Developments in the Met Office 3DVar Scheme for the UK Mesoscale Model

by

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Since its operational implementation in October 1999, described by Andrews et al. (2000), the Met Office Mesoscale 3DVar scheme (Mes 3DVar) has undergone two main upgrades. The first was implemented in June 2000, the second in February 2001.

Of the numerous ingredients in the *June 2000 package*, the most significant was an improved representation of forecast error covariances. The covariance statistics are based on summer and winter data, instead of just winter data, as previously. They use 'Rotated Kinetic Energy Vertical Modes', which replaced unrotated streamfunction and velocity potential vertical modes. This resulted in sharper vertical wind correlations in better agreement with observation. An error in the horizontal spectrum was corrected, which gave unrealistically short horizontal scales, especially in the upper-air. Horizontal scales for wind and temperature were increased further, based on analysis of forecast difference statistics. The streamfunction and velocity potential variances were scaled to give a less divergent wind increment, which should be retained better by the model. Other ingredients included improved observation processing of surface pressure, as already implemented in the global model, and restored use of hourly synops, taking advantage of the availability of time interpolated model background values.

A trial of this package showed a systematic slight improvement in precipitation forecasts at each threshold and forecast time up to t+24 (Figure 1).

The *February 2001 package* had several components: introduction of a soil temperature increment, assimilation of selected wind profiler data and assimilation of higher density Meteosat wind data. The soil temperature increment is equal to the atmospheric temperature increment at the lowest model level. It is added to the surface temperature, T_* and the top deep soil temperature level. Objective verification showed a systematic improvement in screen temperature forecasts up to t+24 (Figure 2). Screen relative humidity errors were also reduced.

Wind profiler data is thinned in time to one report per hour. Monitoring statistics have guided the data selection. The Aberystwyth profiler (03501) is used above 700hPa. The 4 UK boundary layer profilers at Aber (03500), Camborne (03807), Dunkeswell (03840) and Wattisham (03591) are used below 500 hPa. The Swedish weather radar VAD profiler at Leksand (02430) is used below 500 hPa, along with the profilers at Cabauw (06348), Basel (06601) and La Ferte Vidame (07112, above 700 hPa). For quality control, the initial probability of gross error, PGE = 0.05 generally, but is higher (0.1) for La Ferte Vidame and Basel.

Higher density Meteosat wind data have replaced low resolution 6-hourly NESDIS SATOB satellite winds. The EUMETSAT data are available every 90 minutes. Coverage after quality control is improved from ~20 to 100+ data per run, including more in the Biscay area. Most of the extra data are in the 100-400hPa band.

Reference

Andrews, P.L.F., Chalcraft, B.V., Harcourt, S.A., Macpherson, B., Maycock, A., 2000: The UK Met Office Mesoscale 3D-Var Data Assimilation Scheme. CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modelling, Report No 30, pp 1.3-1.4

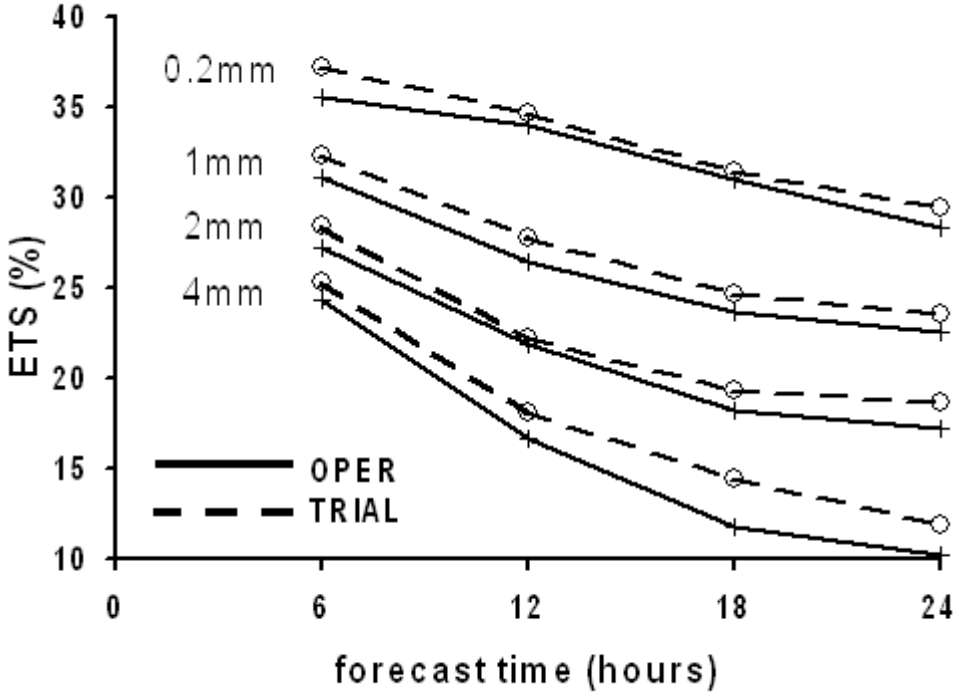

Figure 1: Verification of 6-hourly precipitation accumulations v radar data (at 4 different thresholds) for the 'June 2000 Mes 3DVar package', labelled 'TRIAL', against operational forecasts, labelled 'OPER'. Equitable Threat Score (ETS) as function of forecast time, averaged over 35 forecasts from April 2000.

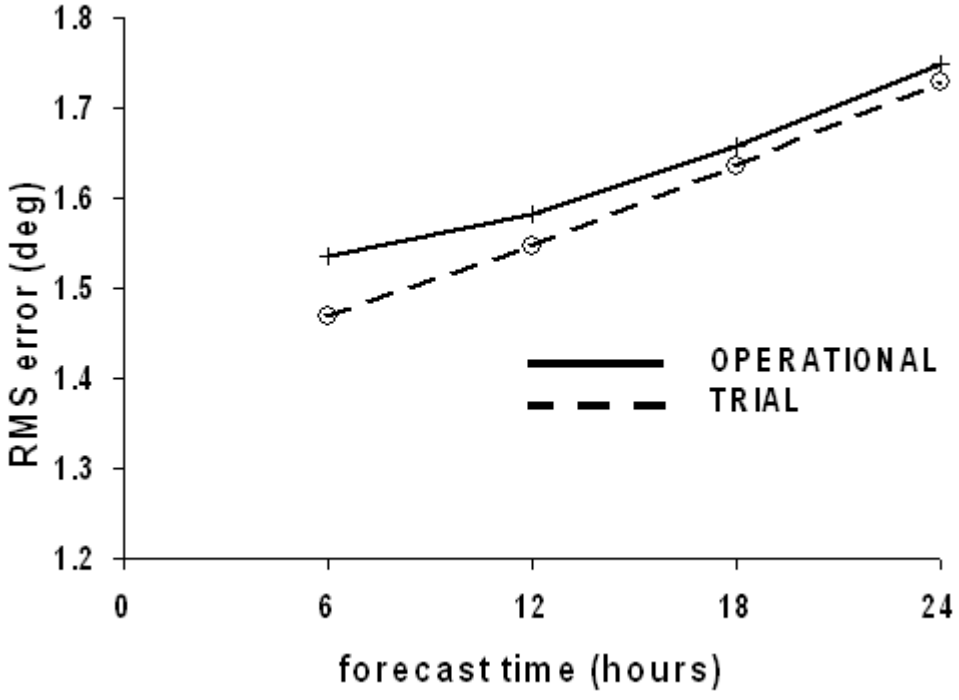

Figure 2: Root-mean-square error in screen temperature as a function of forecast time for the 'February 2001 Mes 3DVar package', labelled 'TRIAL', against OPERATIONAL forecasts. The results are averaged over 80 forecasts in a 3 week period in December 2000 and January 2001. Verification at all UK stations.