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Geoscientific Model Development Discussions

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 #1

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The manuscript describes CR-SIM, a radar and multi-instrument emulator that has a wide range of potential applications. CR-SIM is freely available to the scientific community and has the interfaces necessary to be broadly used (e.g., compatibility with major community models, physics schemes and data formats). Thus, this is an impactful study and provides an important overview of the tool and its applications.

The manuscript layout is excellent and easy to follow. Overall, the methods employed are sound and the analyses are well described. The only major comment I have is that the description of the radar emulator needs more specific details as described below. I also have some other minor and technical comments to consider.

General comments: 1) Since the goal of this journal is to make the model reproducible, more equations, references, and is needed for the following items to achieve this:

a. How are the model PSDs transformed into radar variables? The authors acknowledge Dr. Vivekanandan's the Mueller Matrix code at the end, but I didn't see this cited or described in the text.

b. How is the radar antenna pattern and pulse emulated? What are the range and antenna weighting patterns and are there different options?

c. How are mixed phase hydrometeors treated in the calculation of scattering amplitudes, and how are the mixing ratios of these particles computed from pure liquid and pure ice hydrometeor classes in the models?

2) To give readers a sense of the computational requirements and burden for running a simulation, can you please describe what computing platforms were used for these simulations and what the simulation run times are?

Specific Comments:

Lines 73 – 87: A little deeper treatment of past radar simulators and where the authors' contribution fits is warranted. For example, aside from the applications, this will enable the reader to more clearly see what the strengths and weaknesses of the radar emulator are and how they compare to other emulator tools. For example, some radar emulators such as Snyder et al. (2017a,b) apply a radar forward simulator to the model grid cells whereas other simulators account for the radar observing geometry (e.g., beamwidth, range resolution). Other simulators emulate radar time series signals based on model turbulence whereas others do not. Finally, some simulators take into account complex electromagnetics of hydrometeors or other weather radar observed scatterers.

C. Capsoni, M. D'Amico, and R. Nebuloni, 2001: A multiparameter polarimetric radar simulator. J. Atmos. Ocean. Technol., 18, 1799–1809.

Caumont, O., V. Ducrocq, G. Delrieu, M. Gosset, J. Pinty, J. Parent du Châtelet, H. Andrieu, Y. Lemaître, and G. Scialom, 2006: A Radar Simulator for High-Resolution Nonhydrostatic Models. J. Atmos. Oceanic Technol., 23, 1049–1067, https://doi.org/10.1175/JTECH1905.1.

B. L. Cheong, R. D. Palmer, and M. Xue, 2008: A time series weather radar simulator based on high-resolution atmospheric models. J. Atmos. Ocean. Technol., 25, 230–243.

Jiang, Z., M.R. Kumjian, R.S. Schrom, I. Giammanco, T. Brown-Giammanco, H. Estes, R. Maiden, and A.J. Heymsfield, 2019: Comparisons of Electromagnetic Scattering Properties of Real Hailstones and Spheroids. J. Appl. Meteor. Climatol., 58, 93–112, https://doi.org/10.1175/JAMC-D-17-0344.1.

Line 90: and spectrum width?

Line 105: What particle size spacing is used and what are the minimal and maximum sizes of particles simulated? The truncation can affect the resulting simulated measurements.

Lines 105 – 114: In general, I could follow the authors' description of the scattering properties and implement it into a simulator. However, there is no description of how mixed phase hydrometeors are treated. How is this accomplished?

Line 197: Suggest "for convective cells" since multiple convective cells are evident in the image

Line 251: Should add a reference for the Morrison microphysics scheme

Line 282: It isn't clear which simulation output is saved every 10 minutes (CR-SIM or WRF LES), or both.

Lines 289 – 290: Is spatial or temporal sampling driving these major errors?

Line 332: Should this say minimum detectable reflectivity Zmin, similar to a KASCR?

Can you please provide the sensitivity of the simulated radar?

Lines 342 – 343: How does this compare to the current CWRHI measurement interval?

Lines 351 – 352: References needed for multi-Doppler error sources

Line 356: Which advection-correction technique? Please state and cite

Lines 364 – 366: While this study is examining a hypothetical scenario for VCPs, is the 60 elevation angle scenario practical for the listed update intervals of 2 and 5 minutes? This would require PPI scans every 2 or 5 seconds which is not possible with the X-SAPR (but is with other X-band radar systems). Please elaborate on the technology limitation.

Figure 1: The Doppler velocity and spectrum with colors are saturated in a large portion of the figures. Suggest a wider colorbar range.

Techincal Corrections: Line 280: Suggest "highly heterogeneous" instead of "high heterogenous"

Line 283: Suggest "between 10-minute intervals"

Line 302: Suggest "Each panel shows that CFPs at a single site"

Line 695: Extra comma in the data "May, 20, 2011"

Figure 7 caption: units for cloud water mixing ratio should be g/kg

Figure 9: Suggest "20-second output for 5 minutes" to be more clear in the Forward Model box

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