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Modeling the Dispersal of Particles in the Marine Environment: Applications and Challenges

Lagrangian transport modeling, that is, simulating the dispersal of virtual particles in hydrodynamic flow fields, is a powerful tool in marine science. It helps us addressing diverse scientific and societally-relevant questions concerning, for example, the transport of water masses, mixing of tracers, fate of pollutants, patterns of ecological connectivity, and search and rescue efforts. This contribution provides insights into both the diverse interdisciplinary applications and the emerging challenges of marine Lagrangian transport modeling, with a regional focus on the Baltic Sea. Particular emphasis is placed on improving the representation of particle-type-specific transport processes across scales, from the coast to the open ocean, and across interfaces, including the ocean-atmosphere, ocean-land, and ocean-sediment transitions.