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Interactive comment on "Cloud-Aerosol-Radiation (CAR) ensemble modeling system" *by* X.-Z. Liang and F. Zhang

Anonymous Referee #2

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General comments:

It's virtually impossible to argue against publication of this paper because the effort needed to build the tool used (CAR) and to run all the experiments described herein is of heroic proportions. I can't start to imagine how much hard work has been put to make column versions of various GCM-class radiation codes work with such a wide range of input and parameterizations. The authors should be really commended for their achievement, and a paper that introduces CAR to the world definitely deserves to be published. However, this particular paper packs so much stuff, so many numbers, so many experiments, that makes it hard to follow, digest, and ultimately obtain something of lasting value from (I have at times regretted having accepted to review the paper as I was going through what seemed like an endless parade of results and sce-

narios). After all is said and done, the conclusion is what we already suspected: many cloud and aerosol treatments combined with many RT schemes give a wide range of answers. The full range cannot be given because the number of possible combinations is astronomical, and the individual ranges provided here are just a small, and hard to characterize as representable, sample. It's almost as if the authors made their tool so ambitious, expansive and all-inclusive that in the end it is impractical to use for picking the optimal sets for a particular application. Nevertheless, I recommend publication of the paper to reward the authors for their noble intention to help the GCM community, and their courage for pursuing and completing this line of work.

Specific comments:

– The title of the paper should be "THE CAR Ensemble Modeling System"

– The introduction is long, quite verbose, disorganized and feels often repetitive. It'd benefit from trimming and becoming more focused.

– What is the plan for maintaining, updating, and keeping CAR relevant? For example, if a new version of RRTMG is released will it be incorporated in CAR in a timely manner? If a code/scheme is on its way of becoming obsolete (not used by anyone any longer, – a couple of the RT schemes included in CAR seem to fall in that category, as do some cloud parameterizations) will it be removed from CAR?

– It seems to me that CAR is the type of tool that should be freely and openly available to the intended user community. Yet, I don't see any info in the paper on how to obtain the system. I visited the website as well and couldn't find any relevant information (although the "forum" page appears to be constructed to serve potential users). So, will CAR be available for distribution? If yes, how can one obtain it, by contacting the authors at this stage?

– I find it hard to conceive how CAR would be implemented in a GCM. All the options for cloud parameterizations (cover, water path, indirect effects, etc) would certainly need

to be turned off. And then, would the radiation calculations be purely diagnostic? If they were interactive (with feedbacks) would it be possible to ever interpret the results? Also, the data volume would be tremendous. Even if the tool was publicly available, I'd think that it'd take an enormous investment of time to make the whole system run within (in parallel?) a GCM.

– p. 10201, lines 20-22: This sentence is exactly the same as in p. 10196. Delete.

– p. 10202, lines 26-28: "As discussed earlier, not all of these variations can be practically applied due to the fact that significant system tuning must be made to ensure...". No, it's not a tuning issue, the practical matter is that it's impossible to run all these variations and store/analyze the output!

– I disagree with the way the term "cloud geometry" is used in this paper. For me the term geometry should be reserved for situations when clouds are three-dimensional (e.g., with shapes, sides, etc).

– p. 10197, line 10: "The radiation transfer modeling..." I'm not sure I agree with this statement. Approximate models sacrifice spectral resolution and this results in errors. The statement is more true for LBL calculations.

– p. 10203, lines 8-12: If ICA is used, there is no reason for clouds to be horizontally homogeneous. GCM runs with horizontally inhomogeneous clouds are shown by Oreopoulos et al. (2012), ACP.

– p. 10204, lines 11-12: "whereas McICA assumes all cloud types to follow the same statistical relationship as weighted maximum-random overlap." Simply not true. McICA is not tied to any particular overlap scheme. It can operate on subcolumns generated with any arbitrary overlap assumption. The same misconception persists in line 8 of page 10211. There is NO vertical overlap scheme inherent in McICA!

– p. 10204, lines 24-25. Do MODIS and MISR provide aerosol mass loadings? I thought they provide aerosol optical depths.

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– p. 10206, lines 9-13: How is surface albedo spectral variability handled? Each model has its own band scheme and whatever spectral albedo is available from MODIS should be averaged somehow.

– p. 10213, line 15: "2125"??

– p. 10216, line 15: "based on satellite estimates". Are there really aerosol direct effect estimates from satellites (please provide references) that do not involve radiative transfer calculations, using possibly one of the schemes included in CAR?

– p. 10217, line 15: Again, some of the "observational" estimates of TOA flux (ISCCP, SRB) involve running a RT code with whatever error this state of affairs introduces. Given this, the authors may also want to rethink their conclusion in lines 16-19 of p. 10219.

– p. 10229, lines 17-19: There are other uncertainties in GCMs besides clouds-aerosols-radiation that play a role in the range of climate sensitivities, so I don't think this statement is true.

– The paper needs considerable attention to fix grammar, syntax and spelling errors. It'll be too burdensome to provide a full list, but here are some examples, just from the introduction section (I had already run out of steam by that time):

p. 10194, line 7: "the world's leading"; line 15 "demonstration purposes", p. 10195, line 2: "different parameterization" p. 10196, line 3: "built the innovative Cloud-Aerosol-Radiation"; "collection of alternate"; line 8 "the intercomparison of the numerical" p. 10197, line 24: "in reality to achieve a radiation" p. 10198, line 2: "They are largely alternate"; line 5: "considers"; line 15: "cannot reveal the true uncertainty but rather the errors"; line 19: "and thus hamper the GCM"; line 22 "lack thereof"; line 25-26 badly structured sentence; line 29: "designed to represent" p. 10199, line 2: "collection of parameterization"; line 10: "the best available"; line 11 "alternate scenarios"; line 19 "defined differently" p. 10200, line 10 "of the integrated"; line 11 "host GCM"; line

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15 "when interpreting" (this sentence is problematic as a whole, by the way); line 19, "highlight some key features"; line 25, missing period; line 26 "alternate schemes".

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