Application and verification of ECMWF products 2010–2011 at the Finnish Meteorological Institute

by Juhana Hyrkkènen, Ari-Juhani Punkka, Henri Nyman and Janne Kauhanen

1. Summary of major highlights

ECMWF products are the basement of the FMI production system. Improved resolution has been very useful in a sense that the smaller scale weather phenomena can now be predicted couple of days before the event. Moreover, the development and the better usability of the EPS system has been very useful from the point of forecasting weather extremes and issuing early warnings which is strongly in focus at FMI.

However, during the winter 2010–2011, spring and early summer 2011 we have experienced a negative BIAS in the surface temperature forecasts in the Finnish weather stations. The BIAS has been the largest during the winter (a few cases order of 10 K). ECMWF has already gathered a lot of information about the poor wintertime temperature forecasts and ECMWF is trying to solve the problem with the interaction of the Nordic NMS's. Surprisingly, the negative BIAS in the daytime temperatures has continued also during spring and early summer 2011.

2. Use and application of model output

The most of the weather forecasting products are based on ECMWF. FMI has a forecaster-corrected gridded database which uses ECMWF data as a background field.

The ECMWF model data (gradually also EPS-data) is used widely and operatively in FMI SmartMet-workstation. We have also started to use the new ECcharts –service (http://www.ecmwf.int/eccharts/) which is very useful for worldwide weather forecasting.

2.1. Post-processing of products

FMI are implementing the operational Kalman filter post-processing to its production system. Nevertheless, a manual editing will still play a crucial role in the near future.

2.2 Use of products

ECMWF output are used widely supporting the traditional weather service, and also as input for various applications like limited area NWP modelling (HIRLAM, AROME), dispersion and trajectory models, hydrological models (run by Finland's Environmental Administration), road condition models and wave models.

The better usability of the EPS data has helped forecasters to predict weather extremes and issue early warnings. The last year presented EPS-based probability products have been available in FMI's meteorological workstation - Smartmet over a year. FMI forecasters have been satisfied and we have added some additional parameters as their request like, probability of frost (temperature below 0) and 12 hours rainfalls > 0,3 4,5 and 10 mm.

3. Verification of products

3.1 Objective verification

A new verification user interface which has been in use a couple of years at FMI has provided very useful objective information about the performances of the different data sources.

3.1.1 Direct ECMWF model output (both deterministic and EPS)

ECMWF model has traditionally provided very reliable and unbiased data throughout the year. However, according to the FMI's verification data ECMWF model has had pretty much negative BIAS in temperature forecasts since last winter (mainly in daytime). This negative BIAS can be seen in Figure 1.

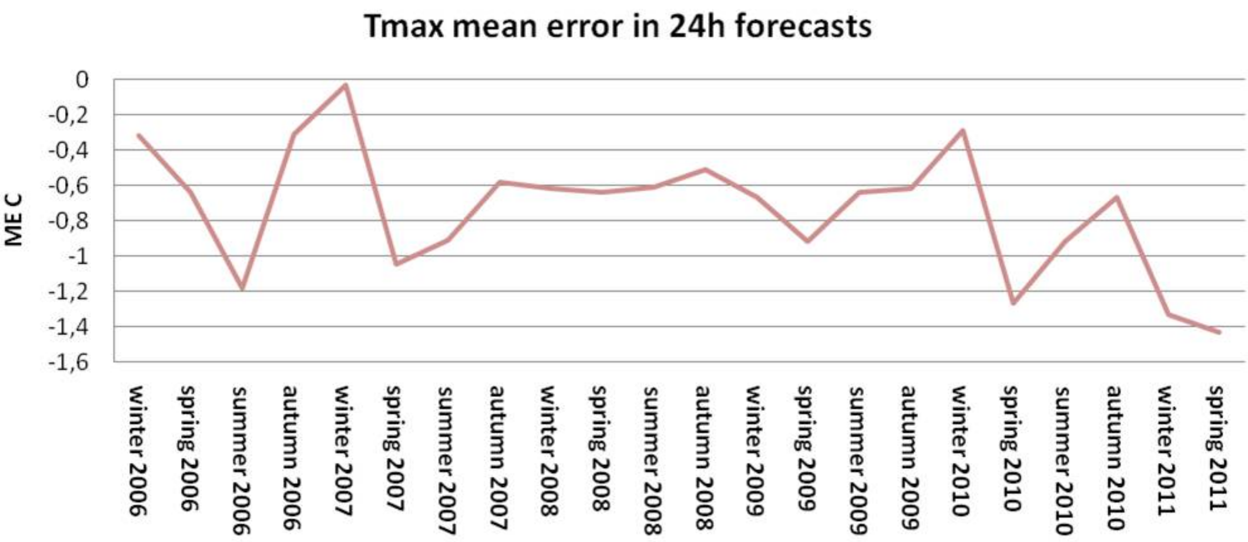

Figure 1 Mean error (ME) of the maximum temperature forecasts (24h) in Finnish weather stations during 2006–2011.

The negative BIAS (about –1,5C) both during winter and spring 2011 has been the largest since year 2006. It seems also that Tmax mean error increases with the length of the forecast (Figure 2). During the winter and spring 2011 there has been a lot of discussion between ECMWF and FMI about the poor wintertime temperature forecasts and according to ECMWF experts the reason has been the lack of super-cooled liquid water in low clouds. In those discussions the focus has mainly been in wintertime problems but surprisingly the similar negative BIAS seems to continue in spring 2011 as well. Even in June 2011 the BIAS was as much as –1,8C (not in figure).

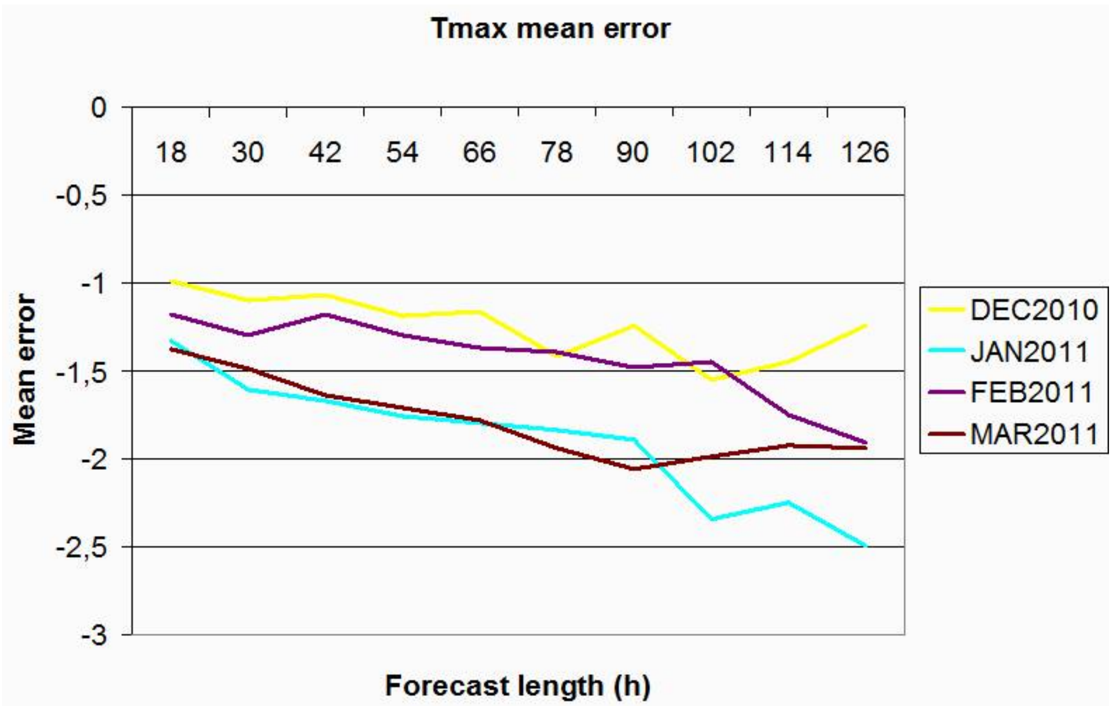

Figure 2 Mean error (ME) of the maximum temperature forecasts (24–126h) in Finnish weather stations during winter 2010–2011

The EPS products can also be verified by the FMI verification system. The preliminary result shows that their pertinence is fairly good. For example the ROC of the temperatures below zero for March are shown in Figure 3.

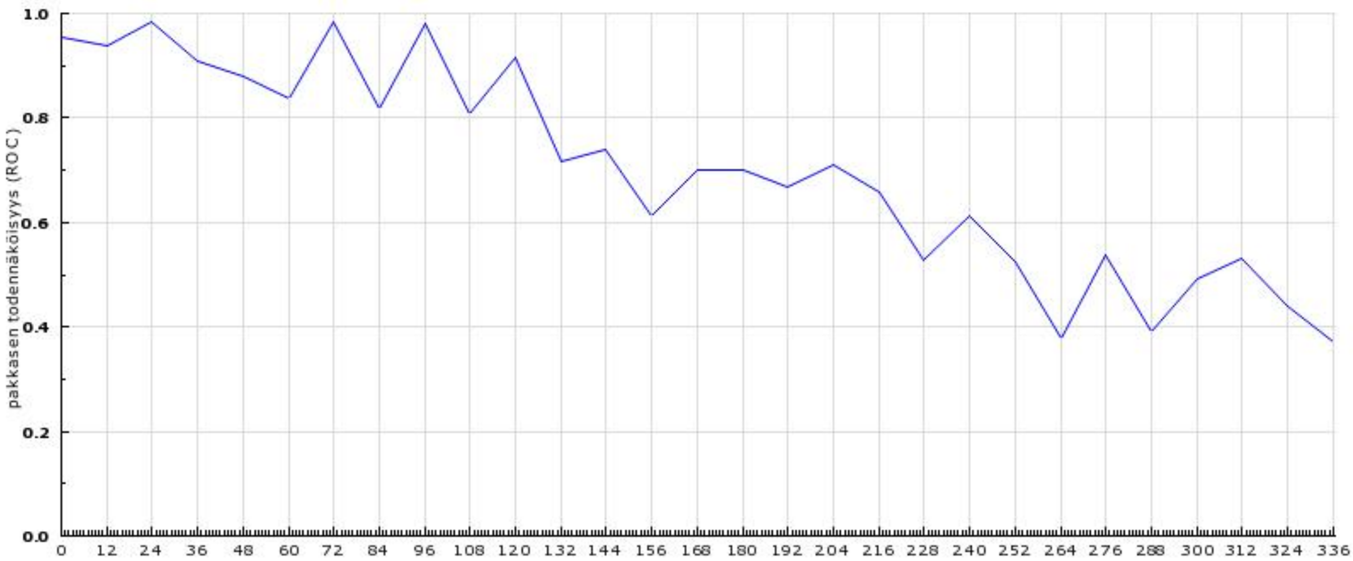

Figure 3 Hit rate (ROC) for the EPS based temperature forecasts. The hit rate is calculated for the predicted probability of the frosty conditions (temperature is below 0°C). The sample is taken from March 2011 at Helsinki-Vantaa weather station. The results are shown by the dependence of the forecast length.

3. 1.2 ECMWF model output compared to other NWP models

The results of the ECMWF temperature forecast output compared to the other data sources are shown in Figure 4. The Finnish HIRLAM model has improved a lot since the last update at the end of 2010 and therefore it has been very competitive against ECMWF. Manually edited fields corrected by meteorologists have been the best data source especially during spring and summer.

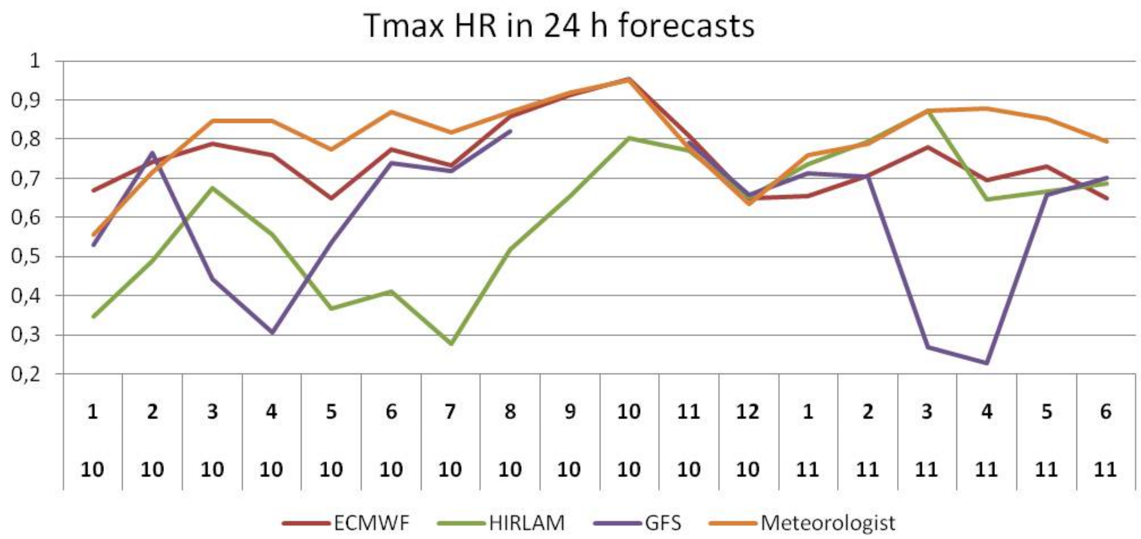

Figure 4 HR of the maximum temperature forecasts (24h) in Finnish weather stations since Jan 2010. A successful temperature forecast means that the difference between forecast and observation is less than 2,5C.

3.1.3 Post-processed products

3.1.4 End products delivered to users

3.2 Subjective verification

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

FMI forecasters have made some remarks about ECMWF model as follows:

- ECMWF wind gust parameter overestimates gusts during cloudy spring and summer afternoons. Worst cases: forecast ~ 30 m/s – observations ~ 15 m/s
- In storm and hard wind situations a forecaster improves remarkably the wind forecast of ECMWF model.
- Gale-force (and stronger) winds on sea areas underestimated by the model. Channelling effect too weak on Gulf of Finland.
- Too much precipitation during spring months
- Too low daytime temperatures during a dry, sunny day.

In heavy rain situations the LAM-models predict better the maximum of precipitation than ECMWF products, but the place of the maximum precipitation is often in some distant of the forecasted place.

3.2.2 Synoptic studies

There are no any extensive synoptic studies made at FMI about the performance of ECMWF data. However, here are a couple of examples about the wintertime problems in ECMWF temperature forecasts (Figures 5 and 6). These examples have been taken from the situations when the cloud forecasts were correct but the cooling at the surface was too strong and the temperature error was 5–10 degrees.

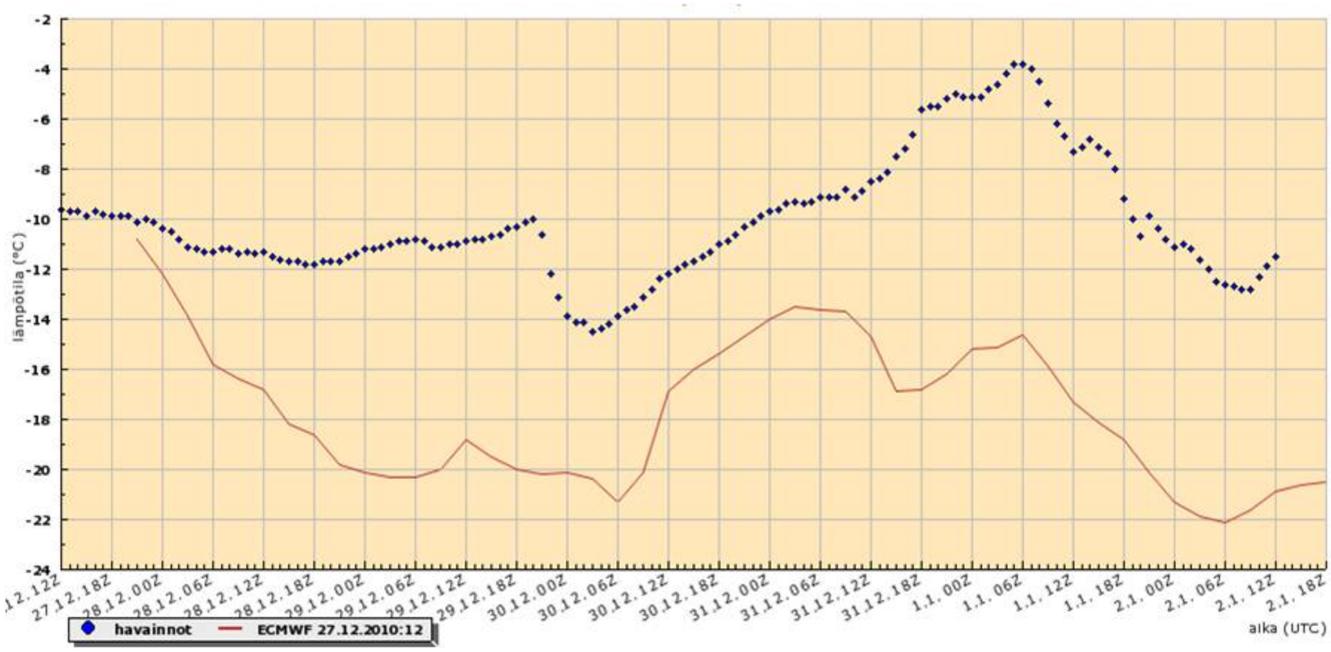

Figure 5 ECMWF forecasts and observations at the turn of the year 2010–2011 in Tampere (27.12.2010 – 2.1.2011). The red curve shows the forecasted temperature and the blue dots show the observations.

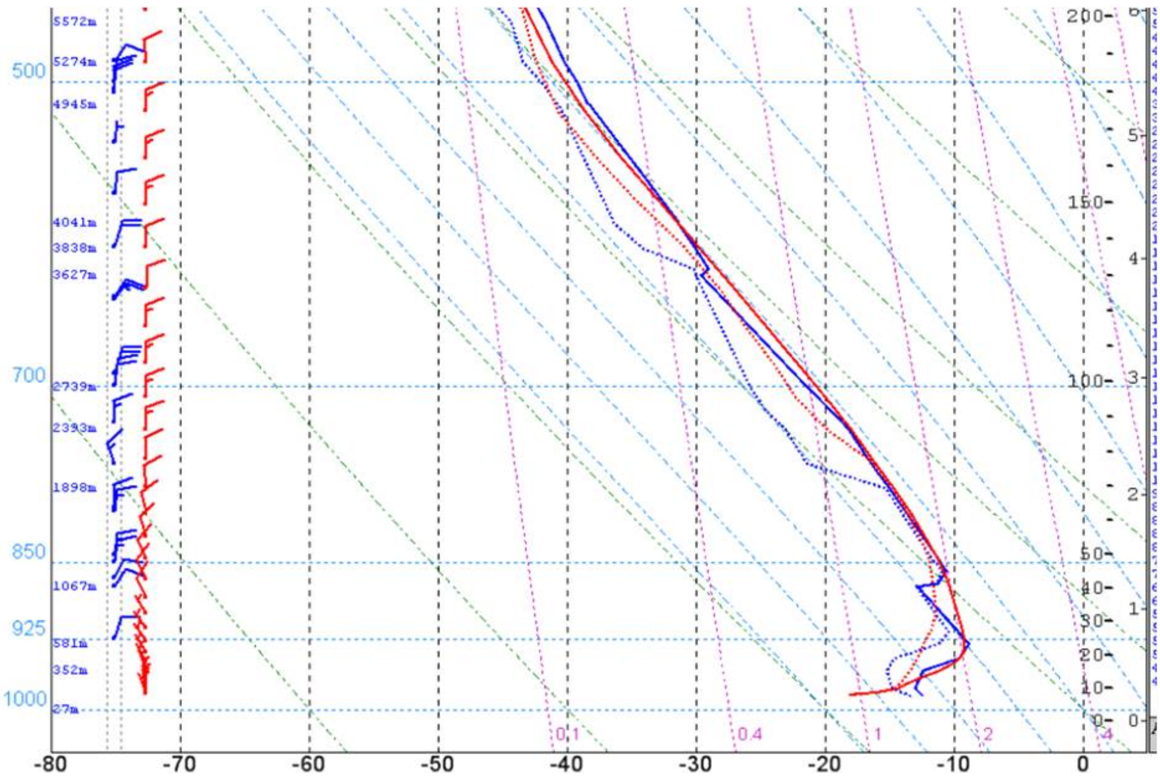

Figure 6 Observed and forecasted sounding 2 Jan in Jokioinen. Observed temperature and dew point are shown in blue and forecasted temperature and dew point are shown in red.