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MOSAIK

PALM-4U Crashcourse

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Definition of simulation setups

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LMUK

palm

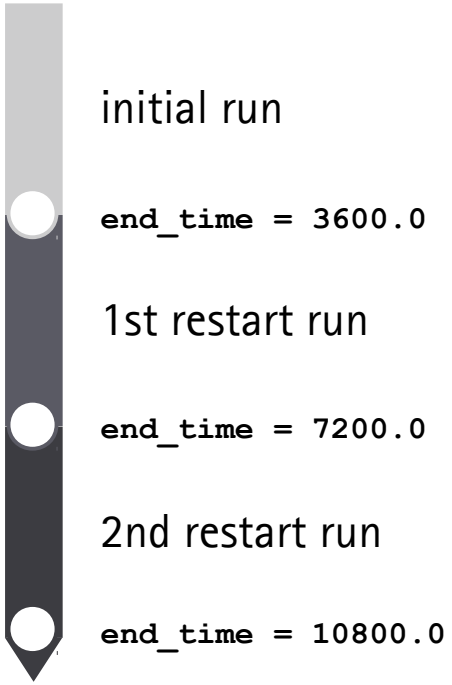
Content

- Overview of input files
- PALM Input Data Standard (PIDS)
  - static driver (e.g. building-height data)
  - dynamic driver (e.g. large-scale forcing)
- Input data requirements
- Description of input files using the example of Berlin test simulation

Overview of input files (I-a)

- Input parameter files (FORTRAN namelists) for
  - initial run (<jobname>_p3d)
  - restart run (<jobname>_p3dr)

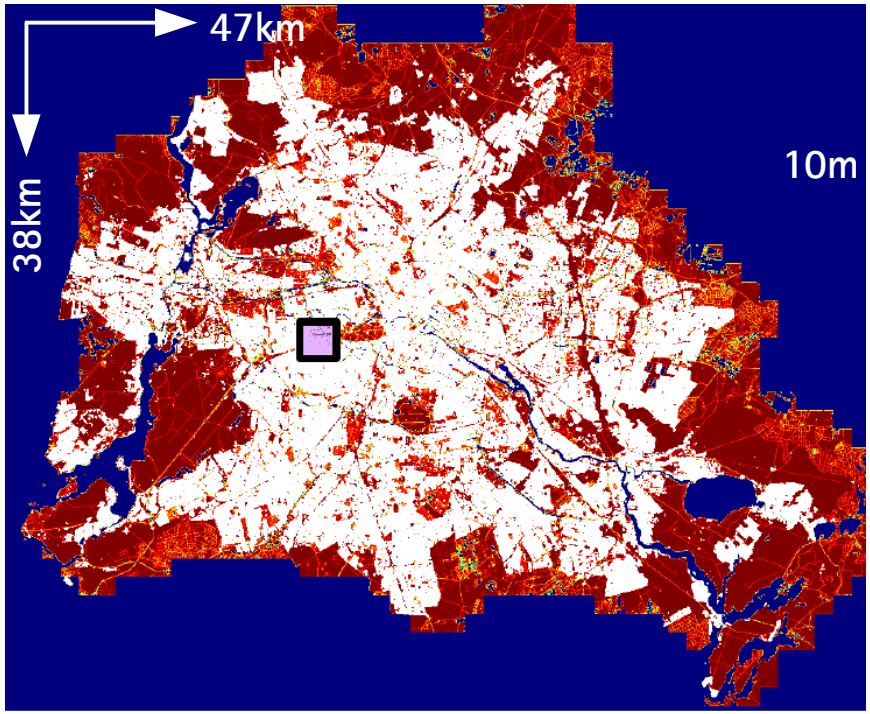
```
&inipar nx = 191, ny = 191, nz = 192,
        dx = 1.0, dy = 1.0, dz = 1.0,

        dz_stretch_level = 2000.0,

        initializing_actions = 'inifor',
        ug_surface = 0.0,
        vg_surface = 1.0,

        humidity = .T.,

        topography = 'read_from_file',
        .... /

&d3par  end_time = 3600.0,
        .... /
```



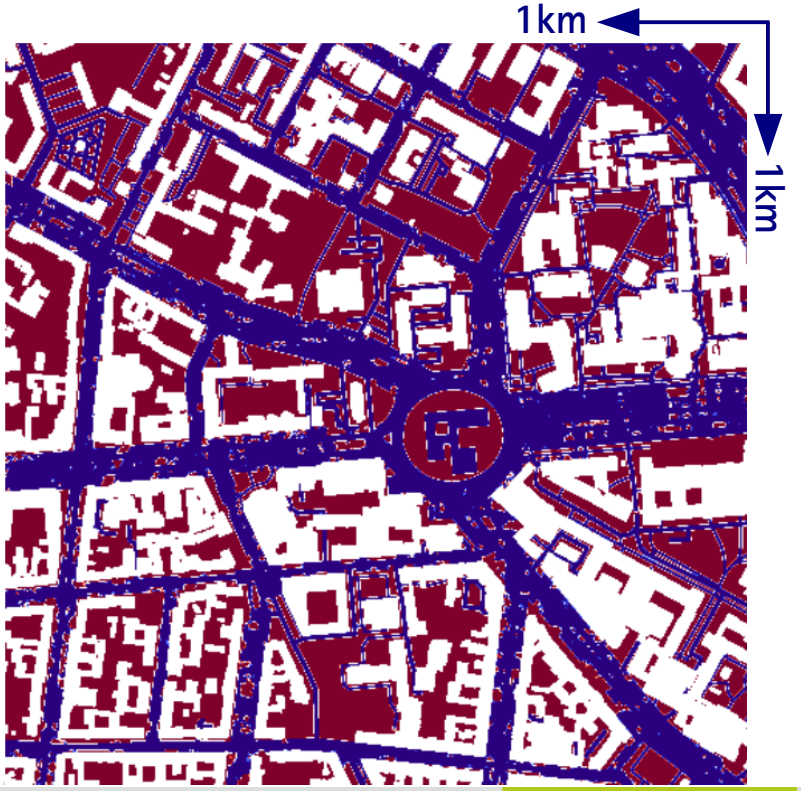
Overview of input files (I-b)

- Input parameter files (FORTRAN namelists) for
  - initial run (<jobname>_p3d, <jobname>_p3d_NO2...NO3...etc.)
  - restart run (<jobname>_p3dr, <jobname>_p3dr_NO2...NO3...etc.)

parent domain | child domain(s)



Example Berlin with nested Ernst-Reuther-Platz

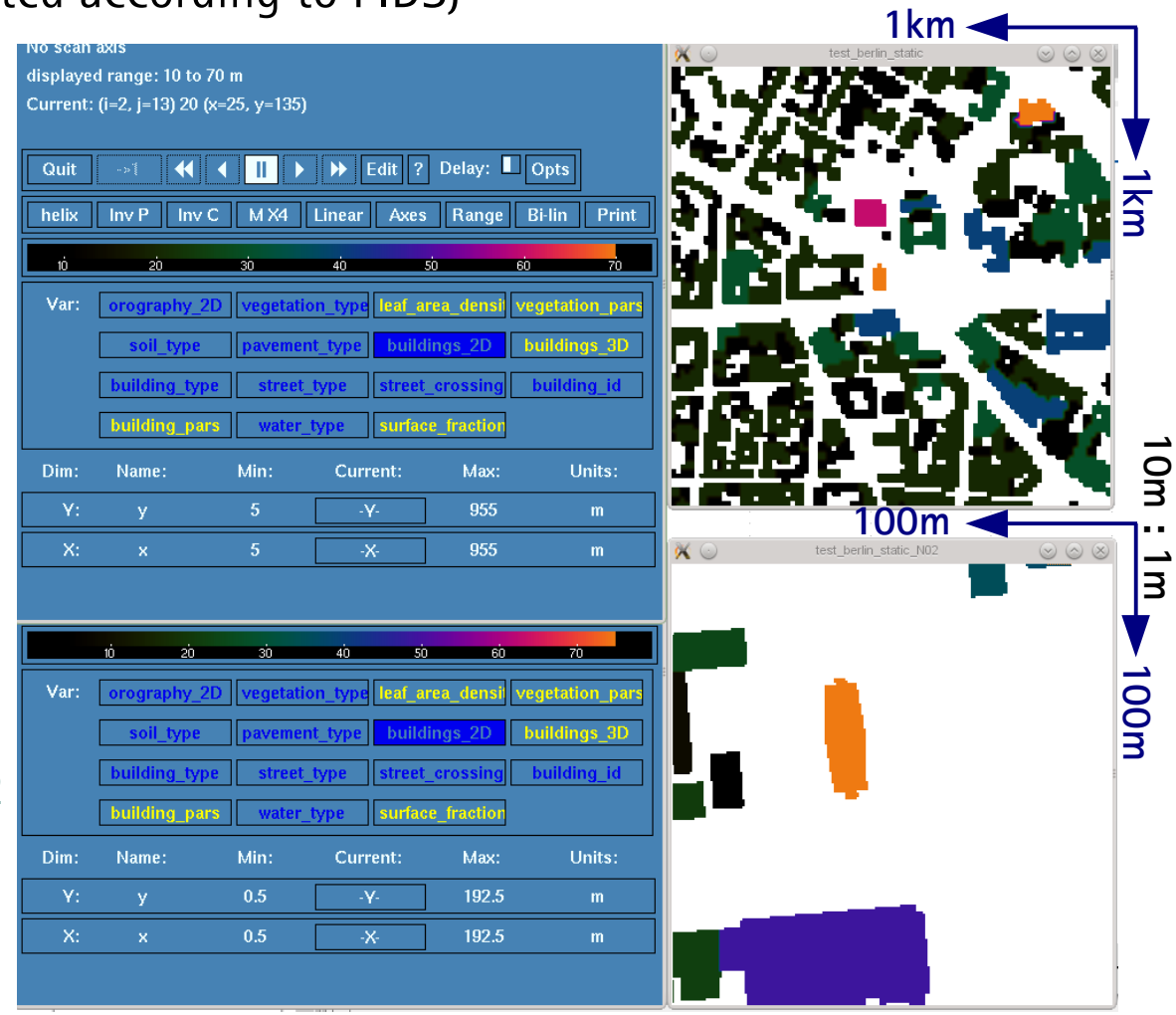


Overview of input files (II-a)

- Drivers (NetCDF files, created according to PIDS)
  - static
    (e.g. building height)

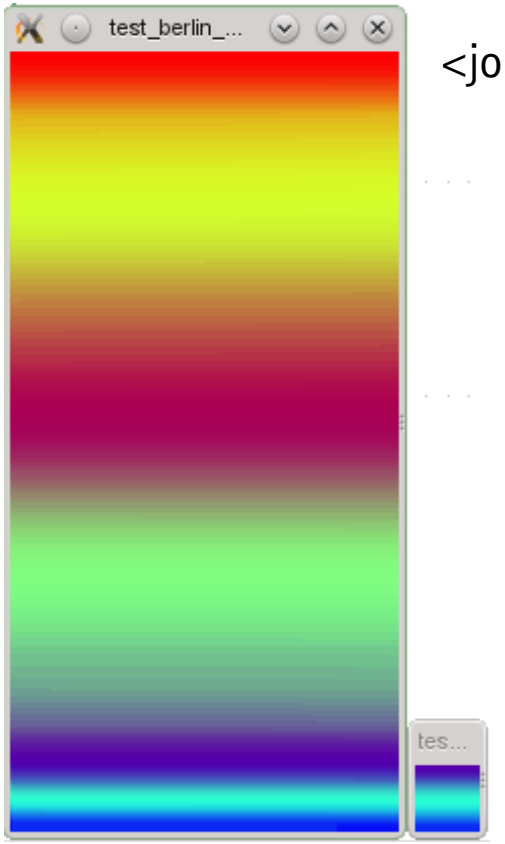
<jobname>_static

<jobname>_static_N02

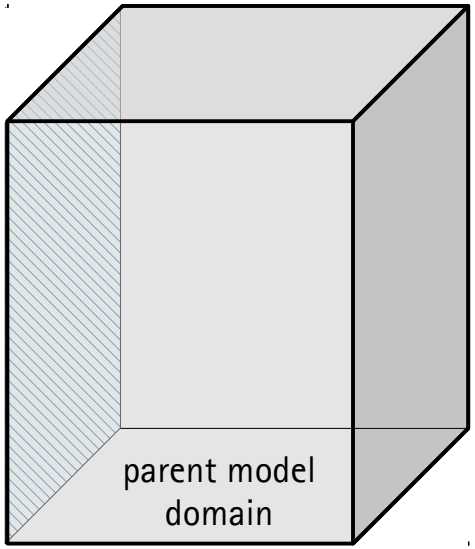


Overview of input files (II-b)

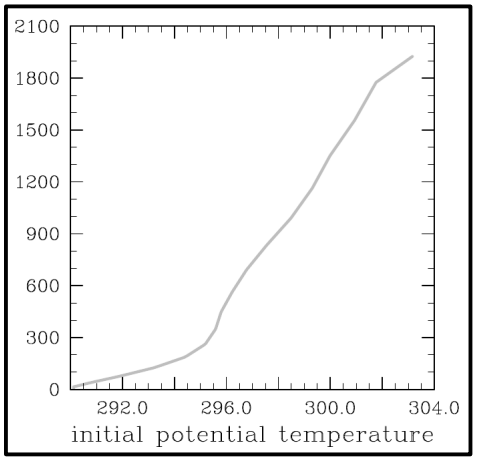
- Drivers (NetCDF files, created according to PIDS)
  - dynamic (processed by INIFOR based on COSMO-DE data)
    e.g. large-scale forcing of potential temperature, left boundary



<jobname>_dynamic



<jobname>_dynamic_N02



init_pt
init_qv
init_u
init_v
init_w
surface_forcing_surface_pressure

init_soil_m
init_soil_t
ls_forcing_left_pt
ls_forcing_left_qv
ls_forcing_left_u
ls_forcing_left_v
ls_forcing_left_w
ls_forcing_north_pt
ls_forcing_north_qv
ls_forcing_north_u
ls_forcing_north_v
ls_forcing_north_w
ls_forcing_right_pt
ls_forcing_right_qv
ls_forcing_right_u
ls_forcing_right_v
ls_forcing_right_w
ls_forcing_soil_evap
ls_forcing_soil_graupel
ls_forcing_soil_rain
ls_forcing_soil_snow
ls_forcing_soil_t_2m
ls_forcing_south_pt
ls_forcing_south_qv
ls_forcing_south_u
ls_forcing_south_v
ls_forcing_south_w
ls_forcing_top_pt
ls_forcing_top_qv
ls_forcing_top_u
ls_forcing_top_v
ls_forcing_top_w
rad_lw_bal_0
rad_sw_bal_0
rad_swd_dif_0
rad_swd_dir_0

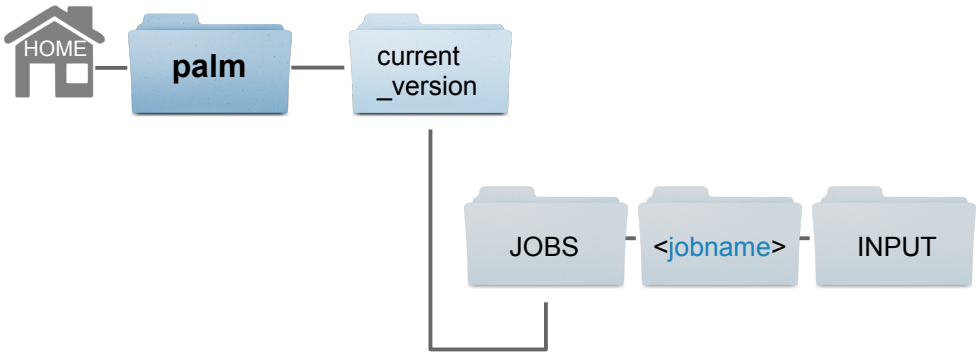
Overview of input files (III-a)

- Two possible radiation schemes:
  - clear-sky
    - calculates short-/longwave radiation fluxes at the surface
    - requires albedo, geographical longitude/latitude, day of year & time of day
  - rrtmg (rapid radiative transfer model, used in weather forecast models)
    - calculates radiative heating rates for each model column (considers clouds/humidity)
    - requires geographical longitude/latitude, day of year & time of day, and optionally different albedos for short-/longwave radiation
    - requires additional libraries & code to be compiled (http://palm.muk.uni-hannover.de/trac/wiki/doc/app/examples/rrtmg)

Overview of input files (III-b)

- Required input files for **rrtmg** scheme (NetCDF files)
  - <jobname>_rlw, <jobname>_rlw_N02
    (Longwave absorption coefficients and other data for RRTMG_LW k-distribution model)
  - <jobname>_rsw, <jobname>_rsw_N02
    (Shortwave absorption coefficients and other data for RRTMG_SW k-distribution model)

Overview of input files (IV)



<jobname>_

- p3d, p3d_N02
- p3dr, p3dr_N02
- static, static_N02
- dynamic, dynamic_N02
- rlw, rlw_N02
- rsw, rsw_N02

PALM Input Data Standard (I)

PALM **I**nput **D**ata **S**tandard (PIDS) v1.7
(applies to PALM-4U)

General remarks on PIDS

PIDS defines all possible input parameters for PALM which must be provided for a model run in NetCDF format (version 4 or higher). The number and choice of parameters depends on the setup. This file gives an overview over all possible quantities that can be contained in the input files.

There are three different types of input files: *static*, *dynamic*, *radiation*, and *chemistry*, which must ne named (e.g. for a job named my_test_setup):

- **my_test_setup_static~~_driver.nc~~** – contains all static information like orography, buildings, and surface classification.
- **my_test_setup_dynamic~~_driver.nc~~** – contains dynamic information for the run, such as time-dependent boundary conditions and the initial state of the atmosphere.
- **my_test_setup_radiation~~_driver.nc~~** – contains static and dynamic information of radiation properties (trace gas profiles, sky view factors).
- **my_test_setup_chemistry~~_driver.nc~~** – contains all information on chemical species and emissions.

PALM Input Data Standard (II)

The origin of the model is the front left corner of the model domain at (z=0,y=0,x=0).

Missing definitions:

- Virtual measurements
- Multi-agent-system parameters
- Radiation quantities (initial profiles for RRTMG, sky view factors, ...)

General remarks on surface classification

? Which data is available ?

The surface classification in PALM follows a three-step approach. First, a bulk land surface and soil classification is set. In a second step (when more detailed information is available), this classification is partly overwritten for each location (y,x). For buildings it is possible to prescribe explicit properties for single surface elements (step three). Surface types must be specified according to PIDS for each individual pixel with location (y,x). Missing values are not allowed for the bulk classification and mismatch of settings is checked by PALM internally.

PALM Input Data Standard (IV)

Global attributes:	Climate and Forecast
(char) Conventions	*„CF-1.7“* - NetCDF convention.
(char) data_content	Text (max. 12 chars, see tables A1,A2)
(char) source	Text
(char) location	e.g. *„Berlin“*, name of city or region
(char) site	*„PALM“*
(float) origin_x	e.g. *„549020.0“*, reference easting in m (UTM)
(float) origin_y	e.g. *„5802436.0“*, reference northing in m (UTM)
(float) origin_z	*e.g. „57.f“, reference height in m above sea level after DHHN2016.*
(float) origin_lat	*„52.37f“*, in degrees north. Defines the lower left corner (y,x) of the model domain
(float) origin_lon	*„9.72f“*, in degrees east. Defines the front left corner (y,x) of the model domain
(float) rotation_angle	*„0.0f“* - clockwise angle of rotation in degrees between North positive y axis and the y axis in the data
(char) references	Citations if required and useful
(char) comment	Miscellaneous information about the data or methods to produce it
(float) palm_version	e.g. *„5.0“* to allow compatibility checks

mandatory

PALM Input Data Standard (V)

Coordinate variables:

(float) time **description:** time since reference point in seconds.

attributes

(char) long_name	*„time“*
(char) standard_name	*„time“*
(char) units	*„seconds since 1970-01-01 00:00:00“*

(float) z **description:** height above ground (center)

attributes

(char) long_name	*„height“*
(char) standard_name	*„height“*
(char) units	*„m“*

(float) y **description:** y-position

attributes

(char) long_name	*„distance to origin in y-direction“*
(char) units	*„m“*

(float) x **description:** x-position

attributes

(char) long_name	*„distance to origin in x-direction“*
(char) units	*„m“*

PALM Input Data Standard (VI-a)

Topography variables:

- Topography can consist of the terrain height, artifical constructs (e.g. buildings), and vegetation on the terrain

[static] ***orography_X (y, x)***

description: terrain height in m above mean sea level.
type: NC_FLOAT
coordinates:

y	y-position (in m)
x	x-position (in m)

attributes:

(char) long_name	*„orography“*
(char) res_orig	Original resolution of the data in m
(char) source	Data source, e.g. *„satellite data“*
(char) units	= *„m“*
(float) _FillValue	= *-9999.9f*
(char) coordinates	= *„E_UTM N_UTM lon lat“*
(char) grid_mapping	= *„crsUTM: E_UTM N_UTM crsETRS: lon lat“*

PALM Input Data Standard (VI-b)

[static] ***buildings_X ([z], y, x)***

description: building topology or building height, depending on setting of attribute *lod*. z = 0 m refers to *origin_z*.

type: NC_FLOAT (for *lod* = *1*), NC_BYTE (for *lod* = *2*),

coordinates:

z	z-position (in m) (*lod* = 2 only)
y	y-position (in m)
x	x-position (in m)

attributes:

(integer) lod	Level of detail (1,2)
lod = 1	surface-mounted buildings (no holes), the variable provides building heights in m
lod = 2	3D-topology, the variable provide either 1b (building) or 0b (no building)
(char) long_name	*„buildings“*
(char) res_orig	Original resolution of the data in m
(char) source	Data source, e.g. *„satellite data“*
(float/byte) _FillValue	*= -9999.9f (lod = 2 only)* or *-127b (lod = 2 only);* missing values

PALM Input Data Standard (VII-a)

Surface classification data (level 1, unresolved)

[static] *vegetation_type (y, x)*

[static] *building_type (y, x)*

[static] *pavement_type (y, x)*

[static] *water_type (y, x)*

[static] *soil_type ([zsoil,] y, x)*

select one of these types for each pixel (y, x), plus soil_type

vegetation_type	description	default albedo_type
0	user-defined vegetation according to *vegetation_pars*	0
1	bare soil (no vegetation)	17
2	crops, mixed farming	2
3	short grass	5
4	evergreen needleleaf trees	6
5	deciduous needleleaf trees	8
6	evergreen broadleaf trees	9
7	deciduous broadleaf	8

building_type	description			albedo_type
	name	type	age	
0	user-defined type according to *building_pars*			
1	R1	residential	- 1950	33
2	R2	residential	1951 - 2000	33
3	R3	residential	2001 -	33
4	O1	office	- 1950	33
5	O2	office	1951 - 2000	33
6	O3	office	2001 -	33

PALM Input Data Standard (VII-b)

Surface classification data (level 2, unresolved)

[static] *vegetation_pars (nvegetation_pars, y, x)*

[static] *soil_pars (nsoil_pars, [zsoil,] y, x)*

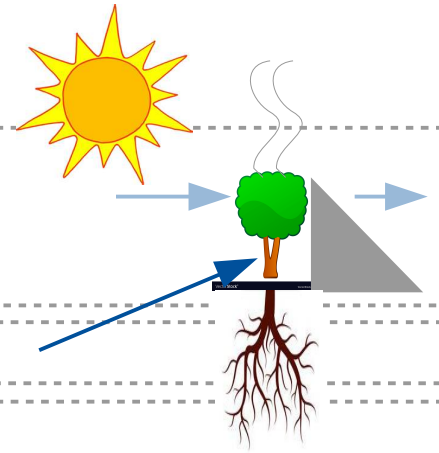
[static] *building_pars (nbuilding_pars, y, x)*

[static] *pavement_pars (npavement_pars, y, x)*

npavement_pars	description
0	roughness length for momentum (m)
1	roughness length for heat (m)
2	albedo type
3	emissivity (0-1)

nvegetation_pars	description
0	minimum canopy resistance (s/m)
1	leaf area index
2	vegetation coverage (0-1)
3	canopy resistance coefficient (1/h
4	roughness length for momentum (
5	roughness length for heat (m)
6	skin layer heat conductivity (stable conditions) (W/m²/K)
7	skin layer heat conductivity (unsta conditions) (W/m²/K)
8	fraction of incoming shortwave radiation transmitted directly to the soil
9	heat capacity of the surface / skin layer (J/m²/K)
10	albedo type
11	emissivity

PALM Input Data Standard (VII-c)



Surface classification (level 3, resolved vegetation)

[static] *leaf_area_density (zlad, y, x)*

[static] *basal_area_density (zlad, y, x)*

[static] *root_area_denstty_lad (zsoil, y, x)*

[static] *building_surface_pars (nbuilding_surface_pars,s)*

nbuilding_surface_pars	description
0	wall fraction (0-1)
1	window fraction (0-1)
2	green fraction on wall (0-1)
3	green fraction on roof (0-1)
4	leaf area index of green fraction
5	heat capacity of wall layer 1
6	heat capacity of wall layer 2
7	heat capacity of wall layer 3
8	thermal conducivity of wall layer 1
9	thermal conducivity of wall layer 2
10	thermal conducivity of wall layer 3
11	indoor target summer temperature

? ? ?

Required level of detail depends on the question, and level of detail depends on the data availability.

PALM Input Data Standard (VIII)

Initialization data

[dynamic] ***init_atmosphere_Y (z, [y], [x])***

description: Initialization of prognostic variables. Y can be:

Y	description
pt	air potential temperature (K)
qv	specific humidity (kg/kg)
u	wind component in x-direction (m/s)
v	wind component in y-direction (m/s)
w	wind component in z-direction (m/s)

[dynamic] ***ls_forcing_Y (time, z)***

description: Large-scale forcing data via profiles of tendencies (requires cyclic boundary conditions). Y can be as follows:

Y	description
ug	geostrophic wind (u-component) (m/s)
vg	geostrophic wind (v-component) (m/s)
sub_w	subsidence velocity of w (m/s)
sdv_lpt	advection of liquid water potential

Input data requirements

? ? ?

Required level of detail depends on the question, and level of detail depends on the data availability.

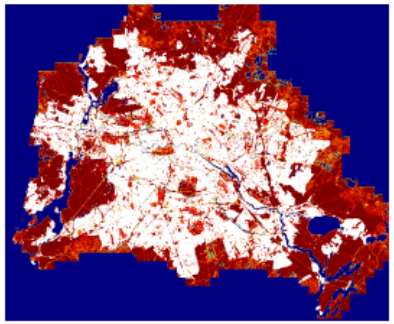
General remarks:

- see PIDS
- Input data required for parent and child domain in respective resolutions
- Quality of simulation results increases with quality of information about land/urban surface element's properties

What we have so far:

Available data for Berlin (10m and 1m, N-S):

- Building height
- Building id
- Building type
- Leaf area index (summer)
- Pavement type
- Street crossings
- Street type
- Terrain height
- Tree type, age, crown diameter, height, species, trunk diameter
- Vegetation on roofs
- Vegetation type
- Water type



Description of input files using the example of Berlin test simulation (I)

Overview of <jobname>_p3d parameter file

✔
```
&nestpar domain_layouts = 'parent',  1,  -1,    36,   0.0,   0.0, ... /
```
✔
```
&inipar nx = 95, ny = 95, nz = 192,     ... /
```
✔
```
&d3par  end_time = 129600.0,      ...  /
```
✗
```
&urban_surface_par
        usm_material_model = .T.,    ... /
```
✔
```
&lsm_par vegetation_type = 2, ... /
```
✔
```
&radiation_par
         radiation_scheme =  'clear-sky',  ... /
```
✔
```
&canopy_par
       canopy_mode = 'read_from_file_3d',  ... /
```
✗
```
&chemistry_par
       bc_cs_b                    = 'neumann',    ... /
```

Documentation of parameters: palm.muk.uni-hannover.de/trac/wiki/doc/app/par

Description of input files using the example of Berlin test simulation (II)

The namelists: nestpar (only for parent domain)

```
&nestpar domain_layouts = 'parent',  1,  -1,    36,   0.0,   0.0,
                          'child',   2,   1,    96,  384.0,  384.0,
                         nesting_mode = 'two-way',
                         nesting_datatransfer_mode  = 'mixed',
/
```

Description of input files using the example of Berlin test simulation (III)

The namelists: inipar (Initialization parameters)

```
&inipar nx = 95, ny = 95, nz = 192,
        dx = 10.0, dy = 10.0, dz = 10.0,

        initializing_actions = 'inifor',

        humidity = .T.,
        topography = 'read_from_file',

        day_of_year_init = 202,
        time_utc_init    = 43200.0,

        spinup_time          = 172800.0,
        spinup_pt_mean       = 280.0,
        spinup_pt_amplitude = 15.0,
        dt_spinup            = 120.0,
/
```

Description of input files using the example of Berlin test simulation (IV)

The namelists: d3par (Runtime / data output parameters)

```
&d3par  end_time = 129600.0,
        npex = 6, npey = 6,

        restart_time = 600.0,
        termination_time_needed = 600.0, !3600.0,

        create_disturbances       = .T.,

        skip_time_data_output     =   0.0,
        dt_data_output            =   600.0,
        dt_data_output_av         =   3600.0,
        averaging_interval        =   3600.0,

        section_xy                = 0, 1, 2, 3, 5, 10,

        data_output_pr = '#u', 'w"u"', 'w*u*', 'wu', 'u*2',
                         ...,

        data_output = 'u', 'v', 'w',
/
```

Description of input files using the example of Berlin test simulation (V)

The namelists: urban_surface_par (parameters for urban surface model)

```
&urban_surface_par
        usm_material_model = .T.,    !switch to predict wall temperature

        ...
/
```

Description of input files using the example of Berlin test simulation (VI)

The namelists: lsm_par (parameters for land surface model)

```
&lsm_par
          constant_roughness = .T.,    !relevant for water bodies
/
```

Description of input files using the example of Berlin test simulation (VII)

The namelists: radiation_par (parameters for radiation model)

```
&radiation_par
         radiation_scheme =  'clear-sky',
         albedo_type = 5,

         dt_radiation = 60.0,

         read_svf_on_init = .F.,       !reading of sky view factors
         write_svf_on_init = .T.,      !writing of sky view factors

         nrefsteps = 2,                !number of reflections between
                                       !surfaces
/
```

Description of input files using the example of Berlin test simulation (VIII)

The namelists: canopy_par (parameters for plant canopy model)

```
&canopy_par
       canopy_mode = 'read_from_file_3d',
       canopy_drag_coeff = 0.3,              !drag_coefficient
                                             !default 0.0
/
```

Description of input files using the example of Berlin test simulation (IX)

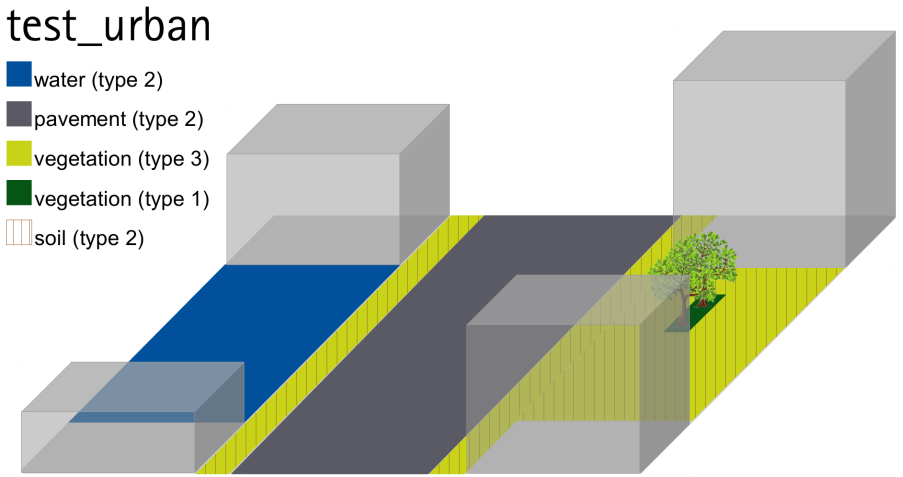
The namelists: chemistry_par (parameters for chemistry model)

```
&chemistry_par
          chem_gasphase_on              = .F.,
          surface_csflux_name           = 'PM10','PM25',   !species
          surface_csflux                = 7.5, 3.75,       !surface flux
          cs_surface                    = 2.0, 1.0,        !initial
                                                           !concentration
/
```

Thank you for your attention

Some final remarks:

- PALM-4U is still under development, so PIDS and INPUT files likely have not reached their final stage yet.
- PIDS and example setups currently available for MOSAIK members in internal section of MOSAIK website. Please contact kanani@muk.uni-hannover.de to get access.



- In case of detailed questions about PIDS, please contact maronga@muk.uni-hannover.de