3.B.3 THE SIMULATION OF THE SEASONAL CYCLE OF THE WEST AFRICAN MONSOON IN A AGCM

Serge Janicot[1*] and Guillaume Blanchon[2]
[1] LMD/IPSL, IRD, Ecole Polytechnique, Palaiseau France
[2] LMD/IPSL, Ecole Polytechnique, Palaiseau, France.

1. INTRODUCTION

The summer monsoon onset over West Africa is specific. If the beginning of the rainy season at the Sahelian latitudes can be characterized by the arrival of the Inter-Tropical front (ITF) at these latitudes in mid-May, the onset of the atmospheric monsoon system, in late June, is characterized by an abrupt latitude shift of the Inter-Tropical Convergence Zone (ITCZ) from 5°N to 10°N, associated with a temporary but regional-scale decrease of convection and rainfall intensity (Le Barbé et al 2002, Sultan et Janicot 2003). This first work, performed by using American reanalyses NCEP-1, enabled to point out interactions with the Saharan heat low activity, this atmospheric center enhancing at the time of the convection decrease in the ITCZ.

2. THE MONSOON ONSET OVER WEST AFRICA IN ARPEGE-CLIMAT AGCM

The Atmospheric General Circulation Models (AGCM) generally do not simulate accurately this ITCZ behavior over the African area: the abrupt shift does not always appear and this onset is often too early in the year. This leads to a limited interest in examining such models to try understanding the related mechanisms.

However recent versions of the Arpege-Climat AGCM show an ITCZ behavior close to the observations. So a detailed analysis was performed in these versions of the model to investigate the associated atmospheric dynamics, following the methodology applied in Sultan and Janicot (2003), while comparing the model outputs to the new version of the American reanalyses NCEP-2 (Kanamitsu et al 2002).

* Corresponding author address : Serge Janicot, LODYC/IPSL, UPMC, T45-55, Boite 100, 4 Place Jussieu, 75252 Paris Cedex 05, France ;
e-mail : jslod@lodyc.jussieu.fr

Two runs have been performed with the French ARPEGE-Climat Version 3 T63 AGCM forced by observed SSTs on the period 1959-1995 (version SF1) and on the period 1950-1999 (version SF2); see Douville et al. 2001 for more details. In the SF2 simulation, a bug in the sea-ice exchanges parametrization present in SF1, was removed. This bug having a priori no impact on the African monsoon, we can consider to have two multi-annual simulations of the same model version. The results obtained are in fact very similar.

The two simulations reproduce quite well the seasonal cycle of the West African monsoon, especially the abrupt ITCZ shift and the concomitant convection decrease, signing the onset of the summer monsoon (not shown). The timing of this onset as well as the interannual dispersion are very good. The mean dates for the onset are 18 June for SF1 (standard deviation of 8 days) and 19 June for SF2 (standard deviation of 10 days) while the mean observed onset date is 24 June (standard deviation of 8 days), obtained both by using daily in-situ rainfall data and satellite OLR values.

The following of the study has been realized through composite fields averaged over all the years by using as the reference date for each year the day of the beginning of the northward shift of the ITCZ.

The analysis of the atmospheric dynamics associated with this latitudinal shift of the ITCZ shows a high signal in the 850-600 hPa vertically integrated moisture convergence and nothing significant in the evaporation modulation, leading the investigation towards the regional-scale atmospheric circulation impact. We observe in agreement with the observations an enhancement of the meridional transverse circulation associated with the dry convection in the Saharan heat low, which induces a subsiding forcing inside the ITCZ deep convection consistent with the convection decrease at the time of the latitudinal shift (Fig.1). This Saharan thermal depression enhancement is concomitant with an increase of the pressure gradient over the North Africa orography axis in agreement with the observation, and leads to an increase of the westerly moisture advection from the northeastern tropical Atlantic between 5°N and 15°N into West Africa (not shown). This moisture import enhancement may explain the abrupt set-up of convection at 10°N and can represent an atmospheric indicator of the summer monsoon onset.

3. CONCLUSION

Two runs have been performed with the French ARPEGE-Climat AGCM forced by SSTs on the periods 1959-1995 and 1950-1999. These two simulations reproduce quite well the seasonal cycle of the West African monsoon, especially the abrupt ITCZ shift observed in averaged in the end of June, signing the onset of the summer monsoon. A detailed examination of the atmospheric dynamics associated with this shift in the model and comparison with the dynamics seen in the NCEP-2 reanalyses show high consistency, and the results highlight the role of the Saharan heat low and of the westerly advection of moisture from the northeastern tropical Atlantic.

4. REFERENCES

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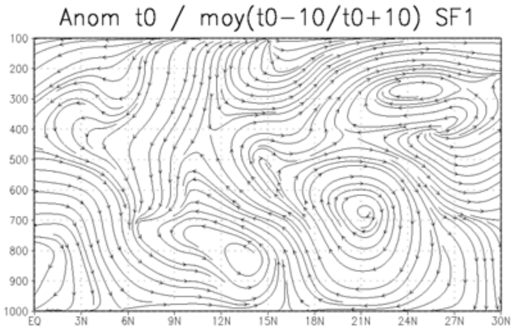

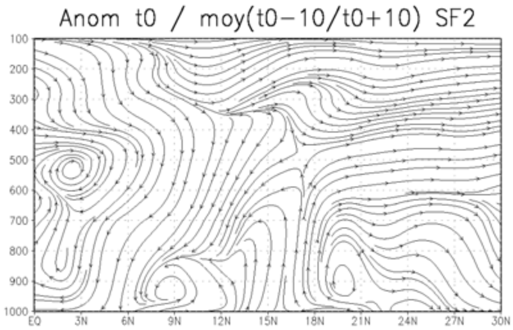

Fig.1 : Latitude-pressure section of the mean composite wind field at the time of the monsoon onset (called t0) expressed in anomaly relative to the average over the period (t0-10 / t0+10), for the run SF1 (up) and SF2 (bottom). t0 represents the date of the beginning of the northward shift of the ITCZ for every year. The mean composites are computed by using these dates t0 as reference for each year.