Application and verification of ECMWF products 2008

National Meteorological Administration of Romania

1. Summary of major highlights

Production of local adapted temperatures - 6-hours spot temperatures and extreme temperatures for 15 day ahead and daily extreme temperatures for monthly forecasts, since November 2008.

The output from the ECMWF system - seasonal forecasting model - was used to generate anomalies against observations at several Romanian stations.

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

Statistical adaptation – MOS – using as input the ECMWF direct model forecast field, is run operationally for 00 and 12 UTC. MOS covers a forecast range up to 7 days for 163 Romanian meteorological stations. Two different types of predictors are used: direct model output and derived quantities, such as relative vorticity, vertical gradients, etc. Main methods are multiple linear regression and linear discriminant analysis. The parameters: 2m spot temperature – 6 hours, daily extremes 2m temperatures, 10 Wind speed and direction(derived from wind components), total cloudiness(3 classes) and total precipitation (3 classes). The model equations were developed at Meteo-France – bilateral co-operation programme, and run at NMA. The results are plotted in maps forms and displayed on the web-site, and in text-form to the end-users. All MOS equations are updated every 2 years.

Since November 2008, statistical adaptation are used to provide temperatures - 6 hours 2m spot temperatures and daily extreme temperatures - up to 14 days using as input VarEPS. Statistical equation – 163 sites – are developed during the first 24 hours and then applied to the other corresponding time lag(steps). The method – pseudo-PP - was developed at Meteo France. The equations developed are applied to individual ensemble runs. Various statistical measures are computed: mean, median, spread, quantiles - and displayed in map and graph format, function of the forecasters demand. Generally the distribution over all country and over separate regions, is used by the forecasters.

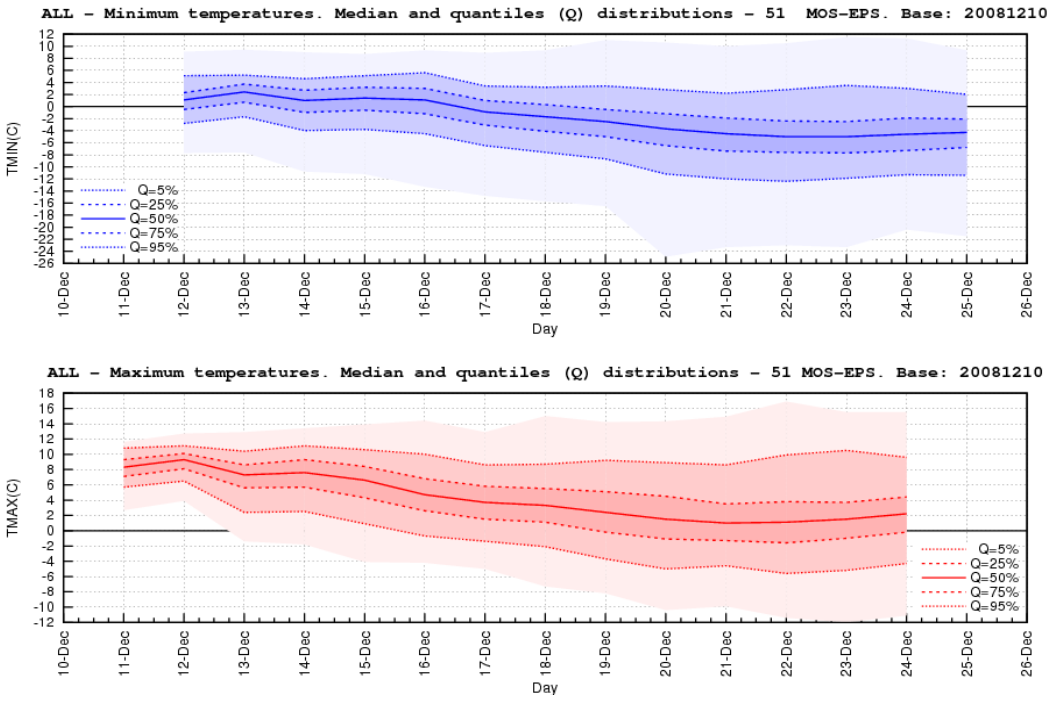


Fig. 1. Example of dissemination of the pseudo_PP extreme temperatures up to 14 days. Quantiles distributions,

using 51 runs and all forecasted temperatures – 163 stations.

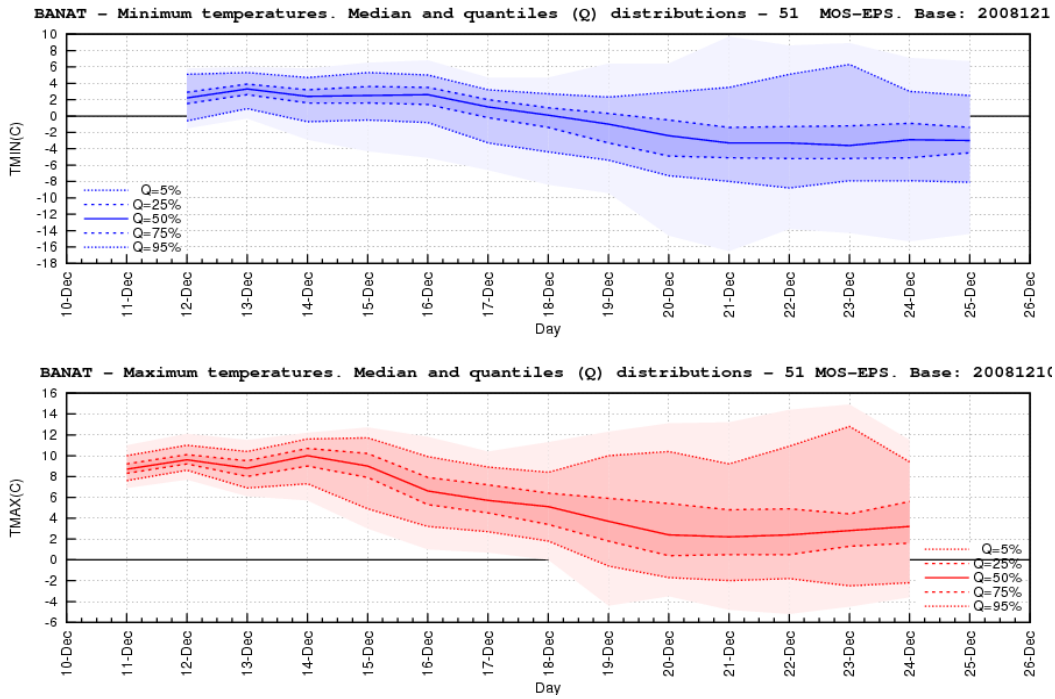


Fig. 2. The same as Fig. 1. but over a region

Monthly forecast

Statistical models – pseudo-PP are also applied to the monthly forecasts, up to 32 days, to provide daily extreme temperatures. These models run each Thursday and the results are available each Friday morning, for the next 32 days.

The results are disseminated, via web-site, in (the) various forms: graphs, daily maps(mean, spread). Weekly average and weekly distribution, are also computed as support for the monthly bulletin.

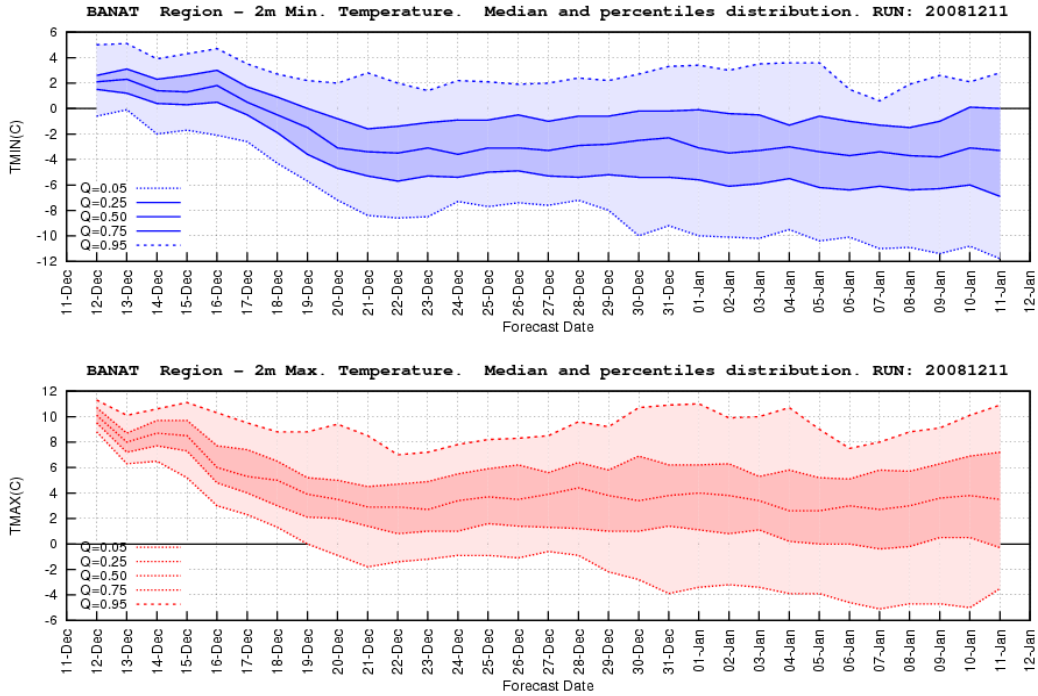


Fig. 3. Example of dissemination of the pseudo_PP extreme temperatures up to 32 days. Quantiles distributions,

using 51 runs and all forecasted temperatures over Banat region.

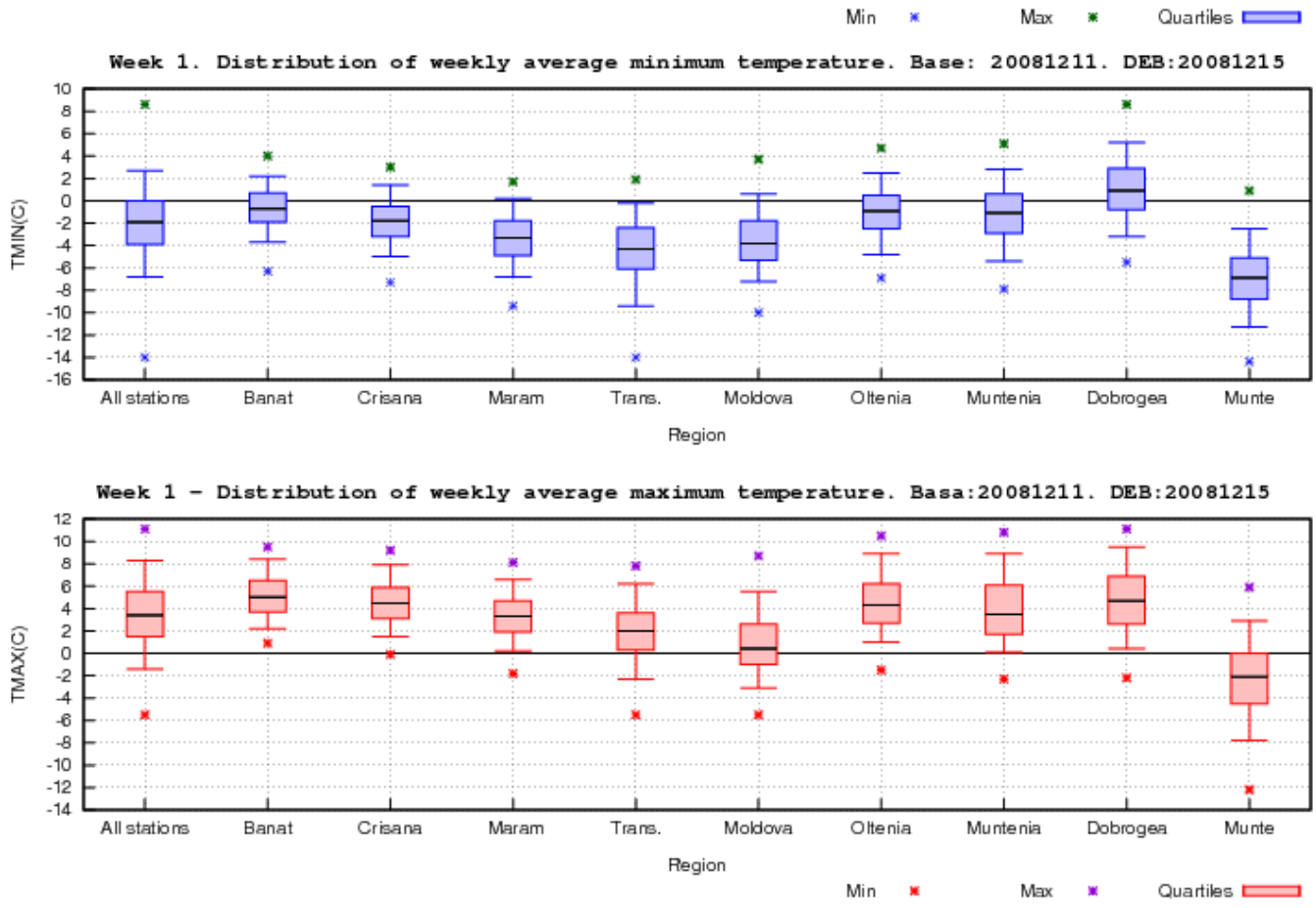


Fig. 4. Example of dissemination of the pseudo_PP extreme temperatures up to 32 days. Weekly average quantiles distributions, using 51 runs and all forecasted temperatures. All stations and separate regions.

2.1.2 Physical adaptation

a) The VarEPS ECMWF system is used for dynamical downscaling at 10 km resolution using the regional climate model RegCM (Giorgi et.al, 1993). The coupled system is operational and the results used as complementary probabilistic forecast, and in research studies of atmospheric dynamical system at mean and long range as uncertainties on initial and LBC, error growth, predictability. During last year two main system improvements have been implemented: the resolution increase (to 10 km) and the finalisation of 40 years run of the system in order to express forecast in terms of percentiles relative to the model climatology (examples in **Fig.5**. for precipitation forecast at 10 km). There are two operational chains:

- Ensemble Regcm3 model (10 km) coupled with ECMWFEPS forecast (membres 1 – 10): runs weekly for 32 days range, with initial/LBC conditions from ECMWF members, on Thursdays at 00 UTC;
- Ensemble Regcm3 (10km) model coupled with ECMWF EPS perturbed forecast (members 1 – 41): runs monthly for 7 months range, with initial/LBC conditions from ECMWF 41 members at 16-th of each month.

Research is going on for using EPS dynamical downscaling for 10 days forecast.

b) trajectories climatology have been computed based on ECMWF analysis for 1961-2000. Direct and inverse trajectories for Bucharest city have been computed using a Lagrangean trajectory model as well as their statistics (grid point frequency over month, season, year – examples in **Fig. 6)**. These are used in order to compute indexes of particle contamination area probability, to be correlated with our urban-scale air pollution forecast system (http://life-airaware.inmh.ro).

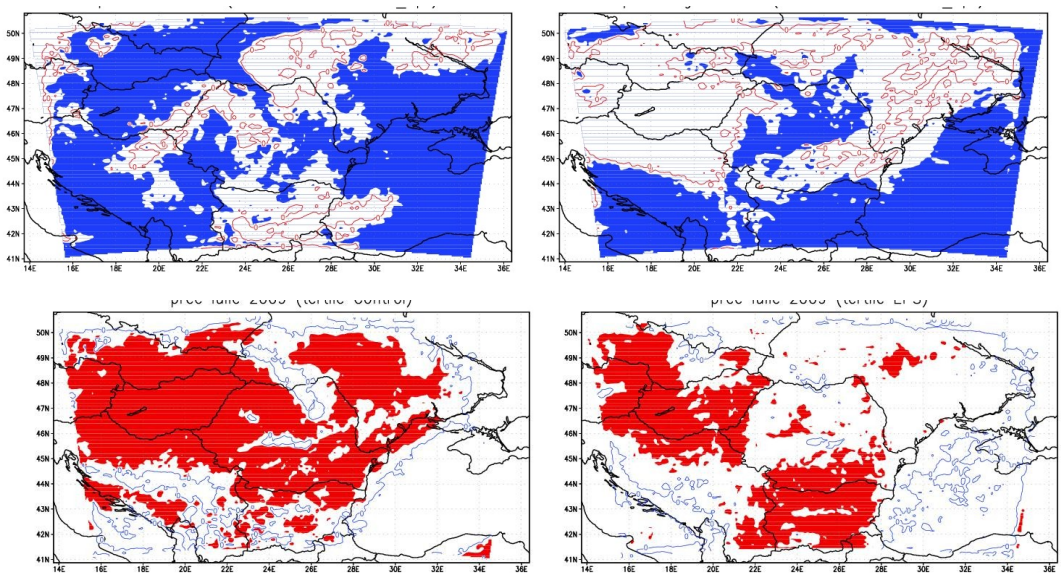


Fig. 5: *top*: precipitation 10km resolution Regcm3 EPS based on ECMWF members 1-10 for July (left) and August (right), based on April; bottom: comparison between ECMWF control - dynamical downscaling for precipitation (July) using RegCM3 model at 10 km and same downscaling of ECMWF-EPS (41 members).

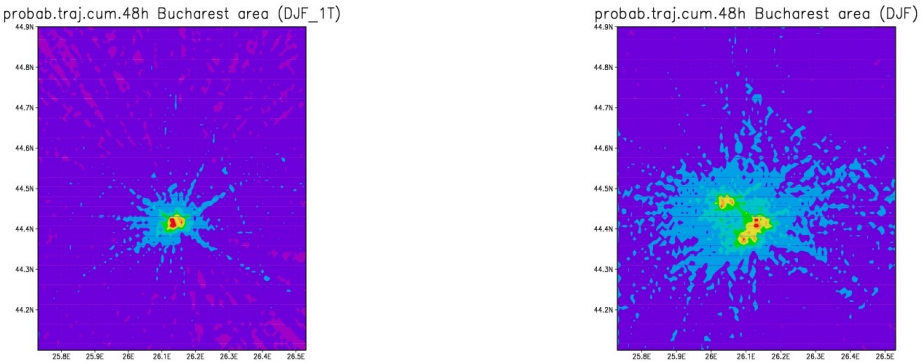
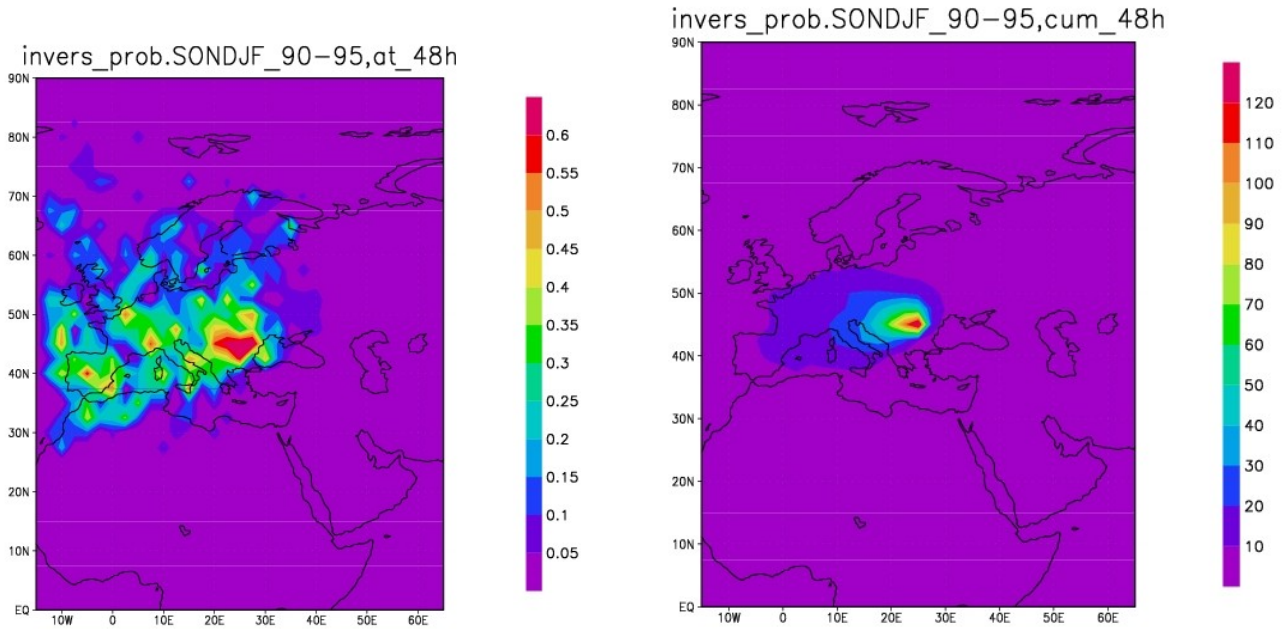


Fig. 6. a) Contamination area along 48 hours from release, on winter, over Bucharest: climatological values over 1990-1995 (left); winter of 2006-200 (right, based on ECMWF.



(b): Autumn+winter climatological (1990-1995) inverse-trajectories position probability over Europe, arriving to Bucharest just 48 hours ago (left) and during the last 48 hours (right), based on ECMWF.

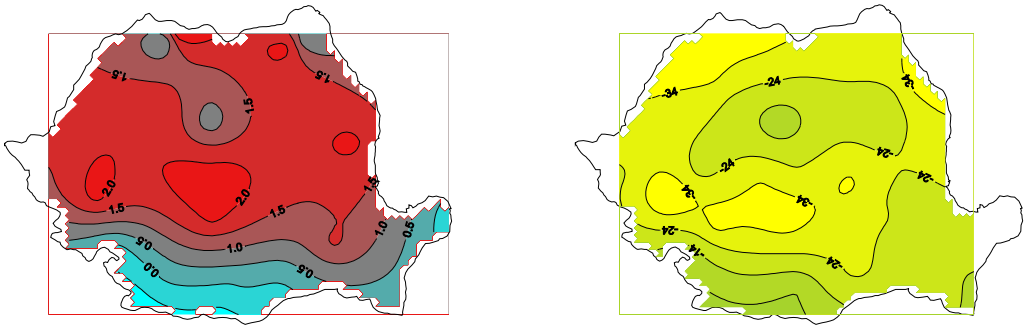
Monthly forecast

The values of the monthly mean temperature and precipitation, resulting from the seasonal forecast were used in a model for the water soil balance developed by the National Meteorological Administration in order to evaluate drought conditions in Romania.

2.1.3 Derived fields

During the cold period of the year, the "Wind Chill", and in the warm period, "Humidex", are computed using the forecast of ECMWF-DMO model (temperature and wind for Wind Chill, and temperature and humidity for Humidex), twice a day.

The output from the ECMWF system - seasonal forecasting model - was used to generate anomalies against observations at several Romanian stations. Monthly anomalies of mean temperature at 2 meters and the total amount of precipitation are plotted in figure 7.



Mean temperature Total precipitation

Fig.7. Anomalies of mean temperatures and amounts of precipitation in Romania for June 2008, issued May 2008 (the reference dataset was the 1961-1990 (observed) climatological mean)

There was also performed a seasonal forecast which is expressed in terms of three (tercile) categories referring to the observed 1961-1990 station climatology. The results for one month and one season are displayed in figure 8 and, respectively, figure 9.

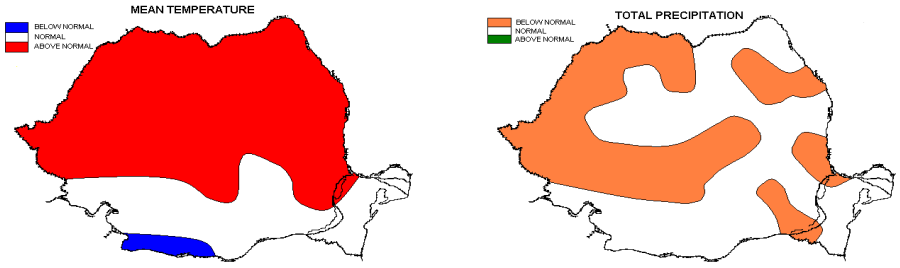


Fig. 8 Tercile categories of mean temperatures and amounts of precipitation in Romania
for June 2008, issued May 2008 (the reference dataset was the 1961-1990 (observed) climatological mean)

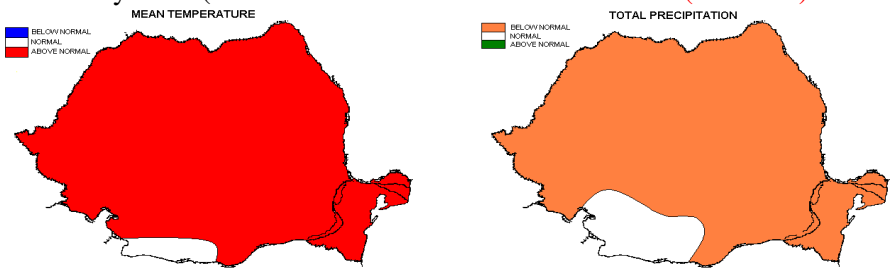


Fig. 9. Tercile categories of mean temperatures and amounts of precipitation in Romania
for the summer of 2008, issued May 2008 (the reference dataset was the 1961-1990 climatological mean)

2.2 Use of products

In 2008, the ECMWF products continued to form the basis of short and medium-range forecasts (in general weather forecasting for public, customers and state authorities, and in the national warning system) at the National Weather Forecasting Centre in Bucharest and also at the Regional Weather Forecasting Centres. For the short range forecast, ECMWF products are used in conjunction with the outputs of high-resolution limited-area local models: ALADIN, DWD-HRM and COSMO_RO. The ECMWF web site products are widely used by forecasters and are integrated into the forecasters' daily routine (EPS esspecially).

The deterministic IFS model outputs, received twice per day via RMDCN, are processed (splitting and adding headers) for telecommunication purposes and routed towards the visualisation systems (NEX-REAP) of National Meteorological Forecasting Centre and of the Regional Meteorological Centres, where graphical products are automatically generated. On the other hand, a large number of graphical products, generated through METVIEW, are available on a dedicate Intranet site.

ECMWF products successfully forecasted the heat waves of June (24) and August (15, 16, 24) 2008 in Romania:

- the weekly temperature anomaly and the 2m temperature EFI signal
- the HUMIDEX levels

Moreover, the heavy rains in May and July 2008 were found to be predicted in the Total Precipitation Index, as well as inside the EPS and EFI products. The actual rainfall levels were also predicted in a high degree by the deterministic forecast.
All of these products were helpful in issuing early severe weather warnings.

Monthly forecast

The monthly forecast was operationally used at the National Meteorological Administration as in the previous year. Once a week, the ensemble means of 2m temperature, precipitation amounts, sea level pressure and 500 hPa geopotential were processed for the following day intervals (days) 5-11, (days) 12-18, days 19-25 and days 26-32. The weekly output fields were mapped (on Romanian territory).

Seasonal forecast

The ECMWF seasonal forecasts were monthly used to assess the reliability of our seasonal forecast which (is performed through) involves a method based on analogy criteria. The ensemble means for 2m temperature, precipitation amounts, sea level pressure at sea level and 500 hPa geopotential were mapped (on Romania) each month for consecutive 7-month forecasted intervals in order to compare them to the output of the analogy method. The local weather parameters, like the mean 2-m temperature at 2 meter and the amount of precipitation were determined for each month at 39 Romanian stations by interpolating (the surrounding) four surrounding grid-points.
In addition, the three-month seasonal mean was calculated to provide an estimation of temperature and precipitation over Romania for a season ahead.

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

The objective verification has been performed by the VERMOD - an unitary system for objective verification of all models used operationally by NMA: ECMWF, ARPEGE, ALADIN, HRM, COSMO. During 2008 no other changes were made. The 00 and 12 hours runs of the models were verified, monthly, against all Romanian SYNOP observations. The verifications were performed for the following variables: 2m temperatures, 10m wind speed, direction and components, total cloudiness and 6, 12 and 24 hours total precipitation amount. A wide range of statistical verification measures are computed and the results are disseminated via dedicated verification web-site.

3.1.2 ECMWF model output compared to other NWP models

Comparisons between models - including MOS - are performed monthly. Some examples of the graphs presentations are shown in Fig.10 and Fig. 11. Comparison of performance of ECMWF model to other NWP models used by your service.

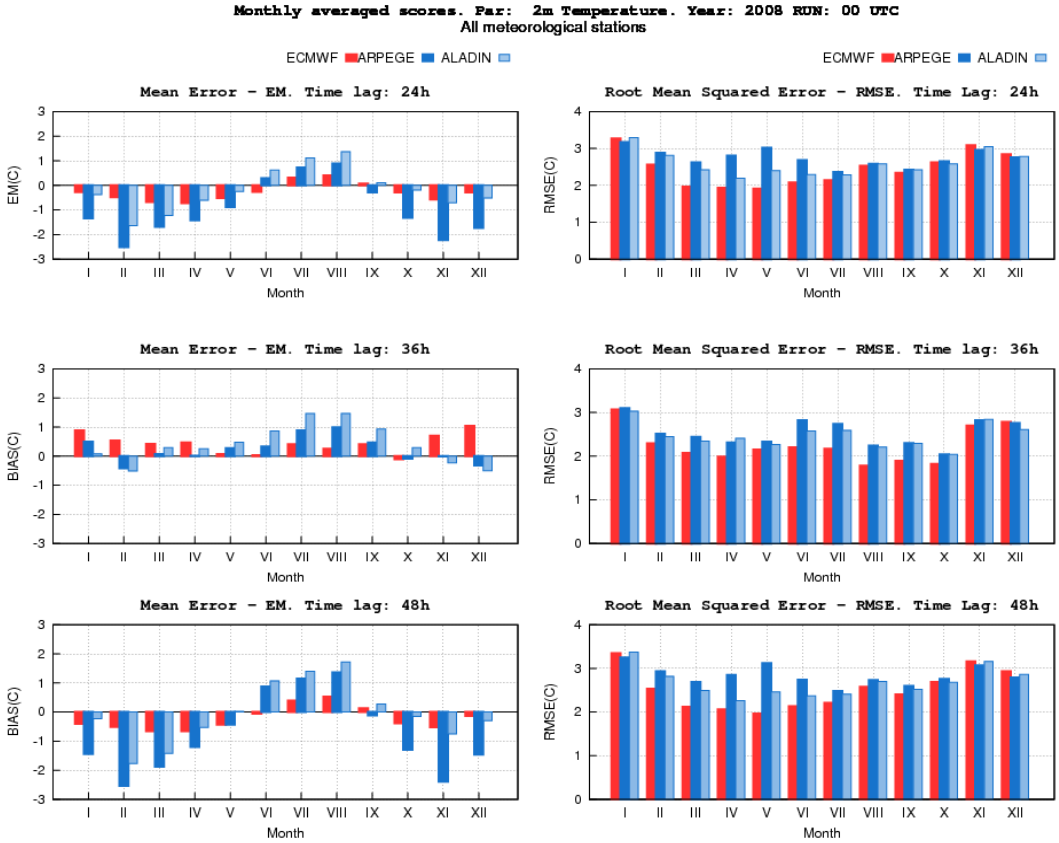


Fig. 10. 2m temperatures - monthly averaged scores distributions – 2008. BIAS and RMSE.

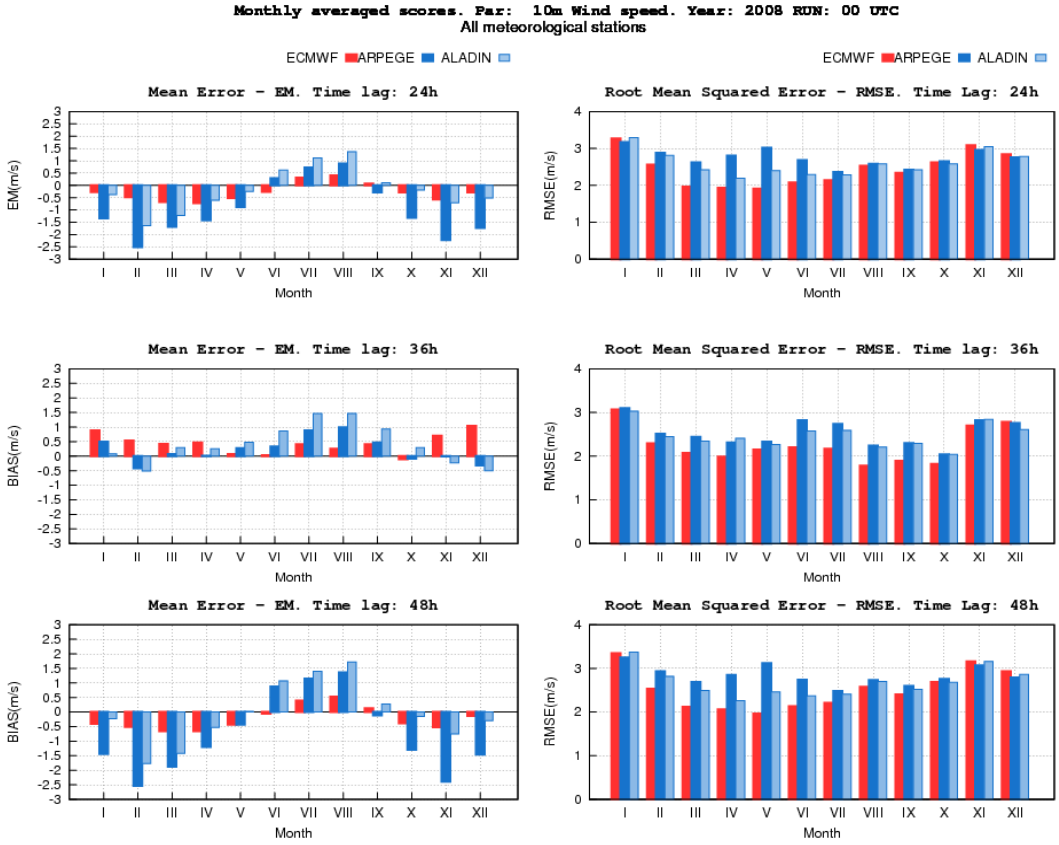


Fig. 11. 10m wind speed - monthly averaged scores distributions – 2008. BIAS and RMSE.

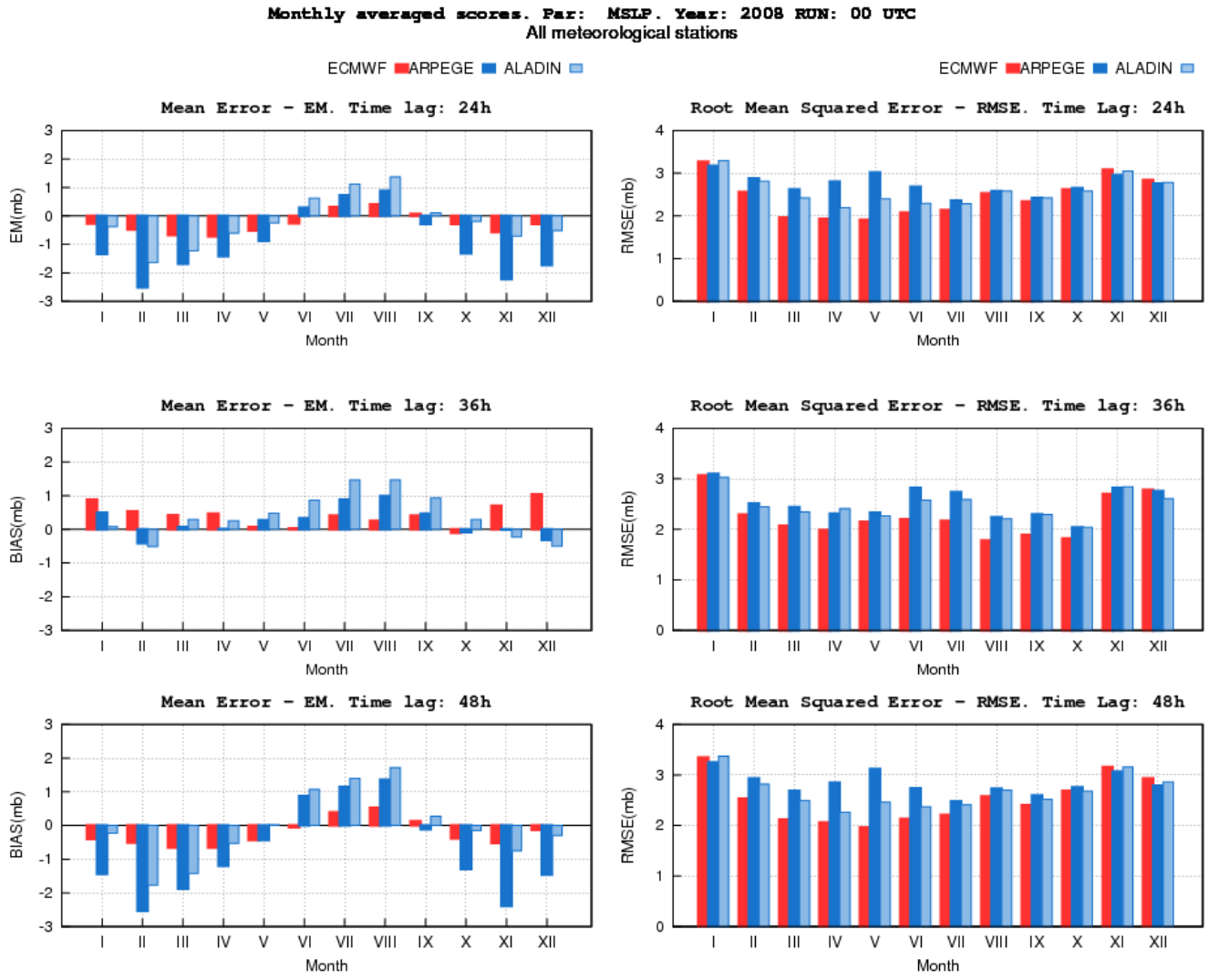


Fig. 12. MSLP - monthly averaged scores distributions – 2008. BIAS and RMSE.

3.1.3 Post-processed products

MOS forecasts are verified together with ECMWF – DMO. The results are displayed in graphs. The NEW-MOS, (version implemented in may 2008) statistical models gives significant improvement for temperature and wind speed.

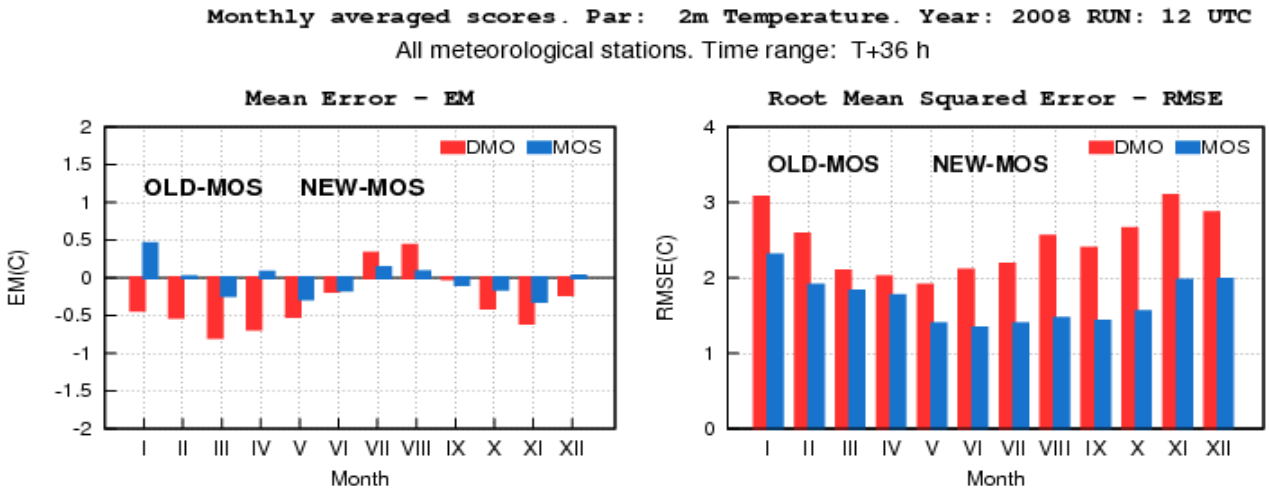


Fig. 13 Monthly averaged scores distribution. 2m temperatures. DMO compared with MOS

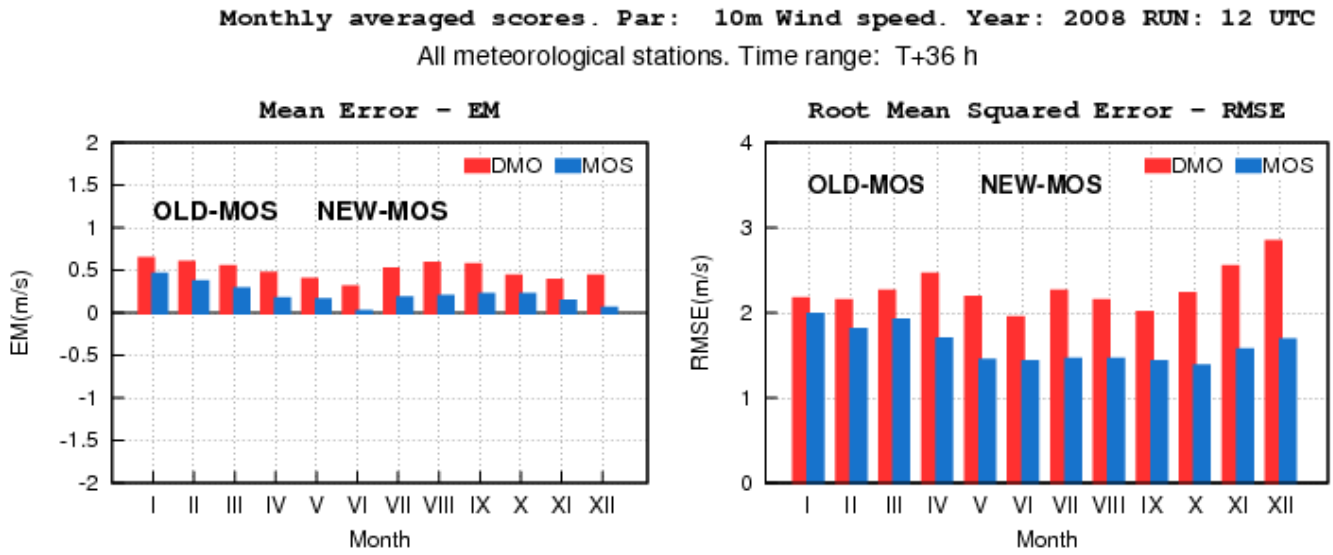


Fig. 14 Monthly averaged scores distribution. wind speed. DMO compared with MOS

3.1.4 End products delivered to users

3.2 Subjective verification

3.2.1 Subjective scores

3.2.2 Synoptic studies

Generally, the IFS/ECMWF analysis or ERA40 re-analysis are used for case studies. For few severe weather events in Romania, the direct model and/or EPS downscaling were carried out using the LAM ALADIN and RegCM3 models. For these studies there were used either the first 10 ECMWF/EPS members either all members by applying a clustering method developed by the Hungarian Meteorological Service. The evaluation of the ECMWF/EPS- and ECMWF-based simulations was carried out by comparisons against observations and/or IFS analysis. Including evaluation of the behaviour of the model

4. References to relevant publications

Caian,M. , Zoran, M. 2008**:** Radiative forcing by forest in the presence of atmospheric aerosols. *Annalae of Forest Research,* 2008

Georgescu, F., S. Tascu, M. Caian, and D. Banciu, 2009: A severe blizzard event in Romania - a case study. *Nat. Hazards Earth Syst. Sci.,* **9**, 623–634, 2009

Tascu, S., 2008, Analysis of a heavy precipitatation case using the ECMWF/EPS downscaled with the LAM ALADIN *(internal report, in romanian)*

I.Oprea, M. Caian, 2008**:** Large-scale and mesoscale analysis of a flush flood event in Romania. *Submitted special issue Hydrate project.*