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Wave induced transport and mixing of buoyant particles

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The modeling of wave-current and wave-turbulence interactions have received much attention during recent years. Both the breaking of surface waves and the inclusion of the Stokes shear production have been shown to increase the upper ocean turbulence. Furthermore the Coriolis force acting on the Stokes drift redistributes the momentum in the upper ocean, leading to a deflection of the currents. An important application affected by these processes that still needs to be studied is the mixing and drift of particles.

Using an ocean column model, modified to take surface wave effects into account, we investigate how the increased mixing by wave breaking and Stokes shear production as well as the stronger veering by the Coriolis-Stokes force effects the drift of suspended particles.

Here the suspended particles are buoyant tracers that can represent oil droplets or plankton, for example fish eggs and larvae. The energy and momentum fluxes as well as the Stokes drift depend on the directional wave spectrum that can be obtained from a wave model or from observations.

Comparing with classical Ekman theory some physical effects on the system are studied, and as a realistic test case we use the model to study the oil drift after an offshore oil spill that took place outside the western coast of Norway in 2007. During this accident the average net drift of oil was observed to be approximately 0.1% of the wind speed at an angle of about 90-120 degrees to the right, far slower and more deflected away from the wind direction than predicted by both numerical and empirical models. With wind and wave forcing from ECMWF reanalysis data, it is shown that the wave effects are important for the resultant drift in this case, and has the potential to improve drift forecasting.