ESS DTP: Project Proposal for REP’s 2018

**Project Title:** Identifying small ice crystals in Arctic and Antarctic clouds with machine learning techniques

**Lead Supervisor Details:** Dr Gillian Young (giyoung@bas.ac.uk)

**Co-supervisor Details (if applicable):** Dr Tom Lachlan-Cope (tlc@bas.ac.uk)

**Project Description (max 500 words please):**

Polar clouds are poorly reproduced by global climate models, largely due to our poor understanding of the small-scale processes which occur within them. These clouds are often mixed-phase, containing liquid cloud droplets and ice crystals. However, we do not have a clear understanding of how many particles of each phase are present within these clouds. Our poor understanding stems from the lack of in-situ cloud measurements from instrumented aircraft in the polar regions, and strongly influences our inability to accurately reproduce these clouds in climate models.

In recent years, the Aerosol-Cloud Coupling and Climate Interactions in the Arctic (ACCACIA) and Microphysics of Antarctic Clouds (MAC) airborne campaigns were conducted in the Arctic and Antarctic respectively to address this lack of in-situ cloud data in these regions. It is hypothesised that small ice crystals (below 50 μm) play an important role in determining the lifetime of polar clouds. At these sizes, spherical cloud droplets and aspherical ice particles may be distinguishable using depolarisation data, and such data are available from the Cloud Aerosol Spectrometer with Depolarisation during both campaigns. We can use these depolarisation data to infer particle asphericity, thus allowing us to gain an understanding of how many droplets and ice particles were present.

This project will use machine learning techniques on these data to infer the presence of small ice crystals co-located with liquid droplets in Arctic and Antarctic clouds. Furthermore, we will take advantage of this large dataset to uncover new knowledge of the small-scale structure of polar clouds. The student will explore the particle depolarisation dataset with various machine-learning algorithms within the Python Scikit-learn toolkit to evaluate which is best suited to this problem. As such, it is desirable that the student has a strong interest in machine-learning and will contribute towards experimental design. Over the 10 week period, the student will work closely with both supervisors to construct a short report of experimental findings from the project, with the aim to identify which machine learning algorithms may be best suited to these data for use in future measurement campaigns.

**Specific details of project:**

- Experience of computer programming with Python.
- An interest in machine learning, or experience/knowledge of such techniques, and appropriate Python tools (desirable but not essential).
- Interest in contributing towards experimental design

Students must meet all of the following criteria. The student must:

- Be studying for a degree in a quantitative discipline outside of NERC's scientific remit (e.g. mathematics, statistics, computing, engineering, physics)
- **Be applying for a placement in a different department to their undergraduate degree**
  - Be undertaking their first degree studies (or integrated Masters)
  - Be expected to obtain a first or upper second class UK honours degree or equivalent
  - Be eligible for subsequent NERC PhD funding (UK, EU or right to remain in the UK)

This project is subject to funding. Please send a CV to the supervisor as soon as possible but no later than **Thursday 31 May 2018**. The project will be carried out over the summer holiday 2018.

**Links to relevant supporting information:**
https://www.atmos-chem-phys.net/16/3651/2016/acp-16-3651-2016.pdf
https://www.atmos-chem-phys.net/17/12219/2017/acp-17-12219-2017.pdf

**Funding Situation:**
This Research Experience Placement (REP) is funded by the Natural Environment Research Council, who supply £2500 per REP. This is meant to cover a stipend of £200 per week for up to 10 weeks, plus £500 in research expenses.