PALM overview

Institute of Meteorology and Climatology, Leibniz Universität Hannover

- First version 1997, continuously developed since then.
- Written in FORTRAN 95 / 2003 / 2008.
- Very high performance and scalability on all state-of-the-art parallel architectures (see lecture “Code parallelization”).
- PALM code is under the GNU General Public License v3.
- PALM project is managed under gitlab (see https://gitlab.palm-model.org).
- Detailed online documentation under https://palm-model.org.
- Many new features have been added since then (see lecture “Current developments”).
- PALM 6.0 has been released Oct 2018, described in a special issue in *Geoscientific Model Development* (see https://doi.org/10.5194/gmd-13-1335-2020).
- Current version used in this webinar is PALM release 23.04 (see https://gitlab.palm-model.org/releases/palm_model_system/-/releases).
- Further extensions are planned for the next years.

Physics / Numerics

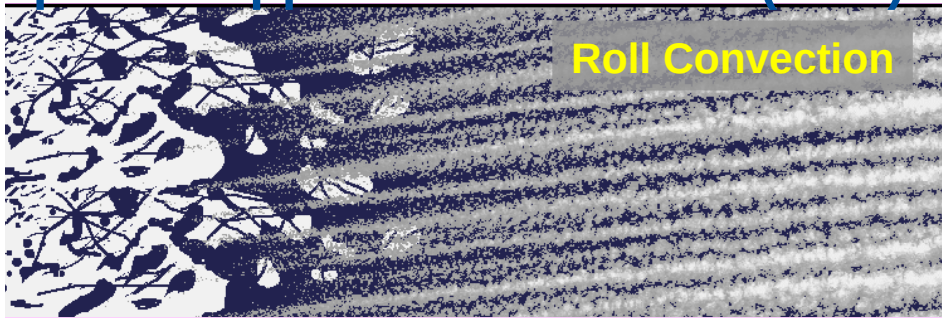
- Cyclic horizontal boundary conditions but also non-cyclic boundary conditions along x or y available.
- Turbulent inflow is realized for non-cyclic boundary conditions.
- Complex topography / 3d-buildings are realized.
- A Lagrangian particle model is embedded (can be used to replace bulk cloud physics two-moment scheme).
- Ocean mode is available, i.e. salinity equation and equation of state for seawater is included; coupled ocean-atmosphere simulations are possible.
- Coupling to larger scale models implemented using large scale advection and nudging.
- Various surface models are included.
- Soil and radiation model available.
- LES-LES-nesting and nesting to meso-scale models is implemented.
- Gas phase chemistry and aerosol model available.
- Wind turbine model for simulating energy output and wakes.
- RANS and DNS mode is included.
- Multi-agent system for simulating effects on population groups.

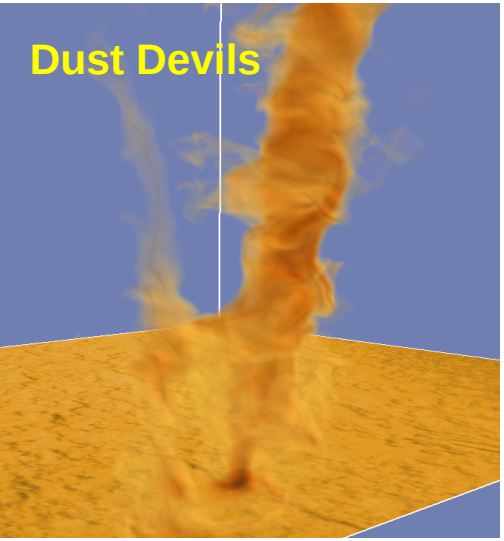
Technical features

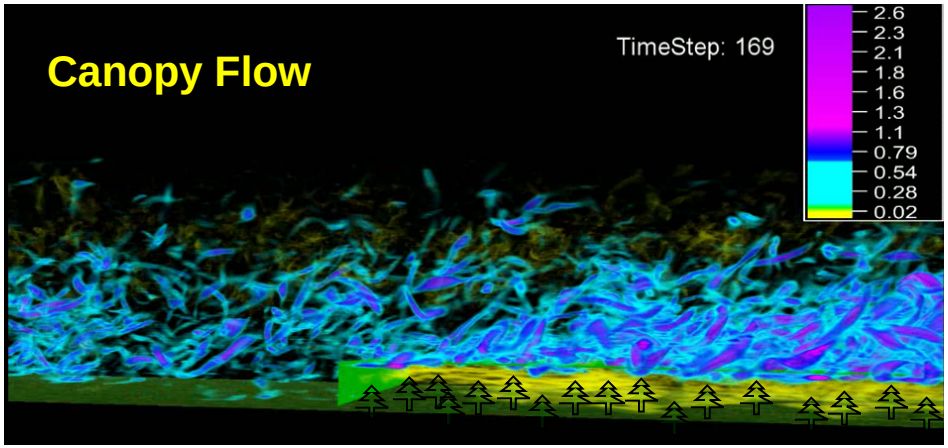
- Scripts allow for very comfortable operation of the model.
- Model can be adapted for any kind of (Unix) system including batch operation by simply adjusting a configuration file.
- Batch jobs and job chains (restart mechanism) can be automatically created.
- Runs are controlled via simple NAMELIST parameter file and in case of complex surfaces by driver files in NetCDF format.
- Error messages inform in case of parameter inconsistencies or other problems that are detected during runtime.
- Standard data analysis is done online during the simulation.
- All output is in standard NetCDF data format.
- A user-interface allows for easy code extensions by the user.
- Code is highly optimized for all state-of-the-art computer architectures and allows for very huge applications (currently 5000^3 gridpoints).

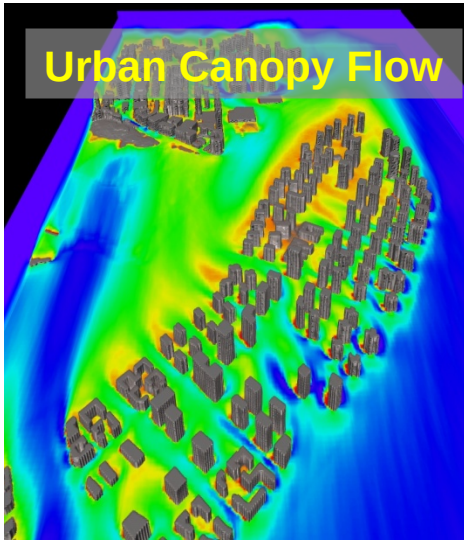
PALM overview

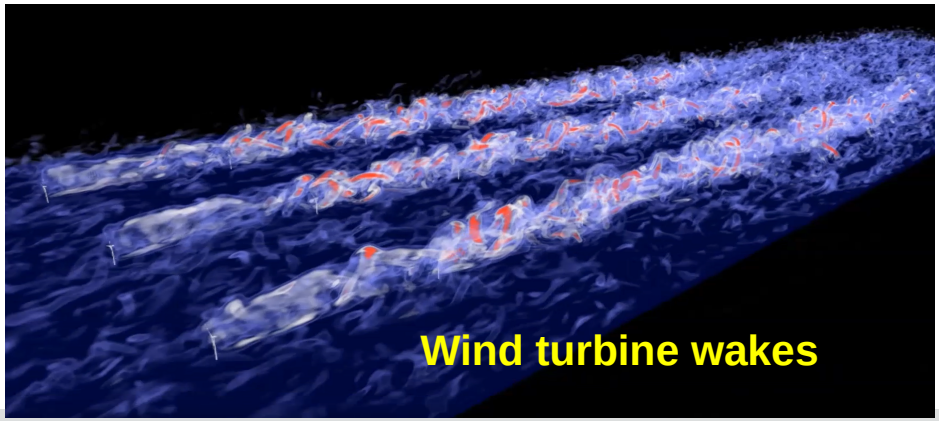
Some examples of applications at IMUK (LUH)

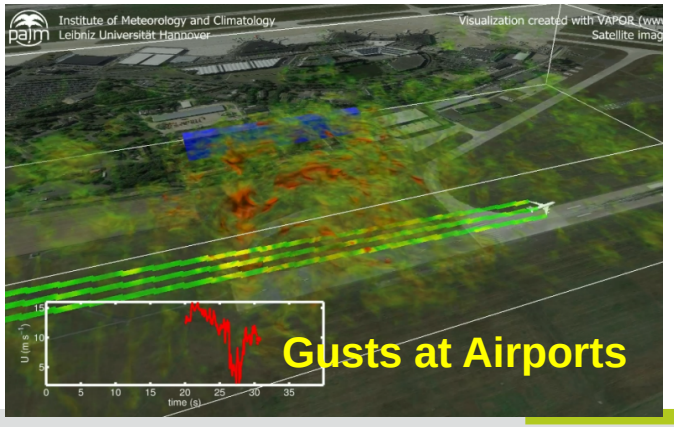












External users / collaborations

- **ForWind** (University of Oldenburg, Germany)
- **DWD** (German Weather Service)
- **KIT** (Karlsruhe Institute of Technology, Germany)
- **University of Bergen** (Bergen, Norway)
- **FMI** (Finnish Meteorological Institute, Helsinki, Finland)
- Department of Atmospheric Sciences, **Yonsei University** (Seoul, Korea)
- School of Earth and Environmental Science, **Seoul National University** (Seoul, Korea)
- Dept. of Intl. Development Eng., **Tokyo Institute of Technology** (Tokyo, Japan)
- Dept. of Earth and Environment, **Boston University** (USA)
- **INPE/CPTEC** Instituto Nacional de Pesquisas Espaciais (Brazil)
- **Chinese University of Hong Kong**, School of Architecture (Hong Kong)
- Institute of Physical Oceanography, **Zhejiang University** (China)
- …

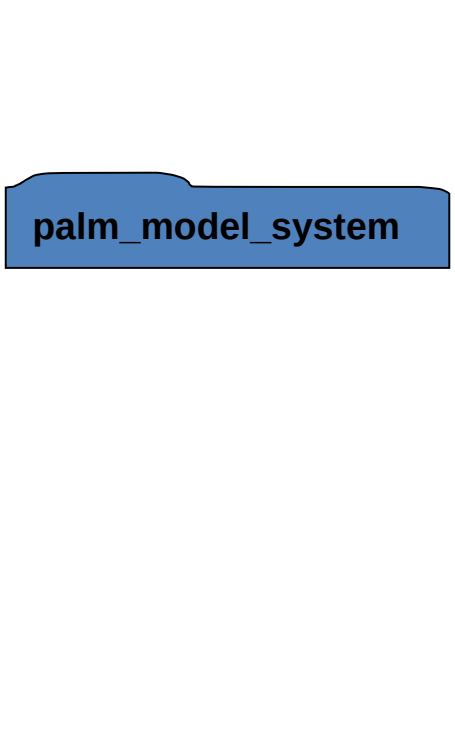
Currently more than 800 registered users on our trac-server.

Areas of application (external users)

- Interaction of boundary layer turbulence with wind turbines / wind farm wakes.
- Improvement of turbulence parameterizations.
- Atmosphere-ocean coupling.
- Ocean mixed layer.
- Turbulence / dispersion in the urban canopy layer.
- …

PALM components

- Beside the model's FORTRAN code, the PALM download contains a variety of further components / files, organized in folders. The subfolders you see below can be found in folder **`palm_model_system/packages/palm/model`**



readme-file containing information about PALM installation and changes included in the release

shell scripts for compiling, testing, and running PALM

PALM source code + Makefile

input files and various output files to check and verify the PALM installation (used by our testserver)

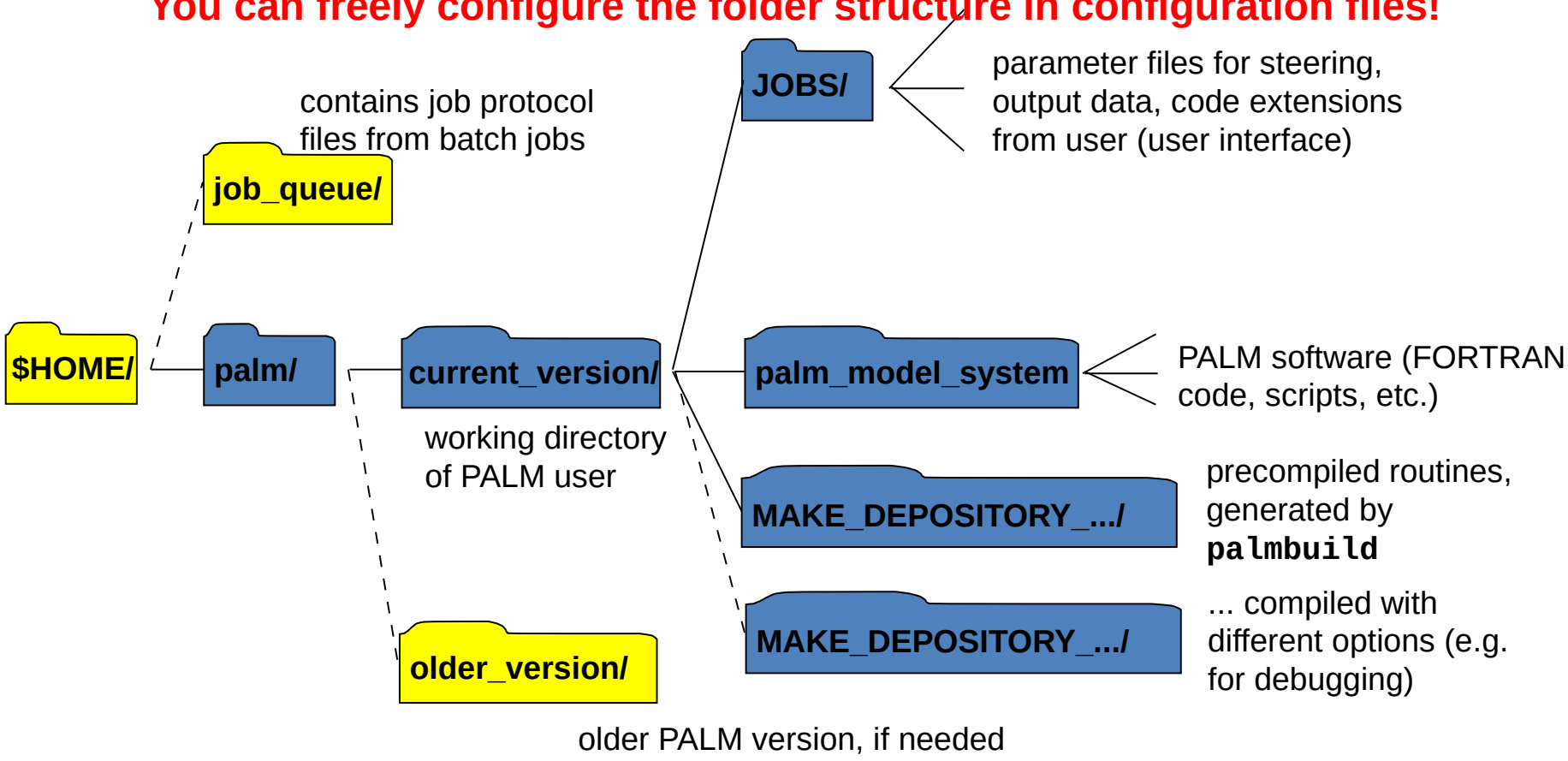
example configuration files for various computers / operating systems

libraries shipped with PALM (e.g. RRTMG)

Please never modify or delete files in *palm_model_system* and its subfolders!

Recommended structure of folders for PALM installation

You can freely configure the folder structure in configuration files!



/fast_io_catalog/ contains a temporary folder created (by **palmrun**) for each PALM run

/fast_io_catalog/ contains large binary data files created by PALM and required e.g. for restarts

optional

automatically generated

created by user

Main modes of operation

- **Interactive mode**
  - PALM is run in interactive shell (terminal session).
  - CPU time as well as number of processors for interactive runs is limited on many systems.
  - Restart runs (job chain) are not possible.
  - Only requires appropriate settings in the configuration file.
- **Batch mode** (running batch jobs)
  - Requires a batch queueing system (e.g. SLURM, PBS, Loadleveler, etc.) on the computer in use.
  - Requires additional settings (for batch directives) in the configuration file.
- **Running batch jobs on remote computers**
  - Requires a batch queueing system on the remote computer.
  - Requires ssh/scp access of the remote computer (in both directions “local <-> remote“), fixed IP-adresses for local and remote computer are required too.
- **Running job chains automatically**
  - Requires a batch queueing system (+ ssh/scp access).

Scripts for operating

PALM is operated mainly by one script, named **`palmrun`**. **`palmrun`** itself calls **`palmbuild`** to compile for the respective runs, if required.

- **`palmrun`**
  - script for running PALM (interactive or batch)
- **`palmbuild`**
  - script for generating a pre-compiled PALM version (object files)
- helper programs
  - small FORTRAN programs, needed e.g. for collecting output data or finding grid setups (`combine_plot_fields, palm_gf,` etc.)

Location of scripts: **~/palm/current_version/bin**

For a detailed **`palmrun`** documentation see
http://palm-model.org/trac/wiki/doc/app/palmrun

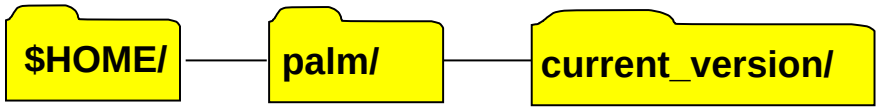
PALM configuration file

palmrun and **palmbuild** require a lot of settings (which depend on the respective computer system used), to be given in configuration files with default names

.palm.config.<configuration_identifier> and **.palm.iofiles**

- **Main purposes of the configuration files:**
  - setting of compiler options
  - setting of preprocessor switches
  - setting of paths for libraries (e.g. NetCDF library)
  - setting of environment variables
  - setting of UNIX-commands to be executed before or after PALM execution
  - handling of input/output files by file connection statements

Default position for **.palm.config.<ci>**:



A default version of this file **.palm.config.default** can be found in:

See http://palm-model.org/trac/wiki/doc/app/palm_config and http://palm-model.org/trac/wiki/doc/app/palm_iofiles for detailed descriptions.

Further requirements for running PALM

The following things are not provided with the download!

- FORTRAN compiler
- MPI-library (must fit to the compiler!), MPI-3 is required
- optional FFTW-library (see *www.fftw.org*) for very fast FFT
- NetCDF-library (see *www.unidata.ucar.edu/software/netcdf/*), required for data output (must fit to compiler **and** MPI-library!)
- graphics software capable to read NetCDF data format (e.g. ncview, NCL, IDL, ferret)
- Batch-system
- Python 3, required for the installer and several helper scripts