An improved approach for land-surface initialization in the Met Office’s seasonal forecasting system (GloSea)

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Overview

• Introduction to GloSea5

• Current land-surface initialization and issues

• Proposed method with Japanese 55-year re-analysis project

• Results:
  • Near-surface temperature bias and skill
  • 2003 European and 2010 Russian heatwaves
Seasonal Forecast System

Global Seasonal Forecast System version 5
- creates Met Office ensemble monthly and seasonal forecasts,
- coupled model (atmosphere + ocean + land-surface + sea ice),
- hindcasts (1993-2015) initialised from ERA-Interim re-analysis (land-surface and atmosphere),
- forecasts initialised from Met Office NWP (land-surface and atmosphere).

MacLachlan et al., RMetS, 2014
Current Initialisation method

• Land-surface variables from NWP (forecasts) and ERA-Interim (hindcasts),

• However, for soil moisture, NWP and ERA-Interim climatologies are significantly different,

• Leads to systematic error in near-surface forecasting temperature,

• Instead, forecast and hindcast soil moistures use a climatology.
What is the solution?

- **Aim:** initialise land surface, particularly soil moisture, more realistically for forecasts and hindcasts

- Calculate soil moisture using data from Japanese 55-year re-analysis (JRA-55)

- **JRA-55:**
  - Provided by Japanese Meteorological Agency (JMA)
  - Covers 1958-present
  - Daily data available in near real-time (two-day lag)
New Initialization

- Force our land-surface model with JRA-55 data for forecasts and hindcasts,

- Forecasts: use daily data

- Hindcasts: use time series from re-analysis,

- Calculate soil temp., snow, as well as soil moisture for consistency.
Results
JRA-55 Experiments

- Hindcast years 1993-2015

- Start dates:
  - Summer: 25/04, 01/05, 09/05
  - Winter: 25/10, 01/11, 09/11

- 7 members per start date, per year

- Control: operational system with climatology
Bias comparison for T 1.5m

- **Summer**
  - Experiment minus ERA-I
  - Operational minus ERA-I
  - Experiment minus oper.

- **Winter**
  - Experiment minus ERA-I
  - Operational minus ERA-I
  - Experiment minus oper.

**Increase in cold bias over Eurasia**

**Decreased warm bias over North America**

**Increase in warm bias/decrease in cold bias (winter)**
Skill comparison for T 1.5m

Summer

- Experiment versus ERA-I
- operational versus ERA-I
- Experiment minus oper.

- Improved skill over North America & Europe
- Patchy over Eurasia

Winter

- Experiment versus ERA-I
- operational versus ERA-I
- Experiment minus oper.

- Improved skill over Eurasia
- Degradation over North America & Africa (winter)
Unable to reproduce the high-temperature anomalies for any event.

Increase in extent in positive temp. anomaly in Atlantic.

Decrease in the temperature anomaly over Europe/ Russia compared with operational model.
Summary

- Unable to initialise GloSea5 soil moisture using NMP and ERA-I owing to different climatologies. Instead, resort to using a single climatology for both,

- Improved technical implementation for land-surface initialisation,

- Force land-surface model with JRA-55 data for hindcasts and forecasts,

- Little impact on temperature anomalies for 2003 and 2010 heatwaves,

- Reduction in warm 1.5m temperature bias over North America, but worsening of cold bias over north of Eurasia,

- Improved skill for 1.5m temperature for North America and Europe.
Questions?
Near real-time data

- Check assumption that soil moisture at day-2 close to value at day-0

Distribution of soil moisture differences for (3rd – 1st) of the month for 1993-2015

+/-1 standard deviation of soil moisture values on 3rd of each month

Soil moisture two-day differences vs inter-annual variability (kg/m²)

Two-day differences generally small compared with inter-annual variability (with few exceptions)