Estimation of Tropical Cyclone Intensity Using Satellite Passive Microwave Observations

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Estimating the intensity of tropical cyclones (TCs) is one of the most important steps in TC forecasts. Currently, TC intensity is almost exclusively estimated by the Dvorak technique, especially when reconnaissance data are not available. The Dvorak technique used visible and IR satellite imagery to observe the central and banding features of TCs. However, the visible and IR images only show the cloud top structure of a TC and cannot measure the detailed rainfall and convective structure at lower levels, especially in the eyewall. Thus, the Dvorak technique has a known problem in determining TC intensity, especially when a central dense overcast (CDO) exists and blocks the cyclone's eye and eyewall features underneath the CDO. Unlike IR and visible sensors, passive microwave channels allow penetration into precipitating clouds, therefore providing information about precipitation and ice particles instead of just the cloud tops. Upwelling radiation at microwave frequencies can be used to retrieve the rain rate in TCs. Many previous studies have proved the concept of using microwave brightness temperatures and retrieved rain rates to estimate TC intensity, but this information is seldom utilized in TC operational forecasts.

In this study, an operational algorithm to estimate the current intensity of TCs using most of the current available microwave satellite sensors will be developed. The technique builds on the results of Cecil and Zipser (and many others) who demonstrated that the storm intensity is very well correlated with variables associated with 85 GHz brightness temperatures and rain rates in the inner core. Using a developmental dataset of 11-yr Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) TC observations, a set of 85 GHz and rain related variables is evaluated and selected as the input variables of the algorithm. The TC intensity will be estimated from a linear combination of these estimators. Regression models are developed for the Atlantic and East Pacific basins. The real-time input will be the inter-calibrated 85-91 GHz microwave brightness temperatures and retrieved rain rates from the Global precipitation Mission (GPM) 1C-constelation and 2A-GPROF-constellation near-real-time products, respectively. The GPM constellation sensors to be used in real-time includes GPM Microwave Imager (GMI), Special Sensor Microwave Imager/Sounder (SSMIS), and Advanced Microwave Scanning Radiometer 2 (AMSR-2). This algorithm is referred to as the **Passive Microwave Intensity Estimation (PMW-IE)** model.