



The importance of choosing interactive coupling on the atmosphere in the Baltic Sea region and in the North Sea-Baltic Sea transition

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For the purpose of a climate study around Denmark, a regional coupled atmosphere-ocean-ice model for the North Sea (NS) and Baltic Sea (BS) is introduced with a horizontal resolution of 6 nautical miles. The coupled model is validated in a hindcast experiment from 1990–2010 with a focus on surface quantities. Lateral boundary conditions are provided from the ECMWF ERA-Interim reanalysis project. The impact of the interactive coupling on the atmosphere is shown to be confined to the Baltic Sea region. Compared with the uncoupled simulation: 1) The coupled model gives warmer winter and colder summer with a maximum difference not exceeding 1° on an average of 21-year daily fields. 2) Winter precipitation is slightly increased by the large-scale higher temperatures over the Baltic; Summer precipitation (convective) is somewhat decreased and controlled by local conditions. This seasonal difference between the two simulations varies within 10 mm month^{-1} . The coupled regional ocean model gives results of SST and SSS with a statistically equivalent quality to the results of the uncoupled simulation for the NS, BS and NS-BS transition in comparison with observations. Sea ice coverage is a sensitive quantity to a warmer winter. The integration of 21-year results of the coupled run shows a reduction of 24% of the ice coverage in the uncoupled one. The coupled models are free of drift and are suitable for long-term climate simulations.

In addition to prevailing large-scale conditions, our ocean model for the NS-BS transition with fine bathymetry (1 nm and 52 vertical layers) shows advantages in simulating local climate. This work is the first to assess the NS-BS water transport with such a high resolution in regional climate research and certainly in a coupled model system. It shows a great potential to improve the prediction of climate change impacts for adaptation work in a coastal country like Denmark.