



Analysis of the ENSO temperature and specific humidity signals in the troposphere and lower stratosphere with global COSMIC GPS RO observations from June 2006 to June 2014

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The specific humidity and the temperature response of El Niño-Southern Oscillation in the troposphere and lower stratosphere (TLS) over different areas i.e., Niño 3.4 (N3.4); $-5^{\circ}\text{S}-5^{\circ}\text{N}$, $180^{\circ}\text{W}-180^{\circ}\text{E}$ (G5); $-30^{\circ}\text{S}-30^{\circ}\text{N}$, $180^{\circ}\text{W}-180^{\circ}\text{E}$ (G30); $-60^{\circ}\text{S}-60^{\circ}\text{N}$, $180^{\circ}\text{W}-180^{\circ}\text{E}$ (G60); $-90^{\circ}\text{S}-90^{\circ}\text{N}$, $180^{\circ}\text{W}-180^{\circ}\text{E}$ (G90) were investigated using Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) Global Positioning System (GPS) radio occultation (RO) data from June 2006 to June 2014. The empirical orthogonal functions (EOFs) and band-pass filtering with different filtering ranges at different altitudes were used to extract the ENSO-related signals of the specific humidity and the temperature over different altitude levels in the TLS. The time series that has the maximum correlation coefficient between the ENSO-related signals and the ONI were regarded as the strongest response to ENSO. The results confirmed that the ENSO was originated from tropical Pacific Ocean. The lag time and the phase of the maximum specific humidity or temperature response to ENSO event does not show a uniform pattern at different altitudes in the troposphere over different areas, but the 1-2 seasons lag ONI was found and consistent with previous study results. The maximum correlation coefficient between the specific humidity and the ONI was about 0.94 at a lag time of 3 months at about 225 hpa altitude over the statistical areas while the maximum correlation coefficients (0.91) between the temperature and the ONI was found at ~ 325 hpa altitude level at a lag time of 1 month in the TLS. The well agreement between the ENSO-related signals in the troposphere and the ONI indicates that the specific humidity and temperature derived from COSMIC GPS RO observations are significant for monitoring the ENSO events.