Forecasts and evaluation of Strong Tropical Cyclones Improved by Incorporating Ocean Surface Waves at Air-Sea Interface

Fangli Qiao[1], Songlin Li[1], Biao Zhao[2], Qi Shu[1], Vladimir Ryabinin[3], Dong Ji[1], Guomin Chen[4] and Ka-Kit Tung[5]

[1]*First Institute of Oceanography and Key Laboratory of Marine Science and Numerical Modeling MNR, Qingdao, China*
[2]*Department of Earth Sciences, Uppsala University, Uppsala, Sweden. Now with Program in Atmospheric and Oceanic Sciences at Princeton University, New Jersey, USA.*
[3]*Individual Researcher, former Executive Secretaery of UNESCO/IOC*
[4]*Shanghai Typhoon Institute, China Meteorological Administration, Shanghai, China*
[5]*Department of Applied Mathematics, University of Washington, Seattle, WA, USA*

Abstract

Tropical cyclones (TCs), also known as typhoons or hurricanes, pose grave threat to coastal population. Due to advances in remote sensing and increasing computing power, recent decades have seen marked improvement in track forecasting. However, TC's destructive power depends on its intensity. Yet modern operational forecasts continue to severely underpredict the peak intensity of strong TCs, while overpredict weak ones. Current forecasting models already include the coupling between the atmosphere and ocean but ignore the significant energy and momentum transfers from the ocean by breaking waves, and the effect of non-breaking waves on mixed-layer depths. Here we demonstrate that by properly accounting for the dynamic air-sea interface, the peak intensity of TCs is correctly forecasted. Probability of detection for rapid intensification in Northwest Pacific increases to 90% compared to 10- 50% from existing models. A long-awaited breakthrough in predictions of TC intensity, especially for strong TCs, becomes achievable. Comprehensive validation was implemented on the performance of the new third-generation Typhoon models, which is crucially important for the development of an ocean-climate seamless forecasting system.