Application and verification of ECMWF products 2014

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1. Summary of major highlights

At the Meteorological and Hydrological Service of Croatia, ECMWF products are considered as the main source in the operational forecast, particularly for the medium- and long-range forecasts. For short range, Aladin model is very important also.

Regular verification is usually done by the point-to-point method, with synop data verified against nearest grid point of the model. The emphasis of the verification is on 2m-temperature and precipitation.

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

2.1.2 Physical adaptation

ECMWF lateral boundary conditions (3 hourly) are used in a local data assimilation cycle (CANARI OI, 3DVar, 6h cycle) and for performing a 72hr forecast with ALADIN 8km model. Production from assimilation cycle is performed in “lagged mode” due to time constraints for availability of ALADIN forecast. In “lagged-mode” ECMWF forecast initialized 6h earlier than ALADIN initial time is used as LBC for 72hr ALADIN integration. ALADIN coupled to ECMWF was run in parallel mode for two years and obtained skill exhibited no significant difference compared to operational ALADIN (initialized from local data assimilation system) coupled to ARPEGE model. From 01 January 2014 operational ALADIN forecast (4 runs per day - 00, 06, 12 and 18 UTC) is performed using ECMWF boundary conditions exclusively.

2.1.3 Derived fields

2.2 Use of products

In the operational forecast, ECMWF products are widely used, especially for the medium- and long-range forecasts. For the short range, the emphasis is put to the high resolution model (ALADIN - ALARO). This is particularly valuable for severe weather and warnings. For the long range, ECMWF forecasts are practically the only source; Service’s end forecasts are based on ECMWF DMO, although some other sources (UKMO, SEECOF, IRI) are also consulted.

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

For the time being, no extensive verification has been delivered for ensemble forecast.

Verifcation of all meteorological parameters is carried out with synop data, usually against nearest grid point of the model. Parameters mostly verified are 2m-temperature and precipitation.

In the 2012 Report, a potential improvement for the medium range 12-hour precipitation forecast has been discusseed. It has been associated with the implemetation of new IFS cycle 38r1, which introduced a series of improvements that were expected to enhance model performance. Unfortunately, results for 2013 don’t confirm that trend completely. Figure 1. presents the behaviour of Hansen Kuipers skill score with respect to lead time (brown line), and it is slightly worse compared to 2012 and 2011. However, it can be noticed that the bias (blue line) is almost optimally calibrated. A significant daily variation of both scores is still present (before noon and afternoon).

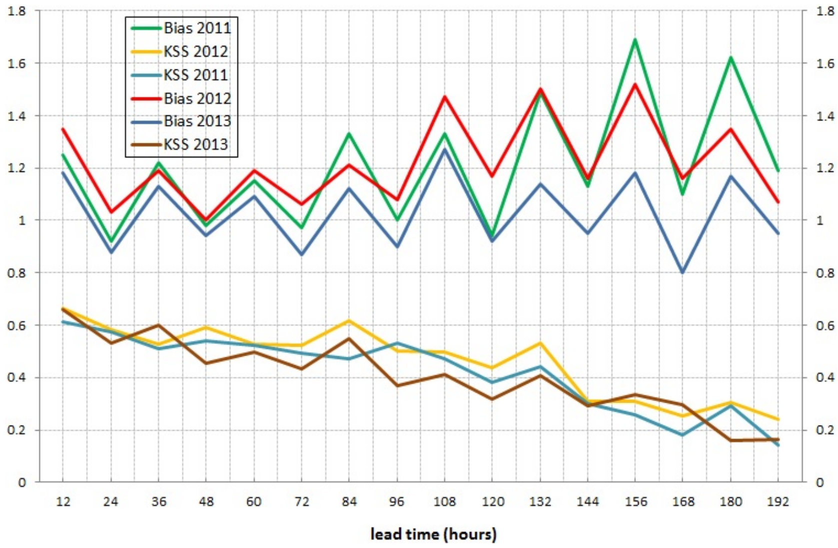

Figure 1. Verification scores for ECMWF 12-hour precipitation forecast (larger than 0 mm) for station Zagreb Maksimir (14240). Bias and Hansen-Kuipers skill score (KSS) are displayed.

For the temperature forecast, the usual behaviour of the scores is observed. Figure 2. presents the increase of the forecast error (MSE) with lead time, compared to different reference forecast: climatology, persistence and combination of the two (CLIPER forecast, or 'damped persistence'). One can notice that at the end of the forecasting period the forecast error equals to reference forecast error. This comparison can be expressed in terms of ECMWF forecast skill against these reference forecast (Figure 3). The skill is approaching zero at the end of the forecasting period (Day 10).

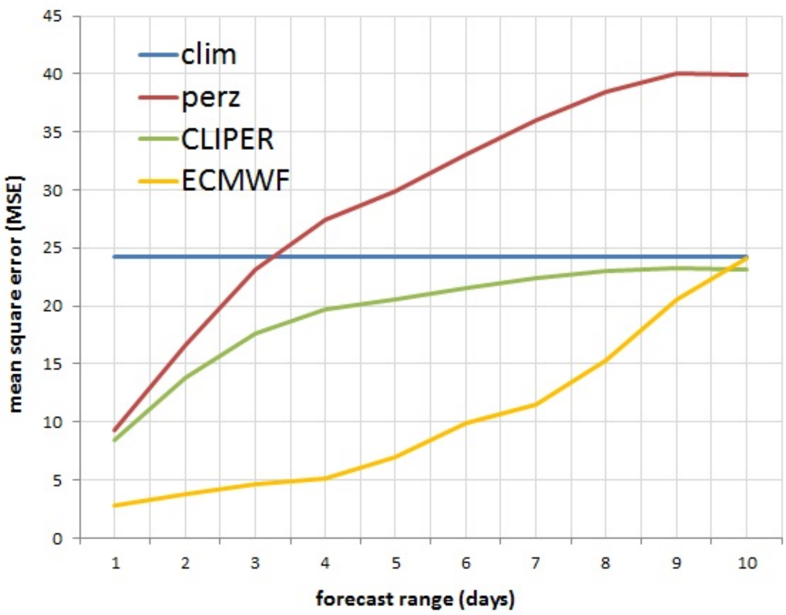

Figure 2. Mean square error (MSE) for 2m-temperature forecast for ECMWF, climatology, persistence and CLIPER forecast, for station Zagreb Maksimir (14240).

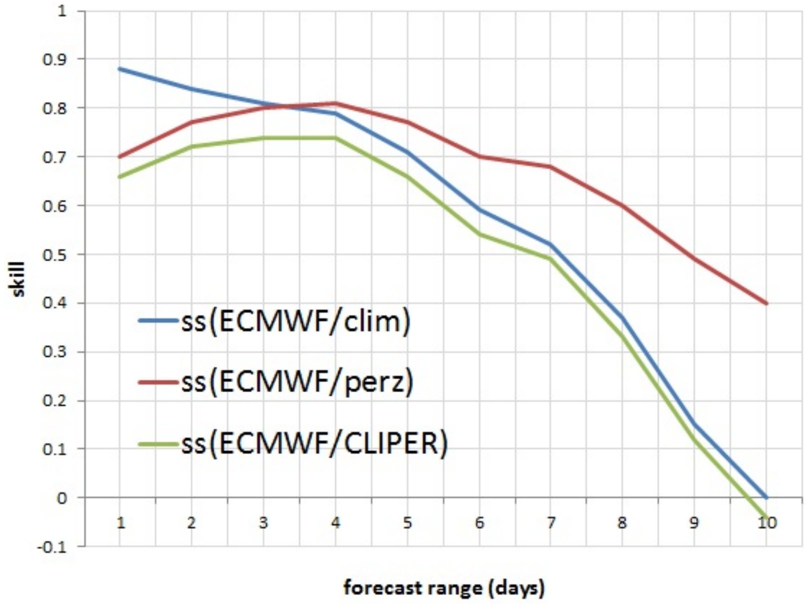

Figure 3. Skill of ECMWF 2m-temperature forecast against climatology, persistence and CLIPER forecast, for station Zagreb Maksimir (14240).

For the temperature forecast, a real time operational verification is also running, with daily visualisation of different forecasts compared to observations. An example of 2m maximum temperature forecast in December 2013 is displayed in Figure 4. A relatively poor skill of both model forecasts (ECMWF and Aladin) is present in several episodes, particularly for Aladin model. For ECMWF, a strong overestimation is observed at the middle of the month, when a prolonged period of stable and foggy days occurred. This deficiency of the model is well known.

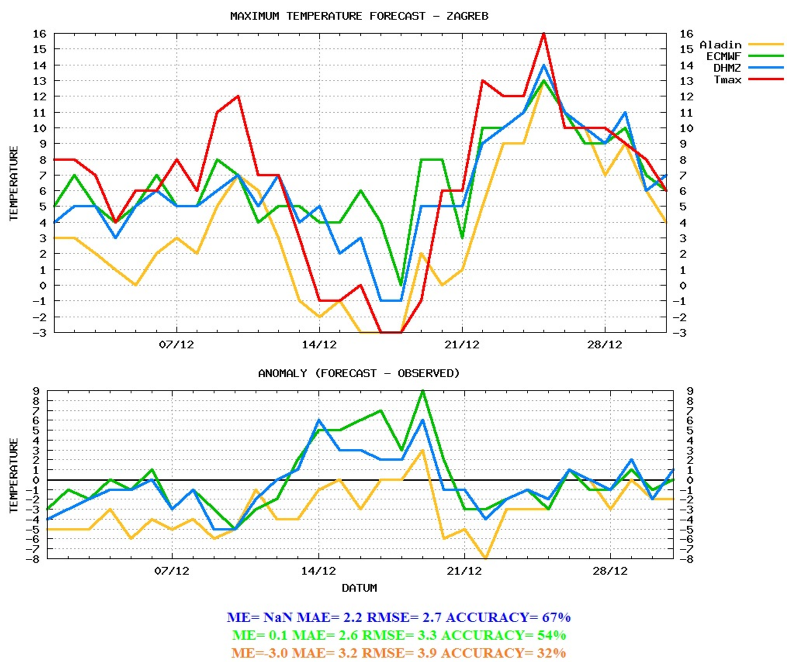

Figure 4. Maximum 2m-temperature forecast (for the following day) for station Zagreb Maksimir (14240) in December 2013. Aladin (yellow line), ECMWF (green line), forecaster's prediction (blue line) and observed temperature (red line) are displayed. Mean error (ME), mean absolute error (MAE) and root mean square error (RMSE) are calculated. Accuracy is defined as the percentage of forecasts with error smaller than 2 degrees.

Long term forecasts are extensively verified on a quasi real-time basis. It is particularly important because the end Service's products (monthly and seasonal forecast) are based on ECMWF direct model output, and issued regularly.

For both the monthly and seasonal temperature forecast, two features can be determined uniquely: so called "weak signal", and a persistent underestimation of temperature (forecasts "too cold"). They have been reported extensively in the previous years, and are not included in this paper.

Figures 5. and 6. present the behaviour of skill scores for the monthly forecast system, for cold and warm seasons respectively. Mean absolute error for weekly temperature forecast is compared to climatology forecast (1981-2010), for both runs (mondays and thursdays) to determine skill. Generally, the mondays run is persistently more skillful than the thursdays one, particularly for the week 1. Furthermore, results tipically exhibit better skill for the cold season compared to the warm one, where the skill beyond week 1 becomes marginable.

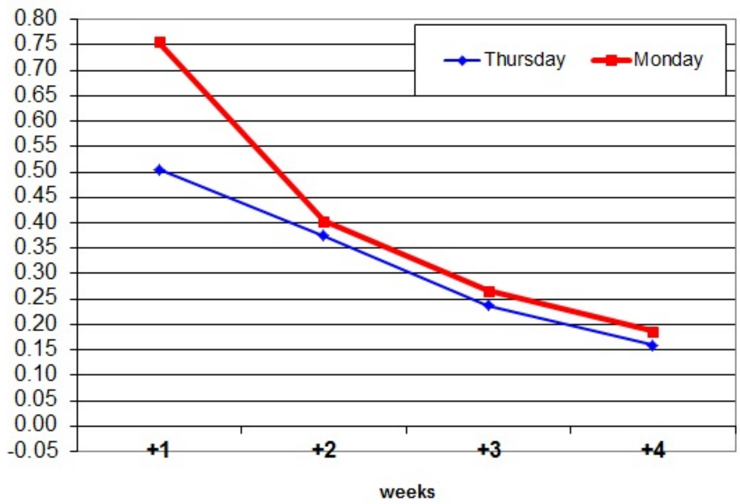

Figure 5. Skill of the monthly forecast system, for weekly temperature anomaly forecast, for station Zagreb Maksimir (14240), for the cold season (Oct 2013 – March 2014)

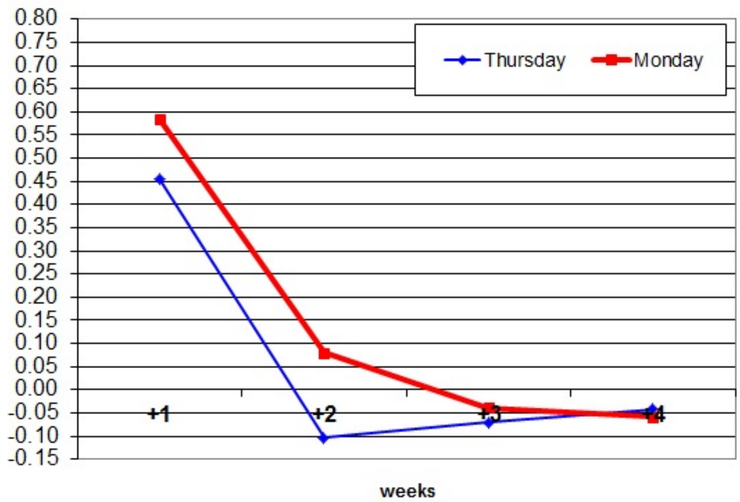

Figure 6. Skill of the monthly forecast system, for weekly temperature anomaly forecast, for station Zagreb Maksimir (14240), for the warm season (Apr – Sept 2013)

Figures 7, 8 and 9 display verification results for the seasonal forecast system. From 2013 climatological reference 1960-1990 is not taken into account any more, and the calculations are made with respect to 1980-2010 climatology exclusively. The difference of mean vs. median reference is observed, but it is still not clear how it should be interpreted.

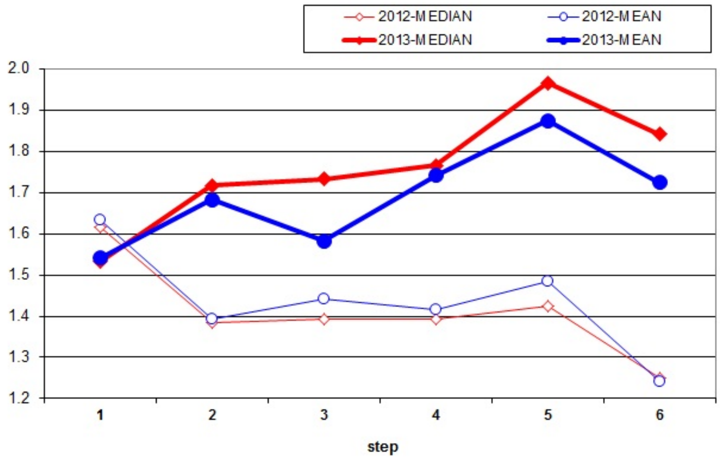

Figure 7. Mean absolute error for the mean monthly temperature forecast (ECMWF seasonal forecast), for different lead times (station Zagreb Maksimir).

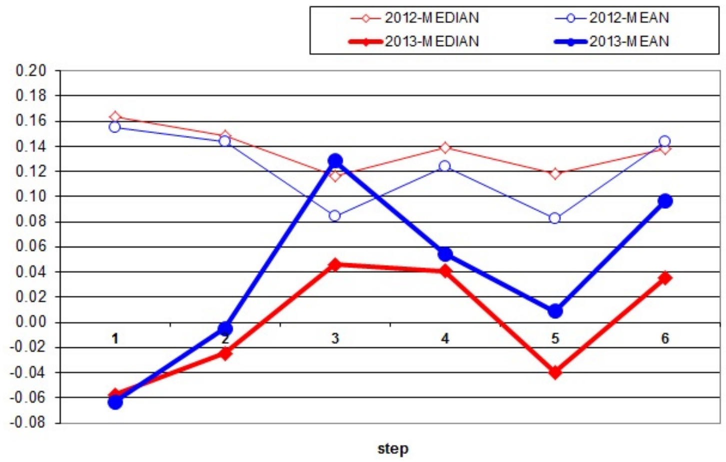

Figure 8. Skill of the mean monthly temperature forecast (ECMWF seasonal forecast), for different lead times (station Zagreb Maksimir).

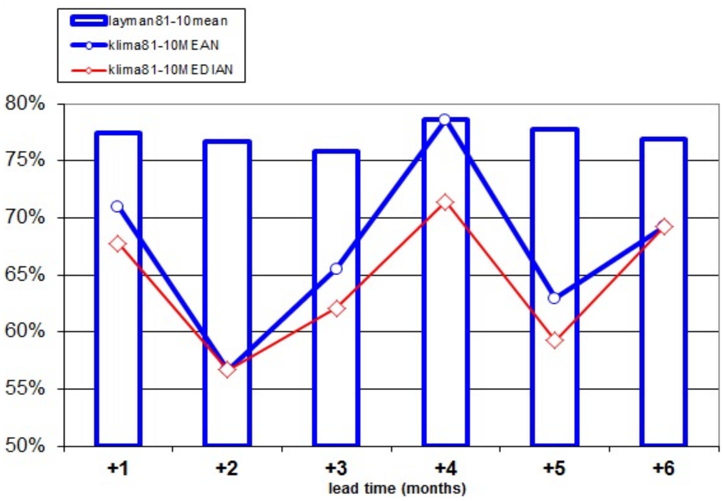

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Figure 9. Percentage of successful forecasts of positive/negative monthly temperature anomaly, for different lead times (station Zagreb Maksimir). ECMWF seasonal forecast is compared to 'layman' forecast which persistently forecasts positive anomaly.

For the mean monthly temperature forecast, mean absolute error is sistematically larger compared to 2012, for all steps, except for step 1. Still, a typical increase of error with respect to lead time is observed, which was not allways the case in the previous years (e.g. 2012). Results are also confusing when translating MAE into the forecast skill, this year by distinguishing the forecast for step 3 and 4. This behaviour was observed before, also by other verifiers, but so far with no systematic explanation? One has to notice that the winter of 2013 was extremely warm in Croatia, and it was not forecasted well. Furhtermore, for one year's verification, the dataset (number of forecast taken into account) is relatively small, etc.

A more optimistic approach is to verify the ability of the forecasting system to resolve relatively warm or cold periods. Figure 9 presents the percentage of successfully forecasted mean monthly positive/negative anomaly. It reveals certain skill that usually ranges between 60 and 75 percent, although with significant variation with respect to lead time. However, such forecast is still less skillful compared to 'laymen' forecast that would - due to experienced warm weather in the recent past – persistently forecast positive anomaly.

3.1.2 ECMWF model output compared to other NWP models

In the short range, performance of ECMWF model is periodically compared to Aladin (ALARO) Croatia model. Results (not presented in this paper) usually exhibit similar level of skill performed by the two models.

3.1.3 Post-processed products

3.1.4 End products delivered to users

3.2 Subjective verification

Subjective verification of ECMWF forecasts is done only occasionally, usually by the individual studies, but no systematic verification has been carried out.

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

3.2.2 Synoptic studies