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Sea-state contributions to sea-level variability in the European Seas

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The contribution of sea-state-induced processes to sea-level variability is investigated through ocean-wave coupled simulations. These experiments are performed with a high-resolution configuration of the Geestacht COAstal model SysTem (GCOAST), implemented in the Northeast Atlantic, the North Sea and the Baltic Sea which are considered as connected basins. The GCOAST system accounts for wave-ocean interactions and the ocean circulation relies on the NEMO (Nucleus for European Modelling of the Ocean) ocean model, while ocean-wave simulations are performed using the spectral wave model WAM. The objective is to demonstrate the contribution of wave-induced processes to sea level at different temporal and spatial scales of variability. When comparing the ocean-wave coupled experiment with in situ data, a significant reduction of the errors (up to 40% in the North Sea) is observed, compared with the reference. Spectral analysis shows that the reduction of the errors is mainly due to an improved representation of sea-level variability at temporal scales up to 12 h. Investigating the representation of sea-level extremes in the experiments, significant contributions (> 20%) due to wave-induced processes are observed both over continental shelf areas and in the Atlantic, associated with different patterns of variability. Sensitivity experiments to the impact of the different wave-induced processes show a major impact of wave-modified surface stress over the shelf areas in the North Sea and in the Baltic Sea. In the Atlantic, the signature of wave-induced processes is driven by the interaction of wave-modified momentum flux and turbulent mixing, and it shows its impact to the occurrence of mesoscale features of the ocean circulation. Wave-induced energy fluxes also have a role (10%) in the modulation of surge at the shelf break.