

Interactive comment on “A dense network of cosmic-ray neutron sensors for soil moisture observation in a pre-alpine headwater catchment in Germany” by Benjamin Fersch et al.

Anonymous Referee #2

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The work presented by Fersch and others introduces new combined dataset for a small catchment of about 1 sqkm area combining a dense network of cosmic-ray soil moisture sensors with additional hydrometeorological data. The dataset presented relates to a field experiment campaign in 2019 that lasted for almost three months covering late-spring and part of the summer in Germany. The manuscript is well-written and presented with good quality figures. There is no question about the volume of data collected and its quality as the group of scientists is very strong in this area. I believe this is a very good set of data to investigate soil moisture dynamics in a 1-sq-km area for climate conditions ad soil/vegetation characteristics similar to this site. I have very few comments:

(1) I think the context chosen by the authors to justify the choice of area is slightly incomplete (or maybe slightly misleading). Reading the relevant sections of the manuscript, it gives the impression that this choice was because typical applications of cosmic-ray sensors are either done for single (isolated) sites or for large-scale continental/national networks, which consequently misses this overlapping aspect of multiple measurements at the same 1 sq-km (grid) area (note that the area represents a tiny fraction of the 55 sq-km Rott catchment). The nature of single sites of large networks is continuous monitoring capability whereas here the data describes a short-term summer campaign (from late-April to early-July). There is nothing majorly wrong with the text but given that this is short campaign, framing the paper more towards the importance of short-term intensive campaigns would, in my opinion, make the paper present better the motivation for this dataset. Authors can cite similar work done for other products such as SMOSMANIA and SMAPEX campaigns, for example. In addition, an area of 1 sq-km is probably related to very small catchments, and the context would probably be better linked to understanding spatial heterogeneity for high-resolution soil moisture applications. I am surprised to see the authors failed to cite seminal work by Roger Grayson, Andrew Western, and Gunther Bloschl in the 1990s that tackle this high-resolution measurement problem with very interesting and impactful results to the hydrological community.

(2) In many instances throughout the paper, I don't understand why the manuscript jumps to figures without following a common numerical order (introduces Figures 1 previously, then refers to Figure 9 here; then refers to Fig 3 later on; Fig 2 is not referred in the text before showing up in the manuscript, etc...). This makes reading through the manuscript a bit more difficult.

(3) The cosmic-ray neutron sensing technique for soil moisture application is now more than 10 years old. I'd strongly encourage the authors and the community, in general, to stop using words like "emerging", "novel", "promising", etc... to describe the technique as these statements now read a bit outdated

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(4) L70-71: Perhaps the authors can include the citation to previous studies that have altered the values of the 'a' coefficients in an attempt to improve the estimated soil moisture signal from the sensor:

Rivera Villarreyes, C. A., Baroni, G., & Oswald, S. E. (2011). Integral quantification of seasonal soil moisture changes in farmland by cosmic-ray neutrons. *Hydrology and Earth System Sciences*, 15(12), 3843–3859. <https://doi.org/10.5194/hess-15-3843-2011>

Iwema, J., Rosolem, R., Baatz, R., Wagener, T., and Bogena, H. R.: Investigating temporal field sampling strategies for site-specific calibration of three soil moisture–neutron intensity parameterisation methods, *Hydrol. Earth Syst. Sci.*, 19, 3203–3216, <https://doi.org/10.5194/hess-19-3203-2015>, 2015.

Heidbüchel, I., Güntner, A., and Blume, T.: Use of cosmic-ray neutron sensors for soil moisture monitoring in forests, *Hydrol. Earth Syst. Sci.*, 20, 1269–1288, <https://doi.org/10.5194/hess-20-1269-2016>, 2016.

(5) Figure 6: There is just too much information in this figure. What is the main purpose of the figure? Do the authors need to show all numbers on those maps? DO they need to show all maps?

(6) As an example of application, the authors could easily have identified how similar or different the measurements are (20+ sensors in a 1 sq-km area seems a bit too much for me). Perhaps they could either look at the different CDF for each measurement and determine if they theoretically come from the same or different distribution using the Kolmogorov-Smirnov test; or apply some temporal stability analysis (???)

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