

## Glacial abrupt climate changes and thermal threshold of the Atlantic meridional overturning circulation

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Abrupt climate changes known as Dansgaard-Oeschger events (DO events) took place frequently in glacial periods. Many geological evidences support the idea that changes of the Atlantic meridional overturning circulation (AMOC) are related to these events, but question on what triggers the AMOC changes remains unsolved. Although the most of studies have regarded freshwater flux from melting ice sheet as a cause of the AMOC changes, we recently identified the existence of the thermal threshold of the AMOC during glacial climate. Here, from the results of climate model simulations about the glacial AMOC, we report that the thermal threshold of the AMOC can be a triggering mechanism of DO events. We investigated the structure of the thermal threshold in glacial climate by conducting ocean general circulation model simulations under various thermal conditions in which degrees of sea surface cooling are systematically changed separately or simultaneously in northern and southern hemispheres. The results suggest that the threshold is located near the condition in which the climate is slightly warmer than the coldest glacial conditions. We also found that the amplitude of AMOC changes in crossing this threshold depends on thermal conditions in northern and southern hemispheres. This amplitude becomes the largest when the southern hemisphere is slightly warmer than the coldest glacial conditions. It is also demonstrated that gradual warming in the southern hemisphere from the colder glacial climate leads to crossing the threshold and can cause very large strengthening of AMOC. Therefore, the thermal threshold could be a triggering mechanism of DO events accompanying the warming of southern hemisphere before their abrupt warming in northern hemisphere.

Keywords: Atlantic meridional ocean circulation, Dansgaard-Oeshger events, Abrupt climate changes, Climate model