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

Introduction

Ocean waves can affect water-level changes through changes to the ocean surface stress, mixing and circulation and wave-induced processes (WIPs) have a major contribution during sea-level extremes. The objective of the present work was to assess the contribution of WIPs to sea-level variability and surge.

Methods

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, implemented in the Northeast Atlantic, the North Sea and the Baltic Sea which are considered as connected basins.

Results

When comparing the ocean-wave coupled experiment with in situ data, a significant reduction of the errors 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 due to wave-induced processes are observed both over continental shelf areas and in the Atlantic.

Conclusion

Wave-induced momentum flux has a major contribution over the North Sea and Baltic Sea, while wave-induced energy flux shows a small impact over these sub-domains. On the other hand, wave-modified mixing had a significant contribution at the shelf break showing that sea-state-dependent energy flux modulates the amplitude of surge in these areas through modified turbulent mixing. In the open ocean, the spatial patterns observed in the North Atlantic Drift and the Bay of Biscay, associated with mesoscale features of the ocean circulation, were driven by the interaction of wave-modified surface stress and vertical mixing.