Extracting likely scenarios from high resolution ensemble forecasts in real-time

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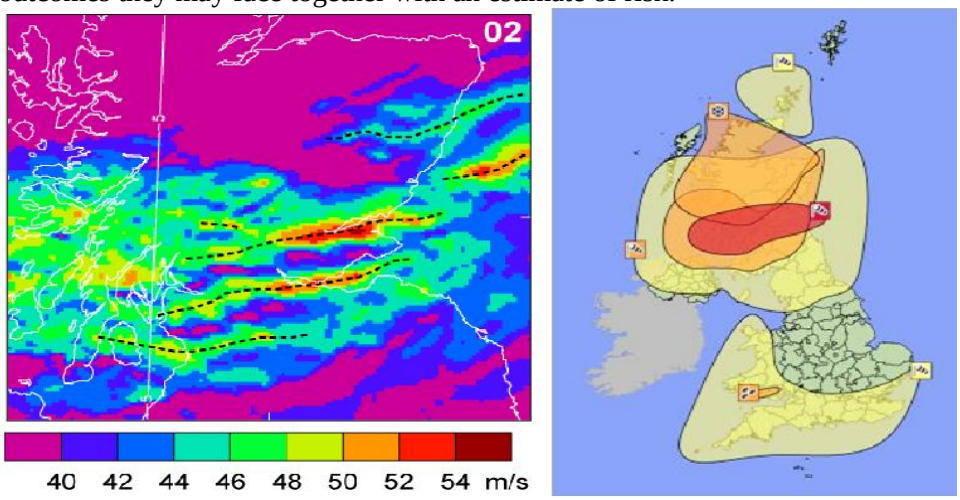
National weather forecast centres are moving to a new generation of ensemble forecast systems that run multiple convection-permitting model forecasts (grid spacing ~2km). They are needed because they can partially resolve the dynamics of small-scale high impact weather phenomena such as intense precipitation. This approach provides a large number of detailed forecasts of local weather for any given forecast time and location, and hence a wealth of new information about the predictability of high-impact events that affect society such as destructive winds, flash flooding, snow and fog. Since the Met Office MOGREPS-UK forecast was one of the first of such systems to go operational, there is now a unique 5-year forecast dataset. One barrier to the full and effective use of these new forecasts is that it is considerably more difficult for a human to fully process such a large amount of information in time to communicate early warnings. Therefore, there is a pressing need to develop a capability to synthesise these data into a manageable number of plausible scenarios or storylines that capture the phenomena of concern and provide emergency responders a clear understanding of the possible outcomes they may face together with an estimate of risk.



Left: Banding in winds within an intense cyclone, as represented by the Met Office high resolution forecast model. Right: The associated national weather warning indicating the risk of high impact. Red indicates where people need to take urgent action.

The project aims to develop new techniques for extracting clusters (groups of similar forecasts) from the ensemble which can be used to provide forecasters a small set of possible scenarios that can be readily understood by end users. Three approaches will be explored in generating scenarios from ensembles: a top-down approach from clustering global and regional forecast ensembles together, a bottom-up approach from statistical clustering of weather variables at high resolution and an approach using physical insight to partition an ensemble before statistical matching. Case studies will be performed that include situations in which the ensemble is perceived to have produced insufficient variability in outcomes (such as a case in winter 2017 in which all

MOGREPS-UK ensemble members produced too much snow over southern England). The goal is to improve early warning services and risk-based decision making.

Training opportunities:
Through collaboration with the Met Office, you will have the opportunity to work with researchers in high resolution modelling and forecast evaluation, operational forecasters and the multi-disciplinary team with expertise in hazards and communication with emergency responders.
While on placement in the Met Office headquarters (Exeter) in the verification team the student will experience the operational environment of real-time forecasting and evaluation of user-facing forecast products. They will gain an appreciation of user-needs and the degree to which added value to forecasts can be created by understanding the user problems and the decisions they need to make.
At Reading, you will be part of the Dynamical Processes Research Group in the Department of Meteorology which brings together about 40 researchers working on the dynamics of weather systems and climate in weekly group meetings. Together with the Mesoscale Dynamics and Data Assimilation Research Groups, this forms a world-renowned critical mass of atmospheric dynamics and predictability research and would enable you to develop your research with help from the other researchers in the group.

Student profile:
This project would be suitable for students with a degree in physics, mathematics or a closely related environmental or physical science. Experience of computational statistics and some prior knowledge of programming in python, matlab or similar would be desirable. Empathy with users of forecasts and understanding of the needs of professional forecasters is an important aspect of the project.

Funding particulars:
This project has CASE sponsorship from the Met Office in addition to the NERC studentship funding.

References:
Vaughan, G. *et al.(*2015) *Cloud banding and winds in intense European cyclones: results from the DIAMET project.* Bulletin of the American Meteorological Society, 96 (2). pp. 249-265.

http://www.reading.ac.uk/nercdtp