Discussion of "Compound soil and atmospheric drought events and CO_2 fluxes of a mixed deciduous forest: Occurrence, impact, and temporal contribution of main drivers"

Author response to Referee 2 comments

Scapucci et al.

May 9, 2024

In the following, *reviewer comments are given in italics*, author comments are given in normal font.

1. General comments

Authors research provides important insights into the response of a montane mixed deciduous forest in Switzerland to CSAD events, which are becoming increasingly prevalent due to climate change. By utilizing multi-year eddy-covariance CO_2 flux data, authors have effectively characterized CSAD events at the study site and quantified their impact on ecosystem and forest floor CO2 fluxes. Authors used data-driven machine learning methods to discern the drivers of CO2 fluxes which capture the complexity of these interactions. Overall, the study represents a significant advancement in our understanding of forest responses to CSAD events and highlights the importance of considering multiple drivers in predicting site-specific drought conditions and long-term forest responses. The only major limitation I see is the lack of information regarding the development of forest structure between the measured years 2015-2018-2022, but I believe that authors could address this easily. I am suggesting minor revision of the paper.

Thank you for acknowledging our study. Please see our responses to your concern below.

2. Line-by-line comments

Line 80: What does percentual cover mean for the species, by leaf area/volume?

The largest limitation of the presented study is bare minimal information regarding the forest structure. I believe that authors should include the development (annual) of standard parameters such as stand LAI and species specific DBH, height and density. This is especially important for the interpretation of the values between years and comparison with reference period. You should show that these differences were not due to differences in forest structure.

As this is managed site, the time between 2015-2022 is pretty long period that could include some significant change in species composition. This could influence your Figure 7,8 comparison of variable sensitivity between years.

Thank you for your suggestions. We have mentioned species cover in Section 2.1. Although the forest is managed, the footprint area of the eddy-covariance tower was undisturbed during our measurement period, thus, structure did not change during 2015 to 2022. Based on your suggestions, we looked at a reliable satellite-based LAI data (NOAA's VNP15A2H data product; https://doi.org/10.5067/VIIRS/VNP15A2H.001) around the flux tower (600 x 600 m^2) and the results confirmed our info (Figure R2.1). There was no significant trend in LAI from 2014 to 2022, and no significant difference between LAI of 2015, 2018, and 2022 as shown in the figure below (Fig. R2.1). We will add this information to our site description in the Methods.

Furthermore, all our driver analyses in the manuscript (CVI and SHAP values) were done year by year, thus, even if structure from one year to another would have changed, the results and our interpretation would be reliable and solid. In order to make this clearer in the manuscript, we will add this more clearly in the Methods and will also refer to it in the Results.

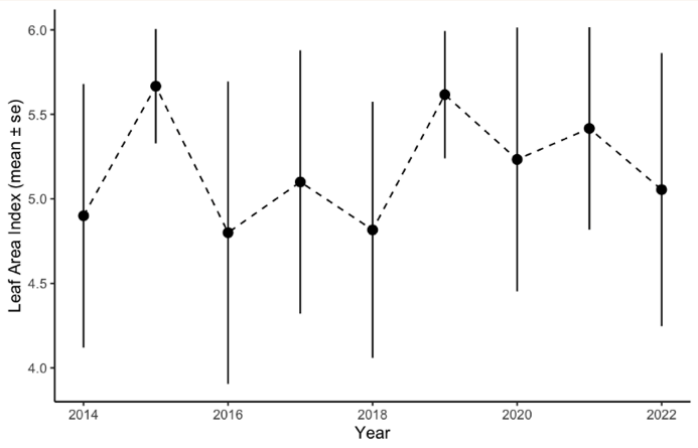

Figure R2.1. Mean (± 95% C.I of mean) leaf area index of the forest site from 2014 to 2022 (April-September) as derived from NOAA's VNP15A2H LAI data product.

Line 82: First time mentioning Fraxinus excelsior, Acer pseudoplatanus etc. please use full latin nomenclature as you did for European beech and Norway spruce.

Thanks for pointing out, the full Latin name will be added where missing.

Line 151: R version missing.

Thanks for pointing it out, the R version will be added to the manuscript as "R version 4.3.3".

I would suggest to include the variable of interest (NEP, Rff) in Figures 5-8 to include in the figures directly, not only in the description.

Thanks for the suggestion, the variable of interests will be added to the figures' captions.

Could the figure 7c, f, I be interpreted in a way that the temperature optimum for NEP shifted between the years? If yes, I think you should explore possible reasons in the discussion.

Thanks for referring to this aspect. Yes, it means that there was a shift among different growing seasons in the optimum values of temperature, interpretated as threshold values and acclimation (see also our response to reviewer 1). This might partly be due to the fact that temperatures at the site have been increasing in the past 20 years. However, in our manuscript we tested the sensitiveness of NEP to abiotic factors like Tair, VPD, and SWC within any given growing season, not along consecutive years. We indeed found that the optimum feature values (Opt. VPD, SWC, Tair) were related to the mean feature values (mean VPD, SWC, Tair) during the respective growing seasons of 2005 to 2022, albeit we did not find a chronological trend (Figure R2.2). We will discuss this topic in the revised manuscript and add this figure as well.

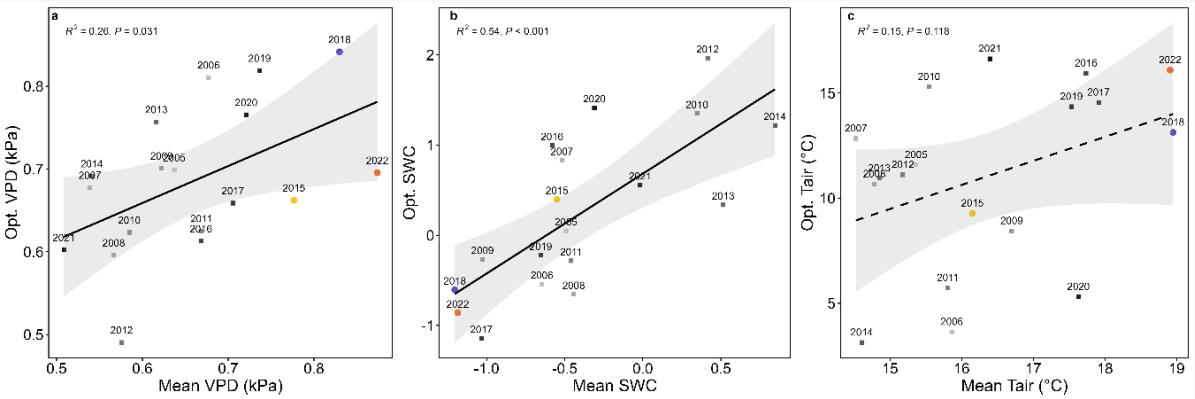

Figure R2.2. Linear regression of maximum marginal contribution (here abbreviated to Opt.) of VPD, SWC and Tair to daytime NEP against the mean VPD, SWC, and Tair measured during the growing season of the same year. SWC values were normalized. The grey areas around the dashed lines indicate the 95% confidence interval.