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Interactive comment on "Multiscale soil moisture estimates using static and roving cosmic-ray soil moisture sensors" *by* David McJannet et al.

Anonymous Referee #1

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The work presented by MacJannet and others investigates the use of mobile cosmic-ray sensors for estimating soil moisture at a range of scales within a 36 km by 36 km area over an arid region in Australia. There are two regions of interest in the analysis, the 36 km x 36 km region aimed at producing 9km resolution soil moisture maps, and an inner region of 10 km x 10 km aimed at producing 1 km resolution soil moisture estimates. The authors highlight the importance of multi-scale soil moisture estimates for remote sensing validation as well as its use along with high-resolution land surface modeling.

The manuscript is concise and well written with clear steps. The figures are appropriate for the tasks taken and discussed in the manuscript. However, my main issue with this manuscript is its lack of novelty. The use of mobile cosmic-ray sensors (i.e., "rover") for

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soil moisture estimates is not new (as pointed out by the authors). The steps taken to convert the neutron counting rates from the rover to the final soil moisture is not new either. The regression analysis done to increase temporal resolution at gridded points within the region has also been done elsewhere. The manuscript reads very much like a technical report in which results are simply reported without much discussion. I don't see a clear scientific question being tackled in this manuscript. Perhaps, the only two pieces of relatively new information I noted were the updated relationship between lattice water and clay content particular applied to their region of interest (in comparison to a previous estimate from Australia) and the impact of number of integration points per area (which is directly related to the speed at which rover surveys are taken) on the quality of the soil moisture maps estimated from coarser to higher resolutions (but refer to my point about this below).

The authors made an important link to remote sensing soil moisture products and land surface modeling, and the manuscript feels a bit incomplete without a proper comparison against additional soil moisture "products". In addition, the authors claimed that the produced maps are "reliable" but how to assess reliability without an independent set of data? I strongly believe an independent set of data and comparison against model and remote sensing could have been an important addition to this manuscript and certainly contributing to its novelty. Unfortunately, I don't see a novel contribution that merits publication in HESS at this stage. My recommendation is for the authors to resubmit the work with a much clearer research question as well as incorporating of other independent soil moisture estimates to verify the impact of the rover soil moisture.

Additional specific comments:

1. Eq. 5: Please, explain what W_lat, W_SOC, and rho_bd are right after the equation is presented. I believe rho_bd is never described properly in the text.

2. Section 2.3: It might be a good idea for the authors to show a picture of the rover system in this section.

3. Section 3.1: I believe Fig 4 is meant to be mentioned in this section (but it is not currently)

4. Section 3.3: I believe Fig 5 is meant to be mentioned in this section (but it is not currently)

5. Section 3.4 and 3.5: The authors assume the reader has good knowledge of spatial statistics and how the fields are ultimately interpolated to produce soil moisture maps. For example, the discussion about “sill” may not be clear to the broad readership of HESS. In fact, what does having or not having a “sill” imply? What does “sill” represent in this case (from a physical soil moisture variability context)? The authors should also highlight the sill parameter in the plots presented in Fig 6.

6. Section 3.5: Ideally, one (including myself) would like to see the soil moisture maps compared against independent measurements. It is expected that the map-derived soil moisture will compare well with the two static sites since the rover was calibrated using the same data. So, the whole approach appears a bit “circular” to me. At the end of this section, the authors make a good point about the importance of these measurements form model testing and remote sensing. I strongly recommend the authors to expand their manuscript to include comparison against remote sensing and land surface model and discuss reasons for similarities and differences.

7. L290-302: There is some potentially interesting analysis here but I also wonder if the results can be strongly influence by the soil properties themselves. In other words, if the authors apply the same comparison between the broad survey and intensive survey using the soil properties (not the estimated soil moisture), would they see a similar behavior? How much of the difference in soil moisture they currently observed is conditioned to the soil properties versus the changes in resolution due to averaging? Also, how can the authors justify comparing measurements, despite being originally taken at different resolution, that essentially come from the same methodology, instrument, and calibration against the same data? This appears a bit weak to me and reinforces my

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point about differences due to variation in soil properties.

8. L329-342: Interesting discussion about the road effect. It can definitely influence the results but I'd expect such influence to be more pronounced in humid sites (and not so much at arid sites)??? Also, because the maps (broad and intensive surveys) are derived from the same approach, any road effect may actually be cancelled out when comparing both surveys.

9. Table 1: Please, add a column with footprint-average soil moisture conditions for each case

10. Figure 7: These maps are interesting but they should be evaluated with other points (any points available within the domain) that had not been directly used to calibrate the rover itself. Otherwise, the only information in those maps are potentially the relative differences between wet and dry areas. Similar comment applies to Figs 9, 10, and 11.

11. Figure 8: The results here are expected and my only interpretation here is that the characteristics of soil moisture at 1km resolution (obtained with the rover) are comparable to finer scale from the static sensor (i.e., there may not be large differences between the 200-300m integrated soil moisture compared to the 1km resolution product).

12. Figure 12: For all soil property maps in the domain (W_lat, W_SOC, rho_bd), can the authors reproduce the same plots? In other words, averages at 1km, 3km, and 9km within the overlapped area for broad and intensive surveys. Can the results tell authors what possible controlling factors are associated with the differences between both surveys? I believe this can initially be expanded to something interesting and novel.

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