Project: **1207**

Project title: **Decadal Variability of the Tropical Pacific and El Niño Events**

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In the first year of the project we carried out coupled and non-coupled simulations with the ROM and REMO with the same atmospheric configuration with a spatial resolution of 24 km for the South America setup (SA). The global configuration of the MPIOM has a variable resolution ranging from 8 km to 24 km. After a spin-up period of 130 years for ROM and two years for REMO, simulations forced by Era-Interim for the period 1980-2017 were analysed. Also, test simulations with a resolution of 6 km for the Peru domain (PE) for 2014-2017 were performed with the aim of studying the coastal El Niño of 2017. As a result of these activities, a research paper is being written with coupled and uncoupled simulations in which the lowest resolution simulations are evaluated.

Results

Precipitation in the SA runs.

In figure 1 we compare REMO and ROM precipitation with ERA5. We can see that for DJF the coupled and non-coupled experiments present a similar spatial distribution of precipitation over land which is overestimated by REMO. Over the ocean, REMO overestimates precipitation in the ITCZ while ROM shows a clear overestimation of the second band of the ITCZ. In JJA the distribution of precipitation over South America is adequately estimated by the coupled simulation and underestimated by the non-coupled. As a result of the coupling, there is a better estimate of precipitation in the Amazon region where it presents values like ERA5. During the austral winter (JJA), is appreciated that the Intertropical Convergence Zone (ITCZ) is more active. The coupled simulations present distributions in similar areas and magnitude, while in the non-coupled experiment precipitation is overestimated.

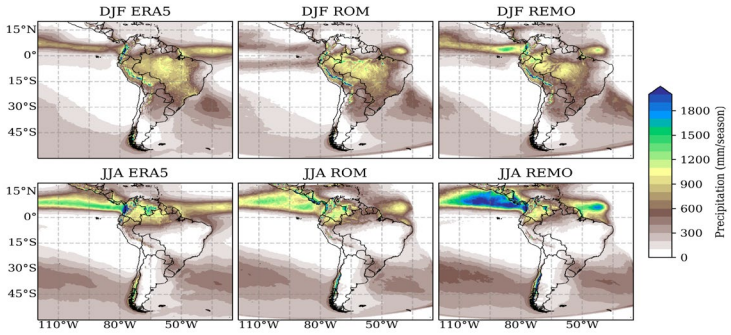

Fig. 1. Distribution and spatial comparison of the 1982-2011 climatology simulation of precipitation for DEF (summer) and JJA (winter).

Regarding the seasonal cycle and interannual variability, the precipitation averaged over Peru shows a distribution of the annual cycle that agrees well with ERA5. However, interannual variability shows an overestimation of the precipitation for the coupled experiments. Over the Niño 1 + 2 area, the annual cycle of precipitation is overestimated, especially in summer. The time series from 1982 to 2017 shows an overestimation of precipitation, especially during the extreme El Niño events 1982-1983 and 1997-1998.

Surface air temperature in the SA runs.

In DJF (not shown), both coupled and uncoupled simulations, similarly to ERA5, show maximum T2M values towards Ecuador, Central America, and northeast Brazil. However, the T2M over the coastal regions in the coupled model is colder of Peru and northern Chile and warmer off Equator and Northern Peru than in REMO and ERA5. For JJA ROM shows a 4 °C bias in front of the northern coasts of Peru and southern Ecuador, while over land ROM shows low biases and REMO shows significant overestimations of T2M, especially over the Amazon and northern Brazil. The probability density functions (PDF) of the mean values, of mean temperature over Peru show that in the DEF quarter, the distributions of the two experiments are consistent with that represented by the ERA5.

3) Precipitation during the 2017 coastal ENSO

During the second semester of 2021, we carried out two more coupled and uncoupled simulations with PE setup for the 2016-2017 period. In general, we observe that the coupled experiment at 6-km improves the results in the Peruvian Andes, with an emphasis on the western North and Central slopes. This improves the results with ROM in the SA setup, which overestimates precipitation in these areas, especially in the months of the 2017 coastal El Niño. This event had a strong impact on the northern coasts of Peru, and for the area between [-81.5W -79.5W] and [-7 °S -3 °S], we found that the coupled experiments in the two setups showed a lower bias compared to the non-coupled experiments. Regarding resolution, the coupled PE experiment shows the lowest BIAS and RMSE, being up to 50 mm less than in coupled SA, which presents a 200 mm RMSE in March of 2017.

Regarding the non-coupled simulations, we observe that the better results are also obtained at the finest resolution. An overestimation of precipitation is observed in the entire mountain range and northern coast of Peru for the SA non-coupled experiment. While for the PE setup the overestimation is lower.

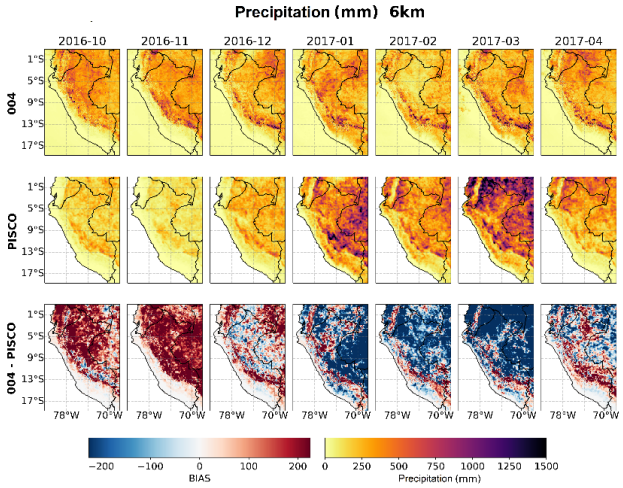

Fig. 3. Monthly spatial distribution of precipitation compared to the gridded dataset PISCO for the coupled experiment with the PE setup

Discussion

The coupling influences significantly the simulated precipitation. This type of response is observed for DEF throughout the tropical Pacific and mainly in the Niño 1 + 2 zone, where it causes an increase of precipitation due to a slight overestimation of sea surface temperature. This behaviour is recurrent for historical simulations (1980-2017), in the Niño 1 + 2 region.

Precipitation in DEF over Peru, especially over the Andean zone, shows an overestimation for the 2 experiments and mainly compared to the ERA5. This distribution of precipitation is mainly related to the winds and the relative humidity in 200hPa. Therefore, no significant differences are observed in these variables and therefore neither in the positioning of the Bolivian High, which is displaced towards a more SE position compared to the ERA5 data. On the other hand, for JJA, at levels of 200hPa, zonal winds from the west are observed.

From the preliminary results of the coupled and non-coupled simulations with PE, we can say that at this spatial resolution a better distribution of precipitation is appreciated, especially on the north coast and the overestimation in the Andes of Peru is partially corrected.