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Importance of a control state for simulating the Atlantic meridional overturning circulation at the LGM

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The ocean circulation in the Atlantic deep ocean is characterized by thermohaline circulation driven by deep convection in northern high latitudes. The heat transport associated with this circulation is comparable to that by atmosphere and has a great role in the present climate. The Atlantic meridional overturning circulation (AMOC) is believed to change in past and future climate changes. Coupled model simulations suggest that the AMOC becomes weak in the future global warming climate. Geological evidence such as carbon isotope ratio indicates that the AMOC was weaker and shallower than the present at the Last Glacial Maximum (LGM). As for global warming climate, almost all model results reach consensus that the AMOC weakens in global warming climate. On the other hand, there is wide discrepancy in simulation of the AMOC at the LGM. Weber et al. (2007) report results of Paleoclimate Modeling Intercomparison Project where half of models reproduce the weakening of the AMOC but the other half simulates the strengthening. The reason for this disagreement between models has not been clarified yet, and investigation on the mechanism of weakening of the AMOC at the LGM is one of the most important topics in the paleoclimate studies.

In this study, by using results of our coupled climate model (MIROC), we focus on role of changes in the sea surface heat and freshwater fluxes and investigate their role in controlling the AMOC at the LGM. In order to individually evaluate role of heat and freshwater fluxes, we conduct additional ocean general circulation model simulations under the sea surface heat/freshwater flux conditions obtained from the present and LGM simulations by MIROC. The results suggest that the freshwater flux changes contribute to weakening of the AMOC at the LGM, whereas the heat flux changes make the AMOC at the LGM stronger than the present. We found that reproducibility of the control state significantly affects response of the AMOC to heat and freshwater changes at the LGM. In the presentation, we are scheduled to report how changes in the heat and freshwater fluxes affect the AMOC at the LGM, and discuss why climate models have difficulty in reproducing the AMOC at LGM, and give implications for mechanisms controlling the AMOC at the LGM.