Abstract

Title: Impacts of Shoaling Ocean Surface Waves on Wind Stress and Drag Coefficient

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This study investigates the impacts of shoaling waves on the wind stress and drag coefficient (C_d) in coastal waters during tropical cyclone (TC) landfall. Numerical experiments are conducted using idealized TCs with two intensities, Category 1 and 5, and two translation speeds, 5 m/s and 10 m/s, propagating toward and normal to the shoreline over two bottom slopes, 1:200 and 1:2000. The wave spectra are simulated using the WAVEWATCH III wave model. The unresolved high-frequency spectral tail is parameterized as a function of wind speed and the full wave spectrum is used to calculate the wind stress and drag coefficient. Our results show that the sea-state dependence of wind stress magnitude (or C_d) is significantly increased in shallow water at a given wind speed. Compared to its deep-water value, C_d is enhanced in the right (due to shoaling fetch-dependent waves) and in the left (due to shoaling opposing-wind swells) TC quadrants. However, C_d is reduced in the front/rear quadrants due to weaker wind seas. The misalignment between the wind stress and wind speed directions is enhanced in shallow water. In general, the shoaling wave effects on the wind stress and C_d are much stronger on steeper bottom slopes and in faster moving storms.