Full details

All details held on the selected case study are shown below.

Went live on	Title	Reference
20 Oct 2009	Research will improve local storm and flash flood forecasts	SID0212

Synopsis
Using new radar techniques to observe the early stages of evolving storms, scientists are developing improved forecast models. These should give better warnings of sudden heavy rainfall, which can lead to flash flooding.

Description
Flash floods are caused by sudden extremely heavy rainfall. Currently, UK forecasts give an indication of a threat of severe storms that might cause flash floods. Yet they cannot predict exactly when and where downpours will occur. Improved atmospheric observations, which can be incorporated into a forecast model, could provide an enhanced indication of heavy rain's location.

Data assimilation, a technique combing radar and other observations with model predictions, provides a better description of the atmosphere's current state. It can be used to originate a weather forecast model. Currently, radar only observes rain once it has started, but the new technique senses changing humidity and atmospheric motions before rain forms. This can be fed into the model to represent evolving convection motions.

The operational radar network has been designed to measure rainfall and to reject echoes caused by radar beams hitting the ground. However, scientists at the Department of Meteorology, University of Reading and the Met Office have jointly developed a technique to exploit echoes from 'ground clutter', building on previous work by the NERC-funded Chilbolton Observatory, as part of NERC's FREE programme.

If air humidity increases, radar waves travel more slowly, which slightly delays the return from ground clutter. By measuring delay from all ground clutter targets surrounding radar, a map of the developing humidity field can be made. This information lets the model track developing storms more accurately, before precipitation forms. The Met Office has developed new signal-processing techniques to measure the delay accurately, and has tested these on two radars in the national weather radar network.

"Methods presently available for measuring humidity at low levels in the atmosphere provide only point observations at ground level and a small number of vertical profiles. The new technique offers the possibility of being able to map near-surface humidity for the first time," said Malcolm Kitchen, Head of Observational Development at the Met Office. "The hope is that the maps will locate areas where moisture convergence is taking place and where convective storms will develop subsequently."

Techniques are also being developed to provide an estimate of the confidence of forecasts of flash flooding. In spite of improved observations, there is never certainty about the precise state of the atmosphere used for weather forecasts.

Experiments are being carried out in which the initial conditions are 'perturbed' to reflect uncertainty. An 'ensemble' of different forecasts is made from these slightly differing starting conditions. On some occasions, small changes in the initial state have little effect on forecast rainfall, leading to greater confidence that a forecast will be accurate. At other times, small changes in initial conditions lead to a spread of forecasts with different rainfalls, in which case confidence in a forecast is low.

A next stage in the project will be to feed an ensemble of forecast rainfall distributions into hydrological models of river flow used for flood forecasting. This will enable the probability of flooding to be quantified and, depending upon the risk, precautionary actions to be taken.

"Our work draws on interactions between different disciplines of observations and measurement, and meteorology and hydrology. In collaboration with the Met Office, we implemented the system on network rain radars to test it on any extreme events that occurred," said Anthony Illingworth, Professor in Atmospheric Physics, University of Reading. "We now need to investigate if extra information on surface level humidity fields, can be fed into forecast models to improve heavy rain predictions."

References and links	
Hyperlinks	1. Met Office - Homepage 2. University of Reading - Department of Meteorology

Impacts	
Actual impacts	Practice, Emergency response
Impact evidence	The system is now operating 24 hours a day, seven days a week, on the Cobbacombe network radar in Devon and the Hameldon Hill network radar in Lancashire. Reading University and the Met Office are evaluating the benefit of this system to the model forecast.
Key outputs	Computer model - it tracks developing storms ahead of rainfall.

Research and funding	
Funding type	Research Programme
Date of research	May 2007 - April 2010

Researchers at Universities		
Grant reference	NE/E002137/1	
Investigator	Professor AJ Illingworth	University of Reading, Meteorology
Co-investigator	Dr RS Plant	University of Reading, Meteorology
Co-investigator	Dr SL Dance	University of Reading, Meteorology
Co-investigator	Dr SL Gray	University of Reading, Meteorology

Classification	
Science themes	Climate system, Earth systems science, Natural hazards, Technologies
Science areas	Atmospheric, Earth, Freshwater, Marine, Terrestrial, Earth observation
Policy areas	Climate/environmental change and impacts
Keywords	Climate models, Climate predictions

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