"Soil moisture retrieval at 1-km resolution making a synergistic use of Sentinel-1/2/3 data"
by Madelon, R. et al.

General comment:

This study aims at producing and evaluating a new soil moisture dataset at 1km spatial resolution, based on both SAR backscatter data and the normalized vegetation index (NDVI) from the Sentinel missions. To reach their objective the Authors adapted the S^2MP algorithm, developed in El Hajj et al. (2017), to move from plot scale to 1km spatial resolutions. To reach the target resolution the Authors investigate advantages on using NDVI from Sentinel-3 (S3) instead of Sentinel-2 (S2; higher resolution as compared to S3), used in previous works (El Hajj et al., 2017). This work is of interest for the journal. Despite this there are major gaps that should be filled. For instance, it would be helpful to elaborate more on the methodology and the Sentinel datasets used (i.e., pre-processing) as well as on the final objective of this study. The introduction section and the abstract need to be revised, focusing on the main target of this work. Finally, the title seems to be not appropriate for the analysis conducted.
Specific comments can be found below.

Specific comments:

RC1-Title: The Authors should consider another title. The actual version is misleading, suggesting that three products (S1, S2 and S3) are used together to derive the 1km soil moisture dataset, which is not the case considering that the algorithm only uses two of them.

RC2-L74: Which is the main reason for using S3 dataset (i.e., NDVI) as compared to S2? Which is (or which should be) the major advantage? Which is the difference between the sensors? This aspect is not treated in detail. A description of the Sentinel missions (not only Sentinel-1) should be included, to better understand which is the usefulness of S3 (i.e., in terms of spatial and temporal resolution and/or processing computation timing). The usefulness of S3 in terms of temporal sampling is only mentioned at line 422. Clarifying this aspect would be useful to better frame the analysis.

RC3-L70-85: I struggle to see the final objectives of this work. Want the Authors to demonstrate which NDVI product is more advantageous between S2 and S3? Do the Authors think that in the future they will move to S3 NDVI? In theory, if good agreement was found between S1+S2 and S1+S3 (line 425), why not using S3 for the following analysis? I think the Authors should elaborate more on their objective and provide insights on what pushed them to use S3 and later on staying with the initial S2 product. This should be clarified in both the introduction section and in the abstract.

RC4–Section2: I did not find a proper description of the Sentinel products used to run the S^2MP algorithm (S1, S2 and S3). The S^2MP section 2.1.1 should go in the method while a sub-section to describe the Sentinel datasets used in S^2MP (i.e., original spatial and temporal resolution) should be added. As an additional suggestion, the HR and CR products used for evaluation could go in another sub-section (i.e., Satellite products used for evaluation) reducing the detailed description and directly referring the reader to the reference work. For instance, at section 2.1.2 both the 1-km and 3-km SMAP+S1 L2 products are described but only the 1-km product is then used.

RC5–L106: SMAP provides passive measurements of *brightness temperature* (passive sensor) in vertical and horizontal polarization and not measurements of land surface SM. This part should be edited.

RC6–L178: *"The Dynamic Land Cover Map product … provided by CGLS was used to evaluate the*

different HR and CR data sets"? In my understanding the objective should be to evaluate the new S^{2}MP product and not the other HR and CR SM products. Please comment on that.

RC7–Figure 1: It's difficult to locate the different test sites. I suggest to add an inset in Figure1 summarizing where the test sites are located. Additionally, it would be useful to add in the maps the in-situ soil moisture sensors location (this would help also the discussion section – line 386).

RC8–L194-195: This part was already mentioned in Section–2.1.1. I suggest to merge the two sections and, as in my previous comment (RC4), to describe the Sentinel products in the data section instead of the S^{2}MP algorithm.

RC9–L201-208: It is only mentioned that the Authors used S3 at 1km spatial resolution while that S1+S2 SM is obtained moving from a 100 m resolution to a 1km spatial resolution. S3 images should have an original spatial resolution of 300m (please check at line 208). How were the images processed? (If a specific product was used it should be cited). Does the S3 NDVI take into account different land uses as the S2 NDVI product? In any case it could be useful to have an idea of the average percentage of crop and herbaceous vegetation for each product over the study areas. Please comment on that.

RC10–L203: It is mentioned that only croplands and herbaceous vegetation are used to derive S^{2}MP$_{S1S2}$. However, in Figure 1 (land cover processed at 1km spatial scale) over some specific regions (i.e., Southwest and Southeast France or North America), forests are the dominant land use. If the Authors are focusing on cropland and herbaceous vegetation, I am wondering why those areas where not masked (i.e., line 331-332 *"As discussed above, the correlation maps show some features related to the dominant land cover class, in particular, higher correlations are found for areas dominated by croplands and herbaceous vegetation"*). Please comment on that.

RC11–L218: Why did the Authors select a threshold of 5%? Please comment on that.

RC12–L212: Why only ascending orbits from SMOS and descending orbits from SMAP were used? It is not explained in the text or at least I did not find it. Please comment on that.

RC13–L242-244: *"The S2 NDVI at 1 km grid ... and compared to the S3 NDVI obtained at 1km"*. This sentence is clearly part of the method. I suggest to remove it from the results section.

RC14–L273-274: Considering the original spatial resolution of S3 an explanation on how this product was processed would be very helpful to understand the results. See my previous comment RC9.

RC15–L276: *"However, taking into account the overall very good agreement of S^{2}MP$_{S1S2}$ and S^{2}MP$_{S1S3}$ maps, for the sake of simplicity and clarity, in the following sections only S^{2}MP$_{S1S2}$ is compared to the other HR data sets"*. This choice makes it difficult to understand the objective of the paper. Which is the point to use the S3 product? This aspect should be clarified throughout the text.

RC16–L369: The Authors should edit the first line of the discussion section. It suggests that four HR soil moisture dataset were produced and evaluated. Whereas, the product evaluated here should be S^{2}MP against the other data sets.

RC17–Section 4.4: The manuscript does not show any time series analysis. It could be interesting to see some time series of the S^{2}MP product against in situ data and the other HR-CR soil moisture products.

RC18: The Authors should check for the acronyms in the abstract section as well as throughout the text. The notation should be uniform. For instance, at line 5 the Authors write NDVI (Normalized Different Vegetation Index) but it should be the opposite considering other notations (i.e. Soil Moisture [SM]). Another example is at line 194 where the notation "soil moisture" should be edited to "SM".

RC19–L130: Maybe the Authors can mention that T is the *"characteristic time length"*.

RC20-L118: The term *"estimation"* before images should be removed.

REFERENCES

El Hajj, M., Baghdadi, N., Zribi, M., and Bazzi, H.: Synergic use of Sentinel-1 and Sentinel-2 images for operational soil moisture mapping at high spatial resolution over agricultural areas., Remote Sensing, 9, 1292, https://doi.org/doi:10.3390/rs9121292, 2017.