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North Atlantic deep water collapse triggered by a Southern Ocean meltwater pulse in a glacial climate state

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It is generally accepted that freshwater pulses in the Southern Ocean drive increases in North Atlantic Deep Water (NADW) formation via a bipolar density see-saw. Here we show that an Antarctic meltwater discharge of comparable magnitude to meltwater pulse 1A could have shut down, instead of strengthened, NADW during glacial times. Conducting model experiments within a glacial climate state, we find that freshwater anomalies applied over the Southern Ocean propagate into the North Atlantic to collapse NADW. Unlike the modern climate simulation, the glacial climate simulation is associated with a more fragile North Atlantic thermohaline circulation, whereby the negative effect of the surface salinity anomaly on NADW formation is able to dominate the bipolar density see-saw. Meltwater pusles over the North Atlantic and subsequent NADW shut down are often invoked to explain cold "Heinrich Events" appearing in the paleoclimate record. Our coupled model results suggest that the trigger for NADW collapse may also originate from the southern hemisphere in glacial epochs. Once North Atlantic Deep Water shuts down, North Pacific Intermediate Water increases from 2.1 Sv to 12.1 Sv, showing that the North Pacific/North Atlantic see-saw also operates in a glacial climate.