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Changes in strength of the West Greenland Current over the past 400 years – evidence of natural climate change and anthropogenic warming during the 20^{th} Century

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There is increasing evidence of recent major changes taking place in high latitude environments, for example thinning of the Arctic pack ice and break-up and retreat of significant tidewater glaciers in Greenland such as Jakobshavn Isbrae. It has been suggested that these changes are linked to recent anthropogenic global warming. However longer time series datasets are needed to investigate natural variability and to assess whether recent changes are indeed a response to global warming.

This study reports changes in the temperature (or relative strength) of the West Greenland Current (WGC) over the last 400 years from a deep water trough (Egedesminde Dyb, $\sim$900m) at the western margin of Disko Bugt, west Greenland. The west coast of Greenland is strongly influenced by the relatively warm and saline WGC. The WGC is produced as the relatively cold and low salinity East Greenland Current (from the Arctic Ocean) and the relatively warm and saline Irminger Current (extension of the North Atlantic Current) mix on rounding the southern tip of Greenland. The relatively high salinity of the WGC produces a dense water mass that fills the deep water trough of Egedesminde Dyb and tends to form the bottom water mass along the Greenland continental margin.

The relative temperature of the WGC is reconstructed using foraminifera and stable isotope data from a box core and piston core recovered from the same location in

Egedesminde Dyb. The two cores have been spliced together based on an age model produced by Pb^{210} measurements and radiocarbon dating. This provides a high resolution record back to approximately 1600 AD. This record covers much of the Little Ice Age (LIA) and the subsequent warming during the 20^{th} Century. The foraminifera preserved in the cores show significant fluctuations between species which prefer the relatively warmer Atlantic sourced component of the WGC and species with an affinity for colder polar waters.

The data shows a remarkable correlation with the reconstructed temperature record from the Dye 3 Greenland ice core and the recent instrumental record of temperature since 1880 from Disko Bugt. A relatively cooler WGC is seen during the LIA from the base of the core at $c.$ 1600 AD to $c.$ 1850 AD. The record even shows the relatively warm episode within the LIA identified from the Dye 3 record. Following this relatively cold water period there is an increase in relatively warm water fauna from the late 1800s into the 20^{th} Century - clearly showing evidence of 20^{th} Century warming.

The data from this core shows a clear correlation between atmospheric temperature changes from 1600 AD to the present and changes in the temperature of the WGC. This variability of the WGC, in particular the increase in temperature during the 20^{th} Century, may have also influenced the activity of one of Greenland's major ice streams, Jakobshavn Isbrae. It has been suggested that the recent retreat of the ice stream might be driven, at least partially, by the influence of the WGC. This study proves that the WGC has indeed varied significantly over the last few centuries and so may well have contributed to the behaviour of this significant glacier.