Supplementary material

Fire-derived organic carbon turnover in soils on a centennial scale

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Methodology

We calculated turnover times based on two data point for each study, the initial stock of PyC and final PyC remaining at the end of the experiment, using equation (1). Most studies had only these two data points and intermediate points that were reported in few studies (Hamer et al., 2004; Brodowski, 2005; Kuzyakov et al., 2009) were not included for consistency. We observed that turnover time for PyC ranges from <10 to 600 years (Supplementary Figure 1).

$$C_t = C_0 . \exp(-k.t) \qquad (1)$$

where C_t is the remaining stock after time t (y), C_0 is the initial stock of PyC ($t=0$), k is the decay rate (y^{-1}) and turnover time τ (y) $=1/k$.

Statistical analysis

Non-parametric test for comparison between factors were carried using Wilcoxon rank sum test. A three way ANOVA was done on the data set using R software to test the interaction between the variables (supplementary table 2). Therefore, the imbalanced design of the grouped data (supplementary table 3) does not introduce any significant error in the interpretation.

Supplementary Table 1:

References	**Type of BC**	**Pyrolysis temperature**	**Soil Type**	**Climate/ Moisture Temperature**	**Duration of the experiment**	**Mineralised PyC (% of the initial PyC)**
(Baldock and Smernik, 2002)	Sap wood, *Pinus resinosa*	150º C	Sand (packed at 1.6 bulk density	At 25º C and volumetric water content of 0.29 cm^3 water cm^{-3} soil	120 days	13%
		≥ 200º C (200-350º C)				<2%
(Hamer et al., 2004)	1. Maize	350º C	Sand + 1ml inoculum + 0.5ml nutrient solution	At 20º C and 60% water holding capacity	60 days	0.78%
	2. Rye	350º C				0.72%
	3. Wood	800º C				0.26%
(Brodowski, 2005) Appendix 7	1. *Zea mays* (maize) 2. *Secale cereale* (rye straw)	350º C	Top soil; Ap horizon; 0-25 cm: Haplic Phaeozem	At 20º C and 70% water holding capacity	2 years	Between 16 and 51 %
Cheng et al., 2008	Hardwood (chestnut, hickory, oak and sugar maple)	(similar to wildfires)		30º C and 70º C	1 year	2.86 % incubated at 30º C and 5.5% incubated at 70º C
(Bruun et al., 2008)	^{14}C labeled roots of Barley (*Hordeum vulgare*)	225º C	Sandy loam	25º C	30 days	1.9%
		300º C				1.4%
		375º C				8.2% (possibly due to Carbonates) of the charcoal-C
(Major et al., 2010)	Mango tree (*Mangifera indica L.*)	400-600º C	Isohyperthermic kaolinitic Typic Haplustox sandy clay loam	MAT = 26º C MAP = 2200 mm (95% of precipitation falls between April and December)	2 years	2.2 % by respiration + 1% mobilized by percolating water

(Hilscher et al., 2009)	Rye grass (*Lolium perenne*), Gr Pine wood (*Pinus sylvestris*), P	350º C under oxic condition, 1 min 4 min charring	Bw horizon of Cambisol under Spruce	at 30º C	48 days	Gr1M: 3.1% Gr4M: 2.5% P1M: 0.66% P4M: 0.46%
(Kuzyakov et al., 2009)	^{14}C labeled *Lolium perenne*	13 h charring at 400º C	Ap horizon of a loamy Haplic luvisol	20º C 70% water holding capacity	1089 days (3.2 years)	4.5 % of the ^{14}C added as BC was released as $^{14}CO_2$ during 3 years. First month: 0.016-0.024% d^{-1} After one year: 0.0012-0.0016% d^{-1} After 3.2 years, 0.00136% d^{-1}
(Zimmerman, 2010)	1.*Quercus laurifolia* (living wood oak) 2.*Pinus taeda* (pine) 3.*Juniperus virginiana* (cedar) 4.*Guibourtia demusei* (tropical hardwood) 5.*Tripsacum dactyloides* (mixed stems and blades of gamma grass) 6.Sugarcane baggase	250º C oxic $\left.\begin{array}{l}\text{400º C}\\ \text{525º C}\\ \text{650º C}\end{array}\right\}$ under N_2	Quartz sand	Incubated in the dark at 32 °C	1 year	0.4-3% (1.4 ± 0.75% average ± stdv) for inoculated biochars C loss 1.0 ± 0.5% for abiotic C loss 10.3 ± 6.2 SD for 100 years and 28.4 ± 20.0 SD for 100 years for microbial incubations
(Nocentini et al., 2010)	Pine needles and pine wood	350º C	Sand	20º C 50% water holding capacity	30 days	0.47% to 0.57% from burned and unburned soil inoculums

(Singh et al., 2010)	*Pinus ponderosa*	450º C	top Cambisol soil	25º C 60% water holding capacity	45 days	0.14%
(Bird et al., 1999)	*Terminalia* tree bush savanna	Wildfires	Coarse sand derived from gneissic granite bedrock	Sub-humid MAT =17.7º C MAP = 630 mm	100 years	50%
(Hammes et al., 2008)	Steppe land cover	Wildfires	Chernozem soil	MAT = 6.6º C (1989-1998) and 5.3º C (1893-1950) MAP = 507.7 mm (1989-1998) and 438.5 mm (1893-1950)	100 years	25%
(Nguyen et al., 2008)	Forest	Wildfires	Humic Nitosols (FAO/UNESCO)	Tropical MAT = 19º C MAP = 2000 mm	100 years	70%
(Cheng et al., 2008)	Hardwood (chestnut, hickory, oak and sugar maple)	Blast furnace temperature	Subsurface soil for incubation	Aged charcoal from areas with MAT ranging between 3.9º C to 17.2º C and MAP between 940 mm to 1500 mm	130 years	22.30%
(Vasilyeva et al., 2010)	Grassland	Wildfires	Chernozem	MAT = +5.5 ˚C MAP = 600 mm/year	55 years	7%

Supplementary table 2: Three-way ANOVA for interactions between variables

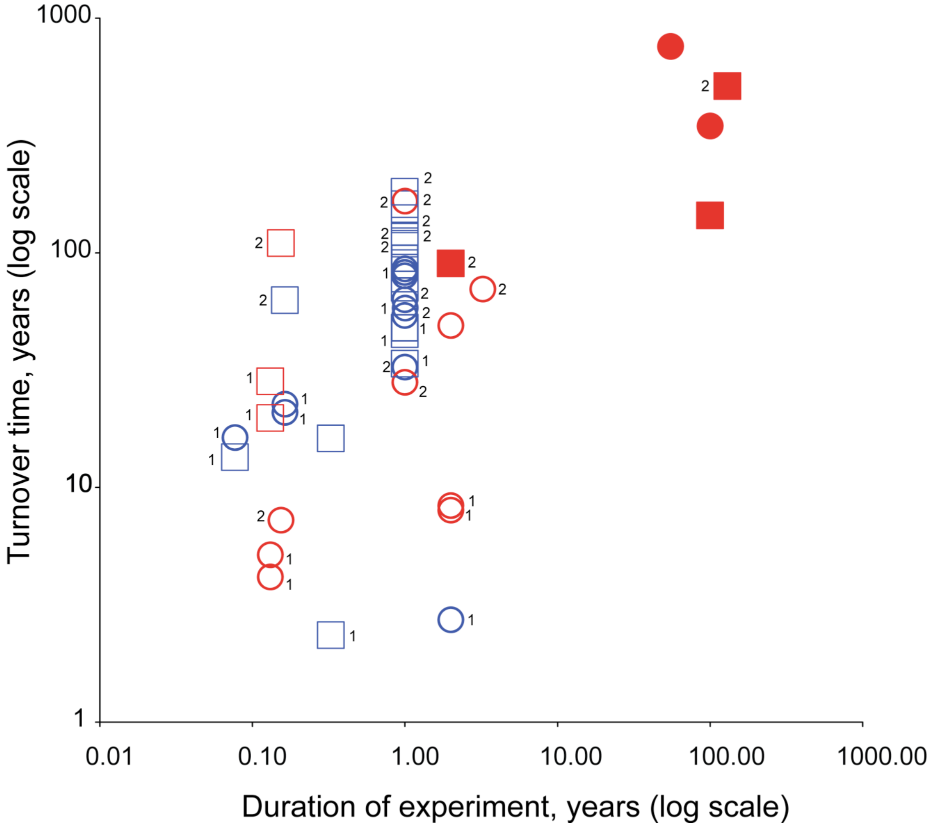
	Df	Sum sq	Mean sq	F value	Pr(>F)
Matrix	2	24838	12419	11.7306	0.0001418 ***
Temperature of pyrolysis	1	35051	35051	33.1074	1.992e-06 ***
Initial biomass	2	3915	1958	1.8490	0.1733280
Medium: Temperature of pyrolysis	1	240	240	0.2263	0.6374453
Medium: initial biomass	1	34	34	0.0321	0.8588546

Temperature of pyrolysis: initial biomass	1	3440	3440	3.2488	0.0806158
Residuals	33	34937	1059		

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Supplementary table 3: Number of data point for each factor in the study

	Incubation	**Field study**	**Grass PyC**	**Wood PyC**	**<400ºC pyrolysis temperature**	**≥400ºC pyrolysis temperature**	**Sand medium**	**Soil medium**
Incubation	**42**	0	17	22	22	20	31	11
Field study	0	**5**	0	2	0	1	0	5
Grass PyC	17	0	**17**	0	10	7	12	5
Wood PyC	22	2	0	**24**	9	15	19	5
<400ºC pyrolysis temperature	22	0	10	9	**21**	0	13	9
≥400ºC pyrolysis temperature	20	1	7	15	0	**21**	18	3
Sand	31	0	12	19	13	18	**31**	0
Soil	11	5	5	5	9	3	0	**12**



Supplementary figure 1: PyC has a turnover time <600 years based on first order decay model.

Turnover time calculated using first order decay vs duration of experiment. The empty symbol represents incubation studies, filled symbol represents field based studies, circles correspond to grass PyC, squares corresponds to wood PyC, colour represents sand (blue) and soil (red) medium, the numbers represent temperature of pyrolysis: (1) for <400ºC and (2) for ≥ 400ºC.

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