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Interactive comment on "Required sampling-density of ground-based soil moisture and brightness temperature observations for calibration/validation of L-band satellite observations based on a virtual reality" *by* S. Lv et al.

Anonymous Referee #3

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The manuscript describes an analysis of uncertainty associated with soil moisture validation based on the sampling density of the ground truth network. The analysis is based on modeling of hydrological and radiative transfer features within a limited geographical area. The area was relatively small, but contained relatively significant land cover variability. On one hand, the analysis is based on modeling only without experiment data, which is clearly a weakness. On the other hand, the approach of the modeling allows evaluation of the ground sampling requirements in controlled scenar-

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ios which does make the study interesting and relevant for the community. However, there is one major issue that needs to be corrected in the analysis. This is the effective assumption that single station within a 400-m resolution cell would represent the average soil moisture within the cell. Authors acknowledge as well that this leads to a (likely) underestimation of the sampling requirement, but do not offer any quantitative analysis on the effect of this assumption. Without a quantitative assessment of this effect, the main results of the manuscript do not hold much weight. Accounting for the soil moisture variability within the cells should not be too difficult using models developed in Famiglietti et al. (2008), for example, and should be included in the manuscript. Other more minor comments will follow below.

Section 1

L39-40: The soil dielectric constant is strongly dependent on the soil moisture at other frequencies as well. The L-band is beneficial because its reduced sensitivity to surface roughness and vegetation compared to higher frequencies.

L46: “tens of kilometers” – here the reference is specifically to SMAP and SMOS and something like “40-km resolution range” could be used for more specificity.

L50-52: The references are not accurately placed here: Delwart et al. (2008) should be mentioned in relation to SMOS only, not SMAP. de Rosnay et al. (2006) presents analysis based on SMOSREX which was conducted close to Toulouse, which is not mentioned in the text, only Spain and upper Danube catchment. Lemaitre et al. (2004) is not that relevant compared to many others. dall’Amico et al. (2012) should be cited, especially as Danube was mentioned in the text. There is a SMOS assessment paper by Kerr et al. which should be cited too. Brown et al. (2008) is a SMOS related paper, not SMAP. Some of additional and very relevant SMAP Cal/Val papers are Colliander et al. (2017b), Chen et al. (2017; 2018), Burgin et al. (2017).

L55-56: “SMAP Cal/Val suggests” – Lv papers do not provide direct reference for this statement. . ..

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L61-66: What is the reference for all these numbers?

L71 & L72: “suggest” -> suggested

L80-81: The first indication that the soil moisture is essentially assumed homogeneous within the 400-m resolution cells.

Section 2

L97: Please justify the selection of this location for the simulation study.

Figure 1: Please include an outline of the Neckar catchment in the images.

L113: SAI is not spelled out.

L114: Please explain in a little more detail how the SAI is estimated for different land cover types.

L119: Baroni et al. (2017) is missing from the reference list.

L134: “soil sand and clay soil fractions” -> remove extra soil after “clay”

L137: Please specify that vegetation optical thickness depends on LAI in the CMEM. Please explain also how the relationship between the LAI and the vegetation optical thickness depend on the land cover type.

L138: Please include a short explanation how the effective soil temperature is computed in CMEM?

L148: SMAP makes the 6 AM overpass during the descending part of the orbit and SMOS makes it during the ascending part of the orbit.

L149: Please include the more detailed definition of “footprint”. Often the 3-dB beam width is used which results in the 40-km footprint, but I suppose the authors are referring here to the main beam.

Figure 2: Please include the footprint centers also in the right-hand side plot for better

illustration of the geometry.

L162-163: This leaves a huge uncertainty to the results. I'm afraid without quantifying this uncertainty somehow the main results of the manuscript are not useful. See the above.

L180: It seems to me the (i/0.4)^2 is an approximation of the SC_ftd=106x106/(43/i)^2 and should be the last term.

L171-192: I think there is some redundancy in this explanation and would encourage the authors to condense it.

Section 3

L207: "below" –> less than

L222: Average sampling distance is not as relevant as the number of stations so I would recommend using that as the primary result and perhaps include the average sampling distance in the parenthesis.

L226: "footprint" -> grid size

L228-235: This is at least partly redundant and not building on what was said on L61-68. Please try to describe the results in light of the rationale and motivation laid out in the introduction.

L243-245: Several studies have shown that intermediate soil wetness levels would create the most heterogeneous soil moisture distributions spatially. The exact behavior of the spatial variance is naturally scale, soil type and land cover dependent. Please address this issue.

Figure 4: The top plot is not described in the caption.

Figure 4: "The grey intensity" – it is not clear what this refers to (same in Figure 7).

L261: Please describe the assumptions made in the CMEM that result in the 10 K and

5 K accuracies.

L268-277: In this paragraph, “already” is used multiple times and it is not the best word unambiguous description of the results.

L308-316: Again, use the introduction and remember to cite the appropriate studies when discussing these results.

L322-323: “thus” used twice in the same sentence.

L326-332: Please discuss the mechanisms that make the spatial variance of soil moisture and brightness temperature increase with occurrence of forests according to your simulations. E.g., is soil moisture always different in forested areas as compared to non-forested areas? If so, what is the driver of this?

Figure 11: To make the plots more readable, please change “selected” in the legends with something like “<15% forested”.

Section 4

L357: What is the reference for this SMAP team suggestion?

References

Burgin et al. (2017). A Comparative Study of the SMAP Passive Soil Moisture Product With Existing Satellite-Based Soil Moisture Products. IEEE TGRS.

Chen et al. (2017). Application of Triple Collocation in Ground-Based Validation of Soil Moisture Active/Passive (SMAP) Level 2 Data Products. IEEE JSTARS.

Chen et al. (2018). Global-scale evaluation of SMAP, SMOS and ASCAT soil moisture products using triple collocation. RSE.

dall’Amico et al. (2012). First Results of SMOS Soil Moisture Validation in the Upper Danube Catchment. IEEE TGRS.

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