第 II 部門 Impact of ENSO and ENSO Modoki on the Paranaiba River Discharges

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1. Introduction

The Paranaiba River source lies in the state of Minas Gerais in the Mata da Corda Mountains (19^0 13′ 21″ S and 46^0 10′ 28″ W), municipality of Rio Paranaiba of Brazil, flowing at an altitude of 1,148 meters. The length of the river is approximately 1,000 kilometers up to the junction with the Grande River both of which then form the Parana River. The drainage area is approximately 36,000 km^2. However, the Fazenda Santa Maria gauge station (17^0 58′ 51″ S and 50^0 14′ 49″ W) is in the Upper Paranaiba river basin and having an area of about 16,750 km^2. This river is the most important resources of water to the Parana River. The water resources of these basins sustain one of the most densely populated regions of South America, where harvests and livestock are among the region's most important assets. Streamflow is a synthesis of precipitation, evapotranspiration and the rest of the hydrologic cycle components, together with possible anthropogenic influences. Not all the signals present in precipitation are reflected in river flow and vice versa. In this study we investigate the ENSO (El Nino and Southern Oscillation) and ENSO Modoki (Ashok et al., 2007) relationship at the basin scale. In general, it is easier to detect a change in discharge than to directly observe changes in the basic climatic variables. Moreover, we could assume that any signal in the river flow must have a climatic origin. Several studies performed on southeastern South America have used river flows as indicators of climatic variability from the interannual to the secular scale. In essence, we will analyze whether the Paranaiba River flow is a good surrogate in studying the climatic variability of precipitation from the interannual to the secular scale.

2. Data and Methods

We use observed daily discharge data at the Fazenda Santa Maria gauge station of the Paranaiba River in Brazil for the period from 1974 to 2006 as a primary data set for this study. Daily climatology and anomalies of river discharge are computed from the 33-year data. Extremely high and low discharge events were cataloged based on a threshold; 1.5σ (σ stands for standard deviation) and -1.5σ are set as threshold for extreme high and low discharges, respectively. The NCEP/NCAR (National Centers for Environmental Prediction/National Center for Atmospheric Research) global atmospheric reanalysis-1 zonal wind (850 hPa) dataset is used from 1 January 1979 to 31 December 2008. The other major dataset used in this study is the global coverage NOAA interpolated of daily averages of outgoing longwave radiation anomalies (here after OLR) data on a 2.5° × 2.5° grid at a standard pressure levels from 1 January 1979 to 31 December 2008. In addition to these the SST anomalies are used from the daily OISST asnalysis version 2 AVHRR-AMSR (Advanced Very High Resolution Radiometer-Advanced Microwave Scanning Radiometer**)** products from NCDC (National Climate Data Center) from 1981 to 2008.

3. Results and Discussions

The relationship between the climatic behavior of rainfall over a river basin and its hydrologic response, through streamflow, can present different degrees of complexity according to the physical characteristics of the basin.

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Many studies use river flows as a surrogate to study climate variability and changes, under the assumption that changes in the rainfall are mirrored and likely amplified in streamflows. In this study we find a good relationship with streamflow extreme events of the Paranaiba with ENSO and ENSO Modoki.

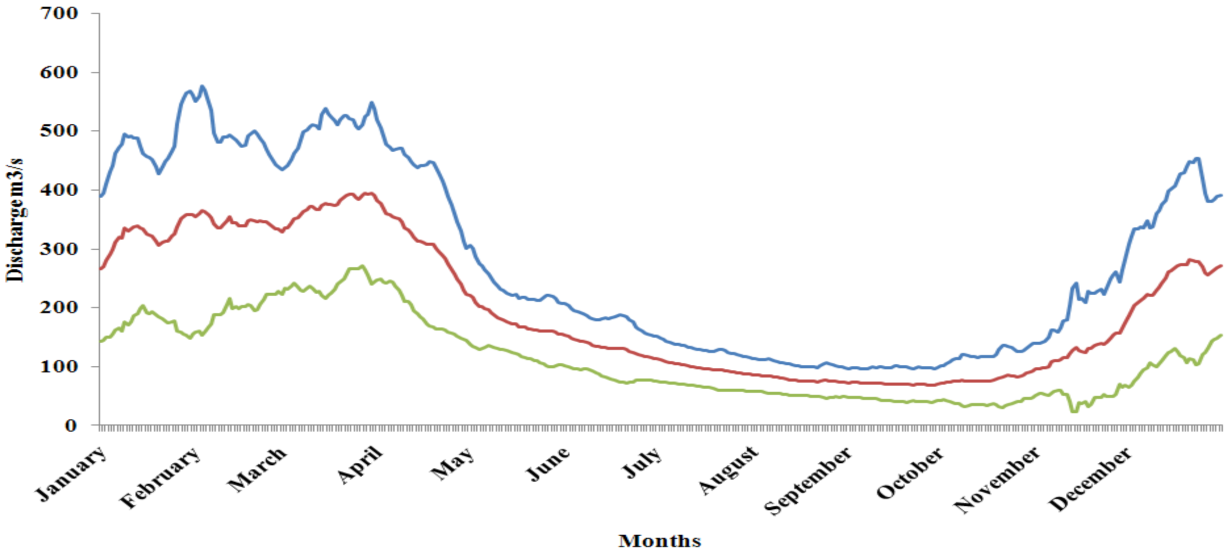

Figure 1: Daily discharge climatology of the Paranaiba river during 1974-2006.

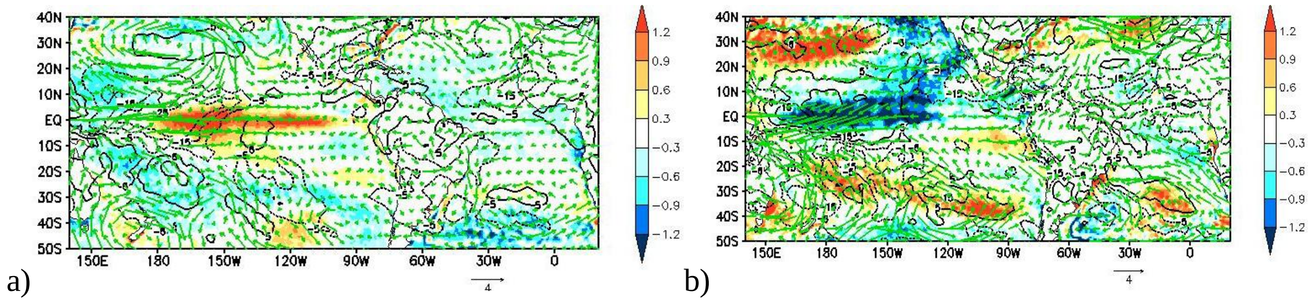

Figure 2: Composite anomalies of SST (shaded), OLR (contour) and wind for DJF:
a) low and b) high discharge periods in the Paranaiba River basin

4. Concluding Remarks

The climatology of streamflow (Fig. 1) at the Fazenda Santa Maria gauge station of the Paranaiba River in Brazil shows significant flow during November to May and very less flow during June-October. The variation in this seasonal streamflow significantly affects the human population. So, it is important to understand the underlying mechanisms that cause that variation. Since the variability of climatic conditions in the Pacific Ocean is a main driver of the rainfall variability over the Paranaiba basin, their roles in river streamflow is explored in this study. A scientific analysis is made to link the streamflow variability with the rainfall and SST variations over the Pacific Oceans on daily time scale. The observed discharge data from 1974-2006 (33 years) at the Fazenda Santa Maria, the down most outlet of the upper basin, shows a strong correlation with the El Nino/Southern Oscillation (ENSO) and recently recognized ENSO Modoki events. In the December-February low streamflow events are influenced by El Nino Modoki (Fig. 2a) and high flow events are influenced by La Nina Modoki (Fig. 2b). In March-May high streamflow events are influenced by La Nina and few extreme events are also influenced by La Nina Modoki, whereas this rainy season low flow events are influenced by El Nino Modoki than El Nino. The climate change induced ENSO Modoki events needs further scientific study for La Plata basins for the societal benefits.