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Ocean sediments reveal clues about future climate development

At the end of the last ice age, before big ice masses dissolved on the continents surrounding the North Atlantic Ocean, some sporadic episodes of rapid melting of the ancient British Ice Sheet affected ocean currents that are very important for Earth's climatic stability. This fact suggests that the warming and accelerated melting of the Greenland Ice Sheet could have consequences for the stability of ocean circulation, and for the future climatic development.

The magnitude of future climate changes critically depends on the response of the ocean circulation to global warming. This is because the ocean currents distribute vast quantities of heat around our planet and by that way influence atmospheric heat and moisture budgets and climatic patterns on a regional to hemisphere-wide scale. A reorganization of the ocean circulation has the potential to induce substantial global-scale and abrupt (<30 years duration) climate changes.

Records of past ocean circulation, derived from deep-sea sediment cores, show that abrupt changes of the ocean circulation and concomitant climate swings are not a new phenomenon but have occurred several times in the past. The melting of the large North American and Scandinavian ice sheets at the end of the last ice age and concomitant freshwater input to the North Atlantic constitutes the largest natural disruption of the ocean circulation of the last 20.000 years and provides a good case to test the linking between ocean perturbation and climate instability.

Stable and radiogenic isotope data from particulate matter and fossil shells of marine micro-organisms in North Atlantic sediments that have been generated in this study to document the sequence of events surrounding the freshwater perturbation, including a large-scale slow-down of the North Atlantic thermohaline circulation.

The freshwater perturbation resulted in a substantial decrease of the northward warm water transports in the Gulf Stream and forced North Atlantic climates into a full-glacial cold period of at least 1200 years duration, while at the same time the trend of climate warming en route into our current warm age was well underway in the southern hemisphere.

An intriguing feature of the new marine profiles is that the slow-down of North Atlantic circulation started some 700-1200 years before the main collapse of the ice sheets i.e., long before the major freshwater perturbation. The early start of the large-scale change in North Atlantic circulation coincided with isolated, very brief meltwater events coming from the small British Ice Sheet (BIS).

The incursion of thin sediment layers consisting of coarse-grained quartz sand indicate that the brief meltwater events were caused by surges of icebergs that melted and delivered their sediment load to the seafloor. The surges marked transient collapses of the ice shelves that surrounded the BIS, leading to intermittent destabilization of the BIS.

The results demonstrate the potential of small-scale freshwater perturbations to cause substantial changes in ocean circulation without a direct linking with catastrophically large freshwater surges. From this it appears that accelerated (but non-catastrophic scale) melting of the Greenland Ice Sheet, may indeed bear significance for the future stability of ocean circulation and climate in the wider North Atlantic region.

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References

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