Air-Sea Interactions over the Tropical Ocean and Earth System Modeling: Progress, Challenges, and Ways Forward

Shuyi S. Chen
Department of Atmospheric Sciences
University of Washington
Email: shuyic@uw.edu

Air-sea fluxes of mass, heat, and momentum are critically important for global weather and climate. Water evaporated from the tropical oceans is a major source of moisture for global precipitation, and salt and organic aerosols from the oceans provide cloud nucleation sites and affect microphysical processes. Transfer of heat and momentum between the atmosphere and ocean drives the atmospheric and ocean circulations and modulates the global water and energy cycle. Although the air-sea transfer processes occur on small scales, their impact on weather and climate is global and across all scales. Progress toward accurate modeling of air-sea fluxes has been limited in part because of the complex physical processes controlling the air-sea fluxes and the lack of observations, especially in high-wind conditions, in which extreme wind-induced surface waves and sea spray push the existing air-sea flux formulations into untested territories. These are not well understood and poorly represented in current weather prediction and Earth system models.

The need for acurrate and integrated impact forecasts of extreme wind, rain, waves, storm surge, and flooding is growing as coastal population and built environment expand worldwide. One of limiting factors is the lack of accurate representation of explicit, physciallly consistent processes controlling the air-sea exchange in fully coupled atmosphere-wave-ocean models, which is foundamental to the global weather and climate modeling across scales. I will present a review of the progress and chalenges in air-sea interaction in context of tropical convection and prediction across scales from hours to subseasonal including examples from tropical cyclones to the MJO. A fully coupled atmoshere-wave-ocean modeling framework and need for in situ and satellite observations going forward will be discussed.