Application and verification of ECMWF products – 2007

F. Gofa and I. Papageorgeiou – Hellenic National Meteorological Service (HNMS)

1. Summary of major highlights

Since the autumn of 2006, a comprehensive and fully automated system for the operational verification of all the NWP products has been implemented at HNMS. Daily verification is performed for the surface and upper-air fields of the ECMWF products as well as for the three high-resolution limited area models (Skiron/Eta, COSMO and RAMS) that are used by HNMS forecasters. In addition, the relative performance of the three models is subject to intercomparison.

2. Use and application of products

The medium-range weather forecasts at HNMS are primarily based on the deterministic ECMWF forecast. Both the 00 UTC and 12 UTC cycles of the forecasts are received daily in 0.5 deg resolution. For the short-range and for the observation of local characteristics of weather patterns in Greece, the output of the limited area models are used in conjunction with the ECMWF products.

The EPS products (plumes, epsgrams, ensemble probability maps) are retrieved daily from the ECMWF web-site and are of particular value for the HNMS forecasters, especially the d+4 to d+7 forecast where the value of the deterministic forecasts is substantially reduced. An increasingly popular ECMWF product at HNMS is the Extreme Forecast Index for temperature and precipitation. As a measure from the distance from the climate (mean), the EFI maps are directly related to the severe weather events. The monthly (weekly anomalies) and the seasonal forecasts are not being used operationally but only for consultative or research purposes.

2.1 Post-processing of model output

2.1.1 Statistical adaptation

A Kalman-filter procedure is operationally applied to adjust the min and max 2m temperatures and this daily forecast is evaluated with ME, SDE and mean absolute errors.

2.1.2 Physical adaptation

The ECMWF model output provides the lateral and boundary conditions for the execution of the daily simulations of the HNMS limited area models (Eta/Skiron, COSMO and RAMS). In addition, ECMWF model output provides us with the necessary input for the MOTHY trajectory model. The MOTHY is part of the operational service of HNMS to help authorities in case of oil spill response and/or search and rescue operations.

2.1.3 Derived fields

2.2 Use of products

As mentioned above, the HNMS forecasting centre uses the ECMWF products in conjunction with the products of its limited area models for the general 6-day forecast that is provided to the public as well as for the sea state forecast for the Eastern Mediterranean and the forecast for aeronautical purposes.

3. Verification of products

The automated system that has recently been developed and applied at HNMS performs daily verification of all the available forecasting systems. The verification is divided into two parts: upper-air fields and surface fields. For the upper-air fields, the gridded forecast fields for temperature and geopotential height at different pressure levels are compared with the relative analysis charts from the ECMWF model output.

The surface verification is performed by using the SYNOP data from 30 surface stations every 6 hours (Fig.1). The parameters that are verified are: MSLP, 2m temperature, 2m dew point temperature, 10m wind speed/direction and total precipitation. The synoptic value for each parameter at each station is compared with the value derived from the deterministic model at three different points: the closest point of model grid to the station, the interpolated value of the parameter using the nine closest points to the station and with the optimum grid point taking into consideration the proximity of the point to the sea or the elevation of the station.

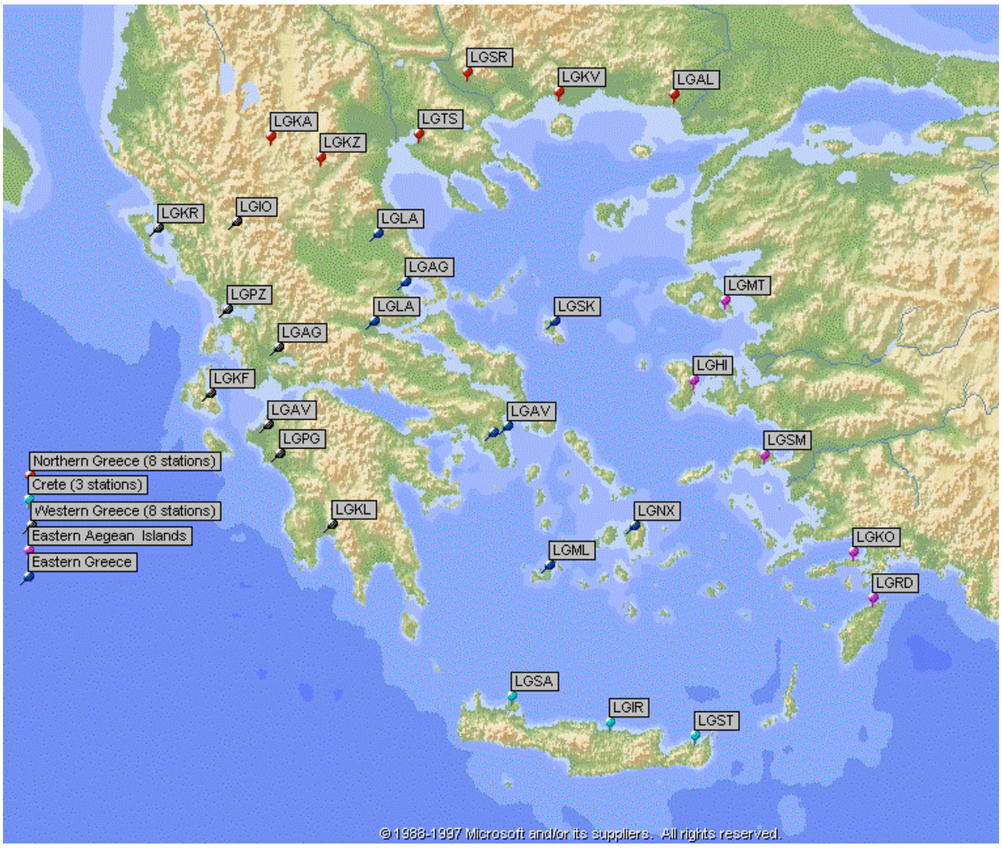

Fig.1 The 30 surface stations that are used for the verification of surface parameters in Greece.

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

The ECMWF deterministic forecasts are verified against synoptic observations. The RMSE and Bias scores are calculated for every forecast cycle, every 6 hours for the t+6 to t+120 forecast hour for every synoptic station. The scores, averaged over the 30 stations for three months of the past winter, are presented below (Fig.2). For the MSLP a small bias of approximately 0.5mb is observed as well as an increasing RMSE from 1 to 3mb from d+1 to d+5. The bias for both the 2m temperature and the wind speed fluctuates in a diurnal cycle in the range of 1^{o}C and 1m/sec respectively while a positive bias is evident for all forecast hours for the wind speed. The RMSE values are rather constant with a slight increase after the third forecast day.

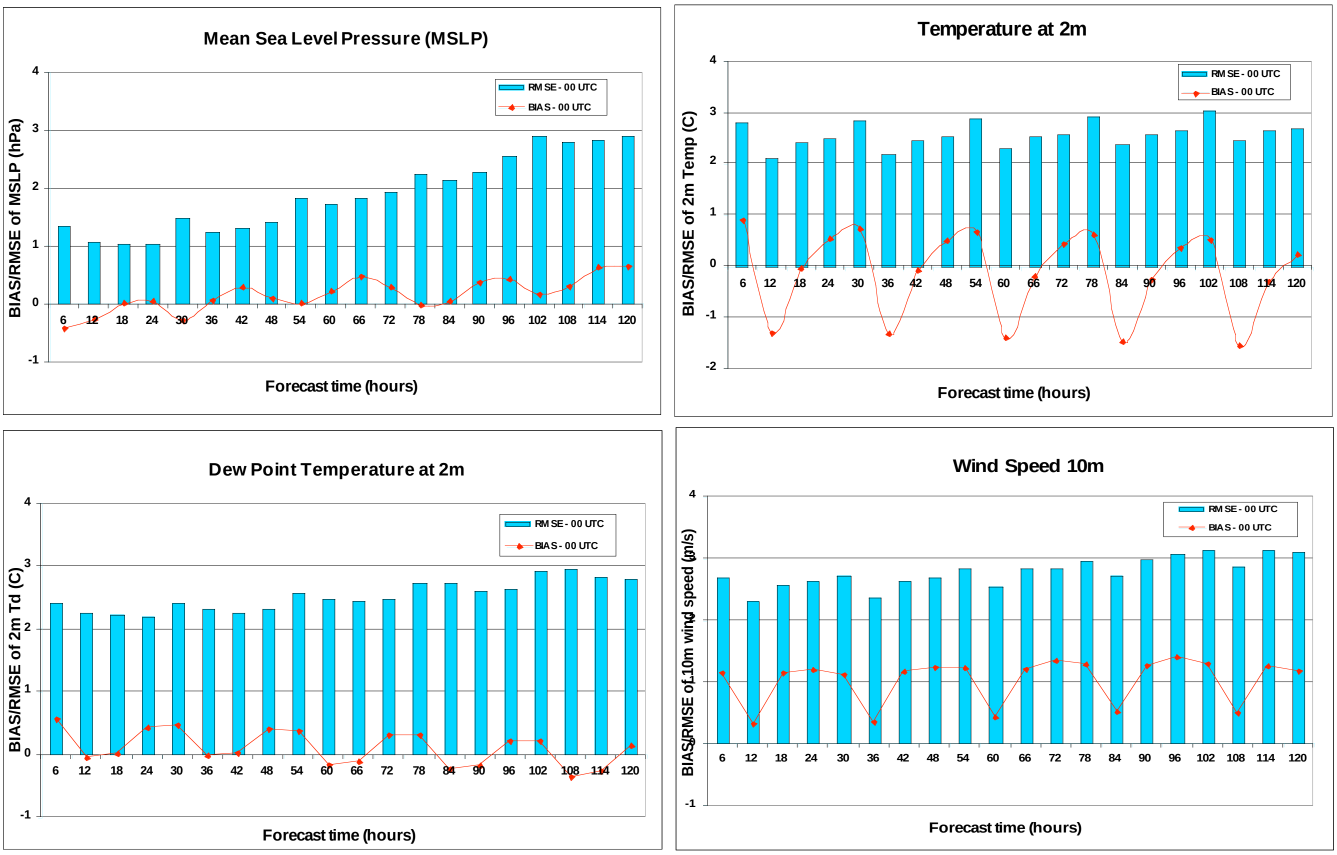

Fig.2 RMSE and Bias scores for ECMWF model calculated for the winter 2006-2007 and averaged over the 30 stations.

Verification of the 6h total precipitation is also performed using the rain gauge data from the 30 synoptic stations with three different points (previously described in section 3) for each station. We carry out categorical verification of the forecasts based on the four categories 0-0.1mm, 0.1-0.5mm, 0.5-5mm and greater than 5mm of precipitation. Contingency tables and various statistical scores are calculated. In the three month period (Dec-Feb 2007) and for the t+24 to t+30 interval the scores show that the ECMWF model underestimates the large precipitation events and generally overestimates the small precipitation events (Fig.3).

METHOD --> CLOSER GRID POINT

	0-0.1	0.1-0.5	0.5-5.0	>5.0	TOTALS
0-0.1	1923.0	21.0	37.0	8.0	1989.0
0.1-0.5	252.0	7.0	37.0	12.0	308.0
0.5-5.0	161.0	22.0	96.0	33.0	312.0
>5.0	4.0	0.0	10.0	29.0	43.0
TOTALS	2340.0	50.0	180.0	82.0	2652.0

METHOD --> INTERPOLATION FROM 9 GRID POINTS

	0-0.1	0.1-0.5	0.5-5.0	>5.0	TOTALS
0-0.1	1846.0	14.0	20.0	5.0	1885.0
0.1-0.5	311.0	10.0	41.0	7.0	369.0
0.5-5.0	180.0	26.0	111.0	42.0	359.0
>5.0	3.0	0.0	8.0	28.0	39.0
TOTALS	2340.0	50.0	180.0	82.0	2652.0

METHOD --> OPTIMUM GRID POINT

	0-0.1	0.1-0.5	0.5-5.0	>5.0	TOTALS
0-0.1	1936.0	21.0	40.0	8.0	2005.0
0.1-0.5	240.0	9.0	37.0	13.0	299.0
0.5-5.0	158.0	20.0	92.0	32.0	302.0
>5.0	6.0	0.0	11.0	29.0	46.0
TOTALS	2340.0	50.0	180.0	82.0	2652.0

	0-0.1 mm	0.1-0.5 mm	0.5-5 mm	>5 mm
BIASR	0.806	3.380	1.994	0.476
PC	0.799	0.850	0.890	0.975
POD	0.789	0.200	0.617	0.341
FAR	0.021	0.973	0.691	0.282
POFD	0.125	0.138	0.100	0.004
KSS	0.664	0.062	0.516	0.337
ORSS	0.962	0.219	0.870	0.984
ETS	0.211	0.019	0.227	0.129

Fig.3 Contingency table and statistical scores for the 6h precipitation for t+30 forecast of the 00UTC run for Dec-Feb 2007.

3.1.2 ECMWF model output compared to other NWP models

Comparison of the performance of ECMWF model with the limited area models used at HNMS is performed on a regular basis. As indicated in the plots of the RMSE for the 2m temperature and the 10m wind speed, the models give similar results for the 72 hour forecast with slightly increased errors for the ECMWF model for the wind speed.

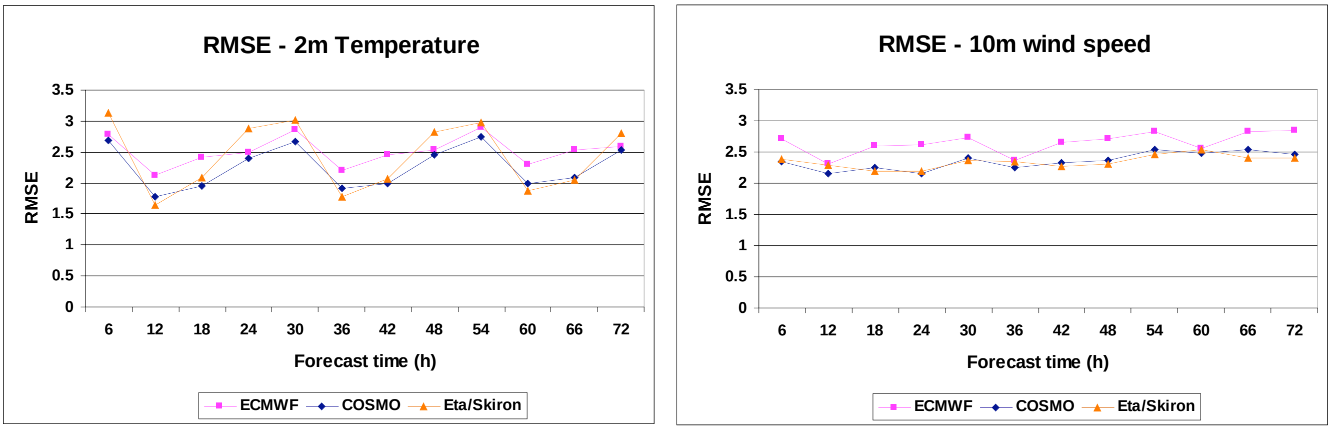

Fig.4 RMSE errors for the winter 2006-2007 averaged over all the synoptic stations.

Statistical scores for the precipitation for all the limited area models are calculated every month. The intercomparison for a 5-month period this winter (Nov2006-Mar2007) reveals that the ECMWF model is statistically better than nearly all the high-resolution models used at HNMS for no-precipitation and for heavy precipitation events (Fig.5).

C1: 0-0.1mm	POD	FAR	ETS	POFD	KSS	BIASR	HSS	ORSS
COSMO	0.868	0.030	0.268	0.255	0.613	0.895	0.423	0.901
SKIRON	0.914	0.030	0.338	0.281	0.730	0.943	0.506	0.926
ECMWF	0.810	0.010	0.253	0.156	0.730	0.819	0.403	0.960
RAMS	0.776	0.025	0.180	0.194	0.581	0.796	0.305	0.870

C4: >5mm	POD	FAR	ETS	POFD	KSS	BIASR	HSS	ORSS
COSMO	0.549	0.606	0.284	0.022	0.527	1.392	0.443	0.964
SKIRON	0.412	0.517	0.275	0.011	0.401	0.853	0.432	0.969
ECMWF	0.402	0.474	0.286	0.009	0.393	0.765	0.444	0.974
RAMS	0.373	0.608	0.225	0.014	0.358	0.951	0.367	0.953

Fig.5 Statistical scores for the 6h precipitation for the D+2 forecast day for a 5-month period.

3.2 Subjective verification

4. References to relevant publications