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A recent systematic increase in vapor pressure deficit over tropical South America

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Using temperature and relative humidity data from the Atmospheric Infrared Sounder (AIRS), the ERA-Interim reanalysis, and global and regional climate model simulations we show a recent increasing trend in the Vapor Pressure Deficit (VPD) in dry months with a value that that is well beyond the range of trends due to natural climate variability. This trend is systematic in the southeast Amazon ($\sim 6 \pm 2$ mb over 1987-2016) but driven by episodic droughts in the northwest, with the highest recorded VPD since 1979 for 2015 El Niño. A bivariant signal attribution analysis demonstrates that the observed increase in VPD cannot be explained by greenhouse-gas-induced (GHG) radiative warming alone. The aerosols-induced (AA) local warming (primarily due to the indirect effect of black carbon aerosols on cloud's lifetime), and land-use-change (LU) induced non-radiative warming/drying have also contributed significantly to the VPD trend. At local scale, the trend in VPD that remains unexplained by this analysis is in Brazil's "arc of deforestation", pointing to the nonlinear interactions among the three drivers (GHG, AA, LU), which leads to intensification of the local atmospheric drying. We further show that there is a negative trend in evaporative fraction in southeast Amazon ($\sim$25% decrease), where lack of atmospheric moisture ($\sim$ -2.5 °C decrease in dew point), reduced precipitation ($\sim$ -15 mm/month decrease) together with higher incoming solar radiation ($\sim$21% cloud-cover reduction) influences the partitioning of surface energy fluxes towards less evapotranspiration. Our results suggest that the VPD rise along with reduced forest evapotranspiration increases the probability of drought severity.