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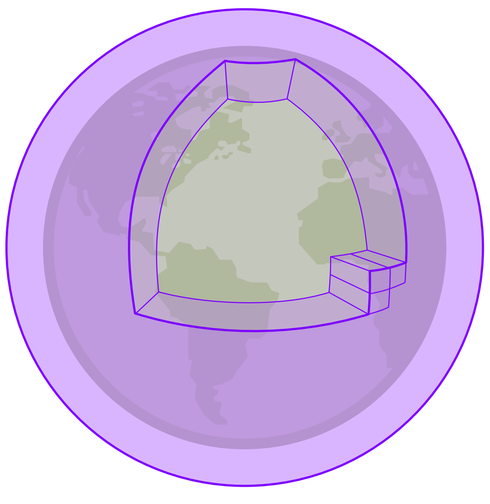
High-resolution superparameterization of OpenIFS with DALES

We present a superparameterization of clouds, convection and turbulence in the global atmospheric model OpenIFS, using a high-resolution, three-dimensional large-eddy simulation, DALES.

Superparameterization can be enabled for a selected region to control the computational cost, leaving the global model's regular parameterization in use on the outside. Previously, superparameterization has been applied uniformly over all columns in the global model, limiting the resolution or the local model's extent.



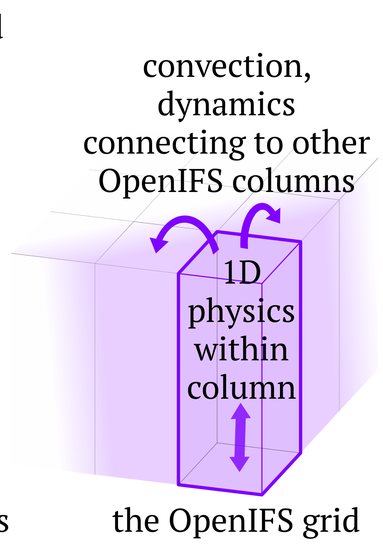
OpenIFS is a global atmospheric model, used for weather forecasts and climate simulations.

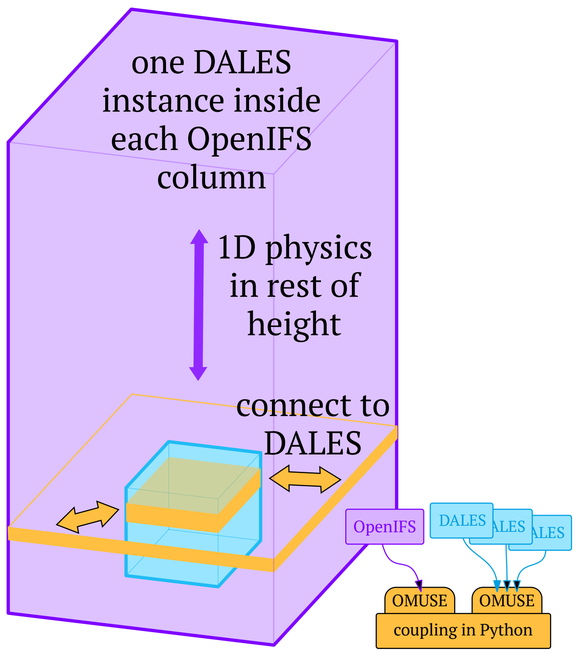
The earth is covered with a grid of OpenIFS columns.

Clouds and convection take place on length scales smaller than the grid size and cannot be explicitly resolved.

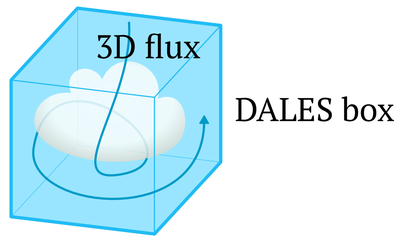
To explicitly simulate clouds in an OpenIFS column, we couple it to a local 3D atmospheric model: **DALES**.

The coupling to DALES replaces parts of the 1D column physics in OpenIFS: clouds, convection, boundary layer schemes.

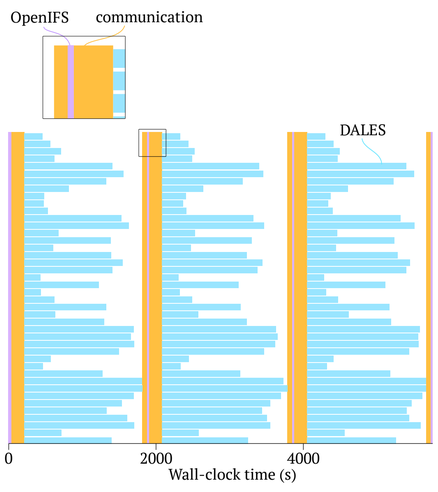




In DALES, the grid is fine enough to resolve clouds and convection in three dimensions.

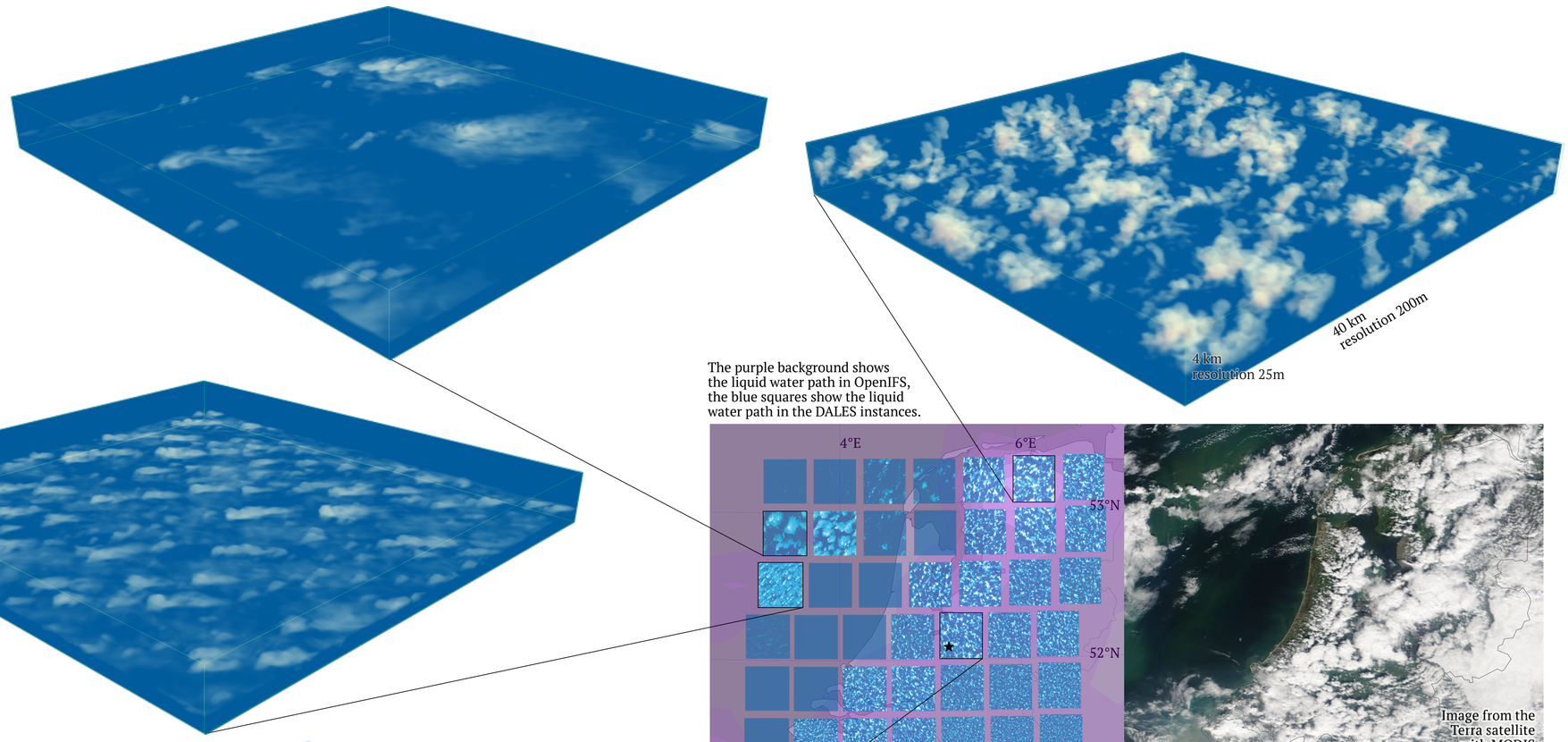


The global model OpenIFS and the local DALES are written in Fortran. We have connected them through a Python program, using the OMUSE framework to connect to the Fortran code.

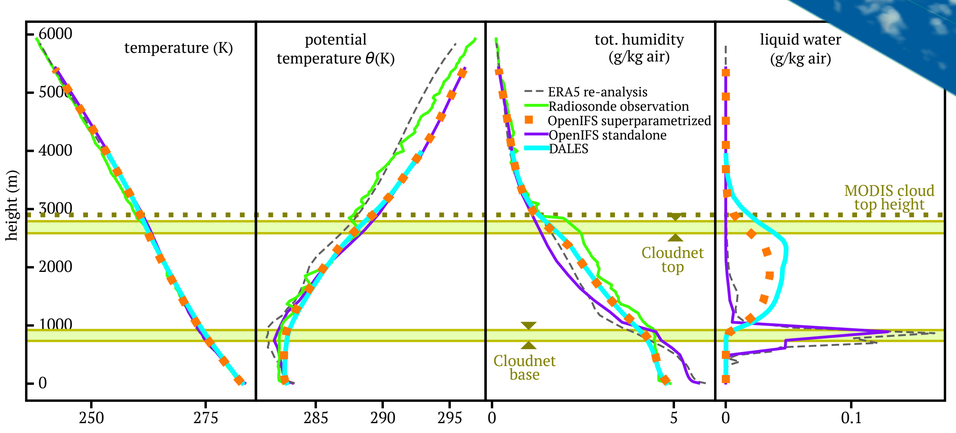


Computational requirements: 21h simulation took 39h on 10 nodes of the ECMWF Cray - 360 cores total.

Most time is spent on DALES. Grid points with more clouds require shorter time steps and take longer to simulate.



Superparameterized simulation over the Netherlands. Different DALES instances show clearly different cloud patterns. Especially the difference between clouds over sea and land conform well to the satellite image.



Comparing altitude dependence of atmospheric quantities; model results and observations.

The superparameterized run shows higher clouds than the ERA5 dataset and standalone OpenIFS. Cloud height observations from MODIS, Cloudnet, and radiosonde match the superparameterized clouds.

References

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