1. Introduction

Using NCEP/NCAR reanalyses, NOAA OLR and observed IRD rainfall over West Africa from 1979 to 1990, we investigated the variability of rainfall and convection over Niamey (Niger, West Africa) during African Easterly waves activity. After detecting on each year the dates of 3-5-day wave activity and considering thresholds on the associated observed rainfall and convection, we have identified two classes of convective events. The first one defines the so-called wet convective events that are associated with cold top clouds and strong rain amount at the surface. The second class is the class of dry convective events associated with cold top clouds and weak observed rain amount at the surface.

2. Wet and dry events in easterly waves.

Figure 1 shows for a wet year (1988, Fig. 1a), a normal year (1989, Fig. 1b) and a dry year (1984, Fig. 1c), the evolution from June to September of the wave regimes characterized by a wavelet analysis with Morlet wavelet on the meridional wind at 700 hPa, the NOAA OLR and the observed daily IRD rainfall at Niamey grid point (Torrence and Compo, 1998). Wavelet analysis (shaded) confirms that most of the disturbances over SAHEL have a period lying between 3 and 5 day. The maximum in the 6-9-day band period is associated to another wave regime occurring mainly in the beginning and in the end of the rainy season (Diedhiou at al., 1999). If we consider all the days affected by a 3-5-day wave regime, we note that it is difficult using the number of waves per year, to distinguish wet (1988) and dry (1984) year over SAHEL. These three years was quite equally affected by the same number of 3-5-day waves. In 1989 (Fig.1b), wet regimes occur from the 1st to 10 August and around 7 September; these waves are associated to cold clouds and high rainfall heights. This is the common case. The wave regimes between 8-16 June and around 21 August 1989 are associated to dry events with cold clouds (OLR between 180 and 200 W/m² for the first case and less than 160 W/m² for the second) and quite no observed rainfall at the surface. As the modulus of the wavelet is positively correlated to the variance of the wave, this means that the variance of the wave, considered only from the fluctuations of the meridional wind, is not a good indicator of the rainfall variability.

*Corresponding author adress: Arona Diedhiou, IRD/LTHE, BP. 53, 38041, Grenoble Cedex 9, (France); e-mail: diedhiou@hmg.inpg.fr
3. The associated composite patterns.

During these 12 years, considering all days that waves occurs, we note that we have 30% of waves without convection, 48% with dry convective events and 22% with wet events.

Figure 2: Mean composite wave pattern and associated OLR anomaly for the wet wave (a), the dry wave (b).

The associated perturbed wind fields and OLR anomaly for these two cases are displayed on figure 2. These patterns are similar to the mean structure of the well know 3-5-day wave. For all the cases, we note a well-marked trough extending meridionally from 30°N to 10°S, with a southeast - northwest tilt north of the AEJ and southwest - northeast tilt south of it (Reed and al., 1977). This is consistent with a zonal momentum transport from the jet to the wave and consistent with a development of these waves from a barotropic instability of the Jet. The coldest clouds associated to the deeper convection are found in the case of wet wave (Fig.2a). The area of maximum convection is found ahead of the trough, in the northern flux and is found mainly over the Sahelian area. Dry convective event (Fig.2b) is a little bit higher than the mean and extends over Guinea Coast. Its maximum is located in and behind of the trough in the southern flux.

Figure 3 displays the vertical cross sections on Niamey longitude (2.5°E) of mean zonal wind. The pattern of zonal wind (Fig. 3a) is different in wet and dry regimes. In the lower levels, the latitudinal extension, the magnitude of the westerlies and the thickness of the monsoon are greater in wet wave regime than in dry wave regime. The AEJ magnitude is weaker in wet regime but at 200 hPa, the TEJ magnitude is greater than in dry regime. The patterns of the associated vertical velocity (not shown) are also different; in wet regime, the core in the ITCZ of upward motion in the upper levels are greater, while, in wet regime, it is mainly the dry convection over the heat low, north of the AEJ, which is higher.

Figure 3: Vertical cross sections over Niamey longitude (2.5°E) of zonal wind (a) and variances terms $v\cdot v$ (b).

4. Perspectives.

This work needs to be completed by a case study using radiosounding data in order to investigate the differences in the vertical profiles of these waves. This study has shown the necessity to well define the wave efficiency and shows the non correlation between the easterly wave activity and the seasonal amount of rainfall over West Africa. In summary: Convection and rainfall can occur without any easterly waves present. Not all easterly waves are associated with rainfall.

5. References:


