LETTER

Underestimated role of East Atlantic-West Russia pattern on Amazon vegetation productivity

The Amazon forest experienced severe droughts in 2005 and 2010; however, the extent to which precipitation anomaly affects the vegetation productivity remains controversial (1, 2). Hilker et al. (3) report significant correlations ($P < 0.05$) between the El Niño southern oscillation (ENSO) and the Amazon vegetation greenness based on the improved moderate resolution imaging spectroradiometer (MODIS) normalized difference vegetation index (NDVI) data for 2000–2012. The opposing findings from previous MODIS measurements are attributed to normalizing the MODIS reflectance to a common view and sun geometry and the use of a less conservative cloud mask. These are important developments, particularly to study the intraannual dynamics of Amazon vegetation greenness. However, we argue that, among the leading global ocean-atmosphere oscillations, ENSO may not be the most prominent indicator of Amazon vegetation productivity.

Here we use the annually integrated 30 y (1982–2011) of 8 km of third-generation (NDVI3g) satellite NDVI (NDVI > 0.1) from Global Inventory Modeling and Mapping Studies data, oscillation indices from the National Oceanic and Atmospheric Administration (www.cpc.ncep.noaa.gov), and the latest gridded Climatic Research Unit (CRU TS 3.21) mean annual precipitation data at 0.5° × 0.5° to show the role of climatic oscillations on Amazon interannual greenness dynamics. The study area is 10° N to 30° S latitude and 80° W to 42° W longitude, the same as in Hilker et al. (3).

Among the 10 leading oscillation indices (www.cpc.ncep.noaa.gov), the East Atlantic-West Russia pattern (EA-WR) controls the ensuing year Amazon forest and savannah greenness in the same direction (Fig. 1 *H* and *I*). The important finding here is that EA-WR has a uniform impact on the Amazon forest and savannah greenness (Fig. 1 *H* and *I*), whereas these two vegetation types' greenness has contrasting responses to precipitation (3) (Fig. 1 *J* and *K*). EA-WR is positively and negatively correlated to Amazon forest and savannah precipitations, respectively (Fig. 1*J*). Precipitation is negatively and positively correlated to Amazon forest and savannah greenness, respectively (3) (Fig. 1*K*). Note the resemblance of relationship of precipitation with EA-WR (Fig. 1*J*) and with vegetation greenness (Fig. 1). As a result, the entire ensuing year Amazon vegetation greenness responds in the same direction to EA-WR (Fig. 1 *H* and *I*).

EA-WR is most active during the northern hemisphere winter and early spring. Between 1982 and 2011, the rare persistent positive phases of EA-WR occurred throughout 2002–2005 winters, which may explain the extreme drought of the Amazon forest during the summer of 2005. The large-scale EA-WR pattern is related to the planetary Rossby wave energy propagation (4) with several anomaly centers ranging from the Caspian Sea to Newfoundland. EA-WR is also associated with North Atlantic sea surface temperature (SST) and zonal wind anomalies over the tropical Pacific (4). The timescale for the SST anomalies to travel across the entire North Pacific is ∼1 y (5), explaining the lagged impact of EA-WR on Amazon vegetation greenness. Therefore, EA-WR, more than ENSO, may explain the entire ensuing year Amazon vegetation greenness dynamics (Fig. 1), although the mechanism is not well known.

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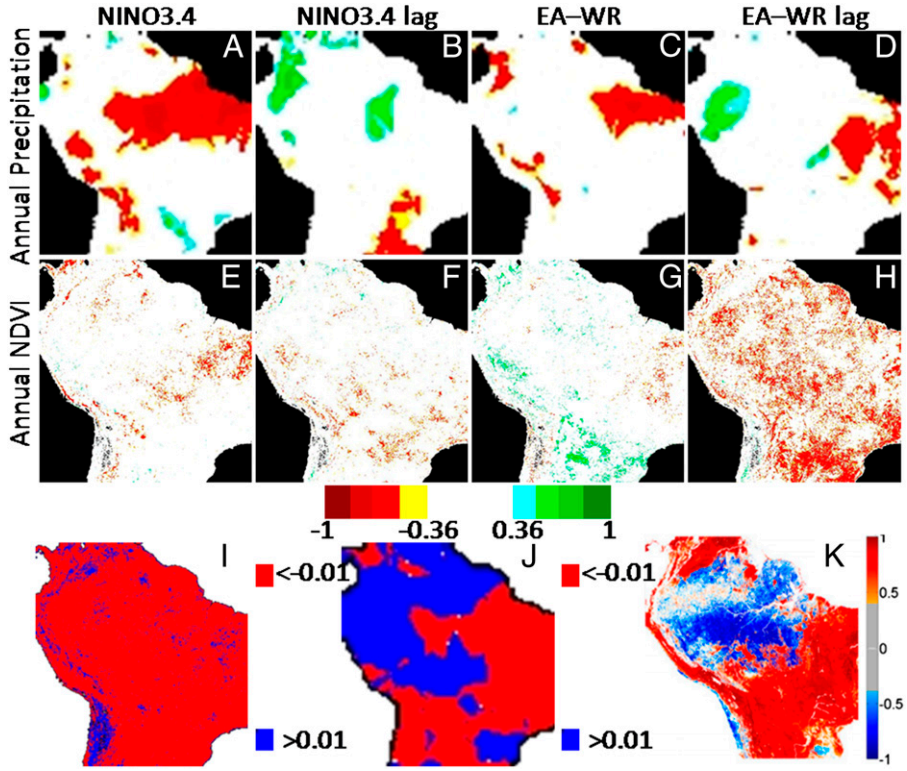

Fig. 1. Impacts of ENSO-Niño 3.4 (NINO3.4) and EA-WR on Amazon vegetation greenness (*E*–*H*) and precipitation (*A*–*D*) between 1982 and 2011. All values (*A*–*H*) are Pearson correlation coefficients. The teleconnection anomalies are calculated as a mean value of December of the preceding year and January, February, and March of the NDVI and precipitation year. The impact of view and sun geometry on NDVI is minimal as the data are integrated for the entire year in this study. All of the teleconnection, NDVI, and precipitation data were detrended. Lag: the relationship between NINO3.4, or EA-ER, and the ensuing year NDVI, or precipitation values. Blank white (*A*–*H*) is not significant at the 95% confidence level from a two-tailed Student *t* test. (*I*) Red (negative) and blue (positive) Pearson correlation coefficient values between EA-WR and the ensuing year NDVI. (*J*) Red (negative) and blue (positive) Pearson correlation coefficient values between EA-WR and the ensuing year precipitation. (*K*) Relationship between precipitation (Pearson correlation coefficient; $P < 0.05$) and Amazon vegetation greenness between 2000 and 2012 (reproduced from ref. 3).