Geophysical Research Abstracts
Vol. 20, EGU2018-18224, 2018
EGU General Assembly 2018

Surface meltwater percolation and runoff buffering on Devon Ice Cap, Canada

David Ashmore and Douglas Mair
University of Liverpool, School of Environmental Sciences, Liverpool, United Kingdom

The Canadian Arctic Archipelago (CAA) contains the largest reservoir of land ice outside the great ice sheets, and currently contributes ∼60 Gt/yr to global sea level rise. Since 2005 CAA glaciers have undergone intense melt at levels likely unseen for several millennia. In this study we focus on Devon Ice Cap (DIC) in the CAA where field measurements reveal major changes in firn stratigraphy post-2005, in particular the development of near-surface ice layers several metres thick in the accumulation zone. Using a high (1 cm) vertical resolution, physically-based, distributed snow evolution model recently calibrated for DIC we simulate summer mass balance, melting, percolation and refreezing from 2001 to 2016, and compare the resultant density structure with field observations. Notably, we effectively vary percolation depth by prescribing the thickness (2 – 50 cm) of the impermeable ice layer at which percolating melt becomes runoff.

This parameterisation has a relatively small effect on the overall ice cap surface mass balance, which is overwhelmed by the signal from intense melting in the ablation area. However, within the percolation zone (c. above 1350 m elevation) modelled runoff varies by ∼30% depending on the impermeable layer parameterisation. In this model we find that in order to generate near-surface ice layers several metres thick, as observed in GPR profiles, it is necessary for percolating meltwater to bypass ice layers several decimetres thick. Our results also indicate that typically over 70% of refreezing takes place in the snowpack, not the multi-year firn. This highlights the important role that each year's snowfall is likely to have in tempering the runoff in response to further CAA warming. The seasonal and multi-year snow/firn evolution of DIC provides insights to percolation and retention processes on the Greenland Ice Sheet, where the accumulation area makes up a larger proportion of the ice sheet and hence where future surface mass balance will be more dependent upon climate driven changes in refreezing processes.