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Interactive comment on "The use of personal weather station observation for improving precipitation estimation and interpolation" *by* András Bárdossy et al.

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We thank Nadav Peleg for taking his time to carefully read our paper and for his constructive remarks.

1. The motivation to use PWS in rainfall estimation is quite clear and well written in the introduction. However, many studies suggest various stochastic and deterministic methods to blend/merge/interpolate different rainfall products, e.g. combining data from rain-gauges, weather radar and CML together. Why not applying an already established method to merge data from trustable rain-gauges

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with PWS? There should be a short explanation in the introduction of why a new merging method is needed.

Merging data requires assumptions on the dependence of the variables and on the error structure of the secondary variable. In the case of PWS, the errors are spatially independent but due to the fact that most of the measurements are likely to be biased the errors do not have zero as mean. This already reduces the number of possible merging methods. Furthermore, quite a few stations may provide erroneous data; that is why we decided to use a filter first. After filtering, some of the established methods such as Co-Kriging could be applied. We tested a non-collocated version of Co-Kriging and found that the *correction* of the secondary observations leads to better results. We'll address this point in the introduction.

2. Empirical distributions are used for all PWS. I was wondering if it wouldn't be more accurate to use a specific distribution instead. For example, the same distribution can be fitted to all the trustable stations (but with different parameters), and the parameters can be spatially interpolated to the PWS (and other) locations.

   This is a good idea and may help identify and to quantify some extremes of the PWS. At the present stage we intended to keep the methodology as simple as possible.

3. I agree that the examples presented in figures 6 to 8 cannot be evaluated against "true-rainfall" due to a lack of spatial information. That is why I believe that there is an added value in comparing the outcomes of the interpolation with data emerging from the weather radar composite in Germany. If you do not trust the radar QPE, there is no need to compare the actual rainfall intensities, but just to demonstrate that the interpolated rainfall fields can assist in revealing high-intensity rainfall features that are "hidden" when using the official rain-gauge network alone.

   We compared interpolated rainfall maps with radar images and discovered quite a few cases where the primary network missed intense precipitation which was

detected using the PWS and also appeared on the radar image. We'll add an example for this to the paper.

4. The potential to use PWS to generate rainfall fields at a minutes-scale is very appealing, especially for applications in urban hydrology. I see the potential in using PWS to simulate rainfall fields at high temporal-resolution, but in the presented study no sub- hourly examples are presented. It will be nice to see if the potential to interpolate the rainfall at high-resolution can be fulfilled and to discuss the limitations of the PWS and methods in going to such fine scales.

   We did not include any examples for short time scales (5 to 30 minutes). The reason for this is that for very fine time scales a space time interpolation is likely to perform much better than the pure spatial interpolation. This however requires some new theoretical developments including advection direction and speed estimations which go beyond the scope of the present paper.

Minor points

L64. 10-min? Yes, some even 1 Minute. In our study, we aggregated all data (i.e. DWD and PWS) to 1h temporal resolution. We will describe our data processing more thoroughly in the revised manuscript.

Figure 2. It can be presented as Supplementary Material.

Based on the comments from referee 1, we will add an additional sub-figure showing a histogram of the available length of the PWS time series and would therefore like to keep this figure in the main text.

L98. "at short time steps" - 1-min? 5-min?

The PWS data are available at 5-min resolution, c.f. answer to L 64.

L102-103. "...thus methods like Co-Kriging or Kriging with an external drift are not applicable" - at this point in the text, some further explanation is needed to put this sentence in context.

Co-Kriging in its regular form cannot be applied but we found a method to use non-collocated observations which we applied. We'll add a few remarks on Co-Kriging.

L102. "is considered to be a random field" - Why? Reading further, this sentence is clear. But it is not clear at first reading.

It should be "not a stationary random field". Will be corrected.

L105. It should be mentioned in the text that alpha defines the percentile threshold. I assume it is subjectively defined?

This was also remarked by referee 1, we'll address this appropriately in the revisions.

Equation 1. I assume Fu stands for distribution function? Please clarify in the text. In addition, there are two commas with empty space in the left term of the equation.

We will clarify this. In Eq. 2 there's a Δt missing between the commas.

Section 3.2. Consider adding a flow chart to illustrate the steps described in this section.

Referee 4 also made a remark that the work flow and interaction of the steps should be pointed out more clearly. We will consider adding a flow chart to make this more clear.

L239. Isn't 95 percentile too low threshold if the goal is to attract the extreme rainfall intensities? Especially for the fine temporal resolution, for which I assume the sample size is quite large.

We tested this for different threshold starting from 95. For the study we've used the 99 percentile.

L397-400. Wouldn't it be more accurate to fit a specific distribution to each secondary station, based on parameters obtained from the primary stations around it?

We do not fit the distribution to the secondary observations as they are biased, but we interpolate the distributions from the primary stations.

The other minor remarks made by the referee will be considered in the revised manuscript.

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