PhD project at the University of Bristol

The evolution of Earth's ice sheets from 300 million years ago to the future: implications for climate and life

Ice sheets (such as exist on Greenland and Antarctica today) are an integral component of the Earth System; they amplify climate change through a range of positive feedback mechanisms, and their future evolution is of particular concern due to impacts associated with sea level rise.

The geological record potentially provides us with unique record through which we can test our understanding of the mechanisms which control ice sheet evolution across a range of timescales. However, this potential has been severely under-utilised, due to (i) a lack of geological information as to the detailed paleogeography (topography and bathymetry) of past time periods, (ii) a lack of synthesis of long-term sea level records, and (ii) a lack of ice sheet models which fully represent the complexity of ice sheet dynamical processes.

In this project, the student will make use of recent advances which address the three issues above, to explore the evolution of Earth's ice sheets from 300 million years ago to the future. In particular, they will use an ice sheet model, coupled to a climate model, to explore the relative roles that changes in atmospheric carbon dioxide and paleogeography play in controlling ice sheet evolution, and the associated mechanisms of inception, growth, and decay of ice. The work will benefit from a recently published set of climate model simulations covering this time period at a frequency of one simulation every ~10 million years. The student will evaluate the ice sheet model simulations with data which they will synthesise from a range of existing geological data which indicate sea level and ice sheet changes over the last 300 million years.

In addition, cold climates associated with ice sheets have likely provided habitats for microbial life to survive relatively unchanged over hundreds of millions of years. The student will explore the implications of their results for understanding the current diversity in polar micro-ecology.

Chrismas, NAM, Anesio, AMB & Sanchez-Baracaldo, P, 2015, 'Multiple adaptations to polar and alpine environments within cyanobacteria: a phylogenomic and Bayesian approach'. *Frontiers in Microbiology*, vol 6.

Ladant, J.B. and Y. Donnadieu (2016), Paleogeographic regulation of glacial events during the Cretaceous supergreenhouse, Nature Communications, in press.

Lunt, D. J., Farnsworth, A., Loptson, C., Foster, G. L., Markwick, P., O'Brien, C. L., Pancost, R. D., Robinson, S. A., and Wrobel, N.: Palaeogeographic controls on climate and proxy interpretation, Clim. Past, 12, 1181-1198, doi:10.5194/cp-12-1181-2016, 2016.

Lear, C.H. and Lunt, D.J., How Antarctica got its ice, Science; doi:10.1126/science.aad6284, 2016.

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There are many training courses which would be highly appropriate for this PhD. In addition to the training opportunities provided in the framework of the DTP itself, the Urbino Summer School and the Karthaus Summer School are both highly relevant and inspiring training opportunities which we anticipate the student will benefit from. There are also several courses run by the University of Bristol which will be useful, including High Performance Computing, Networking, "How to write a PhD", Paper-writing, and "How to manage your supervisor"! Finally, if appropriate the student will attend the MSc module "Introduction to Earth System Modelling".

Case Partner: Getech Group plc (providing an extra £1000 p/a to the student's research costs).

Please contact Dan Lunt (d.j.lunt@bristol.ac.uk) for more details on the project.

See http://nercgw4plus.ac.uk/phd-projects/2017-projects/ for details on eligibility and how to apply, or apply directly from here: http://www.bristol.ac.uk/study/postgraduate/2017/sci/phd-geographical-sciences/