Diagnostic of low frequency phenomena

How far in advance can we predicts large scale pattern leading to severe cold spell over Europe?

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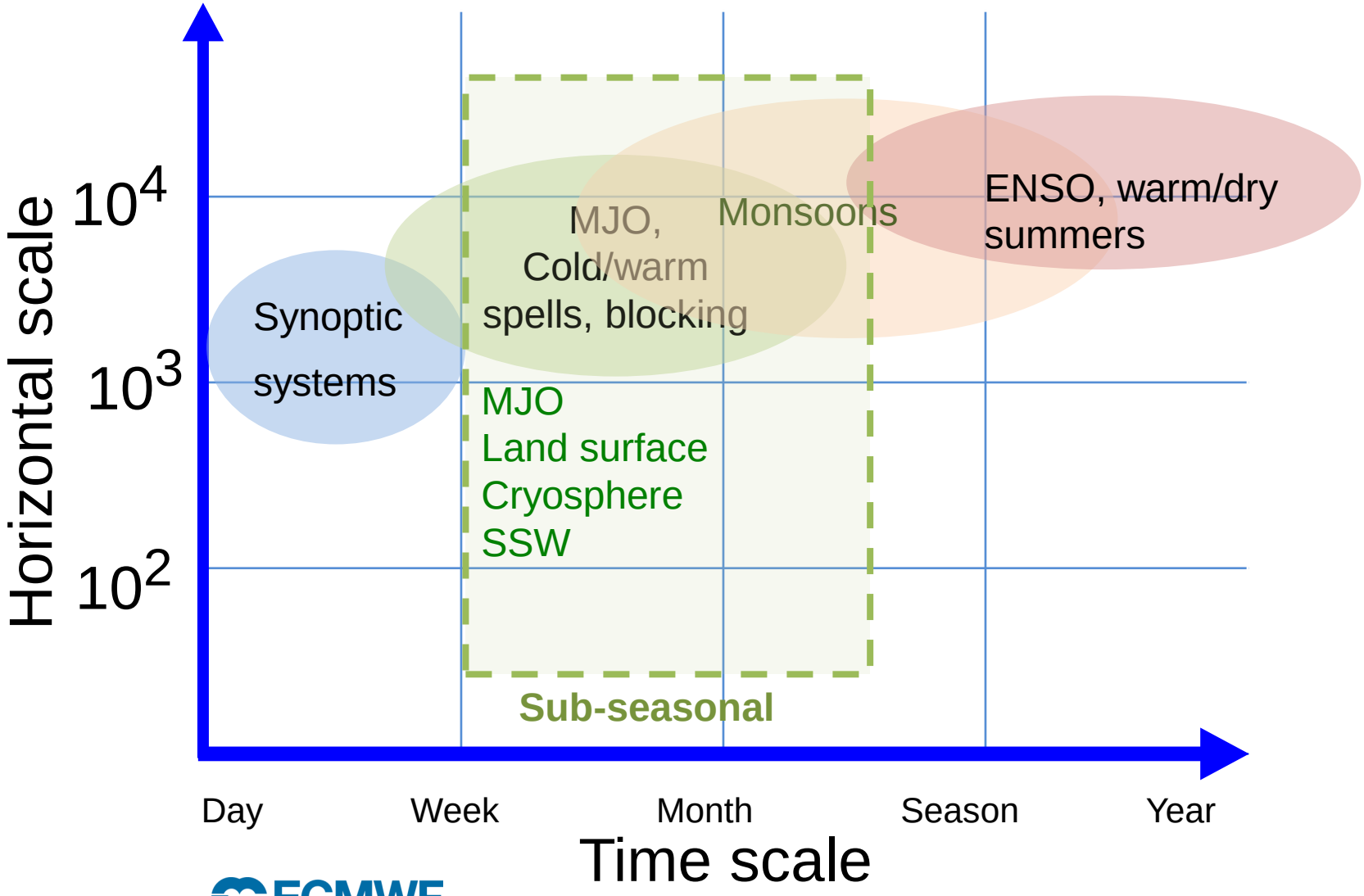
ECMWF

Sub-seasonal range :



Skill of MJO predictions from S2S models:

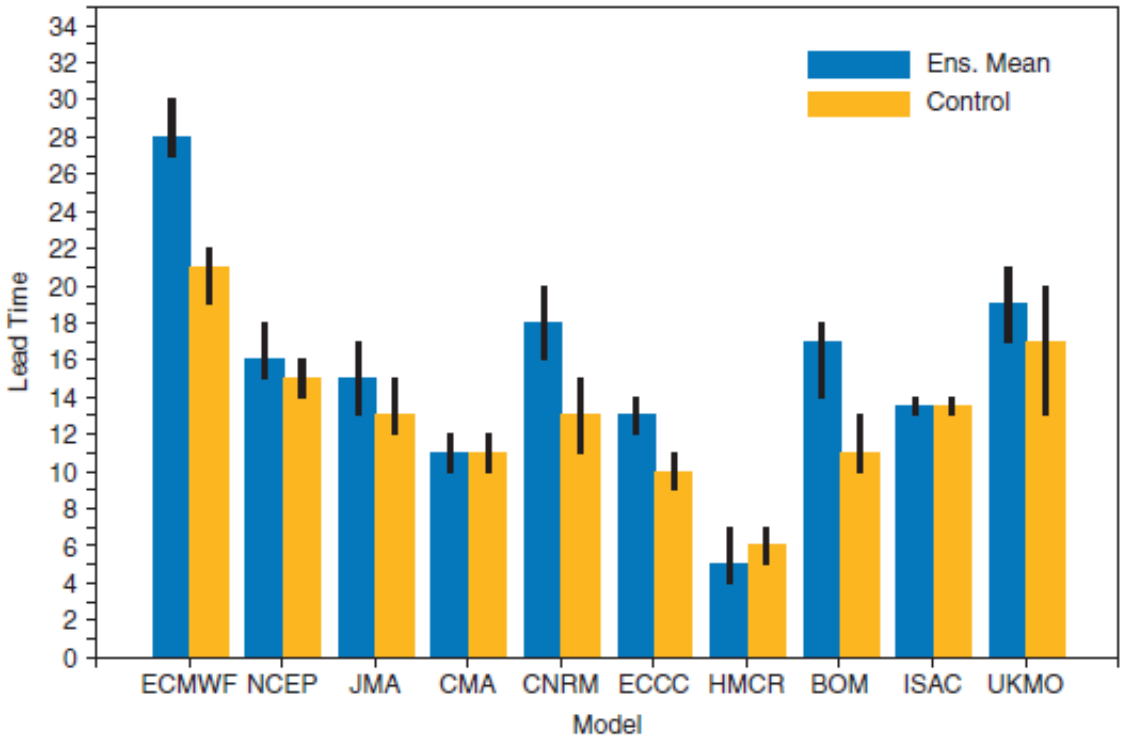


Figure 2. Forecast lead time (in days) when the MJO bivariate correlation between the model ensemble means and control run reaches 0.6. The vertical black bars represent the 95% level of confidence computed from a 10 000 bootstrap re-sampling procedure. [Colour figure can be viewed at wileyonlinelibrary.com].

Vitart 2017 QJRMS

Can we predict, weeks ahead, the changes in large scale flow leading to cold conditions over Europe?

Although forecasts at the extended range are not expected to have skill to predict the day to day variability, they can predict cold/warm spells that persist for longer than a week.

Cold/warm spells are generally associated with persistent high pressure systems (e.g. European Blocking, Greenland Blocking (NAO-)).

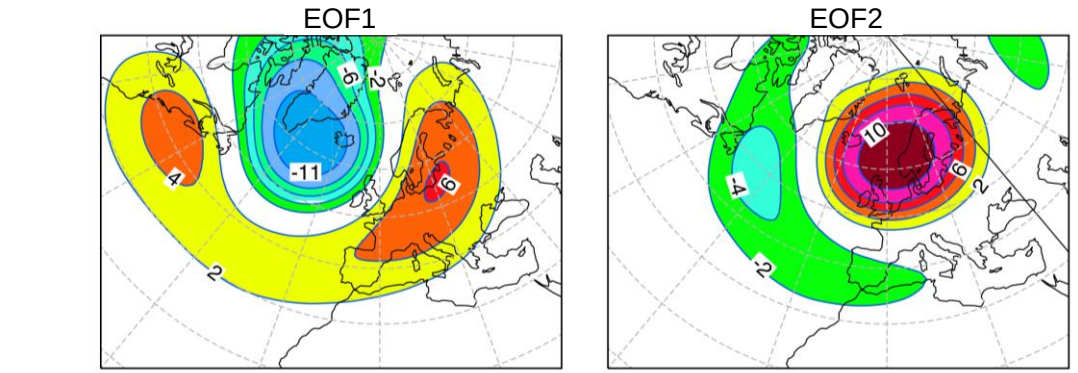
Those systems are sometime associated with global teleconnections linked to tropical organized convection (MJO) (Cassou 2008).

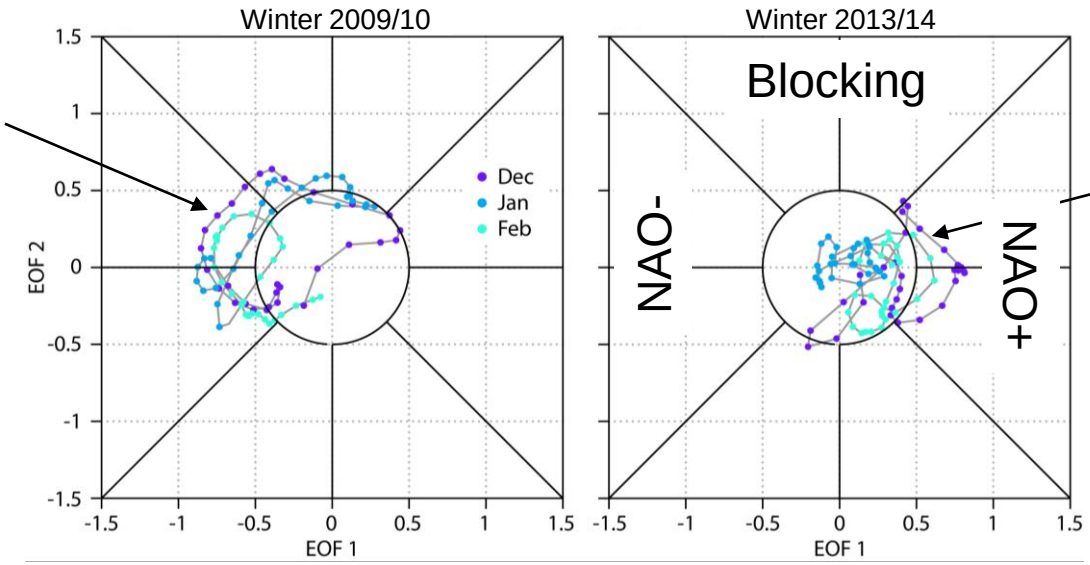
We explore the ability of the S2S systems to predict the winter circulation patterns that are generally associated with cold spells over Europe.

Can we predict weeks ahead the changes in large scale flow leading to severe cold conditions over Europe?

Trajectories in phase space (*c.f.* MJO propagation)

- ±EOF1 and +EOF2 represent quite well ±NAO and BL
- Trajectories in phase space summarise regime evolution
- Unlike MJO, no preferred direction





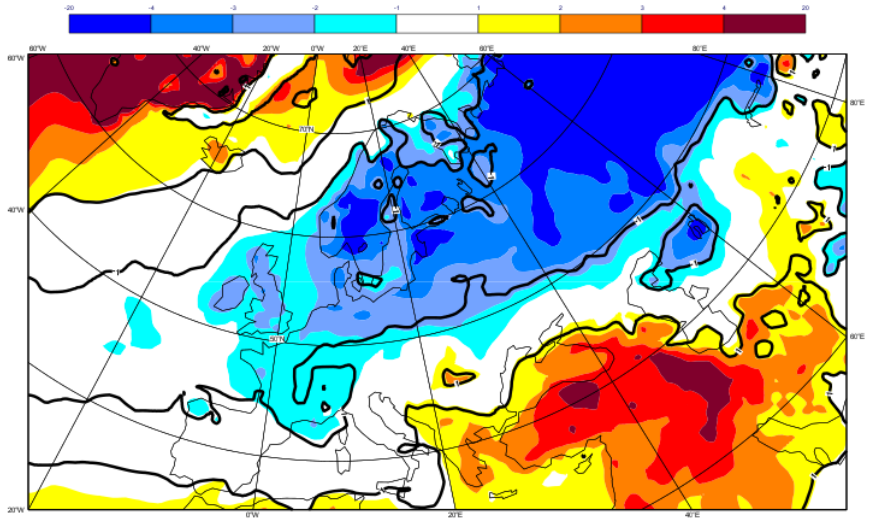
BL: record-breaking cold temperatures over Europe

+NAO: exceptional storminess, but mild temperatures over Europe

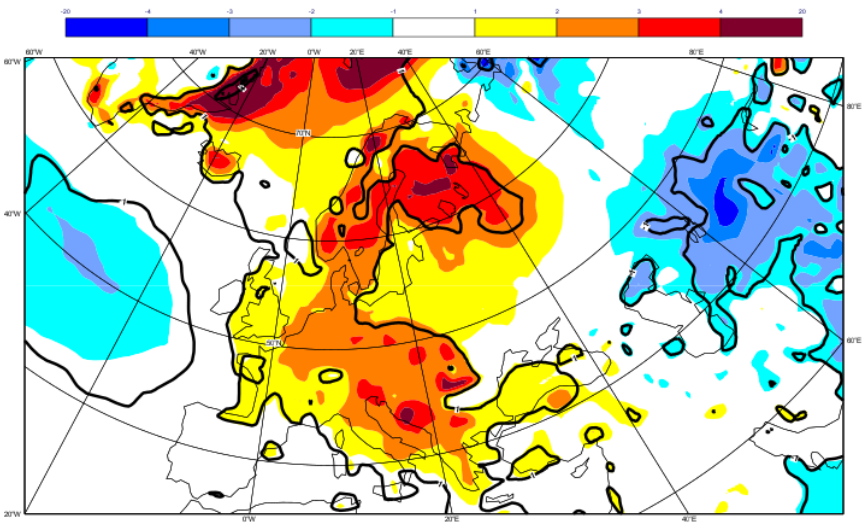
Based on 5-day running means

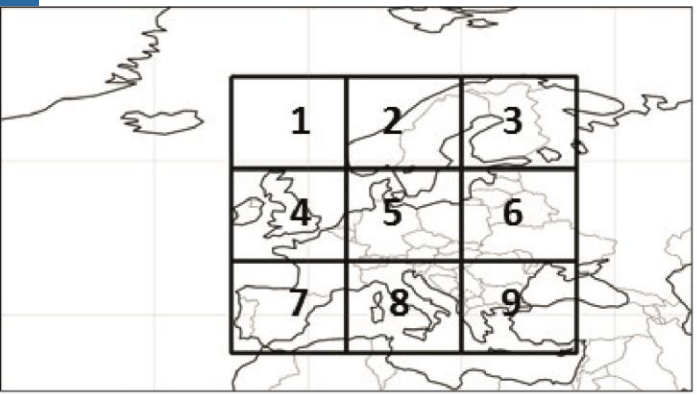
2m temperature anomalies (era-interim)

DJF 2009/10



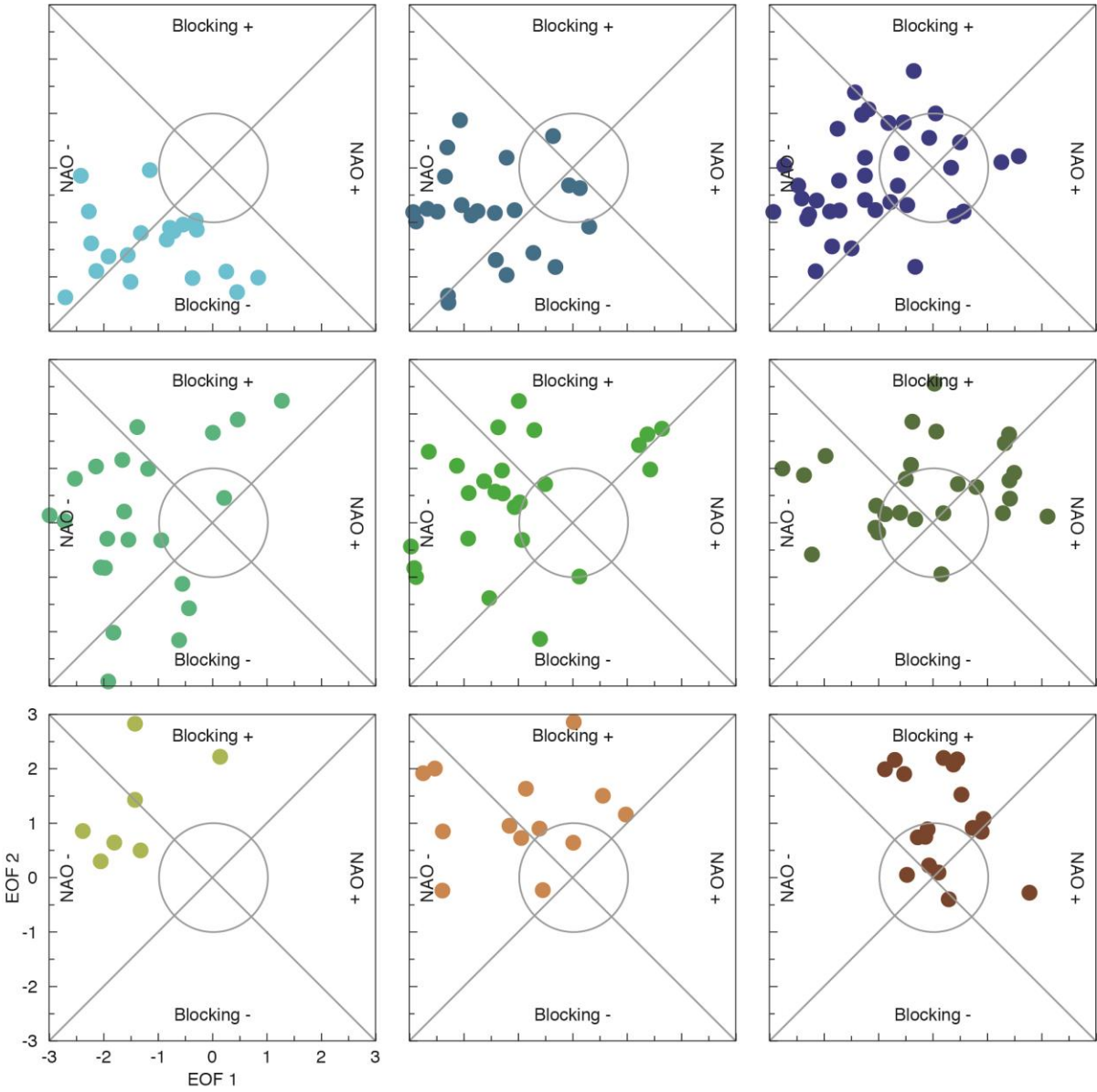
DJF 2013/14



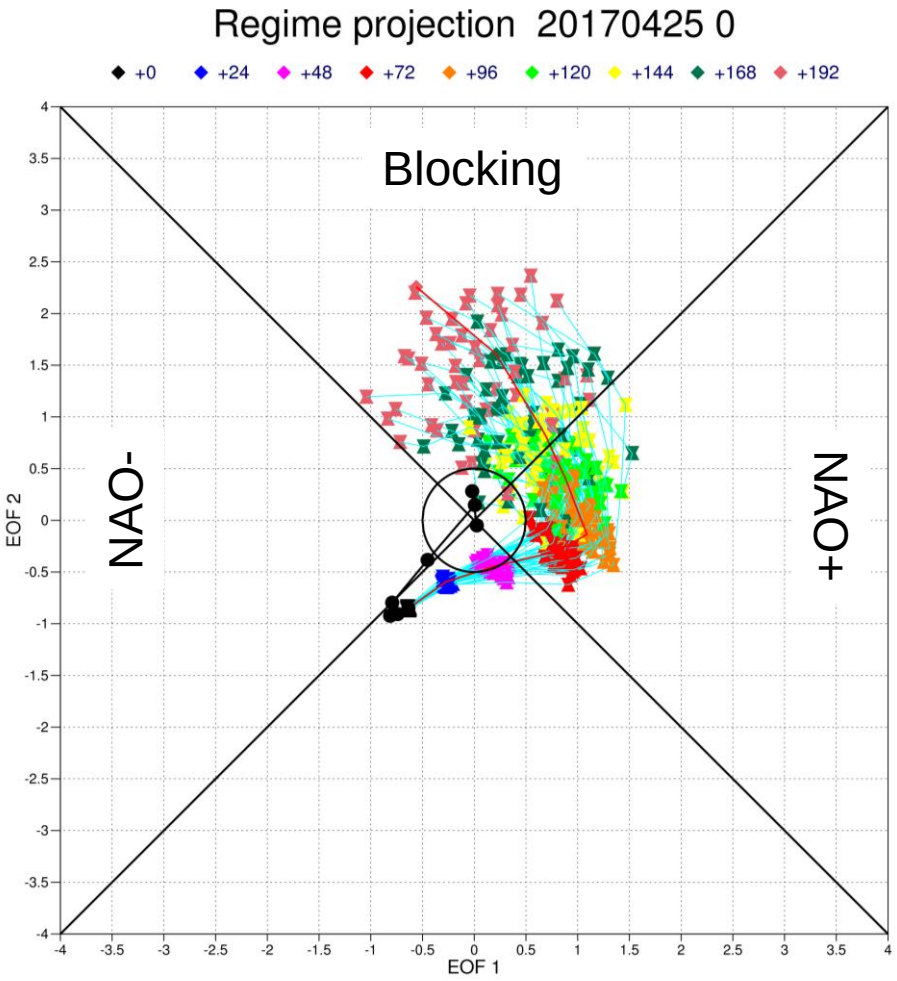


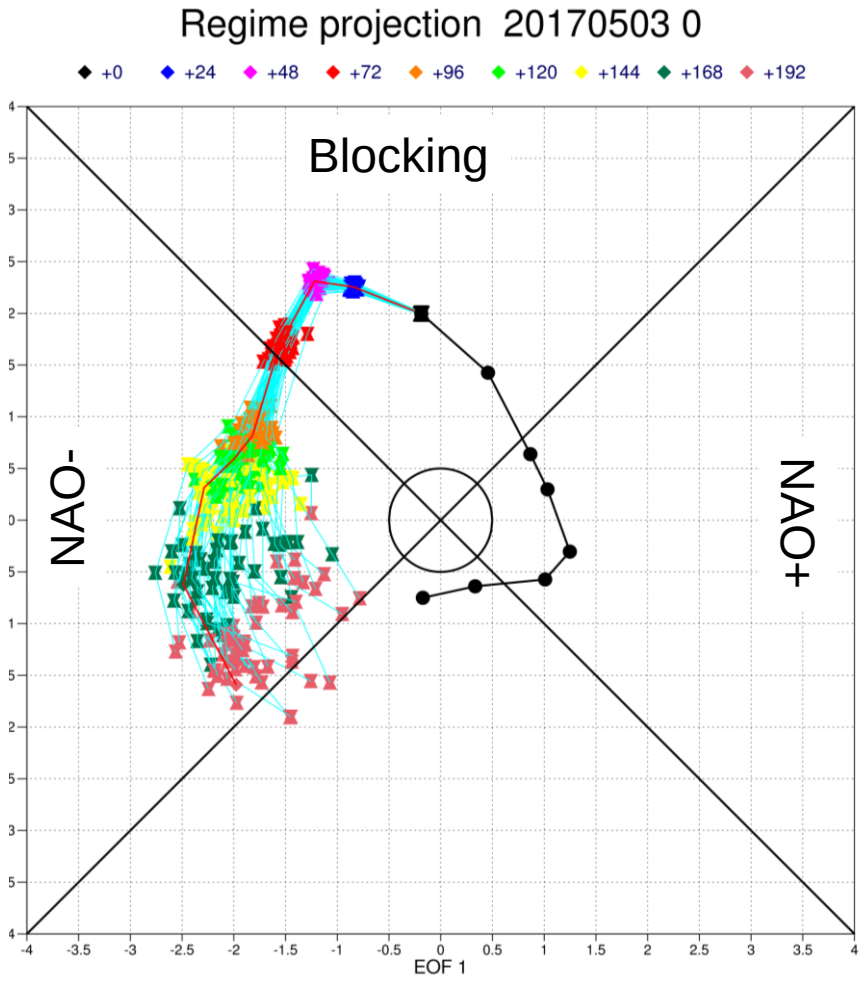
Distribution of severe winter (NDJF) events in era-interim (1980-2015)

When for 60% grid points in each box the daily 2mt < 10th quantile of daily climate for at least 4 consecutive days

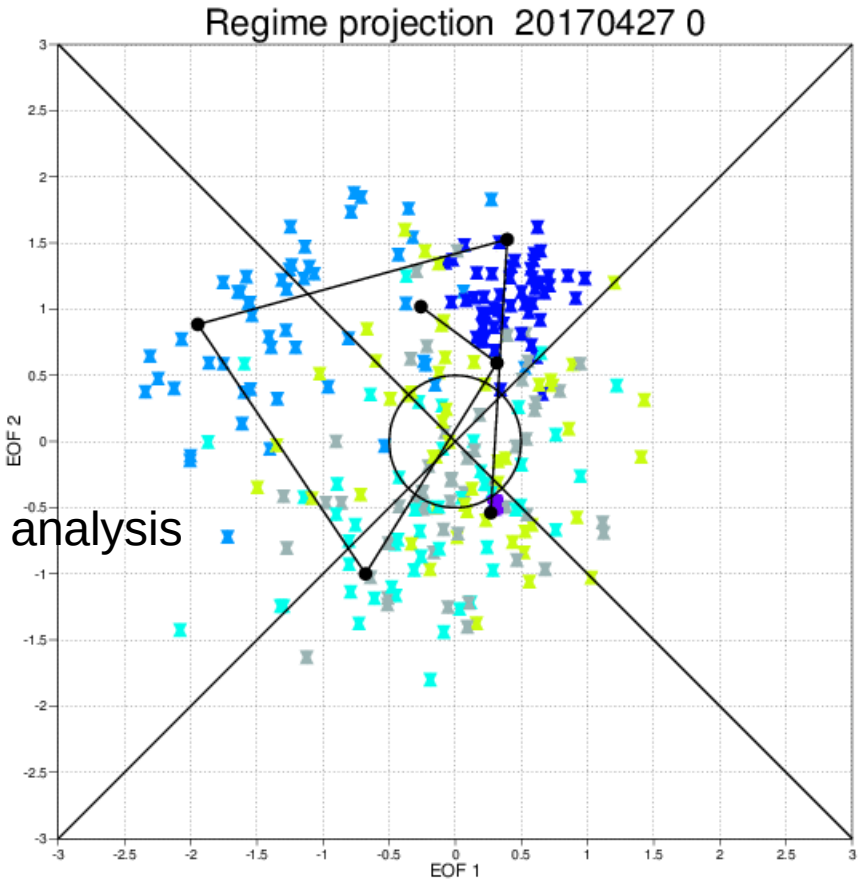


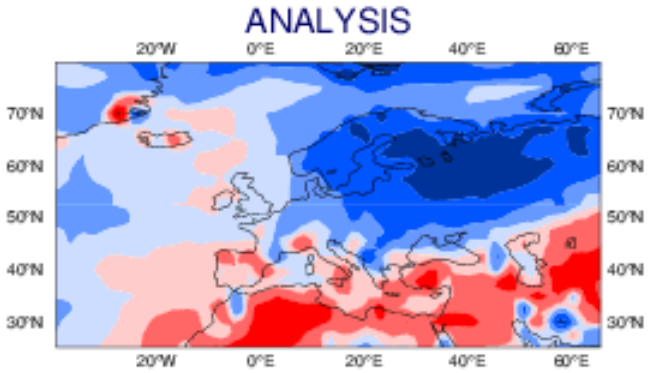
ECMWF ensemble predictions at medium range:

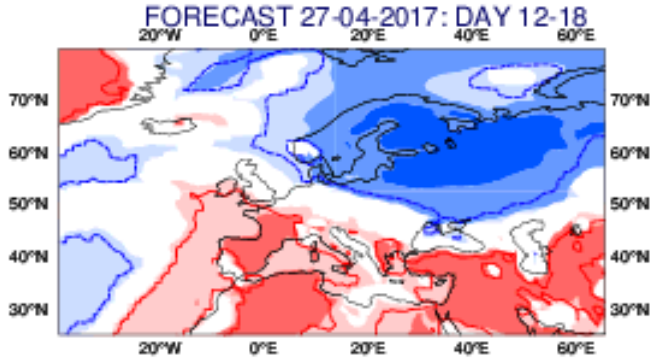




ECMWF Ensemble prediction at subseasonal range:





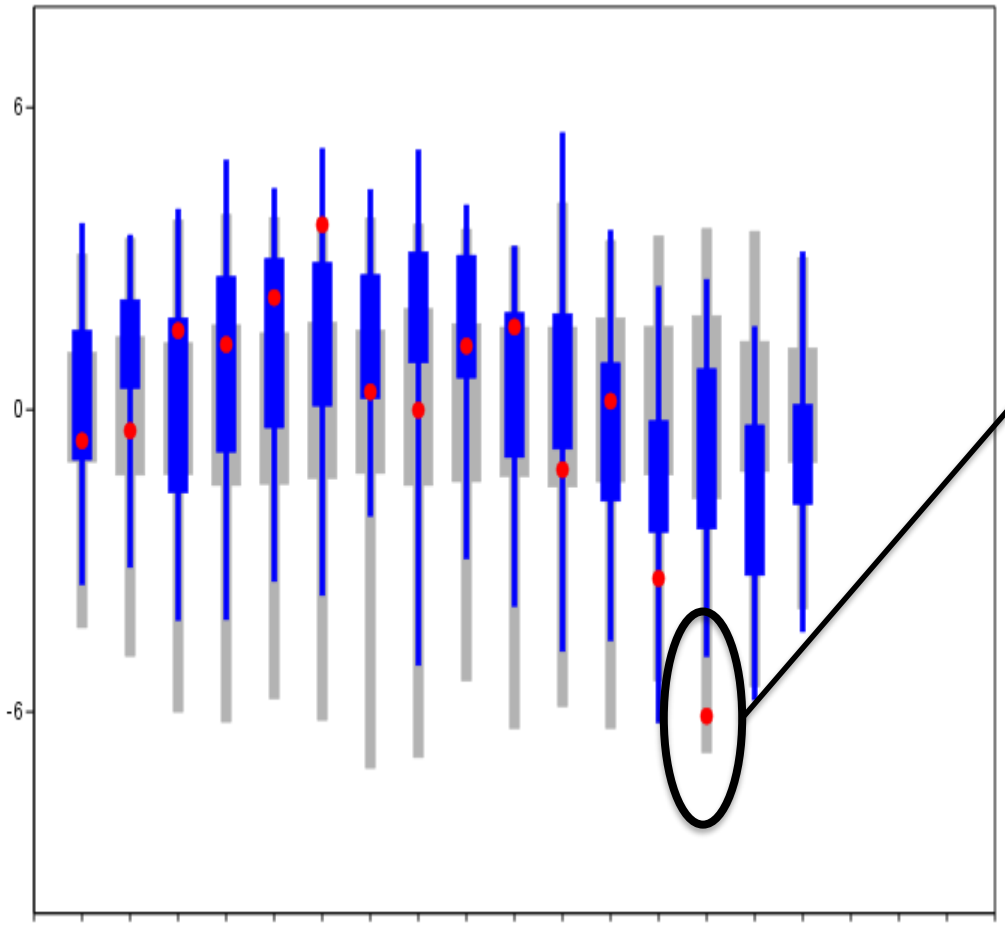


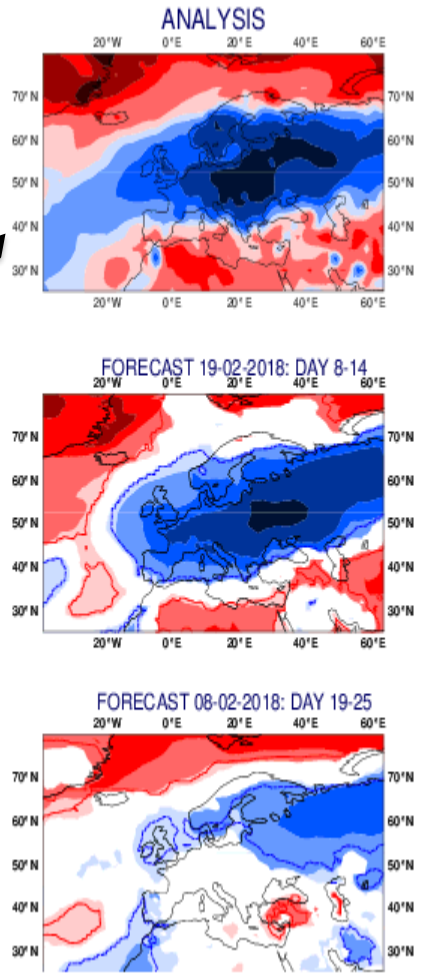
Verifying analysis

- Day 0
- Day+5
- Day+10
- Day+15
- Day+20
- Day+25

2mt over Europe weekly means anomalies at 19-25 days

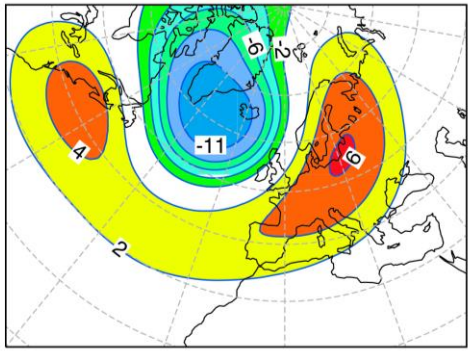
26/2-4/3 2018



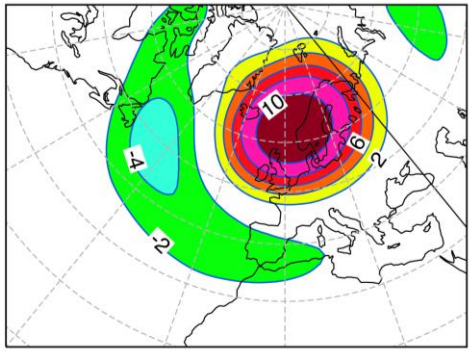


NAO-BL diagrams

The ensemble evolution in the NAO-Blocking diagram :

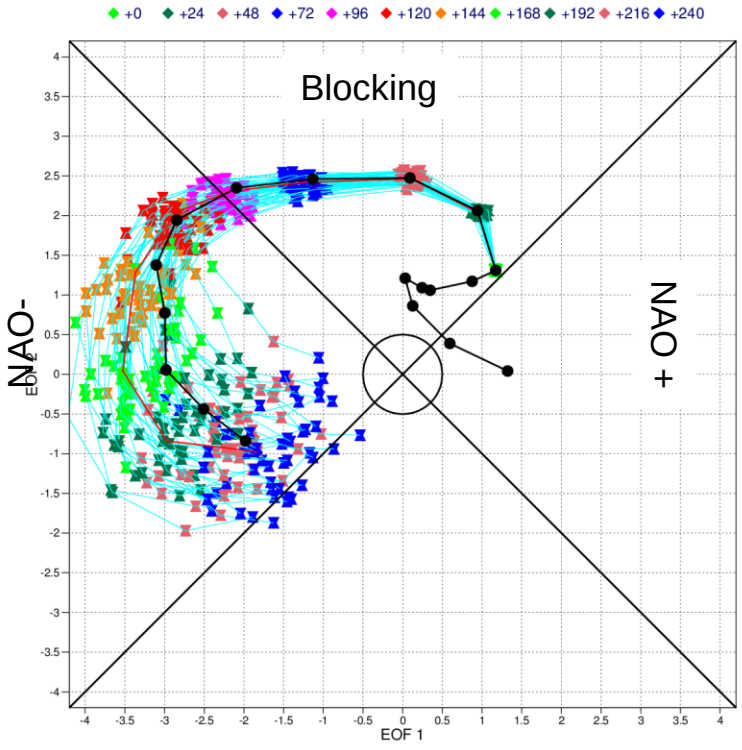


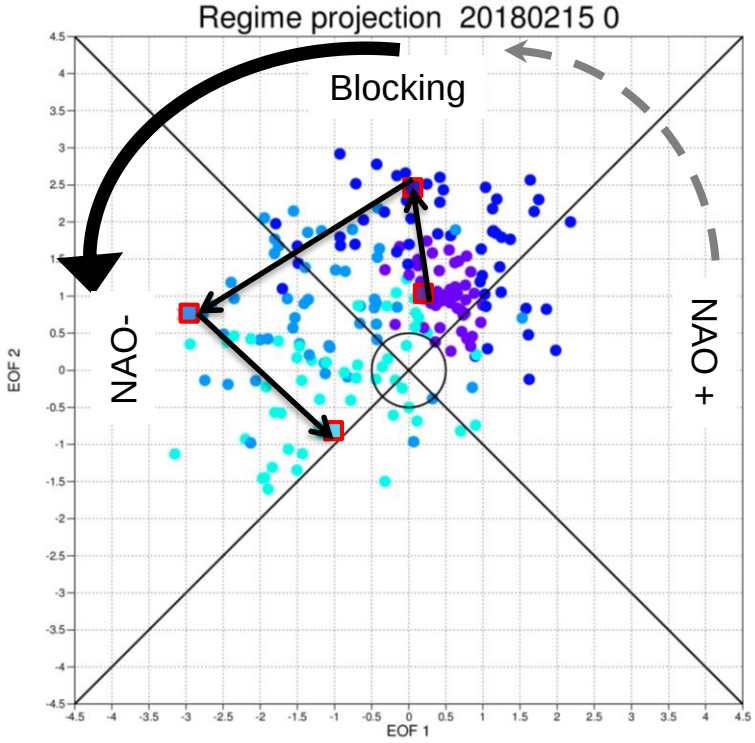
EOF1



EOF2

20170223
Forecast

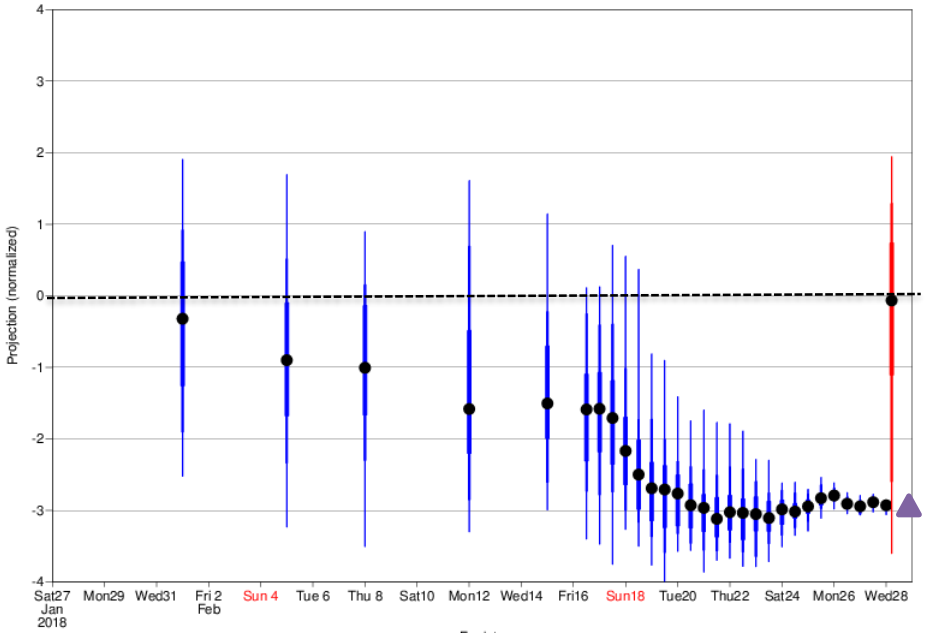




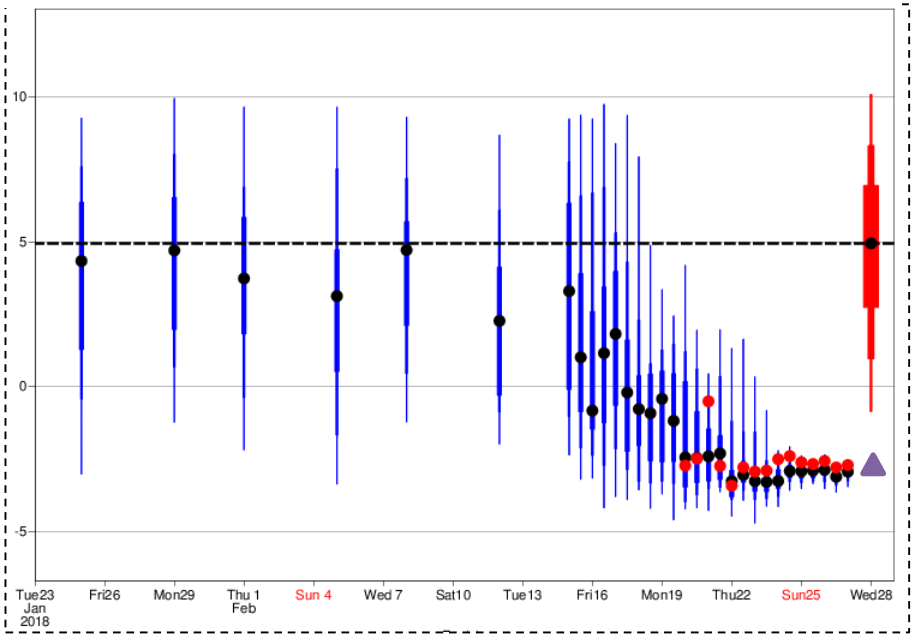
How far in advance we predicted this cold event ?

Predictions initialized at different time and verifying the 3-days mean (27 Feb to 1 March)

NAO predictions



2m temp. in Reading



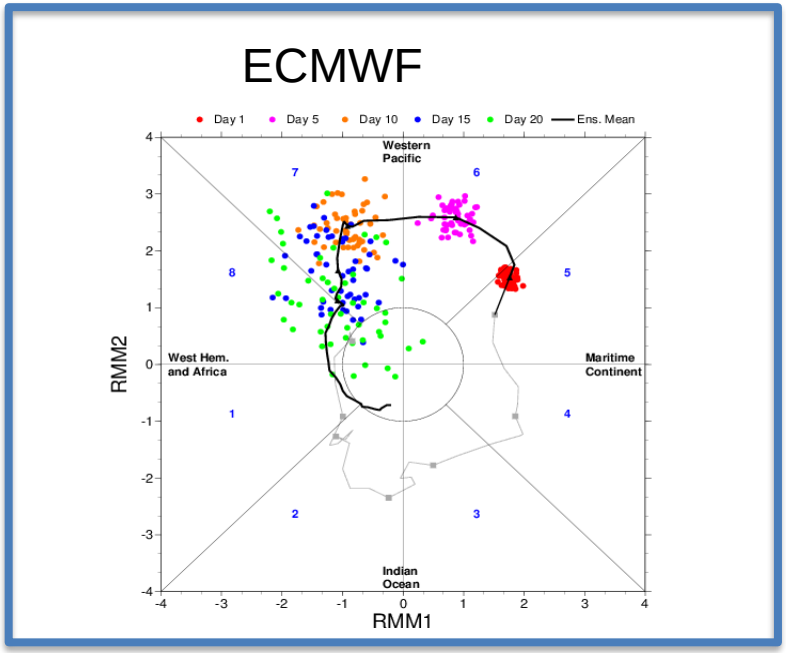
Thanks to
Linus Magnusson

MJO predictions from the S2S:

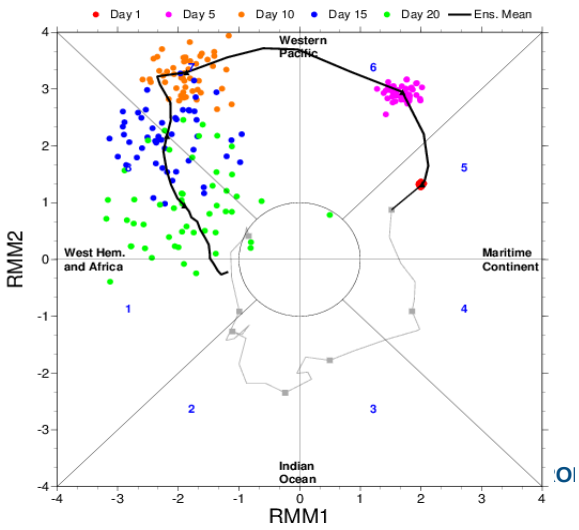
MJO predictions

Forecasts 25 Jan 2018

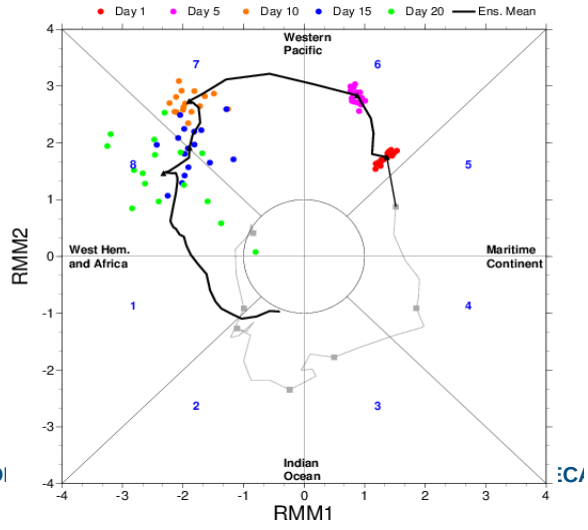
ECMWF



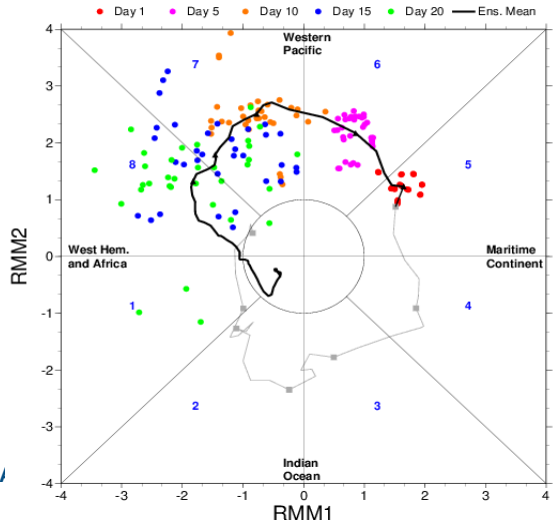
Meteo France



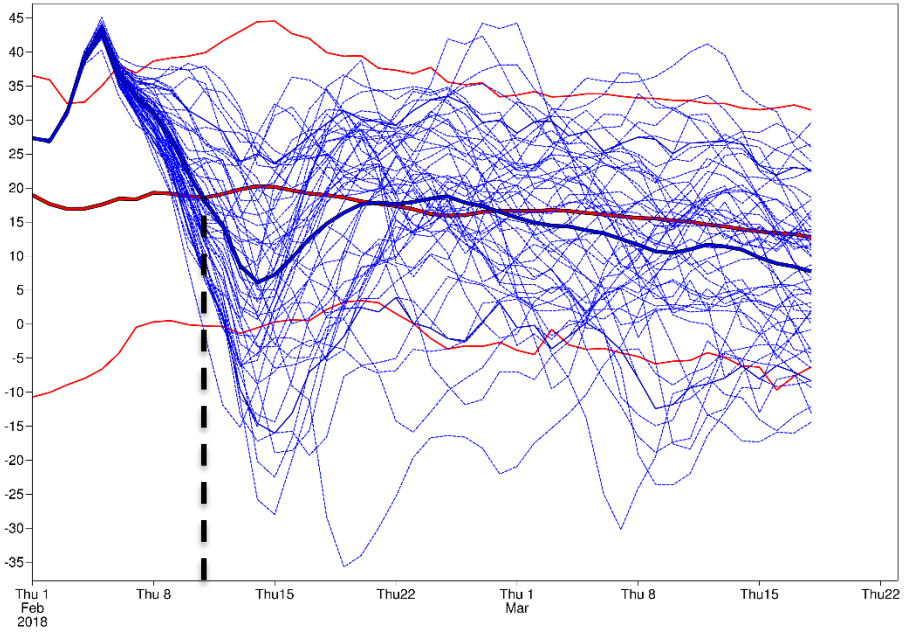
Ncep

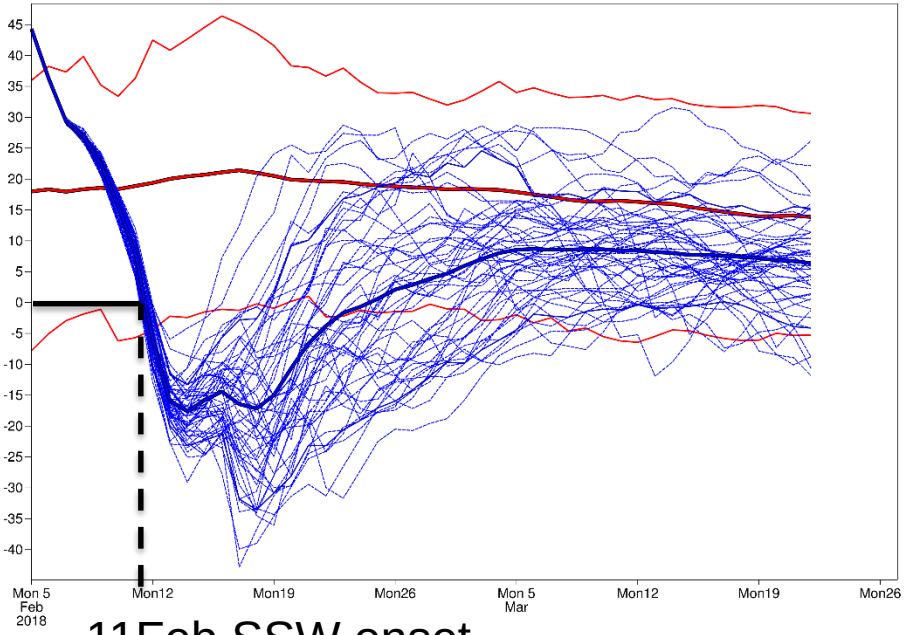


Bom



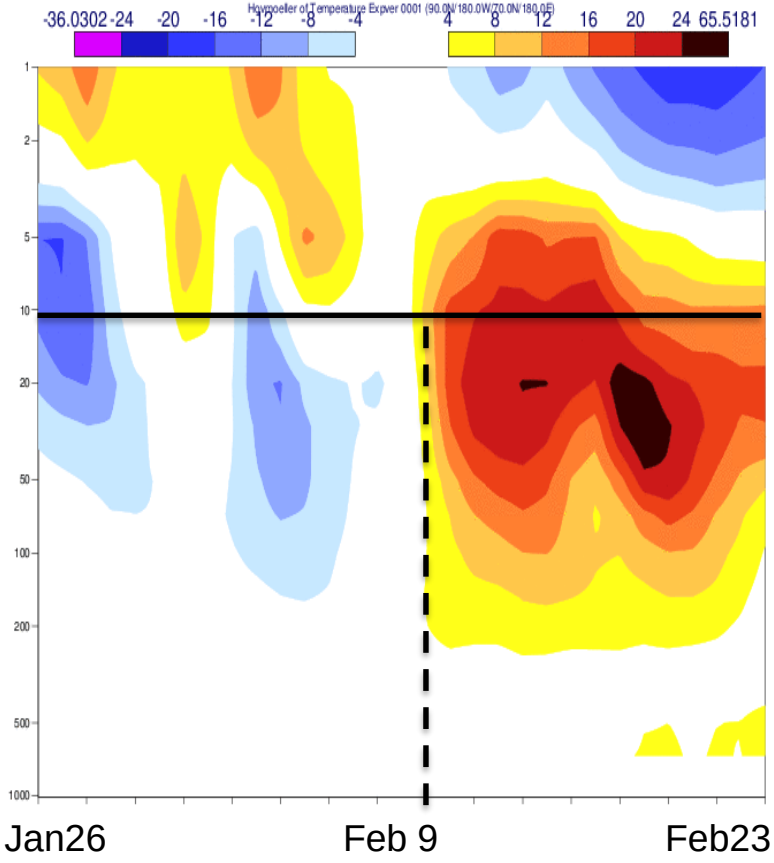
60N zonal mean zonal wind at 10hPa





11Feb SSW onset

Predictions of SSW:

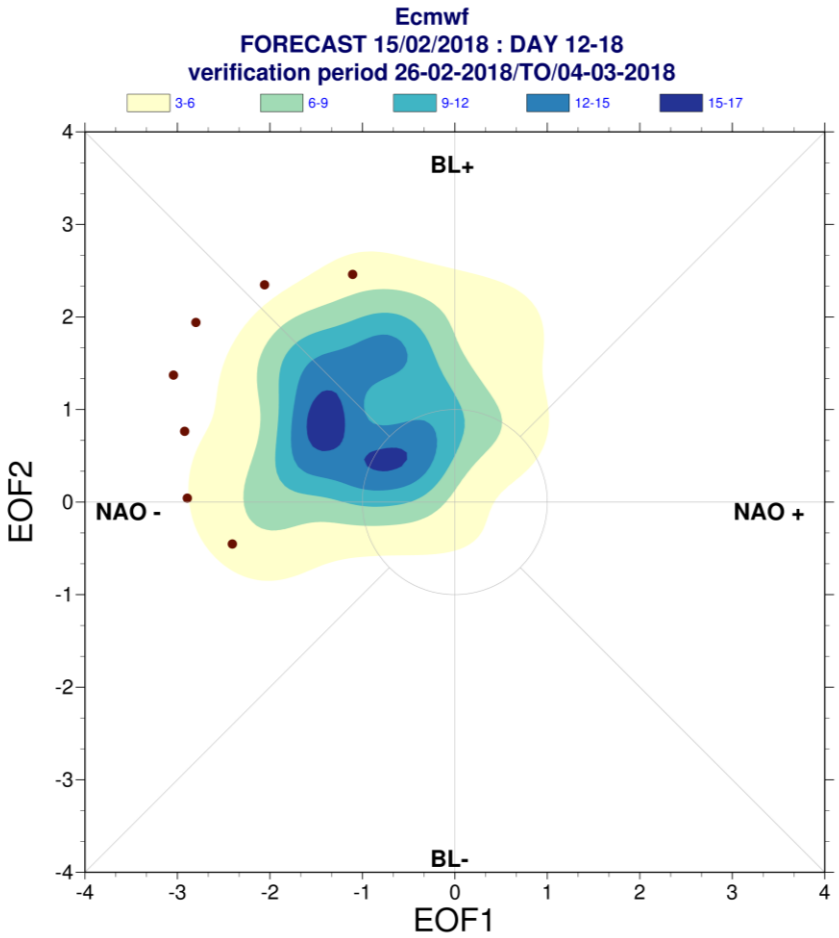


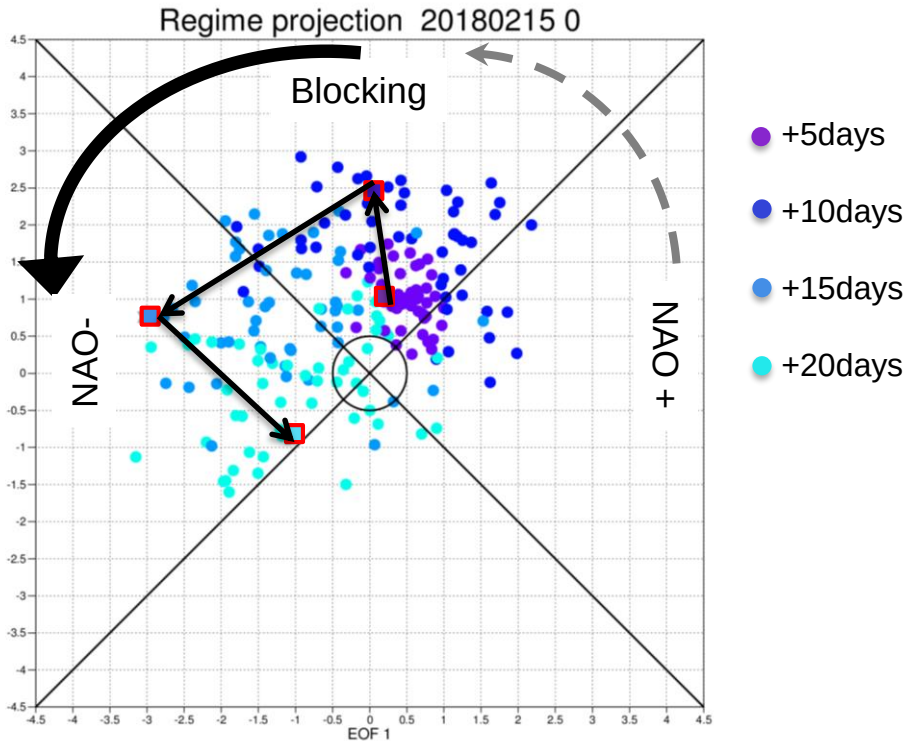
From Linus

NAO-BL diagrams for extended range forecasts:

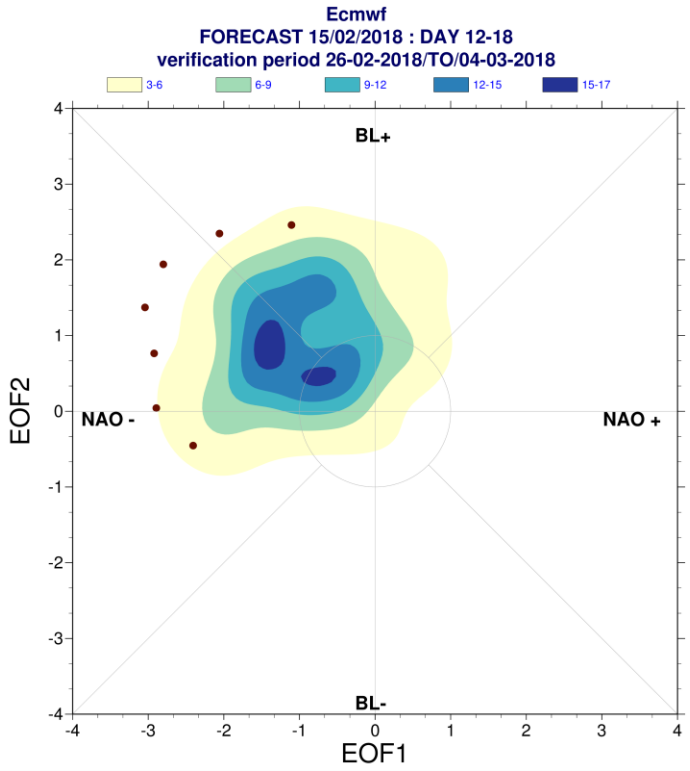
The ensemble evolution in the NAO-Blocking diagram :

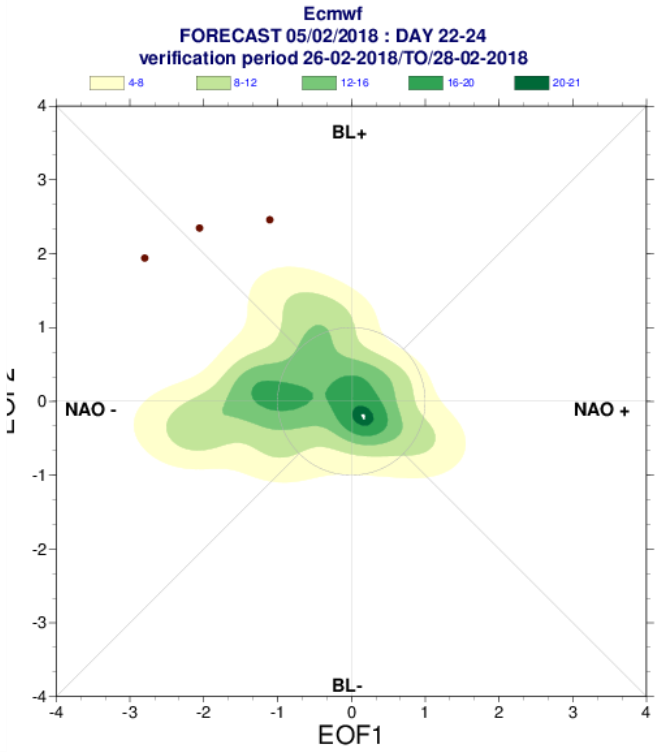
Probability density function versus instantaneous values





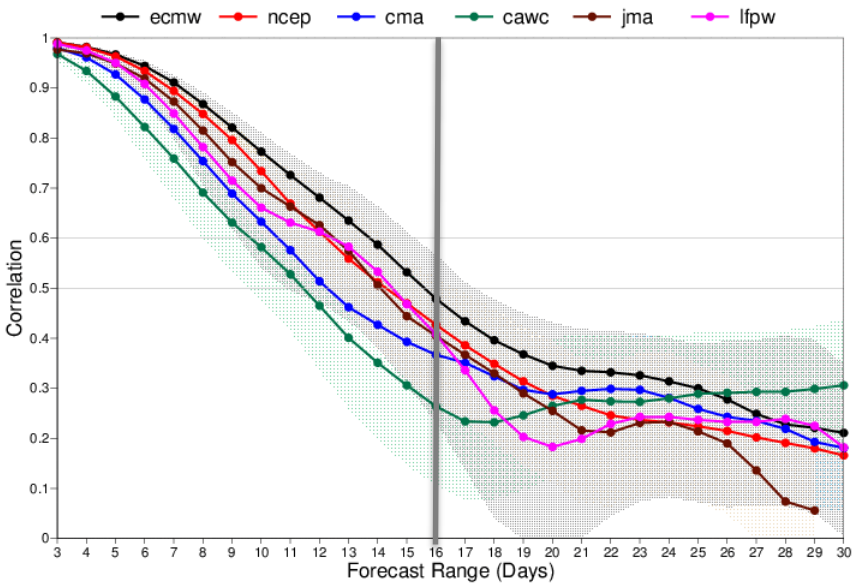
NAO-BL diagrams for extended range:



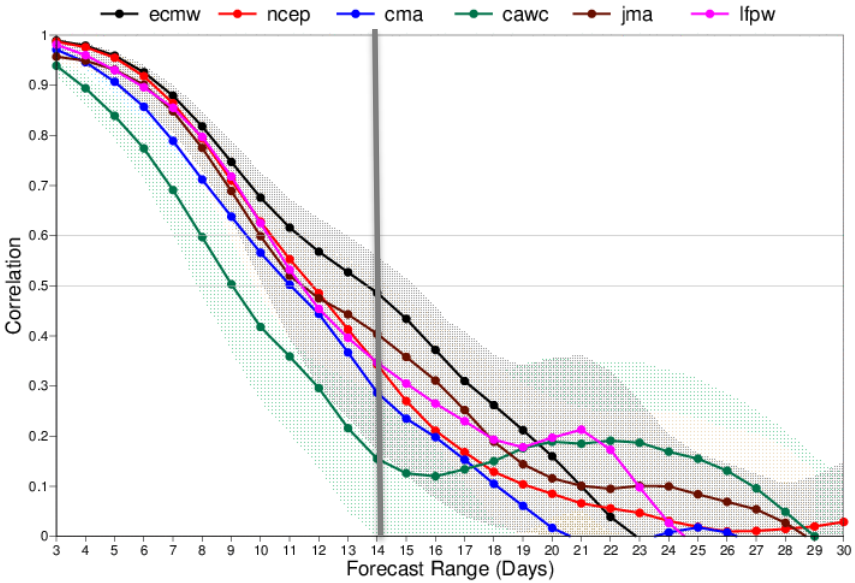


Anomaly correlation

EOF1

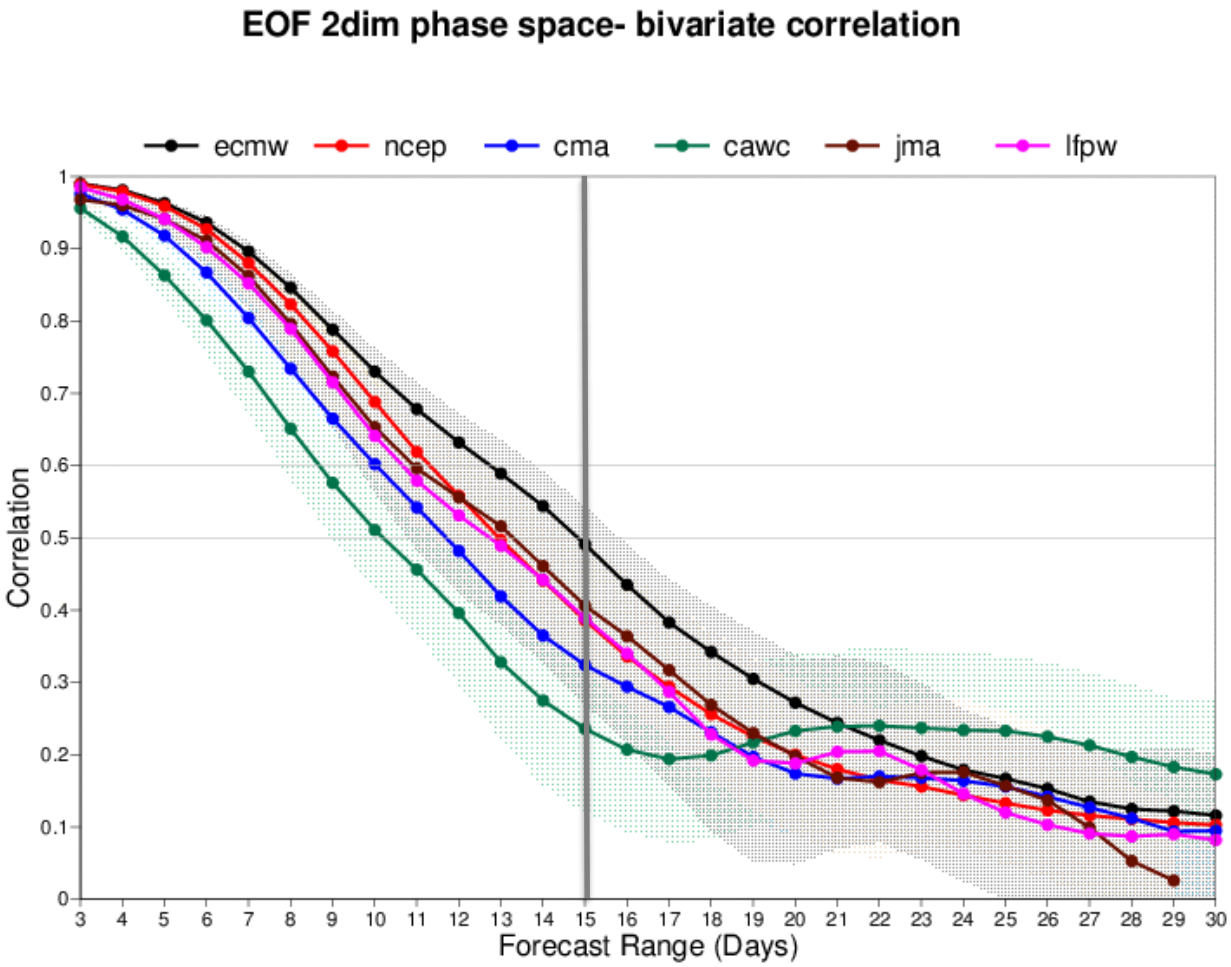


EOF2



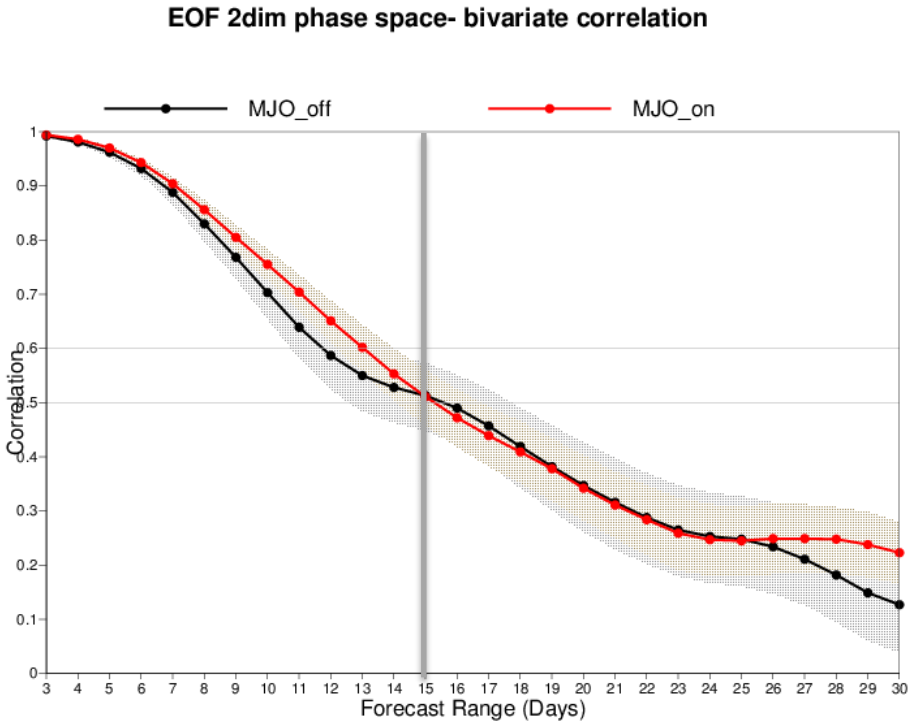
The NAO predictions (EOF1) are skillful up to 16 days ahead
The Blocking predictions (EOF2) up to 14 days

Regime transitions:



Lin et al. (2008)

Deterministic skill associated with MJO at I.C.



Summary

Transitions between regimes associated with high-impact temperature anomalies over Europe have been evaluated using a simple NAO-BL diagram based on the leading 2 EOFs. (Ferranti et al. 2018 QJRMS)

The NAO-BL diagram is effective in providing early warnings for severe cold spell over Europe and it will be made available to the users.

Predictions of stratosheric temperatures will be made available.

This winter we experience an NAO- event of massive amplitude that was predicted about 3 weeks in advance. The associated severe cold conditions were well represented by the weekly mean anomalies at 19-25.

The MJO and possibly the SSW might have played a role in enhancing predictability

Sub-seasonal predictions : S2S partners

	Time-range	Resol.	Ens. Size	Freq.	Hcsts	Hcst length	Hcst Freq	Hcst Size
ECMWF	D 0-46	T639/319L91	51	2/week	On the fly	Past 20y	2/weekly	11
UKMO	D 0-60	N216L85	4	daily	On the fly	1996-2009	4/month	3
NCEP	D 0-44	N126L64	4	4/daily	Fix	1999-2010	4/daily	1
EC	D 0-32	0.6x0.6L40	21	weekly	On the fly	1995-2014	weekly	4
CAWCR	D 0-60	T47L17	33	weekly	Fix	1981-2013	6/month	33
JMA	D 0-34	T319L60	25	2/weekly	Fix	1981-2010	3/month	5
KMA	D 0-60	N216L85	4	daily	On the fly	1996-2009	4/month	3
CMA	D 0-45	T106L40	4	daily	Fix	1886-2014	daily	4
CNRM	D 0-32	T255L91	51	Weekly	Fix	1993-2014	2/monthly	15
CNR-ISAC	D 0-32	0.75x0.56 L54	40	weekly	Fix	1981-2010	6/month	1
HMCR	D 0-63	1.1x1.4 L28	20	weekly	Fix	1981-2010	weekly	10

Summary:

discontinued- Current seasonal forecast products use a shorter climate (1993-2016) in line with C3S.

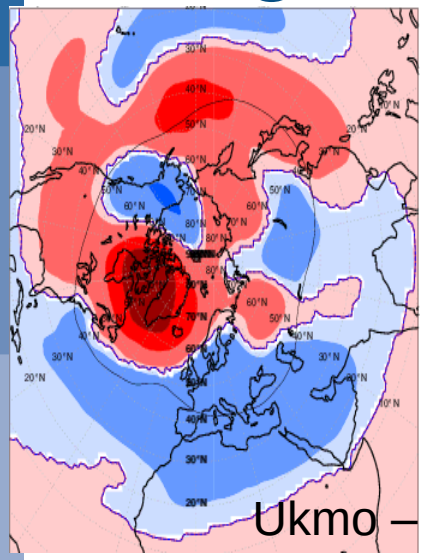
Attribution of seasonal mean anomalies using sub-seasonal forecasts and AMIP simulation is a useful diagnostic tool to develop. (possible collaboration with NCEP)

This winter we experience an NAO- event of massive amplitude that was predicted about 3 weeks in advance. The associated severe cold conditions were well represented by the weekly mean anomalies at 19-25.

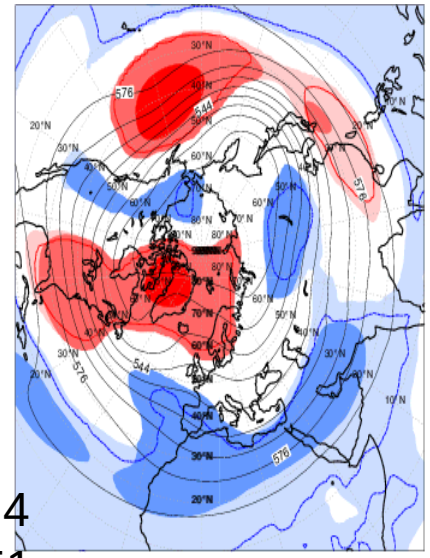
Some S2S forecasts show similar level of predictability for this NAO- event.

The MJO and possibly the SSW might have played a role in enhancing predictability.

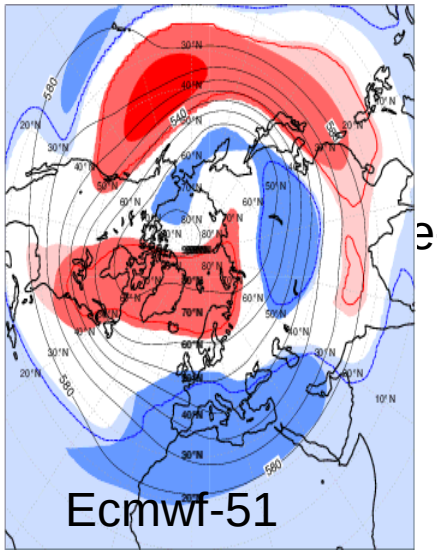
S2S Forecasts 20180208 verifying 0226-0304 fc-range 19-25



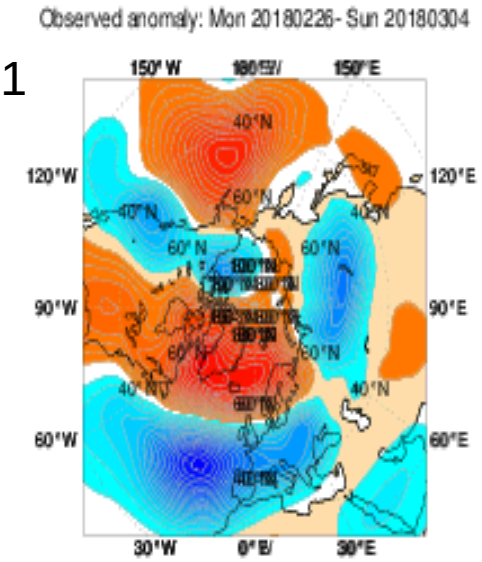
Ukmo – 4

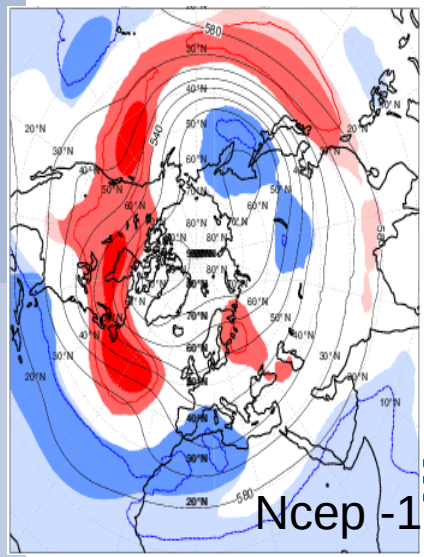


Met Fr-51

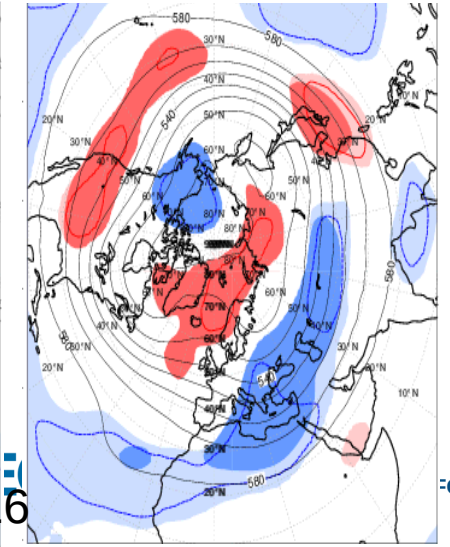


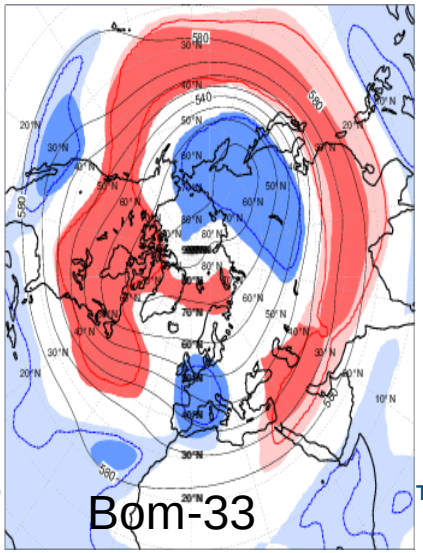
Ecmwf-51





Ncep -16





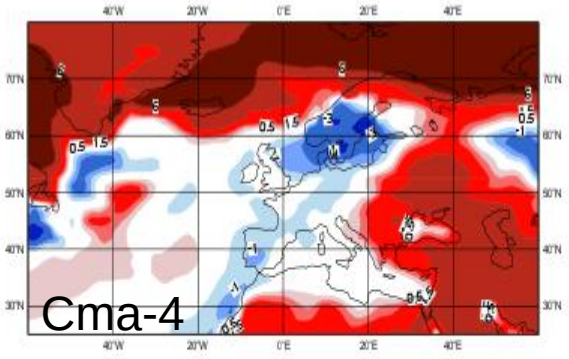
Bom-33

31

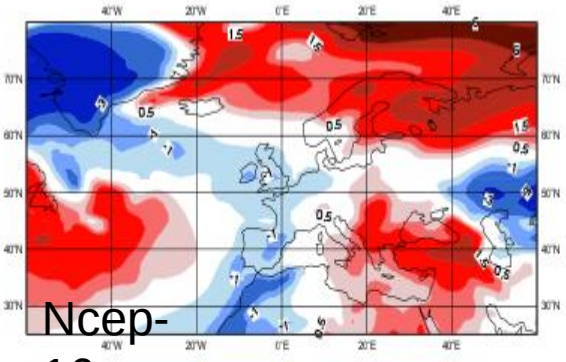
Jma-50

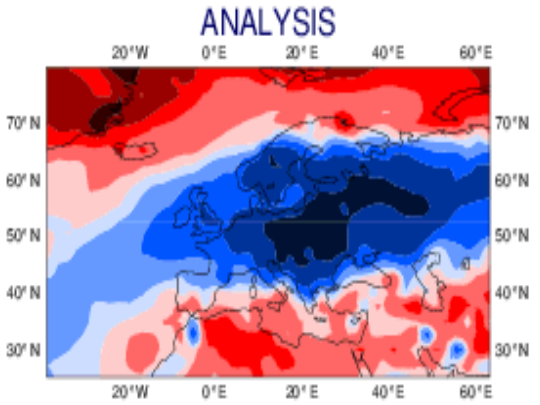
S2S Forecasts 20180208 verifying 02/26-03/

Cma-4

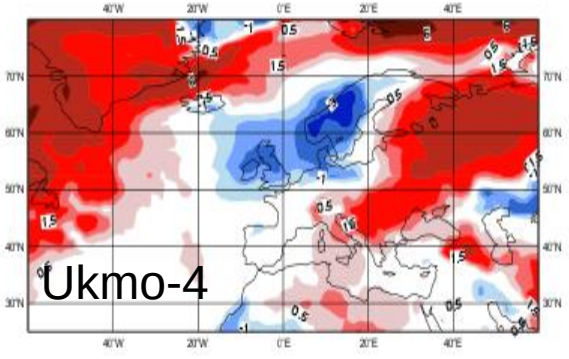


Ncep-16

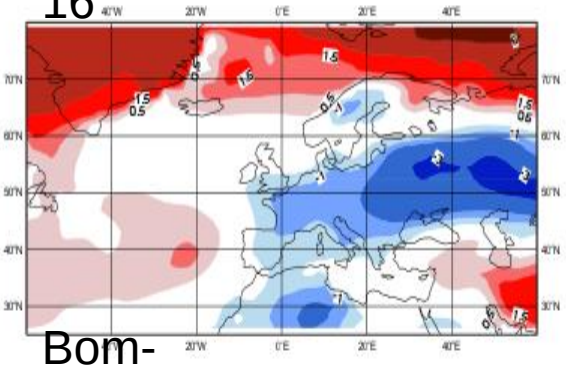




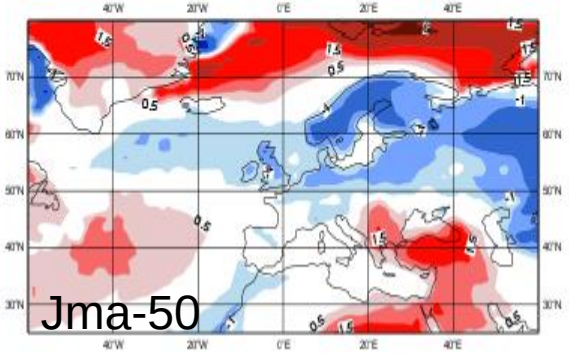
Ukmo-4

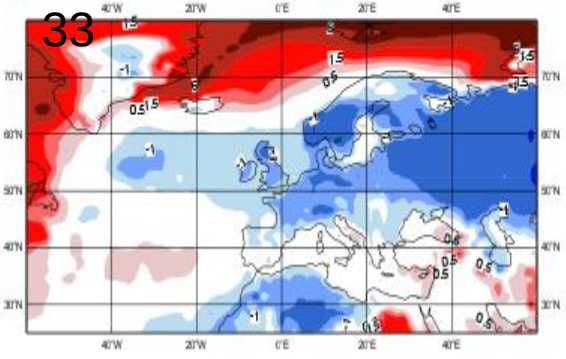


Bom-33

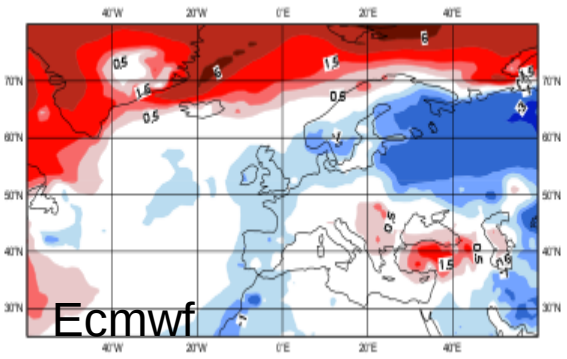


Jma-50





Ecmwf



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Summary:

This winter we experience an NAO- event of massive amplitude that was predicted about 3 weeks in advance. The associated severe cold conditions were well represented by the weekly mean anomalies at 19-25.

Some S2S forecasts show similar level of predictability for this NAO- event.

The MJO and possibly the SSW might have played a role in enhancing predictability further analysis is needed.