The Met Office GloSea5 System

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NMME subseasonal forecast system exploratory workshop, March 2015

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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
Met Office model development process

Model Development

Model Assessment

Process Evaluation Groups

Annual cycle

Top 10 problems

Progress reviewed annually

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# GloSea5 operational system

<table>
<thead>
<tr>
<th>Model version:</th>
<th>HadGEM3 GC2.0 (UM / NEMO / CICE / OASIS)</th>
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<tbody>
<tr>
<td>Resolution:</td>
<td>N216L85 O0.25L75 (mid-lat: ~60 km atm.)</td>
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<td>Forecast length:</td>
<td>7 months (seasonal), 2 months (sub-seasonal)</td>
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<td>Hindcast period:</td>
<td>1996-2009 (14 years)</td>
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Model uncertainties represented by stochastic physics

Initial conditions uncertainties represented by a lagged ensemble
GC2.0
Global Coupled modelling configuration

[Diagram showing connections between GC2.0 components]

- **Unified Model (N216 (~60km))**
  - Global Atmospheres
  - Global Land
  - JULES

- **Global Ocean**
  - NEMO

- **Global Sea Ice**
  - Los Alamos Sea Ice Model

- **ORCA025**
  - CICE
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)

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

* Soil moisture set to climatological average
A day in the life of GloSea5

- **Seasonal forecasts**: 2x forecasts, ~210 days
- **Sub-seasonal forecasts**: 2x forecasts, ~60 days
- **Seasonal hindcasts**: 6x hindcasts, ~210 days
A month in the life ....

MacLachlan et al, 2014, Global Seasonal Forecast System version 5 (GloSea5): a high resolution seasonal forecast system
Examples of products (for internal use)
Forecast maps

Forecast maps from the Met Office Hadley Centre.
Timeseries (plume diagrams)
1- and 3-month outlook for the UK

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

January

January-March

Average UK temperature (Celsius)

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

ROC curves for Philippines:
- Precip tercile categories
- ROC scores
- Mar start
- Valid: Mar (month 2)

2m temp in lower tercile category
Start: Mar
Valid: Apr (month 2)

Reliability diagram:
- Precip tercile categories
- Reliability of use vs probability category (sharpness)
- Forecast probability

2m temp in upper tercile category
Start: Mar
Valid: Apr (month 2)
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.
Model bias

Bias-corrected forecast

At long range, predict anomalies
Model bias

Biases are lead time dependent; can be large.

Processing for bias correction is not trivial.

Use these estimates to identify model inadequacies.
Soil moisture initialisation

Very large discrepancy between analysis for hindcast (green) and forecast (red).

So far no way of reconciling the differences, so initialisation is switched off.

Potentially missing out on important source of predictability.
What next?

- further model development, and related updates to operational system; focus on tropical convection
- higher horizontal resolution (N512, in approx 2 years)
- ‘international’ forecasting system: GloSea5 at KMA
  - larger forecast ensemble
  - larger hindcast sample
- products:
  - tropical storm activity (subseasonal): numbers, ACE, tracks
  - improved bias correction
  - improved interface for forecasters
- no immediate plans for subseasonal-specific hindcast
Computer resource

- 34,560 cpu hours per day
- 4% of Met Office HPC
- 12.6 million cpu hours per year
- 304 GB per day
- 108 TB per year
- 1800 days simulated per day
Questions?
Monthly to Decadal Variability and Prediction – the team:

Adam Scaife, Craig MacLachlan, Drew Peterson, Nicola Martin, Doug Smith, Jo Camp, Rosie Eade, Richard Graham, Michael Vellinga, Jeff Knight, David Fereday, Leon Hermanson, Nick Dunstone, Sarah Ineson, Andrew Colman, and more