IMPACT OF THE MADDEN JULIAN OSCILLATION ON SUMMER RAINFALL OVER WEST AFRICA IN AMIP SIMULATIONS

NIANG Coumbe (1,2,3,4), Elsa Mohino (3), Amadou T. Gaye (1)

(1) Laboratoire de Physique de l’Atmosphère et de l’Océan Simeon Fongang (LPAO-SF), ESP, Dakar, Senegal
(2) Instituto de Geociencias (IGEO), Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain.
(3) Departamento de Fisica de la Tierra, Astronomia y Astrofisica I, Geofisica y Meteorologia, Universidad Complutense de Madrid (UCM), Madrid, Spain
(4) WASCAL, Department of Meteorology and Climate Science, Federal University of Technology Akure (Nigeria)

Email: niangcoumbe@hotmail.fr

Abstract

At intra-seasonal timescales, convection over West Africa is modulated by the Madden Julian Oscillation (MJO). In this work we investigate the simulation of such relationship by 11 state-of-the-art Atmospheric General Circulation Models run with prescribed observed Sea Surface Temperatures (SST). In general, the simulations show good skill in capturing the main characteristics of the summer MJO as well as its influence on convection and rainfall over West Africa. Most models simulate an eastward equatorial Kelvin wave with a time lead of 15-20 day. Results from the simulations confirm that it may be possible to predict low-frequency waves within the MJO and its impact over West Africa. Our analysis of the equatorial waves suggests that the main impact over West Africa is established by the propagation of low-frequency waves, which reproduce the main features and timing of the MJO and its impact over West Africa. Our analysis of the equatorial waves suggests that the main impact over West Africa is established by the propagation of low-frequency waves within the MJO and Rossby spectral peaks. Results from the simulations confirm that it may be possible to predict anomalous convection over West Africa with a time lead of 15-20 day.

Introduction

1. Rainfall variability over West Africa in the 20-60 day which share the same range of periodicity as the MJO (Janicot and Sultan, 2001; Matthews, 2004).
2. Very few studies in evaluating the simulations of MJO impact over WA as well as the mechanisms however need to improve our understanding of the mechanisms underlying the MJO-WA link (Lin et al., 2006; Mohino et al., 2012).
3. Need to evaluate the impact of the MJO on rainfall/convection over WA and the dynamical mechanism involved in state-of-the-art AMIP’s models.

Results

1- Evolution of summer MJO through AMIP

Figure 2: Observed (thick black line) and simulated first two CEOFs of summer OLR and zonal wind at 850 and 200 hPa anomalies from AMIP simulations.

Figure 3: Lead-lag correlations between the principal components associated with the first and second CEOF from observation and AMIP simulations.

Figure 4: Summer composites of deseasonalized OLR (Win-2) according to the eight phases of the MJO, from observation (left) and the ensemble average of models simulation (top) and Correlation between 10° S and 10° N of zonal wind at 850hPa (m/s) for observed (a and b) and simulated (c and d). The red-dashed contours represent the positive values of OLR (SLP) while the black solid contours show the negatives ones in a and c (b and d).

Figure 5: Composites of lead-lag correlations between the principal components associated with the MJO and SLP while the black solid contours show the negative ones in a and c (b and d).

Figure 6: Wavenumber-frequency spectral analysis of deseasonalized OLR from the observation and the ensemble averaged of models simulation (top) and Correlation of the non-thermal OLR composites and each of the correspondingly eigenwaves from observation and AMIP models over the wavenumber-frequency domain (down).

Figure 7: Composite Hovmoller diagram of deseasonalized OLR from the observation and the ensemble averaged of models simulation (top) and Correlation of the non-thermal OLR composites and each of the correspondingly eigenwaves from observation and AMIP models over the wavenumber-frequency domain (down).

Conclusions

* Clear evidences of the impact of MJO on WA rainfall variability during the summer period
* AMIP models tend to show such relationship between the MJO and OLR/ rainfall anomalies in phase with observations
* MJO also impacts the AEJ, particularly over the coastal regions (not shown)
* The combination of westward and eastward propagating signals explain most of the pattern associated with the MJO impact over WA
* Influence of MJO could be used to predict the occurrences of wet and dry spells over WA

References


Acknowledgements

1. 1-Agency Estatal Consejo Superior de Investigaciones Científicas (CSIC) of Spain (L-ECO+ reference COOPA20029 program) / Instituto de Geociencias (IGEO).
2. Universidad Complutense of Madrid (UCM) via the collaboration with LPAO-SF.
4. WASCAL (West African Science Service Center on Climate Change and Adapted Land Use) project.