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Supplement of

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

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Supporting information

Table S1. z_0 values for each PFT

PFT	z_0
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

Table S2. z_0 values for each PFT in JULES-DOCM

JULES PFT	z_0
Tropical broadleaf evergreen forest	1.0188
Temperate broadleaf evergreen forest	0.857235
broadleaf deciduous forest	0.725914
needle-leaf evergreen forest	0.857235
needle-leaf deciduous forest	0.725914
C3 grass	1.13717
C4 grass	1.13717
Evergreen shrubs	1.22839
Deciduous shrubs	1.22839

Table S3. 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).

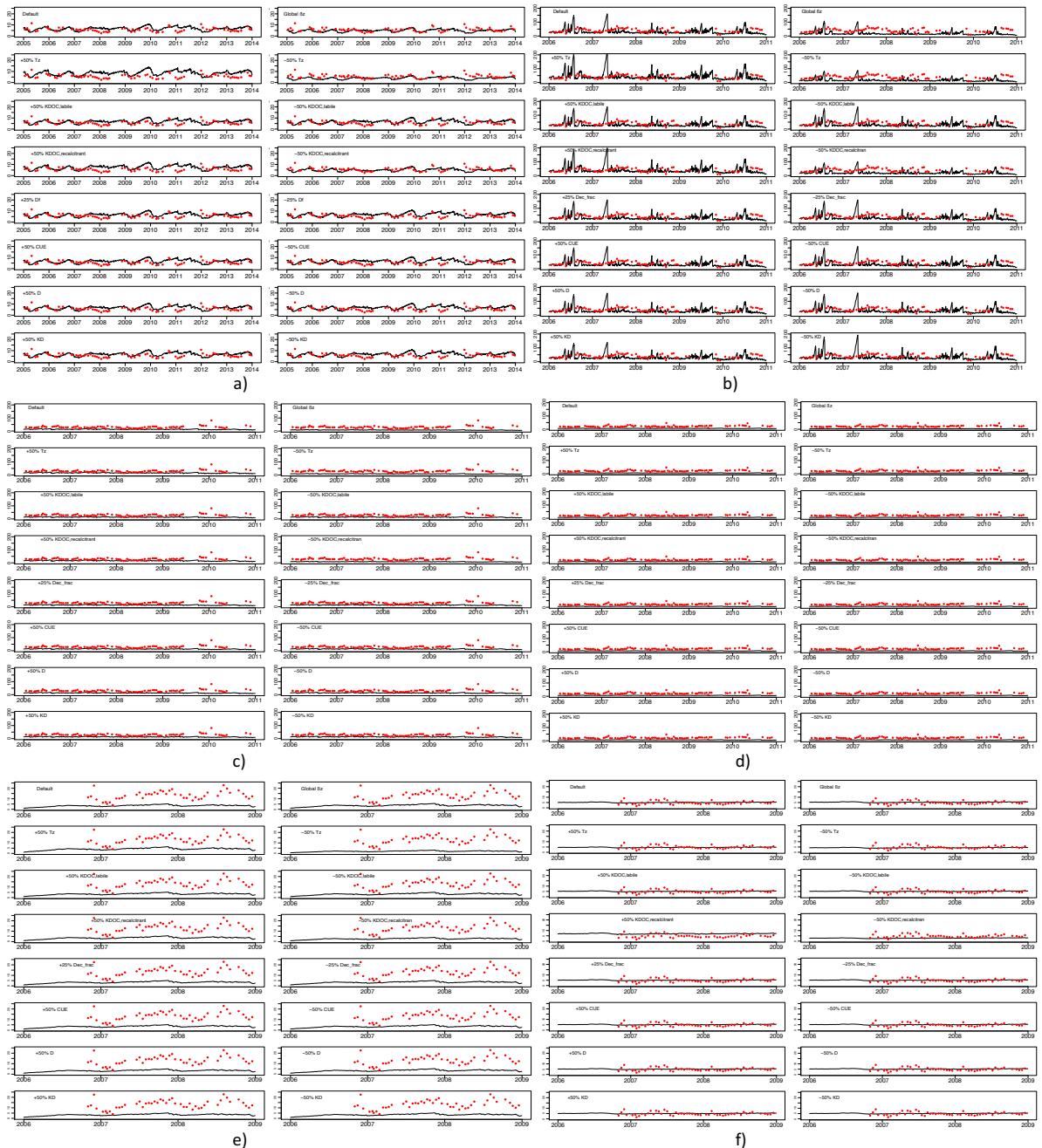


Figure S1. Sensitivity tests (black line) versus measurements (red dot) at a) 20cm depth – 2004-2013, Hainich b) 10cm depth – 2006-2010, Brasschaat c) 35cm depth – 2006-2010, Brasschaat d) 75cm depth – 2006-2010, Brasschaat e) 10 to 28cm depth – 2006-2009, Carlow f) 28 to 78cm depth – 2006-2009, Carlow; X axis is year and Y axis is DOC concentration in mg C L^{-1} . Parameter sets description and values in Table 1

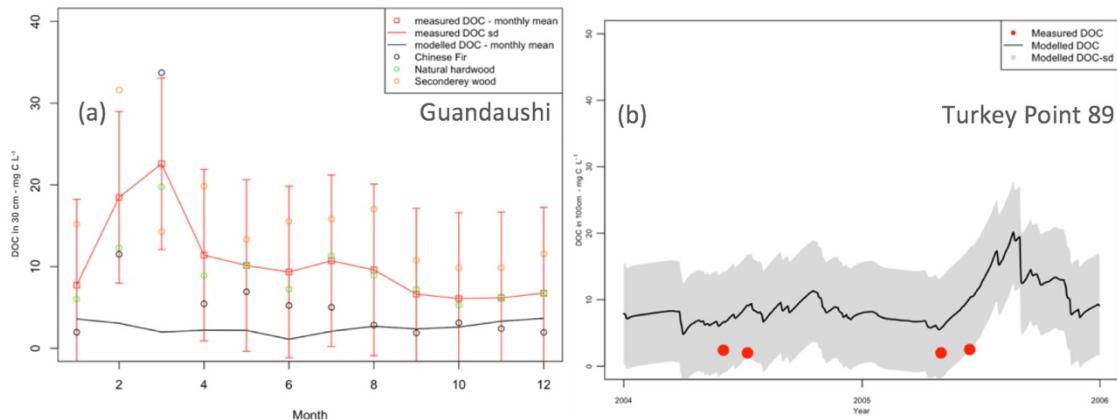


Figure S2. DOC concentration (mg C L^{-1}) for (a) Guandaushi at 30 cm measured (black dot: Chinese Fir, green dot: natural hardwood, orange dot: secondary wood, red square: mean, red line: standard deviation) and simulated (black lines) and for (b) Turkey Point 89 at 100 cm measured (red dots) and simulated (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. S3) and overall model performance in DOC representation in all depths by comparing modelled versus measurements during study period in Hainich, Brasschaat and Carlow (Fig. S4).

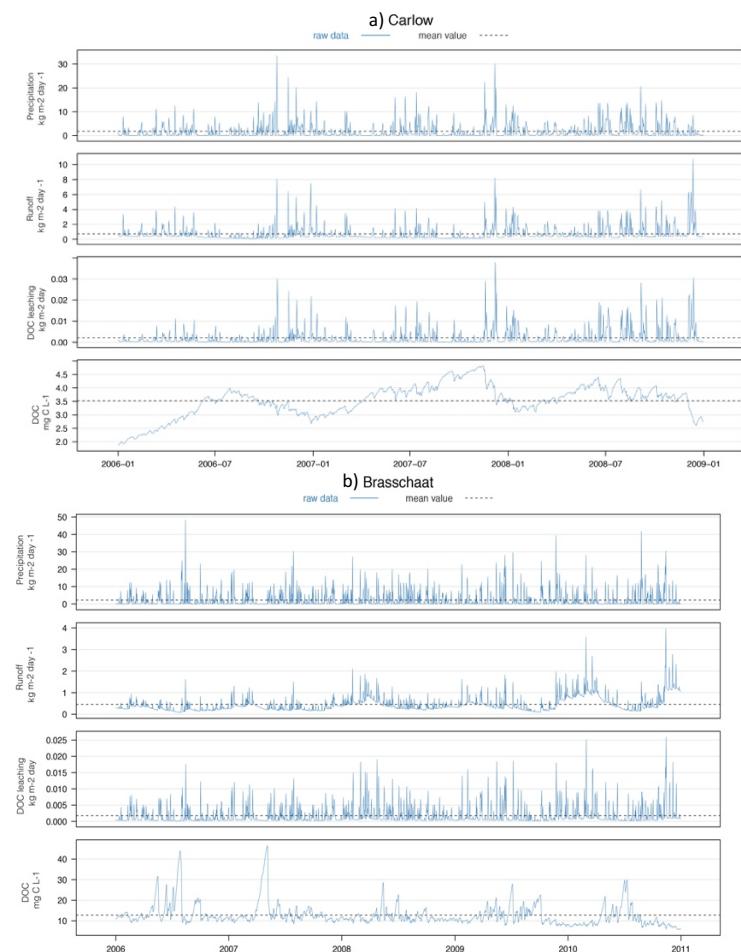


Figure S3. a) Precipitation, runoff, DOC leaching and DOC concentration (down to 3 m averaged) in Carlow from 2006 to 2009 b) in Brasschaat from 2006 to 2010 simulated data with JULES-DOCM

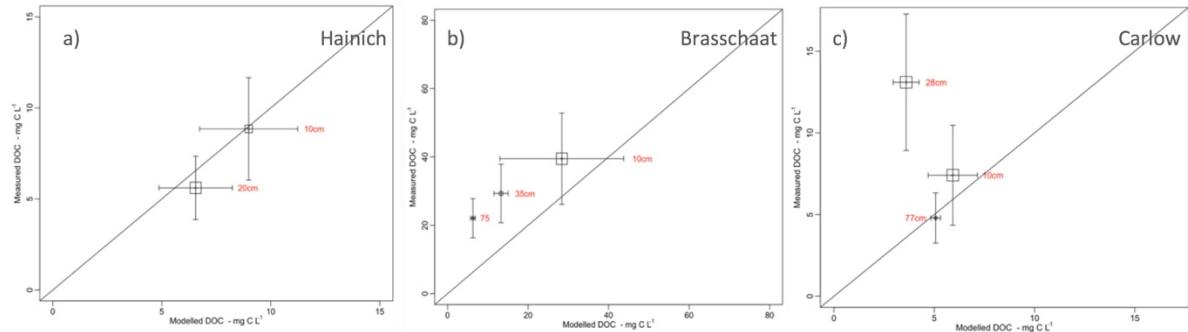


Figure S4. a) Measured vs modelled DOC (mg C L⁻¹) with default set in Hainich from 2006 to 2013 at 10 and 20cm b) in Brasschaat from 2006 to 2010 at 10,35 and 75cm c) in Carlow from 2006 to 2009 at 10,10 to 28 and 28 to 78cm

Sensitivity of model parameters (Table S4) 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 S5). Anova test was used in order to determine each parameter's impact significance on DOC representation (Table S6).

Table S4. JULES-DOCM parameters set for sensitivity test

<i>ID</i>	<i>Description</i>
<i>SET-1</i>	<i>PFT based</i> z_0
<i>SET-2</i>	<i>Global</i> z_0
<i>SET-3</i>	+50% τ_z
<i>SET-4</i>	-50% τ_z
<i>SET-5</i>	+50% $K_{DOC, labile}$
<i>SET-6</i>	-50% $K_{DOC, labile}$
<i>SET-7</i>	+50% $K_{DOC, recalcitrant}$
<i>SET-8</i>	-50% $K_{DOC, recalcitrant}$
<i>SET-9</i>	+25% D_f
<i>SET-10</i>	-25% D_f
<i>SET-11</i>	+50% CUE
<i>SET-12</i>	-50% CUE
<i>SET-13</i>	+50% D
<i>SET-14</i>	-50% D
<i>SET-15</i>	+50% K_D
<i>SET-16</i>	-50% K_D

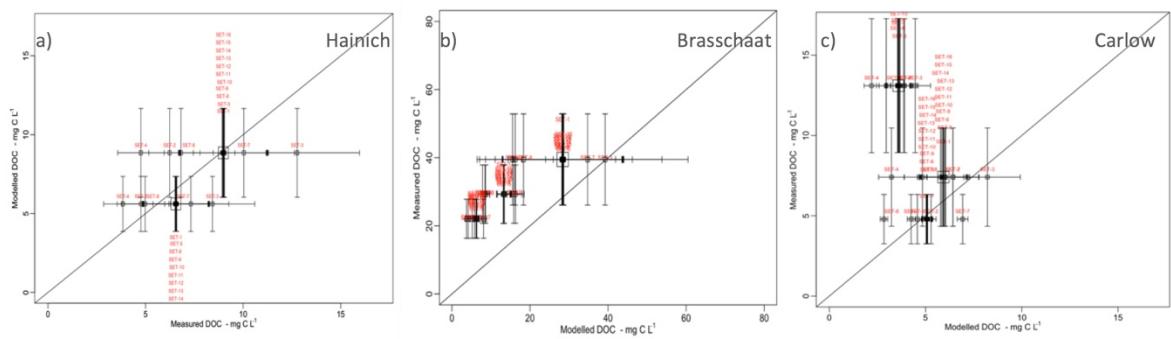


Figure S5. a) Measured (X axis) vs modelled (Y axis) DOC sensitivity runs (Table1) in Hainich from 2006 to 2013 at 10 and 20cm b) in Brasschaat from 2006 to 2010 at 10,35 and 75cm c) in Carlow from 2006 to 2009 at 10,10 to 28 and 28 to 78cm

Table S5. Relative change in simulated DOC (%) for a +50% and -50% changes in model parameters for Hainich, Carlow and Brasschaat

HAINICH	Z_0	τ_Z	$K_{DOC-LABILE}$	$K_{DOC-RECALCITRANT}$	D_f	CUE	D	K_D
50%	- (PFT based z_0)	24.82748	0.2746118	18.51532	-0.590175	-0.06117	-0.04519973	-0.05364935
-50%	-25.12175 (global z_0)	- 36.45213	-0.2729602	-29.18424	0.586697	0.06068464	0.04545651	0.05483722
CARLOW								
50%	- (PFT based z_0)	16.81662	0.9795210	18.77268	-0.2522954	-0.08957044	0.1873639	-0.05575369
-50%	6.52764 (global z_0)	-31.50205	-0.9754175	-27.40512	0.2517171	0.08983245	-0.2774403	0.05659863
BRASSCHAAT								
50%	- (PFT based z_0)	27.52056	0.5294166	23.45682	-0.1300973	-0.1176923	-0.3806475	-1.256365
-50%	-40.6144 (global z_0)	-38.92471	-0.5120930	-36.20752	0.1305755	0.1183834	0.3794148	1.571266

Table S6. Anova test results for sensitivity test of Level-1 sites

ANOVA						ANOVA						ANOVA					
DOC	Df	Sum sq	Mean Sq	F value	Pr(>F)	DOC	Df	Sum sq	Mean Sq	F value	Pr(>F)	DOC	Df	Sum sq	Mean Sq	F value	Pr(>F)
Hainich																	
set-2	1	10686	10686	1066	2.00E-16	set-2	1	116	115.98	20.27	6.81E-06	set-2	1	98664	98664	5924	2.00E-16
set-3	1	10437	10437	491.9	2.00E-16	set-3	1	770	769.7	109.73	2.00E-16	set-3	1	45301	45301	126.7	2.00E-16
set-4	1	22499	22499	2572	2.00E-16	set-4	1	2701	2701.1	703.7	2.00E-16	set-4	1	90625	90625	585.2	2.00E-16
set-5	1	1	1.277	0.094	0.759	set-5	1	3	2.611	0.486	0.486	set-5	1	17	16.76	0.069	0.792
set-6	1	1	1.267	0.093	0.76	set-6	1	3	2.59	0.49	0.484	set-6	1	16	15.69	0.065	0.798
set-7	1	5805	5805	382.7	2.00E-16	set-7	1	959	959.2	145.6	2.00E-16	set-7	1	32911	32911	109.1	2.00E-16
set-8	1	14422	14422	1322	2.00E-16	set-8	1	2044	2044.2	488.3	2.00E-16	set-8	1	78414	78414	462.8	2.00E-16
set-9	1	6	5.898	0.437	0.508	set-9	1	0	0.173	0.033	0.857	set-9	1	1	1.01	0.004	0.948
set10	1	6	5.828	0.427	0.514	set10	1	0	0.172	0.032	0.857	set10	1	1	1.02	0.004	0.948
set11	1	0	0.063	0.005	0.946	set11	1	0	0.022	0.004	0.949	set11	1	1	0.83	0.003	0.953
set12	1	0	0.062	0.005	0.946	set12	1	0	0.022	0.004	0.949	set12	1	1	0.83	0.003	0.953
set13	1	0	0.035	0.003	0.96	set13	1	0	0.096	0.018	0.894	set13	1	9	8.67	0.036	0.849
set14	1	0	0.035	0.003	0.96	set14	1	0	0.096	0.018	0.894	set14	1	9	8.61	0.036	0.85
set15	1	0	0.049	0.004	0.952	set15	1	0	0.008	0.002	0.968	set15	1	94	94.41	0.415	0.519
set16	1	0	0.049	0.004	0.952	set16	1	0	0.008	0.002	0.968	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. S6).

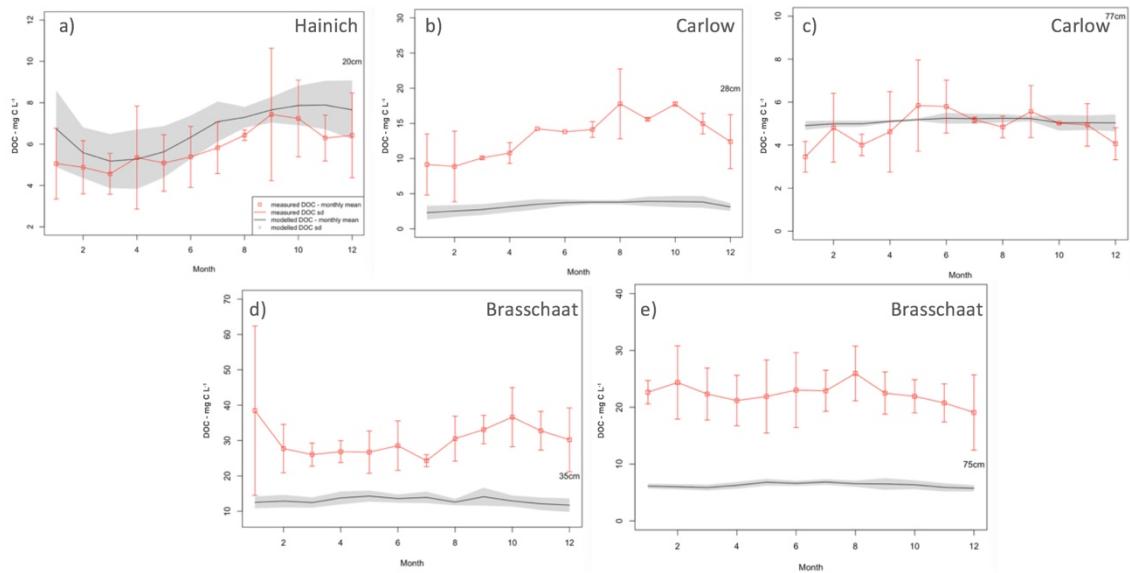


Figure S6. Monthly DOC means modelled versus measured (mg C L⁻¹) for studied period at a) 20cm of Hainich b) 10 to 28cm of Carlow c) 28 to 77 cm of Carlow d) 35cm of Brasschaat e) 75cm of Brasschaat