

**PROJECT TITLE:** Future climate and mass balance of the Antarctic ice sheet

**Lead Institution:** British Antarctic Survey

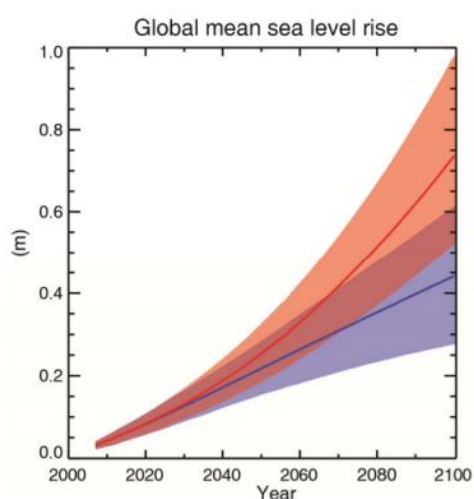
**Main Supervisor:** Dr Andrew Orr, Atmosphere, Ice and Climate team

**Co-Supervisor:** Prof Tony Payne, School of Geographical Sciences, University of Bristol

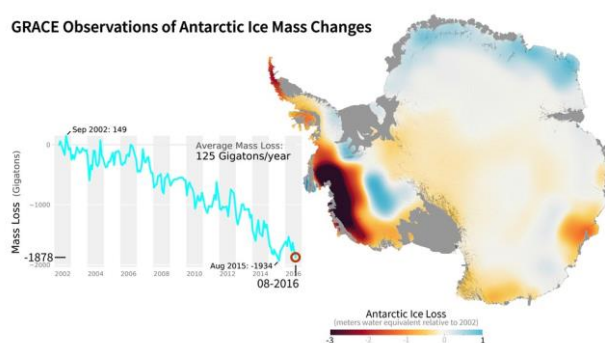
**Co-Supervisor:** Dr Gareth Marshall, British Antarctic Survey

**Co-Supervisor:** Dr Richard Essery, University of Edinburgh

**Project Enquiries:** Dr Andrew Orr - [anmcr@bas.ac.uk](mailto:anmcr@bas.ac.uk)



**Image Caption:** Global average sea level projections based on future scenarios of greenhouse gas emissions or 'representative concentration pathway' (RCP). The four RCPs range from very high (RCP8.5) through to very low (RCP2.6) future concentrations. Credit: IPCC Working Group I.



**Image Caption:** Changes in Antarctic ice mass since 2002, based on observations from NASA's Gravity Recovery and Climate Experiment (GRACE) satellite. Orange and red shades indicate areas that lost ice mass, whilst light blue indicates areas that gained ice. Between 2002 and 2016, Antarctica shed approximately 125 gigatons of ice per year, causing global sea level to rise by 0.35 millimetres per year. Credit: NASA's Goddard Space Flight Center.

## Project Background

The Antarctic Ice Sheet (AIS) is the largest mass of ice on Earth, which would raise sea levels by 58 meters if melted entirely. The AIS has been shown to be highly sensitive to recent climate change. For example, parts of Antarctica are amongst the fastest warming regions on Earth, resulting in the collapse of several ice shelves, while accelerated glacier melting in West Antarctica is responsible for around 10% of global sea level rise. Although a warming atmosphere will result in increased snowfall over the AIS, which could potentially compensate for any ice loss, such changes are perhaps a troubling harbinger of more severe climate change in the coming century, resulting in a potentially catastrophic rise in sea level. Thus, a major emphasis of scientific research is to improve predictions of future climate change to help better constrain the evolution of the AIS, and reduce uncertainty in sea-level projections.

## Project Aims and Methods

The project will use regional modelling of the atmosphere to deliver projections of the future climate of the AIS, including associated changes in surface mass balance and meltwater availability. The climate projections will be used to force an ice-sheet model to explore the effects of climate change on the AIS evolution.

For the atmosphere, we will use the state-of-the-art UK Met Office Unified Model (MetUM) in its regional configuration to derive high-resolution projections that are able to resolve the narrow and steep coastal margins of the AIS. By making improvements to the snow scheme used by the MetUM, these simulations will include a realistic representation of essential snow, firn and ice processes.

For the ice-sheet, we will use the BISICLES adaptive-mesh model applied to the whole of the AIS, with sub-kilometre resolution for grounding lines and ice streams.

These tools will be used to explore projections of the Antarctic climate and AIS to various scenarios of twenty-first century climate change. The simulations will form part of the Polar-CORDEX (Coordinated Regional Downscaling Experiment) initiative, and analysis of the model output will contribute to the Intergovernmental Panel on Climate Change (IPCC) assessment reports.

## Candidate

We seek an enthusiastic, self-reliant, and self-motivated candidate with good numerical and computational skills. The student should have a strong interest in climate science, and an enthusiasm for outreach activities to enable the public to become more aware of its impacts.

## Training

The student will receive excellent supervision and training in climate and ice-sheet modelling, as well as meteorology and atmospheric and snow physics. The training will be through short courses and Summer Schools. In addition, a wide range of generic and personal transferable skills training will be available such as public speaking and interaction with the media. There may also be an opportunity to send the student to Antarctica for a month if they wish, so that they can gain experience in taking observations in polar regions, as well developing a fuller understanding of the environment which they are studying.

## References / Background reading list

- Cornford and others, Century-scale simulations of the response of the West Antarctic Ice Sheet to a warming climate, *The Cryosphere*, **9**, 1579-1600, doi: 10.5194/tc-9-1579-2015, 2015.
- Trusel and others, Divergent trajectories of Antarctic surface melt under two twenty-first-century climate scenarios, *Nature Geoscience*, **8**, 927-932, doi: 10.1038/ngeo2563, 2015.
- Fettweis and others, Estimating the Greenland ice sheet surface mass balance contribution to future sea level rise using the regional atmospheric model MAR, *The Cryosphere*, **7**, 469-489, doi: 10.5194/tc-7-469-2013, 2013.
- Gregory and Huybrechts, Ice-sheet contributions to future sea-level change, *Philosophical Transactions of the Royal Society*, **364**, 1709-1731, doi: 10.1098/rsta.2006.1796, 2006.
- Turner and others, Atmosphere-ocean-ice interactions in the Amundsen Sea Embayment, West Antarctica, *Review of Geophysics*, doi: 10.1002/2016RG000532, 2017.