First impressions of seasonal forecasting system 4

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Seasonal forecasting assumptions

- Seasonal forecasting gives “windows of opportunities” to see past the normal forecasting horizon from the atmospheric initial conditions (~ 3 weeks)

- On average, low resolution (being able to differentiate from climatology) is ok

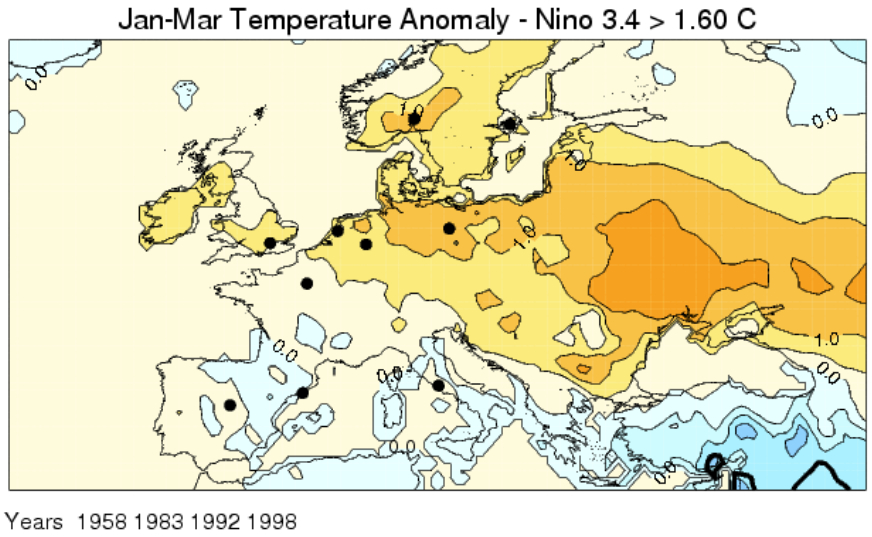
- The key is being able to identify the windows of opportunity but to make “good” decisions the forecast probabilities need to be reliable

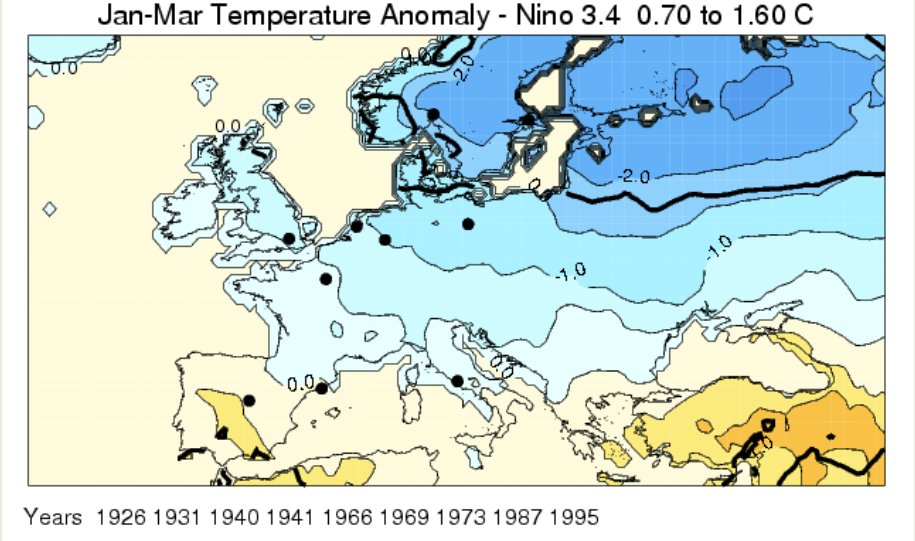
- In winter any predictable signals for Europe come from teleconnections from the tropics - the stratosphere sometimes plays a role in these

3 case studies of winter situations which have a predictable signals

- Compare System 4 hindcasts (15 members, 1981-2010) with System 3 hindcasts (11 members, 1981-2005) & operational forecasts (sub-sampled 11 of 41 members, 2006-2010)

El Nino events – Jan-Mar

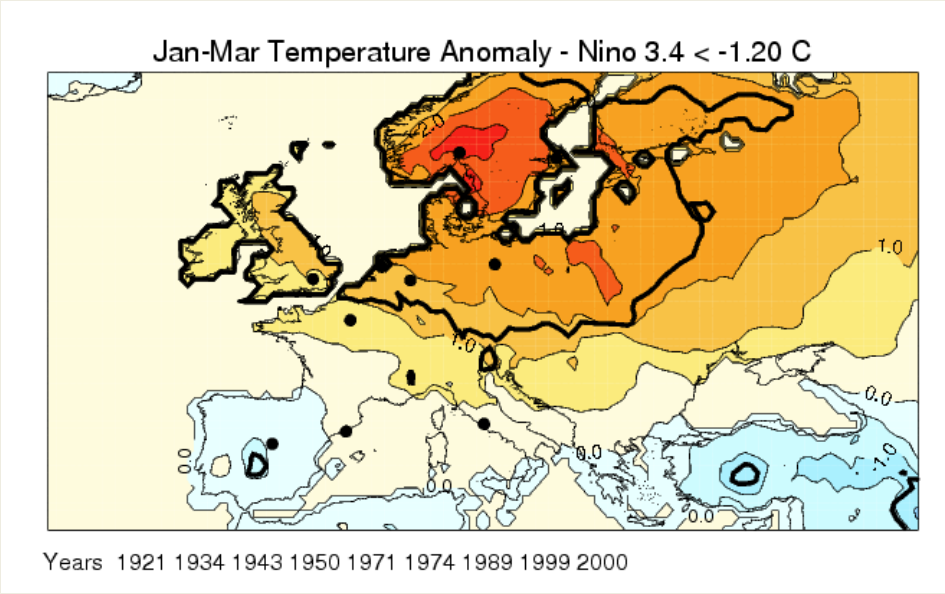


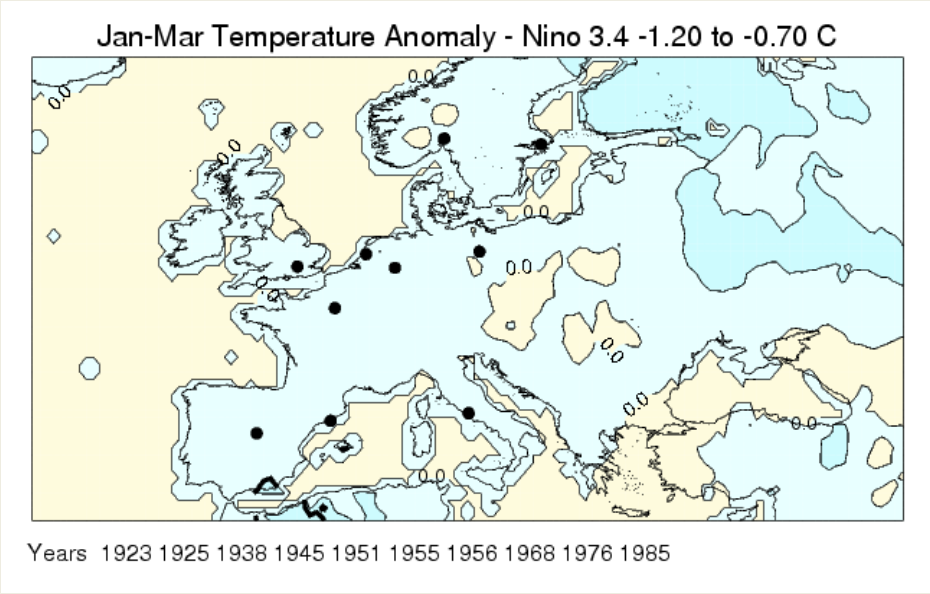


CRU temperature data 1920-2001 (detrended), solid contour significant at 95%

- Weak & moderate El Nino events are cold in northern Europe for 2nd half of winter

La Nina events – Jan-Mar

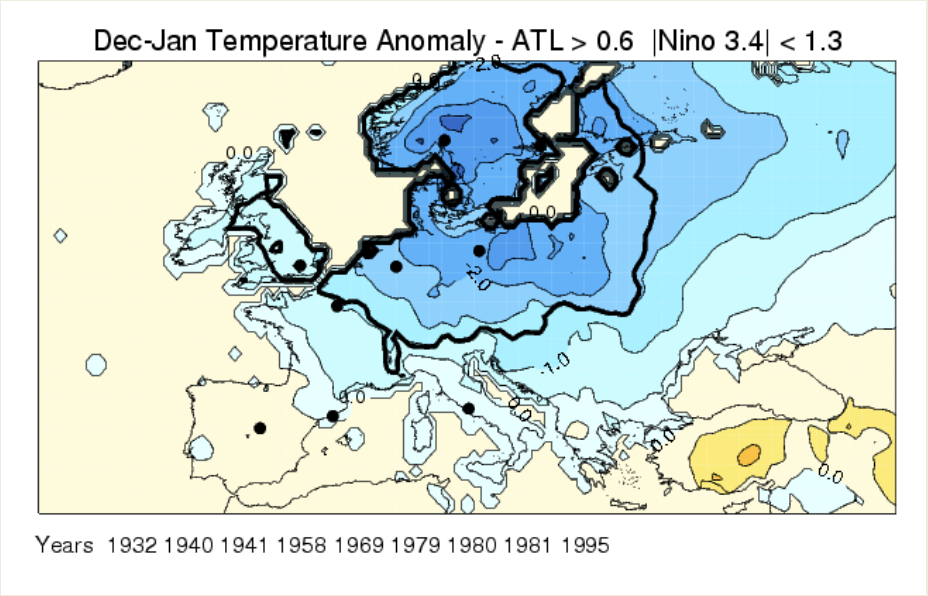


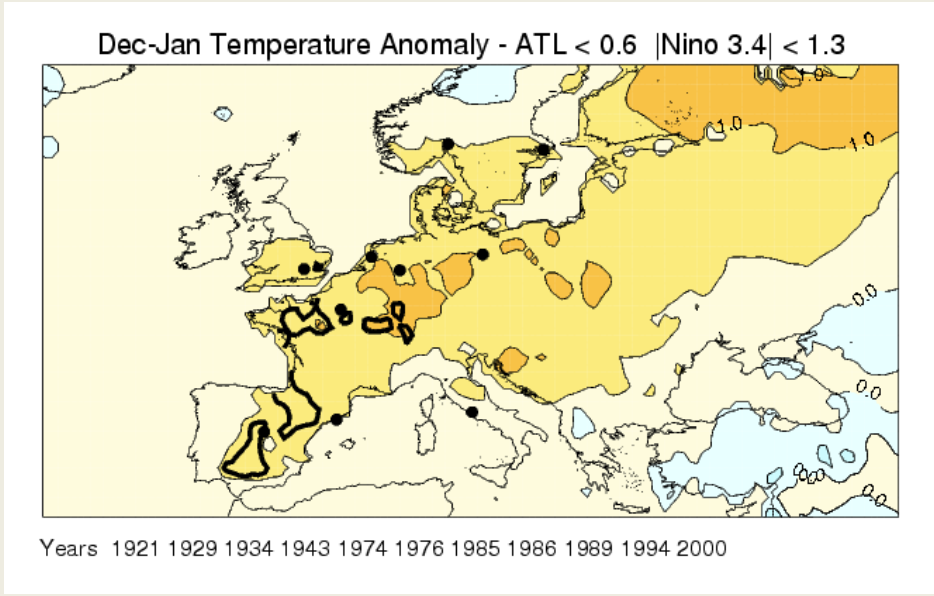


CRU temperature data 1920-2001 (detrended), solid contour significant at 95%

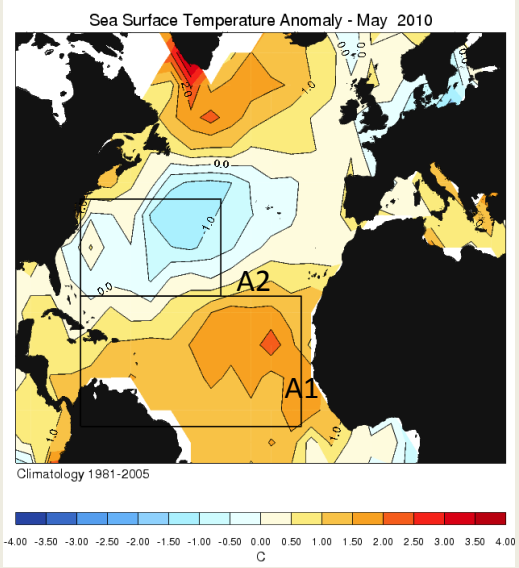
- Strong La Nina events are warm in northern Europe for 2nd half of winter

Tropical Atlantic events – Dec-Jan





• +ve tropical Atlantic SSTs are cold in northern Europe for midwinter (strong ENSO years excluded)



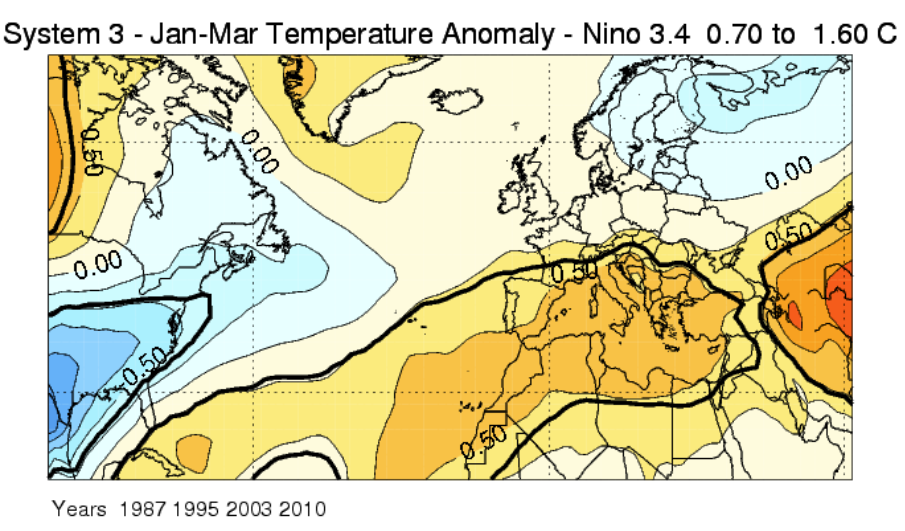
• Significant (curious?) correlation between winter temperatures and preceding Atlantic May SSTs (e.g. Rodwell & Folland, 2002)

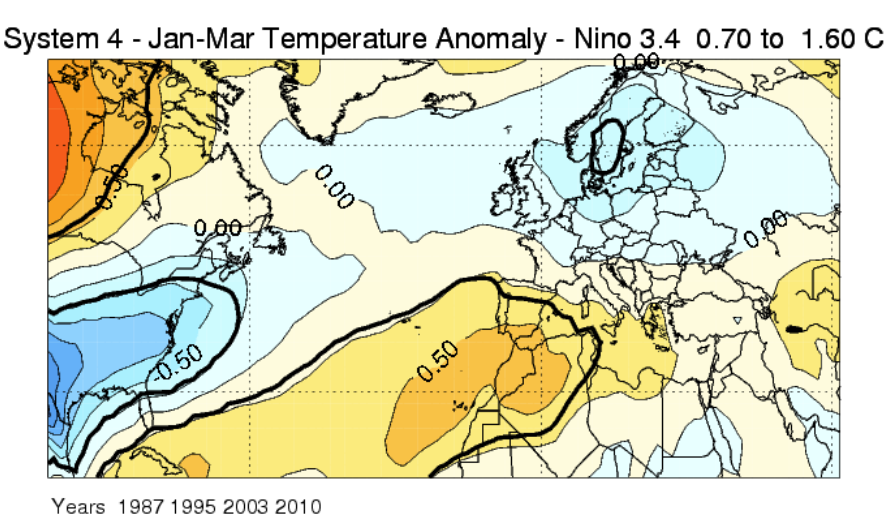
• GCMs respond tropical Atlantic SST anomalies but other parts of the SST tripole also appear to be important in forcing the NAO (e.g. Sutton et al., 2001)

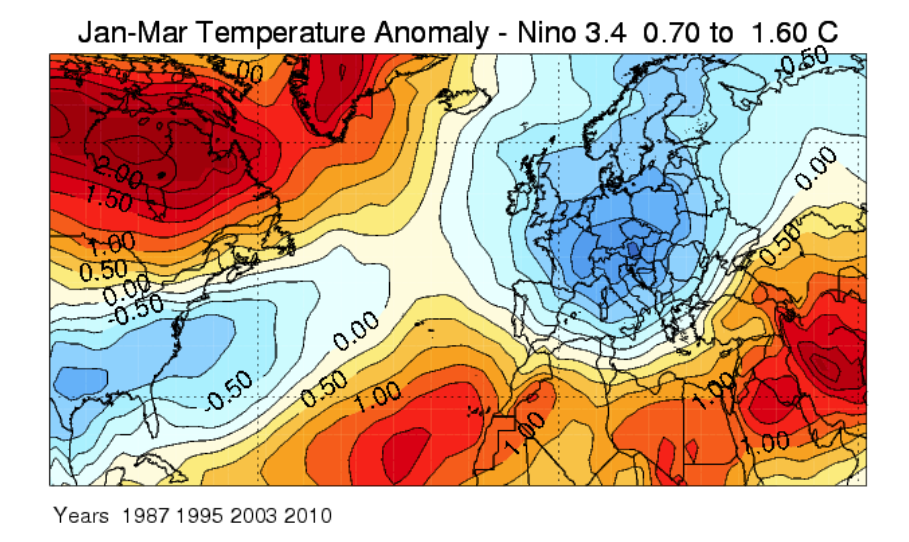
• ATL = A1 – A2

Moderate & weak El Nino events

850 hPa temperature anomaly – December starts

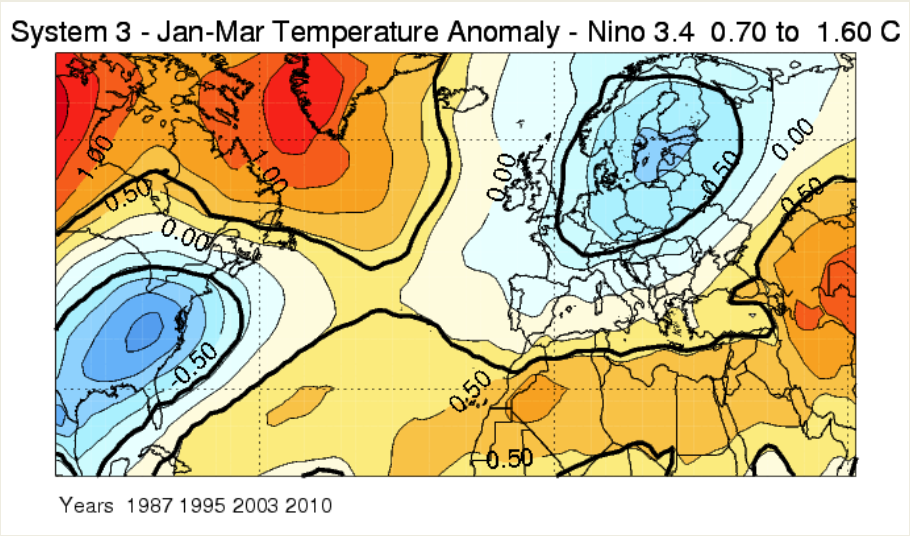


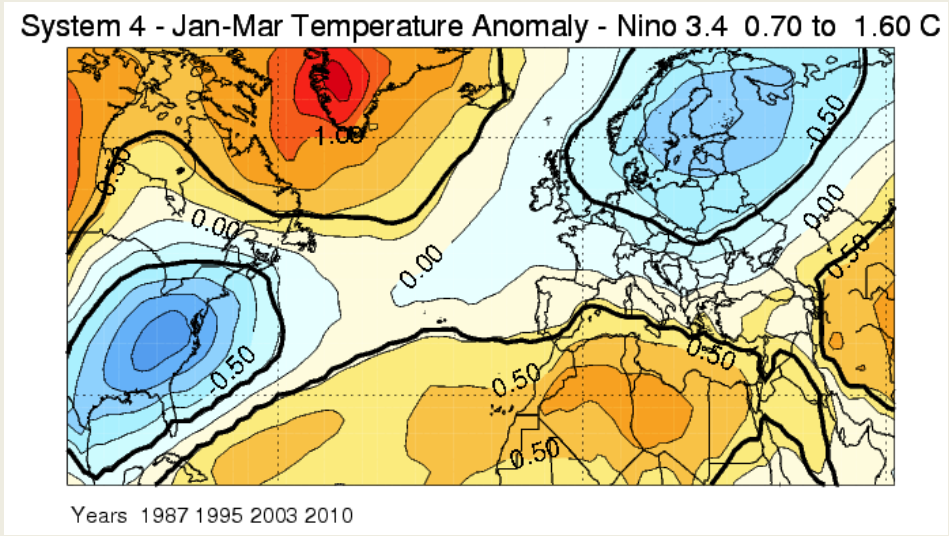


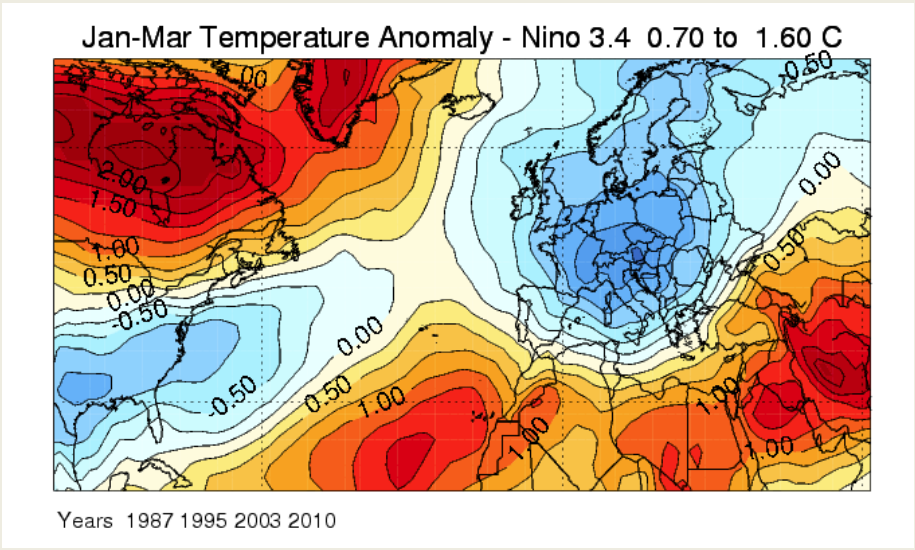


Moderate & weak El Nino events

850 hPa temperature anomaly – January starts

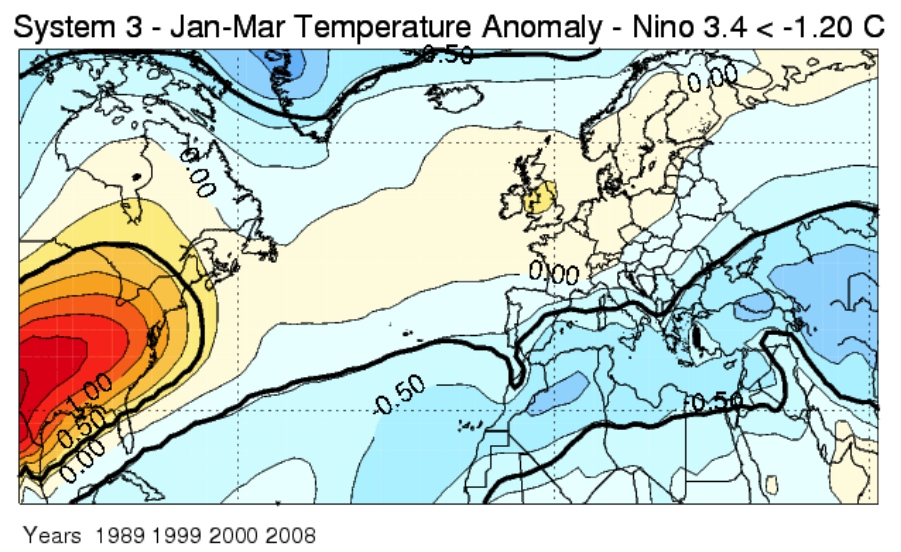


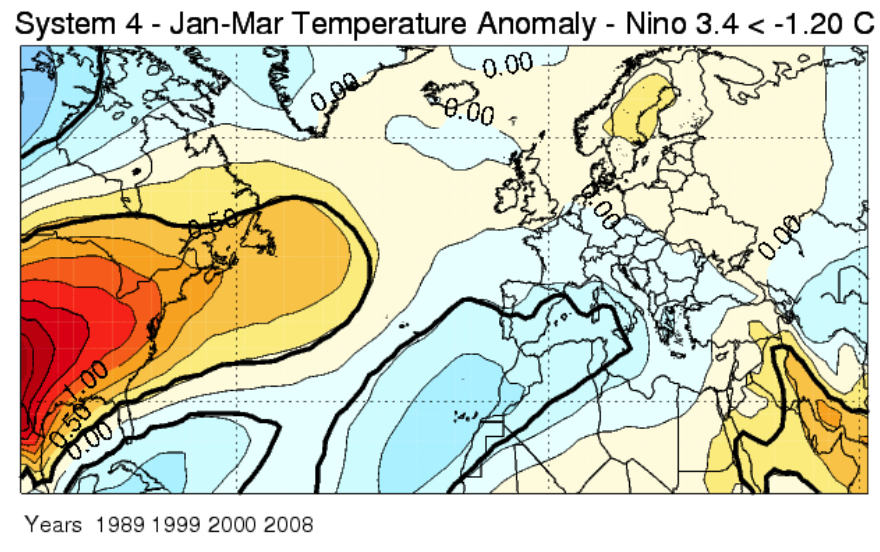


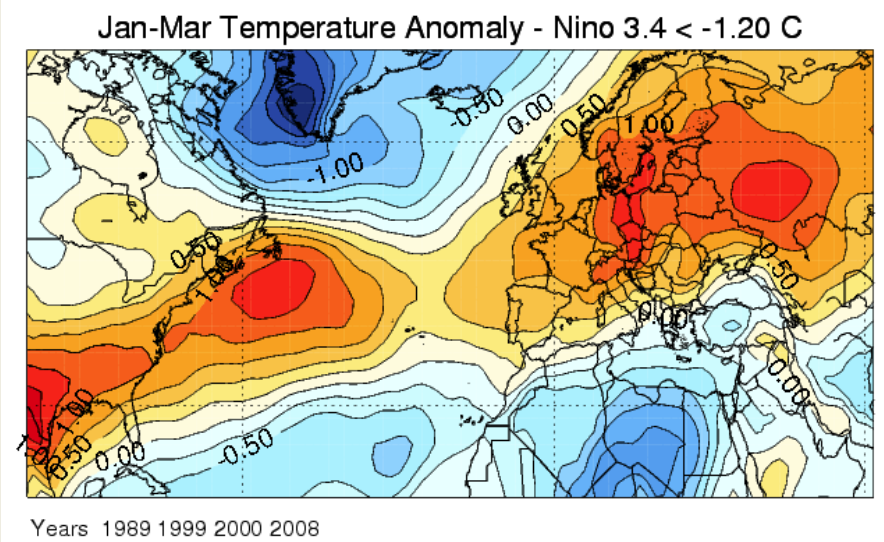


Strong La Nina events

850 hPa temperature anomaly – December starts







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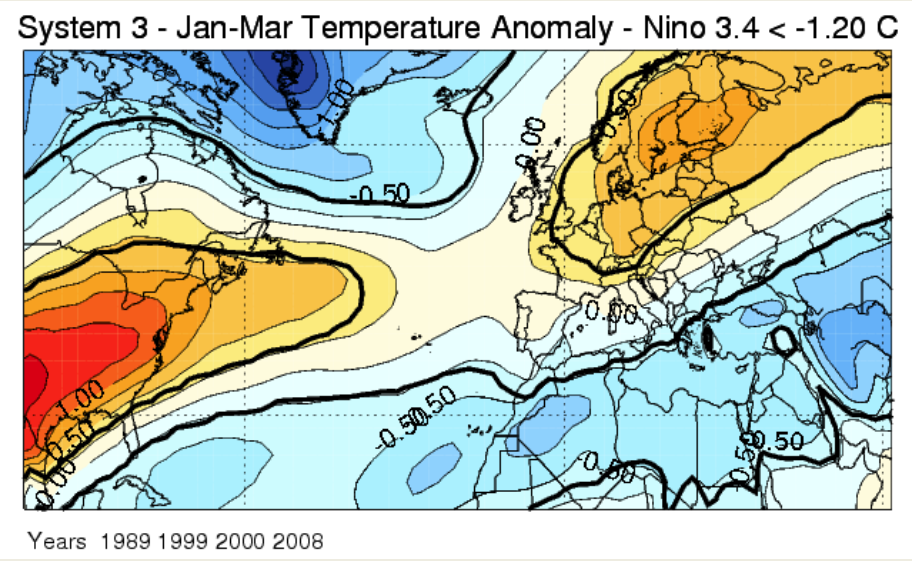

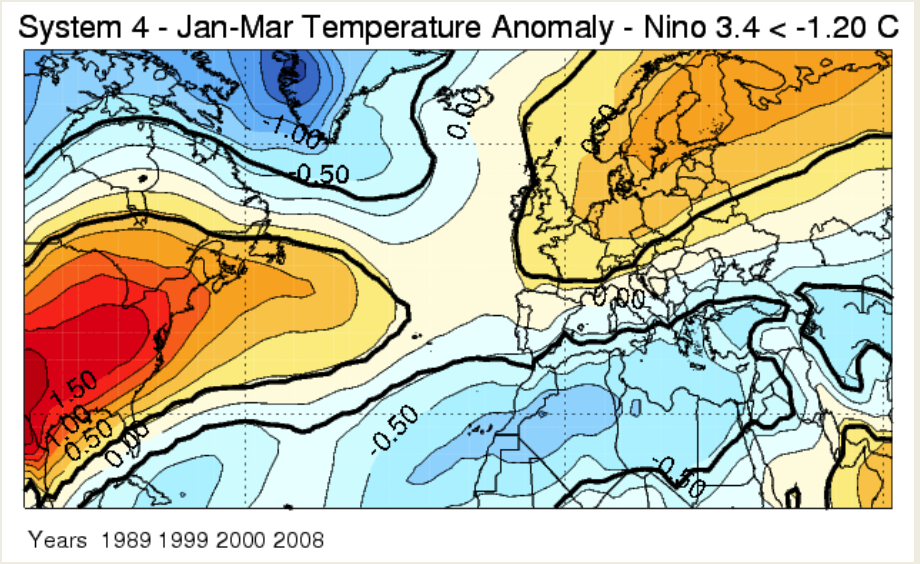

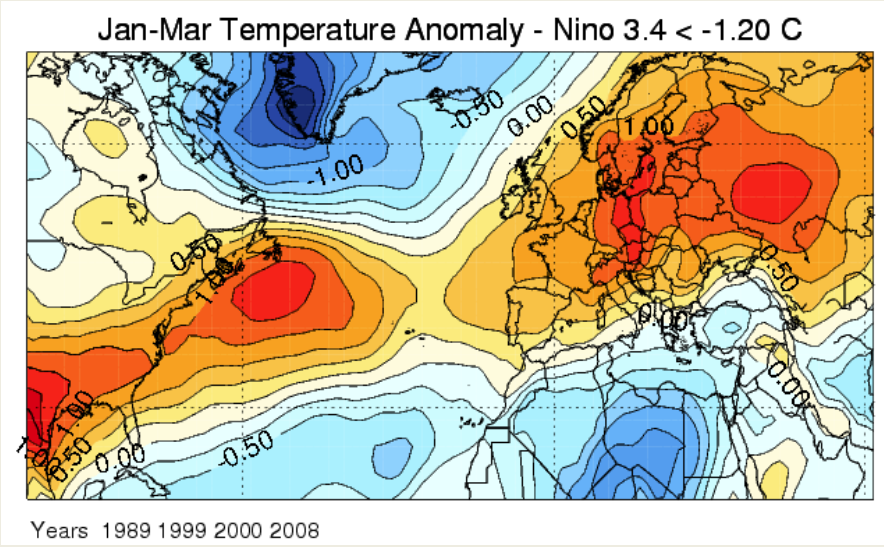

+ve Tropical Atlantic events

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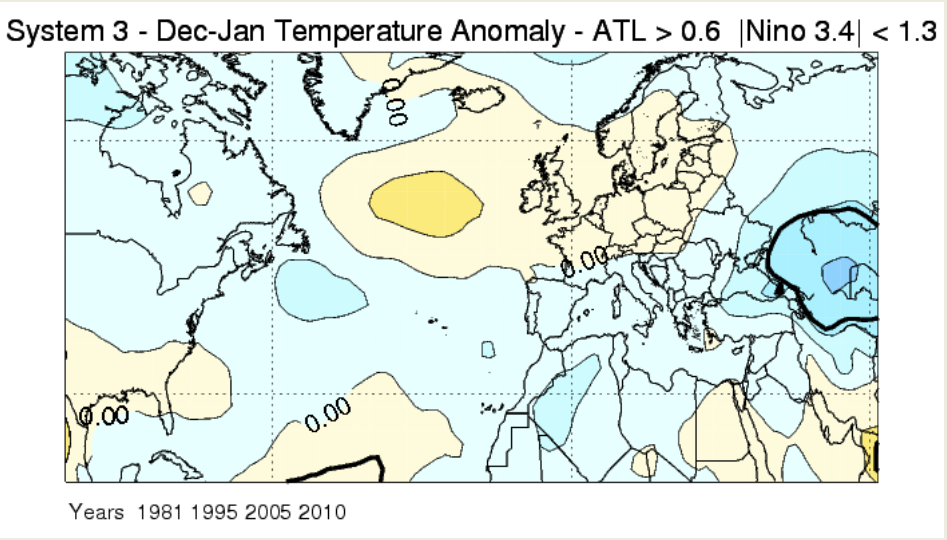

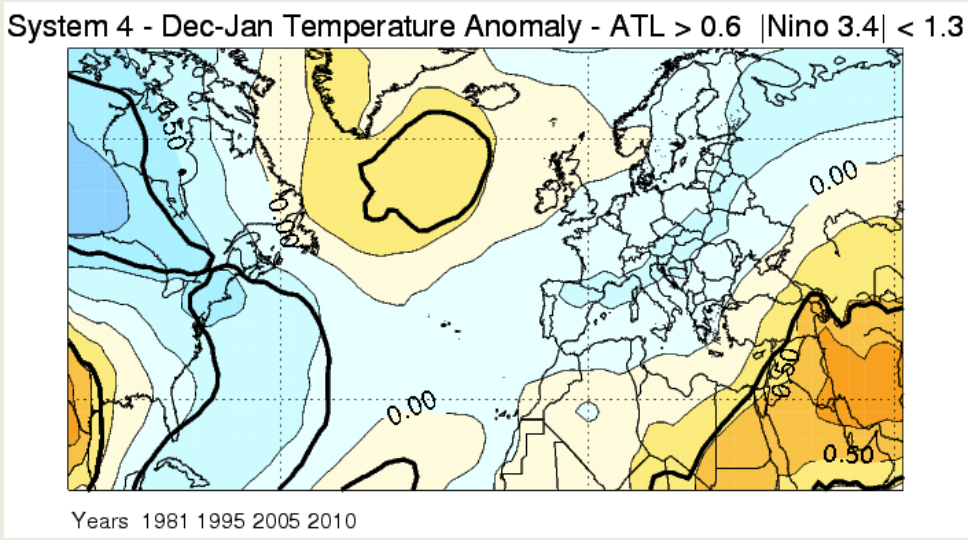

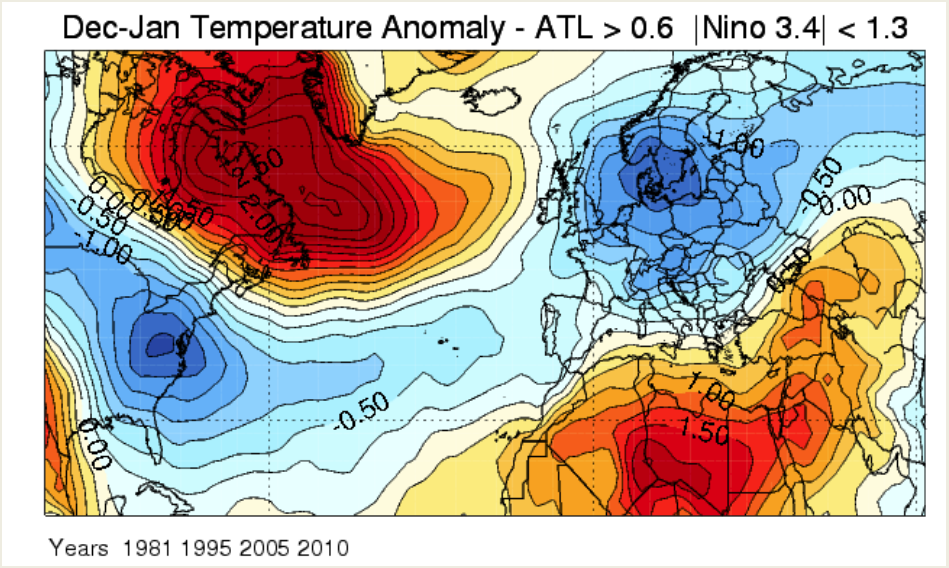

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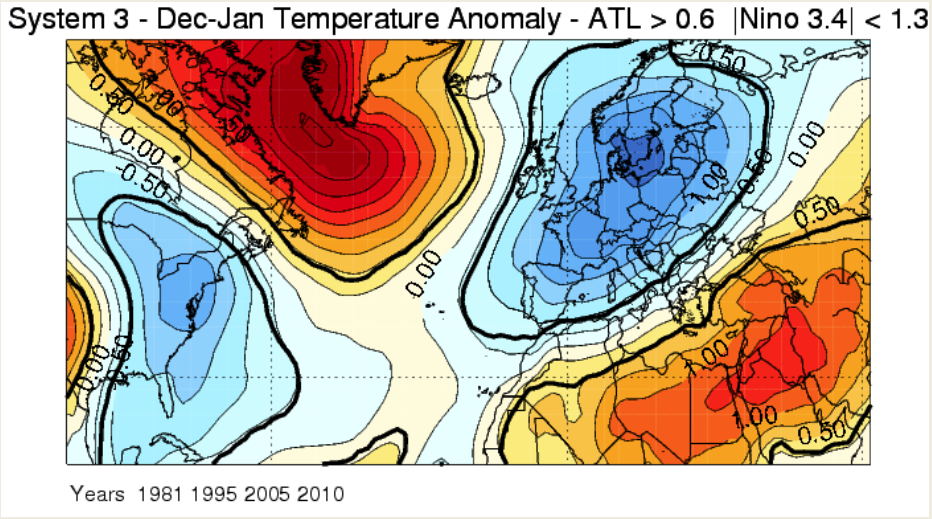
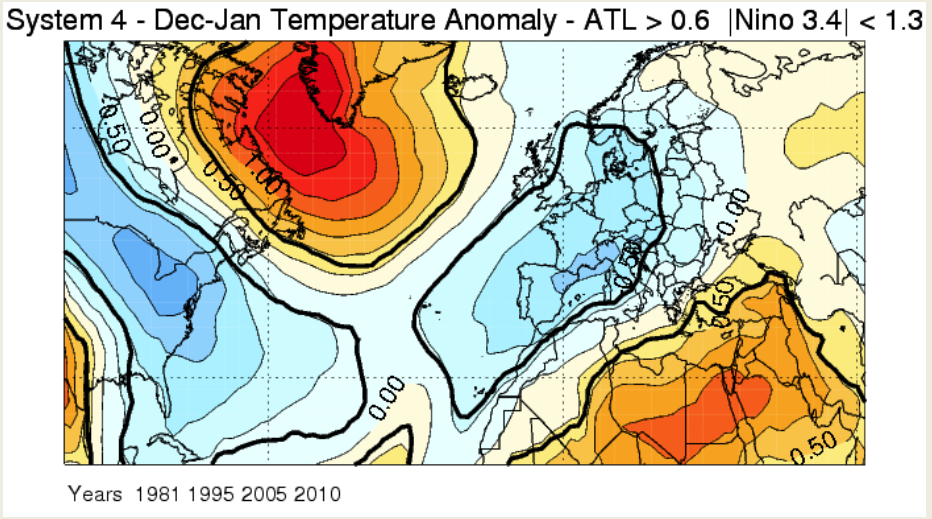
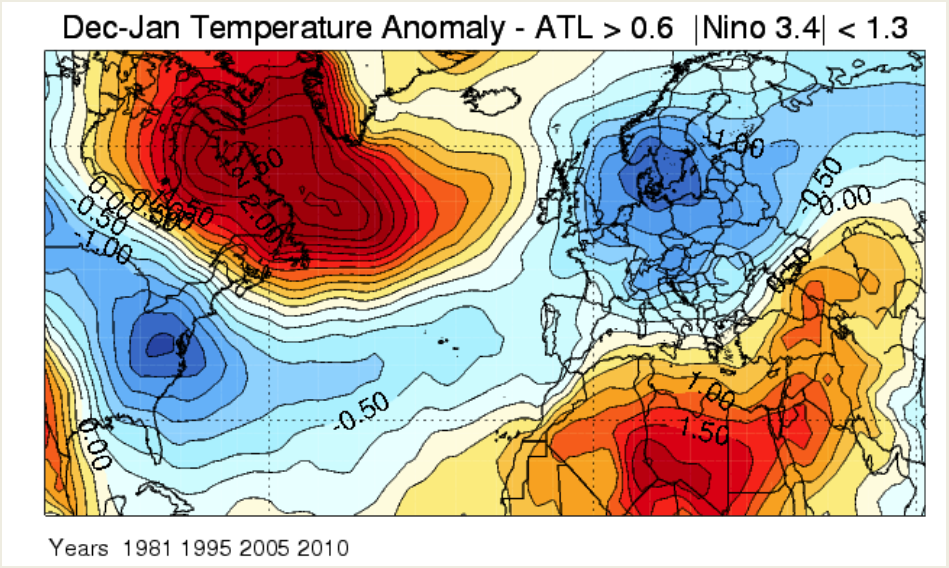




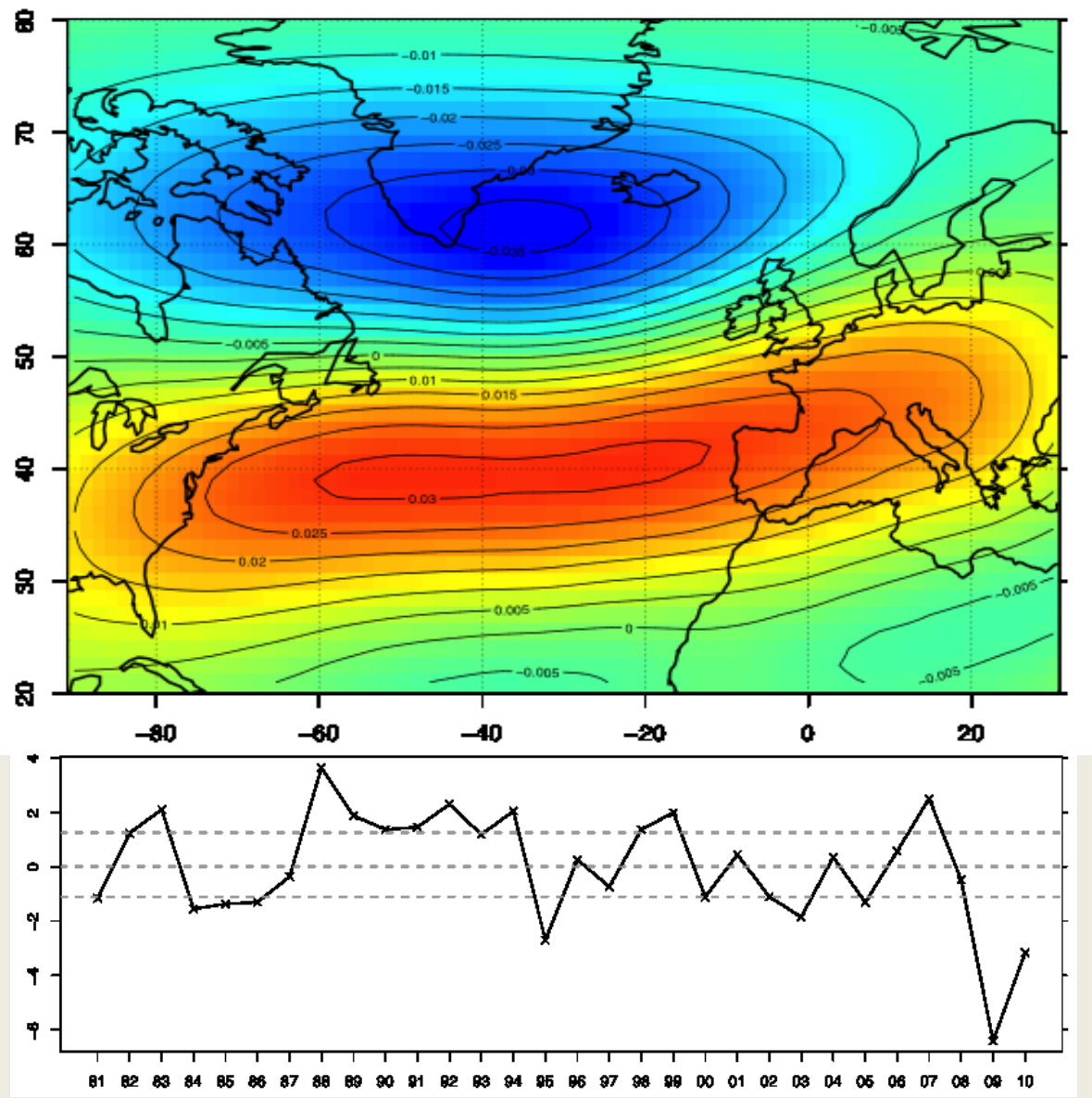


Large scale regimes

- Strong evidence for large scale regimes in the North Atlantic controlling European surface temperatures (e.g. Cassou, 2010).
  - NAO responsible for > 30% of variance in winter surface air temperature (Hurrell, 1995).
- How well can ECMWF system 3 and system 4 seasonal forecasts reproduce modes of variability of 500 hPa geopotential (NAO)? Validation of forecasts (monthly and seasonal means) of NAO.
  - Focus on winter starts (November, December, January) for months 1-4.
  - Is there a flow/forcing dependence of performance?
- Validation of frequencies of daily regimes given link to surface temperatures (e.g. Minvielle, 2010) .

NAO

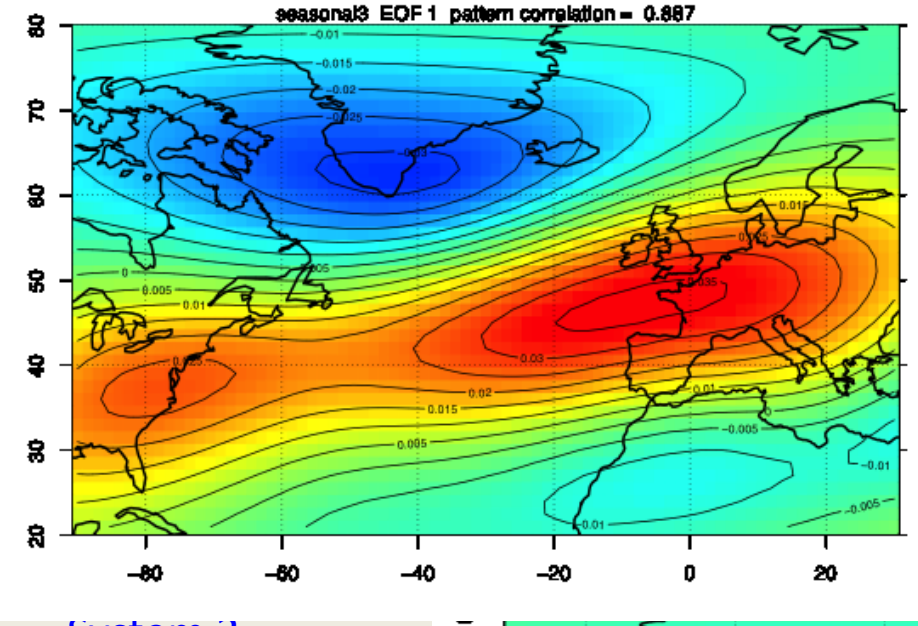
EOF1 1 of 500 hPa anomalies in DJF from ERA-interim – 35% of variance



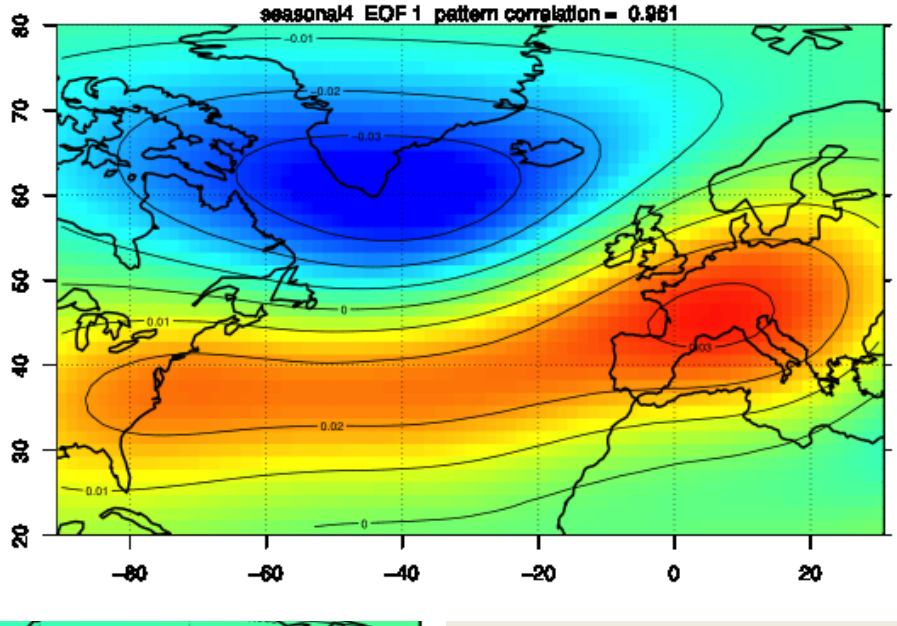
DJF average

NAO – comparison

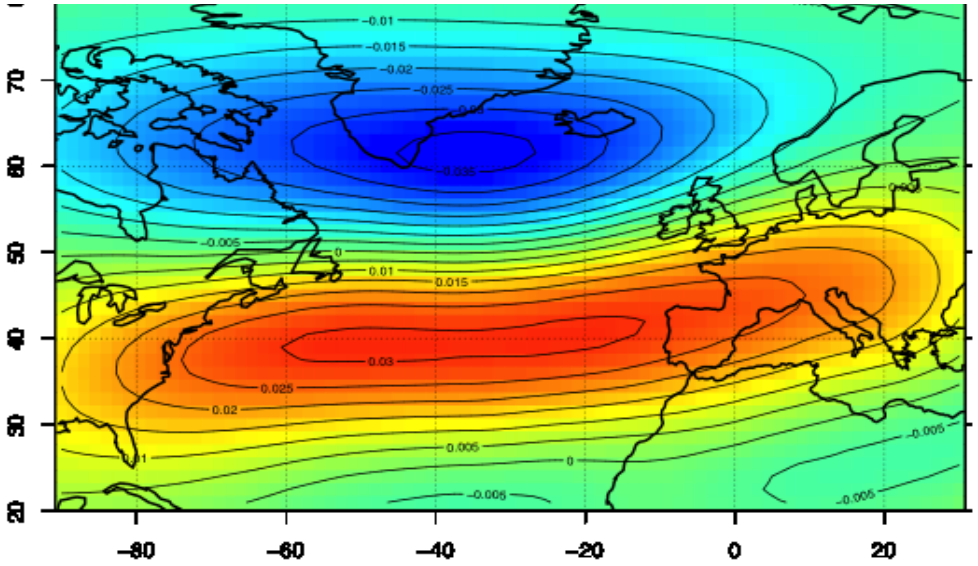
EOF1 1 of 500 hPa anomalies in DJF, 1981-2010



System 3



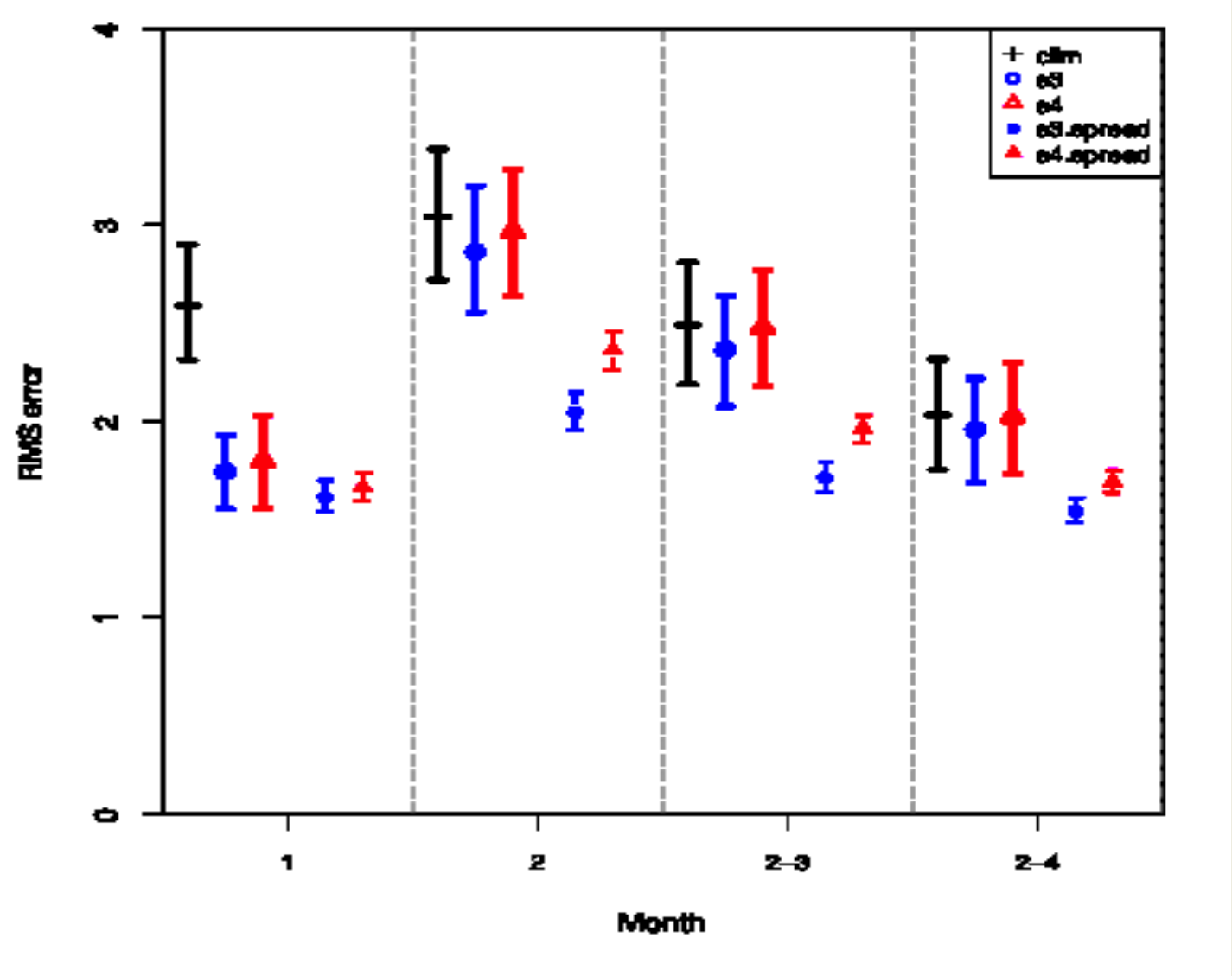
System 4



ERA-interim

Spread-Skill Relationship

EOF 1 500 hPa geopotential height anomalies – Nov, Dec, Jan starts



Brier score (lower tercile)

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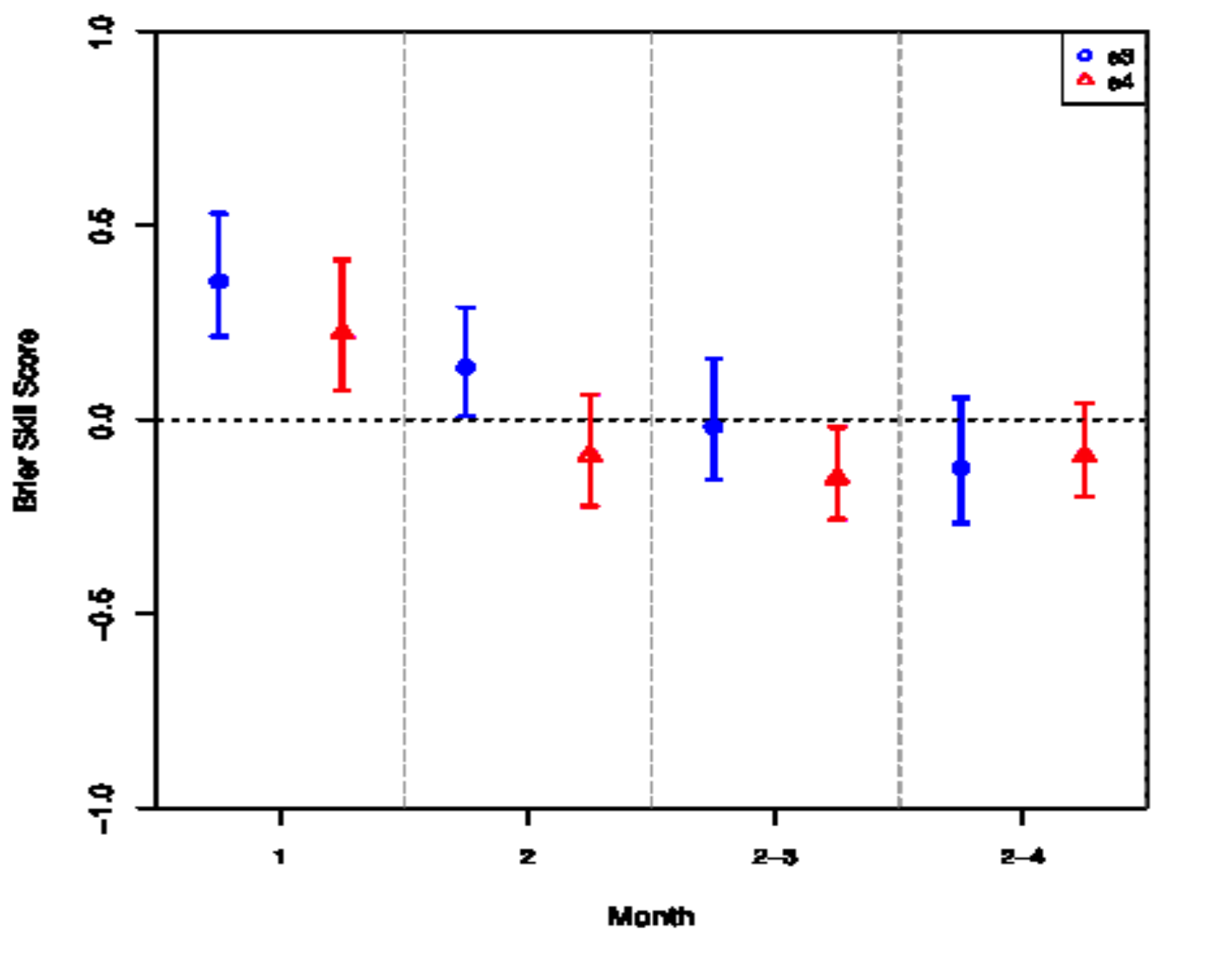

Brier score (upper tercile)

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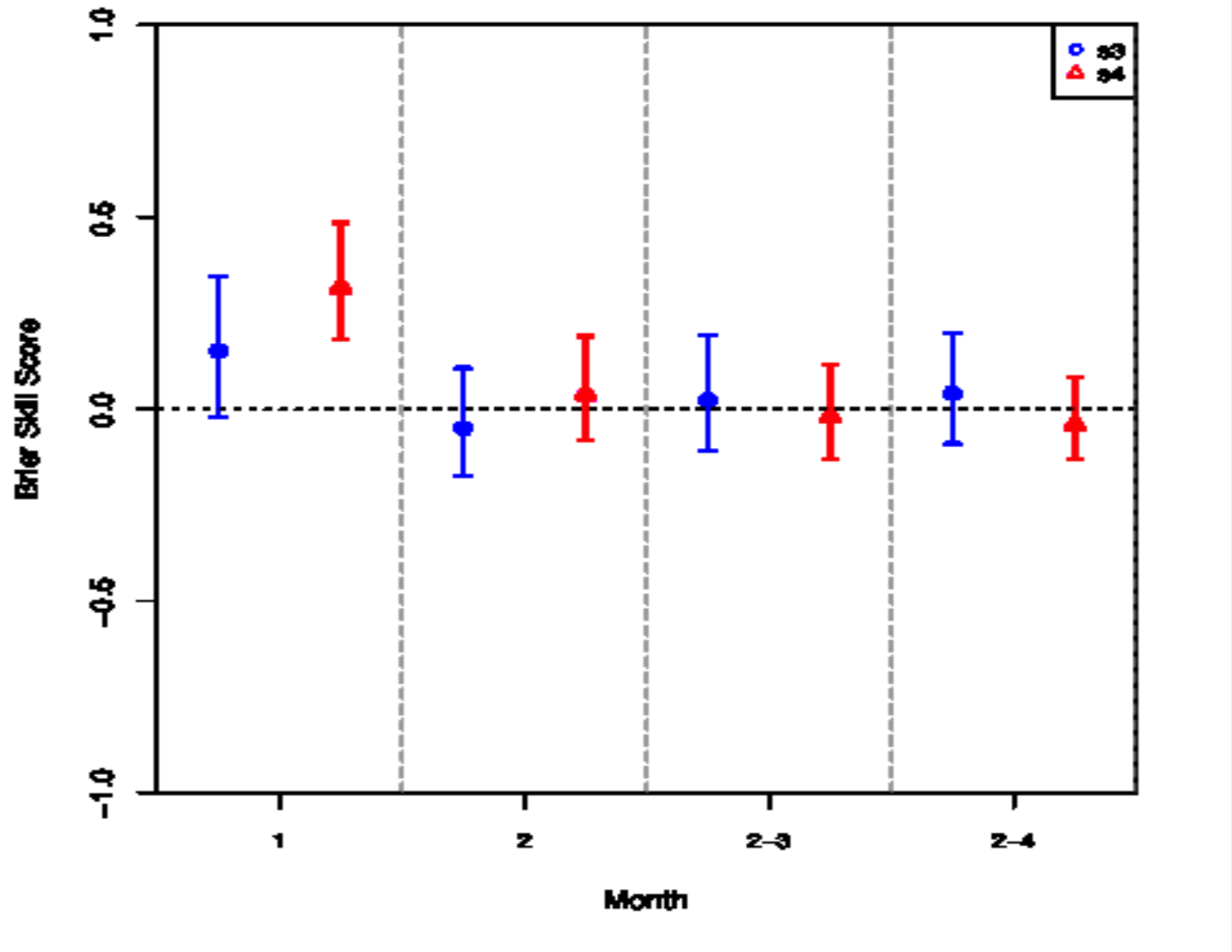
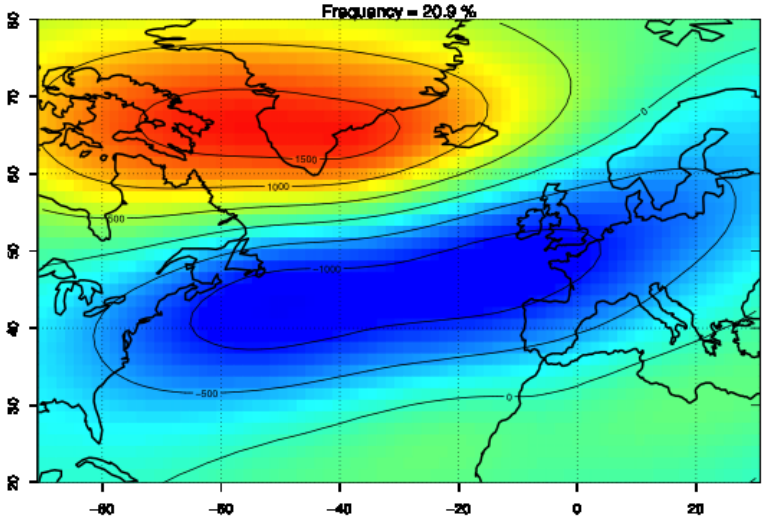
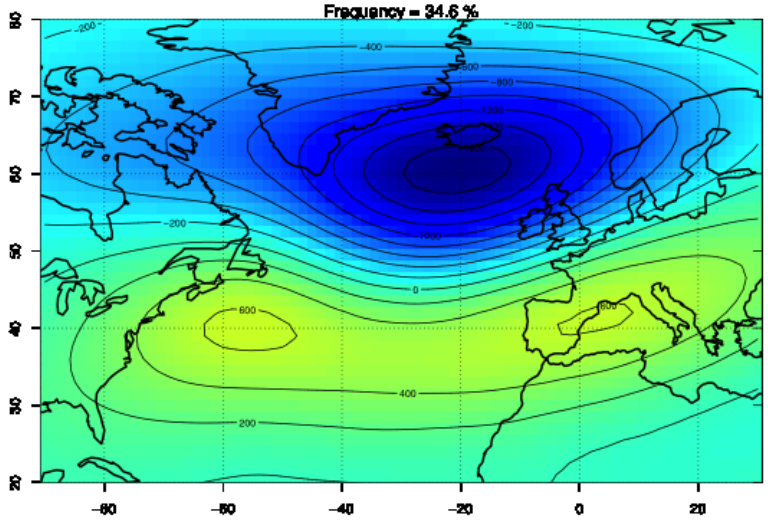


Atlantic regimes - clustering

500 hPa geopotential anomalies – DJf daily data from ERA Interim 1981-2010

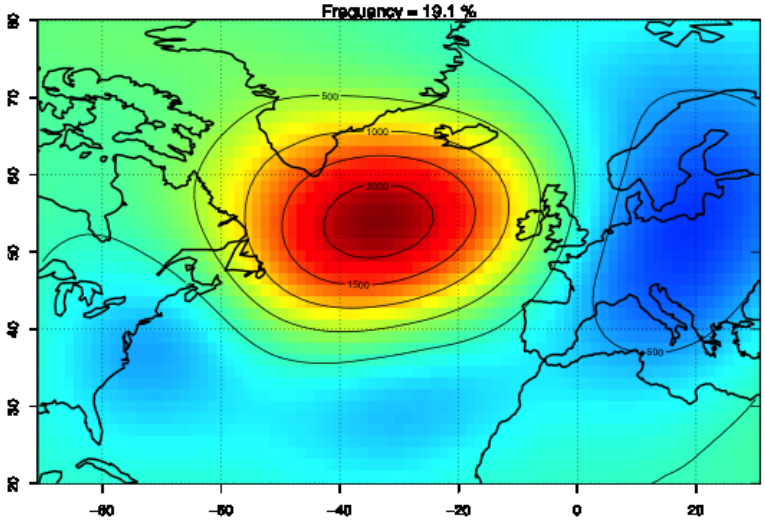
NAO-

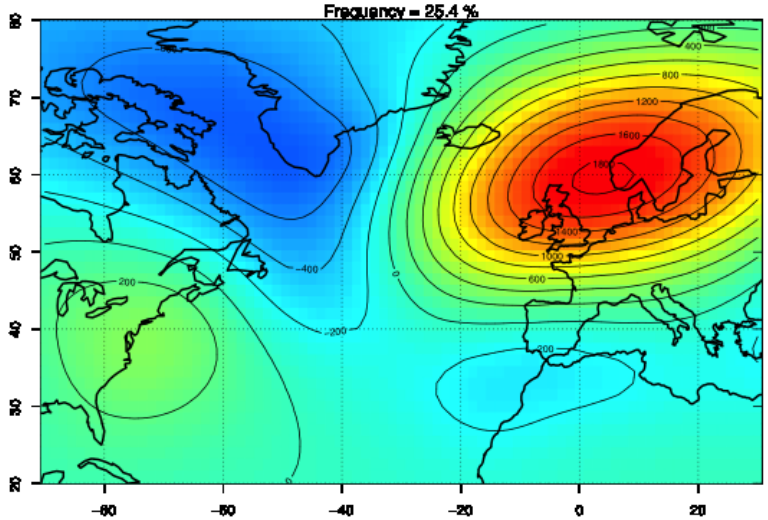




NAO+

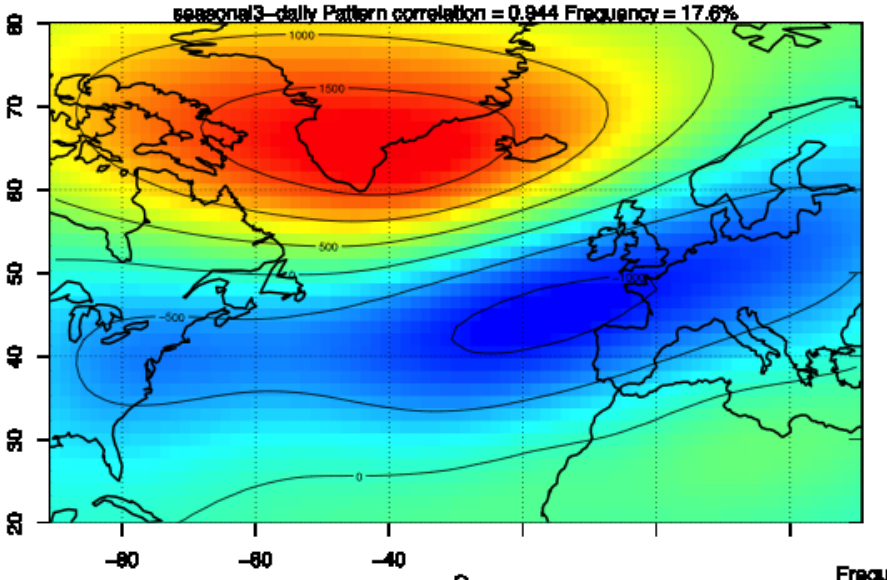
AR

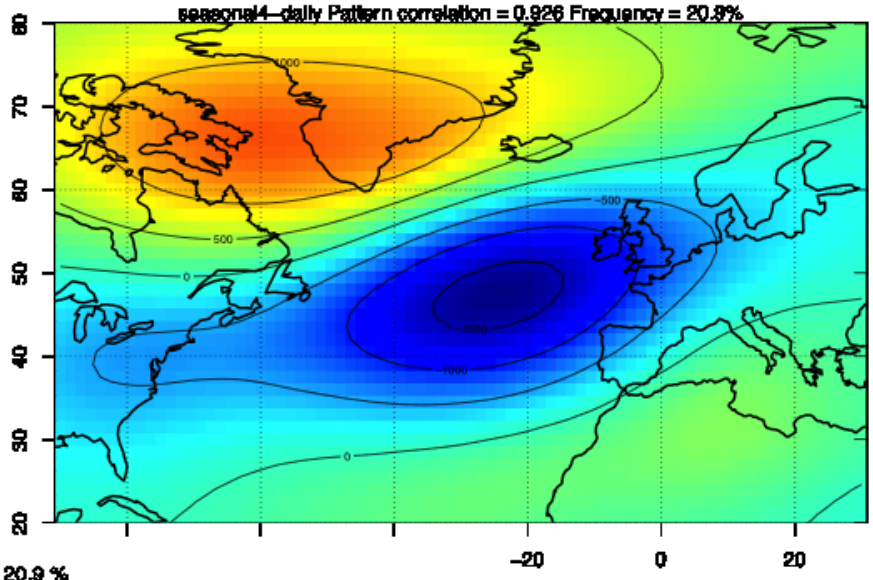


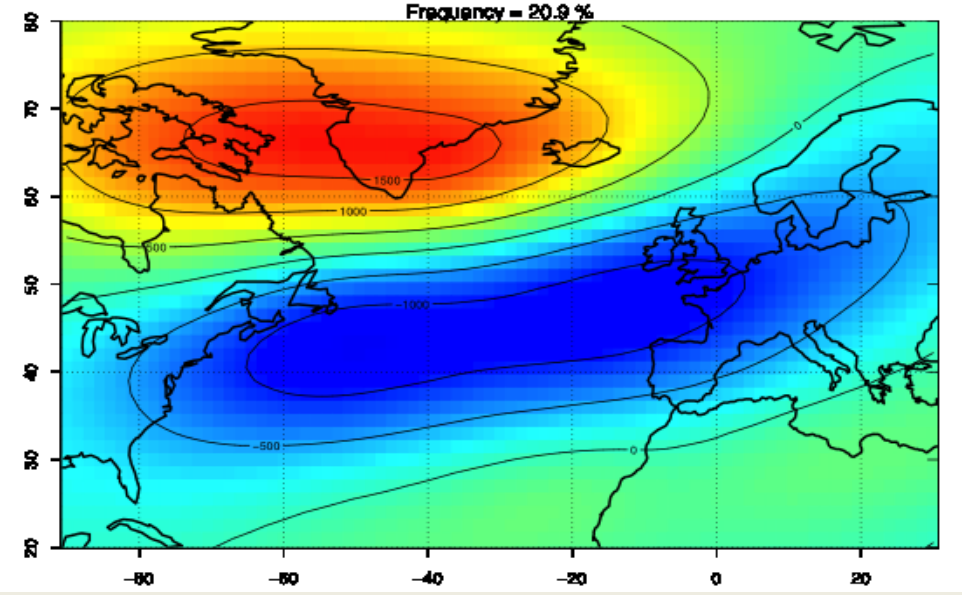


SB

Atlantic regimes: NAO-



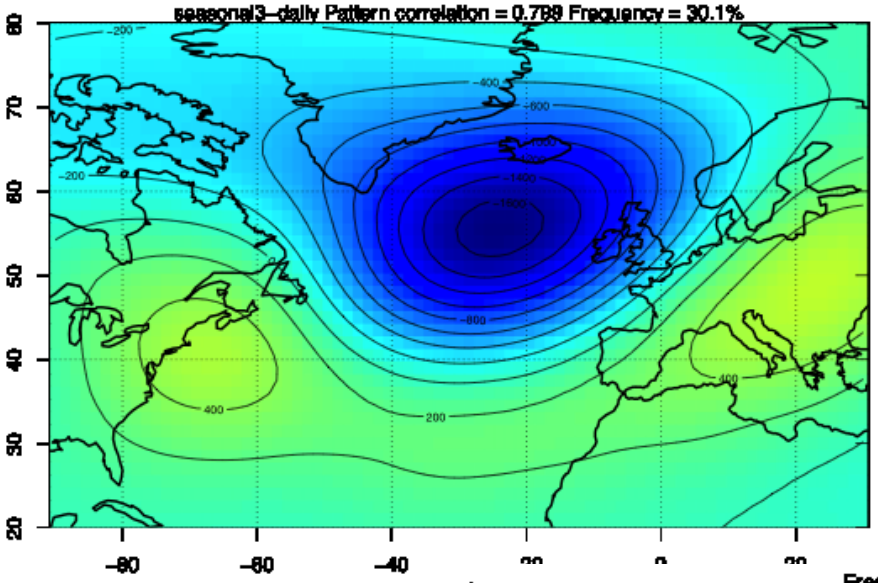




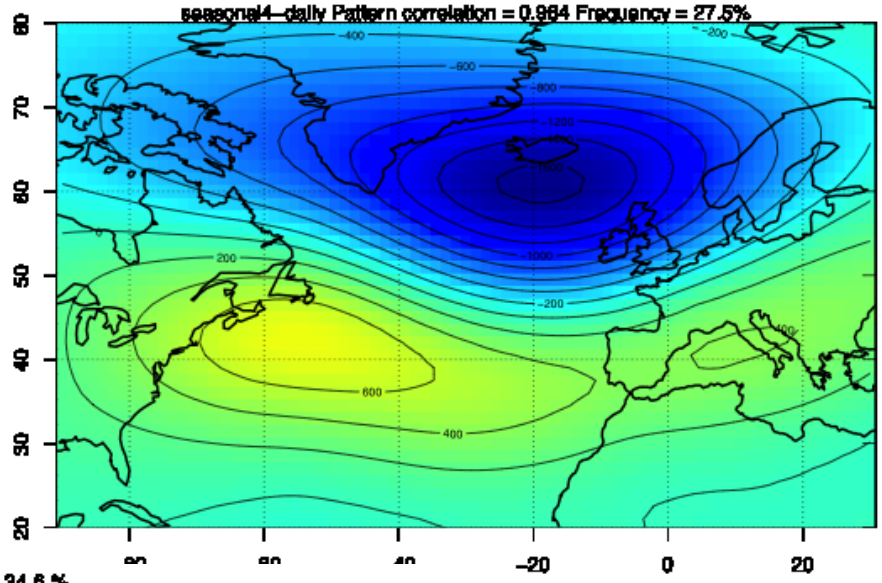
ERA-interim

Atlantic regimes: NAO+

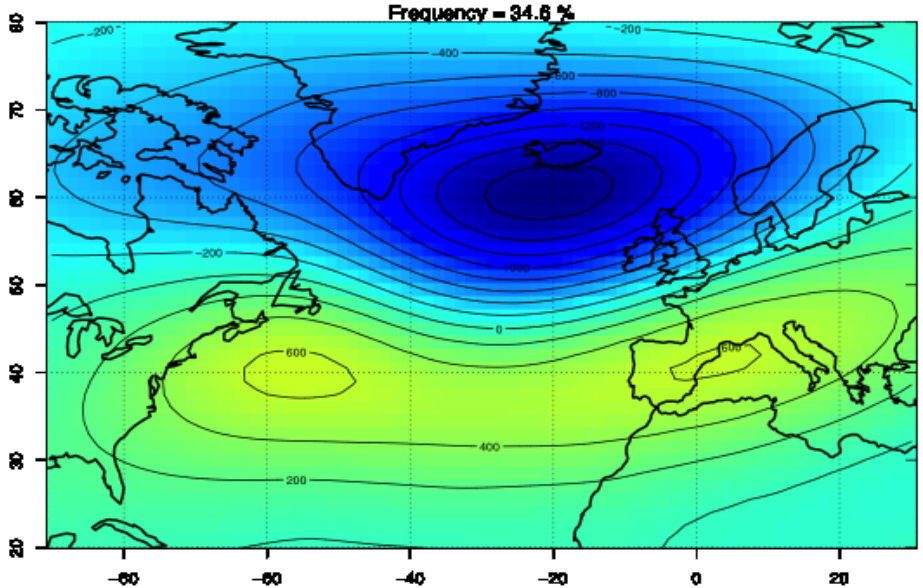
500 hPa geopotential height anomalies – DJF data from November starts



System 3



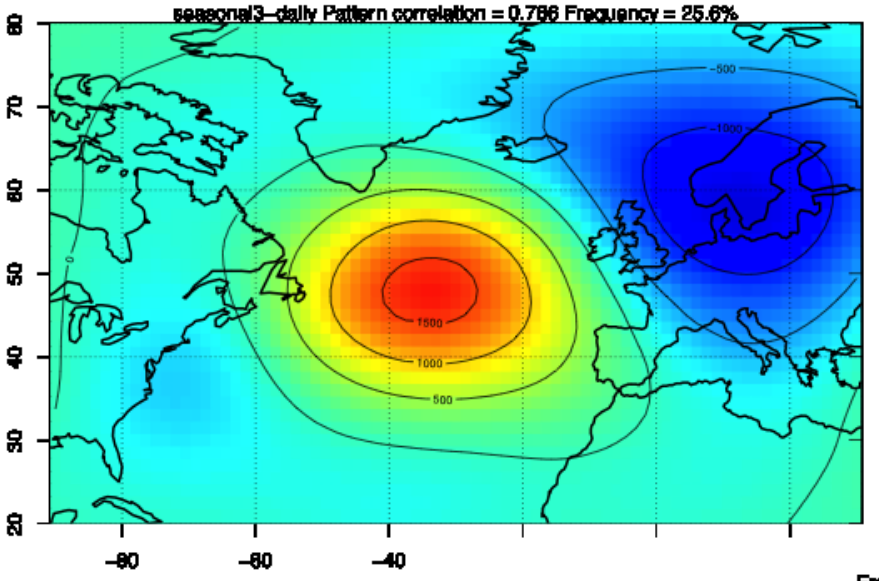
System 4



ERA-interim

Atlantic regimes: Atlantic Ridge

500 hPa geopotential height anomalies – DJF data from November starts



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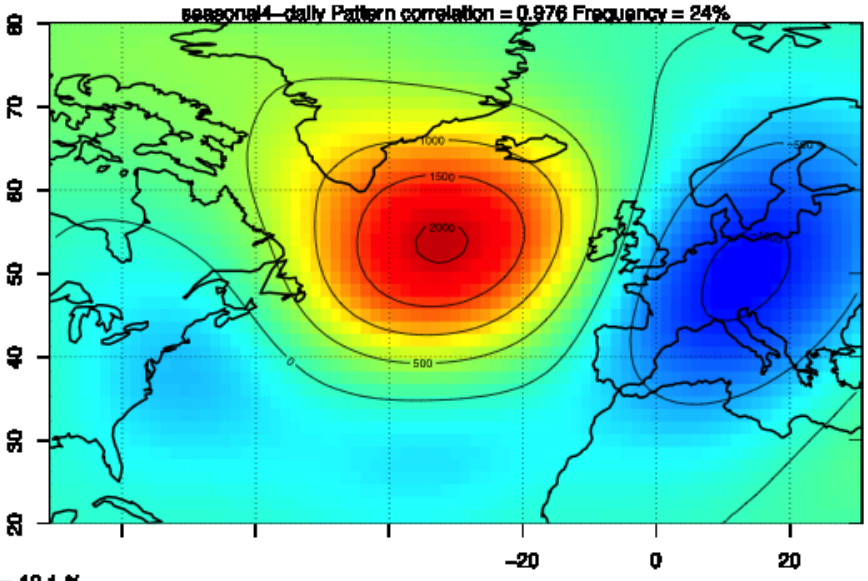

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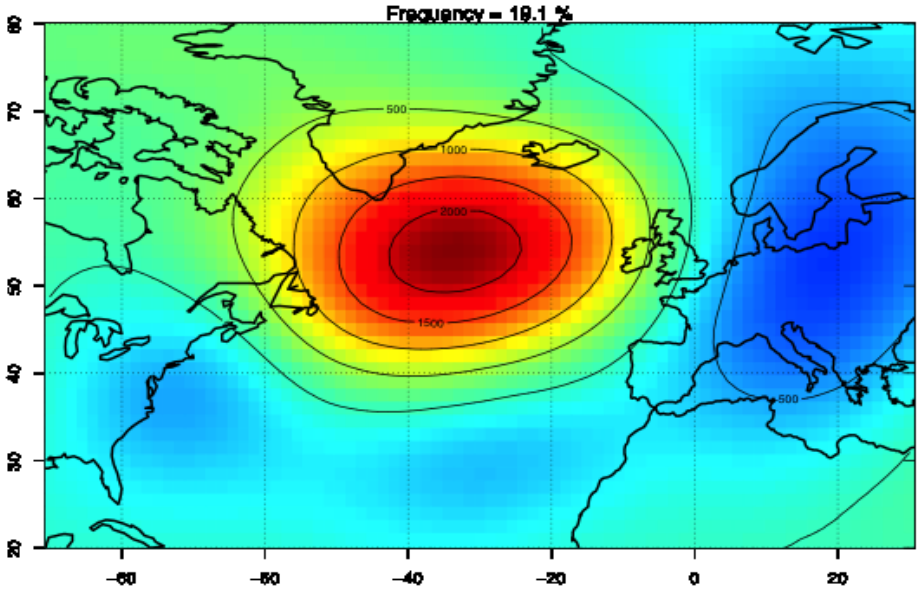
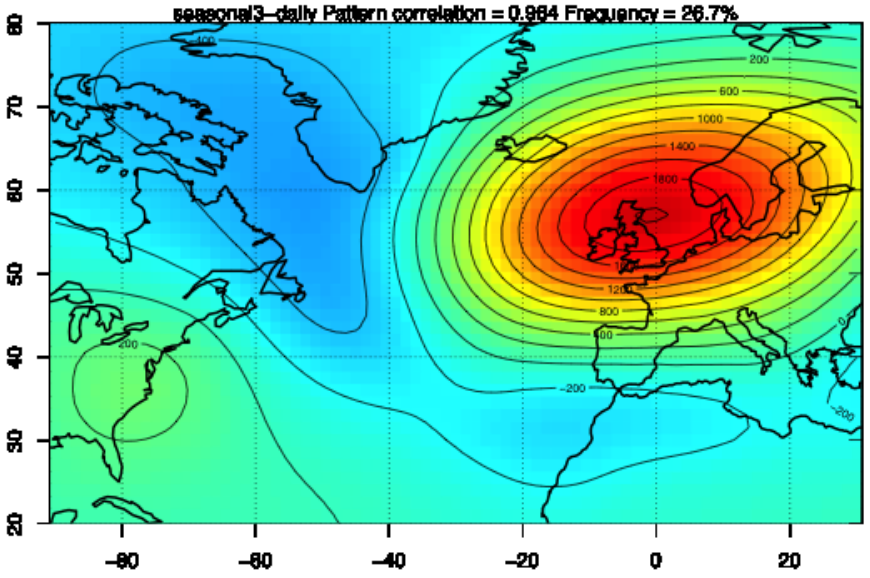
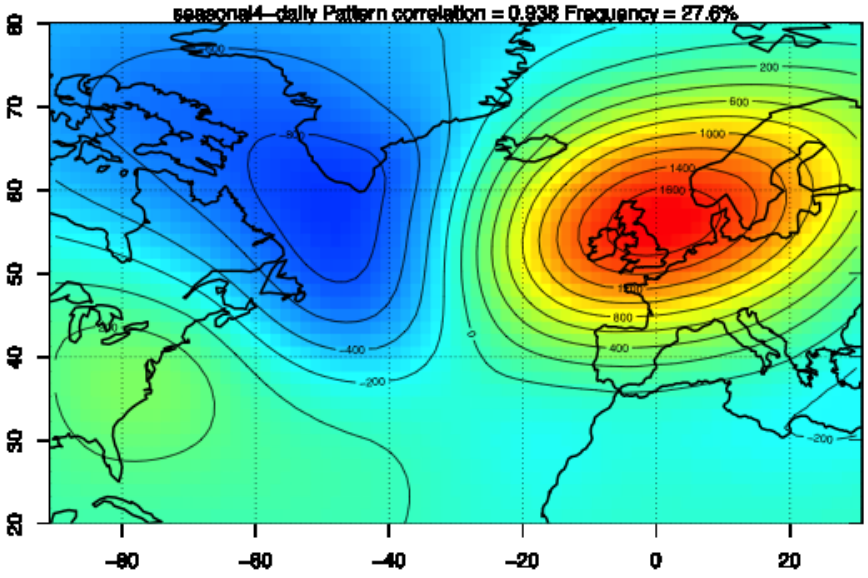
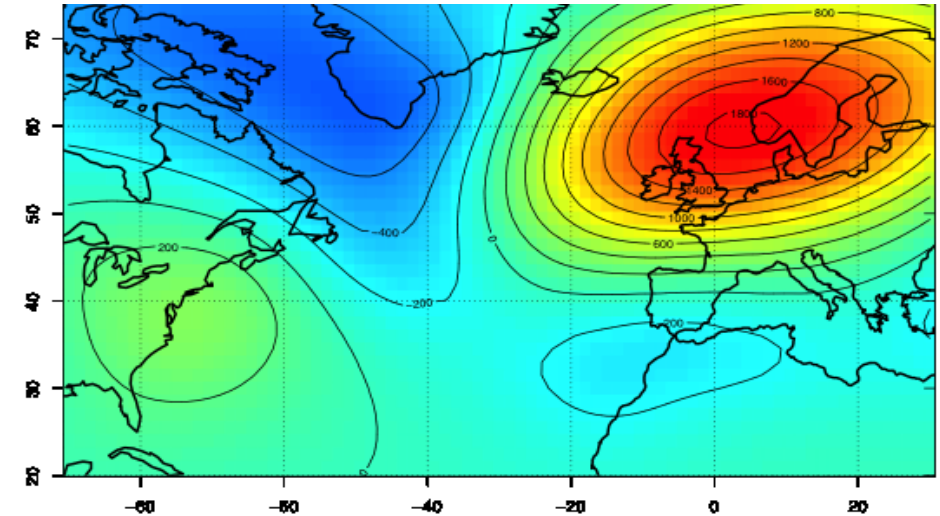


A-interim

Atlantic regimes: Scandinavian Blocking



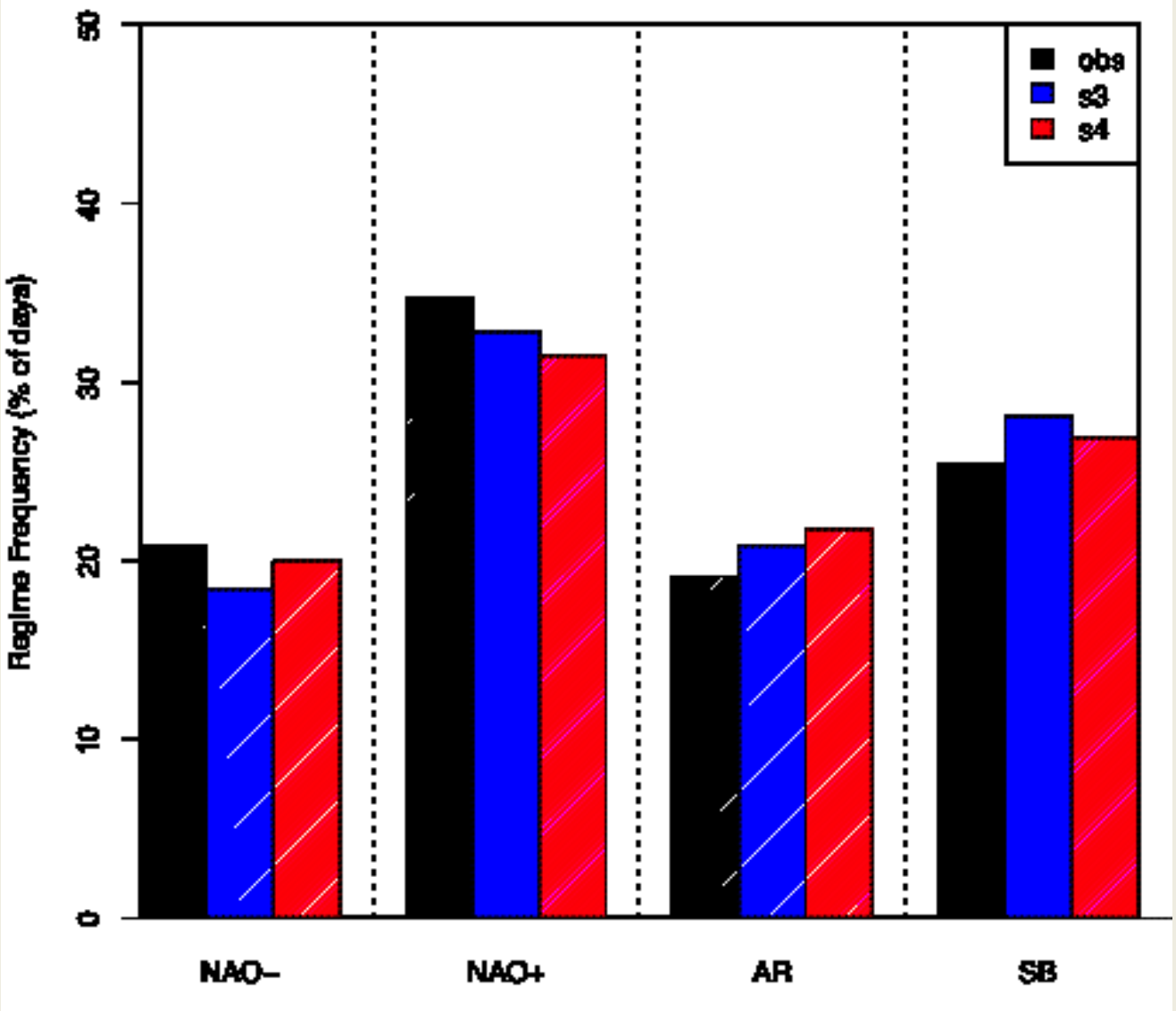




ERA-interim

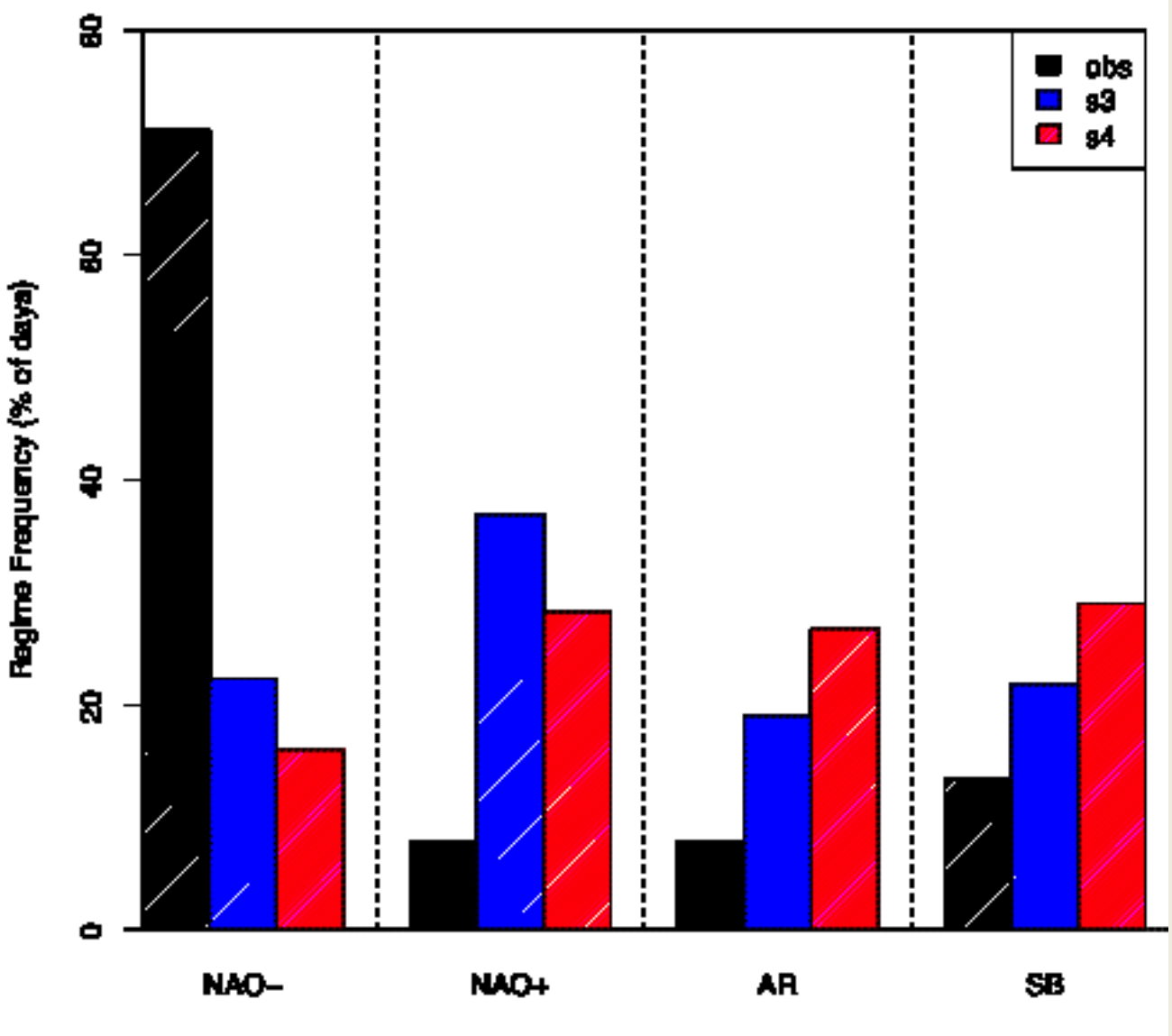
Climatological frequencies

Frequency in each regime – November starts DJF days 1981-2010



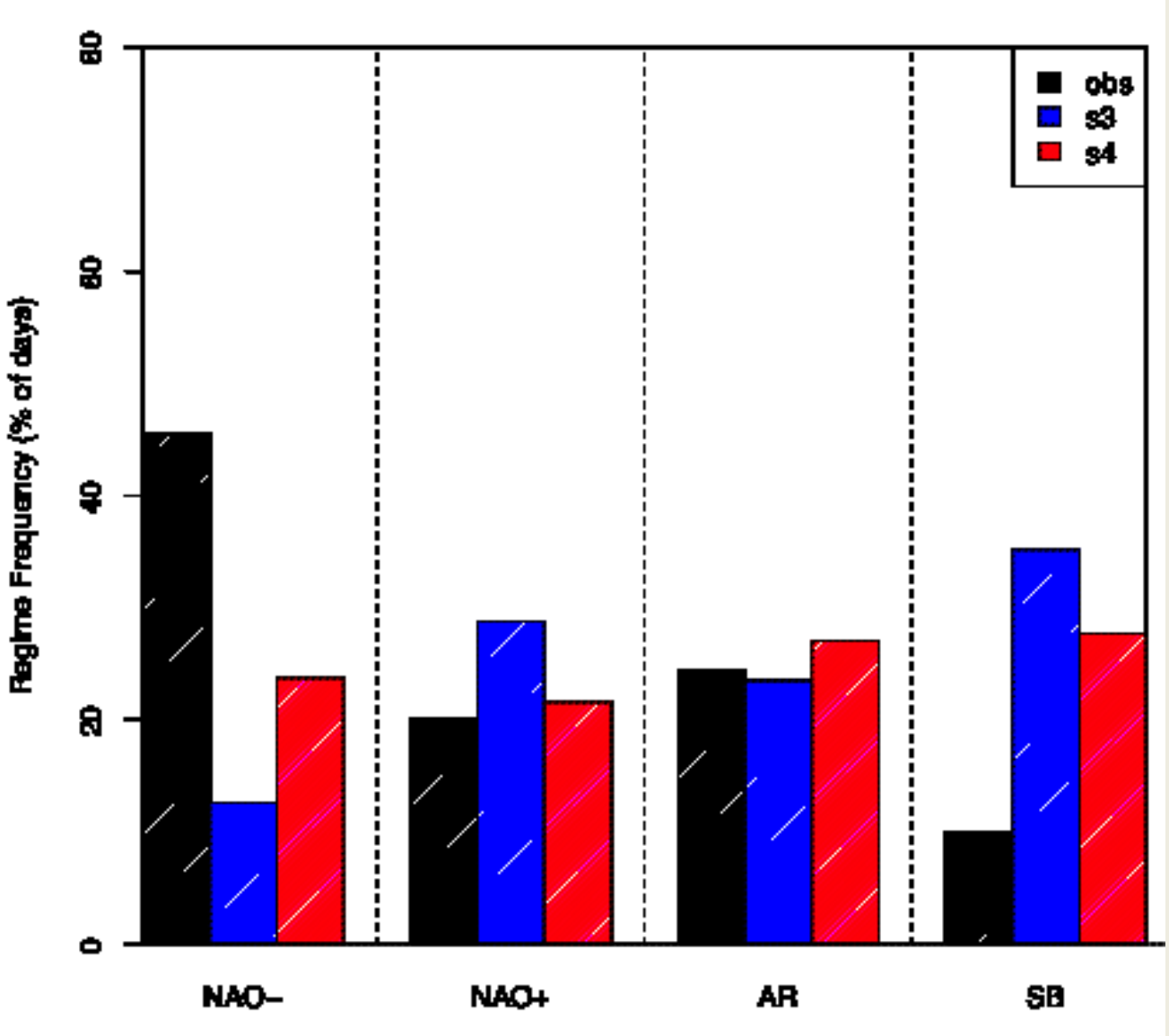
Skill of forecasting regime frequency - 2009

Frequency in each regime – November starts DJF days 2009/10



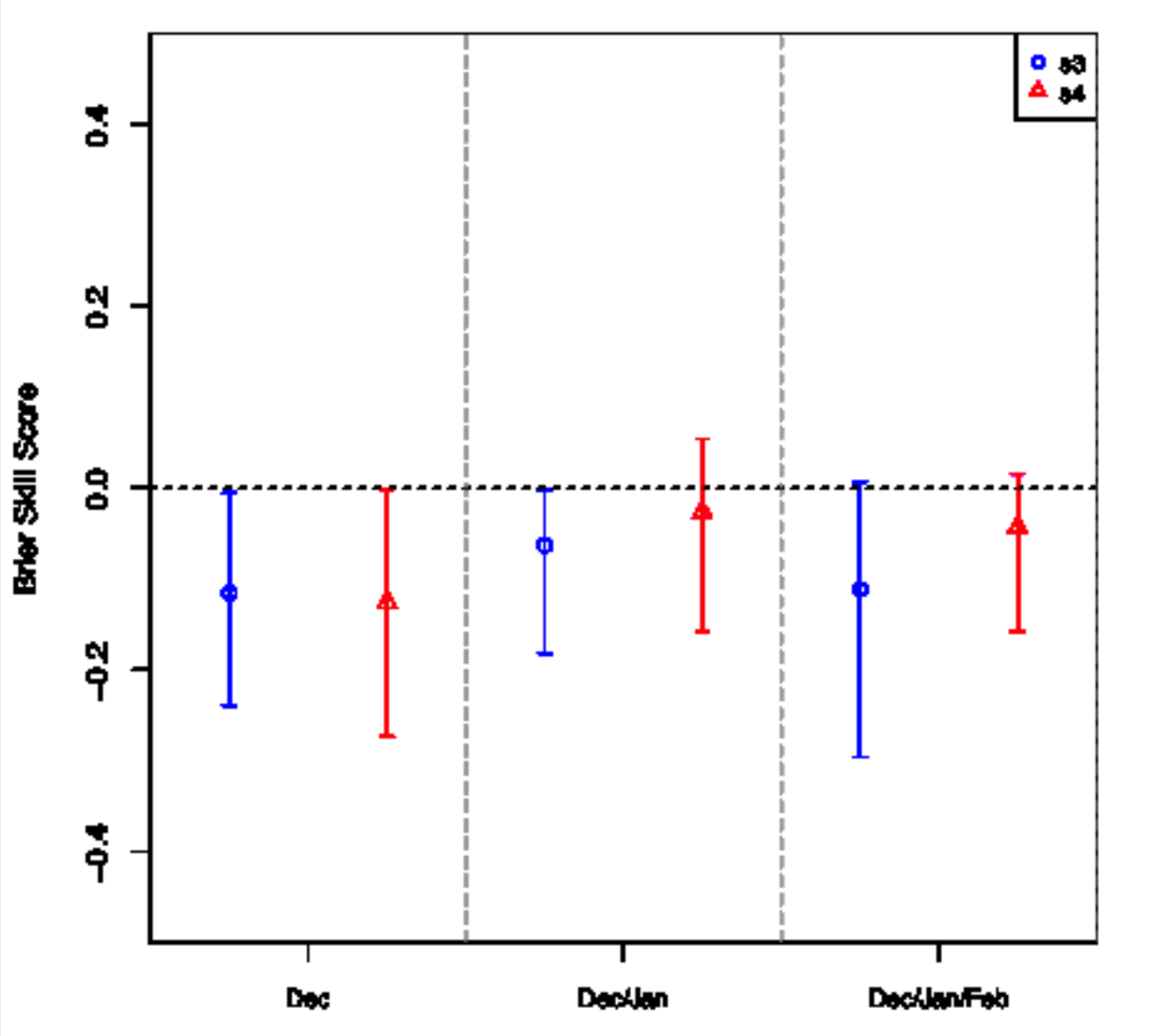
Skill of forecasting regime frequency - 2010

Frequency in each regime – November starts DJF days for 2010



Skill of forecasting regime frequency

Frequency in each regime – November starts DJF days from 1981-2010



Conclusions

- System 4 provides a more adequate representation of North Atlantic modes of variability and weather regimes in winter.
- Improved ensemble spread from more active model physics in system 4.
- No clear separation in skill between system 3, system 4 and climatology on seasonal forecast time-scales (month 2 onwards).
- Skill in front month needs further investigation and may provide insights into monthly forecasting skill.

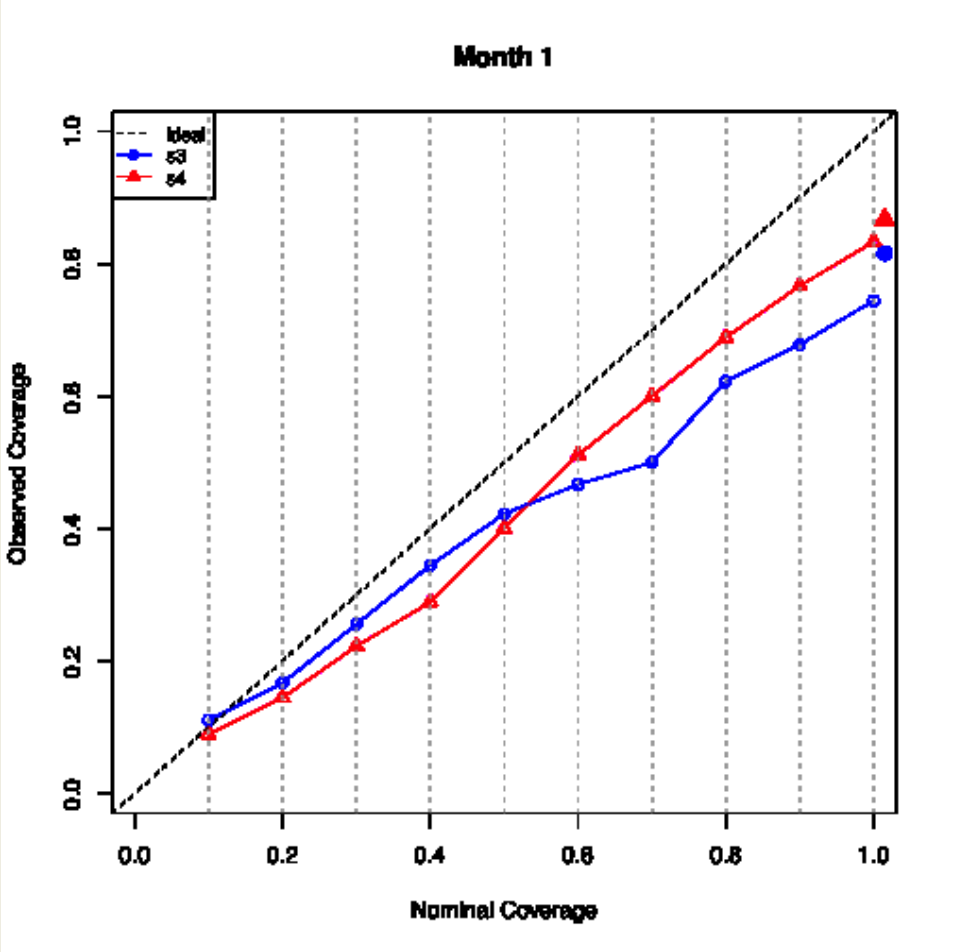
Resolution

EOF 1 500 hPa geopotential height anomalies – Nov, Dec, Jan starts

- Extra slides….

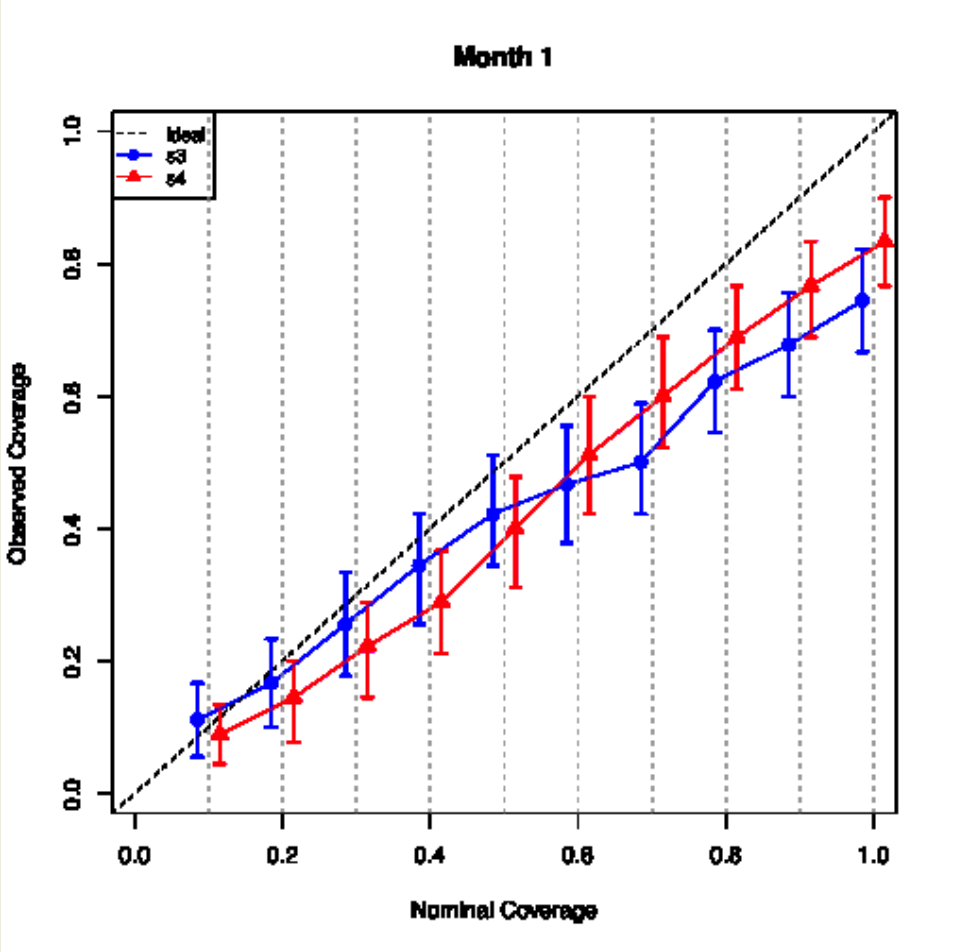
Reliability

EOF 1 500 hPa geopotential height anomalies – Nov, Dec, Jan starts



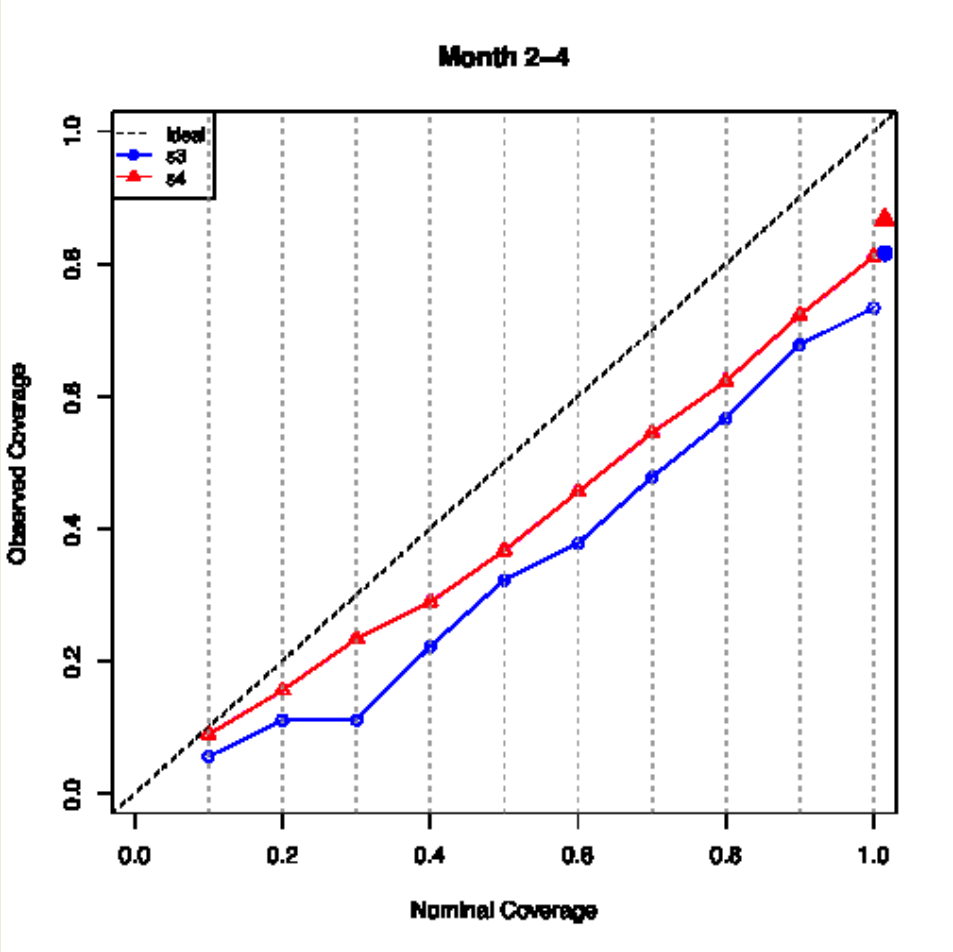
Reliability

EOF 1 500 hPa geopotential height anomalies – Nov, Dec, Jan starts



Reliability

EOF 1 500 hPa geopotential height anomalies – Nov, Dec, Jan starts



Reliability

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