The Radiative Effects of Tropical Tropopause Layer Water Vapor and Ozone on Tropical Cyclone Potential Intensity

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A sudden reduction in tropical tropopause layer (TTL) water vapor was observed in 2011, and was concurrent with reductions in TTL temperature and ozone. Termed "abrupt drops" these large variability events were previously known to be associated with radiative forcing and local radiative temperature changes. A recent study by the author and colleagues (Gilford, Solomon, and Portmann, *submitted to JOC*) used Aura Microwave Limb Sounder (MLS) water vapor and ozone observations and two radiative transfer models to examine the structure and radiative impacts of the 2011 abrupt drop. It was found that ozone and water vapor perturbations both nonlocally radiatively cooled the tropical upper troposphere, leading to a mean cooling of about 0.4K associated with the 2011 abrupt drop. Because the outflow temperatures of tropical cyclones can fall within this upper tropospheric region, abrupt drop radiative cooling could have increased tropical cyclone environmental potential intensities (PI). Notably, the largest reductions in TTL water vapor and ozone occurred over the Western Pacific basin, which recorded an above average tropical cyclone season near the end of the abrupt drop period (2013), including Typhoon Haiyan. In this study we use satellite observations of the 2011 abrupt drop along with the radiative-convective MIT single-column model (Emanuel and Zivkovic-Rothman 1999) to estimate the changes in PI associated with the 2011 abrupt drop in the Western Pacific basin. Results suggest that both dynamical and radiative changes in temperature associated with the 2011 abrupt drop were important for modifying environmental PI in the Western Pacific. We find that environmental PI is very sensitive to the level of outflow because of the substantial temperature stratification in the TTL.

References

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