



CALMO-MAX Summary

COSMO General meeting
2/9/2019

Itzhak Carmona and Yoav Levi

Information about the 5 parameters in CALMO-MAX

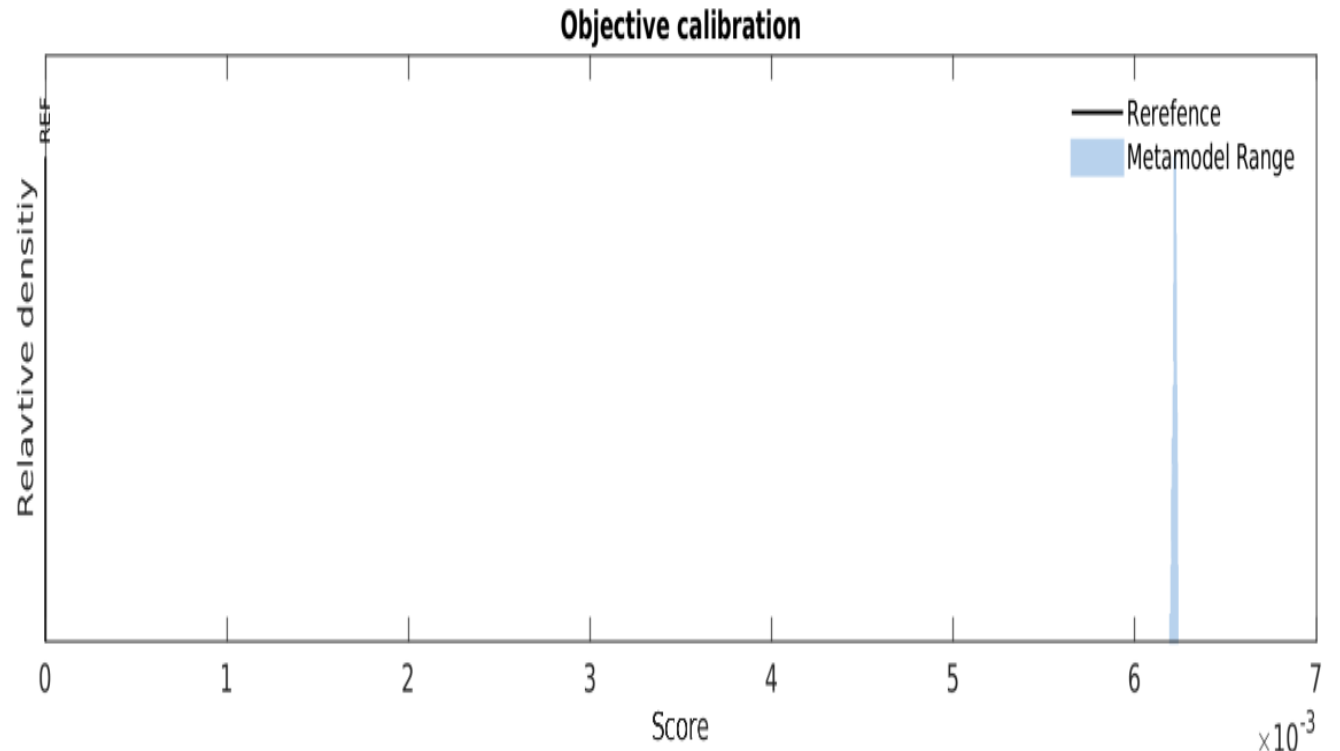
Parameter name	description	Min value	Default	Max Value
Tkhmin [m ² /s]	Minimal diffusion coefficients for heat active in stable BL conditions	0.1	0.4	1
Rlam_heat [no units]	Scaling factor for the thickness of the laminar boundary layer for heat	0.1	1	2
V0snow [no units]	Factor in the terminal velocity for snow.	10	20	30
Radfac [No Units]	Fraction of cloud water and ice considered by radiation scheme	0.3	0.6	0.9
UC1 [No units]	Controlling the vertical variation of critical relative humidity for sub-grid cloud formation (radiation scheme)	0	0.8	1

Thanks' to the university of COTTBUS

- We used mainly Heraklit server with 28-32 cores at COTTBUS's .

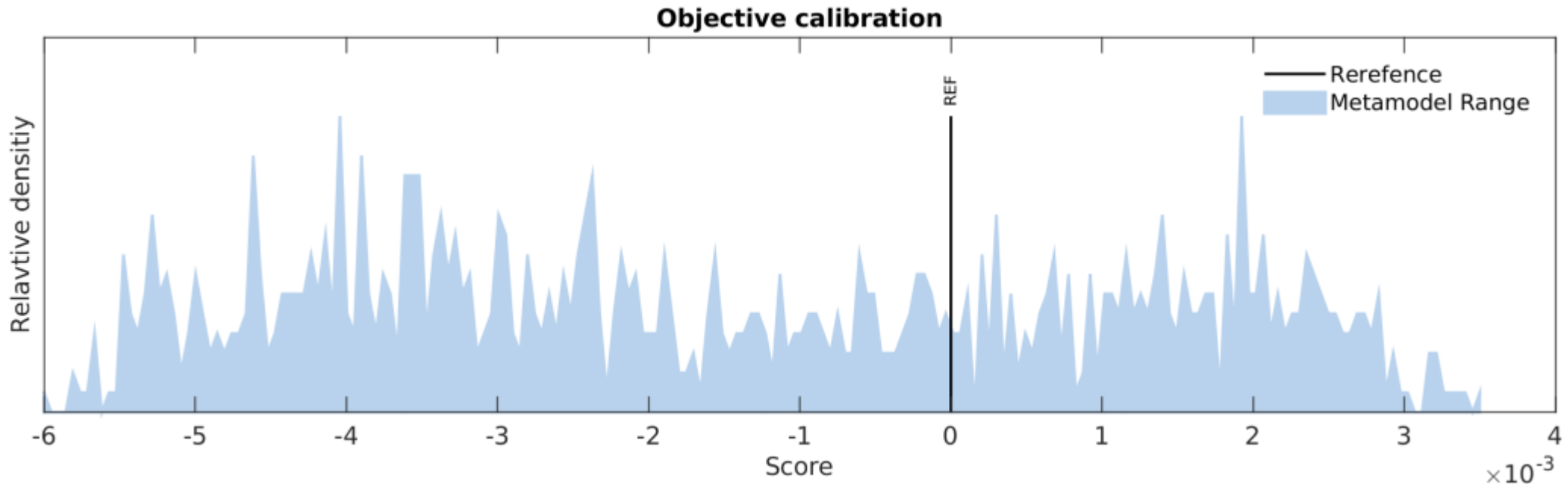
Methodology

- Building Meta Models (MM) using the COSI-FSS score for every 10 days for the year 2013, for tuning.
- In order to save computation time after 40 iteration a converge to the optimal parameter in the 5 dimensions space should occur:



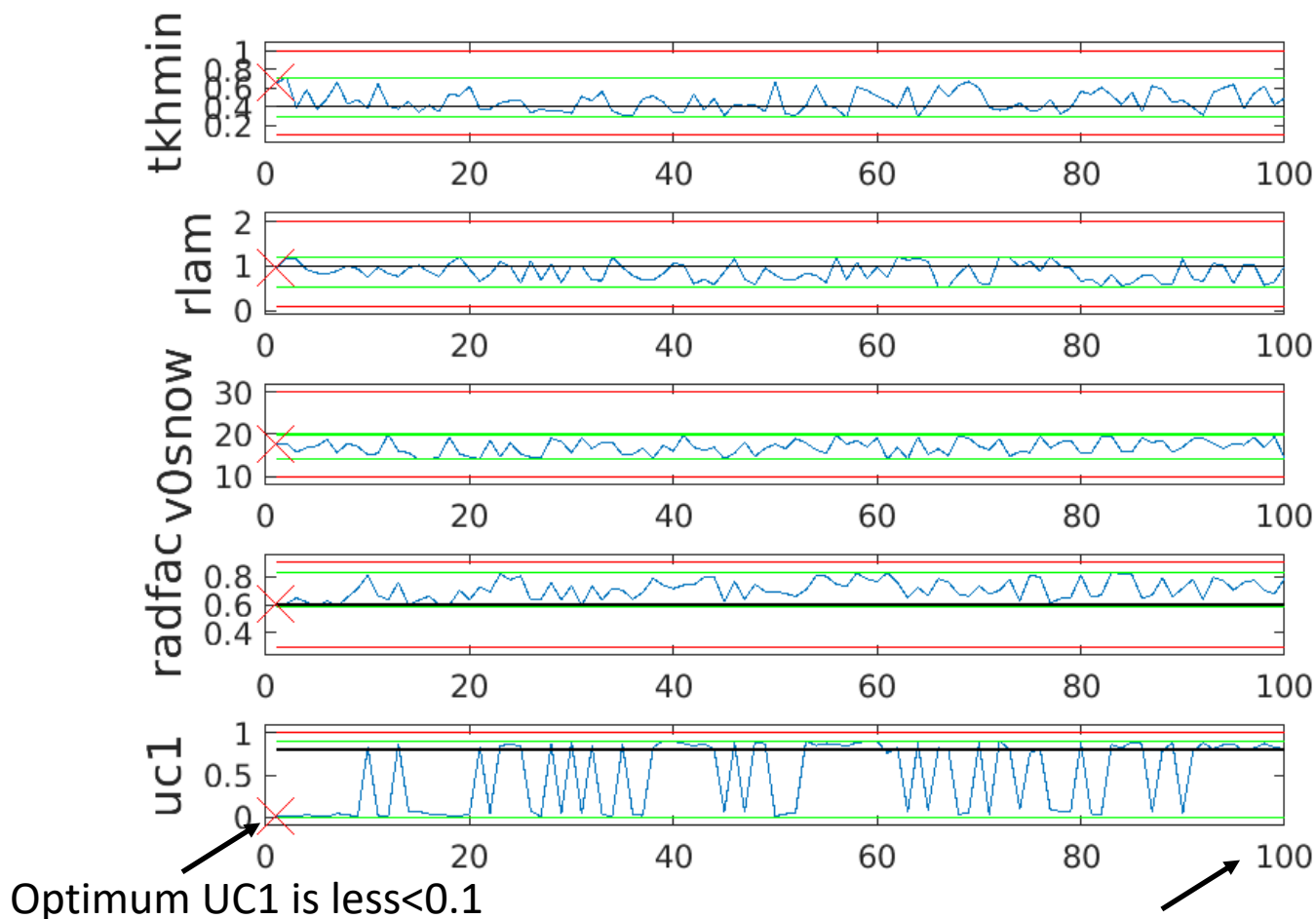
For the second decade (11/2/2013-20/2/2013) convergence was not achieved after 40 iterations !!!

What should we do if the MM does not converge after 40 iterations?

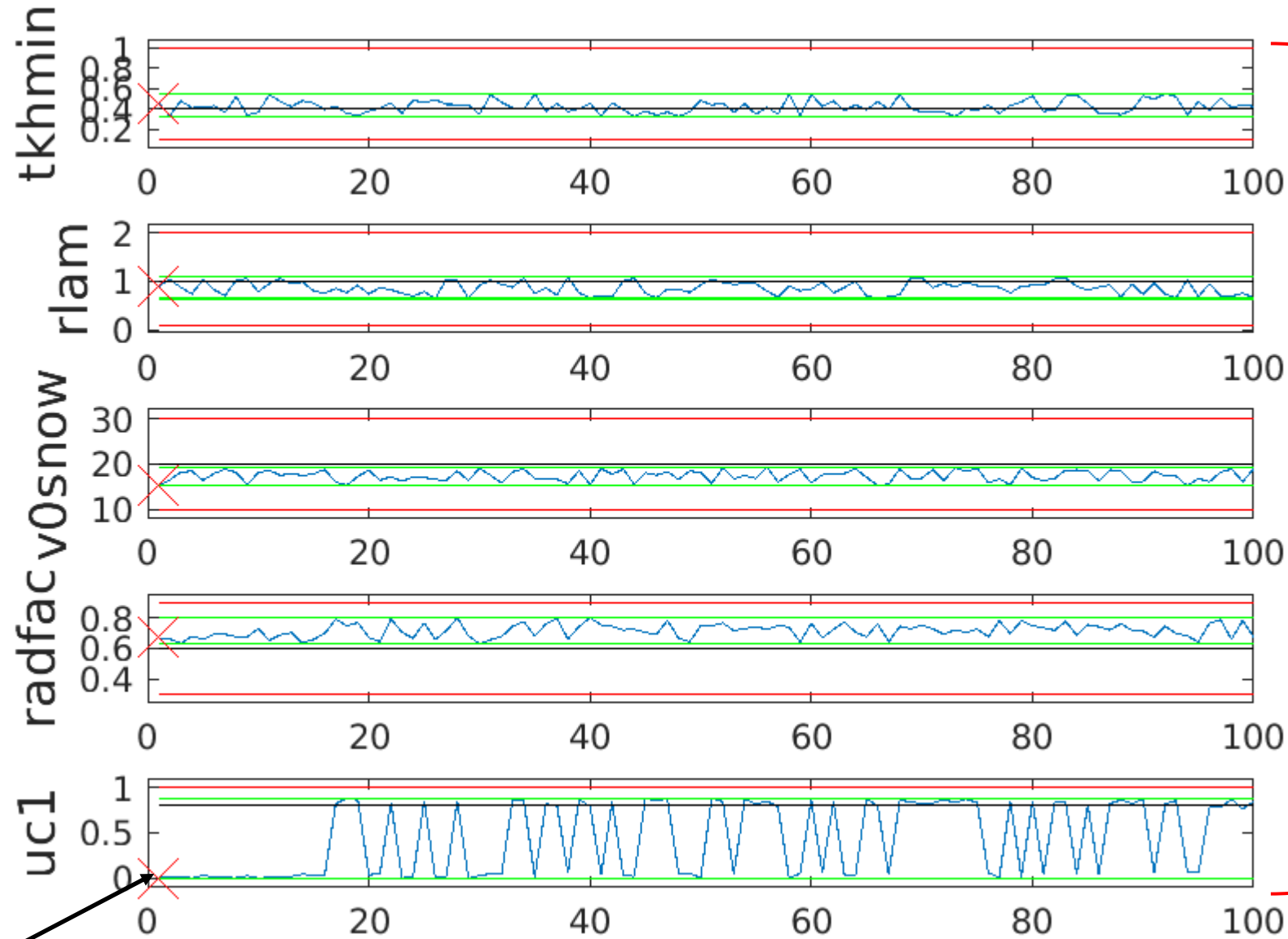


Solving the problem with the non convergence in decade 11-20/1/2013

- We decided to continue running the iteration Matlab script after reaching to 40 iteration , and take the 50 best combinations of 5 parameters instead of 100 best combination as was done before (until 40 iteration)



In iterations ≤ 40 we took the best 100 combination which have the best score out of 1000 scores

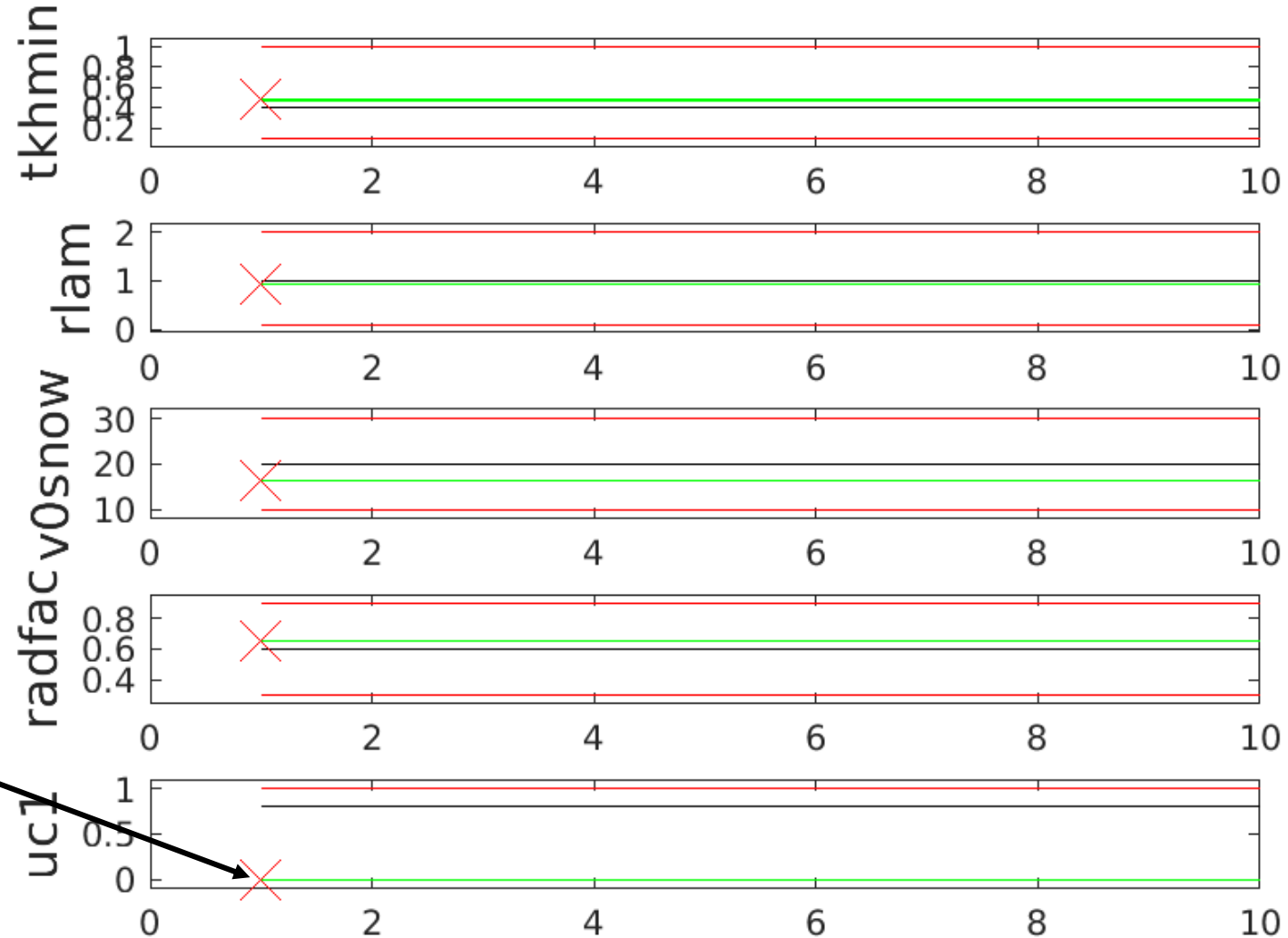




For iterations >40 we took the best 50 combination with the best score out of 1000 scores

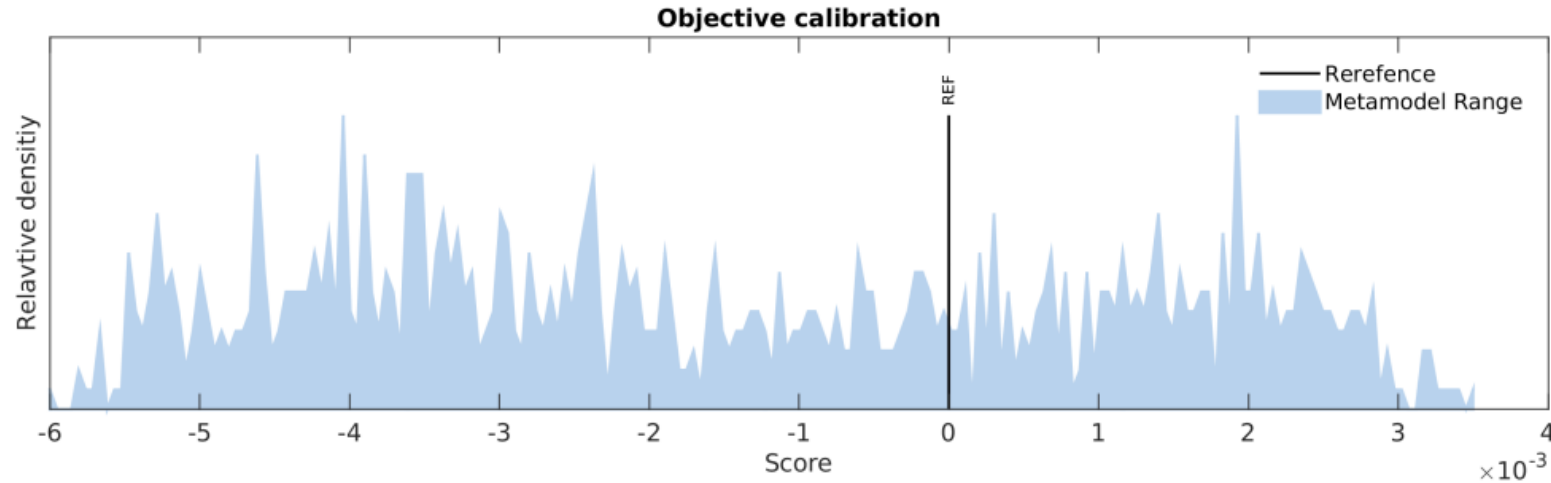
The last Iteration 50

After 44 iterations we decided to take from iteration 45 and after only the 10 Best combinations from the 10 Best scores.

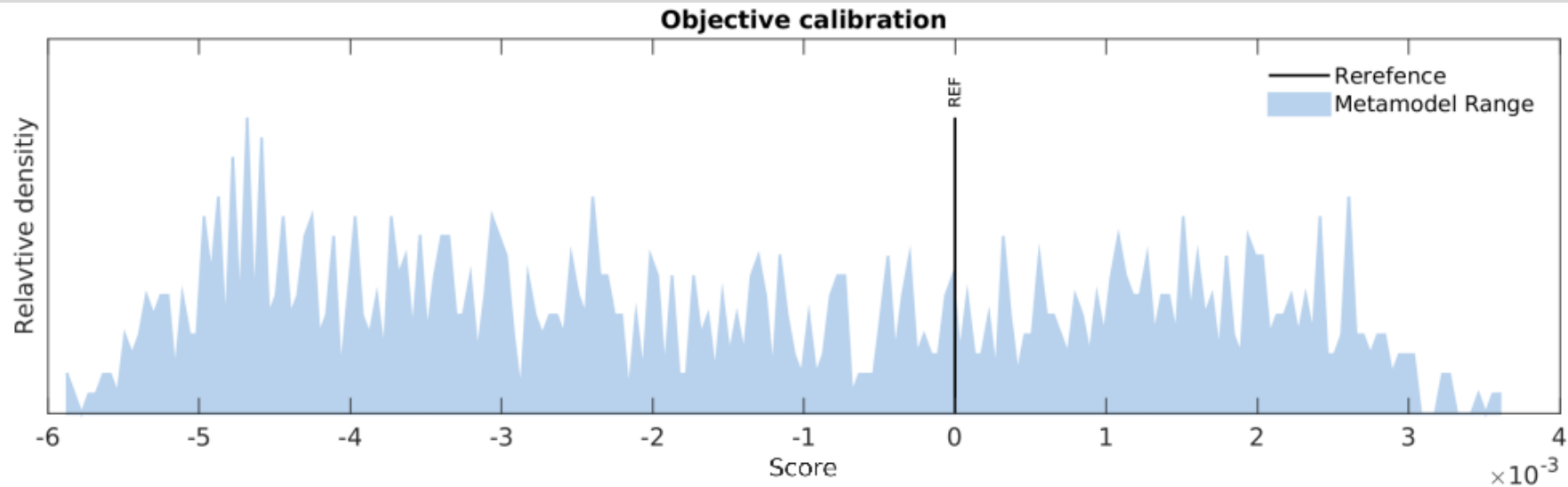


In Iteration 50
there is finally
convergence !!!

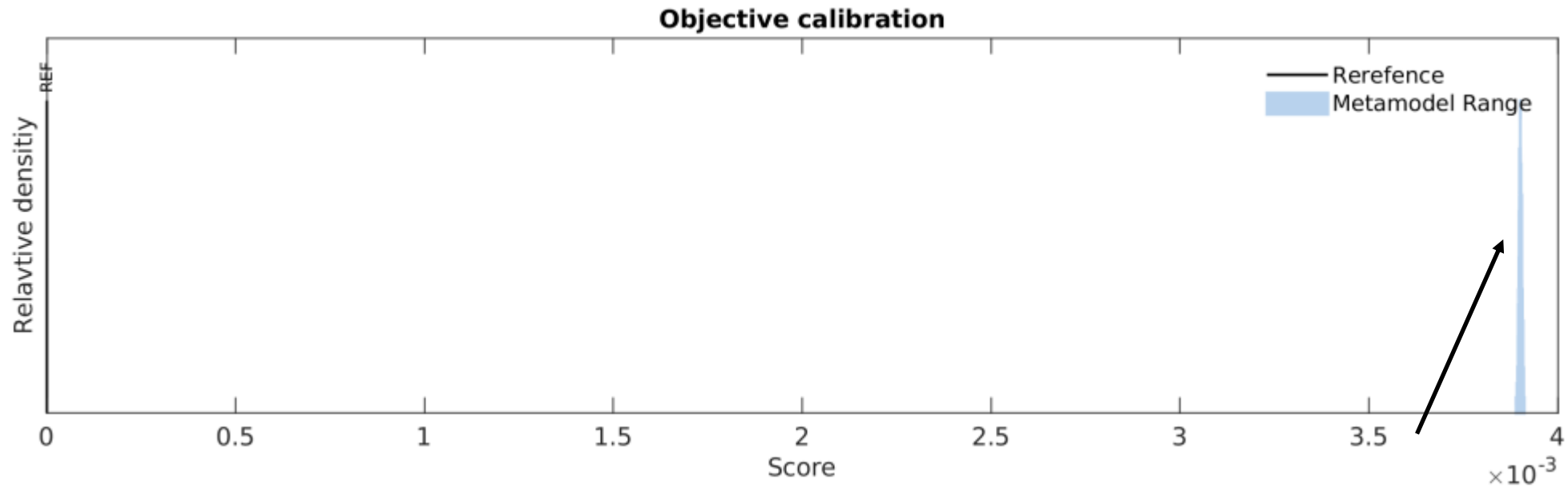
Iteration number 40 for the decade 11-20/1/2013 (until iteration 40 we take every time the best **100** parameter combinations)



Iteration number 44 for the decade 11-20/1/2013 (from iteration 41-44 we take every time the best **50** parameter combinations)



Iteration number 50 for the decade 11-20/1/2013 (from iteration 45-50 we take every time the best **10** parameter combinations)



Finally Converge, When The condition for convergent is : $(\text{Score}_{\max} - \text{Score}_{\min}) / \text{Score}_{\max} < 0.001$ (with another condition that $\text{Score}_{\max} > 0$ and $\text{Score}_{\min} > 0$)

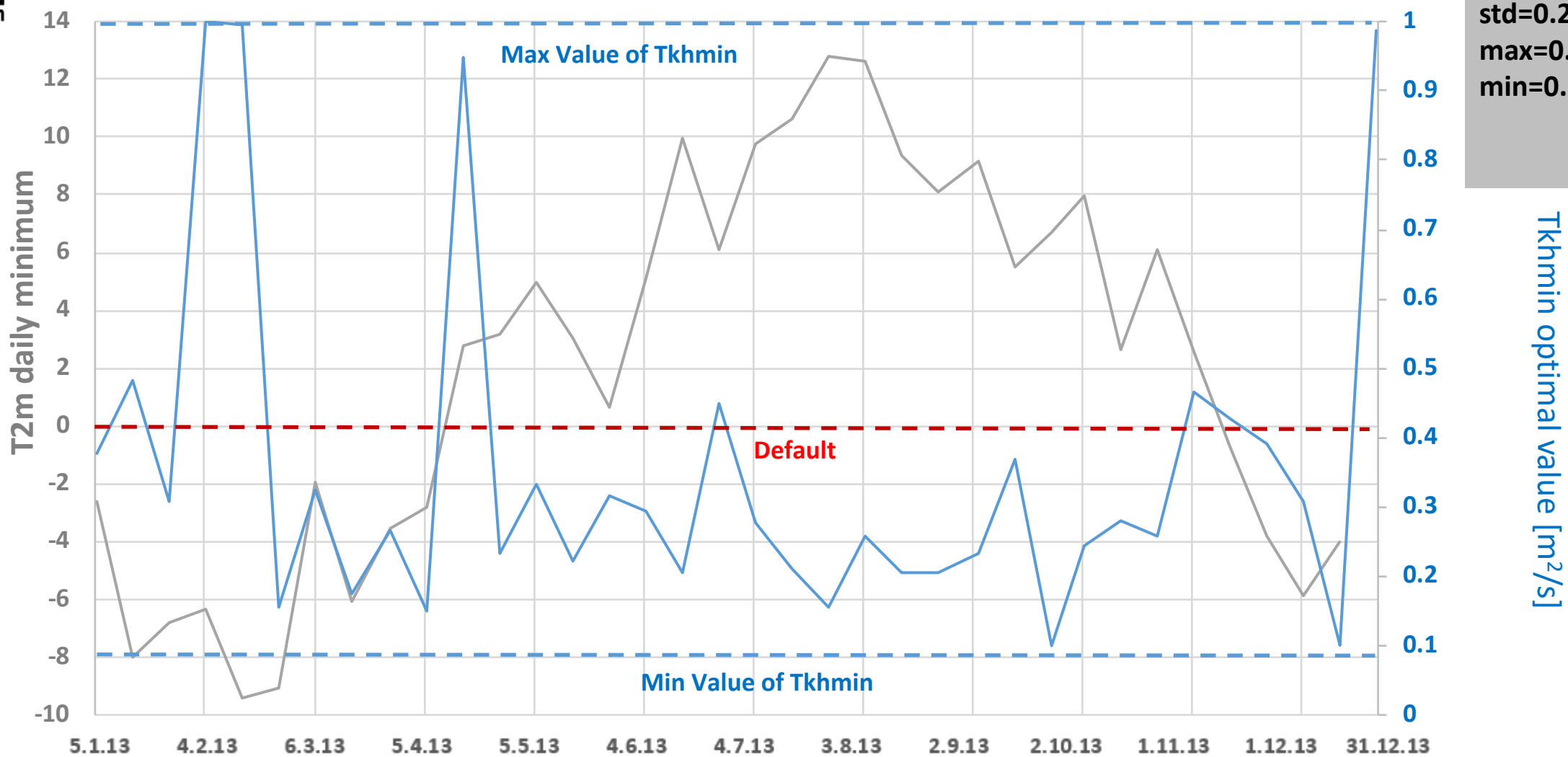
The optimal parameters after different number of iterations

11-20/JAN/2013	iteration number	Tkhmin [0.1-1]	Rlam [0.1-2]	V0snow [10-30]	Radfac [0.3-0.9]	Uc1 [0-1]
Iteration number	40	0.4557	0.8974	15.35	0.6699	0.005659
Iteration number	50	0.48131	0.94376	16.318	0.65394	0.000039597

Optimal Parameter Time Cross section for all decades in 2013

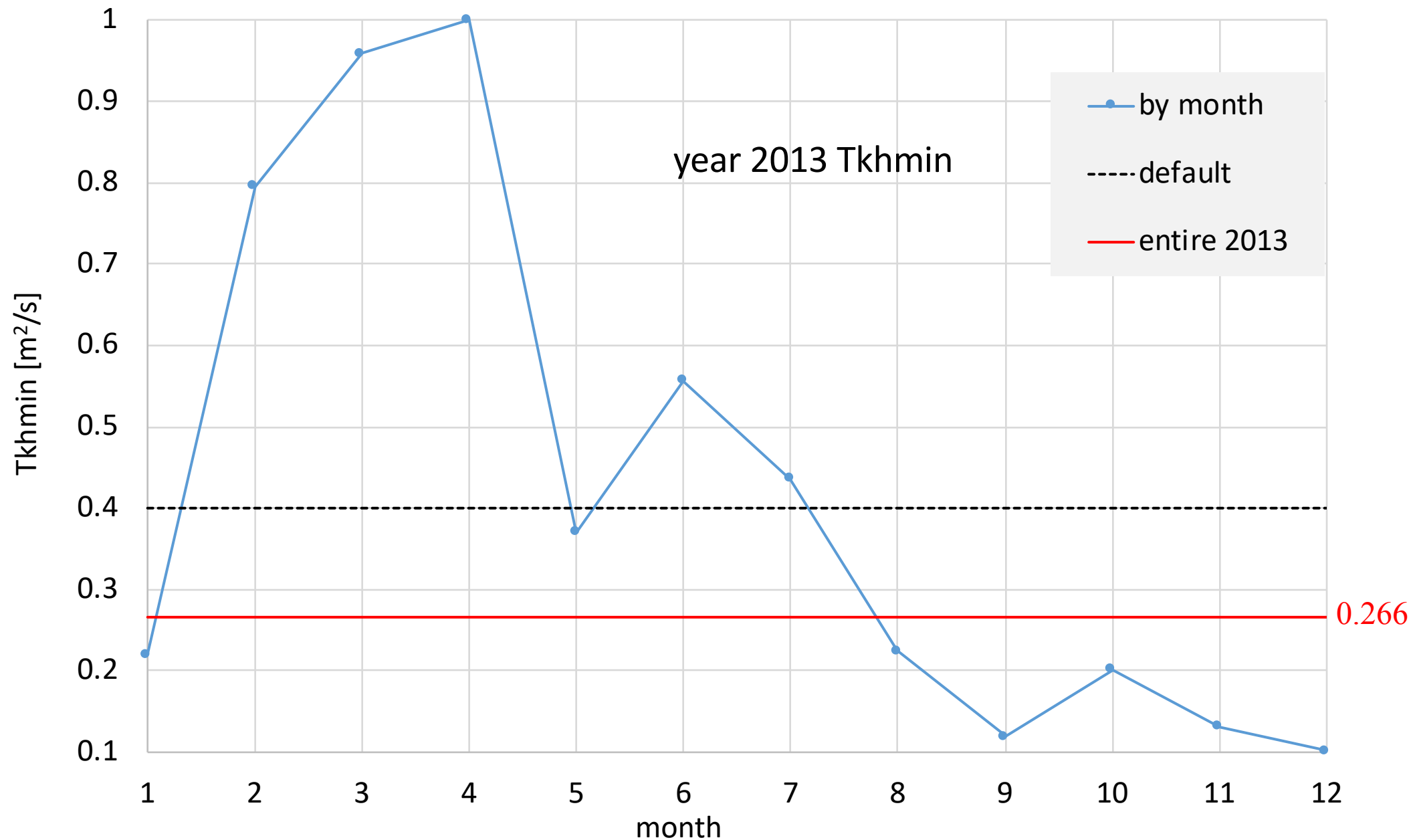
Correlation between Daily Tmin and Tkhmin is -0.37 (sig <5%).

Tkhmin
mean = 0.35
median = 0.28
std=0.25
max=0.9999
min=0.1004



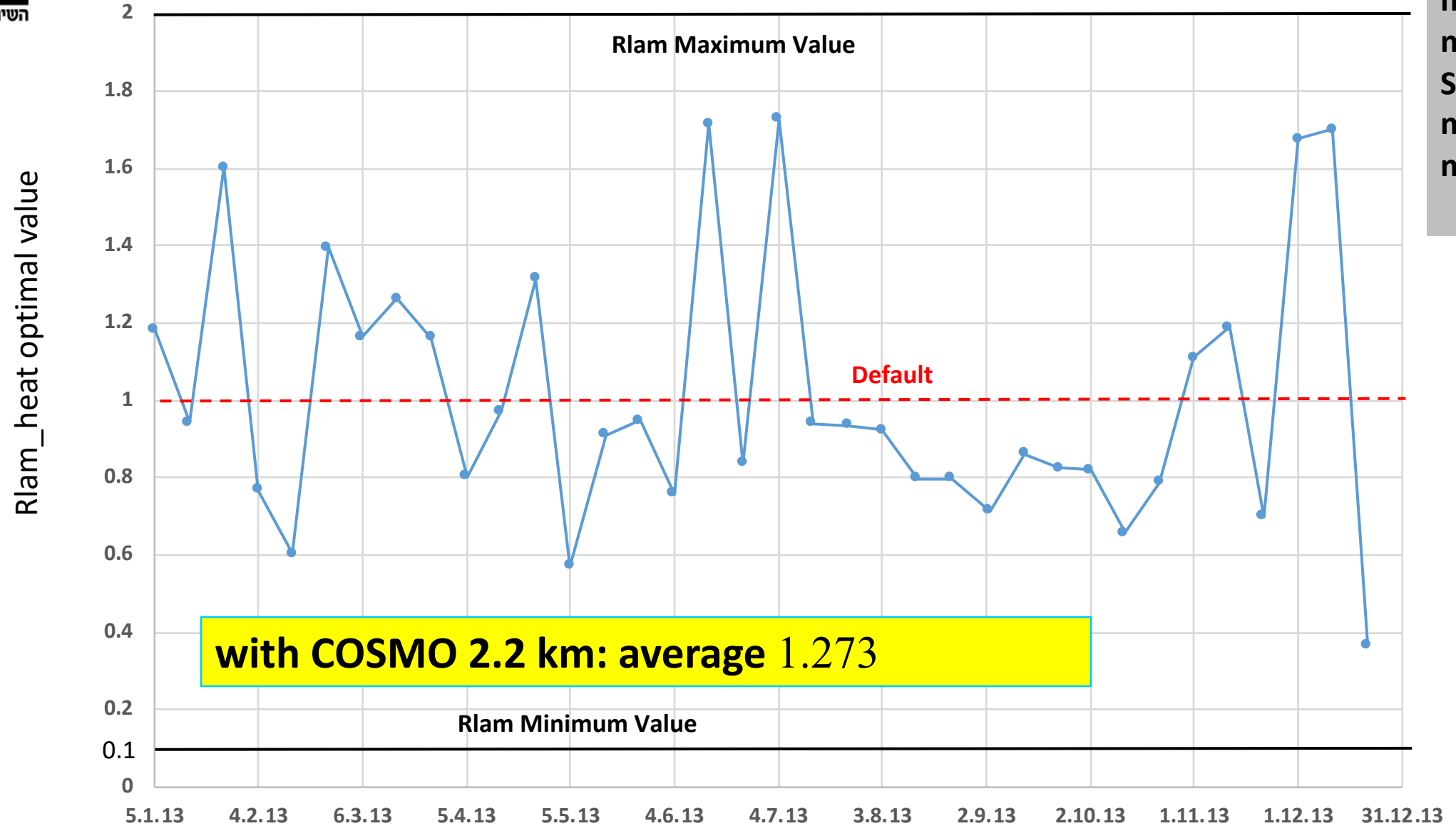
The decade in 2013 (for instance 5/1/13 is the decade of 1-10/1/13 and etc' (plus 5 days and minus 4 days)

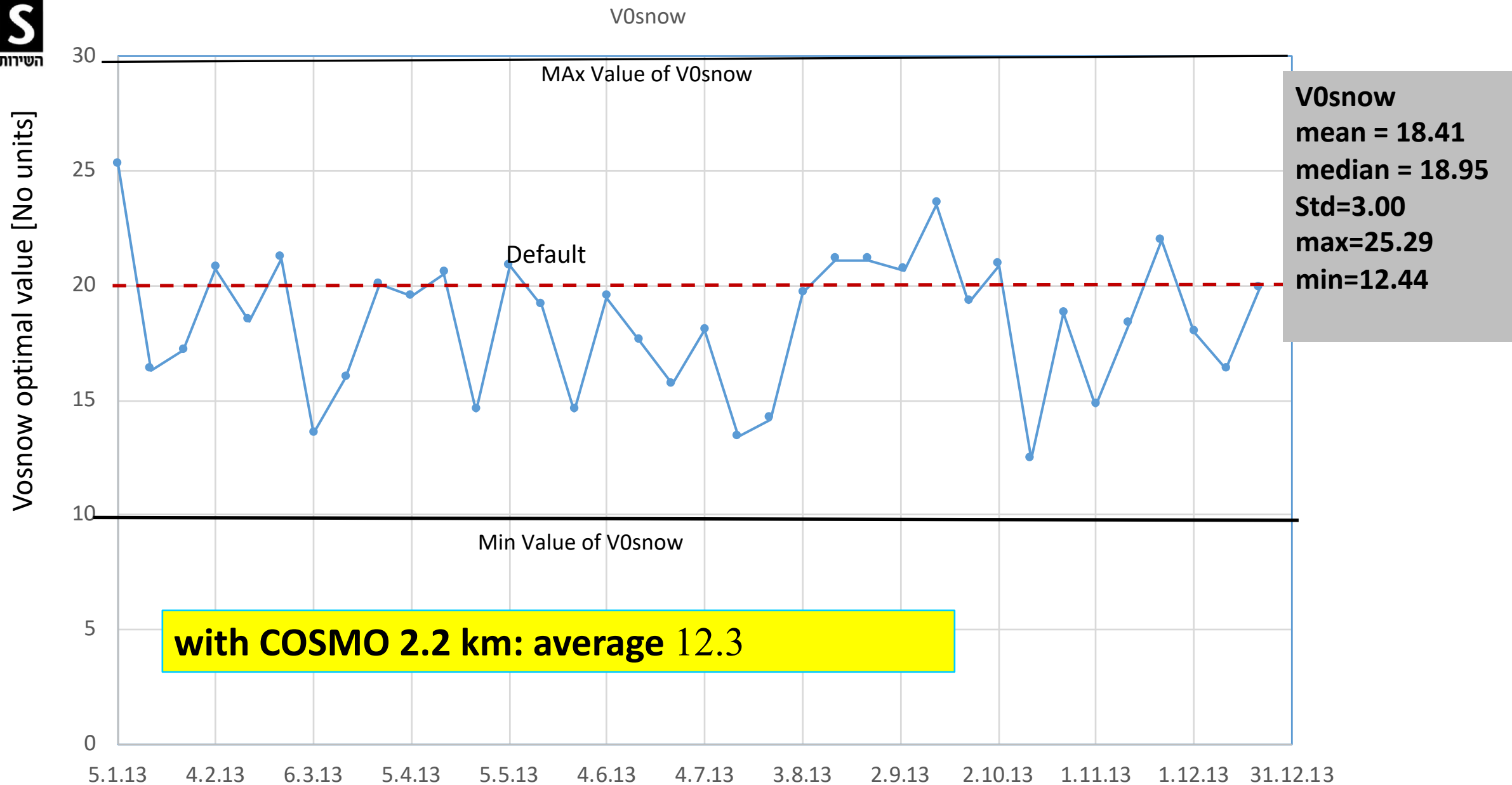
Old slide with COSMO 2.2 km: Tkhmin **Average = 0.266** with seasonal variations



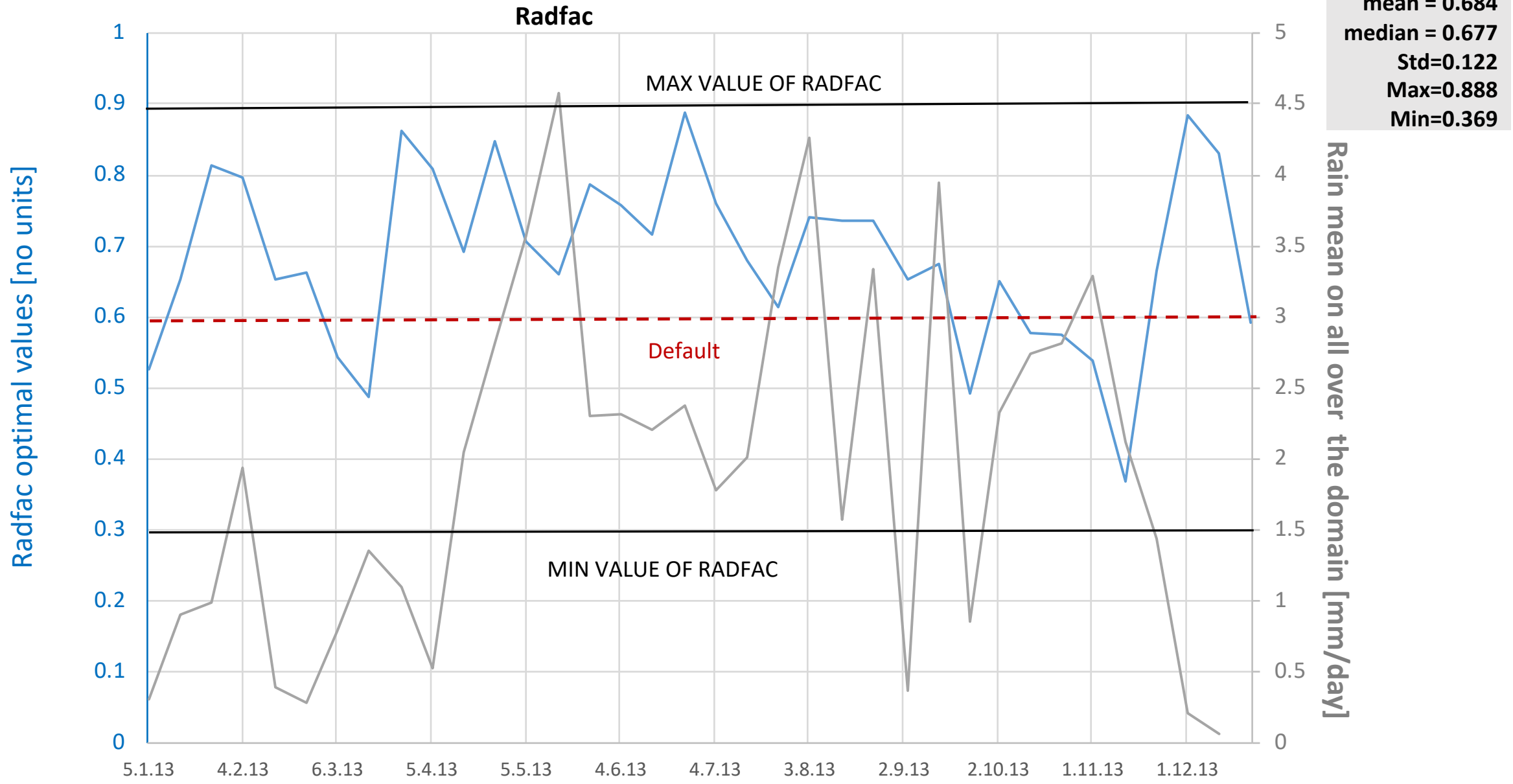
Rlam_heat - Scaling factor for the thickness of the laminar boundary layer for heat

Rlam
mean = 1.01
median = 0.93
Std=0.35
max=1.73
min=0.37



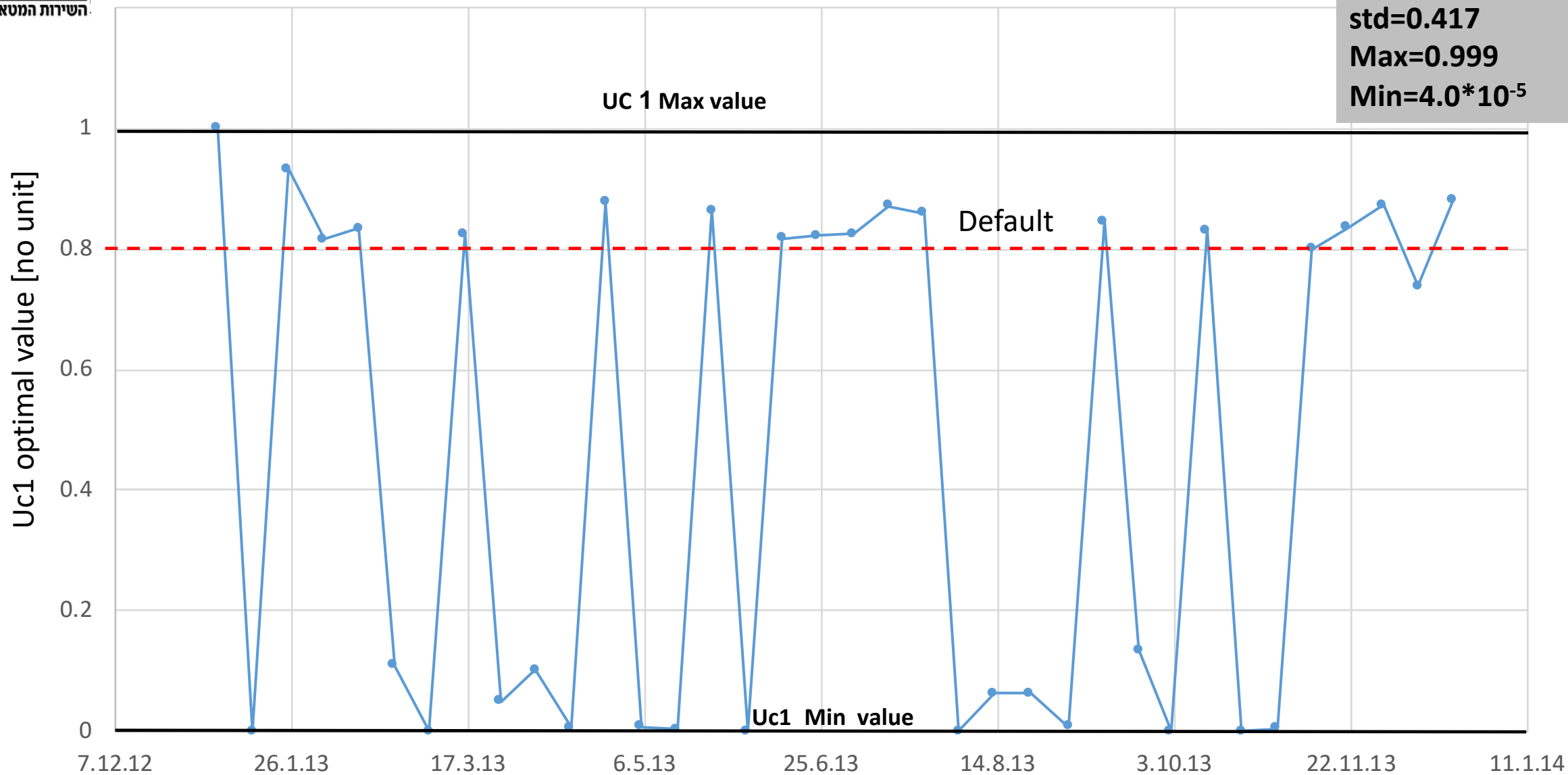


Correlation with Rain -0.053 and with
Sunshine -0.134 correlation with Tdry daily
max -0.059 and with Tday daily min -0.029

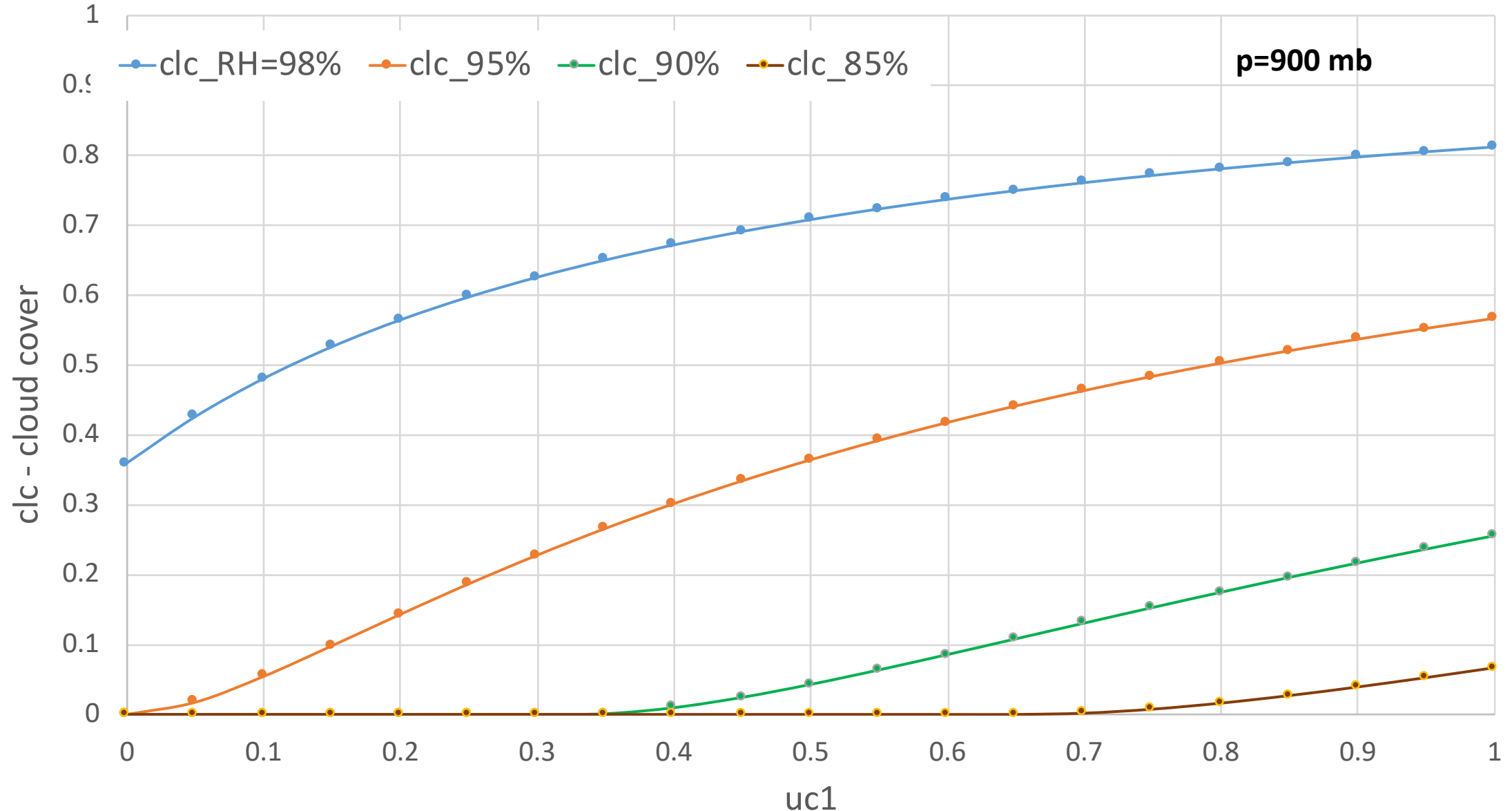


Uc1

uc1
mean = 0.464
median = 0.769
std=0.417
Max=0.999
Min= $4.0 \cdot 10^{-5}$



It seems that uc1 is a good parameter for tuning.
Further investigation with sunshine duration is needed.



Correlation of Sun Radiation with 5 parameters

Correlation coefficient between the decade's average parameter and weather.

Optimum Parameter/ Surface Field	Tkhmin	Rlam	V0snow	Radfac	UC1
Sunshine duration	-0.17	0.29	-0.041	0.13	-0.06
Daily Rain	-0.04	-0.33	-0.07	-0.05	-0.14
Daily max of T2m	-0.34	-0.20	-0.12	-0.06	-0.19
Daily min of T2m	-0.36	-0.21	-0.04	-0.03	-0.19
Daily max of Tdew2m	-0.31	-0.20	-0.04	-0.08	-0.20
Daily min of Tdew2m	-0.33	-0.22	-0.03	-0.06	-0.22

The weather condition do not explain the variance of the decade's optimum parameter values.
Only Tkhmin is correlated to temp.

**Optimum Parameters summary of 36
decades in 2013 (from 1/1/2013-
26/12/2013)**

For 36 decades in 2013 The Nominal Parameters	Tkhmin	Rlam	V0snow	Radfac	UC1
default	0.4	1	20	0.6	0.8
New Mean	0.3530	1.0128	18.41	0.6843	0.4638
Median	0.2791	0.9296	18.95	0.6775	0.7686
STD	0.2451	0.3481	3.00	0.1219	0.4166
Max	0.9999	1.7265	25.29	0.8880	0.9990
Min	0.1004	0.3689	12.44	0.3685	$3.9597 \cdot 10^{-5}$

Summary and Conclusions

- **The Best Score is not sensitive to the value of UC1 parameter. Therefore the optimum UC1 value is not stable and very noisy.**
- **There is no high correlation between the optimum parameters value to the surface fields in the series of 36 decades.**
- However, there is a significant ($p < 5\%$) correlation between the optimum Tkhmin optimum values to daily maximum surface field values (~ 0.36 the correlation) although the correlation is small (0.34)
- There is a significant ($p < 5\%$) correlation between the optimum rlam_heat to Daily Rain (0.34) and also between the optimum rlam_heat to Sunshine duration (0.29). although the correlations are small.

Questions:

- Median or Mean ?

In order to finally determinate the optimum value of the 5 parameters ,
We think it is better to take the median of optimum parameters.

- Further investigation of uc1?
- Segmentation of the data to clear days, rainy days...?

END

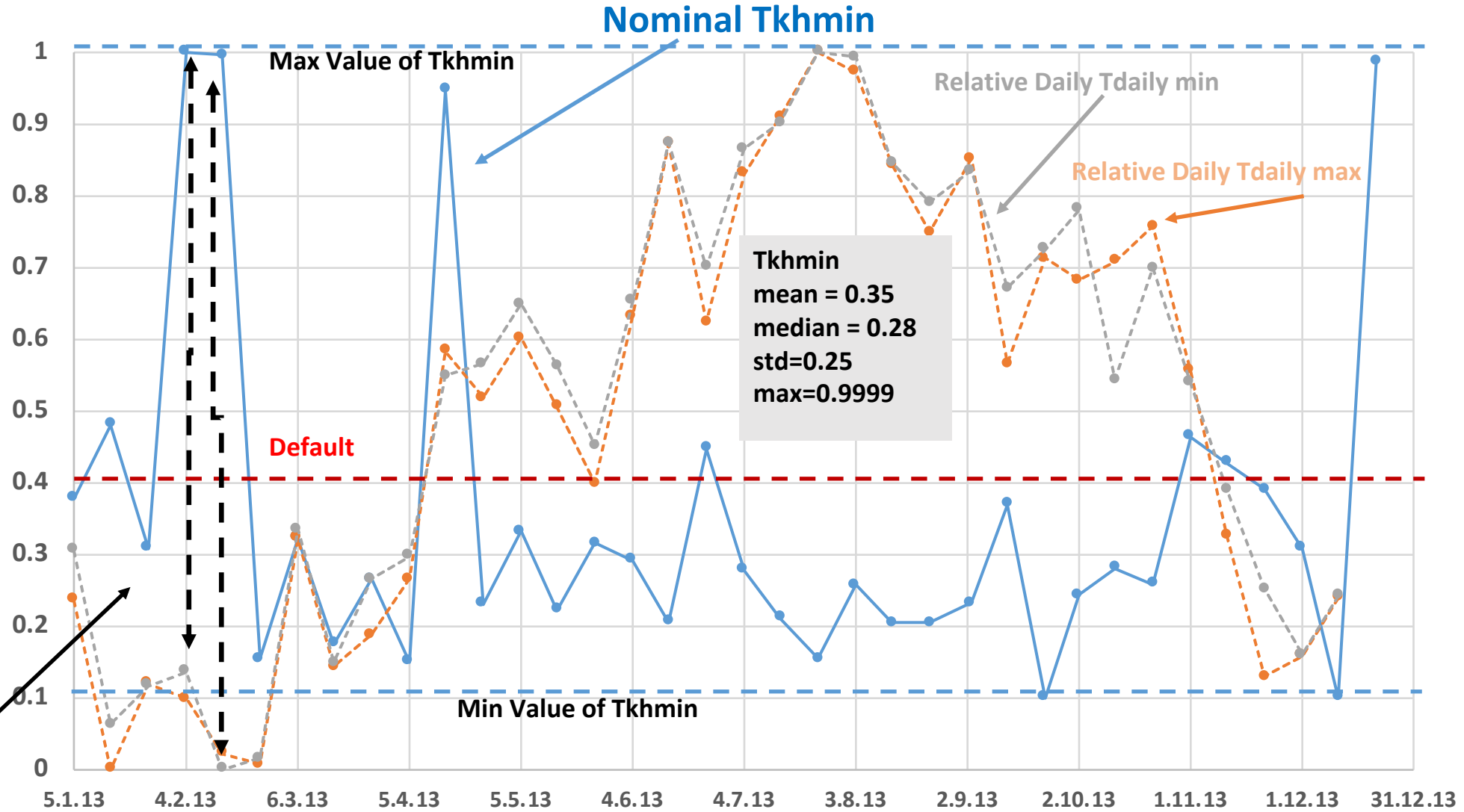
**Thanks for your
attention**

Old slide with COSMO 2.2 km: The 6 tuning parameters for rainy and dry days

COSMO- 2km 2013	rlam_heat	Tkhmin	tur_len	entr_sc (10 ⁻⁴)	c_soil	v0snow
all available days	1.273	0.266	346.5	1.607	0.588	12.3
Rainy days* ≥0.05 [mm/day]	1.305	0.262	354.5	1.760	0.590	11.4
Dry days <0.05 [mm/day]	1.823	0.1003	975.6	1.186	1.989	10.01

Different weather different tuning!

Correlation with Daily Tmin to Tkhmin is -0.37 (sig <5%). Correlation with Daily Tmax to Tkhmin is -0.34 (sig <5%)

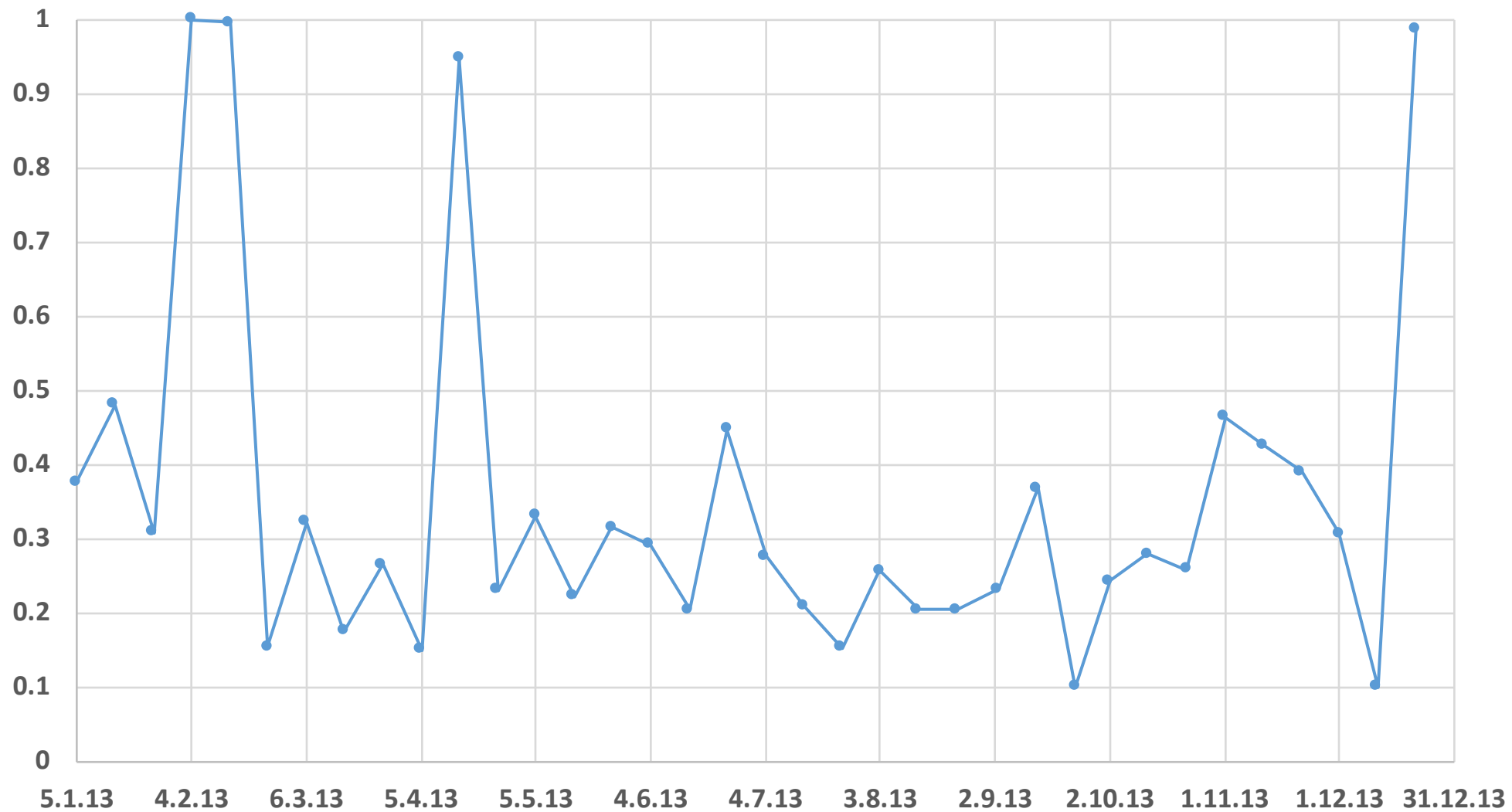


Low Temperature
Maximum Tkhmin

The decade in 2013 (for instance 5/1/13 is the decade of 1-10/1/13 and etc' (plus 5 days and minus 4 days)

Relative Temperature is $(T - T_{min}) / (T_{max} - T_{min})$ is between 0-1

Tkhmin

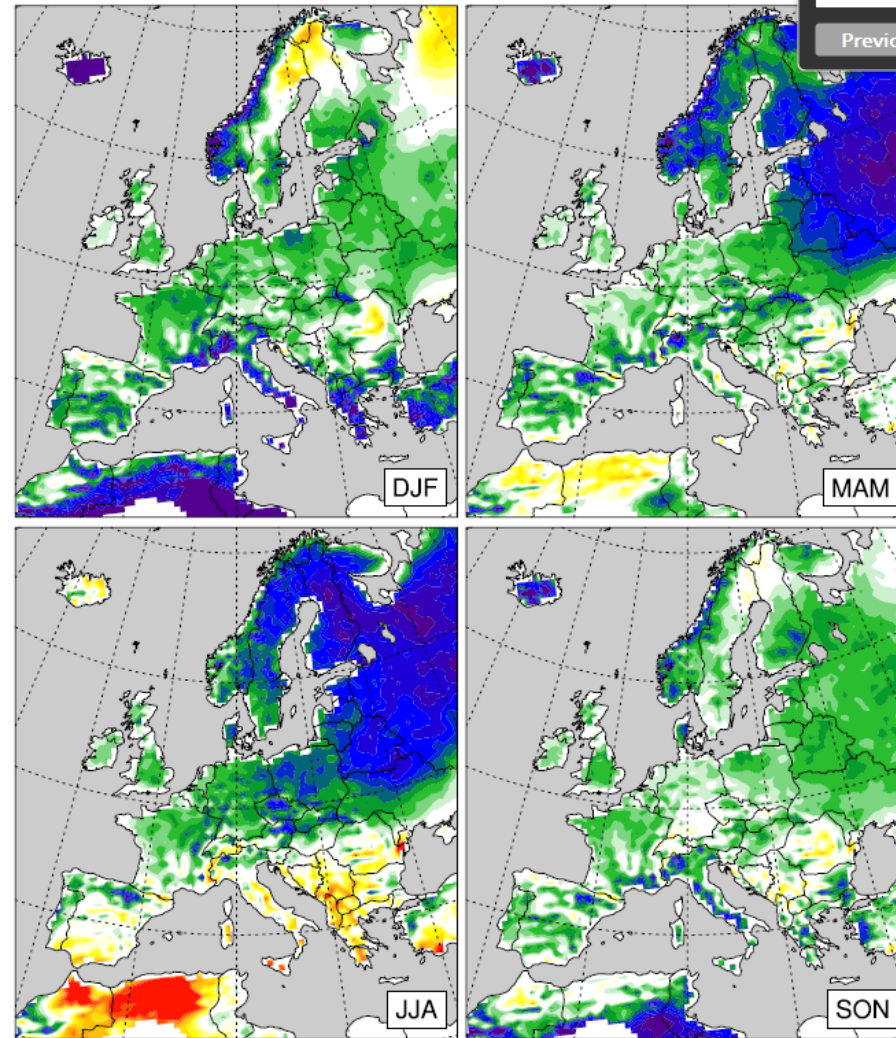


The decade in 2013 (for instance 5/1/13 is the decade of 1-10/1/13 and etc' (plus 5 days and minus 4 days)

We started with..

Acronym	Description of the parameter	Old range
rlam_heat	Scalar resistance for sensible and latent heat fluxes in the laminar surface layer (Land-surface)	[0.1;1; 2]
v0snow	Factor in the terminal velocity for snow (Microphysics)	[10;20;30]
tkhmin (and tkmmin)	Minimal vertical turbulent diffusion rate [m^2s^{-1}] (Turbulence)	[0.1;0.4; 1]
tur_len	Maximal turbulent length scale (m) (Turbulence)	[60;500; 1000]
uc1	Parameter controlling the vertical variation of critical relative humidity for sub-grid cloud formation (radiation)	[0;0.3; 0.6]
radfac	Fraction of cloud water and ice considered by radiation scheme (radiation)	[0.3;0.6; 0.9]
fac_rootdp2	Uniform factor for root depth field (Soil and vegetation)	[0.5;1; 1.5]
l_g	tuning parameter for ground-water runoff (soil and vegetation)	[0.25; 1.59; 10]

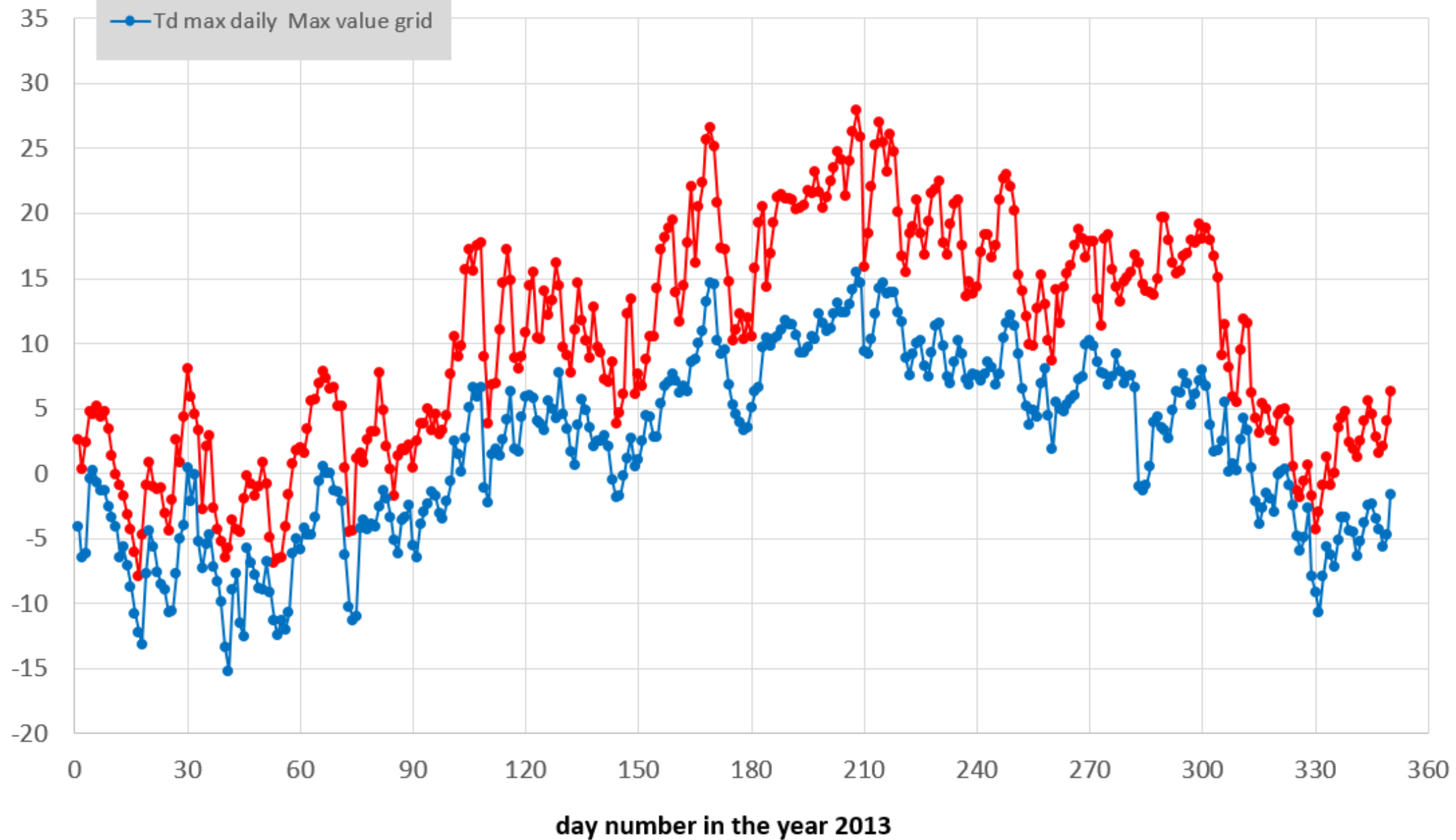
Seasonal T_2M bias CALIBRATION_ref (K), 2001->2009



—●— Daily max Tdry Mean Domain

—●— Td max daily Max value grid

Daily Tmax and Tmin Domain Average for 2013



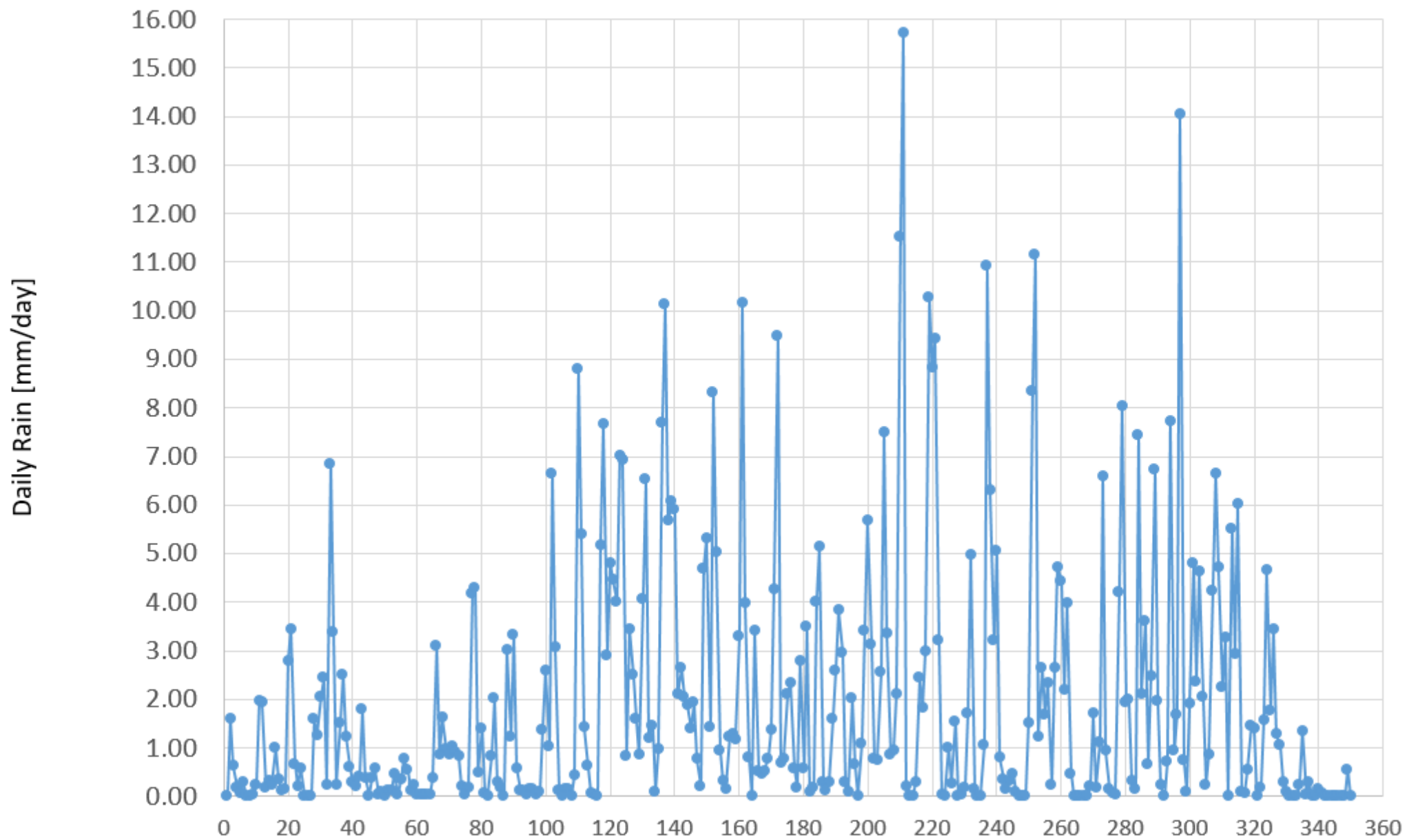
About some of the parameters. The physics behind

	Used at stages:	Brief physical meaning:	Min	Default	Max
rlam_heat	1,2	rlam_heat [<i>no – units</i>] is the parameter which linearly determines the heat resistance length of laminar layer; so that the higher is rlam_heat the higher is the resistance of laminar layer for heat transfer, and consequently, the lower is the heat transfer between the surface and the lower atmosphere	0.1	1	2
tkhmin	1,2,3	tkhmin [m^2/s] and tkmmin [m^2/s] determine the minimum limits for the turbulence coefficients. tkhmin presence is evident when the turbulent diffusion coefficients (then the mixing) are small, which occurs in stable conditions, mainly at night near the surface	0.1	0.4	1
tur_len	1,2,3	tur_len [<i>m</i>] is l_∞ in Blackadar formula (Blackadar, 1962) for the turbulence length. The higher is tur_len, the higher are the turbulent coefficients (both vertical and horizontal) in the middle-upper atmospheric levels, and consequently the higher are the turbulent fluxes (mixing) for all the variables and tracers	100	150	1000
entr_sc	2,3	entr_sc [m^{-1}] is the mean entrainment rate of boundary layer humidity into the shallow convection clouds. The higher is entr_sc, the more effective is the shallow convection vertical mixing	0.05e-3	0.3e-3	2e-3
c_soil	2,3	c_soil [<i>no – units</i>] is the surface-area index of the evaporating fraction of grid-points over land: $c_soil \in [0, c_lnd=2]$. The higher is c_soil, the higher is the surface evaporation	0	1	2
v0snow	2	v0snow [<i>no – units</i>] is the factor in the terminal velocity for snow	10	20	30
crsmin	3	crsmin [s/m] is the minimum value of stomatal resistance used by the BATS approach for vegetation transpiration	50	150	200

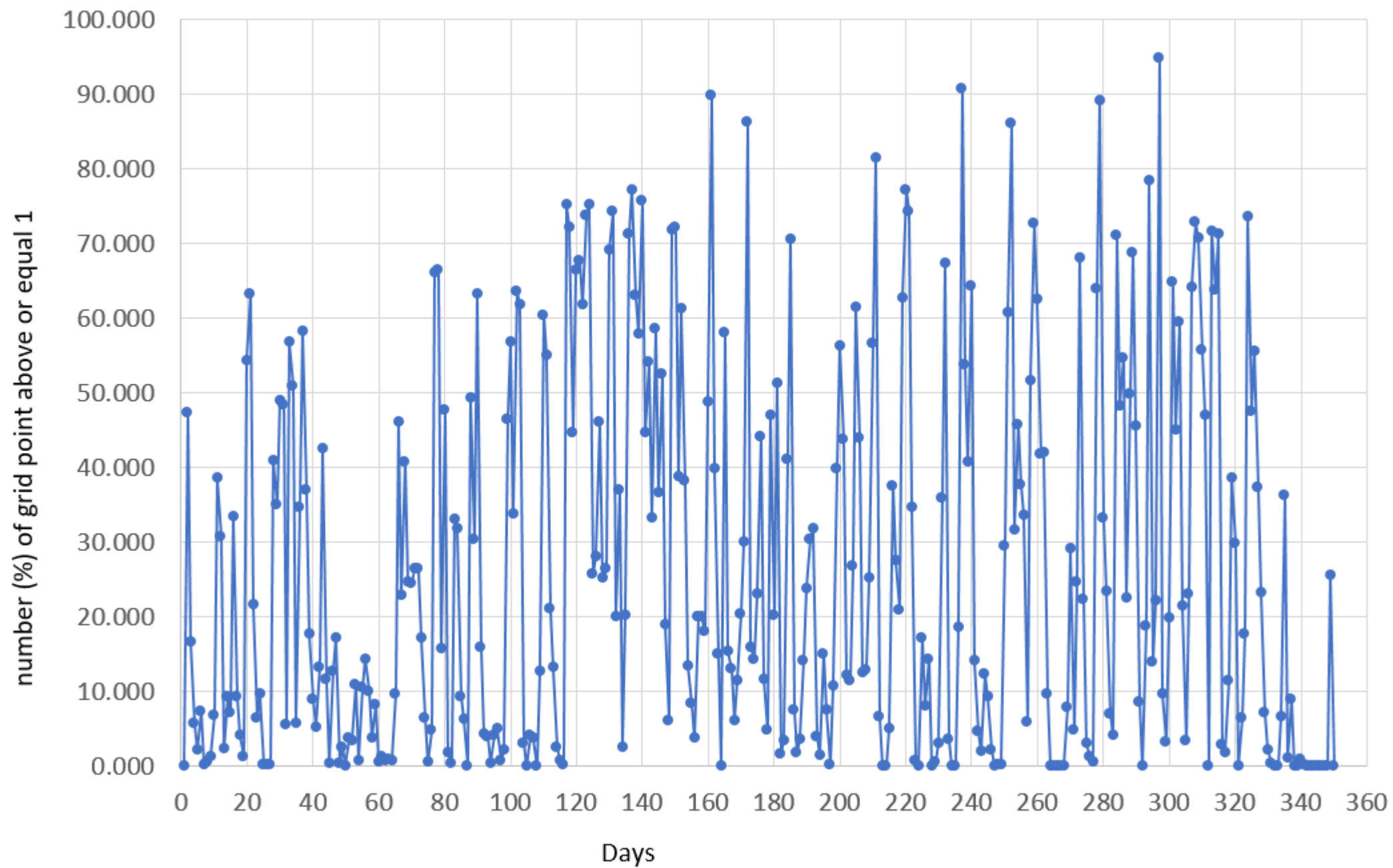
Table 2: COSMO parameters tuned at different stages of the CALMO project

Surface Observations

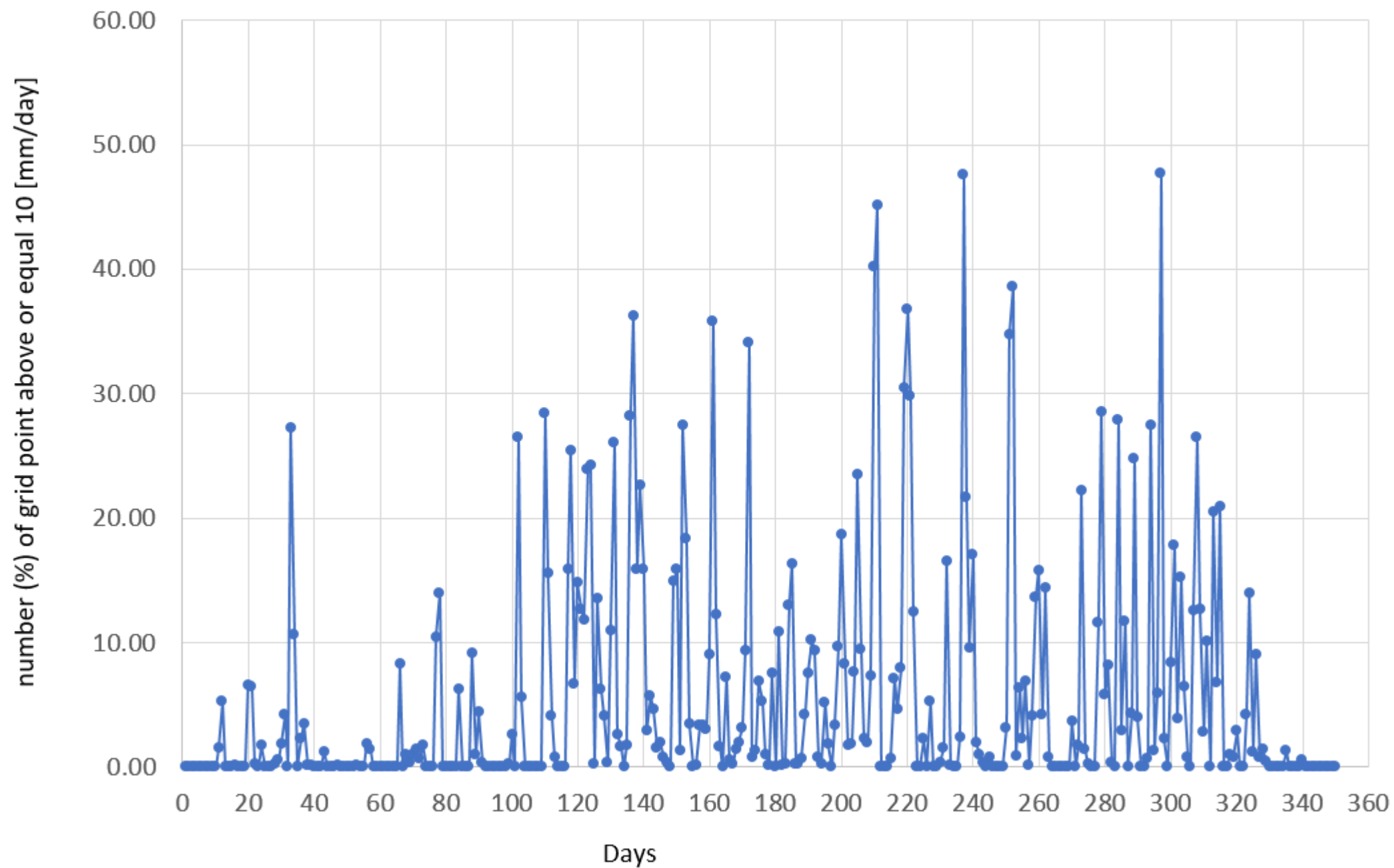
Average Domain Rain [mm/day]



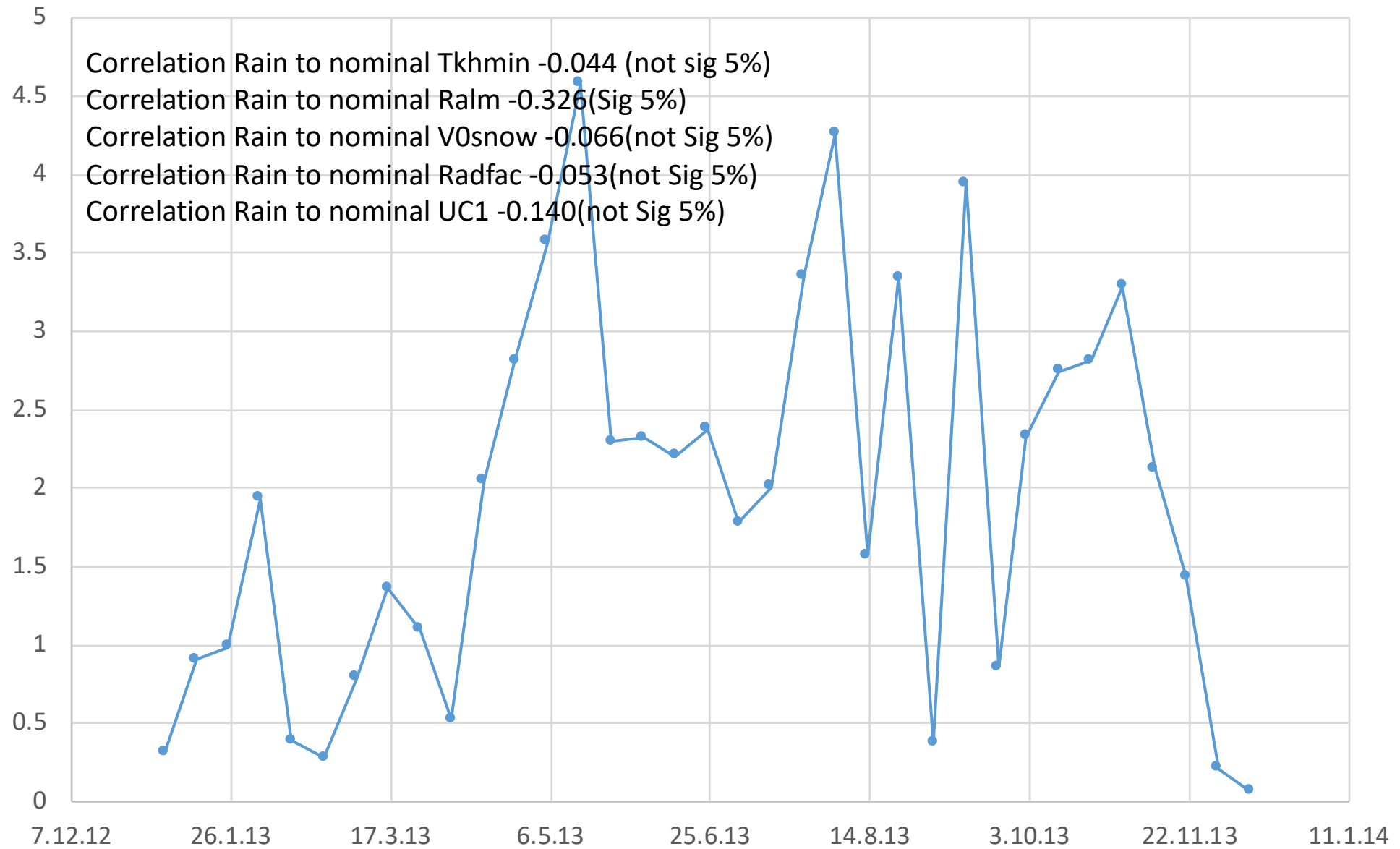
In Swiss Domain percent (%) of grid points of ≥ 1 [mm/day]



In Swiss Domain percent (%) of grid points of ≥ 10 [mm/day]



Rain



Results comparison between COTTBUS's matlab to IMS's matlab

**COSI-FSS for COSMO 1km (SWISS domain) : optimal parameters
daily T2max, T2min, Rain (Tdew is not availed for JAN 2013)**

1-10/JAN/2013	Best iteration number	tkhmin	rlam	v0snow	radfac	uc1
IMS matlab	19	0.37758364	1.1848009	25.291803	0.52719267	0.99897607
MCCOY (Cottbus)	18	0.37754833	1.1868964	25.279624	0.52930843	0.99894820

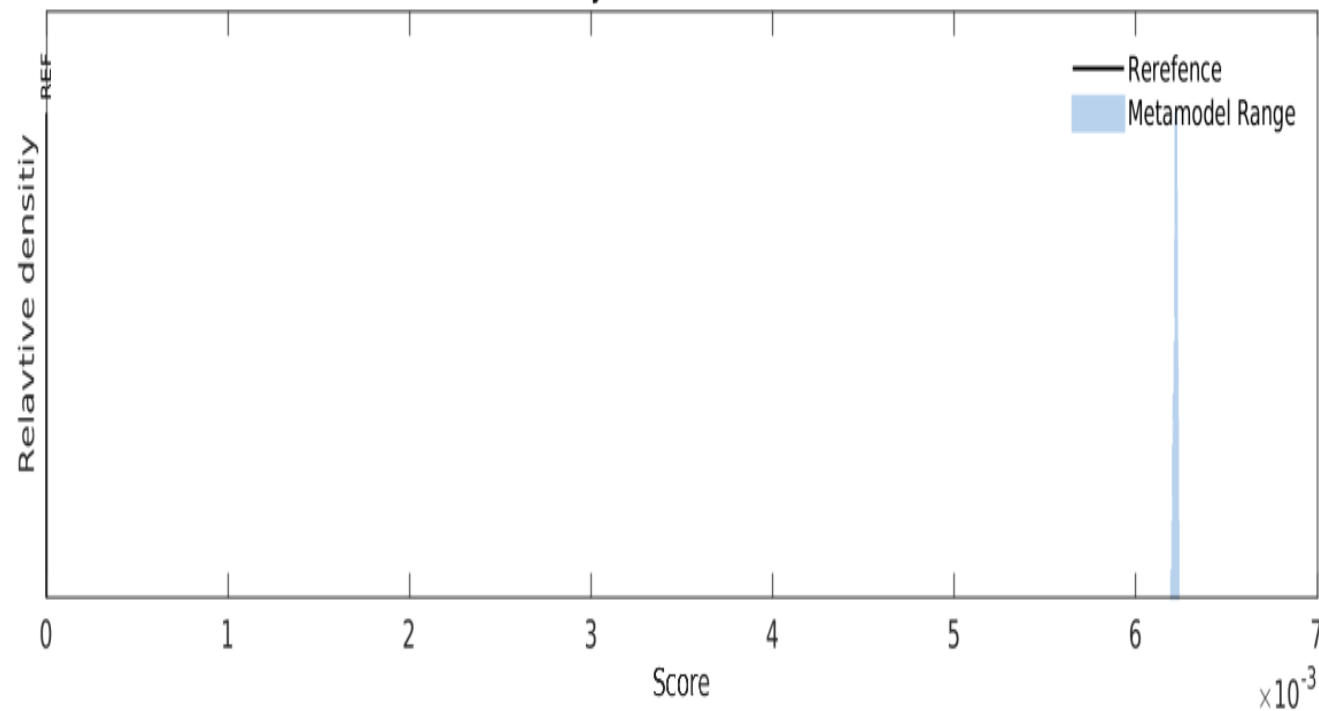
COSI-FSS for COSMO 1km (SWISS domain): optimal parameters daily T2max, T2min, Rain (Tdew is not availed for JAN 2013)

For iteration number 23 (in IMS's Matlab it reached the 45 iteration but we compared iteration number 23 because we wanted to save running time in COTTBUS's Matlab).

11-20/JAN/2013	Best iteration number	tkhmin	rlam	v0snow	radfac	uc1
IMS Matlab	23	0.68426	1.17882	19.91819	0.82551	0.89642
MCCOY (Cottbus)	23	0.63400	1.17328	19.55669	0.79047	0.89438

השירות המטאורולוגי | **IMS RESULTS FOR COSI-FSS (1-10/JAN/2013) for COSMO1km. In the best iteration 19**

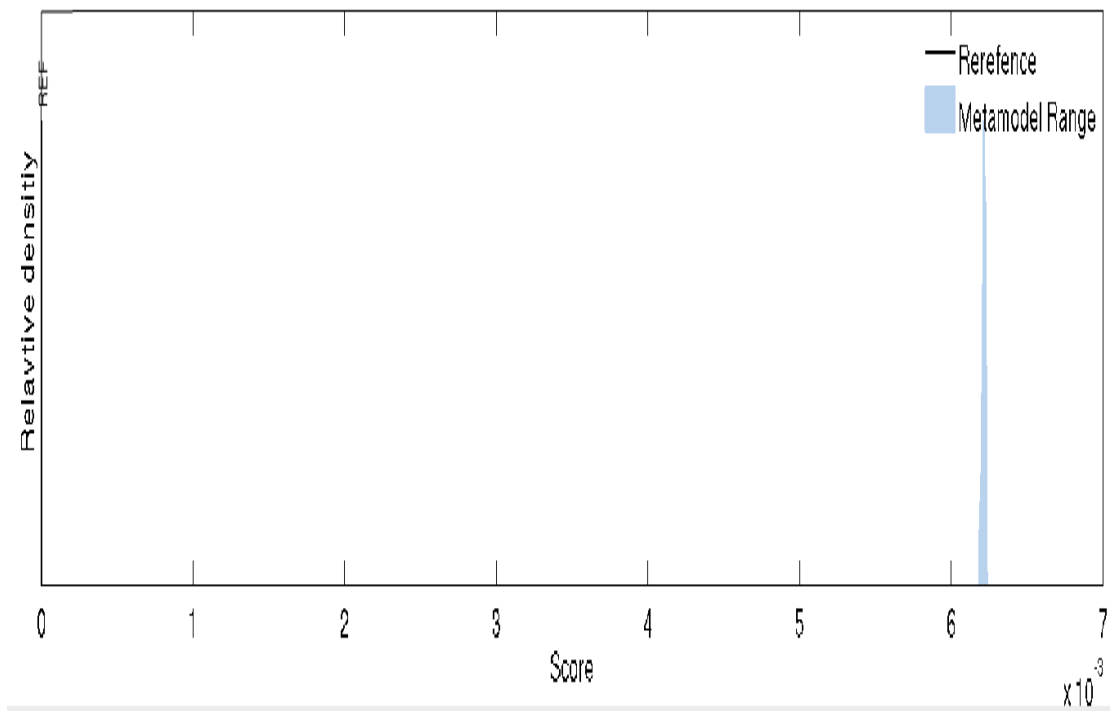
Objective calibration



COTTBUS RESULTS FOR COSI-FSS (1-10/JAN/2013) for COSMO1km. In the best iteration 18

MCCOY RESULTS FOR 1-10/JAN/2013 for COSI-FSS

Objective calibration



MM converge after 19/18 (IMS/COTTBUS) iterations

COSI-FSS for COSMO 1km (SWISS DOMAIN) : OPTIMAL PARMETERS

daily T2max, T2min, Rain (Tdew is not availed for JAN 2013)

	IMS matlab	<i>Best iteration number</i>	Tkhmin [0.1-1]	Rlam [0.1-2]	V0snow [10-30]	Radfac [0.3-0.9]	Uc1 [0-1]
	1-10/1/2013	19	0.3776	1.1848	25.29	0.5272	0.9990
w/o Td	11-20/1/2013	50*	0.48131	0.94376	16.318	0.65394	0.000039597
w/o Td	21-30/1/2013	28	0.3090	1.601	17.15	0.8132	0.9326
w/o Td	31/1/- 9/2/2013	25	0.9999	0.7696	20.72	0.7968	0.8163
	10-19/2/2013	19	0.9960	0.6045	18.45	0.65345	0.8331
	20/2/2013-1/3/2013	32	0.1547	1.3944	21.18	0.6629	0.1092
	2-11/3/2013	29	0.3231	1.1654	13.53	0.5429	0.00018695
	12-21/3/2013	35	0.175996	1.2627	15.99	0.4884	0.8244
	22-31/3/2013	25	0.2659	1.1626	20.04	0.8619	0.05005
	1-10/4/2013 (the parameters in the graph seems to be divergence)	40	0.1508	0.8041	19.52	0.8094	0.1028
	11-20/4/2013 (there is divergence in the parameters)	40	0.9475	0.9718	20.52	0.6912	0.006133

* With the special treatment when there is no convergence in iteration number 40 (see slides before that explain how to treat this problem)

Slide 2: Continue of slides series of COSI-FSS for COSMO 1km (SWISS DOMAIN) : OPTIMAL PARMETERS daily T2max, T2min, Rain (Tdew is not availed for JAN 2013)

IMS matlab	<i>Best iteration number</i>	Tkhmin [0.1-1]	Rlam [0.1-2]	V0snow [10-30]	Radfac [0.3-0.9]	Uc1 [0-1]
21-30/4/2013	33	0.2317	1.3151	14.56	0.8472	0.8767
1-10/5/2013	39	0.331996	0.5718	20.86	0.7064	0.007479
11-20/5/2013	40 (the parameter values almost convergence)	0.22297	0.91132	19.12	0.6611	0.004021
21-30/5/2013	40 (the parameter values almost convergence)	0.3158	0.9476	14.54	0.7875	0.8638
31/5/2013-9/6/2013 (there is divergence in score)	40	0.2926	0.7588	19.50	0.7574	0.0001886
10-19/6/2013	32	0.2057	1.7151	17.56	0.7155	0.8173
20-29/6/2013	40 (it seems to divergent the score graph)	0.4483	0.8379	15.67	0.88795	0.8215
30/6/2013-9/7/2013	36	0.2778	1.7265	18.05	0.75962	0.8253
10-19/7/2013	37	0.2110	0.9414	13.39	0.6802	0.8704
20/2013-29/7/2013	23	0.1543	0.93592	14.16	0.6137	0.8598
30/7/2013-8/8/2013	25	0.2580	0.9233	19.65	0.74059	0.0001458
9-18/8/2013	24	0.2051	0.7973	21.10	0.73598	0.0625997
19-28/8/2013	18	0.2051	0.7973	21.10	0.73598	0.0625997

* With the special treatment when there is no convergence in iteration number 40 (see slides before that explain how to treat this problem)

Slide 2: Continue of slides series of COSI-FSS for COSMO 1km (SWISS DOMAIN) : OPTIMAL PARMETERS daily T2max, T2min, Rain (Tdew is not availed for JAN 2013)

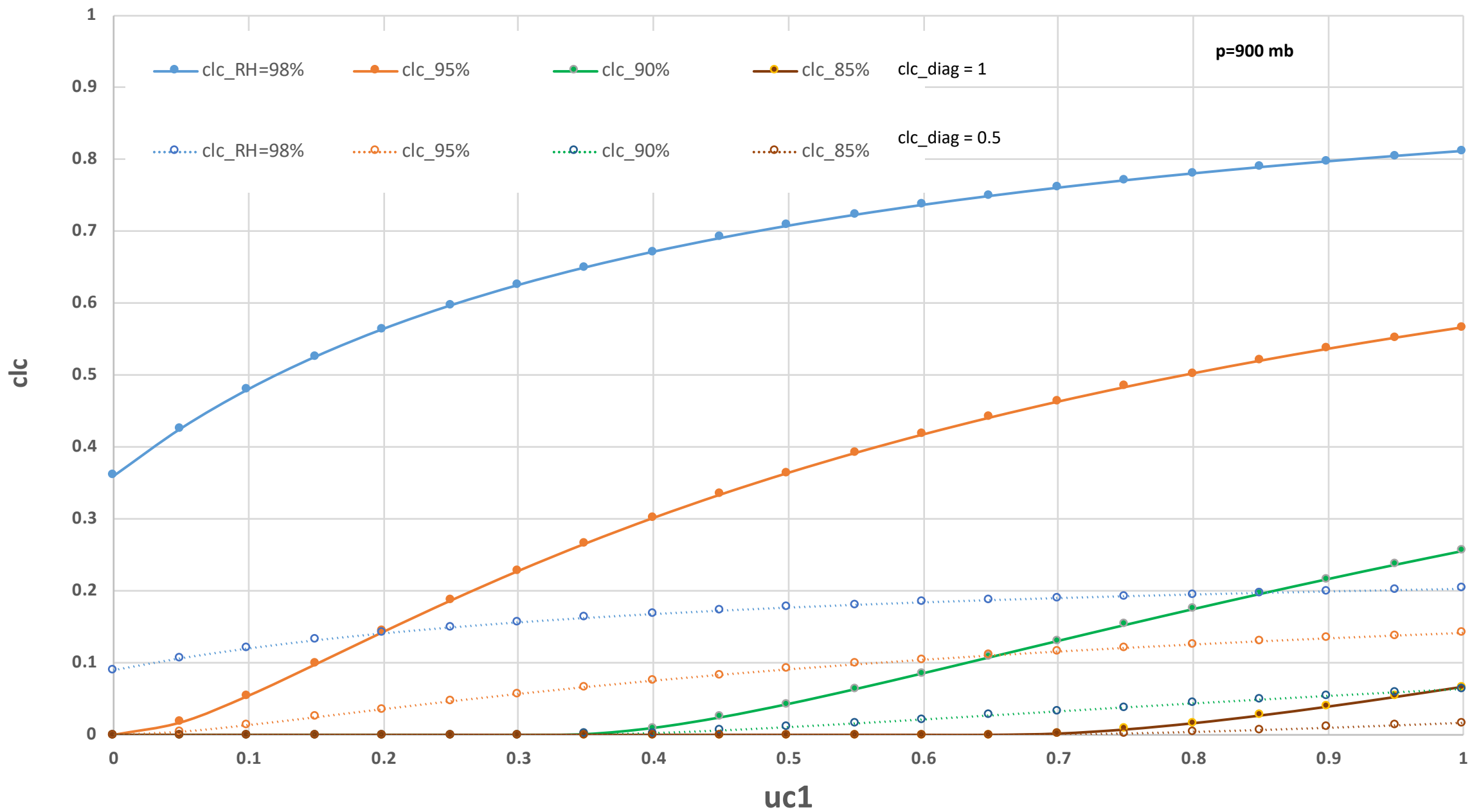
IMS matlab	<i>Best iteration number</i>	Tkhmin [0.1-1]	Rlam [0.1-2]	V0snow [10-30]	Radfac [0.3-0.9]	Uc1 [0-1]
29/8/2013-07/9/2013	19	0.2323	0.7146	20.65	0.6541	0.007403
8-17/9/2013	40 (there is almost convergence)	0.3696	0.8629	23.54	0.6747	0.8461
18-27/9/2013	17	0.1009	0.8263	19.27	0.4935	0.1348
28/9/2013-7/10/2013	37	0.2493	0.8214	20.89	0.6500	0.000158
8-17/10/2013	40 (there is convergence)	0.2804	0.6589	12.44	0.5782	0.8303
18-27/10/2013	23	0.2590	0.7872	18.78	0.5757	0.00005158
28/10/2013-6/11/2013	40 (there is convergence)	0.4649	1.1094	14.78	0.537995	0.005773
7-16/11/2013	23	0.4276	1.190	18.33	0.3685	0.79922
17-26/11/2013	37	0.3907	0.6993	21.96	0.6661	0.8355
27/11/2013-6/12/2013	22	0.3082	1.677	17.99	0.8832	0.8724
7-16/12/2013	24	0.1004	1.6995	16.36	0.8302	0.7379
17-26/12/2013	38	0.9874	0.3689	19.85	0.5914	0.8817

* With the special treatment when there is no convergence in iteration number 40 (see slides before that explain how to treat this problem)

Correlation with all the 36 decades in 2013

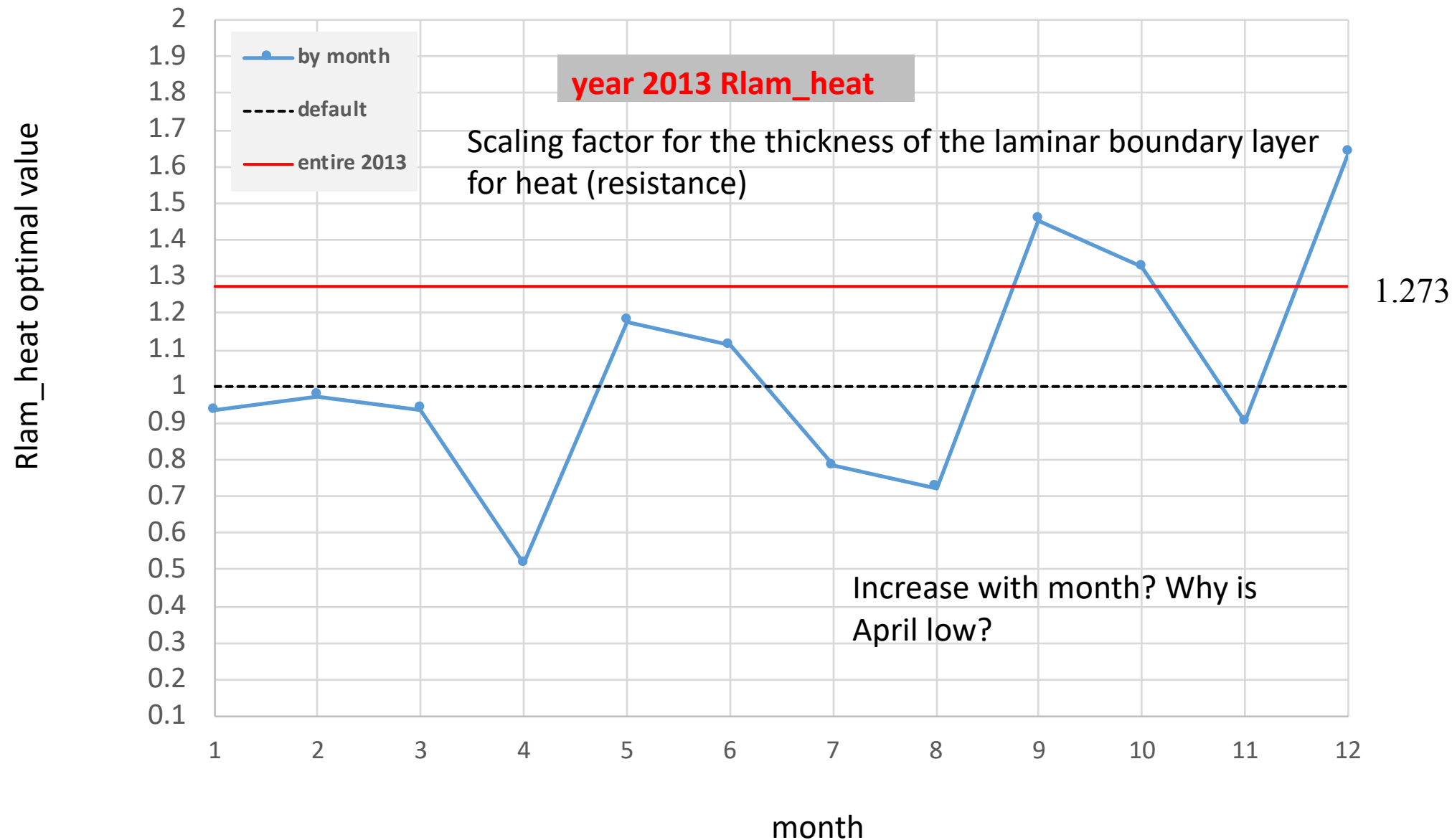
(The correlation is between the nominal parameter in the decade to the mean Swiss Domain filed. The averaged in the decade)

Nominal Parameter/ Surface Filed	Tkhmin	Rlam	V0snow	Radfac	UC1
Sunshine duration	-0.173	0.287 (sig <%5)	-0.041	0.134	-0.059 (not sig 5%)
Daily Rain	-0.044	-0.326 (sig<5%)	-0.066	-0.053	-0.140 (not sig 5%)
Daily max of T2m	-0.34	-0.201	-0.119	-0.059	-0.187 (not sig 5%)
Daily min of T2m	-0.356	-0.208	-0.042	-0.029 (not sig 5%)	-0.187 (not sig 5%)
Daily max of Tdew2m	0.30823-	0.20396-	0.04242-	0.07692-	0.19793-
Daily min of Tdew2m	0.32665-	0.22072-	0.02568-	0.05925-	0.22049-



Old slide with COSMO 2.2 km: average 1.273

The optimal parameters for Method 4 at COSMO 2.2km (Method 4 = Score by COSI method and pr_only=1 (only area average on rain not on Daily Tmin and Tmax))



Old slide with COSMO 2.2 km: average 12.3

