A simple model of Dansgaard-Oeschger cycles based on the bipolar seesaw

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The last glacial period was punctuated by millennial-scale abrupt climate changes in the North Atlantic region, called Dansgaard-Oeschger (DO) cycles (Dansgaard et al. 1993). At the same time, the Antarctic climate changed in antiphase with the DO cycles (Blunier et al., Nature, 1998; Dome Fuji Ice Core Project Members., Science Adv., 2017). This is called the bipolar seesaw (Crowley, Paleoceanography, 1992; Broecker, Paleoceanography, 1998). It is commonly considered that the changes in the North Atlantic drive the changes in the Southern Hemisphere by the bipolar seesaw mechanism (Stocker and Johnsen, Paleoceanography, 2003; WAIS Divide Project Members, Nature, 2015), but the influence of the South on the North is still unclear. Recently, DO-like self-sustained oscillations are found in a coupled atmosphere and ocean GCM (MIROC4m AOGCM) (Abe-Ouchi et al., JpGU 2018 Abstract). To generate these oscillations, the changes in the Southern Ocean through the bipolar seesaw mechanism are suggested to be crucial (Abe-Ouchi et al., JpGU 2018 Abstract). However, most of the simple models for DO oscillations focus only on the North Atlantic and therefore lack the bipolar seesaw mechanism. Based the AOGCM experiments, we propose a simple model of DO cycles obtained by implementing a bipolar seesaw model into an ocean box model. By analyzing this simple model, we show that the period of DO cycle can be strongly related to the time-scale of the bipolar seesaw τ (Stocker and Johnsen, Paleoceanography, 2003).

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