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Rapid Fluctuations in the Deep North Atlantic Heat Budget During the Last Glacial Period: Global Marine and Atmospheric Connections (Outstanding Young Scientist Lecture)

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The 'Gulf Stream' and its northern extension, the North Atlantic Drift, contribute significantly to the heat budgets of the North Atlantic region and the deep Atlantic Ocean via the production and southward export of relatively warm and saline deep-water. Past perturbations to the Atlantic overturning circulation cell are known to have contributed to abrupt and intense climate changes that were rapidly communicated throughout the world, and that may yet recur in the future. It is essential that we refine our understanding of the stability thresholds and the recovery times of the Atlantic overturning circulation system. Typically this requires the comparison of numerical model outputs with observational records. To date, such comparisons have been hampered by a paucity of proxy reconstructions of diagnostic physical parameters of the overturning circulation, including in particular records of deep-water temperature, salinity and flow-rate. Here we present a high-resolution record of deep-water temperature variability that resolves millennial Dansgaard-Oeschger climate fluctuations during the last glacial period. These deep-water temperature changes are interpreted in terms of the varying export of relatively warm and saline northern-sourced deep-water, and demonstrate a tight coupling between the deep Atlantic heat budget, Gulf Stream intensity and Greenland temperatures. It is found that the overturning circulation system may have been more unstable (or indeed more bi-stable) than previously thought, resulting in multiple fluctuations within the so-called 'Heinrich events'. It can also be shown that Greenland interstadials were directly linked to coherent reductions in salinity over the

low- to mid-latitude Atlantic and the Pacific. These results provide the basis for interesting model – data comparisons, and lend direct support to a recently proposal that the global communication of past millennial climate change may have operated in a manner directly analogous to modern inter-annual variability.