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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Closing the water balance with cosmic-ray soil moisture measurements and assessing their spatial variability within two semiarid watersheds" *by* A. P. Schreiner-McGraw et al.

Anonymous Referee #3

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The work presented by Schreiner-McGraw et al. evaluates the soil moisture dynamics measured by cosmic-ray sensors (CRS), in comparison to sensor networks (SN), at two semi-arid sites. The authors exploit the use of CRS and SN in a simple water balance model as well as employing empirical relationships to understand the role of spatial variability in soil moisture and evapotranspiration. The paper is interesting, and I specially liked the fact that, despite similar, conditions at both sites are slightly different (while the site in Arizona exhibits drier than average conditions, the site in New Mexico presents above-average rainfall for the period analyzed). However, despite the

fact that the study has collected a large volume of data, the analyses conducted in the manuscript need to be explained and carried out in more detail. There are a lot of analyses and approaches proposed in the manuscript but they are presented and discussed rather superficially which makes the manuscript very hard to follow, and sometimes not very well connected. What is/are the scientific question/s the authors are trying to answer? What is the main motivation? It is not clear to me what exactly the authors are trying to show (i.e., comparison of CRS with SN at both sites; relationships of within-footprint variability; evaluating use of CRS with EC fluxes; testing a simplified water balance approach with the data). This needs to be better clarified and organized in the revised version, hence I recommend major revisions.

General comments:

1. The water balance approach employed in the paper assumes the control volume is defined by the effective depth of the CRS ($\sim$ 40cm). However, we usually assume the control volume to be defined by the layer containing contribution from active roots, in the process of root water uptake - evapotranspiration. Authors should comment on the potential limitations of using a control volume represented by the measurement directly. Also, how about the lack of energy closure by the EC method (80% closure calculated)?

2. The authors justify the use of Eq. 2 in its simplest form (i.e., without accounting for additional hydrogen sources). However, lattice water is then accounted for when calculating the CRS measurement depth (z*) in Eq. 4. Can the authors explain why lattice water does not matter for theta(N) but seems to matter for z*(theta)? This seems to be rather inconsistent!

3. As pointed out by the authors, there are already studies that focused on understanding the use of CRS in semi-arid sites. In this case, the good agreement between CRS and SN is not necessarily novel (in fact, SRER has been used quite extensively for such comparison). According to the authors, most of this good agreement happens under

relatively dry conditions, as “the CRS method was not able to capture the soil moisture conditions during large rainfall events”. Can the authors comment on possible limitations on the use of CRS for monitoring and predicting (in combination to hydrological models) flash floods events in semi-arid region?

4. Figure 2a: The land cover within the EC footprint suggests less bare soil fraction than the area covered by both CRS and SN. Figure 2b: How strongly do the authors consider the SN placement to be representative of the entire watershed? In addition, there is little overlap between EC footprint and CRS and SN spatial coverage. Can the authors comment on possible impacts and limitations in the analyses due to the those issues?

5. Authors need to explain exactly what they are trying to show in Figure 11. Is there any strong relationship when individual points (i.e., small dots)? There is only one case in which ET seems to respond to sigma (JER) but the error bars for individual bins are quite large.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 5343, 2015.