

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

Anonymous Referee #3

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This paper presents results of VOD data assimilation in the Noah-MP land surface model and its impact on soil moisture GPP, ET and streamflow. VOD products from AMSR-2 at X-Band and C-band are used, and SMAP VOD is assimilated separately and jointly with SMAP soil moisture products. The topic is highly relevant for to land surface scientific community. The paper is very well written, results are clearly presented and validated against a large range of observation types, and the analysis of the results is very thorough. I suggest the paper to be published in HESS after the suggestions below are considered.

Specific comments:

Abstract, lines 11-13: “The results also indicate that the independent information on moisture and vegetation states from SMAP can be simultaneously exploited through

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the joint assimilation of surface soil moisture and VOD.”: I don’t agree with “independent information” as moisture and vegetation states are from the same sensor. Also, this sentence repeats line 9 and do not provide additional information. I suggest removing this sentence.

Line 70: It would be worth mentioning the Copernicus CIMR candidate mission (<http://www.cimr.eu/>). It will include all these frequencies. Although its primary objectives are related to sea ice and SST, it will be very relevant for VOD.

Lines 96-97: “. NASA’s Soil Moisture Active Passive (SMAP; Entekhabi et al. (2010)) mission operates in a protected L-band, which minimizes the impact of RFI contamination.” You should specify “ over the US” because, unfortunately, L-band is much affected by RFI sources in many other regions.

Page 7 top paragraph (lines 194-205): As clearly explained in this section, X-band, C-band and L-band VODs are CDF matched to the GLASS LAI data so that they can be assimilated. However, it is not clear why GLASS LAI CDFs are computed (last sentence). Please clarify.

Page 7: Is there any quality control applied to the VOD data set before assimilation?

Page 8, lines 261-262: are SMAP VOD and soil moisture correlated observation errors accounted? The authors should clarify, and comment and justify the choice made in this study.

Page 10, lines 333-334: I find it confusing to give domain improvements in RMSE (in addition to R) for the comparison against ALEXI in these two sentences. The figures only present R statistics against ALEXI as explained on the previous page.

Page 11, line 340: “The impact of VOD assimilation on other land surface states such as soil moisture, terrestrial water storage, and streamflow is also evaluated using a number of reference products.” Soil moisture and TWS validation results for the OL and the VOD DA experiments are discussed but results of streamflow validation are not

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given in this sub-section. There are streamflow validation results in the next subsection but not comparing VOD DA with the OL. So, it would be interesting in section 3.1 to give streamflow validation results for C-band and X-band VOD DA compared to the open-loop.

Pages 11, lines 371-371 and Table 1: LAI DA has no impact on soil moisture. In this paragraph, the authors should comment on why.

Page 14, lines 453-455, Figure 8: the authors claim that the figure shows an overall improvement of soil moisture in the Western US. However, the figure shows a patchy impact in the Western US, with dominating blueish colours, which are related to degradation. It is perhaps an artefact of the figure which need to be made clearer.

Page 14, line 450 indicates that Figures 8 to 10 show results of SMOS soil moisture and VOD DA. It should be clarified that they show results in the univariate configurations. Also, the caption of Figure 9 has typos (see technical corrections).

Page 15, line 510-515, and abstract line 11: the results presented in this paper clearly support the conclusion that soil moisture assimilation has more impact over water-limited areas. They also show that VOD assimilation has more impact in the eastern US and time series at location D shown in Figure 11 illustrate the impact very well. However, it is not convincing to conclude that VOD has an impact in energy-limited areas as patterns shown in eastern US and point D are not particularly energy limited, with point D is at latitude ~ 33 degrees North. The way it is formulated in the general conclusion line 597-599 is more correct (beneficial in areas with high vegetation and no water limitation). So, the abstract and the discussion page 15 should be updated accordingly.

Technical corrections

Line 110: 'independent reference datasets' is too vague. Please clarify.

Line 327: (Reichle and Koster (2004))

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Line 328: over bare soil and urban areas

Line 332: "4.6 % and 6.8 %"

Figure 9 caption: 'of and VOD' -> 'of SMAP soil moisture and VOD'

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