IMPERIAL

PhD Project Description

Project Title

Antarctic surface hydrology and sea-level rise

Supervisors

Lead Supervisor: Jonathan Kingslake

Research Group

Glaciology. This is a new research group that will be established starting June 2026 in the Department of Earth Science and Engineering.

Jonathan Kingslake's website can be found here and a website about a related ongoing project can be found here.

Note

This project is only a suggestion for a useful starting point for a PhD. I believe in students having independence and freedom when deciding their research direction. I would be happy to discuss any ideas for glaciological research topics whether or not they align with the project outlined here.

Project Summary

The Antarctic Ice Sheet is beautiful, wild, and remote. It works in fascinating and complex ways, which are important to understand, because when the ice sheet shrinks, sea levels rise globally, impacting coastal communities.

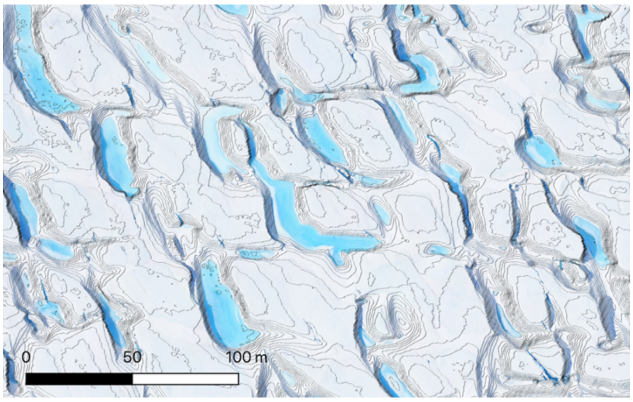

Figure 1: Meltwater pooling on the surface of an Antarctic glacier imaged using an Uncrewed Aerial Vehicle by Rohi Muthyala as part of a NERC-NSF funded project, 50-cm contours shown in black. More details here.

Many interesting processes control how ice sheets grow and shrink. This project will focus on Antarctic surface hydrology, a set of processes that has received relatively little attention, but potentially could have a significant role to play in the ice sheet's future. Antarctic surface hydrology includes the flow and accumulation of meltwater on the ice sheet's surface (Figure 1). These processes are important because they control where on the ice sheet meltwater can flow into and expand fractures, potentially accelerating ice-sheet retreat.

The student will use satellite remote sensing and physics-based modelling to improve our understanding of Antarctica and its dynamic surface drainage systems. They will learn and develop glaciological data analysis and modelling techniques, collaborate with colleagues across and beyond Imperial, and lead the way forward in the growing field of Antarctic surface hydrology.

Research Context and Objectives

Our ice sheets are shrinking, driving sea-level rise and threatening coastal communities worldwide. Predicting how this will continue is vital for mitigating climate risk. Ice shelves—the floating extensions of ice sheets—slow ice flow and sea-level rise, but can collapse rapidly through fracturing driven by surface meltwater. As summarized in Figure 2, previous work by my group and others has shown that coastal areas of ice shelves are more vulnerable to water-driven fracture than upstream areas and that drainage networks (lakes, rivers, and streams) move water long distances onto and across ice shelves towards the vulnerable coastal regions. Furthermore, drainage networks grow larger in warmer summers, suggesting that predicted atmospheric warming will result in water inundating vulnerable areas, potentially triggering collapse. Despite their potential impact on ice loss, these processes are not considered in sea-level projections. The following questions remain unanswered: How does water move across the surface of Antarctica? When and where will ice shelves be inundated this century? And how will this impact sea-level? This PhD project will be part of a larger effort across the research group aimed at answering these questions. Possible directions include the processes that control meltwater drainage, the large-scale evolution of drainage systems, and the impact of meltwater drainage on projections of sea-level rise. In all cases the student will use remote sensing and mathematical/numerical modelling to build understanding of drainage systems and improve our ability to include them in large-scale models. Depending on available funding, there is also the potential to make field observations of relevant processes in Juneau, Alaska.

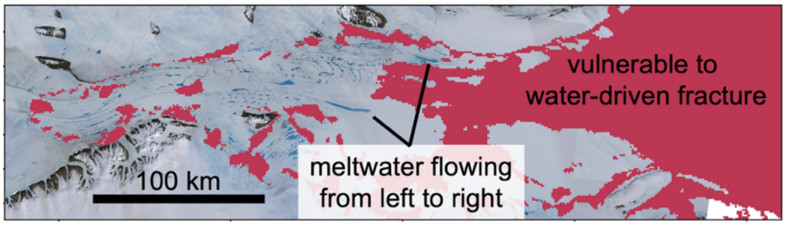

Figure 2: Surface meltwater flows (Spergel et al, 2022) towards the parts of Amery Ice Shelf, East Antarctica, that are most vulnerable to meltwater-driven fracture, shown in red (Lai et al., 2020). See here for the code to produce this plot.

Collaborators and partners on the project:

Depending on the direction taken by the student, potential project partners include

- Alison Banwell, UC Boulder/Northumbria
- Roger Buck, Lamont/Columbia
- Seth Campbell, U Maine
- Christian Schoof, U British Columbia
- Rosie Williams, British Antarctic Survey

Further reading:

The two papers cited above are:

Lai, C.-Y., Kingslake, J., Wearing, M. G., Chen, P. C., Gentine, P., Li, H., Spergel, J. J., & van Wessem, J. M. (2020). Vulnerability of Antarctica's ice shelves to meltwater-driven fracture. *Nature, 584*(7822), 574–578. https://doi.org/10.1038/s41586-020-2627-8

Spergel, J. J., Kingslake, J., Creyts, T., van Wessem, M., & Fricker, H. A. (2021). Surface meltwater drainage and ponding on Amery Ice Shelf, East Antarctica, 1973–2019. Journal of Glaciology, 67(266), 985–998. https://doi.org/10.1017/jog.2021.42

Who are we looking for?

The ideal candidate will have a background in Earth science, Physics, Applied Mathematics, or a related field.

Essential experience: strong computational and mathematical skills; data analysis experience; some mathematical modelling experience; a strong interest in glaciology/polar science; and a strong desire to better understand the fundamental workings of Earth system processes, both because they are important for society and because they are fascinating.

Desirable experience: Numerical solution of differential equations; satellite remote sensing, glaciology or polar science; advanced scientific computing; and advanced communication and scientific writing skills.