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Interactions between ocean circulation and sea ice can explain Dansgaard-Oeschger events over 800 ka

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Oxygen isotope ratios from the North Greenland Ice Core Project (NGRIP) provide accurate proxies for the temperature evolution in Greenland during the last glacial interval (roughly 110 ka to 10 ka b2k) [1]. A striking feature of these records are rapid transitions, called Dansgaard-Oeschger (DO) events, during which tempera-tures in Greenland rose by up to 15 K within a few decades. These warming events are consistently preceded by more gradual warming and followed by more gradual cooling in Antarctica [2]. This bipolar seesaw has been used to construct a synthetic record of Greenland oxygen isotope rations for the past 800 ka (GLt_syn) [3].

In recent work, we have introduced a dynamical system model that explains the DO variability by rapid retreat and slow regrowth of ice shelves and sea ice, in combination with changing subsurface water temperatures due to insulation by an extensive sea ice cover [4].

When forced with multi-millennial global ice volume (GIV) variability, our model reproduces observed features of the records across the last glacial, including the sawtooth shape of the DO cycles, the temporal variations in the frequency of DO transitions, and the shifted anti-phase relationship between Greenland and Ant-arctic records. Further evidence for the hypotheses underlying our model comes from early-warning signals of the DO events that we have recently identified in the decadal-scale frequency band of the NGRIP oxygen isotope record [5].

We show that our model, when forced with GIV variability over the past 800 ka, still reproduces the frequency of DO events except for a few episodes of exception-ally high instability. We finally discuss the specific climatic conditions during these episodes, and which global forcing in addition to GIV could be sufficient to repro-duce the DO frequency during these episodes.

References:

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[2] WAIS members, Nature (2015)
[3] Barker et al., Science (2011)
[4] Boers, Ghil, and Rousseau, Proc. Nat. Acad. Sci. (2018)
[5] Boers, Nat. Comm. (2018)