Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., author comment AC3
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# Reply on RC2

Tobias Sebastian Finn et al.

Author comment on "Ensemble-based data assimilation of atmospheric boundary layer observations improves the soil moisture analysis in idealized limited-area experiments" by Tobias Sebastian Finn et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-672-AC3, 2021

Additionally incorporating the comments by refree #2, we have decided to completely overhaul our manuscript to improve its clarity. As a first step, we will provide additional explanations to concepts that are needed within our manuscript.

To be specific, we will rearange existing sections and create a new, hopefully more logical, structure:

- **Introduction**: We will provide a more gentle entry into the study, explaining the physical circumstances that allow to assimilate atmospheric boundary layer observations into the land surface. In addition, we will make the step from the simplified extended Kalman filter (SEKF) to the localized ensemble Kalman filter (LETKF) more explicit and explain more in detail what is needed for this step. In this introduction, we will clarify the scope of our manuscript as a proof-of-concept. Since the aspect of strongly-coupled data assimilation is only an additional result of our study, we will remove the last paragraph in favor for a more comprehensive introduction of the other parts.
- **Twin experiments**: We will introduce a new section explaining the idea behind our twin experiments. Here, we will shortly discuss the advantages and disadvantages of these experiments compared to "real" data assimilation experiments. In addition, we will explain how our model setup and the ensemble has been created, and how we have synthesized our observations from a single simulation called as our "nature" run. To show that the ensemble generation was successful, we will introduce a new figure that shows the error of the ensemble mean to the nature run and the ensemble spread for the atmospheric temperature in 10 meters height.
- **Data assimilation**: We will introduce the data assimilation concepts and elaborate more on the differences between SEKF and LETKF. Additional, we will shortly explain how these algorithms have been implemented into our data assimilation system. We will provide more technical details and equations in a new appendix.
- **Experimental design**: Here, we will shortly explain our experiments. We will specifically elaborate on the question what is assimilated where and on the differences between these experiments.
- **Results**: We will shorten this results section to streamline it and make it easier to understand.
- **Discussion and Summary**: Here and there, we will streamline this section to shorten the whole length of the manuscript. In addition, we will sketch further steps towards

longer and more realistic experiments, needed to proof the applicability of the LETKF in real global land data assimilation systems.
- **Conclusion**: We will overthink the conclusions to improve the clarity of the implications of our results especially with regard to our idealized experiments.

We hope that this new structure will improve the clarity of our study and manuscript. Its more thorough beginning then hopefully explains the necessary concepts for our study.