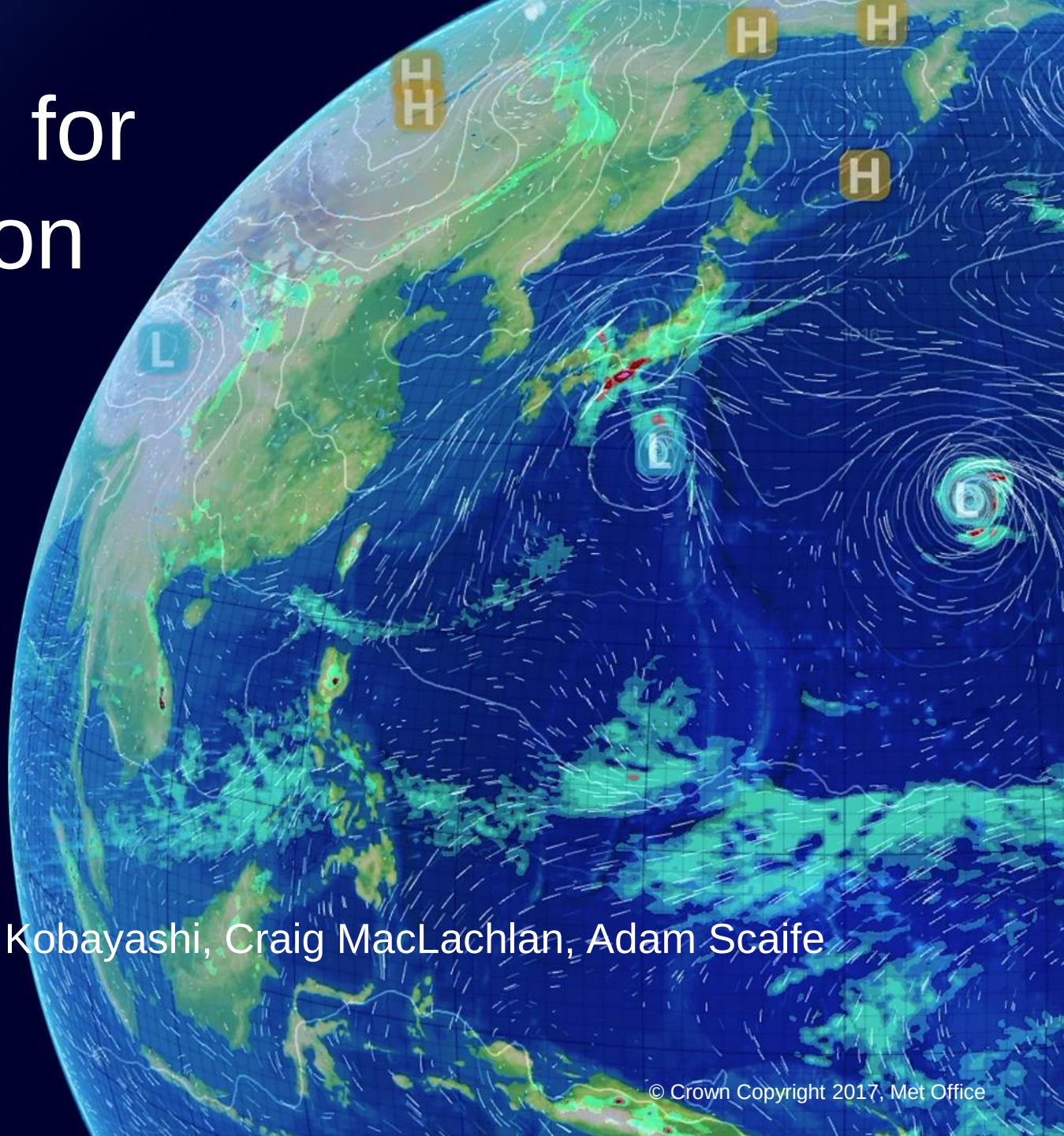
An improved approach for land-surface initialization in the Met Office's seasonal forecasting system (GloSea)



Philip Davis

Ruth Comer, David Fereday, Jeff Knight, Shinya Kobayashi, Craig MacLachlan, Adam Scaife

Met Office

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

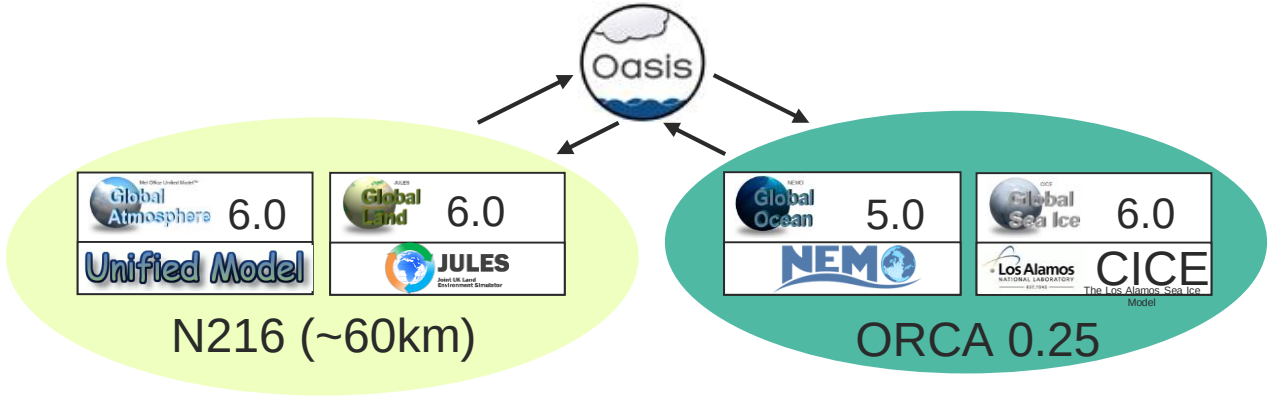
Global Seasonal Forecast System version 5

- 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

GC2.0

Global Coupled modelling configuration



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)

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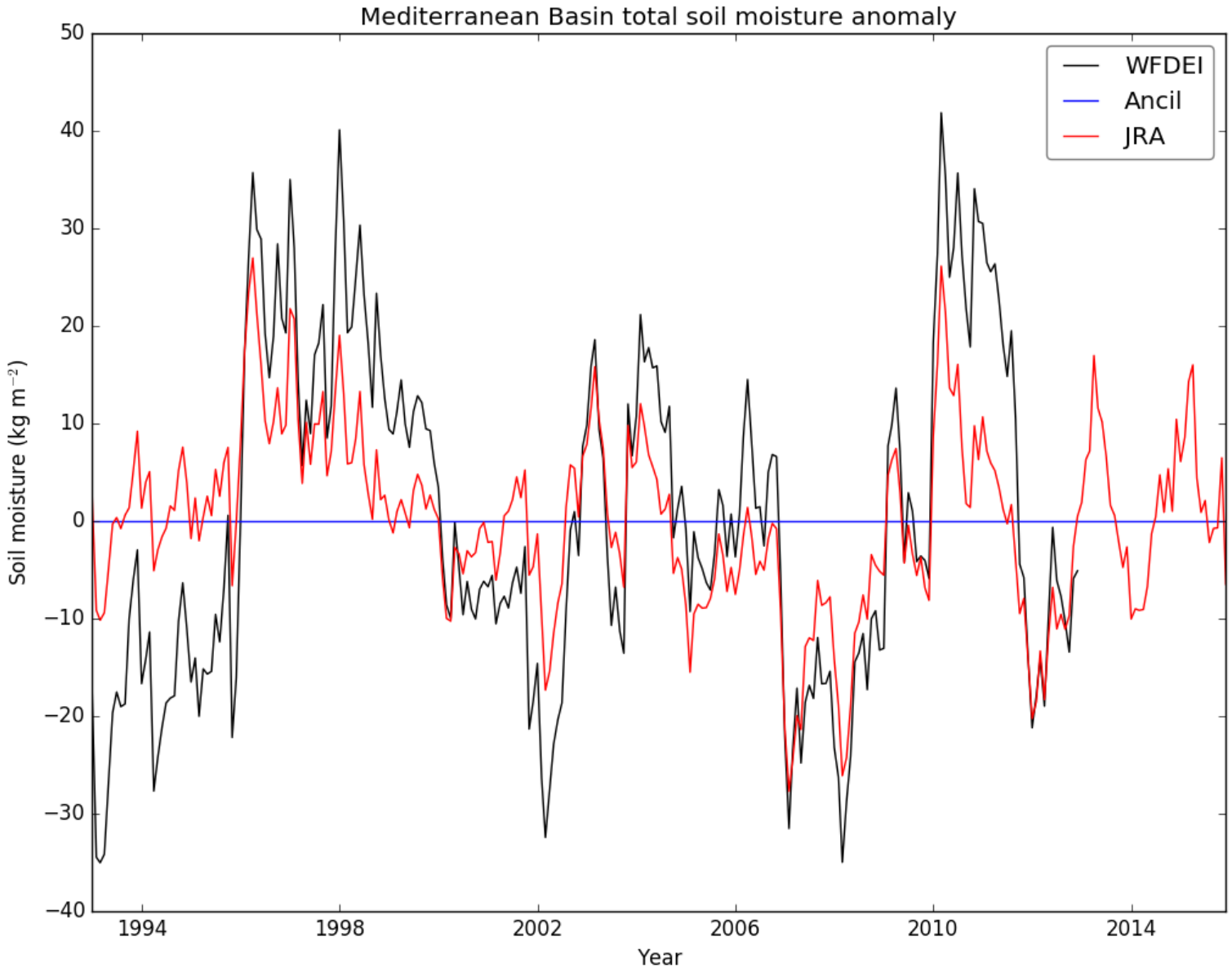
New Initialization

- 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

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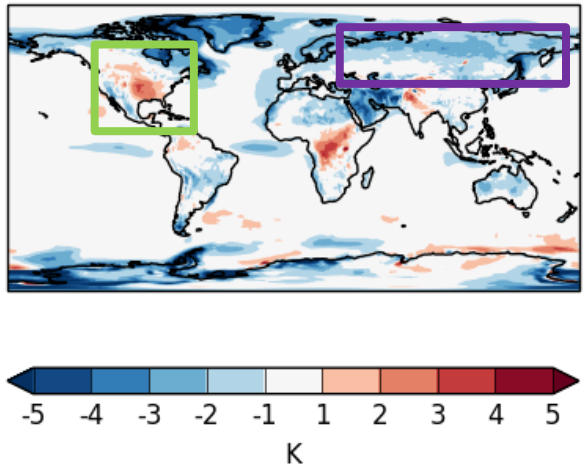
JRA-55 Experiments

- 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

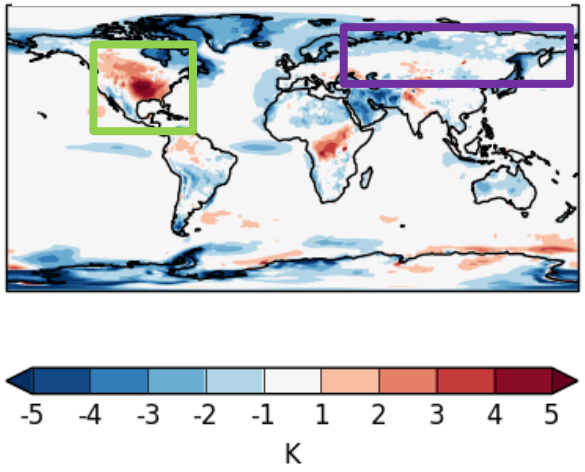
Bias comparison for T 1.5m

Summer

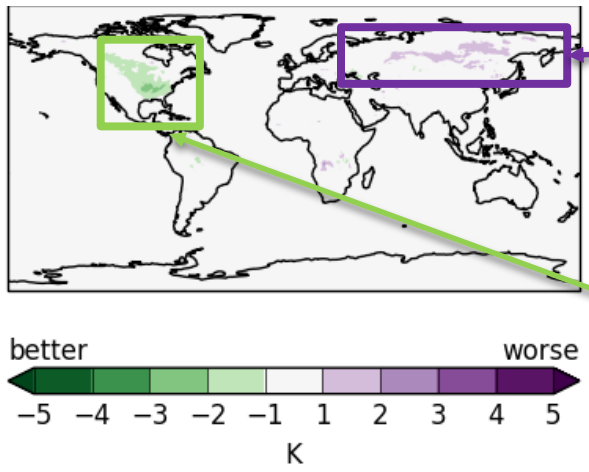
Experiment minus ERA-I



operational minus ERA-I



Experiment minus oper.

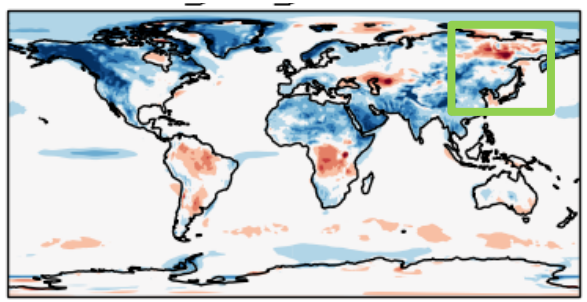


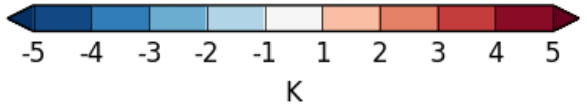
Increase in cold bias over Eurasia

Decreased warm bias over North America

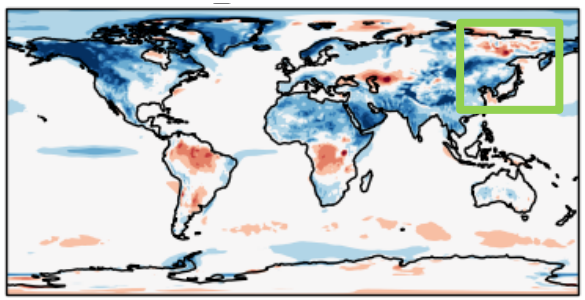
Winter

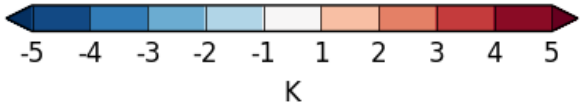
Experiment minus ERA-I



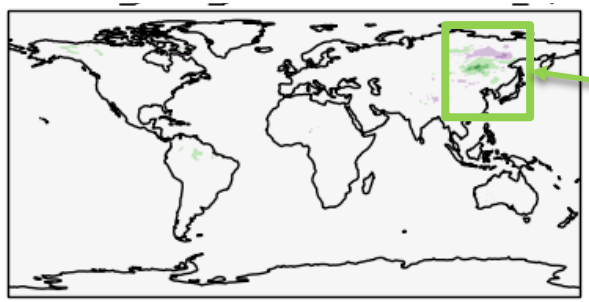


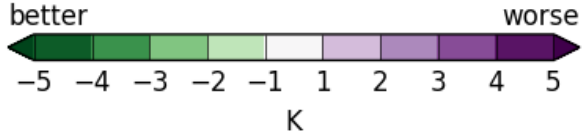
operational minus ERA-I





Experiment minus oper.



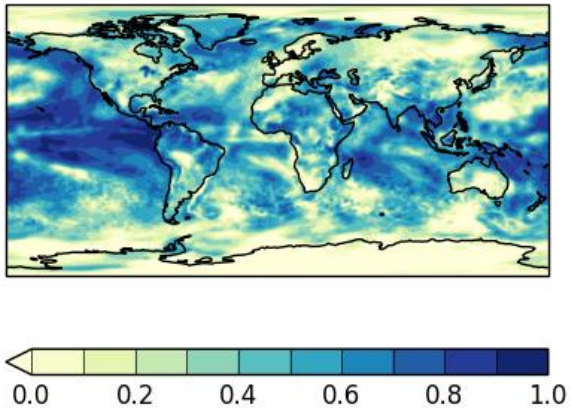


Increase in warm bias/ decrease in cold bias (winter)

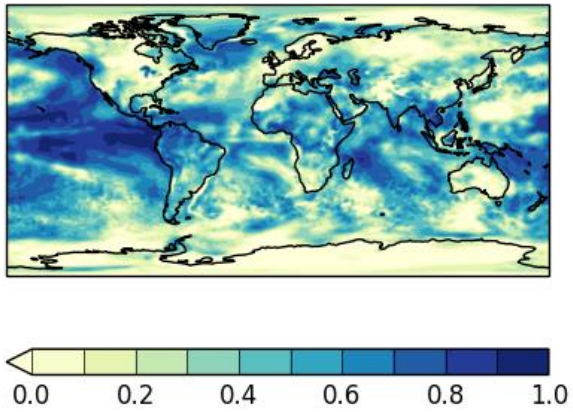
Skill comparison for T 1.5m

Summer

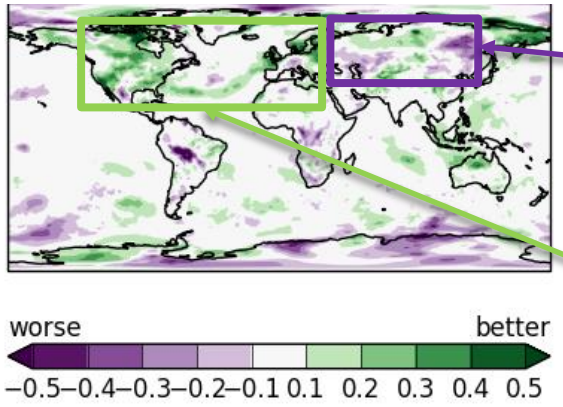
Experiment versus ERA-I



operational versus ERA-I



Experiment minus oper.

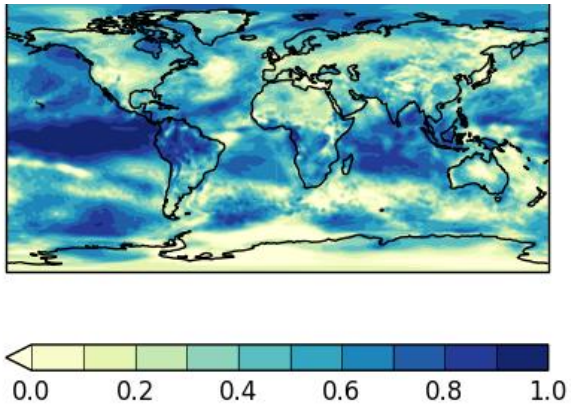


Patchy over Eurasia

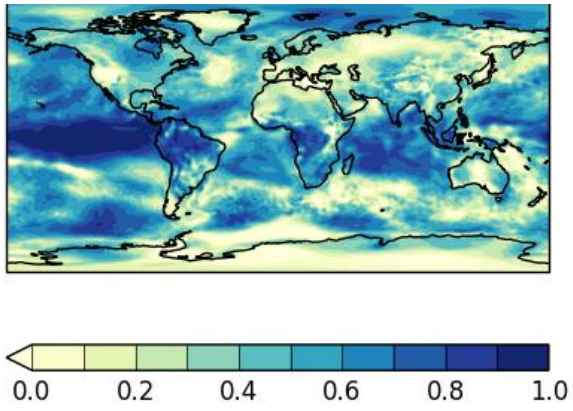
Improved skill over North America & Europe

Winter

Experiment versus ERA-I



operational versus ERA-I



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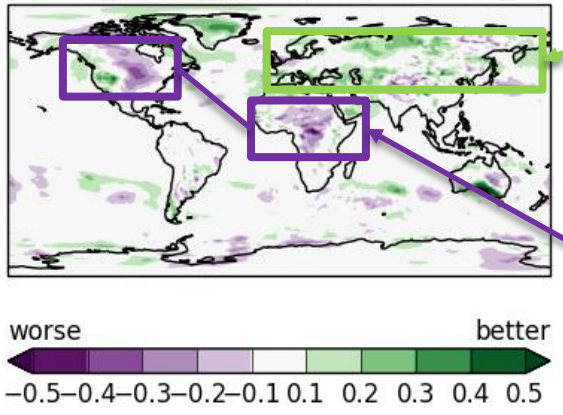


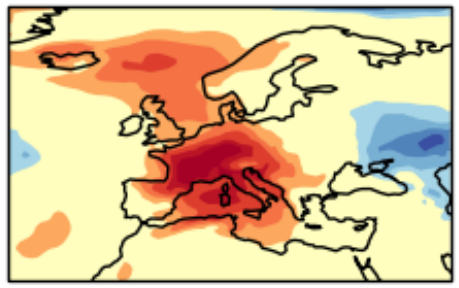
Improved skill over Eurasia

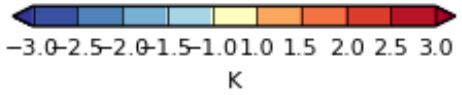
Degradation over North America & Africa (winter)

Temperature anomalies for heatwave events

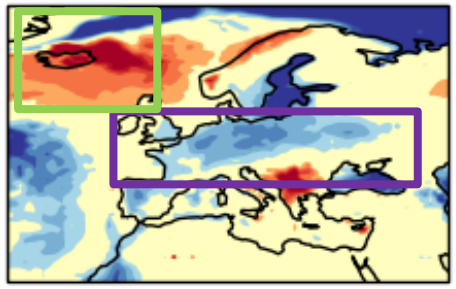
Europe 2003

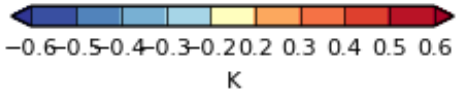
ERA-I



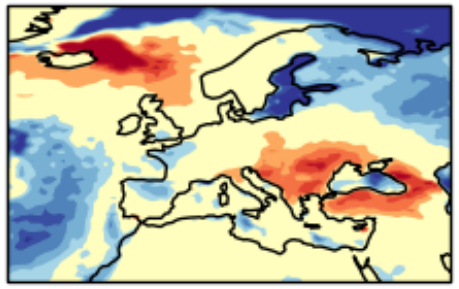


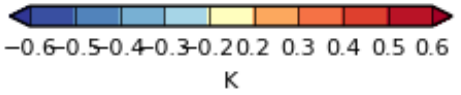
Experiment



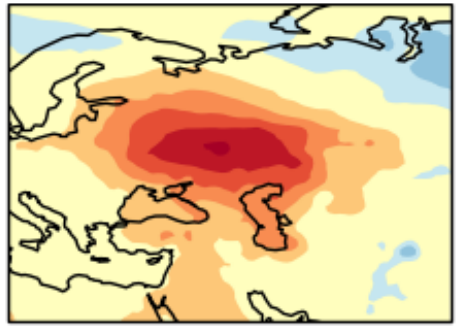


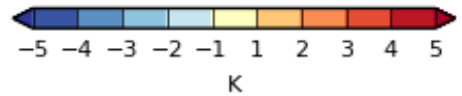
Operational

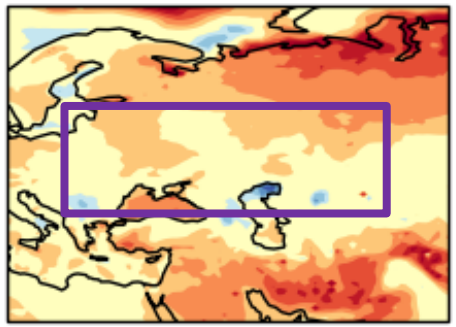


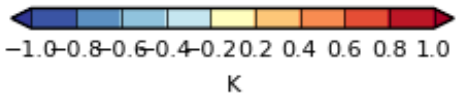


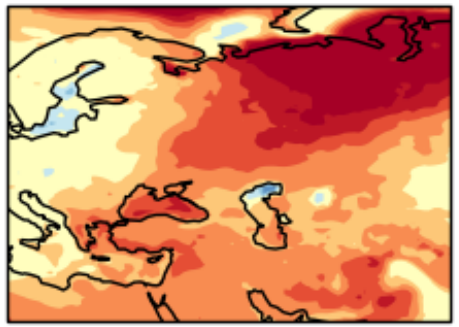
Russia 2010

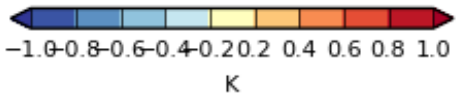












Unable to reproduce the high-temperature anomalies for any event.

Increase in extent in positive temp. anomaly in Atlantic.

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

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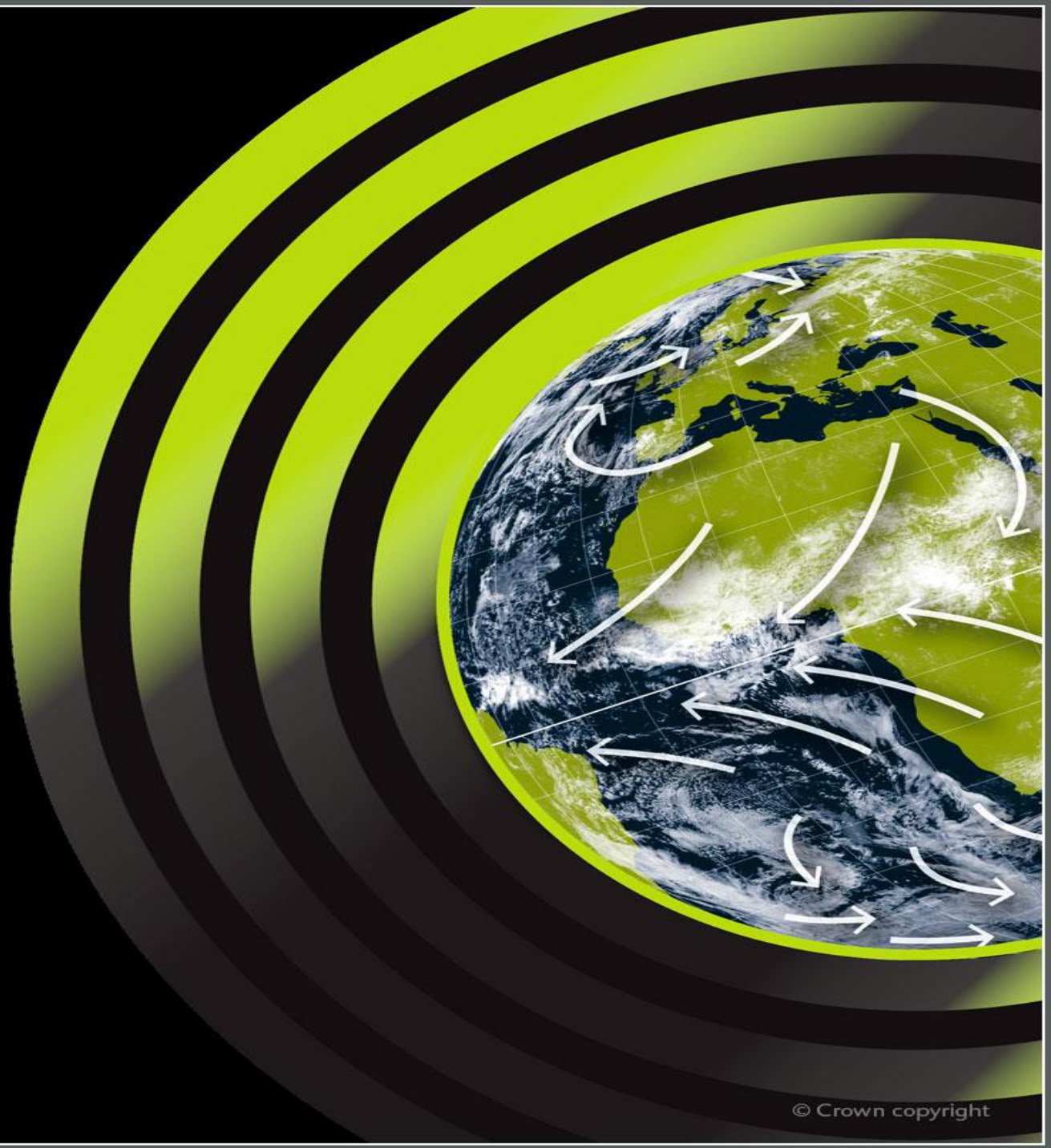
Summary

- 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.

Met Office

Questions?



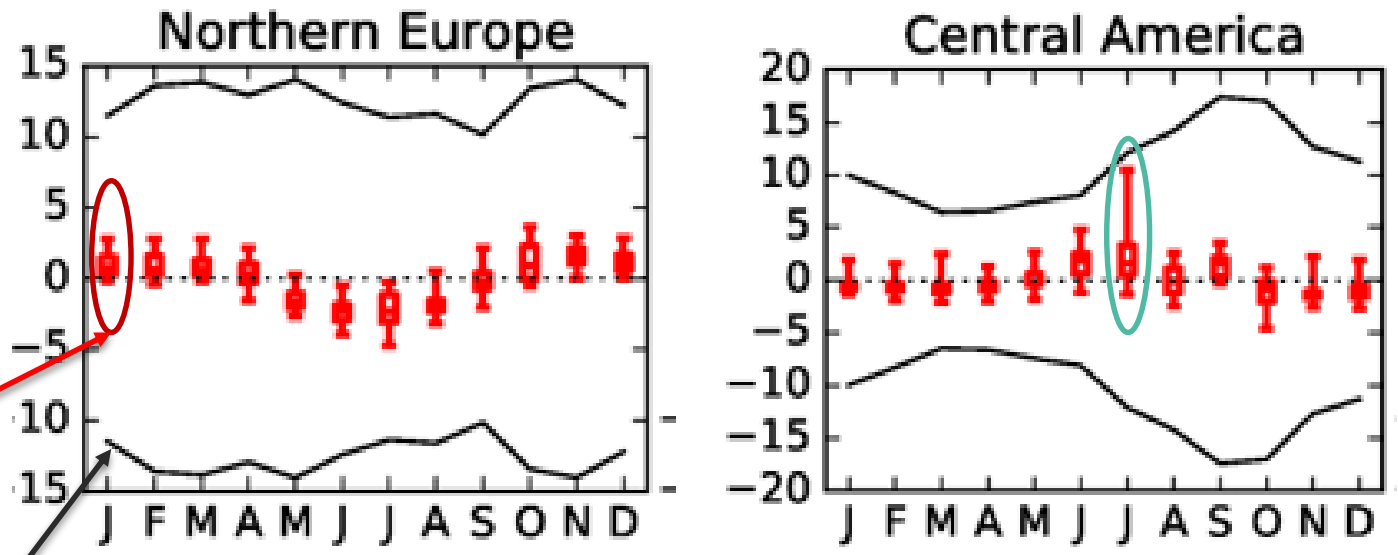
Near real-time data

- 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/m^2)



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