Application and verification of ECMWF products in Turkey 2009

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1. Summary of major highlights

The verification of ECMWF products has continued as in previous years. Turkey became an ALADIN member on 1st of January 2008. In the short range, ECMWF, MM5 and ALADIN models are used together for operational forecasting. Subjective comparison of those models has also been performed.

2. Use and Application of Products

2.1.1 Statistical Adaptation

Kalman Filtering

Kalman Filtering applied to 101 stations including 31 foreign stations from D+1 to D+5 for 2-meter maximum and minimum temperatures.

2.1.2 Physical Adaptation

MM5 Model

A meso-scale MM5 model run operationally 4 times a day for 48 hours using the boundary and initial conditions obtained from ECMWF BC-Suite Project. MSL pressure, sea surface temperature, and upper level temperature, height, u-v wind components and relative humidity parameters are used as initial conditions for MM5.

METU-3 Wave Model

METU-3 is a wind-wave prediction model developed by Coastal and Harbor Engineering Research Center of Middle East Technical University. METU-3 is running operationally at TSMS for wind wave forecast for Mediterranean, Marmara, Caspian and Black Sea. METU-3 is running 2 times a day for 72 hours using 10 meter u-v wind components of ECMWF deterministic model outputs as initial conditions. METU Wave model outputs are significant wave height and directions, mean wave periods and interpolated 10 meter wind speed and directions.

2.1.3 Derived Fields

None

3. Verification of Products

3.1 Objective Verification

3.1.1 Direct ECMWF Model Outputs

24 hourly forecasts between T+00 and T+144 of 12 UTC and 00 UTC deterministic model run are operationally verified with standard statistical scores (mean error, root mean square error and mean absolute error). For the verification of all parameters, 60 Turkish synoptic stations were used, covering the period from January to December 2005.

(i) In the free atmosphere

In the verification process of upper level parameters, observations of 7 our radio-sonde stations used for calculations. For other stations ECMWF analyses values were used.

(ii) Local weather parameters

Interpolated model outputs of local weather parameters (maximum, minimum and 12 UTC of 2 meter temperature, mean sea level pressure, and total precipitation) verified with the corresponding observations. For this process, suitable time steps of model outputs were used. Verified parameters and its periods for the year 2008 are given in below:

- Daily Maximum and Minimum Temperature; D+1, D+2, ..., D+6;
  Scores: ME, RMSE, MAE.
- Mean Sea Level Pressure and 2 m Temperature : D+1, D+2, ..., D+6;
  Scores: ME, RMSE, MAE.
- Total Precipitation existence and contingency tables with 6 categories (0, 0.1-1, 1-5, 5-10,10-20, 20<mm): D+1, D+2, D+3;
  Scores: BIAS, PC, POD,FAR, F, KSS, TS, ETS, HSS, OR, ORSS
- 1000, 850, 700, 500 and 300 hPa Height and Temperature: D+1, D+2, ..., D+6;
  Scores: ME, RMSE, MAE.

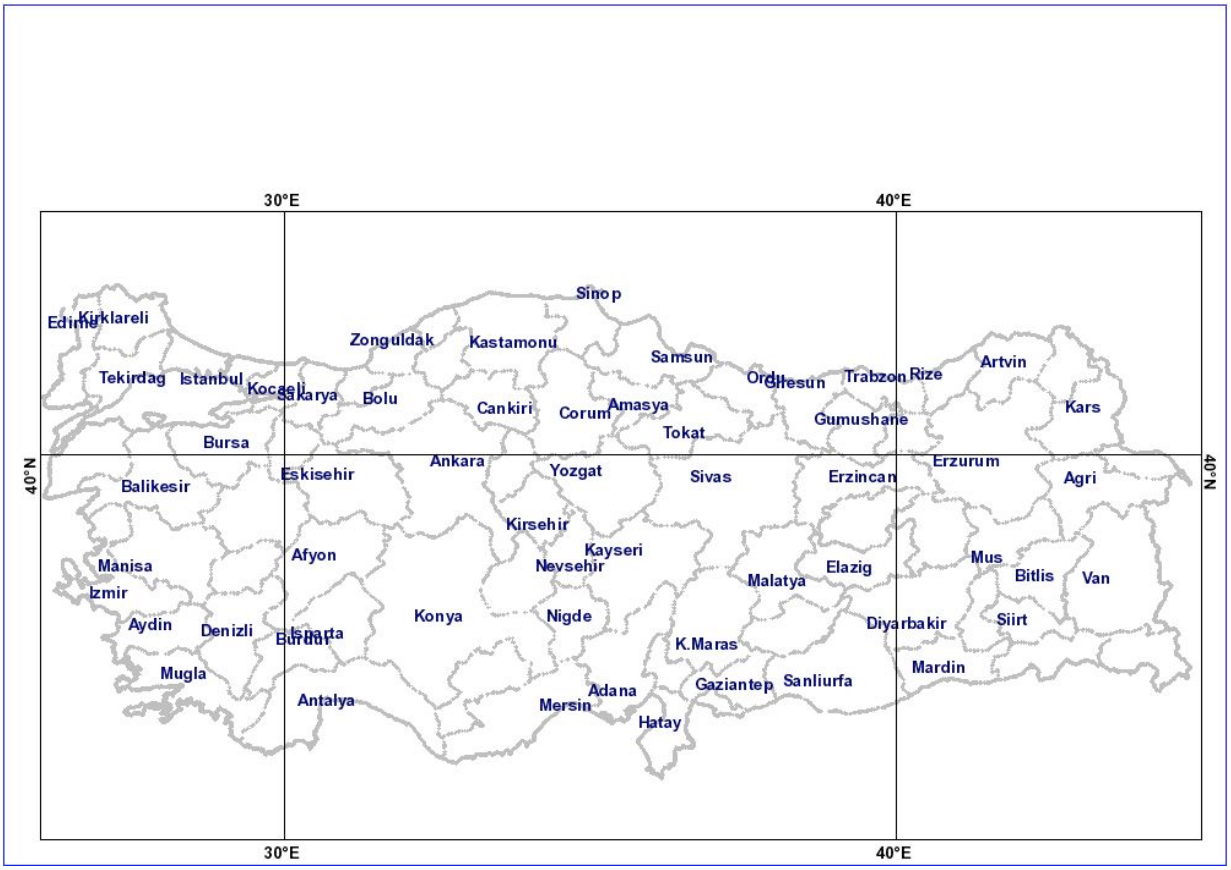

Figure 3.1.1.1. Turkish synoptic and radio-sonde stations used in this study.

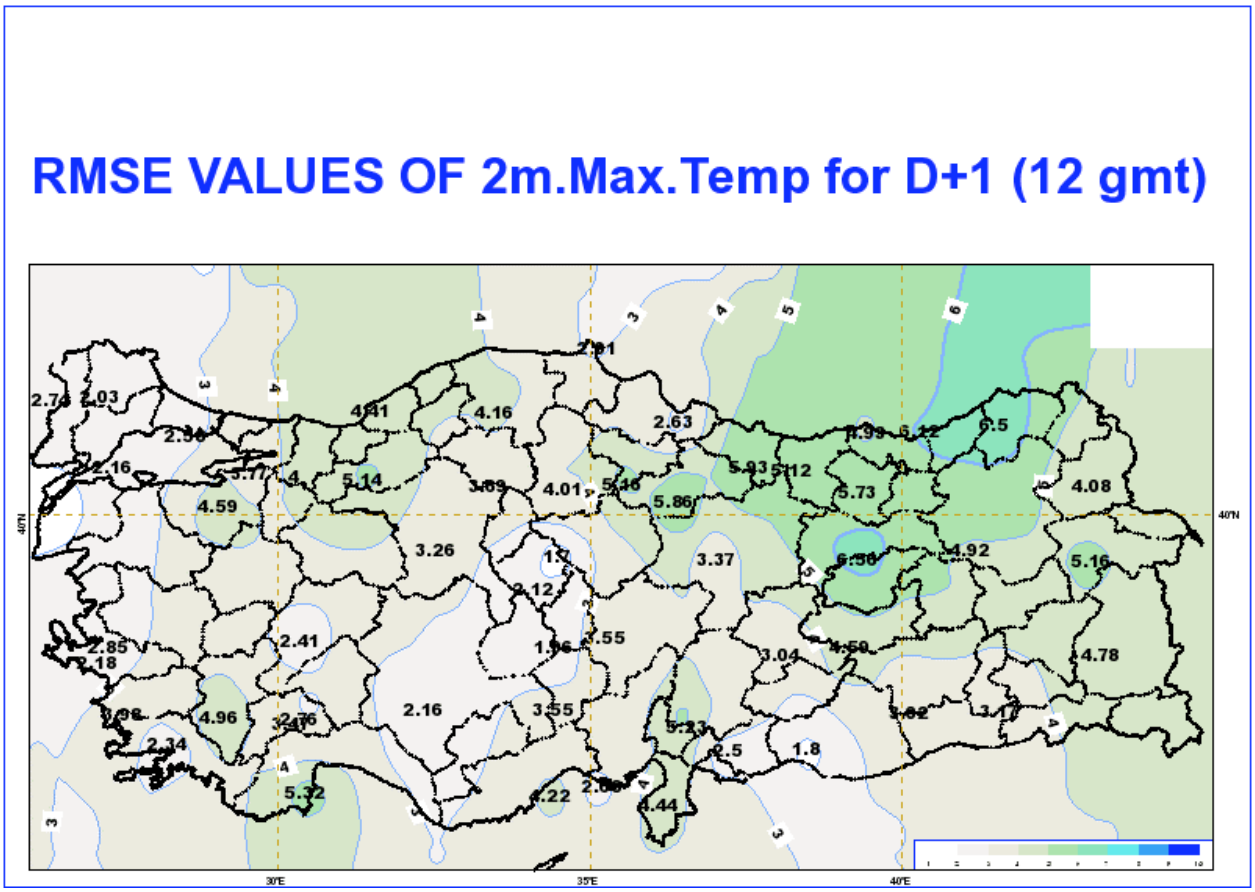

Figure 3.1.1.2. 12 UTC RMSE Values of Maximum Temperature for D+1.

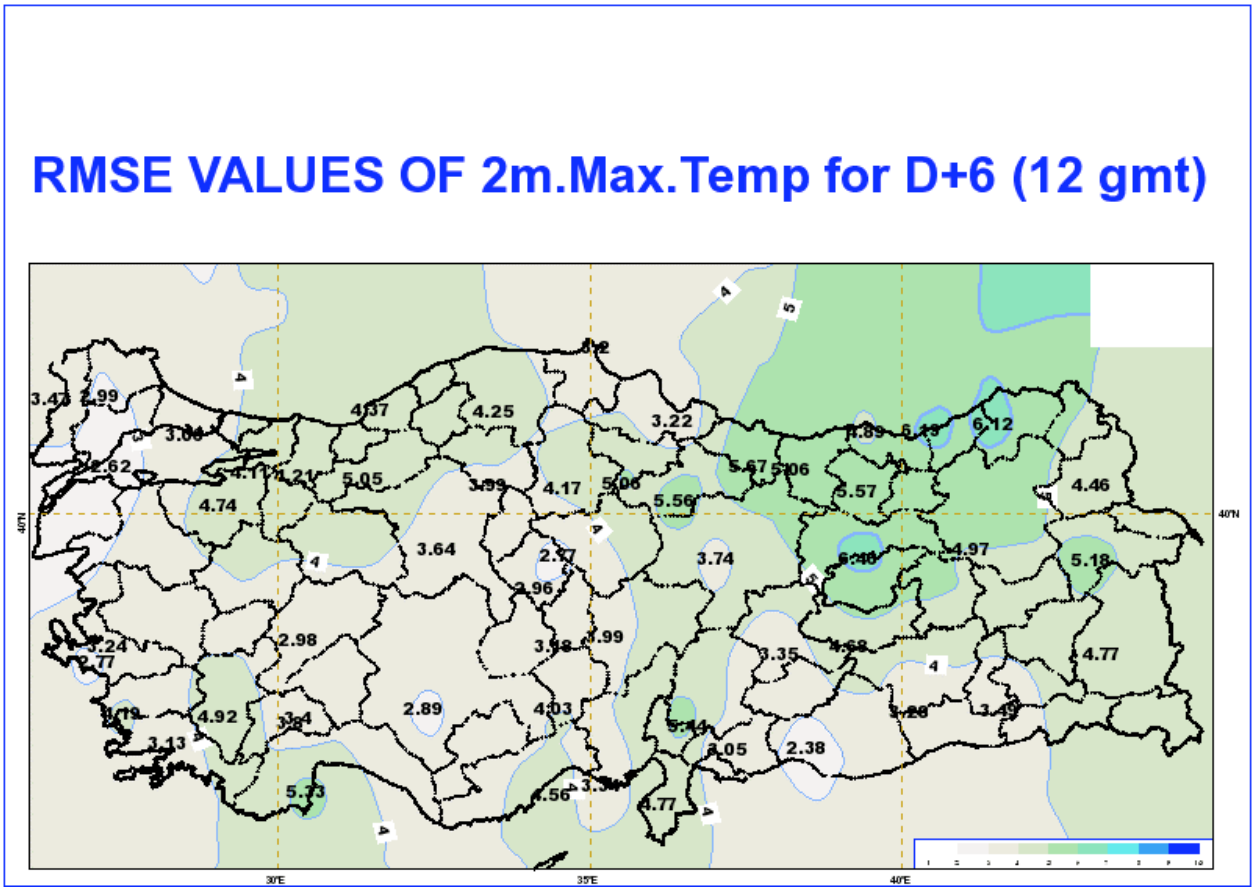

Figure 3.1.1.3. 12 UTC RMSE values of Maximum temperature for D+6.

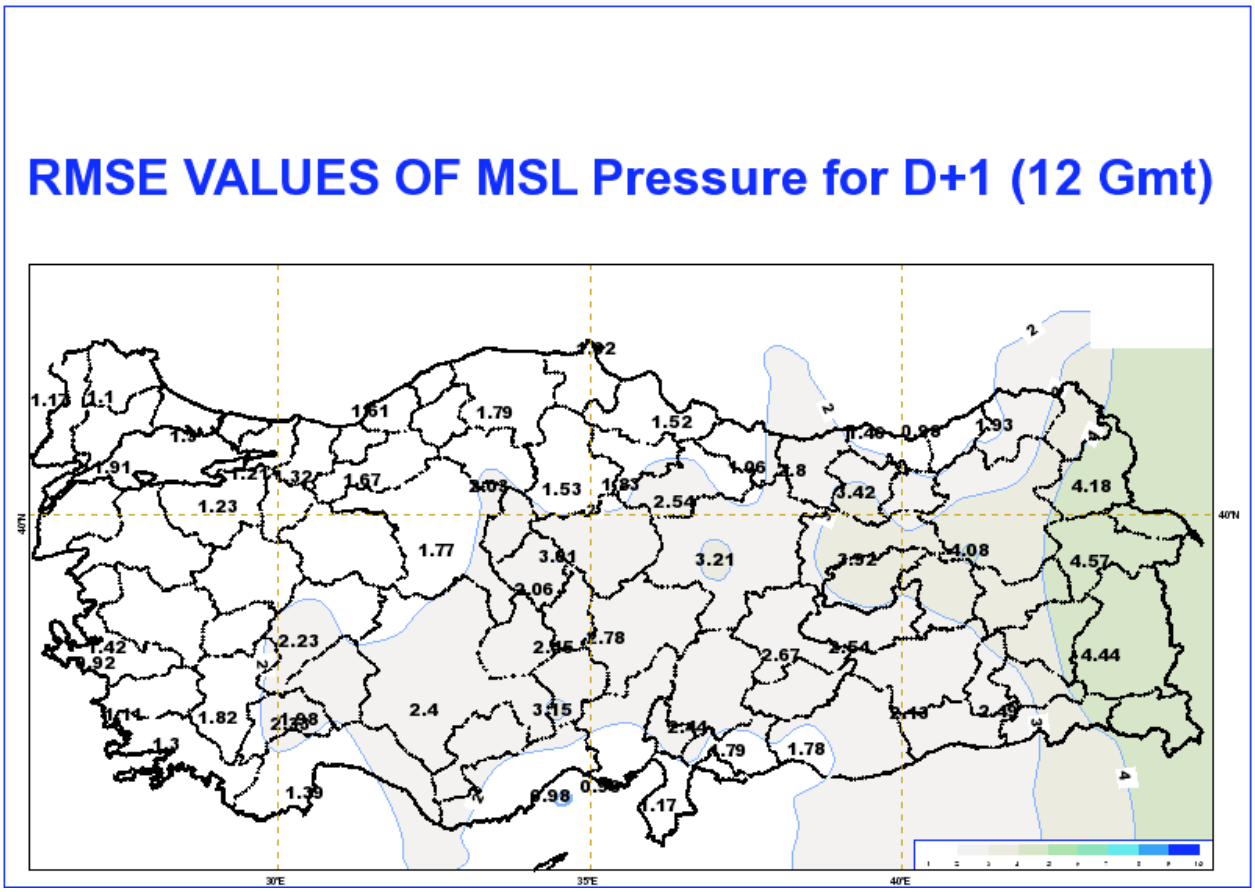

Figure 3.1.1.4. 12 UTC RMSE Values of Mean Sea Level Pressure for D+1

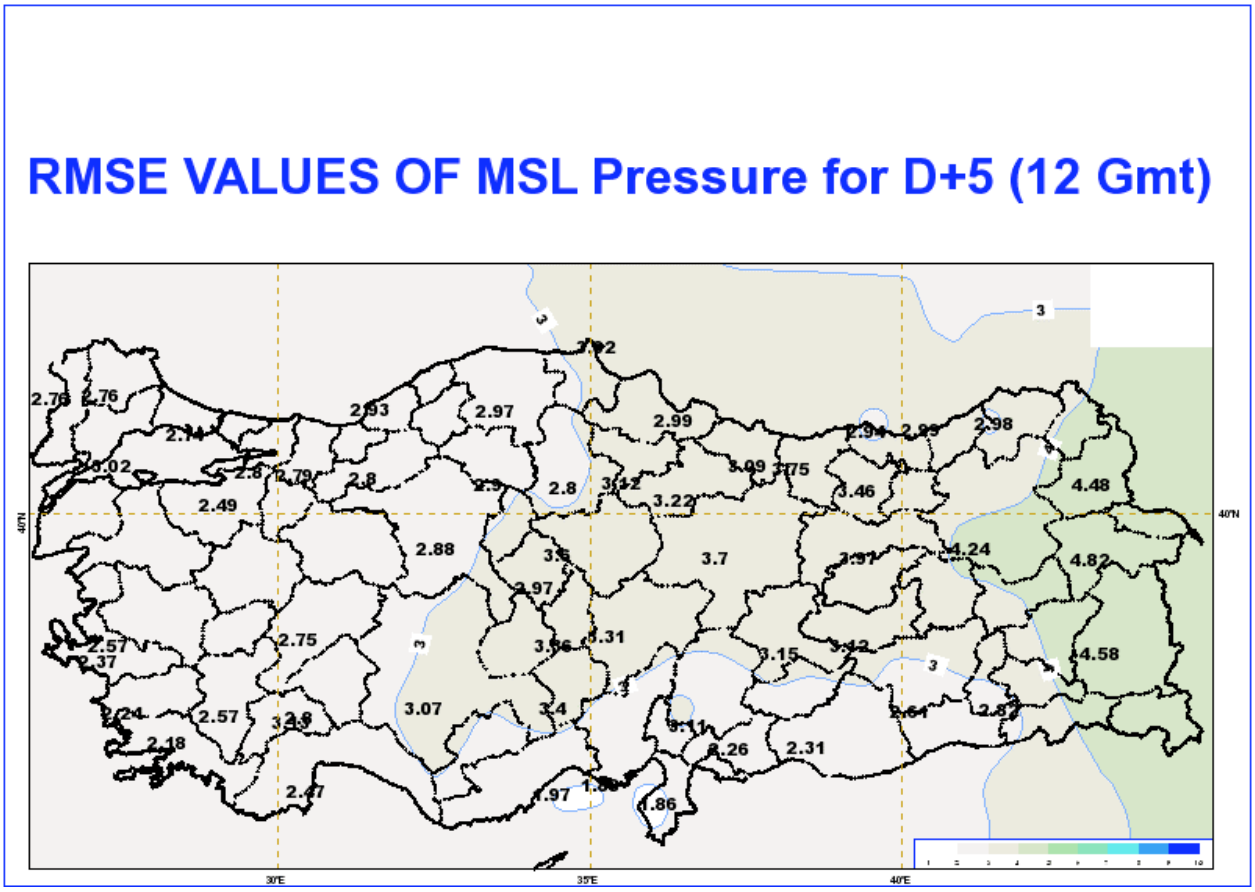

Figure 3.1.1.5. 12 UTC RMSE Values of Mean Sea Level Pressure for D+5

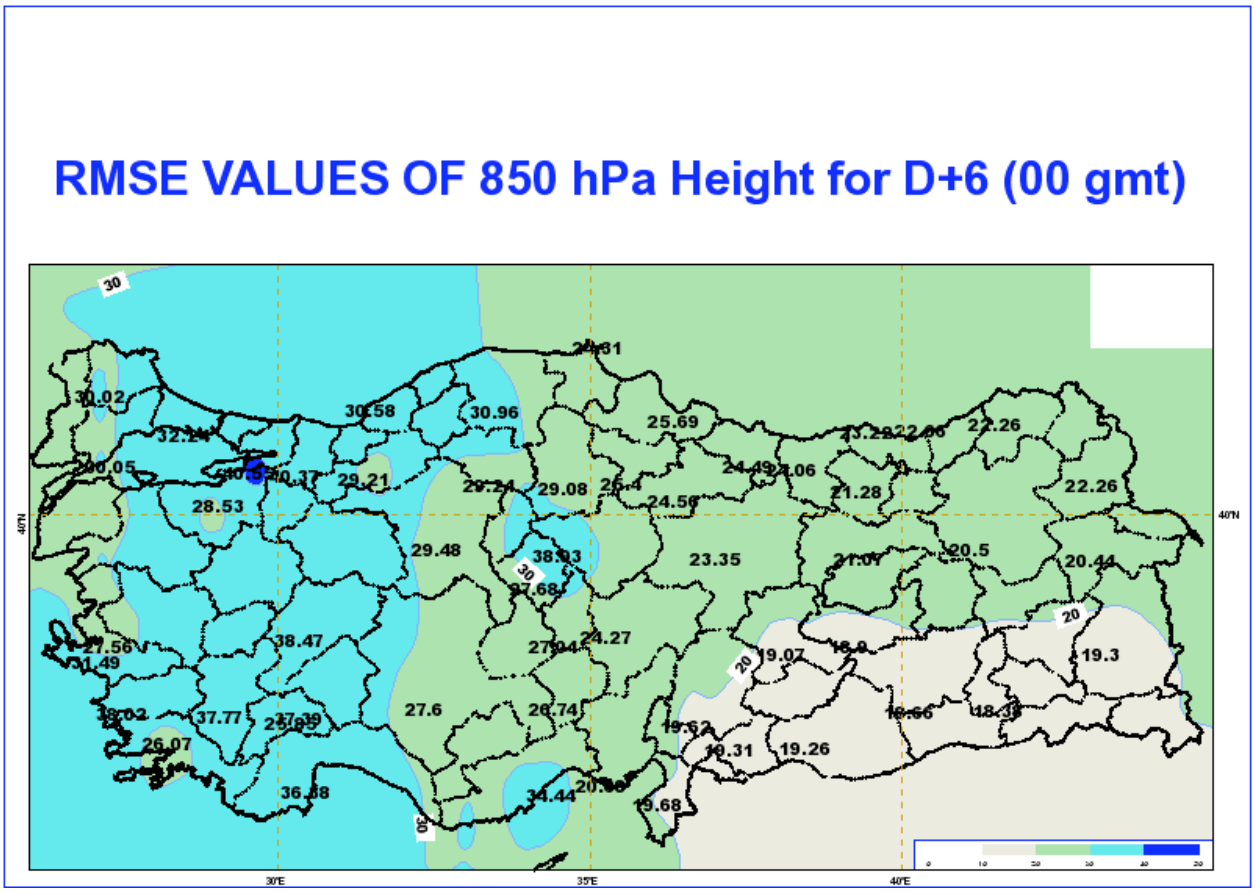

Figure 3.1.1.6. 00 UTC RMSE Values of 850 hPa Height for D+6

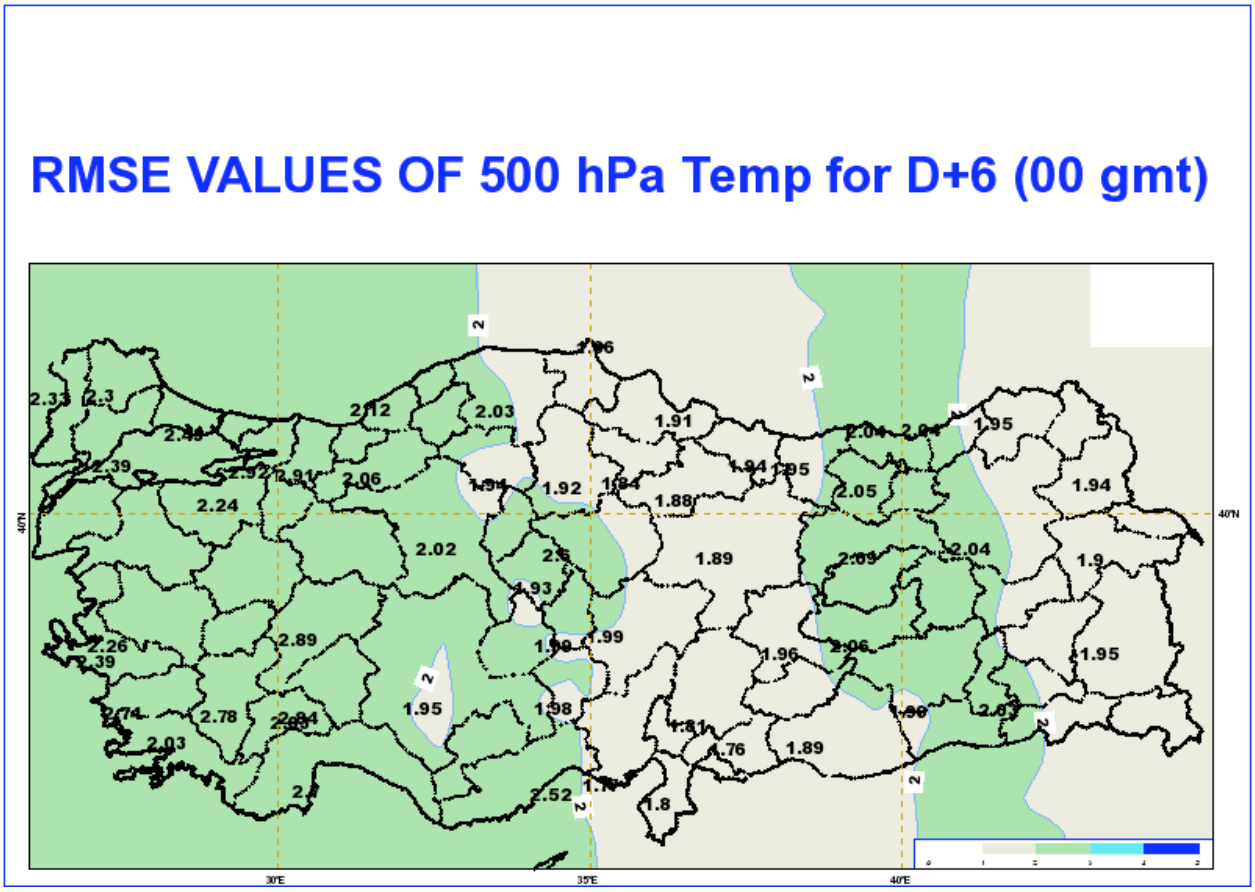

Figure 3.1.1.7. 00 UTC RMSE Values of 500 hPa Temp. for D+6

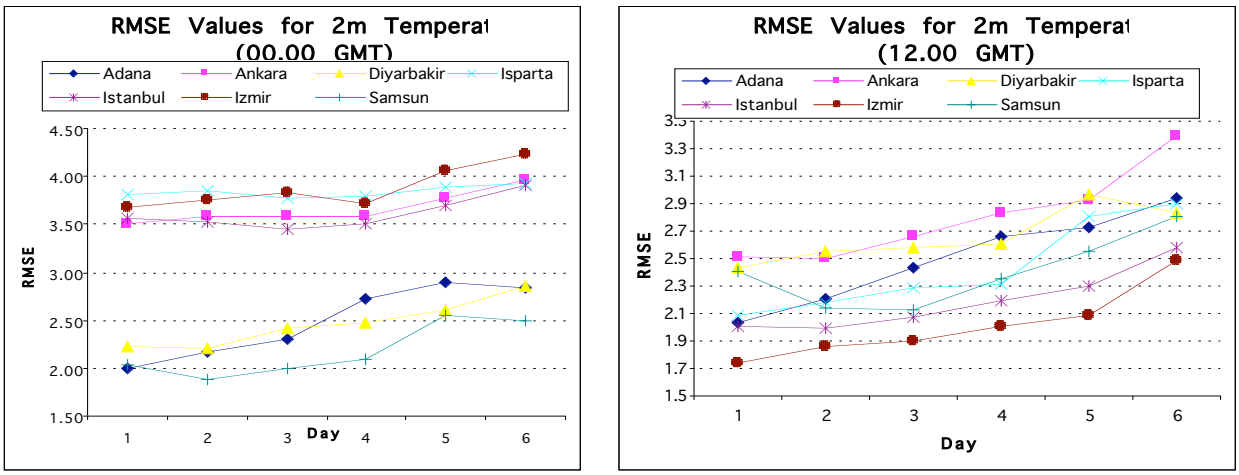

Figure 3.1.1.8. RMS Errors of 00.00 and 12.00 GMT Model Outputs for 2m Temperature forecasts as a function of forecast range for 7 Turkish radio-sonde stations.

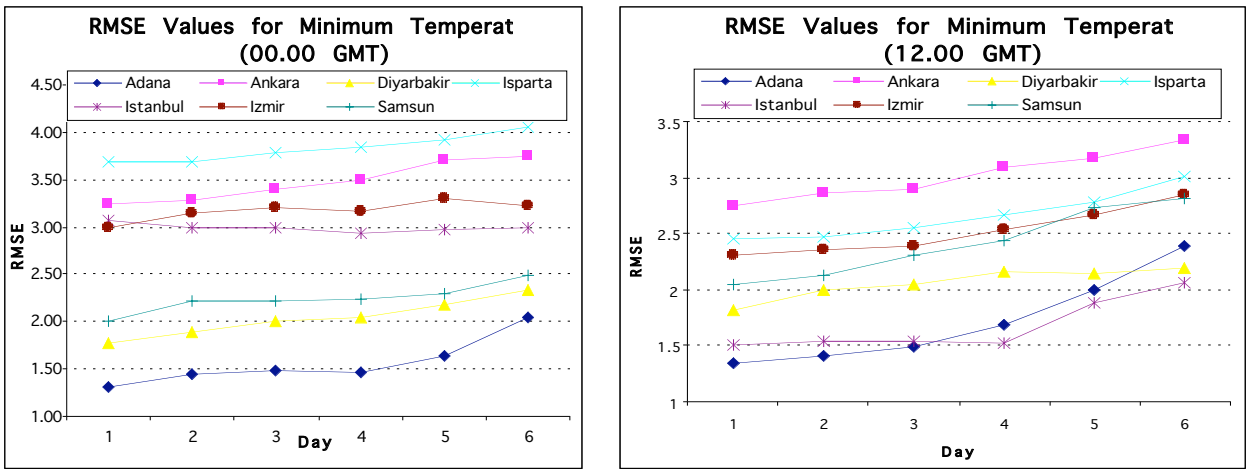

Figure 3.1.1.9. RMS Errors of 00.00 and 12.00 GMT Model Outputs for Minimum Temperature forecasts as a function of forecast range for 7 Turkish radio-sonde stations.

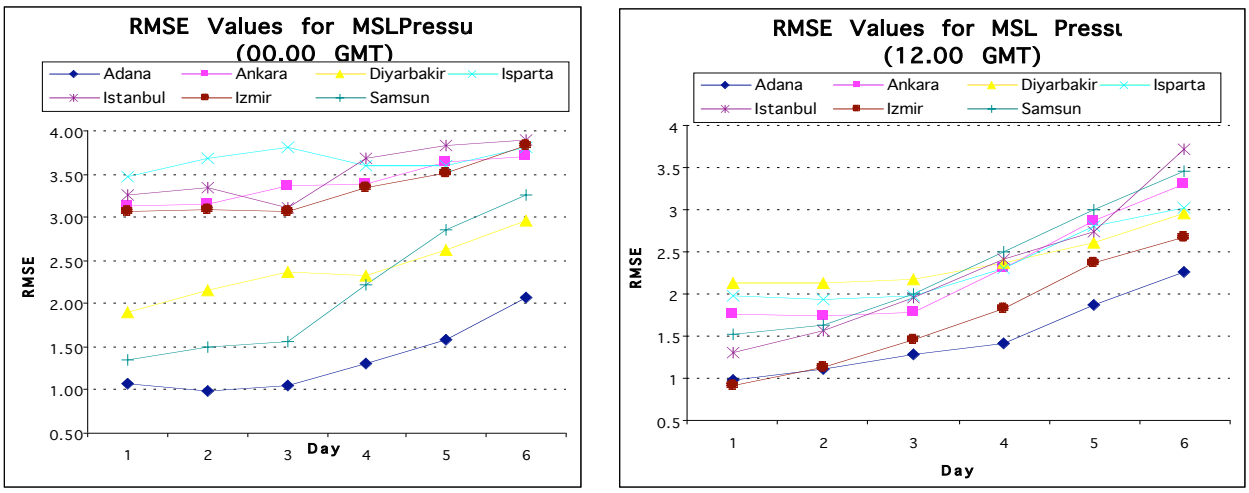

Figure 3.1.1.10. RMS Errors of 00.00 and 12.00 GMT Model Outputs for MSL Pressure forecasts as a function of forecast range for 7 Turkish radio-sonde stations.

Verification of Precipitation

Precipitation forecasts of the ECMWF are interpolated to the station points. Actual values (observed) and interpolated forecast values are compared. 24 hourly total precipitation classified as follows;

		Observation Yes	No
Forecast	**Yes**	a	b
	No	c	d

BIAS = (a+b)/(a+c) **PC** = (a+d)/(a+b+c+d)
POD = a/(a+c) **FAR** = b/(a+b)
F = b/(b+d) **KSS** = POD-F
HSS = 2(ad-bc) / {(a+c)(c+d)+(a+b)(b+d)}
ETS = (a-ar)/(a+b+c-ar) *where* ar =(a+b)(a+c)/(a+b+c+d)
TS = a/(a+b+c) **OR** = ad/bc
ORSS = (ad-bc) / (ad+bc)

Ankara (D+1) (12.00GMT Model Outputs)

106	37	Bias = 0.93	PC = 0.70
48	91	POD= 0.69	FAR = 0.26
		F = 0.29	KSS = 0.40
		TS = 0.55	ETS = 0.25
		HSS = 0.40	OR = 5.43
		ORS= 0.69	

Ankara (D+3) (12.00GMT Model Outputs)

109	42	Bias = 0.97	PC =0.69
46	86	POD= 0.70	FAR=0.28
		F = 0.33	KSS=0.38
		TS = 0.55	ETS =0.23
		HSS = 0.37	OR =4.85
		ORS= 0.66	

Istanbul (D+1) (00.00GMT Model Outputs)

74	146	Bias = 2.97	PC = 0.44
0	39	POD= 1.00	FAR = 0.66
		F = 0.79	KSS = 0.21
		TS = 0.34	ETS = 0.07
		HSS = 0.13	OR = inf
		ORS= 1.00	

Istanbul (D+3) (00.00GMT Model Outputs)

72	141	Bias = 2.92	PC =0.45
1	45	POD= 0.99	FAR=0.66
		F = 0.76	KSS=0.23
		TS = 0.34	ETS =0.08
		HSS = 0.14	OR =22.98
		ORS= 0.92	

Contingency table for 24 hourly precipitation for D+1 in the period Jan-Dec 2008

Ankara (00.00GMT Model Outputs)

Obs \ For	0.0	0.1 - 1.0 mm.	1.0 - 5.0 mm	5.0 - 10.0 mm.	10.0 - 20.0 mm	For >20 mm.
0.0	83	22	19	2	0	0
0.1 - 1.0 mm.	3	56	30	14	3	0
1.0 - 5.0 mm	1	10	12	5	1	0
5.0 - 10.0 mm.	0	3	7	3	0	0
10.0 - 20.0 mm	0	0	1	1	0	0
Obs >20 mm.	1	0	1	0	1	0

Correct (Hit Rates): % 55.20
Small Error Rate : % 28.32
Moderate Err. Rate: % 13.98
Sign. Error Rate: %2.15
Large Err. Rate: %0.00
Very Large Err.: %0.36

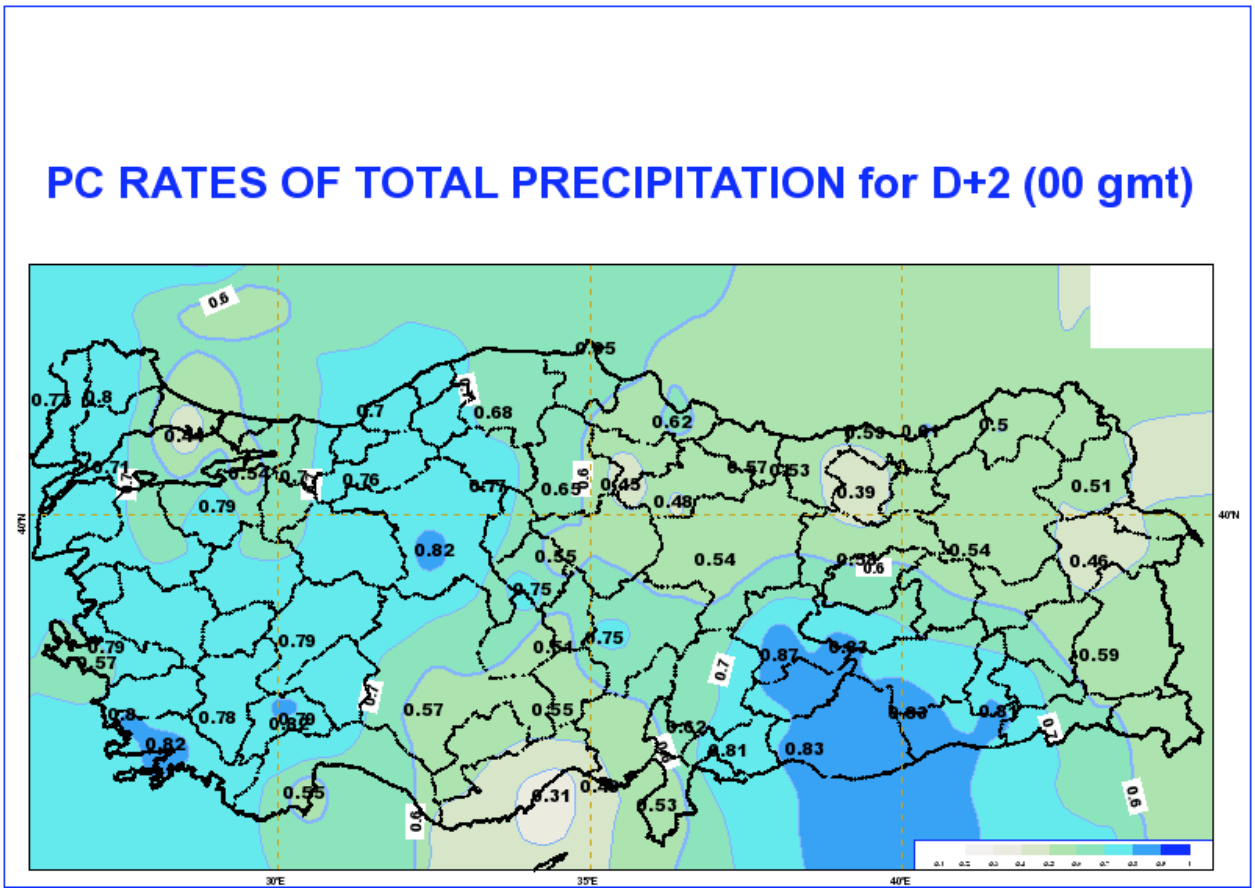

Figure 3.1.1.11 Proportion Correct Rates of D+2 Total Precipitation (00.00GMT Model Outputs)

3.1.2 ECMWF model output compared to other NWP models

A meso-scale MM5 model is running 4 times a day for a range of 48 hours. We perform verification for MSL pressure, 2m temperature, 10 meter u-v wind components and total precipitation parameters of MM5 model (12 UTC run). However, no objective scores of comparison have been computed at ECMWF and MM5 model. In the subjective verification, 2m temperature values of ECMWF give more accurate result than those of MM5. Whereas, MM5 model forecasts for the total precipitation are better than ECMWF.

Another meso-scale model ALADIN is running 2 times a day for a range of 48 hours. Currently we perform verification for 2m temp, 10 meter wind speed and direction, MSL and total precipitation of 12.00 GMT ALADIN run. In the subjective verification ALADIN model forecasts for 10 meter wind speed and direction are better then ECMWF forecasts.

3.1.3 Post-processed products

Kalman Filtering

Kalman Filtering applied to 101 stations including 31 foreign stations from D+1 to D+5 for 2-meter maximum and minimum temperatures. Generally, Kalman Filtering outputs are %5-20 better then direct model outputs.

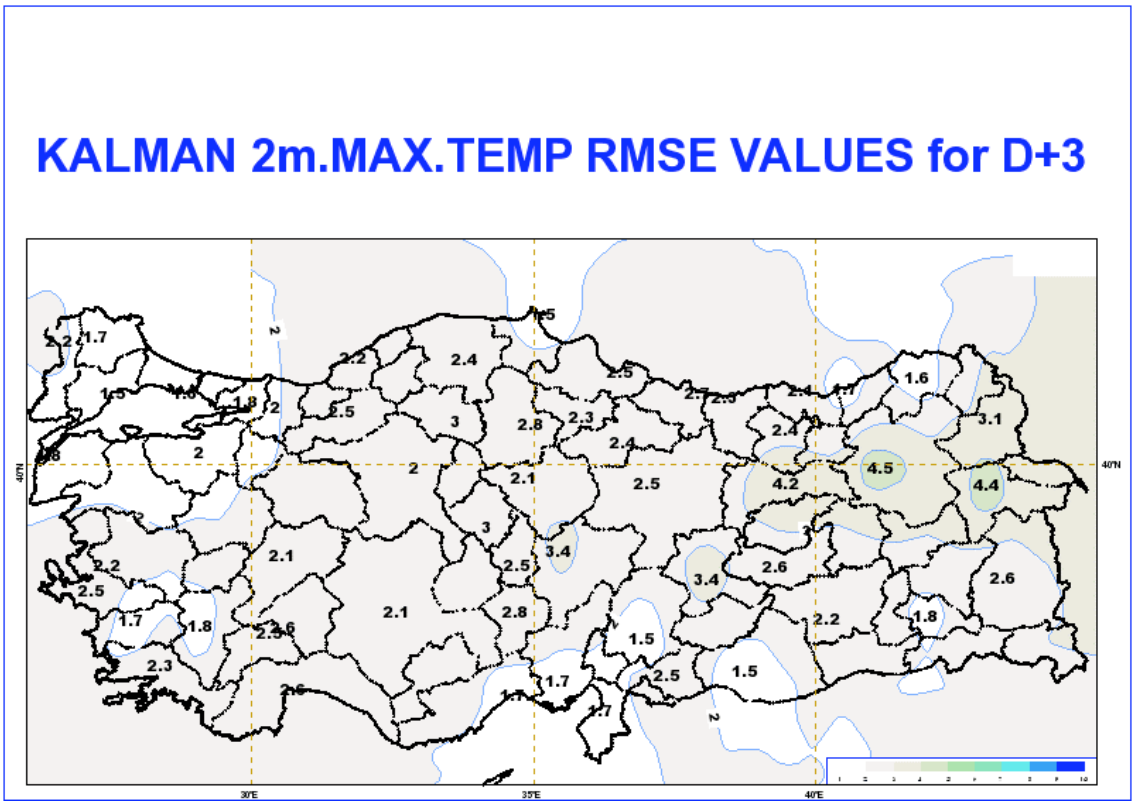

Figure 3.1.3.1. Filtered RMSE Values of Maximum Temperature for D+3

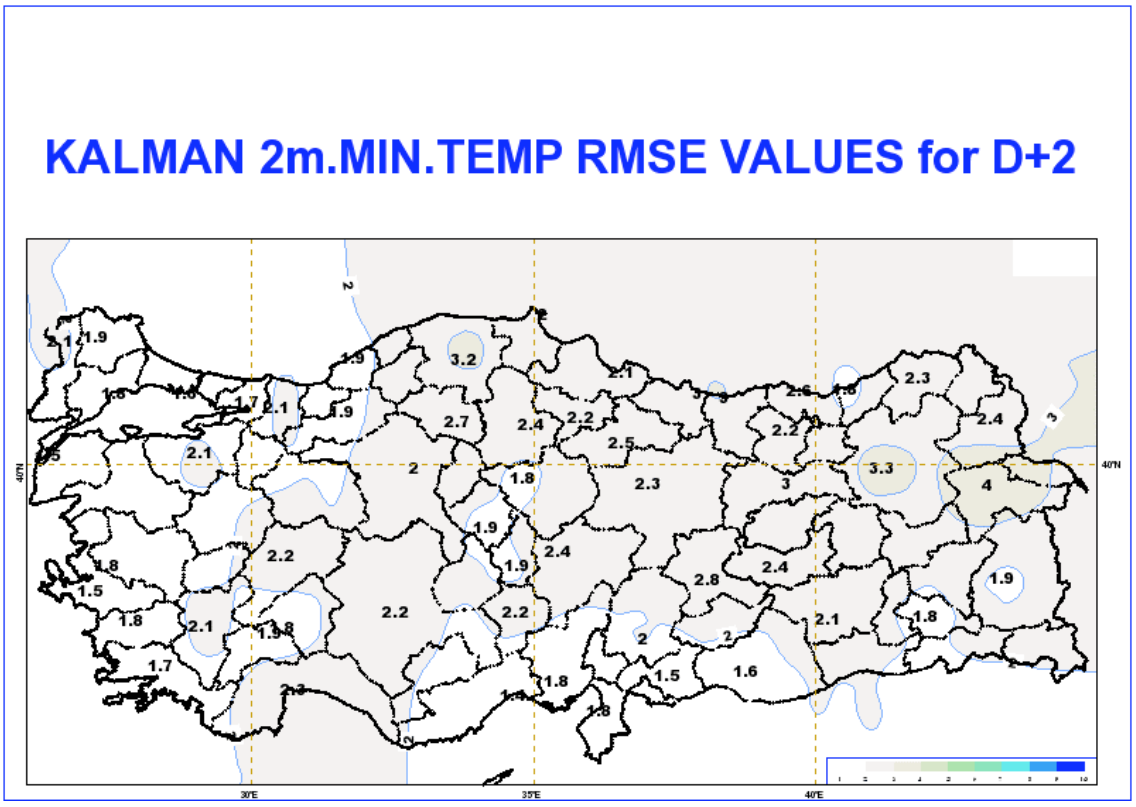

Figure 3.1.3.2. Filtered RMSE Values of Maximum Temperature for D+4

3.1.4 End Products delivered to users

3.2 Subjective verification

3.2.1 Subjective scores

Our Weather Analysis and Forecasting Division (WAFD) uses ECMWF outputs for wide range of purposes from short-range forecasts to the special reports. We compared ECMWF forecasts and those of WAFD forecasts (based on bench forecasters' experience) with observed values. The verification results were based on the observed values received from 60 stations throughout Turkey and ECMWF's D+1, D+2, D+3 and D+4 corresponding forecasts. When "yes-no" type of verification applied for ECMWF precipitation forecasts, little improvements were noted. Most of the figures show a continuing upward trend over the past few years. Based on ECMWF's upward trend, with combining their experiences and ECMWF model outputs, WAFD made better precipitation forecasts than previous years.

3.2.2 Synoptic Studies

None

4. References

ECMWF, (2007): Verification of ECMWF products in Member States and Co-operating States, Report 2007.