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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Multi-source data assimilation for physically-based hydrological modeling of an experimental hillslope" *by* Anna Botto et al.

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Reply to Anonymous Referee 1

We would like to express our great appreciation for the detailed comments, suggestions and corrections, which will greatly help to improve our manuscript. In the following, we provide a point-by-point reply to the main reviewer's comments.

First, I wonder if, in the interest of clarity, it would be possible to reduce the number of scenarios presented (as many as 19!) while preserving the main conclusions drawn in the study.

Thank you for drawing attention to this point. Our main goal was to provide a comprehensive series of simulation scenarios, both in terms of variables to be assimilated and variables to be updated, in order to make our conclusions as general as possible. In our opinion, the number of scenarios presented (19, including two open-loop cases) is appropriate to assess the impacts and trade-offs associated to the different combinations of assimilated and updated variables. We tried to be concise by summarizing the results of all scenarios in Figure 4, which conveys a synthetic but effective overview. Then, for brevity, we only analyse detailed results in a number of selected and representative scenarios.

Second, since an EnKF algorithm is used, it might be worthwhile to assess - perhaps by applying a restart-EnKF in some key scenarios - the effects of numerical inconsistencies introduced when updated, and thus statistically modified, states and parameters are merged into the flow model at the data assimilation times.

Thank you for raising this important issue. We actually considered applying a restart-EnKF, but then we decided not to use it for two main reasons. First, although the restart-EnKF is very valuable in the case of solute transport, where it is important that the contaminant mass after each update is consistent with the updated parameters (e.g., Camporese et al., 2011, 2015), in the case of flow only, possible numerical inconsistencies between the re-initialized system state and updated parameters quickly disappear thanks to the dissipative nature of the Richards equation. Second, but not less important, this strategy would be extremely computationally demanding,

as we would need to restart many times from the beginning an ensemble of strongly nonlinear simulations. In summary, the trade-off between increased computational costs and expected improvements of the results would probably make a restart-EnKF not worth the effort in this context.

Additional minor comments, requests for clarification and proposed changes are provided in the attached document.

Thank you very much for your detailed evaluation of our manuscript. Each minor comment will be carefully considered and properly addressed.

References

Camporese, M., G. Cassiani, R. Deiana, and P. Salandin (2011), Assessment of local hydraulic properties from electrical resistivity tomography monitoring of a three-dimensional synthetic tracer test experiment, Water Resour. Res., 47, W12508, doi:10.1029/2011WR010528.

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