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The Greenland Clipper: a fast ocean connection between Greenland and the Southern Ocean

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The glacial Dansgaard-Oeschger (DO) events are thought to result in a global reorganization of oceanic heat fluxes and heat content.

DO events originate in the North Atlantic, but are communicated all the way to the pole of the other hemisphere. This interhemispheric coupling is known as the bipolar seesaw. A striking feature of the bipolar seesaw is the ~100 year time lag between the initial onset at high northern latitudes and the following adjustments at high southern latitudes.

Here, we focus on this time lag.

Ultimately high southern latitudes are expected to begin their adjustment, when the sea ice margin in the Southern Ocean (SO) shift position due to cooling/warming in the ocean below. But how is the northern signal propagated into the SO, and what processes control the time it takes the SO to change its state?

We expect the SO adjustment to have four components: Planetary waves, geostrophic adjustments in the Atlantic, vertical mixing and finally heat fluxes from baroclinic eddies in the SO.

To investigate the relative importance of these components on the adjustment time in the SO, we apply a fresh water perturbation at high northern latitude in an idealized setup of the Atlantic basin and the Southern Ocean using the newly developed OGCM VEROS. We measure the time it takes the model's Southern Ocean to adjust to the perturbation as a function of different model parameters associated with the components mentioned above.

We find that the adjustment time - which we believe is related to the bipolar seesaw time lag - is dominated by two components. The first is associated with geostrophic adjustment in the South Atlantic, and the second with the eddy heat fluxes in the Southern Ocean. Interestingly we find that in the limit of a high (realistic) eddy transfer (Gent-McWilliams) coefficient, the geostrophic component constitutes the main part of the the adjustment time and quantitatively matches the observed time lag in the bipolar seesaw.

This make us suggest that the bipolar seesaw time lag could be caused mainly by adjustments in

the South Atlantic.