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Hydrology and Earth System Sciences Discussions

Interactive comment on "Development of a window correlation matching method for improved radar rainfall estimation" *by* T. Piman et al.

T. Piman et al.

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Authors are grateful to the Anonymous Referees 1 and 2 for their useful comments and discussion on the paper "Development of a window correlation matching method for improved radar rainfall estimation" by Piman et al.

Following are the responses to the comments and suggestions provided. The paper has been corrected and improved by incorporating the comments and suggestions given by the referees.

1) Anonymous Referee 1

General: The paper describes an interesting extension to the PMM adjustment technique for CAPPI radar data in a tropical environment with limited measurement coverage. The approach attempts to take into account drift and drop fall time. Main (and

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partly limiting) assumptions are a uniform drift and persistence of drop size distribution between 3 km (CAPPI level) and the ground. The approach has been tested on one event of 86 hours duration. If put a bit further into the large picture, referring to other methods which are currently used or being discussed (see my remarks below), the paper should be accepted for publication.

Discussion: There are some special points in this paper which I would like to be investigated further:

Comment 1: How does the approach compare to other ones such as WPMM (I was surprised not to see this method by Rosenfeld), "merging" by Sinclair et al. (see below) or Brandes correction fields?

References: Comparison of Conditional and Bayesian Methods of Merging Radar Raingauge Estimates of Rainfields Scott Sinclair, Uwe Ehret, Andra Bardossy, Geoff Pegram Geophysical Research Abstracts, Vol. 5, 30-1-2003.

Response 1: Radar rainfall measurements can suffer from various types of errors including errors in reflectivity measurement, errors in the conversion of measured reflectivity (Ze) to rainfall intensity (R), mean field bias between radar rainfall and rain gauge rainfall etc. The present study focuses on reducing the errors (collocation and timing errors) in Ze-R conversion and improving on the radar rainfall measurement. The WPMM approach is therefore related to this study. The other two approaches, “merging” by Sinclair et al. and Brandes correction fields are used to correct mean field bias between radar rainfall and raingauge rainfall and hence these two are beyond the scope of the paper. The WPMM has therefore been included and considered among others (TMM and PMM) for comparison with the proposed approach (WCMM) in the revised paper.

Comment 2: What is the impact of the sparse rain gauge network? Would a denser network improve results or be in favor of another adjustment method?

Response 2: The impact of sparse rain gauge network has been analyzed as part of the current research and the results will be presented in a separate journal paper. In the present case study it has been observed that with the sparse rain gauge network the accuracy of Ze-R relationship and rainfall estimation is reduced and the denser network improved the results.

Comment 3: Why was a CAPPI used and not a PPI where the radar measurement would be closer to the ground (and therefore to the rain gauges)?

Response 3: The study watershed is located in the mountainous region. A CAPPI at 3 km above mean sea level is used to avoid ground clutter and ground echoes, especially near the radar site. It should be noted here that the highest point in the study area is 2,565 m above mean sea level. The PPI also circumvents with problems such as altitude changing with distance to the radar and ground echoes problems near the radar. Thus, with the PPI, it is difficult to compare the values of radar reflectivity at different distance from the radar.

Comment 4: Can the results be verified on other rainfall events, also with a different rainfall characteristic?

Response 4: The Ze-R relationship obtained by the WCMM approach has been verified with another rainfall event observed during 11-14 September 2000 and the results are included in the revised paper.

Technical comments

Comment 1: The name of Calheiros (I suspect it is him in the cited reference) is misspelled throughout the paper.

Response 1: The spelling has been corrected throughout the paper.

Comment 2: There are very few other typing errors.

Response 2: The manuscript has been reviewed again and corrected for possible

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typing errors.

2) Anonymous Referee 2

General comment: I have read the paper with great interest and find it a good contribution to the discussion of the application of radar to measure rainfall.

Comment 1: A general trend around The World is that radar with very fine resolutions are put into operation. This goes both for the US and the EU. The resolutions of these radars can go down into the order of 100x100m - but still the researchers with radars having this fine resolution are discussing the very large variabilities in rain, which even radars with the very fine resolution don't capture. In the present paper then resolutions of the radar are: 3x3, 5x5, 7x7 and 9x9 km. It appears to me that some of the radar resolutions presented in the present paper are rather big compared to other radar applications. In the paper the area of the radar windows is in order of 10-80 km2. When the resolution of the radar is in this order of magnitude then the mean area rainfall will most likely be underestimated. I would like the authors to comment on this.

Response 1: The radar used in the study receives reflectivity (Ze) data at 5 min interval with a 250 km observation range and 1x1 km resolution. The study analyzed several space windows (3x3, 5x5, 7x7 and 9x9 km) in the proposed approach (window correlation matching method, WCMM) with radar observations at 1x1 km resolution to determine the best match between the observed Ze and R. For example, for the space window of 3x3 km, a total of nine Ze values (at 1x1 km resolution) were correlated with the observed R by the gauges on the ground to find the best Ze-R pair.

Comment 2: I would like the authors to comment on how the selection of the resolution has an impact on an application e.g. within flood forecasting.

Response 2: The radar resolution has not been varied in the study (please see the Response 1, Anonymous Reviewer 2). It is however expected that the large resolution may results in underestimation of rainfall and hence reduced magnitude of the flood

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peak.

Comment 3: I would like a comment from the authors on if they think that the application of the calibrated radar in the paper, will present more accurate computed runoff in a hydrological model - i.e. compared to the application of rain gauges.

Response 3: Authors are of the opinion that the calibrated Ze-R relationship in the paper will provide more accurate computed runoff using a hydrological model compared to the rainfall observed by rain gauges in a sparse network. In a separate study authors found that the number of rain gauges used in rainfall-runoff model has significant impact on the runoff computation. The runoff results provided by the calibrated Ze-R relationship match well the results obtained using rainfall data from the dense network of rain gauges (13 rain gauges in the present study over the watershed of 3,853 km2, an average of about 300km2/gauge). Once the Ze-R relationship is calibrated it can be used for runoff estimation in un-gauged or poorly gauged basin in the area.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 523, 2007.