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Hydrology and Earth System Sciences Discussions

Interactive comment on "Comparison between radar and rain gauges data at different distances from radar and correlation existing between the rainfall values in the adjacent pixels" *by* S. Sebastianelli et al.

Anonymous Referee #2

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1. General comment

The topic of this manuscript lies in the area of radar – rain gauge rainfall estimation and associated uncertainties. Despite the relevance of the matter, the purpose of the proposed study does not appear sufficiently clear. The analysis is based on the calculation of the correlation coefficient between radar pixels and between radar and rain-gauges. The subject is not adequately treated, the statistical analysis is in general only superficial and does not allow to get any relevant original conclusion. In particular, the

declared aim of the paper (to characterize the radar errors as a function of the distance) is only partially achieved, as detailed in the following major and minor comments.

In addition, there are at least two practical reasons for which this manuscript should not be considered in its actual form for publication as a journal paper:

a) This manuscript presents the same material already published as a conference proceedings, with the same title:

"Sebastianelli S. , Russo F., Napolitano F., and Luca Baldini: Comparison between radar and rain gauges data at different distances from radar and correlation existing between the rainfall values in the adjacent pixels, Int. Workshop ADVANCES IN STATISTICAL HYDROLOGY, May 23-25, 2010 Taormina, Italy"

The analysis, results and conclusions in the manuscript are essentially the same as in the above paper. In addition the above conference proceeding is cited several times in the submitted manuscript, but it is unclear why, since it contains no complementary information.

b) The English is barely appropriate for a conference proceedings, definitely not acceptable for a journal paper. Many sentences in this manuscript are simply not clearly understandable due to the poor syntax. This is just an example of an extremely long and confusing sentence (lines 7-16, page 5176): “In this work, to analyze the trend of the correlation between rain gauges and radar estimates as a function of the distance from radar, we eliminate the numerous couples of homologues components equal to zero of the rain gauges and radar vectors between we are calculated the Pearson correlation coefficient, while, to verify the correlation existing between the rainfall values estimated by the radar in the adjacent pixels, we have not considered pixels with zero rainfall intensities values, because the numerous couples of adjacent pixels with rainfall intensities values equal to zero increase very much the correlation coefficient value, on the other hand the presence of a pixel with a zero rainfall intensity value in many couples of adjacent pixels decreases the correlation coefficient value.”

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I provide in succession a list of major and minor comments. I also suggest the authors to consider the following before re-submitting the paper:

- better focus the goal of the work: what is the expected outcome for hydrological applications?

- expand the statistical analysis, eventually including additional data (e.g. from a nearby sounding or from a numerical model, to estimate the height and depth of the melting layer), in order to separate the effects of beam broadening and the presence of mixed phase precipitation.

- ask someone to help you revise the English.

2. Specific major comments

2.1 What is the statistical significance of the correlation coefficients presented through the paper? In fig. 8 and 10 for example there are many points showing negative correlations. Are these values statistically significant (i.e. what is the associated p-value for a given confidence interval) ? If yes, what is the meaning of the negative correlation ? I understand that the correlation between radar and rain-gauge can be low due to many different reasons, but a negative correlation, if found significant, should imply a thorough analysis of both the overall quality of the data considered (radar and rain-gauges) and the processing procedures adopted.

2.2 Lack of originality: it is well known that the radar estimates of precipitation are worst at far distances, due to intrinsic radar limitations (geometric, propagation effects, ...). What does this work specifically add to the current knowledge of the radar rainfall uncertainties and which are the practical implications of the results presented ?

2.3 In the abstract it is stated that "...at far distances the width of a range-bin is comparable or bigger than the pixel width, so in a pixel there are one or just a few rainfall intensity values. Vice versa, near the radar, there are many radar resolution bins which belong to a single pixel, so great correlation between rainfall intensity values for con-

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tiguous pixels is expected. Moreover, the signal returned from precipitation at far distance from radar antenna can be due to a radar sample volume partially or completely filled with mixed phase or ice particles, or can be quite close to the minimum detectable signal. All these phenomena can influence the goodness of rainfall estimates, introducing errors which increase as the distance from radar increases. The objective of this work is to characterize these errors as a function of the distance." But indeed there is no attempt to identify the role and weight of the specific mentioned error sources 1) Cartesian vs. polar resolution, 2) mixed/ice phase precipitation, 3) radar sensitivity.

2.4 Correlation between rainfall values in the adjacent pixels: It is stressed that the Pearson coefficient tends to decrease as the distance from the radar increases. This does not correspond to what is shown in figures 4-6. The correlation coefficient is very low at short distances (this is explained by the authors as due to the residual clutter), increases until approx. 10 km and then remains roughly constant until approx. 40 km. Then it starts to decrease almost monotonically. What is the reason for this behavior ? What happens after 40 km range and why it starts to happen at 40 km ? (in Summer at 60 km, but the decrease with distance is much less marked, likely due to the higher vertical mixing in the troposphere).

2.5 Section 5 (lines 16-18, p. 5188): "Figure 4 shows that the third method gives the highest values of the Pearson correlation coefficient and this fact is true for all of the rainfall events we have considered." This looks quite obvious since averaging is expected to remove some noise from the data. But what is the purpose of using three different methods for selecting the data to calculate the correlation coefficient? Is there any significant conclusion that can be drawn from such comparison?

3. Minor comments / technical corrections

3.1 The definition of "pixel" should be made clearly. This term is in fact used both for Cartesian pixel and for polar pixel (lines 5-6, page 5178). This is extremely confusing.

3.2 Specify the azimuth and range resolution of the polar radar data.

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3.3 line13, page 5173: “properties of the backscattered echo (intensity, phase, polarization)”. The polarization is not a “property” of the backscattered echo, but depends on the transmitted radar pulse. The target influences the linear depolarization ratio as well as the differential reflectivity factor. In this context, shape is more appropriate than polarization.

3.4 If the low correlation coefficient at short distances is really believed to be caused by a bad clutter removal, then the clutter removal algorithm should be improved or these data should not be considered in the analysis. In fact the purpose of this study is said to be the investigation of the role of several intrinsic limitations of the radar estimates, e.g. geometric (height and width of the radar beam) and physical (phase of the precipitation) phenomena. The effectiveness of the clutter filter (or removal) is specific to the system and location considered and may be completely different for a different radar.

3.5 lines 4-7, p. 5179: “Vice versa larger raindrops can drag along the moisture present in the air, that cannot be detect by the radar and become larger during fall. In this condition the precipitation measured by the rain gauge can be greater than the precipitation measured by the radar”. Normally, the opposite is true. The presence of few big drops in the sampled volume may cause a large reflectivity and a relatively low rain rate, because of the 6th power dependence of the reflectivity on the drop diameter. Consequently the radar tends to over-estimate precipitation. This statement should be clarified.

3.6 line 26, p. 5182: Use “4 dB” instead of “4 dBZ”. A difference between two reflectivity values should be expressed in “dB”.

3.7 Section 3.2: a method for removing measurements affected by ground clutter based on the standard deviation of Zdr and FDP is first described. But in the following paragraph the authors say: “Another method to eliminate the effects of ground clutter is based on the use of Constant Altitude Plan Position Indicators (Pegram and Clothier,

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1999). A CAPPI at the altitude of, say, 2 km above the ground level assures that there is almost not ground clutter and, besides, the bright band is usually above or at the 2 km level because of the high summer temperatures they are experienced in wet season in South Africa." If the first method is used, what is the reason for discussing this second method ? In addition, how can the authors use a result achieved for South Africa in the area of Roma, without any quantitative consideration of the measured melting layer height in the region of interest ?

3.8 Section 3.2: The concept of normalized gamma distribution and the meaning of the three parameters of the gamma DSD should be briefly discussed, otherwise just skip this part and leave a meaningful reference.

3.9 Section 4.2: there is a table with rain-gauge names and locations (table 1), so there is no need to name all individual rain gauges in the text. You can specify the river basin in the table.

3.10 Section 6 (lines 21-26, p. 5191): what is meant with "temporary obstacles" and how frequently are these expected to affect the rainfall estimates ? In addition it is said that "the elevation angle is not always exactly equal to 1.5°, but it can changes (for example because of the wind action)". What is the antenna pointing accuracy? Then you can quantitatively estimate the uncertainty due to this mechanical characteristic, in terms of the height of the radar beam with the distance.

3.11 Section 6: the purpose of the analysis shown in fig. 9 is not clear. It is obviously expected that the correlation coefficient increases with time integration, since doing so the small-scale variability is filtered out. But the authors additionally say that this increase is higher close to the radar, due to the lowest radar beam. Then it should be specified 1) is this trend with the distance statistically significant ? and 2) why it is expected that a lower radar beam will cause a higher correlation increase (respect to father distances) when increasing the time integration period?

3.12 Fig. 11-15. These figures are extremely redundant: a single visibility plot is

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enough.

3.13 Many figures do not meet the quality requirements for a journal publication. In particular the axis labels are often too small and barely readable.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 5171, 2010.