The review comments are shown in black, and the author responses are in red.

We would like to thank the reviewer for reviewing our manuscript. Please find below our responses to the comments.

In this paper, SMAP SM data are analyzed in the Arctic region (specifically in Finland) to assess their capability in estimating SM in this complex environment, explore the relationship between P and SM, estimate precipitation from SM using SM2RAIN algorithm and examine SM drydown pattern from April to September in the years 2018-2019. The analysys shown promising results, with good correlation between SM and P, excluding frozen and snowmelt period; limitations of SM quality in the proximity of water bodies and good spatial accuracy of the SM2RAIN rainfall product (but low intensity accuracy, with overestimation of low rainfall and underestimation of the heavy rainfall). Moreover, the length and the exponential decay time scale of the SM drydown were analyzed, showing stable results both in time and space.

The paper is well organized and well written, the language is fluent and clear.

However I have a few important points that need to be answered before the paper is accepted for publication. Specifically

Major comments:

Lines 179-172 “Using…. 2014)”: Not clear. Hence the SM2RAIN algorithm was not calibrated? This approach is not correct: SM2RAIN parameters need to be calibrated to each pixels, as they are dependent from the soil characteristic of the pixels. All the works of Brocca et al. after 2013 relied on this, to overcome the limits of 2013 paper. SM2RAIN should be calibrated against observations (without considering SM data obtained in frozen conditions). If the Authors prefer to not calibrate the data, they should still use some regionalization procedure to obtain SM2RAIN weight for each pixel (e.g. Filippucci et al 2021; 2022, here applied to ASCAT or S1 data). The parameters can change greatly according to the area. Moreover, this approach do not consider SM2RAIN temporal filter T. This would be important to assess the real performance of SM2RAIN in the area.

We will revise the approach and include both calibration and filtering as suggested.

Moreover, SM2RAIN use interpolated daily data, normalized between 0 and 1. Did the Authors applied interpolation and normalization? It should be written and, if not applies, please explain why.

Yes, we have applied both interpolation and normalization. In case of missing SMAP data, the data are linearly interpolated, and a maximum data gap of three days is considered for the interpolation. We will clarify this in the text.

Regarding SM2RAIn quality, the error introduced by the snowmelt was already analyzed in Brocca et al., 2019, which applied mask to sm data during melting (0<T<3) in order to avoid this kind of noises. This should be implemented also here, to assess the very capabilities of NASA SMAP data.

We will implement this method and exclude the melt season from the SM2RAIN analysis.

Line 419 “while dense….challenge”: I don't think that this conclusion is supported by this analysis. Dense vegetation show a realistic pattern, but it is not verified that the SM beneath the vegetation is actually sensed. One way to obtain a confirmation would be to use SM2RAIN to evaluate precipitation time series for all the pixels and then assess its performance per pixel (with indices as RMSE or Pearson correlation or BIAS). If the results in the densely vegetated area are similar to those around, then this indicates that the capacity of SMAP to estimate SM under vegetation are good. But I expect to find worse correlation. In general, I understand that

the lack of SM data allow to validate SM just in few areas, but precipitation data are available for all the study areas, hence I encourage to use SM2RAIn to gain more information regarding the SM data quality

It is true that the lack of reference SM data complicates the validation of satellite-based SM retrievals. However, research has shown that SMAP is able to detect soil moisture beneath the vegetation (Colliander et al., 2020; Ayres et al., 2021). Using P data together with the SM2RAIN algorithm to evaluate SMAP SM retrievals would be a worthwhile study, but we consider it being out of scope of this study. Nevertheless, we acknowledge that uncertainties exist and will discuss the limitations in the manuscript.

Minor comments:

Lines 55-57 "While these….2019)": This is not completely true, as, for example, brocca et al. do not exclude artic region, just periods in which the soil is frozen. Check and correct

We will check and edit the text accordingly.

Lines 267-269 "This….site": Indeed, the discrepancies in SM between the two sites could be related to different precipitation pattern in the large SMAP pixel. However, it could be also related to error in SM measurement. Since Radar data have 250 meters spatial resolution, you could compare the radar Precipitation obtained in the pixels nearest to the Hyytiälä stations, to ensure that they are correlated with it and therefore there is no error in the observed SM measurements.

We will make the comparison as suggested.

Line 363 "Figure…. on SM": Not clear, please expand the reasoning behind the sentence

There is a typo in the sentence, and it should read Figure 11 instead of Figure 10. We will correct the typo and also ensure that the sentence is clear for the reader.

Lines 386-387 "Our analysis….Fig. 7),": To be checked after proper SM2RAIN calibration (see major comment #1)

We will check and edit the text accordingly.

References:

Ayres, E., Colliander, A., Cosh, M. H., Roberti, J. A., Simkin, S., & Genazzio, M. A. (2021). Validation of SMAP Soil Moisture at Terrestrial National Ecological Observatory Network (NEON) Sites Show Potential for Soil Moisture Retrieval in Forested Areas. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (Vol. 14, pp. 10903–10918). https://doi.org/10.1109/jstars.2021.3121206

Colliander, A., Cosh, M. H., Kelly, V. R., Kraatz, S., Bourgeau-Chavez, L., Siqueira, P., A. Roy, A.G. Konings, N. Holtzman, S. Misra, D. Entekhabi, P. O'Neill, S.H. Yueh.: SMAP Detects Soil Moisture under Temperate Forest Canopies. Geophysical Research Letters. Vol. 47. https://doi.org/10.1029/2020GL089697, 2020.