A climate modeling study on the mechanism of Antarctic ice sheet changes in the past and future

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Combined ice sheet and climate modeling studies have been conducted to project future climate change and Antarctic ice sheet. Paleoclimate is used to validate numerical models used for future projections, and it is indicated the Antarctic ice sheet retreated during the Last Interglacial (about 130,000 years ago), compared to the present interglacial. However, climate model simulations did not reproduce warm climate in the Antarctic region, when the insolation and greenhouse gas concentrations during the Last Interglacial are used. This means that the cause of the difference in the retreatment of Antarctic Ice Sheet between the last two interglacial was unknown.

In this talk, we will present our recent climate modeling results and discuss responsible factors in determining the retreatment of Antarctic ice sheet. A transient simulation from the glacial to the interglacial is conducted using an atmosphere-ocean coupled general circulation model, and we focus on the Atlantic Meridional Overturning Circulation (AMOC) during transition from glacial to interglacial as a probable factor of different Antarctic climate between the last two interglacials. The results show that the faster melting of Northern Hemisphere ice sheet warms Antarctic region through the weakening in the AMOC by the “bipolar seesaw” mechanism of meridional ocean heat transport. The warmer Antarctic climate accompanied with smaller sea ice extent in the Southern Ocean, less sea ice production in the Antarctic coast and stronger deep convection in the Southern Ocean. The results suggest that the difference in Antarctic climate between the last two interglacials could have been caused by Antarctic warming and melting of ice shelves through the “bipolar seesaw” mechanism during the deglaciation, not only by the climatic forcing at the interglacials themselves. The mass balance of Antarctic ice shelves and retreatments of the West Antarctic Ice Sheet are discussed.

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