Supplementary information

Table S1. Soil water content, stoichiometry and nutrient availabilities for both field sites and seasons on the three topographies

	Paracou						Nouragues					
	Wet season			Dry season			Wet season			Dry season		
	Bottom	Slope	Top	Bottom	Slope	Top	Bottom	Slope	Top	Bottom	Slope	Top
Gravimetric water (%)	37 (2)^{ab}	44 (2)^{a}	36 (1)^{b}	19 (1)^{cd}	22 (1)^{c}	15 (1)^{d}	48 (5)^{b}	55 (3)^{b}	66 (3)^{a}	40 (5)^{c}	30 (1)^{c}	52 (3)^{b}
C:N ratio	17.8 (0.7)^{b}	20.1 (1.1)^{ab}	13 (0.8)^{c}	18.7 (1.2)^{ab}	18.8 (0.7)^{ab}	21.0 (0.8)^{a}	15.8 (0.3)^{a}	17.5 (0.3)^{a}	16.0 (0.5)^{a}	16.3 (0.6)^{a}	16.0 (0.3)^{a}	16.3 (0.4)^{a}
Total C (%)	3.1 (0.3)^{b}	4.9 (0.5)^{ab}	3.3 (0.3)^{b}	3.6 (0.7)^{b}	4.8 (0.8)^{ab}	5.9 (0.8)^{a}	5.0 (0.7)^{a}	5.8 (0.4)^{a}	6.6 (0.4)^{a}	4.6 (0.8)^{a}	4.1 (0.2)^{a}	8.2 (0.9)^{a}
Total N (%)	0.17 (0.01)^{b}	0.24 (0.01)^{a}	0.26 (0.01)^{a}	0.18 (0.03)^{b}	0.24 (0.02)^{a}	0.27 (0.03)^{a}	0.32 (0.04)^{b}	0.33 (0.02)^{b}	0.42 (0.02)^{a}	0.27 (0.04)^{b}	0.25 (0.01)^{b}	0.49 (0.04)^{a}
Total P (mg kg^{-1})	78 (3)^{bc}	112 (3)^{a}	65 (3)^{ce}	63 (3)^{de}	96 (4)^{b}	58 (4)^{d}	85 (8)^{cd}	93 (4)^{c}	272 (5)^{a}	69 (8)^{cd}	75 (3)^{d}	267 (6)^{b}
Total Mo (mg kg^{-1})	10.9 (1.1)^{a}	6.6 (0.7)^{b}	10.3 (1)^{a}	2.0 (0.1)^{c}	1.4 (0.1)^{c}	1.8 (0.1)^{c}	6.3 (1.1)^{a}	5.6 (0.6)^{a}	1.5 (0.2)^{b}	5.8 (0.7)^{a}	4.7 (0.6)a	0.1 (0)^{b}
Available N (mg kg^{-1})	10.4 (0.8)^{b}	24.7 (1.9)^{a}	15.3 (1.4)^{b}	4.6 (0.3)^{c}	11.4 (0.7)^{b}	5.9 (0.3)^{c}	9.4 (0.9)^{bc}	7.7 (0.3)^{c}	16.4 (0.9)^{a}	9.0 (0.6)^{bc}	11.0 (1.0)^{b}	15.0 (1.0)^{a}
Available P (mg kg^{-1})	3.3 (0.3)^{a}	1.3 (0.1)^{c}	1.3 (0.1)^{cd}	2.7 (0.2)^{b}	0.9 (0.1)^{d}	1.2 (0.1)^{cd}	1.8 (0.2)^{b}	0.9 (0)^{df}	1.0 (0)^{ef}	2.0 (0.1)^{a}	1.2 (0.1)^{ce}	1.3 (0.1)^{cd}
Available Mo (µg kg^{-1})	6.42 (0.9)^{b}	8.53 (1.61)^{a}	3.96 (0.65)^{bc}	3.97 (0.76)^{c}	5.97 (0.83)^{b}	3.52 (0.31)^{c}	3.47 (0.34)^{a}	1.49 (0.42)^{bc}	0.36 (0.17)^{c}	0.61 (0.26)^{c}	2.48 (0.34)^{ab}	3.76 (1.18)^{a}
pH	4.21 (0.03)^{a}	4.04 (0.02)^{b}	4.06 (0.01)^{b}	3.99 (0.02)^{b}	4.00 (0.02)^{b}	3.88 (0.02)^{c}	3.95 (0.02)^{a}	3.81 (0.01)^{bc}	3.78 (0.06)^{c}	3.82 (0.03)^{bc}	3.80 (0.02)^{c}	3.90 (0.02)^{ab}
Clay (%)	8.5 (0.5)^{b}	17.5 (0.9)^{a}	9.3 (0.1)^{b}	8.7 (0.5)^{b}	17.5 (0.9)^{a}	9.3 (0.1)^{b}	18.2 (0.5)^{c}	26.0 (1.4)^{b}	42.8 (0.9)^{a}	18.5 (0.6)^{c}	25.7 (1.4)^{b}	42.4 (0.8)^{a}
Sand (%)	77.3 (0.9)^{a}	63.5 (1.4)^{b}	76.2 (0.2)^{a}	76.6 (0.9)^{a}	63.5 (1.4)^{b}	76.2 (0.2)^{a}	63.8 (0.9)^{a}	53.2 (2.6)^{b}	22.8 (2.0)^{c}	63.4 (1.0)^{a}	53.5 (2.6)^{b}	23.2 (2.0)^{c}
Bulk density (kg m^{-2})	58.0 (1.9)^{a}	51.9 (1.4)^{b}	56.4 (2.5)^{a}	58.1 (1.8)^{a}	51.9 (1.4)^{b}	56.4 (2.5)^{a}	47.1 (2)^{a}	45.9 (1.2)^{a}	39.1 (1.3)^{b}	46.4 (2.2)^{a}	45.9 (1.2)^{a}	40.0 (1.4)^{b}

Values are means with standard errors in parentheses. Letters denote significant differences (linear mixed effects model with Season and Topography as factors, followed by post hoc tests and with $p<0.05$ as significance level) within a site.

Table S2. Leaf litter water content and stoichiometry at Paracou and Nouragues for both seasons and on the three topographies.

	Paracou						Nouragues					
	Wet season			Dry season			Wet season			Dry season		
	Bottom	**Slope**	**Top**	**Bottom**	**Slope**	**Top**	**Bottom**	**Slope**	**Top**	**Bottom**	**Slope**	**Top**
Gravimetric water (%)	0.64 (0.01)^{a}	0.67 (0.01)^{a}	0.58 (0.02)^{b}	0.42 (0.02)^{c}	0.31 (0.01)^{d}	0.22 (0.01)^{e}	0.67 (0.01)^{a}	0.66 (0.01)^{ab}	0.62 (0.01)^{b}	0.60 (0.01)^{b}	0.44 (0.01)^{c}	0.42 (0.03)^{c}
C:N ratio	36.1 (0.9)^{b}	34.9 (0.7)^{b}	37.5 (1)^{b}	42 (1.5)^{a}	39.5 (0.9)^{a}	42.1 (1.2)^{a}	31.5 (1.8)^{b}	34.2 (0.8)^{b}	34.7 (0.9)^{b}	33.7 (1.2)^{b}	40.8 (1.6)^{a}	38.9 (1.4)^{a}
N:P ratio	59.8 (2.2)^{c}	60.2 (3.3)^{c}	74.6 (3.1)^{b}	63.0 (3.7)^{b}	74.9 (3.7)^{ab}	83.6 (5.5)^{a}	60.4 (3.1)^{b}	64.6 (4.0)^{b}	58.7 (3.1)^{b}	82.3 (5.2)^{a}	79.6 (3.9)^{a}	70.8 (2.9)^{a}
Total C (%)	40.5 (1.1)^{b}	43.9 (0.7)^{b}	44.6 (1.3)^{b}	45.4 (0.6)^{a}	46.0 (0.3)^{a}	45.1 (0.6)^{a}	41.6 (1.1)^{b}	45 (0.6)^{a}	45.6 (0.4)^{a}	45.1 (0.4)^{a}	47.0 (0.7)^{a}	45.9 (0.5)^{a}
Total N (%)	1.14 (0.04)^{a}	1.28 (0.03)^{a}	1.21 (0.05)^{a}	1.11 (0.05)^{b}	1.19 (0.03)^{b}	1.09 (0.03)^{b}	1.39 (0.08)^{a}	1.33 (0.03)^{a}	1.34 (0.04)^{a}	1.37 (0.06)^{b}	1.19 (0.04)^{b}	1.2 (0.03)^{b}
Total P (mg kg^{-1})	200 (14)^{a}	227 (13)^{a}	171 (14)^{a}	190 (24)^{b}	171 (10)^{b}	140 (11)^{b}	251 (26)^{a}	220 (16)^{a}	240 (14)^{a}	180 (12)^{b}	157 (9)^{b}	176 (9)^{b}
Total Mo (mg kg^{-1})	2.8 (0.3)^{b}	1.5 (0.2)^{c}	1.8 (0.4)^{c}	3.4 (0.7)^{a}	1.9 (0.2)^{ab}	3.8 (0.8)^{ab}	1.7 (0.3)^{a}	0.9 (0.2)^{b}	0.5 (0.1)^{b}	1.8 (0.4)^{a}	0.7 (0.1)^{b}	0.7 (0.1)^{b}
Bulk density (g m^{-2})	468.2 (62.5)^{a}	370.4 (23.2)^{b}	469.1 (18.9)^{a}	367.7 (23.0)^{b}	340.2 (20.7)^{c}	347.6 (12.8)^{bc}	441.0 (29.7)^{b}	380.7 (20.7)^{b}	336.7 (20.5)^{b}	571.8 (94.2)^{a}	547.5 (58.4)^{a}	682.3 (72.6)^{a}

Values are means with standard errors in parentheses. Letters denote significant differences (linear mixed effects model with Season and Topography as factors, followed by post hoc tests and with $p<0.05$ as significance level) within a site.

Table S3 Correlation matrix showing Pearson's r for the variable used in the stepwise regression analysis. Data from A Paracou soil, B Nouragues soil and C leaf litter from both sites. Data was averaged per plot prior to calculation. Abbreviations: C = total C, N = total N, P = total P, Mo = total Mo, C:N = C:N ratio, N:P = N:P ratio, P_{in} = available P, N_{in} = available N, Mo_{in} = available Mo, Moisture = water content, pH = pH, Clay = % clay, Sand = % sand and BD = bulk density

A

Soil variables	C	N	C:N	P	Mo	N_{in}	P_{in}	Mo_{in}	pH	Clay	Sand	BD
Moisture	-0,16	0,06	-0,24	0,45	0,64	0,68	0,05	0,55	0,55	0,31	-0,33	-0,23
C		0,78	0,63	0,03	-0,48	0,01	-0,37	-0,06	-0,43	0,20	-0,20	-0,09
N			0,04	0,04	-0,18	0,12	-0,51	-0,14	-0,39	0,17	-0,18	-0,23
C:N				0,02	-0,52	-0,07	-0,01	0,12	-0,19	0,11	-0,12	0,04
P					-0,06	0,69	-0,26	0,49	0,00	0,85	-0,83	-0,63
Mo						0,26	0,34	0,30	0,69	-0,31	0,31	0,21
N_{in}							-0,25	0,33	0,09	0,64	-0,63	-0,45
P_{in}								0,02	0,36	-0,51	0,53	0,54
Mo_{in}									0,52	0,45	-0,44	-0,22
pH										-0,14	0,09	0,18
Clay											-0,99	-0,68
Sand												0,73

B

Soil variables	C	N	C:N	P	Mo	N_{in}	P_{in}	Mo_{in}	pH	Clay	Sand	BD
Moisture	0,75	0,77	0,14	0,65	-0,45	0,48	-0,36	-0,21	-0,20	0,59	-0,62	-0,64
C		0,97	0,25	0,67	-0,52	0,50	-0,18	0,22	-0,12	0,61	-0,63	-0,63
N			0,05	0,75	-0,63	0,62	-0,23	0,15	-0,11	0,70	-0,72	-0,74
C:N				-0,11	0,37	-0,36	-0,02	0,13	-0,05	-0,18	0,20	0,34
P					-0,70	0,80	-0,48	-0,10	0,03	0,90	-0,93	-0,79
Mo						-0,70	0,40	0,06	0,19	-0,86	0,87	0,87
N_{in}							-0,28	-0,05	-0,25	0,81	-0,82	-0,71
P_{in}								0,23	0,11	-0,63	0,60	0,54
Mo_{in}									0,36	-0,12	0,14	0,11
pH										-0,19	0,15	0,09
Clay											-0,99	-0,87
Sand												0,89

C

Litter	C	N	C:N	P	N:P	Mo
Moisture	-0,29	0,55	-0,67	0,65	-0,50	-0,31
C		0,13	0,37	-0,11	0,25	-0,49
N			-0,85	0,61	-0,13	-0,46
C:N				-0,61	0,24	0,22
P					-0,83	-0,26
N:P						0,13

Table S4 Comparison of FLNF rates measured in different studies carried out in primary tropical rainforests. Rates for soil and leaf litter are given and expressed as nmol of ethylene produced per gram of substrate per hour (nmol g^{-1} h^{-1}).

Substrate	**Country**	**Location**	**FLNF Rate (nmol g^{-1} h^{-1})**	**Reference**
Litter	Hawai	Pahoehoe	2.5 (0.4)	Vitousek 1999
	Hawai	A'a	4.0 (1.4)	Vitousek 1999
	Hawai	Thurston	3.15 (0.86)	Crews 2000
	Hawai	Laupahoehoe	1.25 (0.31)	Crews 2000
	Hawai	Kokee	1.08 (0.27)	Crews 2000
	Hawai	Pahoehoe	7.42 (1.85)	Vitousek 2000
	Hawai	Thurston	8.38 (2.10)	Vitousek 2000
	Hawai	Laupahoehoe	1.93 (0.48)	Vitousek 2000
	Hawai	Kokee	3.22 (0.81)	Vitousek 2000
	Costa Rica	Osa Peninsula, Ultisol	8.82 (5.50)	Reed et al 2007
	Costa Rica	Osa Peninsula, Mollisol	5.89 (4.75)	Reed et al 2007
	Panama		0.53 (0.17)	Barron et al. 2009
	Puerto Rico	Wet tropical rainforest	2.0 (0.5)	Cusack 2009
	Puerto Rico	Lower montane rainforest	1.2 (0.5)	Cusack 2009
	Costa Rica	Osa Peninsula	11.39 (2.75)	Reed et al 2010
	Panama	Fairchild	6.52 (1.00)	Wurzburger et al. 2012
	Panama	AVA	0.34 (0.08)	Wurzburger et al. 2012
	Panama	Gigante	0.38 (0.06)	Wurzburger et al. 2012
	Panama	Barro Verde	1.84 (0.42)	Wurzburger et al. 2012
	Panama	Zetek	0.48 (0.21)	Wurzburger et al. 2012
	Panama	Rio Paja	1.58 (0.23)	Wurzburger et al. 2012
	Costa Rica	Osa Peninsula	3.77 (0.46)	Reed et al. 2013
	Costa Rica	Osa Peninsula	0.60 (0.15)	Sullivan et al. 2014*
	French Guiana	Paracou	0.32 (0.10)	This study
	French Guiana	Nouragues	0.18 (0.06)	This study
Soil	Costa Rica	Osa Peninsula, Ultisol	0.080 (0.013)	Reed et al 2007
	Costa Rica	Osa Peninsula, Mollisol	0.042 (0.009)	Reed et al 2007
	Puerto Rico	Wet tropical rainforest	0.11 (0.03)	Cusack 2009
	Puerto Rico	Lower montane rainforest	0.06 (0.02)	Cusack 2009
	Ecuador	1000 m	0.179 (0.112)	Matson et al. 2014
	Ecuador	2000 m	0.313 (0.156)	Matson et al. 2014
	Ecuador	3000 m	0.223 (0.134)	Matson et al. 2014
	Costa Rica	Osa Peninsula	0.017 (0.004)	Sullivan et al. 2014*
	French Guiana	Paracou	0.011 (0.005)	This study

	French Guiana	Nouragues	0.021 (0.011)	This study

** For this study we found no bulk density reported for soil and litter. To calculate the amount of ethylene produced from the kg N ha^{-1} y^{-1} reported in the study we used the bulk density values we measured in French Guiana.*

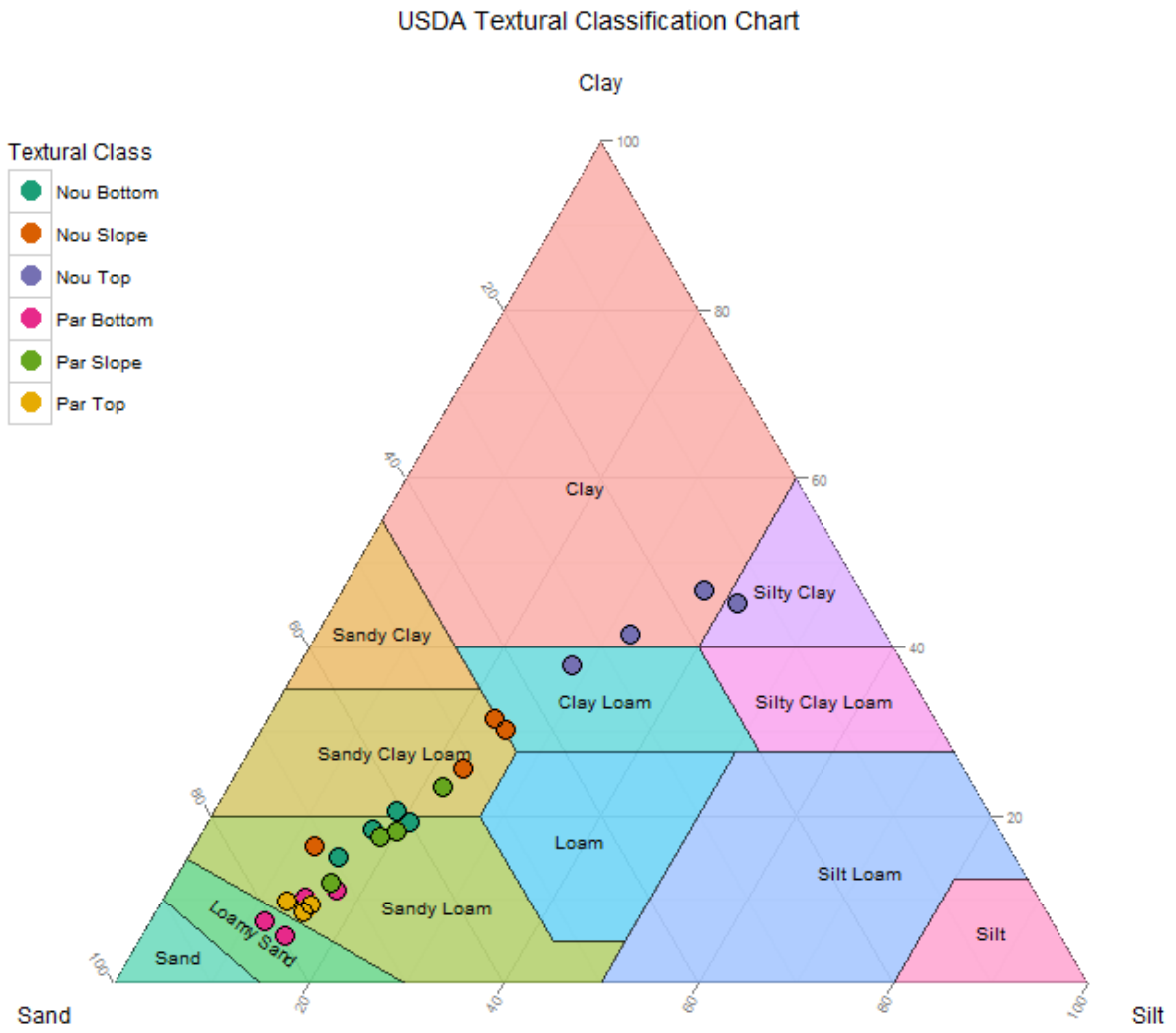

Figure S1. Soil classification based on texture for each of the twelve plots in Paracou and Nouragues. Dots are plot averages.

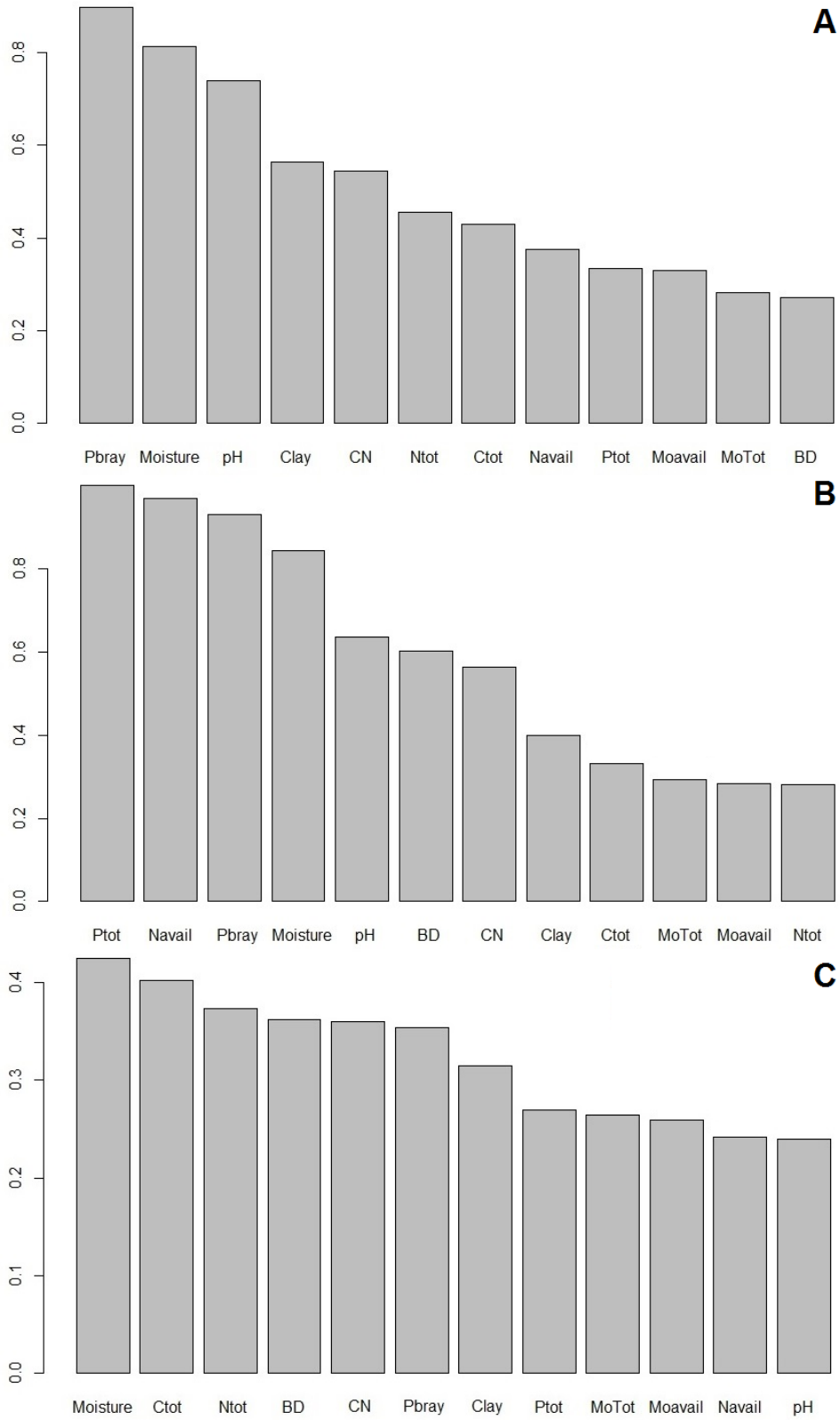

Figure S2 Relative importance of physico-chemical variables in the overall soil dataset (A), in Paracou (B) and in Nouragues (C). Higher relative importance means the predictor value is more likely to play a significant role in explaining the observed

variation in FLNF rate (Burnham and Anderson 2002). Relative importance was calculated by summing the Akaike weights of each model, from all possible first order models, in which the variable participated. Moisture = water content, Ctot = total C, Ntot = total N, Ptot = total P, MoTot = total Mo, CN = C:N ratio, Navail = available N, Pbray = available P, Moavail = available Mo, pH = pH, Clay = percentage clay content and BD = bulk density.

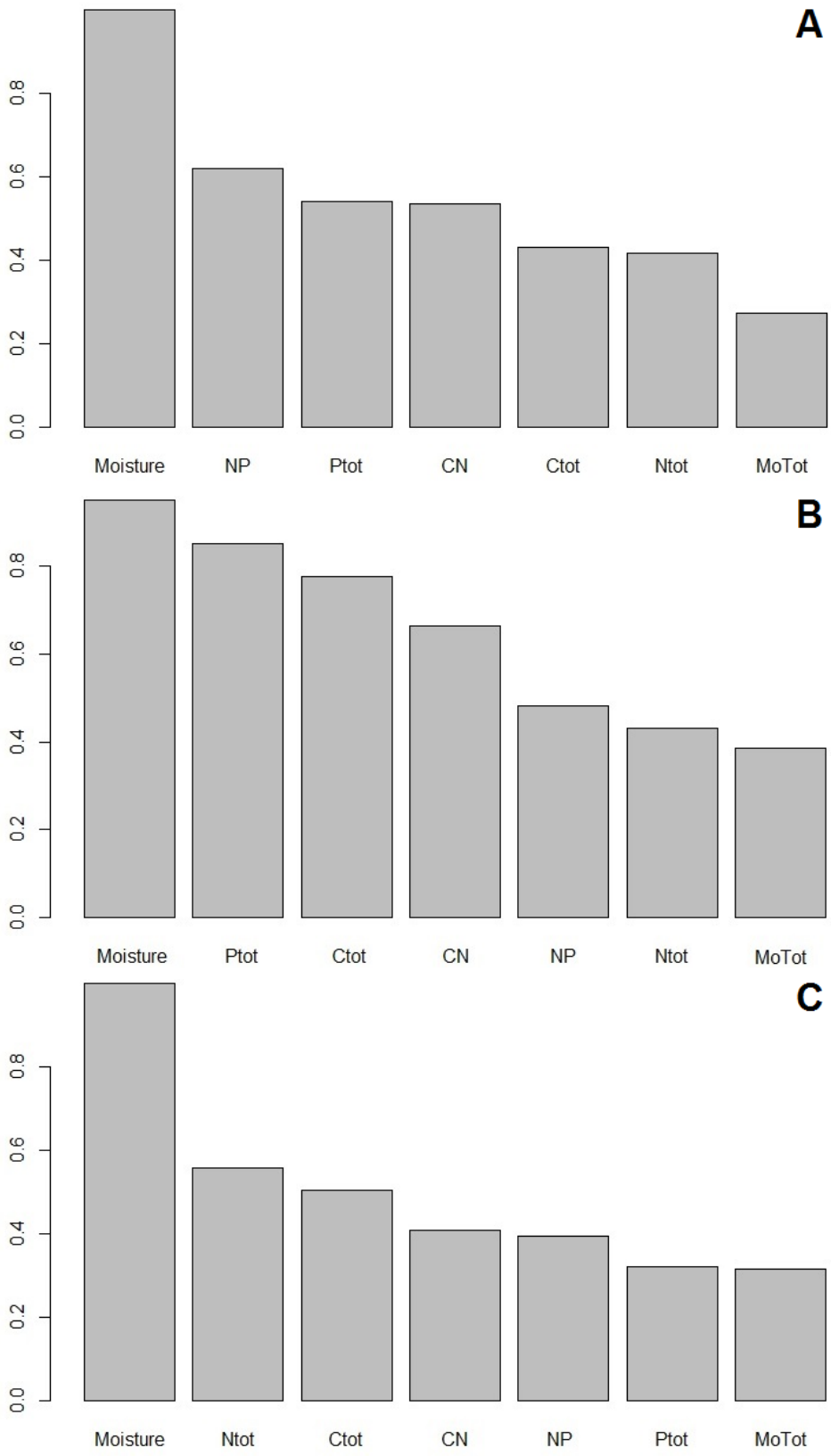
A
0.0
0.2
0.4
0.6
0.8
Moisture
NP
Ptot
CN
Ctot
Ntot
MoTot
B
0.0
0.2
0.4
0.6
0.8
Moisture
Ptot
Ctot
CN
NP
Ntot
MoTot
C
0.0
0.2
0.4
0.6
0.8
Moisture
Ntot
Ctot
CN
NP
Ptot
MoTot

Figure S3 Relative importance of physico-chemical variables in the overall litter dataset (A), in the wet season (B) and in the dry season (C). Higher relative importance means the predictor value is more likely to play a significant role in explaining the observed variation in FLNF rate (Burnham and Anderson 2002). Relative importance was calculated by summing the Akaike weights of each model, from all possible first order models, in which the variable participated. Moisture = water content, Ctot = total C, Ntot = total N, Ptot = total P, MoTot = total Mo, CN = C:N ratio and NP = N:P ratio.

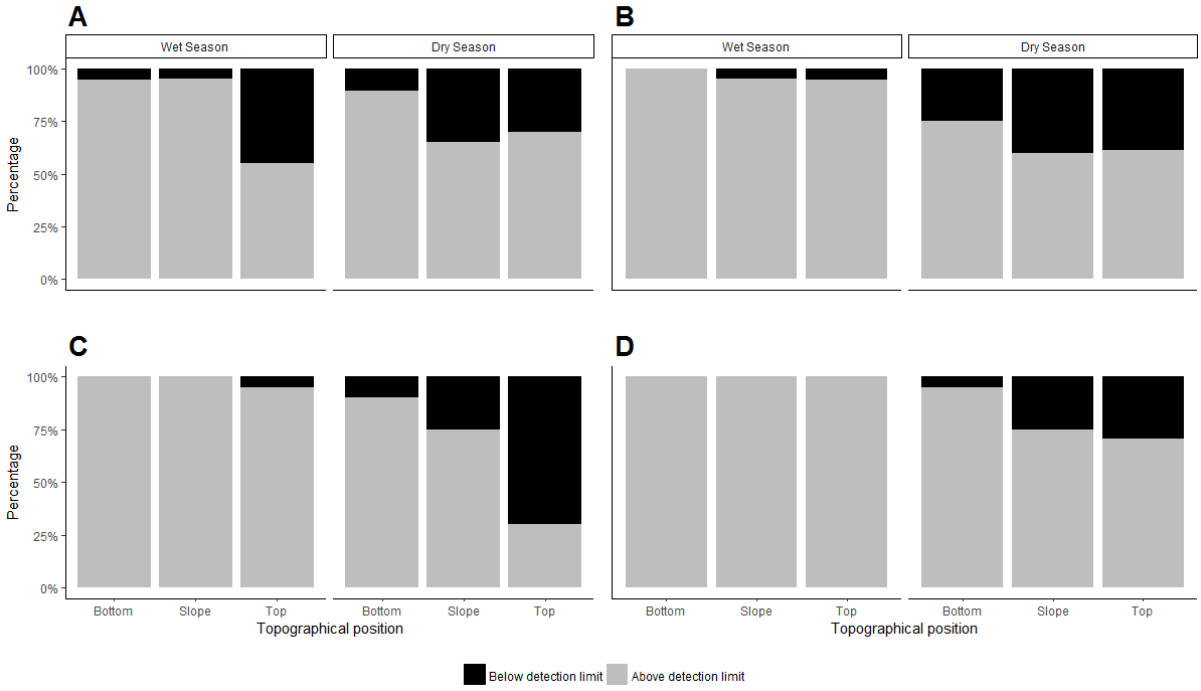

Figure S4. Percentage of N fixation rates below (black) and above (grey) the detection limit as a function of season and topography for (A) Paracou soil, (B) Nouragues soil, (C) Paracou leaf litter and (D) Nouragues leaf litter.

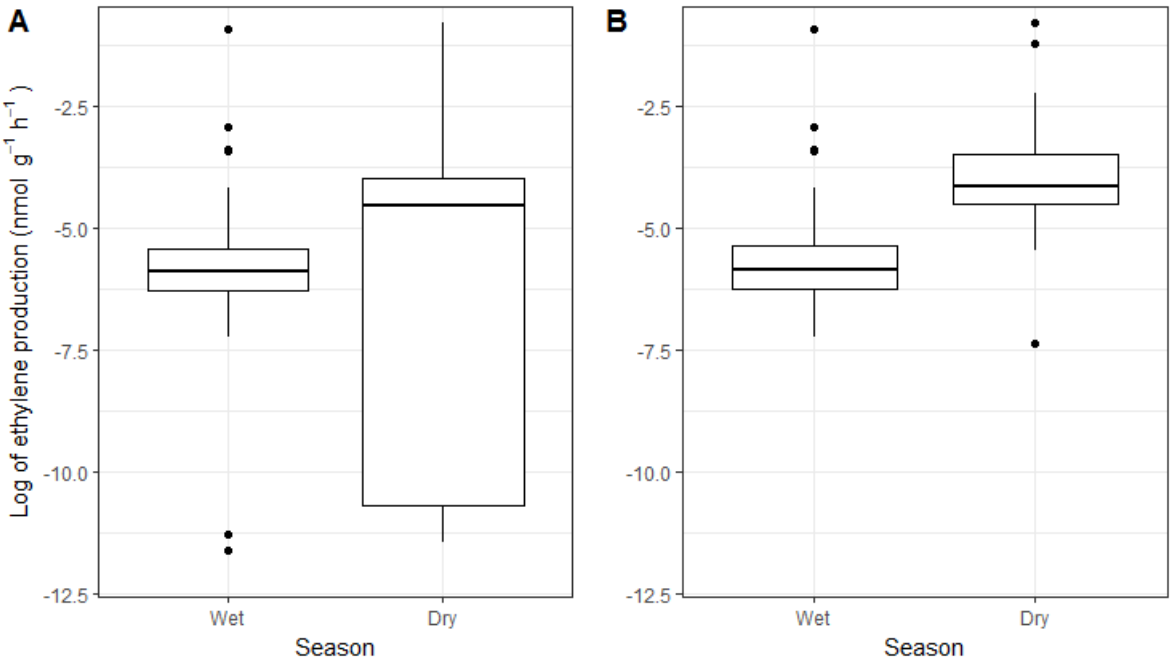

Figure S5. Boxplots comparing the effect of season on N fixation in Nouragues soils using the data set containing all datapoints (A) and the data set excluding datapoints below the detection limit (B).