Dear Prof. Priscilla Minotti,

Thanks for your comments on our paper. Detailed comments and responses are as follows.

The paper is well designed, nicely written, and presents a novel way to downscale precipitation data by combining semivariogram modeling into spatial random forest with well-known precipitation predictors. Although I consider the paper can be published "as is", I have suggestions for the authors:

[1] The proposed method could be given a name.

[Reply 1]

The proposed method is an easy-to-use spatial Random Forest-based downscaling-calibration method. Thus, it will be termed as SRF-DC in the revised paper.

[2] In 5.5. Further Research, the authors could also address some of the following:

[2.1] the upscaling from 1 km to the 10 km IMERG grid was done by pixel averaging. If some other aggregation stats were used (eg. median, max, mode), would the performance of some of the environmental predictors improve (eg. aspect)?

[Reply 2.1]

After our analyses, we found that the pixel averaging is slightly more accurate than the other operations. This is because the average value reflects the overall trend within each 10 km pixel and reduces the influence of outliers in the 1 km pixels (Karbalaye Ghorbanpour et al., 2021).

The above information will be added to the revised paper.

[2.2] Some other predictors could also be included, such as position based on metric distances instead of latitude-longitude, EVI (with is better related to water content in plants or soil than NDVI), wind or atmospheric pressure features.

[Reply 2.2]

--The predictor of position based on metric distances instead of latitude-longitude was not used in our method. The reasons are as follows:

"Since the classical RF does not consider the spatial information in the modeling process, Hengl et al. (2018) proposed an improved RF for spatial estimation, where the buffer distances from the point-based measurements were taken as the predictors. Motivated by this idea, Baez-Villanueva et al. (2020) presented a RF-based method (RF-MEP) for merging satellite precipitation products and rain gauge measurements, where the spatial distances from all rain gauges to the grid cells in the study site were used as the variables. RF-MEP performed better than all precipitation products and some merging methods. However, as stated by Baez-Villanueva et al. (2020), RF-MEP has a huge computational cost, since the number of extra input features equals to that of gauge measurements. Moreover, RF-MEP ignored the spatial autocorrelation between the gauge measurements. In comparison, SRF-DC only requires one extra feature that is estimated by kriging interpolation on the precipitation measurements. Compared to the buffer distance layers, it is much more computationally effective. Moreover, with the variogram-based kriging interpolation, the spatial autocorrelations between the gauge measurements and between the estimated precipitation and gauge measurements are taken into account. Thus, the aforementioned features make our method accurate, effective and easy-to-use.”

The above information can be found in the Discussion.

--We compared the performance of NDVI-based (proposed method) and EVI-based SRF (SRFEVI), and found that the former is slightly more accurate than the latter (Fig. 1). Thus, the NDVI was used in the study site.

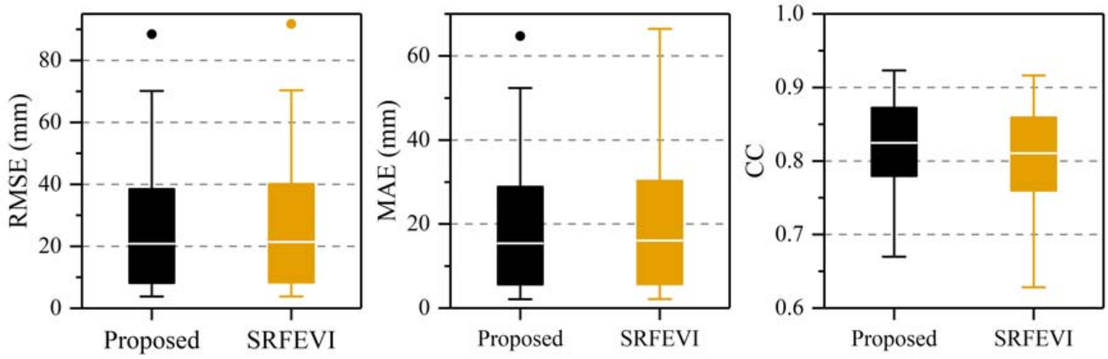

Figure 1 Performance comparison between NDVI-based and EVI-based SRF (i.e. proposed and SRFEVI methods)

--The predictors including wind or atmospheric pressure features were not used in our method, since the highest resolution of the publicly available dataset was 0.1°. The environmental factors should have the resolution of 1 km, since we aim to downscale IMERG from 0.1° to 1 km, and the 1 km environmental factors are taken as the input for the trained SRF.

[2.3] The proposed method could be transferred to use with CHIRPS or TRMM data in other parts of the world, particularly in large tracts of South America, which have complex topography and sparse gauging stations.

[Reply]

Yes. As stated in the last paragraph of our method, “Overall, the proposed methodology is general, robust, accurate and easy-to-use, since its promising performance in the study area with an obvious heterogeneity in terrain morphology and precipitation. Thus, it can be easily applied to other regions, where high resolution and accurate precipitation data is urgently required."

References

Baez-Villanueva, O.M., Zambrano-Bigiarini, M., Beck, H.E., McNamara, I., Ribbe, L., Nauditt, A., Birkel, C., Verbist, K., Giraldo-Osorio, J.D., Xuan Thinh, N. (2020) RF-MEP: A novel Random Forest method for merging gridded precipitation products and ground-based measurements. Remote Sensing of Environment 239:111606

Hengl, T., Nussbaum, M., Wright, M.N., Heuvelink, G.B., Gräler, B.J.P. (2018) Random forest as a generic framework for predictive modeling of spatial and spatio-temporal variables. PeerJ 6:e5518

Karbalaye Ghorbanpour, A., Hessels, T., Moghim, S., Afshar, A. (2021) Comparison and assessment of spatial downscaling methods for enhancing the accuracy of satellite-based precipitation over Lake Urmia Basin. Journal of Hydrology 596:126055

Best wishes,

Chuanfa Chen

Baojian Hu

Yanyan Li