Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Direct numerical simulation of scalar transport in turbulent flows over progressive water waves DI YANG, LIAN SHEN, Johns Hopkins University — The transport of passive scalars in turbulent flows over progressive water waves is studied using direct numerical simulation. A hybrid pseudo-spectral and finite-difference scheme on a wave-surface-fitted grid is used to resolve the flow and scalar fields near the wave surface. Various Schmidt numbers, wave phase speeds, and wave slopes are considered, and their effects on the instantaneous and statistics of scalar concentration are investigated. The scalar field shows apparent wave-phase dependence induced by the wave surface curvature and motions. For slow waves, the scalar field is mainly affected by the wave surface geometry with similarities with the case of a stationary wavy boundary. Differently, when the wave phase speed is large, the wave motion has strong influence on the scalar field. Budget for the intensity and flux of scalar concentration fluctuations are also studied. The analysis provides useful insight into the modeling of scalar transport over progressive waves.

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Date submitted: 08 Aug 2011 Electronic form version 1.4