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A distinct stronger warming in the tropical tropopause layer during 2000s: Association with minor volcanic eruptions

Sanjay Mehta[1*], Massatomo Fujiwara[2], Toshitaka Tsuda[1]

[1]Research Institute for Sustainable Humanosphere (RISH), Kyoto University, Japan, [2]Facaulty of Environmental Earth Science, Hokkaido University, Japan

The trends and various interannual variability components in the tropical tropopause layer (TTL) over the tropics (15oS-15oN) are examined by employing upper air data from GPS Radio Occultation (RO), radiosonde (IGRA, RICH and HadAT2) and ERA-Interim during 2001-2010. The detection capability of the GPS RO, though with limited data coverage, has been shown in previous studies. The temperature anomalies from unadjusted radiosonde (IGRA), adjusted radiosonde (RICH and HaAT2), and ERA-Interim shows favorable comparison with GPS RO except at 100 hPa in ERA-Interim data. Detail analysis of the warming observed in the TTL during 2001-2010 using both standard linear and multiple regressions is carried out. The temperature trend estimated using standard linear regression analysis (i.e. allowing the contributions from various interannual variability) reveals a strong warming of about 0.5-1.5 K/decade in the TTL (about 16-19 km) with maximum warming at about 18 km in each data during 2001-2010. Further, multiple regression analysis is performed while including various interannual components such as Quasi-Biennial Oscillation (QBO), El Nino Southern Oscillation (ENSO) and stratospheric Aerosol Optical Depth (AOD). We performed two types of multiple regression analysis considering without (method-1) and with (method-2) seasonal modulation of the interannual components. The distinct warming in the TTL is partially but not completely removed on removing the QBO and ENSO components. However, on removing the AOD along with QBO, ENSO removes the distinct warming in the TTL. Therefore, this study shows that the strong distinct warming in the TTL is associated with minor volcanic eruptions during 2000s. Positive and significant AOD responses to the temperatures of about 0.1-0.2 K/AOD-Index are observed in the TTL region which explains about 5-15% of the total variance during 2001-2010.

Keywords: Temperature trends, Climate change, Tropical tropopausue layer, El Nino Southern Oscillation, Stratospheric Aerosol Optical Depth