Geophysical Research Abstracts
Vol. 14, EGU2012-6488, 2012
EGU General Assembly 2012
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The Microphysics of Cold Fronts measured during DIAMET

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During the autumn and early winter of 2011 a number of combined airborne, radar and radiosonde studies of frontal systems crossing the UK were undertaken as part of the DIAbatic influence on Mesoscale structures in ExTratropical storms (or DIAMET) project. The main aim of DIAMET is to improve our ability to predict the mesoscale structure of severe storms over the UK for forecast times ranging from several hours to several days. Extratropical cyclones are the major cause of damaging weather in north-western Europe, mainly through the effects of high winds and flooding. Although many such storms are well forecasted on the synoptic scale, the precise timing, location, and evolution of mesoscale and convective-scale structures such as the strong winds and intense precipitation within these cyclones remain uncertain. This project uses the unique measurements of these smaller-scale structures to guide a programme of research into the dynamics and prediction of storms.

In this paper we focus on detailed measurements of the microphysics and dynamics of cold fronts crossing the UK associated with vigorous storm systems during periods with a very strong zonal jet stream. The FAAM BAe 146 research aircraft was used to drop sondes into the systems when out to the west of the UK, and to make insitu measurements in the systems when closer to and over the UK. The aircraft made a number of horizontal passes over and through the frontal cloud at decreasing levels to make detailed measurements of the cloud physics (ice and liquid), dynamics and atmospheric aerosol. The aim was to; measure the cloud microphysics close to cloud top in order to examine the initiation of the ice phase through heterogeneous (or homogeneous if cold enough) nucleation; measure at temperature levels around -7^{o}C to study the freezing of water due to the production of ice by a secondary Ice-particle Production (SIP) mechanism known as the Hallett-Mossop process; to investigate the properties of the solid precipitation just above the freezing level; to quantify the diabatic effects of melting and evaporation below the freezing level. When in range, simultaneous detailed measurements of the structure of the fronts were also made using the scanning radar facility at Chilbolton. The observational study was supported by detailed modelling using a variety of models including the Weather and Research Forecasting (WRF) model. This presentation focuses on the role of the microphysics and dynamics in generating zones of intense convergence, and the changes introduced (e.g. as aerosol properties changed) as the front transitioned from over the ocean to land.