氷期および温暖気候下の南極棚氷底面融解の変動

小長谷貴志[1]、阿部彩子[1]、草原和弥[2]、羽角博康[1]
[1]*東京大学大気海洋研究所*
[2]*Antarctic Climate and Ecosystems Cooperative Research Centre*

Antarctic ice shelves' basal melting under LGM and doubled CO2 climate

Takashi Obase[1], Ayako Abe-Ouchi[1] , Kazuya Kusahara[2] and Hasumi Hiroyasu[1]
[1]*Atmosphere and Ocean Research Institute, the University of Tokyo*
[2]*Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Australia*

Basal melting of the Antarctic ice shelves is an important factor in the retreat of marine Antarctic ice sheet in the past or future, but little consensus exists on how the rate of basal melting changes against climatic forcing. We simulate Antarctic ocean and basal melting of Antarctic ice shelves under the Last Glacial Maximum (LGM) and equilibrium CO2 doubling climate with identical present-day topography, using a circumpolar ocean model with ice shelf cavity component forced by outputs of a climate model. The rate of basal melting increases as the climate is warmed, but change in basal melting in the CO2 doubling climate is much larger than that in the LGM in spite of close magnitude of global radiative forcing in the LGM and CO2 doubling. The response of ocean temperature above the continental shelf, which is most important to the rate of basal melting, is different from Southern Ocean off the continental shelf break. Decreased sea surface cooling, sea ice production and brine rejection under a warmer climate intensifies stratification of the shelf seas and warm water off the shelf break gets easier to intrude onto continental shelves. Sensitivity experiments show that surface heat flux is most important to ocean temperature in the shelf seas. While parameterizations of basal melting for ice sheet models often use subsurface ocean temperature to calculate the rate of basal melting, our results suggest that we should consider ocean temperature above the continental shelf is different from ocean temperature off the continental shelf break, which is affected by water mass formation in the shelf seas.

Number of ice shelves fringes in the Eastern Weddell Sea, draining Antarctic Ice Sheet in the Dronning Maud Land and located downstream of the westward coastal current from Syowa Station, is characterized with narrow continental shelves. Observed basal melting of ice shelves in the Eastern Weddell Sea is small in spite of rare sea ice production in the coast, because westward coastal current transports surface cold and freshwater beneath ice shelves and Antarctic Slope Front isolates ice shelves from warm Circumpolar Current. Amery Ice Shelf is located in the East Antarctica, and is close to one of global bottom water formation site. Basal melting of Amery Ice Shelf is characterized with relatively small basal melting due to cold and saline shelf water in the shelf sea. The model results show that ice shelves in the Eastern Weddell Sea and Amery Ice Shelf are sensitive to both warming in atmospheric conditions and ocean temperature in the Southern Ocean, suggesting surface cold and fresh water mass is vulnerable to both atmosphere and oceanic forcings.

References

Kusahara, K. and H. Hasumi, 2013: Modeling Antarctic ice shelf responses to future climate changes and impacts on the ocean. J. Geophys. Res. Oceans, 118(5), 1–22.