The Autumn Rainy Season over the Eastern Amazon/Northeast Brazil: Rainfall-Producing Atmospheric Mechanisms on Intraseasonal and Submonthly Timescales

Everaldo B. de Souza, *Depto. de Meteorologia - Universidade Federal do Pará - Brasil*
Tércio Ambrizzi, *Depto. de Ciências Atmosféricas - Universidade de São Paulo - Brasil*
Mary T. Kayano, *Instituto Nacional de Pesquisas Espaciais - Brasil*

INTRODUCTION

This work examines the atmospheric circulation anomalies associated with anomalous raingauge-based precipitation over the Eastern Amazon (EAM) and Northeast Brazil (NEB) on intraseasonal and submonthly timescales. It is attempted to isolate and identify the main rainfall-producing atmospheric mechanisms for these scales and regions. The analyses focus on the austral autumn (March to May) when the rainy season is deflagrated over the EAM/NEB. Two contrasting climatic scenarios defined as UNFAV (simultaneous manifestations of the El Niño and the northward SST gradient in the intertropical Atlantic) and FAV (concomitant occurrence of the La Niña and the southward SST gradient in the intertropical Atlantic) are considered. UNFAV (FAV) composites for unfiltered data showed changes in both the Walker and Hadley cells in association with the Atlantic ITCZ anomalously weakened (enhanced) that, in consequence, yields deficient (abundant) rainy season over the EAM/NEB (Figs. 1, 2).

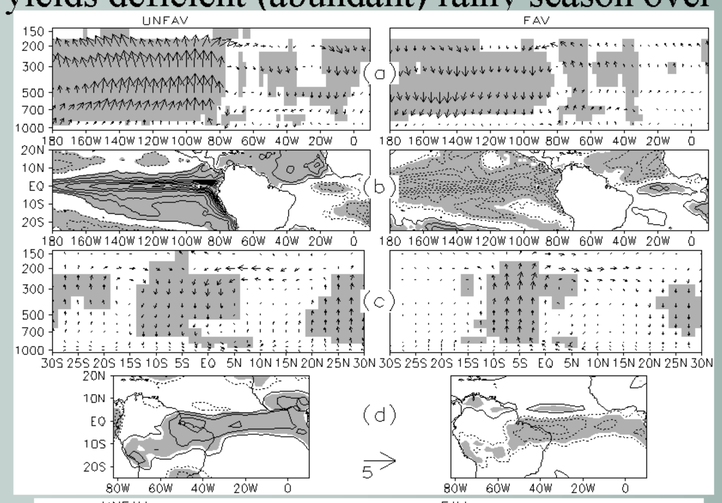

Fig. 1. Composites of (a) longitude-vertical cross-sections of the divergent circulation averaged between 5°N-5°S; (b) SST anomalies; (c) latitude-vertical cross-sections of the divergent circulation averaged between 55°W-35°W; (d) OLR anomalies for the UNFAV (panel on the left) and FAV (panel on the right) scenarios. Vectors in (a) and (c) are scaled according to the 5 m s^{-1} (10^{-4} hPa s^{-1}) vector at the bottom of figure. Nonzero SST and OLR anomalies are contoured every 0.5 °C and 5 W m^{-2} respectively with solid (dashed) contours for positive (negative) anomalies. Shading indicates areas with statistically significant anomalies at the confidence level of 95%.

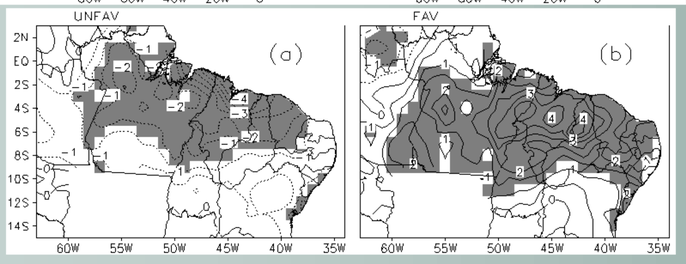

Fig. 2. Composites of regional precipitation anomalies for (a) UNFAV and (b) FAV scenarios. Nonzero anomalies are contoured every 0.5 mm day^{-1} with solid (dashed) contours for positive (negative) anomalies. Shading as in Fig. 1.

EOF Analyses

The regional pluviometric variability over the EAM/NEB is objectively identified through EOF analyses performed on the (30-70 day) intraseasonal and submonthly (≤ 21 day) filtered weekly precipitation anomalies for 18 autumn seasons (1983 to 2000). The principal components (PC) of the first mode of each analysis show strong oscillations during the whole period. In particular, the oscillations observed during UNFAV and FAV years reveal that events with deficient and abundant precipitation over the EAM/NEB occur alternately, even during years characterized by the extreme climatic conditions in both the tropical Pacific and Atlantic Oceans (Fig. 3).

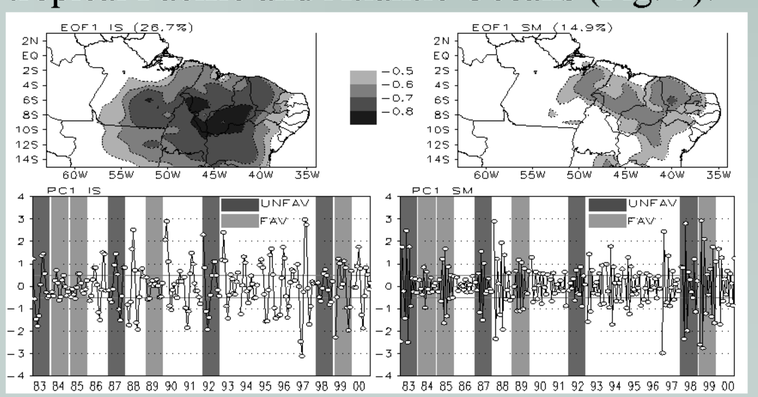

Fig. 3. Spatial patterns (top) and PC coefficients (bottom) of the EOF1 performed on intraseasonal (panel on the left) and submonthly (panel on the right) filtered precipitation anomalies. Contour interval is 0.1 and statistically significant absolute values greater than 0.5 are plotted. Dark (light) gray bars indicate UNFAV (FAV) years

Composite Analyses

based on events with anomalously increased precipitation (objectively selected from the PC series) on intraseasonal and submonthly scales are analyzed separately for the UNFAV and FAV years. These analyses showed that for both scenarios the more important rainfall-producing atmospheric mechanism over the EAM/NEB on intraseasonal scale consists in the establishment of deep convective bands trigged by South Atlantic Convergence Zone events or persistent frontal systems over the northeast Brazil. Such a regional pattern is embedded in a large-scale dynamical environment related to the propagation of the Madden-Julian Oscillation over the tropical South America (UNFAV-IS and FAV-IS composite maps in Figs. 4 and 6). On the other hand, the main rainfall-producing atmospheric mechanism over the EAM/NEB on submonthly scale is the Atlantic ITCZ during FAV years, while a weakened Atlantic ITCZ activity may be forced by meridionally elongated midlatitude wave trains at upper troposphere during UNFAV years (UNFAV-SM and FAV-SM composite maps in Figs. 5 and 7).

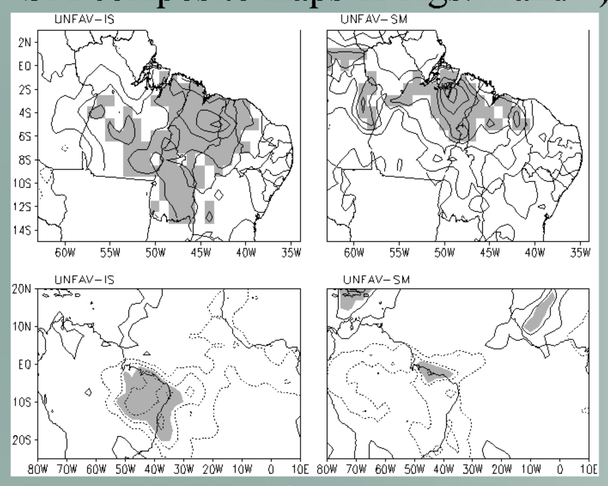

Fig. 4. UNFAV-IS (left panel) and UNFAV-SM (right panel) composites of regional precipitation (top) and OLR (bottom) anomalies. Nonzero precipitation and OLR anomalies are contoured every 0.5 mm day^{-1} and 3 W m^{-2}, respectively. Shading as in Fig. 1

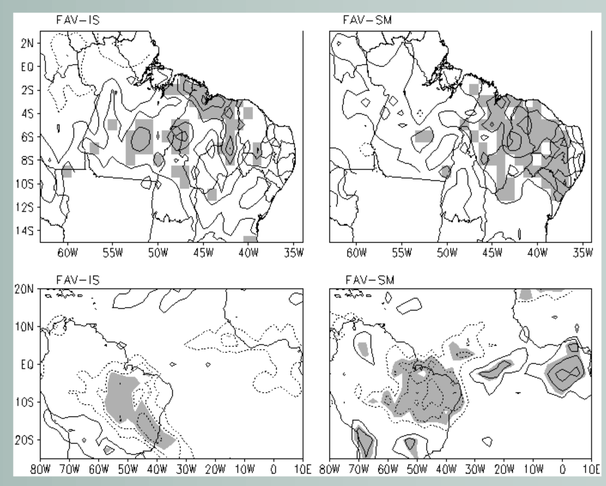

Fig. 5. As in Fig. 4, but for the FAV-IS (left panel) and FAV-SM (right panel) composites

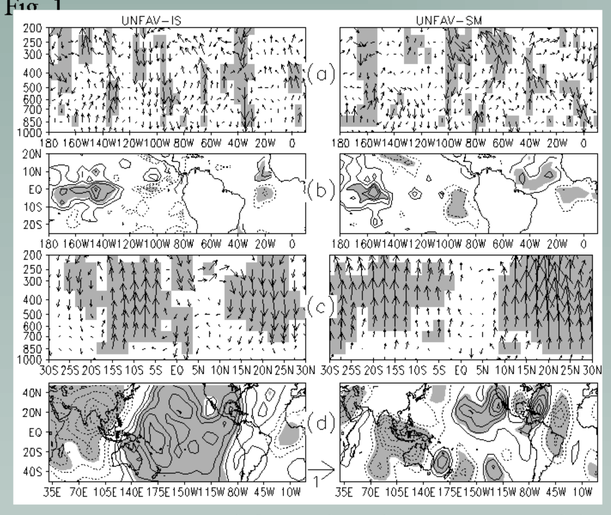

Fig. 6. UNFAV-IS (left panel) and UNFAV-SM (right panel) composites of (a) longitude-vertical cross-sections of the divergent anomalous circulation averaged between 5°N-5°S; (b) SST anomalies; (c) latitude-vertical cross-sections of the divergent anomalous circulation averaged between 55°W-35°W; (d) 200-hPa χ anomalies. Vectors in (a) and (c) are scaled according to the 1 m s^{-1} (10^{-4} hPa s^{-1}) vector at the bottom of figure. Nonzero SST and χ anomalies are contoured every 0.2°C and 0.2e^6 m^2 sec, respectively, with solid (dashed) contours for positive (negative) anomalies. Shading as in Fig. 1

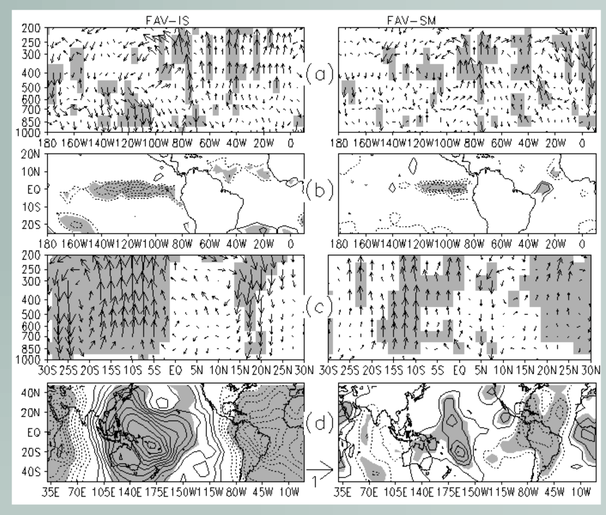

Fig. 7. As in Fig. 6, but for the FAV-IS (left panel) and FAV-SM (right panel) composites