A warming tropical central Pacific dries the lower stratosphere

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The amount of water vapor in the tropical lower stratosphere (TLS), which has an important influence on the radiative energy budget of the climate system, is modulated by the temperature variability of the tropical tropopause layer (TTL). The TTL temperature variability is caused by a complex combination of the stratospheric quasi-biennial oscillation (QBO), tropospheric convective processes in the tropics, and the Brewer–Dobson circulation (BDC) driven by mid-latitude and subtropical atmospheric waves. In 2000, the TLS water vapor amount exhibited a stepwise transition to a dry phase, apparently caused by a change in the BDC. In this study, we present observational and modeling evidence that the epochal change of water vapor between the periods of 1992-2000 and 2001-2005 was also partly caused by a concurrent sea surface temperature (SST) warming in the tropical central Pacific. This SST warming cools the TTL above by enhancing the equatorial wave-induced upward motion near the tropopause, which consequently reduces the amount of water vapor entering the stratosphere. The QBO affects the TLS water vapor primarily on inter-annual timescales, whereas a classical El Niño southern oscillation (ENSO) event has little effect on tropical mean TLS water vapor because its responses are longitudinally out of phase. This study suggests that the tropical central Pacific SST is another driver of TLS water vapor variability on inter decadal timescales.

Keywords: tropical lower stratosphere, water vapor, central Pacific , Convection

