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Assessment of turbulent dispersion in the Red River plume region, northeast Vietnam, based on Lagrangian observations and modeling

Alexei Sentchev, Duc Thinh Nguyen, Duy Vinh Vu, and Stefano Berti

The study aims to assess turbulent dispersion processes in the coastal regions of northeastern Vietnam, in order to meet the major challenge of monitoring the fate of particulate materials in this part of the East Vietnam Sea, home to the most famous tourist sites and economic sites. The study area is strongly influenced by the freshwater discharge of the Red River, which creates a large river plume, greatly affecting coastal circulation and turbulent dispersion. The monsoon wind profoundly alters the dynamics of the river plume, pushing light surface water seaward over long distances, in summer, and toward the coast, in winter. Sea surveys were organized for the first time in this region in 2022 and 2023 to better characterize the processes controlling coastal flow variability and turbulent dispersion in the plume region and surrounding waters. Surface drifters, released in the plume region, were tracked during short periods of time, from one to a few days. Current velocity profiling and CTD profiling have been also done. Estimates of the relative dispersion based on surface drifter measurements have revealed that the dispersion regime is local, mainly ballistic and Richardson, induced by turbulent eddies whose size does not exceed a few km. Local wind variability, combined with variations in bathymetry, considerably affects the transport pathways of real drifters and modifies the dispersion regime. A coastal circulation model was used to better assess dispersion processes over the entire study area and for a wide range of variability in the main forcing terms. Virtual surface drifters were tracked in the model velocity field during the surveying periods. The results revealed that, on scale of several days, the transport of passive tracers is considerably affected by irregularities in current velocity fields associated with zones of current convergence and divergence. The results also demonstrated that merging observations with model outputs significantly improves the representation of small scale features of current variability, turbulent mixing, and horizontal stirring of tracers in the plume region.