

Interactive comment on “Cirrus clouds in a global climate model with a statistical cirrus cloud scheme” by M. Wang and J. E. Penner

Anonymous Referee #2

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Review of 'Cirrus clouds in a global climate model with a statistical cirrus cloud scheme' by Wang and Penner.

The manuscript describes the implementation and testing of a new cirrus cloud scheme in a global climate model (NCAR CAM3). The new scheme is based on the work of Karcher and Burkhardt (2008) and makes use of a PDF of subgrid fluctuations. With the new cloud scheme a series of sensitivity studies is performed with CAM3 and compared to the previous version and some observation. It is argued that the new scheme leads to an improvement of the model compared to previous versions.

The topic of the paper is timely and could be an important contribution to the question of aerosol-cloud-climate feedbacks.

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The manuscript is well written and the methodology is described in detail. My main criticism is that the authors are not open enough about the many simplifications they have to make, namely about their simplifications concerning the co-existence of heterogeneous and homogeneous nucleation. I recommend to accept the manuscript after a major revision of the text, and maybe an additional sensitivity experiment to investigate the effect of pre-existing ice on homogeneous nucleation.

Major points:

- Any effect of pre-existing ice on homogeneous nucleation is neglected (e.g. page 13, 'heterogeneous IN concentration is assumed to have no effect on homogeneous freezing). This is an oversimplification which is wrong and to some extent unnecessary. At least a zeroth-order effect could be included, e.g., using Eq. (44) of Ren and McKenzie (2005, QJ, 131, pp. 1585-1605). I wonder why the authors did not consider this as an additional sensitivity experiment.

- Most problematic in this regard is that the authors write the text as if there would be no co-existence of heterogeneous and homogeneous nucleation, and as if heterogeneous nucleation would have no effect on the number of ice crystals formed due to homogeneous nucleation. Often they do not make a clear distinction between their simplifications used in the model and the processes as they occur in nature. For example, on page 14 they write that '[...] we use the critical heterogeneous IN concentration [...] to determine whether heterogeneous freezing will occur'. In nature, heterogeneous nucleation will always occur before the homogeneous nucleation is reached. What the author want to tell us is that they neglect heterogeneous nucleation. So why not say it that way?

- It is claimed in the manuscript that the authors have implemented a consistent treatment of ice nucleation and cirrus clouds (e.g. page 33). Besides their oversimplified treatment of ice nucleation, they do not advect the cloud fraction of cirrus cloud, and advected cloud ice may evaporate instantly when it is advected into a cloud free grid

C5426

box (page 17). This is obviously a severe inconsistency leading to an overestimation of sublimation of cloud ice.

Minor points:

- page 4: Repeated sentence in paragraphs 2 and 3 of this page. 'In these studies, the individual GCMs ...'. Please rewrite both paragraphs.

- page 5: Typo 'Moreover,To'

- page 38, line below Eq. (A7): Maybe (A6) instead of (A5), and Eq. (10) instead of Eq. (8)?

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 16607, 2009.

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