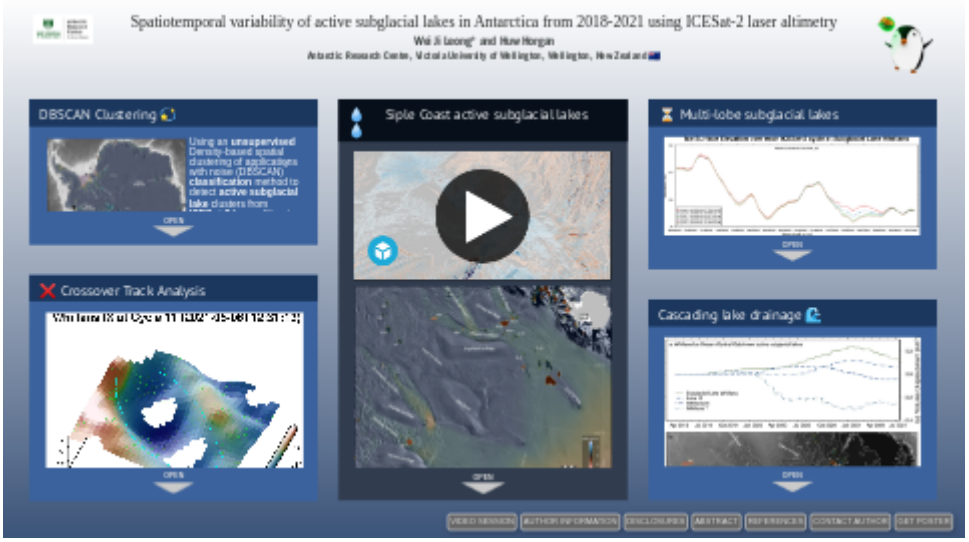
Spatiotemporal variability of active subglacial lakes in Antarctica from 2018-2021 using ICESat-2 laser altimetry



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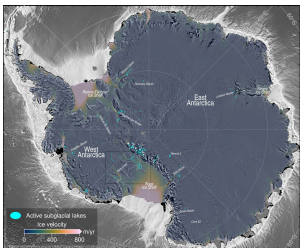
PRESENTED AT:

DBSCAN CLUSTERING 💫



Using an **unsupervised** Density-based spatial clustering of applications with noise (DBSCAN)[1] **classification** method to detect **active subglacial lake** clusters from **ICESat-2 laser altimetry** point clouds.

Fig. 1 Antarctic active subglacial lakes (2018-2021).

❌ CROSSOVER TRACK ANALYSIS

[VIDEO] https://res.cloudinary.com/amuze-interactive/image/upload/f_auto,q_auto/v1639428734/agu-fm2021/6d-02-28-03-0e-85-27-fb-44-9e-d1-0d-16-3e-4d-b6/image/dsm_whillans_ix_cycles_3-12_nclytx.mp4

Fig. 2a: Ice Surface Elevation (top) and Elevation Change (bottom) at Whillans IX over 2018-2021.

High temporal resolution (<3 months) **elevation time-series** from crossing ICESat-2 tracks produced using **x2sys**[2].

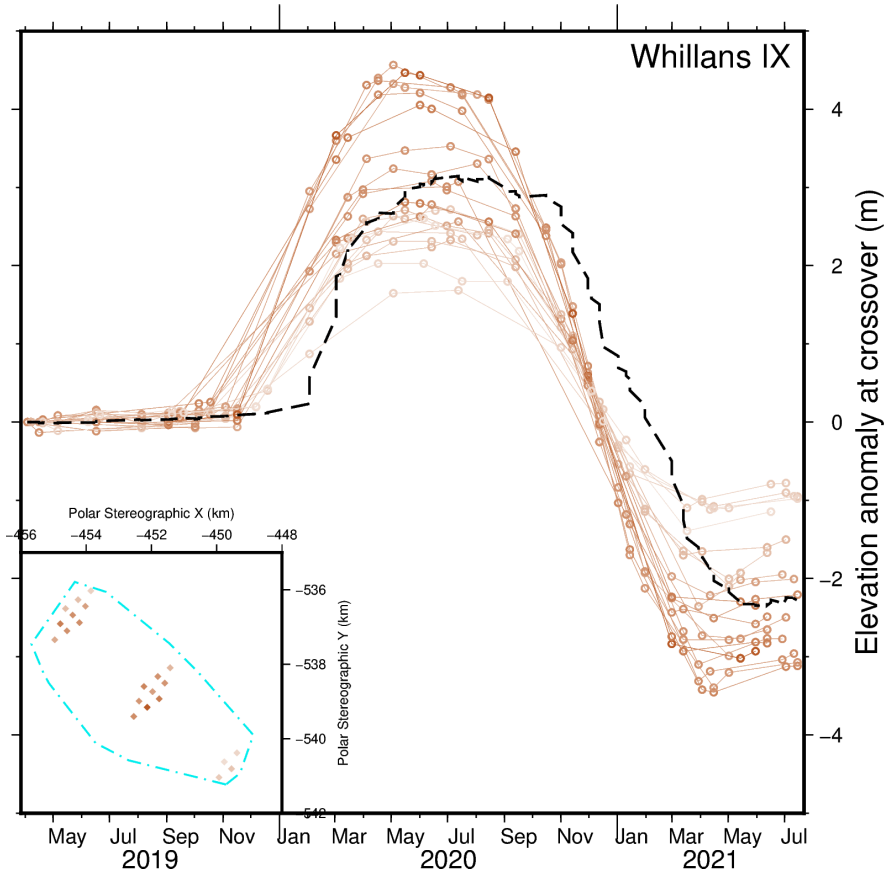


Fig. 2b: Elevation anomaly of crossover points. 91 day rolling mean of elevation anomalies shown as black dashed line.Inset plot shows locations of crossover points (brown) within lake outline (cyan).

SIPLE COAST ACTIVE SUBGLACIAL LAKES

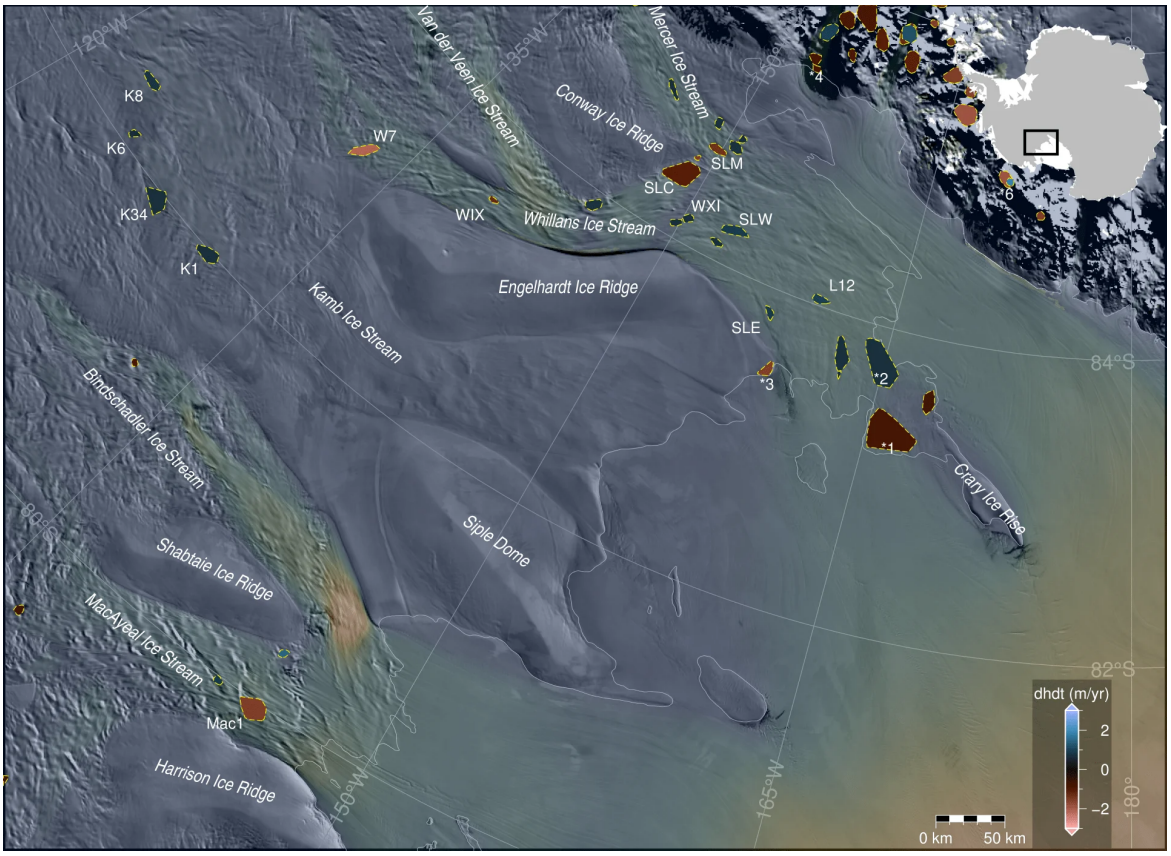


Fig. 3: Siple Coast active subglacial lakes. Coloured polygons show areas with elevation anomalies (high |dhdt|), going from red (surface lowering) to blue (surface uplift). Selected active subglacial lakes and other features of interest (denoted with an asterisk *) are labelled in white. Abbreviations are. Mac1: MacAyeal 1, K1: Kamb 1, K34: Kamb 34, K6: Kamb 6, K8: Kamb 8, SLE: Subglacial Lake Engelhardt, SLW: Subglacial Lake Whillans, WIX: Whillans IX, WXI: Whillans XI, W7: Whillans 7, L12: Lake 12, SLM: Subglacial Lake Mercer, SLC: Subglacial Lake Conway. Grounding line (Deepoorter et al., 2013) is plotted as a white line. Ice flow is from top left to bottom right. Plotted on an Antarctic Stereographic Projection with a standard latitude of 71°S (EPSG:3031).

MULTI-LOBE SUBGLACIAL LAKES

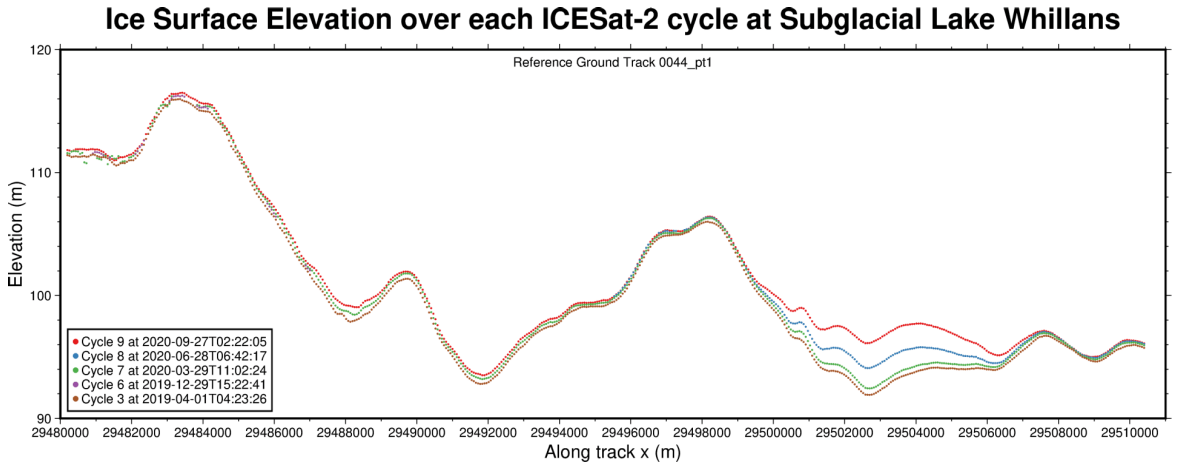


Fig. 4: Along track view of ice surface elevation over Subglacial Lake Whillans from ICESat-2 Cycle 3 to Cycle 9.

ICESat-2's **high along-track resolution** data revealed active subglacial lakes (e.g. WIX and SLW) filling concurrently in **multi-lobe clusters** separated by 1-4km ridges that may indicate **subglacial hydrological linkage**.

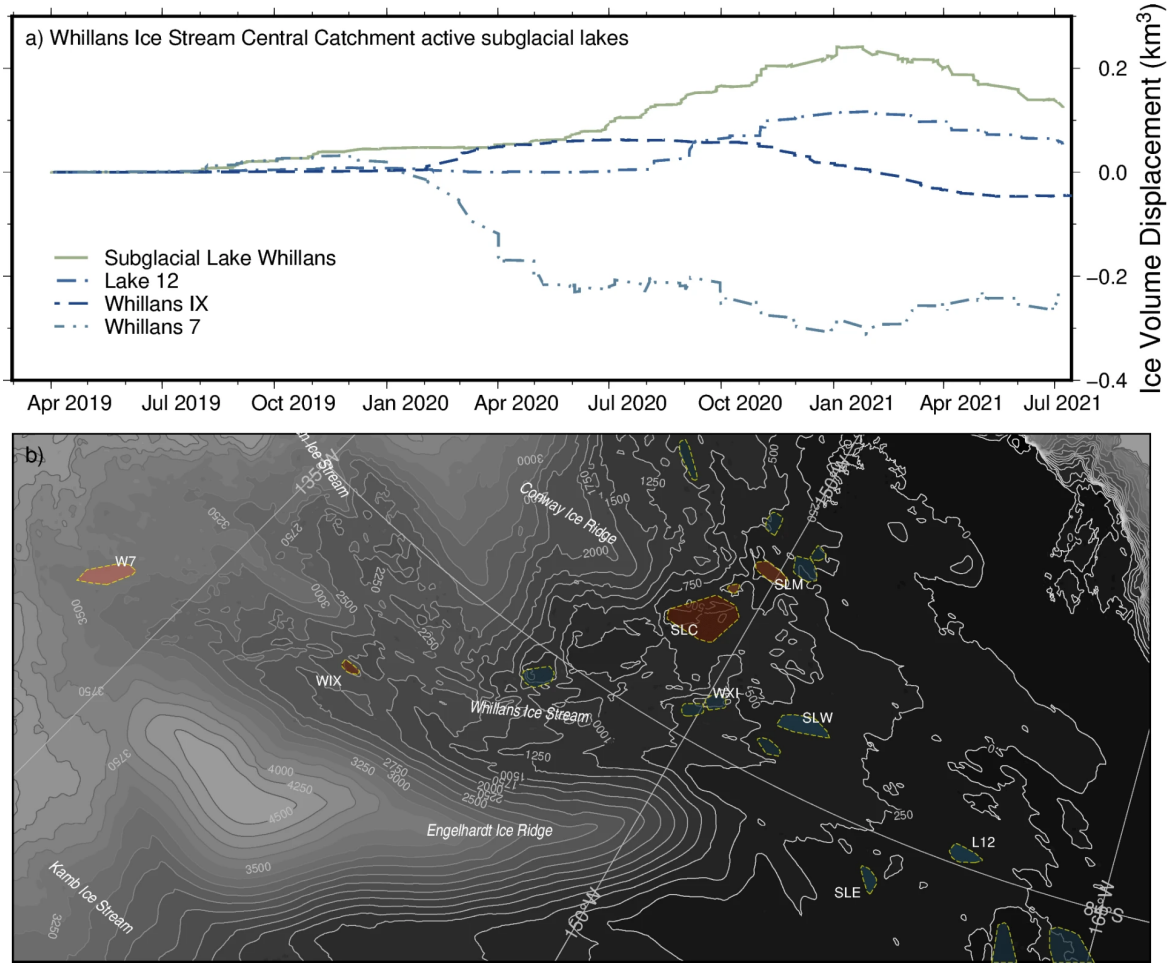


Fig 5: (a) Ice Volume Displacement of subglacial lakes and (b) hydropotential contour map at 250kPa intervals over Whillans Ice Stream.

Over the Whillans Ice Stream central catchment, a lake drainage event starting on Nov 2019 at Whillans 7 (W7) triggered downstream filling events at Whillans IX (WIX), Subglacial Lake Whillans (SLW) and Lake 12 (L12) up to Feb 2021.

Quick filling and steady drainage

An unusual pattern of rapid filling (0.1km3 in 3 months at WIX) and slow drainage (0.3km3 in 11 months at W7) was observed that stands in contrast to previous patterns of slow fill and rapid drainage in the Whillans catchment4,5.

DISCLOSURES

Acknowledgements

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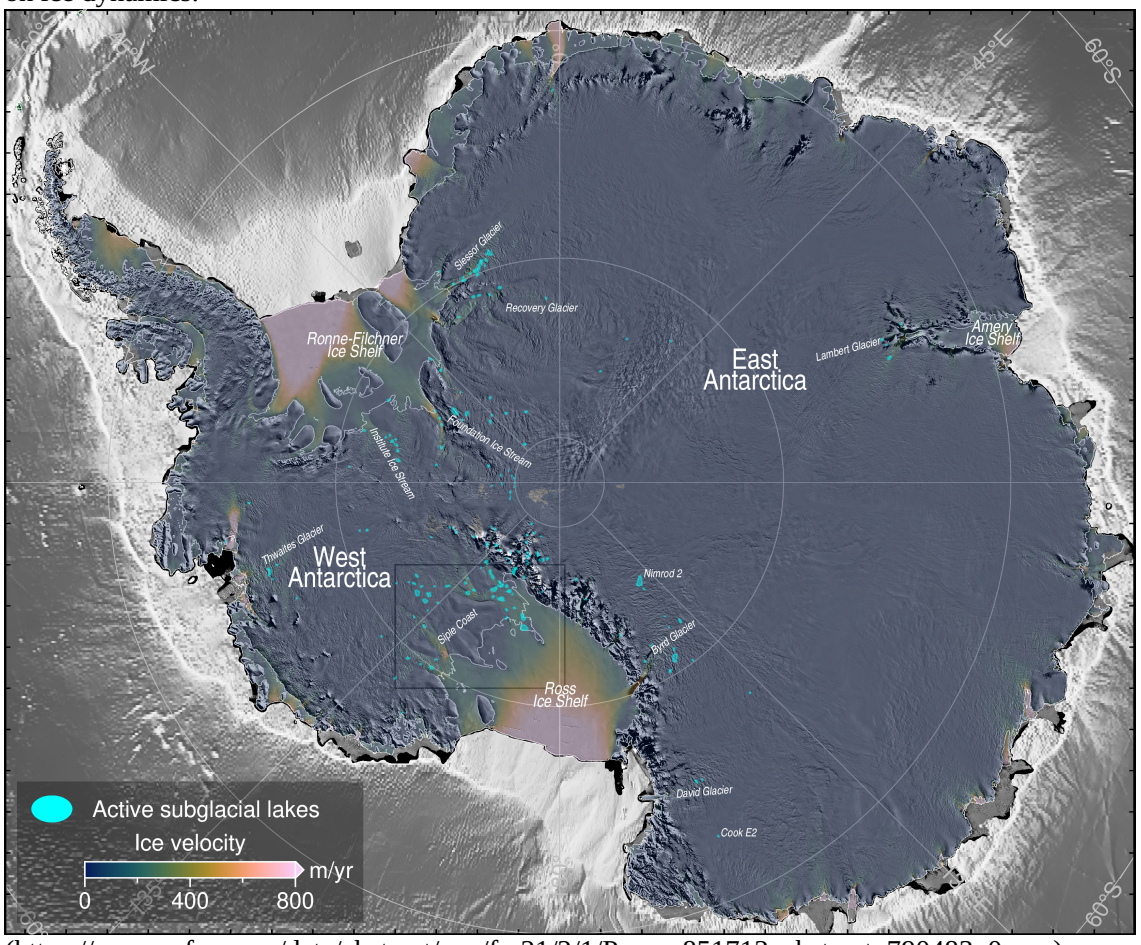
AUTHOR INFORMATION

Thanks for viewing our poster! I'm a researcher based in New Zealand (UTC+13) and am free to have a chat anytime over the AGU week. Feel free to contact me using the form below, or ping me on Twitter (username: @weiji14_).

P.S. Code for poster is at https://github.com/weiji14/agu2021 (https://github.com/weiji14/agu2021) and https://github.com/weiji14/deepicedrain (https://github.com/weiji14/deepicedrain)

ABSTRACT

To understand the movement of subglacial water in Antarctica, we present an updated inventory of active subglacial lakes using ICESat-2 laser altimetry data. The ICESat-2/ATLAS instrument's six-beam laser array captures denser point measurements than the previous generation ICESat and Cryosat-2 satellites, allowing us to examine the spatial and temporal variability of active subglacial lakes with unprecedented detail. Active subglacial lakes are classified directly from the high density ATL11 land ice time-series (60 m along track spatial resolution) point cloud data using an unsupervised density-based clustering algorithm. The key finding we show is how subglacial lake shorelines can migrate spatially over time through fill-drain cycles. In addition, we examine subglacial water connectivity from coupled fill-drain cycles over lakes at the Whillans Ice Stream on the Siple Coast. This study yields new insights into the dynamic nature of the subglacial water system in Antarctica, and will be of interest to biologists quantifying biogeochemical cycle processes and glaciologists studying the influence of subglacial hydrology on ice dynamics.



(https://agu.confex.com/data/abstract/agu/fm21/2/1/Paper_851712_abstract_790483_0.png)

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