**Author Comment: Evaluation of hydroclimatic biases in the Community Earth System Model (CESM1) within the Mississippi River Basin**

***Reviewer 2***

The authors investigated the biases in monthly atmospheric and land surface variables in CESM1 data in the Mississippi River Basin (MRB). They found that there exist large seasonal biases in CESM1 precipitation, runoff, and discharge simulations. By comparing with other CMIP6 model data, they showed that the CESM2 model had better precipitation seasonality than CESM1 model. While this study provides useful information about the CESM1 model quality in the MRB, a few major issues need to be addressed before this paper can be accepted.

We thank Reviewer 2 for the thoughtful comments on our manuscript.

Major comments:

1. The primary concern is the value of evaluating only the CESM1 model when CESM2 large ensemble project data are available for this region. I suggest reorganizing this study to evaluate both CESM1 and CESM2 data and highlight the improvements in the CESM2 model.

   We thank Reviewer 2 for this suggestion and agree that emphasizing the improvements in CESM2 is important. However, we believe that addressing Reviewer 1's comments on clarifying the motivations will better address this. By more clearly stating the value of CESM1 – it being one of the few CMIP5 models that has both a routing model and multiple available modeling projects, including the Last Millennium Ensemble (CESM-LME), which is still widely in use – we can then focus attention on the relevant hydrologic biases present in the region that impact the seasonality of discharge for those that still rely on the CESM1 model output for lack of other options.

2. The division of the MRB into western and eastern parts may not be sufficiently justified. The major sub-basins in the western part, i.e., Upper Mississippi, Missouri, and Arkansas River Basins, have very different atmospheric and hydrological properties. I recommend conducting comparison individually for each major river basins.

   We agree with Reviewer 2 that the major subbasins of the Mississippi River basin have a range of atmospheric and hydrologic properties. We began our investigation by comparing each major subbasin individually rather than by grouping them into the eastern and western parts, but found the seasonal trends among individual basins to be similar enough that grouping them streamlined the results. We can add results from the major sub-basins to an appendix.

3. Figures 3, 4, 7: These figures have two y-axes with different ranges on each side. Does this indicate that the climate model data have significantly different magnitudes compared to reanalysis/observations? I suggest using consistent y-axis ranges for these figures to avoid misleading interpretations, but I understand that the authors may want to compare seasonality patterns rather than magnitudes.

We agree with Reviewer 2 that one y-axis is the most ideal plot layout. With the difference in magnitude between the data sets, the seasonality patterns are not visible if they are plotted on one y-axis; we will add a note in any figure captions where different y-axis scaling is used to avoid misleading interpretations.

4. Line 110: The gauge record was divided into pre- and post-modification periods. Please provide references to support the chosen separation year. Also, I suggest a more thorough discussion of the influences of human modification on river discharge in the MRB. The main stem of the river was heavily controlled by dams and flood protection structures. The influence of these structures on river flows should be mentioned and highlighted.

   We agree with Reviewer 2 that the delineation between pre- and post- modification years needs to be well supported. The years listed in Table 2 are the end of the periods of major river modification when the impacts of the modifications are fully implemented, based on the literature cited in the Table 2 caption. We can further clarify the choice of these years in the text in a revised manuscript, along with more discussion on the influence of dams and flood control structures in the basin.

Minor comments:

1. Line 150: Please provide more details about the lag correlation and spectral angle methods. What formulas were used to calculate these two metrics?

   We agree with Reviewer 2 that this should be specified, and will update the methods section of the manuscript to include this.

2. Table 3: If possible, consider using figures instead of tables to present these results.

   We thank the reviewer for pointing out that clarification is needed. The results in Table 3 summarize values from Figures 2,3, and 4 that are discussed in the text, so we will add clarification in the captions and text or rearrange content for clarity.

3. Figure 2: Adding the names of gauges used for each sub-basin would be helpful.

   We agree with Reviewer 2 and can add the names of the gages in addition to the numbers.

4. Figure 7: Please specify the uncertainty range in the figure caption. Is it a 95% uncertainty interval? Also, clarify the source of uncertainty. Is it coming from inter-annual variability or ensemble variability?

   We agree with the reviewer that this should be specified and will update Figure 7 accordingly.