Update on

Analysis and Evaluation of TERRA_URB Scheme 2 (ÆVUS 2)

Partner COSMO : CIRA, CMCC, ARPAP, RHM, DWD

COSMO GM 2020

PT_AEVUS 2 Introduction

The PT AEVUS2 has been officially approved during the last COSMO GM:

- Task Leader: CIRA and CMCC (from March 2020)
- Duration: 12 months; start/end data: September 2019 - December 2020
- COSMO Participants: CIRA, Arpa Piemonte, DWD, RHM
- External partners: Flemish Institute for Technological Research (VITO), Ruhr University of Bochum, Polytechnic of Torino, IMS
- FTE: 1.1 Year.

During the year : 1 physical meeting in Naples (kick off meeting) and 2 virtual meetings (minute of the meetings and presentations available on COSMO web site).

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

PT AEVUS-2: Main Motivations

Some issues were still open after PT_AEVUS and they need to be addressed by PT_AEVUS 2 or to be better analyzed for the further preparation of a COSMO PP or PT. These are

- The use of hard-coded values for the urban canopy parameters
- Even the basic urban canopy parameters, the ISA fraction and AHF, are far away from being perfect in the existing datasets available in EXTPAR
- A better calibration of parameters is needed
- Usage of skin temperature formulation (itype_canopy =2)
- Mapping Europe into local climate zones is a possible input for urban climate modelling (and also to try to formulate ideas to define urban external parameters also at global levels)

PT_AEVUS 2: request to extend deadlines

Some issues were partly addressed also thanks to the PT_AEVUS 2 extension permitting to spend:

- Additional efforts for the activities concerning definition and implementation of new external urban parameters in grib format.

- Additional efforts for the activities concerning the management of the "double counting effects" due to the inconsistencies existing among the different urban parameters adopted.

- Define a new activity concerning the drafting of a peer reviewed paper showing the added value of urban parameterization (and other selected specific parameterizations) for the 3 test cases analysed in PT_AEVUS and PT_AEVUS2 (Moscow, Turin and Naples)

PT AEVUS-2: Main achievements

Status update on COSMO+TERRA_URB development

- ❑ **cosmo_191107_5.05_urb5**: a basic stable version with TERRA_URB which we have as an outcome from AEVUS PT
- ❑ **cosmo_191107_5.05_urb5 + update from Ulrich Schättler:**
  - Fixed bug with lwrite_const
  - Option for writing tiled variables to Netcdf output (not tested yet)
- ❑ **cosmo_191107_5.05_urb5up* with my new developments (November 2019, distributed before Naples meeting):**
  - New 2D external parameters for urban morphological and thermal properties (URB_BLDH, URB_H2W, …)
  - Skin-layer temperature scheme is controlled in the same way as in v5.06a using **cskinc** namelist parameter
- ❑ **cosmo_191213_5.05_urb6**
  - Resent updates for 5.05urb5 from Ulrich Schättler + support of new external parameters from 5.05urb5up
  - **Bug found:** model crashes when new urban canopy parameters are not defined for grid cells with FR_PAVED = 0.
- ❑ **cosmo_191213_5.05_urb6up3 (February 2020):**
  - Fixed bug for COSMO 5.05urb6
  - Additional developments on the new external parameters (radiative parameters as 2D fields + scaling coefficients)
- ❑ **cosmo_191213_5.05_urb6up4sh (July 2020, sent to Ulrich Schättler as a candidate for further GitHub development) :**
  - Minor inconsistency between TERRA_URB in code and paper description is found and fixed
  - Tuning coefficients for soil hydrology introduces (csoilhyd and crootdp2 as soilhyd and fac_rootdp2 in COSMO-CLM 5.0).
- ❑ **cosmo_191213_5.05_urb6up5sh** (September 2020):**
  - Bug found and fixed for the case when TERRA_URB = true and lemiss = true

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- ❑ **int2lm_190524_2.06up2*** which supports all new 2D external parameters (July 2020)

*up means urban parameters,
**sh means soil hydrology

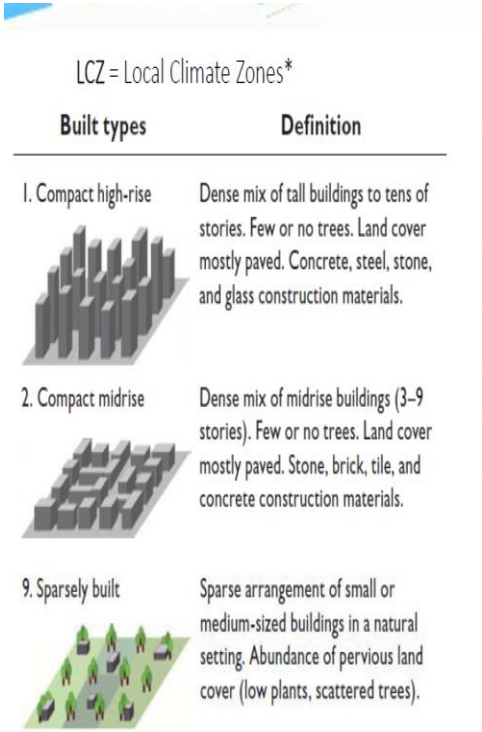
Further update are expected in the next months with support of DWD and with other groups (e.g. further investigation of the interaction between the snow model and TERRA_URB scheme in COSMO)

Slide provided by RHM

PT AEVUS-2: Main achievements

- Deep awareness on the inconsistencies present considering the current external parameters available (ISA and AHF) in EXTPAR and definition of algorithms to overcome this problem.
- On going activities concerning the identification of additional datasets for 2D external parameters describing urban areas also available at global levels to be potentially introduced in EXTPAR

- Different simulations were implemented using Local Climate Zone (LCZ). *LCZs are "regions of uniform surface cover, structure, material, and human activity that span hundreds of meters to several kilometres in horizontal scale" (Oke, 2012); each LCZ has a characteristic screen-height temperature regime that is most apparent over dry surfaces, on calm, clear nights.*

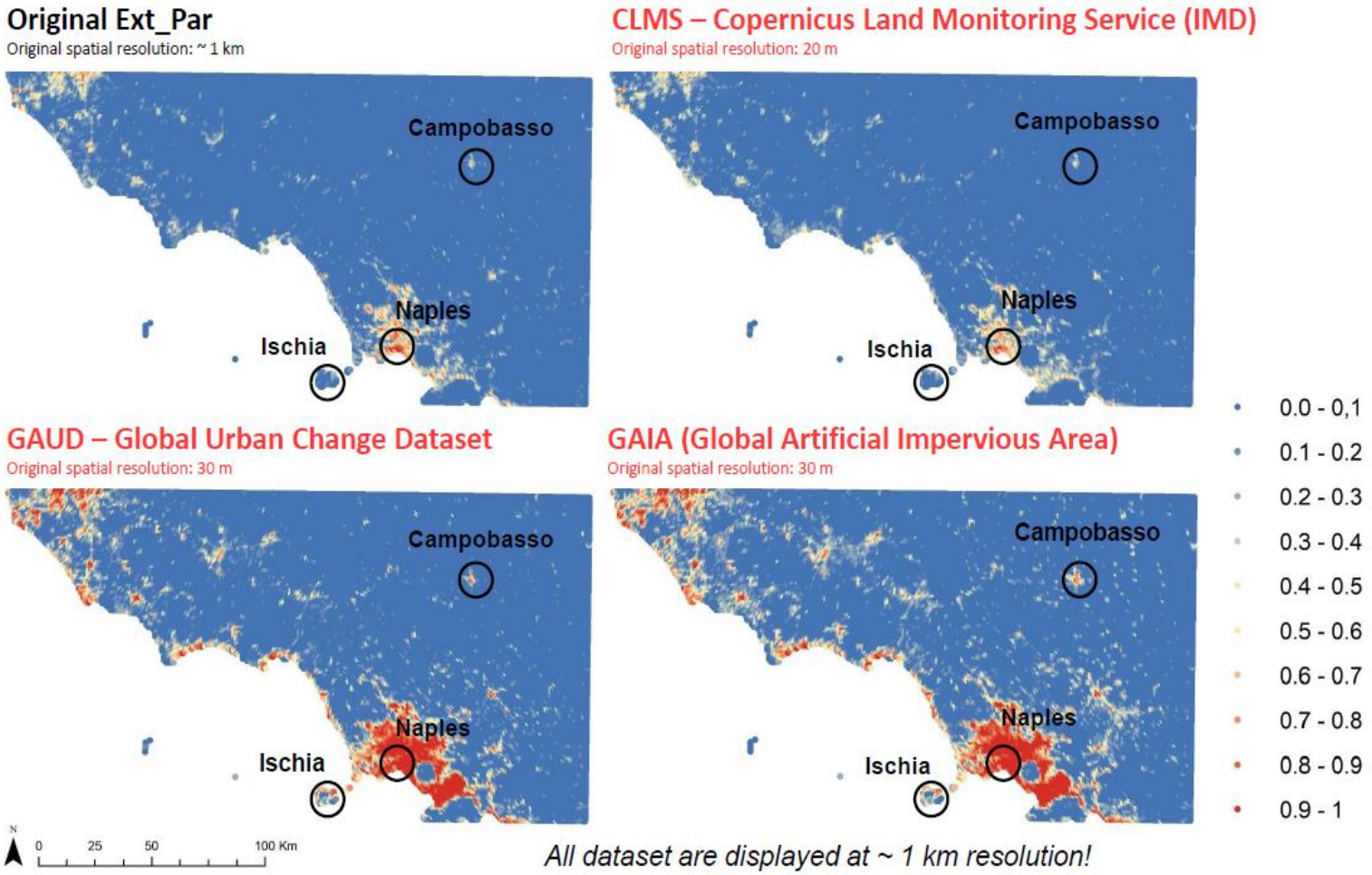


	H/W (a)	Building surface fraction (b)	Mean height of canopy [m]
LCZ 1	>2	0.4-0.6	>25
LCZ 2	0.75-2	0.4-0.7	10-25
LCZ 9	0.1-2.5	0.1-0.2	3-10
sim 6 *	1.5	0.67	15

(a): mean height-to-width ratio of street canyons
(b): ratio of building plan area to total plan area
* : default parameters of TERRA_URB

Which parameters for Turin?

PT AEVUS-2: Main achievements



Updating the current EXTPAR field of ISA with new products

PT AEVUS-2: test cases

The verification is an important aspect of PT_AEVUS 2 to evaluate the performance of the model.

The experiments will be performed over the test cases already defined in the frame of PT AEVUS:

- urban areas of Turin (Italy) and Naples (Italy)
- the Moscow megacity (Russia).

For the validation have been uses the dense surface-layer observations available in the considered cities.

A large set of common simulations have been tested and are currently under evaluation.

PT AEVUS-2: Paper

Focus of paper is to show that running simulation with no "urban approximation" provides in different test cases worst results.

Based on the evidence reported by the three test cases (showing that the **real pattern of UHIs in urban areas can be represented only including urban parameterization**), our aim is to show that it is not recommended to avoid the consideration of urban parameterization.

This is expected to push the community to work and improve the urban parameterizations, covering the already existing gaps.

Additionally other specific settings have been considered related to urban parametrization (**ICON turbulence scheme and itype_canopy= 2** considering the effect of vegetation in the surface energy balance, the canopy temperature)

	CTRL	sm2	sm3	sm4	sm5	sm6	sm7	sm8
terra_urb	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE
old_tur	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE
itype_canopy	1	2	1	2	1	2	1	2

On going activities on PT_AEVUS 2

COSMO Priority Project CITTA':

City Induced Temperature change Through A'dvanced modelling

Project leader: Jan-Peter Schulz (DWD)

Project duration: Jan. 2021 – Dec. 2023 (3 years)

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
KIT:	Julia Fuchs
NMA:	Rodica Dumitrache, Amalia Iriza, Bogdan Maco
PoliTo:	Francesca Bassani
RHM:	Mikhail Varentsov, Denis Blinov, Vladimir Kopeykin, Timofey Samsonov
RUB:	Matthias Demuzere
VITO:	Hendrik Wouters

- A further test case will be intregrated over Bucarest.
- The Partecipation of other colleagues and FTEs are still under discussion

Main goal of PP CITTA'

- Based on results of 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-LAM, the limited-area version of the global ICON model for NWP applications.**

- A method should be designed and implemented in order to avoid inconsistencies among the diffent dataset used to define the urban external parameters.

- Several internal parameters describing the urban geometry and the urban thermal and radiative properties, which were hard coded in TERRA_URB as global constants, will be replaced by 2-dimensional fields from EXTPAR.

- Development of different test cases to evaluate the performances of the new developments.

- Improved representation of vegetated urban areas in TERRA_URB and study of boundary layer clouds over urban areas in ICON-LAM-ART

Thanks for your attention

To have a clear details of the more recent work performed in the PT_AEVUS 2 look at the repository
http://www.cosmo-model.org/view/repository/GM-2020/WG3b
and download presentations and related minutes held during the COSMO Parallel Session on Friday 04 September 2020