Activities and updates from RHM/MSU team

Mikhail Varentsov

and COSMO-Ru team

Outline

1. Overview TERRA_URB developments
2. Developments on external parameters
3. Publication activities
4. Testing recent version 5.10beta
5. Outlook

Status update on COSMO+TERRA_URB development

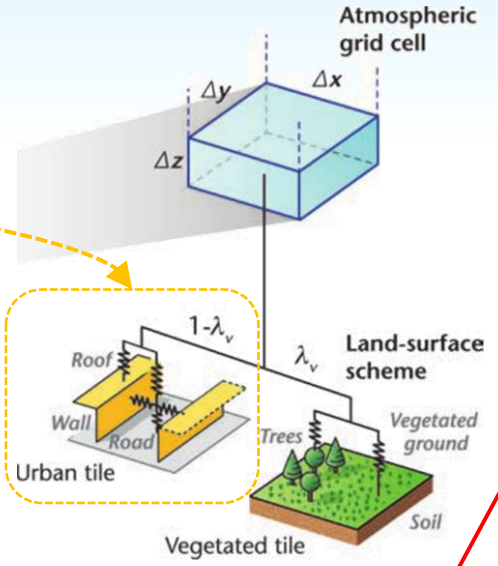
- **cosmo_191107_5.05_urb5**: a basic stable version with TERRA_URB which we have as an outcome from AEVUS PT
- **cosmo_191107_5.05_urb5 + update from Ulrich Schättler:**
  - Fixed bug with lwrite_const, option for writing tiled variables to Netcdf output
- **cosmo_191107_5.05_urb5up* with my new developments (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
- **cosmo_210309_5.10_beta (!!!)**

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

*__up__ means urban parameters,
**__sh__ means soil hydrology

Development on external parameters for TERRA_URB

- **Basic external parameters for TERRA_URB in (Wouters et al., 2016):**
  - Impervious area fraction (ISA)
  - Annual-mean anthropogenic heat flux (AHF)

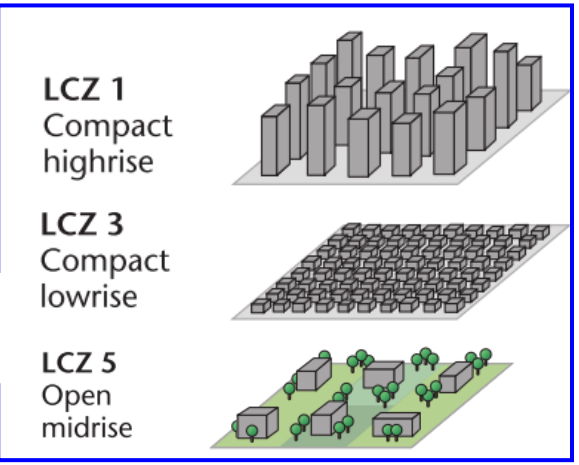


- **Additional 2D external fields to replace hard-coded values introduced in v5.05urb:**

Urban canopy parameters (input of SURY)		
Parameter name	Symbol	Default values
Surface albedo	α	0.101
Surface emissivity	ϵ	0.86
Surface heat conductivity	λ_s	$0.767\,\mathrm{W\,m^{-1}\,K^{-1}}$
Surface heat capacity	$C_{v,s}$	$1.25 \times 10^6\,\mathrm{J\,m^{-3}\,K^{-1}}$
Building height	H	15 m
Canyon height-to-width ratio	$\frac{h}{w_c}$	1.5
Roof fraction	R	0.667

Thermal and radiative parameters of urban materials

Building morphology parameters



- **But how to define all these parameters?**

Development on external parameters for TERRA_URB

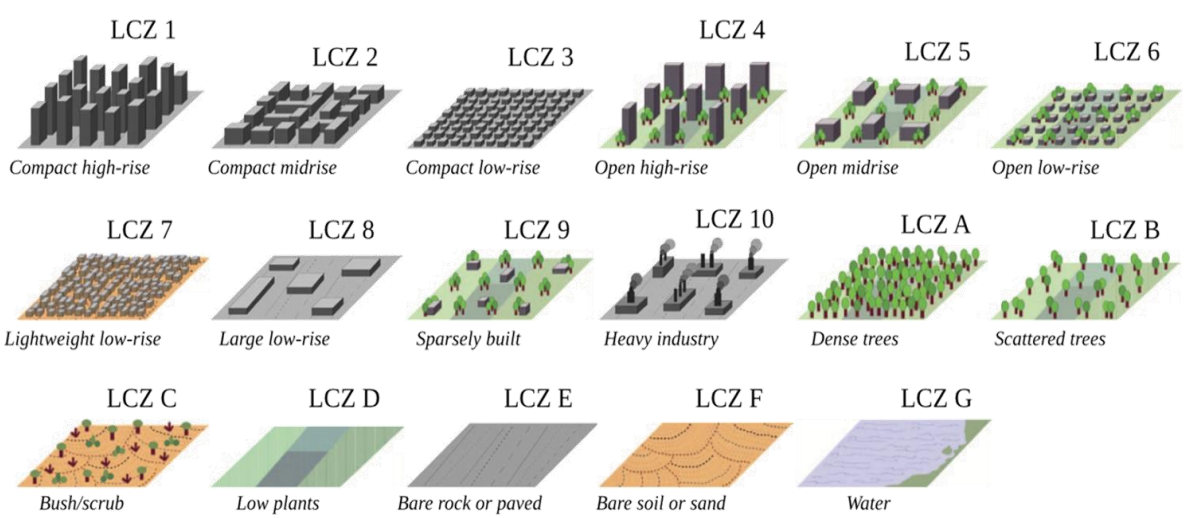
Default urban description from EXTPAR

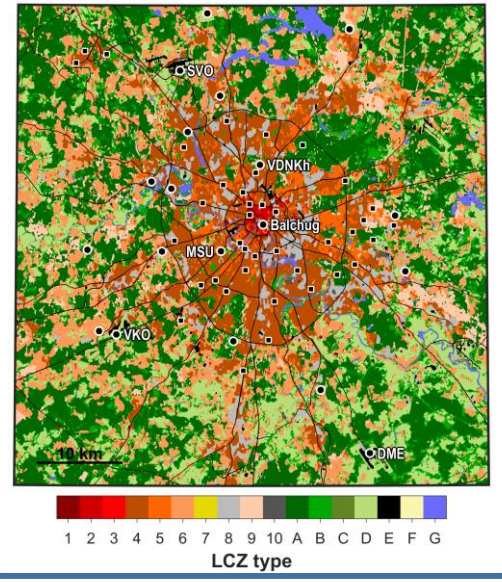
vs

Universal LCZ-based approach (WUDAPT-to-COSMO)

vs

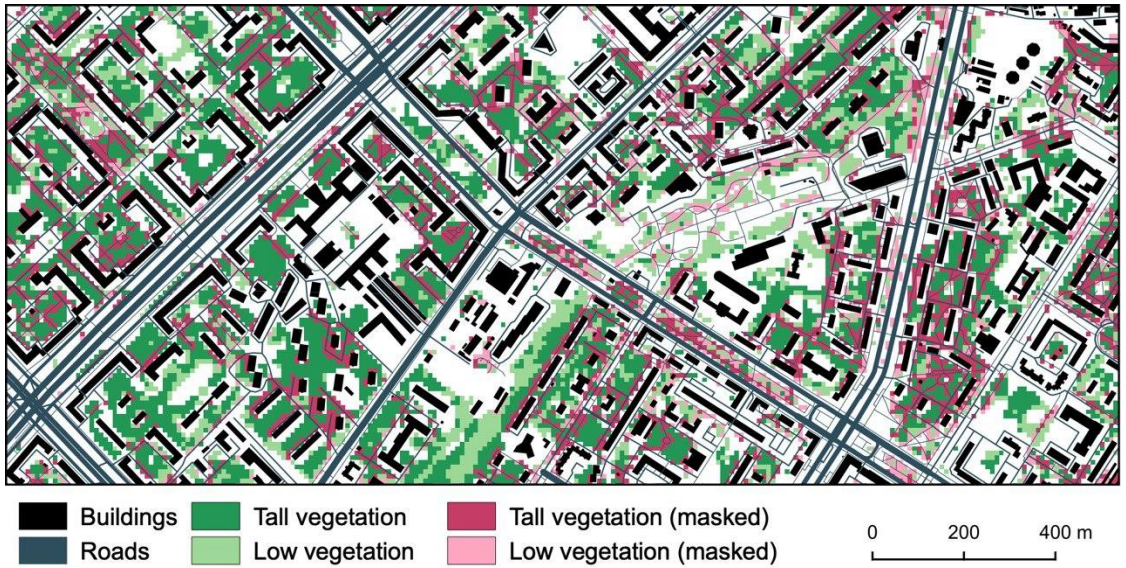
Advanced GIS-based approach





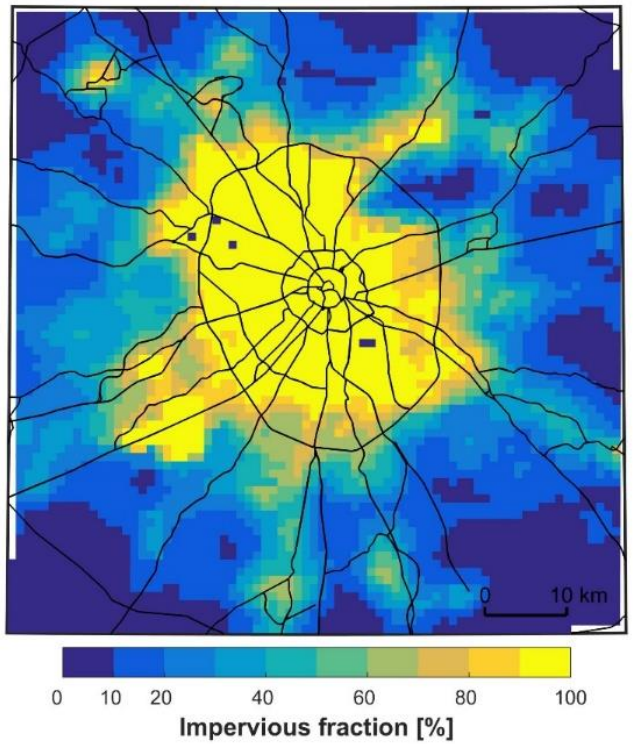
Based on combined use of different global data sets:

- ❑ Built up fraction area from ***Copernicus Global Land Cover*** with 100 m resolution
- ❑ Data on buildings and roads from ***OpenStreetMap***
- ❑ Data on vegetation derived from ***Sentinel-2 satellite images*** with 10 m resolution
- ❑ Literature AHF estimates (Stewart, Kennedy, 2017)

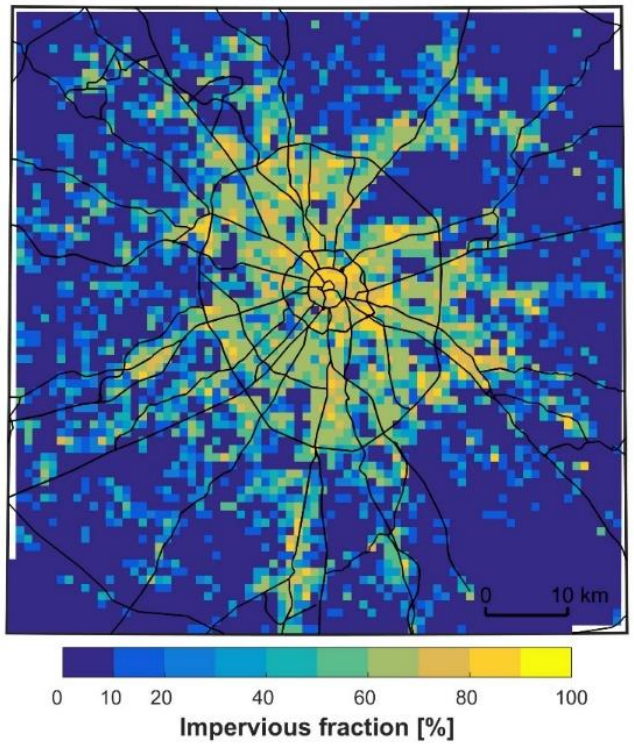


Resulting UCPs: ISA

Values from EXTPAR (DEF)



LCZ-derived ISA



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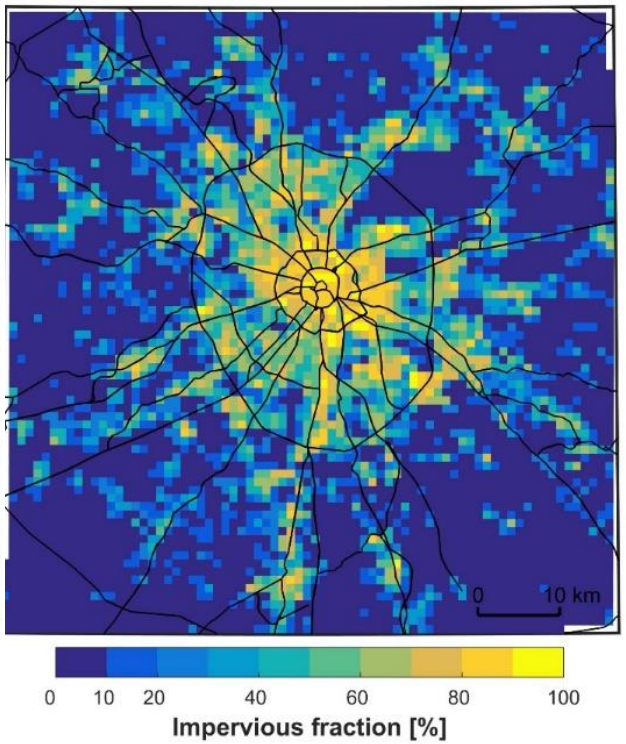

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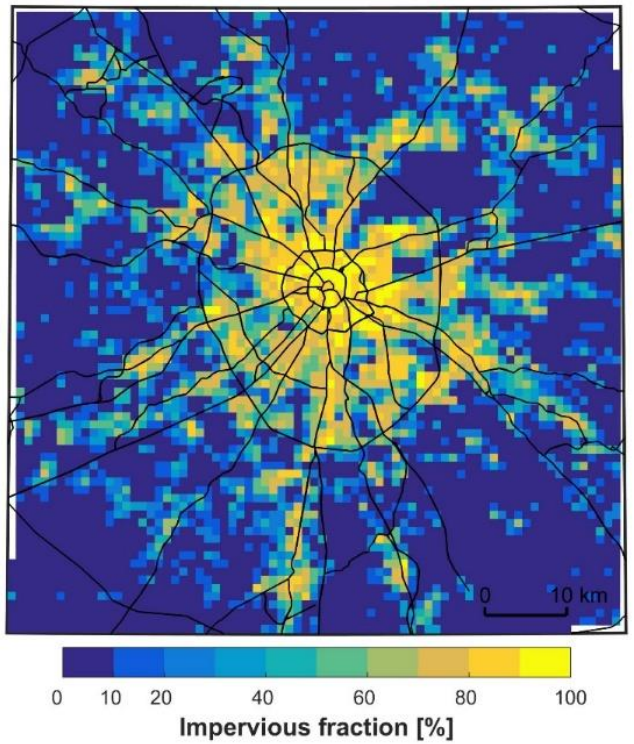
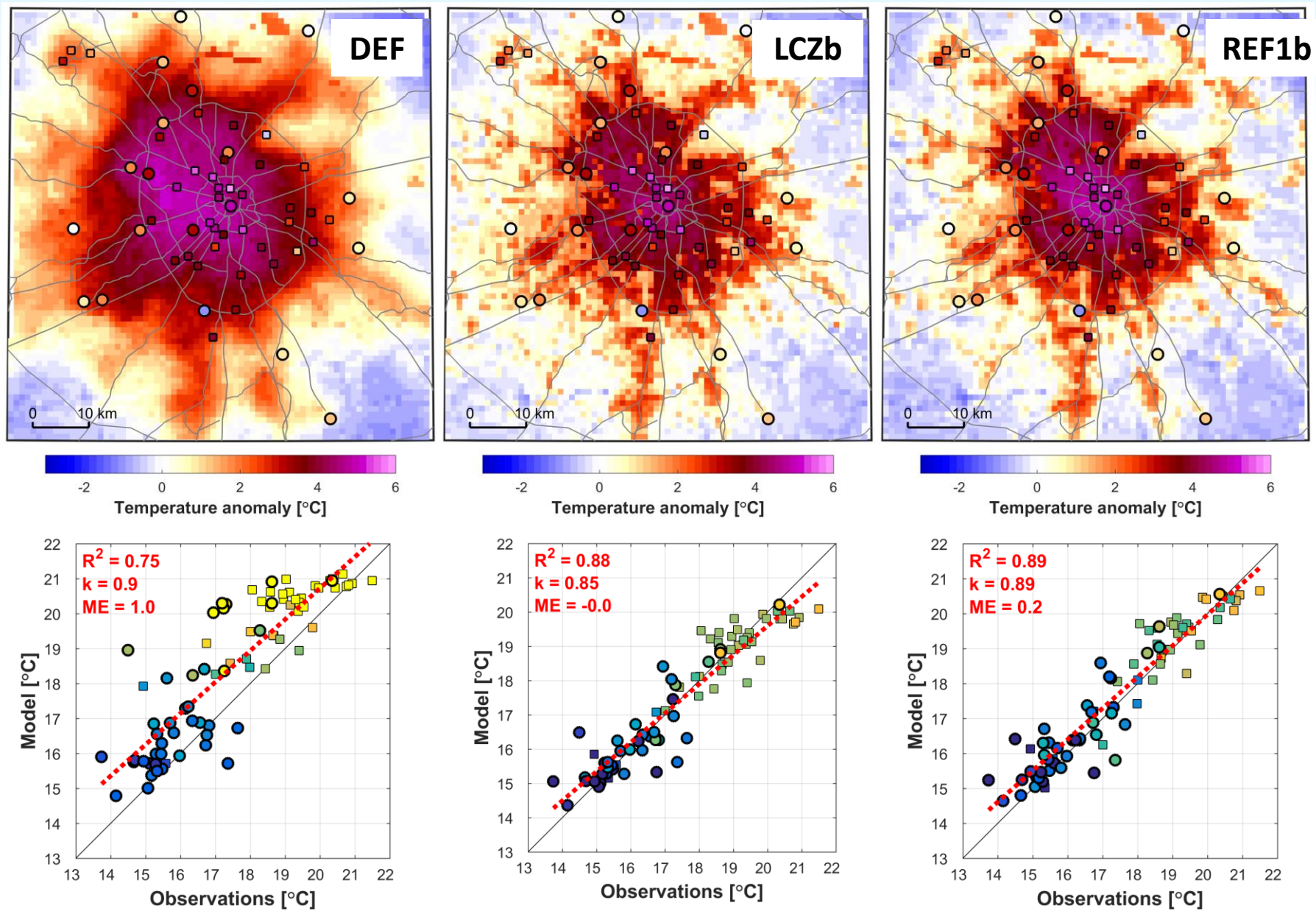


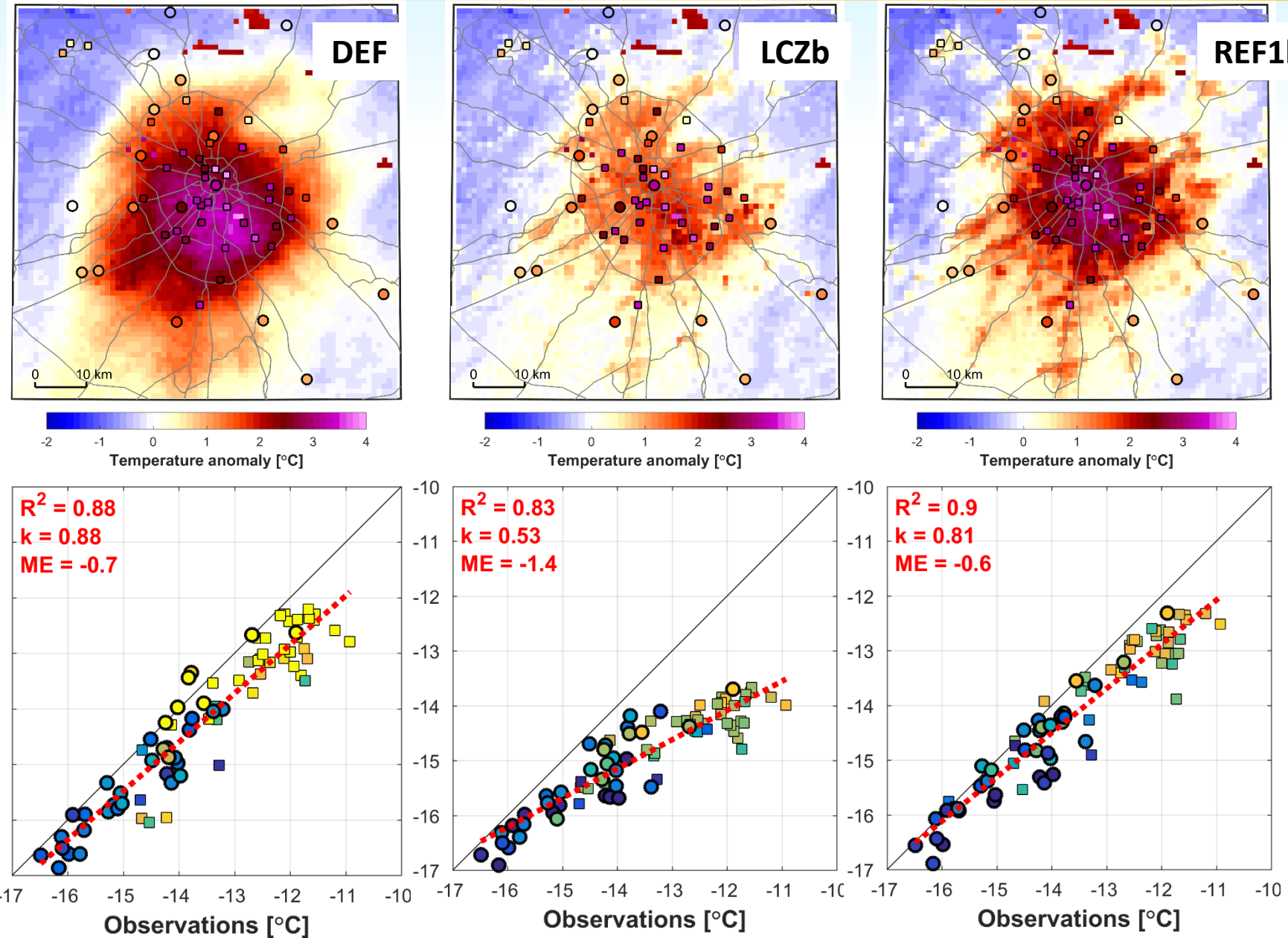
Results with respect to UCPs

UHI spatial patterns: model vs observations (August 2017, nighttime)

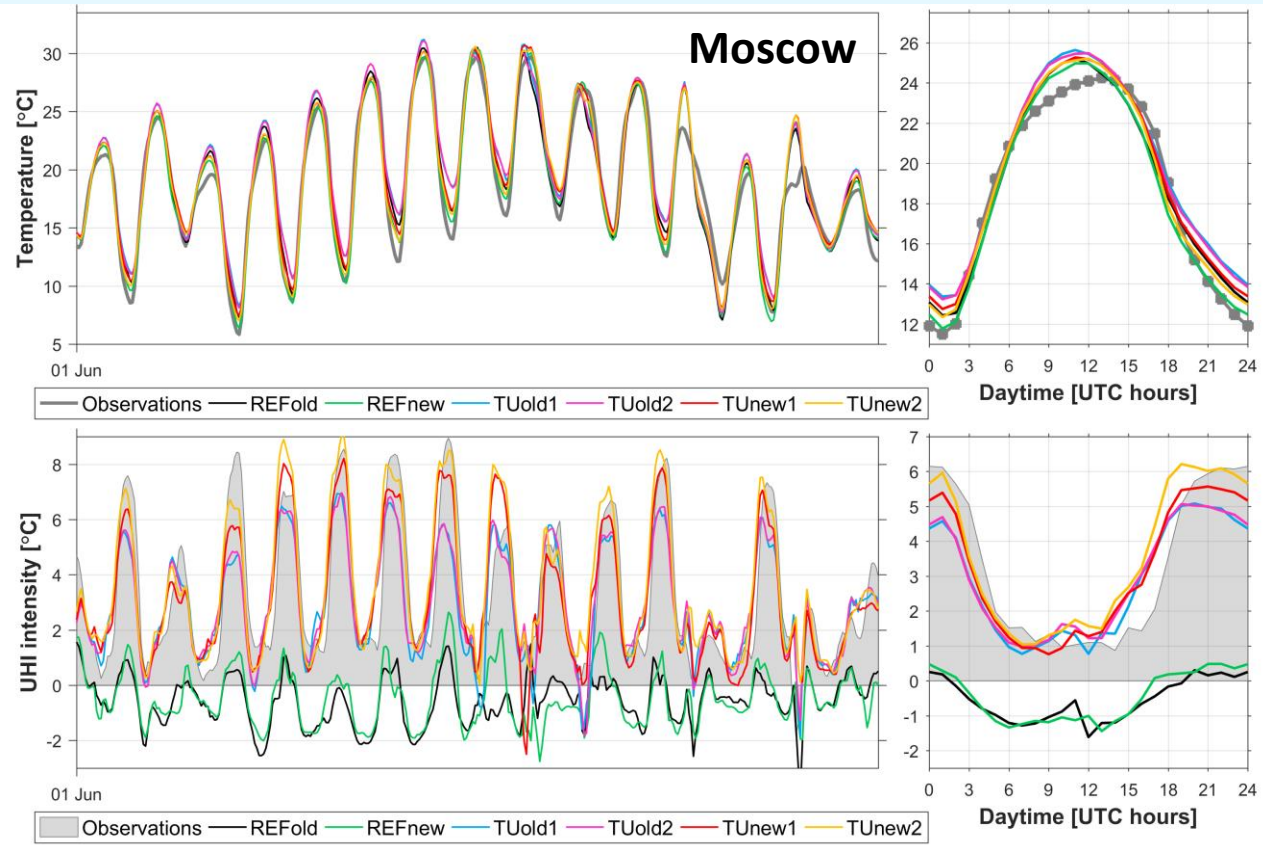


Results with respect to UCPs

UHI spatial patterns: model vs observations (January 2017, daily-mean)



Joint TERRA_URB evaluation for three cities



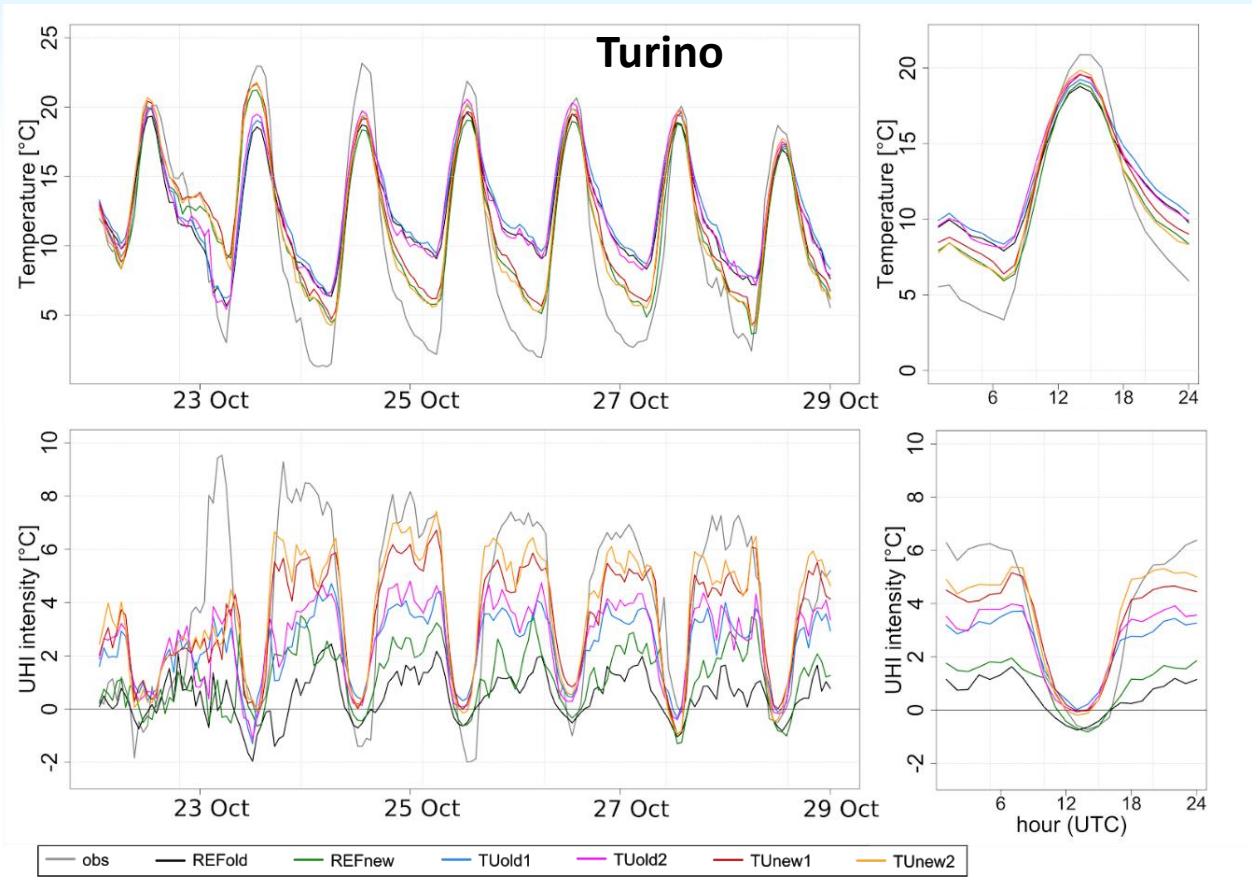
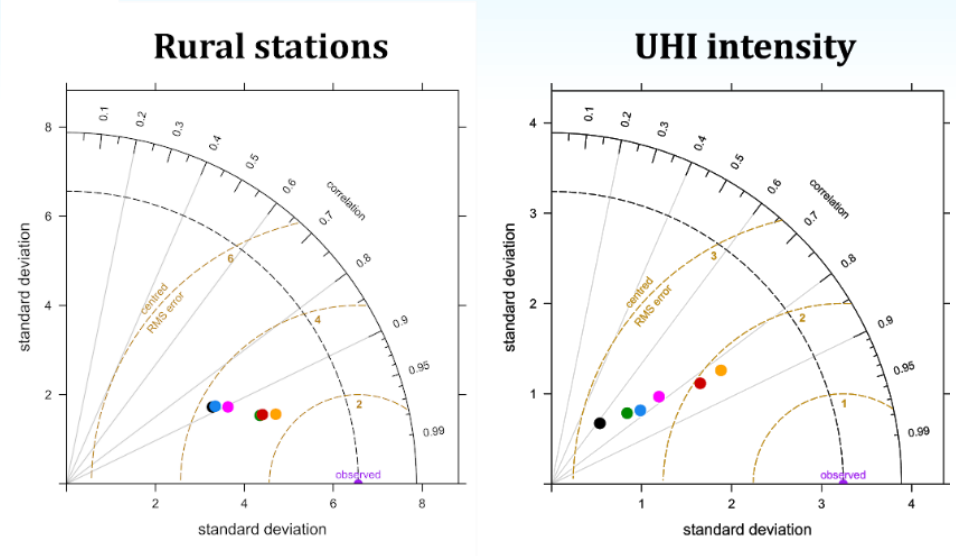


Table 2. Model configuration settings.

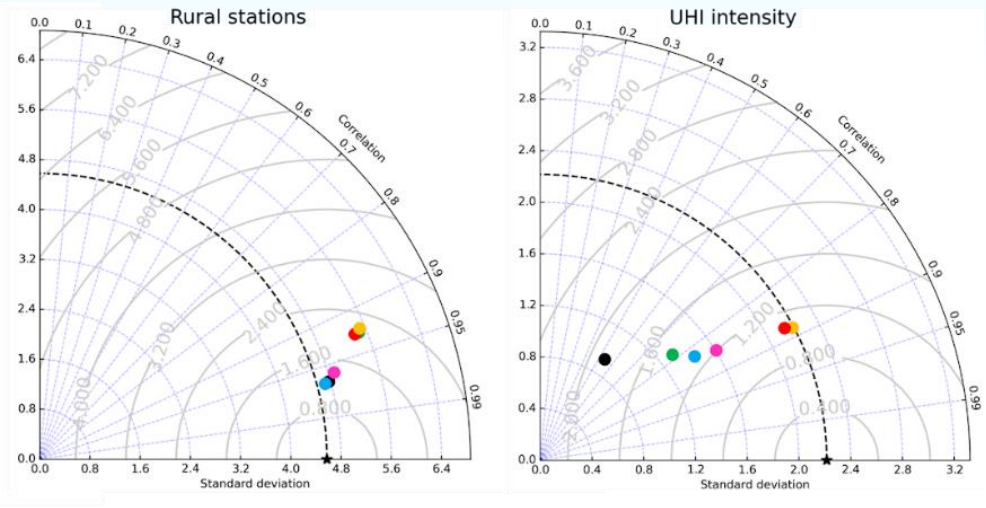
Namelist switch	Configuration explanation	REFold	REFnew	TUold1	TUold2	TUnew1	TUnew2
loldtur	Old (TRUE) or ICON-based (FALSE) turbulence scheme	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE
lterra_urb	TU scheme switched on (TRUE) or off (FALSE)	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE
itype_canopy	Current formulation (1) or skin temperature scheme (2)	1	1	1	2	1	2

Joint TERRA_URB evaluation for three cities

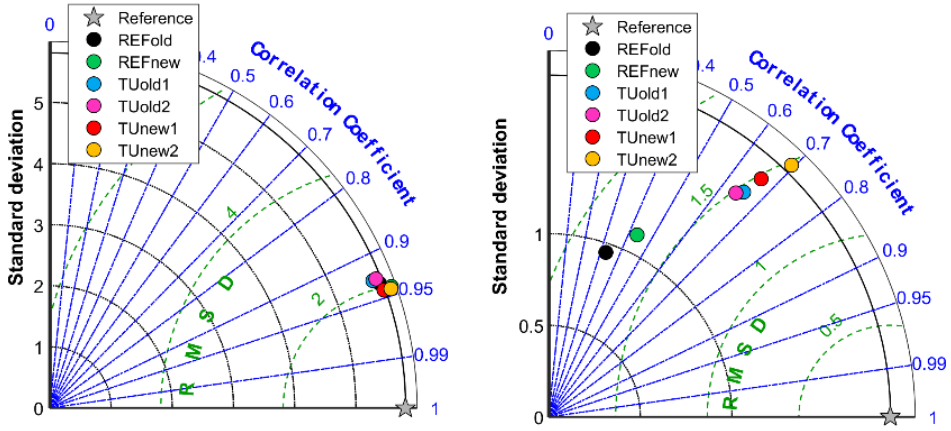
Turino



Naples



Moscow



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itype_canopy	Current formulation (1) or skin temperature scheme (2)	1	1	1	2	1	2

Conclusion: TUnew2 represents UHI in a best way for three cities

Publishing activities

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]

atmosphere

MDPI

Article

Impact of Urban Canopy Parameters on a Megacity's Modelled Thermal Environment

Mikhail Varentsov [1,2,3,4,*], Timofey Samsonov [1,2,4] and Matthias Demuzere [5]

GitHub matthiasdemuzere / WUDAPT-to-COSMO

WUDAPT-to-COSMO

Set of tools to use Local Climate Zone (LCZ)-based urban canopy parameters in DWD's COSMO-CLM NWP and regional climate model.

ISSN 1068-3739, Russian Meteorology and Hydrology, 2020, Vol. 45, No. 7, pp. 515–521. © Allerton Press, Inc., 2020.
Russian Text © The Author(s), 2020, published in Meteorologiya i Gidrologiya, 2020, No. 7, pp. 112–119.

COMMUNICATIONS

Computation of City-descriptive Parameters for High-resolution Numerical Weather Prediction in Moscow Megacity in the Framework of the COSMO Model

T. E. Samsonov[a, b, c] and M. I. Varentsov[a, b, c*]

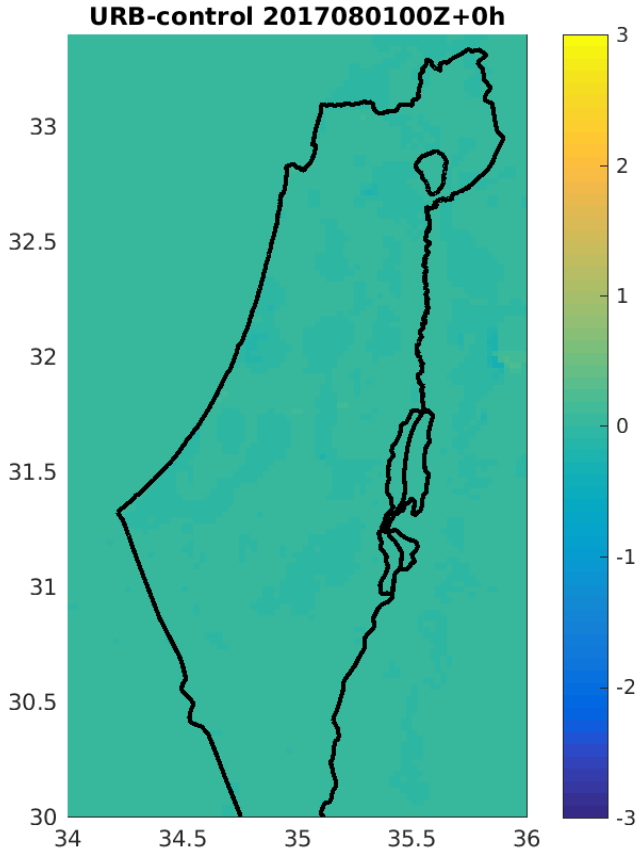
ISSN 1068-3739, Russian Meteorology and Hydrology, 2020, Vol. 45, No. 7, pp. 455–465. © Allerton Press, Inc., 2020.
Russian Text © The Author(s), 2020, published in Meteorologiya i Gidrologiya, 2020, No. 7, pp. 5–19.

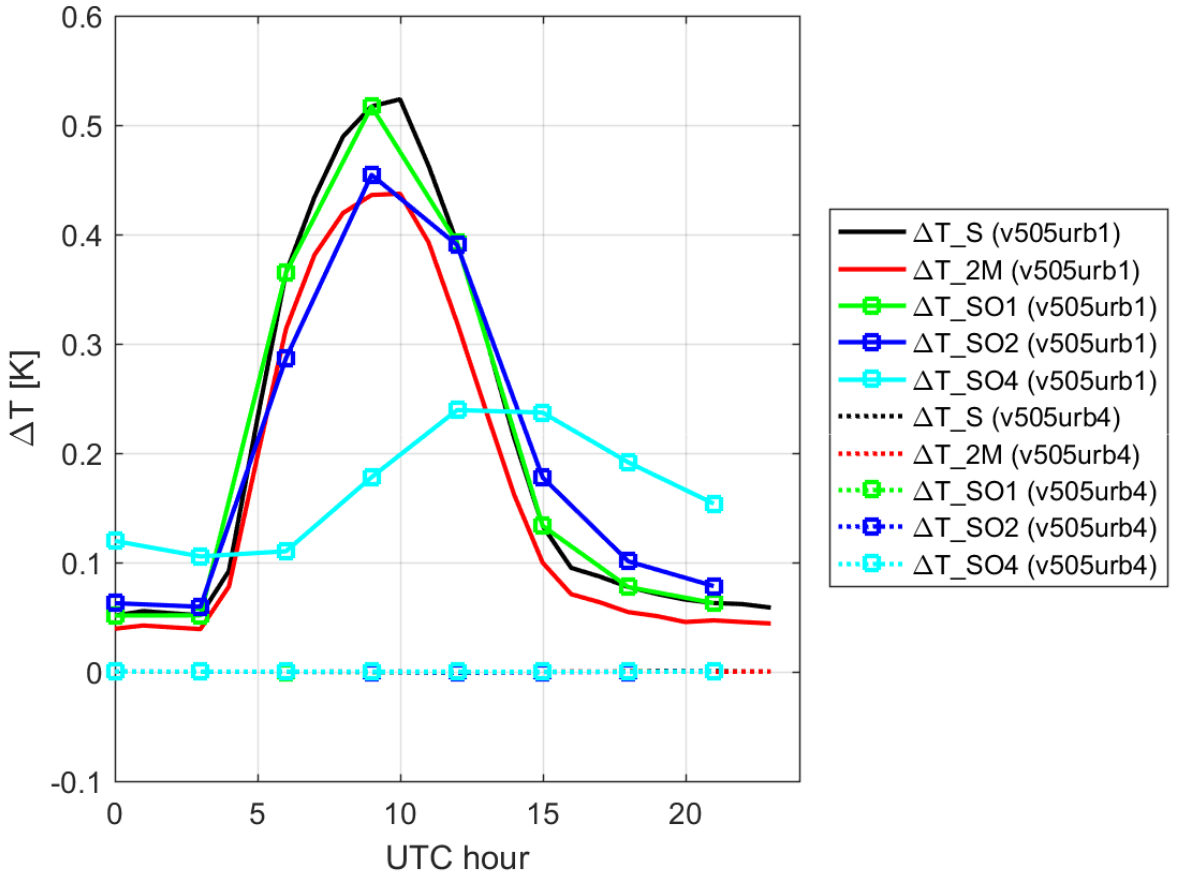
Development of the High-resolution Operational System for Numerical Prediction of Weather and Severe Weather Events for the Moscow Region

G. S. Rivin[a, b*], I. A. Rozinkina[a, b], R. M. Vil'fand[a, b], D. B. Kiktev[a], K. O. Tudrii[a], D. V. Blinov[a], M. I. Varentsov[a, b, c], D. I. Zakharchenko[a, b], T. E. Samsonov[a, b], I. A. Repina[b, c], and A. Yu. Artamonov[c]

Testing the recent 5.10beta version

Background: typical problem for new COSMO & TERRA_URB version (5.0, 5.05): “rural heating”

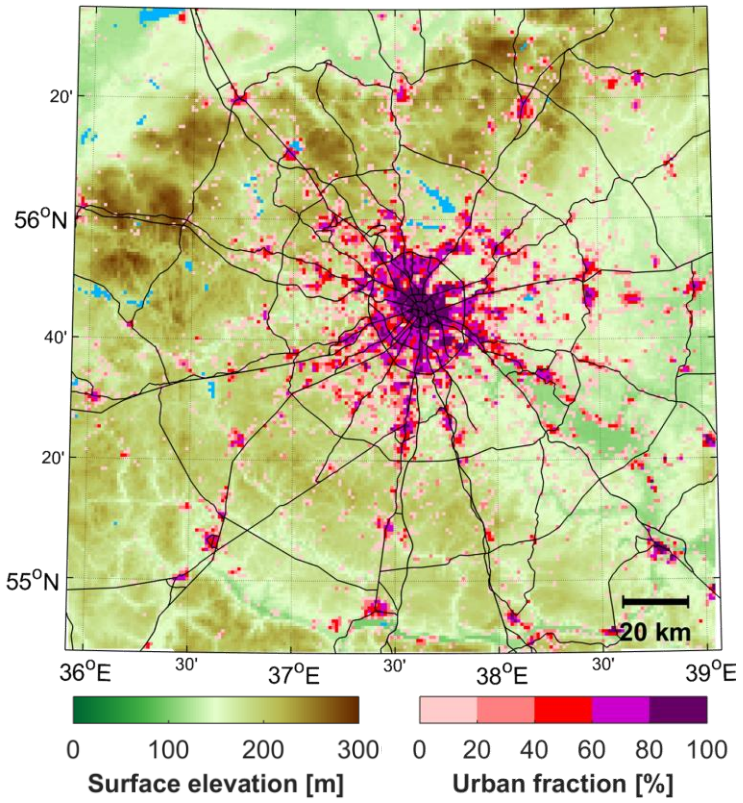


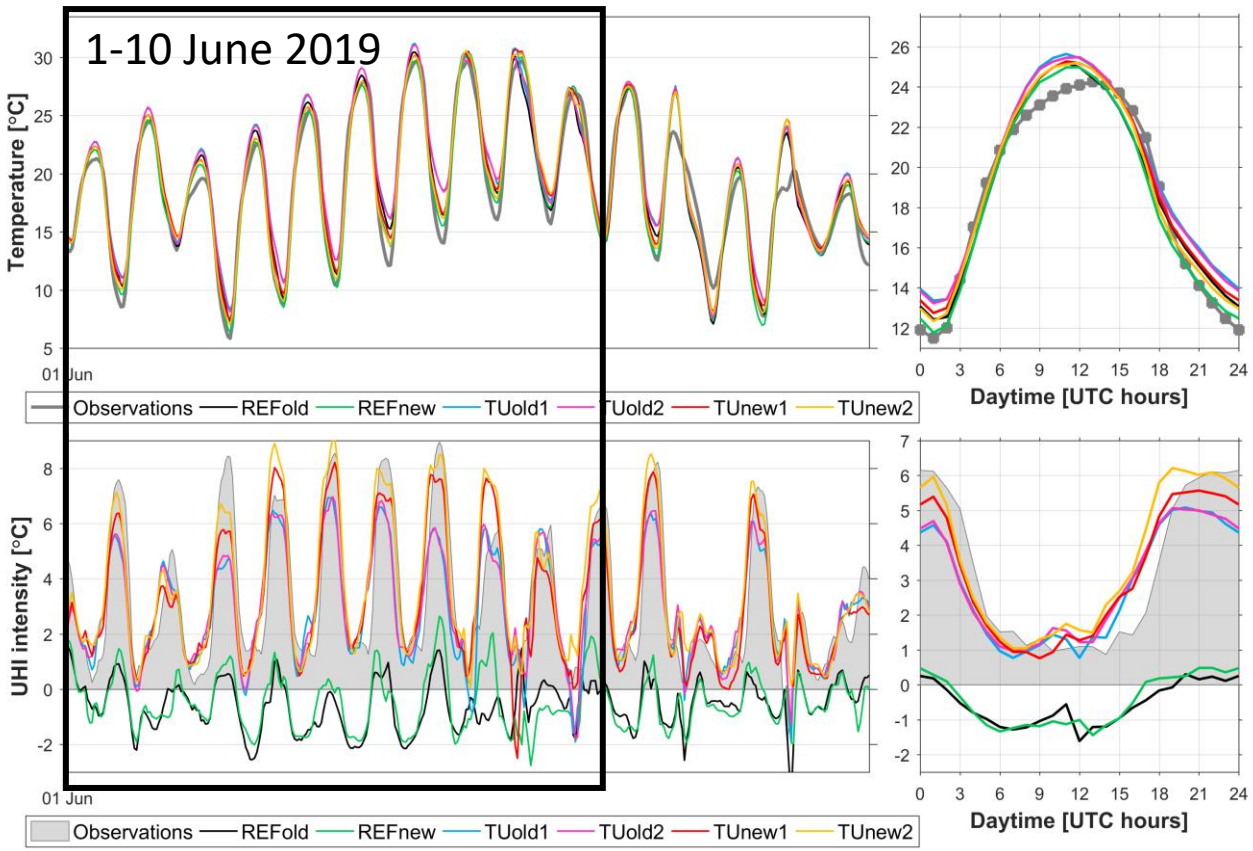


Diurnal variation of the temperature response for switching on the TERRA_URB scheme for **D3 domain with zero ISA and AHF**, averaged over the all land points and over 15 days of simulation (1-15 May).

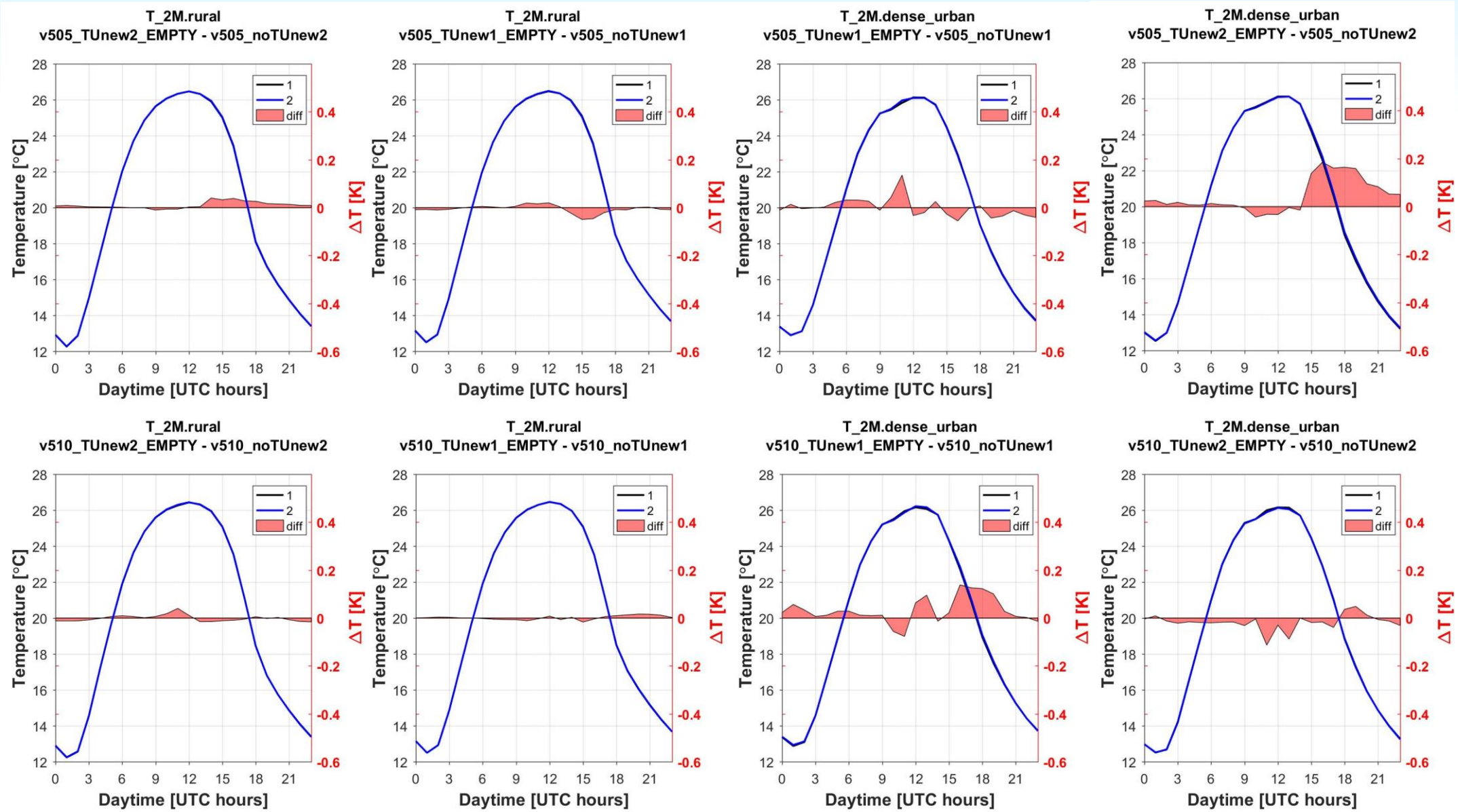
Testing the recent 5.10beta version

- Runs based on TUnew2 simulation from AEVUS paper, a bit shorter period (1-10 June 20)
- New version tested only for finest 1-km domain, IBC taken from 5.05 run for intermediate domain
- No tuning for rooting depth (fac_rootdp2 = 1 instead of 2.5 in previous runs) since it is limited by 1.5 in v2.10
- GIS-based ISA & AHF, model defaults for thermal and morphological UCPS
- Test runs with zero ISA & AHF

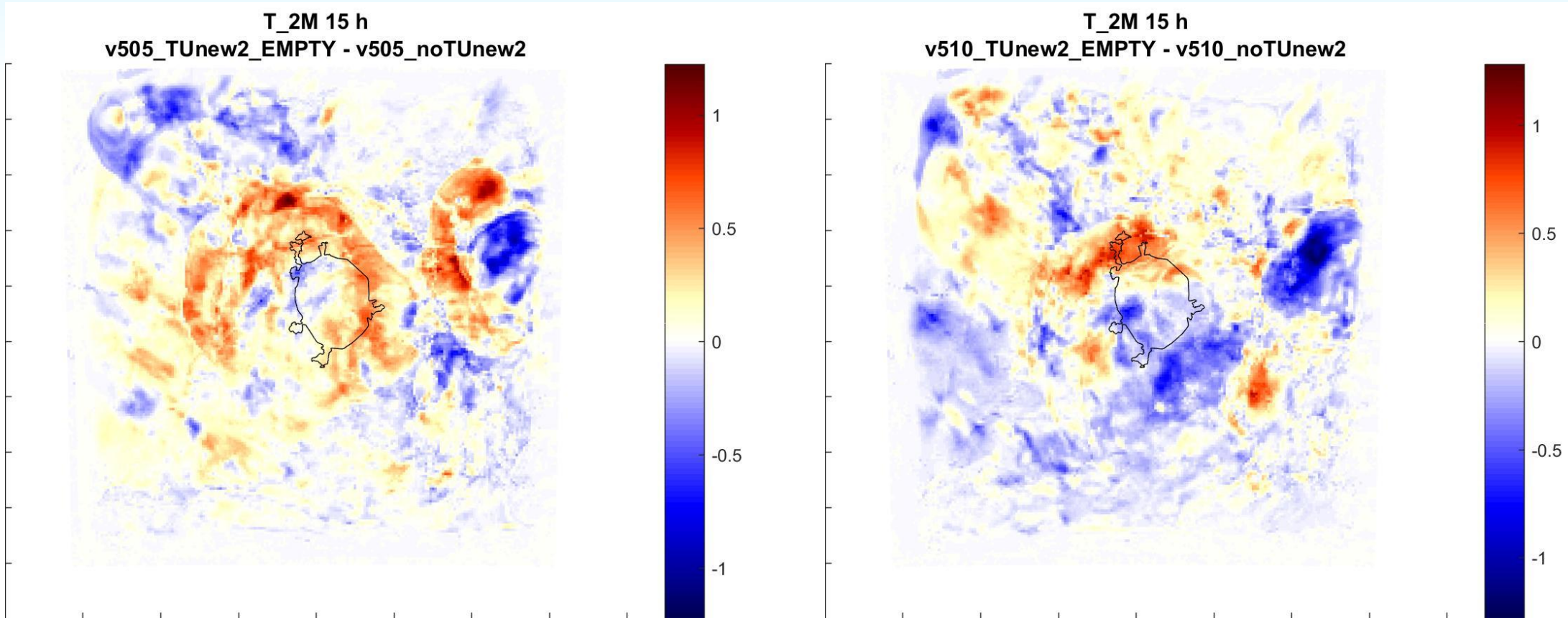




Testing the recent 5.10beta version: noTU & TU_EMPTY

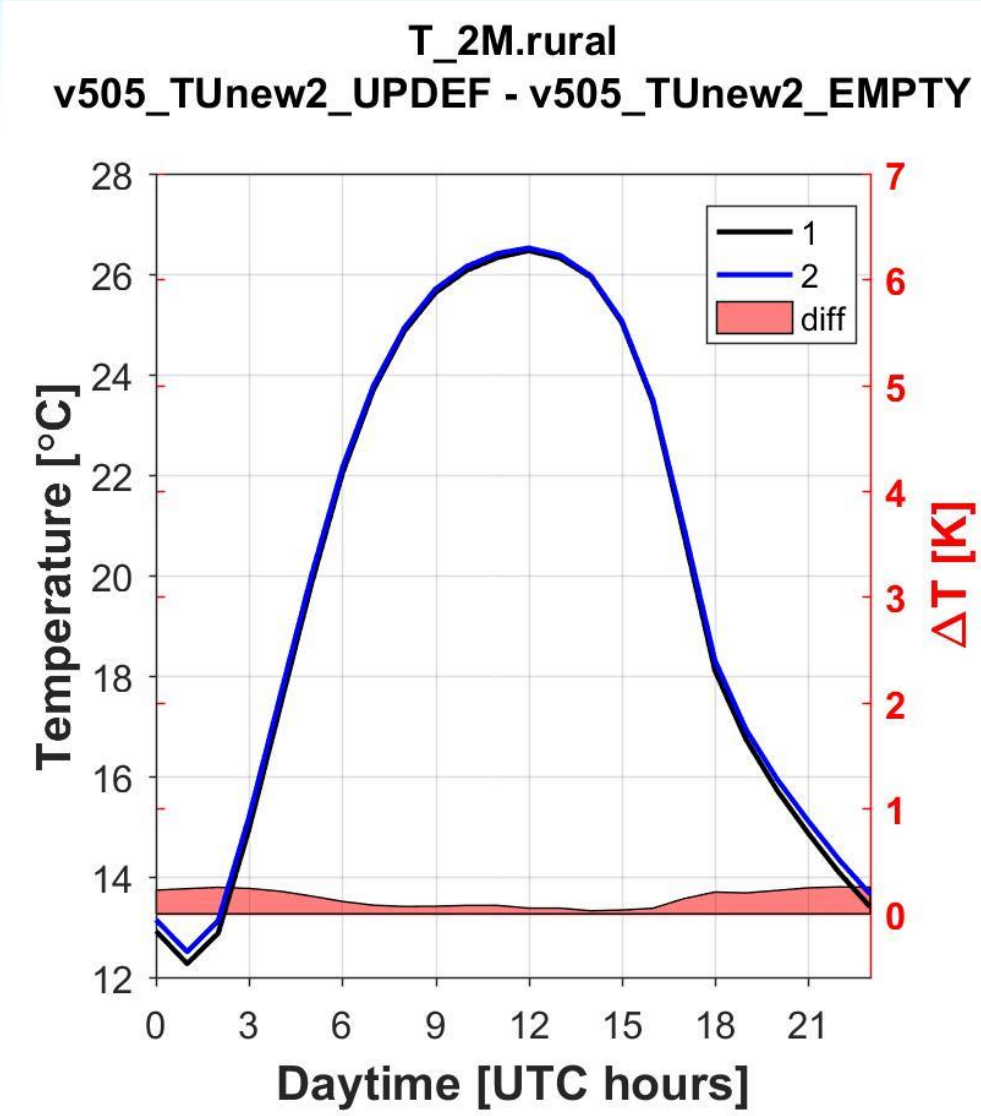


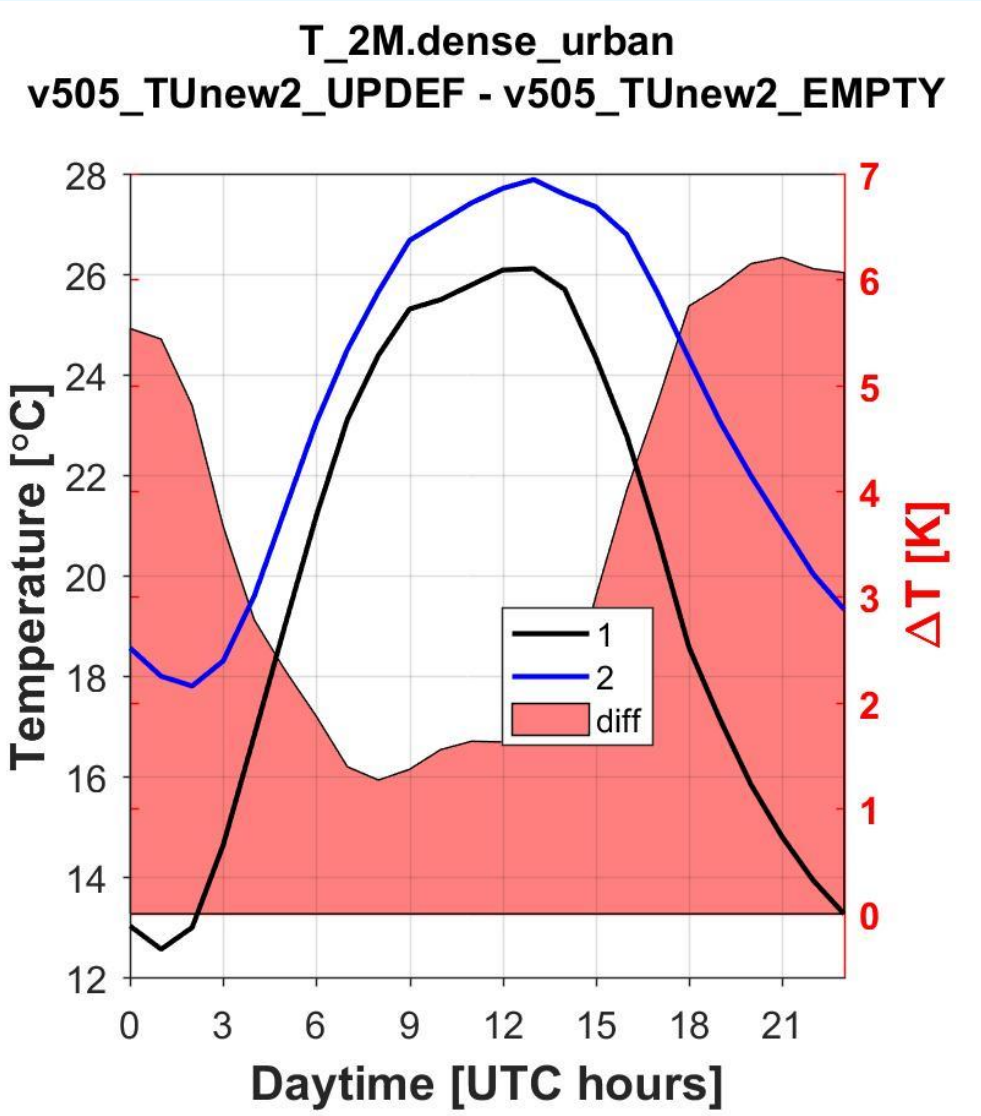
Testing the recent 5.10beta version: noTU & TU_EMPTY



No systematic difference between “noURB” and “EMPTY” runs in both versions,
but still some differences that triggered stochastically fluctuations

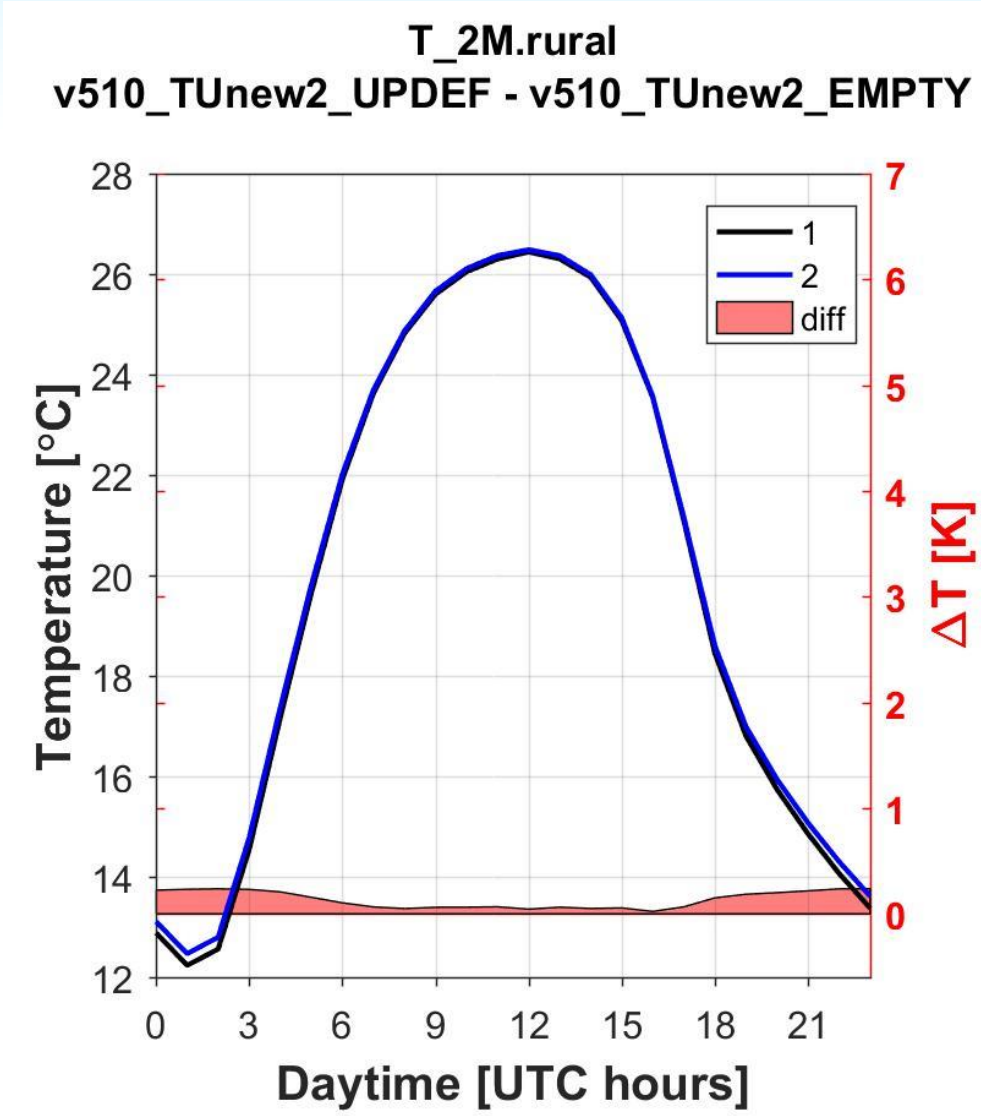
Testing the recent 5.10beta version: TU & TU_EMPTY

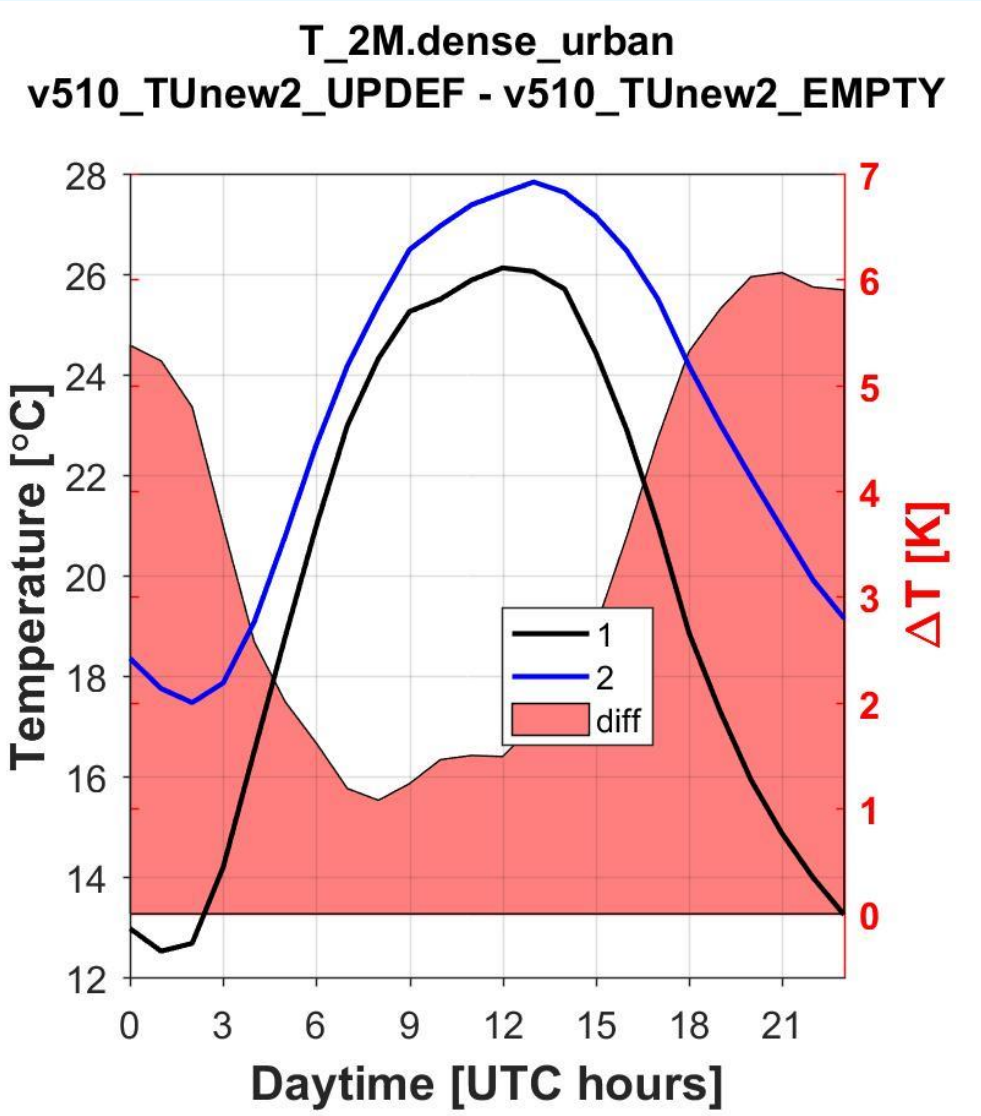




v505

Testing the recent 5.10beta version: TU & TU_EMPTY





v510

Outlook and points for discussion

- ❑ **OK, v510 works. We still need synchronized sensitivity tests for urban canopy parameters. Unrealistic senility results with 5.05urb by Torino team.**

Table 2. Overview of parameter sensitivity experiments. Seven couples of experiments (AL, AH, BL, BH, CL, CH, DL, DH, EL, EH, FL, FH, FL, GH) are performed for which the default urban canopy parameters are modified to the values in the low (L) and high (H) columns. Except for the AHE, L and H correspond to the minimum and maximum values of the urban canopy parameter ranges for the local climate zones of compact low-rise and mid-rise defined in Stewart and Oke (2012). For the GL scenario, the AHE is set to $0\,\mathrm{W\,m^{-2}}$. For the GH scenario, AHE multiplied by 2 compared to the default setup for which the data set and methodology of Flanner (2009, denoted as FL09 in the table) are used.

EXP-ID	Urban canopy parameter	Symbol	L	H
A	surface albedo	α	0.10	0.25
B	surface heat conductivity	λ_s [$\mathrm{W\,m^{-1}\,K^{-1}}$]	0.200	0.968
C	surface heat capacity	$C_{v,s}$ [$10^6\ \mathrm{J\,m^{-3}\,K^{-1}}$]	0.321	1.56
D	canyon height-to-width ratio	$\frac{h}{w_c}$	0.75	2.0
E	building height	h [m]	3	30
F	roof fraction	R	0.40	0.70
G	anthropogenic heat emission	AHE	0	2 × FL09

Should we further use the same H & L values for the unified tests?
Maybe let's increase the H-values?

- ❑ **We need to test many other things indicated by Uli (tile output, GRIB IO, etc.)**
- ❑ **Tests in GPU mode?**

Outlook and points for discussion

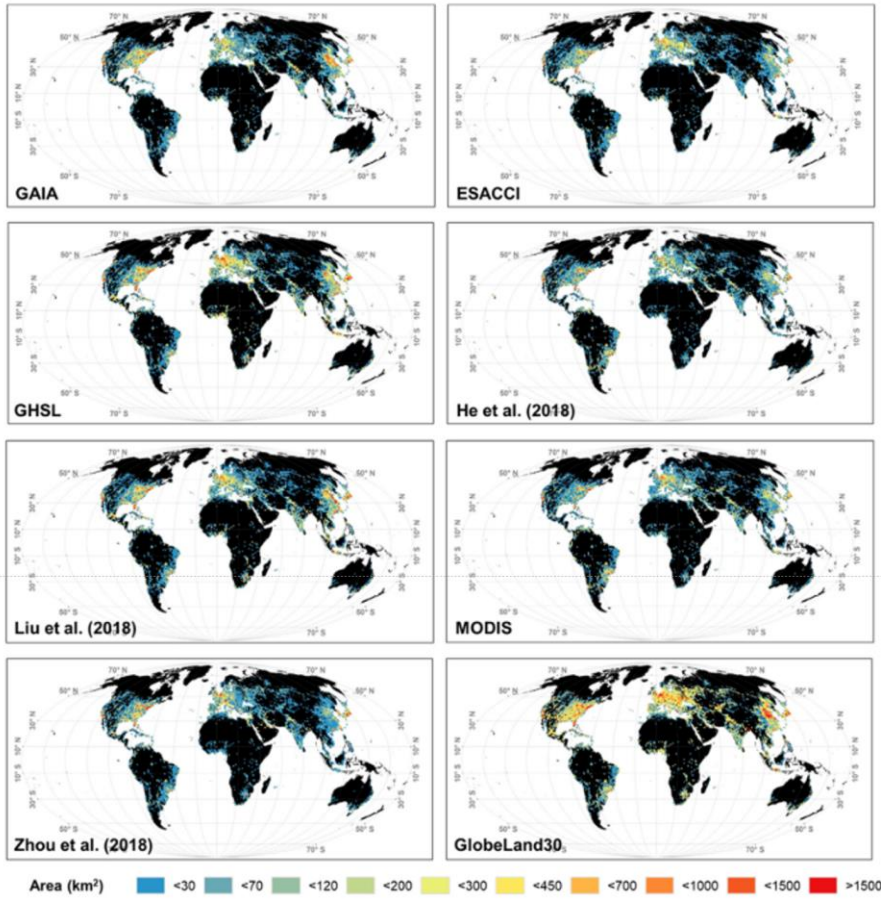
- **Further research on external parameters. Current EXTPAR defaults are too coarse and outdated. But who will take carry about it? It's a great pity that we missed Matthias.**

Other EXTPAR-related issues

Suggestions to replace urban fields currently available in EXTPAR:

- Update EEA imperviousness with new products (100m, state of 2006, 2009, 2012, 2015) (EUROPE)
- global artificial impervious area (GAIA) (30m, globally, 1985-2018, paper, download)
- ESA CCI urban land cover (300m, per year from 1992-2018) (viewer) (Global)
- Copernicus Global Land Cover (100m, 2015) (viewer) (GLOBAL):
- Explore use of Dong et al. (2017) anthropogenic heat flux (hourly, ~1km, state of 2013)

But we need to remember that urban/paved fraction are different parameters…



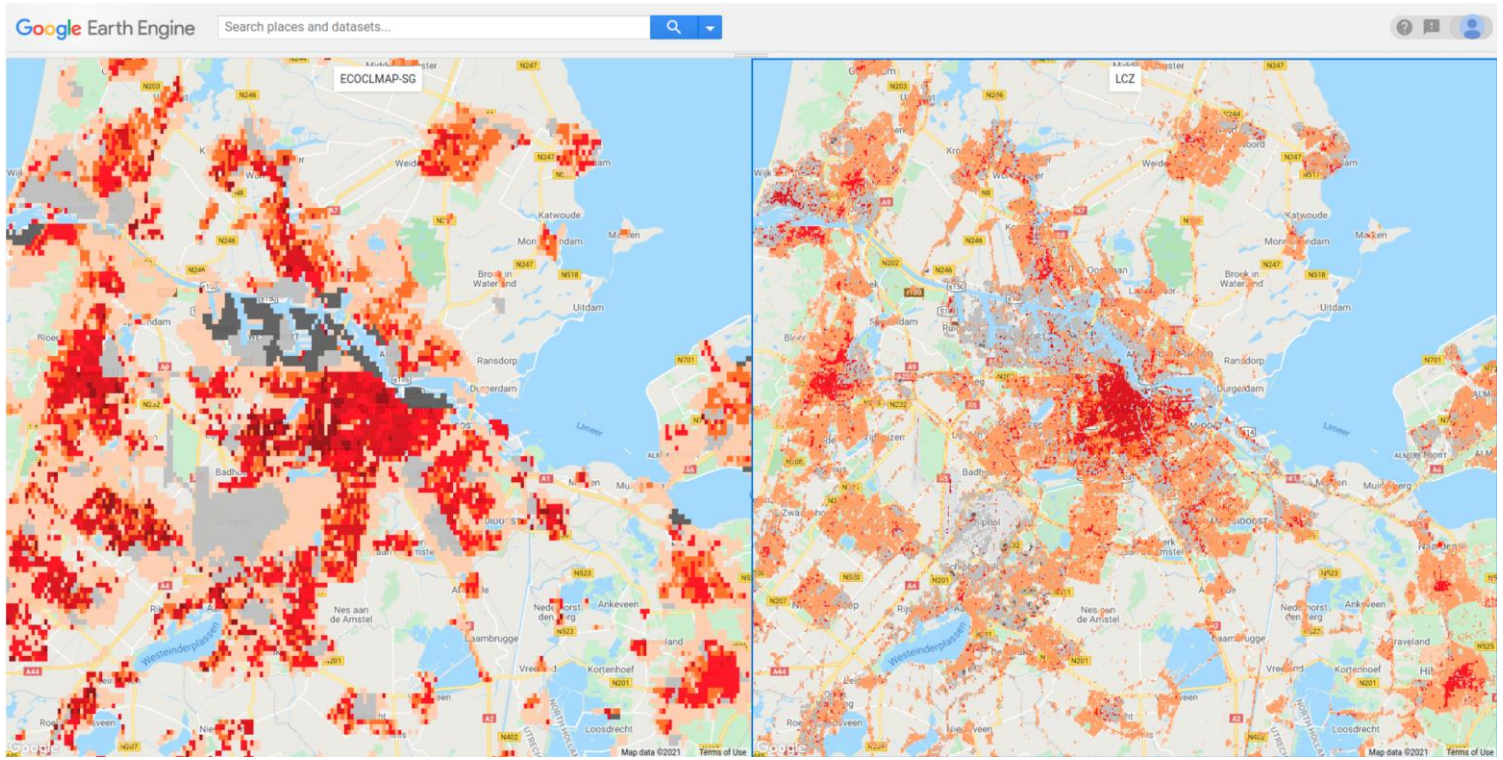
Outlook and points for discussion

- ❑ **Further research on external parameters. Current EXTPAR defaults are too coarse and outdated. But who will take carry about it? It's a great pity that we missed Matthias.**
- ❑ **Recent Ecoclimap Landcover data set with 300-m resolution and LCZs!**

Legend of the land cover map and technical documentation

The land cover types represented in ECOCLIMAP-SG land cover map are:

1. sea and oceans
2. lakes
3. rivers
4. bare land
5. bare rock
6. permanent snow
7. boreal broadleaf deciduous
8. temperate broadleaf deciduous
9. tropical broadleaf deciduous
10. temperate broadleaf evergreen
11. tropical broadleaf evergreen
12. boreal needleleaf evergreen
13. temperate needleleaf evergreen
14. boreal needleleaf deciduous
15. shrubs
16. boreal grassland
17. temperate grassland
18. tropical grassland
19. winter C3 crops
20. summer C3 crops
21. C4 crops
22. flooded trees
23. flooded grassland
24. LCZ1: compact high-rise
25. LCZ2: compact midrise
26. LCZ3: compact low-rise
27. LCZ4: open high-rise
28. LCZ5: open midrise
29. LCZ6: open low-rise
30. LCZ7: lightweight low-rise
31. LCZ8: large low-rise
32. LCZ9: sparsely built
33. LCZ10: heavy industry

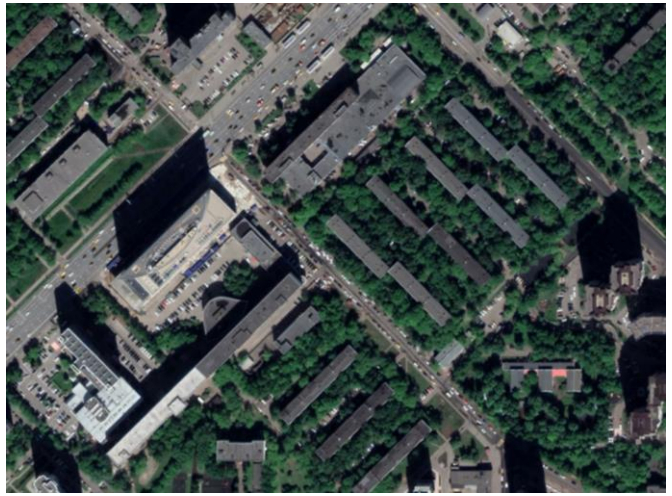


Outlook and points for discussion

- **Further TERRA_URB scientific developments in COSMO/ICON?**
  - Improved prestation of built-up/impervious surfaces.
  - TERRA_URB and snow: in current version, snow cover is assumed everywhere over buildings (including over walls), which is evidently not true.

100 % built up, 100% paved

≈100 % built up, ≈50% paved



Outlook and points for discussion

- ❑ **Participation with COSMO & TERRA_RUB in WMO Research Demonstration Project "Paris Olympic Games 2024" (http://www.umr-cnrm.fr/RDP_Paris2024/?page=home)**
- ❑ **Headed by Valery Masson (developer of the TEB, first urban canopy scheme)**
- ❑ **Alexander Baklanov (WMO) is interested in COSMO/Rosydromet participation**

There are 5 scientific questions that will be addressed during this Paris RDP cover:

1. Nowcasting & Numerical Weather Prediction in cities at about 100m resolution

2. High resolution thunderstorm nowcasting (probabilistic and deterministic) in the urban environment, Urban heat islands and cool areas, air quality, in cities

3. Nowcasting and forecast in coastal cities (for the Marseilles site)

4. Big data, non-conventional data, and their uses

5. Conception and Communication of tailored weather, climate, environmental information at infra-urban resolution.

Thank you for attention!

http://vostokfilms.ru/upload/category/project/photo/026_9916.jpg