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Hydrology and Earth System Sciences Discussions

Interactive comment on "A universal calibration function for determination of soil moisture with cosmic-ray neutrons" *by* T. E. Franz et al.

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General comments: 1.The monitoring of cosmic-ray neutrons is a promising way to close the gap between point measurements and the modelling and remote sensing scale. This paper describes a new universal calibration function to be used in environments unfavourable for standard calibration by using the neutron transport code MCNPx together with observed soil chemistries and pore water distributions. Such a universal calibration function would be very useful for the application of the cosmic ray method for mobile surveys.

2. The manuscript is well written, however, I have made suggestions for improvement (see specific comments).

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3. The abstract should be more informative.

4. The proposed method should be described in a more comprehensive and detailed way. I also suspect that there are some inconstancies. For instance it is not clear to me, whether chemical properties are need for the application or not.

5. As the authors point out, subsurface biomass might lead to large uncertainties in the application of the calibration function. Therefore I would suggest including soil organic carbon content information from soil maps in order to take into account the subsurface biomass or at least to test in which way this property might influence the calibration result.

6. The authors claim that the universal calibration function leads to accurate estimates of soil water content in the support volume of a cosmic ray probe. This conclusion should be substantiated by presenting the accuracy of the universal calibration function in terms of soil water content. For instance, given the extensive COSMOS data sets it should be possible to carry out a split-sample calibration-validation approach.

Specific comments:

P10305 L9-12: I don't agree with the statement that a COSMOS standard calibration using the gravimetric method cannot be applied to soils containing stones. It is rather a question how to account for the content of stones in deriving the volumetric water content.

P10305 L9-12: Which additional information is needed for the application of the universal calibration function to unknown site?

P10307 L7: How much will the radius of the hemisphere depend on air humidity and would this lead to additional uncertainties in the application of the universal calibration function?

P10307 L22: I would suggest to wait until Rosalem et al. is accepted before citing it.

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P10307 L22: I didn't found this equation in Zreda et al., 2012

P10308 L15: You should not mix explanations together details of the company doing the measurements.

P10308 L15: Please briefly explain how you derived the average chemical properties within the support volume (e.g. chemical analysis, averaging procedure etc.)

P10308 L21: What about the COSMOS sites that are covered by other vegetation types than forest?

P10308 L24: I am a bit confused: On the one hand you are using detailed chemical information within the support volume, but here you are stating that you assume pure quartz.

P10309 L2-4: This section should be reformulated in way that shows the difference between Hi and Ai in a simpler way.

P10309 L12: Why is the range chosen to be 10-100 eV? Mostly cosmic-ray neutrons produced by the evaporation process show an energy range between 0.1 and 10MeV. To my knowledge the Hydroinnova CRS1000 probe used in this study uses a Cd-shield to exclude neutrons with energies < 1 eV, not < 10 eV. Furthermore, there is, again to my knowledge, no clear evidence that the CRS1000 neutron counter is not sensible to cosmic-ray neutrons >100 eV.

P10309 L15: From a soil science perspective I would recommend to use the term "soil water content" instead of "pore water value"

P10309 L15: Why were all simulations normalized to a pure water case? I assume that the production rate of pure water is lower compared to a porous medium and thus the simulated neutron intensity might be less comparable.

P10310 L1: Please explain how Ns can be specified

P10310 L5: Please explain in which way you have coupled HYDRUS-1D with MCNPx

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P10310 L11: The RMSE should be expressed in count/h, as it is also done later in the text. In addition, I would suggest expressing the error also in terms of (equivalent) soil water content.

P10310 L14: How is this reflected in Tab. 1

P10310 L17-18: Table S1 presents more than 5 data sets. To which of them are you referring to.

P10310 L23: see comment P10310 L11

P10311 L4: Better: "The problem is less pronounced for the calibration data sets in which the volumetric soil water content was determined using the gravimetric method."

P10311 L7: "shows that"

P10311 L7: Instead of "accurately" you should use "reasonable".

P10311 L6-13: I suppose that a decrease in soil moisture variation will reduce R^2, whereas a decrease in the variation of the other influences should lead to an increase of R^2. For the potential user of the universal calibration function it would be interesting to know, in which way the influencing factors will affect the quality of the sensor calibration.

P10311 L16: Please explain in more detail why the observed hydrogen molar fraction for these cases is higher than for the liquid water case?

P10312 L7: What do you mean with "small axis of variation"

P10312 L11-14: Wouldn't it possible to account for soil organic carbon content quite straightforward by using such information from soil maps.

P10312 L21: see comment P10311 L7. In order to make such a conclusion you should also present the accuracy of the universal calibration function in terms of (equivalent) soil water content.

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P10312 L26: Don't you need also the chemical properties for each site for applying the universal calibration function?

P10313 L2: I think you are referring to Table S1

P10313 L1-16: This section is very speculative. For instance, the use of the proposed method for mapping biomass would need the knowledge of spatial distribution of the soil moisture content in the top 70 cm, which is normally not available.

P10313 L4-7: This is an interesting aspect, but it doesn't fit in the outlook chapter. I would suggest presenting this aspect in an extended version in a separate chapter.

Tables and Figures

Table 1: Why is Ns sometimes assumed?

Fig.1a): the range of the x-axis should correspond to the min. and max. value of soil water content Fig. 3): Is this a curve fitted to the soil moisture data from this site or is it an application of the universal calibration using ancillary data?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 10303, 2012.