

A new urban parameterisation for the ICON atmospheric model



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and the COSMO PP CITTA' team

45th EWGLAM and 30th SRNWP Meeting, ET Surface Aspects, 25-28 Sep. 2023, Reykjavik, Iceland



COSMO Priority Project CITTA':

City Induced Temperature change Through Advanced modelling

Project leader:

Jan-Peter Schulz (DWD, CMCC)

Project duration:

Jul. 2021 – Aug. 2024



Task 1: Implementation of TERRA_URB in ICON

During the COSMO Priority Tasks AEVUS and AEVUS2 the TERRA_URB urban parameterisation in the COSMO model was demonstrated to be able to reproduce the key urban meteorological features. In the framework of the transition of the COSMO Consortium to the ICON model TERRA_URB needs to be implemented in ICON.

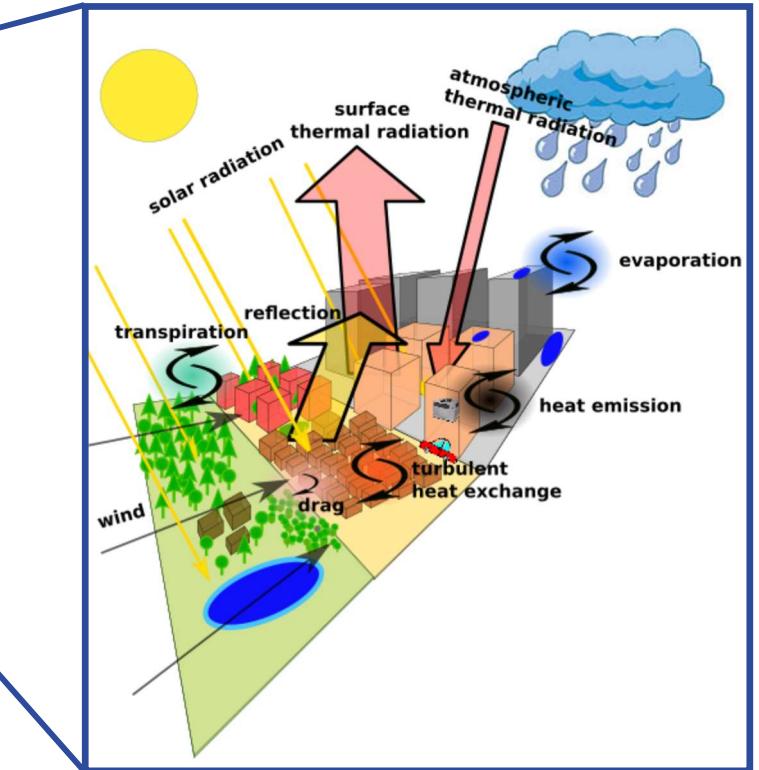
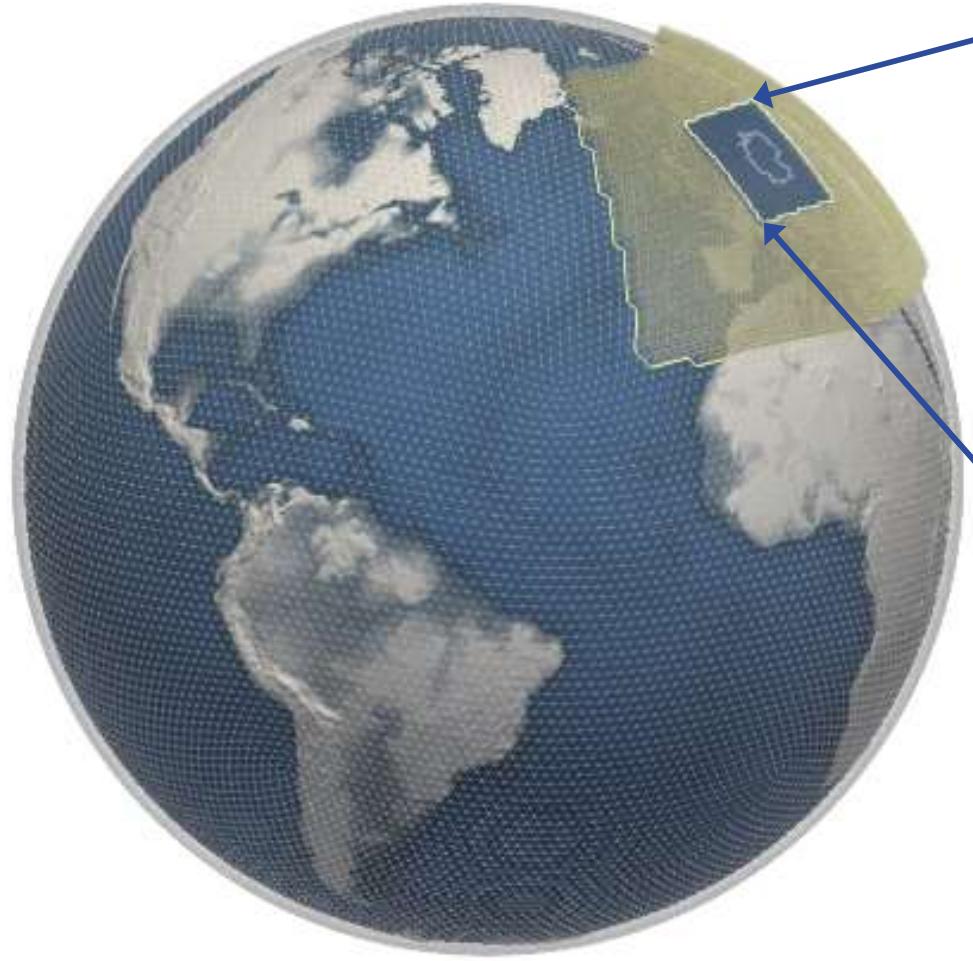
Deliverables: *TERRA_URB in ICON.*

Involved scientists: Jan-Peter Schulz (DWD) 0.4 FTE, Angelo Campanale (CMCC) 0.1 FTE, Massimo Milelli (CIMA) 0.1 FTE

FTEs: 0.6 FTE



Task 1: Implementation of TERRA_URB in ICON



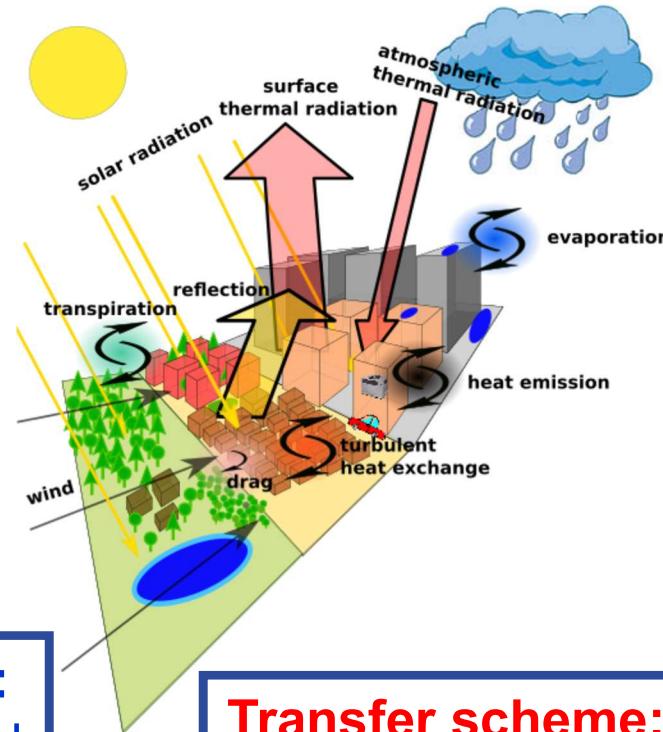
TERRA_URB

(Wouters et al. 2017)

Task 1: Implementation of TERRA_URB in ICON

Modifications in ICON:

Radiation scheme:
Modify albedo
ALB



Land surface scheme:
Introduce puddles
PUDDLE

Land surface scheme:
Set infiltration and bare soil evaporation to zero
NOEVAP

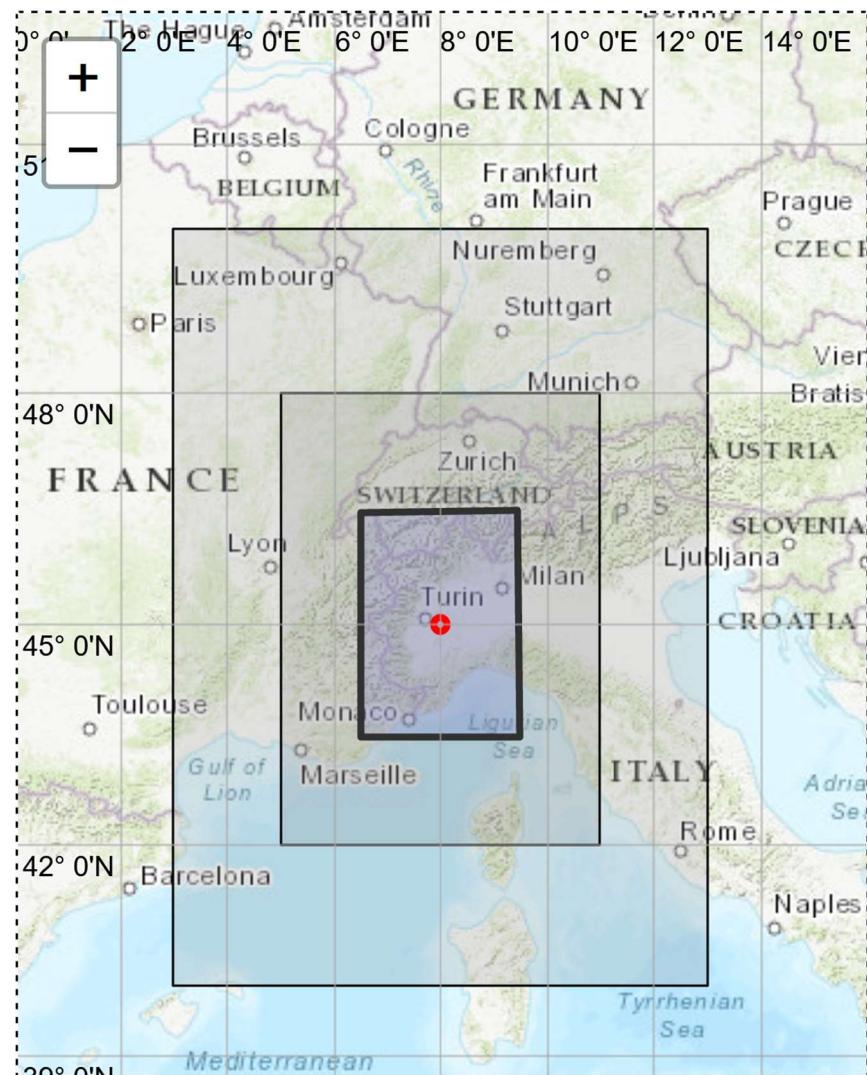
Land surface scheme:
Modify heat capacity and thermal conductivity
THERM

Transfer scheme:
Modify thermal roughness length
TURB

Land surface scheme:
Introduce anthropogenic heat flux
HFLUX



Task 1: Implementation of TERRA_URB in ICON



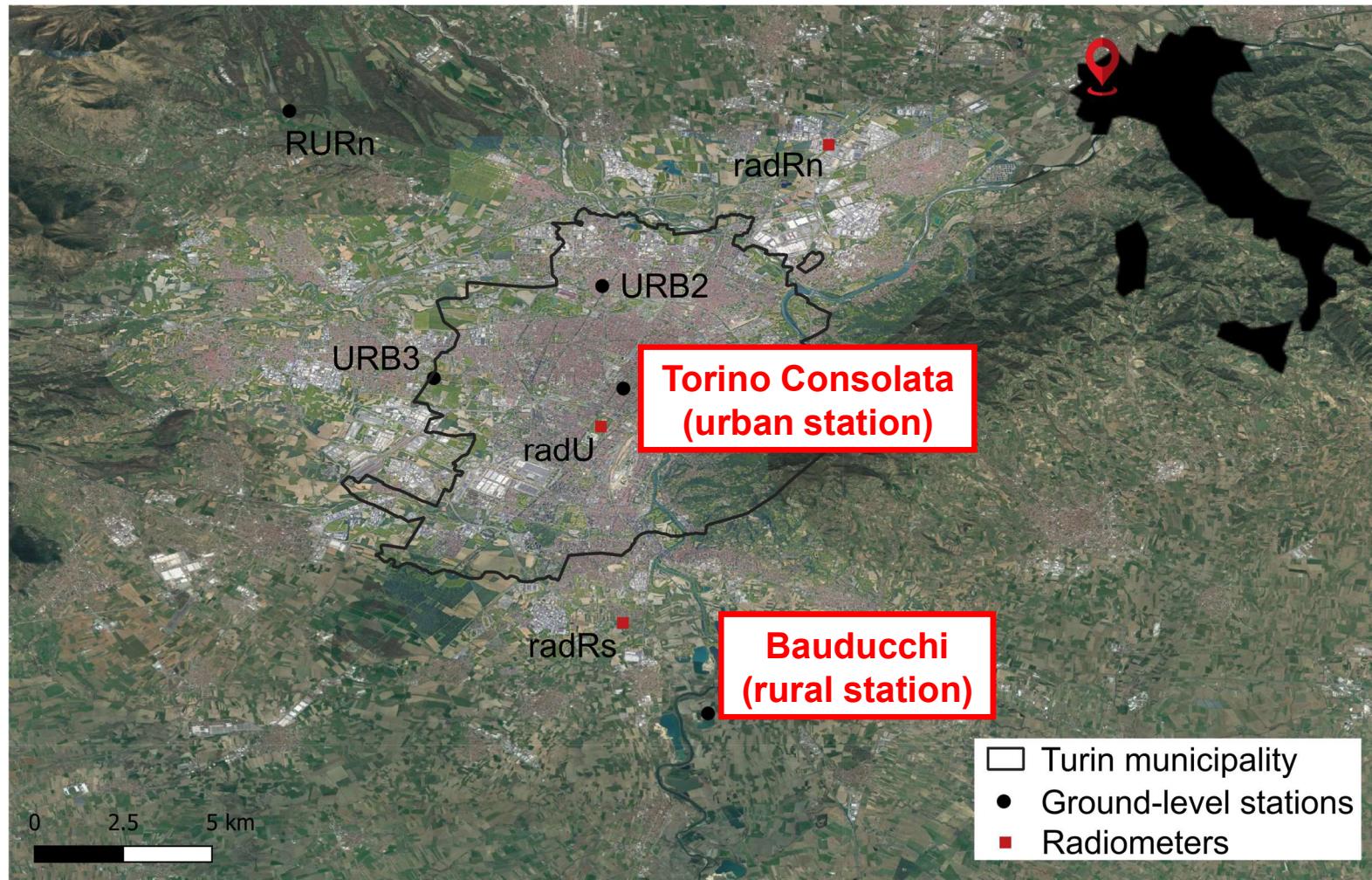
Model setup

Hindcast simulations:

- 2021081100 – 2021081500 (96h)
- Heat wave over north-west of Italy
- IFS 9km -> ICON 900m
- ICON 7km -> ICON 3.5km -> ICON 1.8km -> ICON 900m
- ICON (master branch of June 2023)

M. Milelli (CIMA), F. Bassani (PoliTo), V. Garbero (ARPAP)

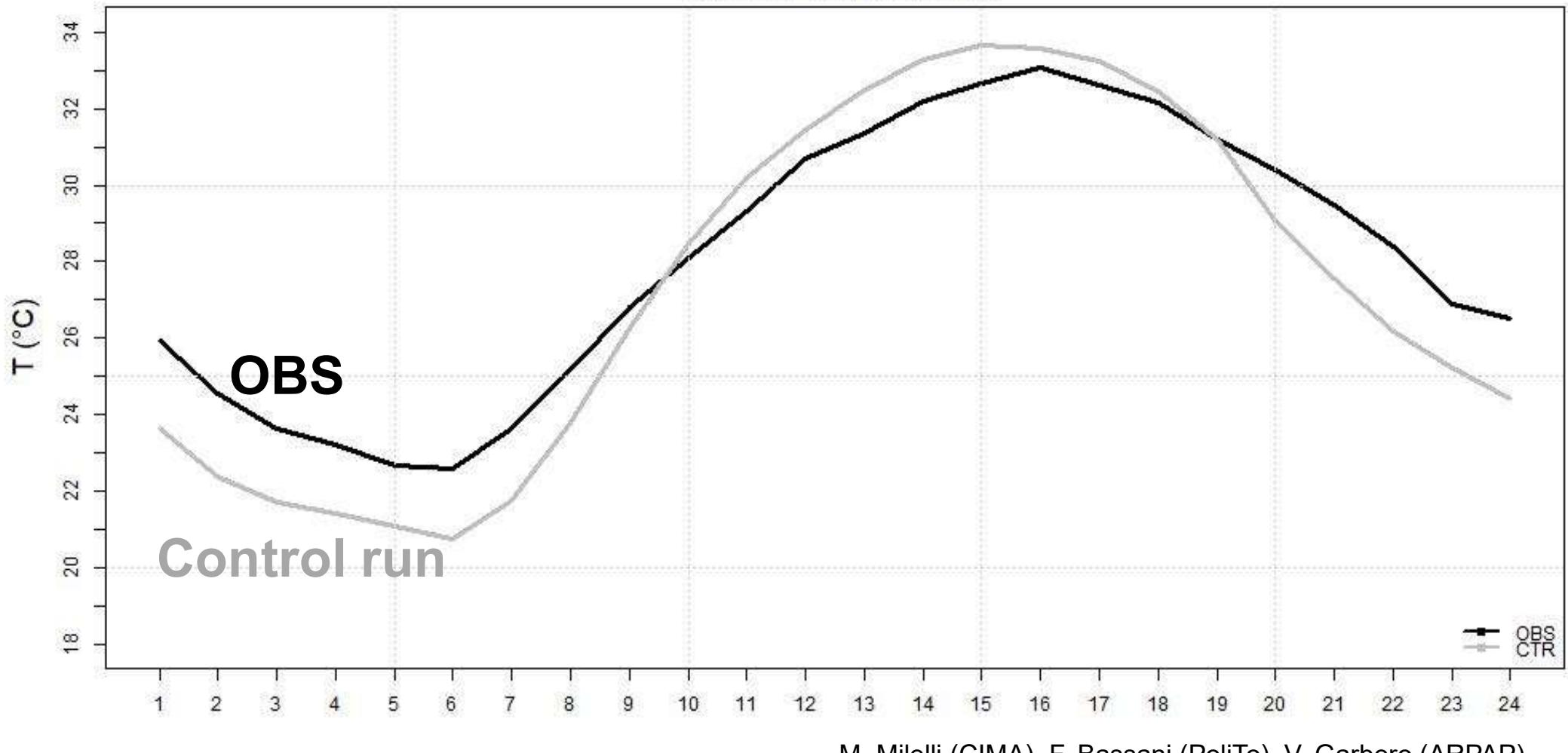
Task 1: Implementation of TERRA_URB in ICON



M. Milelli (CIMA), F. Bassani (PoliTo), V. Garbero (ARPAP)

2-m temperature diurnal cycle

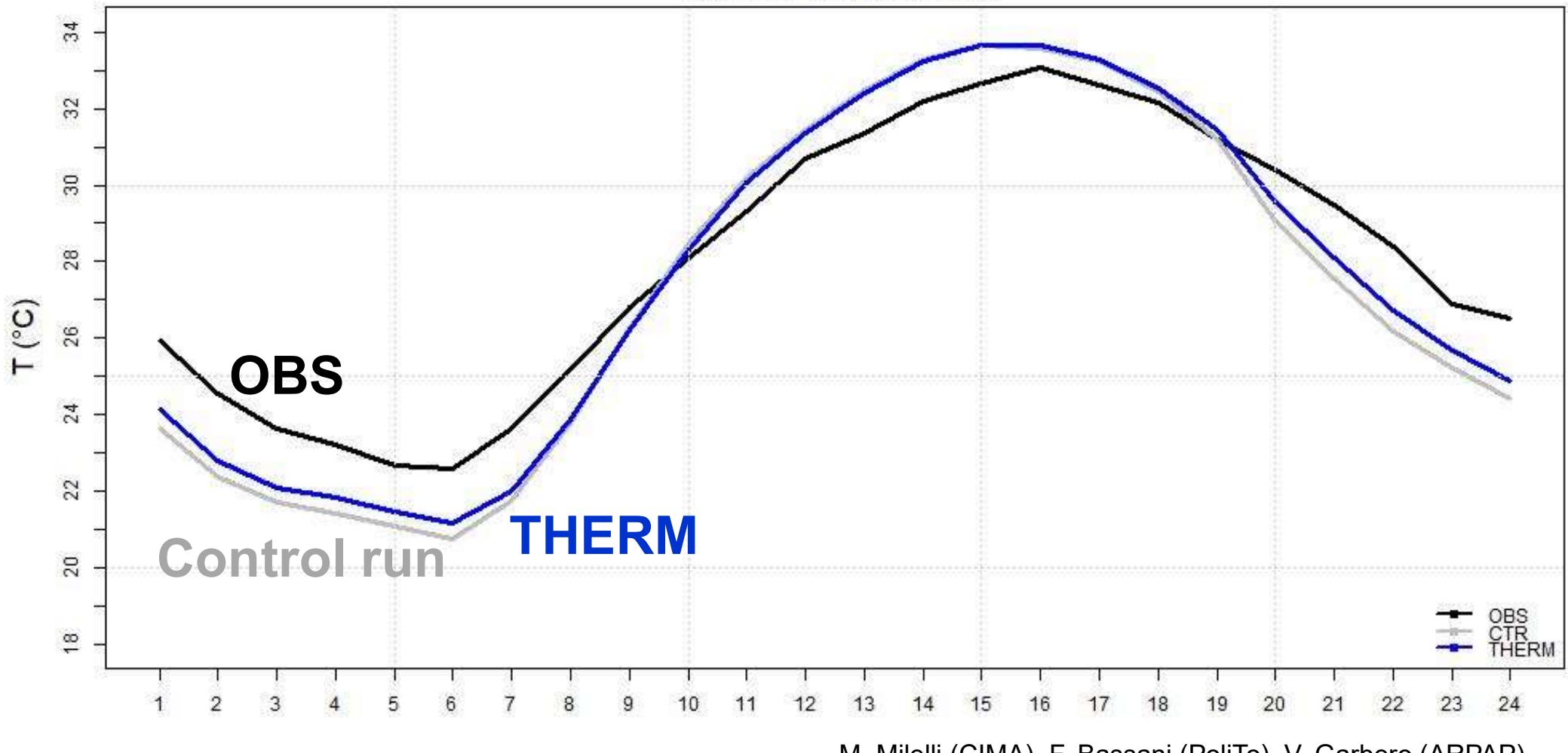
Torino Consolata



M. Milelli (CIMA), F. Bassani (PoliTo), V. Garbero (ARPAP)

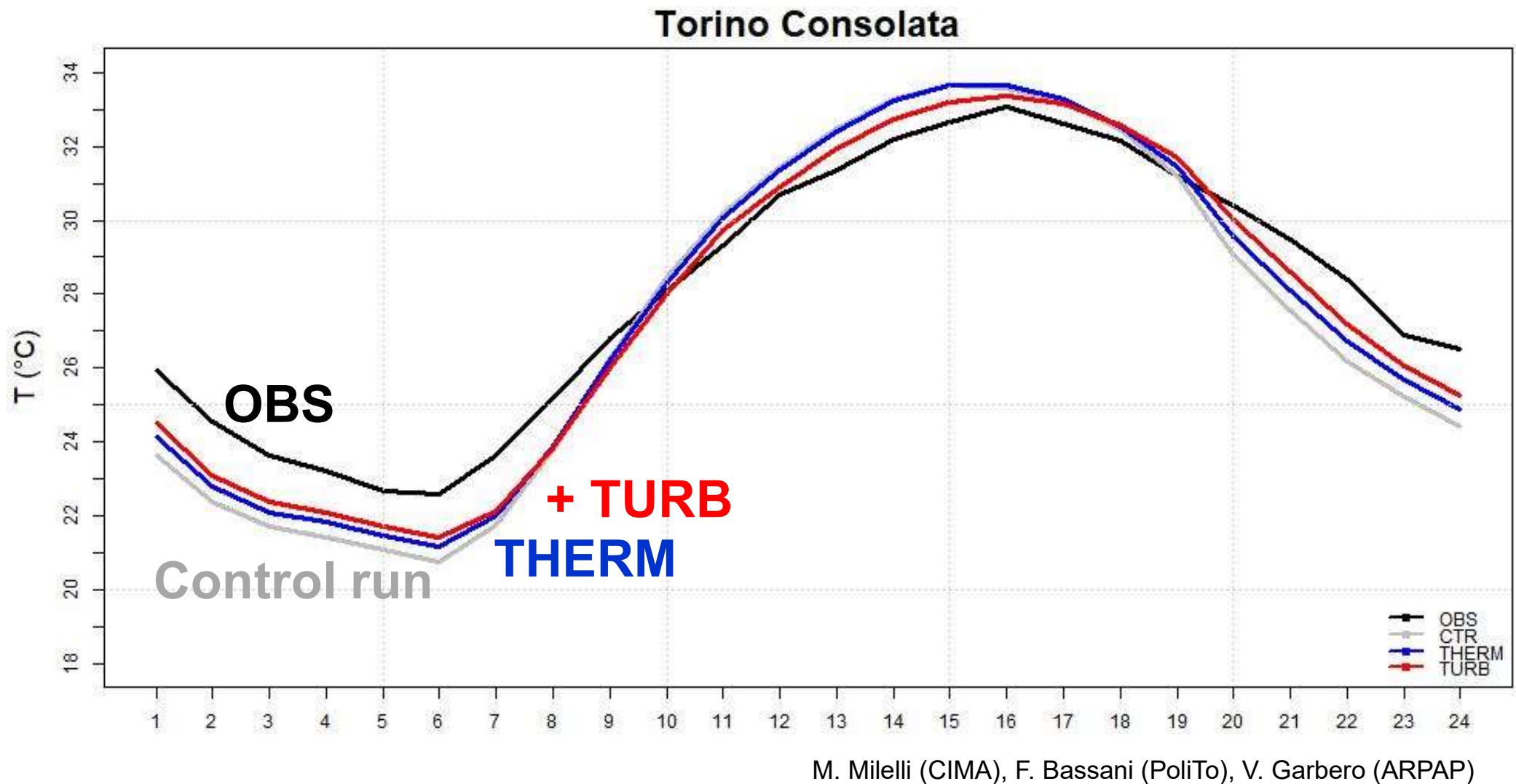
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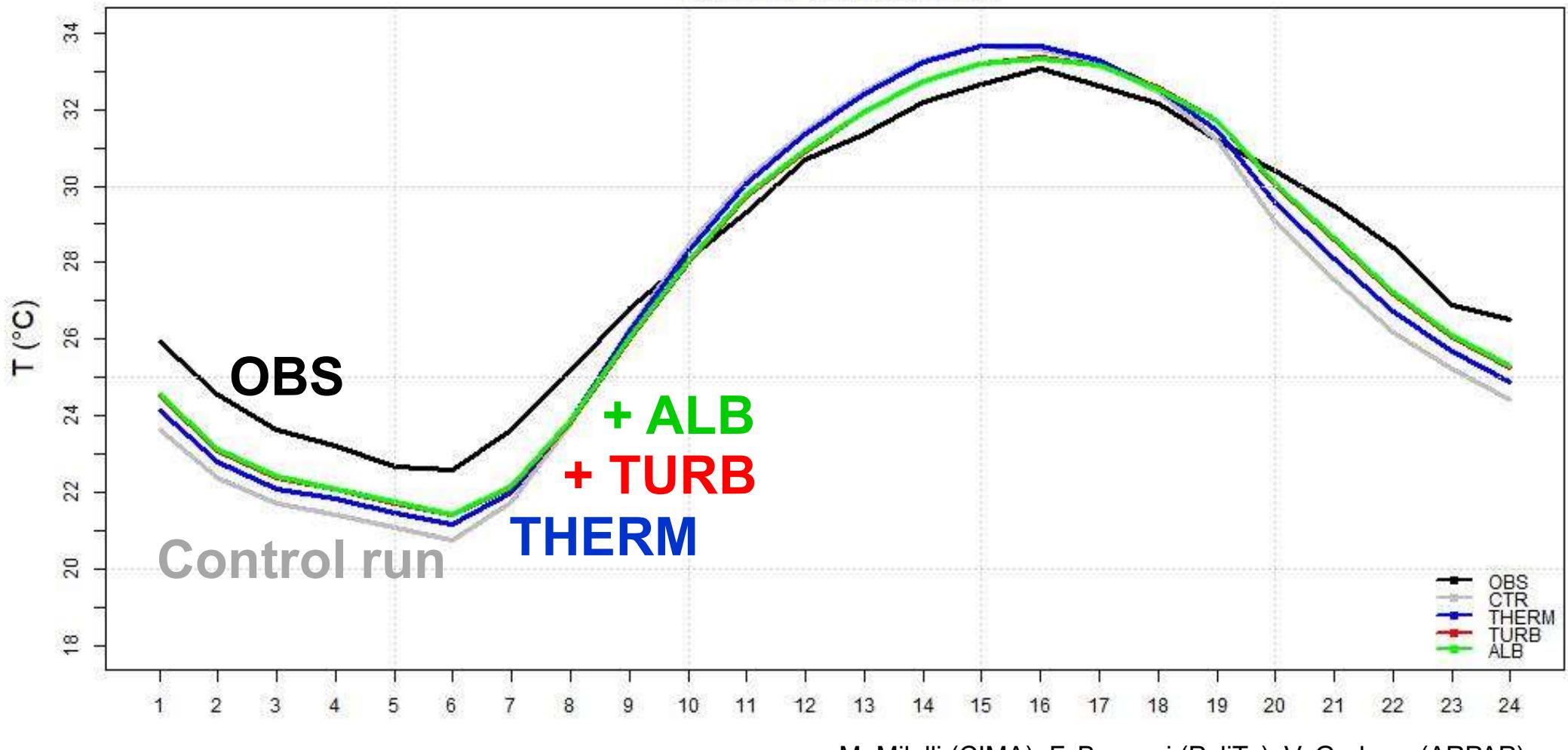
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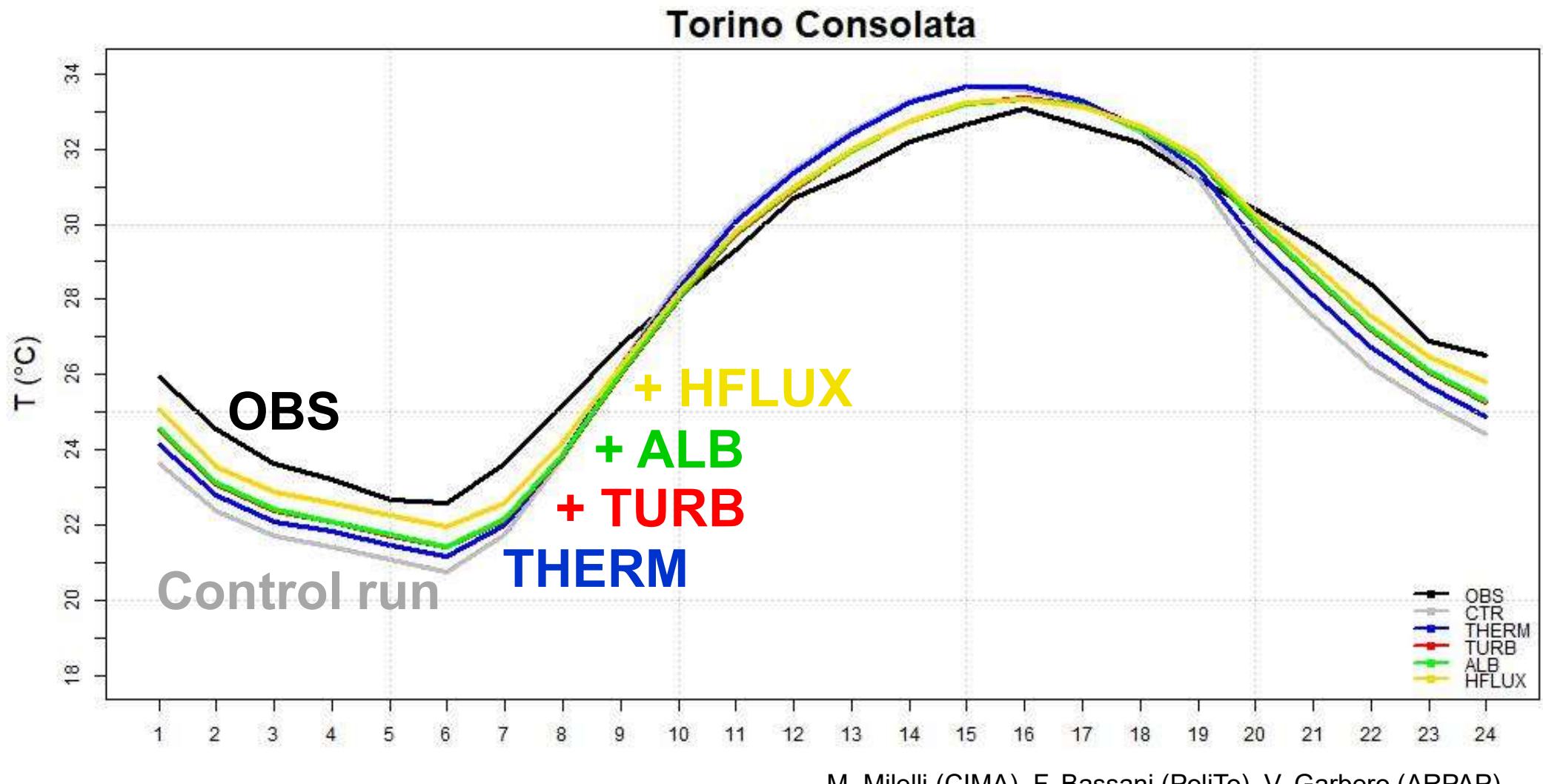
2-m temperature diurnal cycle

Torino Consolata

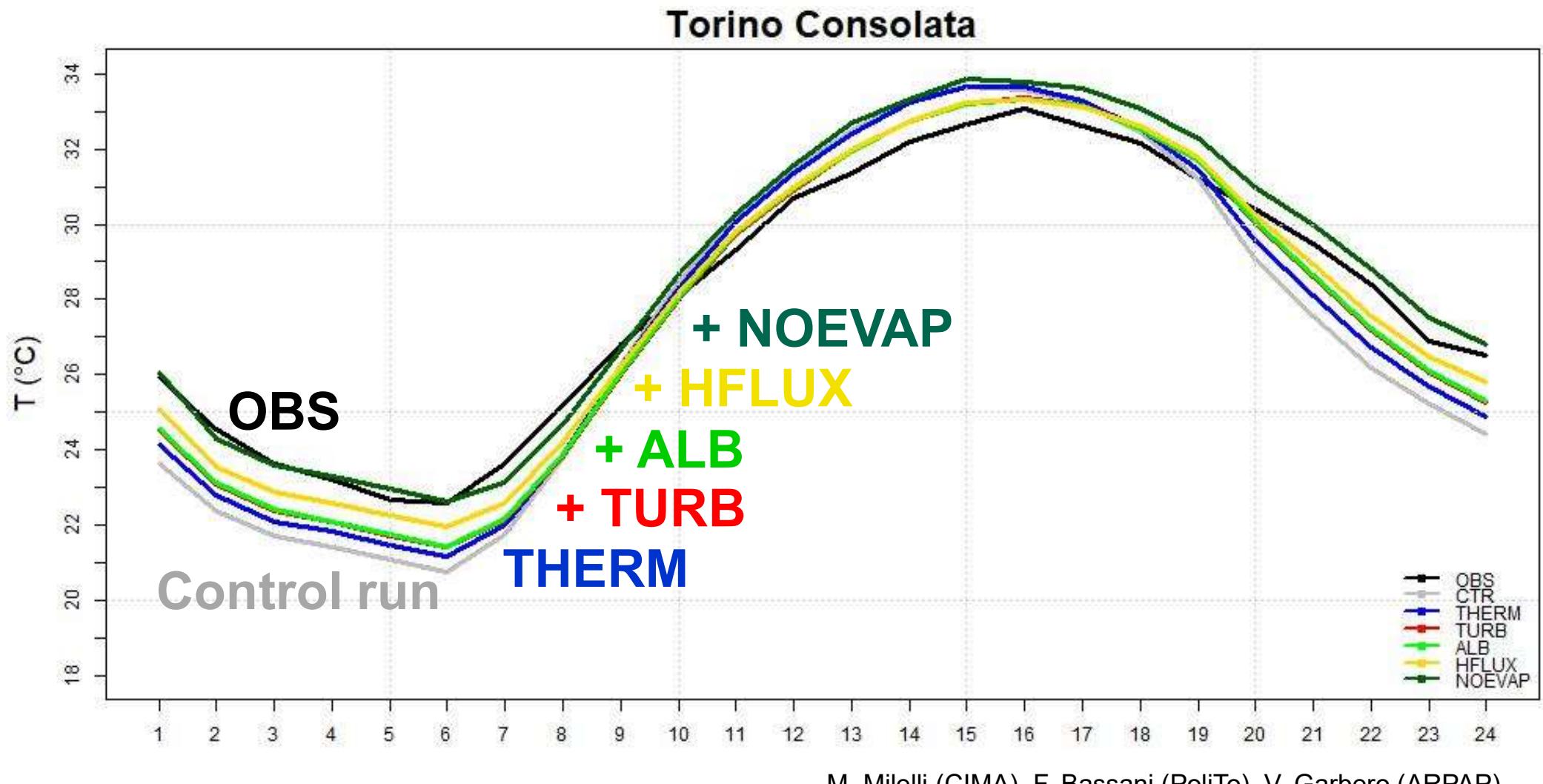


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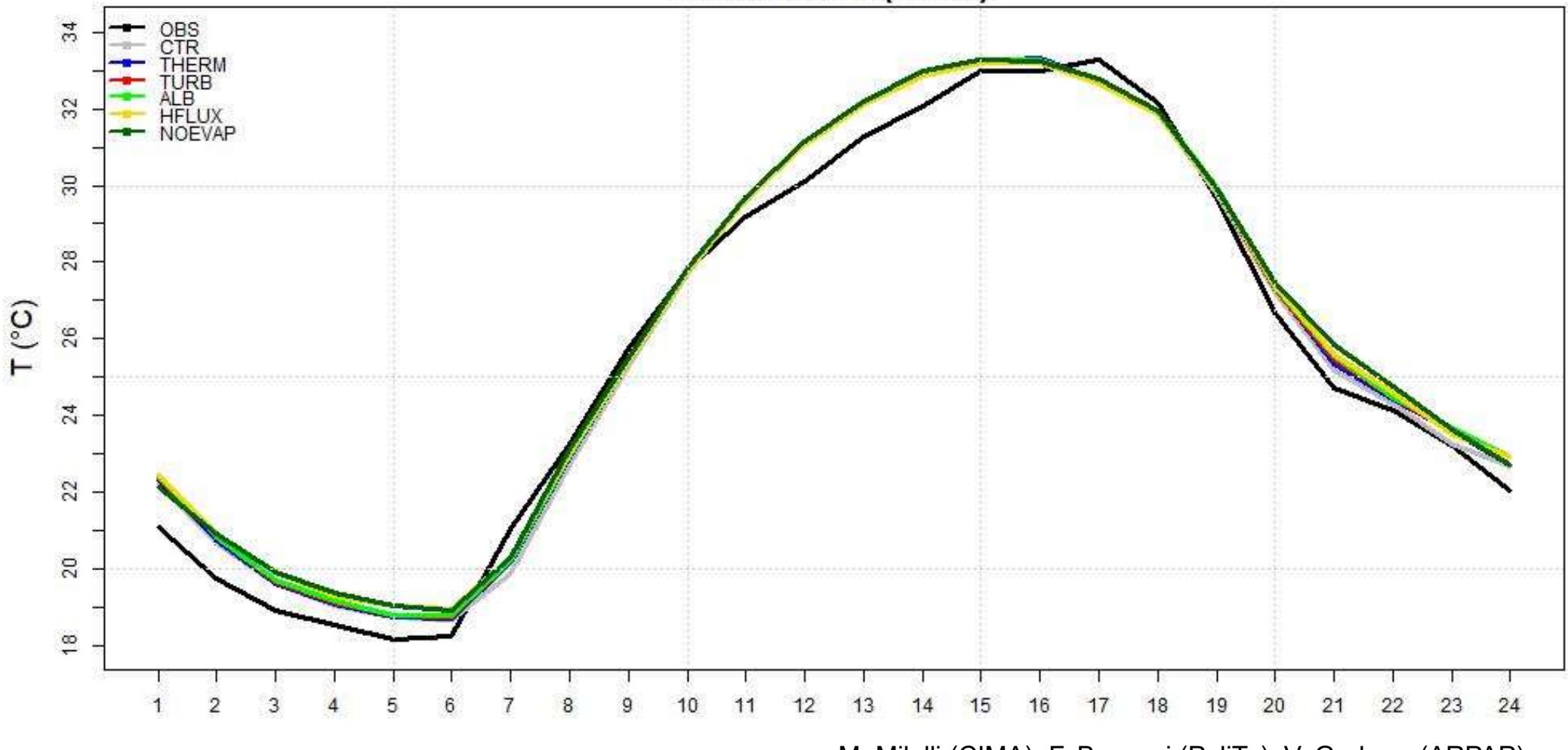


2-m temperature diurnal cycle



2-m temperature diurnal cycle

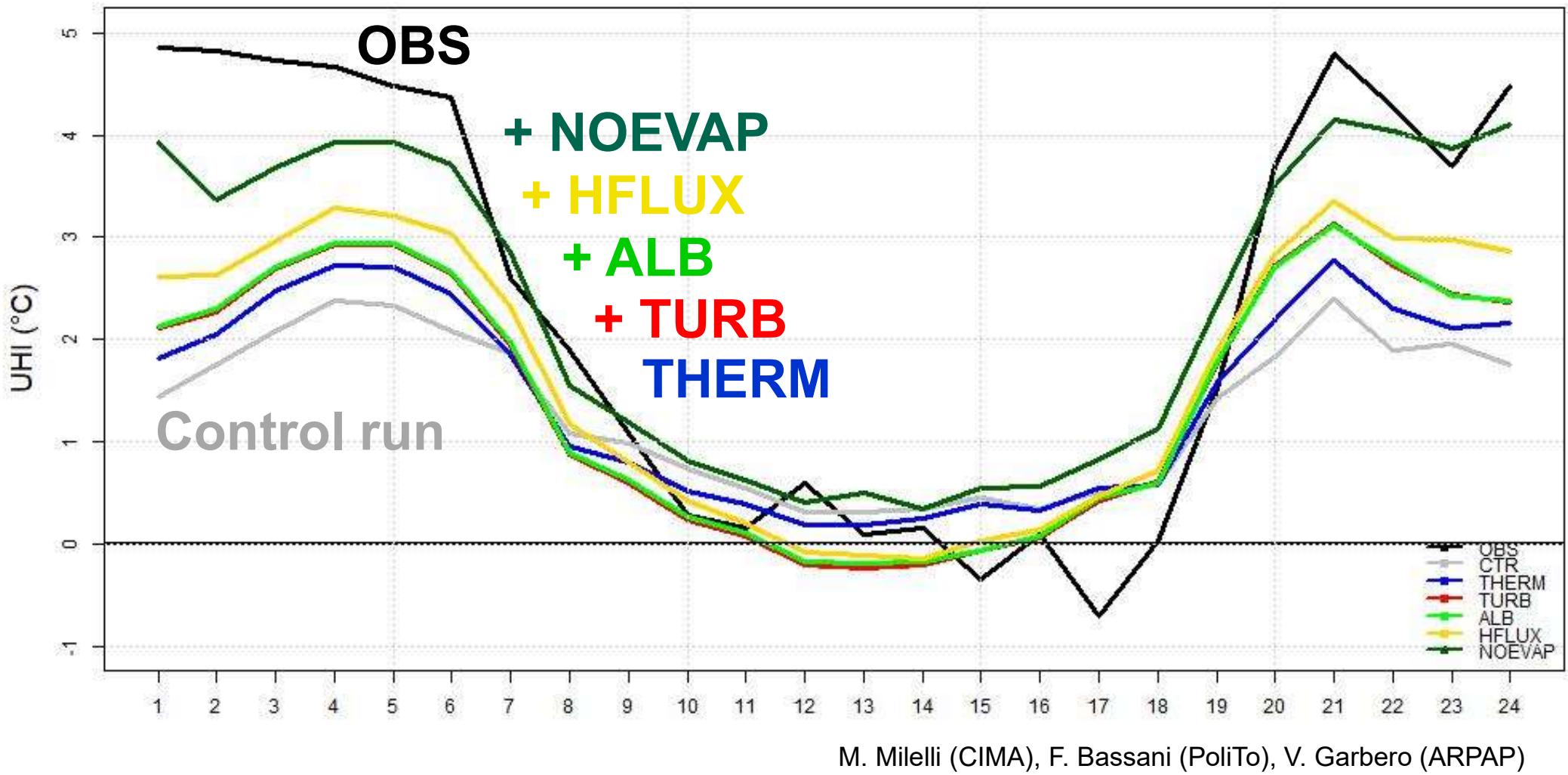
Bauducchi (rural)



M. Milelli (CIMA), F. Bassani (PoliTo), V. Garbero (ARPAP)

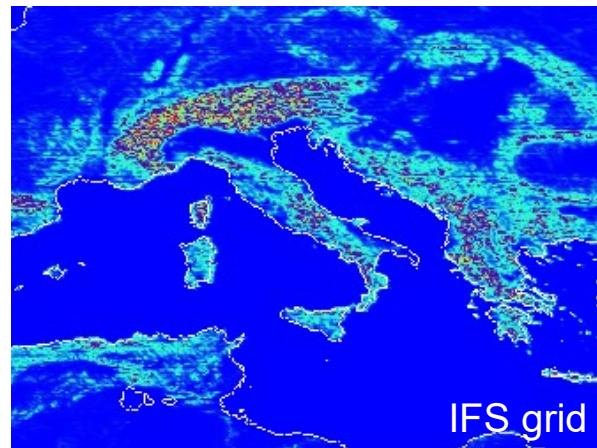
2-m temperature difference: urban – rural

Urban Heat Island (UHI) effect



Model set up

Model Set-Up									
Model	Forcing	Grid type	Grid point	Horizontal resolution	Horizontal discretization	Time step	Vertical coordinates	Scheme of temporal integration	Scheme of spatial differentiation
ICON	IFS (ECMWF) 0,075°	The unstructured icosahedral-triangular grid	451384	2 km	Arakawa C-grid	24 s	65 vertical levels	Two-time level predictor-corrector time stepping scheme	Mixture of finite volume / finite difference discretization



Downscaling from 9 km to ~2 km



A. Campanale (CMCC)

- Period: 16 - 20 Aug. 2017
- TU on = ICON+TERRA_URB on
- TU off = ICON (reference case)

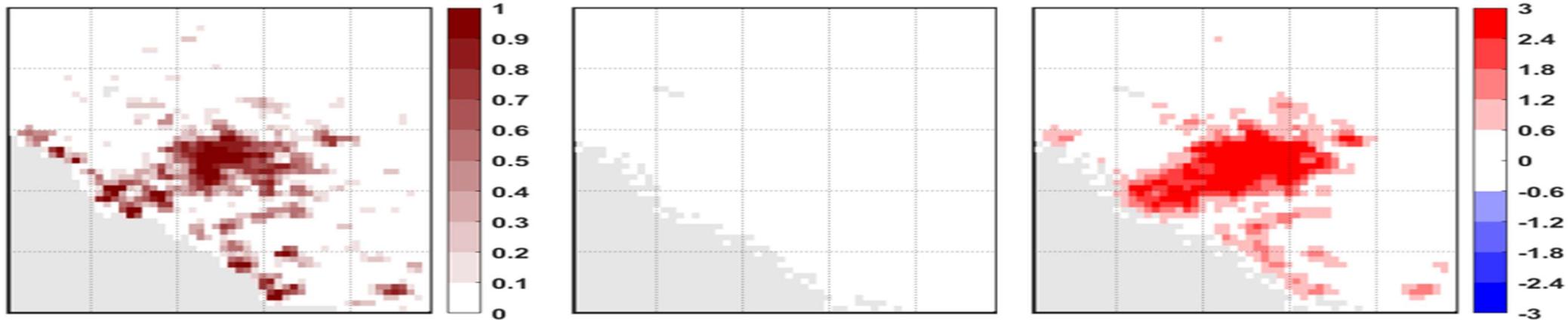


2-m temperature difference: TU on – TU off

Fr_paved = Impervious Surface Area (ISA)



Rome fr_paved

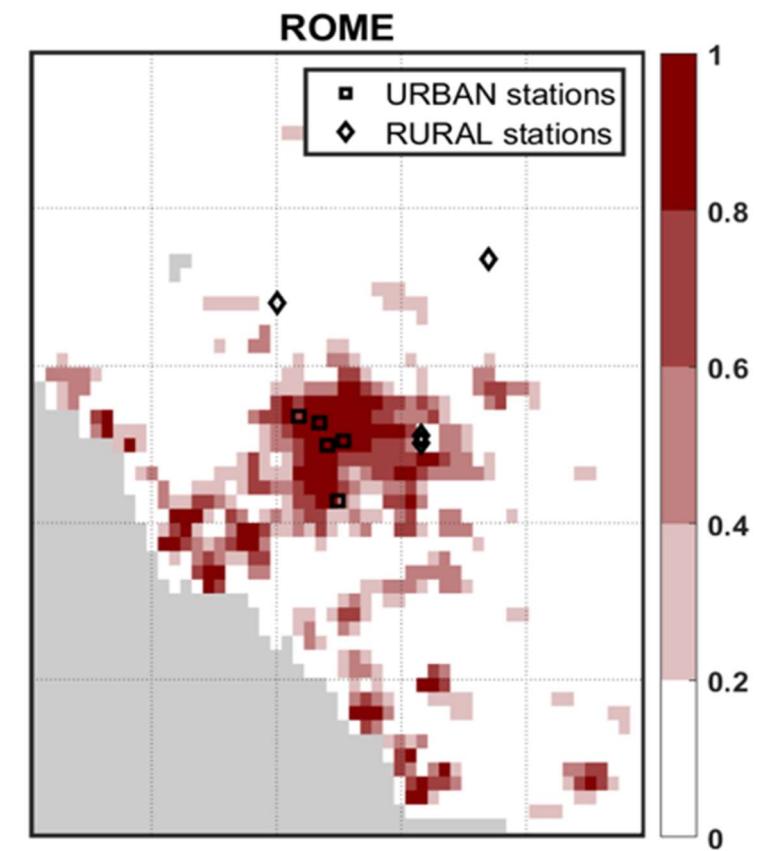
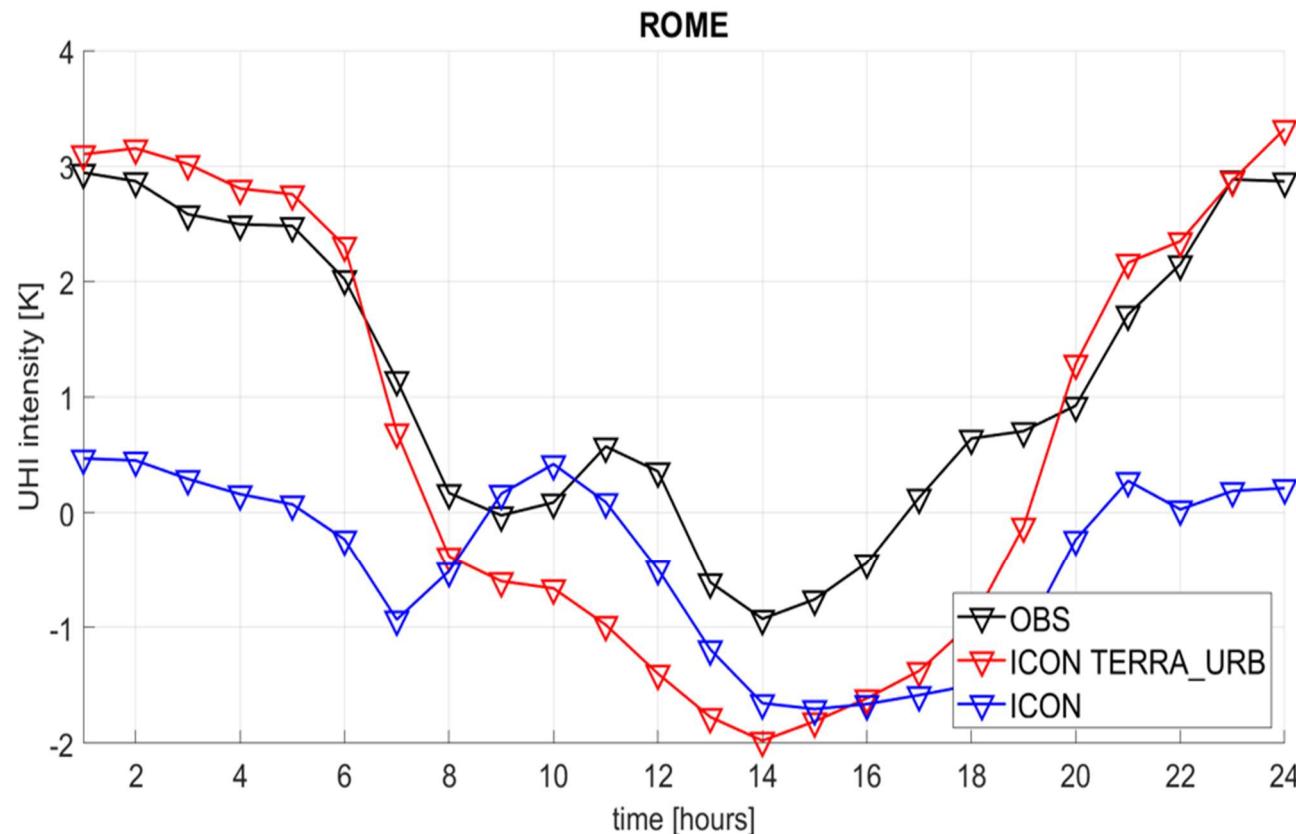


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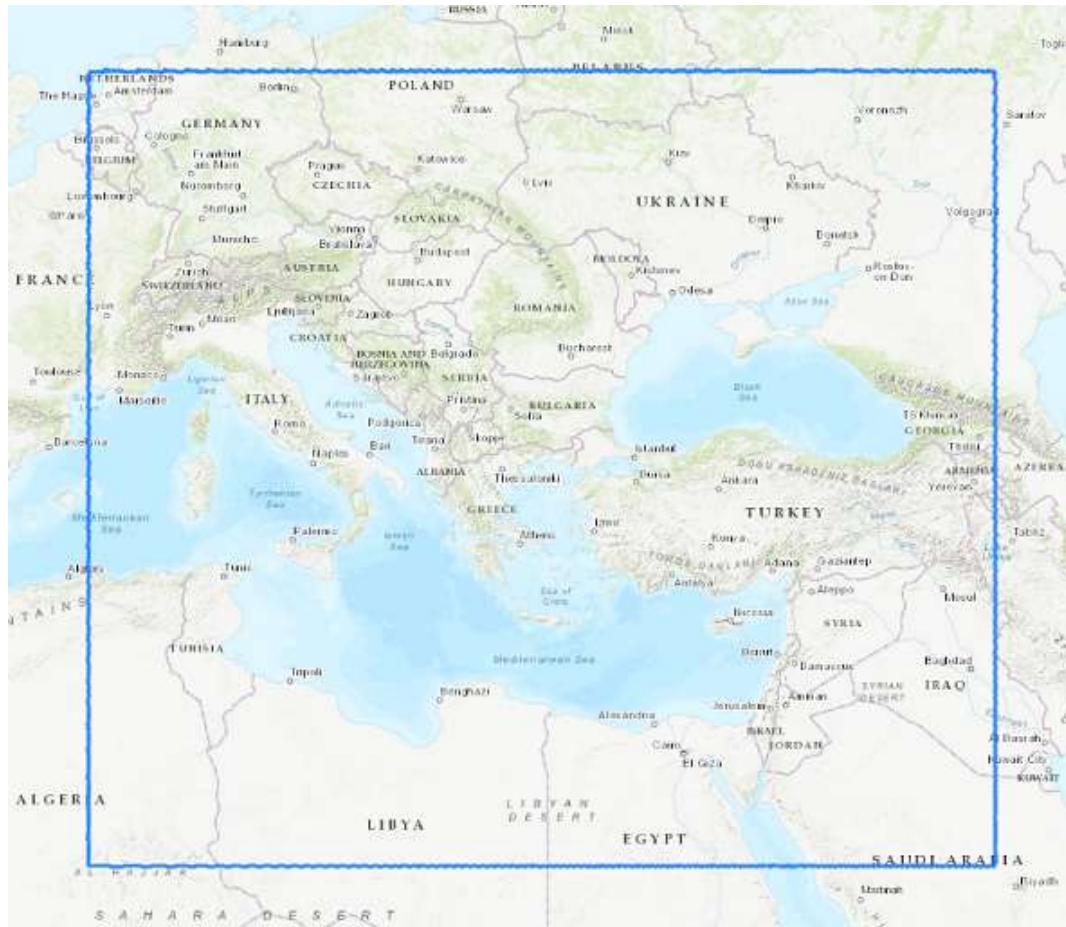
2-m temperature difference: urban – rural

Urban Heat Island (UHI) effect

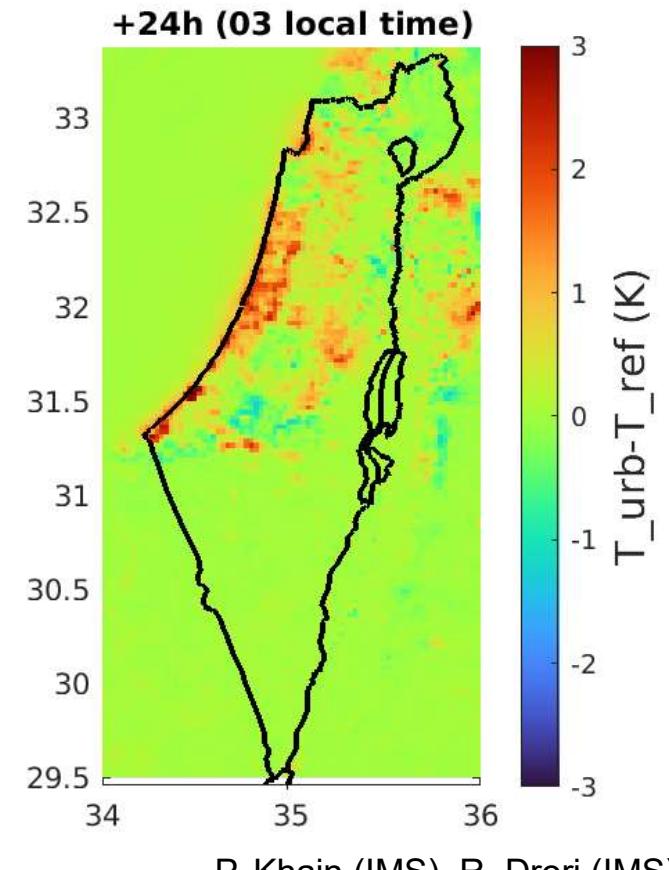


6 days experiment: 27/2/2023 - 4/3/2023, 00 UTC + 78h, ATOS@ECMWF

ICON-IL domain (2.5km) driven by IFS



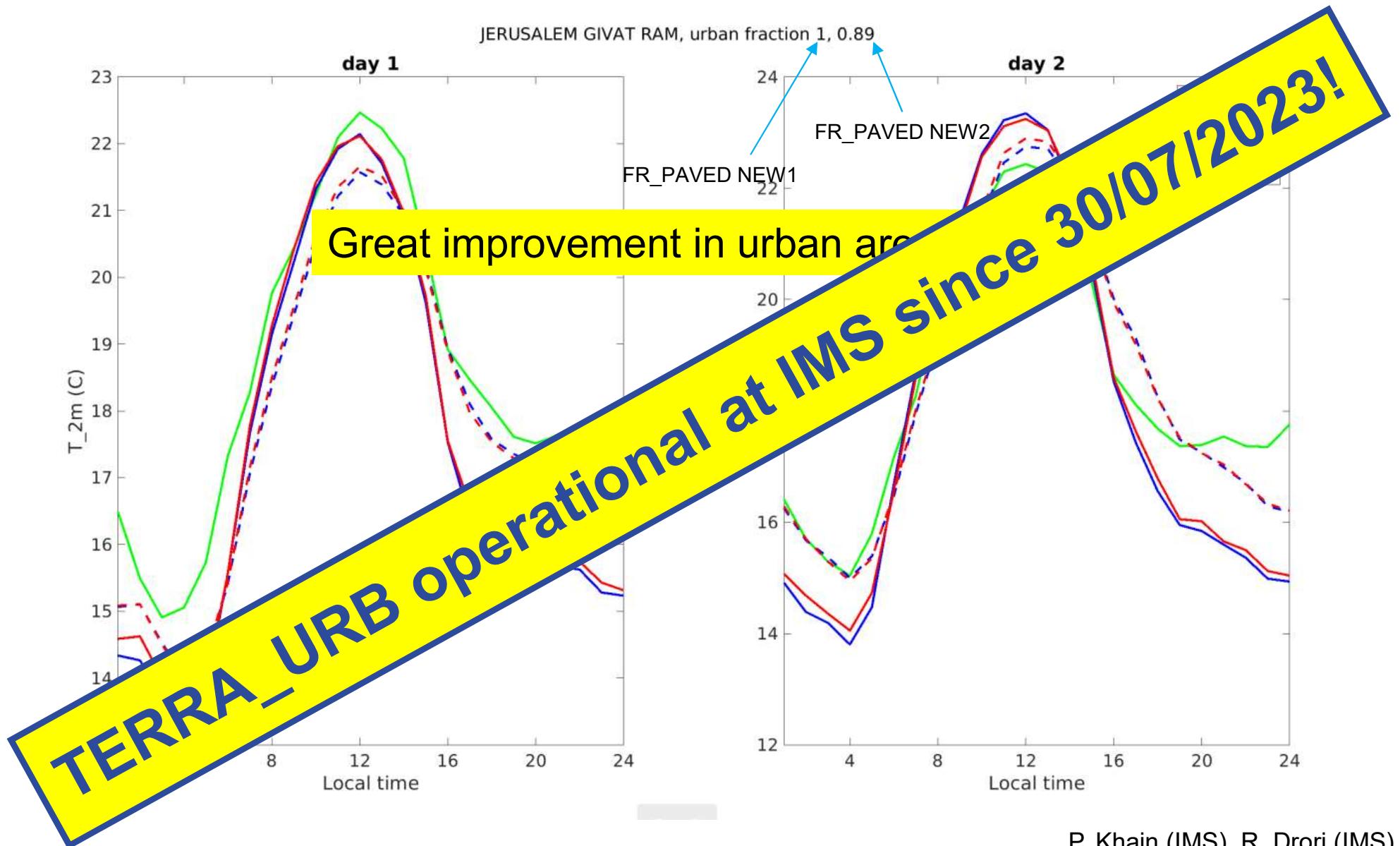
**2-m temp. diff.:
TU on – TU off**



P. Khain (IMS), R. Drori (IMS)



2-m temperature diurnal cycle



Conclusions

- The first aims of the COSMO Priority Project CITTA' are:
 1. Implement the urban canopy scheme TERRA_URB in ICON.
 2. Provide new urban canopy parameters for TERRA_URB in ICON.
- Status:
 1. TERRA_URB is now fully implemented and tested in ICON. It is available in the gitlab icon-nwp master. It is already operational at IMS since July 2023.
 2. The global land use dataset ECOCLIMAP-SG was made available in NetCDF. Preliminary look-up tables were developed. ECOCLIMAP-SG was implemented in the preprocessor EXTPAR, in github. A few adaptations for ICON will come soon.
- Experiments with TERRA_URB in ICON-LAM are on-going in several groups of the project. First results look very promising. Characteristic features of urban surfaces in atmospheric models, for instance the Urban Heat and Dry Island effects, are already represented.