Atmos. Meas. Tech. Discuss., 6, C4313–C4318, 2014
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Atmospheric Measurement Techniques Discussions

Interactive comment on "Evaluation of gridded Scanning ARM Cloud Radar reflectivity observations and vertical Doppler velocity retrievals" *by* K. Lamer et al.

Anonymous Referee #4

Received and published: 7 February 2014

In this article Lamer and coauthors describe a technique to use a sequence of radar cross-wind range-height-indicator scans to construct a 3D description (of cloud reflectivity and vertical velocity) for a cloud field adverting over a Ka-band scanning radar. With a few exceptions noted below, the technique the authors use is well described and results compared with continuous vertically pointing, and higher-temporal resolution observations from second cloud radar.

Assessment/recommendation:

Overall, I find the work interesting and that the case studies represents a very good first

step in establishing this technique as viable approach for reconstructing a 3D cloud field. That said, I do have a few questions, and provide below a list of comments and questions that I think will help the authors improve this manuscript. Therefore, I recommend acceptance with minor revisions.

Main Comments:

1) Confusion in reconstruction details: (p.9589 and appendix material)

I am a bit confused on some details of the reconstruction. The material on page 9589 line 15 seems to make it clear that only points on the Cartesian grid that are WITHIN the radar resolution volume (that is the cylinder shown in figure 3) are "influenced" by a given measurement.

(Point 1A) This does not seem to match up with the description in the Appendix of the Cressman scheme which defines a minimum radius (Rd1) based on the remapping/Cartesian grid spacing. If I understand correctly, if only Cartesian grid points within the radar-resolution-volume are used then there would be no need for Rd1.

(Point 1B), what then is the purpose of the bounding Box show in Figure 3?

(Point 1C) On 9589 line 21 you write " In small distance from radar, the radar volume is very small compared to grid cell and it may not contain any grid point. In those cases, the value r_i , theta_i is considered to influence those grid points located in area at grid resolution distance from r_i , theta_i." I do NOT understand the later part of this sentence (poor grammar?). Please rephrase for clarity.

(Point 1D) Perhaps rephrasing will make it clearer. But regardless of what you do with volumes to small to contain ANY Cartesian grid point, there may still be some Cartesian gird points that are not within ANY radar resolution volume (due for example to unevenness in the elevation/azimuthal spacing).

2) Linear interpolation (9590 Line 2).

With respect to time, you have basically used a nearest-neighbor interpolation in time for the “case 2” points and used linear interpolation in time for “case 1” points. I am not enamored of the linear interpolation, which is likely responsible for some of the shifts you show in figure 6 for the cirrus case. Why not use nearest-neighbor for “case 1” points, as well. This at least would ensure that reflectivity values correspond to measured values.

3) Additional information

9584 Line 5: Please provide additional information. Specifically, in regard to the Cloth-iaux et al. cloud masking, what threshold were used for “on and off”, how large is the spatial-box-filter, and how many iterations?

4) Insects

9584 Line 20: With respect to the insect identification, what threshold was used for the LDR? I might expect to dependence of the LDR with elevation angle, does the data show such exists?

Also, how do you deal with the situation where your think insects are present, but the range-volume is also likely within cloud ? (For example, you might mark x/z grid points influence by a bug-filled measurement as “unknown” with respect to cloud detection and then use some nearest-neighbor (or other interpolation) to decide detection and reflectivity values for these points.

5) Relative frequency vs. cummlative frequency.

Figure 2 and p. 9586 Line 1: It is hardly surprising that with a sensitivity limit of -50 dBZ at 1 km, that there are very few cloud detections below -40 dBZ. One can wonder how many more detections there might be if the radar had a sensitivity of -100 dBZ and how this might significantly change a plot of the cumulative distribution. Because the total number of detection can never be know absolutely, I think it would be far-far better to show a histogram of occurrence for reflectivity (in say -5 dBZe bins)

normalized by the number of observations (NOT – I repeat NOT the number of cloudy detections). This number will not change if the radar sensitivity greatly improves and should much equally if not more clearly show that the number of detection below -40 dBZe is decreasing rapidly such that one expects fewer and fewer detections below -50 dBZe.

6) 9590 Line 2, you write “Furthermore, it should not be higher than a quarter of the scan duration.” Why ?

7) p. 9596. While it is not surprising that VH_RHI would not be a true constant, it seem rather odd to me that a linear model would fit the variations. Is it possible that this linear component really represents an error in the determination of the true <V_f> ? Or some systematic error in azimuth or elevation angle ?

8) Summary, p. 9599 Line 22. Because the cloud masking is a spatial (low-pass) filter, simply removing dBZe values after the fact will not make true range-independent mask (and it is unclear to me if such would even be a good approximation).

9) 9600, Line 10. You write “Near cloud edges, the maximum value interpolation method performs best since the quality of the radar observables strongly depend on signal-to-noise conditions.” Where in the text did you demonstrate this ?

A few things you should probably add to the discussion section:

Additional Point for Discussion #1: Limits of Frozen Advection.

The comparison of the vertically point with scanning radar is a good idea. But it does not test the value of the frozen advection assumption. That is, the reconstruction is not a representation of the cloud field that would be captured by a camera or satellite. It is not an instantaneous snap shot. The cloud continues to evolve during the $\sim$20 minutes of the scan. While the comparison with the vertically pointing radar says something about the quality of the time-interpolation it does address the validity of features in the 3D reconstruction on spatial scales that are larger than the distance between the two

radars.

Additional Point of Discussion #2: Purpose of reconstruction.

I believe the type of reconstruction you are doing is both a necessary activity and valuable. Nonetheless, I think that it would be unwise to use this reconstruction to then retrieve cloud microphysical quantities. As you show nicely in figure 6, the remapping will change the reflectivity distribution and (as you note later) even the size of some features in the cloud field. Rather, I would argue that to the degree one wants a 3D field of say liquid-water-content, it would be better to retrieve this quantity on the "measurement grid" (as much as possible) and then later remap this retrieval to a Cartesian grid much as you are doing for reflectivity. Do you agree? Either way, I think you should point out that small changes in reflectivity and velocity can have a large effect on retrievals and point out the potential for errors (including biases) if the reconstructed data are used for retrievals.

Minor Comments:

1) Abstract p. 9580 line 5 (and similar for Summary 9599 Line 6) you write " . . . a common scan strategy is to repetitively slice the atmosphere from horizon to horizon as clouds advect over the radar (Cross-Wind Range Height Indicator – CWRHI)." I do not believe this is a "commonly" used approach. However, assuming I am wrong please provide several references demonstrating such. Presumably these papers will also have address the limitations and effectiveness of this approach, which should at least be discussed in the context of your present analysis.

2) Introduction p. 9580 line 5. Suggest you change ". . . cloud radars are the primary instruments" to ". . . radar and lidars are . . ."

3) 9851 line 19. Parenthetical Expression "... objectives (large distances vs. cone of silence) . . ." is not helpful. I do not know what "cone of silence" is or why this is "an objective". Suggest should be "(Mapping precipitation over large areas vs. providing

high-sensitivity and high-resolution detection of cloud and precipitation).

4) 9584 Line 9. I do not think the expression "land contamination" reflects a good way to think about this problem. There are no doubt difference between marine stratus at the shore line and marine stratus well off shore. I suggest you write something more along the lines of "The close proximity of this site to the ocean enabled observations of marine stratus because low level winds often advect these clouds shoreward."

5) 9585 Line 23: Of course, it is possible that drizzle is within the cloud but not yet fallen below cloud base or even more commonly is evaporating rapidly and so not detected. You should probably mention these caveats.

6) 9600 Line 19 you write " . . . the Ka-SACR is able to resolve all important structures." This is way over reaching!! You have not defined what constitutes "all important structures" (are structures at spatial scales of 5 km or 10 cm important) nor in my mind established the validity of structures. In fact, I would say the opposite, you have shown by way of example that some structures are stretched or blurred.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 9579, 2013.