Application and verification of ECMWF products in Croatia

August 2008

1. Summary of major highlights

At Croatian Met Service, ECMWF products are the major source of data used in the operational weather forecast, especially for medium- and long-range forecasts. Considering short range forecasts, ECMWF model is used along with Aladin-Croatia (ALARO) and DWD GME/LAM.

Regular verification is done exclusively by the point-to-point method, usually with synop data verified against nearest grid point of the model. However, other methods are occasionally also applied. Operational verification of DMO output and end-forecasts is still not fully implemented.

2. Use and application of products

2.1 Postprocessing of model output

Unfortunately, no significant improvement has been done in this area. A simple linear regression equation (MOS), applied to the 2m temperature forecast and precipitation probabilities, is in use for several years. Recently, new methods, such as neural networks, are being considered. However, standard applications, such as MOS, Kalman filtering or EPS clustering are still not implemented.

2.2 Use of products

Both 00z- and 12z run-products are fully used for several years. Due to better timing, emphasis is naturally still on 12z run, particularly in the morning shift, when major forecasts are being issued. 00z-run is consulted widely in the afternoon shift (for example, when issuing outlook for D2 to D4, weekly forecasts, television bulletin etc.) Still, most of the automated products are derived from 12z-run.

Long range forecasts are also very widely used. Monthly (4 week) forecast is regularly consulted, particularly when issuing monthly forecast for Croatia.

A new version of this product, issued twice a month, will be derived directly from ECMWF 4-week forecast.

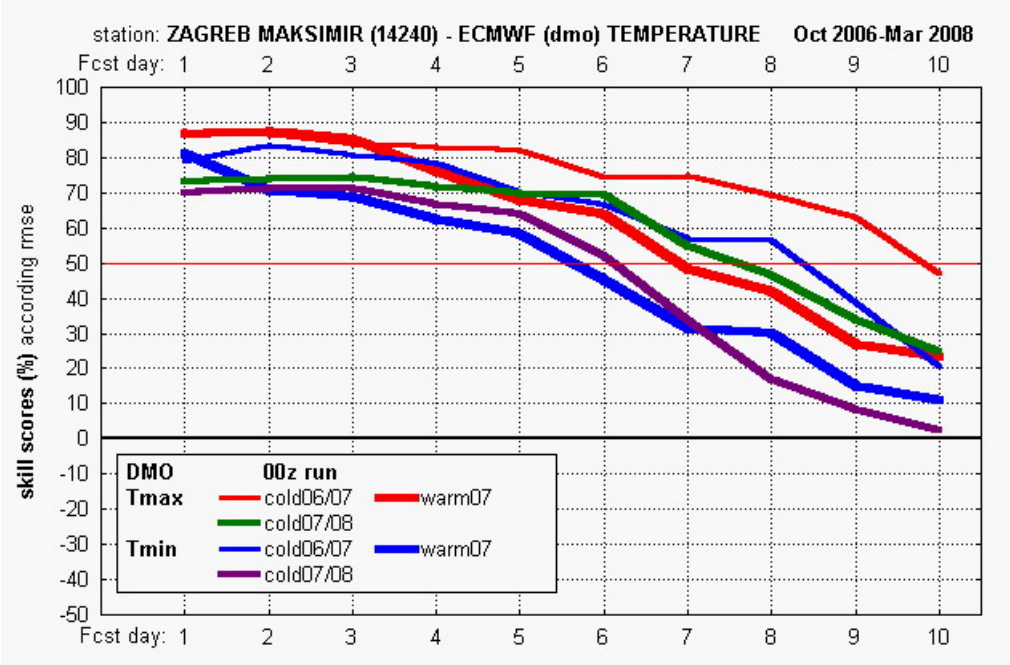
ECMWF seasonal forecast is a basis for regular textual sesonal forecast, issued every month.

Courtesy of Hungarian Met. Service, final products of MM5/Hungary model (nonhydrostatic, 2.5 km resolution, nested boundary contidions in ECMWF) are also available.

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output



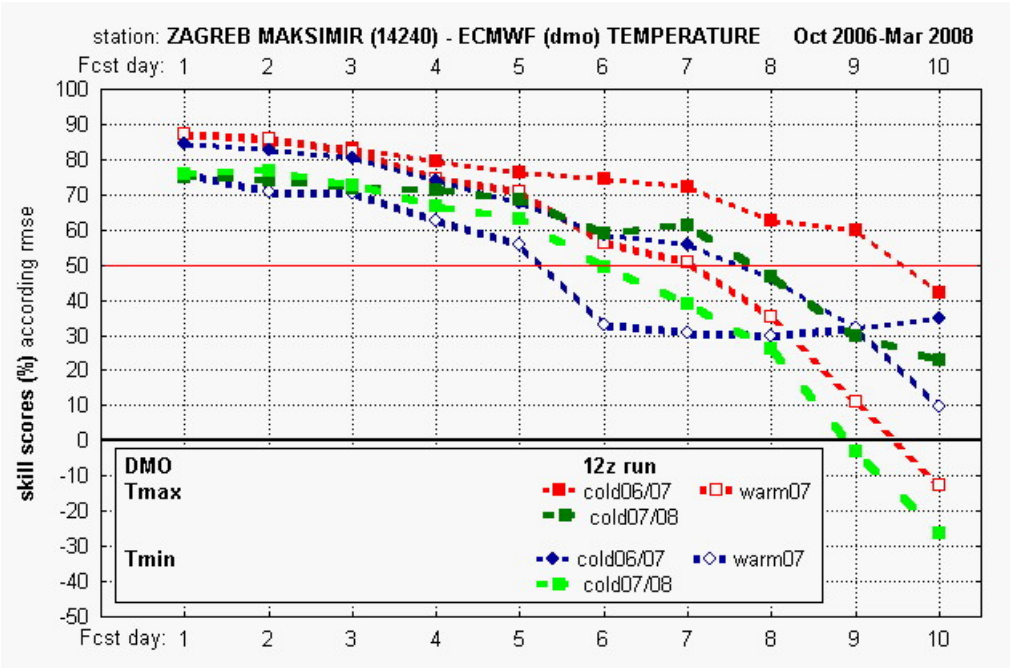


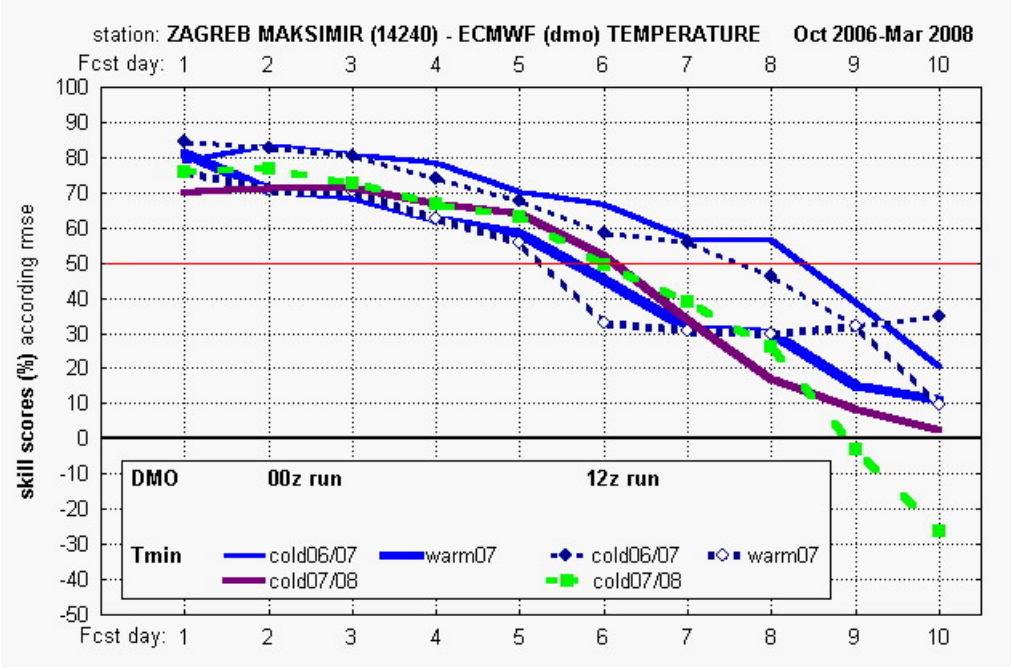
Fig. 1 and Fig. 2 Decrease of the 2m min and max temperature forecast skill, for 00z-run and 12z-run, respectively (Zagreb Maksimir).

Sample is, as recommended, divided in warmer (April to September) and colder (October to March) periods of the year. Skill, calculated against persistence forecast, is reaching zero value usually between D6 and D9.

It can also be noticed that skill for the last cold season (07/08) exhibits significantly worse skill than the previous one (06/07), for both runs.

Furthermore, skill of maximum temperature forecasts seems to be more skillful than minimum temperature forecast, which was not a typical behaviour of the model in the past.

For the first time both 00z- and 12z-runs are verified together (Fig. 3 and Fig. 4). Although forecasters' subjective verification suggested that the model outputs are very often differing significantly, objective verification hasn't confirmed that impression.



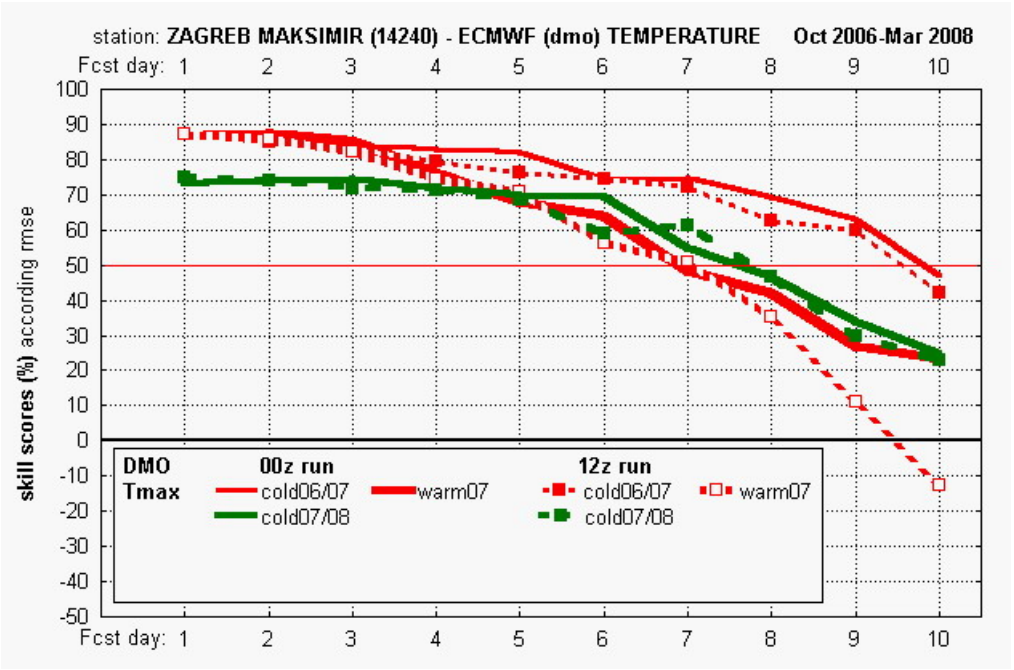


Fig. 3 and Fig. 4 Skill of 2m temperature forecast for both 00z and 12z runs, for minimum and maximum temperature, respectively (Zagreb Maksmir)

Figure 5 presents bias for the 12-hour precipitation forecast.

Results for year 2007 show that the forecast is not so much overbiased as in previous years. Significant daily variation of the bias is, however, still present. One should notice year 2005 (grey line) when daily variation was much less stressed.

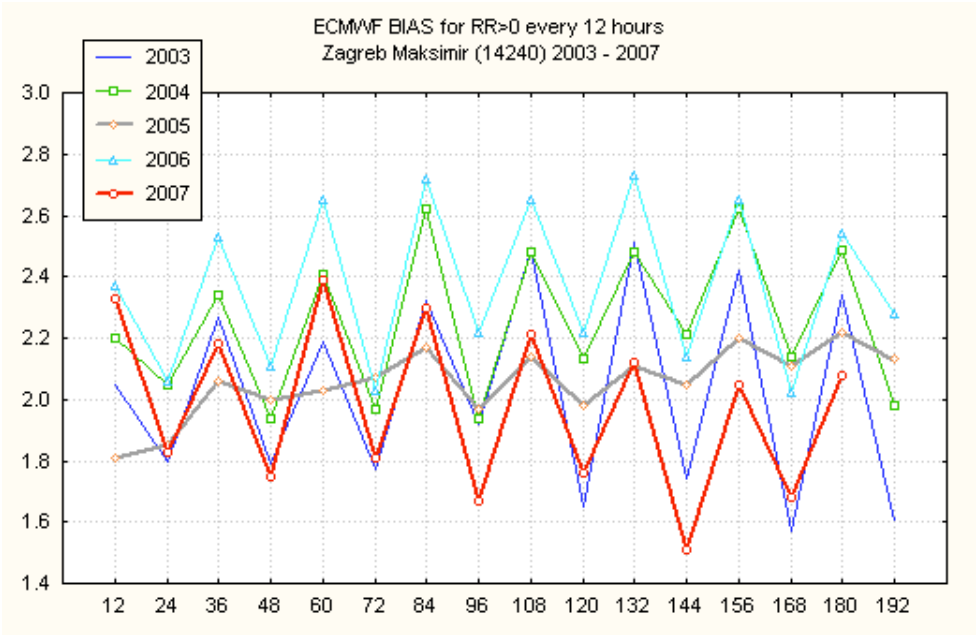


Fig. 5 Bias of 12-hour precipitation forecast for Zagreb Maksimir

Daily variation (before noon and afternoon) is noticeable also in the skill, but not so much as in previous years. Figure 6 shows decrease of Hansen Kuipers Skill score, approaching 0 usually at D8. Last year (bold red line) shows significantly improved skill in the middle range (from D3 to D8).

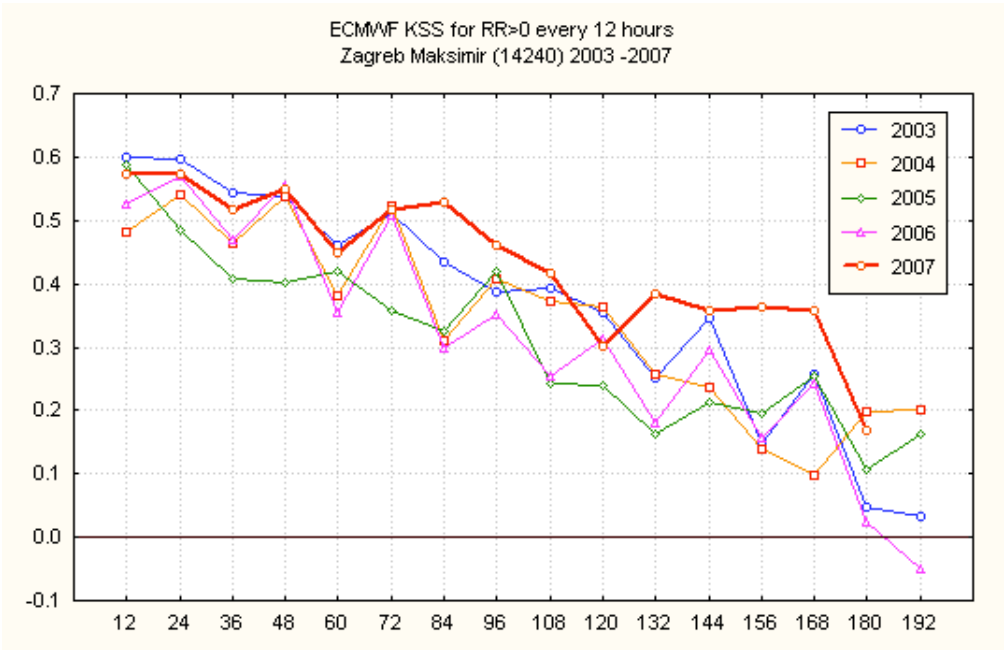


Fig. 6 Skill of 12-hour precipitation forecast for Zagreb Maksimir

3.1.2 ECMWF model output compared to other NWP models

ECMWF is regularly verified against other models, usually against Aladin Croatia (ALARO). Skill of the ECMWF model over Croatia is generally found to be comparable to that of the Aladin model.

Figure 7. shows comparison of 6-hour precipitation forecasts, for bias and Hansen Kuipers skill score. Analysis for last year shows ECMWF has slightly better skill (dashed blue lines). Considering bias, ECMWF (solid blue line) is significantly less overbiased, compared to Aladin (solid red line).

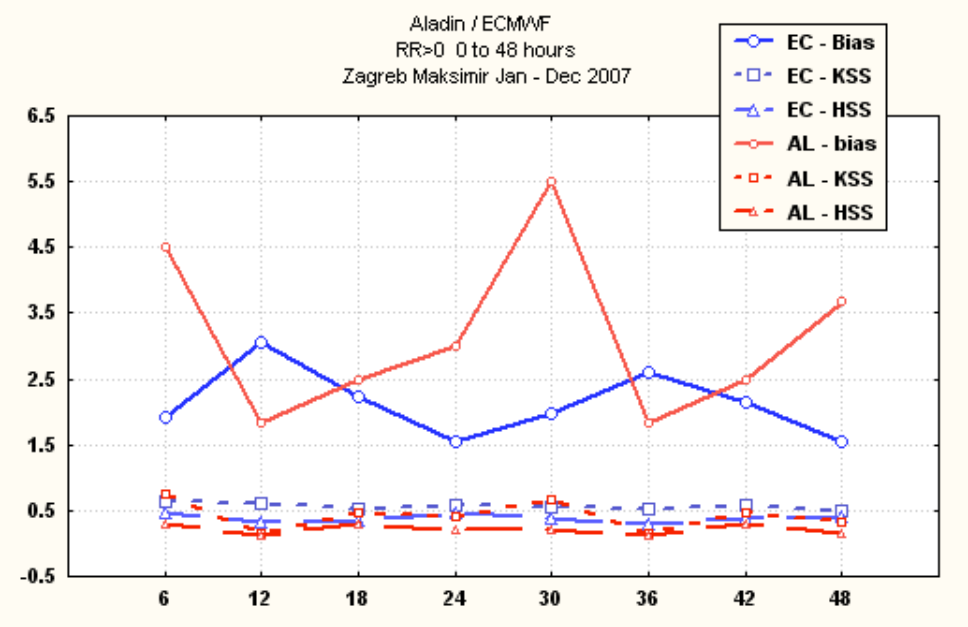


Fig. 7 Comparison of ECMWF and Aladin 6-hour precipitation forecasts (Bias, Heidke skill score and Hansen Kuipers skill score)

3.1.3 Post-processed products

None.

3.1.4 End products delivered to users

Various end products of NMS are regularly verified. Here we present verification of forecast issued daily for WMO web page. This forecast contains forecaster's prediction of minimum and maximum temperature for 5 Croatian cities, for 3 days in advance, as well as description of the weather.

Figure 8 shows mean square error of maximum temperature forecast for station Zagreb Maksimir, since 2003. Time series of MSE is quite unstable, particularly for D3, but D1 and D2 errors are constantly decreasing in last years.

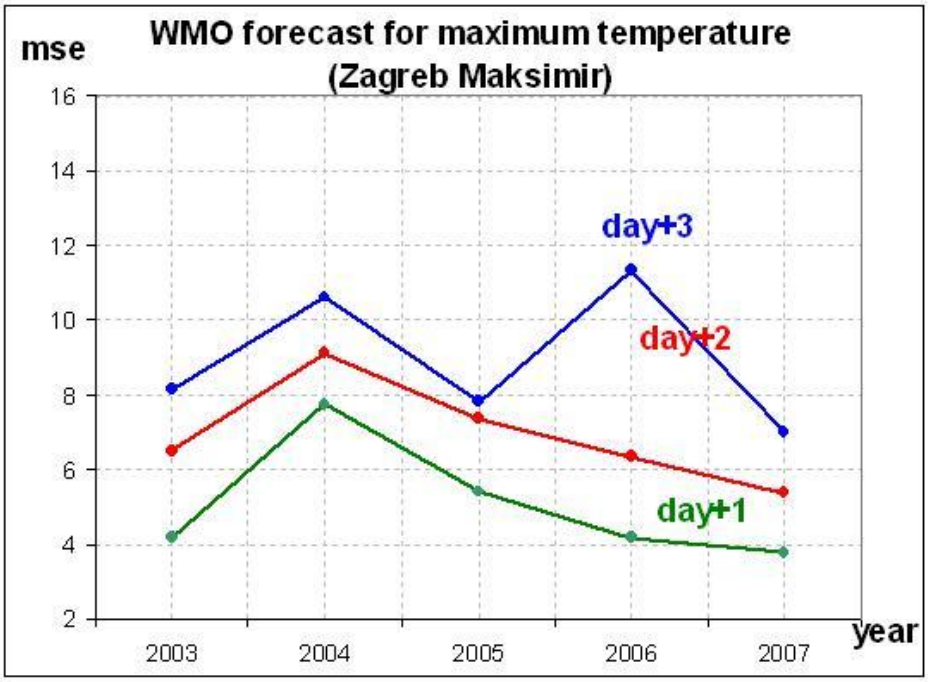


Fig. 8 MSE of end-forecast of maximum temperature for Zagreb Maksimir

3.2 Subjective verification

3.2.1 Subjective scores

3.2.2 Synoptic studies

Subjective verification of medium-range forecasts is done only occasionly, usually through case-studies, but no systematic verification has been done.

4. References

ECMWF, 2005: Verification of ECMWF products in Member States and Co-Operating States, Report 2005

Nurmi, P., 2003: Recommendations on the verification of local weather forecasts, ECMWF Technical Memorandum No. 430, December 2003, 19 pp.

Wilks, D. S., 1995., Statistical Methods in the Atmospheric Sciences. Academic Press, London, 464 pp