Influence of Amazonian Convection Over Tropical North Atlantic SSTs

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Introduction

We propose a physical mechanism that describes the influence of the Amazon River basin (AM) over the Tropical North Atlantic (TNA) region during anomalous convection over the continent. The Amazon driest (wettest) months are characterized by a decrease (increase) in rainfall *(P)*, which in turn increases (decrease) atmospheric surface pressure in the AM thus reducing (increasing) the pressure gradient between the TNA and AM regions (*G*). The latter causes a slowing down (speeding up) of the zonal trade wind velocities (*W*) at the TNA region. The weakening (strengthening) of the trade winds over the TNA is related with a reduction (increase) in evaporative cooling and a subsequent increase (reduction) of TNA sea surface temperatures (*SSTs*).

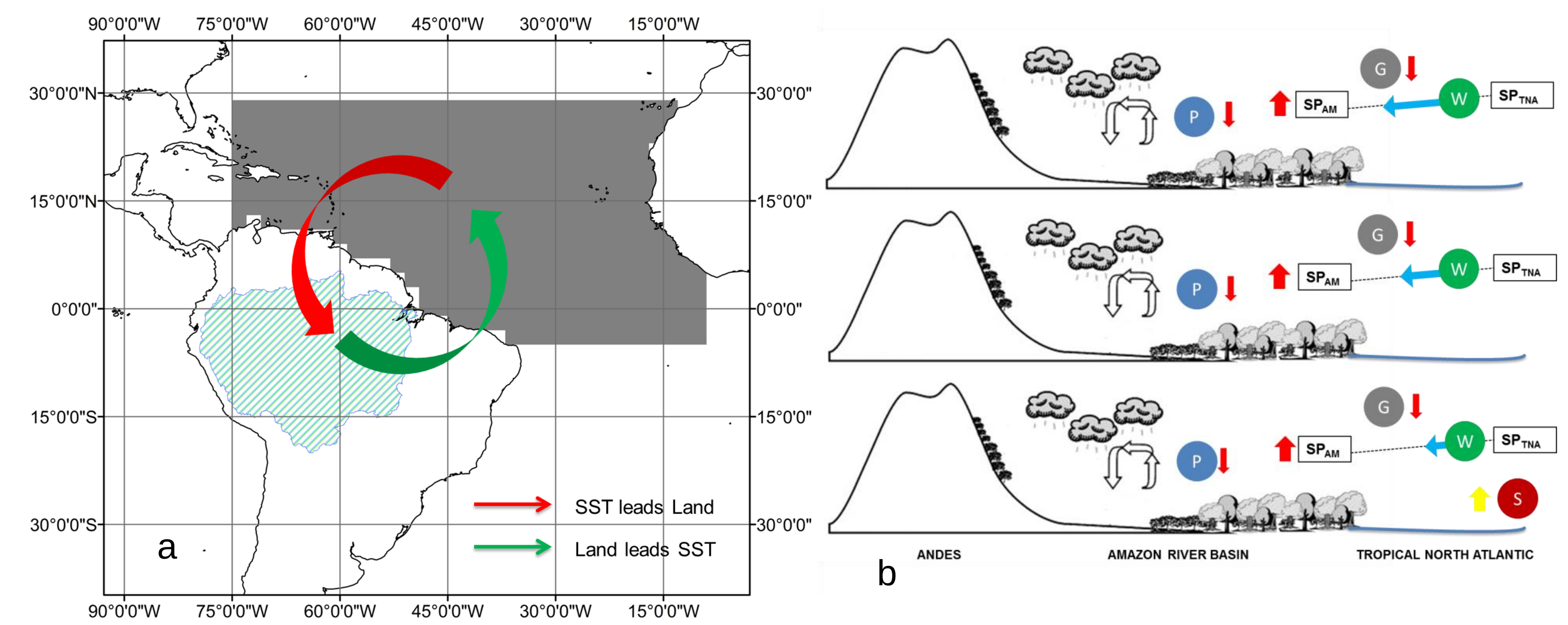
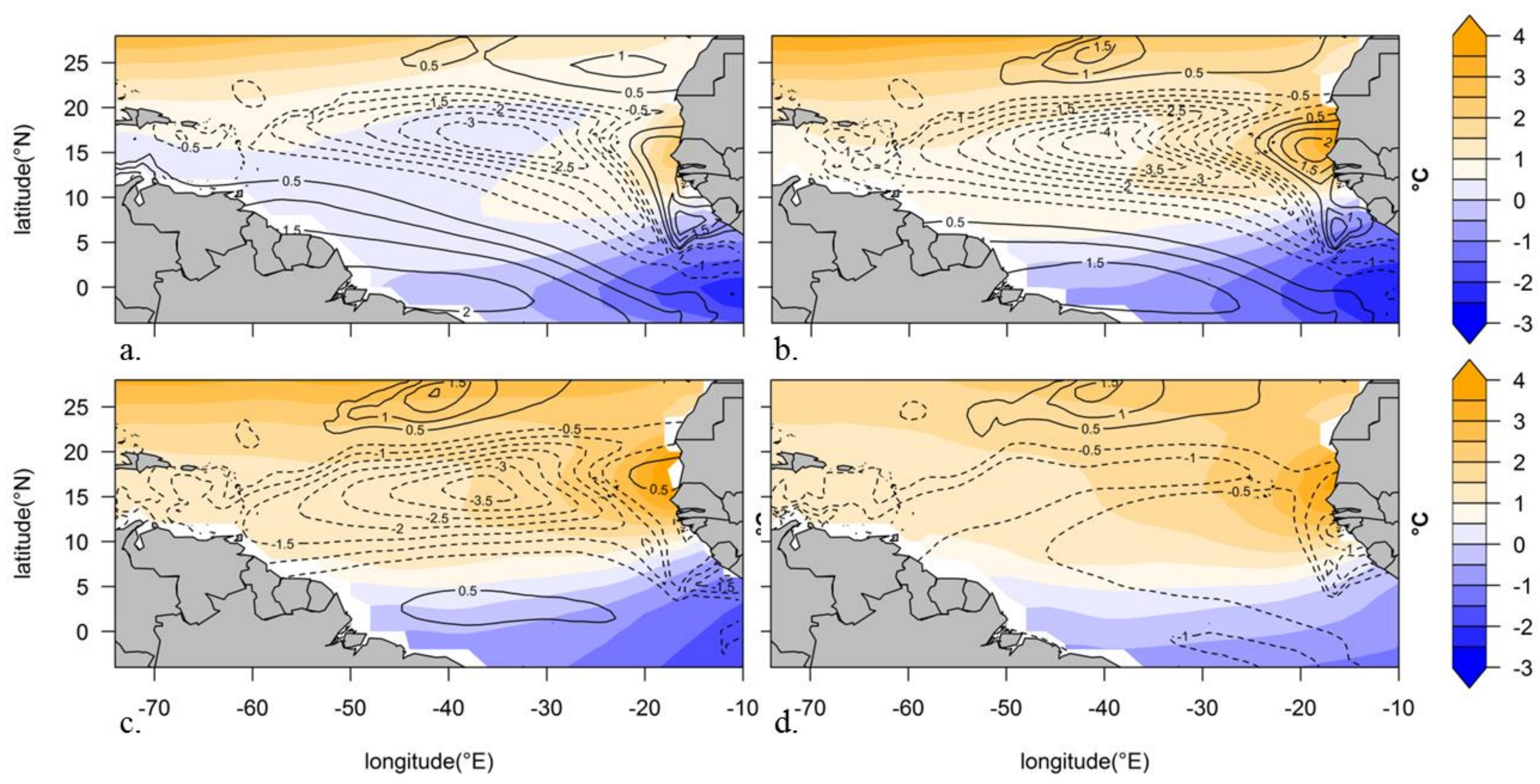


Figure 1. (a) Illustration of the two-way feedbacks between the Amazon basin and the Tropical North Atlantic. (b) Physical mechanism explaining the influence of the Amazon in the TNA.

Data and Methods

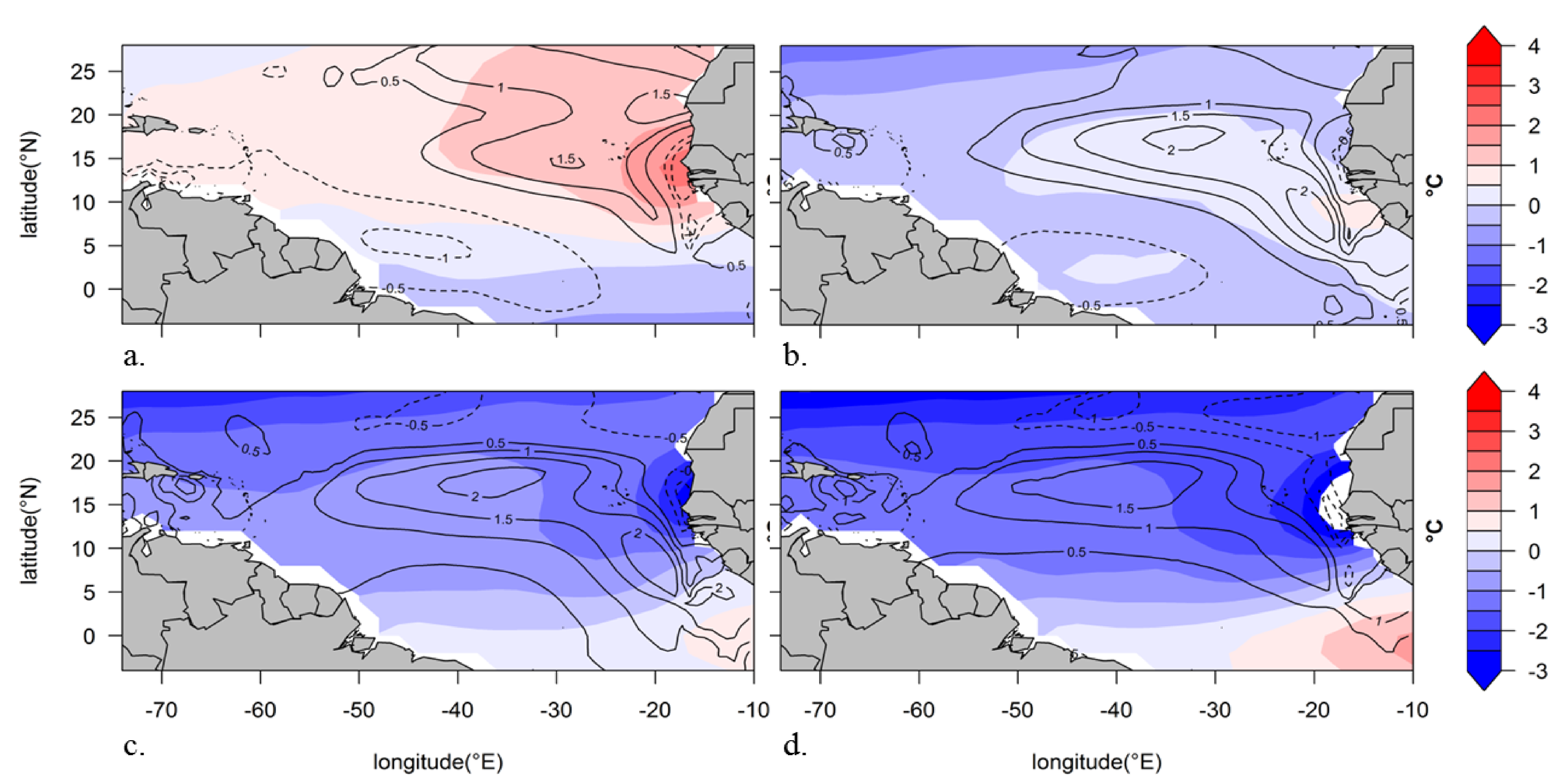
We used four monthly time series to represent the variables involved in the dynamical feedbacks between the AM hydrology and the TNA SSTs, namely the *P-E* index (*P*), defined as the difference between monthly values of Precipitation and Evapotranspiration averaged over the AM River basin. This region is considered as the grids inside the river basin, as defined in the LBA project from 79.5° W to 50.5° W and from 19.5° S to 4.5° N. We also used time series of zonal wind velocities (*W*) at the TNA, the surface atmospheric pressure gradient (*G*) between the AM and the TNA regions obtained from ERA-Interim Reanalysis, and sea surface temperatures in the TNA (*S*) from NOAA's Extended Reconstructed Sea Surface Temperature ERSST (v3b). We searched for dynamical evidence by computing composites of zonal wind velocities anomalies and SST anomalies in the TNA for the seasons when the Amazon undergoes the most contrasting convective conditions, the dry season (JASO) and the wet season (NDJF). We also evaluated the mean monthly evolution of the relevant variables during the extreme AM droughts of 1963, 1980, 1983, 1997, 1998, 2005, 2010, and during the floods of 1989, 1999, 2009.

Amazon dry season



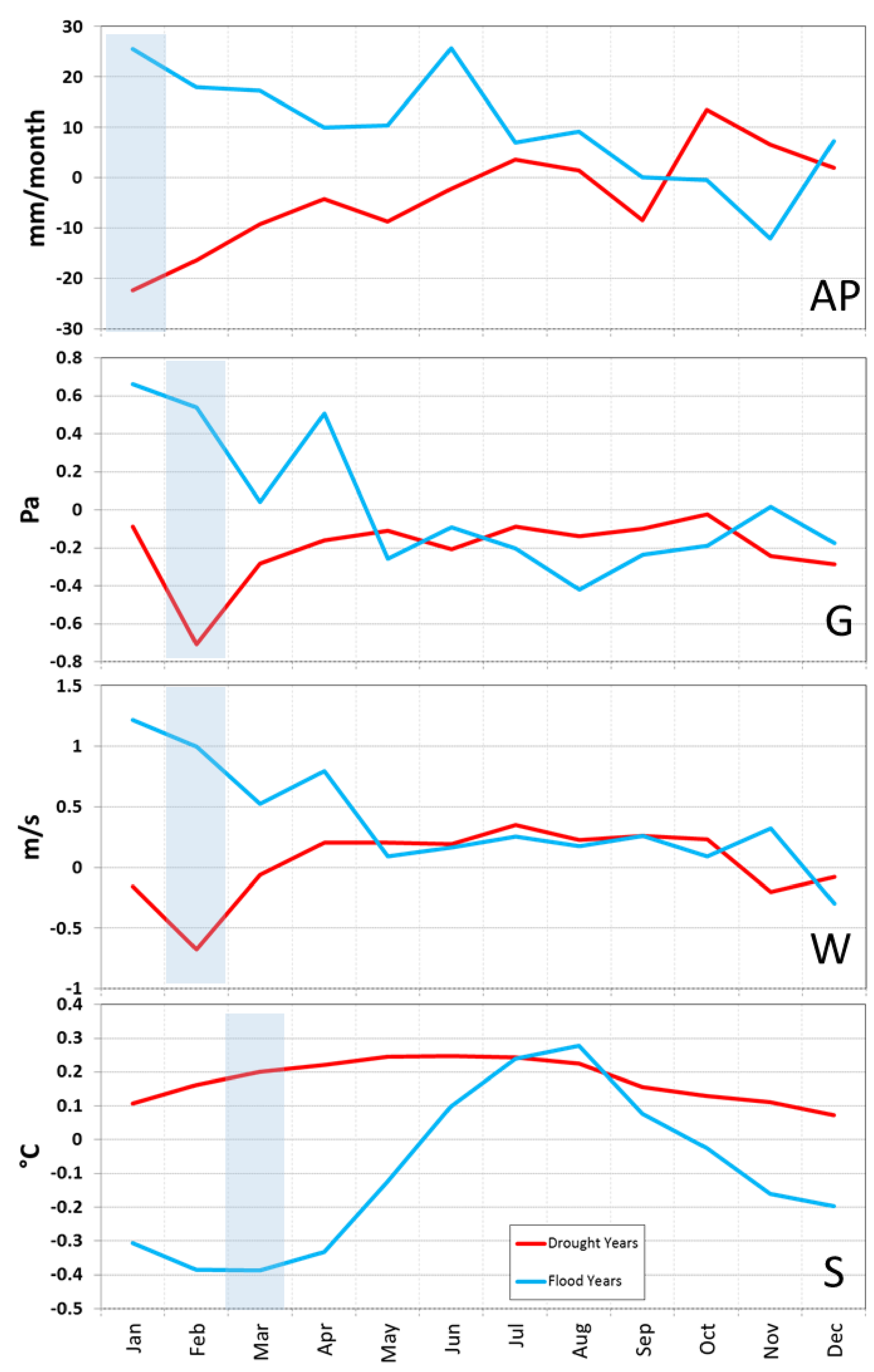
When the AM region experiences reductions of convective processes, the TNA region is characterized by an evident reduction of zonal wind velocities in July over the northeast of the TNA above 15° N and near the African coast, and the SSTs are colder near the Americas. By August, the slower zonal winds towards the AM cover a broader band above 10° N and the SSTs north of the equator are increased in almost 1° C above the conditions found in July. While the reduction of the winds appears to be in phase with the beginning of the dry season, increasing temperatures in the ocean are found from zero to three months lagged.

Amazon wet season



While the AM is in its wet season, starting in November, the conditions are similar to those at the end of the dry season, with a warming of almost 2° C above the mean conditions in the northern TNA, and slower zonal wind velocities near the coasts of South America. When the convective processes become more intense from December to February, during the peak of the South American Monsoon, the zonal winds start to increase their velocities towards the continent and the SSTs become colder, reaching values even 3° C below normal conditions.

Intra-annual variability



During extreme AM droughts, values of *P* almost 20 mm/month below the mean are observed in January; this implies the reduction of convective processes during the peak of the wet season. One month later, in February, *G* reaches a minimum value, in phase with the minimum values of *W* towards the AM, while an ongoing warming of the SSTs occurs during the three first months of the year. On the contrary, during extreme AM floods, there is an increased *P* followed by higher *G*, faster winds in the AM direction, and cooler TNA SSTs. The timing in the mechanism by which AM influences the TNA is well observed and can be identified in the aforementioned results spanning a period of three months.

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