P1.53 IMPACT OF GREENHOUSE WARMING ON THE VARIABILITY OF EASTERLY WAVES, RAINFALL AND CONVECTION OVER WEST AFRICA.

Arona Diedhiou*[1], J.-F. Royer[2], I. Poccard[3], and T. Lebel[1]

[1] LTHE / IRD, BP. 53, 38041, Grenoble Cedex 9 (France)
[2] UDC / CNRM / METEO-FRANCE, 31057, Toulouse Cedex (France)
[3] CRC / université de Bourgogne, 21000, Dijon (France)

1. Introduction

The variability of the African easterly waves, rainfall and convection, is analysed using a climate simulation over the period 1950-2050, performed with the coupled atmosphere-ocean general circulation model of Meteo-France, in order to represent the impact of increasing greenhouse gases and aerosols on climate. In this simulation, the observed concentrations have been updated each year from 1950 to 1999, and then according estimations from the SRES-B2 scenario of IPCC from 2000 to 2050. Anthropogenic sulfate aerosols and ozone photochemistry are also taken into account. The ARPEGE-Climat atmospheric GCM (Déqué et al., 1994), coupled to models of the other climate components, has been used to perform this scenario study. The others models are the OPA oceanic GCM (Madec et al., 1997), the GELATO sea-ice model (Salas y Mélia, 2001) and a zonal model of stratospheric ozone chemistry MOBIDIC. The atmospheric and oceanic models use different grids and are coupled on a daily time-step through the OASIS coupler developed at CERFACS (Terray et al., 1995). A validation study is done using NCEP/NCAR reanalyses. The characteristics of the African easterly waves and their modulation of rainfall and temperature as simulated by the coupled model are investigated.

2. Validation and results of scenario

The coupled model reproduces the main features of the West African climate and simulates a realistic seasonal cycle of rainfall and monsoon variability. However, rainfall is overestimated both in magnitude and in latitudinal evolution, while the Tropical Easterly Jet and the African Easterly Jet are underestimated in magnitude. The rainy season starts earlier in ARPEGE model and a bias of around 2K is found in the whole domain. The latitudinal rainbelt is larger in ARPEGE than in the reanalyses and does not change too much between the wet and dry period (1950-1969 and 1970-1989) even if a decrease of the rainfall is simulated over the area of maxima. We suppose that this may be due to the forcing from the surface conditions especially from simulated SST.
A tendency to an increase of the temperature at 850 hPa over the whole domain has been simulated with an increase of rainfall over Sahel, while over Guinea Coast, there is almost no change (Fig. 1). This is coherent with a northward migration of the mean position of the ITCZ.

*_Corresponding author adress:_ Arona Diedhiou, IRD/LTHE, BP. 53, 38041, Grenoble Cedex 9, (France); e-mail: diedhiou@hmg.inpg.fr

Overall, in spite of the systematic biases, the characteristics of the African easterly waves and their modulation of rainfall and temperature are well simulated by the coupled model.

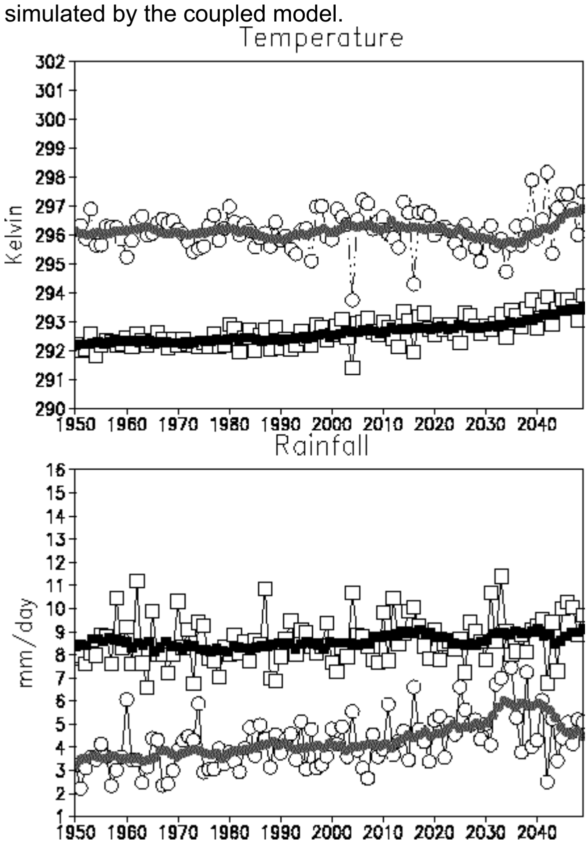

Figure 1: Mean JJAS annual time series of temperature, rainfall on a grid point over Sahel (12.5°N; 2.5°E) and over Guinea (7°N; 2.5°E).

Their kinematics properties (tracks, wavelength and velocity) are realistic. They present over West Africa a wavelength of about 3000-4000 km and a westward velocity of 7-9m/s. However, there is no clear propagation over the eastern Atlantic (Reed et al., 1977; Diedhiou et al., 1999). This is coherent with the weak magnitude of the variance over the ocean(Fig. 3). The tendency to an increase of rainfall over Sahel is coherent with a northward migration of the area of easterly wave activity.
Positive rainfall anomaly is found in and ahead of the wave trough and negative temperature anomaly is located in the southern sector where the meridional advection of moisture is larger (Fig. 3). These anomalies move westward with quite the same speed than the wave. When they are active over Sahel, the waves explain until 80 % of the total cumulated rainfall while over Guinea, this contribution represents around 60 %. Added to this, there is a large occurrence of

convective events associate to weak rain heights and stratiform precipitation especially over Guinea.

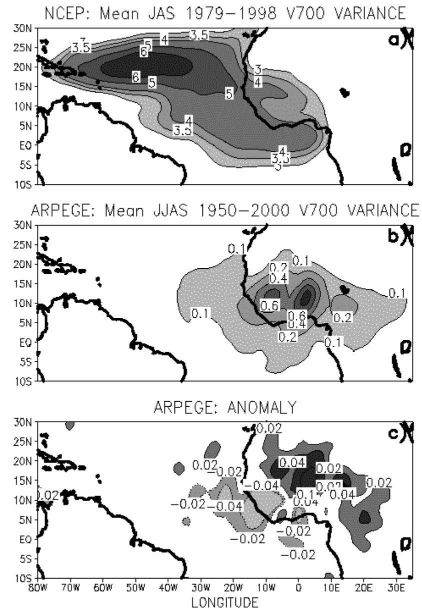

Figure 2: Mean variance of 3-5-day easterly waves during 1979-1998 in NCEP/NCAR reanalyses, in ARPEGE during 1950-2000 and the associated anomaly (difference in ARPEGE between mean present period and mean 2001-2049.

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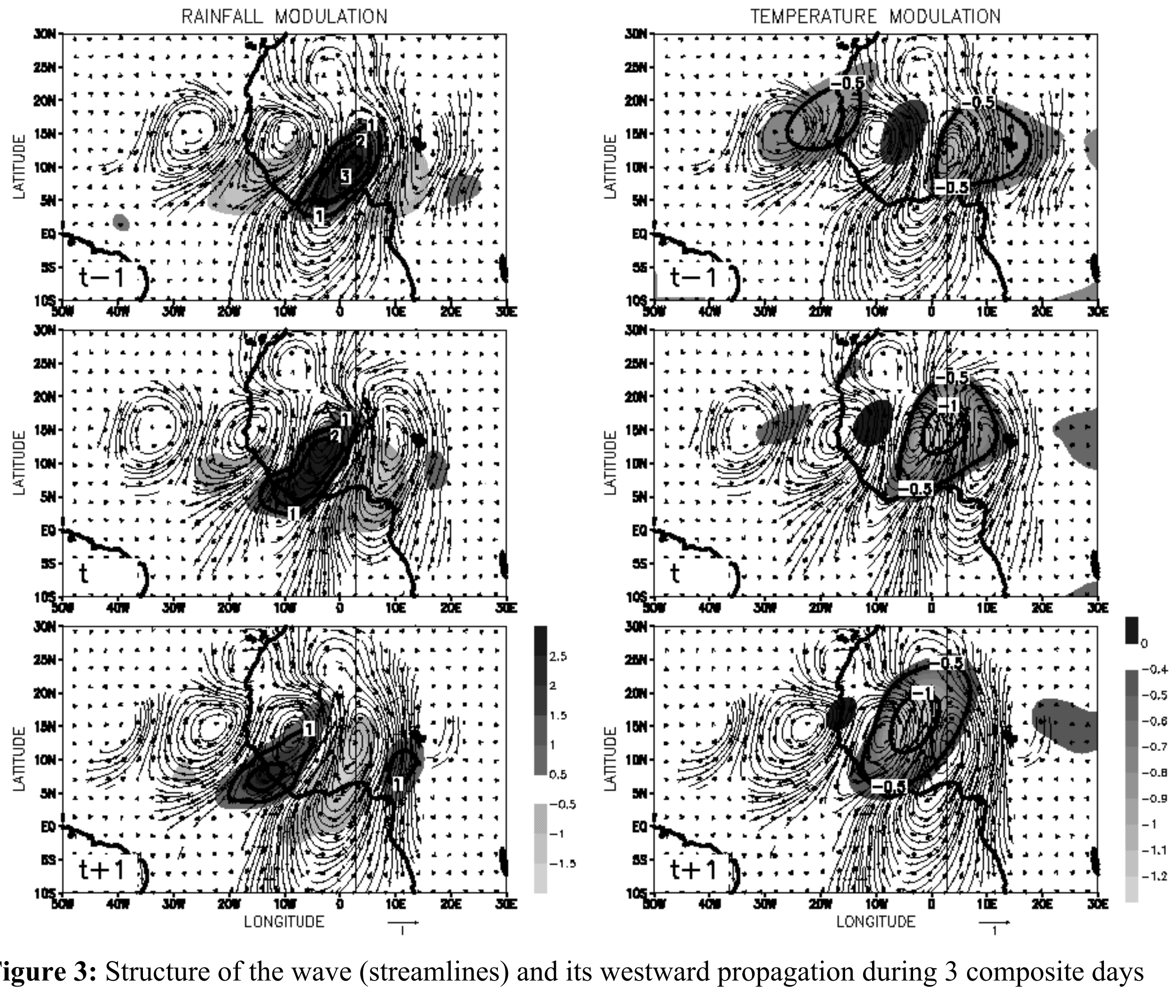

Figure 3: Structure of the wave (streamlines) and its westward propagation during 3 composite days (t-1, t, t+1) as well as its modulation of rainfall (left) and temperature (right) in the ARPEGE model.