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Wave Activity in the Tropical Tropopause Layer in Reanalysis and Chemistry Climate Model Data

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Sub-seasonal variability including equatorial waves significantly influence the dehydration and transport processes in the tropical tropopause layer (TTL). This study investigates the wave activity in the TTL in six reanalysis data sets (RAs; NCEP/NCAR, NCEP-DOE AMIP-II, ERA40, ERA-Interim, JRA25, and MERRA) and four chemistry climate models (CCMs; CCSRNIES, CMAM, MRI, and WACCM) using the zonal wavenumber-frequency spectral analysis method with equatorially symmetric-antisymmetric decomposition. Analysis is made for temperature and horizontal winds at 100 hPa in RAs and CCMs and for outgoing longwave radiation, which is a proxy for convective activity that generates tropopause-level disturbances, in satellite data and CCMs. Particular focus is placed on equatorial Kelvin waves, mixed Rossby-gravity waves, and symmetric eastward-moving intra-seasonal oscillations. It is found that the activities show significant difference among the RAs, ranging from ˜0.5 to ˜1.5 with respect to the RA average. Newer RAs tend to show greater activities. The activities in the CCMs are generally within the range of those in the RAs. It is concluded that the broad range of wave activity found in the different RAs decreases our confidence in their validity and in particular their value for validation of CCM performance in the TTL, thereby limiting our quantitative understanding of the dehydration and transport processes in the TTL.

Keywords: wave activity, tropical tropopause layer, reanalysis, chemistry climate model