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Water mass and transport variability in the North Sea in climate change simulations

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Regionalized climate change simulations for the North and Baltic Sea are carried out with coupled ocean atmosphere models in the framework of the research program KLIWAS. The numerical simulations are performed by the Max-Planck Institute for Meteorology (MPI), the Swedish Meteorological and Hydrological Institute (SMHI) and the Institute of Oceanography (IfM Hamburg). Output from the models is analyzed jointly with the Federal Maritime service (BSH) and the German weather service (DWD/SWA). Since one of the ocean models (MPI-OM) is global in extent it simulates the exchange between Atlantic and North Sea according to the physical forcing, while the other two models are shelf models and thus require boundary conditions at the open model boundaries (English Channel, northern shelf edge, Baltic). The warming and freshening of the North Sea is compared between the different models and related to the atmospheric forcing.
Transport variability is analyzed from the MPIOM simulations. The temperature and transport variability at the northern shelf edge of the North Sea is closely related to the dominant atmospheric circulation (NAO) but shows no obvious trend until 2100 in the A1B scenarios. The Baltic outflow variability on the other hand is dominated by a 30 year cycle associated with strong salinity anomalies. In accordance with observations, the models simulate a low salinity period in Baltic waters for the period 1980-2010. Only the English Channel transport shows a long-term trend with a major decline of Atlantic inflow at the end of the 20th century followed by a slow and steady decline until 2100. The transport variability in the English Channel is correlated with the sea level distribution in the northeastern Atlantic. The reduced inflow through the English Channel results in a slower circulation in the southern North Sea with reductions in current speed in the order of 20%. The simulated wind fields in these runs do not support a deceleration of the circulation since southwesterly winds are increasing, these trends however are not significant.