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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of 3D Thermal Radiation on Cloud Development" *by* Carolin Klinger et al.

Anonymous Referee #1

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Review of "Effects of 3D Thermal Radiation on Cloud Development" by Klinger et al.

Summary This is a potentially interesting paper that may be publishable after suitable major revision. It would benefit from a better focus on its main points that would clarify the contribution of the paper to original knowledge. The simple finding that 3D is different from 1D, and that 3D is needed to improve the development of model clouds is not, in itself, an original finding. Neither are most of the findings regarding changes in cloud circulation, liquid water content and lifetime, but these findings may be helpful in the context of confirming the earlier work of others. The finding that thermal radiation, when correctly treated in a 3D framework, triggers the organization of clouds appears to be the main result, and if so, should be presented as such, but with greater clarity about what is meant by 'organization'.

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Discussion paper

Major revisions 1. The Introduction is not helpful in its present form. There is a jumbled litany of past work that should be more critically presented: a lot refers to standard 1D theory that carries over to cloud development in general. This should be presented separately from the past findings on 3D thermal influences, both on individual cloud development and on cloud fields. Despite the repeated assertion that studies accounting for 3D effects are rare, insufficient acknowledgement is given to the earlier work. The earliest 3D calculation of the cooling rates from the sides of an isolated cloud was probably that of Harshvardhan et al. [JAS, 1981]. Mechem et al. [JAS, 2008] showed the importance of multidimensional radiative transfer to the forcing of large cloud systems.

The Introduction should acknowledge past work and provide motivation for why another such study is warranted. The goal seems to be limited to one brief sentence [p3, l12] that lacks specifics.

2. The Conclusion is not helpful in its present form. It should not be a simple summary of what was done, but rather should conclude what the results contribute to the advancement of knowledge. Have these results simply confirmed what others have previously found [p13, l15-l19]? Have these uncovered something new [organization?].

3. The discussion about resolution and reproducibility [p13, l1-l12] raises additional questions that should be addressed. If the effects are more pronounced at coarser resolution, would they be even smaller if a higher resolution than 50 m had been used? Davies and Alves [JGR 1989], for example, showed that 100 m is far too coarse to capture the peak cooling rates, and even 50 m underestimates the peak rate. This may not matter as much for cloud-tops, but will have a big effect on cloud-side cooling, which is the main novelty of 3D thermal calculations. Since 3D thermal effects should be larger at higher resolution, which is the opposite of the model results presented here, there is something counter-intuitive going on that should be addressed in the text. Are the results perhaps sensitive to initial conditions, requiring multiple samples to reach a firm conclusion? I find this a little troublesome.

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