INTRASEASONAL VARIABILITY OVER TROPICAL AFRICA

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1. INTRODUCTION

Intraseasonal variability within the tropical atmosphere is dominated by the Madden–Julian oscillation (MJO). The MJO convective signal is mainly confined to the warm pool sector, with only weak anomalies over Africa, the Atlantic and South America (e.g., Matthews 2000). However, this does not preclude the existence of modes of variability over these regions. In this paper, an analysis of the intraseasonal variability over tropical Africa is presented, and its relationship to variability over the rest of the globe is discussed.

2. METHOD

An empirical orthogonal function (EOF) analysis is performed on 20–200-day filtered outgoing longwave radiation (OLR) over the tropical African–eastern Atlantic domain (40°W–40°E, 10°S–20°N; see box in Fig. 1a) for the 25 northern summer seasons (JAS) from 1975 to 2000. EOFs 1 and 2 account for 15.8% and 8.4% of the variance, respectively, and are clearly separated from the remaining eigenvectors. A linear regression technique (see Matthews 2000 for details) based on these EOFs is used to construct global anomaly maps showing the “life cycle” of these modes of variability.

3. RESULTS

The dominant mode of intraseasonal convective variability over Africa (EOF 1) has the form of enhanced convection over most of the domain (Fig. 1c). Although the EOF analysis was calculated only over the African domain, there are clearly global scale anomalies associated with this mode. At 20 days before the convection over Africa peaks (Fig. 1a) there is almost zero convective signal over Africa. However, there is a zonal band of reduced equatorial convection over the warm pool from the Indian Ocean to the western Pacific, together with a region of enhanced convection to the north over Southeast Asia. By day -10 (Fig. 1b) the negative convective anomaly has strengthened and moved northwards to 10°N. An equatorial Kelvin wave response to the anomalous latent heating associated with this convective anomaly has propagated eastwards, with 200 hPa easterly anomalies over the equatorial Pacific. The Kelvin wavefront, with its implied anomalous deep ascent, is located over the eastern Pacific and tropical South America, where it has apparently triggered anomalous deep convection. By day 0 (Fig. 1c), the Kelvin wave has propagated eastward to Africa where it appears to have triggered the African convective anomalies of EOF 1. The 1000 hPa streamfunction (Fig. 1d) has anomalous equatorial westerlies over the eastern Pacific and Atlantic at this time, consistent with a Kelvin wave structure. As this circulation extends into west Africa, it develops a southwesterly component, strengthening the mean monsoon winds and moisture supply and contributing to the enhanced convection over Africa. In the meantime, the band of reduced convection over the warm pool has moved further northward over Southeast Asia and been replaced by a band of enhanced convection at the equator. The development of the convective anomalies over the warm pool sector essentially follows the behaviour of the MJO during northern summer (Annamalai and Slingo 2001).

4. CONCLUSIONS

Intraseasonal variability over Africa is strongly linked to variability over the rest of the tropics. In JAS, the dominant mode of variability appears to arise as a response to the equatorial Kelvin wave forced by the heating over the warm pool sector associated with the MJO.

Annamalai, H., and J. M. Slingo, 2001: Active/break cycles: Diagnosis of the intraseasonal variability of the Asian summer monsoon. *Climate Dyn.*, **18,** 85–102.

Matthews, A. J., 2000: Propagation mechanisms for the Madden-Julian Oscillation. *Q. J. R. Meteorol. Soc.*, **126,** 2637–2651.

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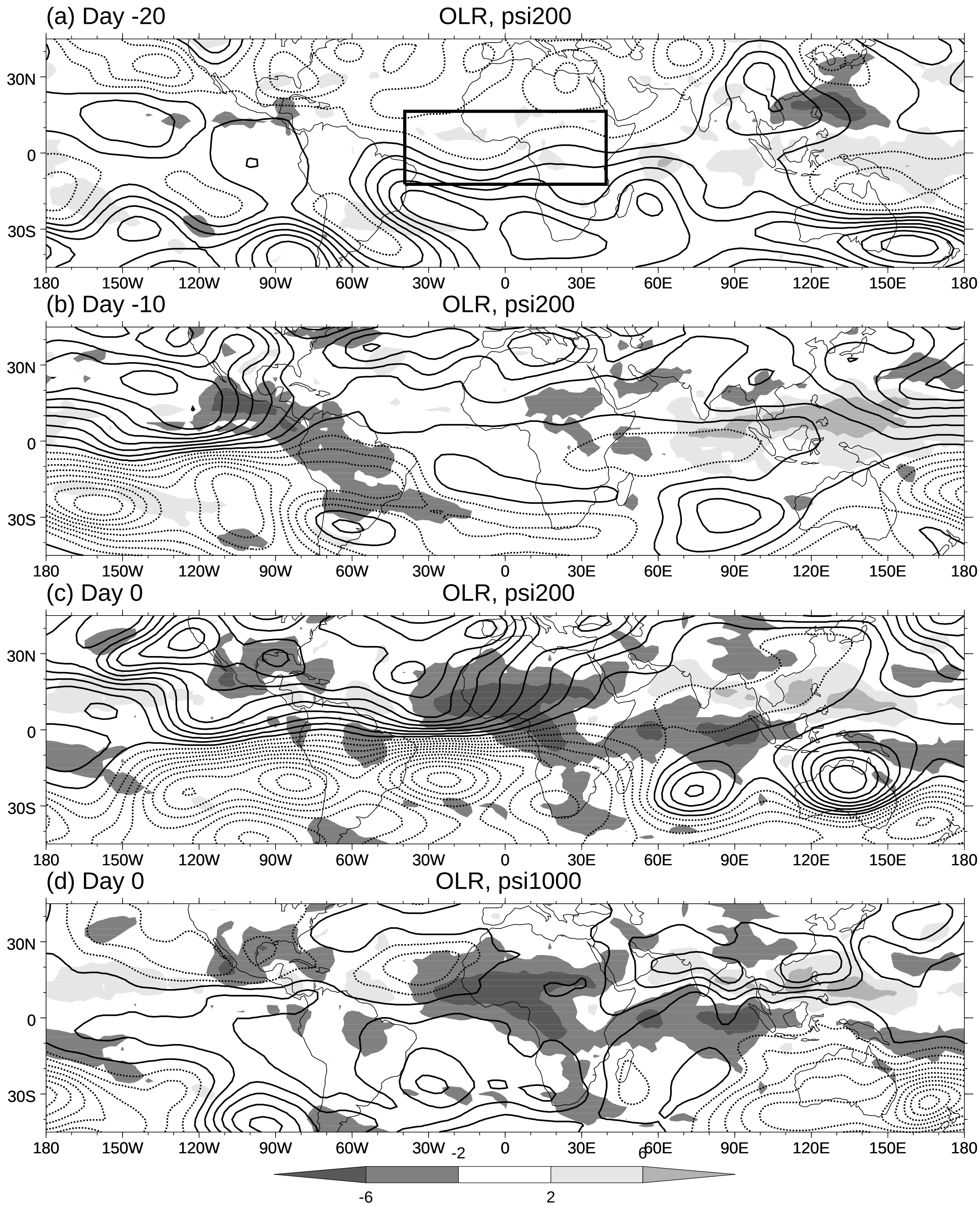

Figure 1: Lagged regression maps of OLR and 200 hPa streamfunction anomalies at (a) day -20, (b) day -10, (c) day 0, and (d) of OLR and 1000 hPa streamfunction. OLR is shaded darkly below -2 W m^{-2} and lightly above $+2$ W m^{-2}. The 200 (1000) hPa streamfunction contour interval is 5×10^5 m^2 s^{-1} (2×10^5 m^2 s^{-1}); negative contours are dashed.