Project: **987**

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

Project lead: **Dmitry Sein**

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Warm biases in the South Eastern Tropical Atlantic are typical in global coupled simulations. It has been conjectured that a higher horizontal resolution in the atmosphere improves the bias thanks to a better representation of the orography in the coastal region (Milinski et al, 2016). During the year this hypothesis was further extended by exploring the role of a correct simulation of the South Atlantic Anticyclone (SAA) in the improvement of the biases when resolution is increased. According to Cabos et al (2017), a weaker simulated SAA tends to trigger basin - wide feedback mechanisms (active mainly in the DJF season) that contribute to the warm biases. To this end we analyse simulations carried out with the regional coupled model ROM and the global Earth System Model AWI-CM.

We have run ROM in two configurations. In AFR the coupled region covers most of the South Tropical Atlantic and includes the whole SAA while the NAT setup includes only its northern part. MPIOM, the ROM ocean component, is global and is common to all simulations. For the atmospheric component REMO we use two resolutions (25 and 50 km). All the setups share the same parameterizations and are forced by ERA Interim. The coupling is active inside the REMO domain. We also analyze the effect of resolution with a set of simulations carried out with AWI-CM. In these simulations AWI-CM has four configurations with different atmospheric (T63 and T126) and oceanic setups: LR and HR. In the LR setup resolution varies from 100 km in the global ocean to 25 km north of 50ºN and has moderate refinement along the coasts. HR uses a locally eddy-resolving mesh. The coarsest resolution on this mesh is set to ∼60 km, and the finest resolution is ∼10 km. The refinement was determined by a low-pass filtered SSH variance pattern derived from the AVISO data.

In AWI-CM runs we found that the impact of higher resolution in the SST biases is weaker when we increase the atmospheric than when we increase the oceanic resolution. In general, the increase of either oceanic or atmospheric resolution lead to a reduction of the biases near the coastal oceanic regions, while for simulations that share the same ocean but have different atmospheric resolution (Fig 1.a,b) the improvement due to higher resolution in the interior is less than in the runs that share the same atmosphere but have different oceans (Fig1.c,d). It seems that for the atmospheric resolutions used in AWI-CM experiments (T63 and T127) a better resolved orography leads to significant improvement of the coastal bias (Milinski et al, 2016). On the other side, the DJF differences in MSLP are significantly larger in the runs that share the same atmosphere but have different oceans (2.c,d) while it is similar the runs that share the same ocean but have different atmospheres being slightly weaker when the atmosphere is coarser (Fig2.a,b). Consistently with Cabos et al (2017), this points to a significant contribution of the large scale feedbacks to the improvement of DJF SST biases when we increase the oceanic resolution. These feedback affect both the interior and coastal biases. Also, a higher bias in JDF is associated to a more southward flux of equatorial water along the African coast (compare Figures 3.a with 3.c and 3.b with 3.d). The effect is not so strong when we compare runs with the same ocean. The coastal improvement is related to a stronger upwelling, as can be seen I A weaker bias is associates to a stronger coastal wind stress curl southward of the ABFZ in DJF. In JJA the region of stronger wind stress curl moves northward. A higher resolution in the atmosphere makes the strong negative wind stress curl more confined to the coast

In the ROM runs, SST biases for AFR are clearly stronger, especially in DJF (Fig.4). This shows the importance of the imposed forcing south of the Angola Benguela Frontal Zone (ABFZ) for the simulation of the SST. For the AFR simulations the impact of higher atmospheric resolution is clear for the ABFZ and the coastal regions south of it. The impact of higher resolution is not so clear in the NAT simulations, pointing to a lesser role of improved orography for these resolutions.

References

1. Cabos, W., Sein, D.V., Pinto, J.G. et al. Clim Dyn (2017). The South Atlantic Anticyclone as a key player for the representation of the tropical Atlantic climate in coupled climate models. doi:10.1007/s00382-016-3319-9
2. Milinski, S., J. Bader, H. Haak, A. C. Siongco, and J. H Jungclaus (2016), High atmospheric horizontal resolution eliminates the wind-driven coastal warm bias in the southeastern tropical Atlantic, Geophys. Res. Lett., 43, 10,455–10,462, doi:10.1002/2016GL070530.

Figures

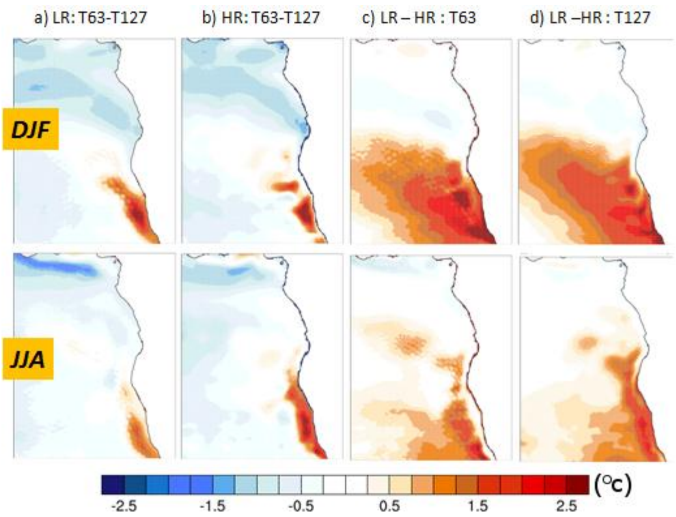

Figure 1. SST differences between setups with a common component: ocean in 3.a (LR) and 3.b (HR) and atmosphere in 3.c (T63) and 3.d (T127).

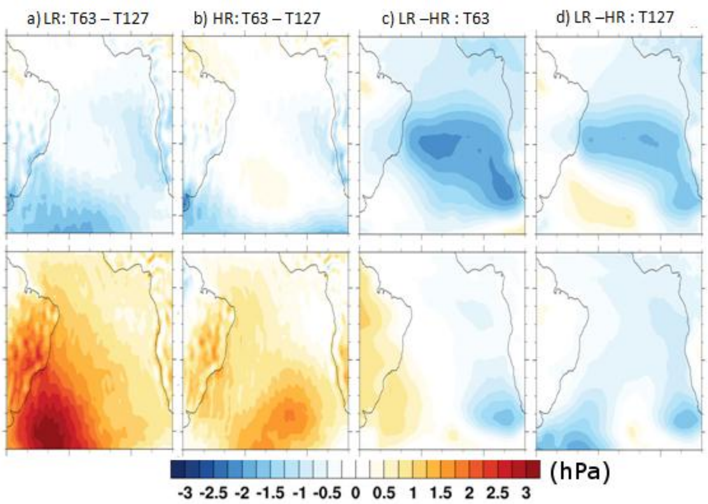

Figure 2. Differences of MSLP between setups with a common component : ocean in 4.a (LR) and 4.b (HR) and the same atmosphere in 4.c

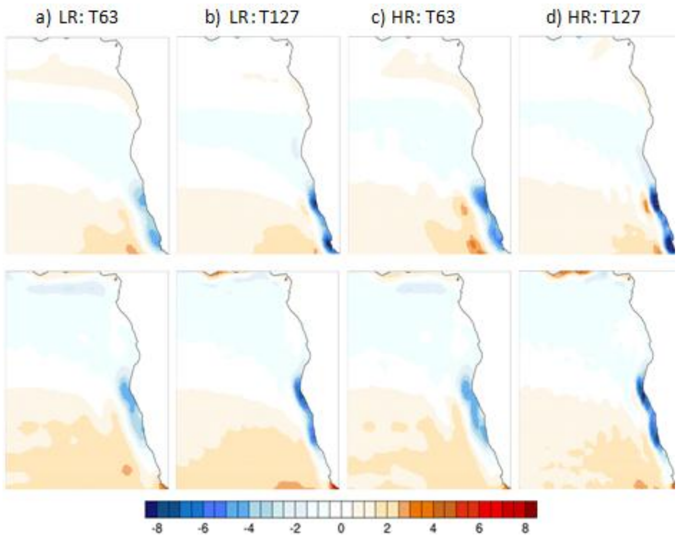

Figure 3. Wind stress curl for the different runs: a) LR:T63 b) LR:T127 c) HR:T63 and d) HR:T127

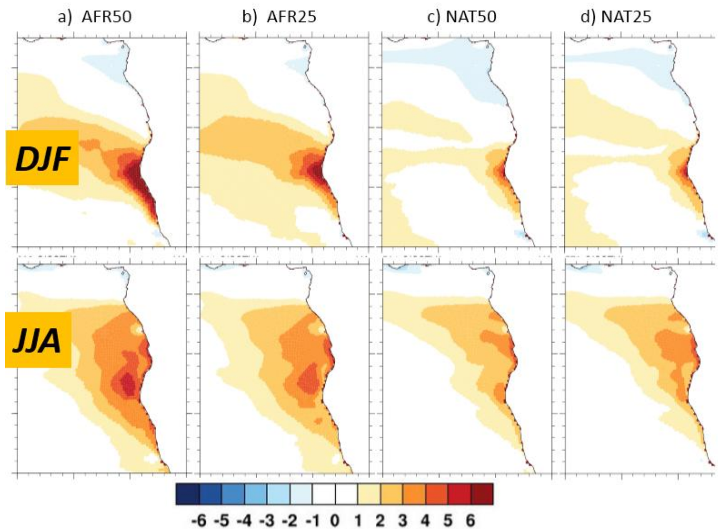

Figure 4. SST bias for two different ROM setups that share the same ocean: a) 50 km NAT b) 25 km NAT. c) 50 km AFR and d) 25 km AFR