MEDIUM-RANGE ENSEMBLE FORECASTS AT THE MET OFFICE

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1. MEDIUM-RANGE ENSEMBLE FORECASTS

The central aim of the Met Office contribution to the THORPEX research programme is to improve the prediction of high-impact weather using multi-models ensemble forecasts. To that end, the Met Office has recently implemented regular medium-range global ensemble forecasts based on the Met Office Global and Regional Ensemble Prediction System (MOGREPS). MOGREPS was originally developed for short-range ensemble forecasting, and comprises a regional model (covering the North Atlantic and Europe) with boundary conditions taken from global ensemble forecasts. The 24-member ensemble forecasts are run twice daily. Perturbations to the initial conditions are generated using an Ensemble Transform Kalman Filter (ETKF) method (Bishop et al, 2001).

For the medium-range ensemble forecasts, the global Unified Model has been ported to the ECMWF supercomputer. Initial conditions for the ensemble forecasts are generated by the MOGREPS system at the Met Office, and transferred to ECMWF (see Figure 1). The global ensemble forecasts are each run to 15 days, using a model with resolution N144L38, i.e. a horizontal resolution of 0.83° latitude by 1.25° longitude, with 38 levels. The model's physical parameterizations are described by Savage and Milton (2007). The forecast model produces output fields which are stored in the THORPEX Interactive Grand Global Ensemble (TIGGE) archive database. Other output streams are used for verification and to generate products - particularly those aimed at forecasting high-impact weather, as described in section 3.

2. MULTI-MODEL ENSEMBLES

As shown in Figure 1, it is planned to combine the Met Office medium-range forecasts with forecasts from other models that will be available via the TIGGE database. We are using an ensemble test-bed based on simple models to help guide the approach we will use to calibrate and combine the ensemble forecasts (Johnson, 2006). Based on that work, we are currently producing an experimental bias-corrected ensemble mean combining Met Office and ECMWF forecasts. We will continue to develop techniques for multi-model ensemble forecasting, and to evaluate the benefits of a possible future operational multi-model ensemble.

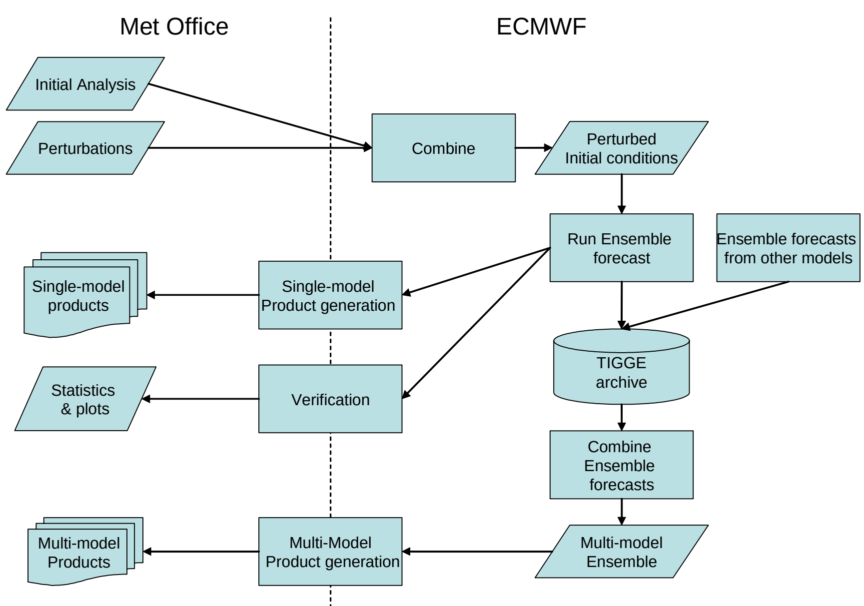

Figure 1. Schematic of the Met Office medium-range ensemble forecast system. At present experimental products and verification statistics are being produced from the single-model forecasts. Work is currently in hand on the combination of forecasts from multiple models.

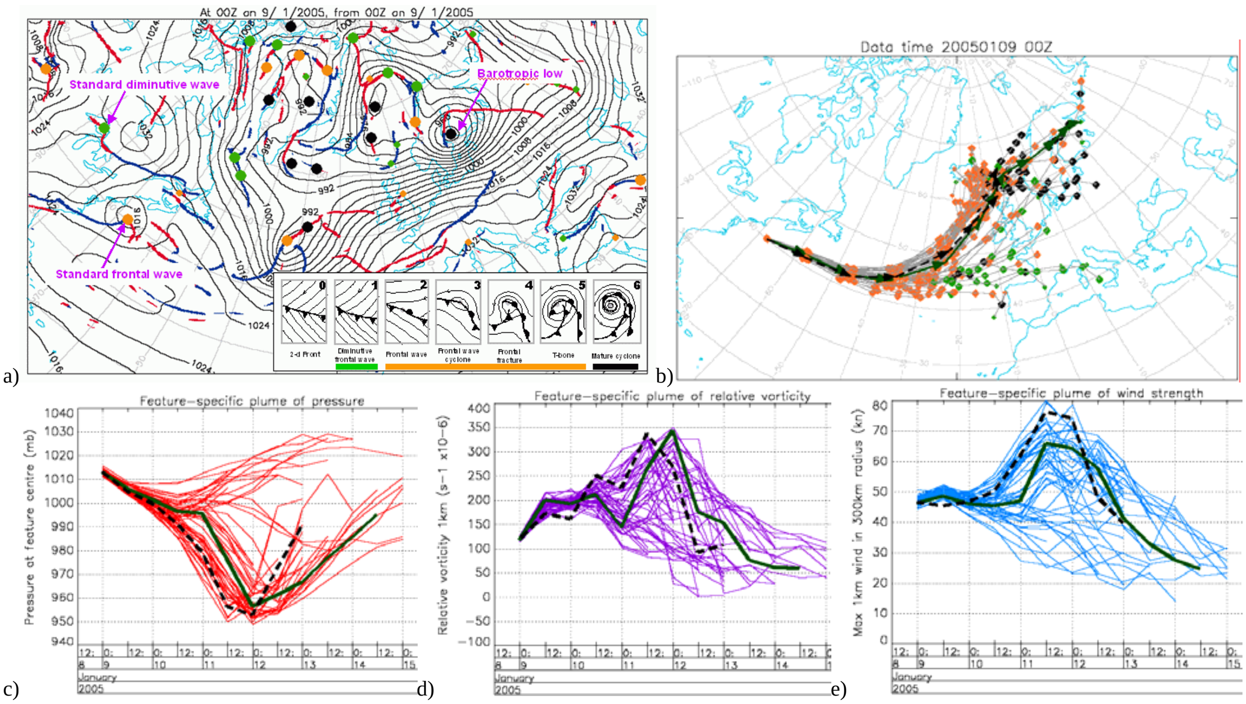

Figure 2. Example case study using the Cyclone Database on ECMWF EPS data from 00Z 09/01/2005: a) Control T+0 image of objectively identified fronts and cyclonic features. The key frontal wave is off the New England coast; b) Forecast tracks from each ensemble member; c/d/e) Associated feature-specific plumes of intensity (control=thick, analysis=dashed).

3. FORECASTING HIGH-IMPACT WEATHER

Ensemble forecasts, and in particular multi-model ensembles, produce vast amounts of data. To aid interpretation a suite of intelligent diagnostics is needed, to highlight when high-impact weather is forecast. For example, a new 'heatwave' product has been developed, showing when temperatures on successive days and the intervening night exceed significant thresholds for health. Similar approaches are used to highlight persistent wet or cold periods.

Much of the high-impact weather in Europe is associated with synoptic features. At the Met Office, the ensemble forecast output is objectively analysed to identify extra-tropical cyclones and fronts, with feature-point attributes stored in a cyclone database (Hewson, 1997). The features are then processed through tailored tracking software, to show how each feature is likely to develop and whether it has potential to cause high-impact weather. This feature-based approach is also able to address some of the deficiencies of the lower resolution ensemble models.

Figure 2 illustrates use of the cyclone database products on the ECMWF EPS in a high-impact weather case study: the development of a frontal wave situated off New England at 00Z on 9th Jan 2005. By 00Z on 12th this low had rapidly deepened to 945mb, resulting in major disruption from heavy persistent rain and hurricane force winds over Northern Scotland. Figure 2a shows the identified fronts and features in the control T+0 forecast. Clicking, within a web browser, on the key frontal wave would bring up plots 2b-e showing how the ensemble is predicting it to develop. There is an interesting bifurcation of the tracks and the feature-specific plumes, but there is a cluster of tracks lending good support to the actual outcome (overlain in black), for both track and intensity.

The products are now available to Met Office forecasters in real time using input from the new Met Office 15-day ensemble. Further products to highlight high-impact weather are being developed, in response to the needs of forecasters and other users. These will also be adapted to benefit from the multi-model ensemble forecasts.

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