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Interactive comment on "Quantifying mesoscale soil moisture with the cosmic-ray rover" *by* B. Chrisman and M. Zreda

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This paper describes an extension of previous work on a soil moisture sensor based on neutron intensity originating from cosmic rays. In this paper, the authors deploy a portable neutron detector (the "cosmic-ray rover"), to measure soil moisture temporal and spatial variation at the meso-scale. The paper presents data from multiple surveys of neutron counts, and the authors analyse this data to produce soil moisture maps of the study area, to test methods for synthesising these maps based on a stationary probe, and to attempt a water balance of the area. This is an interesting study exploring the potential of a new method for mesoscale soil moisture estimation, and would be of interest to HESS readers.

I have two main, and a few minor comments that I recommend the authors to address before publication.

Main comments.

(1) The authors brush relatively lightly over some of the assumptions and uncertainties inherent in the method. Given that the method is new, it would help to convince the reader of its potential if these assumptions were discussed in some more detail. The authors should not be hesitant to state the assumptions/uncertainties as these are to be expected and will presumably be addressed during research in the coming years. I suggest the following additions:

- In Section 3.1, add a summary of the main assumptions of the method

- In Section 3.2, add a description of the assumptions that lie behind each correction factor, and whether there are particular situations when they might be more or less accurate. E.g. Equation (1): Is this ratio constant over the Earth's surface? Equation (3) This is presumably calculated from humidity at the ground surface – but is the neutron intensity affected by humidity in the high atmosphere? Equation (5) Is then that the rover ultimately calibrated on (and hence reliant on) interpolation of point measurements, which as discussed may not represent actual soil moisture heterogeneity?

(2) It would be helpful to add at the start of the paper, a description of the mechanism by which the COSMOS probe/rover work. I.e. what causes neutron intensity to be related to total hydrogen? A diagram may be useful.

Minor comments.

P7129 L20 Need to say what a COSMOS probe is.

P7131 L14 Is the temperature affected by the immediate road environment?

P7131 L21 Not clear how the value of 5% uncertainty was calculated.

P7135 Perhaps not necessary to provide so much detail on lattice water estimation and

measurement in urban environments, given that it is then ignored (L15).

P7136 L22 Not sure convoluting is the correct word here.

P7139 L2 It seems a bit of a stretch to associate the points and the curved relationship in Figure 3.

P7139 L6 Was the Famiglietti study in the same location as this study? If not, I don't see why the scaling should be the same.

P7139 L23 - P7140 L11 This is a nice discussion of possible biases associated with vehicle speeds and interpolations.

P7143 L18 – 22 It was not clear to me what calculation you were using here. Do you mean that you used a linear transform of the cosmic ray measurement to estimate the SMOS value? If so, does this work during/after rainfall events when relative magnitudes of nearsurface/subsurface moisture content would change?

P7143 L29 – P7144 L2 I am unclear why these values do not match exactly if they are all back-calculated from the same measurement.

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