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Incorporating the subgrid-scale variability of clouds in the autoconversion parameterization in a large-scale model

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Precipitation formation in warm clouds is mainly governed by the autoconversion rate being a high nonlinear process. Large scale models commonly calculate the autoconversion rate using the grid-cell mean of liquid cloud water which introduces a strong low-bias because clouds and therefore liquid cloud water are inhomogeneous distributed. The parameterized autoconversion is thus artificially tuned so that accumulated large-scale precipitation matches the observations.

Here, we revise the parameterization for the autoconversion rate to incorporate the subgrid-scale variability of clouds using the horizontal subgrid-scale distribution of liquid cloud water mixing ratio derived from the subgrid-scale variability scheme of water vapor and cloud condensate. This scheme is employed in the ECHAM5 climate model in order to calculate the horizontal cloud fraction by means of a probability density function (PDF) of the total water mixing ratio. The revised parameterization now also ensures the consistency between the calculation of horizontal cloud fraction and the precipitation formation.

An introduction of the improved parameterization and first results of the evaluation of the precipitation rate on a global scale will be presented. Specifically, precipitation and vertically integrated liquid cloud water estimated by the model are compared with observational data derived from ground based measurements and satellite instruments.