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学 位 論 文 題 名

An observational study of tropical cyclone intensity estimation, intensity change processes, and intensity forecast

（熱帯低気圧の強度推定、強度変化プロセス及び強度予報に関する観測的研究）

An observational study of tropical cyclones (TCs) using radar and satellite data is made from the perspective of intensity estimation, intensity change processes, and intensity forecast. First, a system using Doppler radar data is developed, where the TC wind field is retrieved and the central pressure is estimated at 5-min intervals. A verification of intensity estimates relative to the best track data shows that the accuracy of the system is comparable to or better than the accuracies of Dvorak and satellite microwave-derived estimates.

Next, by using radar-retrieved winds and satellite-derived rainfall data, the statistical relationship between the azimuthal structure and intensity change, and intensity change processes in two TCs are investigated. It is found that, during the development stage, the higher the axisymmetricity (the degree of axial symmetry) of the rainfall distribution in the inner-core region, the larger the intensity change in the next 24 h, depending on the current intensity. The relative relationship between axisymmetric and asymmetric terms of rainfall shows that the larger the axisymmetric term and the smaller the asymmetric term, the larger the intensity change is.

Typhoon Noul (2015) was a TC that reintensified with the formation of a symmetric eyewall despite vertical wind shear greater than 10 m s^{-1}. The maximum azimuthal mean tangential wind at 2-km altitude increased from 30 to 50 m s^{-1} during only 5 h, associated with the increase in azimuthal mean reflectivity inside the radius of maximum wind (RMW). It was when the vortex vertically aligned through vortex precession upshear that a symmetric eyewall formed in strong shear.

Typhoon Goni (2015) was a TC that underwent rapid intensification (RI) just after an eyewall replacement cycle. Around the onset of RI, relatively strong outflow outside the

RMW above the boundary layer was observed, which contributed to the rapid contraction of the low-level RMW, causing the RMW to slope greatly outward with height. This increasing outward slope may have been favorable for convection inside the RMW in the free atmosphere. During RI, the low-level outflow changed into inflow just outside the RMW and the secondary circulation became well-established. An updraft peak and the radius of maximum reflectivity between 2- and 9-km altitudes were located inside the RMW. These features are consistent with other intensifying TCs.

Finally, the possibility of further improvement in TC intensity forecast is examined based on the findings in this study. Five new predictors associated with rainfall distribution and structural features are incorporated into a multiple linear regression model, which predicts intensity up to 5 days ahead. The results show that the model produces a 2–6% improvement in the forecast skill, compared against a model without those predictors.

This study advanced the measurement, forecast and scientific understanding of tropical cyclones significantly. The review committee highly evaluated the achievement of this study and concluded that the applicant deserves to receive the degree of Doctor of Environmental Science.