Understanding and modelling the properties of Fog

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Aim

An understanding of the nature of Fog can only be achieved by studying the complex inter-relation between microphysics, radiational cooling and dynamical processes in the atmosphere. The aim of this project is to develop knowledge and to model Fog formation, development and dissipation using high resolution models, whilst also using observations and results from a European COST programme for comparison and data initialisation.

Background

Radiative cooling and moisture balance largely determines the development of Fog, especially Radiation Fog. The strength of turbulent mixing processes near the surface, strongly affect the existence of this type of Fog. The presence of topography can be critical in providing suitable wind conditions and creating or preventing air motion or advecting moisture fluxes. In other Fog, and low cloud events, advection of air with a different thermodynamical and moisture structures is often the dominant process, with radiational processes sometimes only becoming important in the Fog dissipation. In all cases, the development of the microphysical structure of the droplet distribution is constrained to small sizes so that the water does not significantly precipitate out. This study specifically excludes the types of Fog produced by industrial emissions.

Methodology

Ballard and Golding (1991) was an early attempt to model the development of a Fog event in the UK. Prescription of the initial conditions, the radiative balance and vertical resolution of the model were found to be crucial. Recent observations, Garcia (2002) and Pagowski (2003, in press) have been made using Fast Forward Scattering Probes, and have enabled an analysis of the microphysical structure of the "fog clouds" to be made. The nature of these clouds is very inhomogeneous, and variations at resolutions of less than 20m are significant in the structure of these saturated air masses. The droplet size structure, however bears a close resemblance to the observations of small cloud structures (Coals, 2003, submitted to QJ) where a meso-scale model was used to compare model simulations with radar and aircraft observations. Homogeneous and inhomogeneous processes that determine the droplet size structure in warm cumulus clouds are very relevant, (Pagowski, 2003), although it is anticipated that there will be a reduced role for turbulent mixing processes.

The novel science arises from the recent availability of high resolution microphysics data (e.g. Pagowski, 2003), the observational data now being collected from the co-ordinated EU action and the development of the microscale model, where the LEM microphysics is being combined with the variable topography lower boundary. This now enables a detailed comparison of the structure of Fog clouds to be completed.

There are three phases to the project

1. Data will be collected and analysed for the case studies. This will involve participating in the COST 722 action and obtaining data from the French and other organised field observations (Thierry Bergot: see link to COST 722 phase I in the web site below)
2. Initial computer simulations will be used using the Met Office LEM model. The model will be used in a 2-D form, but include the radiation scheme, as recently modified by S. Dobbie. In the second year the updated radiation scheme will be transferred to the updated microphysical Blassius model. Initial calculations of the effects of including topography can be included
3. A detailed sensitivity analysis of the critical parameters, mixing processes, microphysical description, topography and initial conditions will be conducted in relation to the observed data, to determine the relative importance of the processes.

Research training

The student will learn how to analyse data, to liase with other scientists, present results and other develop links with other EU countries, develop new facilities for a microscale model which can be used by others, and learn how to use parallel computing. The student will attend lectures in the School of the Environment, take an active part in the EU COST action and in UWERN activities.