GLOBAL NUMERICAL SIMULATIONS WITH THE WRF MODEL TO STUDY THE INFLUENCE OF TROPICAL OCEANS ON THE SEASONAL PREDICTABILITY IN URUGUAY DURING THE SUMMER OF 2020

Vanessa Bentancur[1], Gabriel Cazes Boezio[1],
vane.bentancur@gmail.com. Vanessa Bentancur.
agcm@fing.edu.uy, Gabriel Cazes Boezio.

[1]Facultad de Ingeniería, Universidad de la República, URUGUAY

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1) INTRODUCTION

ENSO strongly influences climate variability in Uruguay (e.g., Cazes Boezio et al. 2003). Consequently, if the equatorial Pacific Ocean is in El Niño or La Niña condition, the seasonal predictability of surface climate in Uruguay increases. During the 2019-2020 summer season, considered from December 2019 to February 2020, the precipitation anomalies in Uruguay were negative, despite moderately positive SST anomalies in the eastern and central equatorial Pacific Ocean. The observed SST anomalous pattern is consistent with a moderate El Niño Modoki event (Martín Gómez et al. 2020). These results arises interest in a better understanding of the reasons for the negative precipitation anomalies in our region. For that purpose, this work considers a simulation study that uses a general circulation atmospheric model, forced with prescribed SST fields. The model used was the Weather Research and Forecasting (WRF) in global mode (Skamarock et al., 2019), and the SST derives from NOAA CFS-v2 forecasts.

2) DATA AND METHODOLOGY

The initial conditions for the atmospheric fields were obtained from the Global Forecast System (GFS) of NOAA. The CFS v2 of NOAA (Saha et al., 2014) was used to obtain SST anomalies with respect to the 1990-2019 period. These SST anomalies were added to the correspondent climatologies obtained from the NCEP-NCAR Reanalysis (Reynolds et al., 2002). The WRF model was used in a global domain with a horizontal resolution of 2.8125 degrees, corresponding to a grid of 128x64 points. The vertical discretization consists of 65 levels, and the temporal resolution was 10 minutes. We report the results of four experiments, each consisting of ten simulations initialized on different days from October 23th to November 1st. The five experiments are: control simulation (CNTR), with climatological SST fields for the period 1990-2019; Global Ocean-Global Atmosphere (GOGA), with SST fields that include the forecasted global anomalies, Pacific Ocean-Global Atmosphere (POGA), with SST fields that includes SST anomalies in the Pacific Ocean and are climatological elsewhere, and Indian Ocean-Global Atmosphere (IOGA), with SST fields that include SST anomalies in the Indian Oceans and are climatological elsewhere. A similar experiment that prescribes SST anomalies in the Atlantic Ocean was performed, but its results are not discussed here. We define the anomaly of any variable and for any experiment as its mean computed through all the experiment simulations minus the respective CNTR mean. The statistical significance of these anomalies is computed with a Monte Carlo technique as in Cazes Boezio et al. (2008).

3) RESULTS AND CONCLUSIONS.

The mean of GOGA simulations does not show precipitation anomalies over Uruguay during December-February 2019-2020 season. However, the mean of the POGA simulation shows a positive precipitation anomaly over Uruguay, with 95% significance (precipitation fields are not shown here). Figure 1 shows the mean anomalies of meridional wind at the 200 hPa level for GOGA (left panel) and POGA (right panel). Both panels show a Rossby wave train at southern extratropical latitudes, with values significant at the 95% level. We highlight that POGA results are consistent with the response to an El Niño Modoki event during the austral summer season, as described by Martin-Gómez et al. (2020). Both experiments show a cyclonic anomaly westward Uruguay; however, the anomaly is weaker for the GOGA experiment. This difference is a possible cause for the lack of significant precipitation anomalies over Uruguay in the GOGA results.

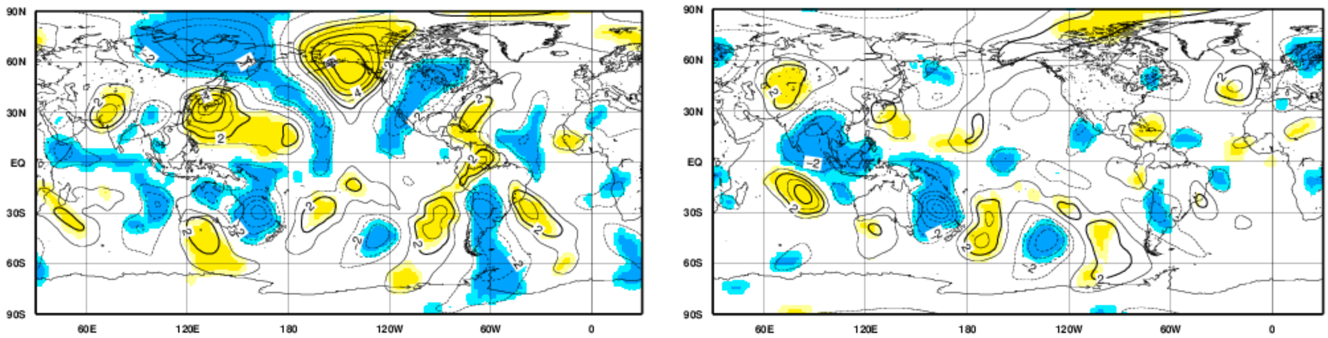

Fig. 1 200hPa meridional wind anomaly for the DJF 2010-2020 season, GOGA experimet (left) and POGA experiment (right). Shadows indicate significance at the 95% level.

Fig. 2 shows 200 hPa wind divergence anomaly for the IOGA experiment (left panel) and the GOGA minus POGA difference of this field (right panel). These results are very similar. Equivalent results for the 200 hPa meridional wind and the precipitation fields show comparable similitudes.

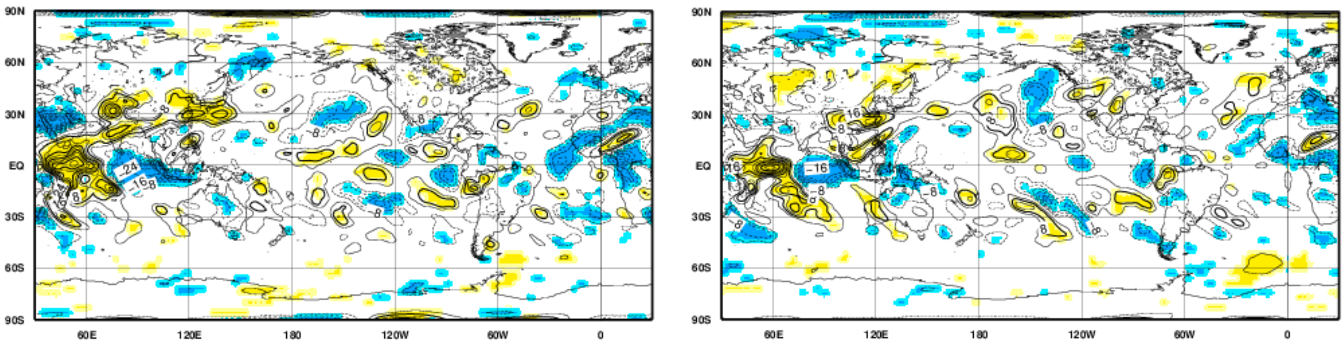

Figure 2. Left: 200hPa wind divergence anomaly for the DJF 2010-2020 season for the IOGA experimet. Right: GOGA minus POGA difference of 200 hPa wind divergence for the same season. Shadows indicate significance at the 95% level.

These similarities are relevant for two reasons. First, the IOGA results indicate that the Indian Ocean affected the higher troposphere circulation around Uruguay in a way that changed the response to the anomalies in the tropical Pacific Ocean. There are previous results about similar effects of the SST anomalies in the Indian Ocean (e.g., Cazes Boezio y Talento 2016). Second, the similitude between the GOGA minus POPGA difference and the IOGA anomalies suggests a linear relationship between SST tropical anomalies over the Indian and Pacific Oceans and the atmospheric circulation. Besides, the anomalies computed from some individual members of the GOGA set of simulations show results compatible with negative precipitation anomalies over Uruguay (not shown here). In summary, we found differences between GOGA and POGA that may contribute to explaining the negative precipitation anomalies over Uruguay during the JDF 2019-2020 season. The internal variability of the atmosphere may have contributed further to these anomalies. Besides, it was found that the SST anomalies over the Indian Ocean significantly affected the effects of the SST anomalies over the Pacific Ocean on the anomalies of atmospheric circulation and precipitation around Uruguay.

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