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2 **The effect of nutrient availability on global forest carbon balance is uncertain**

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15 To the Editor — Fernández-Martínez *et al.*¹ show a chief determinant of nutrient
16 availability on net ecosystem production (NEP) and ecosystem carbon-use efficiency
17 (CUEe, the ratio of NEP to gross primary production i.e. GPP) in global forests. However,
18 their conclusions depend on an improper treatment of differences in the GPP range of
19 nutrient-rich and nutrient-poor forests (uneven sampling effect) and outliers. A statistical
20 re-analysis of their datasets, while *simultaneously* excluding the uneven sampling effect
21 and outliers, indicates no significant control of nutrient availability on carbon (C) balance.

22 First, NEP and CUEe both have a non-linear relationship against GPP (Fig. 1a and 1b)
23 and this indicates that an uneven sampling effect can result in misleading conclusions.
24 Taking nutrient-poor forests as an example, CUEe within the GPP range of 1000~2000 g
25 C m⁻² yr⁻¹ (16 ± 3%; mean ± s.e.m.) is significantly higher than that within the whole
26 GPP range (6 ± 4%) (*t*-test, *p* < 0.05). A generalized linear model (GLM) analysis
27 indicates that differences of GPP ranges (e.g. 1000 ~ 2 000 g C m⁻² yr⁻¹ vs. whole GPP
28 range) significantly affect NEP (*p* < 0.05). Therefore, statistical analysis of Fernández-
29 Martínez *et al.*¹ should have been based on a same GPP range to exclude the uneven
30 sampling effect.

31 Second, three very young forests (< 5 years) with extremely high GPP and NEP are
32 likely outliers, because young forests commonly have low GPP and NEP^{2,3}. When
33 excluding these outliers, the slope of NEP against GPP within a common GPP range
34 (1000 ~ 2200 g C m⁻² yr⁻¹) showed no significant difference (*p* = 0.49) between nutrient-
35 rich forests (slope = 0.44, *p* < 0.05) and nutrient-poor forests (slope = 0.63, *p* < 0.001)
36 (Fig. 1c). The slope of ecosystems respiration (Re) against GPP for nutrient-rich forests
37 (slope = 0.56, *p* < 0.05) also showed no significant difference (*p* = 0.85) from that for

38 nutrient-poor forests (slope = 0.37, $p < 0.05$) (Fig. 1d). These results indicate that
39 nutrient-rich and nutrient-poor forests do not show significant difference in their
40 allocation of GPP to NEP.

41 Statistical analyses by Fernández-Martínez *et al.*¹ have never *simultaneously* excluded
42 the uneven sampling effect and outliers. When doing so, a GLMs analysis indicates that
43 nutrient availability ($p = 0.26$) and nutrient*GPP interaction ($p = 0.49$) both exert no
44 significant control on NEP.

45 Moreover, I propose a non-linear conceptual model of CUEe against GPP (Fig. 1b).
46 Youngest forests commonly show very low GPP and negative CUEe because of higher
47 Re than GPP ², and then CUEe increases rapidly with growing GPP to a critical point
48 which is C neutral. CUEe continues to increase but starts to slow down at a certain stage
49 when nutrient limitation is intensified by biomass nutrient accumulation⁴, and further it
50 reaches a maximum after which CUEe declines slowly due to increasing allocation of
51 GPP to Re ⁵. This conceptual model implies that, instead of nutrient availability, GPP and
52 stand age may jointly determine C allocation of GPP to NEP in global forests.

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54 **References**

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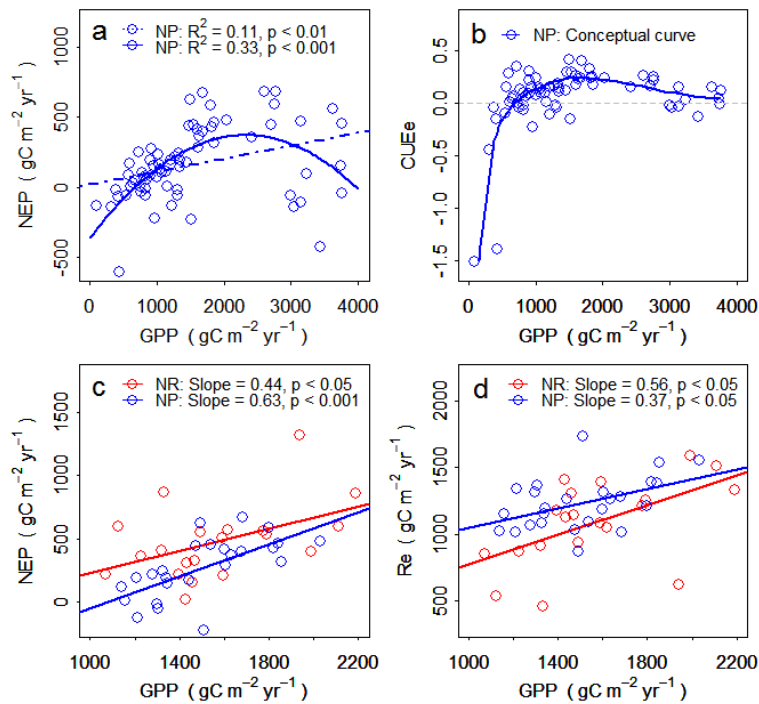
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61 Figure Legends

62 Figure 1. NEP ($\text{g C m}^{-2} \text{ yr}^{-1}$), CUEe, and Re ($\text{g C m}^{-2} \text{ yr}^{-1}$) against GPP ($\text{g C m}^{-2} \text{ yr}^{-1}$) in
63 nutrient-rich (NR) and nutrient-poor (NP) forests. (a) Change in NEP against GPP within
64 whole GPP range in nutrient-poor forests, (b) non-linear conceptual model of CUEe
65 against GPP based on dataset in nutrient-poor forests, (c) comparison of the slope of NEP
66 against GPP, and (d) comparison of the slope of Re against GPP in nutrient-rich and
67 nutrient-poor forests.



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