Application and verification of ECMWF products 2010

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1. Summary of major highlights

At DHMZ, ECMWF products are regarded as the major source of information in operational weather forecasting, particularly for medium- and long-range forecasts. This year a new product - monthly (4-week long) forecast - based on the direct model output from ECMWF has been established. The 3-month forecast, based on ECMWF seasonal forecast, is also issued. Therefore, the emphasis in this report is on the long-term forecasts verification.

Regular verification is usually done by the point-to-point method, with the SYNOP data used to verify the nearest grid point of the model.

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

This year the testing version of the Kalman filter for 2m-temperature has been initiated.

2.1.2 Physical adaptation

2.1.3 Derived fields

2.2 Use of products

ECMWF products are used daily in the operations, particularly for medium and long range forecasts. For severe weather, emphasis is on the high resolution model (ALADIN).

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

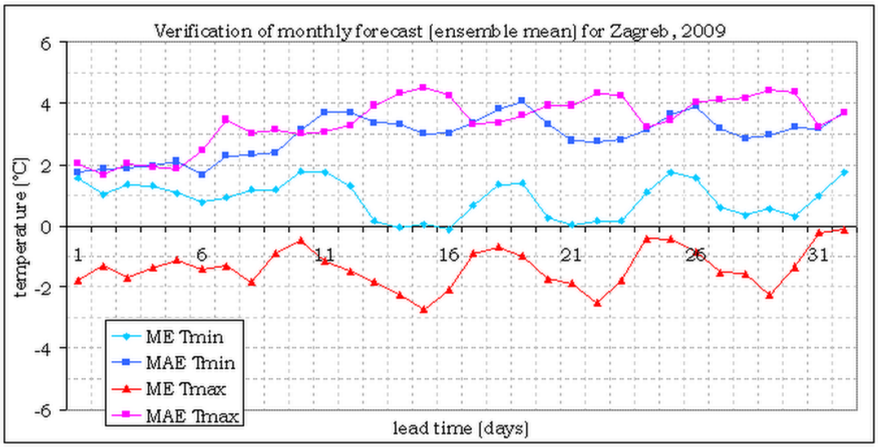
No significant verification is done for ensemble forecasts.

Verification of the medium-range deterministic forecasts is done regularly. Results for the year 2009 show no significant change compared to the previous years, and it is presented briefly in this report. For the 2m temperature and precipitation, skill of forecast typically decreases to zero between D+7 and D+10. Other usual features, such as strong daily cycle in both parameters and an overestimation of total daily precipitation, are also noticed.

A new monthly (4-week long) forecast is established at the beginning of this year. Forecast is issued twice a month for the 7 Croatian regions, and it is based on the ECMWF direct model output, with a short comment. It includes the time-series of temperature and precipitation, as well as expected weekly anomalies with respect to ensemble median.

The behaviour of 2m-temperature forecast is presented in the figures bellow. It can be noticed that the skill of the forecast (MAE) starts to decrease significantly in the range of D+6, and then persists to the end of the forecasting period. Skill of the forecast is also affected by a pronounced bias, particularly by a strong underestimation of max. temperature. An “oscillation” in the forecast bias with the period of 7 days can also be noticed. For the coastal station Zadar (Fig. 1b) the mean error is larger than for the continental station Zagreb. This is probably due to a relatively large orographic difference between the model grid point and the real world.

a)



b)

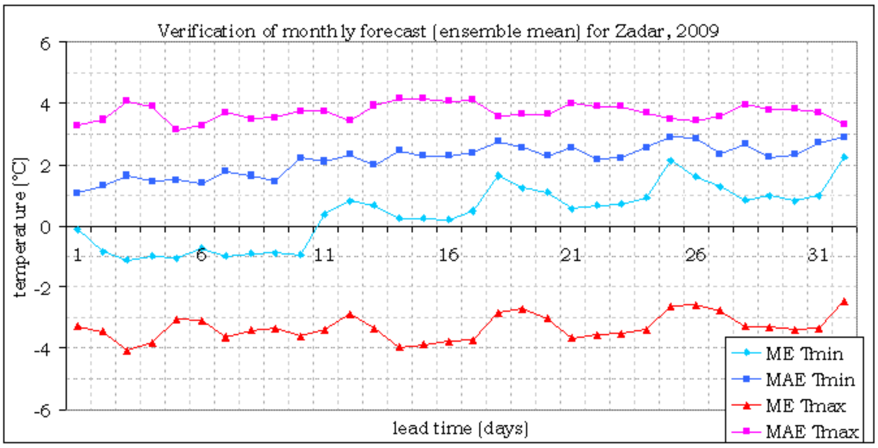


Figure 1. Mean error (ME) and mean absolute error (MAE) of minimum and maximum 2m-temperature forecast (ensemble mean) for the range of 32 days, for stations a) Zagreb (inland) and b) Zadar (coast).

For temperature, an additional approach was also applied. Based on forecasted and observed temperature anomalies for the Zagreb station, a contingency table is calculated for each week of the forecasting period (Table 1). Data is divided into the 3 classes: ‘warm’, ‘average’ and ‘cold’, where the week is regarded as ‘average’ if the max-temperature anomaly does not exceed 1°C, compared to the station climatological mean. Although the result could be strongly influenced by the bias with respect to climatology, it can provide useful information on product reliability. Table 1 shows that forecasts usually capture a relatively warm weather (that was dominant in 2009), but poorly resolve warm and cold periods. The results are very similar throughout the whole forecasting range.

	week	1	
fc\real	warm	avg	cold
warm	30	5	4
avg	0	0	0
cold	0	0	1

	week	2	
fc\real	warm	avg	cold
warm	28	5	5
avg	0	1	0
cold	1	0	0

	week	3	
fc\real	warm	avg	cold
warm	27	6	6
avg	1	0	0
cold	0	0	0

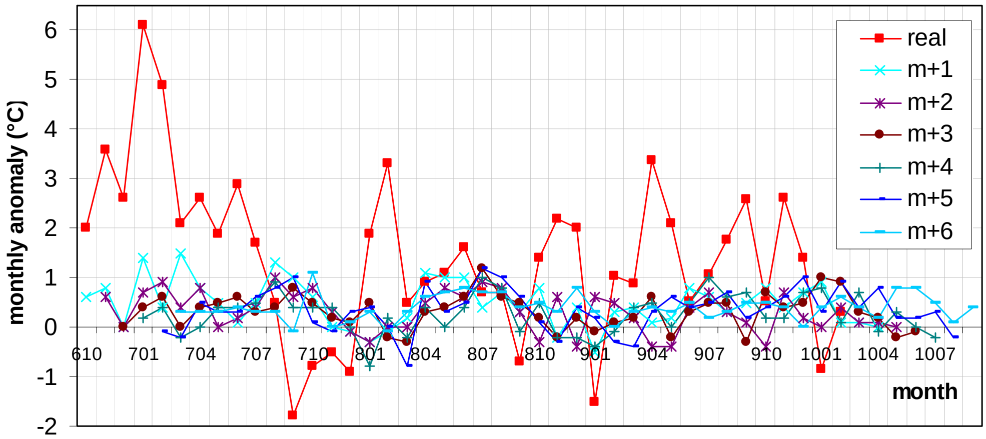
	week	4	
fc\real	warm	avg	cold
warm	27	6	7
avg	0	0	0
cold	0	0	0

Table 1. 3x3 contingency tables for montly (4 week) forecast, based on number of forecasts and observed events (weeks) divided into 3 classes (Zagreb, 2009)

Seasonal forecast is a highly required product by end users. A 3-month forecast, based exclusively on ECMWF seasonal forecast, is issued once a month. Figure 2a presents time-series of observed mean temperature anomaly compared to seasonal forecast with different lead time (up to 6 months). It is clear that variability of the real data is significantly higher than forecast variability ('weak signal forecasts'). For the period displayed, the variance of the real data is about 2.5 degrees, and the variance of the forecast is only about 0.2 degrees.

The difference between forecasted and observed monthly anomaly is shown in Figure 2b. The consequence of a 'weak signal' is that the error is strongly affected by the original signal (observed anomaly), and very little by the forecast itself, so the blue lines in the lower figure are practically an 'inverse' of the red line in the upper figure. Figure 3a indicates that because of predominantly warm bias, the forecasts are too cold. In addition, it can be noticed that forecast error is not changed significantly with lead time.

a)



b)

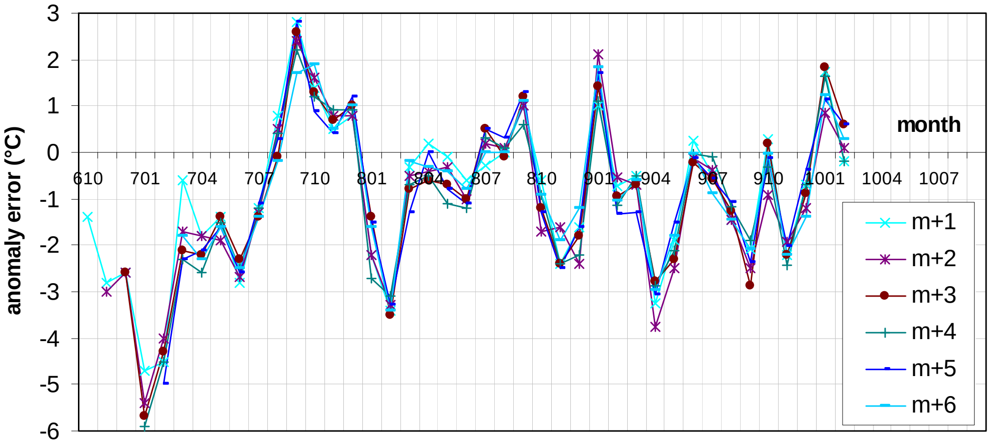
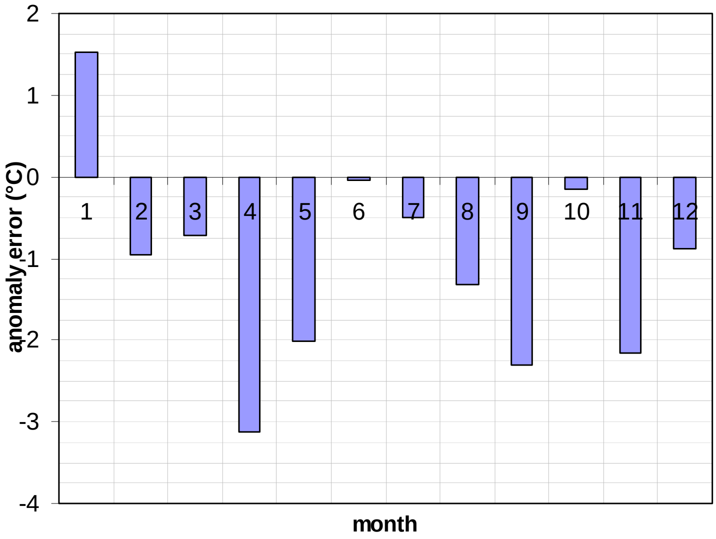


Figure 2. Comparison of ECMWF seasonal forecast (mean monthly temperature) to observed data, for the Central Croatia region for the period October 2006 to July 2010, for different lead times (from m+1 to m+6).

In a) observed anomalies (red line) are compared to forecasts. Error of forecasts (difference between real and forecasted monthly anomaly) is presented in b)



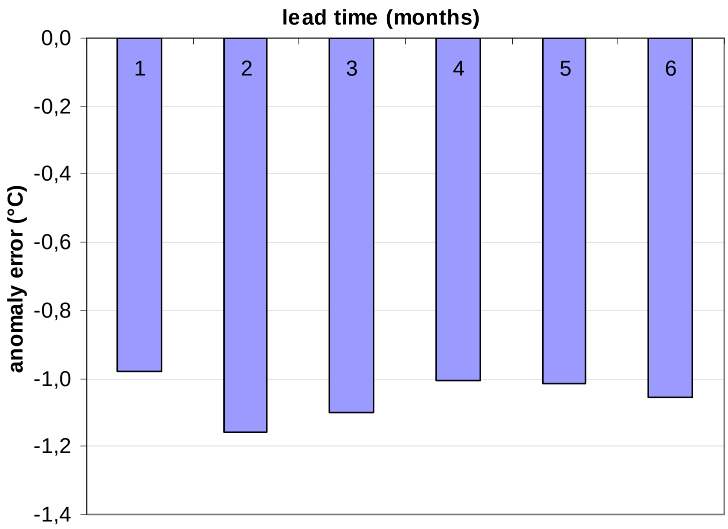


Figure 3. Difference between forecast and observed monthly temperature anomaly for the Central Croatia region for 2009. Error is shown with respect to different a) months; b) lead times

Table 2 presents results calculated by similar methodology as for monthly forecasts. Months are regarded as 'normal', if the temperature anomaly doesn't exceed 0.2 degrees (compared to observed climatological mean). Reliability of the forecast is supported by the fact that in most of the cases when warm event was forecasted, it really occurred. On the other hand, year 2009 was relatively warm, so these warm events occurred often even when cold month was forecasted. According to this approach, a slight decrease of the skill with lead time can be noticed.

Another analysis (not presented in this report) shows that seasonal forecast calculated against model climatological median is slightly closer to reality compared to forecast calculated against model climatological mean.

	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	9	0	0	warm	5	0	1	warm	7	0	0
0.2+/-	2	0	0	0.2+/-	3	0	0	0.2+/-	3	0	1
cold	0	0	1	cold	3	0	0	cold	1	0	0

Table 2. 3x3 contingency tables for seasonal (3 month) forecast, based on number of forecasts and observed events (months) divided into 3 classes (The Central Croatia region, 2009)

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 (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 directly from ECMWF output. See verification in section 3.1.1

3.2 Subjective verification

Subjective verification of medium-range forecasts is done only occasionally, usually through case-studies, but no systematic verification has been done. For some general subjective remarks see previous reports.

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

3.2.2 Synoptic studies

4. References to relevant publications