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Representation of the phosphorus cycle in the Joint UK Land Environment Simulator (vn5.5_JULES-CNP)

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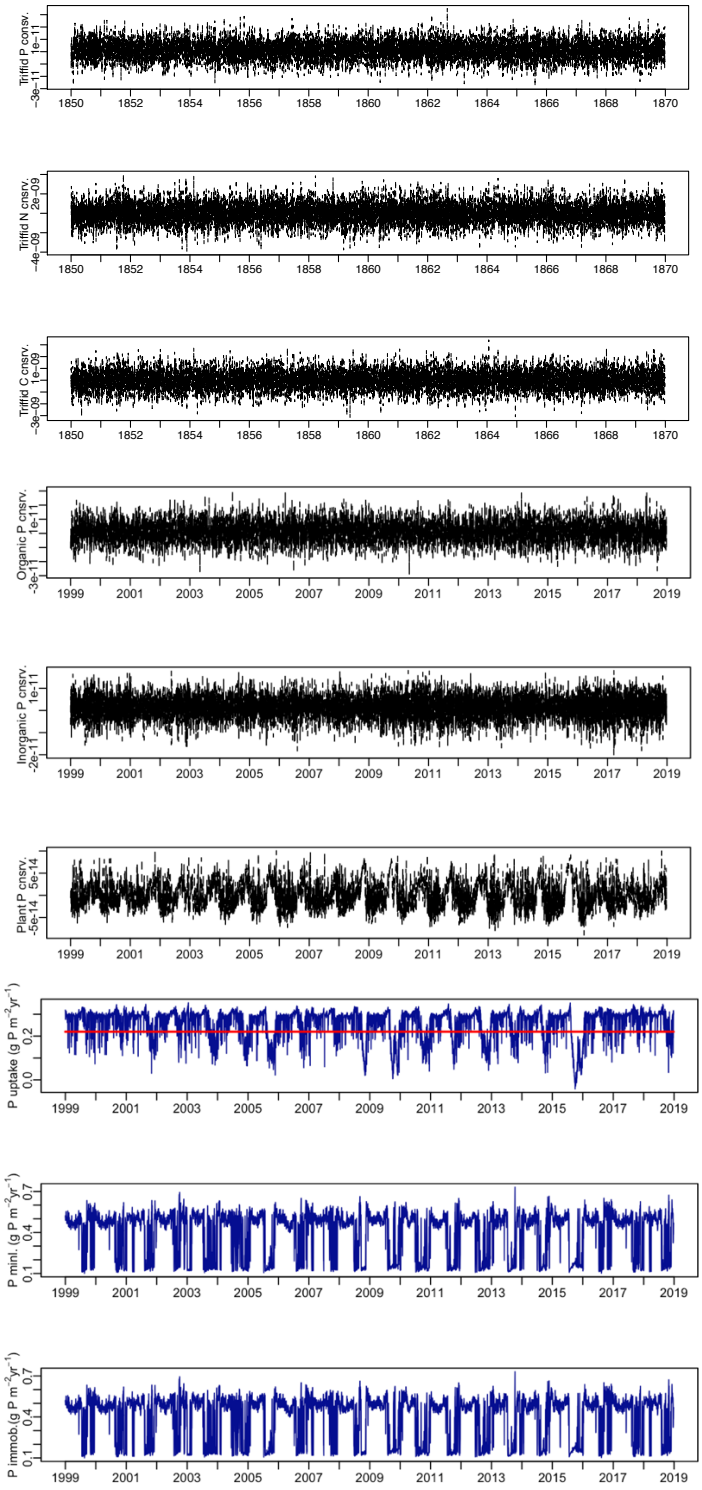

Fig. S1- Historical and and present day mass conservation of C,N and organic, inorganic and plant P and P mineralization, immobilization and uptake fluxes after spin-up.

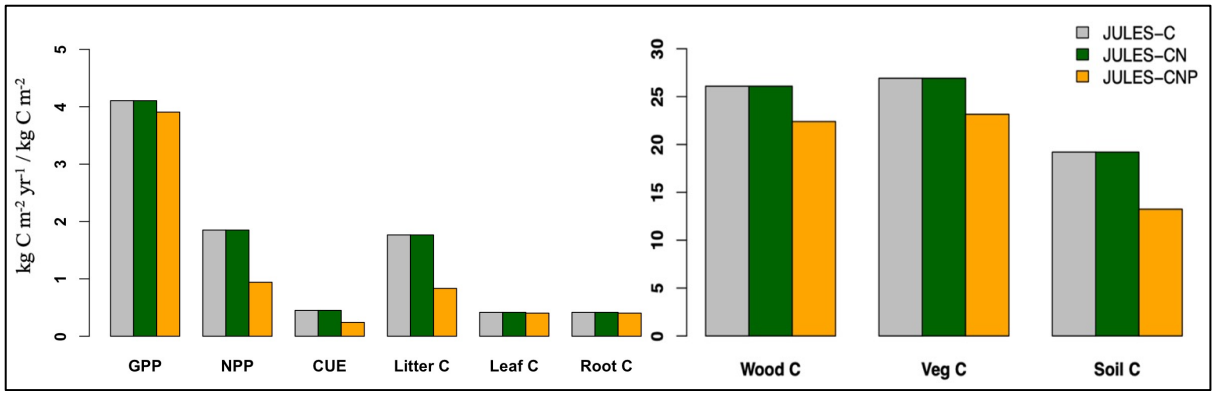

Fig. S2- JULES C, CN, CNP modelled C pools and fluxes under eCO_2.

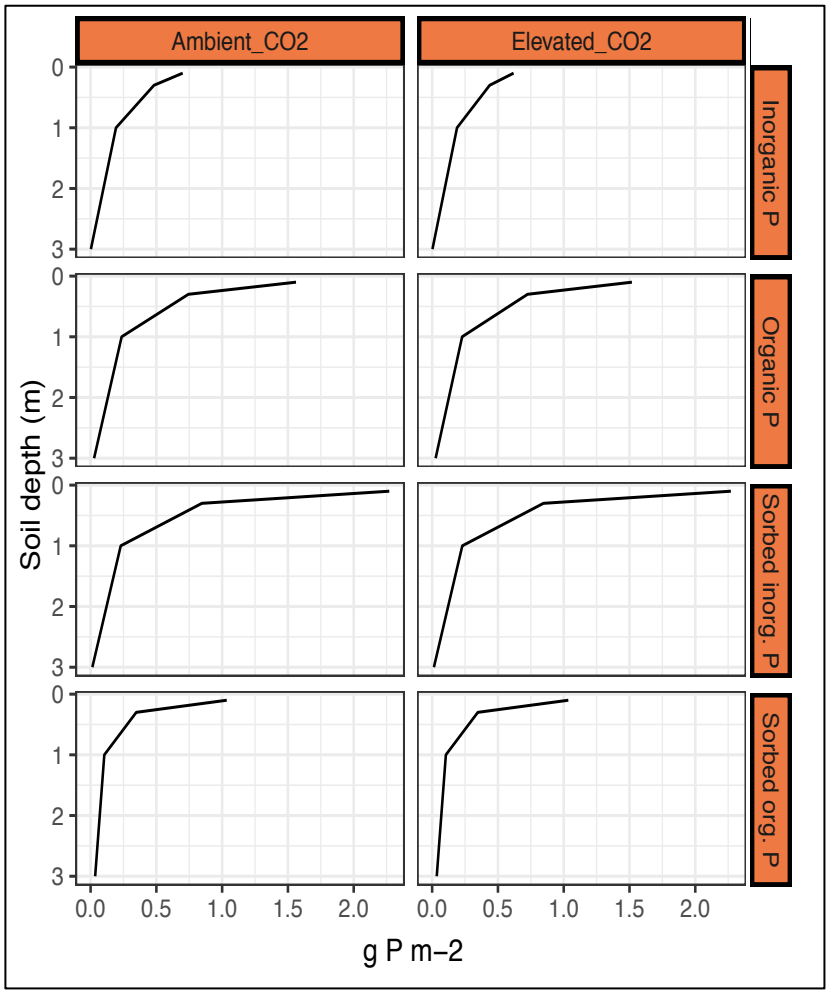

Fig. S3- Organic, inorganic and sorbed forms distribution within the soil layers using two model experiments.

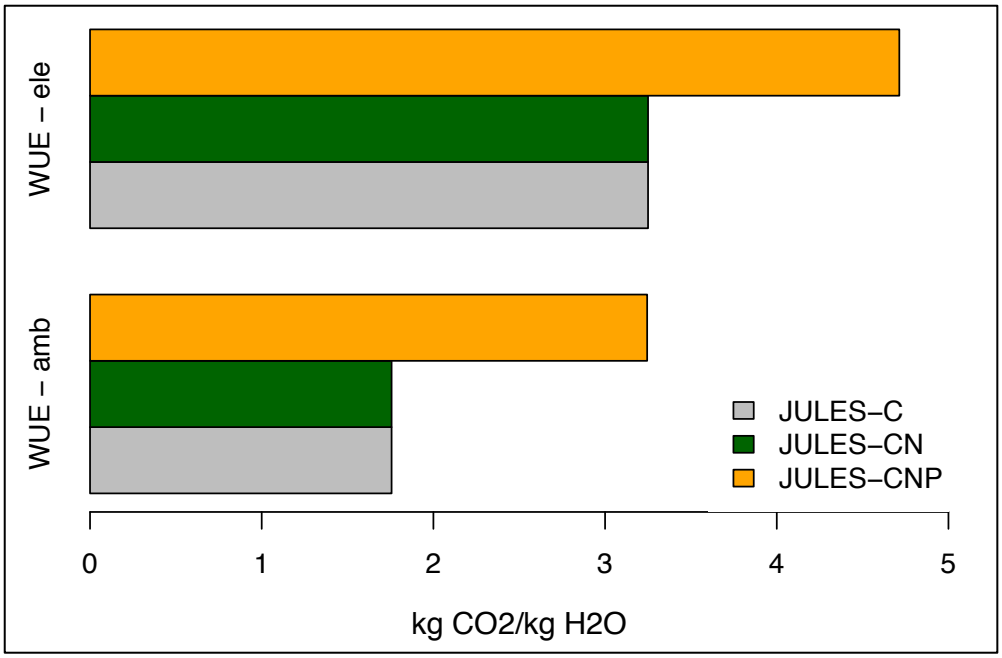

Fig. S4- Water use efficiency using three JULES versions under ambient and elevated CO_2 conditions.

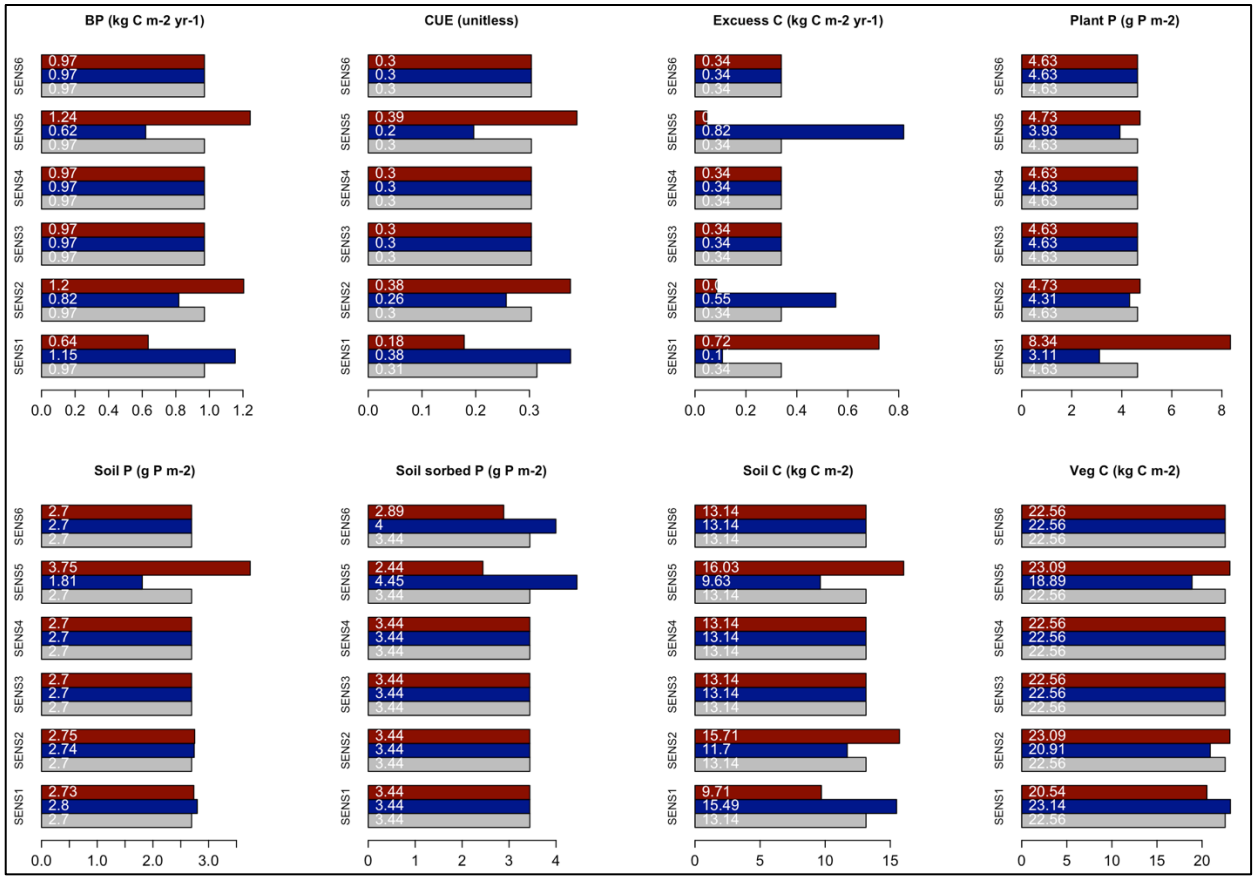

Fig. S5- Model parameters absolute sensitivity values"

Our results show the highest N leaching in year 2017 at 0.34 g N m^{-2} yr^{-1} and averaged 0.025 g N m^{-2} yr^{-1} for the period 2017-2019. Input from N deposition comes from Fleischer et al (2019) and is fixed at a rate of 0.32 g N m^{-2} yr^{-1} and the averaged fixed N and mineralized gas emissions are set at 2.02 and 0.23 g N m^{-2} yr^{-1}, respectively.

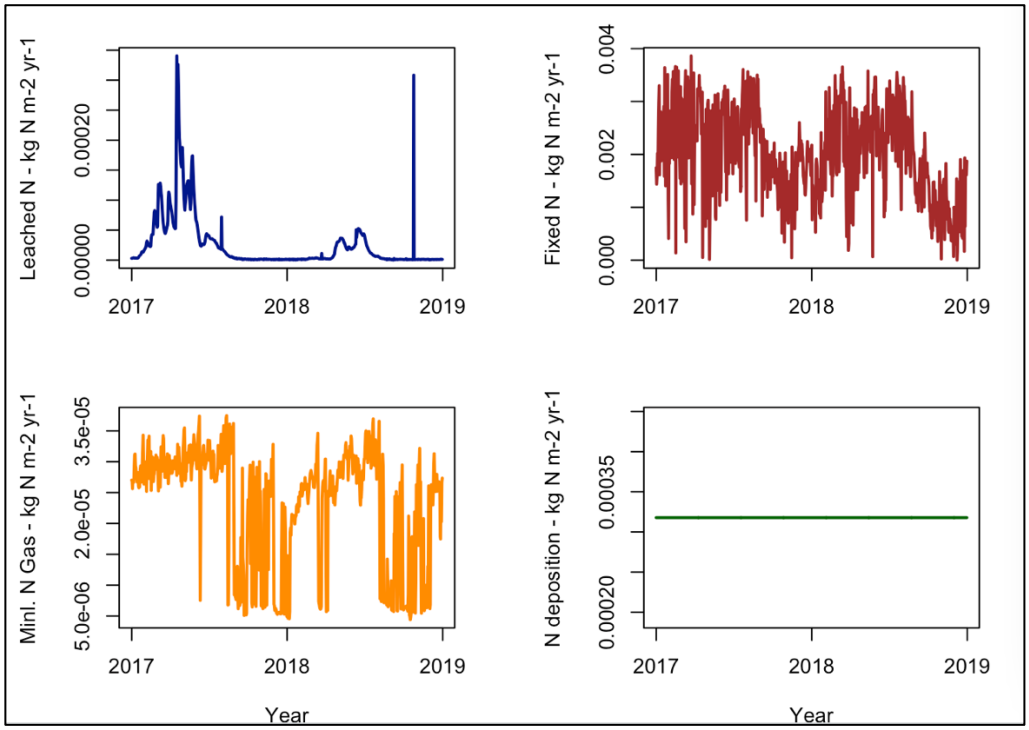

Fig. S6- N leaching, mineralized gas emission, fixed and deposition under ambient CO_2 condition

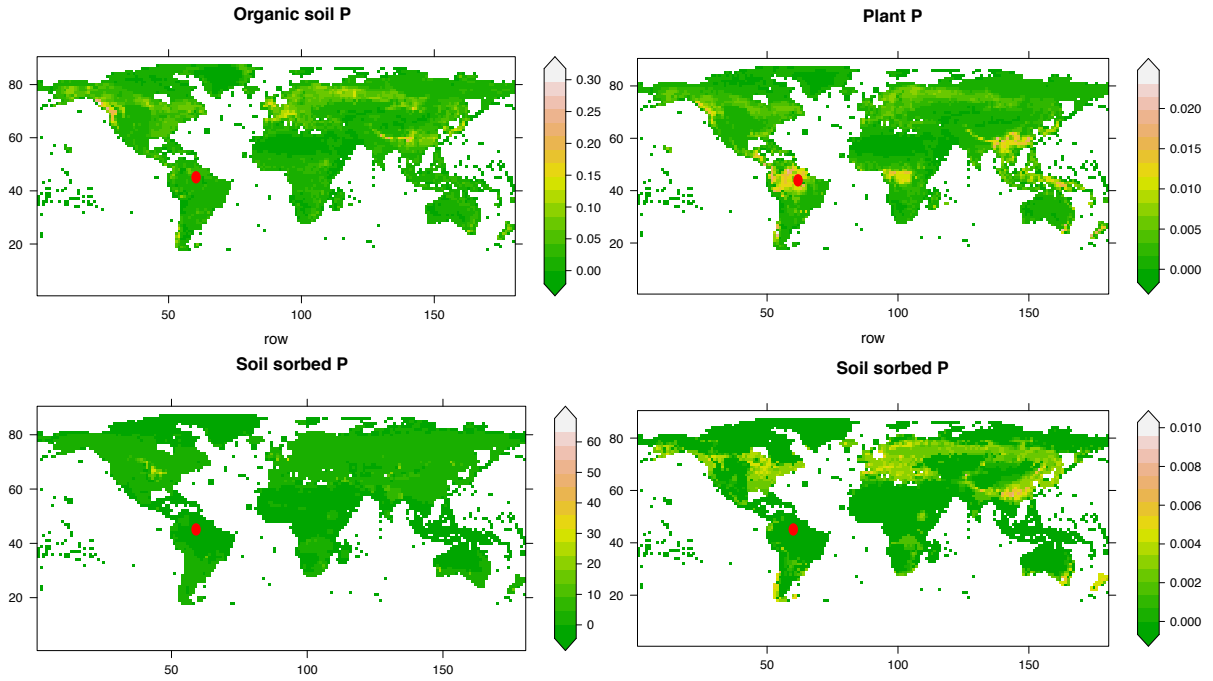

Figure. S7- P pools and fluxes provided by ORCHIDEE CNP and study site using JULES CNP

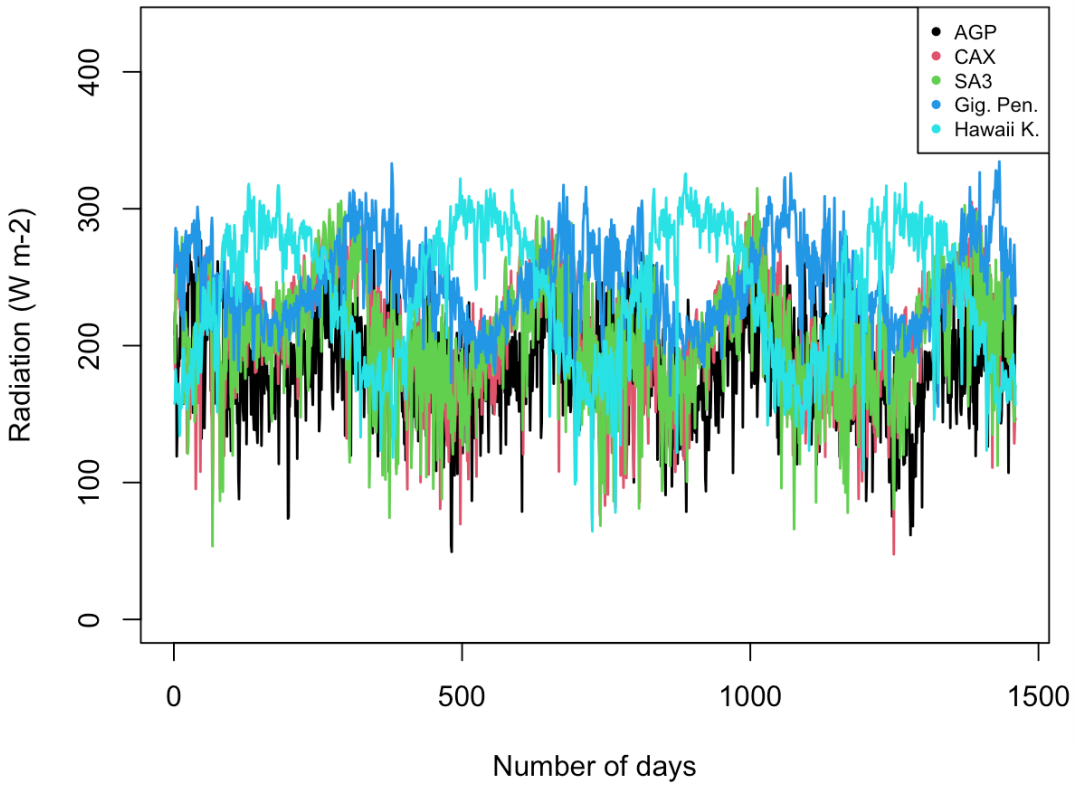

Figure. S8- Solar radiation at the extended test sites

Table S1. C pools and fluxes for 1st and 15-year responses using CNP models by Fleischer *et al.*, (2019)

		GPP	NPP	CUE	Leaf C	Root C	Wood C
	min:	6.7	3.7	-12.3	0.0	0.4	0.0
	max:	32.1	51.2	16.8	2.6	29.9	1.1
1st year	**Avg.**	19.9	23.0	2.5	1.0	6.0	0.2
	min:	3.3	2.2	-13.0	-1.9	0.7	0.4
	max:	21.1	23.0	1.9	10.0	34.8	17.0
15-year	**Avg.**	11.7	9.3	-2.0	4.1	11.5	5.8

Table S2. N pools and fluxes under ambient CO_2 condition

N pools and fluxes	
Organic N (kg N m^{-2})	0.71
Inorganic N (kg N m^{-2})	0.004
Litter N flux (kg N m^{-2} yr^{-1})	0.006
Leaf N (kg N m^{-2})	0.008
Root N (kg N m^{-2})	0.0066
Stem N (kg N m^{-2})	0.009

Table S3. JULES CNP vs ORCHIDEE CNP P pools and fluxes

	This study	ORCHIDEE CNP
Organic P (kg P m^{-2})	0.007	0.01
Plant P (kg P m^{-2})	0.0046	0.0054
Total sorbed P (g P m^{-2})	3.44	3.06
P uptake (g P m^{-2} day^{-1})	0.0003	0.0004