Application and verification of ECMWF products 2007

Met Office, Exeter, UK – Simon.R.Fuller, Julian Heming, Caroline Woolcock

1. Summary of major highlights

1.1 VarEPS

The Met Office has adapted many of their medium range products to take advantage of the new 15 day VarEPS data. Graphical products such as the Stacked probability chart for significant wave height in Figure 1.1 have been modified for 15 days and are available for distribution to customers or internally on our intranet web-site which is used by the forecaster in creating medium range weather forecasts. The opportunity was also taken to integrate our internally produced ECMWF graphics with our new short-range EPS system, MOGREPS. This should enable us to produce seamless products spanning the short to medium-range.

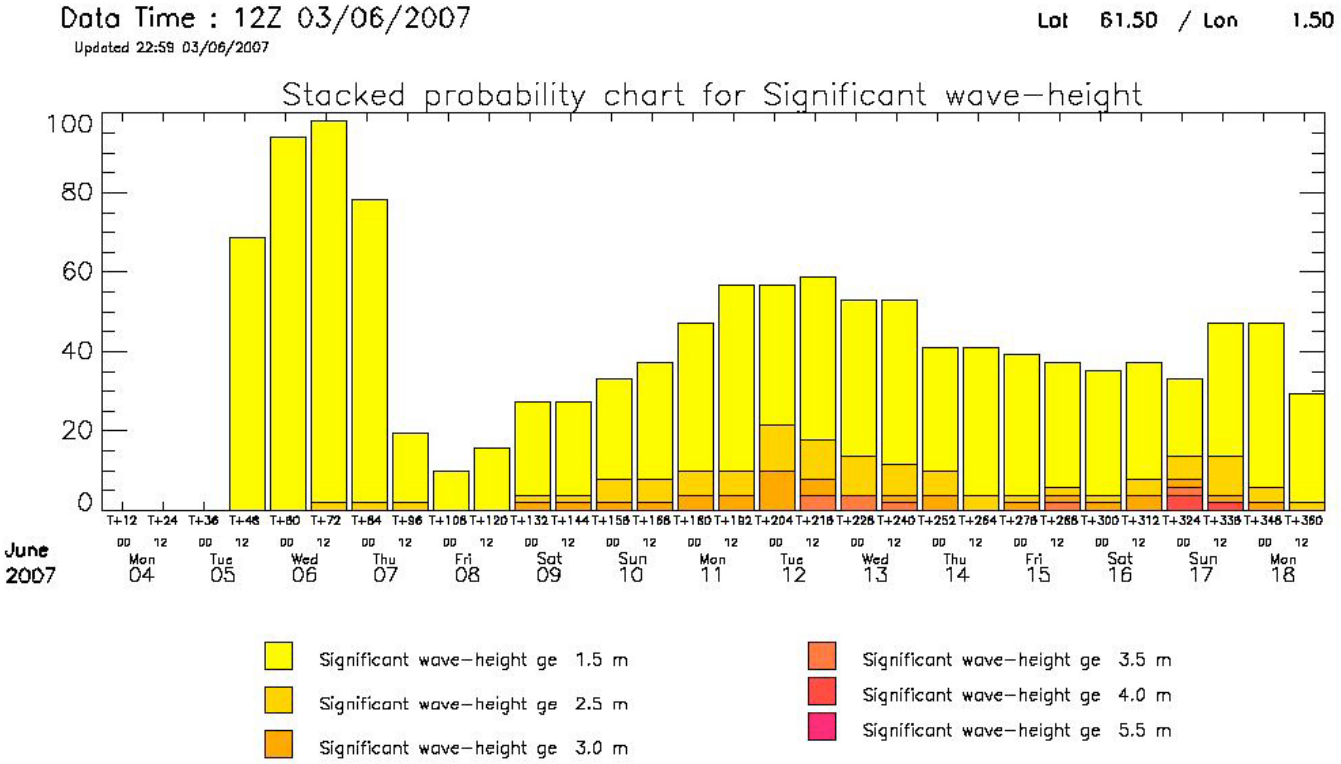

Fig. 1.1 Stacked probability chart for Significant wave-height extended to 15 days

2. Use and application of products

2.1 Post-processing of model data

2.1.1 Statistical adaptation

2.1.2 Physical adaptation

2.1.3 Derived fields

2.2 Use of products

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output

(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 2007 at T+72 and 120, and also for W250 at T+24. However, the Met Office PMSL and 500 hPa T+24 parameter results show a relative improvement in 2006 and are equal to ECMWF in January 2007 (but fall slightly behind again afterwards).

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

(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 used by the Met Office

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 two figures at ANNEX A 3.1.2(a) and 3.1.2 (b) show the differences between Met Office and ECMWF track forecast errors and skill scores against CLIPER. The graphs are for a global homogeneous sample of forecasts from the two models during the period 1994-2006. 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 consistently smaller (by an average 23%) and skill scores consistently higher (by an average 19%) than ECMWF. At the 48-hour lead time Met Office track forecast errors are smaller by an average 10% and skill scores higher by an average 6%. At the 72-hour lead time these figures (ANNEX A 3.1.2 (a,b) are 4% and 1% respectively. These results indicate that the short-range Met Office forecasts of TC track are superior to those of ECMWF.

At longer lead times (96 and 120 hours) skill scores against CLIPER are not available. The results for difference in track forecast errors show a much closer comparison than at shorter lead times. At 96 and 120 hours Met Office forecasts had smaller track forecast errors in six of the 13 years. On average, Met Office errors were 1.1% smaller at 96 hours, but 0.8% larger at 120 hours.

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. However, since then the ECMWF forecasts have continued to improve at lead times of 72 hours and greater such that the performance is now better than the Met Office. Conversely, at 24 and 48 hour lead times Met Office forecasts have improved relative to ECMWF. Hence, by 2006 there was a large differential between the relative performances at short and long lead times. At 120 hours ECMWF's track errors were 28% lower than the Met Office. However, at 24 hours the Met Office's track errors were 32% lower than ECMWF.

The ECMWF analysis error dramatically reduced in 2002-3 and it was speculated in previous years' reports that this was due to increasing usage of new satellite data sources. Since 2003 the difference between the Met Office and ECMWF analysis error (still around 100%) has remained relatively stable (see figure ANNEX A 3.1.2(b)).

3.1.3 Post-processed products

(i) Post-processing of VarEPS data

Site-specific forecasts are created from VarEPS data for sites covering the globe. A Kalman filter is used to correct site-specific biases for parameters such as 2m Temperature and 10m Wind-Speed. These forecasts are then calibrated using the Verification Rank Histogram method to re-weight the ensemble members. The post-processing systems are still being adapted to work completely with the full 15 days. All the data are stored within a database and used to generate products for customers. Figure 3.1.3 (i) shows an ESPgram of 2m Temperature for Heathrow. The software has been adapted to display the full 15 days if required. It is now possible to specify a start time and end time for the EPSgram (the example starts at T+72) so that only the timeframe of interest to the customer is displayed. The red dots on the EPSgram are the SYNOP observations which can be switched off if not required but are useful for monitoring the performance of the ensemble.

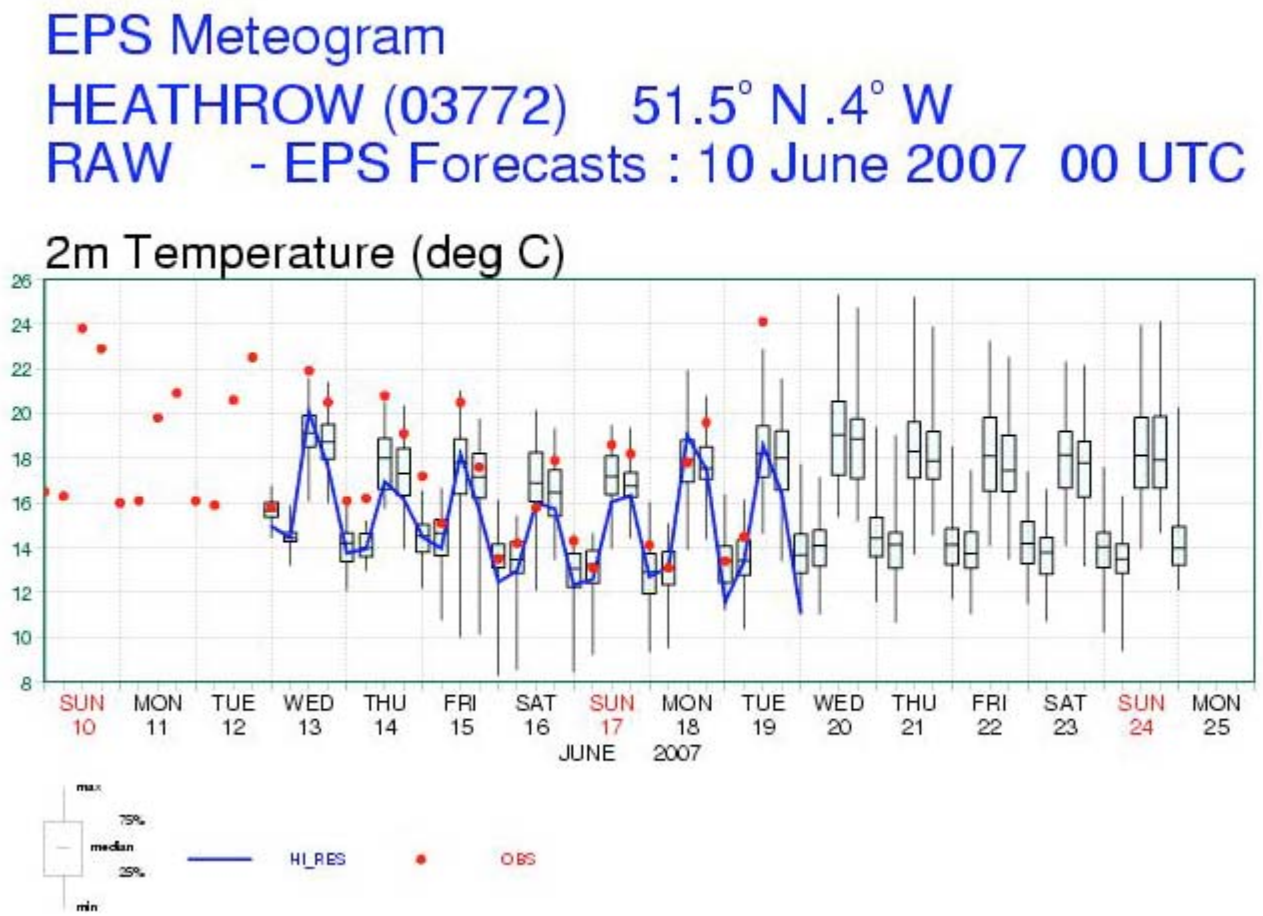

Fig. 3.1.3 (i) EPSgram of 2m Temperature for Heathrow

3.1.4 End products delivered to users

3.2 Subjective verification

3.2.1 Subjective scores

3.2.2 Synoptic studies, evaluation of the behaviour of the model

4. References to relevant publications

Chan, J.C.L. and **Kwok, R.H.F**. (1997). A diagnostic study on the improvement in tropical cyclone motion prediction by the UK Meteorological Office Global Model. *Met*. *Apps*. **Vol.4** pp.1-9.

Jolliffe, I.T. and **Stephenson D.B**. (Editors), 2003. Forecast Verification: *A Practitioner's Guide in Atmospheric Sciences*. Wiley, 240 pp

ANNEX A

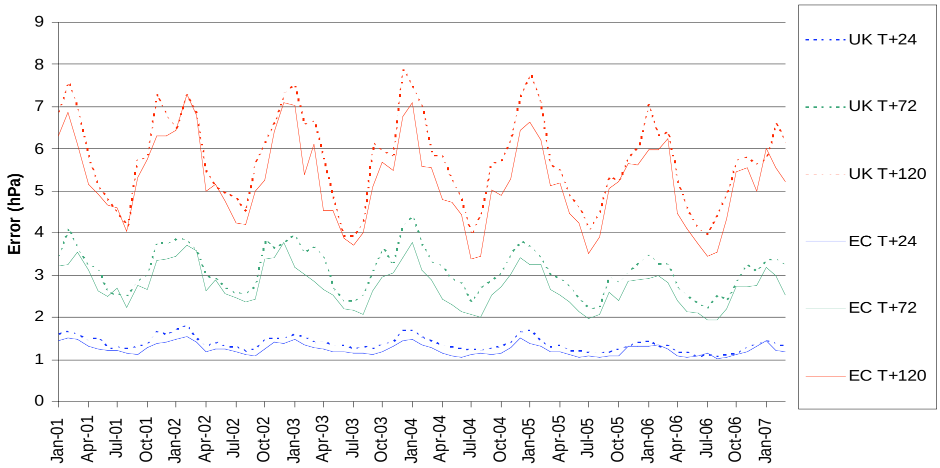

Fig. 3.1.1(i)a RMS errors of PMSL, verified against observations over W.Europe, N.Atlantic, N.America: Jan 2001 - Mar 2007, Met Office (dashed line) and ECMWF (solid line).

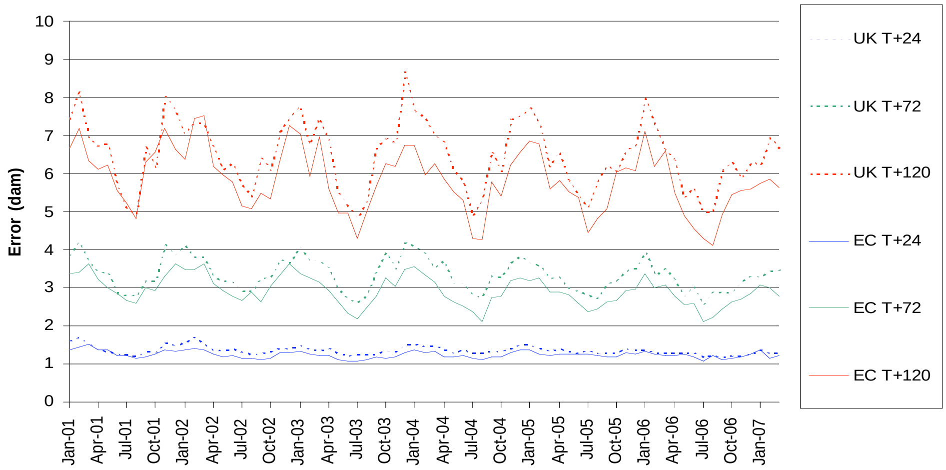

Fig. 3.1.1(i)b RMS errors of 500hPa height, verified against observations over W.Europe, N.Atlantic, N.America: Jan 2001 - Mar 2007, Met Office (dashed line) and ECMWF (solid line).

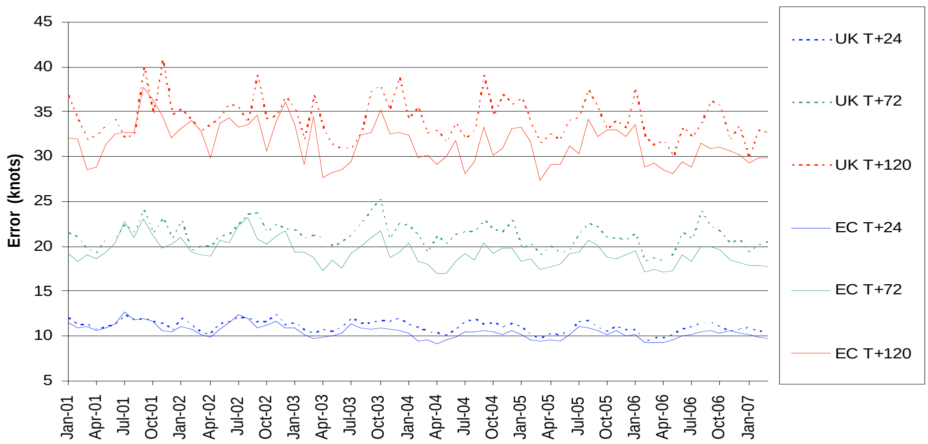

Fig. 3.1.1(i)c RMS vector wind errors at 250hPa, verified against observations over W.Europe, N.Atlantic, N.America: Jan 2001 - Mar 2007, Met Office (dashed line) and ECMWF (solid line).

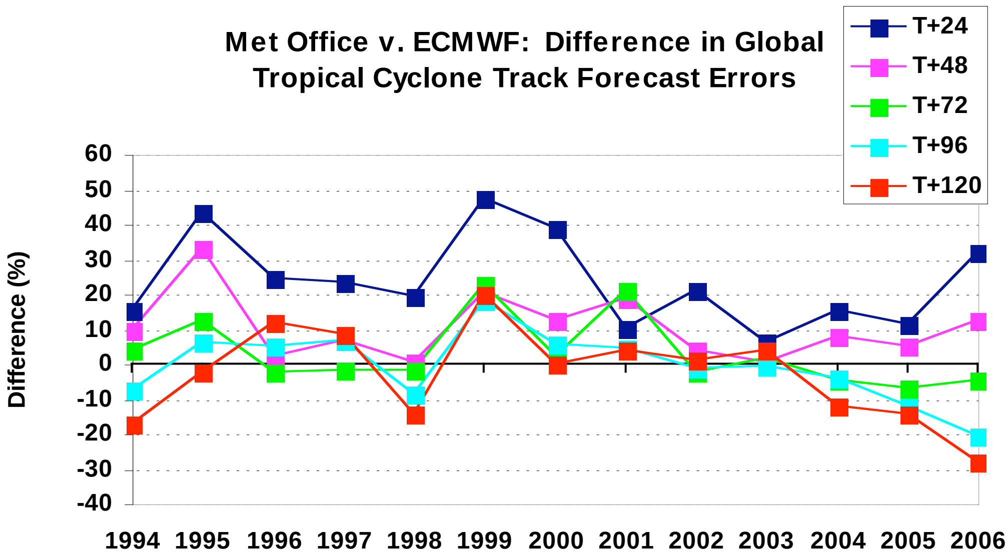

Fig 3.1.2(a)

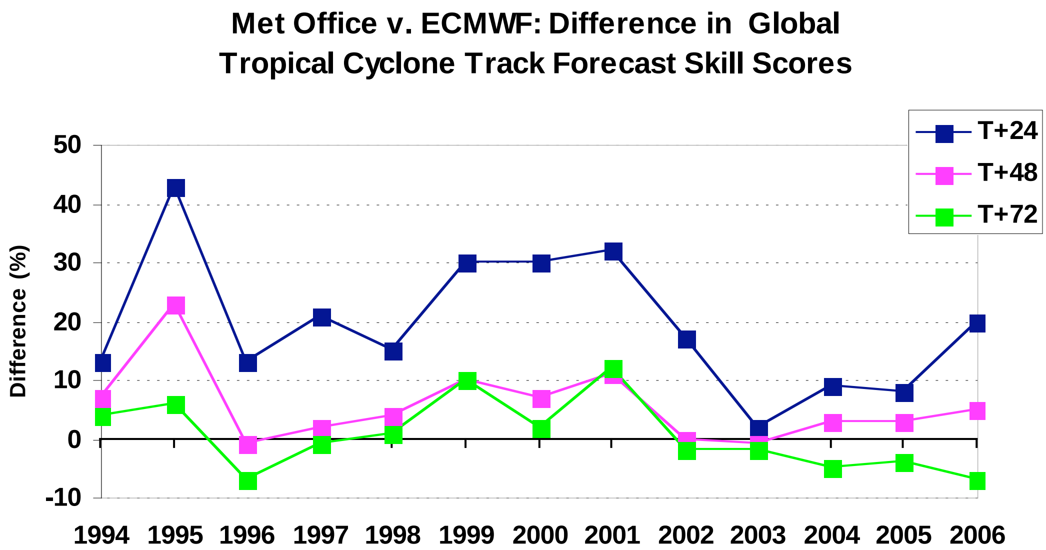

Fig 3.1.2(b)