Warming and climate feedbacks in the southern high latitude driven by obliquity, precession-eccentricity, and atmospheric CO2

*Kanon Kino[1], Ayako Abe-Ouchi[1,2], Ryouta O'ishi[1], Fuyuki SAITO[2], Masakazu Yoshimori[1]

1. Atmosphere and Ocean Research Institute, the University of Tokyo, 2. Japan Agency for Marine-Earth Science and Technology

Polar amplification is widely known as a major characteristic of observed and simulated global warming which induced by increasing atmospheric CO2. In the southern high latitude, a study using GCM investigated climate feedback system to reproduce the warming (Lu and Cai, 2009). A latest study of the Antarctic ice core precisely analyzed phase relationship between temperature changes in the past ages and the periodic changes in the Earth’ s orbital parameters (obliquity, precession and eccentricity (Uemura et al., 2018). In this study, we use MIROC-GCM to investigate the warming in the southern high latitude due to the orbital parameter changes, and climate feedback responses. Results are compared with the doubling CO2 experiment.
We use an AGCM with slab ocean of MIROC-GCM (Hasumi and Emori, 2004) and performed experiments with (1) large obliquity, (2) large precession and the winter solstice (austral summer) at the aphelion (Maximum values in the past ages are used). A seasonal surface feedback analysis method (Lu and Cai, 2009) is also applied.
Results show that warming on the Antarctica (covered by the ice-sheet) due to the orbital parameter change is dominated by short-wave radiation which is not interrupted by cloud, in contrast that the warming due to increasing atmospheric CO2 is dominated by downward long-wave radiation. Results also show that seasonal warming and climate feedback responses on the Southern Ocean are qualitatively common in the insolation and CO2 cases, as well as warming in the Arctic Ocean; little warming in the summer with absorption of energy and large warming in the autumn and winter with releasing of the energy. The strengths of the warming are qualitatively different whether the seasonality, especially spring and early summer, of radiative forcing is favorable for sea ice melt.
We will investigate the changes of the atmospheric circulation, precipitation, and the influence of the oceanic circulation.

Keywords: GCM, Antarctica, orbital parameter, feedback

