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A new atmospheric proxy for sea level variability in the southeastern North Sea: observations and future ensemble projections

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Atmosphere-ocean interactions are known to dominate seasonal to decadal sea level variability in the southeastern North Sea. In this study an atmospheric proxy for the observed sea level variability in the German Bight is introduced. Monthly mean sea level (MSL) time series from 13 tide gauges located in the German Bight and one virtual station record are evaluated in comparison to sea level pressure fields over the North Atlantic and Europe. A quasi-linear relationship between MSL in the German Bight and sea level pressure over Scandinavia and the Iberian Peninsula is found. This relationship is used (i) to evaluate the atmospheric contribution to MSL variability in hindcast experiments over the period from 1871-2008 with data from the 20th century reanalysis v2 (20CRv2), (ii) to isolate the high frequency meteorological variability of MSL from longer-term changes, (iii) to derive ensemble projections of the atmospheric contribution to MSL until 2100 with eight different coupled global atmosphere-ocean models (AOGCM's) under the A1B emission scenario and (iv) two additional projections for one AOGCM (ECHAM5/MPI-OM) under the B1 and A2 emission scenarios. The hindcast produces a reasonable good reconstruction explaining approximately 80 % of the observed MSL variability over the period from 1871 to 2008. Observational features such as the divergent seasonal trend development in the second half of the twentieth century, i.e. larger trends from January to March compared to the rest of the year, and regional variations along the German North Sea coastline in trends and variability are well described. For the period from 1961 to 1990 the Kolmogorov-Smirnow test is used to evaluate the ability of the eight AOGCMs to reproduce the observed statistical properties of MSL variations. All models are able to reproduce the statistical distribution of atmospheric MSL. For the target year 2100 the models point to a slight increase in the atmospheric component of MSL with generally larger changes during winter months (October to March). Largest MSL changes in the order of $\sim$5-6 cm are found for the high emission scenario A2, whereas the moderate B1 and intermediate A1B scenarios lead to moderate changes in the order of $\sim$3 cm. All models point to an increasing atmospheric contribution to MSL in the German Bight, but the uncertainties are considerable, i.e. model and scenario uncertainties are in the same order of magnitude.

Reference:
Dangendorf, S., Wahl, T., Nilson, E., Klein, B., Jensen, J. (2013): A new atmospheric proxy for sea level variability in the southeastern North Sea: observations and future ensemble projections, Climate Dynamics, doi:10.1007/s00382-013-1932-4.