

REPORT #1

Comments:

The author provides a brief comparison of 18 Earth System Models (ESMs) from CMIP6 in simulating carbon cycle variables over South America, including global Gross Primary Productivity (GPP), Net Primary Productivity (NPP), Net Ecosystem Productivity (NEP), Net Biome Productivity (NBP), as well as autotrophic (Ra) and heterotrophic respiration (Rh). The study highlights both the consistencies and discrepancies among the model simulations. However, this work cannot be considered a proper assessment or evaluation. Firstly, it lacks validation against observational data. Secondly, it does not employ rigorous statistical analyses to support the inter-model comparisons. For example, the use of a Taylor diagram would be an appropriate and widely accepted approach for evaluating model performance. Given these shortcomings, the manuscript is not currently suitable for publication. I recommend rejecting the submission.

[Response] Thank you for taking the time to thoroughly review our manuscript and provide constructive feedback. We plan to implement additional statistical analyses to help interpret our results, and Taylor diagrams will be considered in a revised version of the manuscript, to be re-submitted.

Detailed comments:

Line 15: Please also show the fraction of global autotrophic (Ra) and heterotrophic (Rh) respiration.

[Response] Thank you for your observation. The sentence in line 15 now reads:

“Results show that South America accounts for 25-30% of the global Gross Primary Productivity (GPP), 21-28% of the global Net Primary Productivity (NPP), 17-50% of the global Net Ecosystem Productivity (NEP), 15-30% of the global Net Biome Productivity (NBP), 18-30% of the global autotrophic (Ra) and 44% of the heterotrophic (Rh) respiration.”

Line 25: “Carbon is a critical element in the Earth system.”, please give the reference.

[Response] Thank you for the suggestion. We'll include the scientific article reference.

SUAREZ, C. A.; EDMONDS, M.; JONES, A. P. Earth catastrophes and their impact on the carbon cycle. *Elements*, v. 15, n. 5, p. 301–306, 2019.

Line 26-28: This sentence also need corresponding reference.

[Response] Thank you for the observation. We will include this scientific article reference:

JARIWALA, D.; SRIVASTAVA, A.; AJAYAN, P. M. Graphene synthesis and band gap opening. *Journal of Nanoscience and Nanotechnology*, v. 11, n. 8, p. 6621–6641, 2011.

Line 35: Suggest to introduce both biogeophysical and biogeochemical paths, such as changing the energy balance on land surface.
<p>[Response] Thanks for your contribution. We have changed the sentence to consider the paths mentioned:</p> <p>“This increase in atmospheric CO₂ has affected the global climate in several ways by influencing multiple processes in the biosphere, such as photosynthesis and plant respiration, which are influential biogeophysical and biogeochemical paths (Jung et al, 2017).”</p>
Line 43: It's typo? Was it should be 0.076 PgC ?
<p>[Response] Thanks for pointing this out. We fixed that in the sentence:</p> <p>“In 2024, extensive and persistent areas of burning in the Brazilian Amazon, Cerrado and Pantanal biomes in Brazil generated a continuous source of carbon emissions with a record that broke the record of the last 22 years of monitoring carried out by CAMS (acronym in English for Copernicus Atmosphere Monitoring Service) - approximately 0.076 PgC, 47% of which was in the month of September alone.”</p>
Line 60-64: Please provide more information about the model experiments, especially the MIPs (maybe DECK, historical and CORDEX) that related to this study.
<p>[Response] Thank you for the suggestion. We have added more information and a reference:</p> <p>“The most recent phase, CMIP6 (Eyring et al., 2016a), provides a large set of model simulations and includes 23 CMIP6-Endorsed Model Intercomparison Projects (MIPs) which facilitate a better analysis of specific scientific questions. This includes core initiatives like the DECK (Diagnostic, Evaluation and Characterization of Klima) experiments, which establish a fundamental baseline for documenting model characteristics and ensuring comparability across CMIP phases (Eyring et al., 2016a). Additionally, projects like CORDEX (Coordinated Regional Climate Downscaling Experiment) focus on enhancing climate projections at the regional scale through the intercomparison and evaluation of regional climate models (Giorgi et al., 2009).”</p> <p>Giorgi, F.; Jones, C.; Asrar, G. Addressing climate information needs at the regional level: the CORDEX framework. WMO Bulletin, v. 58, p. 175–183, 2009.</p>
Line 65: “discuss”, it will be better to use evaluate or assess.
<p>[Response] Thanks for your suggestion. We have revised the expression “discuss”</p> <p>We evaluate the quality with which the CMIP6 models represent the components of the carbon balance compared to previously published and estimated results.</p>

Line 72: Suggesting to put figure 1 into supplementary materials.
[Response] Thank you for the suggestion. Implemented.
Line 73: “120 PgC yr ⁻¹ ”, please give the reference.
<p>[Response] Thank you for the suggestion. Reference included:</p> <p>“The scope of fluxes and stocks in the terrestrial carbon cycle can be seen in Fig. 1. Plant photosynthesis causes a net absorption of CO₂ from the atmosphere by terrestrial ecosystems of about 127 PgC yr⁻¹ (Zhang et al, 2017)”</p> <p>Zhang, Y., Xiao, X., Wu, X., Zhou, S., Zhang, G., Qin, Y., & Dong, J.: A global moderate resolution dataset of gross primary production of vegetation for 2000–2016. Scientific Data, 4, 170165, https://doi.org/10.1002/joc.4847 , 2017.</p>
Line 82: The authors might indicated the carbon loss by hydrological process such as leaching, “water fluxes” makes people misunderstanding.
<p>[Response] Thank you for your observation. Implemented.</p> <p>“Net Biome Production (NBP) is the flux that measures the change in carbon stocks after accounting for losses due to natural or anthropogenic disturbances such as fire, deforestation, leaching, severe downbursts, and timber products.”</p>
Line 84: It was used as “cVeg” instead of “cVEg”.
<p>[Response] Thank you for your observation. Implemented.</p> <p>“Vegetation carbon (cVeg) or biomass represents the carbon reservoir in the leaf, stem, root, as well as other plant components such as fruits. Carbon stored in the soil (cSoil) is found in organic (plant and animal residues, microbes and microbial by-products) and inorganic (carbon minerals produced by the weathering of the original material, or reaction of soil minerals with atmospheric carbon dioxide) forms.”</p>
Figure 1: Before explain detail of this figure, please give a general figure description.
<p>[Response] Thank you for your observation. We have added a description.</p> <p>“Figure 1. Components of fluxes and stocks in the terrestrial carbon cycle. The green flux represents carbon uptake by vegetation. The red fluxes indicate carbon release through plant respiration (R_a), soil respiration (R_h), and disturbances, whether natural or anthropogenic, such as fire. The sum of respiratory fluxes constitutes the total ecosystem respiration (Reco). The balance between gross primary production (GPP) and plant respiration (R_a) defines the net primary production (NPP). The difference between NPP and R_h describes the net ecosystem production (NEP). Finally, the balance between NEP and all carbon loss fluxes determines the net biome production (NBP).”</p>

Table 1: Please move this table to supplementary materials, for there are too many figures and tables in the manuscript.
[Response] Thank you for the suggestion. The figure was moved to the supplementary material.
Line 101-108: This paragraph seems like discussion, please move it to discussion or just delete it.
[Response] Thank you for the suggestion. We'll delete this paragraph.
Line 134: "km2", please use superscript.
<p>[Response] Thank you for your observation. We'll put in superscript and will review all other instances in the document.</p> <p>"The Amazon biome (Fig. 2) has an estimated area of ~6.38 million km², with relatively low climatic seasonality,..."</p>
Line 138-140: This sentence is hard to understand.
<p>[Response] Thank you for your observation. We agree, and made the sentence easier to read.</p> <p>"The savannas of South America (Fig. 2) have an estimated area of ~3.18 million km², comprising a large part of central Brazil, and parts of the Brazilian states of Amapá, Roraima and Amazonas. Outside Brazil, they are also found in Venezuela, Colombia, southern Bolivia, northern Paraguay and Argentina."</p>
Figure 2: The author did not clearly specify in the manuscript how the Amazonian biome area and the South American Savannas biome areas were defined, which may cause confusion for readers. It is recommended to add a corresponding legend in Figure 2 to clarify the biome boundaries and to improve the image resolution to enhance readability.
<p>[Response] Thank you for your observation. We agree and have improved the description of these areas.</p> <p>"Figure 2: The Amazon Biome (blue area) has an estimated area of ~6.38 million km², with its geographical boundaries established as proposed by Eva et al. (2005), Castanho et al. (2013), Cardoso et al. (2017), Flores et al. (2024), and the IBGE (2023). The South American Savannas (brown area) cover an estimated area of ~3.18 million km², with their geographical boundaries based on Maria et al. (2002), Schmidt et al. (2009), Bridgewater et al. (2004), and the IBGE (2023)."</p> <p>IBGE. Banco de Dados e Informações Ambientais. https://bdiaweb.ibge.gov.br/#/home, last access 23 Sep 2024, 2023.</p>
Line 153: Where is the results? If the authors mentioned some result, please show it in main text or supplementary materials.

[Response] Thank you for your observation. We have' included graphical information (in the table below) showing all the dry and wet years for each model, as well as observational results proposed by Espinoza et al. (2019). This will be included in the supplementary materials.

	Espinoza et al, 2019	ACCESS-ESM1-5	BCC-CSM2-MR	CanESM5	CESM2	CESM2-WACCM	CMCC-CM2-SR5	CNRM-ESM2-1	EC-Earth3-Veg	GFDL-ESM4	INM-CM4-8	INM-CM5-0	IPSL-CM6A-LR	MIROC-ES2L	MPI-ESM1-2-LR	NorESM2-LM	NorESM2-MM	TaiESM1	UKESM1-0-LL	
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TABLE: Determination of dry and wet years in the Amazon biome for each ESM, based on the methodology proposed in this study. Orange blocks represent dry years, blue blocks represent wet years. The first column corresponds to the classification proposed by Espinoza et al. (2019), Table 1.

Espinoza, J. C.; Ronchail, J.; Marengo, J. A.; Segura, H. Contrasting North–South changes in Amazon wet-day and dry-day frequency and related atmospheric features (1981–2017). *Climate Dynamics*, v. 52, n. 9–10, p. 5413–5430, 2019.

Line 165: Is this result supported by any statistical analysis?

[Response] Thank you for the question. In order to evaluate if the trends we found were significant, we have applied the Mann-Kendall tau coefficient analysis, following Mann (1945) and Kendall (1975).

Mann, H. B. Nonparametric Tests Against Trend. *Econometrica*, v. 13, n. 3, p. 245, jul. 1945.

Kendall, K. Thin-film peeling-the elastic term. Journal of Physics D: Applied Physics, v. 8, n. 13, p. 1449–1452, 11 set. 1975.

Line 173: Also need statistical evidence.

[Response] Thank you for the observation. We agree. We will improve this and several other parts of the manuscript to provide statistical evidence to our findings.

Figure 3: what is the yellow dash line and horizontal line represent respectively?

[Response] Thank you for the observation. The dashed yellow line represents the zero line, which we believe it is interesting to highlight. The figure caption will include information on that.