Comment on bg-2021-47

Anonymous Referee #1

Referee comment on "Seasonal ecosystem vulnerability to climatic anomalies in the Mediterranean" by Johannes Vogel et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-47-RC1, 2021

Review of: Seasonal ecosystem vulnerability to climatic anomalies in the Mediterranean. This study analyses the influence of soil moisture and temperature on vegetation activity in the Mediterranean. The research topic is highly relevant since the vegetation of the Mediterranean is highly sensitive to the interannual climate variability. Nevertheless, I find the study affected by several methodological problems related to the choice of data and the spatial aggregation of the different sources of information and also by some statistical issues. Given these limitations, I would not recommend the publication of this manuscript in Biogeosciences. I am providing detailed assessment for these issues below.

20. This statement should be better described. The authors should refer if this is related to future projections or what are the impacts on ecosystems. In the Mediterranean region there is an observed increase of the plant coverage, forest surface and vegetation activity, so the detrimental impacts on the ecosystems should be explained and supported based on literature.

24-25. there is strong diversity of climate regimes in the Mediterranean region, whith areas showing maximum of precipitation in summer months (e.g. NE Spain), so the spatial diversity/complexity is also valid in terms of climate seasonality.

26-30. There is large amount of literature focusing on impacts of climate extremes, particularly droughts, on Mediterranean ecosystems. See e.g. the studies by J. Peñuelas, J.J. Camarero, Dimitros Sarris, etc. This should be acknowledged in this section.

40-41. The authors should note that atmospheric dynamic is the main driver of soil moisture variability and heat waves in the Mediterranean. For example, advections from the Sahara are main driver of heat waves in the region: Saharan air intrusions as a relevant mechanism for Iberian heatwaves: The record breaking events of August 2018 and June 2019 Sousa, P.M., Barriopedro, D., Ramos, A.M., (...), Espírito-Santo, F., Trigo, R.M. 2019 Weather and Climate Extremes. 26,100224 in comparison to the role of moisture anomalies, which explain less than 30% of the variability of extreme temperatures in the region: The synergy between drought and extremely hot summers in the Mediterranean. Russo, A., Gouveia, C.M., Dutra, E., Soares, P.M.M., Trigo, R.M. 2019 Environmental Research Letters 14(1),014011

45-46. Soil moisture is particularly relevant for crops during winter and early spring in the Mediterranean region, a period in which heat is irrelevant. See https://digital.csic.es/handle/10261/101367 In summer, the soil moisture is always very low, and vegetation activity very small (except in forest areas located in the mountain slopes) (Lasanta, T., & Vicente-Serrano, S. M. (2012). Complex Land Cover Change Processes ... Images in Northeast Spain. Remote Sensing of Environment, 124, 1-14.)

45-54: Soil moisture variability is mostly responding to precipitation variability (see cited experimental study by Austin et al. 1998 above). In addition, soil moisture remote sensing estimations are strongly uncertain given temporal inhomogeneities between satellites.

Introduction in general, I cannot find specific focus and the research gap that authors want to address with this research, the reference to the several previous research on drought impacts on ecosystems in the Mediterranean is mostly missing.

69: The classification and aggregation followed by the authors suggest a general lack of knowledge of the diversity of vegetation conditions, seasonality and characteristics in the Mediterranean. The classification is so simple that is absolutely unuseful. The authors are mixing annual croplands (which mostly correspond to wheat and barley in the region, which are active between January and June, with olive trees, vineyards, fruit trees (e.g. almonds) which show longer active periods, from April to October, including summer time). It is not possible to establish reliable results including in a single category vegetation types affected by soil moisture limitations and heat so differently in different seasons. The same happens with grasslands, some of them active in summertime (alpine grasslands in the mountains above 1600 m) with others (e.g. those located in semiarid steppe areas, mostly active in winter and early spring. Also broadleaved forests show extremely different characteristics (from a range of Q. Ilex forests active during all of the year to Abies alba forest only active in summer). I would say that these artificial mixtures in land cover categories mostly invalidate the results obtained by the authors.

75-76: The authors should stress the large limitations of these data, mostly in terms of temporal homogeneity.

75-80: What is the interest of the surface soil moisture to assess drought effects in summer? In this season, main activity and drought impacts are recorded in forests, but given deeper root systems, it would be expected that sensitivity to the surface soil moisture is limited. Thus, even annual crops have deeper root layers (e.g. wheat 50cm).

80-81. What is the relationship between these two soil moisture products.

83-84. Is this introducing inhomogenities between satellite products?

86. This is an oversimplification. there are vegetation types affected by moisture limitations in winter (crops and grasslands of several regions).

85-96: non well-organised description of FPAR, soil moisture. This part of text should be improved.

100-105: Are the series of the different variables normally distributed? On the contrary this approach is not correct. e.g. for biased variables as precipitation, it causes an artificial low frequency of humid conditions and very high frequency of dry conditions. Authors should provide further imformation on the reliability of the chosen standardization approach and this may strongly affect the obtained results as they are focusing on the relationship between variables in the lower tail of the distribution for soil moisture and in the upper tail for temperature.

Figure 5. Given classification used, I think the results of the monthly vulnerability of the different vegetation categories to soil moisture deficits and heat are probably non-reliable. There are some rare results as sensitivity of crops to hot in May (in which high temperatures favor grain filling in cereals) and not to dry conditions (determinant for final crop yields).

Figure 6. The classification for climate regions is also not very fortunate as it is merging areas with vegetation types characterized by different levels of activity across the different months of the year.