Impact of mid-glacial ice sheets on the recovery of the AMOC: Implications on the frequent DO cycles during the mid-glacial period

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It has been shown from ice core reconstructions that glacial periods experienced frequent climate shifts between warm interstadials and cold stadials. The duration of these climate modes varied during glacial periods, and that both the interstadials and stadials were shorter during mid-glacial compared to early glacial. Recent studies showed that the duration of the interstdials was controlled by the Antarctic temperature through its impact on the Atlantic Meridional Overturning Circulation (AMOC). However, similar relation was not found for the stadials, suggesting that other climate factors (e.g., differences in ice sheet size, greenhouse gases and insolation) might have played a role. Thus, for a better understanding of the stability of the climate, it is very important to evaluate the impact of climate factors on the duration of the stadials. In this study, we investigate the role of glacial ice sheets on the duration of stadials. For this purpose, freshwater hosing experiments are conducted with an atmosphere-ocean general circulation model MIROC4m under early-glacial and mid-glacial ice sheet configurations. The impact of mid-glacial ice sheets on the duration of the stadials is evaluated by comparing recovery times of the AMOC after the freshwater forcing is reduced. We find that the expansion of glacial ice sheets during mid-glacial shortens the recovery time of the AMOC. Sensitivity experiments, in which we modify the surface winds show that differences in the surface wind are important in causing the shorter recovery under mid-glacial ice sheet. The wind shortens the recovery time through increasing the surface salinity and decreasing the sea ice at the deepwater formation region. Thus the results suggest that differences in the surface wind between mid-glacial and early glacial ice sheets play an important role in causing shorter stadials during mid-glacial.

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