

Impacts of clouds on the Greenland ice sheet surface melt and mass balance

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Clouds have been recognized to enhance surface melt on the Greenland Ice Sheet (GrIS). However, quantitative estimates of the effects of clouds on the GrIS melt area enhancement and resultant ice-sheet-wide surface mass balance modulations are still lacking. Here we assessed the effects of clouds with the state-of-the-art regional climate model NHM-SMAP (Niwano et al., 2018), conducting a numerical sensitivity test in which clear-sky downward radiations and adiabatic atmospheric conditions were assumed, although the precipitation rate was the same as in the control all-sky simulation. By including or excluding cloud effects, we quantified time-integrated feedbacks for the first time. We found that the surface melt area extent increased by 3.1%, 0.3%, and 0.7% (of the total GrIS area) by the presence of clouds during summer (June to August) in 2012, 2013, and 2014, respectively. During the same periods, clouds reduced solar heating and thus daily runoff by 1.6, 0.8, and 1.0 Gt day⁻¹, respectively: clouds did not enhance the GrIS surface mass loss. In the ablation area, the presence of clouds results in a reduction of downward latent heat flux at the snow/ice surface so that much less energy is available for the surface melt, which highlights the importance of indirect effects of clouds.

References:

Niwano, M., Aoki, T., Hashimoto, A., Matoba, S., Yamaguchi, S., Tanikawa, T., Fujita, K., Tsushima, A., Iizuka, Y., Shimada, R., and Hori, M. (2018): 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, doi:10.5194/tc-12-635-2018.

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