PREFACE Milestone Report

Milestone#: MS27

Milestone name: Results from sensitivity experiments

WP#: WP8

Lead beneficiary: UCM

Achievement date from annex I: 30.04.2017

Actual achievement date: 31.10.2017

Milestone achieved: YES

Comments: The main objective of WP8 is to understand interrelation between errors in simulating tropical Atlantic climate and in simulating climate elsewhere. This includes both climatology and climate variability, as well as modulation of teleconnection patterns.

MS27 is the completion and analysis of a series of sensitivity experiments to support the results of multi-model statistical analysis. MS27 provides input to D6.3.

A control and four sensitivity experiments were performed with UCLA-GCM to assess the impact of model biases in the southern hemisphere and globally on the representation of tropical Atlantic Climate. The following table summarises the experiments:

Simulation	Model	Period	Domain	Resolution	Special Features	Objectives
Control	UCLA-GCM	100 yrs	Global	2.5lon*2lat*29lev	Control made with the version 7.1+Ssib of the UCLA AGCM	Control simulation to use for comparison with other experiments
Southern Ocean - Global	UCLA-GCM	50 yrs	Global	2.5lon*2lat*29lev	Reduction of the incoming SW radiation in the SO	Study of the impact of the SO warm bias in the global circulation
Southern Ocean - Atlantic	UCLA-GCM	100 yrs	Global	2.5lon*2lat*29lev	Reduction of the incoming SW radiation in the Atlantic sector fo the SO	Study of the impact of the Atlantic SO warm bias in the global circulation and the tropical variability
Southern Ocean -Atlantic Indian	UCLA-GCM	100 yrs	Global	2.5lon*2lat*29lev	Reduction of the incoming SW radiation in the Atlantic and Indian sector of the SO	Study of the impact of the Atlantic and Indian SO warm bias in the global circulation and the tropical variability
Anomaly Coupling Global	UCLA-GCM	150 yrs (*)	Global	2.5lon*2lat*29lev	Climatology restored to the observed 1981-2000 climatology	Study of the impact of the global bias in the simulation of the variability of the tropical Atlantic

A variety of analysis has been performed. One expample is the study of the impact of reducing the SST warm bias in the Indian and Atlantic sectors of the Southern Ocean in the simulation of global climate and tropical Atlantic variability. The change in Southern Ocean SST (Figure 1, left) produces a cooling in the southern tropical Atlantic, maybe due to ocean advection and local SST-Stratocumulus interacction (Figure 1, center). The response in the tropical Pacific shows a warming, probably due to an impact of the cooling in the tropical Atlantic through atmospheric changes consistent with a Gill-Matsuno type response to anomalous tropical heating (Figure 1, right).

Also, there is an impact in the tropical precipitation, that shows a reduction in the excessive precipitation that the Control simulation shows in the Southern tropics (Figure. 2).

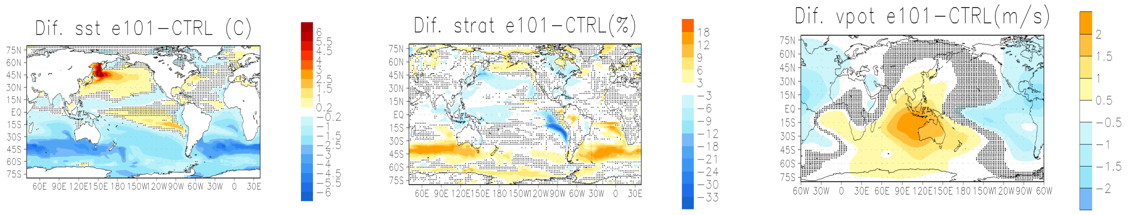

Figure 1: Annual difference between Southern Ocean- Atlantic Indian Experiment and Control for SST (left), Stratocumulus (center) and 200 hPa velocity potential.

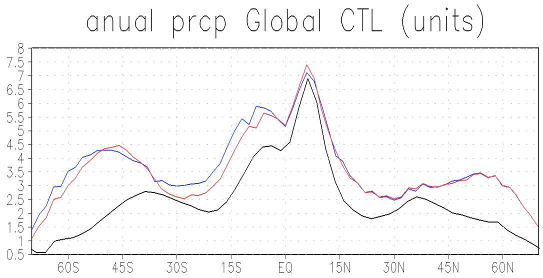

Figure 2: Zonally averaged annual precipitation for CMAP Observations (black), Southern Ocean- Atlantic Indian Experiment (red) and Control (blue).

These changes in the climatology produce also a change in the tropical Atlantic variability and its interactions with the tropical Pacific. The control experiment is not able to reproduce the 6-month lagged relationship between the Atlantic Niño in summer and the Pacific Niño in winter, observed for certain decades (Figure 3, left). This realtionship, and its decadal variability is simulated in the Southern Ocean-Atlantic Indian experiment (Figure 3, right).

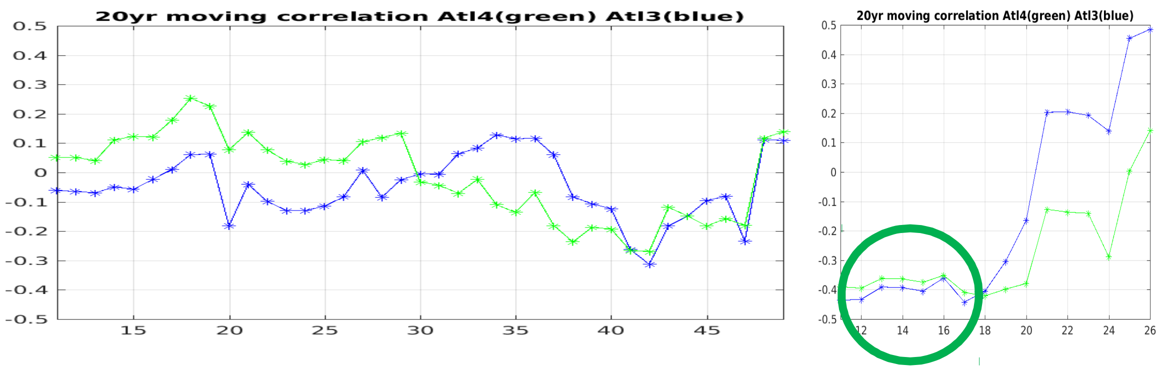

Figure 3: 20-year running correlation between Atl3 (blue) and Atl4 (green) in JJAS and Nino3 in DJFM for Control (left) and Southern Ocean- Atlantic Indian Experiment (right).

The ability to simulate such tropical interaction seems to be related with the decadal variability of the simulated tropical Atlantic equatorial mode. For the decades in which the model reproduces de connetion, the Atlantic Niño mode is stronger and more westward extended (Figure 4, left) that for the decades in which the connection is absent (Figure 4, right).

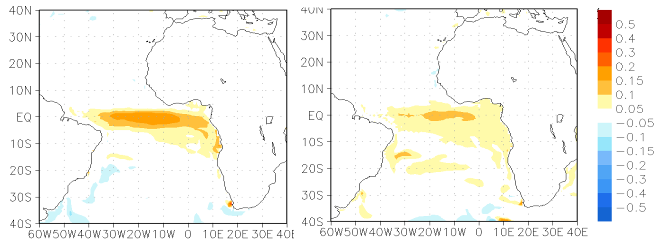

Figure 3: Regression of the JJAS Atlantic SST onto the **Atl3 index** JJAS for the decades with (left) and without (right) Atlantic-Pacific connection.

Another example of the analyses performed is the study of the representation of the Mauritanian-Senegalese (MS) upwelling mean state and variability and its relation to remotely forced errors was analysed in CMIP5 model simulations. The inter-model representation of MS upwelling mean state and variability is correlated with the inter-model variability in the representation of the SST and precipitation mean state (Figure 2). Models with a warmer southern hemisphere present an ITCZ displaced to the south that, in turn produce a weaker but more variable NWA upwelling. Thus, although the intensity of the upwelling is reduced, the variability increases.

The sensitivity experiments have been used to chek the response of the upwelling to a reduction in the southern hemisphere solar incoming radiation. In agreement with the hypothesis of CMIP5 models, the cooling of the extratropical southern hemisphere reduces MS upwelling. Nevertheless, the variability in the upwelling region does not follow CMIP5 hypothesis. These results are being analysed in depth and will be presented in the PREFACE final meeting hold in Lanzarote (Castaño et al., in preparation).

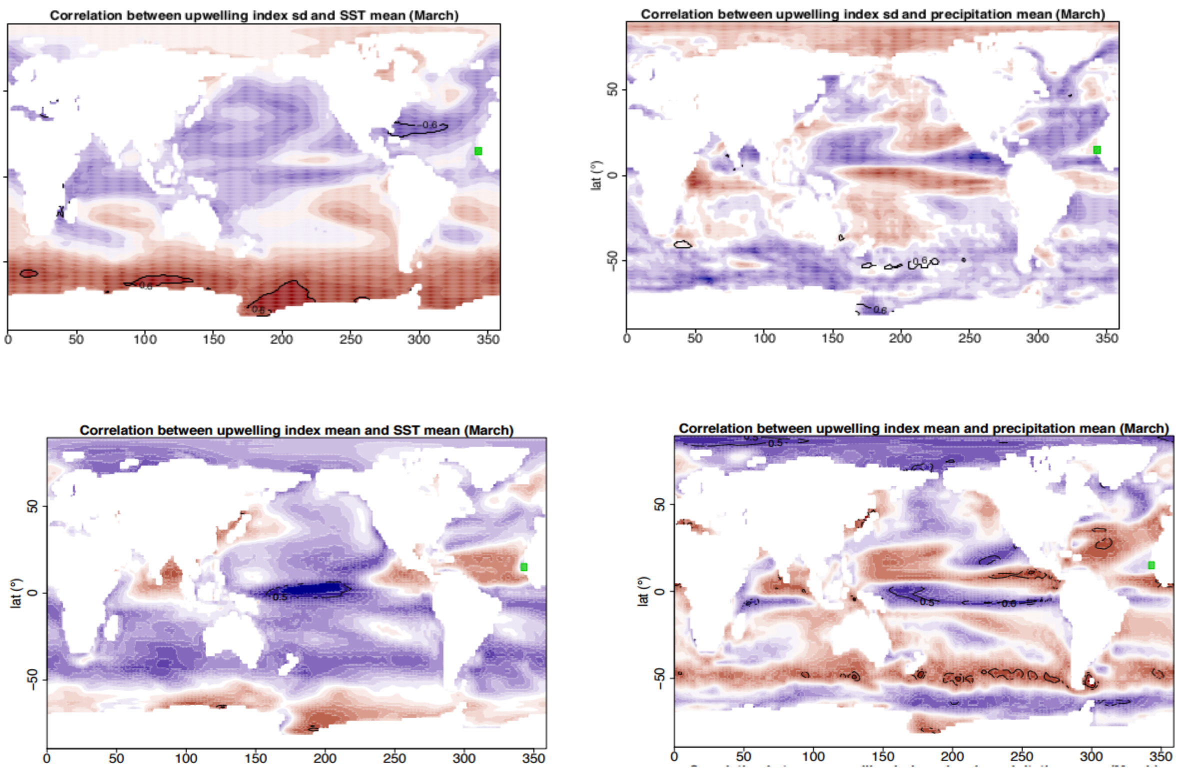

Figure 2: Inter-model correlation for March between MS upwelling-index standard deviation (top) and mean (bottom) and the in-

ter-model mean SST (left) and precipitation (right). Contoured areas show regions significant at the 95% level of significance. Blue for negative, red for positive correlations.