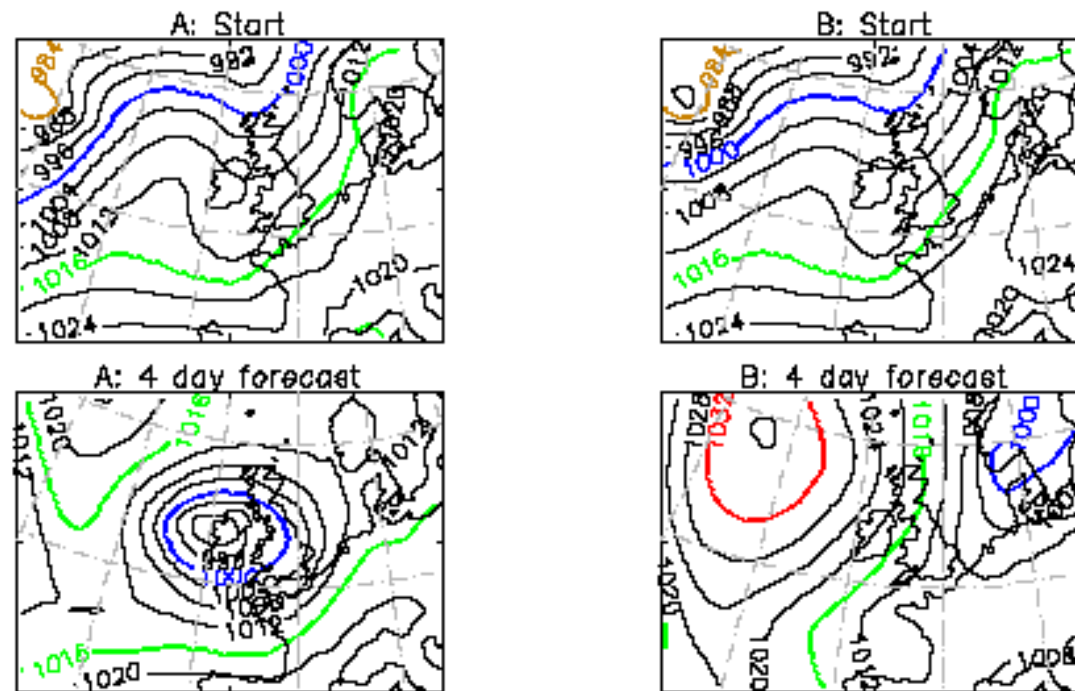# Ensemble Forecasting

Ken Mylne

Ensemble Forecasting Applications Manager, Met Office UK

Chaos – Scientific root of Ensembles

- The atmosphere is a chaotic system: *"… one flap of a seagull's wing may forever change the future course of the weather"*, (Lorenz, 1963)
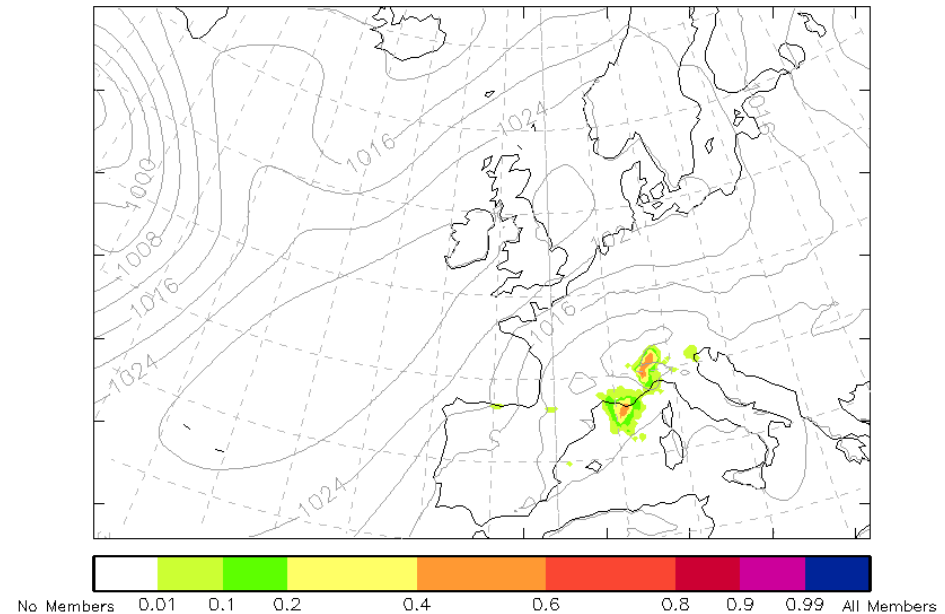

Tiny errors in how we analyse the current state of the atmosphere lead to large errors in the forecast – these are both equally valid 4-day forecasts!

Estimating Probabilities of Events

- Forecasters have always expressed uncertainty – "…*occasional showers, mainly in W, risk of a thunderstorm …*"

- Ensembles are *designed* to estimate the pdf – objective

- School science: *always plot the error bars* – so why not on a weather forecast?

  - Scientific integrity

- Cost-loss: Action when *p>C/L*

  - *The scientific case for using probabilities is clear – so why have we found it so difficult to use and present them?*

MOGREPS (Regional)   Probability map for   24HourPrecip >100.0mm
DT 06Z on Mon 14/06/2010   VT 12Z on Wed 16/06/2010   lead time 54h
(Ensemble Mean PMSL plotted as faint background)

No Members   0.01   0.1   0.2   0.4   0.6   0.8   0.9   0.99   All Members

Heavy rain S. France 15/16 Jun 2010
Prob (24h precip)>100mm

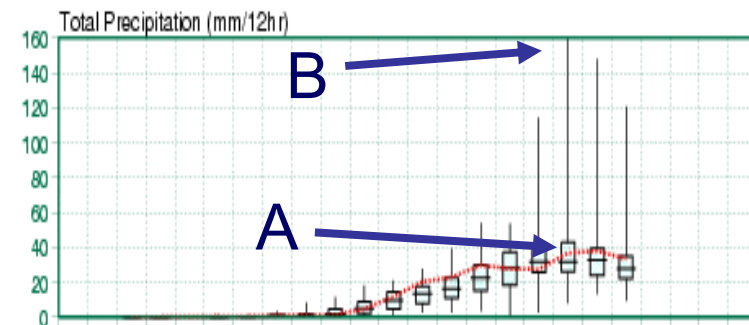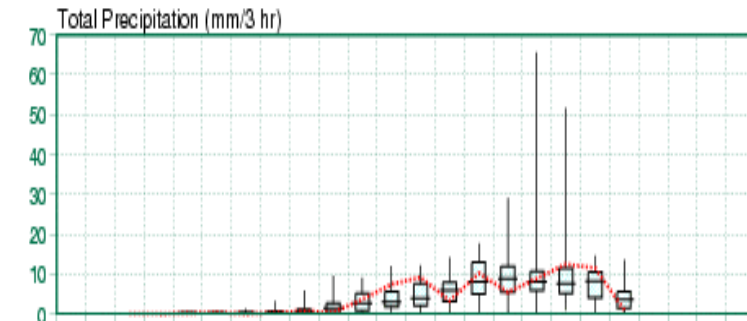# Obstacles and Assumptions

- …the public don't understand probabilities…

- *…uncertainty is too difficult to communicate…*

- …the Press don't get it…

- *…the Met Office is just covering itself…*

- …you can't say 50% - that is admitting defeat…

- *…just tell me what will happen…I just need to make a decision…*

  - or is that "*make my decision for me*" ?

- …sales and marketing staff don't get it…

- *…internal deterministic and ensemble system split.*

Risk Management

- Would you get on a plane with a 1% chance of crashing?
    - …actually we do know pretty well how to make decisions with uncertainty
    - …we just need to do a bit of work on C/L.
- Sebastien Norbert: "*Warning of a lower amount is no warning at all*" – better to warn of low likelihood of high impact.
- *Warnings*: different users have different C/L
    - Probs allow users to interpret
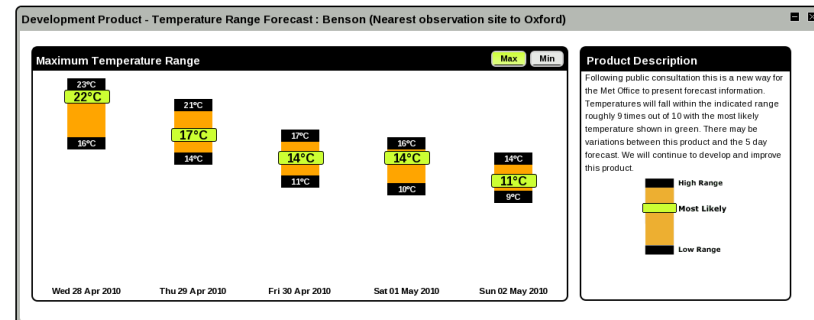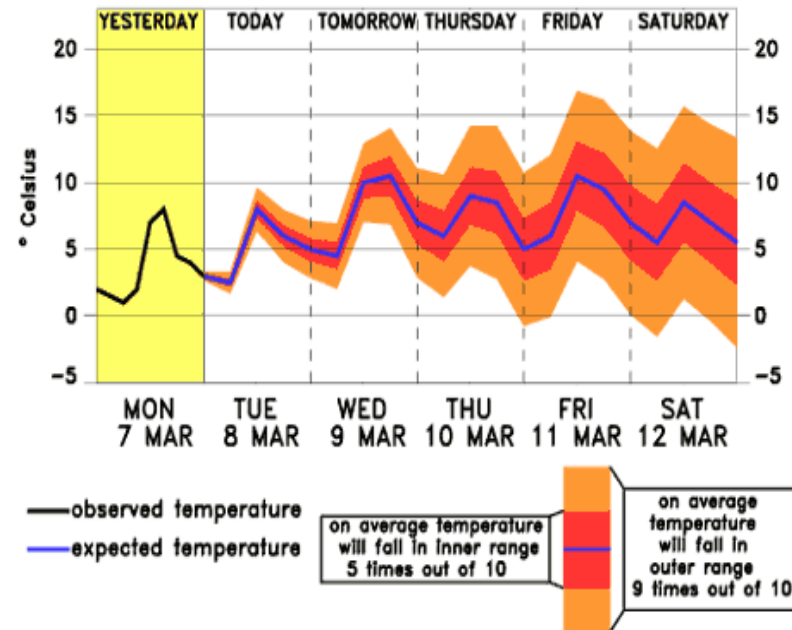   - If we decide, not tuned for most

Total Precipitation (mm/3 hr)

Total Precipitation (mm/12hr)

B

A

A or B

Which would you want to know about?

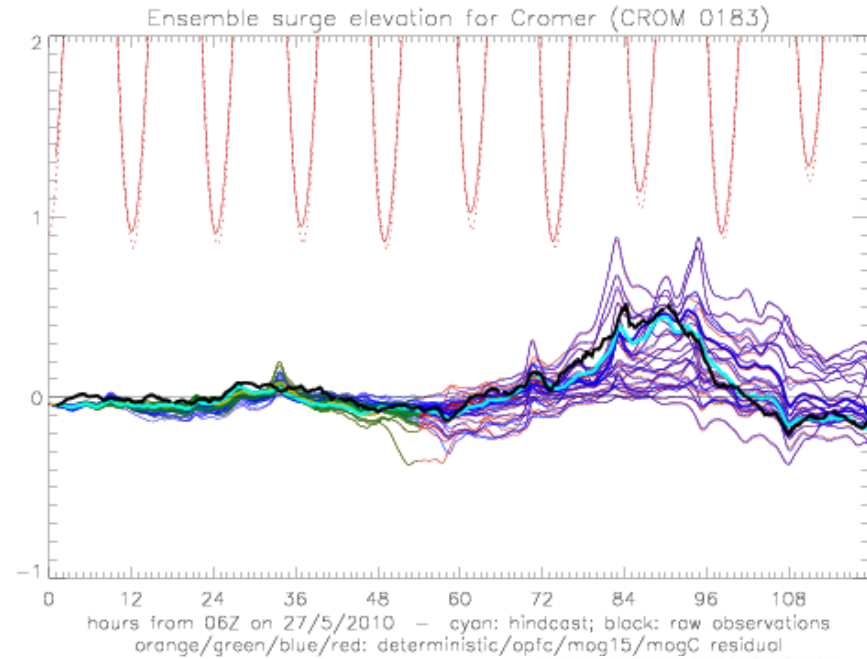# The public don't understand probabilities – *or do they?*

- Experimental Economics Lab experiments have shown that people make significantly better decisions with uncertainty information (see Priscilla Marimo poster)

- Weather Game –

  - Early results show benefit of probabilistic forecasts

- www.metoffice.gov.uk/weather/weather-game

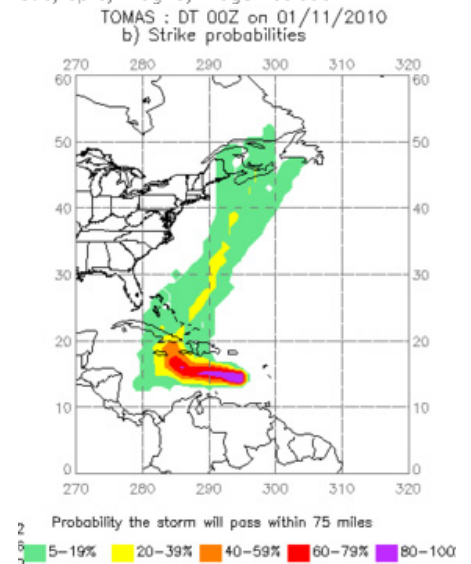- Not too late to help Brad sell more ice cream and win a T-shirt!

Successes

- Storm surge ensemble for Environment Agency

    - "best improvement in 10 years"

- Tropical cyclone tracks

- NSWWS Impact based warnings

- Wind energy

- Energy traders and demand forecasters

Ensemble surge elevation for Cromer (CROM 0183)

hours from 06Z on 27/5/2010 — cyan: hindcast; black: raw observations
orange/green/blue/red: deterministic/opfc/mog15/mogC residual

TOMAS : DT 00Z on 01/11/2010
b) Strike probabilities

Probability the storm will pass within 75 miles
5-19%   20-39%   40-59%   60-79%   80-100

How to stimulate the market?

- Take a risk and stand up to the Press and Critics

  - …be prepared to defend good science

- Use probabilities in our own daily forecasts

  - …discuss high-impact weather risks openly and publicly

  - …breed familiarity…

    - …better understanding for rare events and for one-off

      - …seasonal forecasts

      - …climate change

- Internal education (e.g. customer-facing staff)

- Internal systems – integrated NWP and post-processing

Seamless Climate Services