Numerical Studies of the Nonlinear Interaction between the Ocean Surface Waves and the Turbulent Boundary Layer

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Abstract

Accurate parameterization of air-sea exchange of mass, momentum, and energy requires a quantitative understanding of the transport processes within the interfacial turbulent boundary layer. Although the processes have been studied extensively, there are still uncertainties in quantifying the physical and physicochemical factors involved due to the strong nonlinear complexities implicit in both the surface waves and the underlying turbulence. Owing to the profound difficulties in conducting *in situ* measurements, most of the experimental studies on transport processes at the air-water interface have been conducted in laboratory wind-wave fumes. Numerical simulations offer another means for improving understanding the processes, but only recently have computing resources advanced to make sufficiently large-scale simulations possible.

In this talk we will present recent advances in developing a numerical model for process-oriented studies of the three-dimensional turbulent flow bounded by a nonlinearly evolving ocean surface. The developed model has been applied to the studies of micro processes responsible for the immediate transport next to the ocean surface. Three examples of the model applications will be presented:

Correlation between the submerged “surface renewal eddies” and the characteristic signatures at the air-water interface;

Hydrodynamic mechanism of transport retardation at the air-water interface by the presence of “surfactants”;

Generation mechanism of “micro-breaking wind waves” and their impacts on transport at the air-sea interface.