Seasonal Influence of ENSO on the Atlantic ITCZ and Equatorial South America

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Abstract

In late boreal spring, especially May, a strong relationship exists in observations among precipitation anomalies over equatorial South America and the Atlantic intertropical convergence zone (ITCZ), and eastern equatorial Pacific and central equatorial Atlantic sea surface temperature anomalies (SSTA). A chain of correlations of equatorial Pacific SSTA, western equatorial Atlantic wind stress (WEA), equatorial Atlantic SSTA, sea surface height, and precipitation supports a causal chain in which El Niño/Southern Oscillation (ENSO) induces WEA stress anomalies, which in turn affect Atlantic equatorial ocean dynamics. These correlations show strong seasonality, apparently arising within the atmospheric fields of the chain. This path may and Atlantic SSTA on South American rainfall in May appear independent of that of the northern tropical Atlantic. Brazil’s Nordeste is affected by the northern tropical Atlantic. The equatorial influence lies further to the north over the eastern Amazon and the Guiana Highlands.

Discussion

Rank correlation maps of index time series for the equatorial Pacific and Atlantic show that precipitation anomalies over equatorial South America are linked with concurrent sea surface temperature (SST) anomalies in the equatorial Pacific and Atlantic. In May the area of strong correlation is markedly larger than in other months, extending farther to the south and reaching deep into equatorial South America. Correlation maps of index time series for the equatorial Pacific and Atlantic show that precipitation anomalies over equatorial South America are linked with concurrent sea surface temperature (SST) anomalies in the equatorial Pacific and Atlantic. In May the area of strong correlation is markedly larger than in other months, extending farther to the south and reaching deep into equatorial South America.

The likely reason for this can be seen in fig. 1 which compares correlation maps of precipitation in January and May with ENSO (Nino-3.4) and the Atlantic Niño (Atl-3). In January the correlation patterns are almost mirror images. Indeed, while ENSO and the Atlantic Niño vary independently during most of the year, they correlate well in late boreal spring and early summer, for the analyzed period of satellite data (Fig. 2 circles). The Atlantic SST and wind stress anomaly patterns associated with Atlantic Niño and ENSO in May are depicted in fig. 5. The regression map of negative Nino-3.4 (Fig. 7) with SST anomalies (SSTA) marks the areas of equatorial and coastal upwelling and is weaker but otherwise similar to the regression map of Atl-3 which exemplifies Atlantic Niño. The similarity also hold for the wind stress patterns. Differences occur in the northern tropical Atlantic (NTA). Note that the correlation patterns of wind stress and SST anomalies do not correspond well, indicating that evaporative feedbacks are unlikely to be the main cause for these SSTA.

A map (Fig. 8) of correlation of sea-surface height anomalies (SSHA) with zonal wind stress anomalies (WEA) over the western equatorial Atlantic confirms the remote connection, presumably through equatorial wave dynamics. Positive SSHA peaks in the Atl-3 region with negative off-equatorial SSHA to the west, reminiscent of the observed equatorial Kelvin and Rossby wave packets of ENSO. The higher correlations from April through August of Nino-3.4 with WEA (Fig. 4 triangles) is higher than with Atl-3 (Fig. 2, circles) are another indication that WEA are part of the causal chain linking with concurrent sea surface temperature (SST) anomalies in the equatorial Pacific and Atlantic. In May the area of strong correlation is markedly larger than in other months, extending farther to the south and reaching deep into equatorial South America.

The influence of ENSO on the equatorial Atlantic in spring has been strong in recent decades. A likely reason for this is shown in Fig. 6 which illustrated the long term change of Nino-3.4 standard deviation for each month of the year. Not only have ENSO been recently strong but the biggest percentage increase of ENSO occurred in October and May while in the 1960s and 1970s ENSO was very weak.

Datasets and Analysis Periods

Sea Surface Height: National Geophysical Data Center (1/1982-9/2003)

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