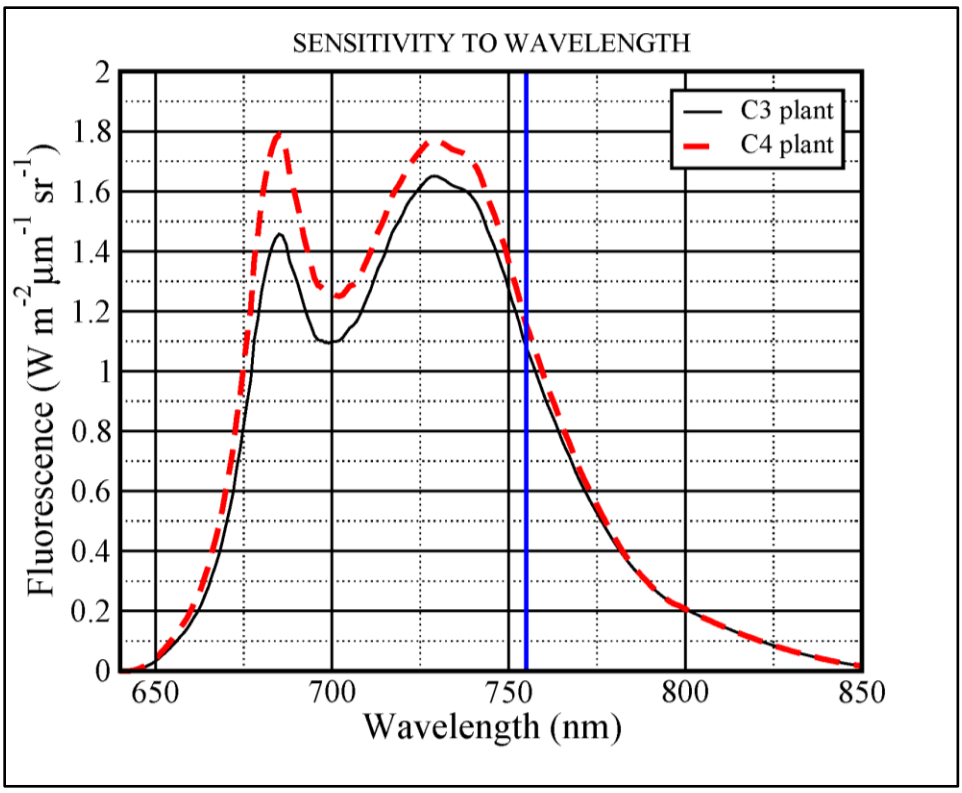

Figure 1: The simulated fluorescence at the top of the canopy as a function of the radiation wavelength and for C3 (black solid line) and C4 (red dashed line) plants from the model SCOPE are shown, respectively. The blue solid line corresponds to wavelength value (i.e., 755 nm) at which the simulated SIF is calculated in this study, i.e., the equivalent of the satellite GOSAT based SIF.

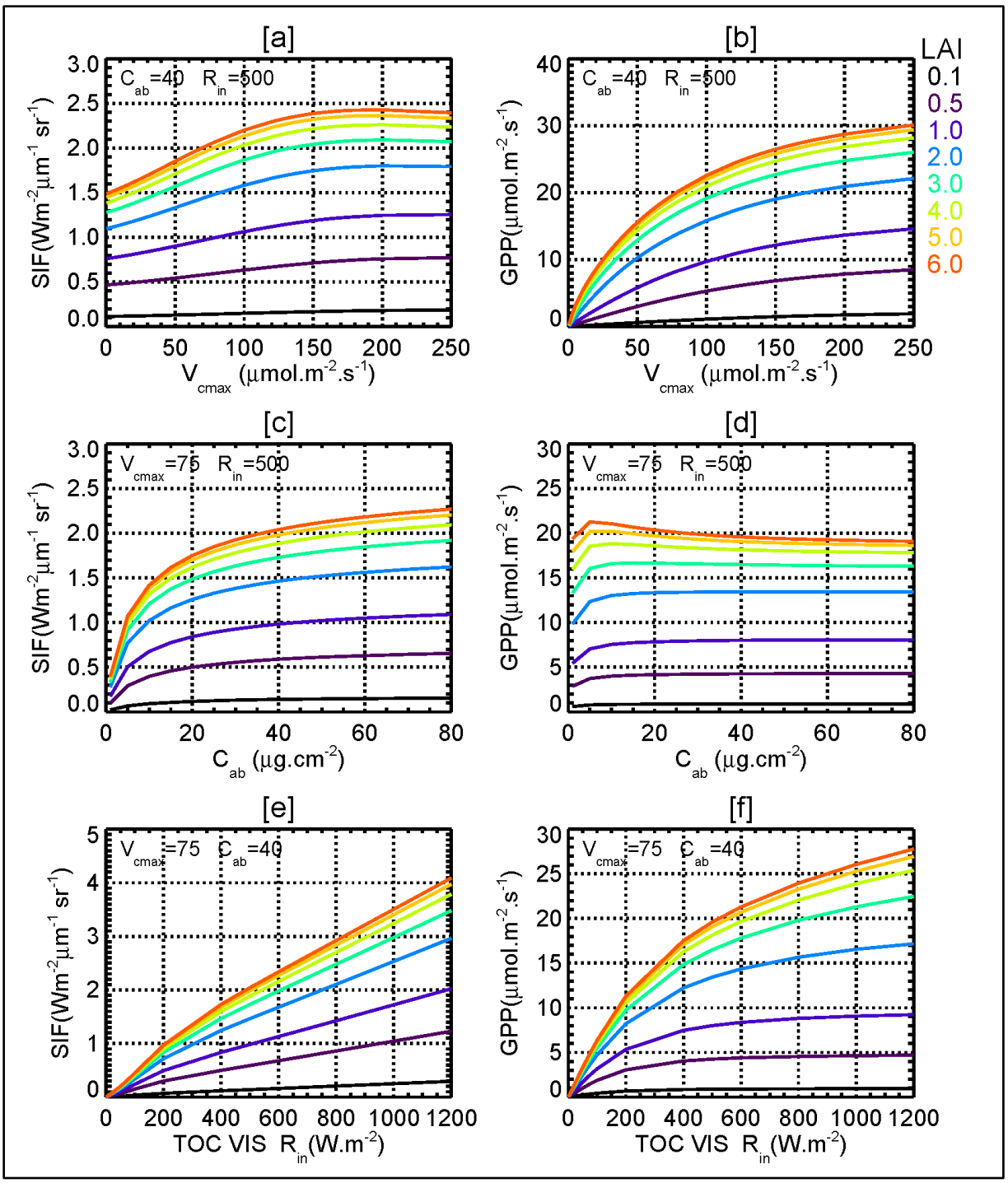

Figure 2: The sensitivities of SCOPE fluorescence (SIF) at the top of the canopy (TOC) of C_3 plant to the carboxylation maximum capacity (V_{cmax}), chlorophyll content AB (C_{ab}), and to TOC visible radiation (TOC VIS R_{in}) for several leaf area index (LAI) are shown. Graphs a) and b) stand for SIF and GPP as function of V_{cmax}, respectively. The graphs (c and d) give the sensitivities of SIF and GPP to C_{ab}, respectively. The graphs (e and f) show SIF and GPP as a function of short wave radiation at the TOC (R_{in}), respectively.

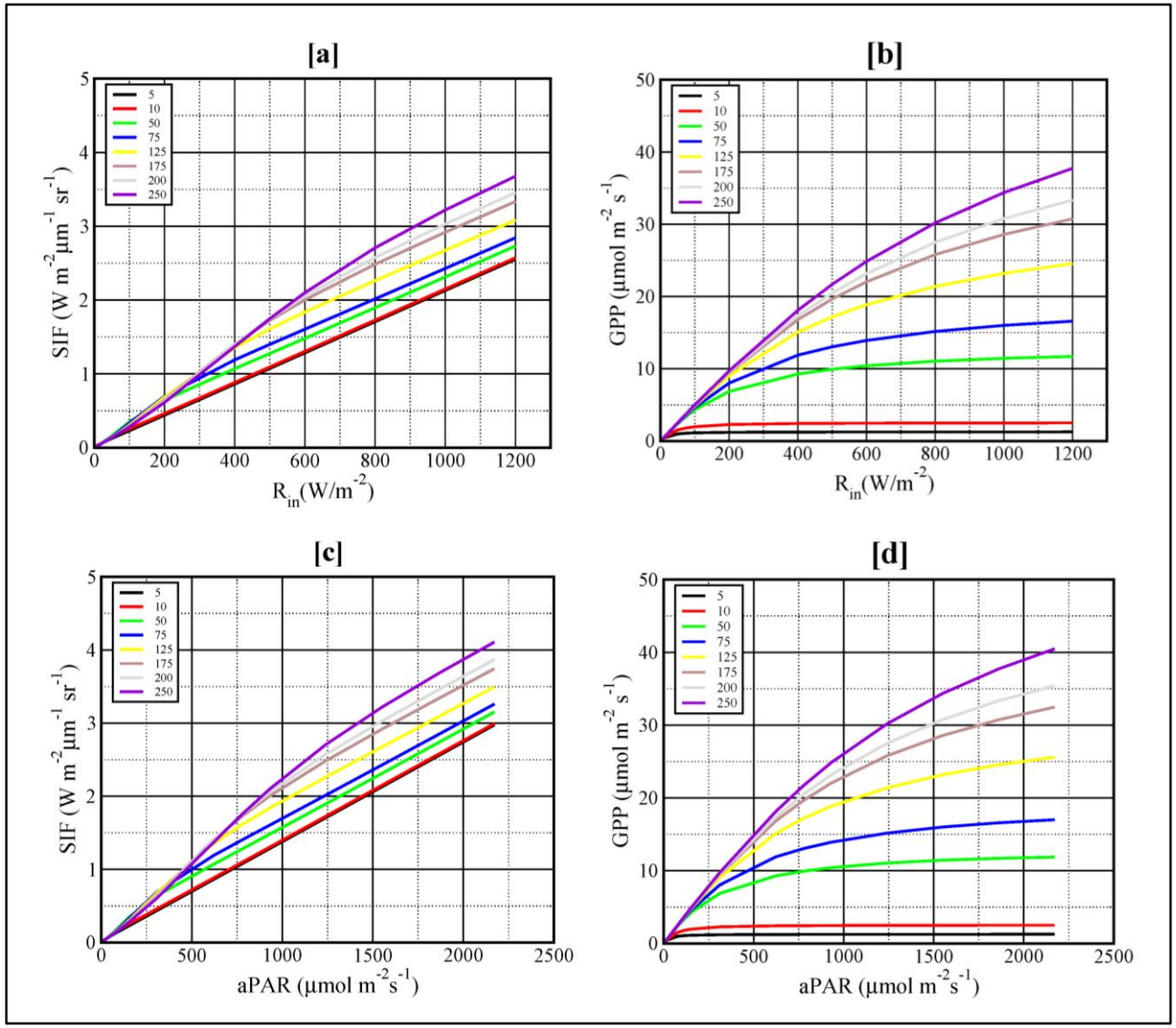

Figure 3: The sensitivities of the SCOPE fluorescence SIF (a and c) and gross primary productivity (GPP) (b and d) to the short wave radiation (R_{in}) and absorbed phtosynthetically active radiation (aPAR) and for several V_{cmax} are presented. LAI and C_{ab} are set to 2 and 40 µg.cm^{-2}, respectively. Results for a C_3 plant are shown

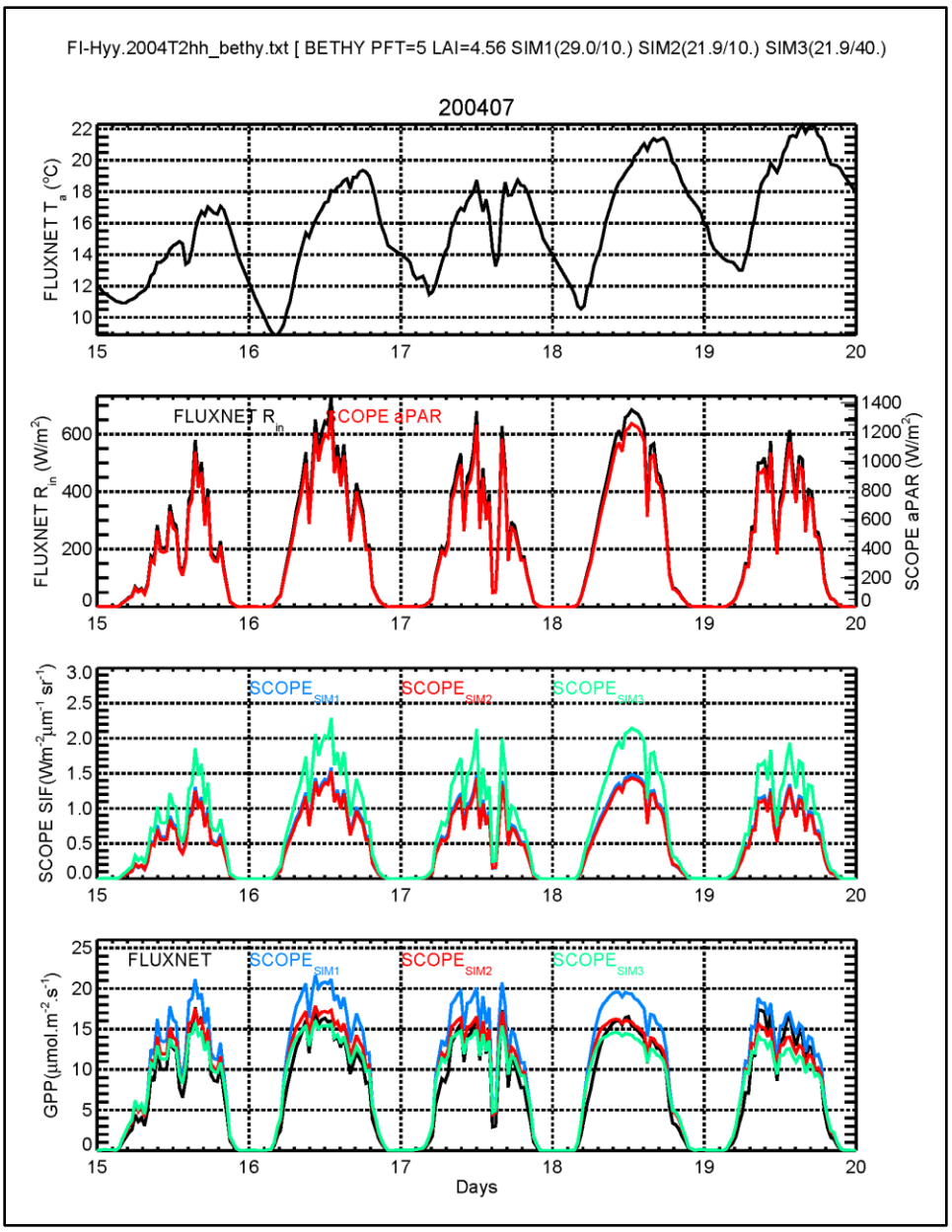

Figure 4: SCOPE simulations of fluorescence SIF, gross primary productivity (GPP), and absorbed phtosynthetically active radiation (aPAR) from in situ measurements at Hyytiala (acronym FI-Hyy and having longitude/latitude of 24.295^{o}E/61.847^{o}N*)* in Finland during 2004 over 15 July to 20 July period. The graph a) presents the temporal variations of the observed temperature. Graph b) shows the temporal variations of both observed short wave radiation R_{in} (black) and SCOPE simulated aPAR (red). Graphs c (SIF) and d (GPP) present SCOPE simulations by using two values of both V_{cmax} and C_{ab} (blue: $SCOPE_{SIM1}$: V_{cmax}/C_{ab} = 29 µmol m^{-2} s^{-1}/10 µg cm^{-2}; red: $SCOPE_{SIM2}$: 21.91/10.; green $SCOPE_{SIM3}$: 21.91/40). The observed GPP from is in black. The other SCOPE parameters are given in Table 2. The C3 plant is considered in SCOPE model.

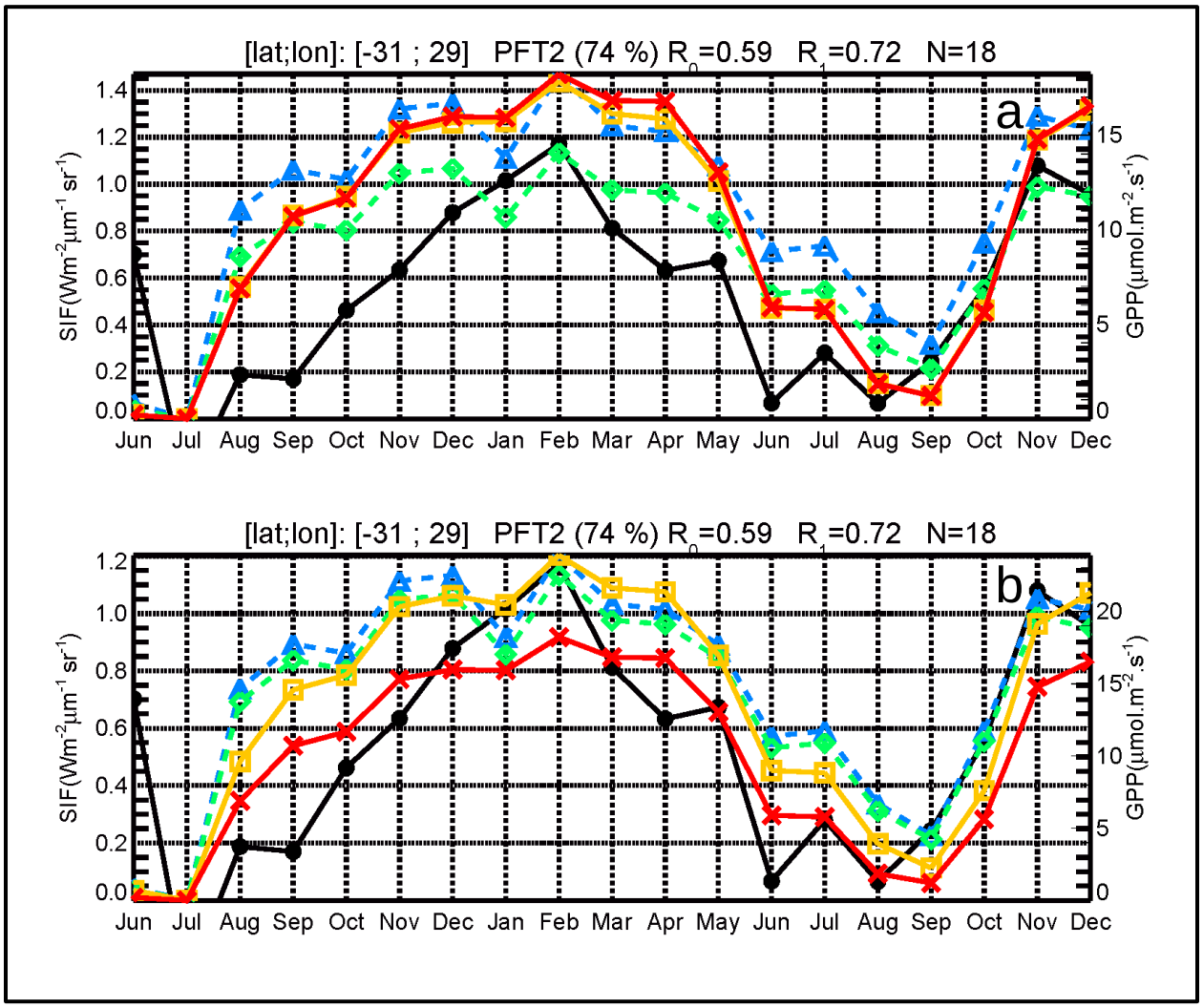

Figure 5: Temporal variations (June 2009 to December 2010) of CCDAS simulations of the fluorescence SIF and GPP for different values of the carboxylation maximum capacity (V_{cmax}) and the chlorophyll AB content (C_{ab}) and for a plant functional type (PFT 2: Tropical broadleaved evergreen tree) are show. In both graphs (a and b), the satellite GOSAT based SIF is shown in black solid line with big dot.

In the graph (a), SIF and GPP are simulated by using V_{cmax} value of 73.5 µmol(CO_2) $m^{-2}s^{-1}$ and two C_{ab} values of 40 µg cm^{-2} (SIF in blue dashed line with triangles and GPP in red solid line with crosses) and 15 µg cm^{-2} (SIF in green dashed line with diamond and GPP in orange solid line with rectangles), respectively. For C_{ab} value of 15 µg cm^{-2}, the correlation coefficient R_0 between simulated SIF and satellite based SIF is given on the top of the graph.

In graph (b), SIF and GPP are simulated by using C_{ab} value of 15 µg cm^{-2} and two V_{cmax} values of 90 µmol(CO_2) $m^{-2}s^{-}1$ (SIF in blue dashed line with triangles and GPP in orange solid line with rectangles) and 73.5 µmol(CO_2) $m^{-2}s^{-1}$ (SIF in green dashed line with diamonds and GPP in red solid line with crosses), respectively. For V_{cmax} value of 73.5 µmol(CO_2) $m^{-2}s^{-1}$, the correlation coefficient R_1 between simulated GPP and satellite based SIF is given on the top of the graph.

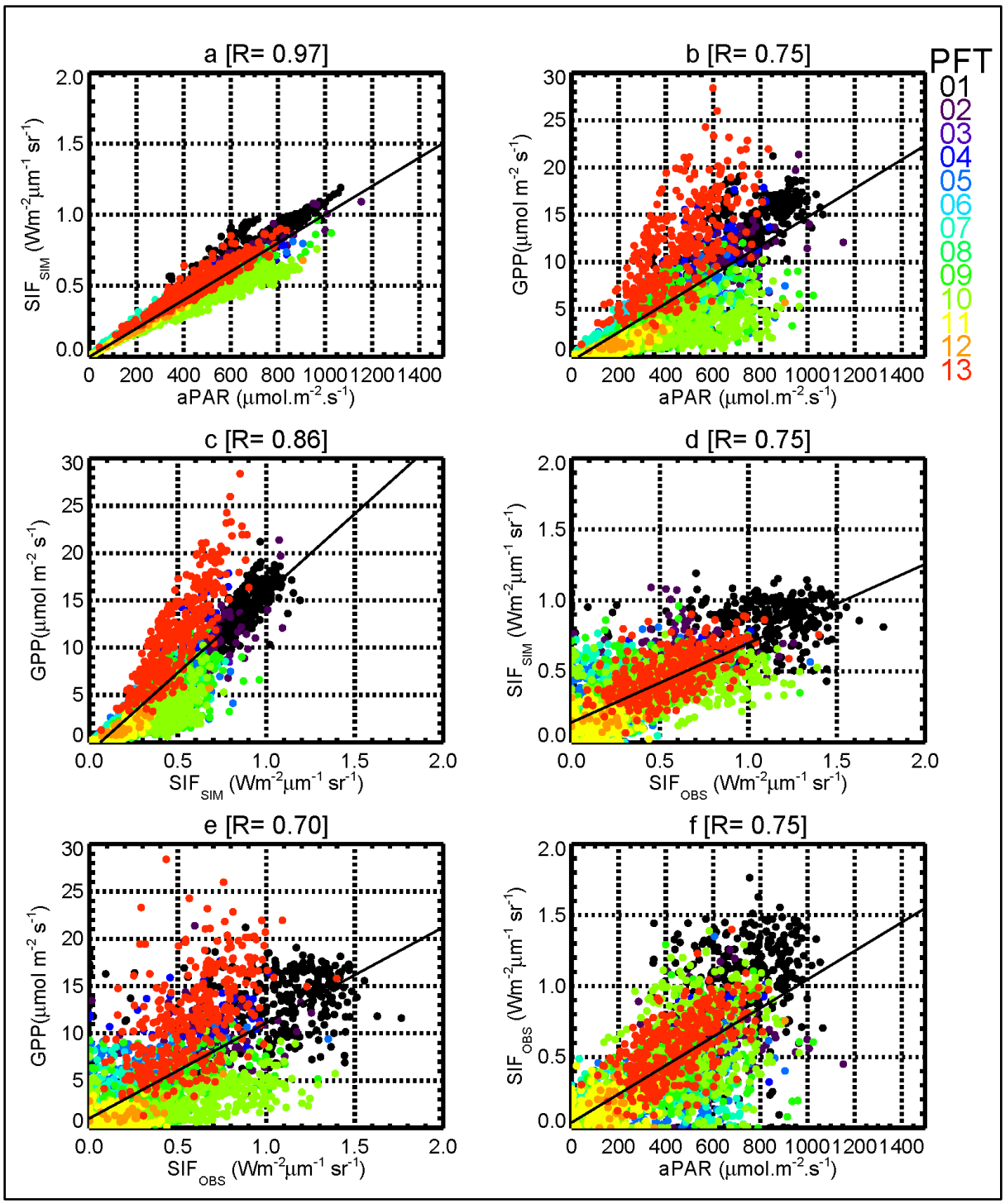

Figure 6: Correlations between CCDAS simulated quantities and between simulated quantities and satellite GOSAT based fluorescence SIF are shown. The graph (a) presents the correlation between CCDAS simulated SIF (SIF_{SIM}) and the simulated absorbed photosynthetically active radiation (aPAR). The graph (b) shows the gross primary productivity (GPP) as function of aPAR. The graph c) displays the correlation between GPP and simulated SIF. The graph (d)

presents the correlation between simulated SIF (SIF_{SIM}) and the satellite based SIF (SIF_{OBS}). The graph (e) displays GPP as function of SIF_{OBS}. The graph (f) shows SIF_{OBS} as a function of aPAR. The dominant plant functional types (PFT) characterizing by the PFTs having at least 50% of the spatial coverage for the pixels of the CCDAS at the spatial resolution of 2°x2° (longitude x latitude) are shown by different colors on the right hand side of the graph (b). The number of pair of data is 2857. The Pearson coefficient of the linear correlation R is indicated. Data for June 2009 to December 2010 period are considered.

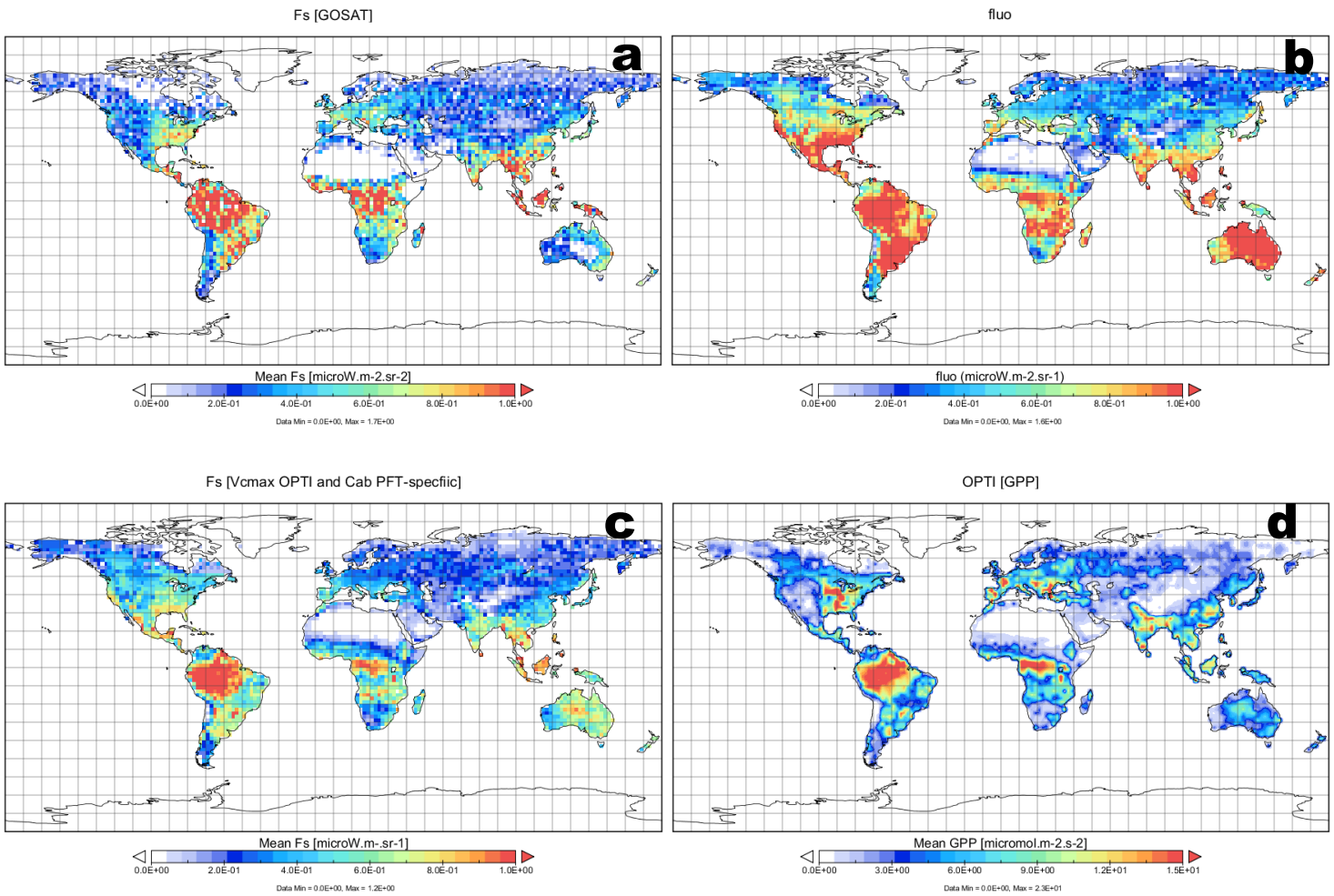

Figure 7: Mean spatial patterns over the year 2010 of (a) satellite GOSAT based fluorescence SIF, (b) CCDAS simulated SIF by using constant value of the chlorophyll content AB C_{ab} for all the 13 PFTs (setting S3 in Table 3), (c) C_{ab} PFT specific (setting S4 in Table 3) are shown. The graph d) displays the mean spatial patterns of the gross primary productivity (GPP) by using both C_{ab} PFT specific and optimized carboxylation maximum capacity (V_{cmax}) (setting S4 in Table 3).

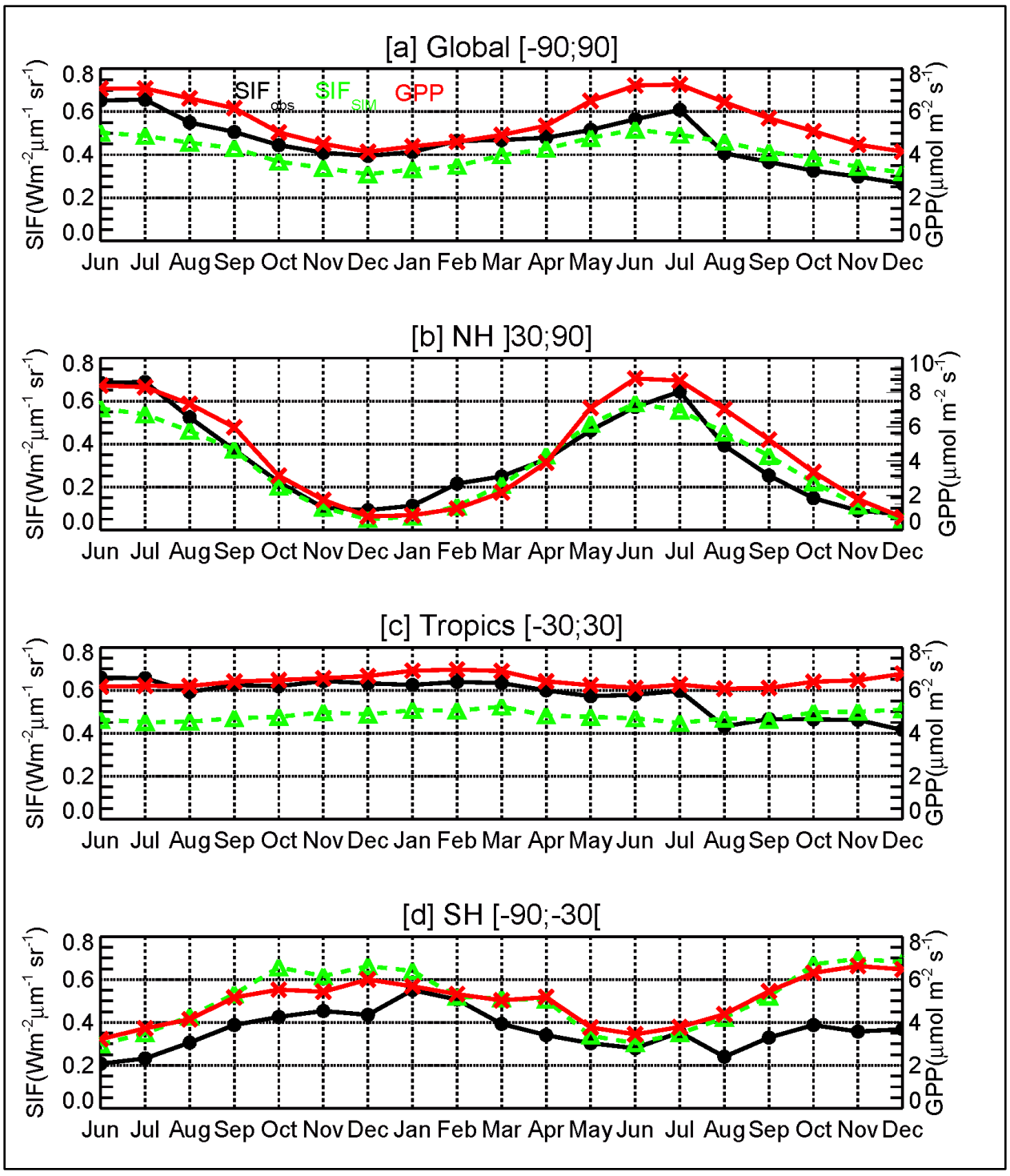

Figure 8: Global (a) and regional (b to d) means of fluorescence SIF and gross primary productivity GPP over June 2009 to December 2010 period are shown. The satellite GOSAT based SIF (SIF_{OBS}: black solid line with big dot), simulated SIF (SIF_{SIM}: green dashed line with triangles), and the simulated gross primary productivity (GPP: red solid line with crosses) are displayed. The CCDAS set up S4 (Table 3) is considered.

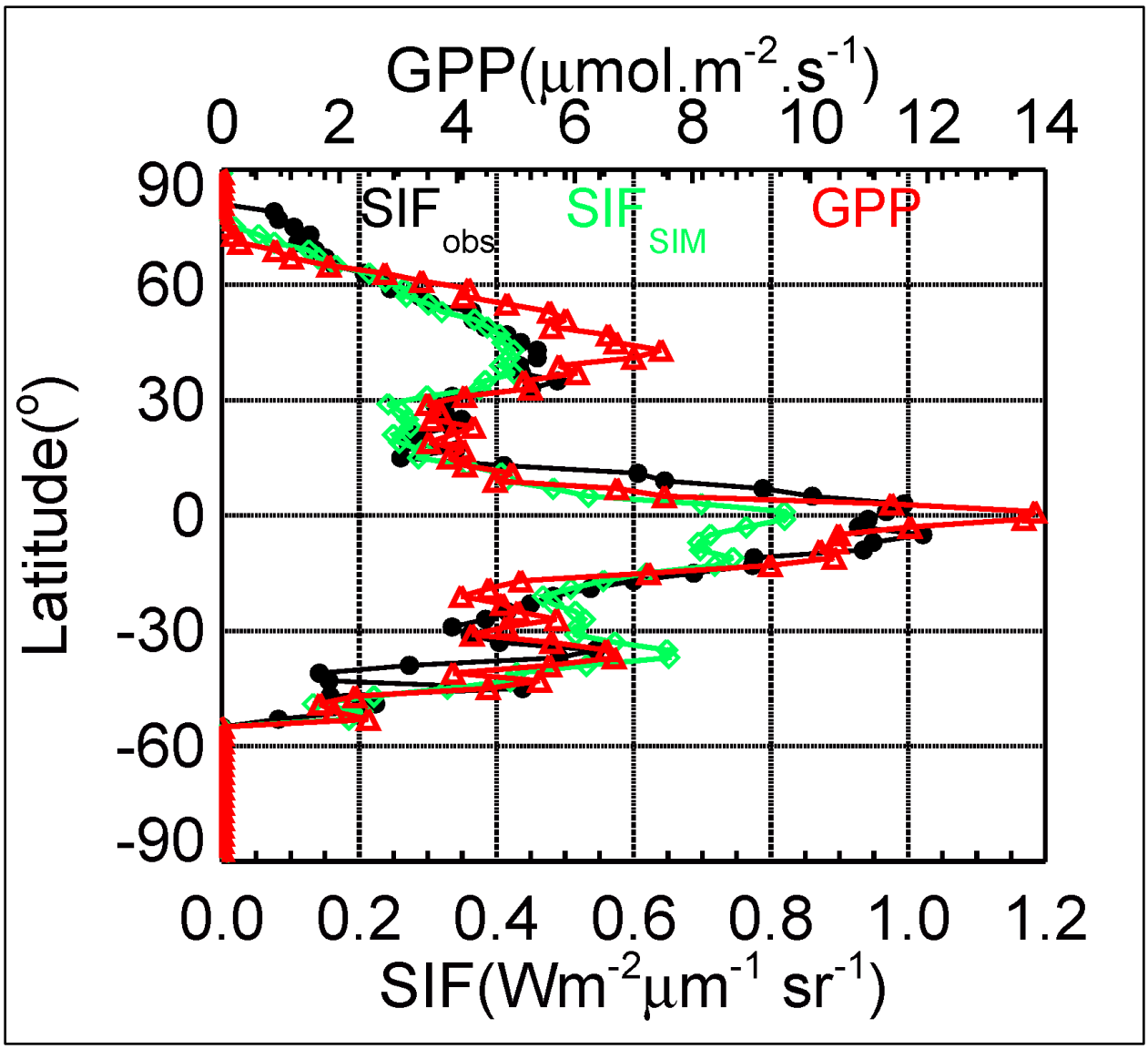

Figure 9: Latitudinal distributions of the satellite GOSAT based SIF (SIF_{OBS}: black solid line with big dot), simulated SIF (SIF_{SIM}: green solid line with diamonds), and gross primary productivity (GPP: red solid line with triangles) within 5° latitudinal band are shown. The CCDAS set up S4 (Table 3) is considered. The period of June 2009 and December 2010 period is considered.

Table 1: Main controlling parameters for the photosynthesis and fluorescence models are given**.** V_{cmax} stands for carboxylation maximum capacity and C_{ab} for the chlorophyll content AB for 13 plant functional types (PFT) as used in the CCDAS.

		V_{cmax} ($\mu mol(CO_2)\ m^{-2}s^{-1}$)		**C_{ab}** ($\mu g\ cm^{-2}$)
PFT number	Plant Function Type (PFT)	Prior value	Optmized values Koffi et al. (2012)	
1	Tropical broadleaved evergreen tree	60	63.8	40
2	Tropical broadleaved deciduous tree	90	73.5	15
3	Temperate broadleaved evergreen tree	41	39.7	15
4	Temperate broadleaved deciduous tree	35	149.2	10
5	Evergreen coniferous tree	29	21.9	10
6	Deciduous coniferous tree	53	136.4	10
7	Evergreen shrub	52	168.9	10
8	Deciduous shrub	160	96.1	10
9	C3 grass	42	18.9	10
10	C4 grass	8	0.7	5
11	Tundra	20	8.5	10
12	Swamp	20	9.3	10
13	Crop	117	47.9	20

Table 2: SCOPE parameters

Parameters	**Symbol**	**Units**	**Range or values**
Incoming short wave radiation	R_{in}	W/m^2	0-1200
Maximum carboxylation rate	V_{cmax}	$\mu mol\ m\text{-}2\ s^{-1}$	1-250
Chlorophyll a + b content	C_{ab}	$\mu g\ cm^{-2}$	1-80
Dry matter content	C_{dm}	g cm	0.012
Leaf equivalent water thickness	C_w	cm	0.009
Senescent material	C_s	/	0.0
Leaf structure Leaf angle distribution parameter a	N $LIDF_a$	/	1.4 -0.35
Leaf angle distribution parameter a	$LIDF_a$	/	-0.15
Leaf width	w	m	0.1
Ball-Berry stomatal conductance parameter	m	/	8
Dark respiration rate at 25 °C as fraction of Vcmax	R_d	/	0.015
Cowan's water use efficiency parameter	k_c	/	700
Leaf thermal reflectance	ρ(thermal)	/	0.01
Leaf thermal transmittance	τ(thermal)	/	0.01
Soil thermal reflectance	ρ_s(thermal)	/	0.06
Leaf area index LAI		/	
fluorescence quantum yield efficiency at photosystem level	fqe	/	0.02
Canopy height	h_c	m	1

Table 3: Set ups for the CCDAS simulations based on the carboxylation maximum capacity (V_{cmax}) and chlorophyll content AB (C_{ab}) are given. The values of prior and optimized V_{cmax} as well as C_{ab} PFT-specific are given in Table 1. The constant value of C_{ab} for all the 13 PFTs is set to 40 $\mu g\ cm^{-2}$.

Model configuration	V_{cmax}	C_{ab}
S1	Prior values	Constant value for all the 13 PFTs
S2	Prior values	C_{ab} PFT-specific
S3	Optimized values	Constant value for all the 13 PFTs
S4	Optimized values	C_{ab} PFT-specific