How far in advance can we predict changes in the large scale flow over the Euro-Atlantic sector?

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Sources of predictability at extended range :



Seasonal predictions : ENSO

Skill is mainly conditioned by ENSO



Fig. 1. Skill (times 100) of official 3-month U.S. temperature forecasts vs lead time (die-aways) for all 10 yr, 3 yr with strong ENSO episodes, and the 7 Other years.

From Livezey and Timofeyeva 2008

MJO role in modulating forecast skill over the extra-tropics:



The atmospheric predictability in midlatitudes depends on internal dynamics of midlatitudes variability and modulation by tropical forcing.

Less skill for forecast with an MJO events was attributed to the inability of the model to sustain the MJO beyond 7 days which contributes to erroneous Rossby wave sources.

Reduction of errors in the tropics (Ferranti et al. 1990) Good representation of the MJO (Hendon et al. 2000) Realistic response in the extra-tropics (teleconnections)

From Hendon et al. (2000)



MJO skill scores improvement:



2-metre temperature ROC area over Northern Extratropics



2-meter temperature anomalies over the Northern Hemisphere

EI 0.48



BoM 0.15



CNRM 0.15



UKMO 0.29

CMA 0.14



<-40m 0 - 10

-40m - - 30 10 - 20





JMA 0.22





NAO Index: mean=0, std=1.02



30 - 40

ECCC 0.21

NCEP 0.32

ISAC 0.25



ECMWF 0.31



-20m - -10 -10m - 0 >40m

Figure 7. Composites of 500 hPa geopotential height anomalies 11 - 15 days (third pentad) after a strong MJO (amplitude larger than 1) in Phase 3 (active phase of the MJO over the east Indian Ocean). Blue (red) colours indicate negative (positive) anomalies for ERA-Interim (top left panel) and ten S2S models. The composites have been calculated over the common reforecast period 1999 - 2010 (1999 - 2009 for UKMO) for the extended winter period (November - March). All the MJO events present during the first 20 days of model integrations were taken into account to produce the composites.

20 - 30

-30m - -20

Vitart 2017

ECCIVITY EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Impact of SSWs on skill scores

Impact of SSWs on forecast skill scores

CSS for 2-m temperature



From Tripathi et al. (2015)

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





Regimes based on clustering of daily anomalies for 29 cold seasons (1980-2008)





- Heat/cold waves have a strong societal impact. The prediction of such events (onset maintenance and decay) a few weeks in advance would be very valuable.
- Vitart (2005) showed that the ECMWF ensemble had some skill in predicting the maintenance of the heat wave during the 2003 summer, but that the predictions of the onset and decay were less successful.
- Strong and persistent large scale high pressure systems are often associated with dry-spells, and with heat-waves in summer and cold-spells in winter. Accurate forecasts of transition to anti-cyclonic flow regimes are therefore crucial for heat/cold wave predictions.
- Here we explore the ability of the sub-seasonal forecast systems to predict the winter large-scale circulation patterns that are generally associated with cold spells over Europe.



Why looking at weather regimes?



- They are often associated with high impact temperature events (e.g. dry spells /heat waves in summer and cold spells in winter).
- With their large scale patterns and tendency to persist for a week or longer are the type of events that could be predicted beyond 10 days.
- They can be associated with global teleconnections (Cassou 2008: Lin et al. 2009).

Predicting skill associated with the Euro-Atlantic Regimes:

NAO+





--- Ifpw

22 23 24 25

21 22 23 24

25 26 27 28 29 30

Ifpw



Framework to evaluate regimes transitions:

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



Based on 5-day running means



+NAO: exceptional storminess, but mild temperatures over Europe

CECMWF

2m temperature anomalies (era-interim)

DJF 2009/10

DJF 2013/14





ECMWF ensemble predictions at medium range:



CECMWF

ECMWF Ensemble prediction at subseasonal range:







ECMWF MONTHLY FORECASTS

FORECAST BASED 01/05/2017 00UTC

ECMWF MONTHLY FORECASTS FORECAST BASED 04/05/2017 00UTC





S2S reforecasts data used for the skill assessment:

model	Bom	Cma	Ecmwf	Ncep
Rfc. lenght	0-60 days	0-60days	0-46 days	0-44 days
Resol.	T47L17	T106L40	T639/319 L91	T126L64
Rfc. size	33	4	11 (4
Rfc. period	1981-2013	1994-2014	1994-2014	1999-2010
Rfc. Freq.	6/months	daily	2/weekly	daily

In order to increase the Cma and Ncep ensemble size, we have combined 3 ensemble forecasts (initiated on consecutive days) into a single 12-member ensemble. (We define the initial date to be that of the central sub-ensemble; this has little effect on results at extended leadtimes).







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



Regime transitions:

EOF 2dim phase space- bivariate correlation



Lin et al. (2008)

CECMWF





Spread/rmse



CECMWF

Extended range forecast:

Regime projection 20170503 0

EOF 1 0.5

1.5

2 2.5 3 3.5

-0.5



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-4+ -4

-3.5 -3 -2.5 -2 -1.5

Deterministic skill associated with MJO at I.C.

EOF 2dim phase space- bivariate correlation





Brier Skill Scores associated with MJO at IC :

Positive NAO



For the NAO+ predictions the skill sensitivity to MJO is small and not significant



Brier Skill Scores associated with MJO at IC :

Negative NAO



Summary

Forecast skill at sub-seasonal and seasonal range is conditioned by the main modes of tropical variability (ENSO and MJO).

The accuracy of sub-seasonal and seasonal forecasts depend upon the model ability to represent tropical-extratropical interactions (teleconnections).

Using the S2S archive we can evaluate the skill in predicting regimes and regime transitions, from medium to extended range.

Transitions between regimes associated with high-impact temperature anomalies over Europe are evaluated using a simple 2-dim diagram based on the leading 2 EOFs.

The ECMWF model is able to reproduce the preferred transitions with good accuracy even beyond the medium range. (no bias)

Some S2S systems show skill beyond 10 days.

Forecasts initiated with an MJO show higher skill in predicting NAO- but not in predicting NAO+ (asymmetry).

Scandinavian Blocking





Anti-blocking (Atlantic Ridge type)





BSS for NAO negative vs MJO phases:





BSS for NAO positive vs MJO phases:





BSS for Blocking negative :





BSS for Blocking:



PC2

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S2S reforecasts data used for the skill assessment:

model	Bom	Cma	Ecmwf	Ncep	jma	Met France
Rfc. lenght	0-60 days	0-60days	0-46 days	0-44 days	0-33	0-61
Resol.	T47L17	T106L40	T639/319 L91	T126L64	T319L60	T255L91
Rfc. size	33	4	11	4	5	15
Rfc. period	1981-201 3	1994-201 4	1994-2014	1999-20 10	1981-201 0	1993-201 4
Rfc. Freq.	6/months	daily	2/weekly	daily	3/month	2/month

In order to increase the Cma and Ncep ensemble size, we have combined 3 ensemble forecasts (initiated on consecutive days) into a single 12-member ensemble. (We define the initial date to be that of the central sub-ensemble; this has little effect on results at extended leadtimes).

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