

# ***Interactive comment on “Assessment of spatial uncertainty of heavy local rainfall using a dense gauge network” by Sungmin O and Ulrich Foelsche***

## **Anonymous Referee #1**

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Review of the manuscript #2018-517: "Assessment of spatial uncertainty of heavy local rainfall using a dense gauge network"

Authors: Sungmin O and Ulrich Foelsche

General remarks:

The study analysed uncertainties in the estimation of areal rainfall from point rainfall measurements using data from a dense gauge network in Austria. The study is interesting especially because it presents results from a dataset with unique characteristics such as high density (150 gauges in 300 sq. km), long record (10 years), and pseudo-uniform configuration (gauges located on an approx. regular grid). The topic addressed

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in the manuscript is within the scope of HESS. However, the manuscript would require considerable revision, before it can be accepted for publication. Following are my comments, which are mainly regarding the interpretation and presentation of results, and as such, can be addressed without much recomputations.

Major comments:

1) Discussion on the required number of gauges: The study provides information on the number of gauges required to estimate areal rainfall within an estimation error (NRMSE) of 20%. Such information would be useful for many purposes including i) the design of new gauge networks, and ii) quantifying estimation errors from the existing networks. However it should be noted that it is BOTH the number and the spatial configuration of the network that determine the estimation error. The interplay between spatial configuration and number of gauges can be easily illustrated using hourly scale results in Figure 5 (bottom-left panel). The authors conclude here that 12 gauges are required at hourly scale for NRMSE to be < 20%. However, from Figure 5, it can be seen that the NRMSE at hourly scale can be brought to within 20% even with 8 gauges, although for a specific spatial configuration. So, from the perspective of gauge network design, meeting the desired error limit with the minimum number of gauges is more useful. On the other hand, with 24 gauges, the NRMSE at hourly scale will be below 20% for all 1000 spatial configurations considered in Figure 5. In short, 20% NRMSE at hourly scale can be achieved with 8-24 gauges depending on their spatial configuration. On average (i.e. not always), 12 gauges ensure <20% NRMSE. I suggest that the authors highlight the role of spatial configuration in section 4 where they provide thumb rules on the number of gauges required at each time scale.

2) Consistency in conclusions from Figures 5 and 6: Firstly, if the metric plotted along y-axis of Figure 6 is the ratio of resampled rainfall to true rainfall, then it cannot be negative. Is it defined as (resampled-truth)/truth? The y-axis label and the figure caption should be changed accordingly. While discussing Figure 5, the authors state that "At the daily scale, more than one gauge per 300 km<sup>2</sup> would be sufficient to reach

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the >20% accuracy level. Correspondingly, at the temporal scales of 1-h, 30-min, and 5-min, more than 12, 18, and 33 gauges, respectively, are needed to achieve the same level of accuracy". In lines 15-17 of Page 7, the study concludes that at least 2-5 gauges are required for reliable areal rainfall estimates with "no significant error" and "More than 5 gauges guarantee a high accuracy of areal rainfall estimates". This conclusion of 2-5 gauges is specific to Figure 6. But the manner in which it is mentioned in Page 7 overrules the conclusions reached via Figure 5 and gives an impression that it is the main conclusion as far as the number of gauges required. The differences between Figure 5 (overall NRMSE for 1000 sub-networks) and Figure 6 (inter-event variability for a particular sub-network) need to be clearly discussed in section 4 and in section 6.

3) Effect of spatial scale: It is expected that the rainfall fields are smoother at coarser spatial and temporal scales. In fact, the behaviour is quantified in the form of correlograms (section 3), where the correlation distance increased with time scale. So, the novelty in the analysis presented in section 5 should be discussed clearly?

Specific comments:

1) Page 3, line 23: The authors mention that the gauges record rainfall every five minutes. As the gauges used are tipping-bucket type, I am assuming that the authors' statement implies that the raw data from the data logger is aggregated every five minutes. Please clarify.

2) Page 4, line 15: How are zero values treated during log-transformation of the data before estimating correlograms? Furthermore, a discussion on how the readers should interpret the correlograms obtained in the log-transformed space would be useful. For example, the correlation distance of 200 km for the wet season and daily scale is based on the log-transformed data. So, I wonder how this correlation distance in log-transformed data reflects in the non-transformed space (i.e. rainfall values). On the same note, can the authors elaborate why Pearson's correlation is used over Spear-

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man's correlation? The latter is more robust to non-normality of the data.

3) Page 6, lines 1-4: All rain rates are wrongly mentioned as mm/day. They should be in mm/h to be consistent with Figure 7. Also, are the percentiles in Figure 7 obtained from the full dataset unlike the analysis in section 4 with 71 events? If so, it should be mentioned at the beginning of the section 5. Moreover, 10% of WEGN records at 30-min scale are lower than 38 mm/h. Please change 40 to 38 in the text.

Minor comments:

1) Page 1, line 3: What is "similar approach"? Please add what it is similar to. 2) Page 5, line 15: Consider changing "reach the >20% accuracy" to "reach <20% estimation error". 3) Page 5, Section 5 heading: Consider changing "spatial scaling" to "spatial scale" as the former implies spatial scale-invariance. 4) Page 6, line 18: Same as above comment on "spatial scaling" 5) Page 8, line 8: It should be "afterward" 6) Figure 5: In the box-plot, what does the whisker indicate? Is it [minimum,maximum] or [5th,95th] percentile?

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