The formation and evolution of the Antarctic Ice Sheet – a combined model-data approach

Supervisors:
Dr Dan Lunt (School of Geographical Sciences, University of Bristol) – Main supervisor
Prof Tony Payne (School of Geographical Sciences, University of Bristol)
Dr Caroline Lear (School of Earth and Ocean Science, University of Cardiff)
Dr Paul Markwick (Getech)
Host institution: University of Bristol

Project description: One of the major transitions in Earth's history occurred about 34 million years ago, with the development of the Antarctic ice sheet. However, we still do not understand the relative importance of the mechanisms which caused this rapid transition from ice-free 'greenhouse' conditions to an 'icehouse' state.

This PhD will aim to evaluate the importance of the possible forcings; namely declining atmospheric CO_2, changes in ocean gateways/paleogeography, and orbital variability; as well as the possible responsible mechanisms, such as ocean circulation, atmospheric variability, and vegetation and ice sheet feedbacks, through a combined modelling and laboratory-based project.

The student will make use of a brand new state-of-the-art ice sheet model, recently developed in the framework of the European ice2Sea project, and used for future ice sheet prediction in the recent IPCC report. The model incorporates recent groundbreaking developments in grounding line migration and second order ice flow. This includes an adaptive grid which gives high resolution in regions where it is required to ensure numerical convergence. This model has never before been applied to paleoclimates, so represents a unique opportunity to provide new insights into this problem.

Furthermore, the student will use unique paleogeographic maps (provided by project partners, Getech), which have unprecedented resolution and accuracy through this transition, to carry our climate model simulations of the transition, using tools originally developed in the UK Met Office, and climate-ice sheet coupling strategies developed in Bristol. These model simulations will be evaluated by comparison with paleodata; work which will be carried out at Cardiff. A component of this data will be generated by the student themselves, using recently drilled high-resolution marine sediment cores (IODP Site 1406). They will generate a deep-ocean Mg/Ca record from the shells of ancient foraminifera, and use it with a paired oxygen isotope record to estimate variations in global ice volume.

As well as tackling a fascinating and important problem in paleoclimate science, this project will equip the student with a variety of modelling and laboratory skills, and provide the opportunity to attend international summer schools and present work at international conferences. In addition, it is anticipated that this will be a CASE project, with a top-up to the student stipend provided by Getech.