Sources of seasonal predictability in the Tropical Atlantic

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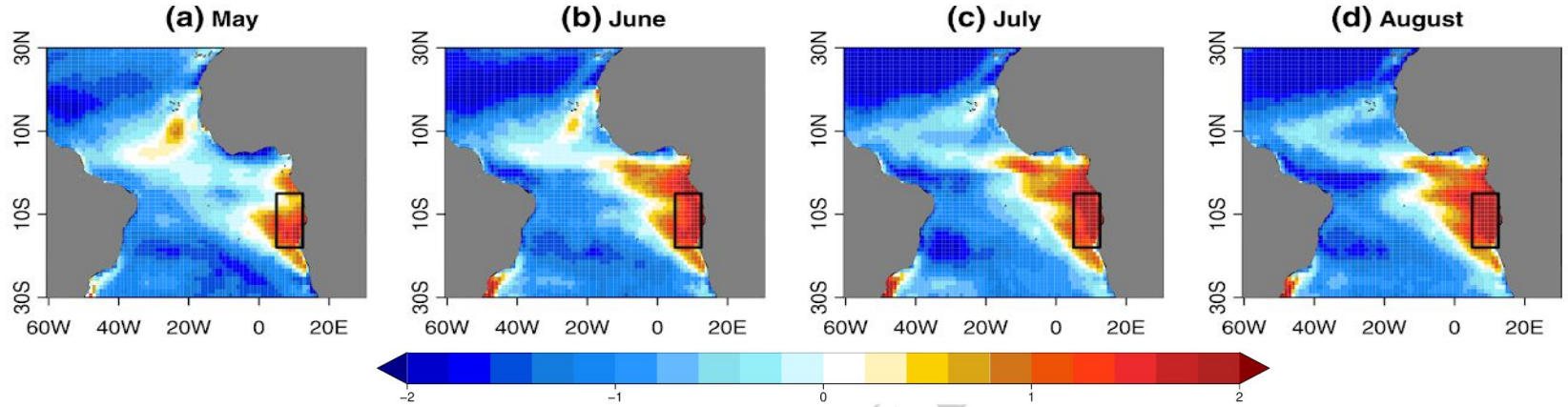
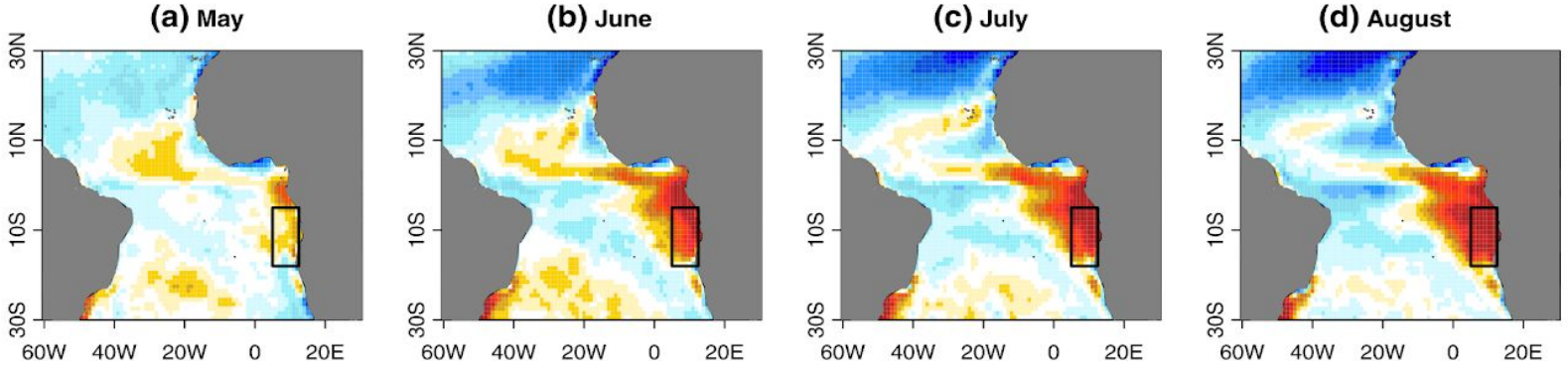
EGU - 2020 - online session

Tropical Atlantic - a region of large biases



SST Biases in a historical simulation performed with the EC-Earth 3.1 coupled model

- Most of coupled model present large SST biases in the Tropical Atlantic (*Prodhomme et al. 2019*).

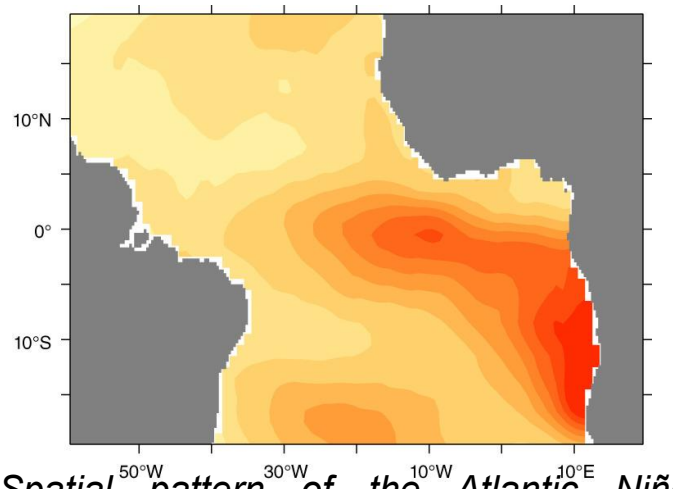


SST Biases in a seasonal forecast performed with the EC-Earth 3.1 coupled model

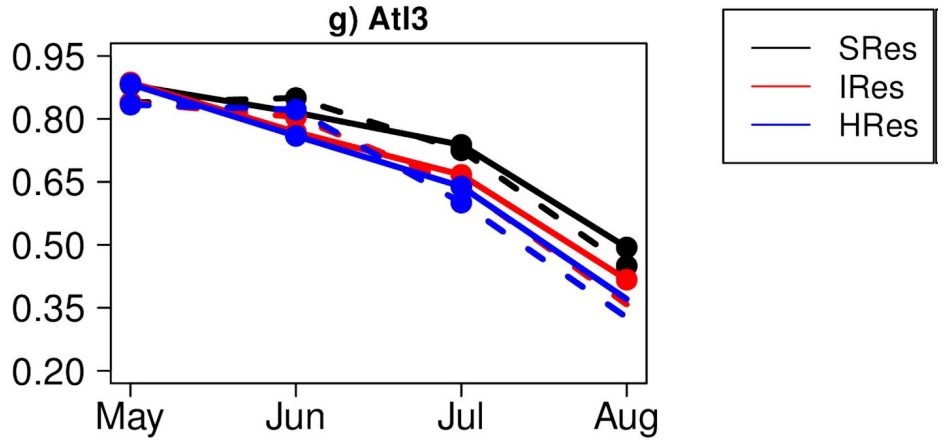
- In initialized seasonal prediction, the biases quickly develops in this region.

Exarchou et al. (2018)

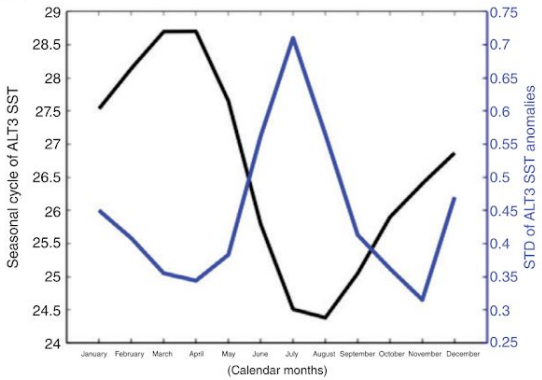
Tropical Atlantic - interannual variability



Spatial pattern of the Atlantic Niño, the dominant climate mode in the tropical Atlantic on interannual time scales with impacts on precipitation over the surrounding continents. (Lubbecke et al 2018)



Correlation in Atl3 (20ºW0 - 3ºS3ºN) for seasonal prediction started in May performed with the EC-Earth 3.0 coupled model at different resolution. Dots shows correlation significant at the 95% confidence level. Dashed line showd correlation with ERSST and tich line with ESA (Prodhomme et al. 2016 - supplementary material)



Seasonal cycle of ATL3 SST (black) and standard deviation of interannual SST anomalies (blue) (Lubbecke et al 2018)

- In the tropical Atlantic, there is a large mode of Interannual variability, called the Atlantic Niño, which peak in summer. The EC-Earth forecast system achieves significant correlation in the Atl3 region, independently of the resolution.

Questions ?

We often think that large biases can lead to lower predictability, however there is no clear evidence that such relationship exists.

- What is the predictability of state-of-the-art seasonal forecast system in the Tropical Atlantic?

- Is there a relationship between the the ability of seasonal forecasts system to forecast the Atlantic Niño and the amplitude of the biases in the same region?

- How remote SST biases and biases during the first months of the forecast can affects the predictability of the Atlantic Niño?

Data

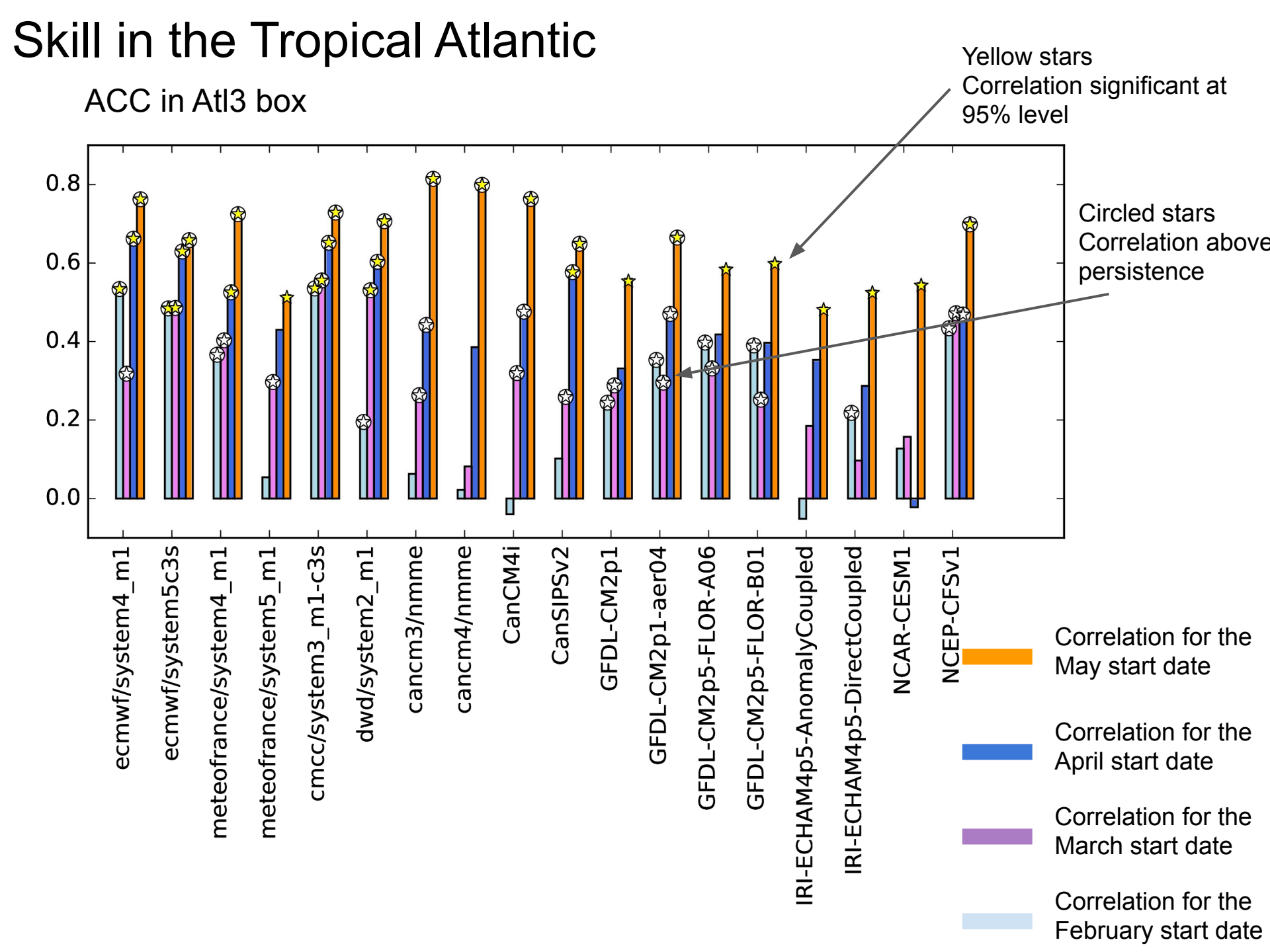
1) ecmwf/system4_m1
2) ecmwf/system5c3s
3) meteofrance/system4_n
4) meteofrance/system5_n
5) cmcc/system3_m1-c3s
6) dwd/system2_m1
7) cancm3/nmme
8) cancm4/nmme
9) CanCM4i
10) CanSIPSv2
11) GFDL-CM2p1
12) GFDL-CM2p1-aer04
13) GFDL-CM2p5-FLOR-A0(
14) GFDL-CM2p5-FLOR-B0:
15) IRI-ECHAM4p5-Anomal
16) IRI-ECHAM4p5-DirectC(
17) NCAR-CESM1
18) NCEP-CFSv1

We use 18 operational seasonal prediction systems, for each of them we keep 10 members, and we use the common hindcast period od 1993-2010.

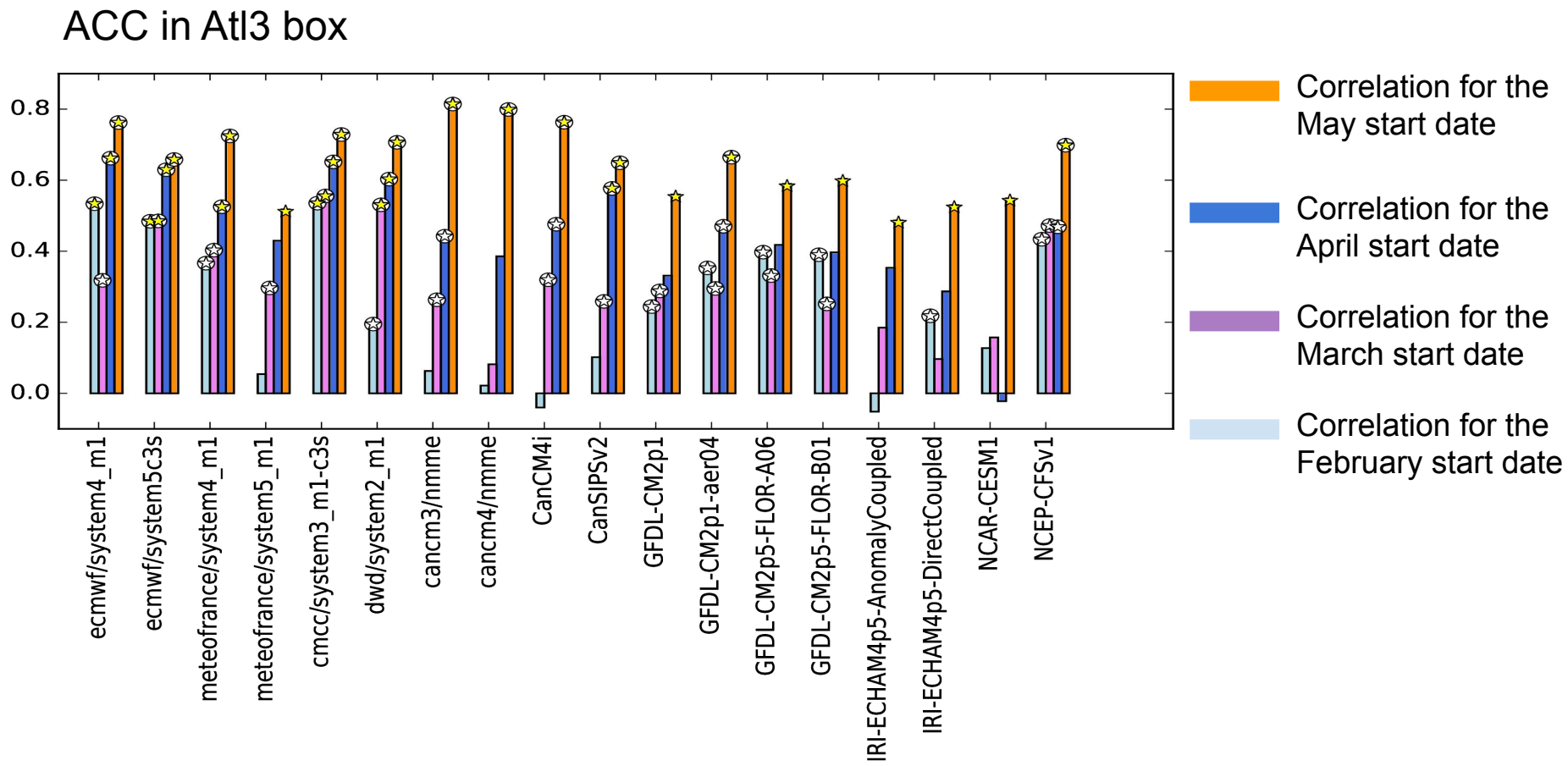
The variables we have available for all system are SST and precipitations.

Prodhomme et al. (in prep)

Skill in the Tropical Atlantic

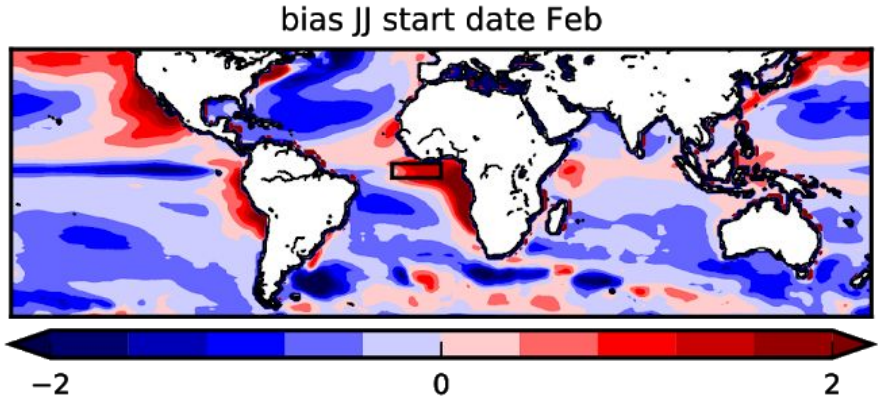


Skill in the Tropical Atlantic

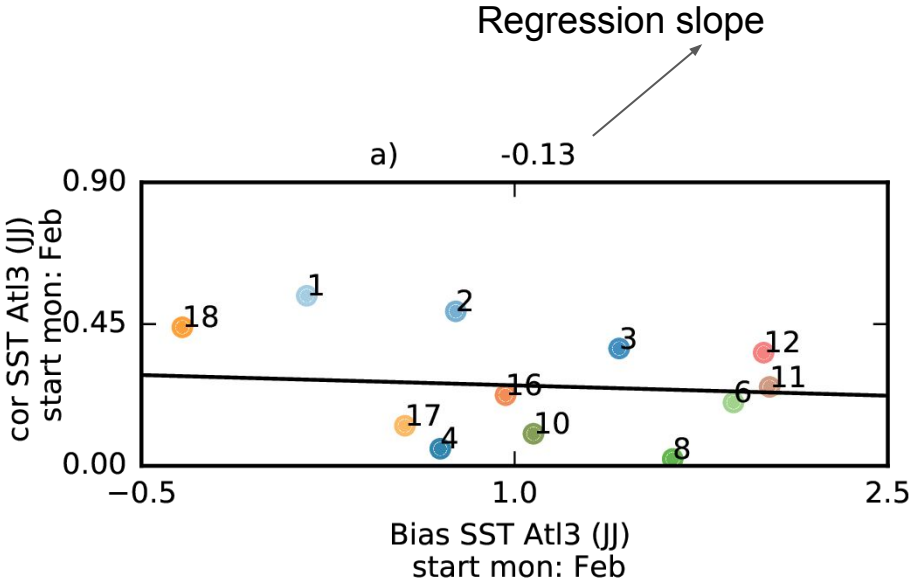


- Compared to previous intermodel comparisons, some operational forecasts systems now achieves significant and above persistence correlation to predict the Atlantic Niño, even from February start date.
- Resolution of the seasonal forecast system is not associated with higher skill in this region (consistently with *Prodhomme et al. 2016*)
- There is no relation between skill achieved in one start date and the skill achieved in other start dates.

Relation between skill and local biases



Multi model mean of SST bias in JJ for seasonal forecast started in February (black box shows Atl3 box)



Regression between correlation in JJ and SST bias in JJ for seasonal forecasts started in February in the Atl3 box

1) ecmwf/system4_m1
2) ecmwf/system5c3s
3) meteofrance/system4_m
4) meteofrance/system5_m
5) cmcc/system3_m1-c3s
6) dwd/system2_m1
7) cancm3/nmme
8) cancm4/nmme
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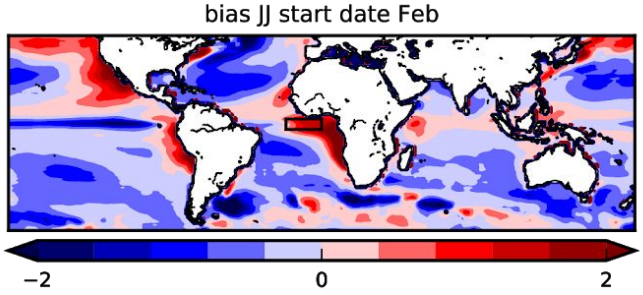
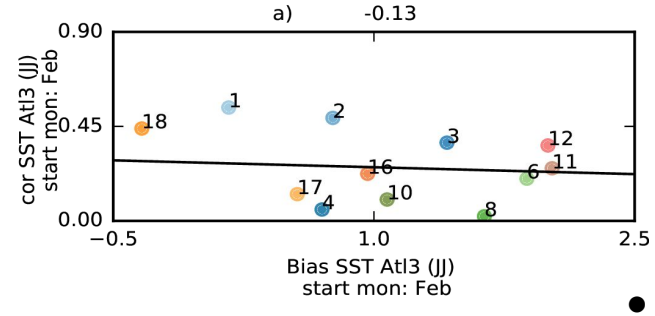
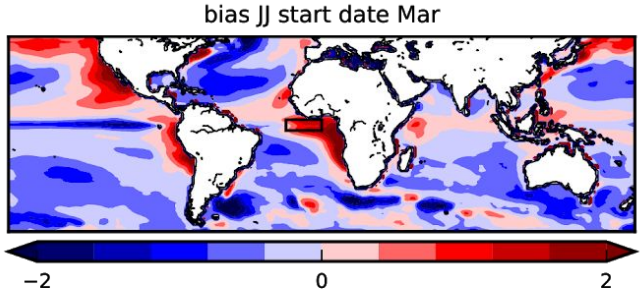
11) GFDL-CM2p1
12) GFDL-CM2p1-aer04
13) GFDL-CM2p5-FLOR-A0
14) GFDL-CM2p5-FLOR-B0
15) IRI-ECHAM4p5-Anomal
16) IRI-ECHAM4p5-DirectC
17) NCAR-CESM1
18) NCEP-CFSv1

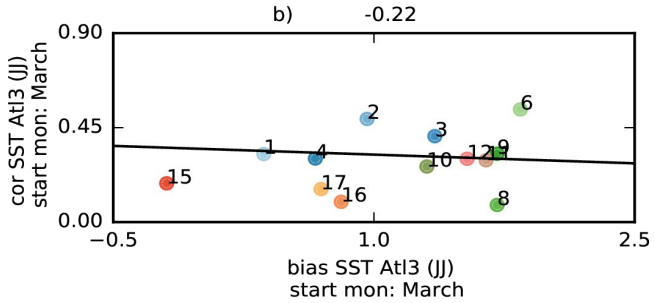
- Biases are large in the Tropical Atlantic in seasonal forecast systems
- The skill is the Atl3 box in not related with simulateneous local bias in the region, suggesting that there is no relation between local bias and skill in this region for the Febrary start date

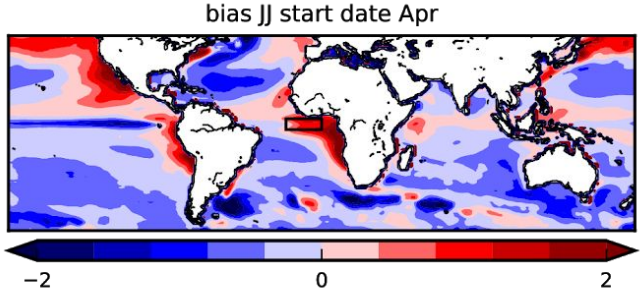
Relation between skill and local biases

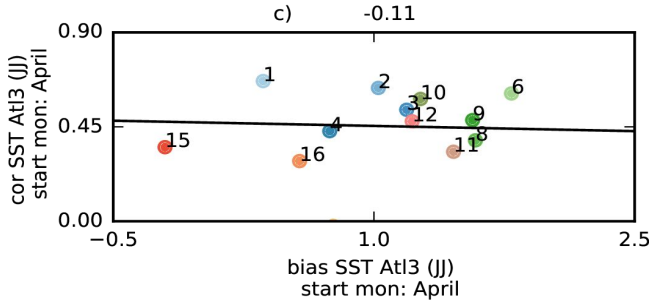


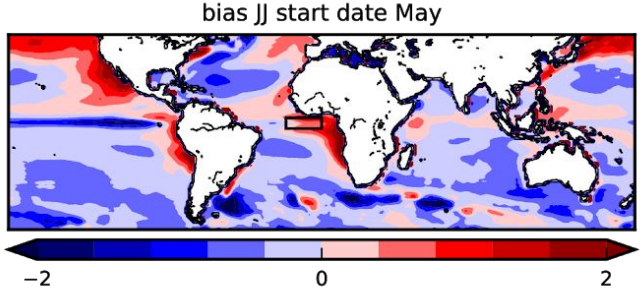


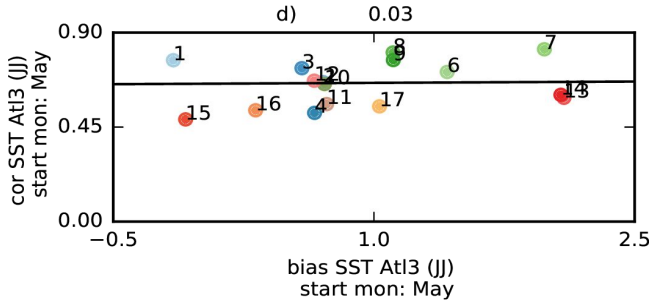








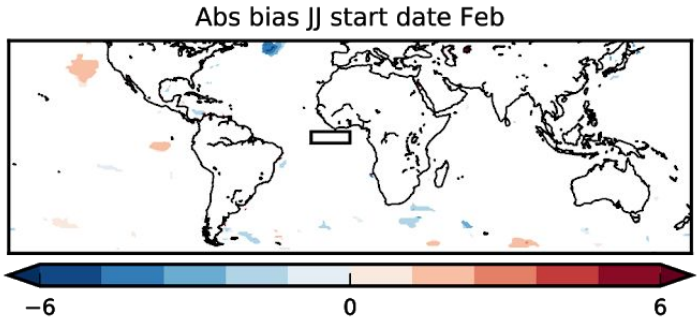




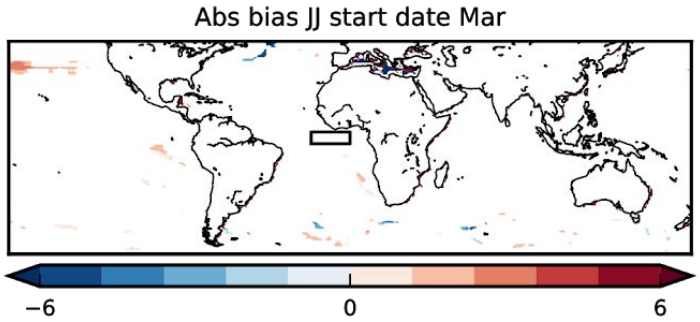
- For all considered startdate (February, March, April, May) the skill is the Atl3 box in not related with SST bias in the region, suggesting that there is no relation between local bias and skill in this region

Relation between skill and SST biases in JJ

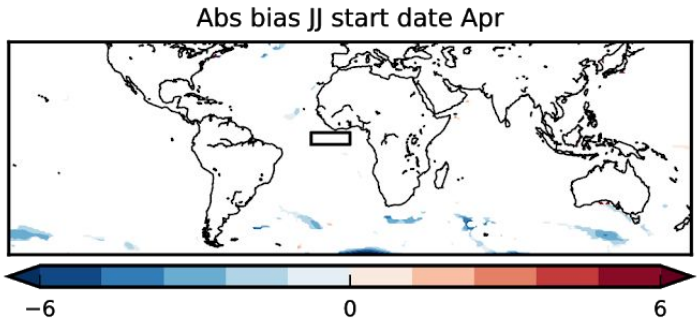
February start date



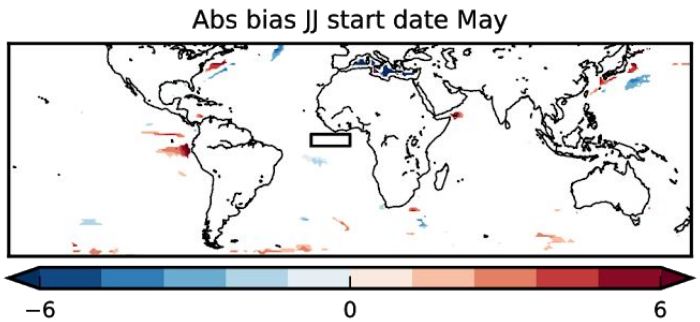
March start date



April start date



May start date

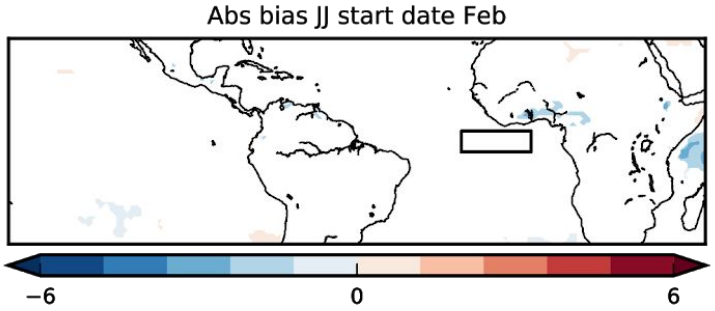


Regression between abolute SST bias in JJ and correlation in JJ in the Atl3 box among all the models, only regression significant at the 95% confidence level are shown.

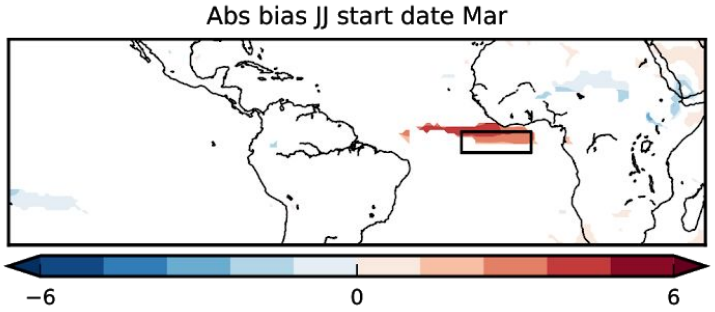
- For all considered startdate (February, March, April, May) the skill is the Atl3 box in not related with the SST biases, suggesting that there is no relation between bias and skill in the Atl3 box.

Relation between skill and precipitation biases in JJ

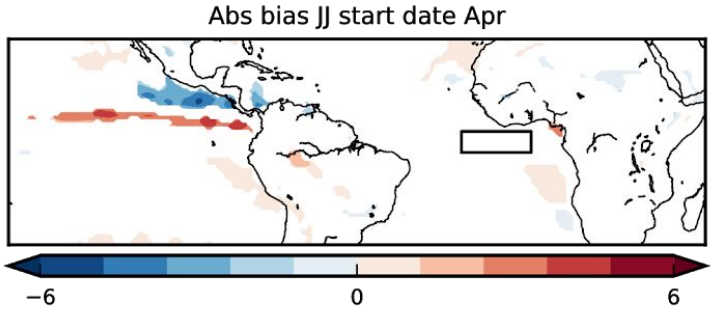
February start date



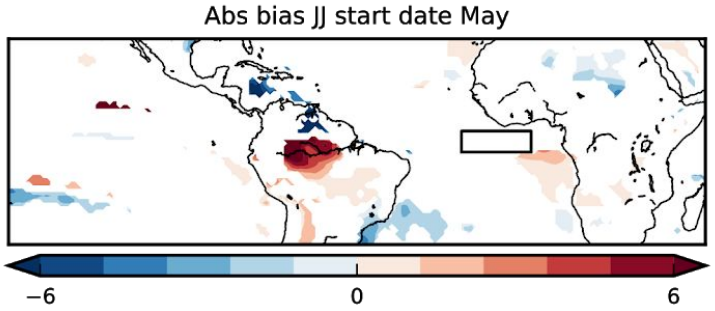
March start date



April start date



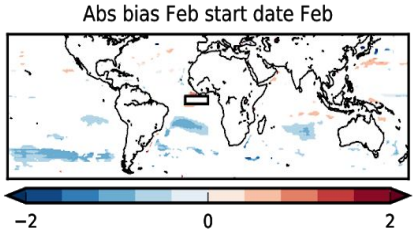
May start date

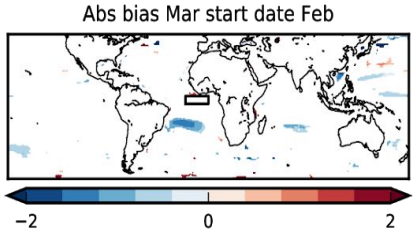


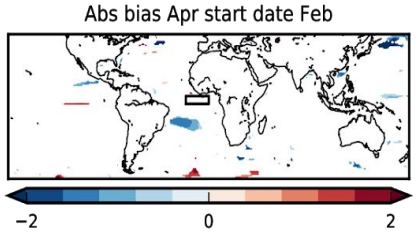
Regression between absolute precip bias in JJ and correlation in JJ in the Atl3 box among all the models, only regression significant at the 95% confidence level are shown.

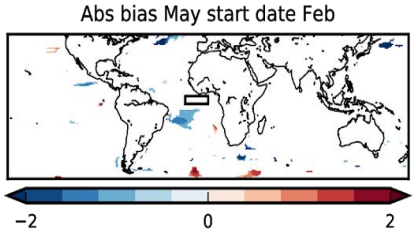
- We find some significant regression value between skill in Atl3 and precipitation biases however the regression give that stronger is the bias higher is the correlation in Atl3.

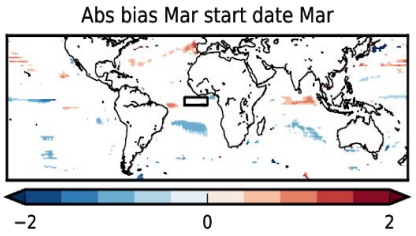
Relation between skill and previous biases

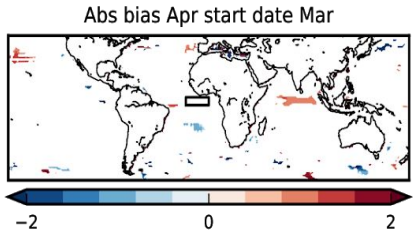


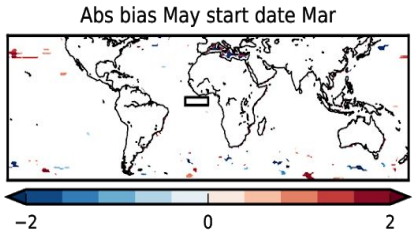




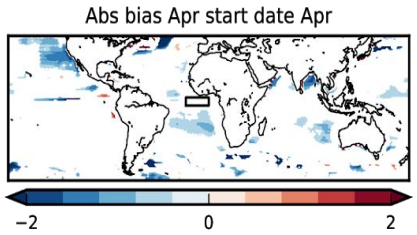


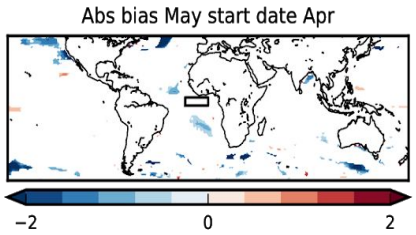


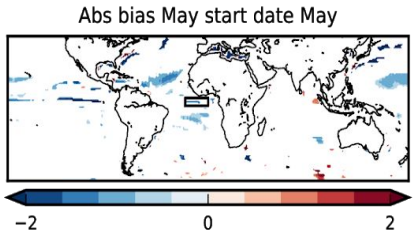




Regression between absolute SST bias in the different lead month and correlation in Atl3 in JJ box among all the considered models. Only points where the regression is significant at the 95% confidence level are shown.







- In the month preceding the Atlantic Niño pic (JJ), for all the start dates we find a significant relationship between SST bias in the South Equatorial Atlantic, especially during the first forecast month.
- This might suggest that the drift after the initialization in this region can lead to lower predictability of the Atlantic Niño.

Conclusions and discussion

- State-of-the-art seasonal forecast systems exhibit significant and above persistence skill to predict the Atlantic Niño.

- There is no relationship between amplitude of SST biases in the equatorial Atlantic and the skill of seasonal forecast systems.

- Generally, skill of the Atlantic Niño is weakly related with local and remote biases.

- The development of an SST bias south of the equator during the first forecast months seems associated to lower predictability of the Atlantic Niño.

This study present several limitations:

- The common re-forecast period between all systems is relatively short

- To better understand relation between skill in predicting the Atlantic Niño and biases it would be essential to have access to more variables (surface winds, thermocline depth, which are not currently available publicly for all systems)

References

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