ATLANTIC SST GRADIENT AND THE INFLUENCE OF ENSO

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Introduction

The tropical Atlantic SST gradient, defined as the difference between North (5N-25N) and South (5S-25S) Atlantic SSTs, is known to regulate precipitation anomalies over the northern Brazil. In March-May, a positive gradient (North Atlantic warmer than South Atlantic) suppresses Nordeste rainfall, similar to the effect of a positive El Niño SST anomaly. Giannini et al. (2004) found that, for 1950-1994, concordant cases (with same sign of Atlantic SST gradient and NINO3 index) dominate La Niñas while discordant cases dominate El Niños, resulting in a diminished impact of the latter on Nordeste rainfall. Building on this insight, the ENSO-Atlantic SST gradient relationship is revisited using a long (1870-present) and detrended SST data set.

Data and methodology

The newly available HadISST data set is used. A 10-year high pass filter is applied to the 1870-2004 time series of SST at each grid point to remove trends but retain interannual variability. The original data with 1°x1° resolution is further interpolated onto a 128x64 Gaussian grid. This resolution is slightly higher than the 5°x5° of Kaplan SST data used by Giannini et al. (2004). For 1950-1994, the main results of Giannini et al. (2004) are recovered using our data set, if the SST is undetrended as in that work.

The North and South Atlantic SST indices, tNA and tSA, are defined in the same way as in Giannini et al. (2004). The boxes chosen for the spatial averaging of SST anomalies for tNA and tSA are indicated in Fig. 1a. The Atlantic SST gradient is defined as G1 = tNA-tSA. This study focuses on the relationship between the March-May average of tNA, tSA, or G1 and the preceding December-January average of NINO3 SST anomaly. These choices are meaningful as the Atlantic SST gradient has its maximum impact on Brazilian rainfall in boreal spring, while the correlation between the Dec-Jan NINO3 index and the tNA SST anomaly peaks at about 4-month lag (choosing January as the base point for NINO3) with tNA lagging NINO3 (e.g., Enfield and Mayer 1997; see also Fig. 2).

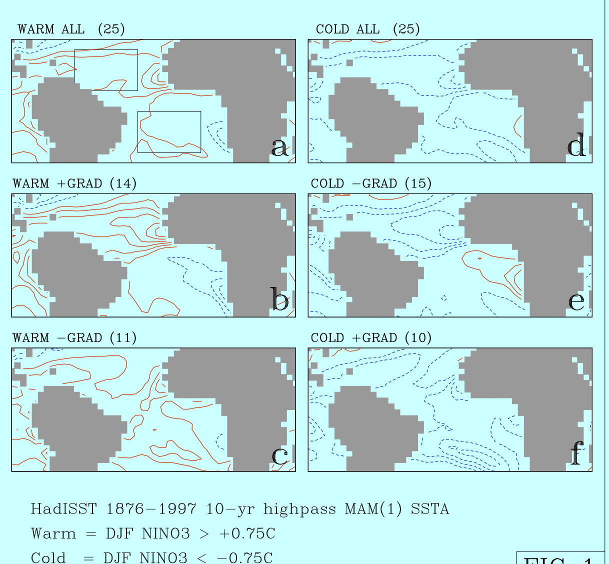

FIG 1

Results

Concordant vs. discordant cases

Figure 1 shows the composite maps of March-May SST anomalies from the major El Niño (Fig. 1a) and La Nina (Fig. 1b) years for 1876-1997. A warm year is included in the composite if the Dec-Jan NINO3 index is greater than 0.75C, cold year if it is less than -0.75C. These choices resulted in an equal number (25 each) of El Niño and La Nina years for 1876-1997. With more samples used to construct the composites, the asymmetry between cold and warm ENSO events documented by Giannini et al. (2004) for 1950-1994 disappears. Both are slightly dominated by concordant cases. In other words, tNA tends to be greater than tSA for El Niño, while the opposite occurs for La Nina. Quantitatively, 14 out of 25 El Niño and 15 out of 25 La Nina years are concordant. The composites of SST anomalies for concordant cases for warm and cold events are shown in Figs. 1b and 1e, and discordant cases in Figs. 1c and 1f. For both cold and warm events, the ratio of concordant to discordant cases is about 4:3, indicating a still significant level of non-ENSO influences that might be attributable to NAO's influence on tNA (e.g., Czaja et al. 2002) or the variability of tSA due to local atmosphere-ocean dynamics in the South Atlantic (e.g., Chang et al. 1998).

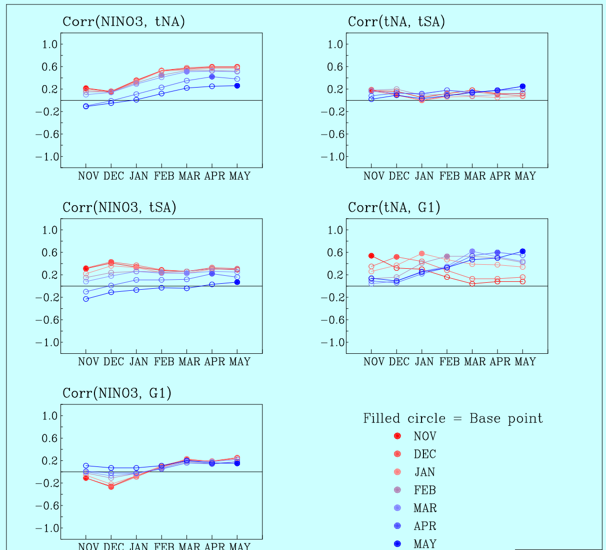

FIG 2

Lag correlation between NINO3 and tNA/tSA

Figure 2 shows the lag correlation of selected pairs among NINO3 index, tNA, tSA, and the Atlantic SST gradient, G1. Consistent with previous studies using shorter SST data sets (e.g., Chang et al. 1998), at 4-month lag, tNA is more strongly correlated with NINO3 than tSA, while tNA and tSA are only very weakly correlated with each other. As a result, G1 is slightly positively correlated with NINO3, as reflected in the fact that concordant cases outnumber discordant ones.

Benguela Nino

In the concordant cases (Figs. 1b and 1e), the composites of SST anomalies show an organized pattern with a maximum (or minimum) off the coast of Angola extending to the central equatorial Atlantic, resembling the structure of the so-called Benguela Niño (Florenchie et al. 2004). The concordant cases are those with a warm (cold) El Niño event coinciding with a cold (warm) Benguela Niño event. Whether or not the two "Niños" occur independently remains to be investigated.

Further remarks

Our results suggest that the asymmetry in Atlantic SST gradient between warm and cold events for 1950-1994 in Giannini et al. (2004) is likely influenced by the trend in Atlantic SST. The latter (at least the trend in tNA) might be related to the trend in NAO. Although removing the trend helped clarify the relationship between ENSO and Atlantic SST gradient, the finding of Giannini et al. (2004) remains relevant for prediction since the trend does contribute to predictability. Following the insight of Giannini et al. that Atlantic SST gradient cooperates with El Niño influences to regulate Brazilian rainfall, we will next examine the effect of preconditions in Atlantic SST gradient on seasonal predictions for South America.

Acknowledgments

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