High resolution simulations of Antarctic ice sheet change (Ref IAP2-18-13)

The British Antarctic Survey, Cambridge, U.K.
In partnership with The University of Durham

Supervisory Team
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Key Words
1. Numerical modelling, Ice cores, Antarctica, sea level rise

Overview

Understanding changes in the Antarctic Ice Sheet (AIS) over longer time periods is critical to predicting the likelihood of future sea level change (de Boer, et al. 2017). Ice core records are one of the best dated and most direct records we have of these AIS changes in the past. The Weddell Sea Embayment (WSE) drains a huge volume of the AIS, and has likely been subject to large ice volume changes, however its contribution to global sea level rise during both the last interglacial and the last deglaciation remain unknown.

This studentship will combine new modelling approaches with new ice core records of water stable isotope measurements including from Berkner Island and Fletcher Promontory ice rises, and use glacio-isostatic adjustment modelling, to uncover the history of the AIS in the WSE over the last 140 thousand of years. The studentship will test how the ice core isotopic record would respond under differing ice sheet changes.

The student will investigate to what degree isotopic records from the last deglaciation reflect regional, i.e. southern hemisphere, climatic changes and to what degree they reflect changes that are associated with WSE AIS (local) changes in the configuration of the ice sheet.

Methodology

The student will use an output from a Glacio-Isostatic-Adjustment (GIA) model and pre-existing climate model simulations (Holloway et al., 2016 and 2017) to look at how glaciological change and bedrock deformation controlled the AIS during the deglacial and last interglacial time periods.

The primary research route will be to run new high resolution isotope-enabled weather forecast-type simulations of the WSE region. Isotopic output from the WRF-isot model, run using a variety of AIS change configurations, will be evaluated against BAS and Washington ice core data (e.g. see Figure 1). New ice
core data from the European oldest ice and WACSWAIN projects may also be available to the student. See https://www.esc.cam.ac.uk/news/warm-climate-stability-of-west-antarctic-ice-sheet. This approach will both help us discriminate between the likelihood of high and low sea level change scenarios during past AIS change events, and understand what can be gleaned from these coast ice core measurements.

Pre-existing global climate model simulations covering the last 140 ky, run using the HadCM3 model, will be used alongside updated AIS change scenarios provided by Dr Whitehouse to drive the new WRF-iso weather forecast model.

See https://www.mmm.ucar.edu/weather-research-and-forecasting-model for more details of WRF. New isotope code for WRF (WRF-iso) has recently been developed by our University of Washington (UoW) collaborators. It is this that now provides an exciting new opportunity to link measurements of water isotopes from small Antarctic islands and Peninsulas, such as JRI, BK, and FP (Figure 1), with Antarctic ice sheet change. To make the best use of our collaborators, the student will spend time at UoW learning how to use this new facility.

Whilst WRF-iso will be the main tool for this project, to understand what we would expect to see in the isotopic record under different scenarios we also require ice sheet scenarios to test. Thus, there is also the potential for the student to generate their own ice history scenarios using ice sheet modelling techniques (Whitehouse et al. 2012ab).

Prof Paul Valdes, University of Bristol, BRIDGE, Department of Geography

Prof Eric Steig, University of Washington, U.S

Timeline


2020 Oct – 2021 Mar. Work towards developing AIS change scenarios for the last deglaciation and interglacial. Spend time at Durham to gain understanding of AIS change scenarios, and possible experience of GIA and ice sheet models.


2021 Oct – 2023 Mar. Possible Antarctic fieldwork to gain field experience on GIA (GPS servicing tasks) and/or ice core field campaigns. Work closely with ice core scientists and finish writing up thesis/manuscripts.

Training & Skills

This project will provide cross-disciplinary scientific training in problem solving, modelling, data analysis and scientific writing. It will provide the student with high-level skills in: (a) glaciology; (b) the interpretation of geophysical and ice core data; and (c) numerical modelling.

The IAPETUS DTP programme will provide comprehensive personal and professional development training alongside extensive opportunities through interactions with a network of academic, research and industrial/policy partners. The student will be registered at the University of Durham. Specific training will be provided through courses:

•NCAS Climate Model Support Workshop (Reading, UK)
•Unified Model (Met Office) training course (Exeter, UK)
•Urbino Summer School in Paleoclimatology (Urbino, Italy)
•PRACE Software Carpentry (UK)

At BAS the student may have opportunities to participate in fieldwork on the Antarctic ice sheets, through, for example, the European Oldest Ice Project or to service GIA instrumentation. In addition to international conferences and workshop attendances, the student will also have an opportunity for a secondment at the University of Washington, US, to work with modelling and ice core partners.

References & Further Reading


Further Information

To request further information and to apply:

Email:
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More information is also available through the following web links:

The British Antarctic Survey: https://www.bas.ac.uk/

Dr Louise Sime: https://www.bas.ac.uk/profile/lsim/

Dr Pippa Whitehouse: https://www.dur.ac.uk/geography/staff/geogstaffhidden/?id=1553

Dr Robert Mulvaney: https://www.bas.ac.uk/profile/rmu/

Professor Paul Valdes: http://www.bristol.ac.uk/geography/people/paul-j-valdes/

Professor Eric Steig: https://www.ess.washington.edu/people/profile.php?pid=steig--eric

Dr Vittoria Guarino: https://www.bas.ac.uk/profile/marino/

The EU WACWAIN project: https://www.esc.cam.ac.uk/news/warm-climate-stability-of-west-antarctic-ice-sheet

The EU Oldest Ice project: https://www.beyondepica.eu/

The WRF model: https://www.mmm.ucar.edu/weather-research-and-forecasting-model