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Introducing cloud horizontal overlap at NWP scales (1-10 km) in a fast 3D radiative transfer model

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Interactions between radiation and clouds are a source of significant uncertainty in both numerical weather prediction (NWP) and climate models. Future models need to both incorporate more realistic description of physical processes and be computationally efficient. With the steadily increasing resolution of NWP models, previously neglected effects like the horizontal propagation of radiation become more important.

Here we present a hybrid radiative transfer model that combines a traditional twostream maximum random overlap (twomaxrnd) radiative solver (Črnivec and Mayer, 2019) with a Neighbouring Column Approximation (NCA) model (Klinger and Mayer, 2019), which parametrizes horizontal photon transport between adjacent grid-cells. Thereby the hybrid includes both subgrid-scale effects and grid-scale horizontal transport. In addition we introduced a horizontal cloud overlap scheme to the hybrid model. In order to differentiate between different overlap concepts and deduce optimal overlap coefficients we used high resolution radiative transfer simulations of LES cloud fields (horizontal resolution of 100-300 m) deploying a very accurate Monte Carlo (MYSTIC) model (Mayer, 2009).

Further we assess the performance of the hybrid model at the NWP scale (1-10 km) for various realistic cloud configurations using results from the benchmark MYSTIC model and determine the differences compared to other solvers that only consider either grid-scale or subgrid-scale effects, twomaxrnd, Tripleclouds and NCA.