Verification of the operational WRF-RTFDDA analyses and forecasts over the Eastern Mediterranean Area

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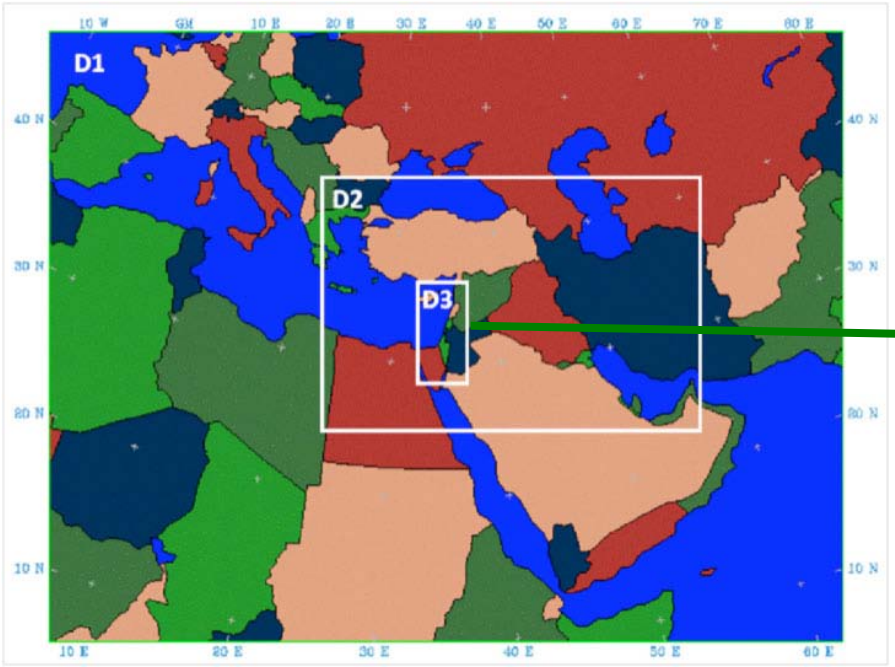
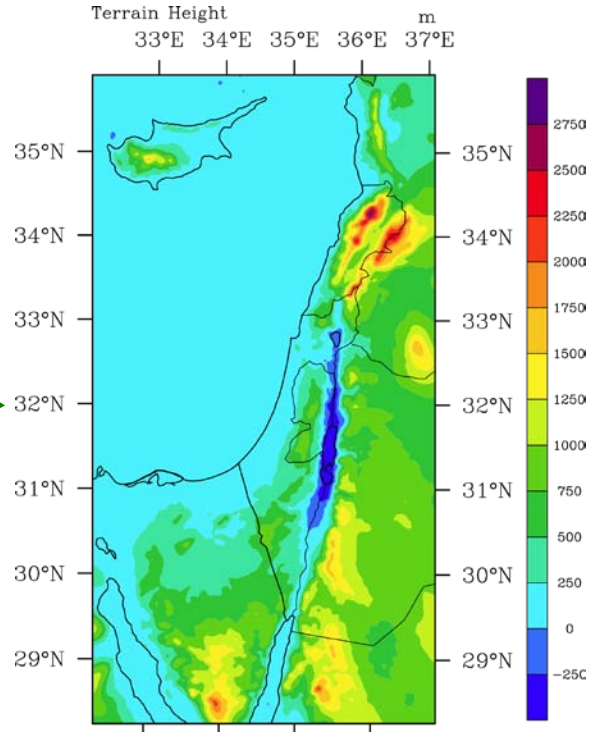
Outline

- Introduction
- Domain Average Errors
- Spatial Distributions of the Errors
- Summary

Introduction (1)





- WRF3.2.1-based RTFDDA+3DVAR hybrid
- 3 doms (30km,10km,3.3km)
- WSM6 Microphysics
- RRTM Longwave radiation
- Dudhia Shortwave radiation
- Modified YSU PBL
- Noah land surface model

Introduction (2)

- Goals: Develop and evaluate an advanced operational WRF-RTFDDA and WRFDA hybrid data assimilation and forecasting system.
- Focus of this study: Skills of the high-resolution domain (Dom 3) and a comparison to the GFS model forecasts.
- Associated poster presentations:

1. Rostkier et al. P39 "A WRF-RTFDDA high-resolution operational system for the Eastern Mediterranean: development achievements and verification strategy."
2. Yu et al. P65 "Application of the WRF-RTFDDA and WRF-3DVAR hybrid system over the Eastern Mediterranean: design and data impact studies."
3. Zhang et al. P40 "Evaluation of WRF-RTFDDA …: High-impact weather events"
4. Liu et al. P38 "Evaluation of the operational WRF-RTFDDA simulated precipitation …"

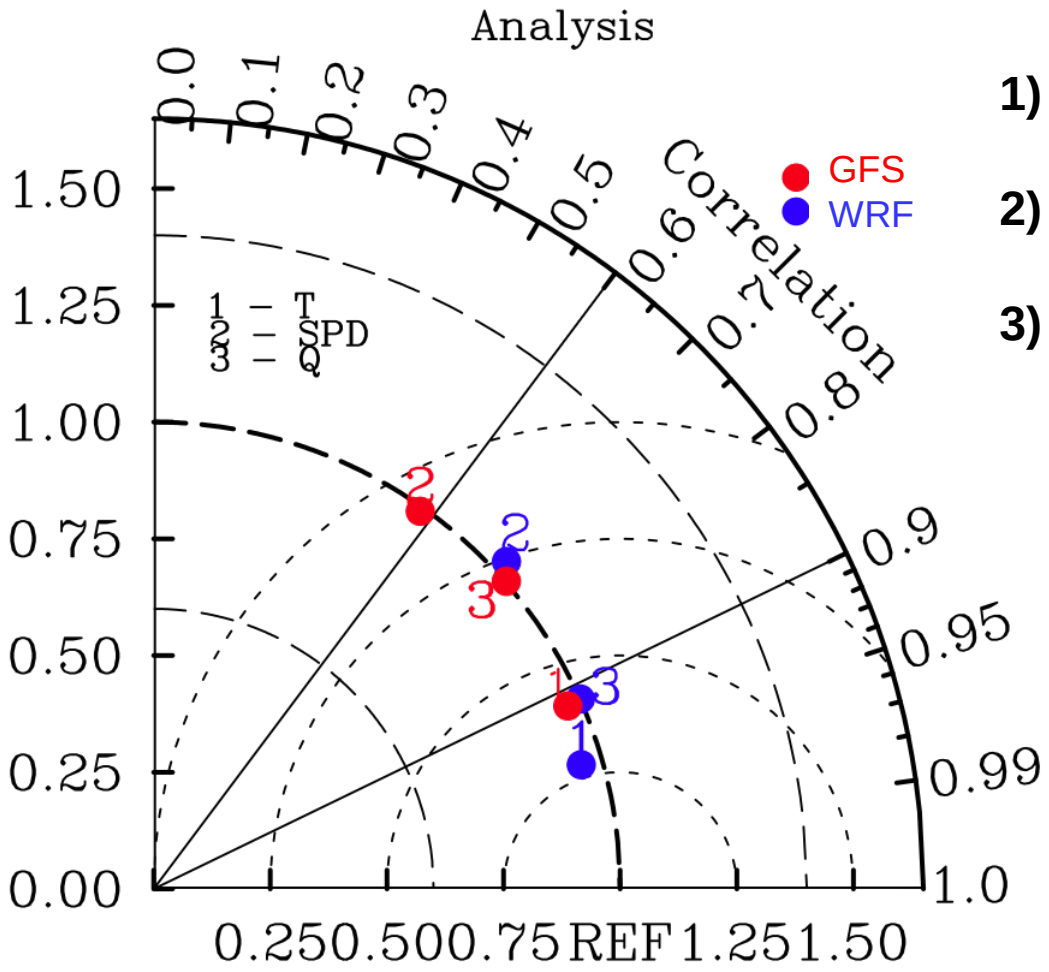
Introduction (3)

- WRF-RTFDDA high-resolution skill is tested with Domain-3 surface analyses and forecasts objectively.
- Time periods: February 2011 (rainy period)
- Statistics metrics: BIAS, RMSE, MAE, CORR:

$$\mathrm{BIAS} = \frac{1}{n}\sum_{i=1}^{n}(m_i - o_i) \qquad \mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(m_i - o_i)^2}$$

$$\mathrm{MAE} = \frac{1}{n}\sum_{i=1}^{n}\left|m_i - o_i\right| \qquad \mathrm{CORR} = \frac{\mathrm{cov}(m_i, o_i)}{\sigma_{m_i}\sigma_{o_i}}$$

WRF vs. GFS Using Taylor diagram



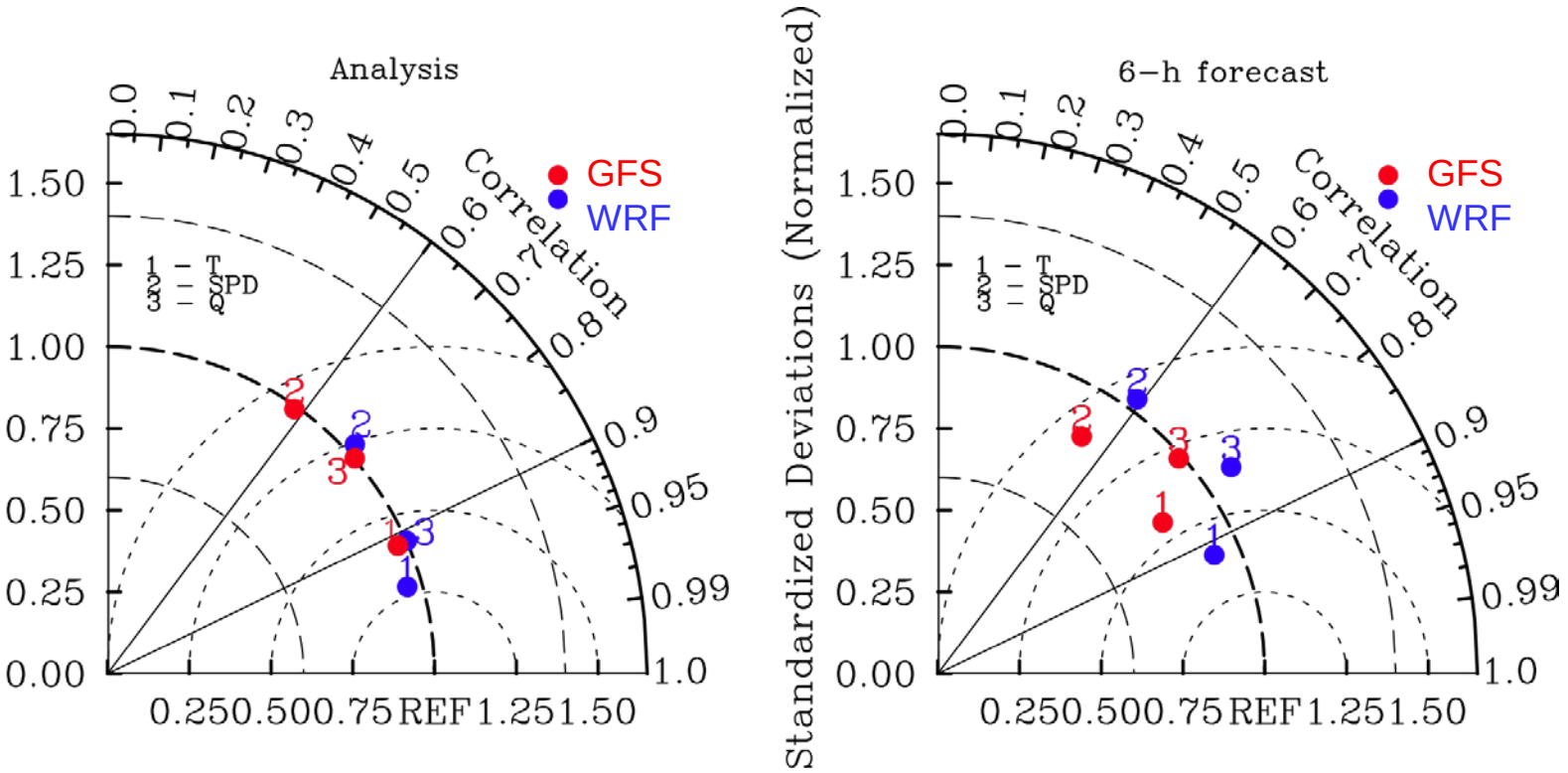
What contains in Taylor diagram:

1) **the correlation between the two fields.**
2) **The ratio of variances of the two fields.**
3) **And the rms difference between two fields.**

$$E'^2 = E^2 - E_0^2 = 1 + \gamma^2 - 2\gamma R$$

What Taylor diagram tells: Comparison of composite skills of two model systems

Taylor diagram for 0h and 6h fcsts



Taylor diagram for 12h and 18h fcsts

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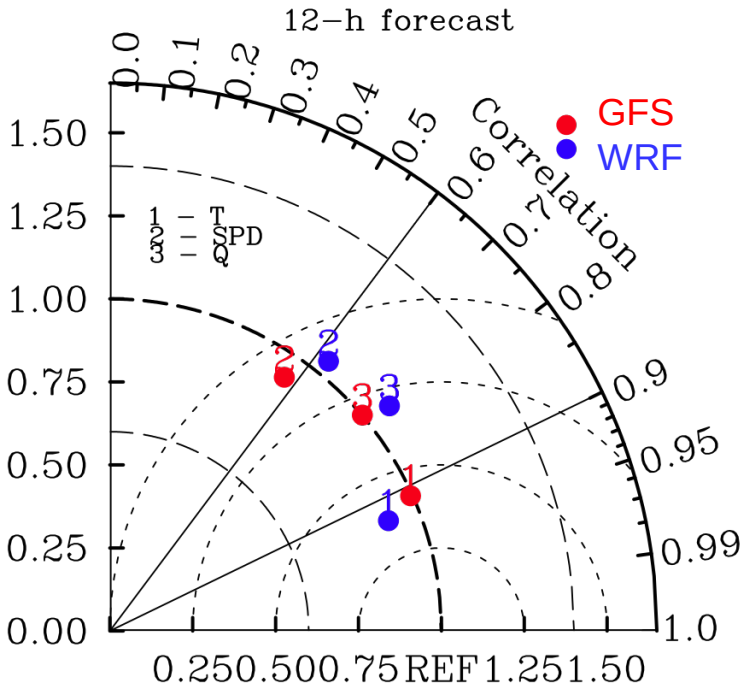
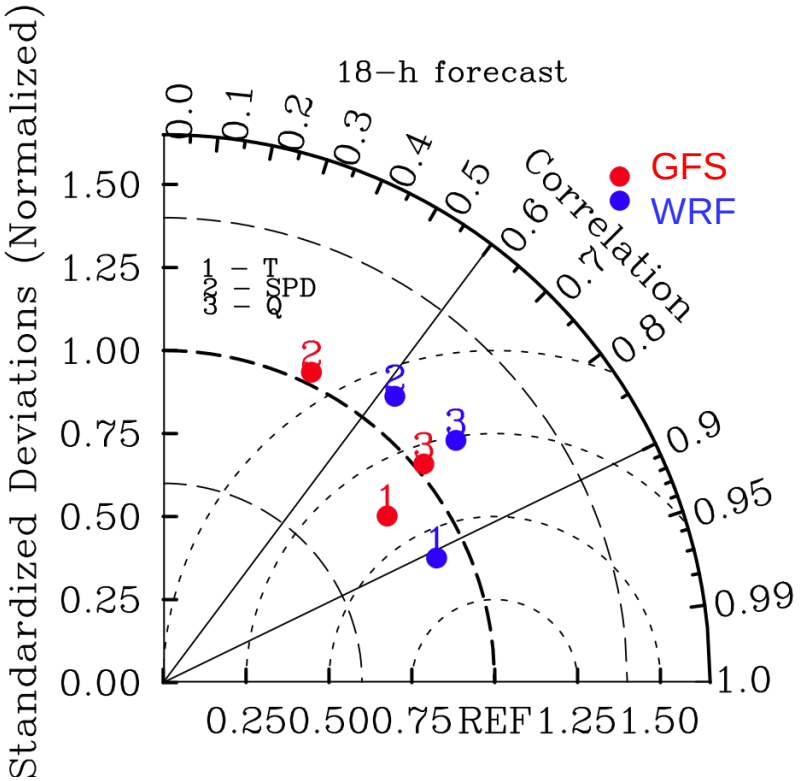




Domain average statistics for T

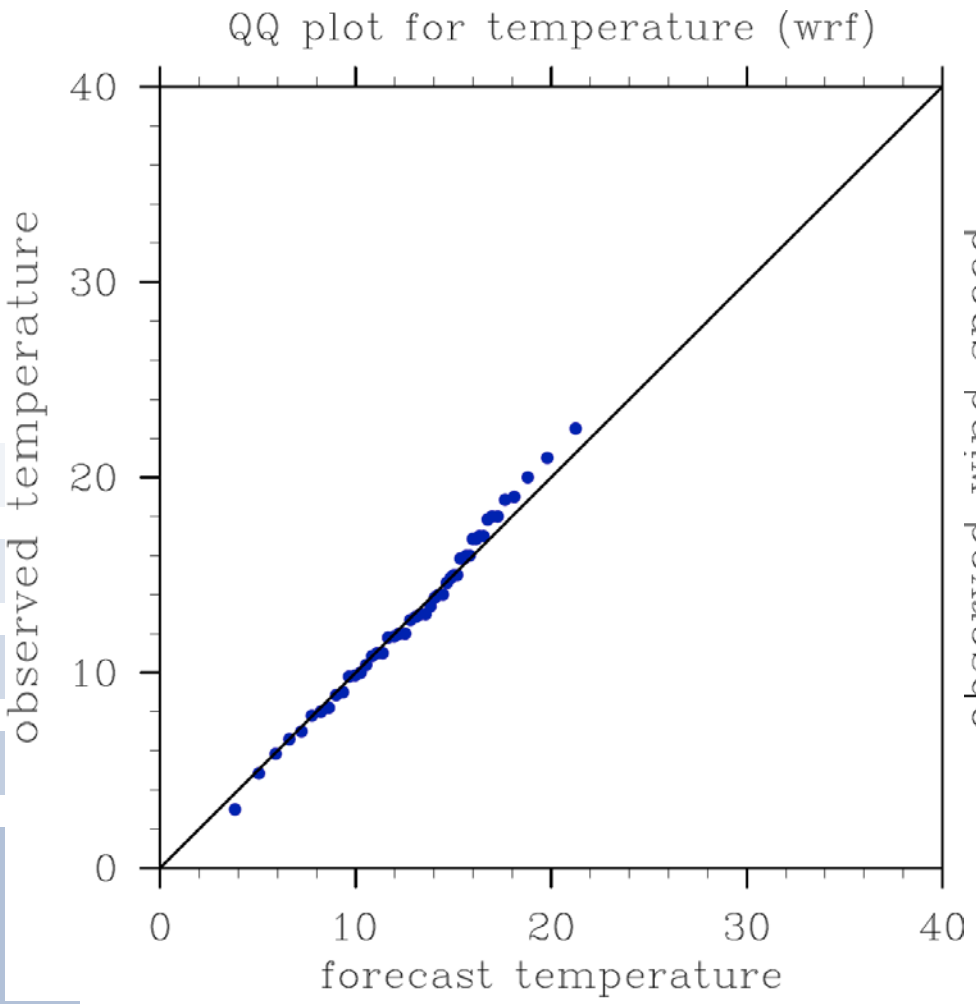
	Model	MEAN	BIAS	RMSE	MAE	CORR
Analysis	WRF	12.73	-0.08	1.16	0.90	0.96
	GFS	12.75	-0.06	2.34	1.79	0.84
6h fcst	WRF	12.74	0.11	1.81	1.47	0.92
	GFS	12.42	-0.21	2.21	1.74	0.83
12h fcst	WRF	12.89	-0.09	1.97	1.65	0.91
	GFS	12.59	-0.39	1.17	0.94	0.93
24h fcst	WRF	12.60	0.20	1.97	1.62	0.91
	GFS	12.60	0.20	2.53	2.06	0.89
48h fcst	WRF					
	GFS	12.67	0.68	2.22	1.65	0.93
Total	WRF	12.87	-0.06	1.87	1.48	0.91
	GFS	12.89	-0.04	2.30	1.80	0.87

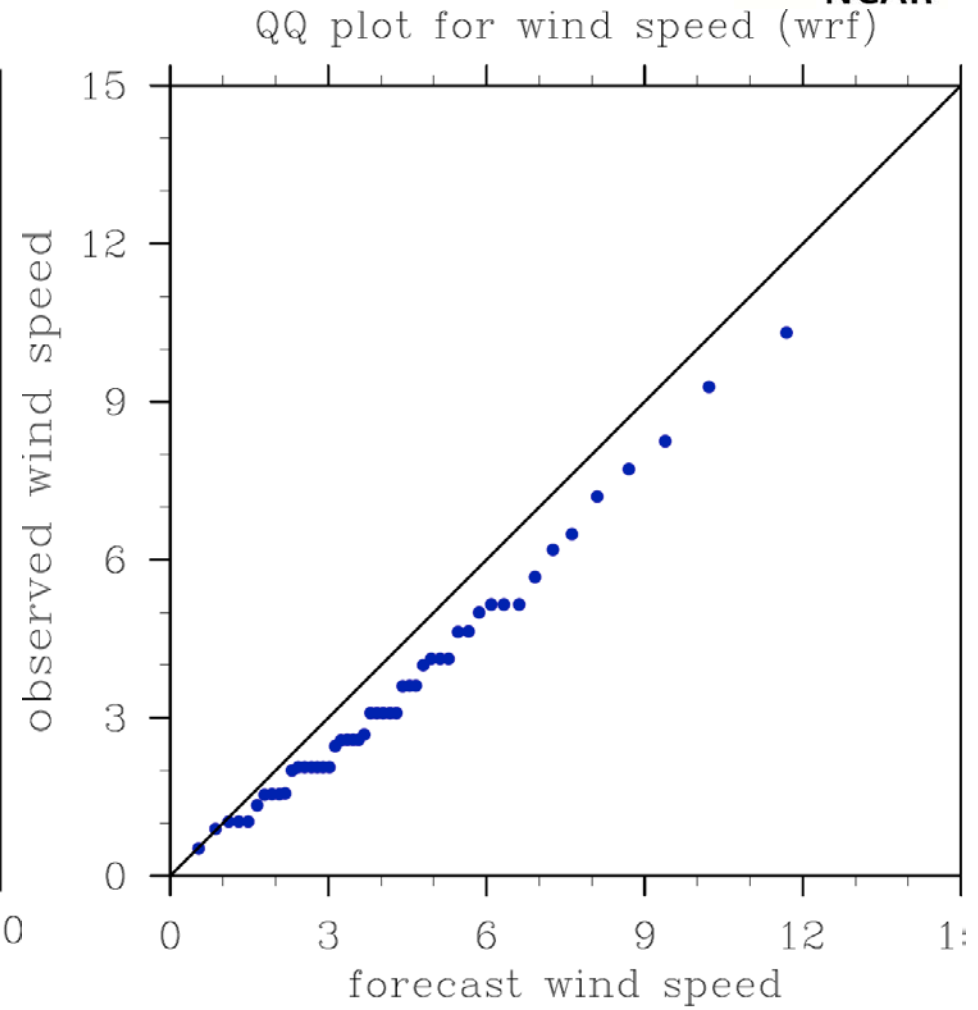
Domain average statistics for Q2

	Model	MEAN	BIAS	RMSE	MAE	CORR
Analysis	WRF	6.73	0.14	0.65	0.50	0.91
	GFS	6.25	-0.34	1.02	0.79	0.77
6h fcst	WRF	6.38	0.14	0.95	0.73	0.83
	GFS	5.91	-0.33	1.01	0.77	0.75
12h fcst	WRF	6.22	-0.33	1.06	0.84	0.80
	GFS	6.16	-0.39	1.17	0.94	0.77
24h fcst	WRF	6.04	-0.37	1.19	0.90	0.77
	GFS	5.89	-0.52	1.12	0.87	0.79
48h fcst	WRF					
	GFS	5.62	-0.73	1.37	1.06	0.68
Total	WRF	6.31	-0.23	1.12	0.87	0.77
	GFS	6.10	-0.44	1.22	0.92	0.72

Domain average statistics for SPD

	Model	MEAN	BIAS	RMSE	MAE	CORR
analysis	WRF	3.90	0.27	1.54	1.17	0.83
	GFS	4.25	0.62	2.54	1.96	0.42
6h fcst	WRF	4.30	0.80	2.28	1.75	0.62
	GFS	3.36	-0.14	1.85	1.41	0.52
12h fcst	WRF	4.31	0.72	2.31	1.75	0.66
	GFS	3.56	-0.03	2.31	1.68	0.49
24h fcst	WRF	4.41	0.46	2.18	1.65	0.67
	GFS	3.54	-0.31	2.28	1.61	0.50
48h fcst	WRF					
	GFS	3.58	-0.09	2.14	1.57	0.63
Total	WRF	4.25	0.49	2.21	1.66	0.65
	GFS	3.67	-0.09	2.11	1.58	0.57

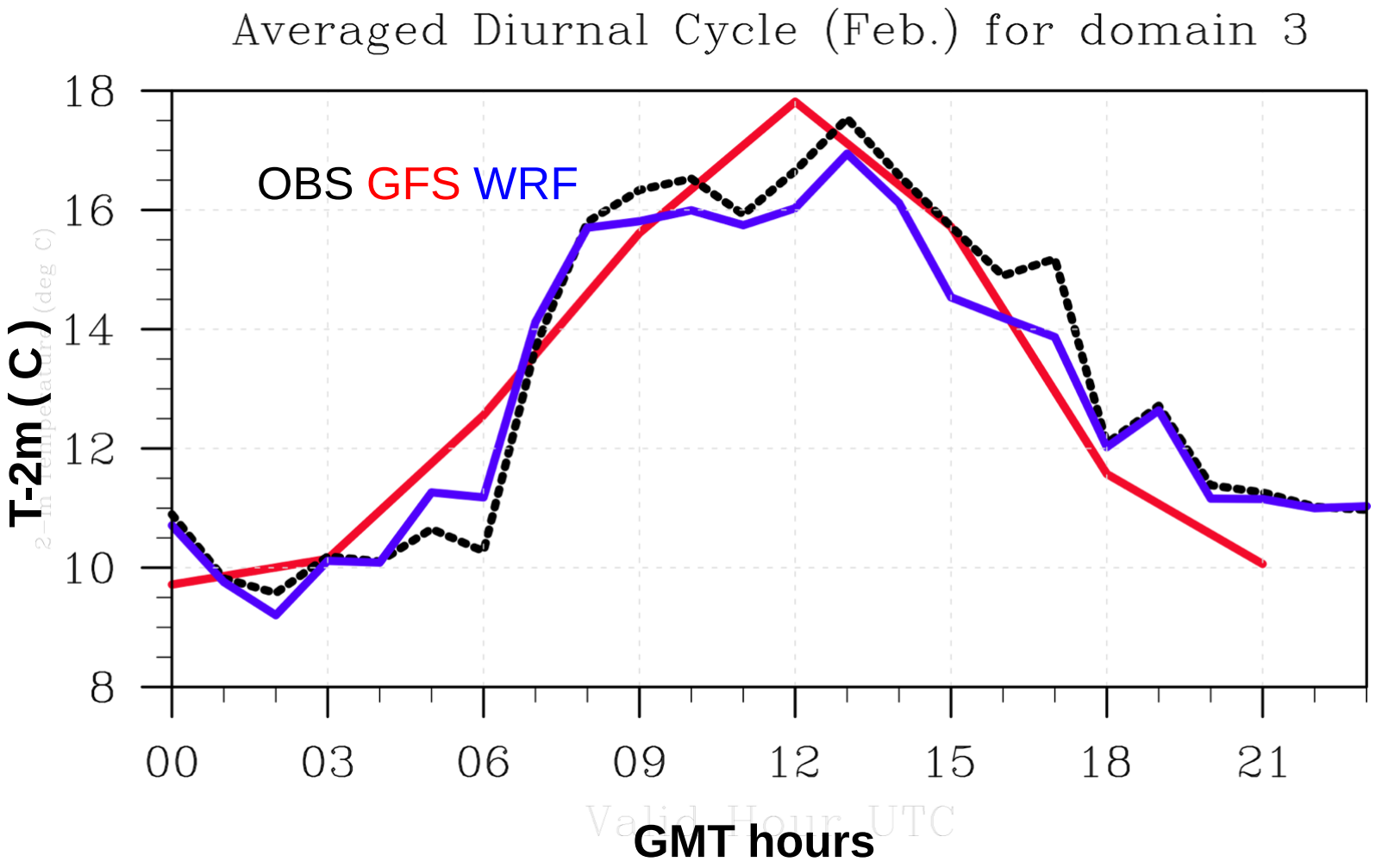




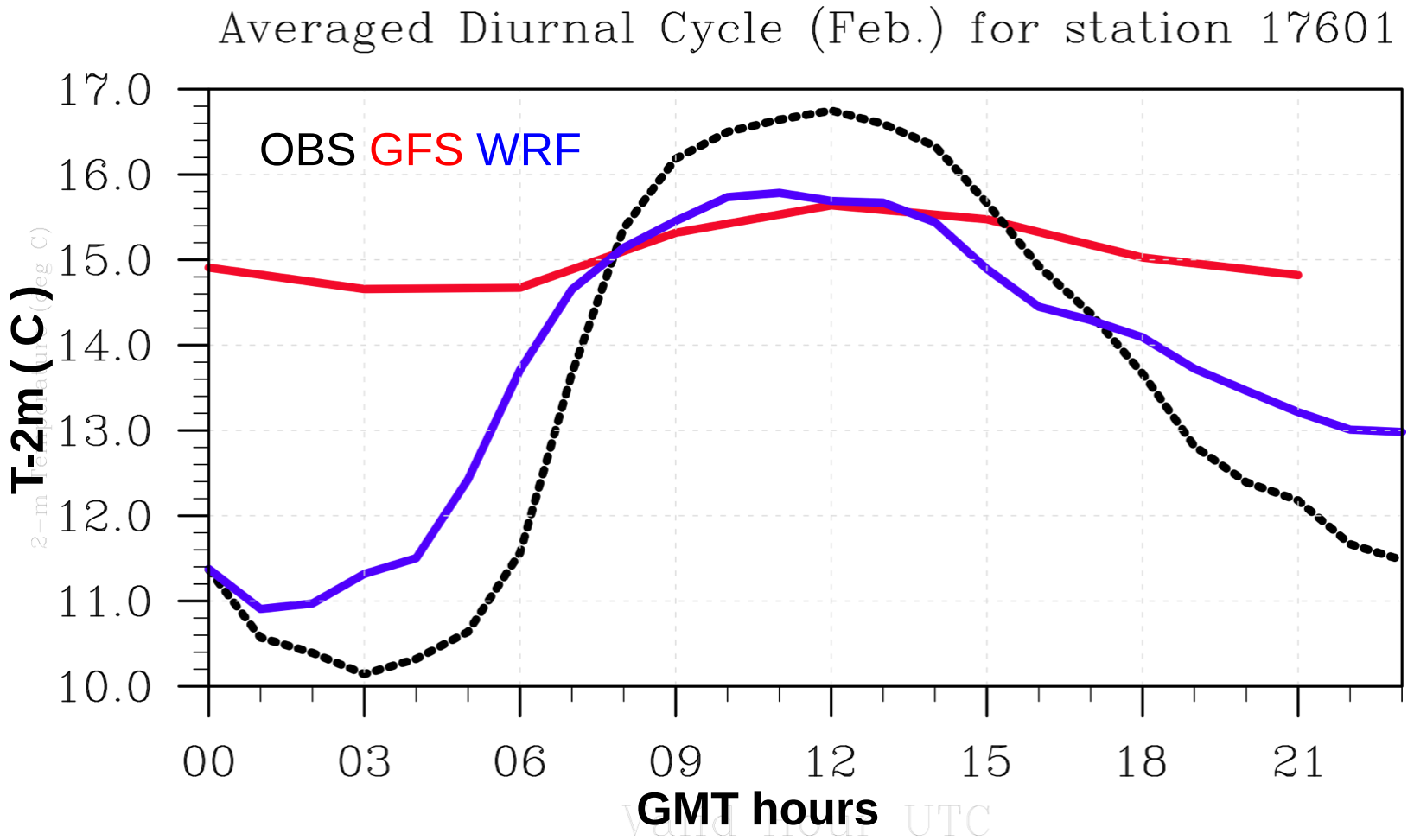
Under estimate the surface temperature diurnal cycle

Over estimate the surface wind speed

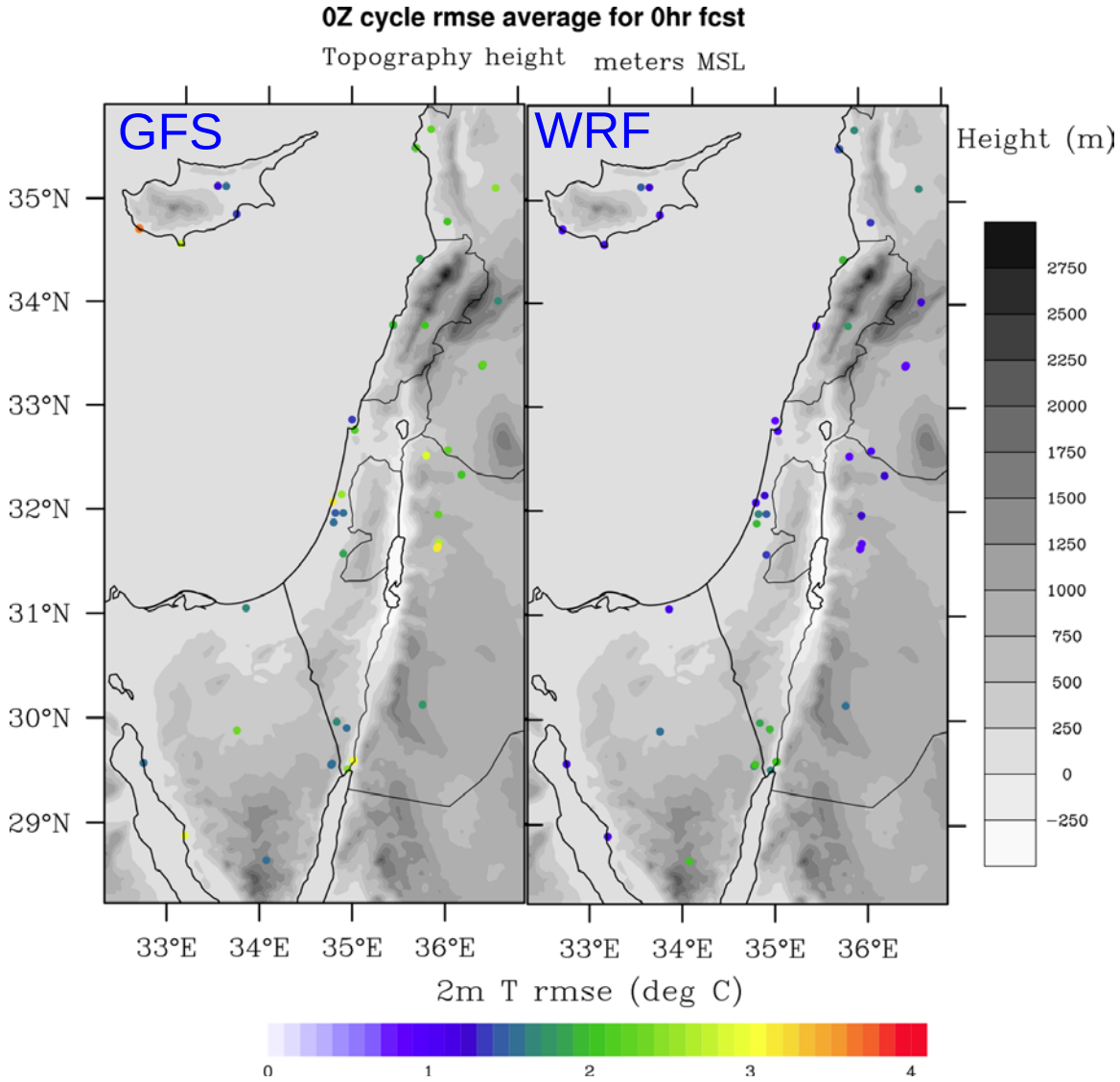
Domain average diurnal cycle



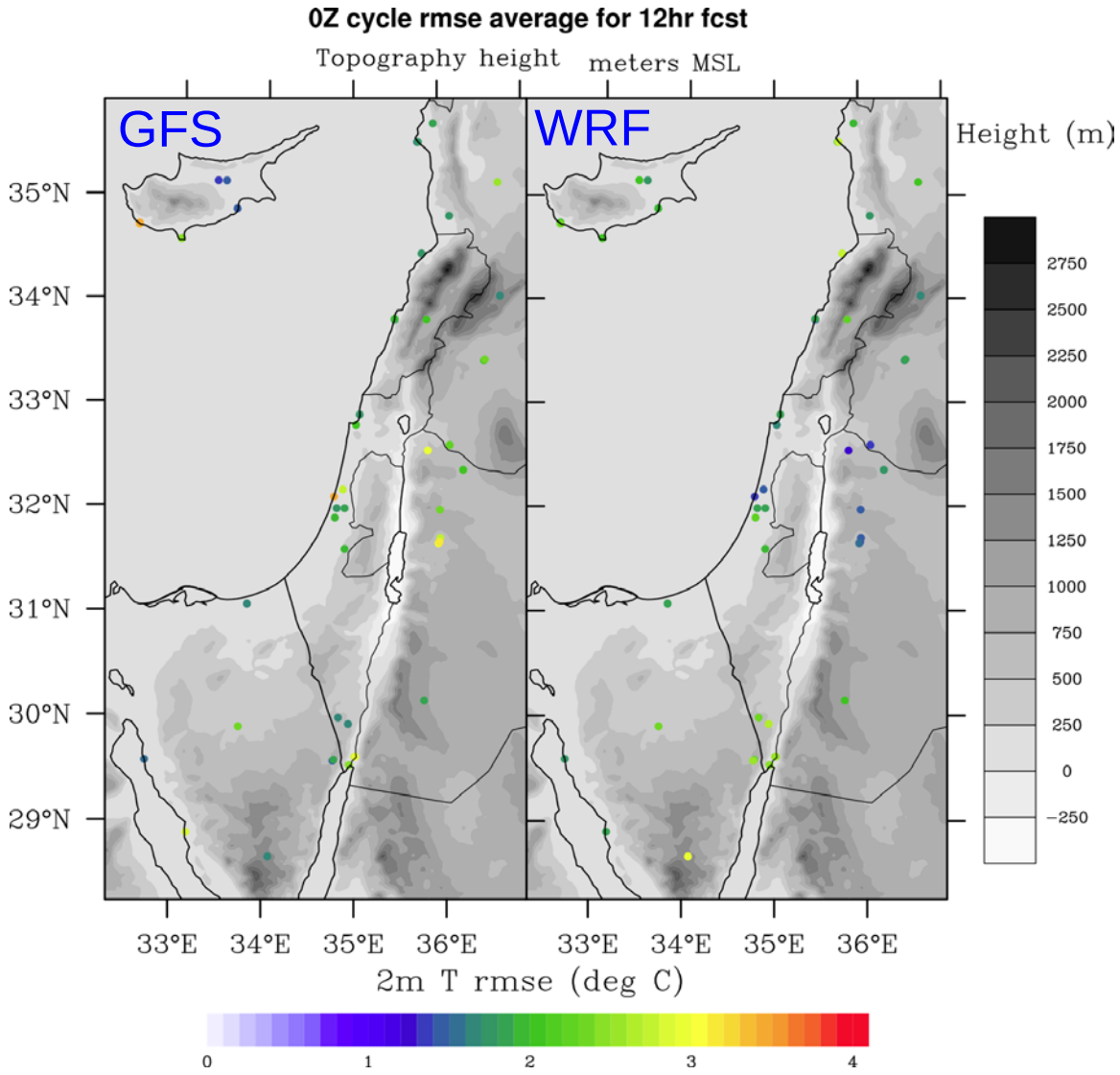
An example of average diurnal cycle



Temperature RMSE for analysis



Temperature RMSE for 12h FCST



Summary

- The analysis surface fields from WRF-RTFDDA high-resolution system significantly outperforms GFS for all the cycles examined.
- The forecasted surface fields from WRF-RTFDDA high-resolution system tend to show smaller biases, RMSEs and MAEs when compared to GFS.
- Possible improvements to the system:

  1) WRF upgrades (dynamics and physics), 2) Data assimilation improvements, 3). Higher-resolution and 4) Ensemble prediction.

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Thank you!

Taylor diagram for 24h, 36h, and all