Dynamical processes in the tropical UTLS: Observational evidences and issues in numerical models

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The tropical upper troposphere and lower stratosphere (UTLS) plays important roles in modulating the Earth's radiation budget by providing a major transport pathway for radiatively active gases. Therefore, physical properties of the tropical UTLS are crucial information for understanding climate variability. In this presentation, important properties of the tropical UTLS and related dynamical processes are reviewed and discussed based on observations and numerical model simulations participated in CMIP5 and CCMI.

Observational analyses show that the zonal-mean climatology and annual cycle of the tropical UTLS temperature are well explained by the shallow branch of the Brewer-Dobson circulation, which are forced by planetary and synoptic-scale waves (zonal wavenumber 1-4). On subseasonal timescale, thermal and circulation variabilities in the tropical UTLS are significantly correlated with tropical convection. Particularly, large-scale temperature and circulation responses to organized deep convection regulates amount of water vapor in the UTLS by forming an effective dehydration process. The CMIP5 and CCMI models reproduce reasonable thermal structures in the tropical UTLS on climatological and seasonal timescales. However, many of the models reveal common limitations in reproducing the observed properties and dynamical processes in the tropical UTLS. Particularly, warm bias near the tropopause appears in many models, and detailed dehydration processes observed on seasonal and subseasonal timescales are only partly reproduced. These limitations could lead to significant overestimations in simulated water vapor in the stratosphere and its impact on surface radiation budget.

Key words: UTLS, stratosphere-troposphere exchange, stratospheric water vapor, ozone, radiation budget.