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CHARACTERIZATION OF THE MONSOON CIRCULATION DIURNAL CYCLE AROUND THE MONSOON ONSET

B. SULTAN (1), P. DROBINSKI (2) and S. JANICOT (1)

(1) LOCEAN / IPSL, France (2) SA / IPSL, France

Introduction

Previous studies have depicted a coherent diurnal cycle in the West African monsoon winds (Parker et al. 2005). The monsoon winds are the weakest in the afternoon when the turbulent boundary layer is deep and the strongest overnight when the boundary layer turbulence is much weaker. The present study addressed the question of this diurnal cycle of the monsoon circulation around the monsoon onset. It is based on a Principal Component Analysis (PCA) and wavelet analyses applied to composite surface wind and temperature fields around the onset date (Sultan et al. 2003).

The two spatio-temporal modes of the diurnal cycle

A composite analysis around the onset date, detected by the ITCZ shift from 5N to 10N (see Sultan and Janicot 2003), is applied to the 1979-2000 NCEP/NCAR reanalyses at the main synoptic hours 0000, 0600, 1200 and 1800 UTC. It reveals an enhancement of the heat low circulation and monsoon surface winds from 1800 to 0600 UTC at the time of the monsoon onset in coherence with the previous work from Parker et al. (2005).

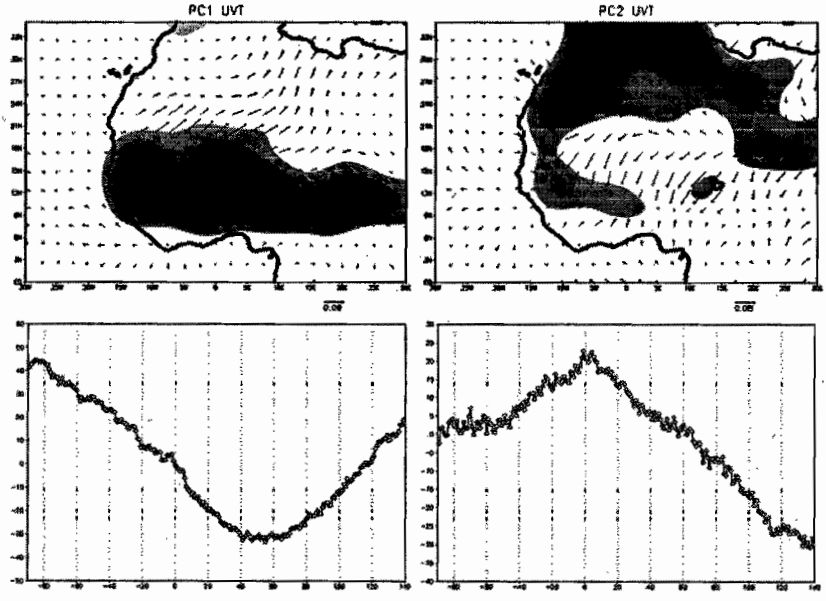

Figure 1 : *PC1 and PC2 loadings (top) and time series (bottom)*

To highlight the temporal and spatial patterns of the diurnal cycle of NCEP/NCAR fields around the onset of the monsoon, we apply a PCA on 1800-0600 differences of the 1979-2000 composite mean of winds and surface temperatures. The meridional and zonal components of the surface wind and the surface temperatures have been considered as the variables of the input matrix of the PCA. The two first modes explain around 75% of the variance of the diurnal cycle of surface wind and temperatures. The first mode shows a northward extension of the wind anomalies in the heat low and a decrease of the temperature diurnal cycle in the Inter-Tropical Convergence Zone around 10°N. The temporal pattern of this mode is gradual with a seasonal peak reached 40 days after the onset of the monsoon (t0). The second mode highlights the evolution of the diurnal cycle of the surface wind between 10°N and 15°N. This diurnal cycle is characterized by a nocturnal jet (Parker et al. 2005) whose intensity increases rapidly 50 days before t0 and reaches its maximum at the time of the monsoon onset. Thereafter the wind diurnal cycle decreases rapidly. The PCA shows a similar temporal pattern for surface temperatures but with spatial anomalies located northward. Indeed, the second mode characterizes an increase of the temperatures diurnal cycle maximum around the onset date north of 10°N near the Atlas Mountains.

A wavelet analysis applied to wind speed

In order to document the temporal pattern of the wind diurnal cycle already pointed out by the second PC, we applied a wavelet analysis to a wind speed index (with 4 values per day) near the area of PC2 maximum loadings in wind fields, e.g. 10°W-10°E ; 10°N-15°N. The wavelet modulus shows highest values for the diurnal cycle between t0 - 40 days and t0. Thereafter, the diurnal cycle amplitude decreases in coherence with the PC2 time series.

Conclusion

This study has pointed out two independent modes describing the spatio-temporal variability of the diurnal cycle in surface wind and temperatures. While the first mode appears to belong to a gradual and seasonal pattern linked with the northward migration of the whole monsoon system, the second mode is characterized by more rapid time variations with a peak of both temperature and wind anomalies around the monsoon onset date. The latter mode is connected with the time pattern of the nocturnal jet reaching its highest values around the onset date as it is suggested by a wavelet analysis applied to surface wind near the location of the nocturnal jet. However, further studies have to be done to explain the temperatures anomalies associated with the second mode, showing an increase of the diurnal cycle in Northern Africa, and to connect this variability to the wind pattern.

References

Parker DJ et al. (2005) The diurnal cycle of the west African monsoon circulation, *Quat. J. of the Royal Meteorol. Soc.*, in press.

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L'EVOLUTION SAISONNIERE DU CYCLE DIURNE DE LA MOUSSON

Des études récentes ont mis en évidence un cycle saisonnier dans les vents de mousson en Afrique de l'Ouest. Ces vents sont les plus faibles dans l'après-midi quand la couche limite turbulente est faible et les plus forts la nuit quand cette couche limite est plus faible.

L'objectif de notre étude est de caractériser l'évolution saisonnière de ce cycle diurne de la mousson en Afrique de l'Ouest avec un accent mis sur le moment de la mise en place de la mousson. Une analyse composite autour de cette date de mise en place de la mousson est appliquée aux champs de réanalyses NCEP/NCAR pour chacune des heures 0000, 0600, 1200 et 1800 UTC. Elle montre un renforcement de la circulation associée à la dépression thermique saharienne entre 1800 et 0600 UTC au moment de la mise en place de la mousson.

Pour mettre en évidence l'évolution spatio-temporelle du cycle diurne, on réalise une Analyse en Composante Principale (ACP) sur les champs composites de températures et de vent de surface en différence entre 1800 et 0600. Les résultats de cette ACP permettent de discuter des interactions entre le cycle saisonnier et particulièrement le démarrage de la mousson et le cycle diurne des champs de surface.

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

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Extended abstracts

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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

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