Estimation of Greenland surface mass balance using positive degree-days method and energy balance model

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A sea level rise is an important topic in a future climate projection. In the past warm period known as the Last Interglacial (LIG), paleoevidences indicate sea level rise of several meters. Paleoclimate modeling community applies past GCM results on ice sheet models and tries to reproduce past sea level rises. Typically, an empirical method called PDD (Positive Degree Days) is applied for the estimation of surface mass balance on the ice sheet as an upper boundary condition (Saito and Abe-Ouchi 2005, Saito et al. 2016). The PDD only refers the surface atmosphere temperature and snowfall. In the present study, we use a process-based land surface model MATSIRO (Nitta et al. 2017) to estimate the Greenland surface mas balance forced not only by temperature and snowfall but also by other surface variables including shortwave and longwave radiation which are based on a regional climate model NHM-SMAP (Niwano et al. 2018) with 5km resolution. We compare the characteristics of resultant ice melt amount from PDD and MATSIRO to evaluate the inclusion of process-based heat and water balance instead of empirical equation. We also interpolated anomaly of two warming GCM experiments result from the presentday experiment and added them to the observed variables which are forcing of MATSIRO to predict the Greenland surface mass balance in the warm climate.

References

Saito F and Abe-Ouchi A (2005) Sensitivity of Greenland ice sheet simulation to the numerical procedure employed for ice-sheet dynamics. Annals of Glaciology 42:331-336, doi:10.3189/172756405781813069.

Saito F, Abe-Ouchi A, Takahashi K, Blatter H (2016) SeaRISE experiments revisited: potential sources of spread in multi-model projections of the Greenland ice sheet. The Cryosphere 10:43-63, doi:10.5194/tc-10-43-2016.

Nitta, T.,   K. Yoshimura, and A. Abe-Ouchi（2017）Impact of Arctic Wetlands on the Climate System: Model Sensitivity Simulations with the MIROC5 AGCM and a Snow-Fed Wetland Scheme.J. Hydrol., 18, 2923‒2936, doi: 10.1175/JHM-D-16-0105.1.

Niwano, M., Aoki, T., Hashimoto, A., Matoba, S., Yamaguchi, S., Tanikawa, T., Fujita, K., Tsushima, A., Iizuka, Y., Shimada, R., and Hori, M.: NHM–SMAP: spatially and temporally high-resolution nonhydrostatic atmospheric model coupled with detailed snow process model for Greenland Ice Sheet, The Cryosphere, 12, 635–655, https://doi.org/10.5194/tc-12-635-2018, 2018.