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Analysis of tropical tropopause layer using the Nonhydrostatic ICosahedral Atmospheric Model (NICAM)

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The tropical tropopause layer (TTL) is a transition region between troposphere and stratosphere and main entrance region where tropospheric air passes through before entering the stratosphere. An amount of water vapor entering the stratosphere is controlled by temperature field in this region. The deep convection and waves around the tropopause are the main factors to control this temperature field. However, it is difficult to observe a in-cloud property, then the role of deep convection with respect to the temperature variation is not well known. Deep convection also acts as an agent for rapid transport of near-surface air into the TTL and sometimes directly into the lower stratosphere. Tropical deep convection is thus an important factor in determining the concentrations of chemical species in the TTL and in the stratosphere. In this study, we analyze the role of deep convection in the TTL using the Nonhydrostatic ICosahedral Atmospheric Model (NICAM), calculated under the real atmospheric conditions during December 2006 to January 2007 (the so-called MJO experiment).

(1) Deep convection is seen over the southern African continent, Indian Ocean, Indonesia maritime continent to tropical western Pacific, South American continent, ITCZ, and SPCZ.

(2) The diurnal cycle of deep convection and temperature variation in the TTL is observed over the Indonesian maritime continents. This temperature variation is associated with the deep convection. The maximum temperature variation reaches ~10 K (in amplitude). However, this impact is in local.

(3) Low temperature regions associated with tropical cyclone are observed over the convective core. The temperature drop reaches ~ 6 K with a 500-km horizontal scale.

(4) Large-scale low temperature regions in the TTL are mainly caused by Kelvin waves (~20 K in amplitude) generated by the large-scale organized convection such as the MJO.

We summarize that the role of deep convection itself with respect to the temperature variation is weak. The main factor controlling the temperature variation is waves, especially Kelvin waves excited by the organized convective clouds such as MJO. However, the deep convection has another possibility that transporting the near-surface air into the TTL and sometimes directly into the lower stratosphere. This problem will be solved using the global nonhydrostatic model, NICAM.

Keywords: TTL, dehydration, NICAM