

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

**David McJannet et al.**

david.mcjannet@csiro.au

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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. R. Baatz (Referee) r.baatz@fz-juelich.de Received and published: 19 September 2017

THANKS - Thanks for your comments and suggestion Roland - much appreciated. Comments below as RESPONSES (changes will be in revised manuscript)

General Comments: The manuscript nicely describes a blueprint for a roving cosmic ray neutron sensor application (CNRS) for remote sensing validations, land surface model validation, and field scale soil moisture retrieval over adequately large farmlands. Conditions for application, and guidelines are outlined in sufficient technical depth. The

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novelty of this manuscript is the clear presentation of the technical methodology, focus on the purpose, conclusiveness of the experiment and validation of the derived data by static and additional roving CRNS experiments. Hence, the manuscript deserves to be published in HESS subject to revisions which can be easily handled by the authors. Specific and technical comments: There are few points which will improve the quality of the paper mostly regarding restructuring of the text and improving clarity of the figures. Although methods and results are mixed at several instances, the manuscript was written fluently and well readable, containing the necessary technical details and contents for reproducible. Along with restructuring, novelties might be marked more strikingly by additional sub headings. I 42: scale hectometers - rephrase RESPONSE: Fixed

I 46: remove "better" otherwise better than what? RESPONSE: Fixed

I 48: I'd suggest to treat land surface modeling separate to remote sensing, and include parameter estimation studies which actually use CRNS already (and are potential cases for rover application at horizontal scale) such as Baatz et al. 2017 "improved land surface model prediction" and Villarreyes et al. 2014 "Inverse modelling of cosmicray..." . RESPONSE: We now treat remote sensing, land surface modelling and parameter estimation studies separately and have included those citations as suggested.

I 83: indicate time over which is averaged (monthly average or daily average) RESPONSE: the time period is daily - fixed

I 86: Stick to one terminology. The authors switch repeatedly between CRNS (this one should be preferred), "cosmic ray soil moisture sensor" and many others throughout the manuscript and headings. RESPONSE: will now use preferred option

I 93: add citation (e.g. Hawdon et al.) RESPONSE: added as suggested

I 131: isn't air pressure (fp) used to scale to sea level (1013 hPa) instead of an additional scaling factor (fs)? This would avoid using a redundant scaling factor fs. RE-

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SPONSE: In our case a reference level for fp of sea level is used so in this case the fs is redundant – we leave it in as it may be used in other studies if a different reference elevation is used for air pressure correction (e.g. site average Pressure).

I 152: This sub-chapter can be restructured mostly to include sections from "Results" but which actually are "Methods". Here, the novelties and blueprint character could be more concise. RESPONSE: Many changes made and all method texts now moved to the methods section as suggested.

I 187: This is not an "additional" part. Now, it is part of this study. RESPONSE: correct – reworded

I 197: This is very likely the approach taken by Baatz et al. "An empirical veg.." Eq. 2. RESPONSE: citation added and new text included

I 209-210: Move to methods RESPONSE: Shifted to methods as suggested

I 214-217: What is remarkable similar? Just the results should be clear enough. Here, the curve-average resulting difference in soil moisture should be also noted, since this is the variable of interest for hydrologists. As it reads now: The interpretation would be that biomass pools are equal. Perhaps, knowing the site conditions, biomass "is basically non-existent". RESPONSE: Removed remarkable and reworded. Added the average soil moisture difference to.

L 219-221: Move to methods. Paragraph reads like the approach described in Baatz et al. 2015. RESPONSE: This reference has been included now

I 228-232: Move to methods. RESPONSE: removed from results and covered in methods

I 232-233: This is a result. RESPONSE: agree

I 233-235: Move to methods. RESPONSE: Have left this here with revised wording as the new lattice water product is a result of this study and the result loses its context if

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this is not included

I 249-251: Move to methods or rephrase. RESPONSE: removed – scale issue covered in methods

I 259: Please investigate. RESPONSE: we have no way to investigate these differences we can only speculate as to the difference based on local observations. Any point in the rover survey is interpolated using a number of neighbouring points based on the variogram relationships – if there is a very abrupt change in counts in an area it will be smoothed by such an approach.

I264: "farm property" seems a key words and should be introduced earlier. RESPONSE: The concept of farm property and the scale of these is now introduced in the methods

I 267-272: Move to methods. RESPONSE: Moved as suggested

I 275-277: Move to after-results e.g. conclusion or outlook. RESPONSE: Moved to discussion section

I 290ff: to methods. RESPONSE: Moved to methods

I 295-299: Link/relate results to driving speed and counting rates. RESPONSE: Link between driving speed, sample points and counting rates now made clearly

I 320: replace will with with RESPONSE: Fixed

Fig. 1: Insert Map of Australia and consider landscape format of the figure. RESPONSE: Map of Australia now added and landscape format used

Fig. 2 and others: Add axis title (Lat/Lon). RESPONSE: Lat long added to Fig 2, 3, 7, 10 and 12

Fig. 3: Consider using color bars with 2 colors for b, c, and d. "m ASL" was used in the text, so please use it in the figure as well. Now it is "m AHD". RESPONSE: Colour

bars with two colours now used for b,c and d. Changed to m ASL to be consistent with text. Also added LAT/long

Fig. 7 and 11: Consider dark Brown- light Yellow or other color bars with 2 colors for neutron counts. Is this already corrected neutron counts? This would be desirable, please indicate. Soil moisture is preferably shown with red-green-blue color bar throughout all plots. The counts shown should be corrected neutron counts. Otherwise, the additional value is not clear. Why are the interpolation patterns for neutron counts not visible in the soil moisture interpolations? I suggest to coarsen the visual representation. RESPONSE: Dark brown to Yellow is now used throughout for neutron count maps. The neurons are 'corrected' and this has now been made clear in moth figure captions and in the figure itself. Soil moisture is now presented as Red-Green-Blue as suggested in plots 7, and 11 (now 12). The interpolation patterns as the neutron counts are interpolated but are then multiplied by the 90m resolution soil grid data. We have made a point throughout to point put the intended resolution of the intensive and broad-scale surveys.

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