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Effect of the wave-induced forcing on the North Sea NEMO during extreme storms

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The effects of wind waves on the North Sea hydrography during two storms are investigated using a coupled WAM-NEMO model system. The additional terms accounting for wave-current interaction that are considered in this study are the Stokes-Coriolis force, sea-state dependent energy flux and sea-state dependent momentum flux. The individual and collective role of these processes is quantified and the results are compared with observational data that include ADCP observations and continuous measurements from data stations. The analyses of the modelling results and the available observations reveal a closer match with observations for the coupled wave-circulation model, especially during extreme events. The two extreme events, the storm Christian (25-27 of October 2013) and about a month later the storm Xaver (5-7 of December 2013), induce different wave and surge conditions over the North Sea. Including the wave effects in the circulation model for the storm Xaver raises the predicted surge of the coupled model by about 40 cm compared with the standalone ocean model integration for the German Bight area. For the storm Christian, a difference of 20-30 cm in the surge level between the coupled and the standalone ocean model is found over the whole southern part of the North Sea. Moreover, the modeled vertical velocity profile fits the observations very well when the wave forcing is accounted for. The contribution of wave-induced forcing has been quantified and examined indicating that this represents an important mechanism for improving ocean state predictions.