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## Reply on RC2 concerning the general remarks

Jieru Yan et al.

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Author comment on "Conditional simulation of spatial rainfall fields using random mixing: a study that implements full control over the stochastic process" by Jieru Yan et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-56-AC2>, 2021

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First, we express our gratitude to Prof. Uijlenhoet for his careful evaluation and valuable suggestions for the improvement of this manuscript. Looking through the comment, we decided to separate the corresponding Author Comment (AC) into two parts: in the first part we present our reply concerning the general remarks from the referee; in the second part, the reply concerning the specific remarks is present. As for the editorial remarks, we thank the referee again and consider making improvement according to each of the editorial remark.

In the general remarks, Prof. Uijlenhoet indicates that there are two limitations, which should be stressed more clearly in the paper. In the following, we present our thinking towards the two issues.

(1) "it is a pure simulation study ..." There are no radar and rain gauge data employed in this study. We have used synthetic rainfall fields for the verification, and the radar and rain gauge data used for application of this approach are derived from the synthetic rainfall fields.

The motivation of doing so is that one can hardly verify the accuracy of a method on the whole without the knowledge of the true rainfall field. There are studies that employ leave-n-out cross validation for the verification, where the QPE is obtained without the knowledge of the n gauge observations, and the estimates at the relevant gauges are compared with the concealed observed values. In this specific setup, one only verifies the accuracy at several points, and the verification of the QPE in terms of the statistics of the entire field (e.g., mean, regional extreme, etc.) is impossible due to the lack of knowledge of the true rainfall field. However, compared to the accuracy at limited points, the accuracy of the QPE in terms of the overall statistics is more important for many applications. Due to the fact that the true rainfall fields are impossible to acquire at the moment, we have used the synthetic ones.

Certainly, synthetic data can only partially represent the reality. As indicated by the referee (Page 2, the 5th bullet in the file "hess-2021-56-RC2-supplement.pdf"), we only introduce random error in the radar estimates, and the systematic errors are not

considered. This remind from the referee is very important. We think the practice of "verification using synthetic data" is appropriate on condition that the synthetic data can represent the reality to some extent (To what extent? At this moment we cannot be more concrete). The specific comment from the referee reminds us that we should improve the synthetic data in terms of the representativeness for the reality, or at least try to consider the range-dependent error, which could become an interesting topic in the future study. Besides, we take the referee's suggestion that we should reflect the fact of using the synthetic data more clearly in the abstract and introduction of this paper.

(2) "the study only considers the estimation of spatial rainfall fields, and completely neglecting the temporal aspect of QPE, which is important for hydrological applications." We have noticed that this issue has been raised again and consider to modify the title of this manuscript to reflect the focus of this study in a more straightforward way, for example, "Simulation of spatial rainfall fields ...", and give a clearer description in the abstract and/or introduction.

This paper only discusses the estimation of spatial rainfall fields. Yet due to the high temporal resolutions of both radar and rain gauge data, the spatial rainfall fields can be estimated at high temporal resolutions, which ends up with QPE at high temporal resolutions. It should be stressed out that such QPEs are obtained in a hind-cast mode, namely, we try to approach the true rainfall field given the observed radar and rain gauge data (some weather condition that has already existed). Unlike the acquisition of QPF (Quantitative Precipitation Forecasts), where modeling of temporal evolution of the precipitation field is of interest, the proposed approach does not involve any temporal simulation. Yet we think that the approach has great potential to improve the quality of QPF. The predictability loss of a nowcast model is caused mainly by (a) the inability of radar to capture the true rainfall field and (b) because the Lagrangian Persistence is unable to model the temporal evolution of the rainfall field (Shehu & Haberlandt, 2020). From this point of view, the approach could be used to improve the rainfall field fed into the nowcast model.

Furthermore, the skill of radar-based nowcasting has been experiencing an evolution from the deterministic to probabilistic frame work to estimate the predictive uncertainty (e.g., Pierce et al., 2012; Shehu 2020). A common approach is based on stochastic simulation in which correlated noise fields are used to perturb a deterministic nowcast (e.g., Seed, 2003; Germann and Zawadzki, 2004; Bowler et al., 2006). What if we feed the nowcast model with multiple realizations of the current rainfall field, for example, the product of the proposed approach? If that is the case, maybe one no longer needs the perturbation for the deterministic nowcast. Besides, if the nowcast community can embrace a change from the deterministic to probabilistic, why not the hindcast community?

## Literature

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