Geophysical Research Abstracts
Vol. 19, EGU2017-8031, 2017
EGU General Assembly 2017

Reconstructing decades of glacial mass loss in the Canadian Arctic Archipelago

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The Canadian Arctic Archipelago (CAA) comprises multiple small glaciers and ice caps mostly concentrated on Ellesmere and Baffin Islands situated in the north (NCAA) and south (SCAA) of the archipelago, respectively. Because they cover a relatively small area and show complex geometries, current regional climate models, generally running at 5 to 20 km horizontal resolution, struggle to accurately resolve surface mass change patterns. Here, we present a 58-year (1958-2015) reconstruction of daily, 1 km surface mass balance (SMB) of the CAA, statistically downscaled from the output of the regional climate model RACMO2.3 at 11 km. By correcting for biases in elevation and ice albedo, the downscaling method significantly improves mass loss estimates over narrow outlet glaciers and isolated ice fields through better resolved marginal meltwater runoff. During the last two decades, CAA glaciers have experienced warmer conditions (+1.1C) resulting in continued mass loss. NCAA and SCAA mass loss accounted for -24.7 $\pm$ 18.0 Gt yr^{-1} and -21.9 $\pm$ 8.2 Gt yr^{-1} respectively, almost tripling (-8.4 Gt yr^{-1}) and doubling (-11.8 Gt yr^{-1}) the 1958-1995 average. Following the recent warming, enhanced meltwater production reduced the refreezing capacity of inland firn layers by about 6%. While the interior of NCAA ice caps can still buffer most of the additional melt, the lack of a perennial firn area over low-lying SCAA glaciers caused uninterrupted mass loss since the 1980s, which, in the absence of significant refreezing capacity, indicates inevitable disappearance of these highly sensitive glaciers.