Tropopause cold layer and its influence on stratospheric moisture

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Characteristics of the tropopause-level cold layer associated with tropical deep convection are examined using CloudSat and Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) GPS radio occultation measurements. Deep convection is sampled based on the cloud top height (>17 km) from CloudSat 2B-CLDCLASS, and then temperature profiles from COSMIC are composited around the deep convection. Response of moisture to the cold layer is also examined in the upper troposphere and lower stratosphere using microwave limb sounder (MLS) measurements.

The composite temperature shows an anomalously warm troposphere (up to 14 km) and a significantly cold layer near the tropopause (at 16-19 km) when deep convection occurs over the western Pacific. The cold layer has a significantly large horizontal scale (˜ 6,000 km in longitude) compared to that of underlying mesoscale convective clusters (occur generally on hundred-kilometer scale), and it lasts more than two weeks with a minimum temperature anomaly of ˜ -2 K, particularly related to the Madden-Julian Oscillation. The water vapor anomalies show coherent structures with the temperature anomalies emphasizing the importance of the freeze-drying mechanism in the western Pacific region. The moisture is also affected by anomalous circulation patterns in the cold layer, and dry air further spreads in the TTL following the circulation patterns. These results suggest that convectively-driven tropopause cold layer and associated transient circulation play an important role in the large-scale dehydration process in the lower stratosphere.

Keywords: Tropopause cold layer, Stratospheric water vapor, Convection

