SHORT-LEAD PREDICTIONS OF INTRASEASONAL OSCILLATIONS OF THE CONVECTIVE ACTIVITY IN WEST AFRICA

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1. Introduction

Recent studies have addressed the question of the intraseasonal timescale of convective activity in the West African monsoon (Mounier and Janicot 2004; Sultan et al. 2003). Two main independent modes of variability have been highlighted: one depicts a westward propagative signal of the deep convective cloudiness over the Sahel and the other is characterized by a stationary uniform modulation of convection in the InterTropical Convergence Zone (ITCZ ;Mounier and Janicot 2004). The aim of this study is first to describe the intraseasonal variability in convection using the Singular Spectrum Analysis (SSA) that allow to capture quasi-periodic modes from noisy and stochastic time series. Thereafter, we examine the short-lead predictability of these intraseasonal modes by using the Maximum Entropy Method (MEM) to extrapolate the SSA modes. The skill of the SSA-MEM forecast is compared to the one of a Multiple Linear Regression (MLR) scheme based on a more physical interpretation of the intraseasonal modes.

2. The SSA Filter

SSA is related to Empirical Orthogonal Function (EOF) but applied to time series providing SSA modes that correspond to intraseasonal oscillations in a frequency band (Vautard and Ghil 1989; Ghil et al. 2002). We first compute a convection index (thereafter called the ITCZ index) by averaging daily NOAA-OLR between 10°W and 10°E and between equator and 12.5°N over the 1979-2000 period. The index is splitted into two samples of 11 years: the training (1979-1989) and the validation periods (1990-2000). SSA is then applied to the 10-90 band-pass filtered ITCZ index for the training period. It reveals three leading modes explaining more than 85% of the 10-90-day variance: a low-frequency mode whose period ranging from 26 to 85 days and two high-frequency modes at 16-27 days and 11-16 days. The summation between these three modes is strongly correlated (R=0.97) with the 10-90-day filtered ITCZ index. The obtained EOF basis can then be used to filter the ITCZ index for the validation index.

3. The SSA-MEM forecast

The combination between SSA and MEM has already found several applications in climate science (Mo 2001; Keppenne and Ghil 1992). It consists first to project the ITCZ index for the validation period to the EOF basis obtained from the training period and to extrapolate the three leading SSA modes by using an auto-regressive (AR) process. Notice that the input data is unfiltered in order to match an operational objective. Although the forecast skill (Tab.1) for the 10-90-day intraseasonal band is low, the predictability of individual intraseasonal modes is higher. The best skill concerns the first mode and the forecast skill for this low-frequency mode is higher by using pentads instead of daily values (R=0.65 and R=0.50 respectively for the 1-pentad and 2-pentad forecast). The second mode appears to be less predictive while the third mode representing the 10-15-day variability shows higher skills.

	5-day	10-day
Mode 1	0.54	0.32
Mode 2	0.37	0.32
Mode 3	0.51	0.38
10-90	0.19	0.10

Table 1: *Skill of the 5-day and 10-day SSA-MEM forecast. The skill is determinated by the correlation between the predicted and observed SSA modes*

The examination of the time series for high-skill and low-skill years for each mode reveals well-known characteristics of the AR forecasts: when the features (amplitude and period) of the intraseasonal mode are well-defined, high quality forecasts can be obtained and at the opposite, when the mode is not well-defined (when amplitude and/or phase change rapidly), the forecast fails.

4. Comparison with MLR forecasts

In order to select atmospheric predictors of these three intraseasonal modes one can apply a composite analysis on several variables from NCEP-NCAR reanalysis set. For each mode, one can get a positive (negative) composite mean sequence by retaining the date of each local maximum (minimum) of the SSA mode (called t0) and averaging an independent atmospheric variable around t0. Composite sequences around t0 for each SSA mode are thus obtained for several variables (OLR, zonal wind at 925hPa and 200hPa, potential velocity at 200hPa). For each mode, we use the corresponding composite sequence to select a set of atmospheric predictors that are a spatial box-average of the atmospheric variables where the composite signal is the most obvious and significant. We then calibrate a MLR model for the training period to predict the different SSA modes and use the same model for the validation period. For the training and validation periods, SSA is used to filter the atmospheric predictors. For the 5-day lag, the forecast skills are not significantly better than the ones of the SSA-MEM method and we can also notice an increase of the interannual variability of the forecast skill. However, the forecast skill of the MLR method is driven by the choice of the atmospheric predictors. We still work to increase the accuracy of this choice by involving a more physical interpretation of the intraseasonal modes.

5. References

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PREVISION A COURTE ECHEANCE DES FLUCTUATIONS INTRA-SAISONNIERES DE LA CONVECTION EN AFRIQUE DE L'OUEST

Des travaux récents ont documenté la variabilité intra-saisonnière de la convection en Afrique de l'Ouest. Deux modes indépendants de variabilité ont été mis en évidence : le premier correspond à une anomalie de la convection sur le Sahel se propageant vers l'Ouest et le second est caractérisé par une modulation stationnaire de la convection au sein de la Zone de Convergence Intertropicale (ZCIT).

Bien que la période dominante de ces deux modes soit autour de 15 jours, une analyse statistique basée sur des spectres singuliers (SSA) appliquée aux données d'OLR de la NOAA montre une modulation de la convection entre 10 et 90 jours. La SSA est basée sur l'analyse en composante principale mais appliquée à une série temporelle pour extraire des modes quasi-périodiques de cette série. Dans cette étude, la SSA est appliquée aux données d'OLR pour mettre en évidence les modes périodiques dominants dans la région de la ZCIT. La predictabilité à courte-échéance de ces différents modes est ensuite examinée en utilisant plusieurs méthodes statistiques (méthodes auto-régressives, régression linéaire multiple).

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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
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75252 PARIS cedex 5

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