Application and verification of ECMWF products 2012

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1. Summary of major highlights

The verification of ECMWF products has continued as in previous years.

2. Use and application of products

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 score of root mean square error. For the verification of all parameters, 79 Turkish synoptic stations were used, covering the period from January to December 2011.

All time steps forecasts between T+00 and T+240 of 12 UTC and 00 UTC deterministic model run are operationally verified with standard statistical score of root mean square error. For the verification of 2 meter temperature and mean sea level pressure 7 Turkish synoptic stations (Ankara, Istanbul, Adana, Samsun, Isparta, Diyarbakır, and Izmir) were used, covering the period from January to December 2011. For the verification of wind speed 5 Turkish synoptic stations (Ankara, Istanbul, Adana, Samsun, Isparta) selected.

Interpolated model outputs of local weather parameters (00 UTC and 12 UTC of 2 meter temperature, mean sea level pressure, wind speed and total precipitation) verified with the corresponding observations. For this process, suitable time steps of model outputs were used.

Figure 1 Turkish synoptic and radio-sonde stations used in this study.

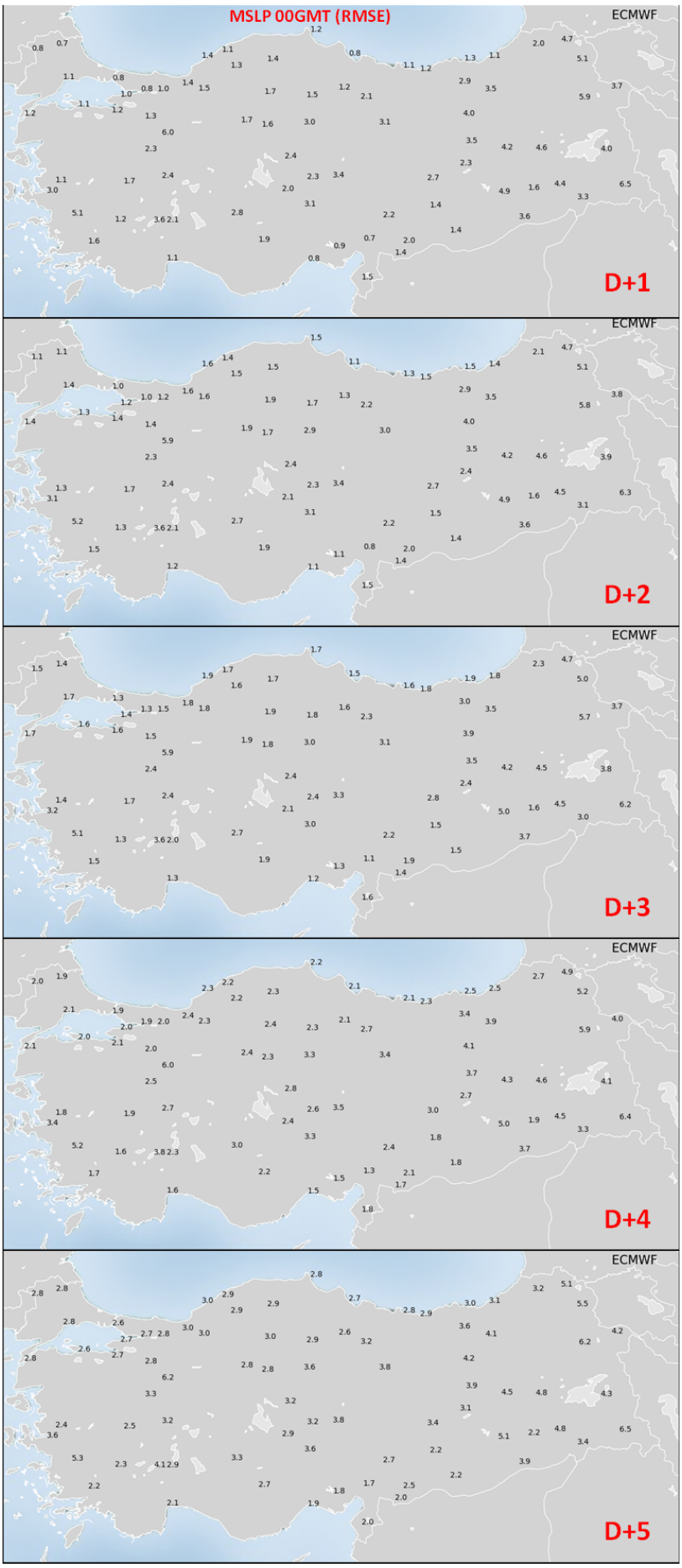

Figure 2 00 UTC RMSE Values of MSLP for D+1 to D+5.

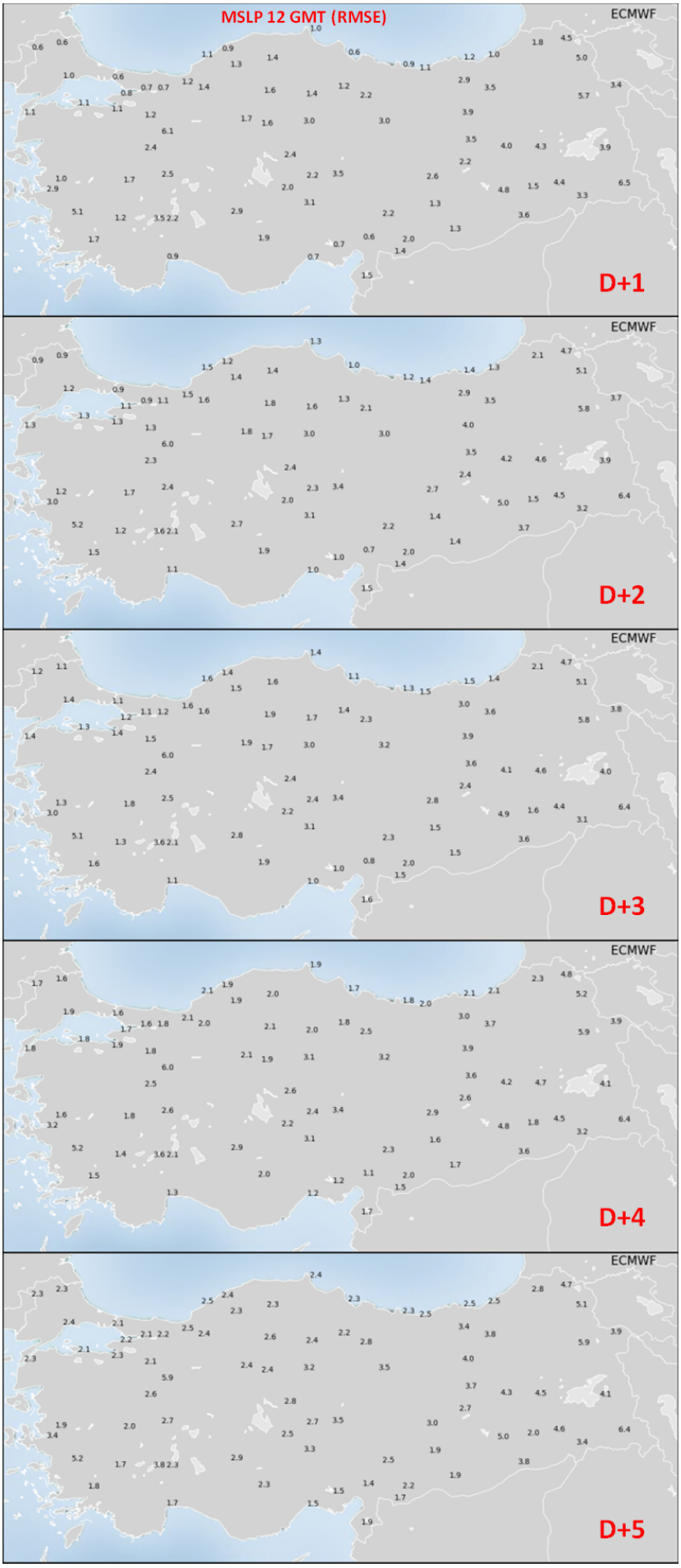

Figure 3 12 UTC RMSE Values of MSLP for D+1 to D+5.

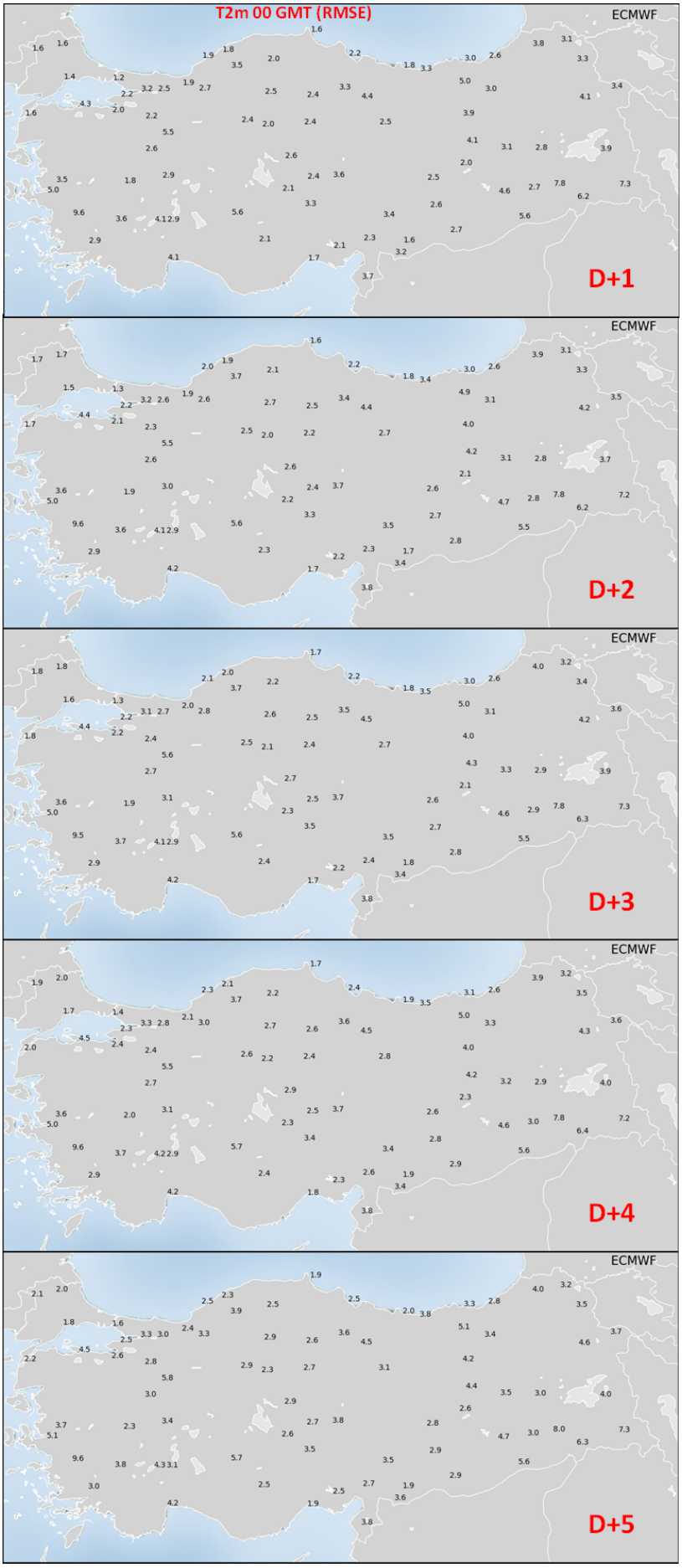

Figure 4 00 UTC RMSE Values of 2m temperature for D+1 to D+5.

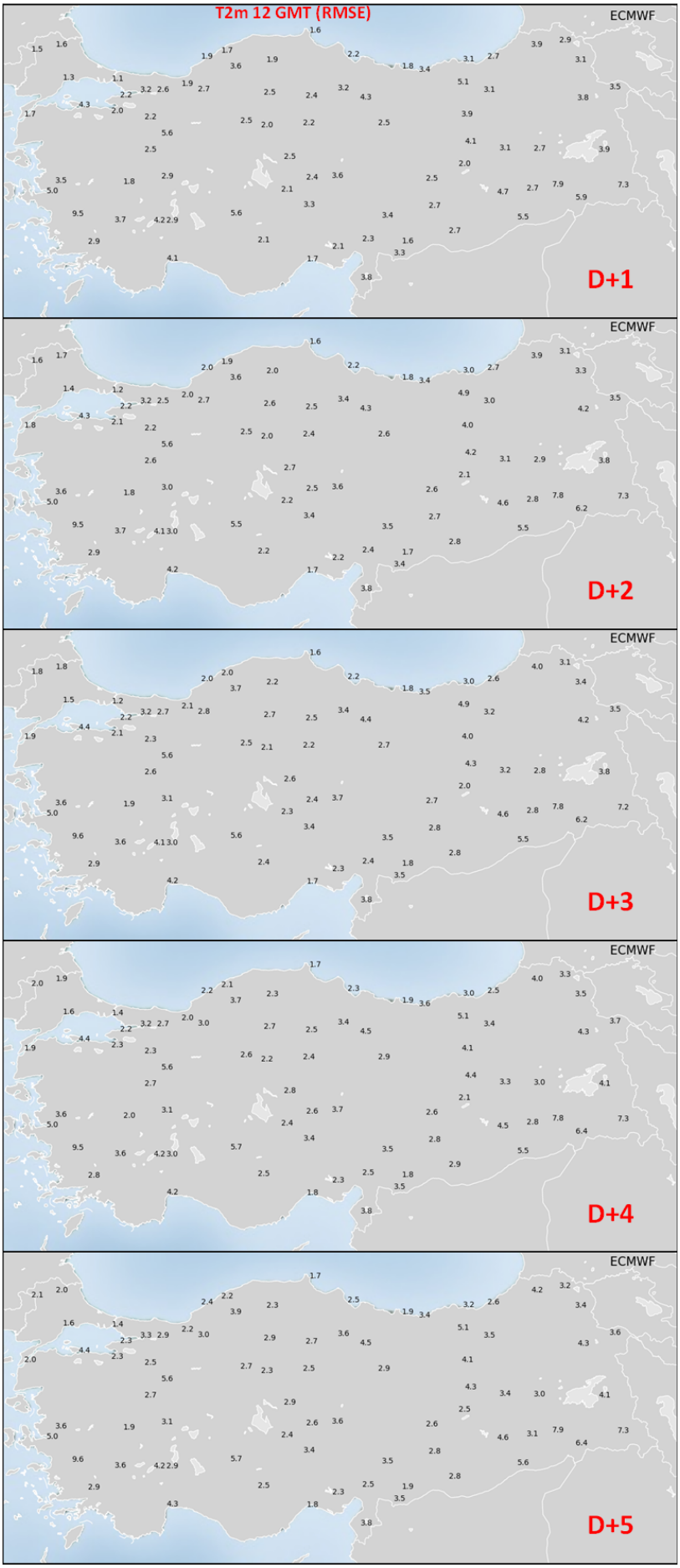

Figure 5 12 UTC RMSE Values of 2m temperature for D+1 to D+5.

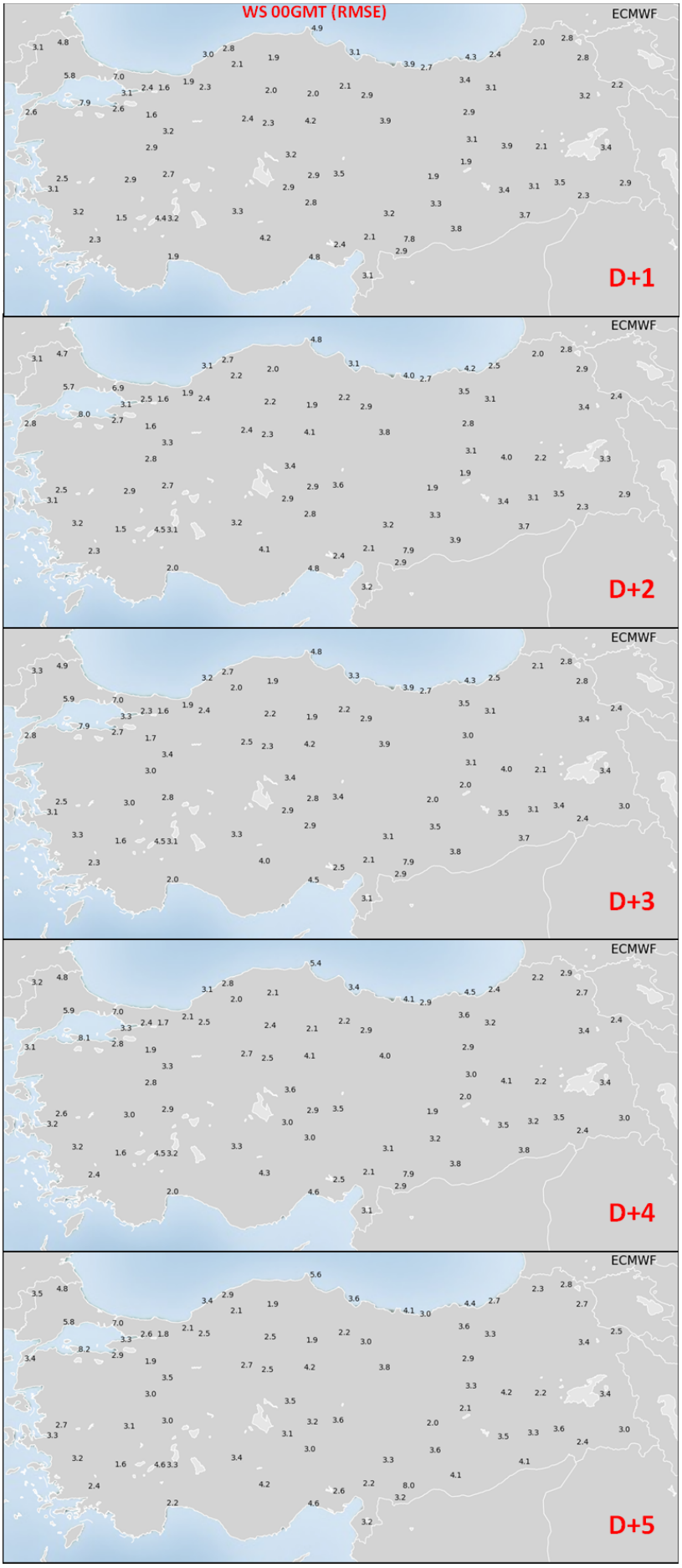

Figure 6 00 UTC RMSE Values of wind speed for D+1 to D+5.

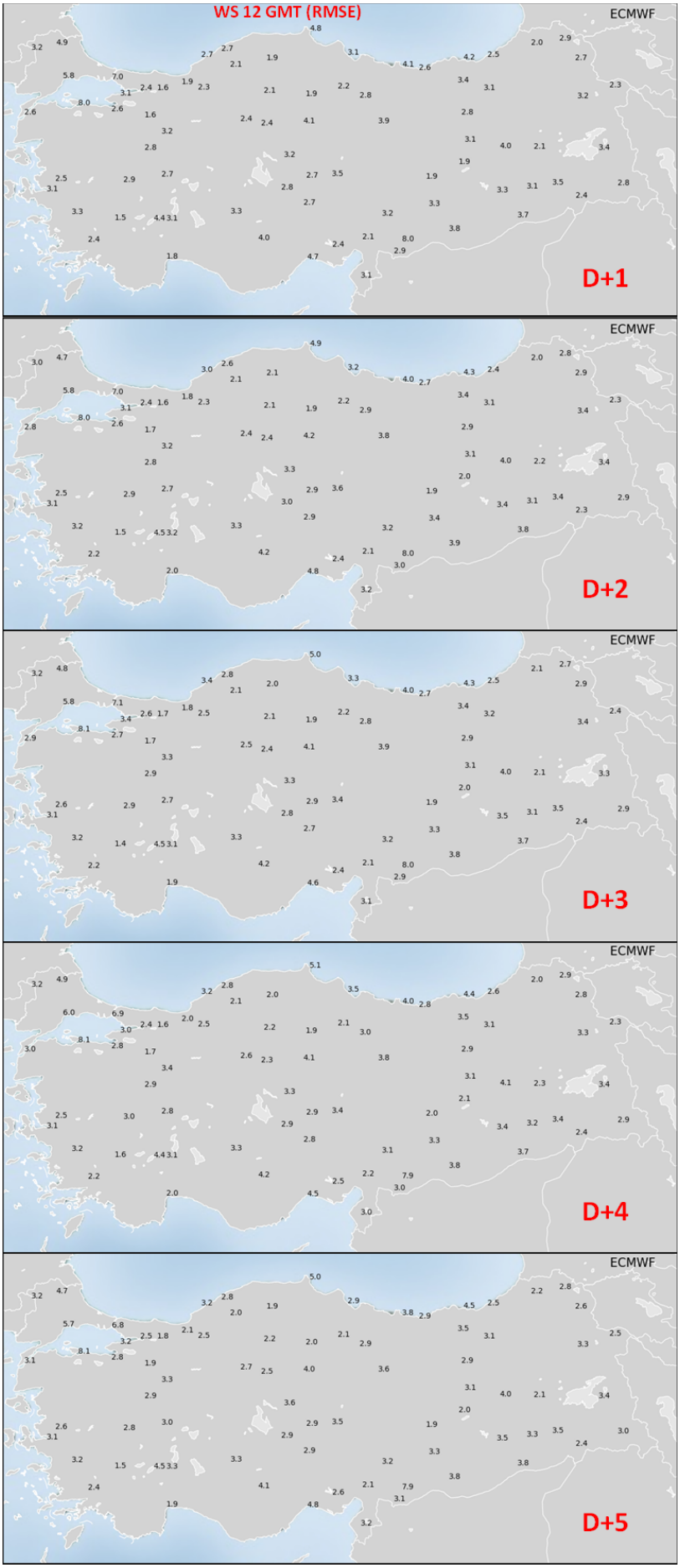

Figure 7 12 UTC RMSE Values of wind speed for D+1 to D+5.

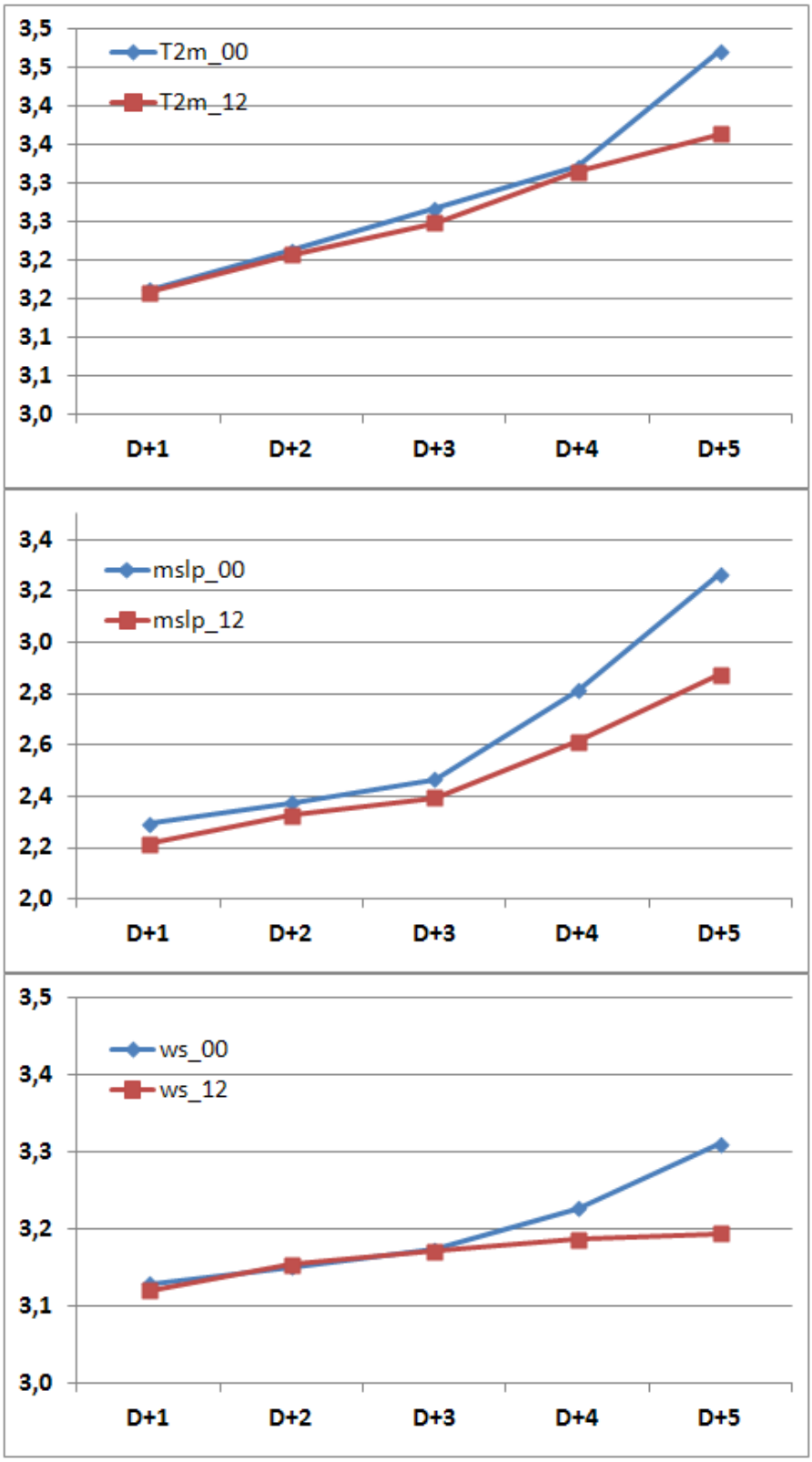

Figure 8 00 and 12 UTC average RMSE values of 79 stations for D+1 to D+5.

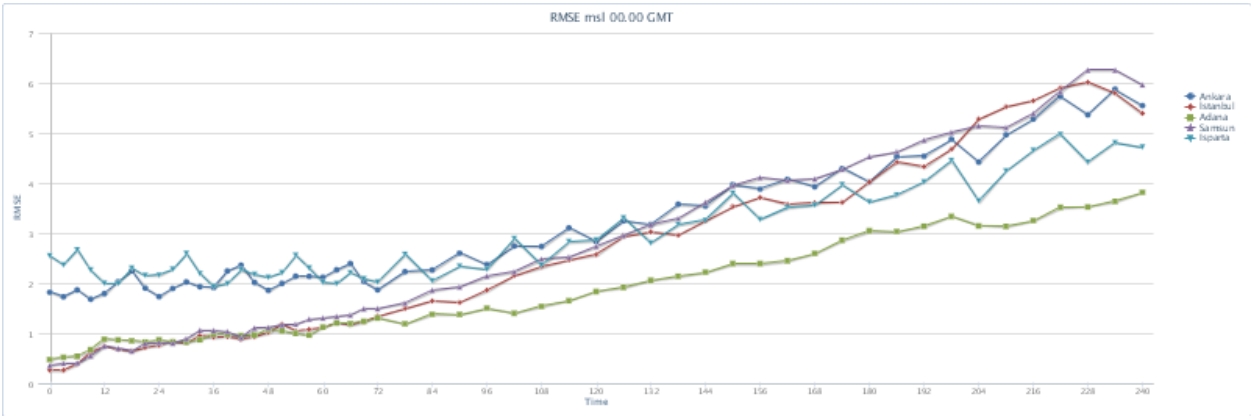

Figure 9 RMSE of 00 UTC MSLP forecasts as a function of forecast range for 5 Turkish radio-sonde stations

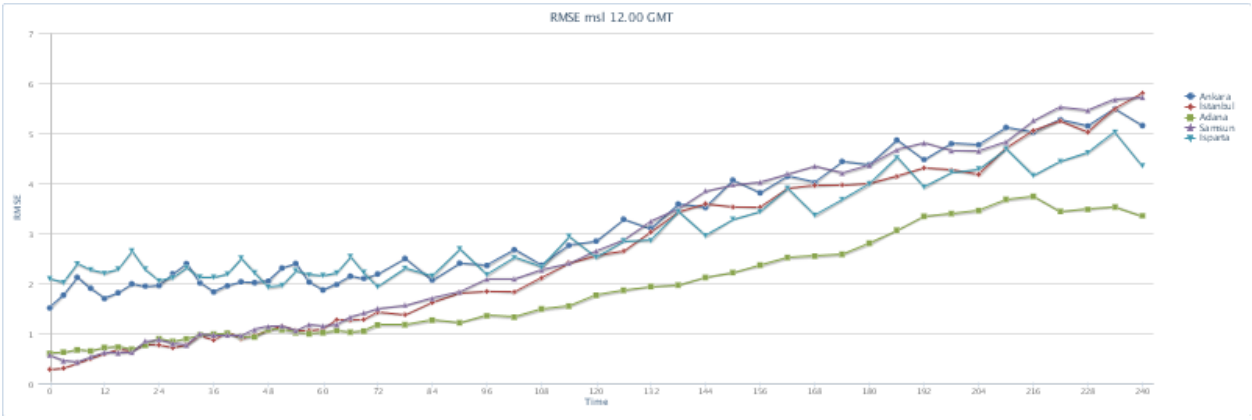

Figure 10 RMSE of 12 UTC MSLP forecasts as a function of forecast range for 5 Turkish radio-sonde stations

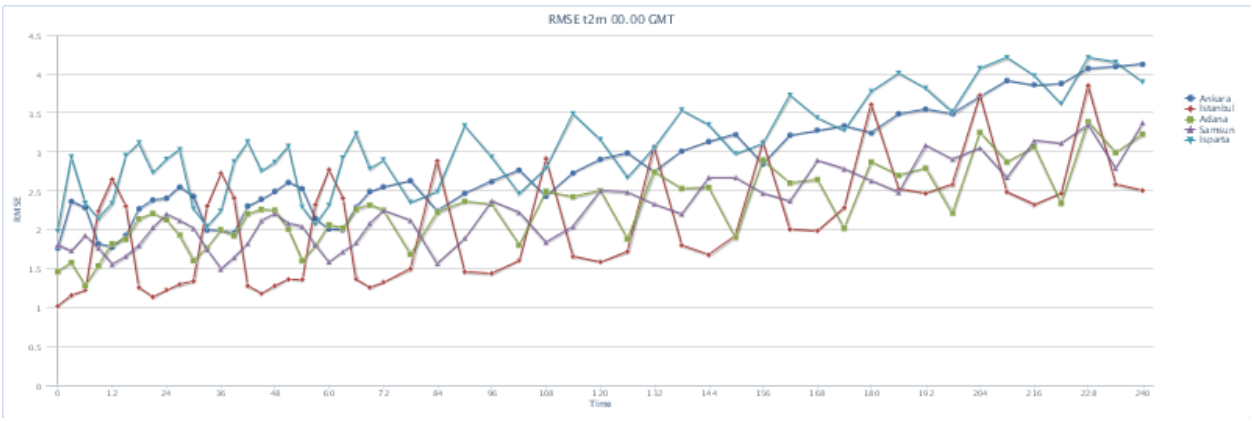

Figure 11 RMSE of 00 UTC 2m temperature forecasts as a function of forecast range for 5 Turkish radio-sonde stations

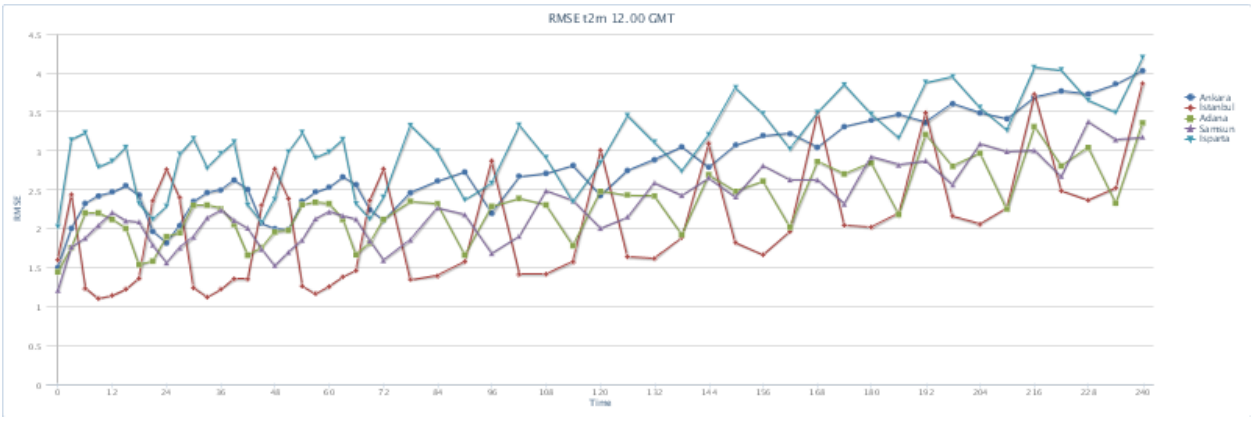

Figure 12 RMSE of 12 UTC 2m temperature forecasts as a function of forecast range for 5 Turkish radiosonde stations

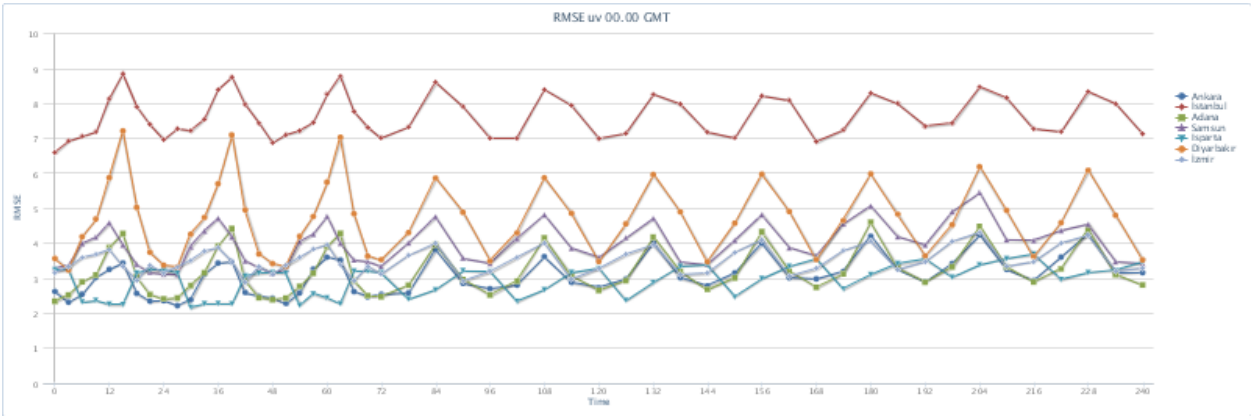

Figure 13 RMSE of 00 UTC wind speed forecasts as a function of forecast range for 7 Turkish radiosonde stations

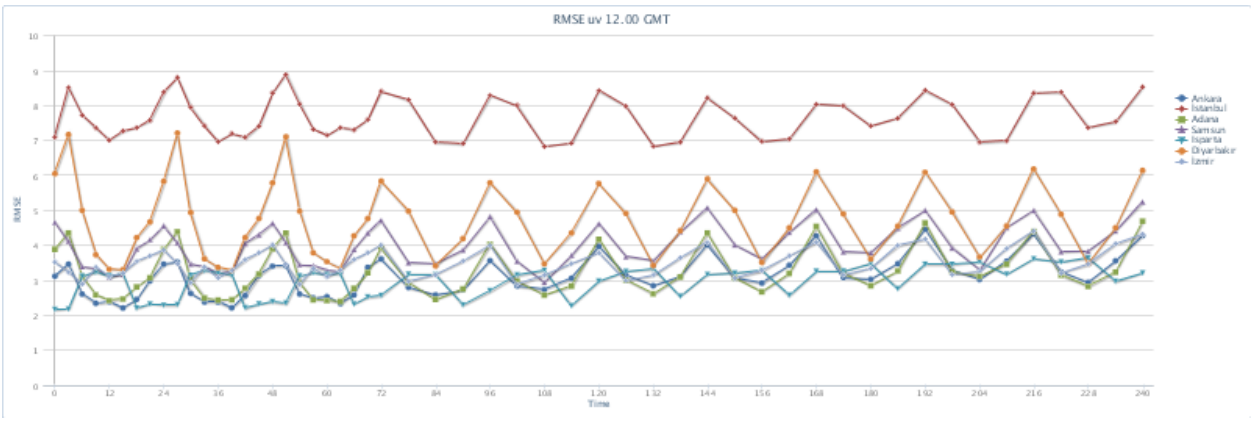

Figure 14 RMSE of 12 UTC wind speed forecasts as a function of forecast range for 7 Turkish radiosonde stations

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 precipitations classified as follows (Nurmi, 2003);

		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)

Stations (D+1) 00 GMT Model Outputs

D+1	Adana	Ankara	Diyarbakır	Erzurum	Istanbul	Isparta	Izmir	Samsun
a	60	71	82	95	89	87	53	109
b	91	66	41	36	58	54	56	117
c	11	24	21	53	16	12	16	11
d	173	176	193	153	174	184	212	96
Total	335	337	337	337	337	337	337	333
FAR	0,60	0,48	0,33	0,27	0,39	0,38	0,51	0,52
HIT	0,70	0,73	0,82	0,74	0,78	0,80	0,79	0,62
BIAS	2,13	1,44	1,19	0,89	1,40	1,42	1,58	1,88
POD	0,85	0,75	0,80	0,64	0,85	0,88	0,77	0,91
TS	0,37	0,44	0,57	0,52	0,55	0,57	0,42	0,46
F	0,34	0,27	0,18	0,19	0,25	0,23	0,21	0,55
HSS	0,35	0,42	0,59	0,46	0,54	0,58	0,46	0,30
ETS	0,22	0,26	0,42	0,30	0,37	0,41	0,30	0,18
ORSS	0,82	0,78	0,90	0,77	0,89	0,92	0,85	0,78
PC	0,70	0,73	0,82	0,74	0,78	0,80	0,79	0,62
KSS	0,50	0,47	0,62	0,45	0,60	0,65	0,56	0,36
OR	10,37	7,89	18,38	7,62	16,69	24,70	12,54	8,13

Contingency table for 24 hourly precipitations (mm) for D+2 in the period Jan-Dec 2011

Adana 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	173	60	18	9	4	0
0,1-1	6	1	2	4	5	1
1,1-5	2	2	8	6	3	1
5,1-10	3	1	7	1	1	0
10,1-20	0	2	1	2	2	0
obs>20	0	1	3	0	2	4

Correct (Hit Rates)	%	56,4	Sign. Error Rate	%	6,9
Small Error Rate	%	26,3	Large Err. Rate	%	1,8
Moderate Error Rate	%	8,7	Very Large Err.	%	0,0

Ankara 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	176	35	22	7	2	0
0,1-1	13	8	9	2	0	0
1,1-5	8	9	16	6	0	0
5,1-10	3	4	5	1	1	0
10,1-20	0	4	2	4	0	0
obs>20	0	0	0	0	0	0

Correct (Hit Rates)	% 59,6	Sign. Error Rate	% 4,2
Small Error Rate	% 24,3	Large Err. Rate	% 0,6
Moderate Error Rate	% 11,3	Very Large Err.	% 0,0

Diyarbakır 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	193	17	13	8	2	1
0,1-1	12	8	6	7	2	2
1,1-5	5	6	10	6	5	2
5,1-10	1	2	2	3	3	2
10,1-20	2	3	2	2	3	2
obs>20	0	0	0	3	2	0

Correct (Hit Rates)	% 64,4	Sign. Error Rate	% 4,7
Small Error Rate	% 17,2	Large Err. Rate	% 1,8
Moderate Error Rate	% 11,6	Very Large Err.	% 0,3

Erzurum 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	153	18	13	3	2	0
0,1-1	35	5	13	8	10	3
1,1-5	8	10	8	4	9	10
5,1-10	6	1	4	2	1	1
10,1-20	2	1	0	0	0	2
obs>20	2	0	0	1	2	0

Correct (Hit Rates)	% 49,9	Sign. Error Rate	% 8,9
Small Error Rate	% 26,4	Large Err. Rate	% 2,1
Moderate Error Rate	% 12,2	Very Large Err.	% 0,6

Istanbul 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	174	39	16	2	1	0
0,1-1	9	15	9	4	1	0
1,1-5	5	17	13	5	1	2
5,1-10	2	2	3	2	1	0
10,1-20	0	1	7	2	3	0
obs>20	0	0	1	0	0	0

Correct (Hit Rates)	% 61,4	Sign. Error Rate	% 2,7
Small Error Rate	% 25,2	Large Err. Rate	% 0,3
Moderate Error Rate	% 10,4	Very Large Err.	% 0,0

Isparta 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	184	25	17	9	3	0
0,1-1	7	9	11	7	8	3
1,1-5	3	4	9	8	4	1
5,1-10	1	3	5	2	3	1
10,1-20	1	2	2	2	1	0
obs>20	0	0	1	0	0	1

Correct (Hit Rates)	%	61,1	Sign. Error Rate	%	6,5
Small Error Rate	%	19,3	Large Err. Rate	%	2,1
Moderate Error Rate	%	11,0	Very Large Err.	%	0,0

Izmir 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	212	31	18	4	2	1
0,1-1	11	6	4	4	3	0
1,1-5	3	8	4	1	1	0
5,1-10	0	1	0	1	1	2
10,1-20	1	2	2	1	2	2
obs>20	1	0	1	1	2	2

Correct (Hit Rates)	%	67,8	Sign. Error Rate	%	3,0
Small Error Rate	%	18,2	Large Err. Rate	%	0,9
Moderate Error Rate	%	9,6	Very Large Err.	%	0,6

Samsun 00 UTC model outputs

obs/for	0-0	0,1-1	1,1-5	5,1-10	10,1-20	for>20
0-0	96	70	35	10	2	0
0,1-1	8	22	18	1	1	0
1,1-5	2	16	16	7	0	1
5,1-10	1	2	7	1	2	0
10,1-20	0	2	4	3	1	0
obs>20	0	0	2	2	0	1

Correct (Hit Rates)	%	41,1	Sign. Error Rate	%	5,1
Small Error Rate	%	39,3	Large Err. Rate	%	0,6
Moderate Error Rate	%	13,8	Very Large Err.	%	0,0

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 72 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 ALARO is running 4 times a day for a range of 72 hours except 18 UTC for 60 hours. Currently we perform verification for 2m temp, 10 meter wind speed and direction, MSLP and total precipitation of 12.00 UTC ALARO run. In the subjective verification ALARO model forecasts for 10 meter wind speed and direction are better than 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 %5-25 better then direct model outputs.

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

Nurmi, P. (2003): Recommendations on the verification of local weather forecasts, ECMWF Technical Memoranda No:430, December 2003.