# Improving our understanding of ice cloud microphysics using new aircraft and multi-wavelength radar measurements

**Lead Supervisor: Chris Westbrook, University of Reading, Department of Meteorology**
Email: c.d.westbrook@reading.ac.uk

**Co-supervisors: Thorwald Stein, U. Reading; Shannon Mason, NCEO & U. Reading**

Ice particles in clouds play an important role for both weather and climate prediction. Half of all precipitation globally is initiated through the formation of ice, while the radiative impact of ice clouds is very important because of their widespread coverage: indeed the parameterization of ice crystal fall-out rates in cirrus clouds is one of the biggest sensitivities in current climate models. Despite their importance, the simulation of these clouds is very different from model to model, and we have poor observational constraints on what the properties of these clouds and the processes operating within them actually are.

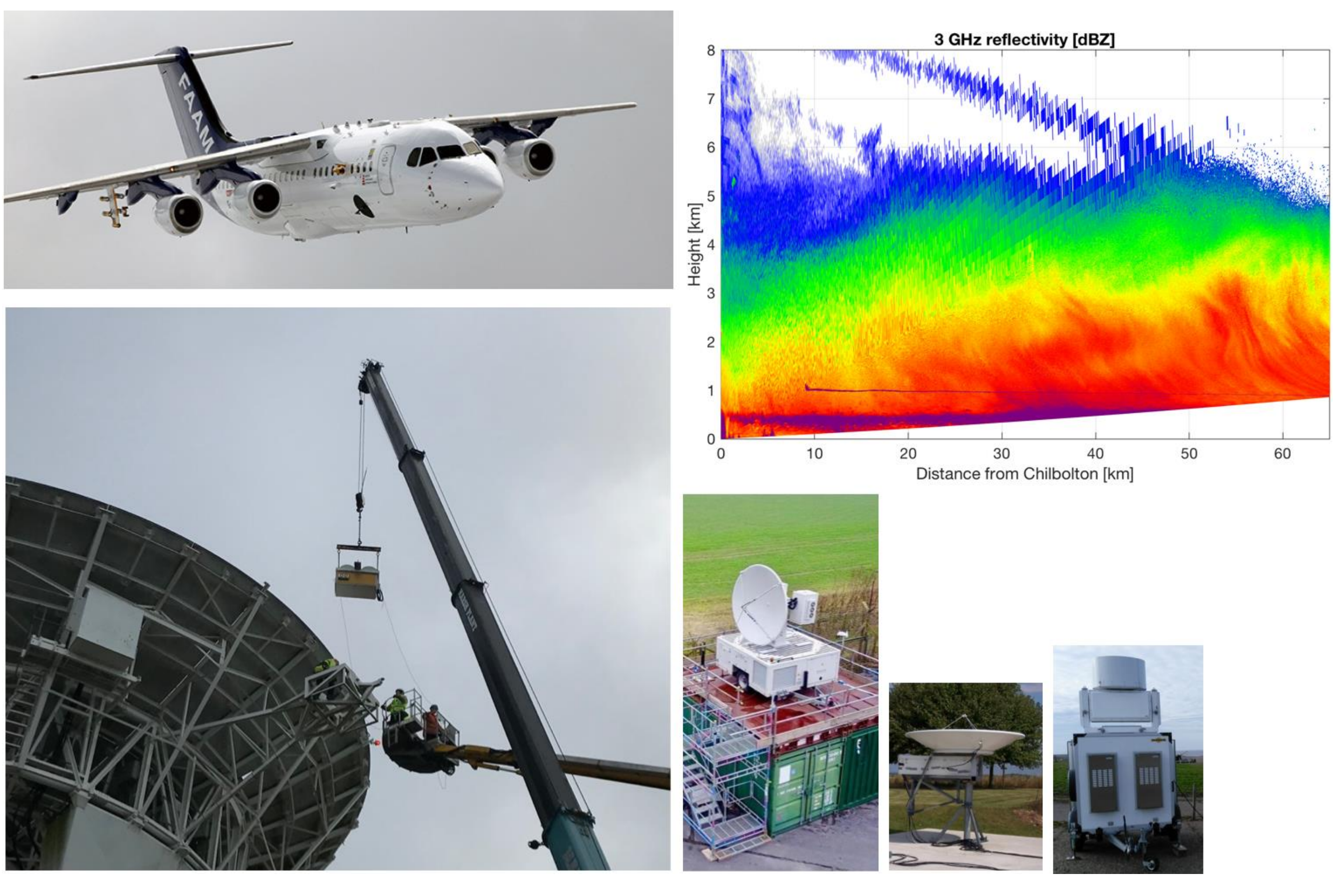


Figure: illustration of preparation and data collection during PICASSO field project, including the FAAM aircraft (top left); the 94GHz Galileo radar being craned onto the side of the 25 metre 3GHz CAMRa radar antenna (the largest of its kind in the world); 10 and 35GHz radars (bottom right) and example data (top right, colours are radar echoes from snowflakes falling through the atmosphere, thin red stripe at 1km height is the FAAM aircraft)

Recently a new field experiment ("PICASSO") has provided exciting new data to help us improve our microphysical understanding of clouds, and also to help us develop better techniques to measure those properties. Co-ordinated measurements from 4 research radars at the Chilbolton Observatory (www.chilbolton.stfc.ac.uk) along with coincident sampling of the cloud particles from the FAAM research aircraft (www.faam.ac.uk) provide a unique data set for the student to analyse. The in-situ data provide us with high-resolution imagery of the sizes and shapes particles on scales from a few microns up to 2 centimetres and provide constraints on the mass of the particles. Meanwhile polarimetric radar data provides data to assess the orientation of the particles, and the multi-wavelength and Doppler spectrum measurements allow fall speeds to be measured.

In these PICASSO case studies we have a system which is constrained from many angles: we directly measure the particle size spectrum, we measure the ice water content, we measure the radar reflectivities etc in each sample of cloud. We also have the opportunity to build on other work in my group on (i) how multi-wavelength reflectivity and Doppler spectra measurements may be used to probe the geometry and size spectrum of the ice particles, and (ii) experimental work which is starting to unravel the details of how ice particle fall speeds are controlled by the mass, size and shape of the particles. Given all this information, we are in a unique position to test the assumptions implicit in contemporary microphysical models and remote-sensing retrieval algorithms, and to develop new ones.

For remote sensing we want to know: what are the biggest sources of uncertainty in remote sensing retrievals of ice clouds? And how could we constrain these algorithms better? Do we need multi-wavelength Doppler radars in space to monitor ice clouds? Or will a single wavelength do the job?

For the modelling world the goal will be to feed our improved understanding & retrievals to evaluation & improvement of microphysical schemes. We already have close links to a group at the Met Office who are running their new microphysics packages for some of the PICASSO cases, so the student could make impact there.

**Training opportunities:**

You will collaborate with other researchers at Reading as well as the University of Manchester and the Met Office. There will likely be opportunities to conduct further measurements with the Chilbolton radars, which could involve the FAAM aircraft as well. You 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 (or expecting) a strong degree in physics, meteorology, mathematics or a related physical science.