Review of the manuscript "SMOS L-VOD shows that post-fire recovery of dense vegetation is slower than what is depicted with X- and C-VOD and optical indices"

This paper studies the time evolution of several climate and vegetation variables before (triggering factors) and after (recovery of vegetation) fire occurrences worldwide. The study is divided in two parts. The first part details fire episodes in the Amazon, California and Australia. The second part extends the research to a global scale. The authors confirm the capacity of different Earth observation sensors to capture drought situations leading to fire ignitions, and nicely show how vegetation recovery can be monitored with microwave and optical-infrared data. Importantly, they demonstrate which VOD frequencies are appropriate for monitoring vegetation recovery after fires in different land cover types. The main finding is that L-VOD, which is more related to tropical biomass, shows delayed recovery if compared to higher VOD frequencies and optical-infrared indices in this forest type.

The paper is well written and, as explained above, the findings are sounding. However, I have some major concerns that must be addressed before being accepted for publication. The most important one refers to the completeness of the fires database. Both major and minor comments are detailed hereafter.

Major comments

1. Figure 4 shows the fires studied in this work during a nine-years study period (July 2012 – December 2020). The authors explain that "the considered fires are well spread spatially […]." However, the map of fires is certainly omitting a large amount of wildfire episodes worldwide and, most importantly, it scarcely includes fire episodes for all relevant fire-prone regions. Probably the most relevant cases in that sense are the Sahel and the Mediterranean, where a large number of wildfires occur within the land cover types under study (grasslands, savannahs…), according to the monthly maps of the product applied. It is likely that, in part, these regions are not well represented in the study because it does not include shrubland covers. This land cover type should be included as well in this research. Hence, please ensure completeness for all fire-prone regions, especially the Mediterranean and the Sahel, and all land cover types (shrublands are lacking). With this, large and continuous fire occurrence patches (similar to those in the Russian and North American grasslands and forests) should be observed in the northern Mediterranean (especially southern Italy, the Iberian Peninsula and Greece), and in the Sahel.

   In the case of Australia, the authors appropriately excluded this continent as explained in section 3.2. However, justification for this exclusion is provided for vegetation variables and vegetation recovery. However, the authors should include the region at least for CVs explaining wildfires ignition in the region (i.e., SM, TWS and P).

   Also, it is quite surprising to me that the number of fires in tropical forests is very low. This is worrying as it can affect the representativeness of the results in tropical forest fires, and consequently the main conclusion of the paper (that L-VOD is the most appropriate for studying fire recovery in the tropics). Can the authors double-check that all fire occurrences in this region have been included?

2. Although the main focus of the paper is on vegetation recovery, the work also details which main climate and vegetation variables act as triggers of fire ignition (mainly precipitation, soil moisture, ground water storage, and fuel availability). In that sense, the introduction should be extended to provide further state of the art. On the one hand, GRACE data (groundwater storage) has been previously applied for fire risk assessment in the United States (e.g., Jensen et al., 2018; Farahmand et al., 2020). On the other hand, SMOS soil moisture data has been applied as an alternative source of moisture information in the McArthur Forest Fire Danger Index (FFDI; Holgate et al., 2017). Also, SMOS SM anomalies have been found to explain anomalous fire episodes in the northwestern Iberian Peninsula (Chaparro et al., 2016) and in Canada (Ambadan et al., 2020). A part from L-band, a nice study of how satellite soil moisture anomalies can be used for fire risk assessment is shown by Forkel et al. (2012; see also my minor comment below).

Minor comments

Line 15 (and through the entire paper): optical vegetation indices → optical-infrared vegetation indices. Or VIS/IR vegetation indices, if you prefer. The point is that EVI includes both visible and infrared bands.

L. 30: Amazônia legal → Amazônia Legal

L. 50: a sentence should be included about the fact that most wildfires are ignited due to human activities. In the Mediterranean regions 95% of fires are due to these causes, and similar percentages are found in other areas (e.g., 90% in South Asia, 85% in South America, 80% in Northern Asia; FAO, 2006).

L. 90-91: according to these lines, it seems that soil moisture could be retrieved only from L-band sensors, while this is not true. I suggest explaining the advantage of L-band (more penetration capacity through soils and vegetation) to provide better motivation on the advantage of using L-band for soil moisture retrievals, and to explain why L-band is more linked to dense biomass (this point is important for the interpretation of results in this paper).

L. 94-95: "This study also presents for the first time L-band used in conjunction with other sensors, from optical (EVI) to X- and C-band…": add (specify): "in the study of vegetation recovery after fires."

L. 120: from SMOS satellite → from the SMOS satellite.

L. 136: please specify which months are not included, and how much months does it add up within the entire study period.

L. 197: watern → water

L. 216: why are VOD data resampled to 1 km resolution and later averaged to the SMOS grid? This does not make sense because VOD at C- and X-bands have much coarser resolutions than 1 km (as in SMOS). Please, be sure to interpolate directly C- and X-VOD data from their native resolution to the SMOS grid. An intermediate step through 1 km may introduce errors.

L. 239: you use "ha" as burned area unit here, but "km^2" throughout the manuscript. Please be consistent, use only one or the other.

L. 241: how was burn severity defined and classified in "moderate", "high", etc… in this case?

L. 303-304: "a strong decrease during the fire event" → Also before it.

L. 311-312: it should be noted that the positive T anomalies and the negative TWS and P anomalies reach their maximum and minimum (respectively) at the end of the fire period. Can you provide a possible interpretation for this?

L. 348: please mention that savannahs and grasslands show positive VV anomalies one year before (as you will discuss it later in the discussion).

Figure 5: there is an interesting result in Fig. 5 which could be highlighted. Note that, in boreal forests, SM and TWS anomalies are negative also one year before fires. This is interesting as it could be in line with results shown in Forkel et al. (2012). In that case, the authors found that negative SM anomalies in Siberia during summer 2002 led to low amount of water being frozen within permafrost soils during winter 2002-2003. Therefore, a low amount of water was stored (frozen) and then released to the soils during permafrost melting in spring-summer 2003. This led to drier than usual soils in summer 2003, which eased the outbreak of large wildfires. In particular, the Forkel et al. stress in the abstract that "analyses of satellite data for 2002–2009 indicate that previous-summer surface moisture is a better predictor for burned area than precipitation anomalies or fire weather indices for larch forests with continuous permafrost." Your results are in line with this finding and this could be briefly included in the manuscript.

L. 340-345: when you comment on TWS and T anomalies, please refer to Figs. 6c and 6d, respectively.

L. 391: the reference to the Australian Bureau of Meteorology should be accompanied by a year and an appropriate reference within the reference list.

L. 401: can you quantify the severity of the fire? Actually, it would be interesting to mention severity indices when discussing the three study cases, if possible.

L. 428: "which is well documented" → "which is well documented in previous fire episodes in this region."

L. 444 and 449: Argentine → Argentina

References

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Forkel, M., Thonicke, K., Beer, C., Cramer, W., Bartalev, S., & Schmullius, C. (2012). Extreme fire events are related to previous-year surface moisture conditions in permafrost-underlain larch forests of Siberia. Environmental Research Letters, 7(4), 044021.

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