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Supplement of

High biodegradability of water-soluble organic carbon in soils at the southern margin of the boreal forest

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Supplementary Text

S1. Additional details of the analysis of WSOM by spectroscopy

Fluorescence Regional Integration (FRI) and the percentage of fluorescence response ($P_{i,n}$) were used for further analysis of the fluorescence spectra in five regions. The volume of the Excitation-Emission Matrix (EEM) i(Φ_i) was obtained through the formula (1) by integrating the area under the excitation-emission spectra. $\Delta\lambda_{ex}$ and $\Delta\lambda_{em}$ represent the intervals of excitation and emission wavelengths, respectively. I （$\lambda_{ex}\lambda_{em}$） is the fluorescence intensity for each matching set of excitation-emission wavelengths. MF_i is the multiplication factor for each region. The normalized volumes of the excitation-emission regions （$\Phi_{i,n}$, $\Phi_{T,n}$） and the percentage of fluorescence response （$P_{i,n}$） were calculated using the following formulas (Chen et al., 2003):

$$\Phi_i = \sum_{ex}\sum_{em} I(\lambda_{ex}\lambda_{em})\Delta\lambda_{ex}\Delta\lambda_{em}$$

$$\Phi_{i,n} = MF_i\Phi_i$$

$$\Phi_{i,n} = \sum_{i=1}^{5} \Phi_{i,n}$$

$$P_{i,n} = \frac{\Phi_{i,n}}{\Phi_{T,n}} \times 100\%$$

S2. Calculation of BWSOC content and *k*

The calculation formulas for the content and relative proportion of BWSOC under specific incubation days are as follows (Houston, 2012; Vonk et al., 2015):

$$\mathrm{BWSOC}_t = \mathrm{WSOC}_{t=0} - \mathrm{WSOC}_t$$

$$\mathrm{BWSOC}(\%)_t = \frac{\mathrm{BWSOC}_t}{\mathrm{WSOC}_{t=0}} \times 100\% = \frac{\mathrm{WSOC}_{t=0} - \mathrm{WSOC}_t}{\mathrm{WSOC}_{t=0}} \times 100\%$$

Microbial utilization of low-concentration substrates follows first-order reaction kinetics, wherein

the change in BWSOC over time follows the formula:

$$\frac{d\mathrm{BWSOC}}{dt} = k\mathrm{BWSOC}$$

Where BWSOC represents the microbial degradable water-soluble organic carbon at any given time, k is the reaction kinetic constant, and t is the incubation time. Integrating the above equation yields:

$$\mathrm{BWSOC} = \mathrm{BWSOC}_u \times \mathrm{e}^{-kt}$$

Where BWSOC_u is the total amount of microbial degradable water-soluble organic carbon in the substrate. Therefore, the value of BWSOC_t at any incubation time t can be expressed as:

$$\mathrm{BWSOC}_t = \mathrm{BWSOC}_u \times (1 - \mathrm{e}^{-kt})$$

Non-linear exponential fitting is performed on BWSOC_t to obtain the reaction kinetic constant k value.

Supplementary Table

Table S1. Partition range of fluorescence spectra, Ex represents the excitation wavelength, and Em represents the emission wavelength.

Region	Ex	Em	Component
I	220-250	250-330	Tyrosine-like aromatic protein
II	220-250	330-380	Tryptophan-like aromatic protein
III	220-250	380-500	Fulvic acid-like matter
IV	250-400	250-380	Soluble microbial byproduct-like matter
V	250-400	380-500	Humic acid-like matter

Table S2. Simple linear-regression statistics for BWSOC and the degradation constant (*k*) versus the $SUVA_{254}$ and *E250/E365*

Outcome	Predictor	Slope β	SE	95 % CI	t	p	R^2
BWSOC	$SUVA_{254}$	-0.158	0.062	-0.295 – -0.020	-2.55	0.029	0.395
BWSOC	*E250/E365*	0.003	0.001	0.0003 – 0.006	2.44	0.035	0.374
k	$SUVA_{254}$	0.014	0.262	-0.570 – 0.599	0.06	0.957	0.000
k	*E250/E365*	-0.006	0.005	-0.018 – 0.005	-1.25	0.240	0.135

Table S3. Model 1 – multiple linear regression predicting BWSOC (g kg^{-1})

Predictor	B	SE	β	95 % CI	t	p	VIF
Intercept	0.203	0.059	-	0.070 – 0.336	3.446	0.007	-
E250/E365	0.002	0.002	0.354	-0.002 – 0.006	1.115	0.294	1.705
$SUVA_{254}$	-0.100	0.080	-0.401	-0.281 – 0.080	-1.262	0.239	1.705
Model fit: n = 12; R = 0.684; R^2 = 0.468; Adjusted R^2 = 0.350; F = 3.963							

Table S4. Model 2 – multiple linear regression predicting *k*

Predictor	B	SE	β	95 % CI	t	p	VIF
Intercept	0.565	0.236	-	0.031 – 1.098	2.394	0.040	-
E250/E365	-0.011	0.007	-0.607	-0.260 – 0.005	-1.577	0.149	1.705
$SUVA_{254}$	-0.309	0.319	-0.373	-1.032 – 0.413	-0.969	0.358	1.705
Model fit: n = 12; R = 0.466; R^2 = 0.217; Adjusted R^2 = 0.043; F = 1.245							

Supplementary Figure

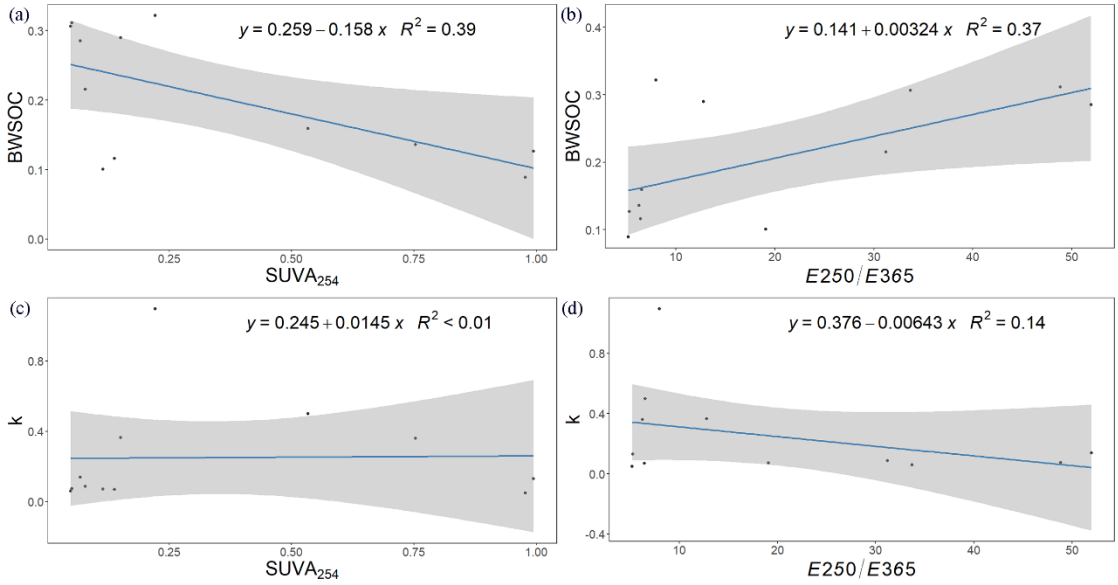

Fig S1. Simple linear regressions between the optical indices and the response variables requested by the reviewer. (a) BWSOC vs $SUVA_{254}$; (b) BWSOC vs *E250/E365*; (c) *k* vs $SUVA_{254}$; (d) *k* vs *E250/E365*. Grey bands are 95 % confidence intervals. Equations and coefficients of determination (R^2) are printed inside each panel.

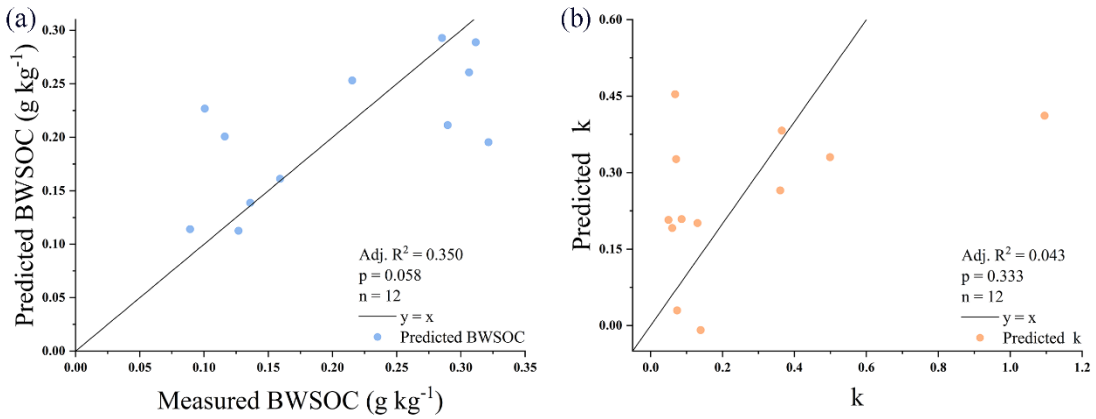

Fig S2. Observed-versus-predicted plots for the multiple-linear-regression models. (a) BWSOC; (b) degradation constant (*k*).

Reference

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