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Interactive Comment

Interactive comment on "Estimating field scale root zone soil moisture using the cosmic-ray neutron probe" *by* A. M. Peterson et al.

Anonymous Referee #3

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General Comments:

In this paper the authors investigate in how far one can use cosmic-ray neutron probes to determine root zone soil moisture down to a depth of 110 cm. Since the cosmic-ray neutron probes are generally only sensitive to soil moisture changes within the upper 30 to 70 cm, the authors test several methods in an attempt to couple the areally averaged shallow soil moisture variation with point measurements of soil moisture at depth to also receive areally averaged soil moisture at depth.

The approach deserves attention since it tackles one of the main problems of the cosmic-ray neutron probe method – the relatively shallow effective measurement depth. If it was indeed possible to extend the shallow soil measurements to cover the entire root zone this would be a big improvement. Therefore, I think that this manuscript

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Interactive Discussion

Discussion Paper

is well-suited for publication in the HESS journal.

The main problem (it is a minor one) that I had with the manuscript is the sometimes changing categorization of the different methods: Upscaling vs. modeling, four estimation techniques vs. three evaluated techniques. Other than that the authors should probably test whether

(1) the inclusion of lattice water and soil organic matter,

(2) the use of the new footprint weighting (by Köhli et al.; 2015) or

(3) adding another calibration date for the cosmic-ray neutron probe (see Iwema et al.; 2015)

would affect their results/conclusions.

Specific Comments:

p. 12790, l. 3: I would either get rid of the quotation marks or explain what you mean by “field scale”?

p. 12790, l. 10: New results by Köhli et al. (2015) suggest that the areal footprint is more in the range of 350^2 m^2.

p. 12790, l. 12: What do you mean by ‘accounted for’?

p. 12790, l. 18: What does ‘the exponential filter’ do?

p. 12790, l. 23-24: It is concluded that the exponential filter method has the most potential because…? This is important and should be in the abstract (it’s your main conclusion after all).

p. 12791, l. 25: The effective measurement depth is less than 30 cm for most soils under wet conditions, for dry conditions the effective measurement depth can be a lot deeper (down to 70 cm).

p. 12791, l. 25-p. 12793, l. 12: Throughout the introduction (and abstract) I am

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getting a little confused with your lists of approaches. In the abstract you mention 1) time stability, 2) landscape unit monitor and 3) exponential filter. In the intro you mention 1) upscaling point measurements and 2) modelling and then 1) averaging point measurements, 2) a single time-stable location and 3) disaggregating into landscape units. Can you maybe use subcategories with a different index (in case some of them are actually subcategories)?

p. 12794, l. 19: This equation has been updated and you should use the newer version that also considers the influence of soil organic matter, root biomass and lattice water. See for example Lv et al. (2014).

p. 12795, l. 2: What is the effective measurement depth used for? You should mention it here.

p. 12795, l. 5: Köhli et al. (2015) also introduced a new distance-weighting scheme that you should use to give modified weights to the samples you took from different distances. Now that the actual footprint diameter is smaller than you assumed, the weights from the more distant soil samples should be reduced.

p. 12795, l. 10: Is noon the value in the middle of the running average (moving window)?

p. 12796, l. 10: Oh, another sub-list. And this time there are four estimation techniques. Maybe use a), b), c) and d) for these four throughout the manuscript while using 1) and 2) to distinguish between 'upscaling' and 'modeling' approaches. This still leaves the 1), 2) and 3) from the abstract (which correspond to b), c) and d), I guess).

p. 12799, l. 7: It would be great to have some visual aid to understand this filter. Maybe you provide a figure showing some of the modeled dynamics in the different layers? Figure 9 provides this information, maybe reference it already at this point?

p. 12800, l. 16: Maybe better call this consistently 'effective measurement depth' instead of depth of influence.

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p. 12800, l. 23: Could you not weight the gravimetric samples according to the actual soil moisture conditions so that they theoretically match the measurements of the cosmic-ray neutron probe? Or did you take just one bulk-sample from 0-20 cm instead of several smaller samples (say from 0-5 cm, from 5-10 cm, and so on)?

p. 12801, l. 2: Recent publications by Lv et al. (2014) and Iwema et al. (2015) suggest that the standard calibration function of Desilets et al. (2010) is actually variable from one location to another and should therefore be calibrated at two different dates (preferably one when soil moisture is high and another one when soil moisture is low). A new calibration function could increase the variability of the soil moisture time series measured by the cosmic-ray neutron probe so that it would match better with you gravimetric soil samples (Figure 2).

p. 12802, l. 10: How is this offset determined?

p. 12803, l. 10: But you found a seasonal pattern that you could work with (if you assume that the grass is consistently drier under wet conditions and becomes more similar to brush under dry conditions). The bigger problem, however, is the large spatial variability within both groups, especially when it gets drier.

p. 12803, l. 20: So here the section 3.3.3 Exponential filter is a subsection of 3.3 Upscaling methods while on page 12792, l. 1 you clearly distinguish between (1) upscaling point measurements and (2) modeling. This further adds to my initial confusion about the structure of your manuscript.

p. 12804, l. 1: Could you remind the reader what T is and what it actually means?

Figures & Tables:

Figure 1: Use a different color for the neutron probe location in the center. Also mention it in the description. It would also be good to add a circle indicating the footprint around the probe.

Figure 7: Could you mark the locations of brush vs. grass on the map of Figure 1?

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Maybe just use two different colors for the dots.

Technical Corrections:

p. 12794, l. 24: '. . .calculate EFFECTIVE measurement depth.'

p. 12795, l. 1: '. . .convert from GRAVIMETRIC to volumetric. . .'

p. 12796, l. 12: 'Nash-Sutcliffe efficiency' is sufficient.

p. 12797, l. 2: The error WHEN/IF using. . .'.

p. 12803, l. 8: 'seasonAL'.

p. 12807, l. 10: One verb too much in this sentence.

References:

Desilets, D., Zreda, M., and Ferré, T.: Nature's neutron probe: Land surface hydrology at an 793 elusive scale with cosmic rays, Water Resour. Res., 46, W11505, doi:10.1029/2009WR008726, 794 2010.

Iwema, J., Rosolem, R., Baatz, R., Wagener, T., and Bogena, H.R.: Investigating temporal field 830 sampling strategies for site-specific calibration of three soil moisture-neutron intensity 831 parameterisation methods, Hydrol. Earth Syst. Sci., 19, 3203–3216, doi:10.5194/hess-19-3203-832 2015, 2015.

Köhli, M., Schrön, M., Zreda, M., Schmidt, U., Dietrich, P., and Zacharias, S.: Footprint characteristics revised for field-scale soil moisture monitoring with cosmic-ray neutrons. Water Resour. Res., 51, 5772-5790, doi:10.1002/2015WR017169, 2015.

Lv, L., Franz, T., Robinson, D., and Jones, S.: Measured and modeled soil moisture compared with cosmic-ray neutron probe estimates in a mixed forest, Vadose Zone J., 13, doi:10.2136/vzj2014.06.0077, 2014.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 12789, 2015.