

Earth Syst. Dynam. Discuss., referee comment RC3  
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## Comment on esd-2021-19

Anonymous Referee #3

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Referee comment on "Vulnerability of European ecosystems to two compound dry and hot summers in 2018 and 2019" by Ana Bastos et al., Earth Syst. Dynam. Discuss.,  
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Review of "Increased vulnerability of European ecosystems to two compound dry and hot summers in 2018 and 2019" by Bastos et al (esd-2021-19)

### General comments

The manuscript talks about a relevant topic showing the importance of consecutive dry and hot events for ecosystems. The paper investigates why temporally-compound compound extremes can amplify the damage to the ecosystem focusing on 2018 and 2019 in Europe.

The paper addresses a relevant scientific question and it is within the scope of ESD with the potential to have an audience from a broader community of climate impact studies, agricultural systems, hydrology, and multi-sector dynamics.

The paper concludes that process-based models miss the legacy effects of consecutive compound hot and dry summers. The final results are based on a) regression and correlation analysis, and b) LSM outputs. However, the data preparation has heavily relied on satellite scans from MODIS and simulation outputs of Land Surface Models.

The paper describes the data sources in great detail which is good. I understand that this is a critical part of the research, but it distracts the reader from the main message. I suggest moving the data construction information to the appendix.

Finally, I suspect the results are reproducible. It would be beneficial if the authors could share the major constructed datasets for regression analysis and related outputs of LSM models.

Below are my technical concerns.

- The title of the paper talks about compound dry and hot summers. The model and data do not include metrics of compound extremes. The T and SM are often separated in the paper and are considered individually. I expected to see some compound indicators. I am not sure the term "compound" in the title is well-represented within the paper.
- The paper is written well. Still, the overall presentation requires revisions. Please describe the main variables in more detail in a table in the appendix. The reader deserves a clear description of the main variables of this study and the main model evaluating the relationship between them (e.g. variables explaining EVI in regression models). There is no single equation neither a table showing the underlying model of the study. While the main work is based on regressions and correlation analysis, the reader should wait until page 7 to learn about them. The problem is that the regression strategy has a vital role here. Are you estimating the marginal impacts for each pixel or a set of clusters? These should be clarified with a written equation with clear indexing of all the variables. In addition, this can be a useful reduced-form model for future studies. In its current form, the regression section looks pretty weak.
- There is no discussion on the goodness of fit for regression and the causal analysis. The lagged EVI used in the model, while can be used to prove the existence of the legacy effect, does not tell us the exact sources of legacy effects. There is a high chance of omitted variables here (e.g. soil moisture in lower layers or disease as discussed in the paper). This could be briefly addressed in the appendix.
- Unfortunately, the interpretations and conclusions are more than what the model results show. For example, the claim in L316-319 is too strong. The correct conclusion is that "the proposed model" and current LSMs did not capture this legacy effect. This effect can be captured in future studies in models with different variables, metrics, and methods. This can be a shortage of the methods of this study. The results can be biased by omitting some variables (e.g. disease, nutrient, radiation, etc). This is the nature of science. Further investigation is required to have such a strong conclusion.
- The paper employs the soil moisture data based on volumetric soil moisture of the top 28 cm. I expected to see other metrics of root-zone soil moisture depending on the vegetation dominance. The soil moisture in lower layers can be "a" major source of legacy effect which is ignored apparently. As mentioned in the paper: "total water storage was lower in 2019 due to the water storage deficit resulting from the 2018 event". Probably, a more precise hydrological product should be used to capture this.
- Other issues.

- Define vulnerability
- L3: "though" does not seem the right word here.
- L10: Please revise the sentence.
- L29: "hot and dry" is better to be replaced by "dry and hot" to better represent the DH abbreviation.
- L65: extra parentheses
- L124: This is the data section. Maybe change the title to show this.
- L268: is this your finding? If not move it to the discussion.