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Ice-shelf instability due to surface meltwater systems on the George VI Ice Shelf

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The evolution of surface and shallow subsurface meltwater bodies across Antarctic ice shelves has important implicationsfor their (in)stability, as demonstrated by the 2002 rapid collapse of the Larsen B Ice Shelf. Ice-shelf break-up may be triggered by stress variations associated with meltwater movement, ponding and drainage, causing ice-shelf flexure and fracture. We have recently begun a four year, jointly-funded US-NSF / UK-NERC project that will provide important geophysical insights into the stability of the George VI Ice Shelf on the Antarctic Peninsula, where hundreds of surface lakes form each summer.

In November 2019, we deployed global positioning systems, pressure transducers, automatic weather stations, and in-ice thermistor strings to record ice-shelf flexure, surface water depths, and surface and subsurface melting, respectively, in and around several surface lakes. Next austral summer (November 2020), we also plan to record fracture seismicity with a passive seismometer deployment, and to conduct ground penetrating radar surveys to detect subsurface water. Instruments, which are all within ~30 km of BAS's Fossil Bluff Station, will remain on the ice shelf until January 2022, resulting in a 27-month observational record in total.

Here, we report results of satellite image analysis of surface and shallow subsurface meltwater bodies, together with preliminary field and modelling results associated with our project. Using $NDWI_{ice}$ thresholds applied to Landsat 8, Sentinel-2 and WorldView optical imagery, we show how patterns of surface meltwater evolve within and between summer melt seasons. Using Sentinel-1 SAR imagery and a convolutional neural network technique, we detect and track bodies of shallow subsurface water and show how they relate to patterns of surface water. We also report on field reconnaissance surveys made to two dolines (drained lake basins) on the ice shelf, and present a simple model to describe the process of doline formation. Throughout the project, we will combine field and remotely sensed data to extend and validate our existing approach to modelling

ice-shelf flexure and stress, and possible ‘Larsen-B style’ ice-shelf instability and break-up at less geographically confined ice shelves.