COSMO Priority Task ÆVUS 2
Analysis and EValuation of TERRA_URB Scheme 2
WG 3b, Urban activities

FRANCESCA **BASSANI*** (1), VALERIA **GARBERO** (2), MASSIMO **MILELLI** (2,3)
(1) Polytechnic of Turin, Italy; (2) Arpa Piemonte, Italy; (3) CIMA Foundation, Italy

---

13 September 2021
23rd COSMO General Meeting – Virtual

* francesca.bassani@polito.it

Overview

- Setup, domain and model version
- Local Climate Zones for ISA and AHF
- Urban Canopy Parameters (UCPs) sensitivity tests
- Case week 2020 for urban geometry parameters (UG)
- Case week 2017 for thermal parameters (T)
- Some fluxes for the most relevant cases (week 2017)
- Conclusions

SETUP, DOMAIN and MODEL VERSION

SETUP

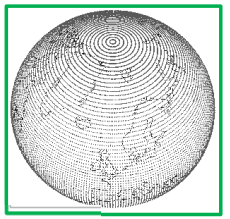
- Initial and boundary conditions from the Integrated Forecast System (IFS, grid resolution: 9km)
- Domain size 350x350 km centered around Turin → final grid spacing: 1km
- Namelist switches from Garbero et al., 2021[1] :
  .loldtur.=F
  .lterra_urb.=T
  itype_canopy=2

MODEL VERSION

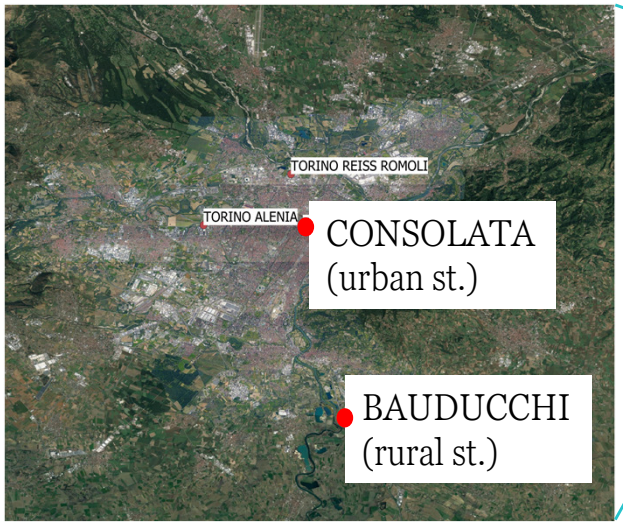
- int2lm 2.10
- cosmo20210721

TEST WEEKS:

- 22-29 October 2017
- 16-23 March 2020



DOMAIN

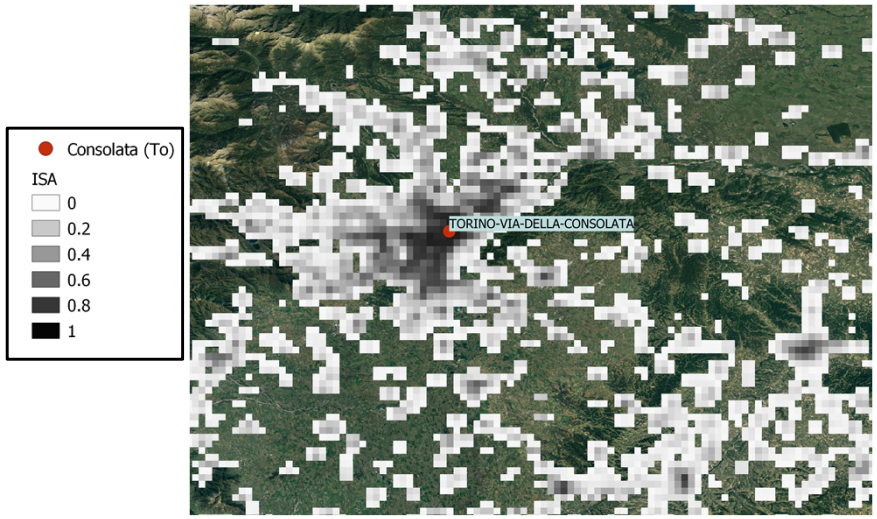


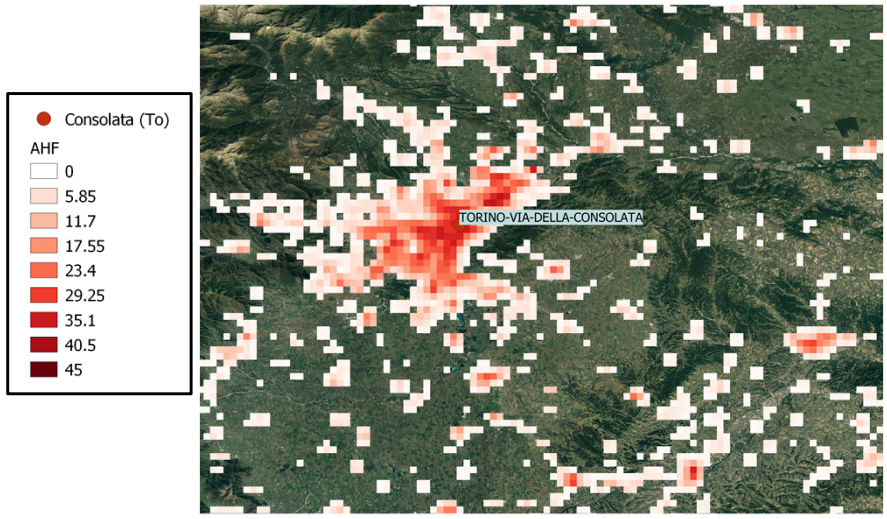
Turin, Italy

[1] Garbero, V.; Milelli, et al. Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities. *Atmosphere* **2021**, *12*, 237.

Local Climate Zones (LCZ)

In all simulations the Impervious Surface Area (**ISA**) and the Anthropogenic Heat Flux (**AHF**) are provided by the Local Climate Zones Classification System[2]





[2] Stewart, I.D.; Oke, T.R. Local Climate Zones for Urban Temperature Studies. *Bull. Am. Meteorol. Soc.* **2012**, 93, 1879–1900.

SENSITIVITY TESTS

» WHAT IS THE IMPACT OF SETTING LOW AND HIGH VALUES OF EACH UCP?

UCPs

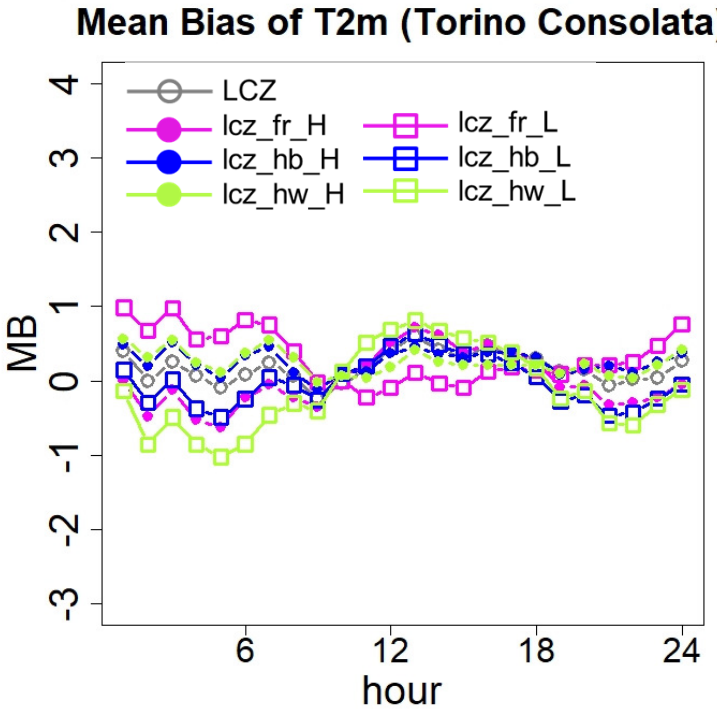
parameter	legend	default value (LCZ)	LOW	HIGH	
building height (H_BLD)	hb	15	3	30	Urban Geometry param. (**UG**)
roof fraction (FR_BLD)	fr	0.667	0.3	0.8	
height to width ratio (H/W)	hw	1.5	0.5	2	
surface albedo (ALB_SO)	as	0.101	0.05	0.25	Thermal param. (**T**)
emissivity (1-ALB_TH)	at	0.86	0.75	0.95	
heat capacity (HCAP)	ca	1.25 E6	0.3 E6	2 E6	
heat conductivity (HCON)	co	0.767	0.2	1.3	

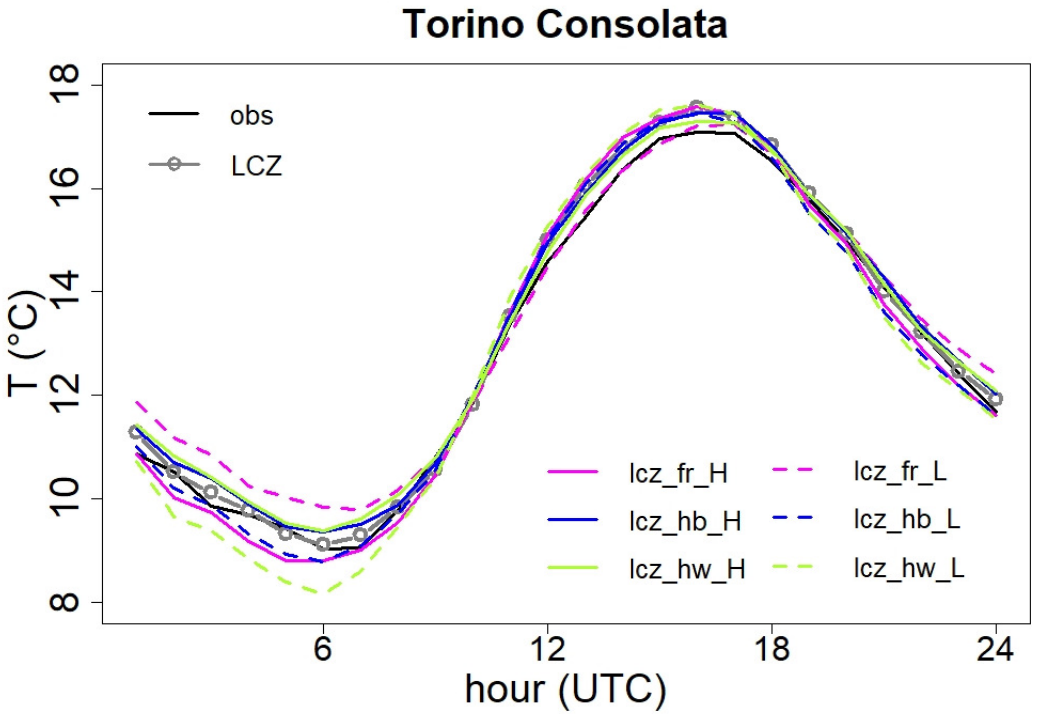
- They are all compared with the control case, which has **default** values (**LCZ**)
  → to check that UCPs work physically correct
- All simulations are labeled: LCZ_[legend column]_[H or L]
  → e.g., LCZ_hb_L for the LOW value of the building height

RESULTS case study March 2020 – T2m

lgd	LCZ	LOW	HIGH
hb	15	3	30
fr	0.667	0.3	0.8
hw	1.5	0.5	2

Urban Geometry param. (UG)



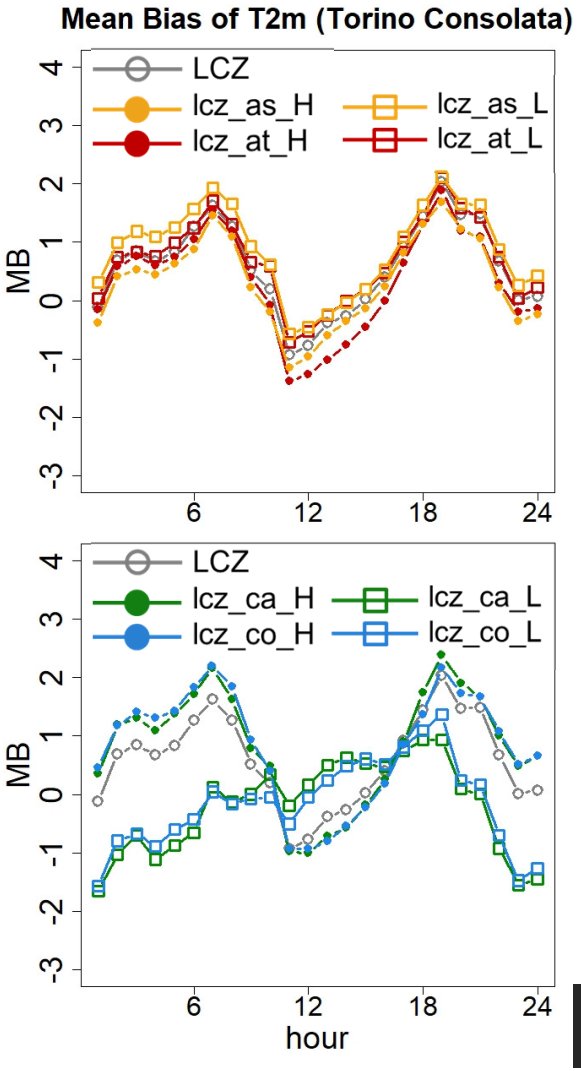


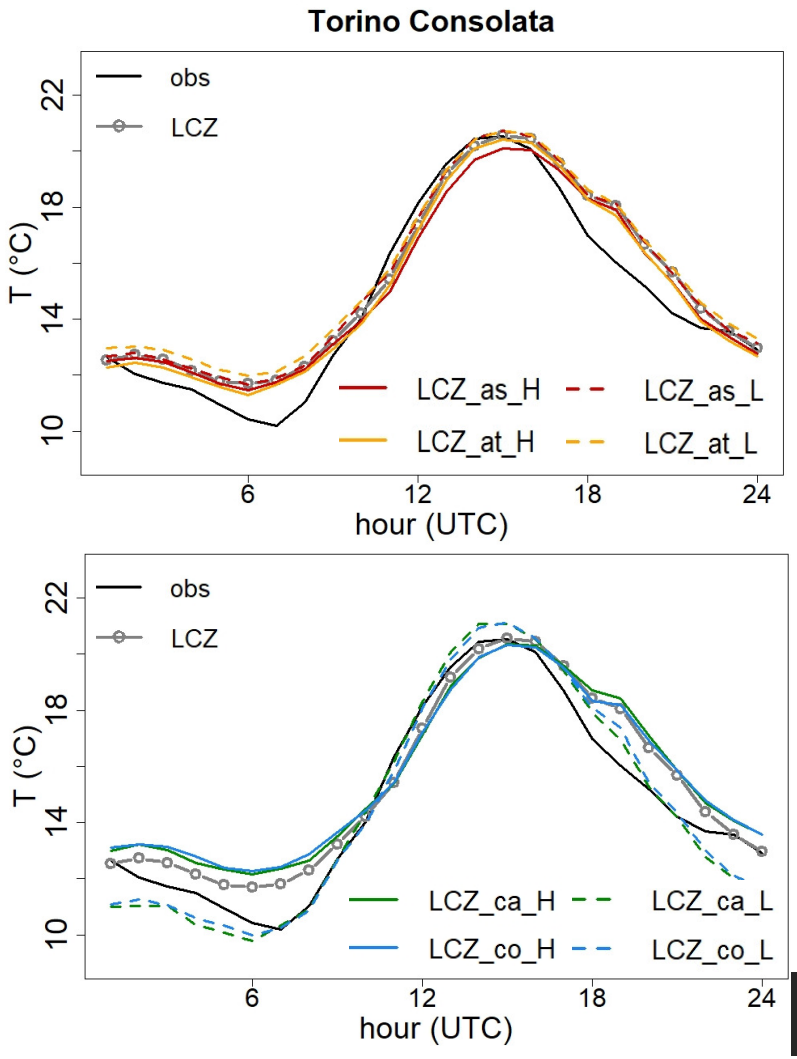
- Coherence among LOW vs HIGH values
- Great impact given by FR:
  - fr_H reduces Tmin, while it has **no** impact on Tmax
  - fr_L increases Tmin **and** reduces Tmax
- Great impact of HW_L on Tmin
- Same pattern for the other case week (Oct. 2017)

Bauducchi (rural station) → **NO** differences among all UG (as expected) ✔

RESULTS case study October 2017 – T2m

lgd	LCZ	LOW	HIGH
as	0.101	0.05	0.25
at	0.86	0.75	0.95
ca	1.25 E6	0.3 E6	2 E6
co	0.767	0.2	1.3





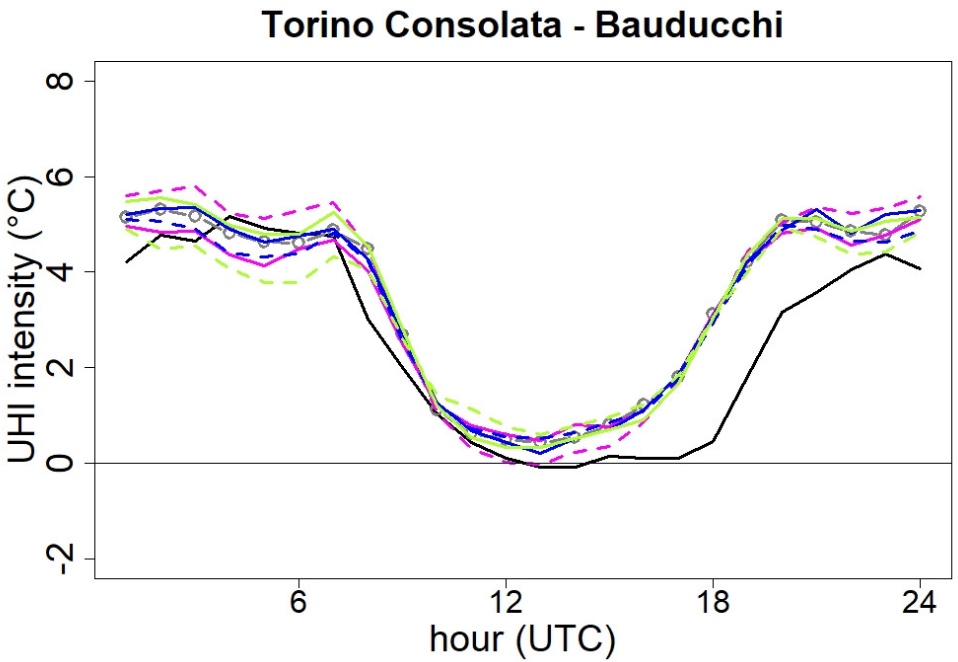
Thermal parameters (T)

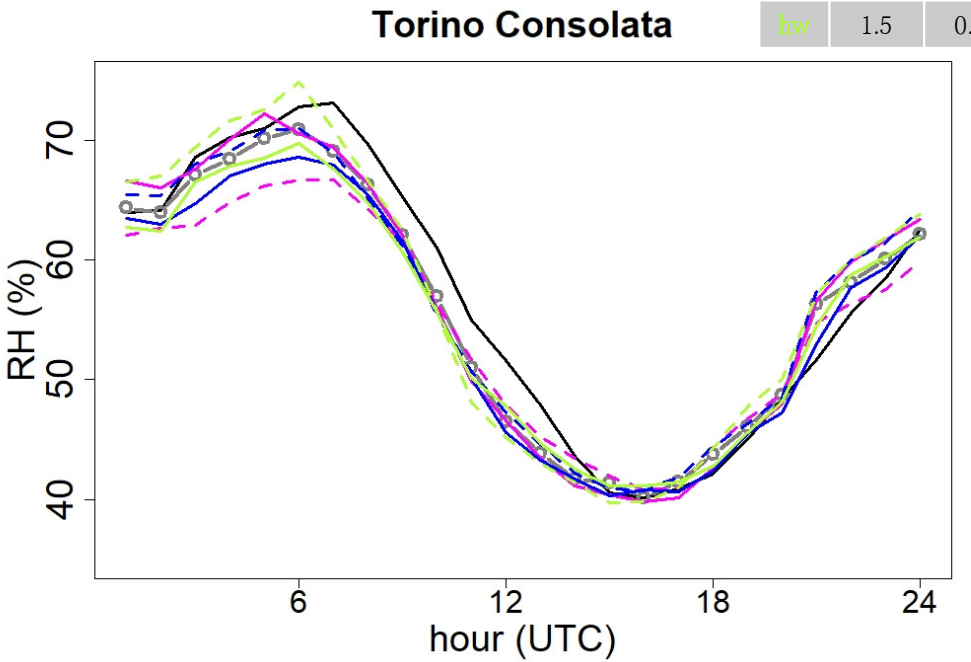
- No relevant impact given by AS and AT:
  - at_H get a bit worst than LCZ at daytime (Tmod<Tobs)
- Great impact of CA_L and CO_L both on Tmin and Tmax
- Same pattern for the other case week (Mar. 2020)

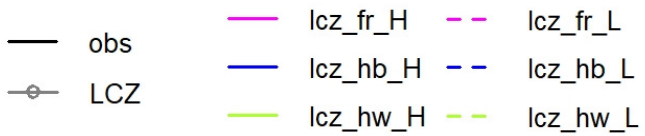
RESULTS case study March 2020 – UHI and RH

Urban Geometry param. (UG)

lgd	LCZ	LOW	HIGH
hb	15	3	30
fr	0.667	0.3	0.8
hw	1.5	0.5	2



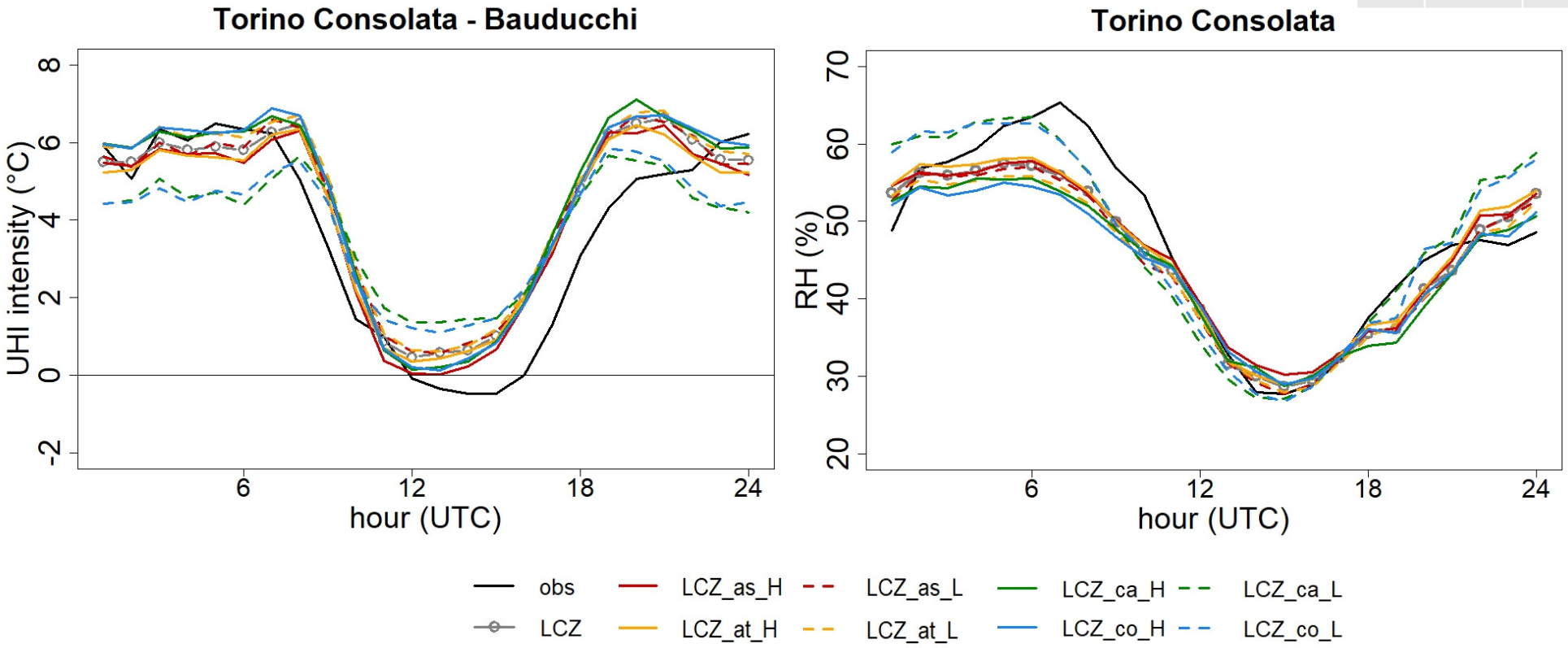




RESULTS case study October 2017 – UHI and RH

lgd	LCZ	LOW	HIGH
as	0.101	0.05	0.25
at	0.86	0.75	0.95
ca	1.25 E6	0.3 E6	2 E6
co	0.767	0.2	1.3

Thermal parameters (T)



RESULTS case study October 2017 – fluxes

lgd	LCZ	LOW	HIGH
hb	15	3	30
fr	0.667	0.3	0.8
hw	1.5	0.5	2

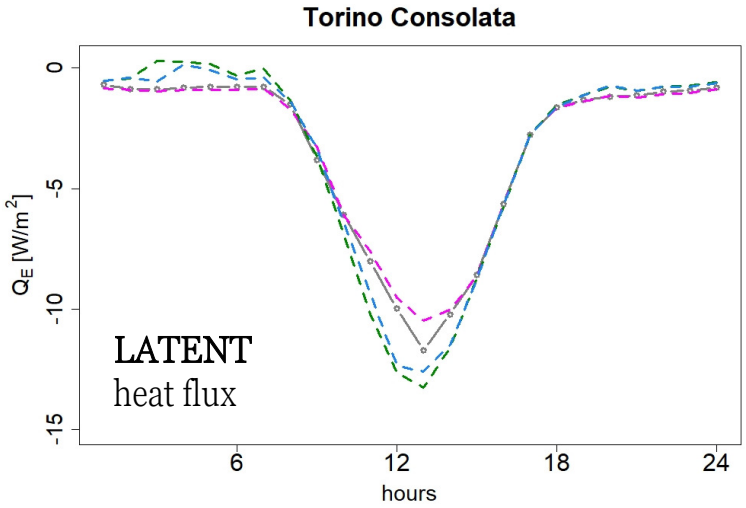
Urban Geometry p. (UG)

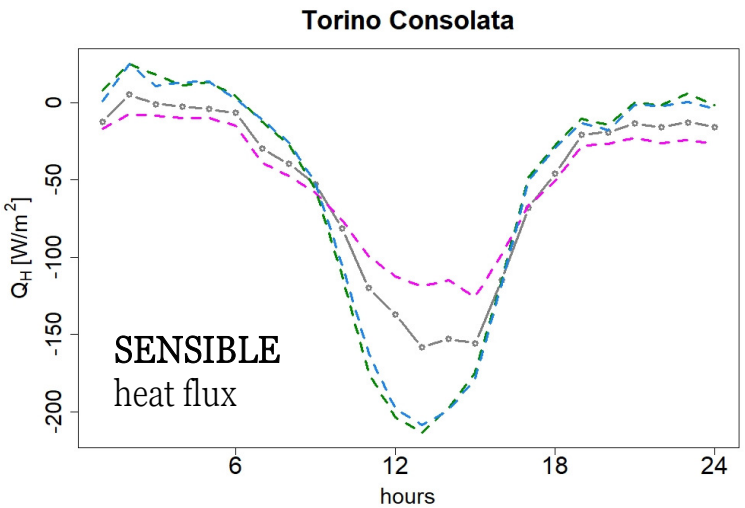
The most impacting cases on the urban station are the **LOW** values of:

- building fraction (fr)
- Heat capacity (ca)
- Heat conductivity (co)

lgd	LCZ	LOW	HIGH
as	0.101	0.05	0.25
at	0.86	0.75	0.95
ca	1.25 E6	0.3 E6	2 E6
co	0.767	0.2	1.3

Thermal parameters (T)





NO obs available for fluxes

LCZ lcz_fr_L LCZ_ca_L LCZ_co_L

LATENT and **SENSIBLE** h.f.:
ca and co provide increasing heat fluxes (in abs), especially at daytime
→ Coherent with T2m, which was higher than LCZ during day

fr impacts the **SENSIBLE** h.f.:
|QH|↓ at night hours
|QH|↑ at day hours
with respect to LCZ

$$Q_K + Q_L + Q_H + Q_E + \Delta Q_S = 0$$

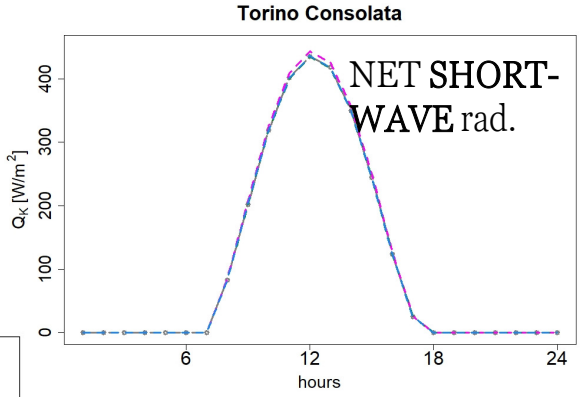
RESULTS case study October 2017 – fluxes

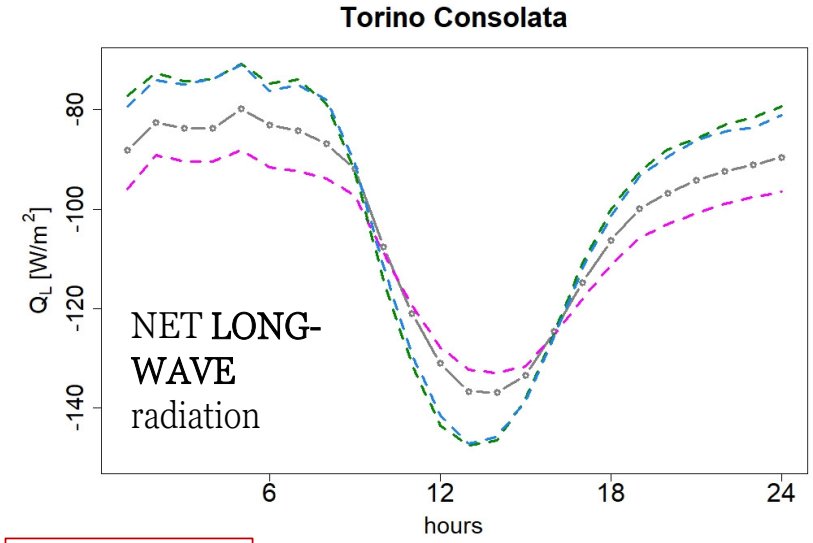
lgd	LCZ	LOW	HIGH
hb	15	3	30
fr	0.667	0.3	0.8
hw	1.5	0.5	2

Urban Geometry p. (UG)

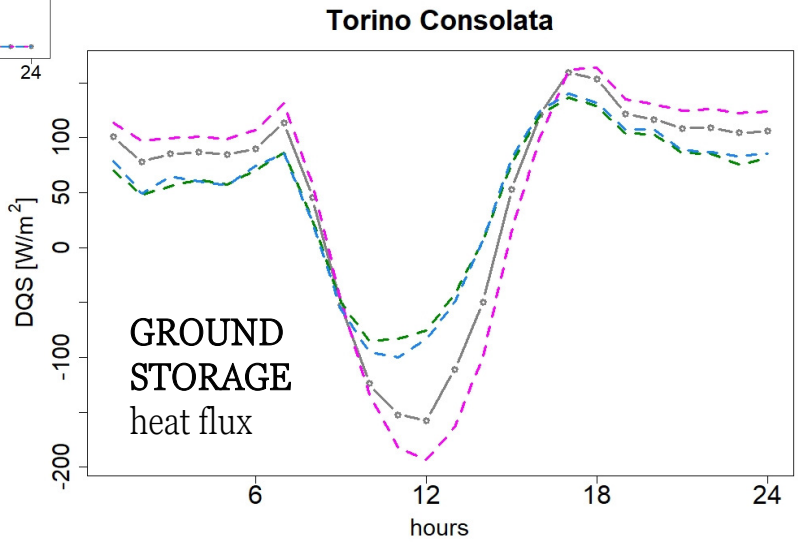
lgd	LCZ	LOW	HIGH
as	0.101	0.05	0.25
at	0.86	0.75	0.95
ca	1.25 E6	0.3 E6	2 E6
co	0.767	0.2	1.3

Thermal parameters (T)





- no influence on Q_K
- $|Q_L|_{ca,co} > |Q_L|_{LCZ}$
- |DQS|: the city absorbs less for fr ↓



NO obs available for fluxes

LCZ lcz_fr_L LCZ_ca_L LCZ_co_L

$$Q_K + Q_L + Q_H + Q_E + \Delta Q_S = 0$$

CONCLUSIONS

- Overall, the sensitivity tests provide **good results**: switching from LOW to HIGH parameters is coherent with the default value of each parameter

  → The UCPs work physically correct for Turin

- As already shown @ICCARUS21, the Urban Geometry parameter which has more impact over Turin is the **building fraction:**
  - in particular, the **LOW** value seems inappropriate to describe the city (most deviation from the default for all variables analyzed)

- Another important impact is given by the **LOW** values of **heat capacity** and **heat conductivity**:
  - the amplitude of T2m variation is out of phase with respect to the default one
  - by varying the thermal properties, the fluxes respond accordingly → as expected