Response to Reviewer #1

Opposite-sign influences of canopy structural and physiological dynamics on water–carbon biogeography

Preprint egusphere-2026-3250

Reviewer 1 Comments:

https://doi.org/10.5194/egusphere-2026-3250-RC1

In this manuscript, Short Gianotti and Entekhabi reveal a scale-dependent relationship between gross primary production (GPP) and evaporative fraction (EF), characterized by a negative correlation at the daily scale but a positive correlation at the monthly scale. The negative GPP–EF relationship is attributed to physiological upregulation and non-negligible increases in canopy cover following rain, whereas the positive relationship is primarily driven by structural changes in canopy extent. This study makes an important contribution to our understanding of ecosystem water–carbon coupling by highlighting the dominant role of vegetation structural dynamics at longer timescales. The manuscript is well written and a pleasure to read. I particularly like the use of a dynamical systems model to demonstrate how daily-scale dynamics eventually converge toward the positive relationship observed at the monthly scale. I have only a few minor suggestions for the authors to consider.

We thank the reviewer for their time and their supportive comments. All of this feedback is gratefully accepted and has been incorporated into an improved manuscript.

Line 108: ‘0.254 mm’ does not seem like an arbitrary threshold. Why?

A very reasonable question, particularly for a European journal and audience. In the United States, standard rain gauge accuracy was set to 1/100 of an inch (0.254 mm), although many modern rain gauges have better accuracy by a factor of roughly 2. Any immeasureable liquid precipitation (values below 0.254 mm) are assigned “trace” designation, usually even when higher accuracy is possible for consistency in long-term records. The WMO uses a 0.2 mm or 0.1 mm threshold for modern gauges. We have changed the text to read:

[Lines 108-109 in tracked changes document:]

We flag days with less than “trace” precipitation as interstorm “dry” days, using the 0.254 mm trace threshold (the largest of the standard rain gauge resolutions). After any day with greater than trace precipitation, we label the following consecutive days without rain a drydown.

Table 1: ‘canopy/average’ → ‘canopy-average’?

Yes, thank you—this has been corrected.

Line 121: Supplemental Section 7?

Yes, thank you—this has been corrected.

Figure 2: It is not so clear to me how dGPP/dEF at daily and monthly scales are calculated. Also in other figures. In the caption, it seems to take the difference between day 1 and day 2 after rain at the daily scale while estimated by linear regression at the monthly scale. It would be great if more details could be given in the method section with formulas.

We have added the following:

[Lines 130-142 in tracked changes document:]

Percentage Relative Changes

In Figure 2b, we use the percentage of peak growing season monthly GPP and EF values. These are calculated as follows: (1) Growing season months are determined for each site as all months with more than 10% of the maximum observed monthly GPP. All GPP and EF values in non-growing season months are discarded. (2) Climatological values are calculated by site as $GPP_{clim}(\tau) = \mathbb{E}\{GPP(\tau)\}$ and $EF_{clim}(\tau) = \mathbb{E}\{EF(\tau)\}$ for month of year $\tau \in \{1, \ldots, 12\}$. (3) The growing season peak, τ_{peak} is determined as the calendar month with the highest climatological GPP value. (4) Percentage values are calculated as $100 \times GPP_i / GPP_{clim}(\tau_{peak})$ and $100 \times EF_i / EF_{clim}(\tau_{peak})$. (5) These fractional values are reassigned time indices

relative to the peak month (e.g., -2 corresponds to 2 months before the local climatological peak GPP). (6) All fractional values for all sites are grouped by their new time indices, and the group means are plotted.

The daily relative changes are calculated similarly for Figure 2e, but relative to the first day of a drydown rather than the peak growing season month. For each drydown of at least 2 days ($n = 42{,}506$ drydowns across 248 sites), we calculate GPP and EF changes relative to their values on the first day of that drydown. These are grouped across all drydowns at all sites, indexed by the number of days after rain, and the mean of the percentage changes are plotted.

[Lines 143 – 148 in tracked changes document:]

Daily Linear Regressions

To see the rapid daily dynamics, we look at the changes in GPP and EF between the first two days of drydowns. To avoid incorporating the dynamics of monthly processes, we cannot regress across drydowns from different times of year. Instead, we calculate the slope $dGPP/dEF$ for each drydown, removing the mean-state information. We plot the median of all slopes by site in Figure 2f as $\frac{dGPP}{dEF} \approx \text{median}\left\{\frac{[GPP_2 - GPP_1]}{[EF_2 - EF_1]}\right\}$. The same approach is used in the site-wise daily slopes of Figure 3ef.

Line 198: It would be great if there were a quantitative analysis.

This is true, and we do get to it in Figure 4 and its discussion, but it is not obvious at this point. We have made some minor changes in the text in Lines 222 – 228 to clarify that, (1) these visual descriptions are a first read and that (2) we will return to further analyses on the next section.

Line 218: This 'gridded mean values' is only clear to me after reading the supplement. It would be great if the supplement were properly referenced.

Absolutely, our error. We have added a reference to Supplementary Section 7 at new line 245-246.

Lines 419-423: Plant physiology and canopy extent can be closely linked through carbon allocation (Hartmann et al., 2020). Assimilated carbon can be allocated to different carbon sinks, including leaf growth, thereby increasing canopy extent. Although I partly agree with this point, the current wording may give the impression that physiological responses and changes in canopy extent in response to soil moisture are independent processes. I would therefore suggest rephrasing this statement to better reflect the coupling between physiological and structural responses.

Reference

Hartmann, H., Bahn, M., Carbone, M., & Richardson, A. D. (2020). Plant carbon allocation in a changing world–challenges and progress. The New Phytologist, 227(4), 981-988.

Very constructive. We have added a sentence to clarify that these are coupled processes in reality:

> [Lines 447-453 in tracked changes document:]
>
> Earth System Models that represent water-carbon coupling using only stomatal conductance or photosynthetic capacity, without allowing canopy extent to properly respond to water availability, will misrepresent both the sign and magnitude of productivity feedbacks at monthly and longer scales. This is true both for models with decoupled physiological and canopy dynamics and for models with errors in physiological-canopy dynamic coupling. Because this sub-grid coupling is exceptionally complex, we strongly suggest that models should prioritize aggregate dynamic $\underline{\mathrm{LAI}}/f_v$ coupled to soil moisture, which is likely a higher-impact improvement than refinements to physiological sub-models alone.

We also had not seen this nicely-written introductory material (despite reading some of the research articles that follow it). It provides a very direct reference to the idea that physiological and ecological processes are in constant communication, and we now cite it in the Discussion section at line 353 of the tracked changes document.