SPECIAL PROJECT PROGRESS REPORT

Reporting year	2023
Project Title:	Intensive test of ICON-LAM Model with urban parameterization scheme TERRA_URB
Computer Project Account:	Spitmil2
Principal Investigator(s):	Massimo Milelli (mcy)
Affiliation:	CIMA Research Foundation
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Valeria Garbero (mcy0) - Arpa Piemonte, Martina Lagasio (it90) - CIMA
Start date of the project:	2023
Expected end date:	2024

Computer resources allocated/used for the current year and the previous one

		Previous year (2023)		**Current year (2024)**	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	3000000 (1900000 from ECMWF web site)	1650000	900000	-
Data storage capacity	(Gbytes)	2000	2000 (/ec/res4/scratch)	1000	-

Summary of project objectives

The final goal of the project is to test intensively the implementation of the urban parametrization (called TERRA_URB) in the official release of ICON model. The technical part of the work is supported by verification, using the data of the Italian network. A long case study (May-June 2023) has been selected, over north-west Italy. In this way it is possible to have a more robust statistics.

Summary of problems encountered

No problems, just a remark. In my request I asked for 3000000 SBU in 2023, but I got 1900000 SBU (from https://hpc-usage.ecmwf.int/sbu-accounting/my-accounts). It was not a problem since I managed to perform the experiments that I had planned.

Summary of plans for the continuation of the project

We are still working on the parametrisation code, because there are still things to fix (even though we got substantial improvements). So in 2024 new tests over the same period are needed to validate the performance of the changes we are making in TERRA_URB.

List of publications/reports from the project with complete references

We are preparing a publication, but the process is still ongoing.

Summary of results since the beginning of the project

The area of study is the city of Torino, Northern Italy (Fig. 1), where we have selected 3 urban stations (URB1, URB2 and URB3) and a reference rural station (RURs). The simulations, obtained with the official ICON v2.6.5 (June 2023) have the following structure:

- hindcast simulations with initial and boundary conditions from ICON EU
- nesting: domain size 350x350 km centered around Turin → final grid spacing: ~1km
- observations provided by the Arpa Piemonte network (hourly data)
- case study: May-June 2023
- zero-order model (TERRA_URB off) -> CTR run in black (or grey)
- urban parameterization (TERRA_URB on) -> URB run in green

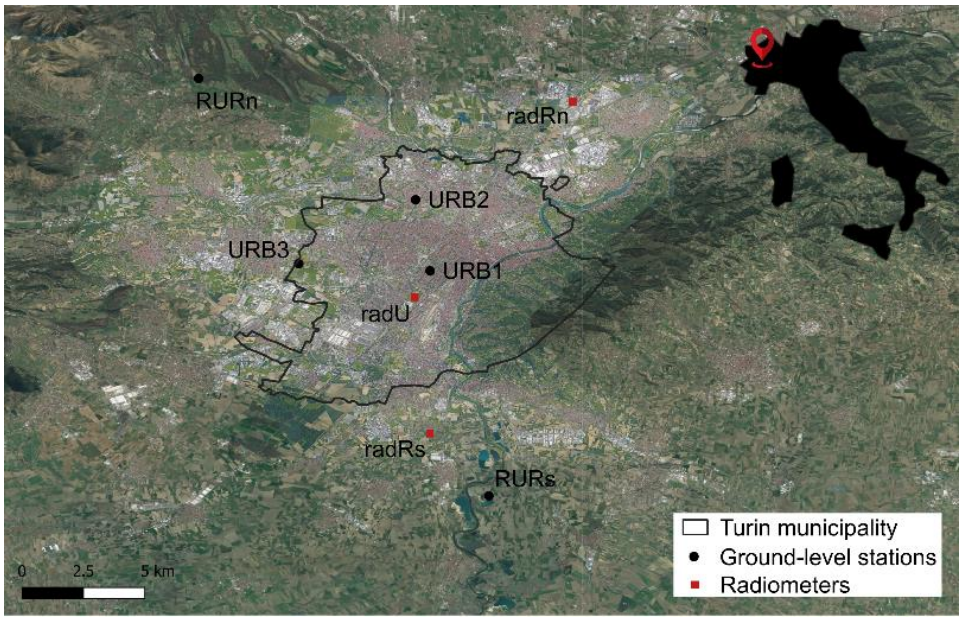

Fig. 1: domain of the study: the area of Turin with the observations

The long period permits to have a more realistic behaviour of the model because different types of weather are considered. May 2023 was rainy (large-scale systems, advection) with temperatures below the average, June was more sunny with convection and a heat wave in the last week.
The simulation domain is shown in Fig. 2 (inner shaded area).

Fig. 2: domain of the simulations (inner shaded area).

As an example, the plots of the diurnal cycle of UHI (UDI) BIAS are shown (Fig. 3 and Fig. 4) considering the differences between T2m (RH2m) in the station URB1 and RURs (Fig. 1). A confidence interval has been calculated according to the bootstrap technique (Hamill, 1999). The main findings are the following:

- For T2m and RH2m URB run is better (from a statistical point of view) during the night
- For T2m and RH2m URB and CTR are statistically similar during the day
- The wind speed is not well described in general and the differences URB/CTR are small (not shown here)
- During the heat wave, the observed UHI (UDI) has a larger amplitude during the night because T (RH) in the city stays higher (lower). The model does not capture this behaviour (Fig. 5).

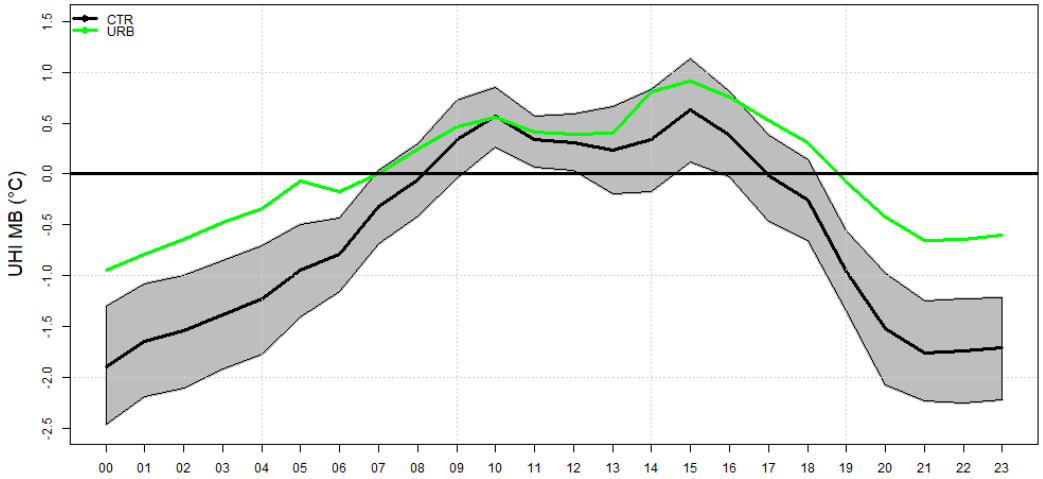

Fig. 3: diurnal cycle of UHI MB between URB1 and RURs

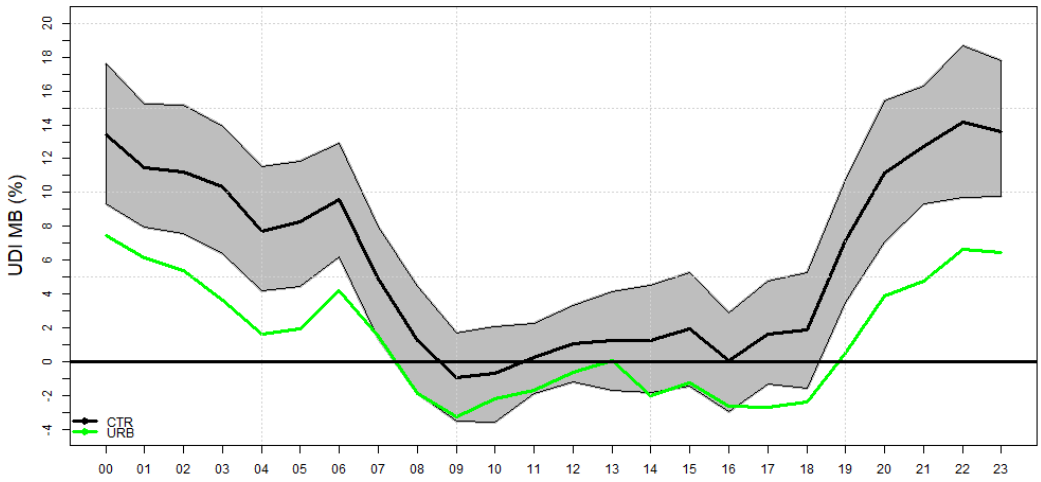

Fig. 4: diurnal cycle of UDI MB between URB1 and RURs

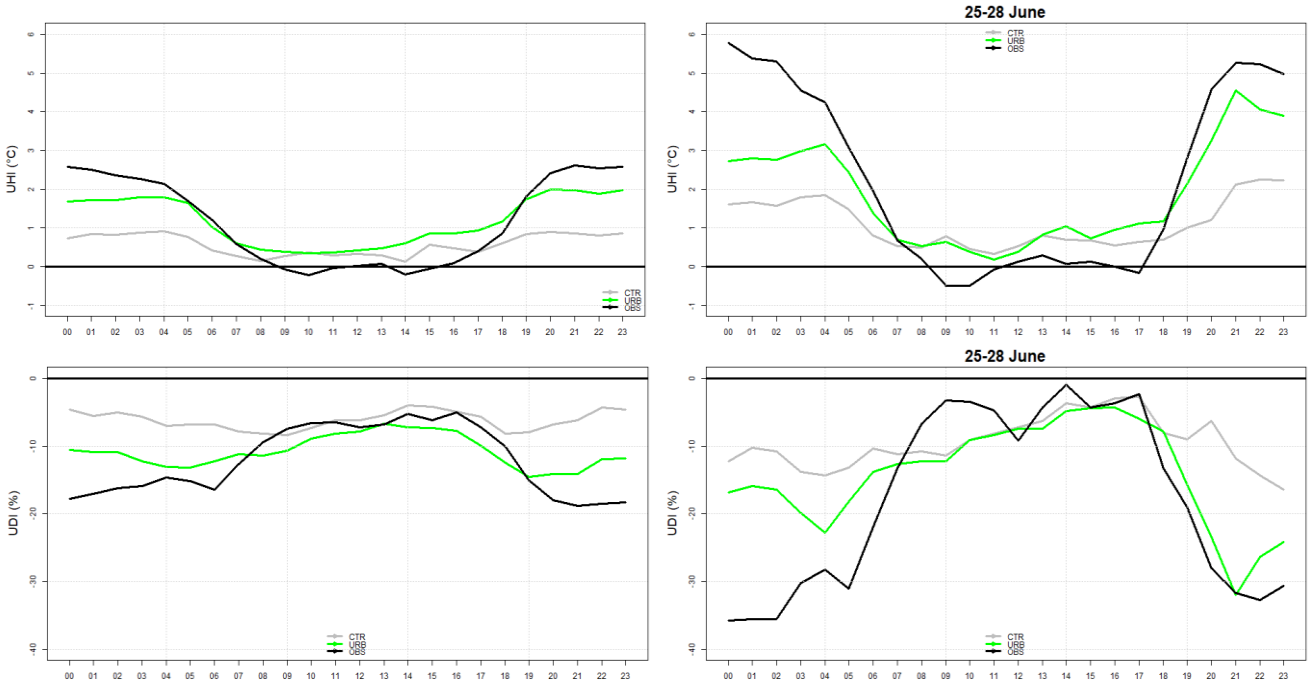

Fig. 5: Diurnal cycle of UHI (upper row) and UDI (lower row) during the entire period (left column) and during the heat wave of 25-28 June (right column)

Despite the improvements there is still something missing in the parametrisation, which becomes more evident in case of heat wave. For this reason the work continues and an extension of SBU has been asked for 2024.

Related literature

- F. Bassani, V. Garbero, D. Poggi, L. Ridolfi, J. von Hardenberg, M. Milelli, An innovative approach to select urban-rural sites for Urban Heat Island analysis: the case of Turin (Italy), Urban Clim., 42 (2022), Article 101099, 10.1016/j.uclim.2022.101099
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- Stewart, I.D.; Oke, T.R. Local Climate Zones for Urban Temperature Studies. Bull. Am. Meteorol. Soc. 2012, 93, 1879–1900
- Wouters, H.; Demuzere, M.; et al. The Efficient Urban Canopy Dependency Parametrization (SURY) v1.0 for Atmospheric Modelling: Description and Application with the COSMO-CLM Model for a Belgian Summer. Geosci. Model Dev. 2016, 9, 3027–3054
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