Representation of dissolved organic carbon in the JULES land surface model (vn4.4_JULES-DOCM)

Supporting information

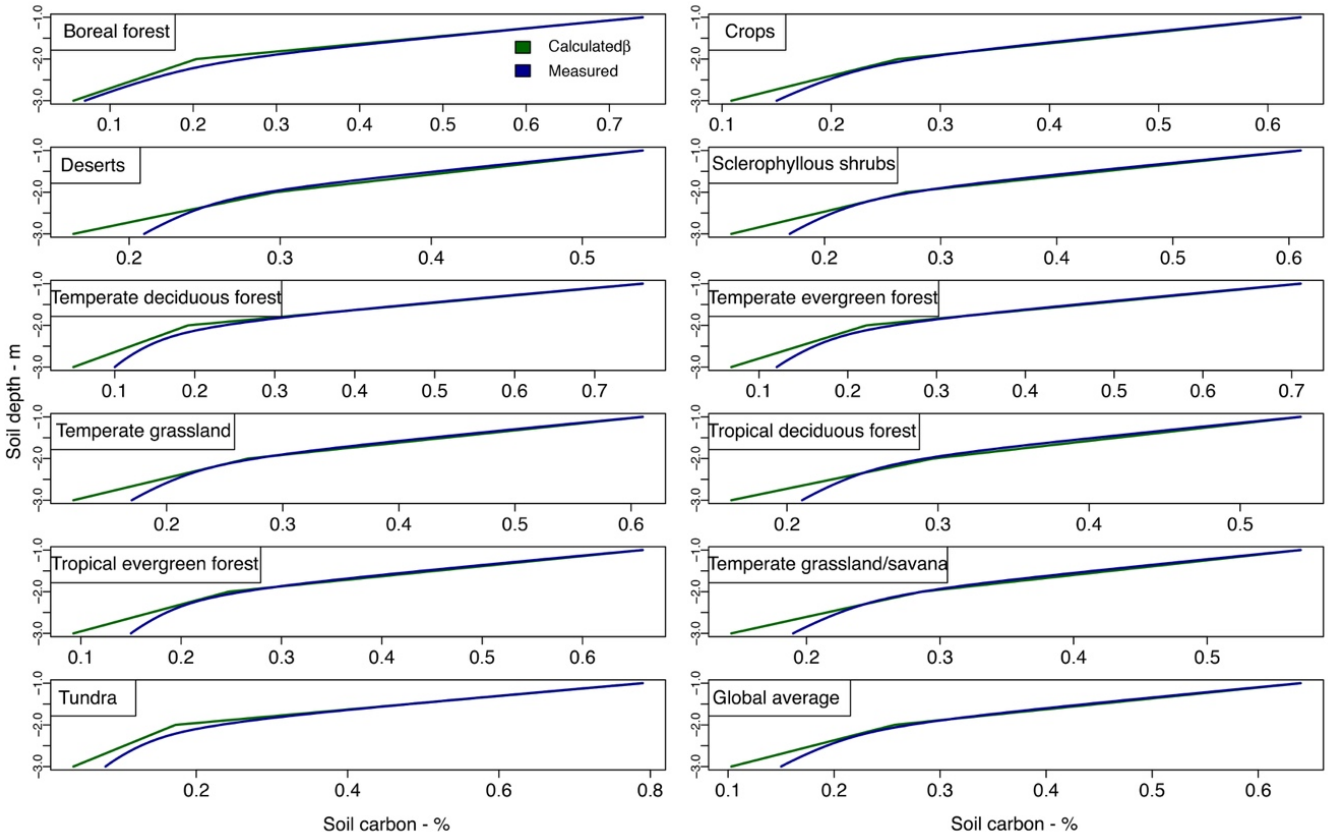

Figure S1. Comparison of SOC percentage in 3 meter of soil for different biomes Calculated β (eq1) and measurements from (Jobbágy & Jackson 2000). X axis is SOC percentage and Y axis is soil depth in meter.

Table S1. Z_0 values for each PFT

PFT	Z0
Boreal forest	0.775625
Crops	1.13717
Deserts	1.67113
Sclerophyllous shrubs	1.22839
Temperate deciduous forest	0.725914
Temperate evergreen forest	0.857235
Temperate grassland	1.22839
Tropical deciduous forest	1.67113
Tropical evergreen forest	1.0188
Temperate grassland/savana	1.45185
Tundra	0.656898
Global average	1.0955

Table S2. Anova test results for Carbon fluxes (Df: Degree of freedom, Sum sq: sum of squares, Mean sq: mean of squares, Pr: p-value)

ANOVA

	Df	Sum sq	Mean Sq	F value	Pr(>F)
GPP					
Hainich	1	102955	102955	5.352	0.0343
	16	307785	19237		
Brasschaat	1	280924	280924	62.27	1.33E-05
	10	45117	4512		
Turkey Point-89	1	9295	9295	4.714	0.162
	2	3943	1972		
NPP					
Hainich	1	88254	88254	7.222	0.0362
	6	73323	12220		
Turkey Point-89	1	39632	39632	7.154	0.116
	2	11080	5530		
SOIL RESPIRATION					
Hainich	1	1400	1400	0.06	0.815
	6	140896	23483		
Brasschaat	1	160497	160947	77.44	1.40E-06
	12	24870	2073		
Turkey Point-89	1	98114	98114	9.687	0.0896
	2	20256	10128		

We include all the sensitivity runs for Level-1 sites: Hainich, Brasschaat and Carlow for all the depths where the measurements were available. Red points are indicating measurements where black points are values from model (Fig. S2). Also representing Level-2 sites: Turkey Point 89 and Guandaushi comparison of modelled DOC versus measured in deeper soil depths (Fig. S3).

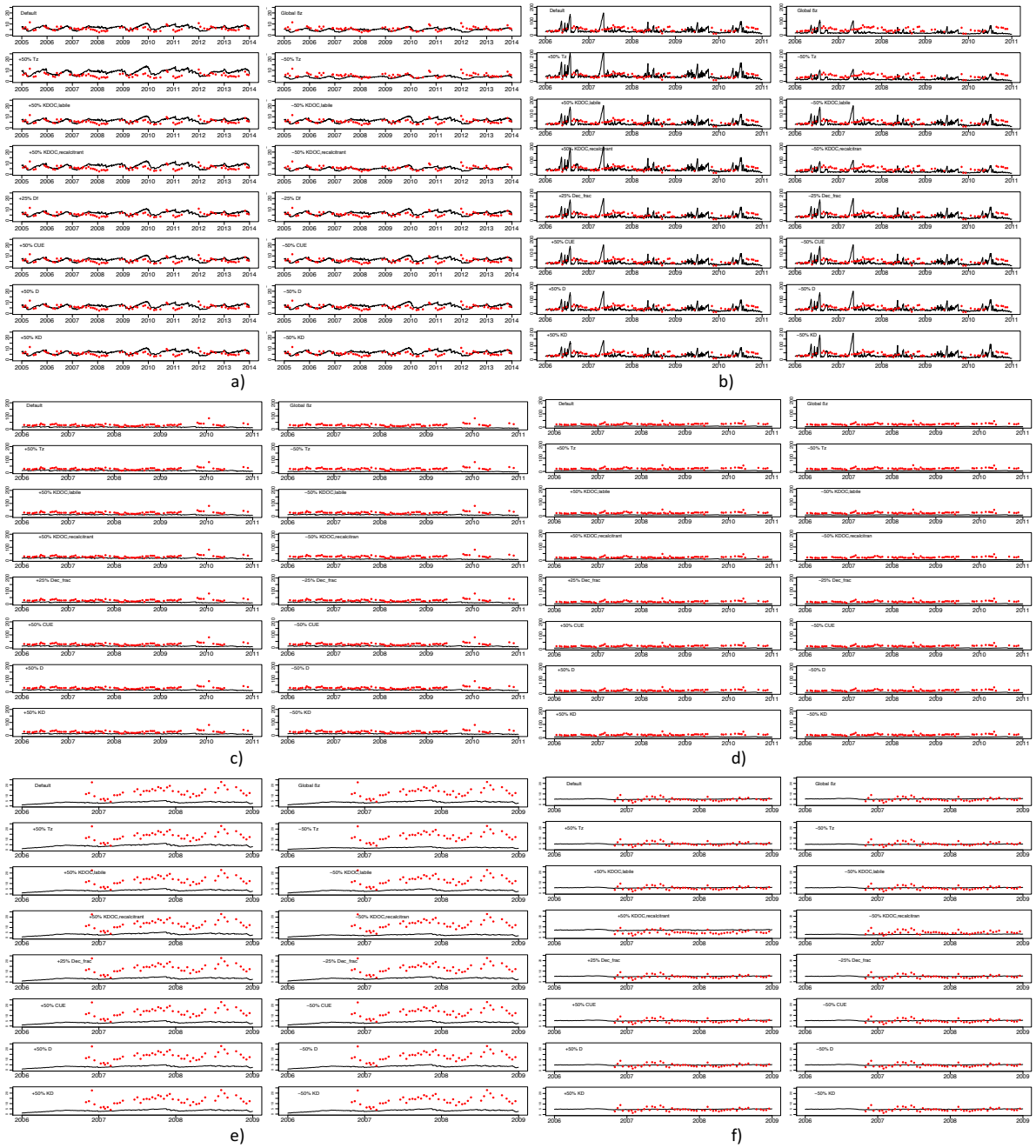

Figure S2. Sensitivity tests (black line) versus measurements (red dot) at a) 20cm depth – 2004-2013, Hainich b) 10cm depth – 2006-2010, Brasschaat c) 35cm depth – 2006-2010, Brasschaat d) 75cm depth – 2006-2010, Brasschaat e) 10 to28cm depth – 2006-2009, Carlow f) 28 to78cm depth – 2006-2009, Carlow; X axis is year and Y axis is DOC concentration in mg C L^{-1}. Parameter sets description and values in Table 1

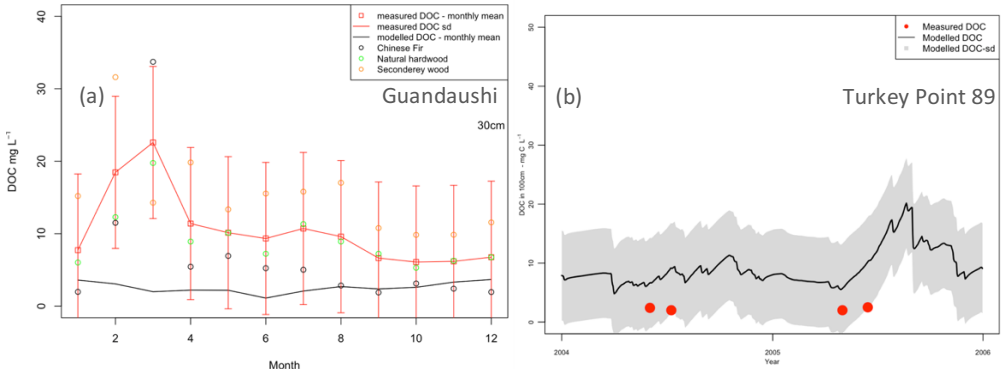

Figure S3. DOC concentration (mg C L-1) for (a) Guandaushi at 30 cm measured (black dot: Chinese Fir, green dot: natural hardwood, orange dot: secondary wood, red square: mean, red line: standard deviation) and simulated (black lines) and for (b) Turkey Point 89 at 100 cm measured (red dots) and simulated (black lines, grey line: standard deviation).

We examine the hydrology of the model and its interaction with DOC concentration and leaching for Level-1 sites: Carlow and Brasschat (Fig. S4) and overall model performance in DOC representation in all depths by comparing modelled versus measurements during study period in Hainich, Brasschaat and Carlow (Fig. S5).

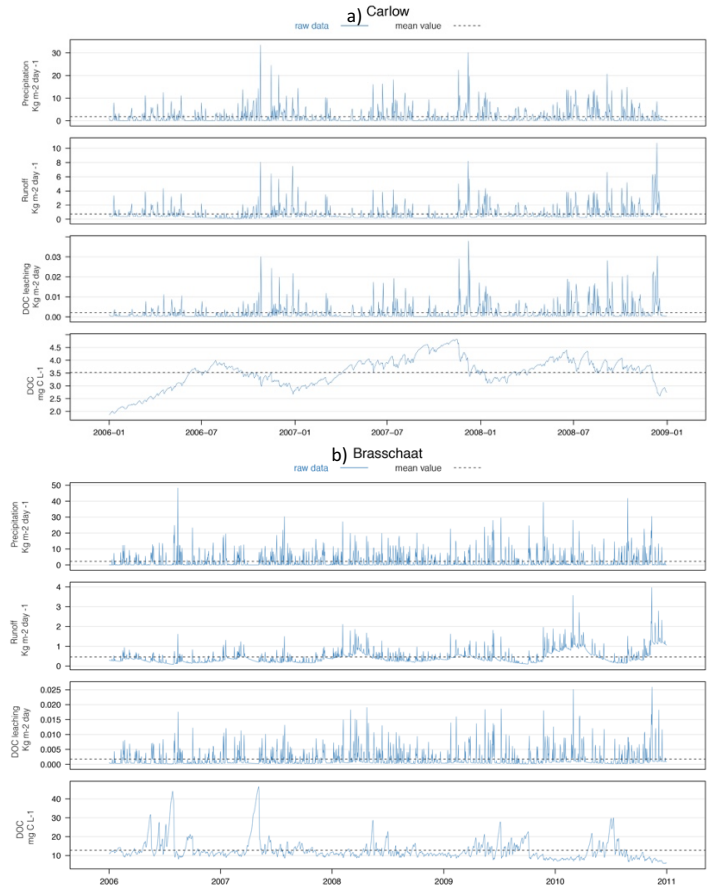

Figure S4. a) Precipitation, runoff, DOC leaching and DOC concentration in Carlow from 2006 to 2009 b) in Brasschaat from 2006 to 2010 simulated data with JULES-DOCM

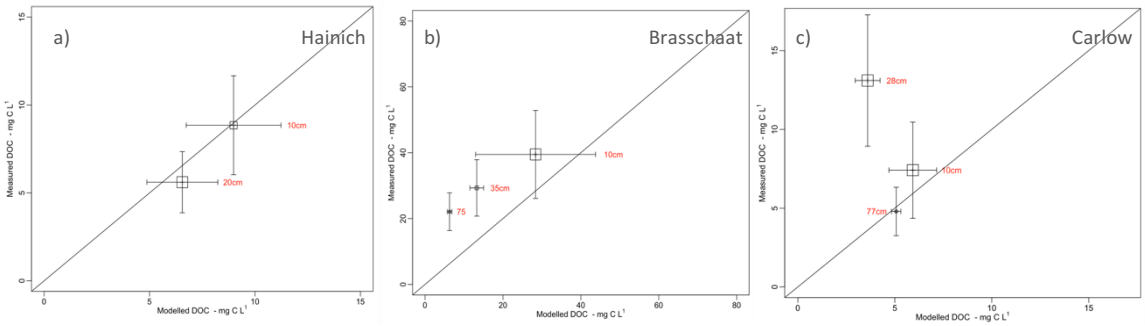

Figure S5. a) Measured vs modelled DOC (mg C L-1) with default set in Hainich from 2006 to 2013 at 10 and 20cm b) in Brasschaat from 2006 to 2010 at 10,35 and 75cm c) in Carlow from 2006 to 2009 at 10,10 to 28 and 28 to 78cm

Sensitivity of model parameters (Table S2) was tested in Level-1 Sites for the depths where the DOC measurements where available (Fig. S5) and the results were reported in percentage of change compared to default parameters set (Table S3). Anova test was used in order to determine each parameter's impact significance on DOC representation (Table S4).

Table S3. JULES-DOCM parameters set for sensitivity test

ID	*Description*
SET-1	*Default*
SET -2	*Global* β_z
SET -3	*+50%* τ_z
SET -4	*-50%* τ_z
SET -5	*+50%* $K_{DOC,\ labile}$
SET -6	*-50%* $K_{DOC,\ labile}$
SET -7	*+50%* $K_{DOC,\ recalcitrant}$
SET -8	*-50%* $K_{DOC,\ recalcitrant}$
SET -9	*+25%* D_f
SET -10	*-25%* D_f
SET -11	*+50% CUE*
SET -12	*-50% CUE*
SET -13	*+50% D*
SET -14	*-50% D*
SET -15	*+50%* K_D
SET -16	*-50%* K_D

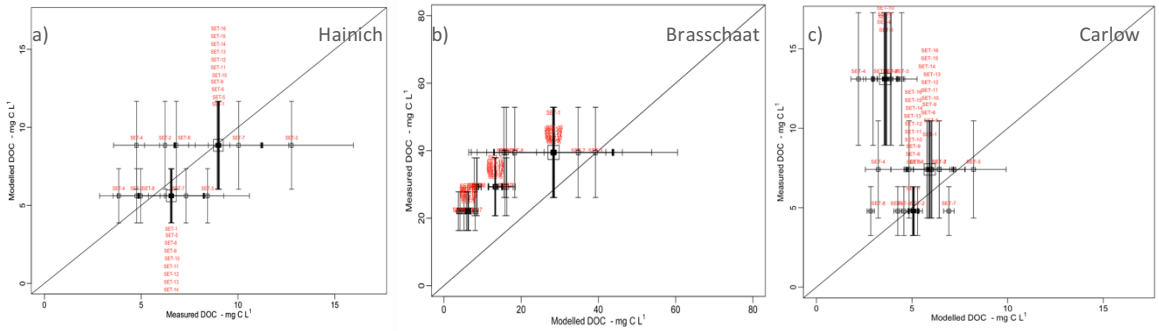

Figure S6. a) Measured (X axis) vs modelled (Y axis) DOC sensitivity runs (Table1) in Hainich from 2006 to 2013 at 10 and 20cm b) in Brasschaat from 2006 to 2010 at 10,35 and 75cm c) in Carlow from 2006 to 2009 at 10,10 to 28 and 28 to 78cm

Table S4. Sensitivity test results for Hainich, Carlow and Brasschaat

HAINICH	β_Z	τ_Z	$K_{DOC\text{-}LABILE}$	$K_{DOC\text{-}RECALCITRANT}$	D_F	CUE	D	K_D
50%	-	24.82748	0.2746118	18.51532	-0.590175	-0.06117	-0.04519973	-0.05364935
-50%	-25.12175	-36.45213	-0.2729602	-29.18424	0.586697	0.06068464	0.04545651	0.05483722
CARLOW								
50%	-	16.81662	0.9795210	18.77268	-0.2522954	-0.08957044	0.1873639	-0.05575369
-50%	6.52764	-31.50205	-0.9754175	-27.40512	0.2517171	0.08983245	-0.2774403	0.05659863
BRASSCHAAT								
50%	-	27.52056	0.5294166	23.45682	-0.1300973	-0.1176923	-0.3806475	-1.256365
-50%	-40.6144	-38.92471	-0.5120930	-36.20752	0.1305755	0.1183834	0.3794148	1.571266

Table S5. Anova test results for sensitivity test of Level-1 sites

ANOVA

DOC Hainich	Df	Sum sq	Mean Sq	F value	Pr(>F)
set-2	1	10686	10686	1066	**2.00E-16**
set-3	1	10437	10437	491.9	**2.00E-16**
set-4	1	22499	22499	2572	**2.00E-16**
set-5	1	1	1.277	0.094	0.759
set-6	1	1	1.267	0.093	0.76
set-7	1	5805	5805	382.7	**2.00E-16**
set-8	1	14422	14422	1322	**2.00E-16**
set-9	1	6	5.898	0.437	0.508
set10	1	6	5.828	0.427	0.514
set11	1	0	0.063	0.005	0.946
set12	1	0	0.062	0.005	0.946
set13	1	0	0.035	0.003	0.96
set14	1	0	0.035	0.003	0.96
set15	1	0	0.049	0.004	0.952
set16	1	0	0.049	0.004	0.952

ANOVA

DOC Carlow	Df	Sum sq	Mean Sq	F value	Pr(>F)
set-2	1	116	115.98	20.27	**6.81E-06**
set-3	1	770	769.7	109.73	**2.00E-16**
set-4	1	2701	2701.1	703.7	**2.00E-16**
set-5	1	3	2.611	0.486	0.486
set-6	1	3	2.59	0.49	0.484
set-7	1	959	959.2	145.6	**2.00E-16**
set-8	1	2044	2044.2	488.3	**2.00E-16**
set-9	1	0	0.173	0.033	0.857
set10	1	0	0.172	0.032	0.857
set11	1	0	0.022	0.004	0.949
set12	1	0	0.022	0.004	0.949
set13	1	0	0.096	0.018	0.894
set14	1	0	0.096	0.018	0.894
set15	1	0	0.008	0.002	0.968
set16	1	0	0.008	0.002	0.968

ANOVA

DOC Brasschaat	Df	Sum sq	Mean Sq	F value	Pr(>F)
set-2	1	98664	98664	5924	**2.00E-16**
set-3	1	45301	45301	126.7	**2.00E-16**
set-4	1	90625	90625	585.2	**2.00E-16**
set-5	1	17	16.76	0.069	0.792
set-6	1	16	15.69	0.065	0.798
set-7	1	32911	32911	109.1	**2.00E-16**
set-8	1	78414	78414	462.8	**2.00E-16**
set-9	1	1	1.01	0.004	0.948
set10	1	1	1.02	0.004	0.948
set11	1	1	0.83	0.003	0.953
set12	1	1	0.83	0.003	0.953
set13	1	9	8.67	0.036	0.849
set14	1	9	8.61	0.036	0.85
set15	1	94	94.41	0.415	0.519
set16	1	148	147.7	0.566	0.452

Seasonality of DOC concentration in different depths of Level-1 sites (Hainich, Carlow and Brasschaat) was tested by comparing monthly modelled DOC means versus measurements (Fig. S7).

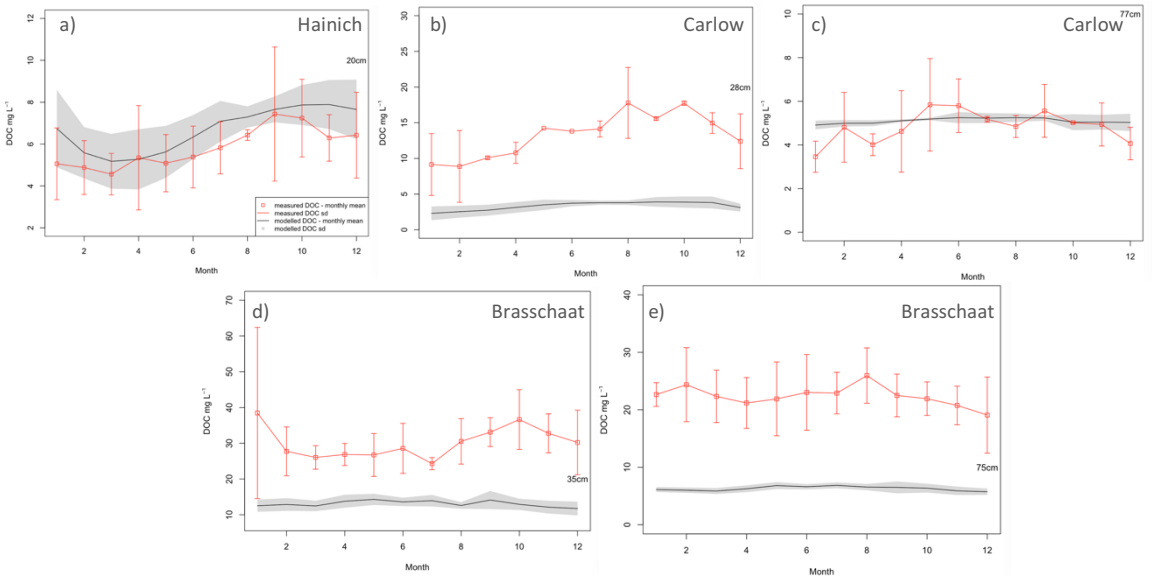

Figure S7. Monthly DOC means modelled versus measured (mg C L-1) for studied period at a) 20cm of Hainich b)10 to 28cm of Carlow c) 28 to 77 cm of Carlow d) 35cm of Brasschaat e) 75cm of Brasschaat

Reference:
Jobbágy, E.G. & Jackson, R.B., 2000. The vertical distribution of soil organic carbon and its relation to climate and vegetation. Ecological Applications, 10(2), pp.423–436.