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Interactive comment on "A flexible three-dimensional stratocumulus, cumulus and cirrus cloud generator (3DCLOUD) based on drastically simplified atmospheric equations and Fourier transform framework" *by* F. Szczap et al.

Anonymous Referee #2

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General Comments:

Methods to compute three-dimensional effects of radiative transfer can be assessed if simulated test cloud fields (scenes) can be generated. This paper notes that there are two main methods to generate cloud fields: 1) large-eddy simulation (LES), and 2) stochastic models such as IAAFT (Venema et al. 2006) and Cloudgen (Hogan and Kew 2005).

This paper proposes an intermediate two-step method, called 3DCloud, in which a cloud field is simulated by a simplified dynamical equation set, and then the cloud

field is statistically adjusted in order to impose a prescribed standard deviation, power spectral slope, and other quantities. The manuscript displays examples of cumulus, stratocumulus and cirrus cloud fields generated by 3DCloud.

To my knowledge, 3DCloud is novel, and it produces plausible results in the examples, but it is unclear what are its advantages as compared to generating cloud fields using LES or existing stochastic models. In particular, it is not clear from the manuscript that 3DCloud is significantly less expensive than LES or significantly more accurate than existing stochastic models.

Specific Comments:

1. What are the advantages of the proposed method over IAAFT or Cloudgen? Is the main advantage accuracy of results? On p. 298, lines 15–18, the manuscript states "The disadvantage of such model lies in that effects of meteorological processes are poorly considered and dominant scales of organization related to turbulent eddy due, for example, to wind shear, convection, entrainment are not considered." Although Cloudgen does consider the effect of wind shear on cirrus fall streaks, it is true that physical processes are not directly modeled by the existing stochastic models. However, does 3DCloud produce more realistic cloud scenes?

Looking empirically at the results, it is not clear to me that there is more realism, as compared to stochastic models, in 3DCloud's stratocumulus (Sc) field depicted in Fig. 7 or the cumulus field depicted in Fig. 8. For instance, the Sc field appears to have smoother small scales than observed Sc clouds, and the simulation doesn't have a large enough domain to contain power in the mesoscale. Also, the spacing between Cu clouds seems to grow closer as the resolution is refined, and it is unclear whether the cloud spacing converges at high resolution. Furthermore, Cu in the BOMEX case are not organized by shear, and hence this aspect of organization cannot be tested. Can the authors compare with stochastic models or at least point to comparable plots by stochastic models in the literature? (Also, it would be nice to have metrics by which to compare the model results, but perhaps that is beyond the scope of this manuscript.)

Thinking more about the theory, we see that in the equation set (5), the momentum equation is missing a pressure term and a turbulent diffusion term. It is not clear to me that, without these terms, wind shear, convection, and entrainment can be accurately modeled. Can the authors give some justification?

2. How does the quality of results from 3DCloud compare to LES? Can the authors plot comparable scenes (planform snapshots of cloud or radiative fields) from LES in order to compare differences?

3. What is the computational expense of 3DCloud as compared to LES? How many iterations did 3DCloud require in order to produce Figs. 7, 8, and 11?

Technical Comments:

The article needs to be proofread more thoroughly. Below are three examples of errors from the first two pages, but many more errors are contained in the following pages.

Abstract: "3DCLOUD model was developed to run on a personnel computer"

p. 297, lines 13–14: "These biases are at least, function of the cloud coverage and of the variability of cloud optical depth or water content."

p. 297, lines 18–20: "Determining the significance of the 3-D inhomogeneity of clouds for climate and remote sensing applications requires to measure and to simulate the full range of actual cloud structure."

Interactive comment on Geosci. Model Dev. Discuss., 7, 295, 2014.