Investigating the impacts of climate change on Russell Glacier and its surrounding landscape

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Introduction

The Arctic is currently warming at a rate 4 times faster than the global average (Rantanen, et. al., 2022) leading to the accelerated melt of the Greenland Ice Sheet. Russell Glacier is an outlet of GrIS and its proglacial front provides an accessible study area for this change. Between 8th June and 10th July, we conducted an expedition to Kangerlussuaq, West Greenland **to investigate current changes to Russell Glacier and its margin due to climate warming.** This was explored through 3 areas: **glaciological** (CC, JM), **glaciofluvial and lacustrine** (HM, IB) and **geomorphological** (MG, JT).

Objectives

Glaciological

- Investigate the factors affecting meltwater stream dynamics on the ice.
- Investigate the relationship between ablation rate and ice debris darkness.

Glaciofluvial and lacustrine

- Understand the fluvial processes in the formation and evolution of lacustrine deltas.
- Investigate the recently changing nature of jökulhlaups and their effects on the delta landscape.

Ice-marginal

- Understand the mechanisms leading to the development of an ice-marginal landsystem and moraine formation.
- Assess the processes of sediment supply and transfer from the ice to the marginal area.

Methods

Glaciological

- Measurements of stream dynamics (width, discharge, and temperature) to compare with secondary weather data and aerial imagery.
- Daily measurements of ablation at 15 stakes, and digital quantification of debris cover.

Glaciofluvial and lacustrine

- GIS mapping and aerial imagery of fluvial, delta, and lake features to compare with historical data. Clast sampling and sediment logs of the landforms.

Ice-marginal

- Mapping of key moraine features and extents, analysis of sediment composition of moraines and up-thrusted outcrops.
- Clast analysis (a, b, c axis, features, rock type. etc.).

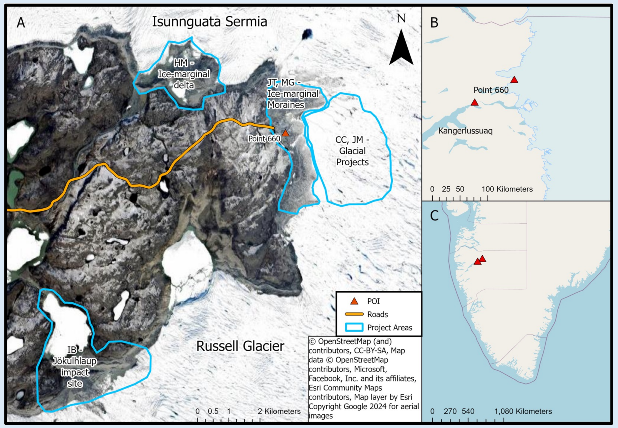

Figure 1: Map to show A) individual field sites by project; B) the location of Point 660 Relative to Kangerlussuaq and C) the expedition location relative to Greenland.

Figure 2: Ice-marginal landforms located around Point 660, Russell Glacier can be seen in the background, moraines display hummocky features, associated with ablation. Kettle holes can be viewed in the foreground. Image credit: Joseph Thomas

***Figure 3*:** Aerial imagery from 18th June showing area of channel 1 at site 3, overlain with channel course as of July 4th shown in pink. The third discharge measurement site is shown in blue. Image credit: Joseph McGrattan

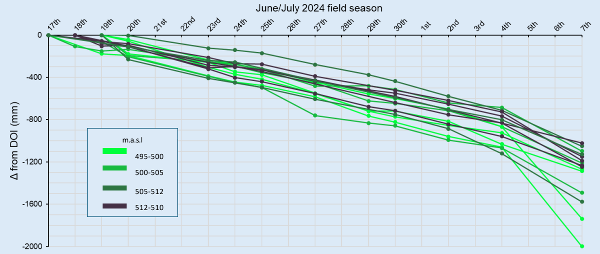

Figure 4: Absolute melt (mm) relative to day of installation (DOI) of 15 ablation stakes drilled into the ice sheet at Point 660. Line colour represents elevation (m.a.s.l) taken on a handheld eTrex GPS. Where the 1m-long stakes melted out, they were redrilled and the measurements totalled post-field.

Key Findings

Glaciological

- Daily stream discharge is mainly controlled by air temperature and cloud cover. Across the study period both width and discharge increased overall. Channel courses varied throughout the study period, showing both increasing and decreasing sinuosity, as illustrated in ***Figure 3***.
- Debris darkness does not fluctuate significantly, suggesting few origins. Instead, debris cover impacts upon plot-scale ablation rates. Regional patterns of ablation (***Figure 4***) mimic daily temperature, solar radiation, and wind controls.

Glaciofluvial and lacustrine

- Surface clast sizes varied across the delta as well as increasing in size with terrace elevation: from silt (bottomset), sand/gravel (foreset), to boulders (topset).
- Locally, jökulhlaups have increased in frequency, while decreasing in intensity. This is reflected in the demographic of the sedimentary deposits in the outlet.

Ice-Marginal

- Moraine formation is likely caused by the ablation of subglacially derived material. Evidence of englacial debris thrusts are present in moraine morphologies (***Figure 2***).
- There was high correlation between predicted and observed clast characteristics for each site location, showing sediment transfer routes from the ice to the proglacial area between fluvial, subglacial and on-ice pathways.

Conclusions

Here we have shown through a multidimensional approach the changes occurring to 3 systems at Russell Glacier's margin. We have investigated both the historical geomorphological development of the region, and contemporary melting due to climate change, with its subsequent effects. In the coming months, data collected will be written up into our undergraduate dissertations.

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Social Media

Further photos from the expedition can be seen on our Instagram
@teamkangncl

References

Rantanen, M., Karpechko A.Y., Lipponnen, A., Nordling, K., Hyvärinen, O., Ruosteenoja K., Vihma, T. and Laaksonen, A. (2022) 'The Arctic has warmed nearly four times faster than the globe since 1979', Nature, Communications Earth and Environment, 3 (168). https://doi.org/10.1038/s43247-022-00498-3

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