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Hydrology and Earth System Sciences Discussions

Interactive comment on "Integral quantification of seasonal soil moisture changes in farmland by cosmic-ray neutrons" *by* C. A. Rivera Villarreyes et al.

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Review of "Integral quantification of seasonal soil moisture changes in farmland by cosmic-ray neutrons" by C. A. Rivera Villarreyes, G. Baroni, S. E. Oswald

General comments: 1. The quantification of seasonal soil moisture changes at the catchment scale is of great interest for the understanding of hydrological processes and for the development of new model concepts. The monitoring of cosmic-ray neutrons seems to be a promising way to close the gap between point measurements and remote sensing. This paper contains an interesting set of findings on the usability of

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this recent method.

2. The paper is not always written in a clear and understandable way; especially the methodology section has to be more comprehensive (see comments below).

3. There are several issues concerning the calibration methodology, e.g. calibration data, validation of the calibration parameters (see comments below).

4. Some of the statements have to revised, e.g. concerning the measurement footprint and the transferability of the calibration (see comments below)

5. Some physical explanations are missing, e.g. effects of snow on neutrons count rate, effects of freezing on MR2 readings. (see comments below)

6. I would suggest to split the Summary and Conclusions section into a Discussion and a short Conclusion chapter

Specific comments:

1. Introduction

P2 L11 Change into: “In addition soil moisture is a key factor for chemical, biological, infiltration and matter transport processes in soils. . .”

P2 L16-19 Recently developed wireless soil moisture sensor networks should be added to the list, since they enable real-time soil moisture measurements from the field to catchment scale (e.g. Bogena et al., 2010, Vadose Zone J., doi: 10.2136/vzj2009.0173).

P4 L6 Change into: “Therefore, it is still. . .”

P4 L9-20 This paragraph is not relevant here and should be deleted.

P5 L1 Explain “water mass in the air/ground interface”

2. Methods and Materials

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P5 L11 Change into: “long-term”; would that be months, years?

P5 L14 Delete “Here”

P5 L17 Include “at the ground.”

P5 L20 Change into “soil nuclei”

P6 L12-13 Delete sentence “We suggest. . .”

P6 L13 Delete “Overall”

P6 References of Equation 1 and 2 are missing

P7 L8 Change “location” into “altitude”

P7 Equation 3 can be omitted

P7 L21 Are these neutron monitoring stations the same mentioned below? This should be mentioned.

P8 L9 Be more specific

P8 L17 Change ”hydrogen . . .humidity” into ”see chapter ...”

P8 L21 Change into: ”at sea level”

P8 L24 Change ”hydrogen molecules” into ”hydrogen nuclei”

P8 L24 Next sentence should be deleted (repetition)

P9 L16 Delete “exact”

P10 L20 Change into “. . . is still under debate.”

P11 L23 There is no maximum footprint! Zedra et al. (2008) suggest the footprint of a CRS to be defined as the area around the probe from which 86% of counted neutrons arise.

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P12 L6 Please define the periods.

P12 L14 As described earlier, the depth of measurement of a CRS is between 0.1 and 0.8 m (later you are stating the mean CRS penetration is 0.45 m). Thus only using near surface measurements could lead to a false interpretation of the CRS data.

P13 L3 As described earlier, data of the 16 locations were only available for the first period. Was the calibration done exclusively using data from the first period?

P13 L7 But the measurement depth of the CRS at medium wet conditions is more than 0.1 m (see above).

P13 L9-14 This paragraph is incomprehensible. Please reformulate.

P13 L16 Explain “three soil moisture time series data of surface from MR2s”

P13 L22 In contrast to the statement above here you are arguing to have use the mean value of 16 MR2 probes.

3. Results

P14 L12-13 The sentence “Though. . .” should be deleted.

P14 L14-18 Instead of this long description the equation should be presented.

P14 L17-18 You should write: “In the following it is tested whether Nf is able to discriminate different field conditions.

P15 L7 Change ”was” into ”would have been”

P15 L9 The units for soil moisture are not consistent throughout the paper. I would suggest using always the notation “% (v/v)” for volumetric soil water content, e.g. 15 % (v/v).

P15 L10 Change into: “Therefore, it can be supposed that the maize corps have been of substantially less influence on the neutron counting rates than soil water”

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P15 L13 Delete “even”

P15 L19-24 Is there a physical explanation for the different Nf-values during periods with snow cover.

P15 L28 Change into “. . .soil physical properties within the field”

P16 L1-2 Figure 5

P16 L7-8 You should also present the RMSE.

P16 L11 Did you combined the measurements of both CRS to reduce variability?

P16 L11-13 Did you use the complete measurement period?

P16 L13 Figure 6

P16 L15-17 This statement is not justified (the differences in soil moisture might be low at the meter scale due to the low soil variability and the homogeneous soil cover).

P16 L21-23 Suppose you want to use the CRS for long-term monitoring of soil moisture. In case the soil moisture would decrease to a value below this minimum soil moisture value, calibration function would not be valid anymore. Therefore, the calibration is only valid for soil moisture higher than the minimum soil moisture value of the calibration period.

P17 L1 Include soil moisture units.

P17 L7-8 This is not an accepted way of testing calibration quality. You should perform a split validation by using different time periods for calibration and validation. It would also be interesting to see, whether the calibration parameters of one CRS can be transferred to the other CRS data without decreasing the calibration quality.

P17 L8 Figure 7

P17 L9-16 The statement in this paragraph are not well-founded. An empirical calibration function is only valid with in the limits of the calibration data set. Also see comment

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P16 L21-23.

P17 L26 Change “mathematical relation” into “Eq. (1)”

P18 L1-2 A transfer of the calibrated parameters to other periods and sites is problematic, see comments P16 L21-23 and P17 L9-16!

P18 L17 Change “deviation” into “measurement error”

P18 L19 Change “came down to meet” into “. . .the soil moisture measurements of CRS decreased again to the level of the. . .”

P18 L22 soil moisture unit missing

P18 L23 Explain “analytical precision”

P19 L2 Change “steep increase” into “fast changes”

P19 L10-12 There is a physical explanation for the low MR2 values in frozen soils (permittivity of water: $\sim$80; permittivity of ice: $\sim$3)

P20 L8 Change into “In the period”

4. Summary and Conclusions

P21 L16-18 Again, this statement hints to the calibration problem (see comment P12 L14)

P21 L20-22 It was not tested that the soil water profile was actually homogenously distributed during the calibration periods (perfect homogenous soil water profiles are very unlikely). Therefore this assumption might be not valid.

P21 L22-23 The presented experiment was not dedicated to detect the integration area of the CRS. The results therefore cannot be used to infer the integration area (see also comment P16 L15-17)

P22 L16-31 There is no need to recapitulate the methodology here.

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P23 L3 Explain “smaller one” (you smoothed the data using a 6-hr moving average)

P23 L6 Do you mean 5 % (v/v)?

References

P26 L11 Blöschl

Tables

Tab. 3 Please add mean and standard deviation

Figures

Fig. 1 The map shows only one CRS. I would be also interesting to see the soil moisture distributions during the three calibration periods (e.g. interpoleted maps).

Fig. 3 Since crop height was of less importance in this study, I would suggest to skip this figure.

Fig. 4 Units are missing

Fig. 7 Units are missing

Fig. 8 The base line of precipitation graph should be shifted to zero.

Fig. 9 The base line of precipitation graph should be shifted to zero.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 6867, 2011.