

Supplementary Materials

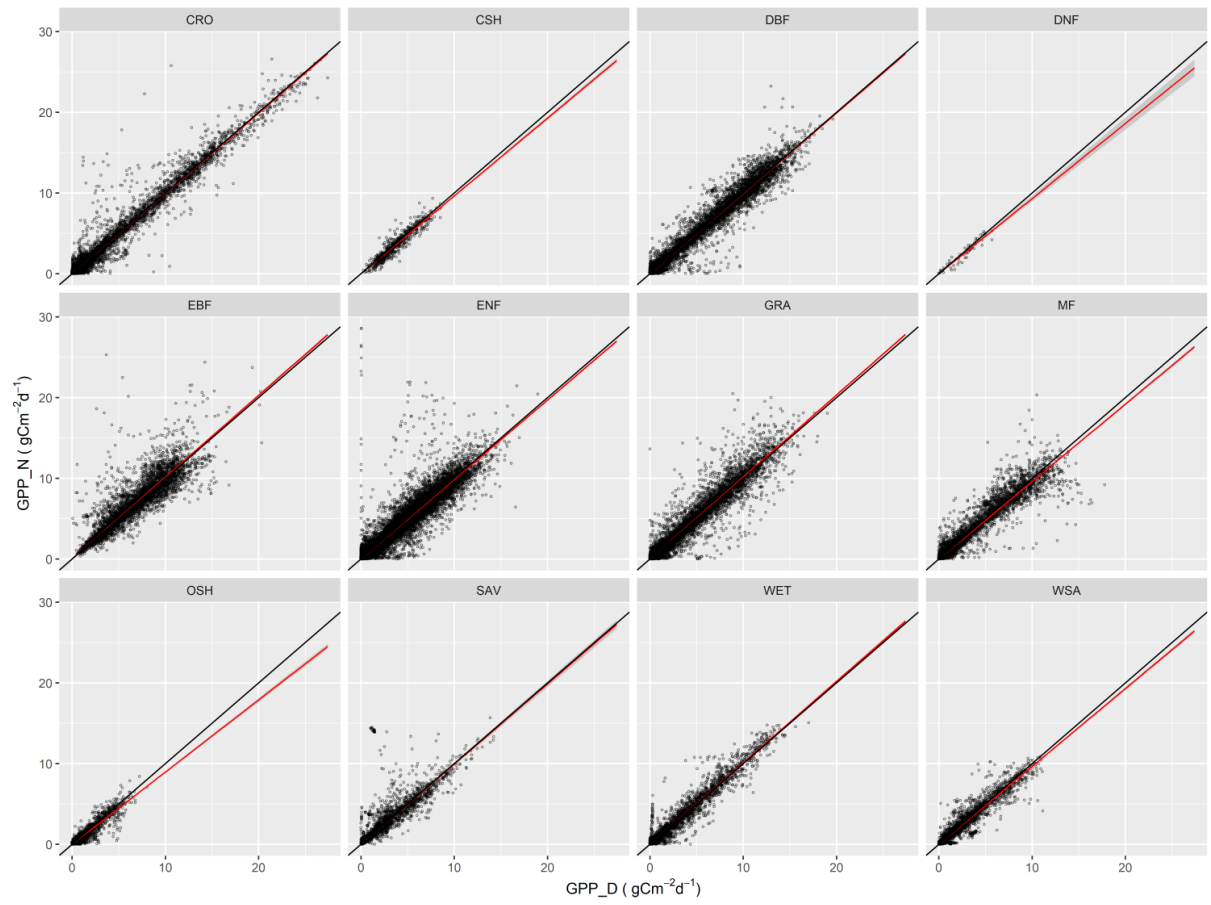


Figure S1 There are significant difference between GPP_N and GPP_D across all 12 biomes except EBF and WET.

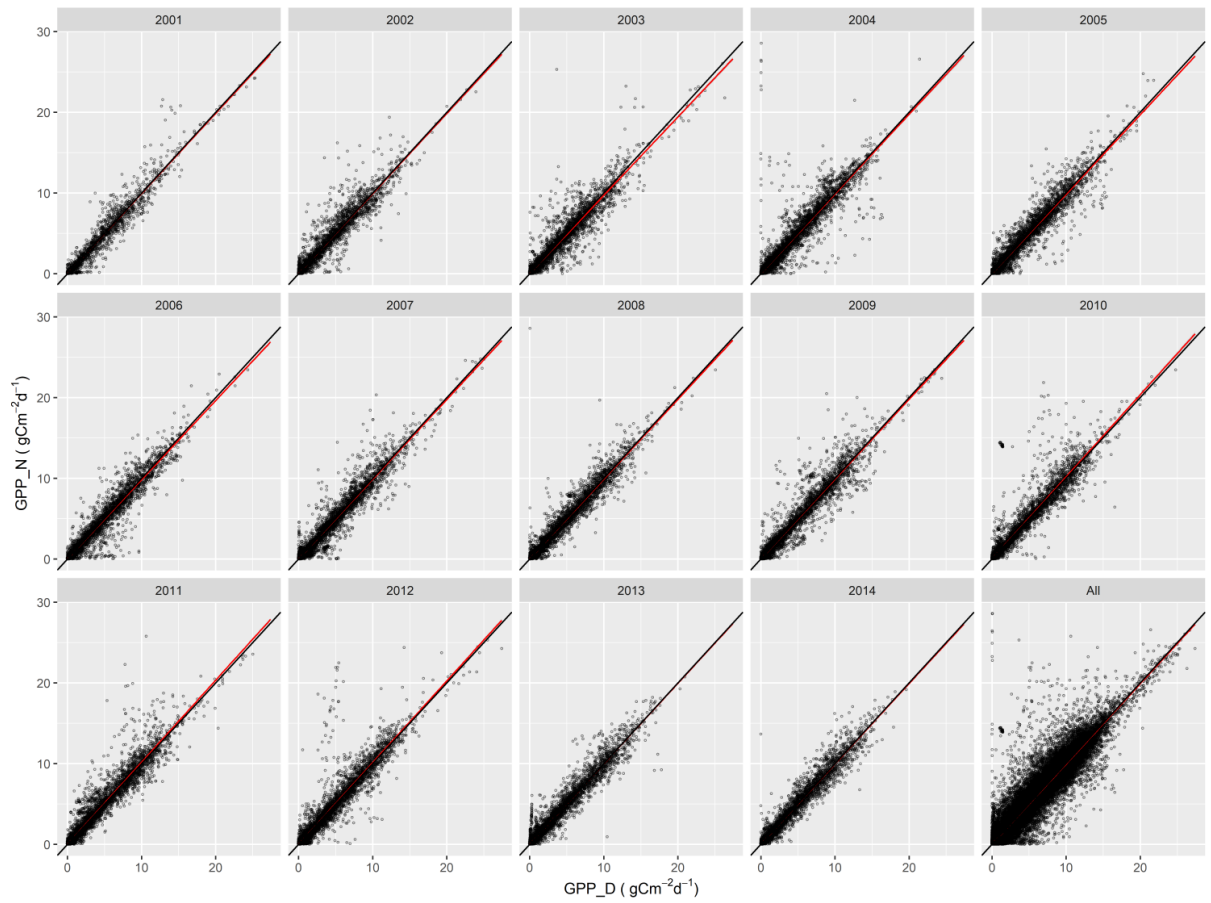


Figure S2. There are significant difference between GPP_N and GPP_D across all 14 years except 2011, 2012 and 2014.

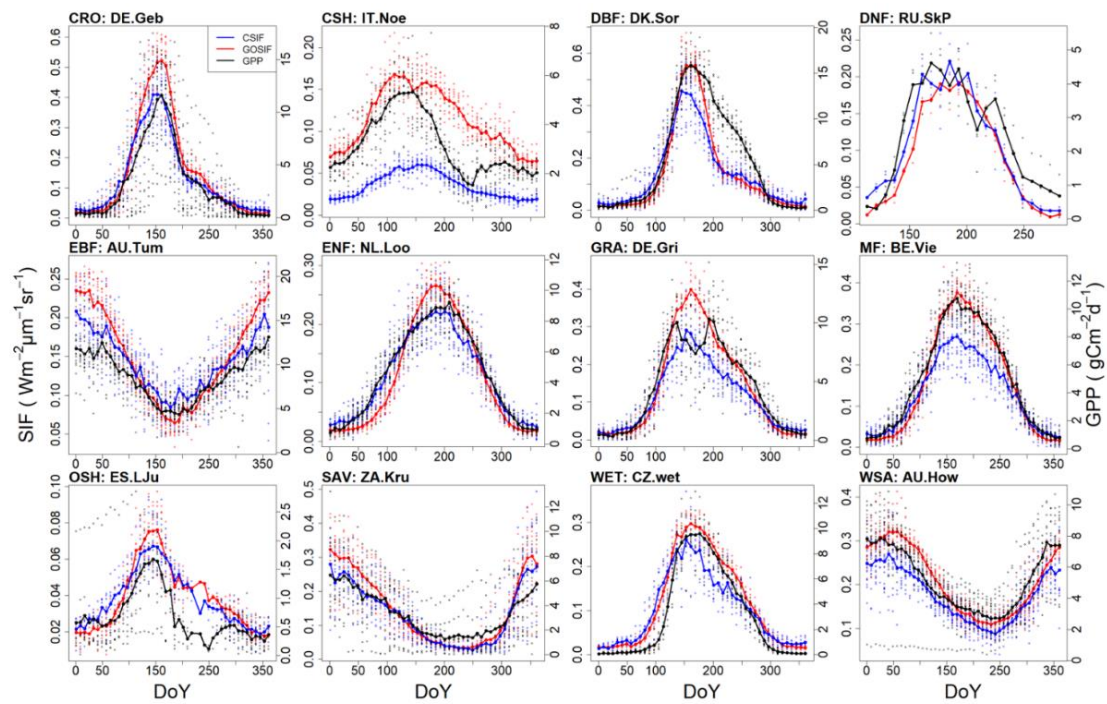


Figure S3. Annual change of SIFc (GOSIF (red) and CSIF (blue)) and GPP (black) for 12 biomes at site level.

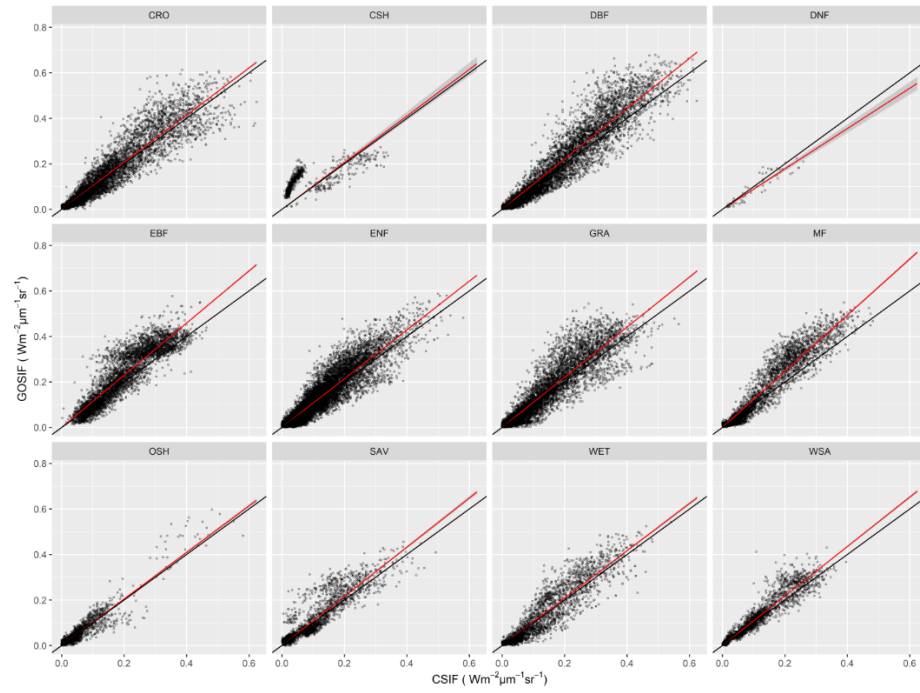


Figure S4. There are significant differences between GOSIF and CSIF across all 12 biomes except CSH.

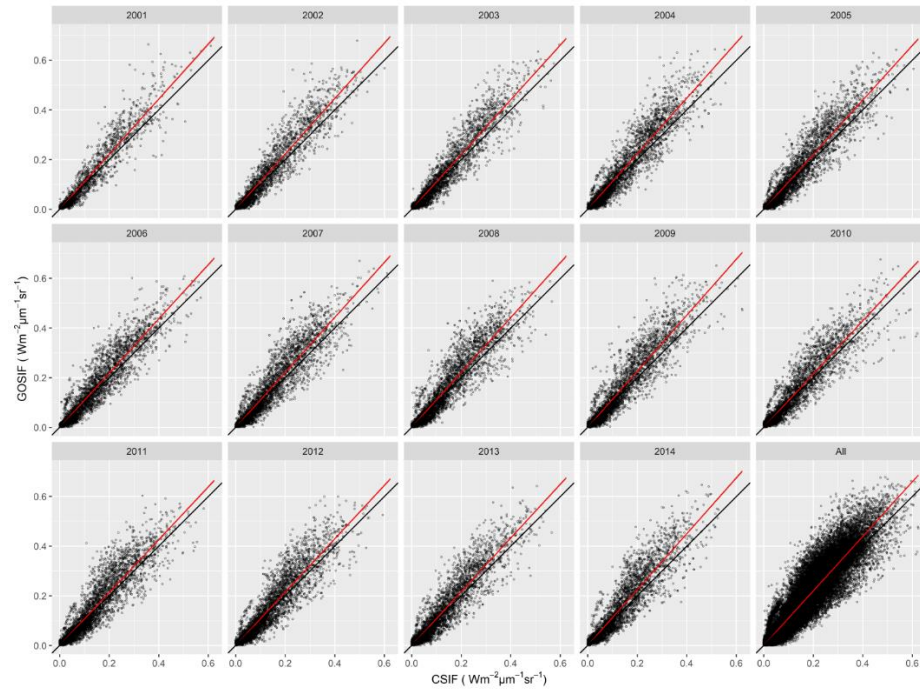


Figure S5. There are significant differences between GOSIF and CSIF across all 14 years.

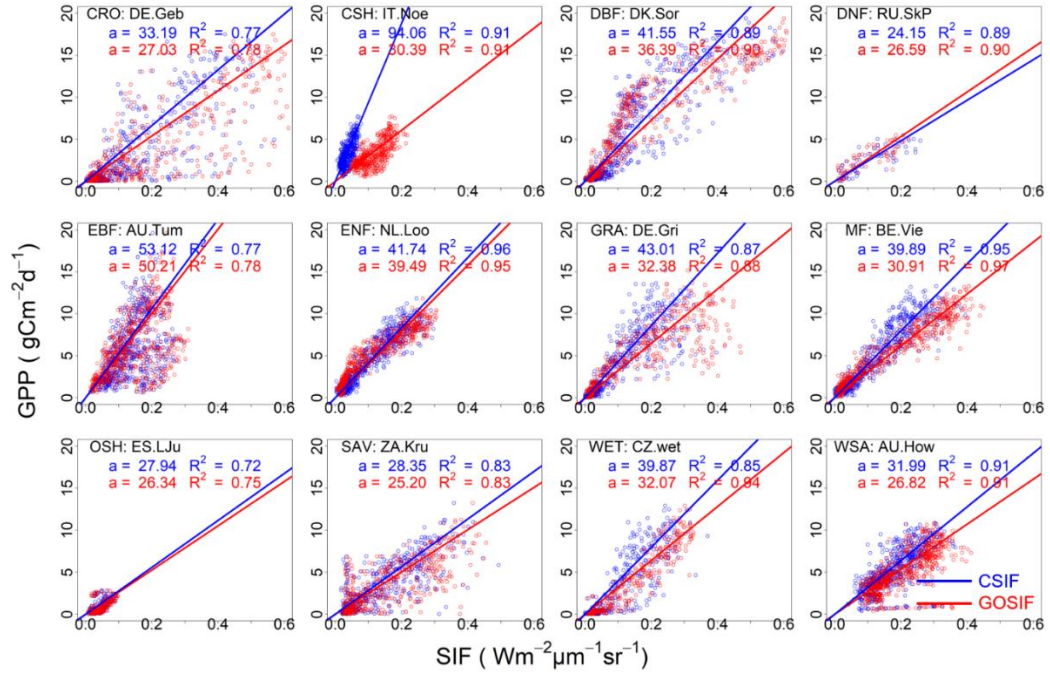


Figure S6. Scatter plots and linear regression of GPP_M and SIFc (CSIF and GOSIF) for 12 individual biomes at site level ($p < 0.001$).

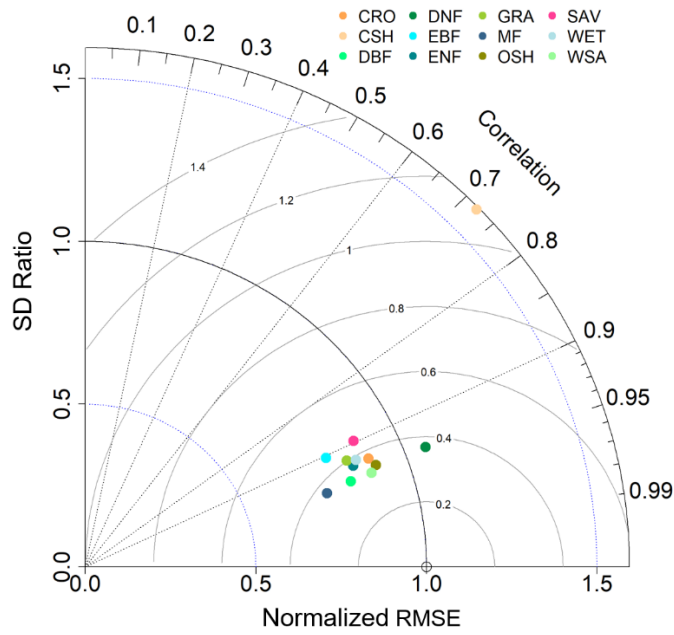


Figure S7. The Taylor diagram showing the difference between CSIF and GOSIF across 12 biomes. Color dots represent GPP in the corresponding legend pie. Taylor diagram is a polar graph in which the cosine of the angle between the X-axis is the correlation coefficient between Flux-GPP and modeled GPP (from CSIF and GOSIF). The radial direction is standard deviation (SD). The grey arcs represent RMSE.

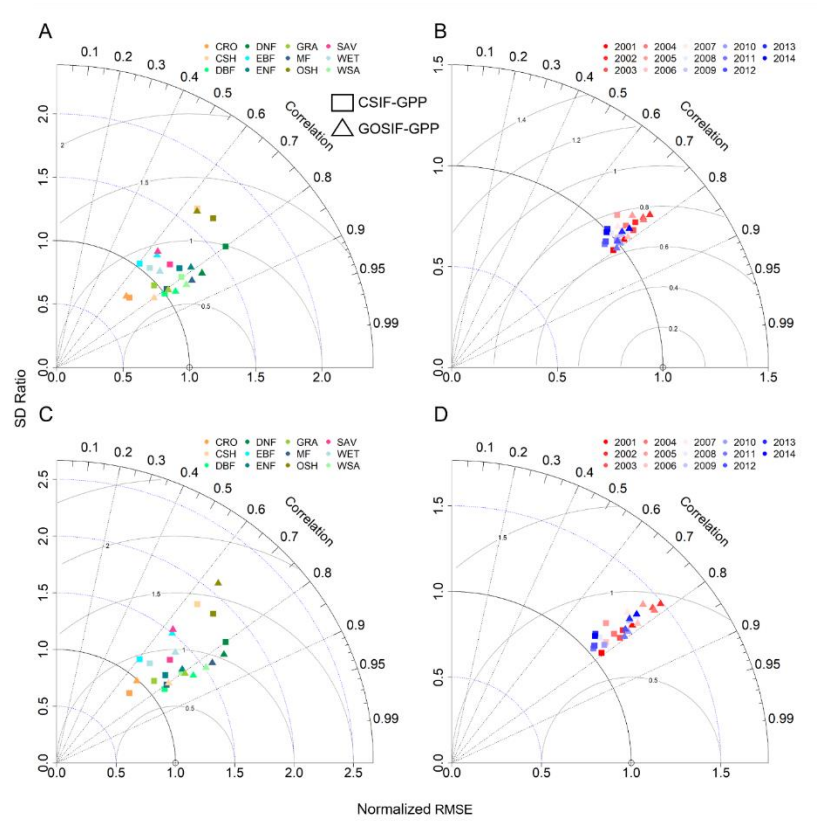


Figure S8. The Taylor diagram showing the performance of CSIF_GPP and GOSIF_GPP with Flux_GPP across 12 biomes (A, C) and 14 years (B, D). A and B for median value based two-slope scheme, C and D for mean value based two-slope scheme. Taylor diagram is a polar graph in which the cosine of the angle between the X-axis is the correlation coefficient between Flux-GPP and modeled GPP (from CSIF and GOSIF). The radial direction is the ratio of standard deviation. The grey arcs represent normalized RMSE for each model.

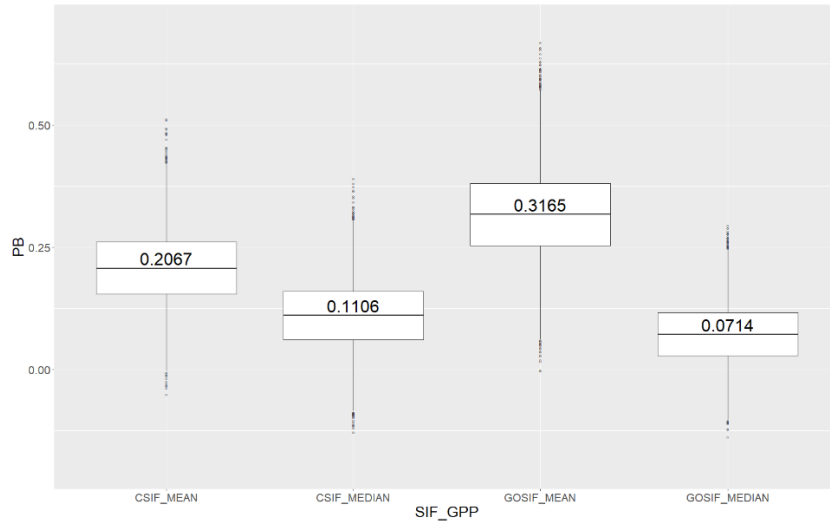


Figure S9. PB distribution of SIF_GPP with EC_GPP among different SIF_GPP derived two-slope schemes. PB represents Percentage Bias ($[\text{sum}(\text{SIF_GPP}) - \text{sum}(\text{EC_GPP})] / \text{sum}(\text{EC_GPP})$) for each SIF_GPP and EC_GPP combination. CSIF_MEAN and CSIF_MEDIAN mean SIF_GPP derived from CSIF with two-slope scheme based on mean values and median values, respectively. GOSIF_MEAN and GOSIF_MEDIAN mean SIF_GPP derived from GOSIF with two-slope scheme based on mean values and median values, respectively. Each box represents a 10 thousand times random sampling, and each sampling used 80% of the total sites (165) for calibration and 20% (43) sites for validation. And the solid line with corresponding value above represents the median value of each box. There were significant differences among all the groups ($p < 0.001$).

Table S1. Introduction of three ecosystem carbon cycle indicators that used in this study. They are GPP_N, GPP_D and GPP_M.

Abbreviation	Indicator name	Description
GPP_N	GPP_NT_VUT_MEAN	From Nighttime partitioning method, average from GPP versions, each from corresponding NEE_VUT_XX version
GPP_D	GPP_DT_VUT_MEAN	From Daytime partitioning method, average from GPP versions, each from corresponding NEE_VUT_XX version
GPP_M	GPP_MEAN	The averaged value from both GPPd and GPPn.

Table S2 208 of 212 FLUXNET2015 Tier-1 sites used in this study. Site descriptions includes site ID, site name, years of data available, latitude, longitude, biome type and correlation coefficient between EC_GPP with CSIF and GOSIF.

ID	SITE_ID	SITE_NAME	Year	LAT	LONG	IGBP	C3/C4	Cor-GOSIF	Cor-CSIF
1	AR-SLu	San Luis	2009-2011	-33.4648	-66.4598	MF		0.53	0.5
2	AR-Vir	Virasoro	2009-2012	-28.2395	-56.1886	ENF		0.79	0.75
3	AT-Neu	Neustift	2002-2012	47.11667	11.3175	GRA		0.79	0.69
4	AU-Ade	Adelaide River	2007-2009	-13.0769	131.1178	WSA		0.67	0.68
5	AU-ASM	Alice Springs	2010-2013	-22.283	133.249	ENF		0.86	0.87
6	AU-Cpr	Calperum	2010-2014	-34.0021	140.5891	SAV		0.8	0.76
7	AU-Cum	Cumberland Plain	2012-2014	-33.61518	150.72362	EBF		0.64	0.59
8	AU-DaP	Daly River Savanna	2007-2013	-14.0633	131.3181	GRA		0.79	0.81
9	AU-DaS	Daly River Cleared	2008-2014	-14.1593	131.3881	SAV		0.79	0.81
10	AU-Dry	Dry River	2008-2014	-15.2588	132.3706	SAV		0.66	0.68
11	AU-Emr	Emerald	2011-2013	-23.8587	148.4746	GRA		0.43	0.63
12	AU-Fog	Fogg Dam	2006-2008	-12.5452	131.3072	WET		0.82	0.78
13	AU-Gin	Gingin	2011-2014	-31.3764	115.7138	WSA		0.56	0.47
14	AU-GWW	Great Western Woodlands	2013-2014	-30.1913	120.6541	SAV		0.05	-0.04
15	AU-How	Howard Springs	2001-2014	-12.4943	131.1523	WSA		0.7	0.71
16	AU-Lox	Loxton	2008-2009	-34.4704	140.6551	DBF		-0.28	-0.09
17	AU-RDF	Red Dirt Melon Farm	2011-2013	-14.5636	132.4776	WSA		0.4	0.45
18	AU-Rig	Riggs Creek	2011-2014	-36.6499	145.5759	GRA		0.89	0.94
19	AU-Rob	Robson Creek, Queensland, Australia	2014-2014	-17.1175	145.6301	EBF		0.33	0.29
20	AU-Stp	Sturt Plains	2008-2014	-17.1507	133.3502	GRA	C4	0.63	0.56
21	AU-TTE	Ti Tree East	2012-2013	-22.287	133.64	OSH		0.85	0.95
22	AU-Tum	Tumbarumba	2001-2014	-35.6566	148.1517	EBF		0.79	0.67
23	AU-Wac	Wallaby Creek	2005-2008	-37.4259	145.1878	EBF		0.65	0.57
24	AU-Whr	Whroo	2011-2014	-36.6732	145.0294	EBF		0.71	0.56
25	AU-Wom	Wombat	2010-2012	-37.4222	144.0944	EBF		0.87	0.83
26	AU-Ync	Jaxa	2012-2014	-34.9893	146.2907	GRA		0.92	0.88
27	BE-Bra	Brasschaat	1996-2014	51.30761	4.51984	MF		0.91	0.89
28	BE-Lon	Lonzee	2004-2014	50.5516	4.74613	CRO	C3	0.68	0.66
29	BE-Vie	Vielsalm	1996-2014	50.30496	5.99808	MF		0.96	0.92
30	BR-Sa1	Santarem-Km67-Primary Forest	2002-2011	-2.85667	-54.95889	EBF		0.27	0.26
31	BR-Sa3	Santarem-Km83-Logged Forest	2000-2004	-3.01803	-54.97144	EBF		0.21	0.02
32	CA-Gro	Ontario - Groundhog River	2003-2014	48.2167	-82.1556	MF		0.89	0.87
33	CA-Man	Manitoba - Northern	1994-2008	55.87962	-98.48081	ENF		0.46	0.46
34	CA-NS1	UCI-1850 burn site	2001-2005	55.87917	-98.48389	ENF		0.82	0.81
35	CA-NS2	UCI-1930 burn site	2001-2005	55.90583	-98.52472	ENF		0.82	0.79
36	CA-NS3	UCI-1964 burn site	2001-2005	55.91167	-98.38222	ENF		0.89	0.85
37	CA-NS4	UCI-1964 burn site wet	2002-2005	55.91437	-98.380645	ENF		0.81	0.73
38	CA-NS5	UCI-1981 burn site	2001-2005	55.86306	-98.485	ENF		0.86	0.83
39	CA-NS6	UCI-1989 burn site	2001-2005	55.91667	-98.96444	OSH		0.86	0.83

40	CA-NS7	UCI-1998 burn site	2002-2005	56.63583	-99.94833	OSH		0.87	0.82
41	CA-Oas	Saskatchewan - Western Boreal	1996-2010	53.62889	-106.19779	DBF		0.97	0.95
42	CA-Obs	Saskatchewan - Western Boreal	1997-2010	53.98717	-105.11779	ENF		0.93	0.91
43	CA-Qfo	Quebec - Eastern Boreal	2003-2010	49.6925	-74.34206	ENF		0.89	0.86
44	CA-SF1	Saskatchewan - Western Boreal	2003-2006	54.48503	-105.81757	ENF		0.88	0.89
45	CA-SF2	Saskatchewan - Western Boreal	2001-2005	54.25392	-105.8775	ENF		0.89	0.9
46	CA-SF3	Saskatchewan - Western Boreal	2001-2006	54.09156	-106.00526	OSH		0.93	0.91
47	CA-TP1	Ontario - Turkey	2002-2014	42.66093611	-80.55951944	ENF		0.65	0.63
48	CA-TP2	Ontario - Turkey	2002-2007	42.77441944	-80.458775	ENF		0.78	0.78
49	CA-TP3	Ontario - Turkey	2002-2014	42.70681111	-80.34831389	ENF		0.85	0.84
50	CA-TP4	Ontario - Turkey	2002-2014	42.710161	-80.357376	ENF		0.83	0.86
51	CA-TPD	Ontario - Turkey	2012-2014	42.635328	-80.557731	DBF		0.89	0.95
52	CG-Tch	Tchizalamou	2006-2009	-4.28917	11.65642	SAV		0.51	0.54
53	CH-Cha	Chamau	2005-2014	47.21022	8.41044	GRA		0.84	0.81
54	CH-Dav	Davos	1997-2014	46.81533	9.85591	ENF		0.73	0.73
55	CH-Fru	Früebüel	2005-2014	47.11583	8.53778	GRA		0.9	0.88
56	CH-Lae	Laegern	2004-2014	47.47808	8.365	MF		0.94	0.89
57	CH-Oe1	Oensingen grassland	2002-2008	47.28583	7.73194	GRA		0.77	0.76
58	CH-Oe2	Oensingen crop	2004-2014	47.28631	7.73433	CRO		0.62	0.63
59	CN-Cha	Changbaishan	2003-2005	42.4025	128.0958	MF		0.97	0.92
60	CN-Cng	Changling	2007-2010	44.5934	123.5092	GRA		0.92	0.93
61	CN-Dan	Dangxiong	2004-2005	30.4978	91.0664	GRA		0.82	0.81
62	CN-Din	Dinghushan	2003-2005	23.1733	112.5361	EBF		0.57	0.62
63	CN-Du2	Duolun_grassland (D01)	2006-2008	42.0467	116.2836	GRA		0.78	0.8
64	CN-Du3	Duolun Degraded Meadow	2009-2010	42.0551	116.2809	GRA		0.08	0.11
65	CN-Ha2	Haibei Shrubland	2003-2005	37.6086	101.3269	WET		0.97	0.95
66	CN-HaM	Haibei Alpine Tibet site	2002-2004	37.37	101.18	GRA		0.9	0.8
67	CN-Qia	Qianyanzhou	2003-2005	26.7414	115.0581	ENF		0.9	0.86
68	CN-Sw2	Siziwang Grazed (SZWG)	2010-2012	41.7902	111.8971	GRA		0.12	0.35
69	CZ-BK1	Bily Kriz forest	2004-2008	49.50213	18.53686	ENF		0.83	0.82
70	CZ-BK2	Bily Kriz grassland	2004-2006	49.49443	18.54285	GRA		0.9	0.88
71	CZ-wet	Trebon (CZECHWET)	2006-2014	49.02465	14.77035	WET		0.94	0.84
72	DE-Akm	Anklam	2009-2014	53.86617	13.68342	WET		0.78	0.67
73	DE-Geb	Gebesee	2001-2014	51.1001	10.9143	CRO		0.8	0.79
74	DE-Gri	Grillenburg	2004-2014	50.95004	13.51259	GRA		0.84	0.83
75	DE-Hai	Hainich	2000-2012	51.07917	10.453	DBF		0.81	0.81
76	DE-Kli	Klingenberg	2004-2014	50.89306	13.52238	CRO	C4	0.66	0.62
77	DE-Lkb	Lackenberg	2009-2013	49.09962	13.30467	ENF		0.94	0.88
78	DE-Lnf	Leinefelde	2002-2012	51.32822	10.3678	DBF		0.84	0.8
79	DE-Obe	Oberbärenburg	2008-2014	50.78666	13.72129	ENF		0.92	0.91
80	DE-RuR	Rollesbroich	2011-2014	50.62191	6.30413	GRA		0.87	0.85
81	DE-RuS	Selhausen Juelich	2011-2014	50.86591	6.44717	CRO		0.72	0.64
82	DE-Seh	Selhausen	2007-2010	50.87062	6.44965	CRO	C3	0.73	0.72
83	DE-SfN	Schechenfilz Nord	2012-2014	47.80639	11.3275	WET		0.81	0.8

84	DE-Spw	Spreewald	2010-2014	51.89225	14.03369	WET		0.91	0.88
85	DE-Tha	Tharandt	1996-2014	50.96235	13.56516	ENF		0.92	0.86
86	DE-Zrk	Zarnekow	2013-2014	53.87594	12.88901	WET		0.84	0.8
87	DK-Eng	Enghave	2005-2008	55.69053	12.19175	GRA		0.75	0.77
88	DK-Fou	Foulum	2005-2005	56.4842	9.58722	CRO		0.57	0.49
89	DK-NuF	Nuuk Fen	2008-2014	64.13083	-51.38611	WET		0.63	0.83
90	DK-Sor	Soroe	1996-2014	55.48587	11.64464	DBF		0.91	0.88
91	DK-ZaF	Zackenbergh Fen	2008-2011	74.48143	-20.55452	WET		0.77	0.93
92	DK-ZaH	Zackenbergh Heath	2000-2014	74.47328	-20.5503	GRA		0.56	0.81
93	ES-Amo	Amoladeras	2007-2012	36.83361	-2.25232	OSH		0.44	0.64
94	ES-LgS	Laguna Seca	2007-2009	37.09794	-2.96583	OSH		0.92	0.86
95	ES-LJu	Llano de los Juanes	2004-2013	36.92659	-2.75212	OSH		0.67	0.61
96	ES-Ln2	Lanjaron-Salvage logging	2009-2009	36.9695	-3.47582	OSH		0.12	0.01
97	FI-Hyy	Hyytiala	1996-2014	61.84741	24.29477	ENF		0.96	0.92
98	FI-Jok	Jokioinen	2000-2003	60.8986	23.51345	CRO	C3	0.89	0.84
99	FI-Let	Lettosuo	2009-2012	60.64183	23.95952	ENF		0.93	0.91
100	FI-Lom	Lompolojankka	2007-2009	67.99724	24.20918	WET		0.98	0.9
101	FI-Sod	Sodankyla	2001-2014	67.36239	26.63859	ENF		0.92	0.88
102	FR-Fon	Fontainebleau-Barbeau	2005-2014	48.47636	2.7801	DBF		0.81	0.77
103	FR-Gri	Grignon	2004-2013	48.84422	1.95191	CRO	C4	0.64	0.65
104	FR-LBr	Le Bray	1996-2008	44.71711	-0.7693	ENF		0.86	0.83
105	FR-Pue	Puechabon	2000-2014	43.7413	3.5957	EBF		0.64	0.62
106	GF-Guy	Guyaflex (French Guiana)	2004-2014	5.27877	-52.92486	EBF		0.1	0.26
107	GH-Ank	Ankasa	2011-2014	5.26854	-2.69421	EBF		0.12	0.33
108	IT-BCi	Borgo Cioffi	2004-2014	40.52375	14.95744	CRO		0.54	0.42
109	IT-CA1	Castel d'Asso1	2011-2014	42.38041	12.02656	DBF		0.64	0.54
110	IT-CA2	Castel d'Asso2	2011-2014	42.37722	12.02604	CRO	C3	0.55	0.55
111	IT-CA3	Castel d'Asso 3	2011-2014	42.38	12.0222	DBF		0.52	0.37
112	IT-Col	Collelongo	1996-2014	41.84936	13.58814	DBF		0.88	0.87
113	IT-Cp2	Castelporziano2	2012-2014	41.70427	12.35729	EBF		0.74	0.74
114	IT-Cpz	Castelporziano	1997-2009	41.70525	12.37611	EBF		0.65	0.76
115	IT-Isp	Ispra ABC-IS	2013-2014	45.81264	8.63358	DBF		0.97	0.94
116	IT-La2	Lavarone2	2000-2002	45.9542	11.2853	ENF		0.77	0.75
117	IT-Lav	Lavarone	2003-2014	45.9562	11.28132	ENF		0.83	0.85
118	IT-MBo	Monte Bondone	2003-2013	46.01468	11.04583	GRA		0.94	0.93
119	IT-Noe	Arca di Noe - Le Prigionette	2004-2014	40.60618	8.15117	CSH		0.69	0.74
120	IT-PT1	Parco Ticino forest	2002-2004	45.20087	9.06104	DBF		0.79	0.85
121	IT-Ren	Renon	1998-2013	46.58686	11.43369	ENF		0.94	0.92
122	IT-Ro1	Roccarespampani 1	2000-2008	42.40812	11.93001	DBF		0.63	0.55
123	IT-Ro2	Roccarespampani 2	2002-2012	42.39026	11.92093	DBF		0.56	0.72
124	IT-SR2	San Rossore 2	2013-2014	43.73203	10.29095	ENF		0.95	0.94
125	IT-Tor	Torgnon	2008-2014	45.84444	7.57806	GRA		0.95	0.91
126	JP-MBF	Moshiri Birch Forest Site	2003-2005	44.3869	142.3186	DBF		0.95	0.92
127	JP-SMF	Seto Mixed Forest Site	2002-2006	35.2617	137.0788	MF		0.88	0.87

128	MY-PSO	Pasoh Forest Reserve (PSO)	2003-2009	2.973	102.3062	EBF		0.21	0.21
129	NL-Hor	Horstermeer	2004-2011	52.24035	5.0713	GRA		0.92	0.87
130	NL-Loo	Loobos	1996-2013	52.16658	5.74356	ENF		0.94	0.93
131	NO-Adv	Adventdalen	2011-2014	78.186	15.923	WET		-0.09	0.27
132	PA-SPn	Sardinilla Plantation	2007-2009	9.31814	-79.6346	DBF		0.58	0.09
133	PA-SPs	Sardinilla-Pasture	2007-2009	9.31378	-79.63143	GRA		0.48	0.07
134	RU-Che	Cherski	2002-2005	68.61304	161.34143	WET		0.53	0.56
135	RU-Cok	Chokurdakh	2003-2014	70.82914	147.49428	OSH		0.7	0.72
136	RU-Fyo	Fyodorovskoye	1998-2014	56.46153	32.92208	ENF		0.93	0.9
137	RU-Ha1	Hakasia steppe	2002-2004	54.72517	90.00215	GRA		0.82	0.82
138	RU-Sam	Samoylov	2002-2014	72.3738	126.4958	GRA		0.28	0.43
139	RU-SkP	Yakutsk Spasskaya Pad larch	2012-2014	62.255	129.168	DNF		0.83	0.8
140	RU-Tks	Tiksi	2010-2014	71.59427	128.88782	GRA		0.82	0.9
141	RU-Vrk	Seida/Vorkuta	2008-2008	67.05468	62.94047	CSH		0.98	0.83
142	SD-Dem	Demokeya	2005-2009	13.2829	30.4783	SAV		0.6	0.56
143	SE-St1	Stordalen grassland	2012-2014	68.35415	19.05033	WET		0.88	0.83
144	SN-Dhr	Dahra	2010-2013	15.40278	-15.43222	SAV		0.71	0.73
145	US-AR1	ARM USDA UNL OSU Woodward	2009-2012	36.4267	-99.42	GRA		0.73	0.75
146	US-AR2	ARM USDA UNL OSU Woodward	2009-2012	36.6358	-99.5975	GRA		0.72	0.74
147	US-ARb	ARM Southern Great Plains	2005-2006	35.5497	-98.0402	GRA		0.87	0.78
148	US-ARc	ARM Southern Great Plains	2005-2006	35.54649	-98.04	GRA		0.92	0.84
149	US-ARM	ARM Southern Great Plains	2003-2012	36.6058	-97.4888	CRO	C3+C4	0.74	0.75
150	US-Atq	Atqasuk	2003-2008	70.4696	-157.4089	WET		0.81	0.81
151	US-Blo	Blodgett Forest	1997-2007	38.8953	-120.6328	ENF		0.93	0.9
152	US-Cop	Corral Pocket	2001-2007	38.09	-109.39	GRA		0.39	0.48
153	US-CRT	Curtice Walter-Berger cropland	2011-2013	41.628495	-83.347086	CRO	C3	0.74	0.77
154	US-GBT	GLEES Brooklyn Tower	1999-2006	41.36579	-106.2397	ENF		0.91	0.86
155	US-GLE	GLEES	2004-2014	41.36653	-106.2399	ENF		0.92	0.88
156	US-Goo	Goodwin Creek	2002-2006	34.2547	-89.8735	GRA		0.82	0.83
157	US-Ha1	Harvard Forest EMS Tower (HFR1)	1991-2012	42.5378	-72.1715	DBF		0.96	0.92
158	US-IB2	Fermi National Accelerator Laboratory	2004-2011	41.84062	-88.24103	GRA		0.85	0.83
159	US-Ivo	Ivotuk	2004-2007	68.4865	-155.7503	WET		0.95	0.88
160	US-KS1	Kennedy Space Center (slash pine)	2002-2002	28.4583	-80.6709	ENF		0.83	0.87
161	US-KS2	Kennedy Space Center (scrub oak)	2003-2006	28.6086	-80.6715	CSH		0.85	0.72
162	US-Lin	Lindcove Orange Orchard	2009-2010	36.3566	-119.8423	CRO	C3	0.45	0.37
163	US-Los	Lost Creek	2000-2014	46.0827	-89.9792	WET		0.85	0.84
164	US-Me1	Metolius - Eyerly burn	2004-2005	44.5794	-121.5	ENF		0.7	0.81
165	US-Me2	Metolius mature ponderosa pine	2002-2014	44.4523	-121.5574	ENF		0.83	0.87
166	US-Me3	Metolius-second young aged pine	2004-2009	44.3154	-121.6078	ENF		0.68	0.78
167	US-Me5	Metolius-first young aged pine	2000-2002	44.43719	-121.56676	ENF		0.82	0.81
168	US-Me6	Metolius Young Pine Burn	2010-2014	44.3232842	-121.6078	ENF		0.64	0.75
169	US-MMS	Morgan Monroe State Forest	1999-2014	39.3232	-86.4131	DBF		0.96	0.93
170	US-Myb	Mayberry Wetland	2010-2014	38.049861	-121.76498	WET		0.58	0.26
171	US-Ne1	Mead - irrigated continuous maize site	2001-2013	41.16506	-96.47664	CRO	C4	0.84	0.87

172	US-Ne2	Mead - irrigated maize-soybean rotation	2001-2013	41.16487	-96.4701	CRO	C3+C4	0.81	0.8
173	US-Ne3	Mead - rainfed maize-soybean rotation site	2001-2013	41.17967	-96.43965	CRO	C3+C4	0.86	0.89
174	US-NR1	Niwot Ridge Forest (LTER NWT1)	1998-2014	40.0329	-105.5464	ENF		0.92	0.85
175	US-Oho	Oak Openings	2004-2013	41.5545	-83.8438	DBF		0.97	0.93
176	US-ORv	Olentangy River Wetland Research Park	2011-2011	40.0201	-83.0183	WET		0.95	0.91
177	US-PFa	Park Falls/WLEF	1995-2014	45.9459	-90.2723	MF		0.95	0.93
178	US-Prr	Poker Flat Research Range Black Spruce	2010-2013	65.12367	-147.48756	ENF		0.82	0.76
179	US-SRC	Santa Rita Creosote	2008-2014	31.9083	-110.8395	MF		0.68	0.82
180	US-SRG	Santa Rita Grassland	2008-2014	31.789379	-110.827675	GRA		0.88	0.91
181	US-SRM	Santa Rita Mesquite	2004-2014	31.8214	-110.8661	WSA		0.86	0.84
182	US-Sta	Saratoga	2005-2009	41.3966	-106.8024	OSH		0.51	0.53
183	US-Syv	Sylvania Wilderness Area	2001-2014	46.242	-89.3477	MF		0.91	0.9
184	US-Ton	Tonzi Ranch	2001-2014	38.4316	-120.96598	WSA		0.87	0.79
185	US-Tw1	Twitchell Wetland West Pond	2012-2014	38.1074	-121.6469	WET		0.72	0.74
186	US-Tw2	Twitchell Corn	2012-2013	38.1047	-121.6433	CRO		0.65	0.64
187	US-Tw3	Twitchell Alfalfa	2013-2014	38.1159	-121.6467	CRO	C3	0.47	0.59
188	US-Tw4	Twitchell East End Wetland	2013-2014	38.10298	-121.6414	Wet		0.53	0.57
189	US-Twt	Twitchell Island	2009-2014	38.1087204	-121.6531	CRO	C3	0.89	0.86
190	US-UMB	Univ. of Mich. Biological Station	2000-2014	45.5598	-84.7138	DBF		0.97	0.94
191	US-UMd	UMBS Disturbance	2007-2014	45.5625	-84.6975	DBF		0.79	0.82
192	US-Var	Vaira Ranch- Ione	2000-2014	38.4133	-120.9507	GRA		0.87	0.87
193	US-WCr	Willow Creek	1999-2014	45.8059	-90.0799	DBF		0.97	0.94
194	US-Whs	Walnut Gulch Lucky Hills Shrub	2007-2014	31.7438	-110.0522	OSH		0.79	0.85
195	US-Wi0	Young red pine (YRP)	2002-2002	46.618778	-91.081444	ENF		0.9	0.9
196	US-Wi1	Intermediate hardwood (IHW)	2003-2003	46.730472	-91.232944	DBF		0.95	0.88
197	US-Wi2	Intermediate red pine (IRP)	2003-2003	46.686889	-91.152833	ENF		0.51	0.55
198	US-Wi3	Mature hardwood (MHW)	2002-2004	46.634722	-91.098667	DBF		0.98	0.96
199	US-Wi4	Mature red pine (MRP)	2002-2005	46.739333	-91.16625	ENF		0.87	0.87
200	US-Wi5	Mixed young jack pine (MYJP)	2004-2004	46.653083	-91.085806	ENF		0.95	0.89
201	US-Wi6	Pine barrens #1 (PB1)	2002-2003	46.624889	-91.298222	OSH		0.82	0.81
202	US-Wi7	Red pine clearcut (RPCC)	2005-2005	46.649111	-91.069278	OSH		0.93	0.89
203	US-Wi8	Young hardwood clearcut (YHW)	2002-2002	46.722333	-91.252417	DBF		0.99	0.95
204	US-Wi9	Young Jack pine (YJP)	2004-2005	46.618778	-91.081444	ENF		0.8	0.79
205	US-Wkg	Walnut Gulch Kendall Grasslands	2004-2014	31.7365	-109.9419	GRA		0.83	0.88
206	US-WPT	Winous Point North Marsh	2011-2013	41.464639	-82.996157	WET		0.83	0.84
207	ZA-Kru	Skukuza	2000-2010	-25.0197	31.4969	SAV		0.75	0.76
208	ZM-Mon	Mongu	2000-2009	-15.43778	23.25278	DBF		0.62	0.61
209	IT-SRo	San Rossore	1999-2012	43.72768	10.28444	ENF			
210	NO-Blv	Bayelva, Spitsbergen	2008-2009	78.92163	11.83109	SNO			
211	US-LWW	Little Washita Watershed	1997-1998	34.9604	-97.9789	GRA			
212	US-Me4	Metolius-old aged ponderosa pine	1996-2000	44.4992	-121.6224	ENF			

Table S3. The definition of 12 IGBP land cover types (biomes) used in this study referred to Belward [1] and Loveland, Reed [2]

IGBP	Code	Class name	Number of site	Definition
CRO	12	Croplands	20	Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single and multiple cropping systems). Note that perennial woody crops will be classified as the appropriate forest or shrub land cover type.
CSH	6	Closed Shrublands	3	Lands with woody vegetation less than 2 m tall and with shrub canopy cover >60%. The shrub foliage can be either evergreen or deciduous.
DBF	4	Deciduous Broadleaf Forest	26	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 m. Consists of broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.
DNF	3	Deciduous Needleleaf Forest	1	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 m. Consists of seasonal needleleaf tree communities with an annual cycle of leaf-on and leaf-off periods
EBF	2	Evergreen Broadleaf Forest	15	Lands dominated by broadleaf woody vegetation with a percent cover >60% and height exceeding 2 m. Almost all trees and shrubs remain green year round. Canopy is never without green foliage.
ENF	1	Evergreen Needleleaf Forest	48	Lands dominated by needleleaf woody vegetation with a percent cover >60% and height exceeding 2 m. Almost all trees remain green all year. Canopy is never without green foliage.
GRA	10	Grasslands	37	Lands with herbaceous types of cover. Tree and shrub cover is less than 10%.
MF	5	Mixed Forests	9	Lands dominated by trees with a percent cover >60% and height exceeding 2 m. Consists of tree communities with interspersed mixtures or mosaics of the other four forest types. None of the forest types exceeds 60% of landscape
OSH	7	Open Shrublands	14	Lands with woody vegetation less than 2 m tall and with shrub canopy cover between 10% and 60%. The shrub foliage can be either evergreen or deciduous
SAV	9	Savannas	8	Lands with herbaceous and other understory systems, and with forest canopy cover between 10% and 30%. The forest cover height exceeds 2 m
WET	11	Persistent Wetlands	21	Lands with a permanent mixture of water and herbaceous or woody vegetation. The vegetation can be present either in salt, brackish, or fresh water.
WSA	8	Woody Savannas	6	Lands with herbaceous and other understory systems, and with forest canopy cover between 30% and 60%. The forest cover height exceeds 2 m.

Reference:

1. Belward, A.S., *The IGBP-DIS global 1 km land cover data set" DISCover": Proposal and implementation plans: Report of the Land Cover Working Group of IGBP-DIS*. 1992: IGBP-DIS Office.
2. Loveland, T., et al., *Development of a global land characteristics database and IGBP DISCover from 1 km AVHRR data*. *Int. J. Remote Sens.*, 2000. **21**: p. 1303-1330.