

Impact of inhomogeneities on non-linear cloud processes

The horizontal variability of clouds contributes to the uncertainties of modelled climate scenarios because grid-cell mean of variables, such as water vapor, are commonly used to calculate the cloud cover (e.g. Pincus and Klein, 2000). This assumption introduces biases to all nonlinear cloud processes, such as precipitation formation and radiation.

A new prognostic parameterization for the subgrid-scale variability of water vapor and cloud condensate introduced by Tompkins (2002) potentially reduces the above mentioned biases. The scheme uses a probability density function (PDF) of the total water mixing ratio to calculate the horizontal cloud fraction in the ECHAM5 model (Figure 1). It has the ability to represent the growth and decay of cirrus cloud decks as well as the creation of cloud in clear sky or breakup of an overcast cloud deck by boundary layer turbulence. 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. Furthermore, applying this scheme also decreases the number of tunable parameters of the model.

Within the PhD project, the cloud cover scheme is analyzed and evaluated with the help of high-resolved satellite data. For these purposes, PDFs of the spatial distributions of the combined vertically integrated water vapor and cloud condensate as derived from spatially high-resolved satellite data are compared to the simulated PDFs. The data is taken from the MODerate Resolution Imaging Spectroradiometer (MODIS) at 5 km horizontal resolution and compared to the model-computed PDF at the resolutions of about 210 km and 310 km. This evaluation will show under which conditions the scheme works correctly and where it has to be improved. Moreover, after a successful evaluation of the scheme, it is also implemented in the non-linear precipitation formation process and an analysis of the results will be made. In the end, the impact of the cloud parameterization improvements on climate change will be analyzed.

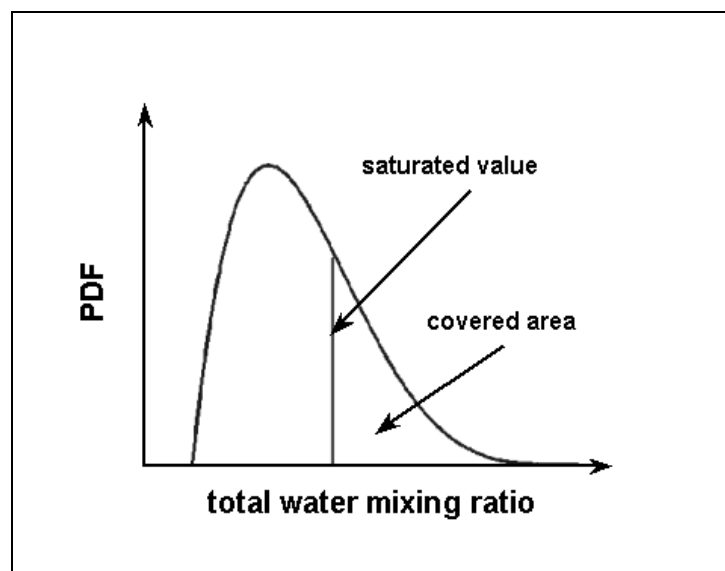


Figure 1. : Tompkins cloud cover scheme. The cloud cover can be determined by the integral of the PDF of the total water mixing ratio from the saturated value to infinity.

References

- Pincus, R., and S. A. Klein, 2000: Unresolved spatial variability and microphysical process rates in large-scale models. *J. Geophys. Res.* **105**, 27059-27065 (2000)
- Tompkins, A., 2002: A prognostic parameterization for subgrid-scale variability of water vapor and clouds in large-scale models and its use to diagnose cloud cover. *J. Atmos. Sci.* **59**, 1917-1942