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The quasi-equilibrium framework revisited: analyzing long-term CO_2 enrichment responses in plant–soil models

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Supplementary Materials

The following Supporting Information is available for this article:

Method S1 Supplementary equations used in this study

Figure S1 Illustration of effect of allocation flexibility on plant response to elevated CO_2 and nitrogen deposition.

Figure S2 Sensitivity test of varying N uptake parameters on CO_2 fertilization effect.

Figure S3 Sensitivity test of varying priming effect parameters on the M-term CO_2 fertilization effect.

Table S1 Relationship of NPP and leaching N rate at different timescales

Method S1. Supplementary equations used in this study

N:C ratio of root is linearly related to N:C ratio of leaf, as:

$$n_r = 0.7\, n_f \tag{Eq. S1}$$

N:C ratio of wood, if variable, is also linearly related to N:C ratio of leaf, as:

$$n_w = 0.005\, n_f \tag{Eq. S2}$$

N:C ratio of leaf litter is related to leaf litter as:

$$n_{fl} = 0.5\, n_f \tag{Eq. S3}$$

Following McMurtrie et al. (2000), nitrogen use efficiency is defined as:

$$NUE = 1/(a_f n_f + a_w n_w + a_r n_r) \tag{Eq. S4}$$

Table S1 Relationship of NPP (kg m^{-2} yr^{-1}) and leaching N rate (N_{loss}, kg m^{-2} yr^{-1}) at different timescales, assuming explicit mineral N pool. VL400 is the very long term timescale under CO_2 = 400 ppm, and M_{800}, L_{800} and VL_{800} are medium, long, and very long term equilibrium point under CO_2 = 800 ppm. Leaching rate is assumed at 0.05 yr^{-1}, which is assumed to be the sum of all N lost from the system (i.e. leaching, denitrification, etc.). Detailed derivations and assumptions provided in Section 3.2 of the manuscript.

Timescale	NPP (kg m^{-2} yr^{-1})	N_{loss} (kg m^{-2} yr^{-1})
VL_{400}	1.68	0.4
M_{800}	1.79	0.23
L_{800}	1.90	0.395
VL_{800}	1.91	0.4

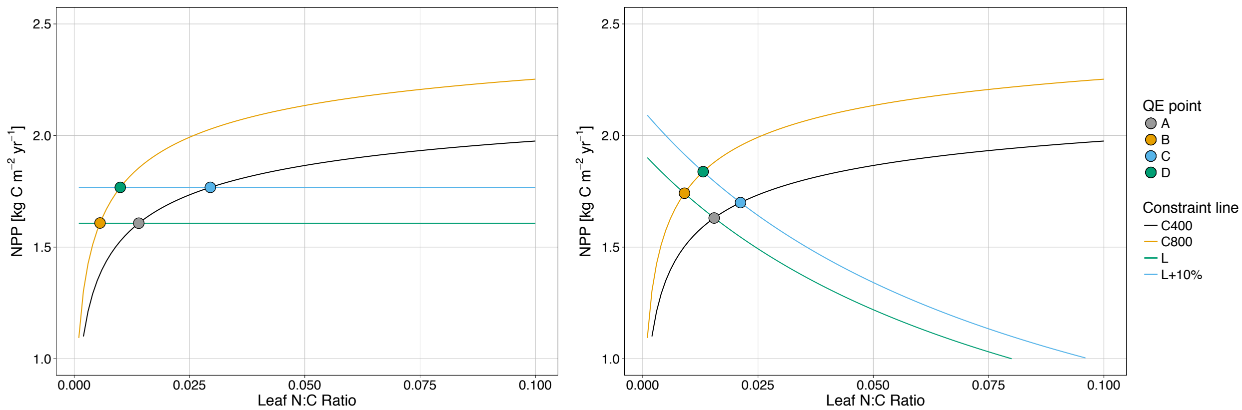

Figure S1 Illustration of effect of allocation flexibility on plant response to elevated CO_2 and nitrogen deposition, with a) as no coupling between allocation of leaf and wood, and b) linear coupling between leaf and wood allocation. No coupling assumes that allocation to wood (a_w) = 0.6, and allocation to leaf (a_f) = 0.2. Linear coupling assumes the same a_f, but a_w = 3a_f. The detailed derivations are shown in Medlyn and Dewar (1996). C400 and C800 are the photosynthetic constraint curves at CO_2 = 400 (aCO_2) and 800 ppm (eCO_2), respectively. L and L+10% are the long-term soil recycling constraint under ambient and ambient + 10% nitrogen deposition rate. Point A is the equilibrium point between C400 and L, point B is the equilibrium point between C800 and L, C is equilibrium point between C400 and L+10%, and D is equilibrium point between C800 and L+10%. The graph shows that linear coupling of a_f and a_w resulted in more responsive NPP to eCO_2 even if N deposition does not change, whereas no coupling between a_f and a_w has no effect of CO_2 on production, unless N deposition increases.

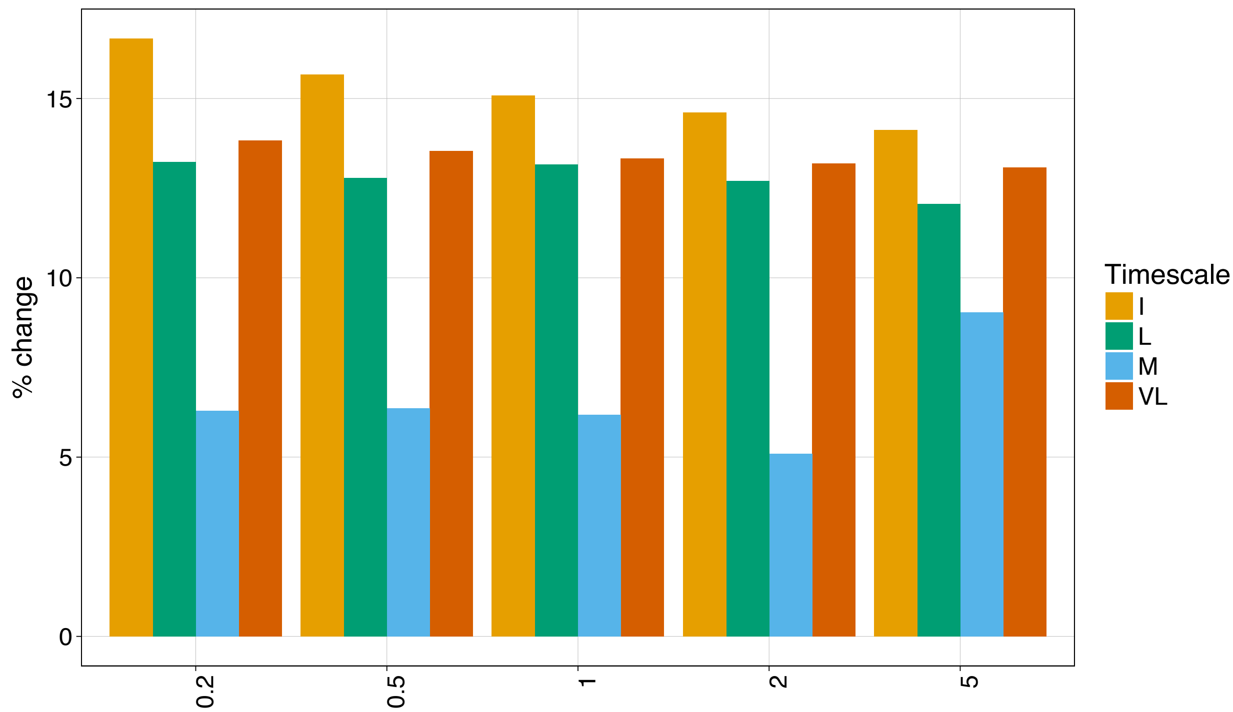

Figure S2 Sensitivity test of varying nitrogen uptake coefficient on the CO_2 fertilization effect (% change) at various equilibrium points. Nitrogen uptake coefficient are 0.2, 0.5, 1, 2 and 5 yr^{-1}. I: instantaneous, M: medium term, L: long term, VL: very long term.

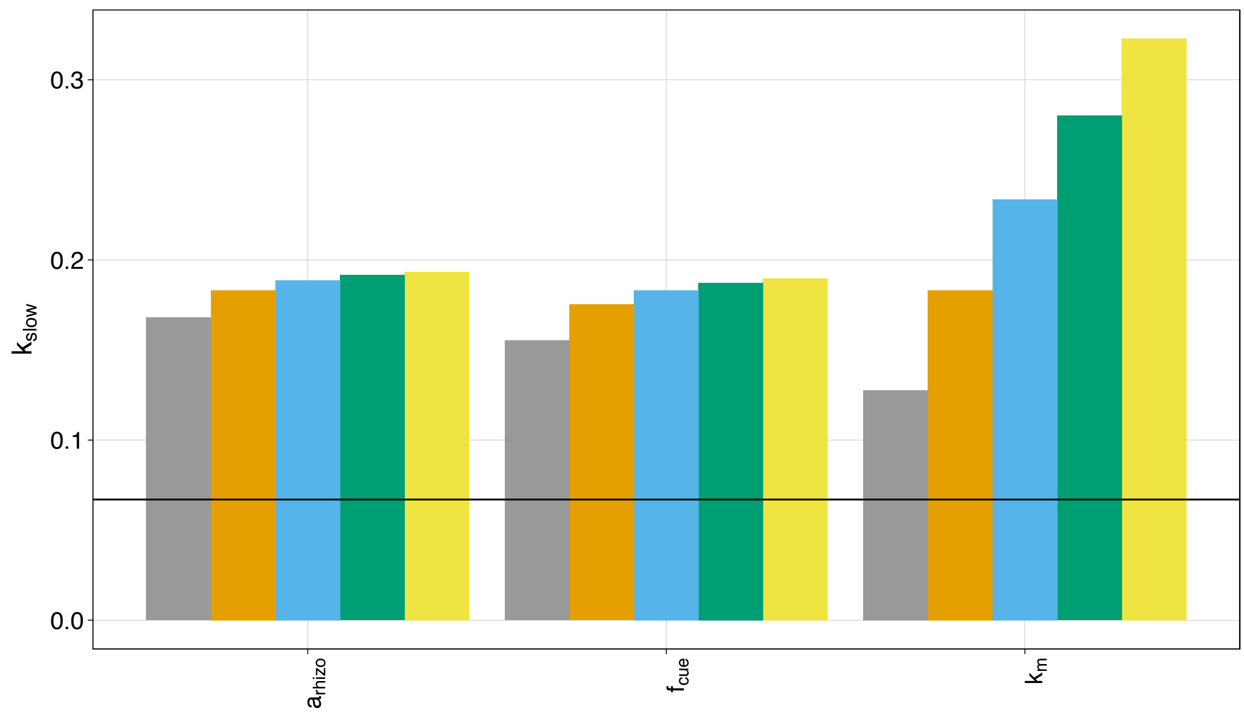

Figure S3 Sensitivity test of varying priming effect parameters on the decomposition rate of slow soil organic matter pool (k_{slow}). Parameters varied are allocation coefficient to rhizosphere (a_{rhizo}), microbial carbon use efficiency (f_{cue}), and scaling factor (k_m). From left to right, value ranges are: 0.1, 0.2, 0.3, 0.4, and 0.5 for a_{rhizo}, 0.1, 0.2, 0.3, 0.4, and 0.5 for f_{cue}, and 1, 2, 3, 4, 5 for k_m. Default values are, Black horizontal line is the existing k_{slow} value, before introducing priming effect.