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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Accounting for three sources of uncertainty in ensemble hydrological forecasting" *by* A. Thiboult et al.

**Anonymous Referee #1**

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This manuscript investigated impacts of different uncertainty sources on streamflow forecasting comparing various combinations including multi-model ensemble, data assimilation, and meteorological ensembles. It fits well the scope of Hydrology and Earth System Sciences and the topic is of interest to a broad ranges of the scientific and engineering community. Their research questions and methodologies are of importance to better improve understanding on prediction uncertainty. However, for some study materials, description and information are not enough to convince general readers of their results. Especially, I have concerns on excessively simplified application of hydrologic models in terms of spatial and temporal scales and interpretation of contribution of different uncertainty sources. Therefore, revisions should be required to clarify several issues shown below before possible publication:



Major comments:

1. Multimoodel ensemble:

- Abstract: One of main findings of this manuscript is that the multimodel approach to take into account structural uncertainty supports the streamflow forecasts to maintain the required dispersion throughout the entire forecast horizon. However, such a statement might mislead a conclusion as if structural uncertainty is a dominating factor rather than forcing uncertainty, which could not convince readers with given results of this study. The fact that contribution of the meteorological ensemble forcing was negligible compared to deterministic one (Fig. 8) could strengthen such misinterpretation. In this study, as I understood correctly, input uncertainty (e.g. forecast forcings) seemed to be compensated by structural uncertainty (e.g. multimodel) to enhance performance metrics. In addition, when we recall one of aims of this study is to decipher the traditional hydrometeorological sources of uncertainty (Page 7183), it is a bit doubtful if their aim was achieved and demonstrated successfully. Please clarify your findings and opinions on hydrologic prediction uncertainty which can be concluded from your study results.

2. Specification of individual model:

- Line 7-8 at page 7186: It is not clear whether or not spatial discretization is considered to construct catchment applications by 20 conceptual lumped models. There are lots of ways and examples to apply lumped hydrologic models considering spatial heterogeneity. Please clarify this sentence and relevant comments below:

- If spatial discretization 'IS' considered related to 1st comment, please clarify what spatial resolution was used. Additionally, how spatial heterogeneity was resolved in parameterization using lumped models?

- If spatial discretization is 'NOT' considered, please clarify how large catchments (> 10,000 square kilometers) were conceptualized and parameterized.

- Regardless of spatial discretization, please clarify which flow routing methods were used in each model.

3. Meteorological ensemble

- In page 7185, rainfall forecasts seemed to be aggregated in space (one point per catchment) and time (daily). Please clarify possible impacts of excessive aggregation of rainfall forecasts on study results.

- For evaluating contribution of different uncertain sources on forecasts, it is essential to check bias of input forcing forecasts for varying lead times, while the manuscript only showed MCRPS. Pleas clarify the detailed analysis on it.

- In Line 8-9 Page 7186, please clarify the sentence such as "modifications include their spatial discretization if they were initially distributed and their evapotranspiration formulation".

4. Information and analysis on catchments

- In Section 2.1, information on catchments is limited. A new table showing information of each catchment such as catchment size, river length, low and high flow, typical time of concentration of flood, and etc, is required.

- Please clarify whether there are critical human intervention facilities such as dam reservoir, water gate, or weir in catchments. If there are, please clarify how such intervention was considered or affected in model configuration or results.

- Analysis on catchments in Results (e.g. Fig. 3, 5, 8, 10, 11, and 12) should be revised with additional analysis or figures regarding catchment characteristics such as catchment size or human intervention (e.g. Rakovec et al. 2015).

References:

Rakovec, O., Kumar, R., Mai, J., Cuntz, M., Thober, S., Zink, M., Attinger, S., Schafer, D., Schron, M., Samaniego, L. (2015): Multiscale and multivariate evalua-



tion of water fluxes and states over European river basins, J. Hydrometeorol., in press, doi:10.1175/JHM-D-15-0054.1.

5. DA

- Please clarify how observation uncertainty was considered in EnKF. In conventional EnKF, noise for observation is commonly added to each ensemble which may lead to increase additional uncertainty. Otherwise, square root formulation can be used to avoid instability coming from observation noise.

- In Section 3.5, please clarify how EnKF perturbation was optimized in details in the case of H. Please remind that authors already mentioned that "the optimal setting may use unrealistically high perturbations that compensate partially for the structural error".

- In Conclusion, authors described quick decrease of reliability is found in EnKF. However, it might be accelerated by coarse spatial and temporal resolution of models and input. Please clarify this issue.

6. Figures and analysis

- Model diagnostic metrics were drawn by aggregating results of all simulation periods. Additional analysis and description on conditional statistics of different flow regimes and seasons are highly recommended.

- Similar figures on reliability and catchment comparison are suggested to be removed or merged together.

Minor comments:

1. Please use a consistent term between catchment and watershed throughout the manuscript.

2. In Fig. 7, the legend of a dotted line is not shown.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 7179, 2015.