Supplementary Materials

Table S1. Published spectral indices for the estimation of ChlFa parameters in other studies. R represents the reflectance.

Index Name	Formula	Reference
ARI2	$R_{800} * (1/R_{550} - 1/R_{700})$	Stratoulias, et al. [62]
CRI1	$1/R_{510} - 1/R_{550}$	Stratoulias, et al. [62]
CRI2	$1/R_{510} - 1/R_{700}$	Stratoulias, et al. [62]
CUR	$R_{683}^2/(R_{675} * R_{691})$	Zarco-Tejada, et al. [20]
Datt	$(R_{850} - R_{710})/(R_{850} + R_{680})$	Zhang, et al. [19]
EVI	$2.5 * (R_{780} - R_{675})/(R_{782} + 6 * R_{675} - 7.5 * R_{445} + 1)$	Stratoulias, et al. [62]
Maccioni	$(R_{780} - R_{710})/(R_{780} + R_{680})$	Zhang, et al. [19]
mND705	$(R_{750} - R_{705})/(R_{750} + R_{705} - 2 * R_{445})$	Stratoulias, et al. [62]
mSR705	$(R_{750} - R_{445})/(R_{705} - R_{445})$	Stratoulias, et al. [62]
NDSI	$(R_{680} - R_{935})/(R_{680} + R_{935})$	Zhang, et al. [19]
NDVI	$(R_{782} - R_{675})/(R_{782} + R_{675})$	Stratoulias, et al. [62]
NDVI750	$(R_{750} - R_{705})/(R_{750} + R_{705})$	Stratoulias, et al. [62]
NPCI	$(R_{680} - R_{430})/(R_{680} + R_{430})$	Zhang, et al. [19]
OCAR	R_{630}/R_{680}	Zhang, et al. [19]
PRI	$(R_{531} - R_{570})/(R_{531} + R_{570})$	Stratoulias, et al. [62]
PSNDa	$(R_{800} - R_{680})/(R_{800} + R_{680})$	Zhang, et al. [19]
PSRI	$(R_{680} - R_{500})/R_{750}$	Stratoulias, et al. [62]
PSSRa	R_{800}/R_{680}	Zhang, et al. [19]
RGI	R_{690}/R_{550}	Stratoulias, et al. [62]
RSI	R_{680}/R_{935}	Zhang, et al. [19]
SIPI	$(R_{800} - R_{445})/(R_{800} - R_{680})$	Stratoulias, et al. [62]
SRPI	R_{430}/R_{680}	Zhang, et al. [19]
SRI	R_{800}/R_{680}	Stratoulias, et al. [62]
VOG1	R_{740}/R_{720}	Stratoulias, et al. [62]
VOG2	$(R_{734} - R_{747})/(R_{715} + R_{726})$	Stratoulias, et al. [62]
VOG3	$(R_{734} - R_{747})/(R_{715} + R_{720})$	Stratoulias, et al. [62]
WBI	R_{900}/R_{970}	Stratoulias, et al. [62]
YCAR	R_{600}/R_{680}	Zhang, et al. [19]

Table S2. The given indices for the estimation of ChlFa parameters. R and the suffixes (λ_1 or λ_2) represent the reflectance and wavelength, respectively.

Index Name	Wavelength	Formula
R	λ_1	$R_{\lambda 1}$
SR	λ_1 and λ_2	$R_{\lambda 1}/R_{\lambda 2}$
D	λ_1 and λ_2	$R_{\lambda 1} - R_{\lambda 2}$
ND	λ_1 and λ_2	$(R_{\lambda 1} - R_{\lambda 2})/(R_{\lambda 1} + R_{\lambda 2})$
ID	λ_1 and λ_2	$(\frac{1}{R_{\lambda 1}}) - (\frac{1}{R_{\lambda 2}})$
DDn	λ_1 and $\Delta\lambda$	$2R_{\lambda 1} - R_{\lambda 1-\Delta\lambda} - R_{\lambda 1+\Delta\lambda}$
mSR1	λ_1 and $\Delta\lambda$	$(R_{\lambda 1-\Delta\lambda} - R_{\lambda 1})/R_{\lambda 1+\Delta\lambda}$
mSR2	λ_1 and $\Delta\lambda$	$(R_{\lambda 1-\Delta\lambda} - R_{\lambda 1})/(R_{\lambda 1+\Delta\lambda} - R_{\lambda 1})$
mND	λ_1 and $\Delta\lambda$	$(R_{\lambda 1-\Delta\lambda} - R_{\lambda 1})/(R_{\lambda 1-\Delta\lambda} + R_{\lambda 1} - 2R_{\lambda 1+\Delta\lambda})$
mID	λ_1 and $\Delta\lambda$	$R_{\lambda 1-\Delta\lambda}(\frac{1}{R_{\lambda 1}} - \frac{1}{R_{\lambda 1+\Delta\lambda}})$

Table S3. The independent *t*-test for ChlFa parameters in all, sunlit and shaded leaves.

	All Leaves Vs. Sunlit			**All Leaves Vs. Shaded**			**Sunlit Vs. Shaded**		
	Df	**t**	***p*-Value**	**Df**	**t**	***p*-Value**	**Df**	**t**	***p*-Value**
$PSII_{max}$	488.65	-2.87	<0.01	352.19	3.38	<0.001	384.12	5.47	<0.001
NPQ	432.19	-0.59	0.55	410.02	0.85	0.40	406.67	1.24	0.21
qL	463.05	-3.27	<0.01	401.89	4.39	<0.001	407.18	6.77	<0.001
ΦP	450.19	-2.92	<0.01	418.15	4.11	<0.001	407.64	6.17	<0.001
ΦN	431.89	1.70	0.09	428.83	-2.52	<0.05	403.64	-3.66	<0.001
ΦF	585.23	4.94	<0.001	314.50	-4.62	<0.001	302.80	-8.22	<0.001

Table S4. The ratio of performance to deviation (RPD) of reported indices for ChlF parameters in all leaves.

	$PSII_{max}$	**NPQ**	**qL**	**ΦP**	**ΦN**	**ΦF**
ARI2	1.00	1.00	1.02	1.01	1.00	1.03
CRI1	1.00	1.00	1.07	1.05	1.02	1.07
CRI2	1.00	1.00	1.06	1.04	1.02	1.05
CUR	1.00	1.01	1.07	1.06	1.04	1.04
Datt	1.01	1.00	1.01	1.01	1.00	1.01
EVI	1.00	1.00	1.00	1.00	1.00	1.00
Maccioni	1.01	1.00	1.01	1.01	1.00	1.01
mND705	1.01	1.00	1.02	1.02	1.01	1.03
mSR705	1.01	1.00	1.01	1.01	1.00	1.01
NDSI	1.00	1.00	1.13	1.11	1.06	1.07
NDVI	1.00	1.00	1.12	1.10	1.05	1.07
NDVI750	1.01	1.00	1.01	1.01	1.00	1.01
NPCI	1.00	1.01	1.00	1.00	1.00	1.02
OCAR	1.00	1.01	1.07	1.06	1.04	1.05
PRI	**1.03**	1.00	1.10	1.07	1.03	1.09
PSNDa	1.00	1.00	1.12	1.10	1.06	1.07
PSRI	1.01	**1.02**	1.01	1.02	1.02	1.00
PSSRa	1.00	1.00	1.08	1.06	1.04	1.06
RGI	1.01	1.00	1.13	1.10	1.05	**1.11**
RSI	1.00	1.00	**1.13**	**1.11**	**1.06**	1.07
SIPI	1.00	1.00	1.00	1.00	1.00	1.00
SRI	1.00	1.00	1.08	1.06	1.04	1.06
SRPI	1.00	1.01	1.00	1.00	1.00	1.02
VOG1	1.01	1.00	1.01	1.01	1.00	1.02
VOG2	1.01	1.00	1.00	1.00	1.00	1.02
VOG3	1.01	1.00	1.00	1.00	1.00	1.01
WBI	1.00	1.01	1.02	1.01	1.00	1.03
YCAR	1.00	1.00	1.09	1.07	1.04	1.07

Table S5. The ratio of performance to deviation (RPD) of reported indices for ChlF parameters in sunlit leaves.

	$PSII_{max}$	**NPQ**	**qL**	**ΦP**	**ΦN**	**ΦF**
ARI2	1.00	1.05	1.13	1.14	**1.12**	1.02
CRI1	1.01	1.02	1.00	1.00	1.00	1.04
CRI2	1.01	1.02	1.00	1.00	1.00	1.04
CUR	1.05	1.05	1.07	1.05	1.05	1.00
Datt	1.04	1.04	1.04	1.04	1.04	1.00
EVI	1.02	1.02	1.15	**1.14**	1.10	1.06
Maccioni	1.03	1.04	1.05	1.04	1.04	1.00
mND705	1.06	1.03	1.03	1.03	1.03	1.00
mSR705	**1.06**	1.03	1.04	1.03	1.03	1.00
NDSI	1.00	1.00	1.03	1.02	1.01	1.05
NDVI	1.00	1.00	1.02	1.01	1.01	1.04
NDVI750	1.05	1.04	1.04	1.03	1.03	1.00
NPCI	1.03	1.01	1.01	1.02	1.02	1.00
OCAR	1.04	1.04	1.06	1.05	1.05	1.00
PRI	1.01	1.00	1.15	1.08	1.04	**1.15**
PSNDa	1.00	1.00	1.03	1.02	1.01	1.05
PSRI	1.04	**1.07**	1.02	1.03	1.04	1.02
PSSRa	1.00	1.01	1.01	1.01	1.00	1.03
RGI	1.00	1.02	**1.16**	1.12	1.08	1.08
RSI	1.00	1.00	1.03	1.02	1.01	1.05
SIPI	1.06	1.00	1.02	1.03	1.02	1.02
SRI	1.00	1.01	1.01	1.01	1.00	1.03
SRPI	1.03	1.01	1.01	1.01	1.01	1.00
VOG1	1.02	1.03	1.09	1.07	1.06	1.01
VOG2	1.02	1.03	1.11	1.07	1.06	1.02
VOG3	1.02	1.03	1.10	1.07	1.05	1.02
WBI	1.03	1.00	1.01	1.01	1.01	1.00
YCAR	1.02	1.02	1.08	1.06	1.04	1.02

Table S6. The ratio of performance to deviation (RPD) of reported indices for ChlF parameters in shaded leaves.

	$PSII_{max}$	**NPQ**	**qL**	**ΦP**	**ΦN**	**ΦF**
ARI2	1.02	**1.07**	1.03	1.07	1.11	1.00
CRI1	1.01	1.05	**1.94**	1.78	1.44	**1.10**
CRI2	1.01	1.07	1.82	**1.82**	**1.50**	1.08
CUR	1.01	1.01	1.02	1.01	1.01	1.00
Datt	1.02	1.05	1.33	1.30	1.23	1.04
EVI	**1.04**	1.04	1.28	1.32	1.22	1.05
Maccioni	1.02	1.05	1.31	1.29	1.22	1.04
mND705	1.01	1.03	1.16	1.14	1.12	1.02
mSR705	1.00	1.02	1.33	1.24	1.16	1.05
NDSI	1.03	1.04	1.39	1.38	1.26	1.06
NDVI	1.04	1.04	1.38	1.36	1.25	1.05
NDVI750	1.02	1.04	1.27	1.24	1.19	1.03
NPCI	1.01	1.00	1.00	1.01	1.01	1.00
OCAR	1.00	1.02	1.03	1.03	1.04	1.00
PRI	1.00	1.00	1.07	1.03	1.01	1.03
PSNDa	1.03	1.04	1.36	1.35	1.24	1.05
PSRI	1.00	1.01	1.01	1.01	1.01	1.00
PSSRa	1.02	1.05	1.55	1.49	1.32	1.07
RGI	1.03	1.01	1.01	1.01	1.00	1.02
RSI	1.03	1.04	1.37	1.36	1.25	1.06
SIPI	1.02	1.00	1.02	1.02	1.01	1.01
SRI	1.02	1.05	1.55	1.49	1.32	1.07
SRPI	1.01	1.00	1.00	1.00	1.00	1.00
VOG1	1.01	1.04	1.37	1.30	1.21	1.05
VOG2	1.00	1.04	1.43	1.35	1.23	1.06
VOG3	1.00	1.04	1.45	1.36	1.23	1.06
WBI	1.01	1.03	1.00	1.01	1.01	1.01
YCAR	1.01	1.02	1.02	1.02	1.03	1.00

Table S7. Developed indices for quantifying ChlF parameters in all, sunlit and shaded leaves.

	All Leaves	**Sunlit**	**Shaded**
$PSII_{max}$	ND_{Log} (700, 1780)	DDn_{1st} (1400, 460)	mND_{EMSC} (860, 60)
NPQ	$D1_{st}$ (2000, 2050)	DDn_{1st} (1730, 770)	ND_{1st} (450, 1100)
qL	$mSR1_{OR}$ (1720, 150)	ND_{SNV} (1300, 1910)	$mSR1_{SNV}$ (1670, 50)
ΦP	DDn_{1st} (2000, 110)	DDn_{1st} (2000, 490)	ND_{OR} (1610, 1660)
ΦN	ID_{1st} (1900, 2000)	D_{1st} (1730, 2490)	D_{OR} (1990, 2010)
ΦF	ND_{1st} (430, 1550)	mND_{Log} (1900, 320)	D_{1st} (1640, 2270)