Application of a Hurricane Boundary Layer Model for Improved Surface Wind Forecast

Student: Mansur Ali Jisan

Faculty: Isaac Ginis

COE/Program: Coastal Resilience Center/Coastal Hazards Modeling

Damaging winds are one of the many reasons behind the catastrophe caused by hurricanes. In most cases, wind damage occurs within the first few hours of landfall when the land roughness changes abruptly from the ocean towards the land. Coastal Resilience Center (CRC) researchers from the University of Rhode Island Graduate School of Oceanography (URI-GSO) are supporting DHS by developing new capabilities for predicting surface wind during hurricane landfall. This study investigates the impact of land-roughness on the hurricane's near-surface wind structure using a physics-based Hurricane Boundary Layer (HBL) model. A hurricane vortex specification procedure is developed using the National Hurricane Center's (NHC) forecast data to realistically represent the storm structure at the top of the boundary layer. The HBL model was applied for two recent hurricanes that made landfall on the United States coast: Hurricane Irma (2017) and Hurricane Florence (2018). In simulating the wind during landfall, we compared the wind structure with and without the influence of land-roughness. These comparisons reveal significant changes in wind speed and spatial distribution due to land-roughness impact. The storm structure was validated against the NHC forecast products of Radius of Maximum Wind, Radius of the 18 m/s wind, and 26 m/s wind. Timeseries comparisons and the wind field's radial distribution were validated against available observations from the aircraft Stepped Frequency Microwave Radiometer (SFMR), National Data Buoy Center's buoys, and land-based stations. The calculated Root Mean Squared Error (RMSE) is within 2-5 m/s, suggesting reasonable agreements with observations. Findings from this research will help improve our understanding and prediction of hurricane wind speed and structure during landfall. It will also help coastal communities and emergency managers to better prepare for the risks presented by future hurricane landfalls.