Multi-polarisation, multi-wavelength radar measurements of ice crystals in clouds

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Ice particles in clouds play an important role for both weather and climate prediction. Microphysical measurements of ice particle properties are essential for representing ice clouds in numerical models used to forecast the weather and make future climate predictions. Data on the sizes, shapes, orientations and concentrations of natural ice particles are needed to constrain these model parameterisations. Similarly satellite missions such as the CloudSat (http://cloudsat.atmos.colostate.edu) and EarthCARE (https://en.wikipedia.org/wiki/EarthCARE), and precipitation rates (such as GPM (http://www.nasa.gov/mission_pages/GPM/main/index.html)) require the same kind of information to constrain their retrieval algorithms.

Research aircraft can provide detailed information on these quantities, but offer a very small sample volume which may not be representative of the broader cloud population. More desirable is the use of remote-sensors which can collect samples from large areas of cloud continuously. The aim of this project is to make new multi-wavelength, multi-polarisation radar measurements of ice clouds, and use these to determine the shapes and orientations of natural ice particles and their size distribution. At Reading we have a long-standing collaboration with the Chilbolton Observatory (http://www.chilbolton.stfc.ac.uk/Chilbolton/default.aspx) which has a unique suite of instruments ideally suited to these kinds of measurements. In a pilot project we used triple-wavelength measurements of ice particles to demonstrate that snowflakes have a fractal geometry, and found evidence that certain types of ice crystals are very efficient at aggregating into large fluffy snowflakes.

There is a wealth of information in these data, and in this studentship we want to fully exploit that data, and push the concept forward even further. We are now in a position to make measurements at different elevations, and at multiple polarisations. This offers more information on the geometry of the particles in the cloud, and how they are oriented. This is an idea that has been studied theoretically, but we would be the first to make actual measurements and interpret them.

We have also pioneered a technique for estimating the particle size spectrum from multiwavelength Doppler spectra. The student will develop this technique, testing it against in-situ data collected in a recent experiment with the FAAM aircraft (http://www.faam.ac.uk) at Chilbolton. Once this is done, the retrieval will be applied to a much longer-term dataset we have already generated, to statistically derive size spectra and fall speed parameters for a large sample of different ice clouds. We will use this data to test numerical model predictions from the Met Office, ECMWF, DWD and other forecast centres to determine the accuracy with which they predict ice water content, snowfall rate and other key cloud properties to identify model biases and suggest improvements.

Training opportunities:
The student will design measurement strategy and conduct corresponding fieldwork with the Chilbolton radars, and will be part of a vibrant research group specialising in radar meteorology and cloud physics.

**Student profile:**
This project would be suitable for students with a degree in physics, mathematics or a closely related environmental or physical science.