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Classifying the impact of natural bathymetry changes on hydrodynamics in the German Bight between 1996 and 2015 (North Sea)

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Coastal regions such as the German Bight (North Sea) often comprise complex bathymetric settings ranging from shelf sea regions to estuaries, tidal flats with barrier islands together with small tidal inlets. Bathymetry is considerably dynamic in shallow and estuarine areas. Consequently, when modeling, the question arises how complicated the relationship between small bathymetric features and large-scale hydrodynamics really is. An analysis of annual calculated bathymetries from 1996, 2006 and 2015 strongly suggests implications on large-scale tidal dynamics. Previous work has shown that bathymetric variation may provoke remarkable responses in tidal dynamics concerning amplitude, phase and asymmetry. A more detailed, shallow-water-focused, three-dimensional modeling approach describing the effects on water level and tide-induced currents is yet to be carried out, though.
The numerical North Sea model of the German Federal Waterways Engineering and Research Institute (Hamburg) has recently been extensively updated and utilizes a consistent annual bathymetry data-base which was spatially and temporally interpolated from many different measuring campaigns. The model uses the 3D-UnTRIM2 method, which takes advantage of the novel subgrid approach. This leads to a tremendous improvement for the accurate representation of bathymetry on the computational grid by taking the statistical depth distribution of the consistent data-base into account. Accordingly, the effect of very small-scale features such as tidal channels can be estimated well with acceptable computational effort.
With this model, a hindcast simulation for the whole year 2015 has been performed. By alternating the underlying bathymetry data-base to earlier years (1996, 2006), a judgment on the impact of real bathymetric changes becomes possible. These calculations allow us to classify and demonstrate areal changes in hydrodynamics in the past 20 years within the whole German Bight. By systematically applying different bathymetries, this study demonstrates the influence of depth changes on tidal parameters, e.g. tidal range, partial tides, as well as velocities and velocity-related measures for a large area.
Since the mean sea level will be represented in the annual bathymetry data-base, the effect of a rising mean sea level (1996 to 2015) as well as natural variation can be interpreted much more accurate. This will add increment value for the understanding of future developments in coastal areas.