

# Products and diagnostics for extended-range forecasts

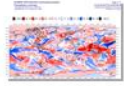
UEF 2019

Linus Magnusson and Laura Ferranti

# Available extended-range products on the web and EcCharts

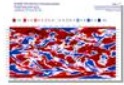
## Web

### Extended range anomaly chart

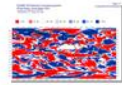


Weekly anomaly -  
Extended range

### Extended range probability

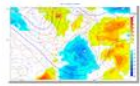


Weekly probability  
anomaly - Extended



Weekly terciles -  
Extended range

### Multiparameter outlook



Multiparameter  
outlook - Extended

### Extended range plumes



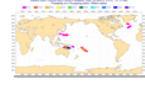
Monthly forecast  
plumes - Extended

### Extended range stamp maps

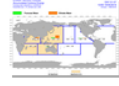


Mean sea level  
pressure and z500

### Extended range tropical storm activity

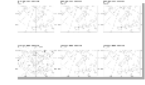


Tropical storm  
probabilities -

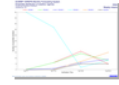


Tropical storm  
frequency -

### Extended range cluster



Weather regime  
clusters - Extended



Weather regime  
time series -

### 500 hPa geopotential anomaly



Large scale mean  
flow - Extended

### Time-longitudes diagram of ensemble mean



Time-longitudes  
diagram - Extended

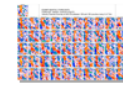
### MJO



MJO index -  
Extended range



Time-longitudes  
sections - Extended



Time-longitudes  
sections of

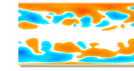
Up to 4 week forecasts



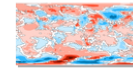
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

## EcCharts

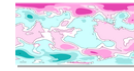
### Extended range: Anomalies



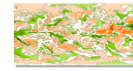
Extended range:  
500 hPa



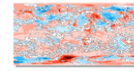
Extended range: 2m  
temperature



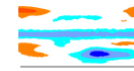
Extended range:  
MSLP weekly mean



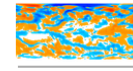
Extended range:  
precipitation



Extended range:  
surface



Extended range:  
10hPa temperature



Extended range:  
Sunshine duration



Extended range: 10  
metre wind weekly



Extended range:  
100 metre wind



Extended range:  
850 hPa wind



Extended range:  
700 hPa wind



Extended range:  
500 hPa wind

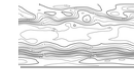


Extended range:  
200 hPa wind



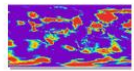
Extended range: 10  
hPa wind weekly

### Extended range: Weekly mean

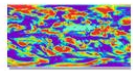


Extended range:  
500 hPa

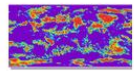
### Extended range - Probability distribution



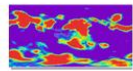
Extended range: 2t  
probability dist. at



Extended range:  
precipitation

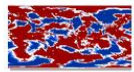


Extended range:  
surface

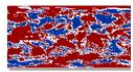


Extended range:  
MSLP probability

### Extended range: Weekly anomaly probability



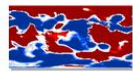
Extended range: 2m  
temperature



Extended range:  
surface



Extended range:  
Precipitation



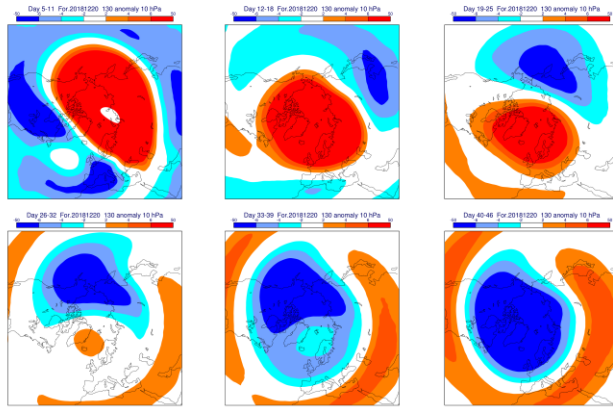
Extended range:  
MSLP probability of

Up to 6 week forecasts

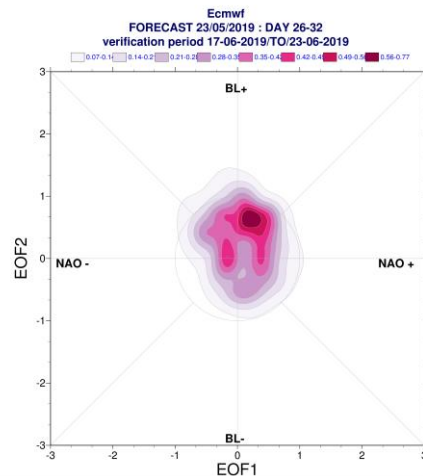
Coming soon:  
Extended-range  
EFI – See Ivan's  
talk

# Test products (limited access for external users)

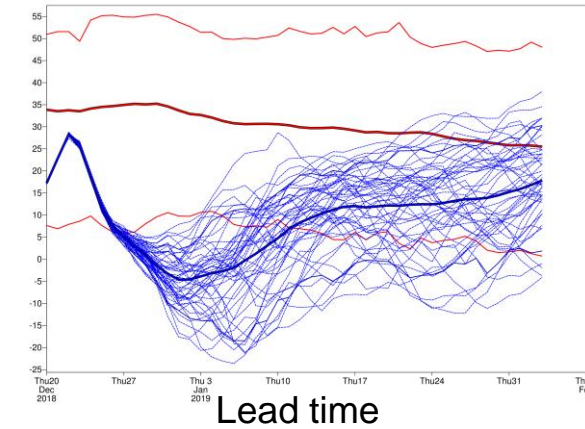
Ensemble mean weekly anomalies for temperature at 10hPa



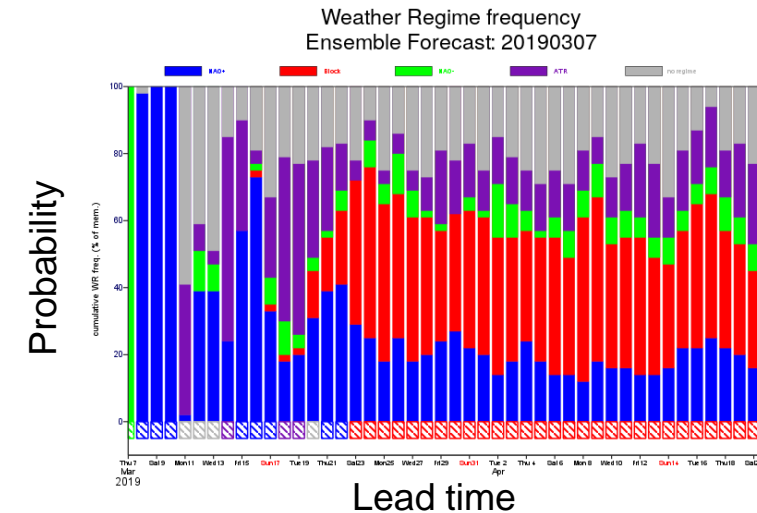
Regime EOF space plots



Plumes for 60N zonal mean zonal wind at 10hPa



Regime distribution on the ensemble



But this is not all:

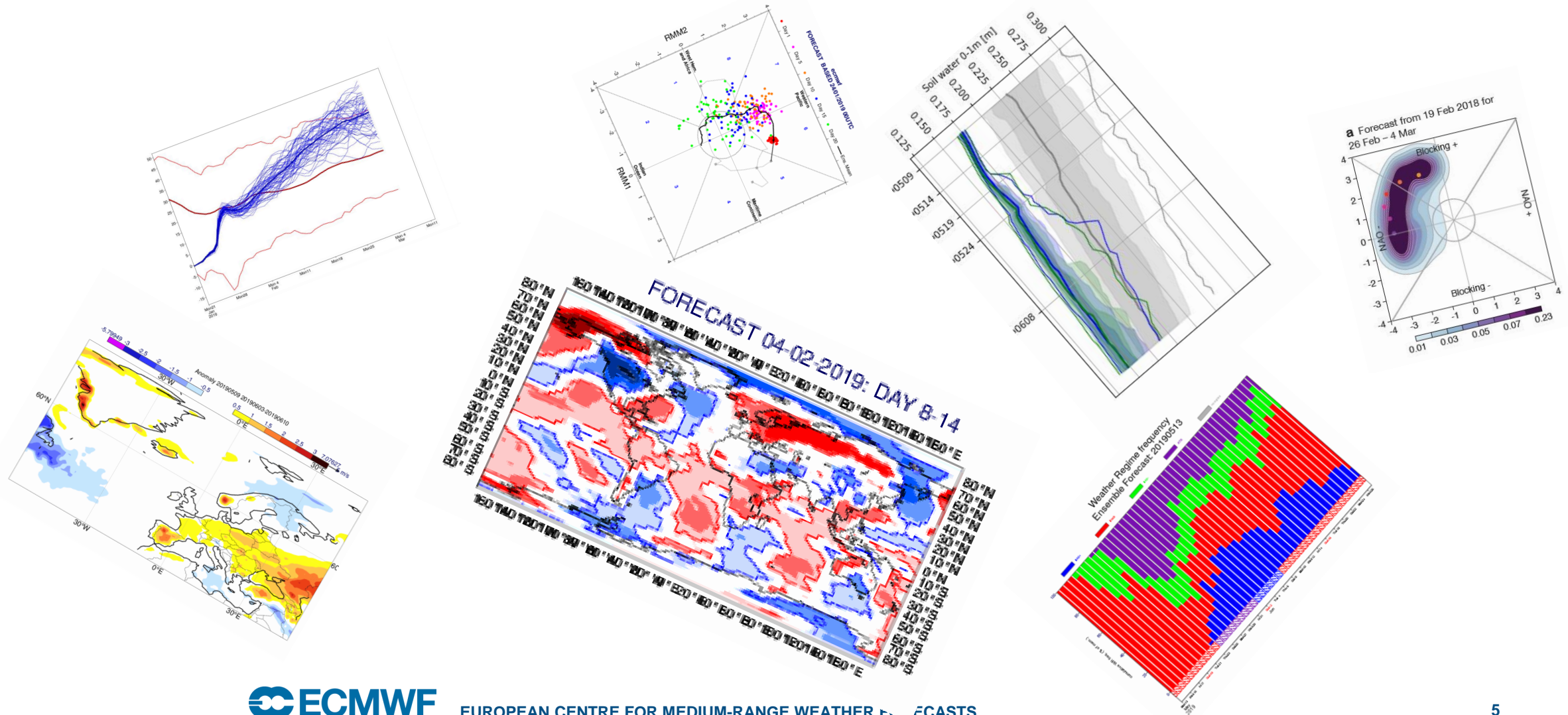
## Operationally available data in ECMWF archive from extended range forecasts

- 105 different “surface” fields archived from the real-time forecasts and reforecasts
  - 8 different variables on 11 pressure levels
  - A few fields on potential temperature and potential vorticity levels
- 
- Every 6<sup>th</sup> hours to 46 days
- 
- Weekly anomalies for each member (type=“fcmean”) and ensemble mean (type=“taem”) are archived for a sub-set of fields
- = much more possibilities from the archived data than just the produced products on the web!



# Mentometer

- Use your imagination: Please send in one wish for new extended-range forecast product!

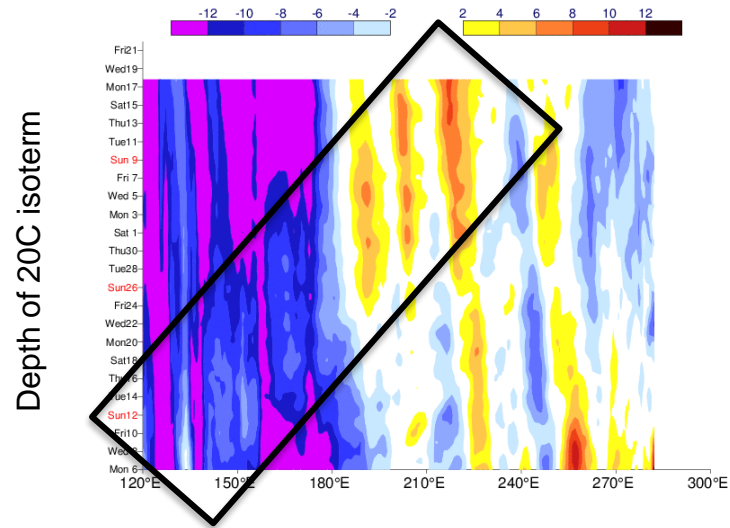




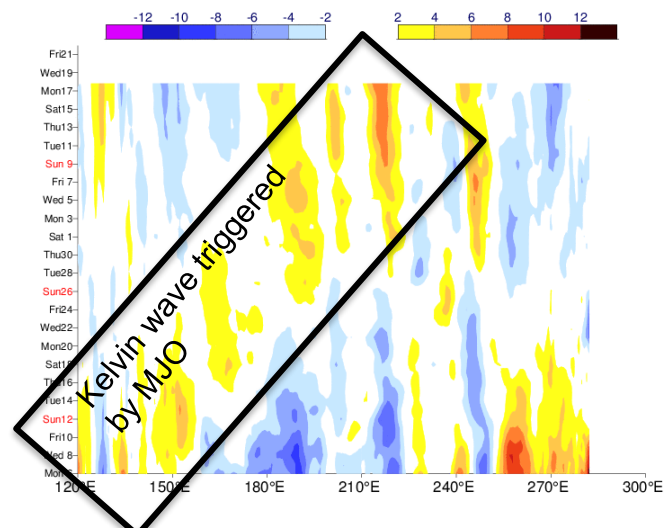
# Example of new archived ocean fields in 46r1: Depth of 20C isotherm

[www.menti.com](https://www.menti.com) 70 55 4

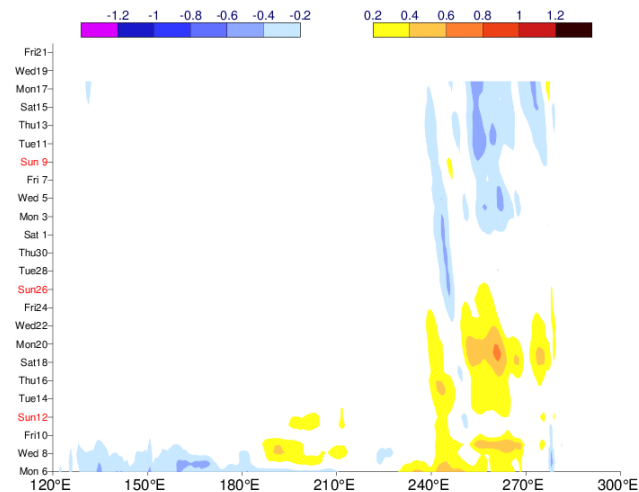
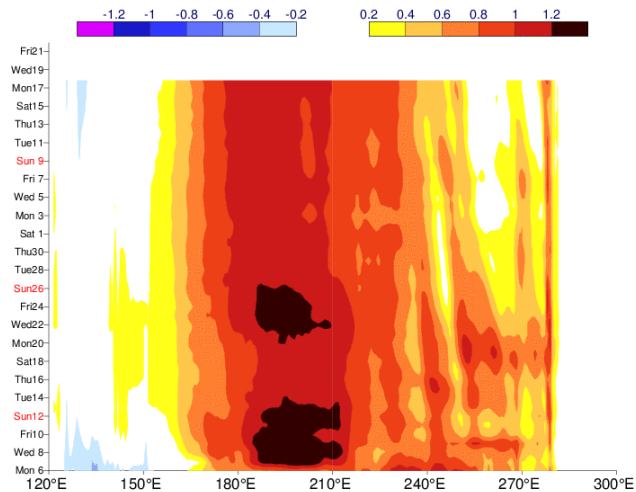
Anomaly along Eq. in respect to reforecasts



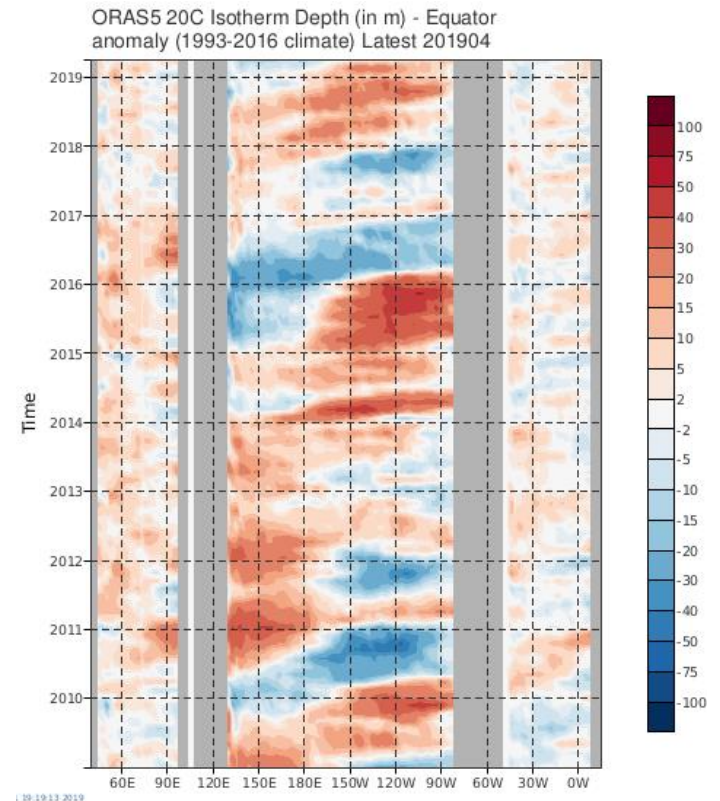
Anomaly along Eq. in respect to forecast mean



Sea-surface temperature



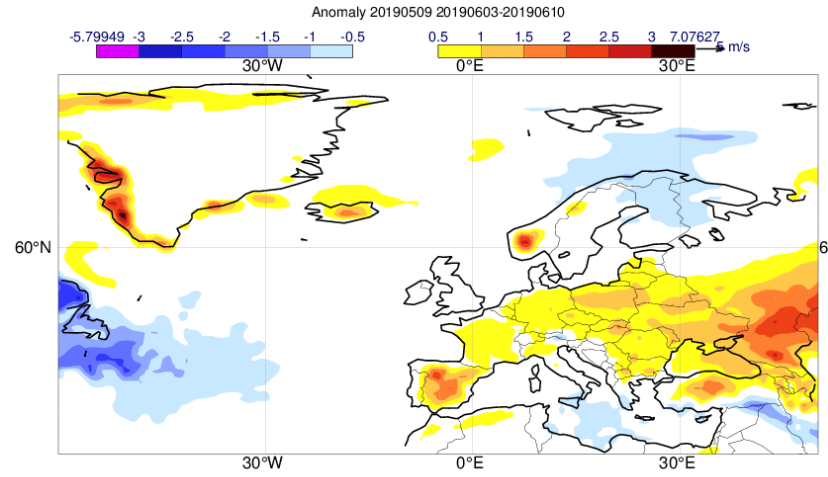
Anomaly along Eq. in ocean reanalysis 2009-2019



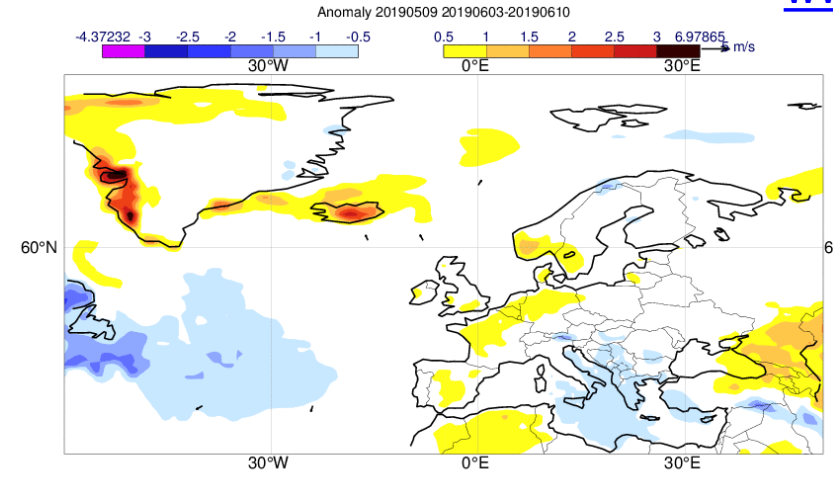
From Ocean5 reanalysis monitoring on the ECMWF web

# Effect of ERA-5 initial conditions for reforecasts: 2-metre temperature anomalies 9 May + 4 weeks

O-suite



E-suite

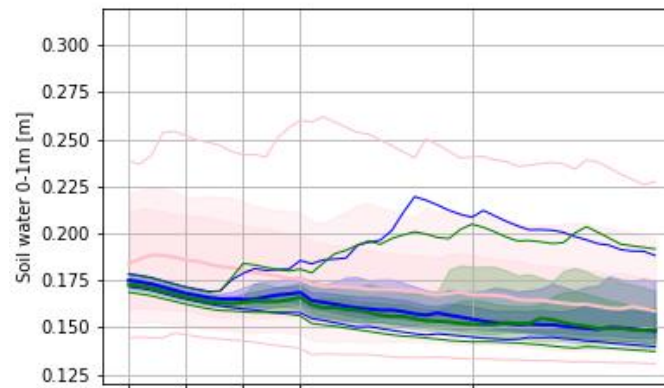
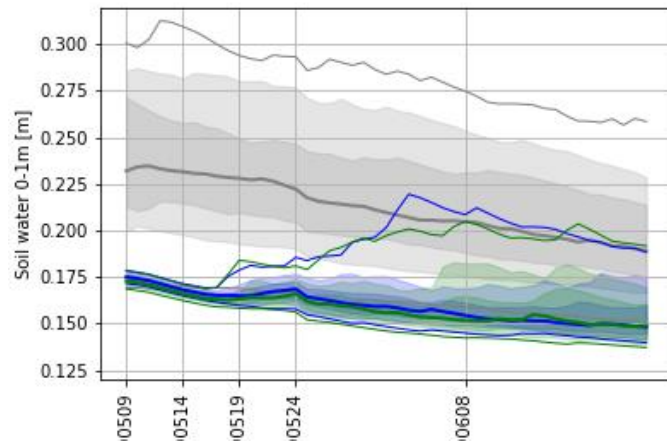


[www.menti.com](https://www.menti.com) 70 55 4

## Soil moisture over Spain (38N-42N, 4W-0W)

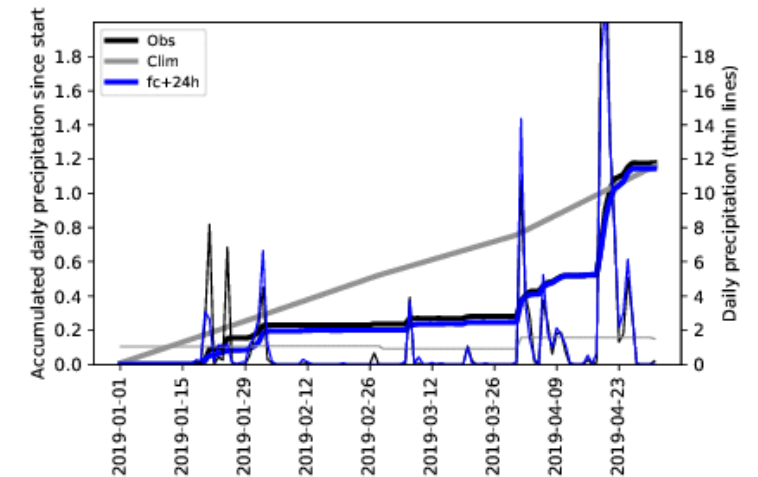
Real-time forecasts and o-suite reforecast (grey)

Real-time forecasts and e-suite reforecast (grey)



Real-time fc:  
O-suite – blue  
E-suite – green

## Accumulated precipitation during 2019



# Regime forecasts: Example of regime definitions and products

Aim of regimes:

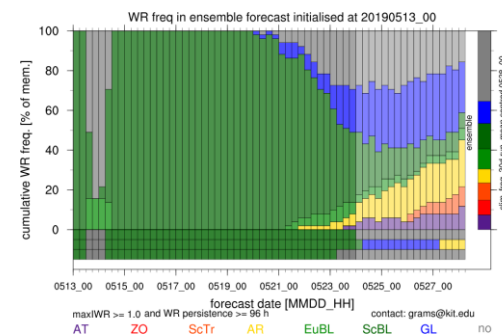
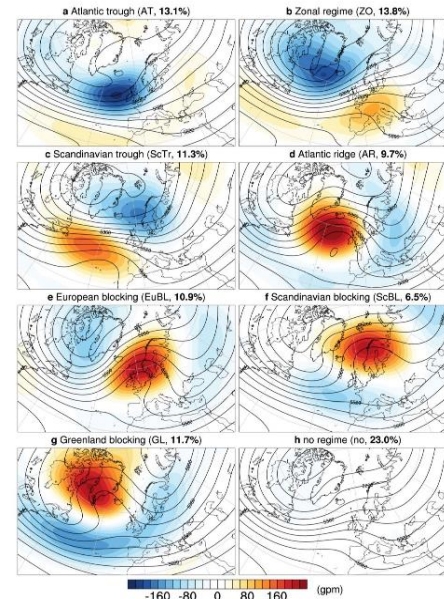
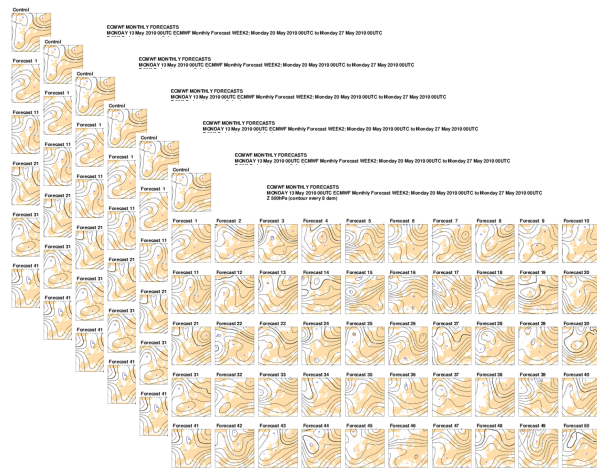
- Using leading modes to condense ensemble information

7 regimes (Grams et. al)

4 regimes (Vautard, 1990)

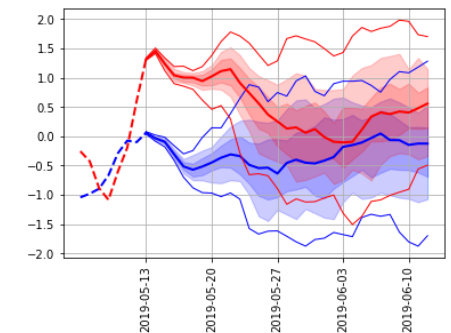
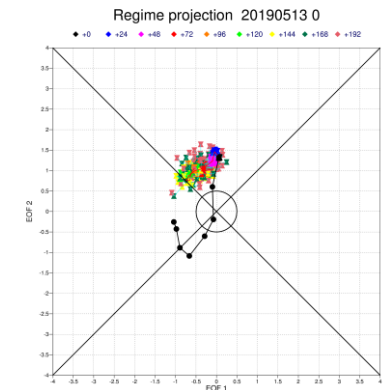
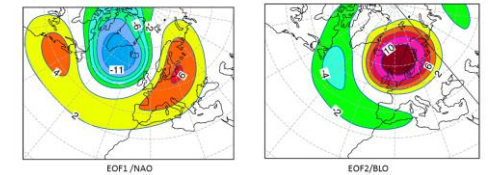
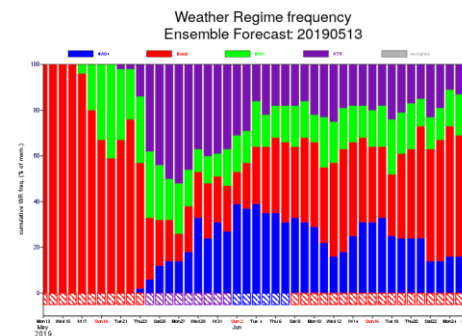
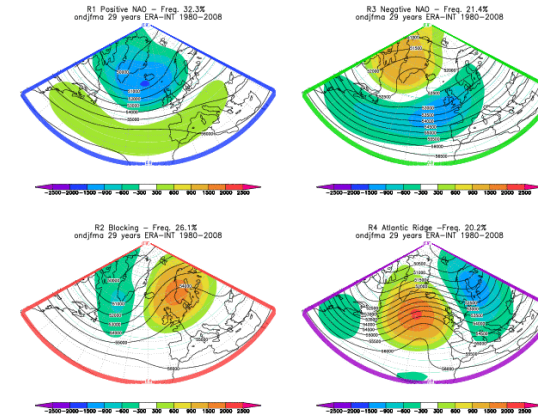
2 regimes (Ferranti et. al, 2018)

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Grams et al. : <https://www.nature.com/articles/nclimate3338>

Grams et al. : <https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/qj.3353>

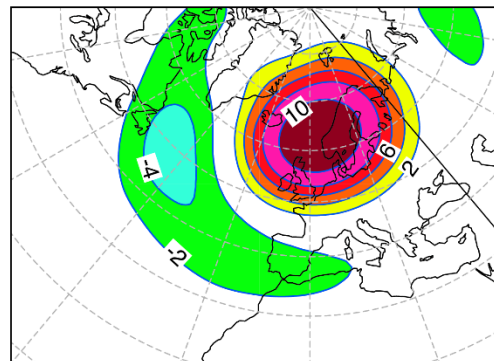


Ferranti, L. et al. 2018 doi:10.1002/qj.3341

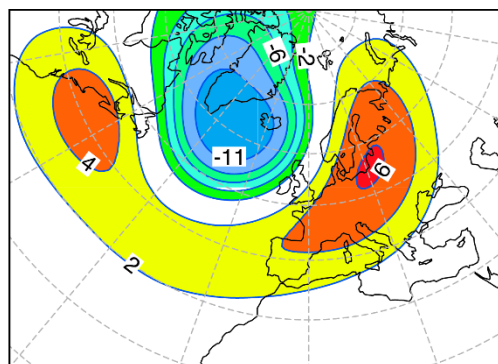


# Regime application: How far in advance we predict changes in large scale flow leading to sever cold spell over Europe?

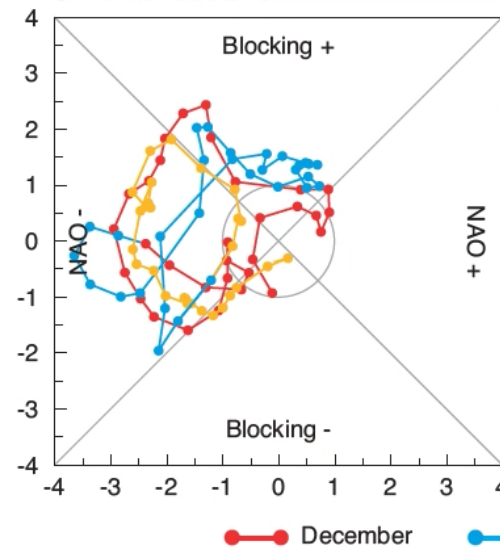
[www.menti.com](http://www.menti.com) 70 55 4



- $\pm$ EOF1 and  $\pm$ EOF2 represent quite well  $\pm$ NAO and BL
- Trajectories in phase space summarise regime evolution

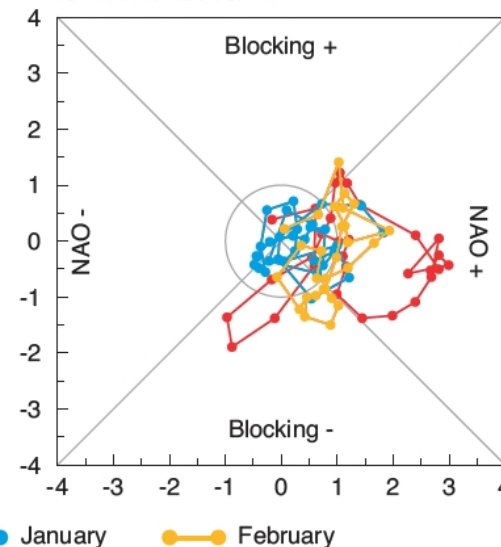


**a** Winter 2009/10



BL: record-breaking cold temperatures over Europe

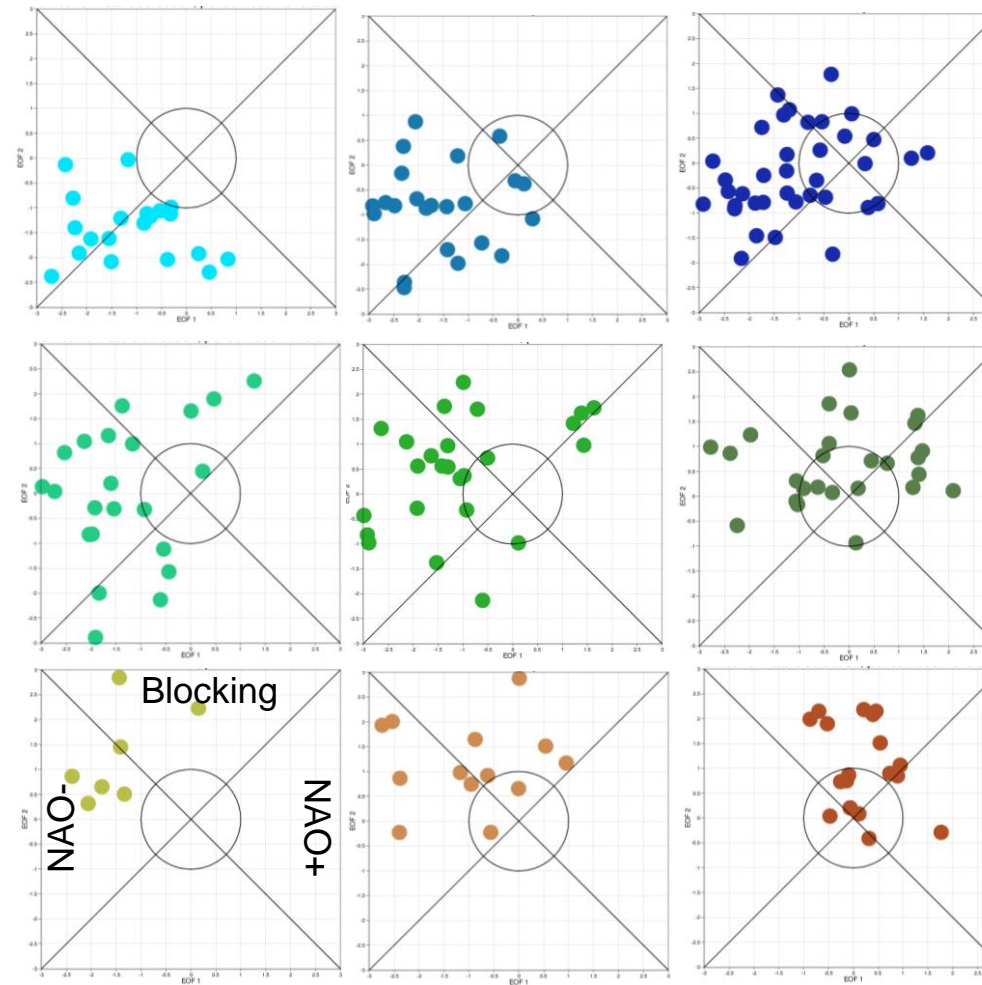
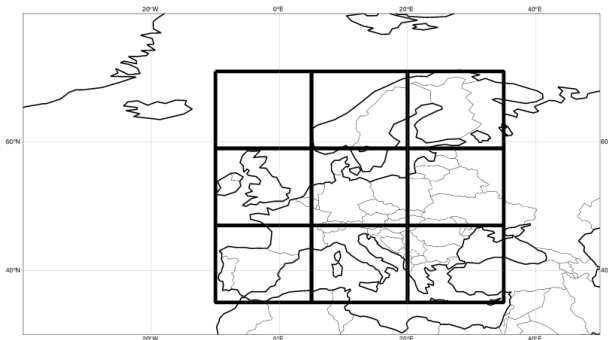
**b** Winter 2013/14



+NAO: exceptional storminess, but mild temperatures over Europe

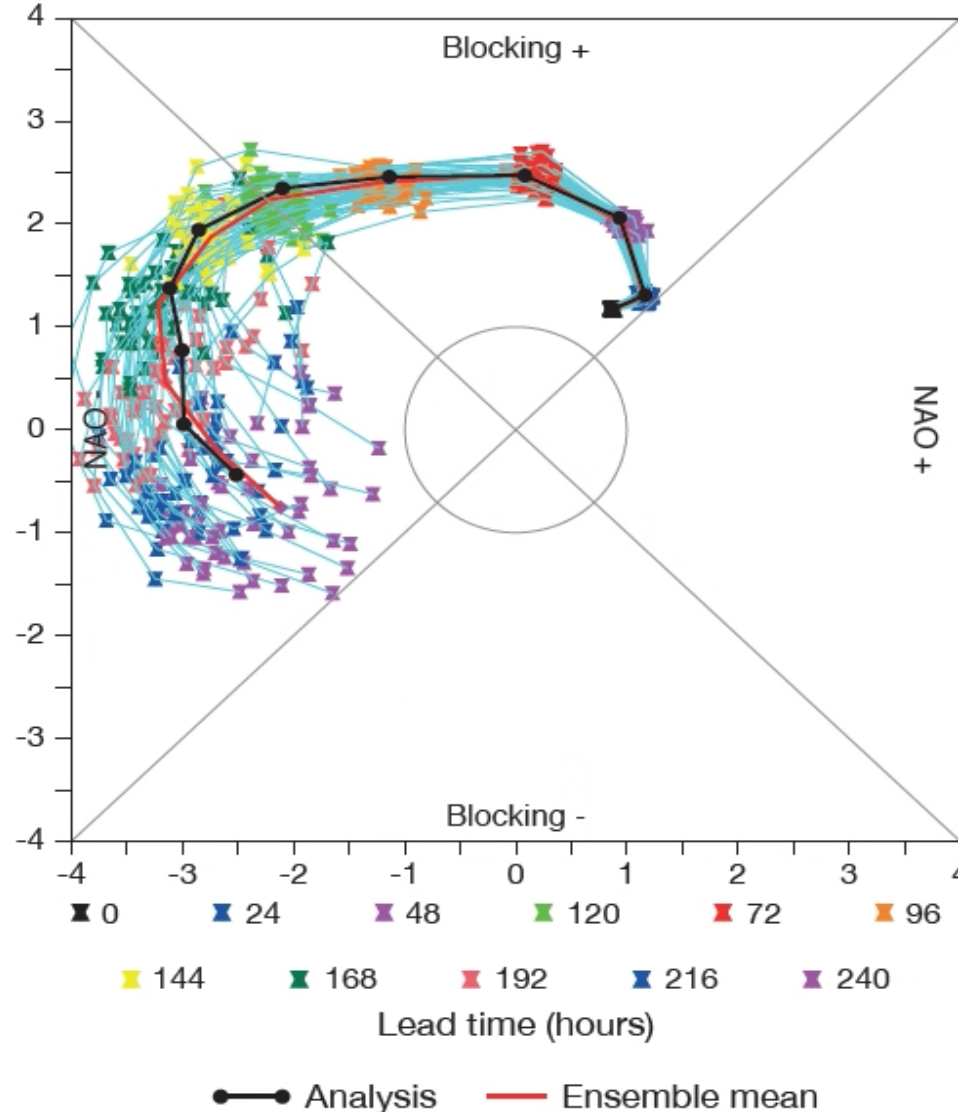
## Distribution of severe winter (NDJF) events in era-interim (1980-2015)

When for 60% grid points in each box the daily t2m < 10<sup>th</sup> quantile of daily climate for at least 4 consecutive days



# How long in advance can we predict regime projections?

[www.menti.com](https://www.menti.com) 70 55 4

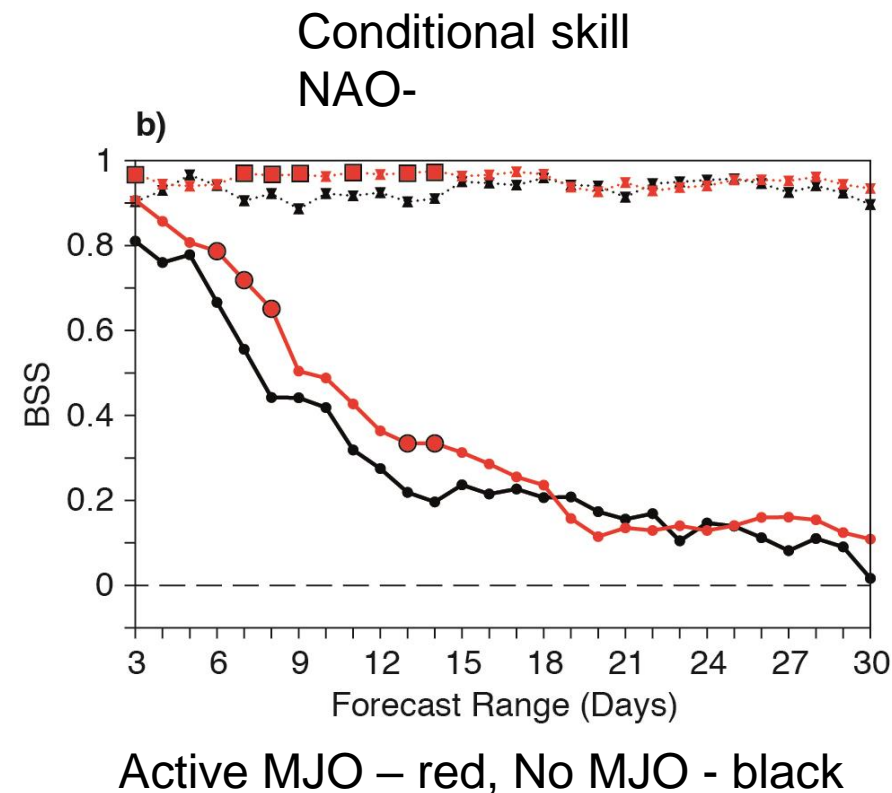
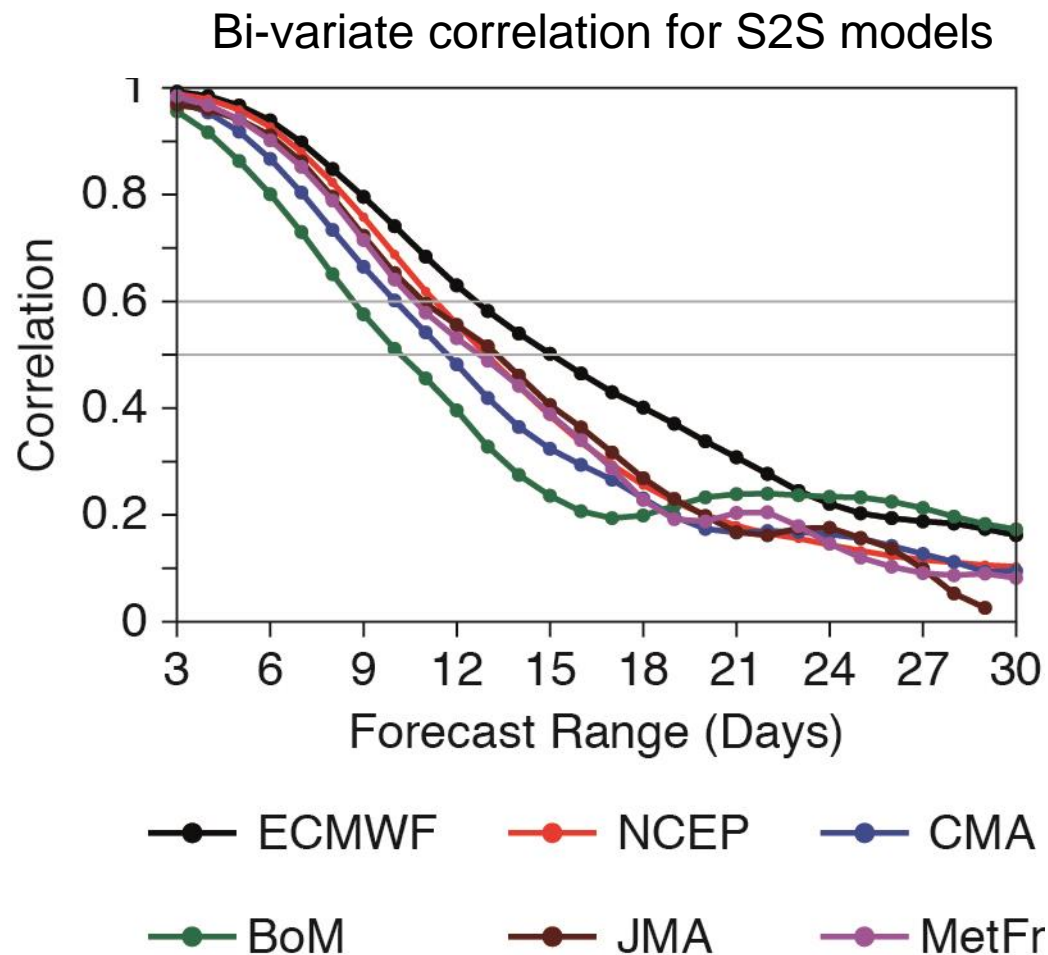


Evolution of ENS forecast up to day 10 in the NAO–BLO diagram. The ENS forecast starts at 00 UTC on 22 February 2018.

Onset of the “beast from the east 2018”

See **ECMWF Newsletter 158** Winter 2018/19  
<https://www.ecmwf.int/en/publications>

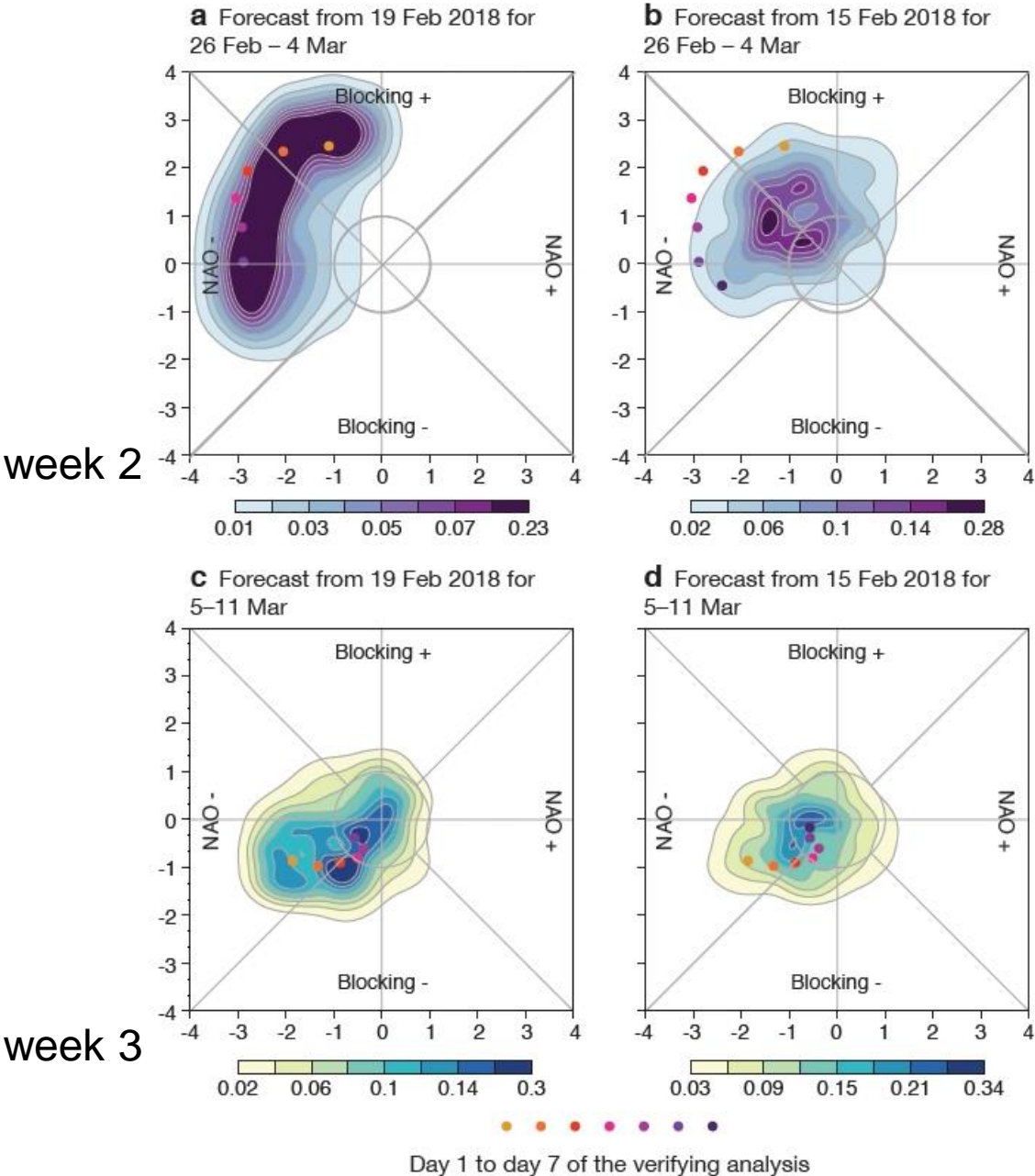
# Forecast skill



Small impact for NAO+ predictions  
Significantly higher skill for NAO- forecasts with  
and MJO in the i.c.



# Test products for subseasonal forecasts based on the results



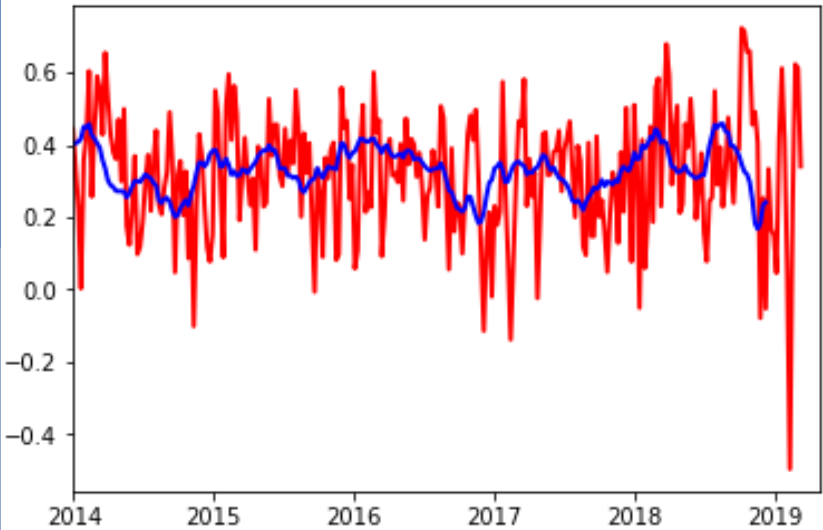
the accuracy of this forecast is link to MJO and SSW

week 2.5

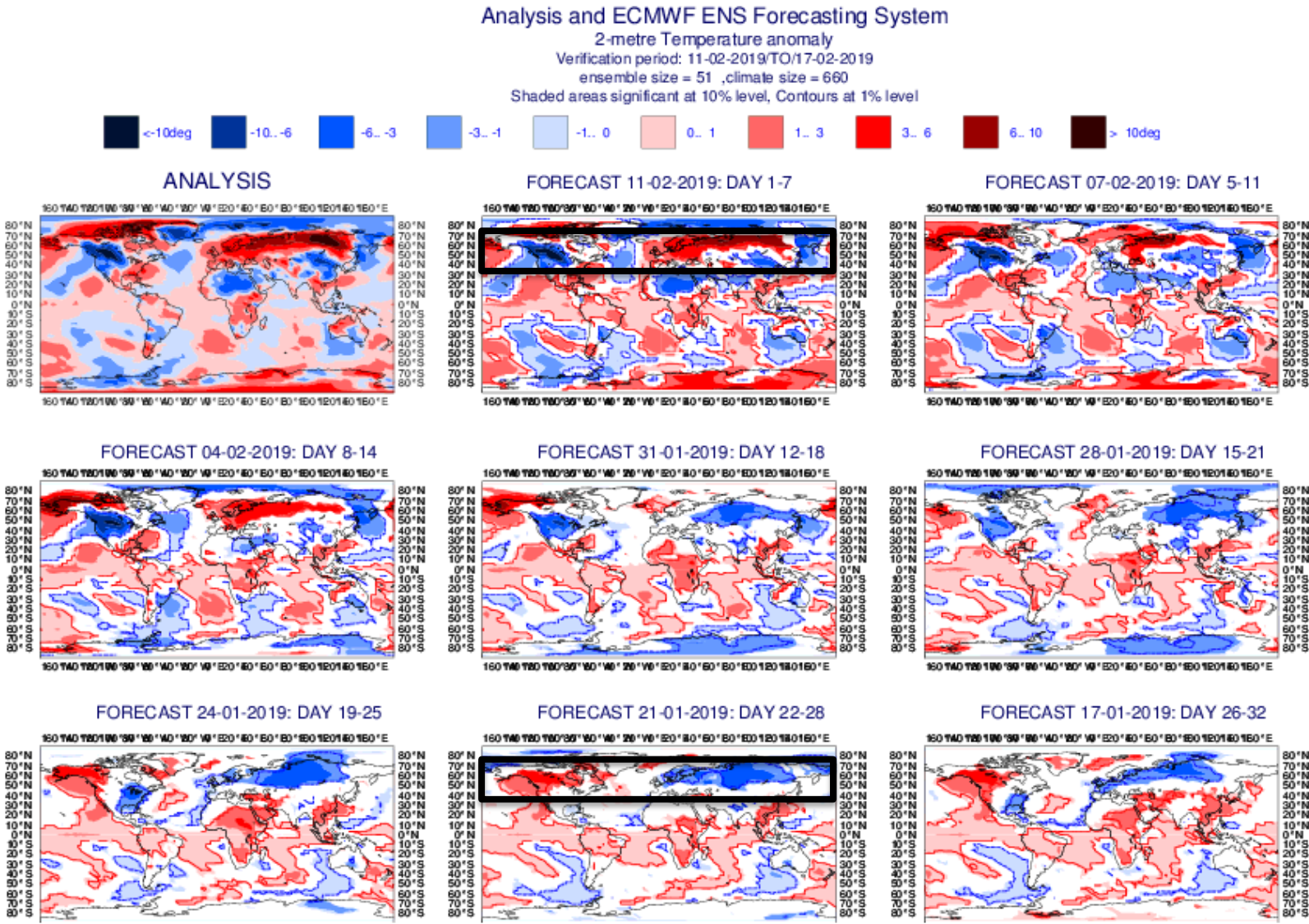
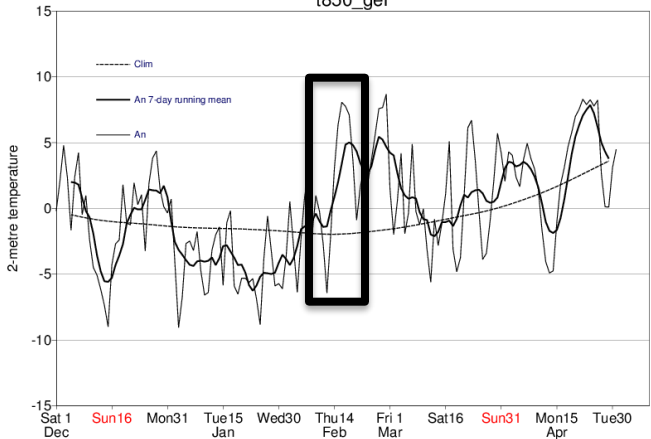
**FIGURE 5** Probability density functions for (a) an ensemble forecast starting on 19 February 2018 for the week starting on 26 February, (b) an ensemble forecast starting on 15 February 2018 for the same week, (c) an ensemble forecast starting on 19 February 2018 for the week starting on 5 March and (d) an ensemble forecast starting on 15 February 2018 for the same week. Daily values of the verifying analysis are represented by dots.

# But sometimes the forecast does wrong...

Anomaly correlation 2-metre temperature N. Hem. Mid, week 4



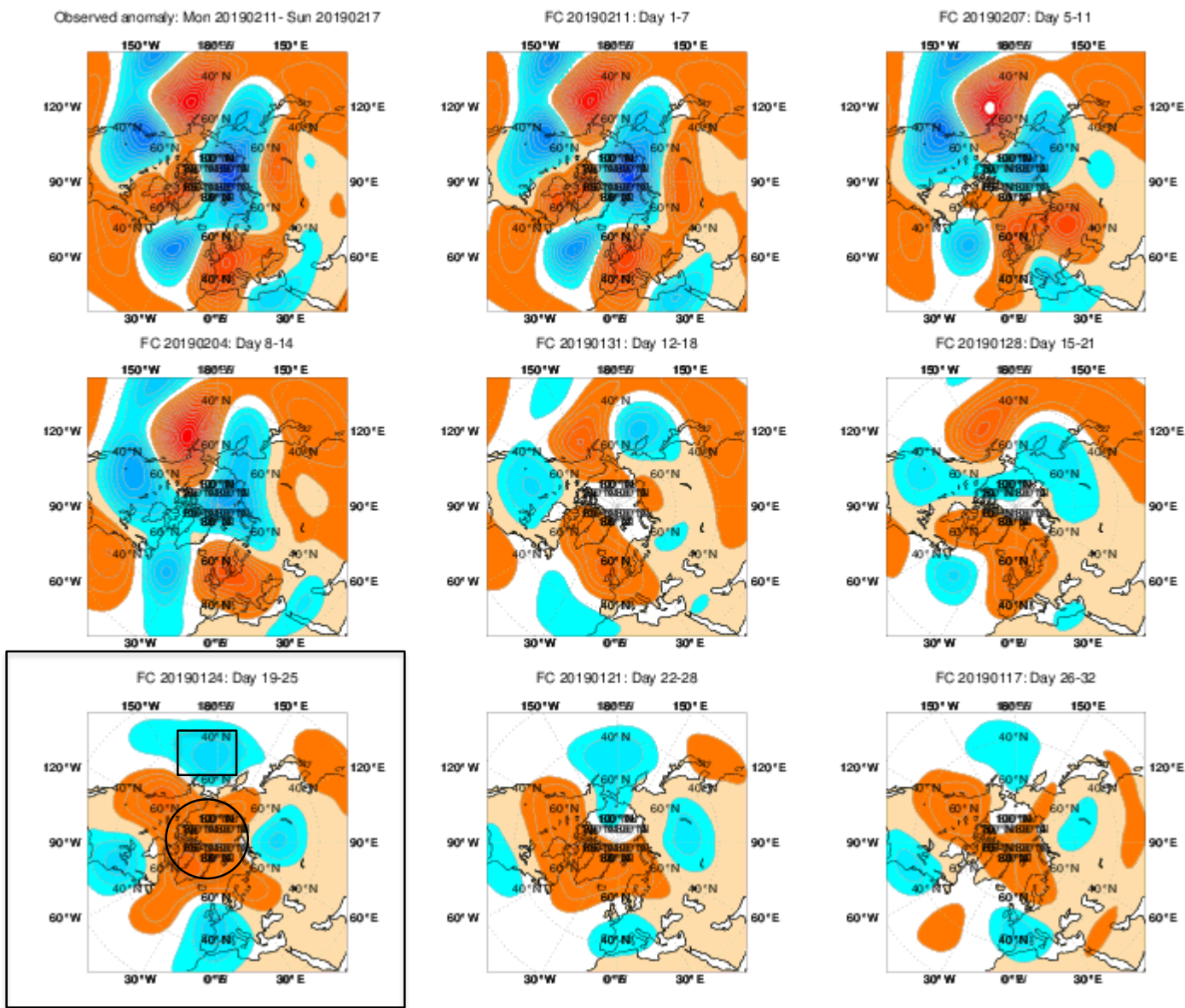
T850 analysis over Germany



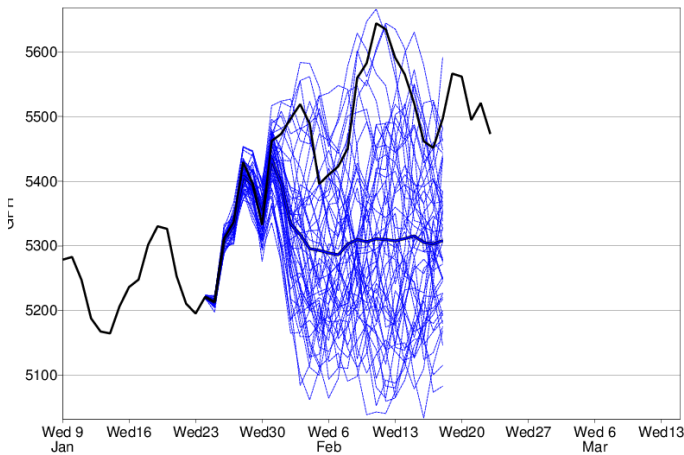


# Z500 anomalies

# Geopotential in 24 Jan forecast and analysis

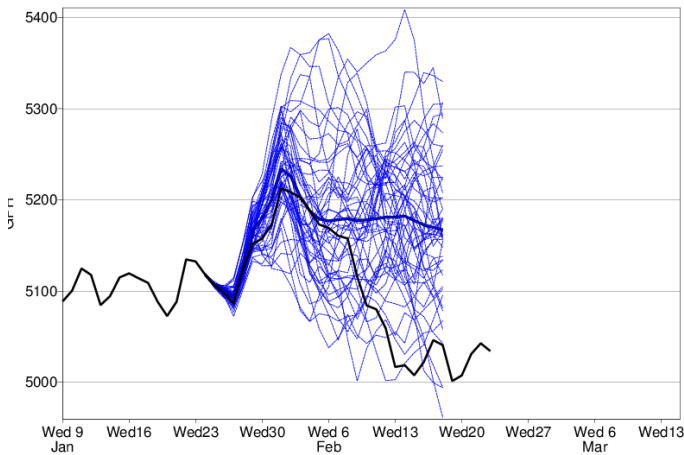


## North Pacific



Forecast – blue  
Analysis - black

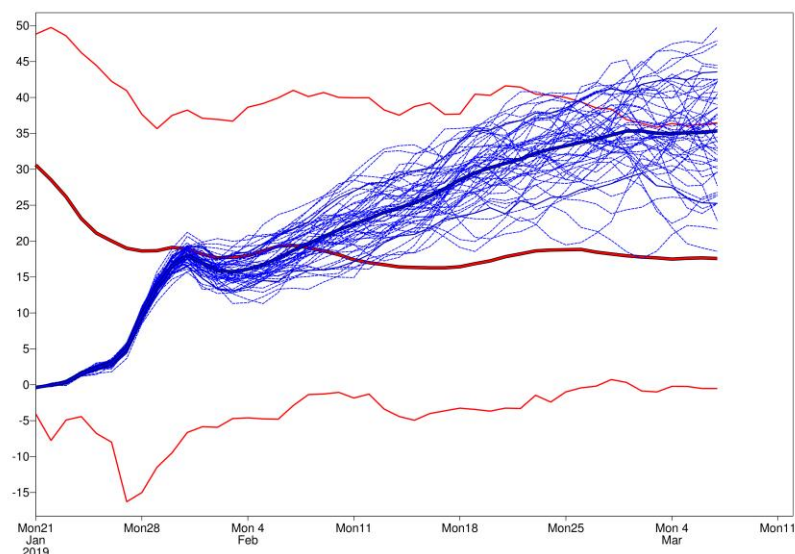
## Arctic (70N-90N)



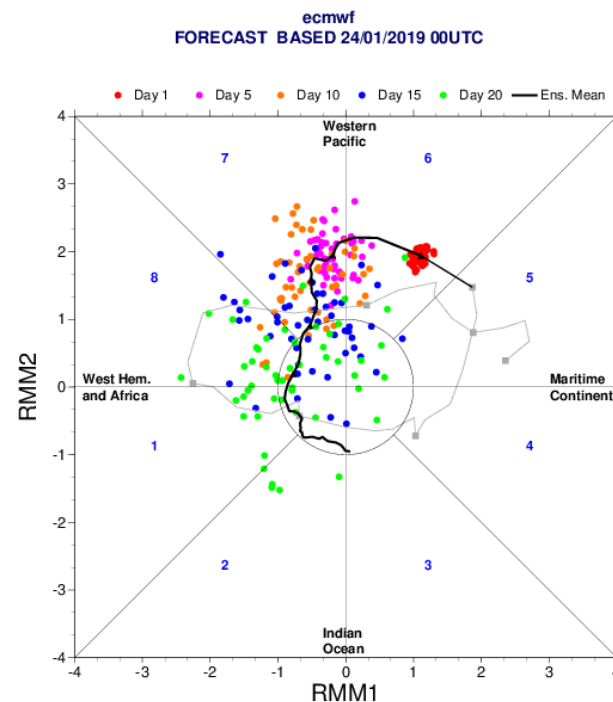
# The suspects....

External forcings + teleconnections vs. internal variability

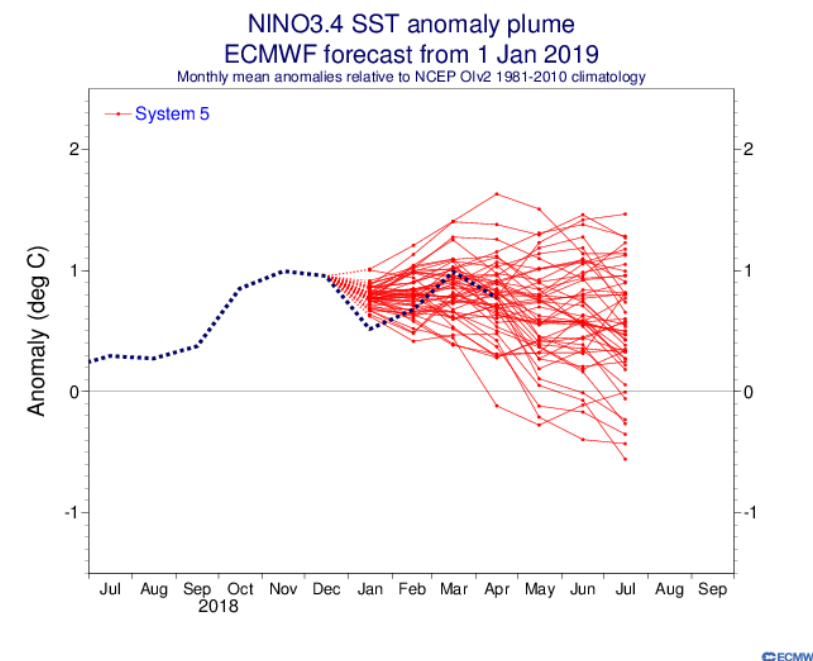
The SSW from January



MJO active in Pacific



Positive ENSO

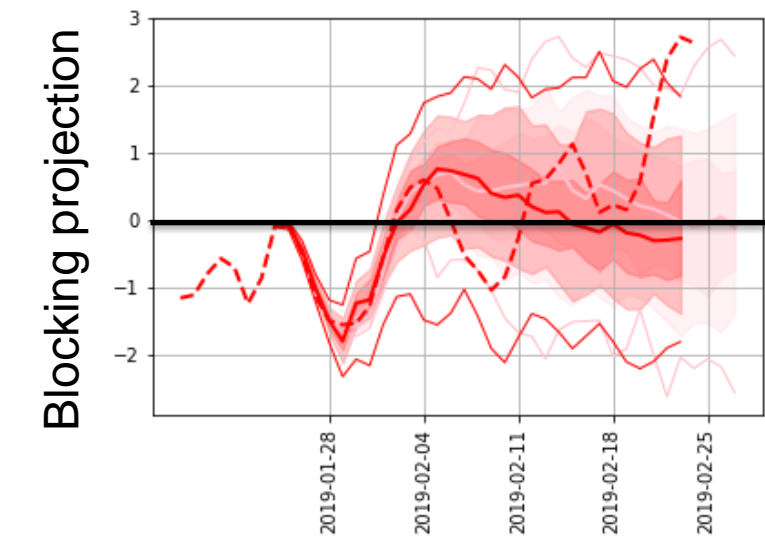
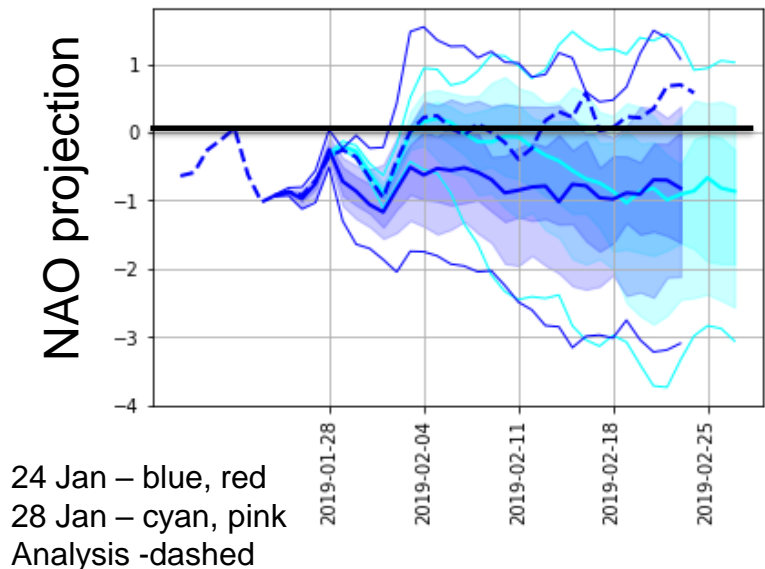


All statistically favour a negative NAO

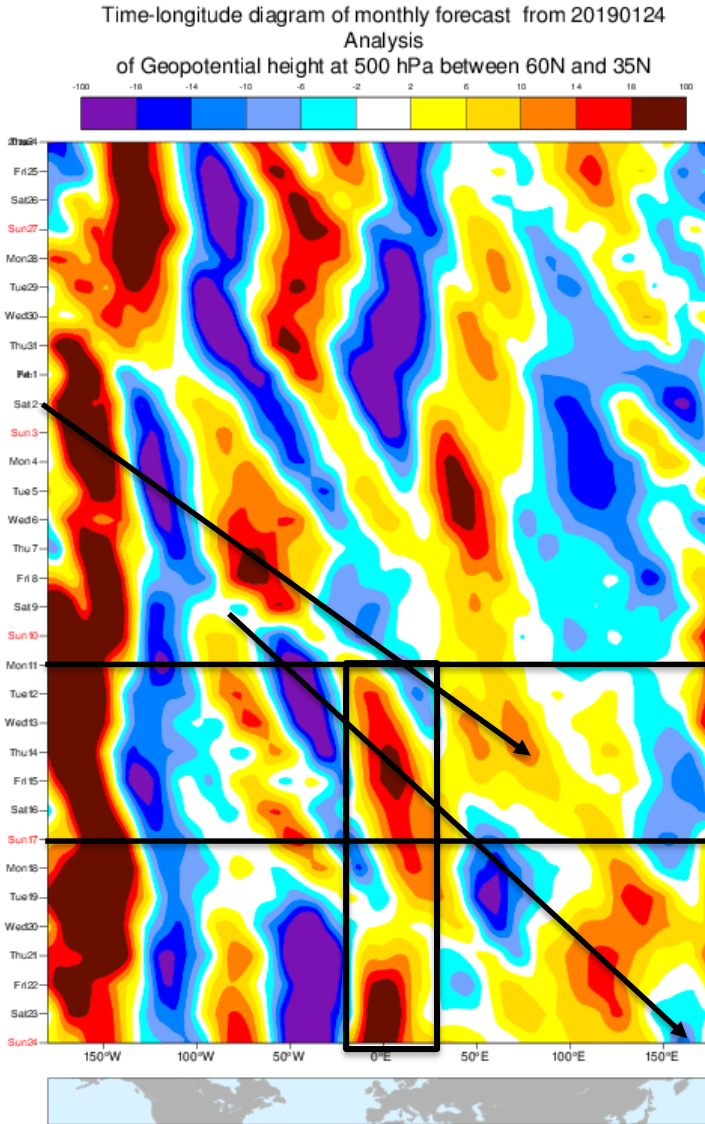


# Regime forecast and Rossby wave packets

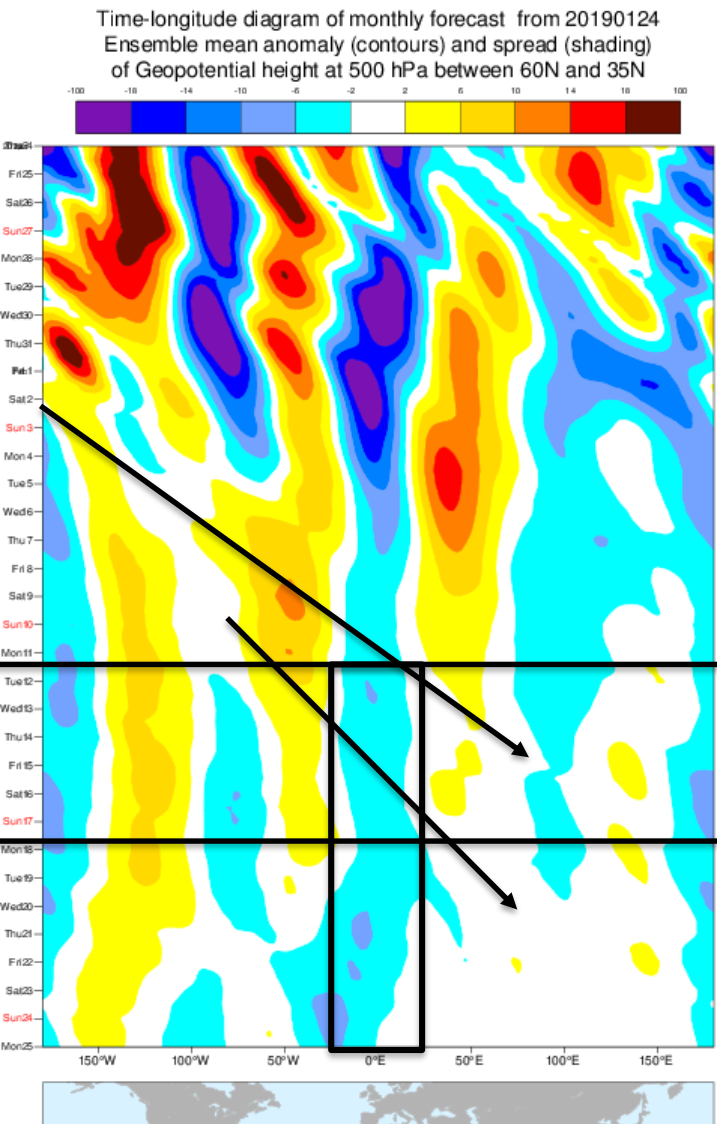
Z500 anomalies 35N-60N



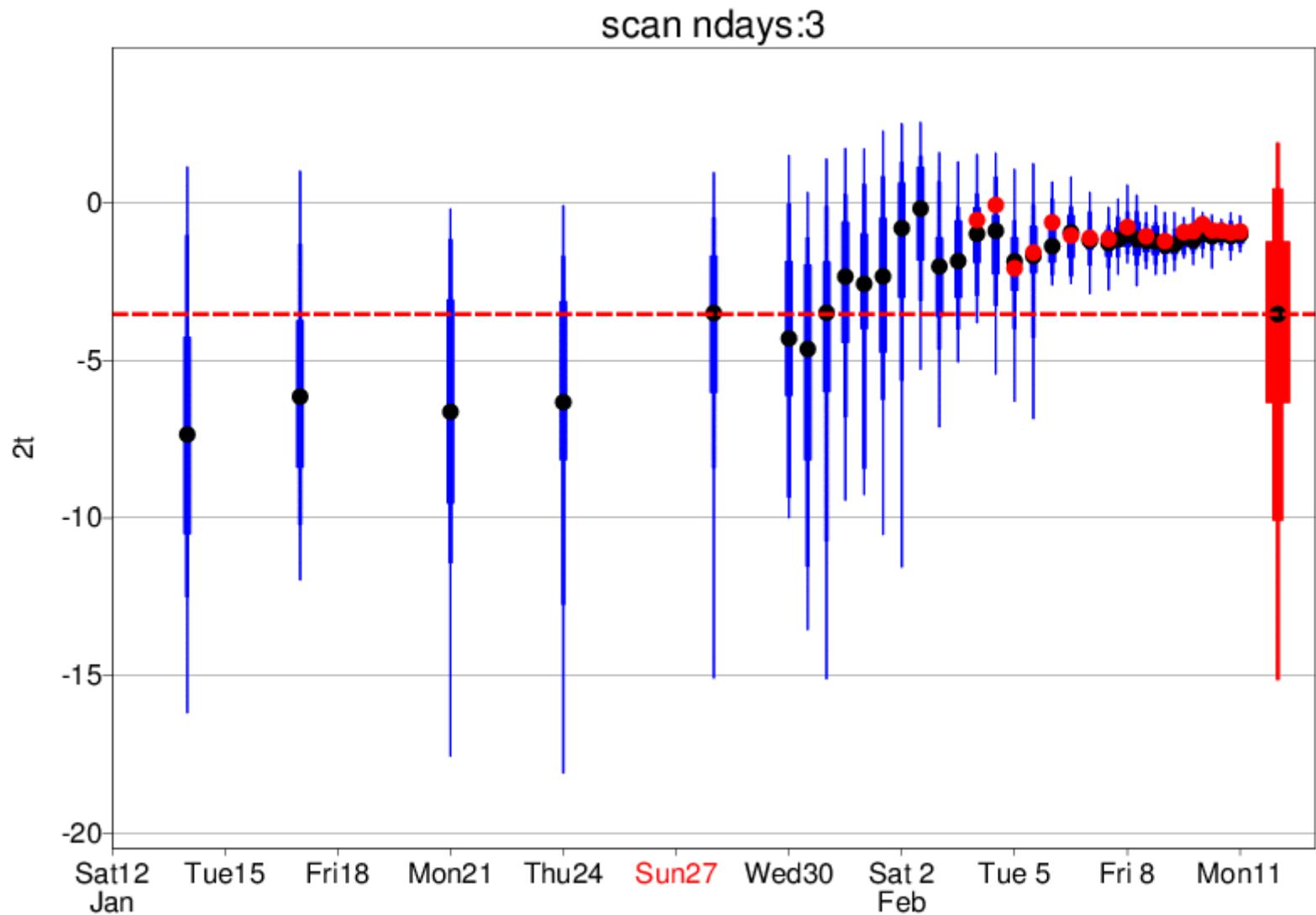
## Analysis



## Ensemble mean 24 Jan



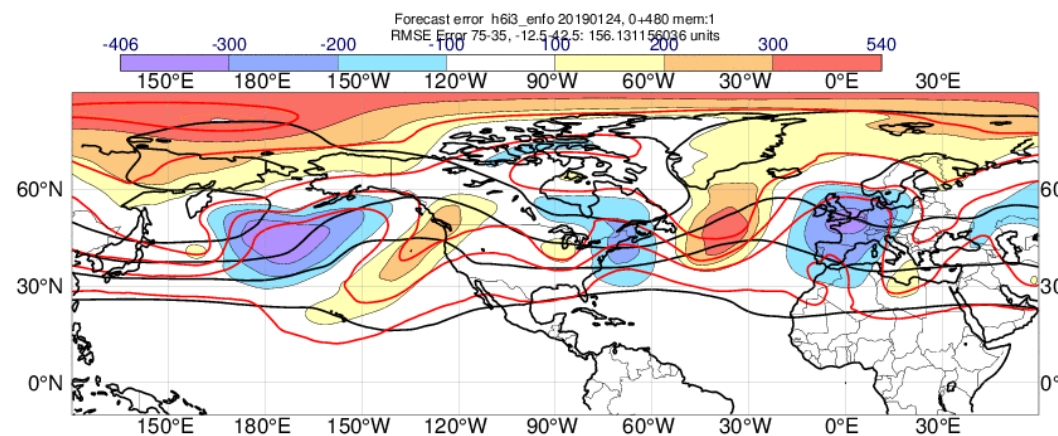
# Forecasts for 2-metre temperature over Scandinavia 11-13 February



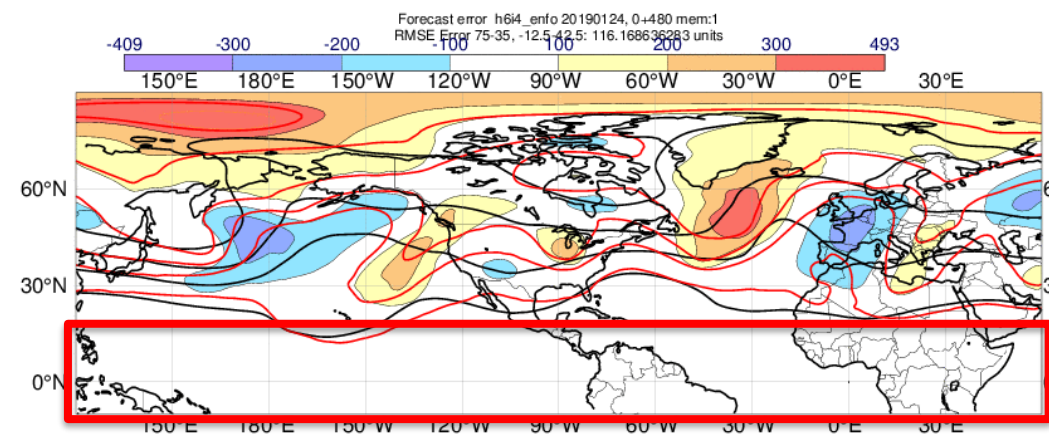
# Relaxation experiments

## Z500 Ensemble mean error in 20-day forecasts from 24 January

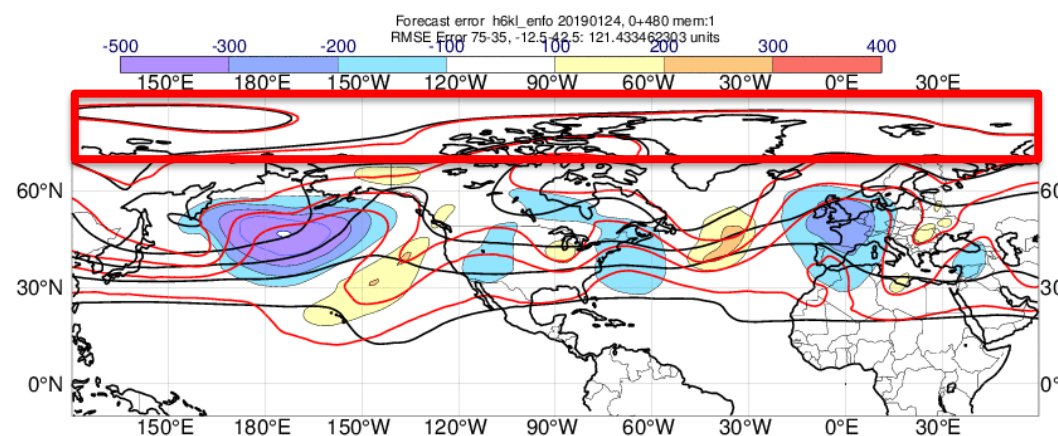
### Control



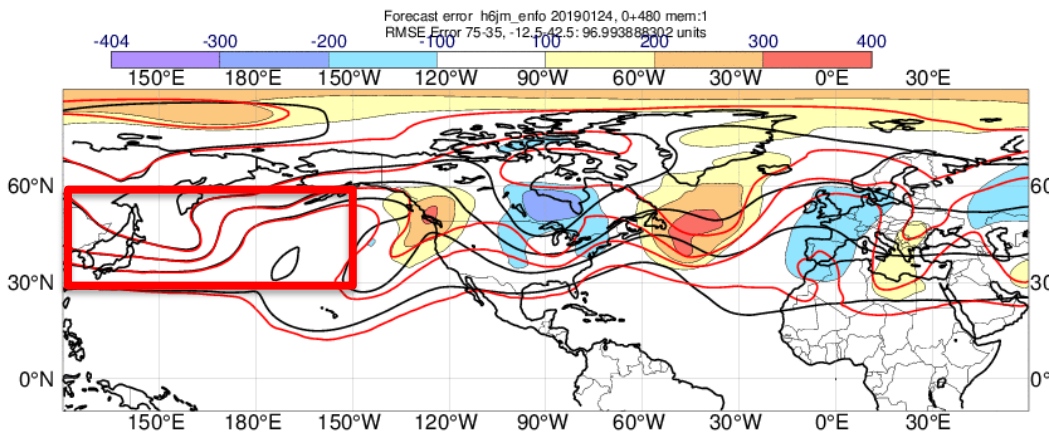
### Full tropics



### Arctic



### N. Pac



Analysis –red  
Ensemble mean – black  
Difference - shade

# Summary Extended-range products and diagnostics

The current archive from the extended-range forecast gives a great opportunity for creating forecast products

Regime forecasts is a practical way to condense ensemble information

Skilful forecasts for NAO and blockings in the extended-range

Challenging to understand difficult forecast cases

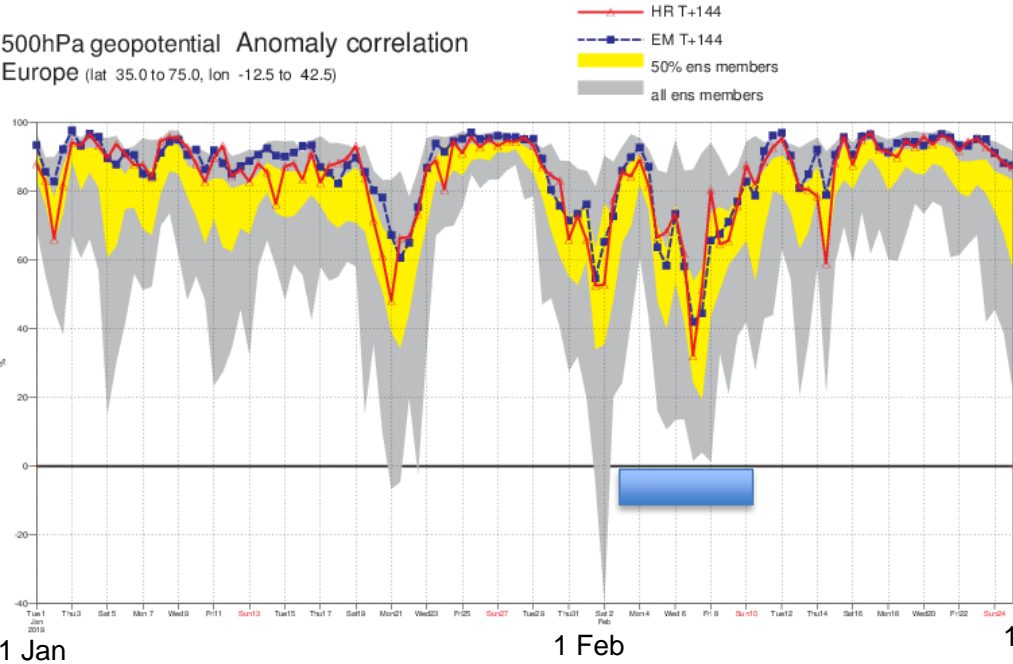
Main part of variability in the mid-latitudes is due to synoptic variability -> limited skill in the extended-range



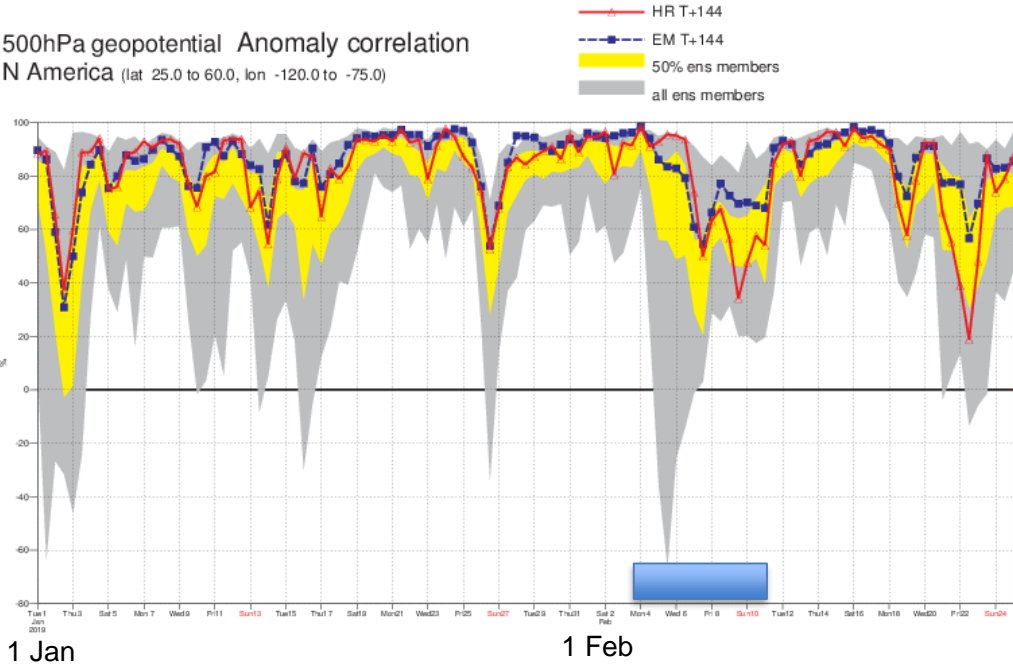
# Mentimeter result

# Medium-range scores for Europe

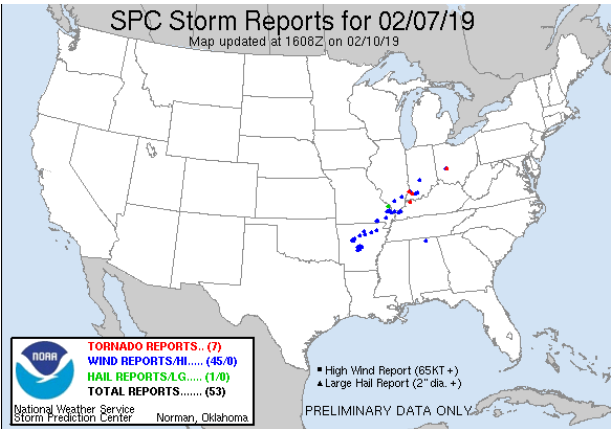
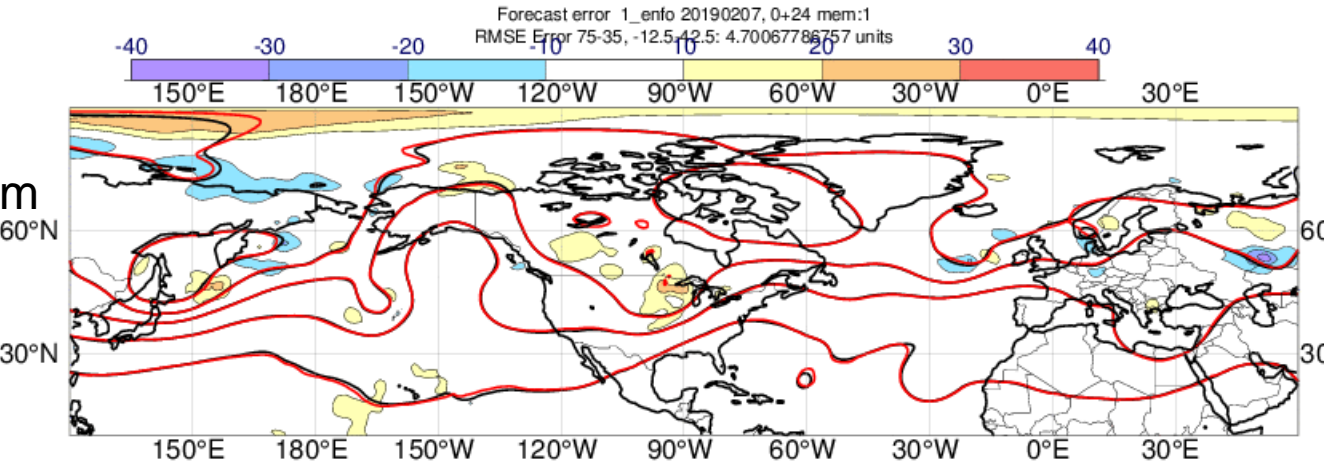
## Europe



## North America



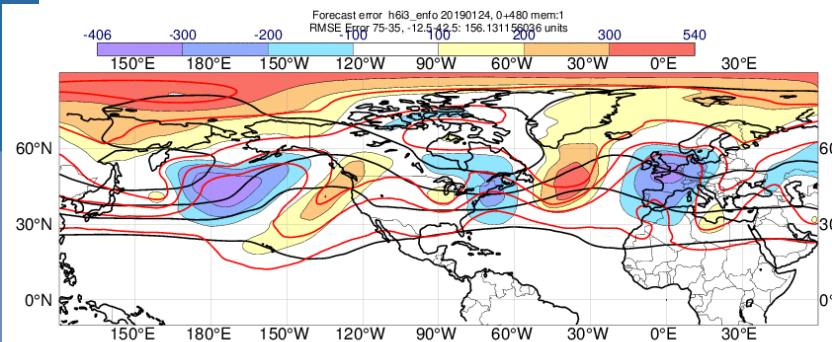
1-day error from  
7 February



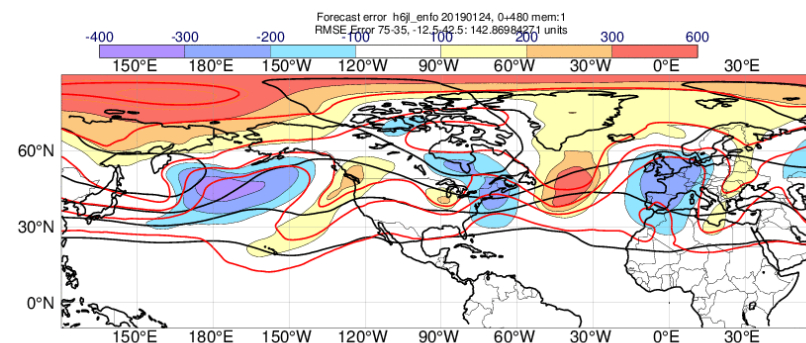
Loaded dice?

# EM Error in 20-day forecasts from 24 January

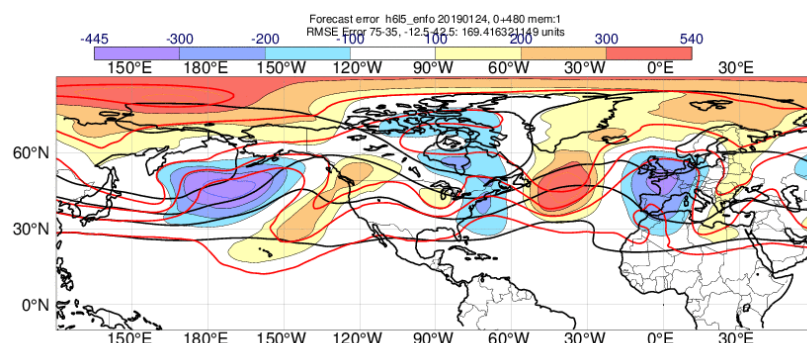
## Control (h6i3)



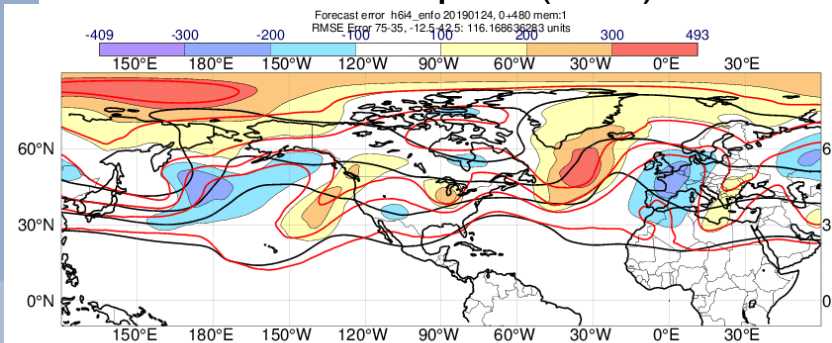
## Indian ocean (h6jl)



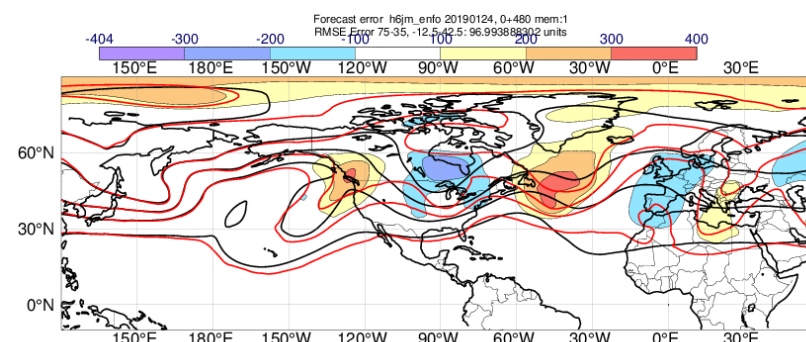
## W. Ex.trop Pac (h6l5)



## Full tropics (h6i4)

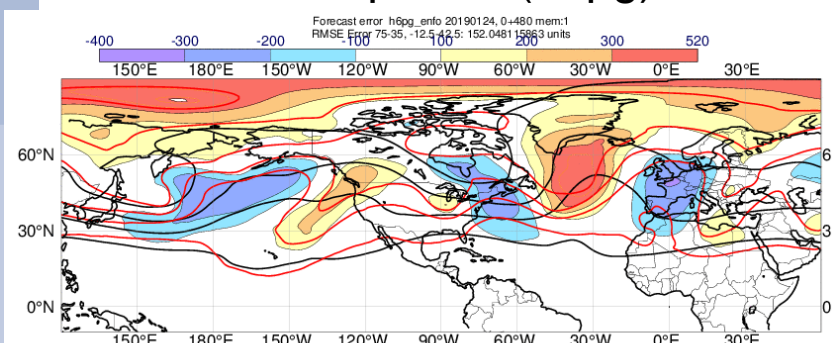


## N. Pac (h6jm)

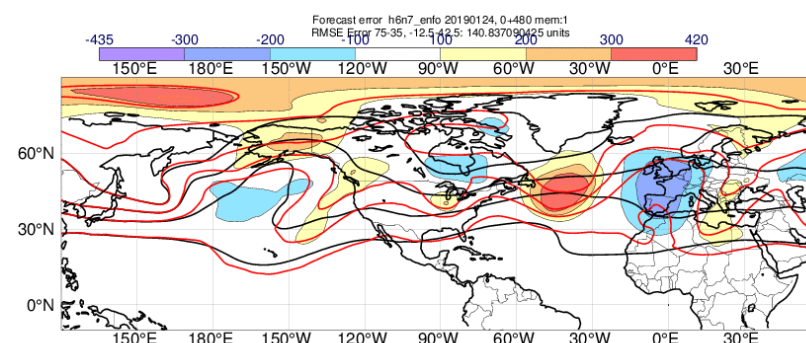


Analysis –red  
Ensemble mean - black

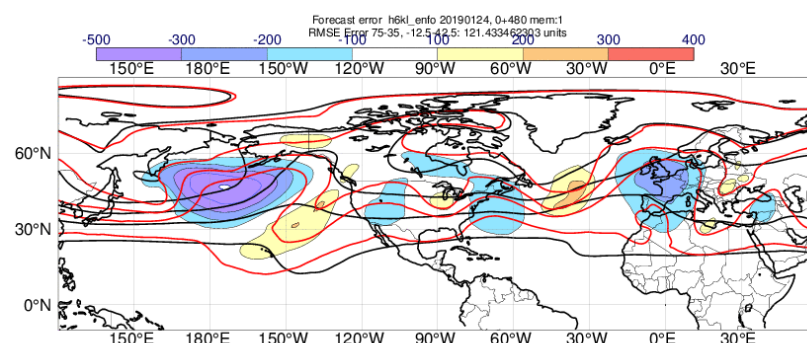
## Trop. Pac (h6pg)



## W. Pac (h6n7)



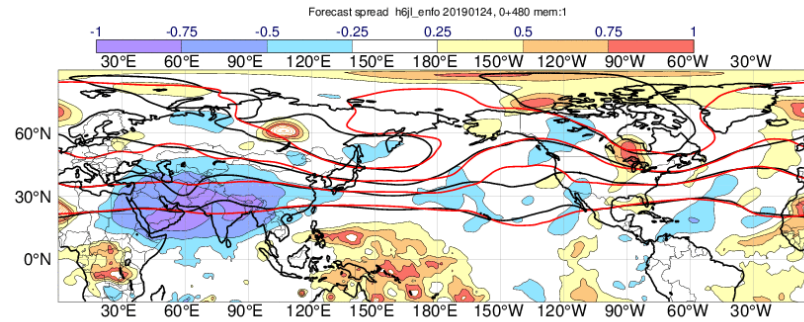
## Arctic (h6kl)



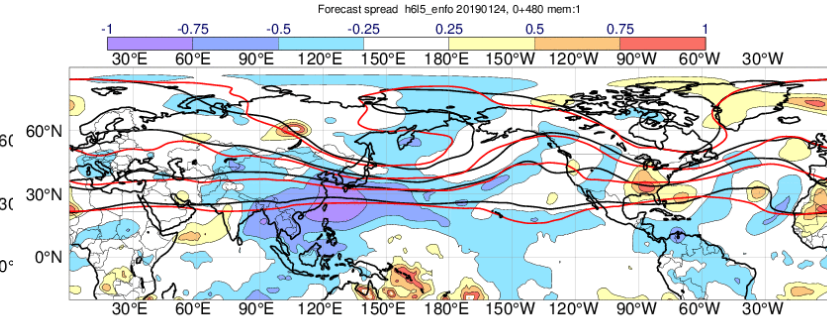


# Spread fraction (exp-cont/cont) in relaxation experiments (24 January + 20 days)

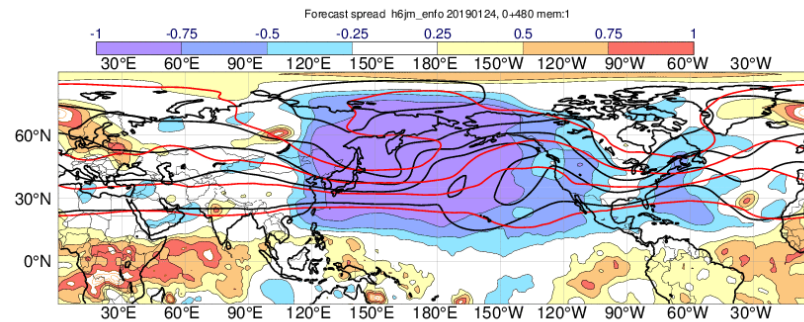
Indian ocean (h6il)



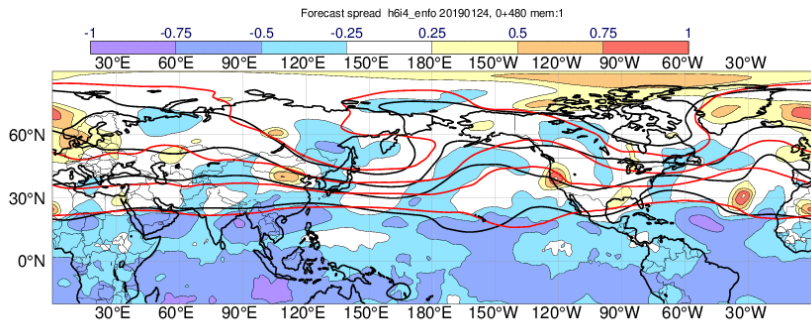
W. Ex.trop Pac (h6l5)



N. Pac (h6jm)

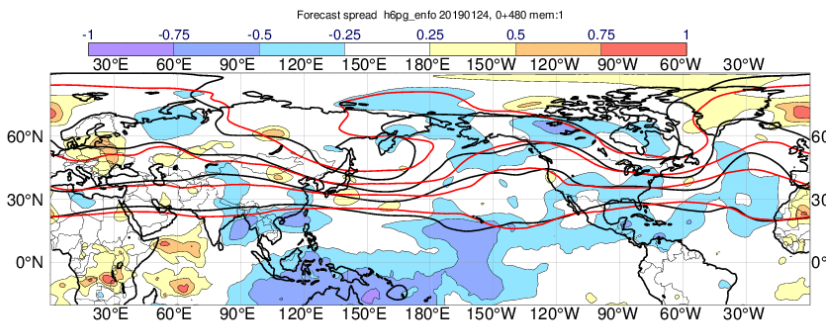


Full tropics (h6i4)

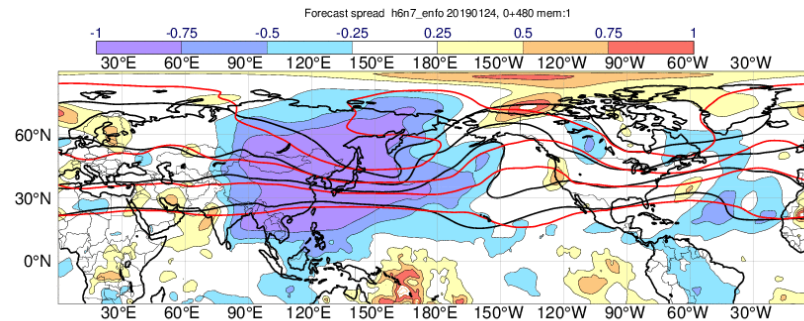


Ensemble mean cont –red  
Ensemble mean exp - black

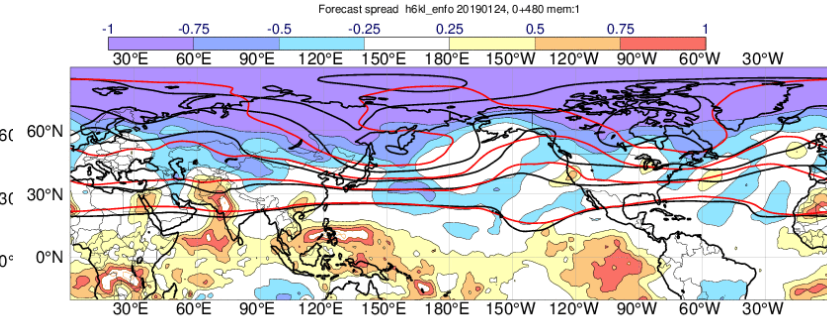
Trop. Pac (h6pg)



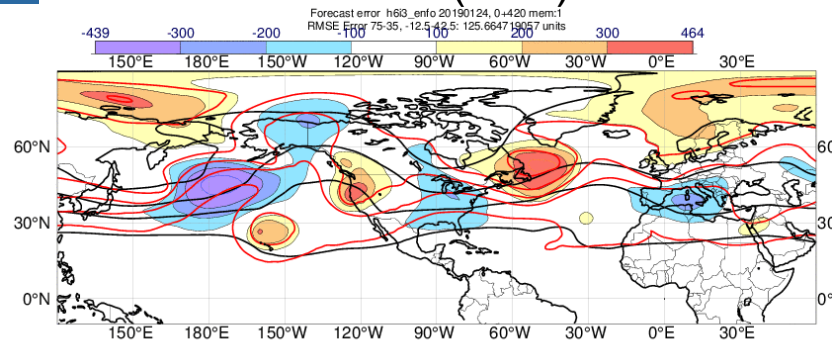
W. Pac (h6n7)



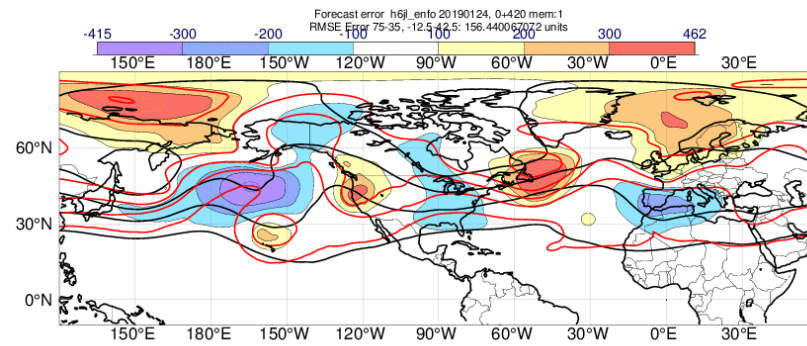
Arctic (h6kl)



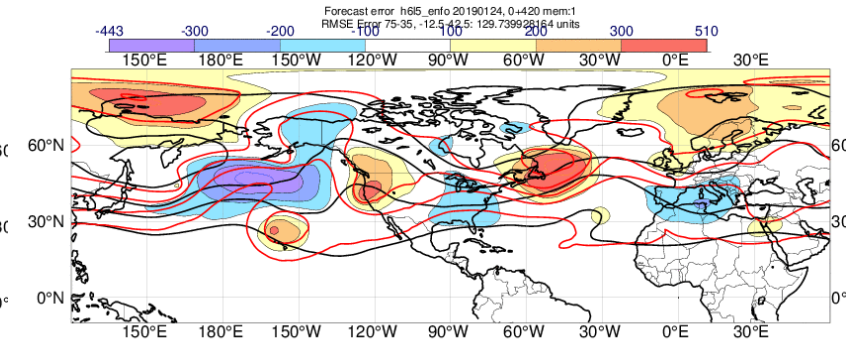
**+420 Hours**  
**Control (h6i3)**



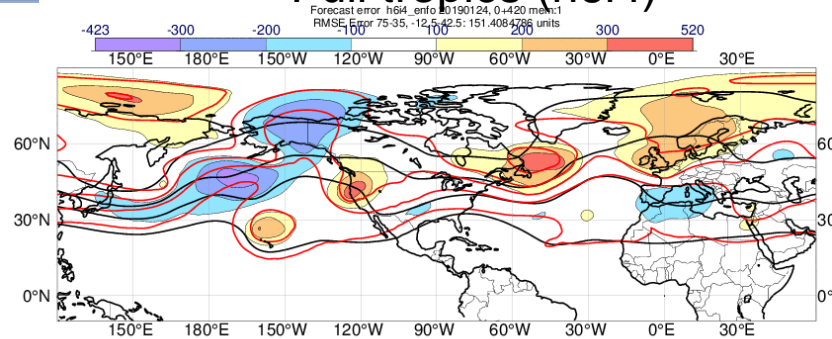
**Indian ocean (h6jl)**



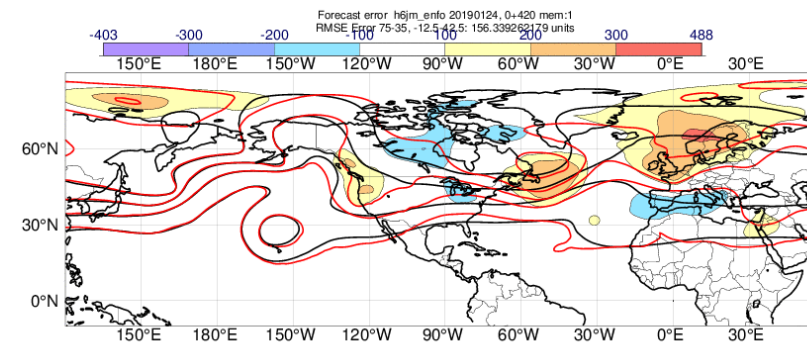
**W. Ex.trop Pac (h6l5)**



**Full tropics (h6i4)**

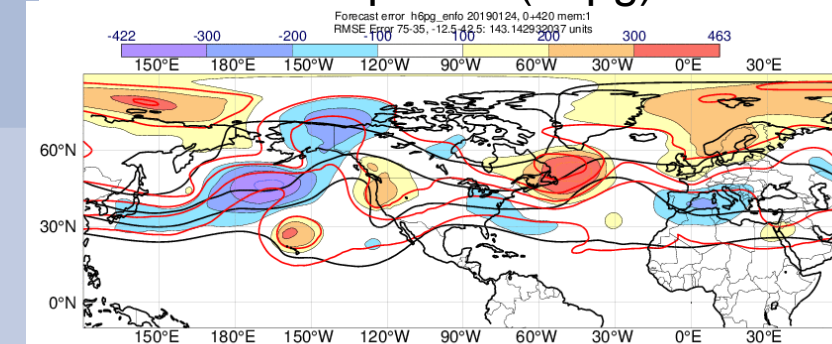


**N. Pac (h6jm)**

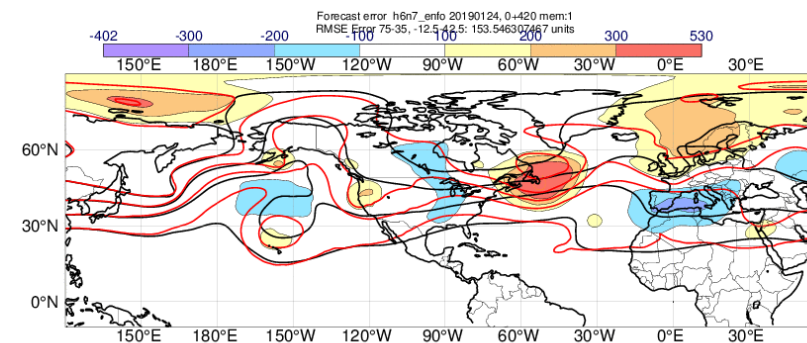


Analysis –red  
Ensemble mean - black

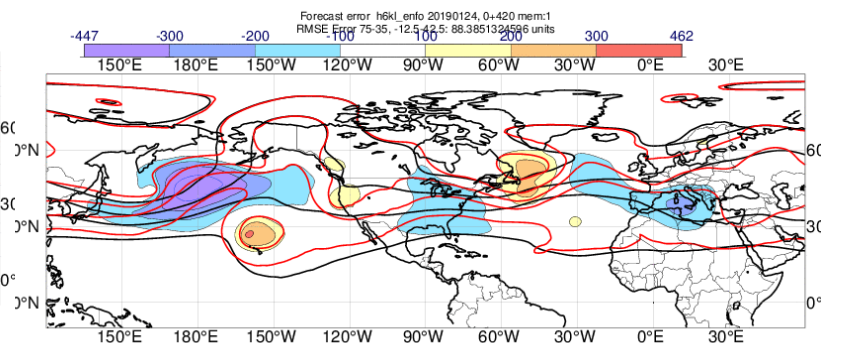
**Trop. Pac (h6pg)**



**W. Pac (h6n7)**



**Arctic (h6kl)**

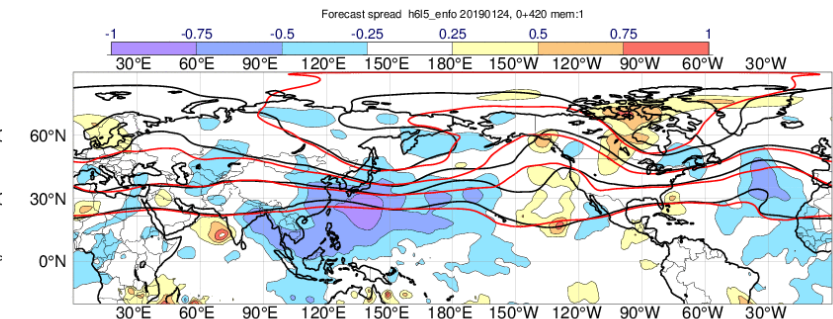
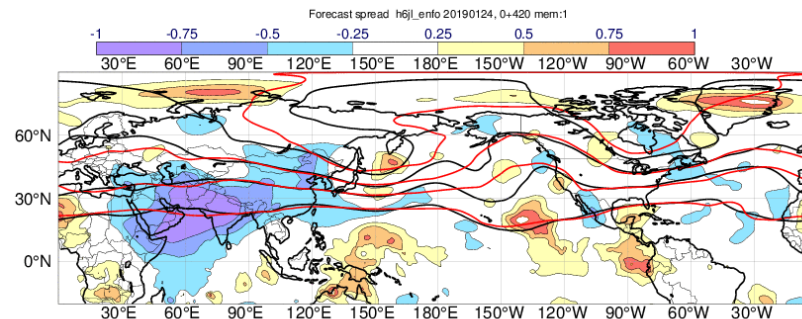




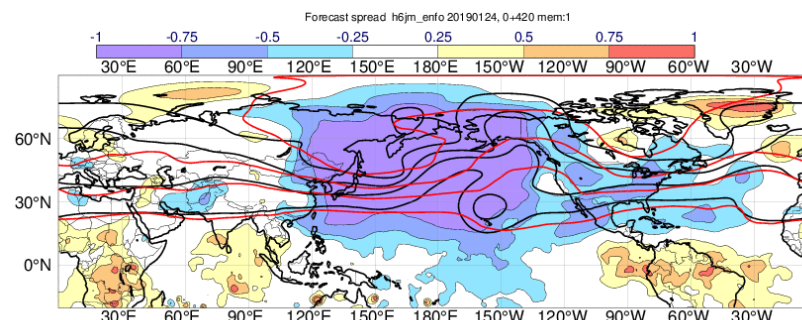
Control (h6i3)

Indian ocean (h6jl)

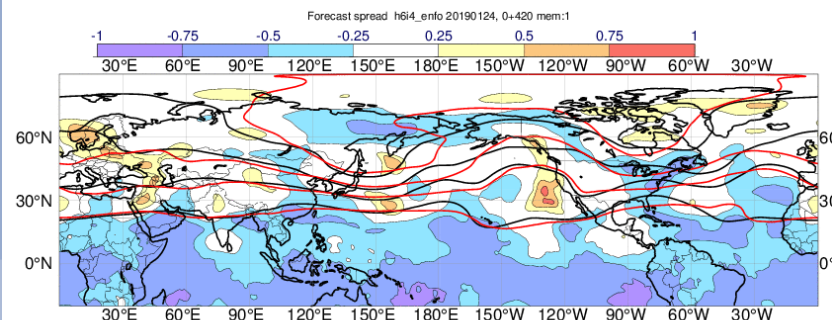
W. Ex.trop Pac (h6l5)



N. Pac (h6jm)

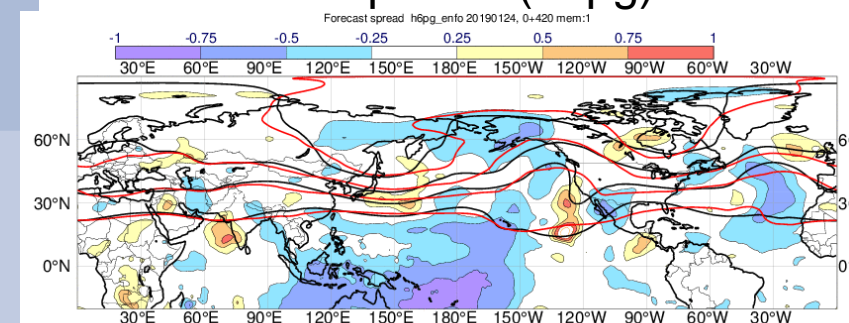


Full tropics (h6i4)

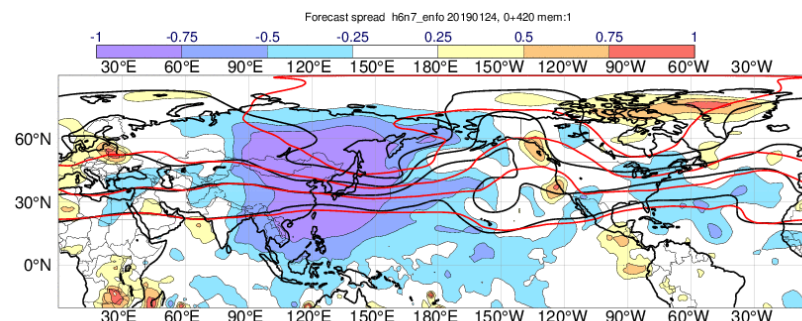


Ensemble mean cont –red  
Ensemble mean exp - black

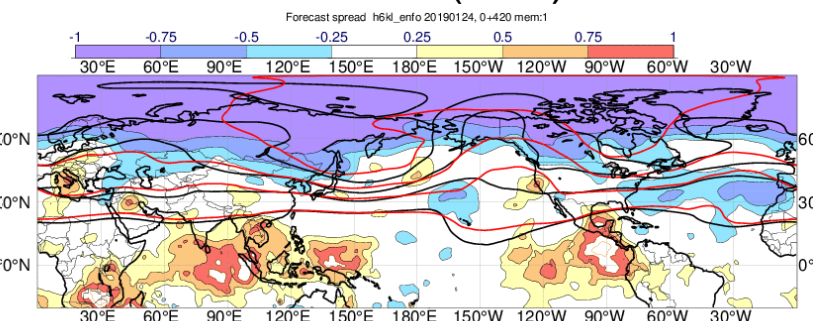
Trop. Pac (h6pg)



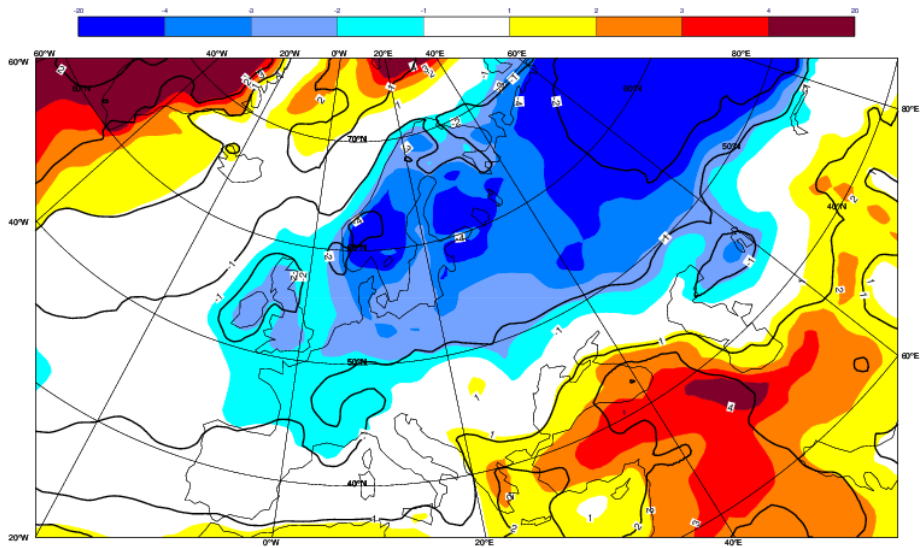
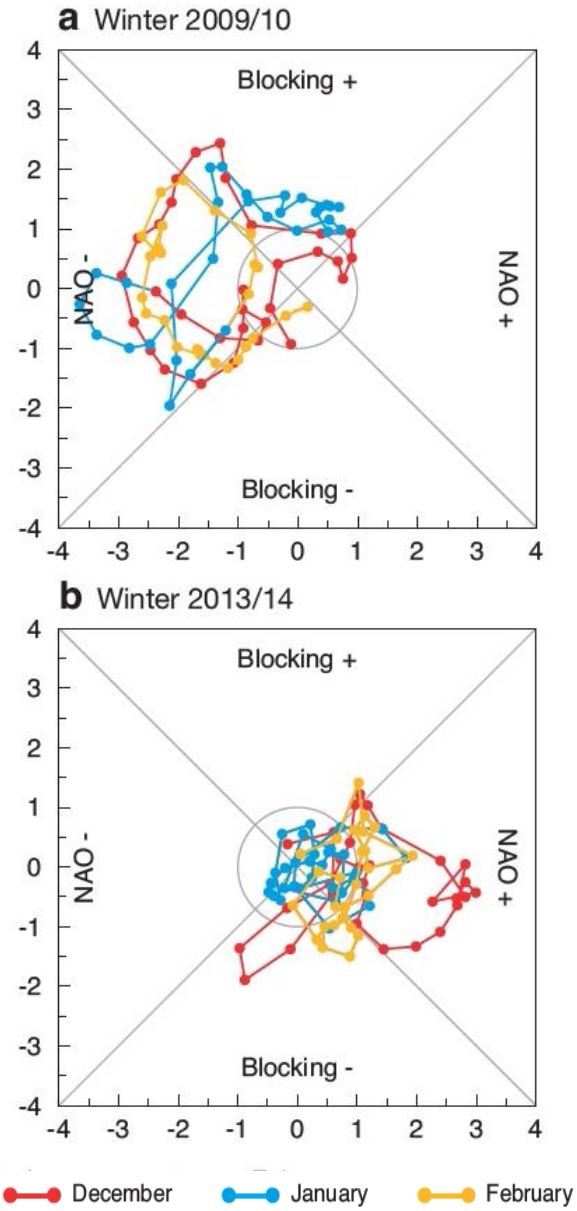
W. Pac (h6n7)



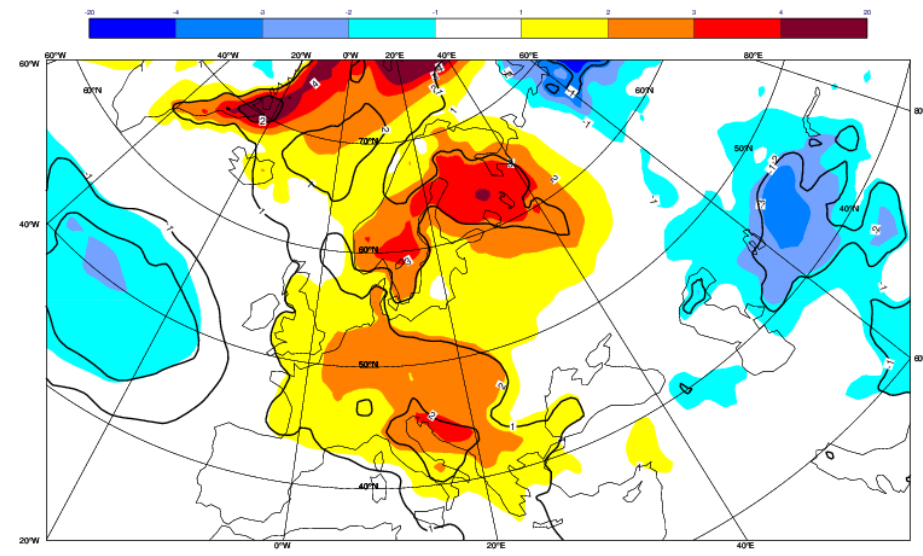
Arctic (h6kl)



# 2M Temp anomalies for DJF:



2009/2010



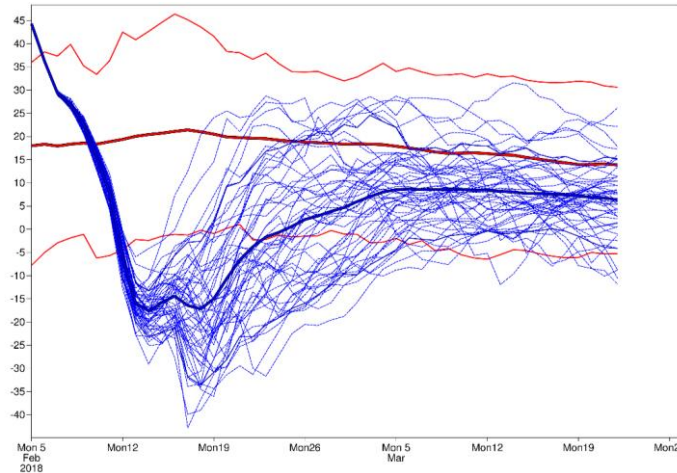
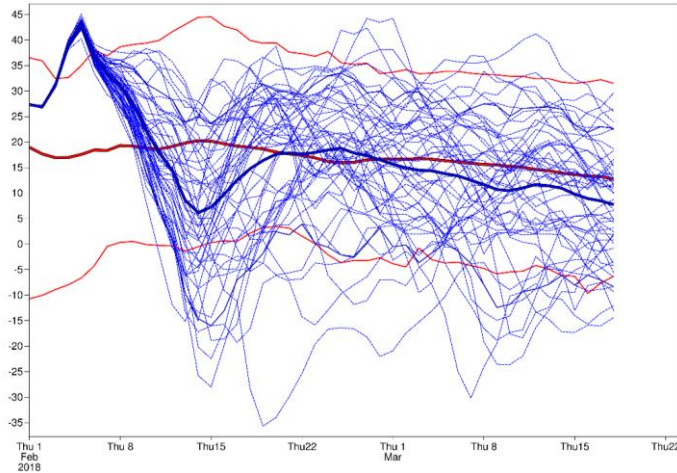
2013/2014



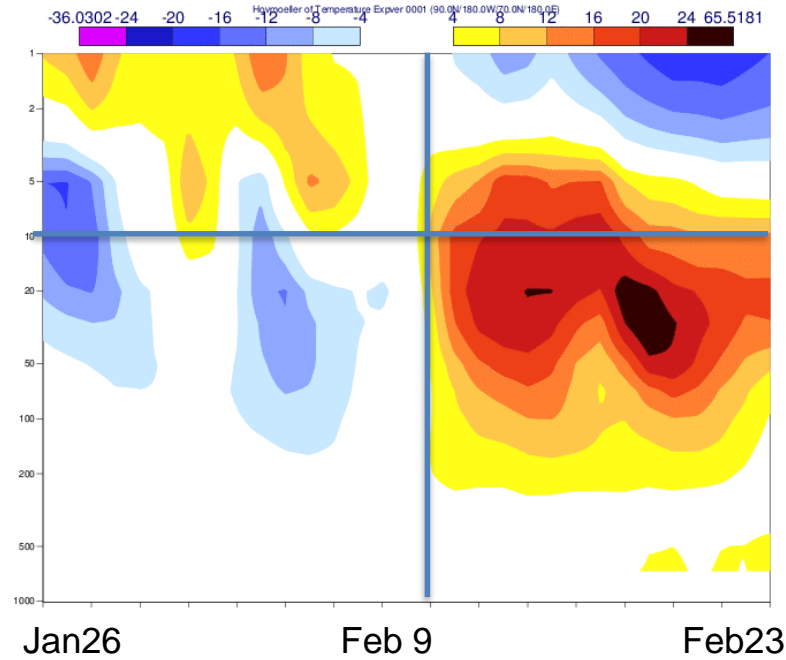
# Drivers of predictability on sub-seasonal scale

## SSW:

60N zonal mean zonal wind at 10hPa

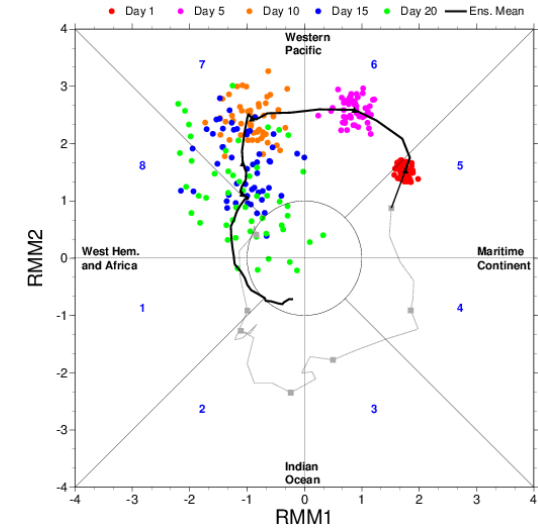


11Feb SSW onset



## MJO:

ecmwf  
FORECAST BASED 25/01/2018 00UTC



Teleconnection from MJO phase 6 on MSLP 10 days later

