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Biogeosciences Discussions

Interactive comment on "Impacts of droughts and extreme temperature events on gross primary production and ecosystem respiration: a systematic assessment across ecosystems and climate zones" *by* Jannis von Buttlar et al.

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We thank the reviewer for the positive and helpful comments. Please find below our detailed responses to their remarks (in italics):

1. I am curious why the authors used LaThuile dataset which includes short term dataset than FLUXNET2015. This is particularly important as this manuscript deals with climate extreme and C fluxes.

We understand that the reviewer is surprised to see that we work with the La Thuile

data set and this indeed needs justification: This activity started as a synthesis activity in the period where only the La Thuile dataset was available. However, please note that we already added more recent data for several sites available from the European flux network (http://www.europe-fluxdata.eu/) so we are basically using an extended La Thuile version of FLUXNET. Still, due to internal reasons, the paper could not be finalized earlier than 2017. We are also aware that the length of the time-series has increased in the US since we started the analysis and the record length of our analysis is not as long as it could have been. However, the complicated data harmonization, upscaling and WAI analyses with the La Thuile dataset were quite extensive and cannot be repeated because the first author has moved on to other duties. We therefore decided to progress with the publication using the La Thuile dataset. We see this paper as a prototype on how one could reanalyze the new FLUXNET releases but also as a benchmark for the results from the numerous papers published on the La Thuile version of the FLUXNET dataset.

2. I am curious why Tmax related events are much more frequent than the others (Tmin, WAI..) in Fig 3a. The extremes were defined as 5

First of all, this is due to the different durations of high temperature extremes detected compared to the detected WAI extremes. Due to the different data streams and climate variables used, temperature values tended to fluctuate with a much higher frequency compared to the rather smooth and slow fluctuations of WAI (cf. Fig 8 for an example). This resulted in many independent but rather short extreme events for temperature compared to fewer but longer extreme events for the strongly auto-correlated WAI. The amount of extreme **days** (in contrast to extreme **events**) was identical for both variables (5% of the data). The small amount of T_{min} extreme events compared to T_{max} is due to the fact that we only investigated (and, hence, plotted in Fig 3) instantaneous responses during the growing season (cf. Sec. 2.5). For extra tropical sites, many of the defined T_{min} extreme events occurred during winter, which is outside the growing season. This explains the much lower number of extreme events in Fig 3.

3. I recommend choosing a few (not all) long-term (>15 years) flux tower data from FLUXNET2015, and testing how your delta GPP, Reco, and NEE are robust with different time spans (e.g. 5, 10, 15 years) or random samples (say, 10 years) many times and check delta GPP, Reco and NEE. Although the authors started with Fig 1 stressing available long-term data, I feel many sites have <5 years data records, which might be not enough to test delta GPP, Reco, and NEE although they include climate extreme years. I think the authors already have all results for individual sites, so it would not require substantial efforts.

First of all, we are not overly concerned about this issue, as the extremes were identified in the meteorological data streams which consisted of 30 year time series for every site. We then only compared the distributions of the flux anomalies during these extremes. Thus, longer flux time series would only make the estimated flux impacts slightly more robust but are unlikely to change the general results on extreme event distributions etc. discussed in this paper. In addition, due to changed professional locations, regrettably, we are unable to do this (see also our response to remark 1 above). We would have to redo the extensive analyses, including meteorological downscaling (which includes downloading current ERA interim datasets, harmonizing them, ,etc), new WAI calculations, etc..

P8 L13: Curious why APAR was used in computing potential evaporation. Net radiation is a better proxy and is available from reanalysis datasets.

Thanks for bringing this to our attention. In fact, net radiation is used in our estimation. We basically scaled potential evapotranspiration (which is estimated via the Priestley Taylor approach using net radiation) with fAPAR, which is a common approach. Our method description (and the more detailed description we are referring to in Tramontana et.al (2016)) does not, however, mention this explicitly. We extended our methods description (line 12ff, page 8) to make this more clear:

"Potential evapotranspiration is estimated based on Priestley and Taylor (1972) from

net radiation (also taken from the reanalysis data) using a Priestley-Taylor coefficient of 1.26. Potential evapotranspiration is then finally scaled with smoothed fAPAR (from MODIS)."

P9 L1: I think some ecosystems (e.g. savanna) reveal seasonally varying sensitivity to water availability (e.g. wet vs dry season).

The referee is right. See the corresponding answer to a similar remark from referee 2 (i.e. the 5th comment) for details.

P10 L27: remove ")"

We removed ")".

P12 L7: add "("

We added "(".

P12 L17: Reco is computed using soil/air temperature from NEE. I am curious if such high sensitivity of Reco to temp extremes is entirely independent from the way to compute Reco.

The reviewer raises very valid issue here. We are confident that this dependence of the different variables does not bias our results very much, as, using th approach of Reichstein et. al. (2005), the temperature dependence of Reco to NEE is computed using a rather short and local time window. If high temperatures during drought extremes would cause an impact on the ecosystem which would change this dependency, the flux partitioning algorithm would reflect this temporal change. We tested our confidence, however, by performing the identical analysis with night time NEE as a directly measured proxy for NEE and mid-day NEE as a proxy for GPP (page 7, line 2-6) and found patterns consistent with the results presented (data is not shown in the submitted manuscript).

P15 L8: The argument, "a stronger increase in Reco led more C gain" looks contradic-

tory. Probably stronger increase in GPP?

Thanks for bringing this to our attention, GPP and Reco were confused here. We changed this to:

“A stronger increase of GPP led to a slight overall increase of NEP (i.e. a C gain)”

P18 L27: add “)”

We added “)”

References

- Reichstein et al, (2005), Global Change Biology 11, 1–16, doi: 10.1111/j.1365-2486.2005.001002.x, On the separation of net ecosystem exchange into assimilation and ecosystem respiration: review and improved algorithm
- Tramontana, G., Jung, M., Schwalm, C. R., Ichii, K., Camps-Valls, G., Ráduly, B., Reichstein, M., Arain, M. A., Cescatti, A., Kiely, G., Merbold, L., Serrano-Ortiz, P., Sickert, S., Wolf, S., and Papale, D. (2016): Predicting carbon dioxide and energy fluxes across global FLUXNET sites with regression algorithms, Biogeosciences, 13, 4291-4313, https://doi.org/10.5194/bg-13-4291-2016.

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