General comment

This study examines the estimation of random error variance in four gridded precipitation datasets derived from various sources using a triangulation method known as the Four Cornered Hat (4CH). The research focuses on Europe (within the overlapping coverage area of the precipitation products) and analyzes the error variance patterns across the different datasets.

The authors have improved the logic and structure of their article while positively addressing my main concern regarding the innovation of the study: their extension of the 3CH method to the 4CH method is built on the work of Sjoberg et al. (2021). But they used additional datasets to compute two of the error covariance terms that must have been neglected in 3CH framework, which is the novel aspect of their work. However, I do not understand why the authors chose to highlight discussion on number that might be relevant for guidance on precipitation forecast verification but are not evaluated or validated, instead of better emphasizing the novelty of their methodological approach. That said, the paper, in its new structure, is acceptable for publication.

Nevertheless, I offer here some responses and clarifications on the authors' answers that might be considered to further improve the paper.

Comment

1) Regarding the evaluation, I acknowledge that the authors present valuable points showing that neither a) in situ network data nor b) E-OBS gauge density information is available for validating their error variance estimates. The authors must be aware that these two kinds of independent validation datasets were given as examples. It is the authors' responsibility to find a way to validate their analysis results to some extent. If this is not possible, I suggest explicitly discussing in the conclusion that validating such numbers is challenging given the current state of the art.

2) Regarding my comment suggesting masking (in grey) pixels where one of the datasets has negative variance in the 4CH method, the authors state in their response: “The numbers, albeit not exact, are still indicative of the product quality.” From my point of view, deriving negative variance for at least one dataset indicates that the 4CH hypotheses do not hold at these particular locations. Since the variance (and covariance) are co-estimated dependently, I would not trust any of these estimates where one of them is incorrect. How can negative variance be linked to product quality? I suggest adding to the manuscript a short message noting that if one of the error estimates is non-physical, the other five estimates at the same location must be treated with caution.

3) Regarding my comment on the disappearance of quality issues observed for the OPERA dataset in the winter/summer stratification, the authors claim that this is a great illustration of the power of the 3CH. I respectfully disagree with this point because, in the conclusion, the authors' final guidance for choosing the verification dataset relies on the non-stratified variance estimates. In the authors' logic OPERA is less useful all year long due to only “a few outliers only present on some days in April or October”, which does not seem accurate to me. The fact that a few outliers strongly influence the overall variance estimate is one of the limit of the current 4CH approach. On the contrary, I suggest the authors emphasize the power of their stratification to move from “static” error variance estimates toward state-dependent error variance estimates. Note that such an approach has been recently introduced in the framework of the Triple Collocation (Pellet et al. 2022).

References :

- Sjoberg, J. P., Anthes, R. A., and Rieckh, T.: The Three-Cornered Hat Method for Estimating Error Variances of Three or More Atmospheric Datasets. Part I: Overview and Evaluation, Journal of Atmospheric and Oceanic Technology, 38, 555–572, https://doi.org/10.1175/JTECH-380D-19-0217.1, 2021.
- V. Pellet, "A Binned Triple Collocation for Estimating Regime-Dependent Uncertainties of Precipitation," in *IEEE Geoscience and Remote Sensing Letters*, vol. 19, pp. 1-5, 2022, Art no. 1005405, doi: 10.1109/LGRS.2022.3162703