Stratospheric dynamical impact on the development of tropical cyclone

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The previous studies demonstrated an enhancement of tropical convection together with an abrupt change in tropical circulation during the Stratospheric Sudden Warming (SSW) events using the satellite observation data [Eguchi and Kodera, 2007; 2010; Kodera et al., 2011, 2015] and numerical simulation [Eguchi et al., 2015]. Eguchi et al. [2015], by using the data from a global nonhydrostatic model, NICAM (Nonhydrostatic ICosahedral Atmospheric Model) [Satoh, et al 2014], which does not make use of cumulus parameterization, showed that the decrease of the static stability in the Tropical Tropopause Layer (TTL) associated with an intensified upwelling due to SSW event caused an enhancement of deep convection in the whole tropics.

The present study investigates the reason why and how the deep convection and tropical cyclones are enhanced when the TTL is cooled by the stratospheric dynamical effect. We used the global data from satellite, reanalysis (JRA55 and ERA-Interim) and NICAM simulation during January–February 2010, when the SSW occurred at the end of January. Once an upwelling occurred in the lower stratosphere and TTL associated with the SSW event, deep convection and tropical cyclones were enhanced globally along the 10◦S latitude (except over South America in the simulation), which were seen in both the reanalysis and simulation. Sudden cooling in the tropical lower stratosphere and upper troposphere were associated with an enhanced Brewer-Dobson circulation caused by the SSW. As a result, ice clouds were formed in the TTL, and the upper troposphere were destabilized, which possibly contributed to development of a tropical cyclone in the south-western Indian Ocean. It was found that deep convection was more enhanced in the presence of negative static stability in the TTL, and might affect the timing of tropical cyclone formation.

Key words: stratosphere-troposphere interaction, tropical tropopause layer (TTL), tropical cyclone/deep-convection

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