Verification studies for COSMO-Ru model

A.Bundel, M.Shatunova, A. Kirsanov, D. Blinov,

Hydrometcentre of Russia, Roshydromet

Overview

1. Tuning of minimal diffusion coefficients for heat (`tkhmin`) and length scale of subscale surface patterns over land (`pat_len`)

(Denis Blinov)

1. Performance of COSMO-Ru2 vs. COSMO-Ru7

(A. Kirsanov and al.)

1. Studies on the role of resolution for precipitation forecasts in various domains

(M. Shatunova)

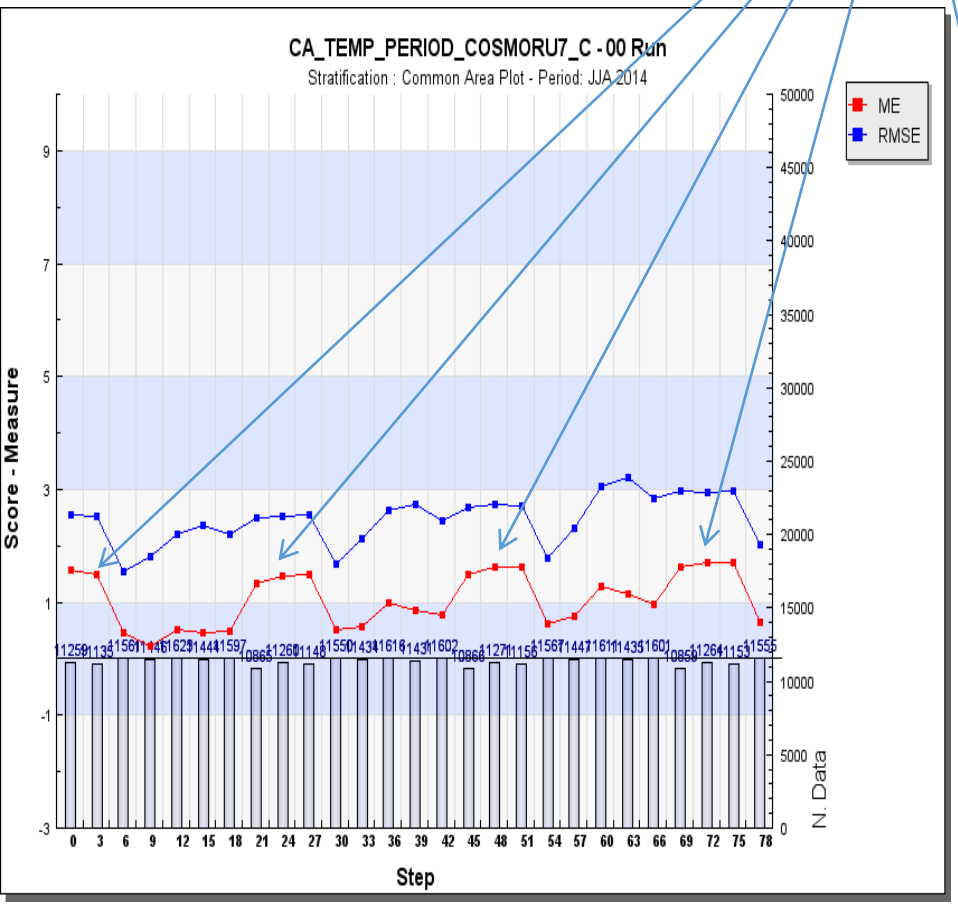
1. Tuning

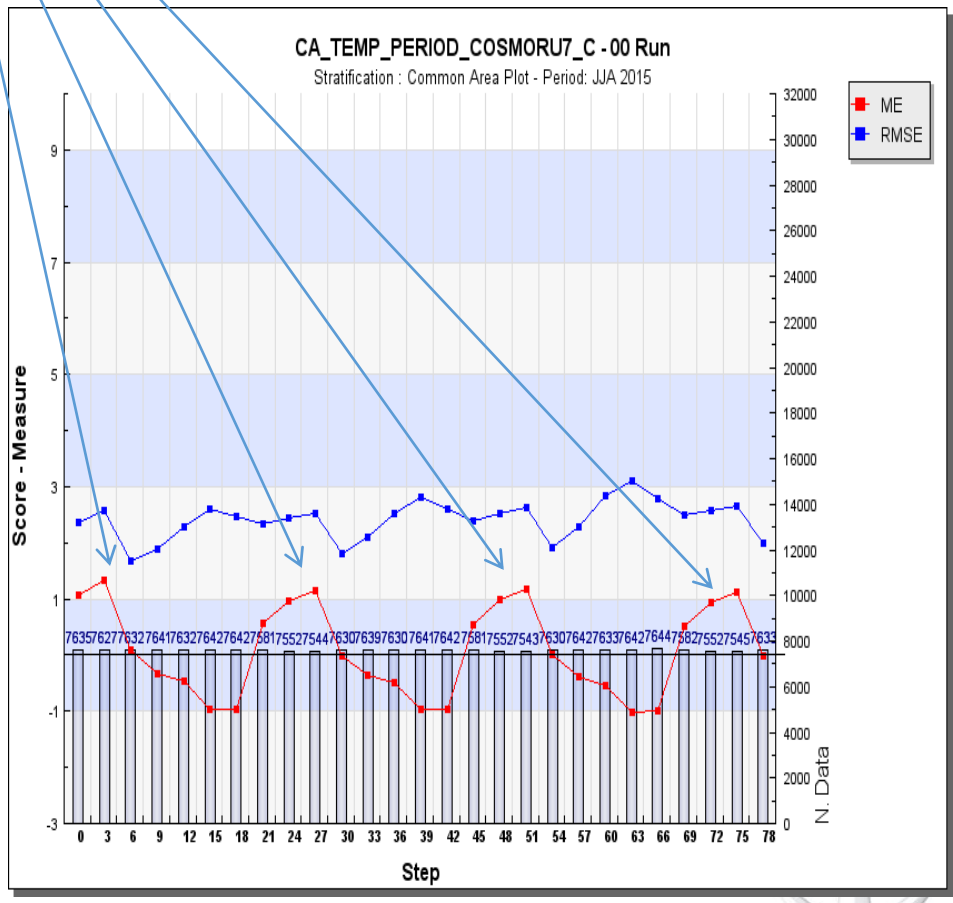
`tkhmin` and `pat_len`

Operational for all COSMO-Ru versions

since 18 May 2016

Motivation: Too high night near surface temperatures in summers





Inspiration by previous studies

- Pavel Khain's report at the CUS2016
- Experiments of Mikhail Varentsov (Moscow State University)

Experiments

- ref0 – No tuning:

  `tkhmin = 0.4, pat_len = 500`

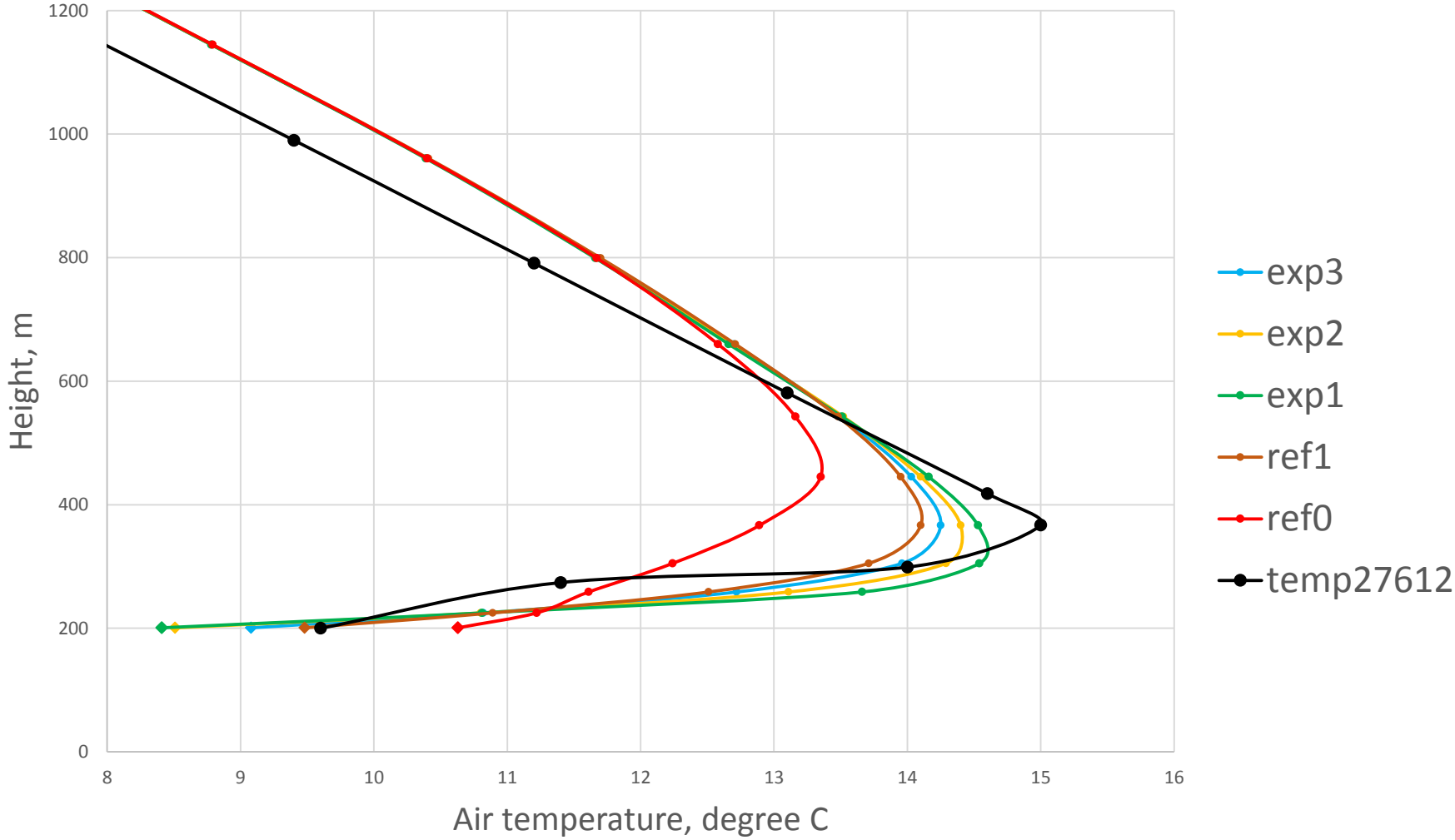
- ref1 – test on pat_len influence:

  `tkhmin = 0.4, pat_len = **50**`

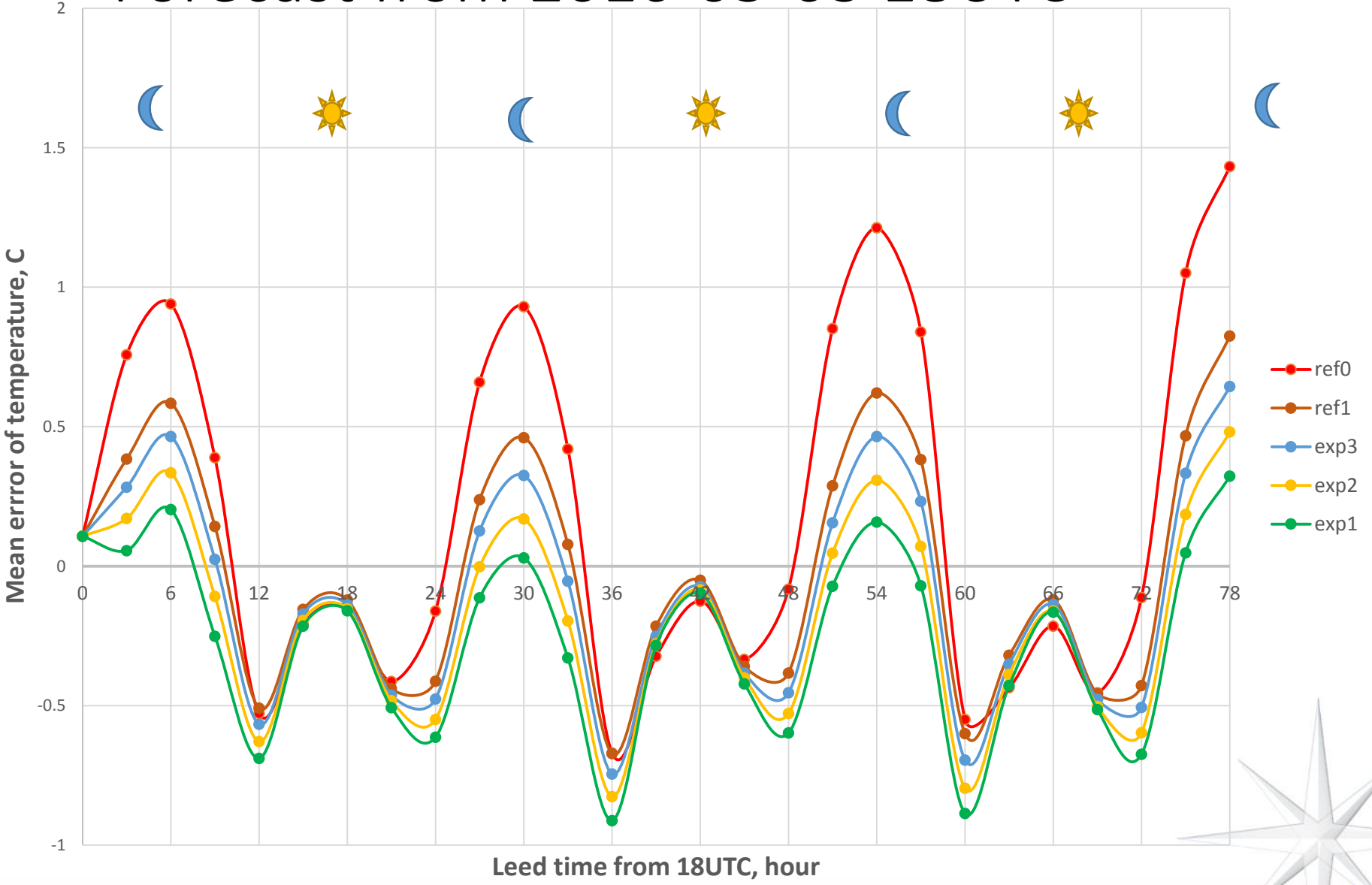
- exp1 : `tkhmin = **0.1**, pat_len = 50`
- exp2 : `tkhmin = **0.2**, pat_len = 50`
- exp3 : `tkhmin = **0.3**, pat_len = 50`

Case of forecasts from 2016-05-03 18UTC was chosen for experiments, when a strong night overheating was observed in the Central region of Russia.

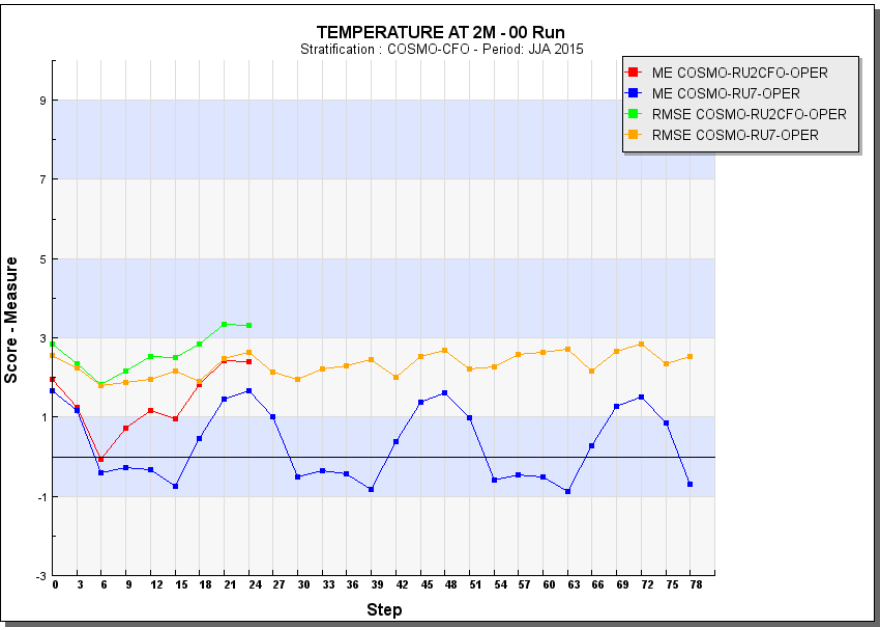
Effect of tuning on night air temperature stratification

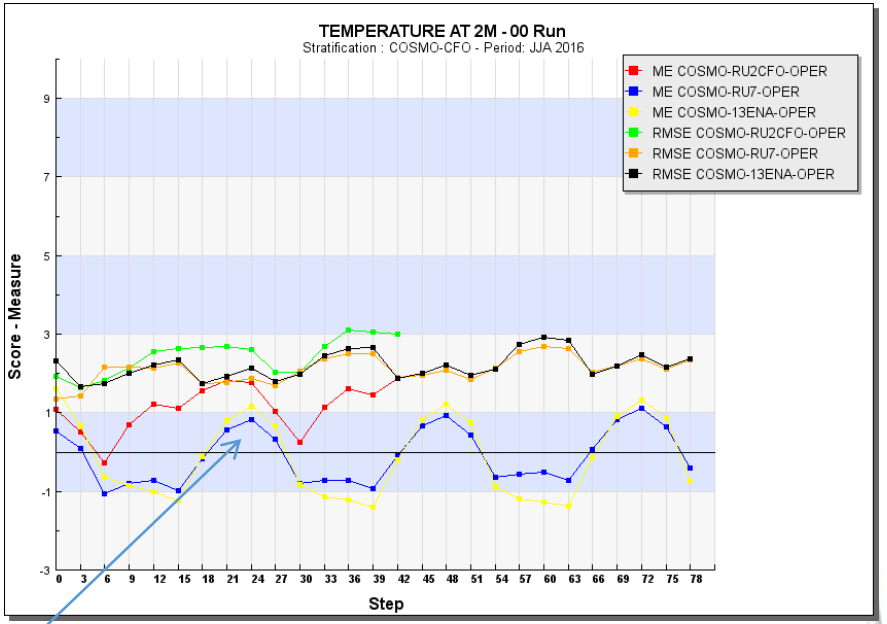


ME for 3155 stations of European Russia, Forecast from 2016-05-03 18UTC



Errors for JJA 2015 (no tuning) and JJA 2016 (new parameters: tkhmin=0.1, pat_len=50, operational from 18 May 2016)





Better scores for night temperature minimums

Conclusions on tuning

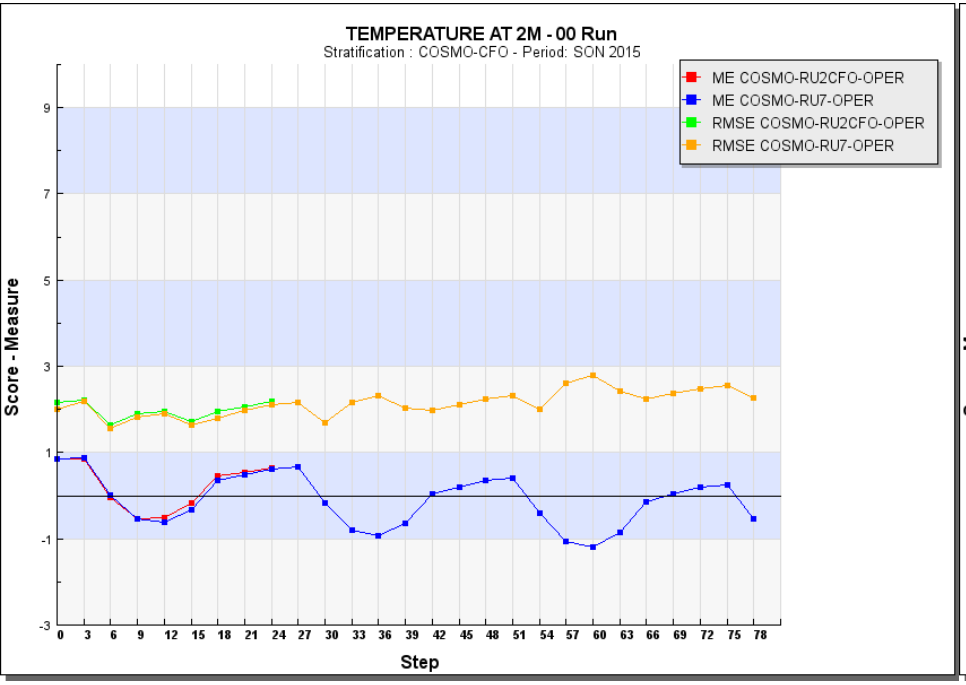
- Decreasing tkhmin и pat_len makes stratification more stable, thus decreasing night air temperature
- The daily temperatures does not change significantly by preliminary verification
- Tuning improves night air temperature minimums (exp1), but the score worsen slightly before and after the minimums

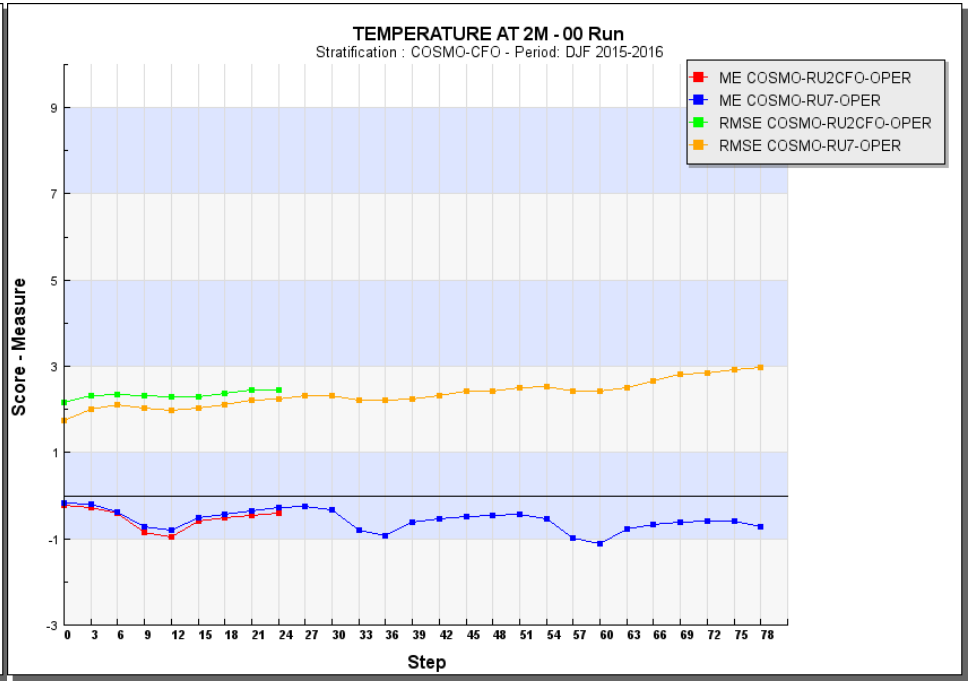
2. Performance of COSMO-Ru2 vs. COSMO-Ru7

Verification domain

- 50-60 north latitude, 30-45 east longitude
- 164 stations
- ME and RMSE for T2M, TD2M, MSLP, WSPEED, TCC

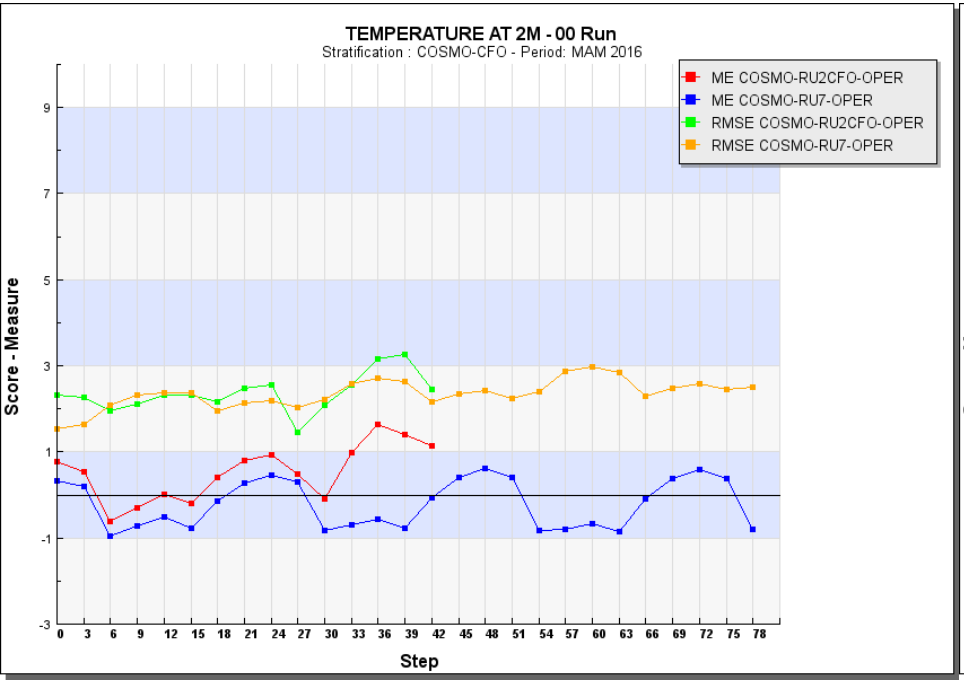
Cold season differences, T2m

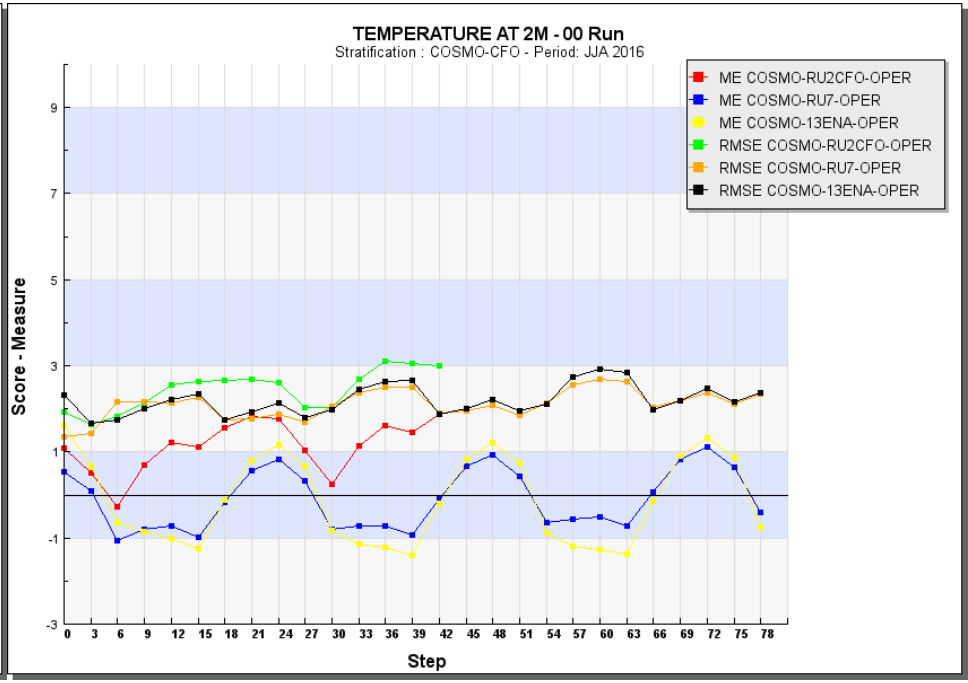




- Differences between COSMO-Ru2 and COSMO-Ru7 performances are insignificant during winter and autumn
- Slightly better COSMO-Ru7 results

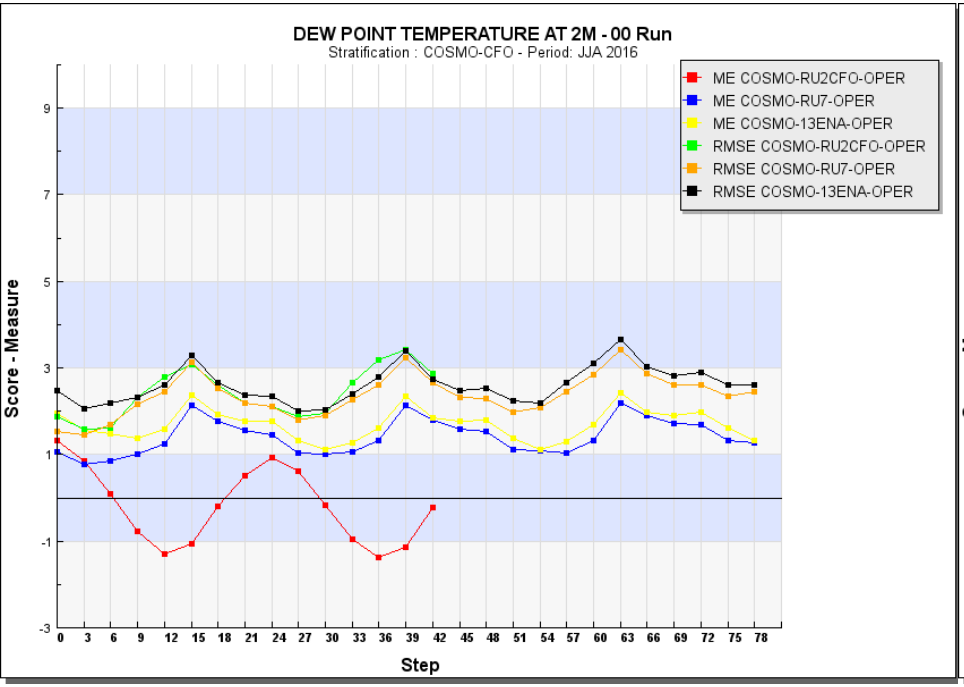
Warm season differences

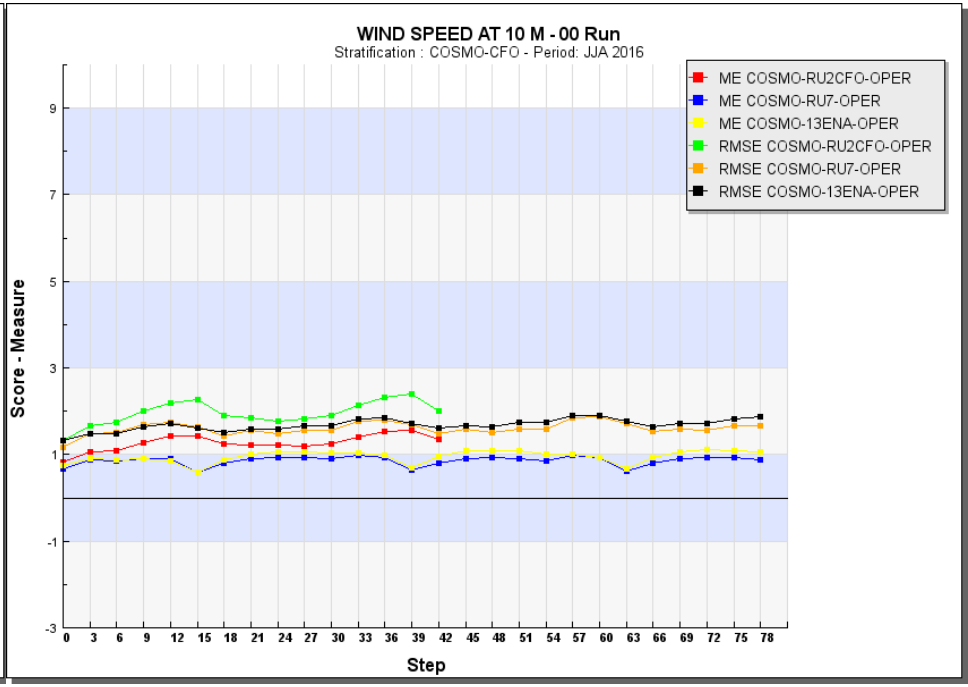




- COSMO-Ru2 is overestimating T2m more than COSMO-Ru7
- COSMO-Ru7 shows generally better performance: data assimilation system properties? influence of parameterizations?

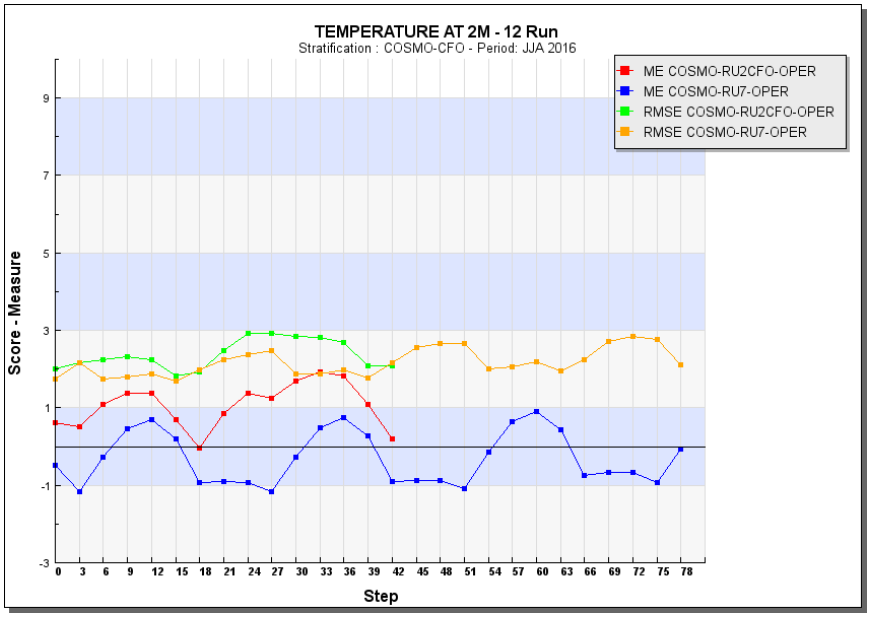
Warm season differences

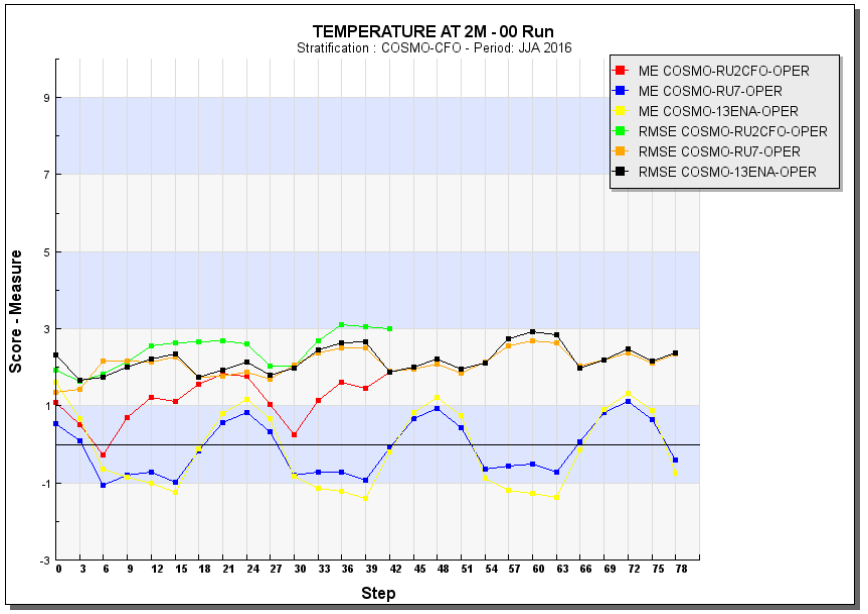




- COSMO-Ru2 shows less overestimation of TD2M than COSMO-Ru7 with similar RMSE
- COSMO-Ru2 shows more overestimation of WSPD than COSMO-Ru7
- COSMO-Ru7 shows generally better performance: data assimilation system properties? influence of parameterizations?
- Work in progress

Verification over COSMO-Ru2 domain





ICON 12UTC → DA+6H → COSMO-Ru7 18UTC → DA+6H → COSMO-Ru2 00UTC

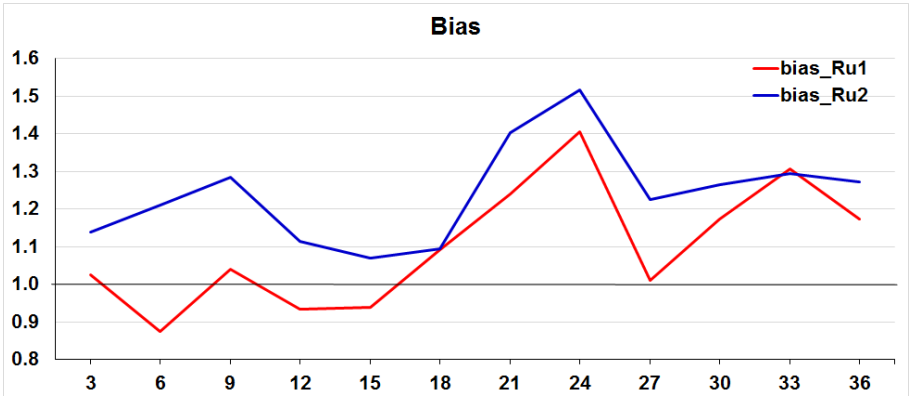
ICON 00UTC → DA+6H → COSMO-Ru7 06UTC → DA+6H → COSMO-Ru2 12UTC

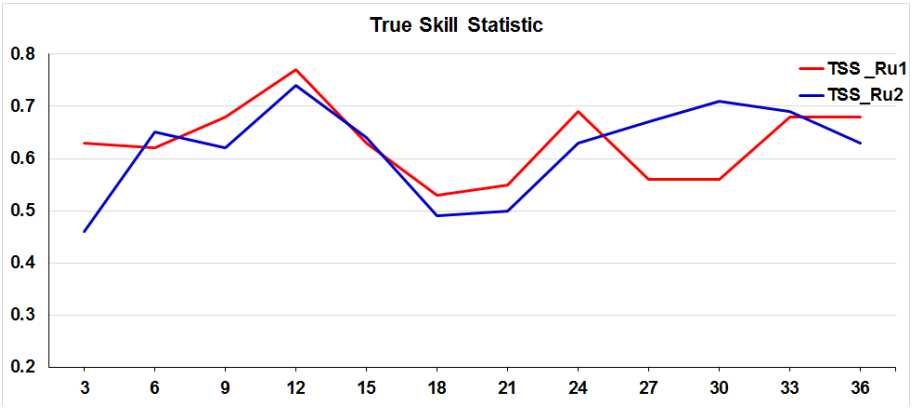
3. Studies on the role of resolution for precipitation forecasts in various domains

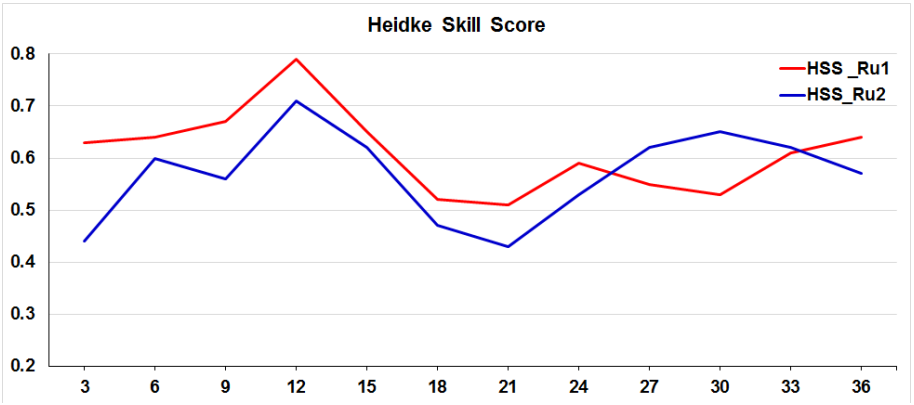
COSMO-Ru1 vs. COSMO-Ru2

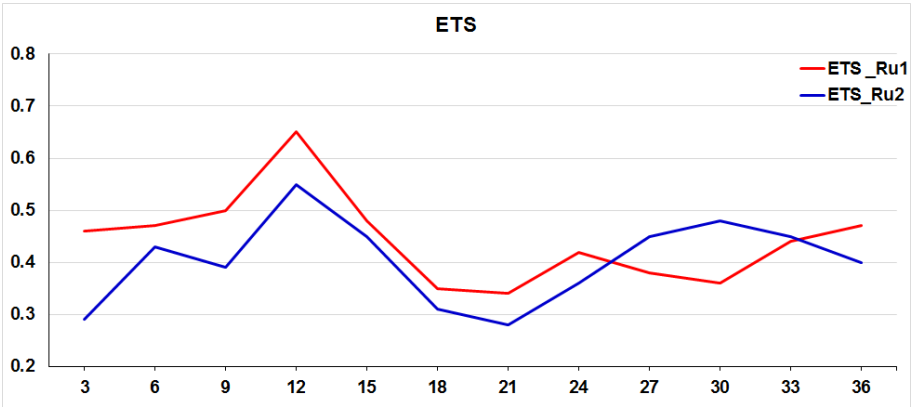
Precipitation > 0.1 mm/h in the Southern region of Russia

Skill scores were calculated for the period Feb.-March 2014, forecast start time 00 UTC.









- COSMO-Ru1 shows higher scores for the 3 h lead time because model ran from forecasted boundary conditions and used additional data assimilation (nudging)
- For the 24-33 h lead time COSMO-Ru2 gives better results

Model spatial resolution effect on precipitation forecast

Verification of moderate and heavy precipitation forecast

COSMO-Ru2, Southern region of Russia

	Threshold (mm/3h)	Forecast lead time (h)											
		3	6	9	12	15	18	21	24	27	30	33	36
CSI	3	0.13	0.23	0.45	**0.69**	0.32	0.46	0.42	0.21	0.17	0.21	**0.58**	**0.56**
	5	0.10		0.30	**0.53**	0.38	0.22	0.43	0.36		0.14	0.35	0.47
	10			0.28	0.19			**0.65**			0.11	0.25	
ETS	3	0.12	0.20	0.41	**0.66**	0.30	0.44	0.40	0.19	0.15	0.18	**0.53**	**0.52**
	5	0.10		0.27	**0.50**	0.37	0.21	0.42	0.34	0.04	0.13	0.31	0.44
	10			0.26	0.18			**0.64**			0.11	0.24	
TTS	3	0.21	0.34	0.53	**0.79**	0.38	0.70	**0.64**	0.59	0.48	0.30	**0.68**	**0.64**
	5	0.19	0.10	0.38	**0.71**	0.47	0.40	**0.65**	**0.71**	0.35	0.32	0.49	**0.59**
	10			0.37	0.25			**0.81**			0.49	0.37	
HSS	3	0.21	0.33	**0.58**	**0.79**	0.46	0.61	**0.57**	0.31	0.26	0.30	**0.69**	**0.68**
	5	0.18	0.11	0.42	**0.67**	0.55	0.35	**0.59**	0.51	0.07	0.23	0.48	**0.61**
	10			0.42	0.31			**0.78**			0.20	0.38	
EDI	3	0.45	0.54	**0.71**	**0.90**	0.63	0.83	**0.80**	**0.72**	0.64	0.50	**0.82**	**0.80**
	5	0.52	0.32	0.59	**0.84**	0.74	0.63	**0.82**	**0.84**	0.53	0.53	**0.67**	**0.76**
	10			**0.65**	0.53			**0.92**			0.74	**0.63**	0.24

Precipitation on February and March 2014 in Sochi region usually occurred during daytime. The most cases of heavy precipitation were observed within the 10-16 h local time (06-12 UTC). Secondary maximum of heavy precipitation (>5 mm/3h) was registered at 22-04 h local time (18-24 UTC).

Model spatial resolution effect on precipitation forecast

Verification of moderate and heavy precipitation forecast

COSMO-Ru1, Southern region of Russia

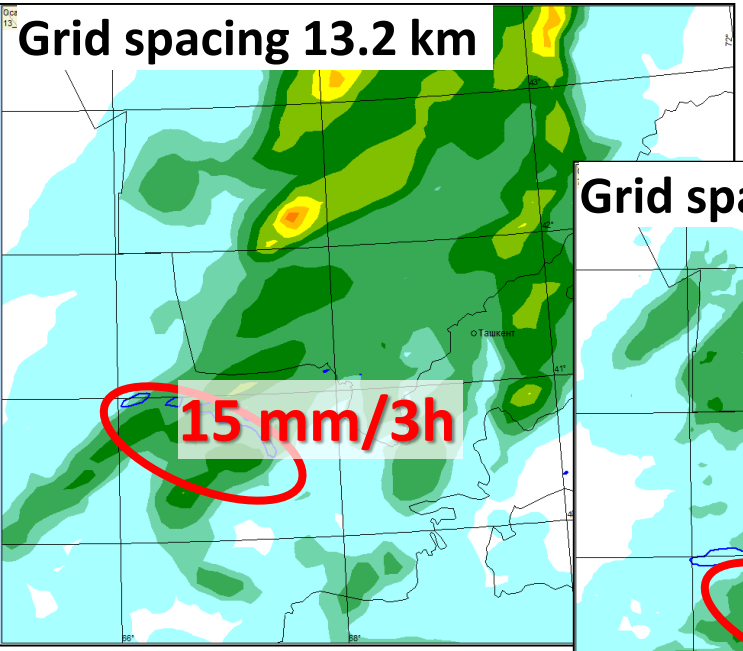
	Threshold (mm/3h)	Forecast lead time (h)											
		3	6	9	12	15	18	21	24	27	30	33	36
CSI	3	0.15	0.18	0.46	**0.53**	0.19	0.16	0.29	0.25		0.20	0.36	**0.61**
	5		0.12	0.46	**0.53**	0.25	0.18	**0.66**	0.50		0.12	0.25	0.38
	10			0.40	0.12			**0.74**	0.19			0.25	
ETS	3	0.14	0.15	0.42	**0.49**	0.17	0.14	0.26	0.22		0.17	0.30	**0.57**
	5		0.11	0.43	**0.51**	0.24	0.17	**0.65**	0.49		0.11	0.21	0.34
	10			0.39	0.12			**0.73**	0.18			0.24	
TTS	3	0.25	0.30	0.49	**0.69**	0.22	0.23	0.48	**0.72**	0.28	0.30	0.43	**0.73**
	5	0.19	0.26	**0.55**	**0.65**	0.26	0.28	**0.79**	**0.75**	0.47	0.21	0.34	**0.52**
	10			**0.56**	0.12			**0.87**	**0.98**		0.49	0.37	
HSS	3	0.24	0.26	**0.59**	**0.66**	0.29	0.25	0.42	0.37	0.11	0.29	0.46	**0.72**
	5	0.14	0.20	**0.60**	**0.67**	0.39	0.29	**0.79**	**0.66**	0.14	0.19	0.35	**0.51**
	10			**0.56**	0.21			**0.85**	0.31		0.16	0.38	
EDI	3	0.49	0.47	**0.72**	**0.82**	0.49	0.46	0.66	**0.83**	0.42	0.50	**0.59**	**0.85**
	5	0.48	0.48	**0.75**	**0.82**	0.67	0.55	**0.91**	**0.89**	0.68	0.45	**0.52**	**0.70**
	10			**0.78**				**0.95**	**1.00**		0.73	**0.63**	0.22

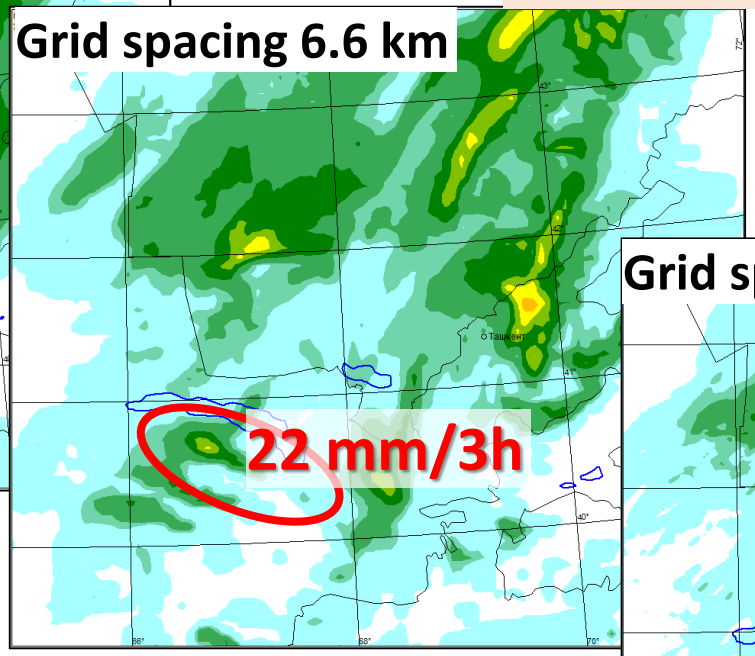
Losing a little in the afternoon precipitation forecast skill, COSMO-Ru1 showed better result for night precipitation forecasting

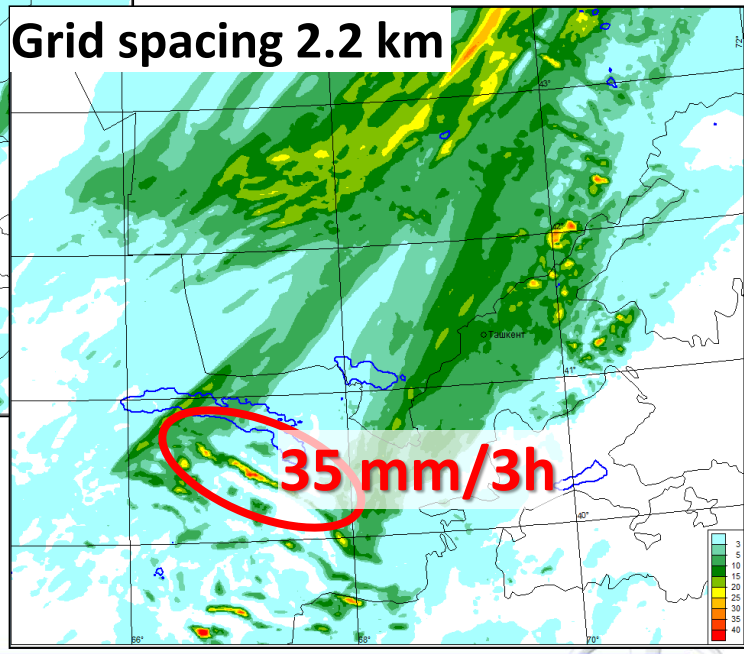
Model spatial resolution effect on precipitation forecast

Heavy precipitation event on 30-31 Mach 2016.
Central Asia region.
3h precipitation sum

In some cases the location of heavy precipitation is of great importance, e.g. for mountainous region







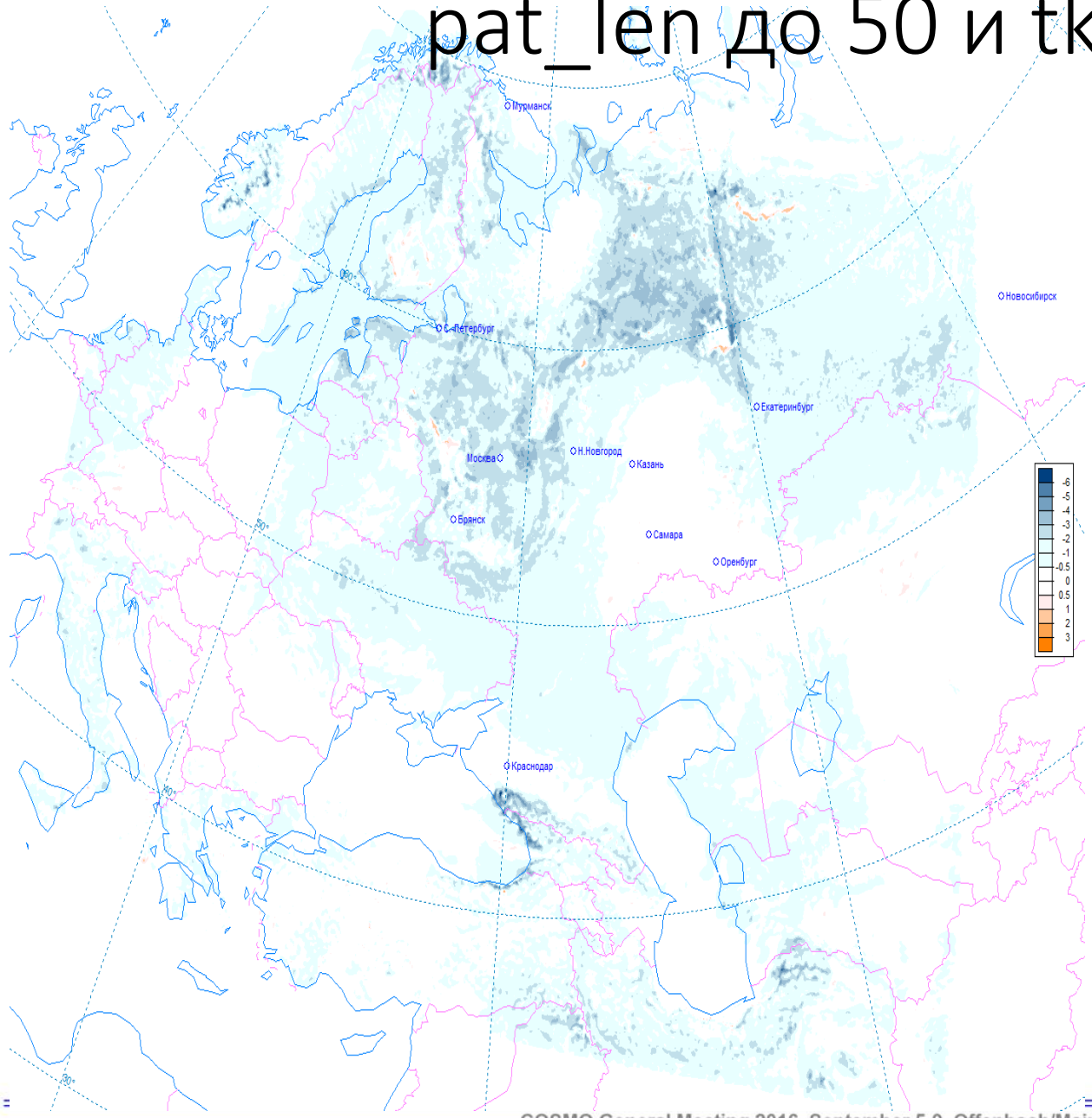
Increasing of model horizontal resolution

→ *More detailed orography*

→ *Appearance of local maximum in precipitation*

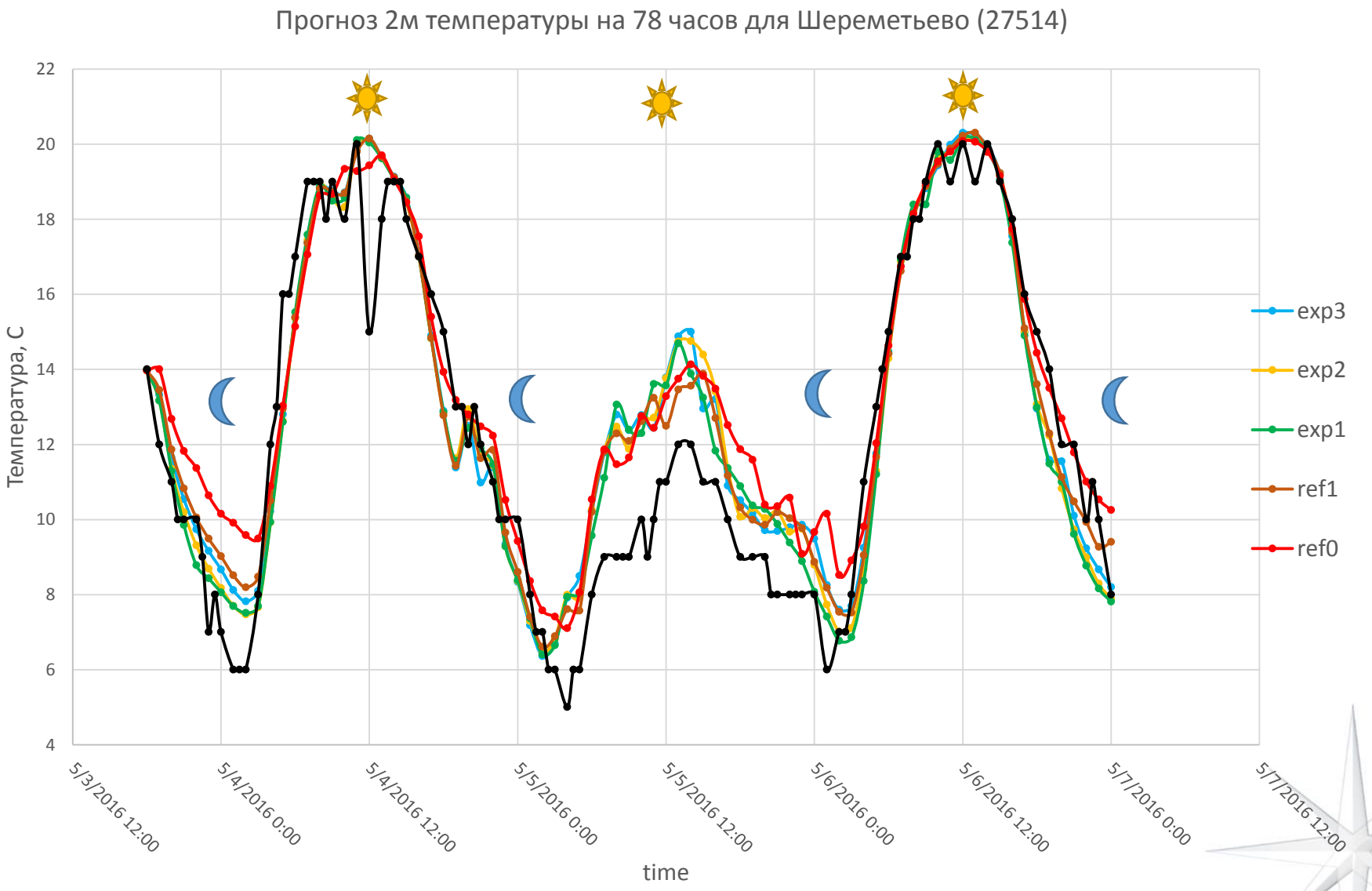
Thank you!

Изменения t2m при уменьшении pat_len до 50 и tkhmin до 0.1 (exp1-ref0)

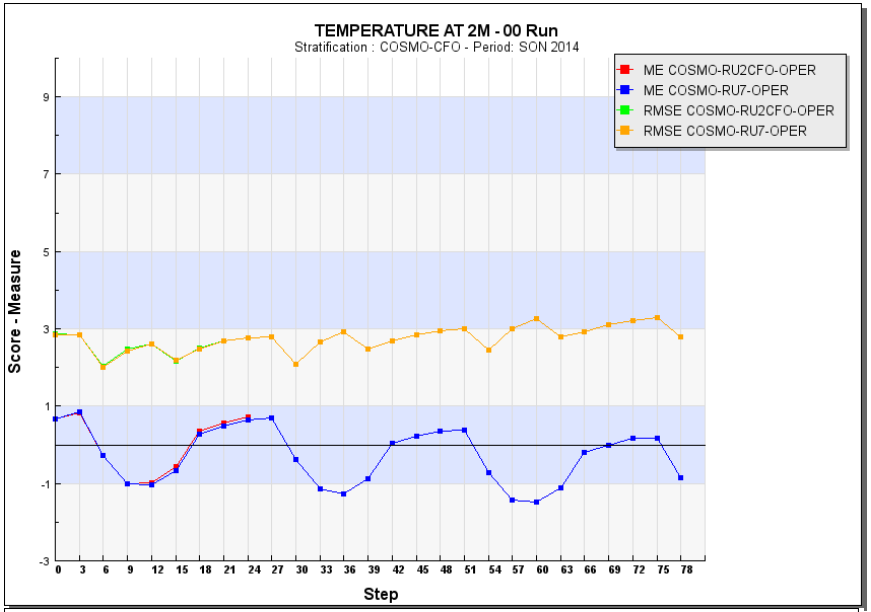


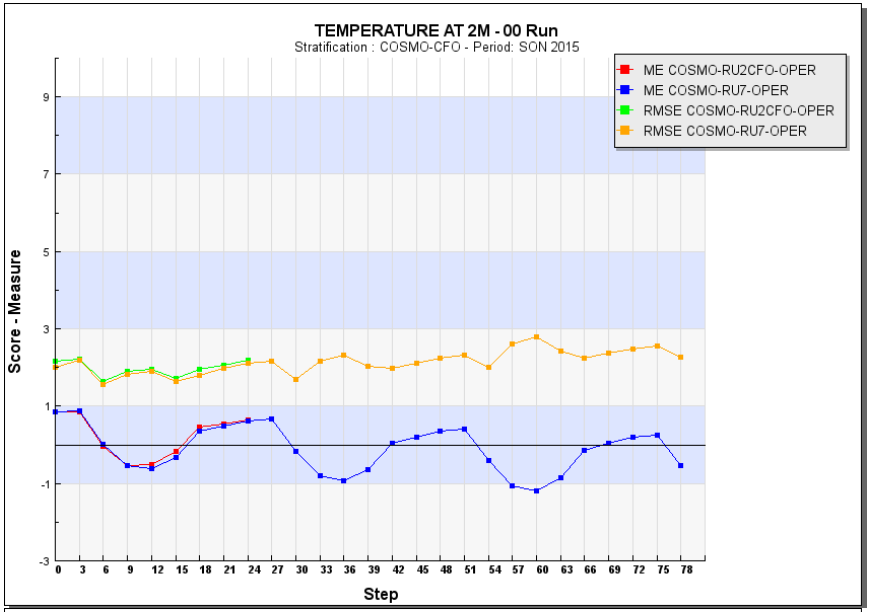
2016-05-04 00UTC

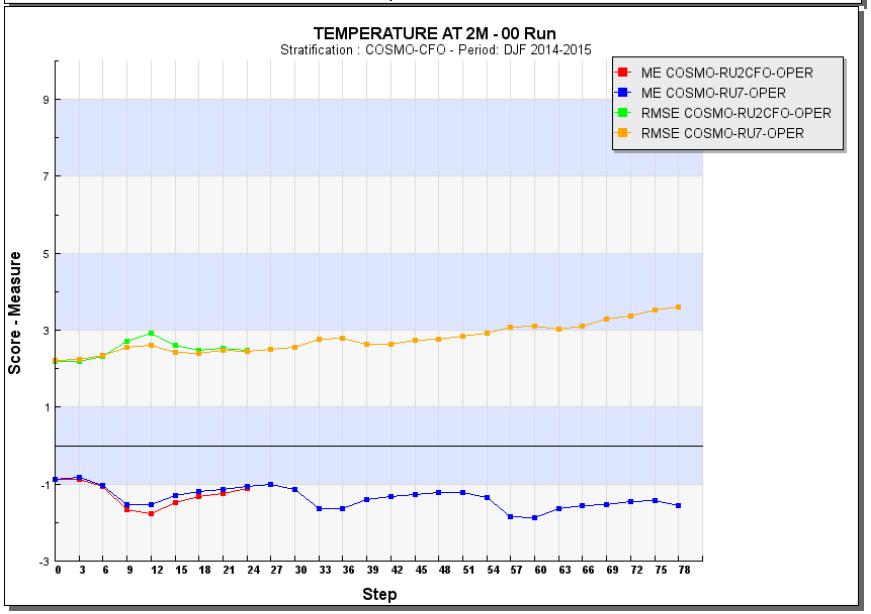
Влияние тюнинга прогноз t_2m в Шереметьево

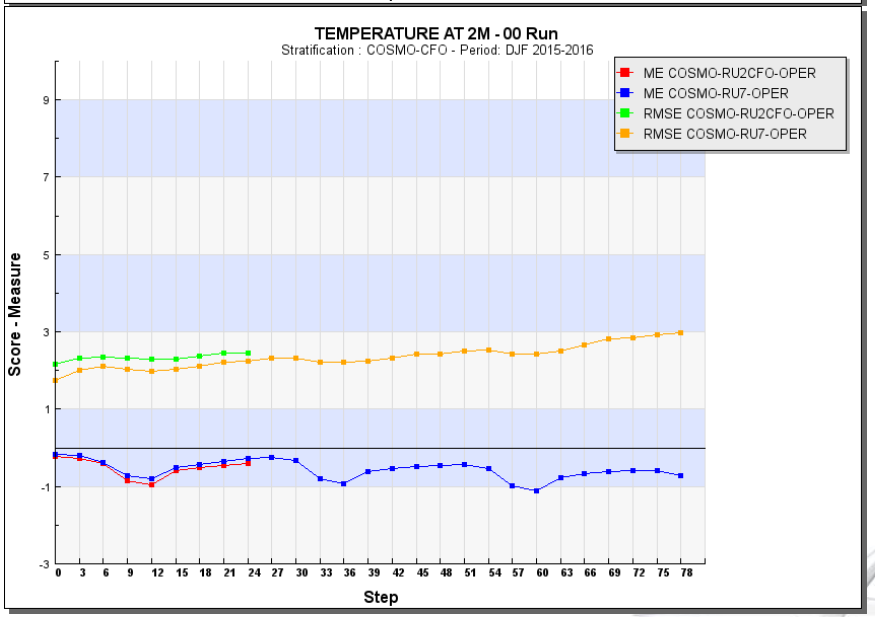


Verification over COSMO-Ru2 domain

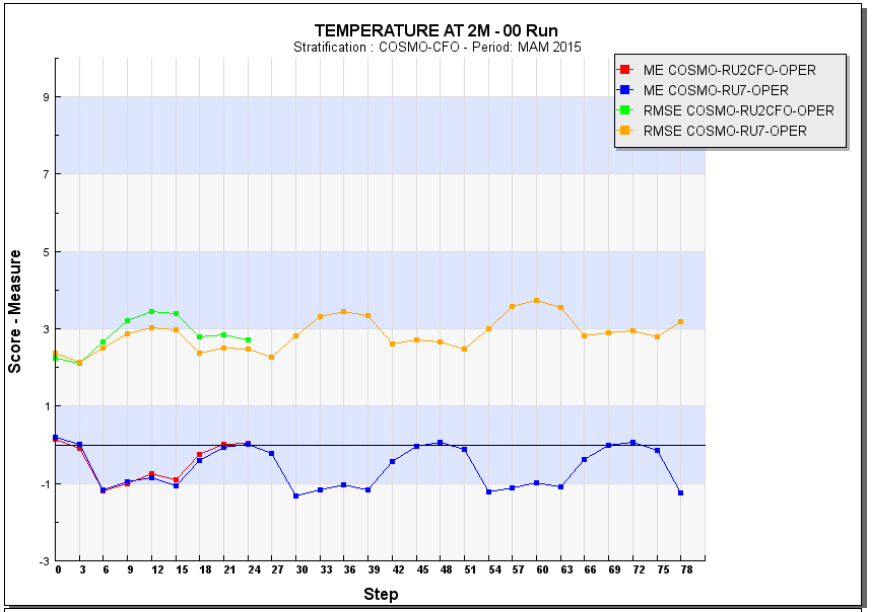


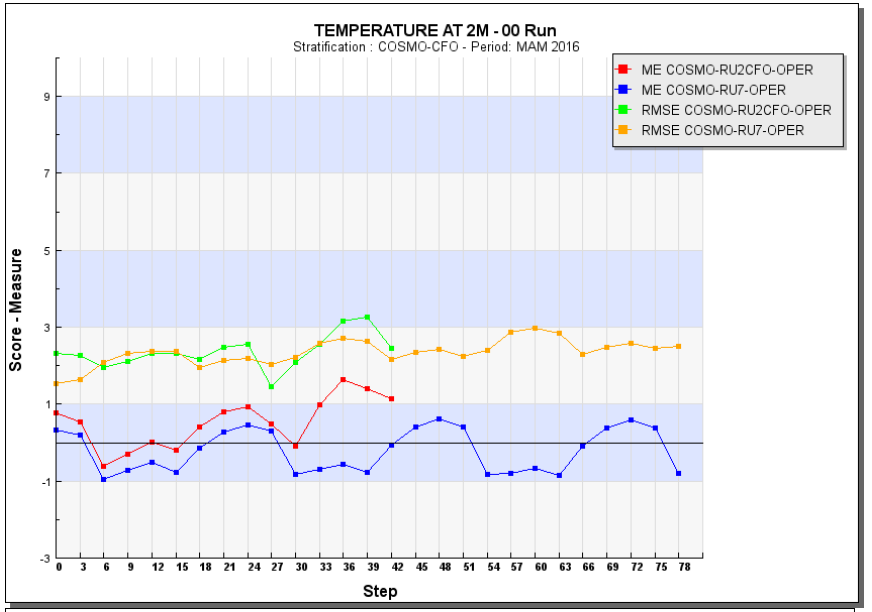


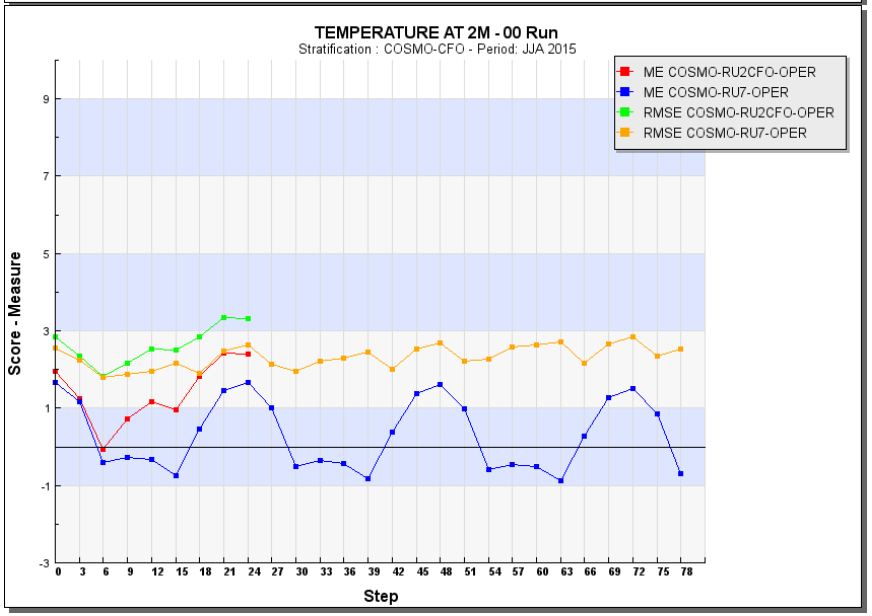


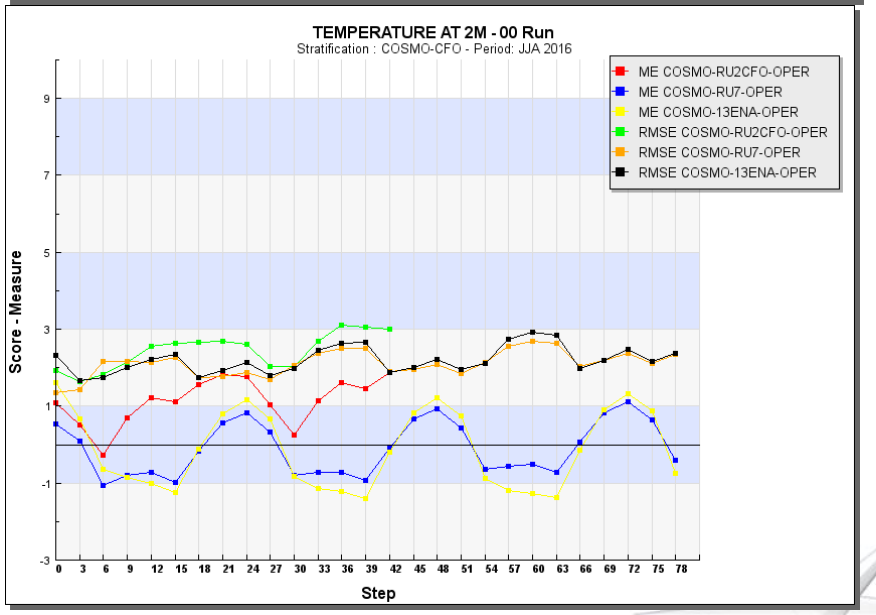


Verification over COSMO-Ru2 domain

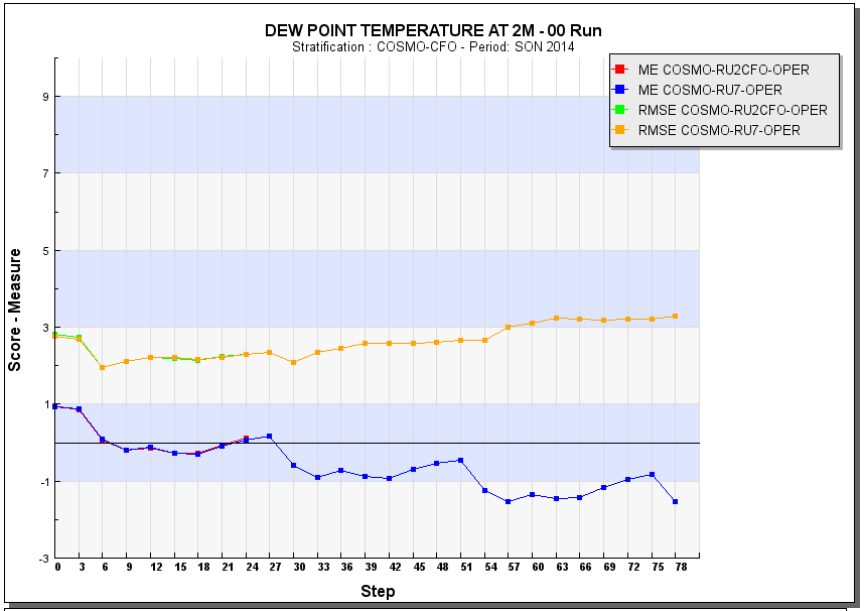


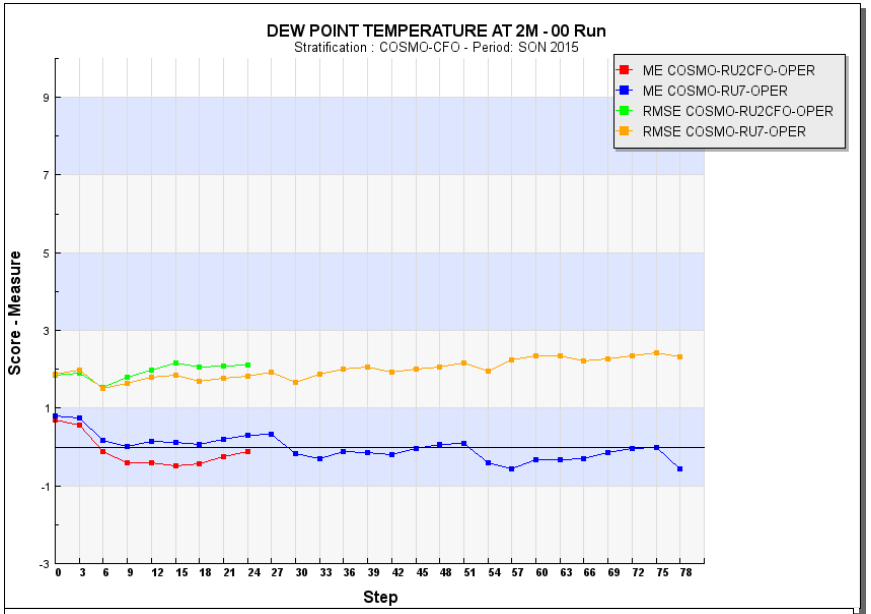


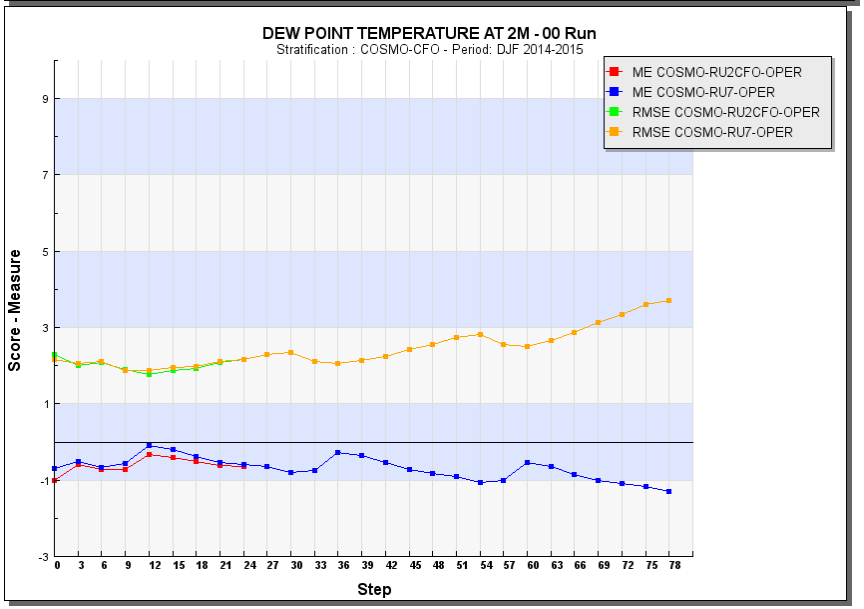


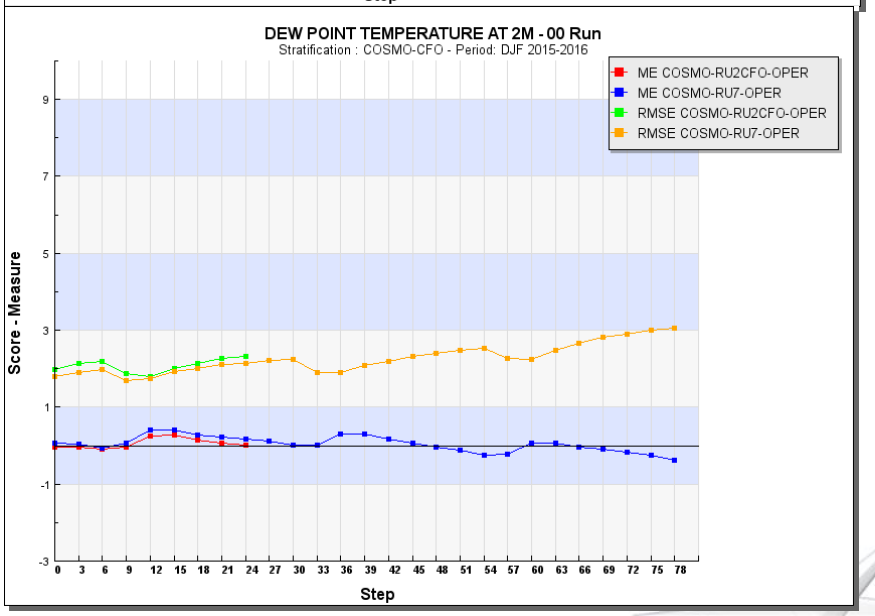


Verification over COSMO-Ru2 domain

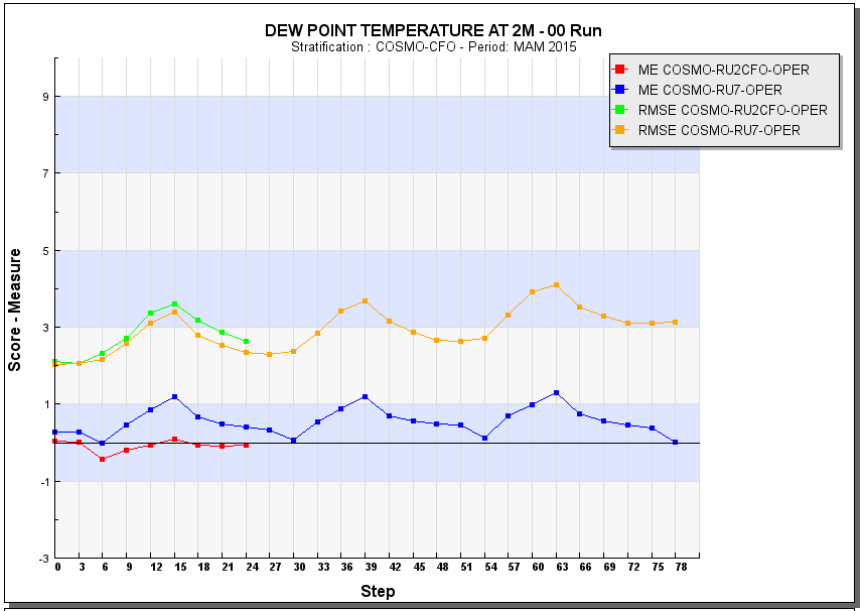


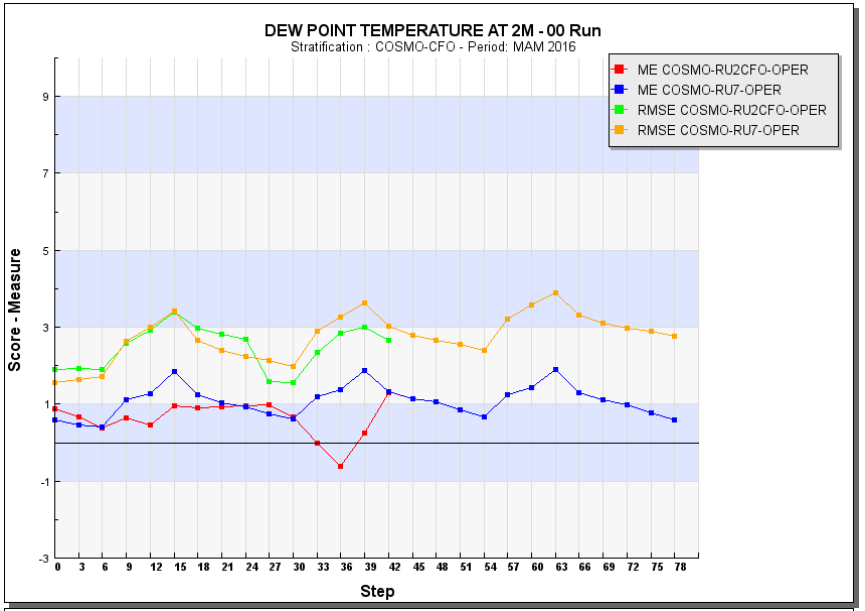


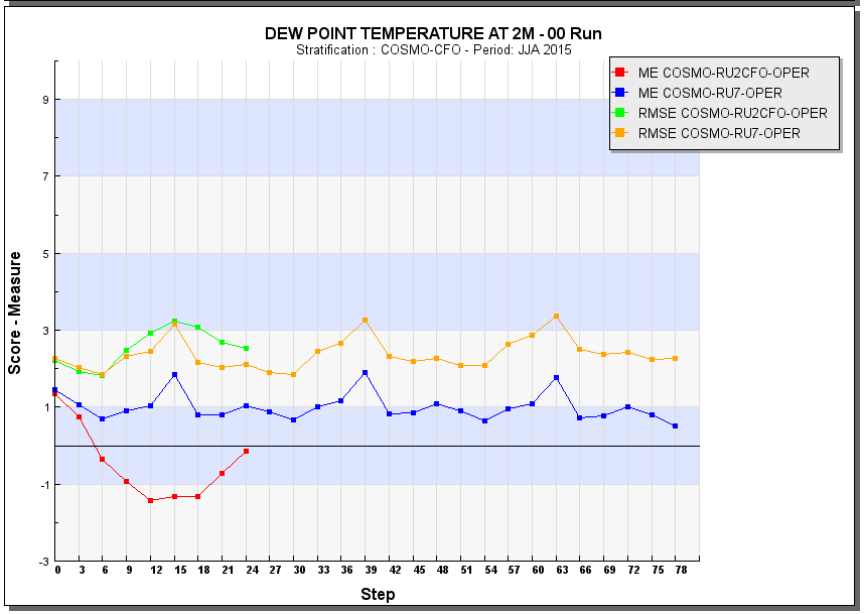


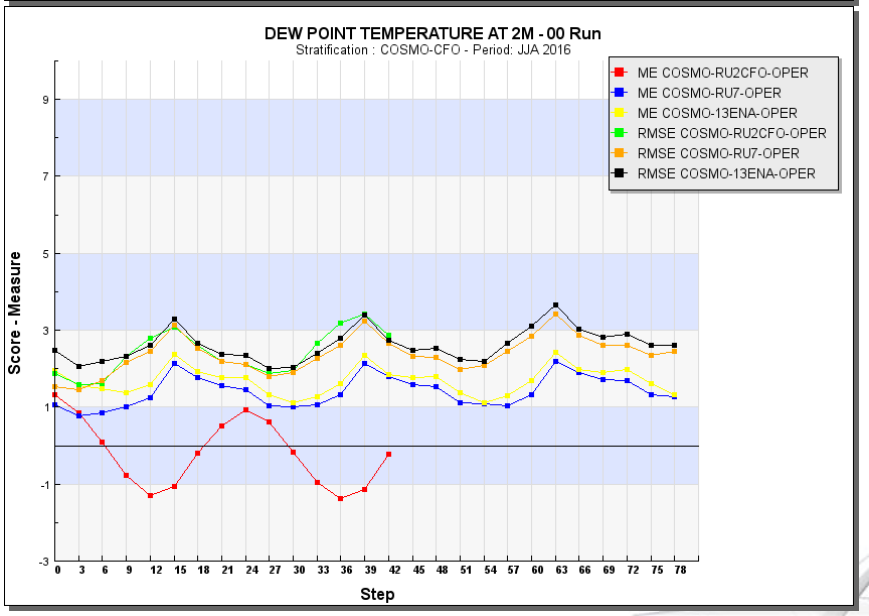


Verification over COSMO-Ru2 domain

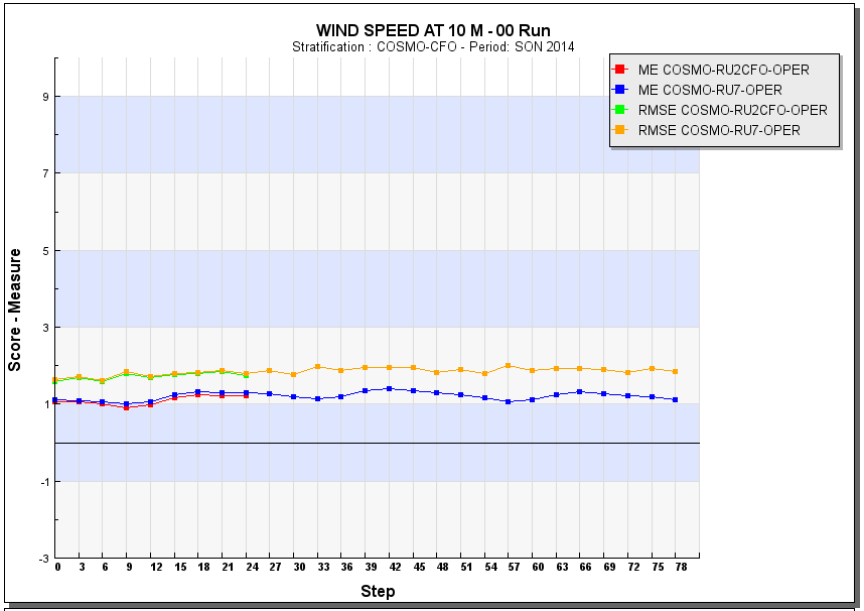


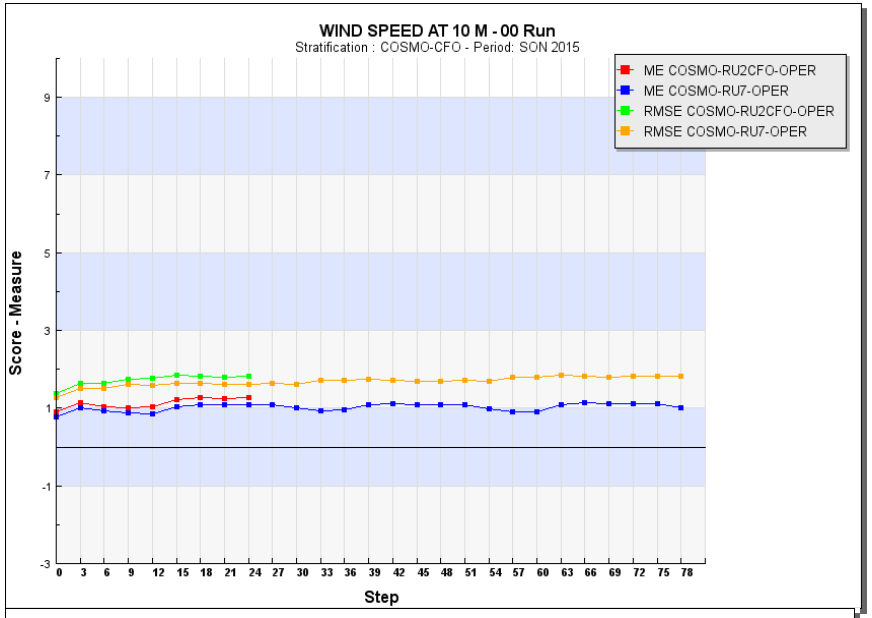


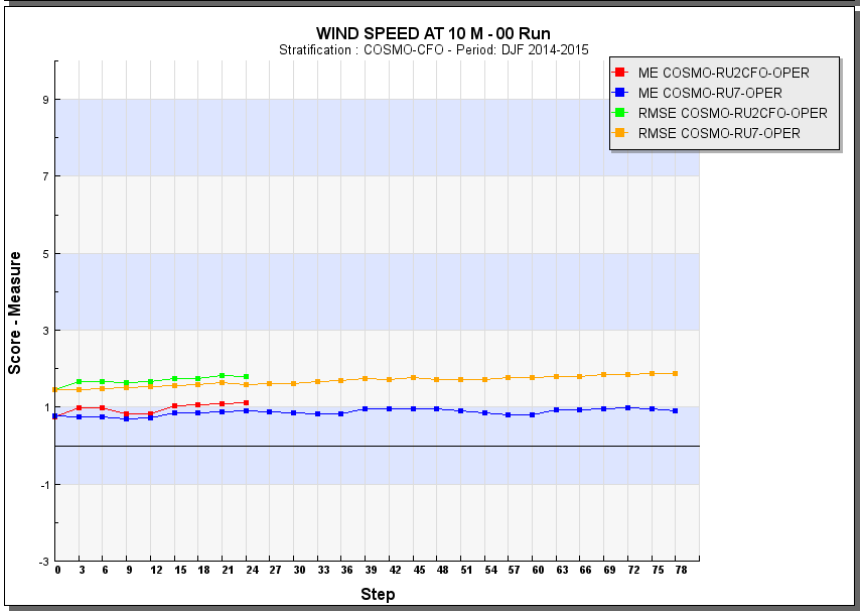


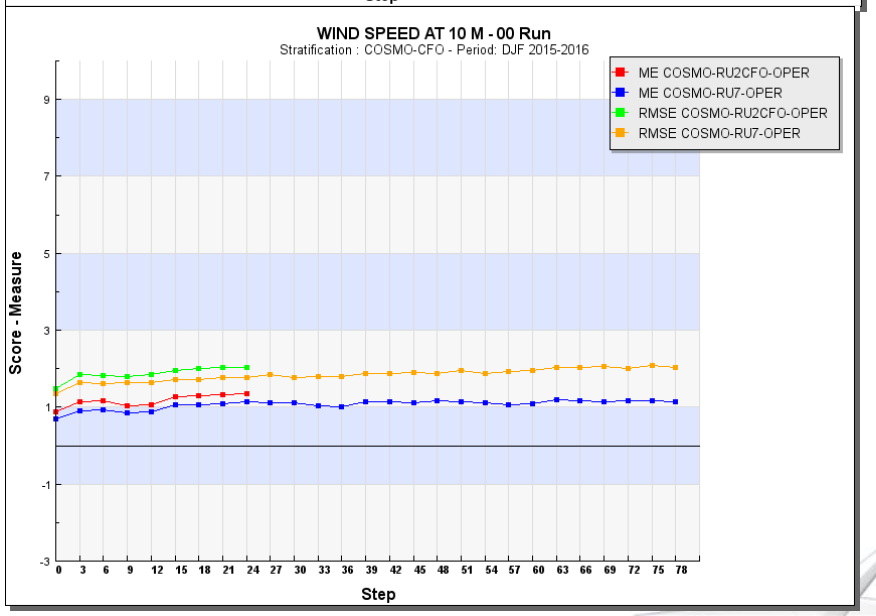


Verification over COSMO-Ru2 domain

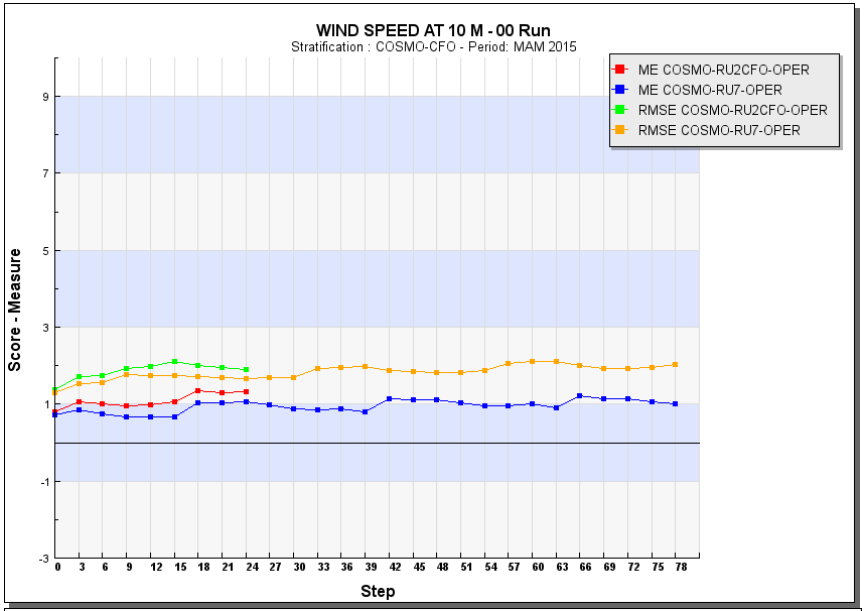


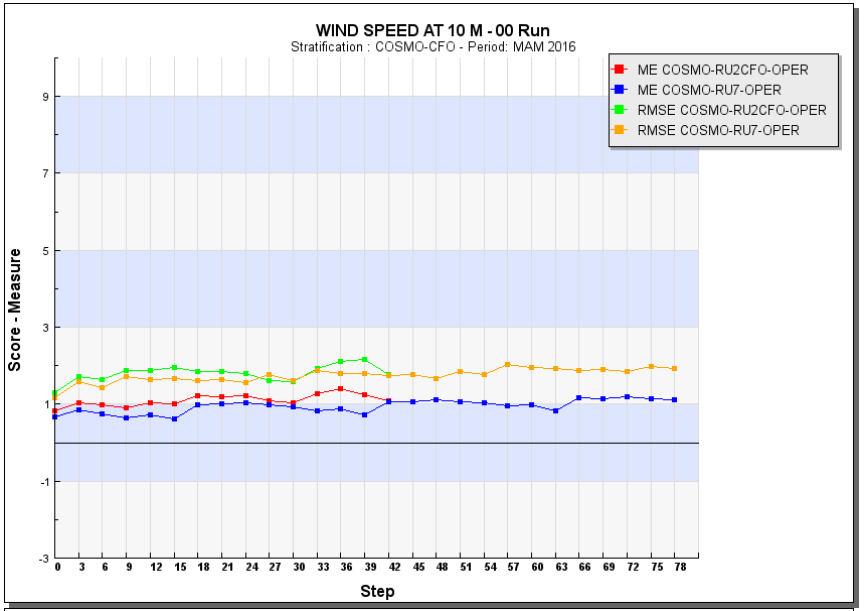


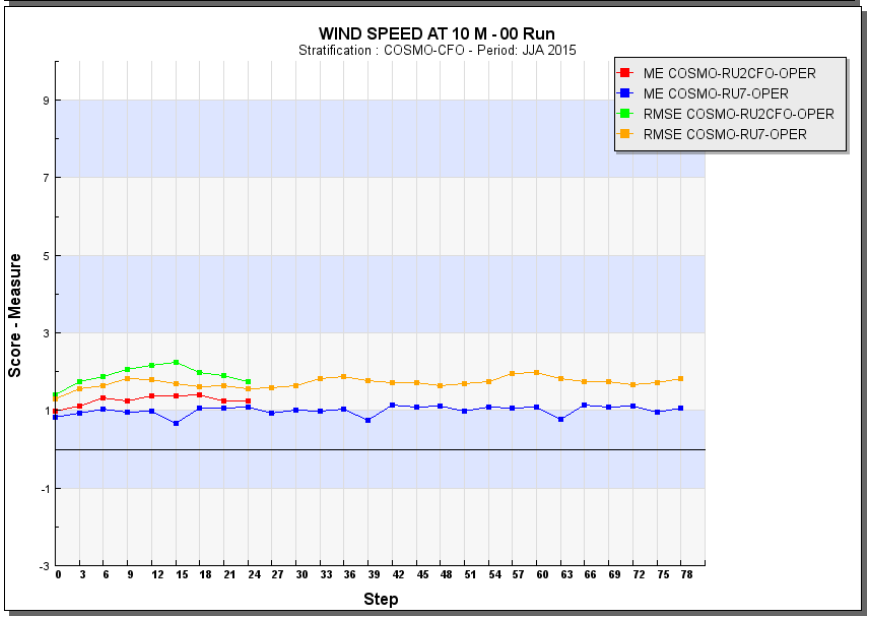


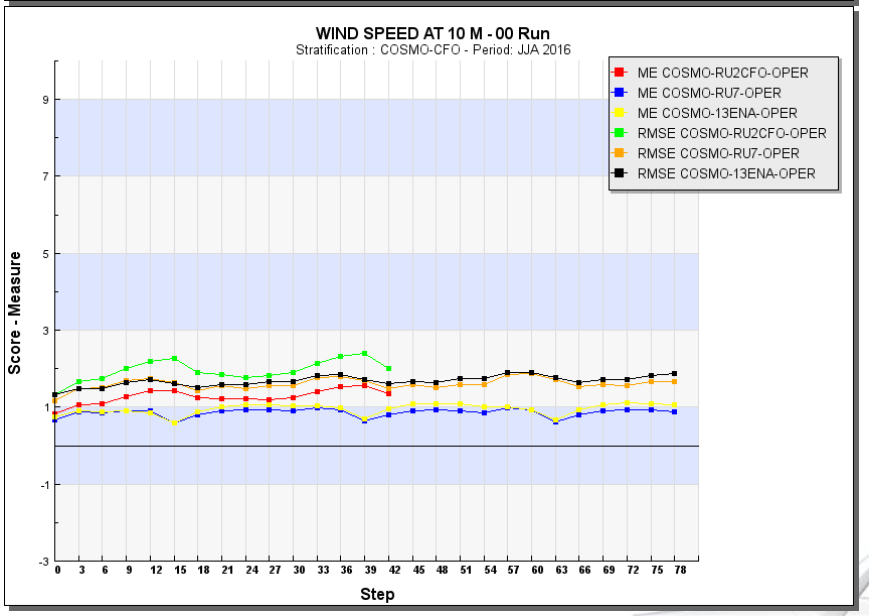


Verification over COSMO-Ru2 domain

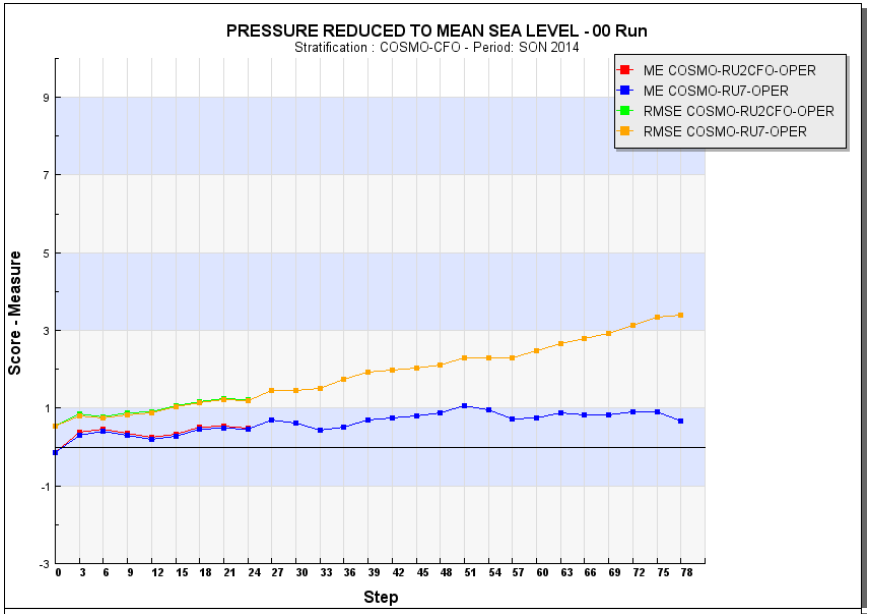


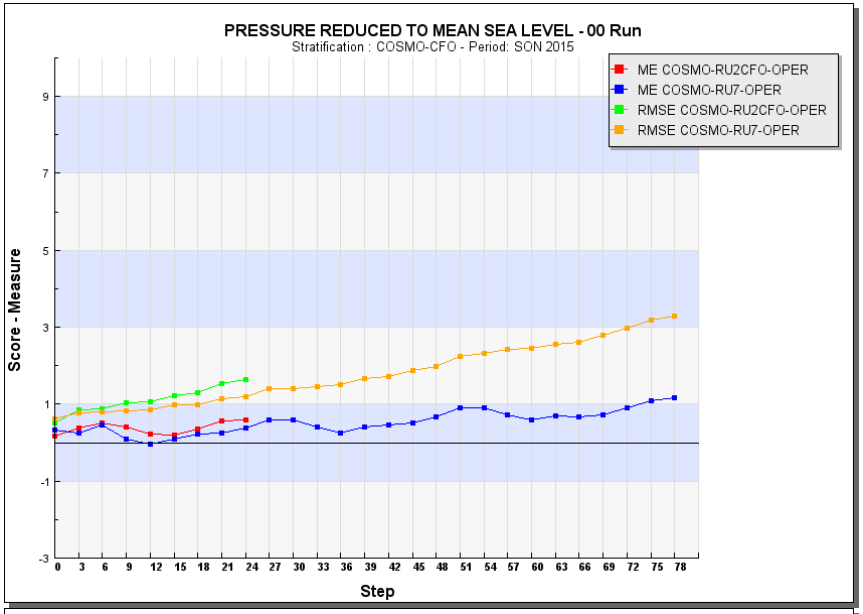


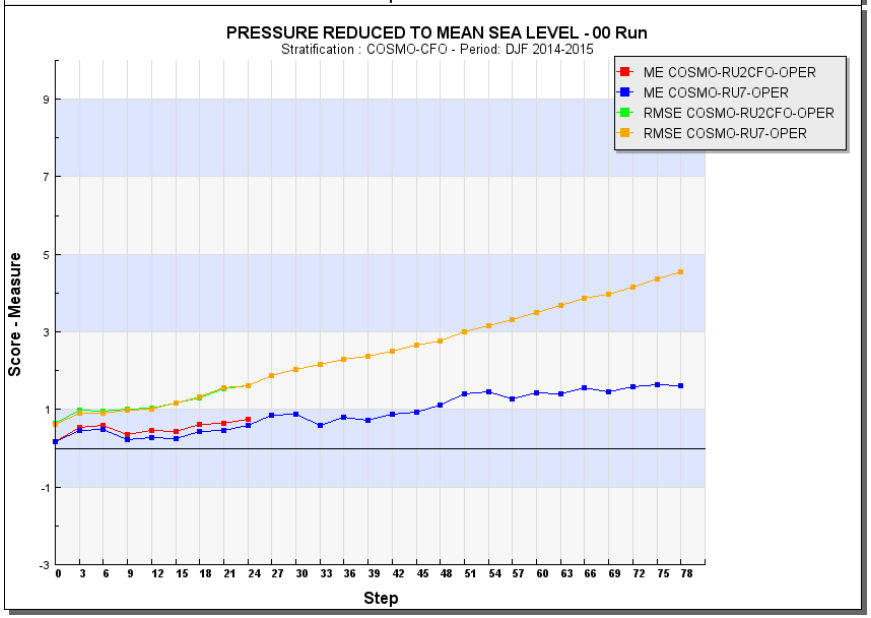


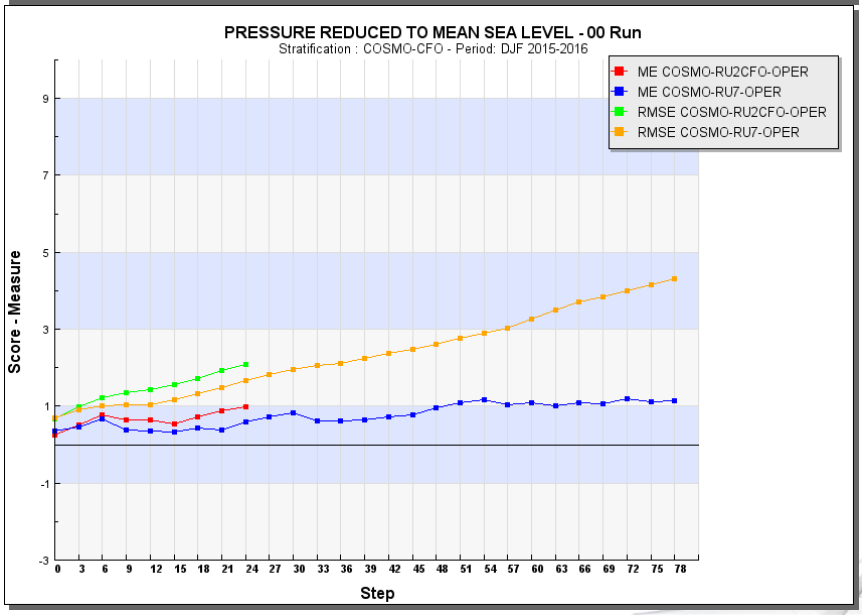


Verification over COSMO-Ru2 domain

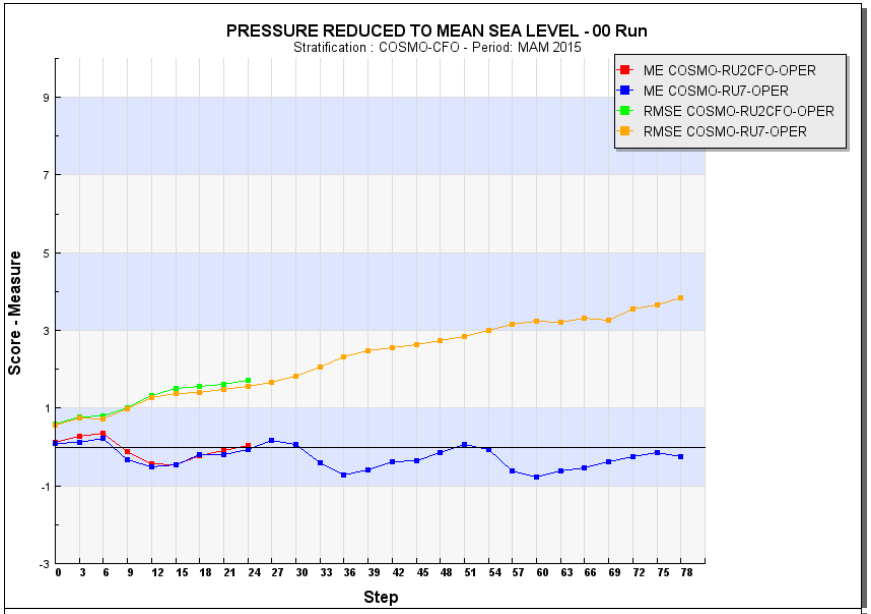


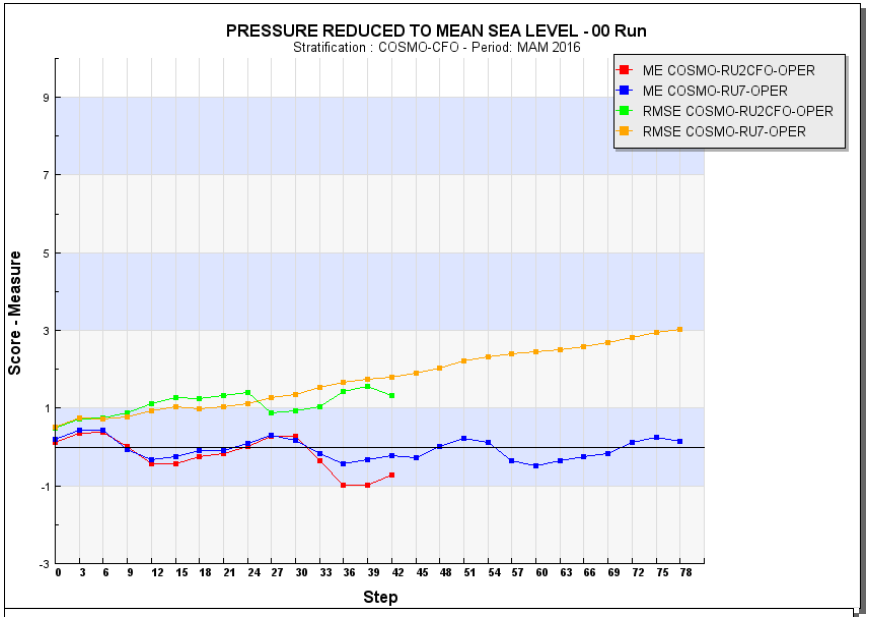


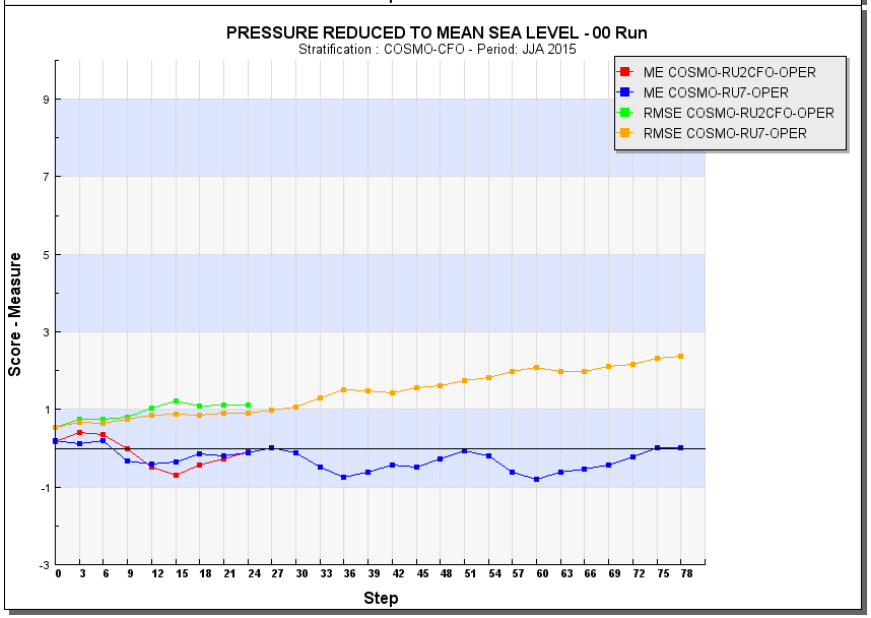


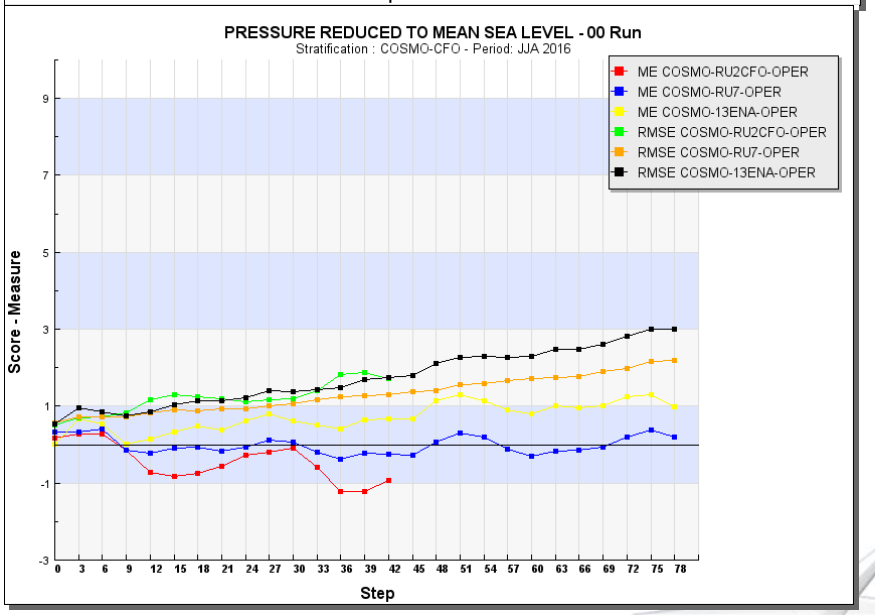


Verification over COSMO-Ru2 domain

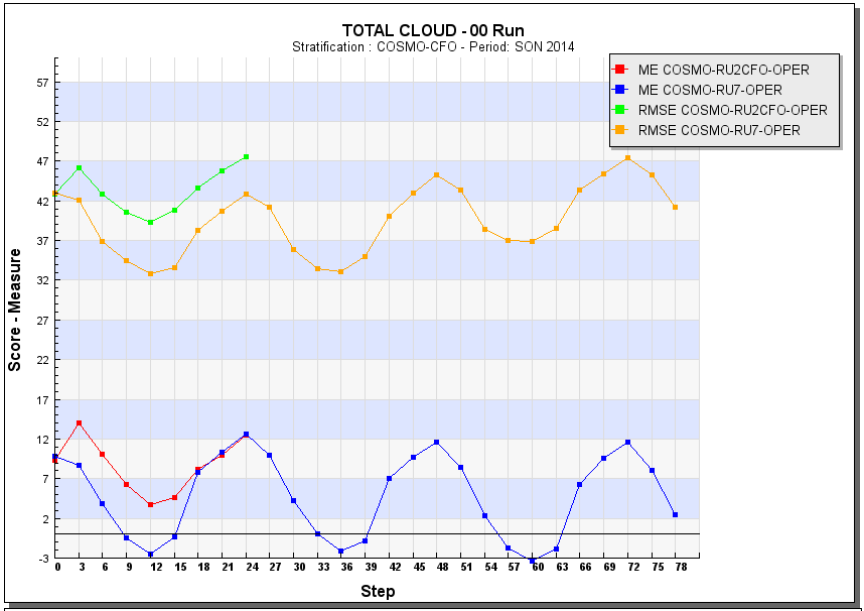


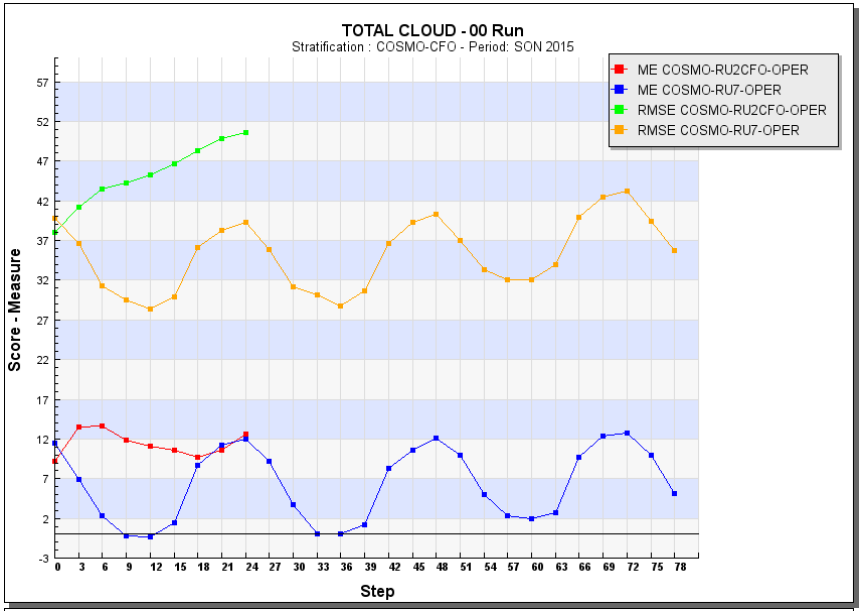


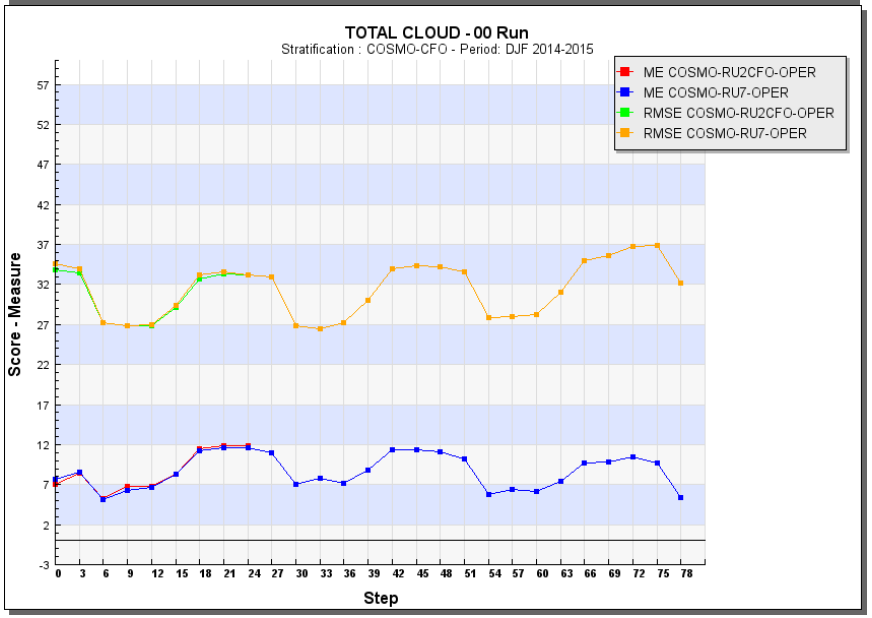


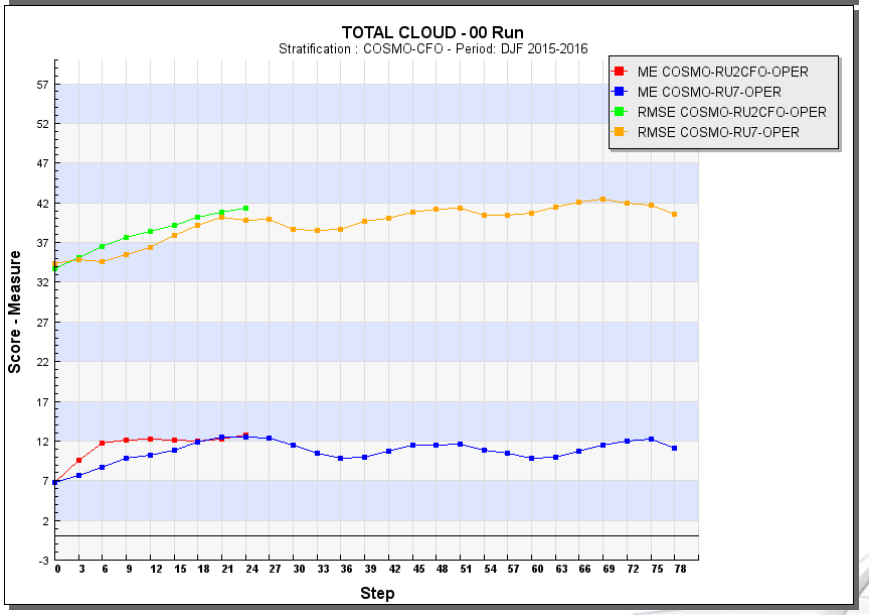


Verification over COSMO-Ru2 domain

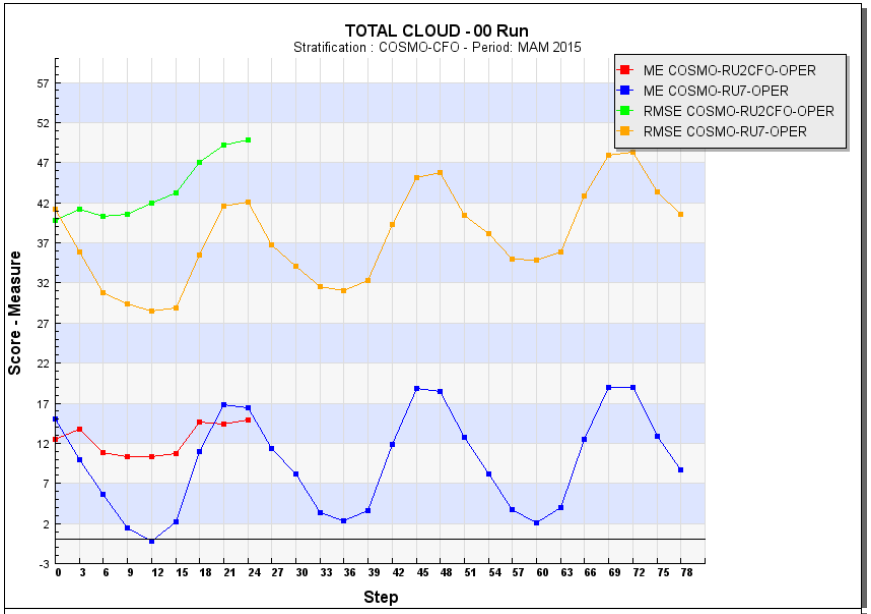


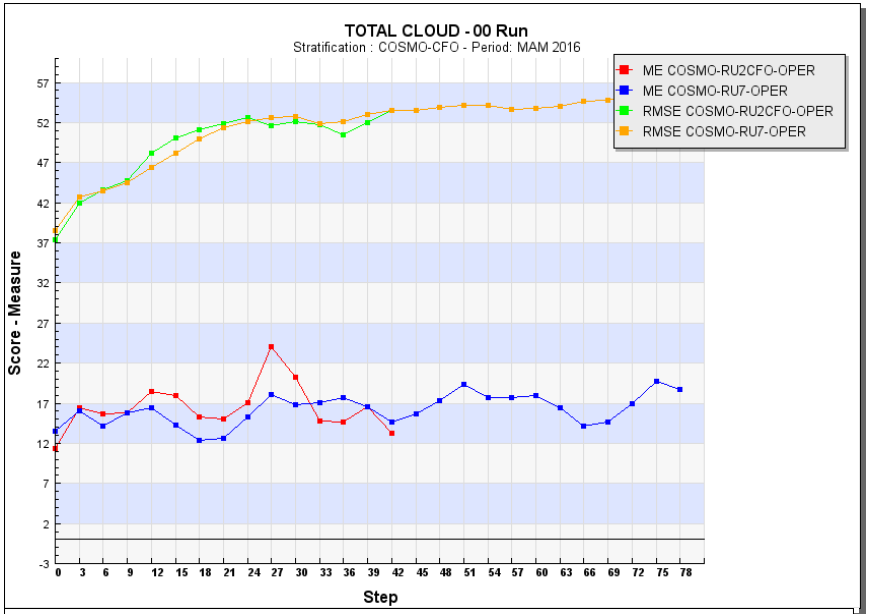


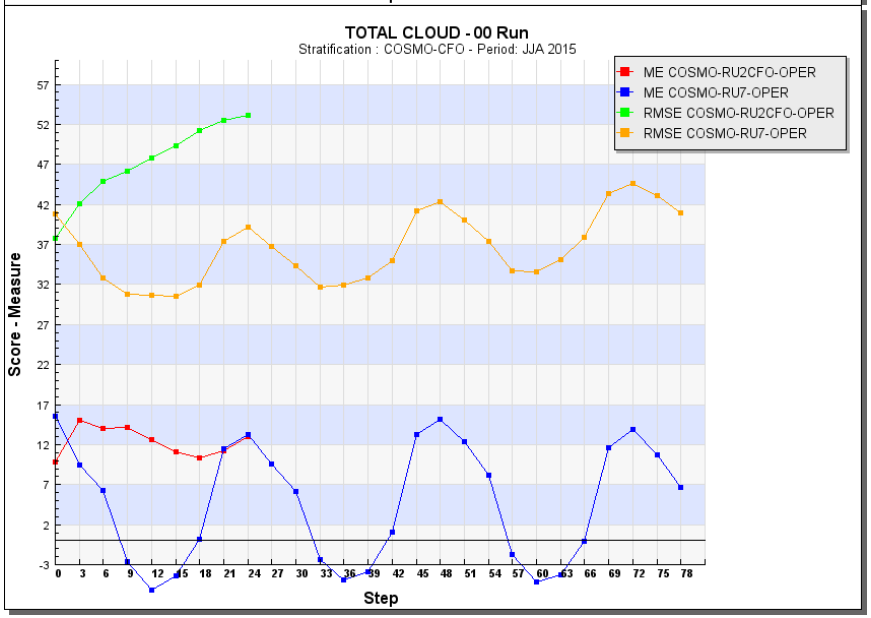


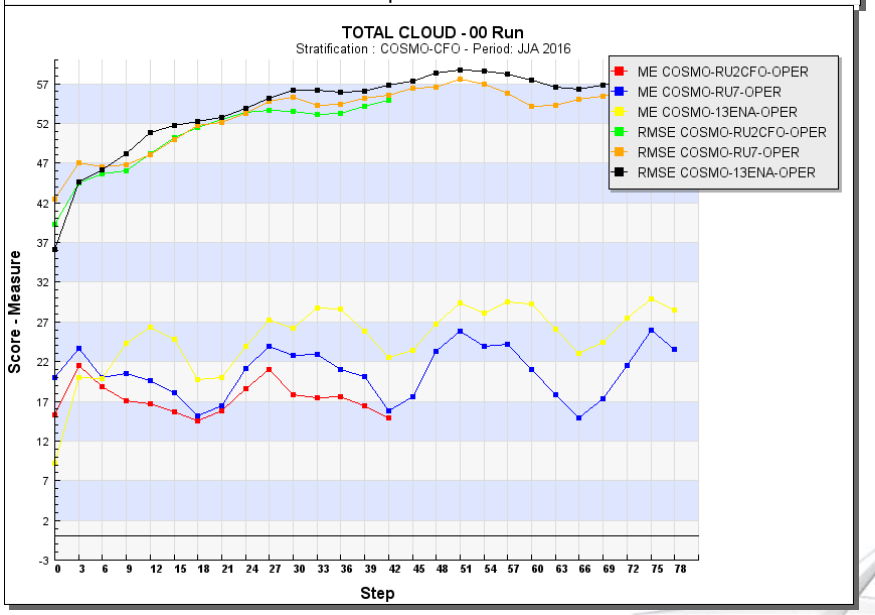


Verification over COSMO-Ru2 domain

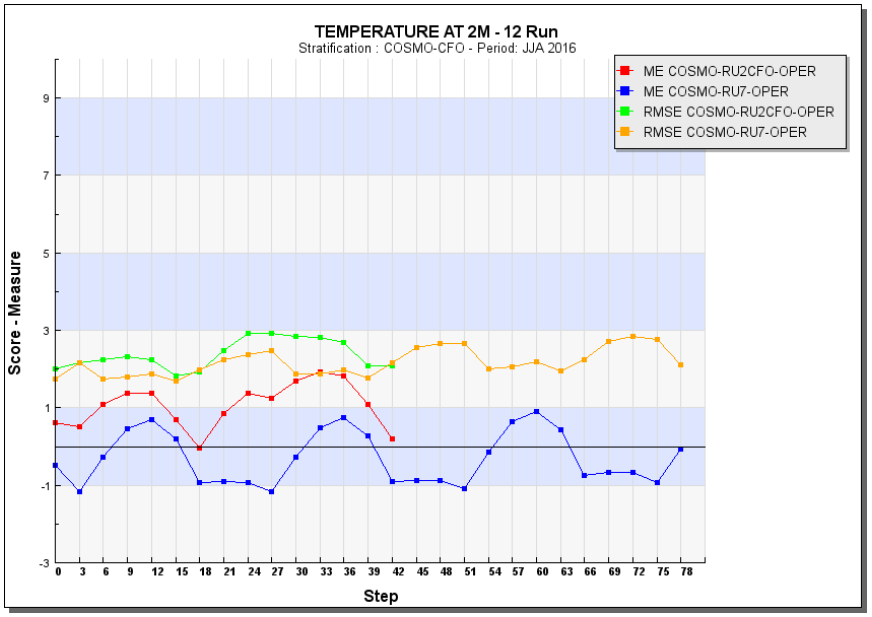


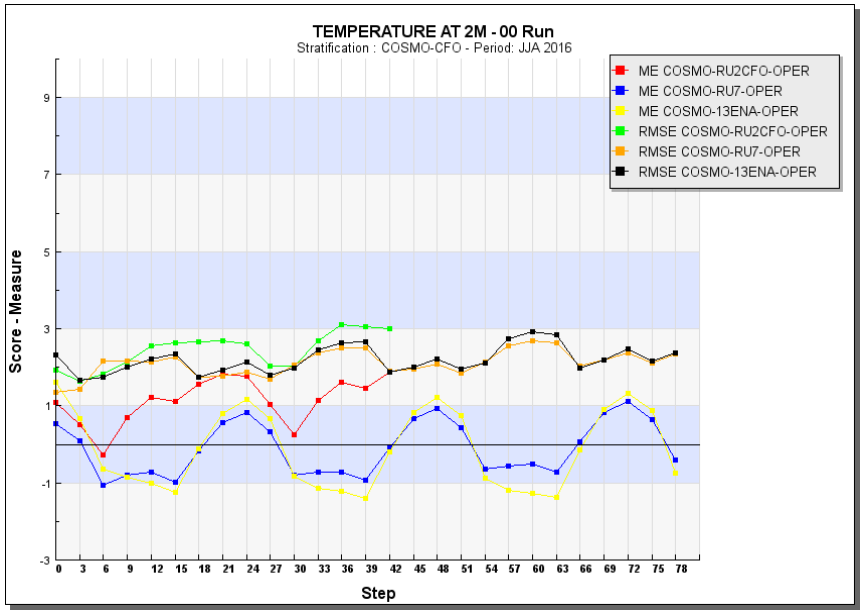






Verification over COSMO-Ru2 domain





ICON 12UTC → DA+6H → COSMO-Ru7 18UTC → DA+6H → COSMO-Ru2 00UTC

ICON 00UTC → DA+6H → COSMO-Ru7 06UTC → DA+6H → COSMO-Ru2 12UTC