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Present and Future Surface Mass Budget of Small Arctic Ice Caps in a High Resolution Regional Climate Model

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Globally, small ice caps and glaciers make a substantial contribution to sea level rise; this is also true in the Arctic. Around Greenland small ice caps are surprisingly important to the total mass balance from the island as their marginal coastal position means they receive a large amount of precipitation and also experience high surface melt rates. Since small ice caps and glaciers have had a disproportionate number of long-term monitoring and observational schemes in the Arctic, likely due to their relative accessibility, they can also be a valuable source of data. However, in climate models the surface mass balance contributions are often not distinguished from the main ice sheet and the presence of high relief topography is difficult to capture in coarse resolution climate models. At the same time, the diminutive size of marginal ice masses in comparison to the ice sheet makes modelling their ice dynamics difficult.
Using observational data from the Devon Ice Cap in Arctic Canada and the Renland Ice Cap in Eastern Greenland, we assess the success of a very high resolution (∼5km) regional climate model, HIRHAM5 in capturing the surface mass balance (SMB) of these small ice caps. The model is forced with ERA-Interim and we compare observed mean SMB and the interannual variability to assess model performance. The steep gradient in topography around Renland is challenging for climate models and additional statistical corrections are required to fit the calculated surface mass balance to the high relief topography. Results from a modelling experiment at Renland Ice Cap shows that this technique produces a better fit between modelled and observed surface topography.
We apply this statistical relationship to modelled SMB on the Devon Ice Cap and use the long time series of observations from this glacier to evaluate the model and the smoothed SMB. Measured SMB values from a number of other small ice caps including Mittivakkat and A.P. Olsen ice cap are also compared with model output. Finally we use climate simulations forced with two different RCP scenarios to examine the likely future evolution of SMB over these small ice masses.