Application and verification of ECMWF products 2009

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1. Summary of major highlights

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

As part of the Met Office contribution to the THORPEX Interactive Grand Global Ensemble, the Met Office has investigated the benefits of combining ECMWF ensemble forecasts with those from the Met Office and the National Centers for Environmental Prediction (NCEP). This multi-modal combination significantly increased the skill of probabilistic forecasts of surface air temperature, but the impact on forecasts of PMSL and 500 hPa height was small. See Johnson and Swinbank (2009).

2.1.2 Physical adaptation

2.1.3 Derived fields

2.2 Use of products

Use of the monthly forecasting system (VarEPS)

Extended-range forecast products are generated using output from the VarEPS system and used to provide services to a range of customers in government, public and business sectors.

Met Office post-processing is performed for mean, maximum and minimum temperature, precipitation and sunshine amount averaged/accumulated over three forecast periods: days 5-11 ahead, days 12-18 ahead and days 19-32 ahead.

Products include global probability forecasts, forecasts for European weather regimes (Grosswetterlagen and Lamb types), and forecasts for the 10 UK climate districts. Global probability products are generated in the form of 1) probability maps for tercile and outer-quintile categories, and 2) for specific regions, probability histograms for quintile categories (well-below, below, near, above, and well-above the climate normal for the region and time of year). For both these formats the forecast variables are temperature, precipitation and wind speed. Forecasts for the 10 UK climate districts are also presented in tercile and quintile formats. Population weighted probability products are also generated. The UK forecasts are expressed both in terms of the probability of each category and a deterministic forecast based on either the ensemble mean or the most probable quantile.

Use of the ECMWF seasonal forecasting system

The Met Office provides seasonal forecast services to a range of customers in government public and business sectors and internationally as part of its commitment as a WMO Global Producing Centre (GPC) for Long-range forecasts. The main tool used is the Met Office global seasonal prediction system (GloSea). Additional use is made of the ECMWF seasonal forecast system and the EUROSIP system, in order to gain a measure of the agreement in forecast signals across the models. This applies to both the forecasts developed and issued by the Met Office for each season for the Europe/UK region - and also to advice provided to Regional Climate Outlook Forums convened to develop consensus forecasts for regions with strong seasonality in rainfall (e.g. West and East Africa). Output from the ECMWF tropical storm tracking algorithm (Vitart 2006), applied to GloSea output, is used to generate seasonal forecasts of North Atlantic tropical storm numbers and Accumulated Cyclone Energy (ACE) Index over the July-November period.

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

3.1.1.(i) in the free atmosphere

ECMWF and Met Office forecast fields of PMSL, 500 hPa height and 250 hPa wind have been verified against observations. Monthly mean RMS errors for an area covering Western Europe, the North Atlantic and North America are plotted in ANNEX A, Figures 3.1.1(i)a,b,c.

The ECMWF lead over the Met Office was maintained up to March 2009. However, the Met Office results show a relative improvement for 250 hPa wind in February 2009.

3.1.1.(ii) of local weather parameters verified for locations which are of interest to your service

3.1.1.(iii) of oceanic waves

The Met Office continues to contribute to the monthly verification exchange of global wave models.

3.1.2 ECMWF model output compared to other NWP models

Verification and Intercomparison of ECMWF Tropical Cyclone Forecasts

The Met Office has objectively verified tropical cyclone (TC) forecast tracks from its global model since 1988 using the verification scheme described on the Met Office web site at http://www.metoffice.gov.uk/weather/tropicalcyclone/method. This scheme has also been used to verify TC forecast tracks from the ECMWF model since 1994. This has enabled intercomparisons of the performance of the two models to be made since then. The first two figures show the differences between Met Office and ECMWF track forecast errors (Figure 3.1.2a) and skill scores (Figure 3.1.2b) against CLIPER. The graphs are for a global homogeneous sample of forecasts from the two models during the period 1994-2008. CLIPER is a benchmark statistical forecast based on a combination of climatology and persistence. In both graphs, positive values indicate the Met Office forecasts were better than ECMWF and vice versa for negative values.

The results at the 24-hour lead time indicate that Met Office track forecast errors are smaller (by an average 17%) and skill scores higher (by an average 14%) than ECMWF. At the 48-hour lead time Met Office track forecast errors are smaller by an average 3% and skill scores higher by an average 1%. By the 72-hour lead time ECMWF was performing better than the Met Office. Track errors were an average 1% lower and skill scores 3% higher.

At longer lead times (96 and 120 hours) skill scores against CLIPER are not available. The results for difference in track forecast errors show the ECMWF errors were lower 1% and 3%. These results suggest that, when averaged over the last 15 years, the Met Office forecasts were better than ECMWF at 24 and 48 hours, but ECMWF were better at longer lead times. However, the averaged statistics only tell part of the story.

Over the years, the relative performance of ECMWF against the Met Office has improved such that by 2003 there was little difference in the performance of the two models at any lead time. In the following three years, ECMWF forecasts continued to improve at lead times of 72 hours and greater whereas at 24- and 48-hour lead times Met Office forecasts improved relative to ECMWF. However, in the last two years (2007 and 2008) ECMWF's relative performance has again improved dramatically at all lead times such that it is now better than the Met Office at all lead times - even 24 hours - by between 23% and 36%. The error statistics from the respective models show that this change is due to a systematic reduction in ECMWF errors rather than an increase in Met Office errors.

Figure 3.1.2c shows that the ECMWF analysis error dramatically reduced in 2002-3 and has reduced again relative to the Met Office in the last two years to the point where the Met Office's analysis error is only slightly smaller than that of ECMWF.

3.1.3 Post-processed products

3.1.4 End products delivered to users

3.2 Subjective verification

3.2.1 Subjective scores

3.2.2 Synoptic studies

4. References to relevant publications

Johnson, C. and **Swinbank, R.,** 2009: Medium-Range Multi-Model Ensemble Combination and Calibration. *Q. J. R. Meteorol. Soc*., **135**, 777-794.

Vitart, F. 2006: Seasonal forecasting of tropical storm frequency using a multi-model ensemble. *Q. J. R. Meteorol. Soc*., **132**, 647-666.

ANNEX A

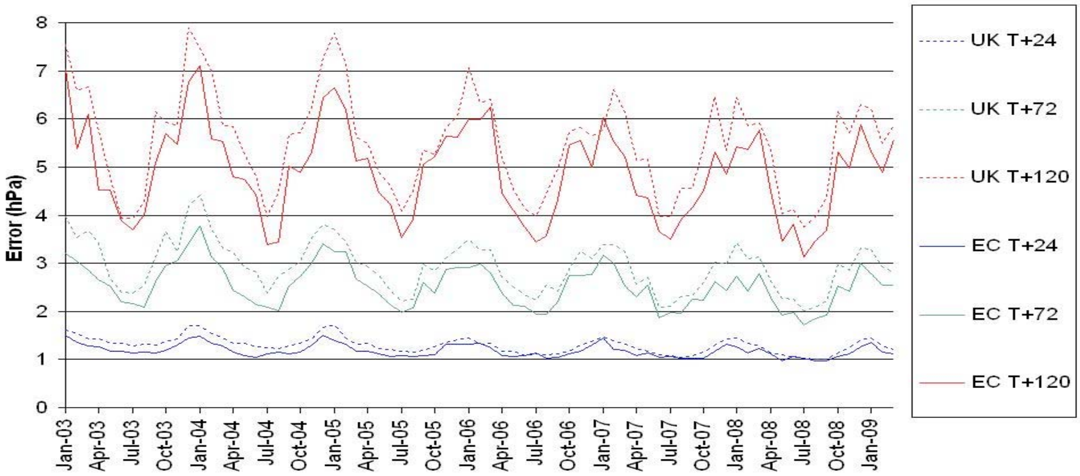

Figure 3.1.1(i)a RMS errors of PMSL, verified against observations over W.Europe, N.Atlantic, N.America: Jan 2003 - Mar 2009, Met Office (dashed line) and ECMWF (solid line).

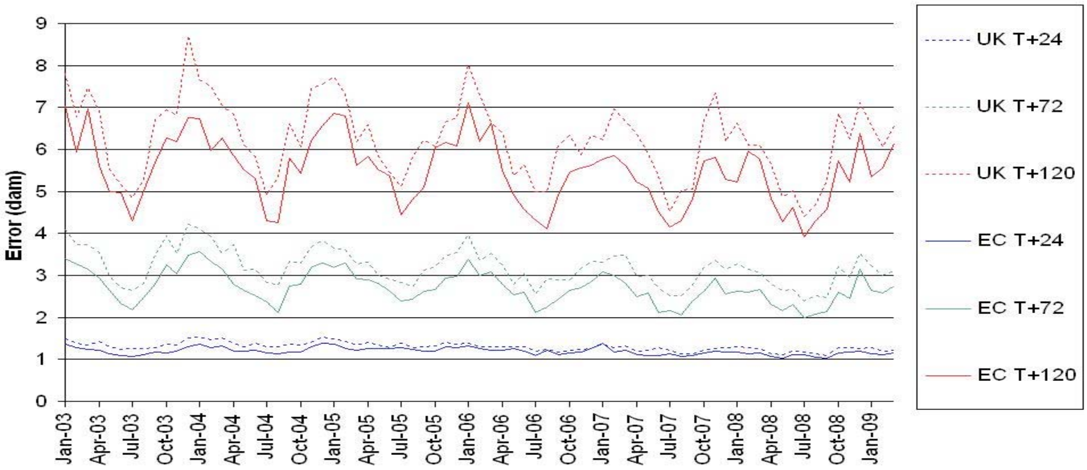

Fig 3.1.1(i)b RMS errors of 500hPa height, verified against observations over W.Europe, N.Atlantic, N.America: Jan 2003 - Mar 2009, Met Office (dashed line) and ECMWF (solid line).

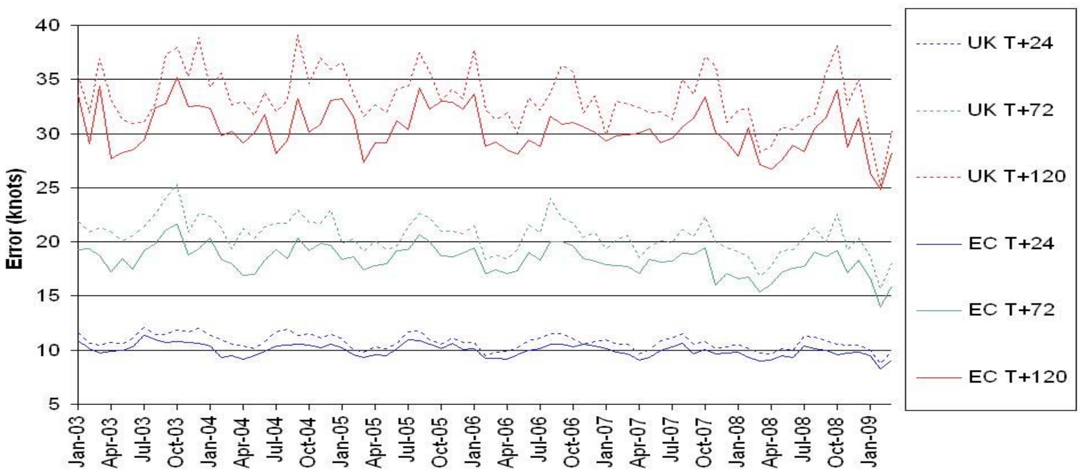

Figure 3.1.1(i)c RMS vector wind errors at 250hPa, verified against observations over W.Europe, N.Atlantic, N.America: Jan 2003 - Mar 2009, Met Office (dashed line) and ECMWF (solid line).

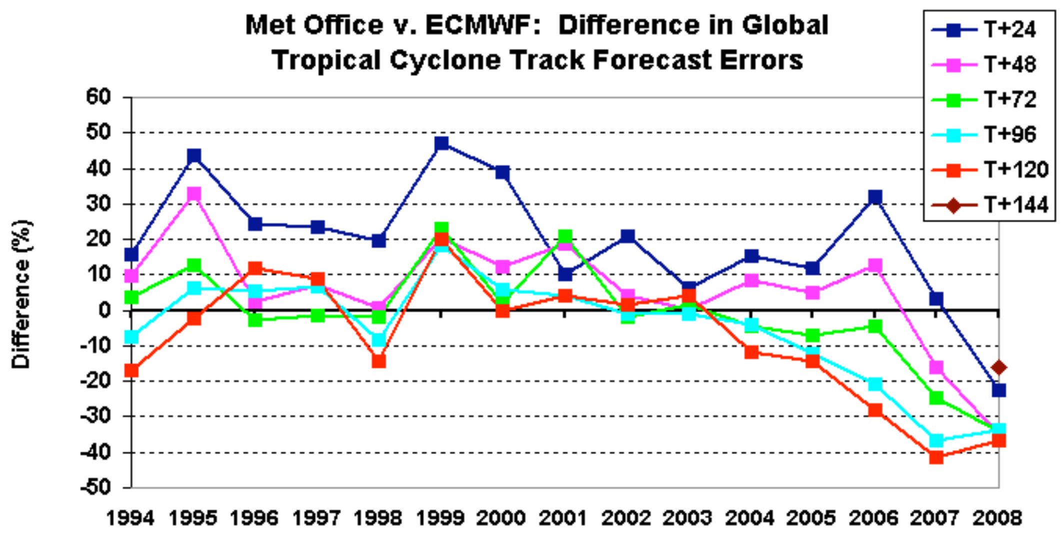

Figure 3.1.2a

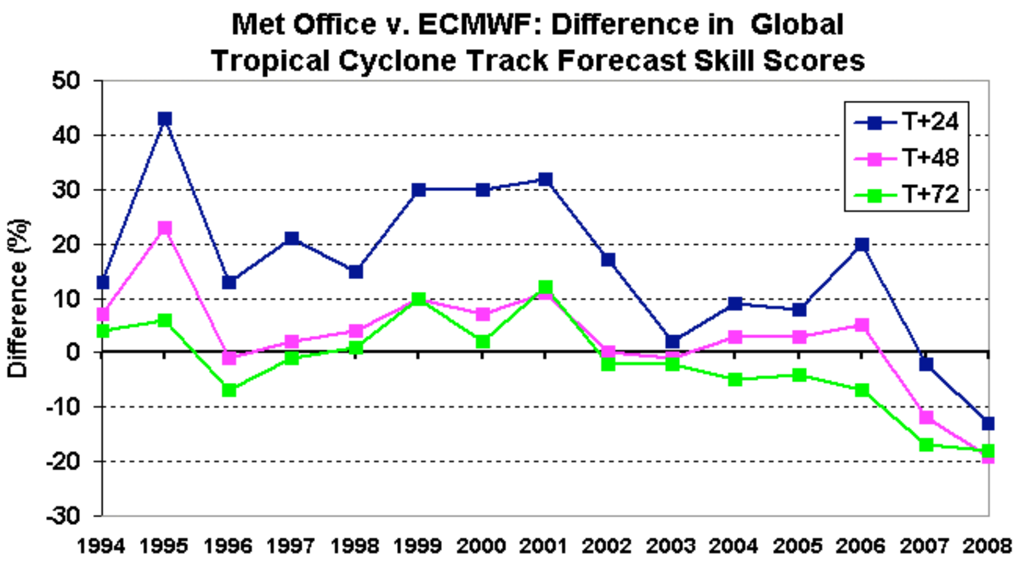

Figure 3.1.2b

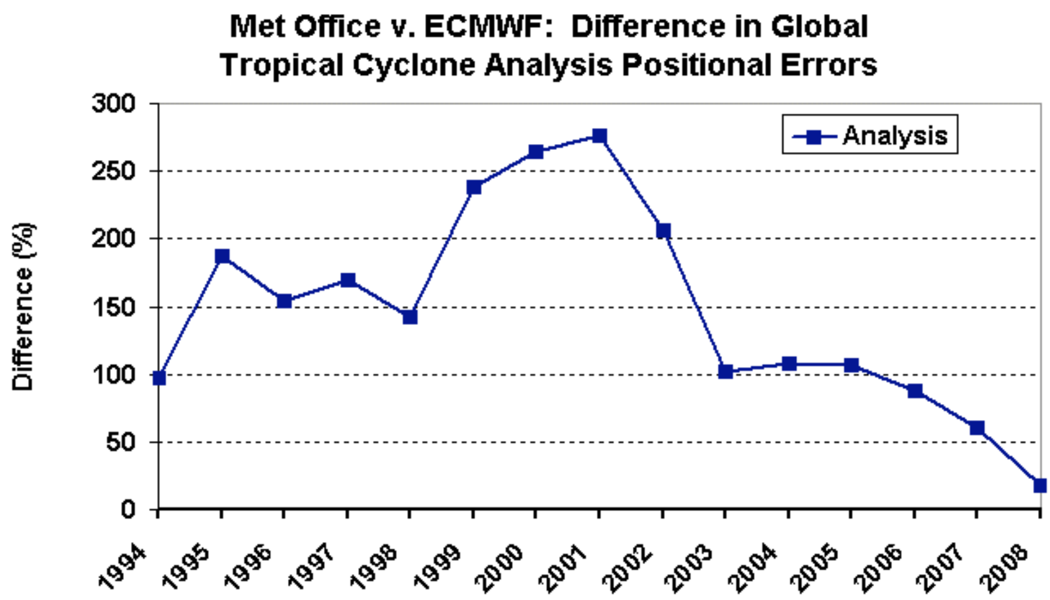

Figure 3.1.2c