

Interactive comment on “Development of the Community Active Sensor Module (CASM): Forward Simulation” by B. T. Johnson and S. A. Boukabara

Anonymous Referee #1

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General Comments

The manuscript "Development of the Community Active Sensor Module (CASM): Forward simulation" describes the development and validation of a radar forward operator designed for use in the Community Radiative Transfer Model (CRTM), which is used for both retrievals and data assimilation. While the development of such an operator is not novel, the application of such an operator in an assimilation framework is an important step in utilizing active remote sensing observations in numerical weather prediction. The manuscript is detailed, straight-forward, and well-written; however, there are some details of the manuscript that should be discussed and addressed before publication.

Specific Comments for Discussion

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On page 6, lines 10–16, the authors discuss the specifics of the hydrometeor model LUT. While some of this information is available in other places, a table giving the particle densities (for frozen hydrometeors), the temperature range (for liquid), and the effective radius/diameter ranges would be helpful.

The authors use Figure 6 to address the effective diameter limit (of $1500 \mu\text{m}$) in the scattering tables; however, it seems as though the effects are also visible in Figure 5, where Z_{eff} , especially for the hail case, starts to diverge from the reference model. This can be seen to a lesser degree in Figure 4 for lower altitudes. The authors should expand this discussion cover all three figures, instead of just Figure 6.

On page 10, lines 15–17, the authors state that an explicit melting model is not used in the GPM-DPR level 2 algorithm. Seto et al. (2013), which describes the algorithm, includes the characterization of the melting layer, both for the effective permittivity, and for the modification of the PSD. This procedure is similar to what was described by Iguchi et al. (2000) for the single frequency retrievals from TRMM-PR.

In Figure 10 there are some high reflectivity artifacts near the surface, but these are not addressed in the manuscript.

The CFADs constructed to analyze the full-year comparison are of attenuation-corrected reflectivity. It seems as this would remove the attenuation component of the modeling, while also introducing some error into the measurements due to the GPM attenuation correction algorithm (I acknowledge that these errors are propagated into the profiles that are used as input to the forward operator). It would be nice to also see comparisons of the uncorrected reflectivities. Additionally, the figure might be more instructive if it gave relative frequency instead of normalized frequency in the colorbars.

In the conclusions, the tangent-linear, and adjoint components are discussed as though these capabilities are already included, even though they are planned enhancements. The text should be modified to make this clear.

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Technical Corrections

Page 2, line 11: "combined CRTM" should be "combined with CRTM".

Page 2, line 13: There is a closing parenthesis without a corresponding opening parenthesis.

Page 3, Figure 2: A symbol is given for rain, but that symbol does not appear in the actual plotted data. The symbol should be removed from the legend.

Page 2, line 6: A comma should be placed between "Evans" and "was."

Page 5, line 2: Except for C_{back} , none of the terms of the equation are defined.

Pages 8-9, Figures 5–7: The densities have different units in the caption and for the colorbar. Use consistent units.

Page 8, line 3: remove the "s" from the end of "contents."

Page 10, line 9: Here the Level 2A GPM DPR product is introduced, but there is no data citation. Please include a data product citation in the references.

Page 11, lines 7–8: The italics are unnecessary.

Page 13, lines 6–7 For "The tangent-linear and adjoint components of CASM, and subsequent Jacobian calculations, provides..." is incorrect in number (i.e., should be "provide").

Page 14, Figure 11: The colorbar should be defined in the caption.

References

Iguchi, T., Kozu, T., Meneghini, R., Awaka, J., and Okamoto, K.: Rain-Profilling Algorithm for the TRMM Precipitation Radar. *J. Appl. Meteor.*, 39, 12, 2038—2052, 2000.

Seto, S., Iguchi, T., and Oki, T.: The Basic Performance of a Precipitation Retrieval Algorithm for the Global Precipitation Measurement Mission's Single/Dual-Frequency

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