NUMERICAL MODEL STUDY OF LANDFALLING TROPICAL CYCLONE BOUNDARY LAYER WINDS

Chang, C.-B.
Texas Tech University

Tropical cyclones (TCs) are among the most devastating of all nature disasters. Individual cyclones are capable of causing catastrophic losses of property and life. The major causes of damage associated with TCs at landfall are the strong winds, heavy precipitation, and storm surges. This study focuses on the strong winds. The effects of sustained high winds are generally confined within tens of kilometers of the coast. Studies showed that within a landfalling cyclone the boundary layer processes driven by terrain forcings could have a critical role in defining the locations and magnitude of surface wind speed and rainfall maximums. This study is motivated by the need of a better understanding of TC boundary layer wind structure over land. Great difficulties in data collection hamper comprehensive observational studies of TC boundary layer winds.

A very-fine resolution dry gradient-wind model with an advanced treatment of boundary layer physics is used to simulate landfalling TC conditions. The model surface pressure field is initialized using an empirical formula. For a TC of interest, the intensity of the model system is specified by adopting the observed or simulated central pressure and size of the TC in the formula. The initial wind field is then determined based on the gradient wind balance equation. The relative simplicity of the model allows us to conduct a large ensemble of short-range (6- to 12-h) simulations encompassing various landfalling scenarios in a short time for a given location. The topics of great interest are the interaction between the boundary layer winds and the coastal environment and the development of internal boundary layer in the vicinity of coastline under different landfalling angles.

The model simulations verified with data compiled carefully from different sources will enable us to investigate quantitatively some non-observable details and mechanisms important in depicting the surface winds and assess the rainfall distribution based on the model vertical motion field. Findings will facilitate the search of empirical parameters relating the high surface winds and heavy rainfall to the damage field. The goal is to develop a prediction system based on a simple modeling technique in conjunction with limited observations to provide near real-time information for effective and rapid damage assessment and mitigation for the coastal regions during a landfalling TC event.

Key Words: model, tropical cyclones, boundary layer winds