Sub-seasonal forecasts at the Met Office

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(and Copernicus Climate Change Service, ECMWF)

Outline

- the tools
- the products
- the users

Global Seasonal Forecast System version 5 (GloSea5)

- ensemble prediction system
- the source for Met Office monthly and seasonal forecasts
- uses a coupled model (atmosphere—land-surface—ocean—sea-ice)
- regular updates
- linked to model development cycle (~ yearly)
- hindcasts computed in near-real time

GloSea5 operational system

Model version: **HadGEM3 GC2.0 (UM / NEMO / CICE / OASIS)**

Resolution: **N216L85 O0.25L75** (mid-lat: ~60 km atm.)

Forecast length: **7 months (seasonal),**
2 months (sub-seasonal)

Hindcast period: **1996-2009 (14 years)**

Model uncertainties represented by stochastic physics

Initial conditions uncertainties represented by a lagged ensemble

Initialisation of the system

Forecast (initialised daily):

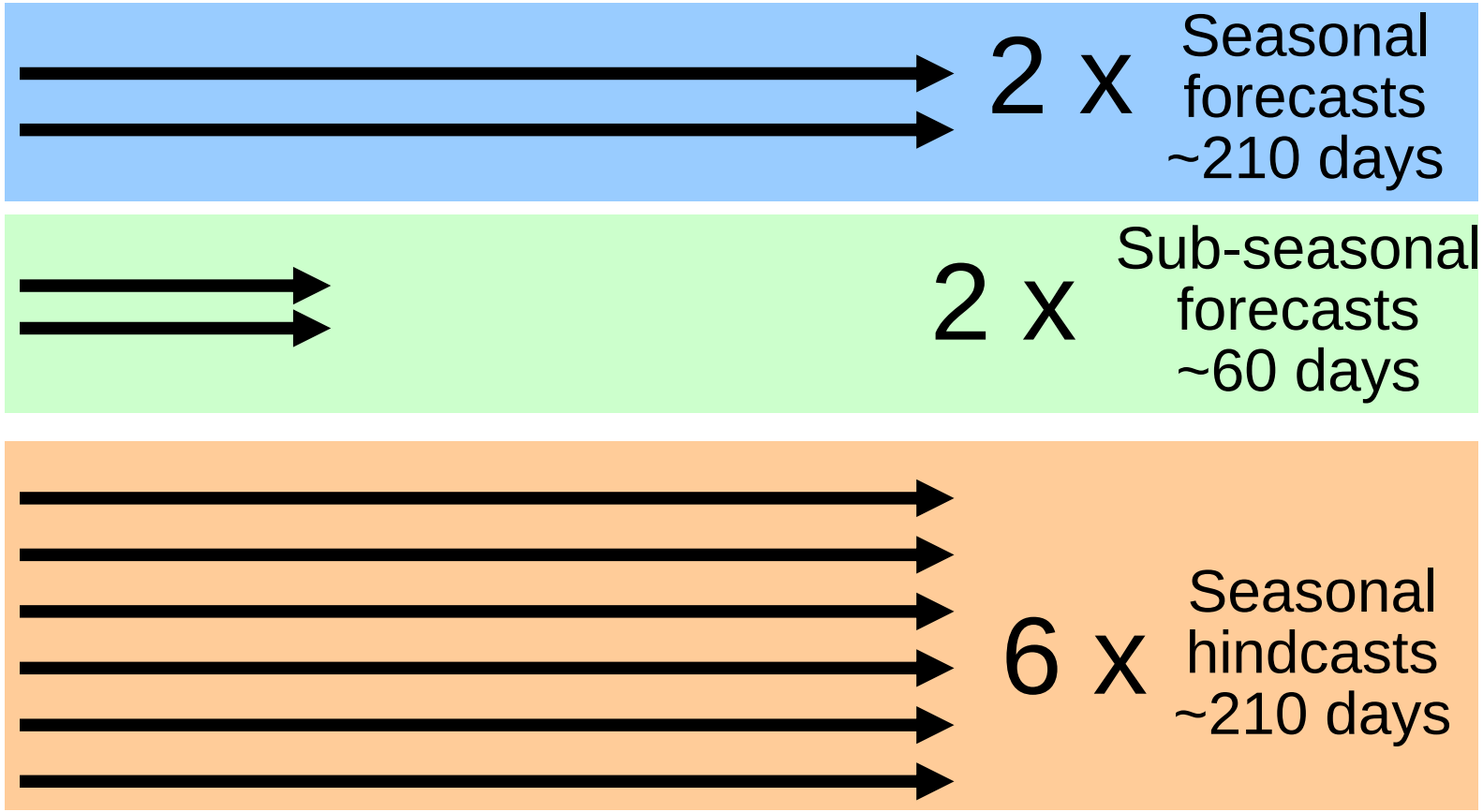
- Atmosphere & land surf *: Met Office NWP analysis (4d-Var)
- Ocean & sea-ice: NEMOVAR (3d-Var joint system for ocean, med-range, monthly and seasonal)

14-year hindcast (1996-2009):

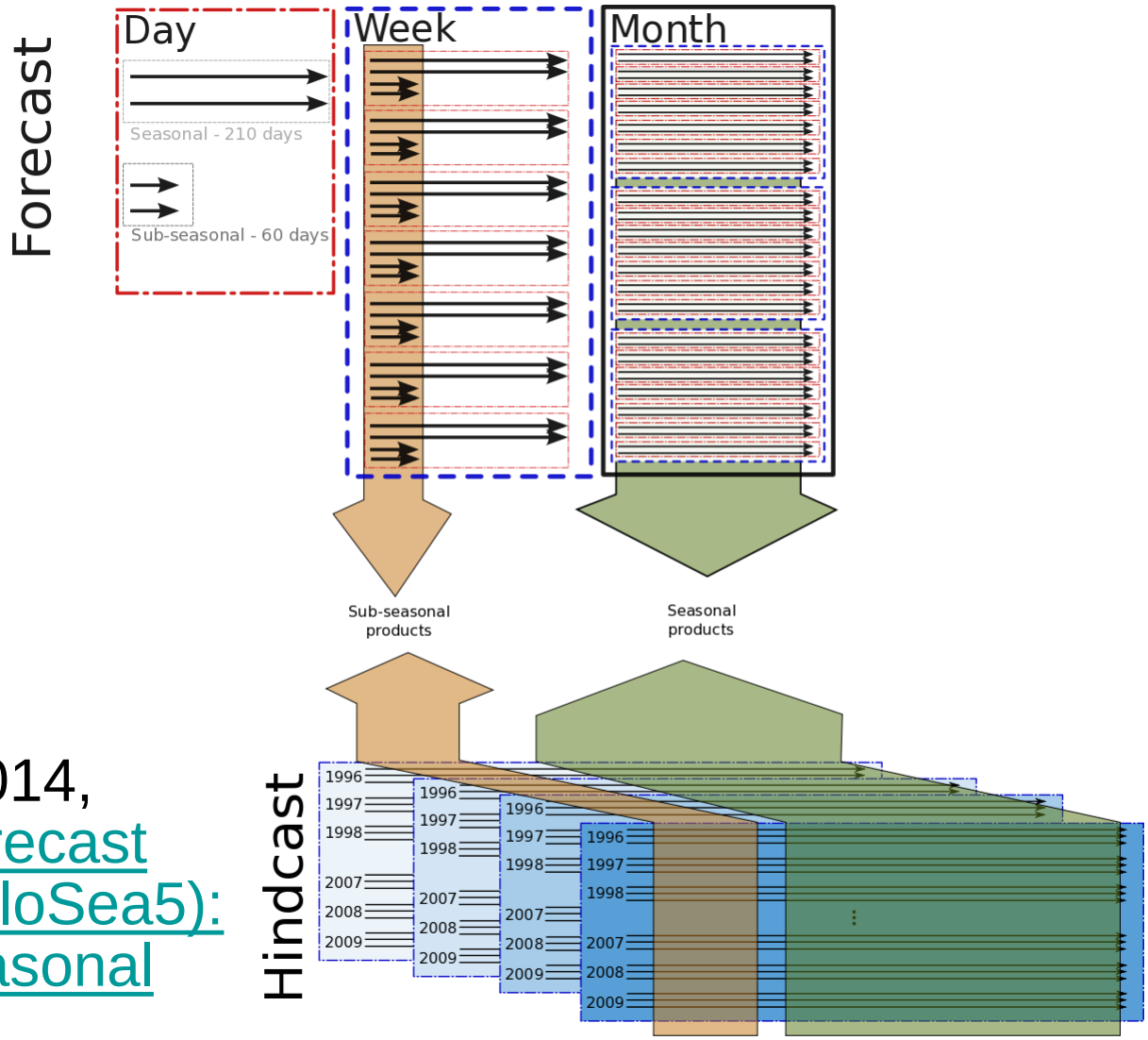
- Atmosphere & land surf *: ERA-interim
- Ocean & sea-ice: NEMOVAR
- Fixed start dates of 1st, 9th, 17th, 25th of each month
- 3 members per start date

* Soil moisture set to climatological average

A day in the life of GloSea5



A month in the life ….



MacLachlan et al, 2014, [Global Seasonal Forecast System version 5 (GloSea5): a high resolution seasonal forecast system]

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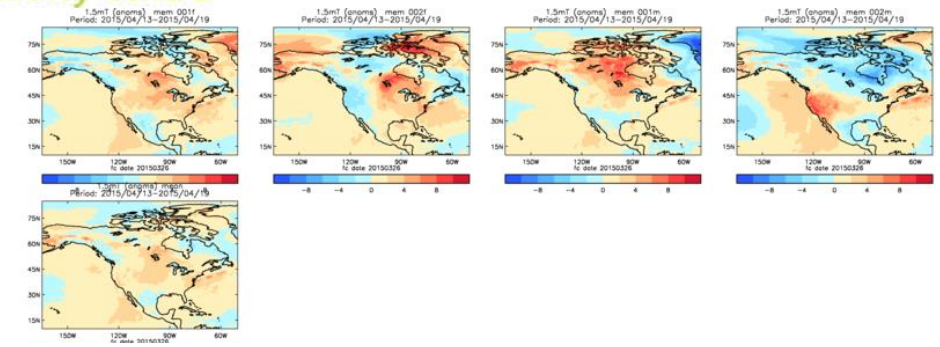
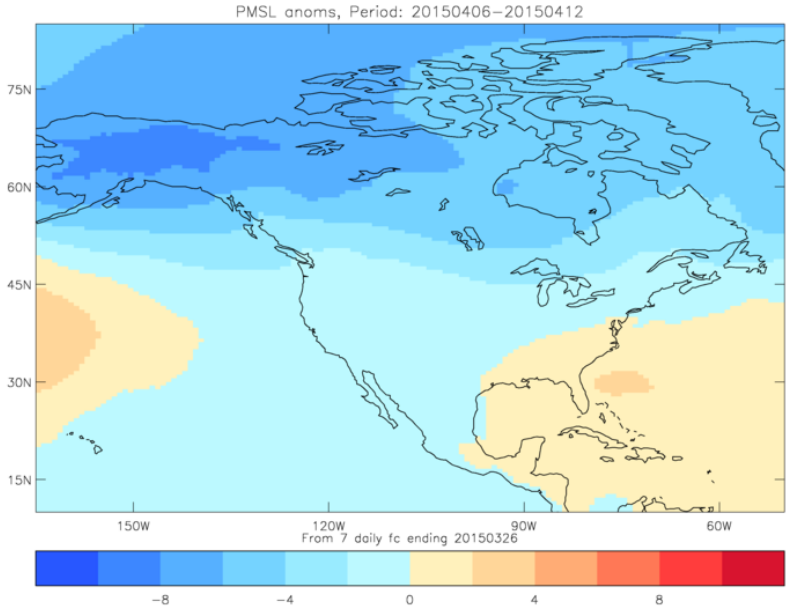
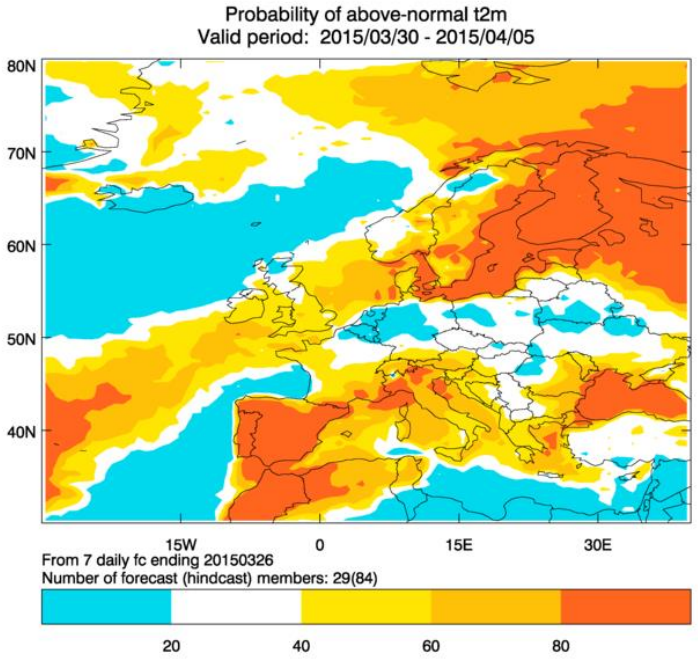
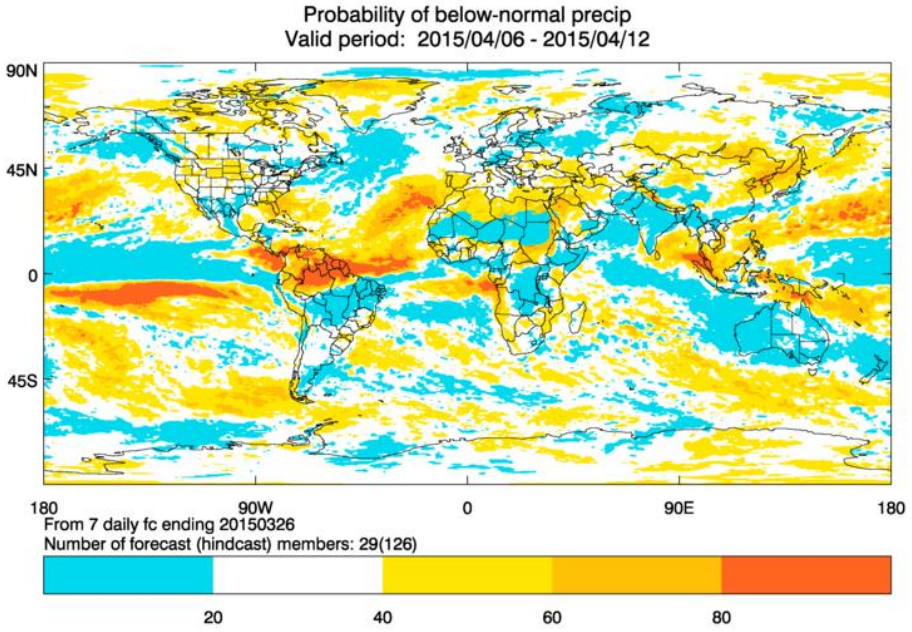
Examples of products (for internal use)

Forecast maps

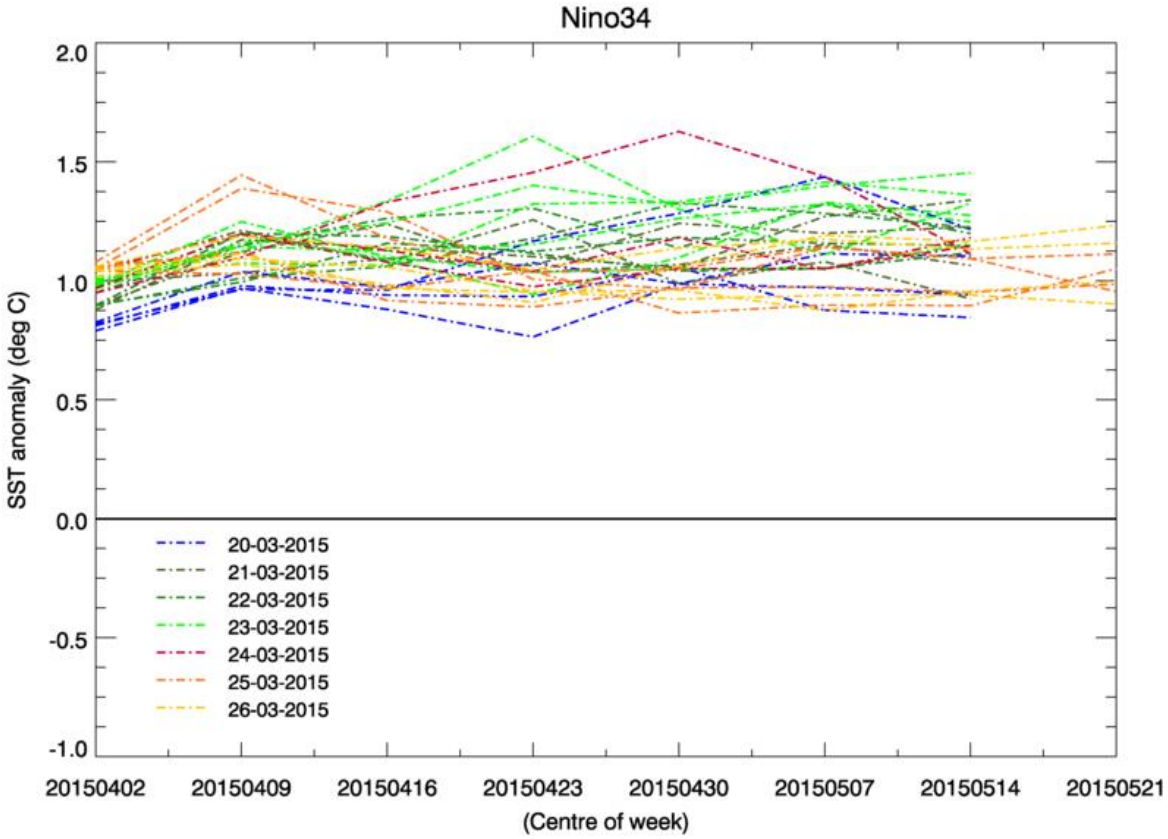


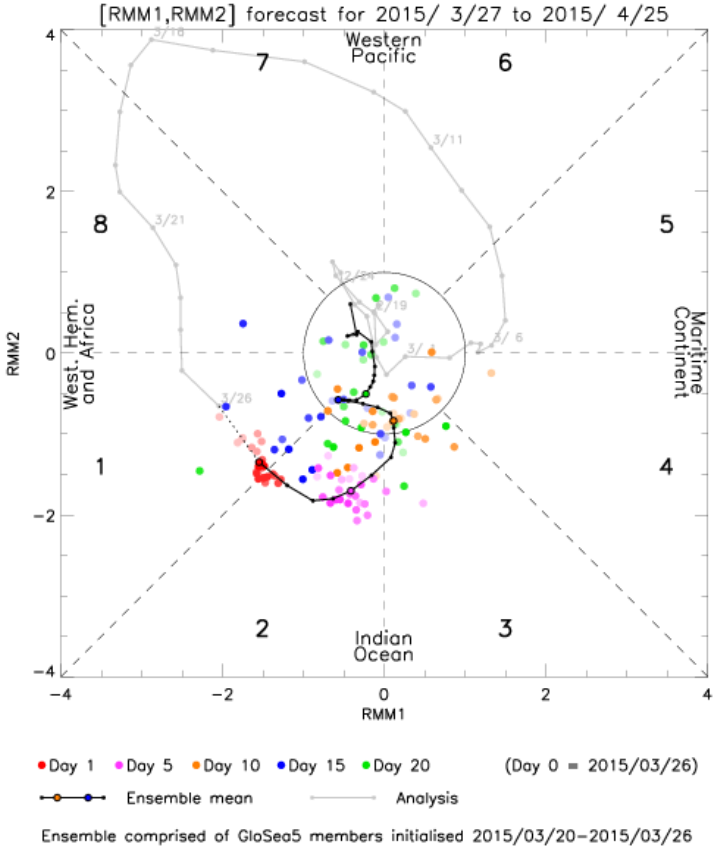




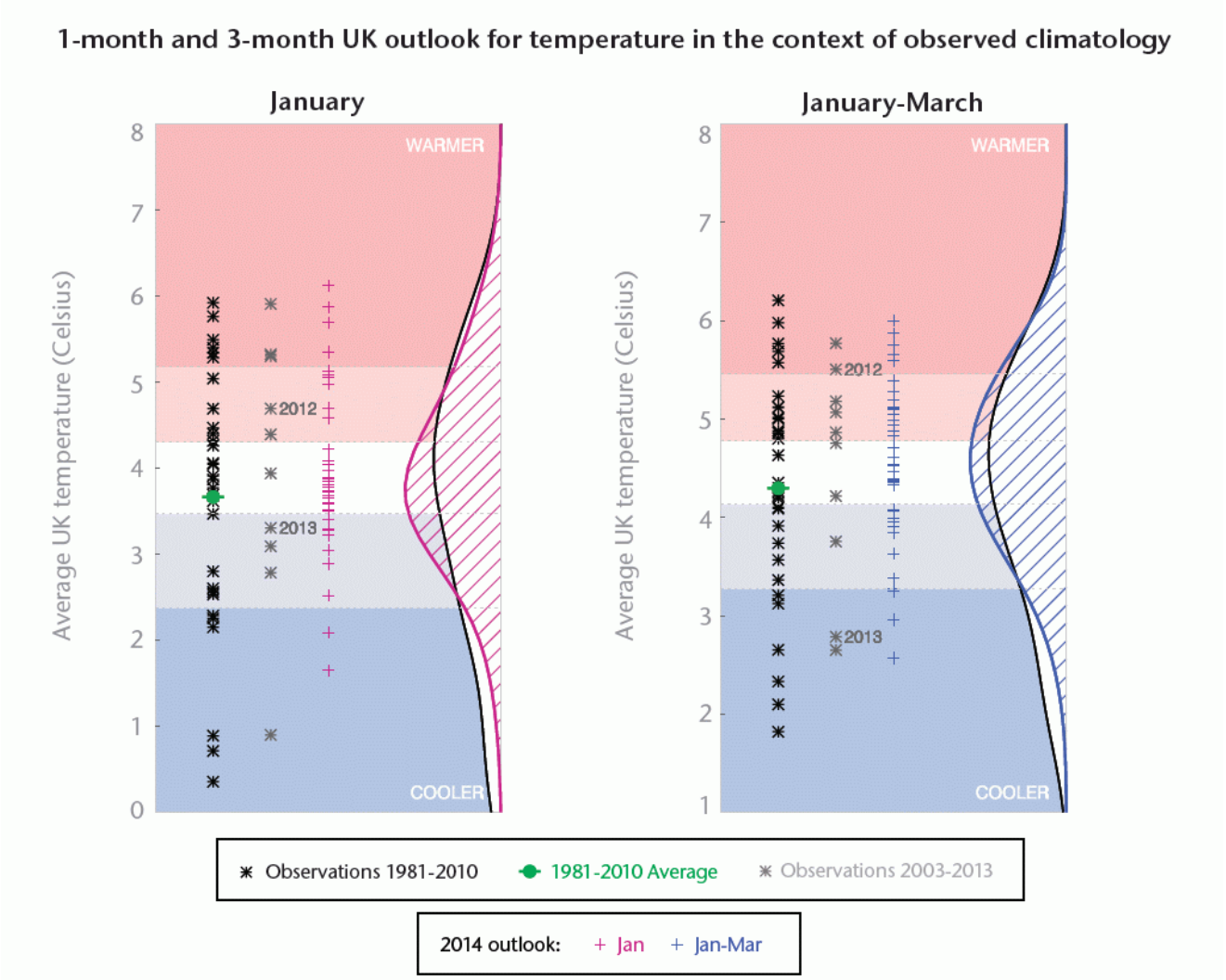


Timeseries (plume diagrams)





1- and 3-month outlook for the UK



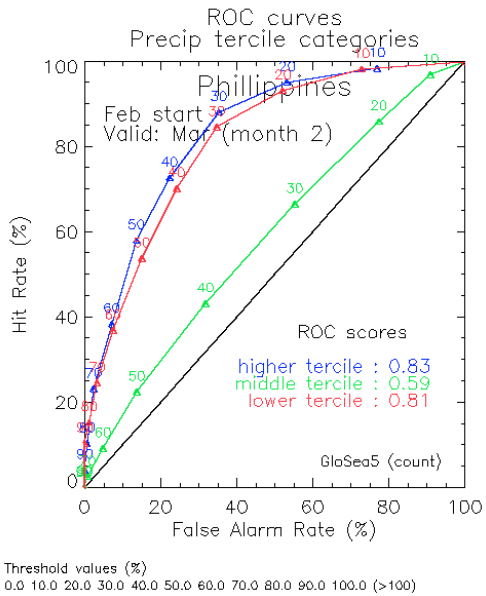
http://www.metoffice.gov.uk/publicsector/contingency-planners

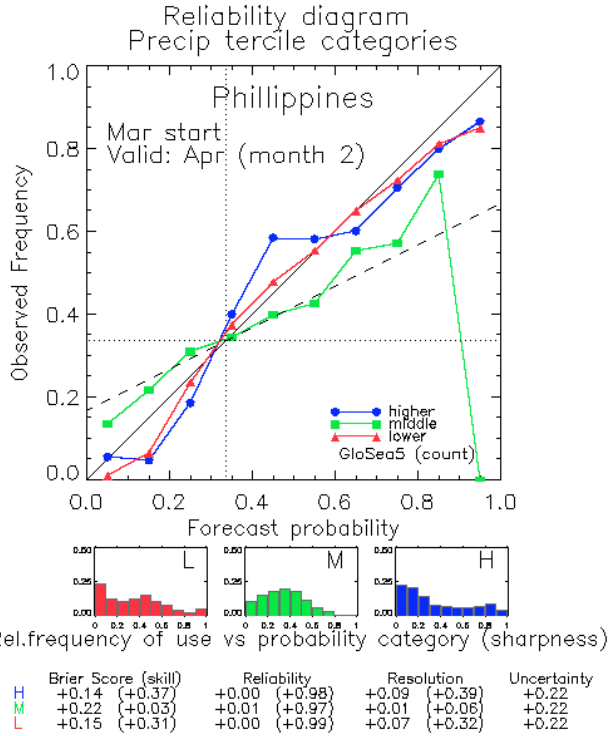
Skill of forecasting system

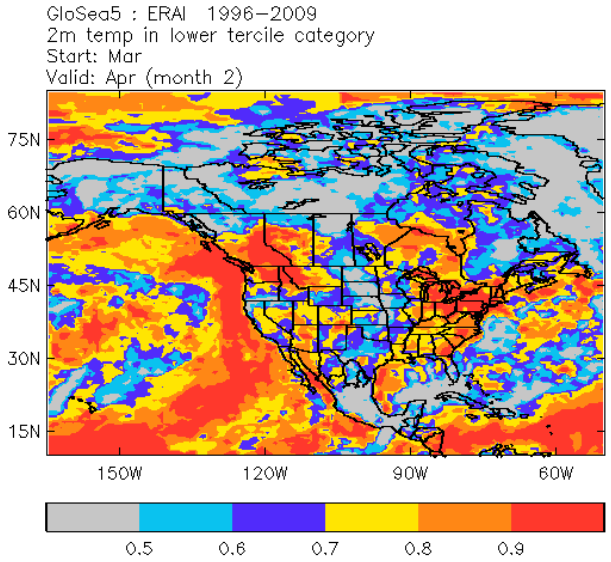
How to assess the model and the system with a small hindcast sample?

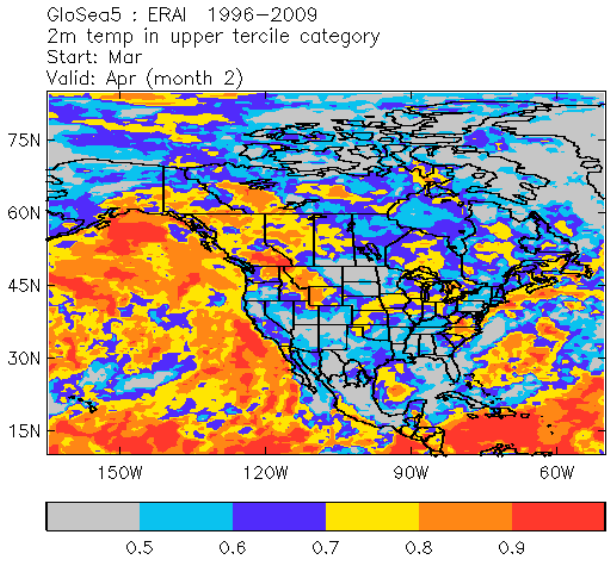
- average skill estimated on the hindcasts
- process-based assessment (from free-model runs, idealised model experiments and initialised hindcasts) - focus on processes related to sources of predictability
- case studies

Some skill scores







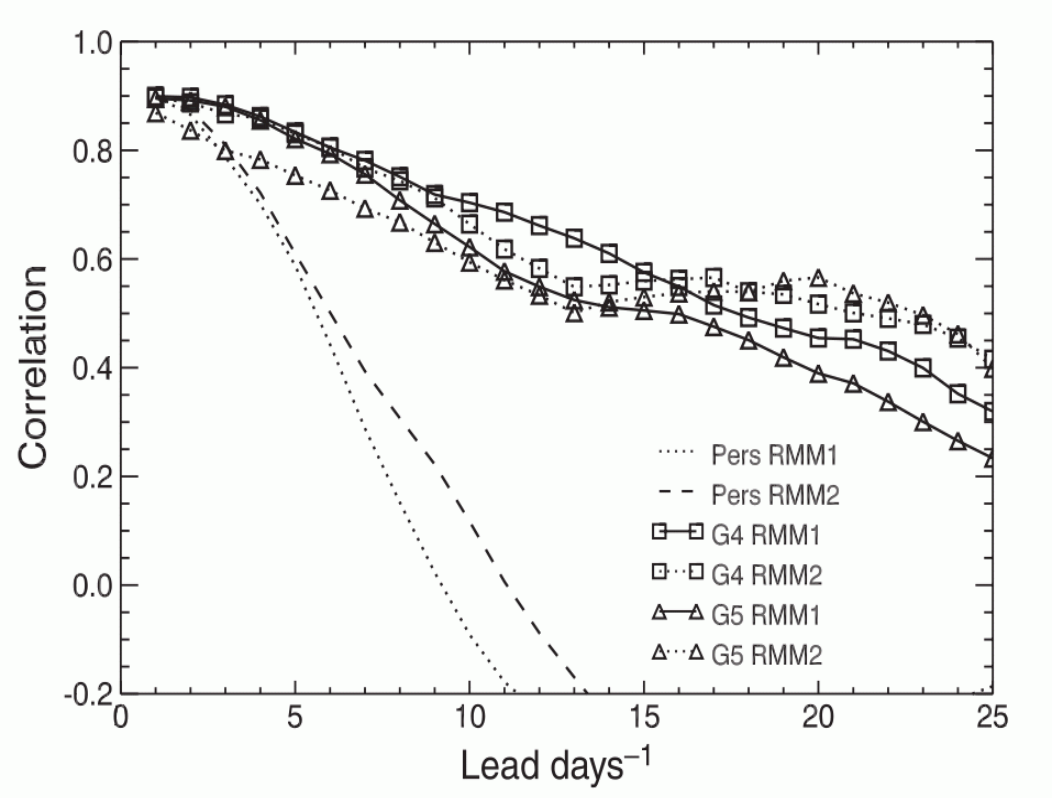


Some skill scores
Madden–Julian Oscillation, MJO

GloSea5 shows skill out to 15 – 20 days.

This suggests potential for sub-seasonal timescale prediction.

However, uninitialised model runs do not represent the MJO well; need to understand why.



Users

Mostly internal:

- forecasters in the Met Office Operations Centre – guidance to government departments (DfID, FCO), national met services (e.g. Philippines), etc

but also some external trials:

- institutes and national met services (e.g. NCMRWF)
- energy trading, hedge funds

The team's reward: feedback

Example: NCMRWF, India

Ashis Mitra

Of interest: predictions of MISO, with consequences for agriculture operations, water management, disaster management and health sector.

Forecasts used so far (last 3 years): weekly mean rainfall; graphics from the internal post-processing system, during the monsoon season

Also of use: for summer, 850 wind and MSLP will be useful; for winter, 2 m temperature, surface temperature, 500hPa wind/geopotential height, 850 wind and rainfall.

Obstacles: systematic skill assessment

Example: NCMRWF, India

Performance in 2015:

In the extended range/seasonal forecast, GloSea5 did not too badly. Reproduced delayed onset, and could represent the Ashobaa cyclone rainfall in forecasts initialised in late May.

Also was able to get the active spell in mid-June, at least in weeks 1 and 2, while week 3 and 4 forecasts dried out too fast. The dry spell in early July was predicted well even at weeks 3 and 4. This fits with the model's tendency to prefer dry/break spells.

The late July activity in Central India was captured well at week 1 and then dried out rapidly.

Example: products for traders

Emily Wallace

- Forecasts provided:
  - timeseries for indices (NAO, AO, ENSO, wind in stratosphere, MJO), circulation regimes for Europe, and derived temperature, precipitation, snow, wind
  - Z500, mslp, temperature, precipitation
  - weekly means for first month, monthly means for 6 months

- As much use of the first month of forecast as of the longer-term info.

- Example: resilience planners in the energy industry (in particular Distribution Network Operators, DNOs).
  - particular interest in a completely seamless forecast of the Christmas period from as far ahead as possible.
  - discussed the possibility of a product predicting fault numbers over this period: starting with a climatology of fault numbers, and moving into seasonal (where probably all they would get is climatology anyway), and then sub-seasonal as we approached the period.

Example: data (Cumulus Trading)

Warwick Norton and Dan Rowlands

- make extensive use of ensemble forecast from ECWMF, Met Office and NCEP (we process these internally to give consistent analysis)
- there is increasing evidence that subseasonal and seasonal prediction is more of an initial value problem (than people think); e.g. Stockdale et al. (2015), Atmospheric initial conditions and the predictability of the Arctic Oscillation.
- this indicates subseasonal and seasonal models should be run more frequently.
  - e.g. the ECWMF seasonal forecast from 1st December 2014 was out of date when it was issued on 8 December because the initial conditions had changed (e.g. the ECMWF monthly had turned the second half of December more westerley) .
  - the ECMWF monthly forecast is incorrect when it is issued (at 2200 UTC) because the12Z forecasts (which are issued earlier) have significantly changed the first 10 days.
- there is sub-seasonal skill out to day 60 on occasions when there are strong teleconnections (e.g. stratosphere/tropical forcing)

Example: data (Cumulus Trading)

forecasts:

- like the way the CFS is run, 16 ensemble members per day of which 9 go out 45 days, 7 out to 90 days (of which 4 are extended to 9 months)
- both the ECMWF monthly and seasonal are not run frequently enough
- GloSea with only 4 ensemble members per day does not capture enough of the signal and so is hard to interpret if initial conditions have materially shifted during the early part of the forecast

hindcasts:

- the CFS is a static model and has precalculated hindcasts likewise ECMWF seasonal
- GLOSEA uses latest model version and calculates hindcasts on the fly as does ECMWF monthly.
- Lagged hindcasts are good and running some members from every day (initial conditions) could help overcoming undersampling particularly in first 10 days which is an issue for bias correction.

Parting thoughts on the user perspective

What is the information content of the forecasts?

- drivers of predictability
- user-relevant variables

What features of forecast system performance are relevant to users?

Does/should forecast system design depend on user needs?

More effort is needed in the science of product development.

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Questions?