EGU22-4765
https://doi.org/10.5194/egusphere-egu22-4765
EGU General Assembly 2022

A new, multi-scale mapping approach for reconstructing the flow evolution of the Fennoscandian Ice Sheet using high-resolution digital elevation models.

Frances E. G. Butcher[1], Anna L. C. Hughes[2], Jeremy C. Ely[1], Christopher D. Clark[1], Emma L. M. Lewington[3], Benjamin M. Boyes[4], Alex C. Scoffield[3,5], Stephen Howcutt[3,6], and Thomas P. F. Dowling[7]

[1]Department of Geography, University of Sheffield, Sheffield, United Kingdom (f.butcher@sheffield.ac.uk)
[2]Department of Geography, University of Manchester, Manchester, United Kingdom
[3]Work done at: Department of Geography, University of Sheffield, Sheffield, United Kingdom
[4]School of Applied Sciences, University of Brighton, Brighton, United Kingdom
[5]Now at: School of Geography, University of Leeds, Leeds, UK.
[6]Now at: Department of Geography & Environment, School of Geosciences, University of Aberdeen, Aberdeen, United Kingdom
[7]NERC National Centre for Earth Observation (NCEO), c/o Department of Geography, King's College London, London, United Kingdom

Data-driven reconstructions of palaeo-ice sheets based on their landform records are required for validation and improvement of numerical ice sheet models. In turn, such models can be used to better predict the future responses of the Antarctic and Greenland ice sheets to climate change. We are exploiting the recent expansion in availability and coverage of very-high-resolution (1–2 m) digital elevation models (DEMs) within the domain of the former Fennoscandian Ice Sheet to reconstruct its flow pattern evolution from the glacial landform record.

The Fennoscandian Ice Sheet reached its maximum extent at 21–20 ka. Previous data-driven reconstructions over the whole ice sheet domain (encompassing Fennoscandia, northern continental Europe and western Russia) have necessarily relied upon landform mapping from relatively coarse-resolution (decametre-scale) data, predominantly from satellite images and aerial photographs. However, high-resolution (1–2 m/pixel resolution) LiDAR DEMs have recently become available over a large portion of the ice sheet domain above contemporary sea level. This reveals previously unobserved assemblages of landforms which record past ice sheet flow, including fine-scale cross-cutting and superposition relationships between landforms. These observations are likely to reveal previously unidentified complexity in the flow evolution of the ice sheet. However, the richness of the data available over such a large area amplifies labour-intensity challenges of data-driven whole-ice-sheet reconstructions; it is not possible to map every flow-related landform (or even a majority of the landforms) manually in a timely manner. We therefore present a new multi-scale sampling approach for systematic and comprehensive ice-sheet-scale mapping, which aims to overcome the data-richness challenge while maintaining rigor and

providing informative data products for model-data comparisons.

We present in-progress mapping products covering Finland, Norway and Sweden produced using our new multi-scale sampling approach. The products include mapping of >200 000 subglacial bedforms and bedform fields, and a summary map of 'landform linkages'. Landform linkages summarise the detailed landform mapping but do not extrapolate over large distances between observed landforms. Thus, they provide a reduced data product that is useful for regional-scale flow reconstruction and model-data comparisons and remains closely tied to landform observations. The landform linkages will be reduced further into longer interpretative flowlines, which we will then use to generate 'flowsets' describing discrete ice flow patterns within the ice sheet. We will use cross-cutting relationships observed in the detailed landform mapping to ascribe a relative chronology to overlapping flowsets where relevant. We will then combine the flowsets into a new reconstruction of the flow pattern evolution of the ice sheet.