MJO phase impact on Euro-Mediterranean winter season storm activity

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- -MJO impact over NAO

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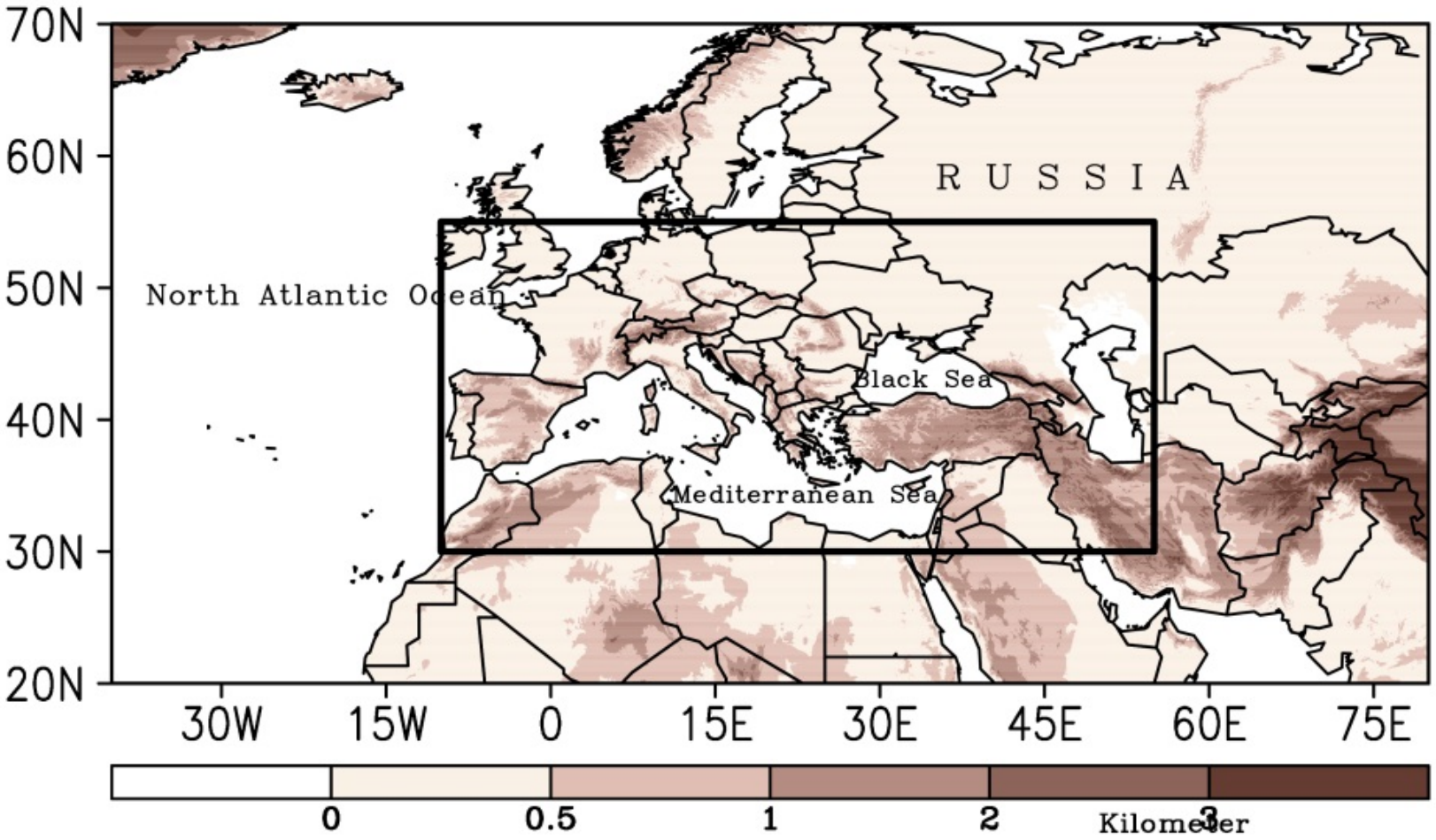
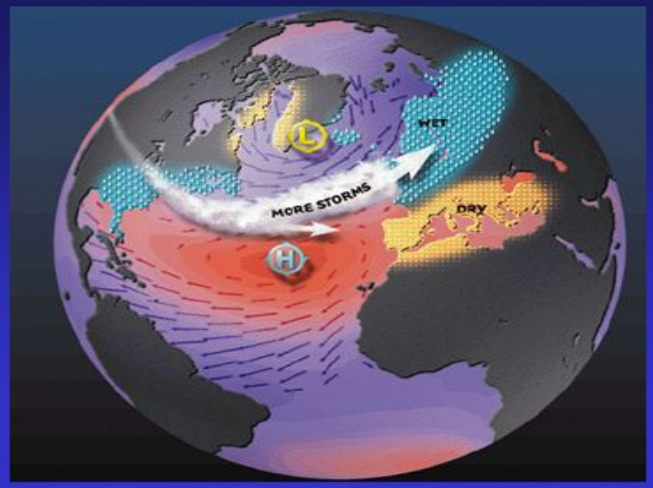
Study Domain



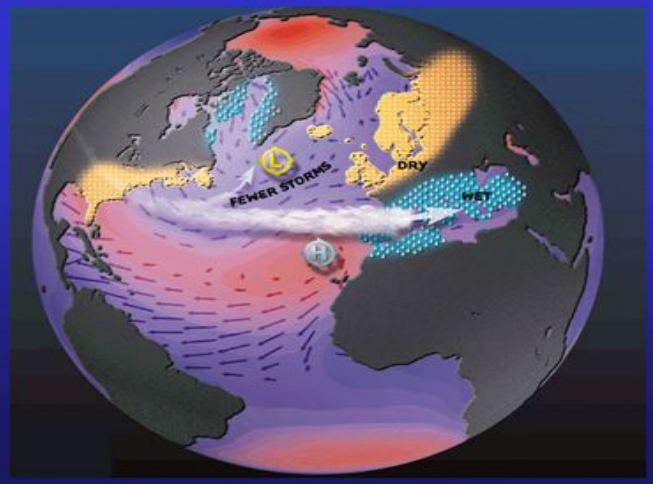
North Atlantic Oscillations (NAO) phases

The two phases of NAO:

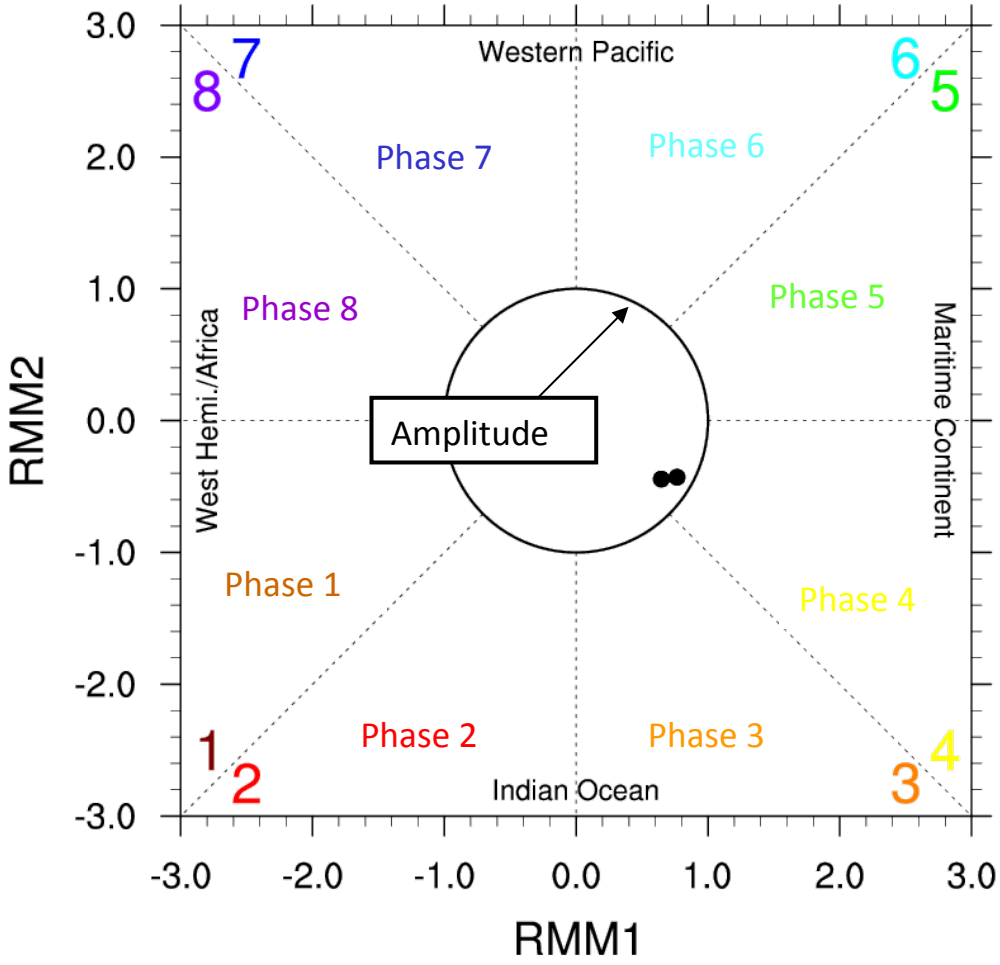
- **The positive phase** shows a stronger than usual subtropical high pressure center and a deeper than normal Icelandic low.The increased pressure difference results in more and stronger winter storms crossing the Atlantic Ocean on a more northerly track.This results in warm and wet winters in Europe and in cold and dry winters in northern Canada and Greenland. The eastern US experiences mild and wet winter conditions.



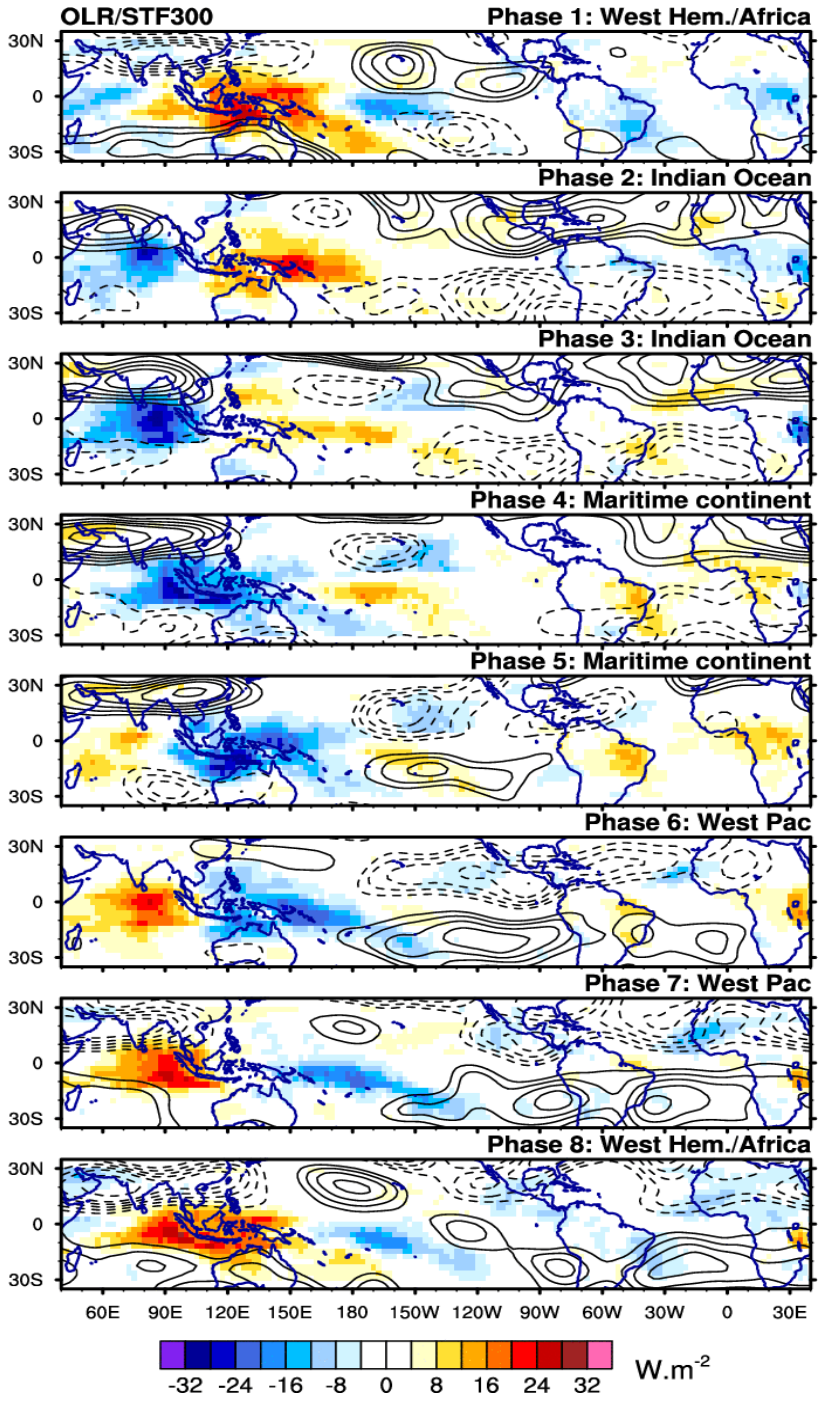
- **The negative phase** shows a weak subtropical high and a weak Icelandic low.The reduced pressure gradient results in fewer and weaker winter storms crossing on a more west-east pathway.They bring moist air into the Mediterranean and cold air to northern Europe. The US east coast experiences more cold air outbreaks and hence snowy weather conditions.Greenland, however, will have milder winter temperatures.



The MJO in the EOF space



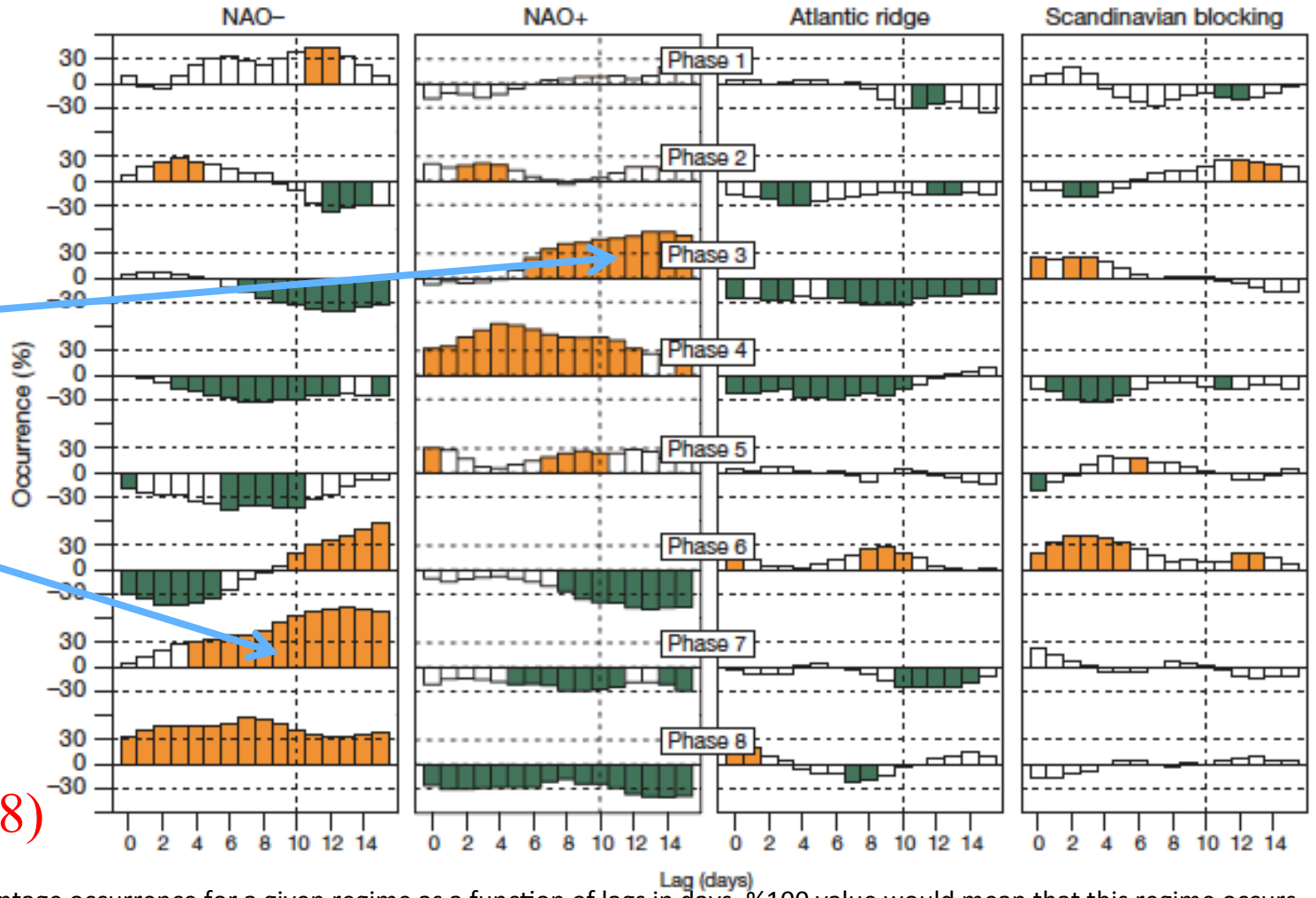
The 8 phases can be spanned in the 2 first EOFs
From combined thermodynamical (OLR) and dynamical (NCEP) fields



MJO impact over NAO

The relationship between the MJO phase and the anomalous frequency of occurrence as a function of lead time for 4 teleconnection patterns

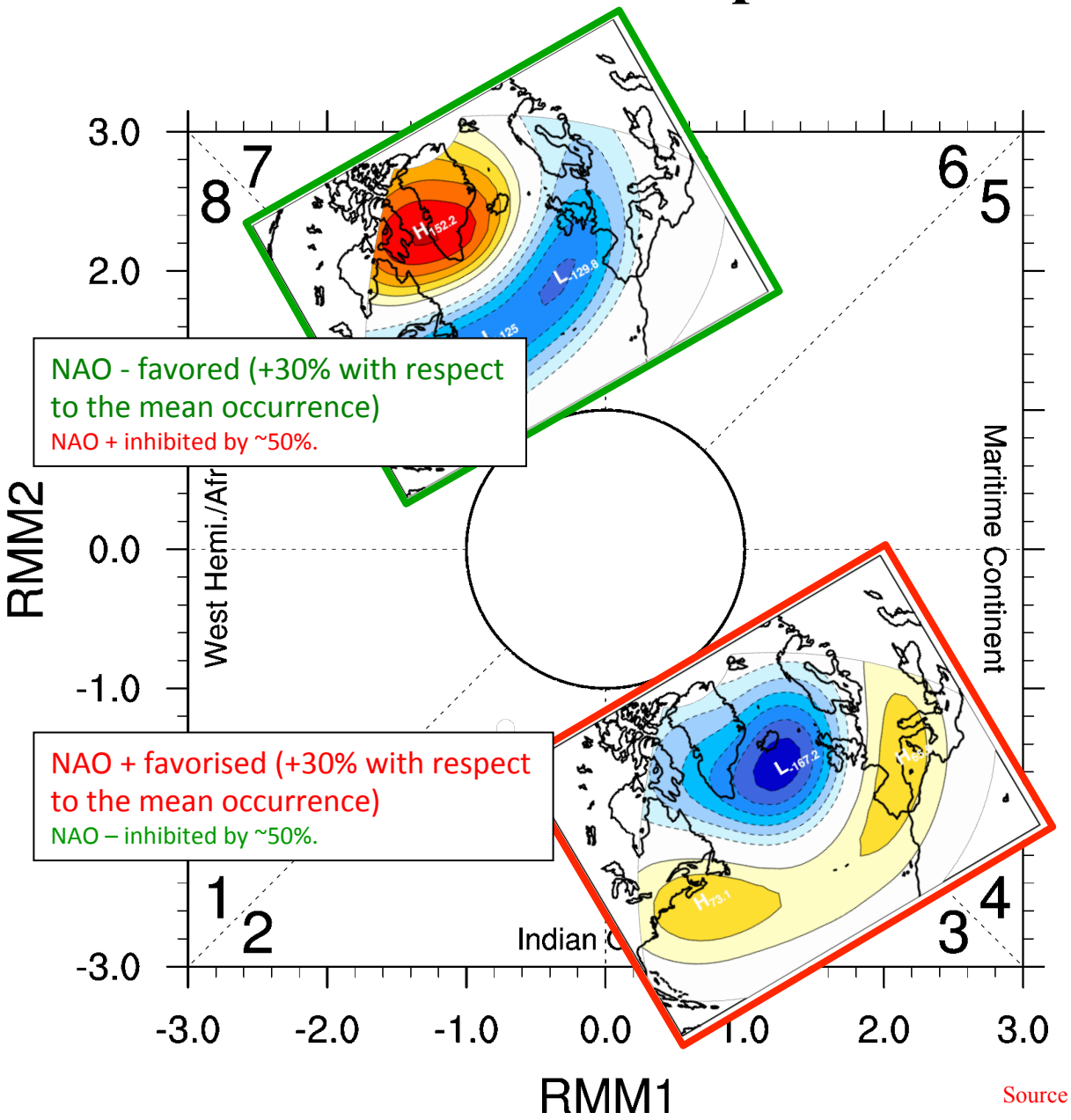
The MJO has a big influence on both NAO phases



Cassou (2008)

Anomalous percentage occurrence for a given regime as a function of lags in days. %100 value would mean that this regime occurs twice as
frequently as its climatological mean.

The MJO as a precursor for NAO



MJO leading by 5 to 10 days the NAO response

Source : Cassou (Nature, 2008), Vitard and Molteni 2010.

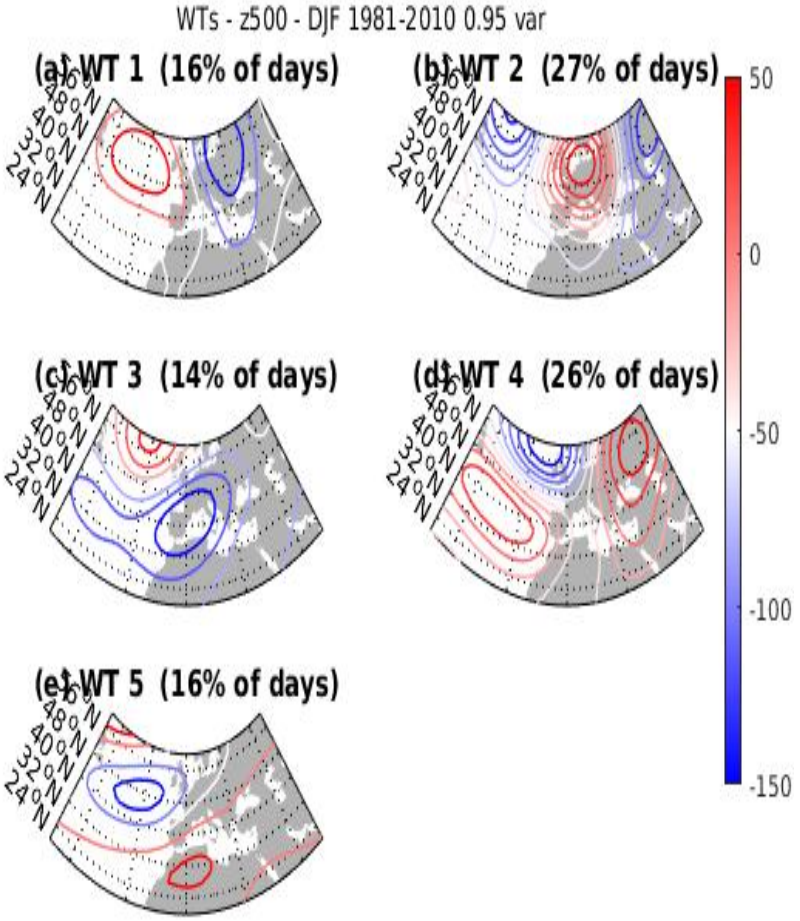
Objectives

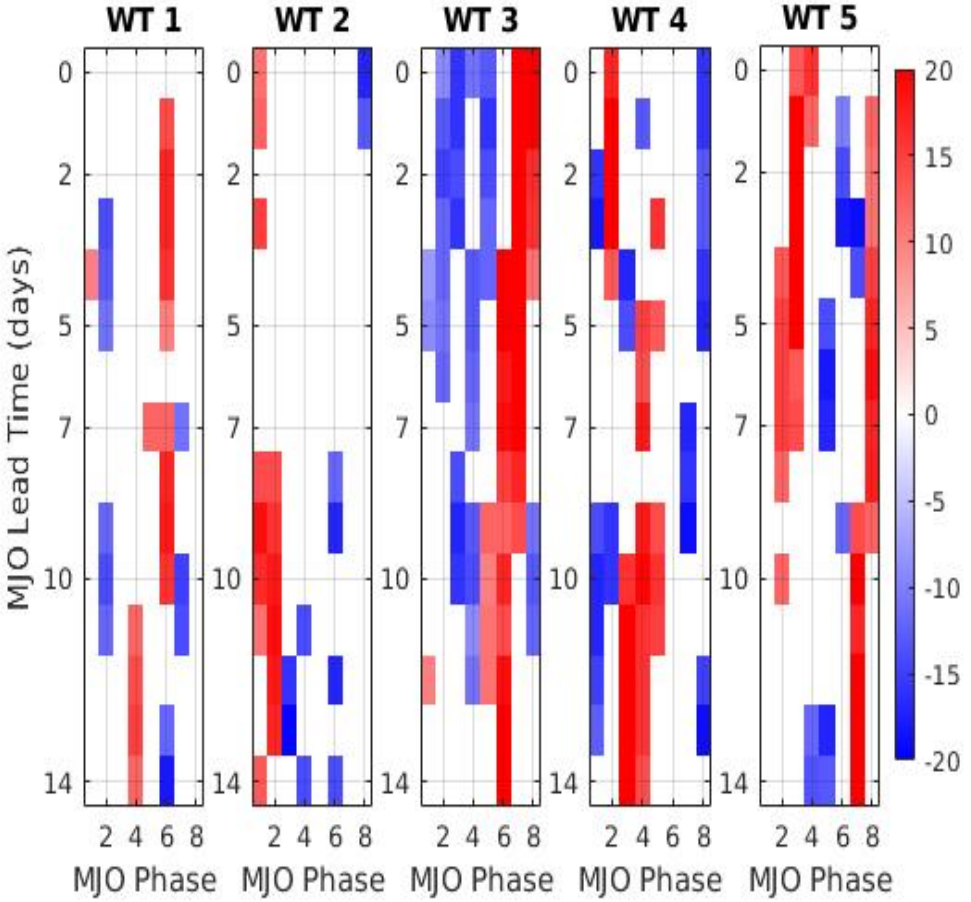
- To improve forecast skills and understanding on the subseasonal timescale
- To implement community-based Early warning Systems for extreme events
- Weather prediction signals for the Study domain the subseasonal timescale
- Impact of MJO phases on Extra-tropical storm trajectories over North Atlantic Ocean

Experimental Setup

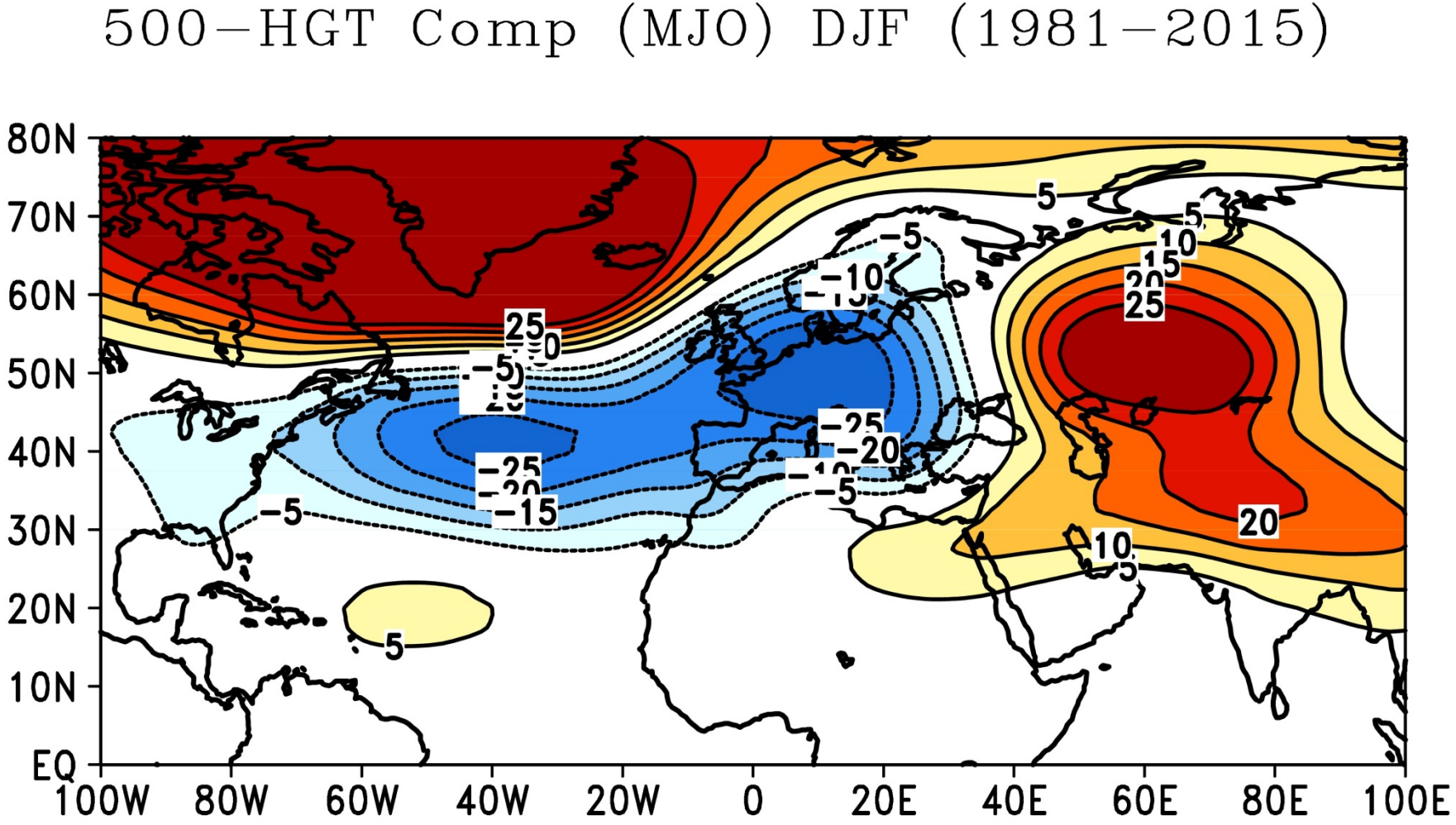
- **Observational datasets**
  - 200-hPa 6-hourly geopotential dataset from NCEP/NCAR with 2.5 x 2.5 degree resolution (1948-2016) for storm tracking analysis
  - Daily geopotential dataset from NCEP/NOAA {iridl.ldeo.columbia.edu} to construct the Weather types composites.
  - Climate prediction indices {iridl.ldeo.columbia.edu}
- **Methodology**

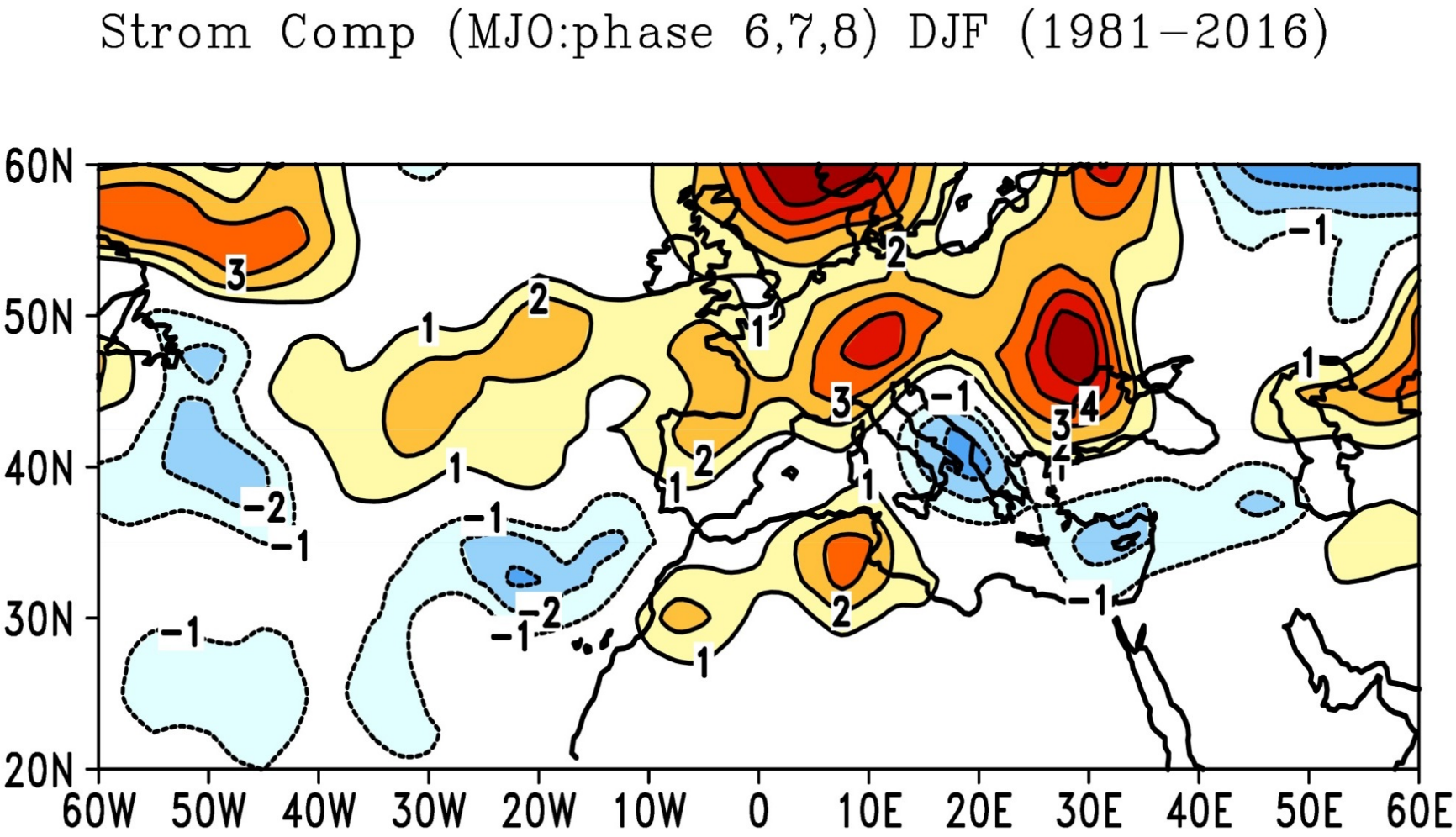
MS scheme is used to track the extra-tropical storm centers at 200-hPa geopotential height (Murray and Simmonds,1991(a,b) for the composite analysis with MJO

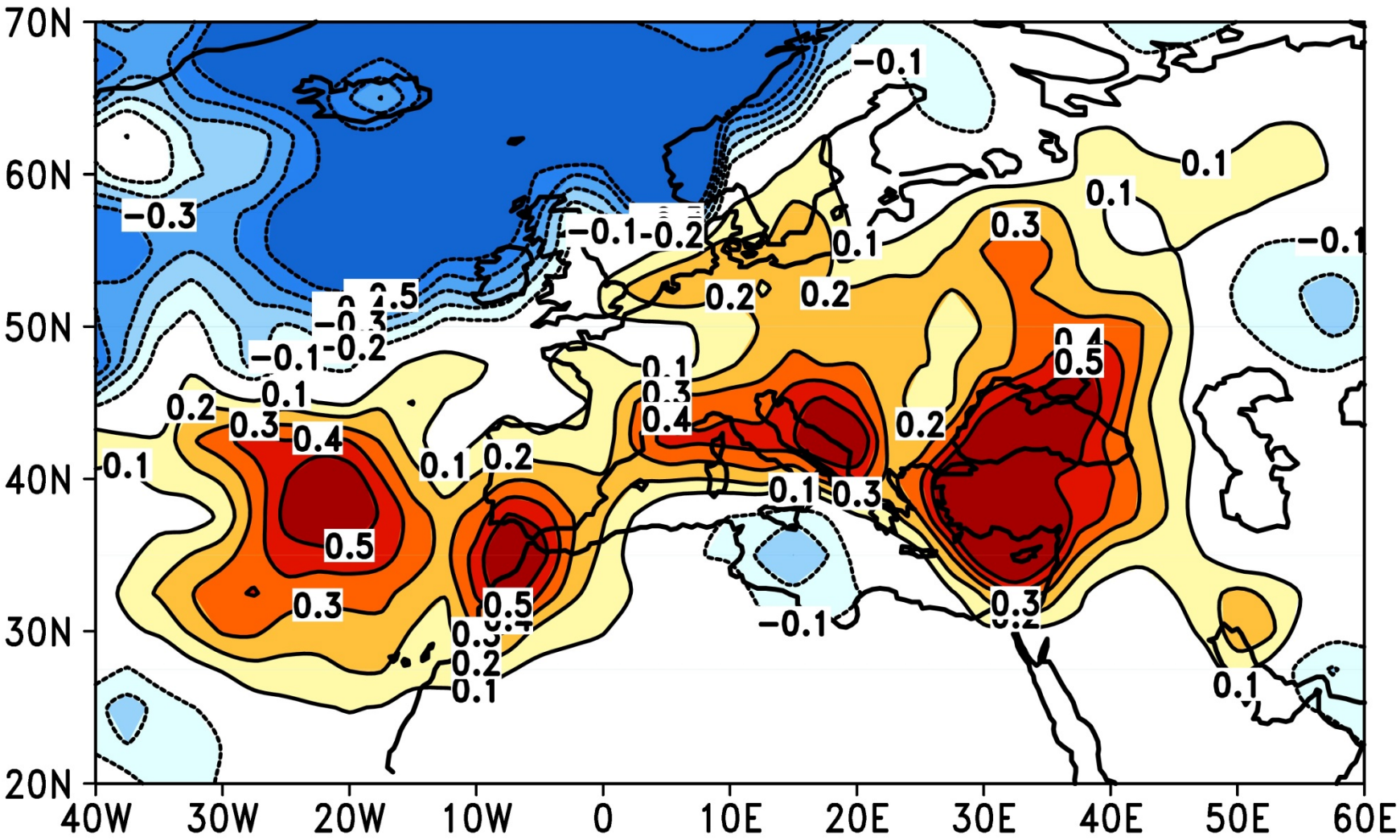

WTs - z500 - DJF 1981-2010 0.95 var
(a) WT 1 (16% of days)
(b) WT 2 (27% of days)
(c) WT 3 (14% of days)
(d) WT 4 (26% of days)
(e) WT 5 (16% of days)
64oN
48oN
40oN
32oN
24oN
50
0
-50
-100
-150


WT 1
WT 2
WT 3
WT 4
WT 5
MJO Lead Time (days)
0
2
5
7
10
14
2 4 6 8
MJO Phase
20
15
10
5
0
-5
-10
-15
-20

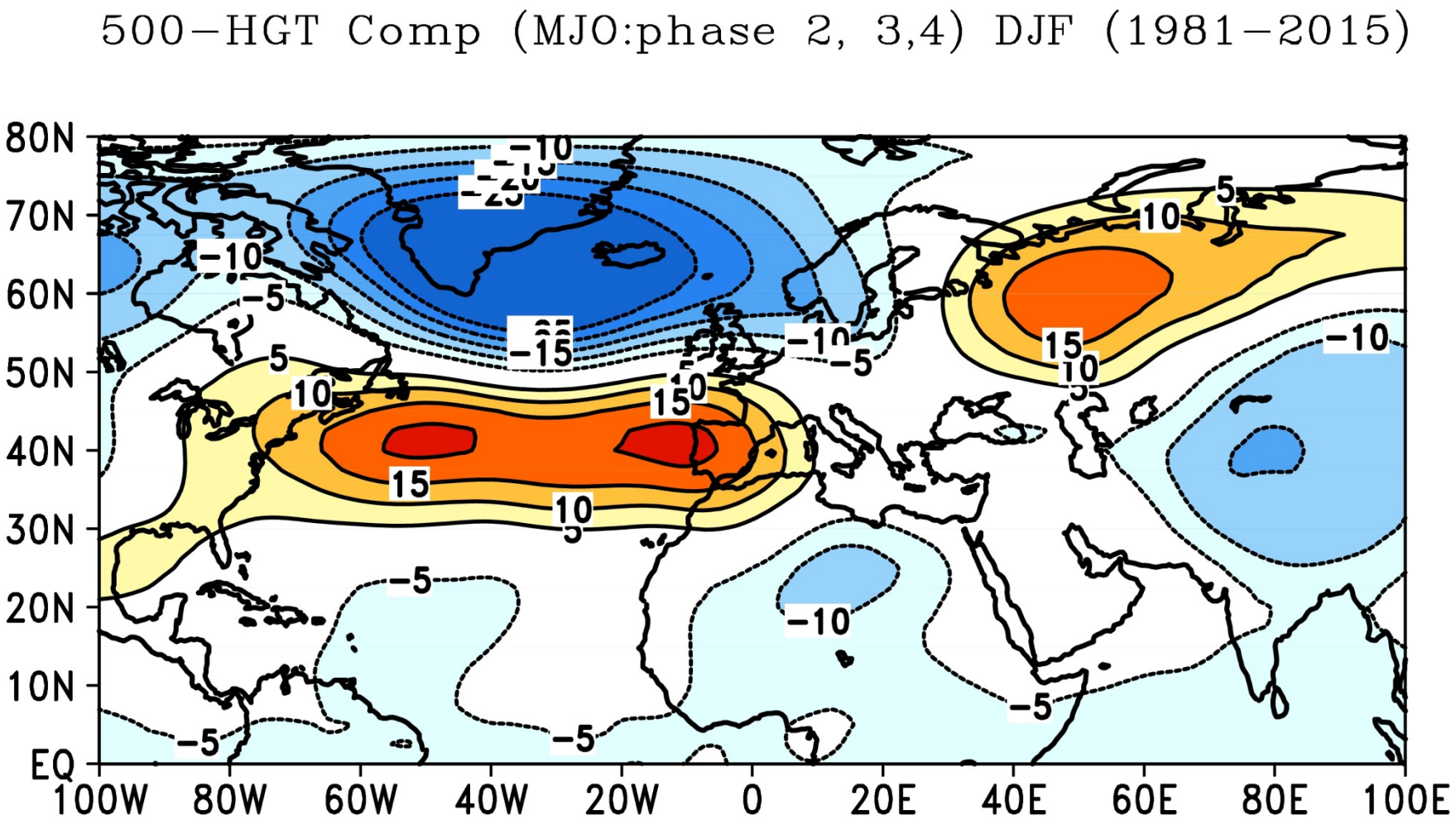
MJO Phase 6, 7, 8

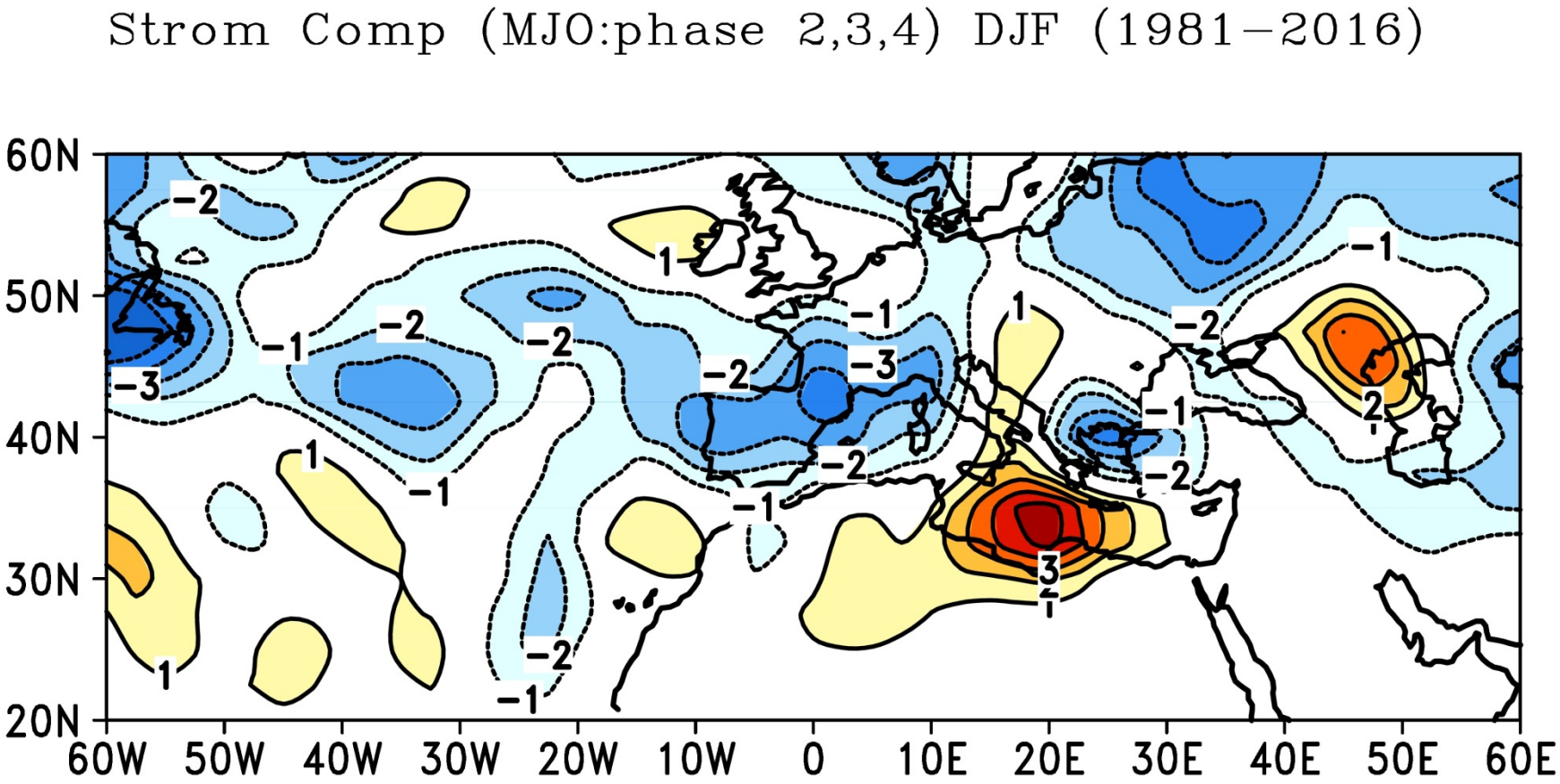

500-HGT Comp (MJO) DJF (1981-2015)
80N
70N
60N
50N
40N
30N
20N
10N
EQ
100W
80W
60W
40W
20W
0
20E
40E
60E
80E
100E

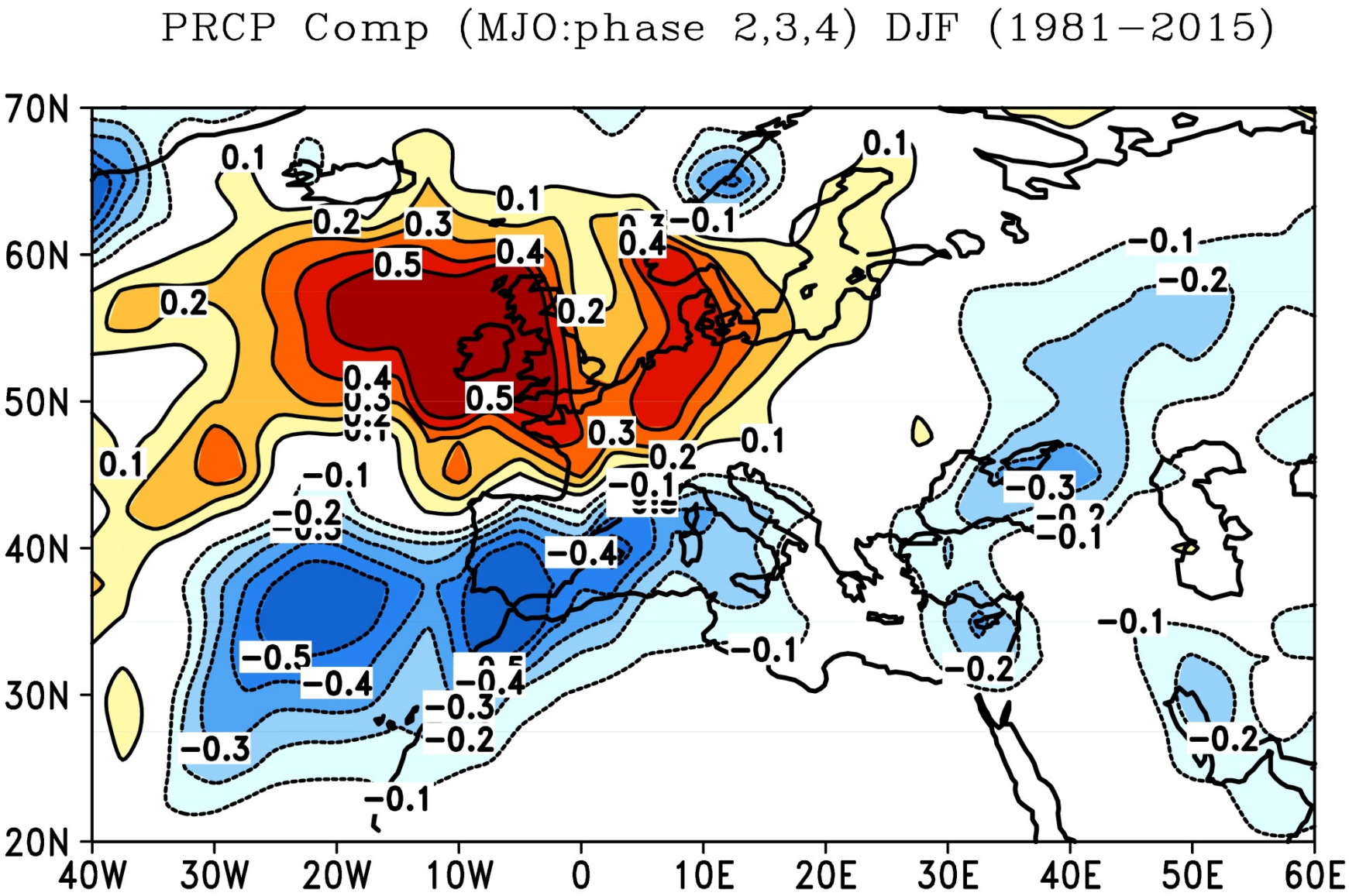

Strom Comp (MJO:phase 6,7,8) DJF (1981–2016)
60N
50N
40N
30N
20N
60W
50W
40W
30W
20W
10W
0
10E
20E
30E
40E
50E
60E


PRCP Comp (MJO:phase 6,7,8) DJF (1981–2015)
70N
60N
50N
40N
30N
20N
40W
30W
20W
10W
0
10E
20E
30E
40E
50E
60E

MJO Phase 2, 3, 4


500-HGT Comp (MJO:phase 2, 3,4) DJF (1981-2015)
80N
70N
60N
50N
40N
30N
20N
10N
EQ
100W
80W
60W
40W
20W
0
20E
40E
60E
80E
100E
-10
-5
5
10
15


Strom Comp (MJO:phase 2,3,4) DJF (1981–2016)
60N
50N
40N
30N
20N
60W
50W
40W
30W
20W
10W
0
10E
20E
30E
40E
50E
60E


PRCP Comp (MJO:phase 2,3,4) DJF (1981–2015)
70N
60N
50N
40N
30N
20N
40W
30W
20W
10W
0
10E
20E
30E
40E
50E
60E

U-Wind composites

Variability of the North Atlantic Jet Stream

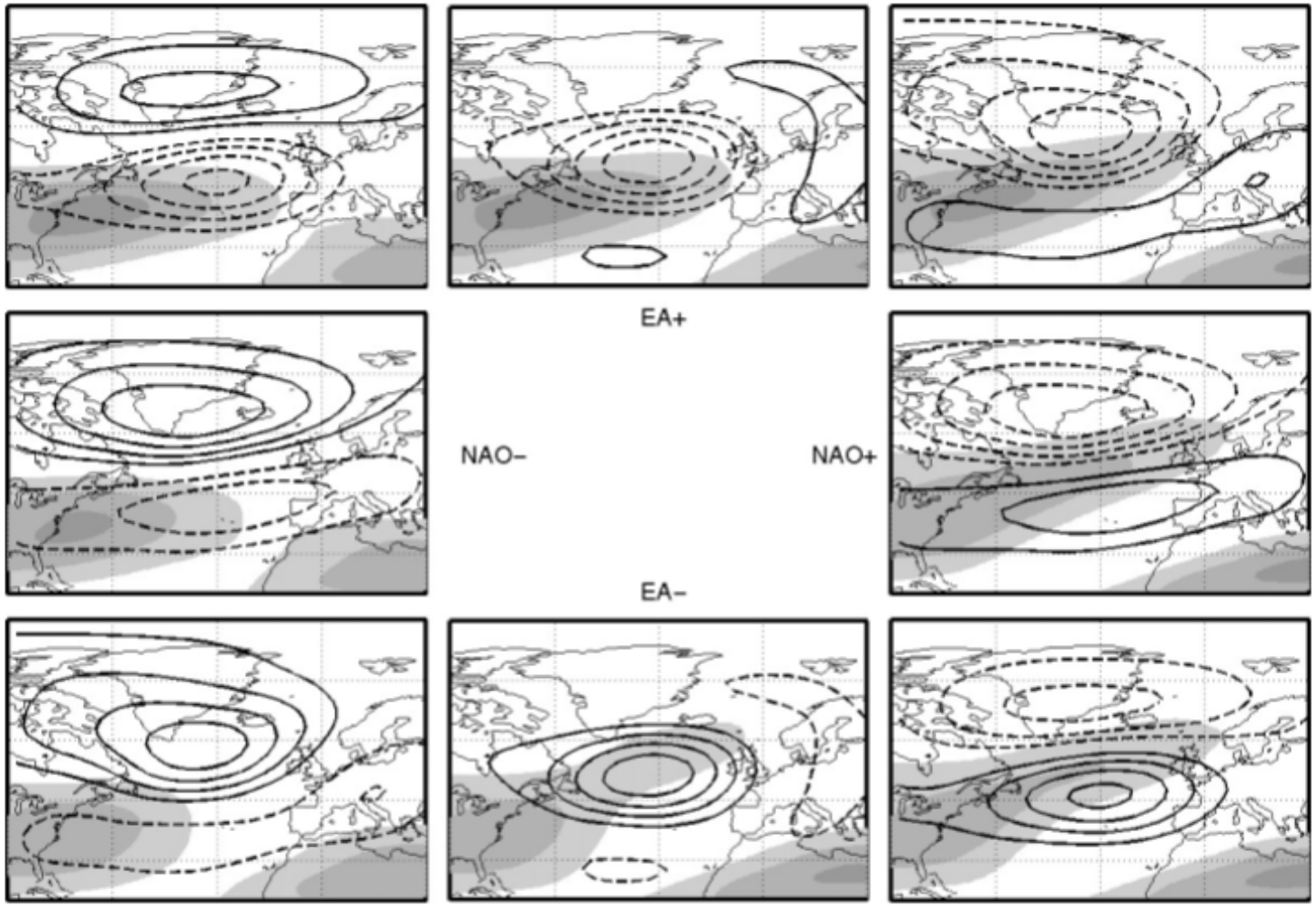
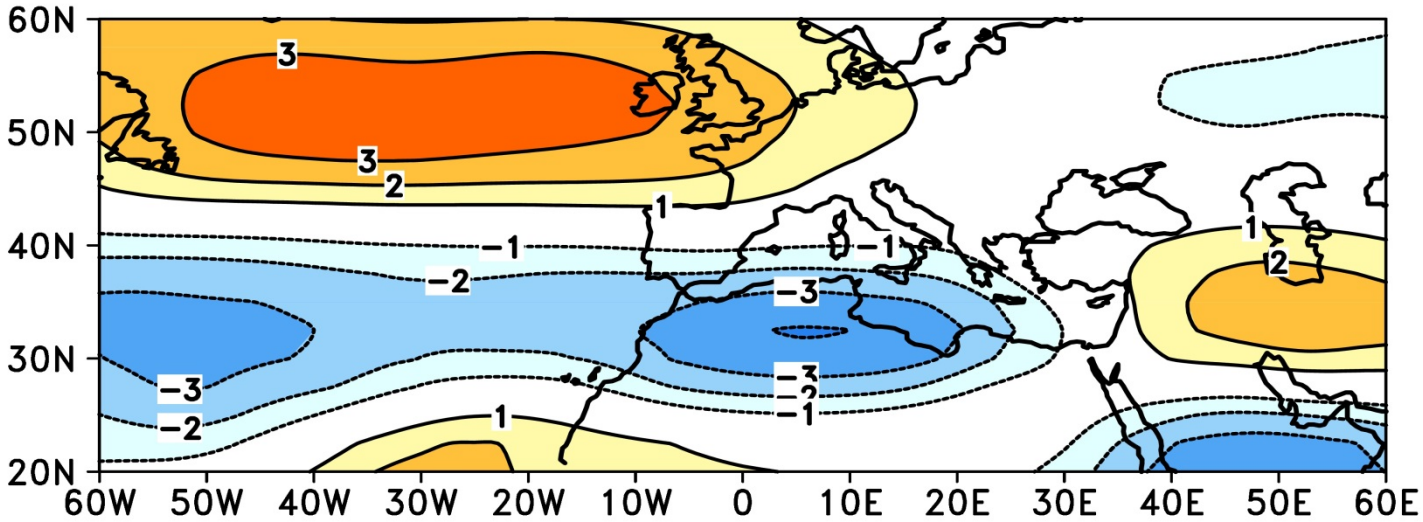


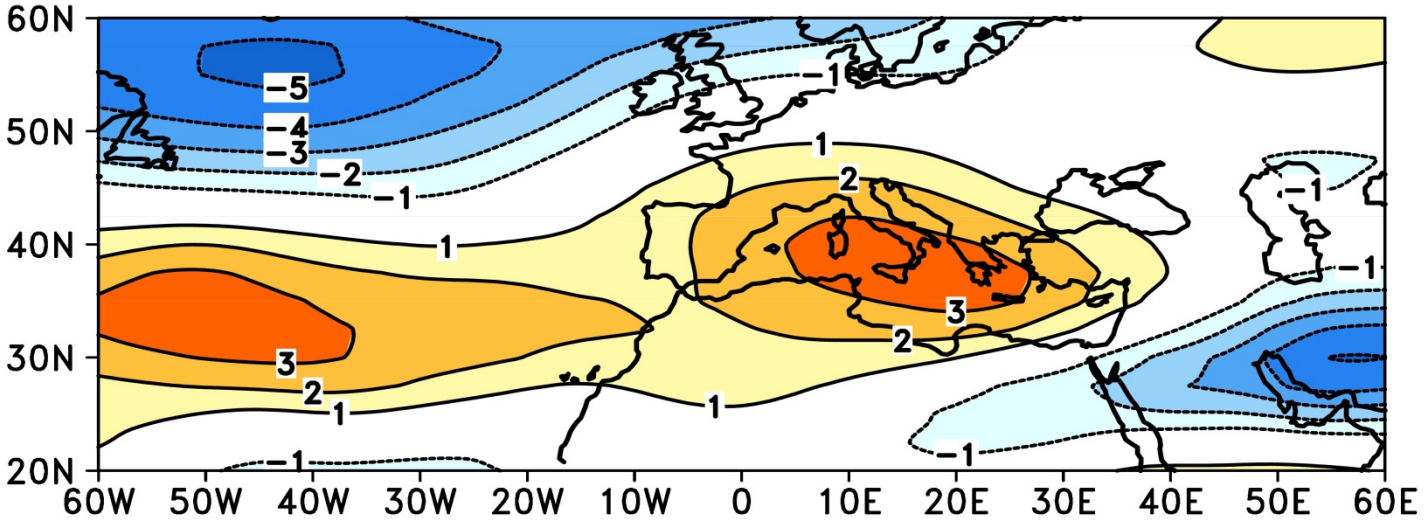
Figure 10. Summary of the circulation at different locations in NAO/EA space. The horizontal axis of the grid of plots is the NAO and the vertical axis is the EA. Z500 anomalies are contoured every 20 m per standard deviation of the principal component time series, and 300 hPa zonal wind is shaded every 10 m s^{-1} starting at 20 m s^{-1}. The corner plots are given by adding the respective NAO and EA maps and scaling by $1/\sqrt{2}$.

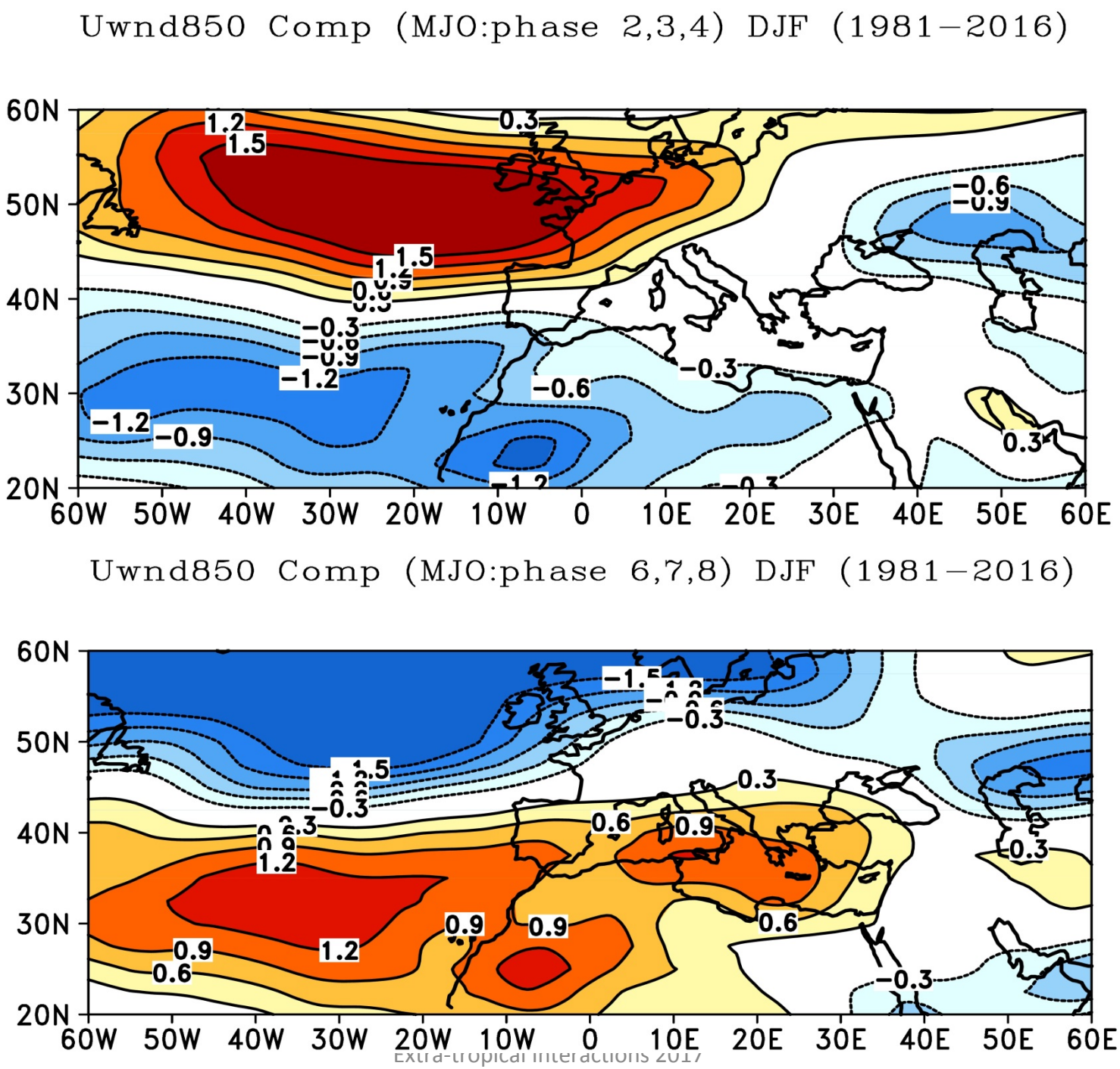
Woollings et al.,2010

Uwnd200 Comp (MJO:phase 2,3,4) DJF (1981–2016)

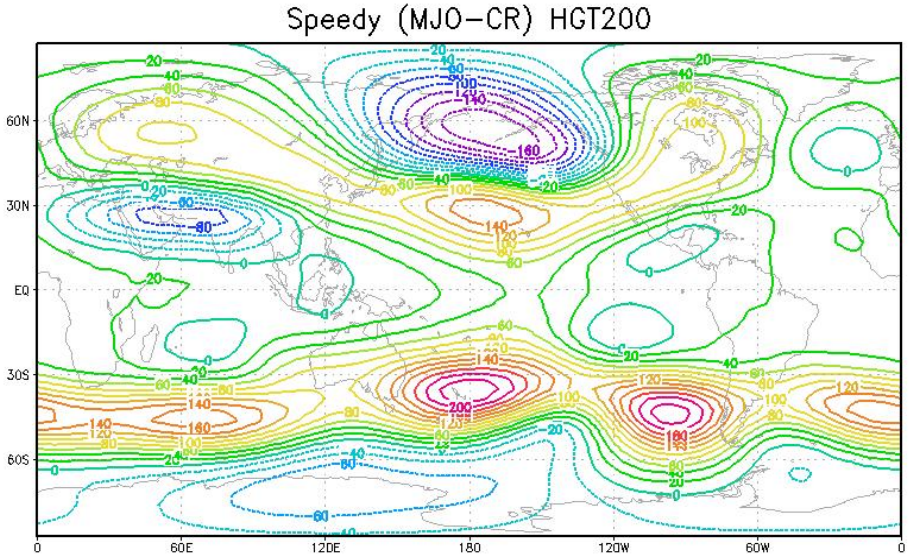


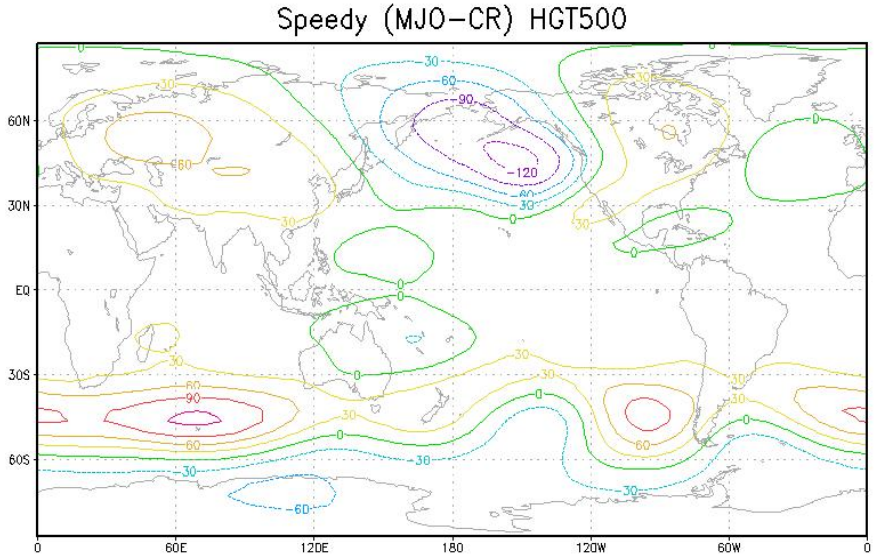
Uwnd200 Comp (MJO:phase 6,7,8) DJF (1981–2016)

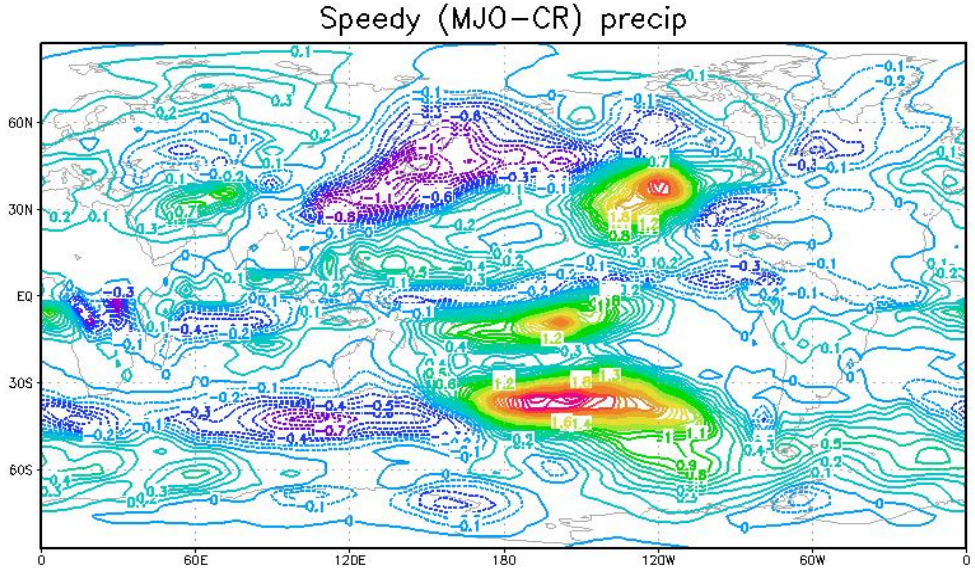



Uwnd850 Comp (MJO:phase 2,3,4) DJF (1981–2016)
60N
50N
40N
30N
20N
60W 50W 40W 30W 20W 10W 0 10E 20E 30E 40E 50E 60E
1.2
1.5
0.3
−0.6
−0.9
−0.3
−1.2
−0.6
−0.3
0.3
Uwnd850 Comp (MJO:phase 6,7,8) DJF (1981–2016)
60N
50N
40N
30N
20N
60W 50W 40W 30W 20W 10W 0 10E 20E 30E 40E 50E 60E
−0.3
0.3
0.6
0.9
1.2
0.9
0.6
−0.3

Speedy Model Run (1980-2015)







Summary and Conclusions

- The MJO affect shows a strong relationship with NAO phase changes (Phase 2,3,3--→NAO+ and 6,7,8--→NAO-)
- The MJO associated significant changes are noted in the upper and lower troposphere in the North Atlantic European Sector
- MJO has the strong influence over storm trajectories in the North Atlantic Ocean
- These findings can have important implications in Euro-Mediterranean subseasonal to seasonal predictability skills

Questions??