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Statistical study of scalar transport in wind-driven free-surface turbulent flows HAMID REZA KHAKPOUR, LIAN SHEN, TAKERU IGUSA, Johns Hopkins University — We examine statistical methods for the study of the correlation between characteristic turbulence structures and scalar transport process in free-surface turbulence. We perform direct numerical simulation for the advection and diffusion of passive scalars in wind-driven free-surface turbulent shear flows. Using conditional averaging of events with strong scalar surface flux or large vorticity components, we characterize the correlation of surface flux with a variety of subsurface vortical structures. We then present a clustering method based on the Expectation-Maximization (EM) Algorithm. This clustering method is found to be effective in identifying dominant flow patterns which are associated with characteristic vortical structures. The method also provides insights into the induction of upwelling by vortical structures which, in turn, greatly enhances the scalar surface flux. The clustering method is general and can also be used for applications beyond interfacial scalar transport.

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