Program Control by Physical Parameters

PALM group

Institute of Meteorology and Climatology, Leibniz Universität Hannover

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Steering of PALM and Interpreting the Output

- This section section describes how to steer the model and how to interpret the model output (**it does not explain, how to start and control model runs**).

Steering of PALM and Interpreting the Output

- This section section describes how to steer the model and how to interpret the model output (**it does not explain, how to start and control model runs**).
- It gives a general overview of the input and output files and explaines the contents of the most important files in some detail.

PALM Input/Output Overview (I)

PALM

program

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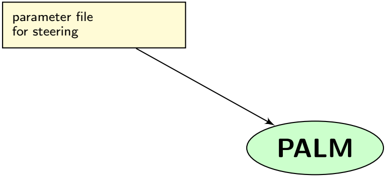

steering data

program

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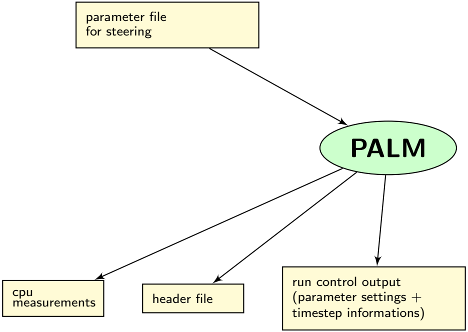

steering data

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run informations

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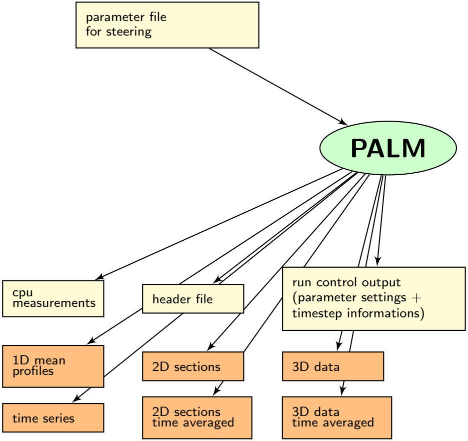

steering data

program

run informations

analysis data

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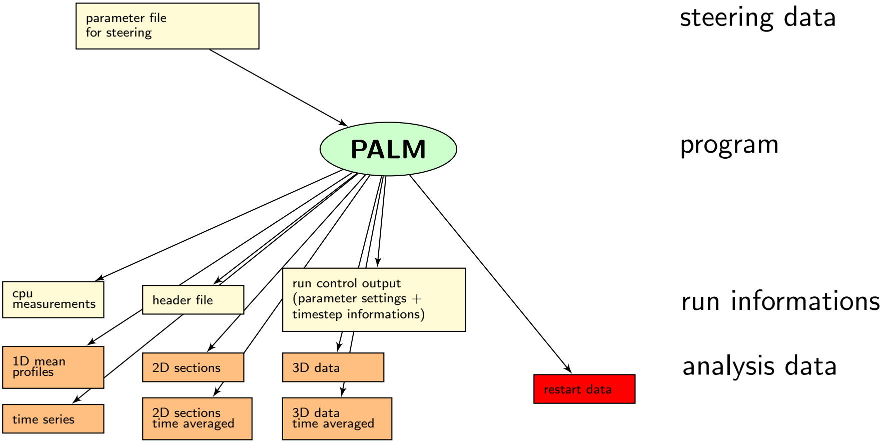

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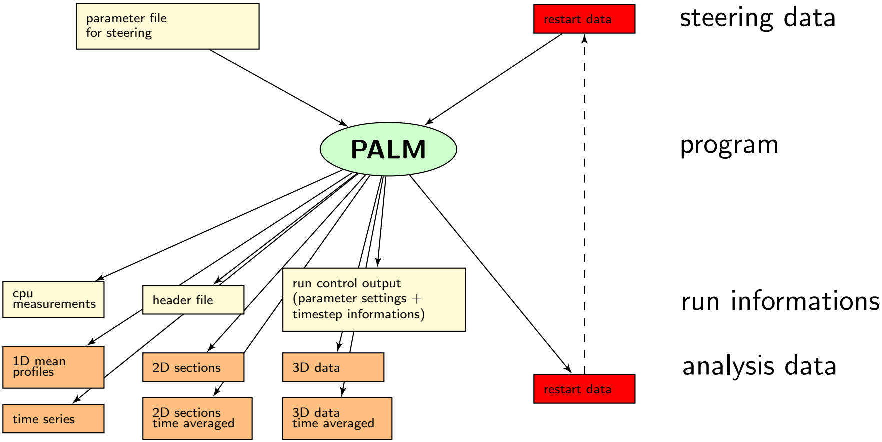

parameter file for steering

restart data

steering data

PALM

program

cpu measurements

header file

run control output (parameter settings + timestep informations)

run informations

1D mean profiles

2D sections

3D data

restart data

analysis data

time series

2D sections time averaged

3D data time averaged

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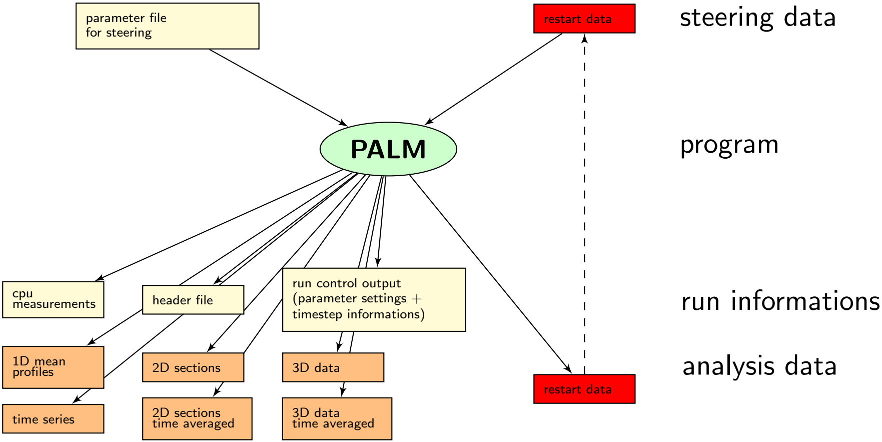

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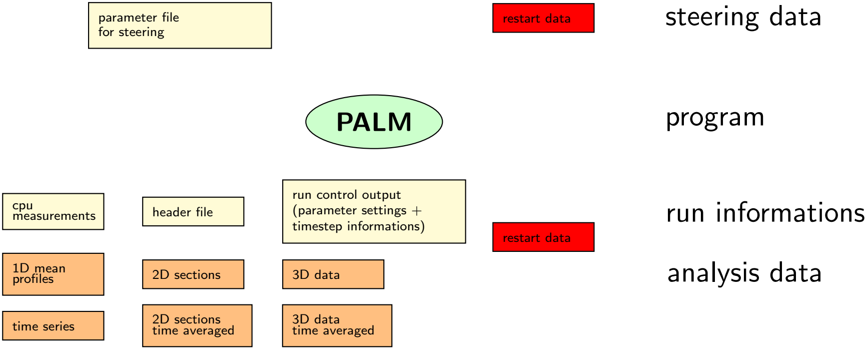
🟨 ASCII 🟧 netCDF 🟥 binary

PALM Input/Output Overview (II)



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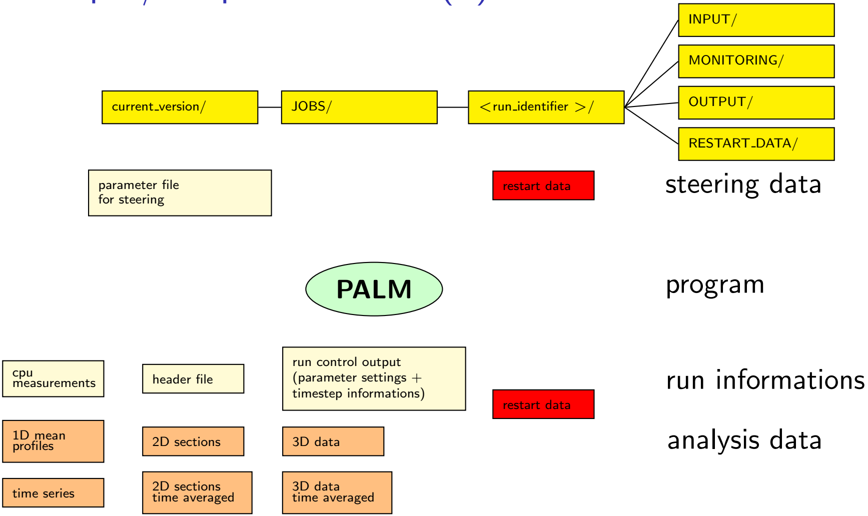

current_version/

JOBS/

< run_identifier >/

INPUT/

MONITORING/

OUTPUT/

RESTART_DATA/

parameter file for steering

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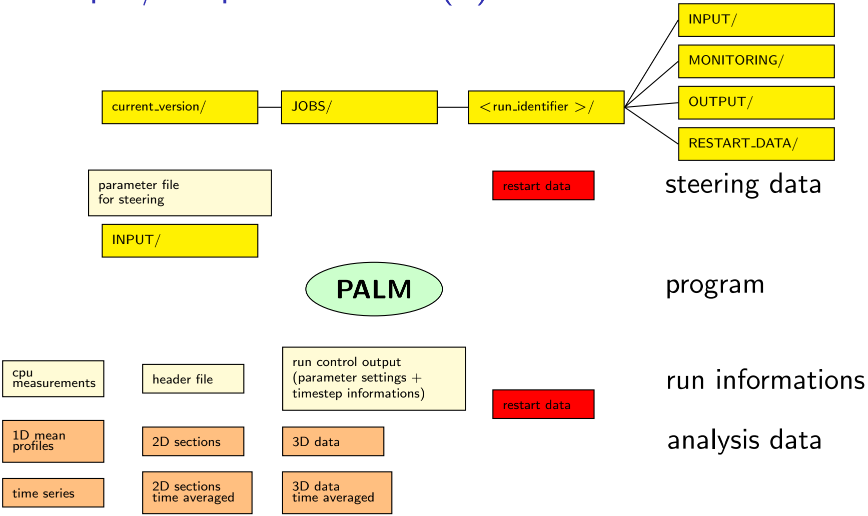

INPUT/

MONITORING/

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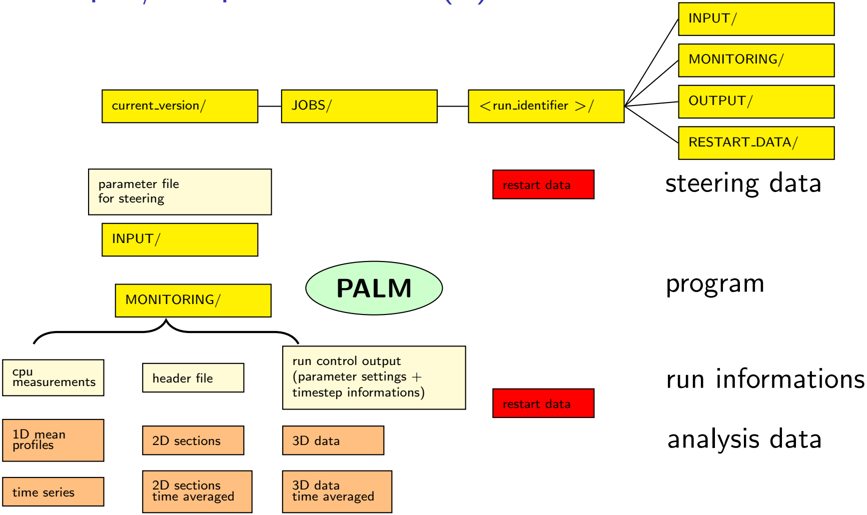

□ ASCII ▨ netCDF 🟥 binary

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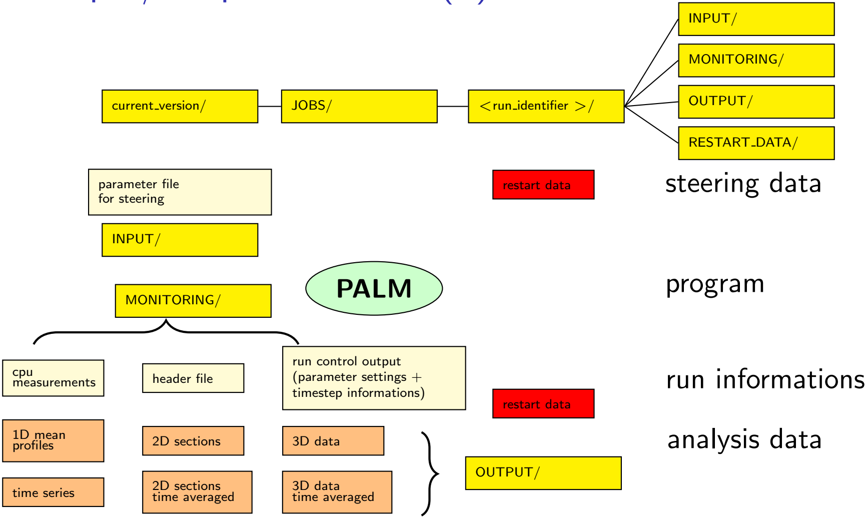

current_version/

JOBS/

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INPUT/

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parameter file for steering

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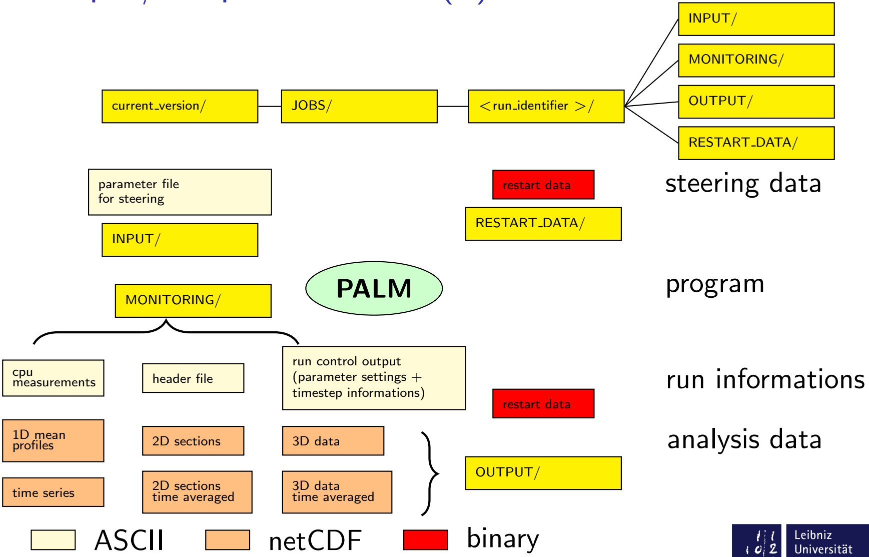

current_version/

JOBS/

<run_identifier >/

INPUT/
MONITORING/
OUTPUT/
RESTART_DATA/

steering data

parameter file for steering

INPUT/

restart data

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PALM

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OUTPUT/

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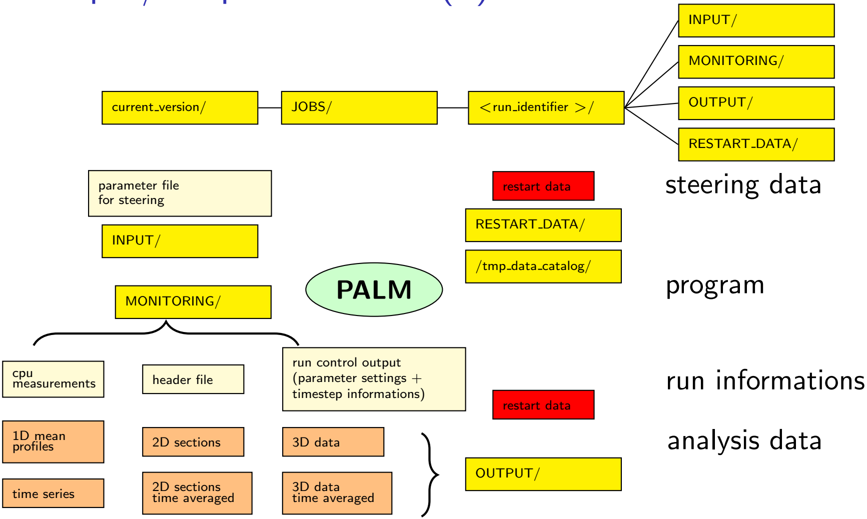

INPUT/

MONITORING/

OUTPUT/

RESTART_DATA/

current_version/

JOBS/

<run_identifier >/

parameter file for steering

INPUT/

restart data

RESTART_DATA/

/tmp_data_catalog/

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OUTPUT/

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The Parameter File

- Physical and numerical features of a PALM run (e.g. initial and boundary conditions, numerical methods) are controlled by a so called **parameter file** which uses FORTRAN-NAMELIST syntax.

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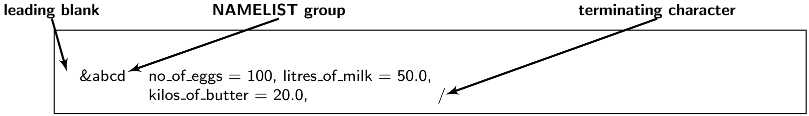

leading blank **NAMELIST group** **terminating character**

```
 &abcd  no_of_eggs = 100, litres_of_milk = 50.0,
        kilos_of_butter = 20.0,                   /
```

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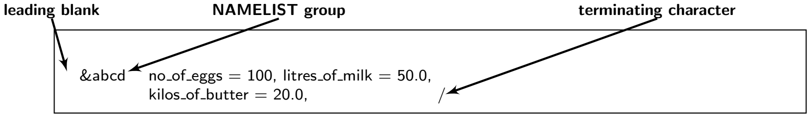

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 &abcd  no_of_eggs = 100, litres_of_milk = 50.0,
        kilos_of_butter = 20.0,                    /
```

- This file can be read from a FORTRAN program in the following way:

```
INTEGER :: no_of_eggs = 30
REAL ::    litres_of_milk = 0.0, kilos_of_butter, kilos_of_cream = 33.0

NAMELIST /abcd/   no_of_eggs, litres_of_milk, kilos_of_butter, kilos_of_cream

OPEN ( 1, FILE='Filename' )

READ ( 1, abcd )
```

An Example of PALM - NAMELIST Input

```
&inipar nx = 39, ny = 39, nz = 40,
        dx = 50.0, dy = 50.0, dz = 50.0,

        initializing_actions = 'set_constant_profiles',
        ug_surface = 0.0, vg_surface = 0.0,

        pt_vertical_gradient       = 0.0, 1.0,
        pt_vertical_gradient_level = 0.0, 800.0,

        surface_heatflux = 0.1, bc_pt_b ='neumann', /


&d3par end_time = 3600.0,

        dt_dopr = 900.0, averaging_interval_pr = 600.0,
        data_output_pr = 'pt', 'u', 'v', /
```

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- There are two NAMELIST groups (&inipar and &d3par).

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- There are two NAMELIST groups (`&inipar` and `&d3par`).
- Assignments to parameters in `&inipar` are ignored within restart runs (exception: `initializing_actions = 'read_restart_data'` is obligatory for restart runs).

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        dx = 50.0, dy = 50.0, dz = 50.0,

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        ug_surface = 0.0, vg_surface = 0.0,

        pt_vertical_gradient       = 0.0, 1.0,
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        surface_heatflux = 0.1, bc_pt_b ='neumann', /

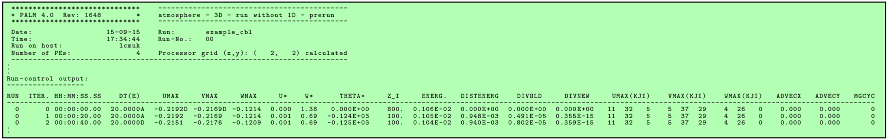

&d3par end_time = 3600.0,

        dt_dopr = 900.0, averaging_interval_pr = 600.0,
        data_output_pr = 'pt', 'u', 'v', /
```

- There are two NAMELIST groups (`&inipar` and `&d3par`).
- Assignments to parameters in `&inipar` are ignored within restart runs (exception: `initializing_actions = 'read_restart_data'` is obligatory for restart runs).
- Values of `&d3par` parameters can be changed for restart runs.

The Run Control File

- For initial runs, the parameter settings and many additional informations about the run (header informations) are printed at the beginning of this file.



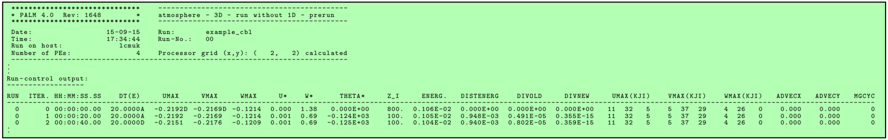
```
 ******************************    -------------------------------------------
 * PALM 4.0  Rev: 1648        *    atmosphere - 3D - run without 1D - prerun
 ******************************    -------------------------------------------

 Date:                 15-09-15    Run:       example_cbl
 Time:                 17:34:44    Run-No.:   00
 Run on host:             lcmuk
 Number of PEs:               4    Processor grid (x,y): (   2,   2) calculated
 ------------------------------------------------------------------------------
.
.
.
Run-control output:
------------------

RUN  ITER. HH:MM:SS.SS    DT(E)    UMAX     VMAX     WMAX     U*    W*      THETA*     Z_I     ENERG.   DISTENERG    DIVOLD     DIVNEW    UMAX(KJI)    VMAX(KJI)    WMAX(KJI)   ADVECX   ADVECY   MGCYC
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
  0      0 00:00:00.00  20.0000A  -0.2192D -0.2169D -0.1214  0.000  1.38   0.000E+00    800.  0.106E-02  0.000E+00  0.000E+00  0.000E+00   11  32   5    5  37  29    4  26   0    0.000    0.000        0
  0      1 00:00:20.00  20.0000A  -0.2192  -0.2169  -0.1214  0.001  0.69  -0.124E+03    100.  0.105E-02  0.948E-03  0.491E-05  0.355E-15   11  32   5    5  37  29    4  26   0    0.000    0.000        0
  0      2 00:00:40.00  20.0000D  -0.2151  -0.2176  -0.1209  0.001  0.69  -0.125E+03    100.  0.104E-02  0.940E-03  0.802E-05  0.359E-15   11  32   5    5  37  29    4  26   0    0.000    0.000        0
.
.
```

The Run Control File

- For initial runs, the parameter settings and many additional informations about the run (header informations) are printed at the beginning of this file.
- The parameter settings are followed by values of specific model variables for certain timesteps (one line for each timestep, the output intervall can be controlled by run parameter `dt_run_control`).



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 -------------------------------------------------------------------------------
:
:
:
Run-control output:
------------------

RUN  ITER. HH:MM:SS.SS    DT(E)     UMAX     VMAX     WMAX     U*    W*      THETA*     Z_I     ENERG.   DISTENERG    DIVOLD      DIVNEW     UMAX(KJI)    VMAX(KJI)    WMAX(KJI)   ADVECX   ADVECY   MGCYC
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
  0      0 00:00:00.00  20.0000A  -0.2192D -0.2169D -0.1214  0.000  1.38   0.000E+00   800.  0.106E-02  0.000E+00  0.000E+00  0.000E+00   11  32   5    5  37  29    4  26   0    0.000    0.000        0
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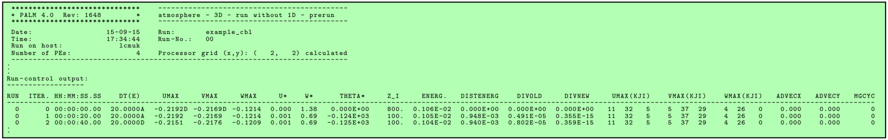
Contents of this timestep output should be carefully checked after each run, because it allows a first control, if the model had run correctly, or if any errors have occurred!



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:
```

The Header File

- The header file contains nearly the same informations as the header of the run control file of the initial run.

```
.
.
.
 Run time and time step information:
 ----------------------------------

 Timestep:             variable     maximum value: 20.000 s    CFL-factor: 0.90
 Start time:              0.000 s
 End time:             3600.000 s

 Time reached:         3601.930 s
 CPU-time used:           4.391 s     per timestep:                     0.017 s
                                      per second of simulated time:     0.001 s


 Computational grid and domain size:
 ----------------------------------

 Grid length:      dx =      50.000 m    dy =      50.000 m    dz =      50.000 m
.
.
.
```

The Header File

- The header file contains nearly the same informations as the header of the run control file of the initial run.
- It is generated for **every** run (initial run as well as restart runs).

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.
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.
.
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.
.
.
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- It is generated for **every** run (initial run as well as restart runs).
- It is created at the beginning **and** at the end of a run (overwrites the file created at beginning).
- Only at the end, cpu time information is included!

```
.
.
.
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 ----------------------------------

 Timestep:             variable     maximum value: 20.000 s    CFL-factor: 0.90
 Start time:              0.000 s
 End time:             3600.000 s

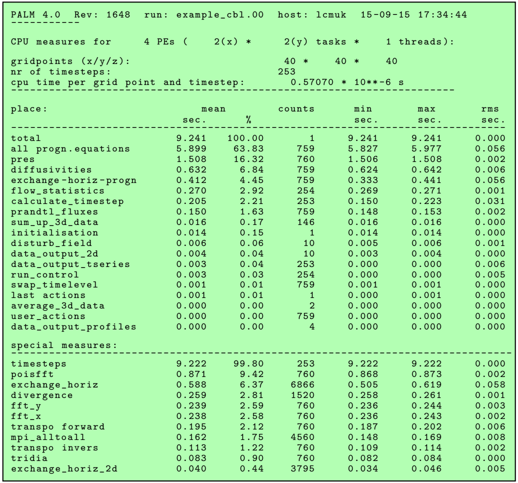
 Time reached:         3601.930 s
 CPU-time used:           4.391 s     per timestep:                     0.017 s
                                      per second of simulated time:     0.001 s


 Computational grid and domain size:
 ----------------------------------

 Grid length:      dx =      50.000 m    dy =      50.000 m    dz =      50.000 m
.
.
.
```

CPU Measurements File

- Contains informations about the CPU requirements of single parts of the program.



```
PALM 4.0  Rev: 1648  run: example_cbl.00  host: lcmuk  15-09-15 17:34:44
-----------

CPU measures for     4 PEs (    2(x) *     2(y) tasks *     1 threads):

gridpoints (x/y/z):                        40 *    40 *    40
nr of timesteps:                          253
cpu time per grid point and timestep:       0.57070 * 10**-6 s
----------------------------------------------------------------------

place:                        mean        counts      min       max       rms
                           sec.      %                sec.      sec.      sec.
------------------------------------------------------------------------------
total                    9.241   100.00       1     9.241     9.241     0.000
all progn.equations      5.899    63.83     759     5.827     5.977     0.056
pres                     1.508    16.32     760     1.506     1.508     0.002
diffusivities            0.632     6.84     759     0.624     0.642     0.006
exchange-horiz-progn     0.412     4.45     759     0.333     0.441     0.056
flow_statistics          0.270     2.92     254     0.269     0.271     0.001
calculate_timestep       0.205     2.21     253     0.150     0.223     0.031
prandtl_fluxes           0.150     1.63     759     0.148     0.153     0.002
sum_up_3d_data           0.016     0.17     146     0.016     0.016     0.000
initialisation           0.014     0.15       1     0.014     0.014     0.000
disturb_field            0.006     0.06      10     0.005     0.006     0.001
data_output_2d           0.004     0.04      10     0.003     0.004     0.000
data_output_tseries      0.003     0.04     253     0.000     0.000     0.006
run_control              0.003     0.03     254     0.000     0.000     0.005
swap_timelevel           0.001     0.01     759     0.001     0.001     0.000
last actions             0.001     0.01       1     0.000     0.001     0.000
average_3d_data          0.000     0.00       2     0.000     0.000     0.000
user_actions             0.000     0.00     759     0.000     0.000     0.000
data_output_profiles     0.000     0.00       4     0.000     0.000     0.000

special measures:
-------------------------------------------------------------------------------
timesteps                9.222    99.80     253     9.222     9.222     0.000
poisfft                  0.871     9.42     760     0.868     0.873     0.002
exchange_horiz           0.588     6.37    6866     0.505     0.619     0.058
divergence               0.259     2.81    1520     0.258     0.261     0.001
fft_y                    0.239     2.59     760     0.236     0.244     0.003
fft_x                    0.238     2.58     760     0.236     0.243     0.002
transpo forward          0.195     2.12     760     0.187     0.202     0.006
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transpo invers           0.113     1.22     760     0.109     0.114     0.002
tridia                   0.083     0.90     760     0.082     0.084     0.000
exchange_horiz_2d        0.040     0.44    3795     0.034     0.046     0.005
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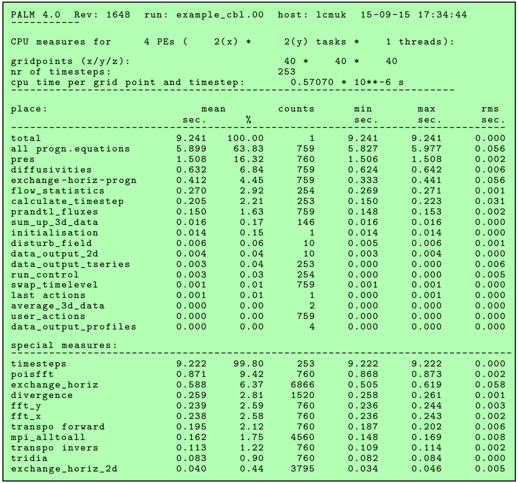

```
PALM 4.0  Rev: 1648  run: example_cbl.00  host: lcmuk  15-09-15 17:34:44
-----------

CPU measures for     4 PEs (    2(x) *     2(y) tasks *    1 threads):

gridpoints (x/y/z):                        40 *    40 *    40
nr of timesteps:                          253
cpu time per grid point and timestep:       0.57070 * 10**-6 s
----------------------------------------------------------------------

place:                        mean        counts      min        max       rms
                           sec.      %                sec.      sec.      sec.
------------------------------------------------------------------------------

total                     9.241   100.00       1     9.241     9.241     0.000
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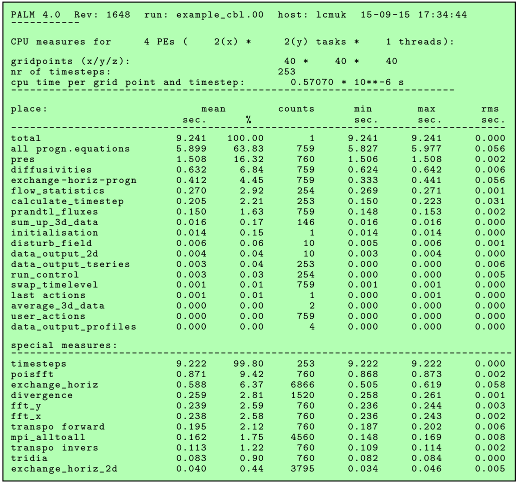

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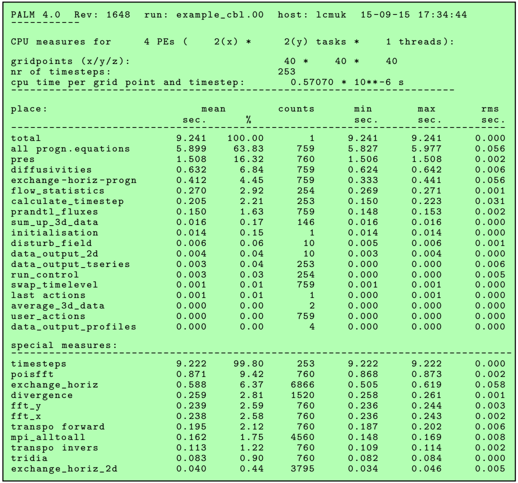

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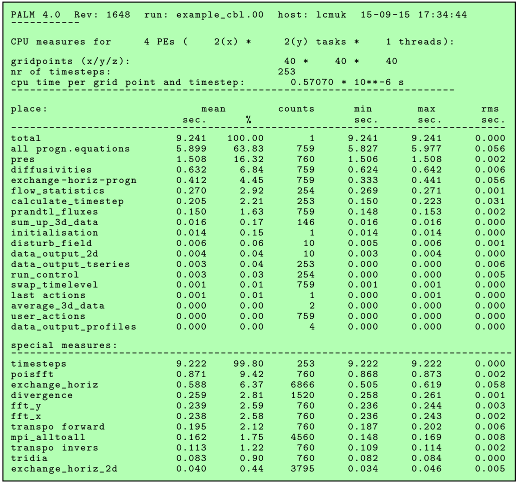
- Time needed for communication (sum of `exchange_horiz(_2d)` and `mpi_alltoall`) should not exceed about 10-15% of the total time.



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Other Files

- Data output files (1D profiles and timeseries, 2D cross sections, 3D volume data) are by default in **netCDF** format which is suitable to be processed by public domain graphics software like **ncview**, **ferret**, **ncl** (used by PALM group), **IDL**, etc.

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  For a first look, `ncview` is a convenient tool.
- `ncdump` can be used to display the netCDF file contents in ASCII format (`ncdump -c` displays only header informations).
- The simple viewer for netCDF-data - `ncview` - as well as ncl graphic software is available on the notebooks and on the IMUK-cluster.

Steering by Unix Environment Variables

Most features of PALM are controlled by the parameter file but a few are exclusively controlled by unix environment variables. The most important one is `write_binary`.

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Variable	**Meaning**	**Value set by `mrun`-option**
`host`	host identifier that mrun is using for the host on which the job is running	`-h`
`maximum_cpu_time_allowed`	cpu time allowed for the job	`-t`
`run_identifier`	identification string for the run	`-d`
`tasks_per_node`	number of MPI tasks to be started on each node	`-T`
`write_binary`	switch for writing binary data to be used for restart runs	`-r` (+setting in configuration file `.mrun.config`)

PALM / netCDF Documentation

- A detailed description of how to use PALM and a complete list of steering parameters and their meaning can be found on the PALM-server:

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- General information about the netCDF data format can be found under

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