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Mapping global leaf inclination angle (LIA) based on field measurement data

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Fig. S1. Leveled digital photography of some plant species.

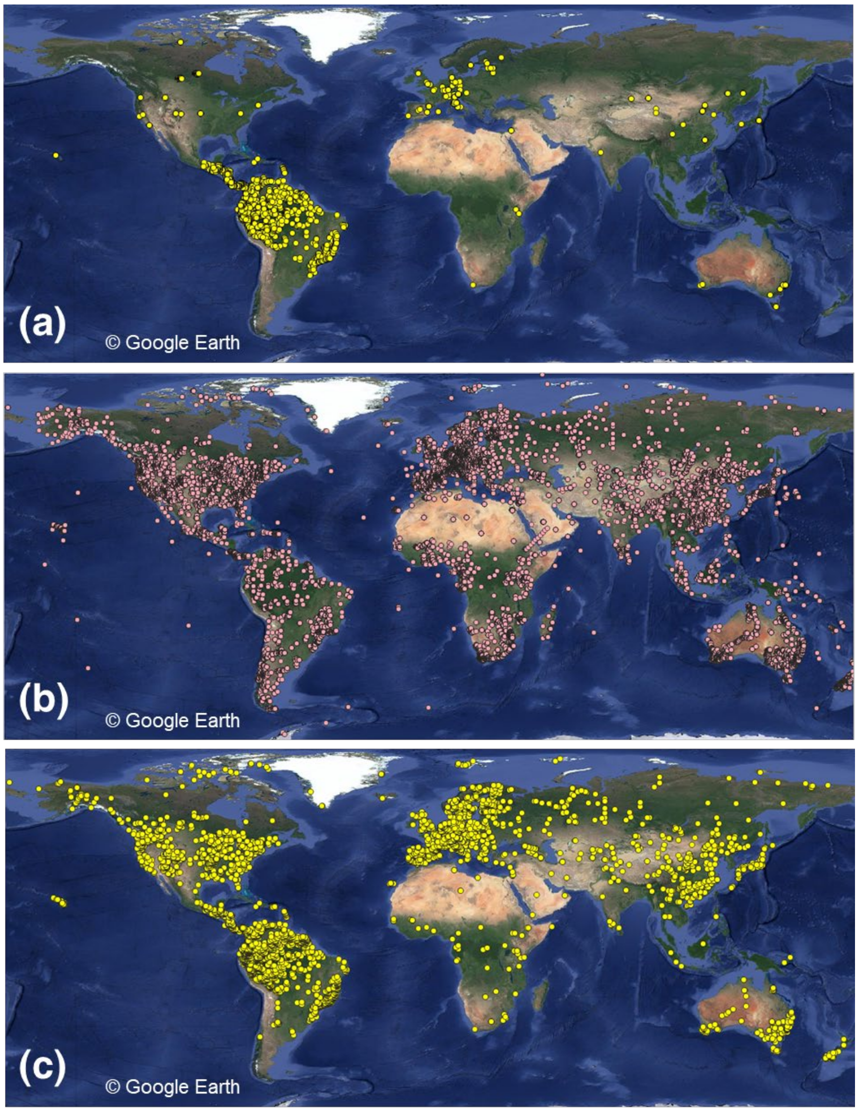

Fig. S2. Spatial distribution of the LIA measurements before (a) and after (c) spatial expansion. (b) shows the TRY species location. Base image from Google Earth.

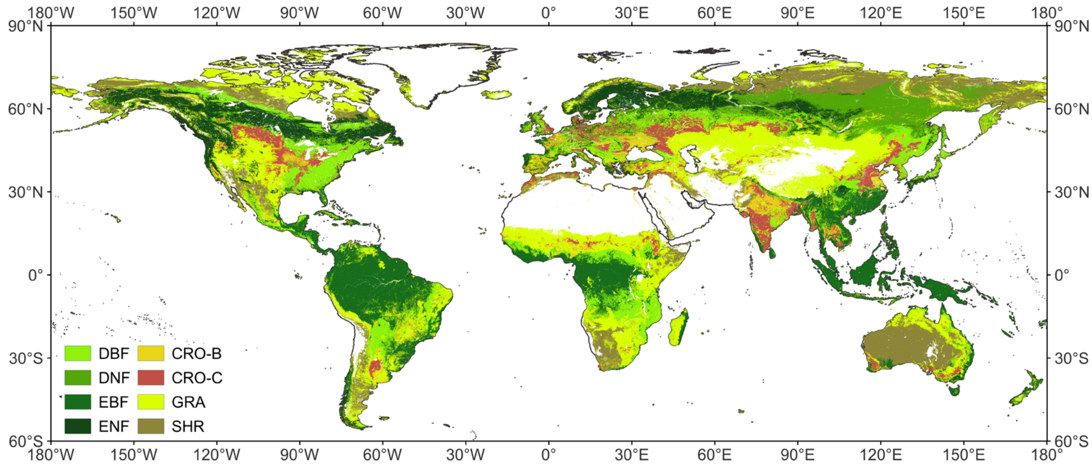

Fig. S3. MODIS plant functional type map aggregated from 2001–2022. DBF: Deciduous broadleaf forest, DNF: Deciduous needleleaf forest, EBF: Evergreen broadleaf forest, ENF: Evergreen needleleaf forest, CRO-B: Broadleaf croplands, CRO-C: Cereal croplands, GRA: Grass, SHR: Shrub.

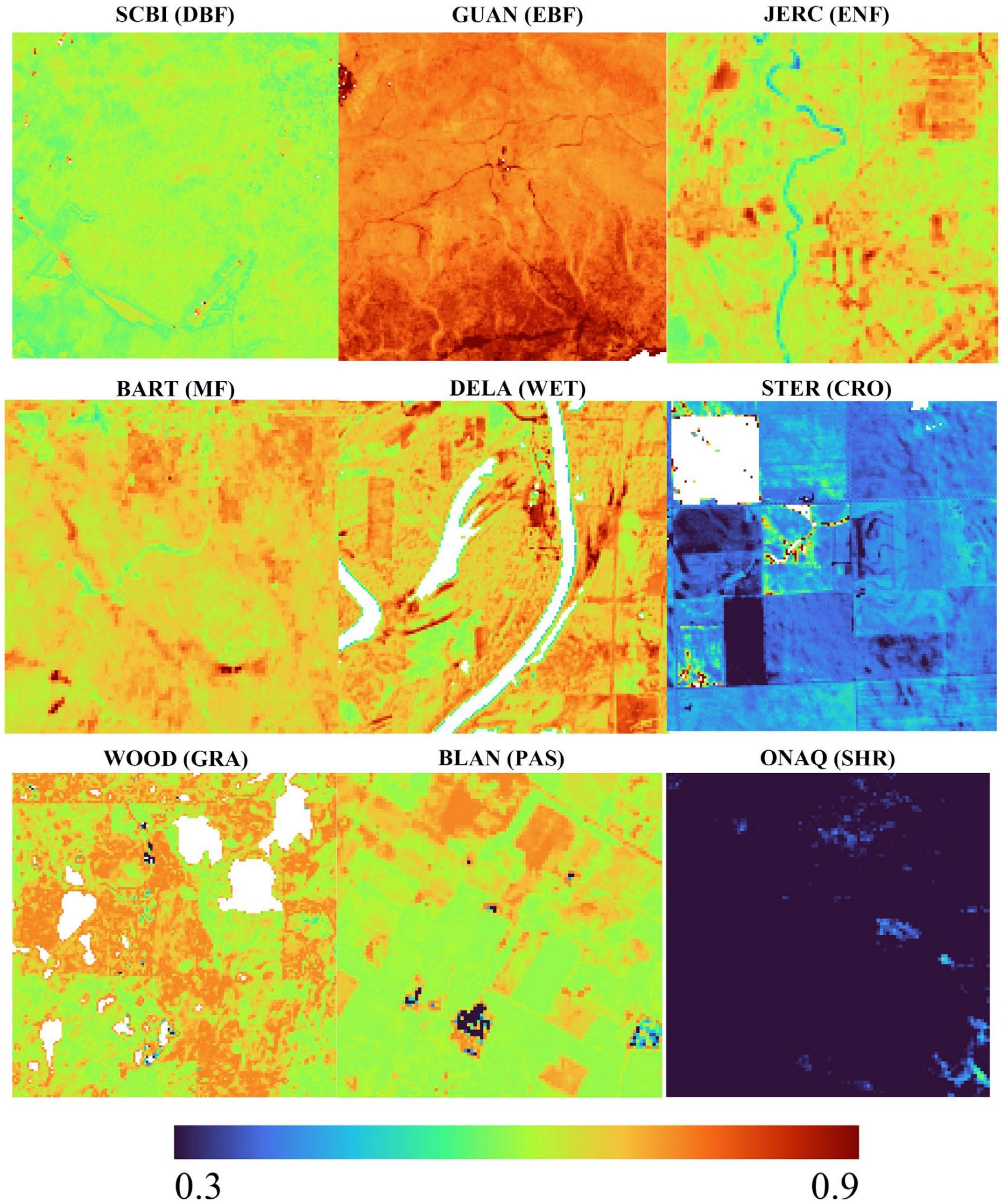

Fig. S4. High-resolution G(0) reference maps for several GBOV sites. Refer to Table S1 for the site information.

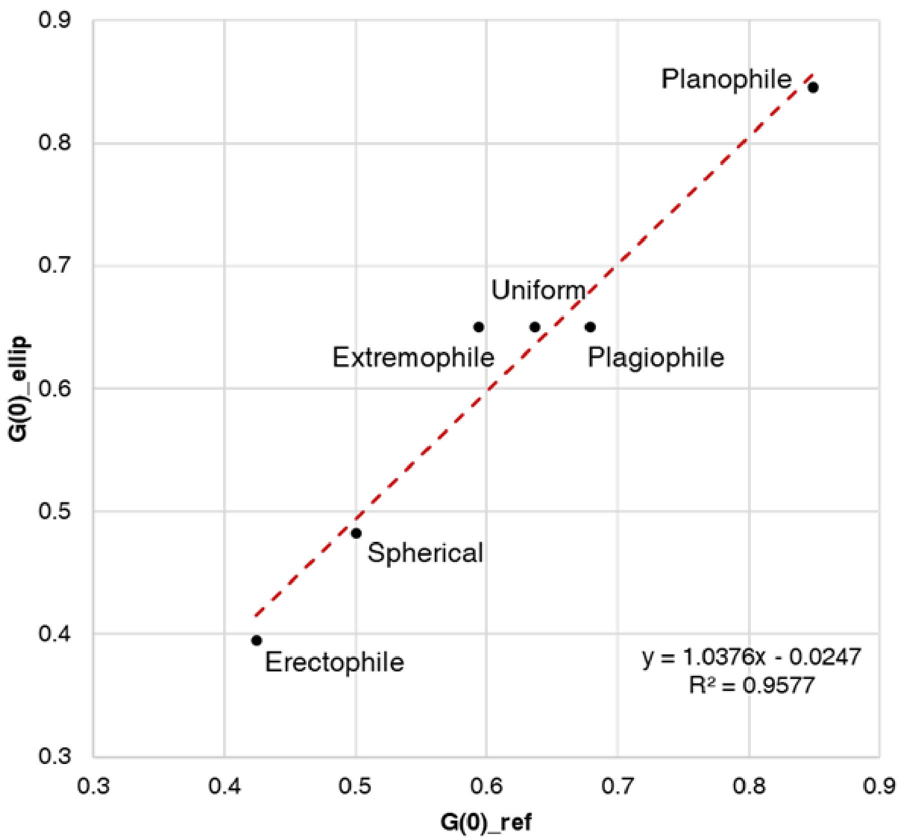

Fig. S5. Comparison of the G(0) calculated from MLA assuming ellipsoidal LIA distribution (G(0)_ellip) and the reference G(0) (G(0)_ref) calculated form the Nilson's algorithm (Nilson, 1971) for six different leaf angle distributions.

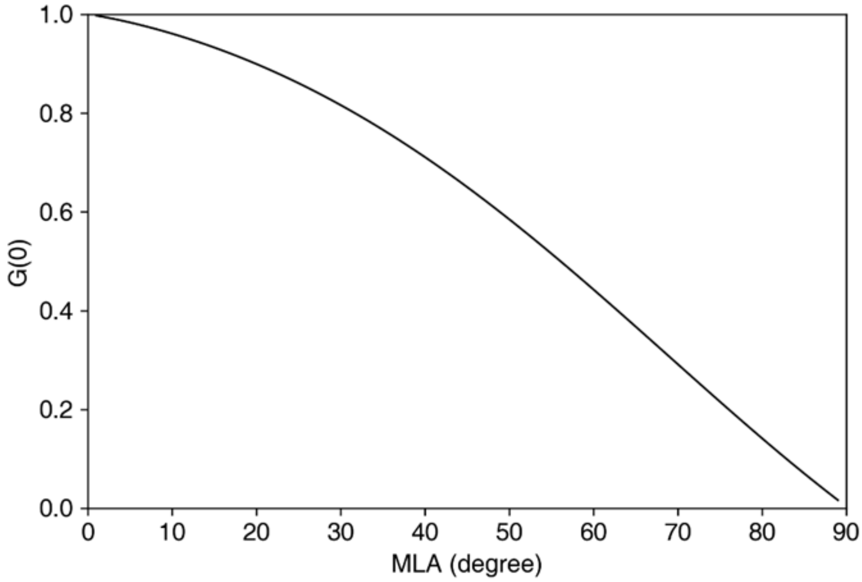

Fig. S6. Variation of G(0) with MLA assuming an ellipsoidal leaf distribution (Eq. 7).

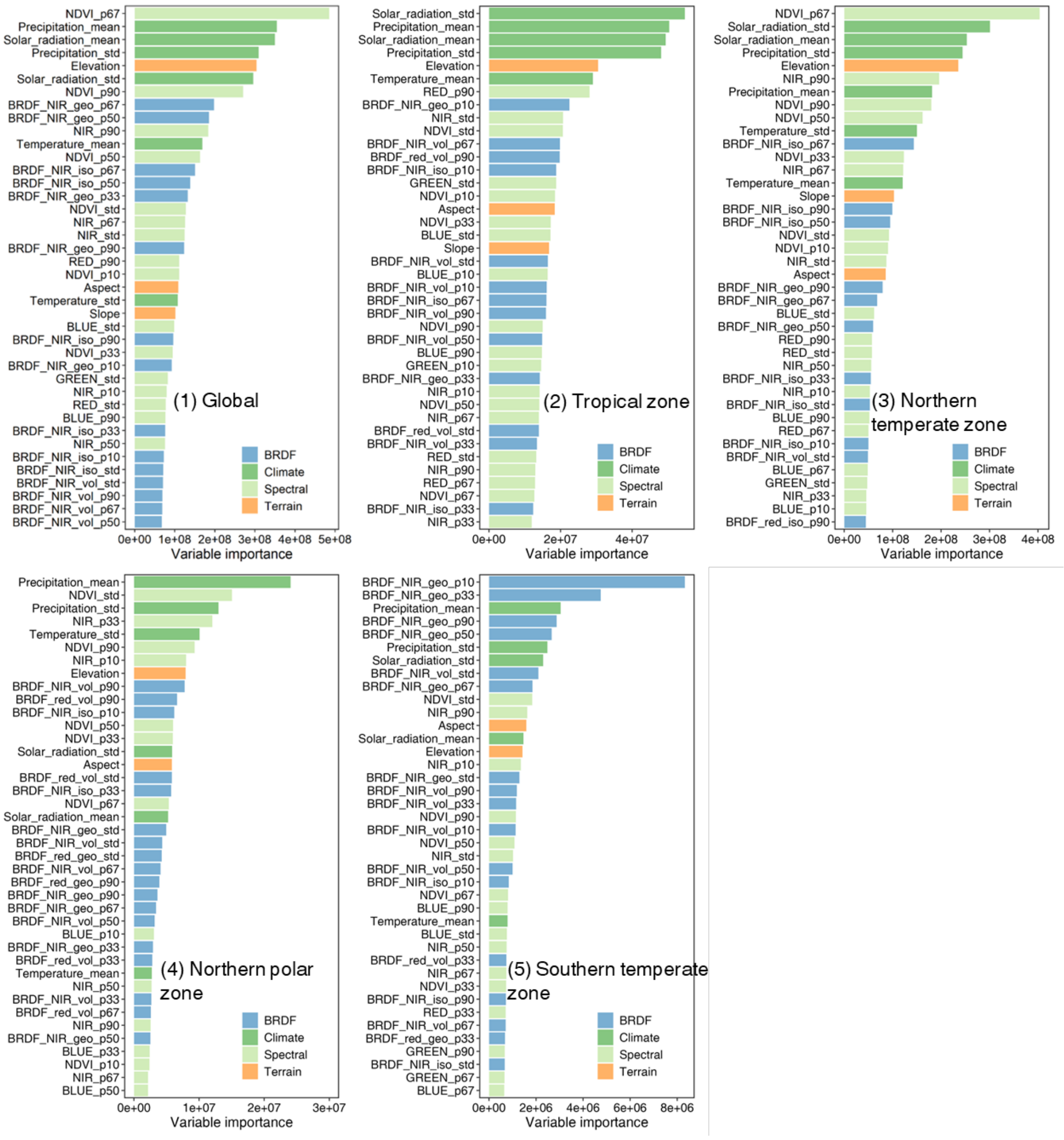

Fig. S7. The variable importance among different climate zones.

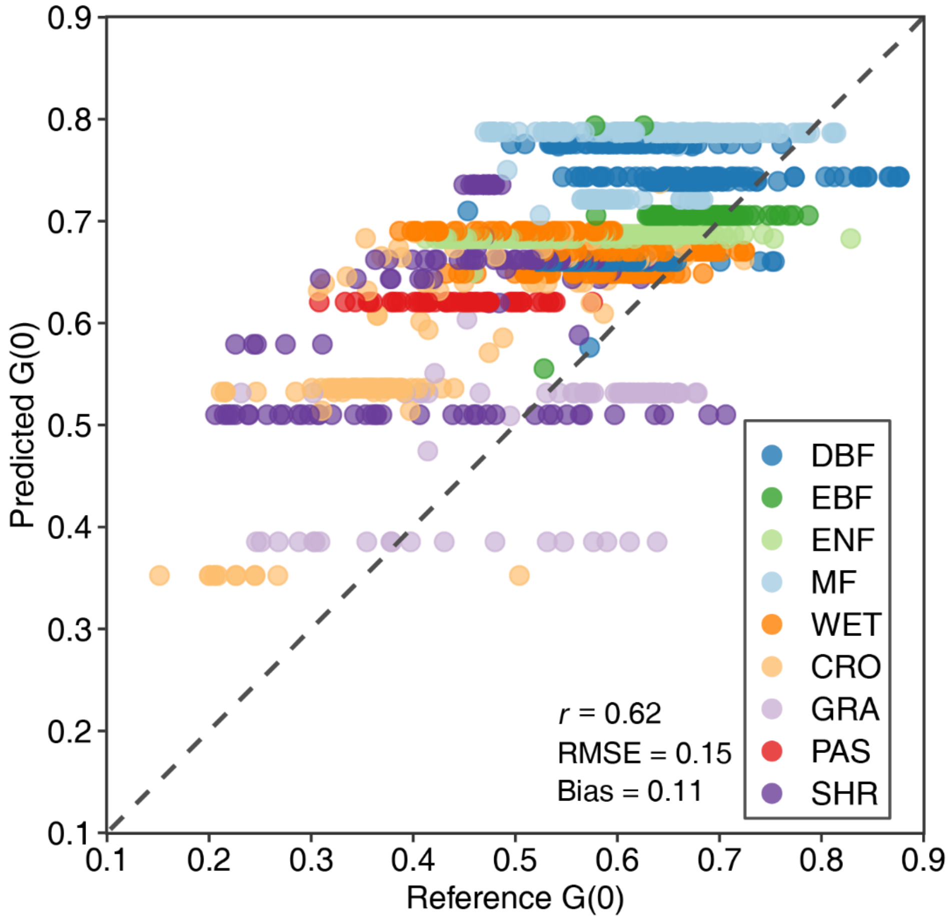

Fig. S8 Comparisons of G(0) derived from mean leaf inclination angle and high-resolution reference data for different plant functional types (see Fig. 2 for the acronyms).

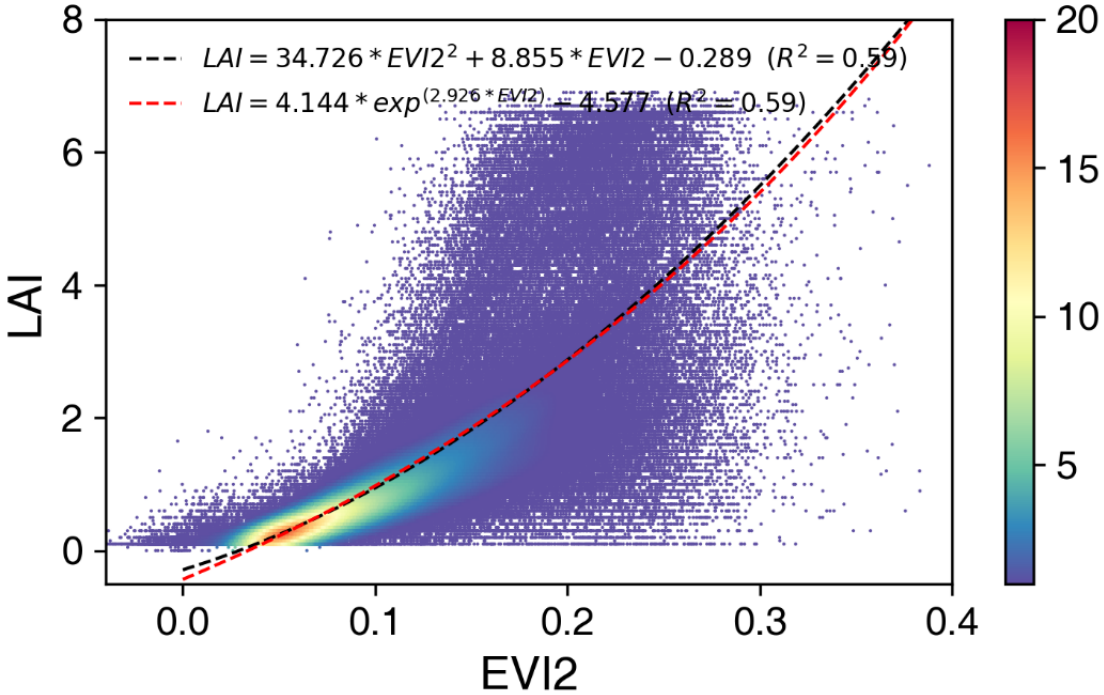

Fig. S9. The nonlinear relationship between MODIS LAI and EVI2. 2,000 points for each biome type were randomly sampled and the LAI-EVI2 pairs with good quality per 8 days for these points were extracted from MODIS LAI and EVI2.

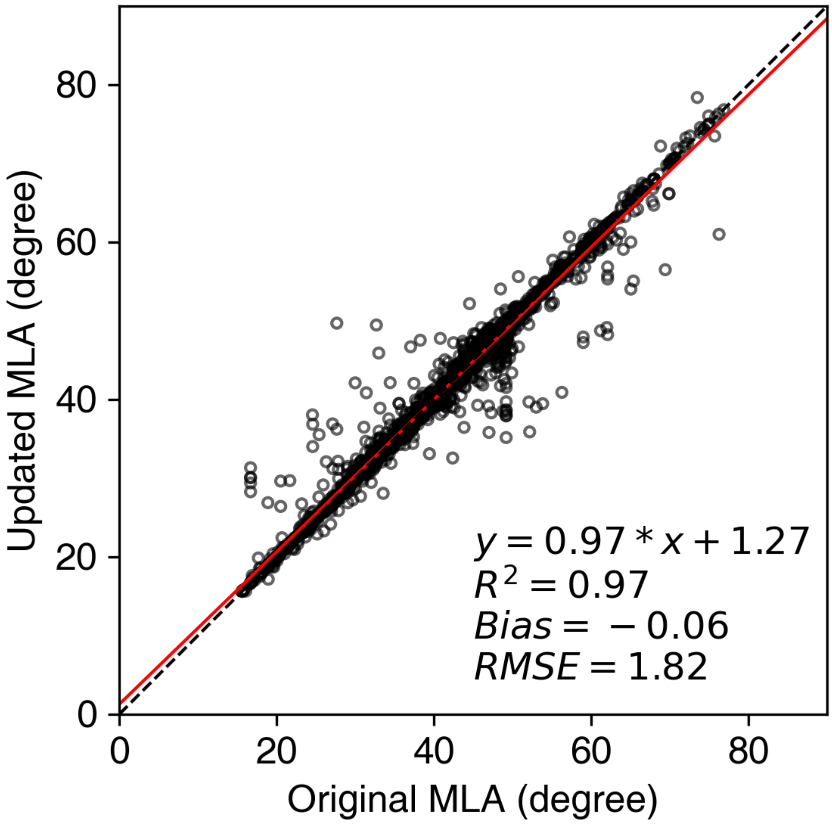

Fig. S10. The comparison between the updated samples using the LAI-EVI2 relationship and the original MLA samples using EVI2. The black dashed and red solid lines represent 1:1 and fitted lines, respectively.

Table S1. Global GBOV and DIRECT 2.1 field measurement sites used in this study. The GBOV biome type was determined from the maximum percentage of the land cover type within a 3 km × 3 km area centered on the site. The DIRECT 2.1 biome type was from the dataset. In the Continuity column, "Y" ("N") indicates > 5 (otherwise) continuous measurements. For the biome-type acronyms, refer to Fig. 2.

Site	Code	Latitude	Longitude	Biome	Year	Project	Continuity
25de Mayo_Alfalfa	25de Mayo_Alfalfa	-37.91	-67.75	CRO	2014	DIRECT 2.1	N
25de Mayo_Shurb	25de Mayo_Shurb	-37.94	-67.79	SHR	2014	DIRECT 2.1	N
AHSPECT-CON	AHSPECT-CON	43.97	0.34	CRO	2015	DIRECT 2.1	N
AHSPECT-CRE	AHSPECT-CRE	43.99	-0.05	CRO	2015	DIRECT 2.1	N
AHSPECT-MTO	AHSPECT-MTO	43.57	1.37	CRO	2015	DIRECT 2.1	N
AHSPECT-PEY	AHSPECT-PEY	43.67	0.22	CRO	2015	DIRECT 2.1	N
AHSPECT-SAV	AHSPECT-SAV	43.82	1.17	CRO	2015	DIRECT 2.1	N
AHSPECT-URG	AHSPECT-URG	43.64	-0.43	CRO	2015	DIRECT 2.1	N
Albufera	Albufera	39.27	-0.32	CRO	2014	DIRECT 2.1	N
Barrax	Barrax	39.07	-2.10	CRO	2004, 2005, 2009, 2010, 2014, 2015	DIRECT 2.1	N
Camerons	Camerons	-32.60	116.25	EBF	2004	DIRECT 2.1	N
Collelongo	Collelongo	41.85	13.59	DBF	2015	DIRECT 2.1	N
Demmin	Demmin	53.89	13.21	CRO	2004	DIRECT 2.1	N
Donga	Donga	9.77	1.78	GRA	2005	DIRECT 2.1	N
Gnangara	Gnangara	-31.53	115.88	DBF	2004	DIRECT 2.1	N
Hailun	Hailun	47.41	126.82	CRO	2016	DIRECT 2.1	Y
Honghe	Honghe	47.65	133.52	CRO	2012, 2019	DIRECT 2.1	Y
LaReina_Cordoba_1	LaReina_Cordoba_1	37.82	-4.86	CRO	2014	DIRECT 2.1	N
LaReina_Cordoba_2	LaReina_Cordoba_2	37.79	-4.83	CRO	2014	DIRECT 2.1	N
Larose	Larose	45.38	-75.22	MF	2003	DIRECT 2.1	N

Liria	Liria	39.75	-0.70	ENF	2017	DIRECT 2.1	N
Moncada	Moncada	39.52	-0.39	CRO	2014, 2017	DIRECT 2.1	N
Muragua-Upper-Tana	Muragua-Upper-Tana	-0.77	36.97	CRO	2016	DIRECT 2.1	N
Plan_De_Dieu	Plan_De_Dieu	44.20	4.95	CRO	2004	DIRECT 2.1	N
Pshenichne	PSH	50.08	30.23	CRO	2013, 2014, 2015	DIRECT 2.1	Y
SanFernando	SanFernando	-34.72	-71.00	CRO	2015	DIRECT 2.1	N
Sonian	Sonian	50.77	4.41	MF	2004	DIRECT 2.1	N
SouthWest_1	SW1	43.55	1.09	CRO	2013	DIRECT 2.1	Y
SouthWest_2	SW2	43.45	1.15	CRO	2013	DIRECT 2.1	Y
Utiel	Utiel	39.58	-1.26	CRO	2006	DIRECT 2.1	N
Wankama	Wankama	13.65	2.64	GRA	2005	DIRECT 2.1	N
Bartlett Experimental Forest	BART	44.06	-71.29	MF	2014-2019	GBOV	Y
Blandy Experimental Farm	BLAN	39.06	-78.07	PAS	2015-2019	GBOV	Y
Central Plains Experimental Range	CPER	40.82	-104.75	GRA	2014-2019	GBOV	Y
Disney Wilderness Preserve	DELA	32.54	-87.80	WET	2016-2019	GBOV	Y
Disney Wilderness Preserve	DSNY	28.13	-81.44	WET	2013-2019	GBOV	Y
Guanica Forest	GUAN	17.97	-66.87	EBF	2015-2019	GBOV	Y
Harvard Forest	HARV	42.54	-72.17	MF	2014-2019	GBOV	Y
Jones Ecological Research Center	JERC	31.19	-84.47	ENF	2013-2019	GBOV	Y
Jornada	JORN	32.59	-106.84	SHR	2015-2019	GBOV	Y
Lajas Experimental Station	LAJA	18.02	-67.08	PAS	2016-2019	GBOV	Y
Moab	MOAB	38.25	-109.39	SHR	2015-2019	GBOV	Y

Niwot Ridge Mountain Research Station	NIWO	40.05	-105.58	SHR	2015-2019	GBOV	Y
North Sterling	STER	40.46	-103.03	CRO	2014-2019	GBOV	Y
Oak Ridge	ORNL	35.96	-84.28	DBF	2014-2019	GBOV	Y
Onaqui	ONAQ	40.18	-112.45	SHR	2014-2019	GBOV	Y
Ordway-Swisher Biological Station	OSBS	29.68	-82.01	ENF	2013-2019	GBOV	Y
Santa Rita Experimental Range	SRER	31.91	-110.84	SHR	2016-2019	GBOV	Y
Smithsonian Conservation Biology Institute	SCBI	38.89	-78.14	DBF	2014-2019	GBOV	Y
Smithsonian Environmental Research Center	SERC	38.89	-76.56	DBF	2015-2019	GBOV	Y
Steigerwaldt Land Services	STEI	45.51	-89.59	MF	2015-2019	GBOV	Y
Talladega National Forest	TALL	32.95	-87.39	DBF	2014-2019	GBOV	Y
UNDERC	UNDE	46.23	-89.54	WET	2014-2019	GBOV	Y
Woodworth	WOOD	47.13	-99.24	GRA	2014-2019	GBOV	Y

Table S2. Typical mean inclination angle (MLA) for different crop types. STD is the standard deviation.

Crop type	MLA (°)	STD (°)	Crop type	MLA (°)	STD (°)
Barley	51.60	—	Coffee	39.10	—
Cotton	42.70	2.40	Cucumber	32.70	—
Faba bean	27.10	—	Horse beans	38.85	4.55
Lucerne	48.10	—	Lupin	17.60	—
Maize	54.01	14.42	Oats	63.20	—
Potato	35.78	4.80	Rape	36.85	4.27
Rice	66.67	5.12	Sesame	40.12	—
Sorghum	59.70	12.73	Soybean	53.66	8.55
Sugar beet	42.90	4.25	Sunflower	36.15	5.19
Tobacco	46.13	9.75	Wheat	59.30	14.00

Table S3. Predefined leaf inclination angle values in the CLM5 model (Lawrence et al., 2019; Majasalmi and Bright, 2019). The mean leaf inclination angle (MLA) is computed from the inclination index (χ_L) ($MLA = arccos(\frac{1+\chi_L}{2})$). EBS: evergreen broadleaf shrub, DBS: deciduous broadleaf shrub. See Fig. 1 for other acronyms.

Plant functional type	χ_L	MLA (°)
Temperate ENF, boreal ENF, boreal DNF, temperate EBS	0.01	59.67
Tropical EBF, temperate EBF	0.10	56.63
Tropical DBF	0.01	59.67
Temperate and boreal DBF and DBS	0.25	51.32
GRA, C3 crop	-0.30	69.51
Temperate corn, spring wheat, temperate soybean, cotton, rice, sugarcane, tropical corn, tropical soybean	-0.50	75.52

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