Wave driving in the tropical lower stratosphere as simulated by WACCM: annual cycle and ENSO-induced changes

Masakazu Taguchi[1]

[1] Aichi Univ of Education

The tropical tropopause (including the so-called tropical tropopause layer) is a vital region to the global troposphere-stratosphere exchange perspective, since it is the main entry of air from the troposphere to the stratosphere. The region is influenced by the upwelling of the wave-driven Brewer-Dobson circulation among others, but the nature of the wave driving is not well understood. Possible changes in the Brewer-Dobson circulation and relevant wave driving under global warming have been receiving increasing attention. This study investigates fundamental dynamics and thermodynamics in the tropical lower stratosphere as simulated by Whole Atmosphere Community Climate Model (WACCM) developed at NCAR (National Center for Atmospheric Research), with a particular focus on the wave driving and activity.

A 50-year control simulation forced with a climatological sea-surface temperature (SST) condition is first used to explore the annual cycle of the tropical lower stratosphere. The mean annual cycle is consistently characterized by lower temperatures, stronger Brewer-Dobson circulation (upwelling and local poleward flow), and stronger nearby wave driving for Northern winter. The seasonal contrast in the wave driving mostly occurs in the Northern flank of the equator, largely contributed by stationary equatorial Rossby waves (through northward and upward propagation as captured by meridional and vertical fluxes of zonal momentum, respectively) and Northern extratropical waves (through equatorward propagation as captured by meridional flux of zonal momentum). The stationary equatorial Rossby waves are understood as a response to the strong convective heating around Indonesia.

Two 3650-day perpetual January experiments including La Nina- and El Nino-like SST perturbations over the eastern tropical Pacific are further compared to explore ENSO (El Nino/Southern Oscillation)-induced changes in the tropical lower stratosphere during Northern winter. It is found that the region cools in response to the El Nino-like SST forcing, accompanied by the locally accelerated Brewer-Dobson circulation. The acceleration of the circulation is associated with strengthening of the tropical/subtropical wave driving in the lower stratosphere. The strengthened wave driving well corresponds to changes in tropical/subtropical stationary waves including a well know equatorial wave response to ENSO-induced re-distribution of convective heating.