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Decadal variability in a new high-resolution model of the North Atlantic ocean

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The climate in the Atlantic region is essentially influenced by the Atlantic meridional overturning circulation (AMOC) which carries warm waters into northern latitudes and returns cold deep water southward across the equator. An important aspect in driving the AMOC is the deep-water mass formation at northern latitudes, but climate scenarios for the future indicate that deep-water formation rate in the North Atlantic could weaken during the 21st century due to global warming. Geological records already indicate that the ocean circulation had almost ceased several times in the geological past due to abrupt changes in the climate. We aim to determine the processes that are responsible for the fluctuations in the deep-water mass formation rates, on interannual to decadal timescales, by using a coupled finite-element sea-ice ocean model approach, that has a special focus on the deep-water mass formation areas in the Atlantic (e.g., Greenland Sea and Labrador Sea) as well as on areas in the Southern Ocean (e.g., Weddell Sea and Ross Sea).
To validate our model setup we made a comparison of the model results with experimental Ocean Weather Ship data (OWS). The comparison of the model and OWS data shows a good agreement for temperature and salinity timeseries in the areas where the model has a high resolution. In the same time, the model tends to overestimate the salinity, by around 0.1-0.3 psu, in the regions where the resolution is coarser.
By applying a FFT analysis, we found that the North Atlantic Deep Water (NADW) index, volume transport, temperature and salinity presents a strong decadal variability at $\sim$15.6 years and $\sim$7.8 years. Using a random forcing run we show that the 15.6 years peak is related to the atmospheric forcing, while the 7.8 years peak is related to an internal mode of the ocean variability. Additionally, our model captures a salinity anomaly event around 1970, which happened due to an increase of the sea ice export through Denmark Strait.