**SLIDE website**

**LANDING PAGE:**

**SLIDE heading with logo on main page and brief header of what the project is about**

This three year project aims to determine how water is stored in lakes under the Greenland Ice Sheet, how they drain and evolve through time, and their wider impact on water drainage and the flow of ice.

**SUB-PAGES**

**Introduction and aims**

The SLIDE team is working in Greenland to investigate lakes that are hidden from sight beneath the ice sheet (also termed subglacial lakes). These lakes exist due to the pressure and insulating effect of ice from above, geothermal heat from below and drainage of a large volume of water from the surface to the bed through cracks in the ice.

There is mounting evidence to suggest that subglacial lakes that fill and drain are common and dynamic components of the hydrological system underneath the ice sheet. But until recently they have been largely ignored. Therefore, the key processes controlling how lakes under the ice sheet form and drain, and their impact on other components of the hydrological system (e.g. channels and cavities), and ice flow have yet to be identified. Thus, the current and future importance of subglacial lakes is unknown.

The SLIDE project addresses this research gap through a dedicated field campaign using geophysical sensors and remote sensing to characterise and monitor multiple subglacial lakes beneath Isunnguata Sermia. These results will be used to constrain a numerical model to determine their impact on the future mass balance of ice sheets.

Our investigation is focused on four subglacial lakes beneath Isunnguata Sermia, a large glacier in south-western Greenland. Isunnguata Sermia drains a 16,000 km2 catchment extending up to the centre of the ice sheet and is 400-800 m thick and moving at a rate of about 120 metres per year in the region we are working, close to where it terminates in a large valley. The four lakes

were serendipitously [discovered](https://tc.copernicus.org/articles/13/2789/2019/tc-13-2789-2019.html) from satellite imagery, which revealed regions of the ice surface (‘bullseyes’) about 1 km wide that were slowly uplifting over a number of years before rapidly subsiding by as much as 30 m over a few weeks to form a surface depression. We interpreted the uplift to record the lakes slowly filling, pushing up the ice, as they capture water draining from the surface through cracks and under the ice. The ice-surface collapses downwards when the lake rapidly drains as a flood downstream and out the front of the glacier.

We have chosen to focus on these lakes due to their location close to the ice margin, logistical support and airport, enabling a low risk and cost research programme, while the access to multiple lakes beneath relatively thin ice (350-500 m) provides an opportunity to characterise the system in detail.

ADD MAP OF IS AND INSTRUMENTS + SOME PHOTOS

**Field work**

The SLIDE team have deployed over 200 scientific instruments on the glacier over two years (2023 and 2024), camping on or close to the glacier. This has involved a team of over 25 scientists, with more than 700 person-days in the field. Logistical support is provided by Chris Sørensen and the Kangerlussuaq International Science Support (KISS) Centre.

We have deployed a range of geophysical sensors to monitor the flow of the ice and to remotely explore the hidden world that exists underneath the glacier. To do this we use:

* GNSS to monitor very precisely how the ice flows and is lifted up and down by the flow of water and filling and draining of lakes underneath it.
* Passive seismic sensors to listen to the sound of water flow under the ice and coming out from the front of the glacier, just like you can hear the flow of a large river on land. These sensors can also listen to the sound of cracking as water forces its way to the bed through cracks and holes in the ice.
* We pull a radar over the glacier surface to image through the ice to the bed to determine what the landscape looks like and to determine the shape of the lakes. We also use a different type of radar that stays in one place, which can be used in tandem with the GPS to determine very accurately the rate of lake filling and drainage.
* Active seismics, involving generating seismic waves by hitting a metal plate with a hammer is also used to determine the landscape under the ice, but also whether that bed is sediment or rock and how deep the lakes are.
* Drones have been used to repeatedly map the topography of the ice surface at centimetre-scale resolution. By then subtracting one image from another we can determine how the surface is moving up and down in response to water flow and lake filling and draining. We also use the images to map the ice surface to identify where water can access the bed through cracks and holes.
* Cryoeggs are spherical sensors, about the size of a melon, that we put down holes or cracks in the ice with the aim that they make their way to the bed of the glacier and send us information back about the lakes and the plumbing system that water moves through. We have also put similar sensors, called pressure transducers, but connected by wires down some holes.
* We have also been measuring how much water is entering the glacier and have a meteorological station to track how the weather is impacting melting of the ice surface.

Although the project is focused on the lakes that exist under the ice, there is also a very large lake that is trapped against the ice, i.e. the ice acts like a giant dam. This lake is about 3 km across and 100 m deep (volume of ~163 million cubic meters, or 65,200 Olympic swimming pools!) and, just like the lakes under the ice, slowly fills before catastrophically draining in a flood under the ice. Last October (2023) this happened, with our sensors picking up the ~10 day-duration glacial lake outburst flood.

**Modelling**

Once we have all the field data we will use this information to build up a picture of how water is moving and being stored under the ice and the impact it has on ice flow. To help do this we will use a numerical model, which acts like a very powerful calculator to help us understand the wider impact of the subglacial lakes and water flow using numbers and equations. We will plug in our results and then vary them to simulate a range of different scenarios that might represent different areas of Greenland or a warming world - for example, by increasing the amount of melt or making the ice thicker or flatter - to see how it impacts their behaviour.

**Blog post – field season**

I am wondering if we should encourage someone to write a blog post on their experiences of one of the field seasons, saying what they were doing, their role, experiences of working in Greenland etc…

**The Team**

List people and affiliation. [given number of people I would suggest listing and then including a link to university websites]

|  |  |
| --- | --- |
| **Name** | **Affilliation** |
| Stephen Livingstone | Sheffield |
| Samuel Doyle | Sheffield/ Aberystwyth |
| Matthew Peacey | Bristol |
| Robert Storrar | Sheffield Hallam |
| Elizabeth Bagshaw | Bristol |
| Adam Booth | Leeds |
| Sammie Buzzard | Northumbria |
| Laura Edwards | Liverpool John Moores |
| Neil Ross | Newcastle University |
| Andrew Sole | Sheffield |
| Mike Prior-Jones | Cardiff |
| TJ Young | St Andrews |
| Ryan Ing | Edinburgh |
| Caroline Clason | Durham |
| Gianluca Bianchi | Cardiff (might be Northumbria - need to check) |
| Guilhem Barruol | Université Grenoble Alpes, France |
| Tifenn Le Bris | Université Grenoble Alpes, France |
| Adrien Gilbert | Université Grenoble Alpes, France |
| Florent Gimbert | Université Grenoble Alpes, France |
| Alexandre Michel | Université Grenoble Alpes, France |
| Thomas Chudley | Durham |
| Lisa Craw | Cardiff |
| Jonathon Hawkins | Cardiff |
| Sian Thorpe | Sheffield |
| Angus Moffatt | Sheffield |
| Siobhan Killingbeck | Swansea |
| Adam Hepburn | Aberystwyth |
| Andrew Jones | Sheffield Hallam |
| Remy Veness | Aberystwyth |

**Links to other sites**

* Blog post that Rob S did - <https://geoscienceforthefuture.com/hidden-lakes-underneath-giant-ice-sheets/>
* Scott’s Instagram site with videos. photos

**Gallery**

Selection of photographs from each of the different field seasons

**Publications**

[Livingstone](https://tc.copernicus.org/articles/13/2789/2019/tc-13-2789-2019.html) et al. (2019).

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