

Response to Reviewers

Article Ref.: *essd-2026-161*

Mapping Plant Growth Index (PGI) over Australia from 1990 to 2024

Earth System Science Data

Reviewer #3

Retkute et al. introduce a retrospective and forecast-aligned Plant Growth Index (PGI), a gridded metric that estimates interannual vegetation status in the form of vegetation growth and water availability over continental Australia. The PGI is calculated using meteorological inputs from light, temperature, and moisture. Benchmarking was performed against various productivity-relevant metrics. The authors imply PGI's utility in monitoring various ecosystems and in climate modeling based on benchmarking results. Overall, the paper is structured well, easily readable, and addresses an important issue. However, the paper is not ready for publication in *Earth System Science Data* without major revisions. The authors need to address major concerns regarding the formulation and justification of the PGI equation and its components and additionally analyze the strength of PGI against productivity-relevant metrics on seasonal timescales relevant to vegetation status.

Response: We thank the reviewer for the insightful suggestions, feedback, and the time they have dedicated to review our manuscript. We have provided a point-by-point response below, addressing each specific comment and suggestion.

Major Comments

R3MC1

The equations for PGI and its components introduce confusion. I'm lacking a physical and conceptual understanding of equation design. The paper mentions that their methods are adapted from a previously used scalar index framework. Because this paper is introducing a new gridded dataset based on these equations, it would be useful to expand on the reasons

and physical meanings of each equation and assumption, with added citations wherever necessary, throughout the methods.

Response:

We thank the reviewer for this constructive comment. We agree that the physical meaning, conceptual basis and assumptions underlying the PGI equations and their components could be explained more clearly.

Action:

In the revised manuscript, have I revised and expanded the Methods section to more explicitly explain the rationale, physical interpretation and assumptions underlying the PGI equations and their component formulations, including their relationship to the underlying scalar index framework, with additional citations where appropriate.

R3MC2

Why is the clear-sky reference the 95th percentile of daily solar exposure; was this cited in another paper for LI or is it introduced for the first time here?

Response:

We thank the reviewer for this important question. The 95th percentile was selected to represent a realistic upper reference level for solar exposure while reducing sensitivity to rare extreme values and potential artefacts. This provides a robust normalisation baseline for the Light Index without relying on absolute maxima.

Action:

In the revised manuscript, we have provided a clearer justification for the 95th percentile clear-sky reference used in the Light Index formulation, including its rationale, assumptions, and citations to related percentile-based normalisation approaches where appropriate.

R3MC3

The paper mentions that top layer soil moisture (0-10 cm) is used as a proxy for root-zone soil moisture in the MI calculation. However, soil moisture behavior differs through the vertical profile, and so do rooting depths. What root depths are being approximated? Is surface soil moisture alone used as a proxy, or was root-zone soil moisture estimated with another

equation? ERA5-Land has different volumetric soil water layers that can be used for this purpose if BARRA-R doesn't contain deeper soil moisture observations, but overall, it's important to incorporate the dynamical nature of soil moisture somehow as water availability may differ over different PFTs and depths.

Response:

We thank the reviewer for highlighting this important point. We agree that soil moisture dynamics vary strongly with depth, rooting characteristics and vegetation type, and that a single surface layer may not adequately represent root-zone water availability across ecosystems.

Action:

We have revised the Methods section to describe the updated Moisture Index calculation using multi-layer BARRA-R2 soil moisture and PFT-specific depth weighting. This revised formulation incorporates soil moisture information across multiple soil depths to better approximate vegetation-dependent root-zone water availability and its vertical structure.

R3MC4

The design of the PGI equation requires a more substantive description. In the way it's designed, what is the physical and conceptual meaning of how the variables are arranged and why?

Response:

We thank the reviewer for this important comment. We agree that the physical and conceptual rationale underlying the structure of the PGI equation and the arrangement of its components merits clearer explanation.

Action:

In the revised manuscript, we have expanded the Methods section (including a dedicated subsection on the physical and conceptual basis of the PGI formulation) to explain the limiting-factor principle, the rationale for the multiplicative formulation, the interpretation of each sub-index, and the key assumptions underlying the arrangement of the PGI components.

R3MC5

In the benchmarking results against GPP, the authors state that strong relationships were observed in cool regions with clear seasonal cycles. However, Pearson's correlation can be high between two distinct curves with different magnitudes and distributions if both exhibit a clear seasonal cycle. It might be helpful for the study to benchmark across distinct seasons rather than the entire time series to see if PGI has a stronger footprint in certain parts of the year and why or why not.

Response:

We thank the reviewer for this constructive suggestion. We agree that seasonally resolved benchmarking could provide additional insight into whether PGI captures vegetation growth potential more effectively during particular phases of the annual cycle, and whether relationships vary across ecosystems and climatic regimes.

Action:

In the revised manuscript, we have extended the benchmarking analyses to include seasonal assessments of PGI–GPP relationships at OzFlux sites, allowing evaluation of whether performance differs across phases of the annual cycle and contrasting environmental settings.

R3MC6

The study makes the assertion that PGI effectively captures vegetation productivity responses during transition seasons. The results do not show or quantify this, as benchmarking was performed across the entire time series, not distinct seasons. The authors should consider defining dry-to-wet and wet-to-dry transition periods respective to the sample sites using known methods of defining seasonal transition timing (e.g. <https://doi.org/10.1002/2016JD025428>). This is important to do across transitions because during these periods, vegetation moves from water/energy limitations to energy/water limitations, respectively. Benchmarking across distinctive seasons (previous response) and transition periods (this response) would make the study more robust and interpretable across different bioclimatic gradients, vegetation-relevant growth periods, and seasonal climate risk assessments.

Response:

We thank the reviewer for this valuable suggestion. We agree that vegetation responses during seasonal transition periods can differ from those during more stable seasonal states, particularly where systems shift between water and energy limitation.

Action:

In the revised manuscript, we have expanded the Discussion to more explicitly consider the role of seasonal transition periods in vegetation productivity dynamics, including the potential implications for interpreting PGI performance across contrasting ecosystems and climatic regimes.

*Minor Comments***R3mC1**

General: When a supplementary figure is mentioned, it is typically structured as “SI Figure S#.” However, the SI figures are labeled as “Figure A#.” Make sure to double check that the letterings are consistent throughout the paper.

Response:

We thank the reviewer for noting this point. The use of “Figure A#” for supplementary figures follows the journal’s appendix/supplementary formatting convention.

Action:

We will nevertheless carefully check the manuscript to ensure that figure labelling and cross-referencing are fully consistent throughout.

R3mC2

[Figure 2c]: Consider adding a letter to the different case sites as each is a different sub-plot. It can get confusing labeling all five examples as Figure 2c rather than Figure 2c-g.

Response:

We thank the reviewer for this helpful suggestion.

Action:

We have relabelled the subplots in Figure 2 as (c), (d), (e), (f), (g) corresponding to the five example sites.

R3mC3

L65-L70: There is a closing parenthesis “)” without an accompanying opening parenthesis “(.”

Response:

We thank the reviewer for catching this typographical error.

Action: Corrected

R3mC4

L120-125: Consider briefly adding the re-gridding approach used to scale data to the BARRA-R 12km (or 0.1°) resolution (e.g., bilinear, linear?). Additionally, if any temporal gap filling was performed to make the datasets consistent with each other, please expand on why or why not.

Response:

We thank the reviewer for this suggestion. We agree that additional detail on spatial harmonisation and data consistency would improve reproducibility.

Action:

In the revised manuscript, we have specified that datasets were regridded to the BARRA-R 0.1° grid using bilinear interpolation. No temporal gap filling was performed, as the underlying BARRA-R meteorological datasets provide complete daily coverage.

R3mC5

L190-195: Some of the available flux tower observations are short (e.g., Fletcherview in Figure 2c seems to have data from 2022-2025). This makes comparing PGI's correlational strength against other sites difficult as temporal span differs. In the written results it might be useful to put the timespan of available flux observations for each site next to their correlation coefficient to help readers with interpretability.

Response:

We thank the reviewer for this useful suggestion. We agree that differences in observation period length may influence interpretation of benchmarking results across sites.

Action:

In the revised manuscript, we will report the available flux observation timespan for each site alongside the corresponding correlation statistics to aid interpretation.