Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
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Comment on hess-2022-123

Anonymous Referee #2

Referee comment on "On soil bulk density and its influence to soil moisture estimation with cosmic-ray neutrons" by Mandy Kasner et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-123-RC2, 2022

Overall Comments

This paper presents an important topic for the calibration of CRNS sensors – whether or not there is a dependence on the soil bulk density. The issue has been somewhat neglected in the application of CRNS for soil moisture sensing, therefore this is an important study, especially for monitoring sites with tillage, or mobile CRNS applications, surveying across different soil types and bulk densities. The study is in the form of neutron transport simulations (using the URANOS model) and a dedicated lab experiment.

The presentation is reasonably good, with some additional details required. The English language is generally quite good, but should be improved. However, as it appears to me, there seems to be some major inconsistency between the theory and the presentation of results, and at times the text contradicts the plotted results. Attempting to untangle this is a major distraction from the message of the paper. Moreover, as presented currently I believe that the results are most likely incorrect, but will be corrected easily.

Detailed Points:

- The Discussion and Results present the increase of neutron counts with increasing bulk density (decreasing porosity) – whereas the theory (Equation 3) suggests that solid matter will scatter more efficiently than the much lower density air in the pore spaces, which implies to me that the neutron count should decrease with increasing bulk density (BD). Perhaps I am wrong, and misunderstand something here? But the text is also contradictory in places e.g. P.7, L.176-77:

"The highest neutron intensity can be achieved for very dry and dense soils, while it decreases with increasing soil bulk density (or decreasing porosity)."

If Fig.2 is plotted correctly, then this should at least be corrected to "….very dry and low density [loose] soils…"

However, I have doubts whether the plots are correct? For Fig.2 & Fig.3 (and subsequent plots with BD/porosity x-axis) – I believe that all the x-axes labels are reversed? Making this assumption, the results would make physical sense, otherwise, as above the results do not match (or are opposite to) the theory presented, as I understand it.

The later text does match the plots, so I am really left wondering if all the discussion and presentation of results has to be revised, as well as the plots… or else explain what I am missing and why we should expect higher neutron counts with higher BD?

- The paper is written in the future tense (e.g. P.2, L.54-55), this not the conventional way to report scientific experiments.
- Take more care with the use of tenses, and prepositions e.g. Title change "influence to soil moisture" to "influence on soil moisture". English should be generally improved and errors removed.
- Section 2.4 Experimental Concept: Where are the tanks located? - how did you control the surrounding environment? Could there have been other non-constant hydrogen pools in the surrounding 100 to 200m?
- 5, L.139-L.140 specify the CRNS detector type (make & model). Why only a 60 minute counting period? Why not longer to improve the count statistics?
- Some figure captions (Fig.2 etc.) have the wrong units for BD – should be g/cm^3 not g/m^3.
- 9, L.191 were the neutron counts first corrected in any way? For example, for changes in atmospheric pressure, air humidity, incoming neutron intensity? Otherwise, neutron counts made at different times cannot be directly compared!
- Table 1. Are the neutron counts assigned to the correct porosities? Whilst data here matches Fig.3, it does not agree with the theory (Eq. 3)
- 11, L.240-242 Is this the right way round? Here both BD and SM vary - so which has the more dominant effect on penetration depth?
- 13, L.293 understimate (?) --> increased porosity should increase counts! Leading to underestimate of SM??.... and Fig.5 Why don't counts increase with porosity? I don't think this is correct?
- Summary & Conclusions: (2.) "On average, neutron count rates decrease by −1% for every +10% increase in porosity". This appears contrary to Eq.3 ? I would expect an increase in count rate. As per Point 1 above, much of this text needs revising if indeed the plot x-axes are reversed.