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Combining model simulations and paleoceanographic reconstructions for a process-based understanding of climate variability in the North Atlantic/Arctic region

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Climate variations on multi-decadal to centennial time scales in the North Atlantic sector are often postulated to result from changes in the ocean's meridional overturning circulation and the associated heat and fresh water transports. Testing this mainly model-based hypothesis for the historically recorded climate change over the last millennium requires at least decadally-resolved constrains on the state of the ocean and its circulation.
Such records have become increasingly available in recent years. For example, the European Union FP7 project THOR (Thermohaline Overturning - at Risk?), delivered the first combined assessment of water mass exchange between the Atlantic and the Nordic Seas. Coeval changes in both kinetic and chemical deep water proxies characterize variability in intensity and properties of North Atlantic Deep Water. Other recently published reconstructions provide information on variations of the oceanic heat transfer into the Arctic or the sea-ice extent in the Arcticover the last millennium.
Here we show that high-resolution geological archives and model simulations over the last millennium can be combined to achieve a quantified, process-based understanding of ocean circulation variability and its impact on climate. On the one hand, reconstructions are necessary to evaluate the models' representation of hydrography, circulation and variability time-scales. On the other hand, the simulations provide the large-scale context to interpret the observed changes at discrete locations.
Specifically, we address the dynamics of variations of the deep overflows across the Greenland Scotland Ridge, the coupling between deep flow and surface properties south of Greenland and the mechanisms leading to heat transport variations into the Arctic. We focus on internally-generated and externally forced variations in the ocean-atmosphere system over the last millennium and address also aspects of model uncertainty.