4B.4 40-day periodicity mode of variability in the West and Central African monsoon

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1. INTRODUCTION

One of the significant modes of convection at intra-seasonal timescale in the West and Central African summer monsoon, recently presented in the literature (Mounier & Janicot, 2004; Matthews, 2004), is of 40-day periodicity (hereafter AM). It depicts over West and Central Africa a global modulation of convection.

To go further into the understanding of the mechanism explaining AM, a statistical decomposition on a larger domain (10°S-30°N / 120°W-40°E) was performed (Mounier *et al*., 2006, in preparation) and two modes modulating significantly the convection over Africa during the summer monsoon and correlated spatially and temporally with AM were obtained (hereafter M1 and M2). Then, using EOF reconstructed indexes over West Africa and composite analysis technique, contributions of M1 and M2 to AM and their tropical or subtropical teleconnections were detailed. M1 modulates slightly convection over the Guinean coast and may be linked with a Kelvin wave type eastward propagating structure whose source is an East Pacific strong Madden-Julian Oscillation (MJO) signal as the one described in Maloney & Kiehl (2002). M2 modulates strongly convection over Sahelian latitudes and Central Africa by developing a equatorially trapped Rossby wave type structure propagating westward.

These results are coherent with Matthews (2004) description of the 40-days intra-seasonal variability mode. The analysis of AM has been then oriented onto other mechanisms not linked with equatorially trapped waves or the MJO and that could also explain part of this mode. The results of this analysis are presented hereafter.

2. DATA and FILTERING TECHNIQUES

The daily Interpolated OLR dataset of 2.5° resolution from the Climate Diagnostics Centre, a convection proxy has been used in this analysis. They have been employed as they are a reference for tropical studies where deep convection and rainfall can be estimated through low OLR values. These data were filtered first temporally, within the 25-90 days windows (*F25-90 filtered OLR)*, then by spectral domains for Kelvin and Rossby equatorially trapped waves and the MJO (for more details on the filtering technique see Wheeler & Kiladis (1999)); these three filtered OLR datasets were summed to obtain an equatorial waves filtered OLR dataset (*Fwaves filtered OLR)*. Finally, to obtain the part of the F25-90 filtered data not linked with Kelvin or Rossby equatorially trapped waves or to the MJO oscillation, the *Fwaves filtered OLR* was removed from unfiltered OLR and the OLR outcome was then filtered temporally within the 25–90 days windows: (*F25-90(minuswaves) filtered OLR data)*.

Furthermore, the NCEP-DOE AMIP-II Reanalysis (R-2) dataset were used to document the low level circulation associated with the different intra-seasonal modes.

3. THE 40-DAY PERIODICITY MODE

Spatial Empirical Orthogonal Function analysis (SEOF; Richman 1986) have been performed on the F25-90 and F25-90(minuswaves) filtered June-September OLR values over the domain 10°S-30°N/30°W-30°E for the period 1979-2000. Composites sequences from the first mode SEOF1 are presented for both sets of data on the next figure (left and middle associated with F25-90 filtered OLR; right associated with the F25-90(minuswaves) filtered OLR). These sequences go from t_0 minus 20 days to t_0 plus 10 days with a 5-days lag. The wet minus dry composite sequence have been constructed by retaining, in the respective PC1 index time series, the dates t_0 where this index is maximum (resp. minimum) and its deviation from its mean for each year is greater (resp. lower) than its standard deviation to define a dry (resp. wet) phase.

The left sequences represents AM, whereas the middle ones depicts the impact of equatorially trapped waves and the MJO onto AM highlighting the part of the convection signal imputable in $W.m^{-2}$ to them. Between the two sequences dynamical fields (geopotential and wind fields at 925 hPa) are similar, only the OLR is different with in the left unfiltered OLR and in the middle Fwaves filtered OLR. A significant coherence exists between dynamical fields and OLR in both cases. First, a MJO signal develops over the Indian Ocean. Composed of a OLR dipole structure, this signal is associated with a northern (southern) anticyclonic (cyclonic) circulation and propagates northwards (t0-20d). Then, a Rossby type anomaly grows east of the African continent and the associated convection enhancement anomaly propagates westward on a Sahelian axes. Symmetrically a convection anomaly develops on a 5°S axis.

The 40-day periodicity mode of the West African monsoon not linked with equatorial waves and the MJO is also presented (Fig. right). It highlights another mechanism linked to the development of an anomaly over the Sahelian latitudes.

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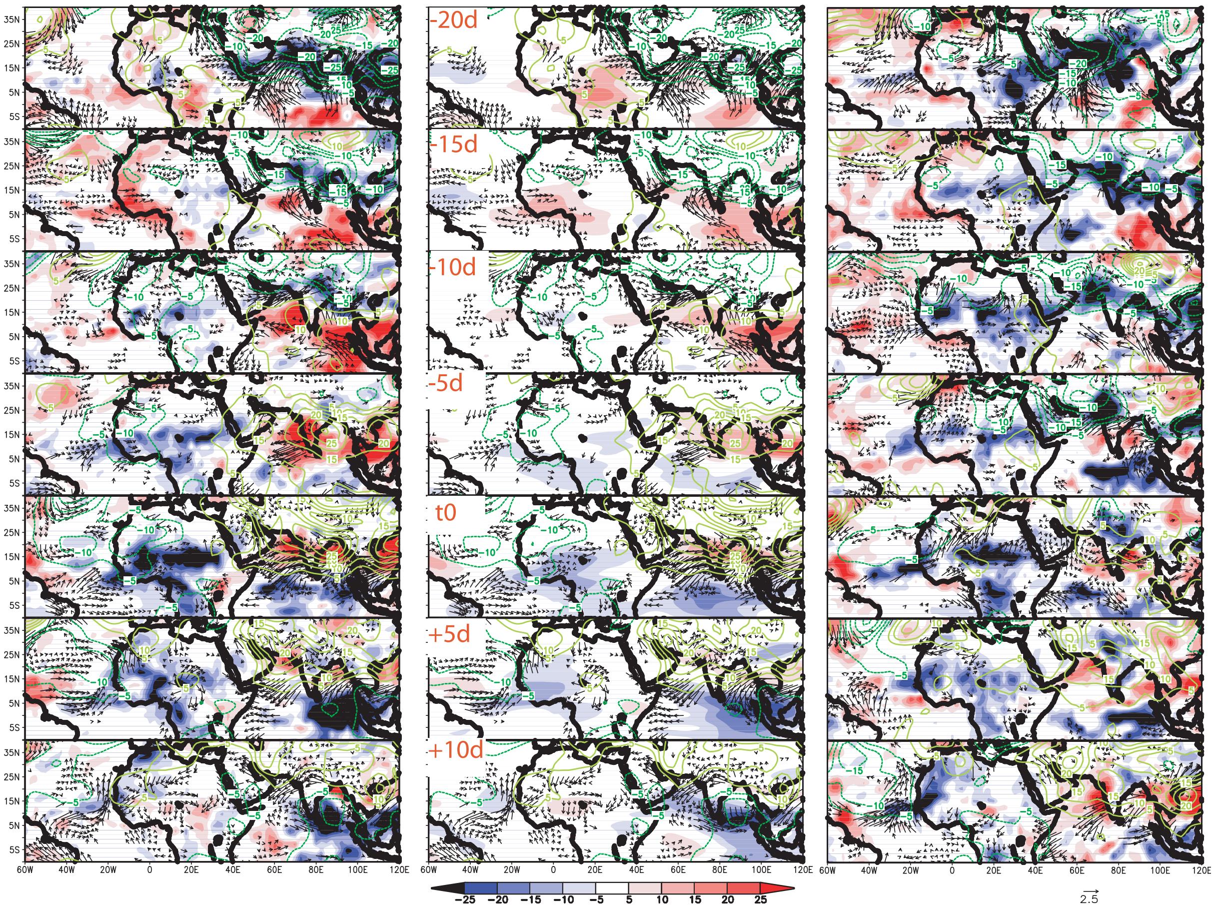

Figure: (**left**) Composite time sequences based on the OLR 25-90 day filtered PC1 index, where we retained the dates (t_0) where this PC is maximum (minimum) and its deviation from its mean is greater (lower) than its standard deviation to define a dry (wet) phase. The respective wet minus dry composite sequence is shown for the unfiltered OLR (W.m^{-2}; shaded), unfiltered 925 hPa geopotential (mgp; contours) and wind fields (m.s^{-2}; vectors). (**Middle**) same as left but for Fwaves filtered OLR (see details in the text). (**Right**) same as left but the composite time sequence is based on *F25-90(minuswaves) filtered OLR (see details in the text)* PC1 index.
These sequences go (top to bottom) from t_0 minus 20 days to t_0 plus 10 days with 5 days lags.

As in the modelisation experiment of Rodwell & Hoskins (1996), a heat source associated to convection enhancement centered at about 20°N over India develops to its west a Gill-type Rossby-wave pattern. For a heating center at this latitude, the symmetric component of response is very weak. Therefore no equatorially trapped Kelvin waves can develop and a northern hemisphere Rossby solution is strongly enhanced associated to enhanced convective activity over Africa. This wave structure, although weak, goes on propagating westward as the heat source over India weakens. So, this mechanism contributes to modulate convection over Africa.

4. CONCLUSION

The AM can be partly explained by mechanisms linked with equatorially trapped Kelvin and Rossby waves and MJO. It could also be explained by a Gill-type Rossby-wave mechanism, linking directly the Indian and the African monsoon activity at intra-seasonal scale.

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