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 #1
Received and published: 24 July 2019

This paper uses a model based virtual reality to determine the number of in-situ stations required to assess L-band soil moisture data. The paper is well written and is easy to read. There is a strong story through the paper leading the conclusions.

Reply: Thank you very much.

There are some minor technical revisions required (provided on the pdf) as well as three other revisions which would help to improve the quality of this already strong paper:

- It would be interesting to see the comparison to actual in-situ soil moisture data to answer the question: is the theoretical number of stations ok when faced with real insitu measurements? For this you would need to have a study area containing a high density of in-situ stations covering the SMAP period. I think it is worth checking if such a comparison could be done or if not recommending it for future research.

Reply: dall'Amico et al., 2012 is cited in Line 52 to show the comparison result between in-situ measurements and satellite products. Other references like Chen's 2017/2018, etc., which indirectly discuss this kind of comparison, are now also added. Line 86: "It is suggested that the core validation sites are met with the 0.04 cm3/cm3 accuracy in terms of unbiased RMSE while the bias will be hard to eliminate. Establishing ground monitoring networks…" and Line 128: "Another case study close to the VR region shows that the bias can reach 0.2 cm3/cm3 over the Upper Danube catchment (dall'Amico et al., 2012)"

- I would have expected a little more discussion on the impact of topography as well as the sand and clay fraction. There seems to be some spatial patterns in the results which correspond to these.

Reply: Line 439-443 is added to address this point as 'Topography also affects the soil moisture and TB distribution, but it is difficult to infer the impact of landuse and vegetation because soil properties determine both the water holding capacity and the plant cover. In practice, soil moisture monitoring networks avoid complex terrain. Homogenous terrain and landscape lead to an overestimation of satellite soil moisture product accuracies.'.

- The study is currently done over a small area in Germany. More information on why this site is chosen is required and more, importantly, the applicability of the results of this study to other areas would be useful for the reader.

Reply: Lines 461-470 are added to make the motivation hopefully more clear "This study isolates the sampling density issue from other factors and is a test of the current Cal/Val network standard without pre-knowledge of the site. The SMAP team suggests 15 sites for a 36 km by 36 km grid-size (Colliander et al., 2017b), and this study agrees with this configuration for typical mid-latitude European regions from the sampling error perspective. For a 36 km by 36 km grid-size, the required sampling sites would range from about 36 (6 km) to 4 (17 km). However, five sites for 9 km by 9 km and three sites for 3 km by 3 km will miss the 70 % confidence level requirements

over this area. Since SMAP's 9-km and 3-km soil moisture products are from a combination of passive and active microwave signals, which have lower accuracy than the passive one(Entekhabi et al., 2010), their Cal/Val campaigns shall determine sampling distances with less confidence level". The landscape simulated by VR01 contains considerable land cover variability (Figure 1), thus our conclusions would apply also to other sites and the typical satellite Cal/Val sites, in particular, except, e.g. for mountainous areas.

Please also note the supplement to this comment: https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-192/hess-2019-192-RC1-supplement.pdf

Reply: Thank you. All comments in the supplement are replied to accordingly. Please see our revised manuscript and the replies in the supplement pdf file.