Review of "Simulation and sensitivity analysis for cloud and precipitation measurements via spaceborne millimeter wave radar" by Kou et al.

General comments

The authors present a forward modeling framework to simulate spaceborne millimeter radar reflectivities and perform a sensitivity analysis to evaluate uncertainties in radar reflectivity caused by varying hydrometeor physical parameters in the forward model. Further, they apply the forward modeling framework to WRF model output for two case studies, a stratiform and a convective case, and compare to CloudSat measurements.

In general the study has some very interesting aspects and is suitable for AMT. The inclusion of a melting model is a rather novel approach and not incorporated in most radar simulators. However, I have major concerns regarding the presentation of the study's motivation and the structure of the paper in general. I therefore recommend major revision.

Specific comments

- The motivation of the study is not stated clearly to me. I think the aim of the authors is to present their forward modeling framework. If that is the case, the framework must either be described in more detail, or the code be made available. In the current state, the framework can't be reproduced from the descriptions in the manuscript (especially instrument specific aspects). Also it might help to give the framework a name, so that it can be referred to when used in the future.

- Further, the motivation of the sensitivity study and its relevance for the other parts of the paper is unclear to me. Quantifying uncertainties in radar reflectivity from varying PSD parameters, PSD models and particle shape and orientation has been done before in different studies as far as I'm aware. Maybe including a literature review in the introduction on this topic might be helpful to understand the importance of this step to the study?

- I recommend reworking the description of the forward modeling framework. While Fig. 1 shows the "sub module structure", the figure is not described that well in the text. I think reworking section 2.1 with a step by step description of Fig. 1 could solve the issue. I am not sure if "submodule" is the right term describing the framework. Maybe the authors mean working steps?

- The authors compare forward simulation results using "conventional" vs "optimized" settings. I am unsure what "conventional" and "optimized" refer to.

Does conventional mean "typically included in radar simulators"? Also "optimized" might not be the best term to use, because it sounds like an optimization algorithm was applied, which is not the case if I understood correctly. (If I am wrong, then the optimization needs to be described more clearly!) It should be stated more explicitly what exactly the terms "conventional" and "optimized" mean and what settings (PSD parameters etc.) were chosen for the case studies. I recommend including e.g. a table listing all settings. Only stating "the PSD parameters were assumed based on the typical empirical values of land stratiform precipitation clouds" (L370) and referencing three studies is not sufficient to me. I would prefer this information to be explicitly stated in the paper rather than having to look up the cited studies and guessing which values were used.

● When introducing models, software etc. the authors often omit citations. This is especially evident in paragraph L43-58 in the introduction, where citations for the discussed radar simulators QuickBeam, SDSU, G-SDSU as well as for WRF-SBM are missing. Further, citations for the described scattering models (Mie, T-matrix) should be included. I noticed some citations listed in the references don't appear in the manuscript. This should definitely be checked and corrected and might explain the missing citations.

● I find the description of the CloudSat and MODIS data that was used lacking. The CloudSat product that was used should be described in more detail and a short overview of CloudSat (resolution, sensitivity) should be included. That could for example be done by adding a new section either after the introduction or after the model overview. Or including 1-2 more sentences in the introduction.

● In section 2.2.1 N and D should be defined.

● What is the bin size of the hydrometeor model?

● For the mass-size parameters "mean" values are used in the study. It should be stated more clearly which literature values are averaged over. I recommend including a sentence like, "For a and b we took literature values from -list of studies- and calculated the mean". The units of a and b as stated in the text and should be included in the figure captions as well.

● Figures 9 and 11: To increase the readability of the figure, the hydrometeor types could be written next to the letters in the subfigures, similar to Fig. 6a,c,e.

Technical corrections

Language: I am not a native speaker, so take my comments with some caution.

Often past tense is used in the article, I would recommend switching to present tense. Sometimes incorrect pronouns are used (e.g. line 95: "...each hydrometeor...., which depends on **their** phase" → **its** phase).

- L34: restructure sentence?

- L35: typical → widely used

- L57: seriously → majorly (or omit)

- L62: I recommend starting a new paragraph beginning with "In this study.."

- L74: I think it should be a "," instead of "." This small typo resulted in me having a lot of trouble understanding the sentence.

- L93: then → further

- L115: omit "a" before D0

- L156: caused → formed

- L161: graupel → snow

- L196: which → and

- L174: prefactor a varies between

- L181: actual → in nature

- L192: omit "still"

- L236-238: unclear sentence

- L257-159: restructure sentence?

- L310: omit "mainly"

- L320: appeared → becomes significant?

- L323-234: unclear sentence

- L488: They → it?

- Figures 2, 4, 6: Optionally, the different y axis scales of the subplots could be noted to avoid confusion.