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Interactive comment on "Assimilation of vegetation optical depth retrievals from passive microwave radiometry" *by* Sujay V. Kumar et al.

Anonymous Referee #2

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Several studies have indicated the great potential of VOD for characterising land surface dynamics. To my knowledge, this study is the first one to report on a large-scale assimilation of VOD retrieved from various satellite sensors into a land surface model with dynamic vegetation. Therefore, I recommend publishing it after addressing several concerns and clarifications.

My major issues:

The study refers to VOD as an estimate of above-ground biomass, which it is not. Although relationships between the two quantities exist, which depend also on the microwave frequency, it is not the same thing -> Rephrase throughout the manuscript.

To my knowledge, VOD (tau) retrievals from SMAP L2 are not independent of optical

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observations but a function of (MODIS) NDVI. Thus, it is not allowed to correlate VOD with (MODIS) LAI or assess its assimilation against that of assimilating LAI. In principle, an indicator of vegetation productivity is assimilated.

The impact of the retrieval algorithm on the results is unclear. For a robust comparison of the perofrmance of the different frequencies, I strongly recommend using the same retrieval algorithm for all frequencies.

It is unclear which VOD data are exactly assimilated. VODCA provides merged C-, X, and Ku-band products based on multiple sensors. Apart from the AMSR sensors mentioned, VODCA C- and X-band products alo use TRMM TMI and Windsat observations.

Line 397ff: it is surprising that the assimilation of L-band VOD gives results similar to those of X-band VOD, particularly because, as mentioned earlier, L-band is less sensitive to vegetation. Is this because you are assimilating NDVI rather than VOD (see my comment above)? Also provide quantitative results in addition to pattern descriptions.

Section 3.5: soil moisture and VOD are both derived from SMAP, which makes them strongly dependent. Do your assimilation operator account for these covariances? I recommend using soil moisture from SMAP and VOD from one of the other frequencies instead. In addition, for comaprability, can you show difference maps of the univariate and multivariate assimilation?

Some smaller issues:

line 8, line 21: do you really mean vegetation indices (i.e. spectral band ratio like NDVI) or vegetation variables (e.g LAI, GPP, biomass etc.)?

correct water limited -> water-limited, energy limited -> energy-limited, etc. when used as adjective.

line 31; for vegetation monitoring 70-100 ,m resolutio is not considered high-resolution

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line 37: Although the benefits of passive MW are clearly acknowledged, it is also has diadvantages in terms of temporal resolution. -> add to manuscript

line 62: why do passive MW observations provide the opportunity to extend the spatial and temporal coverage when solar-reflective observations have been available globally for almost 50 years?

line 70: guranteed (typo)

The work of Teubner et al., 2018, 2019 [1,2] should be acknowledged wrt the relationship VOD-GPP.

Line 143: reference to the SMAP mission and the product used in this study shall be given.

Line 210: reference to Vreugdenhil et al. [3,4], who developed the ASCAT VOD product shall be provided

Line 223: This is not surprising as the 6.9 GHz C-band channel in the eastern US is strongly affected by RFI, whereas with SMAP you indirectly assimilate MODIS NDVI.

Line 228: Why does the rescaling not work in the southwestern US?

Line 278: I recommend using the more recent FLUXCOM roduct (Tramontana, 2016)

Line 319: In terms of radiative transfer mechanisms this is a very strong generalisation. Canyou provide the statistics for each category separately?

Line 329: phrased a bit unclear -> rephrase

Line 340: In the terms and conditions of the ISMN (https://ismn.geo.tuwien.ac.at/en/terms-and-conditions/) it is stated that reference (incl. citations) shall be given to all networks used -> please add

Line 342: which depths were used?

Lines 348-363: Since these results are not shown, I suggest moving these analyses to

a supplement

Line 385: Most LAI products are also derived from LEO orbits

Line 421: Isn't this more a bias correction?

[1] Teubner, I.E., Forkel, M., Jung, M., Liu, Y.Y., Miralles, D.G., Parinussa, R., van der Schalie, R., Vreugdenhil, M., Schwalm, C.R., Tramontana, G., Camps-Valls, G., Dorigo, W., 2018. Assessing the relationship between microwave vegetation optical depth and gross primary production. International Journal of Applied Earth Observation and Geoinformation 65, 79–91. https://doi.org/10.1016/j.jag.2017.10.006

[2] Teubner, I.E., Forkel, M., Camps-Valls, G., Jung, M., Miralles, D.G., Tramontana, G., van der Schalie, R., Vreugdenhil, M., Mösinger, L., Dorigo, W.A., 2019. A carbon sink-driven approach to estimate gross primary production from microwave satellite observations. Remote Sensing of Environment 229, 100–113. https://doi.org/10.1016/j.rse.2019.04.022

[3] Vreugdenhil, M., Dorigo, W., Wagner, W., de Jeu, R., Hahn, S., van Marle, M., 2016. Analysing the vegetation parameterisation in the TU-Wien ASCAT Soil Moisture Retrieval. IEEE Transactions on Geoscience and Remote Sensing 54 (6), 3513-3531. doi: 10.1109/TGRS.2016.2519842

[4] Vreugdenhil, M., Hahn, S., Melzer, T., Bauer-Marschallinger, B., Reimer, C., Dorigo, W., Wagner, W., 2017. Characteristing vegetation dynamics over Australia with ASCAT. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 10 (5), 2240-2248, doi: 10.1109/JSTARS.2016.2618838

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