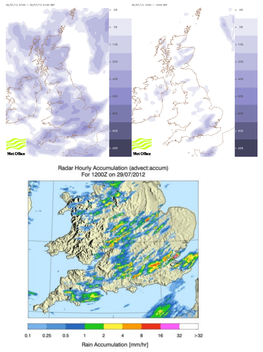
Flooding From Intense Rainfall – WP1: FRANC Forecasting Rainfall exploiting new data Assimilation techniques and Novel observations of Convection

Met Office | University of Reading | University of Surrey | Environment Agency | NERC Science of the Environment

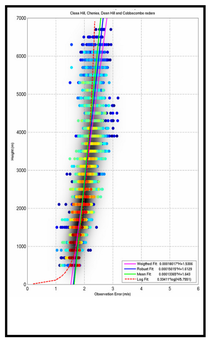
Improving forecast Accuracy

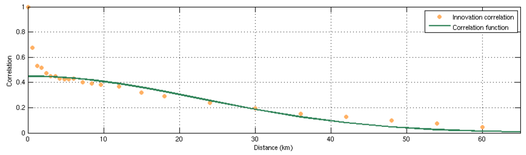
Increased model resolution has allowed forecasting of high intensity localised precipitation as in the **Boscastle storm shown left**. However improvements are still sought through more accurate initial conditions and improved understanding of the growth of forecast errors.



The Met Office now has a 1.5km resolution forecast model for the UK (see left) and a 2.2km ensemble (see far left). The work in FRANC aims to improve the accuracy of those forecasts and the radar derived rainrates (below left) used for their verification, initialization and nowcasts.

Figures show the probability of rain rate exceeding 16mm/hr (described as "intense rain") sometime in the day (0600-2400UTC) from a forecast initiated 1500UTC the previous day (left). Probability of rain rate exceeding 16mm/hr sometime in the one-hour period 1300-1400UTC (right) from a forecast initiated at 0300UTC the same day compared to the radar rain accumulation 1100-1200UTC 29th July 2012

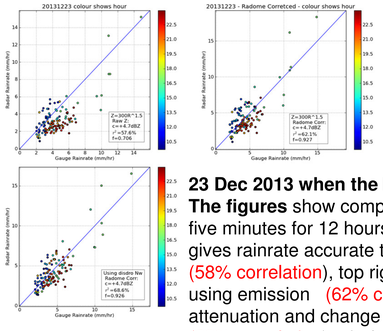




WT3 Correlated observation errors
This work task is about developing novel generic techniques for dealing with observation error correlations in data assimilation, which we will apply to a range of observation types in future Met Office high resolution 4D-Var systems.

Figures show results of Hollingsworth and Lonnberg 1986 method applied to Doppler radar radial wind, left shows error variance as a function of height, above shows correlation as a function of distance where green line is fitted backgound error correlation.

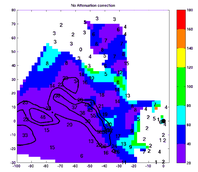
Greater and Improved use of Radar Data



23 Dec 2013 when the N terminal At Gatwick Airport was flooded.
The figures show comparison of rain rate from radar scan every five minutes for 12 hours against new high resolution gauge which gives rainrate accurate to 0.2mm/hr every minute. Top left raw radar (58% correlation), top right Z corrected for attenuation by wet Radome using emission (62% correlation) and bottom left Z corrected for attenuation and change in drop size distribution from disdrometer (69% correlation) - in future will get this from radar polarisation parameter 'differential reflectivity'.

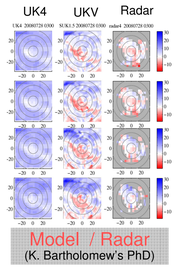
WT1 Radar reflectivity correction with associated errors
i) Provision of attenuation corrected reflectivity values with associated errors for use in 4D-Var assimilation
ii) Provision of more accurate rainfall rates with improved understanding of errors

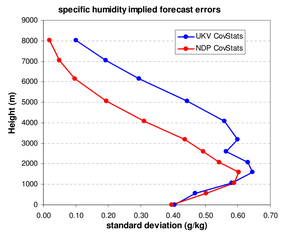
The figure below shows severe attenuation in heavy rainfall on 20 July 2007: London floods. In two hours gauges (black contours) recorded 50mm rain: radar estimates only 20%-40% of gauges (purple).



WT2 Radar refractivity Changes in near-surface radar refractivity are dominated by changes in humidity. Their assimilation should be useful in helping to predict where convective showers will form. The goals of this work task are to optimise the data collection and processing for refractivity retrievals and define the error characteristics. The MO will install this technique across the network, and then develop and test methods for assimilating the data.

Figure to right shows clutter map ie locations where refractivity will be obtained. Far right shows comparison of model and radar refractivity





WT4 Improving the representation of moist processes and unbalanced flows in data assimilation
Data assimilation exploits dynamical relationships between errors associated with different model variables which
i) govern the multivariate spreading and filtering of observational information,
ii) limit initialization shocks and
iii) improve the well-posedness of the estimation problem.
The aim of this work task is to look for a regression between errors in dynamical variables and moisture in view of developing a set of unbalanced moisture control variables. **Figure to left** shows comparison of error variance for RH and a modified humidity transform (Ingleby et al 2012)

WT5 Analysis of linearized models of convection-permitting models - PhD
(i) What kinds of behaviours are missing from linear models used in data assimilation?
(ii) How do the types of linear models compare?
(iii) How can the linear models be used to diagnose stability characteristics of the system?
(iv) How does a change in the regime affect these results?

WT6 Environmental controls on convective-scale error growth - PhD
(i) characterize properties of a convective timescale for cases over the UK
(ii) characterize convective-scale error growth for contrasting cases of convection over the UK for differently-generated ensembles and use this to assess the potential value of convective-scale data assimilation,
(iii) critically assess the hypothesis that a predicted convective timescale can be used to distinguish qualitatively different convective-scale error growth

Flooding from Intense Rainfall

from 2013 - 5 year NERC funded

aims to reduce the risks of damage and loss of life caused by surface water and flash floods

Improve the length and accuracy of forecasts of the occurrence and intensity of rainfall associated with convective storms.

Identify the susceptibility to high-intensity rainfall of different catchment types, based on characterisation of the properties that govern the dynamic, non-linear, hydrological and hydro-morphological processes which initiate, extend and intensify associated flood risks.

Enhance flood risk-management through the development of both flood risk estimation and real-time forecasts of floods associated with high-intensity rainfall, integrating multiple meteorological and hydro-morphological processes occurring before, during and after intense precipitation events.

WP1 FRANC: Forecasting Rainfall exploiting new data Assimilation techniques and Novel observations of Convection – joint with Met Office

WP2 SINATRA: Susceptibility of catchments to INTense RAinfall and flooding

WP3 : to be commissioned Dec 2014

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