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Activities and updates from RHM/MSU team: simulations with different urban canopy parameters for Moscow megacity

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Different data sets on urban canopy parameters

Data set/simulation name	Paved 1	raction	AHF	UCP-Morphology (BLDH, BLDFR, H2W)	UCP-Radiative (TALB, SALB)	UCP-Thermal (HCAP, HCPN)
DEF	Extpar defaults (Elvid	ge et al., 2007)	Extpar defaults (Flanner et al., 2009)	Defaults from Wouters et al., 2016	Defaults from Wouters	et al., 2016
LCZa	ICZ derived		LCZ derived	LCZ dorived	Defaults from Wouters	et al., 2016
LCZb	LCZ-derived		LCZ-derived	LCZ-denved	LCZ-derived values for i	ndividual cells
REF1a		less paved fraction				
REF1b	Expert estimate based on CGLC, Sentinel images and	overlaps with buildings and roads moves to vegetated tile)	Expert estimate based on (Stewart,	Expert estimate based	Defaults from Wouters	et al., 2016
REF2a	(Samsonov,	more paved fraction	2017)		LCZ-derived constants f	or facets
REF2b	Varentsov, 2020)	(vegetation that overlaps with with buildings and roads moves to paved tile)			Defaults from Wouters LCZ-derived constants f	et al., 2016 or facets

Custom-made urban canopy parameters

Based on combined use of different global data sets

- Built up fraction area from *Copernicus Global Land Cover* Ο with 100 m resolution
- Data on buildings and roads from **OpenStreetMap** Ο
- Data on vegetation derived from *Sentinel-2 satellite images* Ο with 10 m resolution



Residential area Industrial area Tall vegetation Mixed vegetation Low vegetation Grass

Water Other

Buildings Roads

Trees and grass in 10 m resolution





Release of Global 100m Land Cover maps for 2015

Today, at the occasion of ESA's biggest Earth observation conference, the 'Living Planet Symposium 2019' (Milan, Italy), the Global Land Service team is thrilled to release a new set of Global Land Cover layers, with an overall 80% accuracy

- lete discrete classification with 23 classes
- · fractional cover layers for the ten base land cover classes: forest, shrub, grass, moss & lichen, bare & sparse vegetation, cropland, built-up / urban, snow & ice, seasonal & permanent inland water bodies
- a forest type layer offering twelve types of forest
- quality indicators for input data (data density indicator), for the discrete map (probability) and for six of the fractional cover layers



(Samsonov, Varentsov, 2020)

ISA in custom-made data set

ISA = max (min (URBAN_FR_{CGLC}, 1 – GREEN_FR), BLDF_FR_{OSM} + ROAD_FR_{OSM}) GREEN_FR = max (GREEN_FR_{OSM}, GREEN_FR_{SENTINEL})



Uncertainty: what to do with vegetation, that intersects with buildings/roads?

(Samsonov, Varentsov, 2020)

AHF in custom-made data set





(Samsonov, Varentsov, 2020)

Urban canopy parameters



Urban canopy parameters

Default values from EXTPAR Custom estimate (REF) LCZ-based AHF (Flanner et al., 2009) 10 km Anthropogenic heat flux [W/m²] Anthropogenic heat flux [W/m²] Anthropogenic heat flux [W/m²]

Urban canopy parameters



LCZ-based UCP →

Custom-made UCPs (based on OpenStreetMap data) →

Simulations set up

Initial and boundary conditions:

Continuous data set, constructed from ICON forecasts for 3 and 6 hours:



Scheme of dynamical downscaling:





Simulations set up

- ✓ TERRA_URB is always on
- ✓ Namelist settings generally similar to ARPAP's one, with exception for itype_aerosol (2 instead 1), hcorr_* parameters (model defaults are used), llake (TRUE instead FALSE) and some parameters for new turbulence

Simulation number	Turbulence	Itype_canopy	ltype_vdif
AEV1	Old	1	-1
AEV2	Old	2	-1
AEV3	New*	1	-1
AEV4	New*	2	-1
AEV5	New*	2	1

*Settings for "new turbulence" include **pat_len**=100 (model default, instead of 750 from User Guide), **c_soil** = 1 (model default, instead of 1.75/1.25 from User Guide)

Additional tuning: rooting depth is increased by 2.5 times to decrease warm and dry bias

Summer case, August 2017

Mean rural temperature \rightarrow

UHI intensity, city center ightarrow

UHI intensity, urban park ightarrow



Summer case, August 2017, DEF

MSK_0.009bg3_DEF Cray_v505up5_AEV5_newturMV_skc_vdif1_rt25_DEF L4n4g





Fields from EXTPAR default constant UCPs

Summer case, August 2017, LCZa

MSK_0.009bg3_LCZMD Cray_v505up5_AEV5_newturMV_skc_vdif1_rt25_LCZ1 L4n4g





LCZ-based UCPs, default thermal parameters

Summer case, August 2017, LCZb

MSK_0.009bg3_LCZMD Cray_v505up5_AEV5_newturMV_skc_vdif1_rt25_LCZ2_eff L4n4g Bias RMSE -0.54 1.42 Rural RHM -0.33 1.30 Rural ME 1.46 -0.14 Urban RHM 1.18 -0.24 Urban ME 1.32 All -0.34 56°N 40' 20' 55°N 30' 30' 37°E 38°E 30 17 18 19 20 21 22 23 24 25 Temperature [°C]



LCZ-based UCPs and thermal parameters

Summer case, August 2017, REF1a

MSK_0.009bg3_EXP_v2a Cray_v505up5_AEV5_newturMV_skc_vdif1_rt25_EXPa1 L4n4g





Custom made UCPs (less ISA), default thermal parameters

Summer case, August 2017, REF1b

MSK_0.009bg3_EXP_v2a Cray_v505up5_AEV5_newturMV_skc_vdif1_rt25_EXPa2_eff L4n4g





Custom made UCPs (less ISA), LCZ-based thermal parameters

Summer case, August 2017, REF2b

MSK_0.009bg3_EXP_v2c Cray_v505up5_AEV5_newturMV_skc_vdif1_rt25_EXPc2_eff L4n4g





Custom made UCPs (more ISA), LCZ-based thermal parameters

Winter case, January 2017

Mean rural temperature \rightarrow

UHI intensity, city center ightarrow





Conclusion

- Simulations with LCZ-based urban external parameters provides as good results as simulations with custom-made reference data set for summer season
- For summer, LCZ-base and REF data set provide a noticeable impartments in comparison to default configuration
- For the winter, LCZ-based approach demonstrates worse results due to underestimation of anthropogenic heat flux

Paper under preparation: Varentsov M., Samsonov T., Demuzere M. Impact of urban canopy parameters on a megacity'smodelled thermal environment. Will be submitted to Atmosphere SI (thanks Eduardo for extending the deadline!).