Application and verification of ECMWF products 2011

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1. Summary of major highlights

At Croatian meteorological service, ECMWF products are still considered as the major source of information in the operational weather forecast, particularly for medium- and long-range forecasts. In the recent years our service introduced long range forecasts as end products: a new monthly (4 week) forecast, based on direct model output by ECMWF, as well as a 3-month forecast, based on ECMWF seasonal forecast. The emphasis in this paper will be on long term forecasts verification.

Regular verification is traditionally done by the point-to-point method, with synop data verified against nearest grid point of the model.

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

Introduction of Kalman filter of 2m-temperature has experienced some difficulties, so no significant improvement has been achieved in the last year.

2.1.2 Physical adaptation

Including limited-area models, hydrological models, dispersion models etc. using ECMWF model data as input

2.1.3 Derived fields

Including post-processing of EPS output e.g. clustering, probabilities

2.2 Use of products

ECMWF products are widely used in daily operational duties, particularly for medium and long range forecasts. For short range, particularly severe weather and warnings, emphasis is put to the high resolution model (ALADIN).

For medium range, appreciation of ensemble approach is constantly increasing.

For long range, ECMWF forecasts are practically the only source. Furthermore, monthly and seasonal forecasts, issued regularly at our service, are based on ECMWF direct model output, with the comment of the forecaster.

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

No significant verification is carried out for medium range ensemble forecasts.

Deterministic medium range forecasts are verified regularly, particularly for temperature and precipitation. However, results for year 2010 don't differ significantly from those from past years, and we won't present them in this paper. Some regular features can be pointed, such as strong daily cycle for both parameters, and overestimation of daily precipitation (see previous reports). For many parameters, skill of the forecast usually decreases to zero between D+7 and D+10 forecast range.

A more extensive verification is carried out for long range forecasts;

For monthly (4 weeks) forecast, comparison of forecasted and observed mean weekly temperatures is displayed in pictures bellow. General underestimation of temperature can be observed on Figure 1. Furthermore, the mean error is the largest for week 1, then decreasing for week 2 and asymptotically approaching some value (around -0.5 °C) for week 3 and 4. Still, the skill of the forecasts (verified against climatology as reference) is constantly decreasing, with positive skill for week 1 and 2, some skill for week 3, and low or negative skill for week 4 (Figure 2).

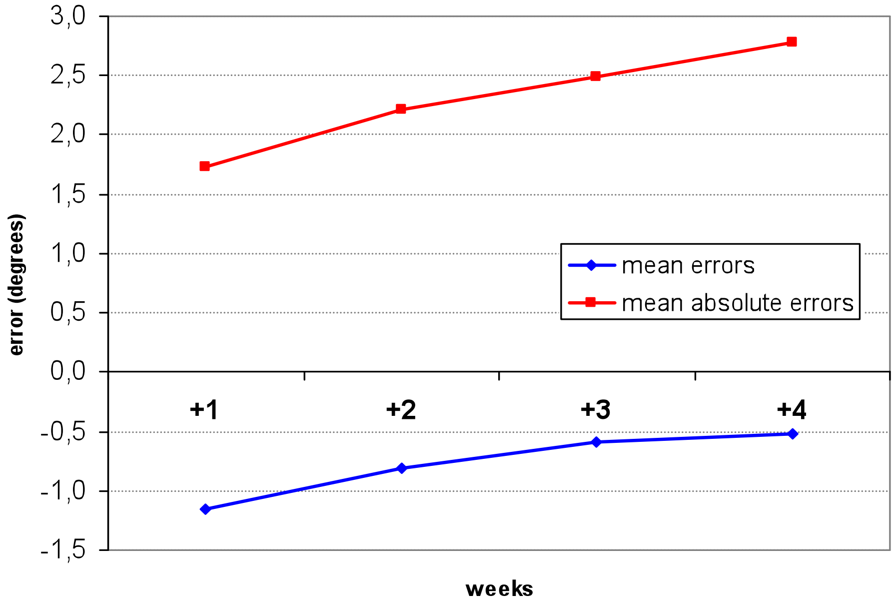

Figure 1 Mean error (ME) and mean absolute error (MAE) of mean weekly 2m-temperature forecast (ECMWF monthly forecast system) for period from 1st July 2010 to 1st June 2011 (station Zagreb Maksimir).

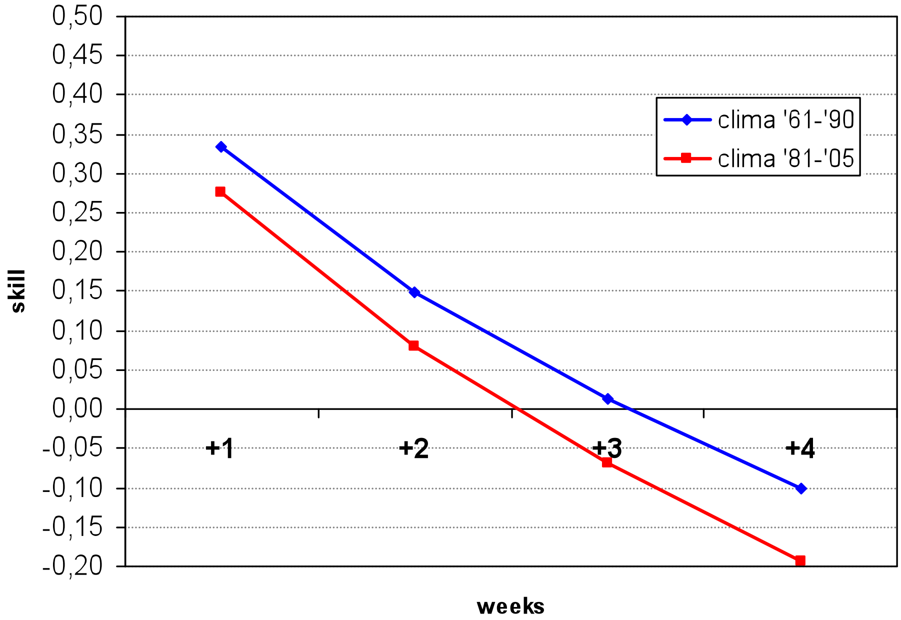

Figure 2 Skill of mean weekly 2m-temperature forecast, verified for two different climatologies (ECMWF monthly forecast system)) for period 1st July 2010 to 1st June 2011 (station Zagreb Maksimir).

Verification for individual days (up to day+32) exhibits a peculiar bias oscillation, with period of 7 days (see report 2010). Another, maybe more appropriate method, is presented in figures bellow. We try to examine how the forecasting system is able to resolve relatively warm and cold events (in this case, weeks), represented by positive/negative mean weekly temperature anomaly. For temperature (Figure 3), success rate is very high for week 1, significantly lower for week 2, and reaches 50% success rate for week 3. For week 4, rate is even lower. Calculation for precipitation anomalies – with similar results – is given in Figure 4.

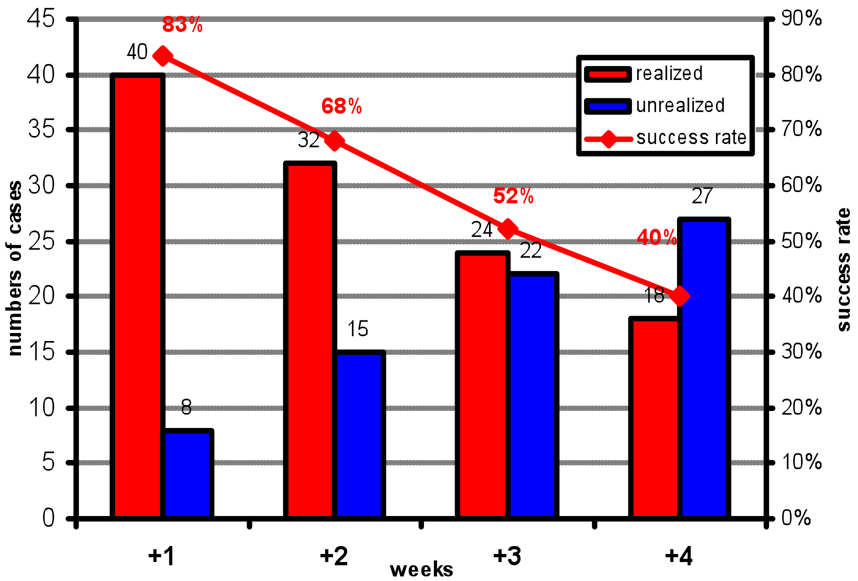

Figure 3 Number of realized and unrealized forecasts of positive/negative weekly temperature anomaly (ECMWF monthly forecast system) for period 1st July 2010 to 1st June 2011 (station Zagreb Maksimir – climatology 1981-2005).

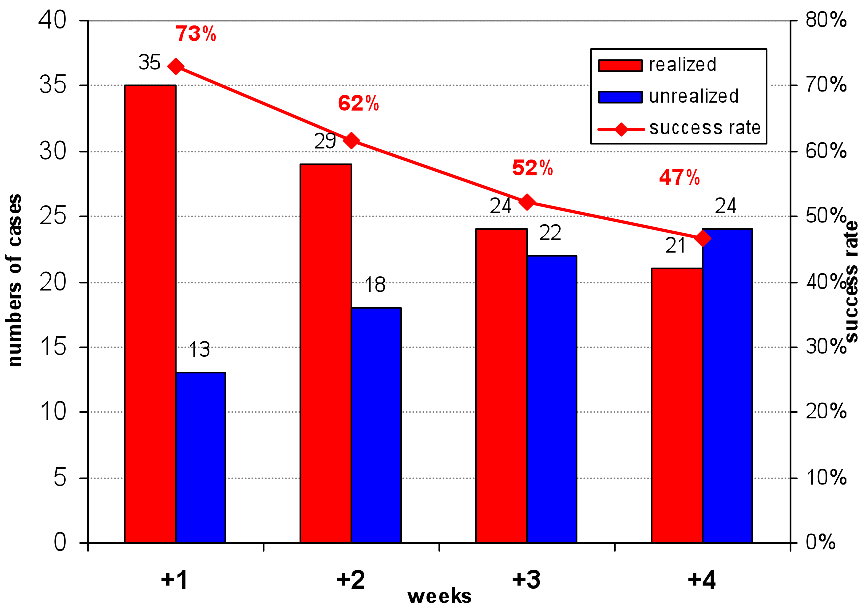

Figure 4 Number of realized and unrealized forecasts of positive/negative weekly precipitation anomaly (ECMWF monthly forecast system) for period 1st July 2010 to 1st June 2011 (station Zagreb Maksimir – climatology 1981-2005).

Seasonal forecast is also a very important product, and it is based on direct model output of ECMWF seasonal forecasting system. General features of verification (mostly done for temperature) such as relatively low variation of forecasts, compared to observed data ("low signal"), and general underestimation of temperature ("too cold") were described in previous report. Figure 5 presents mean absolute error of forecasted monthly temperature anomalies (based on two different climatological periods), depending on forecast range (from month+1 to month+6). No significant change of error through the whole forecasting period can be observed. Scores based on climatological period 1961-1990 seem to be more valuable than for 1981-2005 period.

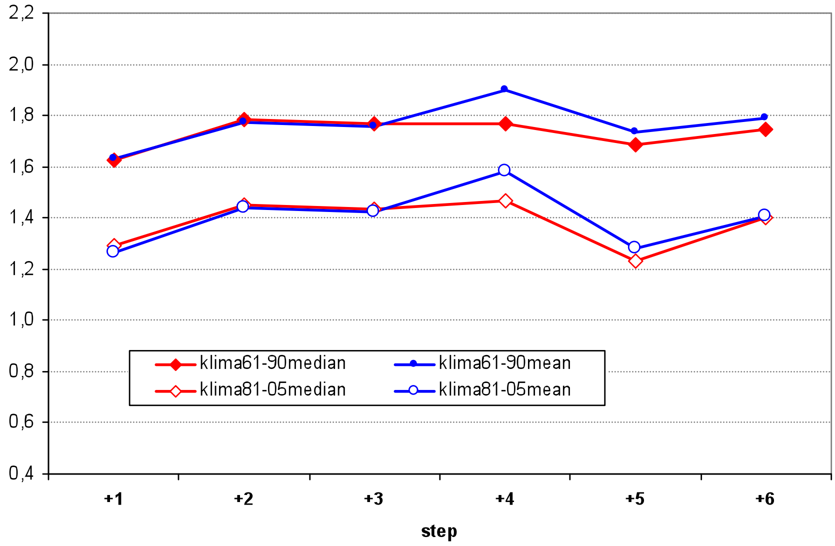

Figure 5 Mean absolute error of monthly temperature anomaly (ECMWF monthly forecast system) for year 2010 (station Zagreb Maksimir), with respect to different forecast range (month+1 to month+6)

Scores can be also presented in terms of the skill (Figure 6) and exhibit somewhat worse results than for previous years. Compared to climatology reference, forecast for month+1 seems to have skill around zero, and than degrades for month+2 and month+3. However, for period month+4 to month+6 the skill improves.

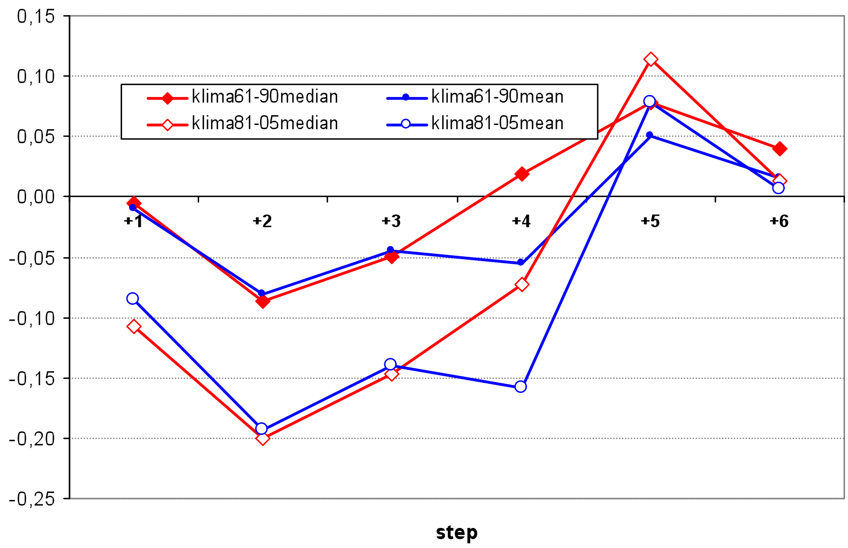

Figure 6 Skill of monthly temperature anomaly forecast (ECMWF monthly forecast system) for year 2010 (station Zagreb Maksimir), with respect to different forecast range (month+1 to month+6).

Alternative methodology - analogue to monthly verification – was also done. Three bins are made: events (months) with absolute value of temperature anomaly less than 0.2 degrees are regarded as 'normal'; months with anomaly larger than 0.2 degrees are considered as 'warm', and those with anomaly less than -0.2 are considered as 'cold'. Results are displayed in Table 1.

	month	1				month	2				month	3	
fc\obs	warm	0.2+/-	cold		fc\obs	warm	0.2+/-	cold		fc\obs	warm	0.2+/-	cold
warm	3	0	2		warm	3	0	2		warm	4	0	2
0.2+/-	6	0	0		0.2+/-	5	0	0		0.2+/-	5	0	0
cold	0	0	1		cold	1	0	1		cold	0	0	1

Table 1 3x3 contingency tables for seasonal (3 month) forecast, based on number of forecasts and observed events (months) divided into 3 classes (Central Croatia region, 2010)

As for previous years, the reliability of the forecast can be argued by the fact that in most of the cases when warm event was forecasted, it really occurred. On the other hand, warm weather is forecasted in general, but in year 2010 – unlike in 2009 – we experienced 3 cold months.

3.1.2 ECMWF model output compared to other NWP models

ECMWF forecasts are often 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 (see previous reports).

3.1.3 Post-processed products

None. Post-processing of ECMWF forecasts is still in development.

3.1.4 End products delivered to users

Seasonal and monthly forecasts delivered to users are derived from ECMWF direct model output. See section 3.1.1.

3.2 Subjective verification

3.2.1 Subjective scores (including evaluation of confidence indices when available)

3.2.2 Synoptic studies

Subjective verification of ECMWF forecasts is done only occasionally, usually through individual studies, but no systematic verification has been carried out. For some general subjective remarks see previous reports.

4. References to relevant publications

Application and verification of ECMWF products 2010 (Croatia)

(http://www.ecmwf.int/products/greenbook/2010/pdf/Croatia_GB_2010.pdf)