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The role of air-sea coupling during glacial Heinrich events

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'Heinrich events' - massive iceberg discharges into the North Atlantic during the last ice age - coincided with cold periods and subsequent abrupt warmings on the Northern Hemisphere. Climate reconstructions suggest that the associated freshwater pulses caused a temporary collapse of the Atlantic Meridional Overturning Circulation (AMOC) by stabilizing stratification in the regions of deep water formation. Using a climate model of intermediate complexity we study the influence of air-sea coupling on the stability of the AMOC. Mimicking Heinrich events, we trigger a complete shut-down of the AMOC by delivery of anomalous freshwater forcing to the northern North Atlantic. It is found that associated changes of the heat transport in the North Atlantic lead to a cooling north of the thermal equator. Due to advection of cold-air and an intensification of the trade winds the Intertropical Convergence Zone (ITCZ) is shifted southward and changes of precipitation lead to generation of a positive salinity anomaly in the northern tropical Atlantic. Advected northward by the wind driven ocean circulation the salinity anomaly increases the upper ocean density in the deep water formation regions, thereby accelerating the recovery of the AMOC considerably. Partially coupled experiments which neglect tropical air-sea coupling reveal that the recovery time of the AMOC is almost twice as long as in the fully coupled case. The impact of a shut-down of the AMOC on the Indian and Pacific ocean can be decomposed into atmospheric and oceanic contributions. Temperature anomalies in the northern hemisphere are largely controlled by atmospheric circulation anomalies, whereas those in the southern hemisphere are strongly determined by ocean dynamical changes. An intensification of the Pacific meridional overturning cell in the northern North Pacific during the AMOC shut-down can be explained in terms of atmospheric teleconnections acting in concert with global ocean adjustment processes.