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Key roles of sea ice-atmosphere feedback in inducing contrasting modes of glacial AMOC and climate

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Over the glacial period, the climate and the Atlantic meridional overturning circulation (AMOC) varied between two contrasting modes, as revealed by Dansgaard-Oeschger (D-O) cycles. Changes in sea ice have been suggested to play an important role in inducing contrasting modes of the AMOC and climate through its insulation effect. On the other hand, previous studies showed that changes in sea ice caused drastic changes in the atmosphere, and suggested that the changes in the atmosphere could feedback on the AMOC and climate. However, the role of sea ice-atmosphere feedback on the AMOC was not fully understood since the cause and result change simultaneously in the coupled atmosphere ocean model. In this study, the role of sea ice-atmosphere feedback on the AMOC is explored with a comprehensive atmosphere-ocean coupled general circulation model (MIROC4m AOGCM). Using the MIROC4m AOGCM, partial couple experiments are conducted, in which the feedback from the atmosphere to the ocean is switched on or off. Simulations reveal that the sea ice-atmosphere feedback plays a role in inducing contrasting modes of the AMOC. The expansion (retreat) of sea ice over the North Atlantic weakens (strengthens) the surface wind, which is associated with an increase (decrease) in the atmospheric static stability near the surface. This weakening (strengthening) of the surface wind reduces (increases) the wind-driven ocean salt transport into the deepwater formation region. As a result, the AMOC further weakens (strengthens). Thus, through its positive feedback, sea ice-atmosphere feedback plays a key role in inducing contrasting modes of the AMOC.