

## ***Interactive comment on “Global Downscaling of Remotely-Sensed Soil Moisture using Neural Networks” by Seyed Hamed Alemohammad et al.***

**Anonymous Referee #2**

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The authors have downscaled global satellite-based soil moisture observations to 2.25km spatial resolution using neural networks. The manuscript is well written, and the methodology is sound. The high-resolution products will be useful for global hydrological and climate studies. However, there are a few issues in this manuscript, hence I suggest some major revisions.

My major concerns are:

1. The training and retrieval in the NN algorithm are based on the hypothesis that it shares the same "relationship" between inputs and outputs to downscale soil moisture from 36km to 9km and to downscale soil moisture from 9km to 2.25km. The author should provide more information about how the SPL3SMP\_E product is enhanced from the SPL3SMP product. As the author mentioned, the native resolution of SPL3SMP\_E

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is actually about 33km. So what is the relationship among 36km, 33km, and 9km?

2. It is a little confusing to add standard deviation of NDVI in the downscale scheme. All the schemes have included NDVI at the higher resolution (9 km for training and 2.25km for retrieval). What additional improvement will the standard deviation of NDVI provide? As the author stated, "This estimate provides a proxy of the heterogeneity within the coarse scale grid". Hasn't the higher-resolution NDVI already provided information about "sub-pixel heterogeneity"? This makes the conclusions somehow self-contradictory. The key of the downscaling algorithm is the higher-resolution NDVI "as an ancillary data to quantify sub-pixel heterogeneity of soil moisture". However, the similar performance of the four schemes suggests that "variability of NDVI within the coarse scale pixel does not provide additional useful information on the spatial heterogeneity of soil moisture for the downscaling".

Specific points:

P2, L29: "Our final product is soil moisture estimates at 2.25km spatial resolution with full global coverage every 2-3 days ... " Is it possible to explain why the final product is downscaled at 2.25km spatial resolution here?

P4, L8: What are the temporal resolution of the in situ soil moisture observations?

P4, L13: 20 measurements at one station?

P4, L14: What is the resolution of the "pixel" here? Does one pixel only contain one station?

P7, Table 1: Are they inputs only for training? It would be better to include the information about retrieval.

P9, L8: The maps look pretty similar, can you tell any difference between them, or which one is better?

P9, L12-13: "... at higher spatial resolutions there is more spatial heterogeneity. The

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latitudinal average for the 36 km product is much smoother than the 2.25 km one." What is the purpose of this? Does more spatial heterogeneity indicate better quality?

P11, Figure 7: Any explanation for the dry bias over the arid area?

P12, L2: How are the metrics calculated? calculate correlation temporally, then average among the pixels/stations? About the error bars on Figure 8, are they standard deviation among pixels or anything else?

P12, L4: For Figure S6, It would be better to show the 10 networks with different colors or symbols on the map... Also, this map should have been mentioned in section 2.4.

P12, Figure 8: It is really hard to tell from the figure if there is any better performance of the downscaled products than the 9km SMAP product.

P12, Figure 8: Any idea why there is poor performance over some network (e.g., SNOTEL) but good performance over some other networks (e.g. SOILSCAPE). Why does SMAP 36km have the best agreement with iRON?

P13, L7-9: This conclusion might only be true among the different NN downscaling schemes.

P13, L20: "... this lowers the quality of the downscaling algorithm in bare soil or sparsely vegetated." Do any of the results support this statement? According to Figure 4, there is very high correlation coefficient over those regions.

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