PREFACE Milestone Report

Milestone#: MS23

Milestone name: Targeted sensitivity experiments

WP#: WP6

Lead beneficiary: MF-CNRM

Achievement date from annex I: 30.04.2017

Actual achievement date: 31.10.2017

Milestone achieved: YES

Comments:

WP6 goal is to reduce systematic error in the simulation of tropical Atlantic climate. MS23 presents a summary and first results of the targeted sensitivity experiments contributing to task 6.3, and provide input to D6.3. Technical issues in performing some experiments delayed MS23 by six months. Despite the delay in MS23, D6.3 was timely delivered.

1- UiB

WIth a collaboration with CNRM, UCM and UniRes, UiB has performed an experiment with anomaly coupling (Toniazzo and Koseki, 2018, in revision) for NorESM to investigate the equatorial Atlantic interannual variability and its dynamics/thermodynamics. The anomaly coupling improves, to some extent, the seasonality of the variability. More interestingly, the Bjerknes Feedback and thermodynamics role for the variability are improved largely. In addition, the evolution and symmetric spatial pattern of warm and cold events are also better with the anomaly coupling. We will perform the same analysis for CNRM-CM5 and UCLA-CGCM. All of those data are stored NIRD/Norstore for sharing.

2- MF-CNRM

Given the importance of atmospheric models errors in CNRM-CM, specific atmospheric only experiments have been performed.

2.1 **Transpose AMIP simulation with CNRM-CM5** model and sensitivity experiments to Q1 (convective heating) focusing on the equatorial region.

This set of experiments focus on understanding the causes of a westerly bias in the equatorial surface winds, which has been shown to already exist in the CMIP3/CMIP5 atmosphere-only simulations, forced with observed sea surface temperatures (AMIP). An ensemble of initialized experiments following the so-called Transpose-AMIP protocol are analysed to further understand the origin of this wind bias.

As the wind bias develops in a few days, the Transpose-AMIP framework allows us to track the development of the model bias away from a well-defined initial state and relate it to other regional biases. The analysis of the zonal momentum budget highlights the important role of biases in the east-west pressure gradient, in agreement with previous studies. Biases in convection in some parts of the tropical Atlantic and adjacent continents appears to be critical, through a large-scale adjustment of the regional zonal circulation. Further sensitivity experiments are carried out to further assess the role of these convection biases. The study highlights that there is not enough moisture convergence on the western equatorial region to trigger convection. The results provide some indications that this may be due to an underestimation of local ocean evaporation.

2.2 **Transpose AMIP simulation with CNRM-CM6** : focus on the strato-cumulus deck region in the Southeastern tropical Atlantic using the new physics package.

Low-level cloud biases in the new version of CNRM-CM are first assessed in AMIP-type simulations. We focus on how the model represents the vertical development of boundary-layer clouds and the transition from stratus to cumulus regimes, using a zonal transect between the Namibian coast and South America. In particular, the representation of this transition is related to biases of the surface energy budget. Then, short-term hindcasts (Transpose-AMIP framework) are used to better understand the mechanisms at play. Low-level cloud biases are shown to be associated with fast processes (a few hours to a few days). Specifically, the drivers for this low-cloud underestimate are further studied to show that they are likely to arise from errors in cloud scheme input coming from the boundary-layer thermodynamics (e.g. turbulence) and structural errors from the cloud parameterization itself (e.g. assumptions of sub-grid variance of thermodynamical variables). This study provides guidance for future improvements of stratocumulus representation in the CNRM-CM model.

3- WU

Bias corrected climate projection RCP8.5

Wageningen has studied the origins of the bias in EC-Earth by means of a heat budget analysis of both model and reanalysis data (Deppenmeier, Haarsma and Hazeleger, 2018: Reinforcing and damping ocean mixing-cloud feedbacks in the tropical Atlantic. To be submitted to GRL. Deppenmeier, Haarsma and Hazeleger 2018: Tropical Atlantic ocean mixing-cloud feedbacks in coupled climate models. In preparation). Lacking vertical entrainment into the mixed layer plays a large role in the feedback development. In an attempt to understand the role of the individual components in the ocean mixing scheme sensitivity experiments have been performed with a 1D version of EC-Earth. From these experiments it emerged that underestimation of the mixing efficiency could be a possible reason for the reduced entrainment of cold waters into the mixed layer. Hence, we have performed a climate projection run with enhanced mixing efficiency. In the tropical Atlantic this led to a SST bias reduction underlining the importance of ocean vertical mixing in this region.

4- CERFACS

Bias correction experiments using the anomaly coupling approach (Toniazzo and Koseki, in rev.) implemented in the CNRM-CM5 model. In these experiments the model climatology (wind stress/SST) are corrected, and the anomalous part evolves freely. Some of the data from these experiments has been shared in NIRD/Norstore.

5- GEOMAR

We performed a number of sensitivity experiments with the Kiel Climate Model (KCM), in which we only varied the atmospheric model resolution, horizontal and vertical. The ocean model resolution was kept fixed at 2° with enhanced meridional resolution in the meridional direction. The sea surface temperature bias in the tropical Atlantic, a common feature of many climate models, could be largely reduced when employing high resolution (T255, L62) in the atmospheric component.