Review of egusphere-2026-4828 - Evaluation of Partitioning Methods to Identify Timescale-Dependent Drivers of Light Use Efficiency in a Wet Tropical Forest

The manuscript presents 11 months (July 2022–May 2023) of eddy-covariance CO2 fluxes, with profile-based storage correction, from a 57 m tower at La Selva, Costa Rica. These are the first EC fluxes reported for the site since Loescher et al. (2003), which is quite valuable given the sparseness of these datasets in tropical regions. The authors compare different NEE partitioning methods: full daytime, morning daytime, afternoon daytime, nighttime and sundown. They show that morning data degrade daytime light-response fits, while the afternoon, nighttime and sundown approaches converge. They report a strong, temporally stable sink (i.e. with almost no seasonality) of about 947 g C m^{-2} yr^{-1} but acknowledge that this value could be influenced by la Niña conditions throughout most of the studiy period. Using afternoon-partitioned GPP, they train random forest models on LUE at half-hourly, daily and weekly resolution. PAR dominates at the half-hourly scale, and temperature and moisture variables gain importance at longer timescales. The manuscript is well written, and the work is very valuable for the tropical flux community, where recent EC records and systematic comparisons of partitioning methods are scarce. The study is well thought out and scientifically sound. The multi-method comparison is a useful quality-assurance step that other tropical sites could explore. My main concerns are the structure of the paper, how gap-filling interacts with the partitioning methods, and how robust the driver attribution for LUE is. I recommend to accept the paper after minor to moderate revisions.

Major points

1. Paper structure

The manuscript pursues two goals: (i) evaluating partitioning methods and (ii) attributing LUE drivers across timescales. I think the authors could shorten the manuscript by more effectively communicating Section 3.1, 3.1.1 and 3.2, which precede one of the actual main results (i.e (i)). I suggest the following:

- Tighten Sects. 3.3.1–3.3.2 considerably, or move much of them (e.g. the detailed parameter comparison and Fig. 2d–e) to the Supplement. The key result, that morning data inflate α and γ while afternoon fits are stable, can be made in far less space.
- State the link between the two parts explicitly (partitioning and LUE drivers). In particular, say how much the LUE driver results would change if GPP_N or GPP_S were used instead of GPP_A. If the drivers are insensitive to the method, as the authors imply, that strengthens the paper. If they are sensitive, it is an important result in itself.
- Shorten the Conclusions. They currently restate most of the Results.
- Fix the section numbering: there are two "Environmental Variables" sections (2.1 title and 2.3), and the conclusions are numbered "1. CONCLUSIONS".

2. Effects of gap-filling on the partitioning methods

According to the authors, 62% of half-hours remain after quality control (L146). The gap-filling scheme (using linear interpolation for less than 90 min, and a mean diurnal variation for up to 6 h, and longer gaps unfilled) affects the partitioning windows very differently (I guess..), but this is not addressed or referred to. Specifically:

- Were gap-filled values included when fitting the light-response curves, the night-time temperature regressions and the sundown NEE–PAR regressions? If so, what is the effect of the the mean diurnal variation filling, with a +- 3-day / +-1 h window, on the morning–afternoon analysis and in the short sundown windows that the analysis focuses on. Please report the fraction of gap-filled data within each method's fitting window (night, sundown, morning, afternoon).
- The u* threshold of 0.313 m s^{-1} (Fig. A2) is quite high and lies well above the nighttime u* values. Thus, nighttime gaps must be very large, and the nighttime method would be based on a small and possibly unrepresentative subset (?). I suggest the authors showing how sensitive is each partitioning method to the u* filtering, particularly the nighttime method.
- L530–532 state that restricting fits to afternoon periods "reduces bias in gap-filled fluxes". Could the authors elaborate on that? I was thinking that given that the gap-filling used here does not rely on light-response curves, how could this be? Please clarify, or show this.

- I recommend a sensitivity test using standard gap-filling methods (e.g. MDS and the nighttime and daytime methods in REddyProc or ONEFlux) and comparing the results with the current ones.
- For the morning and afternoon methods, both GPP and Reco are taken from the fitted light-response function, rather than as residuals of observed NEE. Nighttime GPP is set to zero and gaps > 6 h are left unfilled, so sums of NEE, GPP and Reco may cover different half-hours. In my experience at another tropical site, such inconsistencies can produce substantial mismatches, and even sign differences, at monthly integration. I recommend that, for every method, the reconstructed NEE (Reco – GPP) closes with the observed NEE. From the figures it looks like it does, but I suggest doing it more quantitatively.

3. Robustness of the LUE driver attribution
The results of the random forest analysis are interesting, but several design choices weaken the attribution:

- LUE = GPP_A/PAR, and PAR is also a predictor. Because GPP saturates at high light, LUE decreases with PAR by definition. The negative LUE–T and LUE–VPD relationships (Fig. 6a–c) and the dominance of PAR (Fig. 5d) could potentially be artifacts of the PAR normalization, instead of physiology? The authors could, for example, model GPP with PAR as a predictor, or use LUE at GPPmax and compare the results.
- Record length: with a single 11-month record that is not a full seasonal cycle, and the drying signal concentrated in the last two months, the weekly-scale importance of temperature and SWC is essentially driven by one event. This should be stated as a limitation more clearly, both in the abstract and in the conclusions.
- Validation scheme: see the comments at L335–339 below.

Minor points
L30: And Reco? Please also report mean Reco in the abstract. I know is not the main target of the study, but perhaps is worth reporting there?

L34–36: Is this at all surprising? I recommend that the authors end the abstract with a more specific message.

L42–43: I would not present this as a broad agreement in the GPP community. The size of global GPP is under active debate. See:
- https://www.nature.com/articles/s41586-024-08050-3
- https://www.nature.com/articles/s41586-026-10562-z
- https://doi.org/10.1038/s41586-026-10561-0

L51: The following study could be cited here as well, it gives an observationally constrained timescale for the transit time of carbon in tropical forests:
- https://bg.copernicus.org/articles/22/455/2025/

L61–62: "However, there are uncertainties associated with both approaches." This applies to all approaches. I suggest removing the sentence and going directly to "However, the nighttime method often…".

L68–69: What is the growing season at La Selva? Please rephrase or refer the reader to a part of the year.

L72: "More recently" for a 2016 paper? Please rephrase, or add more recent references.

L76–77: This sentence feels out of place: there is a sudden jump from Reco to global GPP.

L94: A citation is required here.

L96–97: This statement is not entirely correct. In fact, the nighttime method, particularly the one presented by Reichstein et al., (2005), is not used given the very small temperature range in tropical forests, see:
- https://doi.org/10.1016/j.agrformet.2013.04.031

- https://onlinelibrary.wiley.com/doi/10.1111/gcb.15905

I suggest the authors to rephrase that sentence.

L110: Research question 3 needs reformulating; the phrasing sounds odd.

L152: Is 57 m the height of the tower? Please state it explicitly here and I guess this is where the gas analyzer is, right?

L255–256: Solar noon is fixed at the campaign mean (11:45 CST). How sensitive are the morning and afternoon partitioning results to this choice?

L268: Baseline respiration at 0 °C? This is far outside the observed range (about 22–27 °C). A reference temperature within the observed range would be more meaningful, right?

L277–278: Mahecha et al. (2010) show a large spread for tropical sites. Please check the tropical values rather than comparing with the global mean.

L335–336 (rolling-origin validation with a 50/50 split): Please clarify if this validation strategy is a single temporal split, if so, then: the test period contains the end-of-campaign drying, which the model never sees in training, right?

L337–339 (10-fold blocked CV, weekly model): With n ≈ 48 weeks and gaps (e.g. Aug–Sep 2022 in Fig. 4), each block holds about 4–5 weeks. With this I think the per-fold R2 will be unstable(?). Please state whether R2 is computed from pooled out-of-fold predictions or averaged across folds.

L360: Remind the reader what that temperature range is.

L403–407: There are precipitation deficits but lower VPD, attributed to La Niña(?). Is this for the same months? It doesn't makes sense if it is.. no? Please report VPD for the same months with precipitation anomalies.

L430–431: The authors state that taller towers improve the robustness of EC flux estimates: not always. Larger footprints, heterogeneity, morning flush peaks and storage can also become larger issues. Please have this in mind in this part.

L442: Such strong uptake relative to NPP would imply a very high carbon use efficiency, which is difficult to reconcile with other wet tropical forests, but plausible I guess. Please discuss having Chambers et al., (2004) findings in mind: https://esajournals.onlinelibrary.wiley.com/doi/10.1890/01-6012

Table 1 (L461): Please double check this study, as I don't think they used nighttime partitioning (i.e. Reichstein et al. (2005)). See my comment at L96–97.

L462 (Sect. 3.3.1): Please check for and cite other studies that have done similar comparisons in the tropics.

L511–512: No need to repeat this, as it is clear from the legend and caption.

L585: "Earth Science Data Systems, 2025": what is this citation? Is it a Reco study? Please cite the original authors of the LBA-ECO CD-08 dataset or the associated paper.

L605–609: The claim that storage fluxes explain the agreement could in principle be tested, e.g. by repeating the nighttime partitioning without the storage term. This could be shown in the Supplement.

L630–632: Is low turbulence the only concern? The nighttime method also assumes the same temperature dependence during day and night, ignores daytime inhibition of leaf respiration (Keenan et al., 2019) and extrapolates across temperature ranges.

L697: Did the authors test other predictors, e.g. cumulative water deficit (CWD)?

L759: Other sites show lower temperature optima, and including them may change the interpretation, consider this paper: https://iopscience.iop.org/article/10.1088/1748-9326/aa6f97

L761–763: Isn't this true by definition? VPD depends exponentially on temperature through saturation vapour pressure. Please clarify what is meant.

L797–798: Did the authors try another ML method, to check that the results are not specific to random forests?