Application and verification of ECMWF products 2015

Meteorological and Hydrological Service of Croatia – Lovro Kalin and Zoran Vakula

1. Summary of major highlights

At Meteorological and Hydrological Service of Croatia, medium- and long-range forecasts are dominantly based on ECMWF products. For short range, Aladin model is also included.

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

In the last years, a certain improvement of the forecasts skill has been reported. Results for year 2014 confirm that, exhibiting improved bias for the precipitation forecast, as well as temperature forecast (see section 3.1.1). Preliminary results for long range drought forecast (SPI forecast) gave encouraging results (see section 3.1.3).

2. Use and application of products

2.1 Post-processing of ECMWF model output

2.1.1 Statistical adaptation

2.1.2 Physical adaptation

No significant change has been detected since last year. ECMWF lateral boundary conditions are used for running a 72hr forecast with ALADIN 8km model (for details see last year's report)

2.1.3 Derived fields

A study to perform seasonal forecast of Standardized Precipitation Index has been made, with encouraging results (see section 3.1.3)

2.2 Use of ECMWF products

3. Verification of products

3.1 Objective verification

Describe verification activities and show related scores.

3.1.1 Direct ECMWF model output (both HRES and ENS)

In the previous years (see Reports from 2012 and 2013) a certain improvement of the skill of precipitation forecast has been presented. This year's results confirm that trend. Figure 1. presents the behaviour of Bias and Hansen Kuipers skill score (KSS) with respect to lead time. For the KSS (purple line), no significant trend can be observed. However, Bias (red line) exhibits two major improvement characteristics. First, it is much closer to the ideal value of 1, so the forecast are better calibrated, compared to significant overforecasting in the previous years. Second, the daily variation of the Bias (before noon and afternoon) – which has been recognized for the long time in the model – has experienced significant reduction, particularly up to day 5 (120 hour forecast).

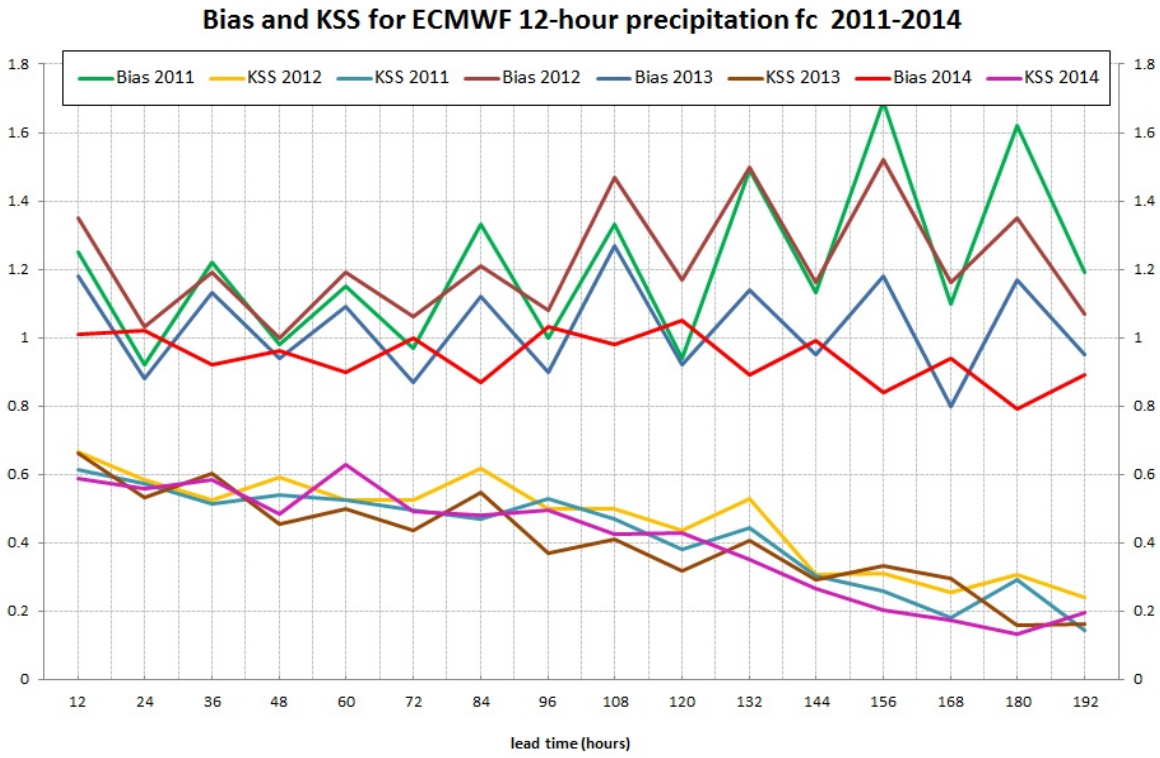

Fig.1 Verification scores for ECMWF 12-hour precipitation forecast (larger than 0 mm) for station Zagreb Maksimir (14240). Bias and Hansen-Kuipers skill score (KSS) are displayed.

For the 2m-temperature forecast, the extensive verification is provided regularly, with various scores, exhibiting typical features of the forecasting system (see previous reports). Figure 2. presents an example of such verification, exhibiting slight improvement of the 2m maximum temperature forecast in the medium range (from day4 to day 9), compared to previous year. Similar results were observed for the minimum temperature, for both runs.

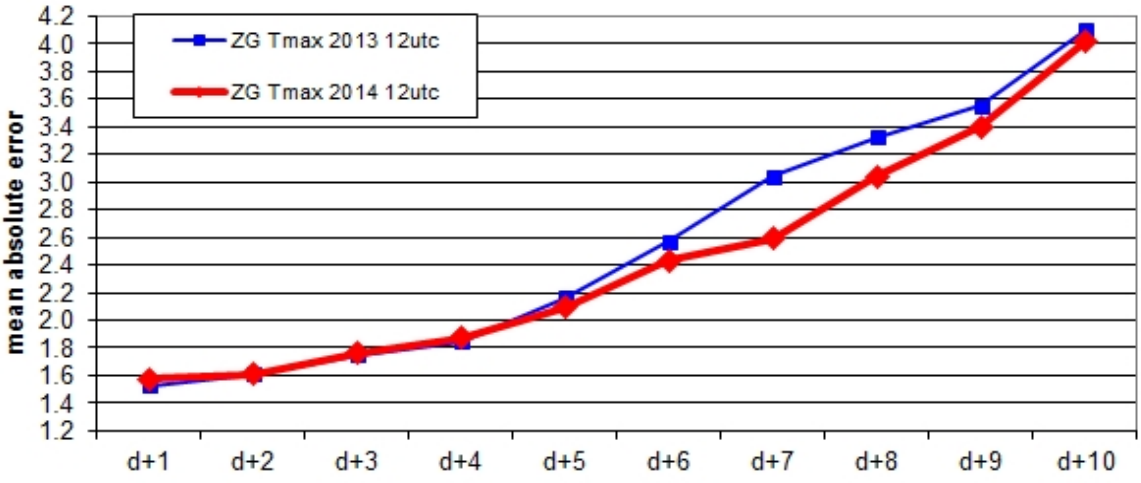

Fig.2 Mean absolute error for 2m maximum temperature forecast for 2013 and 2014., for station Zagreb Maksimir (14240).

Long range forecast are also monitored with special attention, since the Service's monthly and seasonal end product forecast are based on ECMWF-DMO, visualized and interpreted. Classical scores are regularly calculated, for monthly forecast exhibiting decrease of the skill with time, with marginal skill for the week 3 and 4. However, another approach provides better results, when comparing number of successful and unsuccessful forecast of positive/negative temperature/precipitation anomalies (Figure 3).

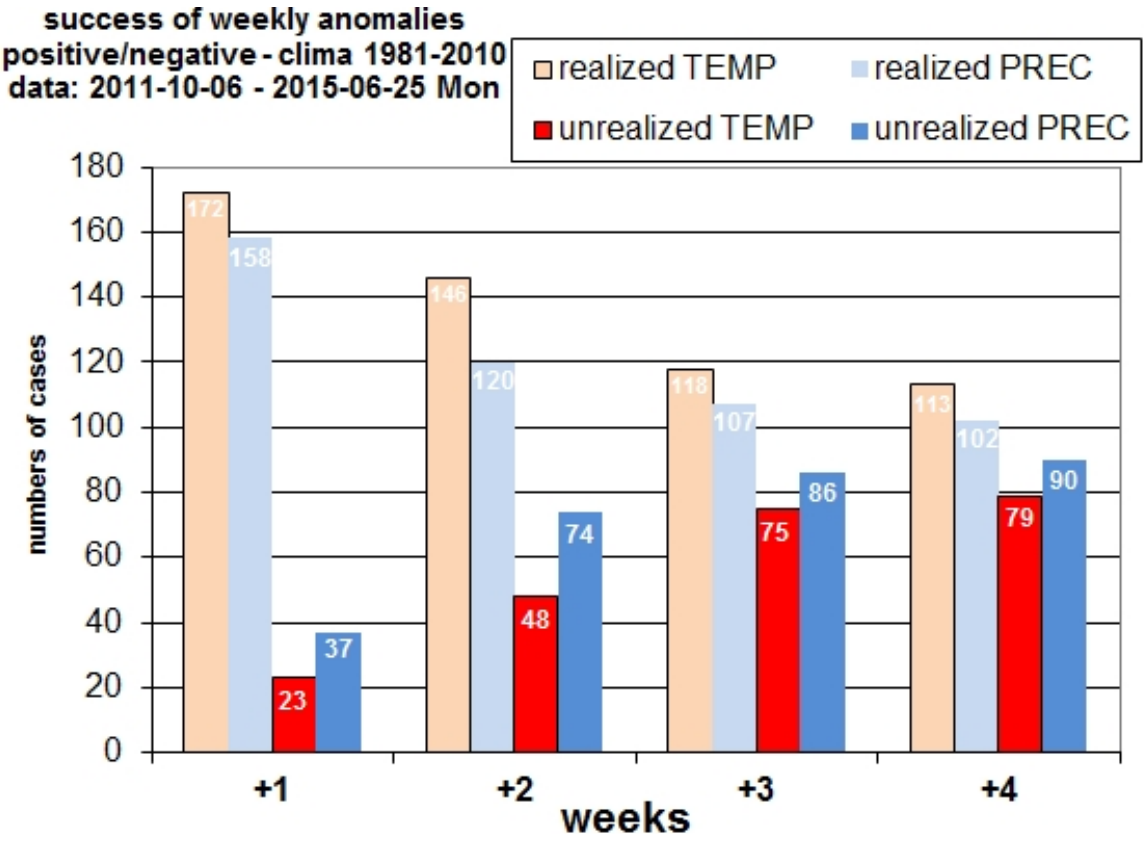

Fig.3 Number of successful/unsuccessful forecasts of weakly temperature and precipitation anomaly (Monthly forecast system), for station Zagreb Maksimir (14240)

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

Since drought causes the highest economic damages among all natural hazards in Croatia, a study has been made to introduce a forecasting component to the existing monitoring system. Previous attempts to employ deterministic output of the long-range system (ensemble mean/median) has brought poor results, so now the whole ensemble was taken into account. Standardized Precipitation Index has been calculated on different time scales (SPI1, SPI3 etc.), and with various combinations of forecasted and observed precipitation (e.g. SPI3 = 2 months observed + 1 month forecasted, etc.). Study has been performed on 23 Croatian stations, spanning the period from May 2011 to August 2014, for which the ECMWF System 4 was available (cca 1000 cases).

An example of verification results are given in Figure 4, presenting the reliability diagram for the SPI1 forecast (based on pure 1-month ECMWF precipitation forecast). With Brier score =0.15 , and Brier Skill Score =0.24 an overall good performance is obtained. With forecast line close to the perfect forecast (diagonal), a relatively good calibration of the system can be observed. Still, a substantial overconfidence is also present, particularly for higher probabilities (0.7 and higher), but this is a very common feature of such forecasting systems. Indeed, the histogram plot reveals a significant number of forecasts with high probabilities which leads to a desired level of sharpness which is often not present at similar systems (notorious “no signal” forecasts).

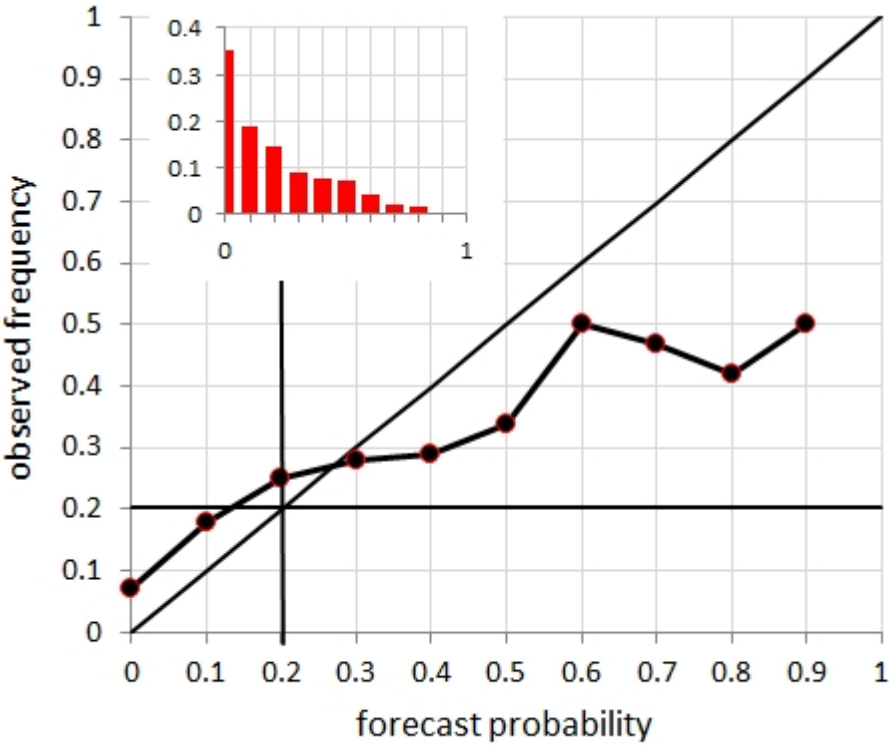

Fig. 4. Reliability diagram for SPI1<-1 forecast, with corresponding frequency distribution in the upper left corner.

Results were – as expected – even better when employing a combination of observed and forecasted precipitation. Figure 5 presents reliability diagram for SPI3 (2 months observed + 1 month forecasted). With BS =0.11 and BSS = 0.52, almost perfect calibration is present, although with a slight overconfidence. However, the histogram plot reveals a significant number of forecasts where 0 percent probability is forecasted.

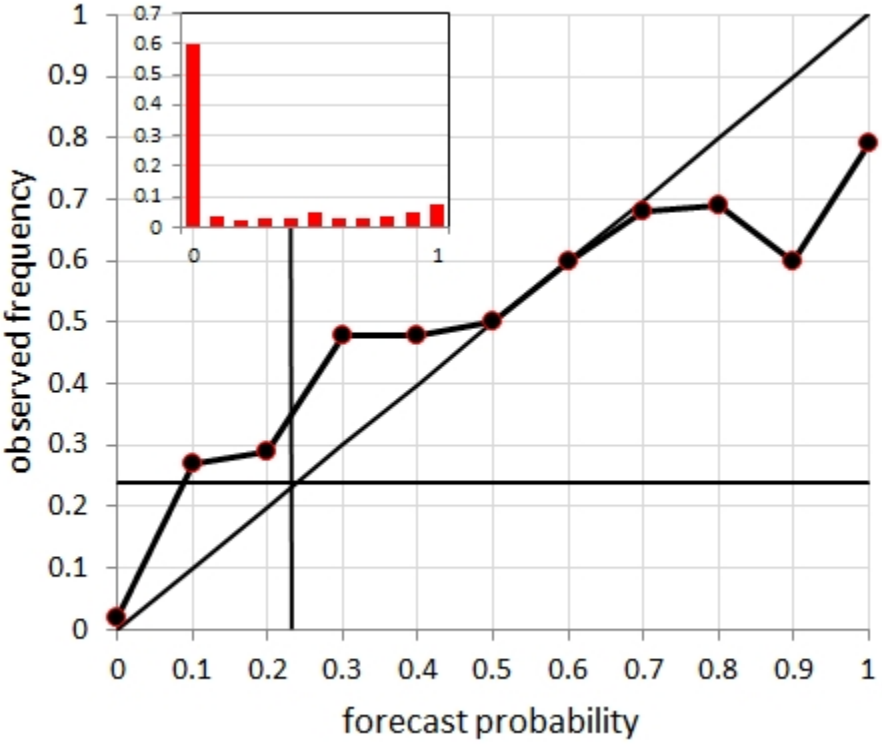

Fig. 5. Reliability diagram for SPI3<-1 forecast, with corresponding frequency distribution in the upper left corner.

All these results encourage the introduction of operational drought forecasting at the Service, that is planned to start this winter.

3.1.4 End products delivered to users

3.2 Subjective verification

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

No regular subjective verification is provided in the Service. Thus, for this year's report purpose we introduced a survey in order to objectively express forecasters' impressions with the model. The authors proposed several characteristics of the model that are widely mentioned, and the forecasters were asked to confirm/reject those proposals. Additional remarks were also welcome. Ten forecasters attended the survey, with some expected but also some surprising results. Most usual features of the model were unanimously confirmed, such as relatively poor behaviour in inversion situations. However, results for the wind forecast are encouraging, with 7 votes for significantly improved wind forecast, and 3 out of 3 in the Maritime Branch, where the wind forecast is regarded as most important one. Extreme precipitation quantities at the end of the forecasting period were also confirmed by most forecasters, but problems with morning temperatures in the snow cover conditions got only 3 votes. Another proposal, describing often mentioned 'jumpiness' of the model was surprisingly confirmed by only one forecaster. Among other remarks, a substantial criticism of the CAPE forecast over the Adriatic Sea was expressed.

3.2.2 Case studies

4. References to relevant publications