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Supplement of

Model–data fusion across ecosystems: from multisite optimizations to global simulations

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Table S1. Allowed range of variation of the optimized parameters. A hyphen means that the parameter is not optimized.

Parameter	Plant functional type						
	TropEBF	TempENF	TempEBF	TempDBF	BorENF	BorDBF	C3grass
Photosynthesis							
V_{cmax}	35 − 95	19 − 51	25 − 65	30 − 80	19 − 51	25 − 65	38 − 102
$G_{s\ -slope}$	6 − 12	6 − 12	6 − 12	6 − 12	6 − 12	6 − 12	6 − 12
c_{Tmax}	50 − 60	33 − 43	43 − 53	33 − 43	33 − 43	33 − 43	36 − 46
c_{Topt}	29 − 45	17 − 33	24 − 40	18 − 34	17 − 33	17 − 33	19 − 35
c_{Tmin}	-3 − 7	-9 − 1	-8 − 2	-7 − 3	-9 − 1	-9 − 1	-8.25 − 1.75
Phenology							
SLA	0.007 − 0.03	0.004 − 0.02	0.01 − 0.04	0.013 − 0.05	0.004 − 0.02	0.013 − 0.05	0.013 − 0.05
LAI_{MAX}	4 − 10	3 − 8	3 − 8	3 − 8	2.5 − 6.5	2.5 − 6.5	1.5 − 3.5
$K_{lai,happy}$	0.15 − 0.7	0.15 − 0.7	0.15 − 0.7	0.15 − 0.7	0.15 − 0.7	0.15 − 0.7	0.15 − 0.7
$K_{pheno,crit}$	-	-	-	0.5 − 2	-	0.5 − 2	0.5 − 2
$c_{T,senes}$	-	-	-	6 − 18	-	-1 − 13	-
$L_{agecrit}$	490 − 970	610 − 1210	490 − 970	120 − 240	610 − 1210	120 − 240	80 − 160
LAI_{init}	3 − 10	1 − 8	1 − 8	-	1 − 6.5	-	0 − 3.5
Soil water availability							
$f_{stressh}$	2 − 10	2 − 10	2 − 10	2 − 10	2 − 10	2 − 10	2 − 10
Dpu_{cste}	0.2 − 10	0.2 − 10	0.2 − 10	0.2 − 10	0.2 − 10	0.2 − 10	0.2 − 10
Hum_{cste}	0.2 − 3	0.25 − 4	0.2 − 3	0.2 − 3	0.25 − 4	0.25 − 4	1 − 10
Autotrophic respiration							
MR_a	0.04 − 0.2	0.08 − 0.24	0.08 − 0.24	0.08 − 0.24	0.08 − 0.24	0.08 − 0.24	0.08 − 0.24
MR_b	0.5 − 2	0.5 − 2	0.5 − 2	0.5 − 2	0.5 − 2	0.5 − 2	0.5 − 2
GR_{frac}	0.2 − 0.36	0.2 − 0.36	0.2 − 0.36	0.2 − 0.36	0.2 − 0.36	0.2 − 0.36	0.2 − 0.36
Heterotrophic respiration							
K_{soilC}	0.1 − 2	0.1 − 2	0.1 − 2	0.1 − 2	0.1 − 2	0.1 − 2	0.1 − 2
Q_{10}	1 − 3	1 − 3	1 − 3	1 − 3	1 − 3	1 − 3	1 − 3
$HR_{H,b}$	2.1 − 2.7	2.1 − 2.7	2.1 − 2.7	2.1 − 2.7	2.1 − 2.7	2.1 − 2.7	2.1 − 2.7
$HR_{H,c}$	-0.59 − 0.01	-0.59 − 0.01	-0.59 − 0.01	-0.59 − 0.01	-0.59 − 0.01	-0.59 − 0.01	-0.59 − 0.01
Decomposition							
$h_{crit,litter}$	0.02 − 0.5	0.02 − 0.5	0.02 − 0.5	0.02 − 0.5	0.02 − 0.5	0.02 − 0.5	0.02 − 0.5
Z_{decomp}	0.1 − 1.5	0.1 − 1.5	0.1 − 1.5	0.1 − 1.5	0.1 − 1.5	0.1 − 1.5	0.1 − 1.5
Energy balance							
$K_{albedo,veg}$	0.8 − 1.2	0.8 − 1.2	0.8 − 1.2	0.8 − 1.2	0.8 − 1.2	0.8 − 1.2	0.8 − 1.2
$Z0_{overheight}$	0.02 − 1	0.02 − 1	0.02 − 1	0.02 − 1	0.02 − 1	0.02 − 1	0.02 − 1

Table S2. Sites used in this study, with their name code made from the country (first two letters) and site name (last three letters).

PFT	Site	Latitude	Longitude	Period	Reference
TropEBF	BR-Ban	-9.824	-50.159	2004-2005	(Da Rocha et al., 2009)
	BR-Cax	-1.720	-51.459	2000-2002	(Carswell et al., 2002)
	BR-Ji2	-10.083	-61.931	2000-2002	(Von Randow et al., 2004)
	BR-Sa3	-3.018	-54.971	2001-2002	(Goulden et al., 2004)
	ID-Pag	2.345	114.036	2002-2003	(Hirano et al., 2007)
TempENF	CA-Ca3	49.535	-124.900	2002	(Jassal et al., 2008)
	CA-TP4	42.710	-80.357	2004	(Arain and Restrepo-Coupe, 2005)
	DE-Bay	50.142	11.867	1998-1999	(Staudt and Foken, 2007)
	DE-Tha	50.964	13.567	1997-2003	(Grünwald and Bernhofer, 2007)
	DE-Wet	50.453	11.458	2002-2006	(Rebmann et al., 2010)
	FR-LBr	44.717	-0.769	2003-2006	(Berbigier et al., 2001)
	IT-Lav	45.955	11.281	2004	(Marcolla et al., 2003)
	IT-Ren	46.588	11.435	2002	(Montagnani et al., 2009)
	IT-SRo	43.728	10.284	2002-2004	(Chiesi et al., 2005)
	NL-Loo	52.168	5.744	2001-2002	(Dolman et al., 2002)
	SE-Nor	60.086	17.480	1996-1997	(Lagergren et al., 2008)
	SE-Sk1	60.125	17.918	2005	(Gioli et al., 2004)
	SE-Sk2	60.130	17.840	2005	
	UK-Gri	56.607	-3.798	2000-2001	(Clement et al., 2012)
	US-Ho1	45.204	-68.740	2003-2004	(Hollinger et al., 2004)
	US-Ho2	45.209	-68.747	1999-2004	(Davidson et al., 2006)
	US-Me2	44.452	-121.557	2004-2005	(Anthoni et al., 2002)
	US-Me4	44.499	-121.622	2000	(Anthoni et al., 2002)
	US-NC2	35.803	-76.668	2005-2006	(Noormets et al., 2010)
	US-Wrc	45.820	-121.952	1999-2002	(Falk et al., 2008)
TempEBF	AU-Tum	-35.656	148.152	2001-2003	(Leuning et al., 2005)
	AU-Wac	-37.429	145.187	2006	(Kilinc et al., 2013)
TempDBF	DE-Hai	51.079	10.452	2000-2006	(Mund et al., 2010)
	FR-Fon	48.476	2.780	2006	(Michelot et al., 2011)
	FR-Hes	48.674	7.065	2001-2003	(Granier et al., 2008)
	JP-Tak	36.146	137.423	1999-2004	(Ito et al., 2006)
	UK-Ham	51.121	-0.861	2004-2005	(Wilkinson et al., 2012)
	US-Bar	44.065	-71.288	2004-2005	(Jenkins et al., 2007)
	US-Ha1	42.538	-72.172	2003-2006	(Urbanski et al., 2007)
	US-LPH	42.542	-72.185	2003-2004	(Hadley et al., 2008)

	US-MOz	38.744	-92.200	2005-2006	(Gu et al., 2012)
	US-UMB	45.560	-84.714	2000-2003	(Nave et al., 2011)
	US-WCr	45.806	-90.080	1999-2004	(Cook et al., 2004)
BorENF	CA-Man	55.880	-98.481	1998-2003	(Dunn et al., 2007)
	CA-NS1	55.879	-98.484	2003-2004	(Goulden et al., 2006)
	CA-NS2	55.906	-98.525	2002-2004	(Goulden et al., 2006)
	CA-NS3	55.912	-98.382	2002-2004	(Goulden et al., 2006)
	CA-Obs	53.987	-105.118	2000-2005	(Krishnan et al., 2008)
	CA-Ojp	53.916	-104.692	2000-2005	(Howard et al., 2004)
	CA-Qfo	49.693	-74.342	2004-2006	(Bergeron et al., 2007)
	CA-SJ3	53.876	-104.645	2005	(Zha et al., 2009)
	FI-Hyy	61.847	24.295	1997-2006	(Suni et al., 2003)
	FI-Sod	67.362	26.638	2001-2006	(Sánchez et al., 2009)
	SE-Fla	64.113	19.457	2001-2002	(Lindroth et al., 2008)
	US-Bn1	63.920	-145.378	2003	(Liu et al., 2005)
	US-NR1	40.033	-105.546	2002-2003	(Sacks et al., 2006)
BorDBF	CA-Oas	53.629	-106.198	2001-2004	(Black et al., 2000)
	SE-Abi	68.362	18.795	2005	(Christensen et al., 2007)
	US-Bn2	63.920	-145.378	2003	(Liu et al., 2005)
C3grass	CA-Let	49.709	-112.940	1999-2005	(Flanagan and Adkinson, 2011)
	CA-NS6	55.917	-98.964	2002-2004	(Goulden et al., 2006)
	CA-NS7	56.636	-99.948	2003-2004	(Goulden et al., 2006)
	CN-HaM	37.370	101.180	2002-2003	(Kato et al., 2006)
	DE-Meh	51.275	10.656	2004-2005	(Don et al., 2009)
	ES-LMa	39.942	-5.773	2004-2005	
	ES-VDA	42.152	1.449	2004	(Gilmanov et al., 2007)
	HU-Bug	46.691	19.601	2003-2006	(Nagy et al., 2007)
	HU-Mat	47.847	19.726	2004-2006	(Pintér et al., 2008)
	IE-Dri	51.987	-8.752	2003-2004	(Peichl et al., 2011)
	IT-Amp	41.904	13.605	2005	(Gilmanov et al., 2007)
	IT-Mal	46.117	11.703	2003-2004	(Gilmanov et al., 2007)
	IT-MBo	46.016	11.047	2004-2006	(Gianelle et al., 2009)
	NL-Ca1	51.971	4.927	2003-2004	(Jacobs et al., 2007)
	NL-Hor	52.029	5.068	2004-2006	(Hendriks et al., 2007)
	SE-Deg	64.183	19.550	2001-2005	(Sagerfors et al., 2008)
	US-ARM	36.605	-97.488	2003-2005	(Fischer et al., 2007)
	US-Aud	31.591	-110.510	2005	(Wilson and Meyers, 2007)
	US-Bkg	44.345	-96.836	2005-2006	(Gilmanov et al., 2010)

US-Bn3	63.923	-145.744	2003	(Liu et al., 2005)
US-Goo	34.250	-89.970	2004	(Wilson and Meyers, 2007)
US-IB2	41.841	-88.241	2006	(Allison et al., 2005)
US-Ivo	68.487	-155.750	2004-2005	(Oechel et al., 2000)
US-Var	38.413	-120.951	2002	(Ma et al., 2007)

Table S3. List of the sampling locations used to derive the extended atmospheric C_{CO2} records. Most sites are fixed ground-based stations, unless specified between brackets.

Station	**Location**	**Latitude**	**Longitude**
ALT	Alert, Canada	82.45°N	62.51°W
AMS	Amsterdam Island	37.95°S	77.53°E
ASC	Ascension Island	7.92°S	14.42°W
ASK	Assekrem, Algeria	23.18°N	5.42°E
AZR	Terceira Island, Azores	38.77°N	27.38°W
BMW	Tudor Hill, Bermuda	32.27°N	64.88°W
BRW	Barrow, Alaska	71.32°N	156.61°W
CBA	Cold Bay, Alaska	55.21°N	162.72°W
CFA	Cape Ferguson, Queensland	19.28°S	147.06°E
CGO	Cape Grim, Tasmania	40.68°S	144.69°E
CHR	Christmas Island	1.7°N	157.17°W
CMN	Mt. Cimone Station, Italy	44.18°N	10.7°E
CPT	Cape Point, South Africa	34.35°S	18.49°E
CRZ	Crozet Island	46.45°S	51.85°E
ESP	Estevan Point, British Columbia	49.58°N	126.37°W
GMI	Mariana Islands	13.43°N	144.78°E
HBA	Halley Station, Antarctica	75.58°S	26.5°W
HUN	Hegyhatsal, Hungary	46.95°N	16.65°E
ICE	Storhofdi, Iceland	63.4°N	20.29°W
IZO	Izana, Canary Islands	28.31°N	16.5°W
KEY	Key Biscayne, Florida	25.67°N	80.16°W
KUM	Cape Kumukahi, Hawaii	19.52°N	154.82°W
LMP	Lampedusa, Italy	35.52°N	12.62°E
MAA	Mawson Station, Antarctica	67.62°S	62.87°E
MHD	Mace Head, Ireland	53.33°N	9.9°W
MID	Sand Island, Midway	28.21°N	177.38°W
MLO	Mauna Loa, Hawaii	19.54°N	155.58°W
MQA	Macquarie Island	54.48°S	158.97°E
NWR	Niwot Ridge, Colorado	40.05°N	105.58°W
PAL	Pallas-Sammaltunturi, GAW Station, Finland	67.97°N	24.12°E
POCS30	Pacific Ocean (ship)	[32.5 − 27.5°S]	[176°E – 168°W]
POCS20	Pacific Ocean (ship)	[22.5 − 17.5°S]	[176°E – 164°W]
POCS10	Pacific Ocean (ship)	[12.5 − 7.5°S]	[178 – 144°W]
POC000	Pacific Ocean (ship)	[2.5°S – 2.5°N]	[172 − 138°W]
POCN10	Pacific Ocean (ship)	[7.5 − 12.5°N]	[166 – 132°W]

POCN20	Pacific Ocean (ship)	[17.5 − 22.5°N]	[158 − 124°W]
POCN30	Pacific Ocean (ship)	[27.5 − 32.5°N]	[150 − 120°W]
RPB	Ragged Point, Barbados	13.17°N	59.43°W
RYO	Ryori, Japan	39.03°N	141.83°E
SCH	Schauinsland, Germany	48°N	8°E
SEY	Mahe Island, Seychelles	4.67°S	55.17°E
SHM	Shemya Island, Alaska	52.72°N	174.1°E
SIS	Shetland Islands, Scotland	60.17°N	1.17°W
SMO	Tutuila, American Samoa	14.25°S	170.56°W
SPO	South Pole, Antarctica	89.98°S	24.8°W
STM	Ocean Station M, Norway	66°N	2°E
SYO	Syowa Station, Antarctica	69°S	39.58°E
TAP	Tae-ahn Peninsula, South Korea	36.73°N	126.13°E
UTA	Wendover, Utah	39.9°N	113.72°W
UUM	Ulaan Uul, Mongolia	44.45°N	111.1°E
WIS	WIS Station, Israel	31.13°N	34.88°E
WLG	Mt. Waliguan, China	36.29°N	100.9°E
ZEP	Ny-Alesund, Svalbard	78.9°N	11.88°E

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