PROJECT TITLE: FUTURE CHANGES TO RAINFALL OVER ANTARCTICA AND THE SOUTHERN OCEAN

DTP Research Theme(s): Changing Planet

Lead Institution: British Antarctic Survey

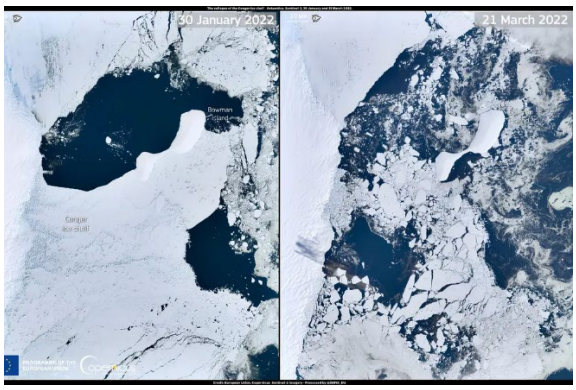
Lead Supervisor: Dr Andrew Orr, British Antarctic Survey, Atmosphere, Ice & Climate team.

Co-Supervisor: Dr Gareth Marshall, British Antarctic Survey, Atmosphere, Ice & Climate team.

Co-Supervisor: Dr Steph Cornford, University of Bristol, School of Geographical Sciences.

Project Enquiries: anmcr@bas.ac.uk

Project keywords: Antarctica, Southern Ocean, rainfall, climate projections, impacts



Before and after the collapse of the Conger ice shelf in East Antarctica in 2022 amid record warm temperatures and rain. (EU/Copernicus Sentinel-2)

Project Background

The cryosphere of Antarctica and the surrounding Southern Ocean are an integral part of the Earth's climate system. For example, its interior ice sheets drain down to the coastline via outlet glaciers, which then break off as icebergs and melt in the ocean. The Southern Ocean sea ice is a key regulator of ocean-atmosphere exchanges of heat, freshwater, and momentum. Additionally, its coastal regions and offshore islands are also home to globally important biodiverse ecosystems. However, although precipitation over these regions is largely snow-dominated at present, climate models suggest that in the future these regions will experience more rainfall due to climate change (Vignon et al., 2021). This is likely to have pronounced impacts by facilitating increased melting of snow and ice on the ground, which in turn will affect sea-ice extent and thickness, ice sheet mass balance, global sea level, as well as flora and fauna (including penguin colonies). Yet despite the severity of these impacts, considerable uncertainty exists regarding the frequency and intensity of changes to snow and rain over these regions in a warming world, as well as how these regions receive rain, such as from incursions of warm maritime air or atmospheric rivers. These represent significant research gaps, which this project aims to address.

Project Aims and Methods

The student will undertake the following objectives to address these key research gaps:

Firstly, they will quantify present-day occurrences of rainfall for Antarctica / Southern Ocean and identify the main meteorological drivers. This will involve the student comparing precipitation characteristics from datasets such as CloudSat satellite data and ERA5 atmospheric reanalysis, as well as from station weather reports (Behrangi et al., 2016). These estimates will be used to quantify present-day occurrences of rain and establish a benchmark for assessment of climate models. To develop a process-based understanding, the atmospheric circulation patterns associated with rain will be investigated using ERA5.

Secondly, they will assess the robustness of simulated precipitation for Antarctica / Southern Ocean in CMIP6 global climate models and identify a subset of the most reliable models for making projections of future changes in rainfall. This will involve comparing output from around 50 historical (present-day) CMIP6

model simulations with the precipitation products used above, with the aim of identifying a sub-set of models that are best able to represent precipitation characteristics for Antarctica/Southern Ocean.

Thirdly, they will analyse projections of rainfall for Antarctica / Southern Ocean from CMIP6 models from present-day to 2100. A special focus will be on the sub-set of well-performing models identified above. Analysis of the drivers of precipitation change will be investigated by examining how precipitation characteristics/changes relate to key aspects such as temperature and moisture increases and climate change emission scenario (McCrystall et al., 2021). Changes in atmospheric circulation patterns/drivers associated with rain will also be identified.

We very much welcome the student to be fully active / engaged in deciding the research aims and methods as this is consistent with them taking full ownership of their PhD, which we absolutely encourage.

Candidate requirements

We seek an enthusiastic and self-motivated candidate with good numerical skills and at least a 2:1 honours degree in a mathematical/physical subject.

Project partners

The GW4+ programme provides comprehensive personal and professional development training alongside extensive opportunities for students to expand their multi-disciplinary outlook through interactions with a wide network of academic, research and industrial/policy partners.

The student will be registered at the University of Bristol and hosted at *the British Antarctic Survey*. BAS will provide expert supervisory input, data, possible fieldwork opportunities, and participation in departmental and institute-wide seminars and training courses.

Training

The student will be working within a strong research community of PhD students and staff. Excellent internal and external training will be provided throughout the studentship. The student will receive training in polar meteorology, atmospheric physics, climate modelling, climate change, and data analysis, both directly from the supervisors and from attending a Climate Modelling Summer School. There will also be opportunities to take the training course on polar fieldwork for early career researchers, which is held at Svalbard. In addition, a wide range of generic and personal transferable skills training will be available such as public speaking and interaction with the media.

Background reading and references

Behrangi, A., et al. (2016), Status of high-latitude precipitation estimates from observations and reanalyses, *J. Geophys. Res. Atmos.*, 121, https://doi.org/10.1002/2015JD024546.

McCrystall et al. (2021), New climate models reveal faster and larger increases in Arctic precipitation than previously projected, *Nat Commun* **12**, https://doi.org/10.1038/s41467-021-27031-y.

Vignon et al. (2021), Present and future of rainfall in Antarctica, *Geophys. Res. Lett.*, 48, https://doi.org/10.1029/2020GL092281.

Useful links

In the first instance, contact the Lead Supervisor to discuss the project.
To submit an application, please send your CV, personal statement, degree transcripts, degree certificates and contact details of two academic referees directly to the Lead Supervisor of the project before **Tuesday 9 January 2024 at 2359 GMT.**

Should you have any enquires, please contact Ali Teague at the BAS Student Office
Please visit our website to find out more about BAS and the BAS PhD Student Programme

The application deadline is Tuesday 9 January 2024 at 2359 GMT. Interviews will take place from 26 February to 8 March 2024. For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.