

Geosci. Model Dev. Discuss., referee comment RC1
<https://doi.org/10.5194/gmd-2021-194-RC1>, 2021
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Comment on gmd-2021-194

Anonymous Referee #1

Referee comment on "The Earth Model Column Collaboratory (EMC²) v1.1: an open-source ground-based lidar and radar instrument simulator and subcolumn generator for large-scale models" by Israel Silber et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-194-RC1>, 2021

Review of "The Earth Model Column Collaboratory (EMC²) v1.1: An Open-Source Ground-Based Lidar and Radar Instrument Simulator and Subcolumn Generator for Large-Scale Models" by Silber et al.

This manuscript documents a new observation simulator for model applications, focused on ground based radar and lidar at individual locations. It documents the simulator methodology, and illustrates a case study application to mixed phase clouds over Antarctica. The paper is well written, and should be publishable with minor revisions. Specifically, there is quite a bit of qualitative analysis in figures 4-5 before getting quantitative in figure 6. There is also discussion of, but no demonstration of the phase ratio. In particular, estimating the phase ratio from lidar and radar properties when the 'truth' for the model exists is a bit strange, and doesn't seem to be the point of a simulator. But at least illustrate the method, and how it might differ or reproduce model 'truth'. I also think the description could be tightened up in the introduction. But it is basically a good paper, suitable for GMD with these minor revisions, echoed in specific comments below.

Specific Comments:

Page 1, L16: What is a cosp Lidar simulator emulator?

Page 1, L17: So if Python it has to be run offline? Is it open source and publicly available? You never state that in the text. At least note it.

Page 2, L19: Provide an example? Suzuki et al 2015 and/or Bodas-Salcedo et al 2013 maybe?

Bodas-Salcedo, A., K. D. Williams, M. A. Ringer, I. Beau, J. N. S. Cole, J.-L. Dufresne, T. Koshiro, B. Stevens, Z. Wang, and T. Yokohata. "Origins of the Solar Radiation Biases over the Southern Ocean in CFMIP2 Models." *Journal of Climate* 27, no. 1 (September 10, 2013): 41–56. <https://doi.org/10.1175/JCLI-D-13-00169.1>.

Suzuki, Kentaroh, Graeme Stephens, Alejandro Bodas-Salcedo, Minghui Wang, Jean-Christophe Golaz, Tokuta Yokohata, and Tsuyoshi Koshiro. "Evaluation of the Warm Rain Formation Process in Global Models with Satellite Observations." *Journal of the Atmospheric Sciences* 72, no. 10 (August 3, 2015): 3996–4014. <https://doi.org/10.1175/JAS-D-14-0265.1>.

Page 2, L21: But retrieving microphysics is not the point. Microphysics in the model is used to simulate the observable (e.g. reflectivity pro backscatter or extinction).

Page 4, L1: Note #1 and #2 for the rad and micro approaches.

Page 8, L6: Can you list all the tuning parameters?

Page 11, L9: This is strange to simulate. The model knows explicitly what it's hydrometers are. Why try to approximate them from the radar/Lidar? Applying this to observations would be useful, but the point of a simulator is to cast the model in observation space...I assume you will compare outputs to model hydrometers I(truth) later?

Page 12, L18: But what is the emulator? How is trained? Unclear what this COSP emulator is. Please add a few sentence description.

Page 12, L30: Where is the model class with data in the figure?

Page 14, L5: Would these model specific things be in the instrument class or model class? Seems like they should be in the model class? Please clarify.

Page 17, L10: This is a good motivational sentence that I'm not sure was well reflected in the introduction, either to the whole paper or just section 4. Suggest stating this

succinctly earlier.

Page 17, L22: Please state why you know it's the autoconversion parameterization at least.

Page 18, L3: Good agreement is not quantitative. See comment on figure 4: skip to figure 6 and use mean profiles to make the statement quantitative please.

Page 19, Figure 4: what do the white lines represent in the EMC2output?

Figure 6 is much better than Figure 4. Maybe showing one row to orient the reader. But then show Figure 6 and make discussion more quantitative.

Page 19, L2: Again: reasonable is not quantitative.

Page 20, Figure 5: Here having time mean profiles and temporal standard deviations would be more effective at discerning differences than the color scales you have chosen. Maybe just skip this figure and clean up figure 6?

Page 20, L7: appear to agree. Again, not quantitative.

Page 21, Figure 6 basically has all the information of Figure 4 and 5. Maybe show only one figure or one row of figure 4 and discuss this figure instead. Add empirical approach? Would be nice to compare the model approaches on the same plot. Since only one line is different between top and bottom rows, I suggest you combine the plots to one for each variable, with all EMC2 methods on the same plot.

Page 22, L7: Which method and result is more correct relative to the observations?

Page 22, L15: Why is empirical approach not in figure 6? Remind the reader if there is an already stated reason.

Page 24, L12: What is the COSP emulator exactly? What is the method? It's not the same code as the on line COSP simulator, so how is COSP emulated? This is not explained.

Page 25, Figure 8: Why is the vertical resolution of the on-line COSP simulator different than the COSP emulator? Where do you get more vertical resolution?

Page 25, L1: I'm not seeing phase ratio statistics in figure 8 as mentioned here. Please clarify what you mean. See general comment: showing the phase ratio using model truth and EMC2 processed data would be good.

Appendix B is never really referred to in the text (looking at different model configurations) and should be moved to the main text with the figure (should be B1, not A2) added to the main text (maybe remove figure 4 & 5).