PROJECT TITLE: Atmospheric ice nucleating particles – in search of a fingerprint of past change in polar snow and ice

DTP Research Theme(s): Changing Planet

Lead Institution: British Antarctic Survey

Lead Supervisor: Dr. Markus M. Frey, British Antarctic Survey, Atmosphere, Ice & Climate Team

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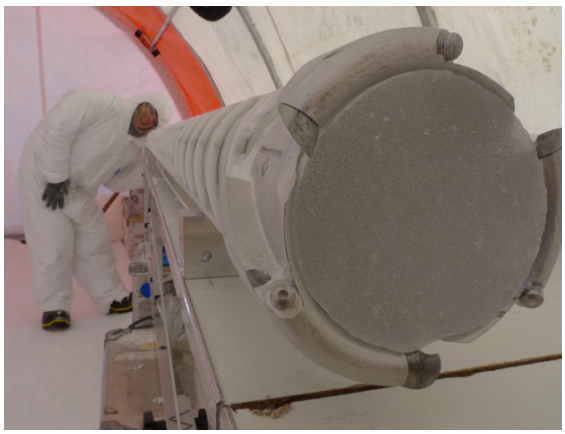
Project keywords: ice nucleating particles, polar snowpack, sea ice, ice cores

Atmospheric ice nucleating particles (INP) can have a large impact on polar clouds and climate but are still poorly understood



Ice cores may hold information on past changes of atmospheric ice nucleating particles (INP) in the polar regions, which is key to understand modern climate change.

Project Background

Cloud droplets freeze homogeneously at temperatures below -37ºC, but the presence of ice nucleating particles (INP) can induce freezing at much higher temperatures. Even small numbers of INP have a large impact on cloud optical properties and lifetime, precipitation and therefore climate. However, INP sources and their temporal and spatial variability are only poorly understood causing significant uncertainty in the representation of clouds in climate models in the Arctic and above the Southern Ocean, including coastal Antarctica. A quantitative understanding of the origin and temporal variability of INP is needed to reduce uncertainties in regional and global climate predictions, especially in the high latitudes, which currently experience the strongest warming. Recent observations suggest that some INP are preserved in polar snow and ice. Thus, polar ice cores may be a potential tool to extend the instrumental record and to infer changes of INP abundance in polar regions over past centuries and millennia.

Project Aims and Methods

The project objectives are (a) to establish the relationship of ice nucleating particle (INP) concentrations in polar air and snow and (b) to evaluate the century-scale atmospheric INP variability at a polar location based on ice core measurements. In a first step the student will validate an existing droplet assay method to measure INP concentrations in polar snow and ice. Then the student will characterise particles under the microscope and measure INP spectra using available air filter and snow samples to quantify the modern air-snow relationship of INPs. And finally, the student will estimate the historic variability and trends of INP abundance over the past few centuries by measuring INP concentrations in a polar ice core. Samples will be available from Antarctica and the Arctic, including Greenland and MOSAiC, a year-round sea ice drift expedition. The atmospheric relevance and climate impacts of the inferred regional atmospheric INP record will be assessed based on a sensitivity study in close collaboration with climate modellers at BAS. The student will be able to shape the design of laboratory and model experiments under guidance of the supervisory team.

Candidate requirements

Degree in physics, chemistry or related Earth/Environmental Science, with experience in experimental work in the laboratory and good numerical skills (e.g. basic knowledge of a scientific programming language).

Training

You will be part of dynamic research teams that are studying a wide range of environmental topics in the polar regions in the 'Atmosphere, Ice and Climate' team at BAS and the Cold Climate group at Cardiff University. You will have outstanding opportunities to develop practical and data analysis competences and gain a deep understanding of both climate science and ice physics. Full training in the instrument, laboratory and modelling techniques will be provided, together with broader transferrable skills training. You may have a potential field work opportunity at a site in the Arctic or Alps. You will attend an atmospheric sciences summer school and receive support to publish results in peer-reviewed journals and at (inter)national conferences.

Background reading and references

Harrison, A. D., et al.: An instrument for quantifying heterogeneous ice nucleation in multi-well plates using infrared emissions to detect freezing, Atmos. Meas. Tech., 11, 5629–5641, doi:10.5194/amt-11-5629-2018, 2018.

Hartmann, M., et al.: Variation of Ice Nucleating Particles in the European Arctic Over the Last Centuries, Geophys. Res. Lett., 46, 4007–4016, doi:0.1029/2019GL082311, 2019.

Rangel-Alvarado, R. B., et al.: Snow-borne nanosized particles: Abundance, distribution, composition, and significance in ice nucleation processes, J. Geophys. Res., 2015JD023773, doi:10.1002/2015JD023773, 2015.

Rhodes, R. H., et al. (inc. Frey, M.M.): Sea ice as a source of sea salt aerosol to Greenland ice cores: a model-based study, Atmos. Chem. Phys., 17, 9417–9433, doi:10.5194/acp-17-9417-2017, 2017.

Useful links

How to apply:

In the first instance, contact the Lead Supervisor to discuss the project.

To submit an application, please send your CV, statement of interest, degree transcripts, degree certificates and contact details of two academic referees directly to the Lead Supervisor of the project before **Friday 8th January 2021 at 2359 GMT.**

Should you have any enquiries, please contact the BAS Student Office

Please visit our website to find out more about BAS and the BAS PhD Student Programme

The application deadline is Friday 8 January 2021 at 2359 GMT. Interviews will take place from 8th to 19th February 2021. For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.