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Hydrology and Earth System Sciences Discussions

Interactive comment on "Radar subpixel-scale rainfall variability and uncertainty: a lesson learned from observations of a dense rain-gauge network" *by* N. Peleg et al.

Anonymous Referee #1

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General Comments

I looked forward to reading the paper and expected reviewing it to be a breeze but it turned into a chore. I found many little points that need to be corrected before I can recommend the paper for publication.

Overall the paper is interesting and adds to our knowledge of rainfall variability. It combines an observational study with data analyses. The authors are clearly familiar with relevant findings in the literature but add little new to the data analysis (however, this is not a condition for this paper to be publishable).

I hope that the authors will continue running the network, perhaps even expanding it,

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and that in the future when the data sample grows larger, they will share many more insightful results with the radar hydrology community.

Specific Comments

Let's start with the title. Was there just one lesson learned? I don't think so. Recommend changing to "lessons learned".

Abstract

Line 9. "Pixel" refers to an image or a field or a map. The authors talk about sub-pixel before defining the size of pixel.

Line 14. Up to this point in the abstract the authors said nothing about the time scales they investigated.

Line 13. When you say "zero-distance correlation. . ." the readers don't know what you are talking about. You need to mention first that your network has 13 stations, each with two side-by-side gauges.

Line 14-16. This sentence is technically incorrect and incomprehensible to those who are not already familiar with the VRF concept.

Line 16-17. This statement is meaningless without some criterion for "representation". . .

Line 17-19. "The radar-rain gauge error. . ." What is that? I suspect, but only because I am familiar with the problem, that you wanted to say something to the effect of "Radar-rain vs. gauge-rain difference" (not error).

Line 20. In this business the truth is unknown and can only be estimated, better or worse. You should not use terms like "ground truth" without a clear context.

OK, so much for the abstract. I hope it is clear that you need to rewrite it.

Introduction.

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Line 26. Replace “ground truth” with “ground reference.”

Page 5, line 1. I think you meant . . .correlation function not correlation coefficient

Data

Line 7. The gauges are not “coupled”, I think that a better and simpler way is to talk about the number of station, each with two side-by-side gauges. Or, double-gauge station. . .

Line 15. I do not think that Villarini et al. (2008) should get the credit here. Instead, you should cite those who conceived, designed and deployed the network.

Line 25. What pulse? Just say “maximum sampling frequency of 1 Hz”. BTW, in the reminder of the section you never tell us how you collected tip data. Did you use the maximum sampling frequency to essentially record time-of-tip or did you accumulate (count) the number of tips in a given interval (I would guess 1 minute). As Ciach (2003) has clearly demonstrated, interpolating between tips results in more accurate estimates of rainfall amounts, especially at shorter time scales and lower rainfall intensities.

Page 8, line 7: mean elevation? What do you need the “mean” for? Is this the elevation of the radar beam over the network? The last sentence in this paragraph is awkward too. What is “substantial” ground clutter? BTW, have you ever detected effects of AP in those 12 pixels?

Next paragraph. Please clarify that saying “the same period” accounts for the days (hours) of radar malfunction and maintenance.

The next paragraph (line 16-24) is the most troubling for me. Why would you derive a separate Z-R for each pixel? First, on what basis, and second, what for? I understand the need to eliminate the overall bias from the radar data. The bias due to radar electronics is the same for all the pixels. Also, all pixels experience roughly the same storms. Therefore, you should adjust all pixels for the same bias and live with the con-

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sequences. Separating the systematic from random effects is one of the fundamental difficulties in rainfall remote sensing. They affect each other but there is little you can do about it. Your estimate of the bias (one value) is just that: an estimate. Also, by studying the effects of a single Z-R you would make the study more relevant to operational applications.

In the same paragraph. Is the upper threshold the only way to eliminate the hail cases? What about the bright band effects? What do the gauges show for the alleged hail cases?

Section 3.

Line 16. It is more conventional to call nugget (1-c1).

Page 10, top. In fact, most networks used double-gauge stations.

Page 10, line 6-11. The fact that the network(s) cover only limited range of distances is only one potential reason for the existing discrepancy between the results reported in the literature. Others include sample size differences, estimation methods, statistical artifacts (e.g. bias in the correlation coefficient due to the skewness of the rainfall distribution).

Section 4.

Page 10. The VRF is due Mejia and Rodriguez-Iturbe (you can just cite the text by Bras and Rodriguez-Iturbe or the references therein). Morissey et al. (1995) proposed a numerical method for calculating it. The method allows accounting for many different covariance models and arbitrary configurations of the investigated network. Krajewski et al. (2000) investigated in detail different aspects of the method application.

Page 11, bottom paragraph. When you talk about how small the VRF is, note that its standard deviation equivalent is much larger.

Summary

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I think that the authors should rewrite this section in the spirit of the title instead of merely repeating the just-presented results. What are the lessons learned? What else do we need to learn?

Figures

Figure 1. Looks good. I would remove the lat/lon coordinates on both the inset and the main panel (nobody will use those for navigation...). Also, you should indicate the direction towards the radar.

Figure 2. I think that you should use the same scale for all three panels, remove the scale description between the panels to make them larger. You call these observations "synchronous." This implies that your clocks are synchronized. But the HOBO loggers are notorious for having clocks drift, sometime substantially. How did you assure time agreement? If you did not, you should point out that this is another source of the scatter.

Figure 3. I do not understand what the points are. Please explain with a formula. Judging from the Table 1, the distances between points should not be evenly spaced but looking at the plot it seems that they are. Also, it is amazing that there is almost no scatter. How did you handle the zeros? What about the bias in the correlation coefficient?

It may be better to just list the values of the parameters of the correlation function. Writing them in the equation form makes it difficult to read (symbols are too small).

Figure 4. This figure is begging for a vertical arrangement of the panels... So is Figure 8.

Figure 5. The caption should provide more details so that the figure is self-described. Also, in panel (b) it seems that the authors report only averages. There should be a scatter associated with each number of gauges (as there are many combinations of 2 out of 13, for example).

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Figure 6. Similar puzzle as for Figure 3. The plot (a) indicates that the authors have a gauge (station) pair every 200 m but Table 1 says otherwise. Also, the vertical axis description is too dense. Since you have a grid you do not need labels every 0.1 for the correlation.

Figure 7. I am totally confused. Please explain precisely what the figure is supposed to show. My guess is that it is supposed to show the contribution of the radar-rainfall error and the rain gauge representativeness error to the variance of the difference between the two. But the caption says (at the end): "true rainfall derived from 12 radar pixels." True rainfall from radar??? I'm lost. Also, please provide details with respect to scales in space and time. I was under an impression that you computed the VRF for the 4 km2 area but it seems that if you are comparing the average of the 12 radar pixels you should calculate the VRF for that area as well.

Figure 9. The presentation in Figure 9 (following German et al. 2006) is interesting but the figure is too small. It too would benefit from a vertical arrangement and an increased size.

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