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Diurnal Variation of Clouds Overshooting Tops Detected by Himawari-8 Satellite and Typhoon Intensity

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The diurnal variation of tropical oceanic convection has been recognized for decades. Recent observational studies have also documented a diurnal cycle associated with the upper-level cirrus canopy of tropical cyclone (TC) measured using the infrared brightness temperature from satellites. However, TC canopy clouds are not always coupled tightly with deep convection. The overshooting top (OT) is an appropriate proxy for deep convection with an intense updraft that can penetrate the tropopause, which has an important influence on typhoon intensification. So far, there are no observational evidences for the relationship between diurnal intensity variation and OT occurrences in TC.

We analyze the diurnal variation of OTs within 45 western North Pacific typhoons, using 9003 Himawari-8 satellite images and a unique OT detection algorithm. We examine the distribution of OTs in different types of typhoons in terms of both intensity and intensity change and the relationship between the OTs and typhoon intensification on a diurnal scale. Our results show that a greater OT density occurs in strong typhoons and rapid intensification (RI) typhoons. Moreover, RI typhoons showed greater diurnal variation than non-RI typhoons. The diurnal cycle of OT density in RI typhoons was in phase with the intensification of the typhoon, with the maximum in the early morning. These observational results are consistent with recently published case study simulations of the diurnal radiation effects on TC in both realistic and idealized scenarios. Therefore, OT density can become a potentially effective indicator to estimate diurnal changes in typhoon intensity.