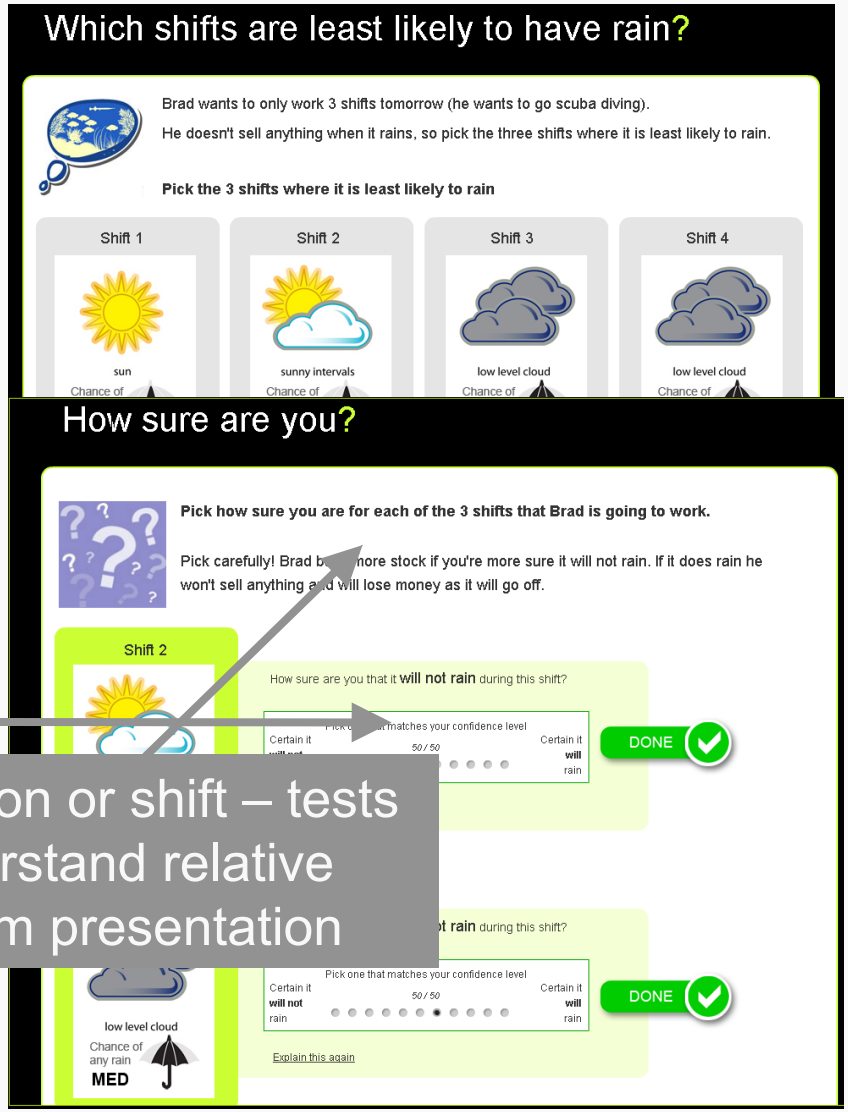

How confident are you about each shift – tests ability to assess probability from presentation

Choose location or shift – tests ability to understand relative probability from presentation

Weather game results

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- On average, participants presented with probabilistic information scored better than those with the deterministic forecast
- No real difference when rainfall probability is accompanied by a graphical representation, might even cause confusion
- In contrast, the graphical representations of temperature show improvement over the table of text
- For rainfall results at least, age and educational attainment are significant influences on a participant's ability to interpret probabilities
- But there are limitations and assumptions in these conclusions, especially because this is just 'everyday' weather

What about the seasonal forecast?

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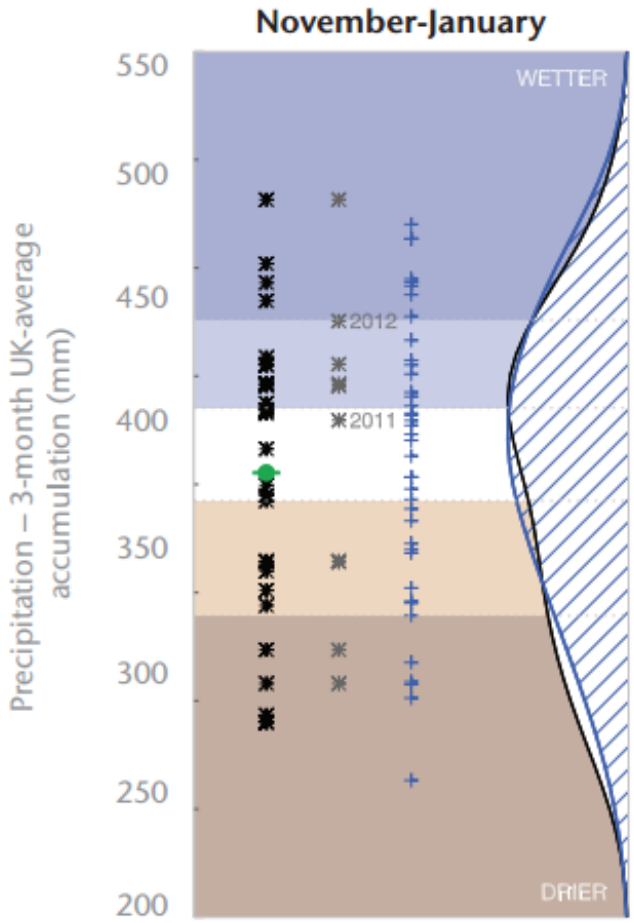
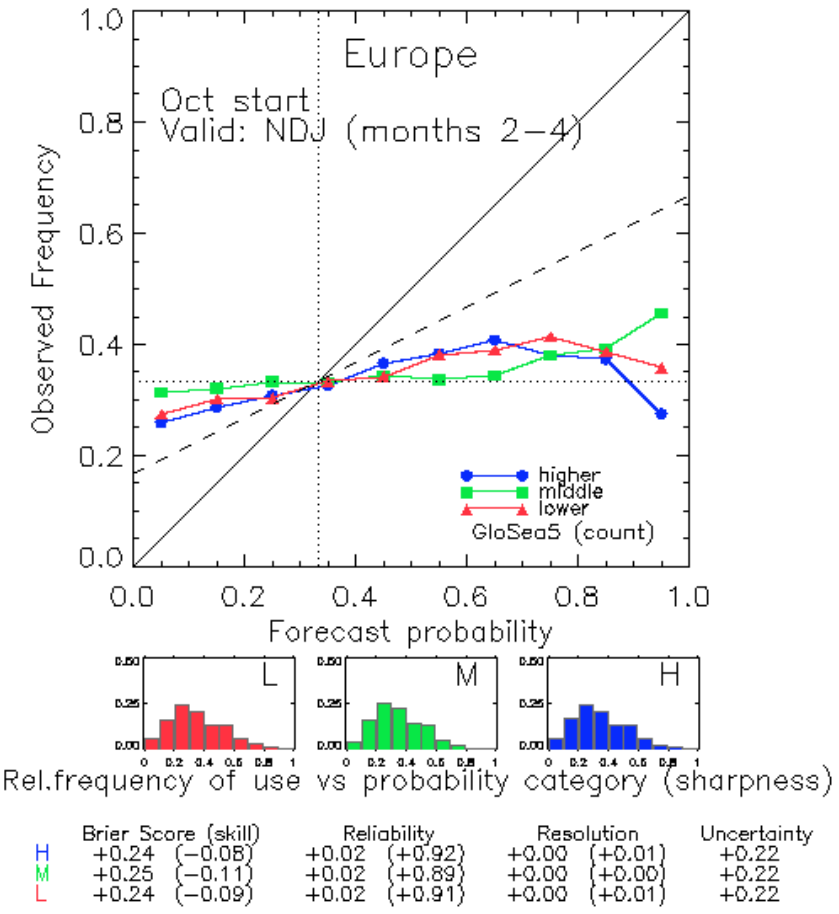
1-month and 3-month UK outlook for precipitation in the context of observed climatology

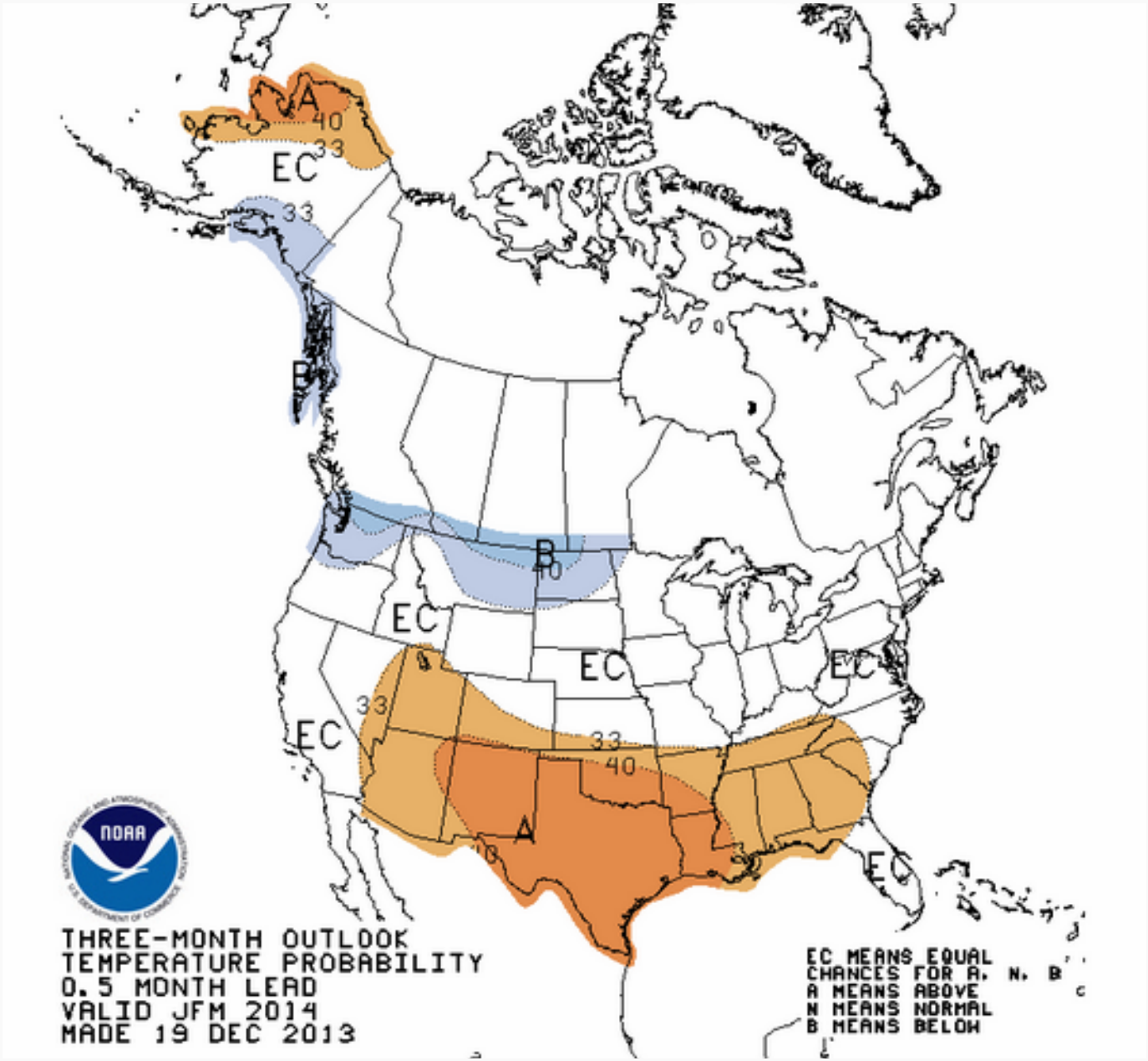




Observations 1981-2010 | 1981-2010 Average | Observations 2003-2012 | 2013-14 outlook: + Nov-Jan

From http://www.metoffice.gov.uk/publicsector/contingency-planners

http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/glob-seas-prob-skill


A
40
33
EC
33
B
B
40
EC
EC
EC
EC
33
33
40
A
EC
NOAA
THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
0.5 MONTH LEAD
VALID JFM 2014
MADE 19 DEC 2013
EC MEANS EQUAL
CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW

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Communication:

Audience considerations

Considerations for communicating ensemble forecasts

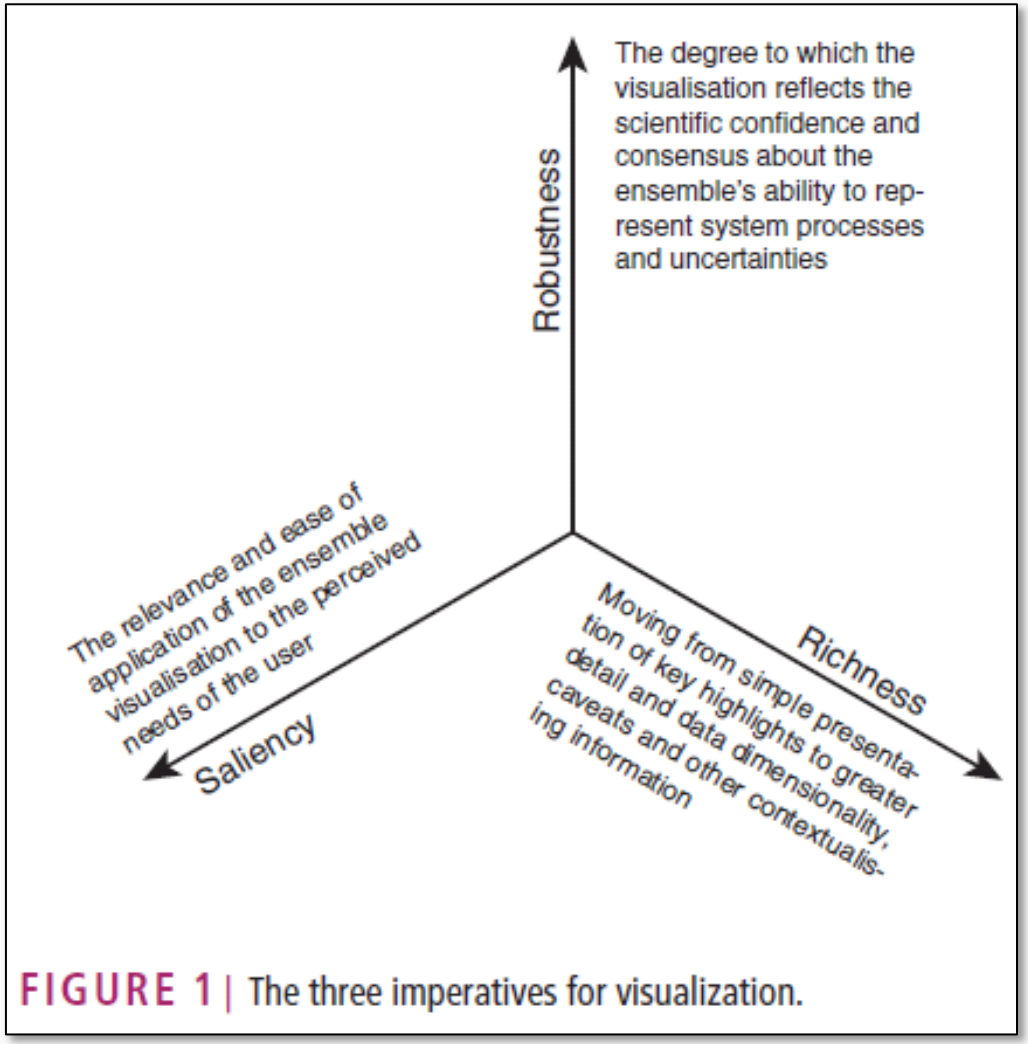
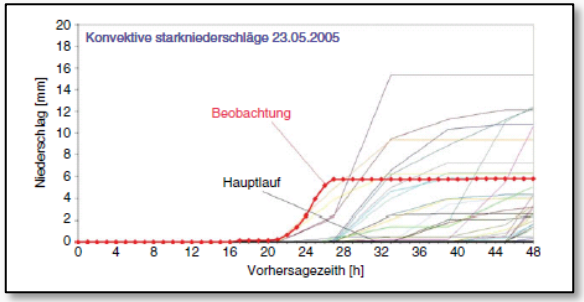
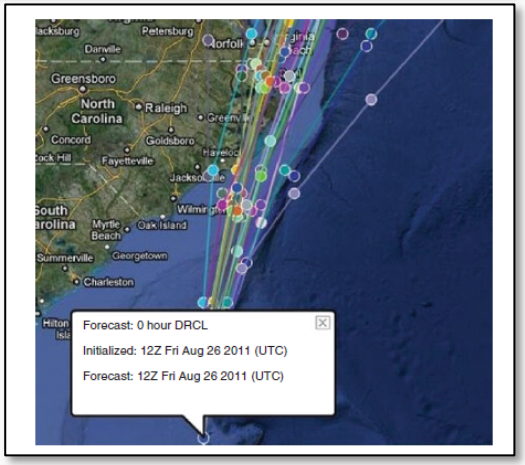
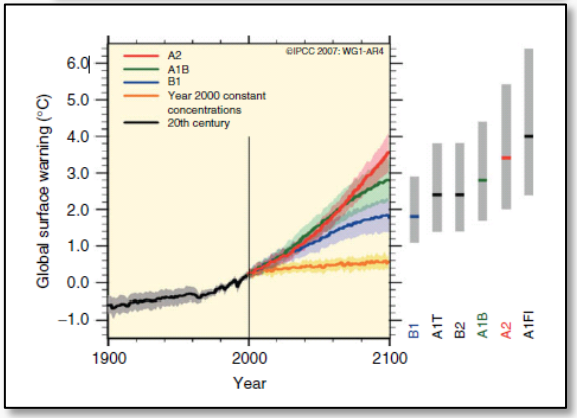


FIGURE 1 | The three imperatives for visualization.







Communicating probabilistic information from climate model ensembles—lessons from numerical weather prediction.
Stephens E, Edwards T, Demeritt, D. (2012) *WIREs Climate Change*. 3: 409-26

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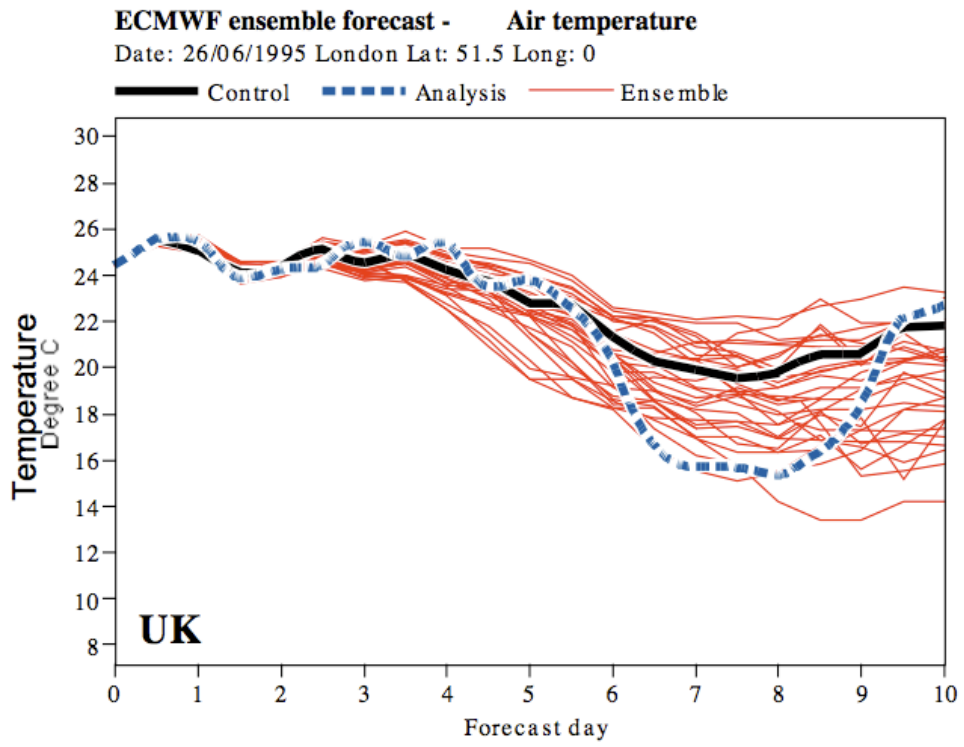
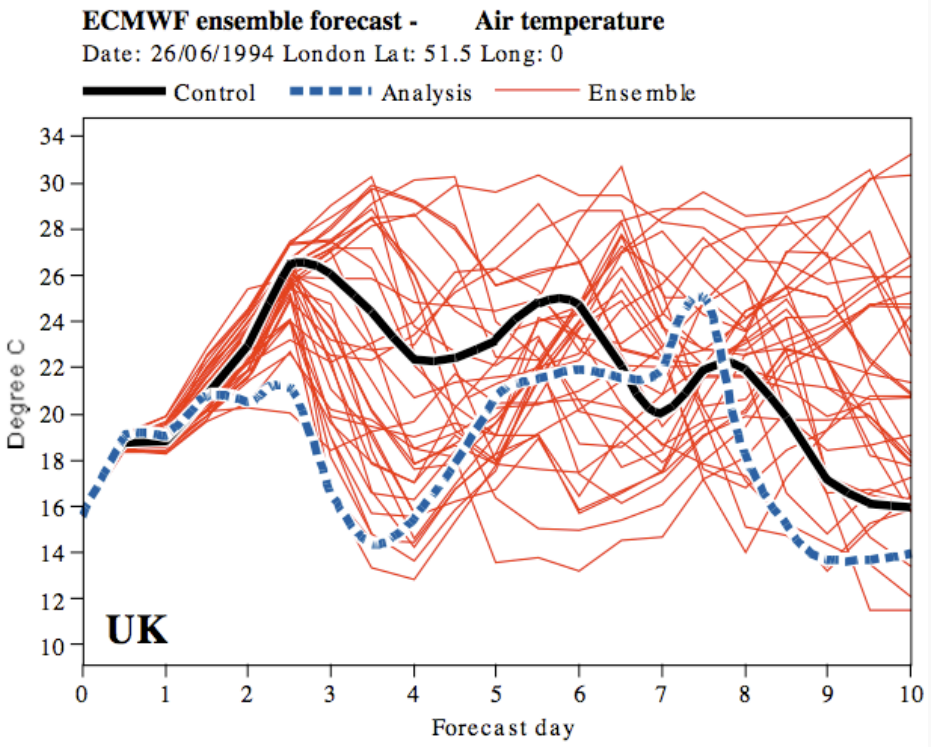
26th June 1995



26th June 1994



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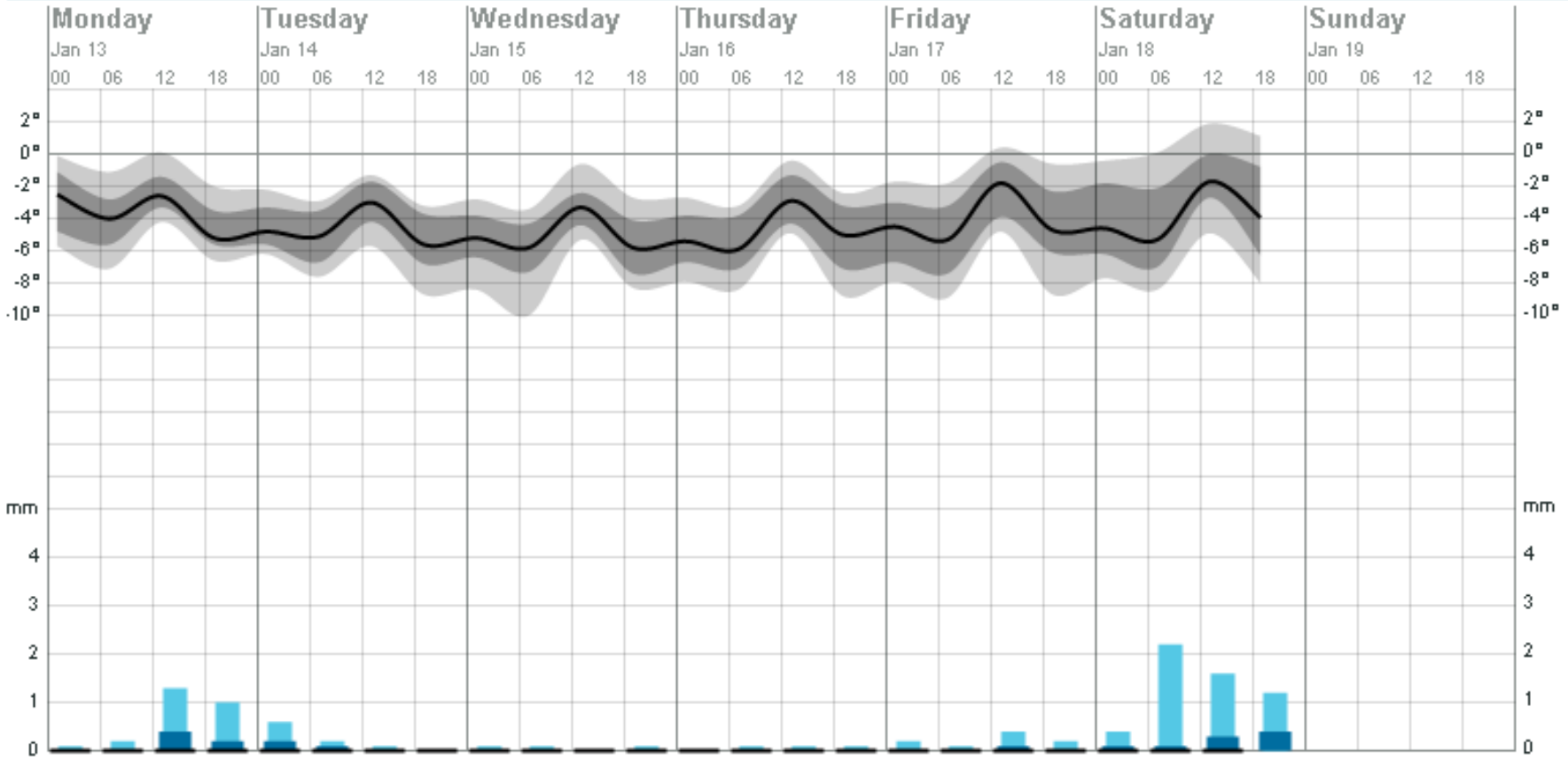
Probability forecast for Stavanger

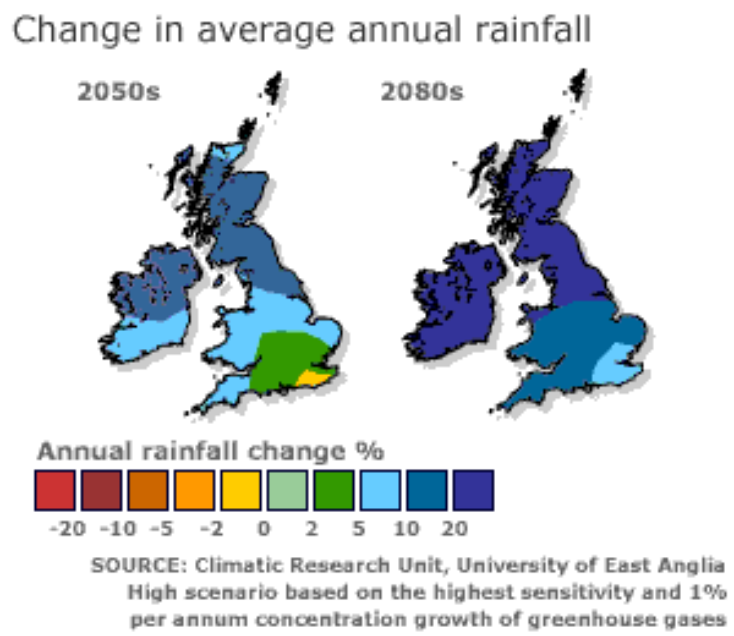


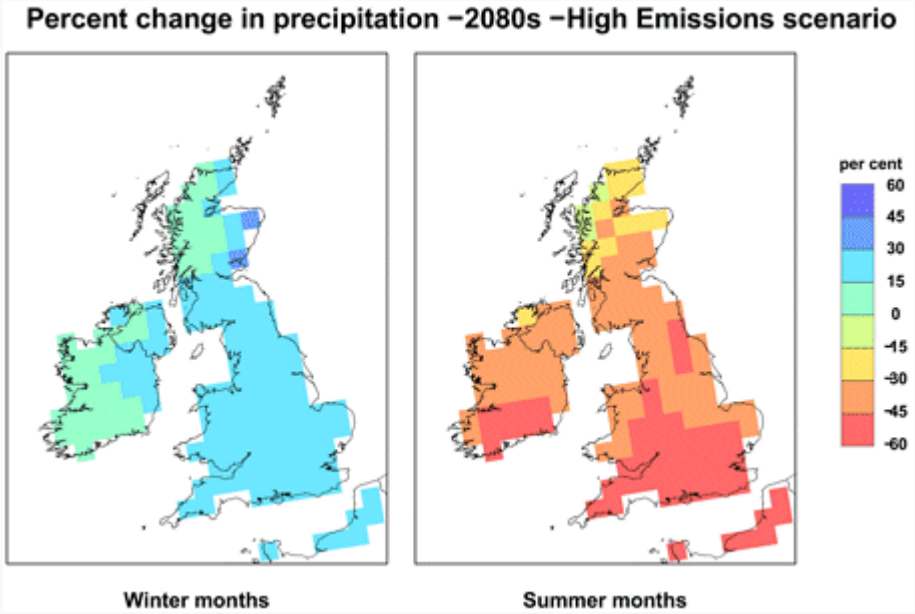
Long time forecast is quite reliable for temperature when the grey area has a narrow spread. Likewise it is quite reliable for precipitation when the blue bars are short.

The long time forecast is uncertain when the gray area has greater spread, and the blue bars are long.

Temperature:
50% probability
30% probability

Precipitation:
50% probability
30% probability


Change in average annual rainfall
2050s
2080s
Annual rainfall change %
-20 -10 -5 -2 0 2 5 10 20
SOURCE: Climatic Research Unit, University of East Anglia
High scenario based on the highest sensitivity and 1%
per annum concentration growth of greenhouse gases


Percent change in precipitation –2080s –High Emissions scenario
per cent
60
45
30
15
0
-15
-30
-45
-60
Winter months
Summer months

So is communication the problem?

Extreme weather events still lead to avoidable deaths, disruption and damage

- Is this because the forecast wasn't understood?
- Is it because the forecast wasn't trusted?
- Is it because the risks were not understood?
- Where does the responsibility lie for ensuring that people take the 'right' decision from a forecast?
- And what can we, as scientists, learn from answering these questions?

Interdisciplinary Research

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"the value of a forecast system may not be solely related to the technical skill of the forecast model; through the course of its production, circulation and potential use it is likely to be influenced by a range of factors, which may be social/political/institutional as well as technical"

(Haines and Stephens, in prep)

Structure, management and evolution of forecast networks

Increasingly not seen as a one-way dissemination

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Model development

Data collection and assimilation

Post-processing of model output

Researchers

General Public Businesses

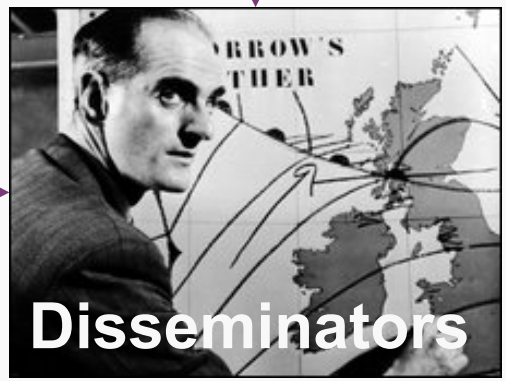
Emergency Responders

Decision-makers

Outside influences, e.g. regulations

Government

Media



- Broadcasts
- Websites
- Direct to businesses
- Internal to some organisations

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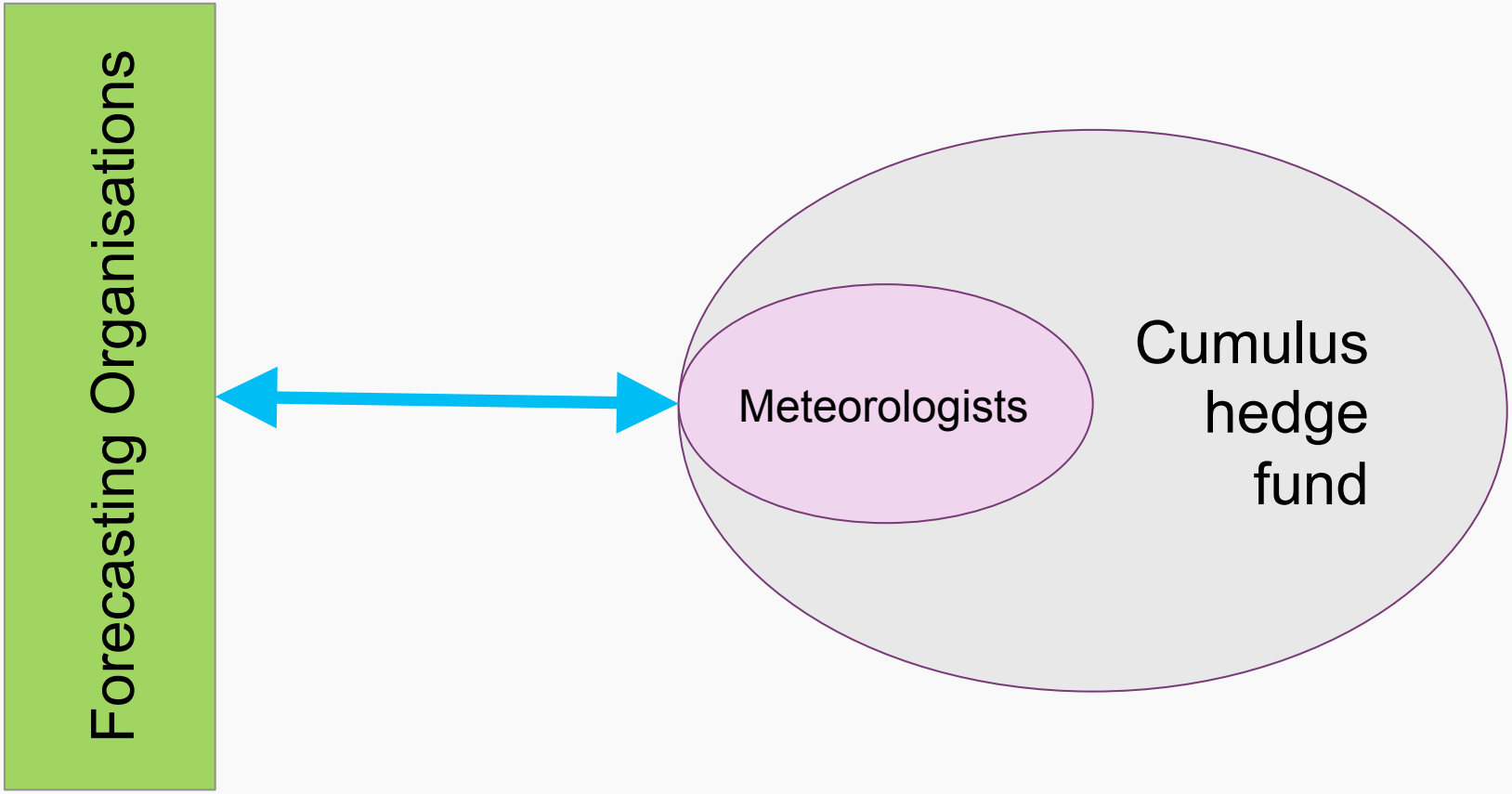
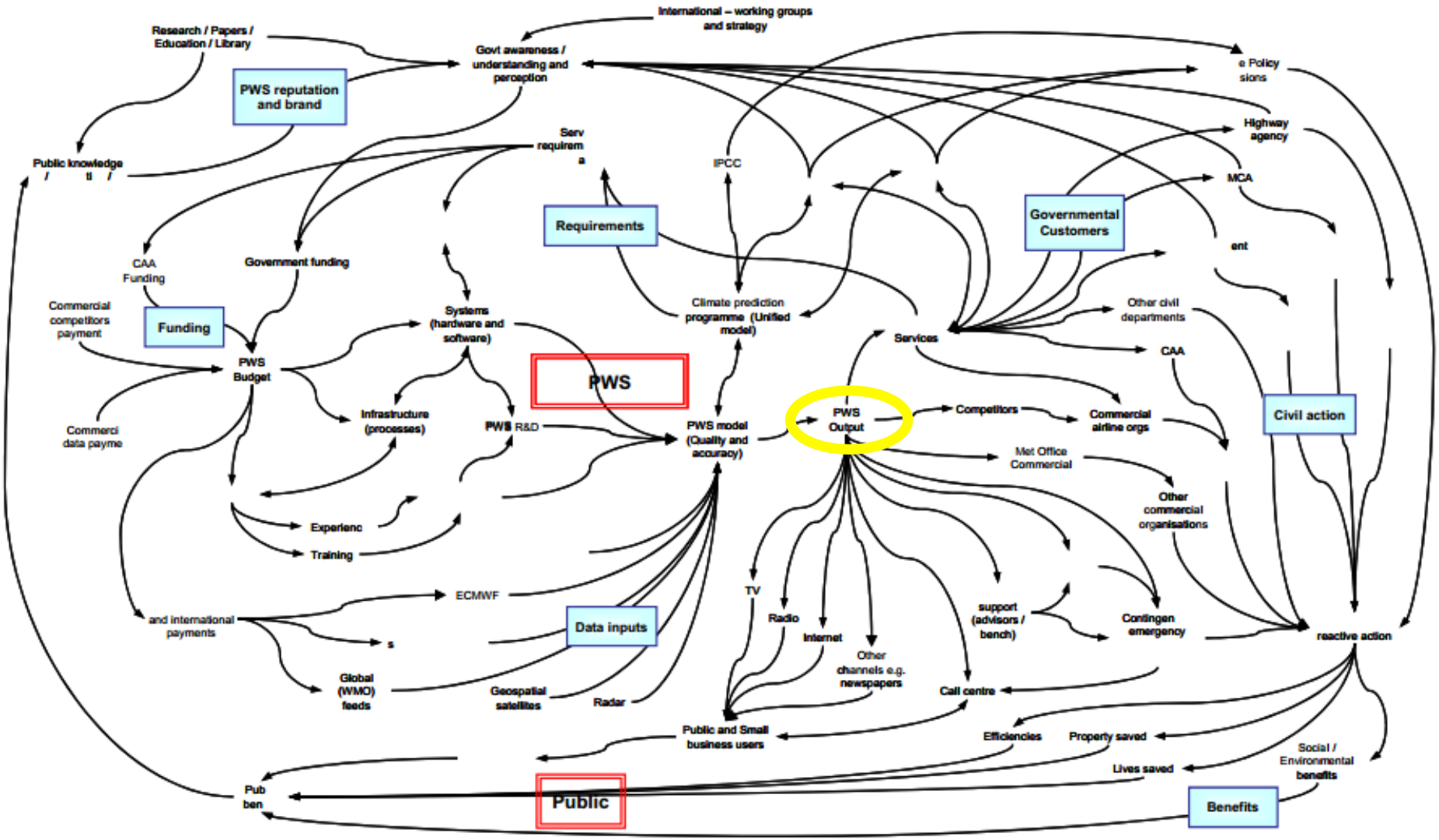


Met Office Causal Map



Structure, management and evolution of forecast networks

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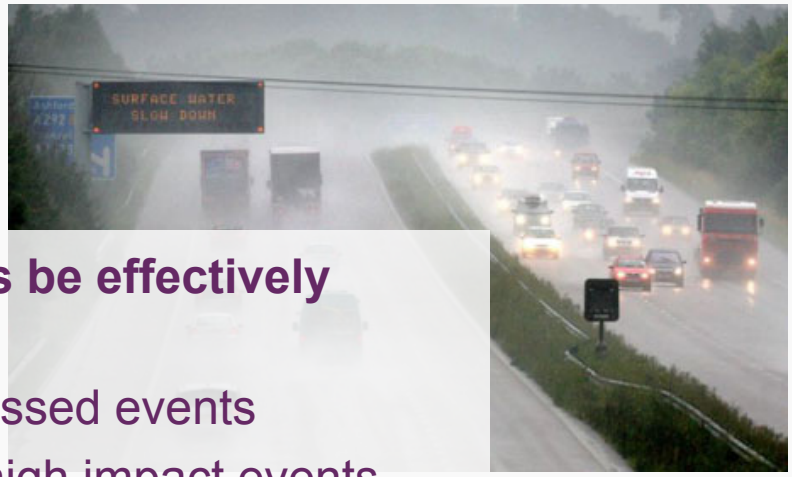

How can uncertain forecasts be effectively utilised?

Balancing false alarms and missed events

Dealing with low probability / high impact events

Can probabilities be trusted?

How can trust be promoted?

How is media criticism dealt with?

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What can scientists learn from engaging with the wider forecast network?

A better understanding of what aspects of a forecast are most useful to end-users (e.g. forecast variables, lead times, metrics), therefore avoiding undertaking research that is irrelevant to what might actually be used (if that is your aim).

How do you go about asking these questions?

In many cases, not asking someone what they want, but engaging with them to work out together what they need.

@liz_stephens elisabeth.stephens@reading.ac.uk

Small group discussion topics

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Think of the scientific and communication challenges of the following scenarios:

- Your predictions have a range of uncertainty that you are confident in?
- Your model has a range of uncertainty but you know the actual uncertainty is much larger?
- You predict a low probability / high impact event?
- You predict something unprecedented (either in terms of magnitude, timing or location)
- Retrospective evaluation of your model against data shows that it has no skill in forecasting the variable that a decision-maker wants, which you have been providing to them for the last 8 years.