

Tropical-Extratropical teleconnections in ensemble EC-Earth simulations

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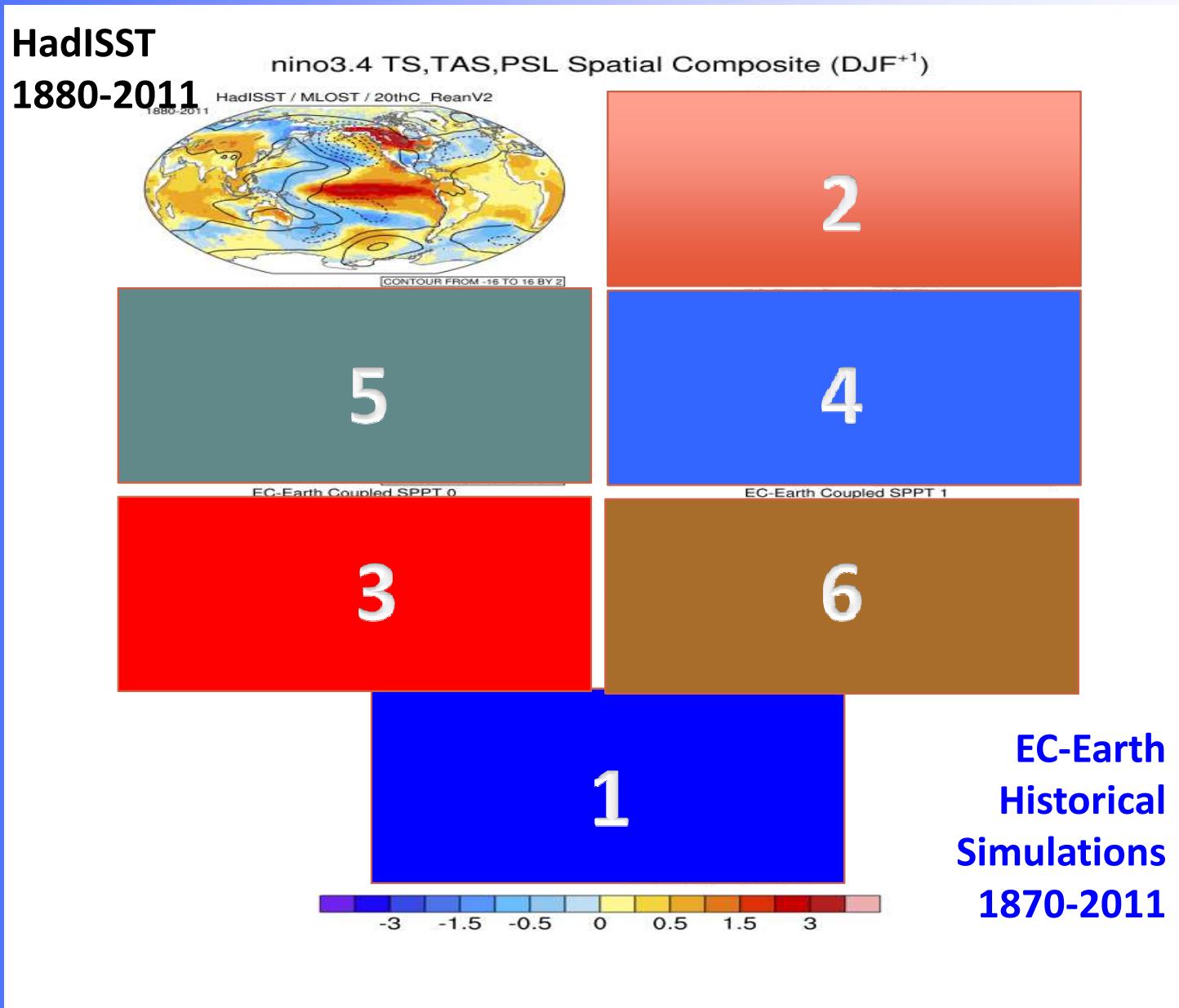
Outline

- Sensitivity of Euro-Atlantic weather regimes to the Atlantic Multidecadal Variability (AMV) phases.
- Teleconnection between El Niño and PNA in DJF

Questions

- How well are weather regimes and teleconnection patterns “reproduced” in EC-Earth?
- What is the degree of “reproducibility” of these teleconnection patterns in a set of climatological sister simulations?
- What are the factors that might weaken or strengthen a teleconnection pattern (or the regime sensitivity to “decadal oscillations”)?

Teleconnections: The “Old Queen” : El Niño-PNA (or PNA-like)



AMV(or AMO)

Environ. Res. Lett. 9 (2014) 034018

Y Peings and G Magnusdottir

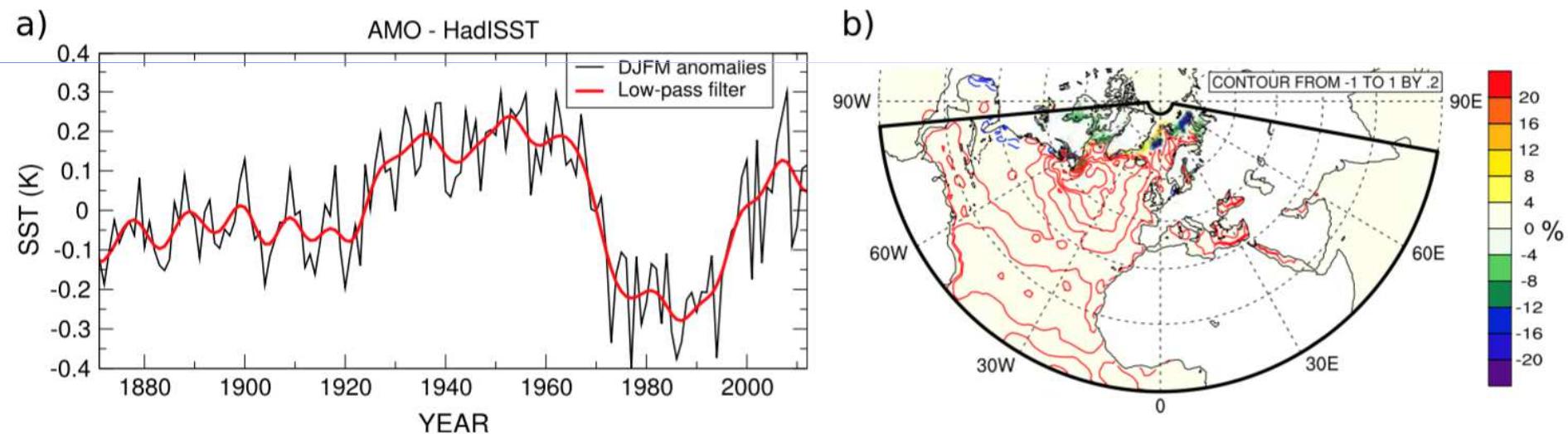


Figure 1. AMO signature in the observations. (a) Winter (DJFM) AMO time series from the HadISST dataset (red). Seasonal anomalies are shown in black. (b) SST (contours in K, positive contours in red, negative contours in blue) and SIC anomalies (shading in %) associated with the AMO signal in observations over 1951–2012 (difference between positive and negative phases of the AMO, based on composite analysis to select positive and negative AMO years). The domain on which the AMO anomalies are imposed in the model is also shown.

AMV index: yearly anomalies of the North Atlantic SSTs between 75° W– 5° W and 0° – 70° N minus 10-year running mean of the global SSTs (area-averaged between 60° S and 60° N) (Trenberth and Shea 2006).

AMO(or AMV) & The Euro-Atlantic Flow Regimes Frequencies

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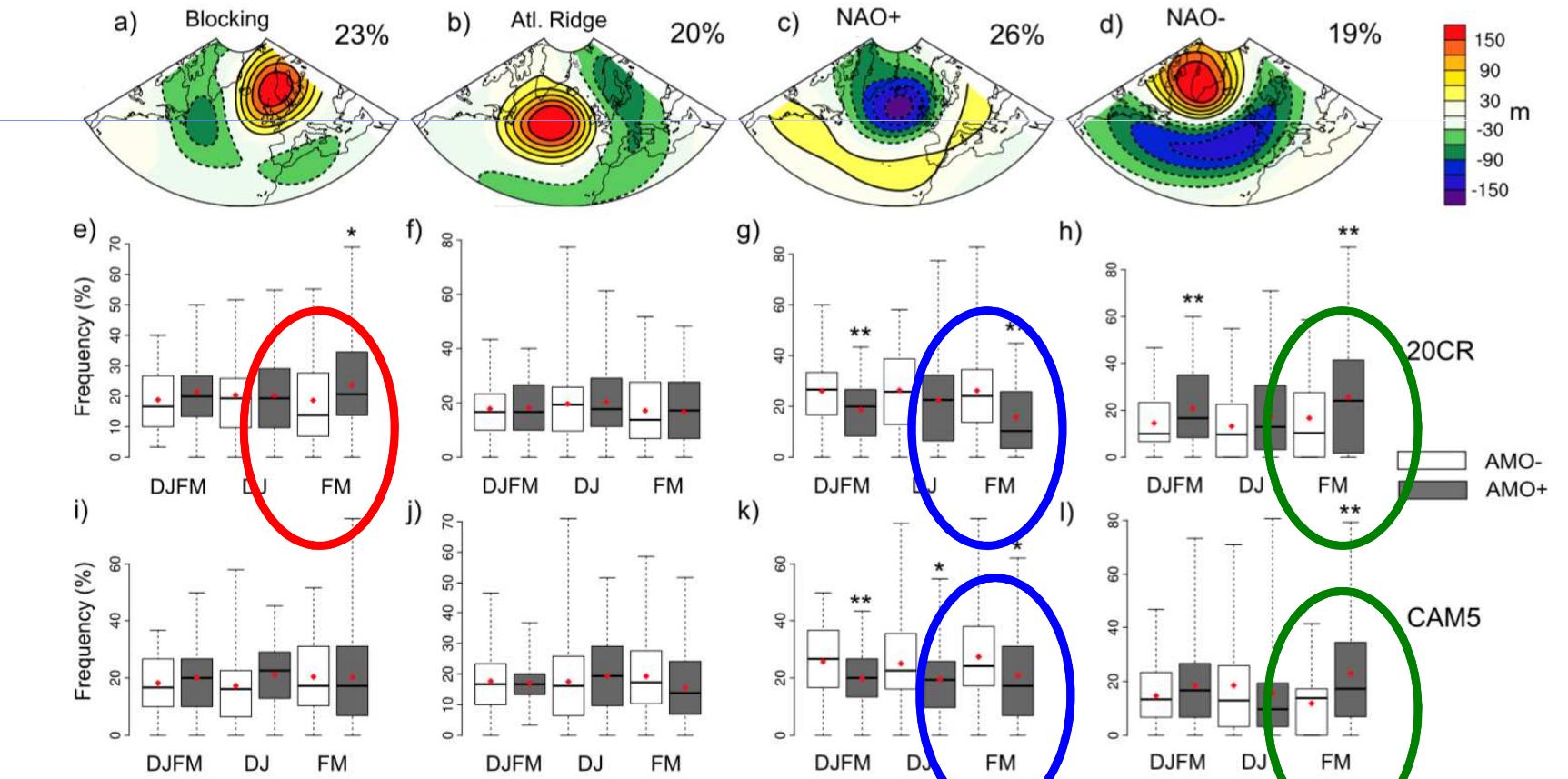


Figure 3. Response of the North Atlantic intraseasonal weather regimes to the AMO. (a)–(d) Winter (DJFM) North Atlantic weather regimes computed over 1901–2010 from the Z500 anomalies (in m) of 20CR. Frequencies of occurrence over the 1901–2010 wintertime days are indicated in %. (e)–(h) Distribution of seasonal regime frequencies in 20CR over 1901–2010, during AMO- (53 years, white boxplots) and AMO+ (57 years, gray boxplots) for winter (DJFM), early (DJ) and late (FM) winter. (i)–(l) same as (e)–(h) except for CAM5 (AMOn in white and AMOp in gray, 50 years for each experiment). Boxplots indicate the maximum, upper-quartile, median, lower-quartile and minimum of the distribution (horizontal bars). The mean of the distribution is shown by red diamonds, and asterisks indicate the significance level of the difference of the mean between AMO- and AMO+ (AMOn and AMOp for the simulations): *: $p < 0.1$; **: $p < 0.05$ (t -test).

AMO(or AMV) & The Euro-Atlantic Blocking

IOP Publishing

Environ. Res. Lett. **10** (2015) 094010

P Davini *et al*

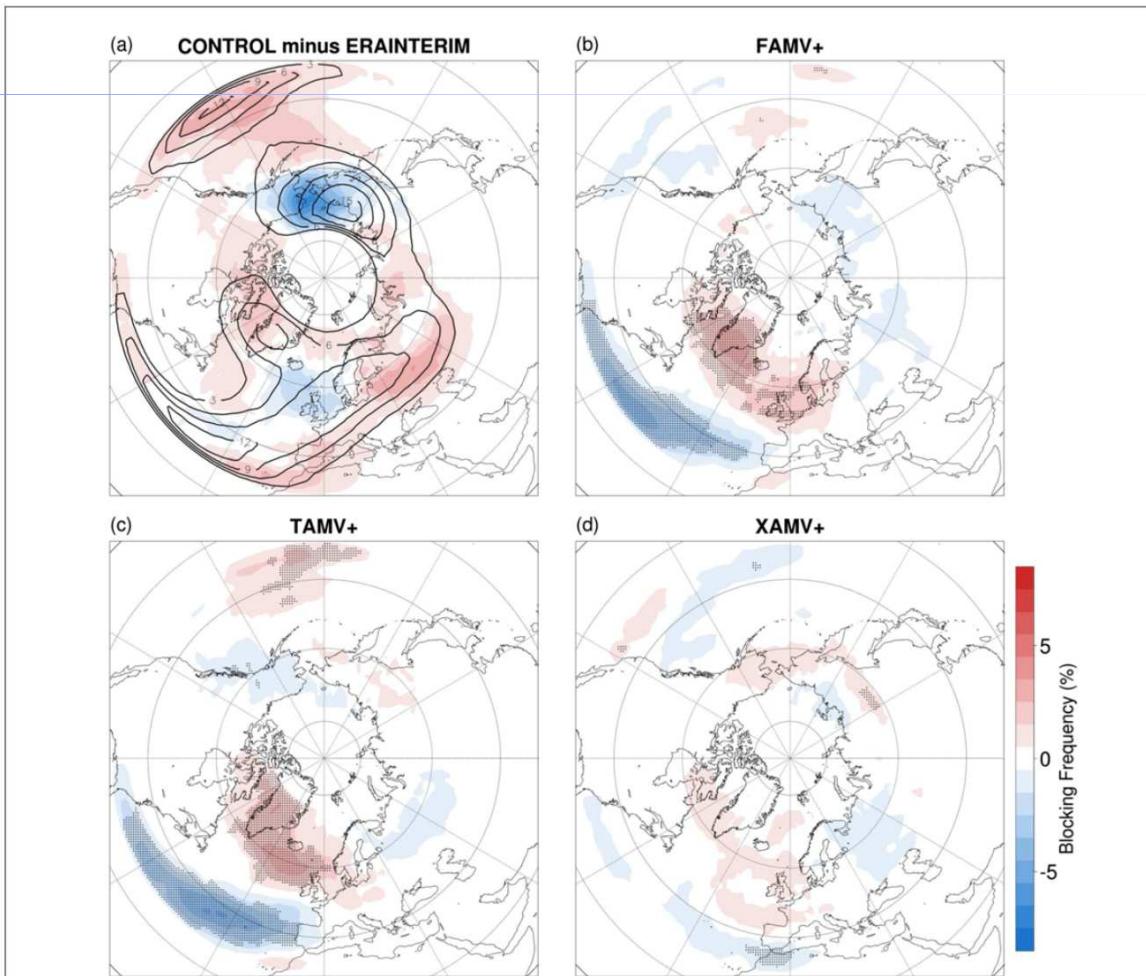


Figure 2. (a) DJFM Blocking frequency bias for the CONTROL experiment with respect to the ERA-INTERIM reanalysis (colors) and CONTROL blocking frequencies (contours). DJFM Blocking frequency anomalies shown as positive minus negative phase for (b) FAMV, (c) TAMV and (d) XAMV experiments. All are expressed as percentage of blocked days per season. In (a) contours are drawn each 3%. Stippled regions show significance at the 2% level.

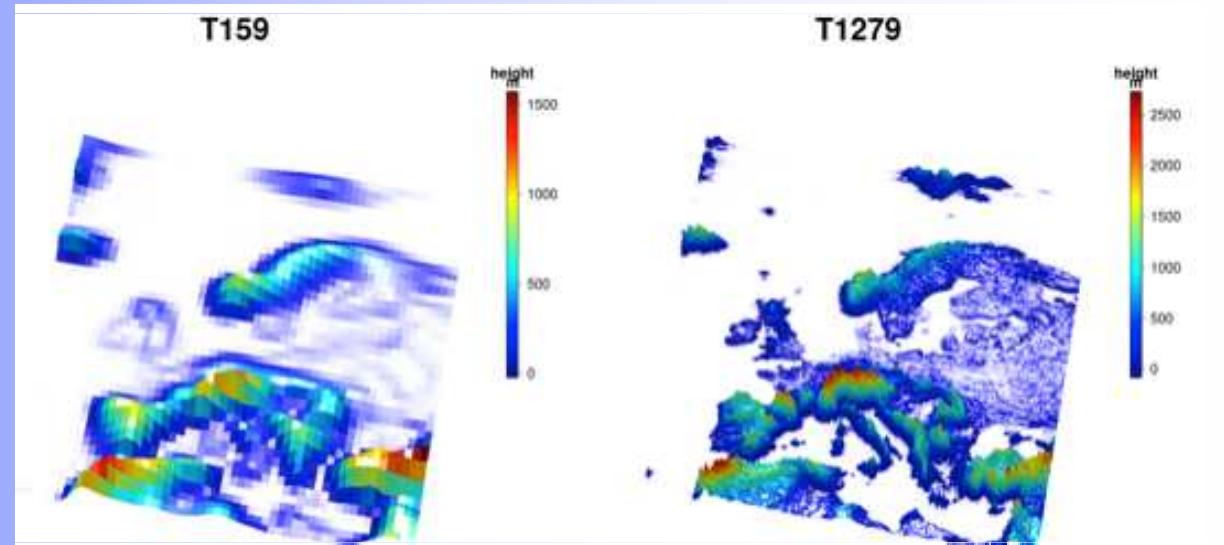
Coupled: T255L91
1850-2100, historical + RCP8.5

Atmospheric-only:
5 horizontal resolutions



Present day
1979-2008

Future Scenario
2039-2068 RCP85



EC-Earth version 3.1

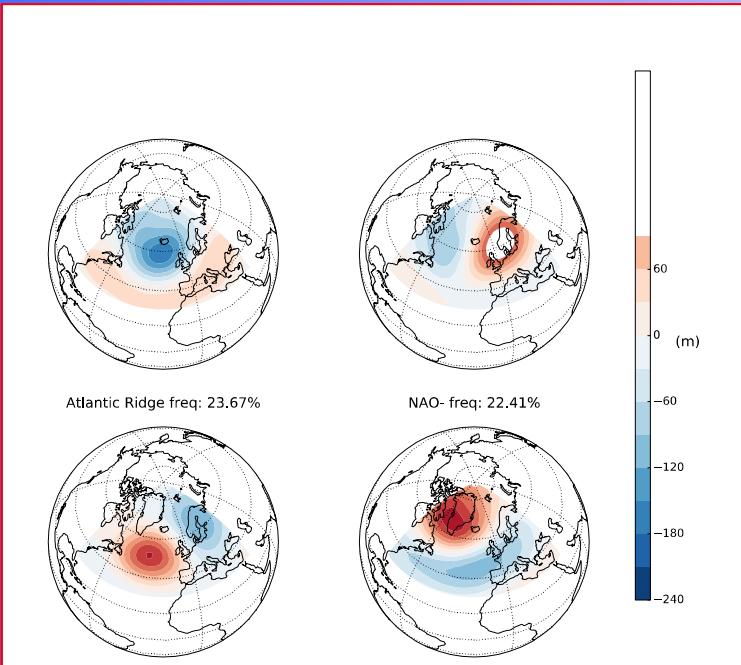
Website and data access:
[\(http://sansone.to.isac.cnr.it/sphinx/\)](http://sansone.to.isac.cnr.it/sphinx/)

T159L91 (125km): 10+10 ensemble members
T255L91 (80km): 10+10
T511L91 (40km): 6+6
T799L91 (25km): 3+3
T1279L91 (16km): 1+1

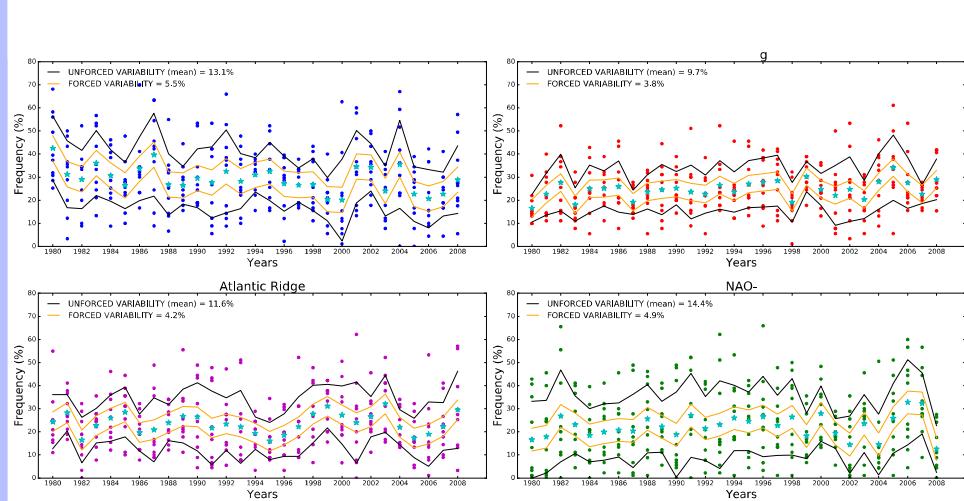
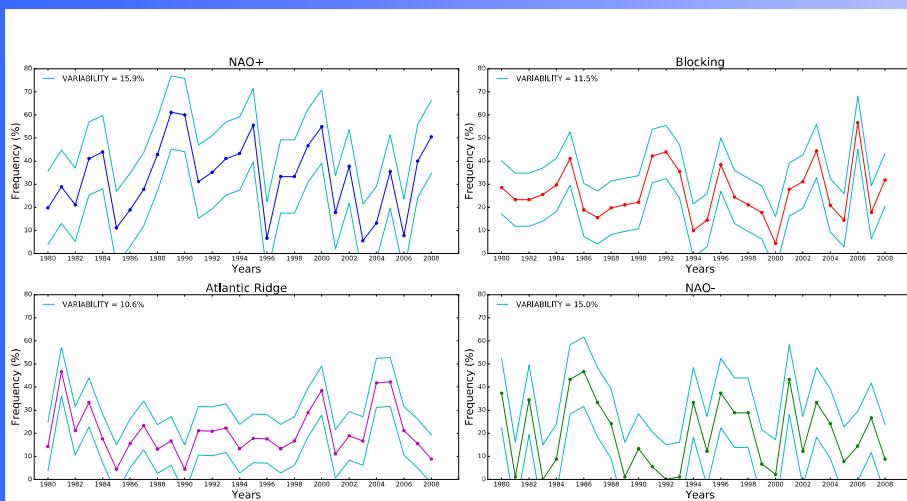
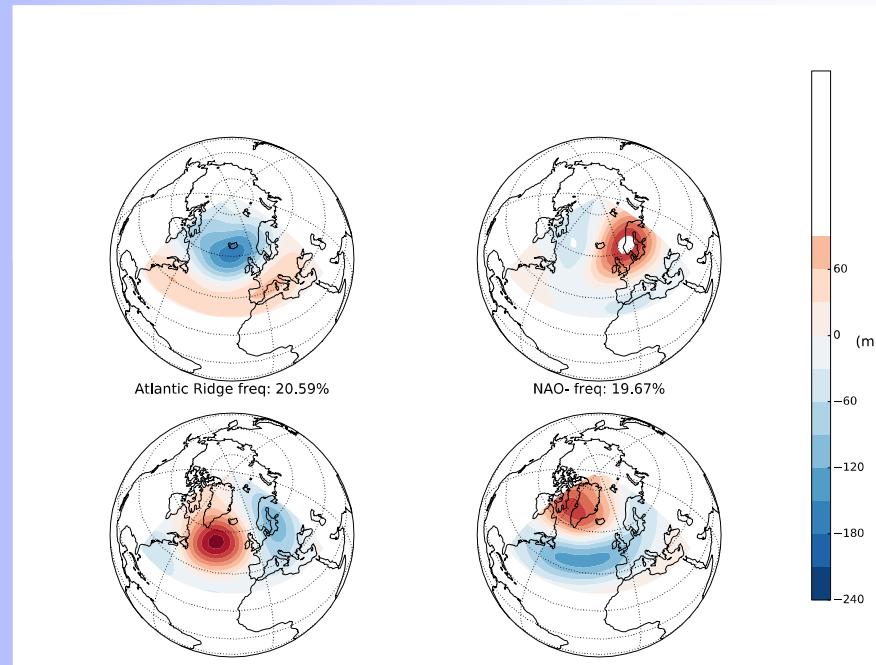
Euro-Atlantic Weather regimes

AMIP T255 [10 ensemble members]

EC-Earth

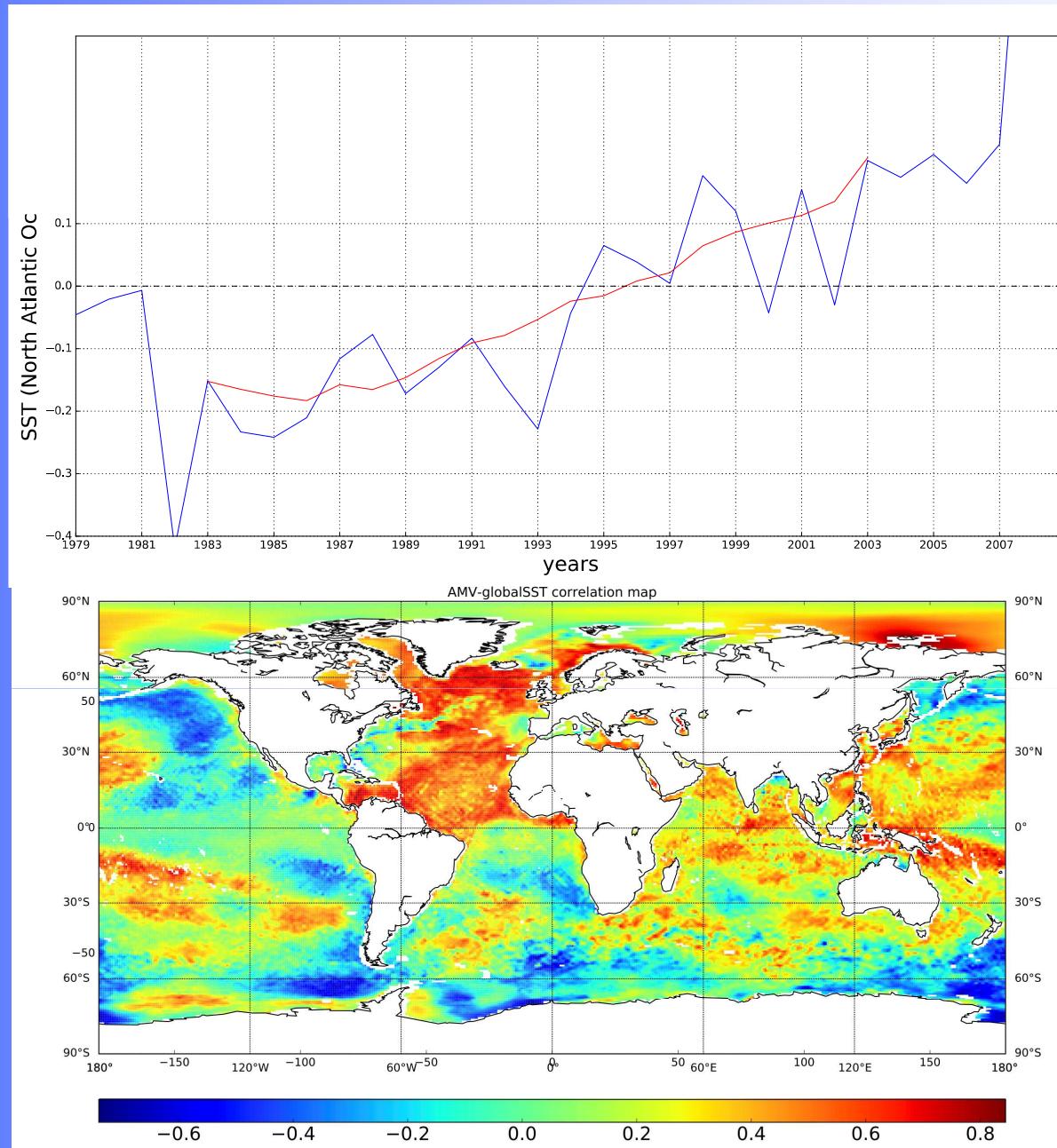


NCEP

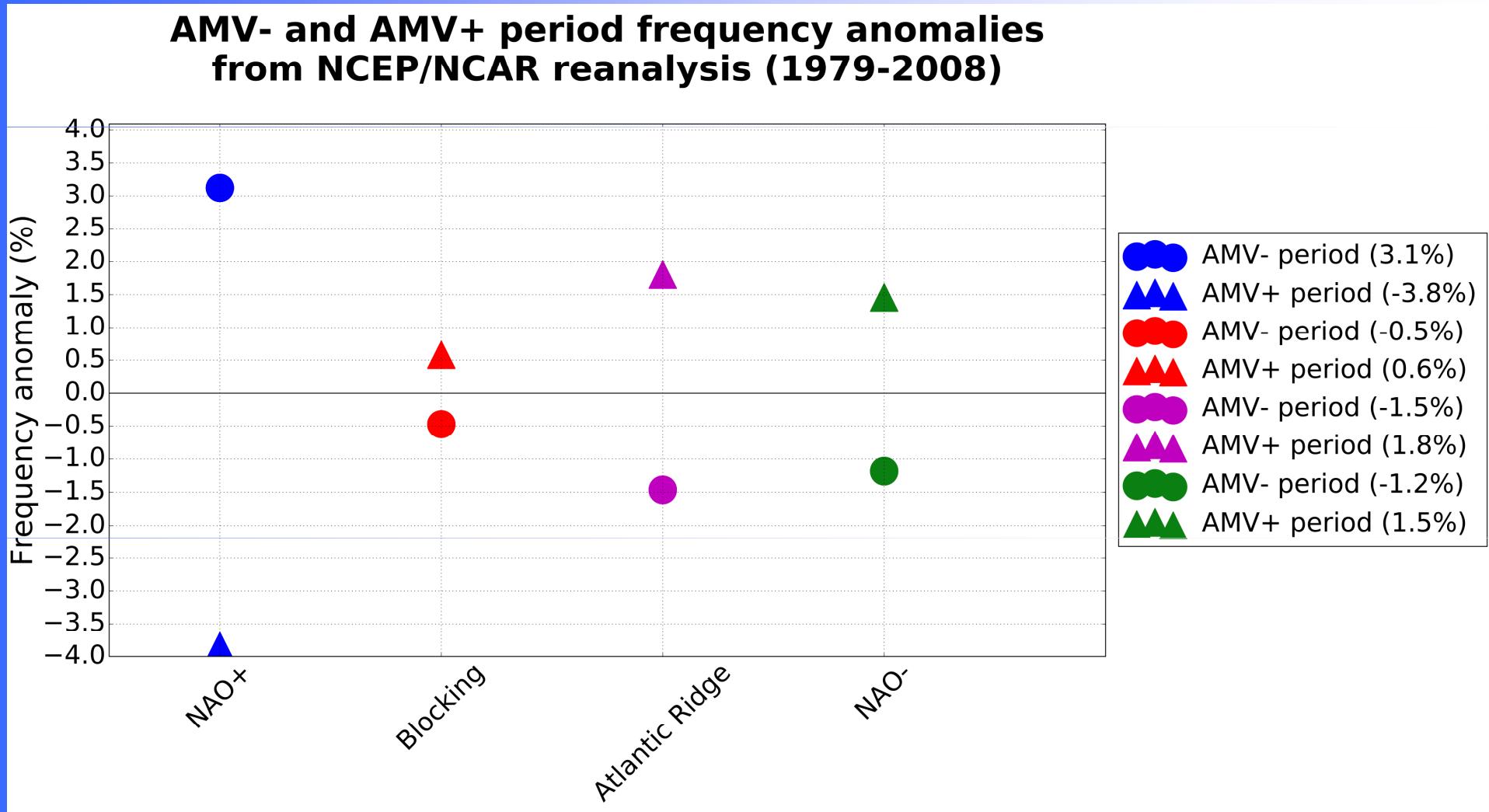


Atlantic Multidecadal Variability (AMV)

AMV- (1979-1995) AMV+ (1996-2008)



Sensitivity of Euro-Atlantic Weather Regimes Frequency to AMV (NCEP)



Sensitivity of Euro-Atlantic Weather regimes Frequency to AMV (EC-Earth-AMIP)

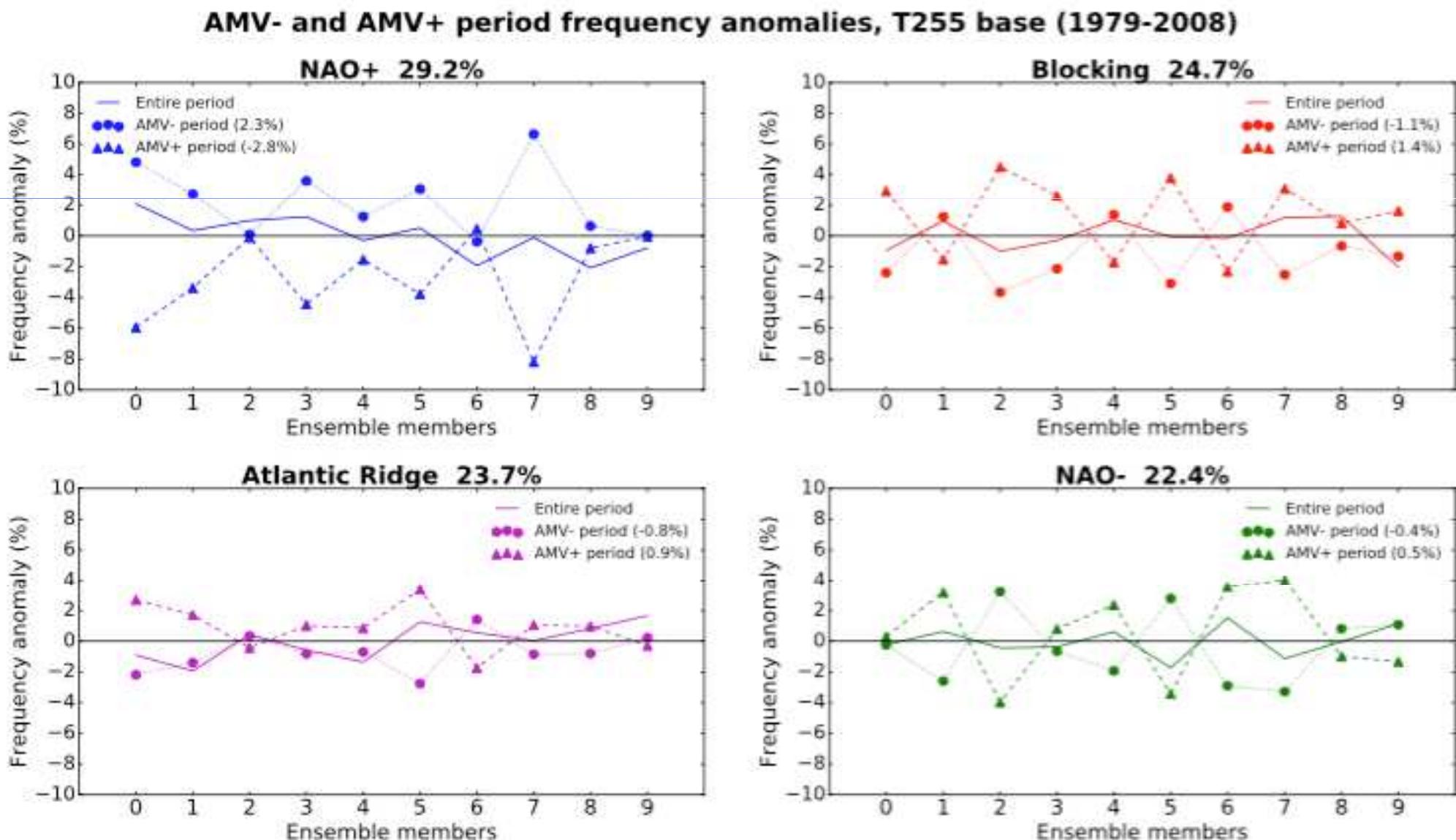
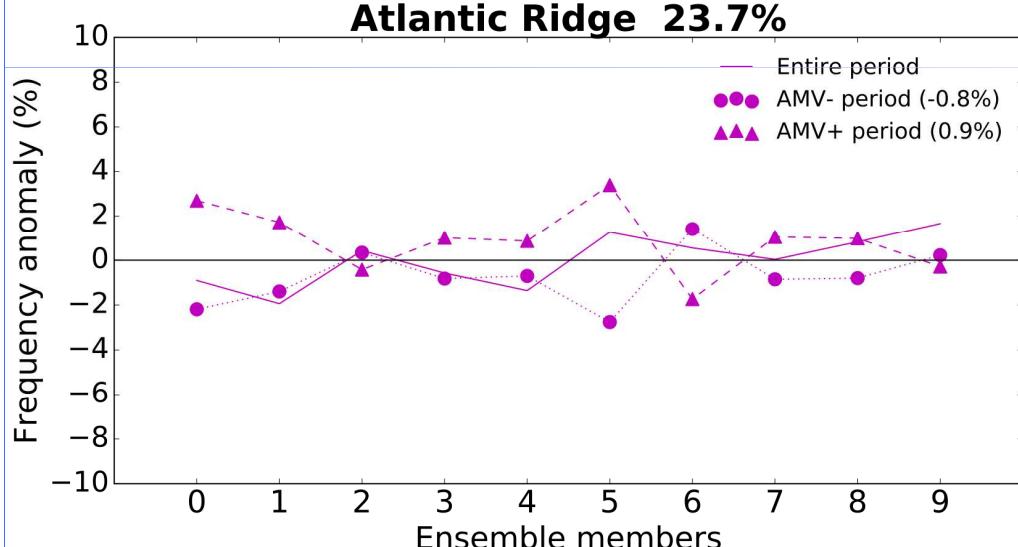
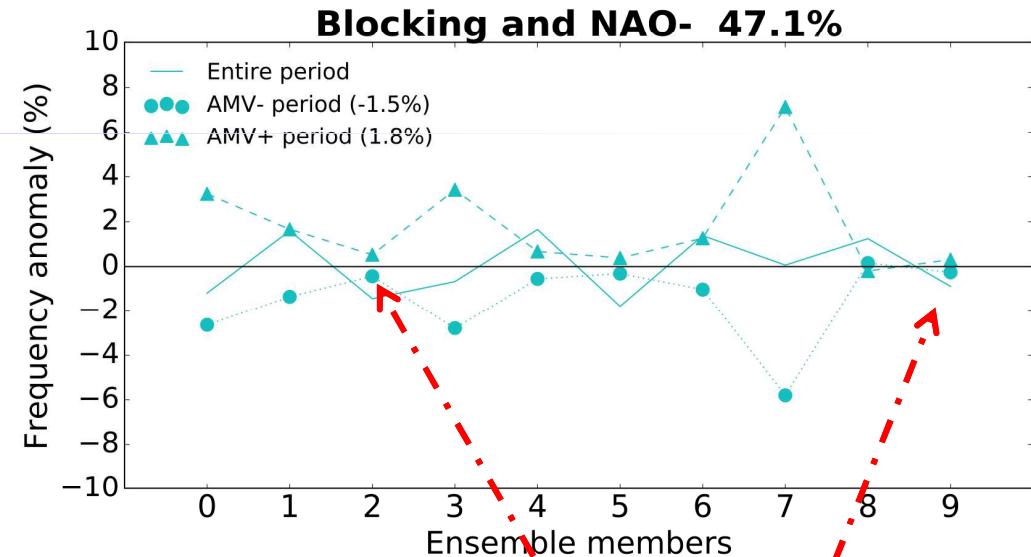
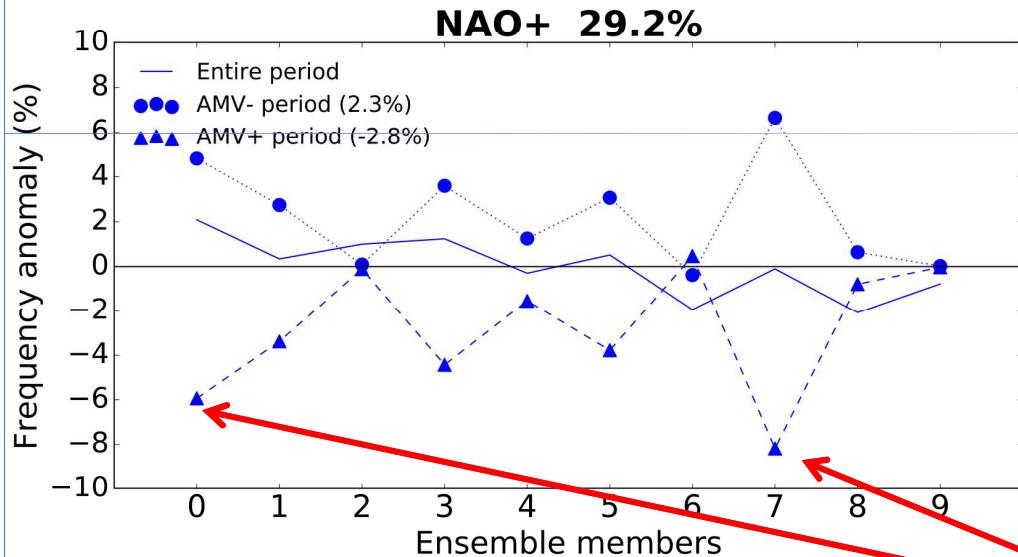


Figure 2: Regime frequencies anomalies with respect to the entire period (1979-2008) shown in solid line; during AMV- (1979-1995) in circles and during AMV+ (1996-2008) in triangles.

Sensitivity of Euro-Atlantic Weather regimes Frequency to AMV (EC-Earth-AMIP)

AMV- and AMV+ period frequency anomalies, T255 base (1979-2008)



**Some Ensemble Members
are more sensitive to the
AMV phase than others.**

N.B. All the ensemble members are forced by the same SSTs and radiative forcings (CMIP5).

Sensitive and Insensitive ensemble members

What are the factors that might amplify (or inhibit) the regime sensitivity to AMV in an “AMIP-world”?

Possible candidates: Eurasian Snow anomalies and/or Stratospheric Warming events in (or not in) phase with the AMV

Positive anomaly of Eurasian Snow Depth in Autumn/Winter → NAO-
Stratospheric Warming events → NAO-

Strategy: Split the ensemble in 5 good (i.e. most AMV sensitive) and 5 bad (i.e. least AMV sensitive) ensemble members and look at the differences in snow depth and T50hPa climatology for AMV+ and AMV- years.

Eurasian Snow Depth

Sensitive minus Insensitive

RED
AMV+

years

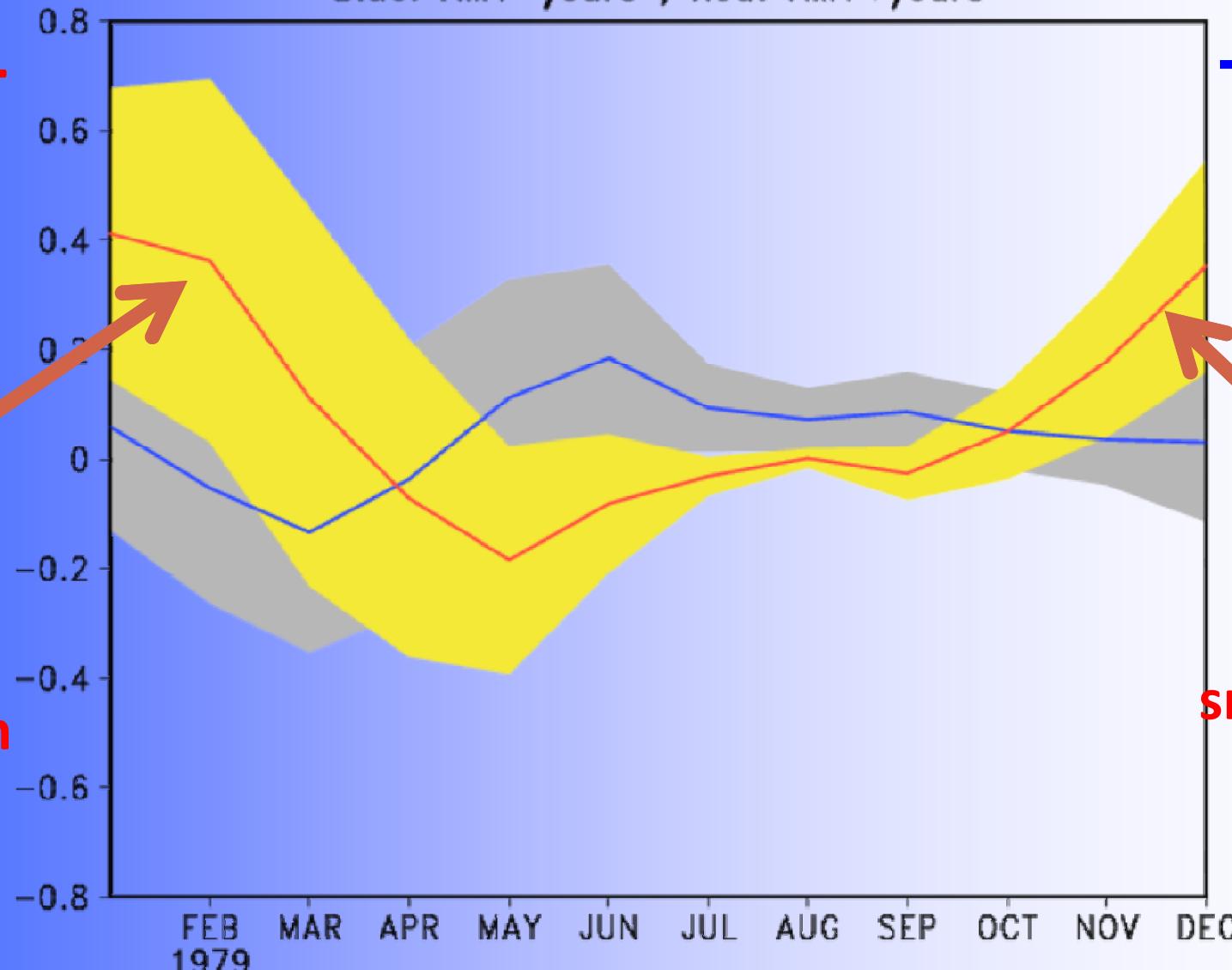
→NAO-

BLUE
AMV-

years

→NAO+

SNOW DEPTH [40–140E 40–75N] – GOOD minus BAD ems
Blue: AMV–years ; Red: AMV+years



Positive
snow depth
anomalies

→NAO-

Positive
snow depth
anomalies
→NAO-

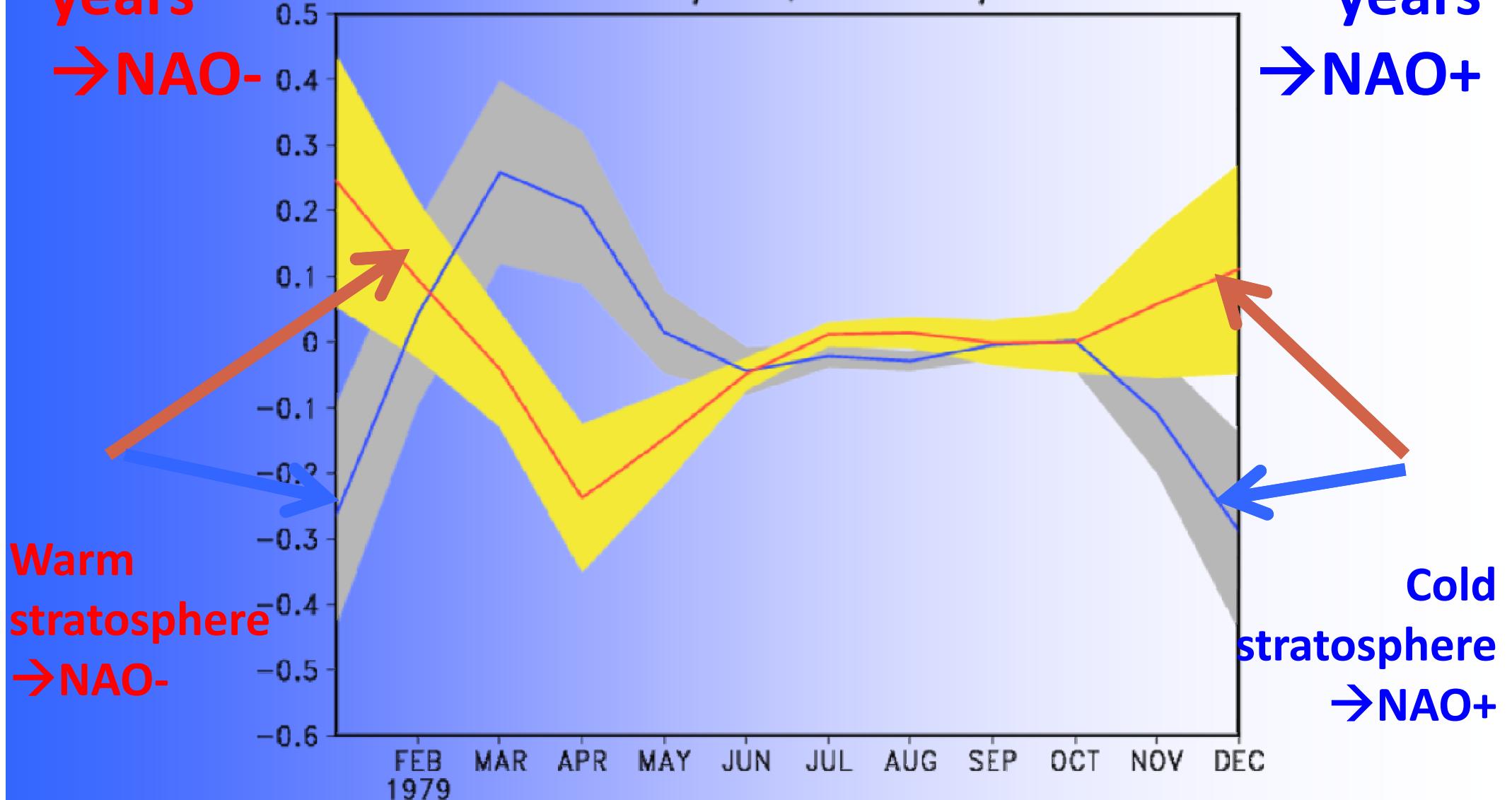
Temperature at 50hPa [40-80N]

RED
AMV+
years
→NAO-

BLUE
AMV-
years
→NAO+

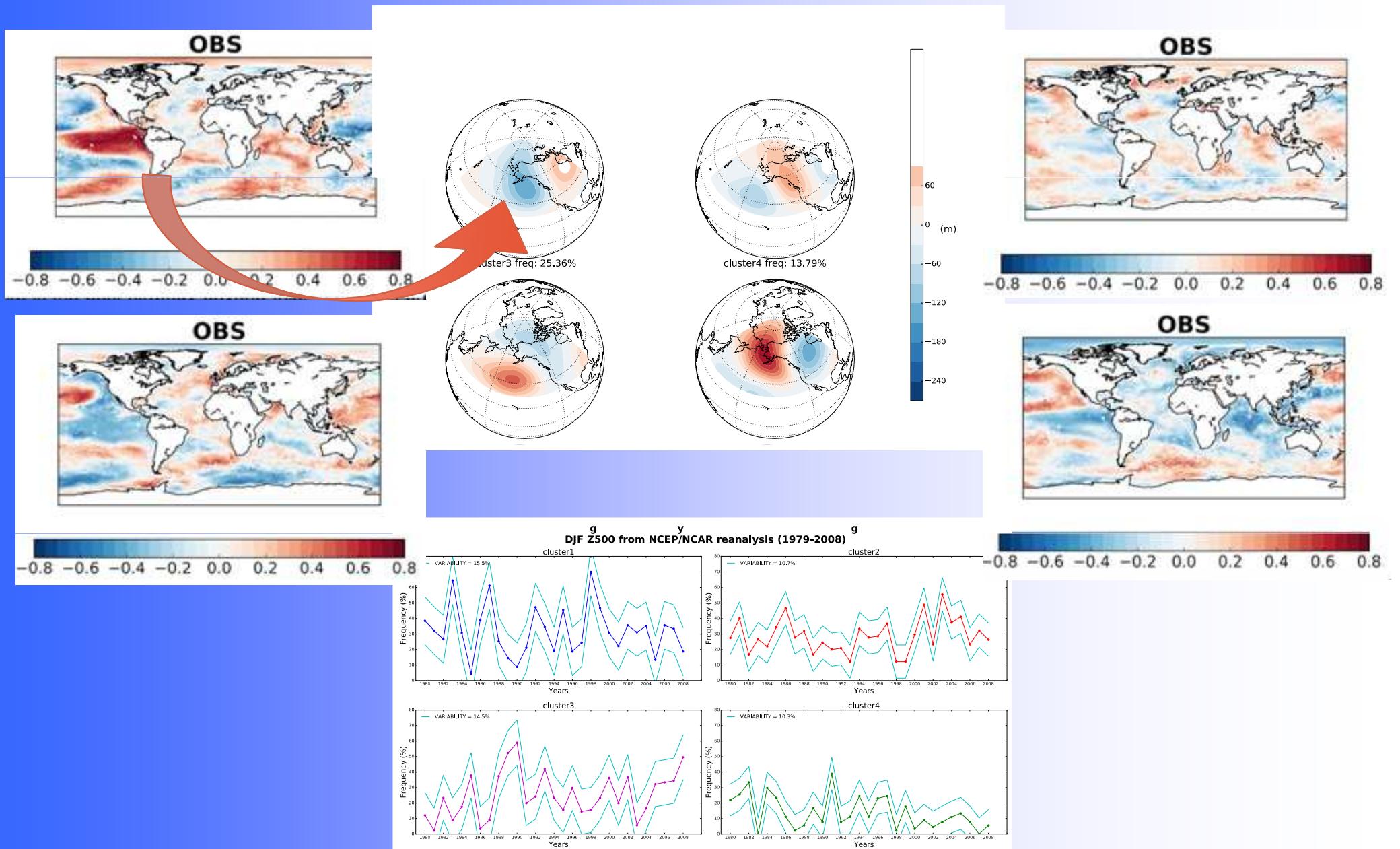
Sensitive minus Insensitive

T50 [40–80N] – GOOD minus BAD ems
Blue: AMV–years ; Red: AMV+years



Pacific-North America Weather regimes

NCEP

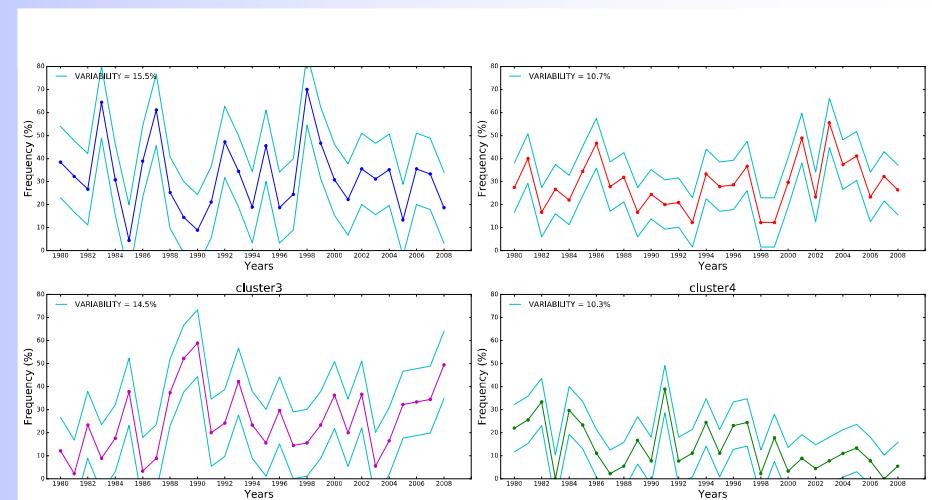
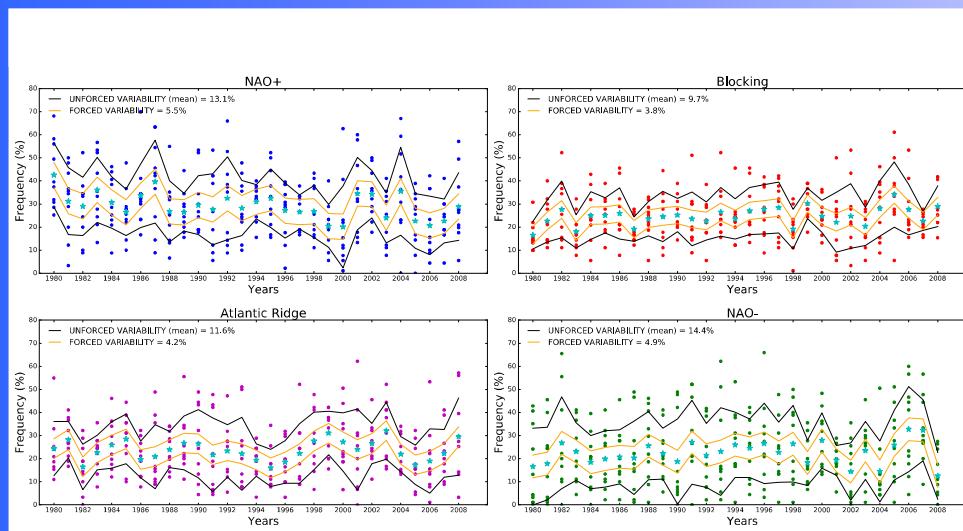
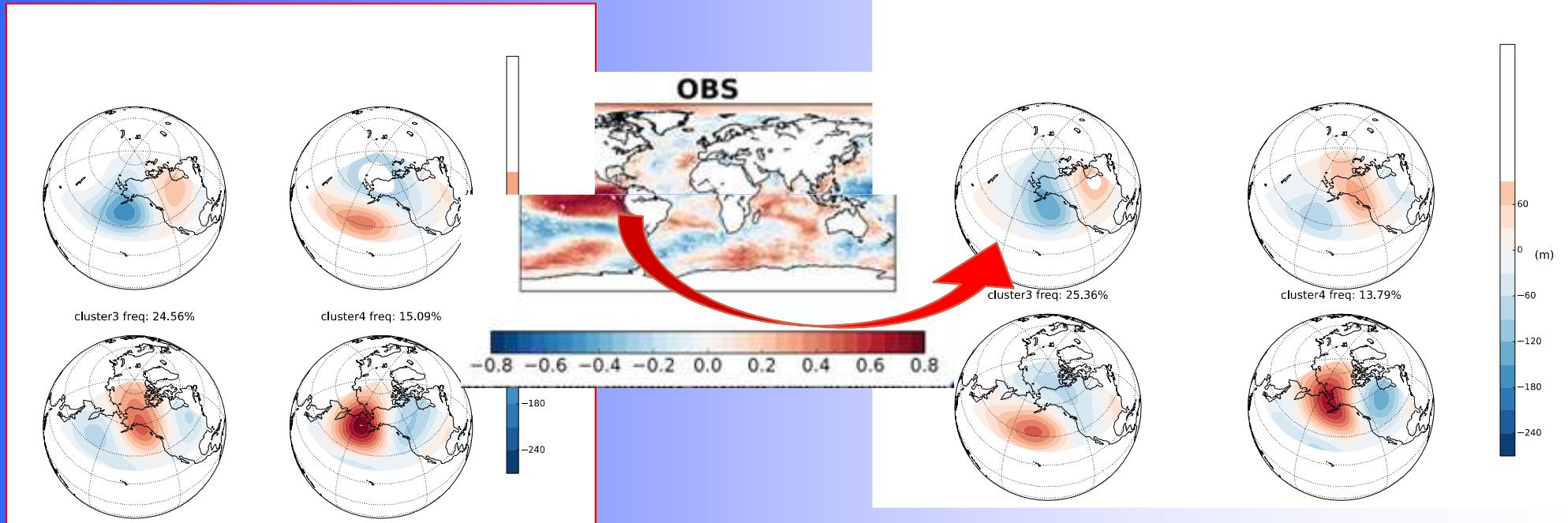


Pacific-North America Weather regimes

AMIP T255 [10 ensemble members]

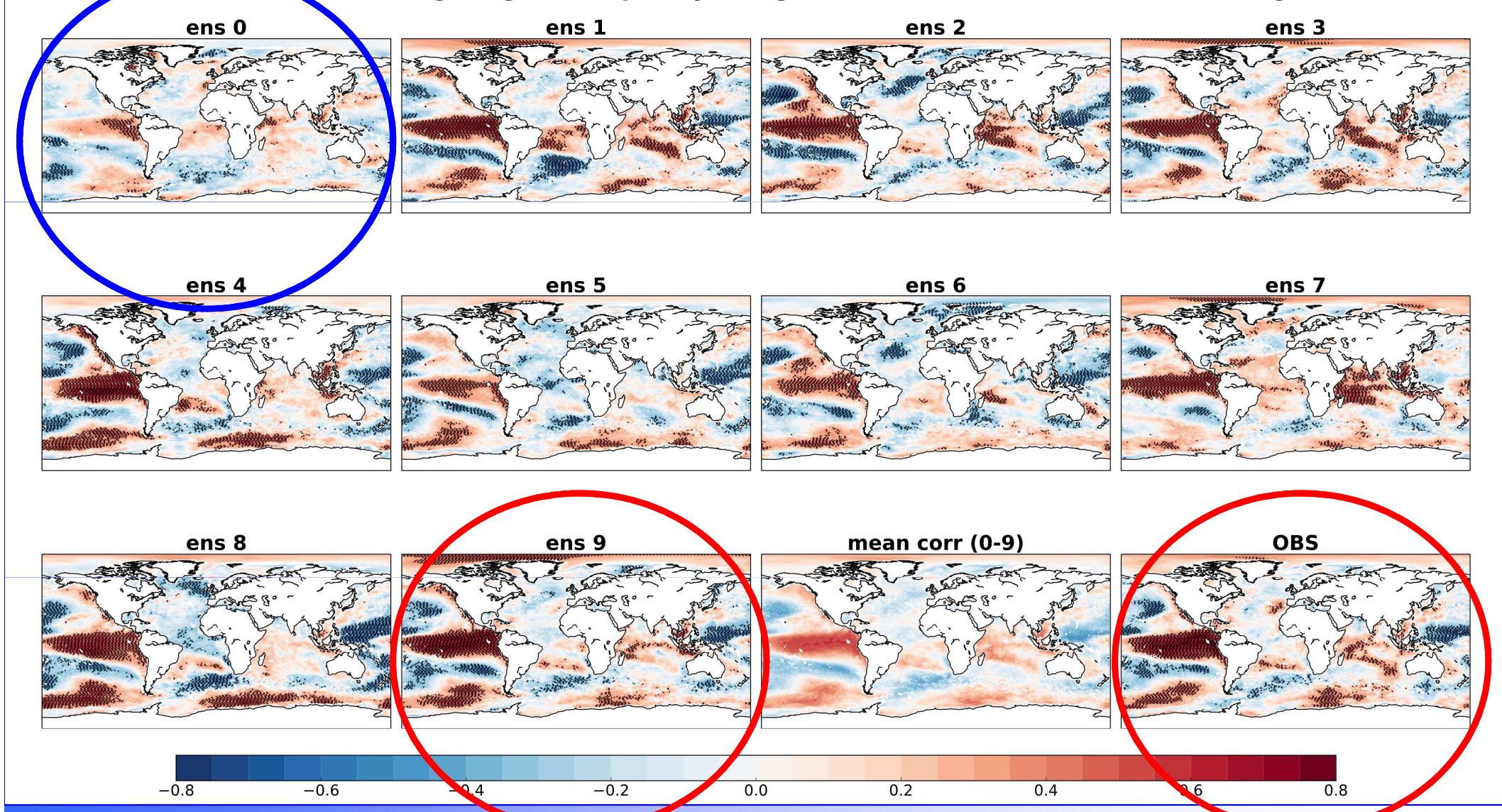
EC-Earth

NCEP

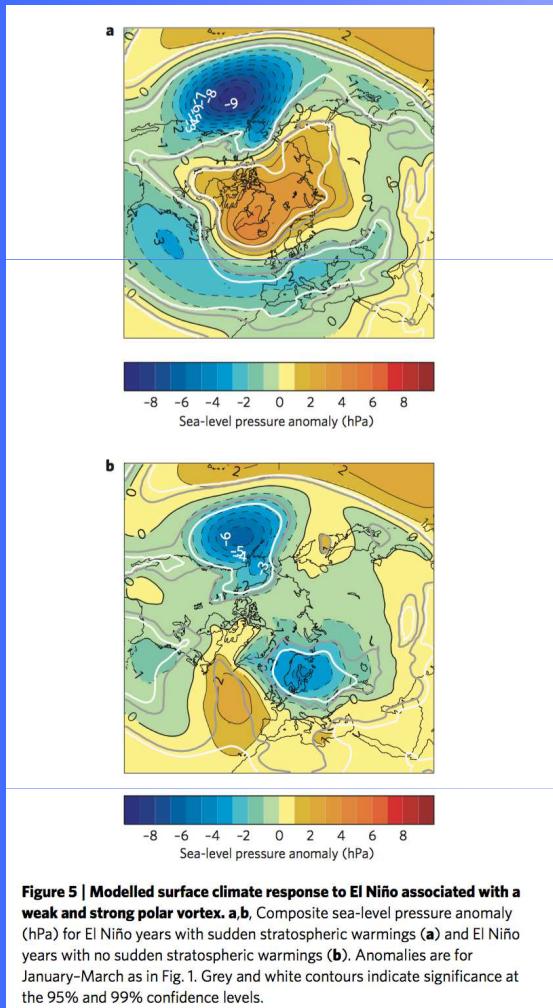


Pacific Trough Frequency & Global SST T255 DJF

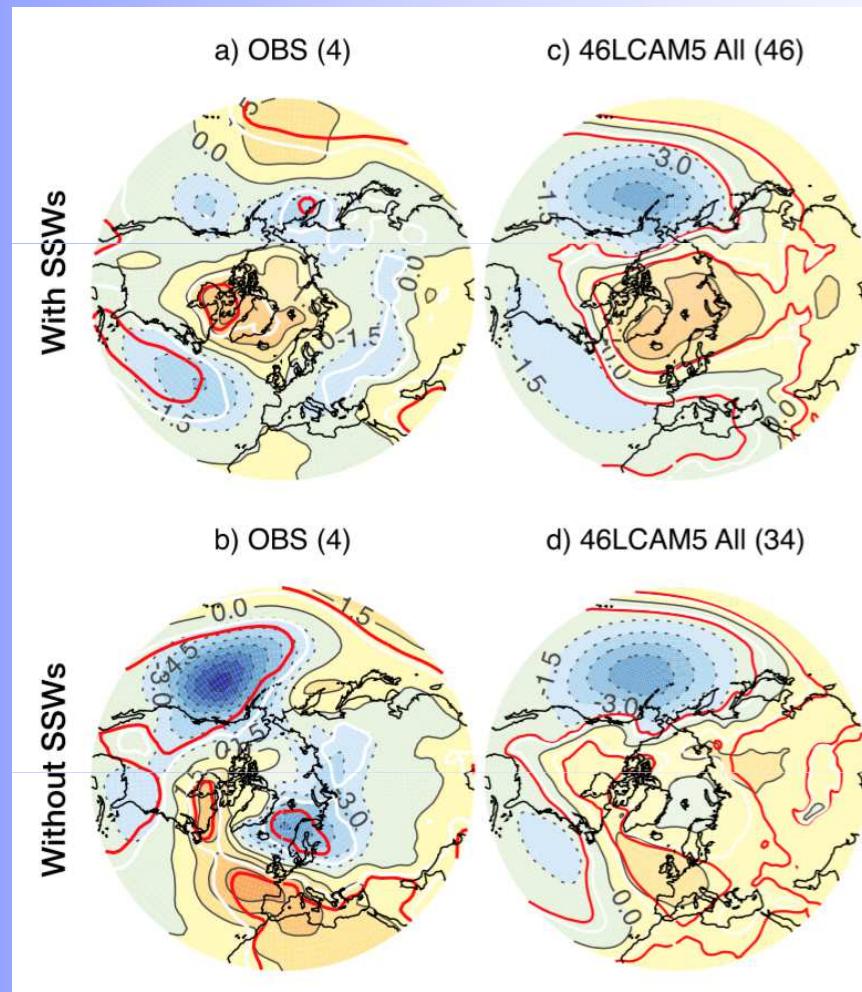
CORRELATION MAP: Pacific trough regime frequency and global SST (Pacific North American region, T255, base)



Possible influence of the stratosphere



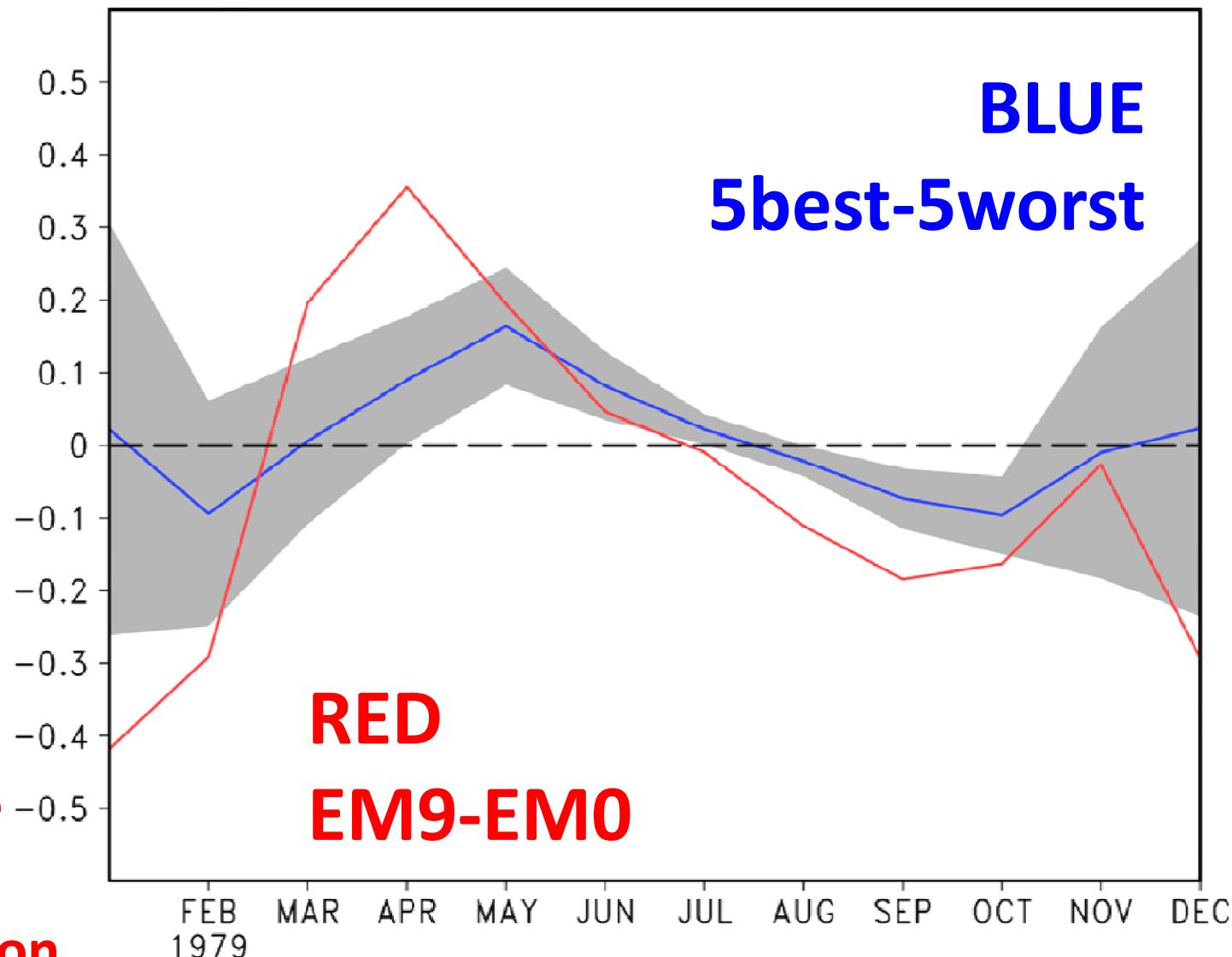
Ineson and Scaife 2009
Nature GeoScience



Richter et al. 2015 ERL

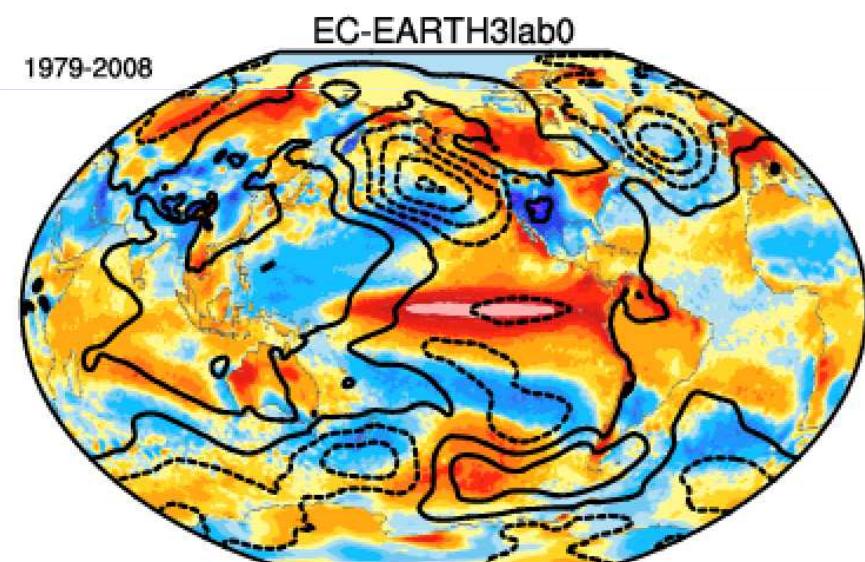
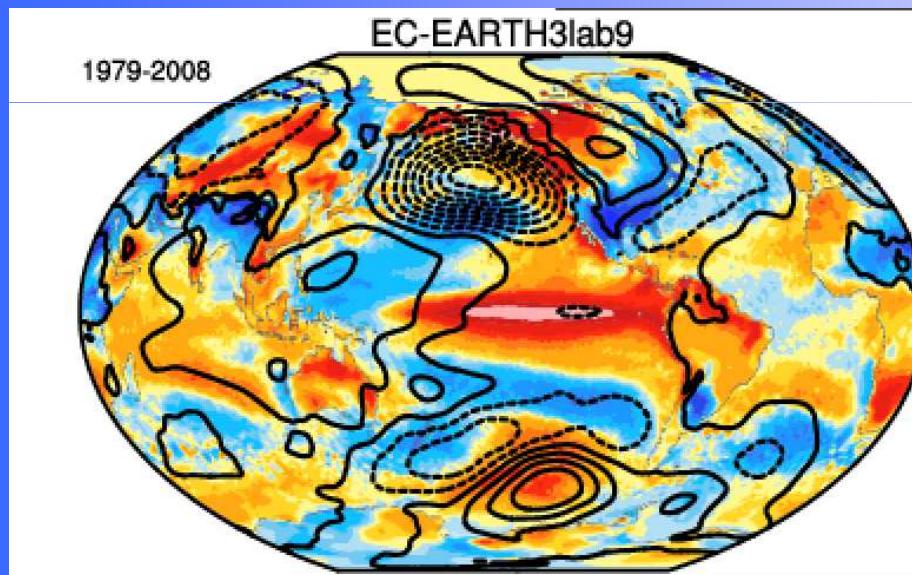
Temperature at 50hPa [40-80N] GOOD minus BAD NIÑO WINTERS

T50 [40–80N] Winter Nino years [83 87 92 95 98 03]
Blue: GOOD minus BAD ems ; Red: EM9 minus EMO



Warm
stratosphere
→ Week
teleconnection

Nino3.4 Teleconnection in ens9 and ens0



Concluding remarks

- Euro-Atlantic and Pacific-American Regime patterns are well simulated.
- As in Peings and Magnusdottir [2014] and Davini et al. [2015], the observations show an increased blocking and NAO- frequency during AMV+ period and a decreased NAO+ frequency during AMV-: there is an opposite sign relationship between the polarities of the AMV and the NAO.
- In AMIP simulations, the sensitivity to the AMV phase changes largely according to the ensemble member. The most sensitive ensemble members are those with positive anomalies in Eurasian Snow Depth and Temperature in the Stratosphere in DJF when the AMV is in a positive phase.
- The DJF PNA-Niño teleconnection exhibits a non-negligible inter-ensemble variability as well.
- The stratosphere might play a role in amplifying or inhibiting the teleconnection. During El Niño winters the best ensemble member has a colder stratosphere than the worst. However the signal is only partially coherent among ensemble members and winters and further investigation is needed to drive conclusions.