Preliminary assessment of the Northern mid-latitude atmospheric circulation simulated by CNRM-CM6.1

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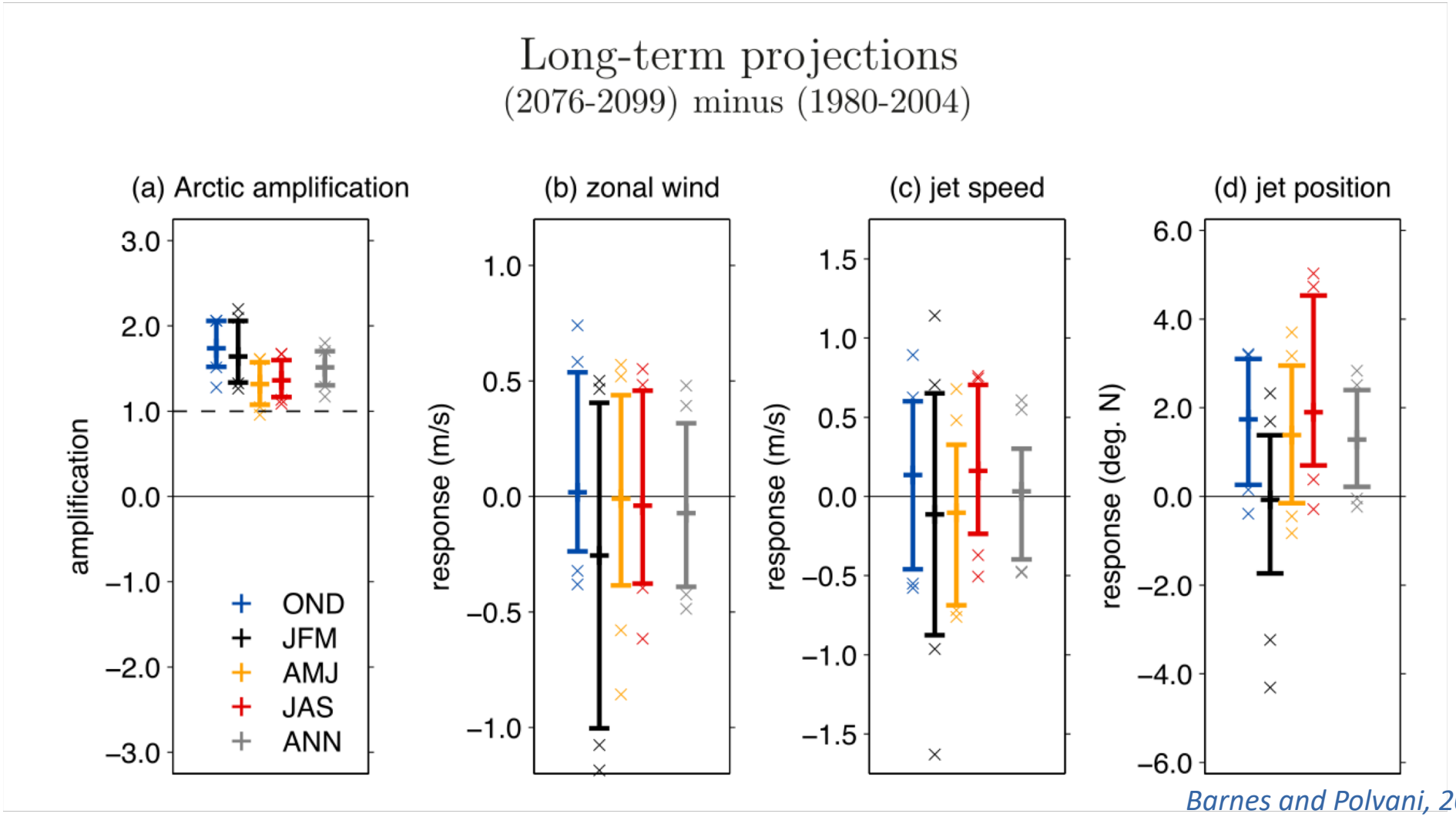
Context

- There are still many **uncertainties** on how the Northern mid-latitudes atmosphere will respond to climate change.

Context



Barnes and Polvani, 2015

Large spread for the zonal wind, jet speed or jet position in JFM (black)

Context

- There are still many **uncertainties** on how the Northern mid-latitude atmosphere will respond to climate change.
- Potential drivers are : **Arctic Amplification**, **Tropical high troposphere warming**, **stratospheric vortex strength** (*Peings et al. 2018 ; Zappa and Shepperd 2017*).

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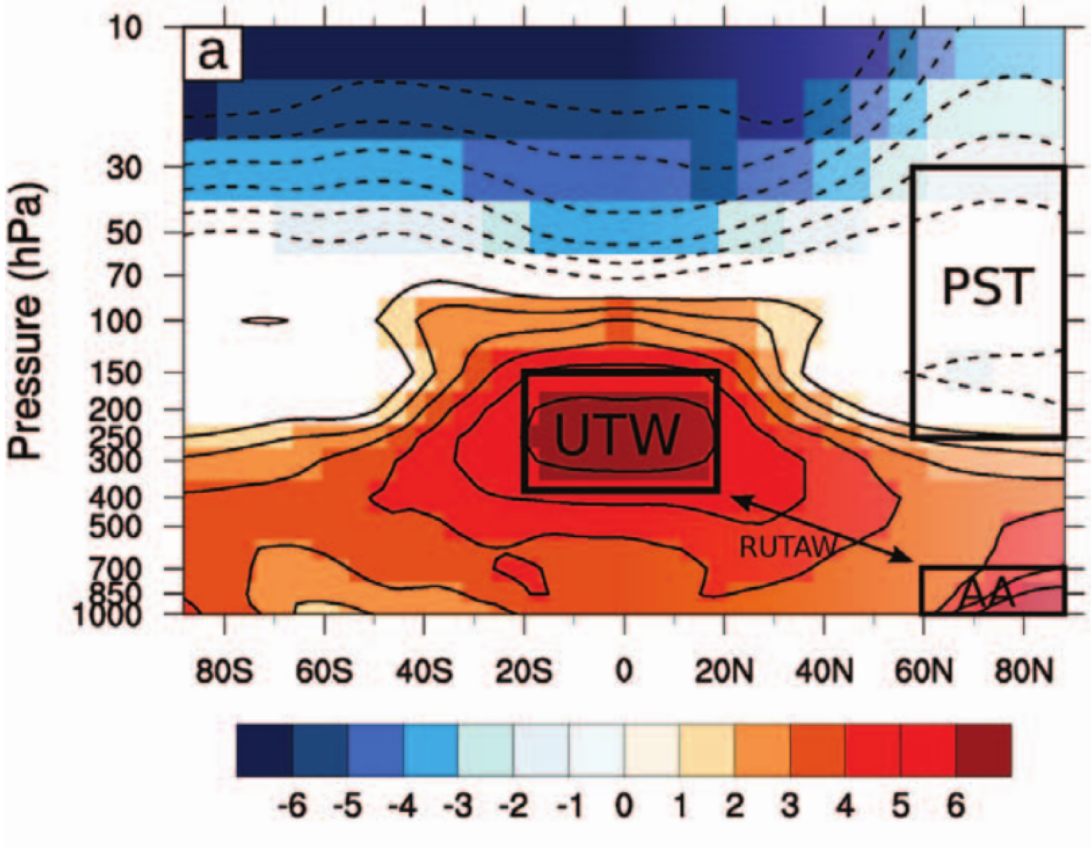
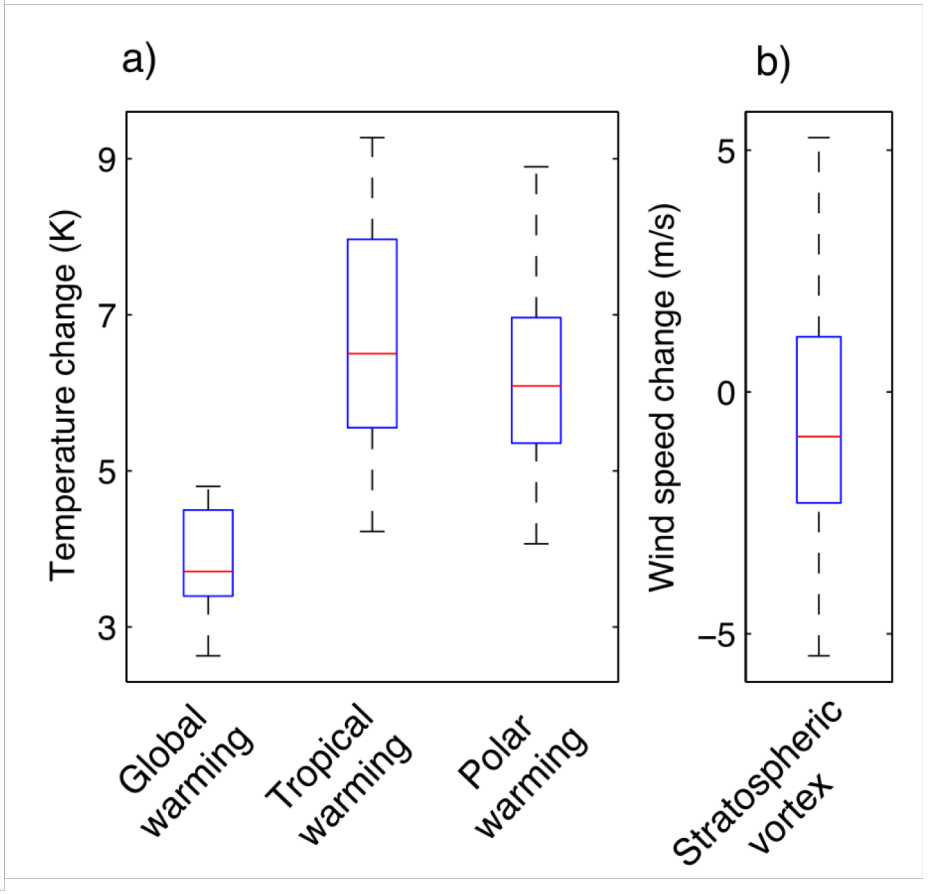


Peings et al. 2018

2066-2095 minus 1976-2005



Zappa and Shepperd 2017

2070-2100 minus 1960-1990

UTW : Upper-troposphere Tropical Warming
AA : Arctic Amplification
PST : Polar Stratospheric Temperature

Context

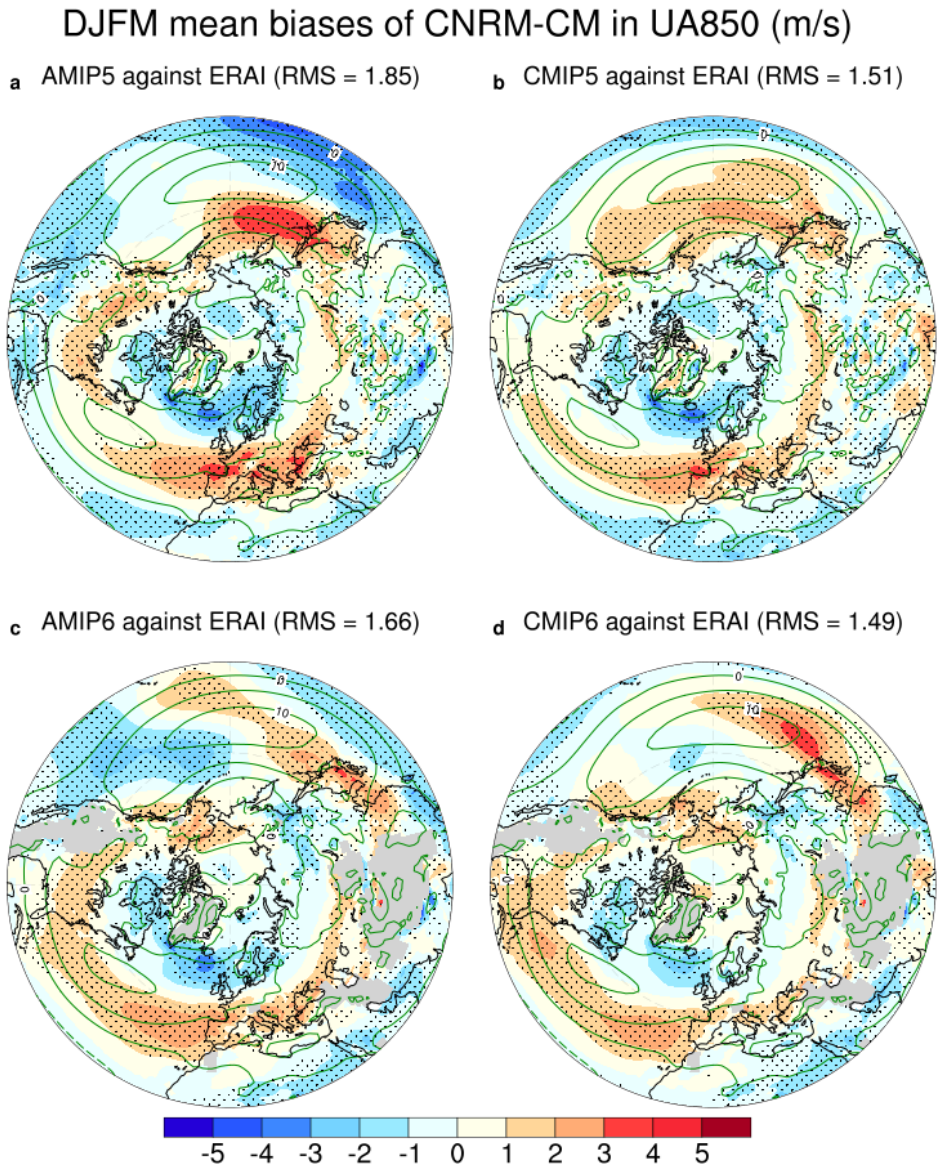
- There are still many **uncertainties** on how the Northern mid-latitude atmosphere will respond to climate change.
- Potential drivers are : **Arctic Amplification**, **Tropical high troposphere warming**, **stratospheric vortex strength** (*Peings et al. 2018 ; Zappa and Shepperd 2017*).
- Climate in the Arctic has been changing rapidly in the recent past decades, thus it is important to focus on **Arctic/mid-latitudes linkages**.

Objectives

- Development and application of diagnostics to characterize the Northern mid-latitude atmospheric circulation: **Jet stream**, **sinuosity**, **blockings** etc
- Apply those diagnostics in CMIP5 and CMIP6 climate models.
- Investigate the mechanisms explaining the mid-latitude atmospheric circulation change, with a focus on polar/mid-latitude linkages and their potential time invariance (e.g., can we use interannual variability to constrain climate change?)

Evaluation of CNRM-CM6-1

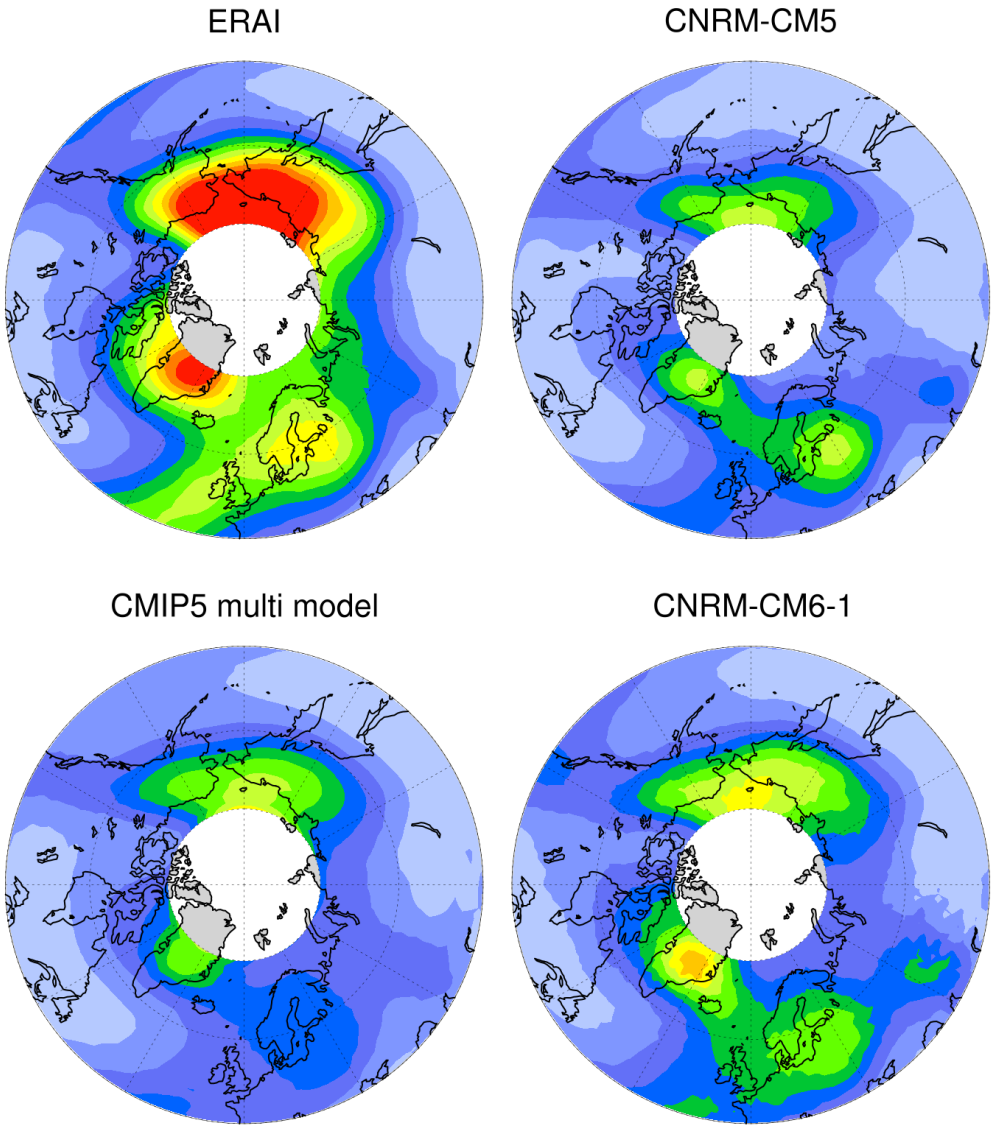
Biases of U850

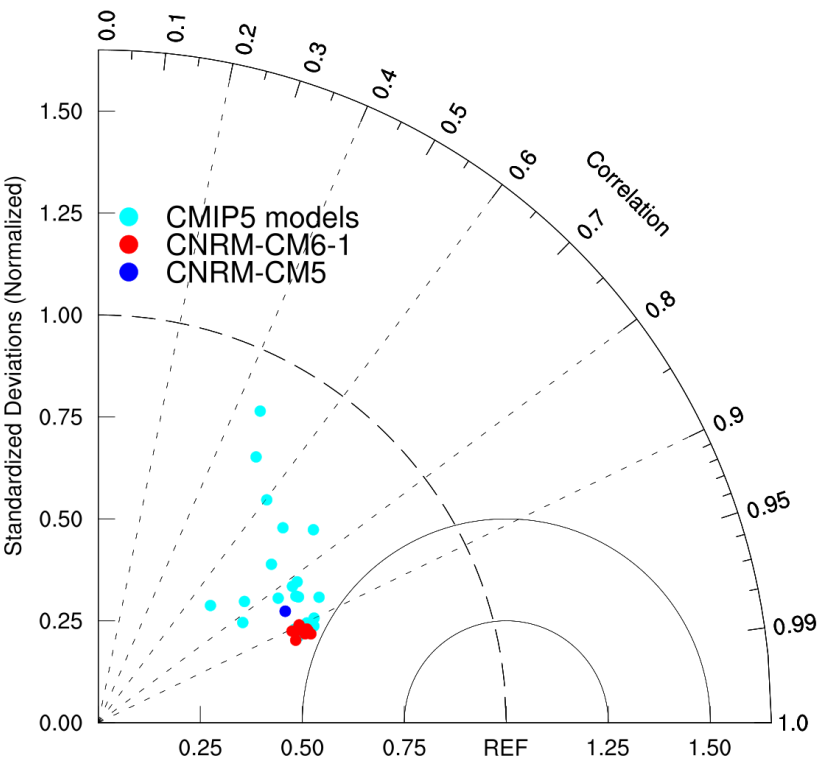


- The jet is **too zonal** in both CNRM-CM models.

- Slight **decrease of the bias** between CNRM-CM5 and CNRM-CM6-1

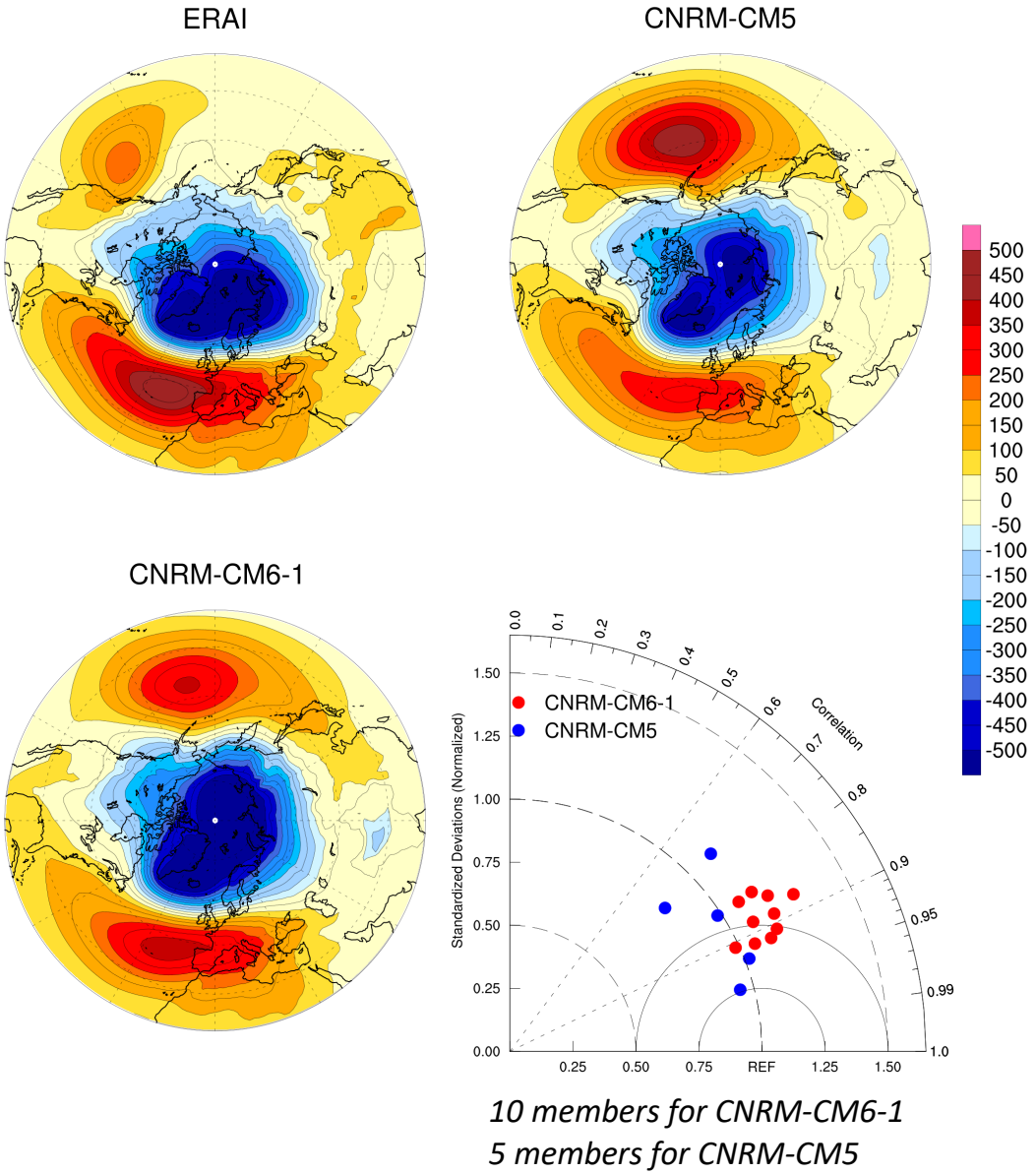
2D blocking index (Scherrer et al. 2007)





Annual climatology of blockings

Northern Annular Mode (NAM)



10 members for CNRM-CM6-1
5 members for CNRM-CM5

- The NAM is the first mode of variability in the Northern Hemisphere.
- NAM computed as the first EOF of Sea level Pressure in DJFM

Evaluation of CNRM-CM6-1 : Summary

- There is a better representation of blockings in CNRM-CM6-1 compared to CNRM-CM5.

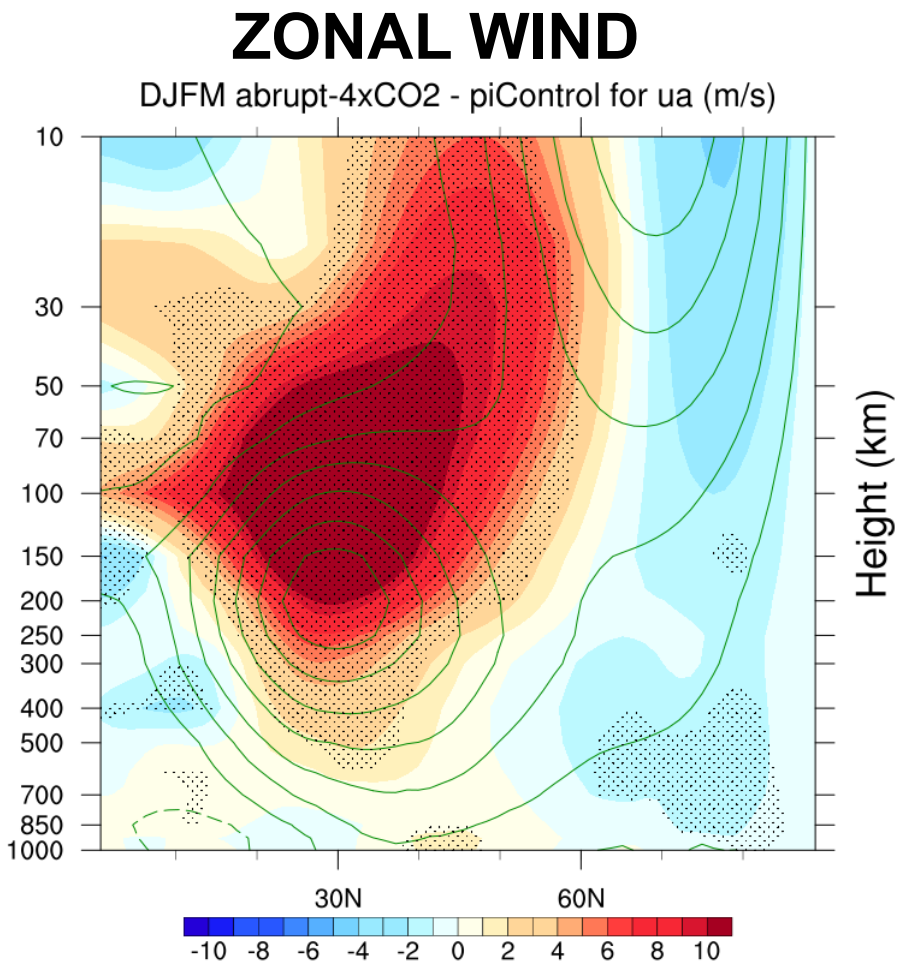
- The bias in U850 has been decreased.

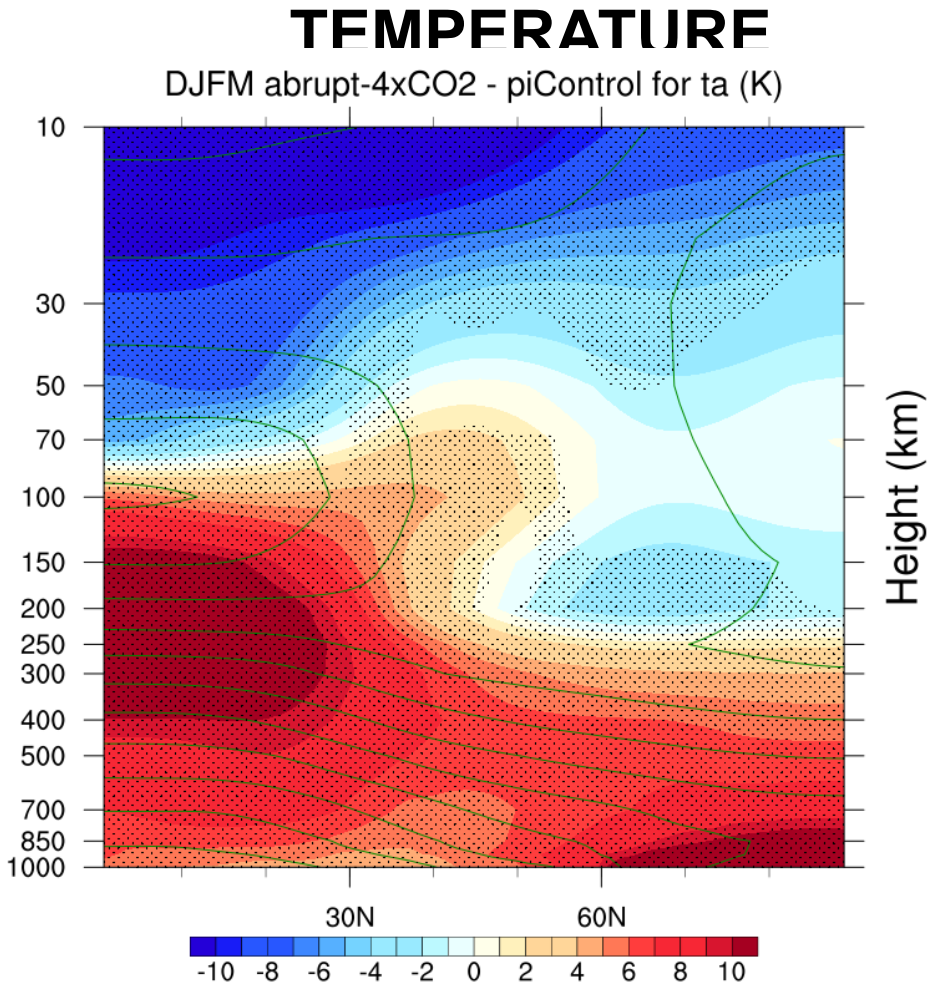
- However, The jet is too zonal in both CNRM-CM models.

- There is a better representation of the seasonal cycle of stratospheric vortex (increased number of vertical levels in the stratosphere)

Sensitivity of CNRM-CM6-1

Response in Abrupt-4xCO2 simulation



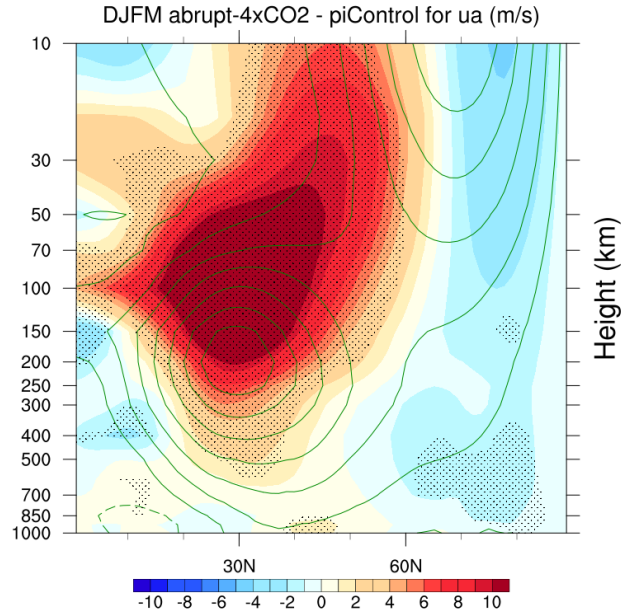


- Arctic amplification and Upper-troposphere Tropical Warming.
- Upward shift of the zonal wind

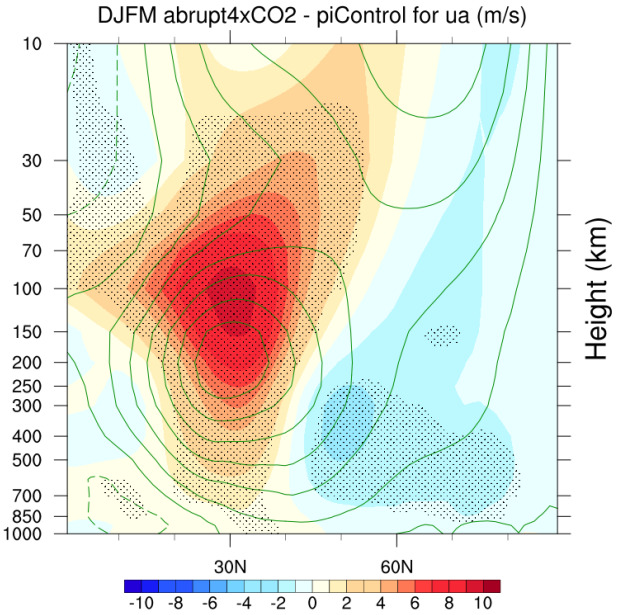
Comparison with CNRM-CM5

ZONAL WIND

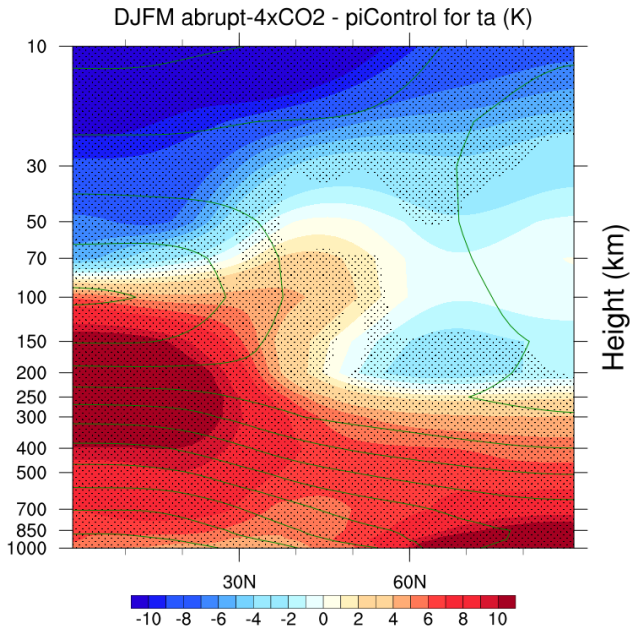
CNRM-CM6-1

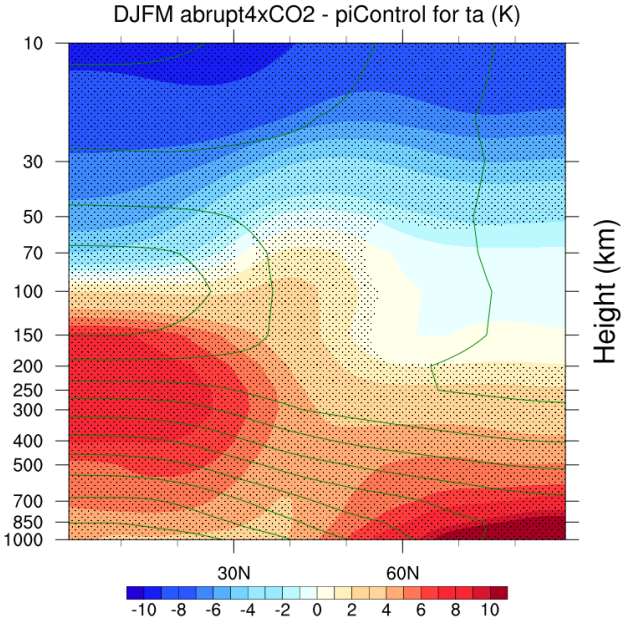


CNRM-CM5



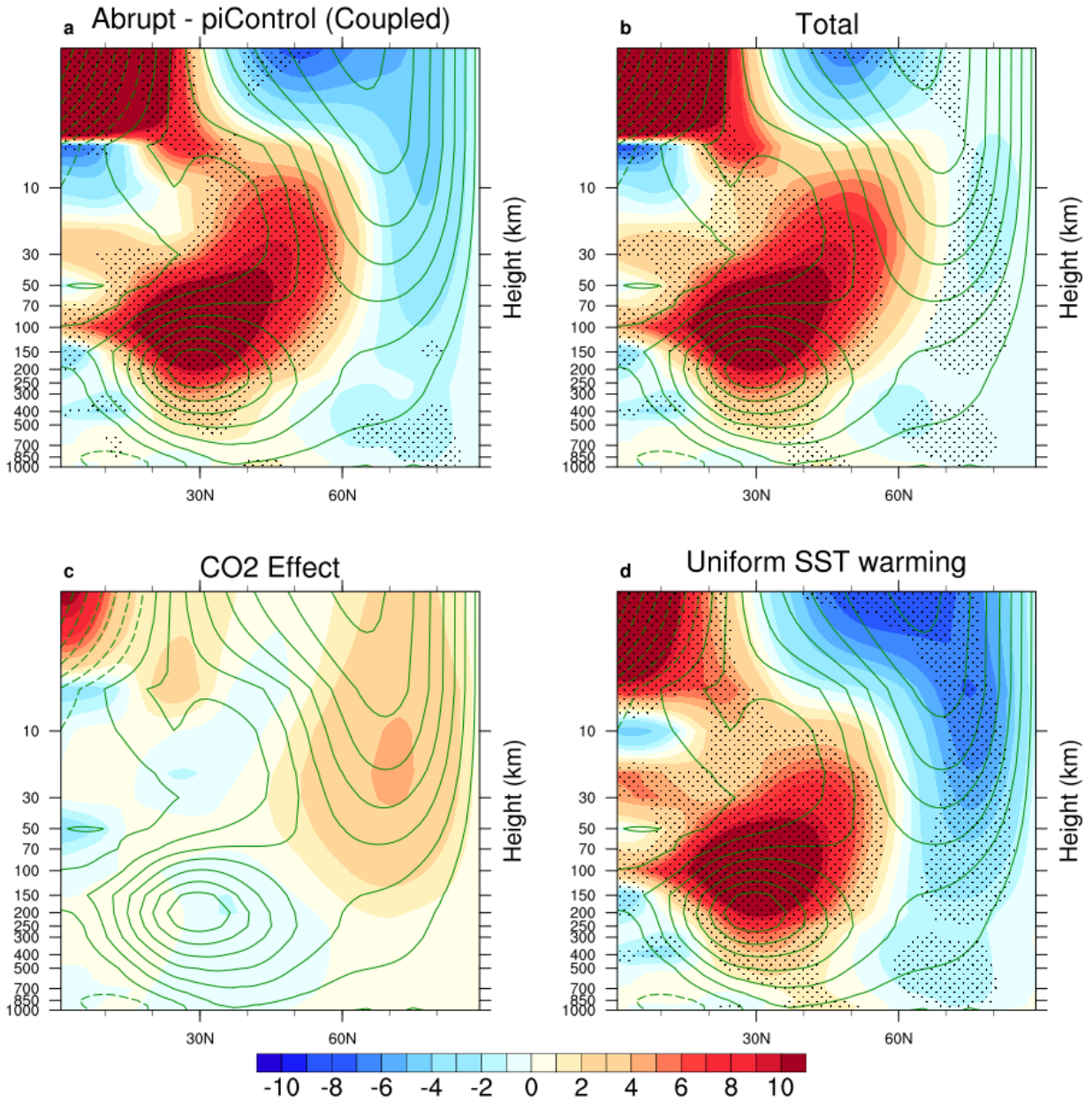
TEMPERATURE





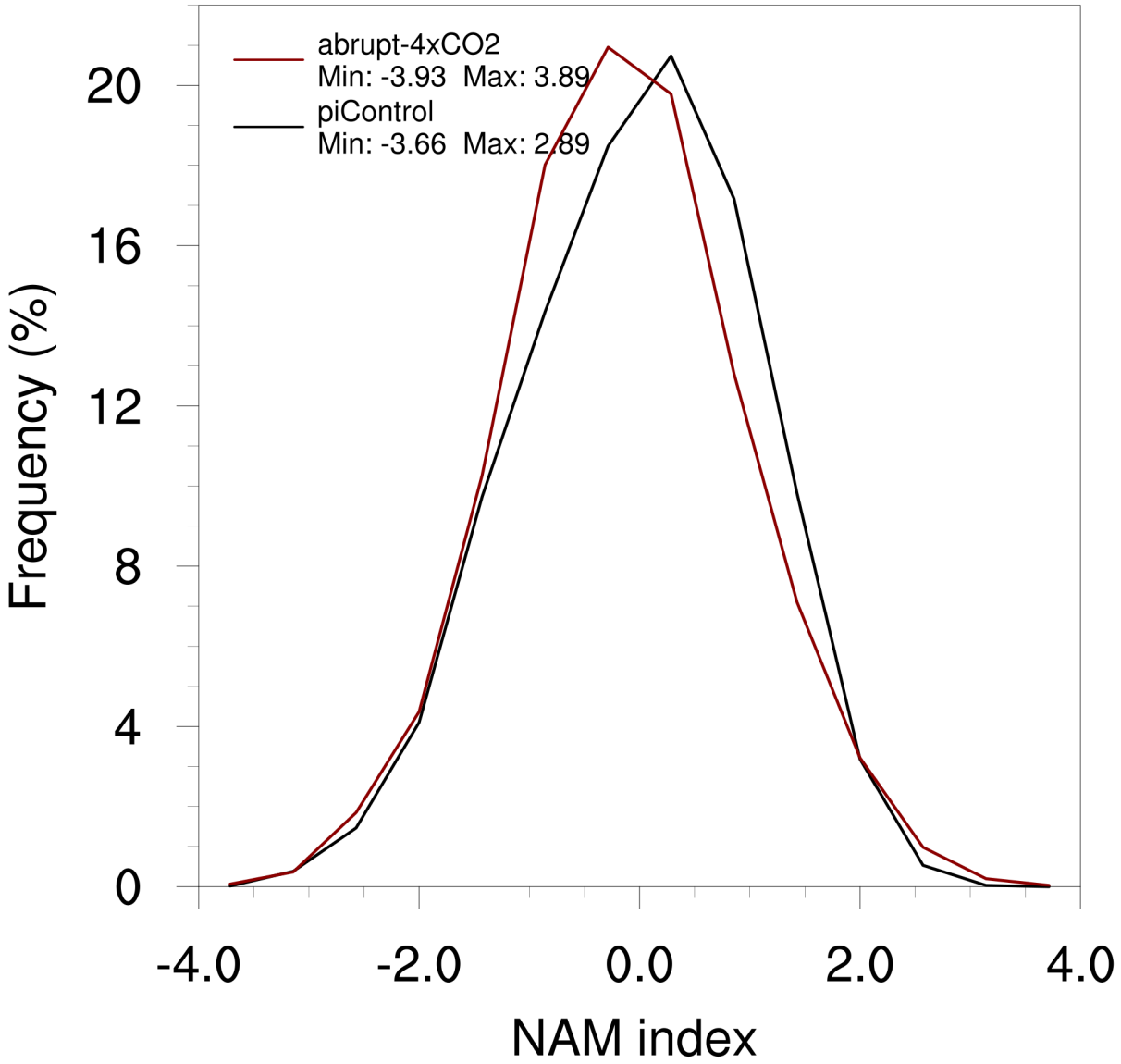
Stronger/higher sensitivity in CNRM-CM6-1

Decomposition of the response (CFMIP)



The total change is dominated by the uniform SST warming

Change in NAM index ?



Shift toward more extreme NAM phases (especially for the positive phase)

NAM computed over the 1500 years of abrupt-4xCO2 and piControl simulations

Conclusions

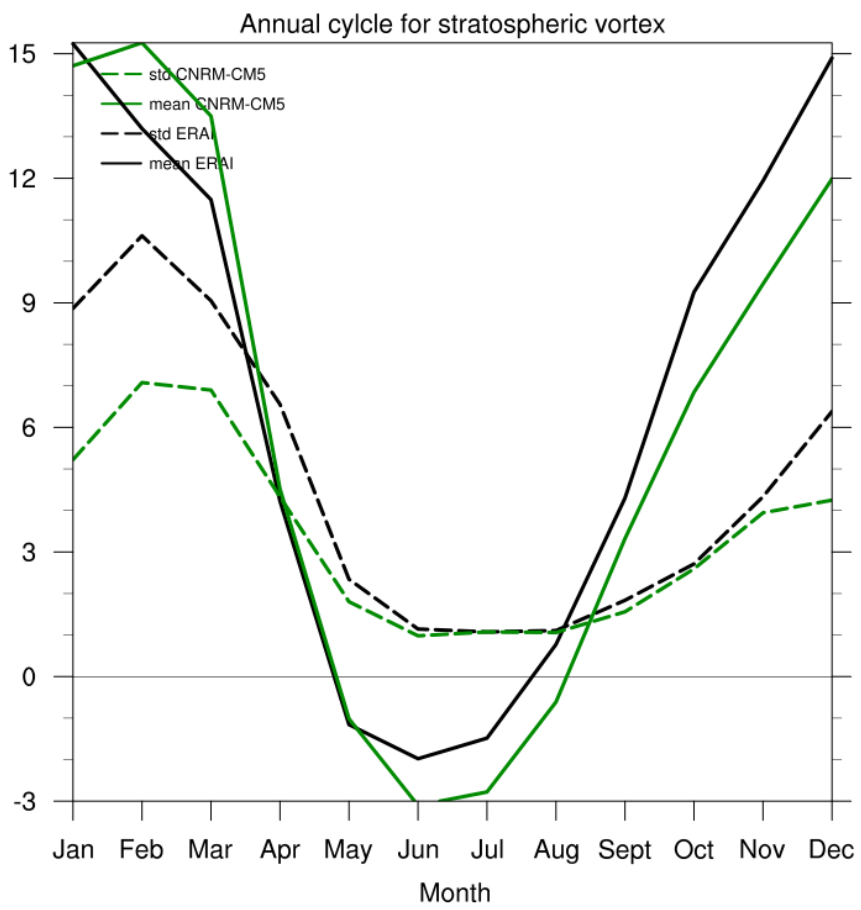
- CNRM-CM6-1 performs slightly better than CNRM-CM5 (weaker biases, better representation of blockings, etc.).

- Investigate the change in blockings, NAM/NAO and other metrics in CNRM-CM6-1 and CMIP6 models.

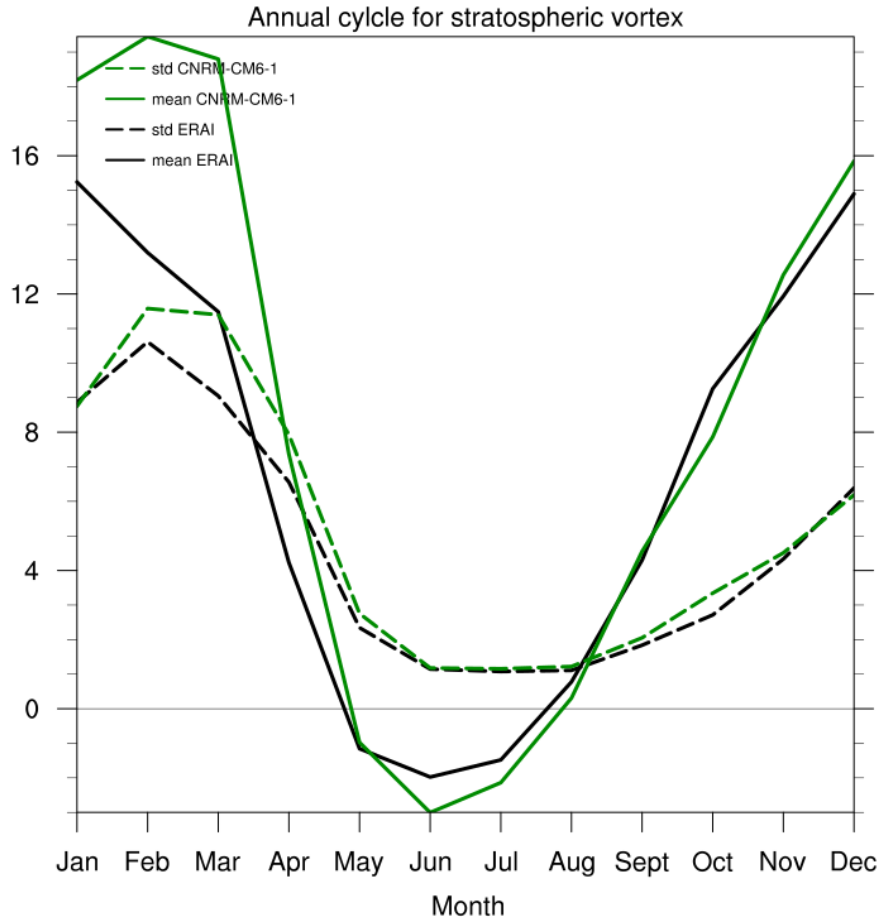
- Investigation of the mechanisms.

Polar stratospheric vortex

CNRM-CM5

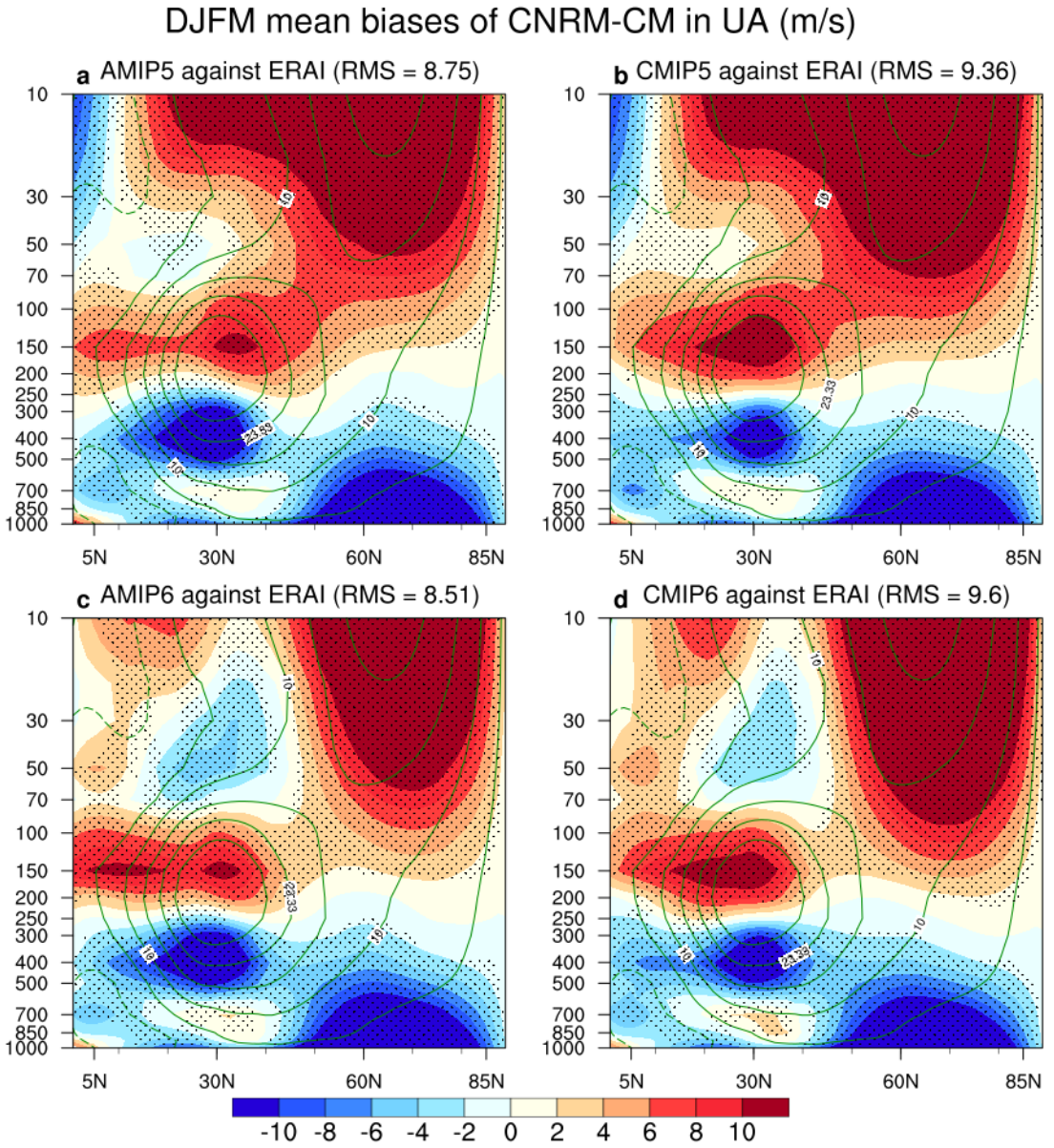


CNRM-CM6-1

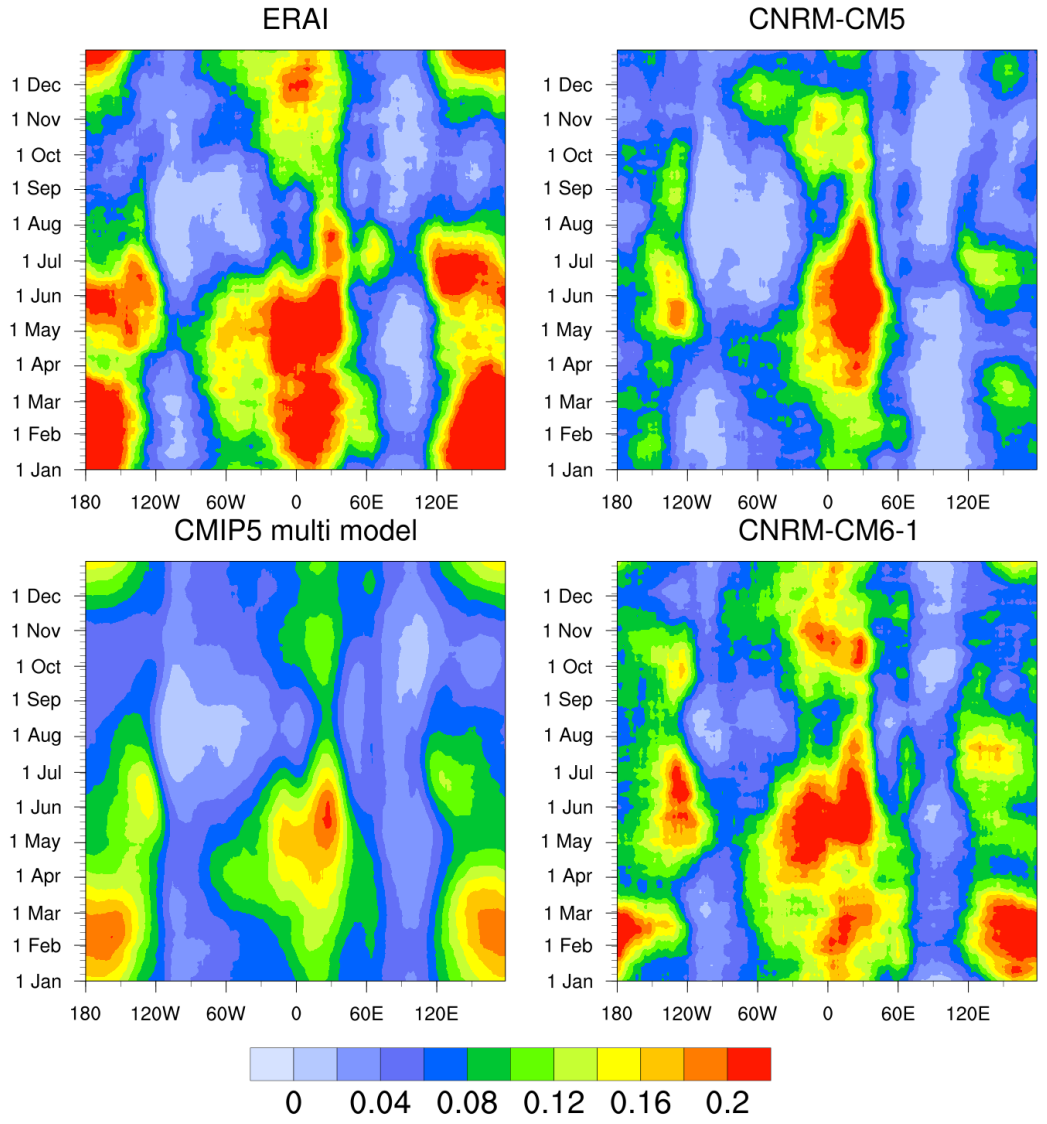


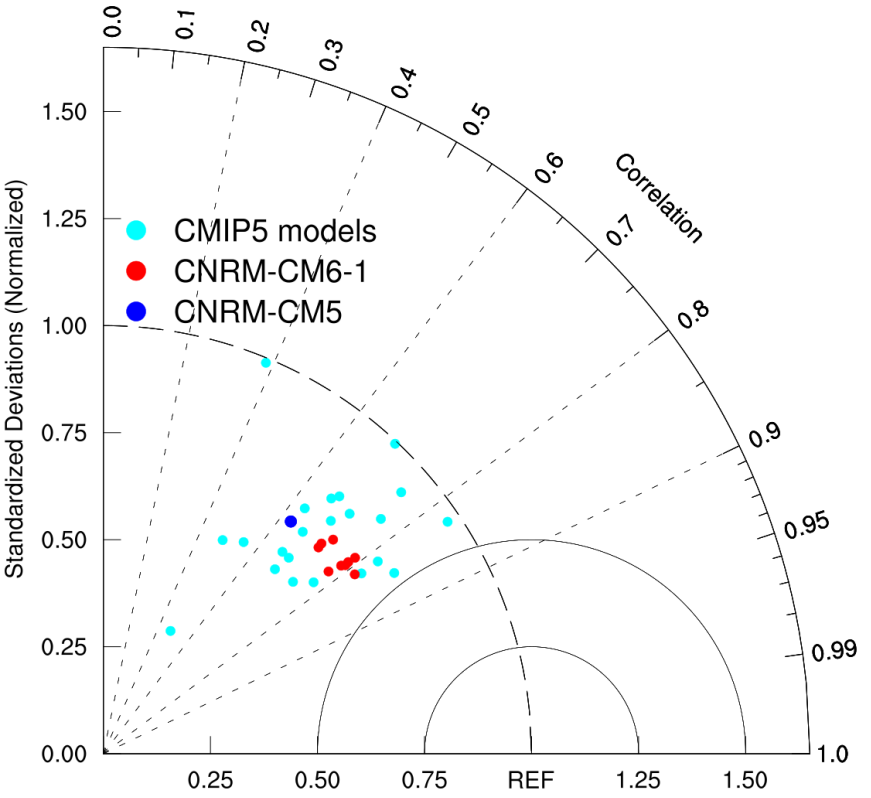
Seasonal cycle of the zonal wind at 50 hPa (between 70°N and 80°N)

Biases of U


DJFM mean biases of CNRM-CM in UA (m/s)
a AMIP5 against ERAI (RMS = 8.75)
b CMIP5 against ERAI (RMS = 9.36)
c AMIP6 against ERAI (RMS = 8.51)
d CMIP6 against ERAI (RMS = 9.6)
10
30
50
70
100
150
200
250
300
400
500
700
850
1000
5N
30N
60N
85N
-10 -8 -6 -4 -2 0 2 4 6 8 10

1D blocking index (Tibaldi-Molteni)





Improvement of the representation of blockings in CNRM-CM6-1

North Atlantic Oscillation