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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Validation of SMAP L2 passive-only soil moisture products using *in situ* measurements collected in Twente, The Netherlands" *by* Rogier van der Velde et al.

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The authors would like to thank the referee for carefully reading our manuscript and providing constructive criticisms. In our responses below we address the expressed concerns.

Referee 1 comment 1: Validating satellite soil moisture product is necessary. However, this study focused on a very specific region (one SMAP pixel), which absolutely limits the value of this study. The authors need to clarify how such one-pixel evaluation can advance the understanding of satellite observed soil moisture. Authors' response: The authors agree with the referee that accuracy assessment of satellite soil moisture prod-

ucts is ideally performed using independent references collected from as many places around the world as possible. The SMAP Cal/Val team has presented the worldwide assessment of the passive-only SMAP soil moisture products in, for instance, Colliander et al. (2017) and Chan et al. (2018). Both are cited in the introduction.

In this manuscript, we report on the validation of the SMAP passive-only product for one of the sites that has also been used by the SMAP Cal/Val team in their worldwide assessments. The assessment presented here is done over a longer time period and covers a wider spectrum of hydrometeorological conditions than in the aforementioned studies, ranging from very wet to very dry and from frozen to hot. In the revision we will add this in the introduction to explain better the difference with the assessments presented in Colliander et al. (2017) and Chan et al. (2018). This study also deals with the difficulties involved in the creation of consistent references for the assessment of satellite observed soil moisture, such as data gaps in the records of individual measurement locations and spatial mismatch errors.

The value of this research lies in the identification of factors that contribute to the differences found between an in-situ reference and the satellite observed soil moisture. Indeed the identification is done for a specific region, but the found contributing factors can be linked to hydrometeorological process, which are universal and occur all around the world. We provide evidence that large mismatches between in-situ reference and SMAP soil moisture can be attributed to situations with strong vertical dielectric gradients found at the onset of soil freezing or wetting. This knowledge can help us to improve the current products and to make better use of the available products.

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Referee 1 comment 2: If I understand correctly, the upscaling method used in this study is standardizing the model simulation by in situ observation. I would like to see how much improvement has been made by incorporating in situ values. If the improvement is tiny, then the contribution of in situ data is negligible. It doesn't make sense to assume model simulation as ground truth and to use it to validate other observations.

Authors' response: Actually, we use the model output to create upscaling functions to translate the spatial mean of point measurements to the domain of the SMAP reference pixel. In all cases the upscaling functions are applied to the in situ measurements and the model simulations are never assumed to be the ground truth.

In the revision we will put an emphasis on clarifying that the SMAP retrievals are validated in all cases using in-situ measurements. Modifications to the Introduction, section 4.1 and 5.2 are expected.

Referee 1 comment 3: The authors keep using the model simulated root zone soil moisture. Please clarify why you don't use top 5-cm soil moisture from the model.

Authors' response: Indeed, we use the model simulated root zone soil moisture for developing the upscaling function and apply the developed functions to the soil moisture measured in situ at a 5 cm depth.

The root zone soil moisture is used in this investigation because this is the shallowest soil layer for which the model (LHM) provides soil moisture contents. Of course, the 5 cm and root zone soil moisture are not the same. In chapter 5, however, we demonstrate that a linear relationship exists between 5 cm in situ measured soil moisture and the model simulated root zone values. The model simulated root zone soil moisture is linearly transformed to match 5 cm in situ measurements using the found relationships.

The reason for selecting this model is because it is the Dutch national hydrological model that couples physically-based modelling approach for the unsaturated, groundwater and surface water flow. In particular, the first and the second are important in regions with shallow groundwater tables, such as the Netherlands.

Referee 1 comment 4: Please describe the uncertainties from in situ measurements and discuss how these uncertainties will influence the findings.

Authors' response: Section 2.2 describes the Twente measurement network and along with it the measurement uncertainty. This is estimated at 0.023 m3 m-3 and 0.027 m3 m-3 for the 5TM and EC-TM probes with the soil specific calibration function developed under laboratory conditions, see P4L15 and P4L24. In-situ measurements from individual stations include also uncertainty due to spatial scale mismatch. In this research we considered this spatial-scale mismatch uncertainty by 1) taking the mean of a number of independent samples, and 2) developing upscaling function using spatially distributed model simulations.

The measurement uncertainty will affect the findings in such way that the larger the number of independent samples used for determining the spatial mean the smaller the effect of the in situ measurement uncertainty will be on the overall error metrics. This is discussed between p12l30 and p13l4, but we will make use of this opportunity to

elaborate this further.

Other specific comments: Referee 1 specific comment 1: Title: “the Netherlands”. Authors’ response: done

Referee 1 specific comment 2: Line 7: “RMSE”. Authors’ response: done

Referee 1 specific comment 3: Table 2: what does “#” mean? Authors’ response: we will replace # with -

Referee 1 specific comment 4: Table 3: reformat the table. Authors’ response: we will reformat the table so that width of columns is more appropriate for text, but please note that this is subject to typesetting.

Referee 1 specific comment 5: Figure 8: enlarge the temperature and precipitation. Authors’ response: we enlarge the temperature and precipitation plots in figure 8.

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