

Response to Interactive discussion

Hydrology and Earth System Sciences (HESS)

Title: A Nonparametric Statistical Technique for Combining Global Precipitation Datasets:
Development and Hydrological Evaluation over the Iberian Peninsula

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We would like to thank Dr. Luca Brocca for his insightful discussion and constructive suggestions. Below we provide a point-by-point response to his comments. Dr. Brocca's comments are in red and our responses in black font.

Short Comments

I quickly read the paper by Md Abul Ehsan Bhuiyan et al. as I am very interested to the proposed methodology. Indeed, as the authors might know, we are working on the combination of state-of-the-art precipitation products (e.g., CMORPH, PERSIANN, 3B42) and satellite soil moisture data (e.g., ESA CCI SM) for improving satellite rainfall C1 HESSD Interactive comment Printer-friendly version Discussion paper estimate (over land). I believe the paper is well written and clear. The final results are very encouraging. However, in my opinion a better description of the different steps involved in the procedure should be given. I reported below my comments/suggestions that I guess could be used from the authors for improving the paper's relevance.

1) As mentioned above, I am very interested to understand the contribution of the different datasets to the final combined precipitation dataset. What is the contribution of the satellite products with respect to the reanalysis? Which is the contribution of satellite soil moisture data? And of air temperature? I believe that running the QRF model in different scenarios considering different subsets of data will easily allow replying to these questions.

Ans:

We appreciate reader's point about the contribution of the different datasets to the final combined precipitation dataset. We demonstrate the relative contribution of each variable based on the variable importance methodology (Breiman, 2001) that is widely applied in this context. Briefly, the mean squared error (MSE) computed from the original model (i.e. considering all variables) is compared against MSE from a new model that holds all variables the same as the original model except one, the one we want to determine its relative importance. Comparison of the MSE between original and new model demonstrates essentially the importance of each variable examined. For more details on the method you can refer to Breiman, 2001.

In this document we present results for the variable importance test only for one of the groups included in our methodology (for warm period-high elevation when rainfall is greater than zero for all products). The importance of the predictor variables depends on the magnitude of the percentage increase in mean square error (%IncMSE) of the model. Higher values of %IncMSE indicate higher importance of the predictor variable.

Figure 1 below shows the variable importance of the seven predictors. According to these results (and for the specific group examined) all variables are important but the level of importance varies considerably between the different variables considered. Soil moisture, reanalysis and CMORPH precipitation rank as most important, with elevation being the least important (see Figure 1 for details).

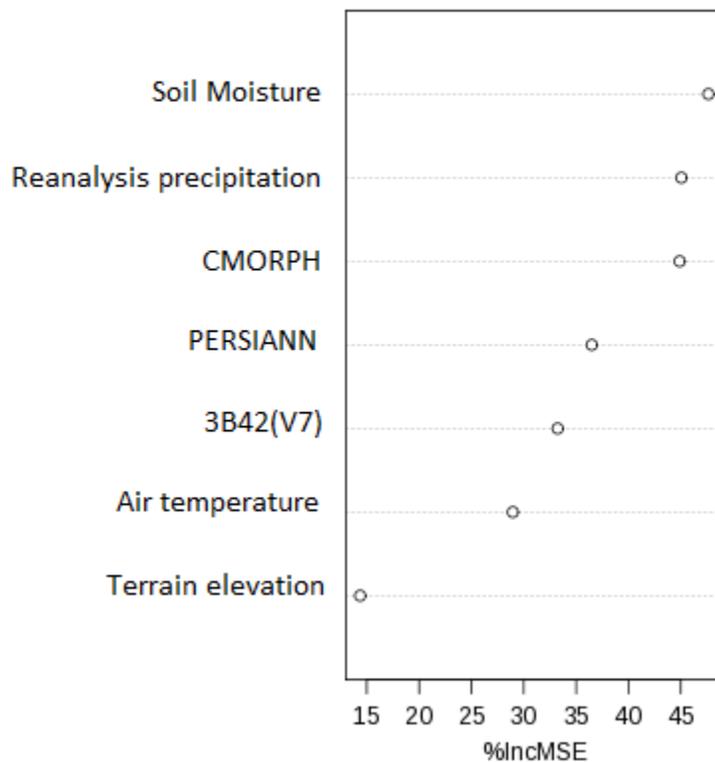


Figure 1: Variable importance plot, where %IncMSE is the percentage increase in mean square error.

We are going to include a complete analysis in the revised paper.

2) Actually, if I well understood, the same data period is used for the calibration and the assessment of the combined precipitation dataset. It is not fair in the comparison with the single products. Likely, a split of the data in a calibration/validation period is needed.

Ans:

First, we would like to clarify that the precipitation error statistics are based on hold-one-out validation. Meaning, each point in the statistics was not included in the calibration of the technique. The hydrologic evaluation on the other hand was based on the final (all points) technique

calibration and it is intended to demonstrate the importance of the ensemble representation and propagation in the hydrologic simulations. This aspect will be better clarified in the revised manuscript.

We would also like to point out that objective of this paper is to present a methodology that allows to combine different sources of information on precipitation and other variables (soil moisture, temperature, terrain complexity, etc.) to provide a more accurate representation of precipitation estimation uncertainty, and through this ensemble representation evaluate how this uncertainty propagates in hydrologic simulations. Results in the current manuscript demonstrate that the Quantile Regression Forests (QRF) technique is successful on doing so, while reducing mean error in both precipitation and flow simulations.

The issue of separating data in calibration/validation is more relevant in the case that we would like to evaluate how stable is the blending algorithm for real-time application, where ground-reference is not yet available. This is an important question, but it is not within the scope of our current manuscript. It is definitely though one to consider as a future step in this line of work.

So, to summarize, our current objectives are more in line with the context of retrospective analysis. Given that a vast majority of studies on hydro-meteorological applications of satellite-precipitation products is based on post-real time products, we consider both valid and significant to be able to apply a method like the one proposed for advancing precipitation reanalysis.

3) What is the final objective of the paper? If the authors want to provide a superior rainfall dataset, it should be tested against the SAFRAN reference dataset. What are the differences in the performance of hydrological modelling between SAFRAN and the combined dataset? This analysis might provide interesting insights.

Ans:

As stated above the aim is mostly to provide a method rather than a “superior dataset”. We are presenting a blending technique that leads to an improved characterization of precipitation estimation uncertainty through an optimal combination of precipitation and other datasets, but we do not claim that we have examined exhaustively the combinations of variables or products that can potentially lead to a “superior product”. In fact we hope that this work will trigger the interest of the community (as in your case) to investigate these aspects in more detail.

Evaluation metrics for rainfall and streamflow simulations are reported in the manuscript based on SAFRAN and SAFRAN-forced simulations as reference respectively. Please take a look at Figs 5,6,9,10 and corresponding text in manuscript.

4) (MINOR) Among the different satellite rainfall products, PERSIANN and CMORPH should be the versions only based on satellite data. Differently, 3B42 (V7) is corrected with rain gauge observations. Therefore, the comparison between them is not fair, and I suggest in using the real-time version of TMPA (3B42RT) for a more interesting comparison.

Ans:

Thank you for this note. In fact, the CMORPH and PERSIANN products considered in this work are also gauge-adjusted. We will clarify this in the revised manuscript.