Application and verification of the ECMWF products – Report 2007

National Meteorological Administration – Romania

1. Summary of major highlights

The medium range forecast activity within the National Meteorological Administration of Romania (NMA) is mainly based on products from the ECMWF deterministic model. The model output fields are made available to the forecasters via NexReap visualisation system and the ECMWF web site. Also, model fields such as 6-hour accumulated precipitation, MSLP and 850 hPa temperature, 500 hPa geopotential height and temperature, relative humidity at 700 hPa are plotted using the Magics and Metview softwares. These fields have proved to be the most useful and have become the main ingredients in the daily routine forecast preparation process. For short range forecast, ECMWF products are used in conjunction with the outputs of ALADIN and COSMO_RO high-resolution limited-area local models whereas for the medium range forecast with ARPEGE (Meteo-France), GME (DWD) and GFS (NCEP).

2. Use and application of products

The operational (D+1 ... D+7) forecast at NMA is based on the last available model run (12 UTC) and then modified related to the current 00 UTC run (due to the receiving time gap of the products - after 10 a.m. Bucharest time). ECMWF products (deterministic T799) are used for the short and medium range forecast generally with very good results (D+2 ... D+4). During the last year, the main goal at the National Weather Forecasting Centre (in Bucharest) was a more probabilistic approach in medium range forecast. For the most part of the situations (with a great percentage of uncertainty) there have been attempts to combine the forecast information of both deterministic and probabilistic systems in order to get a better forecast.

The monthly forecast has been operationally used at NMA since June 2006, after a testing period over March-May 2006. Once a week, fields such as the ensemble mean for 2m temperature, precipitation amount, mean sea level pressure and 500 hPa geopotential height are processed. Regarding the seasonal forecast, the operational processing, resulted from the integration of the ECMWF model, have also started in June 2006. Each month, the monthly mean temperature and precipitation amounts for Romania were analysed for the next 6-month period. This process is repeated whenever new output fields are made available by ECMWF. This information was combined with the one obtained from statistical methods, developed by the National Meteorological Administration, in order to elaborate the seasonal forecast for Romania.

2.1 Post-processing of model output

2.1.1 Statistical adaptation

2.1.2 Physical adaptation

The values of monthly mean temperature and precipitation, resulted from the seasonal forecast are used in a soil water balance model, which was developed at the National Meteorological Administration.

2.1.3 Derived fields

2.2 Use of products

The previous year brought about an increasing use of probability maps for wind speed and precipitation, Extreme Forecast Index for 2m temperature, 10m wind speed, 10m wind gusts and precipitation, especially in the extreme weather forecasting (watch and warnings of severe weather events) with a focus on the precipitation amount or heat waves. The EPS meteograms and the new VarEPS are considered very useful, mainly in decreasing the false alarm rate and because of the need to extend forecasts from 10 to 15 days.

3. Verification of products

The ECMWF ensembles are used as boundary conditions for the Regional Climate Model (RegCM3).

The seasonal forecast verification is performed by using data from 34 meteorological stations over the Romanian territory. The method used is adapted from the one suggested by Preisendorfer and Mobley (1984). It was noticed that the forecasts performance is higher in winter than in spring, both for temperature and precipitation.

3.1 Objective verification

3.1.1 Direct ECMWF model output

The direct outputs of the ECMWF seasonal forecast model have been processed for the geographical region of Romania, using an interpolation method. In this way, it was possible to assess the different forecasted meteorological fields at several stations in Romania, followed by the computation of those values in the respective terciles, calculated for data observed over the interval 1961-1990. The input forecast values from ECMWF were taken from a 2.5ºx2.5º post-processing grid. The verification was performed for mean 2-meter temperatures and precipitation amounts for six forecasted months of the seasonal forecast.

The monthly forecast is generated by an ensemble containing 10 members. These are achieved by coupling with 10 members from global forecast ECMWF (at 2.5º grid mesh) clustered at ECMWF. Simulations for 10 days were performed at 10km grid space using 2 min surface data (4 km). An operational forecast suite together with a verification system for medium term (10 days and one month) was implemented. The operational suite has two directions: the comparison of RegCM3 outputs with the ECMWF outputs and the comparison with observations in order to obtain a better regional forecast. The verification is carried out to find systematic errors and to calibrate the ensemble.

The software has been developed, implemented and run under the Linux OS. The first study has been started for the period 22nd of February - 26th of March 2007. A comparison between forecast ensemble outputs was performed. Also the evolution of each ensemble member both for ECMWF and RegCM3 models was analyzed. In order to compare them, weekly and monthly mean for 32-day forecast were computed. An output analysis has been made for eight regions of climatological interest and Romania (Fig. 1).

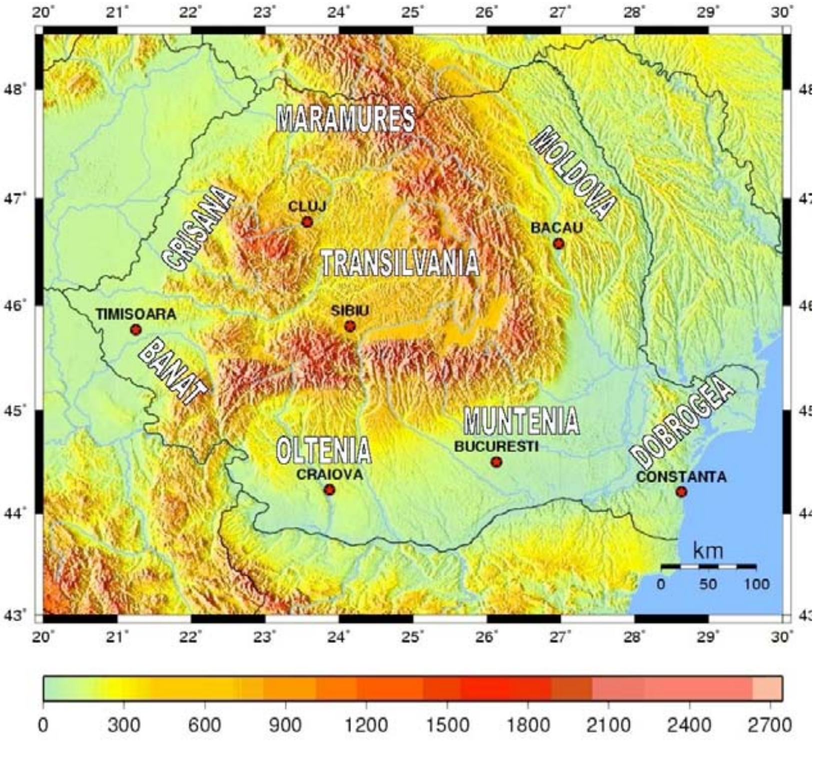
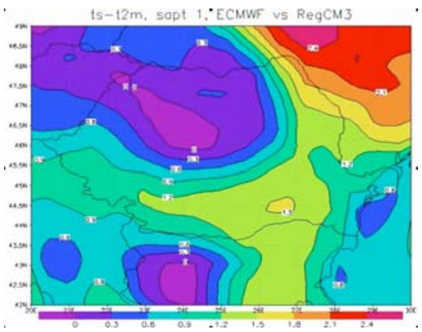


Fig. 1 The 8 regions over Romania

The monthly temperature mean forecasted over the studied period (22.02 - 26.03.2007) was analyzed. It was noticed that for this particular case, ECMWF output have mainly positive differences (maximum 4.5 - 5º C) against the observations, while for RegCM3 these differences are of the order of maximum 0.5 - 1º C. The verification procedure was performed for one monthly forecast and for 10-day forecast (Fig 2-4). Although the results obtained might not be relevant regarding the behavior of the RegCM3 model for Romania, they are encouraging.



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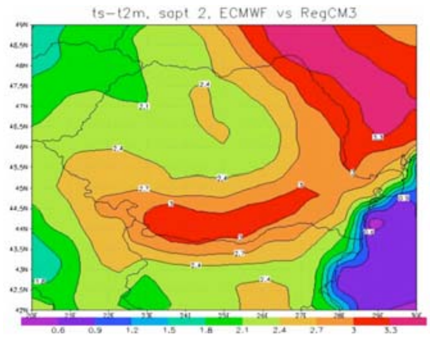

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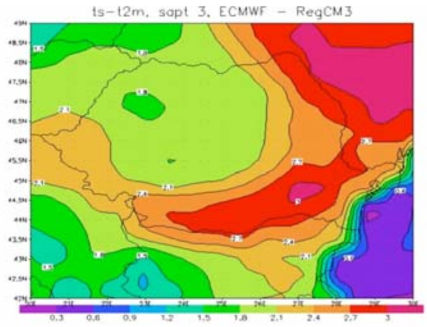

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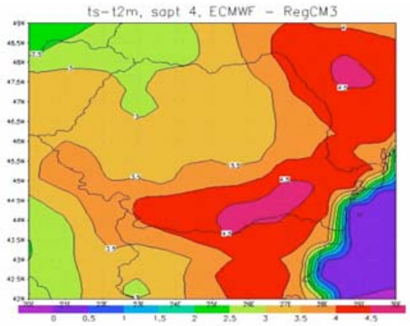

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Fig. 2 Differences of monthly temperature mean (ºC) obtained from 32-days forecast at every 12 hours from ECMWF and RegCM3 ensembles - week 1, 2, 3, 4

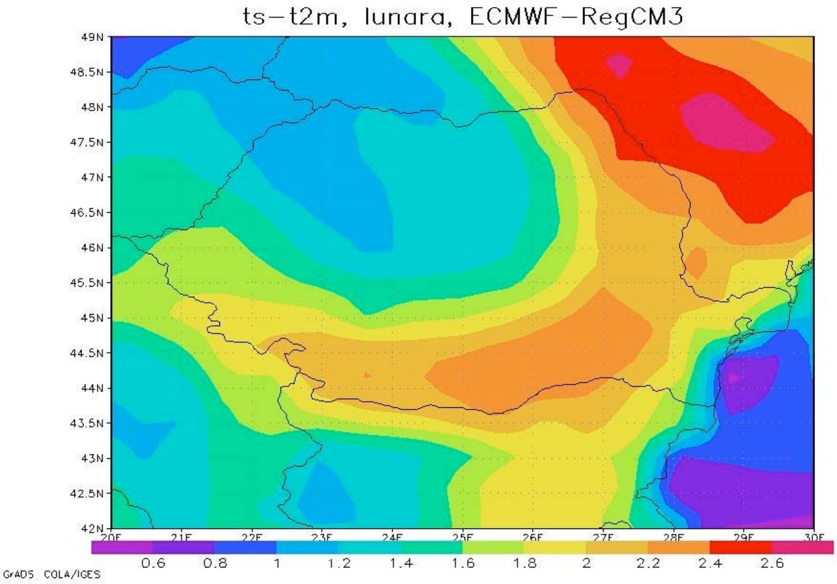
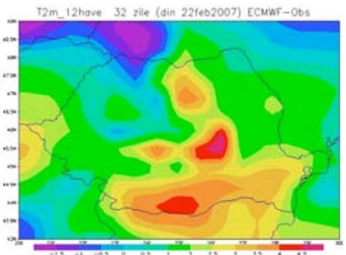


Fig. 3 Difference of monthly temperature mean (ºC) obtained from 32-days forecast at every 12 hours from ECMWF and RegCM3 ensembles monthly forecast



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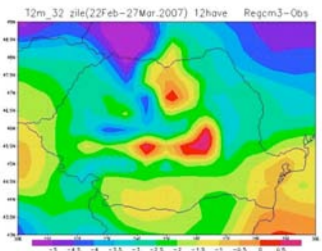

4b

Fig. 4 Difference between the monthly temperature mean (ºC) obtained from 32-days forecast at every 12 hours from ECMWF ensembles (left) and RegCM3 ensembles (right) and the observations

3.1.2 ECMWF model output compared to other NWP models

Regarding the seasonal forecast, the performances of the ECMWF and Météo-France models were studied by using the monthly mean 2-meter temperature and precipitation simulations. The ensemble monthly hindcasts obtained in DEMETER project have been utilized. The analyzed interval was 1958-2001. The simulated parameters are compared with the reanalysis from ERA40. The above mentioned models have been verified on the Atlantic-European area, by assessing the anomalies of the simulated monthly means against the observed ones for the 1958-2001 period. The results have shown that the ECMWF and Météo-France models overestimates in most cases the temperature and underestimates the precipitation over the Atlantic-European area. The correlation coefficients between the simulated and re-analyzed fields of temperature and precipitation have been calculated over the Romanian territory. A good skill in predicting mean temperature and precipitation in the seasonal forecast is found in some regions of Romania.

In 2007 verification procedures for the comparison between the MOS-ECMWF, MOS-ALADIN and MOS-ARPEGE forecasts for 2m temperature was developed. In this report only the 12 UTC runs of the models were used.

The three MOS models have different forecast ranges: MOS-ECMWF up to 180 hours, MOS-ALADIN up to 48 hours and MOS-ARPEGE up to 72 hours. The comparison was made for the Romanian territory, divided in geographical areas: Moldova, Transilvania, Muntenia and Banat. The plots in Fig. 5-8 illustrate the mean error 2m temperature for the three MOS models for the four mentioned areas Transilvania, Moldova, Banat and Muntenia respectively.

Winter 2006 (December 2005 – February 2006)

Regarding this season, the results show that the MOS-ECMWF model has a positive mean error, which means that the model overestimated. The other 2 models, for this season underestimated.

Spring 2006 (March 2006 – May 2006)

For this season, the MOS-ECMWF model overestimated. Note that the 2m temperature over the night is better forecasted. The MOS-ARPEGE model usually underestimated, whereas MOS-ALADIN overestimated.

Summer 2006 (June 2006 – August 2006)

For this season the forecasts are better for MOS-ECMWF and MOS-ARPEGE than MOS-ALADIN which overestimated.

Autumn 2006 (September 2006 – November 2006)

Regarding this season, the results show that there are no significant differences between the three models. The Moldova region has a different behaviour concerning the MOS-ECMWF forecasts. During the night time, the model seems to underestimate, and overestimates over day-time.

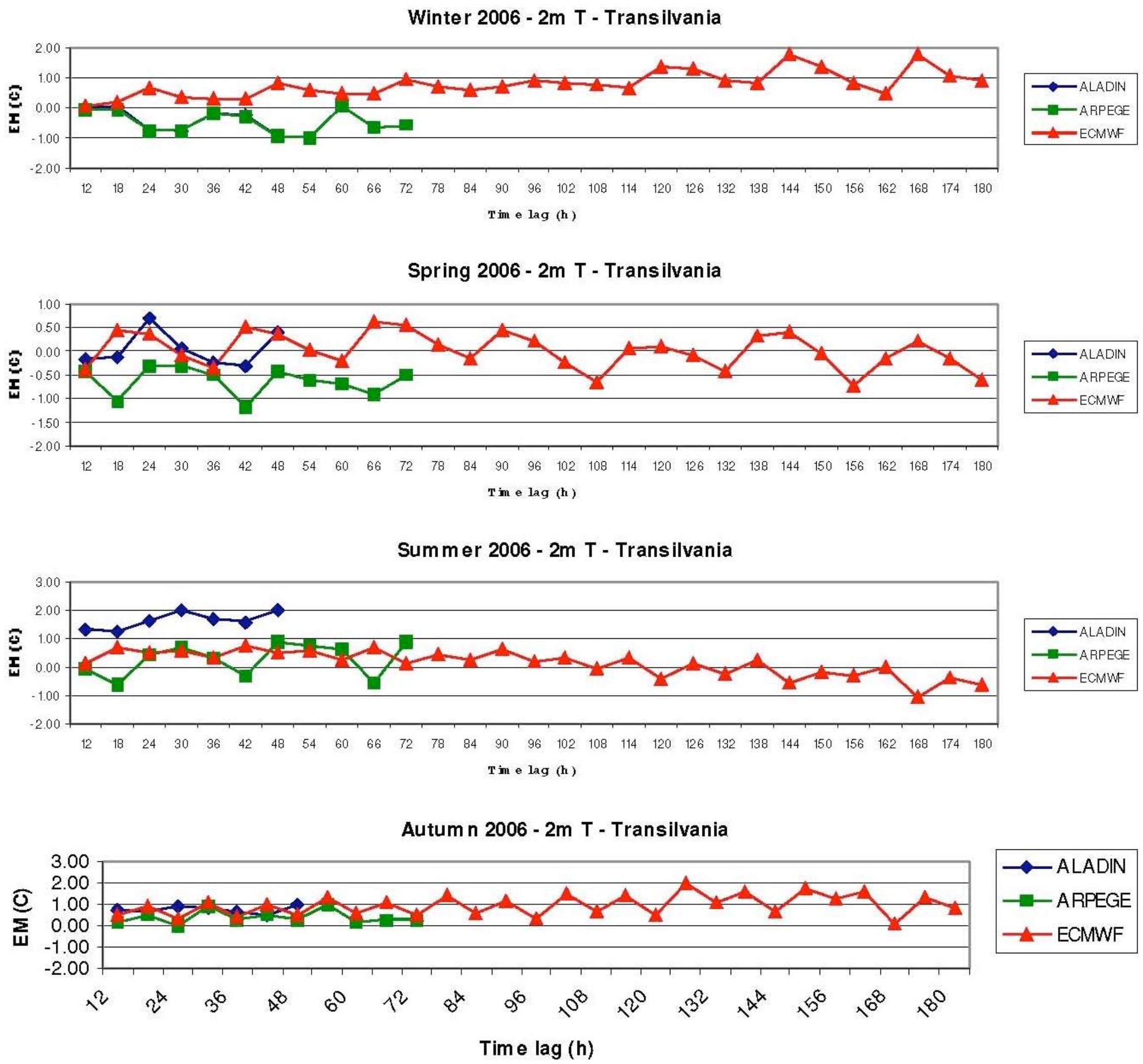

Fig. 5 Mean Error (EM) for 2m temperature, Transilvania area (red: MOS-ECMWF, green: MOS-ARPEGE, blue: MOS-ALADIN)

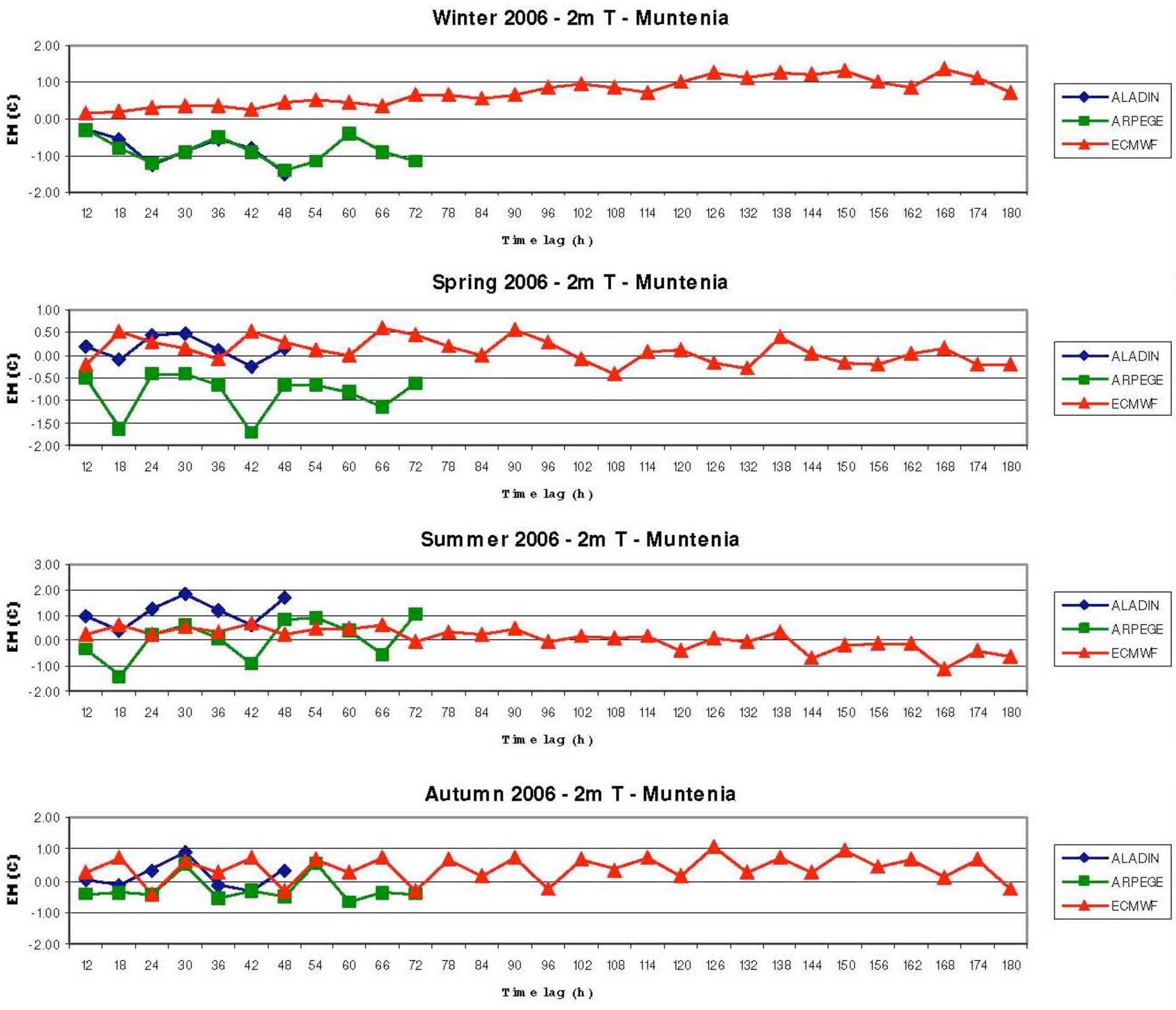

Fig. 6 Mean Error (EM) for 2m temperature, Muntenia area (red: MOS-ECMWF, green: MOS-ARPEGE, blue: MOS-ALADIN)

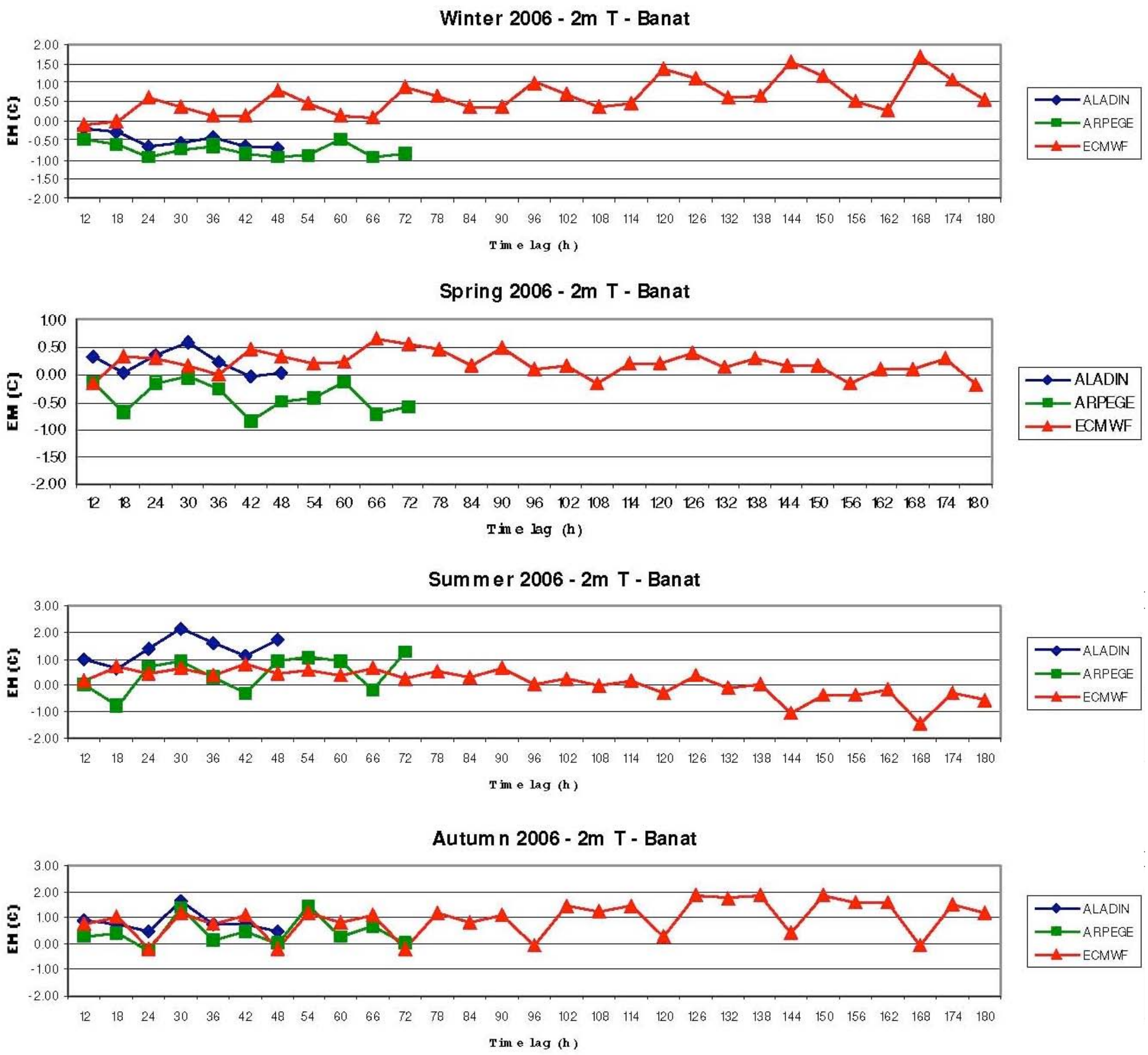

Fig. 7 Mean Error (EM) for 2m temperature, Banat area (red: MOS-ECMWF, green: MOS-ARPEGE, blue: MOS-ALADIN)

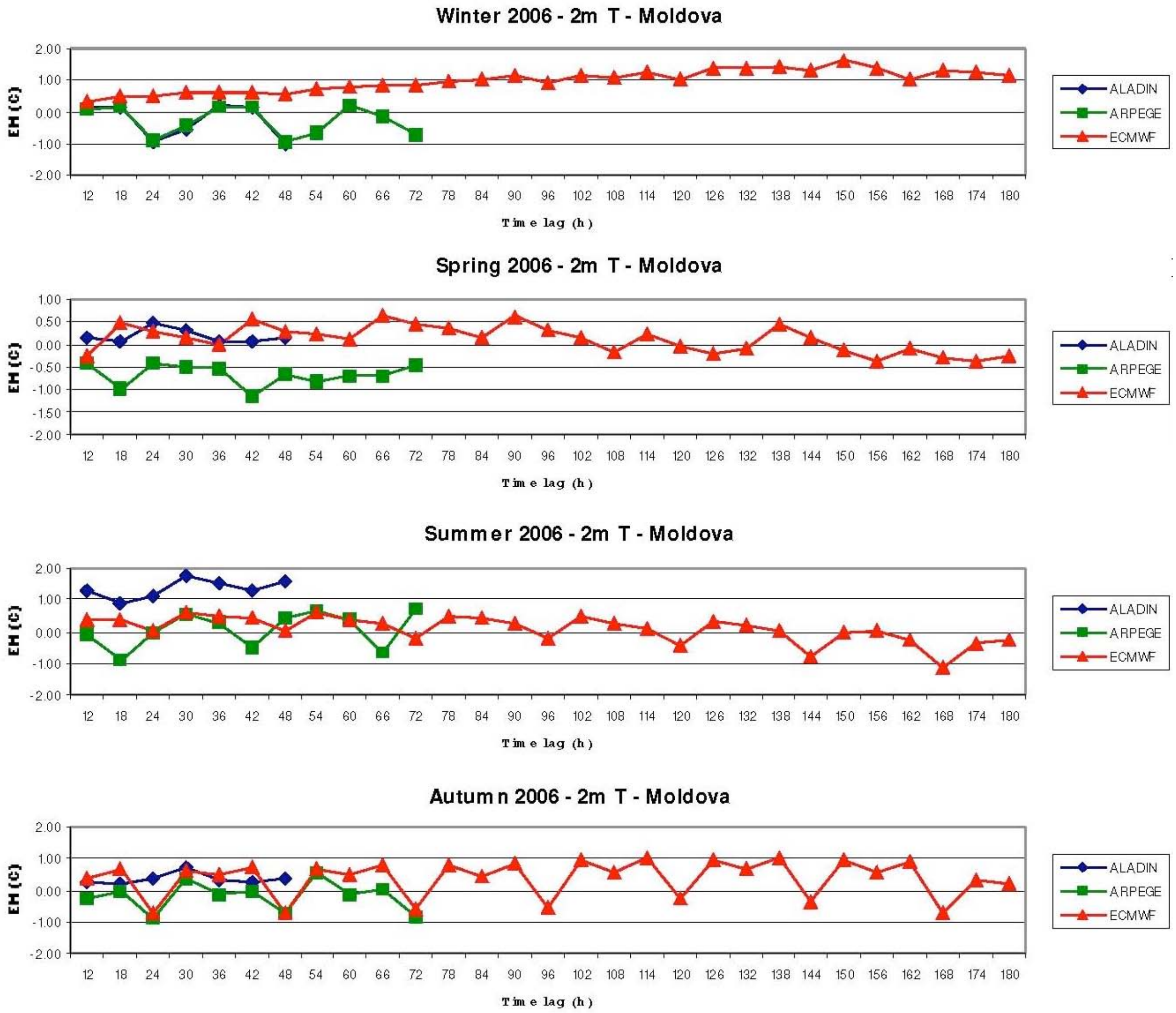

Fig. 8 Mean Error (EM) for 2m temperature, Moldova area (red: MOS-ECMWF, green: MOS-ARPEGE, blue: MOS-ALADIN)

3.1.3 Post-processed products

3.1.4 End products delivered to users

The post-processed products – ECMWF_MOS (2m temperature, extreme temperatures, total cloudiness, 6-h accumulated precipitation, 10m wind) are automatically delivered to some of our customers (service providers) and also represent the guidance for the 3-day city forecasts issued by meteorologists. Those proved to be very skilful and to have an economic benefit.

3.2 Subjective verification

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

At present, neither subjective scores nor confidence indices are used at the NMA. The forecasters are asked to express their confidence in each model's prediction. The goal is to allow us to assess the model performance in the decision-making process involved in the forecast preparation. Work is going on regarding a subjective evaluation tool (trying to find reliable confidence indices) in order to assess the forecasters' confidence in the model solutions.

3.2.2 Synoptic studies

The main goal of the case studies is to identify model behaviour in different weather types. ECMWF produces useful guidance up to at least 7-8 days. The case studies carried out by the forecasters have generally shown a good skill both for the forecasted upper-air fields and in predicting weather parameters over central and south-eastern Europe. For the deterministic model and also for EPS there is some evidence of improved rainfall forecasts over Europe, even convective precipitation (more realistic diurnal cycle). There are still problems with the inconsistency shown especially when south-eastern flow at mid- and upper levels, low cut-off cyclones moving over the Balkan Peninsula and polar air invasions in north-eastern flow are present. EPS rainfall probabilities seem working better during persistent rain/dry weather conditions. ECMWF can reasonably simulate mid-latitude continental summer convection in terms of convective activity (not so good results in intensity of the convection, i.e. amplitudes of the precipitation amount) and temperature and humidity evolution. Also, the EPSgrams are very powerful products to provide the forecaster with an early warning of changes in weather regimes and of the probability of major rain events and seem to be more consistent in the signal, which sometimes might not be the case with the deterministic model.

4. References to relevant publications