

Title: Developing a drought monitoring index for the Contiguous U.S. using SMAP  
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Author's response:

Section 2.1, p. 5: Clarify what product version of the SMAP SPL3SMP data is used here. In the latest SMAP product release (R16) frozen ground or snow-covered areas are masked out using a combined NPR and single-channel algorithm based freeze-thaw retrieval, rather than just NPR (Line 10). The NPR is predominantly used at high latitudes where there's a larger V-H Tb difference and sufficient NPR signal-noise, whereas the single channel algorithm is predominantly used at lower temperate latitudes and over vegetated areas.

The following explanation is added:

For this study, version 4 of SPL3SMP is used, which is the release version from the very beginning of the launch of SMAP. The release number changes over time. R16 version is the latest version released in June 2018. However, in all release versions of SMAP, including version 4, regions with permanent snow/ice, frozen ground, excessive static or transient open water in the cell or excessive radio-frequency interference (RFI) in the sensor data, and heavy vegetation (vegetation water content > 4.5 kg/m<sup>2</sup>) are masked out using a Normalized Polarization Ratio (NPR)-based passive freeze-thaw retrieval.

p. 5, Ln 23 (grammar): "...without the discontinuous data.." should be "...without discontinuous data restrictions due to gaps in the SPL3SMP soil moisture retrievals".

This is fixed now.

p. 7, Ln 7 (grammar): "..of beta.." should be ".. of the beta..".

This is fixed now.

p. 8, Figure 2 caption (grammar): "..bottom row: as the .." should be "..bottom row: same as the...".

This is fixed now.

p. 11, Ln 24: Include Lawston et al. 2017. GRL reference here to justify suspect irrigated lands impact on SMAP soil moisture retrievals.

<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL075733>

Reference is included now.

Results discussion of Figure 5: Can the authors provide a potential reason for the low warm season correspondence in the PNW region? I would also expect to see more of a pattern of low

correspondence over the major mountain areas (e.g. Rockies, Sierra-Cascades) given the coarse SMAP Tb footprint, but this isn't very apparent; can the authors talk to this as well?

The following explanation has been added:

In the warm season, the majority of the grids whose underlying short term and long term beta distribution were different were in the western U.S. The low warm season correspondence in the Pacific Northwest region is particularly apparent. The PNW region is covered by dense forests, mountains, and heavily regulated agricultural lands by irrigation. This contributes to the fact that most grids in PNW do not pass the KS filter. A pattern of low correspondence over the major mountain areas (e.g. Rockies, Sierra-Cascades) is also apparent, given the coarse SMAP brightness temperature (Tb) footprint and dense vegetation.

Results discussion of Figure 6: Can the authors include an additional explanation of the low warm season correspondence in the great lakes region? I suspect this may be due to contamination of SMAP Tb and soil moisture retrievals from small water bodies, since the soil moisture algorithm.

I think you are mistaking the low correlation between VIC and SMAP during the cold season in the great lakes with KS test. As Figure 6 shows in cold season, the KS test has better correspondence than the correlation. Nevertheless, I added the following explanation: The Great Lakes region, Minnesota, and Mid Atlantic Region do not show a high correlation between VIC and SMAP in the cold season. Snow, heavy canopy, and land development cause SMAP retrievals to have errors. In addition, this region does not have a good coverage of soil moisture and has less number of retrievals per grid (Figure \ref{fig:overpass}).

Figure 6-7 captions: Clarify what the black x symbols are in the SPL3SMP maps.

Thank you! The explanation has been added as: The black x symbols in the SPL3SMP maps are the grids that passed neither filter and were shown as white grids in Figure 6.

p. 16 bottom (sentence structure): “..SMAP to offer index..” should be “..SMAP index to offer..” .

It's fixed now.

p. 17 bottom (sentence structure): “Our index SPL3SMP index product maps...” should be “Our SPL3SMP index maps...”.

It's fixed now.

p. 17 bottom: More information and clarification is needed regarding the use of the GRACE NDMC product for the 2017 period. The NDMC product is a model data assimilation product that combines GRACE data with other meteorological information. In 2017 the GRACE sensor was failing and the resulting water storage observations were unreliable. As such, the last GRACE

gravity field retrievals and RL06 reprocessing only go through June 2017 and Aug 2016, respectively. Figure 9 and the associated results and discussion therefore likely don't reflect actual GRACE observations for 2017.

Thank you for mentioning that. In fact, the data from GRACE does look different from the other products, especially on 2017-10-17. The following explanation has been incorporated into the text:

Both SPL3SMP and SPL4SMAU index maps seem to catch this drought event, although the event was more pronounced in the root zone than the surface. The maps of these two figures are also in general agreement. It is important to clarify that for 2017 period, the GRACE sensor was failing and the resulting water storage observations were unreliable. Therefore, the last GRACE gravity field retrievals processing only go through June 2017. Therefore, GRACE NDMC results associated with Figure [tbl:rz\\_2017](#) are not consistent with other products and likely do not reflect actual GRACE observations for 2017.