

Response to Community Comment #1

Overview Comment:

I enjoyed reading this interesting work that has the potential to contribute to reservoir operations in the Niger Basin. I think the topic of the manuscript fits well to the journal. The use of language needs minor edits and the structure could be improved. I listed my main and minor comments below, that I think will improve the flow, the clarity and the significance of the manuscript.

Response: Thank you very much for your great inputs. We are glad to hear that you enjoyed the work. We agree that the work is important in utilizing forecasts to improve reservoir operation. We have tried our best to address all your comments as we revised the manuscript. Please see below on our itemized response.

Main Comments:

1) Abstract: It is not clear which rainfall dataset is used as reference for performance analysis of the GFS forecast. Only later in the text it is mentioned that IMERG Final is the reference dataset. Please provide the numerical values for the performance statistics. For example, the numerical values for the overestimation, underestimation, large random errors, high false alarm etc should be provided. Moreover, a statement that other satellite products are also compared should be provided in abstract.

Response: We have now included (1) a statement indicating that IMERG Final is used as a reference, and (2) a statement indicating that other satellite data products are also compared. We prefer not to provide numerical values for the error characteristics, as they vary highly depending on watershed, climatic regime, lead-time, averaging timescale, averaging spatial scale, and rainfall rate.

2) Abstract: Last sentence: It is not clear whether the authors performed an analysis to support this statement. If yes, this statement should be supported with the method and findings utilized, otherwise it is a general statement and should be removed from abstract.

Response: We agree that we have not provided supporting analysis, and therefore have replaced the statement *“The accuracy of GFS forecasts could be improved by applying post-processing techniques involving near-real time satellite rainfall products.”* with *“We recommend exploring appropriate post-processing calibration techniques, that use near-real time products, such as, IMERG Early, to improve the performance of GFS, particularly at shorter time scales.”*

The reason for our recommendation is that IMERG Early outperforms GFS in most cases, and therefore, it can be used to calibrate GFS. The IMERG Early outperform GFS in Wet Guinea and Savannah regions in terms of bias, and the spatial structure of IMERG Early is the same as IMERG Final – as the main difference between the two products in the

inclusion or exclusion of rain gauge data which affects primarily the bias. However, it is not clear what kind of post-processing technique is more appropriate.

3) I think Section 2.Data and Methodology should be divided into two sections namely “2. Study Area and Datasets” and “3. Methodology”. Lines 141-196 should move to the 2.1. Study Area section. Current Sections 2.1-2.3 should move to new “2.2. Datasets” section. Current Section 2.4 should move to “3.Methodology” section. This section should also include other data processing methods used in the study such as scale matching between products, basin-scale conversion etc. as well as study time period.

Response: We have re-arranged the sections as follows. We have created a separate section labeled “Study Region” and moved Lines 141 – 196 to the Study Region section. In the ‘Evaluation’ Section, we have added the data processing methods.

4) IMERG Early Cal: This product is not shown in Figure 3 and shown in Figure 4 but not discussed in text. The reader has no information about this product until Section 3.5. To eliminate this confusion, please discuss the motivation for producing this rainfall dataset and the methodology for adjusting IMERG Early using IMERG Final in the Methodology section (Lines 347-352 in the manuscript). It may be worthwhile to indicate that the advantage of simple climatological correction for IMERG Early would be the shorter lag time (a few hours) compared to IMERG Final (3.5 months).

Response: We have decided to remove the ‘IMERG Early Cal’ dataset from our evaluation (as also suggested by another Reviewer). The climatological bias correction approach used to generate the ‘IMERG Early Cal’ dataset did not really improve performance compared to IMERG Early.

5) Section 3.4: This section shows the scatterplots comparing correspondence between daily rainfall events between IMERG Final and GFS. Therefore, it is not related to uncertainty but a different way of comparing daily events. Section 3.4 can therefore be merged with Section 3.3.

Response: Yes, however, we formed our different sections based on the different ways of comparisons.

6) Section: 3.6: Please discuss the methodology for changing spatial scale of the products in the Methodology section. Moreover, indicate the reference rainfall product used in this section (IMERG Final). It may be helpful for the reader to include the watershed area next to each watershed name in Figure 9. Also somewhere in the manuscript, the number of rainfall product grids over each dam watershed should be provided.

Response: We have included the methodology in the ‘Evaluation’ Section. We have added the watershed areas.

7) I suggest that the title of the manuscript should be modified to include the use of satellite rainfall products in the comparison. For example something similar to “Performance evaluation of the Global Forecast System’s Medium-Range Precipitation Forecasts in the Niger River Basin using multiple satellite-based products.”

Response: Yes, this is a better title. We have used it.

8) In conclusion section, a discussion on the study findings for dam operation would be beneficial for the reader since the focus is on dam watersheds (for example the impact of change in lead time performance in dam operation).

Response: Yes, this is an important issue. However, it is difficult for us to state the implication of the forecast accuracy on reservoir operation at this stage, simply because the relationship between forecast accuracy and dam operation is not well-known. This could be a good topic for future research – thank you for the idea.

Minor Comments:

Line 37: Typo “Nige” should be corrected “Niger”

Response: Corrected.

Line 36: Figure 1: Figure should appear in the same or next page of the first referral.

Response: Done.

Lines 56-59: This last sentence should move to the next paragraph.

Response: Done.

Line 61: A reference (Huffman et al.) to IMERG product should be provided early in this paragraph.

Response: Done.

Line 76: Typo, please correct “IMERG Fsatellite gauged)”

Response: Corrected.

Line 80: Please provide temporal and spatial resolutions in parenthesis.

Response: We have added this information.

Line 82: Replace “motivate” with “motivated”

Response: The word has been removed due to rearranging.

Line 106: Typo. “mass-flus”

Response: Fixed.

Line 118: Remove “Earth Data”

Response: Word has been removed.

Line 164: Unit is missing for Markala Dam watershed size.

Response: Added.

Line 199: Replace “previous” with “upstream”

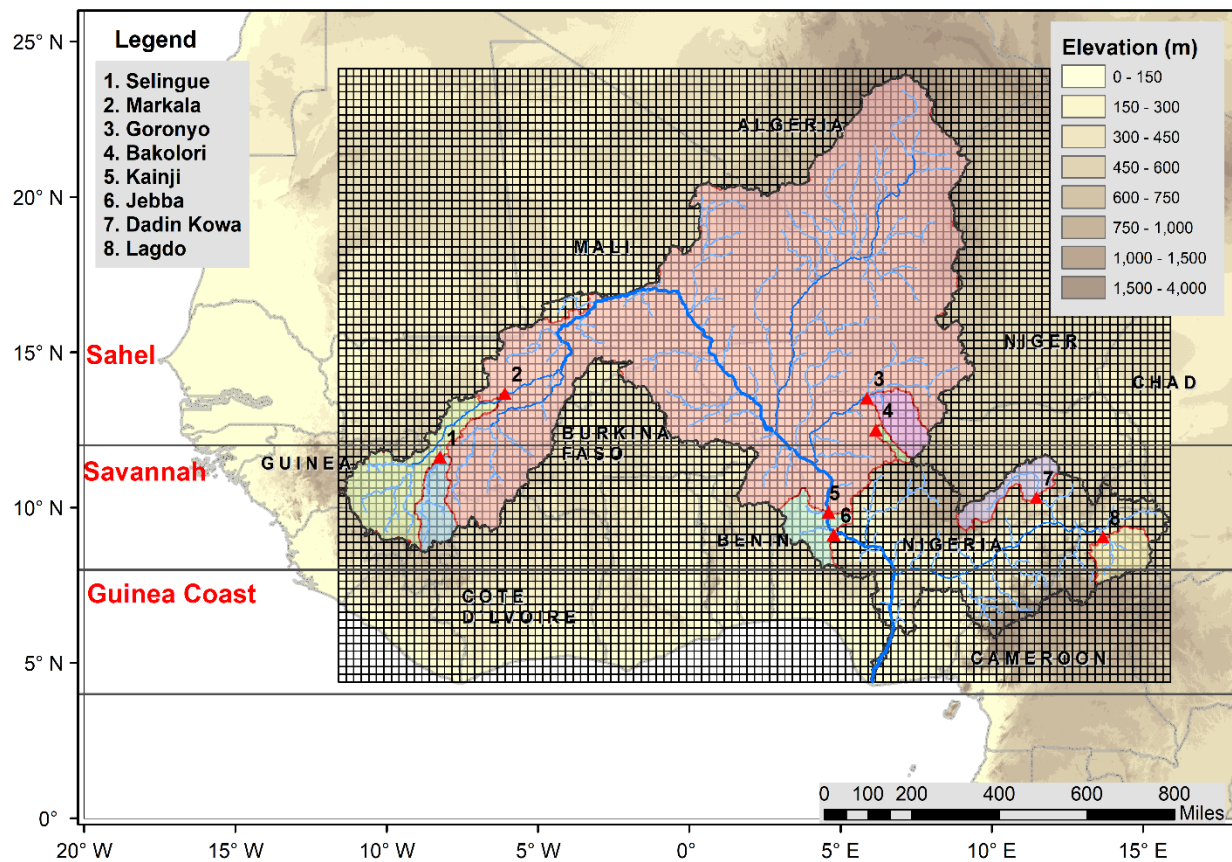
Response: Replaced.

Table 1: Is there a source for this information?

Response: Yes, source has been added.

Figure 1: Please overlay GFS, IMERG and other satellite-product grids on this figure as a reference and to better understand dataset scale in comparison to dam watershed scale.

Response: We tried this (see below) but it did not come out well. So, we opted to keep the original figure.



Line 209: Replace “coefficient if variation” with “coefficient of variation”

Response: Replaced.

Line 207: Coefficient of variation is used in the modified KGE measure proposed by Kling et al (2012) and generally denoted by KGE' . Therefore, please include this information in description of KGE used in this study.

Response: It is now included.

Lines 211-212: I do not recall this classification by Kling et al. (2012). Please check to make sure correct citation is provided for this KGE classification.

Response: We have replaced it by the correct reference.

Lines 215-216: The following information is also important and can be included here: R measure is important in reproducing the temporal dynamics.

Response: We have added it.

Figure 2: It will help readability if horizontal lines are drawn to represent the regions (4,8,12 degrees) as shown in Figure 1.

Response: We have drawn the requested horizontal lines.

Figure 3: Please include which year this graph represents in the caption or text.

Response: Temporal period is provided in the caption.

Line 254: Please provide the methodology used to calculate watershed-averaged rainfall in the methodology section. How many rainfall grids represent each basin etc.

Response: We have added the methodology in Section 2.5 (Evaluation). The watershed areas are already given in Table 21.

Figure 4: Check spelling for Goronye sub-basin throughout the manuscript, for example in Figure 1 it is Goronyo.

Response: We have done this.

Figure 7: Please provide time period information in caption. Color coding of the markers, similar to Figure 5, will improve readability.

Response: We have added the time period information in the caption. We are trying to avoid color as much as possible (to cut publication cost). We thought that the different positions of GFS and satellite products will make it easier to read -

Line 327: I suggest modifying the sentence: The overestimation by IMERG Early is particularly...

Response: The sentence was removed due to re-writing.

Figure 10: This figure should come after first referral in the text (Section 3.7).

Response: We have moved the figure.

Lines 393-394: Check grammar.

Response: We have fixed this.

Figure 12: "daily" should be removed from x and y axis titles.

Response: Done.

Abstract: Include the findings from Sections 3.6 and 3.7 in the abstract.

Response: We have re-written the abstract to include these findings.

Line 432: Typo “featured emerged” replace with “features emerged”

Response: Typo fixed.

Lines 449-450: I did not see a section on calibration of GFS using IMERG-Early. Please clarify or remove this sentence

Response: We have removed this sentence.