



LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
MÜNCHEN

FAKULTÄT FÜR PHYSIK
METEOROLOGIE

MIM



Implementing 3D Radiation into UCLA LES

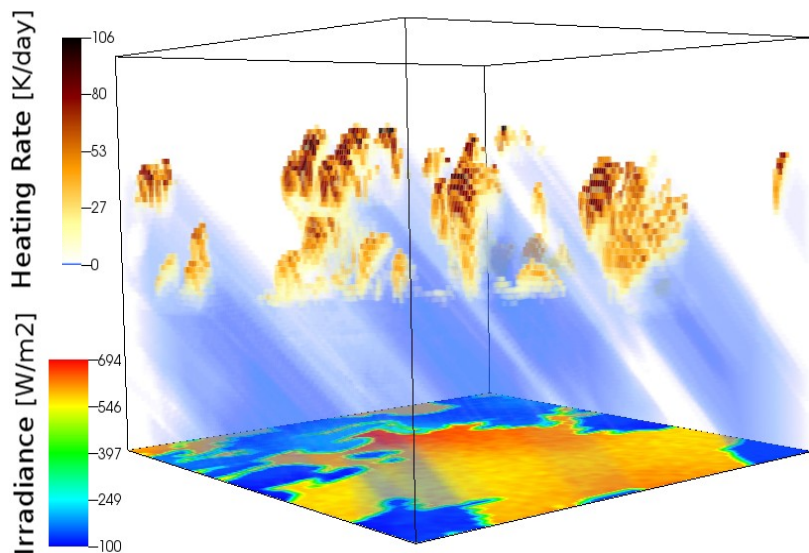
Fabian Jakub, Carolin Klinger
and Bernhard Mayer

Project M7

HD(CP)² M2 Workshop
21. November 2014

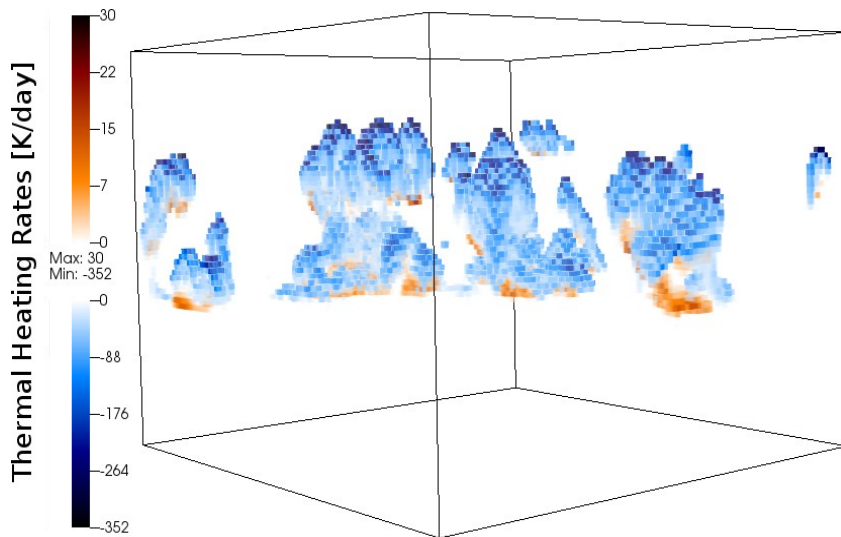
Solar and Thermal Heating Rates in the Atmosphere

Solar – 3D MYSTIC Simulation



- **Warming** at illuminated cloud side
- Shadow at ground – reduced heat flux

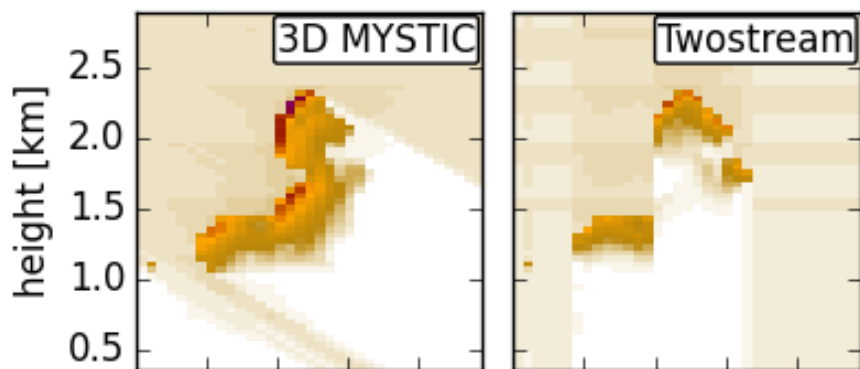
Thermal – 3D MYSTIC Simulation



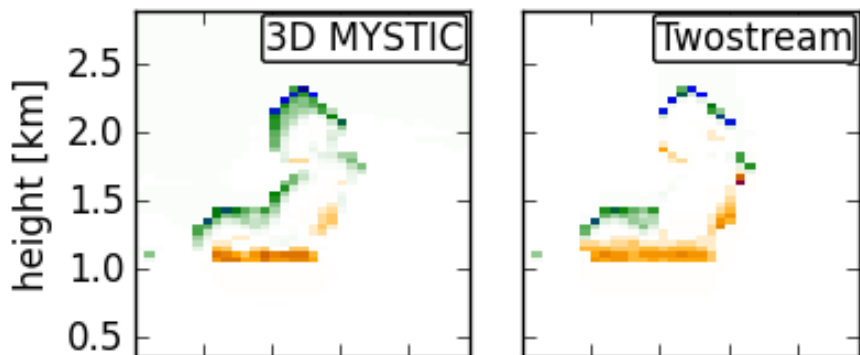
- Cloud side and cloud top **cooling**
- **Warming** at cloud bottom

3D vs 1D

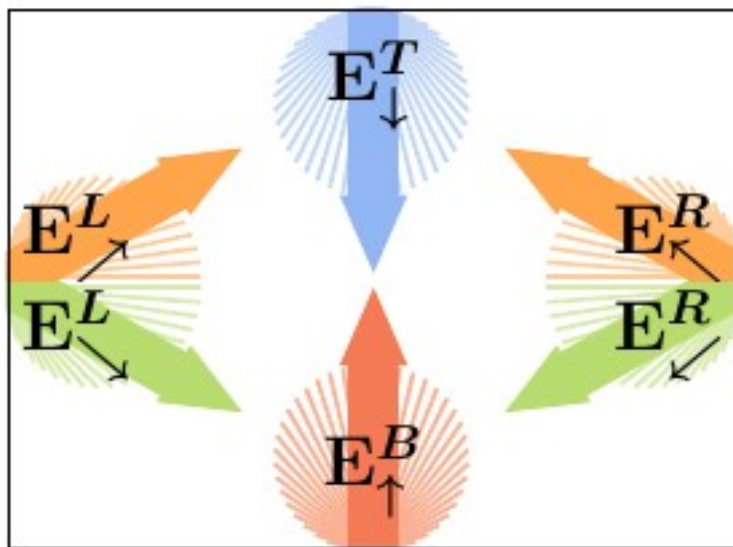
Solar



Thermal

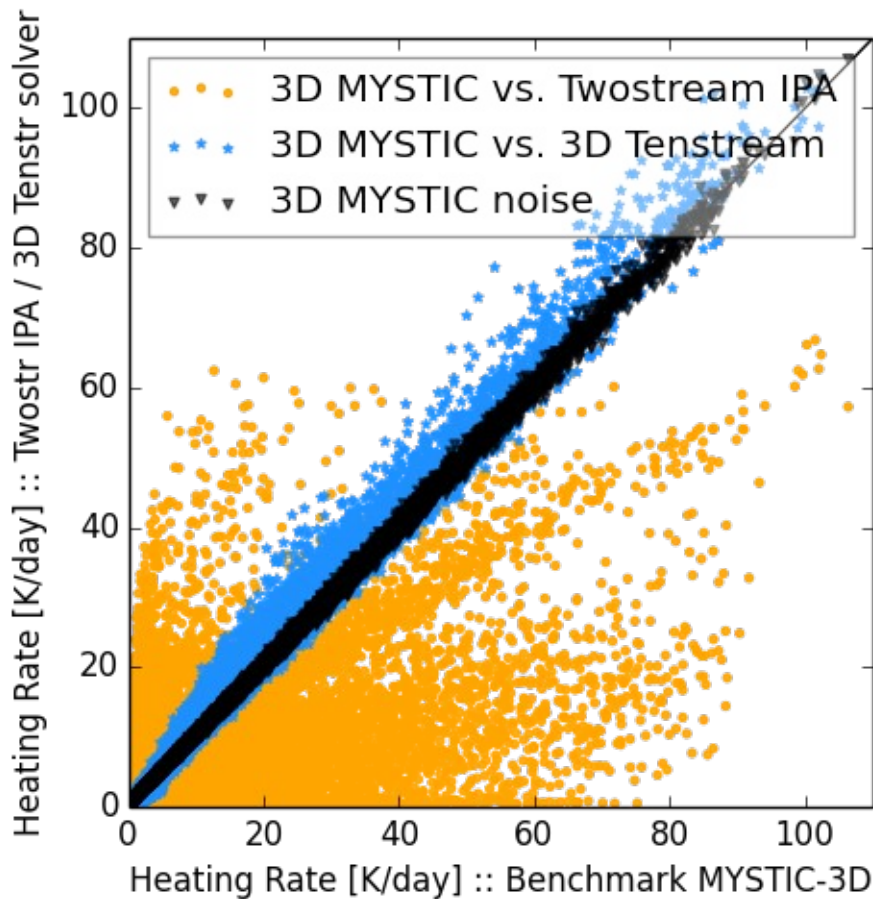


Solar: Tenstream Solver

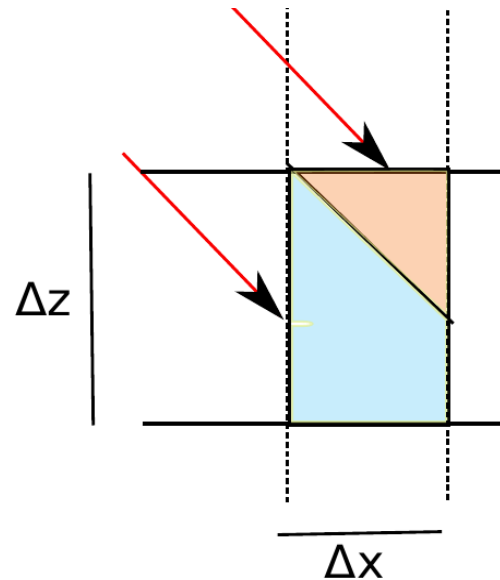
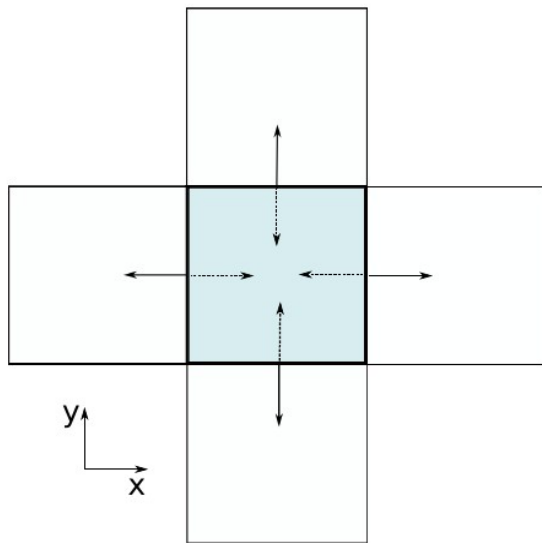


- additional streams to account for horizontal energy transport
- can be applied for solar and thermal radiation
- parallelization with PETSc

Tenstream Performance



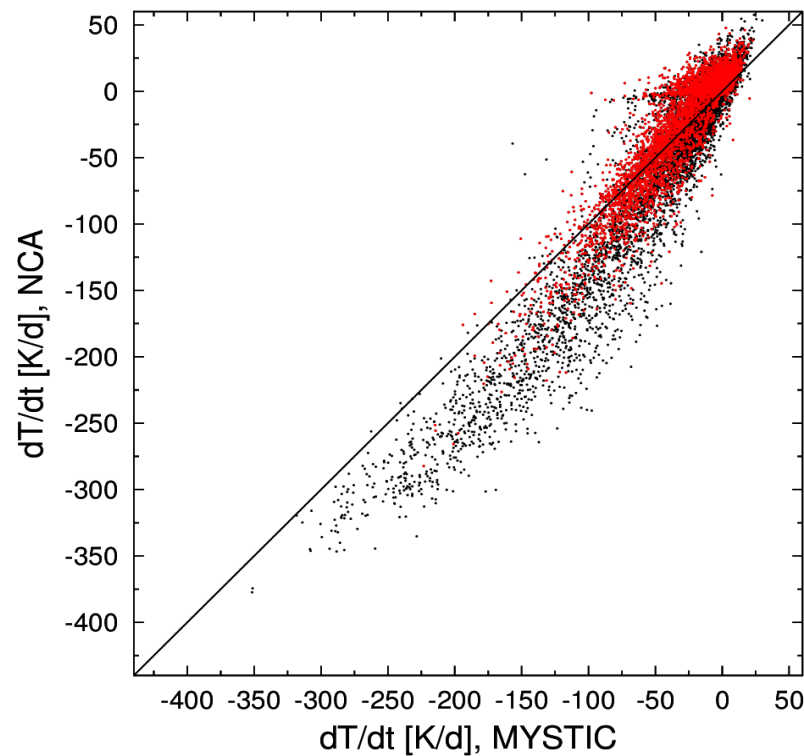
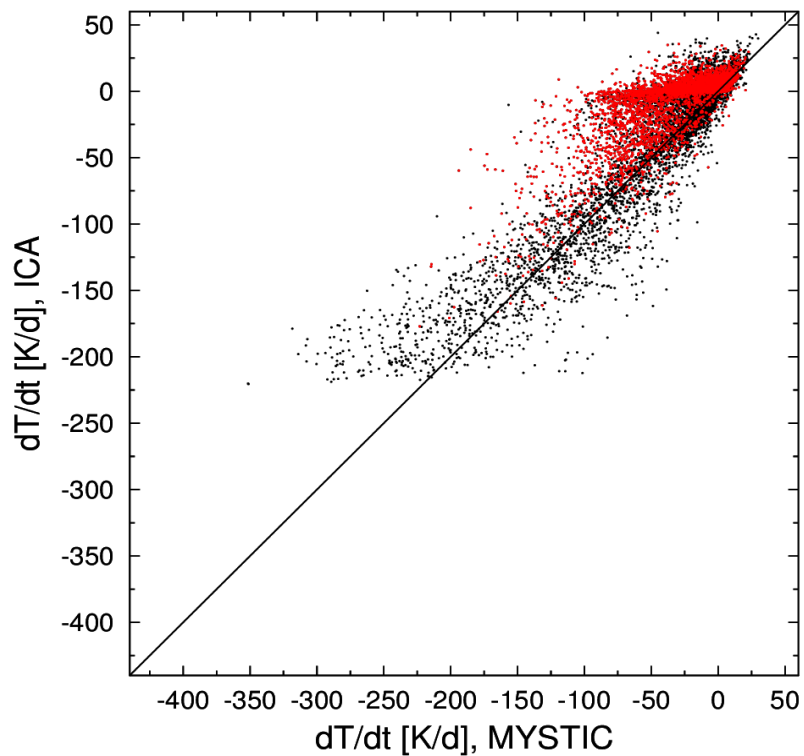
Thermal: NCA - Neighbouring Column Approximation



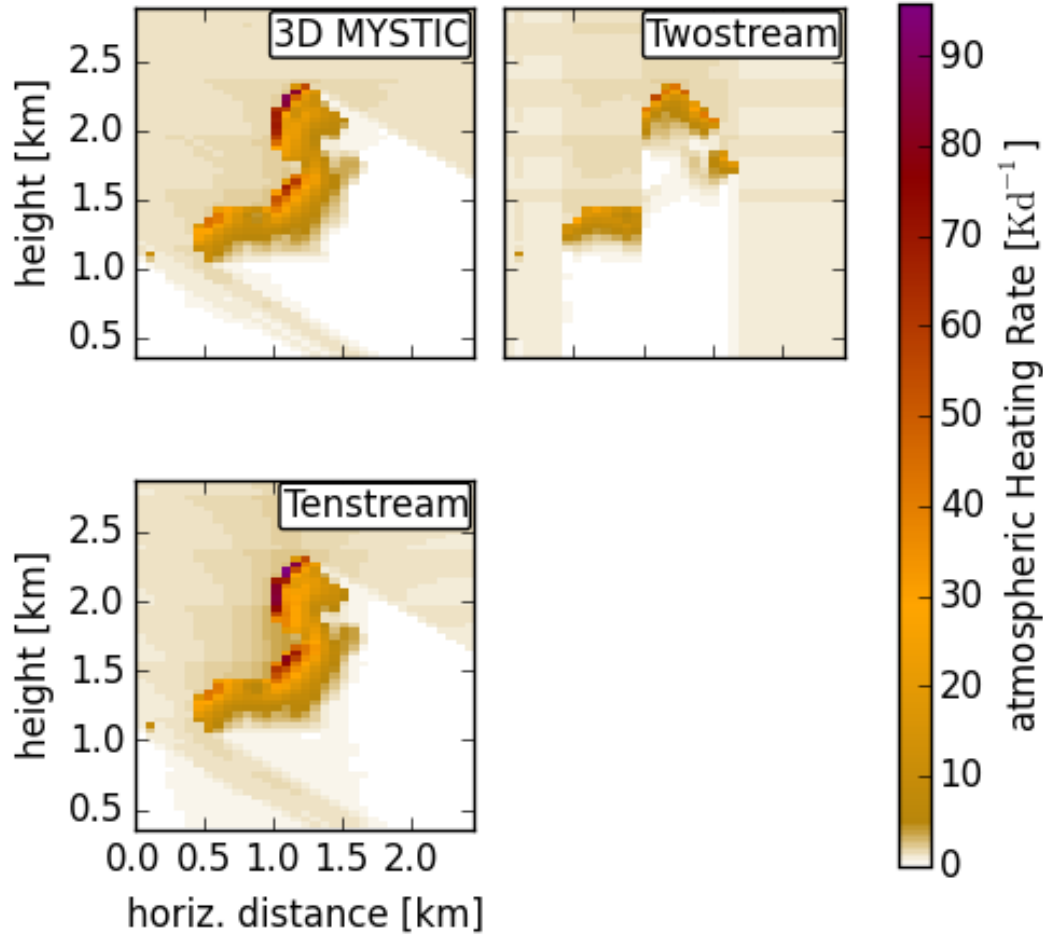
- 5 pt stencil
- side effects from neighbouring columns
- heating rate estimated with one discrete angle

- can be applied to any existing 1d radiation scheme
- allows for parallelization
- computationally extremely efficient

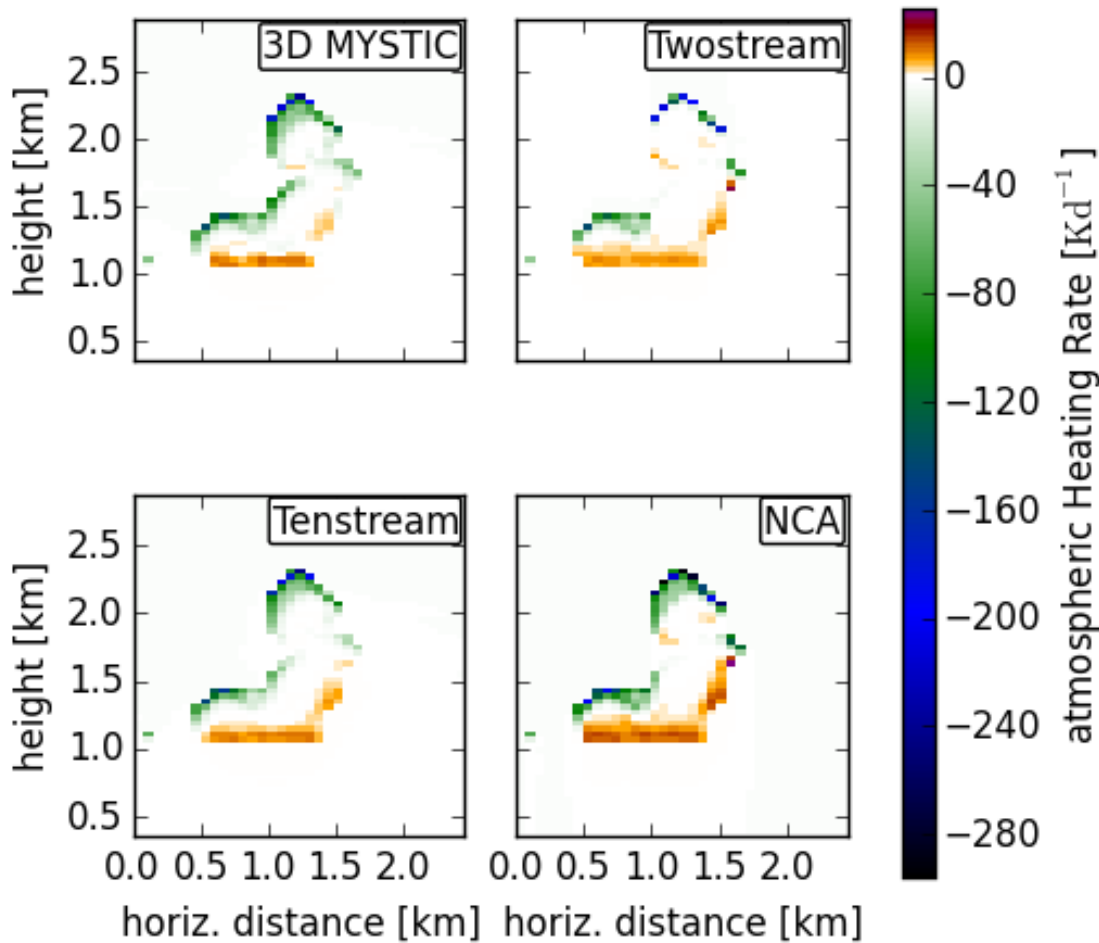
NCA Performance



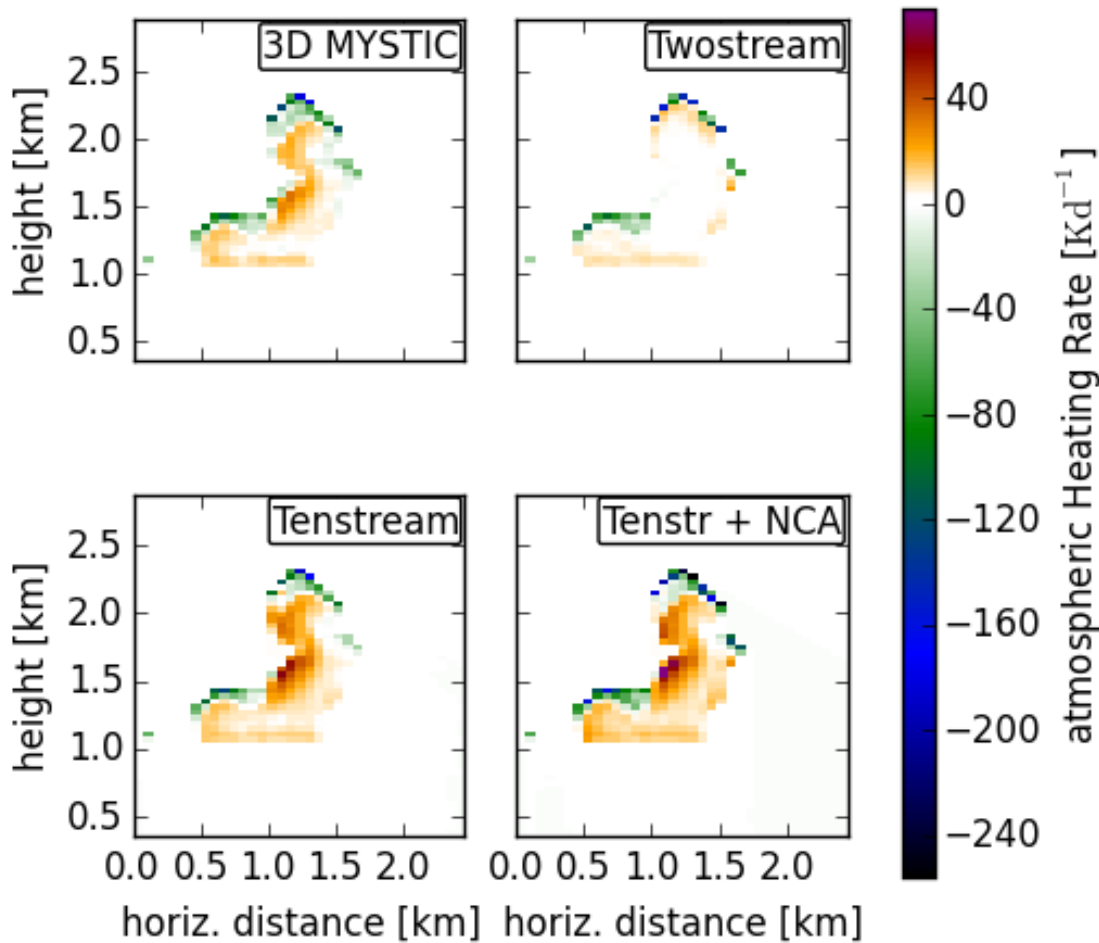
Solar Radiation



Thermal Radiation



Radiation with 3D Parameterizations



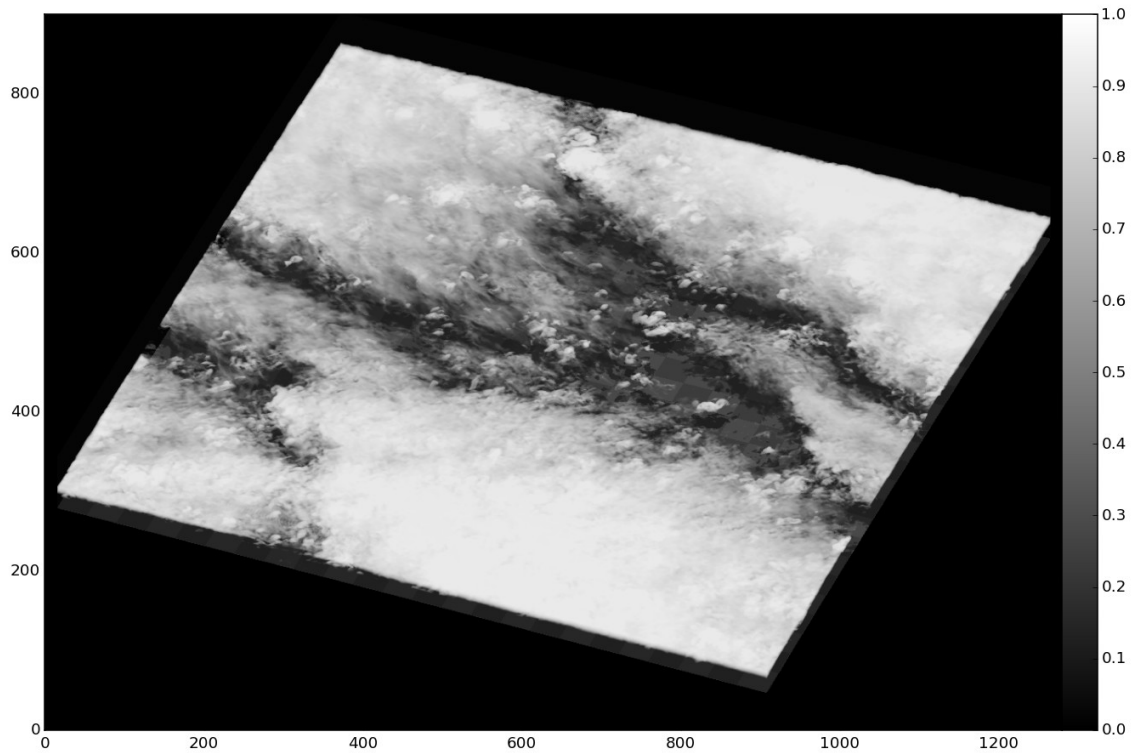
Current and future work

- Present: New 3D solvers are implemented in UCLA LES and are currently tested
- Future: Repeating HPS-simulations (e.g. 26.04) with newly implemented radiation schemes (together with Christopher Moseley)

Implementing 3D radiation schemes into ICON

Leonhard Scheck & Bernhard Mayer

03 – WP3 – Forward Operator for Satellites



HPS – PALM simulation 27.04
MODIS- Geometry



Tenstream Performance

| | | I3RC | |
|--------------------------------|----|-------------|-----------|
| | | θ | |
| | | TwostrIPA | 3D Tenstr |
| Heating Rates in atmosphere | 0 | 44 (-1.2) | 16 (-0.8) |
| | 20 | 60 (-3.0) | 20 (-0.6) |
| | 40 | 100 (-6.6) | 23 (-0.6) |
| | 60 | 171 (-12.2) | 31 (-0.5) |
| | 80 | 376 (-16.2) | 64 (1.5) |
| Surface Heating | 0 | 20 (-2.3) | 11 (-1.6) |
| | 20 | 42 (-1.6) | 14 (-1.7) |
| | 40 | 55 (-0.1) | 13 (-1.5) |
| | 60 | 62 (4.4) | 17 (-1.1) |
| | 80 | 65 (24.2) | 44 (-0.1) |