Priority Task Analysis and Evaluation of TERRA_URB Scheme 2 (ÆVUS 2)

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and the PT_AEVUS2 team

COSMO General Meeting, 6 - 17 Sep. 2021, Video Conference

PT_AEVUS 2 Introduction

The PT AEVUS2 (Version 3.0, 12/03/2021) has been officially approved during on September 2019 during the COSMO GM:

- Task Leader: CIRA and CMCC (from March 2020)
- COSMO Participants: CIRA, CMCC, Arpa Piemonte, DWD, RHM
- External partners: Flemish Institute for Technological Research (VITO), Ruhr University of Bochum, Polytechnic of Torino, IMS
- Total of 1.22 FTE (COSMO) + 0.54 External partners (VITO + POLITO)

PT_AEVUS 2 Goal

- Consolidate the implementation of the TERRA_URB, the urban scheme available in the COSMO model.

- Draft a new PT or PP aiming at transferring these developments into the ICON model.

This PT should be considered as a second part of the work started in PT AEVUS, aiming at having a robust and well documented representation of urban effects in the final unified COSMO release.

The main outcomes of PT_AEVUS are reported in the technical report: http://www.cosmo-model.org/content/model/documentation/techReports/docs/techReport40.pdf

Last achievements

Last activities performed:

- Published the paper ”Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities” by all the team of PT
- Drafting of the PP CITTA’ Project (ensuring the continuation of activities on urban parameterization)
- Currently are still on going some final activities related to the:
  - testing of TERRA_URB parameterization on cosmo_210309_5.10_beta in order to be included in COSMO v6.0
  - Sensitivity test on external 2D parameters describing urban features.

Paper (as technical report)

Centro Euro-Mediterraneo sui Cambiamenti Climatici

Paper presents evaluation results of the Terra Urb scheme in high-resolution simulations with a recent COSMO model version(recent COSMO version 5.05 with TU scheme) for selected European cities: **Turin, Naples and Moscow**.

Additional sensitivity tests have been performed in order to evaluate the **ICON-like turbulence scheme** developed in COSMO and the **use of a new skin-layer temperature scheme**.

The novelty of the work lies in

- use of the recent model version,
- uniform approach for setting up numerical experiments and for the evaluation applied for all different cities.

Please download the paper at the following link: https://www.mdpi.com/2073-4433/12/2/237/htm

atmosphere MDPI

Article

Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities

Valeria Garbero [1,*], Massimo Milelli [1,2], Edoardo Bucchignani [3,4], Paola Mercogliano [4], Mikhail Varentsov [5,6,7,8], Inna Rozinkina [5,6], Gdaliy Rivin [5,6], Denis Blinov [6], Hendrik Wouters [9,10], Jan-Peter Schulz [11], Ulrich Schättler [11], Francesca Bassani [12], Matthias Demuzere [13] and Francesco Repola [4]

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Citation: Garbero, V.; Milelli, M.; Bucchignani, E.; Mercogliano, P.; Varentsov, M.; Rozinkina, I.; Rivin, G.; Blinov, D.; Wouters, H.; Schulz, J.-P.; Schättler, U.; Bassani, F.; Demuzere, M.; Repola, F. Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities.

The effect of TU combined with the ICON-like turbulence and skin temperature schemes provides a <u>substantial improvement in capturing the UHI intensity and improving air temperature forecasts for urban areas.</u> It should be noted that model sensitivity to the change of physical schemes is smaller for Moscow than for Turin and Naples.

Introduction to the new PP CITTA'

Jan-Peter Schulz

Deutscher Wetterdienst, Offenbach, Germany

and the PP CITTA' team

COSMO General Meeting, 6 - 17 Sep. 2021, Video Conference

COSMO Priority Project CITTA':

City Induced Temperature change Through A'dvanced modelling

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

The COSMO PP CITTA' team

ARPAP:	Valeria Garbero, Massimo Milelli
CIRA:	Edoardo Bucchignani
CMCC:	Paola Mercogliano, Carmela Apreda, Carmine De Lucia, Alfredo Reder, Francesco Repola
DWD:	Jan-Peter Schulz
IMGW-PIB:	Adam Jaczewski, Andrzej Wyszogrodzki, Witold Interewicz, Alan Mandal
IMS:	Leenes Uzan, Pavel Khain, Yoav Levi
KIT:	Julia Fuchs
NMA:	Rodica Dumitrache, Amalia Iriza-Burca, Bogdan Maco
PoliTo:	Francesca Bassani
RHM:	Mikhail Varentsov, Denis Blinov, Vladimir Kopeykin, Timofey Samsonov, Gdaly Rivin
VITO:	Hendrik Wouters

Task C: Project coordination

The COSMO Priority Project CITTA' coordinates activities aimed at the development of an urban surface parameterisation in ICON. A coordination task is activated, dealing with the organisation of virtual and physical meetings, writing of reports, and frequent e-mail exchange. A final report will be provided.

Deliverables: Meetings, reports, Final Report.

Involved scientist: Jan-Peter Schulz (DWD) 0.1 FTE/year, Paola Mercogliano (CMCC) 0.05 FTE/year

FTEs: 0.15 FTE/year (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, Mikhail Varentsov (RHM) 0.1 FTE, Carmine De Lucia (CMCC) 0.1 FTE

FTEs: 0.6 FTE (Jul. 2021 – Jun. 2022)

Task 2: External parameters

Subtask 2.1: Consistency of urban external parameters

A method should be designed and implemented in order to avoid inconsistencies due to the differences between the URBAN (based on land use classes) and ISA (Impervious Surface Area, based on independent data sources) fields.

Deliverables: Consistent way to derive urban external parameters in EXTPAR.

Involved scientists: Valeria Garbero (ARPAP) 0.1 FTE, Mikhail Varentsov (RHM) 0.1 FTE, Alfredo Reder (CMCC) 0.1 FTE

FTEs: 0.3 FTE (Jul. 2021 – Jun. 2022)

Task 2: External parameters

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

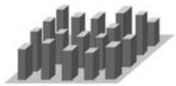
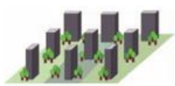
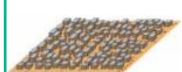
Meanwhile, two raw EXTPAR datasets for TERRA_URB are outdated and should be replaced. Furthermore, several internal parameters describing the urban geometry and the urban thermal and radiative properties, which were hardcoded in TERRA_URB as global constants, will be replaced by 2-dimensional fields 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, Mikhail Varentsov (RHM) 0.2 FTE, Timofey Samsonov (RHM) 0.2 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: 1.7 FTE (Jul. 2021 – Jun. 2022)

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)

C. Apreda (CMCC)

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

C. Apreda (CMCC)

ISA

Milan

ISA – ECOCLIMAP-SG (300 m)

C. Apreda (CMCC)

Task 3: Numerical experiments

The numerical experiments will be carried out in a coordinated way in the different model domains of the project partners involved.

Subtask 3.1: Moscow

Deliverables: Assessment of the new scheme in the Moscow mega-city domain.

Involved scientists: Mikhail Varentsov (RHM), Denis Blinov (RHM), Vladimir Kopeykin (RHM), Gdaly Rivin (RHM)

FTEs: 1.0 FTE (Jul. 2022 – Aug. 2024)

Task 3: Numerical experiments

The numerical experiments will be carried out in a coordinated way in the different model domains of the project partners involved.

Subtask 3.2: Turin

Deliverables: Assessment of the new scheme in the Turin domain.

Involved scientists: Valeria Garbero (ARPAP) 0.4 FTE, Massimo Milelli (ARPAP) 0.25 FTE, Francesca Bassani (PoliTo) 0.35 FTE

FTEs: 1.0 FTE (Jul. 2022 – Aug. 2024)

Task 3: Numerical experiments

The numerical experiments will be carried out in a coordinated way in the different model domains of the project partners involved.

Subtask 3.3: Naples

Deliverables: Assessment of the new scheme in the Naples domain.

Involved scientists: Edoardo Bucchignani (CIRA) 0.3 FTE, Paola Mercogliano (CMCC), Francesco Repola (CMCC), Alfredo Reder (CMCC), Carmela Apreda (CMCC)

FTEs: 1.0 FTE (Jul. 2022 – Aug. 2024)

Task 3: Numerical experiments

The numerical experiments will be carried out in a coordinated way in the different model domains of the project partners involved.

Subtask 3.4: Bucharest

Deliverables: Assessment of the new scheme in the Bucharest domain.

Involved scientists: Rodica Dumitrache (NMA), Amalia Iriza-Burca (NMA), Bogdan Maco (NMA)

FTEs: 1.0 FTE (Jul. 2022 – Aug. 2024)

Task 3: Numerical experiments

The numerical experiments will be carried out in a coordinated way in the different model domains of the project partners involved.

Subtask 3.5: Jerusalem and Tel Aviv

Deliverables: Assessment of the new scheme and generally the urban effects on temperature and wind profiles in Jerusalem and Tel Aviv.

Involved scientists: Leenes Uzan (IMS), Pavel Khain (IMS), Yoav Levi (IMS)

FTEs: 1.0 FTE (Jul. 2022 – Aug. 2024)

Task 3: Numerical experiments

The numerical experiments will be carried out in a coordinated way in the different model domains of the project partners involved.

Subtask 3.6: Warsaw

Deliverables: Assessment of the new scheme and the urban effects in Warsaw.

Involved scientists: Adam Jaczewski (IMGW-PIB), Andrzej Wyszogrodzki (IMGW-PIB), Witold Interewicz (IMGW-PIB), Alan Mandal (IMGW-PIB)

FTEs: 1.0 FTE (Jul. 2022 – Aug. 2024)

Task 4: Further developments and applications of TERRA_URB

Once the model is successfully implemented and tested, further scientific developments and applications of TERRA_URB will be carried out.

Subtask 4.1: Improved representation of vegetated urban areas in TERRA_URB

Deliverables: Vegetated urban areas implemented in TERRA_URB. Assessment of the impact of this new development in the Moscow domain.

Involved scientists: Mikhail Varentsov (RHM) 1.0 FTE, Hendrik Wouters (VITO) 0.05 FTE

FTEs: 1.05 FTE (Jul. 2022 – Aug. 2024)

Task 4: Further developments and applications of TERRA_URB

Once the model is successfully implemented and tested, further scientific developments and applications of TERRA_URB will be carried out.

Subtask 4.2: Boundary layer clouds over urban areas in ICON-LAM-ART

Deliverables: Assessment of the new scheme in ICON-LAM-ART.

Involved scientist: Julia Fuchs (KIT)

FTEs: 1.0 FTE (Jul. 2022 – Aug. 2024)