Estimation of the Antarctic ice sheet surface mass balance using the polar regional climate model NHM-SMAP

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In the Antarctic ice sheet (AIS), the largest ice body in the world, snow and ice mass loss is accelerated since the 1990s. In the future in a warming world, more surface melt and its resultant further mass loss are expected in the AIS like the present-day Greenland ice sheet, where contribution to mass loss by the reduction of surface mass balance (SMB) is now higher than that from the increase in ice discharge. Because mass losses from these big ice sheets affect the global sea level, it is imperative to understand physical mechanisms of the ice sheet surface mass balance modulation. In the present study, we use the state-of-the-art polar regional climate model NHM-SMAP (Niwano et al., 2018) and attempt to simulate the present-day AIS SMB realistically. Although we use the latest version of NHM-SMAP, which participated in the Greenland ice sheet SMB model inter-comparison project GrSMBMIP (Fettweis et al., 2019, in review) recently, the Richards equation to calculate detailed vertical water movement in snow and firn is not employed due to its high computational cost in the current AIS version: a simple so-called “bucket scheme” is used instead. Using the model-calculated results, we will investigate the governing physical process of the AIS SMB modulation. Here, the default horizontal resolution of NHM-SMAP for the AIS is now set to be 12 km, although a horizontal resolution of 6 km has been tested for some selected years as well. Recently, Mottram et al. (2019, in review) conducted an inter-comparison of numerical models that can calculate the AIS SMB for the first time. The horizontal resolutions we set for NHM-SMAP (6 and 12 km) are higher than those employed in the models described by Mottram et al. (2019, in review). Our preliminary results indicate that the AIS-integrated annual SMB simulated by NHM-SMAP is more positive in the 6 km version than the 12 km one. Also, the annual AIS-integrated SMB simulated by the default 12 km NHM-SMAP tends to be less positive than other regional climate models like HIRHAM5, RACMO2.3p2, and MAR v3.10, although it is close to the result by COSMO-CLM2. In the presentation, we will also discuss model validation results by comparing the model-simulated SMB as well as the surface meteorological conditions with in-situ measured data.

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