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Temporal variations in the surface hydrology across Antarctic ice shelves

Rebecca Dell[1], Ian Willis[1], Neil Arnold[1], Alison Banwell[1,2], Hamish Pritchard[3], and Anna Ruth Halberstadt[4]

[1]Cambridge University, Scott Polar Research Institute, Geography, Cambridge, United Kingdom of Great Britain and Northern Ireland (rld46@cam.ac.uk)

[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, United States, 80309

[3]British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET

[4]Department of Geosciences, University of Massachusetts, Amherst, United States, MA 01003

Widespread surface meltwater systems have been identified across numerous Antarctic ice shelves and have been implicated in their possible instability and eventual breakup. It is crucial to better understand the seasonal and year-to-year development of these surface meltwater systems, which comprise saturated firn (slush) as well as distinct water bodies (lakes and streams). It has been suggested that repeated melting and re-freezing of the surface firn pack over successive years reduces the firn air content, and therefore its porosity, encouraging the formation of surface water bodies over time. Firn air depletion and the formation of surface water bodies may contribute to ice shelf instability, as the ice becomes increasingly susceptible to hydrofracture.

Here, we use Google Earth Engine to investigate the distributions of slush and deeper water bodies across all Antarctic ice shelves known to have surface melt, to quantify how surface meltwater systems evolve both seasonally and over successive summers. To do this, we use supervised classification of Sentinel-2 and Landsat 7/8 imagery to guide the selection of suitable $NDWI_{ice}$ thresholds for both the detection of slush and deep surface meltwater. Preliminary results for the George VI Ice Shelf between 2000 and 2017 reveal seasonal patterns in the overall extent of surface meltwater, and the overall meltwater extent typically peaks between January and March each year. The 2009-2010 melt season was characterised by significant melt, and over the course of the melt season the proportion of the overall surface meltwater extent that was held within deep water bodies varied between 0 % (November) and 60 % (January). An increase in the proportion of deep water vs. slush typically aligns with warmer air surface temperatures and, therefore periods of more intense melt.