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Revising a statistical cloud scheme for general circulation models

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Cloud cover is an important factor for global climate simulations (e.g. for radiation). But in a global climate model with a typical resolution around 100 km clouds can not be resolved. The parameterization of cloud cover still is a major reason for uncertainties in climate change simulations. The aim of this study is to revise a statistical cloud scheme with special focus on the representation of low level clouds in the trade wind region. The development is based on the assumed PDF (probability density function) scheme of Tompkins 2002, which is part of the global climate model ECHAM6. The assumed PDF approach is based on the assumption of a certain PDF family and the determination of a certain member by further assumptions or constraints. For the scheme used in this study a beta distribution is assumed and two prognostic equations are added. Besides the original prognostic equations for a shape parameter and the distribution width, adjusted equations for the higher moments variance and skewness are introduced. This change leads to an easier physical interpretation. The source and sink terms due to the physical processes of convection, turbulence and microphysics play an important role in describing the total water PDF and with this the cloud fraction in one grid box. A better understanding of these terms and their effect on the cloud fraction and their vertical distribution is essential for the evaluation and development of the statistical cloud scheme. One known problem of the scheme is the underestimation of subgrid-scale variance of total water (Quaas 2012, Weber 2011). The aim of this study is to improve the representation of subgrid-scale variability by introducing and evaluating different source terms. For this several runs with the ECHAM6 model and modified cloud schemes are performed and analyzed. The focus is placed on the trade wind region to get a better understanding of the important processes for an improved representation of shallow cumuli.

References:

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