



Met Office



Long-range forecasting

Anca Brookshaw



Outline

- What is predictable at long range (and where does predictability come from)?
- Issues 'specific' to long-range predictions (e.g. reference period, temporal and spatial representativity, bias)
- Uncertainty in long-range predictions: sources and ways of estimating it
- Skill of long-range prediction systems
- Format of long-range prediction products



What is a seasonal forecast?

It is not a weather forecast

beyond a few days ahead we cannot predict conditions for a particular day

beyond a (very) few weeks ahead we cannot predict conditions for a particular week

It is a prediction of conditions averaged over several weeks/months

e.g. 'there is a 65% chance that temperatures will be below normal over the UK next winter'

What is a seasonal forecast?

Probabilistic

‘there is a 65% chance that temperatures will be below normal over the UK next winter’

Reference

Space and time average

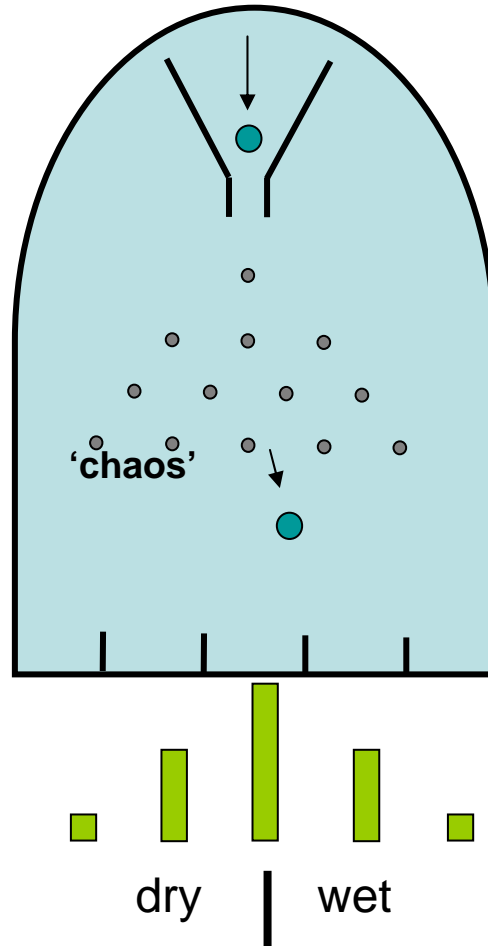


Seasonal: Probabilistic forecast

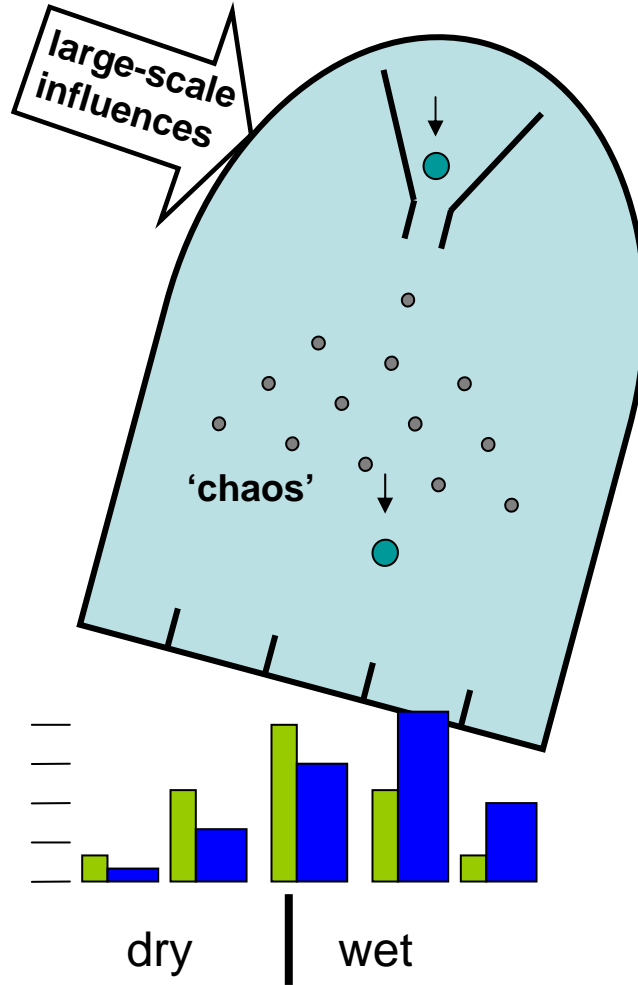
Uncertainties and chaos limit the range of predictability after a few days

..... Is there any hope for seasonal forecasting?

Predictability and chaos



Predictability and chaos





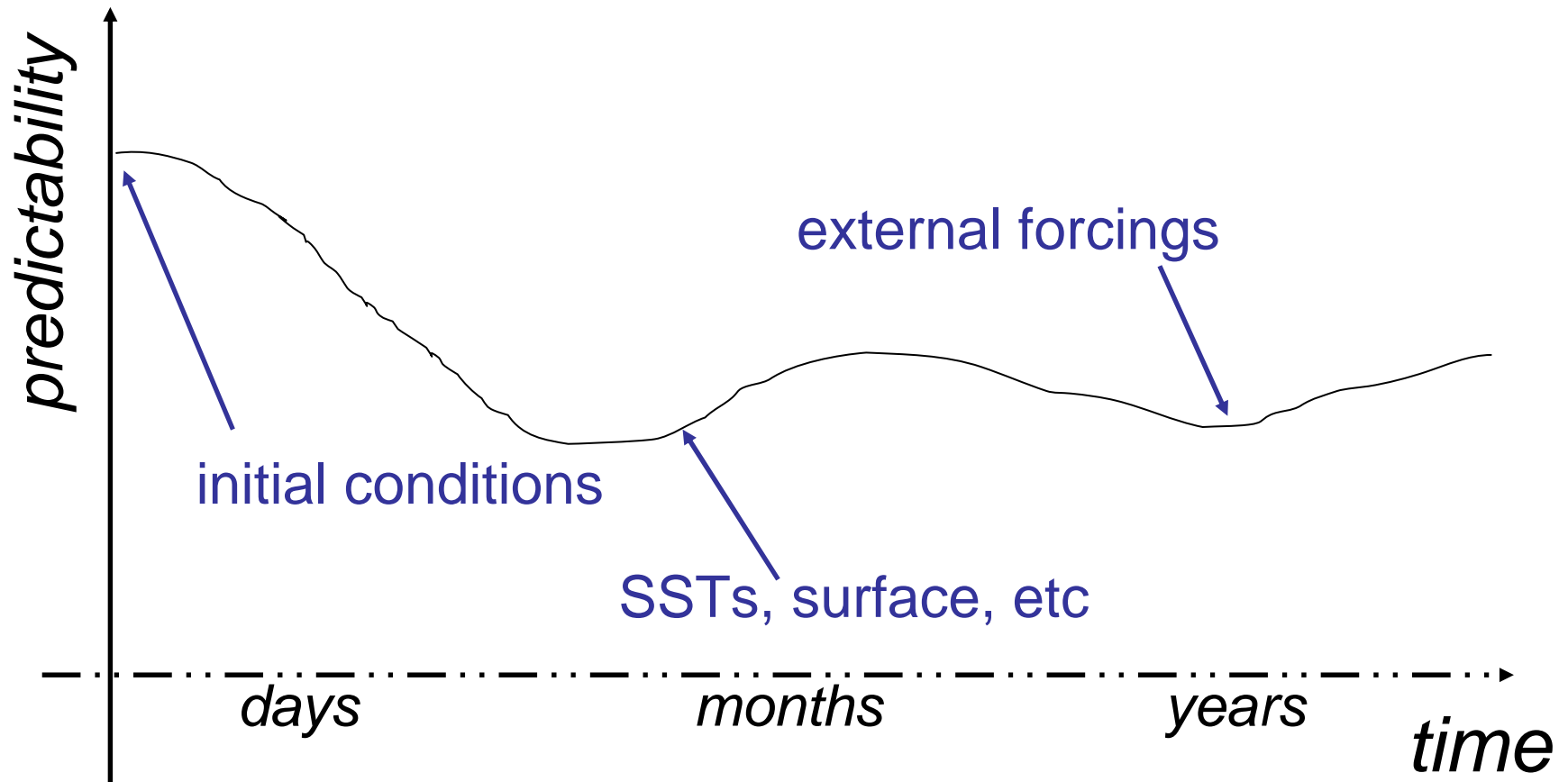
Met Office
Hadley Centre

Predictability and chaos

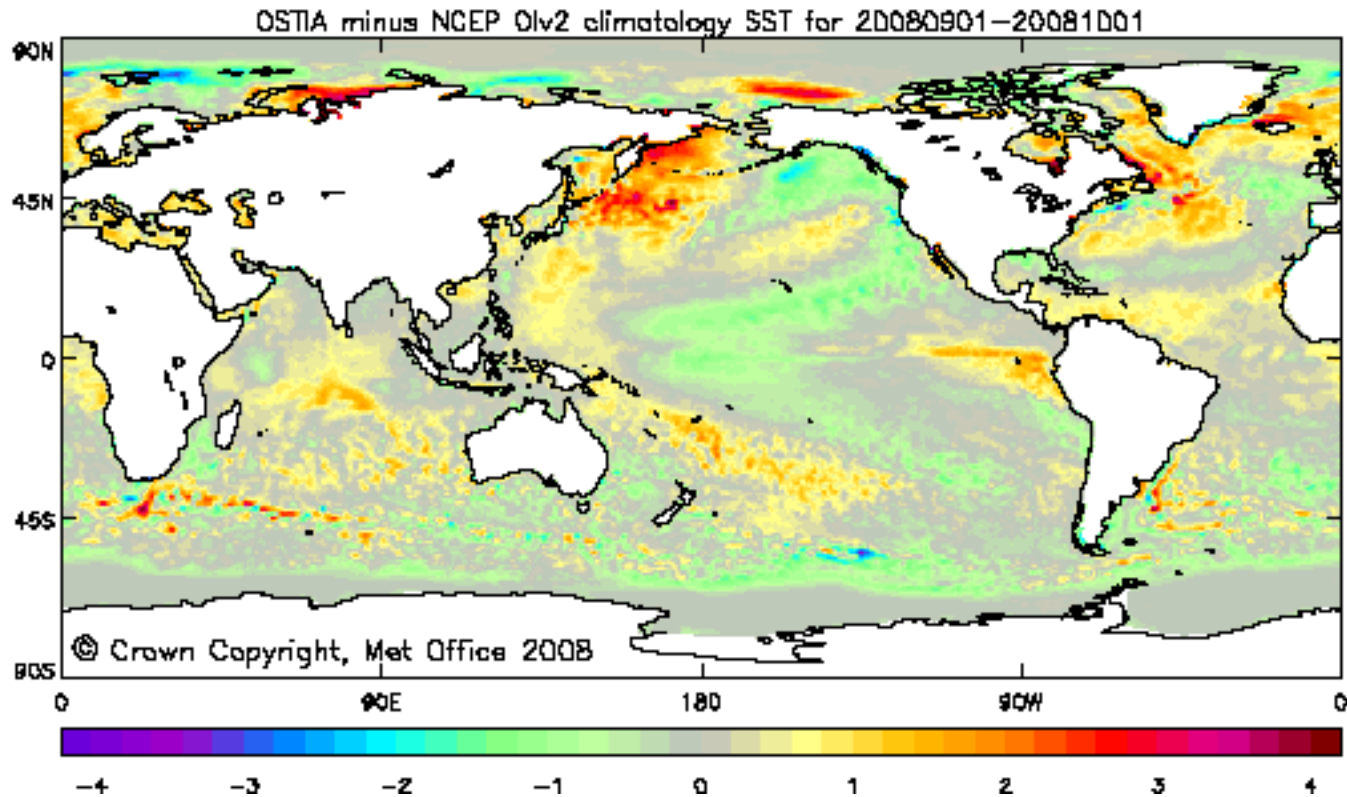
Sources of predictability:

Boundary conditions (SST, soil moisture, etc);

External forcing (emissions, etc)



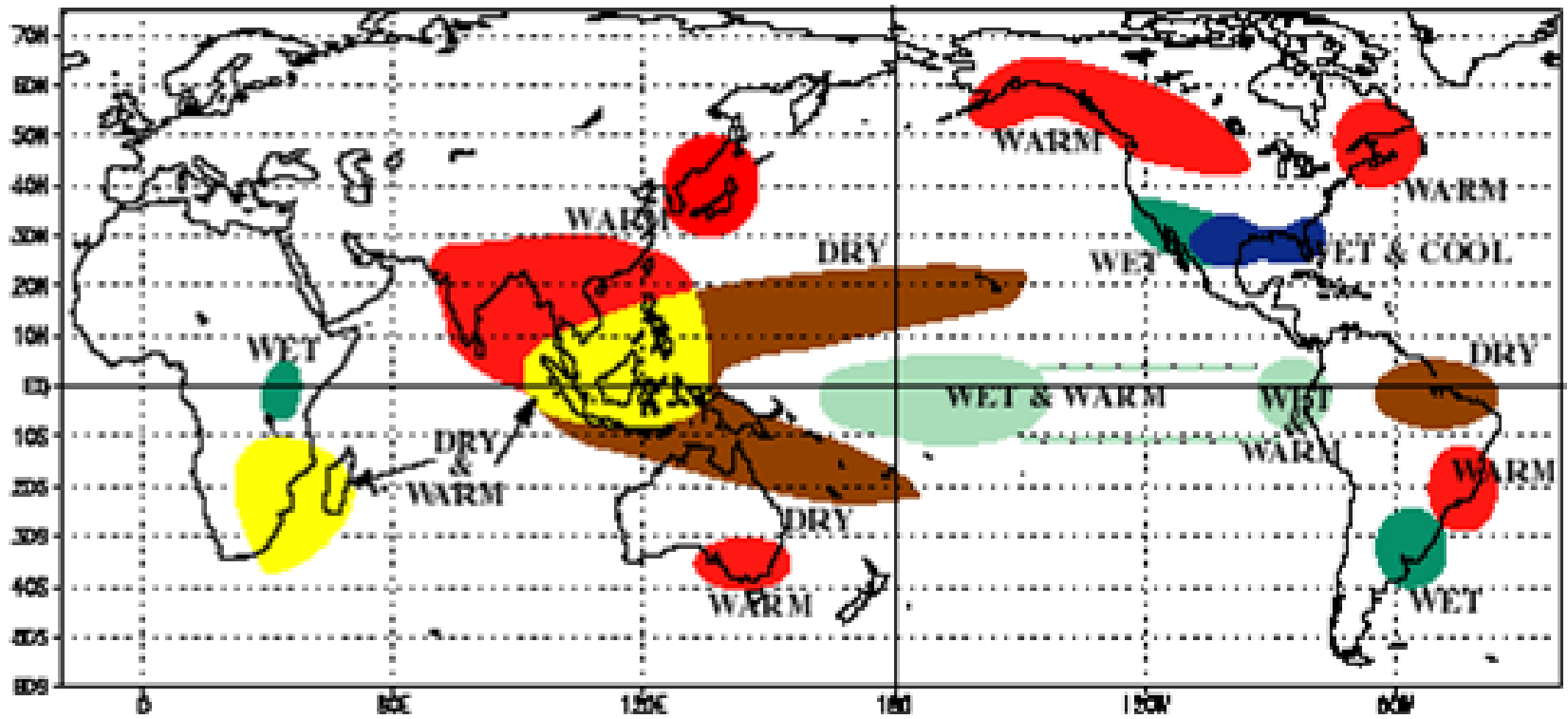
Example: sea surface temperature anomalies



The pattern is large scale and slow-varying in time

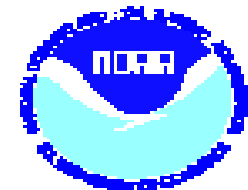
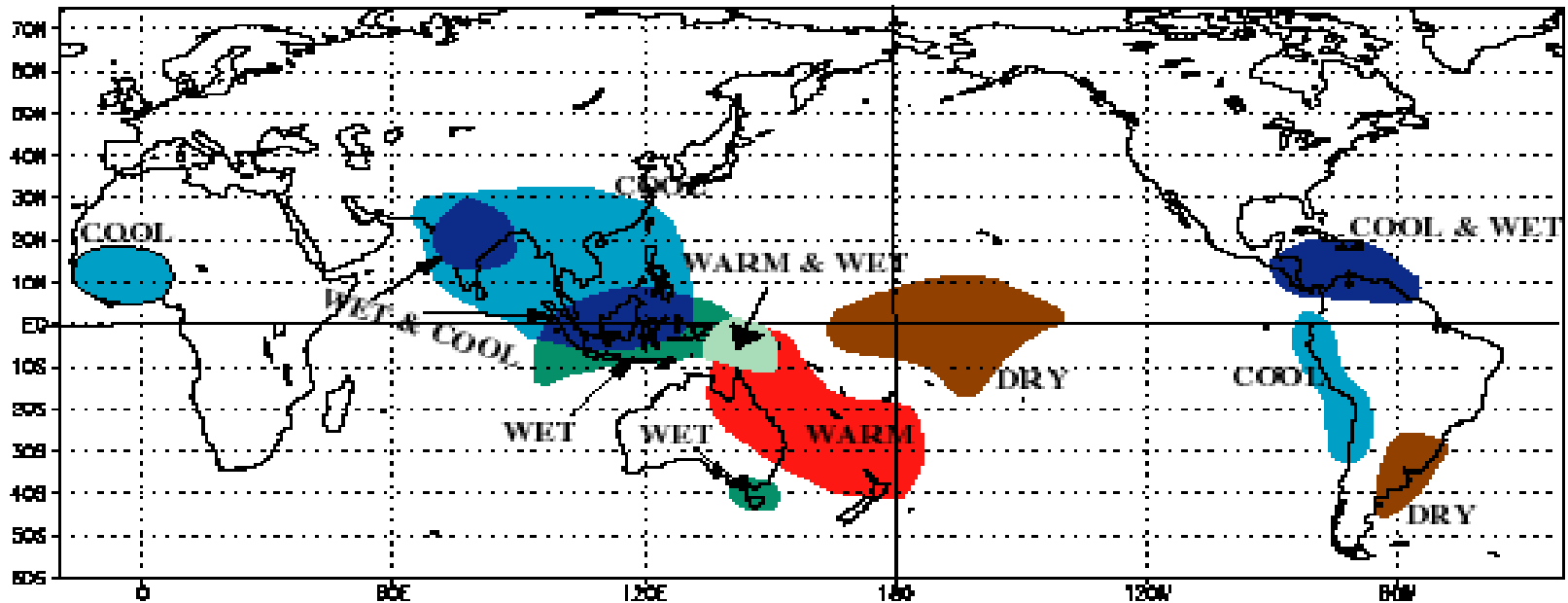
Remote influences: typical El Niño impacts

WARM EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



Remote influences: typical La Niña impacts

COLD EPISODE RELATIONSHIPS JUNE - AUGUST



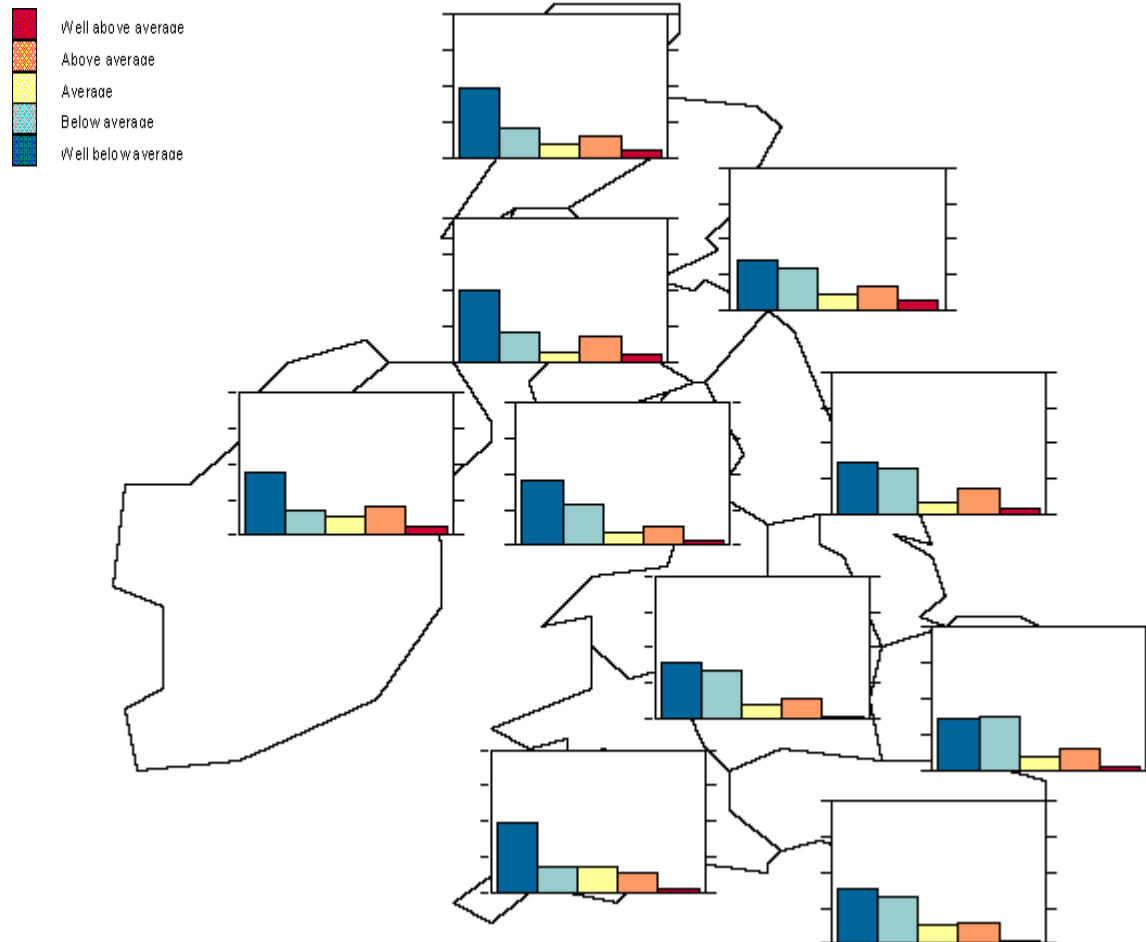
Climate Prediction Center
NCEP

What is a seasonal forecast?

Probabilistic

‘there is a 65% chance that temperatures will be below normal over the UK next winter’

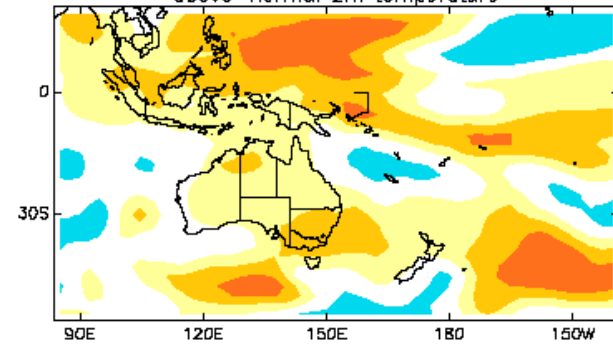
Seasonal: probabilistic forecast



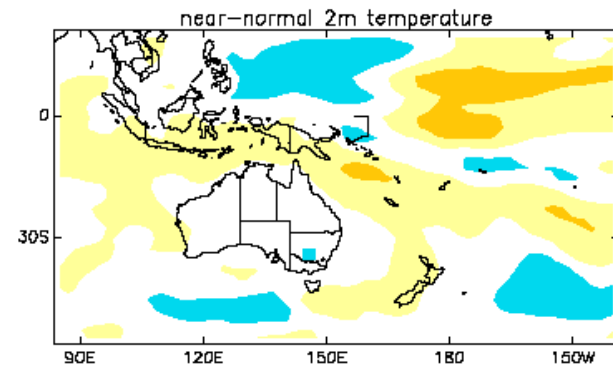
Seasonal: probabilistic forecast

EURO-SIP : Probability of tercile categories Sep/Oct/Nov Issued Aug 2005
above-normal 2m temperature

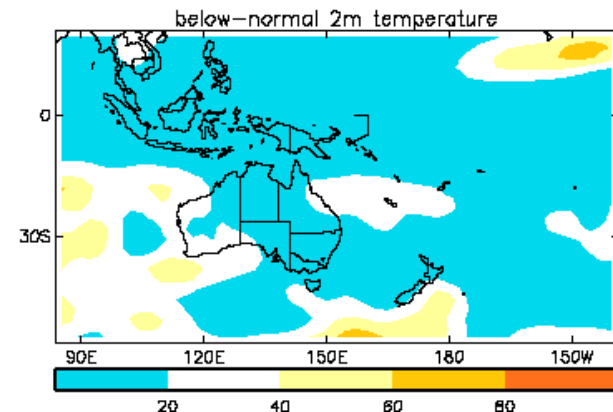
P(above)



P(average)



P(below)



Tercile categories (probabilities)

What is a seasonal forecast?

‘there is a 65% chance that temperatures will be below normal over the UK next winter’



Reference

Reference

- All probabilistic forecast need a reference

50% prob. of rain tomorrow *You have no idea!*

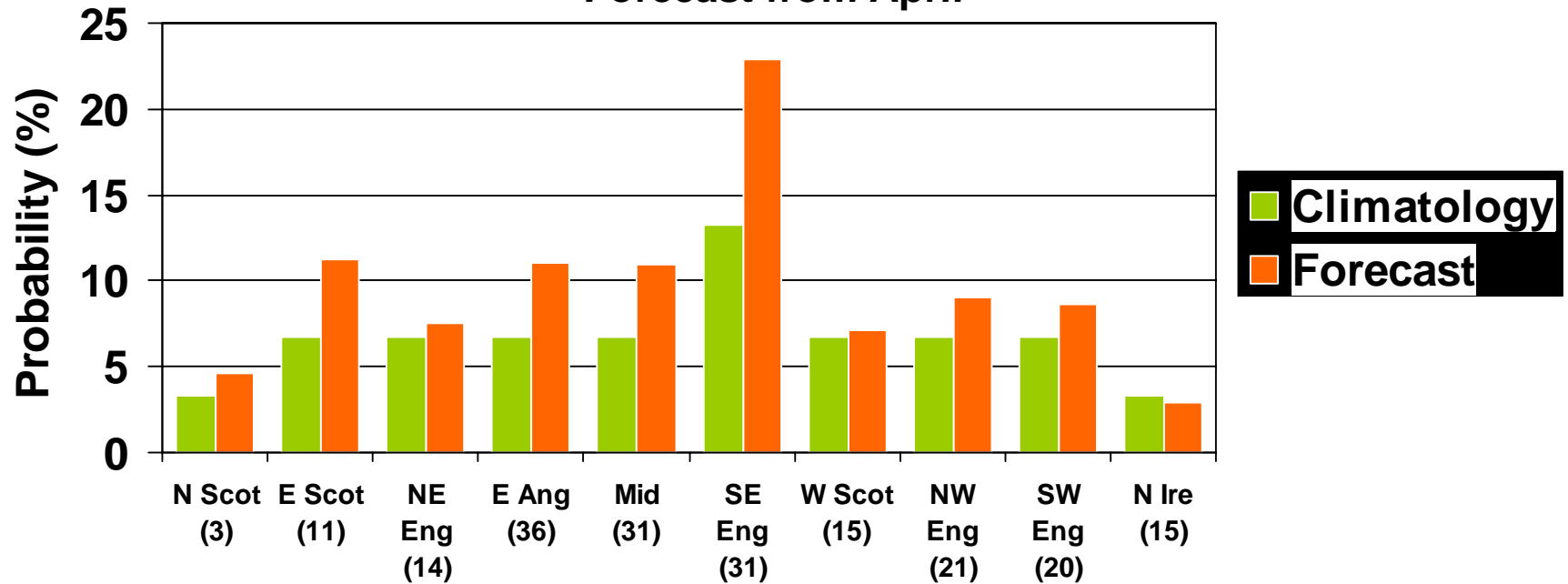
London climatology: 80% | Seville climatology: 10%

Low risk

High risk

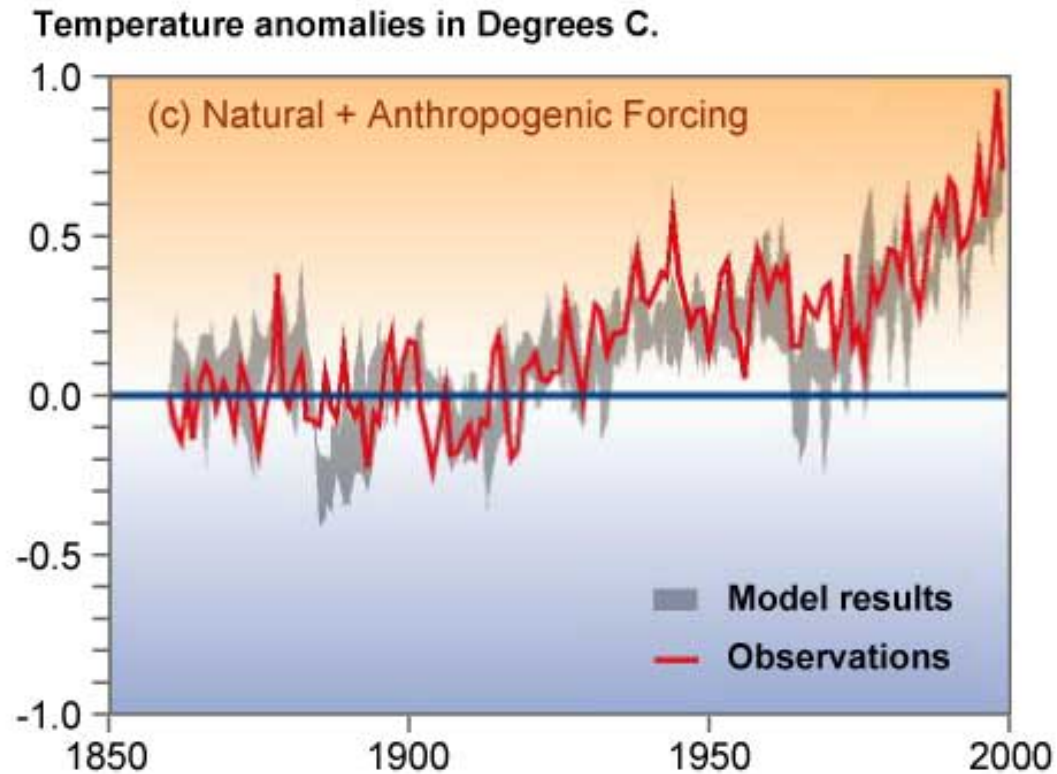
Reference

Risk (probability) of "extreme" number of days with $T_{max} > 24^{\circ}\text{C}$,
June-July-August 2003
Forecast from April



Reference period

- **PROBLEM:**
- *What does “climate” mean under climate change?*



Reference period

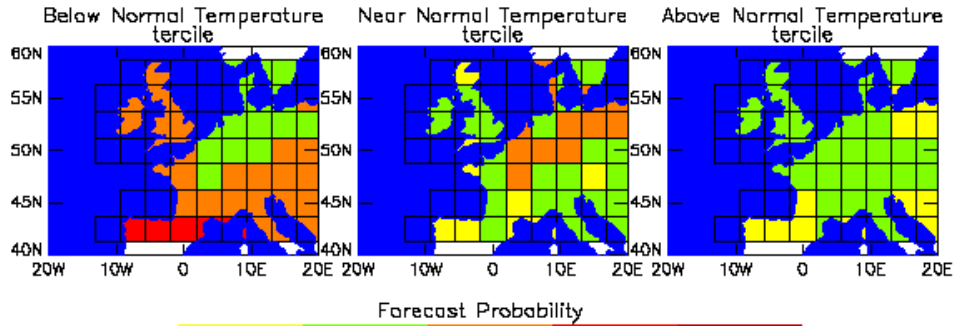
1987-2001

Statistical forecast for summer 2006 from Jan-Feb SST relative to 3 climatologies

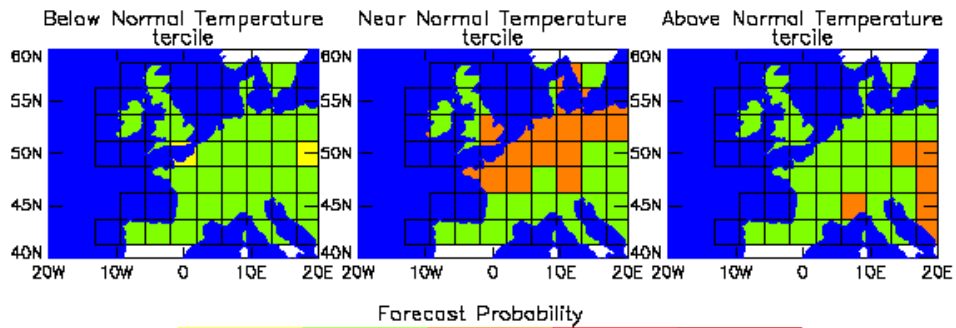
1971-2001

1961-1990

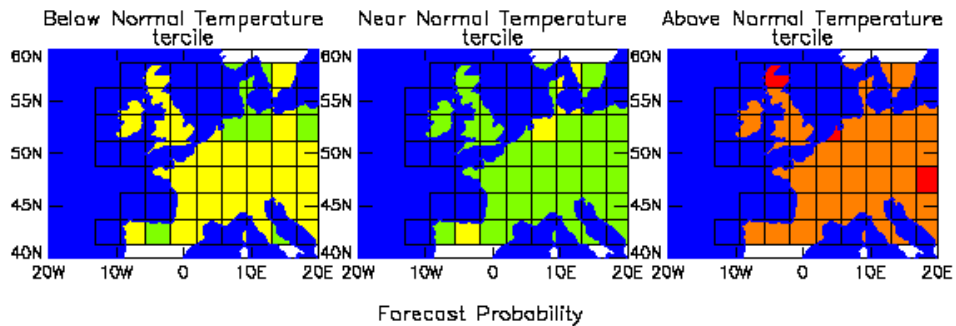
July–August 2006 forecast relative to 1987–2001 climatology: Probabilities



July–August 2006 forecast relative to 1971–2000 climatology: Probabilities

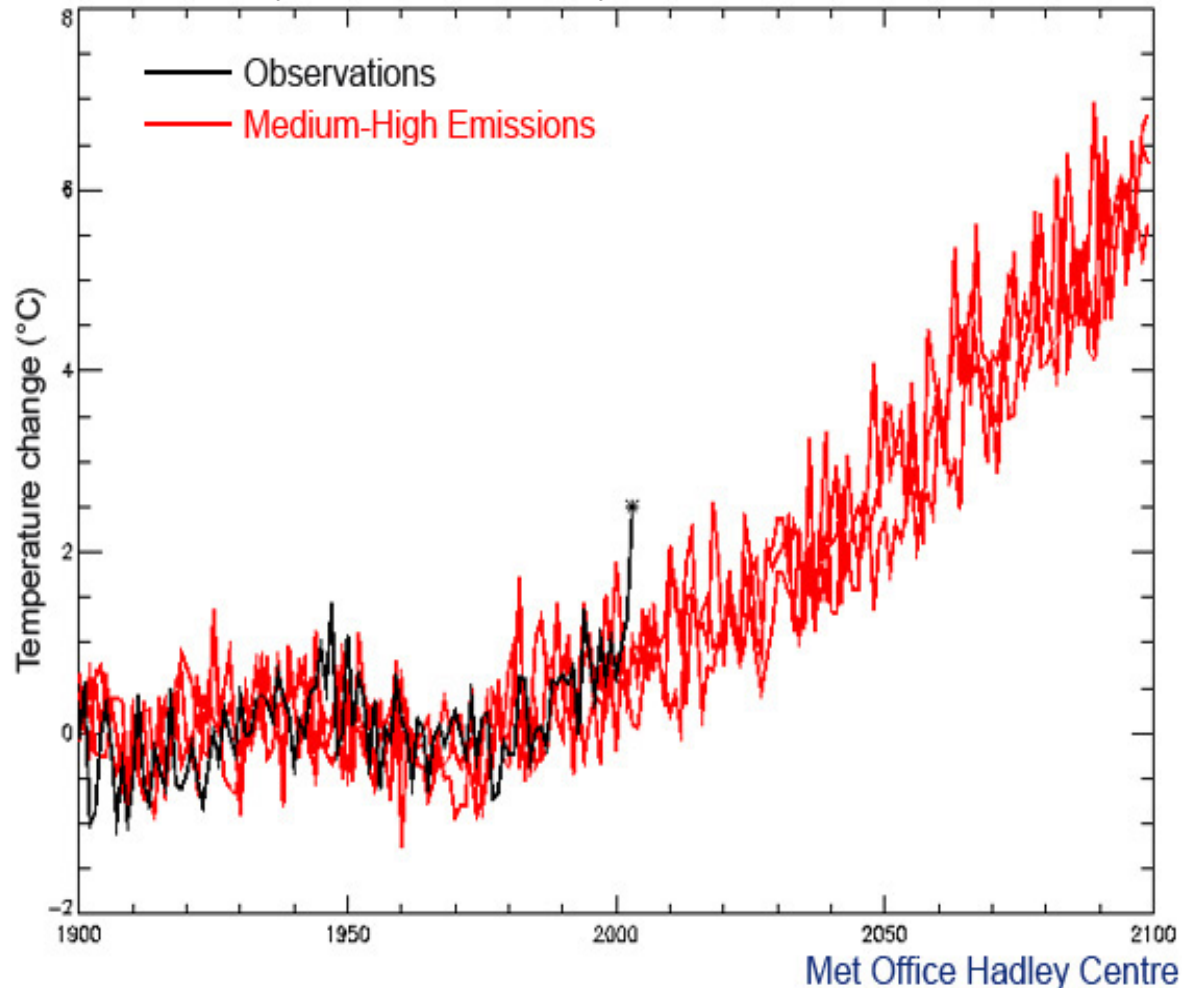


July–August 2006 forecast relative to 1961–1990 climatology: Probabilities



Reference period and climate change

European 2003 summer temperatures could be normal by 2040s, cool by 2060s



What is a seasonal forecast?

‘there is a 65% chance that temperatures will be below normal over the UK next winter’



Space and time average



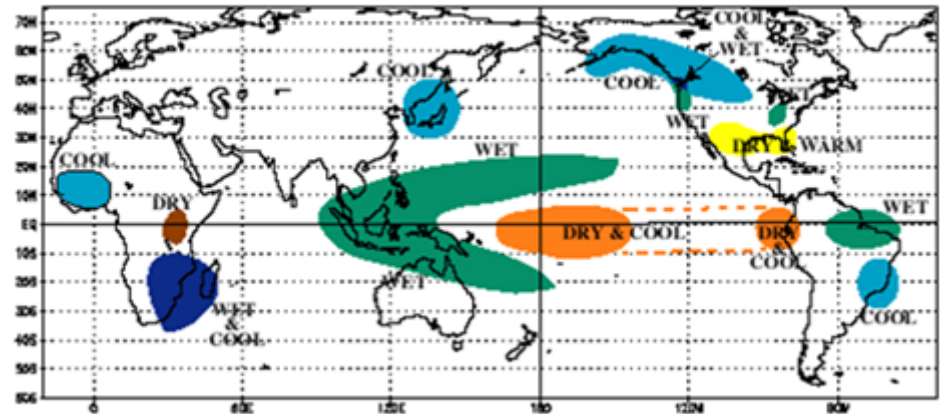
Space and time average

- Beyond a few days ahead we cannot predict conditions for a particular day
- Beyond a (very) few weeks ahead we cannot predict conditions for a particular week

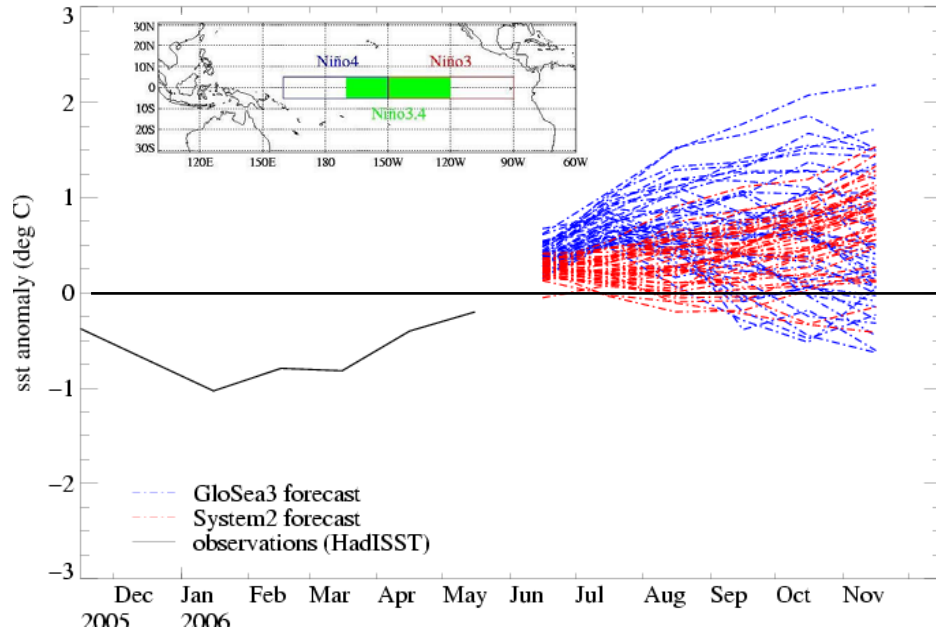
Space and time average

ENSO

COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



Forecast of SST anomaly for region Niño3.4 from 01/06/2006



Space and time average

Tropical storm frequency: July-November, issued June

Met Office Seasonal Forecast

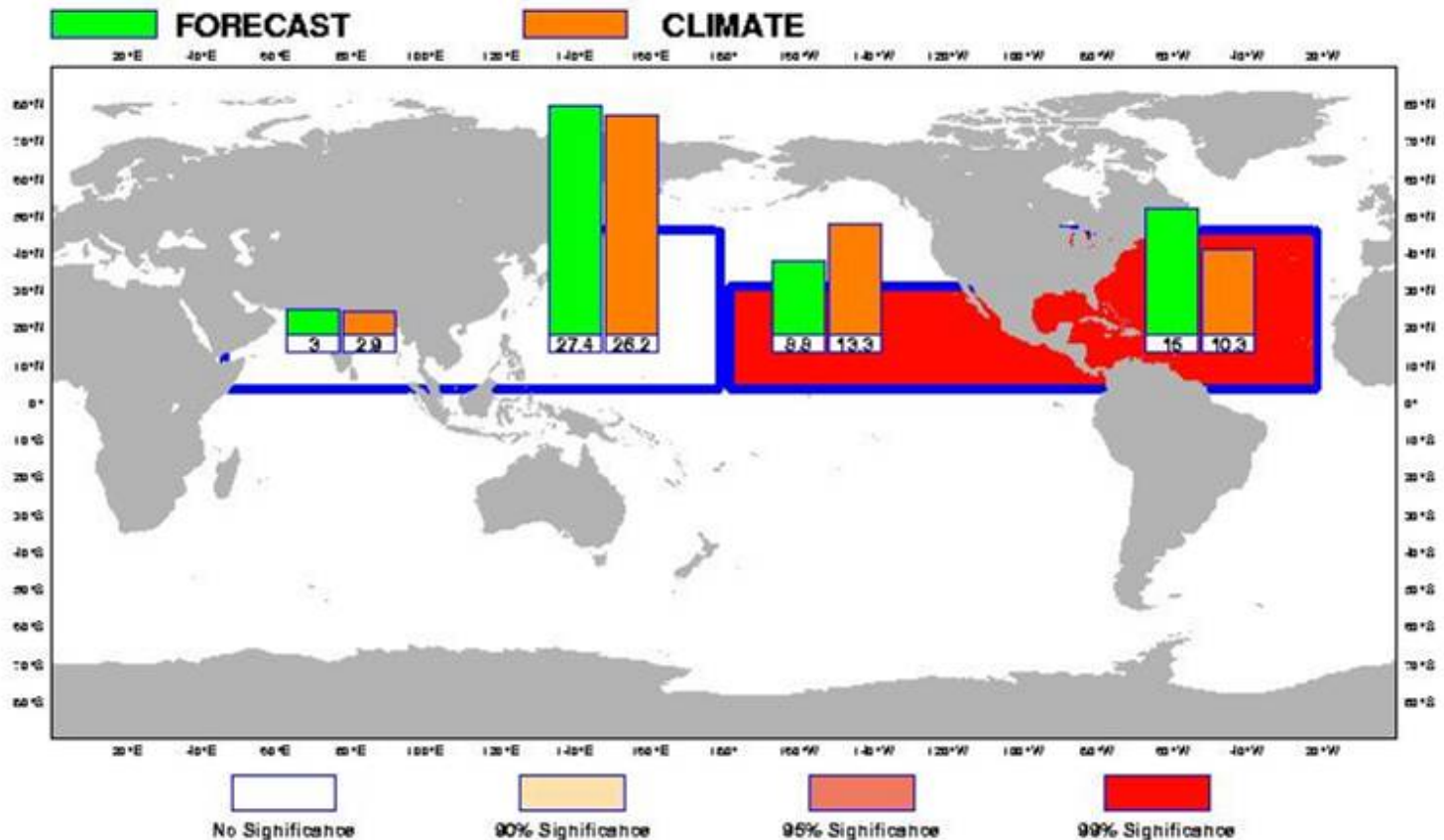
Tropical Storm Frequency

Forecast start reference is 01/06/2005

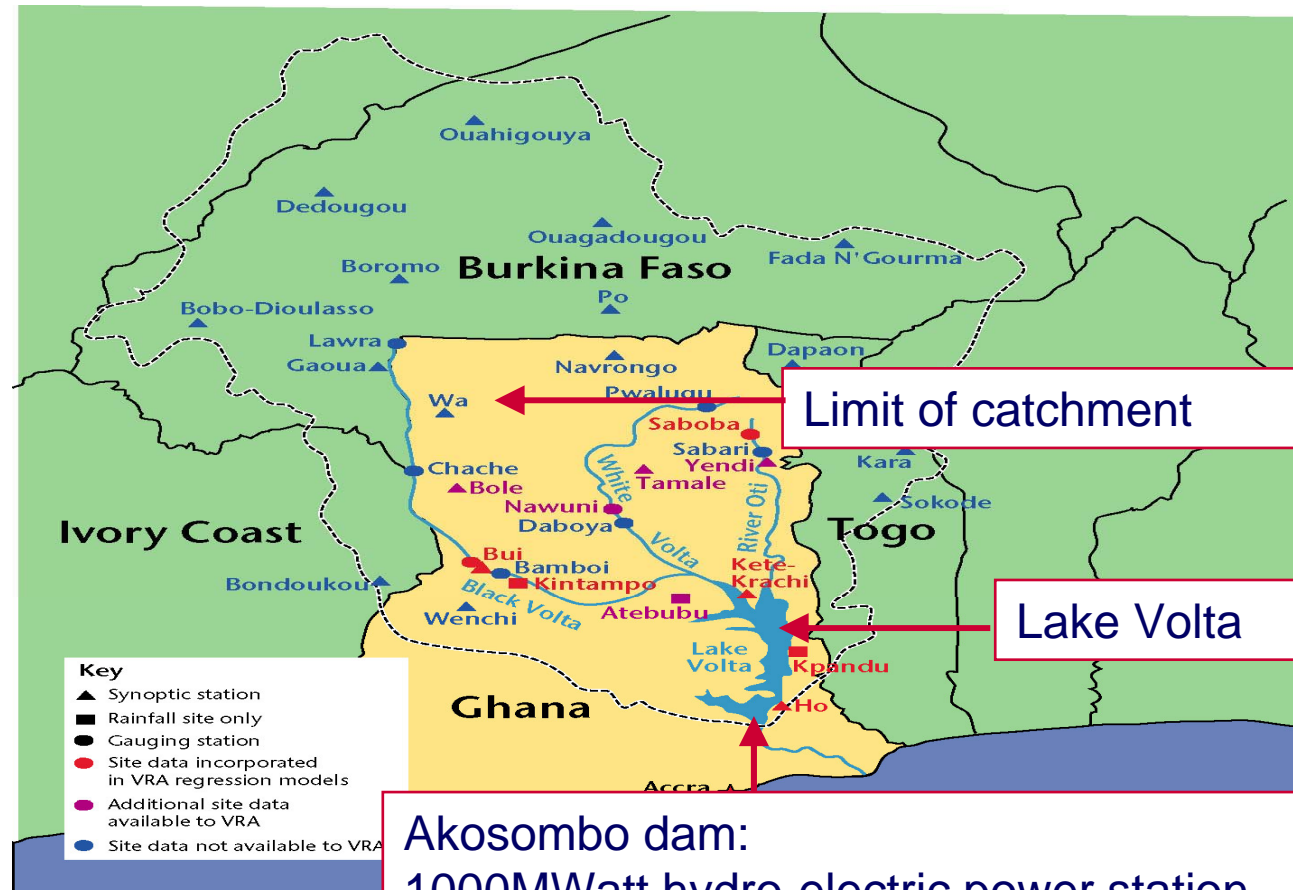
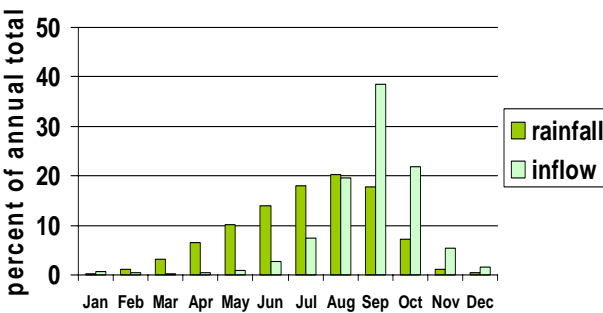
Ensemble size = 41, climate size = 225

JASON

Significance level is 90%



Space-time averaged



Akosombo dam:
1000MWatt hydro-electric power station
~50% of Ghana's electricity



What is predictable at long range (and why)

- 'climate', not 'weather'
- large-area averages, not localised events
- range of outcomes, with probabilities attached to them

Sources of predictability

- initial conditions
- slow-varying boundary conditions (SST, soil moisture, etc)
- external forcings (solar radiation, volcanoes, greenhouse gases)



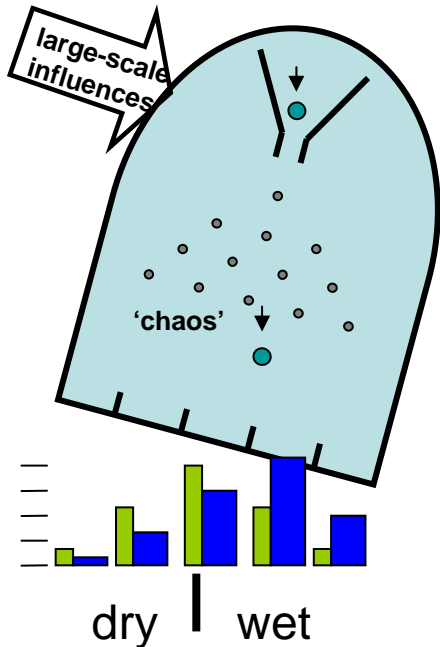
Uncertainty in long-range predictions

Sources of uncertainty

- 'measuring' initial state
- model error
- internal variability (noise)
- evolution of external forcings
- methodology used for post-processing (bias removal, downscaling, etc)

To quantify uncertainty in the predictions: ensembles

Uncertainty and ensemble prediction



- run the model several times, with slight variations (initial conditions, model parameters, etc) – all realisations are equally likely!
- interpret output in 'model' space (calculate category boundaries, derive forecast probabilities)
- interpret implications for conditions in the real world; create products



Skill of long-range predictions

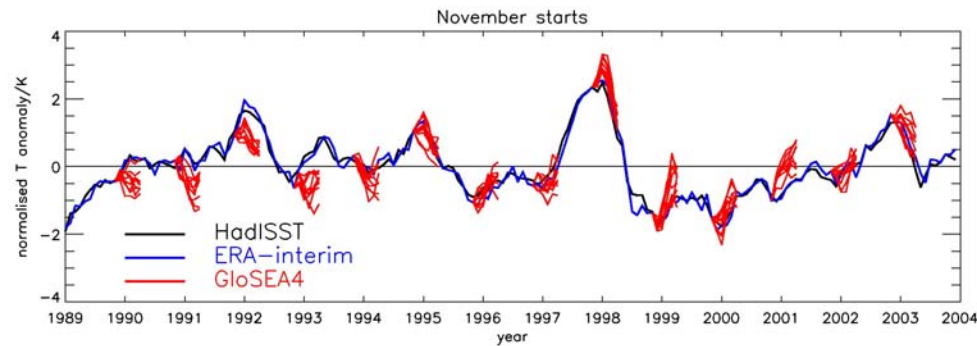
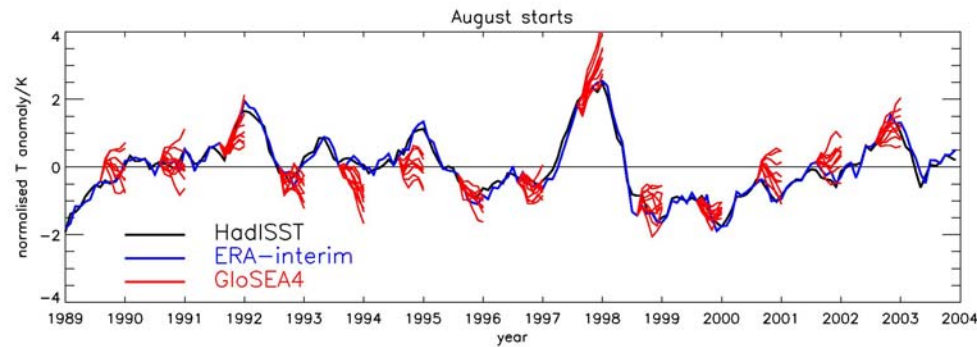
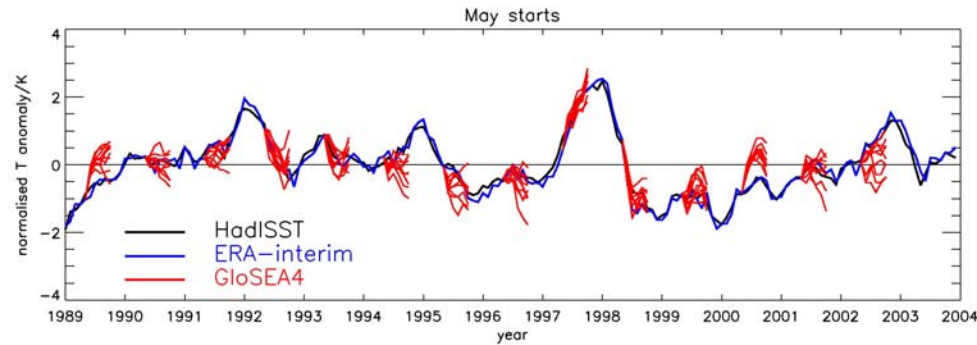
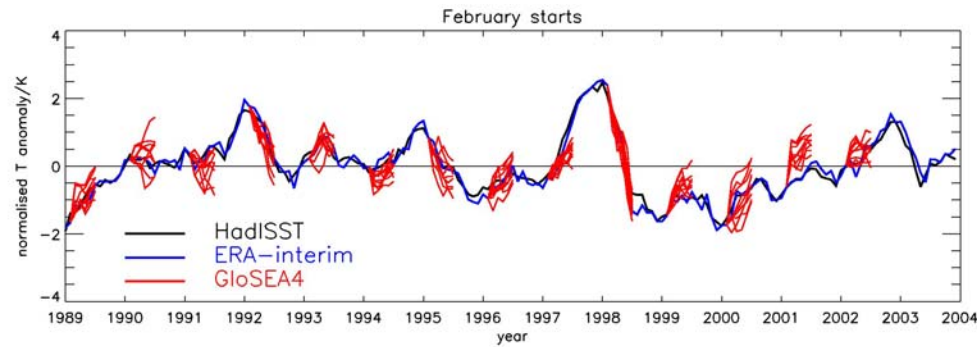
Is not meaningful for individual forecasts (which are probabilistic).

Skill scores specifically designed for probabilistic forecasts are used; they reflect average skill of the system.

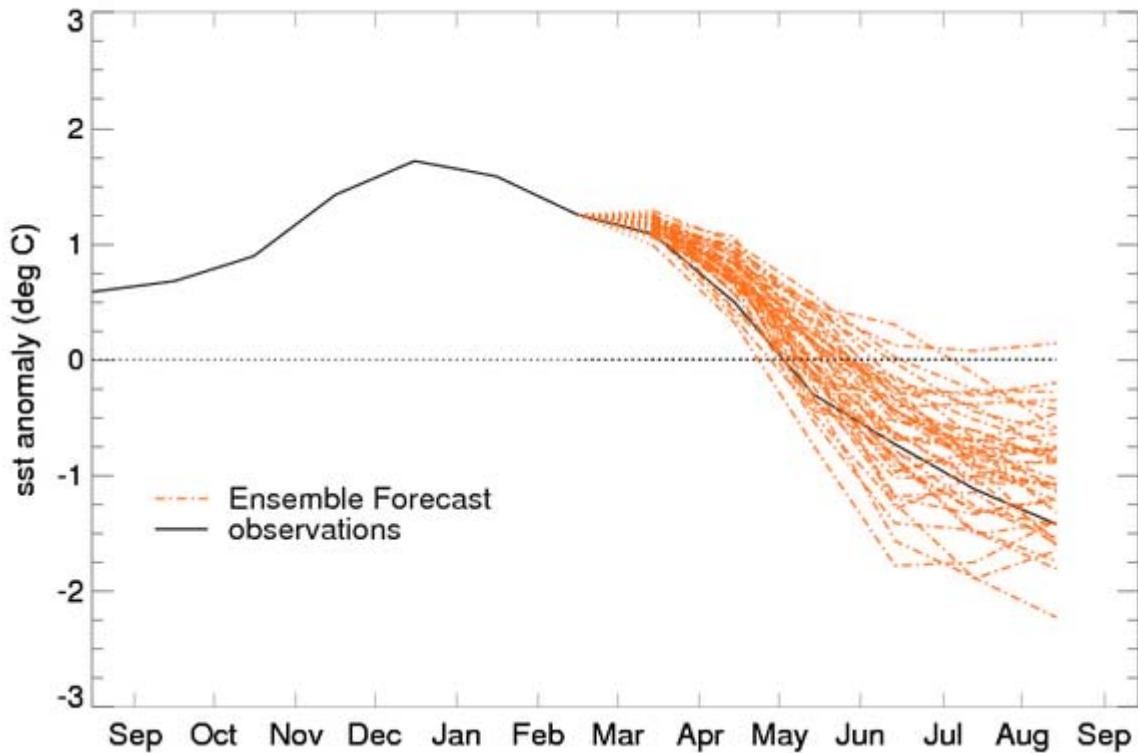
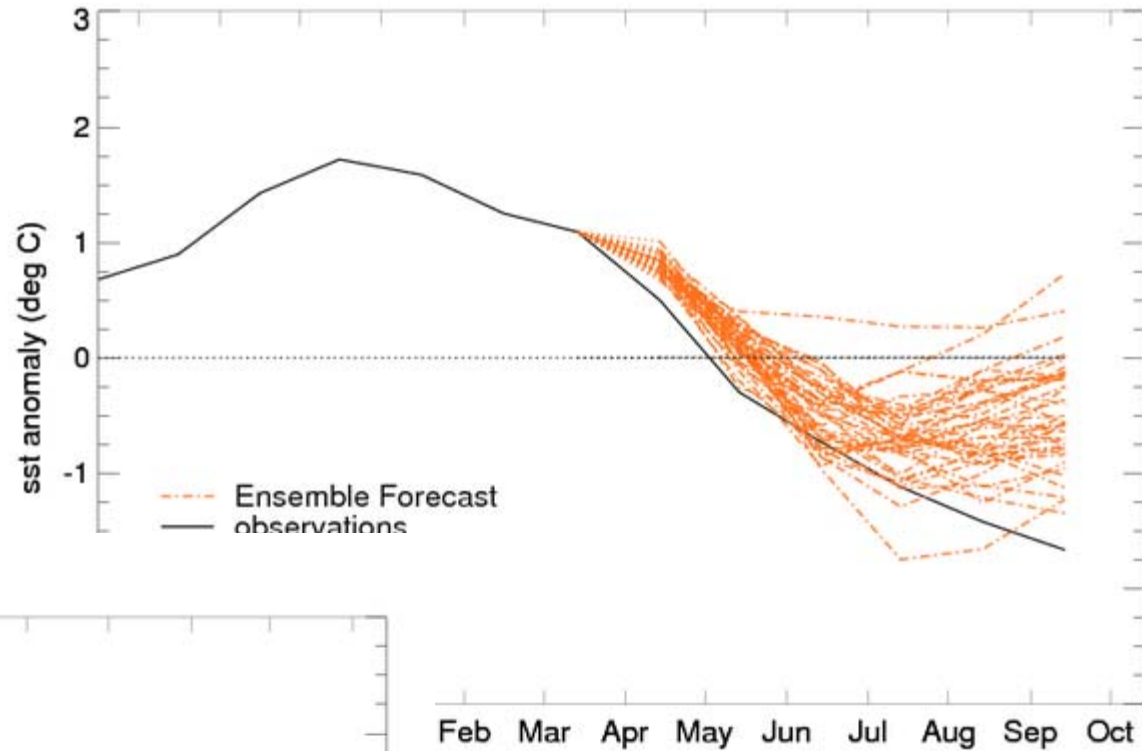
It varies with

- region
- lead time
- time of year
- variable

Example: skill of long-range predictions



Example: skill of long-range predictions





Format of long-range prediction products from the UK Met Office

Expected conditions averaged over a time period (or event counts eg. tropical storms)

- weekly periods out to 1 month ahead
- 3-month periods from 1 to 6 months ahead
- multi-year averages from 1+ year ahead

Probability format, 'broad-brush' events eg.

- probabilities for 3 equi-probable (tercile) categories
below/near/above climate average for the location and time of year
- probabilities for outer-quintile categories (20th/80th percentiles)

Availability:

- every week to 1-month range
- every month to 6-month range
- every year to decadal range



Met Office



The end