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Northern European storm surge climate since the mid-18th century

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Storm surges represent a serious hazard affecting coastal communities. Their intensity and frequency may change in a warming climate, either due to rising mean sea levels or possible changes in regional wind fields. While there is a scientific consensus that sea levels are significantly rising since the late 19th century, possible changes in extreme winds or storminess depend on the region and time period assessed. A major issue is the limited availability of wind observations, hampering reliable estimates of long-term changes in storminess.
Here we assess the characteristics of regional wind storm fingerprints in storm surges as measured by selective tide gauges over the Northern European Shelf. While the availability of reliable atmospheric reanalyses or direct wind observations is mostly limited to the second half of the 20th century, high quality tide gauge measurements extend as far back as the 18th century. Therefore, tide gauges provide a unique insight into the occurrence of land-falling or near-coastal storms, and their variability on decadal and longer time scales. Their use is thus attractive not only regarding the impact on coastal communities, but also for the investigation of long-term climate variability and change. In this study, we investigate the suitability of the six following long Northern European tide gauges as proxies for possible changes and variability in storminess over Northwestern Europe: Brest (1711-2012), Newlyn (1915-2012), Liverpool (1768-2012), Aberdeen (1930-2012), Cuxhaven (1843-2012), Rorvik (1969-2012), and Lerwick (1959-2012). Major extreme surge events are identified and compared to changes in winds in atmospheric pressure data. This is done by (i) an objective composite and correlation analysis using state of the art atmospheric reanalysis fields (NCEP, 20CR, ERA-20C), and (ii) a direct comparison of storm tracks and their respective storm surge fingerprints at each tide gauge. We discuss the spatial and temporal representativity of each tide gauge record with respect to the variability of storminess over the 2nd half of the 20th century. Hereafter, we assess their long-term changes back into the 18th century and compare them to conventional storminess proxies such as geostrophic winds.