Review of the manuscript "*Applying sequential Monte Carlo Methods into a distributed hydrologic model: lagged particle filtering approach with regularization"* by Noh, Tachikawa, Shiiba, and Kim

In this article the authors present a modification of the classical particle filtering approach called the lagged regularized particle filtering approach. The new approach is applied to a distributed hydrological model in order to illustrate the benefits of this approach in comparison to a systematic importance resampling filter.
The article is well structured and describes the theory and practical application of the approach in a reasonable manner. However, it does not illustrate and discuss in sufficient detail the advantages and disadvantages of the lagged RPF. Furthermore, some of the conclusions are not sufficiently supported by the results presented. Finally, the English grammar and syntax needs to be revised. Hence, I recommend major revision.

Manuscript Evaluation Criteria

Scientific Significance: 3
Scientific Quality: 3
Presentation Quality: 3

1. Does the paper address relevant scientific questions within the scope of HESS? Yes
2. Does the paper present novel concepts, ideas, tools, or data? Yes
3. Are substantial conclusions reached? Partly
4. Are the scientific methods and assumptions valid and clearly outlined? Yes
5. Are the results sufficient to support the interpretations and conclusions? No
6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Yes
7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes
8. Does the title clearly reflect the contents of the paper? Yes
9. Does the abstract provide a concise and complete summary? No
10. Is the overall presentation well structured and clear? Yes
11. Is the language fluent and precise? No
12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Yes
13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? Yes
14. Are the number and quality of references appropriate? Yes
15. Is the amount and quality of supplementary material appropriate? N/A

Major Comments:

Although the authors describe well the theory and implementation of the lagged regularized particle filter, their results are either unsatisfactory or insufficient to support the conclusions. The authors claim, that "the accuracy of lagged RPF is higher than the other filters in the calibration period" (p. 3402). However, the difference between the Nash-Sutcliffe model efficiency of the SIR and the lagged RPF is only 0.05, which is negligible. Furthermore, the performance of the SIR and the lagged RPF is clearly equal for the validation period according to the Nash-Sutcliffe model efficiency.
The authors also claim that "lagged filtering is evaluated to have more proper probabilistic bands, whereas SIR reproduced more diffuse probable density" (p. 3403). However, this finding is not supported neither by the predictive QQ plots (Fig. 10) nor the forecasts (Fig. 8). Fig. 8 only shows that the uncertainty bands are narrower for the lagged RPF in comparison to the SIR. This does not necessarily mean that they are more appropriate, as is shown in the predictive QQ plots. Fig. 10 shows that lagged RPF tends to underpredict the observations (most likely due to the narrower uncertainty bands!) whereas SIR tends to overestimate the predictive uncertainty. Hence, the only result which is shown by the authors is that both approaches (SIR & lagged RPF) have a similar overall performance (see Nash-Sutcliffe efficiency) but generate different problems for the predictive uncertainty.
Finally, the authors claim that the lagged RPF preserves particle diversity better than the SIR. This is indeed proven by Fig. 11. Unfortunately, the authors mention only once (p. 3398) that this gain comes with a 2.6 times higher computational cost than compared to the SIR. Hence, if I would double the amount of particles for the SIR approach, I would have a comparable computational cost and probably a similar or even better n_{ratio} and also maybe even better simulation results. Thus, one could ask the question why implement a relatively complex approach (such as lagged RPF) when a simple increasing of particle numbers would most likely have the same effect (or even better)?
The authors need to do a better job in justifying the use of the lagged RPF. The theoretical advantages of the lagged RPF are that it prevents particle filter degeneracy and sample impoverishment. For example, these problems become very relevant when a lot of error sources are included into the model (e.g. error in input forcing like precip, temp, evap; process errors; and parameter uncertainty). Hence, I suggest that the authors rethink their case studies in order to illustrate better what the advantages of the lagged RPF are and thus rewrite the chapter 5 and 6.

Minor Comments:

- Please correct references Salaman and Feyen into Salamon & Feyen
- Describe in more detail why you chose 0.05 for $alpha_{soil}$ and 50mm for $beta_{soil}$. Are these typical error ranges reported in literature? Are those values based on a sensitivity analysis?
- Abstract: the abstract only contains a general description of what methods/models have been used in this work, and only in the very last sentence you mention something about the result. Please rewrite the abstract so that you write more

about the results (which is supposedly the most important part of a paper) and only very briefly mention the methods and models applied.

- There are numerous errors in English grammar and syntax which I will not list here in detail. I strongly suggest that before resubmitting this work is proofread with a focus on English grammar and syntax.