Impact of glacial ice sheets on the duration of the stadial climate: Role of surface wind and surface cooling

*Sam Sherriff-Tadano[1], Ayako Abe-Ouchi[1]

1. Atmosphere and Ocean Research Institue, University of Tokyo

It has been shown from ice core reconstructions that glacial periods experienced 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 Marine Isotope Stage 3 (MIS3) compare to MIS5. Recent studies showed that the duration of the interstdials is controlled by the Antarctic temperate through its impact on the stability of the Atlantic Meridional Overturning Circulation (AMOC). However, similar relation could not be found for the stadials, suggesting that other climate factor (e.g. differences in ice sheet size, greenhouse gases and insolation) may play a role. Thus, for a better understanding of the stability of the climate, it is very important to evaluate the impact of these climate factors on the duration of the stadial climate. In this study, we investigate the role of glacial ice sheets. For this purpose, freshwater hosing experiments are conducted with an atmosphere-ocean general circulation model MIROC4m under several ice sheets configurations computed in an ice sheet model Icies (Abe-Ouchi et al. 2013). The impact of glacial ice sheets on the duration of the stadial climate is evaluated by comparing the behavior of the weak AMOC after the freshwater forcing is reduced. All experiments show a drastic weakening of the AMOC in response to the freshwater hosing, which accompanied a cooling over the North Atlantic, a southward shift of the tropical rain belt and a warming over the Antarctic. We find that experiments with smaller ice sheet takes more time to recover after the freshwater hosing is reduced. Sensitivity simulations show that differences in the surface wind is important in causing the shorter stadial under larger ice sheets, while differences in the surface cooling has an opposite effect. Thus our result suggests that differences in the surface wind induced by the ice sheets play an important role in causing shorter stadials during MIS3 compare to MIS5.

Keywords: AMOC, Stadial, Ice sheet

