Linking proglacial and subglacial geomorphology in southwest Greenland

Supervisors

Main supervisor: Doctor Steven Palmer (University of Exeter)
Co-supervisor: Doctor Stephen Cornford (University of Bristol)
Co-supervisor: Dr Tim Barrows (University of Exeter)
Co-supervisor: Dr Anne LeBrocq (University of Exeter)
Co-supervisor: Dr Alastair Graham

Project enquiries - Email: s.j.palmer@exeter.ac.uk **Contact number:** +44 (0) 01392725807

Host Institution: University of Exeter

Project description

The Greenland Ice sheet (GrIS) is the largest single contributor to sea level rise from the cryosphere, though large uncertainties exist in the projected rates of mass loss. Improved understanding of the controls on ice flow is required to better predict the future contribution of the GrIS to global mean sea level. Subglacial topography strongly influences the behaviour of the overlying ice and previous studies have used airborne ice-penetrating radar to derive gridded subglacial bed elevation datasets from ice thickness measurements acquired along discrete flightlines (Bamber et al., 2013). However, poor radar performance near the margin caused by ice crevassing introduces errors in derived bed elevation within ~10 km of the ice sheet margin. It is in these ice marginal areas, where ice is thinnest, that ice dynamics is most sensitive to topography. Therefore, there is a need for novel methods to provide improved knowledge of subglacial bed elevation near the margins of the GrIS.

The approach proposed in this PhD project is to use the glacier foreland, where we have detailed topographic information, as a proxy for understanding the less accessible subglacial regions. The successful candidate will use high resolution (2 m) satellite elevation data (Noh & Howat, 2015) acquired over Greenland to produce a geomorphological map of the foreland, identifying former ice-marginal features delineating former ice sheet extent. The resulting maps will be validated using a combination of airborne LiDAR measurements and field observations, including initial age estimation of features located at a former ice margin. The map will then be utilised in the following ways:

1. The topography data will be used to synthesise ice-penetrating radar datasets of subglacial topography over the currently ice free areas, assuming a range of typical airborne survey line spacing and orientations. These 'artificial' subglacial topography grids will be compared with the known topography to investigate the sensitivity of derived subglacial topography datasets to the airborne survey design and flight line orientation.

2. Ice marginal features identified in the mapping will be used to constrain an ice sheet dynamical model, in order to investigate the Holocene retreat of this sector of the ice sheet.

It is intended that these analyses will lead to (i) a novel method for optimising airborne ice-penetrating radar survey design; (ii) improved methods for interpreting ice-penetrating radar datasets near ice sheet margins; and

(iii), improved understanding of Holocene ice retreat in West Greenland.

The successful candidate will receive training in state of the art remote sensing and GIS techniques, and will also have the opportunity to map proglacial geomorphological features in SW Greenland to validate the remote sensing analysis. The candidate will be part of vibrant community of researchers at the University of Exeter, and amongst the wider GW4+ community.

Bamber, J. L., Griggs, J. A., Hurkmans, R. T. W. L., Dowdeswell, J. A., Gogineni, S. P., Howat, I., Mouginot, J., Paden, J., Palmer, S., Rignot, E., and Steinhage, D. (2013) A new bed elevation dataset for Greenland, The Cryosphere, 7, 499-510, doi:10.5194/tc-7-499-2013.

Noh, M. J., & Howat, I. M. (2015). Automated stereo-photogrammetric DEM generation at high latitudes: Surface Extraction with TIN-based Search-space Minimization (SETSM) validation and demonstration over glaciated regions. GIScience & Remote Sensing, 52(2), 198-217.