南極における棚氷海洋間相互作用に気候変化が与える影響

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]*北海道大学低温科学研究所*

Responces of melting below Antarctic ice shelf to climate

Takashi Obase[1], Ayako Abe-Ouchi[1], Kazuya Kusahara[2] and Hiroyasu Hasumi[1]
[1]*Atmosphere and Ocean Research Institute, University of Tokyo*
[2]*Institute of Low Temperature Science, Hokkaido University*

The Antarctic Ice Sheet is buttressed by floating ice shelves. Calving at ice shelf front and basal melting below ice shelf are main ablation processes of Antarctic ice sheet(Rignot et al., 2013). Future collapse of West Antarctic Ice Sheet(WAIS) caused by enhanced basal melting and thinner ice shelf has potential contribution to global sea level rise in the magnitude of 5m. Pollard and Deconto(2009) showed increase of ocean temperature and enhanced basal melting of ice shelf in warmer climate is crucial to the retreat of WAIS using 3-dimensional ice sheet-shelf model. Since increase or decrease of basal melt rate time as the climate and topography change is challenging, they used simple parameterization. Sensitivity of basal melting to ocean temperature is investigated using ocean general circulation model which considers circulation of ice shelf cavities and basal melting of ice shelf. Kusahara and Hasumi (2013) developed ocean general circulation model which resolves all Antarctic ice shelves, and they estimated basal melt rate at present state and its sensitivity to surface air warming. But the variation of basal melt rate on longer time scale by a ocean model which resolves whole Antarctica is not investigated.

In this study, circumpolar ice shelf-sea ice-ocean coupled model(Kusahara and Hasumi, 2013) is used and sensitivity of basal melting to climate is investigated. Two experiments beside CTRL case are carried. One is doubled CO2 and the other is Last Glacial Maximum(LGM). Northern boundary and surface boundary condition is needed since the model used in present study is regional model. These boundary conditions are taken from the experiments carried out by atmospheric and ocean general circulation model. Topography of ice sheet and ice shelf is fixed to present state. Simulated basal melting over whole Antarctica in the CTRL case is 810 Gt/yr. Distribution of basal melt rate shows active melting near grounding line and ice shelves in western side of Antarctic Peninsula, in constrast less melting in Ross ice shelf. Total basal melting is 4.9 times larger than CTRL in doubled CO2 case, and is 40% decrease in LGM case. Heterogenous sensitivity to climate of basal melting in each ice shelf is found. Total basal melting in Filchner-Ronne ice shelf is multiplied 4 times in doubled CO2 case, whereas Ross ice shelf is hardly changed.

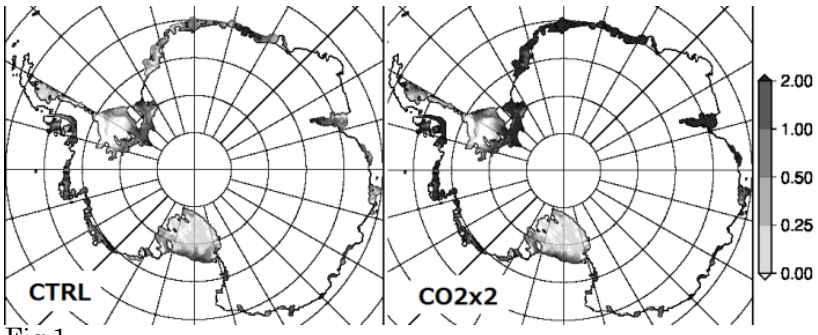

Fig.1
Spatial distribution of annual basal melting rate[m/yr] in CTRL case(left) and doubled CO2 case(right)

References

Pollard, D. and DeConto, R. M, Modelling West Antarctic ice sheet growth and collapse through the past five million years, Nature.(2009)

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