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Atmospheric Chemistry and Physics Discussions

Interactive comment on "An Improved Hydrometeor Detection Method for Millimeter-Wavelength Cloud Radar" *by* Jinming Ge et al.

Anonymous Referee #1

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Review of "An improved hydrometeor detection method for millimeter-wavelength cloud radar" by Jinming et al.

The authors outline a radar cloud detection algorithm, apply it to simulated data, process 2 months of real data and show comparisons to ARM's operational cloud radar detection. The authors conclude that their algorithm is an improvement since it detects more clouds.

Overall, there needs to be more done to show that the algorithm in indeed "new and improved" as they state repeatedly throughout the manuscript. As is, the study presents a slightly-modified detection algorithm, applies it to a small amount of real data without concretely showing if the increased detection represents a true improvement.

The manuscript seems to claim that using the SNR for detection is better than previous work since SNR is Gaussian-distributed. First, the authors show the skewness of the noise distribution to be near-zero and conclude that the distribution is Gaussian. A skewness of zero is a necessary but not sufficient condition for a Gaussian distribution: this only implies the distribution is symmetric. Instead one should show that the noise PDF is best-fit by a Gaussian PDF. Regardless of the actual distribution of the SNR, the transformation from power-space to SNR-space (i.e. Eq. (1)) before applying averaging and a thresholding mask is pointless. As long as the noise is randomly distributed, averaging like the authors do will still reduce the noise and a threshold can still be applied. A Gaussian-distributed weighted average (i.e. Eq. 2) can still be used on non-Gaussian noise. The only new part of the algorithm is to applying an existing bilateral filter to avoid smearing edges of cloud boundaries.

The authors also assume that a higher rate of detection by their algorithm is an improvement over the ARM method. However, they do not demonstrate whether or not this increase is caused by an increase rate of false detections. I suggest that the authors use the MPL as a truth for cloud detection and compare both their algorithm and ARM's to that. Otherwise, there is no way of knowing if the cloud mask is truly improved. I am particular considered about their increased detection around 2km since in their example (Fig. 6) many false positives exist at that height. The authors claim that this is dust since the MPL backscatter is larger, but the larger backscatter only exists near the surface. Most of the radar detections around 2km have lower backscatter and appear to be false positives. Even if they are dust, isn't it undesirable to have them in your cloud mask?

I would also suggest that the author assess improvement using more than 2 months of data. Part of the strength of both the CloudSat and MMCR algorithms which the authors refer to is that they have process a lot of data between them.

Some effort should also be made to compare to the newer ARM KAZR and ARM scanning radar cloud mask. The ARM MMCR are now longer used at any of the ARM

sites.

A few other thoughts that would improve the manuscript. It would be instructive to see the steps of the detection method (i.e. Fig. 3) illustrated using an image of real data. Also, to aid in determining if you are detecting dust in the radar cloud mask, using the MPL depolarization instead of backscatter would identify dust more clearly. Finally I would suggest adding a confusion matrix as a complement to Fig. 7 would which show that any agreement there isn't due to some cancellation of errors.

MINOR COMMENTS

line 25: the authors does examine returns at various significance levels

line 27: change "reducing noise" to "reducing the noise"

line 29: remove comma

line 33: change "hydrometeor identifications" to "hydrometeor identifications in simulated clouds"

line 35-36: "move around our planet" is awkward wording

line 41: replace "stage of" with "component of"

line 43: change "cannot be accurately represented" to "are difficult to represent"

line 50: change "models" to "models,"

line 60: remove "are powerful instruments"

line 63: change "and they have excellent sensitivity" to "making them sensitive"

line 68: change "in" to "at"

lines 71-76: Here you should also mention that the MMCR are no longer used by the ARM program and have been replaced with KAZR.

line 86: remove successfully modified and

lines 88-95: all of this can be removed, none of this discussion is necessary

lines 95-96: don't understand the sentence here

line 141: what are "internal and external sources"

Fig. 1a: why does the power "cutoff" at the high-end of the distribution

line 152-154: is there a reason to expect noise to be range dependent?

line 157-158: change "randomly Gaussian distributed" to "random"

line 187: "about three standard deviations" or "at three standard deviations"?

lines 188-203: most of this discussion is unnecessary: it is generally understood that average will reduce noise.

lines 207-208: clarify "cloudy or clear side"

line 213: replace "prevent" with "reduce"

line 225: replace "must be limited to a mediujm size since" with "is a compromise between"

lines 245-247: The first sentence says sigma_n is estimate, the second sentence says that sigma_n = sigma_0 / 2. Which is it?

line 297: replace "good" with "well"

line 301: remove "in nature"

line 331: remove "respectively"

line 348-349: This isn't correct. There are many false clouds in the radar mask that don't correspond to large lidar backscatter.

line 364: remove "wispy-high-level"

line 395-396: remove first sentence here. Don't speculate on unpublished results.

Fig. 6e: add a zoom-in view on the cirrus like in Fig. 6b/c

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