

The topic is of significant interest to the HESS readers as it combines advanced multi-scale measurements with land surface modeling. The manuscript is fluently written and represents a much needed study to advance hyper-resolution land surface models through calibration with scale-consistent terrestrial soil moisture observations using cosmic ray neutron sensors.

The authors have clearly addressed the points I have mentioned in the previous review and provided arguments for their case where appropriate. The manuscript improved meaningfully and should be published in HESS after minor revision. Please address the comments below.

General:

Figure 6: Based on your Figure 6, I actually find that CRNS do improve modeled LE in most of the cases shown. Furthermore, pretty much in contrast to PS measurements. This is a contradiction to the conclusion and actually would strengthen the publication.

I suggest splitting Figure 6 into two subfigures. You will recognize two point clouds:

1 cloud for the PS which covers the entire area (=> no improvement to LE, but to SM)

1 cloud for the CRNS which covers the better left corner (=> improved LE+SM)

The centers-of-mass for PS and CRNS points are different. This is not adequately reflected in the text. I would argue that your one-objective calibration with the CRNS improves LE overall (not at all sites, but overall), while PS data does not. This would be an excellent result for the present study but it is not drawn / concluded yet. It would be an example of a successful scale consistent calibration compared to the scale mismatch calibration with PS.

The finding that CRNS improve LE overall actually contradict to a few of the results and conclusion in the manuscript as is:

p11 l22: "While calibration errors decreased for soil moisture, latent heat flux estimation improved for fourteen out of twenty-four calibrations (Figure 6). This means that an improvement in simulated soil moisture did not necessarily lead to better estimation of surface energy fluxes."

p15 l15: "The single-objective calibration of JULES parameters against point-scale soil moisture and Cosmic-Ray Neutron Sensor neutron counts did not necessarily yield an improvement in latent heat flux simulation. The analysis of these single-objective calibrations and multi-objective calibrations (against (1) PS soil moisture and latent heat flux and (2) CRNS neutron counts and latent heat flux) revealed that differences between calibrations with these two soil moisture observation methods did overall not yield substantially different surface energy flux estimations."

Accordingly, few sentences of the results, conclusion and abstract need to be rewritten to include the new results. Furthermore I suggest to combine the new Figure 6 a+b with Figure 8 a+b (also split this one into PS + CRNS).

There are some cases in which consistency throughout the manuscript would be beneficial e.g. RMSE or RMSD, always use “energy fluxes”, write “eddy” with or without capital letter.

Minor points:

p1 l16-19: I still see a beneficial, however limited effect on latent heat flux from the calibration of soil moisture. Quantify the even limited (but this is subjective) effect of calibrating soil parameters with the s_i in the abstract.

p1 l.27: „Koster et al. 2004“

p2 l.6 (Blyth et al. 1993) – is there a newer reference available, as land surface models and stomatal resistance parameterization should have improved significantly from 1993.

p3.l10: The hypothesis could be more clear and better linked to the question two lines before. I suggest to reuse “reduced observation scale” and “LSM energy flux”. I would also omit “estimates”, because it is rather limiting and not needed.

p.3 l 24-25: sentence seems out of place. Consider moving or removing.

p4 l 9: Many readers familiar with the topic will skip reading the introduction and may want to start reading here. Therefore, I suggest here to write “Point Scale (PS)” out once more.

p5 l6 & 9: In case it is, add “linear correlation” to be more clear.

p5 l 11: $m^3 m^{-3}$ (add minus)

p7 l25: remove “observed” in “observed PS observed”;

p7 l25: “CRNS observed neutron counts” shall be consistent throughout the manuscript. Sometimes it is CRNS neutron counts, sometimes CRNS soil moisture. I suggest to use “CRNS neutron counts” here and later use more often the simple and short version “CRNS” instead.

p7 l28: is RMSE the same as RMSD? Better be consistent and use one single term.

p7 l30 “parameter: b ” – b in brackets

p8 l6: here and in l15, Pedotransfer function either with capital letters or not. Either is fine, but use consistently throughout the manuscript.

p8 l10 “Clay” +l

p8 l12: If possible use the greek symbol for bulk density ρ and “dry” in subscript.

p9 l24: remove “.”

l25: add space before “Figure 3”

l26: “between PS and CRNS soil moisture (...”

l26 “bias” – I suggest to use “bias” in the Figure as well or use the same wording in the text as was used in the Figure.

l28-29: The meaning of the sentence is not 100 percent clear to me.

p10 l6: AmeriFlux with capital F, and same throughout the manuscript (see <http://ameriflux.lbl.gov/> website)

p10 l13: There are more factors to neutron intensity e.g. altitude, sensor type. Those should be named as well.

p10 l17: “quite similar” is unclear. Rather “close by RMSE ...” or showed “similar dynamics but different means”

p10 l17 remove “) “

p9 l25-p10l25: I suggest to give the paragraph a more concise and maybe shorter structure.

p10 l33: clarify or omit “(bias)”.

p11 l9: Start a new sentences with “Actually...”

l12: add space after Figure 5

l29: Is there one space too much between “flux estimation”?

l30-32: Reverse sentence order: “Improvement in latent heat flux was actually substantial in jfour cases for PS calibration and five cases for CRNS calibration.”. remove “just”

l32-33: Same, reverse order.

p12 l6: “Happened”. Maybe reformulate to “was the case”.

l20: Remove “only”

l21 Add space bettween wasbelow

l30: I suggest to remove “as discussed previously”.

l34: “AT” -> “At”

p13 l11: “sites. To”

l21: Error! Reference source not found

l22: I suggest to remove “values”. I also suggest to replace “which therefore have normalized RMSE of 1” by “to 1 (-)”

p13 l23: “cross. The”

p15 l5: The first sentence should well introduce the conclusion but the JULES LSM is not mentioned here while being the second most important component of your study. Add JULES to what you investigated and leave something else for the second sentence.

p15 l11: “happened in different ways”... rephrase. Differences do not happen. They are there and have reasons.

l14: no new paragraph here

l19: Suggestions: new paragraph before “These”

l19-21: I have a problem understanding the sentence: The “did not... to reject...reduce...mismatch does not...” makes it very hard for me to understand what this sentence actually wants to say. I suggest to rephrase into the direction: “outcomes did... to confirm... improve scale consistency...”.

l22: Here (in the conclusion) it is important to be precise. Energy flux estimates can come from Penman-Monteith, measurements or models (or even laboratories etc.). I suggest to go through the manuscript and use e.g. “prediction” or “simulated” (as used in your the abstract) when the energy flux is modeled, and “observation” when it is measured by eddy covariance.

l22: Add “energy” between “surface flux”. Be consistent throughout the manuscript, not sure where else it is used this way.

l23: remove “relatively”

l23: replace against with “with”

l24: remove “simulated surface energy fluxes”.

l25: If I remember it correctly, the model was calibrated with “CRNS neutron flux”, not with “CRNS soil moisture data”. There may be other occurrences in the manuscript.

l25: remove “Another factor, related to this and that contributed to this result, was that”.

p16 l5: Rephrase sentence, not clear yet.

l6: remove “.”

Figure 5: Why is the calibrated soil moisture in CRNS SM at WR site (lower part) so much noisier than the calibrated soil moisture at PS SM at WR site?

p37: Move or remove “Appendix 3:”

p38: “We wide” rephrase.