ONE Planet
Doctoral Training Partnership

Natural Environment Research Council

Project title: Quantifying the controls on, influences and glaciological impacts of glacier disconnections on ice masses worldwide

Ref: OP2302

Keywords: Glaciology, climate change, numerical modelling

One Planet Research Theme:
Climate & Climate Change ☒ | Earth System Processes ☐ | Anthropocene ☐ | Environmental Informatics ☐

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Key Research Gaps and Questions:
Research Aim: to quantify the controls, influences and impacts of glacier disconnections on glaciers and ice caps worldwide.

Hypothesis: glacier tongue stagnation and accelerated recession is observed where complete disconnection occurs within ice-flow units.

Research Questions: RQ1. What are the climatic, glaciological and topographic controls on disconnections? **RQ2**. How prevalent are they in different regions and topographies? **RQ3**. What are their glaciological consequences?

A glacier disconnection on Juneau Icefield, Alaska.

Project Description: Global glaciers lost 335 ± 144 billion tonnes of ice per year from 2006-2016, driving 21% of sea level rise (Hugonnet et al., 2021). 40% (107.9 Gigatonnes) of this mass loss was from northern Arctic Canada, Alaska and from around the Greenland Ice Sheet. Large losses will continue, due the substantial ice volume here (Edwards et al., 2021). Smaller ice masses in western Canada, the Himalaya and the European Alps are critically important for their water resources (Immerzeel et al., 2020; Huss and Hock, 2018).

There are key elements of ice loss that we do not fully understand, and these hamper our ability to predict future glacier behaviour. An *important but understudied and unquantified glaciological threshold* may be passed if rising equilibrium line altitudes (ELAs) intersect with icefalls. Increased melt at the icefall makes it narrow and thin. Ultimately a severing, or 'disconnection', between the glacier's accumulation and ablation areas can occur. This will decrease down-glacier nourishment, cause glacier tongue stagnation, and accelerate terminus recession. This process has been observed in Alaska (Davies et al., 2022), Canada (Jiskoot et al., 2009; Rippin et al., 2020) and Europe (Le Heron et al., 2022). Accelerating climate change and rising glacier ELAs (Zemp et al., 2021) make disconnections a critical threat to global ice masses. However, both the wider prevalence and nature of this threshold process, and its significance for controlling glacier wastage, are poorly understood. *This limits our ability predict future icefield melt, fragmentation, contributions to global sea level rise and reductions in meltwater availability.*

This project will focus on representative glaciers and icefields in different regions, for example the **Himalaya, Alaska, western** and **Arctic Canada, Greenland periphery** and **European Alps**, all with different climates, hypsometries and topographies. The project will map glacier structures, disconnections and hypsometric characteristics and determine prevalence of, and controls on, glacier disconnections. It will consider their influence on glacier area, velocity and volumetric change and will assess the potential for future non-linear or threshold behaviour for the studied glaciers and icefields. Applicable techniques will include remote sensing, numerical modelling and field observations, depending on student interests and skillsets, and full training will be given.

Prerequisites: Essential: Remote sensing experience, experience of studying glaciers. Desirable: experience of glaciological fieldwork, experience of numerical modelling. For more information, please contact Bethan Davies (Bethan.davies@newcastle.ac.uk).

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