CONSORTIUM FOR SMALL SCALE MODELING COSMO

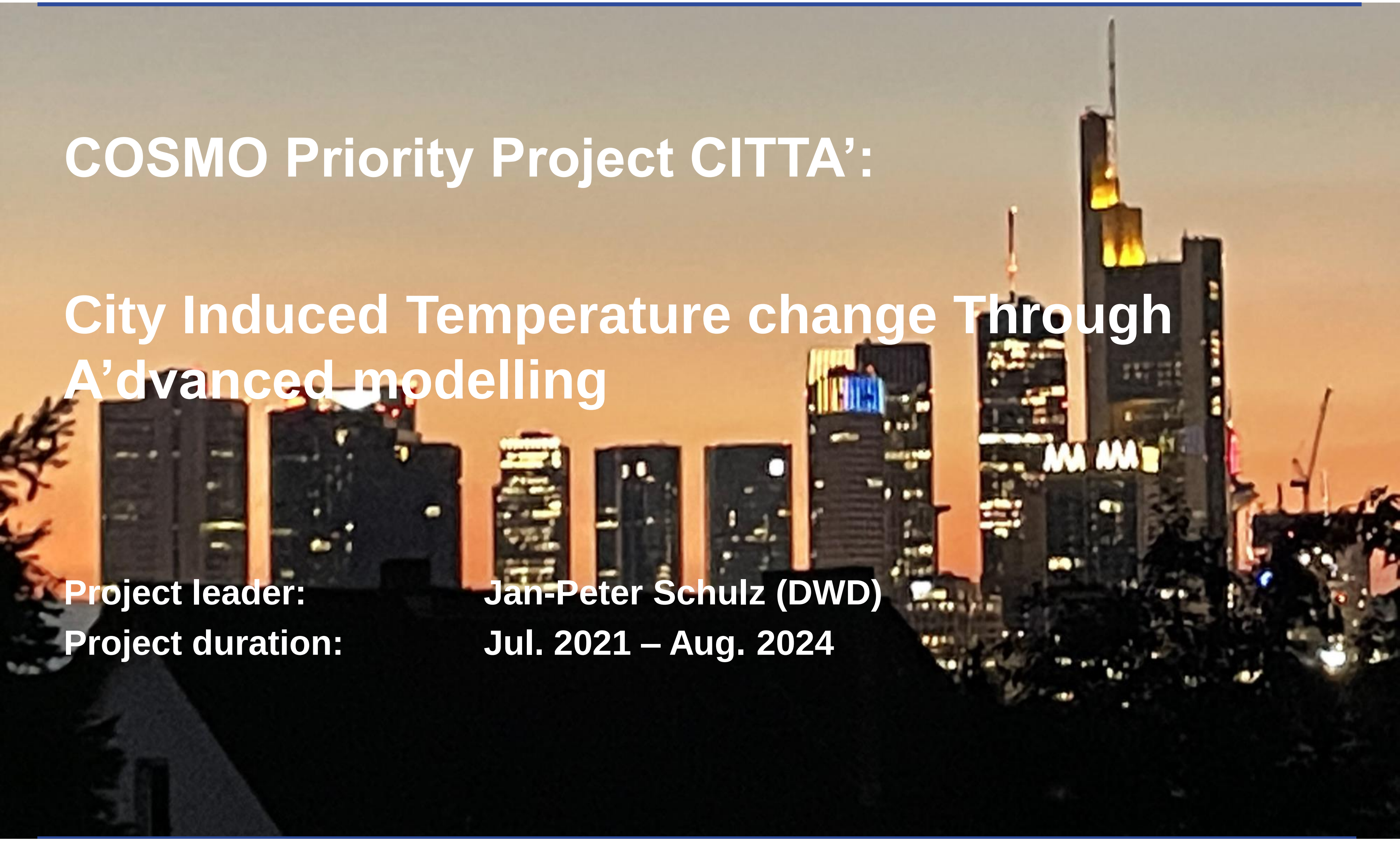
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

A new urban parameterisation for the ICON atmospheric model

Jan-Peter Schulz, Paola Mercogliano, Marianna Adinolfi, Carmela Apreda, Francesca Bassani, Edoardo Bucchignani, Angelo Campanale, Davide Cinquegrana, Carmine De Lucia, Rodica Dumitrache, Giusy Fedele, Valeria Garbero, Witold Interewicz, Amalia Iriza-Burca, Adam Jaczewski, Pavel Khain, Yoav Levi, Bogdan Maco, Alan Mandal, Massimo Milelli, Myriam Montesarchio, Mario Raffa, Alfredo Reder, Leenes Uzan, Hendrik Wouters, Andrzej Wyszogrodzki, and the COSMO PP CITTA' team

COSMO General Meeting, 12-16 Sep. 2022, Athens

Photo: J.-P. Schulz



COSMO Priority Project CITTA':

City Induced Temperature change Through A'dvanced modelling

Project leader: Jan-Peter Schulz (DWD)
Project duration: Jul. 2021 – Aug. 2024

Photo: J.-P. Schulz

Task 1: Implementation of TERRA_URB in ICON

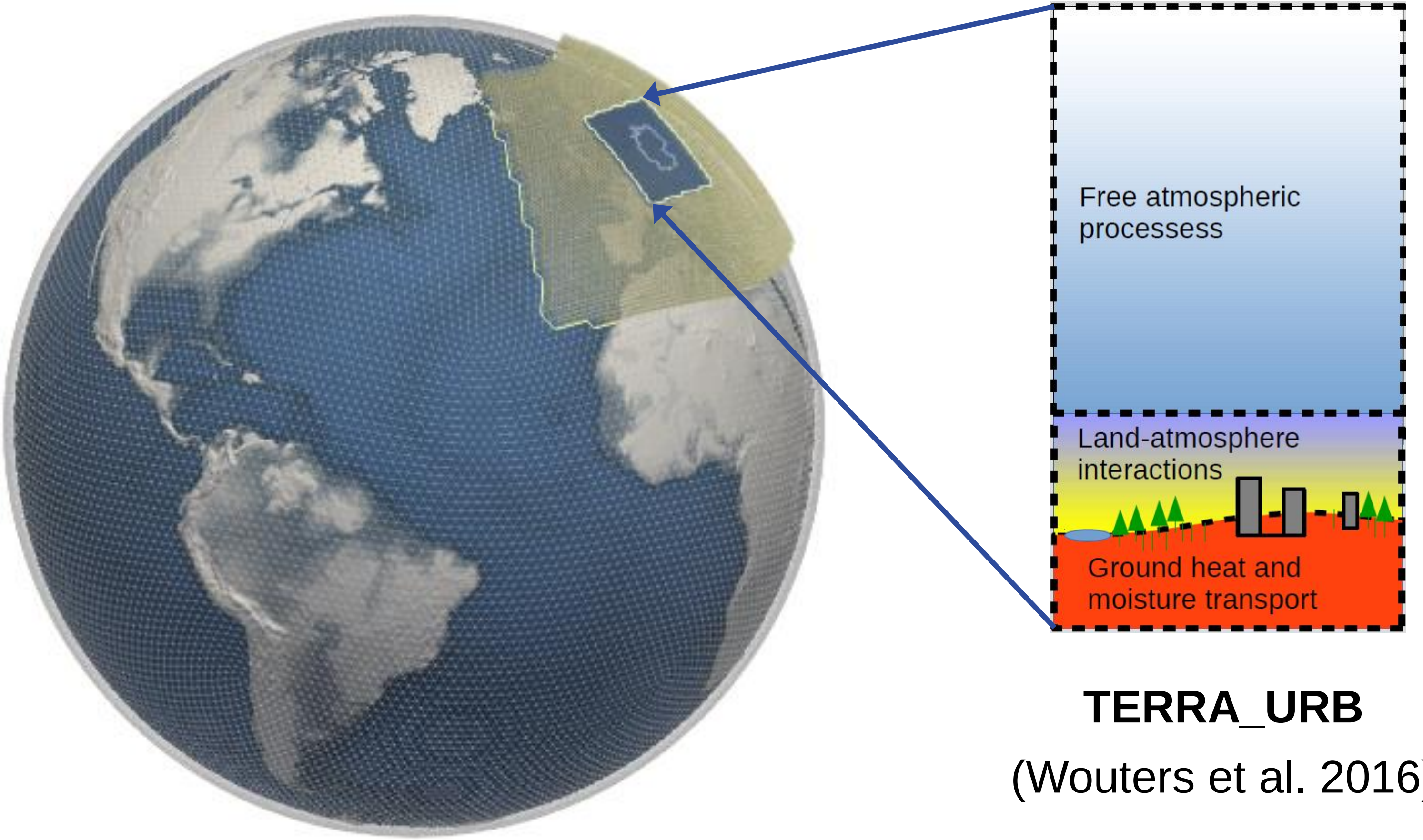
During the COSMO Priority Tasks AEVUS and AEVUS2 the TERRA_URB urban parameterisation in the COSMO model was demonstrated to be able to reproduce the key urban meteorological features. In the framework of the transition of the COSMO Consortium to the ICON model TERRA_URB needs to be implemented in ICON.

Deliverables: TERRA_URB in ICON.

Involved scientists: Jan-Peter Schulz (DWD) 0.4 FTE, Carmine De Lucia (CMCC) 0.1 FTE, Angelo Campanale (CMCC) 0.1 FTE

FTEs: 0.6 FTE

Task 1: Implementation of TERRA_URB in ICON

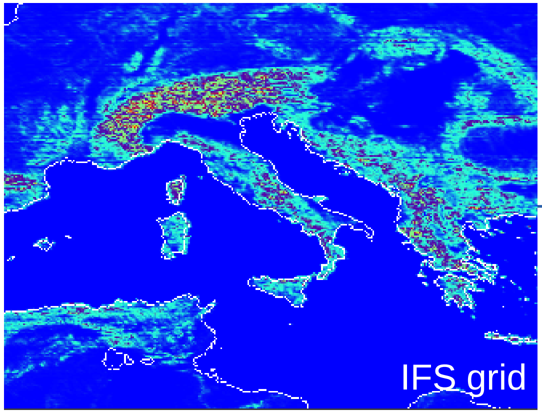


TERRA_URB

(Wouters et al. 2016)

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

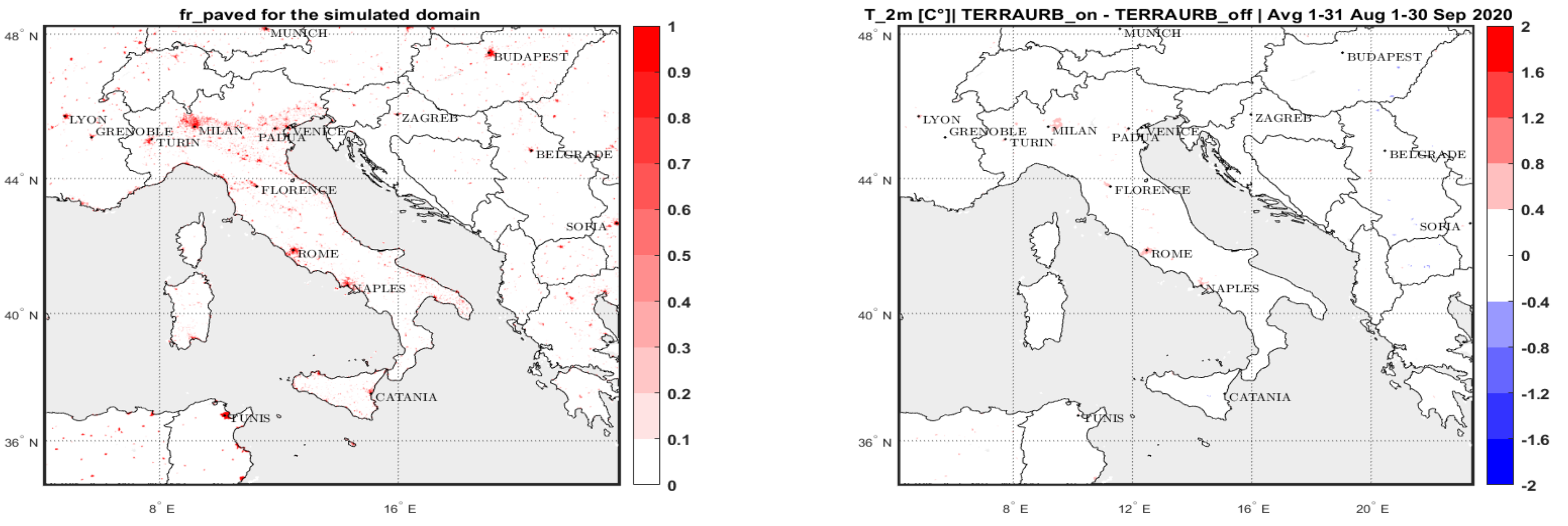


Downscaling from 8,5km to ~2km

A. Campanale (CMCC)

Task 1: Implementation of TERRA_URB in ICON

T_2m difference averaged over Aug.-Sep. 2020

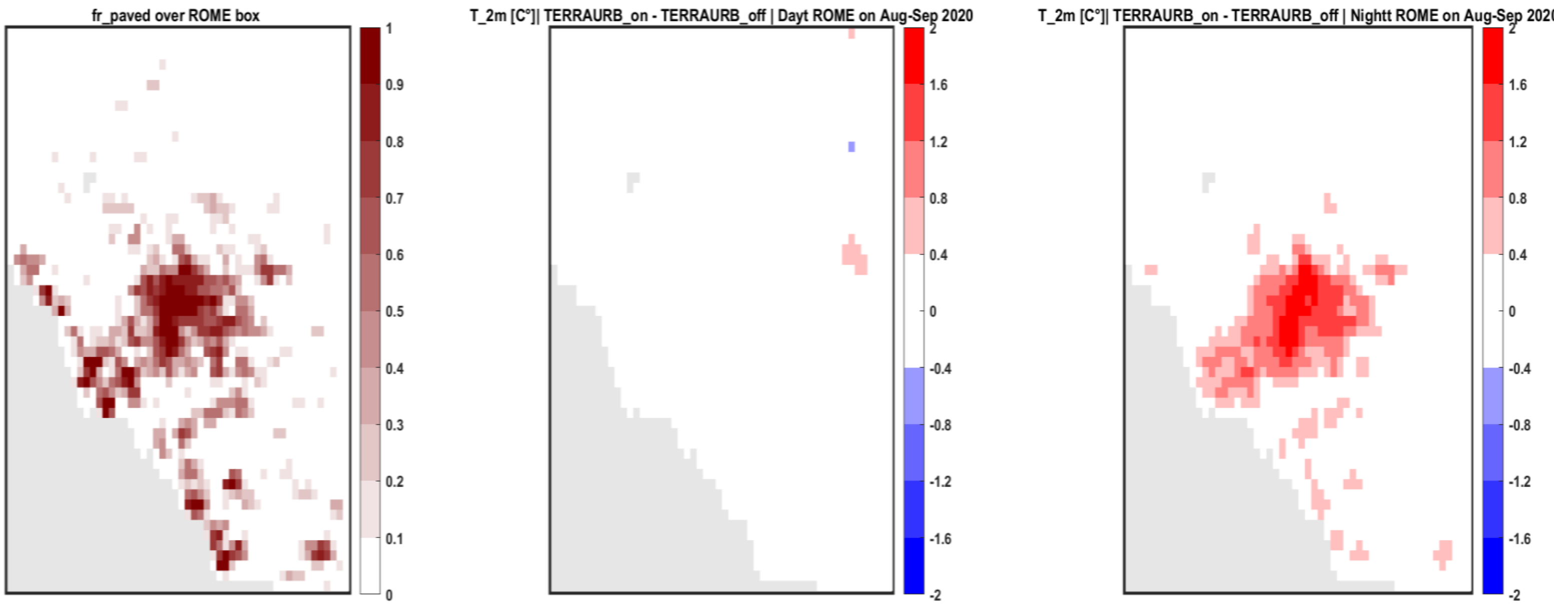


A. Campanale (CMCC)

Task 1: Implementation of TERRA_URB in ICON

T_2m difference at day and at night over Rome in Aug.-Sep. 2020

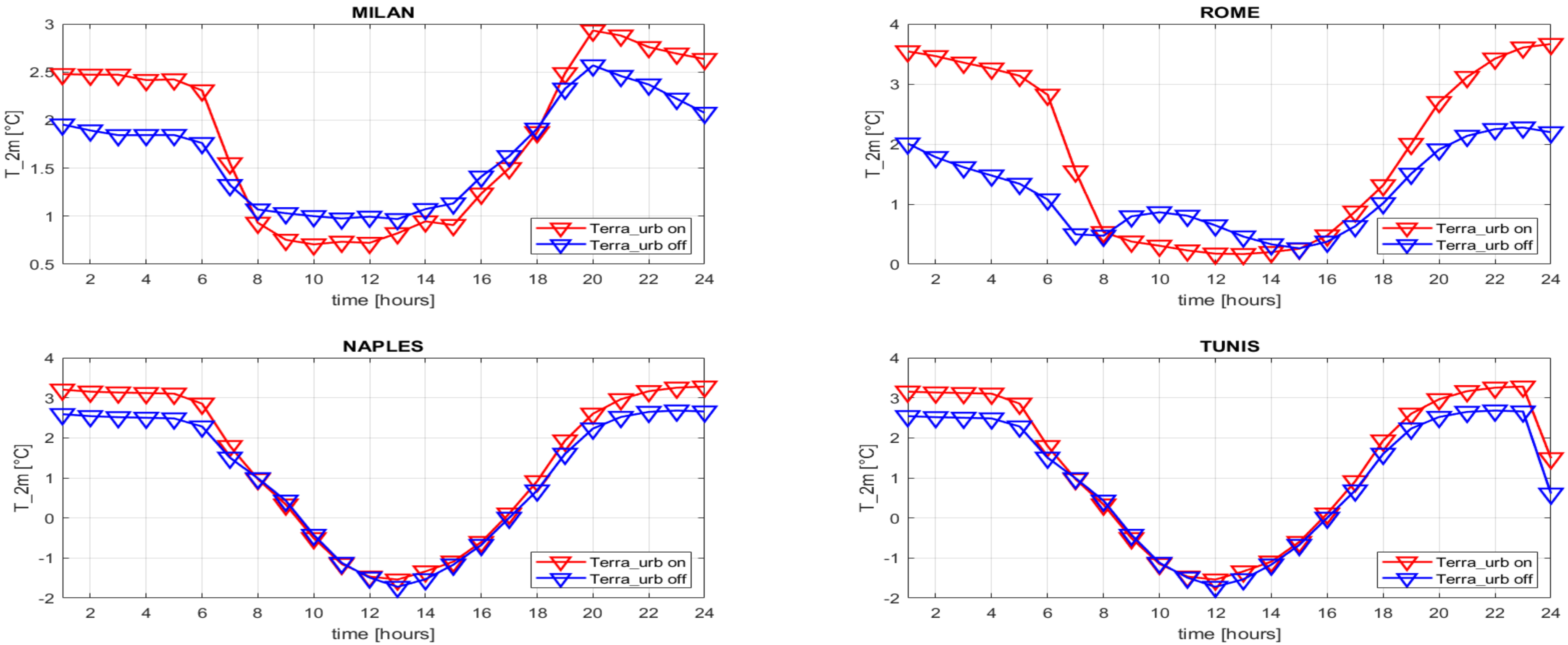
Day **Night**



A. Campanale (CMCC)

Task 1: Implementation of TERRA_URB in ICON

Urban heat island effect for Milan, Rome, Naples and Tunis in Aug-Sep 2020



A. Campanale (CMCC)

Task 2: External parameters

Subtask 2.2: New urban external parameters in EXTPAR for ICON(-LAM)

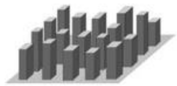
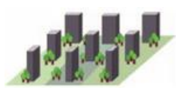
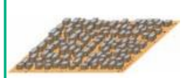
Meanwhile, two raw EXTPAR datasets for TERRA_URB are outdated and should be replaced. Furthermore, several internal parameters describing the urban geometry and the urban thermal and radiative properties, which were hardcoded in TERRA_URB as global constants, will be replaced by 2-dimensional fields from EXTPAR.

Deliverables: New urban external parameters in EXTPAR for ICON-LAM.

Involved scientists: Carmela Apreda (CMCC) 0.2 FTE, Adam Jaczewski (IMGW-PIB) 0.35 FTE, Andrzej Wyszogrodzki (IMGW-PIB) 0.15 FTE, Valeria Garbero (ARPAP) 0.15 FTE, Massimo Milelli (ARPAP) 0.05 FTE, Francesca Bassani (PoliTo) 0.2 FTE, Jan-Peter Schulz (DWD) 0.2 FTE

FTEs: 1.3 FTE

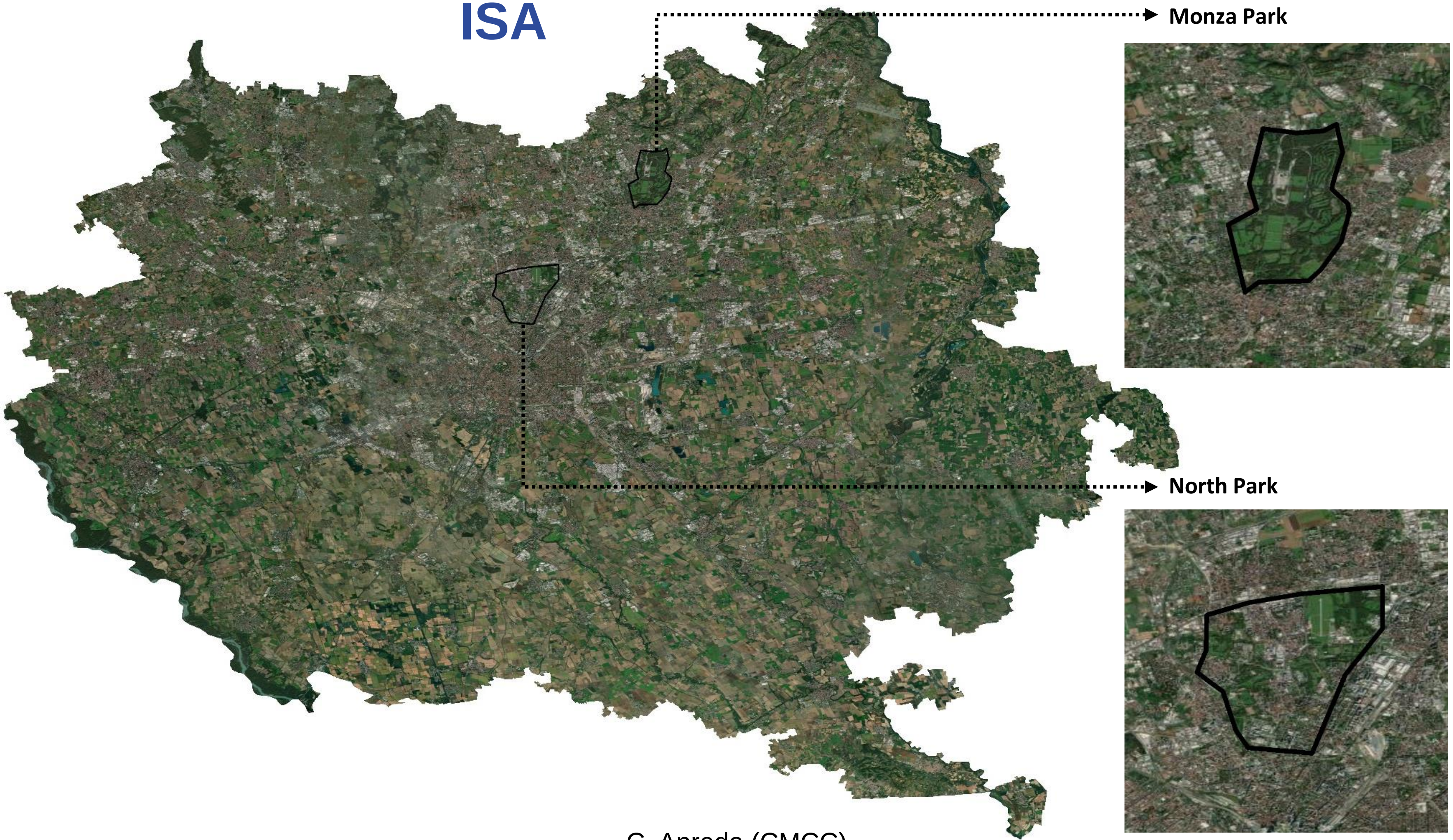
Description of LCZs classes – ECOCLIMAP-SG

Dataset/*Producer*	Classes*	Descriptions
ECOCLIMAP-SG/*CNRM*	 24. LCZ1: compact high-rise	• Strong built-up NDVI <= 0.2 and high rise buildings (3D roughness 50-100m) • Strong built-up NDVI <= 0.2 and very high rise buildings (3D roughness > 100m)
	 25. LCZ2: compact midrise	• Continuous urban fabric (from CLC) • Strong built-up NDVI <= 0.2 and medium rise buildings (3D roughness 25-50m)
	 26. LCZ3: compact low-rise	• Strong built-up NDVI <= 0.2 and low rise buildings (3D roughness <25m)
	 27. LCZ4: open high-rise	n.a. - Despite the class is included in the legend of ECOCLIMAP-SG, the data are not available in the European map. Technical documentation doesn't provide further details.
	 28. LCZ5: open midrise	• Medium built-up 0.2 < NDVI <= 0.3 (o 6)
	 29. LCZ6: open low-rise	• Light built-up 0.3 < NDVI <= 0.4
	 30. LCZ7: lightweight low-rise	n.a. - Despite the class is included in the legend of ECOCLIMAP-SG, the data are not available in the European map. Technical documentation doesn't provide further details.
	 31. LCZ8: large low-rise	• Industrial or commercial unit, Airports (from CLC) • Built-up with highly reflecting roof (associated to productive and commercial use) • Roads
	 32. LCZ9: sparsely built	• Road and rail networks and associated land, Mineral extraction sites, Dump sites, Construction sites, Green Urban Areas, Sport and leisure facilities (from CLC) • Very light built-up NDVI > 0.4
	 33. LCZ10: heavy industry	• Port areas (from CLC)

Stewart I.D., Oke T.R., 2012. Local Climate Zones for Urban Temperature Studies. Bull Am Meteorol Soc., 93(12):1879-1900. doi:10.1175/BAMS-D-11-00019.1

Milan

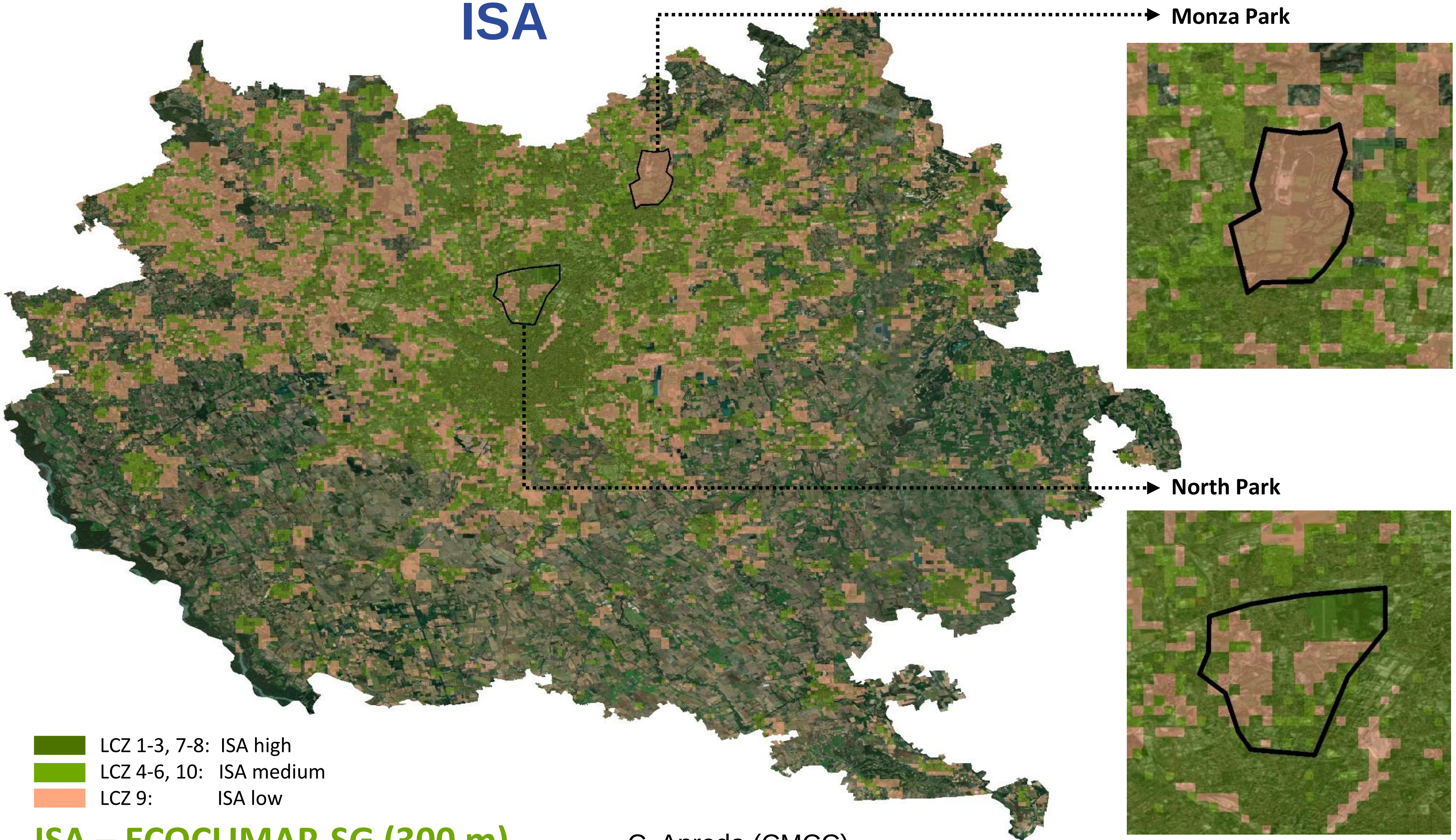
ISA



C. Apreda (CMCC)

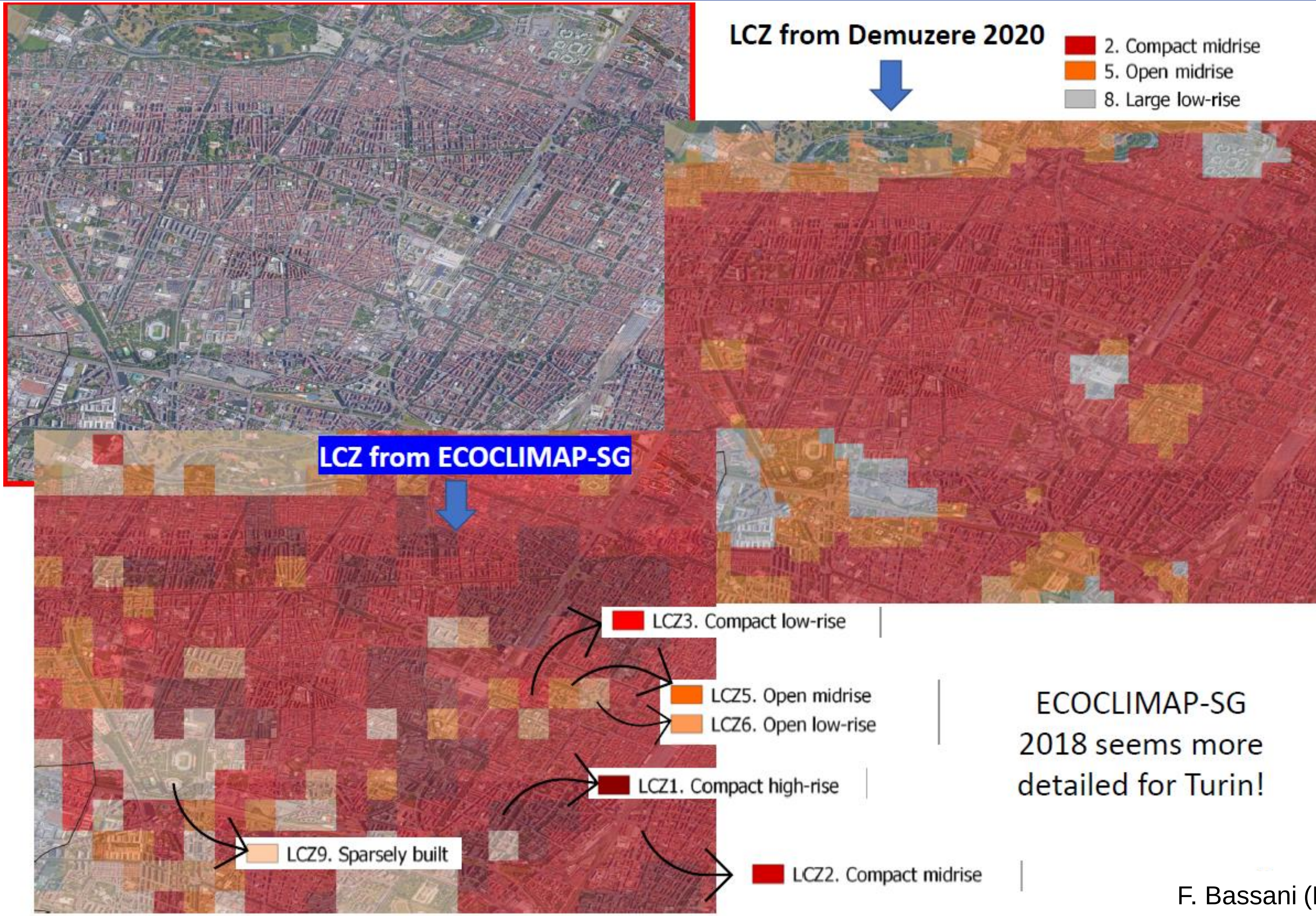
Milan

ISA



ISA – ECOCLIMAP-SG (300 m)

C. Apreda (CMCC)



ECOCLIMAP-SG 2018 seems more detailed for Turin!

F. Bassani (PoliTo)

ECOCLIMAP-SG vs Globcover 2009

ECOCLIMAP-SG		GLOBCOVER
1. sea and oceans	water	21 'water bodies
2. lakes	water	21 'water bodies
3. rivers	water	21 'water bodies
4. bare land	nature	20 bare areas
5. bare rock	nature	20 bare areas
6. permanent snow	nature	22. pernament snow & ice
7. boreal broadleaf deciduous	nature	07 closed broadleaved deciduous forest
8. temperate broadleaf deciduous	nature	06 open/closed broadleaved deciduous forest
9. tropical broadleaf deciduous	nature	06 open broadleaved deciduous forest
10. temperate broadleaf evergreen	nature	05 closed broadleaved evergreen forest
11. tropical broadleaf evergreen	nature	05 closed broadleaved evergreen forest
12. boreal needleleaf evergreen	nature	08 closed needleleaved evergreen forest
13. temperate needleleaf evergreen	nature	08 closed needleleaved evergreen forest
14. boreal needleleaf deciduous	nature	09 open needleleaved decid. or evergr. forest
15. shrubs	nature	13 closed to open shrubland
16. boreal grassland	nature	14 closed to open herbaceous vegetation
17. temperate grassland	nature	14 closed to open herbaceous vegetation
18. tropical grassland	nature	14 closed to open herbaceous vegetation
19. winter C3 crops (lower temperatu	nature	02 rainfed croplands
20. summer C3 crops	nature	02 rainfed croplands
21. C4 crops (warmer environments)	nature	02 rainfed croplands
22. flooded trees	nature	16 closed to open forest regulary flooded
23. flooded grassland	nature	18 closed to open grassland regularly flooded

ECOCLIMAP-SG natural classes correspond well with GLOBCOVER natural classes and the corresponding values could be copied.

On the other hand the CITTA project gives exceptional opportunity to update the lookup tables according to recent state of the art.

A. Jaczewski (IMGW-PIB)

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.
- Both activities are on-going:
  1. Substantial components of TERRA_URB are already implemented in ICON. Further developments will come soon.
  2. The global land use dataset ECOCLIMAP-SG was converted and made available in NetCDF. A preliminary set of look-up tables was developed. The implementation of ECOCLIMAP-SG in the preprocessor EXTPAR is on-going.
- Experiments with TERRA_URB in ICON-LAM have started in several groups of the project. First results look promising. Characteristic features of urban surfaces in atmospheric models, for instance the Urban Heat Island effect, are already represented.