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The Stokes drift in ocean surface drift prediction

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Ocean surface drift forecasts are essential for numerous applications. It is a central asset in search and rescue and oil spill response operations, but it is also used for predicting the transport of pelagic eggs, larvae and detritus or other organisms and solutes, for evaluating ecological isolation of marine species, for tracking plastic debris, and for environmental planning and management. The accuracy of surface drift forecasts depends to a large extent on the quality of ocean current, wind and waves forecasts, but also on the drift model used. The standard Eulerian leeway drift model used in most operational systems considers near-surface currents provided by the top grid cell of the ocean circulation model and a correction term proportional to the near-surface wind. Such formulation assumes that the 'wind correction term' accounts for many processes including windage, unresolved ocean current vertical shear, and wave-induced drift. However, the latter two processes are not necessarily linearly related to the local wind velocity. We propose three other drift models that attempt to account for the unresolved near-surface current shear by extrapolating the near-surface currents to the surface assuming Ekman dynamics. Among them two models consider explicitly the Stokes drift, one without and the other with a wind correction term. We assess the performance of the drift models using observations from drifting buoys deployed in the Estuary and Gulf of St. Lawrence, Canada. Drift model inputs are obtained from regional atmospheric, ocean circulation, and spectral wave models. The performance of these drift models is evaluated based on a number of error metrics (e.g. speed, direction, separation distance between the observed and simulated positions) and skill scores determined at different lead times ranging from 3h to 72h. Results show that extrapolating the top-layer ocean model currents to the surface assuming Ekman dynamics for the ageostrophic currents, and adding the Stokes drift predicted by a spectral wave model, leads to the best drift forecast skills without the need to include a wind correction term.