Clouds and Weather systems

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Introduction:

Accurate weather forecasting depends on computer models which simulate the dynamics and physics of the atmosphere. Many processes are represented explicitly in the models, but others require an indirect formulation known as parameterisation. Prominent among these parameterised processes is the physics of clouds. At Manchester we have extensive expertise in cloud physics, through laboratory and field measurements, detailed process models and improved parameterisations for the large-scale models. A question that we now face is how far do we need to go – how detailed do these parameterisations need to be to get accurate forecasts of weather systems?

Initial studies suggest that some changes to the physics of ice (such as ice crystal fall speed, which depends on shape) have very little effect on weather system evolution (Dearden et al 2016) but there is a great deal more to explore. Latent heating in mixed phase clouds, for example, and the whole area of radiative effects on cyclones have not been carefully studied. The student will be able to choose from a number of different approaches, depending on their aptitude and interests, and develop the project according to the results they obtain.

Project Summary:

A starting point to the project could be a case study using the WRF model of a cyclone over the Atlantic in September-October 2016. This was a period when an intensive field campaign using German, French and British aircraft made detailed measurements of a number of weather systems. The case study would essentially be a test bed to try out different ideas in the model, and compare to observations from aircraft and from satellites. The student would learn how to set up and run the model, and perform a set of diagnostics. Perturbations to the cloud parameterization schemes would then identify areas of sensitivity that could be followed up in later work.

The project could continue along a modelling path, for example by setting up a seasonal simulation using WRF to allow a statistical evaluation of the effect of changing cloud parameters. Sensitivity to aerosol formulations could also be investigated here (e.g. what effect does ingesting Saharan dust have on the evolution of a weather system)?

Alternatively, the project could concentrate on the effects of radiation, using laboratory and field measurements to examine the way solar radiation is scattered and absorbed in the atmosphere and how this affects the dynamics of weather systems. This approach would suit a student who wanted to perform some experimental work during their PhD.

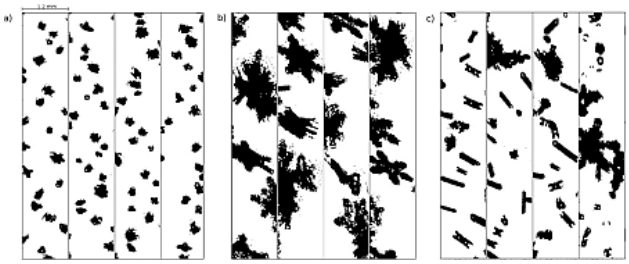

Image 1 - Ice particles in clouds imaged by aircraft-borne instruments

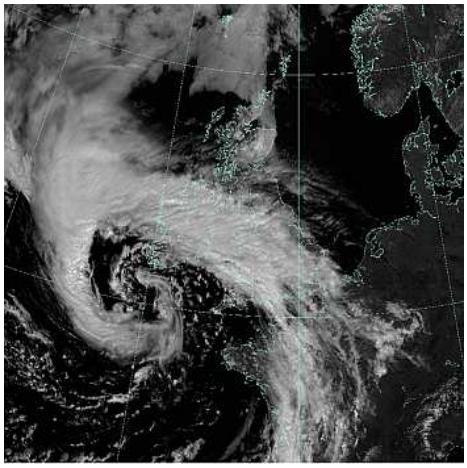

Image 2 - Weather system impinging on the UK in August 2012

References

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