ONSET OF THE RAINY SEASON OVER TROPICAL BRAZIL IN OBSERVATIONS AND A GENERAL CIRCULATION MODEL SIMULATION

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The intent of this paper is to present and document the hypothesis that the influence of sea surface temperature (SST) on rainfall in tropical Brazil is largely through its influence on onset and end of the rainy season, rather than on rain rates during the rainy season itself. The observations are compared with one 50 year run of the European Centre / Hamburg Atmospheric Model version 4.5 general circulation model (GCM), although in this abstract, although only the observations are shown.

The observations utilize rainfall data from more than 600 stations in tropical South America from 1976 to 1997 averaged onto a 2.5 degree grid. The December-February (DJF) climatological total is shown in Fig. 1. The rainfall maximum is at the southern extreme of its annual cycle, with an extension to the southeast known as the South Atlantic convergence zone (SACZ). The GCM climatology captures most of the observed pattern, although its SACZ is rather weak.

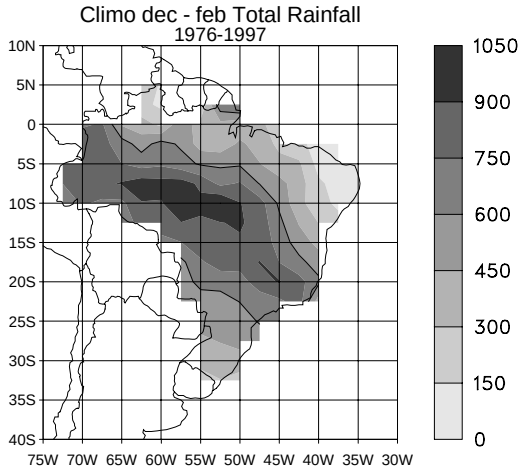

Fig. 1. Climatology of DJF rainfall in millimeters. 600 millimeter isopleth is contoured.

Figure 2 shows the simultaneous correlation between DJF SST in Nino 3.4 (5°N-5°S, 170°W-120°W) and rainfall. Although one must be careful when using linear correlations because of the non-normality of rainfall, this figure does suggest a relationship between SST and rainfall in the region south of the equator and east of 60°E. A regression (not shown) reveals a 100-200 mm deficit in this region associated with a 1 standard deviation increase in SST (~0.8 C).

Onset and end of the rainy season are defined by the following:

$$\sum_{t=1}^{day} R(t) - \bar{R} \times day$$

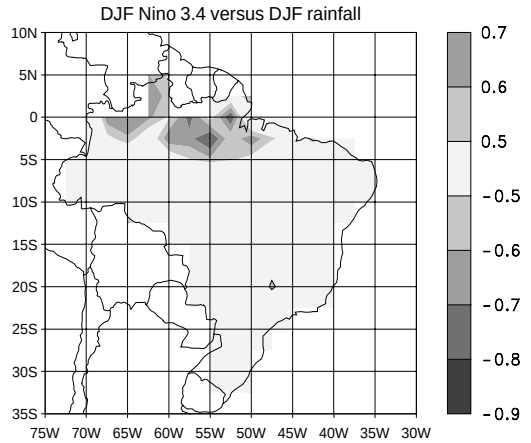

Fig. 2. Simultaneous correlation between DJF SST in Nino 3.4 and gridded rainfall. Contours indicate positive correlations.

where *R(t)* is the daily varying climatology (or single year's daily total) and $\bar{R}$ is the annual daily average, averaged over the desired stations. The beginning (end) of the rainy season is defined as when rainfall exceeds (is less than) its annual average.

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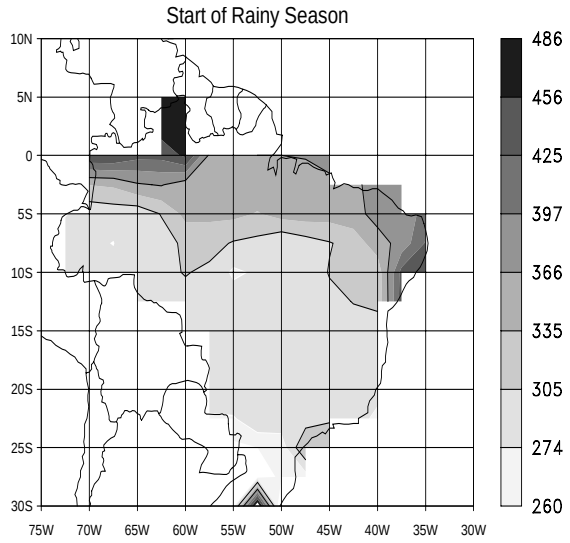

Fig. 3. Climatological onset of rainy season. Scale is in Julian days, by month. Contours indicate October-November and December-January divisions.

The climatological onset of the rainy season, using the above definition, is shown in Fig. 3. The rainy season begins in central Brazil in mid-October and progresses northward, with onset in the far north occurring in April. In the region east of 60°W and just south of the equator, the rainy season begins in December, suggesting that a late (early) onset will result in a deficit (excess) of rainfall in the DJF season. Using seasons defined by the equation, the correlation between the date of onset and the rainy season total is -0.88, while that between rain rate and the total is 0.55.

Figure 4 shows the correlation between DJF SST and DJF rainfall in the east-central Amazon, the starting date in that region, and the rain rate during the rainy season. The correlations with the seasonal total (Fig. 4a) and onset date (Fig. 4b) both exhibit a similar pattern, with the largest correlations along the equator, east of 150°W. The similarity of these patterns suggests that the influence of SST on calendar-season rainfall totals is through its influence on onset date. On the other hand, the rain rate during the (interannually varying) rainy season shows no large correlation with SST (Fig. 4c). These results suggest that once the rainy season begins, SST has little role in determining rainfall amounts; its influence is solely through the onset date.

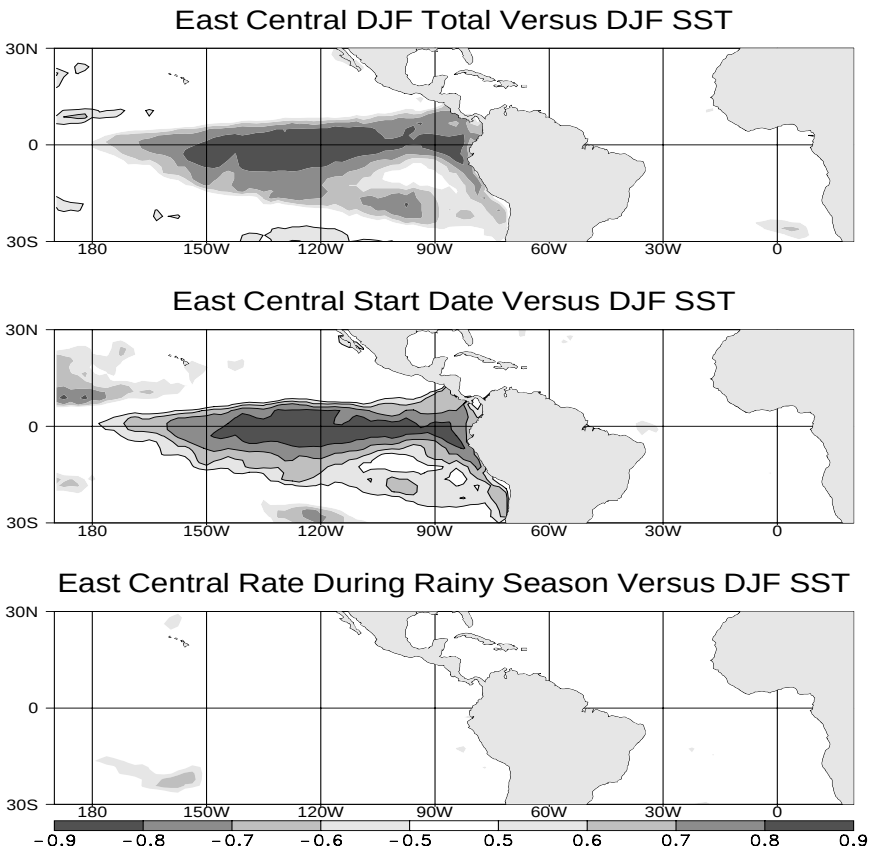

Fig. 4. Correlation between DJF SST and east central amazon a) DJF mean rainfall, b) start date of rainy season, and c) rain rate during rainy season. Positive correlations are both contoured and shaded.

An interpretation of the results presented here is that when SST is warm in the eastern Pacific, the transition of convection from the Northern Hemisphere summer position in the eastern Pacific north of the equator into the Amazon Basin is delayed. Likewise, when SST is warm from May-July in the western Atlantic south of the equator, which is when the rainy season ends in the east-central Amazon, it seems to be associated with a delayed withdrawal of convection there (not shown).

This talk focuses on the timing-driven variability hypothesis in a GCM. The GCM is sensitive to SST anomalies, but not always in the same location as those that influence observed rainfall anomalies.