Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., author comment AC2
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Reply on RC2

Thomas Hermans et al.

Author comment on "Advancing measurements and representations of subsurface heterogeneity and dynamic processes: towards 4D hydrogeology" by Thomas Hermans et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-95-AC2, 2022

Dear reviewer,

Thank you for reviewing the paper and for your constructive comments. Below, we provide a response to your comments.

- Concerning the detailed level of information. We realize that the different subsections are relatively long with a lot of details provided. We think this level of details is necessary to stress the challenges. However, we also recognize that there is some redundancy, including between the different sections, and we will try to reduce as much as possible the length of the text. We wrote a small summarizing paragraph at the end of each section to deliver a simplified message, and we will try to strengthen this in the revision.
- On delivering opinion about when 4D is needed. In the current version, we provide a general discussion on processes requiring a 4D characterization in the concluding remarks, rather than discussing every process individually, as it is impossible to provide an exhaustive list of these processes. We recognize that this is coming a little bit late and we will strive to discuss important elements earlier in the manuscript. In this section, we stress that 4D is key for process understanding, and a necessary step for upscaling processes at larger scales. We also propose to generalize the use of (global) sensitivity analysis to investigate the role of spatial heterogeneity and time variations, so that simplifications used are based on scientific evidence. However, we agree that this message could be stronger, and we will follow your suggestion to extend this part.
- On the suggestion to use more computing power. Our main message did apparently not come across: we indeed identify cloud computing as one avenue to allow the inclusion of more complexity when it is needed, but this is only one of the recent innovation that is listed among others that are dealing with the modelling approach itself (use of proxy, upscaling methods, Monte Carlo based approaches). We will revise the manuscript to make it clear that cloud computing is just one of the proposed innovation.
- About the scale. We agree that the scale is of uttermost importance. For the four processes we have selected, understanding the implications of variability at a very small scale (pore-scale to meter scale) is key to be able to upscale and simplify the processes at a larger scale. For example, mixing and reactions are often not adequately represented by macro-dispersion. The idea of a figure is appealing, we tried to include it in figure 1, but what your propose would be indeed clearer. We will strengthen the message about the scale issue in more detail in the revised manuscript.

Best wishes,

For the authors,

Thomas Hermans