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Supplement of

On the relationship between ecosystem-scale hyperspectral reflectance and CO_2 exchange in European mountain grasslands

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Supplementary Material

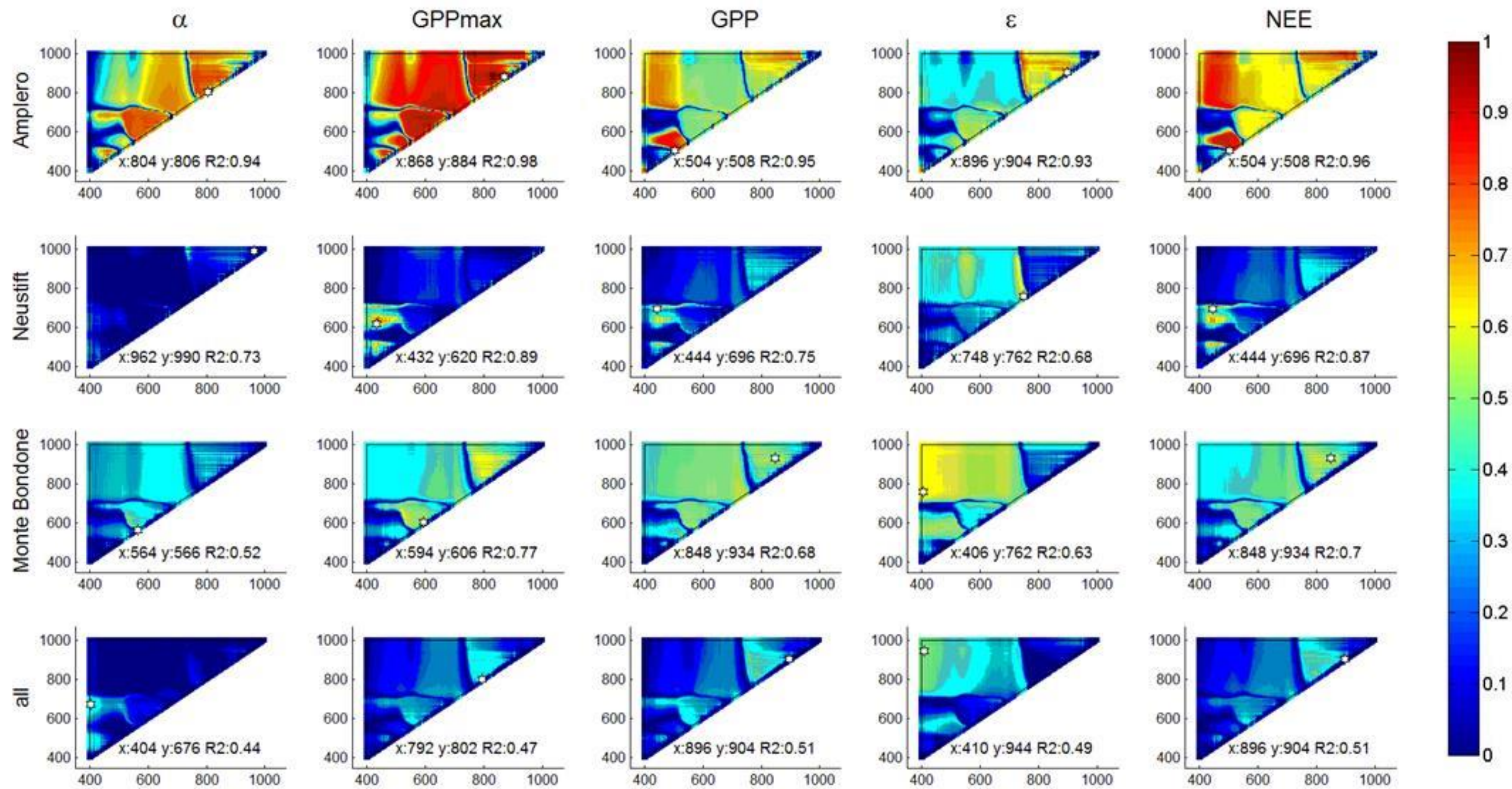

Figure S1. Correlograms of R^2 values for α, GPP_{max} and midday averaged GPP, ε and NEE and NSD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the linear model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2. The masked correlograms are shown in Figure 4.

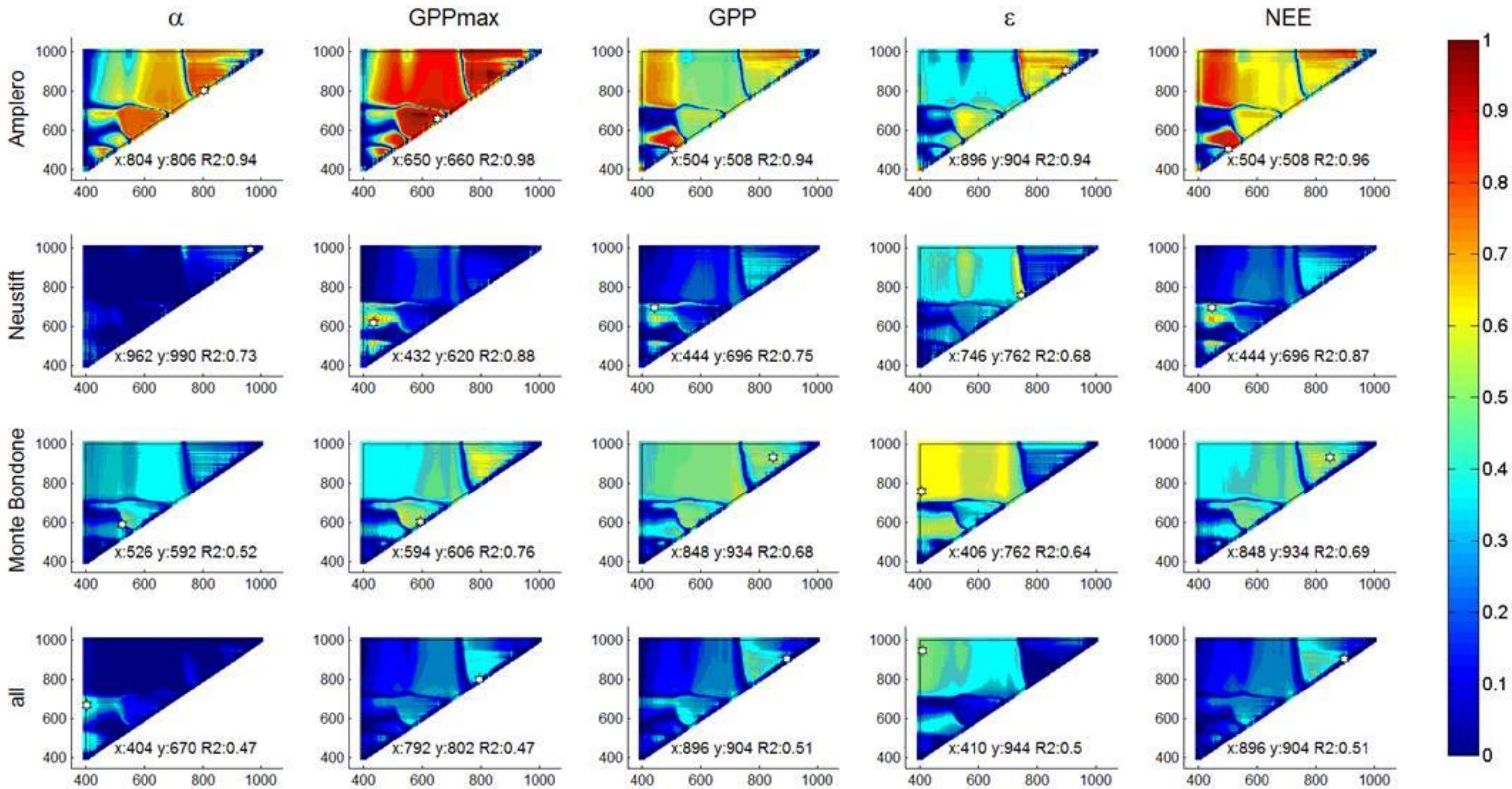

Figure S2. Correlograms of R^2 values for α, GPP_{max} and midday averaged GPP, ε and NEE and SR-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the linear model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2. The masked correlograms are shown in Figure 5.

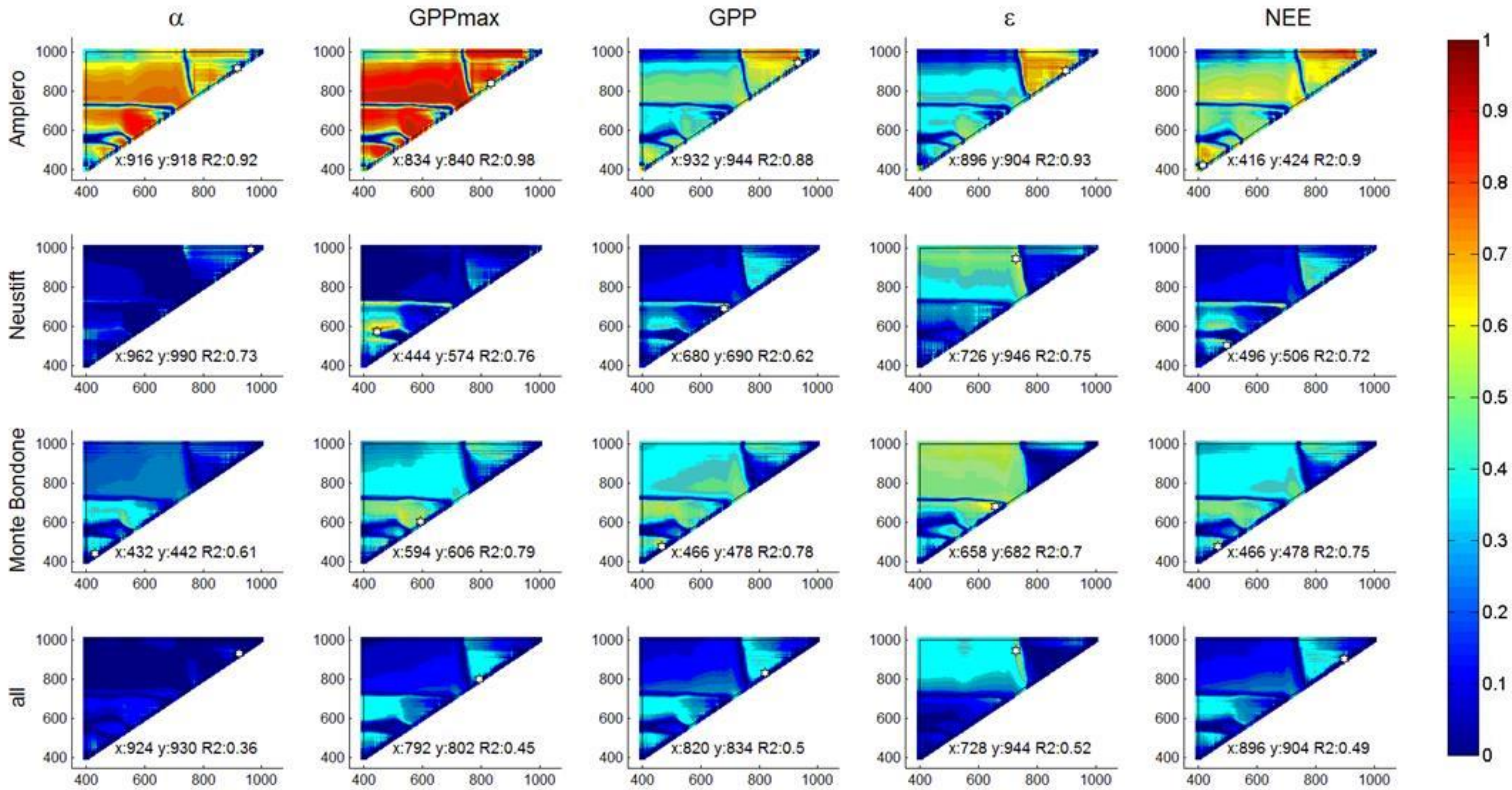

Figure S3. Correlograms of R^2 values for α, GPP_{max} and midday averaged GPP, ε and NEE and SD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the linear model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2. The masked correlograms are shown in Figure 6.

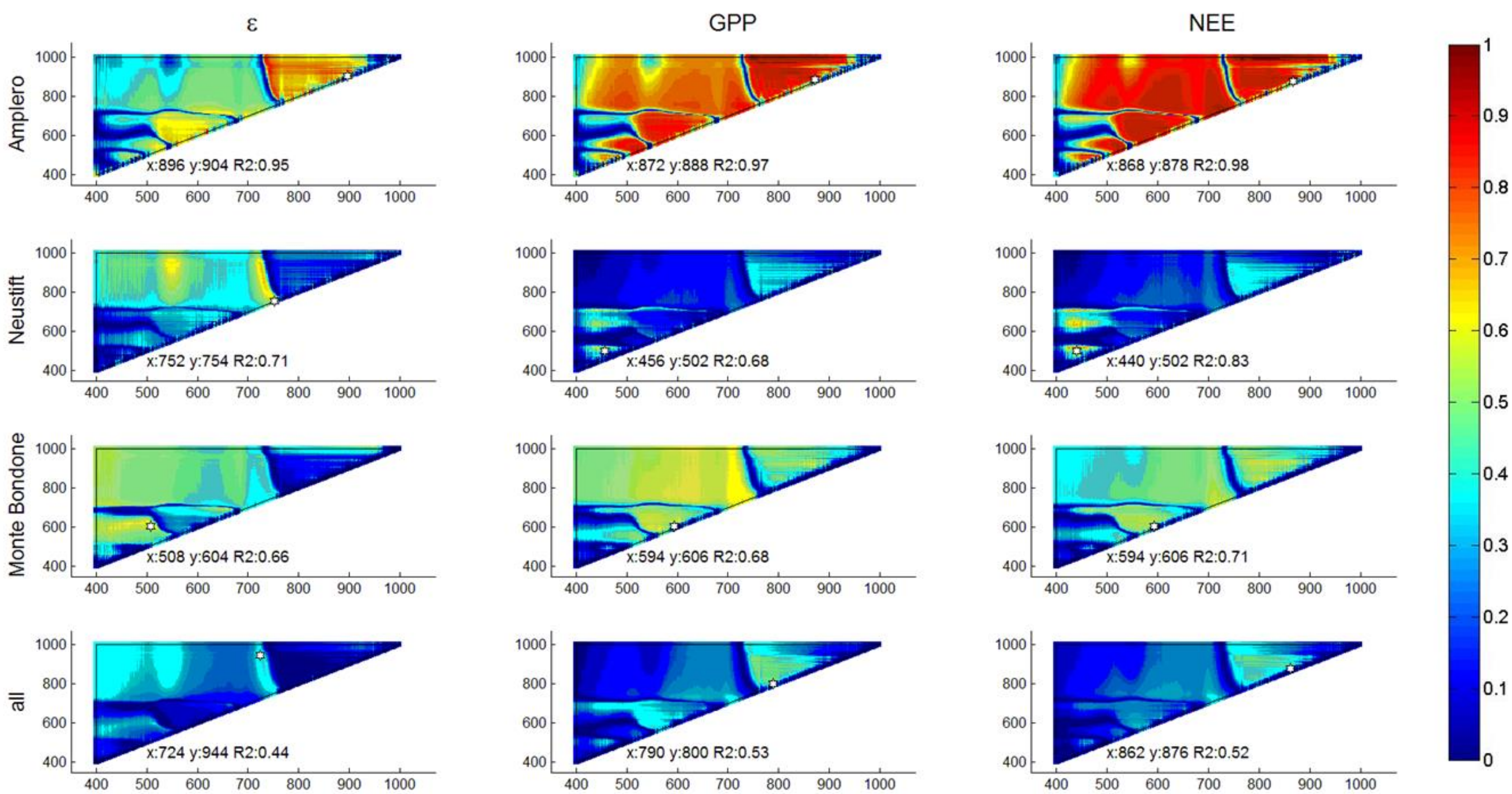

Figure S4. Correlograms of R^2 values for daily averaged GPP, ε and NEE and NSD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the linear model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2.

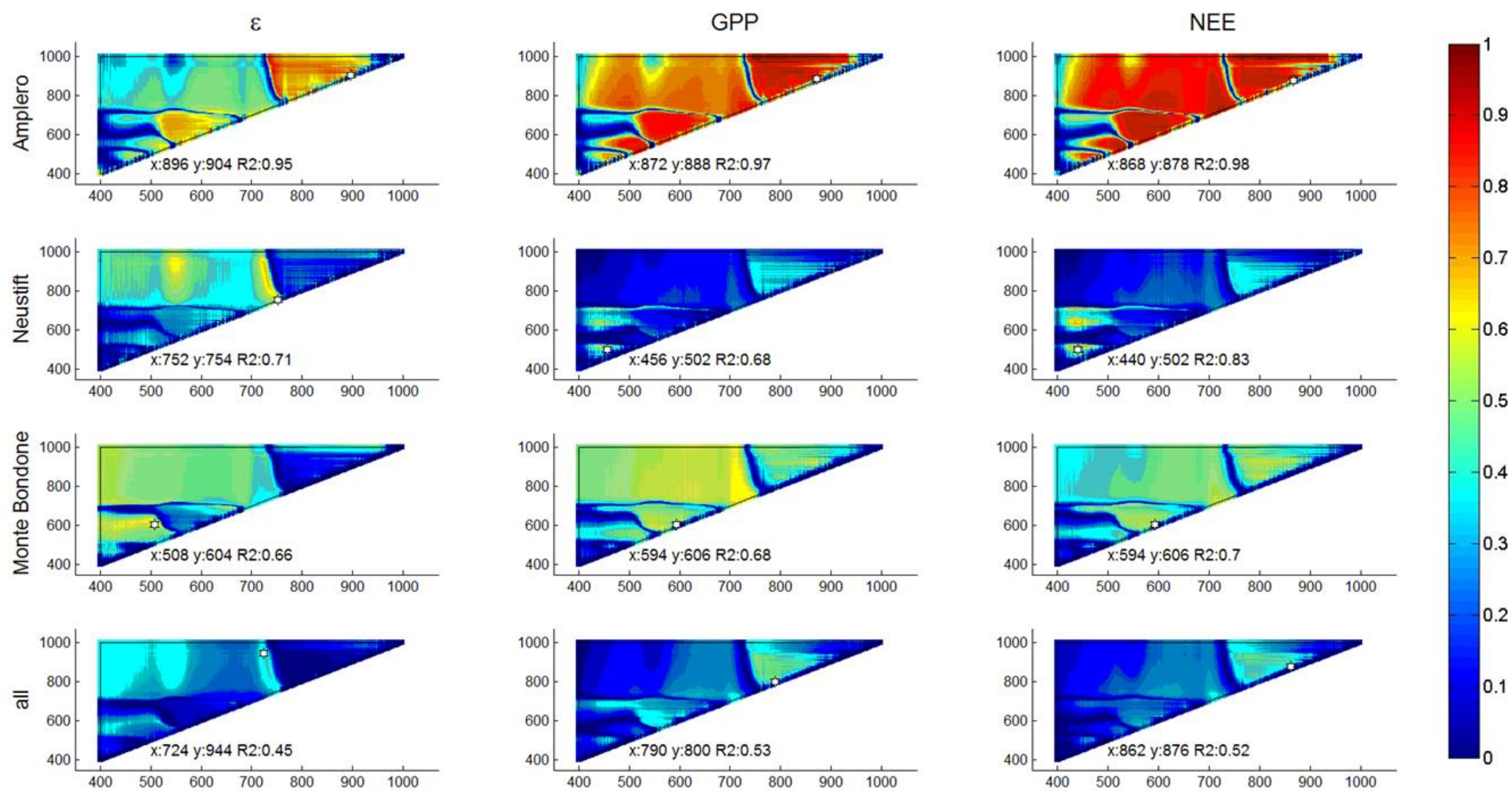

Figure S5. Correlograms of R^2 values for daily averaged GPP, ε and NEE and SR-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the linear model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2.

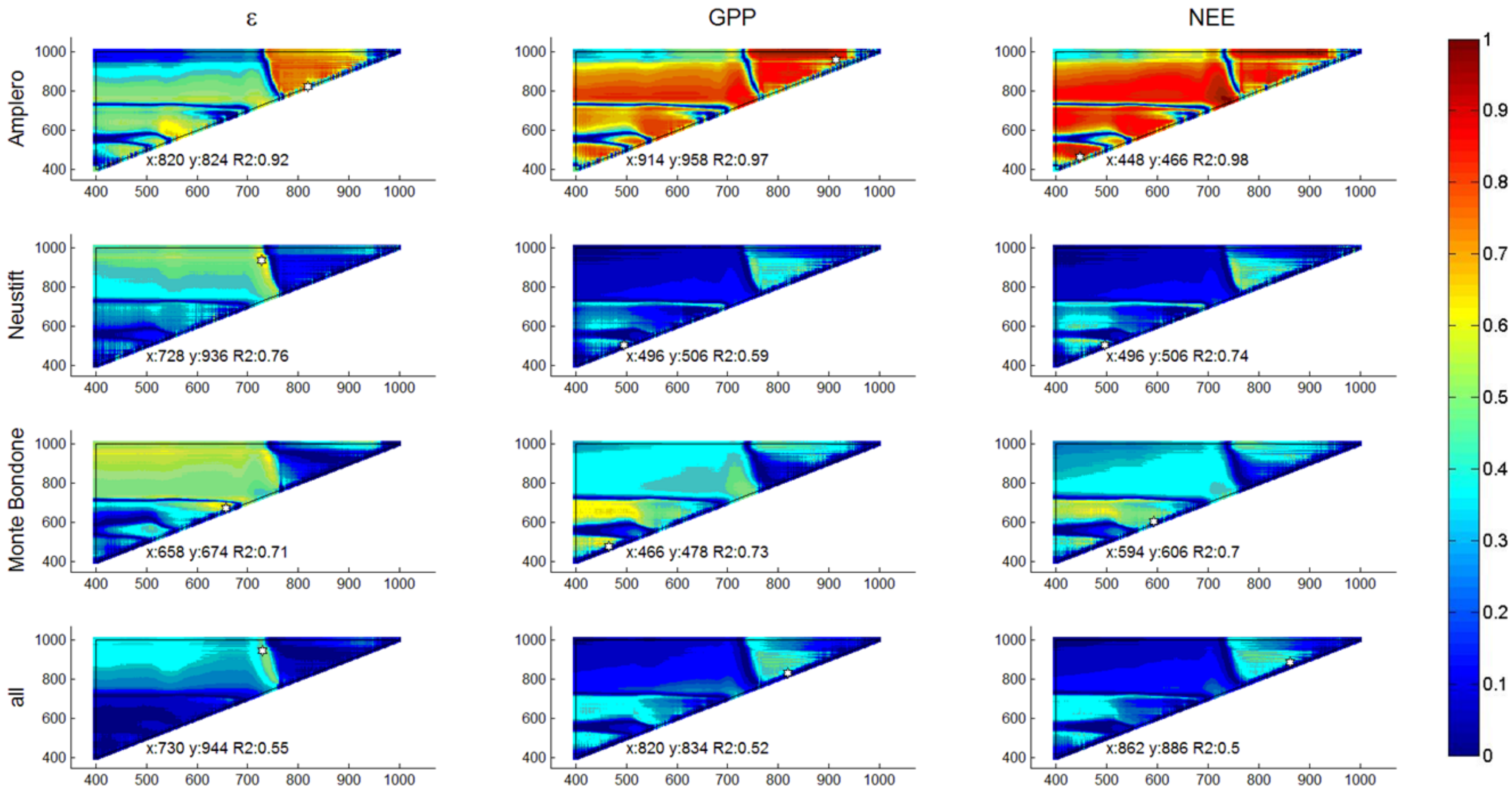

Figure S6. Correlograms of R^2 values for daily averaged GPP, ε and NEE and SD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the linear model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2.

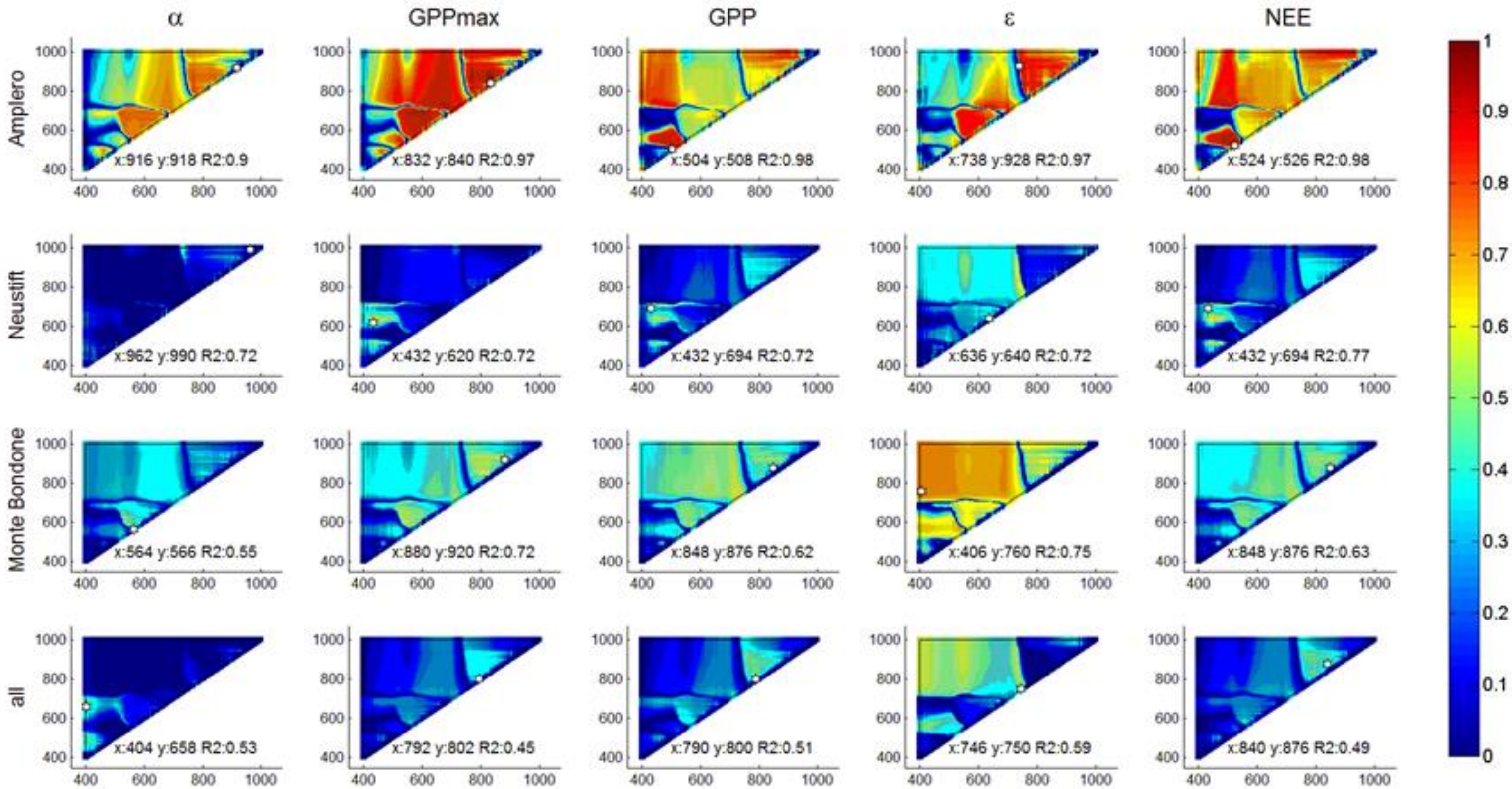

Figure S7. Correlograms of R^2 values for α, GPP_{max} and midday averaged GPP, ε and NEE and NSD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the exponential model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2. The masked correlograms are shown in Figure 7.

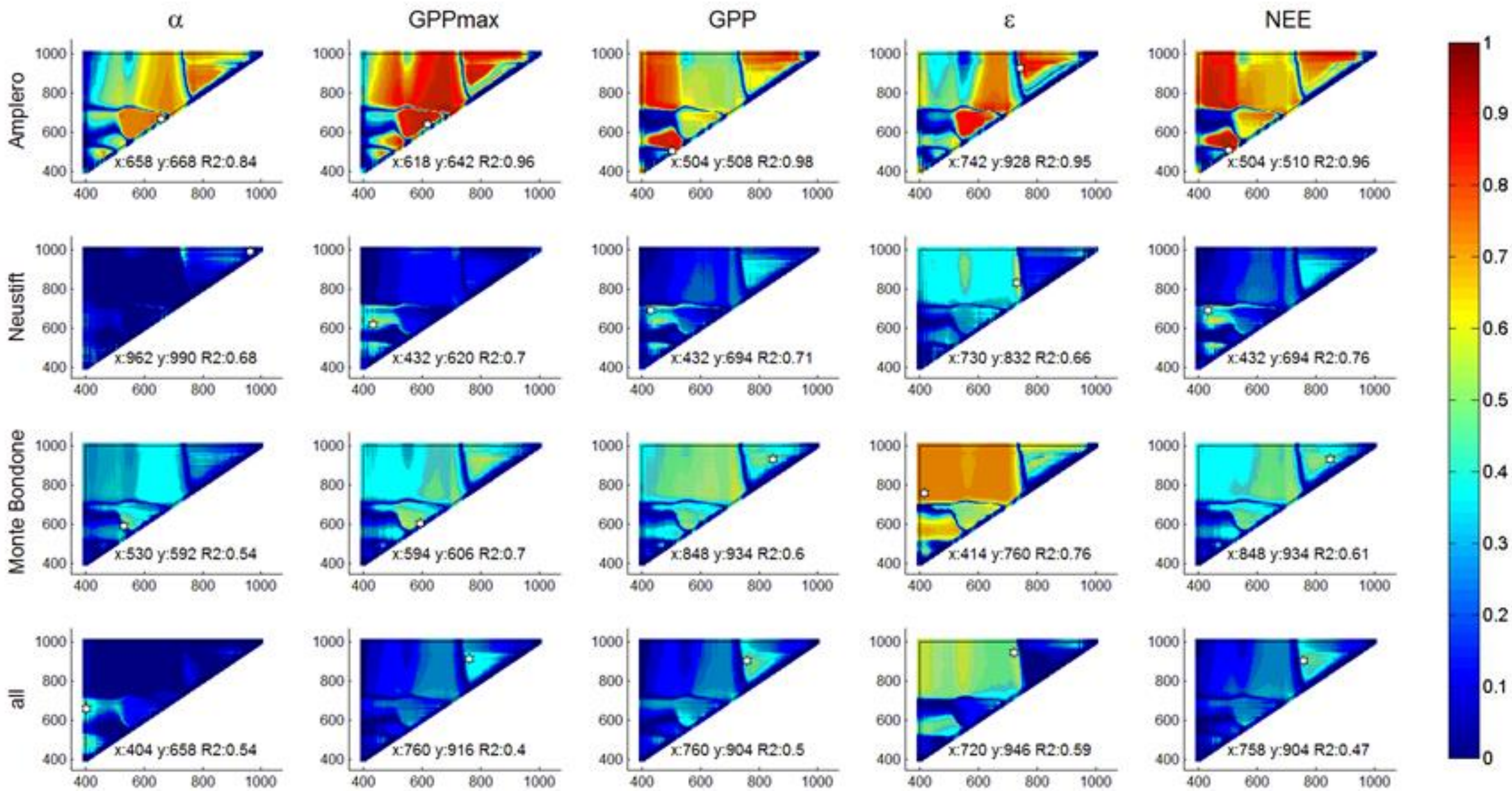

Figure S8. Correlograms of R^2 values for α, GPP_{max} and midday averaged GPP, ε and NEE and SR-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the exponential model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2. The masked correlograms are shown in Figure 8.

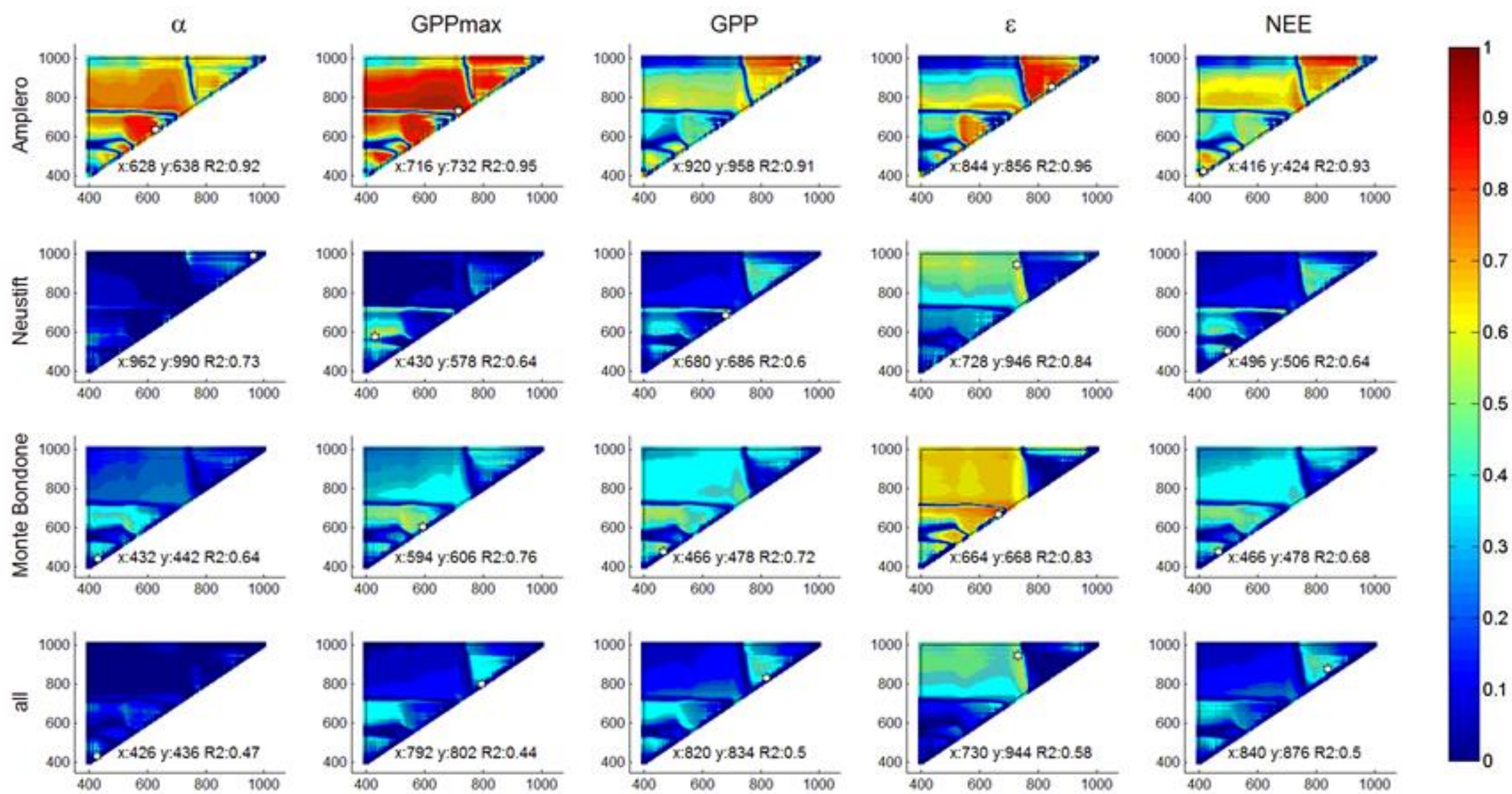

Figure S9. Correlograms of R^2 values for α, GPP_{max} and midday averaged GPP, ε and NEE and SD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled for the exponential model. The asterisks indicate the position of paired band combinations corresponding to the maximum R^2. The masked correlograms are shown in Figure 9.

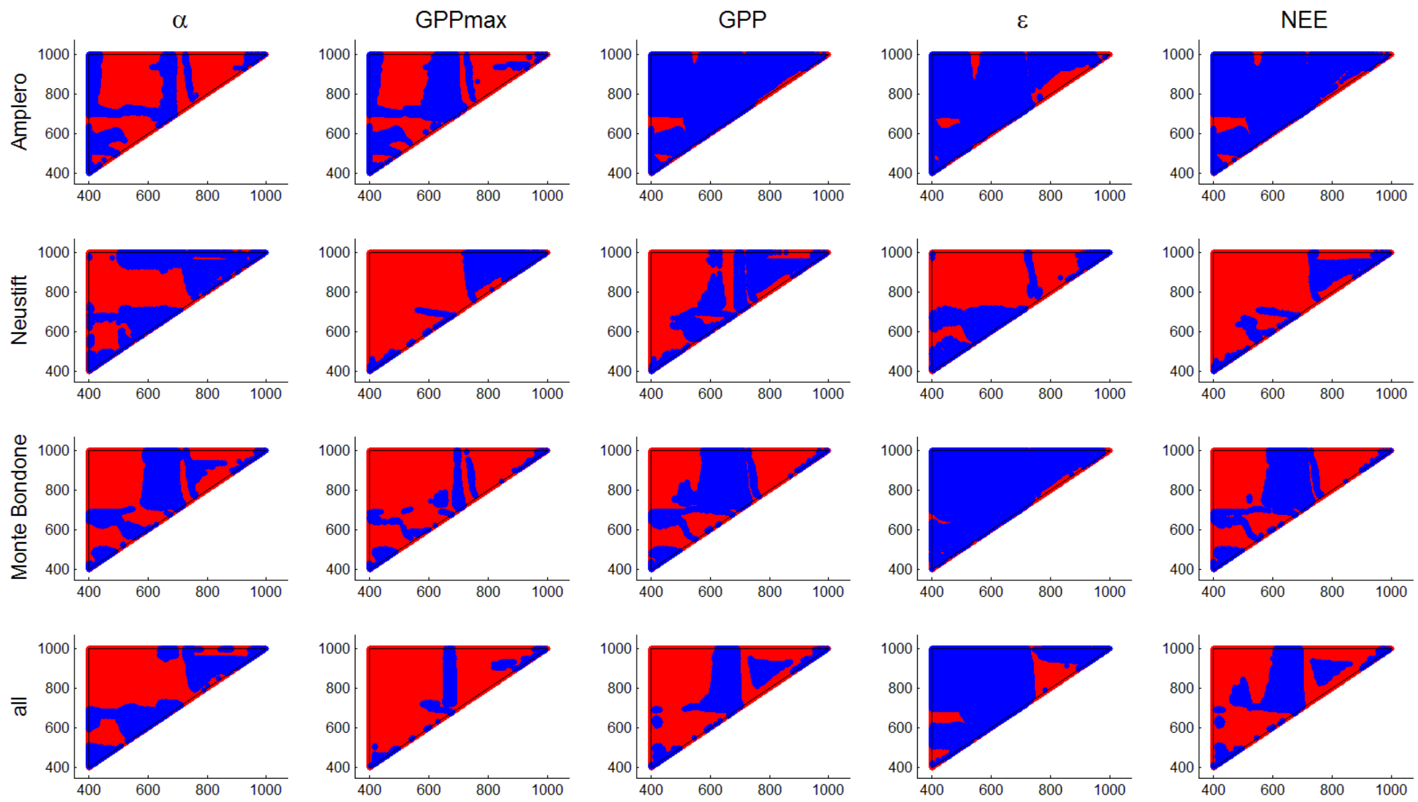

Figure S10. Correlograms of the differences between AIC (Akaike information criterion) obtained for linear and exponential models for α, GPP_{max} and midday averaged GPP, ε and NEE and SR-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled. Red areas indicate waveband combinations where the linear model performed better than exponential one, while blue areas indicate the reverse.

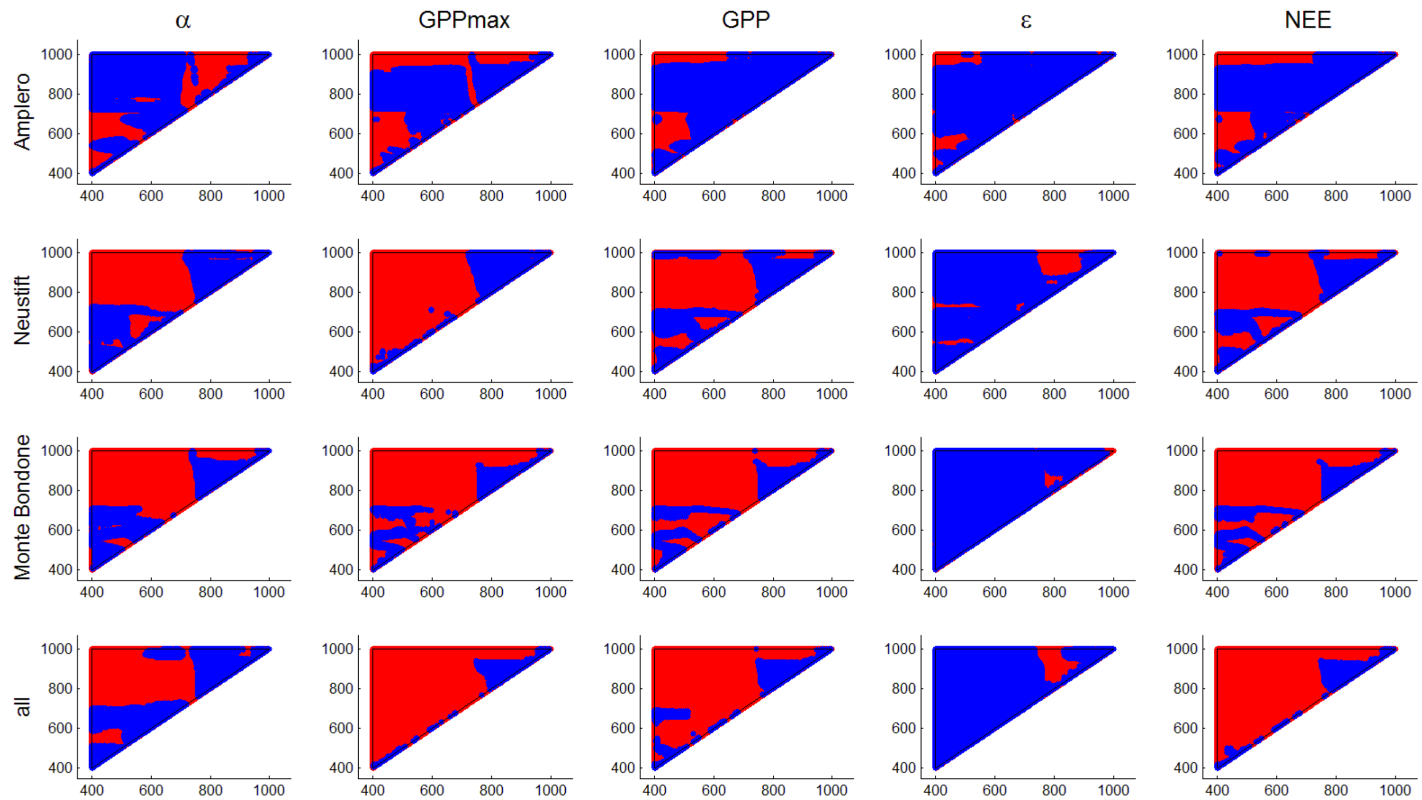

Figure S11. Correlograms of the differences between AIC (Akaike information criterion) obtained for linear and exponential models for α, GPP_{max} and midday averaged GPP, ε and NEE and SD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled. Red areas indicate waveband combinations where the linear model performed better than exponential one, while blue areas indicate the reverse.

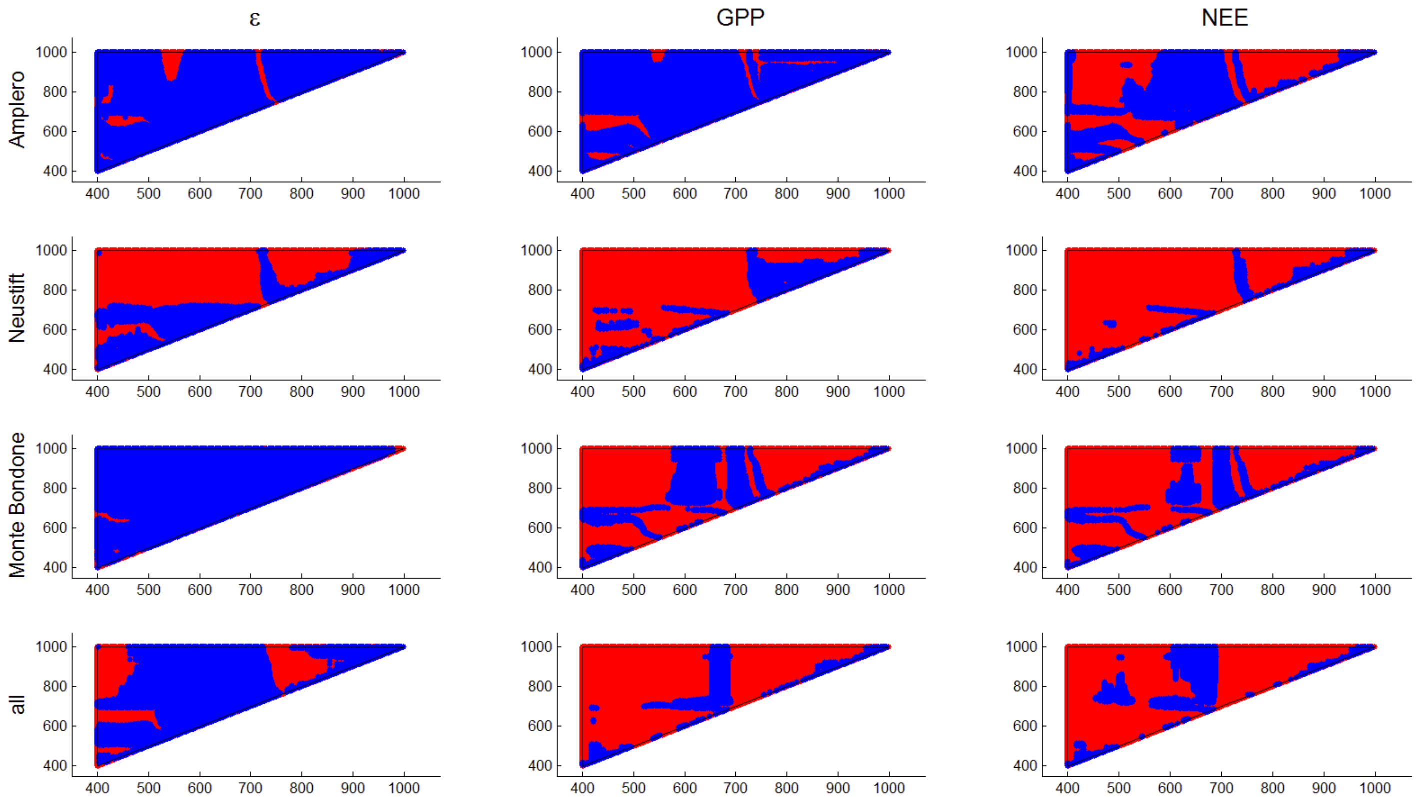

Figure S12. Correlograms of the differences between AIC (Akaike information criterion) obtained for linear and exponential models for daily averaged GPP, ε and NEE and NSD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled. Red areas indicate waveband combinations where the linear model performed better than exponential one, while blue areas indicate the reverse.

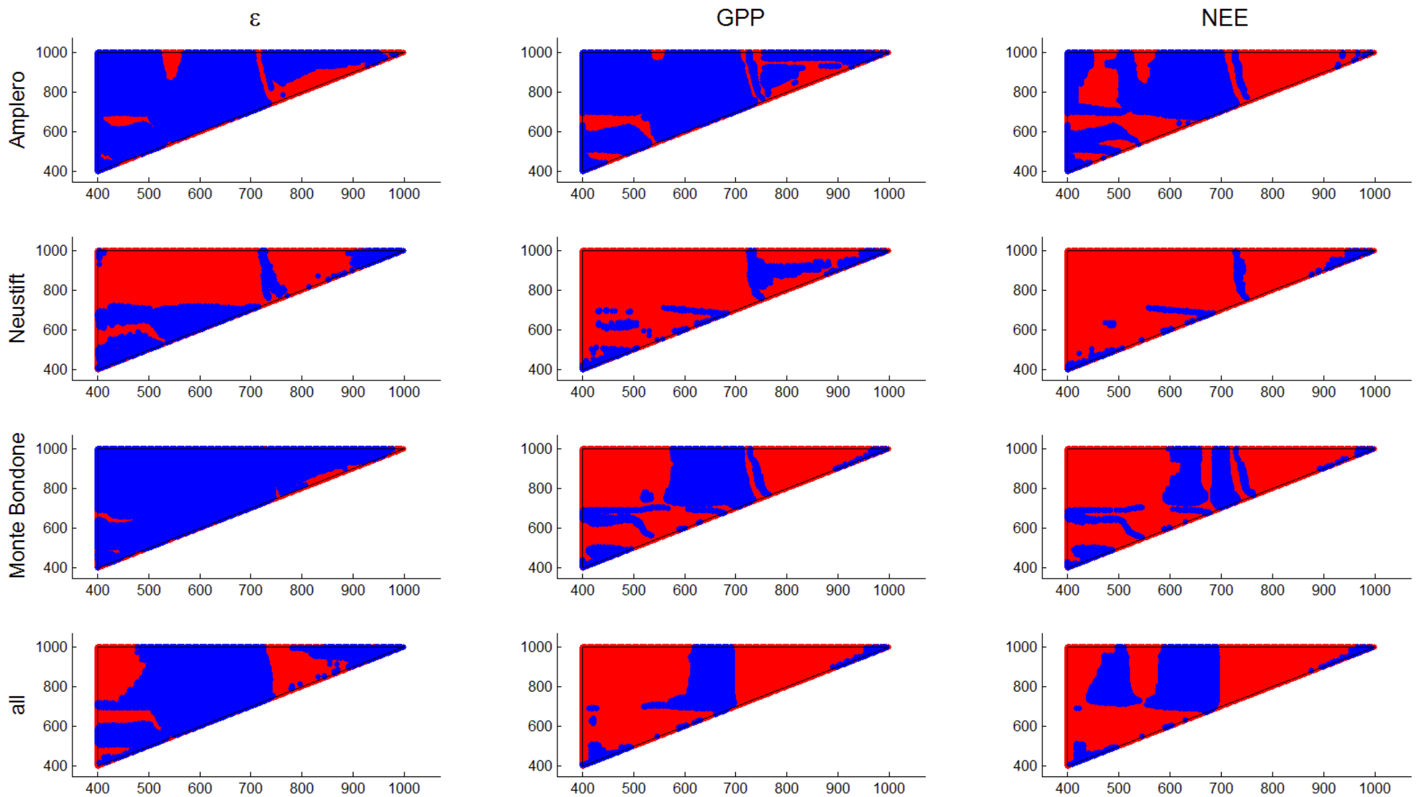

Figure S13. Correlograms of the differences between AIC (Akaike information criterion) obtained for linear and exponential models for daily averaged GPP, ε and NEE and SR-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled. Red areas indicate waveband combinations where the linear model performed better than exponential one, while blue areas indicate the reverse.

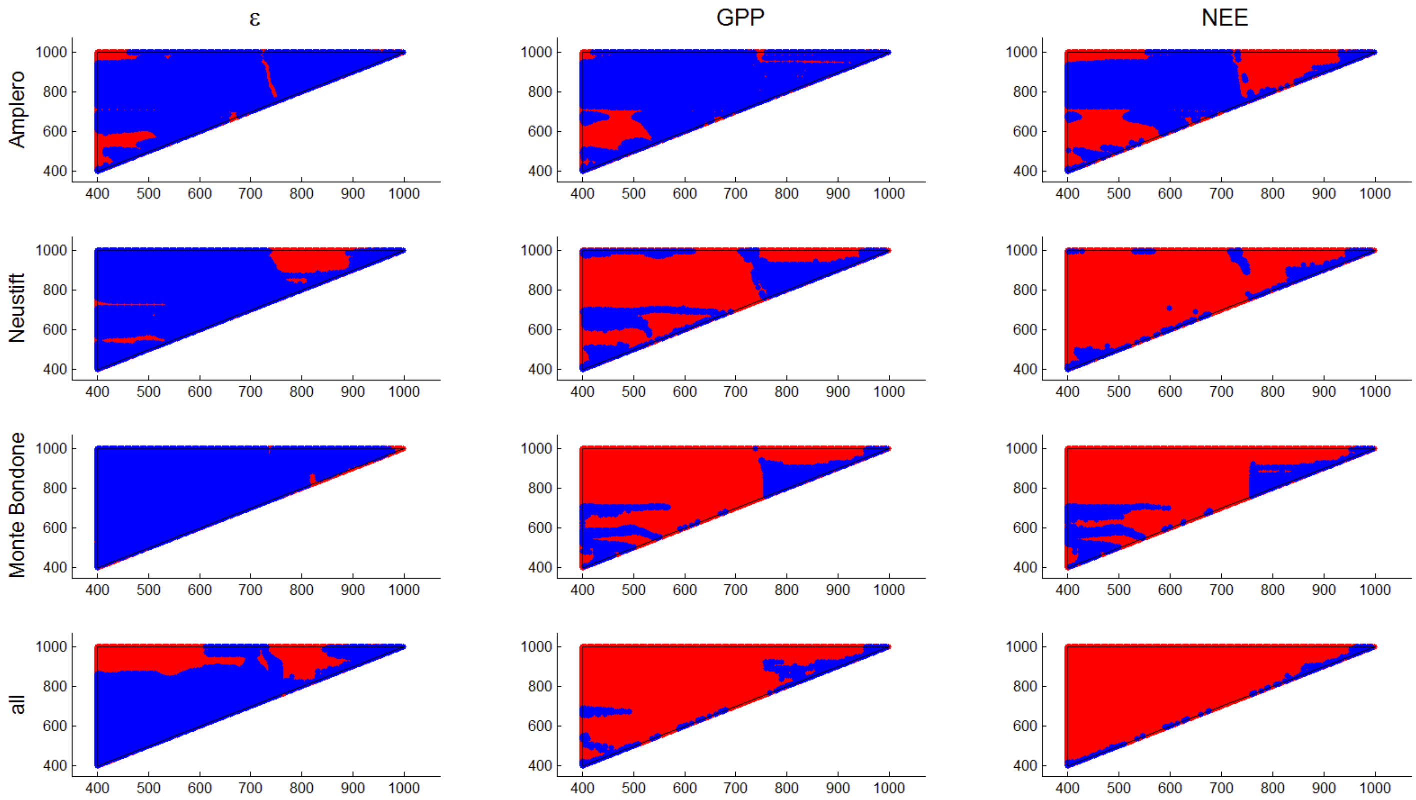

Figure S14. Correlograms of the differences between AIC (Akaike information criterion) obtained for linear and exponential models for daily averaged GPP, ε and NEE and SD-type indices for Amplero, Neustift, Monte Bondone (both study years pooled) and all sites pooled. Red areas indicate waveband combinations where the linear model performed better than exponential one, while blue areas indicate the reverse.

Table S1. Results of statistic of linear and exponential regression models between VIs and daily average of ecophysiological parameters: ε, GPP and NEE. R^2—Coefficient of determination; RMSE—Root Mean Square Error; and AIC—Akaike information criterion. Bold letters indicate the best model between linear and exponential models. Dark grey shading highlights the model with the lowest AIC.

	ε											
	Amplero			Neustift			Monte Bondone			All		
	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC
VI	-	$\frac{\mu mol_{CO2}}{\mu mol_{phot}}$	-	-	$\frac{\mu mol_{CO2}}{\mu mol_{phot}}$	-	-	$\frac{\mu mol_{CO2}}{\mu mol_{phot}}$	-	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-
Linear model												
SR	**0.7**	**0.0**	**-64**	0.4	0.0	-52	0.3	0.0	-101	0.2	0.0	-192
GRI	0.4	0.0	-59	**0.5**	**0.0**	**-57**	0.4	0.0	-105	**0.4**	**0.0**	**-202**
WI	0.6	0.0	-62	0.2	0.1	-48	0.4	0.0	-102	0.2	0.0	-194
NDVI	0.5	0.0	-60	0.4	0.0	-53	0.5	0.0	-106	0.2	0.0	-196
SIPI	0.4	0.0	-58	0.3	0.0	-52	**0.5**	**0.0**	**-108**	0.2	0.0	-193
CI	0.5	0.0	-61	0.4	0.0	-54	0.4	0.0	-103	0.2	0.0	-196
PRI	0.7	0.0	-64	0.1	0.1	-47	0.0	0.0	-91	0.0	0.0	-185
EVI	0.5	0.0	-60	0.4	0.0	-54	0.5	0.0	-107	0.2	0.0	-196
NPQI	0.0	0.0	-55	0.0	0.1	-45	0.3	0.0	-100	0.1	0.0	-193
NPCI	0.4	0.0	-58	0.2	0.1	-48	0.0	0.0	-91	0.0	0.0	-184
SRPI	0.4	0.0	-58	0.2	0.1	-48	0.0	0.0	-91	0.0	0.0	-184
Exponential model												
SR	0.8	0.0	-69	0.4	0.0	-53	0.4	0.0	-103	0.2	0.0	-193
GRI	0.4	0.0	-58	**0.5**	**0.0**	**-57**	0.5	0.0	-106	**0.4**	**0.0**	**-208**
WI	0.6	0.0	-62	0.2	0.1	-47	0.4	0.0	-105	0.2	0.0	-194
NDVI	0.7	0.0	-66	0.4	0.0	-52	0.5	0.0	-108	0.2	0.0	-198
SIPI	0.6	0.0	-62	0.3	0.0	-51	**0.5**	**0.0**	**-109**	0.2	0.0	-195
CI	0.6	0.0	-63	0.4	0.0	-53	0.5	0.0	-106	0.2	0.0	-199
PRI	**0.8**	**0.0**	**-71**	0.2	0.1	-48	0.0	0.0	-91	0.0	0.0	-185
EVI	0.8	0.0	-68	0.4	0.0	-54	0.5	0.0	-109	0.2	0.0	-198
NPQI	0.0	0.0	-54	0.0	0.1	-45	0.4	0.0	-104	0.1	0.0	-192
NPCI	0.4	0.0	-58	0.2	0.0	-49	0.0	0.0	-91	0.0	0.0	-184
SRPI	0.3	0.0	-58	0.2	0.0	-49	0.0	0.0	-91	0.0	0.0	-184

	GPP											
	Amplero			Neustift			Monte Bondone			All		
	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC
VI	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-
Linear model												
SR	0.9	1.0	28	0.1	6.2	106	0.5	2.6	121	0.2	4.8	324
GRI	0.7	1.5	35	0.1	6.2	106	0.5	2.6	121	0.1	5.2	333
WI	**0.9**	**0.9**	**25**	0.0	6.3	106	0.4	3.0	127	0.1	5.1	329
NDVI	0.8	1.4	33	0.2	6.1	105	0.6	2.5	120	0.3	4.7	322
SIPI	0.6	1.8	38	0.2	5.9	104	0.5	2.6	120	0.3	4.4	319
CI	0.8	1.2	31	0.2	5.8	104	**0.6**	**2.4**	**116**	0.2	4.7	322
PRI	0.7	1.5	34	0.2	5.9	104	0.2	3.4	134	0.3	4.6	317
EVI	0.8	1.4	34	0.1	6.1	105	0.5	2.8	124	0.2	4.8	324
NPQI	0.3	2.5	44	0.1	6.3	106	0.1	3.6	137	0.1	5.2	333
NPCI	0.4	2.1	41	**0.4**	**5.4**	**102**	0.2	3.3	133	**0.3**	**4.5**	**316**
SRPI	0.4	2.2	42	0.4	5.5	102	0.2	3.3	133	0.3	4.6	318
Exponential model												
SR	0.9	0.9	26	0.1	6.2	106	0.5	2.7	122	0.2	4.8	325
GRI	0.7	1.5	35	0.1	6.2	106	0.5	2.7	122	0.1	5.2	333
WI	**0.9**	**0.8**	**24**	0.0	6.3	106	0.4	3.1	129	0.1	5.1	331
NDVI	0.9	1.1	29	0.1	6.1	105	0.6	2.5	120	0.3	4.7	322
SIPI	0.7	1.6	35	0.2	5.9	104	0.6	2.5	118	**0.3**	**4.4**	**315**
CI	0.9	1.0	28	0.2	5.9	104	**0.6**	**2.3**	**115**	0.2	4.7	324
PRI	0.7	1.5	35	0.2	5.9	104	0.2	3.4	134	0.3	4.6	319
EVI	0.8	1.2	31	0.1	6.1	105	0.4	2.8	125	0.2	4.8	325
NPQI	0.2	2.5	44	0.1	6.3	106	0.1	3.6	137	0.1	5.2	333
NPCI	0.4	2.3	43	**0.3**	**5.5**	**102**	0.2	3.4	133	0.3	4.5	319
SRPI	0.3	2.4	43	0.3	5.6	103	0.2	3.4	134	0.3	4.6	320

	NEE											
	Amplero			Neustift			Monte Bondone			All		
	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC
VI	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-	-	$\frac{\mu mol_{CO2}}{m^2 s}$	-
Linear model												
SR	**0.9**	**0.7**	**21**	0.1	5.5	102	0.5	2.4	117	0.2	4.0	304
GRI	0.9	1.1	30	0.1	5.5	102	0.4	2.6	120	0.1	4.2	309
WI	0.9	0.8	23	0.0	5.7	103	0.3	2.7	122	0.1	4.2	310
NDVI	0.9	1.0	27	0.2	5.3	101	0.5	2.4	117	0.2	3.9	303
SIPI	0.8	1.5	35	0.2	5.1	99	0.5	2.4	116	0.3	3.8	302
CI	0.9	0.8	23	0.2	5.1	100	**0.6**	**2.2**	**113**	**0.3**	**3.9**	**300**
PRI	0.8	1.4	33	0.2	5.3	101	0.2	3.0	129	0.1	4.2	310
EVI	0.9	1.1	30	0.1	5.4	101	0.4	2.5	119	0.2	4.1	307
NPQI	0.3	2.6	45	0.1	5.5	102	0.1	3.1	130	0.0	4.5	318
NPCI	0.6	2.0	40	**0.4**	**4.5**	**96**	0.3	2.7	123	0.2	4.1	307
SRPI	0.5	2.1	41	0.4	4.6	96	0.3	2.7	123	0.1	4.2	308
Exponential model												
SR	0.9	1.1	28	0.1	5.6	102	0.4	2.5	118	0.2	4.0	305
GRI	0.8	1.3	32	0.1	5.6	102	0.4	2.6	121	0.1	4.2	310
WI	0.9	1.2	30	0.0	5.8	104	0.3	2.8	124	0.1	4.2	311
NDVI	0.9	0.7	22	0.1	5.5	102	0.5	2.4	117	0.2	3.9	303
SIPI	0.8	1.2	31	0.2	5.2	100	0.5	2.3	114	**0.3**	**3.8**	**300**
CI	**1.0**	**0.6**	**18**	0.2	5.3	101	**0.6**	**2.2**	**111**	0.3	3.9	302
PRI	0.7	1.6	36	0.2	5.4	101	0.2	3.0	128	0.1	4.2	311
EVI	0.9	1.0	27	0.1	5.5	102	0.4	2.6	121	0.2	4.1	308
NPQI	0.2	2.7	45	0.1	5.6	103	0.1	3.2	130	0.0	4.5	318
NPCI	0.4	2.3	42	**0.3**	**4.8**	**98**	0.3	2.8	124	0.2	4.1	309
SRPI	0.4	2.4	43	0.3	4.9	98	0.3	2.8	124	0.1	4.2	310