COSMO Priority Task ÆVUS

Analysis and EValuation of TERRA_URB Scheme

Valeria Garbero
Massimo Milelli

Overview

Official release of COSMO5.04g_urb1, leading to the COSMO5.05_urb1

1. **SubTask0:** installation and debugging of the beta COSMO version including TERRA_URB

2. **SubTask1:** selection of case studies

3. **SubTask2:** simulation setup and runs

4. **SubTask3:** calibration of the TERRA_URB scheme

5. **SubTask5:** writing of the final report

	04	05		2018				2019					
				09	10	11	12	01	02	03	04	05	06
Task													
0													
1													
2													
3													
4													
5													
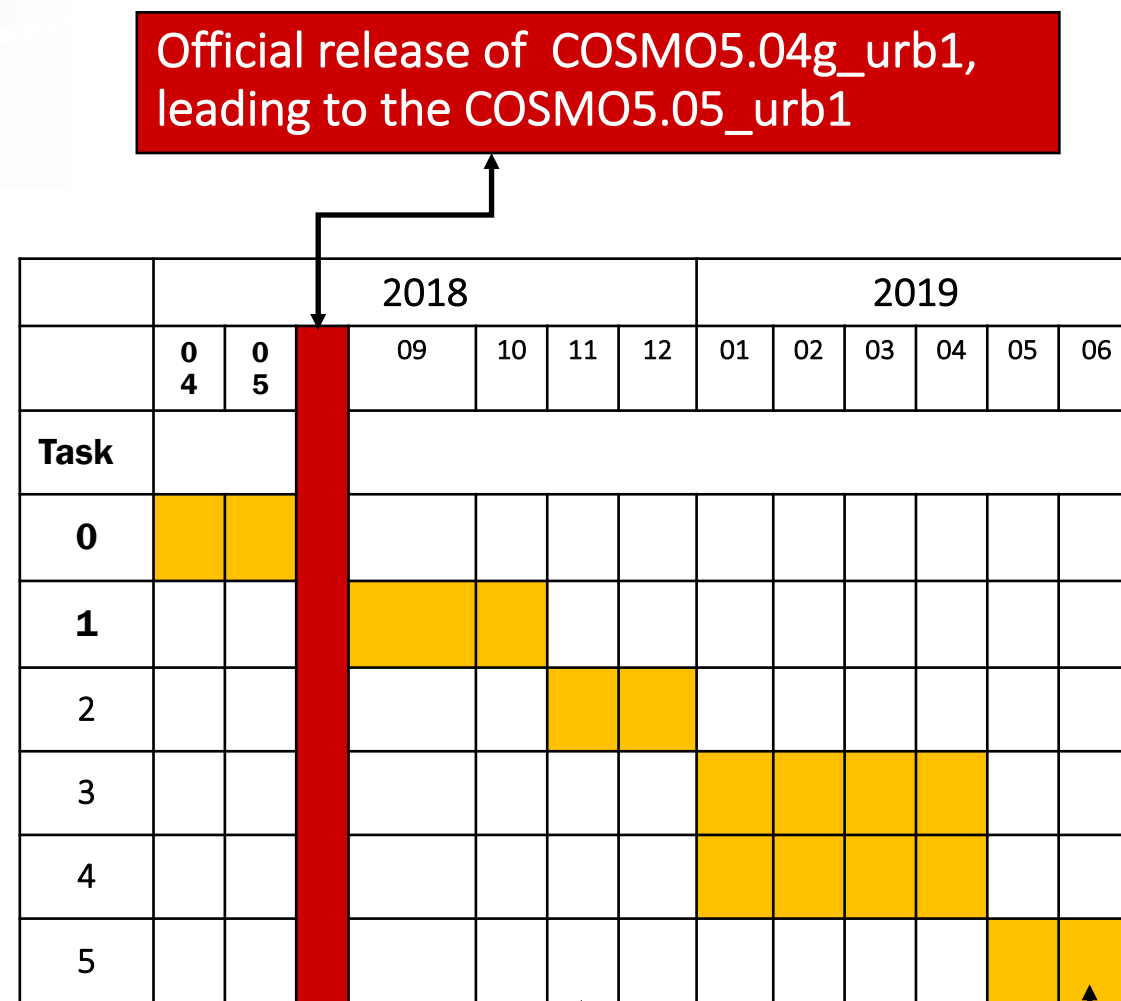
Bugs fixed by Uli COSMO_urb4_1.tar.bz2

Release of COSMO_181030_5.05_urb3 and int2lm_181109_2.05a

Bugs fixed by Mikail COSMO_urb4.tar.bz2

Arpa Piemonte
Agenzia Regionale per la Protezione Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

1. Version: COSMO_180223_5.05_urb1 available since 8th May 2018 (results presented in GM2018)

2. Version: COSMO_181030_5.05_urb3 and INT2LM_181109_2.05a available since 22 October 2018 that includes the updated skin temperature scheme (Jan-Peter)

3. Version: COSMO_urb4_1 available since 11th April 2019 that contains bug fixing by Uli but still has problems with itype_canopy=2

4. Version: COSMO_urb4 available since 14th June 2019 that contains bug fixing by Mikhail with reference to itype_canopy=2
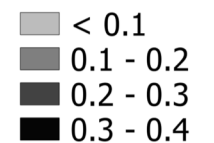
installed on the CIRA supercomputer "TURING"

• COSMO run in analysis mode at 1 km resolution over a domain that includes Piemonte region

• Boundary and initial conditions provided at 9 km resolution every 6 hours by IFS

• No assimilation

Orography (m)
- 0
- 1
- 150
- 300
- 500
- 750
- 1000
- 1250
- 1500
- 1750
- 2000
- 2500
- 3000
- 3500
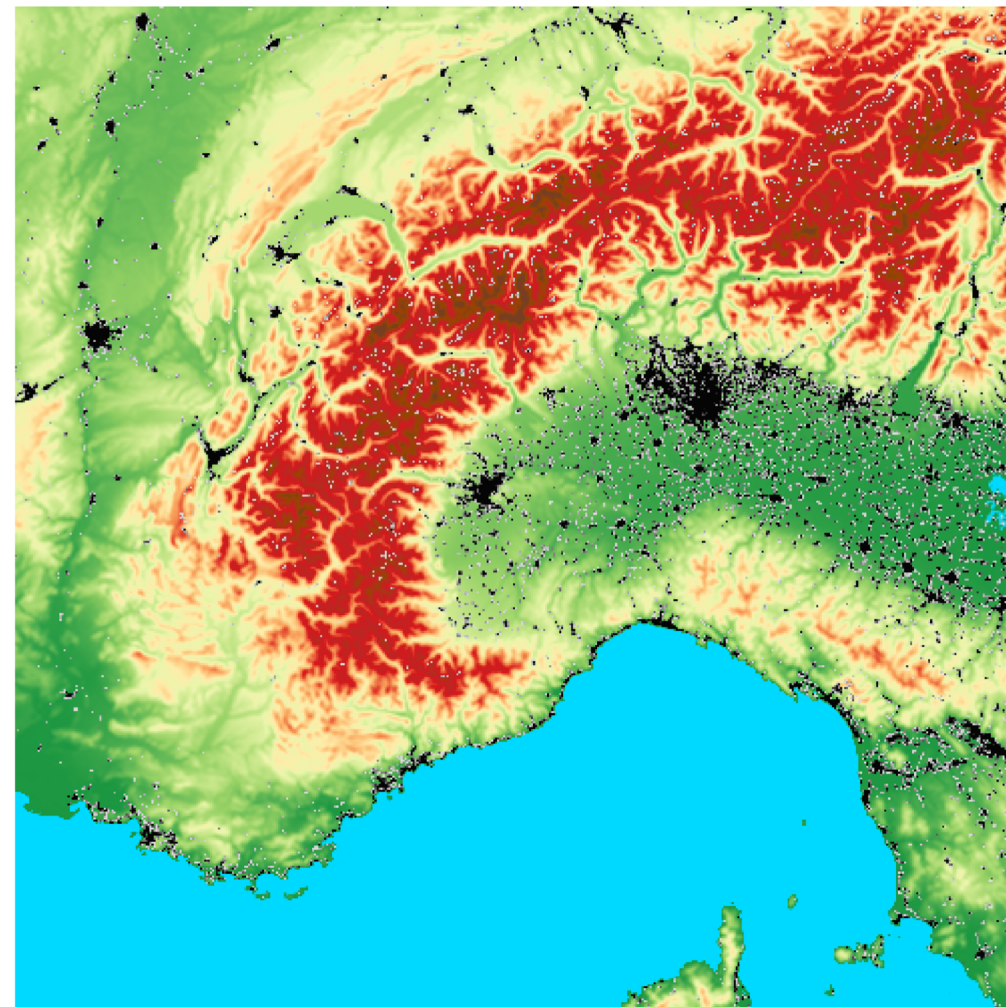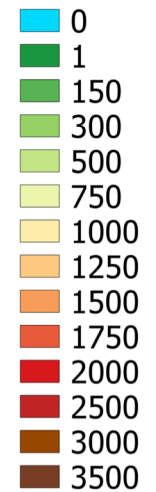
Urban fraction (%)
- < 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4

COSMO run by activating or not the urban scheme TERRA_URB

Param	CTRL	URB
lterra_urb	F	T
ntiles	0	2
itype_ahf		1
itype_kbmo_uf		1
itype_eisa		2

Required urban canopy parameters provided by EXTPAR

- ✓ urban area fraction (impervious surface fraction ISA)
- ✓ annual-mean anthropogenic heat flux (AHF)
- ✓ building area fraction (URBAN)

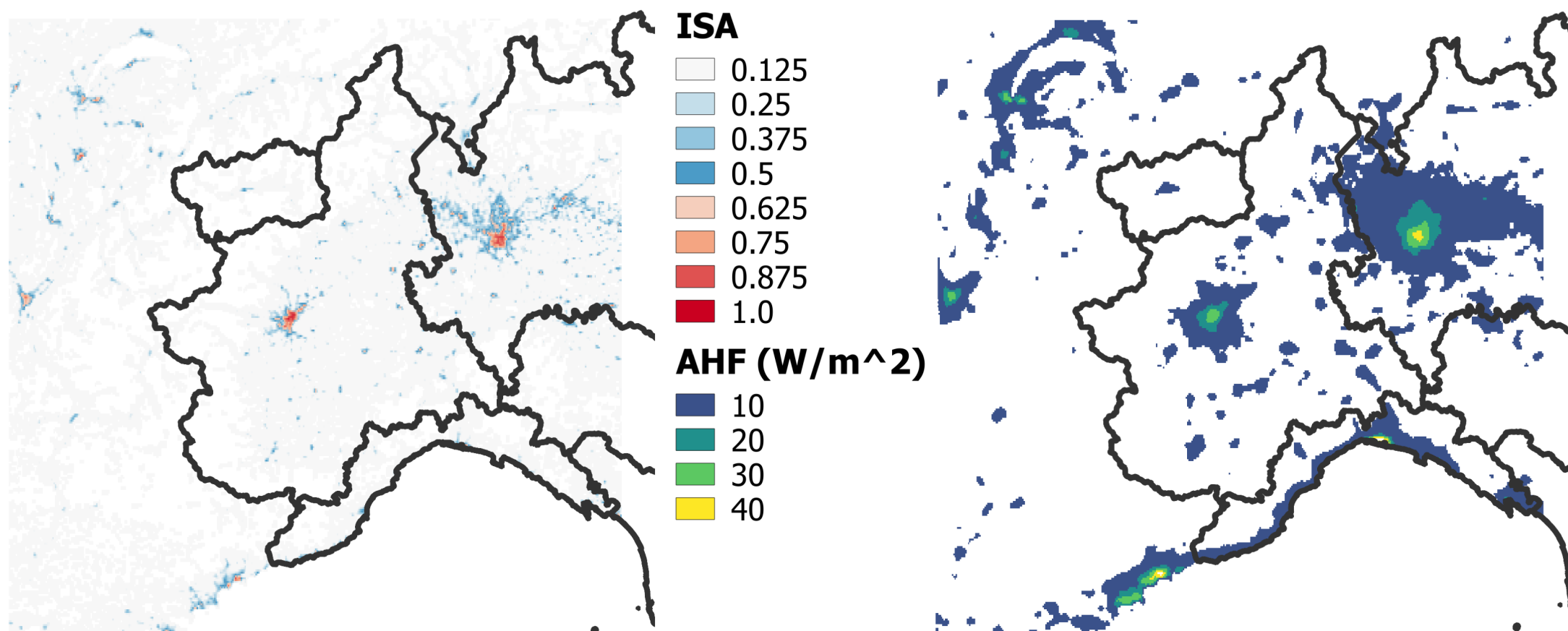## and using the canopy scheme or the skin conductivity scheme to calculate the surface temperature

Param	C1	C2
itype_canopy	1	2
calamurb		1000
cimpl		120

Required parameter provided by EXTPAR

- ✓ skin conductivity field (SKC)

Urban canopy parameters provided by EXTPAR

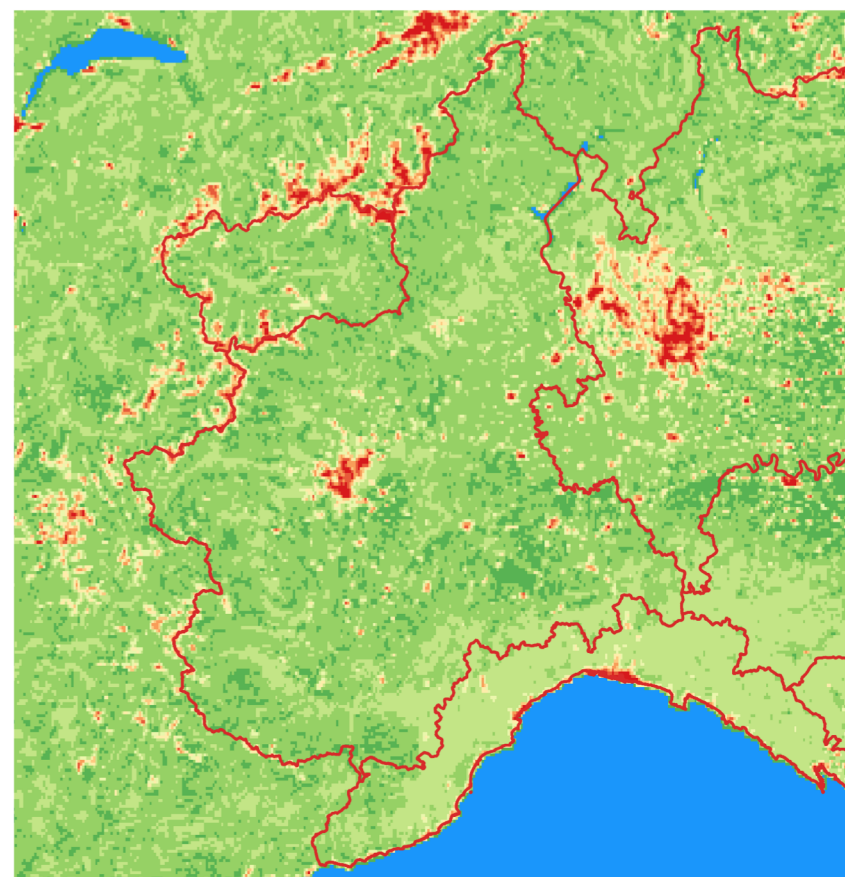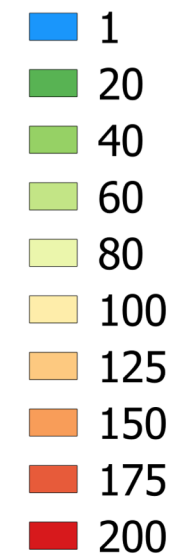## Urban canopy parameters provided by EXTPAR
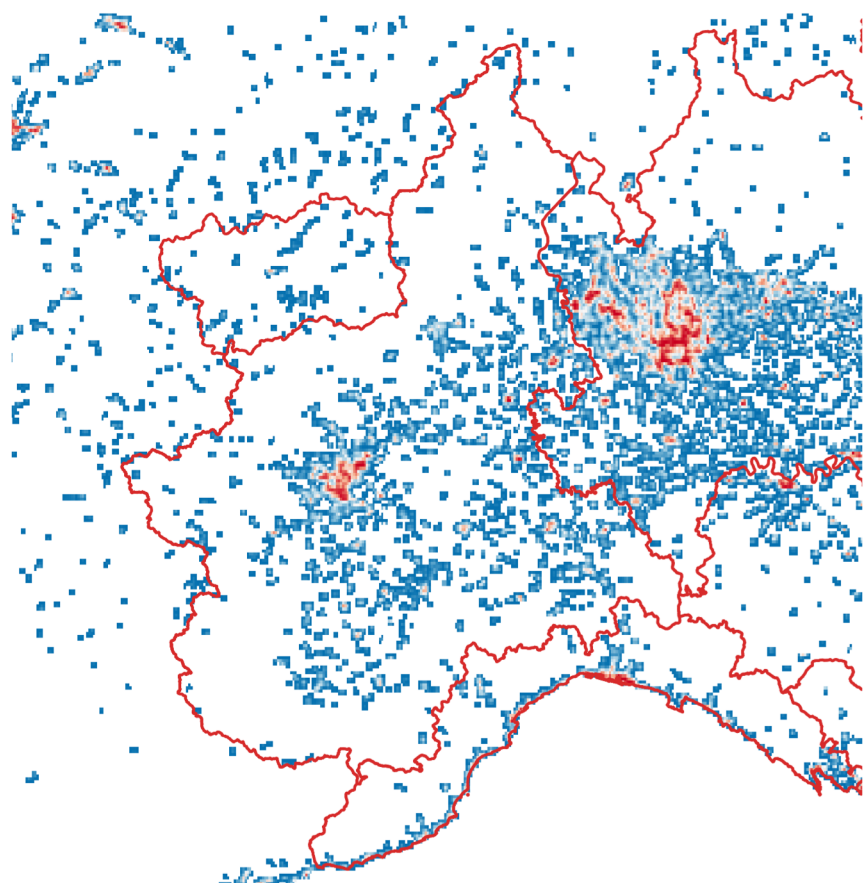
Subtask2: set up

Following Uli's suggestion, the configuration that corresponds to DWD setting for the COSMO-D2 (old physics settings) has been chosen, except for some parameters modified according to Jan-Peter's suggestion.

4 different configurations have been tested on two test-cases - July 2015 and October 2017 - and evaluated using the Arpa Piemonte network (few urban stations, many non-urban stations)

1. **CC1:** lterra_urb=F and itype_canopy=1
2. **UC1:** lterra_urb=T and itype_canopy=1
3. **CC2:** lterra_urb=F and itype_canopy=2
4. **UC2:** lterra_urb=T and itype_canopy=2
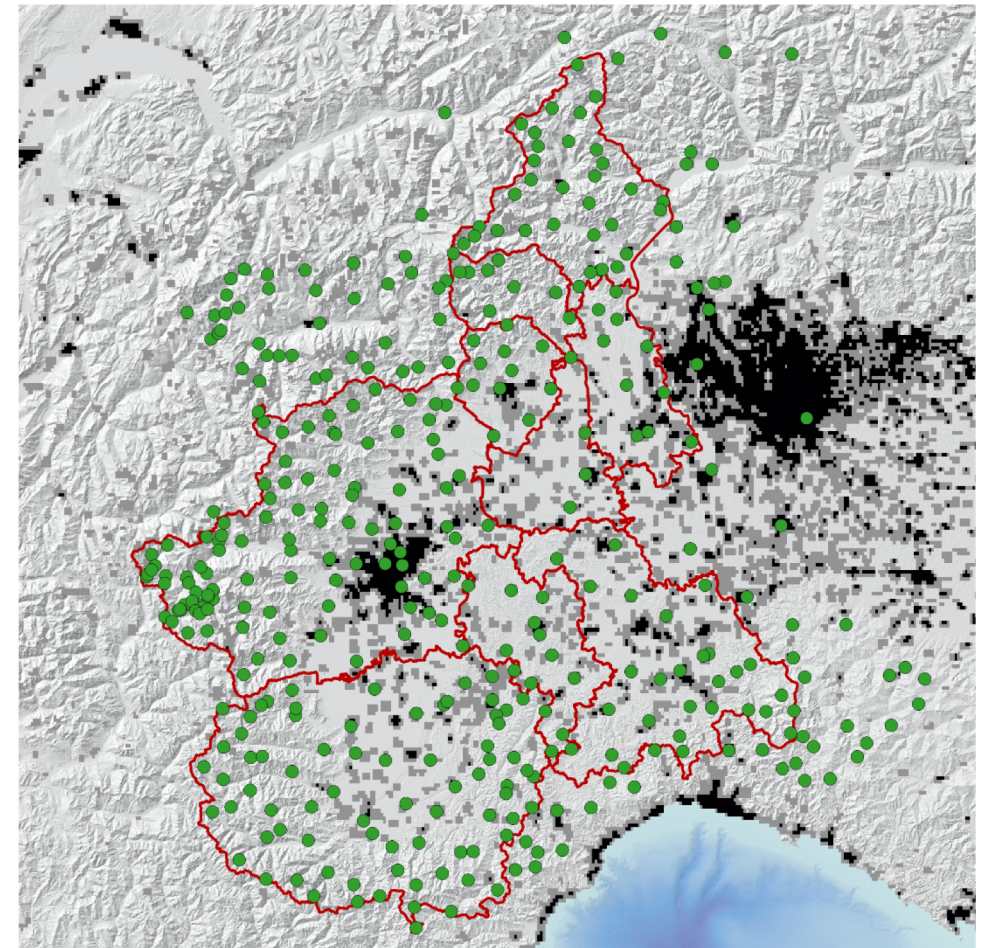
&TUNING	default	URB
pat_len	100	500
tur_len	500	150
tkhmin	0.75	0.4
tkmmin	0.75	0.4
rat_sea	10	20
rain_n0_factor	1	0.1
q_crit	4	1.6
qc0	0	0.0002
gkwake	0.8	0.5
mu_rain	0	0.5
v0_snow	25	20

&PHYSICS	default	URB
loldtur	F	T
itype_gsp	3	4
lsuper_coolw	F	T
lforest	F	F
itype_albedo	1	4
itype_aerosol	1	1
ltur	T	T
itype_vdif	1	-1
ltkeshs	T	F
itype_turb	3	3
lsoil	T	T
itype_evsl	2	4
itype_tran	0	1

| &PHYSICS	default	URB
itype_trvg	2	2
itype_root	1	2
itype_heatcond	1	3
cwimax_ml	0.00001	0.0005
lemiss	F	F
lstomata	F	F
lconv	T	T
lconv_inst	F	T
itype_conv	0	3
llake	F	F
lseaice	T	F
lsso	T	F
ltkesso	T	F

* Jan-Peter's suggestions

The different configurations have been evaluated using <u>all the stations</u>

URB configuration warms up more than CTRL configuration, slightly worsening the 2m temperature forecast in the early morning and improving it during the day

C1 configuration forecasts higher 2m temperature than C2 configuration during the night and rather similar 2m temperature during the day


T (°C) - 2015/07/01-07
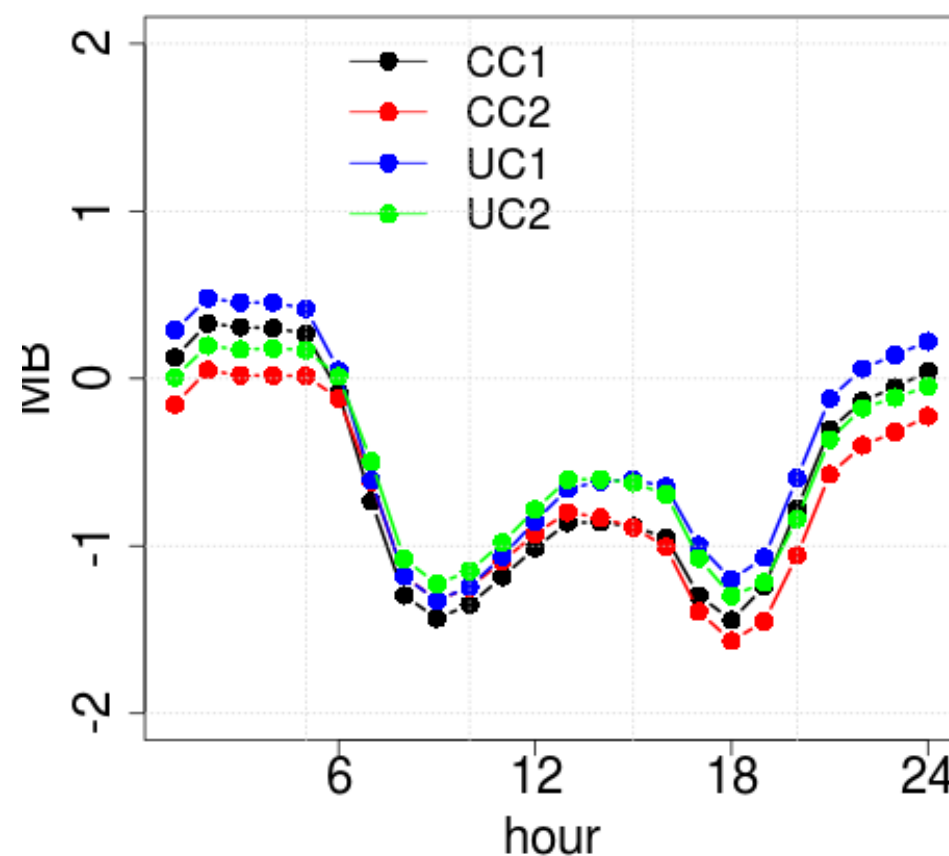
- CC1
- CC2
- UC1
- UC2

Is the namelist correct? How to improve forecast?

2m temperature in Turin

The different configurations have been evaluated using <u>4 urban stations</u> in Turin

URB configuration significantly improves the 2m temperature forecast in urban area even if it overheats too much

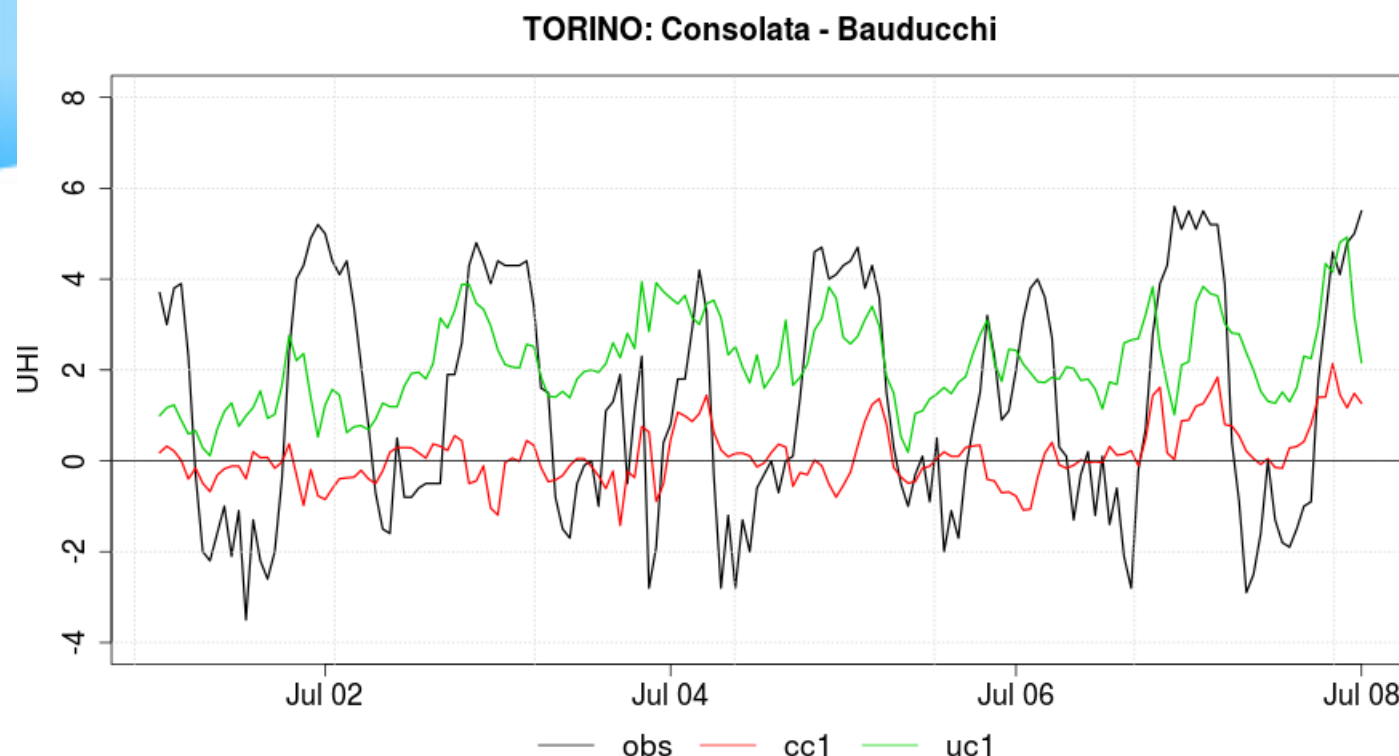C1 seems to have performance similar to C2 in urban areas

T (°C) - 2015/07/01-07
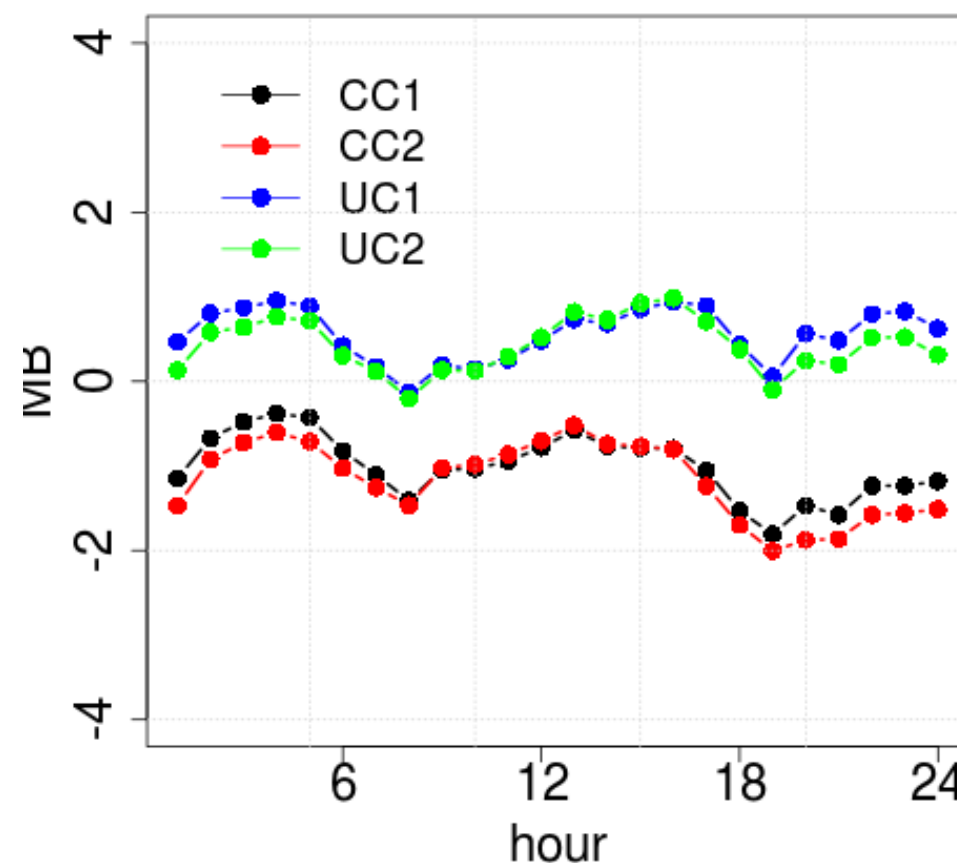
- CC1
- CC2
- UC1
- UC2

hour

2m temperature in Turin

TORINO: Consolata - Bauducchi

Urban Heat Island (UHI) is measured as the temperature difference between urban area and its surroundings
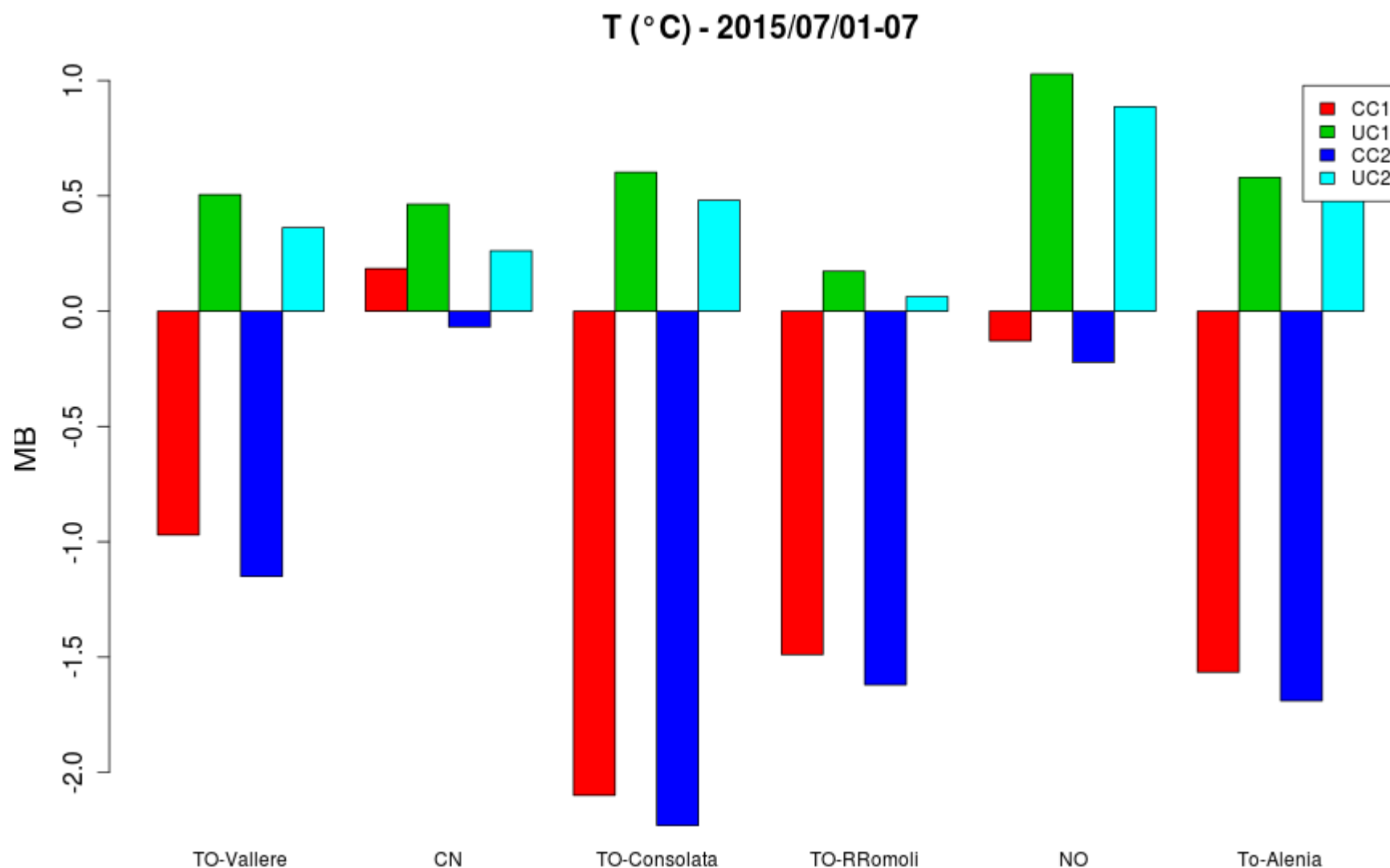
URB configuration is able to represent the UHI effect, even if the cooling of urban area due to building shadows during the day is not well reproduced.
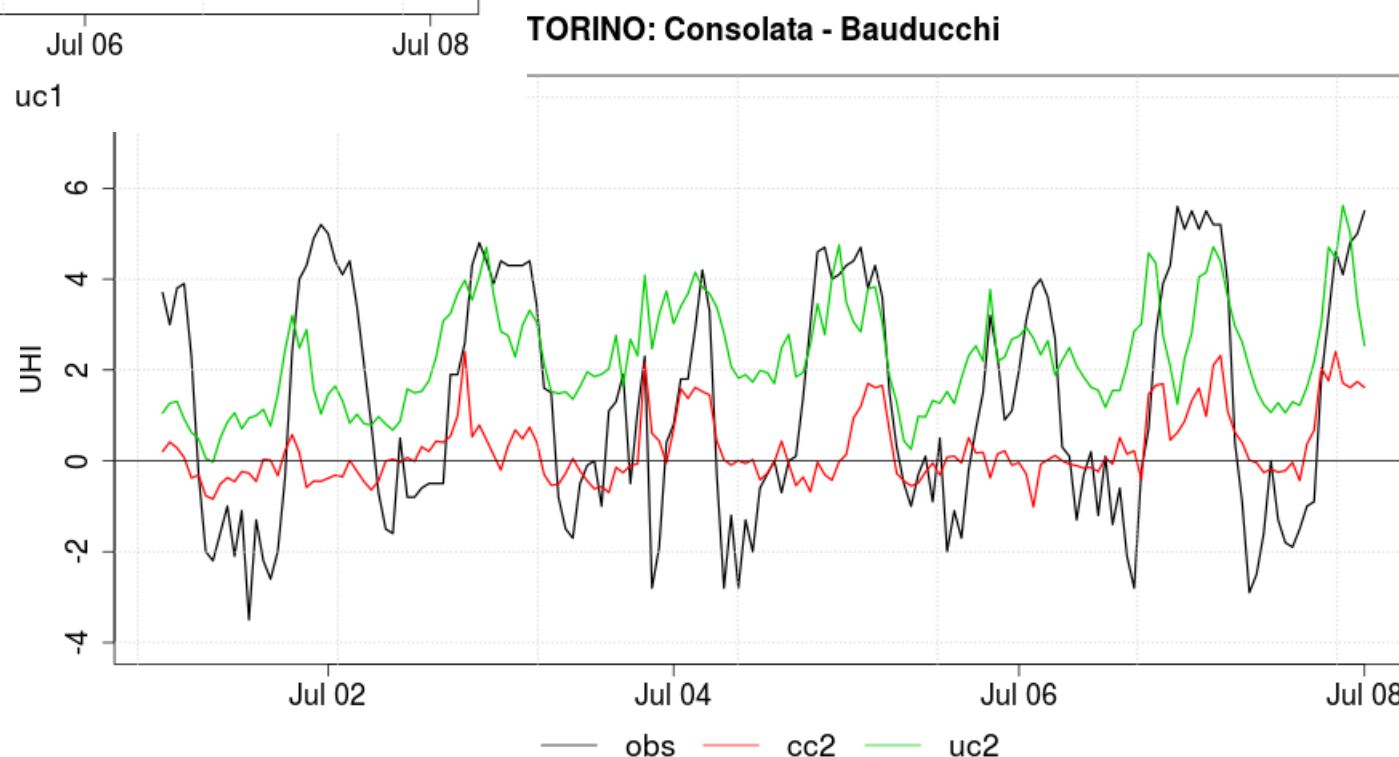
TORINO: Consolata - Bauducchi

2m temperature in Turin

URB configuration significantly improves the 2m temperature forecast in major urban area even if it overheats too much

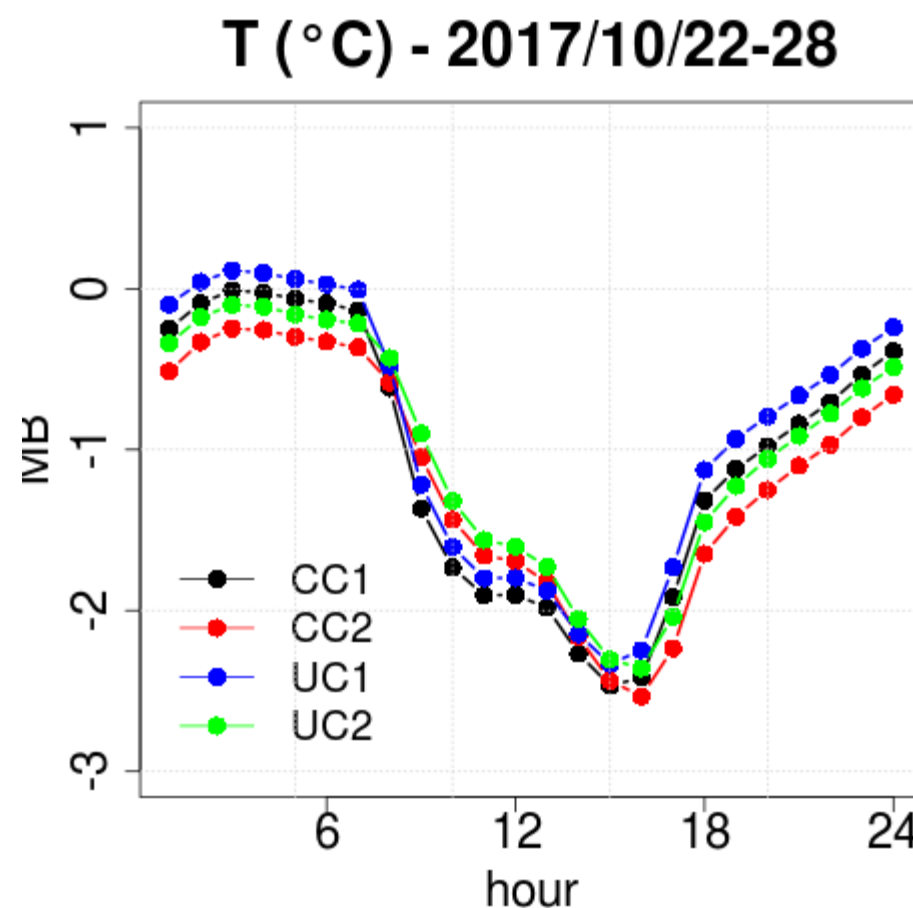T (°C) - 2015/07/01-07

The different configurations have been evaluated using <u>all the stations</u>

URB configuration warms up more than CTRL configuration, improving the 2m temperature forecast

C1 configuration forecasts higher 2m temperature than C2 configuration during the night and rather similar 2m temperature during the day

T (°C) - 2017/10/22-28

MB

CC1
CC2
UC1
UC2

hour

Is the namelist correct?

2m temperature in Turin

The different configurations have been evaluated using <u>4 urban stations</u> in Turin

URB configuration significantly improves the 2m temperature forecast in urban area compared to CTRL configuration, although it overestimates it in the early morning and underestimates it during the day
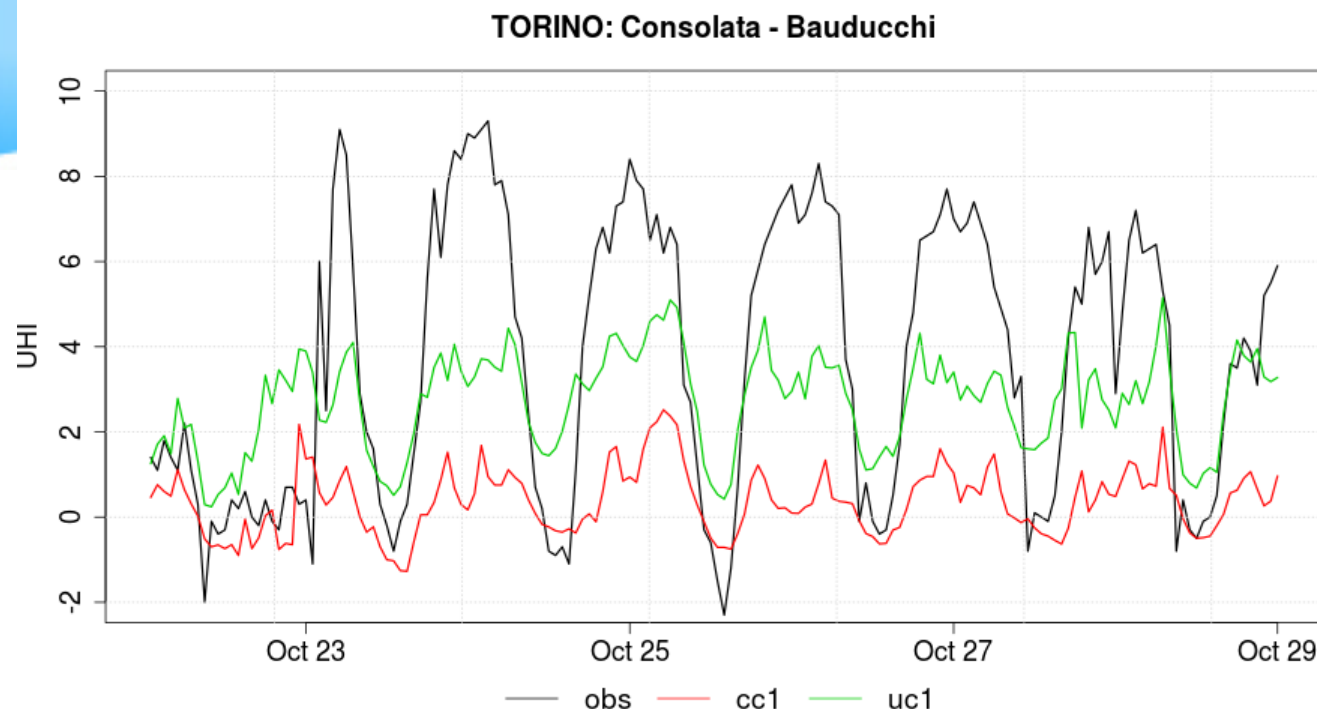
C1 seems to have performance similar to C2 in urban areas
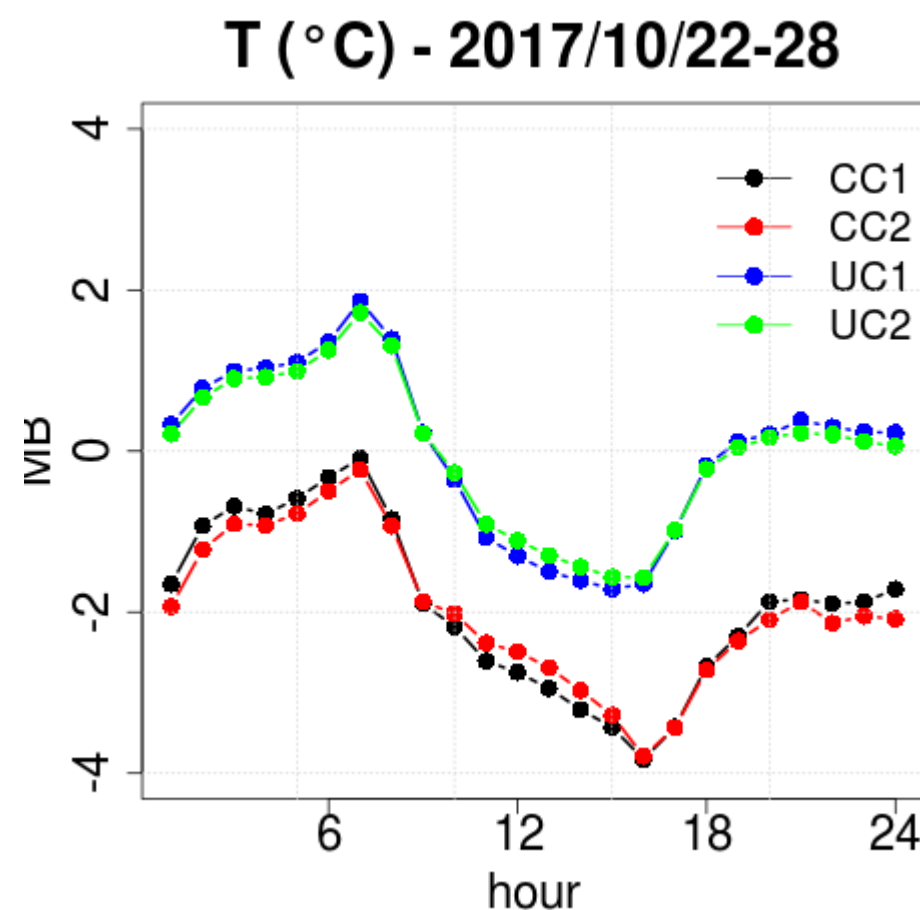
T (°C) - 2017/10/22-28

2m temperature in Turin

TORINO: Consolata - Bauducchi

Urban Heat Island (UHI) is measured as the temperature difference between urban area and its surroundings

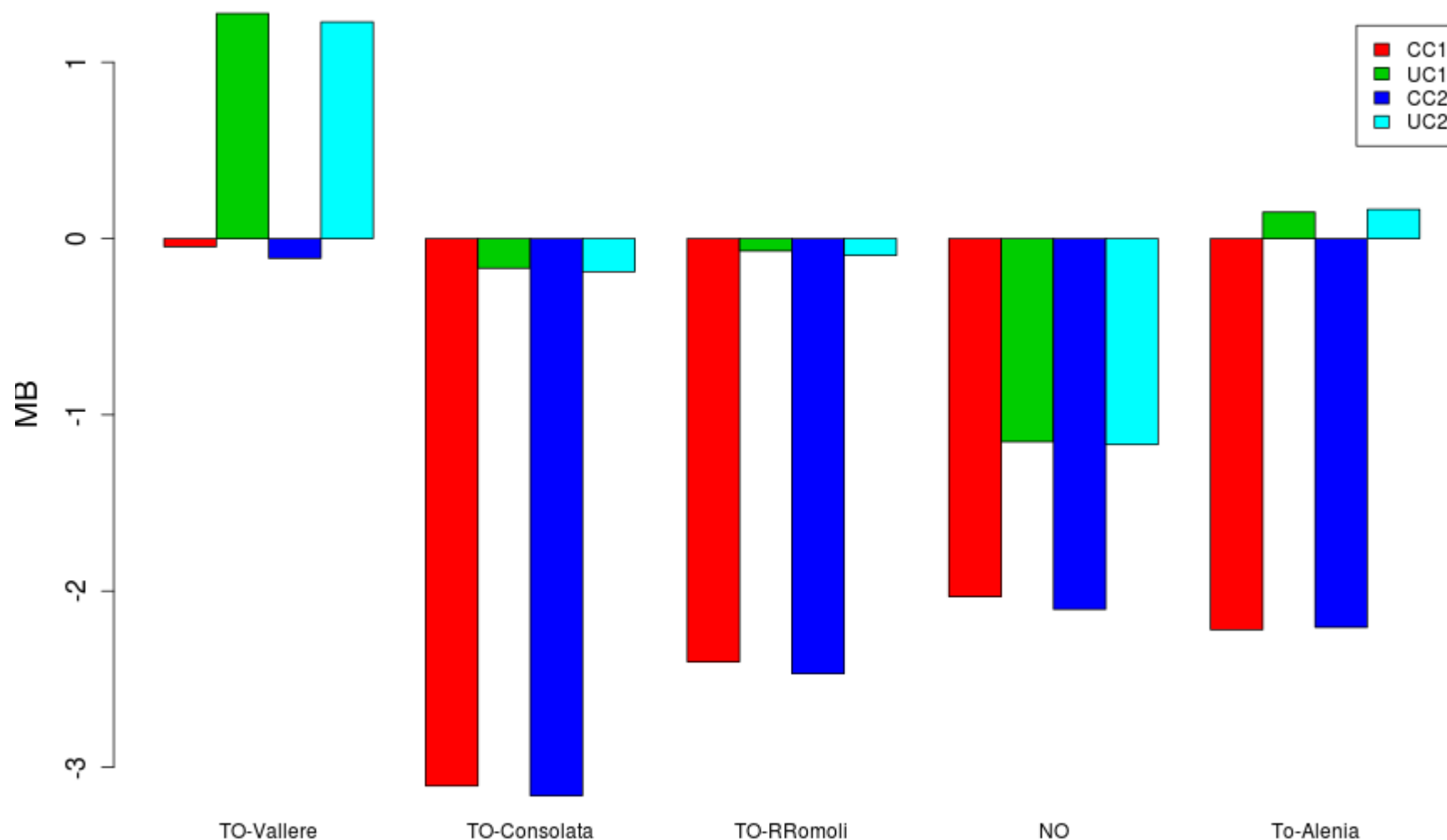URB configuration is able to represent the UHI effect, even if it overheats too much at night and too little during the day in urban area
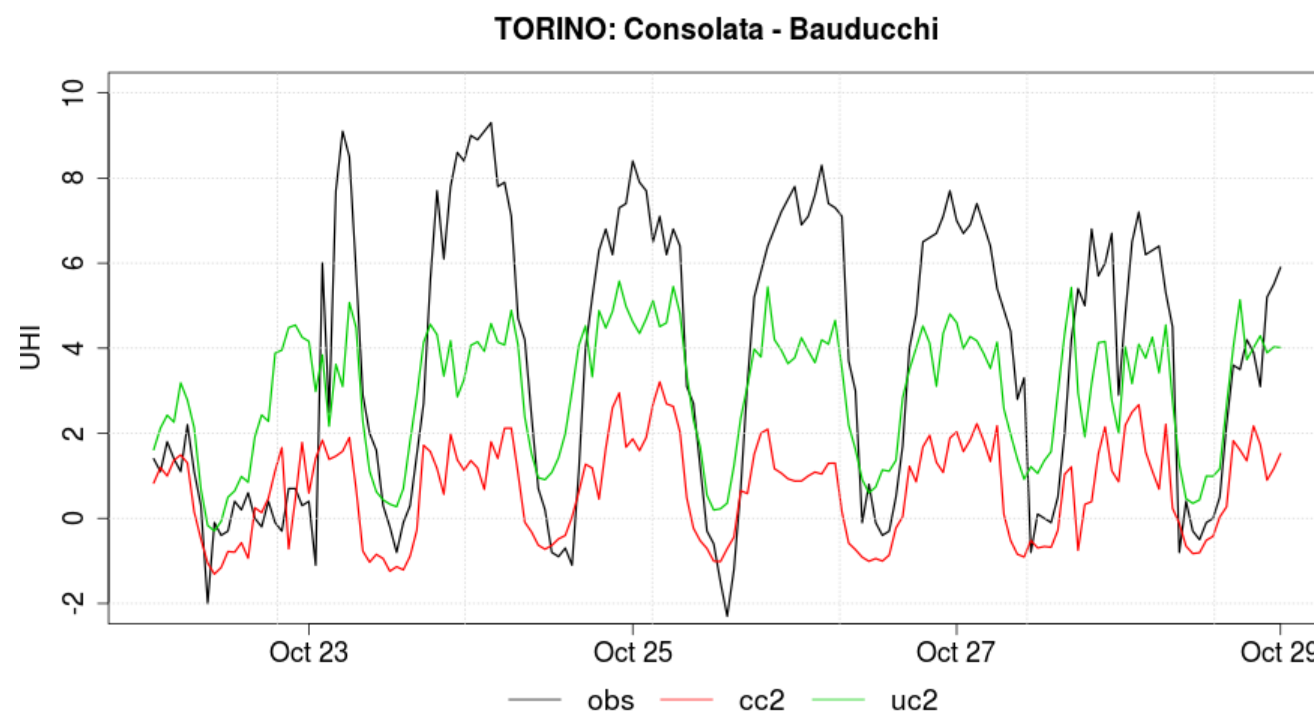
TORINO: Consolata - Bauducchi

2m temperature in Turin

URB configuration significantly improves the 2m temperature forecast in major urban area

1) Calibration of the model by comparing:

▪ simulated <u>2m air temperature</u> with the observations provided by meteorological stations

▪ <u>surface temperature</u> with the Land Surface Temperature (LST) provided by the satellites

▪ vertical temperature with the observations provided by 3 radiometers (1 in the city center, 2 in the suburban area)
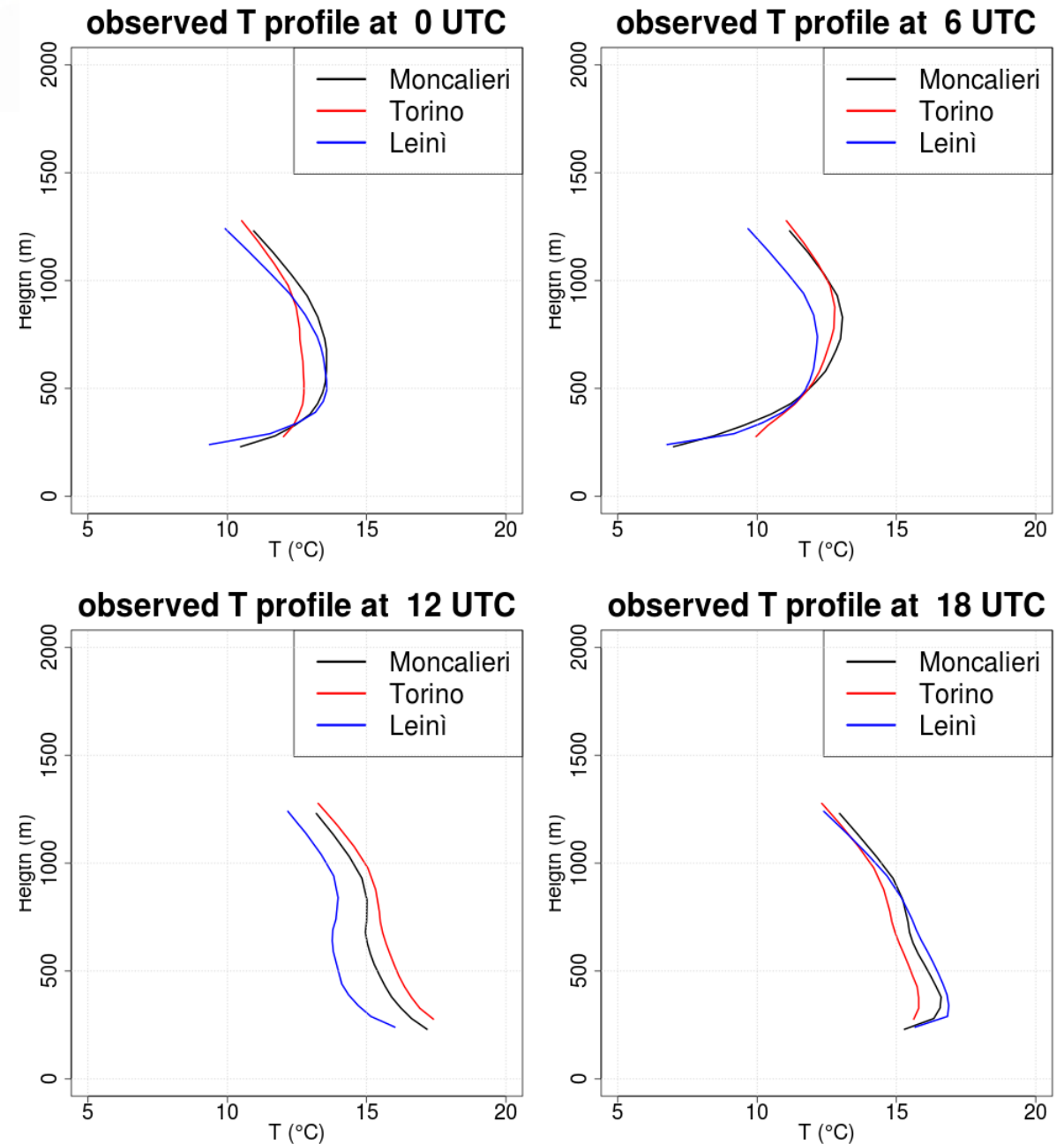LST data are available:
- twice a day at 1 km resolution from MODIS or COPERNICUS and at 100 m resolution from LANSAT
- every 15 minutes at 3 km resolution from LSASAF EUMETSAT

2) More suitable and specific external parameters should be investigated and implemented
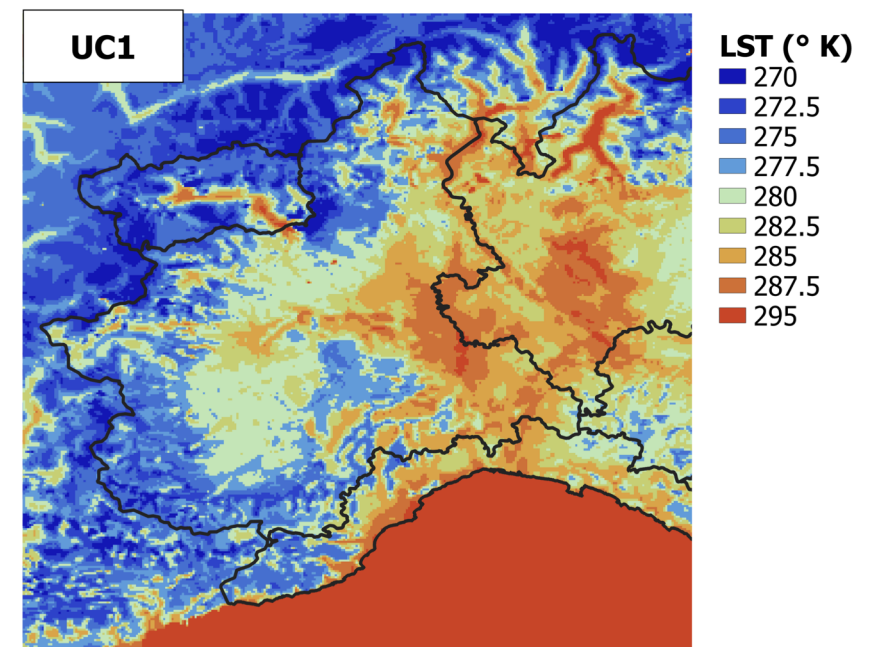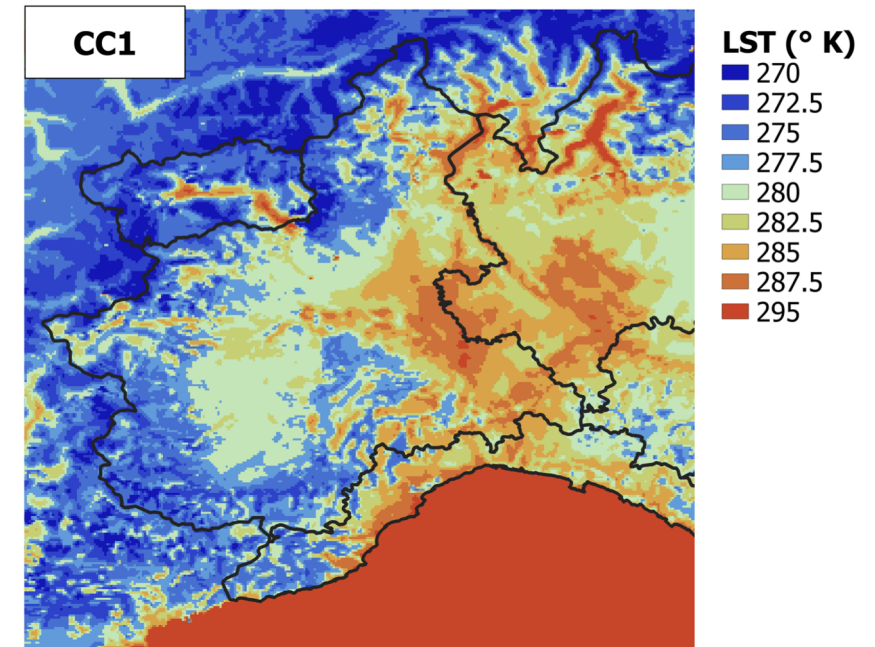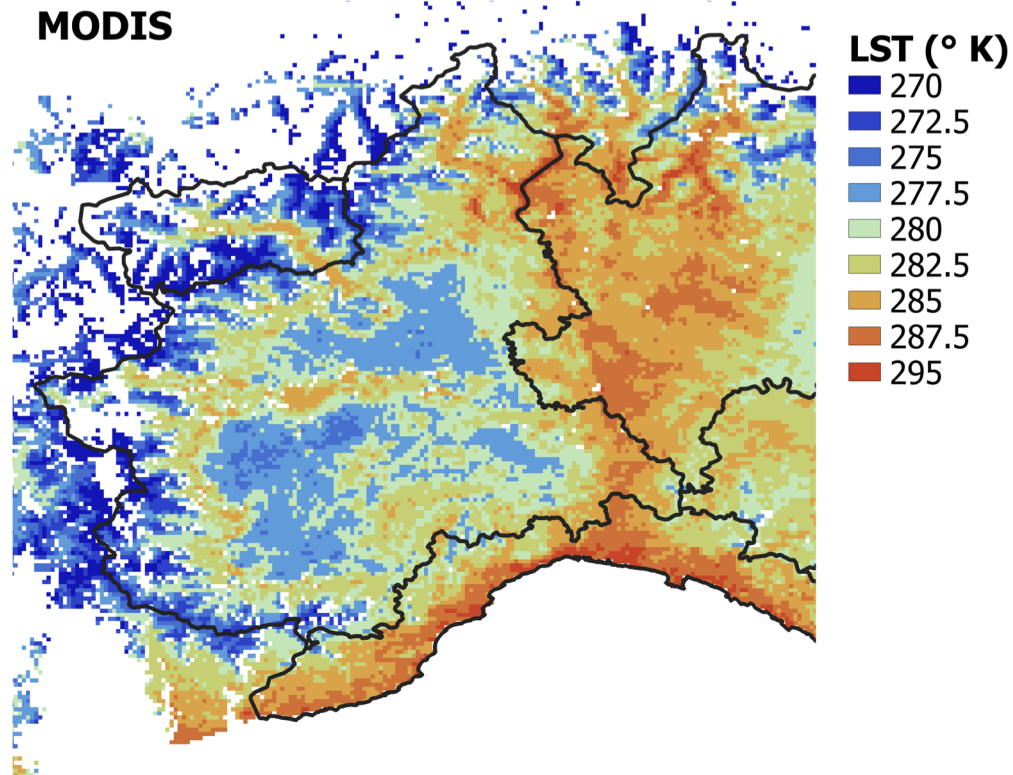
Vertical temperature profiles averaged during the period 22-28 October 2017

Observations provided by 3 radiometers, one in the city center and two in the suburban area

Future work: PT-AEVUS2

Land Surface Temperature (LST) provided by MODIS in comparison with simulated surface temperature (kpds5=85)

MODIS

LST (° K)
- 270
- 272.5
- 275
- 277.5
- 280
- 282.5
- 285
- 287.5
- 295

CC1

LST (° K)
- 270
- 272.5
- 275
- 277.5
- 280
- 282.5
- 285
- 287.5
- 295

UC1

LST (° K)
- 270
- 272.5
- 275
- 277.5
- 280
- 282.5
- 285
- 287.5
- 295

Future work: PT-AEVUS2

Land Surface Temperature (LST) provided by MODIS in comparison with simulated surface temperature (kpds5=85)

MODIS

CC2

UC2