GPC Exeter forecast for winter 2014-2015

Outline

- GPC Exeter: GloSea5
- main points on capability of relevance to extra tropics
  - wintertime atm circulation
  - related variables
  - limitations
- forecast for winter 2014-2015

GloSea5 operational system (since June 2013)

Model version: **HadGEM3 GA3.0**

Resolution: **N216L85 O(.25)L75**
(0.83º long x 0.55 º lat; ~50 km atm.)

Simulations length: **7 months**

Initial conditions uncertainties represented by **lagged ensemble**

Model uncertainties represented by SKEB2 **stochastic physics** (Tennant et al. 2011)

Initialisation of the system

Forecast (initialised daily):

- Atmosphere & land surf: Met Office NWP analysis (4d-Var) (currently running with land surface initialisation switched off)

- 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: seasonal ODA reanalysis
- Fixed start dates of 1st, 9th, 17th, 25th of each month
- 3 members per start date

Ensemble: lagged approach

<u>Seasonal Forecast</u>:

- 2 members run each day.

- Seasonal forecast updated weekly by pulling together last 3 weeks (i.e. 42 members)

<u>Monthly Forecast</u>:

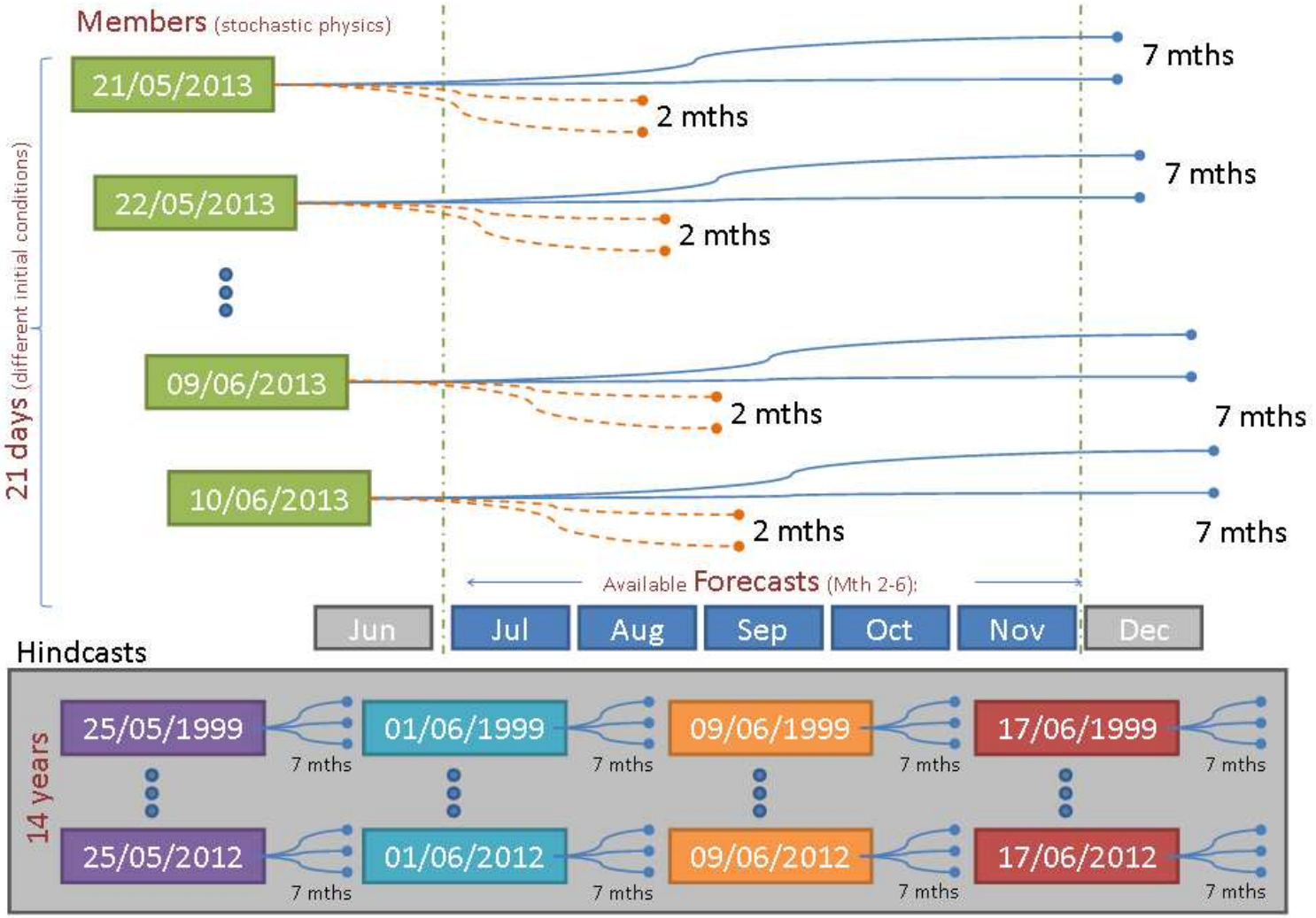
- 2 additional members run each day.

- Monthly Forecast updated daily by pulling together last 7 days (i.e. 28 members)

<u>Hindcast (for monthly-seasonal):</u>

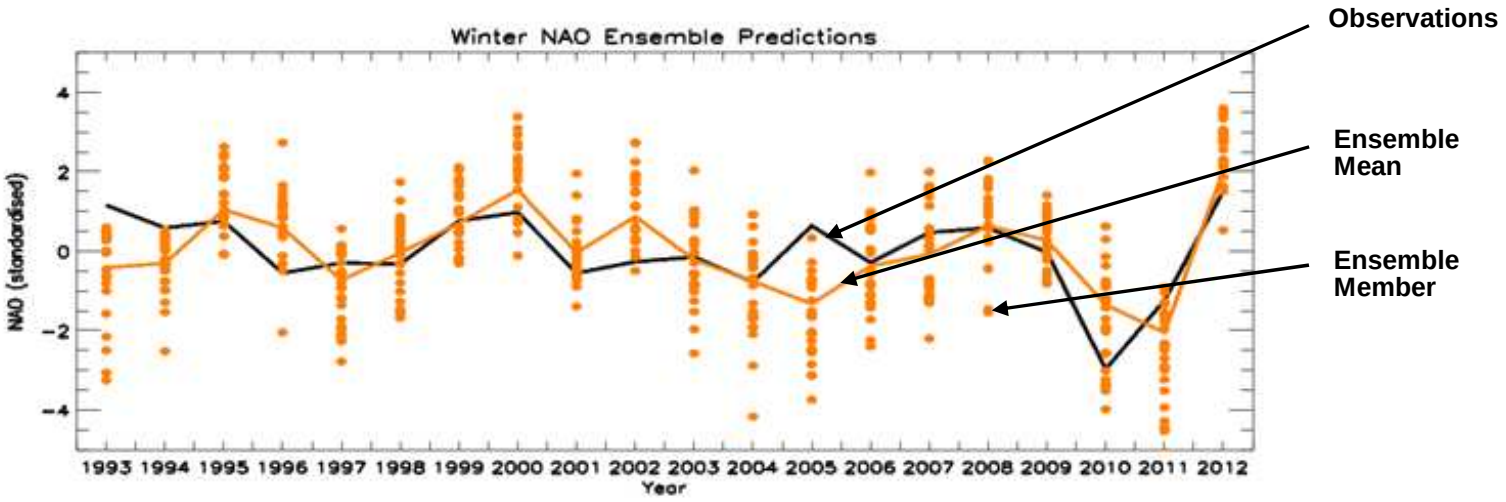
14 year hindcast *run in real time* (42 members run each week = 14 years x 3 members)

GloSea5 Scheduling



Predictability of the NAO

Retrospective winter forecasts from early November



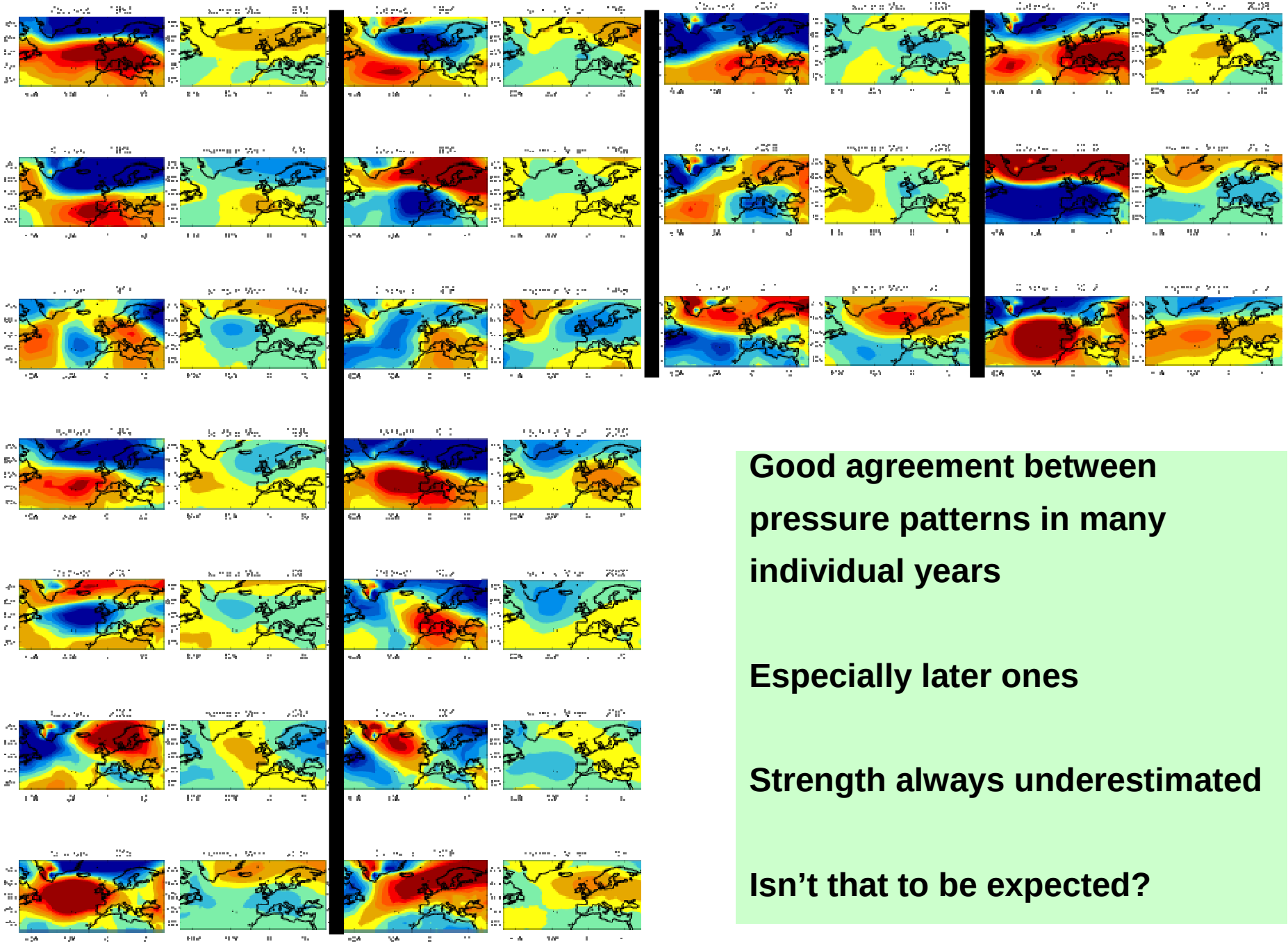
Winter NAO skill: correlation=0.62

Significant at the 98% level

Similar result holds for AO and SAM

Scaife et al 2014, MacLachlan et al 2014, Seviour et al 2014

Individual winters



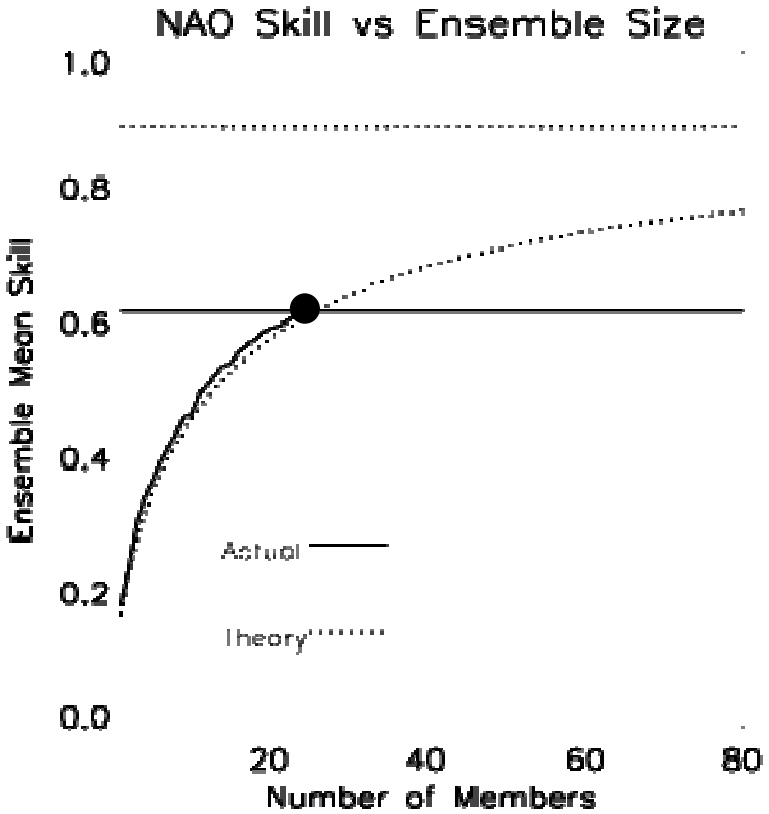
Good agreement between pressure patterns in many individual years

Especially later ones

Strength always underestimated

Isn't that to be expected?

Effect of ensemble size on skill

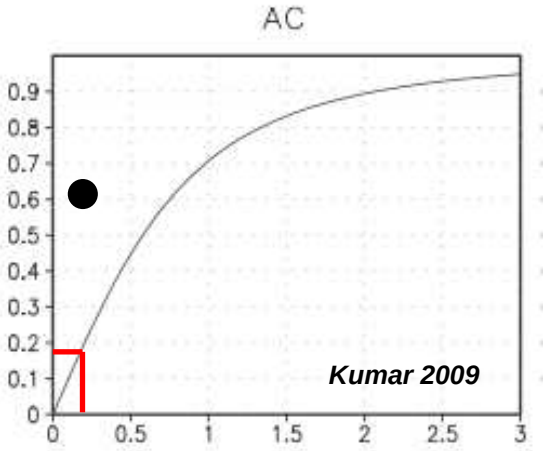


Resample for different ensemble sizes

Approaching theoretical asymptote

> 0.8 is possible with this system!

BUT signal to noise is small ~0.2 ???

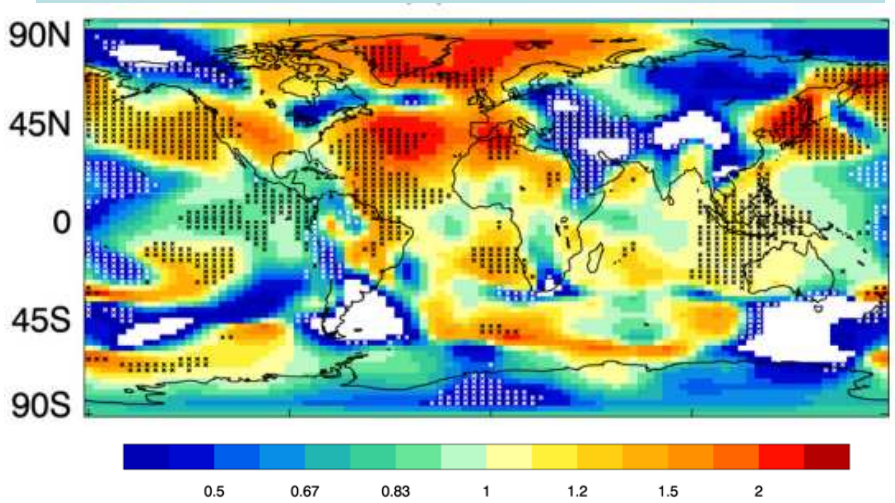


Signal to noise

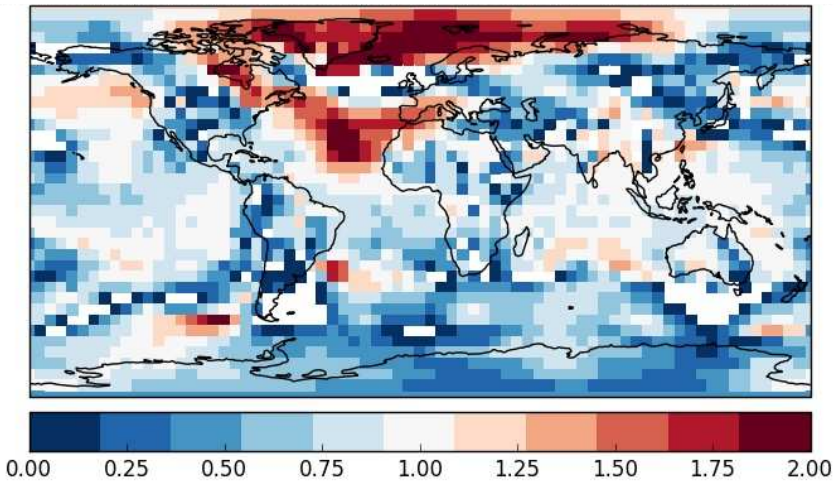
Scaife et al, GRL, 2014

Signal to noise and skill

Met Office, winter forecasts



Repeated over satellite period



blue ⇒ models **overconfident** (agree with each other but not with reality)

red ⇒ models **under confident** (unexpected!)

Implies real world more predictable than models

Members are not potential realisations of reality....

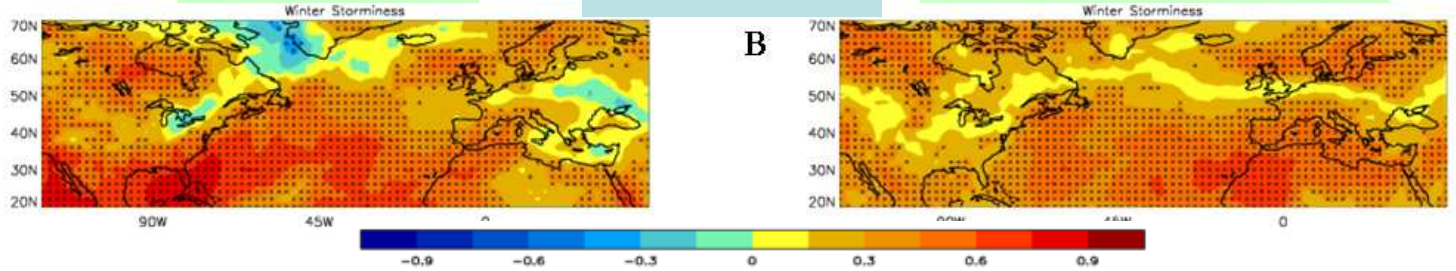
(Eade *et al*, 2014)

Skilful prediction of extreme events

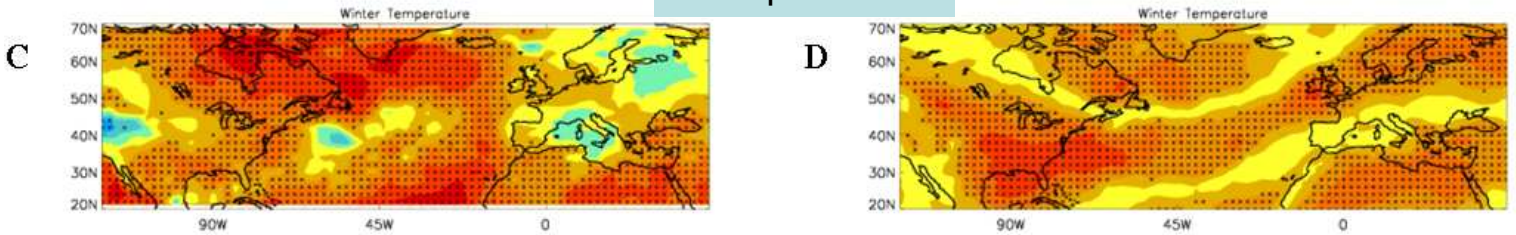
Raw model

From NAO forecast

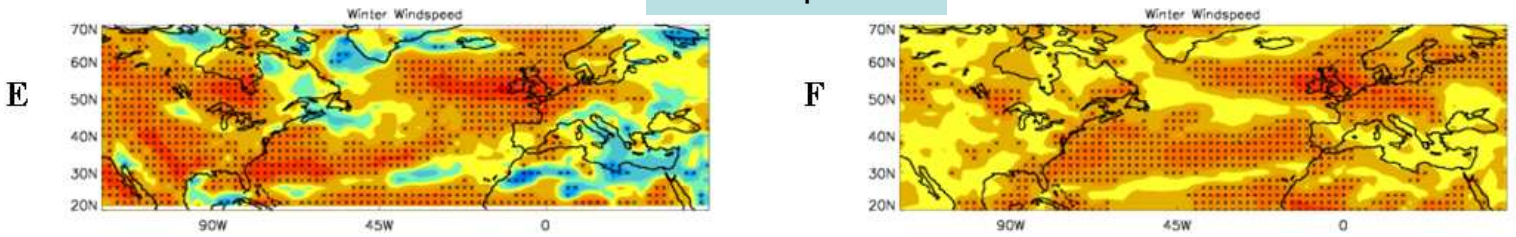
storminess



temperature



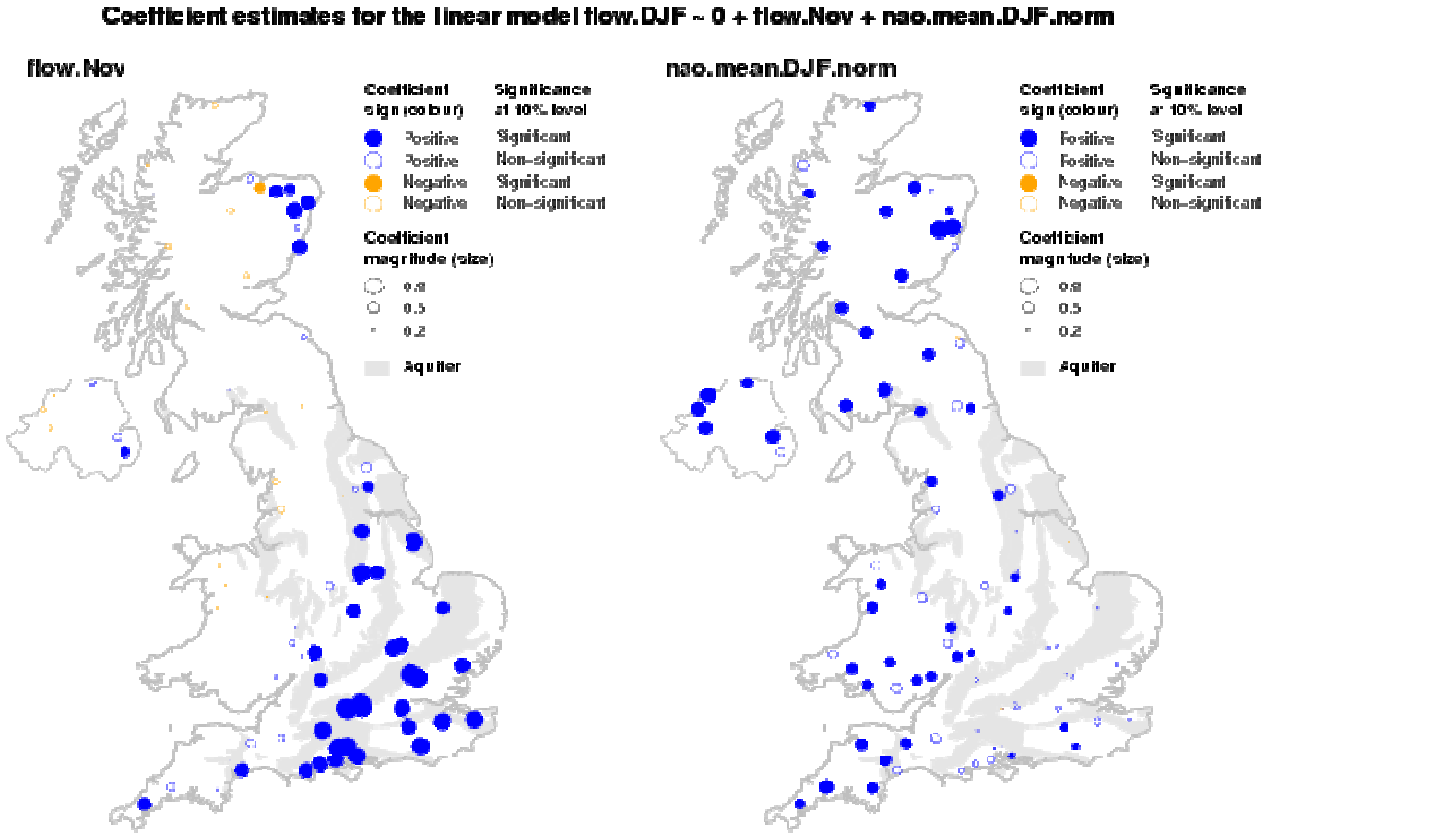
windspeed



Higher skill over Europe from forecast of NAO!

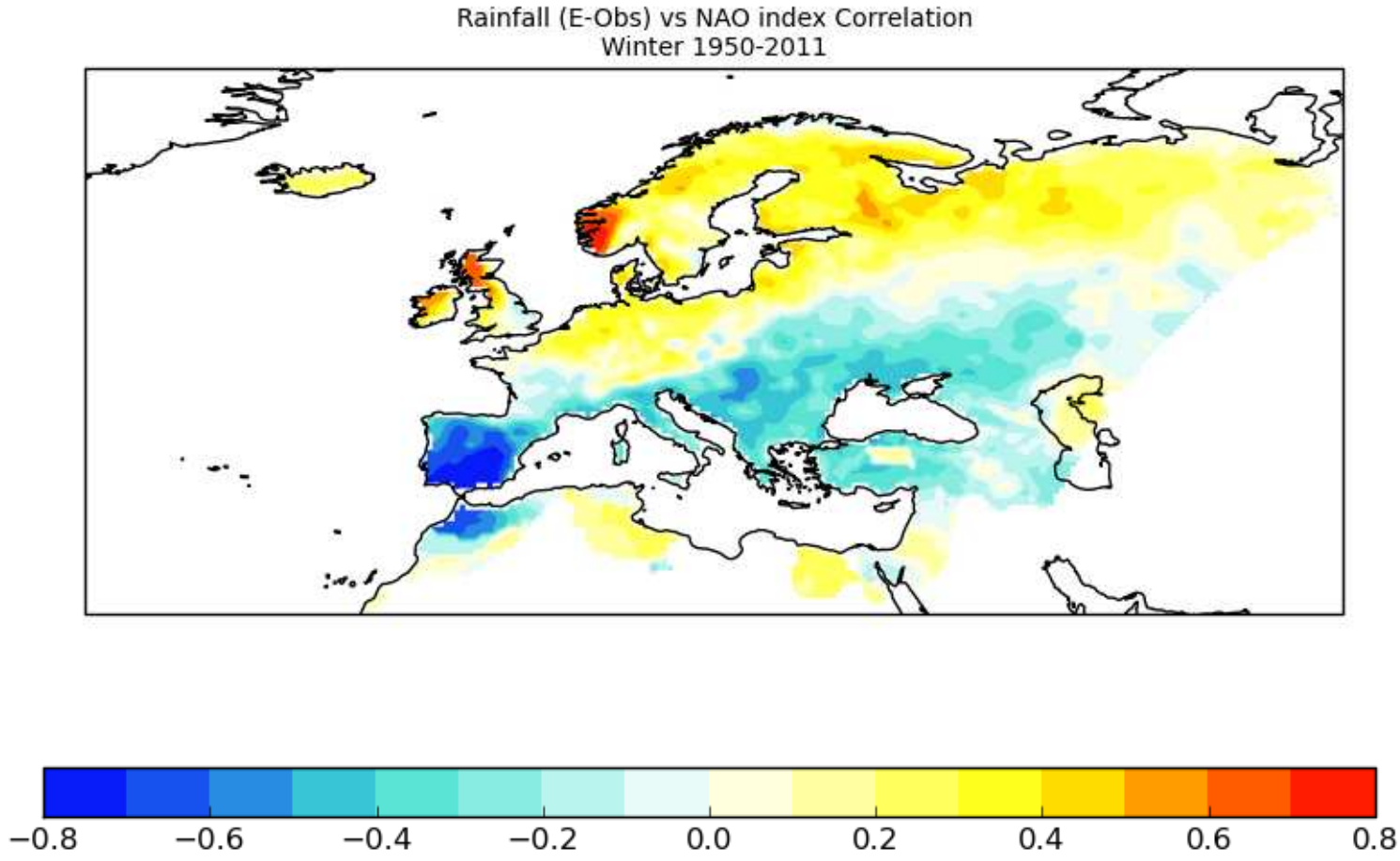
Scaife et al, GRL, 2014

Impacts: hydrology

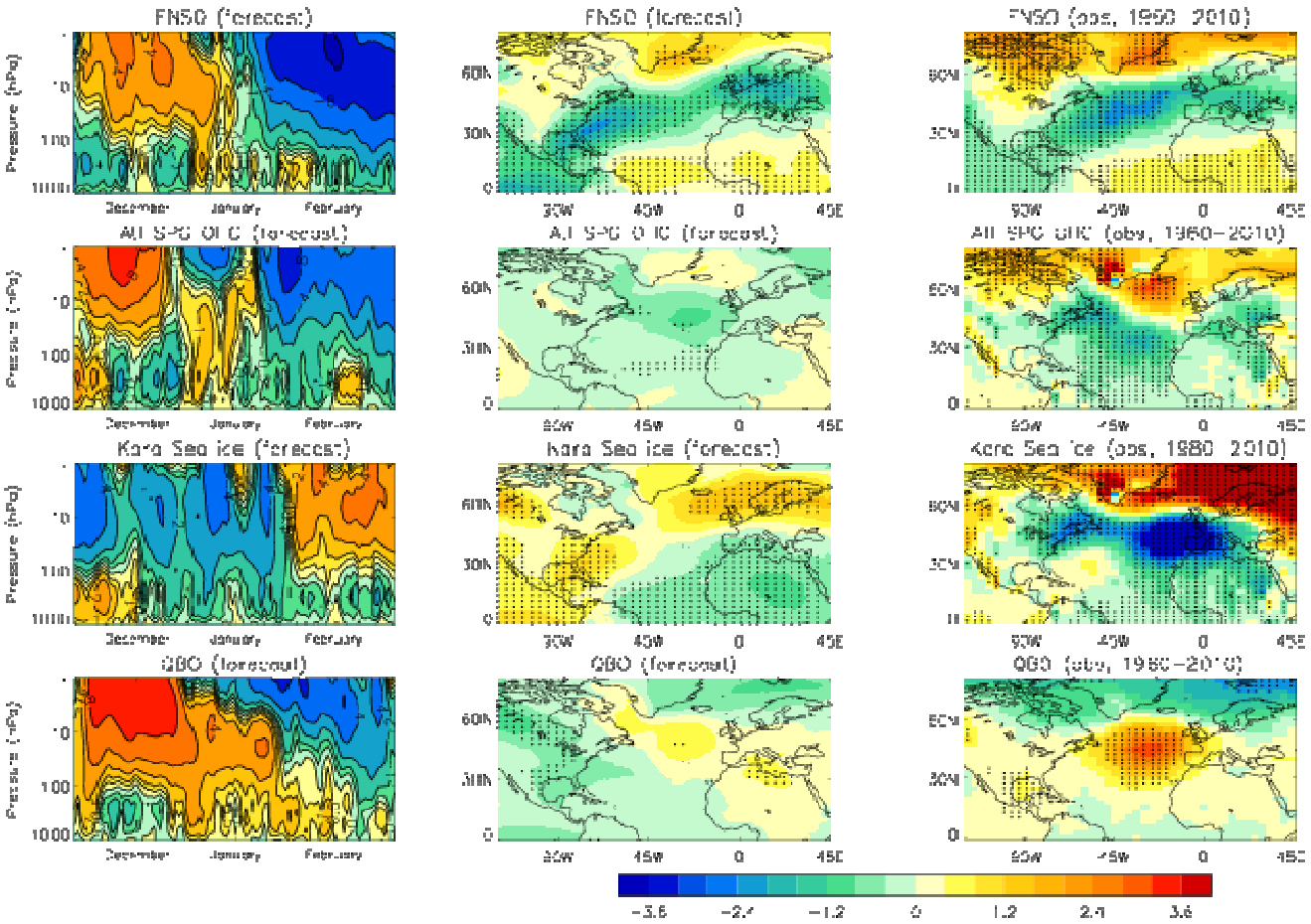


With CEH, Svensson et all, in preparation

How well does the NAO ‘describe’ local conditions?



Sources of predictability



Strongest minus weakest cases for November predictors:

ENSO Niño3.4, Atlantic Tripole, Kara sea-ice, QBO

Response is weaker in model than obs

Sources of predictability

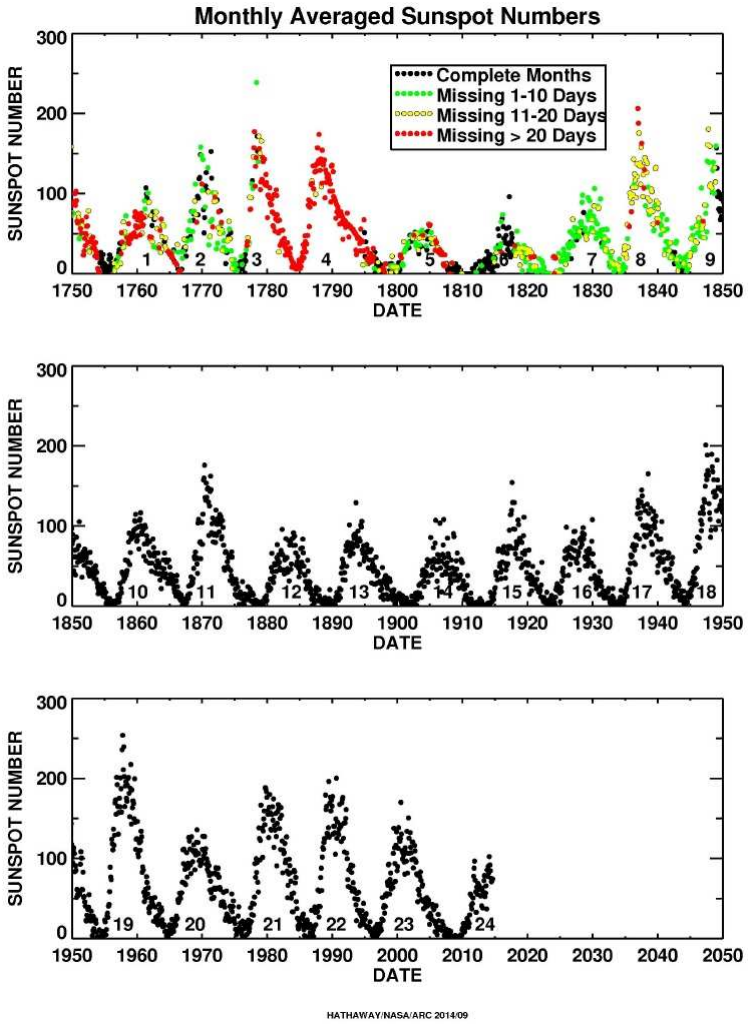
- ENSO (seasonal)
- QBO (seasonal)
- ATLANTIC SST (seasonal)
- SEA ICE (interannual)
- SNOW (seasonal)
- VOLCANOES (interannual)
- SOLAR (interannual)

- other SST?

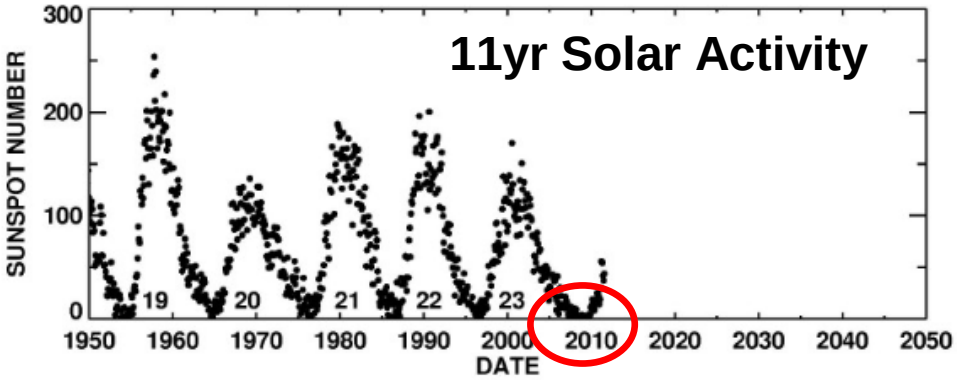
Sources of predictability

- ENSO (seasonal)
- QBO (seasonal)
- ATLANTIC SST (seasonal)
- SEA ICE (interannual)
- SNOW (seasonal)
- VOLCANOES (interannual) – not expected to contribute this year
- SOLAR (interannual) – not expected to contribute this year

Solar Cycle (From NASA)

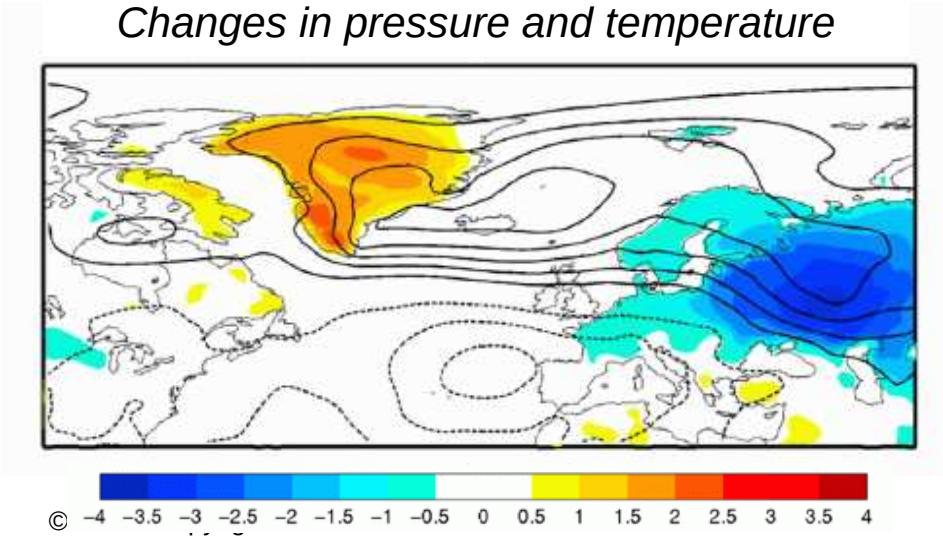


Solar variability



Solar Minimum minus Solar Maximum:

Changes in pressure and temperature



Surface air temperature anomalies **(Woollings et al, GRL)**

Solar min increases risk of:

- **Blocking**
- **Easterly weather types**
- **Cold Europe**
- **Cold UK**

Sources of predictability

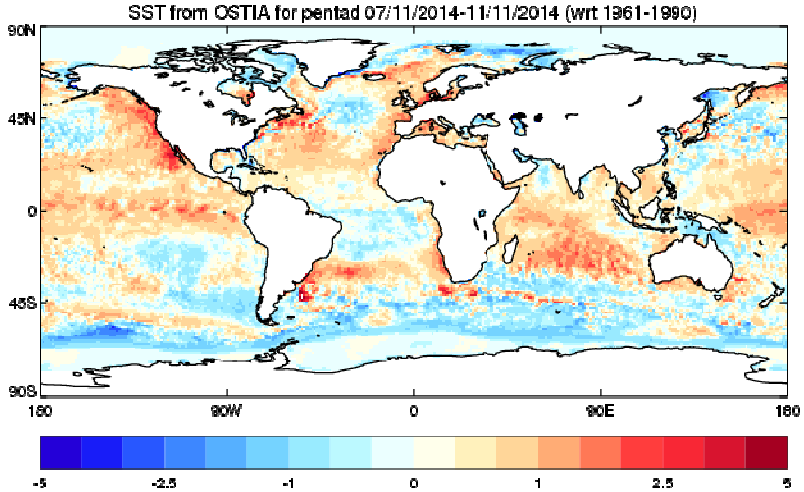
- ENSO (seasonal) – moderate El Niño → negative NAO late winter
  - observations, models
- QBO (seasonal) – easterly phase → negative NAO early winter
  - observations, models (to a certain extent)
- ATLANTIC SST (seasonal) – tripole in May SST → DJF NAO
  - observations, models
- SEA ICE (interannual) – low September sea-ice → negative DJF NAO
  - observations, models ; not yet well established
- SNOW (seasonal) – Eurasian snow cover or advance of snow in October → negative correlation with AO;
  - observations (no consensus), not in models

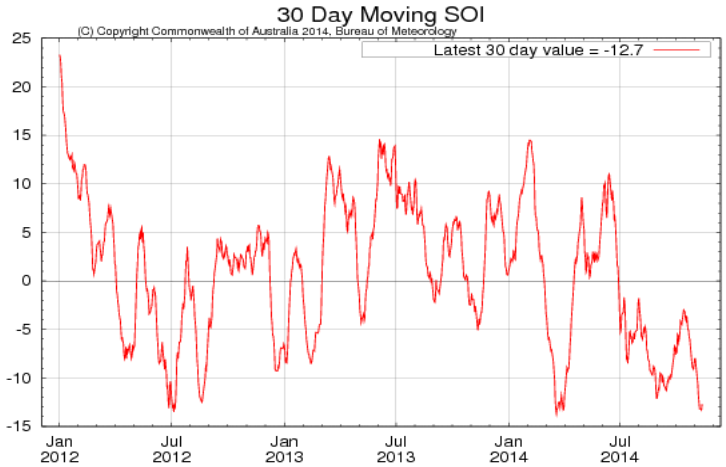
Met Office
Hadley Centre

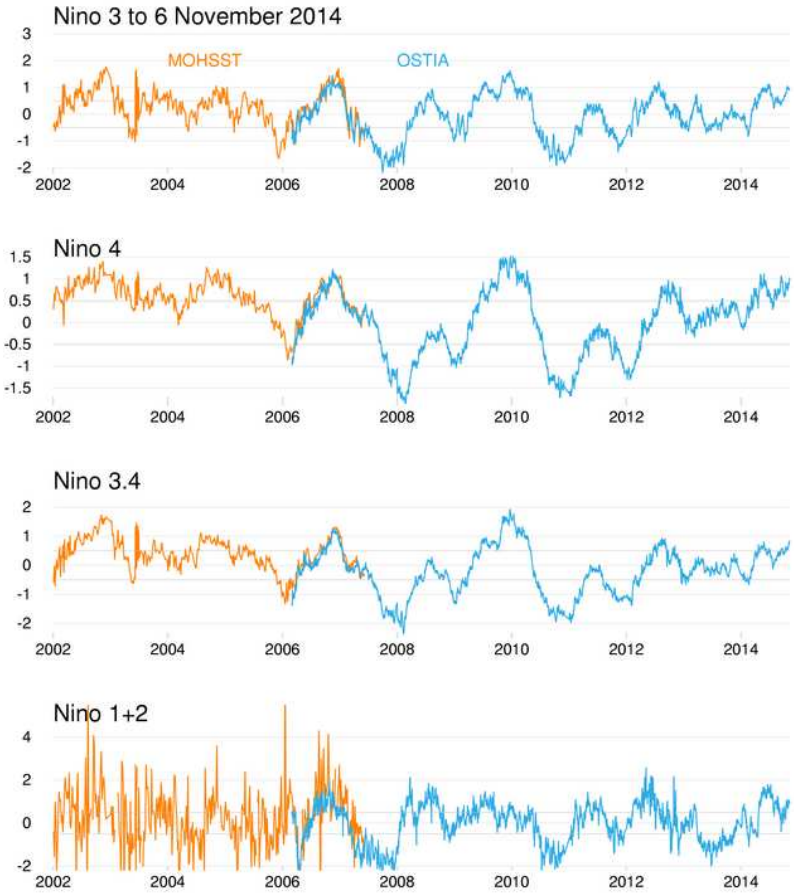
Observations

ENSO

7-11 Nov



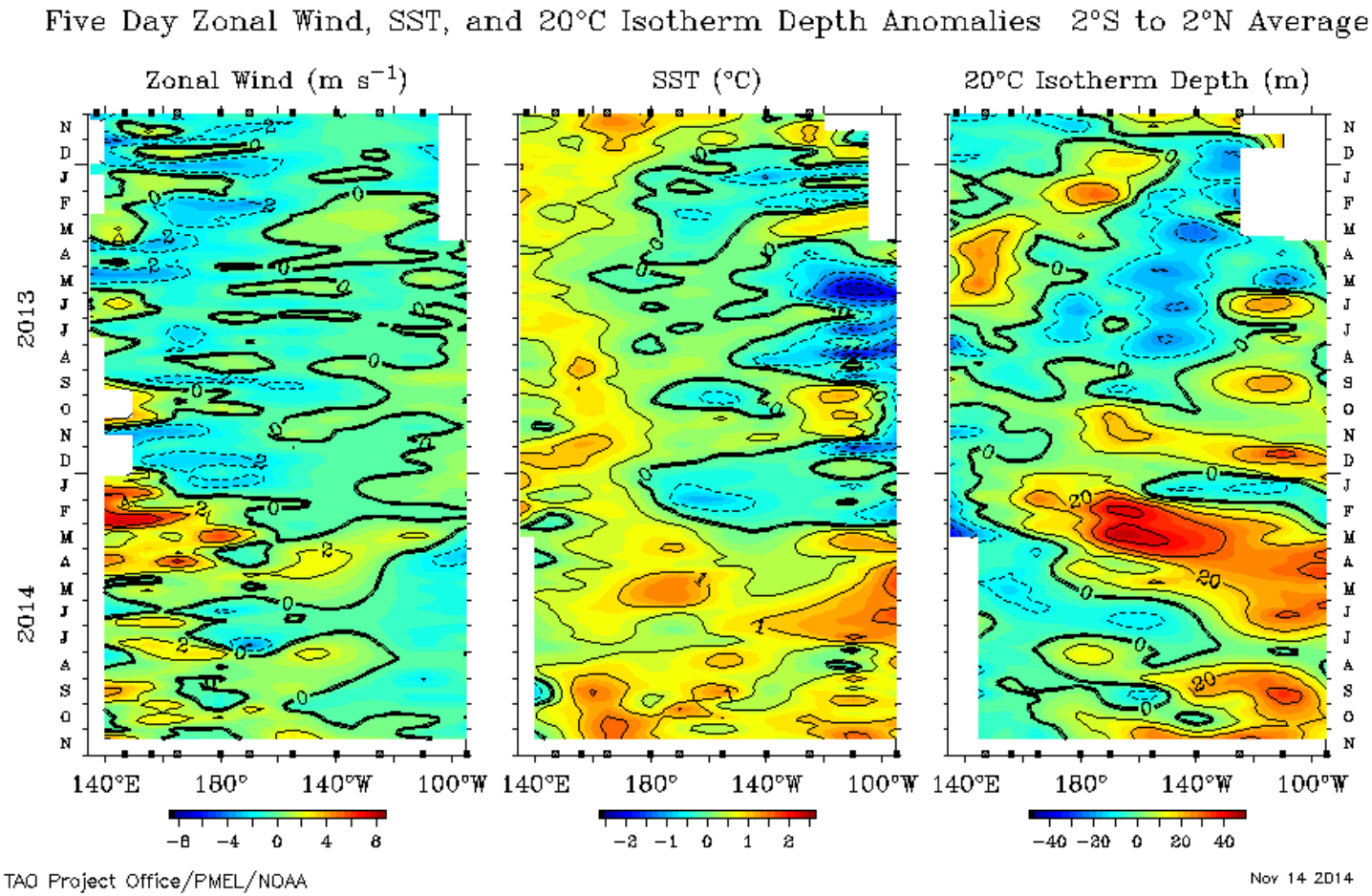




ENSO - 14 Nov

u wind SST 20 deg isotherm

Time



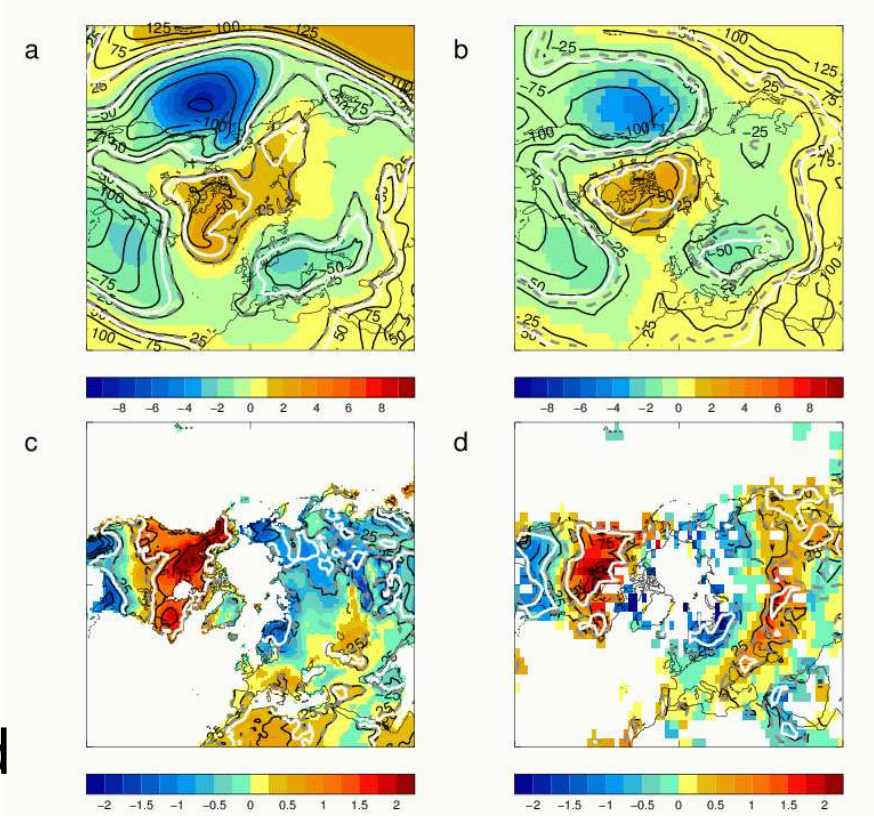
El Niño and Europe

Late winter North Atlantic – European response to El Niño tends to be:

- pressure pattern resembling negative phase of the North Atlantic Oscillation (a, b)

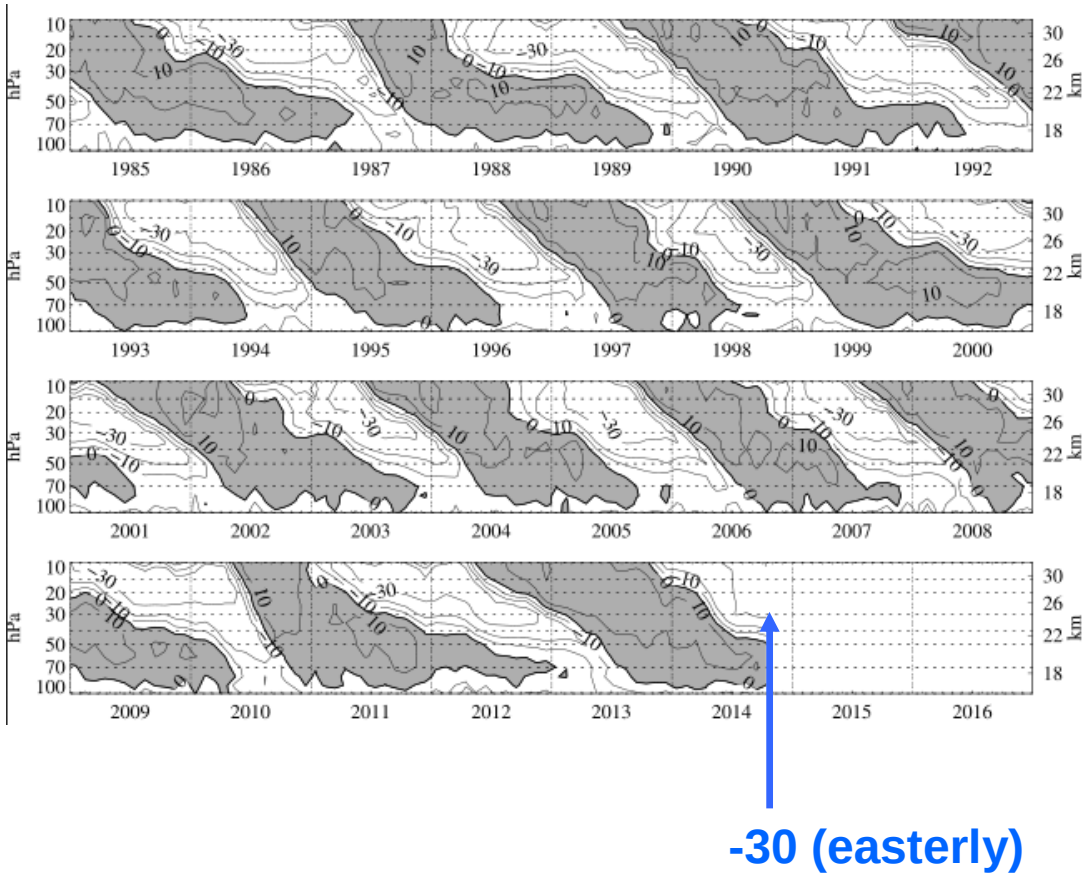
- cold in northern Europe, mild in southern Europe (c, d)

This response can be reproduced in a models which have a good representation of the stratosphere (Bell et al. 2009, Ineson and Scaife, 2009, Cagnazzo and Manzini 2009)



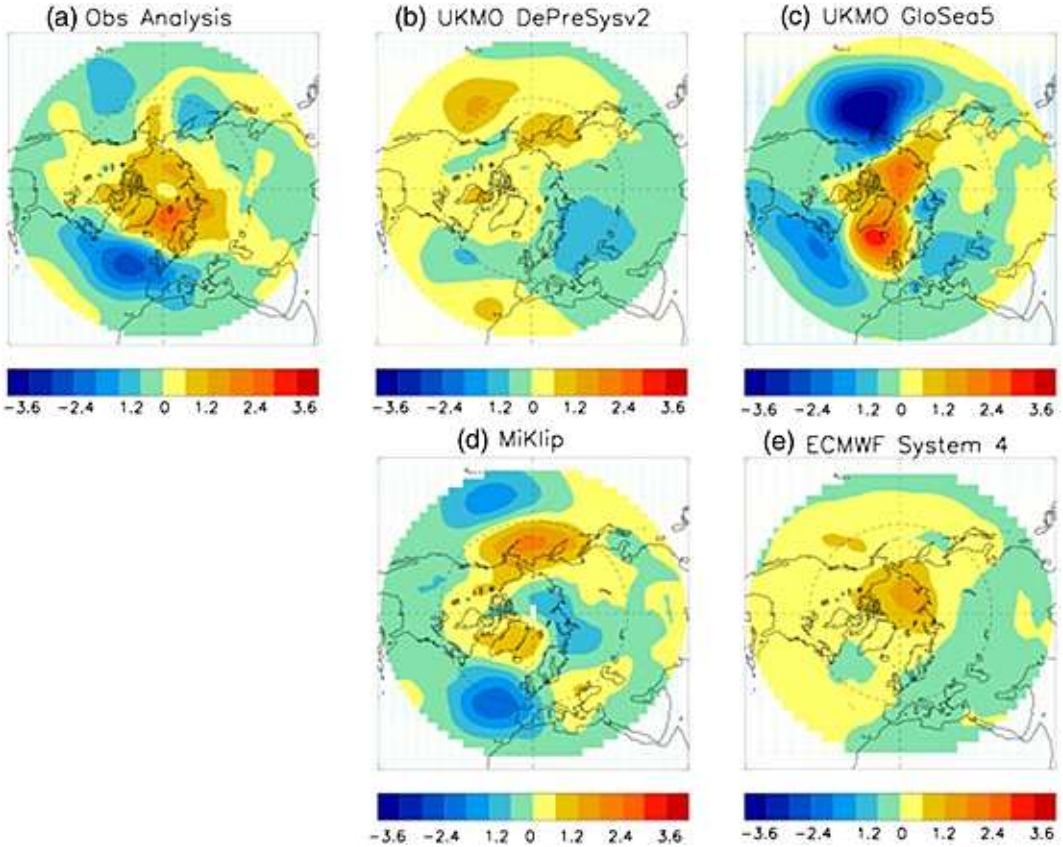
Stratosphere – QBO

Singapore ū (m s^{-1})

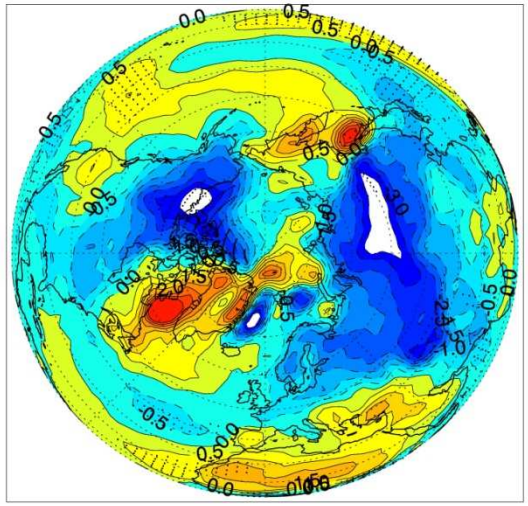


Quasi-Biennial Oscillation (QBO)
easterly-westerly phase
December-February

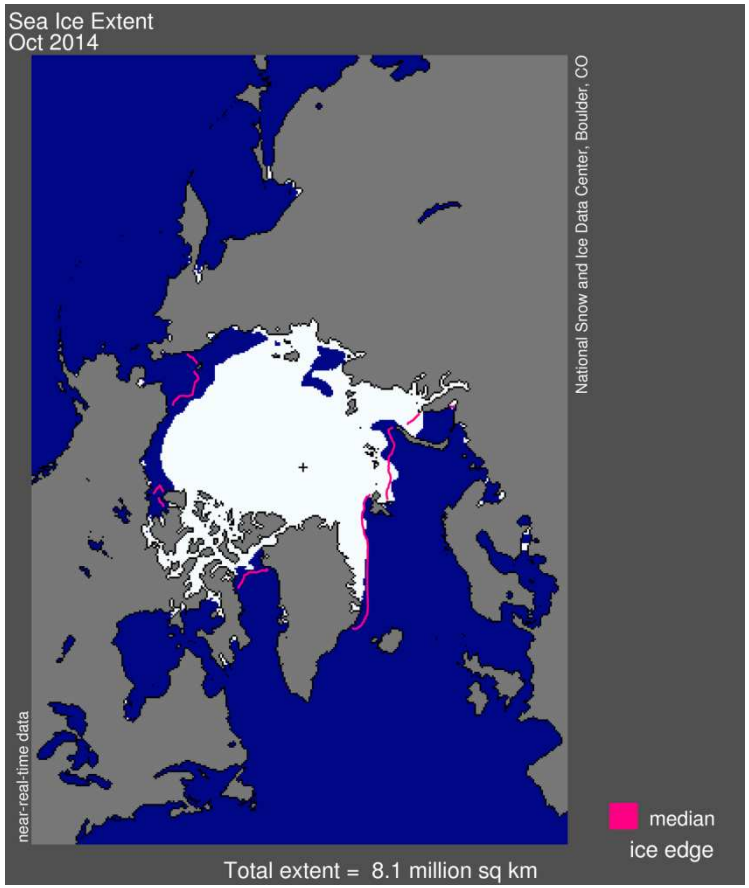
mean sea level pressure

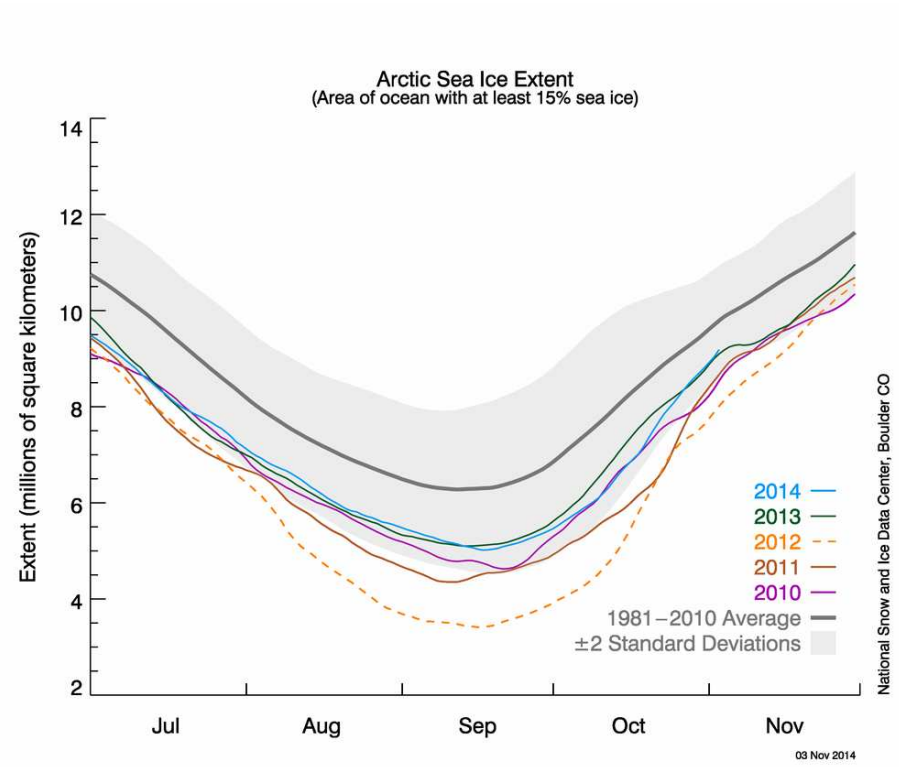


temperature



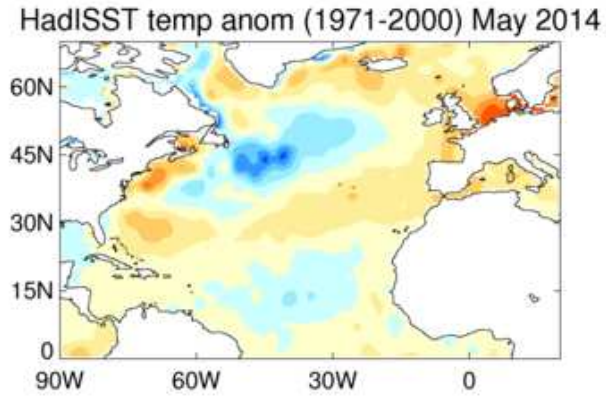
Arctic sea ice cover – to 14 Nov





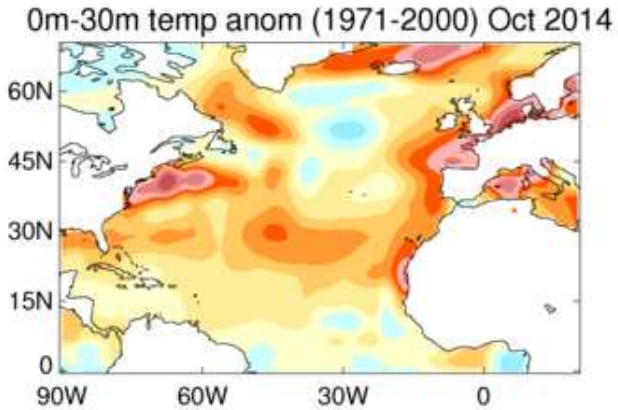
North Atlantic sea-surface temperature

May 2014



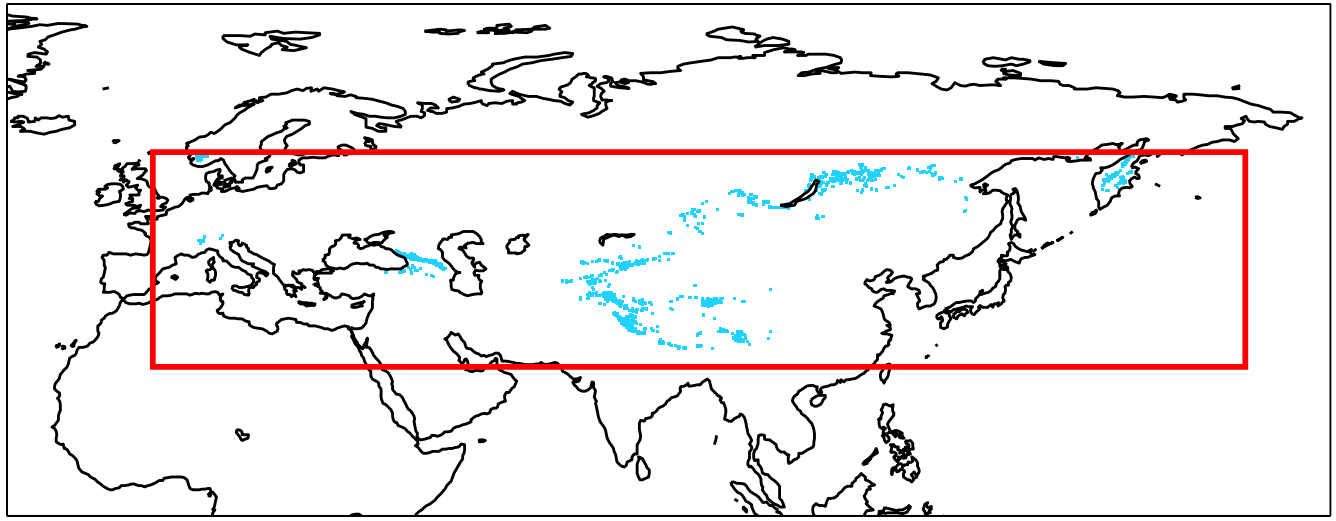
NAO prediction based on this factor alone: +0.5

October 2014 – consistent with May pattern

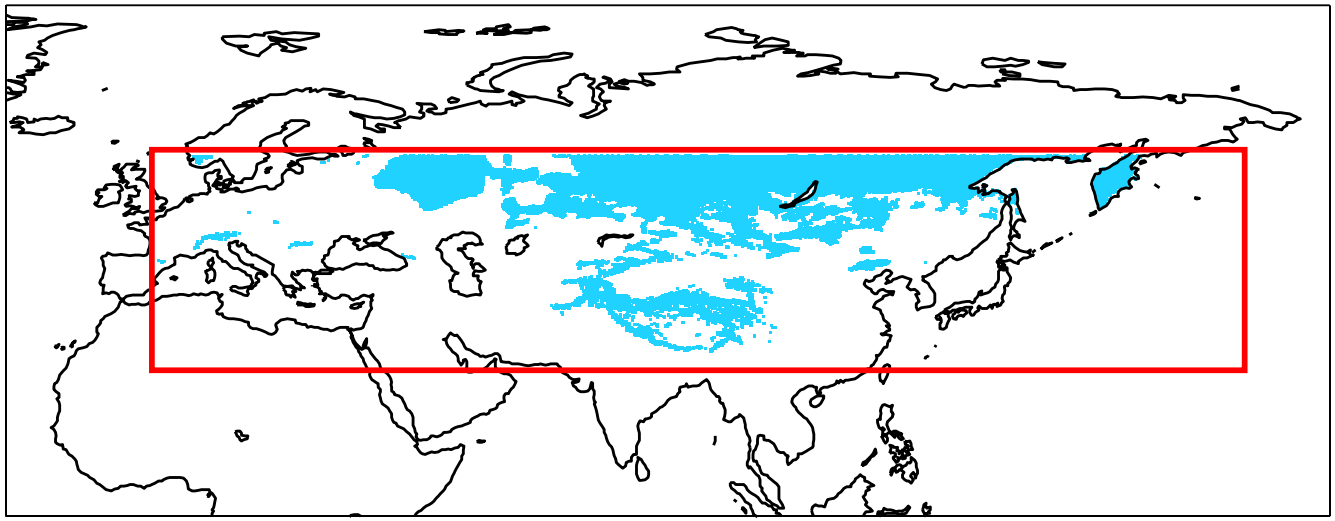


snow cover driven predictability

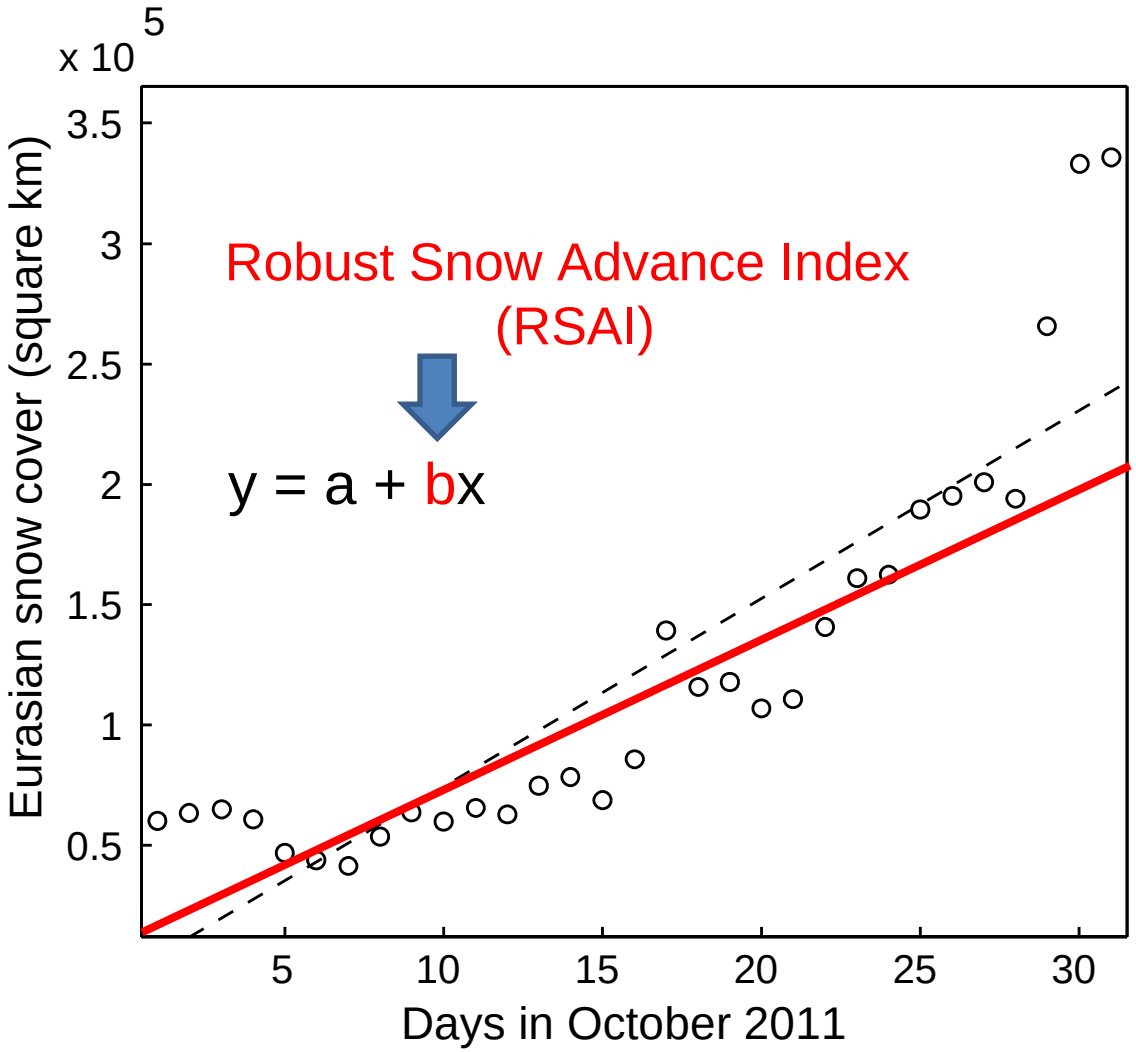
Snow cover on 01/10/2009



Snow cover on 31/10/2009



(October) Snow Advance Index (SAI)



Cohen and Jones (2011)
Brands et al. (2012)

Brands et al. (2014)

Hindcasts" with a longer index: weekly SAI (n = 39)

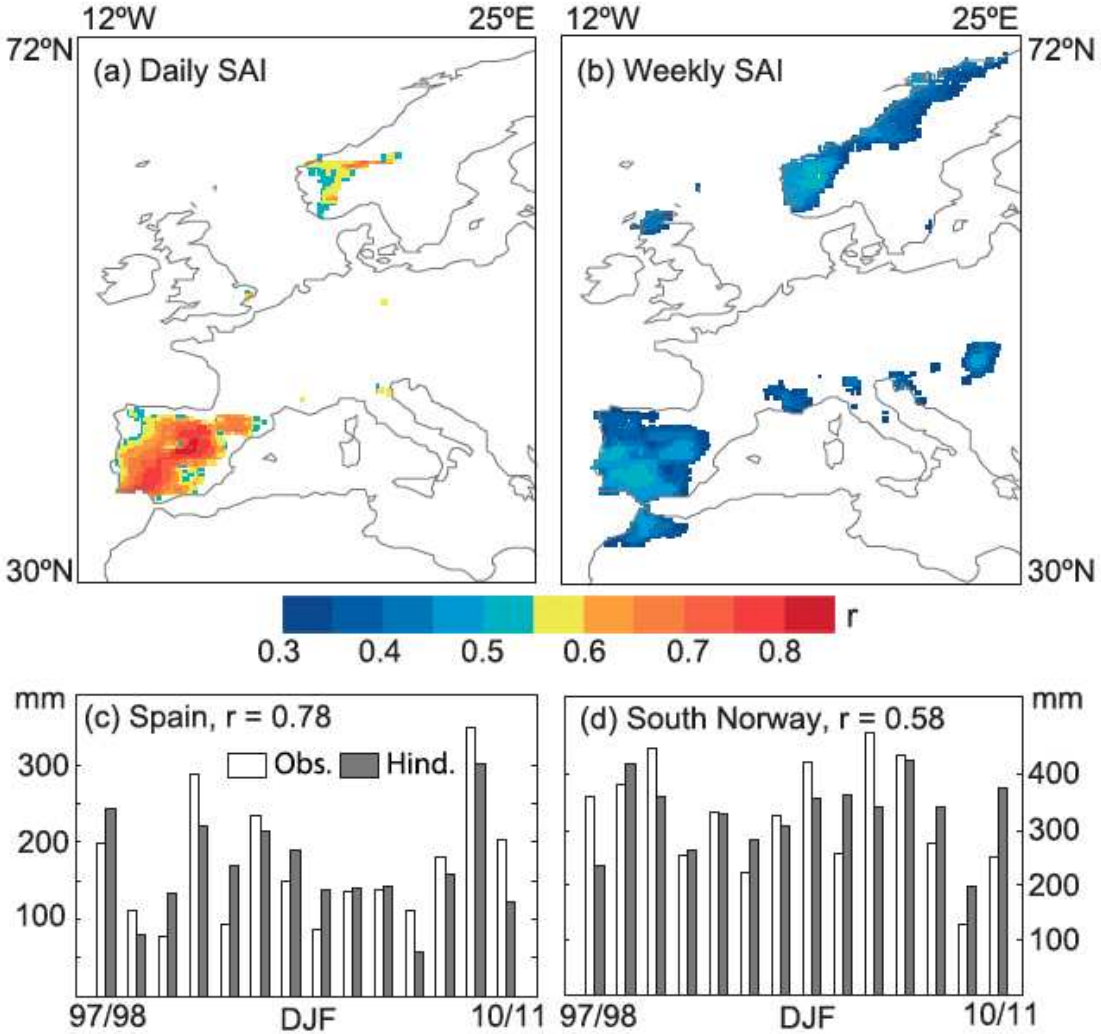
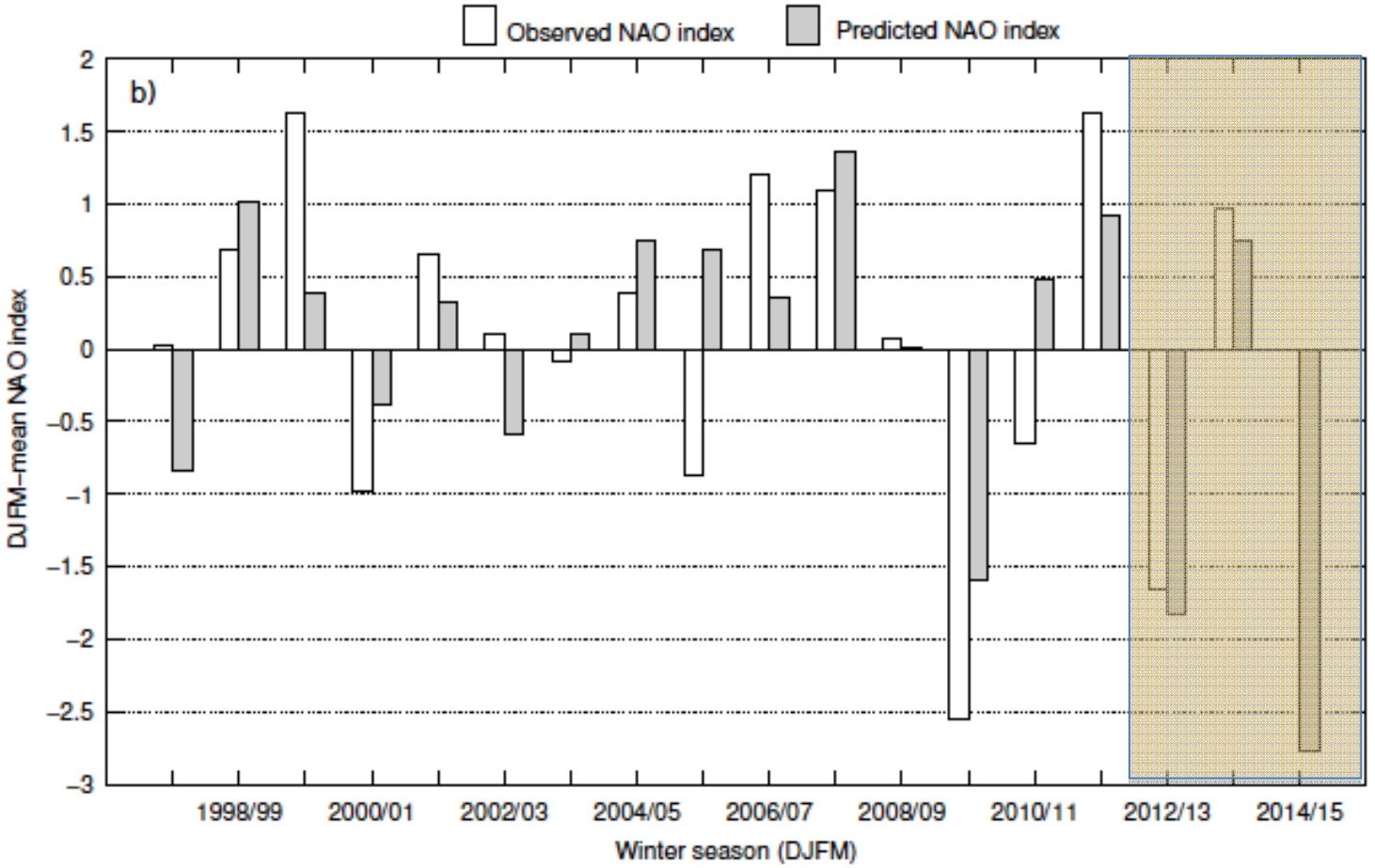


FIG. 2. Significant ($\alpha_{local} = 0.05$) r between hindcast and observed DJF precipitation sums, applying (a) the daily SAI ($n = 14$; critical value = 0.53) and (b) the weekly SAI ($n = 39$; critical value = 0.32). Spatially averaged hindcasts based on the daily SAI are contrasted against its corresponding observations for (c) Spain and (d) southern Norway; all calculations are based on E-OBS.

Predictibilidad de la NAO

(media de DJF, detrended)

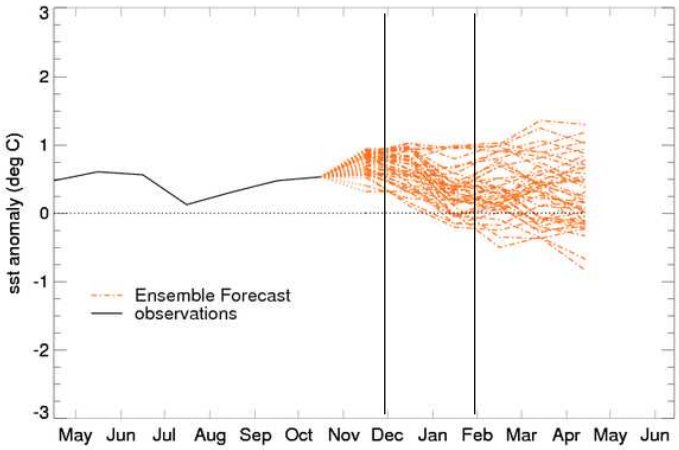


Correlación entre el RSAI en Octubre y la NAO en invierno (media de DJF, detrended)

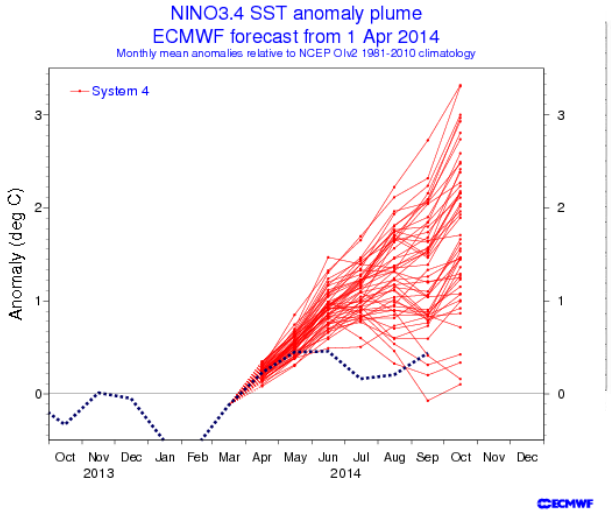
Predictions: large scale

Nino3.4 forecasts Nov 2014- Apr 2015

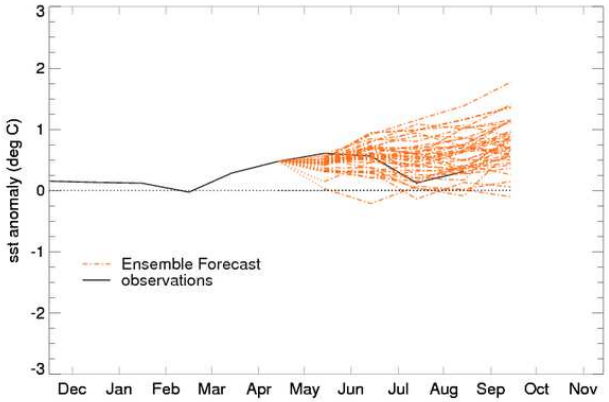
(baseline: 1996-2009; initial conditions: up to 1 November 2014)



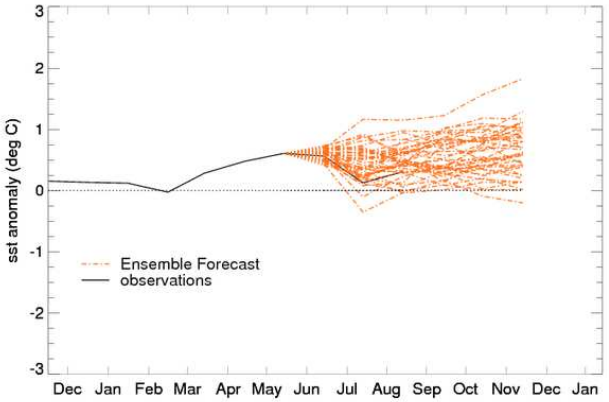
April



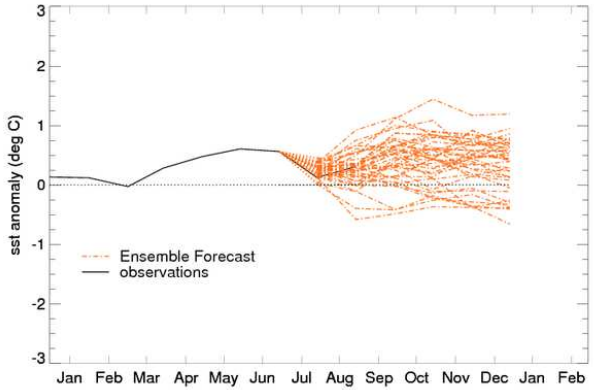
May



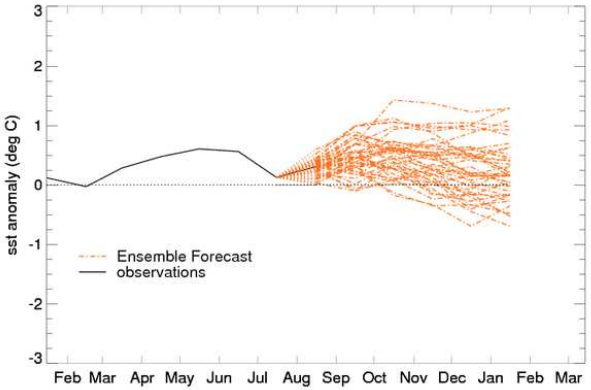
June



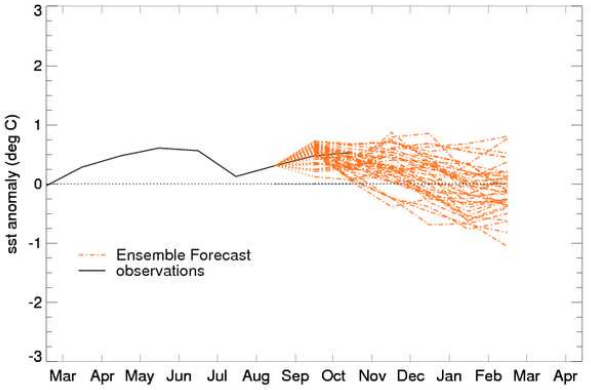
July



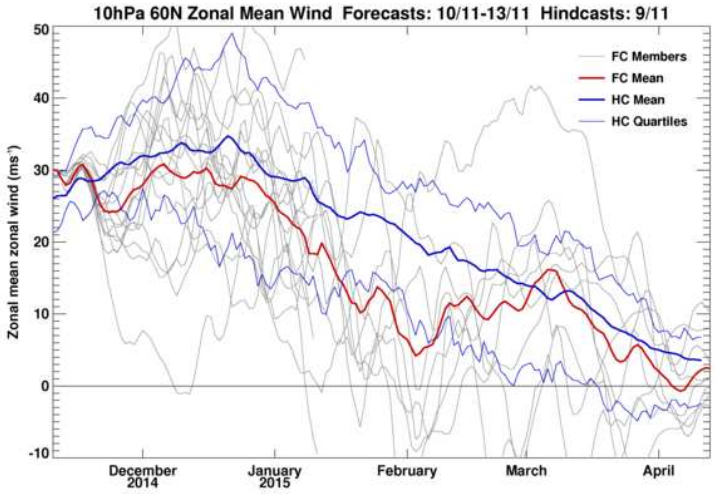
August

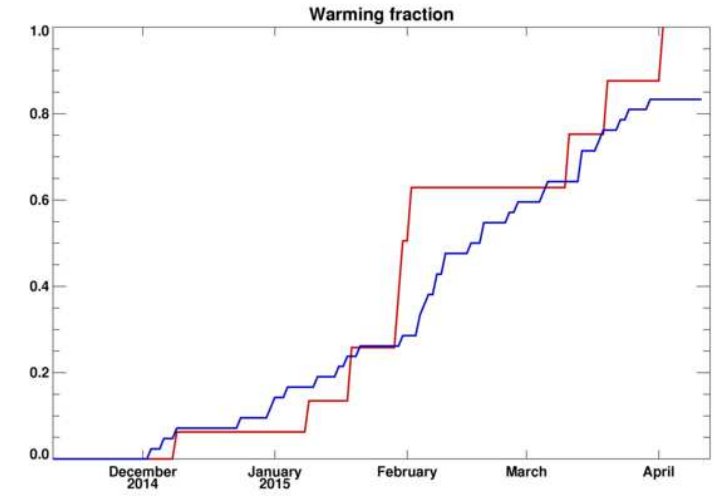


September

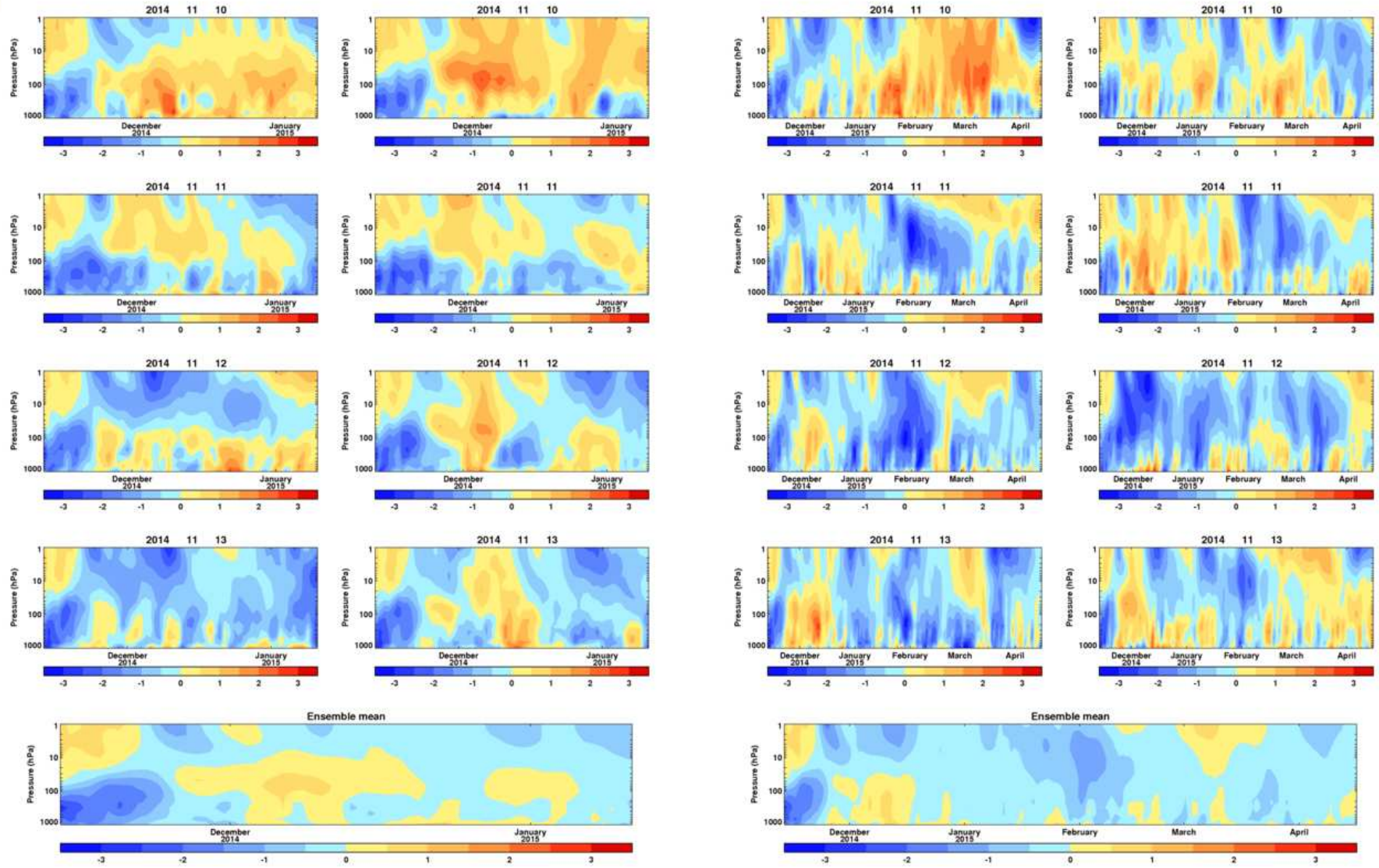


Stratosphere at 60N





Stratosphere at 60N



Summary – sources of predictability

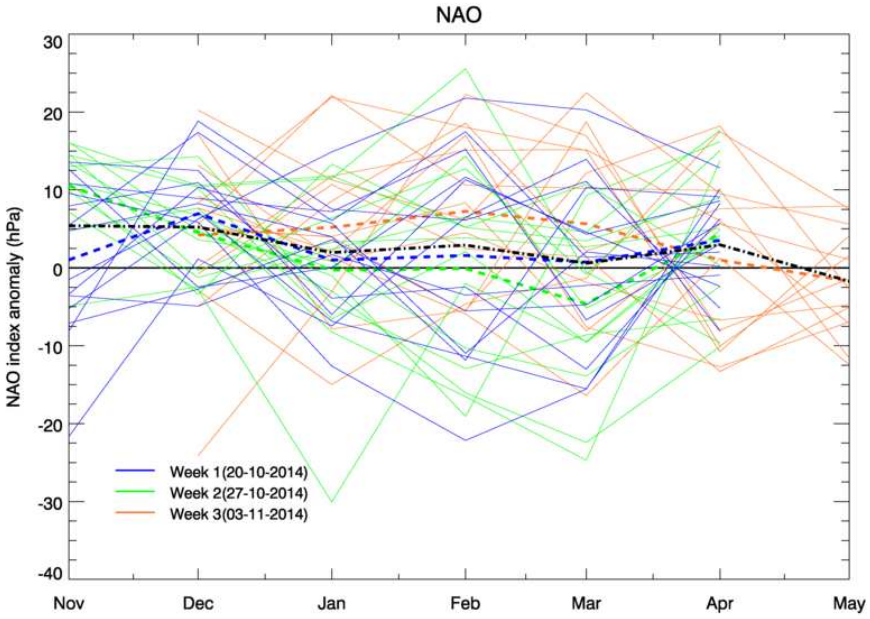
- ENSO – neutral-weak El Niño → negative NAO late winter?
- QBO – easterly phase → negative NAO early winter
- ATLANTIC SST – May SST → DJF NAO: + 0.5 stdev
- SEA ICE – relatively low September sea-ice → weakly favours negative DJF NAO
- SNOW – above-average snow advance in October? → favours negative AO?

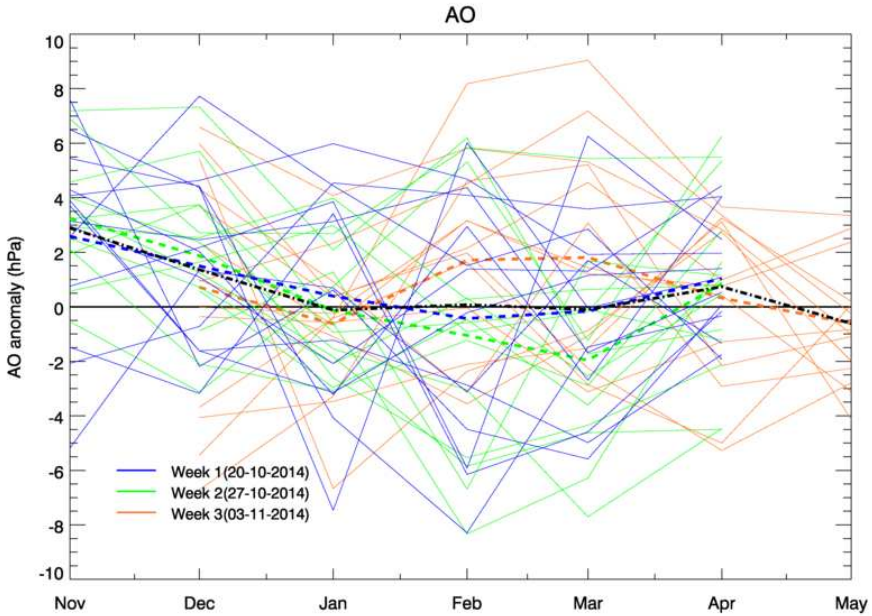
Met Office
Hadley Centre

Predictions: regional December-January-February

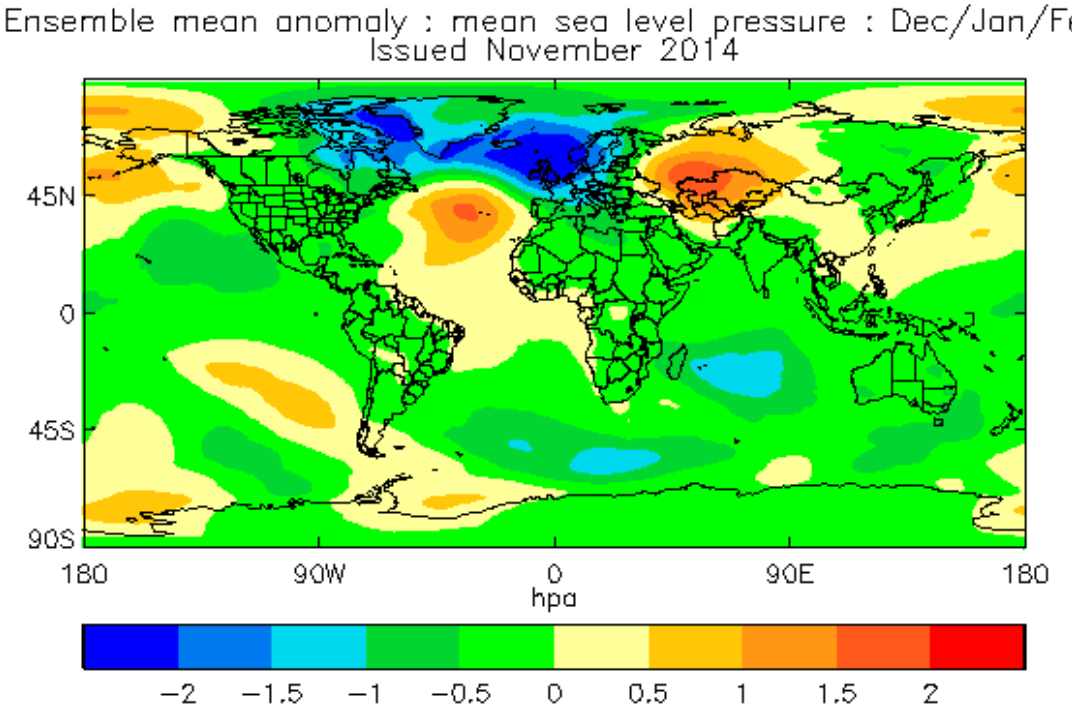
GloSea5 initialised around 1 November 2014

NAO and AO
November 2014 – April 2015





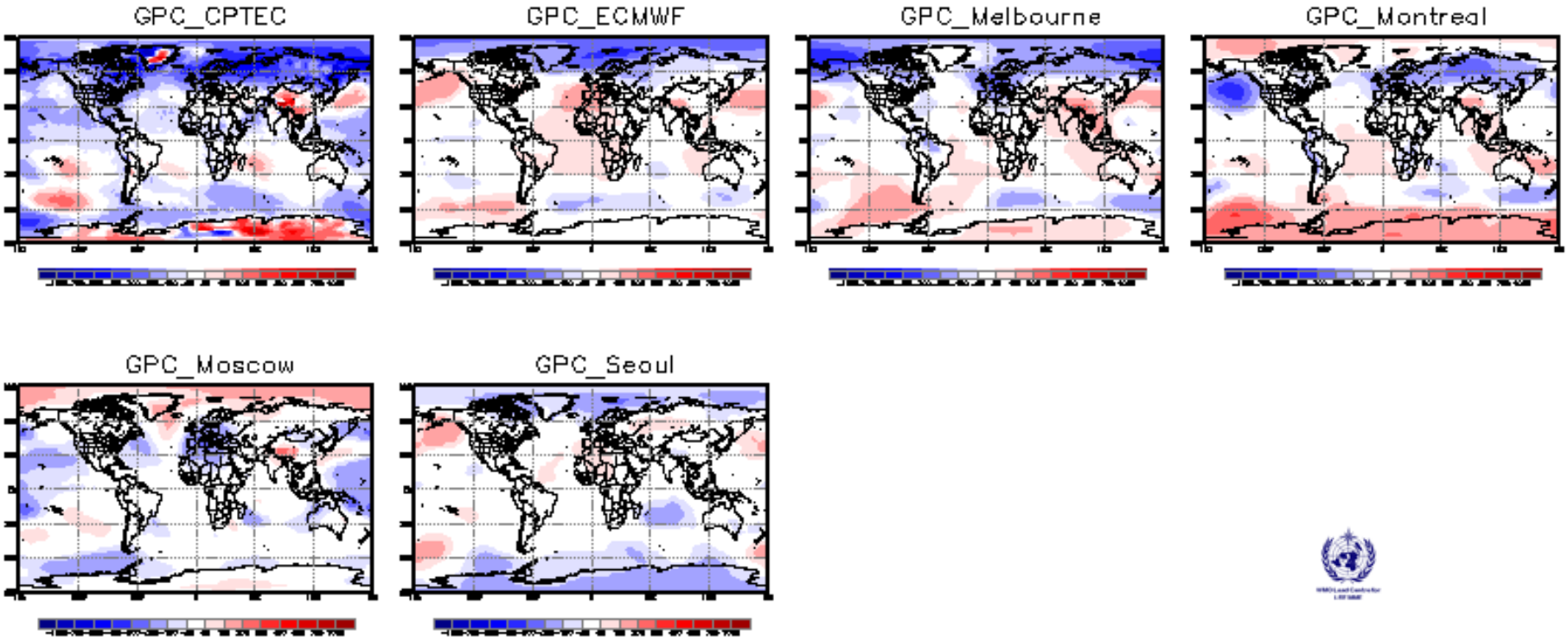
Ensemble mean PMSL DJF 1996-2009 climate



GPC output DJF PMSL anom

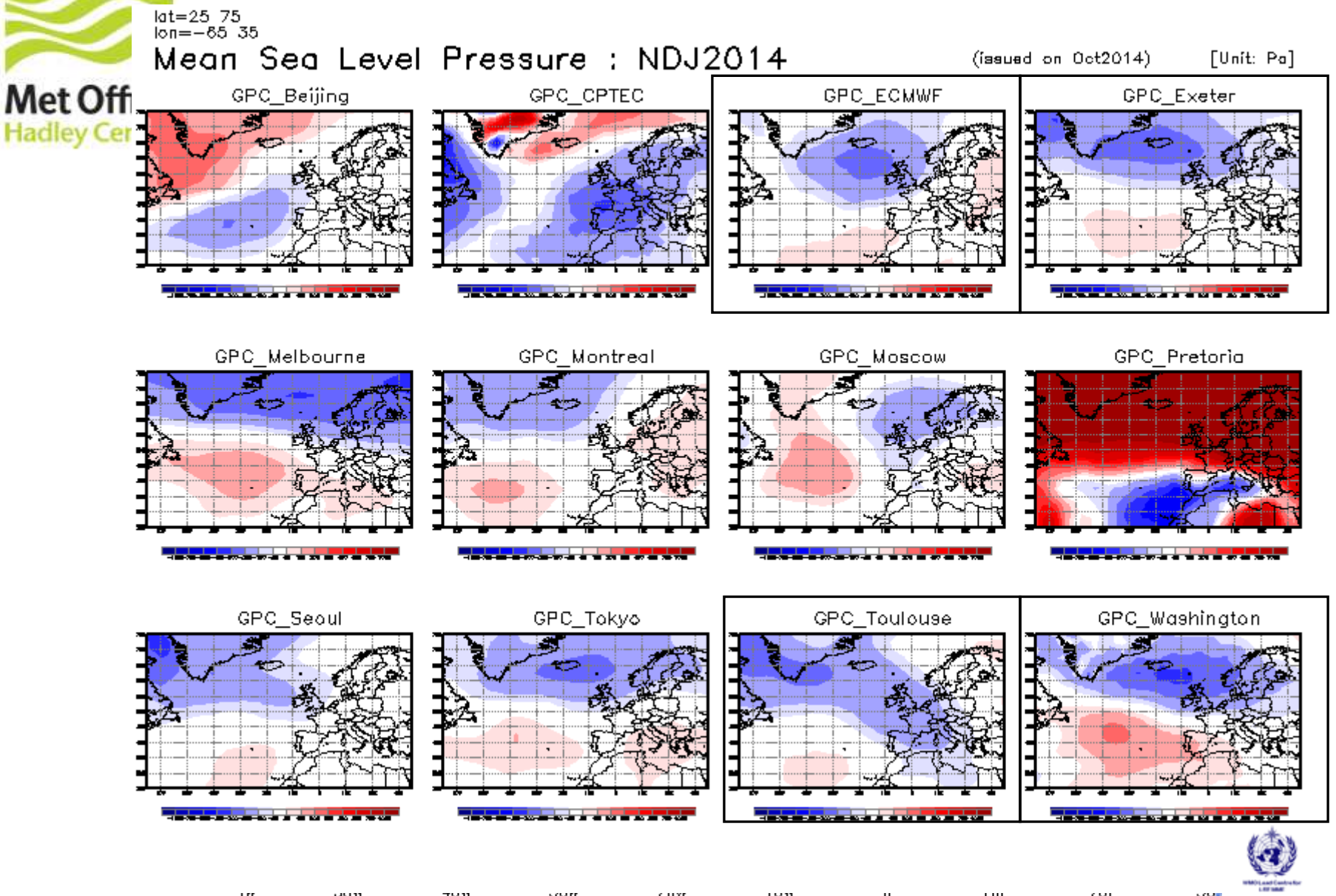
lat=−90 90
lon=−180 180

Mean Sea Level Pressure : 02014 (issued on Nov) [Unit: Pa]

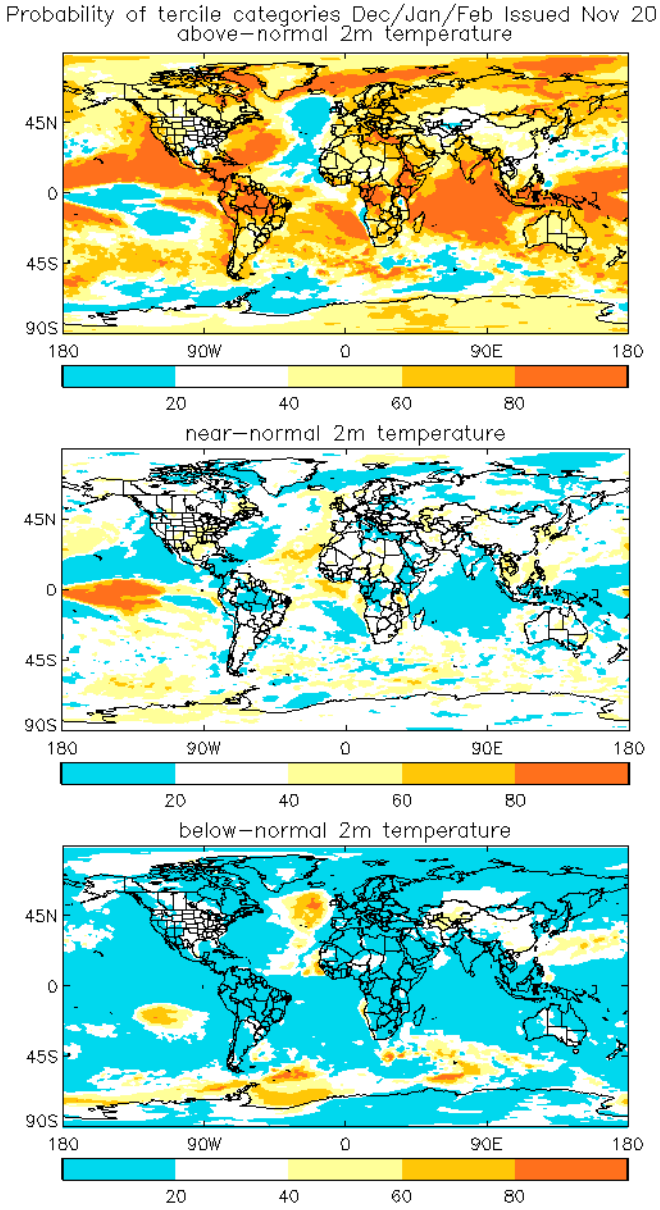


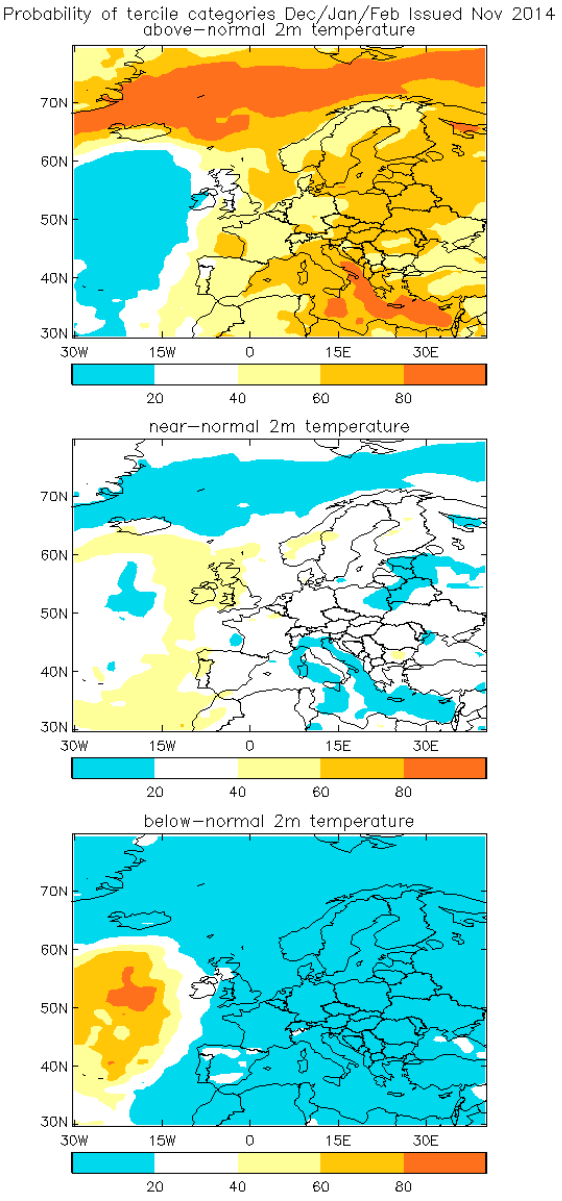
−1000 −700 −500 −400 −300 −200 −100 −50 50 100 200 300 400 500 700 1000 Pa

GPC output NDJ PMSL anom

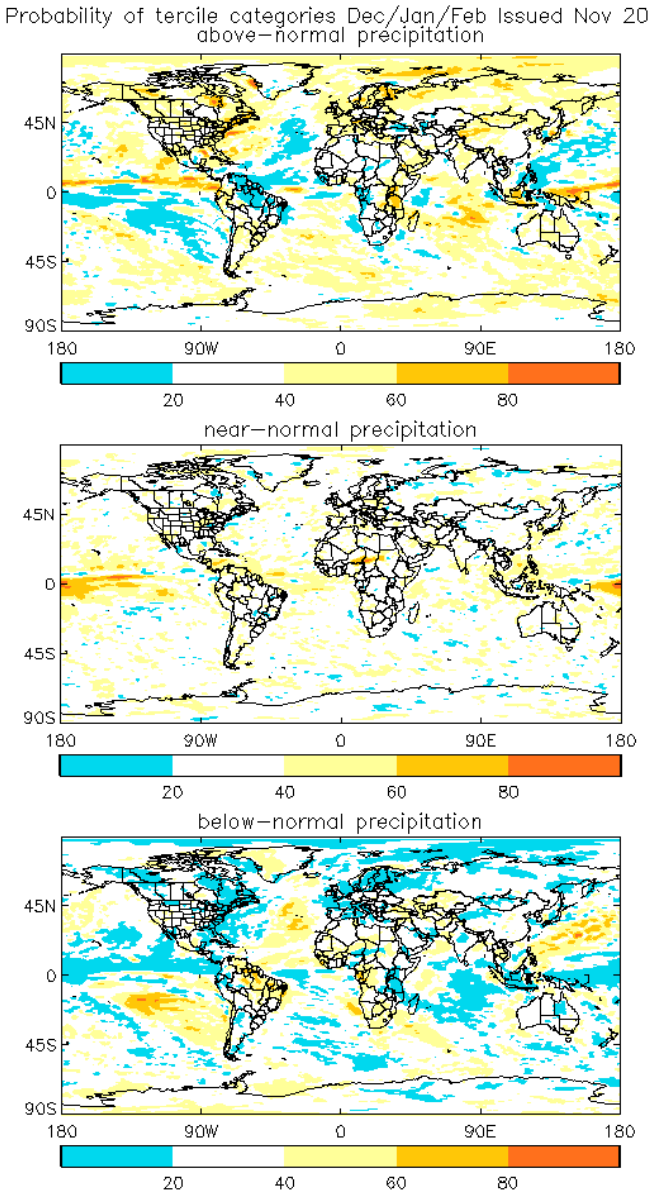


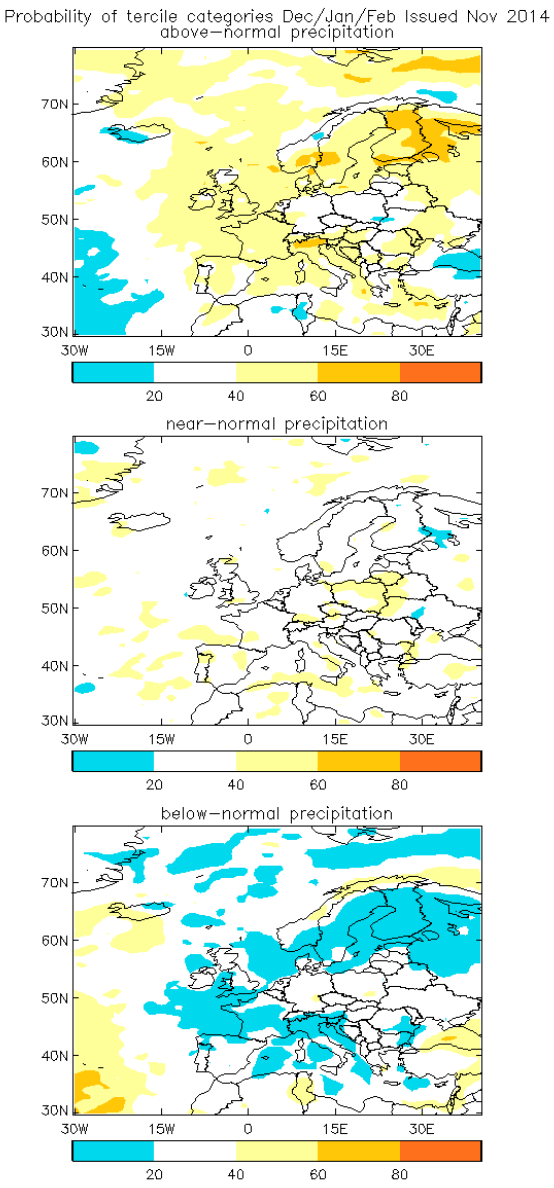
Temperature, DJF 2014/15 (1996-2009 climate)





Precipitation, DJF 2014/15 (1996-2009 climate)



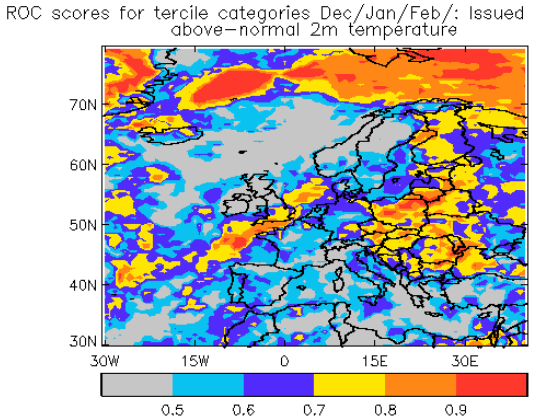


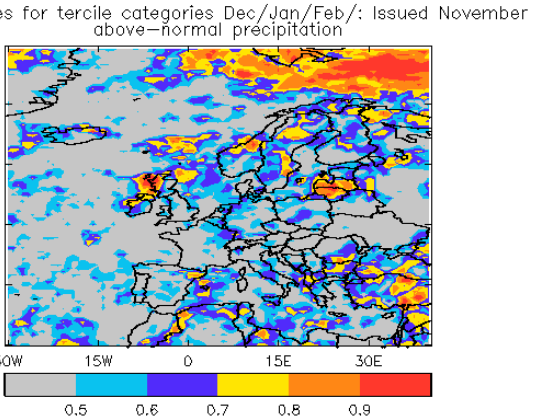
temperature

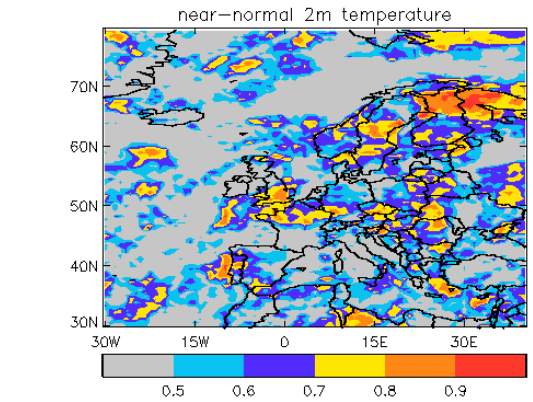
precipitation

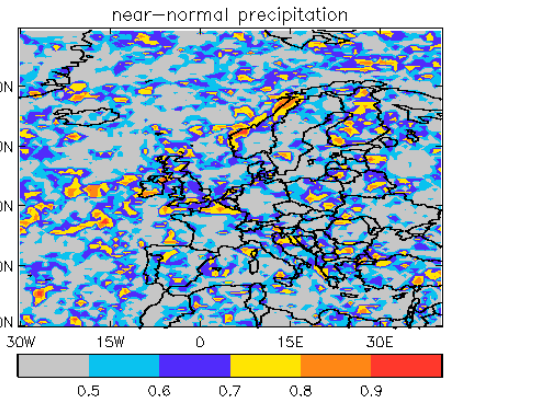
DJF

Above

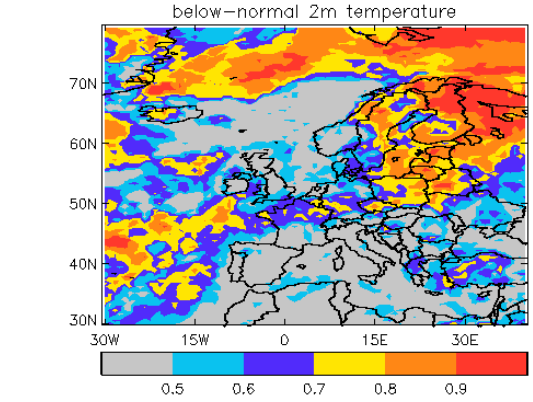


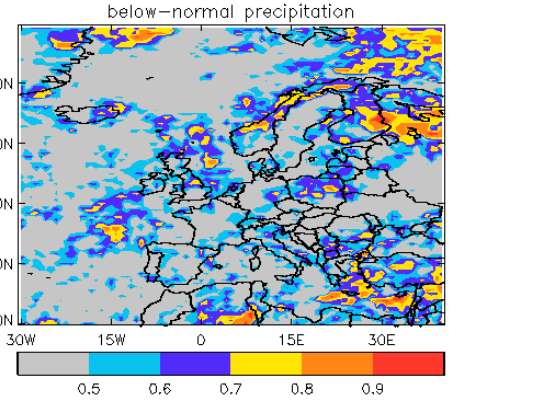






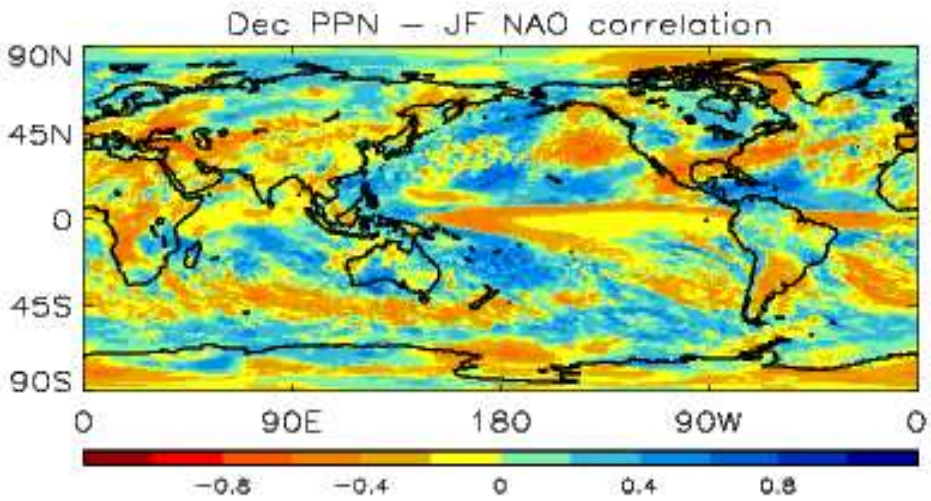
Below

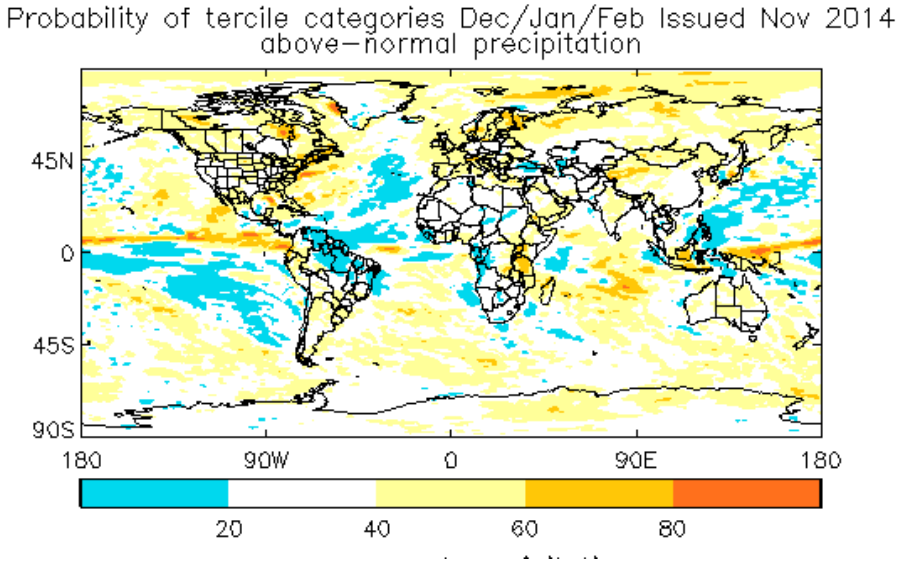




Atmospheric teleconnections to tropical rainfall

Global Rainfall – NAO correlation



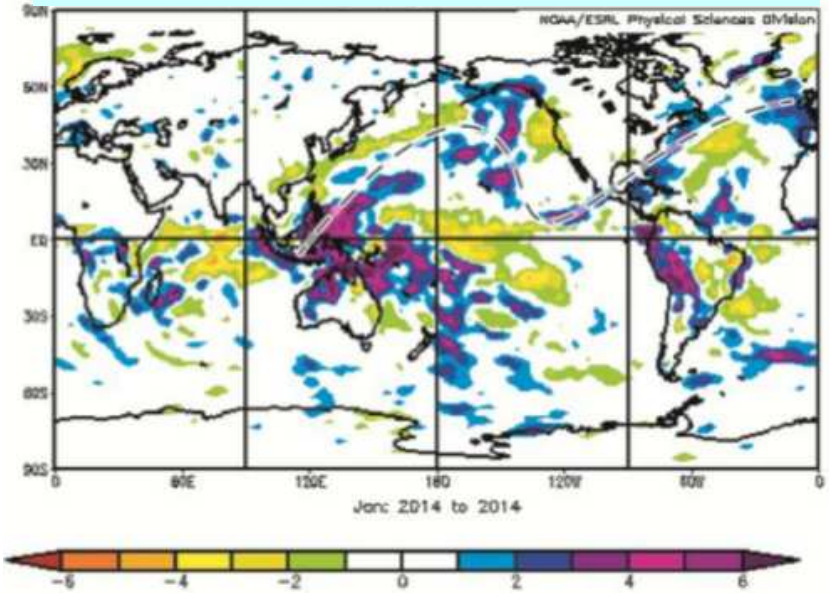


Tropical rainfall connected to extratropics in HadGEM3 model

Similarities with 2013/14?

Winter 2013/14: dynamical drivers

January rainfall anomalies

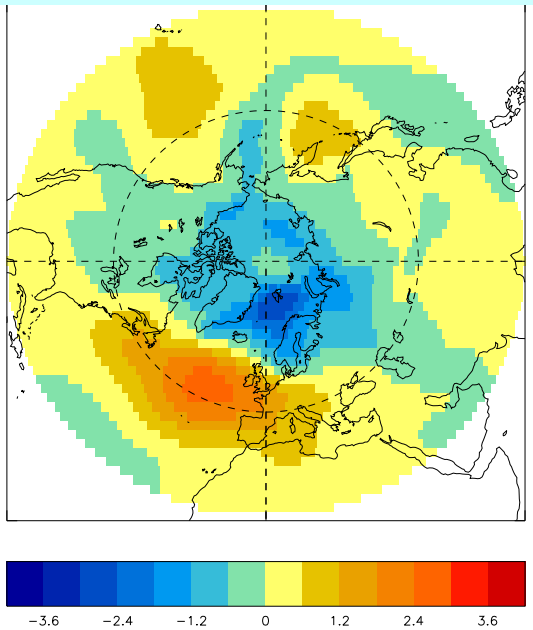


High rainfall over west Pacific

Hemispheric Rossby wave

=> Strong jet stream near UK

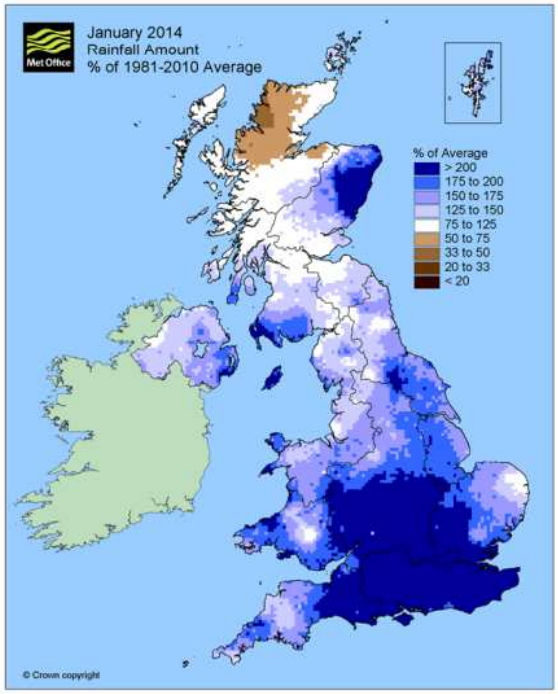
Sea level pressure associated with westerly QBO

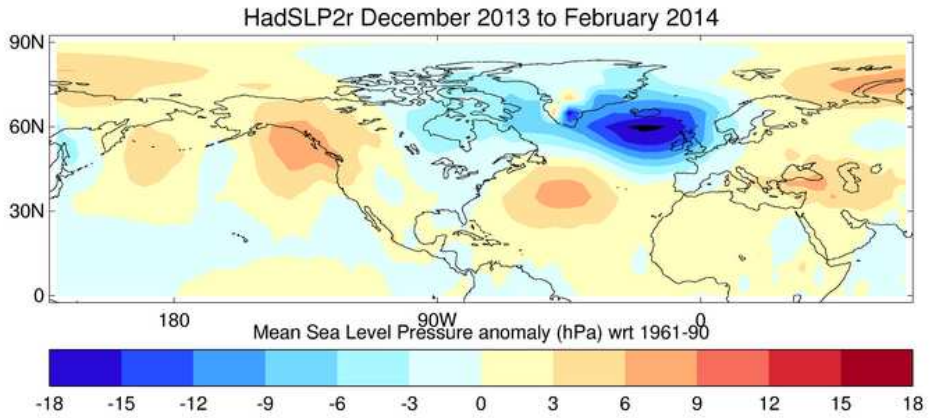


Strong westerly QBO

=> Strong jet stream

Winter 2013/14 in the UK





Wettest winter in England and Wales for 248 years!

Widespread flooding and coastal damage

Slingo et al 2014, Palmer et al 2014, Huntingford et al 2014

Summary

- the latest signal from model(s?) is similar to that in October: positive NAO for DJF 2014/15
- not clear which driver may be responsible for this response in models; most drivers which are in an active phase would typically favour the opposite
- early indications (but how skilful?) of potential for stratospheric warming later this winter, and thus of change from positive NAO

Overall, no clear-cut conclusion.

The end