Urban surface model

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This document contains the description of configuration parameters and input files of Urban Surface Model (USM) which is an optional module of the model PALM.

A Configuration file PARIN

1 Section &d3par

New options were added into the original PALM variable data_output. All new data output variables have prefix "us_", most of them also one of suffixes "_roof", "_west", "_east", "_south", "_north". Suffix "_roof" means horizontal surfaces, e.g. ground or roof, the other represent walls facing into corresponding direction. Most of variables can also be averaged by "_av" suffix. Next list omits all prefixes and suffixes. Thus to include e.g. the surface temperatures of east walls into the output a quantity us_t_surf_east has to be added to data_output configuration variable.

Variable name	Explanation
surfz	height of surface
surfcat	category of the surface
surfalb	albedo of the surface
surfemis	emissivity of the surface
radnet	net radiation for given surface
rad_insw	total incoming shortwave radiation
rad_inlw	total incoming longwave radiation
rad_inswdir	incoming direct shortwave radiation
rad_inswdif	incoming diffusion shortwave radiation
rad_inswref	reflected shortwave radiation
rad_inlwdif	incoming diffusion longwave radiation
rad_inlwref	reflected longwave radiation
rad_outsw	total outgoing shortwave radiation
rad_outlw	total outgoing longwave radiation
rad_ressw	residua of sw radiation absorbed in surface after last reflection
rad_reslw	residua of lw radiation absorbed in surface after last reflection
rad_hf	heat flux caused by radiation
t_surf	surface temperature
t_wall_{k}	temperature of k-th layer of the wall/ground/roof corresponding to surface
wshf	surface heat flux
wghf	ground heat flux
lad	leaf area density in gridbox
canopy_hr	heat rate from absorbed radiation in canopy
svf_{i}_{j}_{k}	shape view factors of surface adjacent to gridbox i,j,k (diagnostic only)
diff_{i}_{j}_{k}	transparency factors of surface adjacent to gridbox i,j,k (diagnostic only)

2 Section &urban_surface_par

The presence of the section &urban_surface_par enables USM in PALM. The available configuration parameters are:

Parameter Name	FORTRAN Type	Default Value	Explanation
split_diffusion_radiation	L	.T.	perform splitting of total sun/sky radiation to the direct/diffusion part
usm_energy_balance_land	L	.T.	calculate energy balance for horizontal surfaces (diagnostic only)
usm_energy_balance_wall	L	.T.	calculate energy balance for vertical surfaces (diagnostic only)
usm_material_model	L	.T.	calculate diffusion of heat in ground, walls and roofs
usm_anthropogenic_heat	L	.F.	calculate anthropogenic heat in USM model
mrt_factors	L	.F.	compute factor for postprocessing calculation of MRT (mean radiant temperature)
nrefsteps	I	0	number of reflections in radiation model
ra_horiz_coef	R	1.0	coefficient for tuning of r_a for horizontal surfaces
land_category	I	1	default category for land surface
pedestrant_category	I	2	default category for wall surface in pedestrian zone
wall_category	I	2	default category for wall surface over pedestrian zone
roof_category	I	2	default category for roof surface
write_svf_on_init	L	.T.	write calculated svf and csf to files
read_svf_on_init	L	.T.	read svf and csf from files instead of their calculation
usm_lad_rma	L	.T.	enables using one-sided MPI operations for distribution of LAD values between processes

3 Section &canopy_par

A new value is available for parameter canopy_mode in canopy_par section:

canopy_mode	read_from_file_3d	read the 3D structure of plant canopy from file PLANT_CANOPY_DATA_3D (see later)

B Input files

1 URBAN_SURFACE

This file contains column-separated surfaces and their properties. Each gridbox [i,j] describes properties of corresponding horizontal surface (ground or roof) and possible walls adjacent to right (east) and north edge of the gridbox. The wall is described in three zones – pedestrian, wall and roof. The height of each zone can be configured independently for each gridbox [i,j]. The vertical structure described in this file have to exactly correspond to structure given in the file TOPOGRAPHY_DATA. Structure of each record follows:

Basic parameters:

i, j	coordinates
height	height of horizontal surface, i.e. ground or roof (m)
nz	height of horizontal surface in grid points
isroof	horizontal surface is roof (1) or ground (0)
dirwe	index of west-east wall (=nz(i+1,j)-nz(i,j))
dirsn	index of south-north wall (=nz(i,j+1)-nz(i,j))

Horizontal surface parameters:

surfcat	number of category of surface
surfalbedo	albedo of surface (overrides albedo of the category)
roofthick	thickness of roof material

Wall parameters:

wenz1	height of the pedestrian zone of the wall
wecat1	category of the pedestrian zone of the wall
wealbedo1	albedo of the pedestrian zone of the wall
wethick1	thickness of the pedestrian zone of the wall
wenz2, wecat2, wealbedo2, wethick2	the same parameters for wall zone
wenz3, wecat3, wealbedo3, wethick3	the same parameters for roof zone
snnz1, sncat1, snalbedo1, snthick1, snnz2, sncat2, snalbedo2, snthick2, snnz3, sncat3, snalbedo3, snthick3	the same for south-north wall

2 SURFACE_PARAMETERS

This file describes categories of surfaces (ground, roofs and walls) and its properties (column-separated). Some parameters (emissivity, albedo and thickness) can be overwritten for particular surfaces in the file URBAN_SURFACE.

cat	number of category
albedo	albedo of the surface
emissivity	emissivity of the surface
lambda_s	heat conductivity between air and surface (W m^{-2} K^{-1})
roughness	roughness relative to concrete
csurf	surface skin layer heat capacity (J m^{-2} K^{-1})
thickness	thickness of the surface (wall, roof, land) (m)
rho_c	volumetric heat capacity rho·C of the material (J m^{-3} K)
lambda_h	thermal conductivity lambda_h of the wall (W m^{-1} K^{-1})
name	description of category (only for readability of the file)

3 PLANT_CANOPY_DATA_3D

The file is column-separated and describes a three-dimensional structure and properties of the resolved plant canopy (trees, shrubs) within the grid of the model. First line contains a single integer number prescribing the number N of vertical levels (from model bottom) which may contain plant canopy. Further lines contain values of four variables that describe the plant canopy. Each line specifies values of one variable for one column of the model grid (x=i, y=j, z=*) as follows:

varnum	number of input variable 1 = leaf area density (lad_s) 2 = canopy drag coefficient (cdc) 3 = leaf scalar exchange coefficient (lsec) 4 = leaf surface concentration (lsc)
i,j	horizontal coordinates of the grid column
v1, v2, . . . , vN	values of variable varnum for levels [nzb, nzb+1, . . .] where nzb is model bottom

Any non-specified values (i.e. coordinates that have no entry in the file and everything above level N) are treated as zero for all four variables.

4 ANTHROPOGENIC_HEAT

The file describes anthropogenic heat. Only the heat at surface is considered for now.

i, j	coordinates of gridbox
aheat	daily average of anthropogenic heat (W m^{-2})

5 ANTHROPOGENIC_HEAT_PROFILE

The file describes diurnal profiles of the anthropogenic heat.

ihour	hour of the day
aheatcoef	coefficient of diurnal profile of anthropogenic heat (ah_hour = aheat · aheatcoef)