

PROJECT TITLE: Impact of accelerating Greenland ice melt on ocean circulation and global climate

DTP Research Theme(s): Changing Planet

Lead Institution: University of Bristol

Lead Supervisor: Jonathan Bamber, University of Bristol, School of Geographical Sciences

Co-Supervisor: James Screen, Mathematics and Physical Sciences, University of Exeter

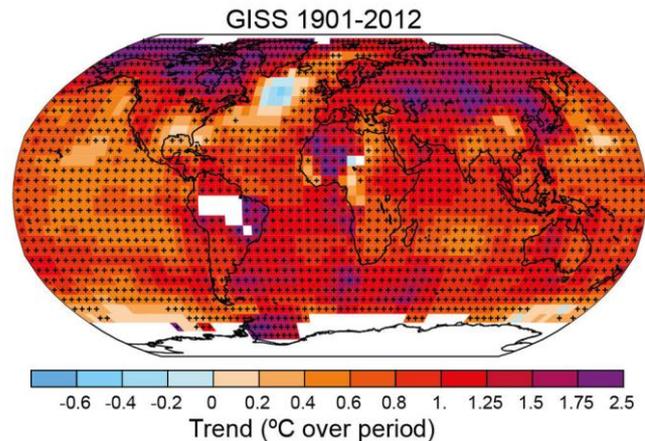
Co-Supervisors: Robert Marsh & Simon Josey, National Oceanography Centre, University of Southampton

Project Enquiries: Jonathan Bamber, j.bamber@bristol.ac.uk

Project keywords: Greenland, ocean circulation, Atlantic climate change



Icebergs calving into the North Atlantic from the Greenland ice sheet



The North Atlantic "cold blob" in blue that might be caused by increased meltwater from Greenland and Arctic glaciers.

Project Background

Northwest Europe is about 2-3°C warmer than areas at a similar latitude because of the heat transported poleward from the equator by the Gulf Stream. Much of this heat is released to the atmosphere in two areas of the North Atlantic close to the southern tip of Greenland via the Atlantic Meridional Overturning Circulation (AMOC). Numerous modelling studies and paleo-climate records suggest that the AMOC could be bi-stable: it may have an "off" state and an "on" state, which represents a tipping point with profound implications for global climate. Even if there is no tipping point, a weakening of the AMOC would have a huge impact on the climate of NW Europe and beyond. One factor that has been proposed to influence the strength of the AMOC is the amount of freshwater that enters the North Atlantic, especially near Greenland.

Project Aims and Methods

The primary aim of this PhD is to investigate the impact of changes in freshwater input on the strength of the AMOC using a combination of observations and ocean modelling. We have direct and indirect estimates of the strength of the AMOC that cover roughly the last century. We also have estimates of changes in the freshwater input from Arctic glaciers and the Greenland Ice Sheet (GrIS) for the last four decades but the record is incomplete: it does not cover recent years when the ice has been melting fastest and does not include reliable estimates into the future (c.f. Bamber et al, 2012; 2018). The GrIS is currently contributing more to sea level rise than any other source and at the same time generating huge quantities of extra freshwater.

The first part will be to produce the freshwater time series from 1979 to 2100 using climate model projections to force an ice sheet model in a realistic way. Arctic sea ice has also been changing rapidly since the 1970s and it will be important to consider how this might affect the AMOC. The second part of the project will involve using the freshwater data in ocean modelling experiments for the last 40 years and up to 2100 to investigate what impact the increasing freshwater input has on the strength of the AMOC and carry out a series of sensitivity studies related to AMOC stability and climate forcing (c.f. Dukhovskoy et al 2019 and Boning et al 2015). Within this overall framework, the student will have the opportunity to shape the research to suit their own interests and expertise as the project develops. An imaginative and creative approach is valuable.

Candidate requirements

This project would be ideally suited to someone with a good quantitative background, familiar with climate science, and comfortable with computer programming, although training in various programming languages is provided. *We welcome and encourage student applications from under-represented groups. We value a diverse research environment.*

Collaborative partner

The National Oceanography Centre, Southampton is a world leading institute that undertakes observations and modelling of the physical, chemical and biological processes influencing the world's oceans. The student will be working with, and learning from, experts in ocean modelling, physical oceanography and the role of oceans in the climate system.

Training

Training will be a core component of this PhD. The student will benefit from working in an experienced multi-disciplinary team that will provide world-leading training in climate science, glaciology, oceanography and numerical modelling. In addition, they will have the opportunity to join a major new collaboration on Arctic-to-midlatitude teleconnections, which includes scientists at the Universities of Bangor, Bristol, Exeter, Oxford, Reading and Southampton, and the National Oceanography Centre. Training opportunities are available via summer schools and in-house events in all aspects of the project from climate science to how to write a PhD.

Background reading and references

- Bamber, J., M. van den Broeke, J. Ettema, J. Lenaerts, and E. Rignot (2012), Recent large increases in freshwater fluxes from Greenland into the North Atlantic, *Geophysical Research Letters*, 39(19), L19501, doi:10.1029/2012gl052552.
- Bamber, J. L., A. J. Tedstone, M. D. King, I. M. Howat, E. M. Enderlin, M. R. v. d. Broeke and B. Noel (2018) "Land Ice Freshwater Budget of the Arctic and North Atlantic Oceans: 1. Data, Methods, and Results." *J. Geophys. Res. Oceans* doi: 10.1002/2017JC013605
- Boning, C. W., E. Behrens, A. Biastoch, K. Getzlaff, and J. L. Bamber (2016), Emerging impact of Greenland meltwater on deepwater formation in the North Atlantic Ocean, *Nature Geoscience*, 9(7), 523-527, doi:10.1038/ngeo2740.
- Marsh, R., et al. (2015), NEMO-ICB (v1.0): interactive icebergs in the NEMO ocean model globally configured at eddy-permitting resolution, *Geoscientific Model Development*, 8(5), 1547-1562, doi:10.5194/gmd-8-1547-2015.
- Rahmstorf, S., J. E. Box, G. Feulner, M. E. Mann, A. Robinson, S. Rutherford, and E. J. Schaffernicht (2015), Exceptional twentieth-century slowdown in Atlantic Ocean overturning circulation, *Nature Clim. Change*, 5(5), 475-480, doi:10.1038/nclimate2554.

Useful links

- <http://www.bristol.ac.uk/geography/courses/postgraduate>
- <https://noc.ac.uk/science/research-areas/marine-systems-modelling>
- <https://www.rapid.ac.uk/index.php>
- https://www.southampton.ac.uk/oes/research/groups/physical_oceanography.page

NERC GW4+ DTP Website:

For more information about the NERC GW4+ Doctoral Training Partnership please visit

<https://www.nercgw4plus.ac.uk>.

Bristol NERC GW4+ DTP Prospectus:

<http://www.bristol.ac.uk/study/postgraduate/2021/doctoral/phd-great-western-four-dtp/>

How to apply to the University of Bristol:

<http://www.bristol.ac.uk/study/postgraduate/apply/>

The application deadline is Friday 8 January 2021 at 2359 GMT.

Interviews will take place during week commencing 8th February 2021.

General Enquiries:

Bristol NERC GW4+ DTP Administrator

Email: bristol-nercgw4plusdtp-admin@bristol.ac.uk