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A flexible three-dimensional stratocumulus, cumulus and cirrus cloud generator (3DCLOUD) based on drastically simplified atmospheric equations and the Fourier transform framework

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Abstract. The 3DCLOUD algorithm for generating stochastic three-dimensional (3-D) cloud fields is described in this paper. The generated outputs are 3-D optical depth (τ) for stratocumulus and cumulus fields and 3-D ice water content (IWC) for cirrus clouds. This model is designed to generate cloud fields that share some statistical properties observed in real clouds such as the inhomogeneity parameter ρ (standard deviation normalized by the mean of the studied quantity), the Fourier spectral slope β close to −5/3 between the smallest scale of the simulation to the outer L_{out} (where the spectrum becomes flat). Firstly, 3DCLOUD assimilates meteorological profiles (humidity, pressure, temperature and wind velocity). The cloud coverage C, defined by the user, can also be assimilated, but only for stratocumulus and cumulus regime. 3DCLOUD solves drastically simplified basic atmospheric equations, in order to simulate 3-D cloud structures of liquid or ice water content. Secondly, the Fourier filtering method is used to constrain the intensity of ρ, β, L_{out} and the mean of τ or IWC of these 3-D cloud structures. The 3DCLOUD model was developed to run on a personal computer under Matlab environment with the Matlab statistics toolbox. It is used to study 3-D interactions between cloudy atmosphere and radiation.

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