Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC4
https://doi.org/10.5194/hess-2021-56-RC4, 2021

Comment on hess-2021-56

Scott Sinclair (Referee)

Referee 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-RC4, 2021

General comments

The authors introduce a new technique for estimating the true rainfall field by combination of weather radar and rain gauge observations. They also outline a method for estimating the marginal rainfall distribution in the field by combining both observations of the true rainfall.

The new estimation technique is compared in a synthetic experiment with some commonly used alternatives such as Kriging, Kriging with external drift, and Conditional Merging. The performance of the technique is shown to have some advantages relative to the other methods, in particular in reducing the bias in estimation of the extremes, while showing comparable performance to Kriging with drift for estimating the field mean.

I think there are many interesting questions still to be answered before understanding whether the proposed technique will allow a better esimation of the rainfall field and the uncertainty of estimation than the established Kriging methods. For example, does the uncertainty of estimation in figures 7c and 8 represent something more physically meaningful than the Kriging variance?

It would also be of value to understand whether this technique has better performance over a range of time/space scales than other methods. If I understand correctly, in this method both the marginal spatial distribution and spatial correlation are fixed for each field, while for Kriging only the spatial correlation is fixed for instance.

However, the paper already represents a very interesting and useful contribution to the topic and can already be published in my opinion.

Detailed and editorial comments
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* pg 3 , line 87 - consider rewording "Uniform ... to a quantile map". The terminology is a bit confusing. Do you mean transform to a Uniform distribution

using a quantile map?

* pg 4, line 95 - is this quality control step justified by any reason other than practical considerations of the method?

* pg 4, figure 1 - at what spatial scale/domain size can the spatial CDF be considered valid? At some point the domain must be too large for a single CDF to represent all processes? Will the CDF be different for each time-step in a temporal simulation?

* pg 5, figure 2 - Label axes

* Lines 163, 164 - how to decide to increase N?

* Figure 3b - Does a different intermittency u0 change the results shown in the paper in any relevant way?

* Figure 6 - Edit caption to specify that this is for the single field example in fig 5.

* Figure 7 - the gauge layout is a uniform sampling from the field. How would a more 'realistic'/random distribution of gauges in space affect the outcome of the experiments?

* Figure 9 - Errors in estimating the (single?) extreme for each field? What about all extremes above a certain qauntile?

* Line 367 - as above these are the summary of the distributions from single-extreme errors?

* Table 1 - Also also consider including the "extremes of errors" e.g. RM shows less likely, but larger extremes in the errors. Are the extreme errors bounded to be in the same order of magnitude for both methods?