Modelling Lagrangian trajectories during storm events: the importance of ocean-wave coupling

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Skilful forecasts of the sea surface dynamics are important for many human activities. During storm events, wave-current interactions might represent a leading order process of the upper ocean. North-west (NW) European shelf seas can be affected by extremely severe storms, increasing the need for accurate predictions of the surface ocean dynamics. In this work we assess the impact of ocean-wave coupling on the surface dynamics of the NW shelf during four storms occurred in winter 2016.

We compare two versions of the Met Office ocean-wave forecasting system at a resolution of 1.5 km: one uses the ocean and wave models in uncoupled mode while the other is a coupled system including three ocean-wave interactions, namely the Coriolis-Stokes forcing, a wave-modified water-side momentum flux and a sea-state dependent sea surface roughness. The assessment is conducted using ocean currents and Stokes' drift from the two systems to simulate the Lagrangian trajectories of a number of SVP (15m-drogued) and iSphere (surface) drifters affected by the storms.

Ocean-wave coupling generally improves the accuracy of the simulated surface dynamics by 4%, with higher improvements on the shelf (+8%) than in the open ocean (+3%). The Coriolis-Stokes forcing is the dominant wave-current interaction for both type of drifters; for iSpheres, the second wave effect is the wave modified water-side stress while for SVPs is the wave dependent sea surface roughness.

In conclusion, during storms ocean-wave coupling is able to improve the accuracy of the predicted surface dynamics, with higher impacts on the shelf. This seems to be a consequence of the contrasting dynamical regimes characterizing deep and shallow marine environments, with stronger tidal currents, a more vigorous wind-driven circulation and a more pronounced Coriolis-Stokes veering on the shelf than in the open ocean.