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Effects of periodic forcing anomalies on storm surge prediction in the North Sea-Baltic Sea transition zone

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Flooding from the sea poses a major threat to health and property in coastal regions. In the North Sea-Baltic Sea transition area, extreme sea level variations are mainly driven by atmospheric forcing. In this region, storm surges generated either externally, or internally in the North Sea or Skagerrak/Kattegat, enter the transition zone from the north. Elevated water levels transmitted into the region from the Baltic Sea originate from prevailing meteorological forcing over the Baltic Sea, but with additional contributions from pre-filling of the basin and seiches. We use a regional storm surge model to simulate the spatial and temporal development of water levels during past storm surge events. The storm surge model is driven by the ERA-Interim based UERRA HARMONIE/V1 regional reanalysis. While the atmospheric reanalysis shows good agreement with observations at the six hourly analysis, the hourly re-forecasts experience spikes in the first time steps following analysis e.g. in wind speed. We hypothesize that the occurrence and periodicity of the spikes may generate artificial oscillations and enhanced mixing when used as forcing for storm surge models. The sharp temporal gradients in surface stress introduced by the spikes have the potential to enhance mixing in the water column. Anomalous wave propagation due to the pulsating recurrence of the spikes may generate internal waves with increased mixing due to e.g. internal wave breaking. We evaluate the impact of the anomalous spikes on the storm surge model by generating test cases where the spikes are eliminated, and compare them to the same storm surge events with the original spiky forcing data. The experiments are conducted for the North Sea and Baltic Sea with a particular focus on the transition zone. This area is especially interesting since it is strongly influenced by freshwater exchange from the Baltic Sea, while the subsurface exchange with the Baltic Sea is restricted by the bathymetry. Enhanced mixing and wave propagation therefore significantly alter the simulated hydrography and water level. We evaluate the ability of the model setup to capture the temporal and spatial development of storm surges by comparisons to tide gauge observations in the region.