Application and Verification of ECMWF Products 2021

Organisation: National Meteorological Administration

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Summary of major highlights

- the graphical package (based on grib-api, perl and NCL-NCAR) used for ECMWF products was changed since 2018 and it was developed within NMA and RC-LACE;
- for the HRES hourly model, we added convection indices; the output data covers Romanian area;
- no changes for MOS statistical models.

1. Use and application of products

2.1 Direct Use of ECMWF Products

Since the summer 2018, the graphics for the main chain of ECMWF products (grid=0.5x0.5, up to 10 days of forecast) was changed. The actual graphical package was developed within NMA and RC-LACE. It is a flexible, portable and easy to use tool, designed for deterministic and ensemble systems. It is based on grib-api, perl and NCL-NCAR programming languages. Figure 1 shows examples of this kind of maps for a some of the meteorological parameters available.

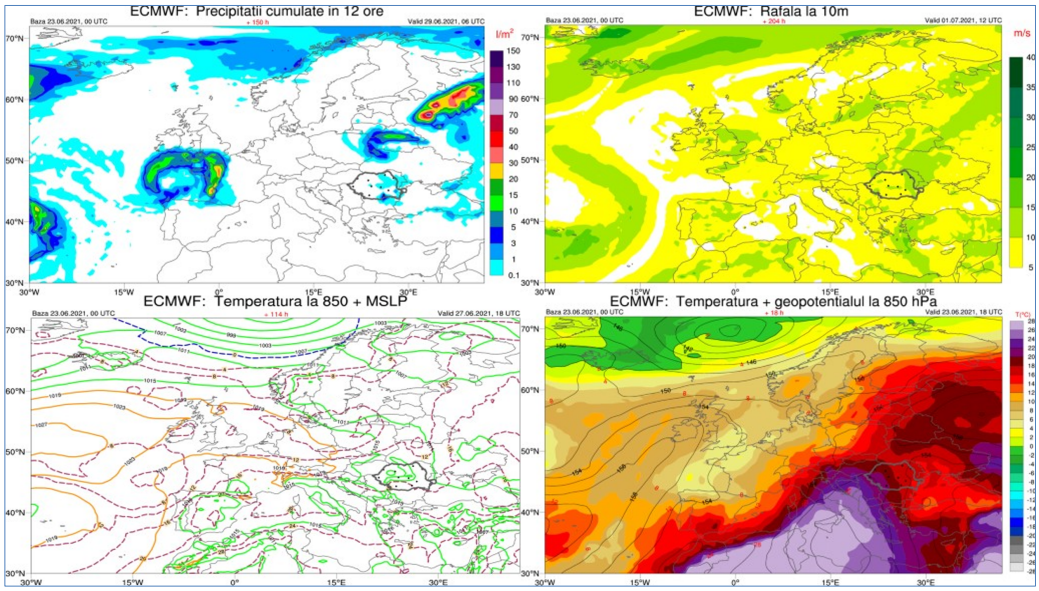


Figure 1. Example of maps obtained with the new graphical package.

The HRES hourly data from 0 to 90 hours for the four runs (00/06/12/18 UTC) are selected in automatic dissemination for different meteorological parameters (such as precipitation, the wind components, cloudiness). The output data covers Romania. These parameters are plotted and displayed on the website (Figure 2).

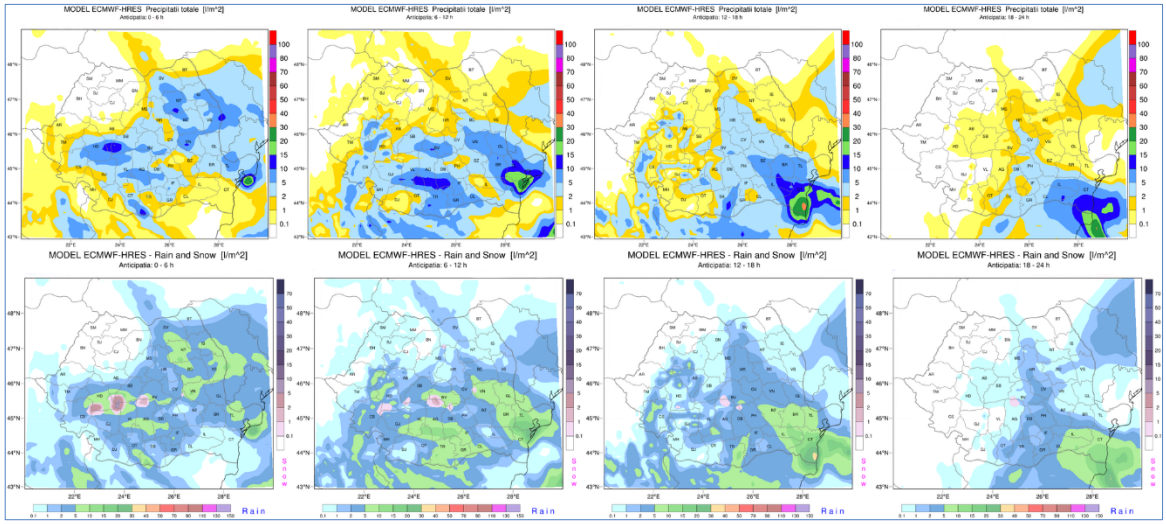


Figure 2. Example of HRES output displayed on the website (6-hour cumulated precipitation).

The ECMWF products available at NMA are used for the short and medium range forecasts. These products are provided to forecasters in order to issue forecasts for public, state authorities, national warning system or to customers (and mass media) in different format types (graphical or grib data files).
The graphical products are available for the Weather Forecast Department, in real time, and are obtained using graphical packages developed at ECMWF: Metview and Magics.
Some examples of graphical products, which are available on a specific web site, are as follows:

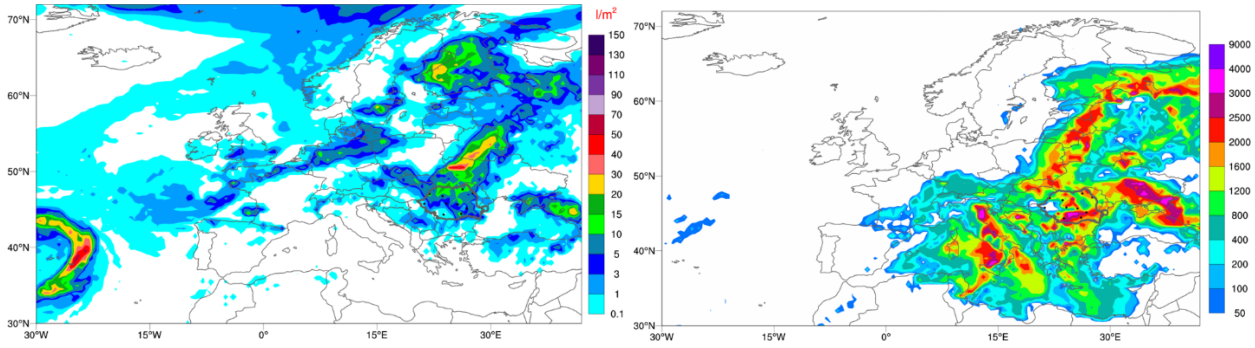


Fig.3 **left** – cumulated precipitation in 12 hours, Base: 23.06.2020, 00.00 GMT, Valid: 26.06.2020, 18 GMT – 27.06.2020, 06 GMT
right – CAPE, Base: 23.06.2020, 00.00 GMT, Valid: 23.06.2020, 18 GMT

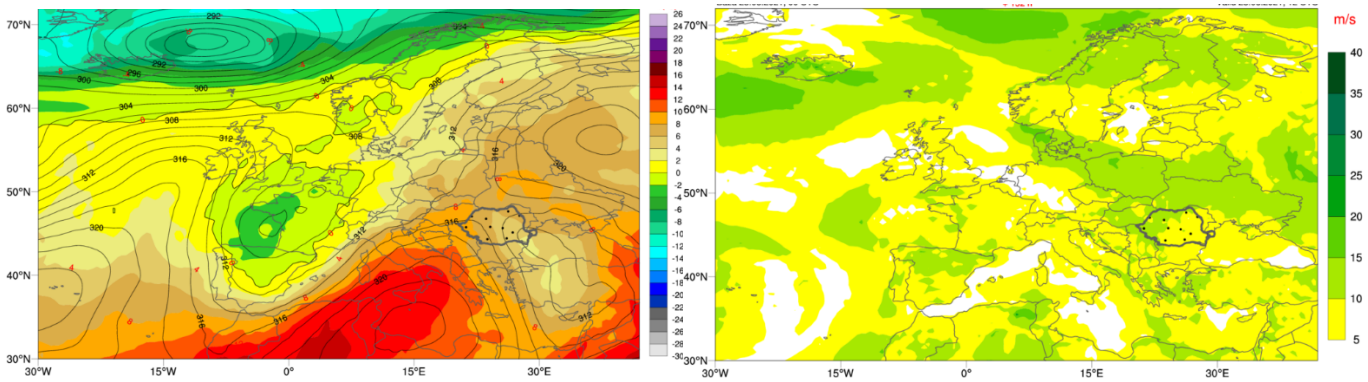


Fig.4 **left** – Temperature and geopotential at 700 hPa, Base: 23.06.2020, 00.00 GMT, Valid: 23.06.2020, 00.00 GMT
right – Wind gust at 10 m, 23.06.2020, 00.00 GMT, Valid: 28.06.2020, 12 GMT

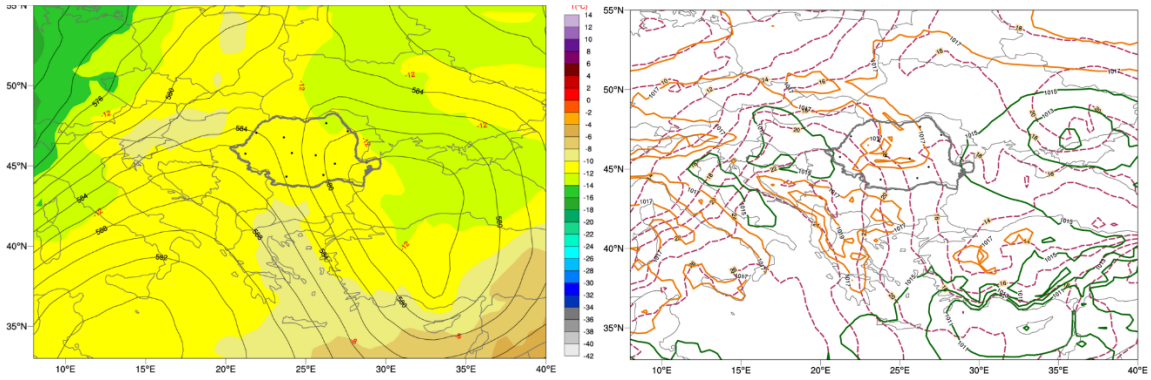


Fig.5 **left** – Mean see level pressure and temperature at 850 hPa, Base: 23.06.2020, 00.00 GMT, Valid: 23.06.2020, 00.00 GMT
right – Temperature and geopotential at 500 hPa, Base: 23.06.2020, 00.00 GMT, Valid: 24.06.2020, 06.00 GMT

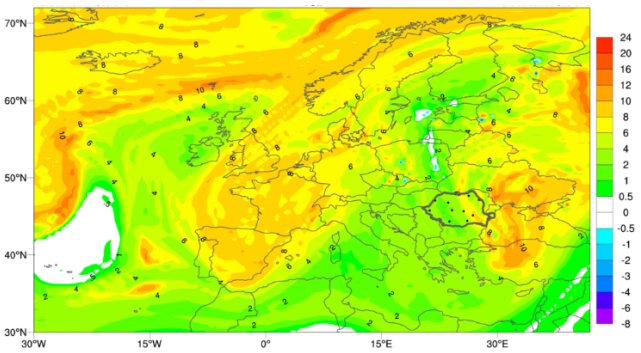


Fig.6 200 hPa potential vorticity

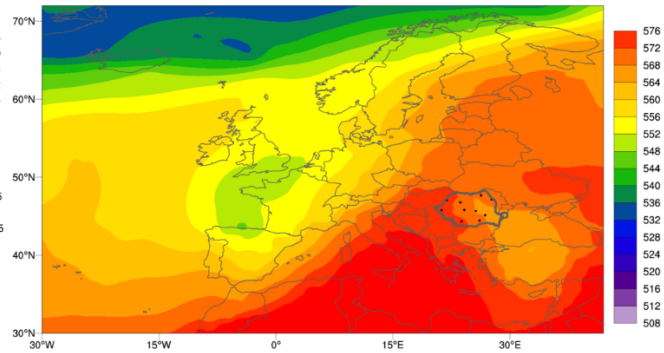
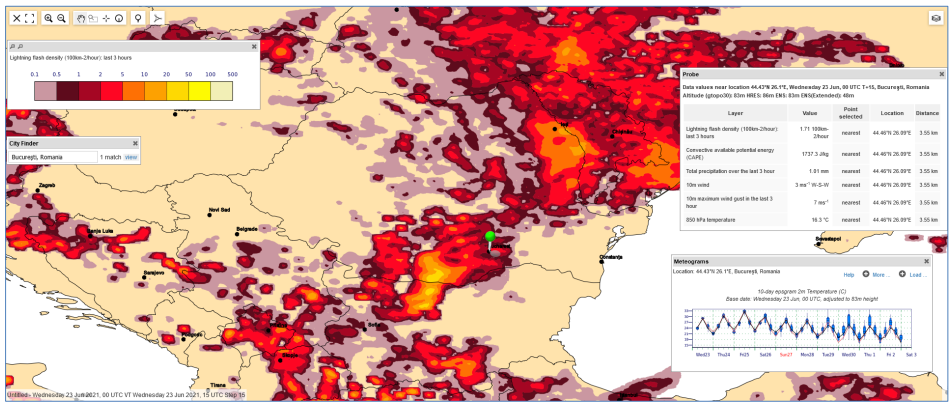


Fig.7 HGT 500 – 1000 hPa

Some very useful products for the short and medium range forecasts, that NMA uses are provided by the ecCharts application and here are some examples that proved to be very useful in operational forecast activity:

a)



b)

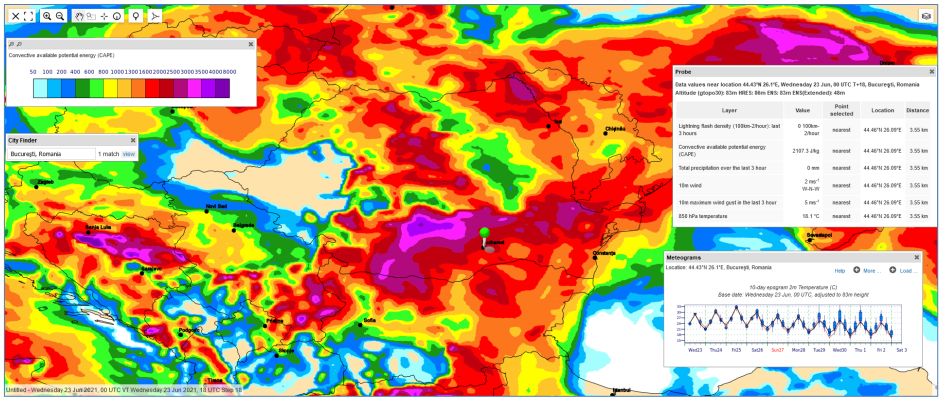


Fig.8 Lighting flash density (a) and CAPE (b)

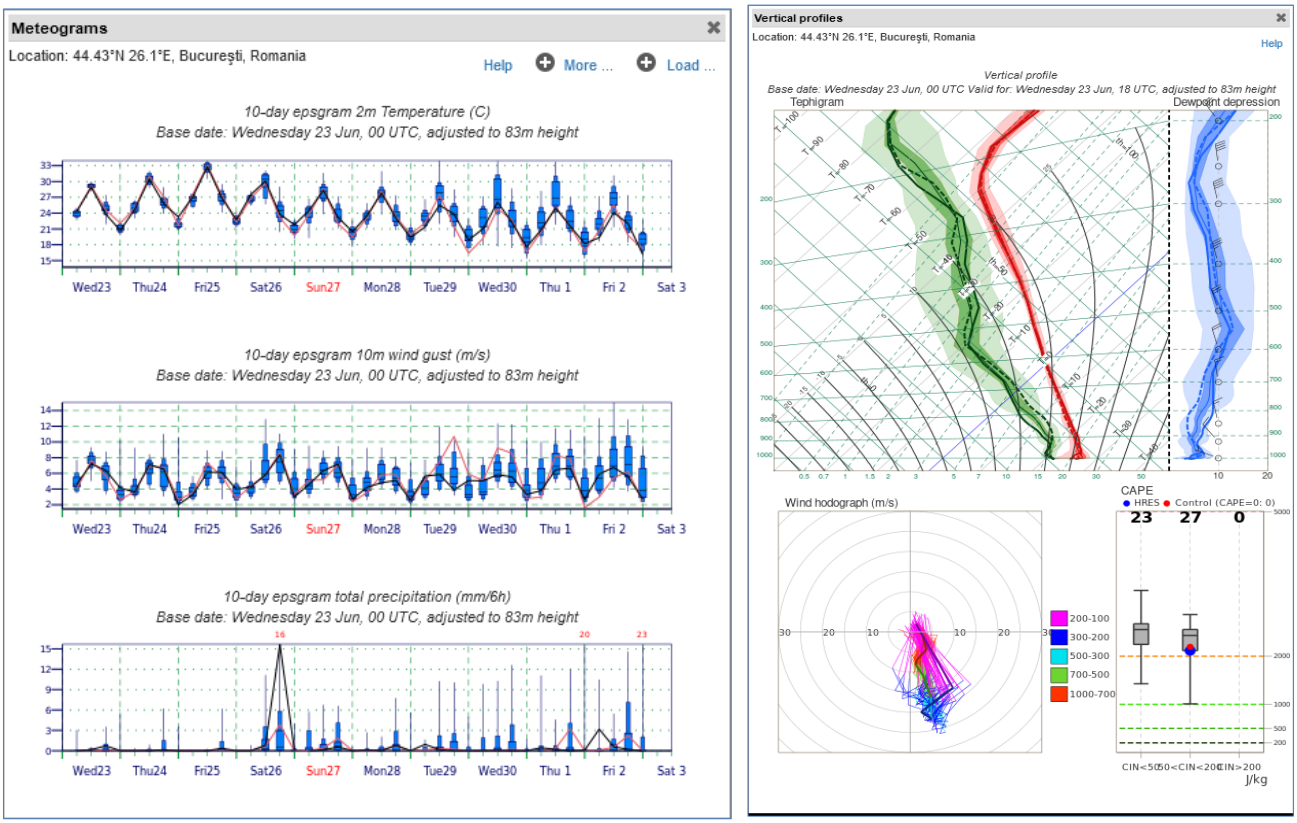


Fig.9 – **Left**: Meteogram for Bucharest, Base: 23.06.2020, 00.00 GMT: 2m temperature (ºC), 10m wind gusts (m/s) and total precipitation (mm/6h; **right**: Vertical profile for Bucharest, Base: 23.06.2020, 00.00 GMT for 23.06.2020, 18:00 GMT

Also, the Open Charts catalogue is very useful, providing a quick overview on all parameters, forecast range, or type of product, i.e. HRES, ENS, EFI.

For the HRES hourly model, we added convection indices. The output data covers Romanian area. These parameters plus those used since December 2018 are plotted and displayed on the website (hourly data from 0 to 90 hours for the runs: 00/06/12/18) (Figure 10).

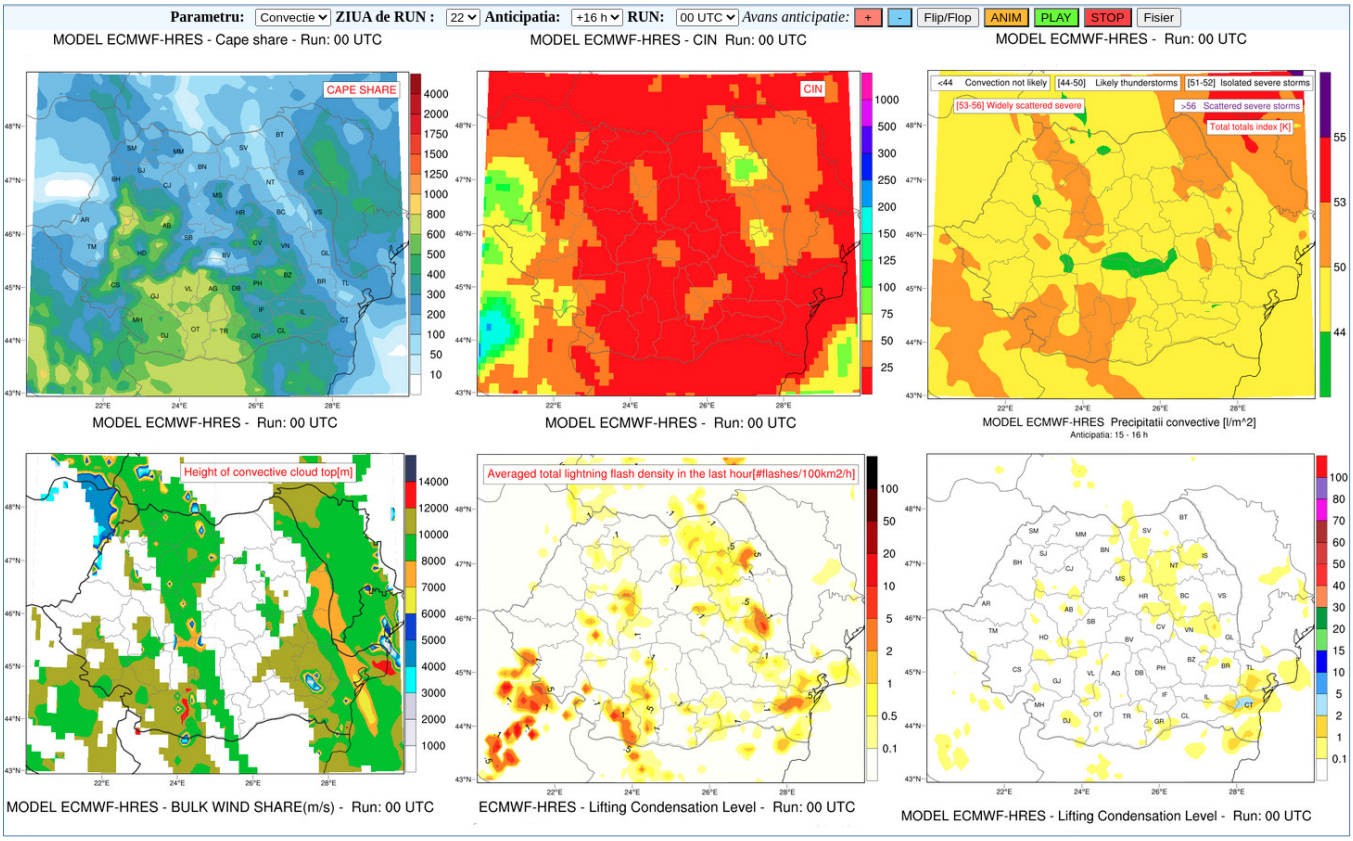


Figure 10. Example of HRES- 1-hour output displayed on the website. (hourly convection indices for 22 June, +16 hours, 00 UTC run)

In NMA we enhanced the post-processing of the 4 weeks forecast for Romania, for getting additional support to the forecast operations. This is done in two ways. First is by providing overlapped information of the predicted field and probabilities (Figure 11). The second is by provided the re-constructed forecast (based on predicted anomalies by SYS5-ENS system and the local re-gridded observed climatology over the last 20 years, i.e. the same climatology as the one used in ENS predictions). The aim of this re-construction (performed for t2m and precipitation) is to use the full-value predicted in applications and guidance that require information relative to the observed climatology. A third mention is that the predicted anomalies are scaled by a factor based on the ratio between forecasted-SYS5/observed variability in order to avoid negative precipitation on the re-constructed field, and to get estimates of anomalies in the observed-space.

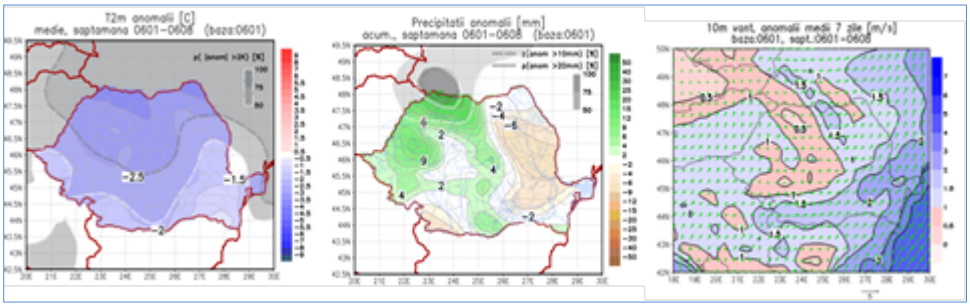


Fig.11. Predicted SYS5-ENS field of t2m anomalies (left), precipitation anomalies (middle) and 10m wind (right) as weekly means: in grey there is overlapped the probability field > 50% from SYS5-ENS.

2.2 Other uses of ECMWF output

2.2.1 Post-processing

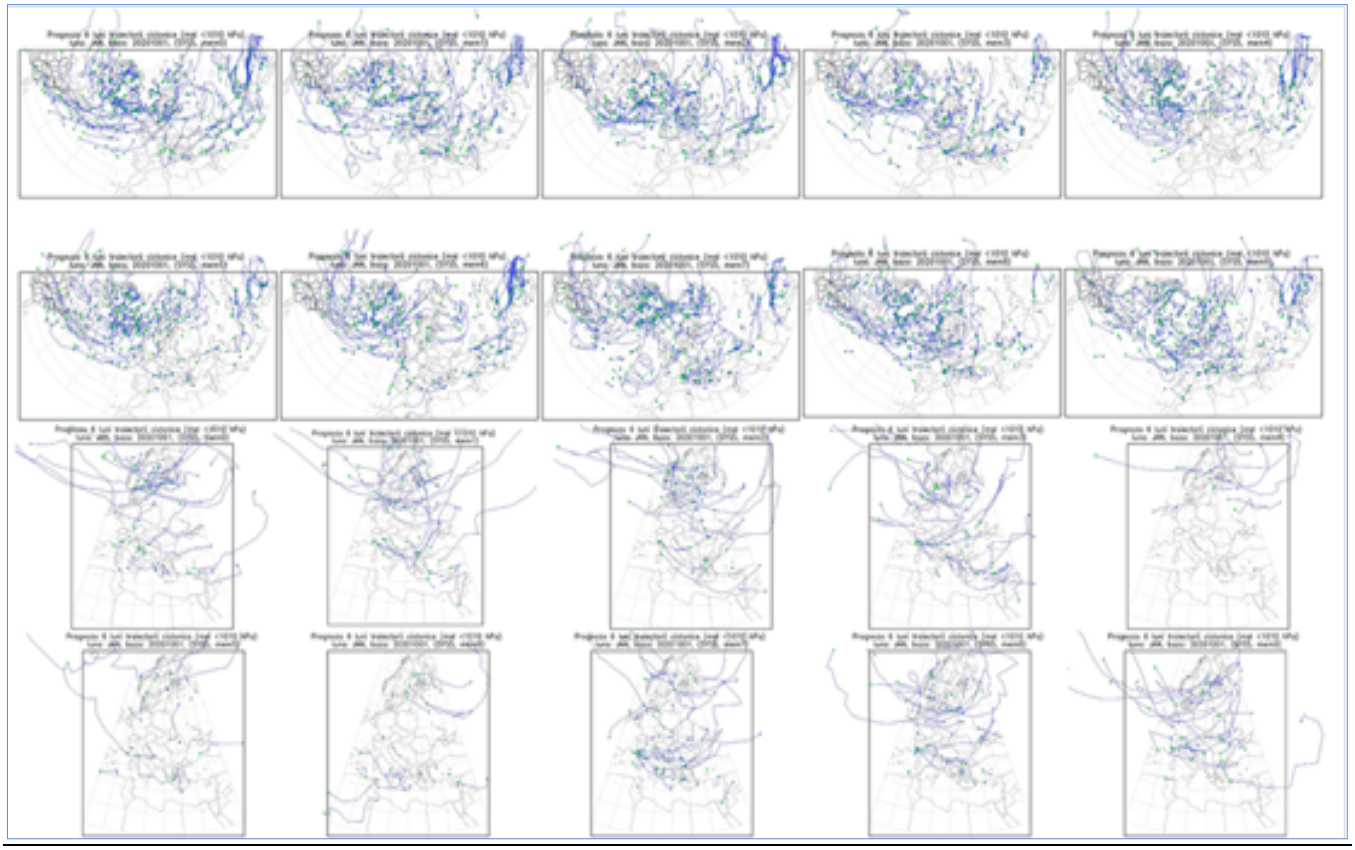
2.2.2 Derived fields

In NMA it was implemented the seasonal prediction of the draught index SPEI. Based on predicted 2m temperature and precipitation. The method is based on observed time-series for 1990 to present-month, re-gridded at 10 km resolution (Rocada database, Dumitrescu et al., 2015). This series is merged with the predicted 6 months fields that are first reconstructed based on predicted anomalies and Rocada local climatology, in order to embed the forecast into the observed climate. The results are for now encouraging and computations have been performed since March 2020. This serves as guidance each month, in addition to other materials, to the Agro-meteorological department for the following 6 months estimates and are provided together with uncertainty derived from the ensemble. We are currently performing back-computations with the SYS5-ENS seasonal forecast system in order to have a robust skill analysis to be reported.

2.2.3 Modelling

In NMA we implemented a trajectory computation algorithm based on mean sea level pressure, that was tested in runs using ERA5 data over 1980-2020 (Caian et al., in prep). We are currently running this algorithm in order to test its potential use in monthly/ seasonal prediction of storm-tracks based on SYS5-ENS predicted MSLP (6h) for the next 30 days/ 6 months (Figure12). Analysis of tracks density and mainly of their anomalous origins (Atlantic / Mediterranean) are thought to be predictive indicators for sub-regional impact (through local amplification, e.g. the Black Sea), as already emphasised in some studies for SE Europe and Romania. For that reason, the forecast skill of MSLP from SYS5-ENS system is currently under analysis.

a)



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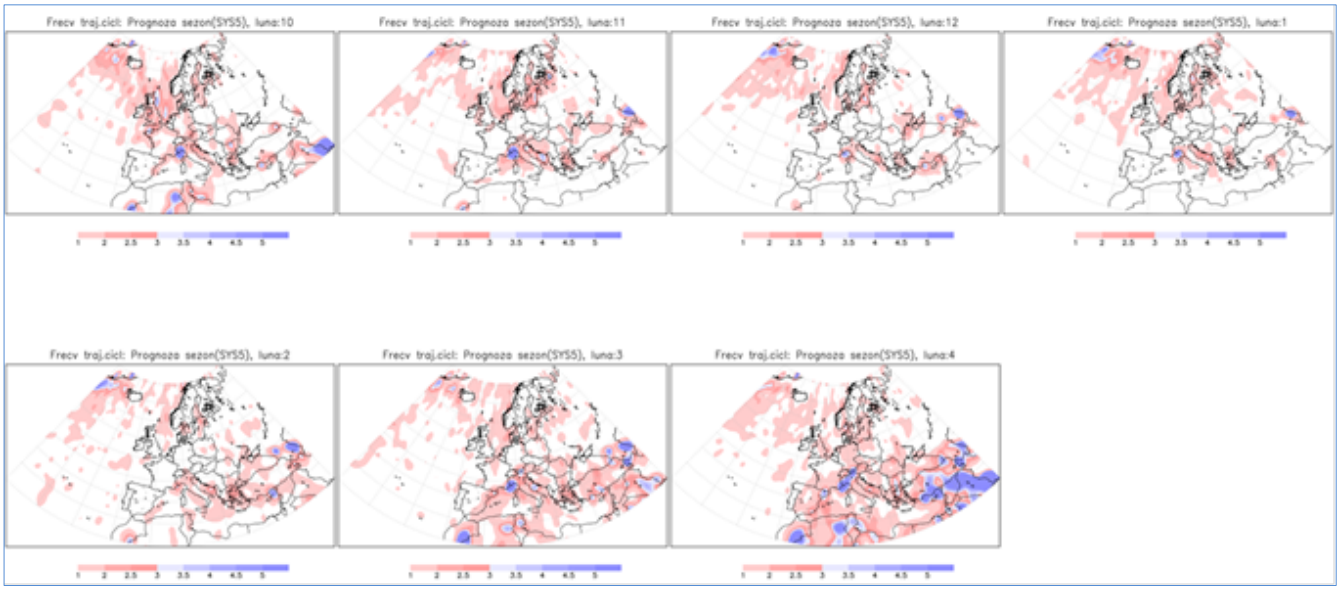

Fig. 12: a) Example of mid-latitude storm-tracks trajectories forecast computed based on SYS5-ENS seasonal forecast of MSLP for areas: NH (Eur-Asia) (top, 10 members) and Romania (bottom, same 10 members): example for month: base+4 months forecast; b) example of computed number of normalised tracks number over Euro-Atlantic domain; this information served to analyse Mediterranean activity (the main source of tracks for Romania) and storm branches split and are analised in conjunction with forecasted Jet. *Note:* March and April months were indeed wet to extremely wet months reported to the climatology, as indicated by the forecast of storm-tracks based October (this figure).

3. Verification of ECMWF products

3.1 Objective verification

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

The VERMOD tool is still in use. We do objective verification of all models operationally in National Meteorological Administration (NMA) for ECMWF, ARPEGE, ALADIN, COSMO, and ICON outputs (Figure 13). Statistical verification scores are calculated daily and monthly (Figure 14) and annually (Figure 15) and display on the verification website.

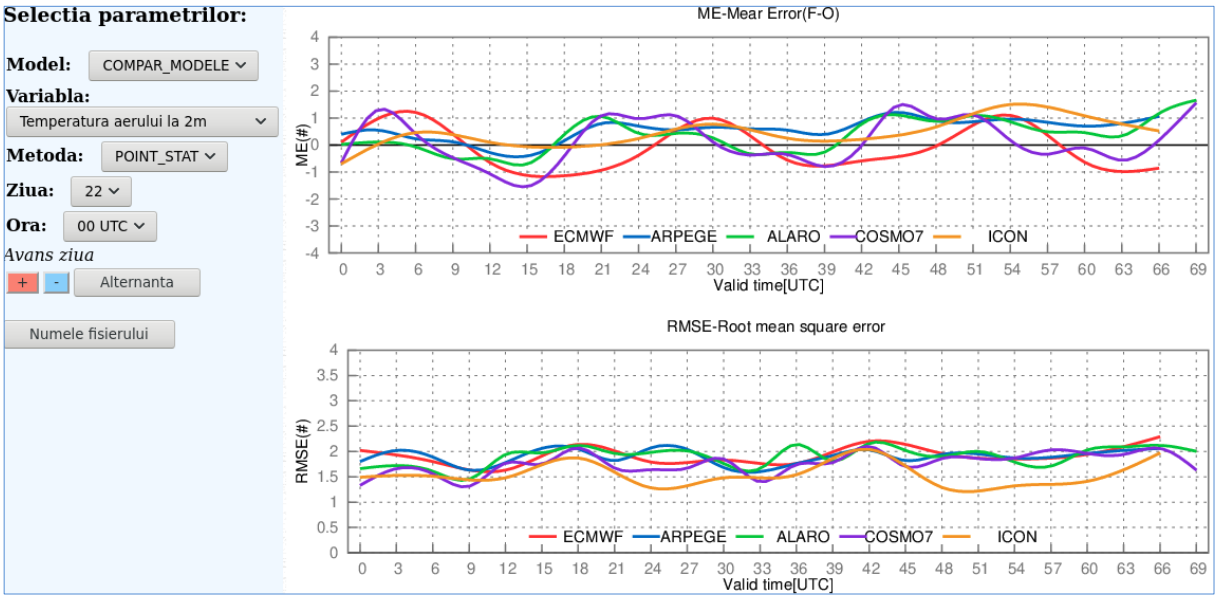

Figure 13. Example of a daily comparative score for T2m

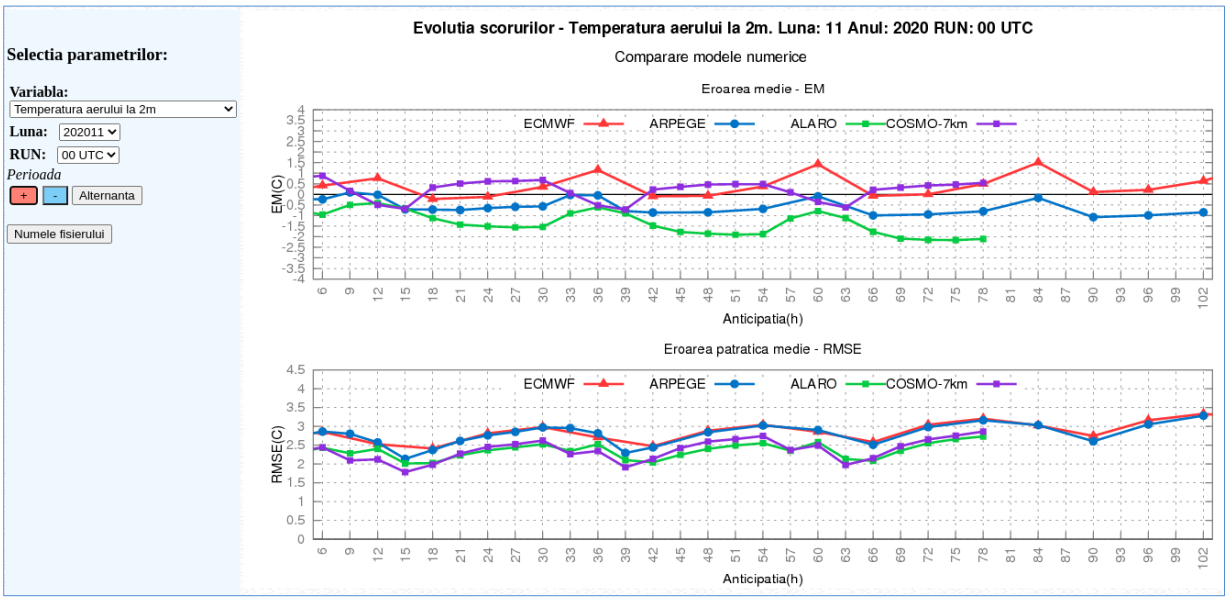

Figure 14. Example of a monthly comparative score for T2m. November 2020

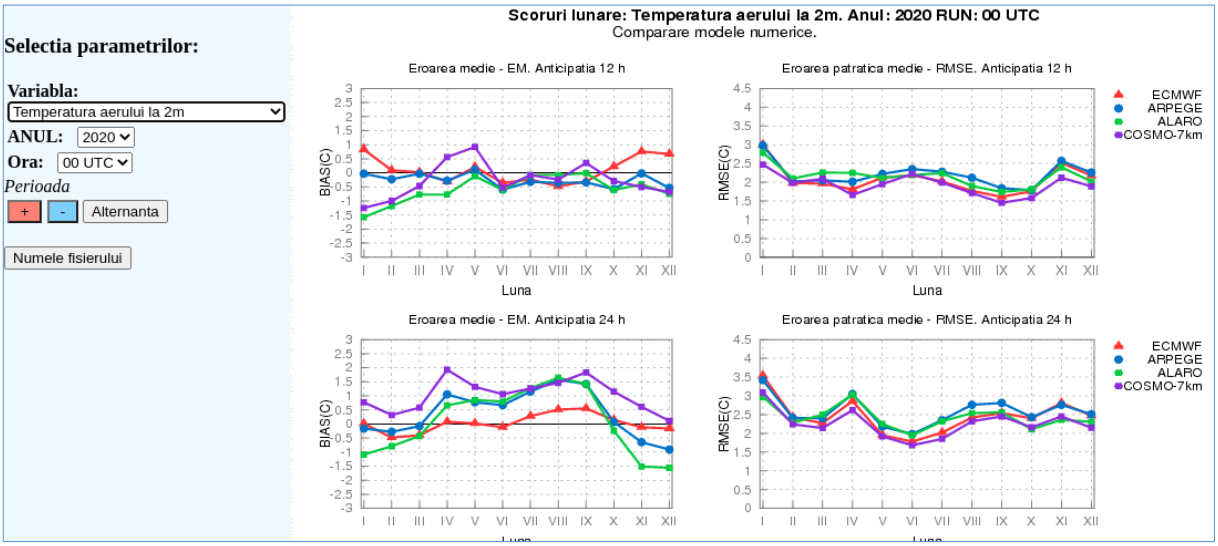

Figure 15. Example of 2m Temperature. BIAS and RMSE scores using all meteorological station. Year - 2020

The GRID_STAT procedure (base on METv8.1 - upgrade from METv5.2, verification tool from NCAR) is used to produce daily Verification of all models (surface parameters) used at NMA and we plot graphics for each model and a comparative one.

For 24 hours of cumulative precipitation, we display Fraction Skill Score (FSS) for the 24, 48, and 72 hours anticipation on the dedicated statistical and verification website (Figure 16).

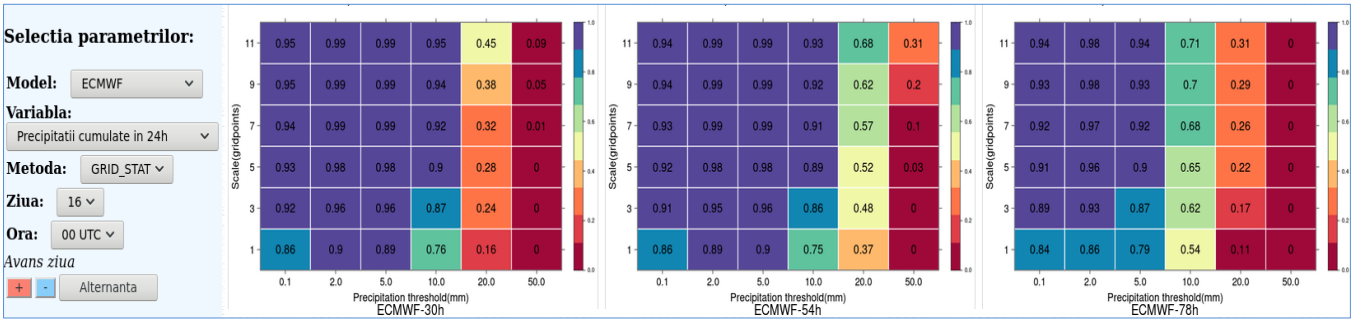

Figure 16. Example of the web user interface- FSS for HRES-ECMWF

3.1.2 Post-processed products and end products delivered to users

3.1.3 Monthly and Seasonal forecasts

3.2 Subjective verification

3.2.1 Subjective scores

On our internal website, we display comparative forecasts for 24 hours cumulated precipitation from the following models: ECMWF (12 UTC, 00 UTC), ARPEGE (00 UTC), ALARO (00 UTC), COSMO-7km (00 UTC), ICON-2.8km (00 UTC) and COSMO-2.8km (00 UTC) for the 24, 48 and 72 hours anticipation. Comparisons are done against SYNOP observations and SYNOP observations combined with hydrological measurements and radar estimates.

3.2.2 Case studies

2. Requests for additional output

5. References to relevant publications