Unstructured Grid Model Simulations in the North and Baltic Seas

Sebastian Grashorn[1], Emil V. Stanev[2], Wolfgang Koch[2], Y. Joseph Zhang[2]

[1]Helmholtz-Zentrum Geesthacht, Institute of Coastal Research, Data Analysis and Data Assimilation1

[2]Virginia Institute of Marine Science, Center for Coastal Resources Management, USA

A two-way coupled model system based on the unstructured grid model SCHISM (Semi-implicit Cross-scale Hydroscience Integrated System Model) and the surface wave model WWM-III (Wind Wave Model) has been developed for the North and Baltic Seas to investigate the specific dynamics in the two basins and in the multiple straits connecting the two basins, and more specifically on how the model replicates the temporal and spatial variability of physical processes.

The validation of the simulated data indicates the realism in the simulations of the exchange flows. The results demonstrate that the amplitudes of the tidal signal decrease in the Danish straits, but in contrast the role of the barotropic forcing due to weather systems increases. In this transition zone reversal of transports is well manifested by the increased difference between the surface and bottom salinity values. In the western Baltic Sea small sub-basins like Arkona and Bornholm play the role of reservoirs for denser water which under specific conditions cascade on their way to the Gotland deep. Unlike the intermediate and deep water salinity in the Baltic Sea, which is strongly affected by fluxes in the straits, the simulated winter-refill and evolution of cold intermediate water are rather driven by surface cooling and processes in the upper mixed layer. The spatial SST patterns reveal the large-scale upwelling events, which contribute to the cooling of surface water by cold intermediate water.

The model setup is also used to investigate the impacts of a storm surge event that happened in the North and Baltic Sea. The results show that the highest effects of the wave-current interactions can be observed in coastal areas. Strong longshore currents and a pronounced surface elevation setup are generated in shallow areas during the storm surge event due to effects of the waves on the current system. The analysis of numerical simulations demonstrates that the significant wave height in coastal areas is substantially affected by the tidal signal and wave-current interaction. The validation against observations justifies the superiority of using a coupled model system when investigating geophysical processes in the coastal areas, especially during storm surge events.