Web meeting
PT AEVUS2

Francesca Bassani, Valeria Garbero, Massimo Milelli

18/03/2020

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- **Part I (AEVUS)**

  Impact of different model parameterizations:

  - different turbulence schemes
  - urban scheme on/off
  - canopy scheme / skin conductivity scheme

- **Part II (AEVUS 2)**

  Impact of different model configurations:

  - no intermediate step (9km → 1km)
  - boundary and initial conditions by ICON

- **Part III (AEVUS 2)**

  Urban parameter calibration

Set-up

Part I (AEVUS)

9 km → 5 km → 1 km

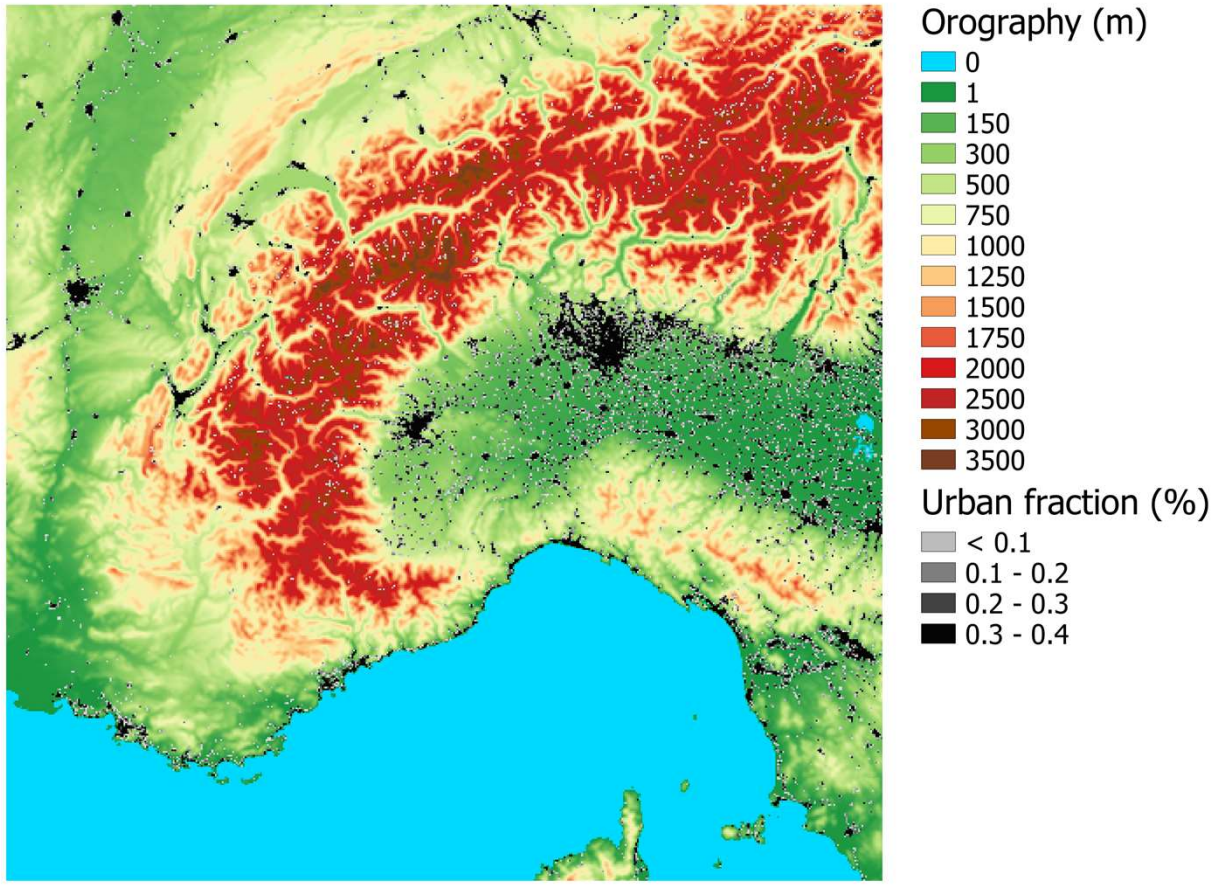
(IFS) (COSMO) (COSMO)

Part II & Part III (AEVUS2)

9 km → 1 km

(IFS) (COSMO)

Piemonte domain



External Parameters

2 different dataset of external parameters:

1) provided by WebPep through ExtPar → used when TERRA-URB is switched off

1) created a new dataset, where the external parameters affected by the "double-counting effect" have been modified and calculated according to the functions implemented in ExtPar but weighted excluding land use class 19 (urban) → used when TERRA-URB is switched on

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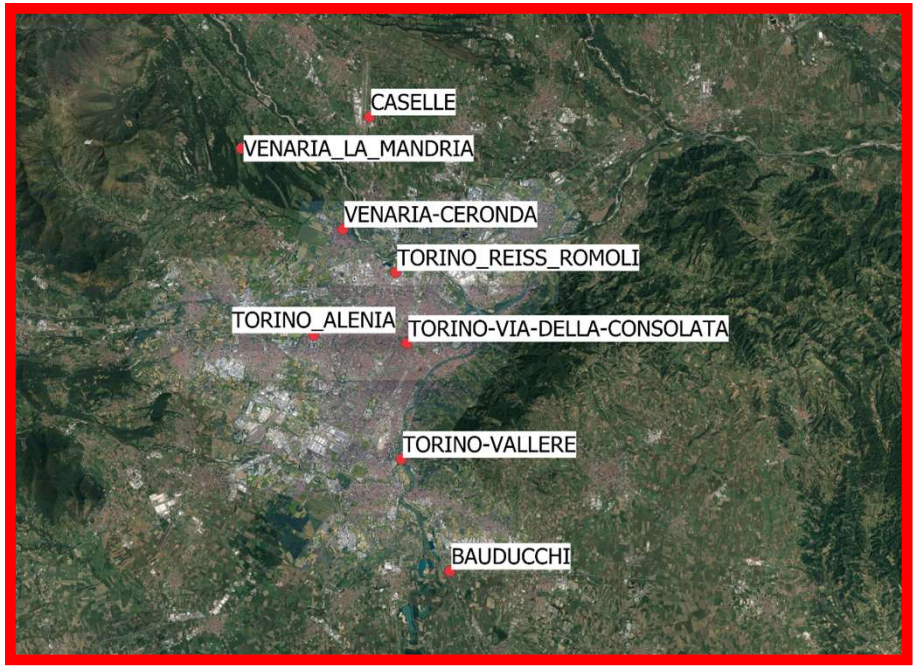
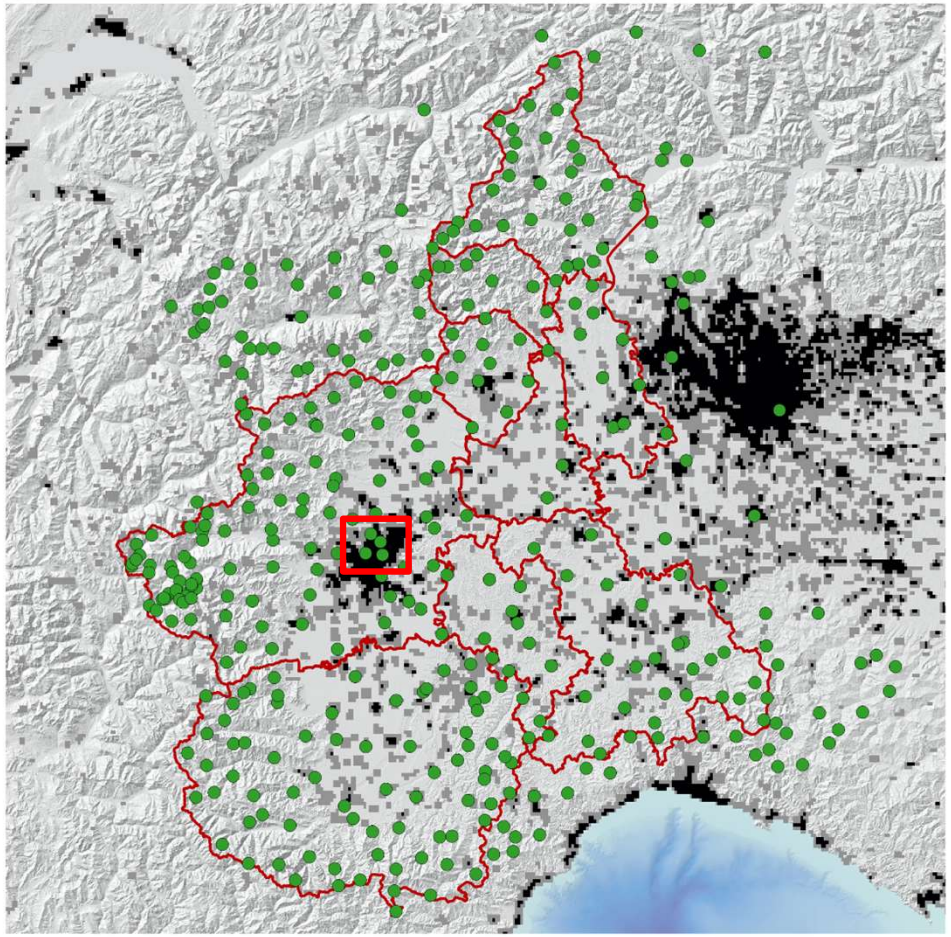
Verification

- Comparison have been performend between simulations and observations provided by the Arpa Piemonte network (few urban stations, many non-urban stations)





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MG1

Part I -AEVUS

Configurations set-up

- A “best configuration” has been chosen as suggested by Jan-Peter and 6 different configurations have been tested

- Each simulation runs from 15th (00:00) to 29th October 2017 (00:00): the first 7 days are used to assess the soil of the model (“spin-up”), but the comparison have been done for the test-case week **22-29th October 2017**

- Evaluation of different model parametrisations
  1. different turbulence schemes
  2. urban scheme ON/OFF
  3. canopy scheme / skin temperature scheme

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Diapositiva 6

f1 per quanto riguarda lo spin-up, da come l'ho capita io, COSMO aveva dei problemi soprattutto in modalità forecast a simulare l'umidità del suolo. In qualche modo la perdeva dopo un pò (troppa evaporazione). Introducendo però i parametri suggeriti da JP (itype_evsl= 4, itype_root= 2, cwimax_ml= 0.0005, itype_heatcond= 3, itype_canopy= 2) questo problema si riduce, infatti abbiamo visto che se facciamo solo una settimana di simulazione (sim7) non cambia molto rispetto a sim6.

famiglia; 14/03/2020

MG1 per quanto riguarda lo spin-up, da come l'ho capita io, COSMO aveva dei problemi soprattutto in modalità forecast a simulare l'umidità del suolo. In qualche modo la perdeva dopo un pò (troppa evaporazione). Introducendo però i parametri suggeriti da JP (itype_evsl= 4, itype_root= 2, cwimax_ml= 0.0005, itype_heatcond= 3, itype_canopy= 2) questo problema si riduce, infatti abbiamo visto che se facciamo solo una settimana di simulazione (sim7) non cambia molto rispetto a sim6.

Matteo Garbarino; 16/03/2020

Tested configurations

	sm 0	sm 1	sm 2	sm 3	sm 4	sm 5
Old tur	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE
TERRA_URB	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE
itype canopy	1	1	1	2	1	2

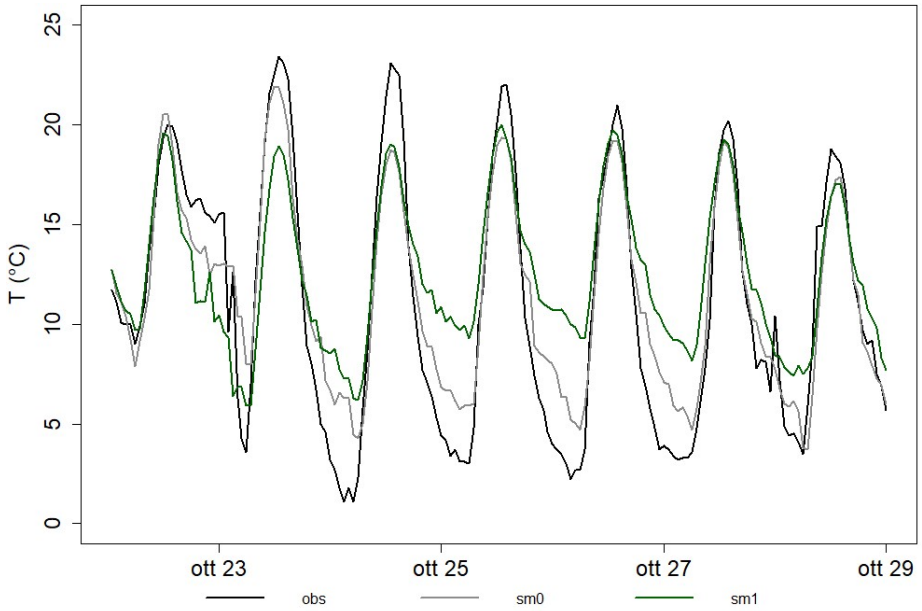
- sim 0 and sim 1 → ExtPar output (TERRA_URB = false)
- sim 2, 3, 4 and 5 → ExtPar output modified to prevent the double counting effect on each tile (TERRA_URB = true)

T 2m

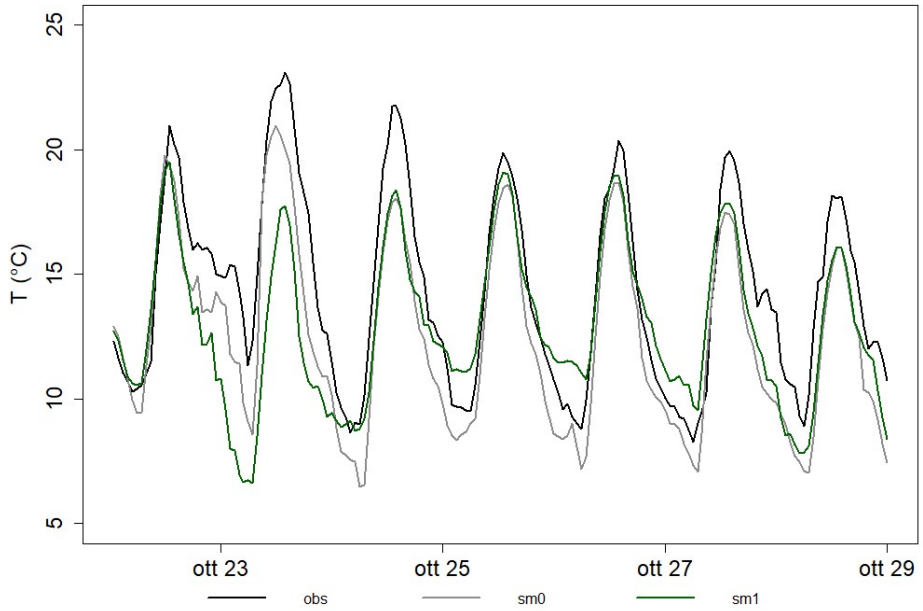
Effect of the new physics

itype_canopy = 1 and TERRA_URB off

Bauducchi rural station



urban station



Sim 0: new turbulence → best

Sim 1: old turbulence

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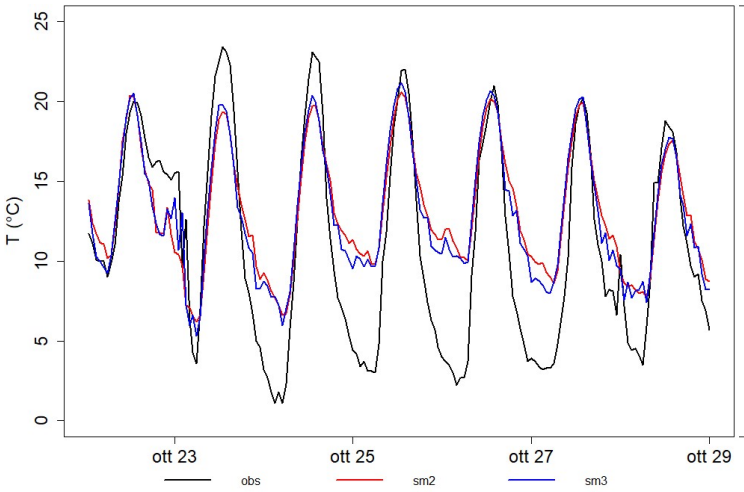
T 2m

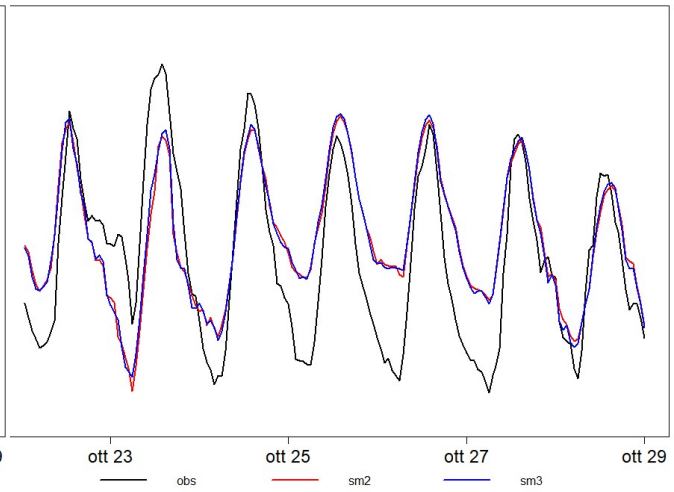
Effect of itype_canopy

old physics and TERRA_URB on

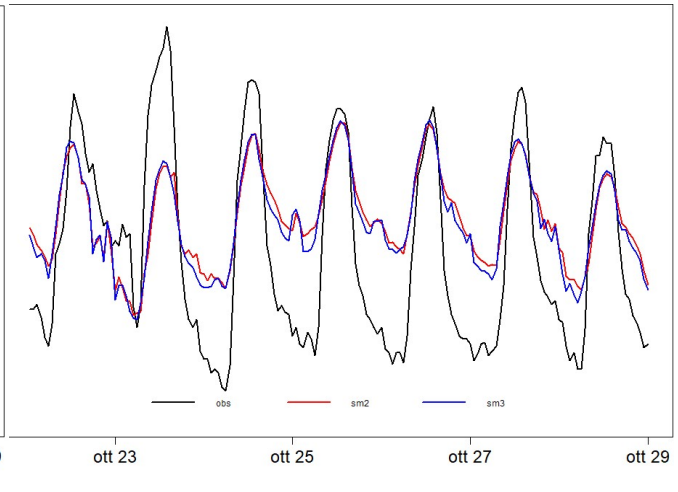
Bauducchi rural station



urban station



Venaria La Mandria rural station



Sim 2: it_canopy = 1

Sim 3: it_canopy = 2 ➡ best effect in rural areas

*Venaria not well represented, diurnal variation too small:

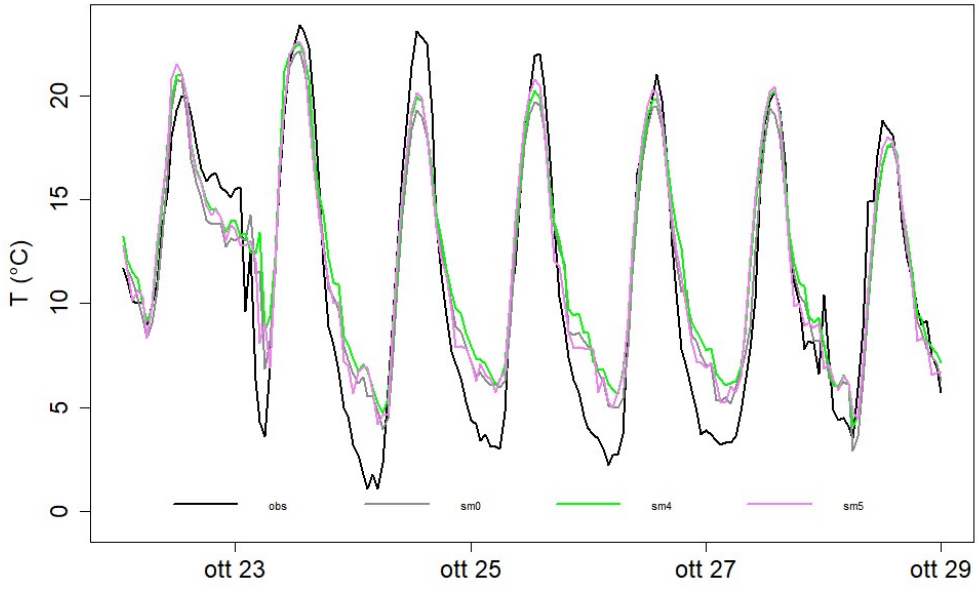
are the urban parameters correct?

T 2m

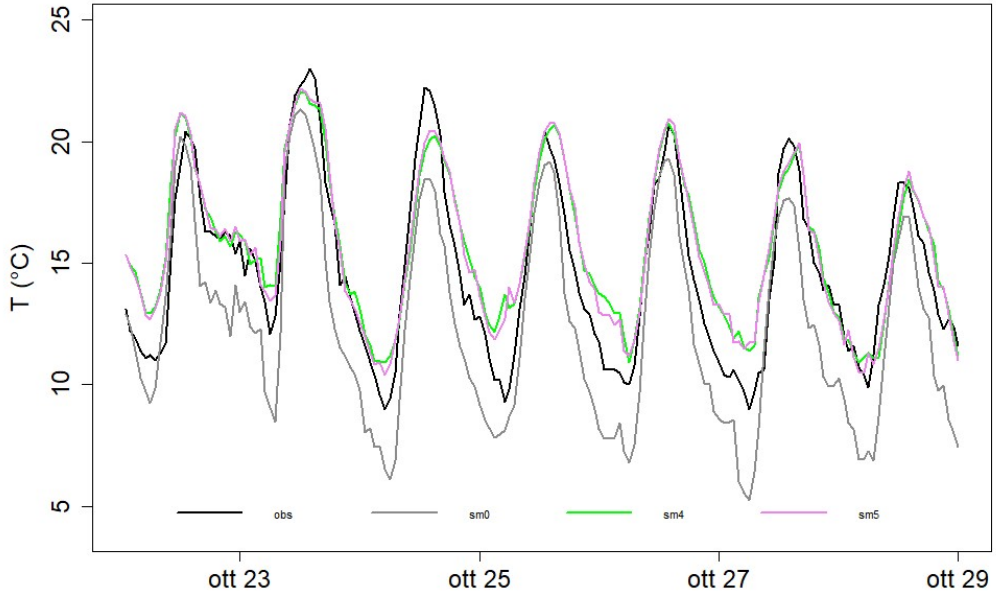
Effect of TERRA-URB

New turbulence

Bauducchi rural station



Consolata urban station



Sim 0: TERRA_URB=off, itype_canopy=1

Sim 4: TERRA_URB=on, itype_canopy=1

Sim 5: TERRA_URB=on, itype_canopy=2 ➡ best, even too warm during night

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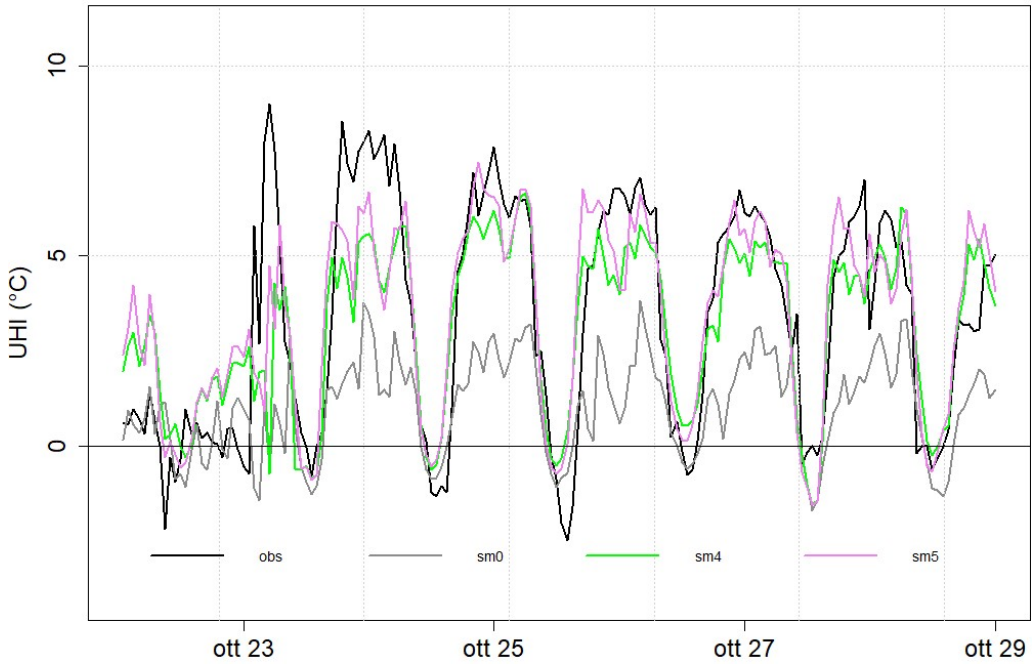
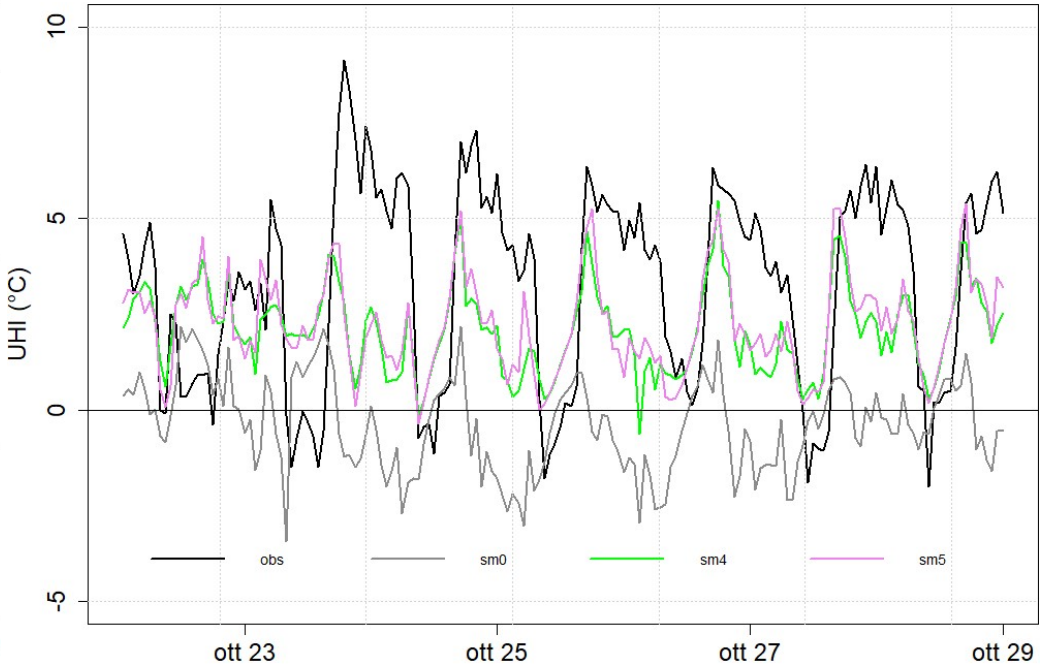
Urban Heat Island

best namelists

3 urban stations – Bauducchi



3 urban stations – Venaria La Mandria



Sim 5 (TERRA-URB=TRUE, OLDTUR=FALSE, itype_canopy=2)
better represents the observed data
unsatisfactory agreement for Venaria

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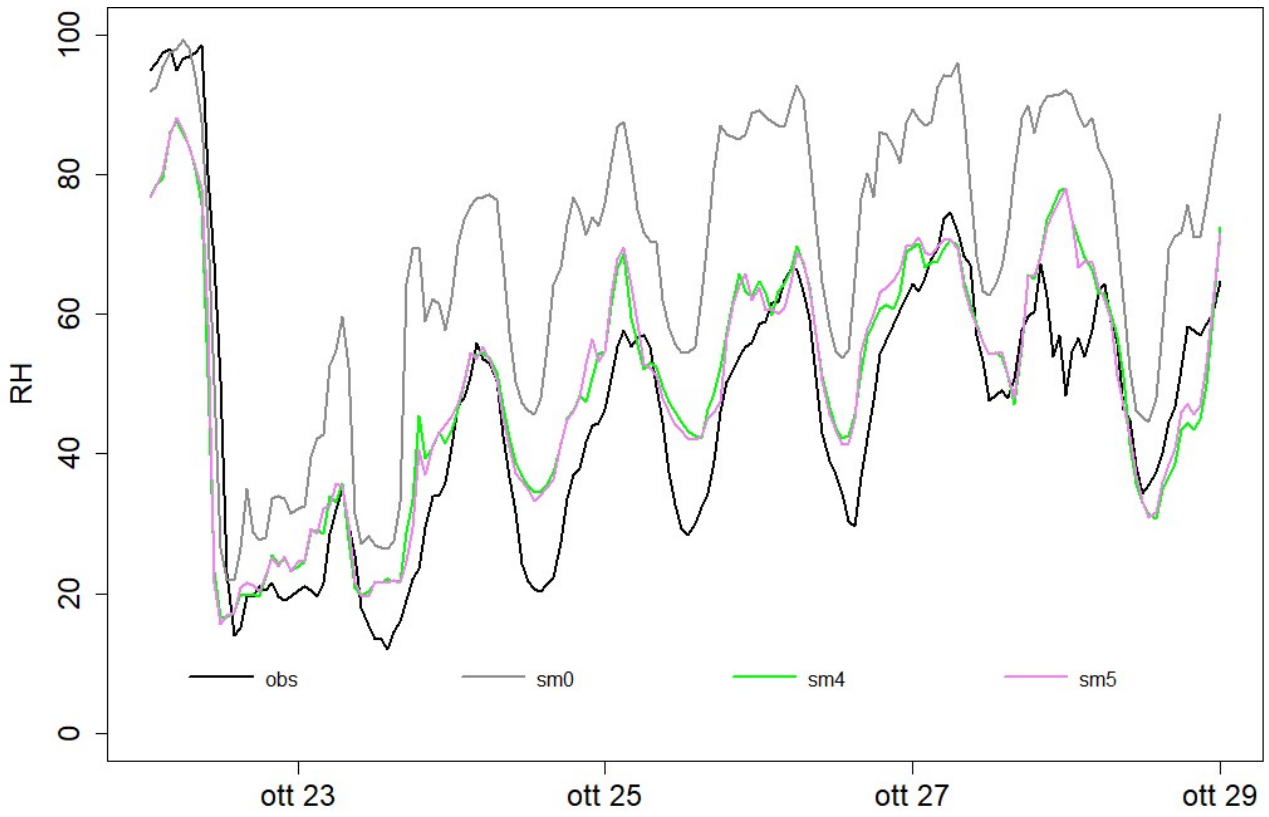
Relative Humidity
best namelists

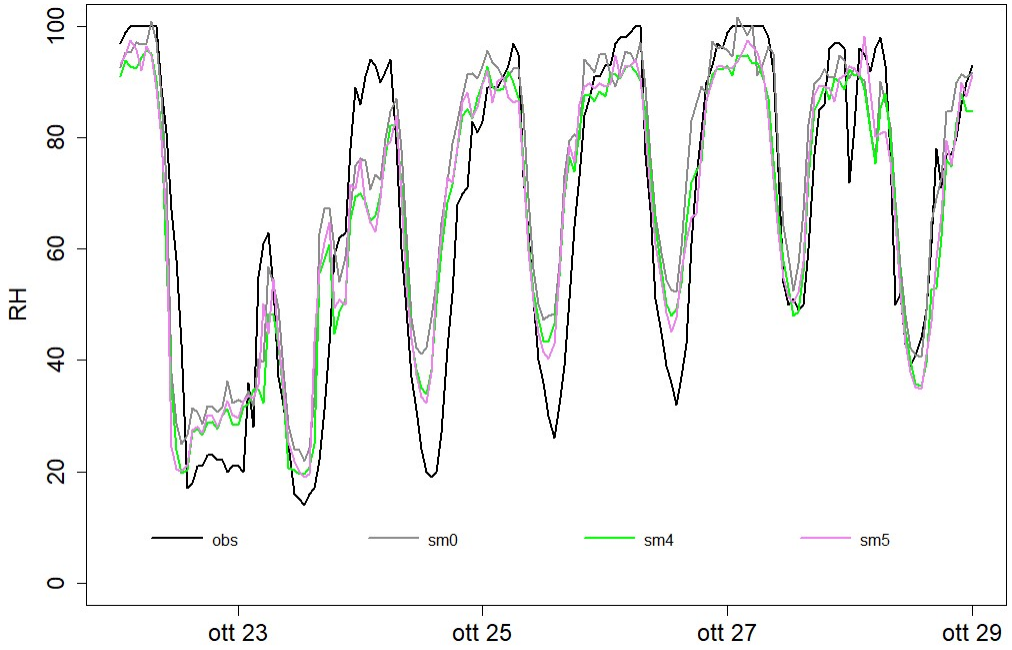
urban station



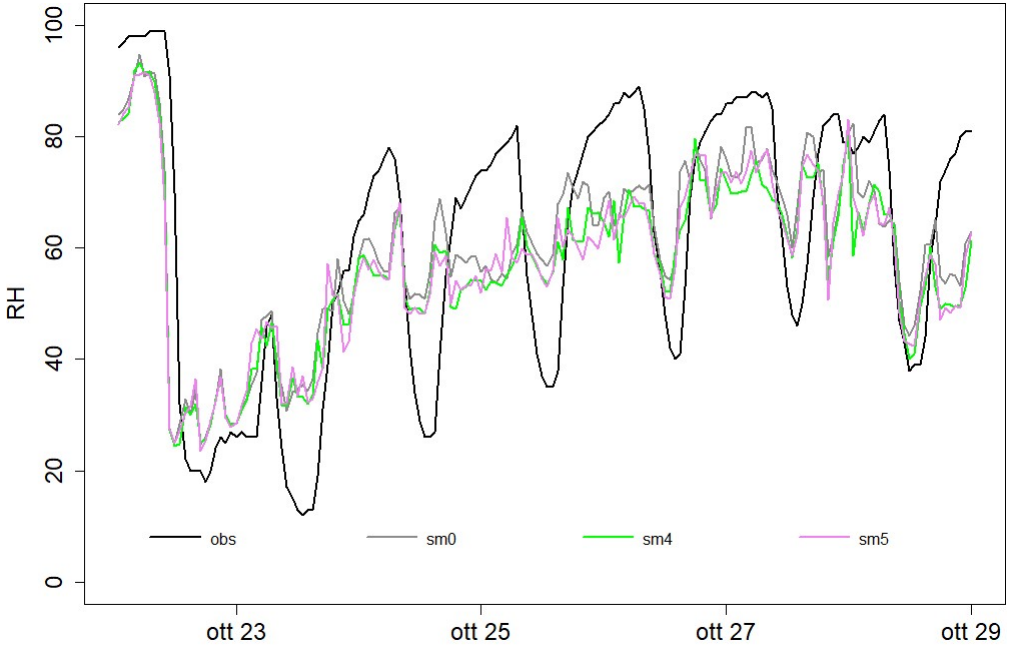
Sim **4** and **5** (terra_urb=TRUE) better represent the urban areas than sim **0**

Relative Humidity
best namelists

Bauducchi (rural station)



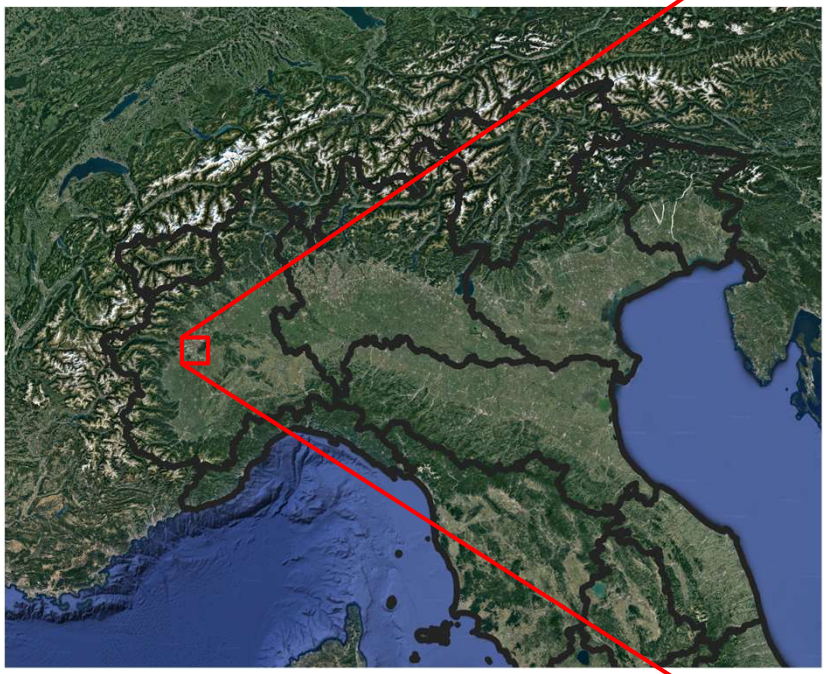
Venaria La Mandria (rural station)

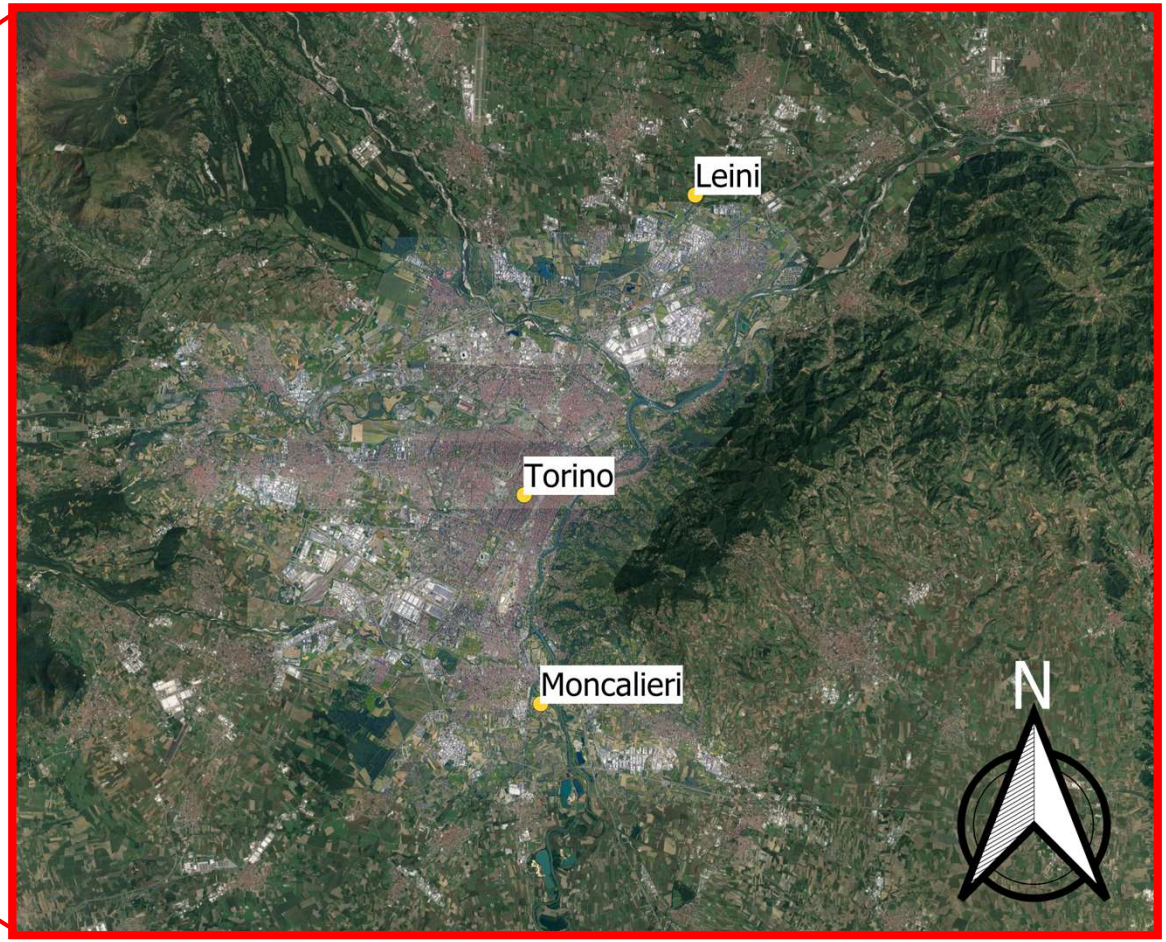


All the configurations do not show significative difference
Venaria not well represented: is it considered too urban?

Vertical T profiles

Radiometers position





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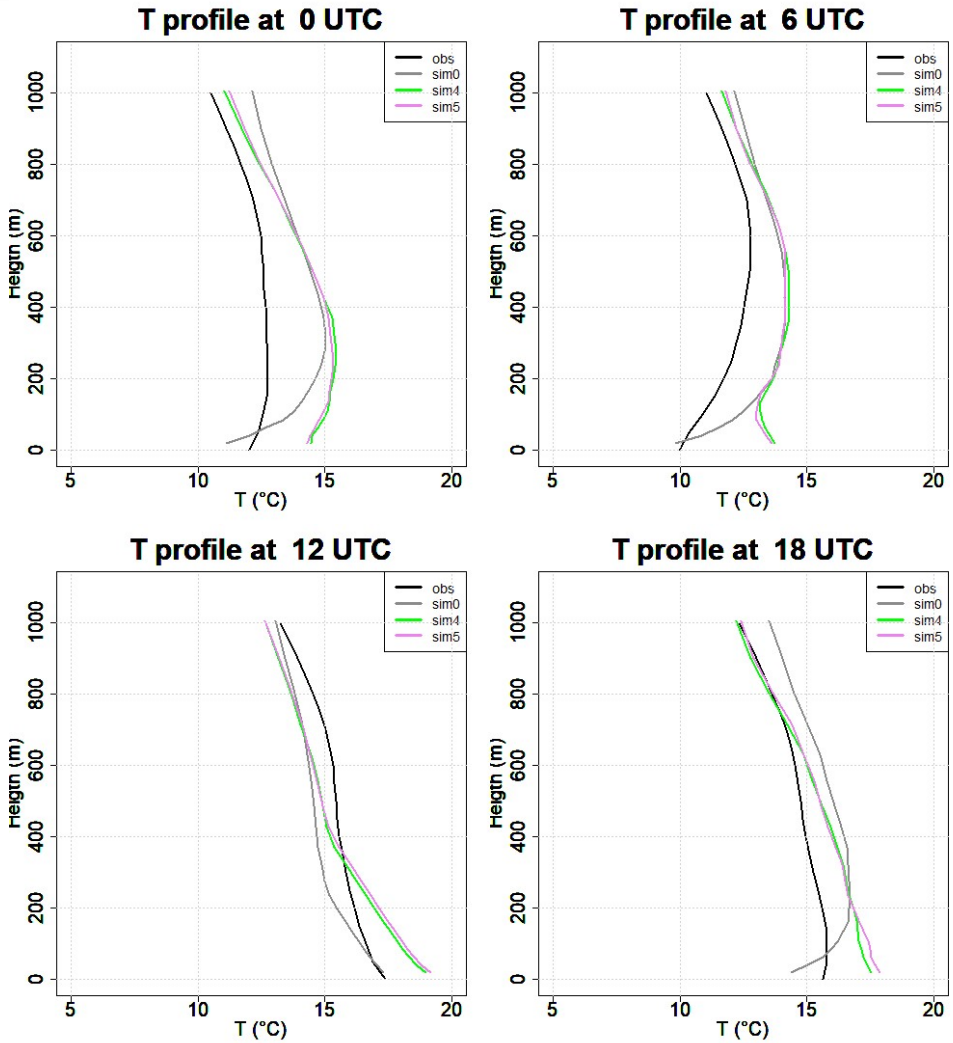
Vertical T profiles
best namelists

Torino city center

rather unsatisfactory behaviour for all the radiometers (both urban and rural)



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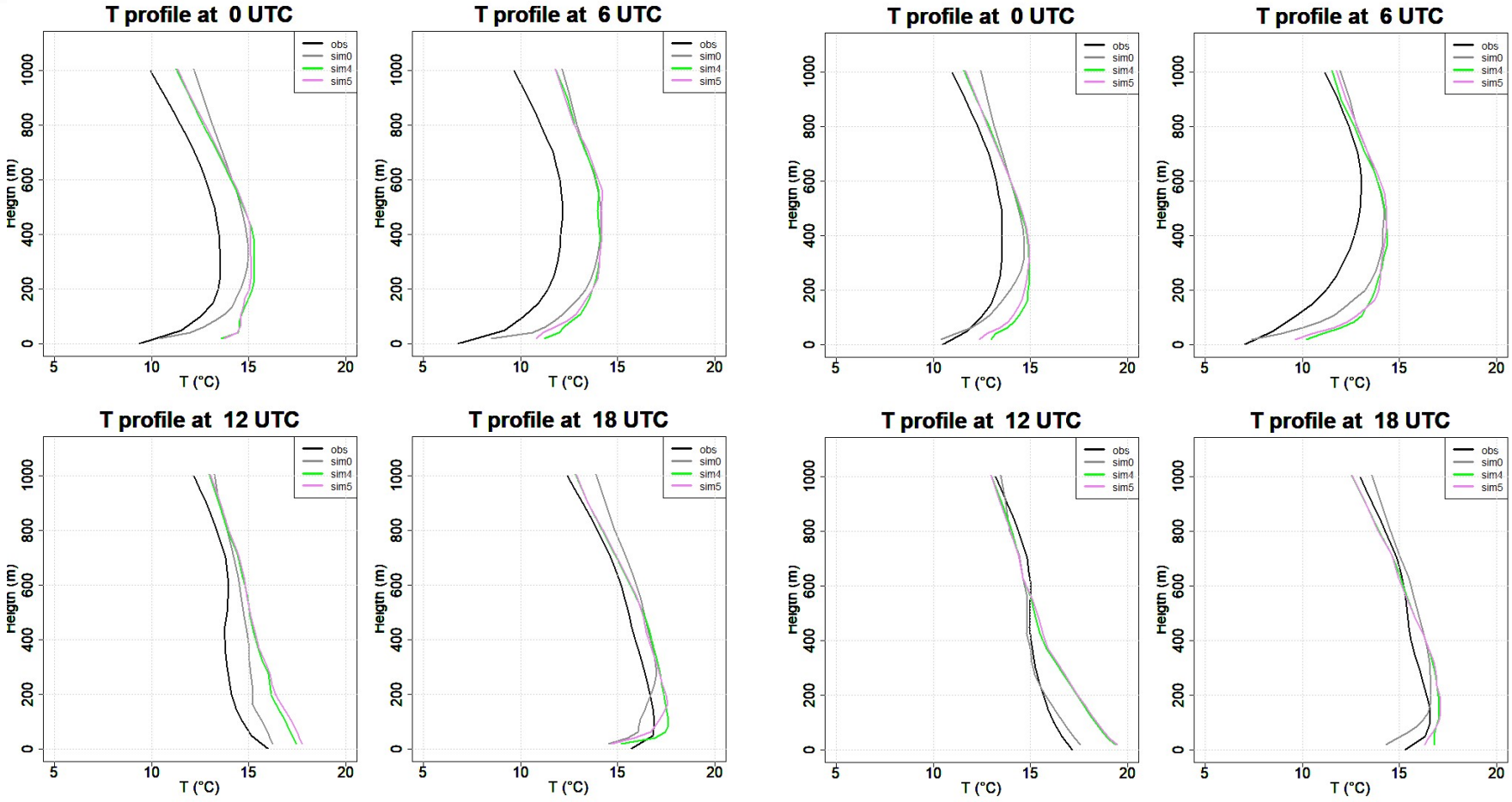
Vertical T profiles
best namelists



Leinì (North)

Moncalieri (South)

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PART II
Configurations set-up

Best namelists from the previous analysis: **new** physics, TERRA_URB **on** and itype canopy = **2**

- Boundary and initial conditions (analysis) provided at 9 km resolution every 6 hours by IFS
- COSMO run at 1 km resolution over a domain that includes Piemonte region

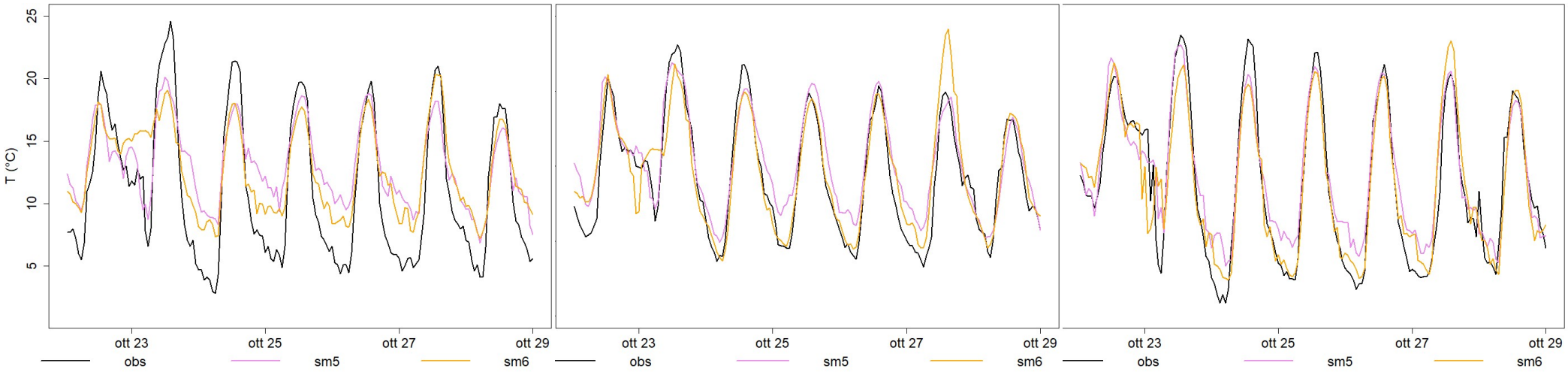
→ Sim 6: 9 km → 1 km
→ Sim 7: 9 km → 1 km (no spin up)

- Boundary and initial conditions provided at 13 km resolution by ICON
- COSMO at 5 km resolution
- COSMO at 1 km resolution over a domain that includes Piemonte region

→ Sim 8: 13 km → 5 km → 1 km

T 2m
Effect of no intermediate step

Venaria La Mandria (rural station) | Mean of 3 urban stations | Bauducchi (rural station)



Sim 5: 9 km → 5 km → 1 km | Sim 6: 9 km → 1 km
(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Sim 6 is quite similar to Sim 5 for maximum T, while there is an improvement in minimum T

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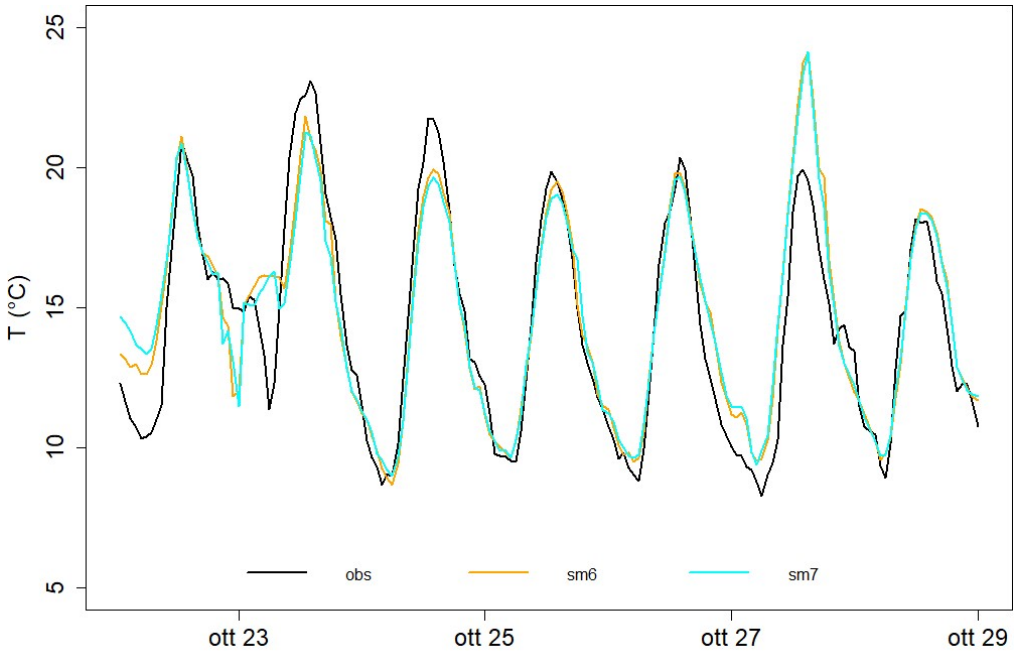
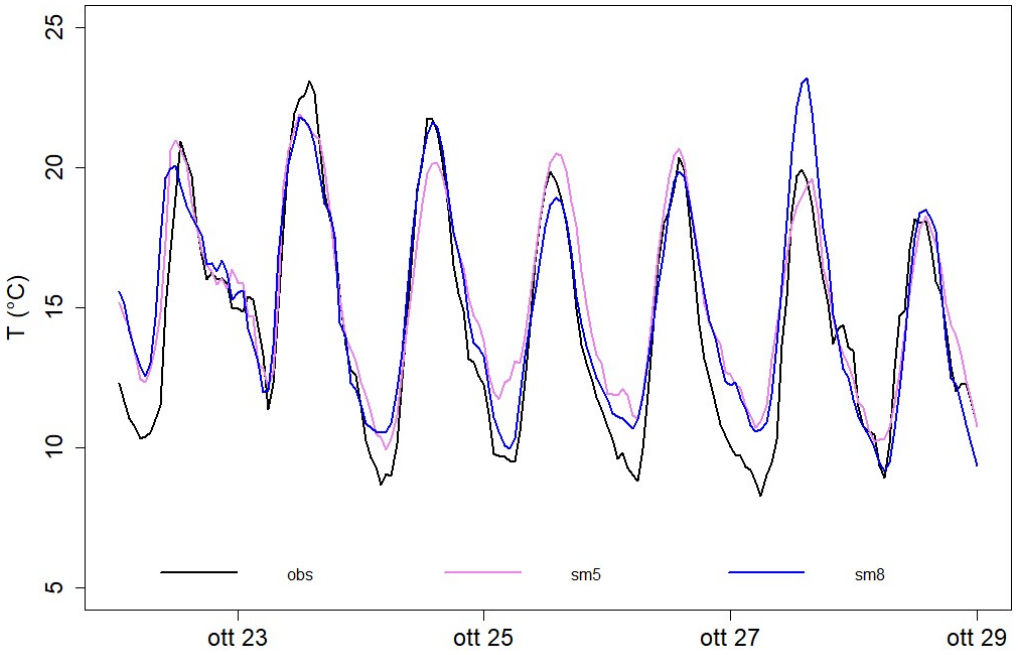
T 2m

Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up
Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km
(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Mean of 3 urban stations





There are no differences between sim **6** and sim **7**;
Sim **8** (ICON i.c. & b.c.) works well (few differences with Sim. **5**)

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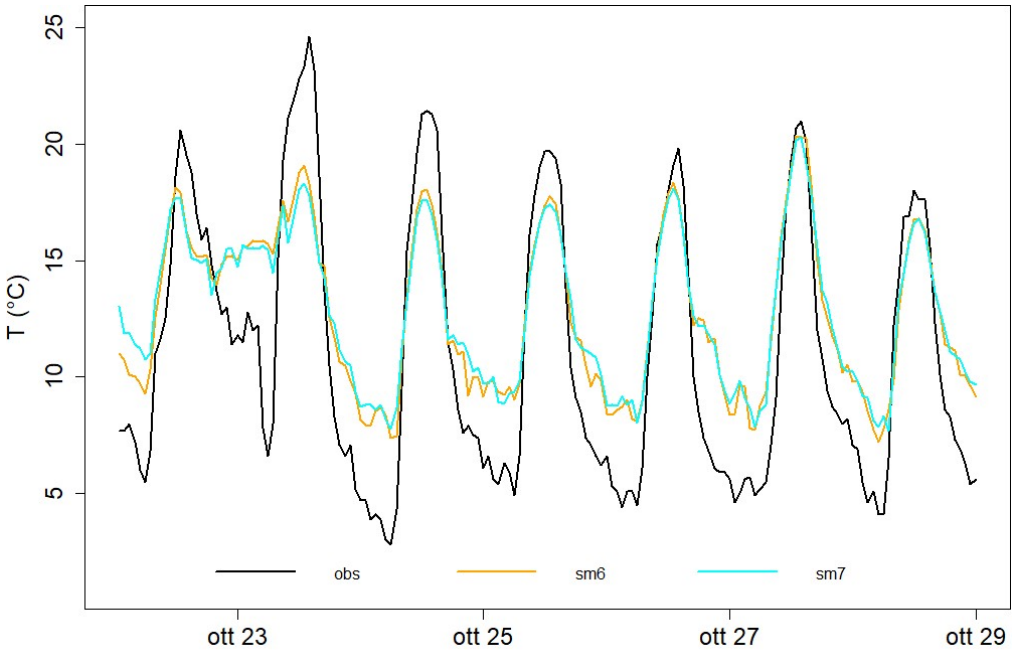
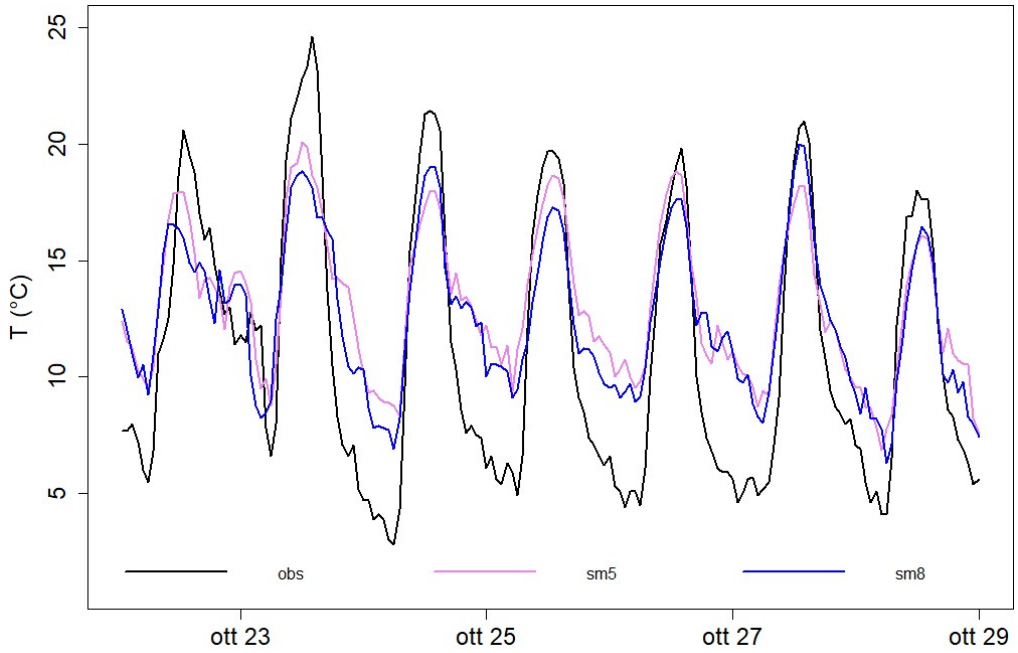
T 2m

Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up
Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km
(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Venaria La Mandria (rural station)





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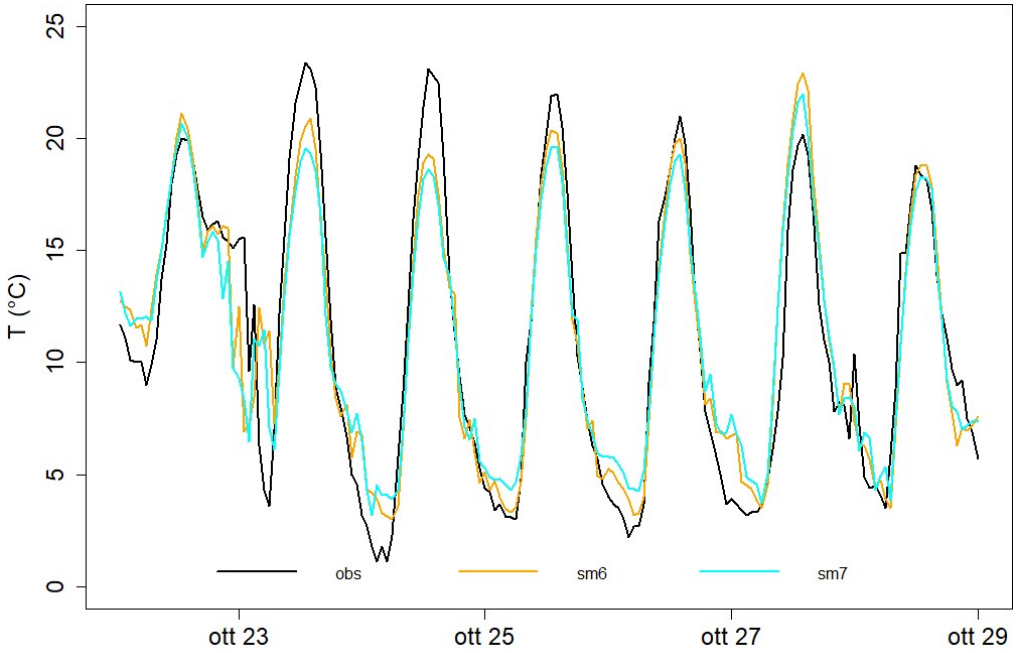
T 2m

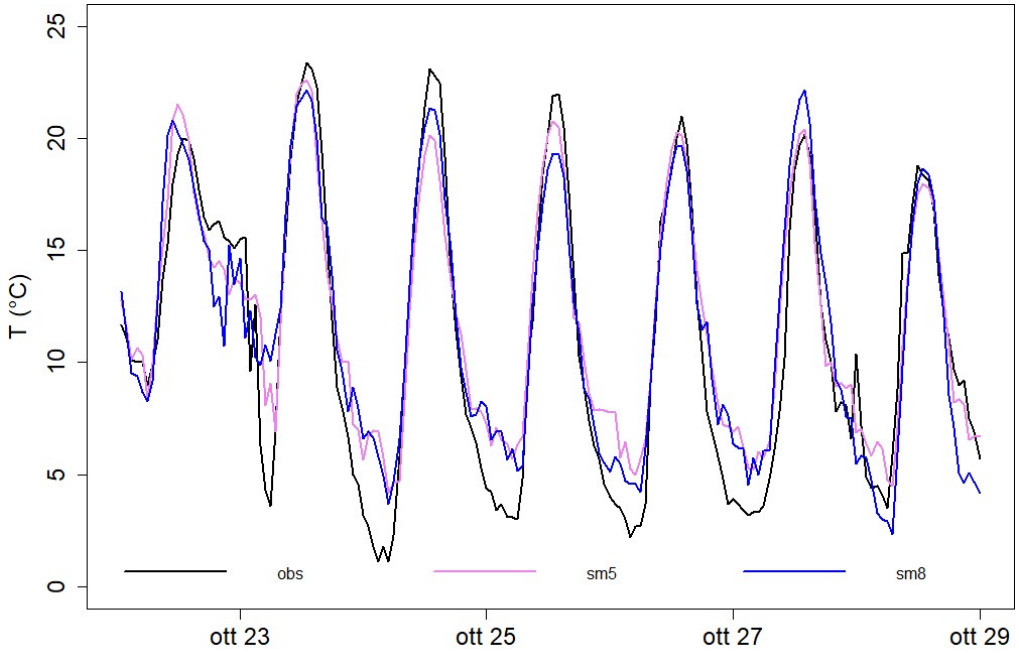
Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = 2)

Bauducchi (rural station)





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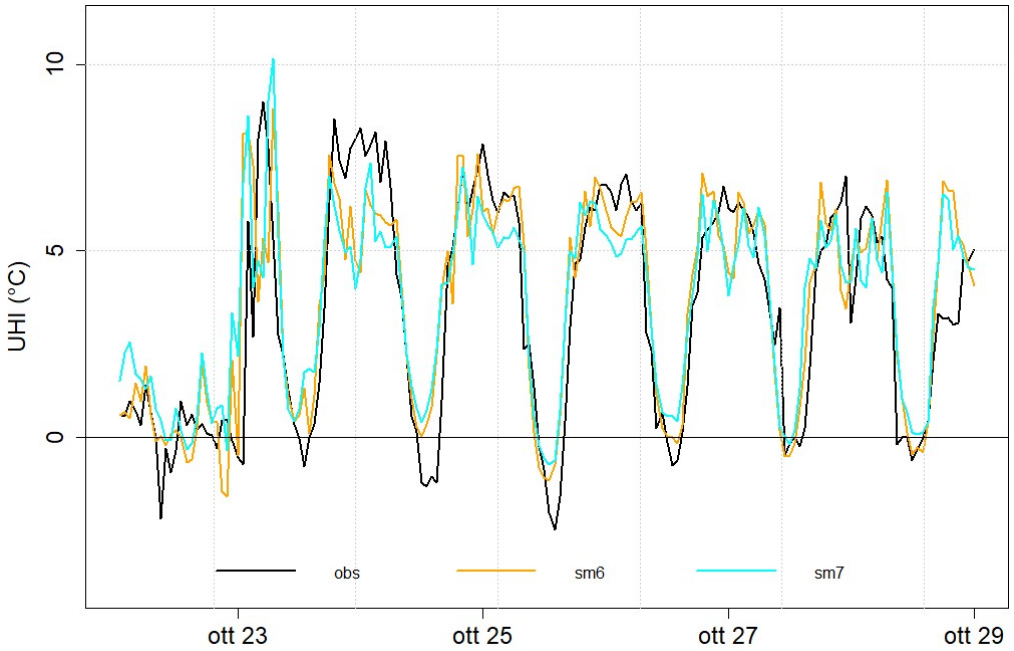
UHI

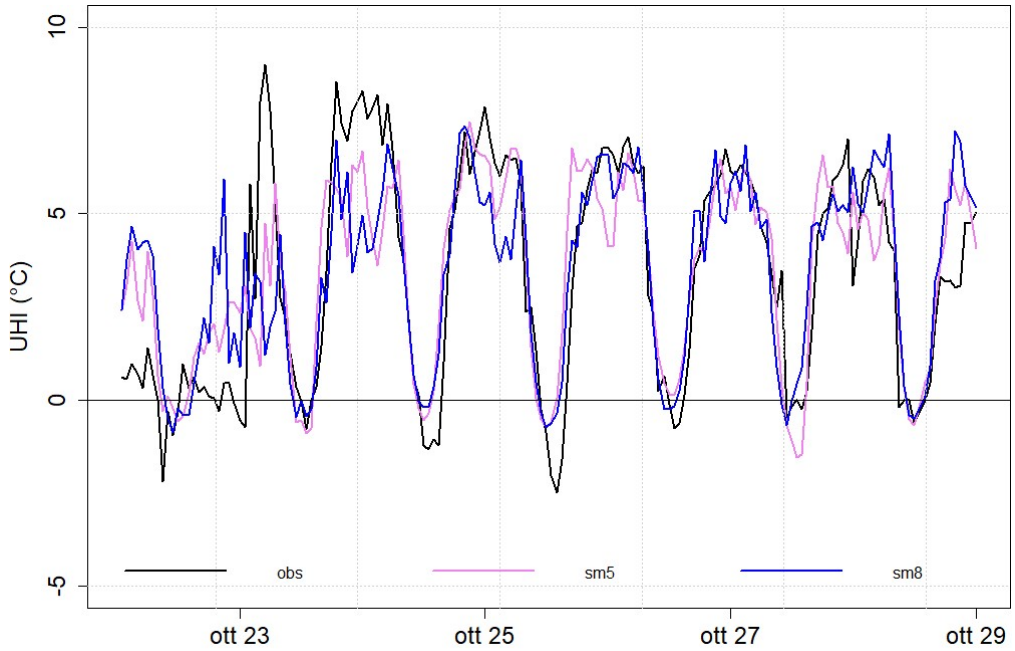
Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = **2**)

3 urban stations – Bauducchi





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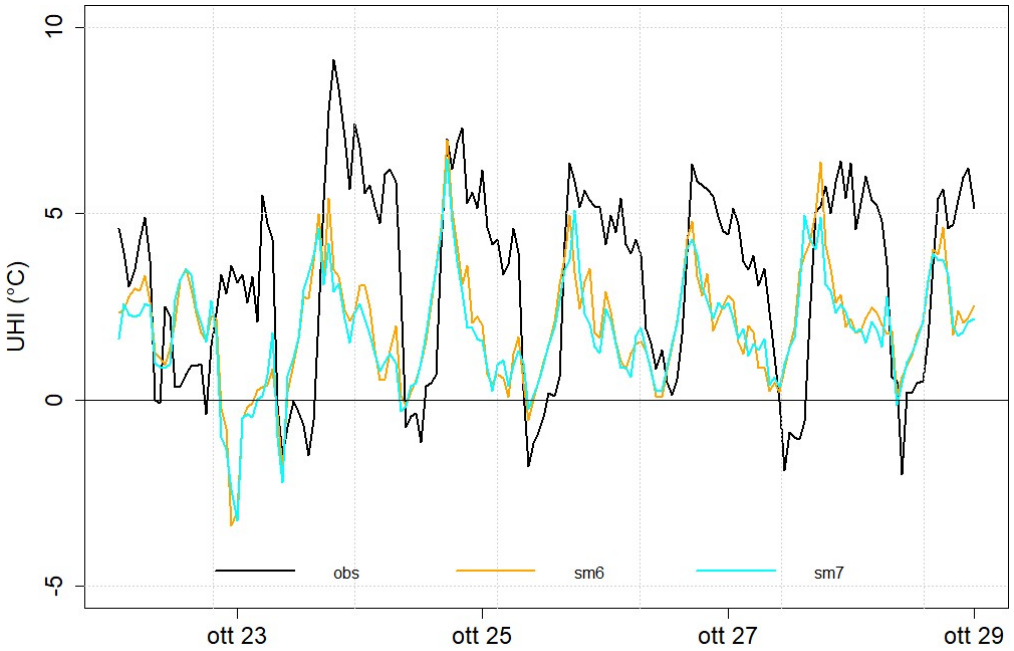
UHI

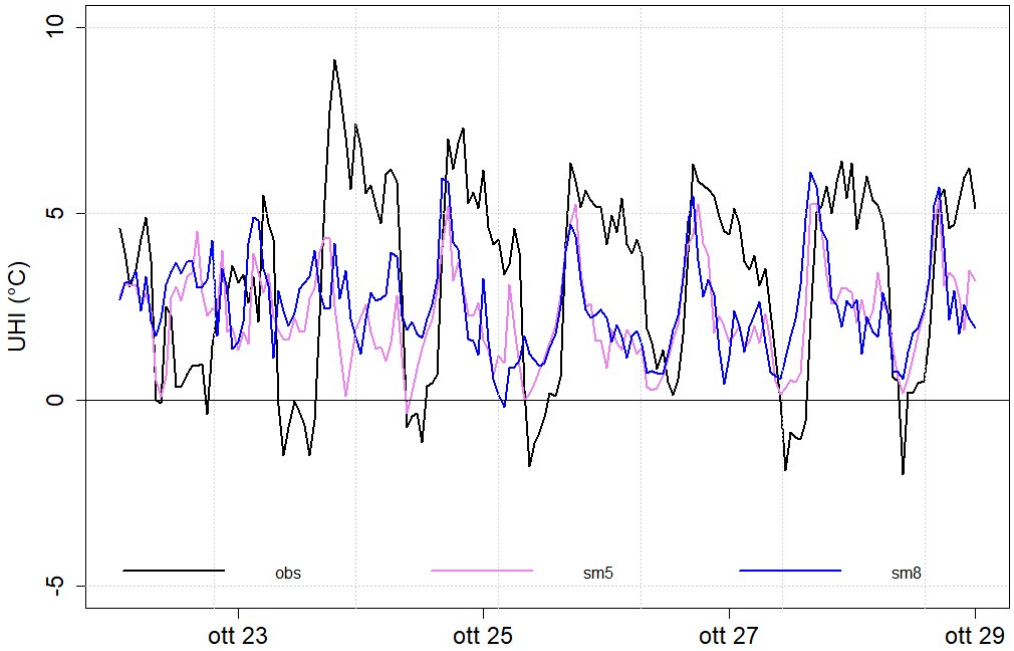
Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = 2)

3 urban stations – Venaria La Mandria





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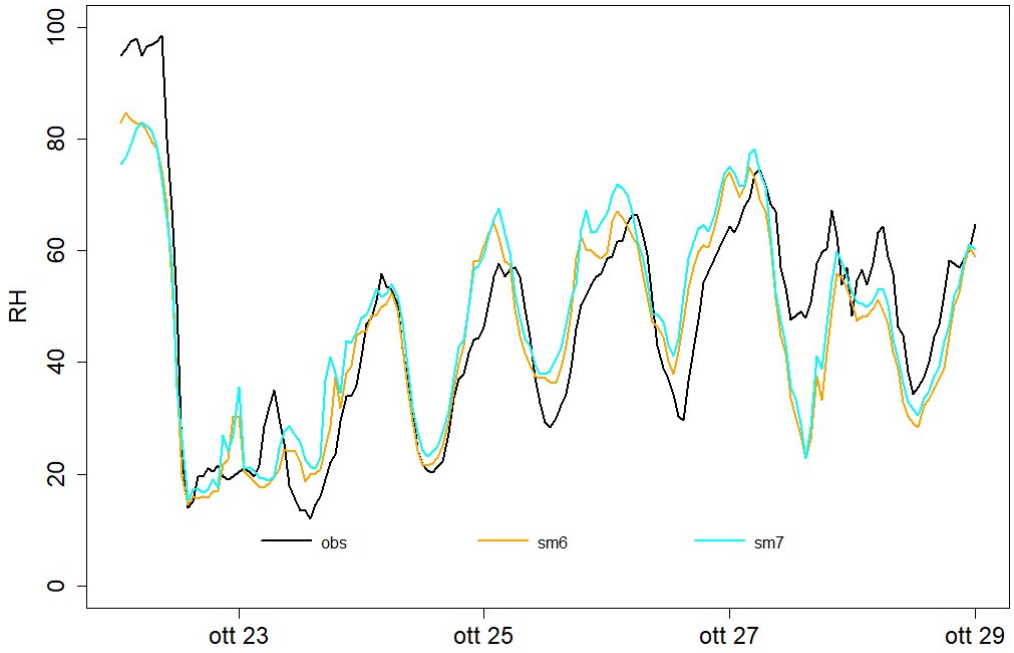
Relative Humidity

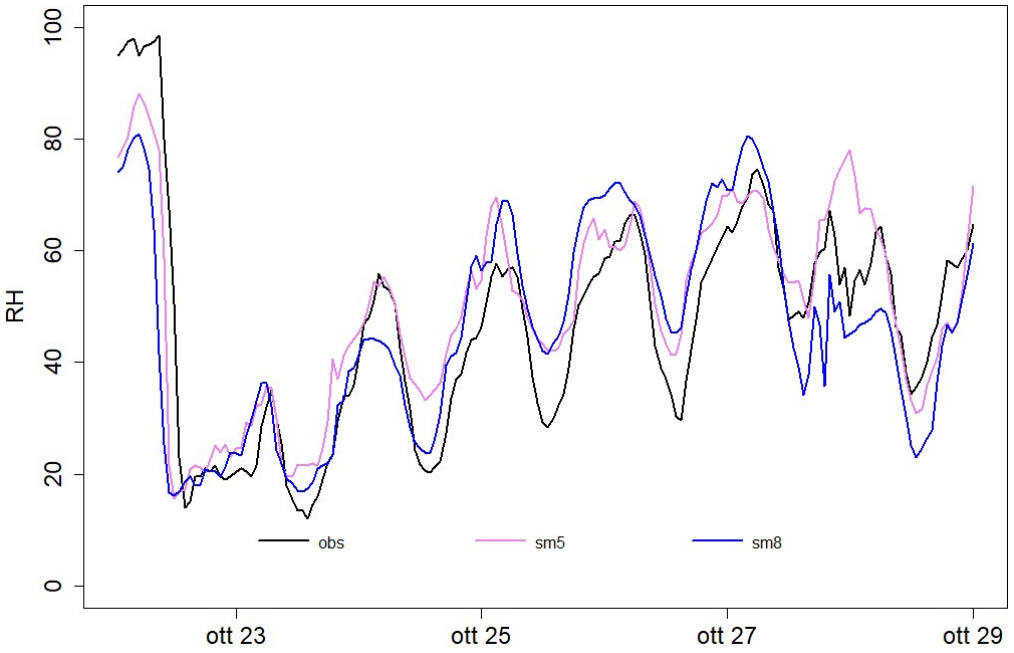
Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = **2**)

3 urban stations





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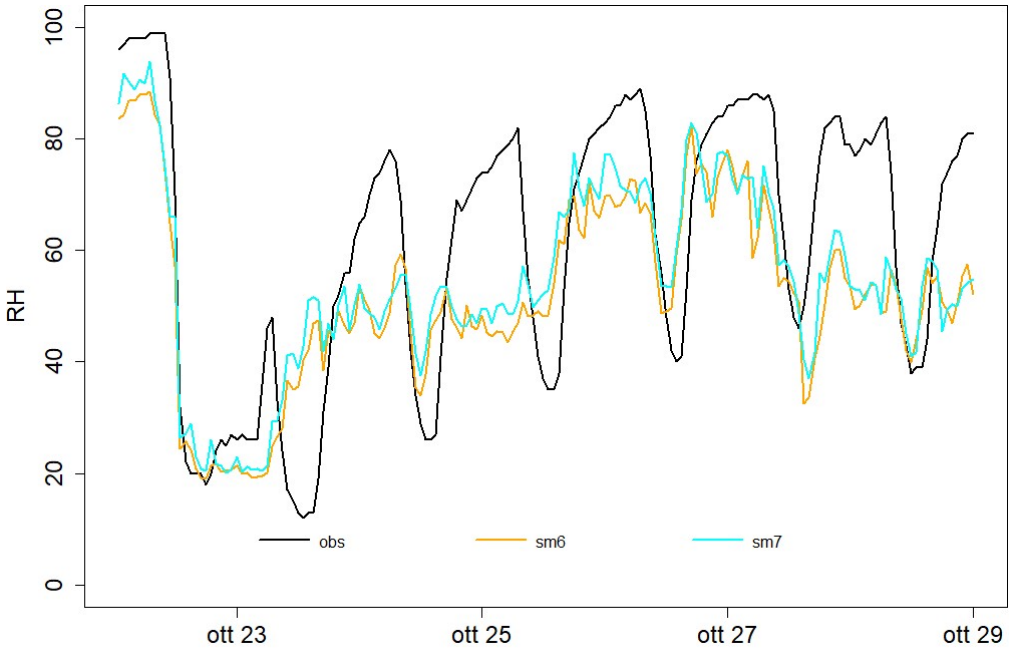
Relative Humidity

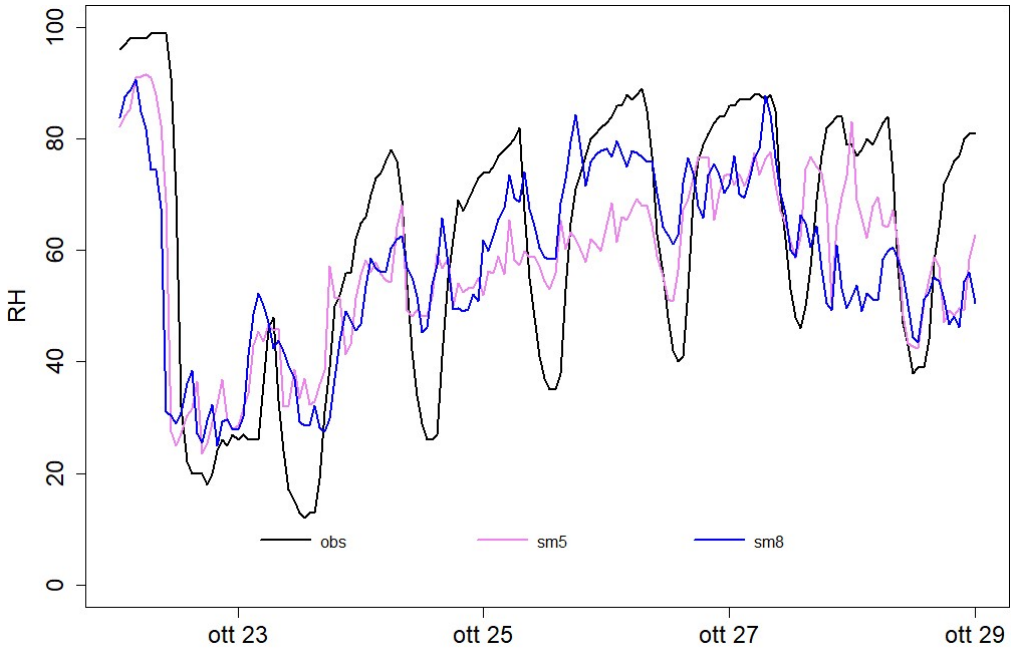
Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Venaria La Mandria (rural station)





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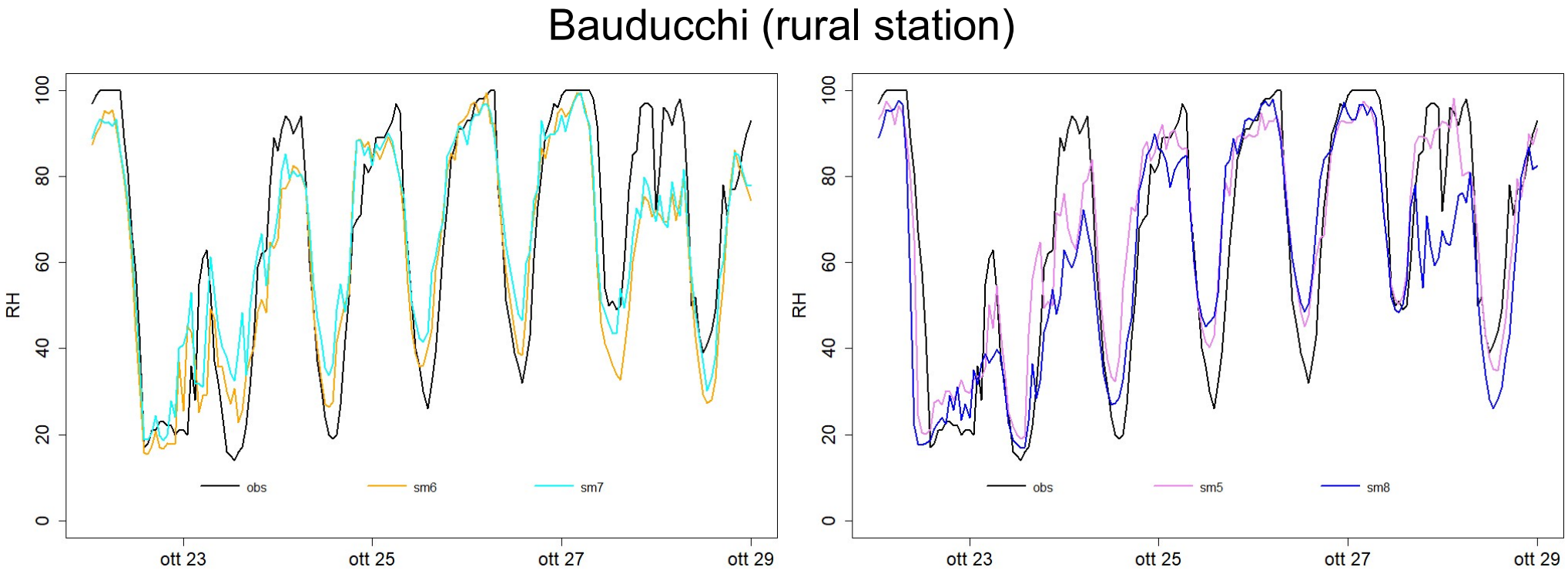
Relative Humidity

Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = **2**)



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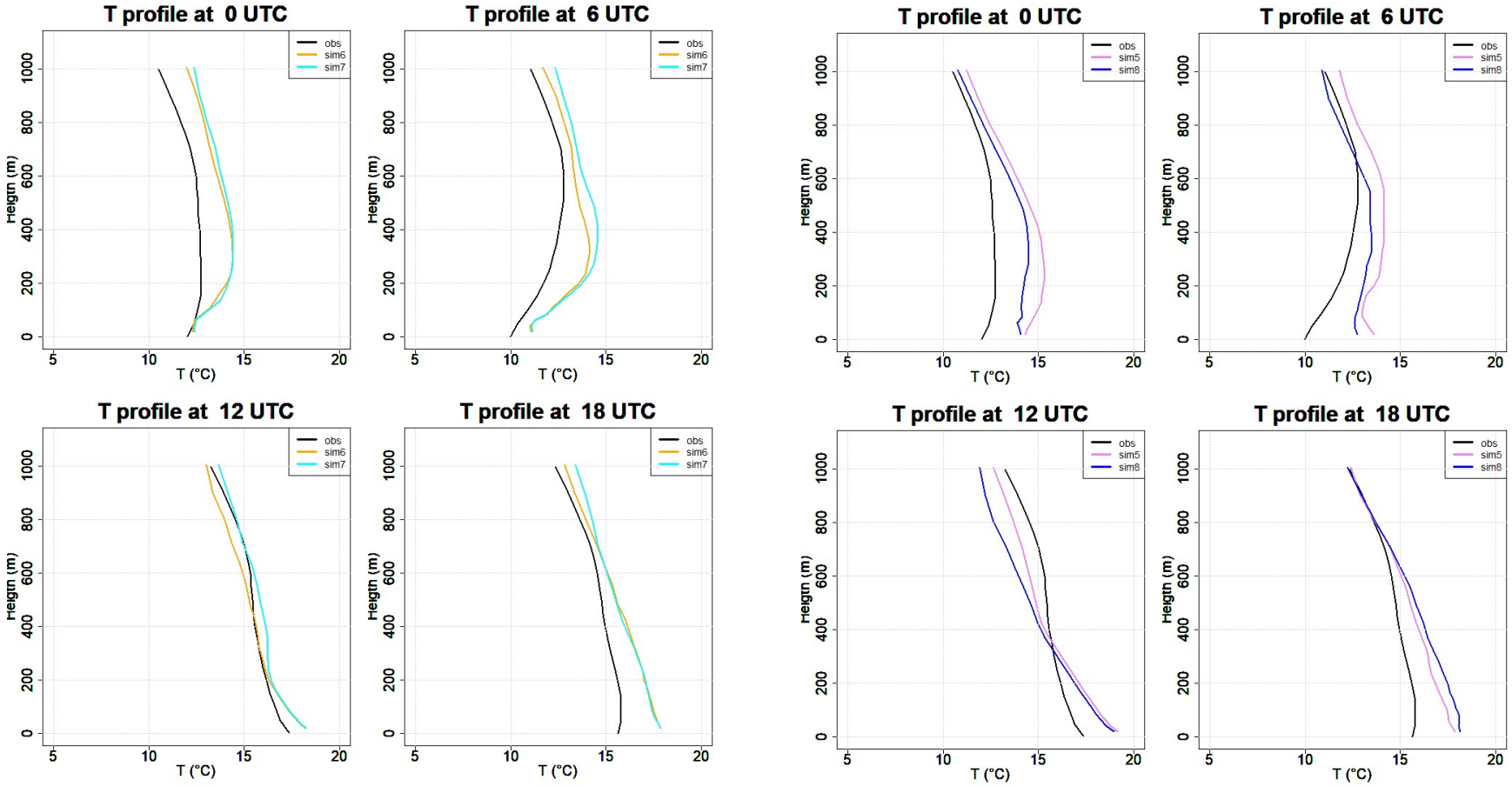
Vertical T profile

Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = 2)



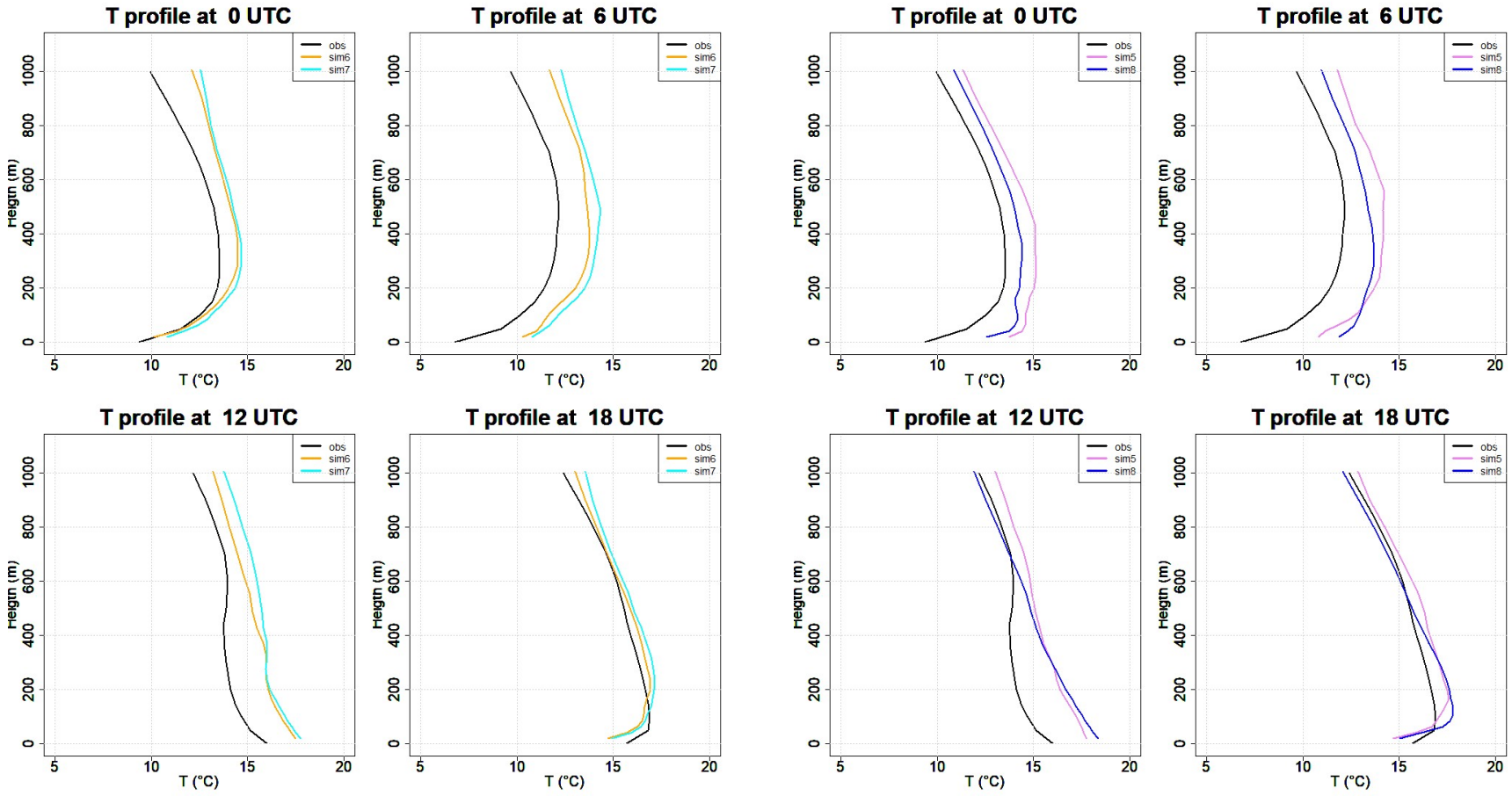
Torino (city center)

Vertical T profile

Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = 2)



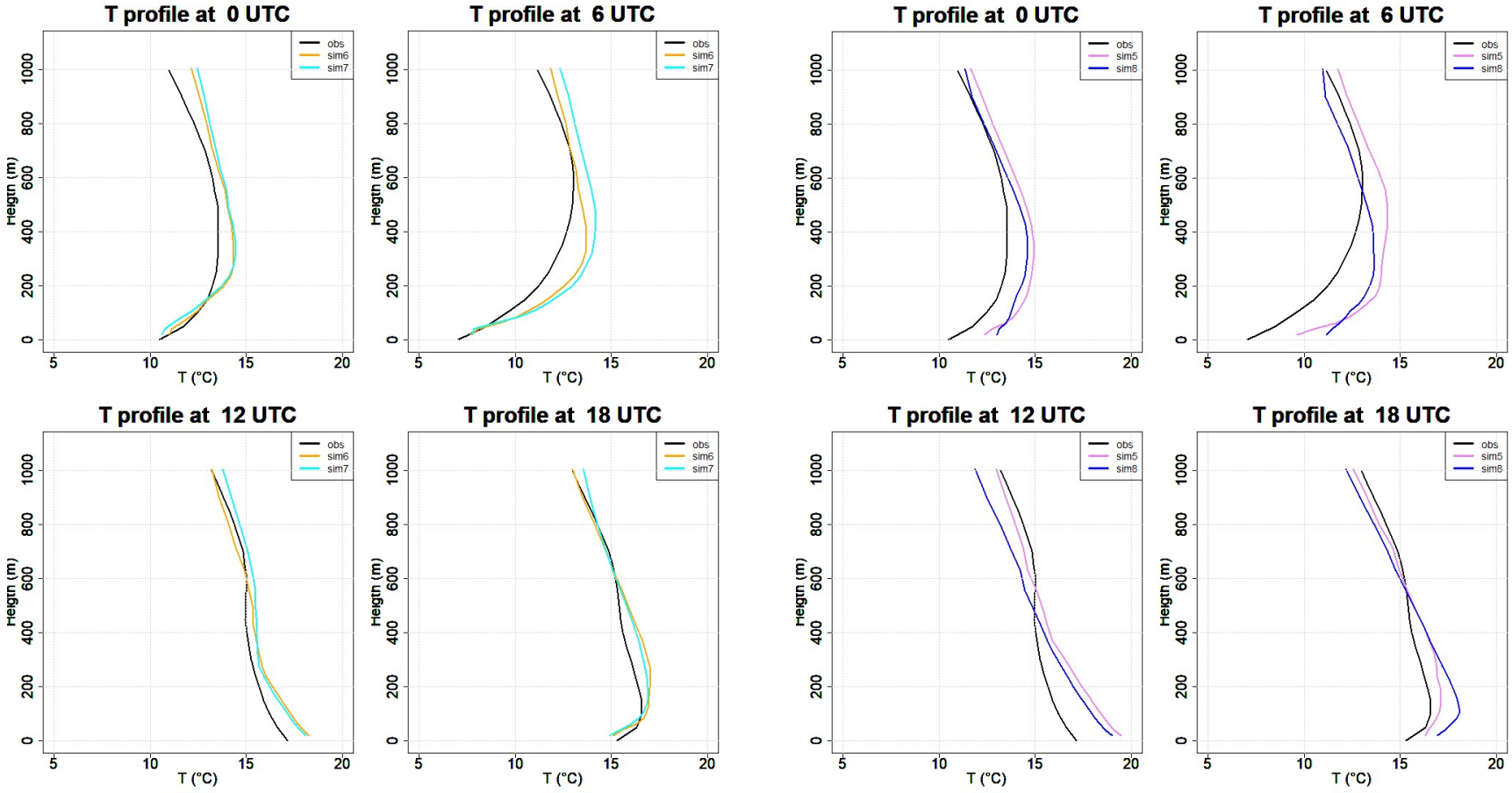
Leinì (North)

Vertical T profile

Sim 6: 9→1 km | Sim 7 = Sim 6 no spin-up

Sim 5: 9→5→1 km | Sim 8: 13 km (ICON)→5→ 1km

(**New** physics, TERRA_URB **on** and itype canopy = 2)



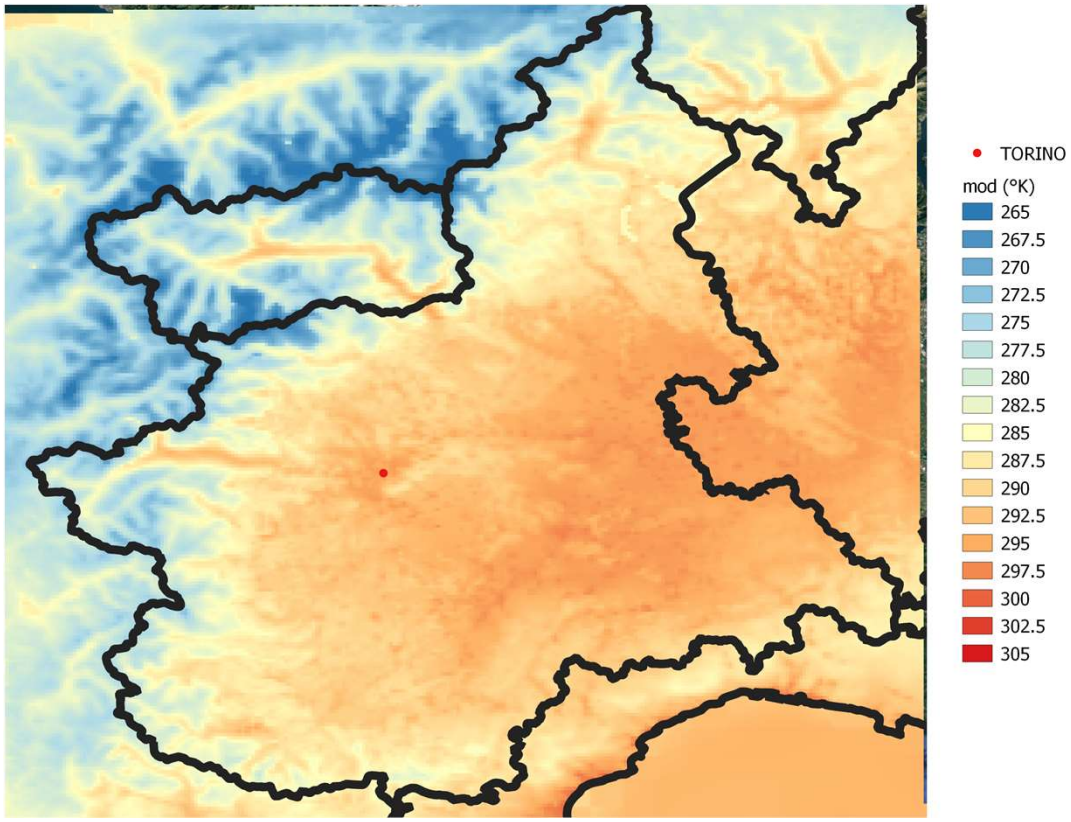
Moncalieri (South)

Skin Temperature

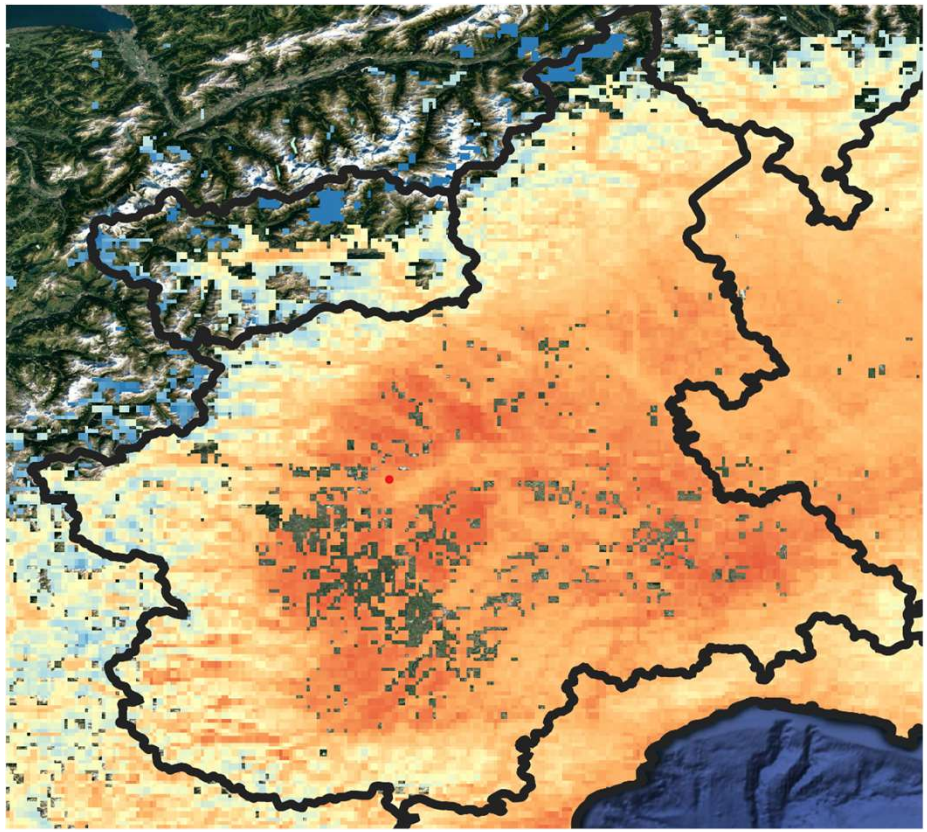
Sim 6: 9→1 km

(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Simulated



Observed, Land Surface Temperature (MODIS)



22nd October 2017, h 10:00

PIEMONTE Arpa Agenzia Regionale per la Protezione Ambientale

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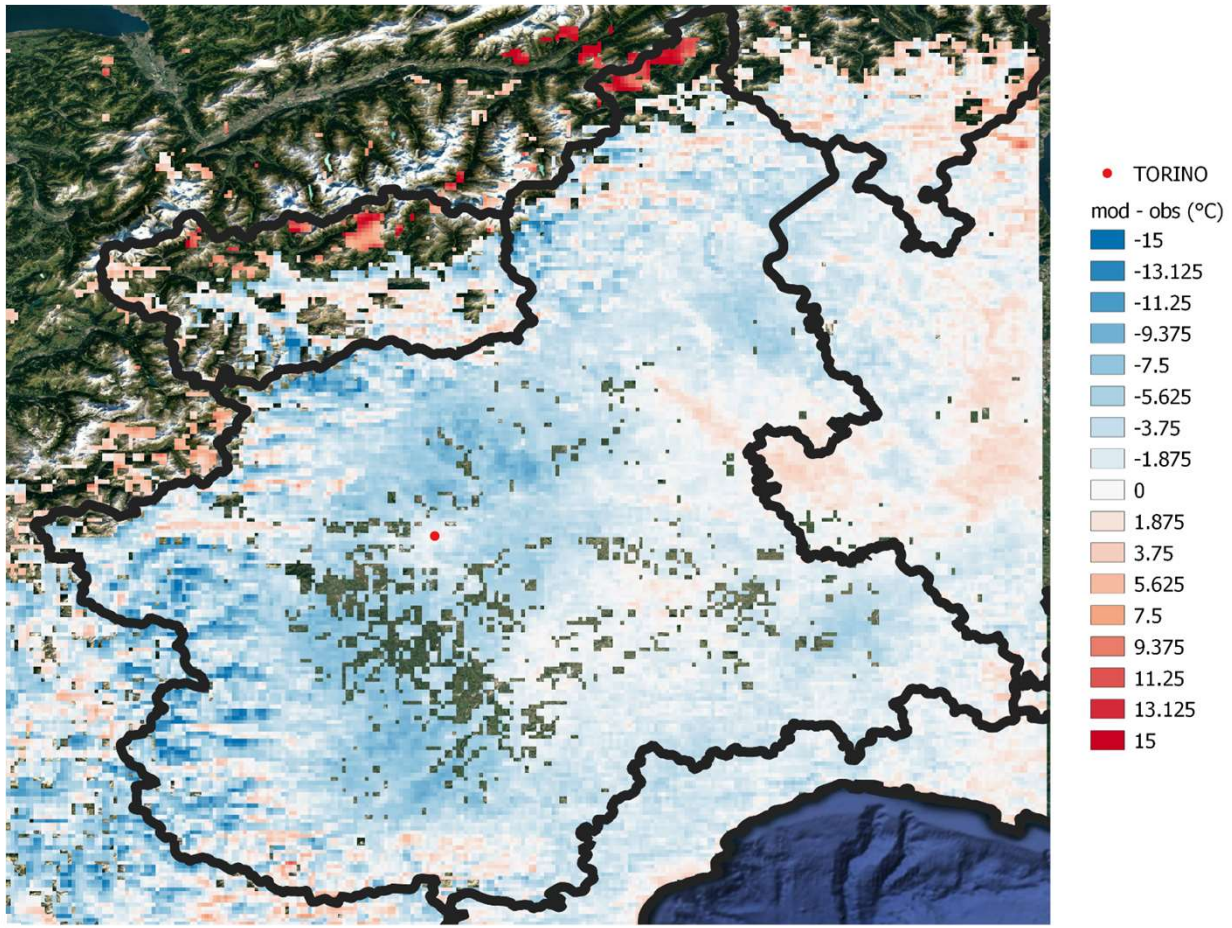
Skin Temperature

Sim 6: 9→1 km

(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Surface Urban Heat Island (SUHI) = T_{skin} simulated – T_{skin} observed



22nd October 2017, h 10:00

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Politecnico di Torino

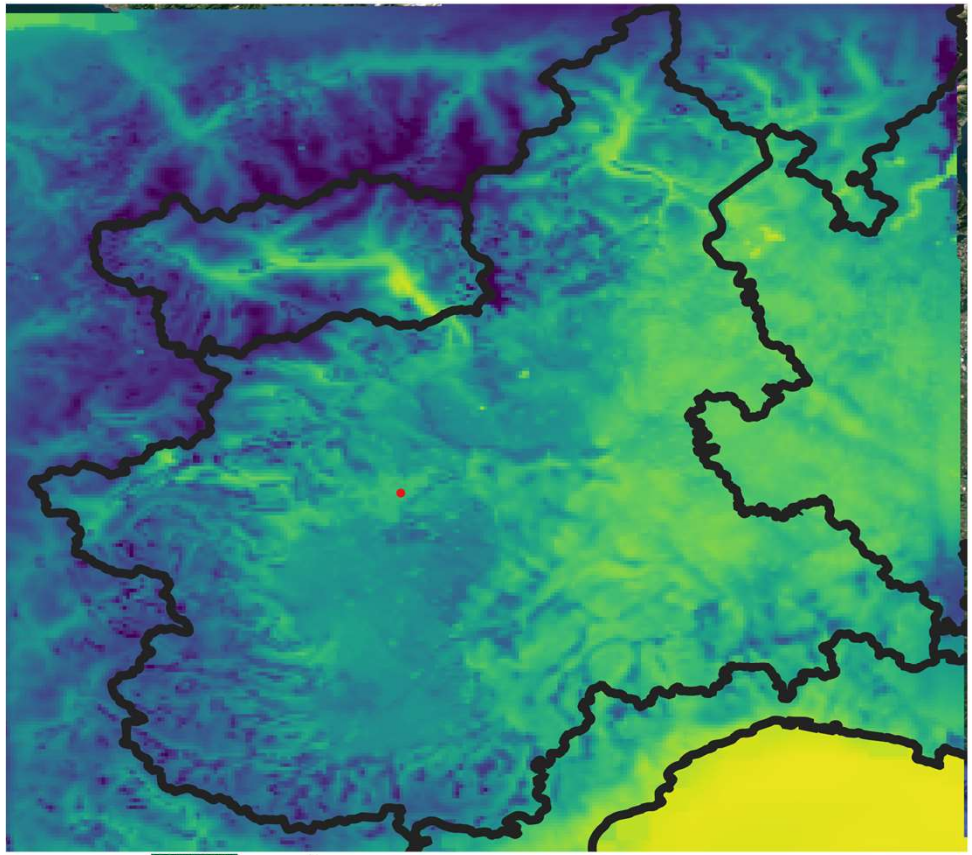
Istituto Superiore per la Protezione dell'Ambiente

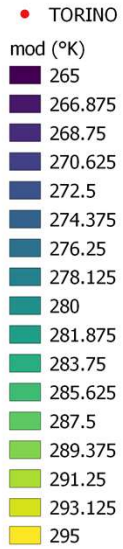
Skin Temperature

Sim 6: 9→1 km

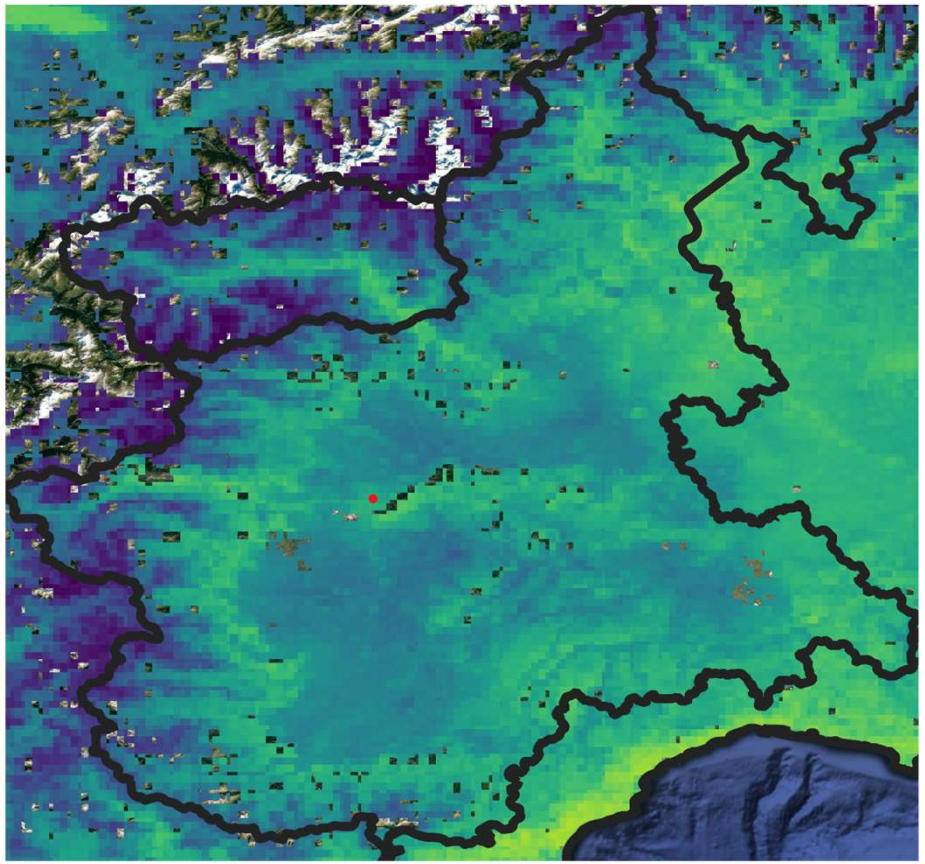
(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Simulated





Observed, Land Surface Temperature (MODIS)



27th October 2017, h 21:00

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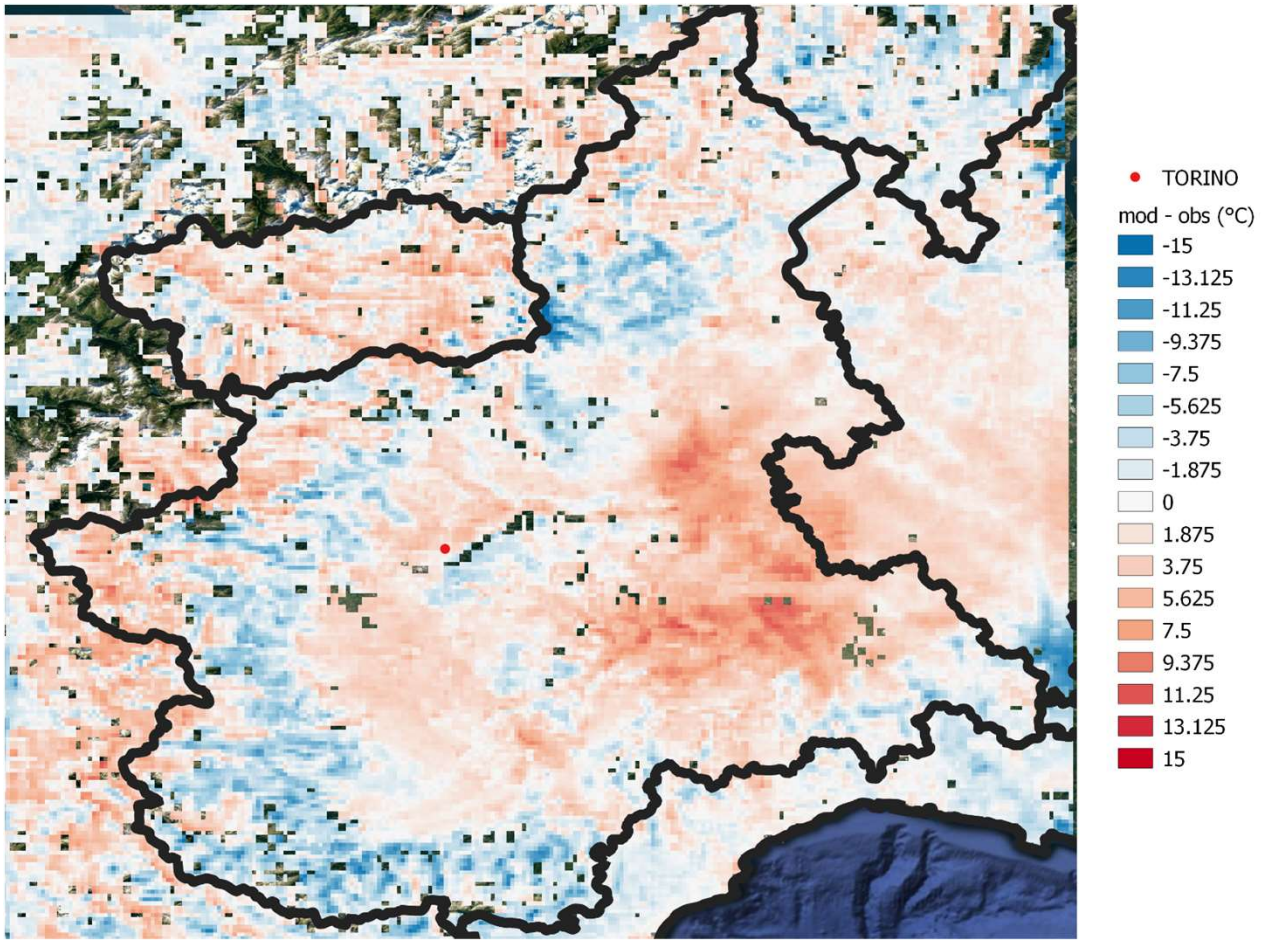
Skin Temperature

Sim 6: 9→1 km

(**New** physics, TERRA_URB **on** and itype canopy = **2**)

Surface Urban Heat Island (SUHI) = T_{skin} simulated – T_{skin} observed



27th October 2017, h 21:00

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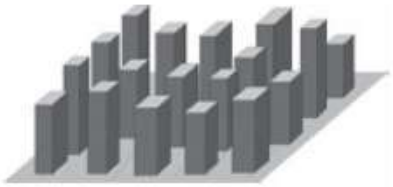
Part III

Small – large urban area

Default configuration for sensitivity analysis:
Sim 6 (9 km → 1 km)
New physics, TERRA_URB **on** and itype canopy = **2**

LCZ = Local Climate Zones

Built types	Definition
1. Compact high-rise 	Dense mix of tall buildings to tens of stories. Few or no trees. Land cover mostly paved. Concrete, steel, stone, and glass construction materials.
2. Compact midrise 	Dense mix of midrise buildings (3–9 stories). Few or no trees. Land cover mostly paved. Stone, brick, tile, and concrete construction materials.

	H/W (a)	Building surface fraction (b)	Mean height of canopy [m]
LCZ 1	>2	0.4-0.6	>25
LCZ 2	0.75-2	0.4-0.7	10-25
sim 6 *	1.5	0.67	15

(a): mean height-to-width ratio of street canyons
(b): ratio of building plan area to total plan area
* : default parameters of TERRA_URB

inadequate values for Turin (**LCZ 2** do not represent the whole city, it could be suitable for few districts only)

I. D. Stewart e T. R. Oke, Local Climate Zones for Urban Temperature Studies, *Bulletin of the American Meteorological Society* 93, n. 12 (2012): 1879–1900.

Configurations tested

Default configuration for sensitivity analysis:
Sim 6 (9 km → 1 km)
New physics, TERRA_URB **on** and itype canopy = **2**

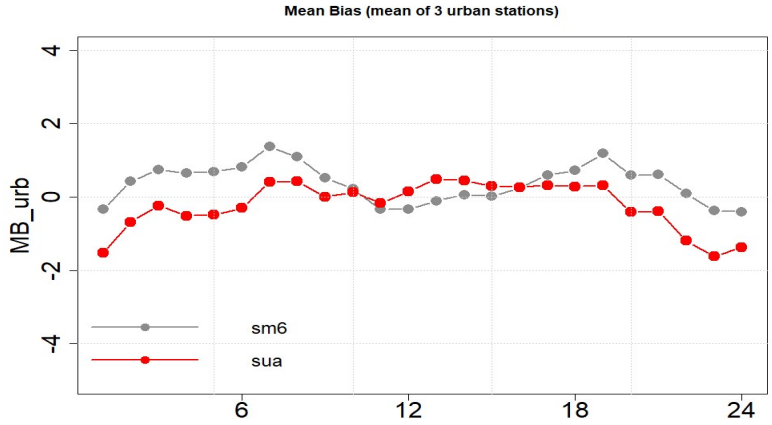
	H/W	Building fr.	H [m]
sim 6	1.5	0.67	15
sua	0.2	0.2	3
LCZ 9	0.1-2.5	0.1-0.2	3-10

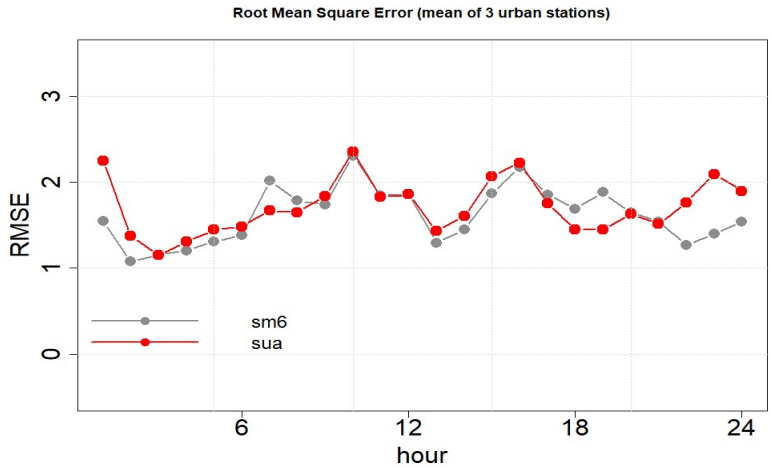
= Small Urban Area

9. Sparsely built

Sparse arrangement of small or medium-sized buildings in a natural setting. Abundance of pervious land cover (low plants, scattered trees).

I. D. Stewart e T. R. Oke, Local Climate Zones for Urban Temperature Studies, *Bulletin of the American Meteorological Society* 93, n. 12 (2012): 1879–1900.





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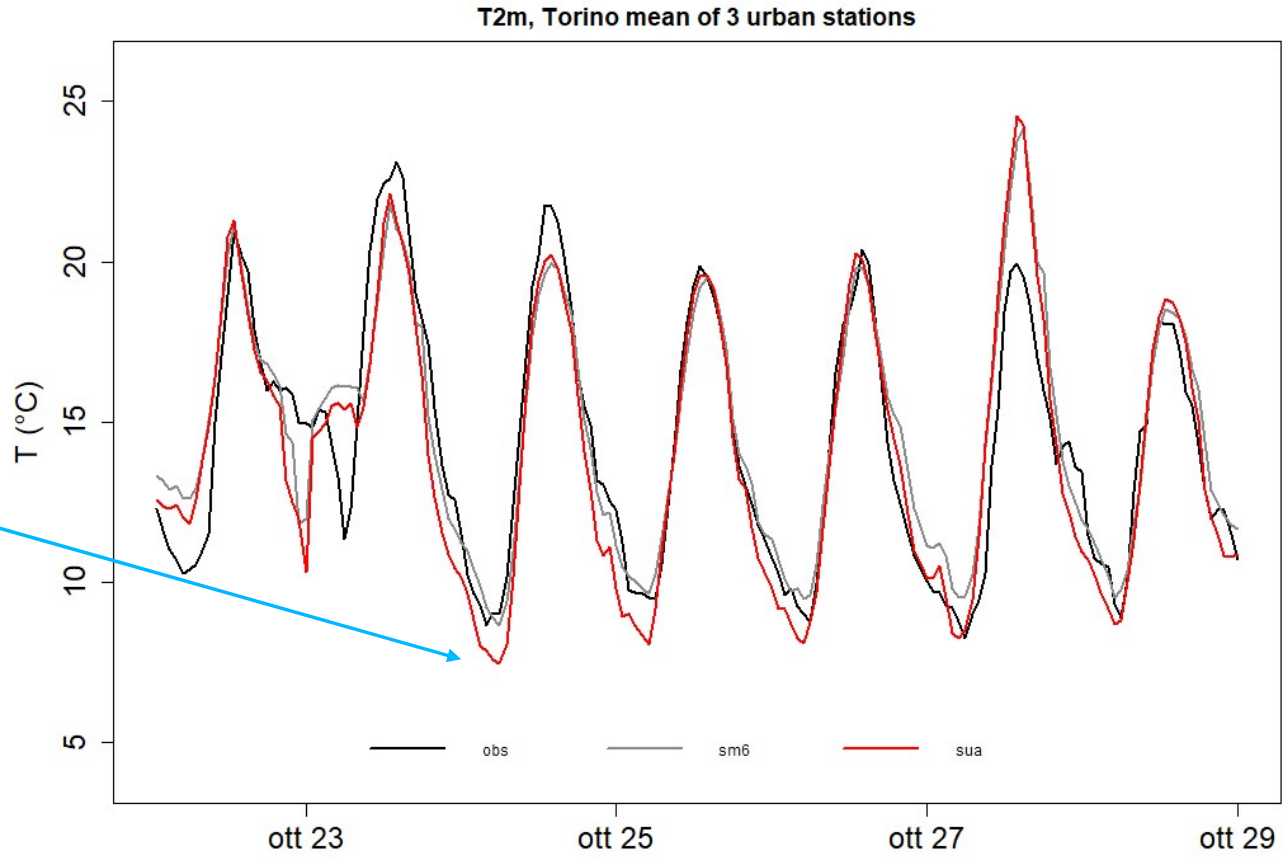
T 2m

Default configuration for sensitivity analysis:
Sim 6 (9 km → 1 km)
New physics, TERRA_URB **on** and itype canopy = **2**

The greatest impact is on minimum temperatures

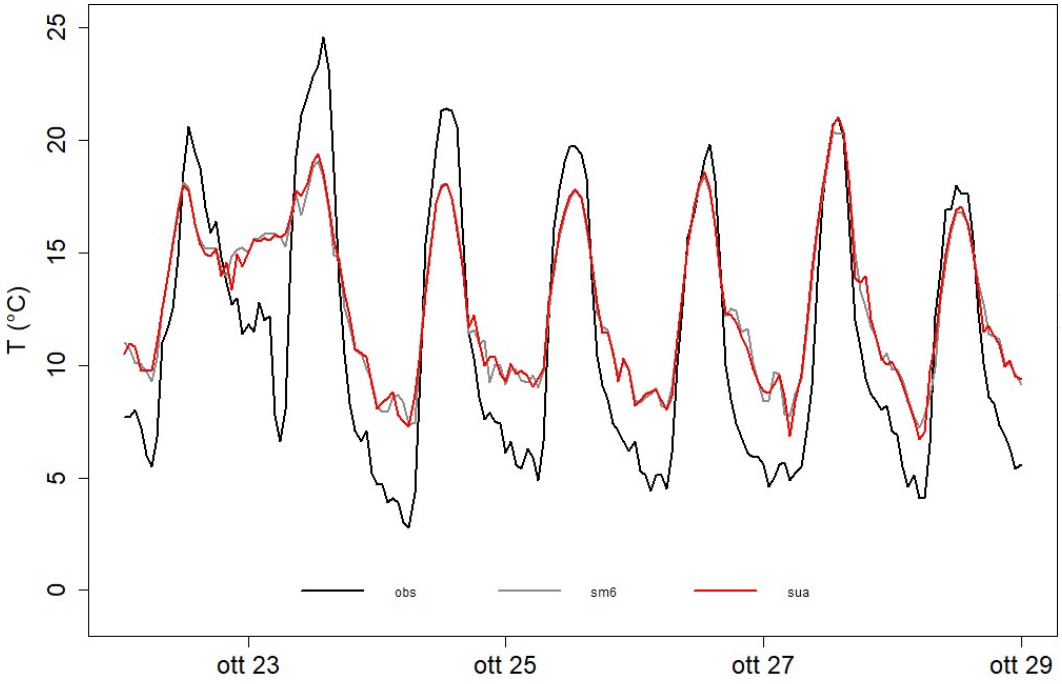


POLITECNICO DI TORINO

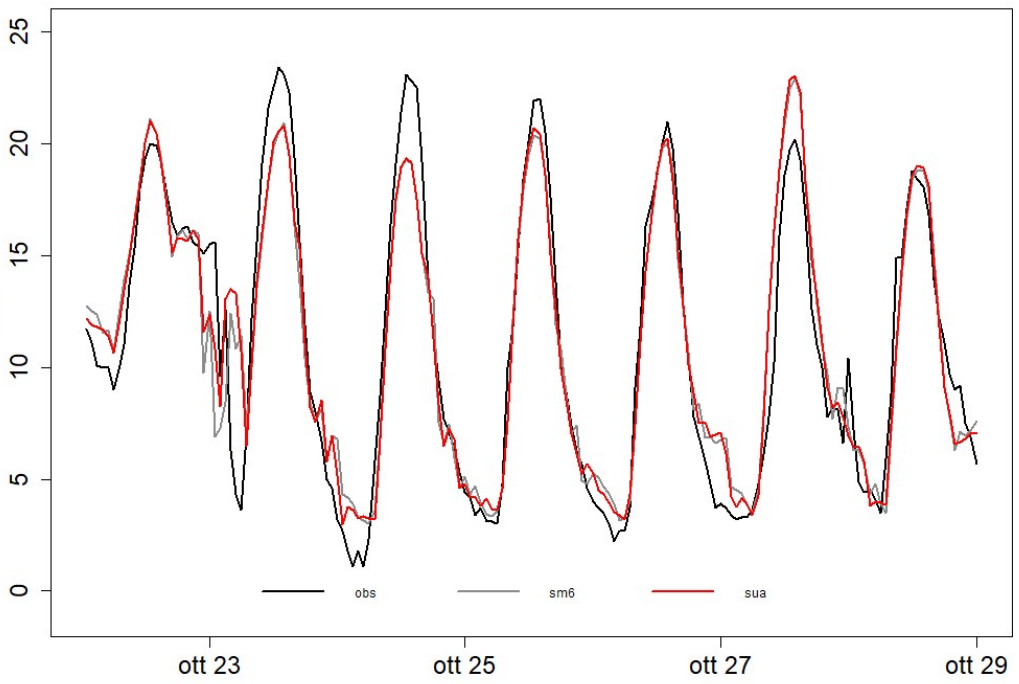
T 2m

Default configuration for sensitivity analysis:
Sim 6 (9 km → 1 km)
New physics, TERRA_URB **on** and itype canopy = **2**

Venaria La Mandria (rural station)



Bauducchi (rural station)



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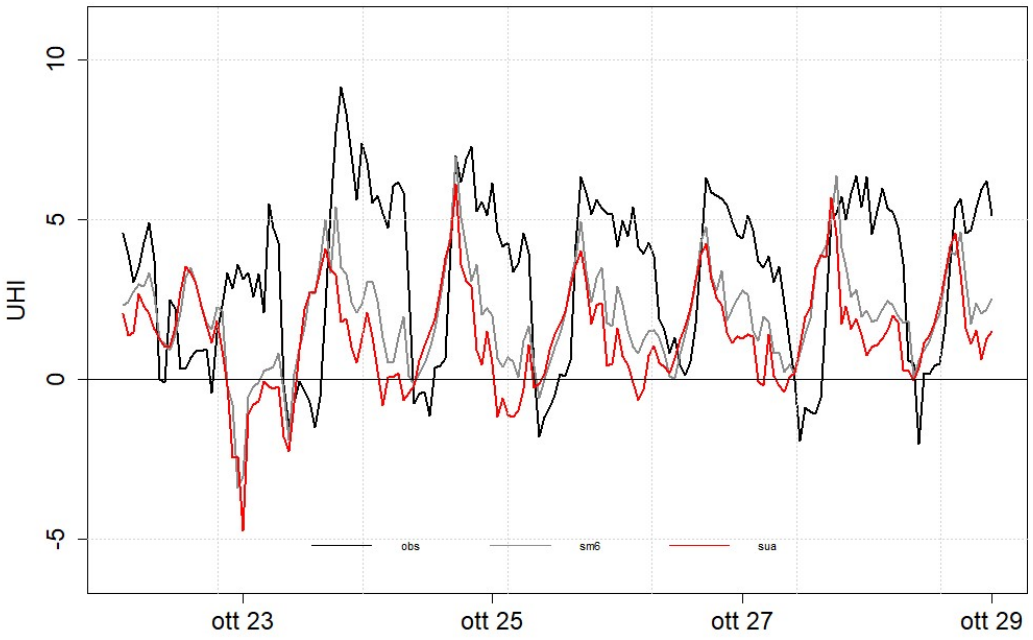
UHI

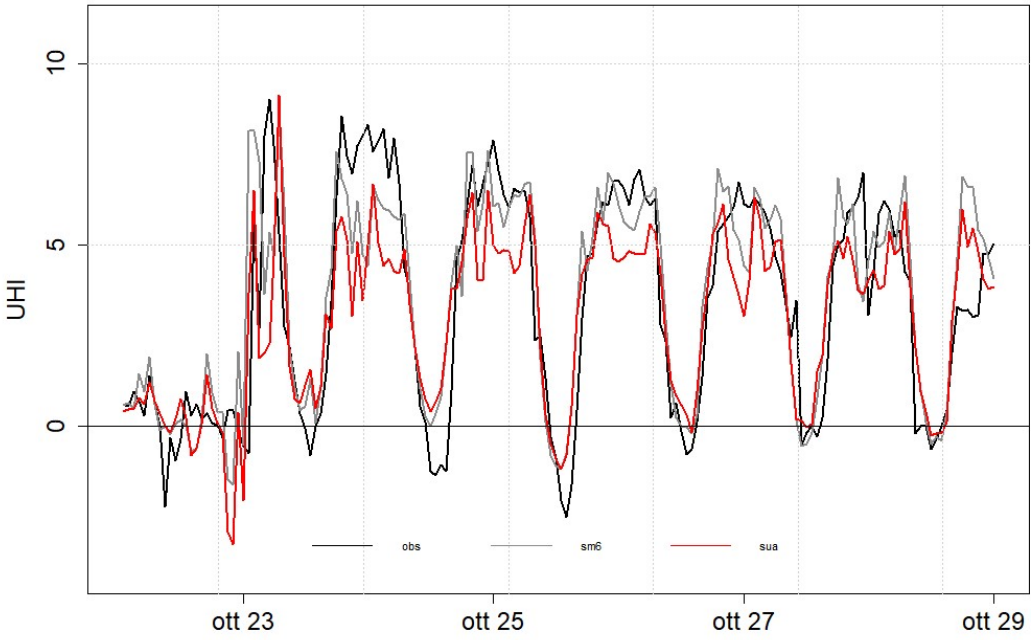
Default configuration for sensitivity analysis:
Sim 6 (9 km → 1 km)
New physics, TERRA_URB **on** and itype canopy = **2**

T (3 urban stations) – T (rural stations), °C

Venaria La Mandria (rural station)



Bauducchi (rural station)



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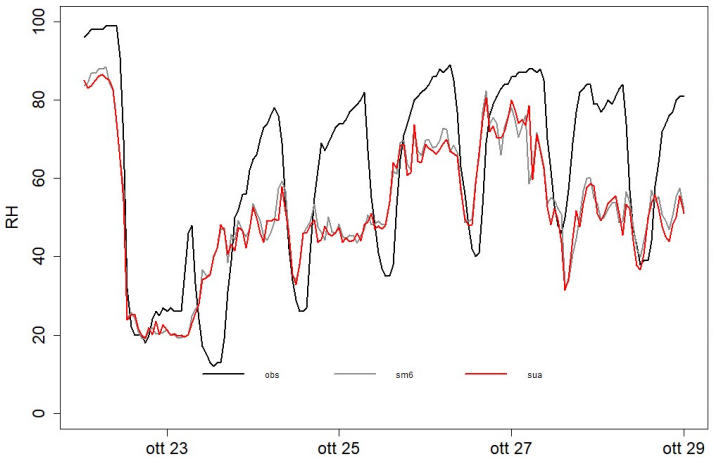
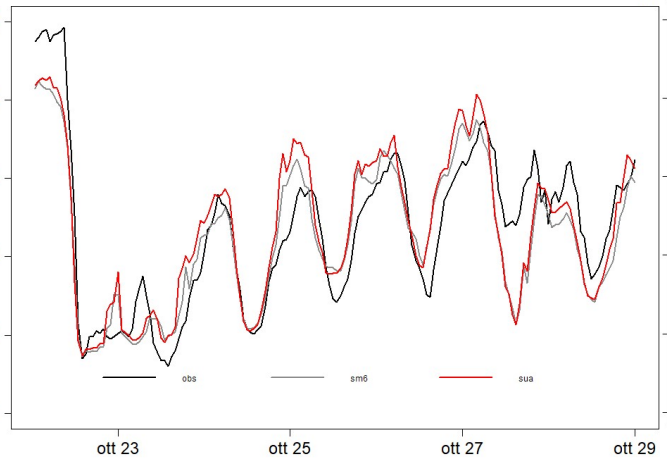
Relative Humidity

Default configuration for sensitivity analysis:
Sim 6 (9 km → 1 km)
New physics, TERRA_URB **on** and itype canopy = **2**

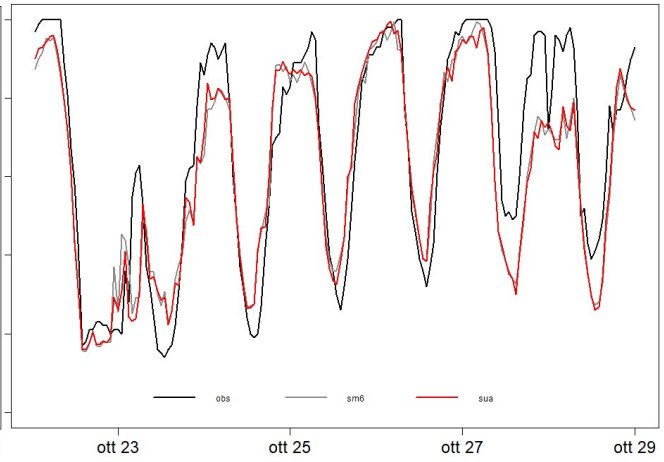
Venaria La Mandria (rural station)



Torino mean of 3 urban stations



Bauducchi (rural station)



While in rural areas there are no differences, **sua** shows a greater RH in the urban area (less buildings than **Sim 6**!)

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Conclusions 1/2

Our analysis could not be interpreted as «absolute», because:

- We tested a case-study of ONE week only
- We focused on temperatures (and UHI) and relative humidity only

However…

- TERRA_URB = ON provides a good impact on the results
- The Skin Temperature formulation is more representative of reality, indeed itype_canopy = 2 works better
- The new physics implementation yields to results closer to the observed data

In Part I the best configuration is **Sim. 5**

- There is a further improvement in simulating the Sim. 5 without intermediate step (Sim. 6, 9km → 1km)
- The soil does not show the spin-up (Sim. 6 is overall equal to Sim. 7)
- ICON initial and boundary conditions (Sim. 8) are almost the same as IFS (negligible differences between Sim. 5 and Sim. 8)
- Northern rural areas (e.g. Venaria La Mandria) are not well represented: the model is likely to see a wrong soil type and/or an excessive urban fraction

→ The best configuration is **Sim. 6**

Conclusions 2/2

Considerations and future work

- Why vertical temperature profiles are so distant from observed data and worse than temperatures at 2m?
  - Maybe the model needs calibration …
  - Maybe it depends on Anthropogenic Heat Flux (AHF) too → sensitivity tests for AHF required (scheduled)

- The Local Climate Zones (LCZ) can well represent an urban area:
  - We should try to implement them in the model

- H/W, building fraction and canopy height should enter the model as external parameters (not as universally valid constant values):
  - We should try other database for external parameters (especially those related to urban areas)