Monitoring and modelling changes to polar ice sheets and ice caps over the last 50 years

Supervisory team: Dr. Robert Bingham, Dr. Noel Gourmelen & Dr. Dan Goldberg (GeoSciences, Edinburgh)

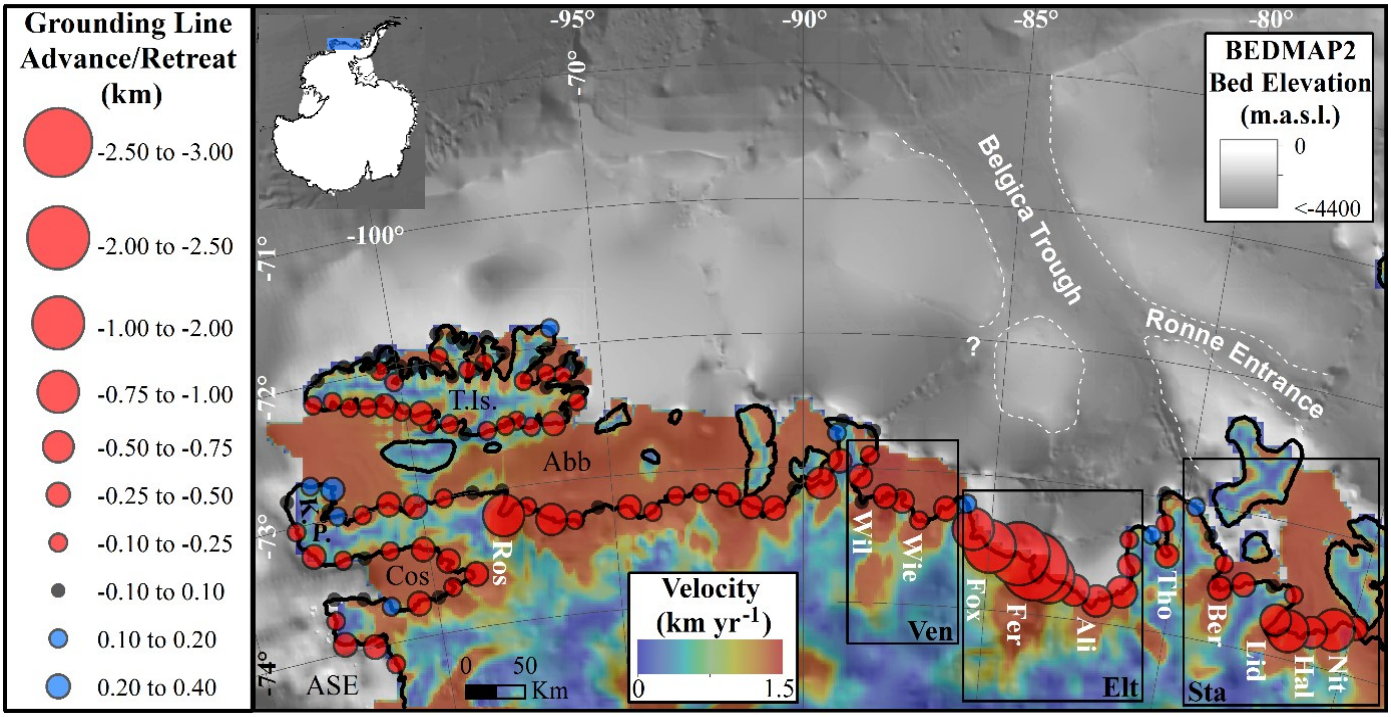

Figure 1: Example of Remote Sensing analysis applied to show pervasive retreat of part of West Antarctica's margin. From Christie et al. (2016), a research project run by the same supervisory team at Edinburgh.

Project Summary (30 words)

Combining Remote Sensing, GIS, Geophysical Analyses and Ice-Ocean Modelling, you will map and explain changes occurring around polar ice masses over the last 50 years.

Background and Rationale

A number of recent studies have begun to highlight the potential to analyse remote sensing imagery to monitor changes that have occurred to the Earth's ice sheets, ice caps and glaciers over the last few decades. A common technique has been to map changes to glacier frontal positions using Landsat data, which has shown significant and widespread retreat in locations such as the Antarctic Peninsula (Cook et al., 2016), parts of East Antarctica (Miles et al., 2013) and in parts of Greenland and glaciated Arctic islands (Carr et al., 2013). In West Antarctica, Christie et al. (2016) have mapped pervasive retreat of the grounding line over the last 40 years using a combination of Landsat and InSAR. These studies are just opening the door to the vastly wider potential for deploying remote sensing data and auxiliary information, such as that stored in the internal geometry of radar-imaged internal layers (Bingham et al., 2015), to reconstruct recent change across the polar ice masses on a more holistic scale. The ultimate goal of this project is to develop a framework for making best use of the existing data to map changes around the polar ice masses for the last 50 years, and to use these data to inform us on the processes responsible.

Aim and Key Research Questions

The aim of the proposal is to formalise a framework for making best use of available remote sensing (e.g. Landsat, MODIS, ASTER, SPOT) and geophysical data (radar sounding) to capture past change to polar ice masses. It is anticipated that the initial focus will be on Antarctica, but the ambition is to develop a workflow applicable to all polar ice masses. There is considerable flexibility in the direction that the project may ultimately take.

Key research questions are as follows:

1. Are changes to West Antarctic ice fronts and grounding lines related to El Nino Southern Oscillations?
2. Have changes at the ice front been transmitted inland in terms of optically-detectable signals of ice-flow change?
3. How can radar-imaged internal layers be used in ice-sheet modelling for the purposes of unravelling ice-sheet history?

Methods and Timescale of Activities

By undertaking this project, as part of a highly-integrated group at Edinburgh, you will gain strong expertise in using a mix of techniques in remote sensing, image manipulation, glaciological interpretation, and ice-sheet modelling to build an archive of past ice change that will be of high impact to the scientific community. The project has some flexibility as regards its ultimate direction, but an indicative outline of some key stages is as follows:

1. Apply techniques of Christie et al. (2016) to map changes to grounding-line position around unmapped West Antarctica, and then on to East Antarctica.
2. Develop techniques to move towards automation of grounding-line and ice-front mapping.
3. With Antarctic archive, explore relationship of mapped changes to e.g. El Nino Southern Oscillation.
4. Explore transmission of mapped grounding-line/frontal changes inland through geometry of radar-imaged internal layers.
5. Translate above methodologies to Greenland Ice Sheet and/or additional polar ice caps.

Training / Advantages of doing your Ph.D. based in Edinburgh with this supervisory team

- Specific advantages of doing your Ph.D. in Edinburgh are:
  - As part of the Edinburgh E3 Doctoral Training Programme you are provided with a formal programme of training in research skills and multiple opportunities to interact with internationally leading Geoscientists.
  - You will join Edinburgh's 25+ Glaciology and Cryosphere group, which meets twice a week for research interaction, i.e. exchanging knowledge and practicing conference presentations in a friendly, informal setting.
  - Multiple opportunities to attend research talks in physical geography and earth science and meet international visitors – we attract many!
  - Multiple opportunities to build transferable skills profile, e.g. through becoming integrated into the School of GeoSciences Graduate School; becoming part of the wider Scottish SAGES Graduate School. A fringe benefit is that these activities offer many opportunities for meeting like-minded people and socialising!
  - Many opportunities (but no obligation) to teach undergraduate students, including on field trips.
- Advantages of doing THIS Ph.D. with THIS TEAM are:
  - You will **gain skills in the key areas important for future glaciological research**, namely remote sensing and modelling.
  - Though fieldwork is not integral, **the supervisory team are very encouraging of giving you field experience during your studentship** if that is your desire. Please contact r.bingham@ed.ac.uk to discuss.
  - Supervision by a team with a strong track record of facilitating students to present their work at international conferences, publishing their work in scientific papers, and successfully finding positions at the end of the Ph.D.

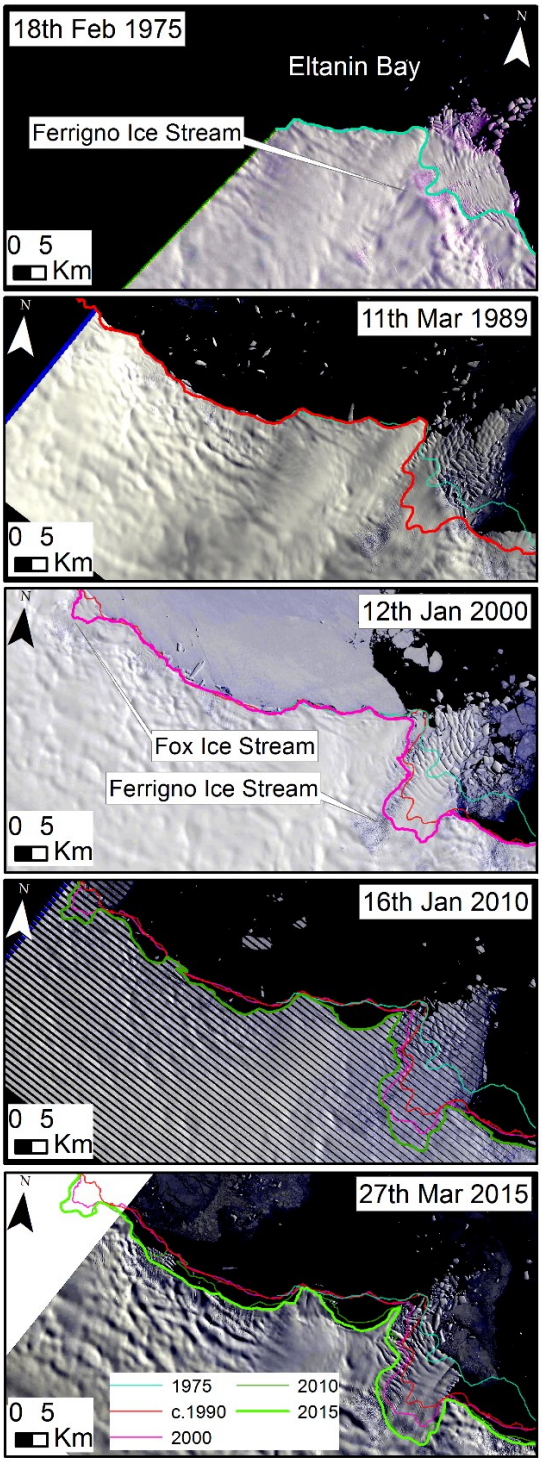

Figure 2: Mapped changes to part of West Antarctica's ice front over 40 years. This study from our group was highlighted as NASA's Image of the

Required skills and qualifications prior to application

We seek an enthusiastic student with a suitable Undergraduate and/or Masters Degree qualification equipped with quantitative skills in Earth Sciences, Physical Geography and/or Physical Sciences.

References (further reading):

Bingham RG et al. (2015) *J. Geophys. Res.*, 120, 655-70; Carr JR et al. (2013) *J.Geophys. Res.*, 118, 1210-1226; Christie, FWD et al. (2016) *Geophys. Res. Lett.*, 43, 5741-5749; Cook AJ et al. (2016) *Science*, 353, 283-286; Miles, BWJ et al. (2013) *Nature*, 500, 563-566.