



PROTEZIONE CIVILE

Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

PP CITTA'

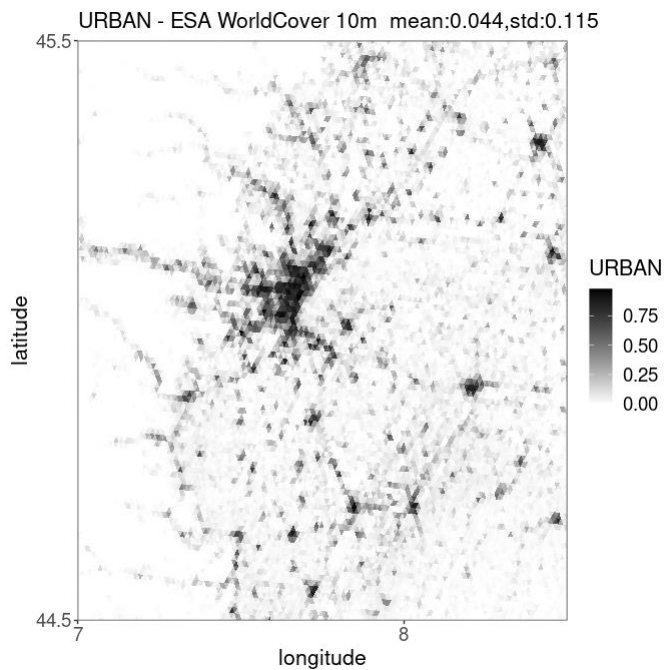
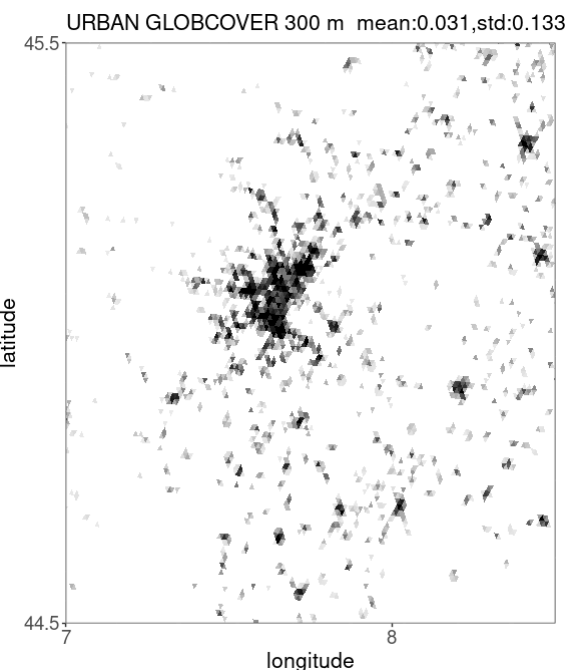
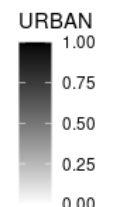
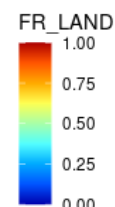
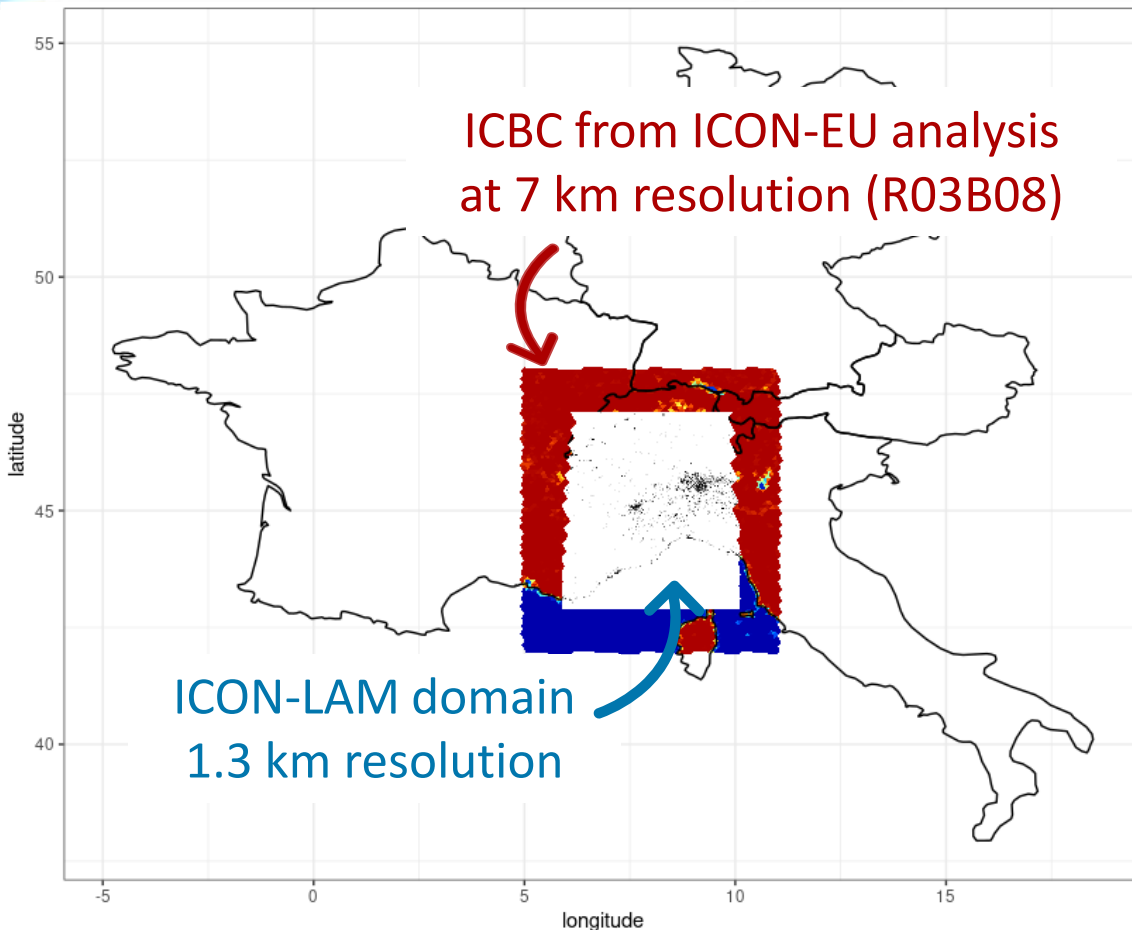
Update on high-resolution experiments with ICON-LAM

Valeria Garbero, Arpa Piemonte

ICON set-up

2 different Land Use Classification:

1. **GLOBCOVER 300 m** resolution (2019),
23 Land Use Classes, URBAN: LU=19
2. **ESA WorldCover 10 m** resolution (2021),
10 Land Use Classes, URBAN: LU=50*



*Roni Drori (IMS) converted 10 ESA LU classes into 23 GlobCov classes

ICON+TERRA_URB experiments

1 week simulation in hindcast mode during a heat waves: 9-16 June 2022

ICBC	Res	LU	Lterra_urb	c_soil	tkmmin	tkhmin	Name
ICON-EU	1.3 km	GLOBCOVER	FALSE	1.25	0.75	0.5	CTRL
ICON-EU	1.3 km	GLOBCOVER	TRUE	1.25	0.75	0.5	URB1
ICON-EU	1.3 km	ESA	TRUE	1.25	0.75	0.5	URB2
ICON-EU	1.3 km	ESA	TRUE	0.8	0.75	0.5	URB3
ICON-EU	1.3 km	ESA	TRUE	1.25	0.3	0.3	URB4

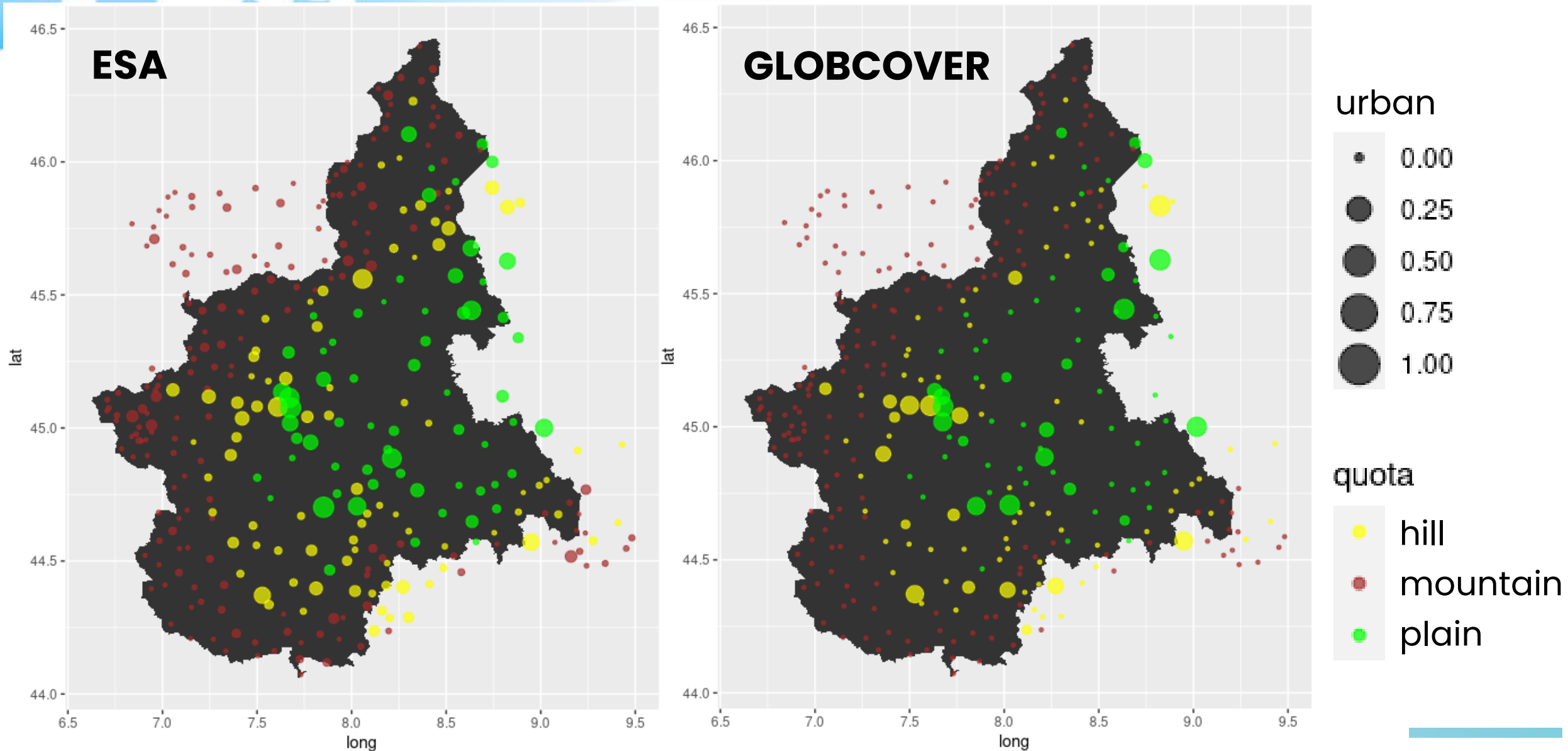
DWD
namelist

lurbalb =TRUE
lurbahf=TRUE
itype_eisa=3

Tuning suggested by Pavel:

1. Reducing c_soil to reduce the fraction of evaporating surface
2. Reducing tkhmin and tkmmin to reduce the minimum allowed turbulence kinetic energy

Verification: Arpa Piemonte stations



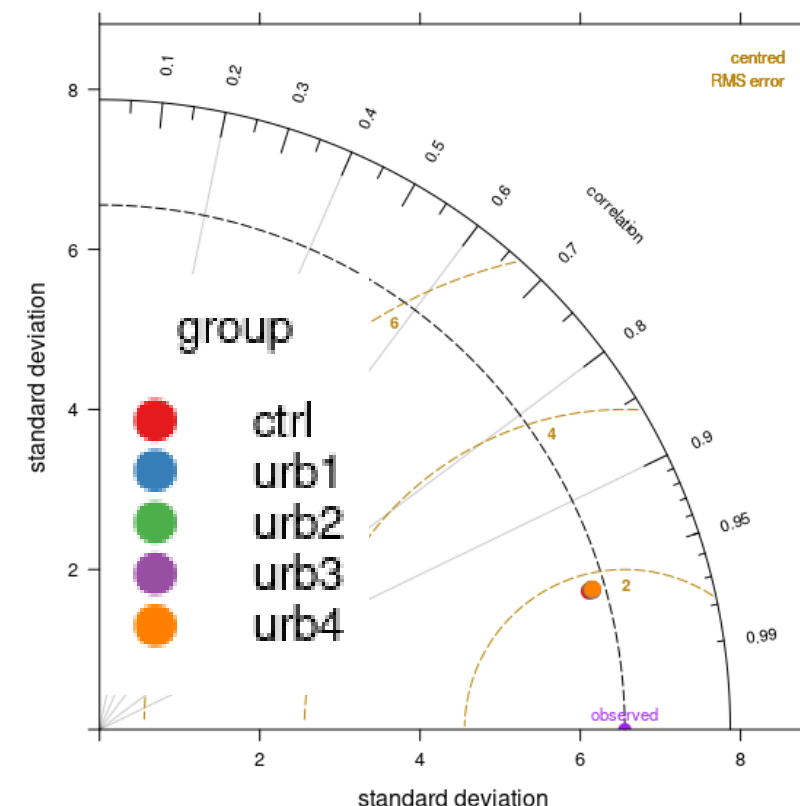
2M TEMPERATURE

Name	MB	RMSE	r	rank°
CTRL	-0.263	1.80	0.962	5
URB1	-0.175	1.79	0.962	4
URB2	-0.0209	1.81	0.961	3
URB3	0.139	1.81	0.962	1
URB4	-0.0226	1.80	0.962	2

*The ranking is based the COE performance, *Coefficient of Efficiency* based on Legates and McCabe

- **CTRL** underestimates mean 2m temperature
- **URB1** (lterra_urb=TRUE) slightly reduces MB and RMSE
- **URB2** (ESA lu) improves MB but increases RMSE
- **URB3** (c_soil=0.8) overestimates mean 2m temperature
- **URB4** (thmmin=thkmin=0.3) slightly reduces RMSE and improves r

Taylor Diagram: 2m temperature (° C)



Good and comparable performance for all configurations, but improvement in MB for urban ones

2M TEMPERATURE



Name	MB	RMSE	r	rank
CTRL	-0.281	1.72	0.964	5
URB1	-0.21	1.71	0.964	4
URB2	-0.0977	1.70	0.964	3
URB3	0.0677	1.68	0.964	1
URB4	-0.0891	1.70	0.964	2

- **CTRL** underestimates mean 2m temperature both during night and day
- **URB1** (Iterra_urb=TRUE) reduces MB and RMSE, particularly during night
- **URB2** (ESA lu) improves MB and RMSE during day but during night it overestimates t2m and worsens RMSE and r
- **URB3** (c_soil=0.8) improves MB and RMSE during day but worsens MB and RMSE during night
- **URB4** (thmmin=thkmin=0.3) slightly improves indices during night

ESA LU increases RMSE during night

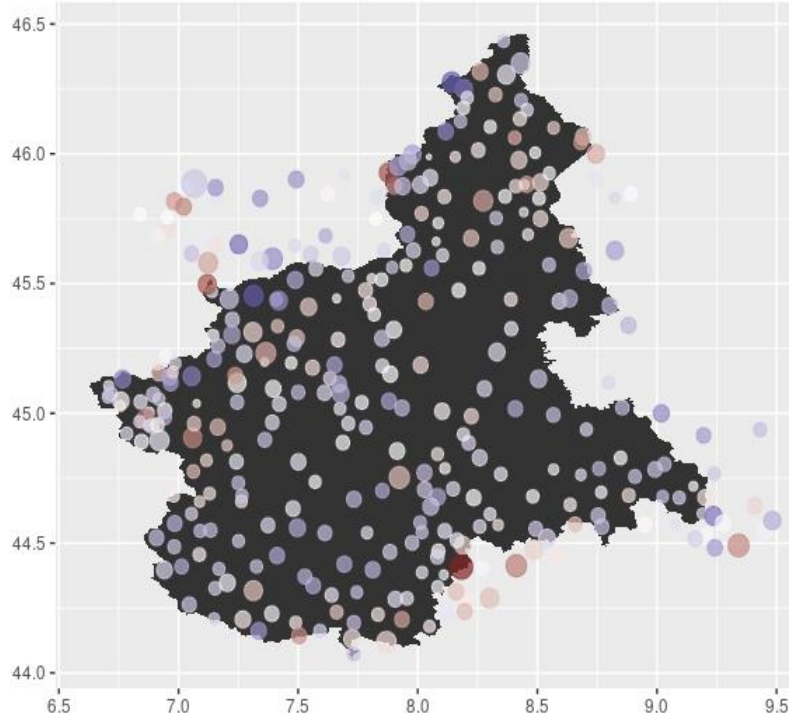


Name	MB	RMSE	R	rank
CTRL	-0.225	1.98	0.924	5
URB1	-0.0908	1.97	0.924	1
URB2	0.144	2.02	0.920	3
URB3	0.290	2.04	0.920	4
URB4	0.119	2.00	0.921	2

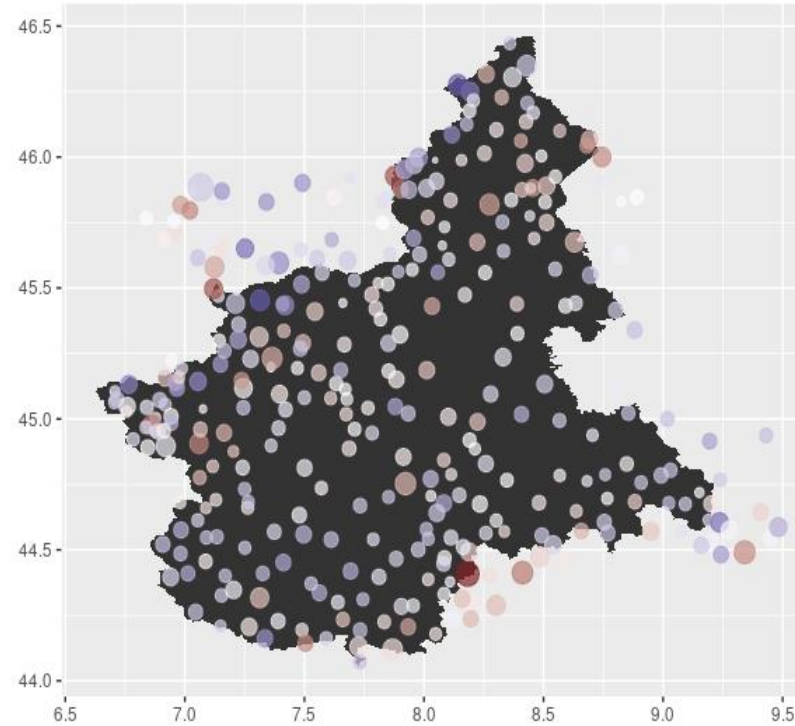
Good and comparable performance for all configurations, but improvement in MB for urban ones, both during day and night

2M TEMPERATURE

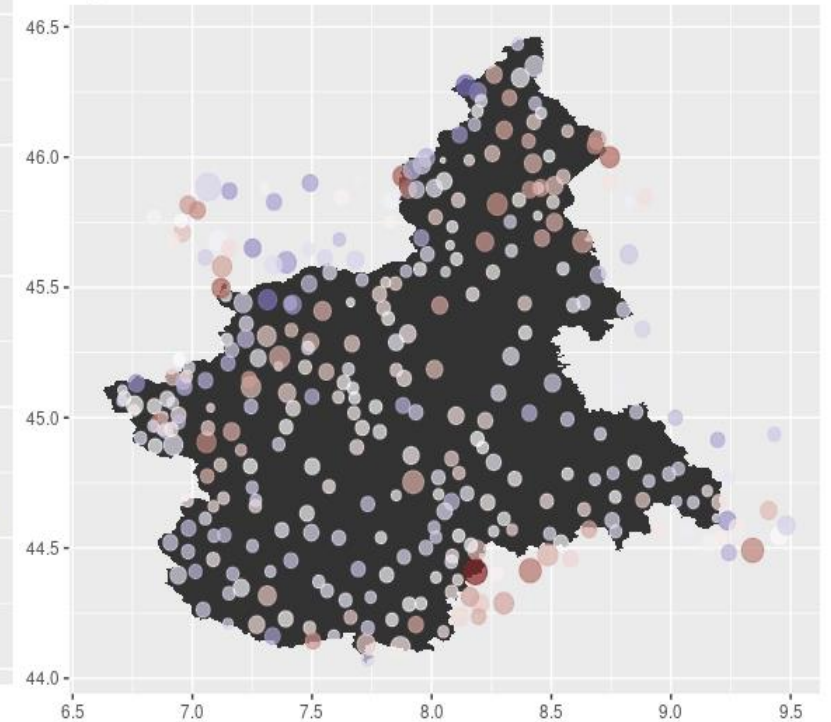
exp=CTRL



exp=URB1



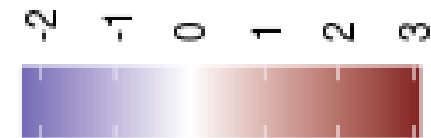
exp=URB2



RMSE



MB



2M TEMPERATURE in «urban» stations

URBAN: ISA>0.5 – GC

Name	MB	RMSE	r	rank
URB3	-0.045	1.47	0.952	1
URB4	-0.177	1.46	0.953	2
URB2	-0.189	1.49	0.951	3
URB1	-0.091	1.53	0.948	4
CTRL	-0.747	1.76	0.948	5

URBAN: ISA>0.5 – ESA

Name	MB	RMSE	r	rank
URB3	0.014	1.37	0.961	1
URB4	-0.126	1.37	0.96	2
URB2	-0.122	1.39	0.961	3
URB1	-0.250	1.48	0.959	4
CTRL	-0.891	1.82	0.953	5

- **CTRL** strongly underestimates mean 2m temperature
- **URB1** (lterra_urb=TRUE) reduces MB and RMSE
- **URB2** (ESA lu) worsens MB but improves RMSE and r
- **URB3** (c_soil=0.8) improves MB (slight overestimation) and RMSE
- **URB4** (thmmin=thkmin=0.3) worsens MB (underestimation) and r

Marked improvement for urban configurations in reproducing 2m temperature in urban stations
ESA land use classification seems to improve all the indices -> URB3 best configuration

2M TEMPERATURE in «periurban» stations

PERIURBAN: 0.01<ISA<0.5 – GC

Name	MB	RMSE	R	rank
URB2	0.250	1.91	0.931	5
URB3	0.430	1.93	0.932	3
URB4	0.239	1.89	0.933	2
CTRL	-0.299	1.83	0.939	4
URB1	-0.020	1.83	0.937	1

PERIURBAN: 0.01<ISA<0.5 – ESA

Name	MB	RMSE	r	rank
URB2	0.034	1.91	0.942	5
URB3	0.209	1.91	0.942	2
URB4	0.029	1.90	0.942	4
CTRL	-0.273	1.87	0.946	3
URB1	-0.165	1.87	0.945	1

- **CTRL** underestimates mean 2m temperature
- **URB1** (Iterra_urb=TRUE) reduces MB (slightly underestimation) and improves r
- **URB2** (ESA lu) changes MB (slightly overestimation), worsens RMSE but improves r
- **URB3** (c_soil=0.8) worsens MB (overestimation)
- **URB4** (thmmin=thkmin=0.3) slightly improve MB and RMSE

Slight improvements in MB for urban configurations in reproducing 2m temperature in peri-urban stations

ESA land use classification improves the correlation but increases the RMSE

2M TEMPERATURE in «rural» stations

RURAL: ISA<0.01 – GC

Name	MB	RMSE	R	rank
URB3	0.127	1.81	0.96	1
URB4	-0.034	1.81	0.96	2
URB2	-0.032	1.81	0.96	3
URB1	-0.192	1.80	0.961	4
CTRL	-0.234	1.81	0.961	5

RURAL: ISA<0.01 – ESA

Name	MB	RMSE	r	rank
URB3	0.067	1.71	0.962	1
URB2	-0.074	1.71	0.962	2
URB4	-0.073	1.71	0.962	3
URB1	-0.182	1.73	0.961	4
CTRL	-0.202	1.73	0.961	5

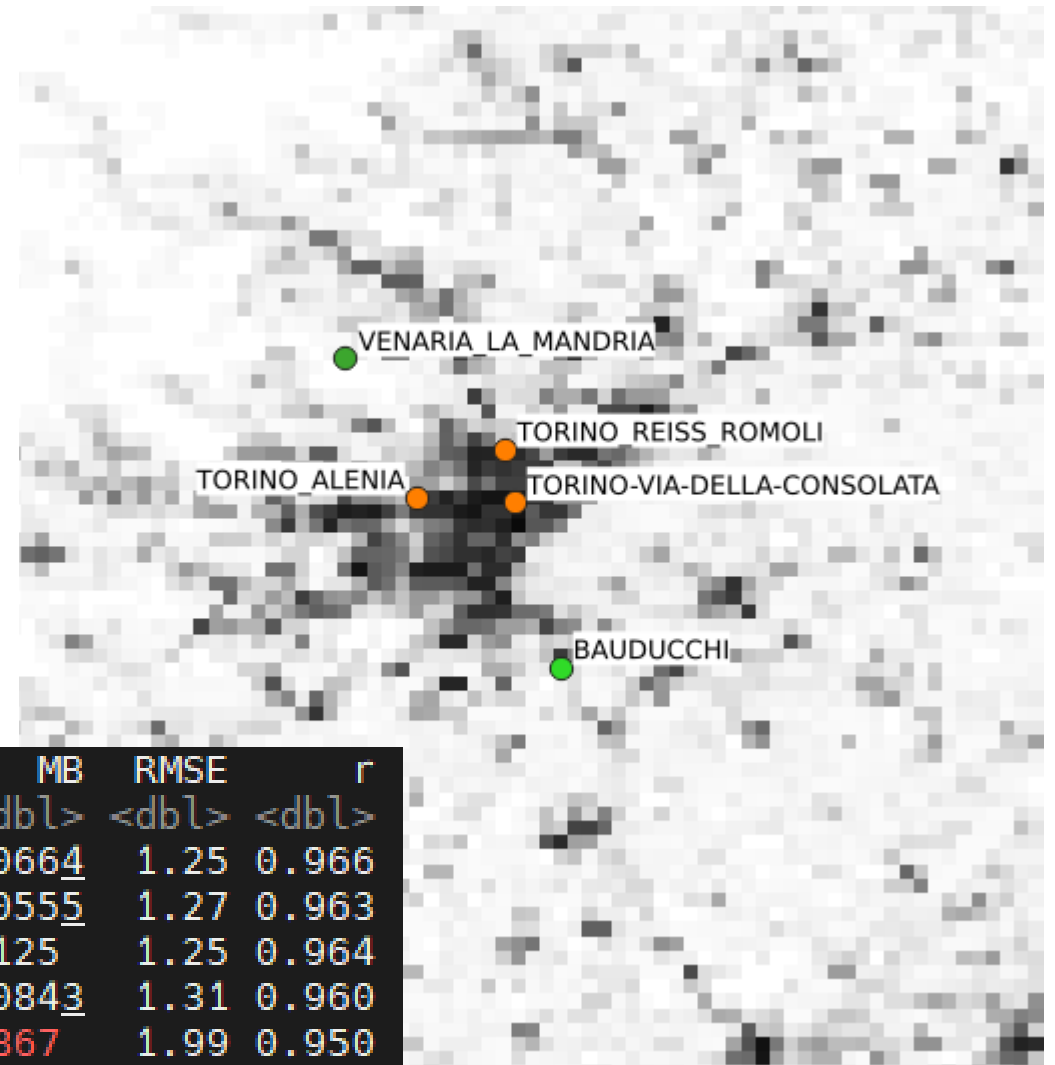
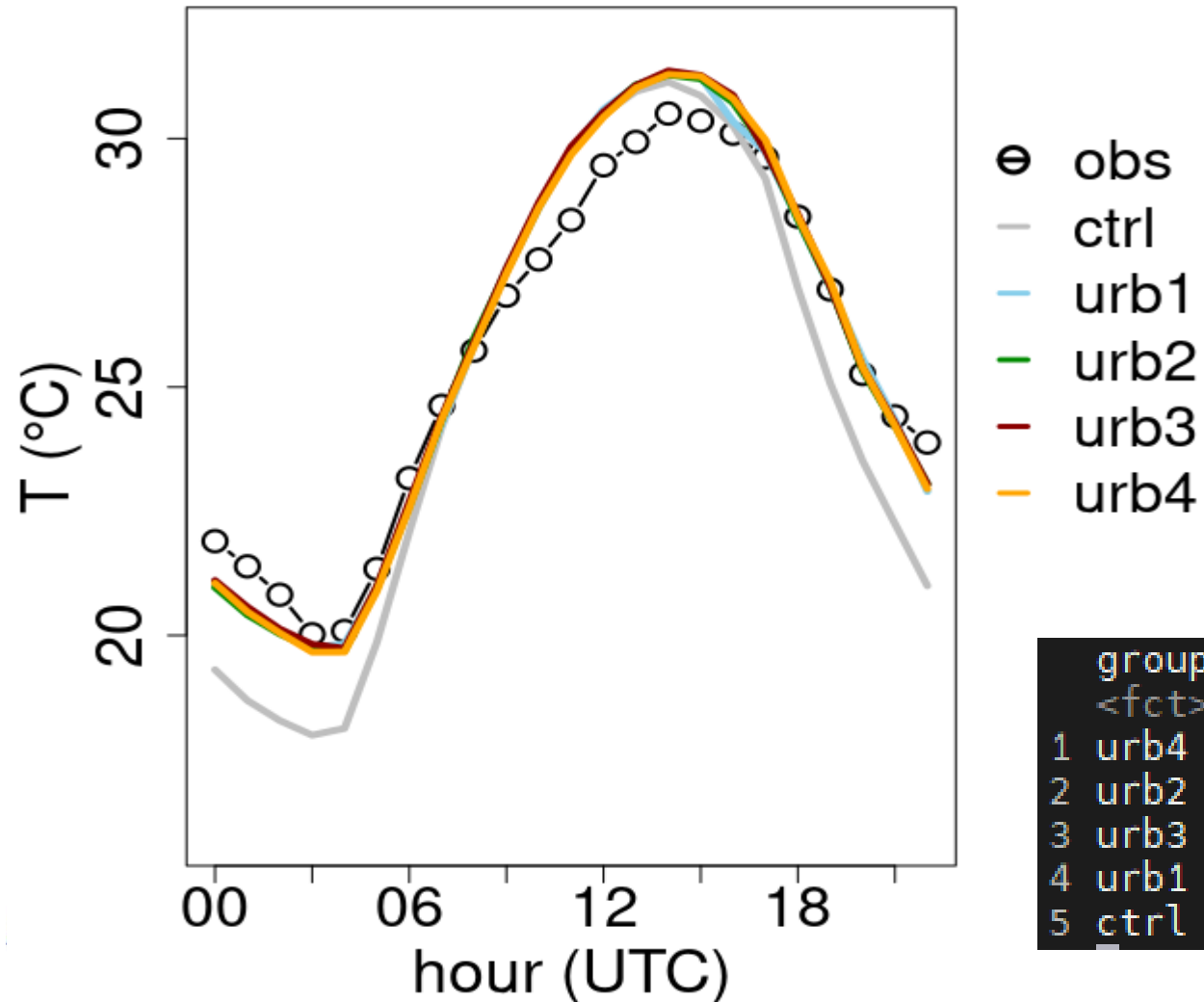
- **CTRL** strongly underestimates mean 2m temperature
- **URB1** (lterra_urb=TRUE) reduces MB and RMSE
- **URB2** (ESA lu) improves MB (slight underestimation), RMSE and r
- **URB3** (c_soil=0.8) changes MB (slight overestimation)
- **URB4** (thmmin=thkmin=0.3) does not shows any effect

Marked improvement for urban configurations in reproducing 2m temperature in rural stations
ESA land use classification seems to improve all the indices -> URB3 best configuration

2M TEMPERATURE

focus on Turin

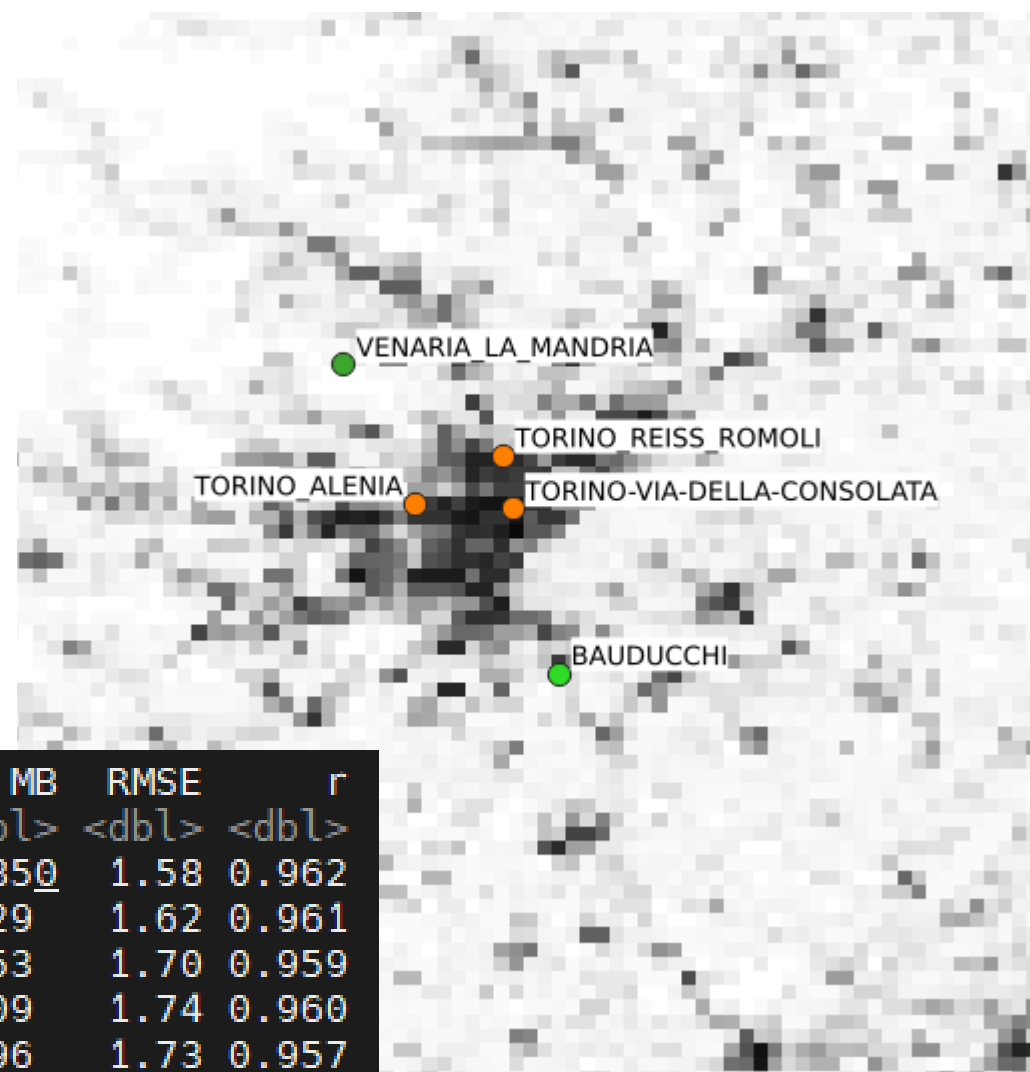
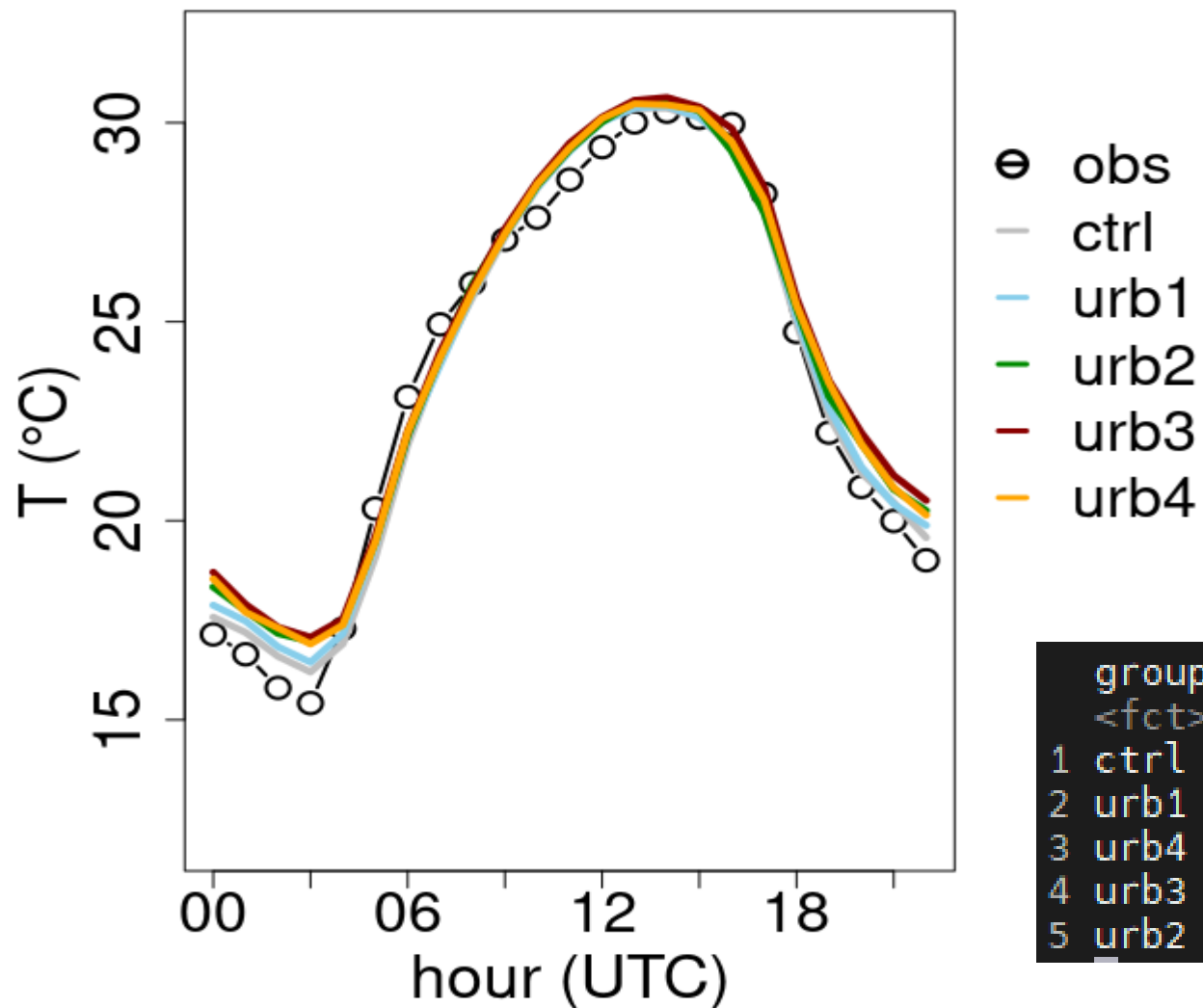
Urban station



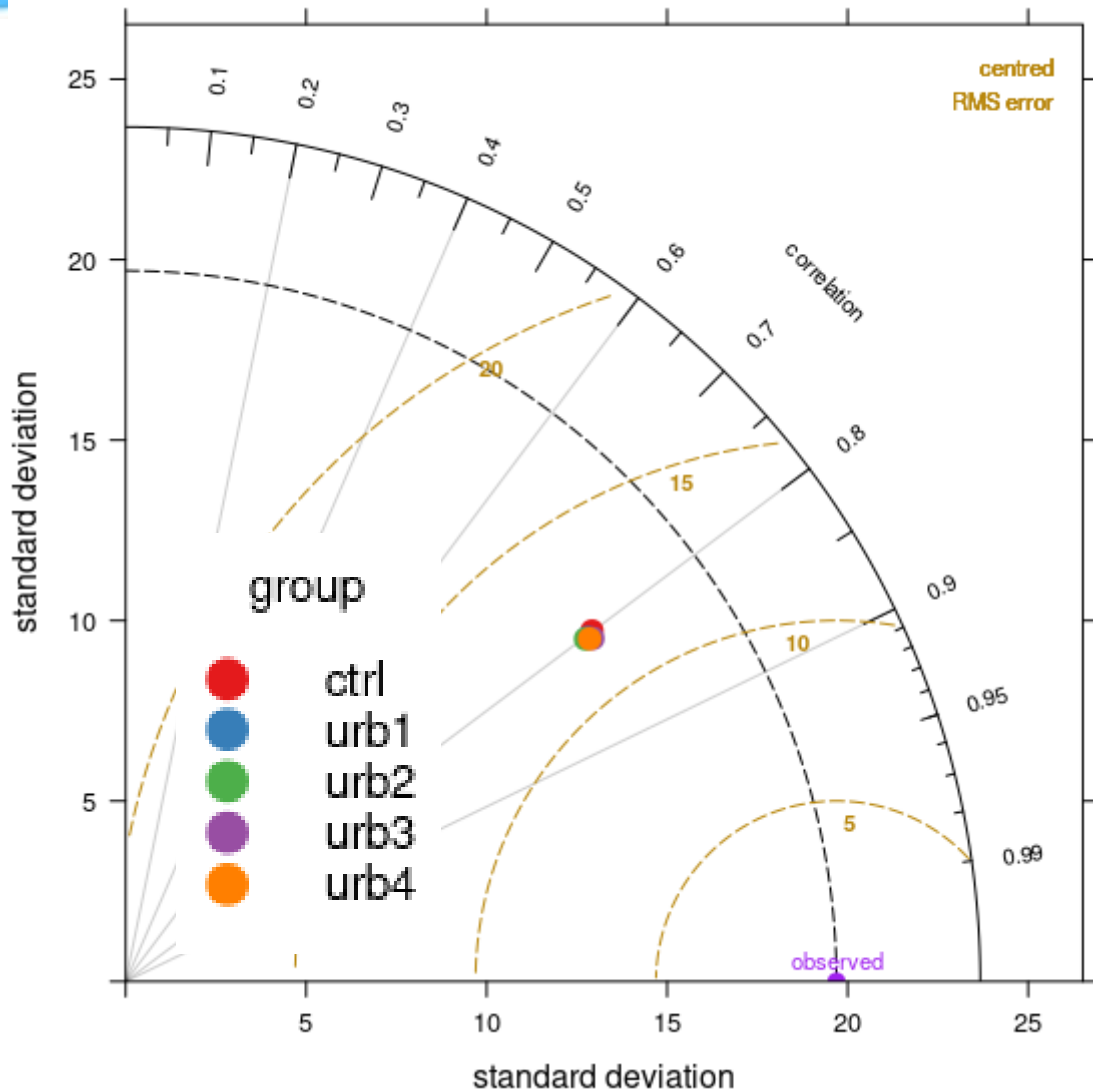
2M TEMPERATURE

focus on Turin

Rural station



2M RELATIVE HUMIDITY



- **CTRL** overestimates mean 2m relative humidity
- **URB1** (lterra_urb=TRUE) slightly improves MB, RMSE and r
- **URB2** (ESA lu) changes MB (slight underestimation)
- **URB3** (c_soil=0.8) worsens MB (overestimation) but improves r
- **URB4** (thmmin=thkmin=0.3) slightly improves MB, RMSE and r

group	MB	RMSE	r
<fct>	<dbl>	<dbl>	<dbl>
1 urb3	-1.89	11.8	0.806
2 urb4	-0.506	11.7	0.804
3 urb2	-0.611	11.8	0.802
4 urb1	0.461	11.8	0.802
5 ctrl	1.25	11.9	0.799

Quite good and comparable performance for all configurations, but improvement in MB and r for urban ones

2M RELATIVE HUMIDITY



	group	day	MB	RMSE	r
	<fct>	<fct>	<dbl>	<dbl>	<dbl>
1	urb3	Day	-0.666	10.3	0.811
2	urb4	Day	0.694	10.5	0.803
3	urb2	Day	0.649	10.5	0.801
4	urb1	Day	1.76	10.8	0.799
5	ctrl	Day	2.33	10.9	0.797
6	urb1	Night	-2.19	13.6	0.722
7	urb4	Night	-2.98	13.8	0.721
8	ctrl	Night	-0.962	13.7	0.714
9	urb2	Night	-3.23	13.9	0.718
10	urb3	Night	-4.41	14.4	0.714

- **CTRL** overestimates rh2m during day and slightly underestimates it during night
- **URB1** (lterra_urb=TRUE) improves r and RMSE, particularly during night
- **URB2** (ESA lu) improves during day but worsens during night
- **URB3** (c_soil=0.8) improves r and RMSE during day but worsens MB, r and RMSE during night
- **URB4** (thmmin=thkmin=0.3) slightly improves indices both during night and day

Quite good and comparable performance for all configurations, but improvement for urban ones

2M RELATIVE HUMIDITY in «urban» stations

URBAN: ISA>0.5 – GC

Name	MB	RMSE	R	rank
URB3	-1.87	12.0	0.795	1
URB4	-0.484	12.1	0.792	2
URB2	-0.568	12.0	0.791	3
URB1	0.474	12.1	0.790	4
CTRL	0.923	12.1	0.790	5

URBAN: ISA>0.5 – ESA

Name	MB	RMSE	r	rank
URB3	-0.413	7.06	0.916	1
URB4	0.786	7.33	0.911	2
URB2	0.604	7.42	0.907	3
URB1	1.61	7.54	0.909	4
CTRL	5.73	10.5	0.880	5

- **CTRL** overestimates mean rh2m
- **URB1** (lterra_urb=TRUE) reduces MB
- **URB2** (ESA lu) improves RMSE and r
- **URB3** (c_soil=0.8) improves r and RMSE and change MB (underestimation)
- **URB4** (thmmin=thkmin=0.3) increases MB but improves RMSE and r

Improvement for urban configurations in reproducing 2m relative humidity in urban stations, particularly for ESA land use classification

PERI-URBAN: $0.01 < ISA < 0.5$ – GC

Name	MB	RMSE	R	rank
CTRL	1.07	10.9	0.859	1
URB1	-0.865	11.1	0.852	2
URB4	-2.37	11.3	0.852	3
URB2	-2.67	11.6	0.844	4
URB3	-4.0	12	0.846	5

PERI-URBAN: $0.01 < ISA < 0.5$ – ESA

Name	MB	RMSE	r	rank
URB3	-2.48	11.2	0.833	1
URB4	-1.04	11.0	0.83	2
URB2	-1.17	11.1	0.829	3
URB1	0.233	11.0	0.829	4
CTRL	1.01	11.1	0.829	5

2M RELATIVE HUMIDITY in «peri-urban» stations

- **CTRL** overestimates mean rh2m
- **URB1** (lterra_urb=TRUE) underestimates rh2m and worsens RMSE and r
- **URB2** (ESA lu) worsens MB and r
- **URB3** (c_soil=0.8) worsens MB (underestimation) and RMSE but improves r
- **URB4** (thmmin=thkmin=0.3) improves MB and r

Not significantly improvement for urban configurations in reproducing 2m relative humidity in peri-urban stations
GlobCover land use classification seems to perform better

2M RELATIVE HUMIDITY in «rural» stations

RURAL: ISA<0.01 – GC

Name	MB	RMSE	R	rank
URB3	-1.87	12.1	0.795	1
URB4	-0.484	12.1	0.792	2
URB2	-0.568	12.0	0.791	3
URB1	0.474	12.0	0.790	4
CTRL	0.923	12.1	0.790	5

RURAL: ISA<0.01 – ESA

Name	MB	RMSE	r	rank
URB3	-1.25	13.2	0.751	1
URB4	0.086	13.1	0.750	2
URB2	0.035	13.2	0.747	3
CTRL	0.914	13.2	0.748	4
URB1	0.621	13.3	0.745	5

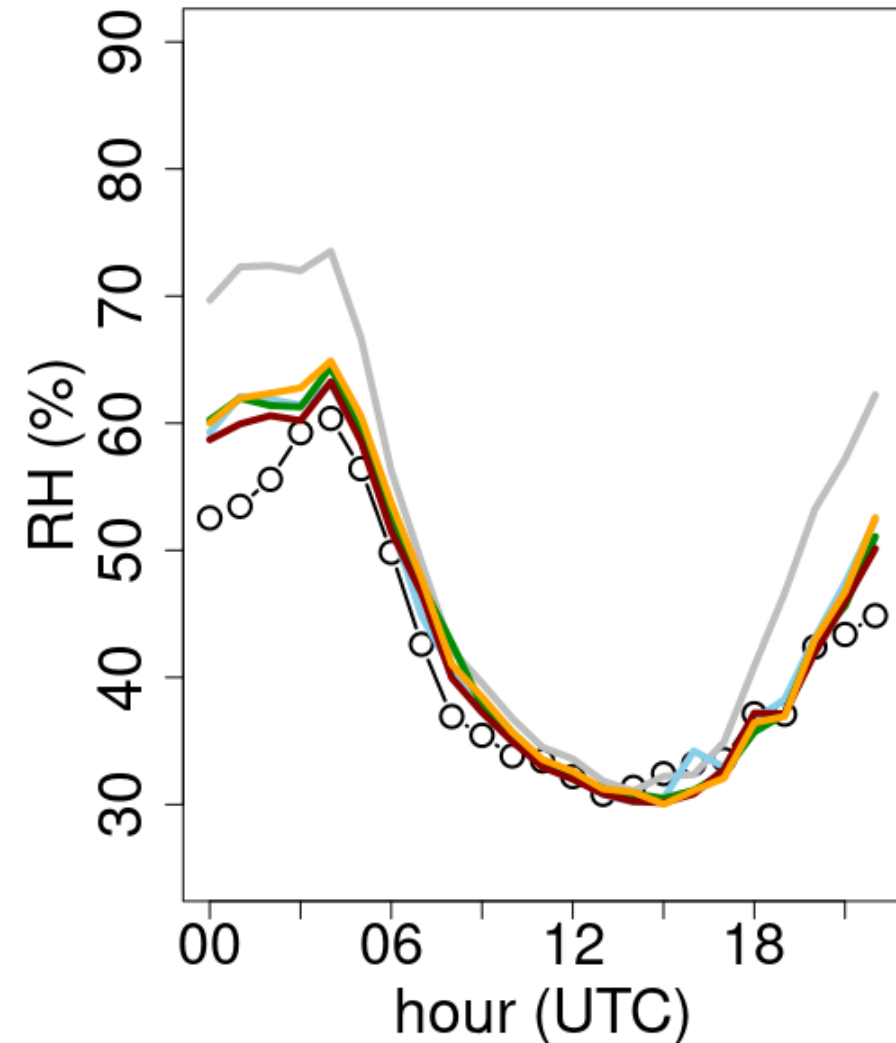
- **CTRL** overestimates mean rh2m
- **URB1** (lterra_urb=TRUE) reduces MB
- **URB2** (ESA lu) improves MB, but worsens RMSE and r
- **URB3** (c_soil=0.8) changes MB (underestimation) and improves r
- **URB4** (thmmin=thkmin=0.3) worsens MB but improves RMSE and r

Not significant improvement for urban configurations in reproducing 2m relative humidity in rural stations
GlobCover land use classification seems to perform better

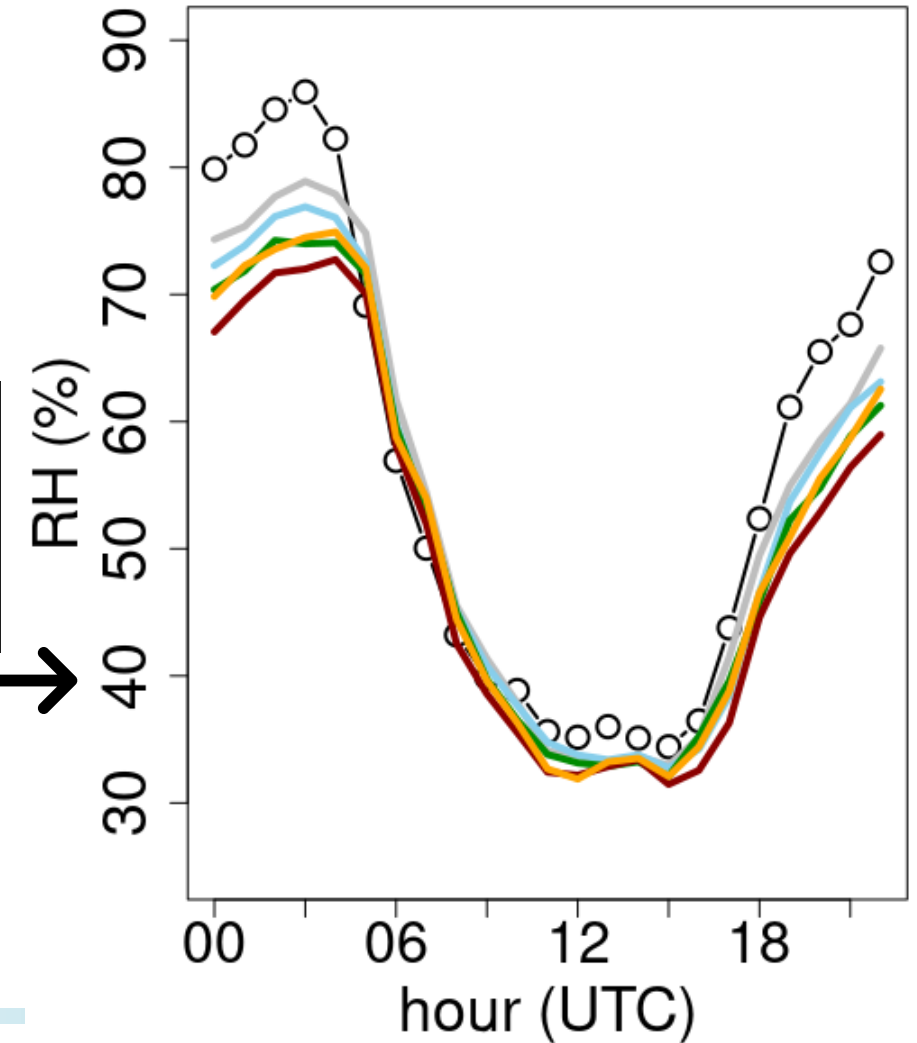
2M RELATIVE HUMIDITY

focus on Turin

Urban station



Rural station



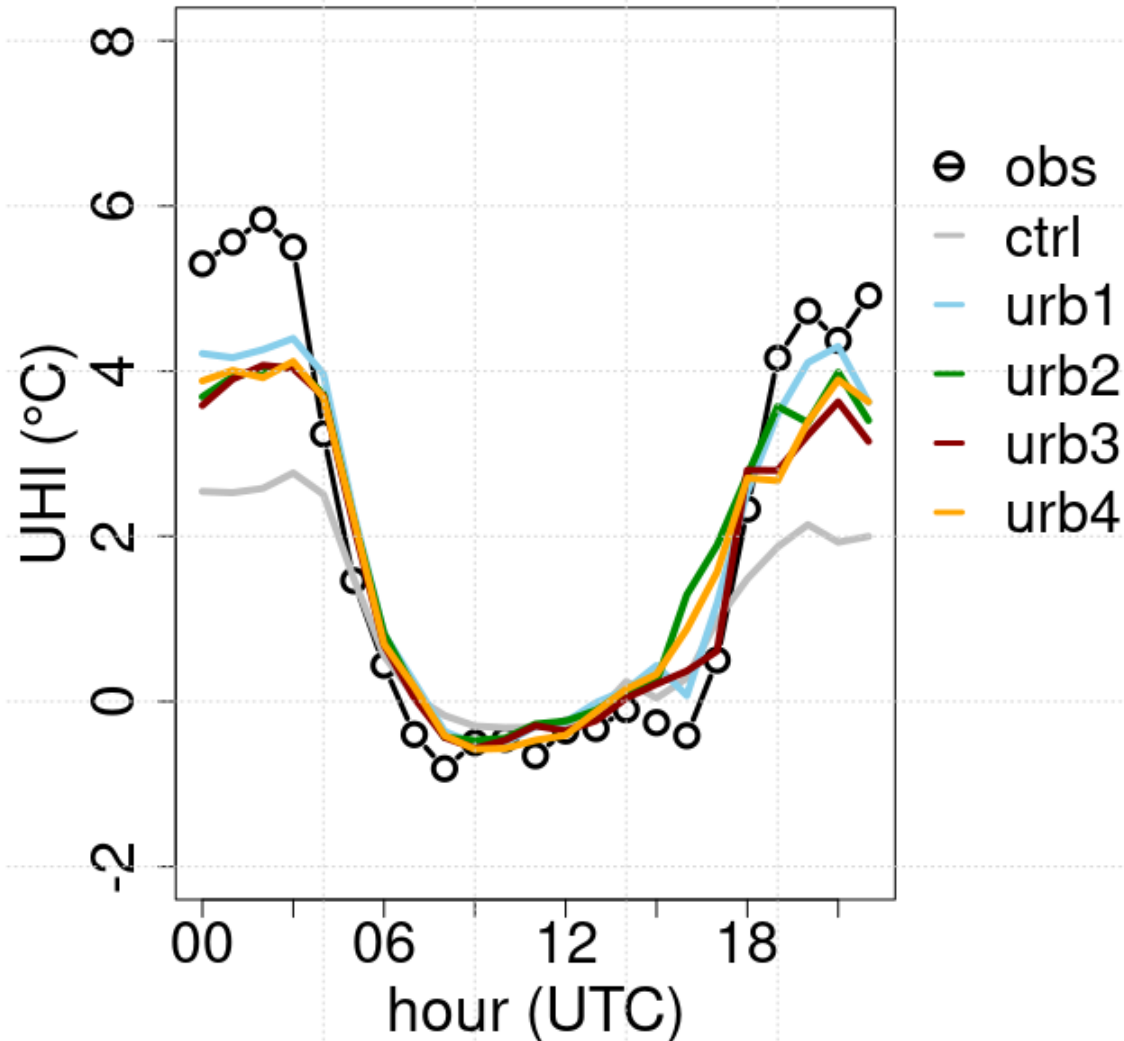
group	MB	RMSE	r
<fct>	<dbl>	<dbl>	<dbl>
1 urb3	1.96	6.97	0.895
2 urb2	2.61	7.89	0.870
3 urb4	3.10	7.84	0.882
4 urb1	2.78	7.95	0.869
5 ctrl	8.60	13.2	0.808

group	MB	RMSE	r
<fct>	<dbl>	<dbl>	<dbl>
1 ctrl	-2.36	10.7	0.874
2 urb1	-3.59	11.3	0.866
3 urb4	-4.78	11.4	0.875
4 urb2	-4.77	11.8	0.864
5 urb3	-6.49	12.5	0.868

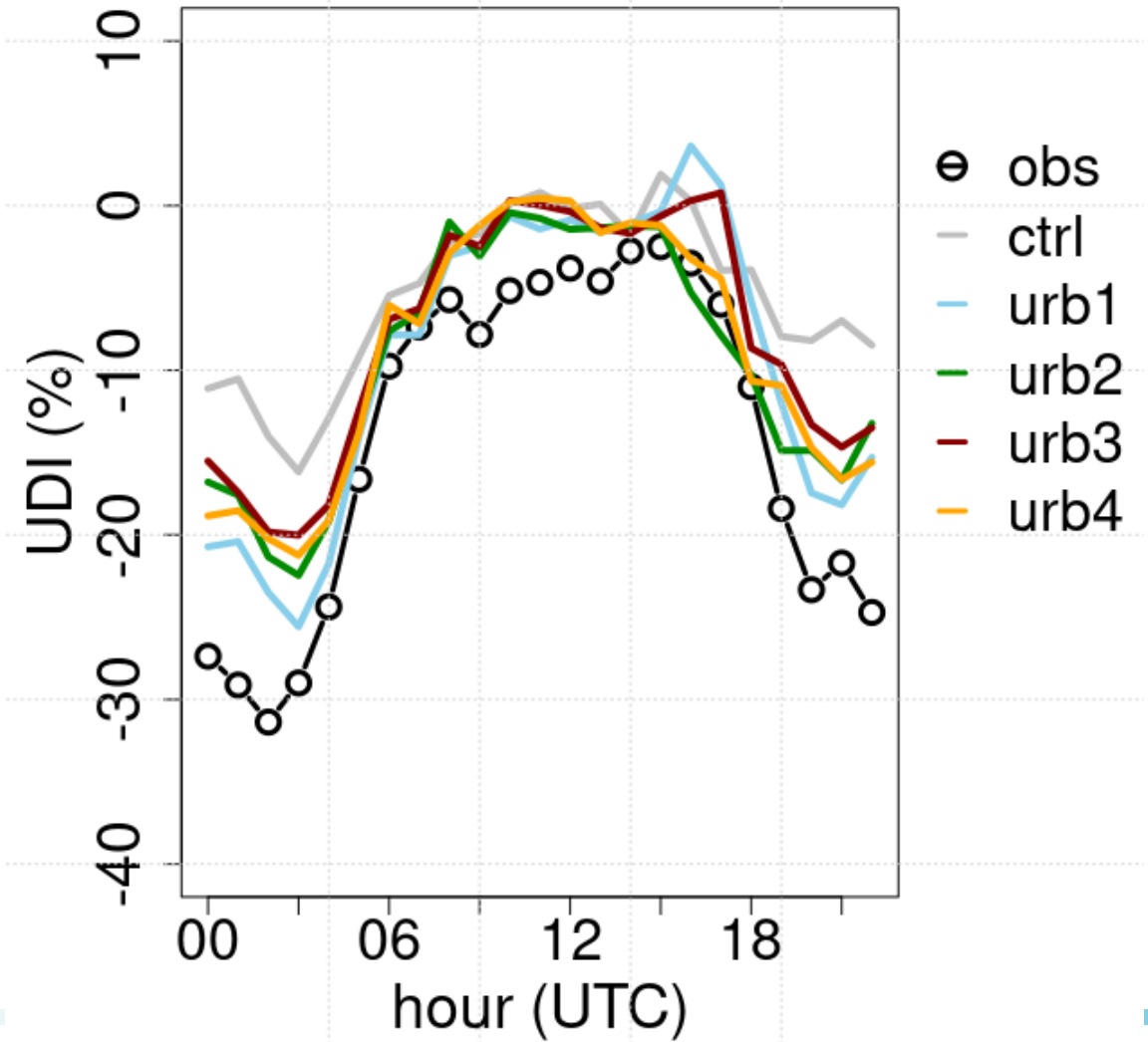
obs
ctrl urb1 urb2 urb3 urb4

UHI and UDI in Turin

TO CONSOLATA - BAUDUCCHI



TO CONSOLATA - BAUDUCCHI





CONCLUSIONS AND FUTURE WORKS

Very good preliminary results: TERRA_URB in ICON definitely improves the reproduction of 2m temperature and relative humidity in urban stations

ESA land use classification improves model performance in urban stations, but it worsens performance elsewhere: too few natural classes?

1. Further calibration to obtain optimal configuration. Any suggestions?
2. ECOCLIMAP dataset (33 classes, 10 LCZ urban classes)
3. IFS initial and boundary conditions