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MECHANISMS OF INITIATION AND MAINTENANCE OF THE WALKER CIRCULATION AND ASSOCIATED RAINFALL OVER SOUTH HEMISPHERE

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1. INTRODUCTION

Lorenz (1967) emphasized that potential energy generation due heating, change of available potential energy into kinetic energy (K_E), by adiabatic processes (conversion), and K_E dissipation by friction must be considered as the most three important steps to the obtenaince of the atmospheric energy cycle. In the present work the energetic of the two areas enclosing the Walker Circulation (WC) region is applied issuing the energy cycle of such phenomenon. The first area lies between 0-10°S and a global longitudinal belt, and the second one encloses a region between 5°N-10°S and 100°E-90°W. The main issue of this work is to make either a quantitative or a qualitative analysis of the energetics of such a regions. The energetics is evaluated for the four seasons and for an El Niño composed. The composite analysis must show how Sea Surface Temperature can determine or modulate the WC energy pattern.

2. ENERGY BUDGET EQUATIONS

In the present study the energeyics of the WC into two main areas is studied. The balance equations used in this context are given below:

$$\frac{\partial AZ}{\partial t} = (KZ - AZ) - (AZ - AE) + BAZ + GZ$$
$$\frac{\partial AE}{\partial t} = (AZ - AE) - (AE - KE) + BAE + GE$$
$$\frac{\partial KZ}{\partial t} = (KE - KZ) - (KZ - AZ) + BKZ + B\phi Z - DZ$$
$$\frac{\partial KE}{\partial t} = (AE - KE) - (KE - KZ) + BKE + B\phi E - DE$$

These balance equations are the result of a mathematical manipulation of the fundamental physical laws of the dynamic Meteorology in an open atmospheric system. The partition into zonal and eddy components of both the APE (A_Z and A_E, respectively) and K (K_Z and K_E, respectively), as proposed by Lorenz (1955, 1967), is adopted. The processes associated with the generation of A_Z and A_E (G_E and G_Z, respectively) and the conversion between the various energy forms, indicated by (K_Z-A_Z), (A_Z-A_E), (A_E-K_E) and (K_E-K_Z), are also those described by Lorenz (1955, 1967). In an open area of the atmosphere the energy budget is complicated by nonzero boundary transports of energy. To take account of these, Muench (1965) considers four new components of the energy budget representing the transports of A_E, A_Z, K_E, and K_Z (BA_E, BA_Z, BK_E, and BK_Z, respectively). The last terms in both the K equations, namely DZ and DE, denote the dissipation of K_Z and K_E, respectively.

3. RESULTS AND DISCUSSIONS

The results show that for the two choused areas there is a constant generation of A_E which is converted into K_E along entire year (Figure 1). However K_E presents variations along the year, such variations include a maximum value during Austral Summer (DJF) and minimum values during Spring (MAM) and Autumn (SON). Moreover, when K_E has maximum values K_Z presents its minimum values, and vice-versa. Those patterns are more convincingly in area 2. Such results show that the basic state is stronger during JJA. It was observed that the G_E shows maximum values at two different level pressures; the first one lies between 400

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and 200 hPa, and a second, near surface, between 900 and 800 hPa. It means that, in those levels, the latent and sensible heating rates exceed the radiative heating. For the WC the generation of the A_E occurs during the warm air rising over SA, Indonesia, and Africa regions, and the coldest air sinking over adjacent oceans (Atlantic, Pacific and Indian oceans). A simplified scheme of the energy cycle of the WC can be seen in Figure 2. This figure shows that there is generation of A_E and this energy is converted into K_E. This conversion occurs because there is warm air rising over main branches of the WC and sink motion of cold air over descending branches of the WC (not showed).

4- CONCLUSION

The results showed that for both studied areas, during all seasons, there is generation of A_E which is converted, almost simultaneously, into K_E. However, variation in the value of K_E is observed to occur during the year. The value of K_E is higher during Austral Summer seasons and it presents smaller values during the transitions seasons (MAM and SON). Variations in K_E are associated with variations in the values of K_Z. When K_E has minimum values K_Z presents its maximum values, mainly in the region 2. When the energy cycle terms are compared with each other we can observe that the most dominant terms are: G_E, A_E, C_E, K_E, and K_Z . It was observed that the generation terms present maximum values between 400 and 200 hPa and between 900 and 800 hPa, just where the values of the latent and sensible heating rate are higher than radiative cooling rate (not showed). When the efficiency (defined as C_E/G_E) is evaluated it was observed that it was maximum during El Niño Years and during La Niña events the efficiency is near climatology. The values of the efficiency do not change very much for the 2 studied regions.

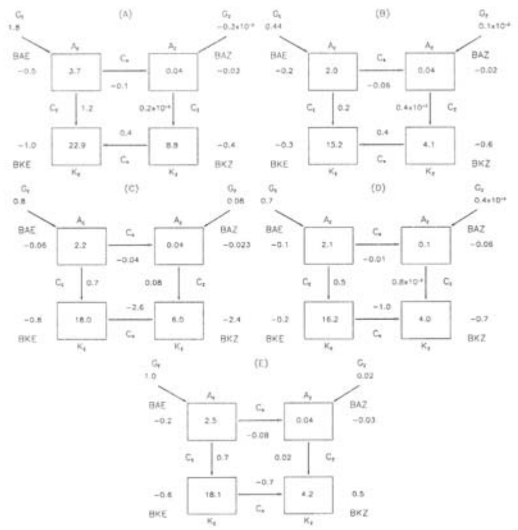

Fig. 1- Climatology of the energy cycle integrated between 1000-100 hPa for the first area (0º-10º S), figs a-d, and for annual mean (d). The units of the energy components (A_Z, A_E, K_Z and K_E) are in 10^4 J m^2 and the terms of generation and conversion are in $10xWm^{-2}$.

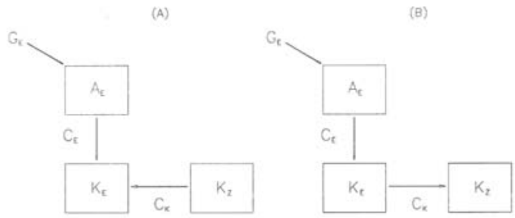

Fig. 2- Diagram of the Lorenz energy cicle for the WC during Austral Summer and Austral Winter.

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