Dear Dr. Zhao and Dr. Zhou:

Thank you very much for your time and effort in editing and reviewing our manuscript. We would also like to thank Dr. Vergopolan and three anonymous referees for their positive and constructive review comments. The manuscript has greatly benefited from these insightful suggestions.

We have carefully considered the review report returned by Anonymous Referee #2 and made some major revisions. First, we clarified the intention of Fig. 8 in the manuscript. Second, we added the spatial R and RMSD curves of the resampled SPL2SMAP_S product to Fig.8b as suggested. Third, we added a figure (Fig. 12) in the discussion section to demonstrate that the 1-km GLASS SM product have added value with respect to the 0.1° ERA5-Land product.

We hope that our revisions have addressed your concerns. Please find the point-by-point reply to the comments below.

Sincerely,
Yufang Zhang & co-authors

Report #1

I consider most of my comments properly addressed. I only have two comments left, which I hope the authors could address:
Thank you for your attentive review and insightful comments, we have carefully considered your suggestions and revised our manuscript accordingly.

- I find the newly added Figure 8 confusing.

8b shows that there is virtually no difference between GLASS (1km) vs. CCI (0.25 deg) and ERA5 (0.1 deg) and CCI (0.25 deg), which essentially suggests that there is no added spatial information in the 1km GLASS product than there is in the 0.1 degree ERA5 product. 8a compares GLASS with a 3km product, but that's not put in relation with the other products, so how much GLASS and SPL2SMAP_S agree isn't very informative in any regard. Wouldn't it make more sense to compare both GLASS and the SPL2SMAP_S to both ERA5 and CCI? Either way, please clarify the intention of the figure and which conclusion is drawn from it. (I don't find the RMSD comparison meaningful in any way, because all that says is that GLASS holds less bias, which is trivial because - as mentioned - bias is not a meaningful metric to compare SM products at different scale.

Response: Fig. 8 intended to quantitatively demonstrate the spatial consistency between the GLASS soil moisture product and two global microwave soil moisture products at

different spatial resolutions (1 km and 0.25°). We have clarified the intention of this figure in the manuscript. (Line 575–584)

It is true that the spatial R curves of the resampled ERA5-Land (blue) and GLASS (orange) at 0.25° only differ slightly, suggesting that the two products are rather close at the 0.25° spatial resolution. But this doesn't mean that the original 1-km GLASS product doesn't contain more spatial information than the 0.1° ERA5-Land product. We have added a figure in the discussion section to clarify this point, which would also be explained in detail in the response below.

Fig.8a aims to compares the GLASS and SPL2SMAP_S soil moisture products at 1 km resolution, and since the other soil moisture products (ERA5-Land and CCI) are of much lower resolution, they are not added to this plot. To make the comparison more informative, we have calculated the spatial R between the resampled SPL2SMAP_S and CCI products as you suggested and added the curve to Fig.8b. We found that it achieves relatively lower spatial R values than those of the resampled GLASS product, and a possible cause for this could be the discontinuous spatial coverage of the SPL2SMAP_S product. (Line 609–628)

We agree that while using point-scale in situ soil moisture dataset to validate soil moisture products at different resolutions, bias is not so meaningful. However, in Fig.8, we compare soil moisture products at the same resolution (1 km) or resampled to the same resolution (0.25°), and we believe that the RMSD between them can be severed as a reference, thus we decide to keep this metric in Fig.8.

- Spatial detail is confused with spatial information.

It is true that Figure 10a looks more detailed than Figs. 10b and c. However, one could also create a nice looking, highly-resolved plot at any resolution using randomly created data, but that doesn't mean that spatial variations would reflect true soil moisture variations in any way.

The authors acknowledge that the details "well reflect the distribution patterns of terrain and vegetation". Analyses regarding correlations w.r.t in situ data, especially spatial correlations, suggest that there isn't any more spatial INFORMATION in the GLASS data than there is in ERA5-Land, even though there is more spatial DETAIL. This is expected, of course, because the prediction model relies heavily on the ERA5 data, but it needs to be articulated accordingly. Pointing out that GLASS maps contain more "spatial detail" isn't useful, because the data suggest that, if anything, these spatial details do NOT reflect higher-resolution soil moisture variation.

Response: It can be seen from Fig.10 that, in the southeastern Tibetan Plateau where the vegetation is much denser, the GLASS soil moisture map shows higher soil moisture levels as expected, and it also exhibits consistency with the CCI product, while the

ERA5-Land product here is suspected to be underestimated. Therefore, we believe that the spatial details contained in the GLASS product can reflect soil moisture variations in a relatively reasonable way. (Line 638–641)

Nevertheless, we admit that Fig. 10 alone can't quantitatively demonstrate that the 1-km GLASS SM product have added value with respect to the 0.1° ERA5-Land product. Therefore, we calculated the spatial R for the XGBoost model on a daily basis using soil moisture measurements from representative stations, and then compared it with that of the ERA5-Land product interpolated onto the 1 km grid. Although the earlier results show that the temporal R values achieved by the XGBoost model at representative stations are similar to those of the coarse-scale ERA5-Land soil moisture product (Fig. 5 (a)), the spatial R values achieved by the XGBoost model improved significantly compared to those of the ERA5-Land product, with the median spatial R increasing from 0.60 to 0.66 (Fig. 12). Accordingly, it is reasonable to believe that the 1-km GLASS SM product does provide more spatial information which reflect fine-scale soil moisture variations, rather than just adding ineffective details. (Line 704–726)