Interactive comment on "The Cloud Resolving Model Radar Simulator (CR-SIM) Version 3.2: Description and Applications of a Virtual Observatory" *by* Mariko Oue et al.

Anonymous Referee #2

Received and published: 28 November 2019

The manuscript introduces a software (CR-SIM) for simulating ground-based radar and lidar observations, based on input from atmospheric models. The software itself is presented and several possible applications are demonstrated. Tools of this type are needed to e.g. plan measurement campaigns and evaluate models using real observations. Accordingly, there exist important objectives and the manuscript fits GMD well.

As far as I can judge (with no direct experience of data of the type targeted by the software), the application examples are described sufficiently well. At least, the number of "use cases" is sufficiently high to convince a reader about the value of the software. On the other hand, I find the description of the features and limitations of the software

too short. I fully understand that not all details can be considered (but are hopefully covered by the user guide), but basic facts should be clarified in the manuscript, acting as the entrance points for potential users.

First of all, it should more clearly be expressed how CR-SIM relates to similar software. Is there any other software that can do the same things as CR-SIM? Is CR-SIM unique in any way? Further, the use of "Finally" on line 84 gives the impression that the review of other software is complete, but I strongly doubt that is the case. For example,

Matsui, T., Dolan, B., Rutledge, S. A., Tao, W.âĂŘK., Iguchi, T., Barnum, J., & Lang, S. E. (2019). POLARRIS: A POLArimetric Radar Retrieval and Instrument Simulator. Journal of Geophysical Research: Atmospheres, 124, 4634–4657. https://doi.org/10.1029/2018JD028317

seems to have a similar scope as CR-SIM but is not mentioned.

The output variables should be better defined. For the radar ones (Table 2) not even the units are given. The dielectric factor used in the conversion to reflectivity can be defined in different ways. Does CR-SIM allow different options, or what option is used? Equations or citations for the relationship between the scattering matrix elements and the output variables should be given (see e.g. Eqs. 1-16 in Matsui et al.).

It is said that propagation effects are not treated. What is included in the term "propagation effects"?

Are there any other limitations that should be mentioned? As far as I understand, attenuation due to gases is not considered. That should be a significant effect at 94 GHz. Would be good to clarify if the attenuation due to liquid cloud droplets is included in the attenuation terms. Is the surface assumed to be flat or curved? Is refraction of importance? Ice particles seem to be treated as spheroids consisting of a mixture of ice and air. Just the choice of mixing rule (that is not specified) causes modelling uncertainties.

As a user, you need an estimate on the overall modelling uncertainty. For example, are differences between real observations and simulations of 3 dBZ significant or not?

I found the manuscript hard to read due to the high usage of acronyms. Consider if some acronyms can be avoided, or adding a table of acronyms. Specific comments:

Line 88: What do you mean with "quality-controlled" and how do you ensure it?

Line 94: T-matrix and DDA are general methods to calculate scattering properties, not scattering datasets. Is there any scattering dataset that could be coupled to your model?

Line 108: How is bulk density defined?

Line 138: Do you get the fall speed from the models, or by an external expression? If the later, add a reference.

Lines 153-154: I don't get what you want to say what this sentence.

Line 196 and elsewhere: I don't think you can expect that all readers know the frequency of the radar bands (C, X, ...). At least define at the first usage of each band.

Line 223: Start a new paragraph at "Figure 5 ..."

Line 238: "affects" -> "effects".

Lines 294-297: I could not understand this description.

Line 331: Is CWRHI something built into CR-SIM, or done by external processing?

Line 441: Is not the basic output from scanning radars in polar coordinates? If yes, is not this code essential to use CR-SIM and should then be fully integrated, as you claim that CR-SIM output "can be easily compared with real observations"?