

Dear Daniel,

Thank you for your comments on our revised manuscript. The final comments from the reviews have now been addressed (see below).

Best wishes,

Rebecca & Co-authors

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## R1

The authors provide thoughtful and comprehensive responses to all my previous concerns, and the ms has been significantly strengthened in almost every area (methodological clarity, expanded analysis, data visualization, references). I recommend acceptance and congratulate them on a great job!

One minor technical note: re "Code availability" on page 15, it would be better to create a permanent archive and DOI using Zenodo and reference that, rather than a GitHub repository that could be removed in the future.

The code has now been uploaded to Zenodo:  
<https://doi.org/10.5281/zenodo.10927091>.

## R2

Thank you for putting in substantial work to revise the paper and for including an additional framework breaking down contributions to soil beta and gamma parameters. A few suggestions are included below:

1. Line 105 (Equation 10): the  $\tau_s$  in the first term on the right side of the equation should be initial  $\tau_s$  ( $\tau_{s\_zero}$ ), correct? That would be required for this term to cancel out with the  $C_{s\_zero}$  on the other side of the equation.

This was very well spotted! This has been corrected.

2. Please include somewhere in Section 2.3 what year the initial values of NEP,  $\tau_s$  and NPP are calculated from. My assumption would be the last year of the spinup or the first year of the 1% per year simulation, though the former may be more ideal.

This is stated within the first paragraph: "decadal time-average at the start of C4MIP simulation", but is now repeated in the section to improve clarity.

3. My remaining questions are on what you refer to as the "transient NEP effect on tau\_s" (5th term on the right side of Equation 13). I am struggling with understanding of the significance and meaning of this term here:

a) Please clarify the meaning of this term further. What is meant by "transient NEP effect on tau\_s"? I referred back to the Varney et al. (2023) paper and still find this confusing.

b) Since the 1% per year simulation is initialized from equilibrium, would NPP-R\_h, and hence, NEP\_zero, not be close to 0? If that is the case, then the "transient NEP effect on tau\_s" (5th term on the right side of Equation 13) would be 0 and could be excluded from the rest of the equations. It also appears from Figure 4 that this term makes very little contribution and is, therefore, hardly addressed in the manuscript anyway.

I understand the confusion here as this term is negligible and could have been neglected. It was included for mathematical completeness of the equations, meaning that both sides of the equation are exactly equal to one another. I have included an additional paragraph.

***“The NEP term is used to represent the transient state of the system where NPP does not equal R\_h. However, it is noted that if the initial state is in equilibrium, then the initial NEP (NEP\_0) will be approximately equal to zero. This means the  $\Delta C_{s,\tau_{NEP}}$  term (representing the difference in  $\tau_s$  from using NPP or R\_h in the definition) will be negligible. Despite initialising at the start of the C4MIP simulations (decadal time-average at the start of C4MIP simulation), this term is included within the analysis for completeness to ensure exact values of  $\Delta C_s$ .”***