**Hydrology and
Earth System
Sciences
Discussions**

Interactive comment on "Precipitation accumulation analysis – assimilation of radar-gauge measurements and validation of different methods" *by* E. Gregow et al.

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This paper discusses a study of the performance of different radar-rain gauge merging techniques for Finnish summertime conditions. A new hybrid method that first uses linear regression followed by an objective analysis is found to perform better than any of these two methods separately. The topic of the paper is very relevant for Hydrology and Earth System Sciences. There are several issues that need to be addressed before I think the paper is ready for publication, and I think this will require a major effort. Specific comments are given below.

1   Specific comments

1. It should be made very clear what the novel contribution of this paper is, given the papers on this topic that the authors cite. One of the novel aspects could be that this study is carried out at high latitudes, but then the difference between the summertime climate of Finland should be compared to that of e.g. Belgium (Goudenhoofdt and Delobbe, 2009).

2. One of the conclusions of the Goudenhoofdt and Delobbe (2009) paper was that geostatistical methods consistently outperformed other methods (for daily accumulations). What is the reason for not testing these methods in this study? It would have made sense to me if this was at least discussed, and I think this should be done in a revised version of the manuscript.

3. It is unclear to me where LAPS adds anything to the paper. In the description of LAPS (Section 2.1) it is stated that "the LAPS suite implemented at FMI is able to process several types of in-situ and remotely sensed observations" (p.2457, lines 12-13). However, it is not clear from this section how these data are processed. If I understand correctly from Section 3.1, the only thing LAPS does is convert radar reflectivities to rainfall rates and subsequently computes hourly accumulations. If this is the case, I don't think it is necessary to mention LAPS (simply stating the employed $Z - R$-relations and that accumulations are computed by summing the 5-minute data should suffice). This would simplify the paper and improve its readability.

4. Information on how surface precipitation is computed from volume radar data is scattered over several sections (Sections 2.1, 2.2, and 3.1). This is confusing, because there seem to be some contradictions. For example, it is still not clear to me whether a VPR correction is used or not. On p.2458, lines 15-18 the FMI VPR correction scheme is discussed, but on lines 20-21 of the same page

it is stated that volume data are used in this study. This implies that no VPR correction is applied to these data, as the result of such a correction would not be volume data but surface reflectivity. In Section 3.1, in the description of the LAPS_radar product, no mention is made of a VPR correction. I suggest rewriting and merging Sections 2.1, 2.2, and 3.1. The resulting section should include a clear description of how hourly rainfall accumulations are computed from 5-minute volume radar data. This should also include information on how rainfall estimated from different radars are combined. Rewriting this section will probably be easiest if LAPS is removed from the paper (see my previous comment).

5. In Section 2.2 the error sources in radar rainfall estimates are discussed, but no mention is made here of the errors related to variations in drop size distributions. This is discussed later, but should be included here. This should be solved by rewriting several sections (see my previous comment).

6. On p.2458, line 11, "calibration differences between radars" can be removed in the listing of sources of error in radar rainfall estimation because this is the result of the already mentioned "electronic mis-calibration" (p.2458, line 10) of one or more radars.

7. On p.2459, line 8, the uncertainty of the weighing gauge is stated to be 0.2 mm. Is this including or excluding the sources of error discussed on lines 4-6 of the same page?

8. On p.2459, lines 12-19, the FTA gauges are discussed. Can the authors give an indication of the uncertainty in these measurements? And how does this compare to that of the weighing gauges?

9. On p.2461, lines 3-4, two $Z - R$-relations are given (one for rain and one for snow). How do you determine which one of these to use?

10. In Section 3.2, the linear regression analysis method is discussed. Can the authors briefly describe how this method relates to methods that have been presented in the literature?

11. On p.2461, lines 20-28 and on p.2463, lines 1-20, it is discussed how some data are discarded because of extremely low or high gauge/radar ratios. Why are these criteria different for the different methods? And what effect does this have on the results?

12. On p.2462, Eq.(4), it is not clear to me how the variable Y (the "corrected radar estimate") is computed. Please clarify.

13. On p.2464, Eq.(6), what is the value of w_b that was used here?

14. On p.2464, lines 4-5, can the authors describe how the values of r are successively decreased?

15. On p.2464, line 6, the conditions for the iteration to terminate are given. How is the RMSE that is used as a criterion computed? And how often is the iteration terminated because the maximum number of iterations has been reached, and what are typically the values of RMSE in these cases?

16. On p.2465, Eq.(8), the expression given in this equation is simply the mean error (or bias). I think that the sum should be over $|\text{Analysis} - \text{Gauge}|$.

17. On p.2465 line 23 - p.2466, line 13, the authors draw some conclusions from the analyses based on the comparison of the corrected data to the rain gauges that have been used to correct the radar data. I don't think these conclusions can be drawn based on these analyses. Instead the authors could consider using techniques such as cross-validation (i.e. removing a gauge from the dataset used for correction of the radar data to use it for verification).

18. On p.2466, lines 22-25, the reasons for the differences between the independent and dependent verification are discussed. It is argued that high accumulations have a large impact. Can the authors elaborate on why this is the case? Are there relatively more high-intensity values in the independent dataset?

19. On p.2467, lines 1-2, for which method and at what intensity is this systematic overestimation observed?

20. On p.2468, lines 10-14, new information is given on the correction methods. This should be described in the sections describing the methods, not in the conclusions.

21. In Tables 1 and 2, the standard deviation of the R/G ratio is given. Because of the high skewness of this ratio (minimum 0, maximum infinity, and mean approximately 1), I think the standard deviation of the logarithm of this ratio would make more sense.

22. In Figures 2-5, I suggest using shading or colors to indicate density of points in these graphs (bivariate histograms). This will aid interpretation of these graphs.

23. In Figure 6, could the mean rainfall intensity values be added to the figure?

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