Application and Verification of ECMWF Products 2019

Organisation: Nationala Meteorological Administration

Authors: Gabriela Băncilă, Cristian Crăciun, Simona Tașcu, Otilia Diaconu, Aristița Busuioc, Zenaida Chițu, Mihaela Caian

1. Summary of major highlights

- a new graphical package (based on grib-api, perl and NCL-NCAR) is used for ECMWF products;
- the HRES hourly data from 0 to 90 hours for the four runs (00/06/12/18 UTC) are plotted daily;
- no changes for MOS statistical models;

NMA used the ENS monthly and seasonal forecasts in the following applications:

- direct forecasts post-processing (anomalies reconstruction for required climatologies; additional probabilities computations from members; fields: t2m, precipitations wind 10m, mslp, snow fall, snow depth, geopotential and temperature at 850 hPa, 500 hPa, 200 hPa);
- compute derived prediction indices from ENS-ECMWF monthly-seasonal forecasts: stratosphere, S/T exchange, regional extremes indices (e.g. Mediterranean storm-tracks, Mediterranean-Black cyclogenesis indices; tropopause folding parameters);
- indirect use of forecasts: dynamical (DD) and statistical (SD) downscaling at high resolution (down to 5km) of 4 (DD) respectively 25 (SD) members over Romania;
- case-studies using direct forecast and dynamically adapted forecast.

2. Use and application of products

2.1 Direct Use of ECMWF Products

We use weather regimes for extended prediction, as analogue prediction support and to estimate regime transitions.

Starting from 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 maps for some meteorological parameters.

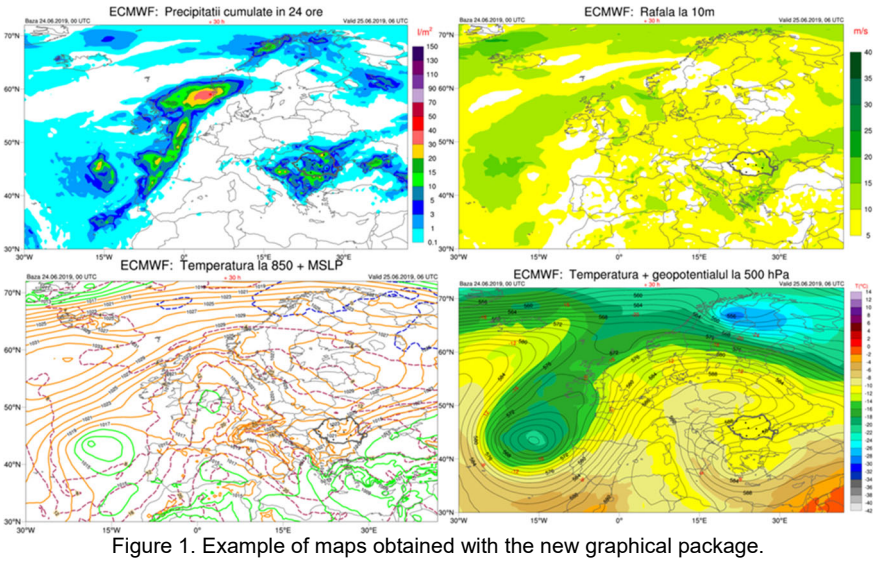

Figure 1. Example of maps obtained with the new graphical package.

Since the end of December 2018, the HRES hourly data from 0 to 90 hours for the four runs (00/06/12/18 UTC) were selected in automatic dissemination for different meteorological parameters (such as precipitation, the wind components, cloudiness). The output data covers Romanian area. These parameters are plotted and displayed on the website (Figure 2).

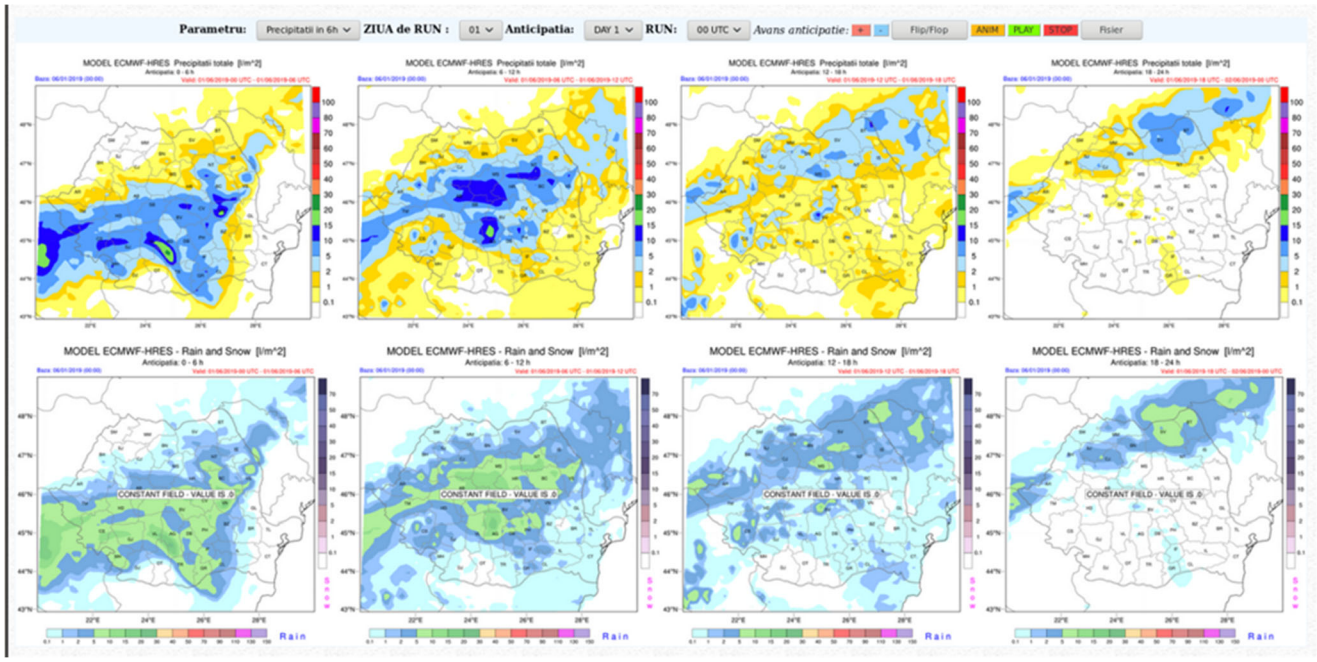

Figure 2. Example of HRES output displayed on the website (6-hour cumulated precipitation).

The ECMWF products available at NMA are used for the short and medium range forecasts. These products are provided to forecasters (public, state authorities, national warning system) or to customers (more mass media) in different type format (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:

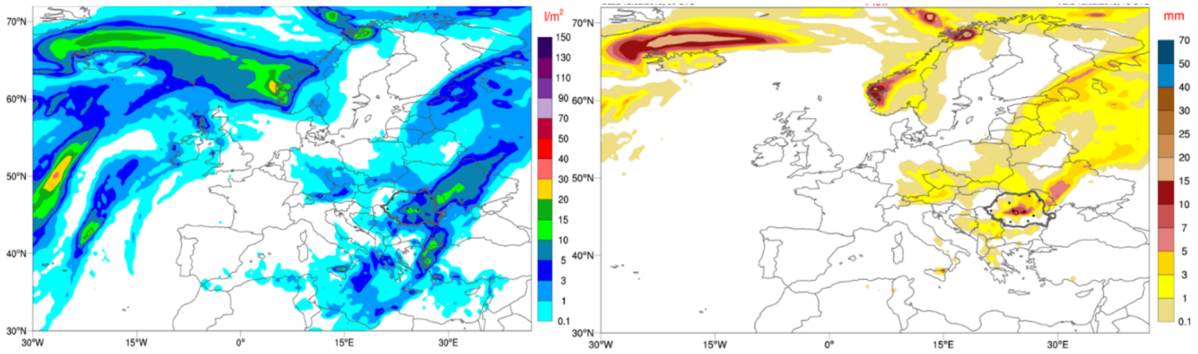

Fig.3 **left** – cumulated precipitation in 12 hours, Base: 12.02.2018, 00.00 GMT, Valid: 12.02.2018, 06 GMT – 12.02.2018, 18 GMT
right – cumulated snow in 12 hours, Base: 12.02.2018, 00.00 GMT, Valid: 12.02.2018, 06 GMT – 12.02.2018, 18 GMT

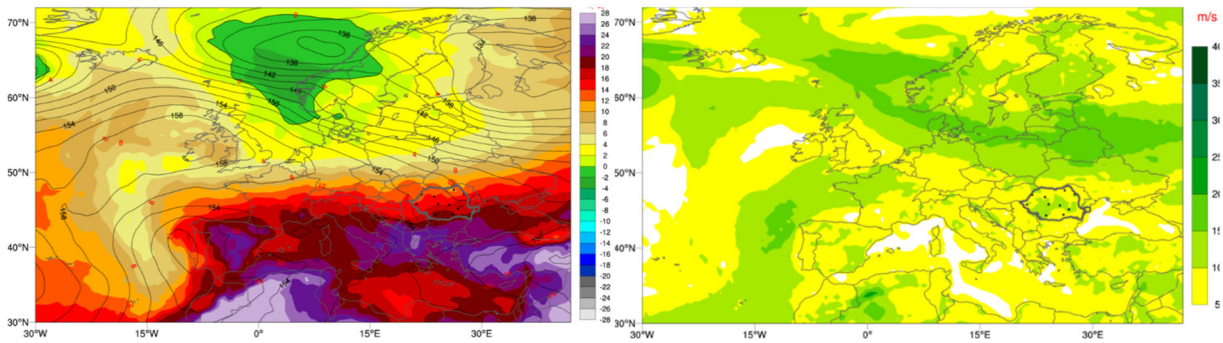

Fig.4 **left** – Temperature and geopotential at 850 hPa, Base: 03.07.2018, 00.00 GMT, Valid: 03.07.2018, 12 GMT
right – Wind gust at 10 m, Base: 03.07.2018, 00.00 GMT, Valid: 03.07.2018, 12 GMT

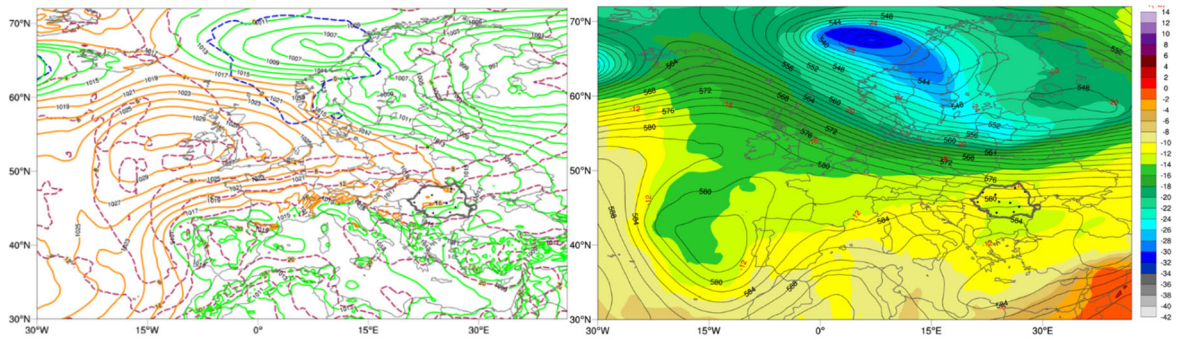

Fig.5 **left** – Mean see level pressure and temperature at 850 hPa, Base: 03.07.2018, 00.00 GMT, Valid: 03.07.2018, 12 GMT
right – Temperature and geopotential at 500 hPa, Base: 3.07.2018, 00.00 GMT, Valid: 03.07.2018, 12 GMT

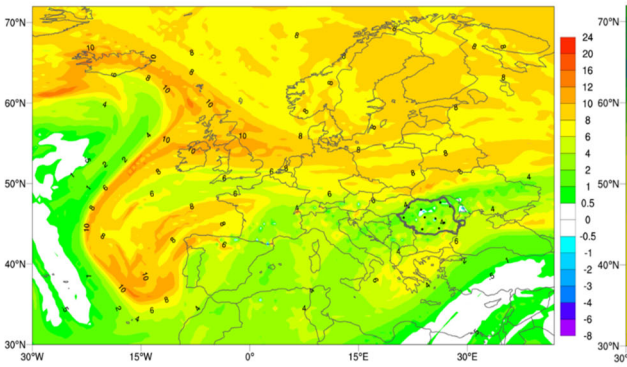

Fig.6 200 hPa potential vorticity

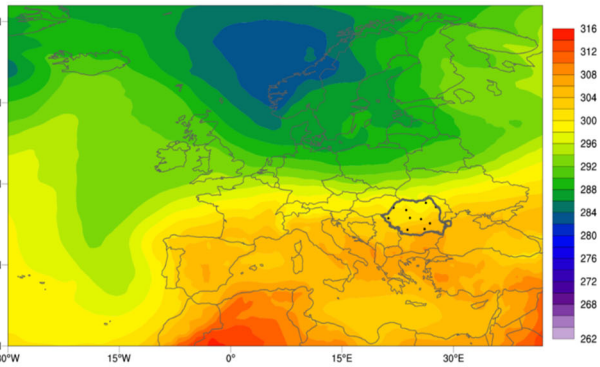

Fig.7 HGT 700 – 1000 hPa

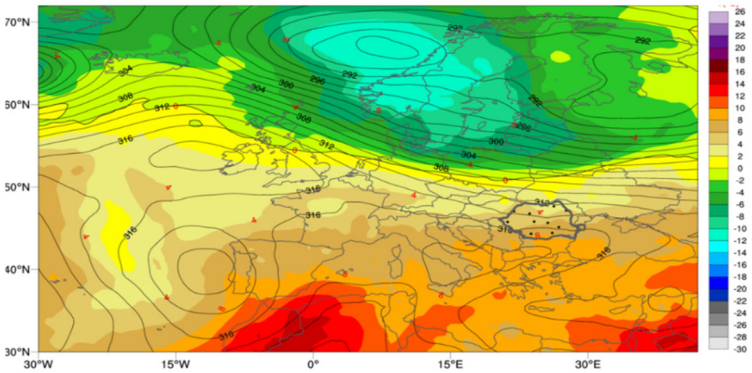

Fig.8 700 hPa temp & geop

Some other usefull products for the short and medium range forecasts, that NMA used daily during 2018, are provided by the ecCharts aplication and here are some examples that proved to be very useful in operational forecast activity:

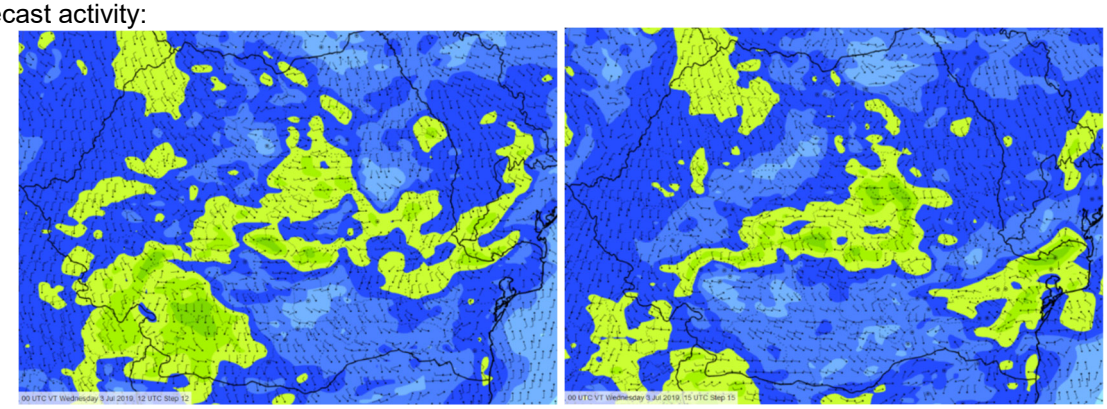

Fig.9 MSLP, WIND at 10 m and Wind Gust in the last 3 hour, Base: 03.07.2018, 00.00 GMT,
left – valid for 03.07.2018, 12.00 GMT; **right** – Valid for 03.07.2018, 15.00 GMT

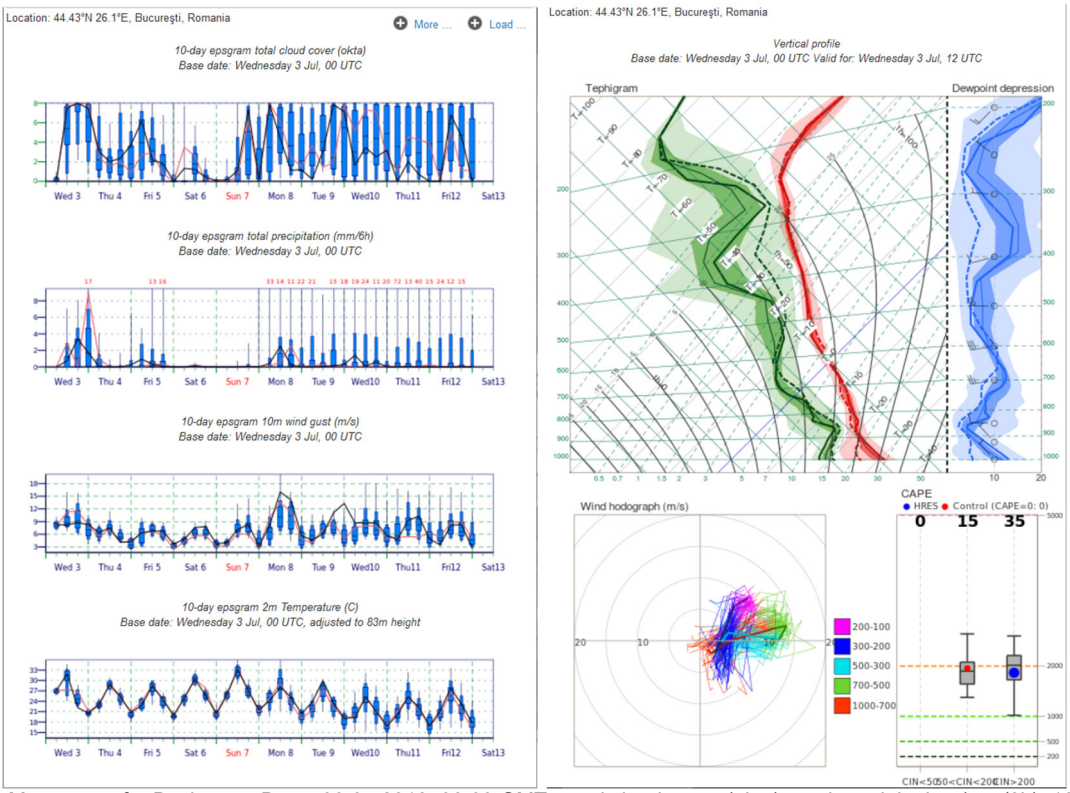

Fig.10 – **Left**: Meteogram for Bucharest, Base: 03.07.2018, 00.00 GMT: total cloud cover (okta), total precipitation (mm/6h), 10m wind gusts (m/s) and 2m temperature (ºC); **right**: Vertical profile for Bucharest, Base: 03.07.2018, 00.00 GMT

2.2 Other uses of ECMWF output

2.2.1 Post-processing

The MOS statistical models have been operational since 2004. No major changes occurred in basic models from that moment until now. Starting with 2012 the discriminated analysis was replaced with logistic regression, for all MOS systems. The models provide twice a day, local forecasts up to 10 days, to 163 meteorological stations for the following main parameters: 2m temperatures, extreme temperatures, 10m wind speed and direction, total cloudiness (3 classes) and total precipitation (3 classes). The results are represented in map format, text format, and displayed on the website. In 2014 a MOS version using HRES ECMWF model was developed and implemented on “ecgate”.

NMA performs high spatial resolution statistical downscaling over Romania using models (SDMs) calibrated in MOS version. The added value of the SDMs will be assessed against the direct ECMWF outputs. Preliminary verification is carried out for predictands: monthly mean t2m and total precipitation, as well as the predictors that will be used in the SDM calibaration (temperature at 850 hPa, specific humidity at 700 hPa and sea level pressure)

2.2.2 Derived fields

An automatic dissemination is made for the probabilities products derived from ENS output. Different thresholds, for several parameters are plotted in operational mode and displayed on the intranet page (Figure 11).

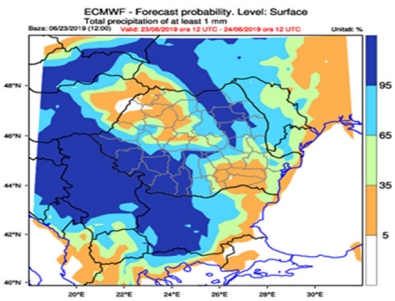

Figure 11. Example of probabilites plot.

Gridded soil moisture data based on ESA Cimate Change Initiative and ENS-ECMWF is used for exploring the observed and modeled preconditioning of landslide occurrence at regional scale.
We apply COST-project software to seasonal forecast to compute predicted analogues based on regionally-relevant teleconnections.

2.2.3 Modelling

NMA started testing since August 2018 operational dynamical downscaling of seasonal predictions from ENS-ECMWF for 4 members (0-3), using RegCMv4.5 model at 10km resolution. This DD is run once per month. Initial conditions from observations at 10km are inserted. The RegCM model was preliminary calibrated over the target area for high resolution and the optimal configuration was identified using a genetic algorithm. There are 2 purposes of this DD: - quantify eventual added value (at sub-regional scale) ; use its results as input for statistical downscaling in user-applications.

3. Verification of ECMWF products

3.1 Objective verification

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

There are no major changes regarding the objective verification. The VERMOD tool, an unitary system for objective verification of all models, is used operationally by the National Meteorological Administration (NMA) for ECMWF, ARPEGE, ALADIN, ALARO, COSMO outputs (Figure 12). A wide range of statistical verification measures are computed daily and monthly. The results are disseminated via dedicated statistical and verification website. The results are averaged over different regions (meteorological stations).

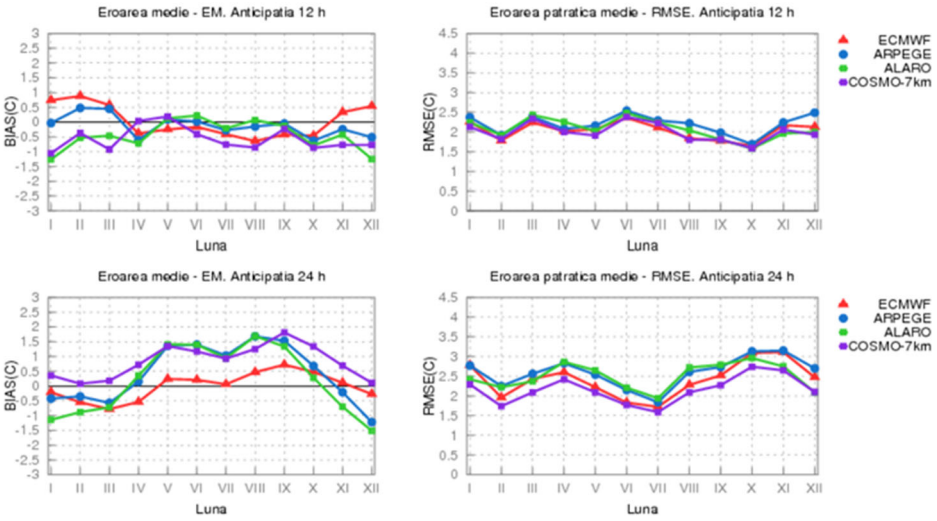

Figure12. Example of comparative scores for T2m

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 (including evaluation of confidence indices when available)

Since 2016, the procedure for displaying comparative rainfall forecast (amount in 24 hours) of NWP models in NMA (Figure 13).

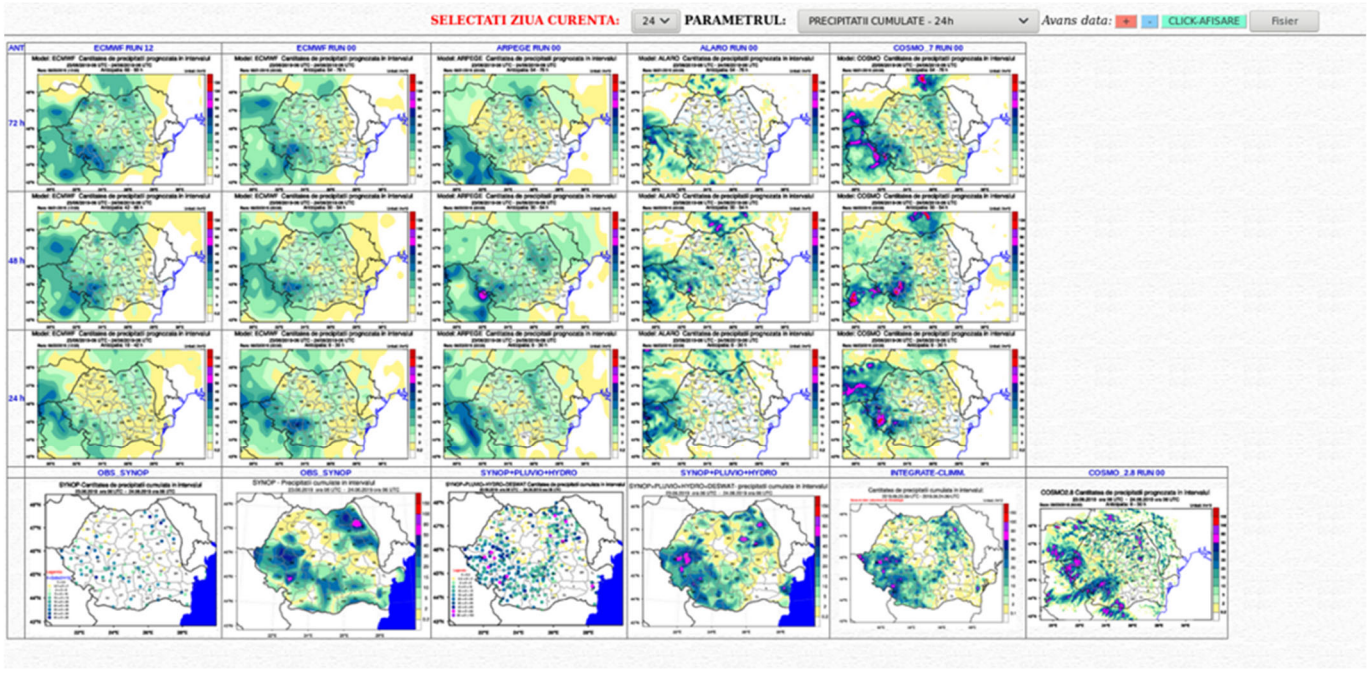

Figure 13. Example of comparative rainfall forecast.

3.2.2 Case studies

We performed case studies based on ENS extended predictions:

- seasonal prediction: sensitivity to hres sst initial conditions: - investigate the role of high-resolution sst nudging (E Atlantic) with a regional dynamical downscaling of seasonal ENS-ECMWF prediction: case-study: summer 2018
- flooding prediction: using high resolution dynamical downscaling of ENS-ECMWF coupled with a hidrological model for flooding prediction (case-study Crisul-Alb, Romania, April 2000, Fig. 14)
- large-scale preconditions for late-spring extreme cold events in ENS-ECMWF monthly forecast: case-study: April 2017, Romania.

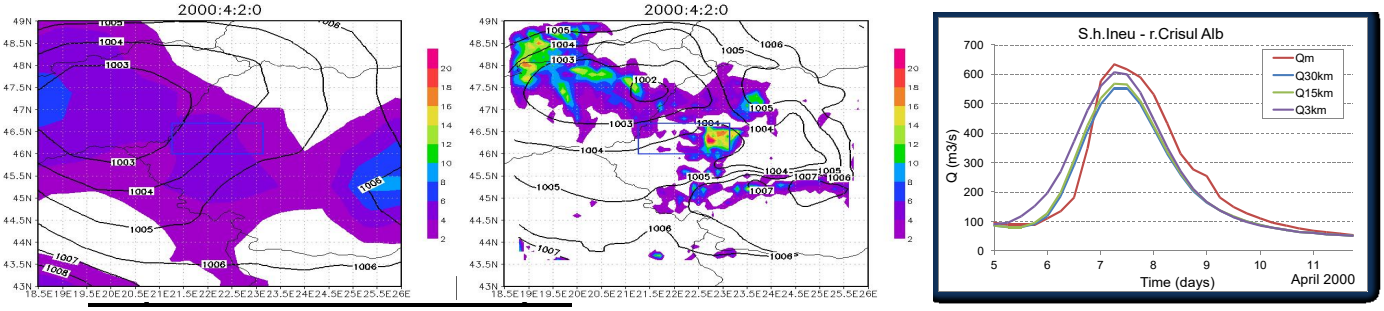

Fig. 14: a) ENS-ECMWF precipitation accumulated over 24 hours for 2nd of April 2000; b) the same from dynamical downscaling (DD) of a) at 3 km resolution; c) Flow simulation at hydrometric station Ineu on the Crişul Alb River for three atmospheric resolutions DD in April 2000, forced by ENS-ECMWF forecast based 1st of April 2000.

4. Requests for additional output

5. Feedback on ECMWF "forecast user" initiatives

6. References to relevant publications

M. Caian, R. Mic, C. Corbus, M. Matreata, C. Angearu "Extreme flood modelling over Crisul Alb basin in Romania" - submitted Natural Hazards
M. Georgescu, M. Caian, S. Stefan " - to be submitted