In situ observation of typhoon central pressure using dropsondes

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After the US aircraft reconnaissance in the western North Pacific was terminated in 1987, typhoon intensity is estimated by the Dvorak technique using satellite cloud pattern. Consequently, uncertainty of intensity estimation became large for very intense typhoons. Accurate intensity estimations are essential for prevention and mitigation of typhoon disaster. They are also important information for a study of long-term change of typhoon with the climate change. To improve this problem, the T-PARCII (Tropical cyclone-Pacific Asian Research Campaign for Improvement of Intensity estimations/forecasts) project performs an in situ observation of typhoons. In this project, Nagoya University and Meisei Electric Co., Ltd developed a new dropsonde and a four-channel dropsonde receiver. Using these systems on a jet aircraft, the T-PARCII project performed aircraft observations of very intense typhoons in 2017 and 2018. Typhoon Lan (2017) was the most intense typhoon in 2017 and was categorized as a supertyphoon by JTWC. It moved northeastward in the east of the Okinawa main island at 23 N on 21 October and at 28 N on October 22, 2017. In these two days, we made dropsonde observations inside of the eye and in the surrounding area of the eyewall. The T-PARCII team also made aircraft observations of Typhoon Trami (2018) during the period from 25 to 28 September 2018 in collaboration with the SATREPS ULAT group as well as Taiwan DOTSTAR. The observed dropsonde data were transmitted to GTS (Global Telecommunication System) in real time and were used for typhoon forecasts in 2018.

Because the height of dropsonde is derived from GPS, error of height data becomes large just before the dropsonde reaches to the sea surface. As a result, the sea level pressure is uncertain. Typhoon intensity is represented by the central sea level pressure. Accurate estimation of sea level pressure is necessary for a typhoon intensity information. We, therefore, developed two schemes to estimate the sea level pressure from dropsonde data. Temperature, humidity and pressure are measured by sensors of dropsonde. We assume that the accuracy of these data is sufficiently high and height is also accurate above ~500 m in height. In the scheme I, the sea level pressure is calculated by a pressure correction method from 50~100 observed points in 900~750 hPa. The final result is the average of these calculated sea level pressure values. In the scheme II, heights of observed pressure levels below 800 hPa are calculated by the hydrostatic equation using virtual temperature. The sea level pressure is corrected from the lowest grid point.

These schemes were examined by special observations around Minami-Daitojima comparing dropsonde observations with balloon sonde observations launched from Minami-Daitojima Island as well as the JMA surface observation. The maximum difference of sea level pressure is less than 3 hPa. The central sea level pressures of typhoons Lan and Trami were calculated by the schemes I and II. The results by these two schemes agreed well each other. We consider that the sea level pressures were estimated with a sufficient accuracy. They were compared with the JMA best track data. The difference of central pressure of typhoon Trami was about 5 hPa on September 25 when the typhoon was most intense. It was about 10 hPa on September 28 when the typhoon was weakened in the south of the Okinawa main island.

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