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Development of a Fast Three-Dimensional Dynamic Radiative Transfer Solver for Numerical Weather Prediction Models

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The increasing resolution of numerical weather prediction models makes 3D radiative effects more and more important. These effects are usually neglected by the simple 1D independent column approximations used in most of the current models. On top of that, these 1D radiative transfer solvers are also called far less often than the model's dynamical core.

To address these issues, we present a new „dynamic" approach of solving 3D radiative transfer. Building upon the existing TenStream solver (Jakub and Mayer, 2015), radiation in this 3D model is not solved completely in each radiation time step, but is rather only transported to adjacent grid boxes. For every grid box, outgoing fluxes are then calculated from the incoming fluxes from the neighboring grid cells of the previous time step. This allows to reduce the computational cost of 3D radiative transfer models to that of current 1D solvers.

Here, we show first results obtained with this new solver with a special emphasis on heating rates. Furthermore, we demonstrate issues related to the dynamical treatment of radiation as well as possible solutions to these problems.

In the future, the speed of this newly developed 3D dynamic TenStream solver will be further increased by reducing the number of spectral bands used in the radiative transfer calculations with the aim to get a 3D solver that can be called even more frequently than the 1D two-stream solvers used nowadays.

Reference:
Jakub, F. and Mayer, B. (2015), A three-dimensional parallel radiative transfer model for atmospheric heating rates for use in cloud resolving models—The TenStream solver, Journal of Quantitative Spectroscopy and Radiative Transfer, Volume 163, 2015, Pages 63-71, ISSN 0022-4073, .