1.35P

DOMINANT CONVECTIVELY COUPLED 15 DAYS PERIODICITY KELVIN WAVES MODE AND ITS INFLUENCE DURING THE WEST AFRICAN MONSOON (WAM) ONSET

Flore MOUNIER (1), Serge JANICOT (2) and George N. KILADIS (3)

(1) Laboratoire de Météorologie Dynamique/Institut Pierre Simon Laplace, Palaiseau, France
(2) LOCEAN / IPSL, Institut de Recherche pour le Développement, Paris, France.
(3) Aeronomy Laboratory, NOAA, Boulder, CO, USA

1. Introduction

The intra-seasonal variability of the West and Central African convection during the monsoon season has been address only by few studies. Indeed, much of the researches have been on the decenal or interannual variability due to the important drought of the Sahel the second half of the twentieth century and on synoptic time scale of easterly waves. In between these two levels of variability, Kiladis & Weickmann (1997) showed at the 6-30-days time scale connections between convection in the region 5°-15°N/10°-20°E and the moisture advection over West Africa during the northern summer. More recently, Sultan et al. (2003) highlighted, based on a regional rainfall index computed on the area 12.5°-15°N / 10°W-10°E and filtered between 10 and 60 days, a westward propagating signal of convection along the Sahelian latitudes, with a dominant periodicity around 15 days. Matthews (2004) focused on the 20-200 period range and identified by an empirical Orthogonal Function (EOF) analysis a dominant mode over the whole African monsoon region which might arise as a remote response to the intra-seasonal Madden-Julian Oscillation (MJO) over the warm pool region. Grodsky & Carton (2001) showed that intra-seasonal modulation of convection may also occur during northern spring in the ITCZ over the Tropical Atlantic with a dominant periodicity between 10 and 15 days.

Moreover, Mounier & Janicot (2004) highlighted evidences of two independent modes of convection at intra-seasonal time scale in the west African monsoon; the first one being coherent with the dominant "Guinean" 15-days mode that interests this study. One of the questions they raise was whether the fluctuations associated with this mode are an inherent feature of the WAM or a larger scale one independent dynamically to the WAM. And finally, the impact and the dynamics of convectively coupled Kelvin waves for the particular case of the West African monsoon was presented in (Mounier et al. submitted). Here these points are discussed.

2. Dominant convectively coupled 15 days periodicity Kelvin waves mode

The dominant mode of convection at intra-seasonal timescale of the West African summer monsoon is the "Guinean" mode of about 15-days periodicity. It depicts a stationary modulation of the ITCZ convection without any significant change in its latitudinal location. However, over the tropical belt, it is associated to an eastward propagating modulation of convection strength, even visible on scale as small as cloud cluster (not shown here) and also to a modulation of the zonal wind component over the eastern equatorial Atlantic. The propagative nature of this "Guinean" mode established in Mounier & Janicot (2004) make an extended S-EOF (ES-EOF) analysis interesting. Therefore, an ES-EOF analysis was performed on temporally refine 10-25-day bandpass filtered OLR values, over the domain (120°W-40°E / 10°S-30°N) for the monsoon season (June to September) of years 1979 to 2000. The OLR data are from the NOAA (National Oceanic and Atmospheric Administration) (see Liebman and Smith, 1996). Figure 1 portrays components of the "Guinean" mode resulting from an ES-EOF analysis. ES-EOF3 and ES-EOF4 are in temporal quadrature, they depicts the "Guinean" mode and its eastward propagation nature. It also highlights the scale of the signal. This propagation happens along the position of the ITCZ during the WAM period (7.5°N). ES-EOF1 and ES-EOF2 are not presented as they are out of the scope of our mode.

The analysis of the associated circulation has highligted interaction between convectively coupled Kelvin waves of lower periodicity and the dominant 15-days "Guinean" mode. Indeed, study of the dominant 15-days "Guinean" show that the appearing stationary convection modulation mode is linked, on a larger scale, to an eastward propagation along the ITCZ position. Convection anomalies growing on the west side of the Atlantic and propagating then eastward up to the east side of the African continent. This propagation is coherent horizontally and vertically to convectively coupled Kelvin waves. However, part of it could also be coherent with the Grodsky & Carton (2001) hypothesis on the monsoon flux modulation by ocean-continent interactions.

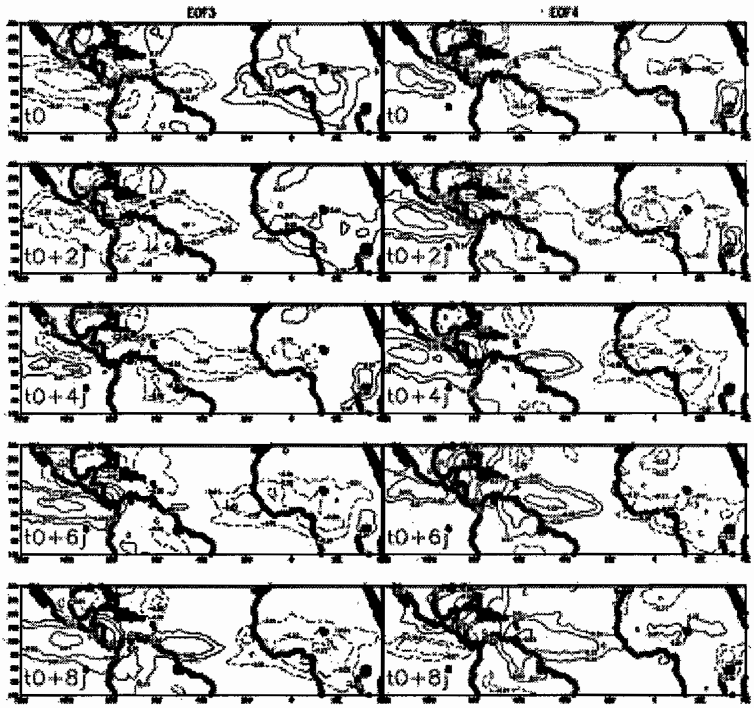

Figure 1 : Representation of ES-EOF3 and ES-EOF4 resulting from an ES-EOF analysis performed on 10-25-days filtered OLR data over the domain 120°W-40°E / 10°S-30°N. Negative values (dotted) are for convection enhancement and positive value are for convection weakening. Variance percentages are respectively for EOF3 and EOF4, 2.91% and 2.71%. The sequence goes from t0 (top) to t0+8days (bottom) with a 2 days gap in between.

3. Influence of 15-days mode and Kelvin waves on the WAM onset

To go further into the understanding of the interaction between convectively coupled Kelvin waves and the dominant 15-days periodicity mode a real time analysis was performed on a critical stage of the WAM, the onset of year 1984. The year 1984 onset was dated on the 3d of July following Sultan & Janicot (2003) technique. The year 1984 being particularly dry, rainfall over the Sahel is depleted compared to the averaged ones. Indeed, the Sahel has encountered a persisting drought since the seventies, year 1984 being the driest one. It is characterised by a reinforcement of north-east and south-east trade winds and a reduction of the sea surface temperature over the tropical Atlantic and by a decrease in the averaged velocity of the Tropical Easterly Jet (TEJ). However our concerned is on interactions between convectively coupled Kelvin wave and the ITCZ shift, and year 1984 is on this point a suitable example to characterise it. Indeed, in 1984, the ITCZ did stay south of its averaged position during the full monsoon season. Then, links with Kelvin waves may be facilitated.

This 1984 onset was characterised (not shown) by the arrival of a Kelvin wave train that modulated the "Guinean" mode. A study of other onset cases will be needed to understand how important this modulation of the "Guinean" mode by Kelvin waves is with regards to the onset.

4. Conclusion

The Some questions arise from this analysis: which mechanism is responsible of the birth of these Kelvin waves in the Western side of the Atlantic. Is this mechanism modulated by the Central and North American monsoon? How much of the Indian monsoon convection anomaly could be imputable to African "Guinean" mode? The answer to these questions might help to better understand connection between the three dominant monsoon regimes.

Reference

Grodsy S. A. & Carton J. A., 2001. Coupled land/atmosphere interactions in the West African Monsoon. Geophysical Research Letter, 28, 1503-1506.

Kiladis, G.N. and K.M. Weickmann, 1997. Horizontal structure and seasonality of large-scale circulations associated with submonthly tropical convection. Mon. Wea. Rev., 125, 1997-2013.

Kiladis, G.N., C.D. Thorncroft and N.M.J. Hall, 2005. A new perspective on African easterly waves. Part I: Observations. Submitted to *J. Atmos. Sci.*

Liebmann B. & Smith C. A., 1996. Description of a complete (interpolated) outgoing longwave radiation dataset. Bulletin of American Meteorological Society, 77, 1275-1277.

Matthews, 2004. Intraseasonnal variability over Africa during northern summer. Journal of Climate, 17, 2427-2440.

Mounier, F., S. Janicot and G. Kiladis, 2005. The West African monsoon dynamics. Part IV: The 15-day "Guinean" mode and its interaction with Kelvin waves. Submitted to *J. Climate*.

Sultan B. & Janicot S., 2003. The West African monsoon dynamics. Part II: the "preonset" and "onset" of the summer monsoon. Journal of Climate, 16, 3407-3427.

Afrikaanse Moesson Multidisciplinaire Analyse
Afrikanske Monsun : Multidisiplinaere Analyser
Analisi Multidisciplinare per il Monsone Africano
Analisis Multidiciplinar de los Monzones Africanos
Afrikanischer Monsun : Multidisziplinäre Analysen
Analyses Multidisciplinaires de la Mousson Africaine

African Monsoon Multidisciplinary Analyses

1st International Conference

Dakar, 28th November – 4th December 2005

Extended abstracts

Isabelle Genau, Sally Marsh, Jim McQuaid, Jean-Luc Redelsperger, Christopher Thorncroft and Elisabeth van den Akker (Editors)

AMMA International

Conference organisation:
Bernard Bourles, Amadou Gaye, Jim McQuaid, Elisabeth van den Akker

English and French editing :
Jean-Luc Redelsperger , Chris Thorncroft, Isabelle Genau

Typesetting:
Sally Marsh, Isabelle Genau, Elisabeth van den Akker

Printing and binding:
Corlet Numérique
14110 Condé-sur-Noireau
France
numeric@corlet.fr

AMMA International Project Office
IPSL/UPMC
Post Box 100
4, Place Jussieu
75252 PARIS cedex 5

Web : http://www.amma-international.org/
Email amma.office@ipsl.jussieu.fr

Tel. +33 (0) 1 44 27 48 66
Fax +33 (0) 1 44 27 49 93

Back page photo: (Françoise Guichard, Laurent Kergoat)

Convective wind system with aerosols, named “haboob”, Hombori in Mali, West Africa.