Application and verification of ECMWF products in Croatia - July 2007

By Lovro Kalin, Zoran Vakula and Josip Juras (Hydrological and Meteorological Service)

1. Summary of major highlights

At Croatian Met Service, the ECMWF products are considered as the most important source of data used for operational weather forecast, particularly for medium- and long-range forecasts. Both 00Z- and 12Z run-products are now equally used. At the short range, ECMWF products are used together with the Aladin Croatia/Alaro and the DWD GME/LAM.

Verification is mostly done by the point-to-point method; usually synop data are used to verify the nearest model grid point. Various objective scores are calculated, and an effort has been made lately to verify operational forecasts issued by duty forecasters.

2. Use and application of products

2.1 Postprocessing of model output

No significant improvement has been made in this area. A simple linear regression equation (MOS), applied to the 2m temperature forecast and precipitation probabilities, is in use for several years. The work is still in progress to utilise different applications, such as MOS, Kalman filtering, EPS clustering.

2.2 Use of products

The 00Z-run products, previously used only partly, are now fully implemented in operational forecast, particularly in the afternoon shift. Objective comparison of different ECMWF runs is not available; however, subjective impression is that model outputs very often give significantly different "scenarios", even for the range from D3 to D7 (particularly 2m - temperature and precipitation).

Long range forecasts are also widely used. Monthly (4 weeks ahead) forecast is regularly consulted, particularly when issuing monthly forecast for Croatia. ECMWF seasonal forecast is a basis for regular seasonal forecast, issued once (?) every month.

Courtesy of Hungarian Met Service, final products of the MM5/Hungary model (nonhydrostatic, 2.5 km resolution, nested in ECMWF boundary conditions) are in use in operational forecast for several months now. It is still in testing phase, but initial experience is positive.

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output

Fig. 1 and Fig. 2 show the 2m min and max temperature forecast skill against increasing forecast range. The two periods are shown, the warm (April to September) and the cold period (October to March), in order to point to usually better skill during the cold period of the year.

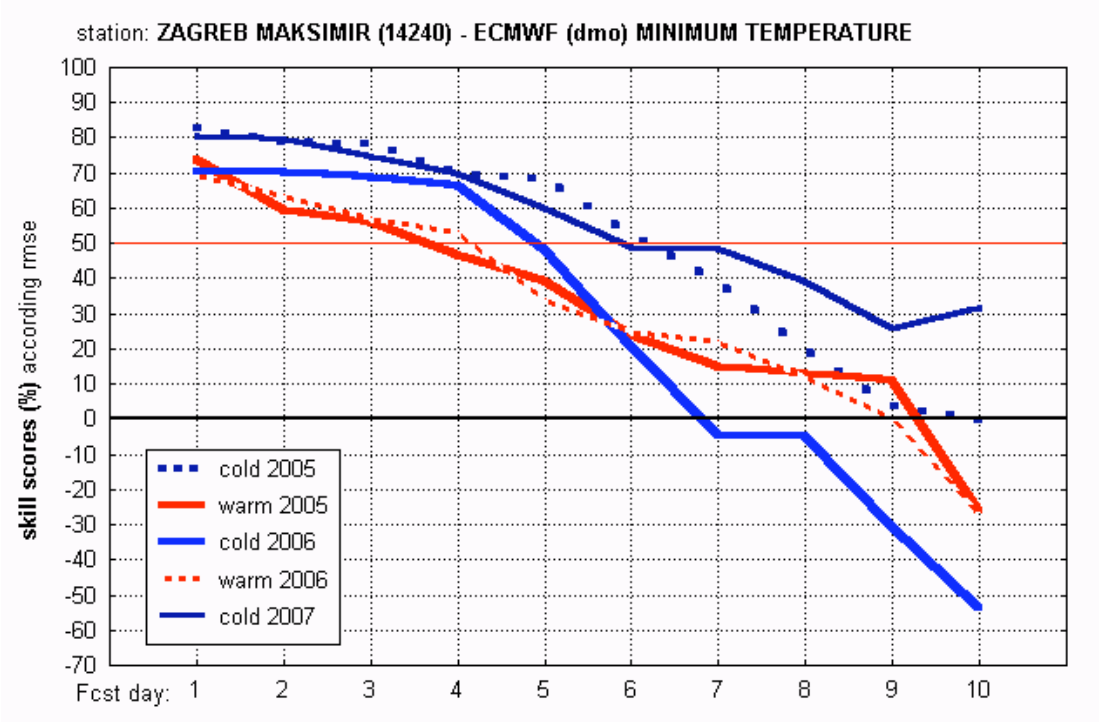

Fig. 1 Skill of 2m minimum temperature forecast (Zagreb Maksimir)

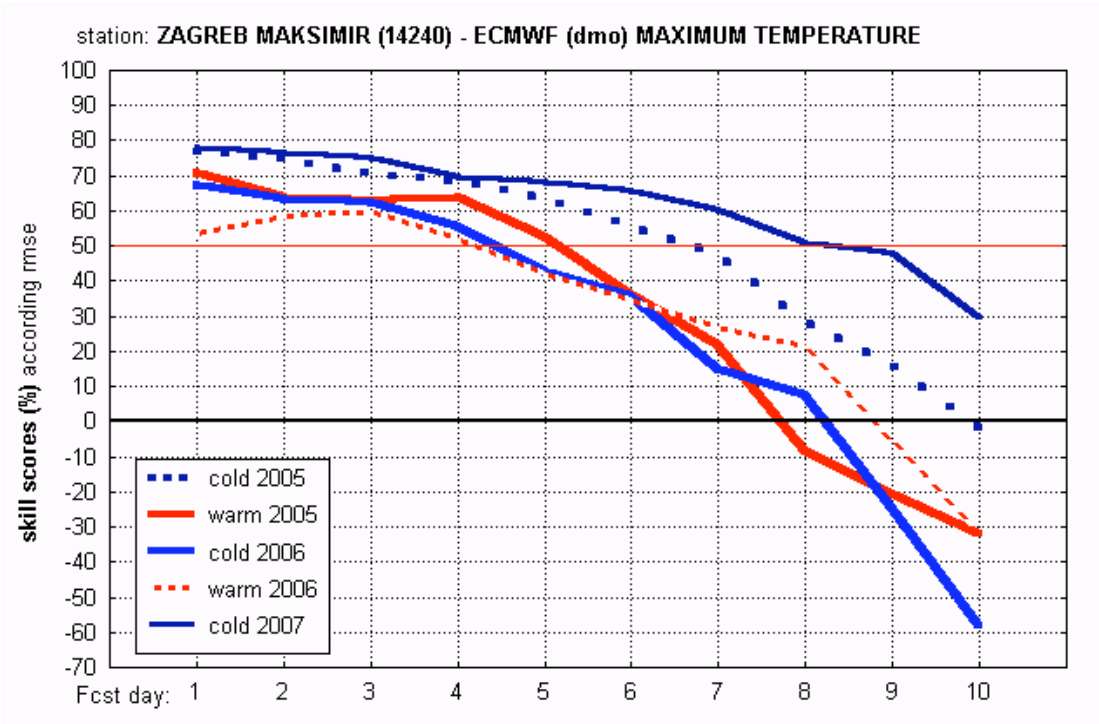

Fig. 2 Skill of 2m maximum temperature forecast (Zagreb Maksimir)

A decrease in skill is seen, approaching zero for the period between D7 and D10.This feature is not obvious for the cold period 2005/2006, with the skill better up to D5, but more rapidly decreasing afterwards. One should notice relatively good results for the most recent cold period (2006/2007). Climatologically, this was extremely warm season, in most Croatian regions the warmest on the record.

In the above examples skill of the ECMWF forecast is calculated against persistence forecast. Another possibility is to take climatology, or combination of climatology and persistence, called "damped persistence" or CLIPER forecast. Fig. 3 shows mean square error (MSE) of such forecasts, compared to ECMWF.

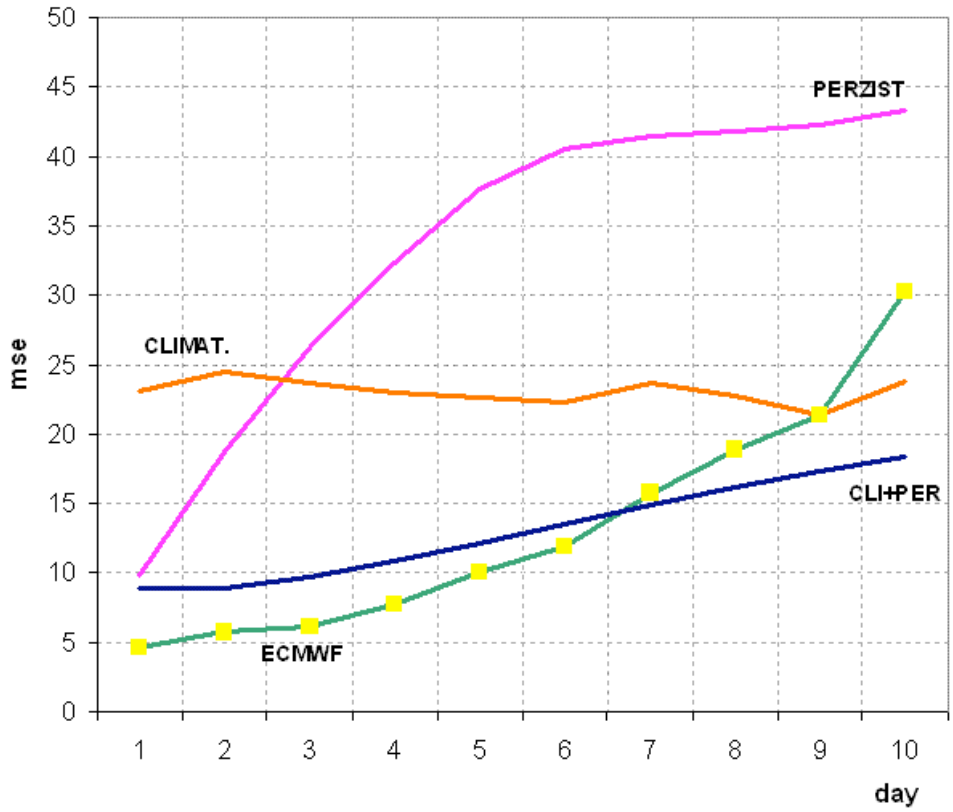

Fig. 3 Mean square error of ECMWF maximum temperature forecast, compared to climatology, persistence and CLIPER forecast, for Zagreb Maksimir

It can be noticed that, up to D7, MSE for ECMWF forecast is smaller when compared to any of these reference forecasts, but then exceeding MSE of CLIPER forecast. In terms of forecast skill (ECMWF against different reference forecast), the results are shown in Fig. 4. ECMWF skill against climatology approaches zero at D9, and against CLIPER at D7.

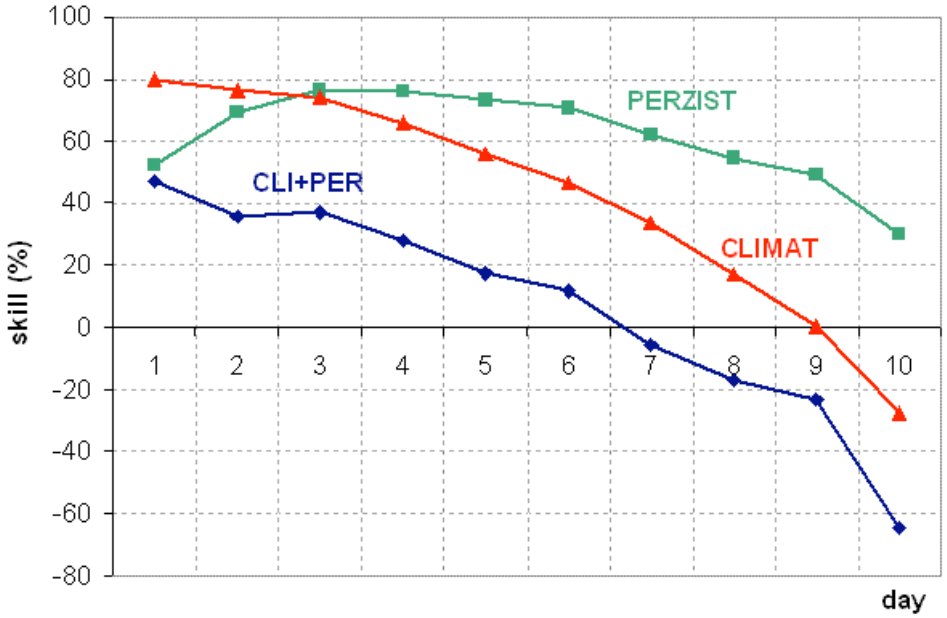

Fig. 4 Skill of ECMWF maximum temperature forecast against different reference forecasts (climatology, persistence, CLIPER), for Zagreb Maksimir

Fig. 5 shows biases for the 12-hour accumulated precipitation forecast over various forecast ranges. Results for year 2005 (green line) suggest a decrease of usually significant biases in daily variation. However, the calculations made for 2006 do not confirm such a tendency. Furthermore, the 12-hour accumulations show larger biases than in 2005.

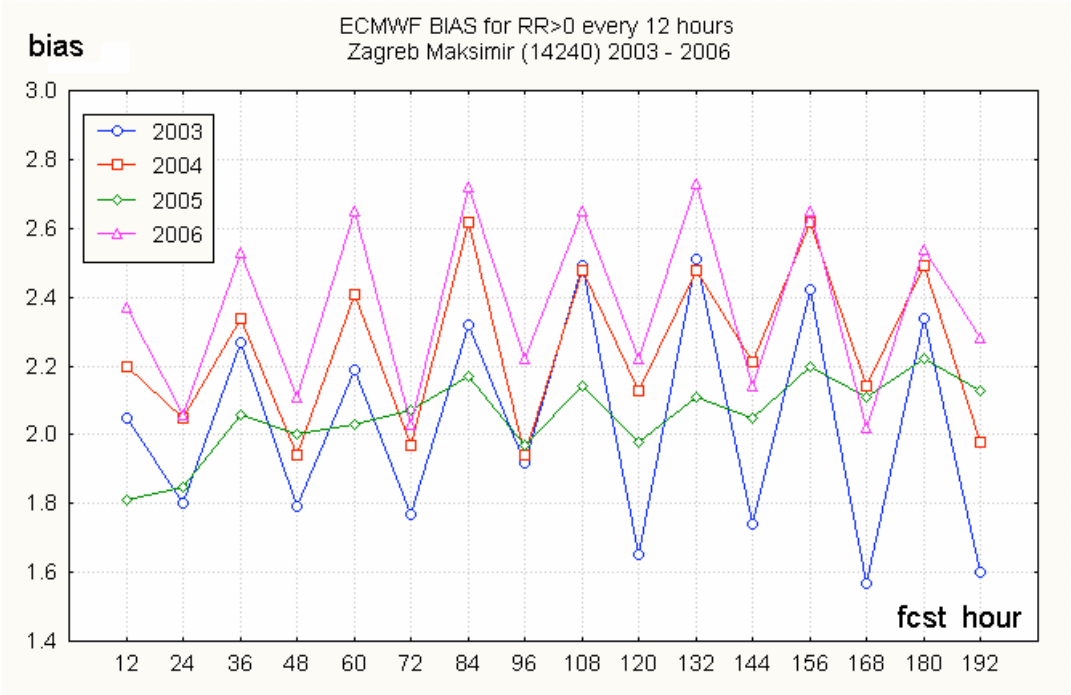

Fig. 5 Bias of 12-hour precipitation forecast for Zagreb Maksimir

Daily variation (before noon and afternoon) is noticeable also in the skill. Fig. 6 shows a decrease of the Hansen Kuipers Skill score, approaching zero at D8.

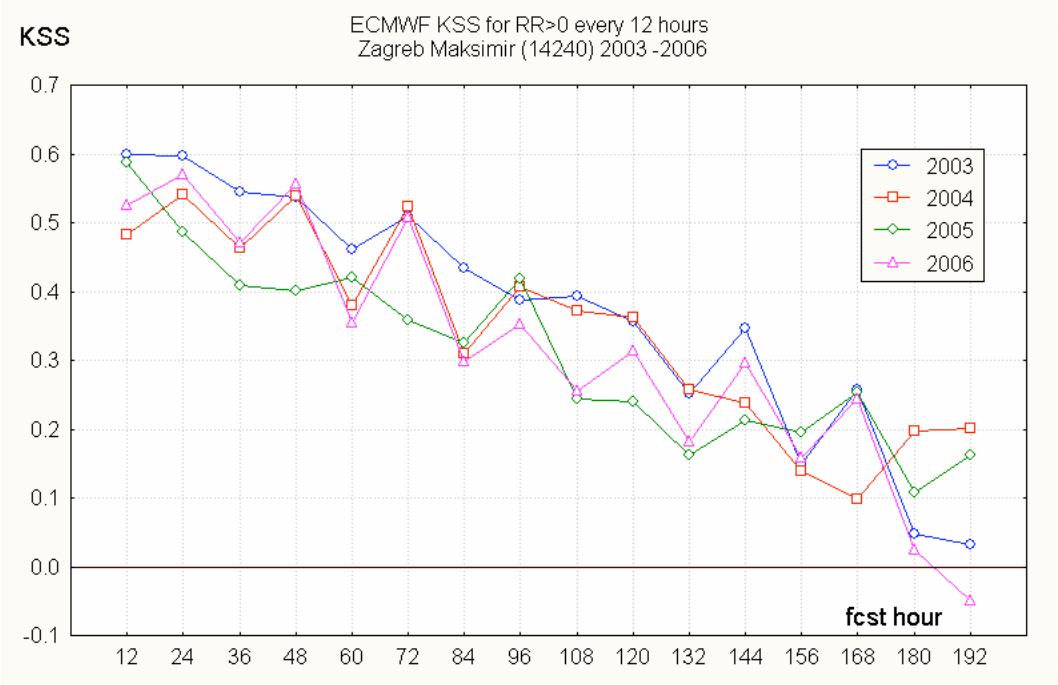

Fig. 6 Hansen Kuipers Skill score of 12-hour precipitation forecast for Zagreb Maksimir

3.1.2 ECMWF model output compared to other NWP models

Comparison of ECMWF forecasts against other models (usually Aladin Croatia) is carried out regularly. Skill of the ECMWF model over Croatia is generally found to be comparable to that of the Aladin model.

3.1.3 Post-processed products

None.

3.1.4 End products delivered to users

Several end products of the Croatian NMS are regularly verified. Here we present verification of temperature forecast issued daily for the WMO web page. This forecast started in 2002, containing the duty forecaster's prediction of minimum and maximum temperature for 5 Croatian cities for 3 days in advance, as well as the description of the weather.

Fig. 7 shows mean absolute error (MAE) of minimum temperature forecast for Zagreb Maksimir since 2003. Time series of MAE for D1 is quite stable, but variation increases for D2 and D3. It can be noticed also that for last year D3 forecast has better skill than D2 forecast.

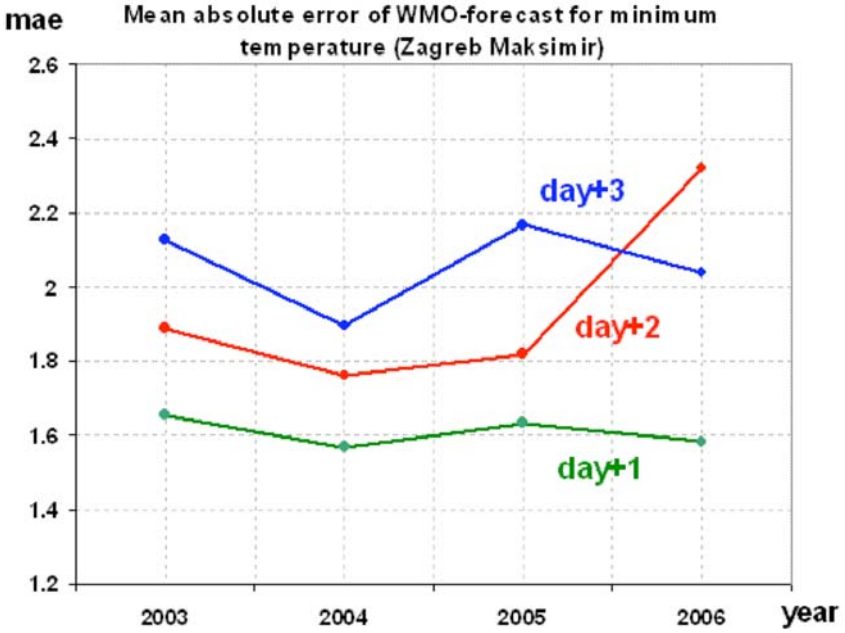

Fig. 7 MAE of end-forecast of minimum temperature for Zagreb Maksimir

Errors and their variation are, as expected, larger for maximum temperature forecast (Fig. 8). For last year (climatologically extremely warm), D1error even exceeded D2 error.

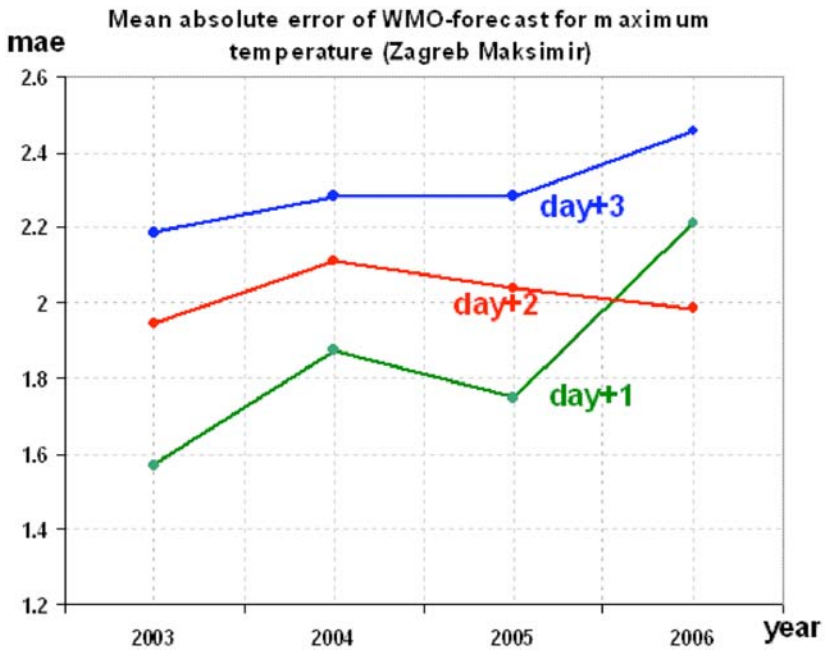

Fig. 8 MAE of end-forecast of maximum temperature for Zagreb Maksimir

3.2 Subjective verification

3.2.1 Subjective scores

3.2.2 Synoptic studies

Subjective verification of medium-range forecasts is done only occasionally, usually through various case-studies, but no systematic verification has been made. The conclusion is that forecasts are usually good, even in the short range. As for long range forecasts, they are improving in the past years, especially for monthly forecast (2nd and 3rd week of the forecast).

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