

Addressing Challenges in Simulating Inter-annual Variability of Gross Primary Production

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Introduction

This supporting information file contains details on the calculation of the water availability indicator ([Text S1](#), Fig. [S1](#)), additional details on P-model description and equations ([Text S2](#), Fig. [S2](#), Table [S1](#)), a short discussion on some of the supporting results ([Text S3](#) – [Text S5](#)), figure to support the choice of a model equation (Fig. [S3](#)), a figure showing the location of sites used in the study (Fig. [S4](#)), figures (Fig. [S5](#) – [S10](#)) and tables (Tables [S2](#) – [S7](#)) to supplement the results presented in the main text, and details on site characteristics (Table [S8](#)).

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Text S1 Calculation of Water Availability Indicator (WAI)

WAI was calculated using a water bucket model, similar to the methods of Bao et al. (2022), as a proxy for the soil moisture available to the vegetation (Tramontana et al., 2016). This model (Fig. S1) is a simplified version of the hydrological model used in the study of Trautmann et al. (2018).

Text S2 Implementation of Drought Stress in the P_{hr}^W Model

We implemented a drought stress function to improve hourly gross primary production (GPP) estimates produced by the P_{hr} model. We calculated hourly instantaneous GPP with the instantaneous values of forcing data following the equations in Fig. S2. Then the acclimated GPP (GPP_{acclim_t}) was calculated at each timestep t by considering acclimation (on the parameters shown with sky blue box in Fig. S2) as described in Sect. 2.2 of Mengoli et al. (2022).

We calculated WAI using the method described in Text S1. Then we calculated a drought stress function (Bao et al., 2022; Horn & Schulz, 2011) as shown in Eq. (S1) and (S2). W_t in Eq. (S2) denotes soil water supply, i.e., WAI_t/AWC at timestep t , as described in Table 1 of the main paper. The symbols in bold are calibrated parameters as described in Table 1 of the main paper. The lag parameter (α) for soil moisture effect was only parameterized for arid sites where the Köppen–Geiger (KG) climate class starts with ‘B’ (Beck et al., 2018; Rubel et al., 2017).

$$fW_t = \frac{1}{1 + \exp(k_W(W_{f_t} - W_t))} \quad (S1)$$

$$W_{f_t} = (1 - \alpha) \cdot W_t + \alpha \cdot W_{f_{t-1}} \quad (S2)$$

To calculate our final hourly simulated GPP (GPP_{sim_t}) by the P_{hr}^W model, we multiplied the GPP_{acclim_t} produced by P_{hr} model at each timestep t , with corresponding values of fW_t , viz. Eq. (S3).

$$GPP_{sim_t} = GPP_{acclim_t} \times fW_t \quad (S3)$$

Text S3 Performance of P_{hr}^W , P_{hr} Models in an Irrigated C_4 Cropland

The P_{hr}^W model failed to capture the annual average of GPP fluxes in an irrigated cropland for most of the years (Fig. S6). This could be due to an inaccurate estimation of drought stress as we do not consider any information on irrigation. Moreover, this site is a C_4 cropland, and no distinct treatments were formulated in the P_{hr}^W model for C_4 vegetation.

Text S4 Bao_{dd} Model Performance: Site-specific Example

The Bao_{dd} model was originally parameterized using daily data by Bao et al. (2022). We wanted to perform a direct comparison in model performance between the Bao_{hr} model and the Bao_{dd} model. Bao_{dd} model captured the annual average of eddy covariance derived GPP better in the case of site-year and site-specific model parameterization compared to the two other generalized parameterization strategies, i.e., PFT-specific and global parameterization (Fig. S7).

Text S5 Model Performance at Different Climate-vegetation Types

The median model performance decreases from site-year-specific to site-specific to PFT-specific to global parameterization for most climate-vegetation types and both P_{hr}^W and Bao_{hr} models (Fig. S9). At temperate grasslands and boreal forests, the median values of NNSE are similar per PFT and global parameterization of the P_{hr}^W model. At boreal forests, the median values of NNSE are similar per PFT and global parameterization of the Bao_{hr} model as well.

For the parameterization of the P_{hr}^W model, the highest median value of NNSE was found for tropical forests and tropical grasslands for per-site-year parameterization (median NNSE: 0.89), tropical forests for per-site parameterization (median NNSE: 0.88), tropical grasslands for per-PFT parameterization (median NNSE: 0.80), and temperate forests for global parameterization (median NNSE: 0.76). For Bao_{hr} model parameterization experiments, the highest median value of NNSE was found for tropical forests for per-site-year (median NNSE: 0.91), per-site (median

NNSE: 0.9), and global (median NNSE: 0.8) parameterization experiments, and tropical grasslands for per-PFT (median NNSE: 0.81) parameterization experiments.

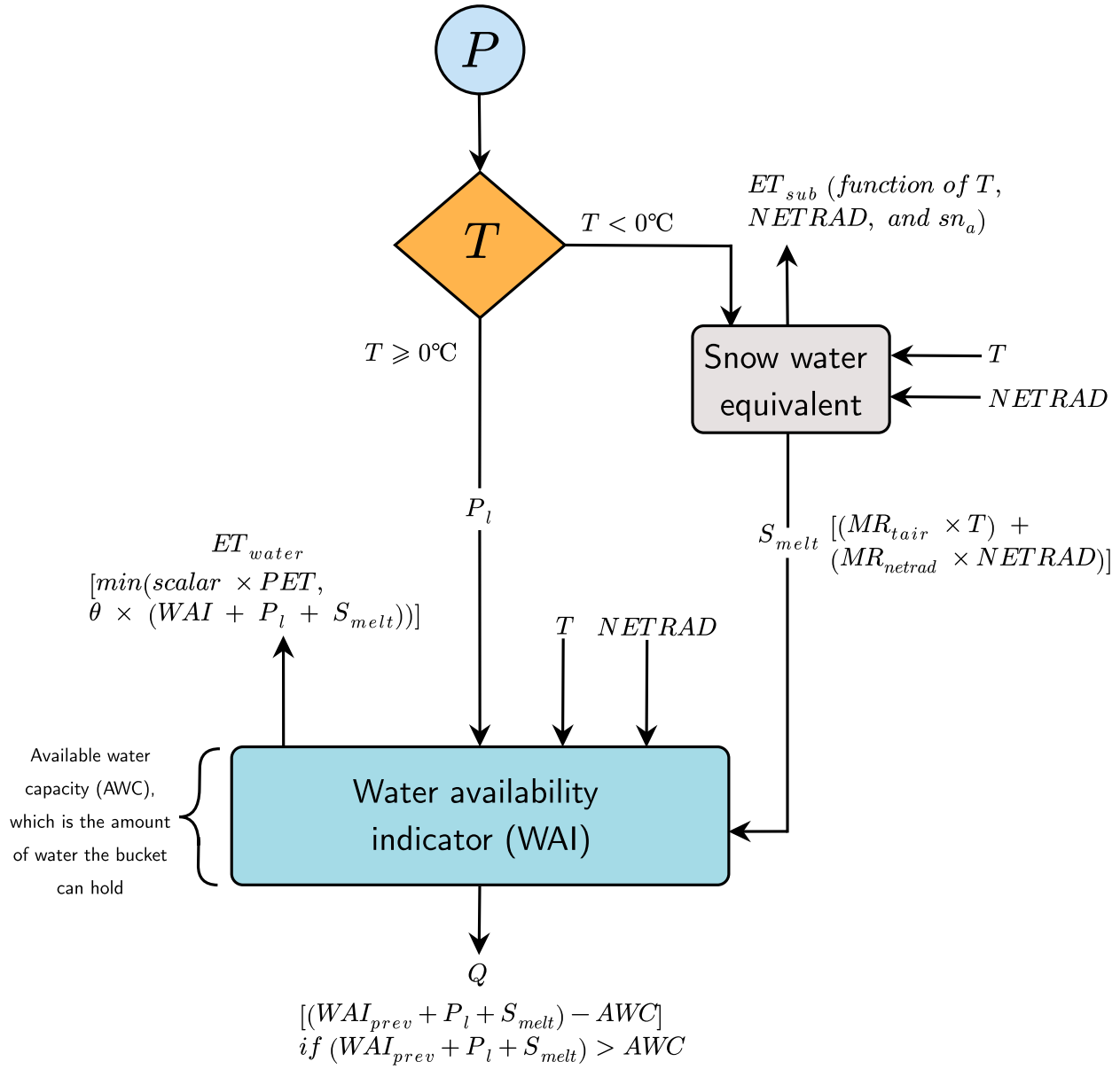


Figure S1: The schematic of the water bucket model used in this study. P , T , PET , and $NETRAD$ are precipitation, temperature, potential evapotranspiration, and net radiation respectively, and were used as forcing (see Table A1 of the main paper). P_l , ET_{sub} , ET_{water} , S_{melt} , and Q are liquid precipitation, evapotranspiration by sublimation, evapotranspiration from the water bucket, water melted from snow, and runoff respectively. Simulated evapotranspiration (ET_{sim}), which was used in the cost function was calculated as the sum of ET_{water} and ET_{sub} . θ , AWC , PET_{scalar} , sn_a , MR_{tair} , and MR_{netrad} are the calibrated model parameters. The description of these parameters can be found in Table 1 of the main paper.

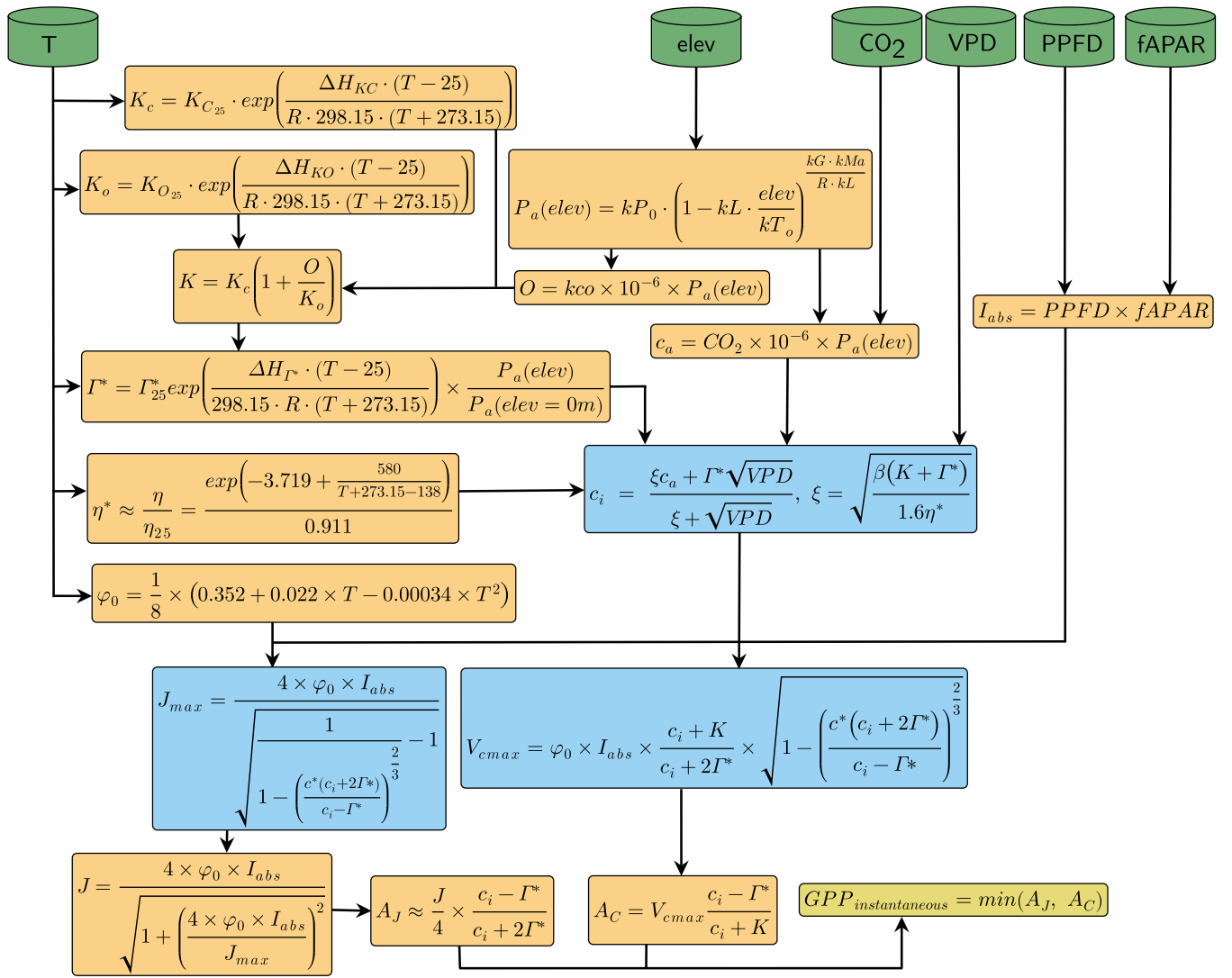


Figure S2: A slightly revised version of the P_{hr} model schematics. This figure is adapted from Fig. 1 of Mengoli et al. (2022). The variables in dark green are forcing data as described in Table A1 of the main paper. The model parameters in this figure are described in Table S1. The parameters in the sky blue box are the parameters considered for acclimation. The box with an olive green color shows the model output.

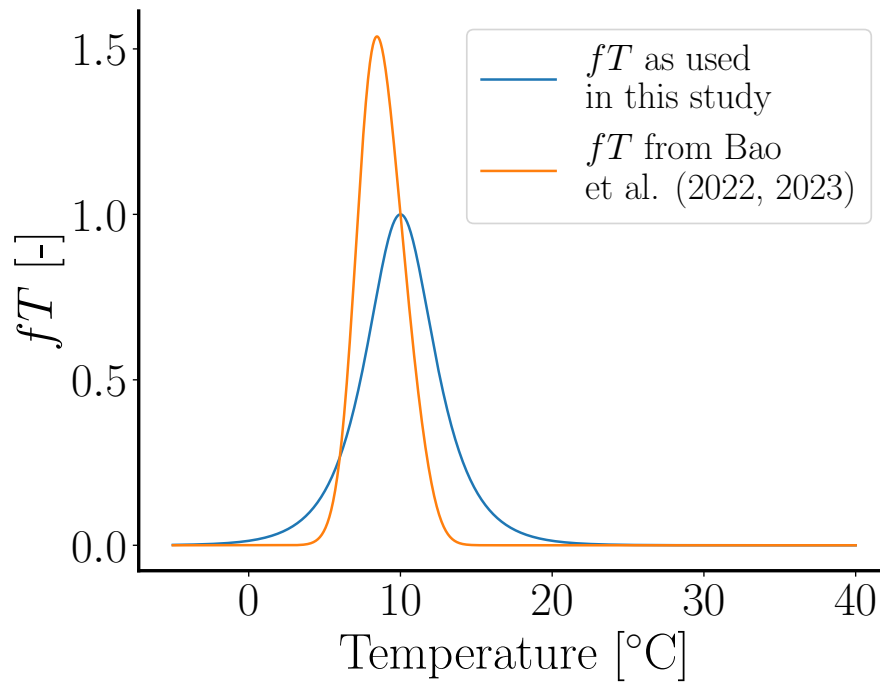


Figure S3: Comparison of partial sensitivity function of temperature (fT) between Bao et al. (2022, 2023) and a slightly modified version which was used in this study. The modified version produced values of fT between zero and one for a typical temperature range. Whereas, the previous version can produce values of fT greater than one for optimal temperature.

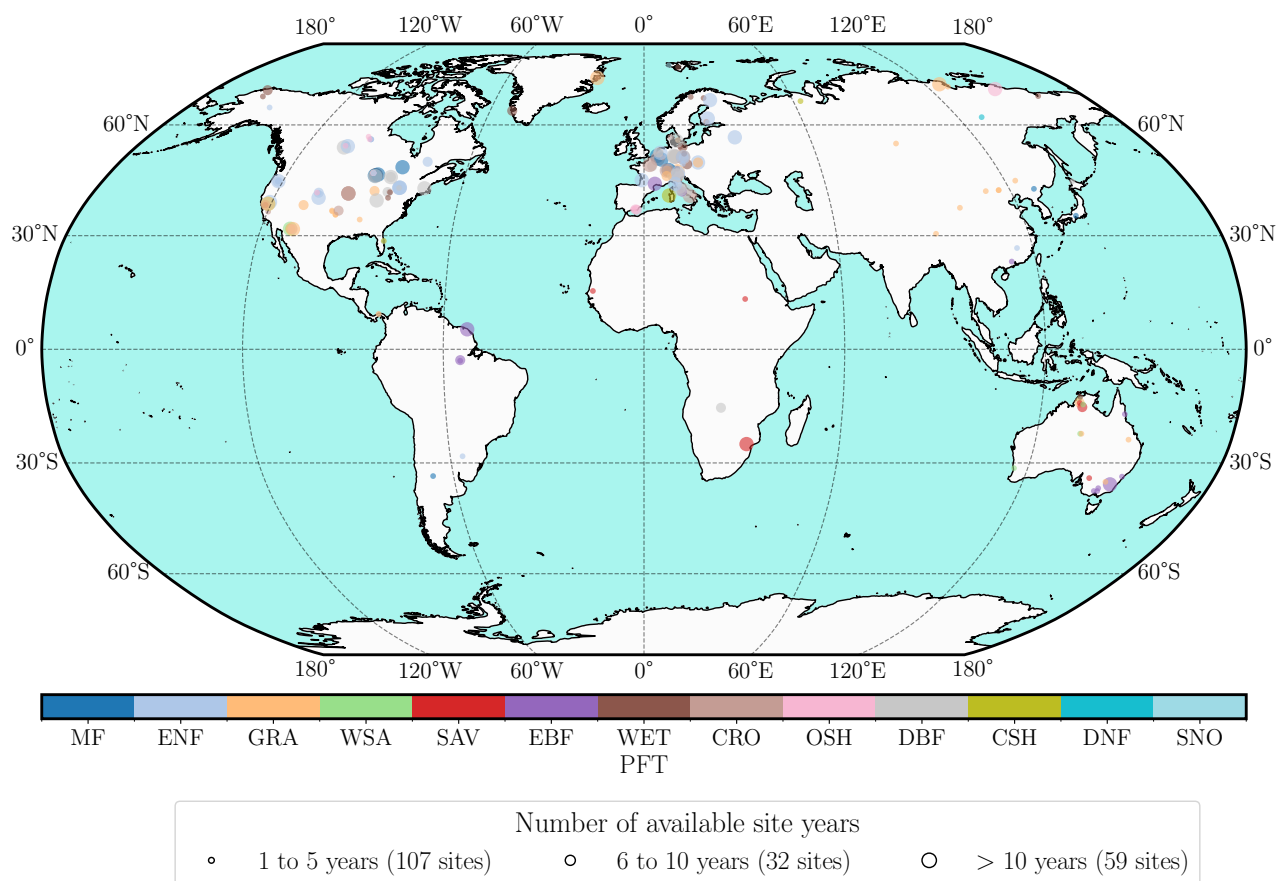


Figure S4: The distribution of a total of 198 EC sites used in this study. The sites represent a wide variety of plant-functional types (PFT), located in varying latitudinal sections, and contain measurement records of varying lengths. The description of PFTs can be found in FLUXNET.org (2024). The coastlines and islands were provided by Elson et al. (2023).

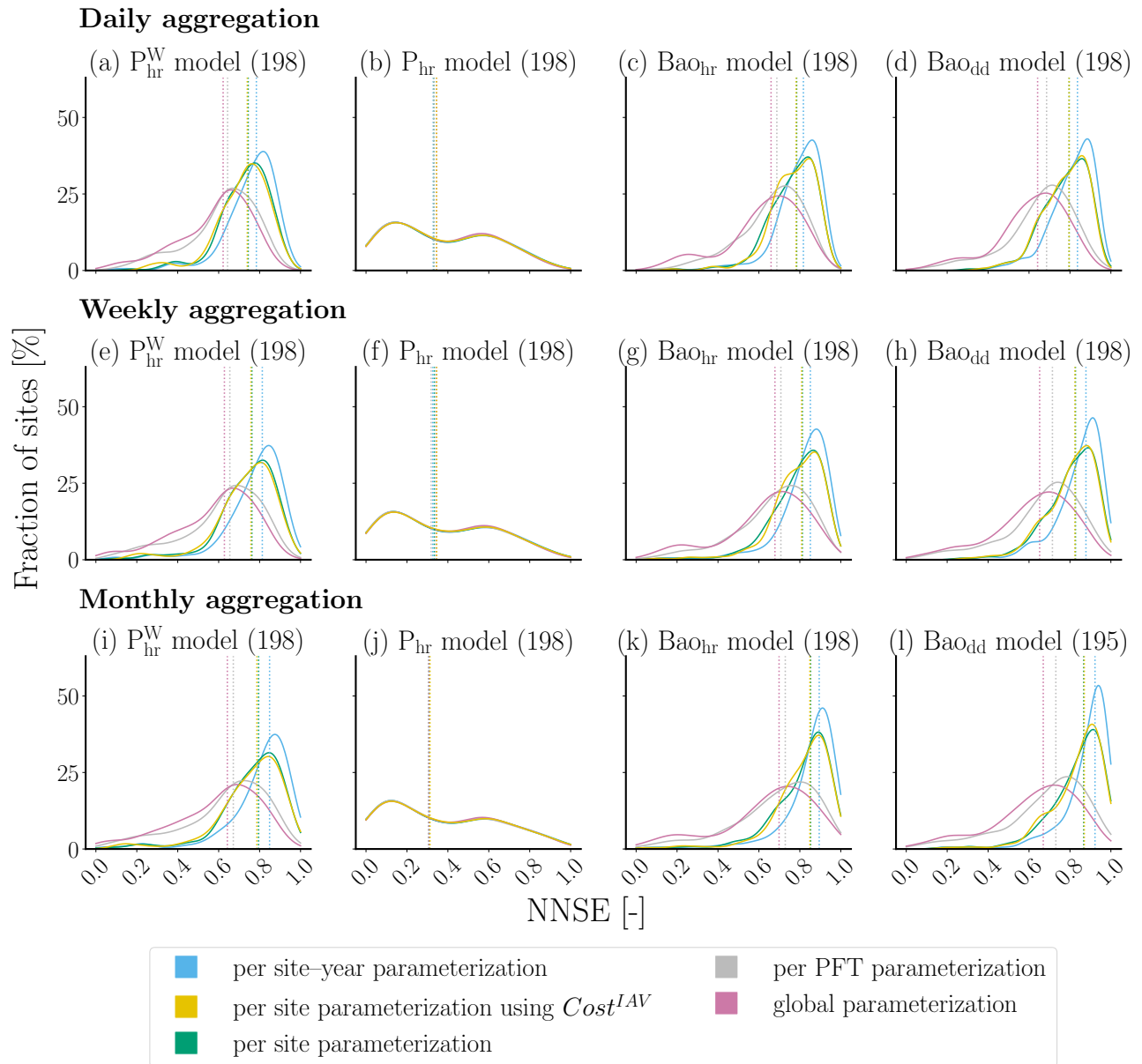


Figure S5: Distributions of model performance measure (normalized Nash-Sutcliffe efficiency, viz. NNSE) at daily scale (first row), at weekly scale (second row), and at monthly scale (third row) from P-model of Mengoli et al. (2022) with drought stress parameterized at hourly scale (P_{hr}^W), P-model of Mengoli et al. (2022) without drought stress parameterized at hourly scale (P_{hr}), global best model of Bao et al. (2022) parameterized at hourly scale (Bao_{hr}), and global best model of Bao et al. (2022) parameterized at daily scale (Bao_{dd}). The dotted vertical lines represent the median model performance, which are summarized in Table S2. The numbers in parentheses beside the model name on top of each of the sub-figures represent the total number of sites. The model performance at a monthly scale could be calculated for fewer sites as some sites have a very low measurement period (see Appendix C of the main paper).

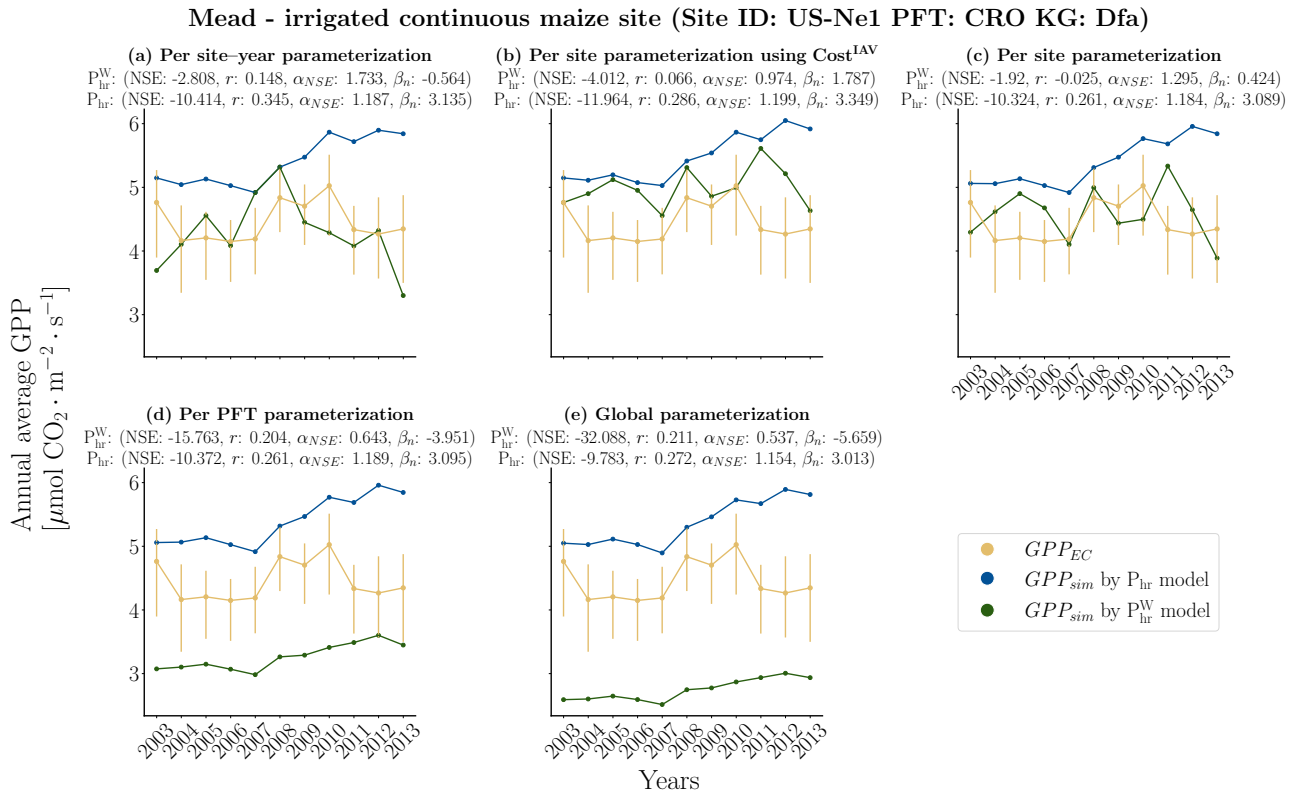


Figure S6: Comparison of annual average of gross primary production (GPP) derived by eddy covariance measurements (GPP_{EC}), and GPP simulated (GPP_{sim}) by the P-model of Mengoli et al. (2022) parameterized at hourly scale without drought stress (P_{hr} model) and with drought stress (P_{hr}^W model). The five subplots show simulated GPP from **(a)** site-year specific parameterization, **(b)** site-specific parameterization using an additional constraint on inter-annual variability in the cost function ($Cost^{IAV}$), **(c)** site-specific parameterization, **(d)** plant-functional types (PFT) specific parameterization, and **(e)** global parameterization. The values of the model performance measure (Nash-Sutcliffe efficiency, viz. NSE, correlation coefficient, viz. r , relative variability, viz. α_{NSE} , and bias, viz. β_n) are shown on top of respective subplots. Maize is cultivated in this site and has an annual average temperature of $\approx 10.55^\circ\text{C}$, and an annual average precipitation of ≈ 832.2 mm during the observation period (Pastorello et al., 2020; Suyker, 2016a). The vertical error bars represent the uncertainty range (see Sect. 2.4.3 of the main paper) of the annual average of GPP_{EC} for the corresponding years. The site ID, PFT, and Köppen–Geiger climate class (KG) of the site are provided on top of the figure in bold.

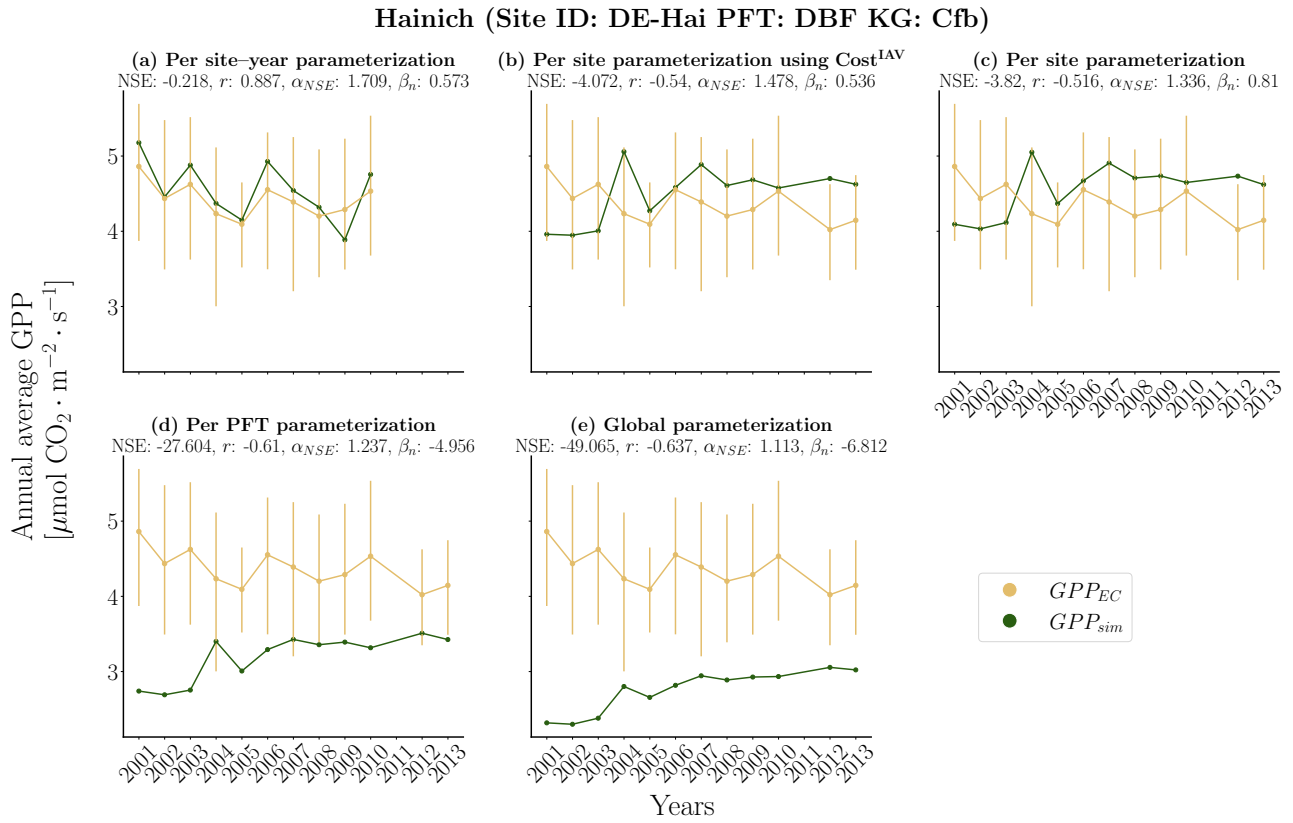


Figure S7: Comparison of annual average of gross primary production (GPP) derived by eddy covariance measurements (GPP_{EC}), and GPP simulated (GPP_{sim}) by the light use efficiency model of Bao et al. (2022), which was parameterized with daily data (Bao_{dd} model). The five subplots show simulated GPP from (a) site-year specific parameterization, (b) site-specific parameterization using an additional constraint on inter-annual variability in the cost function (Cost^{IAV}), (c) site-specific parameterization, (d) plant-functional types (PFT) specific parameterization, and (e) global parameterization. The years 2010 to 2012 could not be parameterized in the case of site-year parameterization, as there were no good quality evapotranspiration estimates from latent heat flux measurements for those years. The values of the model performance measure (Nash-Sutcliffe efficiency, viz. NSE, correlation coefficient, viz. r , relative variability, viz. α_{NSE} , and bias, viz. β_n) are shown on top of respective subplots. This site represents an average 140-year-old deciduous forest (Tamrakar et al., 2018) with a distinct seasonal cycle and an annual average temperature of $\approx 8.3^\circ\text{C}$, and an annual average precipitation of 750–800 mm during the observation period (Knobl et al., 2003a; Pastorello et al., 2020). The vertical error bars represent the uncertainty range (see Sect. 2.4.3 of the main paper) of the annual average of GPP_{EC} for the corresponding years. The site ID, PFT, and Köppen–Geiger climate class (KG) of the site are provided on top of the figure in bold.

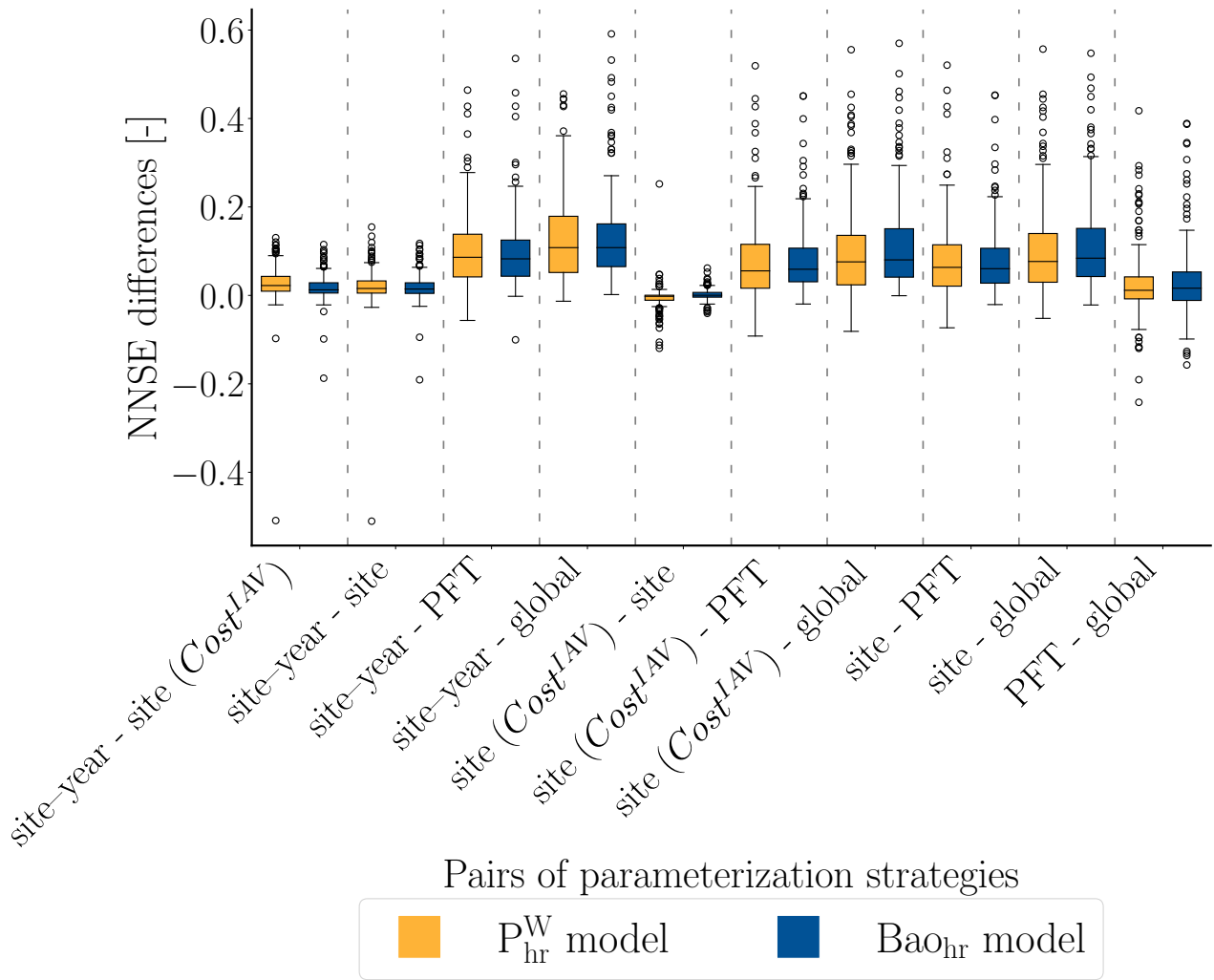


Figure S8: Distributions of the differences between model performance measures (normalized Nash-Sutcliffe efficiency, viz. NNSE) calculated at hourly scale, from various pairs of model parameterization experiments conducted for the P-model of Mengoli et al. (2022) with drought stress, parameterized with hourly data (P_{hr}^W model) and the light use efficiency model of Bao et al. (2022), parameterized with hourly data (Bao_{hr} model). $Cost_{I_{AV}}$ in parentheses denotes the usage of an additional constraint on annual gross primary production flux during per-site parameterization. The boxes are spanned between the first and third quartiles of the differences, and the line in the middle represents the median. The whiskers show the farthest data point from the box within $1.5\times$ of the interquartile range. The circles represent the outliers that go beyond the limits of the whiskers. The vertical dotted grey lines separate each pair of model parameterization strategies.

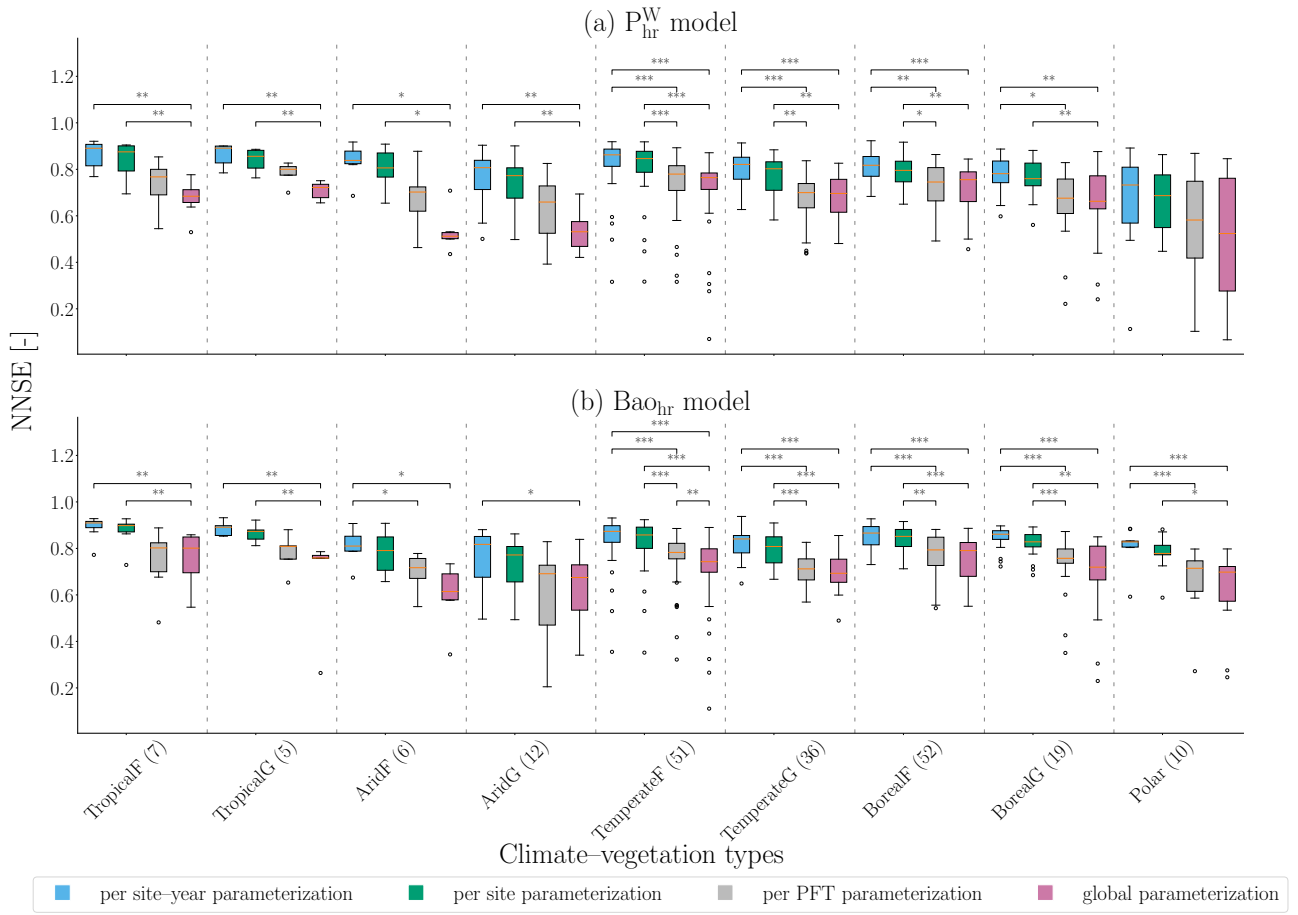


Figure S9: Box-plots showing the range of the hourly model performance metric (normalized Nash-Sutcliffe efficiency, viz. NNSE) for the sites in different climate-vegetation types, and different parameterization experiments. The subplots show the model performance for the **(a)** P-model of Mengoli et al. (2022) with drought stress function, parameterized with hourly data (P_{hr}^W model), and **(b)** the light use efficiency model of Bao et al. (2022) parameterized with hourly data (Bao_{hr} model). The numbers in parenthesis beside the name of each climate-vegetation type on the x-axis are the number of sites present in a specific climate-vegetation type. The boxes are spanned between the first and third quartiles of NNSE values, and the line in the middle represents the median. The whiskers show the farthest data point from the box which is within $1.5\times$ of the inter-quartile range. The circles represent the outliers that go beyond the limits of the whiskers. The results of statistical significance testing using a two-sample Kolmogorov-Smirnov test (Hodges, 1958) between a pair of model parameterization strategies (connecting bars over boxplots) are shown as * ($0.05 > p\text{-value} \geq 0.01$), ** ($0.01 > p\text{-value} \geq 0.001$), *** ($p\text{-value} < 0.001$) if the distributions of model performances were not identical. No bars and star symbols over a pair of boxplots signify that the distributions of model performances from a pair of parameterization strategies were identical and the null hypothesis could not be rejected ($p\text{-value} \geq 0.05$). The vertical dotted grey lines separate each climate-vegetation type.

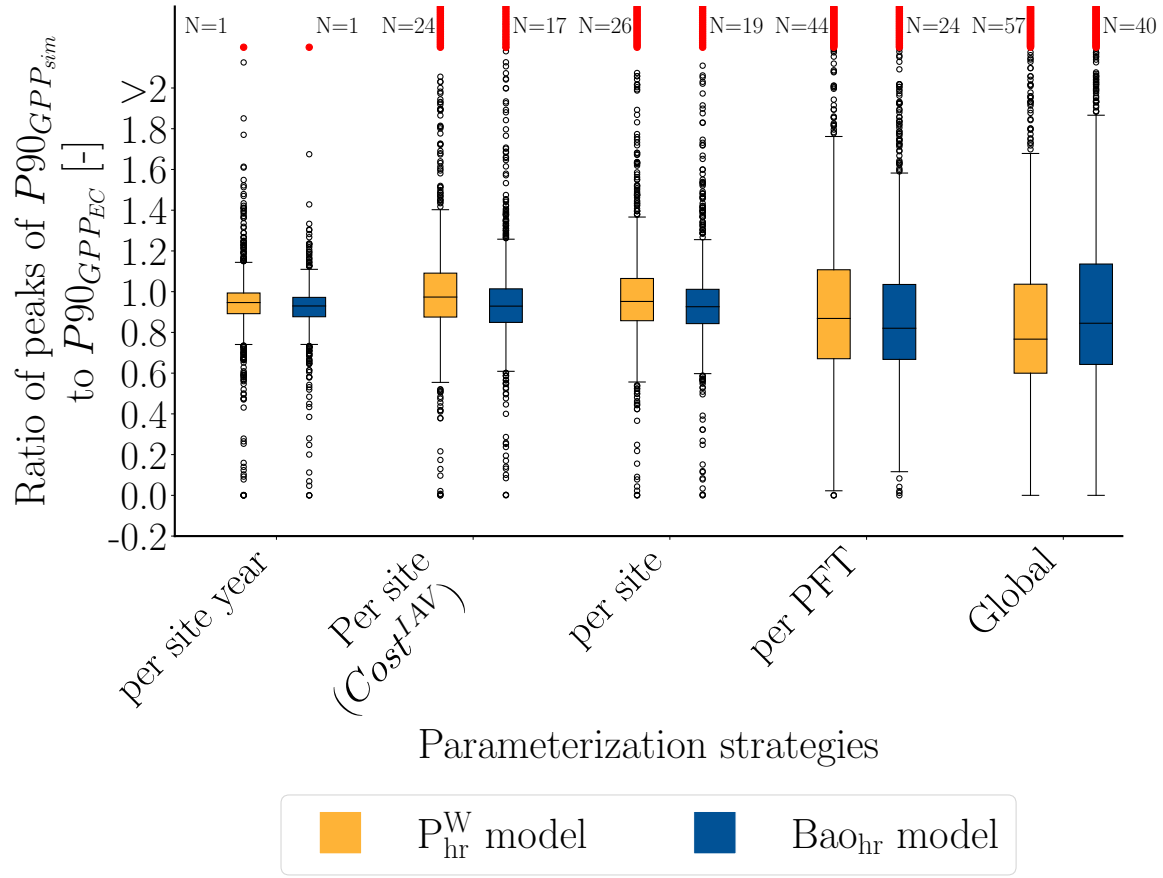


Figure S10: Distributions of the ratios of percentile 90 of simulated gross primary production ($P90_{GPP_{sim}}$) to percentile 90 of gross primary production derived from eddy covariance measurements ($P90_{GPP_{EC}}$). The $P90_{GPP_{sim}}$ was estimated from the gross primary production simulated (GPP_{sim}) by the P-model of Mengoli et al. (2022) with drought stress function which was parameterized with hourly data (P_{hr}^W model), and the light use efficiency model of Bao et al. (2022) which was also parameterized with hourly data (Bao_{hr} model). The boxes are spanned between the first and third quartiles of the ratios, and the line in the middle represents the median. The whiskers show the farthest data point from the box within $1.5 \times$ of the interquartile range. The white circles represent the outliers that go beyond the limits of the whiskers (but ≤ 2.2). The solid dark red circles are the outliers that go beyond 2.2. N represents the total number of such sites for the respective distribution.

Table S1: Description of the P_{hr} model parameters. After Mengoli et al. (2022).

Symbol	Description	Value and/or unit	Reference
$V_{c_{max}}$	Maximum rate of carboxylation (or maximum rate of Rubisco activity)	$\mu\text{molCO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$	Mengoli et al. (2022)
ΔH_a	Activation energy for $V_{c_{max}}$	$65330 \text{ J} \cdot \text{mol}^{-1}$	Mengoli et al. (2022)
J_{max}	Maximum rate of electron transport	$\mu\text{mol electrons} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$	Mengoli et al. (2022)
ΔH_{aj}	Activation energy for J_{max}	$43900 \text{ J} \cdot \text{mol}^{-1}$	Mengoli et al. (2022)
R	Universal gas constant	$8.314 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$	Mengoli et al. (2022)
$\chi = c_i : c_a$	Ratio of leaf-internal to ambient partial pressures of CO_2	–	Mengoli et al. (2022)
c_i	Leaf-internal CO_2 partial pressure	Pa	Mengoli et al. (2022)
c_a	Ambient CO_2 partial pressure	Pa	Mengoli et al. (2022)
ξ	Sensitivity of χ to vapor pressure deficit	$\text{Pa}^{0.5}$	Mengoli et al. (2022)
$\varphi_0(T)$	Temperature dependence function of quantum efficiency	$\text{mol} \cdot \text{mol}^{-1}$	Mengoli et al. (2022)
β	The ratio of cost factors for carboxylation and transpiration capacities at 25°C	146 [–]	Mengoli et al. (2022)
c^*	The cost factor for electron-transport capacity	0.41 [–]	Mengoli et al. (2022)
K_c	Michaelis–Menten constant for carboxylation	Pa	Mengoli et al. (2022)
$K_{C_{25}}$	Michaelis–Menten constant for carboxylation at 25°C	39.97 Pa	Mengoli et al. (2022)
ΔH_{KC}	Activation energy for K_c	$79430 \text{ J} \cdot \text{mol}^{-1}$	Mengoli et al. (2022)
K_O	Michaelis–Menten constant for oxygenation	Pa	Mengoli et al. (2022)
$K_{O_{25}}$	Michaelis–Menten constant for oxygenation at 25°C	27480 Pa	Mengoli et al. (2022)
ΔH_{KO}	Activation energy for K_o	$36380 \text{ J} \cdot \text{mol}^{-1}$	Mengoli et al. (2022)
K	The effective Michaelis-Menten coefficient for Rubisco kinetics	Pa	Mengoli et al. (2022)
kP_o	Standard atmospheric pressure at 0 m a.s.l.	101325 Pa	Stocker et al. (2020)
kL	Mean adiabatic lapse rate	$0.0065 \text{ K} \cdot \text{m}^{-2}$	Stocker et al. (2020)
kT_o	Base temperature	298.15 K	Stocker and Hufkens (2021)
kG	Gravitational constant	$9.80665 \text{ m} \cdot \text{s}^{-2}$	Stocker et al. (2020)
kM_a	Molecular weight for dry air	$0.028963 \text{ kg} \cdot \text{mol}^{-1}$	Stocker et al. (2020)
kco	Partial pressure of oxygen with kP_o	$2.09476 \times 10^5 \text{ Pa}$	Stocker et al. (2020)
Γ^*	Photorespiratory compensation point	Pa	Mengoli et al. (2022)
Γ_{25}^*	Photorespiratory compensation point at 25°C	4.332 Pa	Mengoli et al. (2022)
ΔH_{Γ^*}	Activation energy for Γ^*	$37830 \text{ J} \cdot \text{mol}^{-1}$	Mengoli et al. (2022)
η^*	Temperature dependence of the viscosity of the water, relative to its value at 25°C	–	Mengoli et al. (2022)
$P_a(\text{elev})$	Atmospheric pressure at given elevation a.s.l. (elev)	Pa	Mengoli et al. (2022)
J	Rate of electron transport	$\mu\text{mol electrons} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$	Mengoli et al. (2022)
A_C	Rubisco-limited assimilation rate	$\mu\text{molCO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$	Mengoli et al. (2022)
A_J	Electron-transport limited assimilation rate	$\mu\text{molCO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$	Mengoli et al. (2022)
A	Assimilation rate	$\mu\text{molCO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$	Mengoli et al. (2022)

Table S2: Median normalized Nash-Sutcliffe efficiency (NNSE) obtained at each modelling experiment at daily, weekly, and monthly aggregations

Temporal resolution	Models	Parameterization strategies				
		Per site-year	Per site using $Cost^{IAV}$	Per site	Per PFT	Global
Daily aggregation/ scale	P_{hr}^W	0.784	0.740	0.744	0.643	0.622
	P_{hr}	0.329	0.344	0.331	0.331	0.345
	BaO_{hr}	0.817	0.782	0.784	0.688	0.659
	BaO_{dd}	0.837	0.796	0.796	0.686	0.642
Weekly aggregation	P_{hr}^W	0.813	0.758	0.762	0.654	0.628
	P_{hr}	0.326	0.346	0.334	0.318	0.343
	BaO_{hr}	0.851	0.809	0.813	0.707	0.678
	BaO_{dd}	0.878	0.824	0.827	0.714	0.652
Monthly aggregation	P_{hr}^W	0.849	0.787	0.795	0.672	0.642
	P_{hr}	0.307	0.313	0.309	0.305	0.308
	BaO_{hr}	0.895	0.849	0.853	0.729	0.698
	BaO_{dd}	0.922	0.870	0.867	0.731	0.670

Table S3: Sum of squared error (*SSE*) values obtained from modeling experiments of various complexities

Temporal scale/ aggregation	Models	Parameterization strategies				
		Per site-year	Per site using $Cost^{IAV}$	Per site	Per PFT	Global
Hourly scale	P_{hr}^W	7.41×10^7	8.60×10^7	8.84×10^7	1.31×10^8	1.49×10^8
	Bao_{hr}	6.10×10^7	7.13×10^7	7.01×10^7	1.22×10^8	1.32×10^8
Daily scale/ aggregation	P_{hr}^W	1.20×10^6	1.45×10^6	1.48×10^6	2.45×10^6	2.84×10^6
	Bao_{hr}	9.59×10^5	1.16×10^6	1.15×10^6	2.29×10^6	2.47×10^6
	Bao_{dd}	6.19×10^5	8.30×10^5	8.51×10^5	1.65×10^6	2.04×10^6
Monthly aggregation	P_{hr}^W	2.49×10^4	3.26×10^4	3.25×10^4	6.41×10^4	7.75×10^4
	Bao_{hr}	1.72×10^4	2.27×10^4	2.28×10^4	5.94×10^4	6.41×10^4
	Bao_{dd}	1.01×10^4	1.70×10^4	1.76×10^4	4.39×10^4	5.68×10^4
Yearly aggregation	P_{hr}^W	2.61×10^2	5.11×10^2	3.64×10^2	1.88×10^3	2.48×10^3
	Bao_{hr}	3.44×10^2	3.67×10^2	4.14×10^2	2.21×10^3	2.43×10^3
	Bao_{dd}	1.04×10^2	2.34×10^2	2.51×10^2	1.48×10^3	1.97×10^3

Table S4: Sample size (n) used in of various modeling experiments

Temporal scale/ aggregation	Models	Parameterization strategies				
		Per site-year	Per site using $Cost^{IAV}$	Per site	Per PFT	Global
Hourly scale	P_{hr}^W	7.51×10^6	7.54×10^6	7.54×10^6	7.54×10^6	7.54×10^6
	Bao_{hr}	7.51×10^6	7.54×10^6	7.54×10^6	7.54×10^6	7.54×10^6
Daily scale/ aggregation	P_{hr}^W	3.57×10^5	3.58×10^5	3.58×10^5	3.58×10^5	3.58×10^5
	Bao_{hr}	3.57×10^5	3.58×10^5	3.58×10^5	3.58×10^5	3.58×10^5
	Bao_{dd}	2.81×10^5	2.81×10^5	2.81×10^5	2.81×10^5	2.81×10^5
Monthly aggregation	P_{hr}^W	1.21×10^4	1.21×10^4	1.21×10^4	1.21×10^4	1.21×10^4
	Bao_{hr}	1.21×10^4	1.21×10^4	1.21×10^4	1.21×10^4	1.21×10^4
	Bao_{dd}	9.87×10^3	9.89×10^3	9.89×10^3	9.89×10^3	9.89×10^3
Yearly aggregation	P_{hr}^W	1.01×10^3	1.01×10^3	1.01×10^3	1.01×10^3	1.01×10^3
	Bao_{hr}	1.01×10^3	1.01×10^3	1.01×10^3	1.01×10^3	1.01×10^3
	Bao_{dd}	8.70×10^2	8.72×10^2	8.72×10^2	8.72×10^2	8.72×10^2

Table S5: Total number of parameters (K) parameterized in modeling experiments of various complexities. The number of parameters only varies between parameterization strategies as more parameters were parameterized for finer parameterization strategies and are the same across all the temporal scale/ aggregations.

Models	Parameterization strategies				
	Per site-year	Per site using $Cost^{IAV}$	Per site	Per PFT	Global
P_{hr}^W	1.18×10^4	1.83×10^3	1.83×10^3	1.23×10^2	1.00×10^1
Bao_{hr}	2.34×10^4	3.60×10^3	3.60×10^3	2.39×10^2	1.90×10^1
Bao_{dd}	2.33×10^4	3.60×10^3	3.60×10^3	2.39×10^2	1.90×10^1

Table S6: P-values obtained by performing two-sample Kolmogorov-Smirnov test (Hodges, 1958) between samples of performances for a plant-functional type (PFT) from P-model of Mengoli et al. (2022) with drought stress function, parameterized with hourly data (P_{hr}^W model) and the light use efficiency model of Bao et al. (2022) parameterized with hourly data (Bao_{hr} model) for a specific parameterization strategy. The symbols beside the p-values signify if the distribution of model performance were identical or not: *n.s.* (p-value ≥ 0.05 , distributions were identical and null hypothesis could not be rejected), * ($0.05 > \text{p-value} \geq 0.01$, distributions were not identical and null hypothesis was rejected), ** ($0.01 > \text{p-value} \geq 0.001$, distributions were not identical and null hypothesis was rejected), * * * (p-value < 0.001 , distributions were not identical and null hypothesis was rejected)

PFT	Parameterization strategies			
	Per site-year	Per site	Per PFT	Global
CRO	0.306 ^{<i>n.s.</i>}	0.027*	0.068 ^{<i>n.s.</i>}	0.068 ^{<i>n.s.</i>}
CSH	1.0 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}	0.6 ^{<i>n.s.</i>}	0.6 ^{<i>n.s.</i>}
DBF	0.006**	0.006**	0.71 ^{<i>n.s.</i>}	0.156 ^{<i>n.s.</i>}
DNF	1.0 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}
EBF	0.588 ^{<i>n.s.</i>}	0.999 ^{<i>n.s.</i>}	0.588 ^{<i>n.s.</i>}	0.588 ^{<i>n.s.</i>}
ENF	0.153 ^{<i>n.s.</i>}	0.054 ^{<i>n.s.</i>}	0.03*	0.03*
GRA	0.69 ^{<i>n.s.</i>}	0.492 ^{<i>n.s.</i>}	0.199 ^{<i>n.s.</i>}	0.492 ^{<i>n.s.</i>}
MF	0.352 ^{<i>n.s.</i>}	0.126 ^{<i>n.s.</i>}	0.352 ^{<i>n.s.</i>}	0.352 ^{<i>n.s.</i>}
OSH	0.3 ^{<i>n.s.</i>}	0.898 ^{<i>n.s.</i>}	0.126 ^{<i>n.s.</i>}	0.3 ^{<i>n.s.</i>}
SAV	0.931 ^{<i>n.s.</i>}	0.931 ^{<i>n.s.</i>}	0.931 ^{<i>n.s.</i>}	0.143 ^{<i>n.s.</i>}
SNO	1.0 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}
WET	0.004**	0.081 ^{<i>n.s.</i>}	0.336 ^{<i>n.s.</i>}	0.571 ^{<i>n.s.</i>}
WSA	0.931 ^{<i>n.s.</i>}	0.931 ^{<i>n.s.</i>}	0.931 ^{<i>n.s.</i>}	0.931 ^{<i>n.s.</i>}

Table S7: P-values obtained by performing two-sample Kolmogorov-Smirnov test (Hodges, 1958) between samples of performances for a climate–vegetation type from P-model of Mengoli et al. (2022) with drought stress function, parameterized with hourly data (P_{hr}^W model) and the light use efficiency model of Bao et al. (2022) parameterized with hourly data (Bao_{hr} model) for a specific parameterization strategy. The symbols beside the p-values signify if the distribution of model performance were identical or not: *n.s.* (p-value ≥ 0.05 , distributions were identical and null hypothesis could not be rejected), * ($0.05 > \text{p-value} \geq 0.01$, distributions were not identical and null hypothesis was rejected), ** ($0.01 > \text{p-value} \geq 0.001$, distributions were not identical and null hypothesis was rejected), * * * (p-value < 0.001 , distributions were not identical and null hypothesis was rejected)

Climate–vegetation type	Parameterization strategies			
	Per site–year	Per site	Per PFT	Global
TropicalF	0.575 ^{<i>n.s.</i>}	0.963 ^{<i>n.s.</i>}	0.963 ^{<i>n.s.</i>}	0.053 ^{<i>n.s.</i>}
TropicalG	0.873 ^{<i>n.s.</i>}	0.873 ^{<i>n.s.</i>}	1.0 ^{<i>n.s.</i>}	0.079 ^{<i>n.s.</i>}
AridF	0.931 ^{<i>n.s.</i>}	0.931 ^{<i>n.s.</i>}	0.931 ^{<i>n.s.</i>}	0.143 ^{<i>n.s.</i>}
AridG	0.998 ^{<i>n.s.</i>}	0.998 ^{<i>n.s.</i>}	0.869 ^{<i>n.s.</i>}	0.1 ^{<i>n.s.</i>}
TemperateF	0.408 ^{<i>n.s.</i>}	0.562 ^{<i>n.s.</i>}	0.877 ^{<i>n.s.</i>}	0.283 ^{<i>n.s.</i>}
TemperateG	0.707 ^{<i>n.s.</i>}	0.51 ^{<i>n.s.</i>}	0.51 ^{<i>n.s.</i>}	0.34 ^{<i>n.s.</i>}
BorealF	0.004 ^{**}	0.002 ^{**}	0.077 ^{<i>n.s.</i>}	0.046 [*]
BorealG	0.009 ^{**}	0.027 [*]	0.068 ^{<i>n.s.</i>}	0.306 ^{<i>n.s.</i>}
Polar	0.052 ^{<i>n.s.</i>}	0.168 ^{<i>n.s.</i>}	0.418 ^{<i>n.s.</i>}	0.787 ^{<i>n.s.</i>}

Table S8: Details of 198 EC sites used in this study. Site ID is the ID of a site assigned by Pastorello et al. (2020). Lat, Lon, Obs. period, PFT, KG, Elev. are latitude, longitude, observation period, plant function type, Köppen–Geiger climate class, and elevation (in m). Site PFT and KG are the same as assigned by Pastorello et al. (2020), and elevations were taken from Table S2 of Bao et al. (2022). We assign PFT of the site AU-ASM as WSA (contrary to SAV as assigned by Pastorello et al., 2020) as this site represents woody Mulga (*Acacia aneura*) and seasonal grassy surface layer (Cleverly, Boulain, Villalobos-Vega, et al., 2013).

Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
AR-SLu	-33.46	-66.46	2009 to 2011	MF	BSh	506.0	Garcia et al. (2016) and Ulke et al. (2015)
AR-Vir	-28.24	-56.19	2010 to 2012	ENF	Cfa	105.0	Posse et al. (2016a) and Posse et al. (2016b)
AT-Neu	47.12	11.32	2002 to 2012	GRA	Dfc	970.0	Wohlfahrt et al. (2008, 2016)
AU-Ade	-13.08	131.12	2007 to 2009	WSA	Aw	90.0	Beringer, Hacker, et al. (2011) and Beringer and Hutley (2016a)
AU-ASM	-22.28	133.25	2010 to 2014	WSA	BWh	606.0	Cleverly, Boulain, Villalobos-Vega, et al. (2013) and Cleverly and Eamus (2016a)
AU-Cpr	-34.0	140.59	2010 to 2014	SAV	BSk	62.0	W. S. Meyer et al. (2015) and W. Meyer et al. (2016)
AU-Cum	-33.61	150.72	2012 to 2014	EBF	Cfa	20.0	Beringer, Hutley, et al. (2016) and Pendall and Griebel (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
AU-DaP	-14.06	131.32	2007 to 2013	GRA	Aw	71.0	Beringer and Hutley (2016b) and Beringer, Hutley, et al. (2011)
AU-DaS	-14.16	131.39	2008 to 2011	SAV	Aw	110.0	Beringer and Hutley (2016c) and Hutley et al. (2011)
AU-Dry	-15.26	132.37	2008 to 2014	SAV	Aw	175.0	Beringer and Hutley (2016d) and Cernusak et al. (2011)
AU-Emr	-23.86	148.47	2011 to 2013	GRA	BSh	170.0	Schroder (2014) and Schroder et al. (2016)
AU-Fog	-12.55	131.31	2006 to 2008	WET	Aw	4.0	Beringer and Hutley (2016e) and Beringer et al. (2013)
AU-Gin	-31.38	115.71	2011 to 2013	WSA	Csa	51.0	Macfarlane et al. (2016)
AU-RDF	-14.56	132.48	2011 to 2013	WSA	Aw	188.0	Beringer and Hutley (2016f) and Bristow et al. (2016)
AU-Rob	-17.12	145.63	2014	EBF	Cfa	710.0	Beringer, Hutley, et al. (2016) and Liddell (2016)
AU-TTE	-22.29	133.64	2012 to 2014	GRA	BWh	553.0	Cleverly and Eamus (2016b)
AU-Tum	-35.66	148.15	2001 to 2014	EBF	Cfb	1200.0	Leuning et al. (2005) and Woodgate et al. (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
AU-Wac	-37.43	145.19	2005 to 2008	EBF	Cfb	545.0	Beringer, Hutley, et al. (2016) and Kilinc et al. (2013)
AU-Whr	-36.67	145.03	2011 to 2014	EBF	Cfa	165.0	Beringer, Cunningham, et al. (2016) and McHugh et al. (2017)
AU-Wom	-37.42	144.09	2010 to 2014	EBF	Cfb	705.0	Arndt et al. (2016)
AU-Ync	-34.99	146.29	2012 to 2014	GRA	BSk	126.0	Beringer and Walker (2016) and Yee et al. (2015)
BE-Bra	51.31	4.52	1999 to 2014	MF	Cfb	16.0	Carrara et al. (2004) and Neiryneck et al. (2016)
BE-Lon	50.55	4.75	2004 to 2014	CRO	Cfb	167.0	De Ligne, Manise, Moureaux, et al. (2016) and Moureaux et al. (2006)
BE-Vie	50.31	6.0	1996 to 2014	MF	Cfb	450.0	Aubinet et al. (2001) and De Ligne, Manise, Heinesch, et al. (2016)
BR-Sa1	-2.86	-54.96	2002 to 2011	EBF	Am	88.0	T. R. Baker et al. (2004) and Saleska (2016)
BR-Sa3	-3.02	-54.97	2000 to 2004	EBF	Am	100.0	Asner et al. (2004) and Goulden (2016a)
CA-Gro	48.22	-82.16	2003 to 2014	MF	Dfb	340.0	A. Barr et al. (2013) and McCaughey (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
CA-NS2	55.91	-98.52	2001 to 2005	ENF	Dfc	260.0	D. Baldocchi and Penuelas (2019) and Goulden (2016b)
CA-NS3	55.91	-98.38	2001 to 2005	ENF	Dfc	260.0	D. Baldocchi and Penuelas (2019) and Goulden (2016c)
CA-NS4	55.91	-98.38	2002 to 2005	ENF	Dfc	260.0	D. Baldocchi and Penuelas (2019) and Goulden (2016d)
CA-NS5	55.86	-98.48	2001 to 2005	ENF	Dfc	260.0	D. Baldocchi and Penuelas (2019) and Goulden (2016e)
CA-NS6	55.92	-98.96	2001 to 2005	OSH	Dfc	244.0	D. Baldocchi and Penuelas (2019) and Goulden (2016f)
CA-NS7	56.64	-99.95	2002 to 2005	OSH	Dfc	297.0	D. Baldocchi and Penuelas (2019) and Goulden (2016g)
CA-Oas	53.63	-106.2	1996 to 2010	DBF	Dfc	530.0	A. G. Barr et al. (2004) and Black (2016a)
CA-Obs	53.99	-105.12	1999 to 2010	ENF	Dfc	628.94	A. Barr et al. (2013) and Black (2016b)
CA-Qfo	49.69	-74.34	2003 to 2010	ENF	Dfc	382.0	D. Baldocchi and Penuelas (2019) and Margolis (2016)
CA-SF1	54.48	-105.82	2003 to 2006	ENF	Dfc	536.0	Amiro (2009, 2016a)
CA-SF2	54.25	-105.88	2001 to 2005	ENF	Dfc	520.0	Amiro (2009, 2016b)
CA-SF3	54.09	-106.01	2002 to 2006	OSH	Dfc	540.0	Amiro (2009, 2016c)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
CA-TP1	42.66	-80.56	2003 to 2014	ENF	Dfb	265.0	Arain (2016a) and Arain and Restrepo-Coupe (2005)
CA-TP2	42.77	-80.46	2003 to 2007	ENF	Dfb	212.0	Arain (2016b) and Arain and Restrepo-Coupe (2005)
CA-TP3	42.71	-80.35	2003 to 2014	ENF	Dfb	184.0	Arain (2016c) and Arain and Restrepo-Coupe (2005)
CA-TP4	42.71	-80.36	2002 to 2014	ENF	Dfb	184.0	Arain (2016d) and Arain and Restrepo-Coupe (2005)
CA-TPD	42.64	-80.56	2012 to 2014	DBF	Dfb	260.0	Arain (2016e) and Chu et al. (2018)
CH-Cha	47.21	8.41	2005 to 2014	GRA	Cfb	393.0	Hörtl Nagl, Feigenwinter, et al. (2016a) and Merbold et al. (2014)
CH-Dav	46.82	9.86	1997 to 2014	ENF	ET	1639.0	Hörtl Nagl, Eugster, Merbold, et al. (2016) and Zielis et al. (2014)
CH-Fru	47.12	8.54	2005 to 2014	GRA	Cfb	982.0	Hörtl Nagl, Feigenwinter, et al. (2016b) and Imer et al. (2013)
CH-Lae	47.48	8.36	2004 to 2014	MF	Cfb	689.0	Etzold et al. (2011) and Hörtl Nagl, Eugster, Buchmann, et al. (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
CH-Oe1	47.29	7.73	2002 to 2008	GRA	Cfb	450.0	Ammann et al. (2009) and Ammann (2016)
CH-Oe2	47.29	7.73	2004 to 2014	CRO	Cfb	452.0	Dietiker et al. (2010) and Hörtnagl, Maier, et al. (2016)
CN-Cha	42.4	128.1	2003 to 2005	MF	Dwb	738.0	Guan et al. (2006) and Zhang and Han (2016)
CN-Cng	44.59	123.51	2007 to 2010	GRA	BSk	171.0	Dong (2016)
CN-Dan	30.5	91.07	2004 to 2005	GRA	Dwc	4286.0	Shi et al. (2006, 2016)
CN-Din	23.17	112.54	2003 to 2005	EBF	Cfa	507.0	Yu et al. (2006) and Zhou and Yan (2016)
CN-Du2	42.05	116.28	2007 to 2008	GRA	Dwb	1350.0	S. Chen (2016) and S. Chen et al. (2009)
CN-Du3	42.06	116.28	2009 to 2010	GRA	Dwb	1350.0	Shao (2016a)
CN-HaM	37.37	101.18	2002 to 2004	GRA	ET	3190.0	Kato et al. (2006) and Tang et al. (2016)
CN-Qia	26.74	115.06	2003 to 2005	ENF	Cfa	109.0	Wang and Fu (2016) and Yu et al. (2006)
CN-Sw2	41.79	111.9	2010 to 2012	GRA	BSk	1438.0	Shao (2016b)
CZ-BK1	49.5	18.54	2004 to 2014	ENF	Dfb	908.0	Acosta et al. (2013) and Sigut et al. (2016a)
CZ-BK2	49.49	18.54	2006 to 2012	GRA	Dfb	855.0	Sigut et al. (2016b)
CZ-wet	49.02	14.77	2006 to 2014	WET	Cfb	426.0	Dušek et al. (2012) and Dušek et al. (2016)
DE-Akm	53.87	13.68	2009 to 2014	WET	Cfb	-1.0	Bernhofer et al. (2016a)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
DE-Geb	51.1	10.91	2001 to 2014	CRO	Cfb	161.5	P. M. Anthoni et al. (2004) and Brümmer et al. (2016)
DE-Gri	50.95	13.51	2004 to 2014	GRA	Cfb	385.0	Bernhofer et al. (2016b) and Prescher et al. (2010)
DE-Hai	51.08	10.45	2000 to 2012	DBF	Cfb	430.0	Knohl, Tiedemann, Kolle, Schulze, Kutsch, et al. (2016) and Knohl et al. (2003b)
DE-Kli	50.89	13.52	2004 to 2014	CRO	Cfb	478.0	Bernhofer et al. (2016c) and Prescher et al. (2010)
DE-Lkb	49.1	13.3	2009 to 2013	ENF	Dfb	1308.0	Lindauer et al. (2014) and Lindauer et al. (2016)
DE-Lnf	51.33	10.37	2002 to 2012	DBF	Cfb	451.0	P. M. Anthoni et al. (2004) and Knohl, Tiedemann, Kolle, Schulze, Anthoni, et al. (2016)
DE-Obe	50.78	13.72	2008 to 2014	ENF	Cfb	734.0	Bernhofer et al. (2016d)
DE-Seh	50.87	6.45	2007 to 2010	CRO	Cfb	103.0	Schmidt et al. (2012) and Schneider and Schmidt (2016)
DE-SfN	47.81	11.33	2012 to 2014	WET	Cfb	590.0	Hommeltenberg et al. (2014) and Klatt et al. (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
DE-Spw	51.89	14.03	2010 to 2014	WET	Cfb	61.0	Bernhofer et al. (2016e)
DE-Tha	50.96	13.57	1996 to 2014	ENF	Cfb	380.0	Bernhofer et al. (2016f) and Grünwald and Bernhofer (2007)
DE-Zrk	53.88	12.89	2013 to 2014	WET	Cfb	0.0	Sachs et al. (2016) and Zak et al. (2015)
DK-Eng	55.69	12.19	2005 to 2008	GRA	Cfb	10.0	Pilegaard and Ibrom (2016)
DK-Fou	56.48	9.59	2005	CRO	Cfb	51.0	Olesen (2016)
DK-Sor	55.49	11.64	1996 to 2014	DBF	Cfb	40.0	Ibrom and Pilegaard (2016) and Pilegaard et al. (2011)
ES-Amo	36.83	-2.25	2007 to 2012	OSH	BSh	58.0	López-Ballesteros et al. (2017) and Poveda et al. (2016)
ES-LgS	37.1	-2.97	2007 to 2009	OSH	Csb	2267.0	Reverter et al. (2010) and Reverter et al. (2016a)
ES-LJu	36.93	-2.75	2004 to 2013	OSH	Csa	1600.0	Cañete et al. (2016) and Serrano-Ortiz et al. (2009)
ES-Ln2	36.97	-3.48	2009	OSH	Csb	2249.0	Reverter et al. (2016b)
FI-Hyy	61.85	24.3	1996 to 2014	ENF	Dfc	181.0	Mammarella et al. (2016) and Suni et al. (2003)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
FI-Jok	60.9	23.51	2000 to 2003	CRO	Dfb	109.0	Lohila, Aurela, Tuovinen, et al. (2016) and Lohila et al. (2004)
FI-Let	60.64	23.96	2009 to 2012	ENF	Dfb	111.0	Korkiakoski et al. (2017) and Lohila, Korkiakoski, et al. (2016)
FI-Lom	68.0	24.21	2007 to 2009	WET	Dfc	269.0	Aurela, Lohila, Tuovinen, Hatakka, et al. (2016) and Aurela et al. (2015)
FI-Sod	67.36	26.64	2001 to 2014	ENF	Dfc	180.0	Aurela, Tuovinen, et al. (2016) and Thum et al. (2007)
FR-Fon	48.48	2.78	2005 to 2014	DBF	Cfb	92.0	Bazot et al. (2013) and Berveiller et al. (2016)
FR-Gri	48.84	1.95	2004 to 2014	CRO	Cfb	125.0	Buyse et al. (2016) and Loubet et al. (2011)
FR-LBr	44.72	-0.77	1996 to 2008	ENF	Cfb	61.0	Berbigier and Loustau (2016) and Berbigier et al. (2001)
FR-Pue	43.74	3.6	2000 to 2014	EBF	Csa	270.0	Ourcival (2016) and Rambal et al. (2004)
GF-Guy	5.28	-52.92	2004 to 2014	EBF	Am	48.0	Bonal and Burban (2016) and Bonal et al. (2008)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
GL-NuF	64.13	-51.39	2008 to 2014	WET	ET	60.0	Hansen (2016) and López-Blanco et al. (2017)
GL-ZaF	74.48	-20.55	2008 to 2011	WET	ET	65.0	Lund et al. (2016a) and Soegaard (1999)
GL-ZaH	74.47	-20.55	2000 to 2014	GRA	ET	48.0	Lund et al. (2012, 2016b)
IT-BCi	40.52	14.96	2004 to 2014	CRO	Csa	20.0	Magliulo et al. (2016) and Vitale et al. (2015)
IT-CA1	42.38	12.03	2011 to 2014	DBF	Csa	200.0	Sabbatini, Arriga, Bertolini, et al. (2016) and Sabbatini, Arriga, and Papale (2016)
IT-CA2	42.38	12.03	2011 to 2014	CRO	Csa	200.0	Sabbatini, Arriga, Bertolini, et al. (2016) and Sabbatini, Arriga, Gioli, and Papale (2016)
IT-CA3	42.38	12.02	2011 to 2014	DBF	Csa	197.0	Sabbatini, Arriga, Bertolini, et al. (2016) and Sabbatini, Arriga, Matteucci, and Papale (2016)
IT-Col	41.85	13.59	1996 to 2014	DBF	Cfb	1560.0	Matteucci (2016) and Valentini et al. (1996)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
IT-Cp2	41.7	12.36	2012 to 2014	EBF	Csa	19.0	Fares et al. (2014) and Fares et al. (2016)
IT-Cpz	41.71	12.38	2000 to 2008	EBF	Csa	68.0	Garbulsky et al. (2008) and Valentini, Dore, et al. (2016)
IT-Isp	45.81	8.63	2013 to 2014	DBF	Cfa	210.0	Ferréa et al. (2012) and Gruening, Goded, Cescatti, and Pokorska (2016a)
IT-La2	45.95	11.29	2000 to 2002	ENF	Cfb	1350.0	Cescatti et al. (2016) and Marcolla et al. (2003)
IT-Lav	45.96	11.28	2003 to 2014	ENF	Cfb	1353.0	Gianelle, Zampedri, et al. (2016) and Marcolla et al. (2003)
IT-MBo	46.01	11.05	2003 to 2013	GRA	Dfb	1550.0	Gianelle, Cavagna, et al. (2016) and Marcolla et al. (2011)
IT-Noe	40.61	8.15	2004 to 2014	CSH	Csa	25.0	Marras et al. (2011) and Spano et al. (2016)
IT-PT1	45.2	9.06	2002 to 2004	DBF	Cfa	60.0	Manca and Goded (2016) and Migliavacca et al. (2009)
IT-Ren	46.59	11.43	1999 to 2013	ENF	Dfc	1730.0	Montagnani and Minerbi (2016) and Montagnani et al. (2009)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
IT-Ro1	42.41	11.93	2000 to 2008	DBF	Csa	235.0	Rey et al. (2002) and Valentini, Tirone, et al. (2016)
IT-Ro2	42.39	11.92	2002 to 2012	DBF	Csa	224.0	Papale et al. (2016) and Tedeschi et al. (2005)
IT-SR2	43.73	10.29	2013 to 2014	ENF	Csa	4.0	Gruening, Goded, Cescatti, and Pokorska (2016b)
IT-SRo	43.73	10.28	1999 to 2012	ENF	Csa	4.0	Chiesi et al. (2005) and Gruening, Goded, Cescatti, Manca, and Seufert (2016)
IT-Tor	45.84	7.58	2008 to 2014	GRA	ET	2160.0	Cremonese et al. (2016) and Galvagno et al. (2013)
JP-MBF	44.39	142.32	2004 to 2005	DBF	Dfb	585.0	Kotani (2016a) and Matsumoto et al. (2008)
JP-SMF	35.26	137.08	2002 to 2006	MF	Cfa	205.0	Kotani (2016b) and Matsumoto et al. (2008)
NL-Hor	52.24	5.07	2004 to 2011	GRA	Cfb	-2.0	Dolman, Hendriks, et al. (2016) and Jacobs et al. (2007)
NL-Loo	52.17	5.74	1996 to 2014	ENF	Cfb	25.0	E. J. Moors (2012) and E. Moors and Elbers (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
PA-SPn	9.32	-79.63	2007 to 2009	DBF	Am	78.0	Wolf, Eugster, and Buchmann (2016a) and Wolf et al. (2011)
PA-SPs	9.31	-79.63	2007 to 2009	GRA	Am	68.0	Wolf, Eugster, and Buchmann (2016b) and Wolf et al. (2011)
RU-Che	68.61	161.34	2002 to 2005	WET	Dsc	6.0	Merbold, Kutsch, et al. (2009) and Merbold et al. (2016)
RU-Cok	70.83	147.49	2003 to 2013	OSH	Dfc	48.0	Dolman, Van Der Molen, et al. (2016) and Van der Molen et al. (2007)
RU-Fyo	56.46	32.92	1998 to 2014	ENF	Dfb	265.0	Kurbatova et al. (2008) and Varlagin et al. (2016)
RU-Ha1	54.73	90.0	2002 to 2004	GRA	Dfb	446.0	Belelli et al. (2016) and Belelli Marchesini et al. (2007)
RU-Sam	72.37	126.5	2002 to 2014	GRA	Dsd	16.0	Boike et al. (2013) and Kutzbach et al. (2016)
RU-SkP	62.26	129.17	2012 to 2014	DNF	Dfd	246.0	Maximov (2016)
RU-Tks	71.59	128.89	2010 to 2014	GRA	Dsd	7.0	Aurela, Laurila, et al. (2016)
RU-Vrk	67.05	62.94	2008	CSH	Dfc	100.0	Friberg, Biasi, and Shurpali (2016)
SD-Dem	13.28	30.48	2005 to 2009	SAV	BWh	500.0	Ardö et al. (2008, 2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
SE-St1	68.35	19.05	2012 to 2014	WET	Dfc	351.0	Friberg, Jammet, and Crill (2016) and Jammet et al. (2015)
SJ-Adv	78.19	15.92	2012 to 2014	WET	ET	16.0	Christensen (2016)
SJ-Blv	78.92	11.83	2008 to 2009	SNO	ET	25.0	Boike et al. (2016) and Lüers et al. (2014)
SN-Dhr	15.4	-15.43	2010 to 2013	SAV	BWh	40.0	Tagesson et al. (2014, 2016)
US-AR1	36.43	-99.42	2009 to 2012	GRA	Cfa	611.0	D. Baldocchi and Penuelas (2019) and Billesbach et al. (2016a)
US-AR2	36.64	-99.6	2009 to 2012	GRA	Cfa	646.0	D. Baldocchi and Penuelas (2019) and Billesbach et al. (2016b)
US-ARb	35.55	-98.04	2005 to 2006	GRA	Cfa	424.0	Fischer et al. (2012) and Torn (2016a)
US-ARc	35.55	-98.04	2005 to 2006	GRA	Cfa	424.0	D. Baldocchi and Penuelas (2019) and Torn (2016b)
US-ARM	36.61	-97.49	2003 to 2012	CRO	Cfa	314.0	Bagley et al. (2017) and Biraud et al. (2016)
US-Atq	70.47	-157.41	2003 to 2008	WET	ET	15.0	Kwon et al. (2006) and Zona and Oechel (2016a)
US-Blo	38.9	-120.63	1997 to 2007	ENF	Csb	1315.0	B. Baker et al. (1999) and Goldstein (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
US-Cop	38.09	-109.39	2001 to 2007	GRA	BSk	1520.0	Bowling (2016) and Sullivan et al. (2019)
US-CRT	41.63	-83.35	2011 to 2013	CRO	Dfa	180.0	J. Chen and Chu (2016a) and Chu et al. (2018)
US-GBT	41.37	-106.24	2001 to 2003	ENF	Dfc	3191.0	D. Baldocchi and Penuelas (2019) and Massman (2016a)
US-GLE	41.37	-106.24	2005 to 2014	ENF	Dfc	3197.0	Arain and Restrepo-Coupe (2005) and Massman (2016b)
US-Goo	34.25	-89.87	2002 to 2006	GRA	Cfa	87.0	Meyers (2016) and Runkle et al. (2017)
US-Ha1	42.54	-72.17	1991 to 2012	DBF	Dfb	340.0	Antonarakis et al. (2017) and Munger (2016)
US-IB2	41.84	-88.24	2004 to 2011	GRA	Dfa	226.5	Allison et al. (2005) and Matamala (2016)
US-Ivo	68.49	-155.75	2004 to 2007	WET	ET	568.0	McEwing et al. (2015) and Zona and Oechel (2016b)
US-KS1	28.46	-80.67	2002	ENF	Cfa	1.0	Bracho et al. (2008) and Drake and Hinkle (2016a)
US-KS2	28.61	-80.67	2003 to 2006	CSH	Cfa	3.0	D. Baldocchi and Penuelas (2019) and Drake and Hinkle (2016b)
US-Lin	36.36	-119.84	2009 to 2010	CRO	BSk	131.0	Fares (2016) and Fares et al. (2013)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
US-Los	46.08	-89.98	2000 to 2014	WET	Dfb	480.0	I. Baker et al. (2003) and A. Desai (2016a)
US-Me1	44.58	-121.5	2004 to 2005	ENF	Csb	896.0	D. Baldocchi and Penuelas (2019) and Law (2016a)
US-Me2	44.45	-121.56	2002 to 2014	ENF	Csb	1253.0	Campbell et al. (2004) and Law (2016b)
US-Me3	44.32	-121.61	2004 to 2009	ENF	Csb	1005.0	A. Barr et al. (2013) and Law (2016c)
US-Me4	44.5	-121.62	1996 to 2000	ENF	Csb	922.0	P. M. Anthoni et al. (1999) and Law (2016d)
US-Me5	44.44	-121.57	2000 to 2002	ENF	Csb	1188.0	P. M. Anthoni et al. (2002) and Law (2016e)
US-Me6	44.32	-121.61	2010 to 2014	ENF	Csb	998.0	Chu et al. (2018) and Law (2016f)
US-MMS	39.32	-86.41	1999 to 2014	DBF	Cfa	275.0	D. D. Baldocchi et al. (2005) and Novick and Phillips (2016)
US-Myb	38.05	-121.77	2011 to 2014	WET	Csa	-1.0	D. Baldocchi and Penuelas (2019) and Sturtevant et al. (2016)
US-Ne1	41.17	-96.48	2001 to 2013	CRO	Dfa	361.0	Amos et al. (2005) and Suyker (2016a)
US-Ne2	41.16	-96.47	2001 to 2013	CRO	Dfa	362.0	Amos et al. (2005) and Suyker (2016b)
US-Ne3	41.18	-96.44	2001 to 2013	CRO	Dfa	363.0	Amos et al. (2005) and Suyker (2016c)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
US-NR1	40.03	-105.55	1999 to 2014	ENF	Dfc	3050.0	Albert et al. (2017) and Blanken et al. (2016)
US-Oho	41.55	-83.84	2004 to 2013	DBF	Dfa	230.0	J. Chen et al. (2016) and Chu et al. (2018)
US-ORv	40.02	-83.02	2011	WET	Cfa	221.0	Bohrer (2016) and Brooker et al. (2014)
US-PFa	45.95	-90.27	1996 to 2014	MF	Dfb	470.0	A. Desai (2016b) and Keppel-Aleks et al. (2012)
US-Prr	65.12	-147.49	2010 to 2014	ENF	Dfc	210.0	Ikawa et al. (2015) and Kobayashi and Suzuki (2016)
US-SRC	31.91	-110.84	2008 to 2014	OSH	BSh	991.0	Kurc (2016) and Wolf, Keenan, et al. (2016)
US-SRG	31.79	-110.83	2008 to 2014	GRA	Csa	1291.0	D. Baldocchi and Penuelas (2019) and Scott (2016b)
US-SRM	31.82	-110.87	2004 to 2014	WSA	BSk	1120.0	Barron-Gafford et al. (2013) and Scott (2016c)
US-Sta	41.4	-106.8	2005 to 2009	OSH	Dfb	2069.0	Ewers and Pendall (2016) and Reed et al. (2018)
US-Syv	46.24	-89.35	2001 to 2014	MF	Dfb	540.0	A. Barr et al. (2013) and A. Desai (2016c)
US-Ton	38.43	-120.97	2001 to 2014	WSA	Csa	177.0	D. Baldocchi and Ma (2016) and D. D. Baldocchi et al. (2010)

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Table S8 – *Continued from previous page*

Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
US-Tw1	38.11	-121.65	2012 to 2014	WET	Csa	-9.0	D. Baldocchi and Penuelas (2019) and Szutu et al. (2016)
US-Tw2	38.1	-121.64	2012 to 2013	CRO	Csa	-5.0	D. Baldocchi (2016a) and D. Baldocchi and Penuelas (2019)
US-Tw3	38.12	-121.65	2013 to 2014	CRO	Csa	-9.0	D. Baldocchi and Penuelas (2019) and Szutu and Baldocchi (2016)
US-Tw4	38.1	-121.64	2013 to 2014	WET	Csa	-5.0	Chamberlain et al. (2017) and Sanchez et al. (2016)
US-Twt	38.11	-121.65	2009 to 2014	CRO	Csa	-7.0	D. Baldocchi (2016b) and D. Baldocchi and Penuelas (2019)
US-UMB	45.56	-84.71	2000 to 2014	DBF	Dfb	234.0	Aron et al. (2019) and Gough et al. (2016a)
US-UMd	45.56	-84.7	2007 to 2014	DBF	Dfb	239.0	Atkins et al. (2018) and Gough et al. (2016b)
US-Var	38.41	-120.95	2000 to 2014	GRA	Csa	129.0	D. Baldocchi et al. (2016) and D. D. Baldocchi et al. (2004)
US-WCr	45.81	-90.08	1999 to 2014	DBF	Dfb	520.0	I. Baker et al. (2003) and A. Desai (2016d)
US-Whs	31.74	-110.05	2007 to 2014	OSH	BSk	1370.0	Biederman et al. (2017) and Scott (2016a)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
US-Wi0	46.62	-91.08	2002	ENF	Dfb	349.0	J. Chen (2016a) and Chu et al. (2018)
US-Wi1	46.73	-91.23	2003	DBF	Dfb	352.0	J. Chen (2016b) and Chu et al. (2018)
US-Wi2	46.69	-91.15	2003	ENF	Dfb	395.0	J. Chen (2016c) and A. R. Desai et al. (2008)
US-Wi3	46.63	-91.1	2002 to 2004	DBF	Dfb	411.0	J. Chen (2016d) and Chu et al. (2018)
US-Wi4	46.74	-91.17	2002 to 2005	ENF	Dfb	352.0	J. Chen (2016e) and Chu et al. (2018)
US-Wi5	46.65	-91.09	2004	ENF	Dfb	353.0	J. Chen (2016f) and Chu et al. (2018)
US-Wi6	46.62	-91.3	2002 to 2003	OSH	Dfb	371.0	J. Chen (2016g) and A. R. Desai et al. (2008)
US-Wi7	46.65	-91.07	2005	OSH	Dfb	335.0	J. Chen (2016h) and Chu et al. (2021)
US-Wi8	46.72	-91.25	2002	DBF	Dfb	348.0	J. Chen (2016i) and Chu et al. (2018)
US-Wi9	46.62	-91.08	2004 to 2005	ENF	Dfb	350.0	J. Chen (2016j) and Chu et al. (2018)
US-Wkg	31.74	-109.94	2004 to 2014	GRA	BSk	1531.0	Biederman et al. (2017) and Scott (2016d)
US-WPT	41.46	-83.0	2011 to 2013	WET	Cfa	175.0	J. Chen and Chu (2016b) and Chu et al. (2016)
ZA-Kru	-25.02	31.5	2000 to 2013	SAV	BSh	359.0	Archibald et al. (2009) and Scholes (2016)

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Site ID	Lat	Lon	Obs. period	PFT	KG	Elev.	Reference
ZM-Mon	-15.44	23.25	2000 to 2009	DBF	Aw	1053.0	Kutsch et al. (2016) and Merbold, Ardö, et al. (2009)

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