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Evaluation of a statistical subgrid-scale variability scheme for water vapor and cloud condensate in a GCM using observational data

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One source for uncertainties in modeled climate scenarios is the horizontal variability of clouds which results from using grid-cell mean of variables, such as water vapor, to calculate the cloud cover (e.g. Pincus and Klein, J. Geophys. Res., 2000). This method introduces biases to all nonlinear cloud processes, such as precipitation formation and radiation. In order to reduce the above mentioned biases, a prognostic parameterization for the subgrid-scale variability of water vapor and cloud condensate was implemented by Tompkins (J. Atmos. Sci., 2002) in the ECHAM5 climate model. The scheme uses a probability density function (PDF) of the total water mixing ratio to calculate the horizontal cloud fraction. The PDF assumes a beta-function shape whose parameters are prognostic variables in the model and evolve as a function of atmospheric processes such as turbulence, convection, and large-scale cloud microphysical processes. This study evaluates the parameters of the PDF scheme on the global scale by means of high-resolution satellite data. In detail, the statistical parameters skewness, distribution width and mean of the combined vertically integrated water vapour and cloud condensate simulated by the model are compared with the values derived from MODIS data. The results of this evaluation show under which conditions the scheme works correctly and where it has to be improved.