Teleconnections associated with the 3 recent strongest ENSO events: impacts on European winter

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- The winter 2016 has been anomalously warm in many regions of the world, including Europe.

- These anomalies were largely well captured by the seasonal forecasts initialized since August.

  El Nino as a window of opportunity for predictive skill

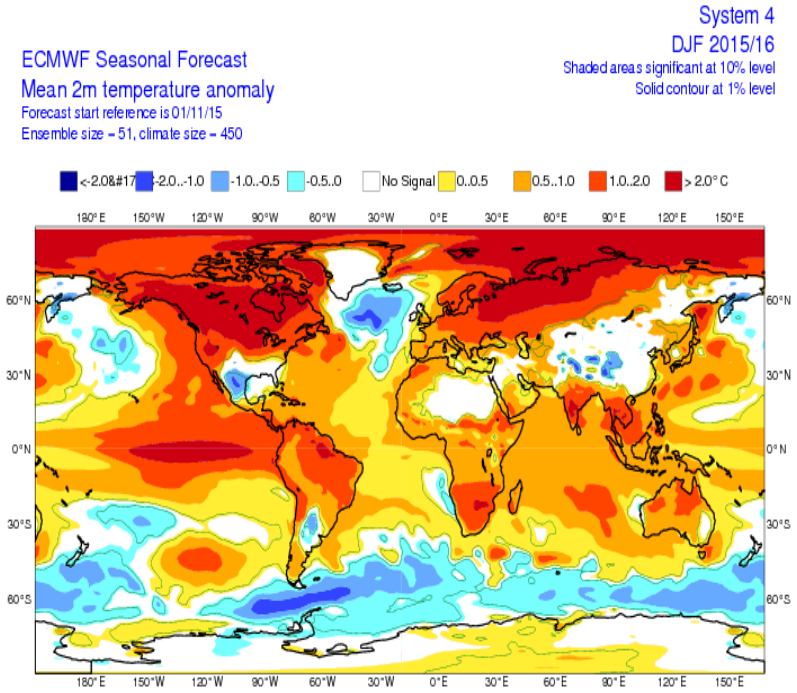
- There have already been a few attribution studies on the anomalous European weather. The question of the role of ENSO in a changing climate is open.

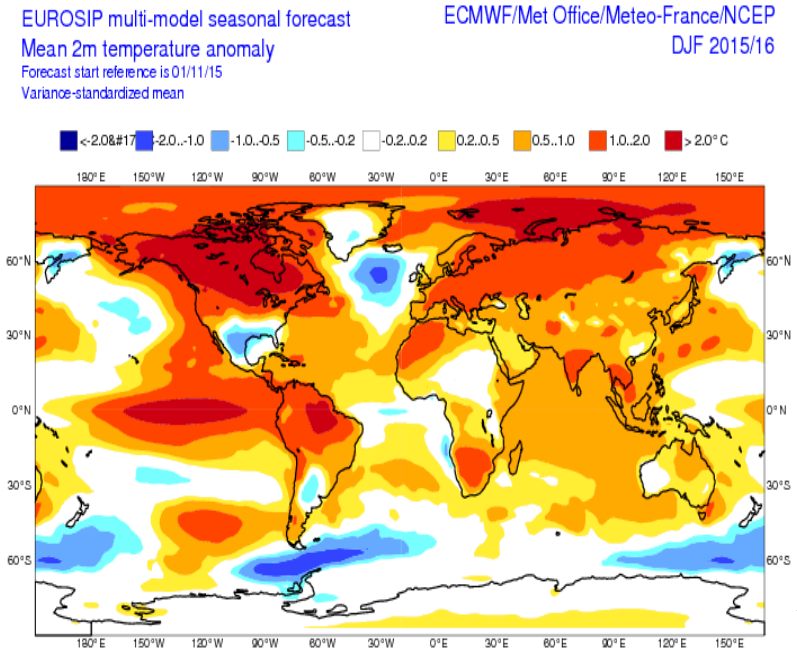
- Here we attempt to gain insight into this question by characterizing the 3 largest El Nino events during the Era-Interim record and in S4 reforecasts: 1982/3, 1997/8 and 2015/6

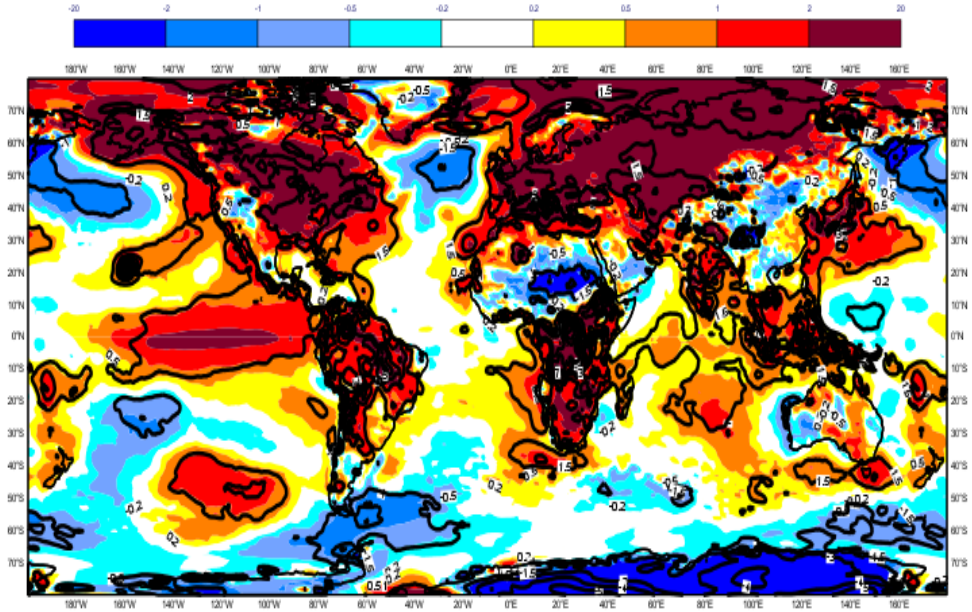
- The focus is on the European response to a large El Nino.

- We use DJ composites.

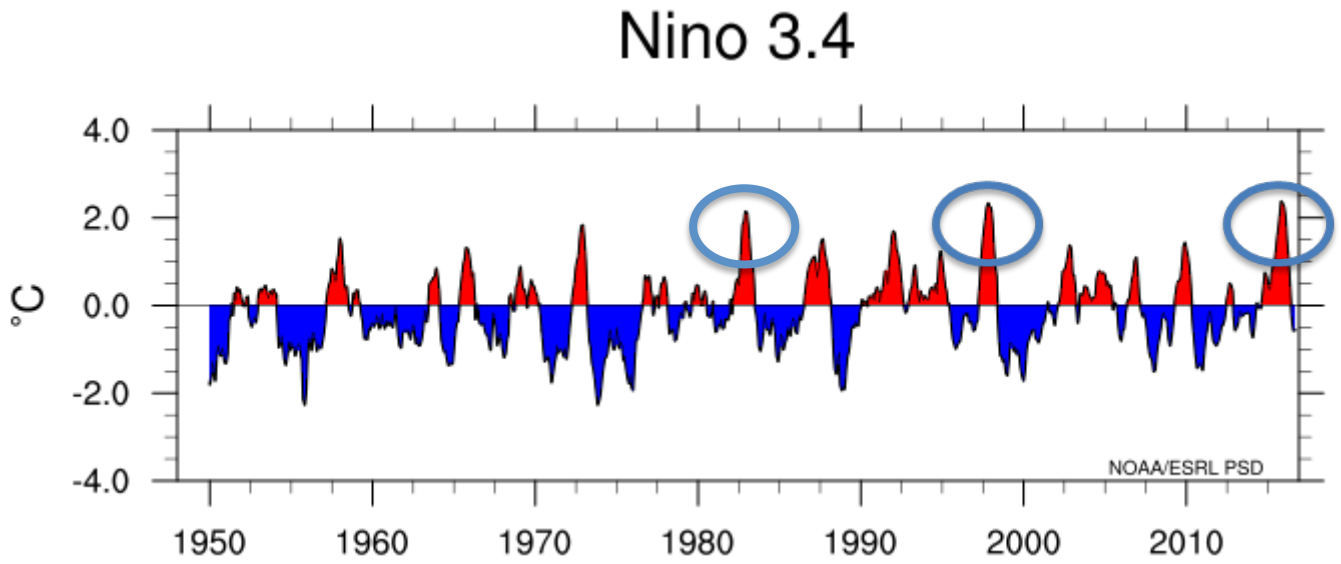
2mt anomalies for DJF 2016: analysis







[5N-5S, 150W-90W]

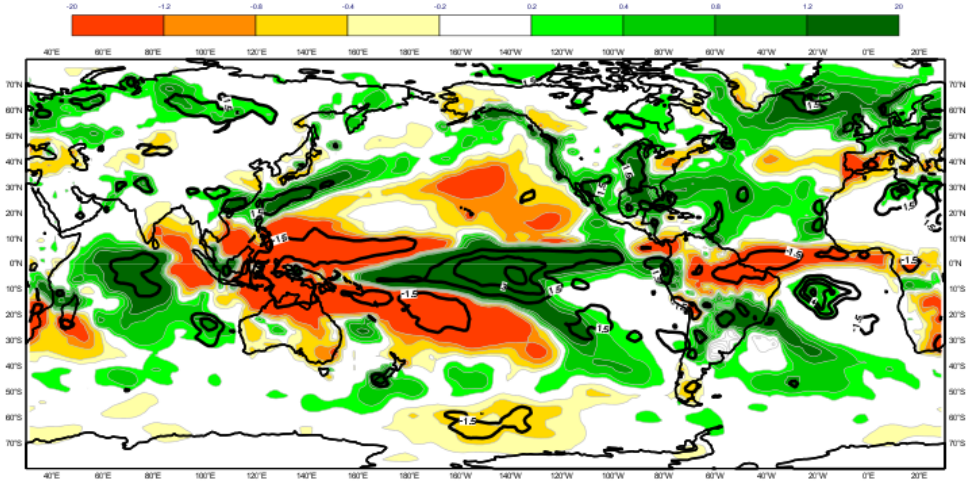


Toniazzo and Scaife 2006 showed that the ENSO response over the Atlantic sector is not linear.

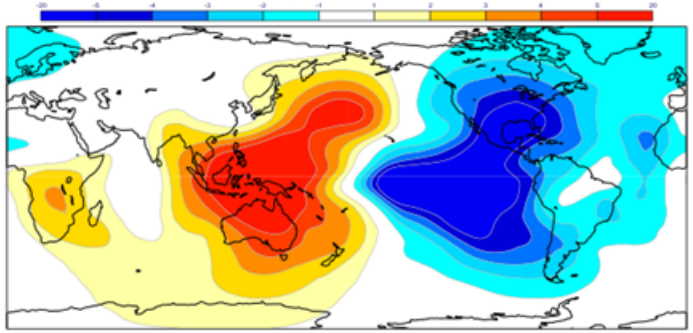
From NOAA/CPC

Dec-Jan 1982/83 analysis

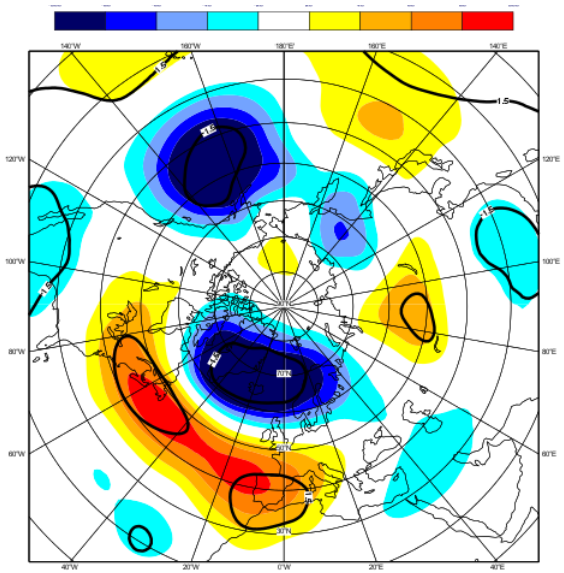
GPCP Precip anomalies



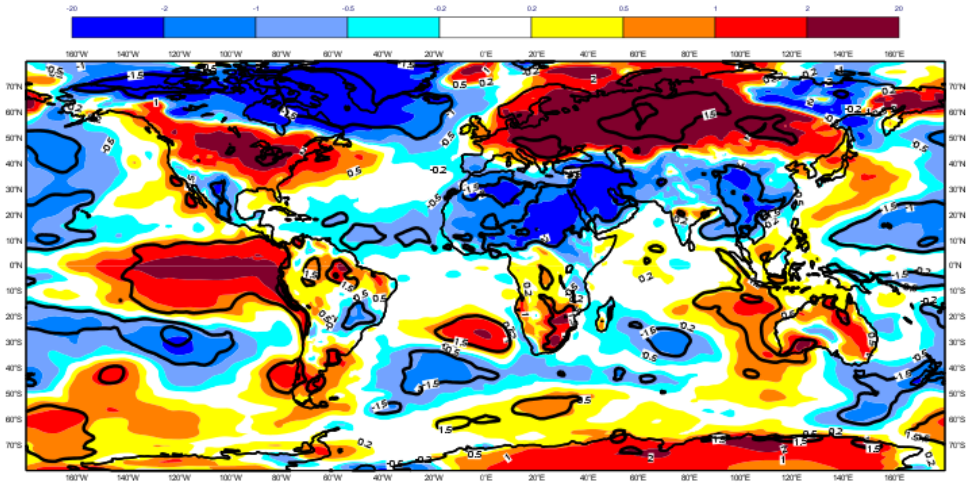
200hPa Velocity Potential anomalies



Z500 anomalies



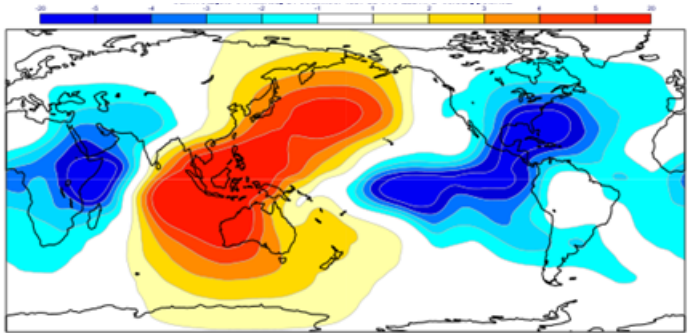
T2m anomalies

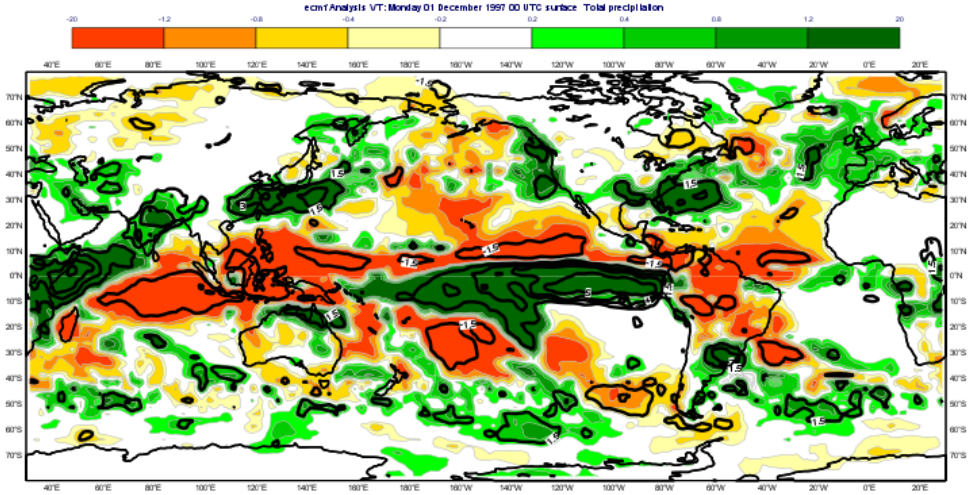


Dec-Jan 1997/98 analysis

Precipitation anomalies

200hPa Velocity Potential anomalies





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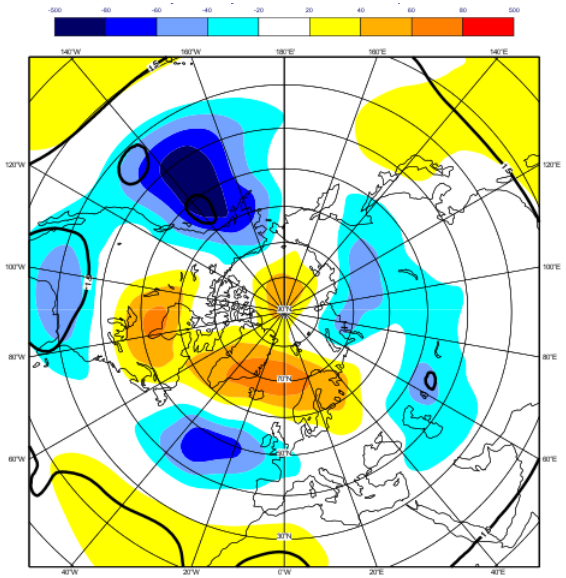

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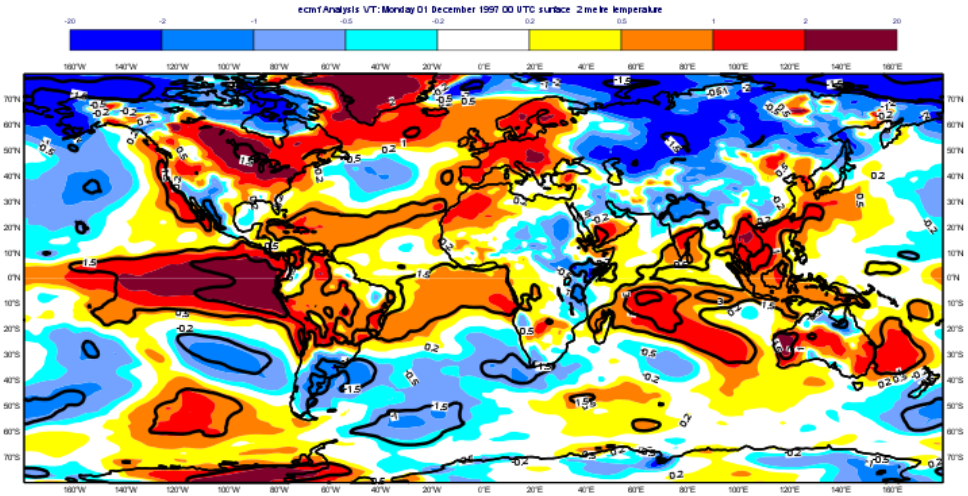
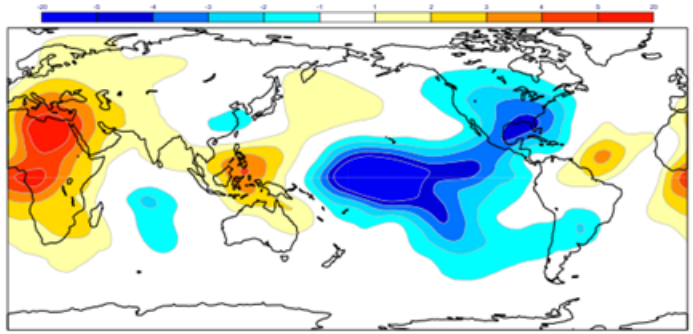


Dec-Jan 2015/16 analysis

200hPa Velocity Potential anomalies



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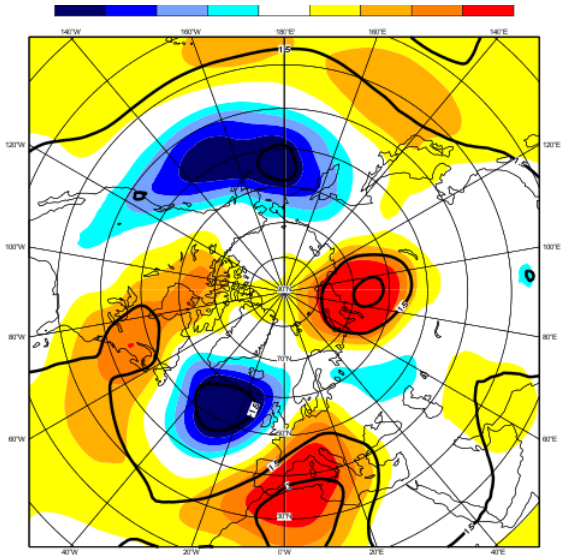
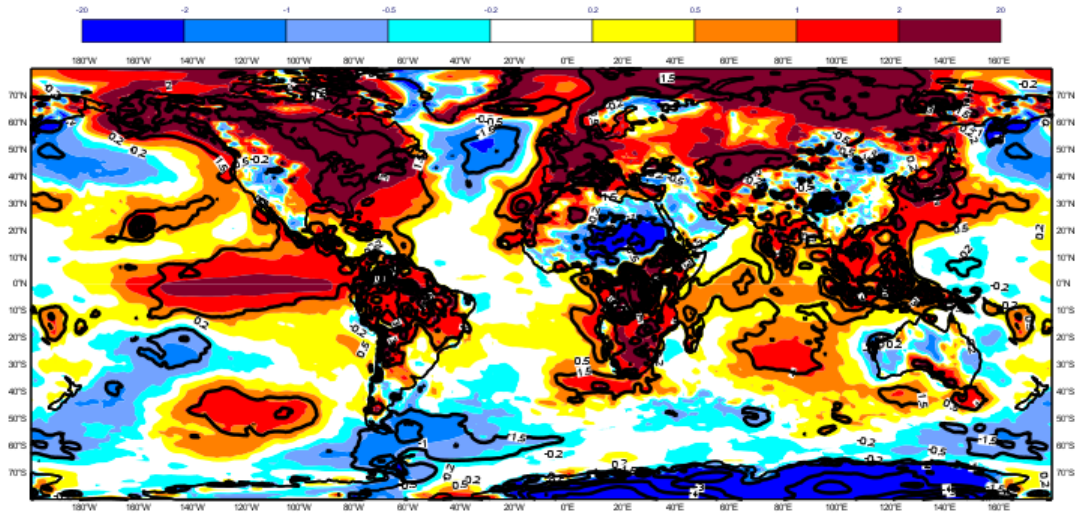
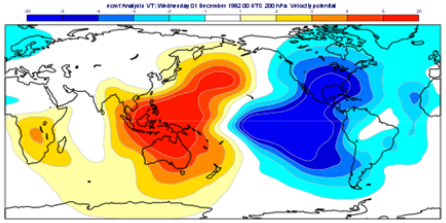
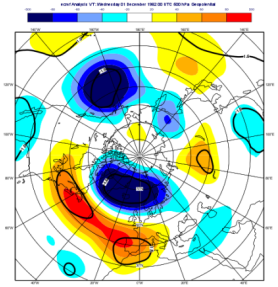
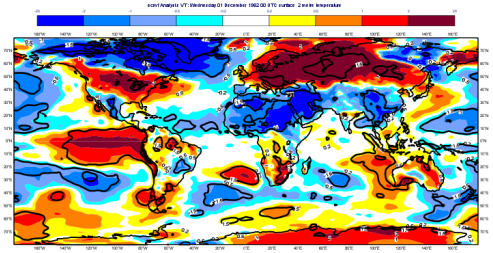
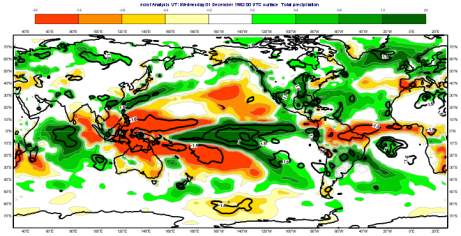


T2m anomalies

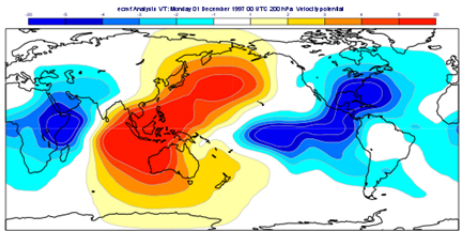
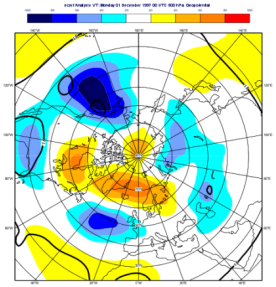
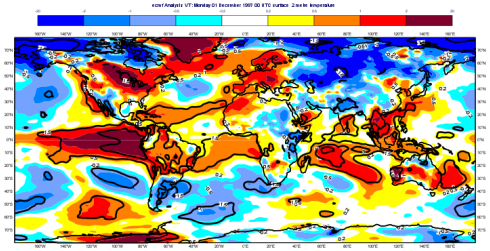
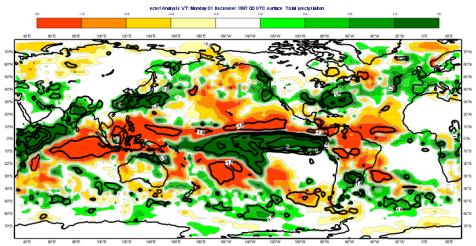


The 3 recent strong ENSO events

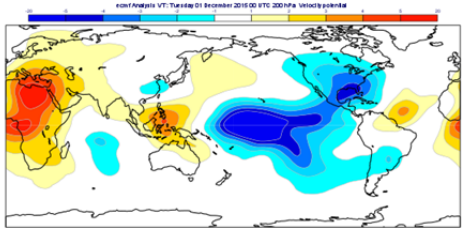
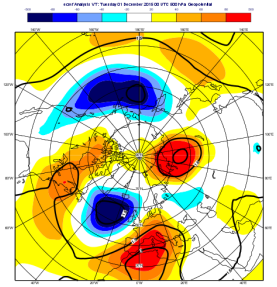
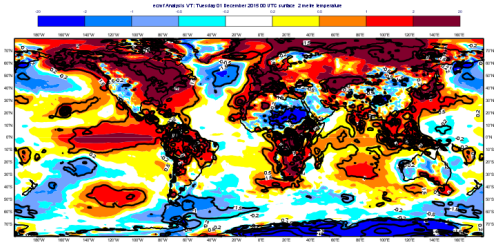
Dec-Jan 1982/83

Dec-Jan 1997/98

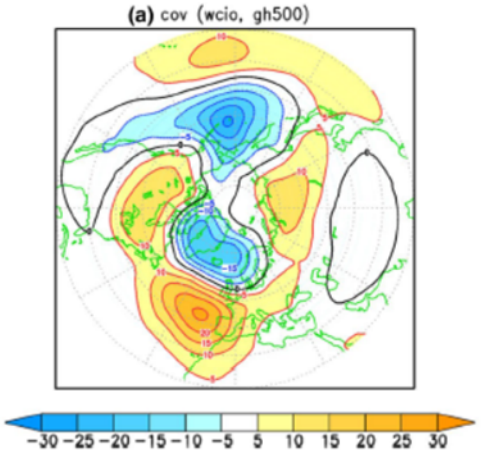
Dec-Jan 2015/16

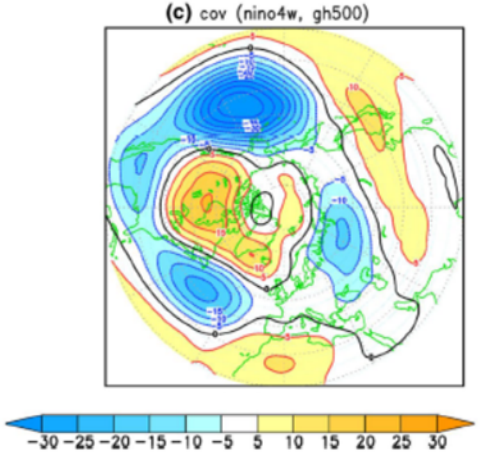




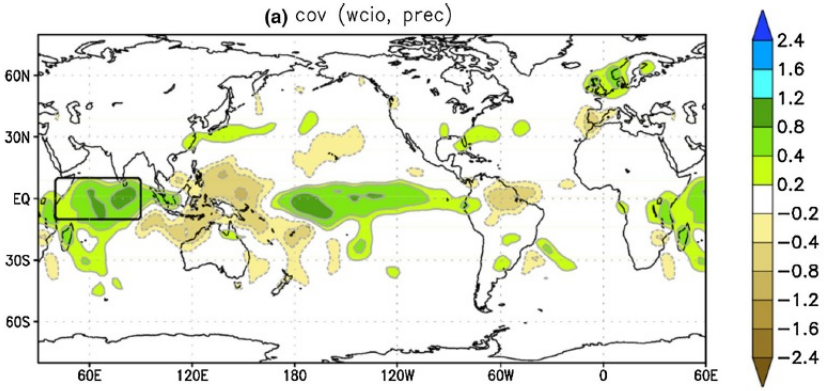
There is diversity in response over Europe. Large differences are seen between the 3 events in the Walker circulation over Africa and Indian Ocean

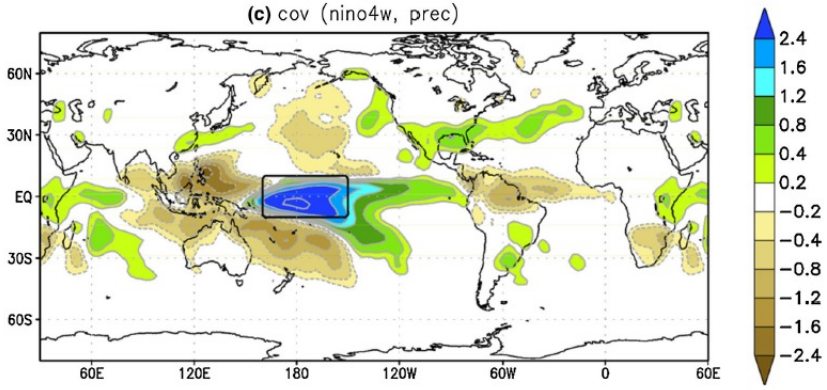
Teleconnections and heat sources over the tropical Indian and Pacific oceans using ECMWF re-analysis (erainterim) 30 years

From Molteni et al 2015









Convection over Indian Ocean=> +ve NAO

Convection Central Pacific=> PNA-like

Dynamical influence of separate teleconnections from the Pacific and Indian Oceans

The extra-tropical teleconnections associated with an active Pacific and Indian Ocean might be explained in terms of linear wave interference.

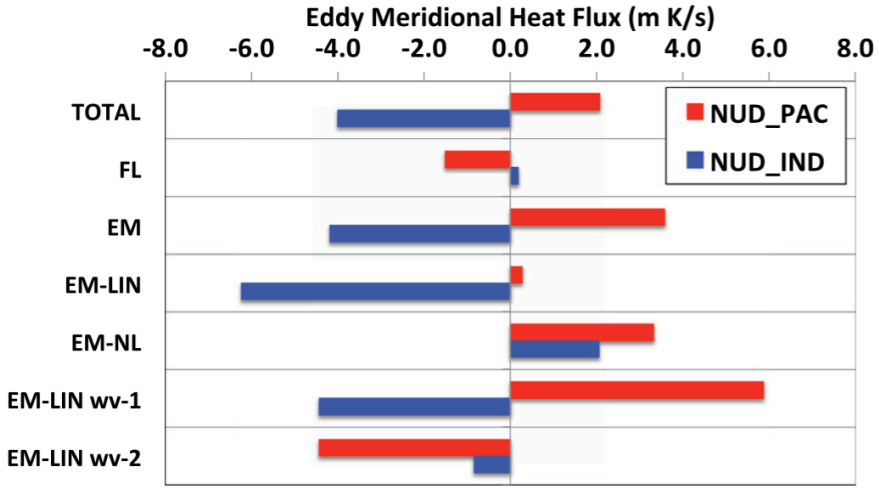
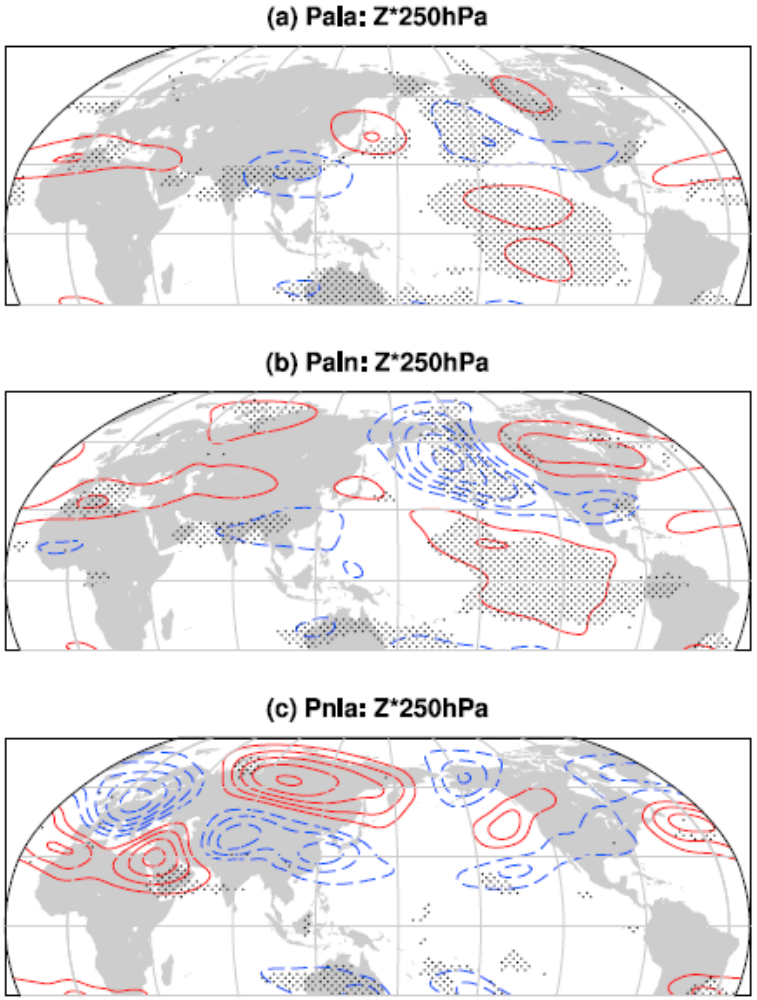


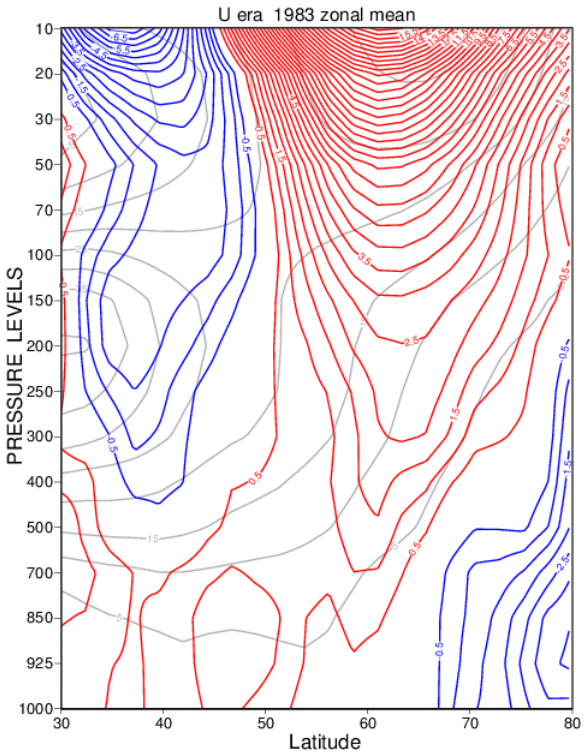
FIG. 9. (top) The contribution to the 100-hPa eddy meridional heat flux response ($\Delta\{\langle v^*T^*\rangle\}$), averaged between 40°–80°N, from the different terms in the decomposition described in section 2d. Red (blue) bars show the values for NUD_{PAC} (NUD_{IND}). Unlike the data in all other figures, the values in this figure have *not* been normalized by the amplitude of the tropical SST anomalies (see section 2d).



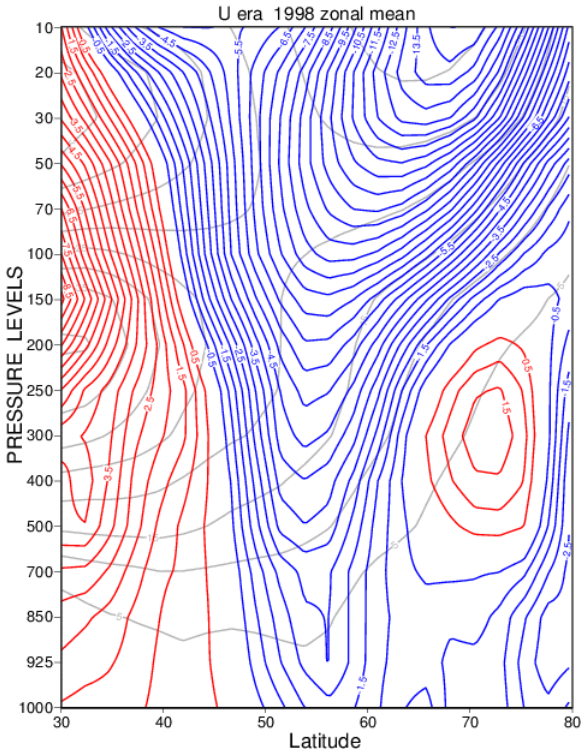
From Fletcher and Cassou 2015

Zonal mean zonal wind anomalies DJ :

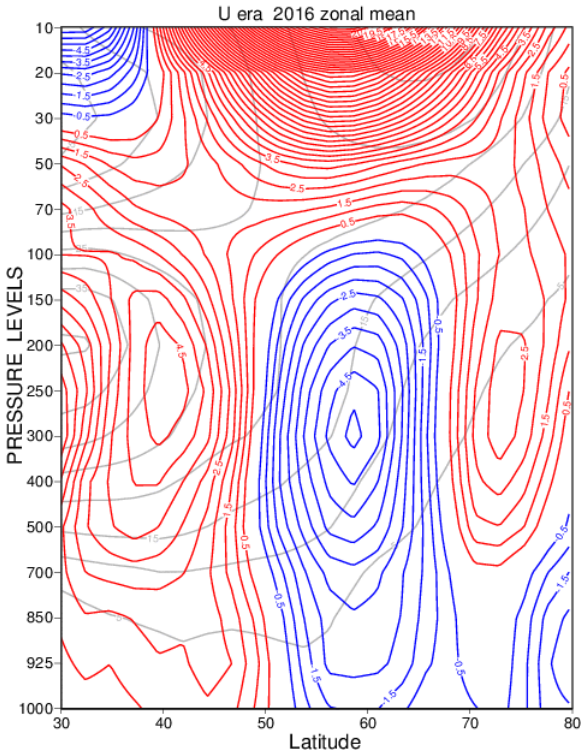
1982/83



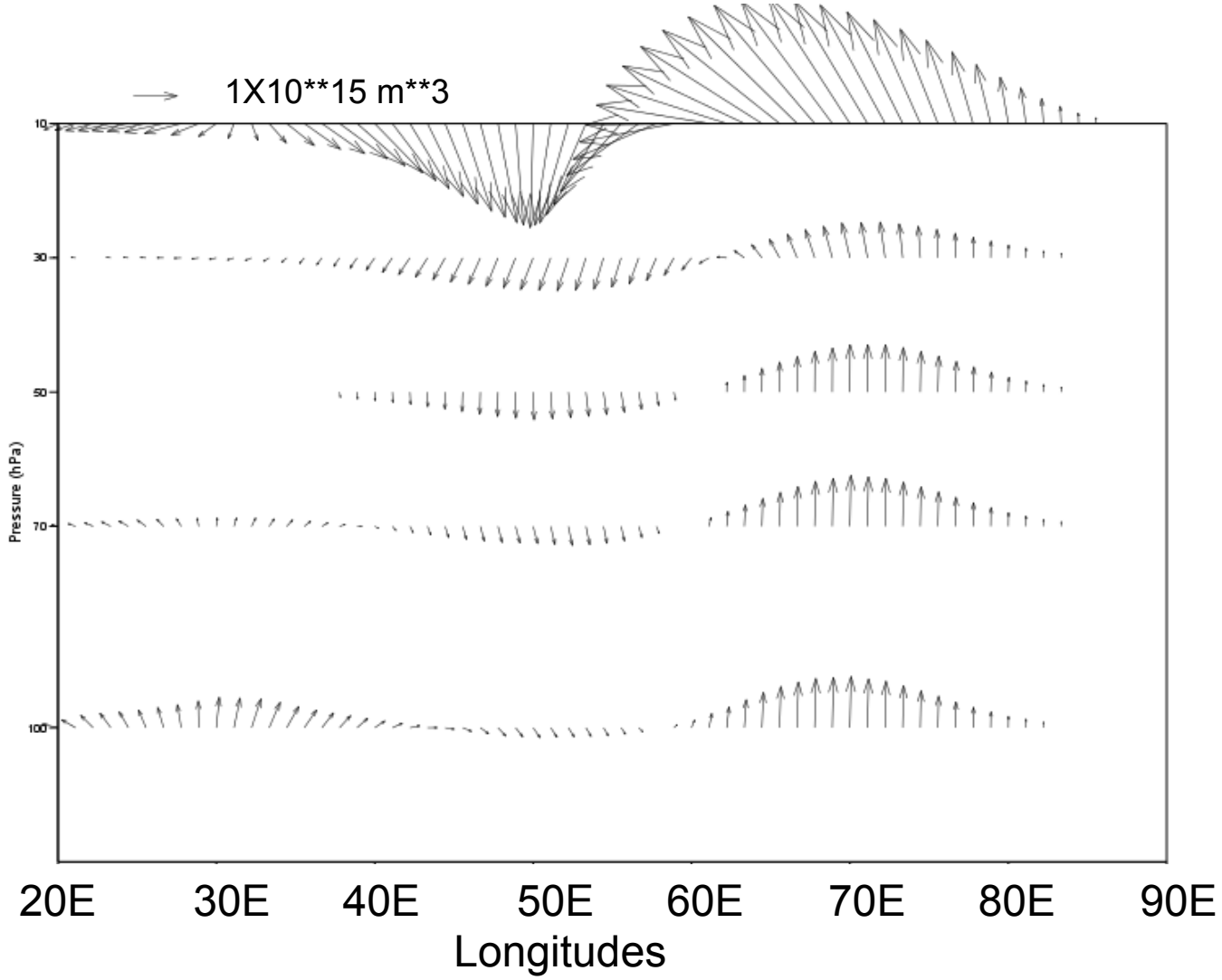
1997/98



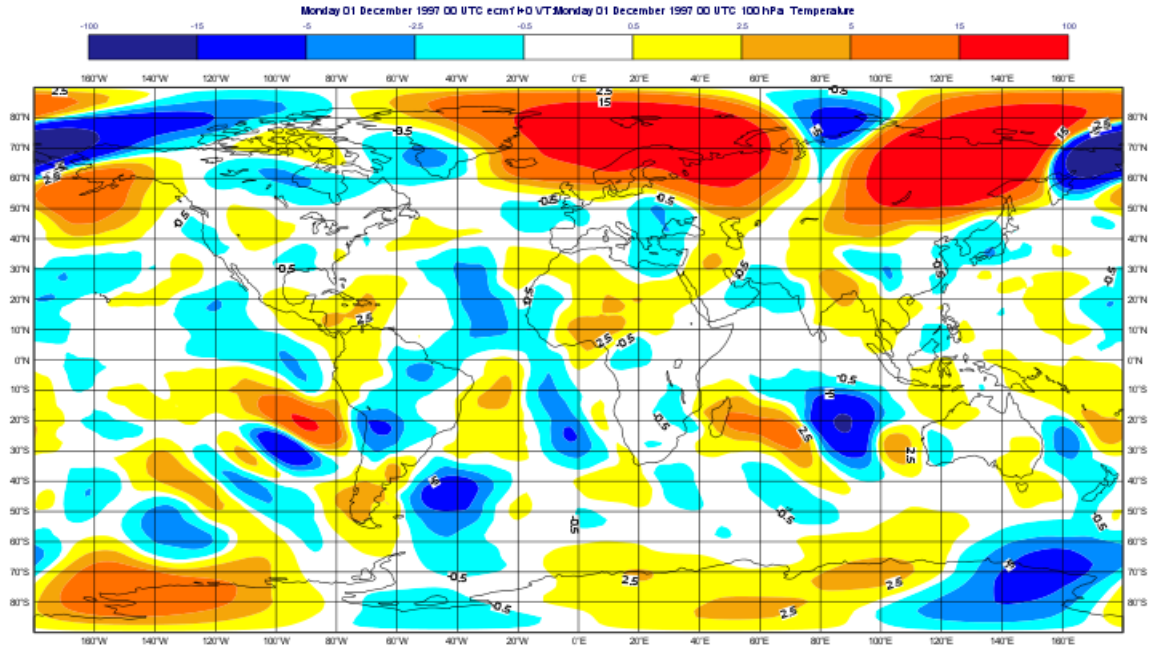
2015/16

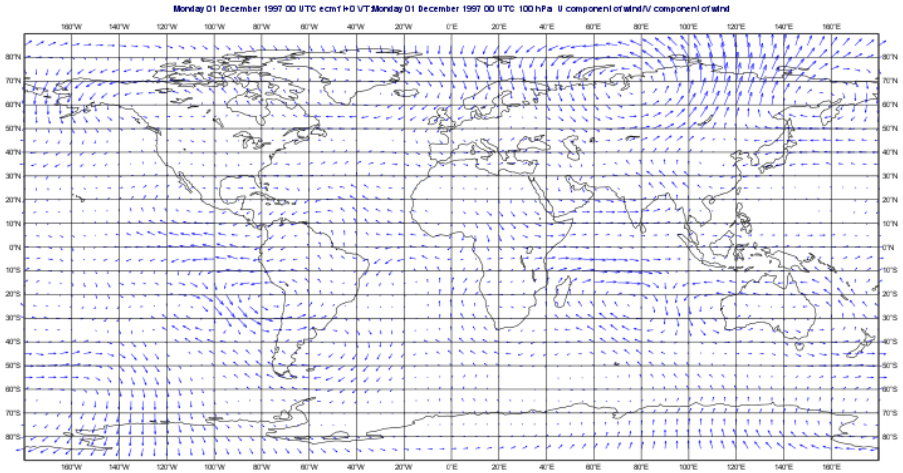


E-P flux differences DJ 1998 – DJ(1983+2016)/2

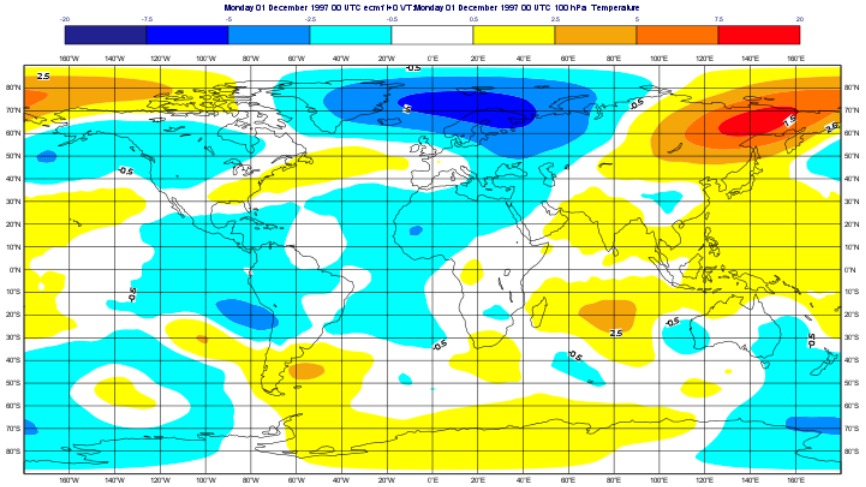


Eddy meridional heat flux at 100hPa: DJ 1998 – DJ (1983 and 2016 average)

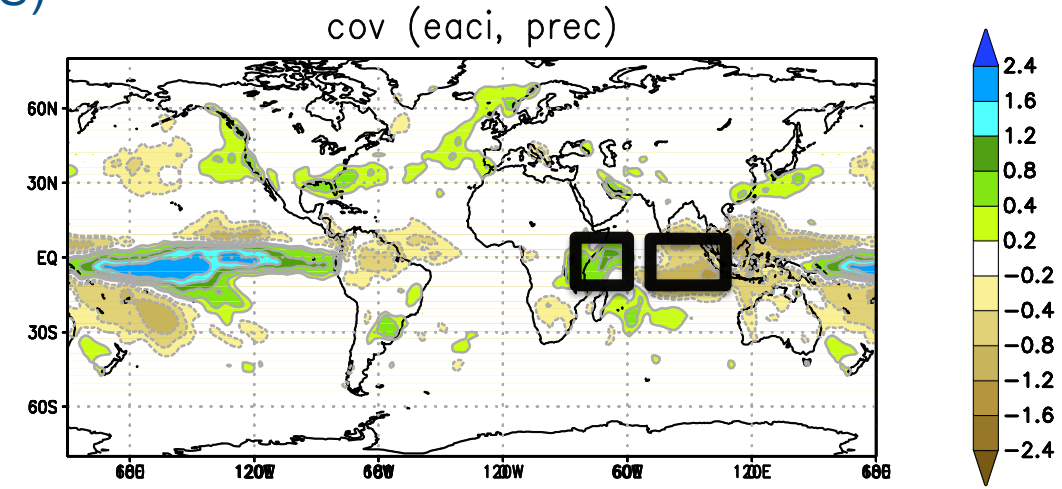




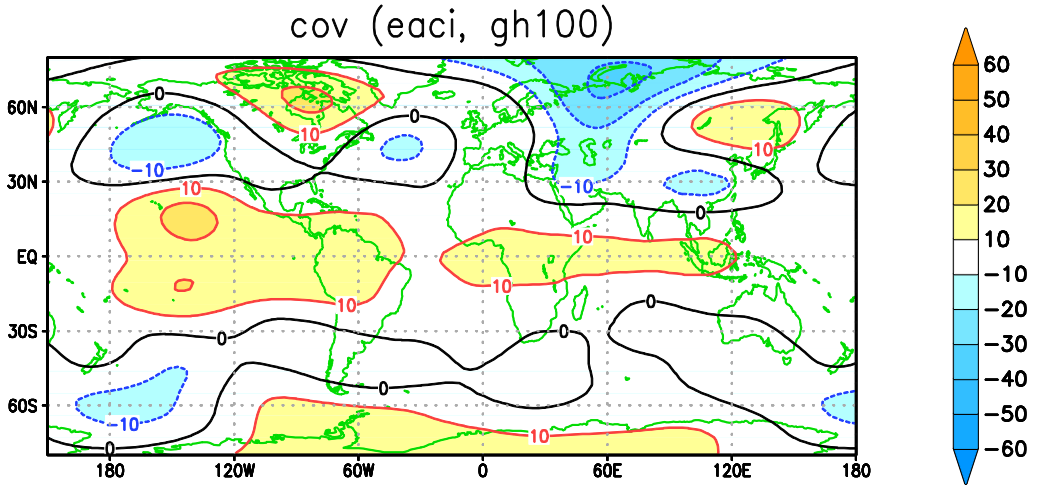
Tstar and Wstar diff. 1998-(1983+2016)/2



Cov of precip and gh_100 with precip in (30-60E, 10N-10S) - (70-100E, 10N-10S)



Anticyclonic circulation at 100hPa → warming → deceleration of the Polar vortex

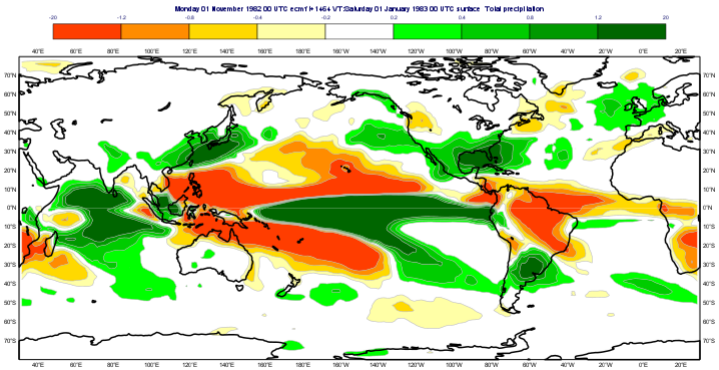


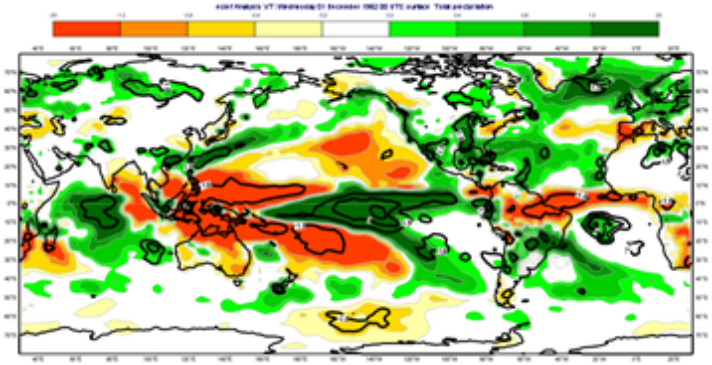
Sys4 performance from Nov forecasts : precip. anomalies

Sys 4 ens. mean

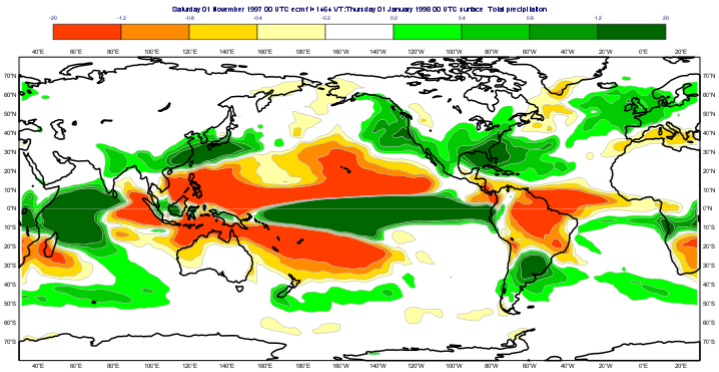
GPCP

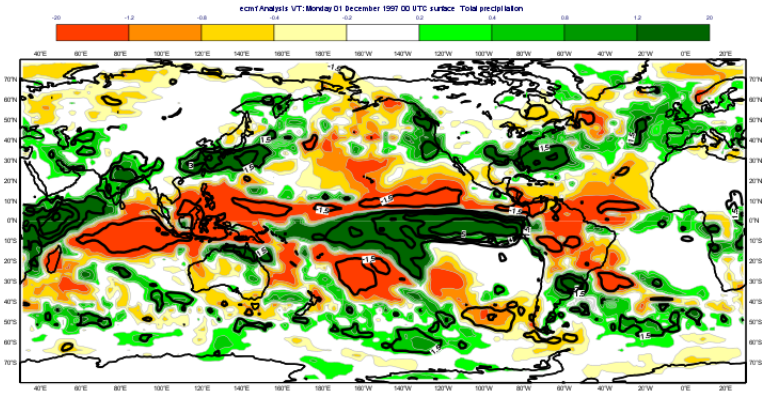
DJ 1982/3



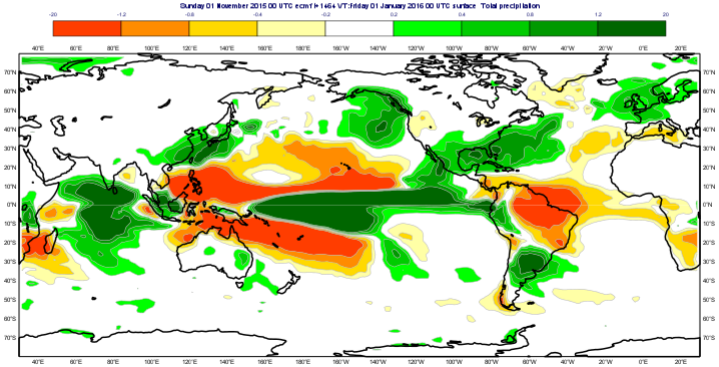


DJ 1997/8





DJ 2016/7



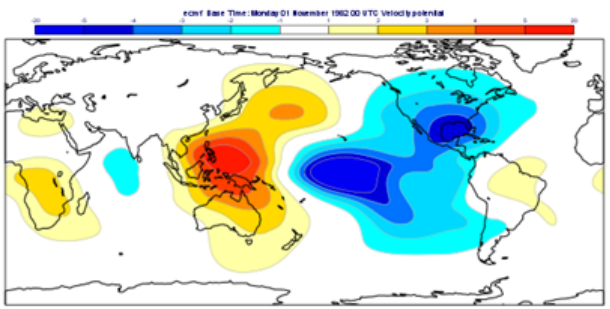
Sys4 performance from Nov forecasts :

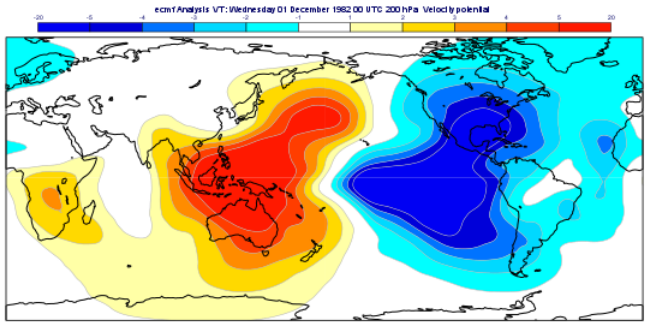
Vel. Pot. Anomalies at 200hPa

Sys 4 ens. mean

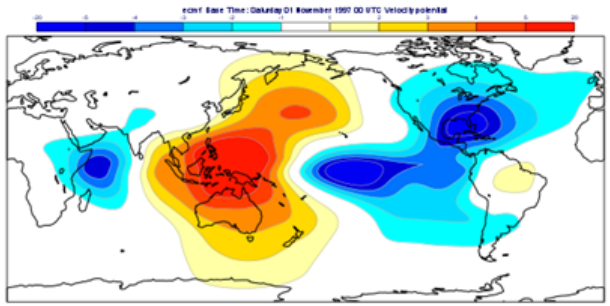
Analysis

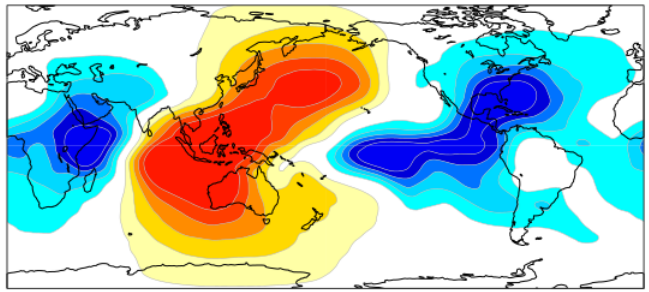
DJ 1982/3



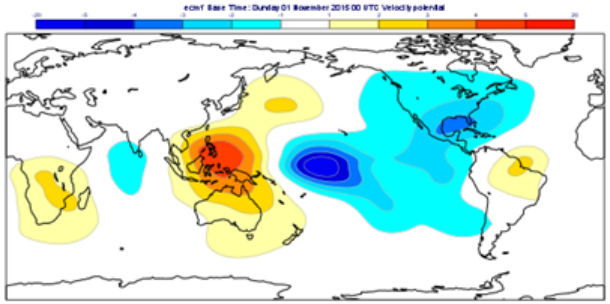


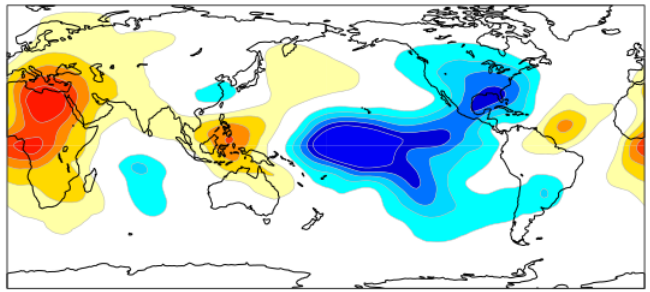
DJ 1997/8



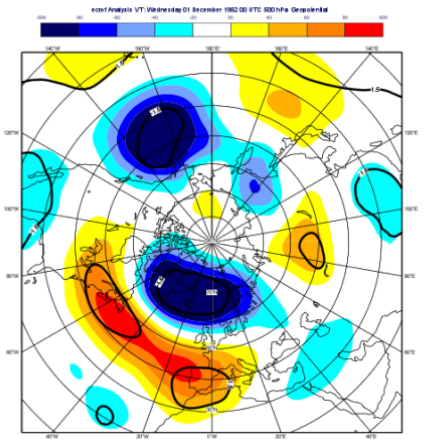
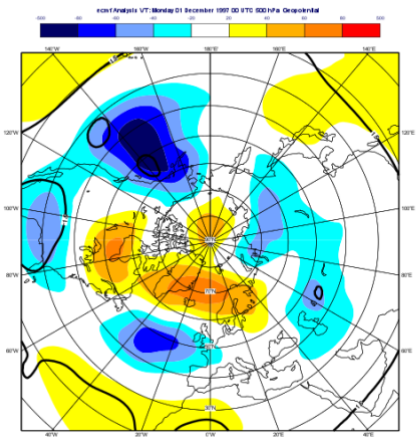
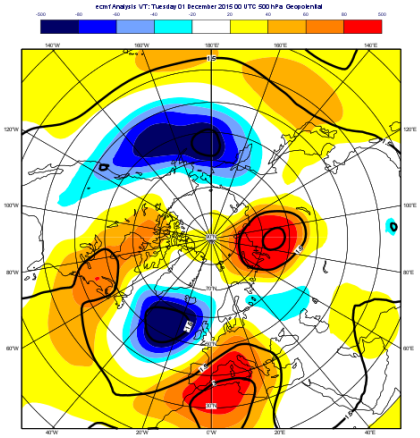
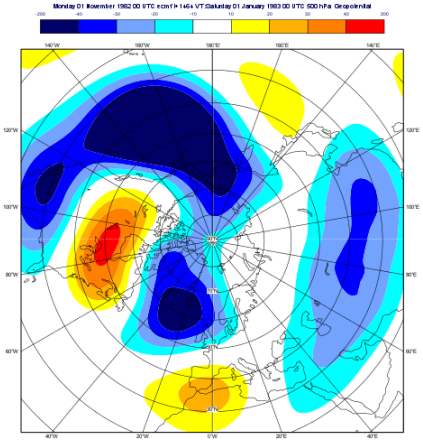
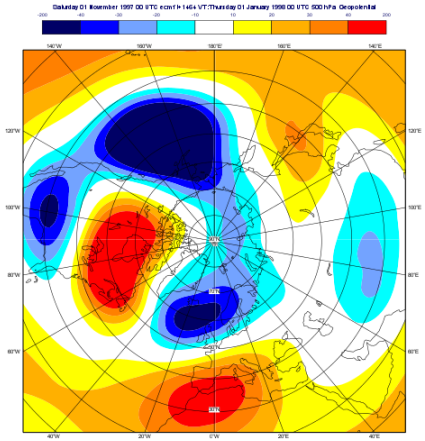
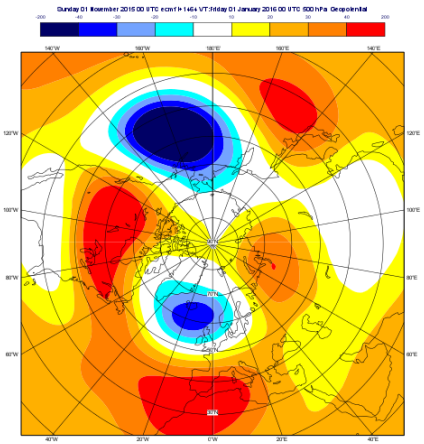


DJ 2015/6





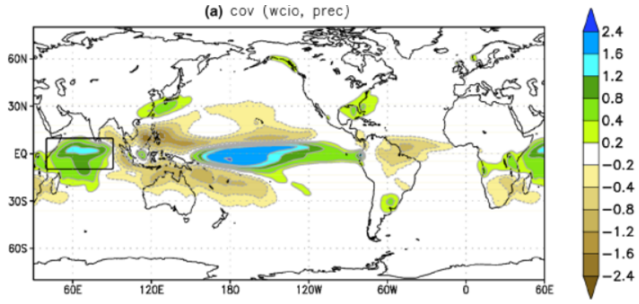
Extra-tropical response analysis and model for December-January:

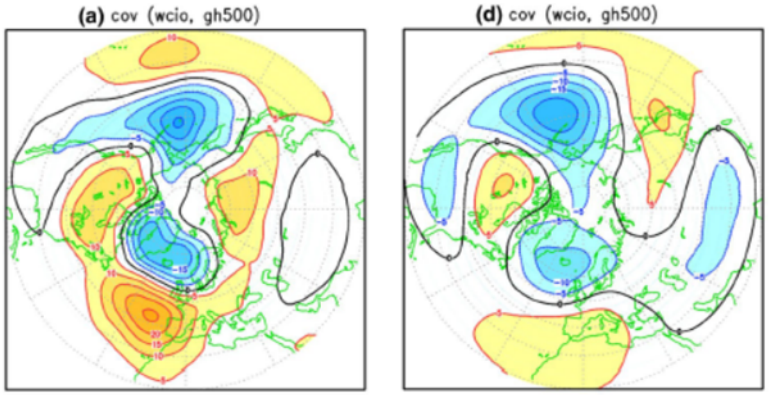
	1982/83	1997/98	2015/16
Analysis			
Sys4 ens. mean **Nov. Start** **51 members**			

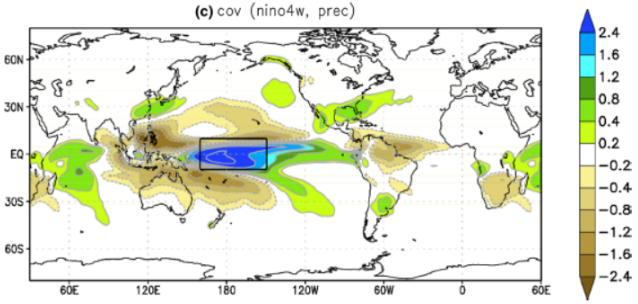
Extra-tropical model teleconnections based on 30 years of reforecast:

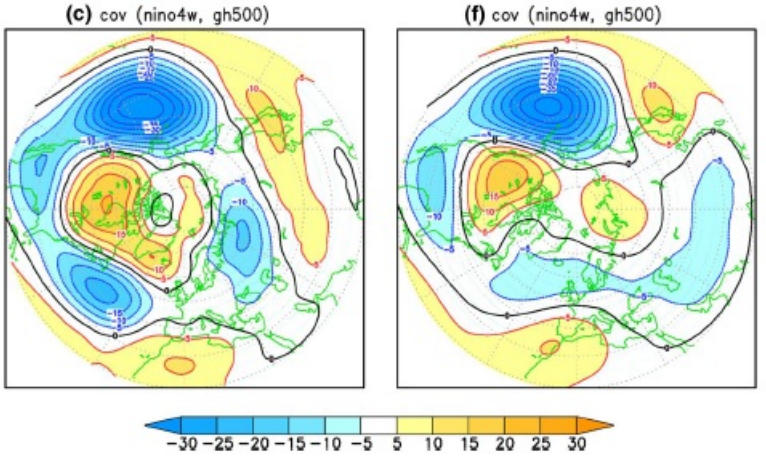
From Molteni et al. 2015

Era-interim System4





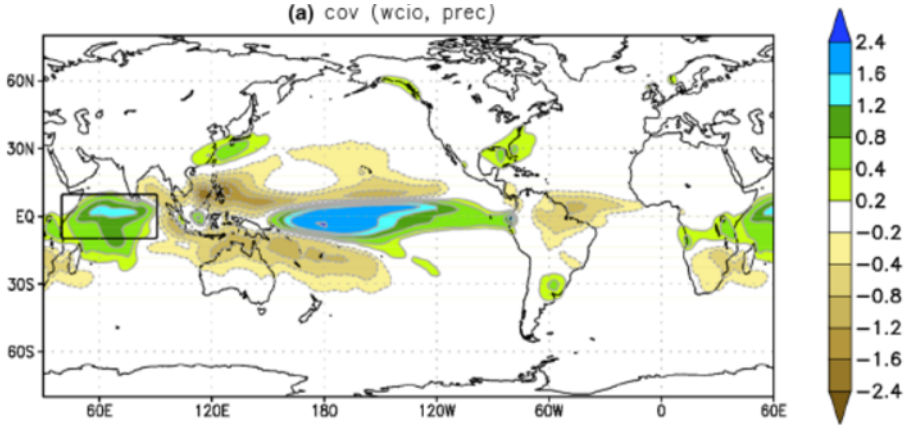




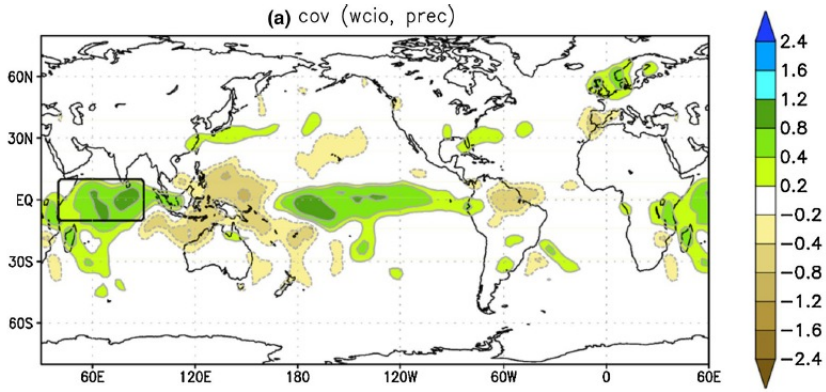
Extra-tropical model teleconnections based on 30 years of reforecast:

From Molteni et al. 2015

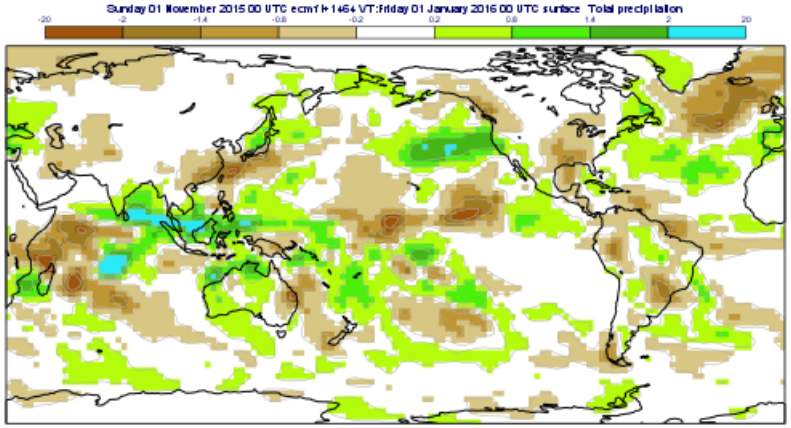
System4

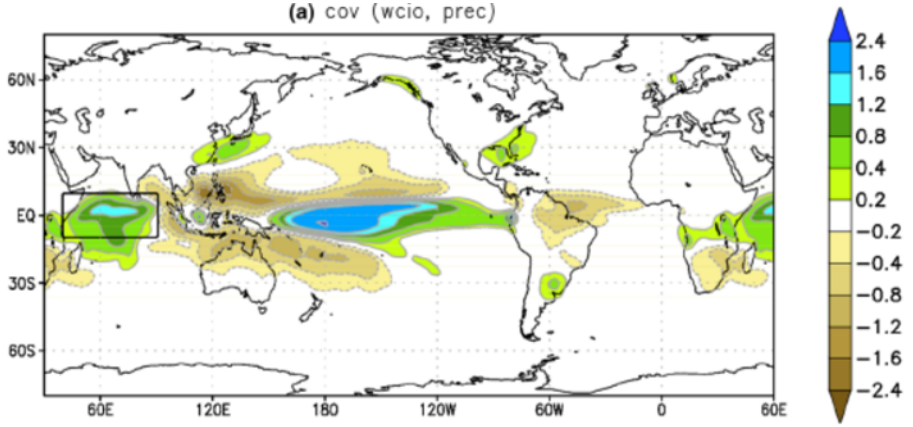


era-interim



The inter-ensemble precipitation differences between members with low NAO - high NAO response

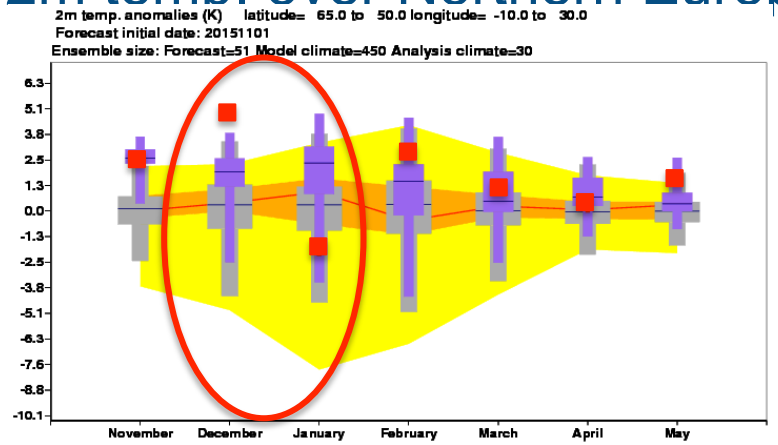


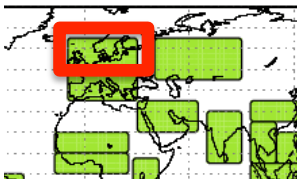


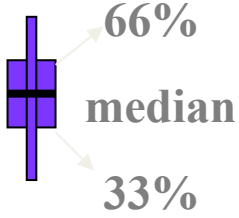
Teleconnection on the sub-seasonal time scale:

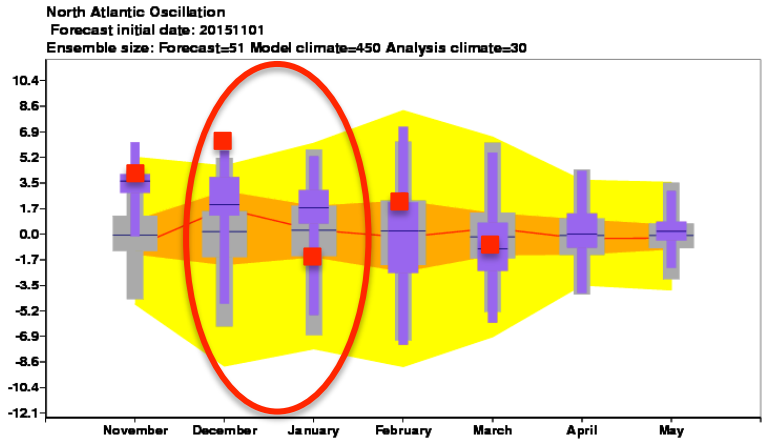
Monthly means anomalies:

2m temp. over Northern Europe

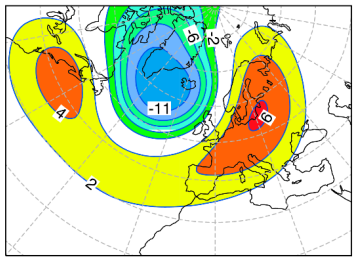


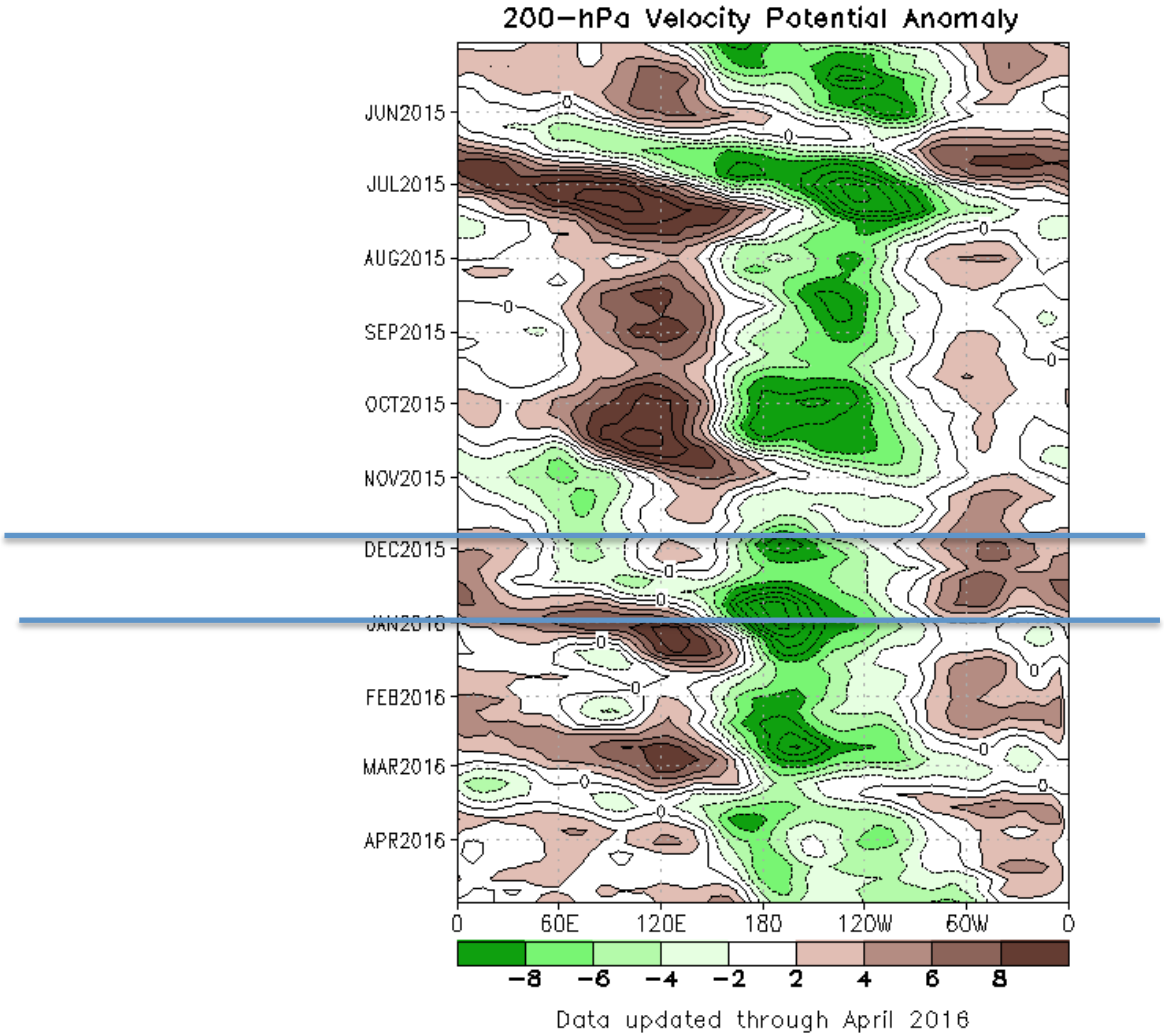




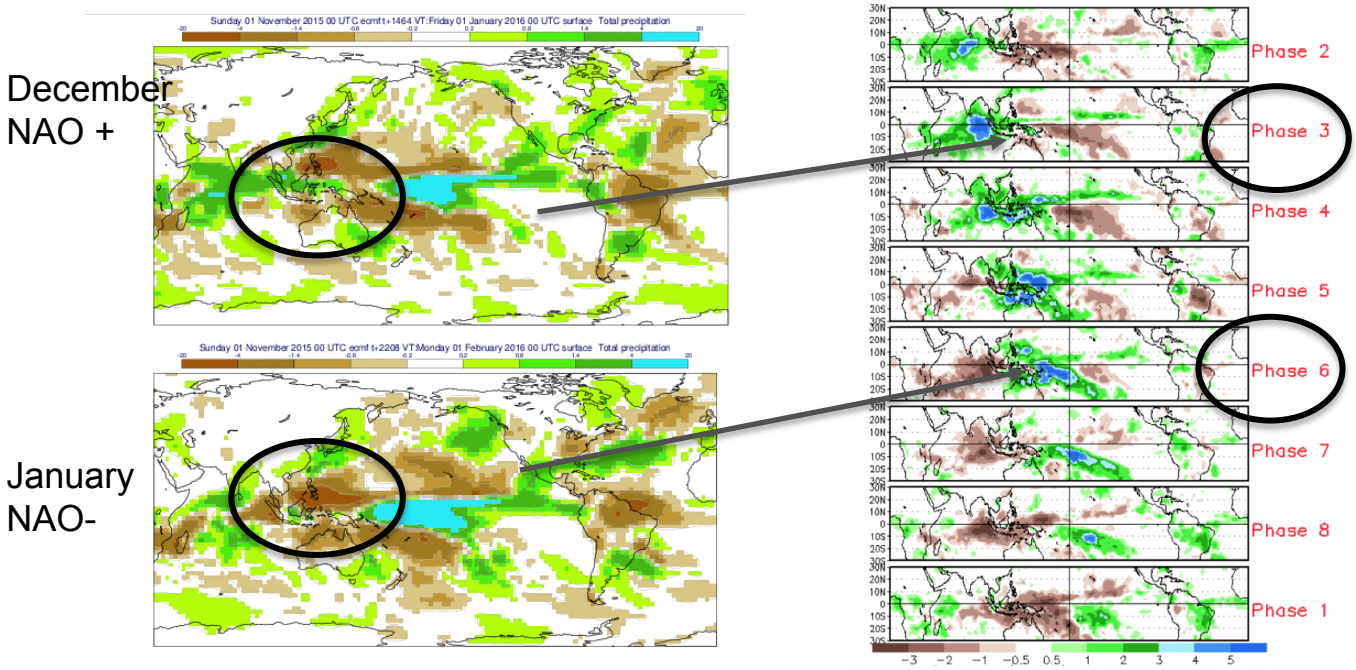


NAO pattern




200-hPa Velocity Potential Anomaly
JUN2015
JUL2015
AUG2015
SEP2015
OCT2015
NOV2015
DEC2015
JAN2016
FEB2016
MAR2016
APR2016
0
60E
120E
180
120W
60W
0
-8
-6
-4
-2
2
4
6
8
Data updated through April 2016

Precipitation composites anomalies: taking the members with the strongest change in NAO between December to January



Summary:

- The ENSO 1982/83 and 2015/16 events show similar characteristics in the tropical and extra-tropical anomalies. In both years during DJ strong westerlies (NAO+) were observed.

- The ENSO 1997/98 event is characterized by a large upper level divergence over the tropical Western Indian ocean and Africa. These anomalies might play a role in the warming of the polar vortex and in turn in the weakening of the westerlies in the troposphere.

- The current seasonal forecast system underestimate the link between Indian ocean precip. and the NAO and shows an incorrect sign in the weak NAO signal associated with the Central Pacific precip.

- Results indicate that the model is not responsive to the heat source anomalies over the Western Indian Ocean but it is sensitive to the ones over Eastern Indian Ocean and Pacific.