

WG 3b, PT AEVUS 2 & PP CITTA

Activities and Updates CIRA - CMCC

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**CIRA – Italian Aerospace Research Center

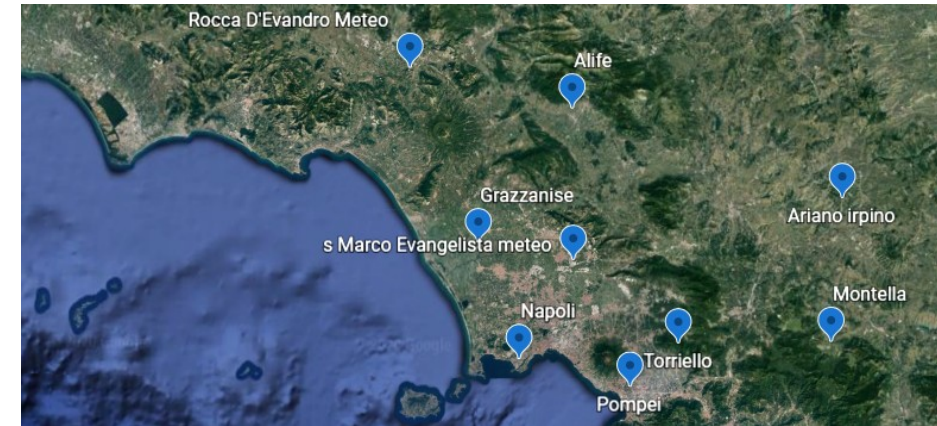
COSMO GM 2021

Urban session

13th September 2021

Model version:

- o int2lm_210430_2.09
- o cosmo_5.05
- o cosmo_210318_5.10_beta + urb_patch_210426 (April 26th)
- o cosmo_210624_5.10_beta (June 24th)



Simulated domain:

- COSMO-LM resolution: **0.009°** (about 1 km)
- Computational domain: **260 x 138 points**; 60 vertical levels; time step 10 s.
- Domain: **12.22° – 14.55°E; 40.63° - 41.88° N** (Rotated North Pole: -166°; 41°)
- Forcing data: **ECMWF IFS (resolution of 0.075°)**
- Test cases considered: **from August 8th to August 14th 2017**
- Namelist: The best configuration tested in the paper: Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities by Garbero et al. (<https://doi.org/10.3390/atmos12020237>)

The question: Are the urban canopy parameters loaded correctly from EXTPAR file?

Proposed Approach: As the parameters are set to a constant value, we run the same experiment loading them both from the external parameters file and from the namelist file.

label	Description	Parameters	Model version
T0	Empty city	ISA=0; AHF=0	v5.05 - v5.10 (April the 26 th)
T1	loading H_BLD	H_BLD=15	v5.05 - v5.10 (April the 26 th)
T2	loading FR_BLD	FR_BLD=0.667	v5.05 - v5.10 (April the 26 th)
T3	loading H2W	H2W=1.5	v5.05 - v5.10 (April the 26 th)

Note: the T0 compares an empty city with an experiment where Terra_Urb is disabled

Test: Is the difference exactly zero for all fields?

label	DESCRIPTION	COSMO v.5.05	COSMO v5.10b
T0	Empty city	Stochastic	Zero diff
T1	loading H_BLD	Zero diff	Zero diff
T2	loading FR_BLD	Stochastic	Stochastic
T3	loading H2W	Zero diff	Zero diff

Zero diff. means: yes, the difference between all pairs of output fields is zero.

Stochastic means: no, but the differences are stochastic fluctuations.

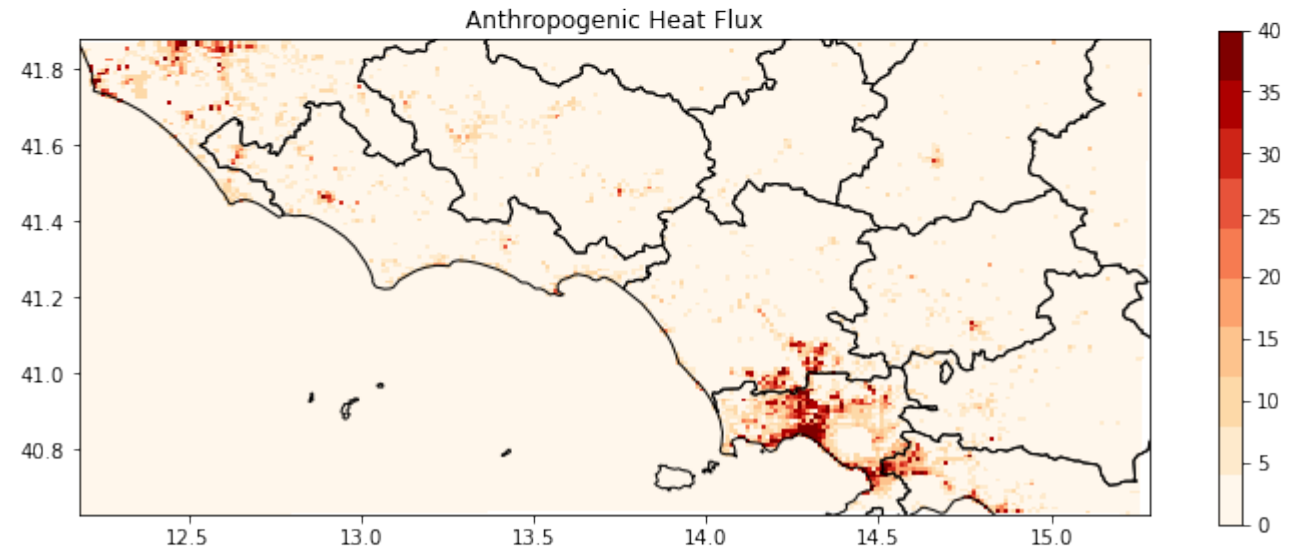
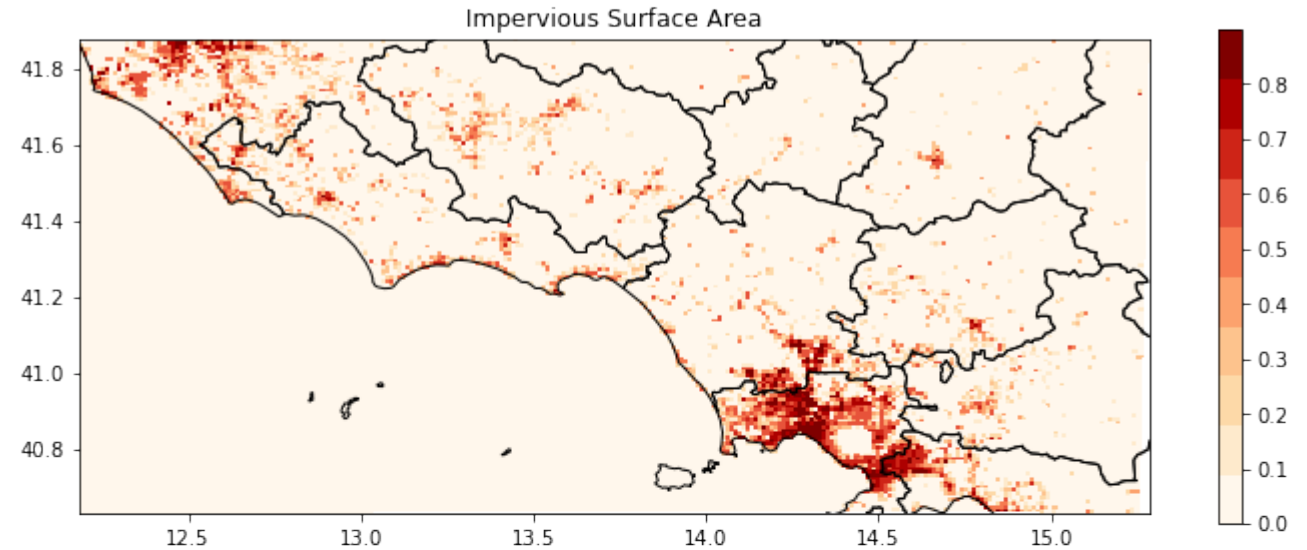
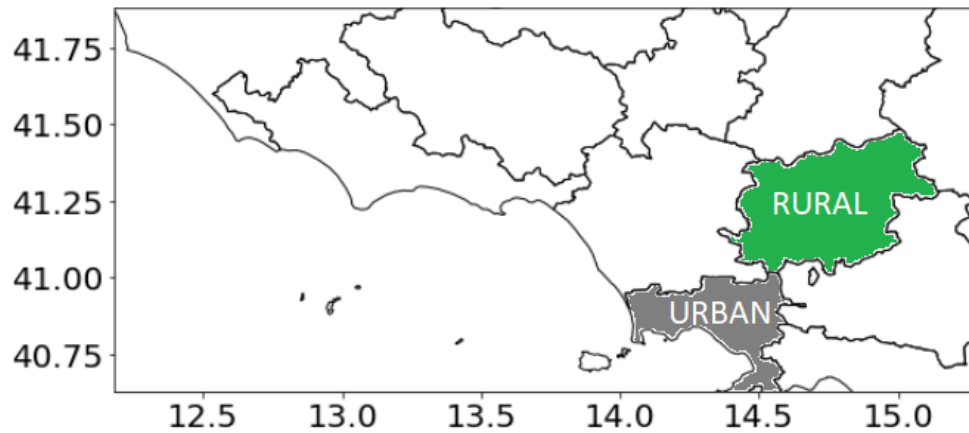
means: no, there are remarkable (**systematic**) differences on most of the fields (T2m, RELHUM, wind, etc...).

Note: Stochastic fluctuations could appear, they are due to limits of floating point representation.

The idea is to test for each urban canopy parameter an extremely low and an extremely high value, using both COSMO 5.05 and 5.10b.

label	parameter	LOW	HIGH	COSMO versions
S0	H_BLD	3	30	v5.05 - v5.10 (last)
S1	FR_BLD	0.3	0.8	v5.05 - v5.10 (last)
S2	H2W	0.5	2	v5.05 - v5.10 (last)
S3	ALB_SO	0.05	0.25	v5.05 - v5.10 (last)
S4	ALB_TH	0.05	0.25	v5.05 - v5.10 (last)
S5	HCAP	0.3E6	2E6	v5.05 - v5.10 (last)
S6	HCON	0.2	1.3	v5.05 - v5.10 (last)

1. Selection of an urban and a rural zone based on ISA and AHF.
2. The diurnal cycle is computed for mean temperature over the selected areas.



Builds Height

[m]

The aerodynamic roughness length:

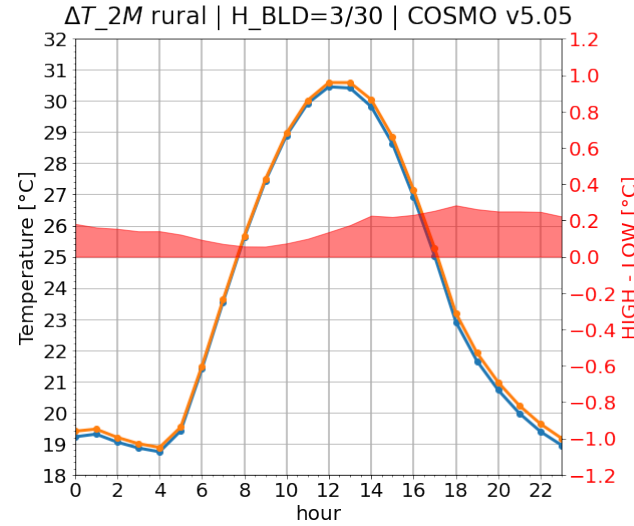
$$z_0 = 0.075H$$

- The higher roughness length results in lower wind speeds.
- The urban excess heat is more accumulated in the urban centres.
- Higher buildings also yield a higher effective heat capacity and heat conductivity of the soil layers below.

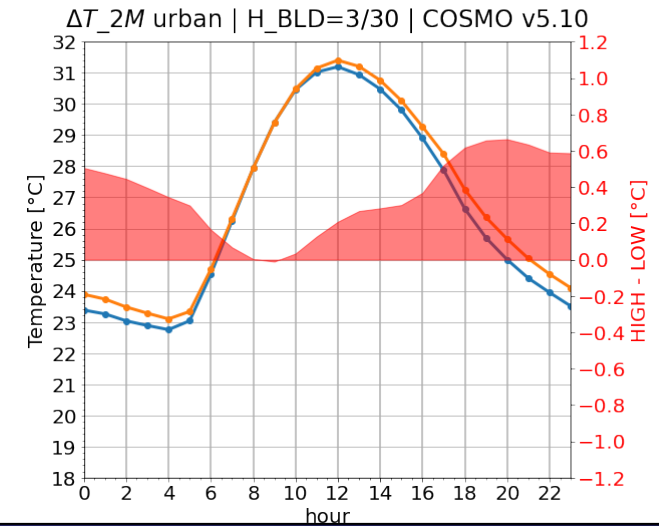
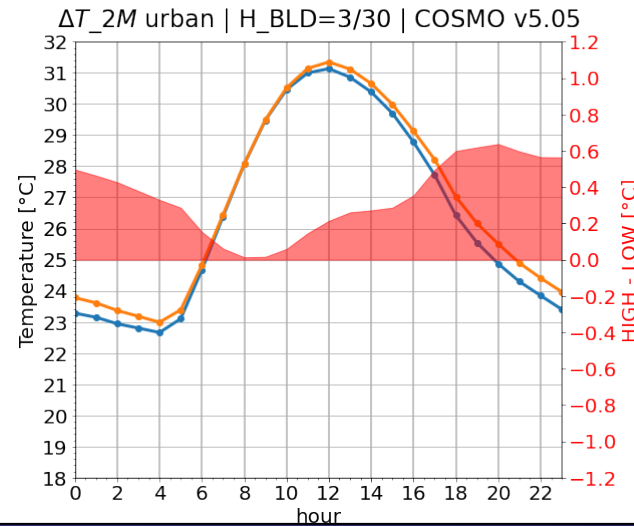
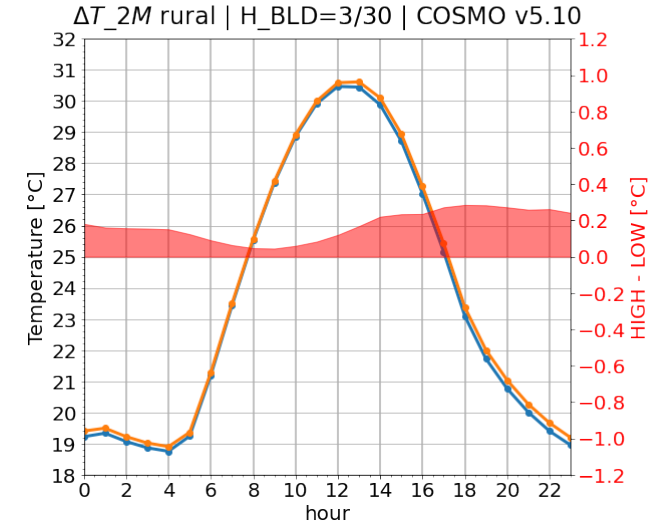
RURAL

URBAN

COSMO 5.05



COSMO 5.10



— LOW
— HIGH

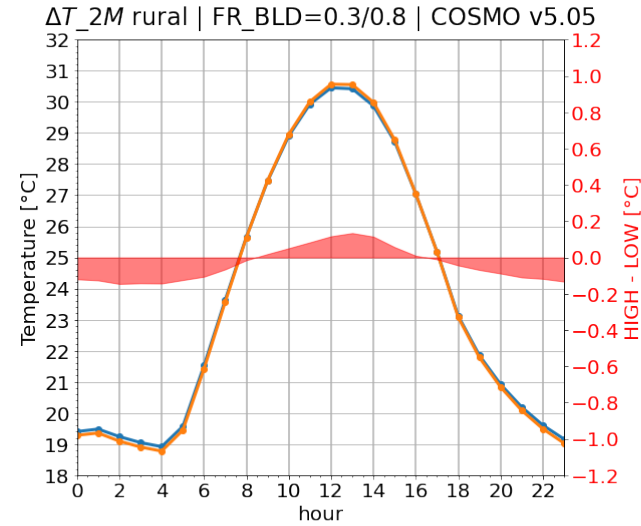
Urban Build Fraction (a.k.a. Roof Fraction)

- A larger roof fraction implies a reduction in effective heat capacity and heat conductivity.

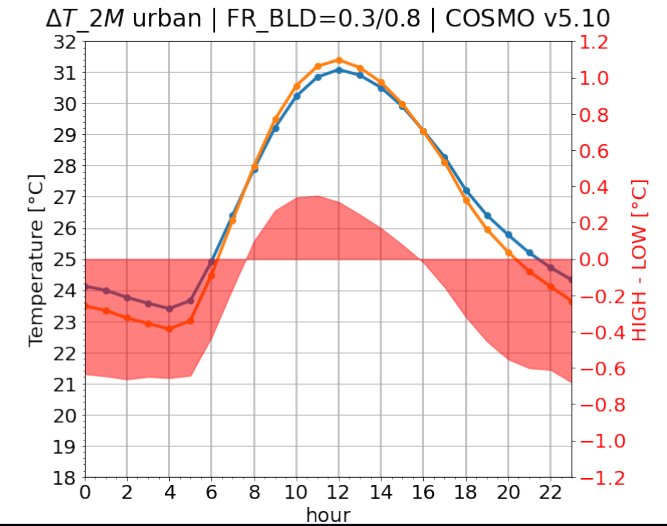
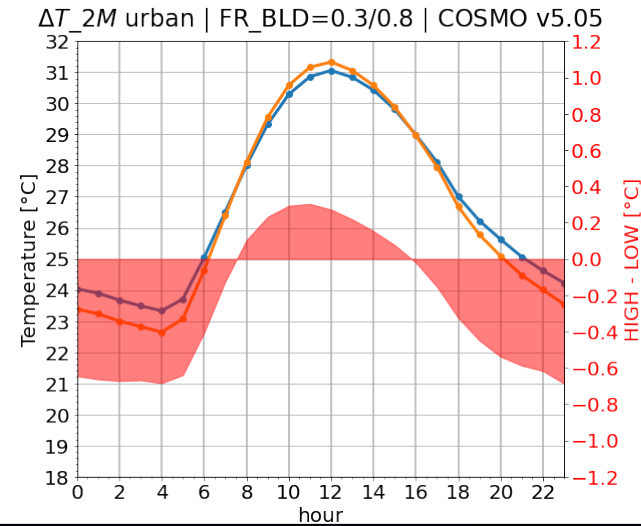
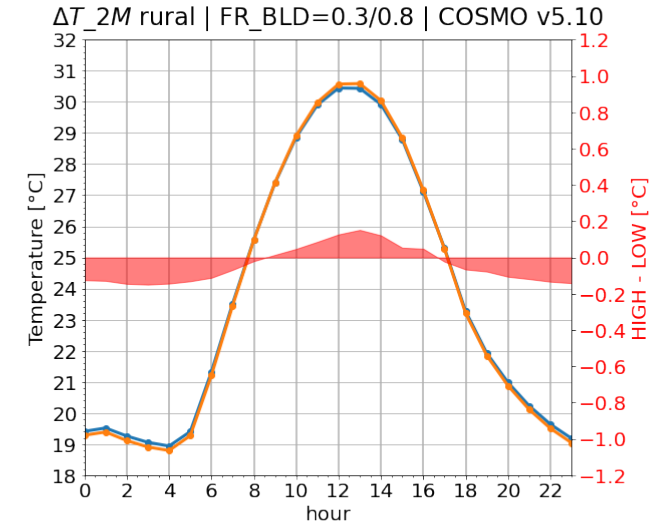
RURAL

URBAN

COSMO 5.05



COSMO 5.10



— LOW
— HIGH

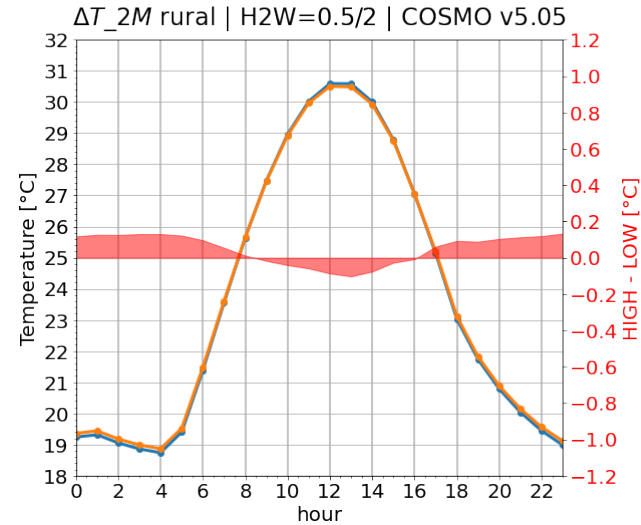
Height/Width

- A higher canyon H/W ratio leads to an overall increase on screen-level.
- Increase radiative trapping, lower effective albedo, hence a greater conversion of solar radiation in heat.
- Increase the heat transfer below the surface imply a higher heat capacity and conductivity.

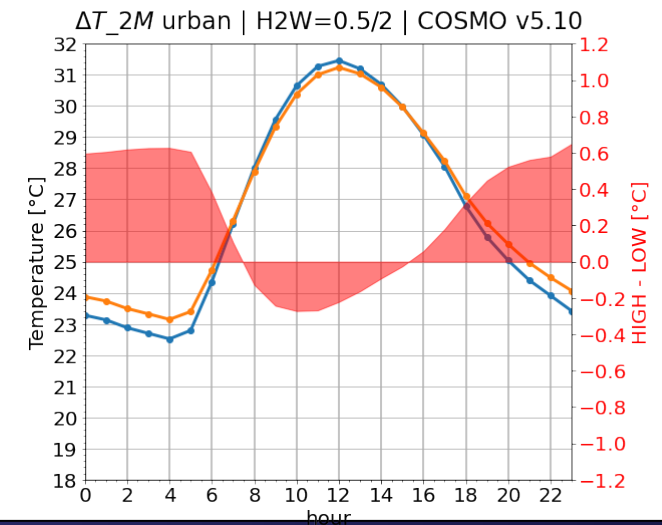
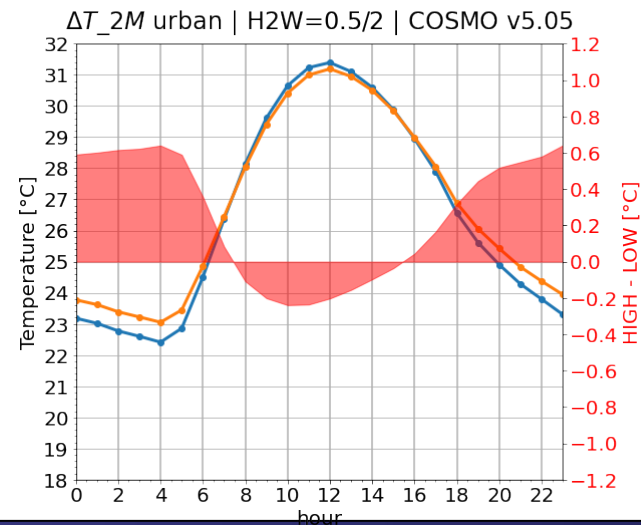
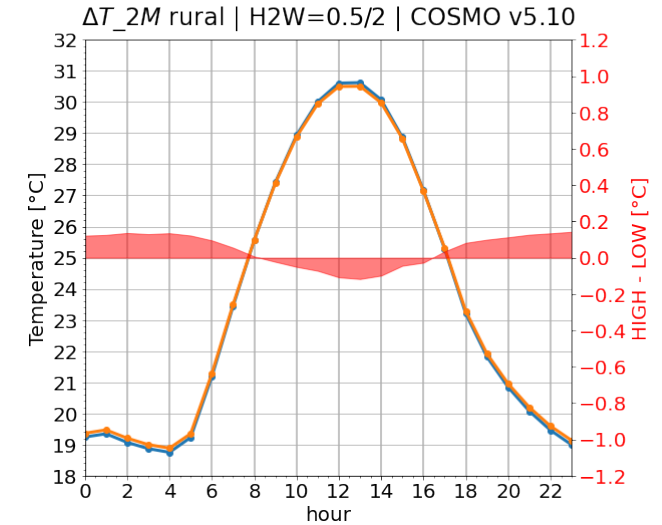
RURAL

URBAN

COSMO 5.05



COSMO 5.10



— LOW
— HIGH

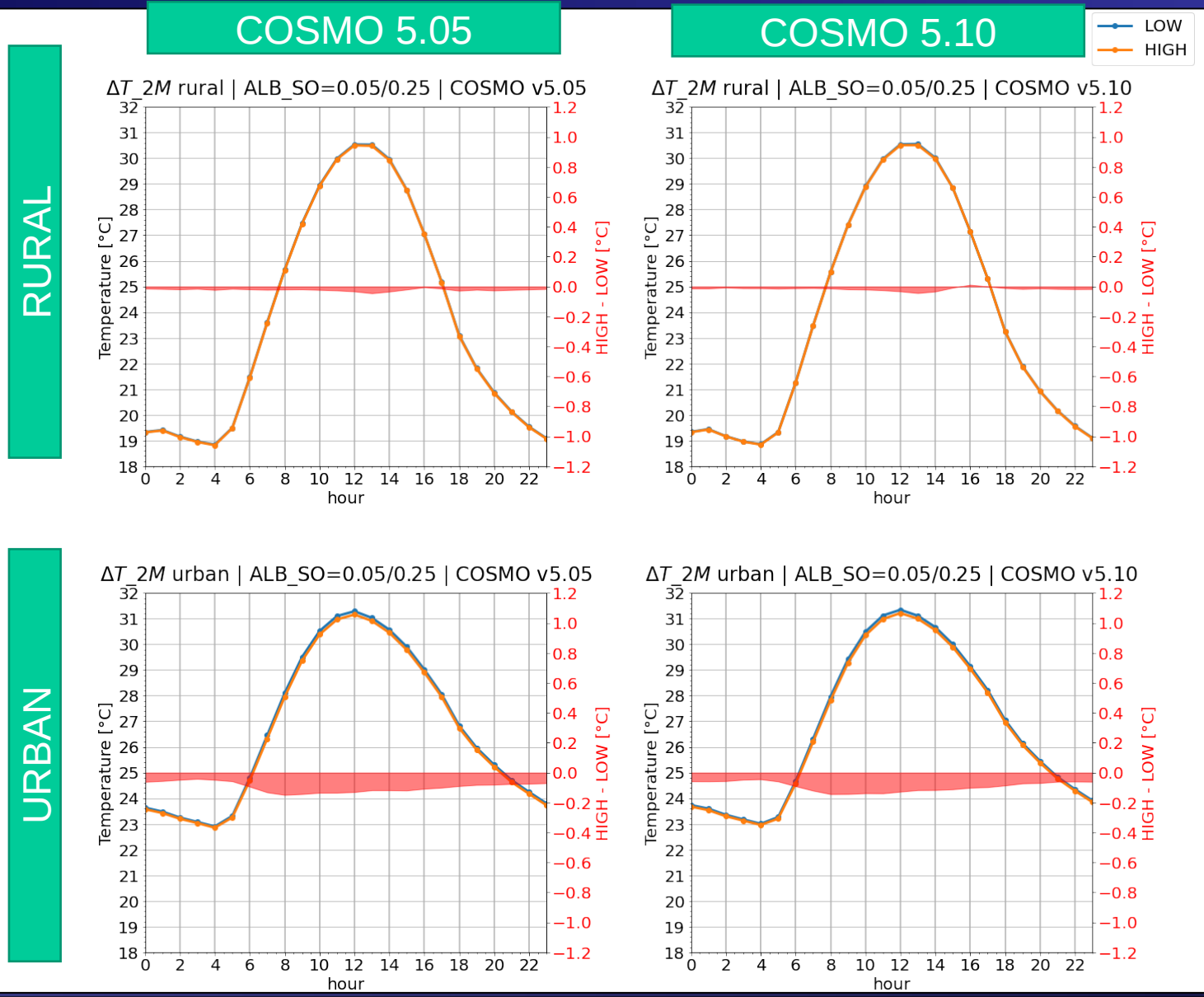
Urban material shortwave albedo

A higher ALB_SO implies more reflected solar radiation.

At daytime should it be closer to Roof Fraction effect?

MAYBE?

Is there an additional documentation?



Urban material thermal albedo (1 - emissivity)

A higher ALB_TH implies more radiated heat at nighttime

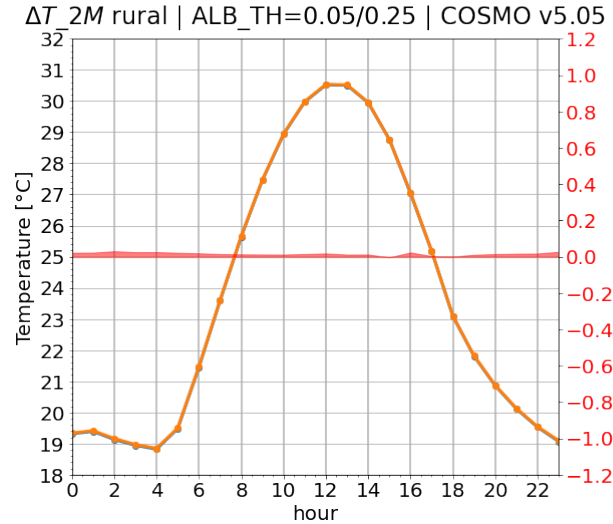
MAYBE?

Is there an additional documentation?

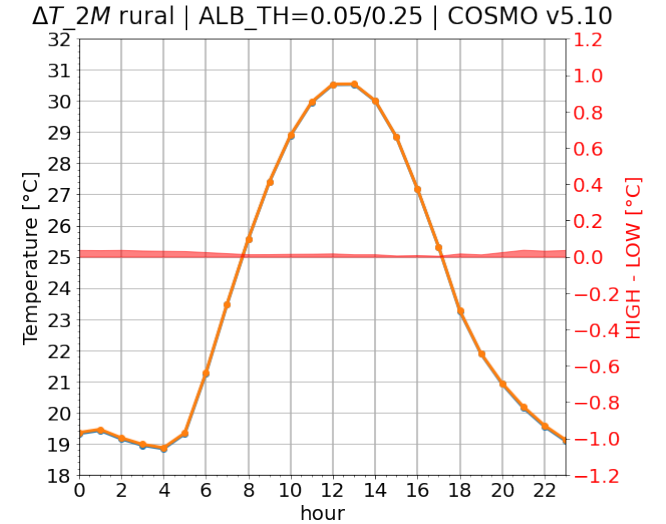
RURAL

URBAN

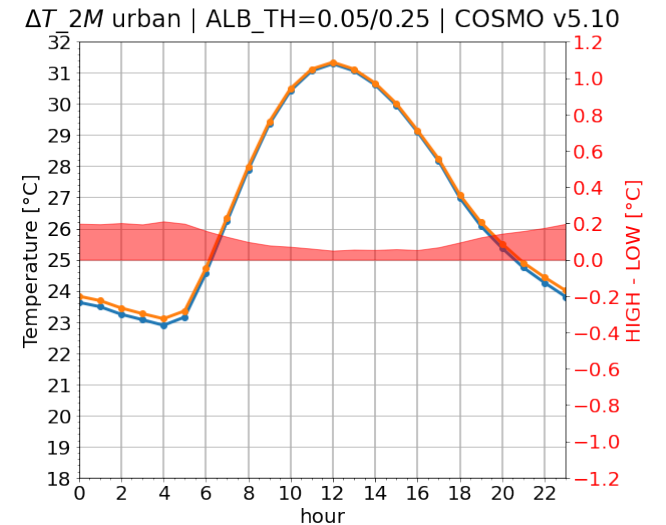
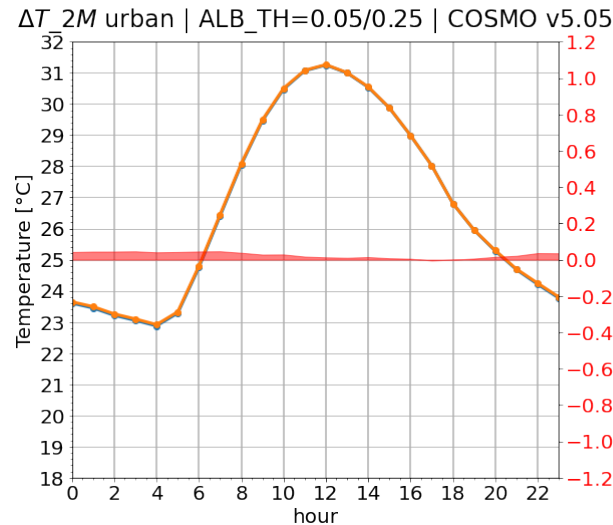
COSMO 5.05



COSMO 5.10



— LOW
— HIGH



Volumetric heat capacity of urban material
[$J \cdot m^{-3} \cdot K^{-1}$]

Heat stored at daytime and released at nighttime

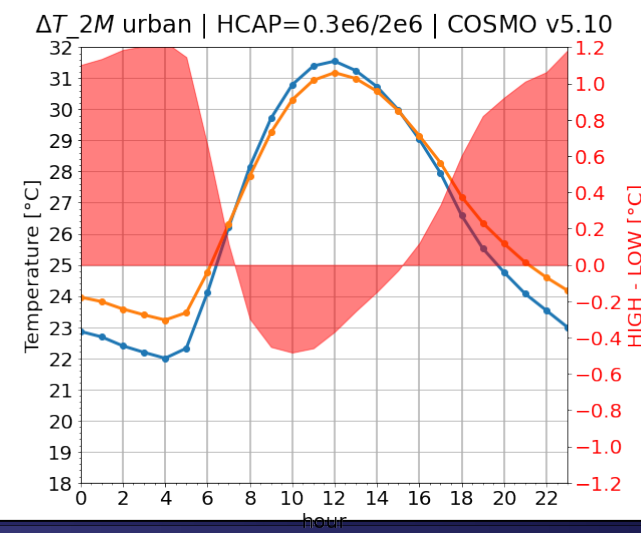
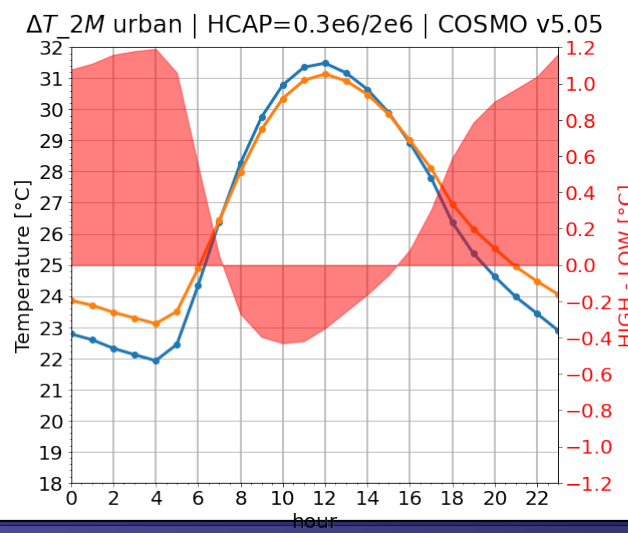
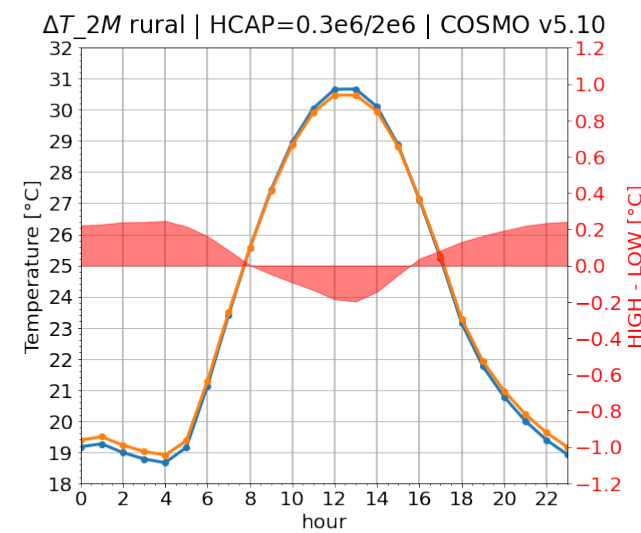
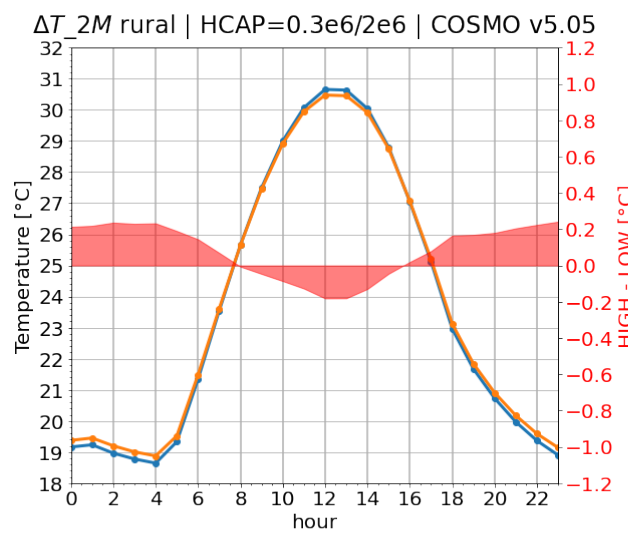
RURAL

URBAN

COSMO 5.05

COSMO 5.10

LOW
HIGH

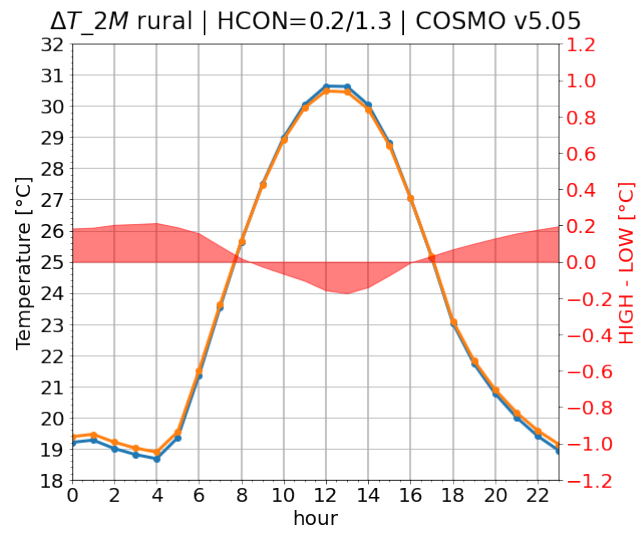


Heat conductivity of urban material [W · m⁻¹ · K⁻¹]

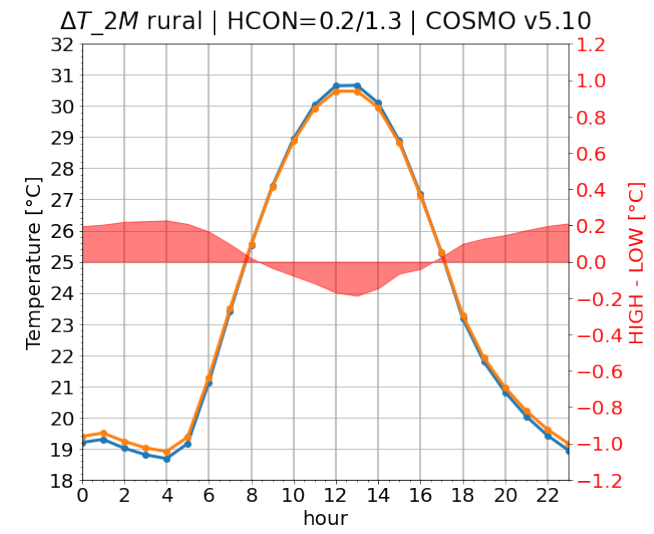
Heat stored at daytime and released at nighttime

RURAL

COSMO 5.05

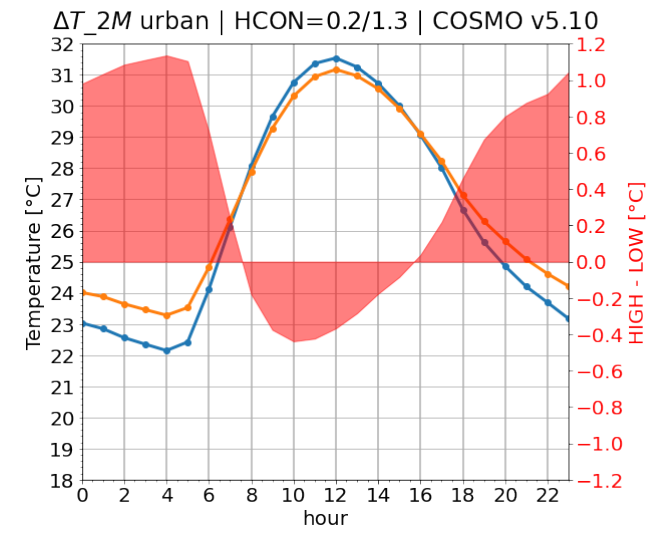
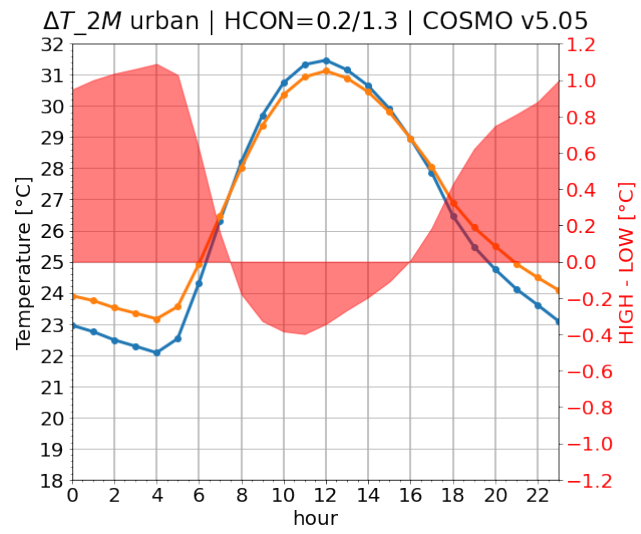


COSMO 5.10



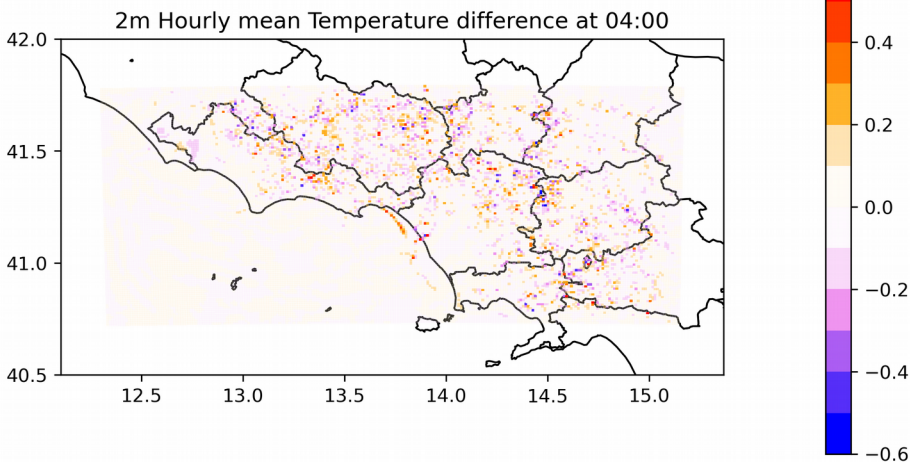
LOW
HIGH

URBAN



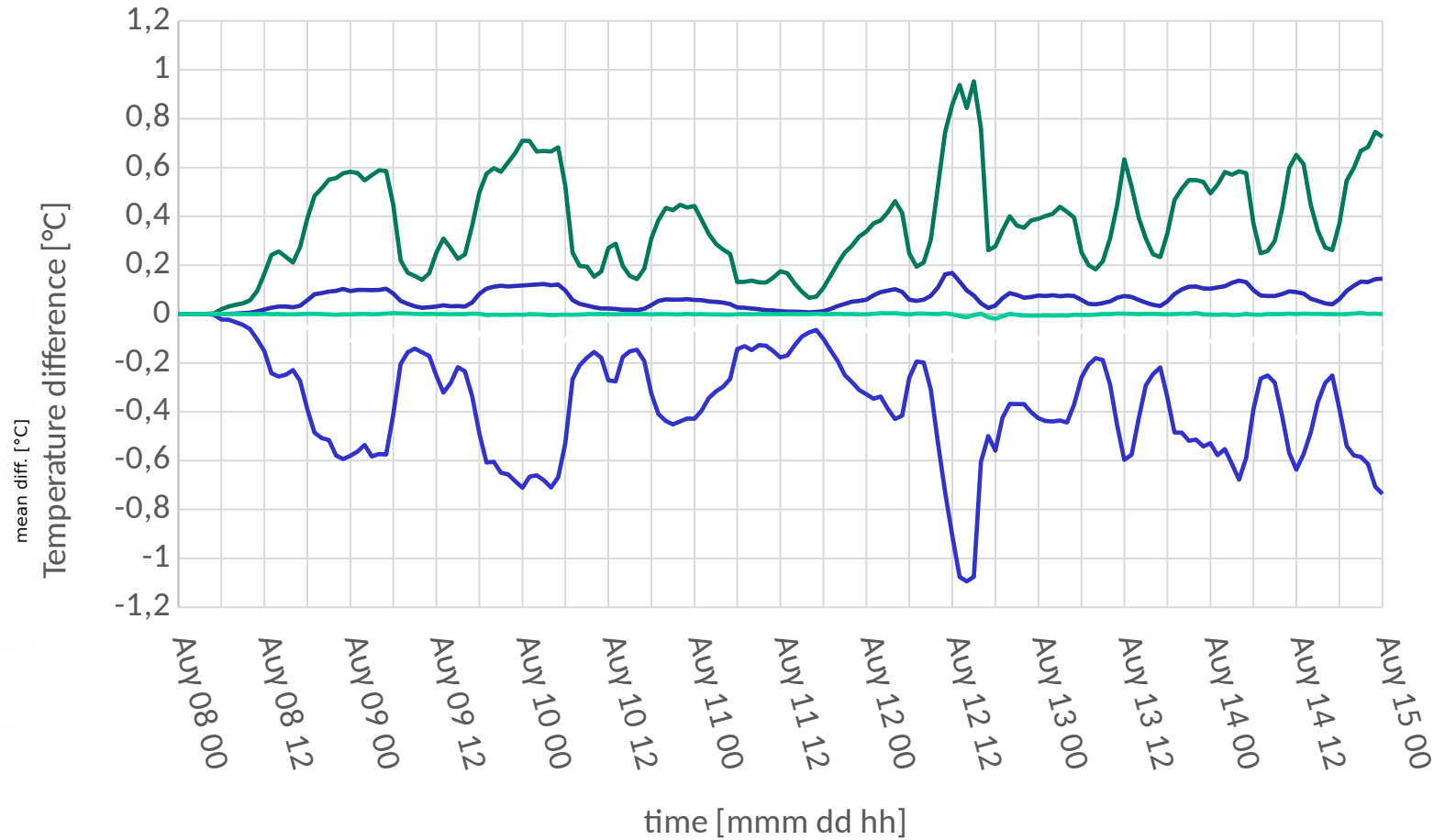
The base configuration was run again using the last version of COSMO (June 26th)

- Differences are stochastic fluctuations scattered over the whole domain.
- It's a symmetrically distributed noise.



Statistics about T_{2M} difference over whole domain

— T_{2M} mean — 1st perc. — 10th perc. — 90th perc. — 99th perc.



Thank you for your attention.
Any questions ?