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Analysis of the Tropical Tropopause Layer using the global nonhydrostatic atmospheric model

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The tropical tropopause layer (TTL) is the region where the tropospheric air passes through before entering the stratosphere.

In particular, water vapor mixing ratio which affects the stratospheric ozone is determined by dynamics and transport in the TTL. In this study, we attempt to understand dynamical processes with small to planetary scales affecting the TTL using the output data from the Nonhydrostatic ICosahedral Atmospheric Model (NICAM) calculated on the Earth Simulator in Japan.

In this presentation, we show the results from output data calculated under an aqua planet condition. The horizontal spacing for this study is about 3.5km. The vertical spacing is about 700 m in the TTL. Following three results are obtained.

(1) A Super Cloud Cluster (SCC) and a Super Convective System (SCS: Chen et al., 1996) were both propagating eastward along the equator at about 17 m/s and 12m/s,respectively.

(2) Anomalously cold regions where the dehydration occurred were found around the tropopause. Following two disturbances seem to have had a central role in producing the cold temperatures.

(i) The cold phase of an equatorial Kelvin waves around the tropopause which had been generated by the SCC below (Horizontal scale: 14,000 km in zonal and 3,000 km in meridional).

(ii) The top of the SCS which was overshooting the tropopause (Horizontal scale: 700 km both in zonal and meridional).The region around the top of the SCS was 4 K colder than the cold phase of the Kelvin waves, and resulted in the lowest saturation mixing ratio (about 4.08∗10E-7 kg/kg). However, we also need to consider the area of the low temperature regions to estimate the impact on the total dehydration. The cold region by the Kelvin waves was much broader in area than that by the overshooting SCS. Therefore, the Kelvin wave may contribute to the dehydration more efficiently.

(3) Another coldest region was found around the tropopause. This was caused by smaller scale gravity waves. Interestingly, these gravity waves were embedded in the cold phase of the Kelvin waves. This cold area has very low saturation mixing ratio(4.96∗10E-7kg/kg). It is suggested that the combination of Kelvin waves and gravity waves would be one of the major mechanisms to produce coldest temperatures and hence to cause strong dehydration around the tropical tropopause.