Development of meso-scale numerical models for short range forecasting of severe convective storms and impact on flooding

Dr Alan Gadian, with Prof Keith Beven (Lancaster)

The aim of this project is to develop a meso-scale model which can an integrate hydrological models and improve our understanding of the processes that produce floods and lead to suggestions for improvement in the quality of forecasting these severe events. The work will involve collaboration with the hydrological group, Prof Keith Beven at Lancaster University and Dr Jutta Theilen, Flood Forecasting Group, Joint Research Centre (EU), Ispra, Italy. The major conclusion from 2003 International Conference on Quantitative Precipitation at Reading University, was that nowcasting techniques need to be replaced by short term, less than 6 hour, forecasting tools. The input precipitation is seen as a major limitation in the forecasting of floods.

Cloud Resolving modelling can provide high resolution data for input into hydrological models. They can be used as a statistical tool to simulate rainfall precipitation in ungauged catchments where severe rainfall could be a future cause of severe flooding, especially if a change of land-use etc. is being envisaged. Although it is unlikely that such mesoscale models can actually predict the exact geographical location of future storms, they are capable of initiating and producing realistic rain fields. For example, Thielen and Gadian, 1997 and 1996 were able to simulate the Halifax storm over the Pennines. The magnitude and location of the precipitation depends not only on the large scale meteorological synoptic situation, e.g moisture transport and inversions etc., but also strongly on local factors such as topography, surface roughness and feedback from surface sensible and water fluxes (Thielen et al 2000). These feedback processes from surface fluxes of heat which can be provided by a hydrological model, can be important in the cloud initialisation. The project is aimed at merging the hydrological and meteorological models to provide a tool for increased accuracy in flood prediction.

The meteorological model initially being proposed for use for this project will be the EULAG formulation. (Smolarkiewicz & Pujykiewicz. *Jou Atmos Sci*, 1992, 49, 2082-96). This is a computational fast, robust and can be run on many platforms. It solves a finite difference form of the Navier Stokes equations in an anelastic form. There is now a variable horizontal grid scheme, which enables the model to effectively nest over specific domains of interest. The UK NERC community is now developing a new microscale model. This new model will also be used for this project, and will include new elements in the microphysical schemes.

It is important to incorporate the crucial processes for rainfall production, as well as runoff. The simple soil parametrizations, Bowen Ratio and conversion of incoming solar radiation to surface heat flux will require feedback from the surface hydrological model. Current studies would seem to emphasise the effects of surface heat fluxes on rainfall development, with latent contributions acting a little slower. However, it is known that it is the in fact the Bowen ratio which determines the structure and intensity of convective storms, and the magnitude of the fluxes primarily determines the speed of the development.

Methodology and approach

The approach of this proposal is to develop simultaneously, the LISFLOOD and the Cloud Resolving models. The meteorological model will be developed to include large scale initialisation from global forecast models and to modify microphysical schemes to make them more general. The meteorological modelling would be carried out in liaison and participation with the Natural Hazards Group, JRC at ISPRA, Italy (Dr Jutta Thielen is a proposed partner). The EU group produces daily forecasts of flood prediction, and is keen to develop the use of meso-scale modelling connections. From a UK viewpoint, it is anticipate that this approach could valuably be linked with UK Hydrological models, such as TOPMODEL, and be of much interest to the UK JCMM Met Office group.