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An Approach to Realistic Parameterization (REP) Model of Typhoon Pressure and Wind Fields Around Taiwan

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Typhoon-induced storm surge modeling involves forcings of 10-m wind and sea level pressure fields, typically determined by an adequate parametric typhoon model based on typhoon tracks, sizes, and intensities or a fully dynamical simulation by numerical weather prediction (NWP). Parametric models have been widely developed to simulate tropical cyclones. In conventional Holland-type parametric models, a typhoon or hurricane is modeled as a symmetric or quasi-symmetric vortex. These symmetric assumptions fit the observation well in deep-ocean areas or areas with flat topography. A tall Central Mountain Range (CMR), however, will cause these models to produce significant errors. The presence of CMR can impact TCs moving over it or passing by, resulting in storm surge modulation in Taiwan's vicinity. The diversity of the environment surrounding Taiwan generates various physical issues that complicate storm surges. In this paper, we aim to create a new weather model for storm surge calculation while only the track and intensity are known for a tropical cyclone, and this model shall be able to present the terrain blockage effect. Because the wind velocity is much faster than the moving speed of the typhoon, the flow field soon transfers from a transition stage into a quasi-steady state. As a result, the weather field is primarily controlled by storm intensity and topography and has less effect from the storm trajectory. This paper presents a new statistical method for generating a realistic weather field based on the location and intensity of the typhoon. Instead of using conventional parametric models to represent the structure of wind and pressure fields of a typhoon, we aim to develop a Realistic Parameterization (REP) Model by employing a 10-m (above sea level) wind field and sea-level pressure from historical typhoons to provide more realistic typhoon model and to generate better storm surges when the influence of topography is non-negligible. We adopted the ERA-5 reanalysis data from the European Centre for Medium-Range Weather Forecasts (ECMWF) with a total of 3200 data from 1981 to 2021. ERA-5 reanalysis data were validated against ground observation from the Central Weather Bureau (CWB) in Taiwan, including pressure and wind speed gauge data. The storm surge was simulated using the COMCOT-SS model. The results were compared with the tidal gauge data from CWB as well. Excellent comparison results can be seen. After the validation, the ERA-5 data were used as the database to generate the weather field by providing the location and intensity of the typhoon.

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