NERC-funded Research Experience Placement (REPs) Summer 2025

Project title

Instrument Development for Measuring Ice Nucleation: from Antarctic Sources to Southern Ocean Clouds

Lead supervisor

Nina Kinney

Project description

The freezing of water to form ice is fundamental to numerous environmental processes on Earth, from winter frosts to cloud glaciation. The nucleation of an ice crystal from a droplet of pure water is kinetically hindered, so water droplets will frequently persist in a supercooled liquid state to temperatures well below their melting point, even as low as -40°C. A rare but diverse subset of atmospheric aerosols (including volcanic ash, bacteria, and spores), referred to as ice-nucleating particles (INPs), can induce ice formation at warmer temperatures. The formation of ice in clouds by INPs impacts cloud lifetime, precipitation likelihood and reflectivity, which ultimately determines their potential to cool or warm the planet. The sources of INPs in the atmosphere over the Southern Ocean are particularly understudied, and their properties are not yet well understood.

We currently have a set-up in our lab in Cambridge to measure immersion freezing of INP samples collected in Antarctica. However, measurement of INPs directly in the field is crucial to improve the quality and timeliness of the observations. In this project, the student will be supported to build a field-portable instrument capable of measuring droplet freezing temperatures for INP analysis. This will involve assembling a Peltier-driven droplet freezing stage in the lab, testing and calibrating the new instrument using test-solutions, and comparing it with our current lab set-up. There is a possibility of a small software development component as well. Depending on the student's interests they may also use the newly developed set-up to analyse suspensions of recently collected samples of Antarctic mosses and lichens. Through this project, the student will build an in-depth understanding of the droplet freezing instrumentation and its use in atmospheric research and will gain an insight into the potential sources of INPs to Southern Ocean clouds and their significance.

The project will involve a lab-based component which will be carried out at the British Antarctic Survey (BAS) in Cambridge. Full-time or part-time in-person working for the duration of the project (6-10 weeks) is preferred to maximise opportunity for the student to develop the portable droplet freezing instrument and conduct ice nucleation measurements in the lab. There is also flexibility for a shorter (1-2 week) visit to BAS for the instrument set-up, with further software development and analysis work supported remotely. The project will be supervised by Nina Kinney, Megan Malpas and Floortje van den Heuvel within the Atmosphere, Ice and Climate team at BAS. The project student will be encouraged to participate in lab and team meetings (online or in person) for the project duration.

Project restrictions

None noted

Working arrangements

The project will involve a lab-based component which will be carried out at the British Antarctic Survey (BAS) in Cambridge. Full-time or part-time in-person working for the duration of the project (6-10 weeks) is preferred to maximise opportunity for the student to develop the portable droplet freezing instrument and conduct ice nucleation measurements in the lab. There is also flexibility for a shorter (1-2 week) visit to BAS for the instrument set-up, with further software development and analysis work supported remotely.

The student will be encouraged to attend hybrid weekly INP lab user meetings, Climate Processes group meetings and monthly Atmosphere, Ice and Climate group meetings during the project. The student would also be encouraged to present the results of their project to the wider team at an Atmosphere, Ice and Climate seminar.