Project: **987**

Project title: **The role of the South Atlantic Anticyclone in the Tropical Atlantic climate variability**

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During the year, our attention was mainly focused in the analysis of a possible mechanism of generation of the South Eastern Tropical Atlantic in which the South Atlantic Anticyclone (SAA) plays a key role on the seasonal cycle of the tropical Atlantic. To this end we carried out a series of sensitivity studies with the parameterization of the precipitation in the two domains represented in Figure 1. The experiments used in Cabos et al (2016) are listed in table 1.

In previous experiments in which we used the standard model configuration adjusted for Europe and northern high latitude the model had excessive rainfall in the ITCZ. With the aim to reduce ITCZ rainfall, two parameters were changed in the range of accepted physical values of the critical relative humidity for sub grid-scale cloud formation and the altitude of cloud top to be reached before any cloud can produce rain. We found that the excessive rainfall in the initial experiments in the Atlantic ITCZ region was progressively reduced at the expense of a positive bias in cloudiness and thus a negative bias in solar irradiance over almost the entire Atlantic Ocean basin. Despite this negative radiation bias, the strong warm SST bias develops in the southeastern Atlantic Ocean, lending credence to our conclusion that the weaker South Atlantic Anticyclone (SAA) and the ensuing changes in surface wind stress sets in motion the described oceanic dynamic responses off the Angolan coast that we believe are responsible for the warm bias in our coupled simulations. These simulations with our regionally coupled atmosphere-ocean model were carried out in two different coupled domains. Both domains include the equatorial Atlantic and a large portion of the northern tropical Atlantic, but one extends southward, and the other north-westward. The SAA is simulated as internal model variability in the former, and is prescribed as external forcing in the latter.

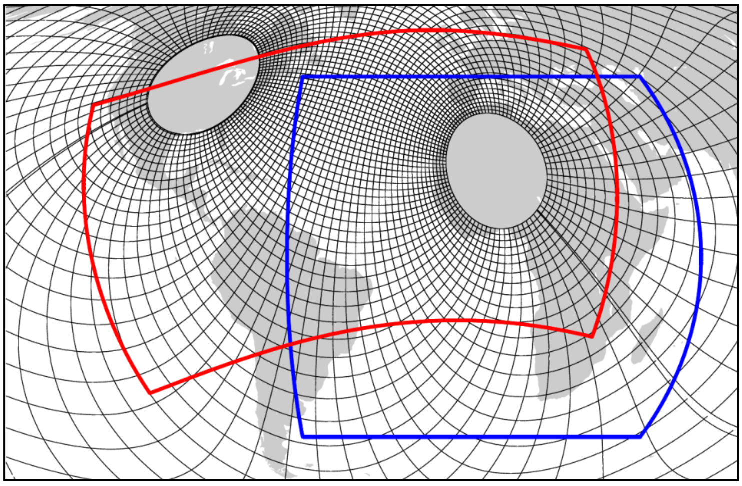

Figure 1. *MPI-OM TR04 setup (black lines). REMO-DEP setup (blue line) and REMO-NAT setup (red line). Every 12n grid line is shown.*

We found that in the first case, the model shows significant warm biases in sea surface temperature (SST) in the Angola-Benguela Front zone (Figure2c). If the SAA is externally prescribed, these biases are substantially reduced (Figure2b). The biases are both of oceanic and atmospheric origin, and are influenced by ocean-atmosphere interactions in coupled runs. The strong SST austral summer biases are associated with a weaker SAA (Figure 3), which weakens the winds over the south eastern tropical Atlantic (SETA), deepens the thermocline and prevents the local coastal upwelling of colder water. The biases in the basins interior in this season could be related to the advection and eddy transport of the coastal warm anomalies. In winter, the deeper thermocline and atmospheric fluxes are probably the main biases sources.

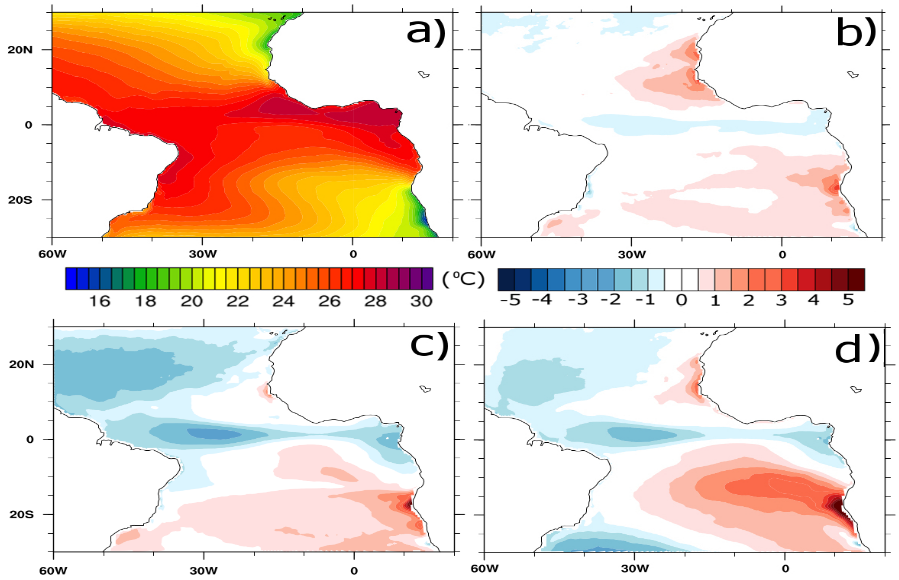

Figure 2. *DJF SST for the 1980-1999 period. Panel a) shows the Reynolds OISST V2climatology. The remaining figures show the difference of simulated DJF SST climatology with OISST V2 for b) TR04, c) NAT50C, and d) AFR50C*

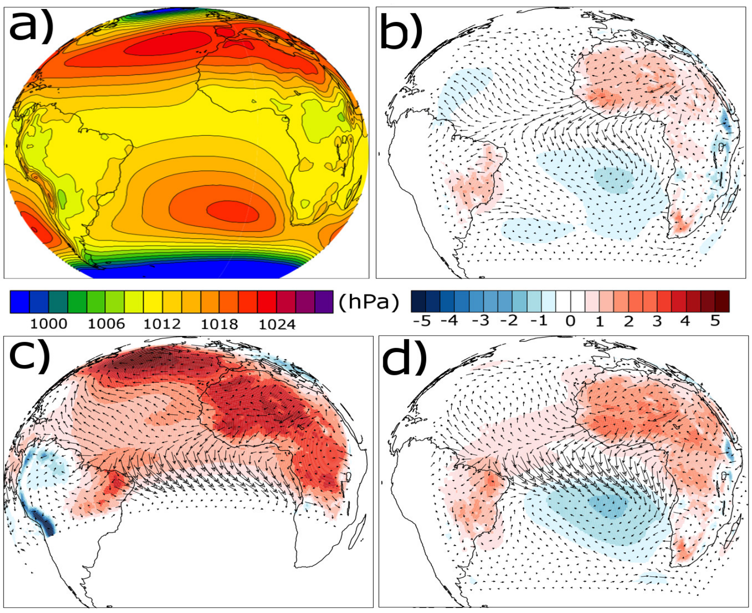

Figure 3. *DJF MSLP for 1980-1999. a) ERA 40 climatology. The remaining figures show the DJF difference of simulated MSLP with ERA40 for coupled simulations: b) AFR50U and c) NAT50C d) AFR50C. Pressure is given in Pascal. Note that the NAT domain extends roughly to 15S.*

Biases in incoming solar radiation and thus cloudiness seem to be a secondary effect only observed in austral winter. We conclude that the external prescription of the SAA south of 20°S improves the simulation of the seasonal cycle over the Tropical Atlantic, revealing the fundamental role of this anticyclone in shaping the climate over this region (Figure 4).

We also have carried out the spin up simulations with MPIO-OM and ROM and made the necessary preparations for the ensemble runs with the 50 km REMO atmosphere. We intend to carry out the ensemble simulations during the following year.

Finally, following the recommendations of the advisory committee, we carried out a set of simulations with one of our domains with 25 km resolution in the atmosphere. This domain does not include the Southern part of the SAA, as our main objective in these experiments was to found possible improvements in the simulation of the equatorial dynamics by a better resolution. Although it seems that for the large scale circulations the improvements are not too strong, the better simulation of alongshore winds along the African coast makes us to believe that a 25 km would improve the simulation of the upwelling in the Angola-Benguela region in our domain that includes the hole of the SAA. This would allow us to test the hypothesis of Milinski et al (2016) about the importance of a better representation of the orography in the coastal region for the improvement of the biases in the SETA region.

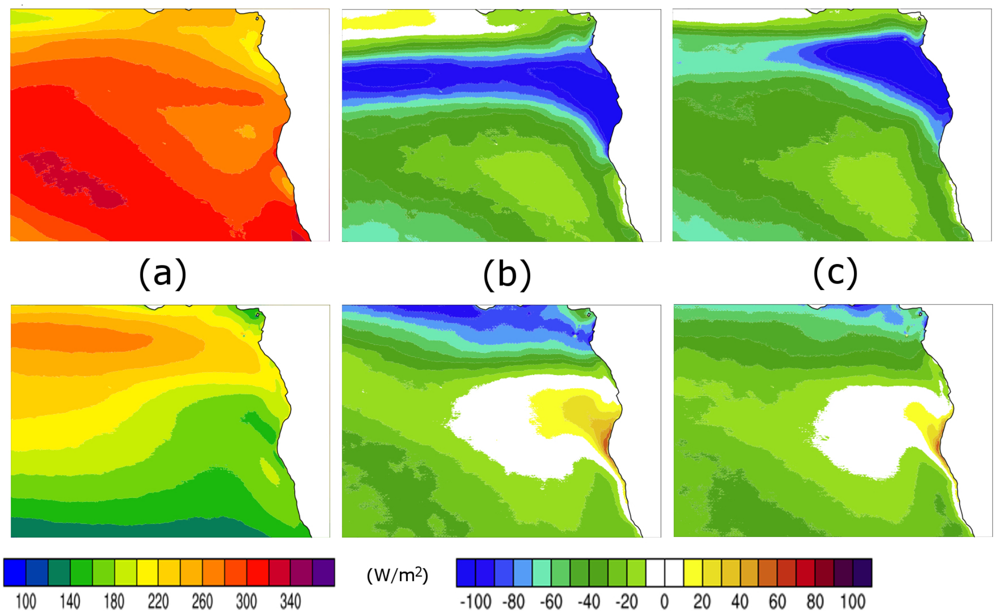

Figure 4. *Surface incoming short wave radiation flux (W/m^2) for 1980-1999 for DJF (upper panels) and JJA (lower panels) a) SARAH-MA climatology. The remaining figures show the biases with respect to SARAH-MA for b) AFR50C and c) AFR50U.*

Table 1 Summarizes and labels each one of the NAT and AFR experiments, according to horizontal resolution, precipitation parameterization and whether it is coupled or not.

Exp. No.	Atmosheric Horiz.Res (km).	Description
AFR50C	50	Coupled
NAT50C	50	Coupled
AFR50U	50	Atmospheric uncoupled
TR04		Oceanic uncoupled

References

1. Cabos, W., Sein, D.V., Pinto, J.G. et al. (2016). The South Atlantic Anticyclone as a key player for the representation of the tropical Atlantic climate in coupled climate models. Clim. Dyn., doi:10.1007/s00382-016-3319-9