



Revisiting sea level changes in the North Sea during the Anthropocene

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The North Sea is one of the best instrumented ocean basins in the world. Here we revisit sea level changes in the North Sea region from tide gauges, satellite altimetry, hydrographic profiles and ocean reanalysis data from the beginning of the 19th century to present. This includes an overview of the sea level chapter of the North Sea Climate Change Assessment (NOSCCA) complemented by results from more recent investigations.

The estimates of long-term changes from tide gauge records are significantly affected by vertical land motion (VLM), which is related to both the large-scale viscoelastic response of the solid earth to ice melting since the last deglaciation and local effects. Removing VLM (estimated from various data sources such as GPS, tide gauge minus altimetry and GIA) significantly reduces the spatial variability of long-term trends in the basin. VLM corrected tide gauge records suggest a transition from relatively moderate changes in the 19th century towards modern trends of roughly 1.5 mm/yr during the 20th century. Superimposed on the long-term changes there is a considerable inter-annual to multi-decadal variability. On inter-annual timescales this variability mainly reflects the barotropic response of the ocean to atmospheric forcing with the inverted barometer effect dominating along the UK and Norwegian coastlines and wind forcing controlling the southeastern part of the basin. The decadal variability is mostly remotely forced and dynamically linked to the North Atlantic via boundary waves in response to long-shore winds along the continental slope. These findings give valuable information about the required horizontal resolution of ocean models and the necessary boundary conditions and are therefore important for the dynamical downscaling of sea level projections for the North Sea coastlines.