New tools for the evaluation of convective scale ensemble systems

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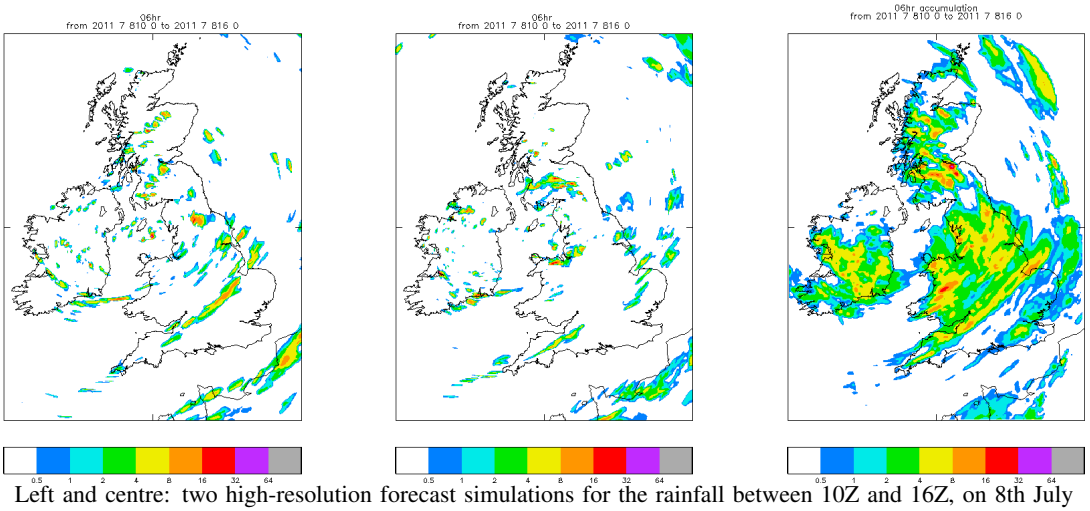
In the last few years, advances in computing power have allowed various weather forecasting centres to begin using very high-resolution simulations, in which the model grid boxes are $\sim$ 1km. However, substantial uncertainty on such fine scales is an intrinsic part of the dynamics of the atmosphere. Future improvements in prediction are therefore most likely to come from knowledge of the size and character of the uncertainties. The uncertainty can be assessed by running a number of slightly different simulations, known as an ensemble. The construction and interpretation of high-resolution ensembles poses many theoretical and practical questions. Techniques that are standard at low-resolution no longer work: new tools and new thinking are urgently needed.

The project has two main objectives:

1. **Process analysis of ensemble forecasts** We will investigate the physical mechanisms, sensitivities and predictability of case-study events within an ensemble framework. The aim is to develop systematic, automated methods of assessing the key meteorological and physical processes that control the forecast uncertainty. To do so, we intend to exploit and adapt techniques from ensemble data assimilation, a sophisticated mathematical method that combines observations and model data to give a best estimate of the state of the atmosphere.

2. **High-resolution ensemble performance** Ensembles have traditionally been evaluated against observations by comparing the standard deviation across the ensemble of simulations (the "spread" of the forecast) against the root mean square error (RMSE, the "skill" of the forecast). If the ensemble captures forecast uncertainties well then spread and skill should be equal. However, RMSE is not suitable for assessing skill at high-resolution. A small-scale feature that is basically well captured by the model, but very slightly displaced would be evaluated as a poor forecast by RMSE relative to another forecast that totally misses the feature. So how then can we tell if a high-resolution is capturing the forecast uncertainity well or not?



Left and centre: two high-resolution forecast simulations for the rainfall between 10Z and 16Z, on 8th July 2011. Right: actual rainfall, as estimated from radar data.

Student profile:
Suitable for candidates with a degree in mathematics, physics or a closely related physical or environmental science. Those with specific interests in predictability and numerical weather forecasting are strongly encouraged to enquire further.

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