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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Calibration approaches of cosmic-ray neutron sensing for soil moisture measurement in cropped fields" *by* C. A. Rivera Villarreyes et al.

Anonymous Referee #1

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Summary

This study investigates applicability of the cosmic-ray neutron sensing for soil moisture for a field cropped with sunflower and winter rye. Several calibration procedures to relate neutron count rates with in-situ soil moisture measurements are compared and the effects of biomass on the cosmic-ray signal are analysis. The paper is not always written in a comprehensible way. The novelty this study is the long-term application of a CRP to a field which is cropped with two different types of corps. However, the in-situ data might not represent well enough the actual soil field soil moisture. Another important problem of this study is limited transferability of the simple calibration ap-

proach. Several important methodical and textual issues need to be addressed before publication can be recommended (see detailed comments below).

General comments:

1. The universal calibration function of Franz et al. (2013) considers directly the effects of biomass and thus is a better approach to understand the biomass effects on the CRP signal. The simple approach presented in this study is of less generic nature limiting its potential for application at other test sites.

2. The difficulty of capturing area-average soil moisture at intermediate scales from point measurements was already demonstrated in many studies (e.g. Famiglietti et al., 2008). A good representiveness of in-situ measurement locations is especially important for this study, because calibration procedures are evaluated. According to recent publications on CRP calibration (e.g. Desilets et al., 2010; Franz et al., 2012; Zreda et al., 2012) vertical soil moisture distribution should be measured at 18 locations within the CRP footprint. In this study however, only five locations were used for calibration. In addition, a comparison with measurement campaigns revealed significant deviations between both data sets by 20% and 25%. Although the authors did some statistical testing using older data, it is still questionable where these locations can adequately represent the average soil moisture within the CRP footprint.

3. The vertical depth weighing function used in this study was calibrated jointly with the neutron calibration function. This might have introduced complicated interdependencies between the different calibration parameters.

4. The abstract is too short.

Specific comments:

P4238 L9 and P4239 L25 The term “cosmic-ray probe” and its acronym “CRP” are well established (e.g. Zreda et al., 2012), so there is no need to introduce a new term which will only introduce confusion.

HESSD

10, C1656–C1661, 2013

P4240 L6 Explain “bounded water”

P4240 L21-22 You are not providing detailed soil properties, so how do you know that the soil is homogeneous?

P4241 L19 “increases” instead of “decreases”

P4241 L24 “soil water content” instead of “texture” (otherwise the sentence does not make any sense)

P4242 L25 “. . .function to convert fast neutrons into soil moisture. . .”

P4243 L1 the term “ca.” is rather unusual in English publications. Better use terms like “approximately” or “about”

P4243 L8 The more advanced equation including soil organic matter of Franz et al. 2013 should be used here.

P4243 L12 delete “C” P4243 L20 “. . .was used as. . .”

P4244 L2 Delete “On the one hand,..”

P4244 L3 You should mention here that all calibration approaches used in this study are based on the function developed by Desilets et al. (2010).

P4244 L13-19 All equations are variations from a function developed by Desilets et al. (2010). Please reformulate this section accordingly.

P4246 L11-12 Explain in more detail.

P4246 L15 In these studies the sensor locations were chosen in a way that an averaging will directly produce a horizontally weighed average. Therefore they cannot be compared with this study in which the sensor locations are not reflecting the decreasing sensitivity of the CRP with horizontal distance.

P4247 L12-16 Please quantitative measures for the homogeneity of the spatial and vertical soil texture distribution (e.g. min-max ranges).

HESSD

10, C1656–C1661, 2013

P4247 L17-23 A temporal soil moisture stability analysis should have been performed to select the most representative sites (e.g. Vachaud et al. 1985; Vanderlinden et al., 2012).

P4248 L2-10 Actually the two measurement campaigns indicate that the five in-situ soil moisture measurement locations are creating a significant soil moisture overestimation (0.011 m^3/m^3 and 0.035 m^3/m^3 or 21% and 25 %, respectively). Therefore, it is questionable where these locations can adequately represent the average soil moisture within the CRP footprint. A good representiveness of the in-situ measurement locations is especially important for this CRP calibration evaluation study.

P4248 L24-25 Atmospheric water vapour corrections eliminate temporally varying neutron attenuation efficiency of atmospheric hydrogen. Therefore is a correction with a constant factor is without any effect.

P4248 L27 What is the meaning of the "+/-" numbers?

P4249 L2-12 This section fits better in the method chapter.

P4249 L24- P4250 L3 This result is actually no surprise. A splitting of the data set into calibration and validation subsets would shed more light on the meaningfulness of the different calibration approaches.

P4250 L5-6 Fig. 4 doesn't show any criteria showing the quality of the CRP calibrations. Please reformulate.

P4250 L13 "... down to..."

P4250 L20-22 This statement is in contradiction with findings of Franz et al. (2012). One reason for this outcome might also be the low number of measurement locations.

P4251 L14 "... was already explained..."

P4251 L24-26 This statement is unclear. Please give more information.

HESSD

10, C1656–C1661, 2013

P4252 L2-4 This statement is unclear. Please reformulate.

P4252 L12-18 I don't see the benefit of introducing this statistic. It is also not used to validate the calibration approaches. Therefore I suggest omitting it.

P4253 L3-5 In this study, the CRP is underestimating soil moisture over a period of more than one month. The underestimation reported by Franz et al. (2012) lasted only some days (during the infiltration of a sharp wetting front). Therefore this reference is not adequate. In fact the discrepancy might be due to the influence of the biomass on neutron count rate.

P4253 L17-22 The effects of lattice water and organic matter on the neutron count rate should be quantified before make such a statement.

P4253 L25 "make it"

P4254 L4-6 A large part of the scatter is produced by the CRP measurement noise. There this statement is not appropriate.

P4254 L12-15 Why are so many dates missing in Fig. 7b (Fig. 5 indicates a lower number of data gaps)?

P4254 L13-15 Either results are shown or this sentence should be omitted.

P4254 L29 Please provide the equation.

P4255 L4-11 Why is No for WR much higher than for S? In order to better understand the relationship between Natt and biomass, you should also present the time series.

P4255 L11-13 Why should the Poisson's variability produce this discrepancy?

P4255 L20 Please only provide conclusions (a summary should be given in the abstract).

References

Famiglietti , J. S., D. R. Ryu, A. A. Berg, M. Rodell, and T. J. Jackson. 2008. Field obser-

HESSD

10, C1656–C1661, 2013

vations of soil moisture variability across scales. Water Resour. Res. 44(1):W01423. doi:10.1029/2006wr005804.

Vanderlinden, K., Vereecken, H., Hardelauf, H., Herbst, M., Martinez, G., Cosh, M. H., and Pachepsky, Y. A., 2012, Temporal stability of soil water contents: A review of data and analyses: Vadose Zone Journal, v. 11, no. 4.

Vachaud, G., Desilans, A. P., Balabanis, P., and Vauclin, M., 1985, Temporal stability of spatially measured soil-water probability density-function: Soil Science Society of America Journal, v. 49, no. 4, p. 822-828.

Figures

Fig. 2 The different scenarios are well described. Therefore, this figure is unnecessary.

Fig. 4 Please indicate the calibration approach used

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