Application and Verification of ECMWF Products 2021

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1. Summary of major highlights

It is expected that a more detailed description of any items included here will appear in section(s) below.

ECMWF data and products are widely used in ESTEA although there is still of potential to use them more (especially IFS-ENS, long-term products, etc).
Regular verification for short- and medium-range is done by the point-to-grid method, with SYNOP data verified against nearest grid point of the model.
Also in June 2021 a survey was made to get better understanding of use and estimation of ECMWF's different parameters and forecasts. Summary figure and general conclusions comes further below.

2. Use and application of products

Include, as appropriate, medium-range high-resolution (HRES) and ensemble (ENS) forecasts, monthly forecasts, seasonal forecasts.

2.1 Direct Use of ECMWF Products

In ESTEA, ECMWF model output is in the widest and the most popular use in comparison to other models (MetCoOp-HARMONIE, ESTEA-HARMONIE, ESTEA-HIRLAM, FMI-HIRLAM, GFS etc.). ECMWF HRES runs are utilized on the everyday basis for operational weather prediction. ECMWF ENS runs are in rarer use. They are utilized to obtain affirmation for the ready forecast, to provide weather forecasts for the specific locations, to predict critical weather situations (e.g. storm tracks), and also for the longer predictions (e.g. sea ice formation).

Monthly and seasonal forecasts cannot be highly trusted in Estonia, as weather processes there are highly variable and change rapidly. Mostly these forecasts are analysed to make announcements in press and for public presentations.

The direct data from ecCharts are sometimes used to get additional information for the forecasts, as these contain the parameters and tools not available in ESTEA products, such as meteograms and hazardous events probabilities. However, it is found to be quite slow and cannot be extensively used in operative work.

The data presented in "Open Charts" is used to get an overview of large-scale circulation patterns. This page is beneficial in terms of getting the 00 UTC model's run earlier in the morning.

2.2 Other uses of ECMWF output

2.2.1 Post-processing

Statistical adaptation - include post-processing strategies for standard HRES and ENS output. Any details of products which are created using Artificial Intelligence (AI) and/or Machine Learning (ML) techniques would be particularly welcome at this time.

2.2.2 Derived fields

There are several products based on the data derived from ECMWF forecasts, which were developed by ESTEA for the internal use by the agency's weather forecasters. These products include a large variety of parameters and probabilities derived from ECMWF forecasts expressed in maps and graphs. The example of the 2 m temperature and 10 m wind fields derived from ECMWF forecast is presented in Figure 1.

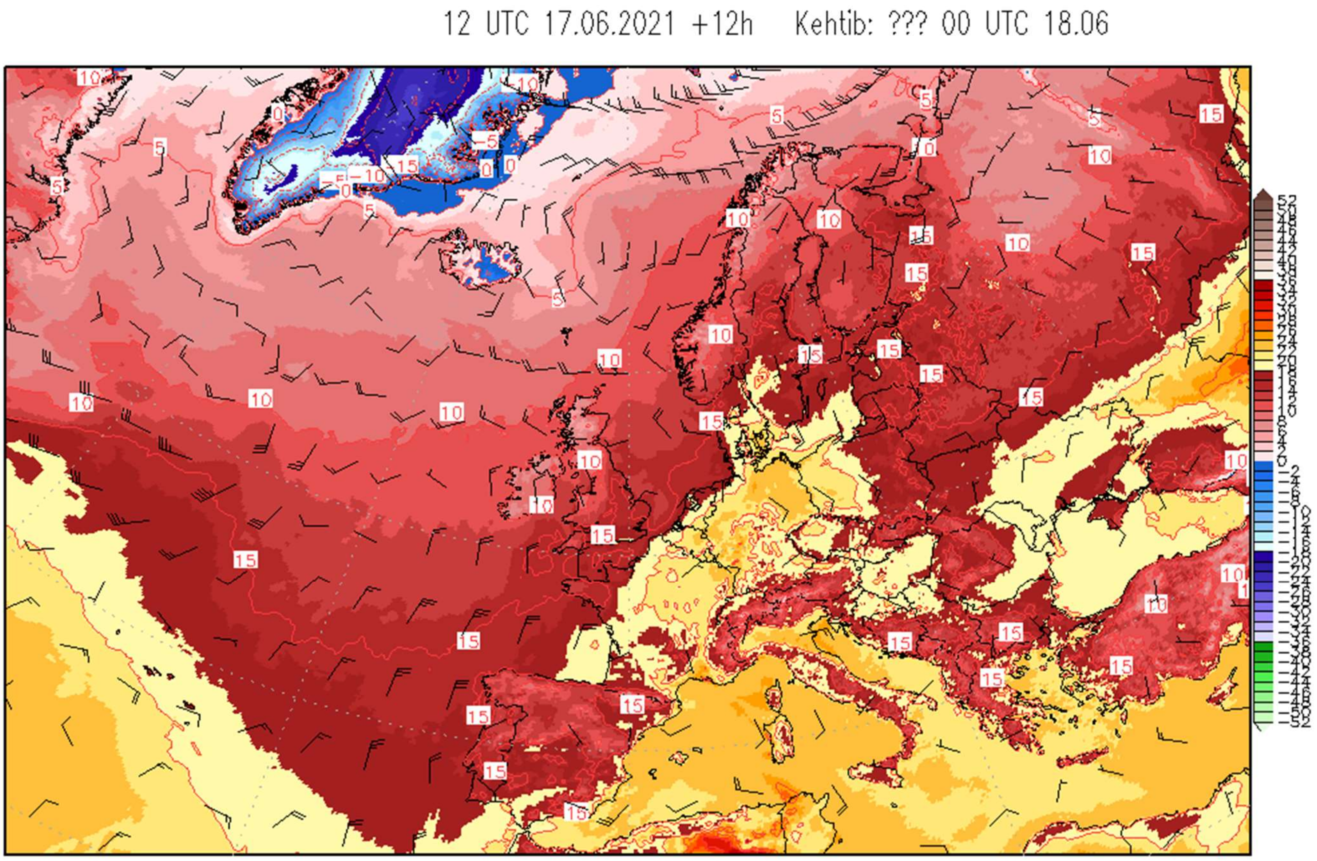

Figure 1. 2 m temperature and 10 m wind velocity fields on 18 June at 00 UTC based on 17 June 12UTC ECMWF HRES forecast presented in ESTEA local product "EKPortaal".

2.2.3 Modelling

ECMWF forecast output is provided as boundary conditions for limited-area models ESTEA-HIRLAM and ESTEA-HARMONIE. Also, hydrological department of the agency uses the data in hydrological model.

3. Verification of ECMWF products

3.1 Objective verification

The only direct ECMWF HRES model output verification is done regularly in ESTEA.

3.1.1 Direct ECMWF model output (both HRES and ENS), and other NWP models

Verification of ECMWF HRES is produced monthly for a time period of maximum 90 hours. Mean sea level pressure, 2m temperature, 2m dew point temperature, 2m relative humidity, 10 m wind speed, precipitation accumulated for 1 and 3 hours are analysed for Estonian domain. Methodology used for that includes calculation of minimum, maximum and mean error, absolute mean error as well as root squared mean error. Also the comparison of model-based forecasts used in ESTEA (ECMWF, ESTEA-HIRLAM, MetCoOp-HARMONIE, ESTEA-HARMONIE) to each other is completed every month. The following figures present the period of 01.01.-31.12.2020 for verification. ESTEA model (HIRLAM and HARMONIE) are not presented here as there were some gaps in data in 2020.

From these figures (Figure 2 – Figure 6) it is possible to see that ECMWF-HRES performs better compared to MetCoOp-HARMONIE parameters related to the humidity (RH, Td) and mean sea level pressure (MSLP). For 10m wind speed (10WS) the figures show that both models tend to overestimate wind speed (obs – model) all around the year and ECMWF even more than MetCoOp-HARMONIE. 2m temperature (2T) forecasts is quite similar for both models, in autumn it seems to be a little bit better MetCoOp-HARMONIE but in winter the situation is opposite.

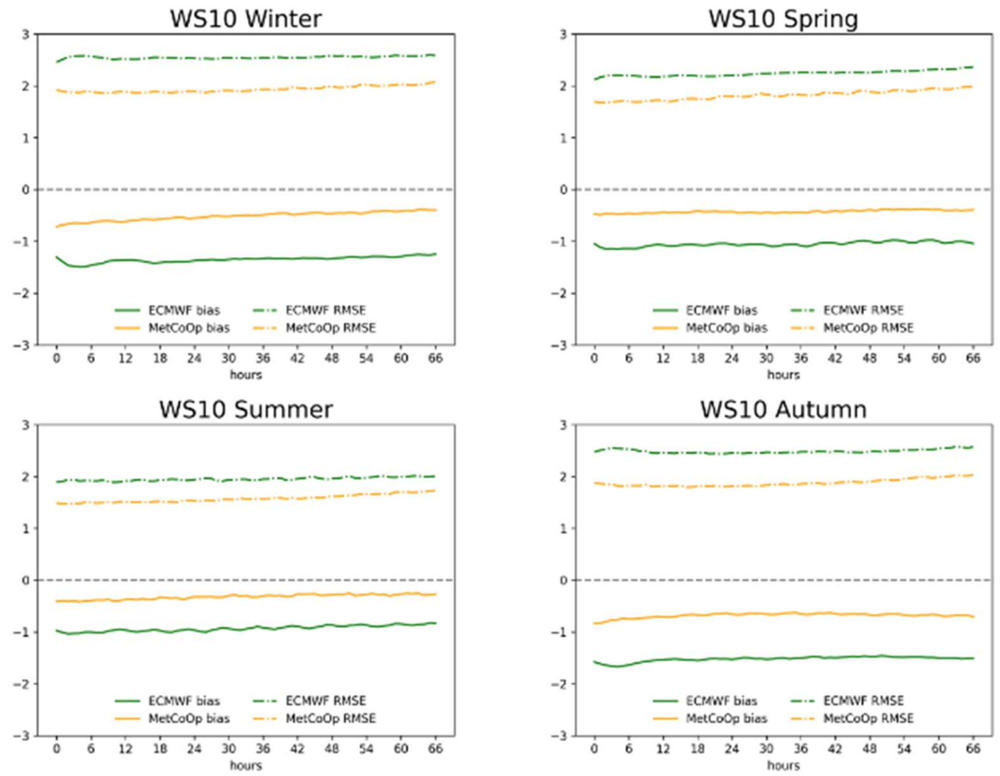

Figure 2. 10m wind speed (WS10) bias and RMSE results for MetCoOp-HARMONIE (yellow) and ECMWF (green).

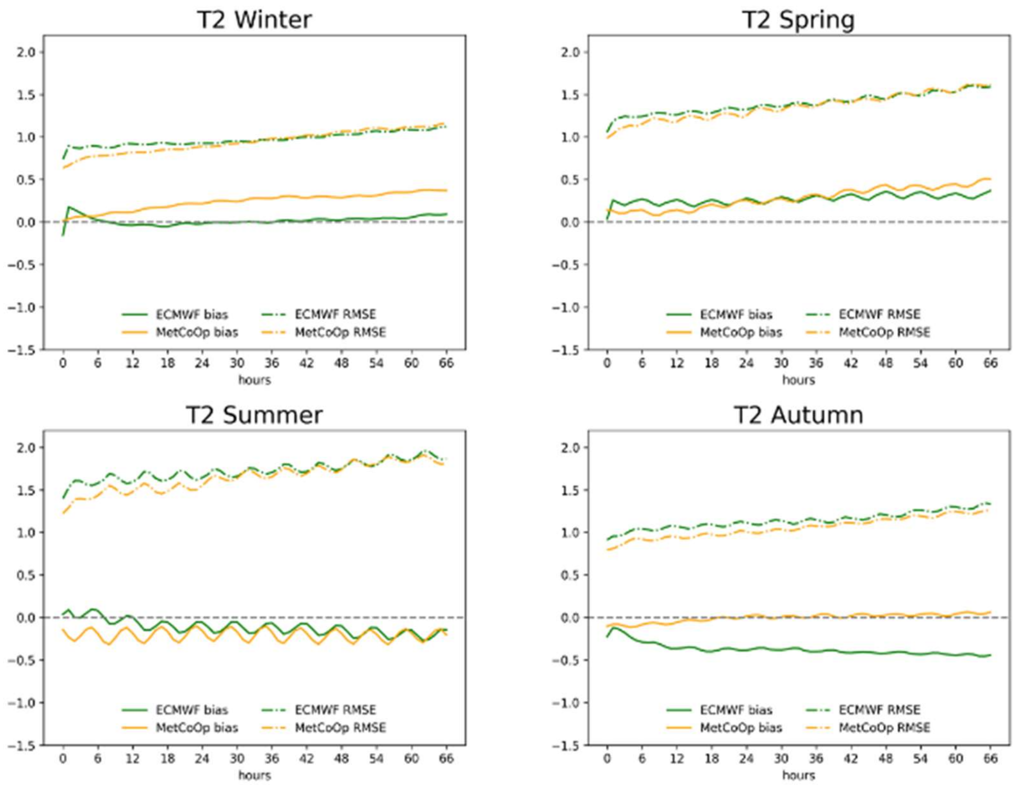

Figure 3. 2m temperature (T2) bias and RMSE results for MetCoOp-HARMONIE (yellow) and ECMWF (green).

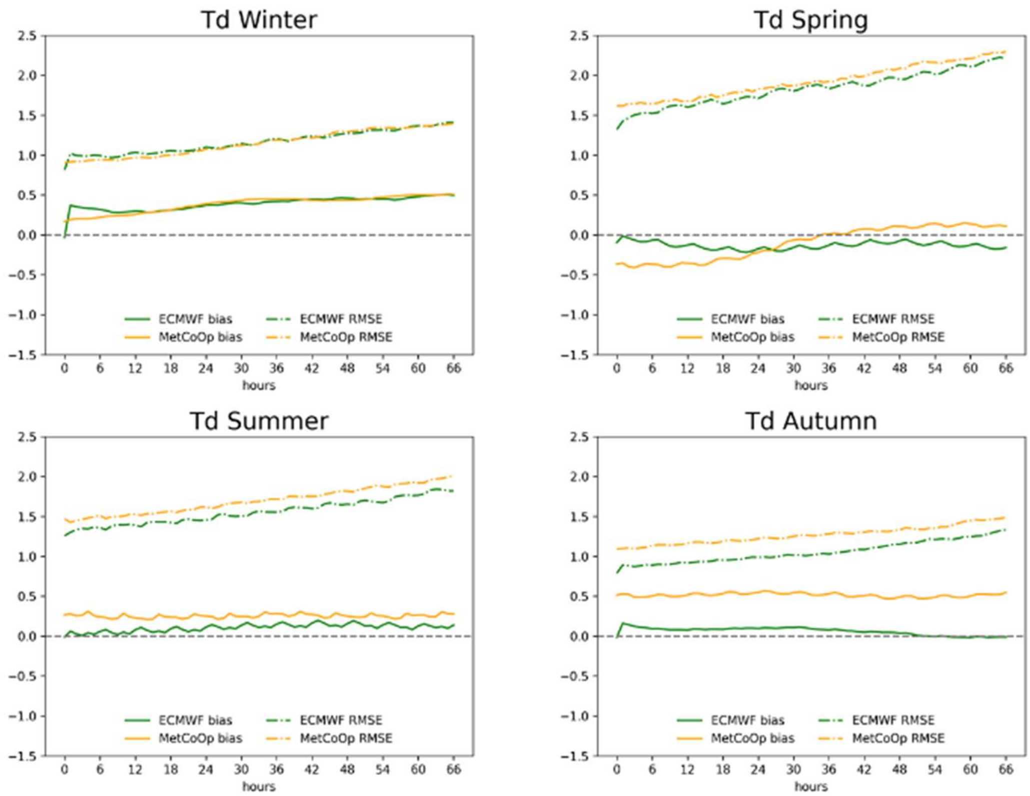

Figure 4. 2m dewpoint temperature (Td) bias and RMSE results for MetCoOp-HARMONIE (yellow) and ECMWF (green).

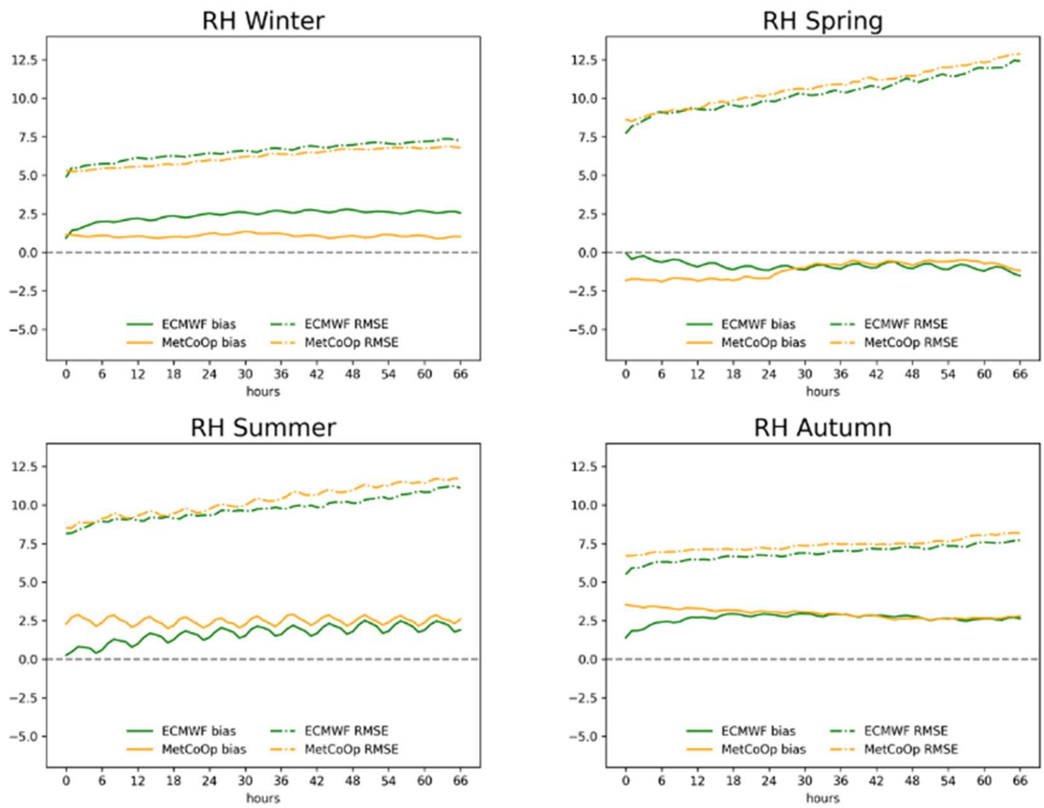

Figure 5. 2m relative humidity (RH) bias and RMSE results for MetCoOp-HARMONIE (yellow) and ECMWF (green).

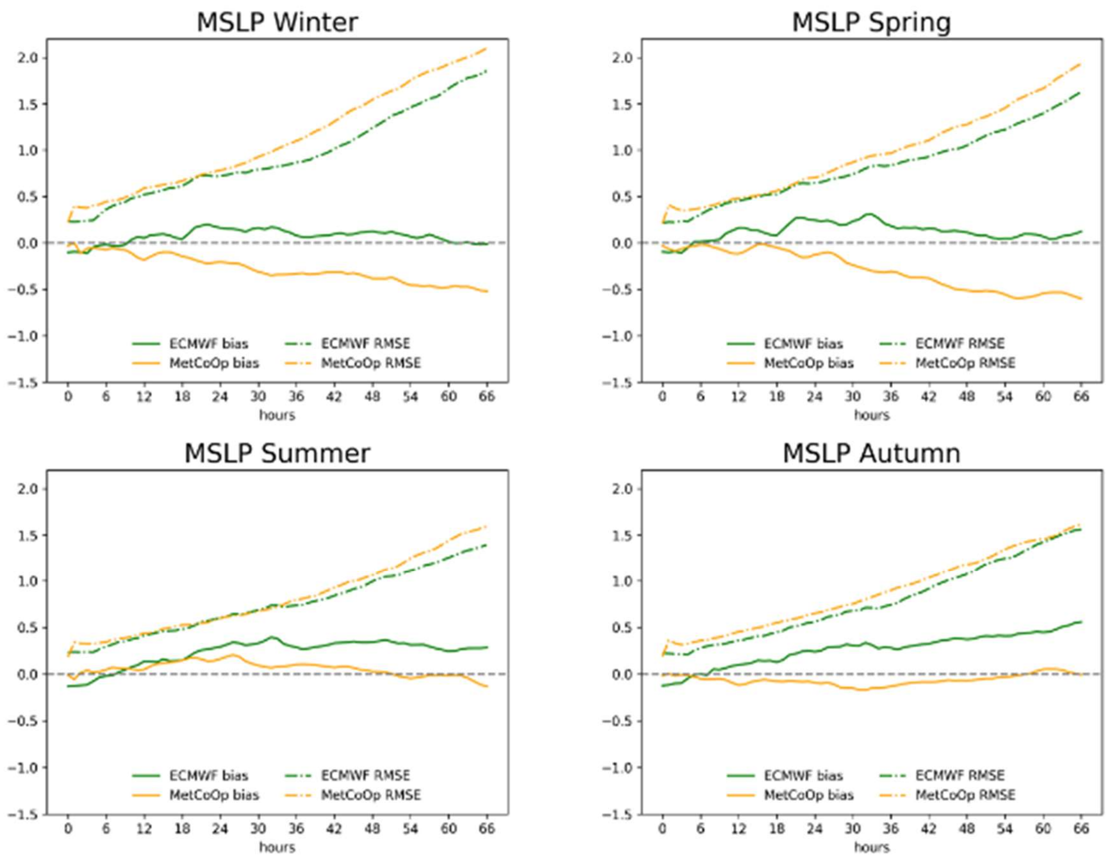

Figure 6. Mean sea level pressure (MSLP) bias and RMSE results for MetCoOp-HARMONIE (yellow) and ECMWF (green).

3.1.2 Post-processed products and end products delivered to users

e.g. Calibrated ENS probabilities, etc. For lead times up to day 15.

3.1.3 Monthly and Seasonal forecasts

Focus on lead times beyond day 15.

3.2 Subjective verification

3.2.1 Subjective scores

Include evaluation of confidence indices when available.

The results and conclusions from the survey made by ESTEA’s forecasters in June 2021 are presented in the following section. Forecasters had a chance to evaluate ECMWF parameters in 5 points scale where 1 shows “very bad”, 2 “bad”, 3 “average”, 4 “good” and 5 “very good”. Answers and comments were gotten from 14 forecasters which is ~75% of the total forecasters working at ESTEA. It is possible to see (Figure 7) that worst results were given to the visibility and ice depth categories. The best results were given to the parameters in different pressure height levels. From the surface parameters has the highest values mean sea level pressure and wind parameters (speed, direction, gusts).

Some conclusions and comments which were given in the survey:

1. Spring time temperature extremes (minimum in night and maximum in noon) are not well predicted. Usually depending on the location temperature differences might be 6 degrees. It mostly depends on the forecasted cloudiness (clear or cloudy) which affects the temperatures.

2. Convective precipitation’s timing and location does not follow the actual situation but it gives an idea on which area has a higher probability of convective processes. Generally predictions are trustworthy for about 24 hours.

3. Average 10m wind speed tend to usually be a little bit overestimated (2-3 m/s) but storms are mostly well predicted.

4. Long term predictions (90 hours and longer) tend to change quite often as the cyclone trajectory changes.

5. Concerning the forecasted ice formation and melting in lakes (Lake Peipus, Lake Võrtsjärv) and also in the Baltic Sea it is quite problematic and often does not follow the real situation. Wrong predictions affect the local conditions and cause wrong temperature and wind forecast for the location.

6. Visibility (especially fog) and low cloudiness is not well predicted and for aviation forecasters it is still troublesome to get an accurate forecast. Mostly ECMWF tends to underestimate the real conditions.

7. Formation of glazed frost is a phenomena which occurrence has increased recent years and it has seriously affected electricity grids and traffic conditions. It could be possible to have some probability product for glaze.

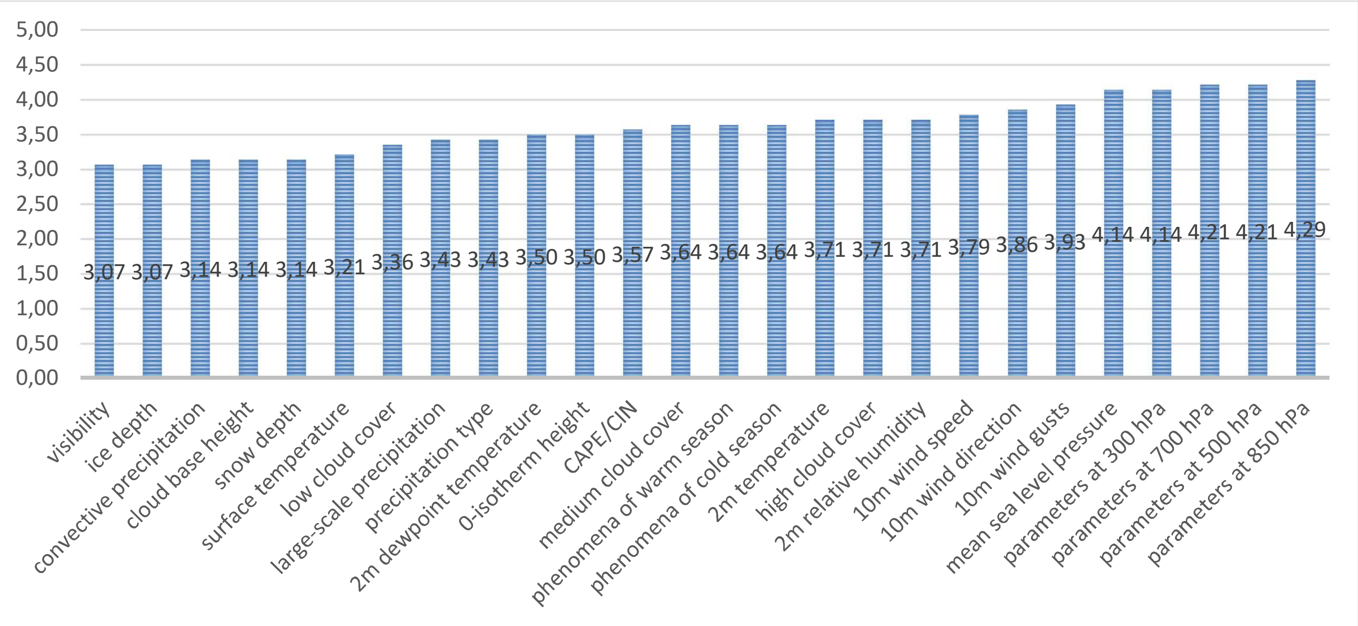

Figure 7. ESTEA's forecasters feedback for different ECMWF parameters predictions.

3.2.2 Case studies

Severe weather events/non-events are of particular interest. Include an evaluation of the behaviour of the model(s). Reference to major forecast errors, even if they are not in a "severe weather" category, are also very welcome.

4. Requests for additional output

Include here any particular requests you may have for new or modified ECMWF products.

A more explained and simplified IFS-ENS products. Probability forecasts for blizzard, glaze and hail.

5. References to relevant publications

No publications have been cited in this report.