Evolution of Tropical Tropopause Temperature Induced by Convective and Stratiform Latent Heating

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Cold temperatures in the tropical tropopause layer, especially over the Western Pacific, have been associated with the dehydration process of air entering the tropical lower stratosphere. In boreal winter, the spatial distribution of temperatures below ~190 K resembles a horseshoe shape, a pattern thought to be due to the large-scale dynamical response to diabatic heating. However, regions such as equatorial Africa and South America do not have this cold horseshoe structure despite frequent tropical convection over these regions. In addition, tropical convection generates stratiform and convective precipitation, where the former causes heating mostly above the melting layer and the latter at lower altitudes. Currently it is not well understood whether convective or stratiform heating differ in their influence on tropopause temperatures. We will address these two problems by using estimates of latent heating from the TRMM SLH product in conjunction with temperature retrievals from COSMIC and Aura MLS. With respect to observed latent heating events we construct time-lagged composites to examine the evolution of the large-scale temperature structure induced by convective and stratiform latent heating.

For heating over the Maritime Continent in boreal winter, temperature composites show that a warm anomaly exists west of the heating location several days before the heating onset. The warm anomaly is tilted eastward with height suggestive of a Kelvin wave. A weak cold anomaly is observed above the heating location prior to the heating onset. After the onset, the cold anomaly strengthens, spreads eastward and upward, and the tilt of the cold anomaly also becomes flatter, a result similar to modeling results from Ryu et al. (2008). The existence of a wave approaching the heating from the west may be associated with the MJO as described by Masunaga (2006). Structures in the composites from stratiform and convective heating have similar structures, with the former having slightly stronger temperature anomalies. Results from this study will have strong implications on our understanding of the dehydration process and the mechanisms responsible for the cold temperatures over the Western Pacific.

Key words: tropical tropopause layer, latent heating, equatorial waves, dehydration, convection

References

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