Article: Assessing inter-annual variability in nitrogen sourcing and retention through hybrid Bayesian watershed modeling

Response to Anonymous Referee #1: Responses in red

General comments:

This is a well-written paper, presenting an interesting model of nitrogen loading across river basins, accounting for temporal variability. In general, the methods appear to be appropriate, with assumptions and potential biases considered and appropriately accounted for, while the results are well interpreted and implications for policy are discussed.

I suggest below some specific comments, most of which are very minor in nature.

Thank you for the feedback on our manuscript; we address your specific comments below.

Specific comments:

Equation 1 (line 160). I am not sure I completely understand this formulation. It seems like there are only 2 upstream LMSs considered (k and l), while line 161 mentions "n". I do not have access to the original reference, but I wonder if some minor clarification would be helpful here.

"n" is a count variable that ranges from 1 to n. In our study, the largest value for n was 3 for site HR3. The "k and l" in the parentheses in this sentence confused this. We will clarify this in our revisions.

Section 2.9 (lines 216 to 232). Has a sensitivity analysis been carried out to investigate the effects of changing the informative priors? If not, I think this would be useful in understanding the robustness of the model. In any case, I think that some discussion of this is required.

In Strickling & Obenour (2018), such a sensitivity analysis was carried out on the data by running the hybrid watershed model with uninformative priors. This produced only small changes in the parameter estimates. In this study we are working with a larger observational dataset (25 load monitoring sites, compared to 21 sites in Strickling & Obenour), such that the influence of the priors is likely smaller. As such, we don't think this exercise would add new insights. We will note this briefly in our revisions to the Methods section.

Section 3.3 (lines 260 to 275). Can the CI endpoints be reproduced here? Currently, I feel that the point estimates without this context suggest greater certainty in these values than is the reality.

We agree that the point estimates might imply higher certainty than is warranted, but we do not want to duplicate all of the 95% CIs from Table 3, which might make the text cumbersome. We will add coefficients of variation (CV) in this section to convey the uncertainty in the point estimates.

Technical corrections:

Line 46. A comma between "reservoirs" and "using" might be useful.

We agree and will edit the text at line 46.

Line 144. I think "plant" is unnecessary, being effectively a repetition here.

We agree and will edit the text at line 144.

Line 172. Is 10^5 definitely correct here? (It seems very large for an offset for a log transformation.)

We had incremental loading on the order of -50,000 kg/yr. in certain watersheds downstream of impoundments (FL6, and FL 9) that required us to use this offset. While this offset may seem large, incremental loads can reach above 10^6 kg/yr (see Figure S7), so that it is not particularly influential. Note: the axis labels on Fig S7 should be "$* 10^6$", not "$+ 10^6$". This will be revised for the final manuscript.

Line 261. "ECs" need to be defined here. The acronym is only defined in the captions for Tables 2 and 3, but not in the main text.

We agree and will define "EC" at Line 189.

Line 620. "CI" needs to be defined as "credible interval" in the caption of Table 2.

We agree and will edit the text in the caption of Table 2.

.Supplementary material: Can the figure captions be checked to ensure that the captions contain all required information? E.g. It would be helpful for Figure S3 to define the dashed line in the caption, while dots and lines could be defined in the caption of Figure S4 (so that this is self-contained without relying on the caption of Figure 3).

We have checked all captions in the SI and will edit them so they are self-contained.