M7 Radiation

Impact of 3D Radiation on Clouds

Fabian Jakub, Carolin Klinger, Bernhard Mayer

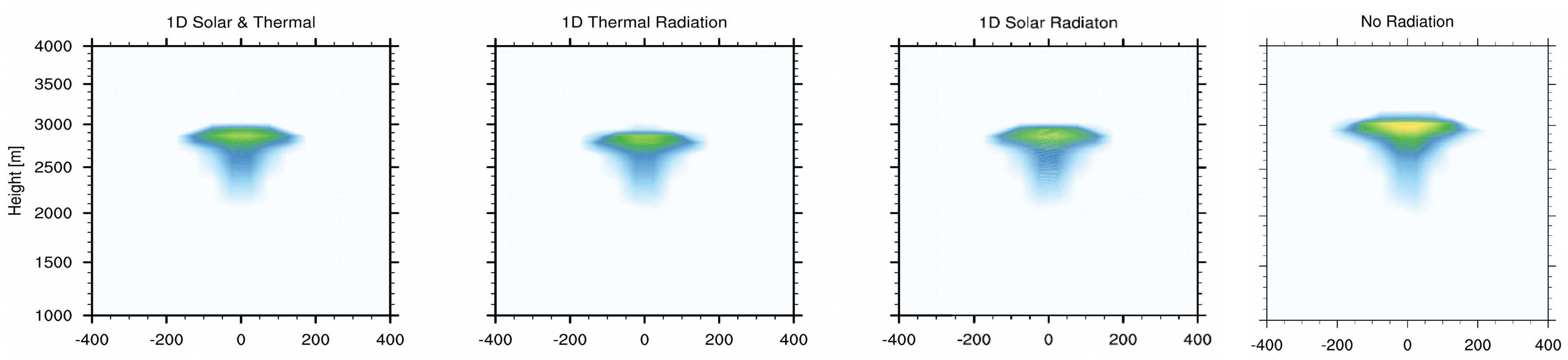
The two radiation parametrizations **TenStream** & **NCA,** introduced in a companion poster, were implemented into UCLA LES.

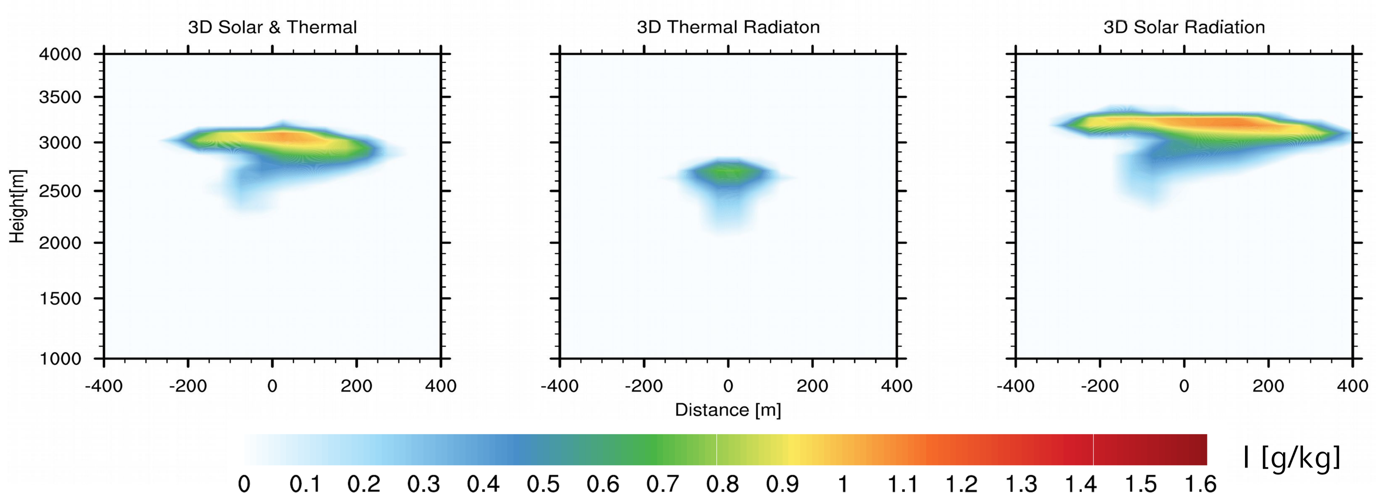
First test studies have been simulated with the **TenStream** solver and are shown in the following.

A simple example – Heat Bubble

In order to study the effects of solar and thermal radiaton on clouds, a heat bubble experiment is performed; the model is initially forced by a 0.96 K temperature perturbation and driven by no radiation, 1D radiation and 3D radiation. Solar and thermal effects are studied independently and combined. The spatial resolution is 50 m with a domain size of 64x64 grid boxes in the horizontal.

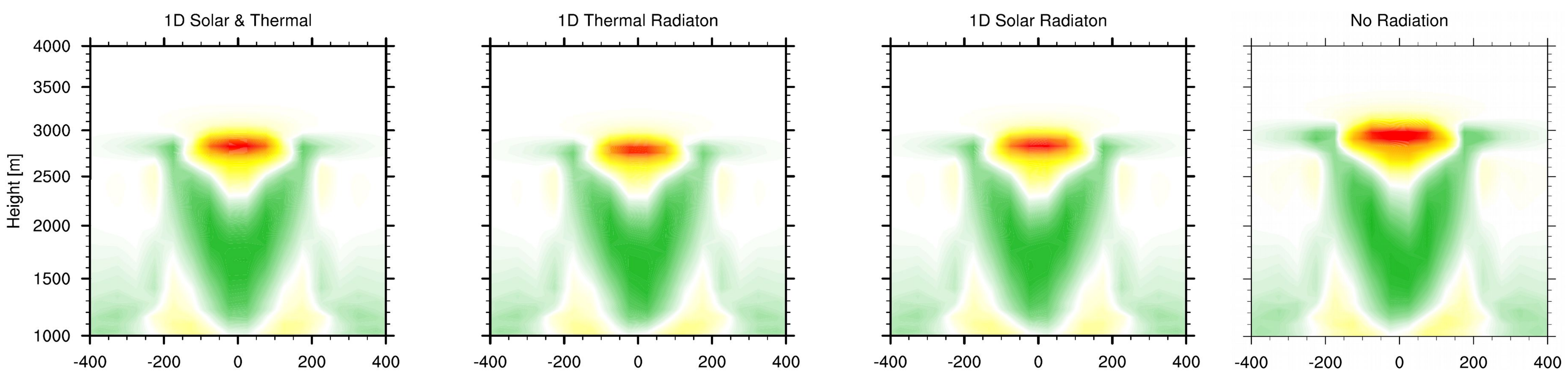
Liquid Water Mixing Ratio [g/kg], 25 min

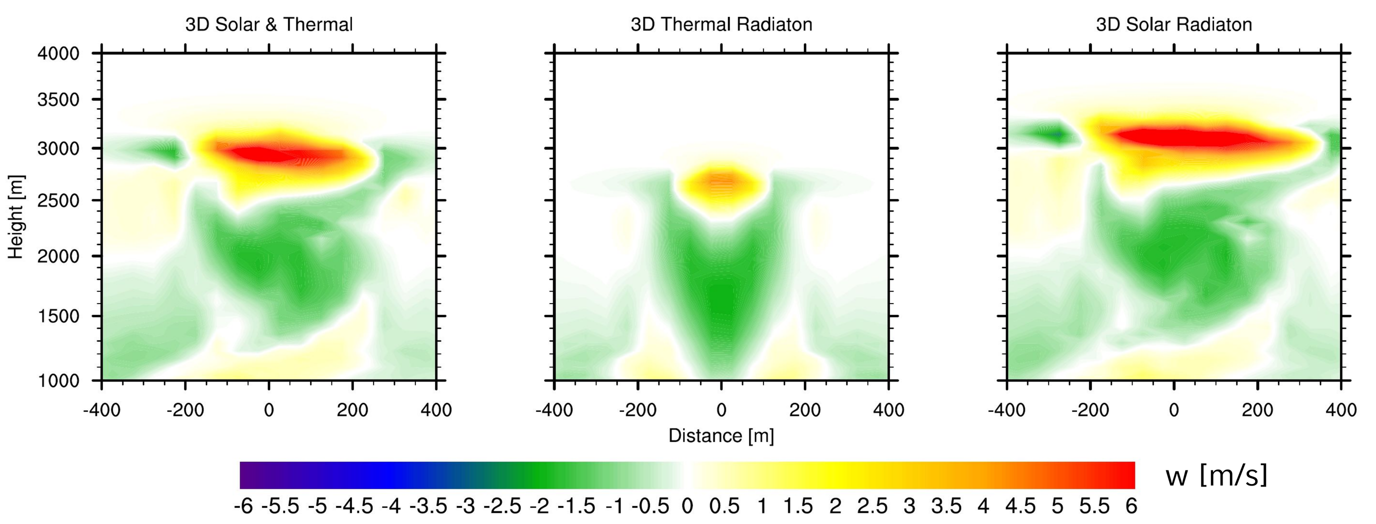




- Reduced liquid water mixing ratio for 3D thermal simulations
- Increased liquid water mixing ratio for 3D solar simulations

Vertical Velocity [m/s], 25 min

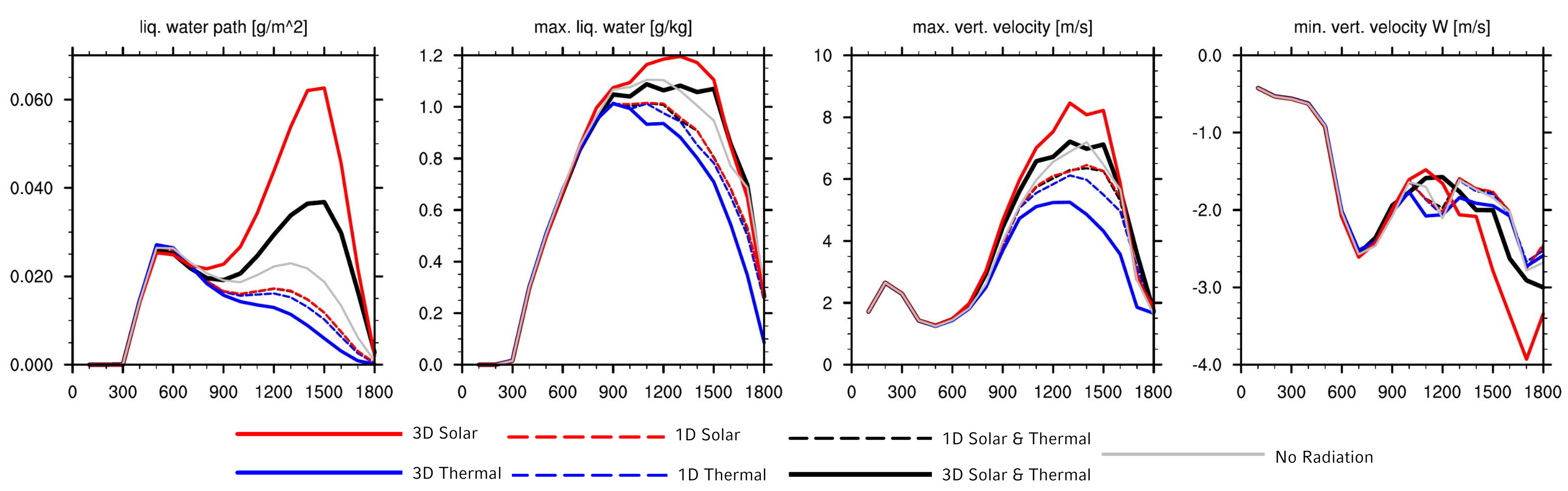




- Reduced upwind for 3D thermal simulations
- Increased upwind for 3D solar simulations

→ There is little difference between the 1D radiation simulations and the no-radiation simulation. In contrast the 3D radiation simulations show a clear impact on vertical wind and liquid water content.

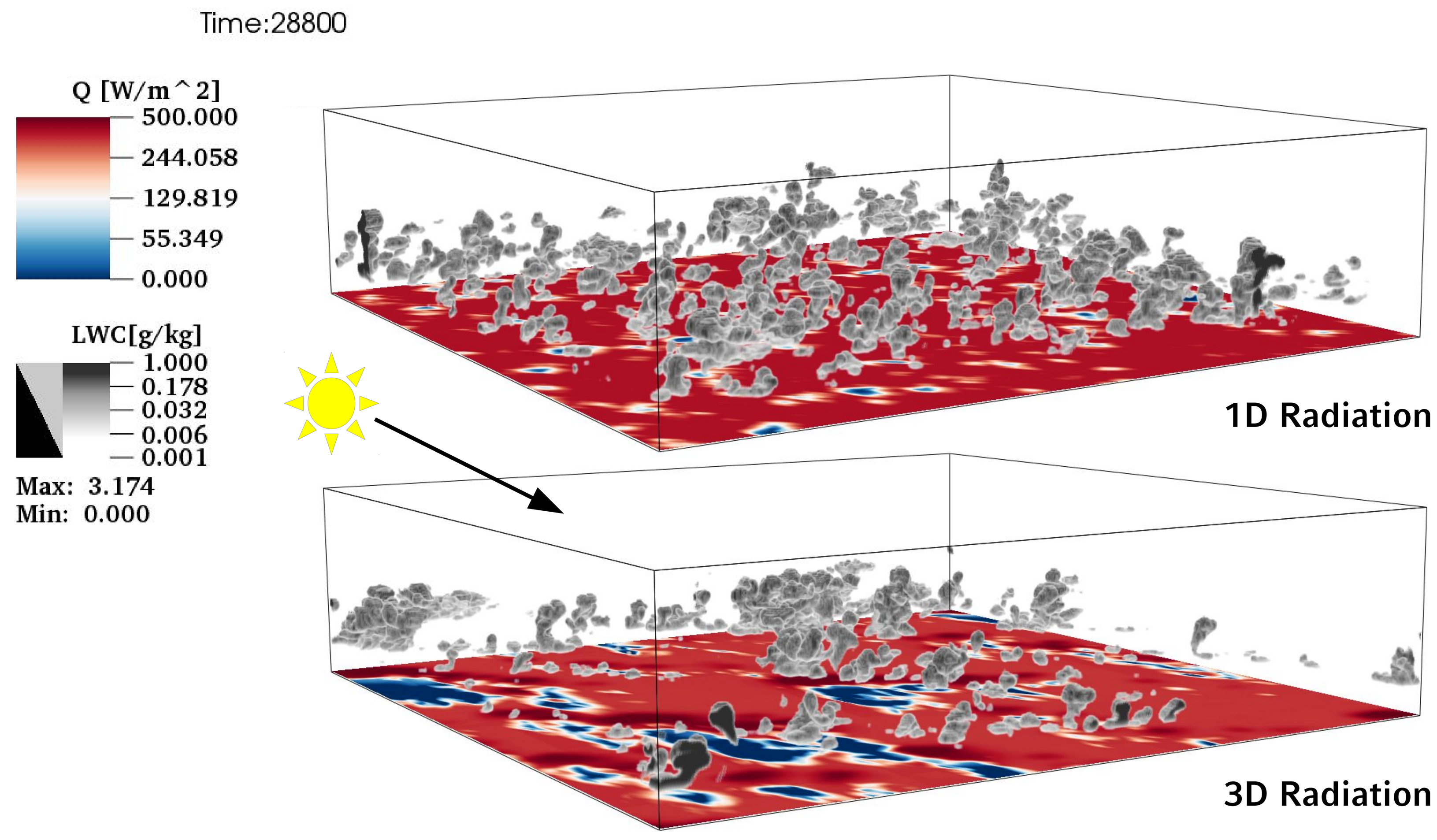
Time Series



Time series of liquid water and vertical velocity for the heat bubble simulation. Thermal radiation decreases the upward velocity as well as the liqud water mixing ratio. Solar radiation increases the upward velocity and the liquid water mixing ratio. The effects are much more dominant in the 3D radiation simulations compared to the 1D simulations. The combined solar and thermal 3D simulation partially cancels the individual 3D effects of the solar and thermal simulation.

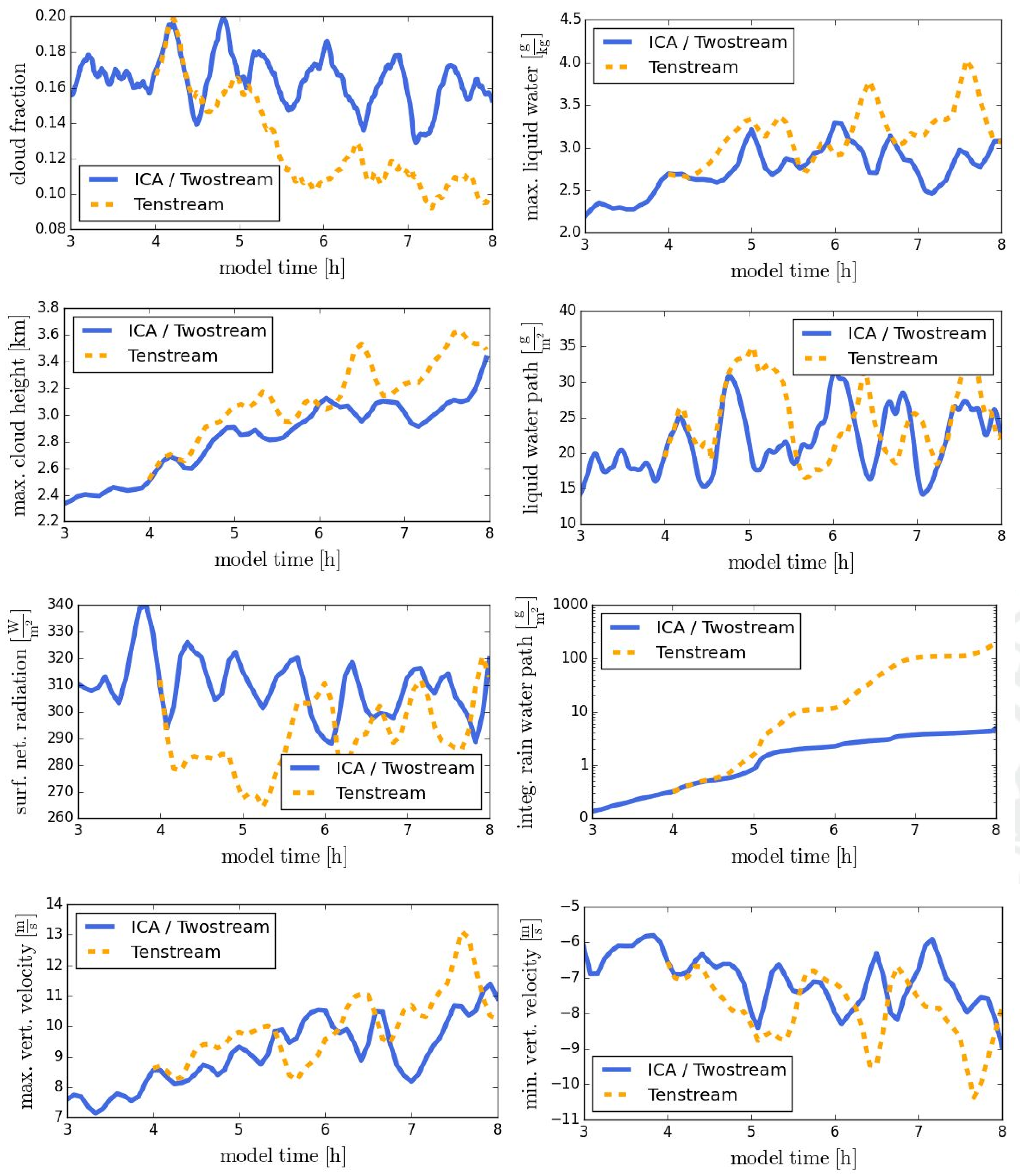
Complex Cloud Field

This simulation has a spatial resolution of 50 m with a domain size of 512x512 grid boxes. The simulation is started with 1D radiation. After a spin up time of 4h, the radiation scheme is switched from 1D ICA **TwoStream** to 3D **TenStream**.



- Interactive soil model
- Solar zenith angle: 60°
- Surface albedo: 0.2
- Initial sounding from RICO

Time Series



References

Klinger, C. and Mayer, B., 2014, Three-dimensional Monte Carlo calculation of atmospheric thermal heating rates, Journal of Quantitative Spectroscopy and Radiative Transfer, Volume 144, Pages 123-136, ISSN 0022-4073, http://dx.doi.org/10.1016/j.jqsrt.2014.04.009.

Jakub, F. and Mayer, B., 2015, A Three-Dimensional Parallel Radiative Transfer Model for Atmospheric Heating Rates - the TenStream Solver, Journal of Quantitative Spectroscopy and Radiative Transfer, submitted.

Klinger, C. and Mayer, B., 2015, The Neighbouring Column Approximation (NCA) - A fast Approach for the Calculation of 3D Thermal Heating Rates in Cloud Resolving Models, Journal of Quantitative Spectroscopy and Radiative Transfer, in preparation.

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