Responses to reviewer 1#'s comments point by point

MS No.: essd-2025-64
Title: Remote sensing of young leaf photosynthetic capacity in tropical and subtropical evergreen broadleaved forests
Author(s): Xueqin Yang et al.

General Comments of Reviewer 1#:
The manuscript presents a significant advancement in understanding the photosynthetic capacity of young leaves in tropical and subtropical evergreen broadleaved forests through a novel satellite-based approach to estimate Vc,max25. The proposed approach for deriving Vc,max25 is well-constructed and contributes to filling a critical gap in our understanding of leaf age and its impact on photosynthetic efficiency. A few minor revisions could improve the clarity and completeness of the manuscript:
Response: *We appreciate the time and efforts of the editor and referees in reviewing this manuscript and the valuable suggestions offered. Please see our response to your comments in the supplement below.*

Minor Comments:
Comment 1: 1. While the approach for deriving Vc,max25 from SIF data is compelling, the assumption of a constant Vc,max25 for old leaves could benefit from further explanation.
Response: *Thank you for the positive comments on the novelty of our proposed dataset. We agree with the reviewer that it is a necessary to provide more explanation about the assumption of a constant $V_{c,max25}$ for old leaves. We have referenced additional literature. Existing studies (Niinemets et al., 2015; Kitajima et al., 1997; Yoder et al., 1994) suggest that the photosynthetic capacity of old leaves in tropical evergreen forests tends to remain relatively stable over time, especially compared to young leaves, which exhibit more pronounced seasonal fluctuations. While this assumption may introduce some bias, it enables us to focus on the dominant seasonal patterns driven by young leaves, which have been shown to play a key role in the overall canopy photosynthesis.*

*In this study, we set a constant value of $V_{c,max25}$ = 20 μmol m^{-2} s^{-1} for old leaves, derived from the asymptotic trend between leaf ag and $V_{c,max}$ (**Figure R1**). This value reflects the stabilization of photosynthetic capacity at a low level once leaves reach their old-age stage.*

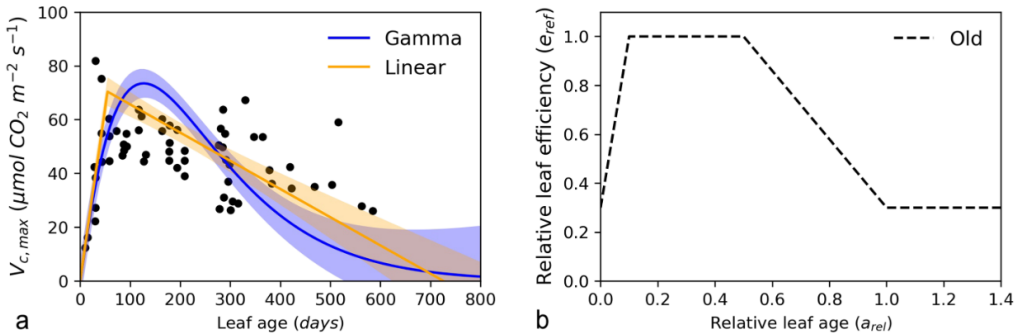

Figure R1 *$V_{c,max}$ (**a**) andRelative leaf efficiency (e_{rel}) as a function of relative leaf age (a_{rel}) (**b**) (cf. Chen et al., 2020).*

Reference:

Chen, X., Maignan, F., Zhang, Y., Viovy, N., Bastos, A., Liu, L., Goll, D., Wu, J., Liu, L. Y., Yue, C., Peng, S. S., Yuan, W. P., da Conceicao, A. C., O'Sullivan, M., and Ciais, P.: Novel Representation of Leaf Phenology Improves Simulation of Amazonian Evergreen Forest Photosynthesis in a Land Surface Model, J. Adv. Model. Earth Syst., 12, e2018MS001565, https://doi.org/10.1029/2018ms001565, 2020.

Kitajima, K., Mulkey, S. S., and Wright, S. J.: Decline of photosynthetic capacity with leaf age in relation to leaf longevities for five tropical canopy tree species. American Journal of Botany, 84(5), 702-708. 1997.

Niinemets, Ü., Cescatti, A., Rodeghiero, M. and Tosens, T.: Leaf internal diffusion conductance limits photosynthesis more strongly in older leaves of Mediterranean evergreen broad-leaved species. Plant, Cell & Environ., 28: 1552-1566. https://doi.org/10.1111/j.1365-3040.2005.01392.x. 2015

Yoder, B. J., Ryan, M. G., Waring, R. H., Schoettle, A. W., and Kaufmann, M. R.: Evidence of reduced photosynthetic rates in old trees. Forest Science, 40(3), 513-527. 1994

Comment 2: 2. The results show interesting seasonal trends in young leaf Vc,max25. It would be useful to discuss the ecological implications of these seasonal variations in the context of the carbon cycle.

Response: *Thank you very much for your insightful comments on the seasonal trends in $V_{c,max25}$ of young leaves. We agree that discussing the ecological implications of these seasonal variations in the context of the carbon cycle would be highly valuable.*

The seasonal trends in $V_{cmax,25}$ of young leaves is indeed intriguing and likely related to both plant growth strategies and environmental factors. The relatively higher $V_{c,max25}$ in young leaves during the early growing season may be an adaptive strategy for plants to rapidly establish their photosynthetic capacity, allowing them to make the most of favorable light and temperature conditions and giving them a competitive edge in highly competitive environments such as tropical and subtropical forests. These variations may also be closely linked to seasonal fluctuations in environmental factors, with plants adjusting their $V_{c,max25}$ to cope with water stress during the dry season and maximizing photosynthetic efficiency during the rainy season. At the ecosystem level, these seasonal variations in young leaf $V_{c,max25}$ directly influence a plant's carbon uptake capacity, potentially leading to more carbon being fixed within plant biomass and affecting atmospheric CO_2 concentrations. This, in turn, could create feedback loops within the climate system and interact with other ecological processes such as soil carbon cycling and microbial activities.

We added some expand in ***section 4*** *as follows:*

"Furthermore, the seasonal fluctuations in $V_{c,max25}$ of young leaves are closely associated with both plant growth strategies and environmental factors. Higher $V_{c,max25}$ values in young leaves during the early growing season may reflect an adaptive strategy

*to quickly establish photosynthetic capacity, especially beneficial in competitive environments like tropical and subtropical forests. These seasonal variations directly impact a plant's carbon uptake capacity, potentially leading to increased carbon sequestration within plant biomass and influencing atmospheric CO_2 concentrations, which could create feedback loops within the climate system" (**In revision lines 580-586**)*

Comment 3: 3 The authors could briefly discuss the limitations of the proposed method, particularly in regions with high cloud cover or in areas where SIF data quality might be compromised. This would help users of the dataset understand its potential applications and limitations in various settings.

Response: *Thank you for your insightful comments. High cloud cover can lead to reduced quality in optical remote sensing data, or poor SIF data quality itself, both of which can impact the accuracy of $V_{c,max25}$ estimations. We have carefully considered your suggestions and have incorporated a detailed quality control (QC) metric to ensure the reliability of our methodology and prevent potential misuse of the data.*

*We provided information of data quality control (QC) for the $V_{c,max25}$ of young leaves product to prevent data misuse. In the QC system (**Table S5**), data quality is divided into four levels: level 1 represents the highest quality; level 2 and level 3 represent good and acceptable quality, respectively; and level 4 warns to be used cautiously. This QC product is generated based on Pearson's correlation coefficients (R) and the root mean square error (RMSE), which were obtained by comparing the seasonal $V_{c,max25}$ estimated from RTSIF- and GOSIF-derived GPP. Results showed that more than 91.5% of pixels are with QC at best and only less than 0.03% are with QC at level 3 and level 4. These details are elaborated in **section 2.6 (In revision lines 350-356)**.*

2.6 Quality control (QC) for young leaves $V_{c,max25}$ product

*We provided information on data quality control (QC) along with the $V_{c,max25}$ of young leaves product. In the QC system (**Table S5**), data quality was divided into four levels: Level 1 represents the highest quality, Level 2 and Level 3 represent good and acceptable quality, respectively, and Level 4 should be used with caution. This QC product was generated based on Pearson's correlation coefficients (R) and the root mean square error (RMSE), which were obtained by comparing the seasonal $V_{c,max25}$ estimated from RTSIF- and GOSIF-derived GPP.*

Table S5 Information of data quality control (QC) for the $V_{c,max25}$ product

QC class	QC value	R	RMSE (μmol m^{-2} s^{-1})
Best	1	0.6-1	0-10
Good	2	0.4-0.6	10-20
Acceptable	3	0.2-0.4	20-30
Cautious use	4	<0.2	>30