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Stratosphere-troposphere coupling: The interannual variability of tropical temperature, water vapor, and clouds as seen from the A-Train

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The primary tropical interannual modes of variability are the El Niño Southern Oscillation and quasibiennial oscillation (QBO). We find through satellite remote sensing soundings of temperature and water vapor, from the A-Train constellation of satellites, that the ENSO and QBO jointly impact the tropical tropopause layer (TTL) temperature and water vapor distribution. Although the QBO is a zonally symmetric phenomenon, the ENSO breaks that symmetry via the migration of convection between the tropical western Pacific (TWP) and the tropical central Pacific (TCP). Furthermore, we find that the joint impacts depend on the relative phase of the ENSO and QBO with TWP (TCP) experiencing enhanced (reduced) anomalies when these modes are in phase. When the ENSO and QBO fall out of phase the anomaly enhancement (reduction) migrates to the TCP (TWP). Our results indicate that processes in the TCP may have a pronounced impact on the zonal mean TTL water vapor distribution when the ENSO and QBO are out of phase. Furthermore we quantify the ENSO and QBO interannual impacts on the tropical cloud distribution as seen by CloudSat and CALIPSO. The results show the distinct impact of ENSO induced SST anomalies on the migration of convection. However, we also find observe that ENSO impact all the prominent tropical cloud types with their anomalies following water vapor from the boundary layer up to ~13-14 km, and temperature at higher altitudes. Another robust feature is the eastward tilt signature of Kelvin waves on the cloud distribution in the TWP, consistent with the eastward tilt of temperature anomalies in the same region in the TTL. This lends credence to the hypothesis that cloud amount is primarily determined by temperature variance in the TTL. A statistically significant QBO signal in cloud amount is also observed.