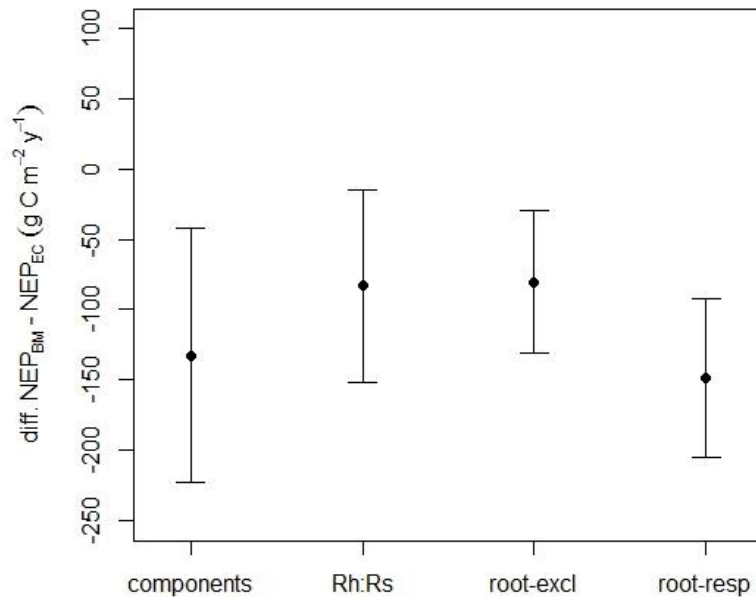
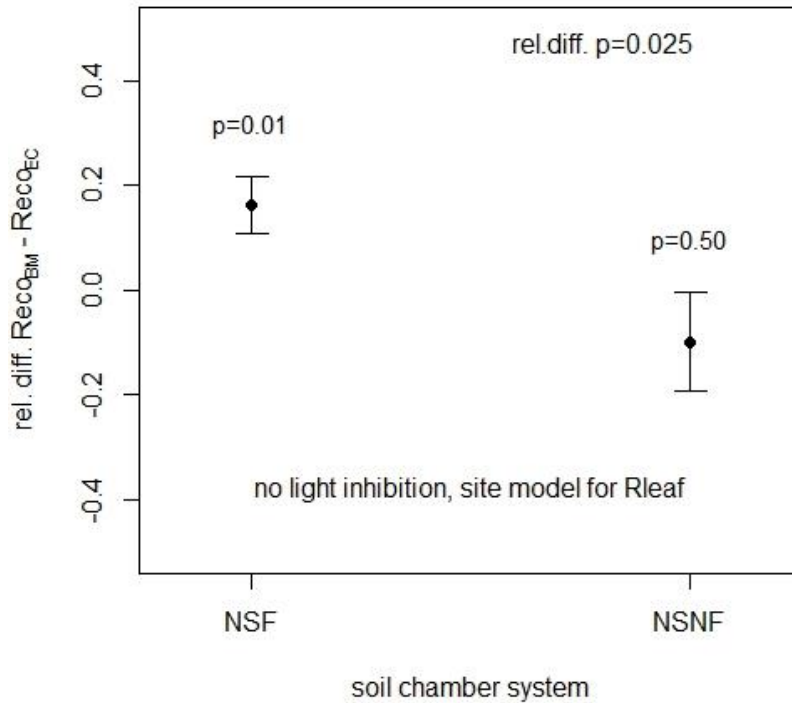


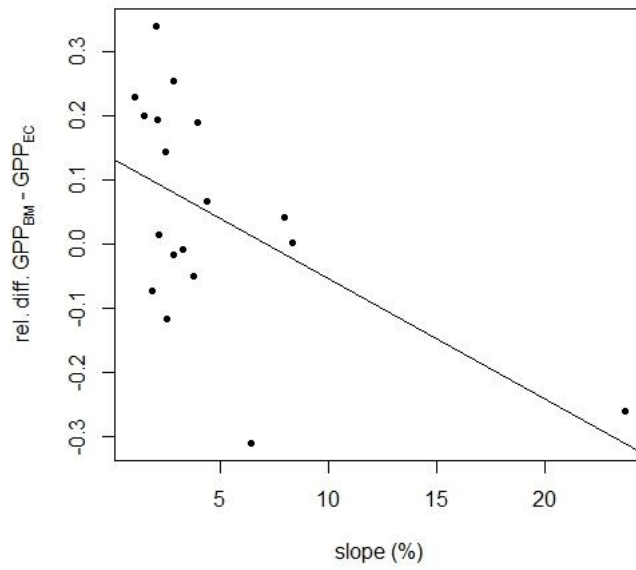
Supplementary Figure 1. Geographical location of the study sites. The map was produced using the freely available package rworldmap of the R platform¹, for which the GNU General Public License applies²



Supplementary Figure 2. Difference of net ecosystem production (NEP) from biometric methods (BM) and eddy-covariance (EC) according to the different method used to measure soil heterotrophic respiration in BM: (i) components integration (components), (ii) fixed ratio between soil heterotrophic respiration and total soil respiration (Rh:Rsoil), (iii) root exclusion method (root-excl), and (iv) measurements of soil respiration and root respiration (root-resp) (see Methods for more details on the four techniques). Points: mean; bars: s.e.m.



Supplementary Figure 3. The relative difference between ecosystem respiration from biometric methods (Reco_{BM}) or eddy-covariance (Reco_{EC}) [$(\text{Reco}_{\text{BM}} - \text{Reco}_{\text{EC}})/((\text{Reco}_{\text{EC}} + \text{Reco}_{\text{BM}})/2)$] when using different chamber systems to measure soil respiration (NSNF: non-steady-state non-through-flow chamber, NSF: non-steady-state through-flow chamber) for sites not accounting for light inhibition in estimating leaf respiration (R_{leaf}) but using site-specific parameterization for the empirical models scaling up the point measurements of R_{leaf} at the annual scale. Points indicate means with bars indicating s.e.m; the p value above each point indicates the significance level of the difference between Reco_{BM} and Reco_{EC} , whereas the significance level p of the effect of the chamber system is indicated as rel. diff. p (relative difference between Reco_{BM} and Reco_{EC}) and is reported in the top right of the panel.



Supplementary Figure 4. Relationship between the relative difference between gross primary production from biometric methods (GPP_{BM}) and eddy-covariance (GPP_{EC}) [$(GPP_{BM} - GPP_{EC})/((GPP_{EC} + GPP_{BM})/2)$] and site slope.

Supplementary Table 1. Annual values of net ecosystem production (NEP, gC m⁻² y⁻¹) from biometric methods (NEP_{BM}) and eddy-covariance (NEP_{EC}), ecosystem respiration (Reco, gC m⁻² y⁻¹) from biometric methods (Reco_{BM}) and eddy-covariance (Reco_{EC}) and gross primary production (GPP, gC m⁻² y⁻¹) from biometric methods (GPP_{BM}) and eddy-covariance (GPP_{EC}) of the study dataset.

site	Fluxnet	measurement period		NEP		Reco		GPP	
		BM	EC	NEP _{BM}	NEP _{EC}	Reco _{BM}	Reco _{EC}	GPP _{BM}	GPP _{EC}
Caxiuanã ³⁻⁵	BR-Cax	2004-2011	1999	23	560	3205	3070	3228	3630
Changbai Mountains ^{6,7}	CN-Cha	2003	2003	NA	NA	1242	1292	NA	NA
Chibougamau E OBS ⁷⁻⁹	CA-Qfo	2005	2005	-238	-15	1032	702	794	687
Collelongo ^{10,11}	IT-Col	2007	2007	NA	NA	764	727	NA	NA
Dooray ¹²	IE-CLa	2003	2003	939	831	NA	NA	NA	NA
Duke Forest ¹³⁻¹⁵	US-Dk3	1998	2004	502	523	1908	1733	2410	2256
Fujiyoshida ^{16,17}	JP-Fuj	1999-2008	2000-2008	302	388	NA	NA	NA	NA
Hainich ^{10,18,19}	DE-Hai	2000-2002	2002	260	564	NA	NA	NA	NA
Harvard ²⁰	US-Ha1	<1999	1999	165	200	NA	NA	NA	NA
Hesse ^{7,21-24}	FR-Hes	1997	1997	245	207	1199	1249	1444	1456
Huhus ²⁵	no	2001-2004	2001-2004	NA	NA	793	785	NA	NA
Lageren ²⁶	CH-Lae	<2009	2006-2009	306	435	NA	NA	NA	NA
Jacaranda ^{5,27}	BR-Ma2	2001	2000	NA	NA	3210	3180	NA	NA
Marys River Fir ²⁸	US-MRf	2011	2011	NA	NA	2009	1275	NA	NA
Metolius ²⁹⁻³¹	US-Me4	1996	1996	7	287	894	885	901	1172
Morgan Monroe ³²	US-MMS	1998-1999	1998-1999	325	262	NA	NA	NA	NA
NAU Centennial Thinned ³³	US-Fmf	2007	2007	-281	-51	NA	NA	NA	NA
NAU Centennial Undisturbed ³³	US-Fuf	2007	2007	-169	58	NA	NA	NA	NA
Prince Albert SSA SOJP ^{34,35}	CA-Ojp	1999-2000	2000	-20	78	NA	NA	NA	NA
Prince Albert SSA SOAS ³⁶⁻⁴⁰	CA-Oas	1994-1995	1994	-151	206	1492	1117	1342	1323
SMEARII ^{7,41}	FI-Hyy	2003-2006	2003-2006	NA	NA	919	829	NA	NA
Sylvania hardwood ^{19,42-44}	US-Syv	2002-2003	2002-2003	44	102	1013	974	1057	1076
Takayama ^{45,46}	JP-Tak	1993-2003	1994-2003	210	237	NA	NA	NA	NA
Tapajos km 67 ⁵	BR-Sa1	1999-2006	2002-2005	219	-110	2770	3250	2989	3140
Thompson NSA NOBS ⁴⁷⁻⁵⁰	CA-NS1	1994-2002	1999-2002	-132	15	NA	NA	NA	NA
Tumbarumba ^{7,51,52}	AU-Tum	2003	2003	434	517	1452	2069	1890	2586
TurkeyPointTP02 ^{53,54}	CA-TP1	2006	2006	44	34	773	569	850	603
TurkeyPointTP89 ^{7,53,54}	CA-TP2	2006	2006	482	727	1985	2055	2583	2782

TurkeyPointTP74 ^{53,54}	CA-TP3	2006	2006	213	511	1278	751	1587	1262
TurkeyPointTP39 ^{53,54}	CA-TP4	2006	2006	164	148	1526	1293	1762	1441
University of Michigan ^{55,56}	US-UMB	1999-2001	1999-2001	159	158	1449	1087	1608	1245
Walker Range ^{29,57,58}	US-WBW	1995-1996	1995-1996	260	523	1625	1036	1885	1559
Willow Creek ^{20,42,59,60}	US-WCr	<2002	2000-2003	146	262	1251	888	1397	1150
Wind River ^{61,62}	US-Wrc	1995-2000	1999-2000	35	130	NA	NA	NA	NA
Wytham Woods ^{63,64}	no	2008	2007-2008	170	130	2027	1980	2197	2110
Xishuangbanna ⁶⁵	CN-Xsh	2003-2006	2003-2006	358	119	2242	2475	2600	2594
Yamashiro ⁶⁶	JP-YMS	2000-2005	2000-2002	91	123	NA	NA	NA	NA
Yatir ^{10,67,68}	IL-Yat	2002	2002	NA	NA	731	456	NA	NA

Fluxnet: indicates if site is in Fluxnet (<http://www.fluxdata.org/default.aspx>) or *European Fluxes Database Cluster* (<http://gaia.agraria.unitus.it/home/sites-list>) with code. BM: biometric methods; EC: eddy-covariance; NA: not available.

Supplementary Table 2. Components and aggregated values of net primary production (NPP, gC m⁻² y⁻¹) and heterotrophic ecosystem respiration (Rh, gC m⁻² y⁻¹) determined for the study sites with biometric methods.

site	NPP											Rh		
	total	above ^(a)	below ^(b)	leaves	wood		roots		under. ^(e)	reprod. ^(f)	herbiv. ^(g)	other ^(h)	soil	cwd ⁽ⁱ⁾
					incr. ^(c)	turn. ^(d)	coarse	fine						
Caxiuanã ^{4,5}	1377	922	423	368	382	106	55	368	NAs	42	24	32	1354	220
Chibougamau EOBS ⁹	302	197	105	38	91	NAs	NAs	NAs	68	NA	NA	NA	540	NA
Dooray ¹²	1266	NAs	NAs	NAs	NAs	171	NAs	43	NA	NA	NA	NA	318	9
Duke Forest ^{13,15}	707	NAs	NAs	NAs	NAs	NA	NAs	32	NAs	NAs	NAs	NAs	208	0
Fujiyoshida ¹⁷	742	512	230	208	271	20	40	190	NA	33	NA	NA	420	20
Hainich ^{18,19}	697	NAs	NAs	NAs	177	NA	94	NAs	NAs	NAs	NA	NA	437	NA
Harvard ²⁰	565	320	245	130	130	NA	25	220	60	NAs	NA	NA	400	NA
Hesse ²¹⁻²⁴	643	510	133	131	379	NA	76	57	0	NA	NA	NA	338	60
Lageren ²⁶	761	651	110	242	369	NA	38	72	40	NAs	NA	NA	455	NA
Metolius ^{30,31}	228	136	92	59	77	NA	NAs	NAs	NAs	NA	NA	NA	221	NA
Morgan Monroe ³²	974	537	437	205	286	NA	24	413	18	14	14	NA	562	87
NAU Centennial Thinned ³³	240	132	108	50	70	NA	13	95	12	NA	NA	NA	509	12
NAU Centennial Undisturbed ³³	268	119	149	46	66	NA	11	138	7	NA	NA	NA	430	7
Prince Albert SSA SOJP ³⁴	170	90	80	20	70	NA	10	70	0	NA	NA	NA	170	20
Prince Albert SSA SOAS ³⁷⁻⁴⁰	441	352	89	123	176	NA	32	57	53	NA	NA	NA	591	NA
Sylvania hardwood ^{19,43,44}	314	212	102	128	84	NA	3	99	0	NA	NA	NA	227	43
Takayama ⁴⁵	650	450	200	180	160	NA	20	180	110	NA	NA	NA	390	50
Tapajos km 67 ⁵	1499	1186	300	650	536	160	100	200	NA	NA	NA	13	830	450
Thompson NSA NOBS ⁴⁷⁻⁴⁹	211	145	67	39	72	NA	9	57	35	NA	NA	NA	329	14
Tumbarumba ⁵¹	1040	NAs	NAs	NAs	NAs	NA	NAs	NAs	NAs	NA	NA	NAs	606	NA

TurkeyPointTP02 ^{53,54}	346	282	64	82	98	NAs	58	6	101	NA	1	NA	270	6
TurkeyPointTP89 ^{53,54}	870	694	176	344	345	NAs	95	81	0	NA	4	NA	272	25
TurkeyPointTP74 ^{53,54}	639	423	216	161	235	NAs	44	172	25	NA	2	NA	330	38
TurkeyPointTP39 ^{53,54}	634	453	181	234	185	NAs	71	110	32	NA	2	NA	398	52
University of Michigan ^{55,56}	677	354	323	149	198	17	42	281	NAs	NAs	7	NA	518	NA
Walker Branch ^{57,58}	788	608	179	242	321	NA	16	164	7	16	22	NA	441	87
Willow Creek ^{20,59,60}	613	300	313	135	155	NA	31	282	10	NAs	NA	NA	502	79
Wind River ⁶²	597	449	142	135	233	NA	51	91	66	NAs	15	6	346	216
Wytham Woods ⁶³	704	442	262	240	165	NA	33	229	NA	37	NA	NA	531	3
Xishuangbanna ⁶⁵	880	NAs	NAs	NAs	NAs	NA	NAs	NAs	NAs	NAs	NA	NA	454	68
Yamashiro ⁶⁶	507	427	80	258	169	61	22	58	NAs	NA	NA	NA	366	50

(a) aboveground; (b) belowground; (c) NPP related to increment in standing wood biomass; (d) NPP related to branch turnover; (e) understory; (f) reproductive materials (e.g. seeds, fruits, inflorescences); (g) NPP lost because of herbivory; (h) NPP related to neglected NPP components (e.g. production of volatile organic compounds, mycorrhizal production, production of epiphytes, NPP related to dissolved organic carbon), and (i) heterotrophic respiration due to coarse woody debris. Green cells: data available; NAs: data not available separately but aggregated in total NPP or other NPP components (e.g. aboveground and belowground NPP); yellow cells and NA: data not available.

Supplementary Table 3. Components and aggregated values of ecosystem respiration (Reco, gC m⁻² y⁻¹) determined for the study sites with biometric methods.

site	Reco	Ra ^(a)	Rsoil ^(b)	Rleaf ^(c)	Rwood ^(d)	Rroot ^(e)			Ru ^(f)
						coarse	fine	total	
Caxiuanã ⁴	3205	1851	1612	502	871	183	295	478	NA
Changbai Mountains ⁶	1242	NA	593	264	385	NAs	NAs	NAs	NAs
Chibougamau EOBS ⁹	1032	492	710	128	126	NAs	NAs	170	68
Collelongo ¹¹	764	NA	428	275	61	NAs	NAs	NAs	0
Duke Forest ¹³	1908	1703	928	492	488	61	662	723	NAs
Hesse ²¹	1199	801	663	194	282	NAs	NAs	325	0
Huhus ²⁵	793	NA	497	224	72	NAs	NAs	NAs	NA
Jacaranda ²⁷	3210	NA	1210	980	420	NAs	NAs	NAs	150
Marys River Fir ²⁸	2009	NA	1205	422	382	NAs	NAs	NAs	NA
Metolius ^{30,31}	894	673	683	157	54	NAs	NAs	462	NAs
Prince Albert SSA SOAS ^{38,39}	1492	901	905	464	123	214	100	314	NAs
SMEARII ⁴¹	919	NA	607	252	61	NAs	NAs	NAs	NAs
Sylvania hardwood ^{19,44}	1013	743	724	115	131	NAs	NAs	497	0
Tapajos km 67 ⁵	2770	1490	1200	740	380	NAs	NAs	370	NA
Tumbarumba ⁵¹	1452	845	876	405	170	34	236	270	NAs
TurkeyPointTP02 ^{53,54}	773	504	539	234	1	NAs	NAs	269	NA
TurkeyPointTP89 ^{53,54}	1985	1713	511	1203	271	NAs	NAs	239	0
TurkeyPointTP74 ^{53,54}	1278	948	558	527	193	NAs	NAs	228	NA
TurkeyPointTP39 ^{53,54}	1526	1128	671	726	129	NAs	NAs	273	NA
University of Michigan ^{55,56}	1449	931	1036	246	167	NAs	NAs	518	NAs
Walker Branch ^{57,58}	1625	1097	882	409	247	NAs	NAs	441	NAs
Willow Creek ⁵⁹	1251	784	890	57	225	NA	502	502	NA
Wytham Woods ⁶³	2027	1493	619	716	689	NA	88	88	NA

Xishuangbanna ⁶⁵	2242	1720	885	955	334	NAs	NAs	431	NAs
Yatir ^{67,68}	731	NA	440	228	63	NAs	NAs	NAs	NA

(a) ecosystem autotrophic respiration; (b) total soil respiration; (c) leaf respiration; (d) aboveground wood respiration; (e) root respiration; (f) understory respiration. Green cells: data available; NAs: data not available separately but aggregated in other components (e.g. Reco or total Root); yellow cells and NA: data not available.

Supplementary Table 4. Location and characteristics of the study sites.

site and references	location			climate			canopy			fertility ^(g)	elevation variability ^(h)	slope ⁽ⁱ⁾
	country	latitude	longitude	zone ^(a)	MAT ^(b)	MAP ^(c)	leaf type ^(d)	leaf habit ^(e)	LAI ^(f)			
Caxiuana ^{5,69}	BR	-1.7197	-51.4590	Tr	26.9	2314	BRO	EVE	5.3	I	11.0	2.5
Changbai Mountains ⁶	CN	42.4025	128.0958	Te	3.6	700	MIX	MIX	6.2	F	16.8	2.7
Chibougamau E OBS ^{8,9}	CA	49.693	-74.432	B	0	961	NED	EVE	3.7	I	5.9	2.5
Collelongo ^{11,19}	IT	41.8494	13.5881	Te	7.1	1104	BRO	DEC	5.2	F	109.9	25.3
Dooray ¹²	IE	52.95	-7.25	Te	9.3	850	NED	EVE	8.7	F	29.7	7.4
Duke Forest ^{29,70}	US	35.9782	-79.0942	Te	15.6	1064	NED	EVE	5.2	I	10.6	4.3
Fujiyoshida ^{17,71}	JP	35.4514	138.7653	Te	9.7	2025	NED	EVE	5.5	I	44.1	5.5
Hainich ¹⁸	DE	51.0793	10.4520	Te	7.75	775	BRO	DEC	4.8	F	31.5	5.6
Harvard ²⁰	US	42.5378	-72.1715	Te	7.1	1066	BRO	DEC	4	I	21.0	5.5
Hesse ²³	FR	48.6742	7.0656	Te	9.2	820	BRO	DEC	5.6	F	17.3	3.3
Huhus ^{19,25,72}	FI	62.87	30.82	B	2.0	724	NED	EVE	2.1	I	NA	NA
Lageren ²⁶	CH	47.478	8.36533	Te	7.4	1000	MIX	MIX	5.5	M	99.2	24.0
Jacaranda ^{5,69}	BR	-2.6091	-60.2093	Tr	27.1	2272	BRO	EVE	5.3	I	19.1	3.3
Marys River Fir ^{28,73}	US	44.6465	-123.5515	Te	9.8	1557	NED	EVE	9.4	F	42.2	9.5
Metolius ^{30,31}	US	44.42	-121.67	Te	8.4	370	NED	EVE	1.5	M	96.5	23.7
Morgan Monroe ²⁰	US	39.3232	-86.4131	Te	11.1	1012	BRO	DEC	4.9	M	16.5	4.7
NAU Centennial Thinned ³³	US	35.1426	-111.7273	Te	9.3	632	NED	EVE	1.2	M	18.2	6.2
NAU Centennial Undisturbed ³³	US	35.0890	-111.7620	Te	9	684	NED	EVE	2.2	M	22.1	4.0
Prince Albert SSA SOJP ^{34,74}	CA	53.916	-104.69	B	0.5	406	NED	EVE	1.3	I	4.9	2.1
Prince Albert SSA SOAS ⁷⁴	CA	53.629	-106.2	B	0.5	406	BRO	DEC	2.4	I	8.1	2.1
SMEARII ⁴¹	FI	61.85	24.28	B	4.3	648	NED	EVE	6.3	M	NA	NA
Sylvania hardwood ⁴²	US	46.242	-89.3477	B	3.9	771	MIX	MIX	4.1	I	9.0	2.8
Takayama ^{45,71}	JP	36.1462	137.4231	Te	7.3	2400	BRO	DEC	3.5	F	92.0	19.7
Tapajos km 6 ^{75,75}	BR	-2.8567	-54.9589	Tr	25.9	2091	BRO	EVE	5.3	I	2.7	3.8
Thompson NSA NOBS ^{49,76}	CA	55.88	-98.48	B	0.8	439	NED	EVE	4.4	I	6.1	1.3
Tumbarumba ^{51,77}	AU	-35.6557	148.1521	Te	9.2	1011	BRO	EVE	1.38	M	27.6	6.4
Turkey Point TP02 ^{53,54}	CA	42.6609	-80.5595	Te	7.8	1010	NED	EVE	1	F	7.0	2.0
Turkey Point TP89 ⁵³	CA	42.7744	-80.4588	Te	7.8	1010	NED	EVE	12.8	F	7.1	1.8
Turkey Point TP74 ⁵³	CA	42.7068	-80.3483	Te	7.8	1010	NED	EVE	5.9	M	6.0	1.0
Turkey Point TP39 ⁵³	CA	42.7098	-80.3574	Te	7.8	1010	NED	EVE	8	M	6.1	1.5
University of Michigan ⁵⁵	US	45.5598	-84.7138	Te	5.5	817	BRO	DEC	3.5	I	12.9	2.8
Walker Range ²⁰	US	35.9588	-84.2874	Te	13.8	1352	BRO	DEC	6.2	I	23.6	3.9
Willow Creek ²⁰	US	45.8058	-90.0797	B	4.8	776	BRO	DEC	4.2	F	7.3	2.1
Wind River ^{61,78}	US	45.8205	-121.9519	Te	8.7	2467	NED	EVE	6.92	M	26.2	13.8
Wytham Woods ^{63,64}	UK	51.46	-1.32	Te	10.1	730	BRO	DEC	7.8	F	37.4	7.9
Xishuangbanna ^{65,79}	CN	21.9275	101.2653	Tr	21.7	1487	BRO	DEC	5.5	I	20.2	8.3
Yamashiro ^{66,80}	JP	34.7948	135.8462	Te	15.5	1449	BRO	MIX	3	I	62.5	11.4
Yatir ^{68,81}	IL	31.347	35.052	Te	17.6	275	NED	EVE	1.6	I	25.1	4.2

(a) climatic zone: Bo: boreal, Te: temperate and Tr: tropical; (b) mean annual temperature ($^{\circ}\text{C}$); (c) mean annual precipitation (mm y^{-1}); (d) needleleaved (NED), broadleaved (BRO) or mixed (MIX); (e) evergreen (EVE), deciduous (DEC) or mixed (MIX); (f) leaf area index (m^2 leaf m^{-2} ground); (g) fertile (F), moderately fertile (M) and infertile (I); (h) elevation variability refers to the standard deviation of the elevation (m) of 729 pixels composing a 2430×2430 m quadrat centered around the EC tower, and (i) the slope (%) was derived from the elevation and distance of the highest and lowest pixels within the quadrat in (h). NA: data not available.

Supplementary Table 5. Net ecosystem production ($\text{gC m}^{-2} \text{y}^{-1}$) from biometric methods based on temporal differences in ecosystem carbon stocks ($\text{NEP}_{\text{BM-AS}}$) and eddy-covariance (NEP_{EC}).

	measurement period	$\text{NEP}_{\text{BM-AS}}$							NEP_{EC}	
		Total	Phytomass				Necromass			Soil
			wood ^(a)	leaves	fine roots	understory	litter	cwd ^(b)		
Dooray ¹²	2002	1346	1051	NA	43	NA	NA	137	115 ^(c)	890
Brasschaat ⁸²	2002-2010	175	206	3	0	34	-72	2	1	250
Harvard ⁸³	1993-2000	160	100	NA	NA	NA	NA	40 ^(d)	20 ^(e)	200
HBS00 ⁸⁴	2002-2008	-92	0	NA	NA	NA	-18	-41	-34	-118
Morgan Monroe ²⁰	≤1999	320	320	NA	NA	NA	NA	NA	0	236
Walker Branch ²⁰	1972-1999	264	264	NA	NA	NA	NA	NA	0	577
Lageren ²⁶	2006-2009	429	407	NA	NA	NA	NA	NA	22	435
Yamashiro ⁶⁶	1999-2003	172	130	NA	NA	NA	NA	11	31	123

(a) including stem, branches and coarse roots; (b) coarse woody debris; (c) soil stock difference derived from current soil stocks of the plantation and soil stocks of a grassland similar to the site before planting; (d) derived from input (mortality, turnover) and output (decomposition); (e) derived from the residence time of ^{14}C at the site. NA: data not available.

Supplementary Table 6. Impact of the spatial scaling factor for wood respiration rate (wood area or wood volume) and of the leaf type (needleleaved, broadleaved or mixed) on the annual estimate of wood respiration and leaf respiration (R_{wood} and R_{leaf}, respectively) and the proportion of R_{wood} and R_{leaf} to the total ecosystem respiration, Reco (R_{wood}:Reco and R_{leaf}:Reco, respectively).

Upscaling factor	R _{wood}		R _{wood} :Reco		R _{leaf}		R _{leaf} :Reco	
	p	R ²	p	R ²	p	R ²	p	R ²
Wood scaling factor	0.34	0.073	0.77	<0.01	n.a.	n.a.	n.a.	n.a.
Leaf type	n.a.	n.a.	n.a.	n.a.	0.20	0.78	0.29	0.12

n.a.: not applicable

Supplementary Table 7. Components of net primary production (NPP), autotrophic respiration (Ra), heterotrophic respiration (Rh) and soil respiration (Rsoil) considered for the study sites and their classification as necessary (neces), ancillary (ancil) or no needed (no) for the site inclusion in the dataset of net ecosystem production (NEP), ecosystem respiration (Reco) and gross primary production (GPP).

	NEP			Reco			GPP		
	neces	ancil	no	neces	ancil	no	neces	ancil	no
<i>NPP</i>									
Foliage	x					x	x		
Above wood	x					x	x		
Fine roots	x					x	x		
Coarse roots	x					x	x		
Understory		x				x		x	
Branch turnover		x				x		x	
Reproductive organs		x				x		x	
Herbivory		x				x		x	
Mycorrhizae		x				x		x	
Other ^(a)		x				x		x	
<i>Ra</i>									
Foliage (Rleaf)			x	x				x	
Above wood (Rwood)			x	x				x	
Roots (Rroot)			x	x				x	
Understory (Ru)			x			x			x
<i>Rh</i>									
Soil heterotrophic (Rh-soil)	x						x		x
Coarse woody debris (Rh-cwd)		x				x			x
<i>Rsoil</i>									
			x	x					x

(a) production of volatile organic compounds, epiphytes and dissolved organic carbon

Supplementary Table 8. Characteristics of the allometric relationships (AR) used to measure the standing biomass of above- (stem and branches) and belowground wood (coarse roots) and of the method used to measure leaf production (litter traps, LT, or AR) at the sites with biometric measurements of net primary production.

Site	AR aboveground wood			AR belowground wood			AR quality ^(a)	leaf production
	species-specific	site-specific	variable ^(b)	species-specific	site-specific	variable ^(b)		
Caxiuanã ⁴	no	no	D, TH, WD	no	no	fixed ^(c)	L	LT
Chibougamau EOBS ⁹	yes	no	D, TH	yes	no	D	M	AR ^(d)
Dooray ¹²	yes	no	D, TH ^(e)	yes	no	D, TH ^(e)	M	LT
Duke Forest ¹³	yes	yes	D	yes	yes	D	H	LT
Fujiyoshida ¹⁷	yes	yes	D	yes	yes	D	H	LT
Hainich ¹⁸	NA	NA	NA	NA	NA	NA	NA	LT
Harvard ²⁰	yes	no	D	yes	no	D	M	LT
Hesse ²³	yes	yes	D	yes	yes	D	H	LT
Lageren ²⁶	yes	no	D, TH, WD, E	yes	no	D, WD, A	M	LT
Metolius ^{30,31}	yes	no	D	no	no	^(f)	L	AR ^(g)
Morgan Monroe ³²	yes	no	D	yes	no	D	M	LT
NAU Centennial Thinned ³³	yes	yes	D	yes	no	D	M	LT
NAU Centennial Undisturbed ³³	yes	yes	D	yes	no	D	M	LT
Prince Albert SSA SOJP ³⁴	yes	yes	D	yes	yes	D	H	AR ^(h)
Prince Albert SSA SOAS ^{37,40}	yes	yes	D	yes	no	D	M	LT
Sylvania hardwood ^{43,44}	NA	NA	NA	NA	NA	NA	NA	LT
Takayama ⁴⁵	yes	yes	D	yes	yes	D	H	LT
Tapajos km 6 ^{5,85}	no	no	D, WD	no	no	fixed ⁽ⁱ⁾	L	LT
Thompson NSA NOBS ⁴⁹	yes	yes	D	yes	yes	D	H	LT
Tumbarumba ⁵¹	yes	yes	D	yes	yes	D	H	LT
TurkeyPointTP02 ⁵⁴	yes	yes	D	yes	yes	D	H	LT
TurkeyPointTP89 ⁵⁴	yes	yes	D	yes	yes	D	H	LT
TurkeyPointTP74 ⁵⁴	yes	yes	D	yes	yes	D	H	LT
TurkeyPointTP39 ⁵⁴	yes	yes	D	yes	yes	D	H	LT
University of Michigan ⁵⁵	yes	no	D	no	no	fixed ⁽ⁱ⁾	L	LT
Walker Range ⁵⁷	yes	yes	D	no	no	fixed ^(c)	M	LT

Willow Creek ²⁰	yes	no	D	no	no	fixed ^(c)	L	LT
Wind River ⁶²	yes	no	D	yes	no	D	M	LT
Wytham Woods ⁶³	yes	no	D	no	no	fixed ^(c)	L	LT
Xishuangbanna ⁶⁵	no	yes	D	no	yes	D	L	LT
Yamashiro ⁶⁶	yes	yes	D	no	yes	D	M	LT

(a) H: high, M: moderate, L: low (see Methods for details); (b): tree and stand characteristics representing the independent / driving variable(s) in the allometric relationships, with D: tree diameter, TH: tree height, WD: wood density, E: site elevation, and A: stand age; (c): fixed fraction of aboveground wood production (20-21%); (d): leaf production-to-stem production ratio; (e): equation for whole tree (aboveground + belowground); (f): simulations from process-based model; (g): proportion of current year vs. old leaves biomass; (h): relationship with diameter; (i): same production-to-biomass ratio as for aboveground wood, and (j): relationship above vs. belowground wood.

Supplementary Table 9. Amplitude of confidence interval (equivalent to four times the s.e.m) approximated following Luyssaert et al. (2007)¹⁹ (approx) or directly estimated (estim) for the net ecosystem production (NEP, gC m⁻² y⁻¹), ecosystem respiration (Reco, gC m⁻² y⁻¹) and gross primary production (GPP, gC m⁻² y⁻¹) from biometric methods on forests of the boreal (B), temperate (Te) or tropical (Tr) zone.

site	Climate	NEP		Reco		GPP	
		approx	estim	approx	estim	approx	estim
Chibougamau EOBS ⁹	B	NA	NA	774	714	774	428
Caxiuanã ⁴	Tr	NA	NA	590	1646	590	1356
Dooray ¹²	Te	210	414	NA	NA	NA	NA
Jacaranda ⁵	Tr	NA	NA	588	1842	NA	NA
Tapajos67 ⁵	Tr	NA	NA	586	1724	586	1724
Tumbarumba ⁵¹	Te	NA	NA	446	290	446	290
Wind River ⁶²	Te	420	534	NA	NA	NA	NA
Wytham Woods ⁶³	Te	NA	NA	756	588	756	628

NA: not available

Supplementary Table 10. Contribution of mycorrhiza production to total stand net primary production (NPP) from field- and culture studies. Data are reported for each site (for field studies), with mean \pm s.e.m, minimum and maximum values, and number of replicates (for both field- and culture studies).

Forest type and reference	% NPP
<i>Abies amabilis</i> (23 y old) ⁸⁶	14%
<i>Abies amabilis</i> (180 y old) ⁸⁶	15%
<i>Pinus sylvestris</i> ^{87,88}	15%
Mixed conifer-deciduous ⁸⁹	21%
Piñon-juniper ⁹⁰	18%
<i>Pinus taeda</i> ¹⁵	0.3%
Average field-studies (this table)	14 \pm 3% (0.3-21%, n=6)
Average culture-studies ⁸⁸	9 \pm 1% (1-21%, n=33)

Supplementary Methods

We report here a summary of the methodological approach used at each site for the biometric determination of the production and respiratory components to estimate NEP, Reco and GPP. Thus, the document provides site overviews about measurement techniques, protocols, measurement periods, replicates, data processing etc. However, note that this text does not necessary include all methodological information extracted from the literature for a given site (see Supplementary Data 1 for the dataset used in the analysis) and, according to the information available, might contain information on a given process or variable only for a portion of the sites.

Caxiuanã

Net primary production (from Doughty et al 2014⁴; otherwise indicated)

Stem and branches: allometry

Coarse roots: assumed as 21% of aboveground wood production

Leaves: litter traps (collected each 14 days – litter decomposition in canopy not taken into account)

Fine roots: in-growth cores

Understory: not measured for trees with diameter < 2.5 cm

Reproductive material: litter traps (collected each 14 days)

Branch turnover: taken into account (survey each 2 months)

Herbivory: image analysis of leaf damage by herbivores (each month)

VOC: empirical – combination from different sites⁵

DOC: empirical – combination from different sites⁵

Respiration (from Doughty et al 2014⁴; otherwise indicated)

Methods

Soil: closed dynamic chambers + infra-red gas analyzer (IRGA) (July 2009 – April 2011, monthly); replicates: n=25

Fine roots: trenching experiment (3 plots: control, no roots no mycorrhiza, no roots yes mycorrhiza)

Soil – heterotrophic component: Rsoil-Root

Stem: closed dynamic soil chambers + IRGA (July 2009–December 2010, every 2 months); replicates: n=25 trees, 1.3 m height.

Coarse roots: assumed 21% of aboveground wood respiration

Leaves: NIGHTTIME: leaf dark respiration on cut branches with cuvette + IRGA (measurements during 2 months Jan-Feb 2007); replicates: n=30 trees, for each tree, one branch sunlit and one shaded. DAYTIME DATA: daytime respiration was assumed to be only 33% of the nighttime respiration to account for daytime photoinhibition of leaf dark respiration⁵

Understory: not accounted

Coarse woody debris: derived from data on amount of wood falling due to mortality multiplied by 76% (amount of dead wood respired away before entering the soil; this factor, 76%, is from another site)⁵

Scaling

Soil:

TEMPORAL: averaged per month with no consideration of seasonality

SPATIAL: basic calculation

Stem:

TEMPORAL: bimonthly averages with no consideration of seasonality (little seasonal variation in stem respiration was documented⁵)

SPATIAL: stem area (considering BRANCHES and that stem respiration constant with height). Relationship between woody NPP and woody respiration: the trees measured for woody respiration grew faster than the average trees in the plot. Therefore, when scaled to the plot level, respiratory fluxes were reduced by 11%.

Leaves:

TEMPORAL: The wet season respiration mean was applied to all months with >100 mm rain; for the dry season, measured dry season respiration was linearly scaled by the soil moisture saturation

SPATIAL: LAI.

Changbai Mountains

Net primary production

No data available meeting quality standard for our analysis

Respiration⁶

Methods

Soil: chambers with offline CO₂ measurements (gas chromatography) on surface with cut understory (9-11 a.m., each 4–8-day from April to November, monthly from December till March, in 2003); replicates: n=6

Stem: chambers with online CO₂ measurements (LI-6400) (3-7-day intervals from May to December, in 2003); replicates: n=6, for 4 main tree species.

Leaves: CO₂ exchange with LI-6400 at night (9:00–11:00 p.m., monthly from May to September, in 2003)

Understory: chambers with offline CO₂ measurements (gas chromatography) at night

Coarse woody debris: not measured.

Scaling:

Soil:

TEMPORAL: relationship with temperature (seasonal and site data)

SPATIAL: basic calculation

Stem:

TEMPORAL: relationship with temperature (seasonal and site data)

SPATIAL: wood volume (comprising BRANCHES)

Leaves:

TEMPORAL: relationship with temperature (seasonal and site data)

SPATIAL: LAI / leaf biomass

Understory:

TEMPORAL: relationship with temperature (seasonal and site data)

SPATIAL: LAI / leaf biomass

Chibougamau EOBS

*Net primary production*⁹

Stem: allometry, average of 2003-2008 (2005 as measurement year)

Coarse roots: allometry, average of 2003-2008 (2005 as measurement year), assuming absence of coarse root mortality and turnover (as in all sites)

Branches: allometry

Leaves: allometry

Fine roots: product of standing biomass at the site (soil cores in 2005, 2006 and 2007) and fine root turnover rate from a nearby site (minirhizotron and fine root biomass from root cores)

Understory: nonvascular: 50% of GPP; vascular: present (e.g. shrubs) but not accounted for.

*Respiration*⁹

Methods

Soil (comprising nonvascular): automated chamber system (May to October 2005; n=6-9 but different nonvascular understory)

Fine root respiration: $R_{soil} - R_h$ -soil

Soil – heterotrophic component: trenching method (data from 2005)

Stem: chambers+ LI-COR, both automatic (4 periods growing season 2005) and manual (7 times during growing season 2005); replicates: breast height: n=8-12 trees for 2 species, and crown: n=2-6 trees and 2 species.

Branches: chambers + LI-COR, both automatic (4 periods growing season 2005) and manual on cut branches (7 times during growing season 2005); replicates: n=1-6 trees for 1-2 species (branches analyzed: 2 automatic and 82 manual)

Leaves: LCA-4 portable gas exchange system on 1-year-old shoots on cut branches (4 days in August and September 2005); replicates: n=3-4 trees and 2 branches for 2 species; 21 shoots per species analyzed; estimate growth respiration added (coefficient \times biomass new leaves)

Understory: nonvascular: in R_{soil} ; vascular: not measured.

Coarse woody debris: not mentioned / not measured

Scaling:

Soil:

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)

SPATIAL: type ground cover and site ground cover proportion taken into account; correction of 16% because previous research detected this error

Stem:

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)

SPATIAL: stem surface

Branches:

TEMPORAL: classical relationship with temperature but Q_{10} assumed (not measured)

SPATIAL: dry mass (branch biomass in six branch diameter classes from inventory/allometry)

Leaves:

TEMPORAL: classical relationship with temperature but Q_{10} assumed (not measured)

SPATIAL: dry mass

Collelongo

Net primary production

Not available for study period considered (2007)

Respiration¹¹

Methods

Soil: Chambers with closed dynamic system (EGM 4, PP-System, Hitchin, UK) (May 2007 until May 2008, each 2-6 weeks for 1 year except between December to March when snow covered the soil); replicates: n=50, 5 collars in 10 plots

Stem: Cuvette + LCA-4 open-system infrared gas analyzer (Analytical Development Company, Hoddeson, UK) (growing season of 2007 + winter campaign in February 2008); replicates: n=10 trees

Leaves: detached leaves + portable gas exchange system (LiCor 6400) (measurements on one occasion in July 2007, during three periods in the day); replicates: 10 shade and 10 sun leaves (fully expanded leaves)

Understory: negligible

Coarse woody debris: negligible

Scaling

Soil:

TEMPORAL: relationship with temperature and soil water content

SPATIAL: basic calculation

Stem:

TEMPORAL: relationship with temperature

SPATIAL: woody surface area (considering also BRANCHES)

Leaves:

TEMPORAL: temperature response based on data from literature⁹¹

SPATIAL: leaf area index (LAI); the partition of LAI into sun and shaded leaves based on a precedent study carried out at the site

Dooray

Net primary production¹²

Stem and branches: allometry, 2002-2003

Coarse roots: allometry, 2002-2003

Leaves: litter traps + allometry, 2002-2003

Fine roots: ingrowth cores, 2003

Understory: not mentioned

Branch turnover: considered

Respiration¹²

Methods

Soil: automatic chamber + IRGA, used to check the model for seasonal Rsoil (120 days but no info on the year)

Soil – heterotrophic component: trenching experiment: soil respiration measurements on 30 cm deep collars that killed all roots (validated models for 2002-2003)

Coarse woody debris: negligible but aboveground dead considered in this category: chamber + IRGA of dead branches and needles in laboratory

Scaling

Soil:

TEMPORAL: function of soil temperature and soil moisture content

SPATIAL: basic calculation

Coarse woody debris:

TEMPORAL: temperature function

SPATIAL: basic calculation from surveys of standing aboveground dead

Duke Forest

Net primary production (from Hamilton et al 2002¹³; otherwise indicated)

Stem and branches: allometry

Coarse roots: allometry

Leaves: allometry + litter traps

Fine roots: bi-weekly soil cores, including estimates of root mortality and decomposition

Understory: included with overstory

Reproductive material: litter traps

Herbivory: accounted for

Dissolved inorganic/organic carbon: accounted for

Mycorrhizal transfer: accounted for¹⁵

Respiration (from Hamilton et al 2002¹³; otherwise indicated)

Methods

Soil: Soda lime (monthly from January 1997 onwards, daily measurements); replicates: n=4 for 3 plots⁹²

Fine roots: MAINTENANCE: measurements on roots still attached to the tree using a portable gas exchange system in July 2000 (other year than measurement year 1998);

GROWTH: calculated as 25% of total yearly fine root production

Soil – heterotrophic component: Rsoil – Rroot

Stem: MAINTENANCE: cuvette + automated open-system infrared gas-analysis systems (in October at end of growth); replicates: n=5 trees in 3 plots; GROWTH: from measurements of heat of combustion and the fraction of carbon, nitrogen and ash in each sample.

Branches: MAINTENANCE: as for stem, but respiration rates for branch sapwood were assumed to be 2.52 times higher than for stem; GROWTH: as for stem

Coarse roots: as for stem, for both MAINTENANCE and GROWTH

Leaves: MAINTENANCE: night respiration of detached leaves using an open gas-exchange system with a conifer cuvette (LI 6400) (mid-June, late July, early September 1999, other year than measurements year 1998, 21.00 - 04.00 h); replicates: n=3 samples from 3 trees, for 2 species; taken into account higher respiration in top canopy than lower canopy and that 75% sun and 25% shade leaves (for pine – dominant) and 100% shade (for sub-dominated);

PHOTOINHIBITION: assumed that the respiration rate during the day was 60% of the rate during the night; GROWTH: from measurements of heat of combustion and the fraction of carbon, nitrogen and ash in each sample⁹³.

Understory: included in overstory

Coarse wood debris: negligible

Scaling

Soil:

TEMPORAL: temperature response function

SPATIAL: basic calculation

Stem:

TEMPORAL: temperature response function: Q_{10} from measurements; base respiration rate: from literature (generic, no species-specific)

SPATIAL: sapwood volume (also for BRANCHES)

Leaves:

TEMPORAL: temperature response function : Q_{10} and base respiration rate from measurements;

SPATIAL: proportion sun/shade leaves

Fine roots:

TEMPORAL: temperature response function; Q_{10} from literature and base respiration rate measured

SPATIAL: biomass

Coarse roots:

TEMPORAL: temperature response function: Q_{10} and base respiration rate like stem

SPATIAL: sapwood volume

Fujiyoshida

*Net primary production*¹⁷

Stem and branches: allometry, 1999-2008

Coarse roots: allometry, 1999-2008

Leaves: allometry + litter traps, 1999-2007

Fine roots: sequential monthly core sampling, 2000

Understory: not measured for trees <5 cm DBH

Reproductive material: accounted for (litter traps), 1999-2007

Branch turnover: accounted for through surveys, 2000-2004

Twigs (and bark): accounted for (litter traps), 1999-2007

*Respiration*¹⁷

Methods

Soil: chambers + LiCor 6200 gas exchange analyzer (monthly intervals in 2006-2007, measurements at noon); replicates: n=20

Fine roots: fresh cut roots in chambers (December 2006, May, September, October and December 2007) on fine <2 mm and middle size roots >2 mm

Soil – heterotrophic component: Rsoil - Rroot

Coarse woody debris: from amount dead branches from surveys, assuming that dead woody debris pool constant

Scaling

Soil:

TEMPORAL: temperature function

SPATIAL: basic calculation taking into account presence lava flow (17.6% area)

Fine roots:

TEMPORAL: temperature function

SPATIAL: biomass of fine and middle size roots, separately, taking into account presence of lava flow (17.6% area)

Hainich

Net primary production

Stem and branches: allometry, 2000-2002¹⁹

Coarse roots: allometry, 2000-2002¹⁹

Leaves: litter traps, 2002¹⁸

Fine roots: sequential coring, 2002^{18,94}

Understory: sequential harvesting, 2002^{18,94}

Reproductive material: accounted for, 2002¹⁸

Respiration

Methods

Soil: see below Rh-soil

Soil – heterotrophic component: component integration method for 2002, with laboratory incubation and upscaling using field data¹⁸

Coarse woody debris: not measured

Scaling

Soil heterotrophic respiration:

TEMPORAL: temperature and moisture response function¹⁸

SPATIAL: respiration expressed as $\text{g CO}_2\text{-C g}^{-1}\text{ C soil}$; upscaled using amount of C per soil layer in $1\text{ m}^2\text{ soil}$ ¹⁸

Harvard Forest

Net primary production

Stem and branches: allometry, 1999²⁰

Coarse roots: allometry, 1999²⁰

Leaves: litter traps, 1999²⁰

Fine roots: sequential coring, 1979⁹⁵

Understory: allometric equations for woody vegetation and biomass harvest for herbaceous vegetation (no time info)²⁰

Reproductive material: litter traps, 1999²⁰

Respiration

Methods

Soil: chambers + infrared gas analyzer (June 1995 - May 1996, 9.00-13.00 am, each 1-3 weeks interval except when snow cover); replicates: n=36⁹⁶

Soil – heterotrophic component: assumed as 50% of Rsoil⁹⁷

Coarse woody debris: not measured

Scaling

Soil:

TEMPORAL: temperature and moisture function⁹⁶

SPATIAL: basic calculation, with taking into account different vegetation cover areas^{20,96}

Hesse

Net primary production

Stem and branches: allometry, 1997²¹

Coarse roots: allometry, 1997²¹

Leaves: litter traps, 1997²¹

Fine roots: ingrowth cores, 1997^{22,24}

Understory: negligible

Respiration

Methods

Soil: chambers + LI-COR (each 2-4 weeks during June 1996 – November 1997); 6 plots with 12 measurements per plot during 8am – 4pm (24h measurement campaign confirmed 8h was ok)⁹⁸

Fine roots: Rsoil - Rh-soil

Soil – heterotrophic component: trenching + modelling⁹⁹

Stem and branches: chambers + IRGA (STEM: monthly for whole year 1997, n=15 trees;

BRANCHES: May to October 1997, continuous; 3 branches within 1 tree), both maintenance and growth respiration accounted for¹⁰⁰

Leaves: branch bag + IRGA (2 bags, one top and one down in canopy May to October 1997, continuous); both maintenance and growth respiration are accounted for; photo-inhibition accounted for²¹

Understory: negligible

Coarse woody debris: data provided without details on methodology²³

Scaling:

Soil:

TEMPORAL: relationship based on soil water content and temperature⁹⁸

SPATIAL: basic calculation

Stem/branches:

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)¹⁰⁰

SPATIAL: wood volume

Leaves

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)²¹

SPATIAL: LAI/leaf biomass

Huhus

Net primary production

Not available

*Respiration*²⁵

Methods

Soil: automated chambers (April to November each year from 2001 to 2004); replicates: n = 4

Stem: automated chambers (April to November each year from 2001 to 2004); replicates: n=3 trees (as most of studies, assumed that efflux constant along the stem)

Leaves: automated chambers (April to November each year from 2001 to 2004); replicates: n=4 branches different position of 4 trees

Understory: negligible

Coarse woody debris: not measured.

Scaling

Soil:

TEMPORAL: temperature functions (seasonal and site based)

SPATIAL: basic calculation

Stem:

TEMPORAL: temperature functions (seasonal and site based)

SPATIAL: stem volume (BRANCHES not included)

Leaves:

TEMPORAL: temperature functions (seasonal and site based)

SPATIAL: leaf area index

Jacaranda

Net primary production

No data available meeting quality standard for our analysis

Respiration (Chamber et al 2004²⁷; otherwise indicated)

Methods

Soil: chamber + IRGA system (8 times during the day (08.00–16.00 h) between July 2000 and June 2001 at 4-6-week intervals); replicates: n=54

Stem: chambers + infrared gas analyzer (IRGA) (8 times between August 2000 and June 2001 at 4-6 week intervals); replicates: 50 trees from five growth classes

Leaves: dark chambers + LiCor 6400 (from April to November 2001, hourly intervals over a combined 24-h period for the same leaf); leaves from 20 large trees (>14 m in height).

Daytime flux was reduced by 40% to account for photoinhibition.

Understory: taken from another tropical site (Pasoh, Malesia) from the literature

Coarse woody debris: chambers + IRGA and surveys (1996-1997)¹⁰¹; estimates for smaller debris (fine woody debris) available at the site

Scaling

Soil:

TEMPORAL: likely average per month (no seasonality)

SPATIAL: basic calculation

Stem:

TEMPORAL: likely average per month (no relationship between R_{wood} and stem surface temperature)

SPATIAL: wood area (including BRANCHES) and taking into account growth rate per tree (5 classes) and number of trees within each 5 classes

Leaves:

TEMPORAL: likely average per month (no seasonality)

SPATIAL: leaf area index

Lageren

*Net primary production*²⁶

Stem and branches: allometry, 2006-2009

Coarse roots: allometry, 2006-2009

Leaves: allometry + litter traps, 2006-2009

Fine roots: standing root biomass (estimated as 50% of foliage biomass based on literature) + turnover measured on site from maximum fine root biomass (sequential coring) and annual fine root growth (ingrowth cores)

Understory: accounted for from litter production

Reproductive material: allometry, 2006-2009

Twigs: accounted for (allometric 2006-2009)

*Respiration*²⁶

Methods

Soil: chambers + IRGA (2006 to 2009, every 2–3 weeks), automatic : n=1, and manual: n=17

Soil – heterotrophic component: two methods: root exclusion and root excised (from September 2006 till September 2007, root exclusion also likely from March 2006 till May 2008)¹⁰²

Coarse woody debris: not measured

Scaling

Soil:

TEMPORAL: function of temperature¹⁰²

SPATIAL: basic calculation

Soil – heterotrophic component:

TEMPORAL: function of temperature¹⁰²

SPATIAL: basic calculation

Marys River Fir

Net primary production

Not available

*Respiration*²⁸

Methods

Soil: automatic chambers + infrared gas analyzer (Li-Cor 6262) (measured every 4 h continuously whole year but with gaps ca. 35% of time); replicates: n=6

Stem: chambers + ADC LCA3 open system (different 3-days periods along year to capture seasonality); replicates: n=3-8 trees, north side of trees

Leaves: portable photosynthesis system (Model LiCor 6400) on branches cut during night and measured in lab between 06:00 and 09:00 am (measured on one occasion end August 2011); replicates: n=8 branches from 4 trees, mid to upper canopy. Correction factor 1.13 applied to base respiration to fit global relationship between leaf N and respiration rate.

Understory: sparse, not measured

Coarse woody debris: not measured.

Scaling

Soil:

TEMPORAL: gaps were interpolated (when <4 h) or filled with a temperature and soil moisture model (when > 8h) validated at the site

SPATIAL: upscaling done using extensive data from 3 to 5 periodic spatial surveys per year on 20 separate locations

Stem:

TEMPORAL: temperature function

SPATIAL: sapwood volume (including BRANCHES)

Leaves:

TEMPORAL: temperature function, with base respiration rate (R_{20}) made as function of N (varying seasonally) and with Q_{10} dependent on temperature (4-day running mean temperature)⁹¹

SPATIAL: leaf mass and PAI (plant area index)

Metolius

Net primary production

Stem and branches: allometry, 1996³⁰

Fine + coarse roots: derived from measurements of aboveground NPP and simulation of aboveground vs belowground NPP (average of 3-PG and PnNET-II₃₀₀ simulations)³¹

Leaves: from specific leaf area (m² leaf g⁻¹ dry weight) and mean leaf area of newly expanded foliage, which was determined from a subsample of branches from at least 12 trees (in 1996)³⁰

Understory: NPP determination not mentioned

Respiration

Methods

Soil: chambers + LICOR 6200 infrared gas analyzer (IRGA) (23 measurements during the year, March 1996-March 1997)³⁰

Fine roots + coarse roots: derived from the total belowground flux (which is root NPP + Rroot, ^{30,103}) with subtraction of root NPP (see above)

Soil – heterotrophic component: Rsoil - Rroot

Stem: Chambers + ADC LCA3 open system (on five days from January to October 1996; days of year 9, 156, 184, 213, and 284); replicates: n=10 young trees and n=10 old trees, on north side of tree³⁰

Leaves: LI-COR 6400 open system + ADC LCA3 open system; nocturnal respiration measured four days through the year 1996 (in February, April, June, July); replicates: n=4-6 of 2 trees, for needles 1 year-old (in July, 3 age needle classes at 3 heights in the canopy were measured: based on these results they did not estimate respiration of expanding foliage separately and assumed that age class 1 represented the mean for all classes)³⁰

Understory (mainly strawberry, *Fragaria vesca*): derived from *P. ponderosa* data corrected for seasonal changes in the fraction of daytime respiration (photosynthetic light response at 0 PAR) by *F. vesca* vs. *P. ponderosa* (for 1996)³⁰

Coarse woody debris: not mentioned

*Scaling*³⁰

Soil:

TEMPORAL: temperature response function

SPATIAL: basic calculation

Stem:

TEMPORAL: temperature response function

SPATIAL: sapwood volume (including BRANCHES)

Leaves:

TEMPORAL: temperature response function

SPATIAL: hemi-surface area (HSA; one-half the total surface area)

Understory: as for Leaves

Morgan Monroe

*Net primary production*³²

Stem and branches: allometry, 1998-1999

Coarse roots: allometry, 1998-1999

Leaves: litter traps, 1998-1999

Fine roots: standing biomass + empirical model of Aber et al 1985¹⁰⁴

Understory: harvesting in mid-summer of 1998-1999

Reproductive material: litter traps, 1998-1999

Herbivory: accounted, 1998-1999

Twigs: litter traps, 1998-1999

*Respiration*³²

Methods

Soil: chambers + LiCor analyzer (each 2-3 weeks, 1998-1999, 10.00-14.00 h); replicates: n=50

Soil – heterotrophic component: assumed as 50% of Rsoil⁹⁷

Coarse woody debris: surveys + decomposition rate from literature

Scaling

Soil:

TEMPORAL: function of temperature and water potential

SPATIAL: basic calculation

NAU Centennial Undisturbed

*Net primary production*³³

Stem and branches: allometry, 2006-2007

Coarse roots: allometry, 2006-2007

Leaves: litter traps, 2006-2007

Fine roots: minirhizotron technique, 2006-2007

Understory: harvest peak biomass, 2006-2007

*Respiration*³³

Methods

Soil: average of three methods: closed dynamic chambers, static chambers and soil CO₂ profiles (in 2007)

Soil – heterotrophic component: trenching experiment in 2005 in nearby similar site

Coarse woody debris: based on surveys and decomposition rate measured at the site

Scaling

Soil:

TEMPORAL: function of temperature and water content

SPATIAL: basic calculation

NAU Centennial Thinned

*Net primary production*³³

Stem and branches: allometry, 2006-2007

Coarse roots: allometry, 2006-2007

Leaves: litter traps, 2006-2007

Fine roots: minirhizotron technique, 2006-2007

Understory: harvest peak biomass, 2006-2007

*Respiration*³³

Methods

Soil: average of three methods: closed dynamic chambers, static chambers and soil CO₂ profiles (in 2007)

Soil – heterotrophic component: trenching experiment in 2005 in nearby similar site

Coarse woody debris: based on surveys and decomposition rate measured at the site

Scaling

Soil:

TEMPORAL: function of temperature and water content

SPATIAL: basic calculation

Prince Albert SSA SOAS

Net primary production

Stem and branches: allometry, 1994³⁷

Coarse roots: allometry, 1995⁴⁰

Leaves: litter traps, 1994³⁷

Fine roots: minirhizotron technique, 1995⁴⁰

Understory: harvesting, 1994³⁷

Respiration

Method

Soil: closed gas exchange system including LI-6200 photosynthesis system and LI-6000-09 soil respiration chamber (late May-late September 1994, 10:00 -16:00 hour); replicates: n=20-30³⁸

Fine roots: in situ: closed system + LI-COR 6200 (once during growing season); replicates: n=10-20 samples³⁹

Soil – heterotrophic component: Rsoil - Rroot

Stem: automated chambers + LI-COR 6252 (several times between May – September 1994); replicates: n=16-20 trees; separation maintenance and growth respiration by subtracting the out-of-season respiration from the growing season respiration³⁹

Coarse roots: assumed same rates as another, northern, site³⁹

Leaves: chambers + closed system LI-6200 (June, July, August 1994); replicates: n=15-30 samples of 3-8 trees of 2 species³⁹

Understory: LEAVES: chambers + closed system LI-6200 (5 sun and 5 shade leaves, 1994);

WOOD: assumed as having same respiration rate as in northern site³⁹

Coarse woody debris: not mentioned.

Scaling:

Soil³⁸:

TEMPORAL: temperate response function

SPATIAL: different microsites taken into account

Stem³⁹:

TEMPORAL: temperature response function at site

SPATIAL: sapwood volume

Leaves³⁹:

TEMPORAL: temperature response function taken from same species in another, northern, site

SPATIAL: leaf area index

Understory³⁹:

TEMPORAL: LEAVES and WOOD: temperature response function taken from same species in another, northern, site

SPATIAL: LEAVES leaf area index, and WOOD: sapwood volume

Roots³⁹:

TEMPORAL: temperature response function taken from same species in another, northern, site

SPATIAL: biomass/volume

Prince Albert SSA SOJP

*Net primary production*³⁴

Stem and branches: allometry, 1999-2000

Coarse roots: allometry, 1999-2000

Leaves: allometry for new leaves, 1999-2000

Fine roots: ingrowth core method, 1999-2000 (two years together)

Understory: measured: leaf and wood NPP of saplings (allometry for 1999-2000) and leaf and wood apical NPP of herbs/shrubs (harvest for 1999) – not measured: nonvascular NPP and NPP due to stem secondary growth of shrubs (both thought to be negligible; mosses covered only 1% ground)

*Respiration*³⁴

Methods

Soil: chambers + infrared gas analyzer (4 to 5 times per year in 1999-2000); replicates: n=16

Soil – heterotrophic component: 53% of R_{soil} from literature + Monte Carlo approach

Coarse woody debris: based on surveys and decomposition rate from literature

Scaling

Soil:

TEMPORAL: function of temperature and moisture

SPATIAL: basic calculation

SMEARII

Net primary production

Not available

*Respiration*⁴¹

Methods

Soil: automated chambers (hourly measurements, 2003-2006; n=3) + manual chambers (5-8 sampling periods per summer; n=14-20)

Stem: automated chambers (2003-2006, only on one trees, with one chamber below the crown and one in the crown; in summer 2003 the system was circulating among different trees and stem heights to capture variability)

Leaves/branches: automated chambers (whole years for 2003-2006); n=3-4 shoots

Understory: considered with soil

Coarse woody debris: not measured.

Scaling

Soil:

TEMPORAL: gaps in automated data filled with temperature functions (varying with seasonality)

SPATIAL: basic calculation

Stem:

TEMPORAL: gaps in automated data filled with temperature functions (varying with seasonality); lag between stem temperature and CO₂ efflux considered

SPATIAL: wood surface area (including BRANCHES)

Leaves:

TEMPORAL: gaps in automated data filled with temperature functions (varying with seasonality)

SPATIAL: leaf area needles

Sylvania hardwood

Net primary production^{19,43}

Stem and branches: allometry, 2002-2003

Coarse roots: allometry, 2002-2003

Leaves: allometry + litter traps, 2002-2003

Fine roots: in-growth cores, 2002-2003

Understory: negligible

Respiration^{19,44}

Methods

Soil: soil chambers + LI-6400 portable system (3–4 weeks in the 2002 and 2003 growing seasons); replicates: n=20 plots

Fine root respiration: Rs-Rh

Soil – heterotrophic component: no methodological info available (assumed lowest quality category)

Stem/branches: chambers + LI-6400 portable system (monthly in growing season 2002 and 2003); replicates: n=12-19 trees per 3 species. Only stem measured but assumed that branches had the same respiration rate as stem.

Leaves: detached leaves analyzed with LI-6400 portable system (June, July and August 2002 and 2003); replicates: n=20-30 leaves from 7-10 trees per 3 species.

Understory: negligible

Coarse woody debris: chambers + LI-6400 portable system (as for soil) on large debris (every 3–4 weeks during the growing season 2002 and 2003).

Scaling

Soil:

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)

SPATIAL: basic calculation

Stem:

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)

SPATIAL: sapwood volume

Leaves:

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)

SPATIAL: dry biomass

Coarse woody debris:

TEMPORAL: classical relationship with temperature and Q_{10} (seasonal and site data)

SPATIAL: surface area

Takayama

*Net primary production*⁴⁵

Stem and branches: allometry, 1999-2003

Coarse roots: allometry, 1999-2003

Leaves: litter traps, 1999-2003

Fine roots: minirhizotron + seasonal core sampling 2000

Understory: harvest of dominant understory species in 1993-1994 but trees with DBH<5 cm not measured

*Respiration*⁴⁵

Methods

Soil: chambers + IRGA (measured continuously for 24-48 hours once or twice a month, 1999-2003); replicates: n=4

Soil – heterotrophic component: trenching experiment in 1999

Coarse woody debris: pool of coarse woody debris on the forest floor assumed in steady state; so decomposition= production (from surveys/litter traps)

Scaling

Soil:

TEMPORAL: temperature function

SPATIAL: taking into account comparison of the 4 chambers studied with 100 chambers in another study focused on soil heterogeneity at the site (note that site has ridges, valleys etc. so with topographical complexity)

Tapajos km 67

Net primary production (from⁵ and references therein)

Stem and branches: allometry

Coarse roots: assumed some production-to-biomass ratio of aboveground wood and coarse root biomass being 21% of aboveground wood biomass

Leaves: litter traps

Fine roots: sequential coring (every two months for two years; 0-10 cm depth with correction for soil depth of 1.0 m using root biomass profiles, compartment flow model of Sanantonio and Grace 1987¹⁰⁵); replicates: 6 plots for two soil types.

Understory: ground vegetation and trees <10 cm diameter not measured

Reproductive organs: litter traps

Branch turnover: surveys

VOC: empirical for similar sites

DOC: negligible

Respiration (from Malhi et al 2009⁵ and cited references)

Methods

Soil: chambers: Keller et al 2005¹⁰⁶ (1.5 y with sampling at monthly interval, 08.00-18.00, n=8), Silver et al 2005¹⁰⁷ (07/1999-05/2001, 1-2.5 months interval, 6 plots on two soil types), Davidson et al in⁵ (2000-2005, 5 times per year; n=18), Varner et al in⁷⁵: no info.

Fine roots: steady-state mass balance approach based on quantifying above-ground and below-ground litter input, assuming that heterotrophic respiration rates are equal to litter input rates, and allocating the remaining soil respiration to root respiration; at the clay sites, the mass balance approach provided root respiration consistent with trenching approach⁵.

Soil – heterotrophic component: Rsoil - Rroot

Stem: chambers + infrared gas analyzer (February, April, July, and October of 2004); replicates: 21 individual trees/large vines¹⁰⁸

Leaves: Leaf dark respiration rates assessed from light-response curves from 68 leaves from 26 individuals (with photosynthetic gas exchange system LI-6400, morning hours 08.00-13.00)¹⁰⁹. Photoinhibition equations of Atkin et al. (2000)¹¹⁰ applied to these values and integrated throughout the canopy^{5,111}. Total leaf respiration is the sum of nighttime leaf respiration and daytime leaf respiration.

Understory: ground vegetation and trees <10 cm diameter not measured

Coarse woody debris: derived from decay rate equation based on site measurements¹¹²

Scaling

Soil:

TEMPORAL: no info (likely average through year, no seasonality)

SPATIAL: taking into account two soil type and their proportion (32% and 68%)

Stem:

TEMPORAL: no info (likely average through year, no seasonality)

SPATIAL: wood surface area (considering also BRANCHES)

Leaves:

TEMPORAL: no info

SPATIAL: leaf area index

Thompson NSA NOBS

Net primary production

Stem and branches: allometry, 1999-2001⁴⁹

Coarse roots: allometry, 1999-2001⁴⁹

Leaves: allometry + litter traps, 1999-2001⁴⁹

Fine roots: maximum-minimum soil core method for 2001 (difference between midsummer and autumnal biomass)⁴⁹

Understory: apical growth harvested in 1999-2001⁴⁹, nonvascular growth measured in 1994³⁷
– secondary growth shrubs not measured⁴⁹

Respiration

Methods

Soil: chambers + infrared gas analyzer on soil with mosses (monthly during the growing season between May 2001 and August 2002); replicates: n=8-16⁴⁸

Soil – heterotrophic component: trenching experiment in 2001-2002⁴⁸

Coarse woody debris: surveys and measured decomposition rates in 2000⁴⁷

Scaling

Soil:

TEMPORAL: temperature function

SPATIAL: basic calculation

Tumbarumba

*Net primary production*⁵¹

Stem and branches: allometry, 2002-2003

Coarse roots: allometry, 2002-2003

Leaves: litter traps, 2002-2003

Fine roots: sequential coring, 2003

Understory: approximated as percentage of overstory NPP using data from a similar site

*Respiration*⁵¹

Methods (data from Nov 2001- Aug 2002 and March 2005)

Soil: chambers using absorption of CO₂ by soda lime (24-h period each month during the year); replicates: n=30 plots with 90 measurements per plot.

Fine root respiration: trenching (monthly measurements over one year) + chambers of intact fine roots in situ

Soil – heterotrophic component: R_{soil} - R_{root}

Stem: chambers with LI-6200 gas analysis system on different tree sizes

Branches: chambers with LI-6200 gas analysis system on different branch diameter classes

Coarse roots: chambers with LI-6200 gas analysis system on different root diameter classes

Leaves: leaf gas exchange system at night and day (with leaves covered by cloth) on saplings and mature trees (n=8) and on range of leaf ages and positions in the canopy

Understory: as for leaves

Coarse woody debris: not mentioned / not measured

Scaling

Soil:

TEMPORAL: Model of soil temperature, volumetric soil moisture content, and plot data for forest floor litter mass, rate of litterfall, total biomass, soil carbon content, plot number and month.

SPATIAL: Soil respiration calculated for each of four vegetation classes and total site respiration determined from the fraction of the total area occupied by each vegetation class.

Stem/branches/coarse roots:

TEMPORAL: temperature response function

SPATIAL: sapwood volume

Leaves:

TEMPORAL: temperature response function

SPATIAL: leaf area index

Understory:

TEMPORAL: temperature response function

SPATIAL: leaf area index

Roots:

TEMPORAL: temperature response function (seasonal and site data)

SPATIAL: Respiration rate per root surface area multiplied by specific root area and fine root mass per hectare, and seasonal variation in root mass

TurkeyPointTP02

*Net primary production*⁵⁴

Stem and branches: allometry + accounting branch/tree mortality, 2006

Coarse roots: allometry, 2006

Leaves: allometry+ litter traps, 2006

Fine roots: fine root biomass stock + fine root turnover rate as average of three methods: mass balance approach of Raich and Nadelhoffer (1989)¹⁰³, relationship between available N from mineralization following Aber et al. (1985)¹⁰⁴, and fixed turnover rate (0.60 yr⁻¹) from the literature.

Understory: allometry + harvesting for grasses, 2006

Herbivory: from literature, 2006

Respiration^{53 54}

Methods

Soil: chambers + LI-6400 photosynthesis system (monthly basis from 1 January 2006 to 31 December 2006); replicates: n=12⁵³

Fine root respiration: derived from ratio Rroot: Rh-soil from trenching experiment⁵⁴ and total soil respiration⁵³

Soil – heterotrophic component: Rsoil - Rroot

Stem: assumed same respiration rate as in TurkeyPointTP89 (see below)

Leaves: dark foliar gas exchange measurement (i.e. net CO₂ exchange of foliage at zero light level) with small chamber (for 10-15 needles 1-year-old) and LI-6400 to generate the light response curves (monthly basis from June to August in 2006 and additional in April, May, September, and November in 2007); in mid-canopy, replicates not reported. Interannual variability of leaf respiration was assumed to be small⁵³.

Understory: not measured

Coarse woody debris: debris stock mass multiplied by a decomposition rate from literature⁵⁴

Scaling

Soil⁵³:

TEMPORAL: model between respiration and temperature, precipitation, mean thickness of the forest floor horizon (cm) and carbon-to-nitrogen ratio of the forest floor

SPATIAL: basic calculation

Stem⁵³:

TEMPORAL :model between respiration and temperature, precipitation and DBH

SPATIAL: sapwood volume (considering also BRANCHES)

Leaves⁵³:

TEMPORAL: model between respiration and temperature, precipitation, VPD and PAR

SPATIAL: surface area of needles / LAI

Soil – heterotrophic component⁵⁴:

TEMPORAL: model between respiration and temperature

SPATIAL: basic calculation

TurkeyPointTP89

*Net primary production*⁵⁴

Stem and branches: allometry + accounting branch/tree mortality, 2006

Coarse roots: allometry, 2006

Leaves: allometry+ litter traps, 2006

Fine roots: fine root biomass stock + fine root turnover rate as average of three methods: mass balance approach of Raich and Nadelhoffer (1989)¹⁰³, relationship between available N from mineralization following Aber et al. (1985)¹⁰⁴, and fixed turnover rate (0.60 yr⁻¹) from the literature.

Understory: allometry + harvesting for grasses, 2006

Herbivory: from literature, 2006

Respiration^{53,54}

Methods

Soil: chambers + LI-6400 photosynthesis system (monthly basis from 1 January 2006 to 31 December 2006); replicates: n=12⁵³

Fine root respiration: derived from ratio Rroot: Rh-soil from trenching experiment⁵⁴ and total soil respiration⁵³

Soil – heterotrophic component: Rsoil - Rroot

Stem: soil chambers + LI-6400 (monthly basis, from April to November 2006)⁵³

Leaves: dark foliar gas exchange measurement (i.e. net CO₂ exchange of foliage at zero light level) with small chamber (for 10-15 needles 1-year-old) and LI-6400 to generate the light response curves (monthly basis from June to August in 2006); mid-canopy for 2-3 trees. Interannual variability of leaf respiration was assumed to be small⁵³

Understory: negligible

Coarse woody debris: debris stock mass multiplied by a decomposition rate from literature⁵⁴

Scaling

Soil⁵³:

TEMPORAL: model between respiration and temperature, precipitation, mean thickness of the forest floor horizon (cm) and carbon - to - nitrogen ratio of the forest floor

SPATIAL: basic calculation

Stem⁵³:

TEMPORAL :model between respiration and temperature, precipitation and DBH

SPATIAL: sapwood volume (considering also BRANCHES)

Leaves⁵³:

TEMPORAL: model between respiration and temperature, precipitation, VPD and PAR

SPATIAL: surface area of needles / LAI

Soil – heterotrophic component⁵⁴:

TEMPORAL: model between respiration and temperature

SPATIAL: basic calculation

TurkeyPointTP74

*Net primary production*⁵⁴

Stem and branches: allometry + accounting branch/tree mortality, 2006

Coarse roots: allometry, 2006

Leaves: allometry+ litter traps, 2006

Fine roots: fine root biomass stock + fine root turnover rate as average of three methods: mass balance approach of Raich and Nadelhoffer (1989)¹⁰³, relationship between available N from mineralization following Aber et al. (1985)¹⁰⁴, and fixed turnover rate (0.60 yr⁻¹) from the literature.

Understory: allometry + harvesting for grasses, 2006

Herbivory: from literature, 2006

Respiration^{53,54}

Methods

Soil: chambers + LI-6400 photosynthesis system (monthly basis from 1 January 2006 to 31 December 2006); replicates: n=12⁵³

Fine root respiration: derived from ratio Rroot: Rh soil from trenching experiment⁵⁴ and total soil respiration⁵³

Soil – heterotrophic component: Rsoil - Rroot

Stem: soil chambers + LI-6400 (monthly basis, from April to November 2006)⁵³

Leaves: dark foliar gas exchange measurement (i.e. net CO₂ exchange of foliage at zero light level) with small chamber (for 10-15 needles 1-year-old) and LI-6400 to generate the light response curves (monthly basis from June to August in 2006); mid-canopy for 2-3 trees. Interannual variability of leaf respiration was assumed to be small⁵³

Understory: not measured

Coarse woody debris: debris stock mass multiplied by a decomposition rate from literature⁵⁴

Scaling

Soil⁵³:

TEMPORAL: model between respiration and temperature, precipitation, mean thickness of the forest floor horizon (cm) and carbon-to-nitrogen ratio of the forest floor

SPATIAL: basic calculation

Stem⁵³:

TEMPORAL :model between respiration and temperature, precipitation and DBH

SPATIAL: sapwood volume (considering also BRANCHES)

Leaves⁵³:

TEMPORAL: model between respiration and temperature, precipitation, VPD and PAR

SPATIAL: surface area of needles / LAI

Soil – heterotrophic component⁵⁴:

TEMPORAL: model between respiration and temperature

SPATIAL: basic calculation

TurkeyPointTP39

*Net primary production*⁵⁴

Stem and branches: allometry + accounting branch/tree mortality, 2006

Coarse roots: allometry, 2006

Leaves: allometry+ litter traps, 2006

Fine roots: fine root biomass stock + fine root turnover rate as average of three methods: mass balance approach of Raich and Nadelhoffer (1989)¹⁰³, relationship between available N from mineralization following Aber et al. (1985)¹⁰⁴, and fixed turnover rate (0.60 yr⁻¹) from the literature.

Understory: allometry + harvesting for grasses, 2006

Herbivory: from literature, 2006

Respiration^{53 54}

Methods

Soil: chambers + LI-6400 photosynthesis system (monthly basis from 1 January 2006 to 31 December 2006); replicates: n=12⁵³

Fine root respiration: derived from ratio Rroot: Rh-soil from trenching experiment⁵⁴ and total soil respiration⁵³

Soil – heterotrophic component: Rsoil - Rroot

Stem: soil chambers + LI-6400 (monthly basis, from April to November 2006)⁵³

Leaves: dark foliar gas exchange measurement (i.e. net CO₂ exchange of foliage at zero light level) with small chamber (for 10-15 needles 1-year-old) and LI-6400 to generate the light response curves (monthly basis from June to August in 2006; additionally in April, May, September, and November in 2007); mid-canopy for 2-3 trees. Interannual variability of leaf respiration was assumed to be small⁵³

Understory: not measured

Coarse woody debris: debris stock mass multiplied by a decomposition rate from literature⁵⁴

Scaling

Soil⁵³:

TEMPORAL: model between respiration and temperature, precipitation, mean thickness of the forest floor horizon (cm) and carbon-to-nitrogen ratio of the forest floor

SPATIAL: basic calculation

Stem⁵³:

TEMPORAL :model between respiration and temperature, precipitation and DBH

SPATIAL: sapwood volume (considering also BRANCHES)

Leaves⁵³

TEMPORAL: model between respiration and temperature, precipitation, VPD and PAR

SPATIAL: surface area of needles / LAI

Soil – heterotrophic component⁵⁴:

TEMPORAL: model between respiration and temperature

SPATIAL: basic calculation

University of Michigan

*Net primary production*⁵⁵

Stem and branches: allometry

Coarse roots: allometry

Leaves: litter traps

Fine roots: standing fine root biomass + turnover, with turnover as average of 3 methods: (1) from minirhizotron at the site, (2) N model of Aber et al. (1985)¹⁰⁴ and (3) mass balance approach of Raich and Nadelhoffer (1989)¹⁰³

Understory: WOOD: allometry but saplings < 10 cm DBH not measured – LEAVES: allometry

Branch turnover: measured through surveys of net coarse woody debris production

Herbivory: considered

Respiration

Methods

Soil: chambers + gas analyzer (LI-COR LI-6400) (along year and also with snow with frequency every 3 days in summer to every 30 days in winter); replicates: n=3 collars in 8 plots⁵⁶

Fine roots: Rs – Rh (see below)

Stem: chambers + gas analyzer (multiple times along 1999-2001); replicates: n=1-9 trees of 5 species⁵⁶

Leaves: MAINTENANCE: gas exchange detached leaves at night on fully expanded leaves (in 1999-2001 on multiple times varying from 1 to 9 per species); replicates: 6 leaves in upper and 6 leaves in lower canopy of 2-3 trees for 4 overstory species and 2 understory species.

GROWTH: from biomass and fixed coefficient⁵⁶

Understory: WOOD: not measured; LEAVES: measured⁵⁶

Soil – heterotrophic component: using the component integration method, with soil taken from the site and analyzed for respiration in laboratory⁵⁵

Coarse woody debris: not measured.

*Scaling*⁵⁶

Soil:

TEMPORAL: function of temperature and soil water content developed for three periods (early season, late season, winter)

SPATIAL: test between measuring plots and entire EC footprint

Stem:

TEMPORAL: function of temperature and developed for three periods (early season, late season, winter) with uncommon formulation for equations

SPATIAL: sapwood volume (including BRANCHES)

Leaves:

TEMPORAL: function of temperature

SPATIAL: leaf area

Walker Range

Net primary production^{57,58}

Stem and branches: allometry

Coarse roots: assumed 20% of aboveground wood increment

Leaves: litter traps

Fine roots: minirhizotron + fine root biomass

Understory: saplings: allometry; herbs: negligible

Reproductive material: accounted for

Herbivory: accounted for

Twigs: accounted for

VOC: negligible

Respiration (from Edwards and Hanson 2003⁵⁸ and Hanson et al 2003⁵⁷; otherwise indicated)

Methods

Soil: chamber + gas analyzer (weekly or be-weekly 1992-1999); replicates: n=30

Fine roots: as 50% of soil respiration from generic/general relationships⁹⁷

Soil – heterotrophic component: Rsoil - Rroots

Stem: chambers + infrared gas analysis. OVERSTORY: measurements taken through the year for both growing and non-growing season from 8.00-16.00 h; replicates: 6 trees for 3 species in 1993-1996, 6 trees for 1 species 1998-2000, with trees with different DBH on both north/south side. UNDERSTORY: measurements through the year; replicates: 10 trees for 2 species in 1994-1995. Estimates MAINTENANCE and GROWTH respiration both available based on non-growing season data (when only maintenance) applied to growing season (when both maintenance and growth) and/or growth derived from tissue construction factor.

Branches: chambers + infrared gas analysis (both for growing and non-growing season in 1997-1999); branches 1 year-old with diameter 1-2 cm; 1-2 branches of 1-3 trees of 3 species. Estimates MAINTENANCE and GROWTH respiration both available as for stem (see above).

Leaves: MAINTENANCE: chambers + infrared analysis on cut branches and/or in situ with dark chambers (measurements late summer after completion leaf growth in 1995, 1997 and 1999; n=3-40 leaves per species from mid-canopy, 4 overstory and 3 understory species); GROWTH: dry mass multiplied by factor

Understory: accounted for (see above in stem/leaves)

Coarse woody debris: assumed 10% of dead wood pool

Scaling (from Edwards and Hanson 2003⁵⁸ and Hanson et al 2003⁵⁷, otherwise indicated)

Soil:

TEMPORAL: based on temperature and soil water¹¹³

SPATIAL: basic calculation

Stem/branches:

TEMPORAL: temperature response function based on Q₁₀ at the site

SPATIAL: wood volume

Leaves

TEMPORAL: temperature response function based on Q₁₀ at a nearby similar site

SPATIAL: LAI

Willow Creek

Net primary production

Stem and branches: allometry, 1989-1999²⁰

Coarse roots: 20% above ground wood production²⁰

Leaves: litter traps, 1989-1999²⁰

Fine roots: average of two methods: empirical model of Aber et al. 1985^{20,104} and measured standing stock + turnover from similar sites⁵⁹

Understory: allometry for woody plants + harvest for herbaceous plants²⁰

Respiration

Methods

Soil: chambers + infrared gas analyzer (IRGA, LiCor) (monthly when the ground was not snow-covered in 2001-2002); replicates: n=32⁵⁹

Fine roots: empirical model based on temperature and root tissue N concentration for similar sites^{59,114}

Soil – heterotrophic component: Rsoil - Rroots

Stem: chambers + infrared gas analyzer (from May to November 2002); replicates: 20 trees (6-8 for 3 species) of various DBH, random azimuth⁵⁹

Coarse roots: not measured

Leaves: MAINTENANCE: gas exchange system on cut branches performed in dark (period full leaf expansion – thus mid-late summer, measured at predawn); replicates: 40 leaves per species for 3 dominant species, leaves from low, mid and high positions in the canopy;

GROWTH: mass-based empirical model⁵⁹

Understory: not measured

Coarse woody debris: chambers and ground survey⁶⁰

Scaling

Soil:

TEMPORAL: model dependent on temperature and soil water content based on site measurements⁵⁹

SPATIAL: basic calculation

Stem:

TEMPORAL: classical Q₁₀ model dependent on temperature and based on site measurements⁵⁹

SPATIAL: sapwood volume (considering also BRANCHES)

Leaves:

TEMPORAL: Q₁₀ model dependent on temperature and also with acclimation^{59,91}

SPATIAL: leaf biomass

Wind River

*Net primary production*⁶²

Stem and branches: allometry, 1995-1999

Coarse roots: allometry, 1995-1999

Leaves: litter traps, 1997-1999

Fine roots: standing biomass + turnover measured on site (data period 1999-2000)

Understory: accounted for

Herbivory: accounted for in 1995, 1996 and 1999

Epiphytes: accounted for

*Respiration*⁶²

Methods

Soil: chambers + infrared gas analyzer (April, June, August and October 1997 and January 1998); replicates: n=8, probably done for portions with bare soil and no living roots.

Soil – heterotrophic component: component integration method⁹⁷. Rh-soil divided into three portions: (i) litter (measured: standing biomass and decomposition rate with litterbags or literature), (ii) dead roots (measured: standing biomass and decomposition rate with litterbags or literature) and (iii) mineral soil (respiration mineral soil = $R_{soil} - R_{litter} - R_{dead\ roots}$)

Coarse woody debris: surveys + decomposition derived in situ from difference in standing dead wood at two different times; respiration coarse woody debris includes also respiration of stem heart-rot obtained from surveys and assuming same decomposition rate for coarse woody debris.

Scaling:

Soil:

TEMPORAL: not accounted for

SPATIAL: amount of soil

Wytham Woods

*Net primary production*⁶³

Stem and branches: allometry, 2008

Coarse roots: assumed 20% of aboveground woody production

Leaves: litter traps, 2008

Fine roots: indirectly derived for 2008 from total belowground C allocation method (TBCA) having/assuming all other components

Understory: not measured

Reproductive material: litter traps, 2008

*Respiration*⁶³

Methods

Soil: soil chambers + portable infra-red gas analysis (IRGA) (monthly per year); replicates: n=30-35.

Fine roots: Rsoil – Rh-soil

Soil – heterotrophic component: root exclusion method: measurements on bags with mesh size stopping roots (April-Nov 2008)¹¹⁵

Stem: adapted soil chambers + portable infra-red gas analysis (IRGA) (monthly from April to November 2008 always same moment, the morning); replicates: n=8 for 2 species.

Leaves: no info on method (measurements on one occasion in 2001, night); replicates: 20 measurements (for shade and sun leaves) on 5 trees for 2 dominant species (data for other species derived from data for dominant species); PHOTOINHIBITION accounted for

Understory: not measured

Rh CWD: MAG – FCWD, with MAG the mean annual production of aboveground coarse woody debris (CWD) and FCWD is the CWD fraction entering the soil

Scaling

Soil:

TEMPORAL: fixed: monthly values determined from measurements during that month

SPATIAL: basic calculation

Stem:

TEMPORAL: fixed: monthly values determined from measurements during that month, with November taken for the winter period

SPATIAL: stem area (assumed based on literature) with branches accounted for

Leaves:

TEMPORAL: relationship with temperature with Q_{10} assumed as equal to 2

SPATIAL: leaf area index

Xishuangbanna

*Net primary production*⁶⁵

Stem and branches: allometry, 2003-2006

Coarse roots: allometry, 2003-2006

Leaves: litter traps, 2003-2006

Fine roots: sequential soil coring (no info about years)

Understory: allometry+ litter traps, 2003-2006

Reproductive material: litter traps, 2003-2006

Twigs: litter traps, 2003-2006

Epiphytes: litter traps, 2003-2006

Respiration^{65,116}

Methods

Soil: chambers + gas chromatographic analysis (once a week at 09.00-11.00 am for whole year, 2003-2007); replicates: n=6.

Fine root respiration: R_{soil} – R_{h-soil}

Soil – heterotrophic component: trenching

Stem: chambers + infrared gas analyzer Li-820 LI-COR (January, April, June and October, no info on years); replicates: 5 trees for 10 species (north and south faces separately).

Leaves: portable photosynthesis system Li-6400 (January, April, June and October, no info on years); replicates: 3 trees, 3 layers per trees, and 3 leaves per layer + 3 leaves on saplings.

Coarse roots: respiration per unit root biomass assumed equal as the one of stem biomass

Understory: comprised in other compartments (Stem and Leaves)

Coarse woody debris: empirical relationship ($R_h\text{-cwd} = k \times (\text{total cwd carbon density})$) independent to decay class and other environmental factors and with parameters from literature

Scaling

Soil:

TEMPORAL: function temperature¹¹⁶

SPATIAL: basic calculation

Stem:

TEMPORAL: temperature response function

SPATIAL: sapwood volume

Leaves:

TEMPORAL: temperature response function

SPATIAL: LAI

Coarse woody debris:

TEMPORAL: fixed (see above)

SPATIAL: derived from inventory of standing dead wood

Yamashiro

*Net primary production*⁶⁶

Stem and branches: allometry, 1999-2003

Coarse roots: allometry, 1999-2003

Leaves: litter traps, 1999-2003

Fine roots: indirectly derived from site measurements of soil C fluxes

Understory: allometry for woody vegetation and destructive sampling for herbaceous vegetation

Branch turnover: taken into account

*Respiration*⁶⁶

Methods

Soil: chambers + IRGA (from one to four times per month, for a total of 74 times from July 2002 to May 2003; extra measurements on 4 occasions in summer 2002 on a larger sample size); replicates: n=96 (for entire period) and n=264 (for 4 occasions in summer 2002).

Fine roots: automated chambers + IRGA; measurements in situ on attached roots from April 2004 to September 2005

Soil – heterotrophic component: Rsoil - Rroot

Coarse woody debris: surveys + respiration measurements

Scaling

Soil:

TEMPORAL: function of temperature and water content

SPATIAL: basic calculation

Fine roots:

TEMPORAL: function temperature¹¹⁷

SPATIAL: relationship between Rroot and root diameter, using probably root biomass

Coarse woody debris:

TEMPORAL: function based on temperature and moisture

SPATIAL: debris size and C density

Yatir

Net primary production

No data available meeting quality standard for our analysis

Respiration

Methods (in our analysis data used from October 2001 to September 2002)

Soil: chambers + LI-6400 system (from October 2000 to September 2006; regular measurements performed between midday and early afternoon, while 16- to 24-h cycles measurements carried out periodically); replicates: n=29 collars⁶⁷

Fine roots: not available

Soil – heterotrophic component: not available

Stem: chambers + LI-6400 analyzer (46 occasions between March 2002 and April 2005, in afternoon between 14:00 and 16:00; on some days repeated measurements made at different times through the diurnal cycle); replicates: n=12 trees⁶⁸

Leaves: LI6400-05 Conifer Chamber + LI-COR LI6400 portable photosynthesis system (measurements between March 2002 and October 2004, mainly in night); replicates: n=6-12 trees, measurements on current and previous year needles⁶⁸

Understory: not measured

Coarse woody debris: not measured

Scaling

Soil⁶⁷:

TEMPORAL: relationship with water content, temperature and PPFD

SPATIAL: corrected for rock-covered surface area

Stem⁶⁸:

TEMPORAL: temperature response function

SPATIAL: wood area (considering also BRANCHES)

Leaves⁶⁸:

TEMPORAL: temperature response

SPATIAL: projected leaf area

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