

Effective dissemination of uncertain forecasts

Liz Stephens,

UUEM Workshop, January 10th 2013



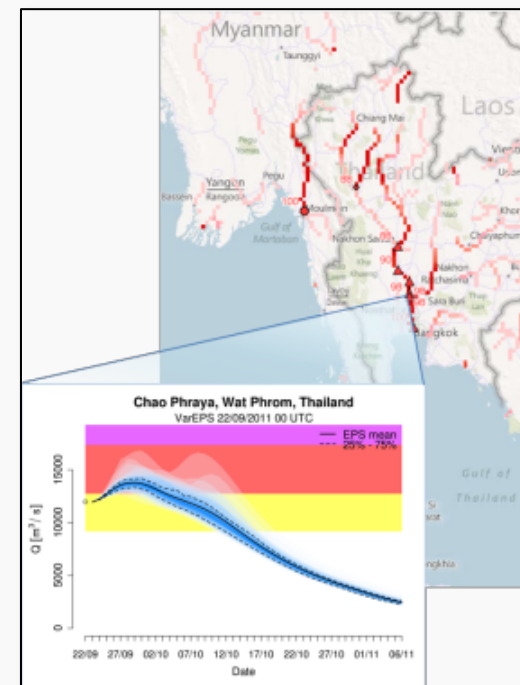
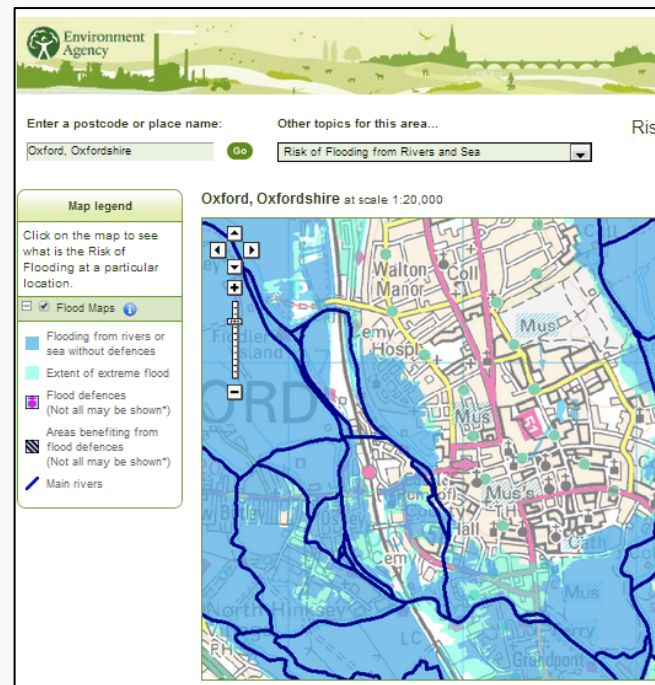
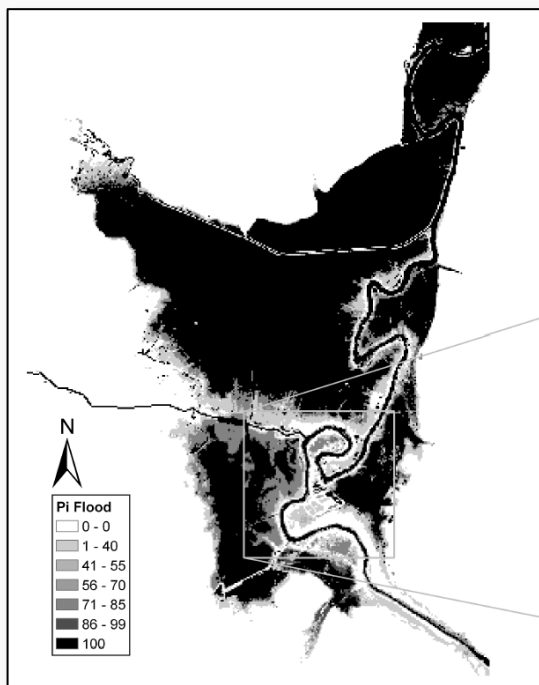
@liz_stephens



The Leverhulme Trust

Brief biography...

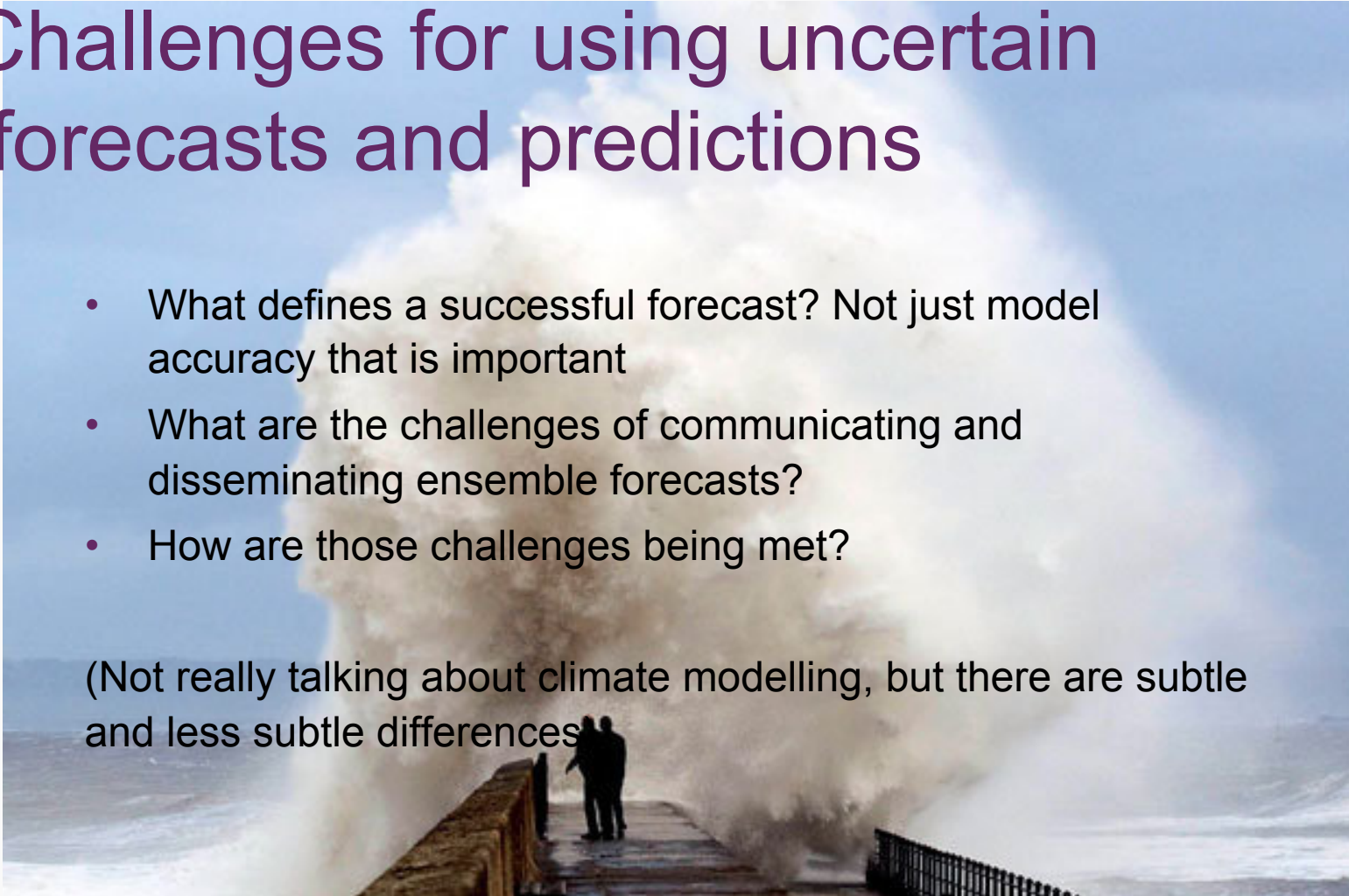
- Geographer / hydrologist
- PhD in modelling flood risk (U. Bristol)
- Worked on communication of uncertainty (PhD internship with Met Office)
- Moved into interdisciplinary work on usability of forecasts, with anthropologists and physicists (U. Oxford)
- Recently started a Leverhulme fellowship looking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



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)

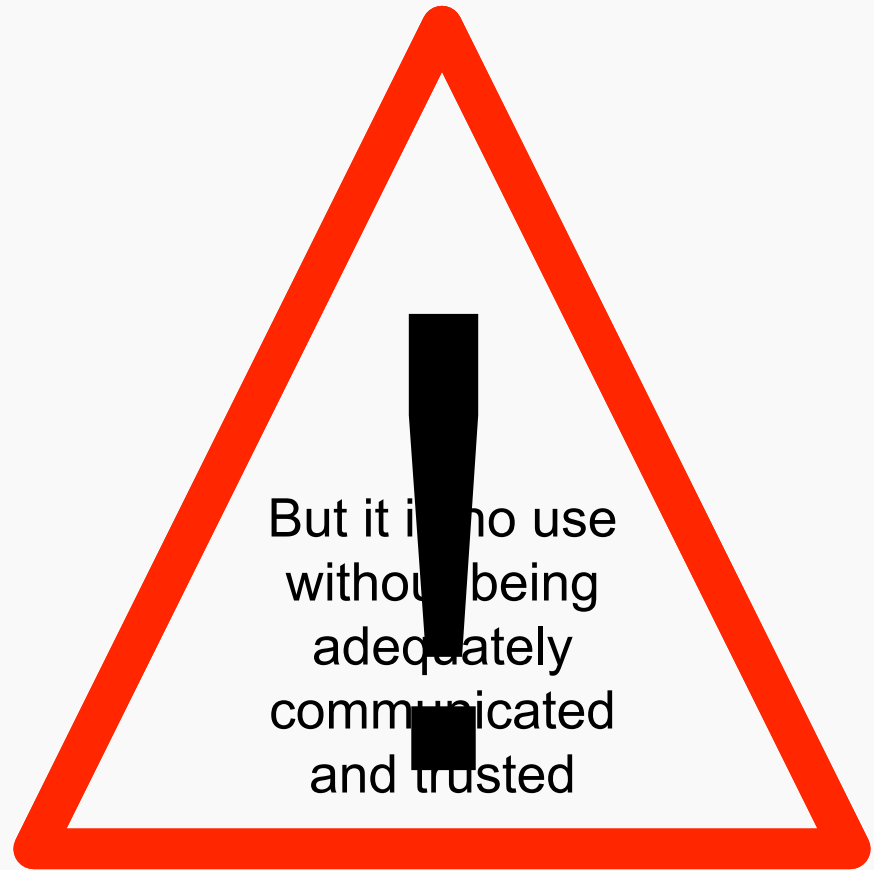


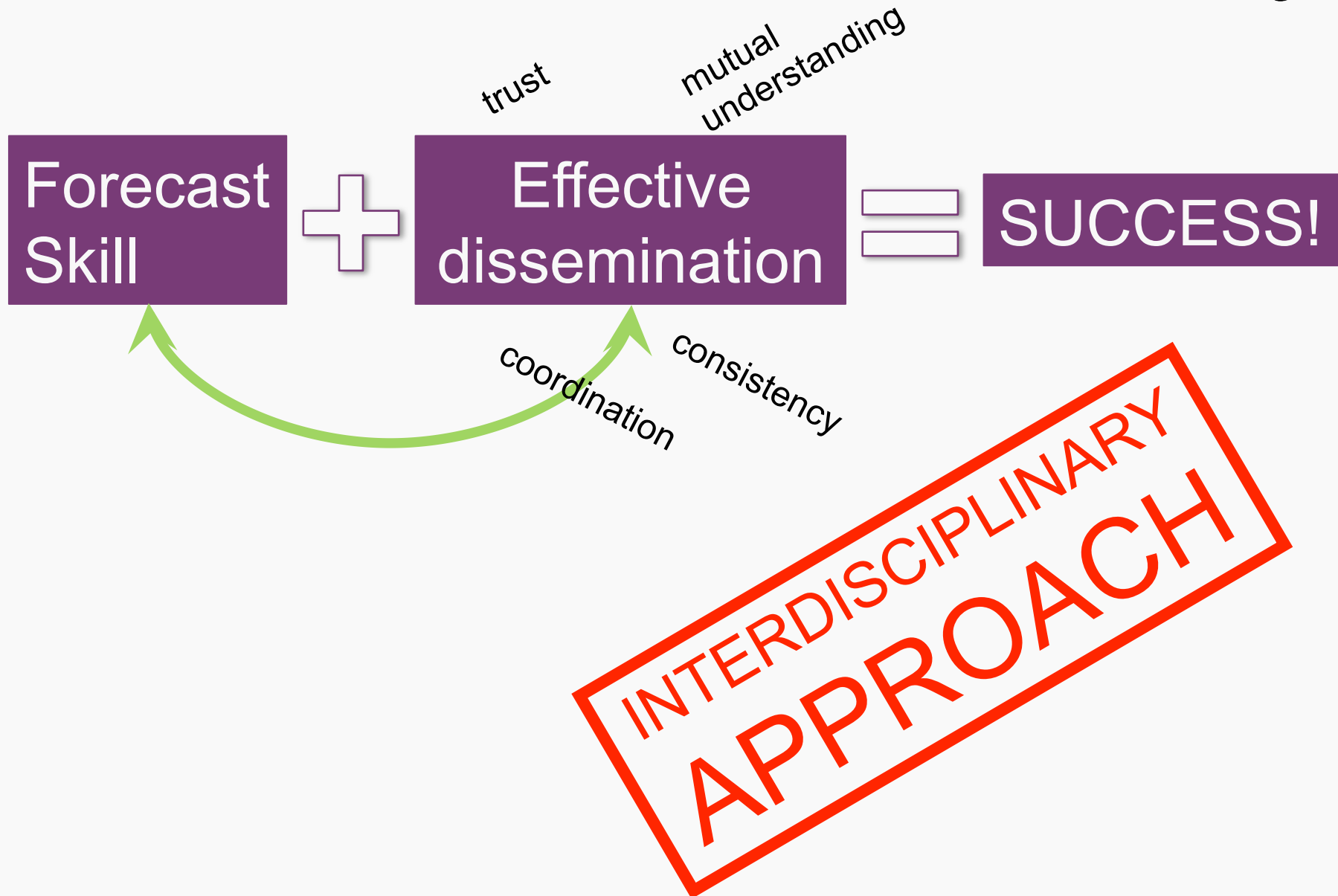


So how do you make [issue]
a good forecast?

[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





An extreme event: Hurricane Sandy

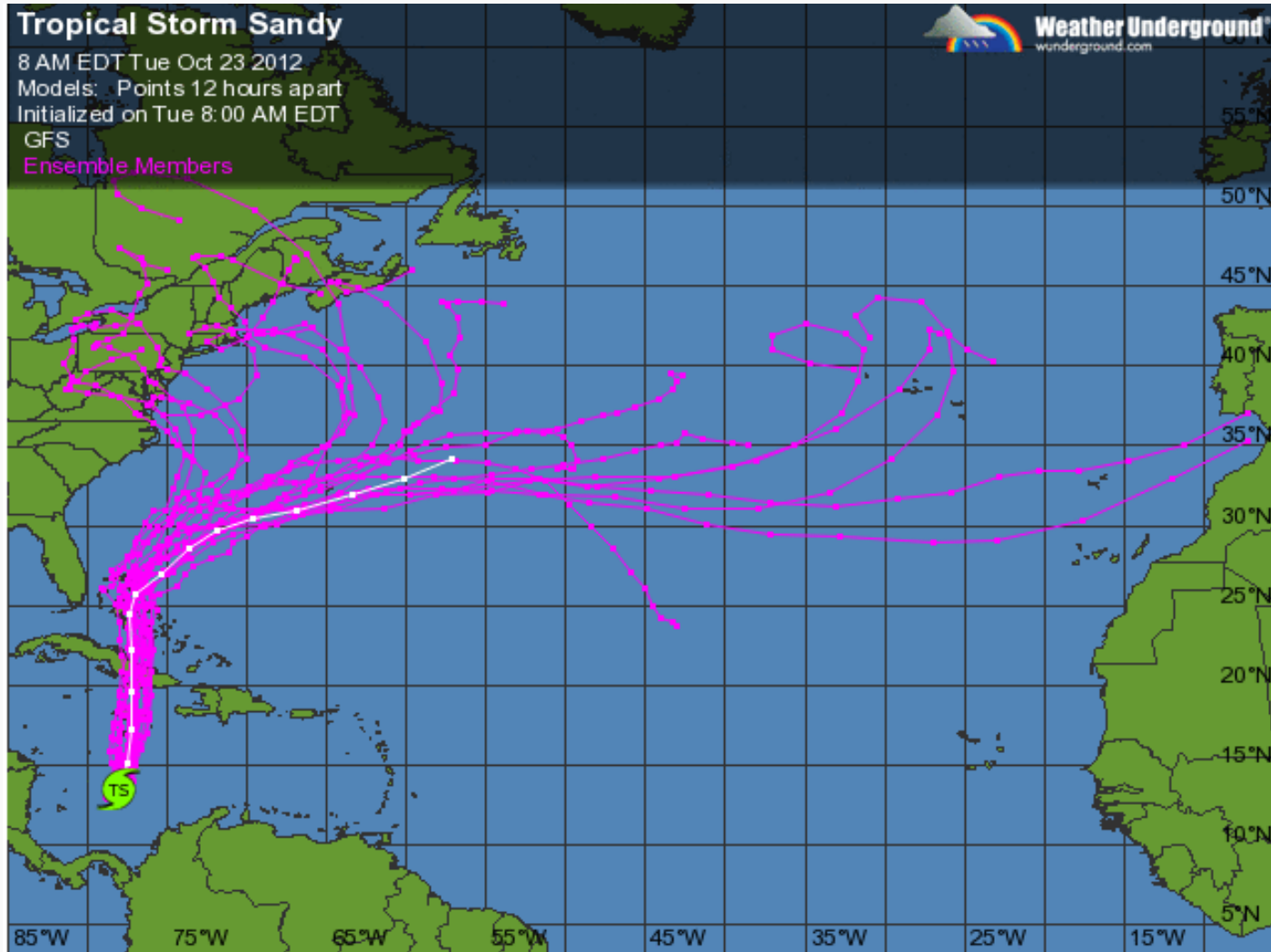


Figure 2. The Tuesday morning 06Z (2 am EDT) run of the GFS model was done 20 times at lower resolution with slightly varying initial conditions of temperature, pressure, and moisture to generate an ensemble of forecast tracks for Sandy (pink lines). These forecasts show substantial uncertainty in Sandy's 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.



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Experts Say Sandy Showed Limits of an Accurate Forecast

Published: October 28th, 2013, Last Updated: October 24th, 2013

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By Andrew Freedman

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“

Yet Sandy also demonstrated the frustrating limitations of an accurate forecast. Despite the advanced notice and the huge threat it posed everywhere from Massachusetts to Maryland, the storm still killed 159 people, including 44 within New York City alone. Most of the New York victims drowned from coastal flooding.

Even now, nearly a year after Sandy helped reshape the weather enterprise in the U.S., a gap is growing between the capabilities of weather forecasters and the state of risk communications and emergency preparedness in the country.

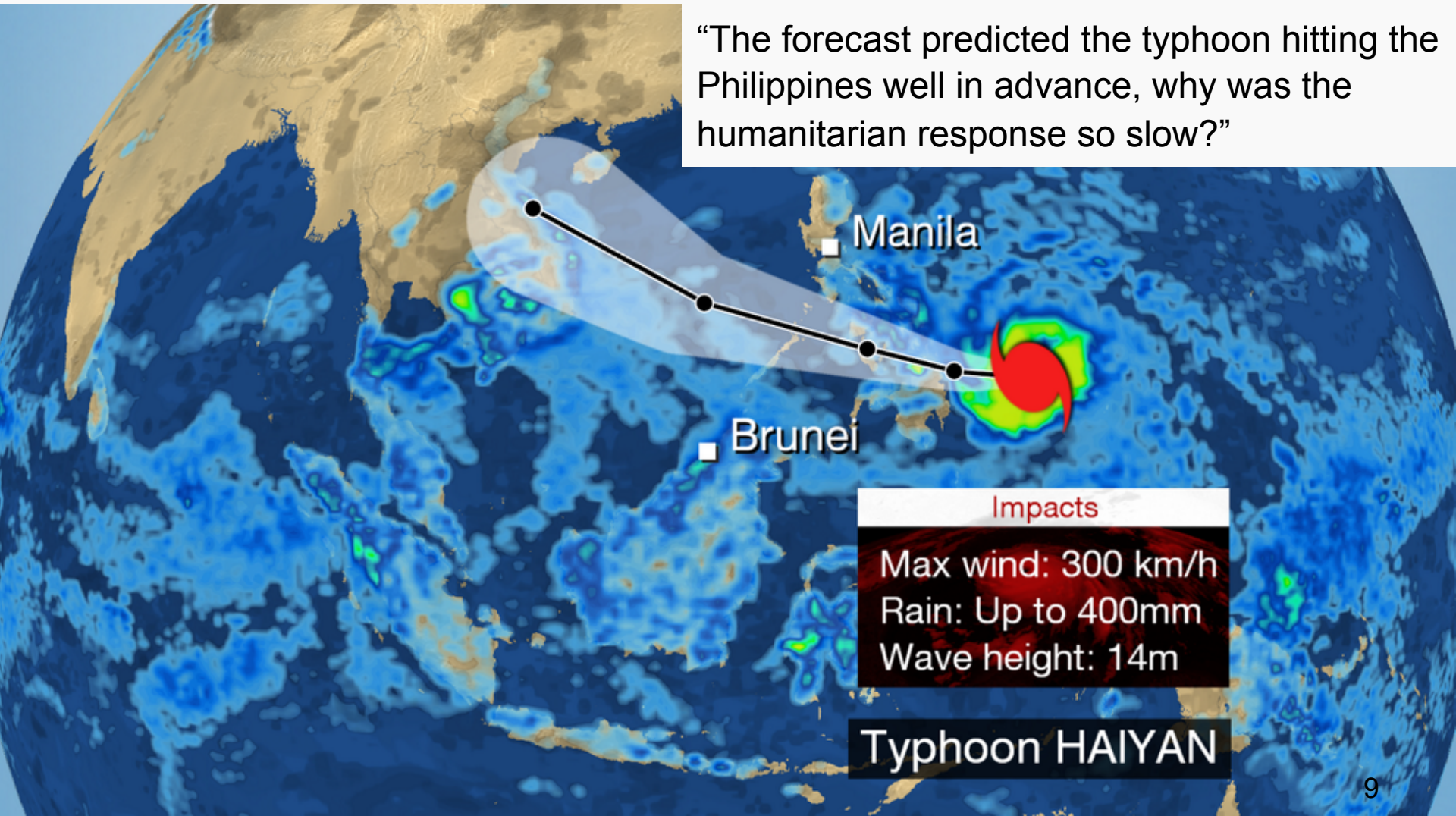
”

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

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

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

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.

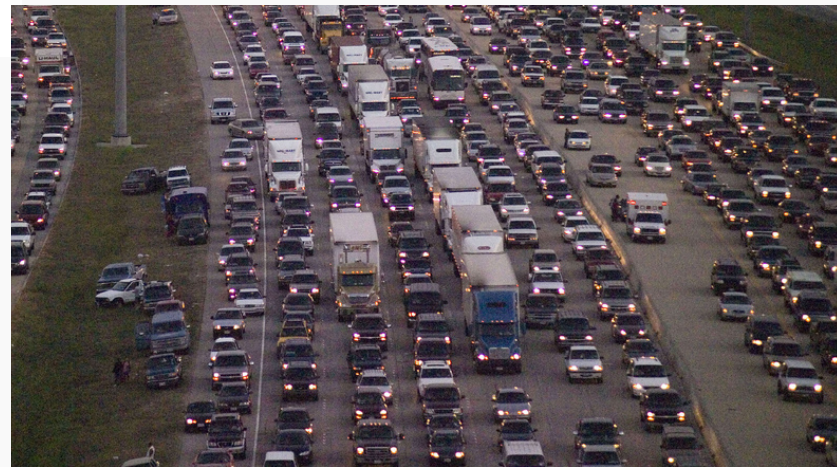
"I'd like to offer an apology because some people could have been saved if the town had issued an evacuation advisory or order," the mayor of the island, Masafumi Kawashima, said.

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.

[Clip: Ignoring advice to evacuate](#)

Related Stories



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

(Rayner et al. 2005)

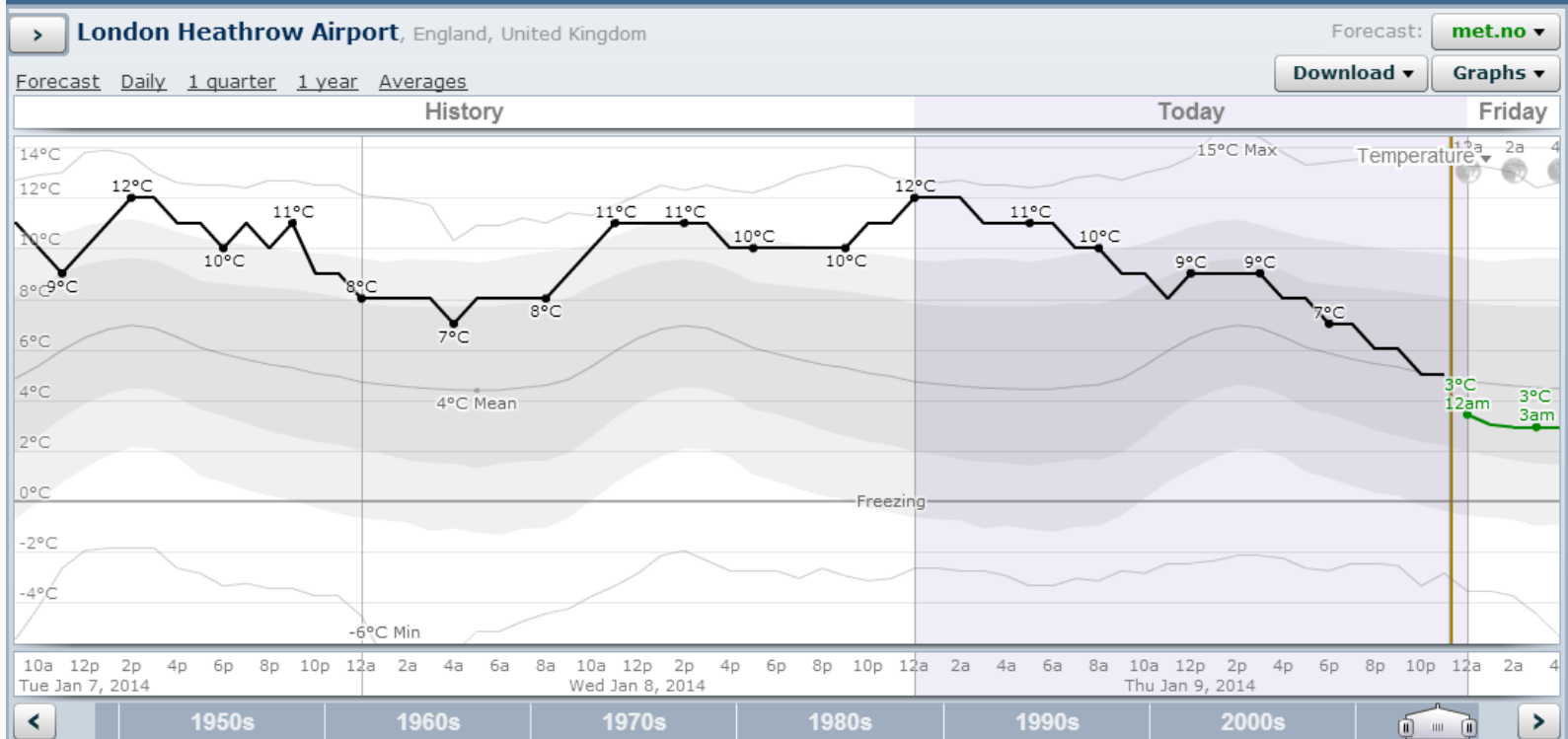


Priorities for water resources industry in US:

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

Let's start with communication:

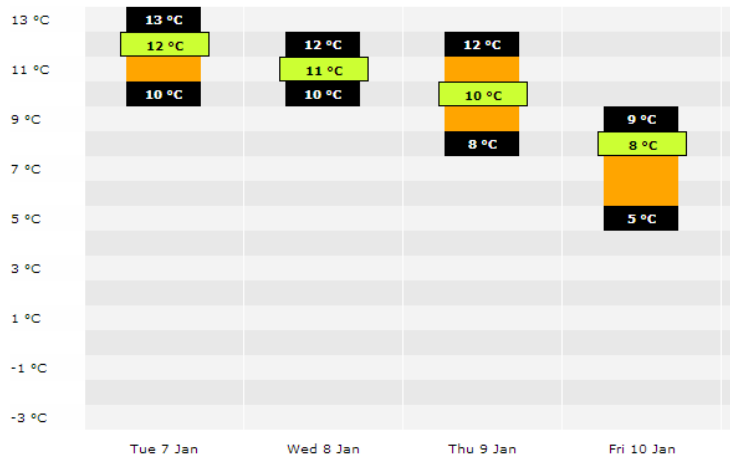
What is currently out there?
Is it being understood?



London

Five day maximum temperature range

Max temp range **Min temp range**



Key:

- High range
- Most likely
- Low range

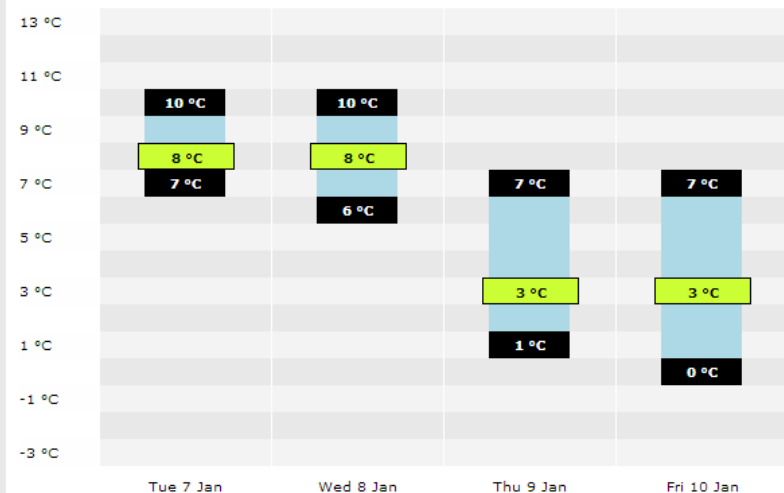
Issued at: 1400 on Tue 7 Jan 2014

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

London

Five day minimum temperature range

Max temp range **Min temp range**

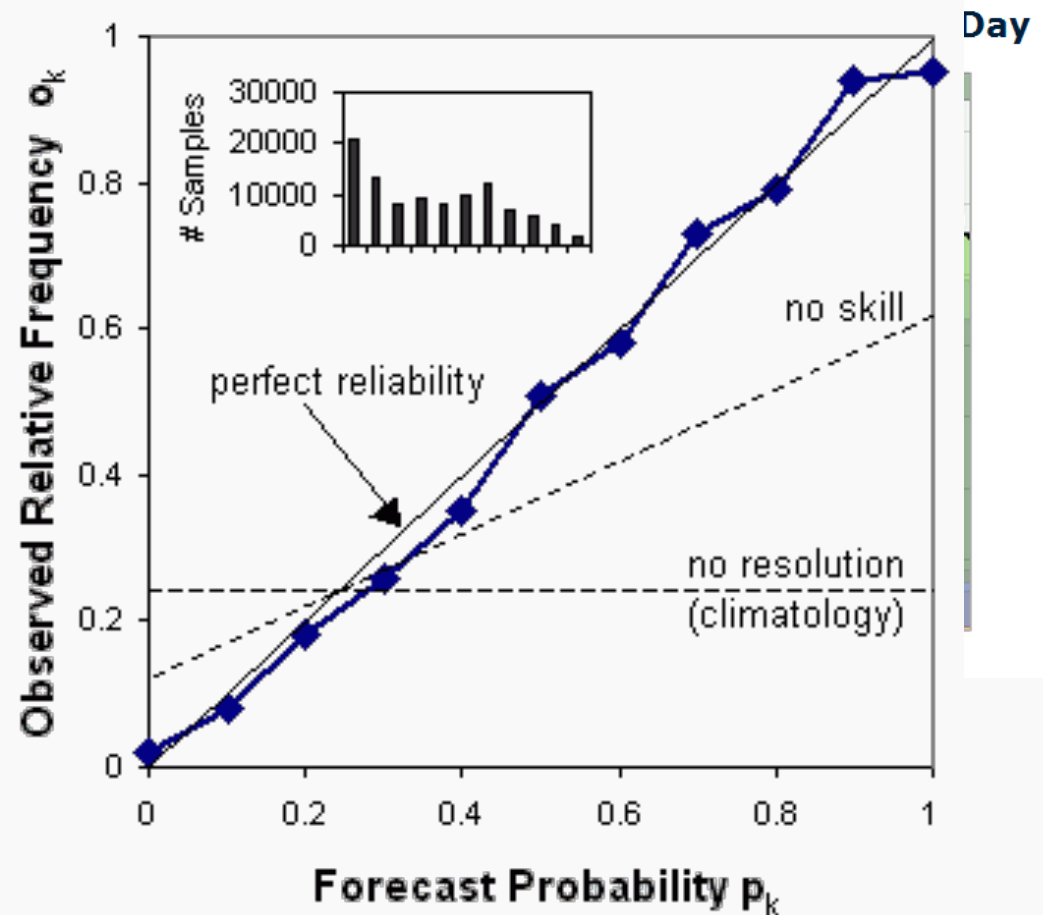


Issued at: 1400 on Tue 7 Jan 2014

Is this useful information?



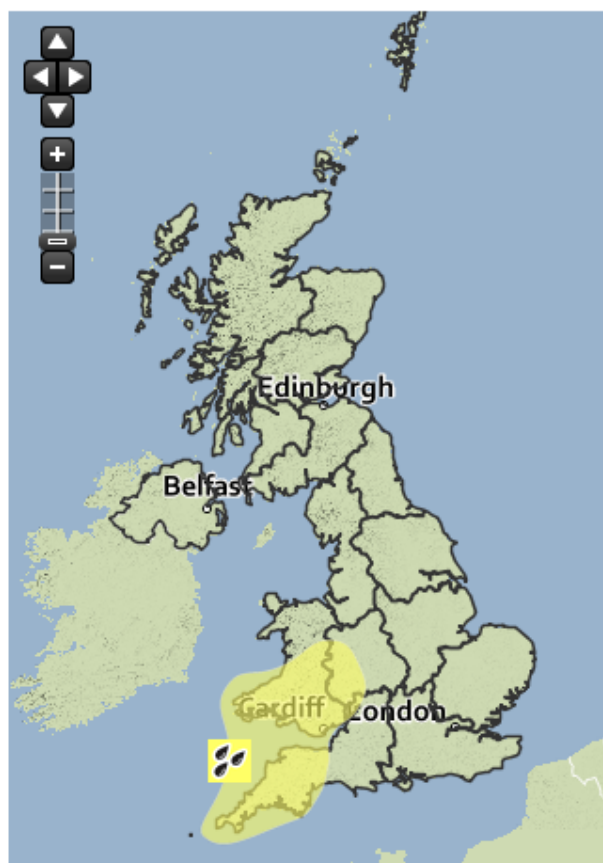
Met Office Android App



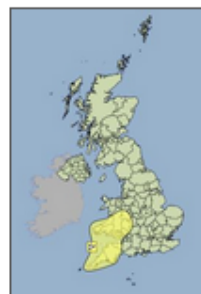
Warnings overview: United Kingdom

Issued on Wed 8 Jan

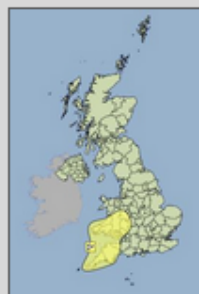
Wed 8 Jan



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



Orkney & Shetland

Highlands & Eilean Siar

Grampian

Strathclyde

Central, Tayside & Fife

**SW Scotland, Lothian
Borders**

Northern Ireland

Wales



North West England

North East England

Yorkshire & Humber

West Midlands



East Midlands

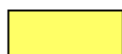
East of England

South West England



**London & South East
England**

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.

Communication: The public



**Plan your journey
around the weather**



Not through it

Check the forecast and you could avoid the worst of the weather.

Leave earlier? Leave later? Change your route or your plans? Make time for winter.

Be informed
Have you checked
the latest traffic
and weather?

 **HIGHWAYS**
AGENCY
www.highways.gov.uk/winter



Communication of ensemble forecasts



What prohibits organisations from presenting information from an ensemble forecast?

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, they 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

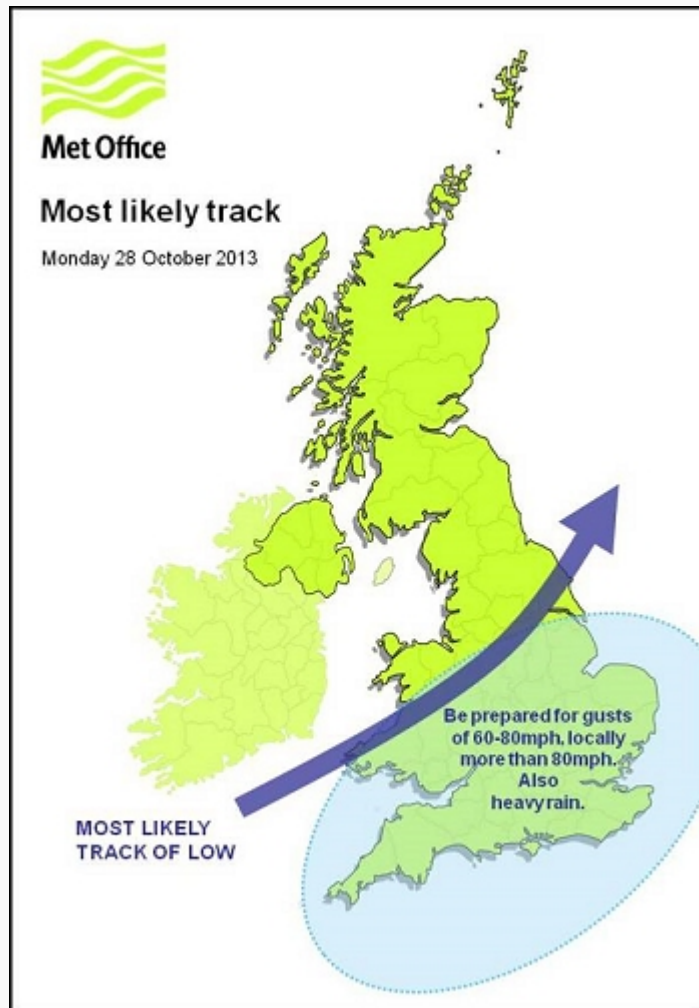
People won't be able to make use of the extra information (Is it just converted to a binary prediction?)

Newest	Oldest	Best rated	Worst rated
 View all			
<p>The only problem I can see with using percentages is that innumerate DM journalists will be unable to understand it. For the rest of us it will be a useful tool.</p> <p>- Steve, Eastleigh, 9/11/2011 23:35</p> <p> Report abuse Click to rate   Rating  123 </p>			
<p>Just the same system we have had in NZ for years,its very easy to understand,dont worry your weather will still be rubbish</p> <p>- J R, Akl NZ, 10/11/2011 1:14</p> <p> Report abuse Click to rate   Rating  75 </p>			
<p>The USA have been using many of these features for years. One would have to be a right dumb cluck not to understand these very basic features of a weather forecast. But then, the education system in the UK has been dumbed down for many years.</p> <p>- John McCullough, Belfast, 9/11/2011 23:15</p> <p> Report abuse Click to rate   Rating  59 </p>			
<p>If people are really confused by expressing chances as a percentage, it speaks volumes about the appalling ignorance about basic maths in the country.</p> <p>- Timelord, London, UK, 10/11/2011 7:56</p> <p> Report abuse Click to rate   Rating  56 </p>			



Why do meteorologists want to present uncertainty to the public?

Communication



“Why doesn’t the BBC present uncertainty in its forecasts?”

Former hurricane causes forecast uncertainty



19 September 2012 Last updated at 13:35

?

Met Office Weather Game

Which town is likely to reach 20°C?

Week 1 of 4

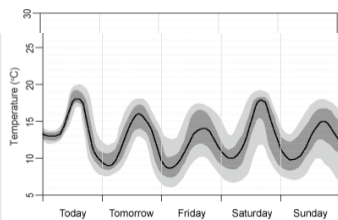


Brad sells more ice creams if the temperature reaches 20°C.

It's Wednesday today - choose the town where you think Brad should work on Saturday (he needs to buy a permit)

Which town is more likely to reach 20°C on Saturday?

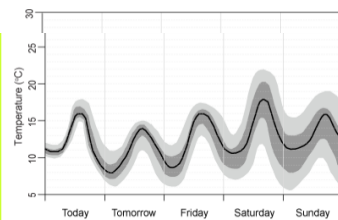
Stonemouth



Temperatures will fall in the dark grey range roughly 5 times out of 10, and the light grey range roughly 9 times out of 10

High Range
Most Likely
Low Range

Rockford



Temperatures will fall in the dark grey range roughly 5 times out of 10, and the light grey range roughly 9 times out of 10

High Range
Most Likely
Low Range

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

Which shifts are least likely to have rain?



Brad wants to only work 3 shifts tomorrow (he wants to go scuba diving).

He doesn't sell anything when it rains, so pick the three shifts where it is least likely to rain.

Pick the 3 shifts where it is least likely to rain

Shift 1



sun
Chance of

Shift 2



sunny intervals
Chance of

Shift 3



low level cloud
Chance of

Shift 4



low level cloud
Chance of

How sure are you?



Pick how sure you are for each of the 3 shifts that Brad is going to work.

Pick carefully! Brad buys more stock if you're more sure it will not rain. If it does rain he won't sell anything and will lose money as it will go off.

Shift 2



How sure are you that it will not rain during this shift?

Pick one that matches your confidence level

Certain it will not rain 50 / 50

Certain it will rain

DONE



low level cloud
Chance of any rain
MED

Pick one that matches your confidence level

Certain it will not rain 50 / 50

Certain it will rain

DONE

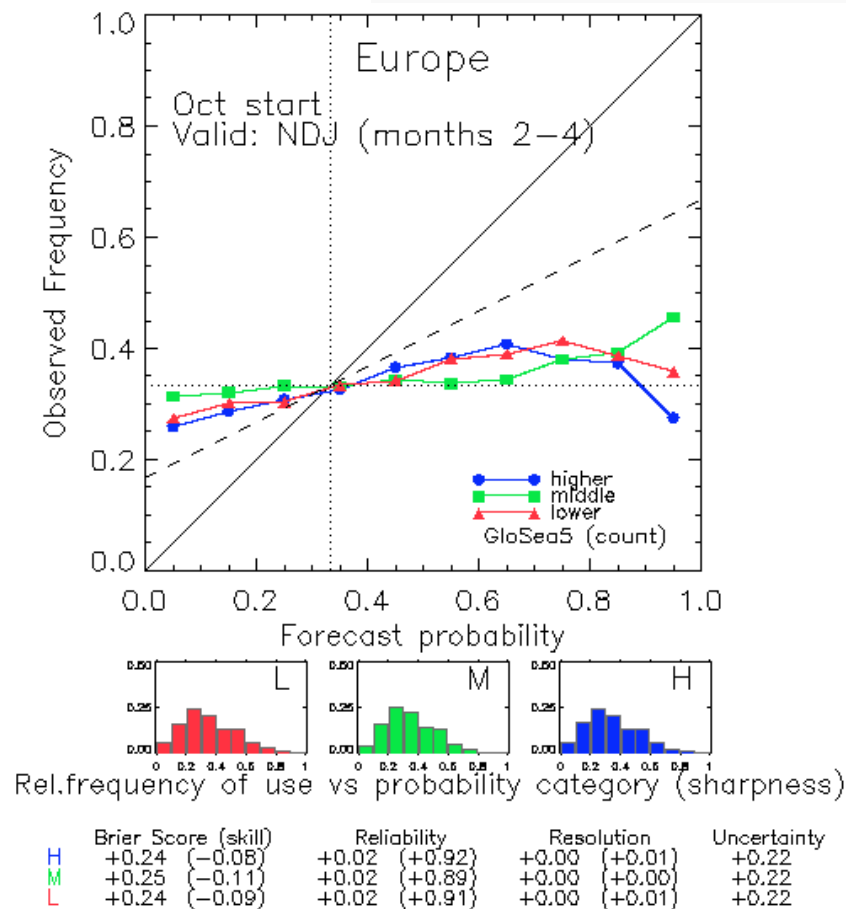
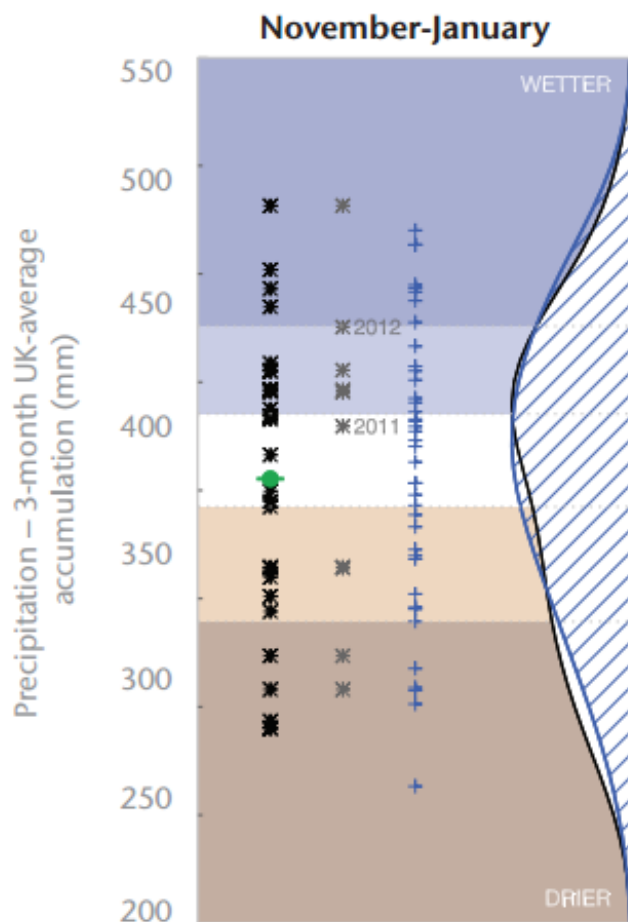
Explain this again

Weather game results

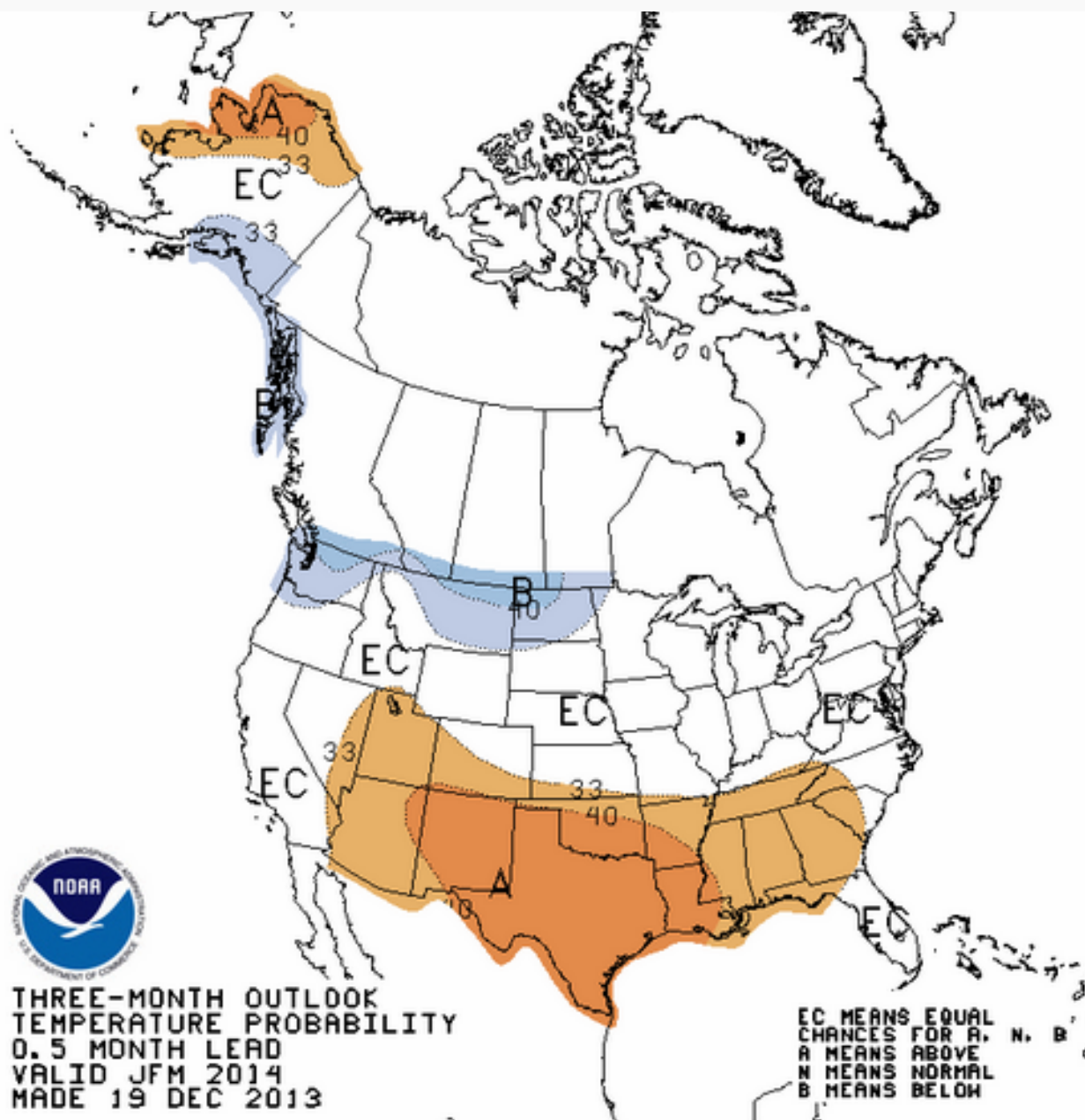
- On average, participants presented with probabilistic information scored better than those with the deterministic forecast
- No real difference when rainfall probability is accompanied by a graphical representation, might even cause confusion
- In contrast, the graphical representations of temperature 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?

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



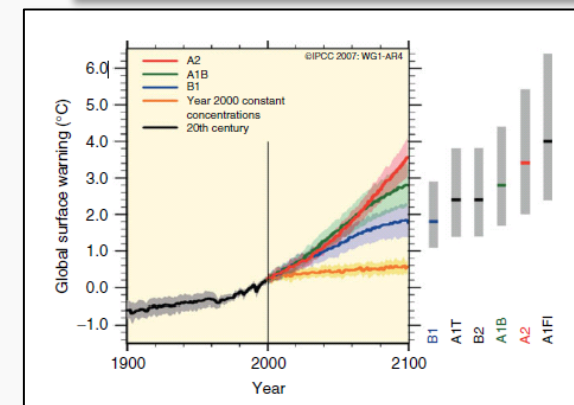
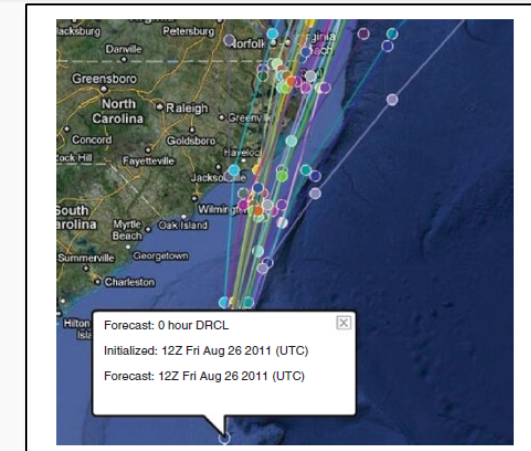
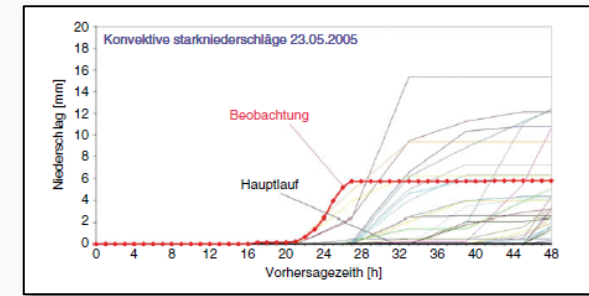
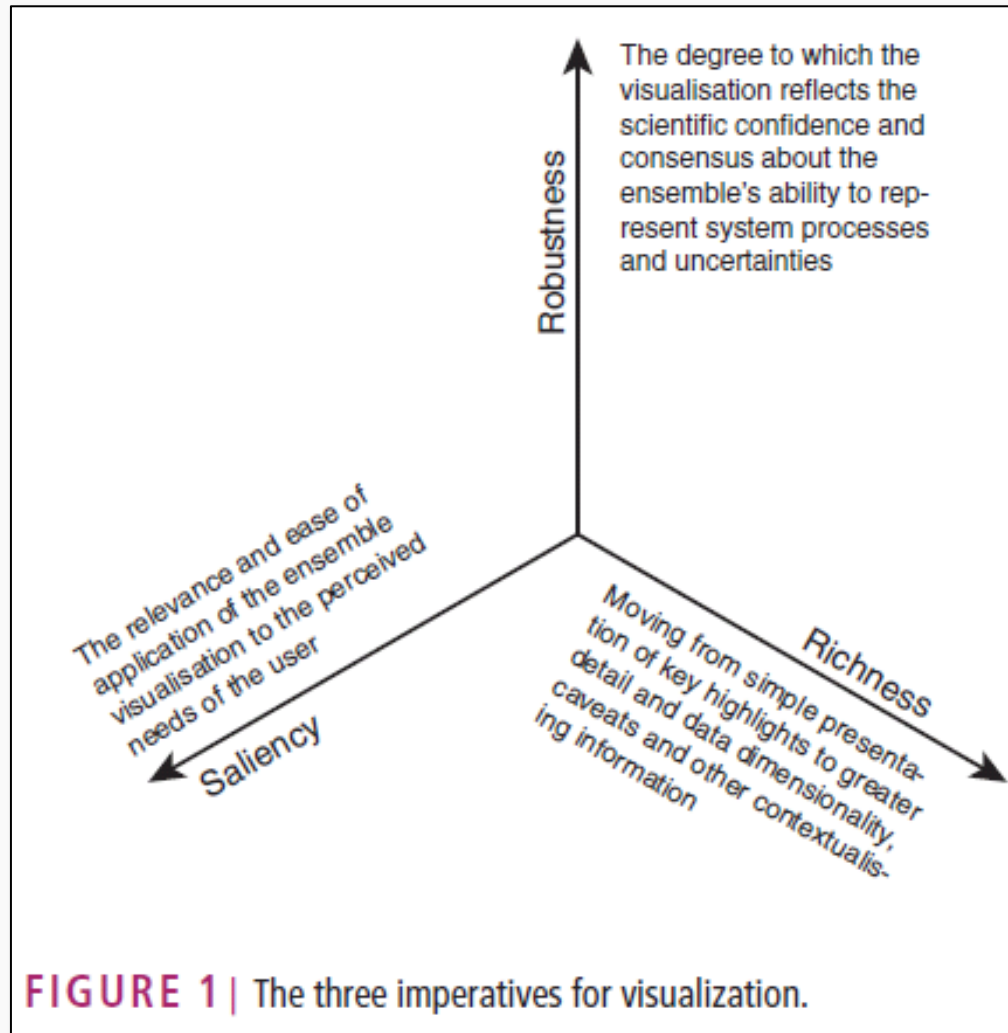
* Observations 1981-2010 ● 1981-2010 Average * Observations 2003-2012 2013-14 outlook: + Nov-Jan



Communication: Audience considerations



Considerations for communicating ensemble forecasts



Communicating probabilistic information from climate model ensembles—lessons from numerical weather prediction.

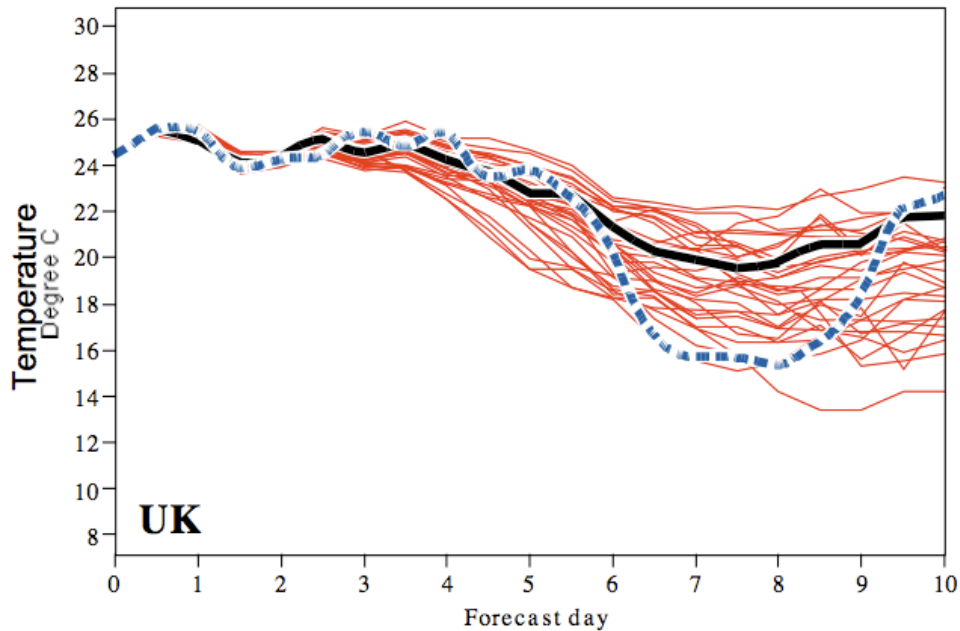
Stephens E, Edwards T, Demeritt, D. (2012) *WIREs Climate Change*. 3: 409-26

26th June 1995

ECMWF ensemble forecast - Air temperature

Date: 26/06/1995 London Lat: 51.5 Long: 0

— Control - - - Analysis — Ensemble

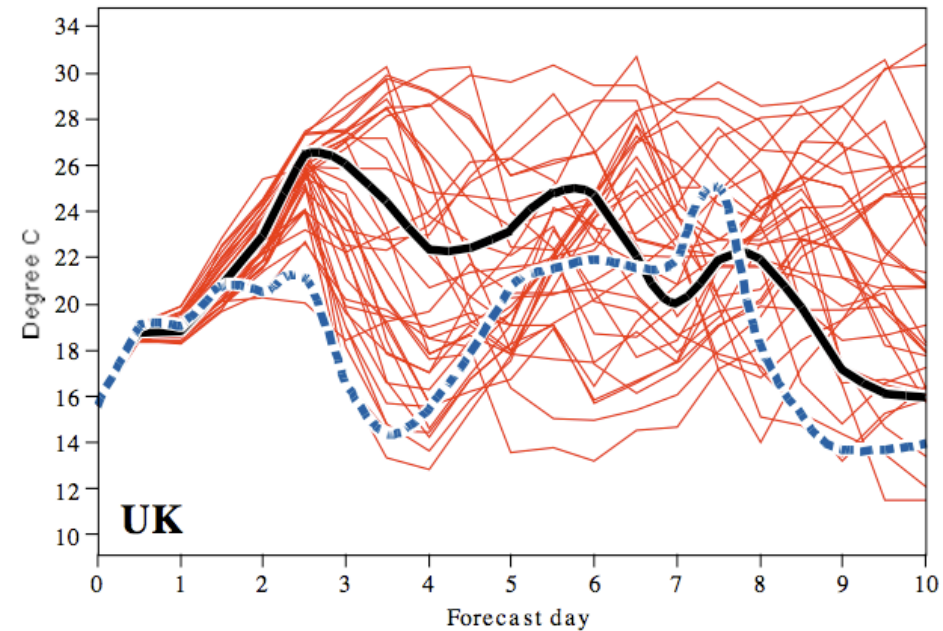


26th June 1994

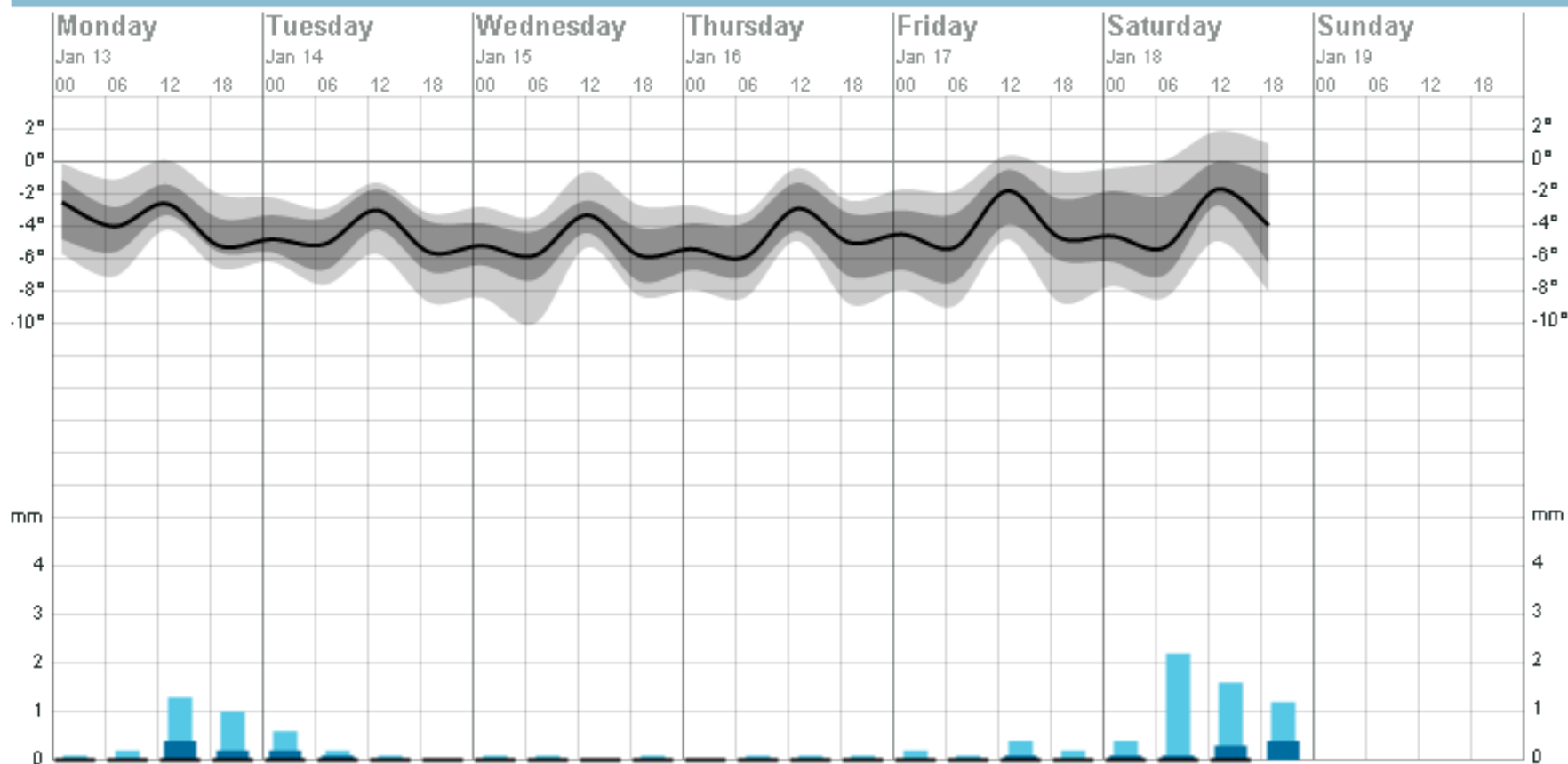
ECMWF ensemble forecast - Air temperature

Date: 26/06/1994 London Lat: 51.5 Long: 0

— Control - - - Analysis — Ensemble



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

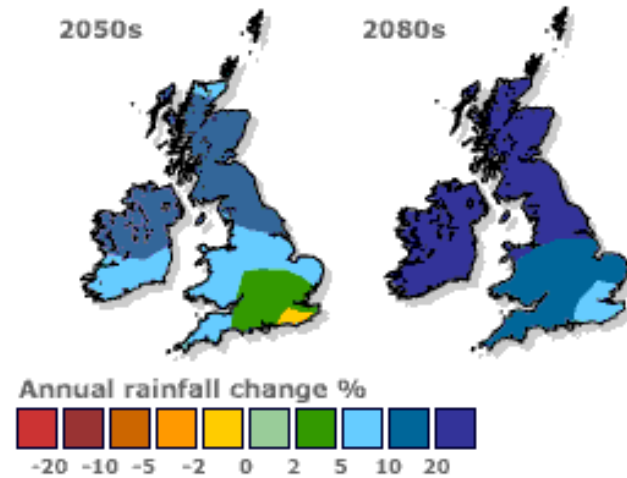
■ 30% probability

Precipitation:

■ 50% probability

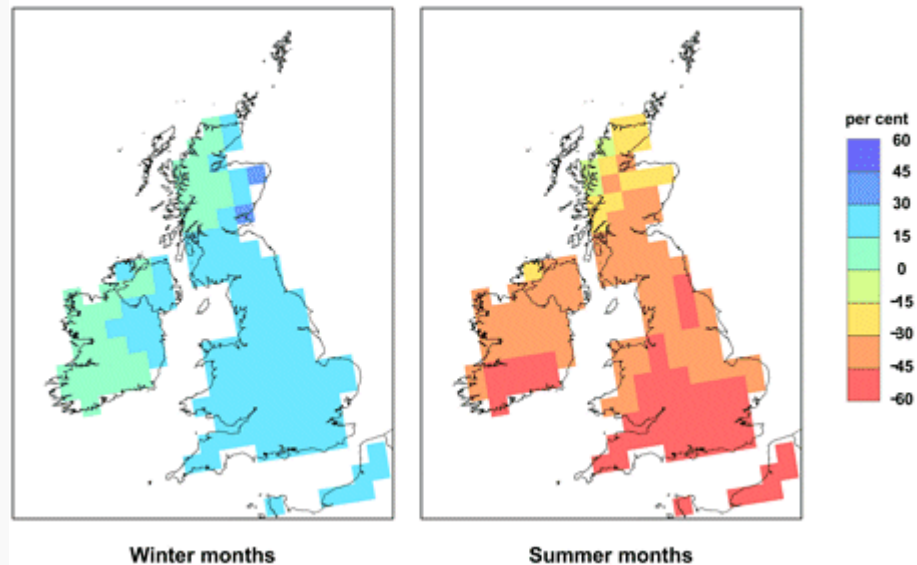
■ 30% probability

Change in average annual rainfall



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



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?



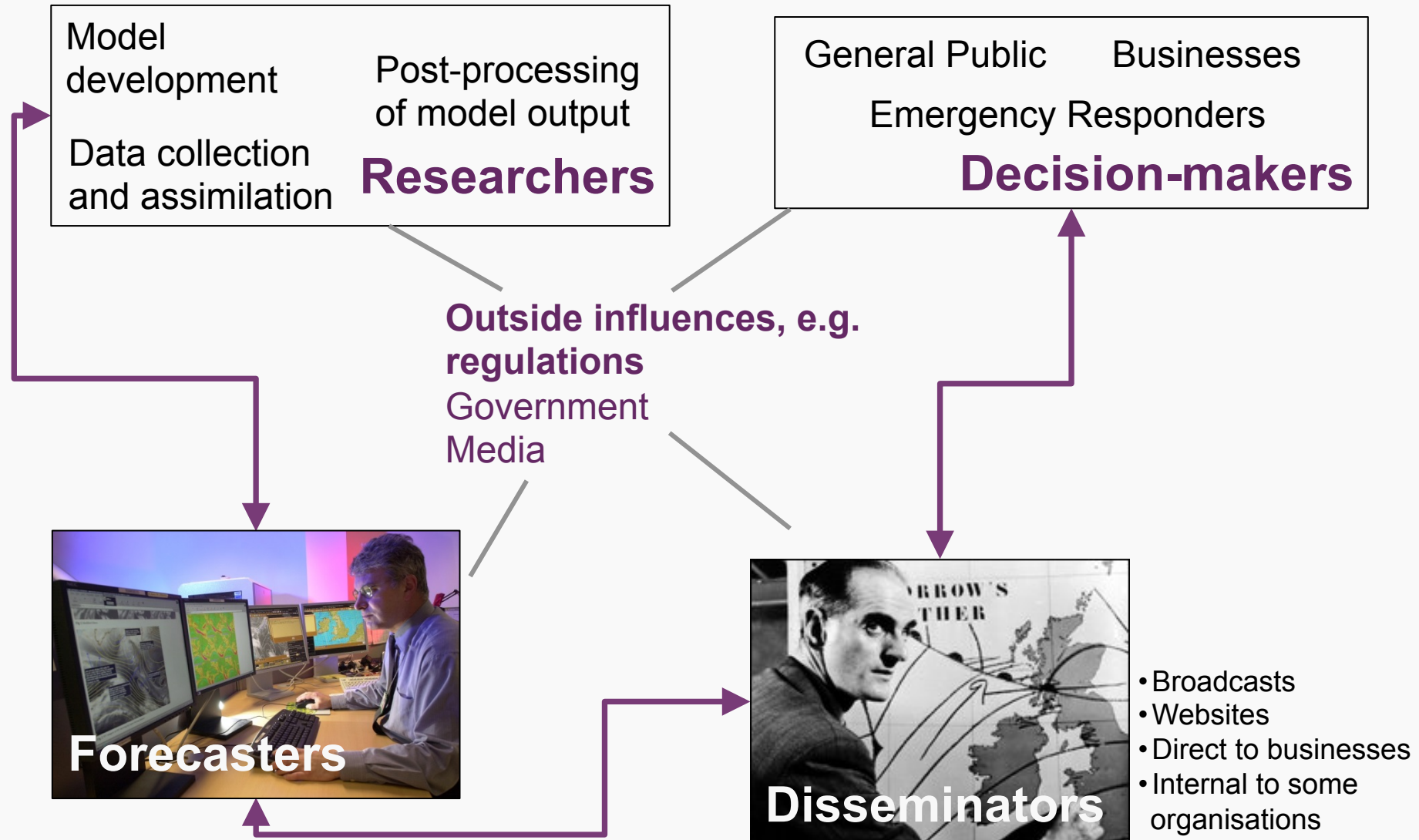
Interdisciplinary Research

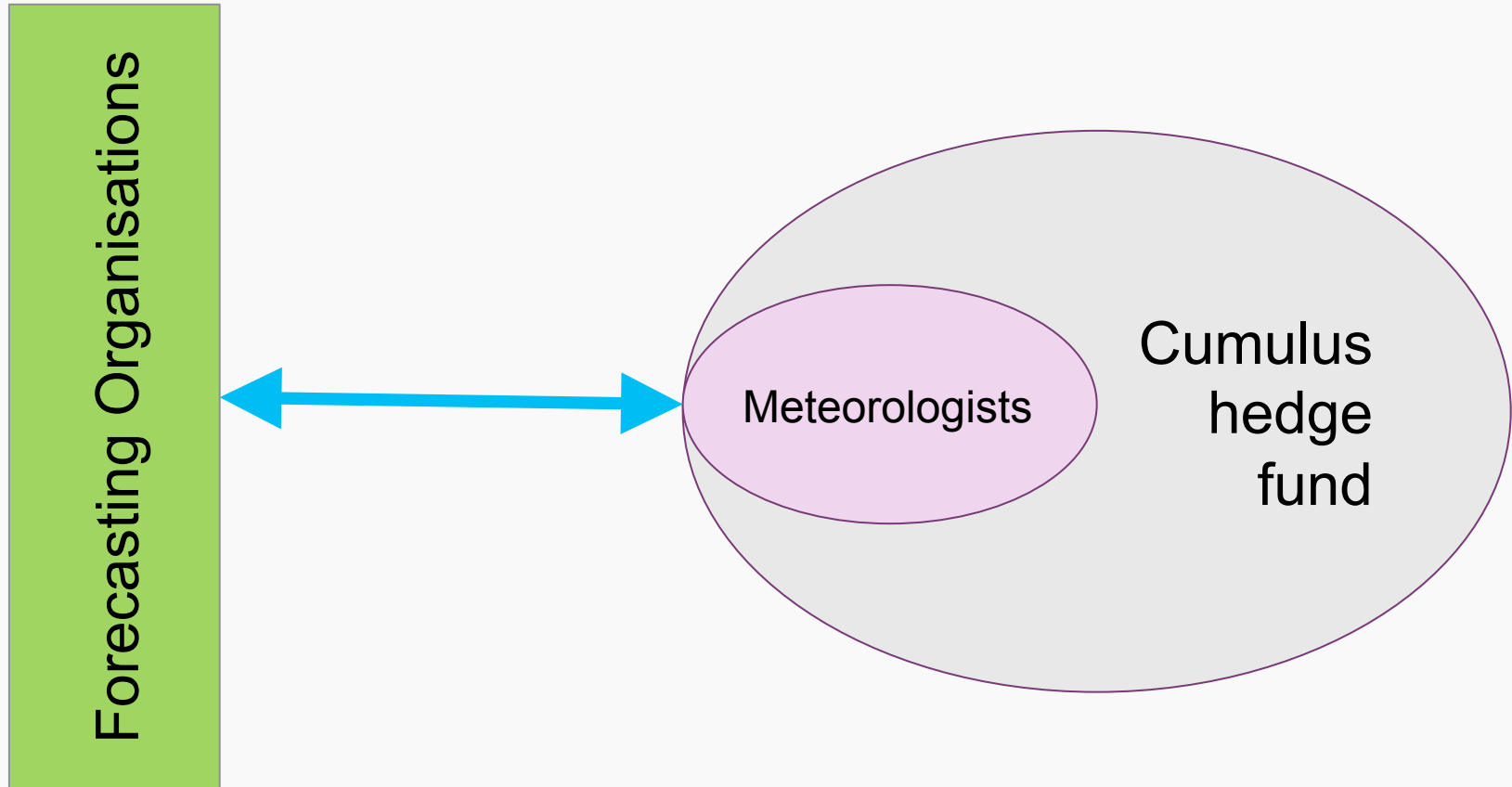
“the value of a forecast system may not be solely related to the technical skill of the forecast model; through the course of its production, circulation and potential use it is likely to be influenced by a range of factors, which may be social/political/institutional as well as technical”

(Haines and Stephens, in prep)

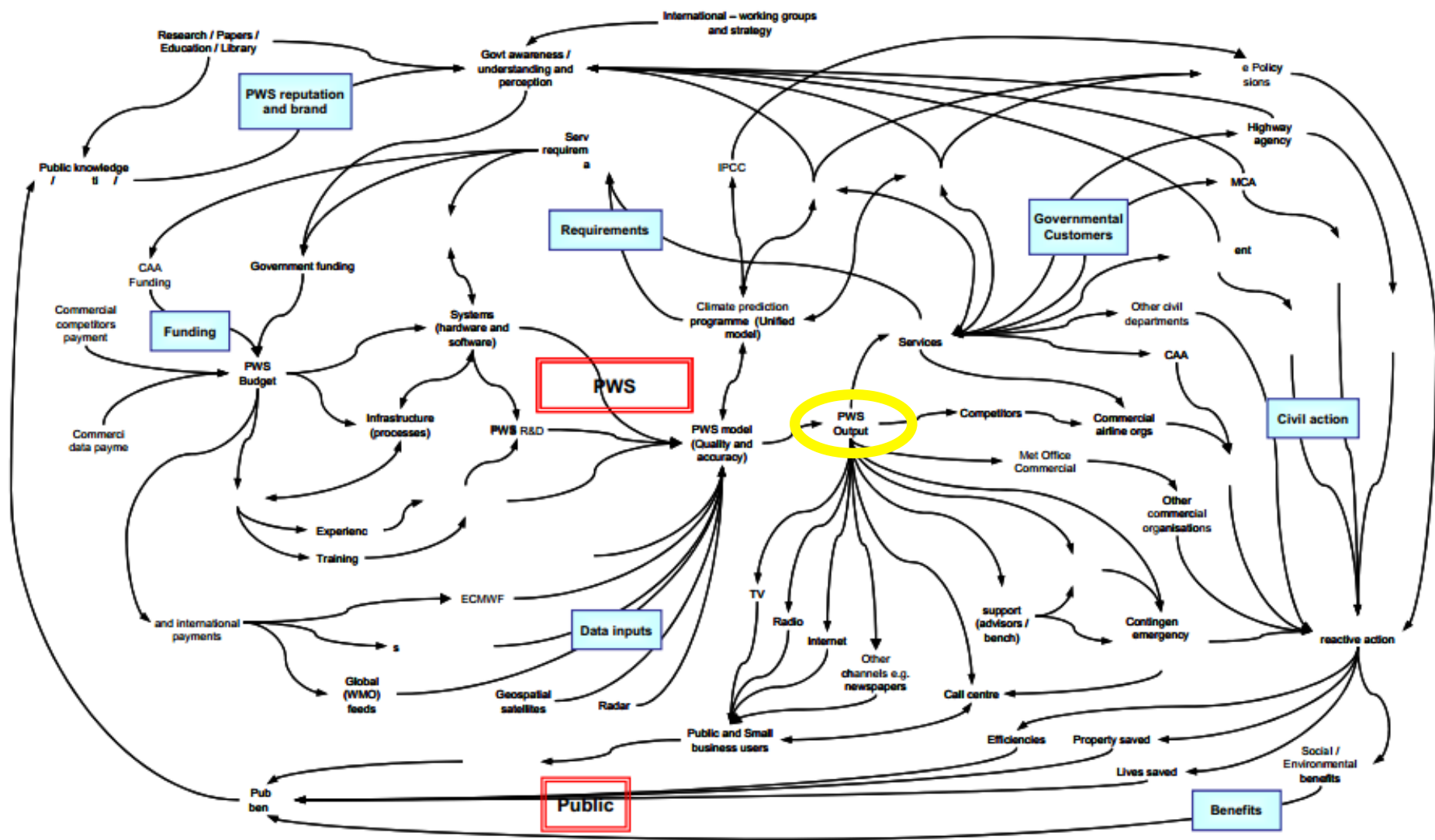
Structure, management and evolution of forecast networks

Increasingly not seen as a one-way dissemination





Met Office Causal Map



Structure, management and evolution of forecast networks



How can uncertain forecasts be effectively utilised?

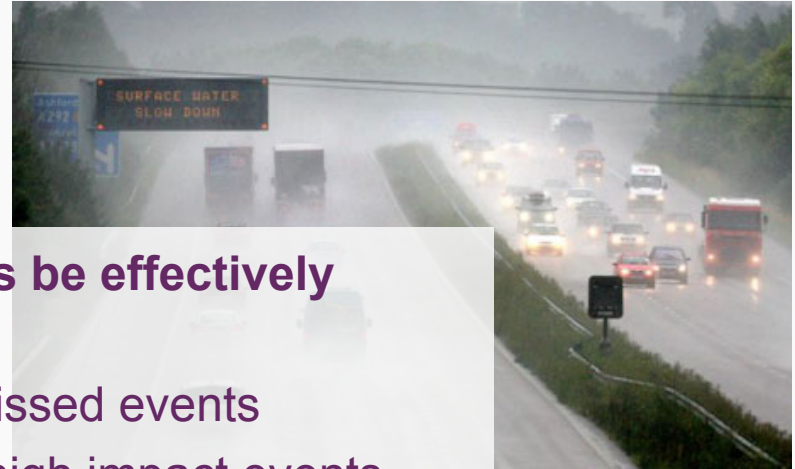
Balancing false alarms and missed events

Dealing with low probability / high impact events

Can probabilities be trusted?

How can trust be promoted?

How is media criticism dealt with?



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.

Small group discussion topics

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.

