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Supplement of

Modeling the impacts of diffuse light fraction on photosynthesis in ORCHIDEE (v5453) land surface model

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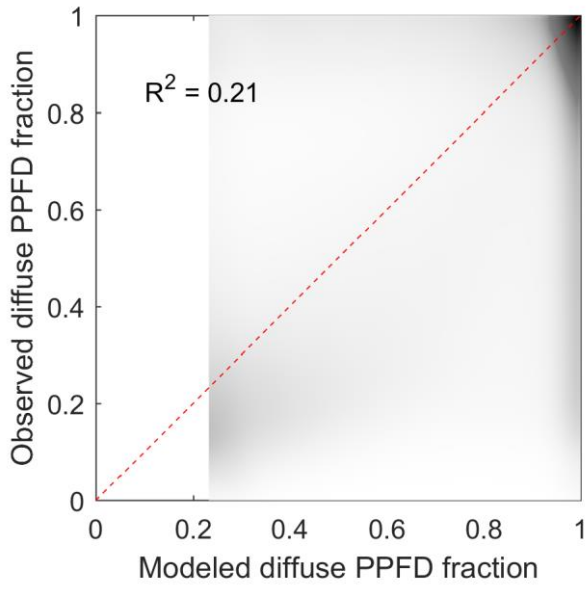


Figure S1. Same as Figure 3 but diffuse PPFD fraction calculated using method from Spitters (1986).

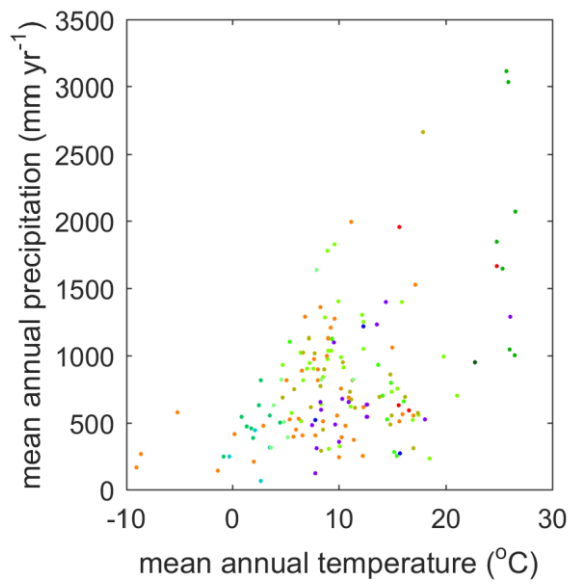


Figure S2. Mean annual temperature and annual mean precipitation of at the sites used in this study. The colors indicate different PFTs. Color codes are shown in Figure 4

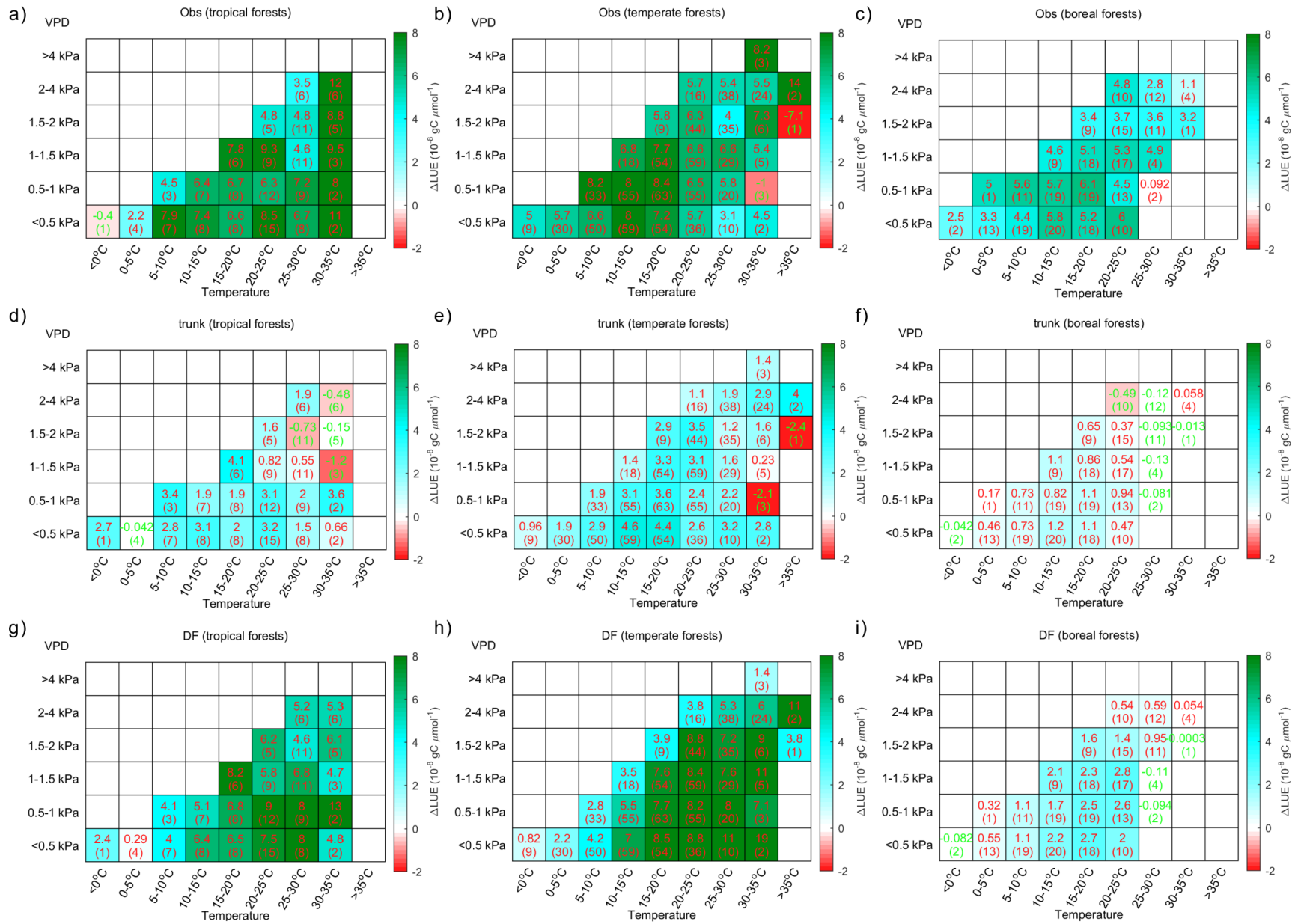


Figure S3. Same as Figure 10 but for tropical forests (a, d, g), temperate forests (b, e, h) and boreal forests (c, f, i) respectively

Table S1. Plant functional types (PFT) in ORCHIDEE

PFT number	PFT abbreviation	PFT name
1		Bare soil
2	TrEBF	Tropical broad-leaved evergreen forests
3	TrDBF	Tropical broad-leaved raingreen forests
4	TeENF	Temperate needleleaf evergreen forests
5	TeEBF	Temperate broad-leaved evergreen forests
6	TeDBF	Temperate broad-leaved summergreen forests
7	BoENF	Boreal needleleaf evergreen forests
8	BoDBF	Boreal broad-leaved summergreen forests
9	BoDNF	Boreal needleleaf summergreen forests
10	C3Gra	C3 grasslands
11	C4Gra	C4 grasslands
12	C3Cro	C3 croplands
13	C4Cro	C4 croplands

Table S2. The information of the flux sites used in this study

Site name	Latitude	Longitude	PFT_ORCHIDEE	Time	Reference
AT-Neu	47.12	11.32	GraC3	2002-2006	(Wohlfahrt et al., 2008)
AU-Tum	-35.66	148.15	TeEBF	2001-2006	(Leuning et al., 2005)
AU-Wac	-37.43	145.19	TeEBF	2005-2007	(Kilinc et al., 2013)
BE-Bra	51.31	4.52	MF*	1997-2006	-
BE-Jal	50.56	6.07	MF	2006	-
BE-Lon	50.55	4.74	CroC3	2004-2006	(Moureaux et al., 2006)
BE-Vie	50.31	6	MF	1996-2006	(Aubinet et al., 2001)
BR-Ban	-9.82	-50.16	TrEBF	2003-2006	-
BR-Ji1	-10.76	-62.36	GraC4	1999	(von Randow et al., 2004)
BR-Ji2	-10.08	-61.93	TrEBF	2000-2002	(von Randow et al., 2004)
BR-Ma2	-2.61	-60.21	TrEBF	1999-2006	(Araujo et al., 2002)
BR-Sa2	-3.01	-54.54	CroC3	2001-2002	(Sakai et al., 2004)
BR-Sa3	-3.02	-54.97	TrEBF	2000-2003	(Saleska et al., 2003)
BR-Sp1	-21.62	-47.65	TrDBF	2001-2002	-
CA-Ca1	49.87	-125.33	TeENF	1997-2005	(Humphreys et al., 2003)
CA-Ca3	49.53	-124.9	TeENF	2001-2005	(Humphreys et al., 2006)
CA-Gro	48.22	-82.16	MF	2003-2005	(McCaughey et al., 2006)
CA-Oas	53.63	-106.2	BoDBF	1997-2005	(Black et al., 1996)
CA-Obs	53.99	-105.12	BoENF	1999-2005	(Bergeron et al., 2007)
CA-Ojp	53.92	-104.69	BoENF	1999-2005	(Howard et al., 2004)
CA-Qfo	49.69	-74.34	BoENF	2003-2006	(Bergeron et al., 2007)
CA-SF1	54.49	-105.82	BoENF	2003-2005	(Amiro et al., 2006)
CA-SJ3	53.88	-104.65	BoENF	2004-2005	(Gower et al., 1997)
CA-TP2	42.77	-80.46	TeENF	2003-2005	(Arain and Restrepo-Coupe, 2005)
CA-TP3	42.71	-80.35	TeENF	2003-2005	(Arain and Restrepo-Coupe, 2005)
CA-TP4	42.71	-80.36	TeENF	2003-2005	(Arain and Restrepo-Coupe, 2005)
CA-WP1	54.95	-112.47	MF	2003-2005	(Syed et al., 2006)
CA-WP2	55.54	-112.33	GraC3	2004	(Glenn et al., 2006)
CA-WP3	54.47	-113.32	GraC3	2004	(Glenn et al., 2006)
CH-Oe1	47.29	7.73	GraC3	2002-2006	(Ammann et al., 2009)
CH-Oe2	47.29	7.73	CroC3	2005	(Dietiker et al., 2010)
CN-Anh	33	117	TeDBF	2005-2006	-
CN-Bed	39.53	116.25	TeEBF	2005-2006	-
CN-Cha	42.4	128.1	MF	2003	(Guan et al., 2006)
CN-Do1	31.52	121.96	GraC4	2005	(Yan et al., 2008)
CN-Du1	42.05	116.67	CroC3	2005-2006	(Chen et al., 2009)
CN-Du2	42.05	116.28	GraC3	2006	(Chen et al., 2009)
CN-HaM	37.37	101.18	GraC3	2002-2004	(Kato et al., 2006)
CN-Xfs	44.13	116.33	GraC3	2004-2006	(Miao et al., 2009)
CN-Xi1	43.55	116.68	GraC3	2006	(Chen et al., 2009)
CN-Xi2	43.55	116.67	GraC3	2006	-
CZ-BK1	49.5	18.54	TeENF	2000-2006	(Acosta et al., 2013)
CZ-BK2	49.5	18.54	GraC3	2004-2006	-
CZ-wet	49.03	14.77	GraC3	2006	(Dušek et al., 2012)
DE-Bay	50.14	11.87	TeENF	1996-1999	(Valentini et al., 2000)
DE-Geb	51.1	10.91	CroC3	2004-2006	(Anthoni et al., 2004)
DE-Gri	50.95	13.51	GraC3	2005-2006	(Prescher et al., 2010)

DE-Hai	51.08	10.45	TeDBF	2000-2006	(Knohl et al., 2003)
DE-Har	47.93	7.6	TeENF	2005-2006	(Bernhofer et al., 1996)
DE-Kli	50.89	13.52	CroC3	2004-2006	(Prescher et al., 2010)
DE-Tha	50.96	13.57	TeENF	1996-2006	(Grünwald and Bernhofer, 2007)
DE-Wet	50.45	11.46	TeENF	2002-2006	(Rebmann et al., 2010)
DK-Fou	56.48	9.59	CroC3	2005	-
DK-Lva	55.68	12.08	GraC3	2005-2006	-
DK-Ris	55.53	12.1	CroC3	2004-2005	-
DK-Sor	55.49	11.65	TeDBF	1996-2006	(Pilegaard et al., 2011)
ES-ES1	39.35	-0.32	TeENF	1999-2006	(Reichstein et al., 2005)
ES-ES2	39.28	-0.32	CroC3	2004-2006	-
ES-LMa	39.94	-5.77	TeDBF	2004-2006	-
ES-VDA	42.15	1.45	GraC3	2004-2006	-
FI-Hyy	61.85	24.29	BoENF	1996-2006	(Suni et al., 2003)
FI-Kaa	69.14	27.3	GraC3	2000-2006	-
FI-Sii	61.83	24.19	GraC3	2004-2005	-
FR-Aur	43.55	1.11	CroC3	2005	-
FR-Fon	48.48	2.78	TeDBF	2005-2006	(Delpierre et al., 2016)
FR-Hes	48.67	7.06	TeDBF	1997-2006	(Granier et al., 2000)
FR-Lam	43.49	1.24	CroC4	2005	(Béziat et al., 2009)
FR-Lq1	45.64	2.74	GraC3	2004-2006	-
FR-Lq2	45.64	2.74	GraC3	2004-2006	-
FR-Pue	43.74	3.6	TeEBF	2000-2006	(Rambal et al., 2004)
GF-Guy	5.28	-52.93	TrEBF	2004-2006	(Bonal et al., 2008)
HU-Bug	46.69	19.6	GraC3	2002-2006	(Nagy et al., 2007)
HU-Mat	47.85	19.73	GraC3	2004-2006	-
ID-Pag	2.35	114.04	TrEBF	2002-2003	-
IE-Ca1	52.86	-6.92	CroC3	2004-2006	-
IE-Dri	51.99	-8.75	GraC3	2003-2005	-
IL-Yat	31.35	35.05	TeENF	2001-2006	(Grünzweig et al., 2003)
IT-Amp	41.9	13.61	GraC3	2002-2006	(Papale et al., 2015)
IT-Be2	46	13.03	CroC4	2006	(Papale et al., 2015)
IT-Bon	39.48	16.53	TeENF	2006	(Papale et al., 2015)
IT-Col	41.85	13.59	TeDBF	1996-2006	(Valentini et al., 1996)
IT-Cpz	41.71	12.38	TeEBF	1997-2006	(Garbulsky et al., 2008)
IT-Lav	45.96	11.28	TeENF	2000-2006	(Marcolla et al., 2003)
IT-Lec	43.3	11.27	TeEBF	2005-2006	(Papale et al., 2015)
IT-LMa	45.58	7.15	TeDBF	2003-2006	(Papale et al., 2015)
IT-Mal	46.12	11.7	GraC3	2003-2006	(Papale et al., 2015)
IT-MBo	46.02	11.05	GraC3	2003-2006	(Marcolla et al., 2011)
IT-Noe	40.61	8.15	TeENF	2004-2006	(Papale et al., 2015)
IT-Pia	42.58	10.08	TeENF	2002-2005	(Papale et al., 2015)
IT-Ren	46.59	11.43	TeENF	1999-2006	(Montagnani et al. 2009)
IT-Ro2	42.39	11.92	TeDBF	2002-2006	(Tedeschi et al., 2006)
IT-SRo	43.73	10.28	TeENF	1999-2006	(Chiesi et al., 2005)
JP-Mas	36.05	140.03	CroC3	2002-2003	(Saito et al., 2005)
JP-Tak	36.15	137.42	TeDBF	1999-2004	(Yamamoto et al., 1999)
KR-Hnm	34.55	126.57	CroC3	2004-2006	(Lee et al., 2003)
NL-Ca1	51.97	4.93	GraC3	2003-2006	(Jacobs et al., 2007)

NL-Haa	52	4.81	GraC3	2003-2004	(Jacobs et al., 2007)
NL-Lan	51.95	4.9	CroC4	2005-2006	-
NL-Loo	52.17	5.74	TeENF	1996-2006	(Moors, 2002)
NL-Lut	53.4	6.36	CroC3	2006	-
NL-Mol	51.65	4.64	CroC3	2005-2006	-
PL-wet	52.76	16.31	GraC3	2004-2005	-
PT-Esp	38.64	-8.6	TeEBF	2002-2006	-
PT-Mi2	38.48	-8.02	GraC3	2004-2006	-
RU-Cok	70.62	147.88	BoDBF	2003-2005	(van der Molen et al., 2007)
SE-Abi	68.36	18.79	BoDBF	2005	-
SE-Deg	64.18	19.55	GraC3	2001-2005	-
SE-Fla	64.11	19.46	BoENF	1996-2002	-
SE-Nor	60.09	17.48	TeENF	1996-2005	(Lagergren et al., 2008)
SE-Sk2	60.13	17.84	TeENF	2004-2005	-
UK-AMo	55.79	-3.24	GraC3	2005	-
UK-EBu	55.87	-3.21	GraC3	2004-2006	-
UK-ESa	55.91	-2.86	CroC3	2003-2005	-
UK-Gri	56.61	-3.8	TeENF	1997-2006	-
UK-Ham	51.12	-0.86	TeDBF	2004-2005	(Wilkinson et al., 2012)
UK-PL3	51.45	-1.27	TeDBF	2005-2006	-
UK-Tad	51.21	-2.83	GraC3	2001	-
US-ARb	35.55	-98.04	GraC4	2005-2006	(Fischer et al., 2012)
US-ARc	35.54	-98.04	GraC4	2005-2006	(Fischer et al., 2012)
US-ARM	36.61	-97.49	CroC3	2003-2006	(Fischer et al., 2007)
US-Atq	70.47	-157.41	GraC3	1999-2006	(Kwon et al., 2005)
US-Bar	44.06	-71.29	TeDBF	2004-2005	(Richardson et al., 2007)
US-Blo	38.9	-120.63	TeENF	1997-2006	(Baker et al., 1999)
US-Bn1	63.92	-145.38	BoENF	2003	(Liu et al., 2005)
US-Bn2	63.92	-145.38	BoDBF	2003	(Liu et al., 2005)
US-Brw	71.32	-156.63	GraC3	1998-2002	(Kwon et al., 2005)
US-CaV	39.06	-79.42	GraC3	2004-2005	-
US-Dk1	35.97	-79.09	GraC3	2001-2005	(Katul et al., 2003)
US-FPe	48.31	-105.1	GraC3	2000-2006	-
US-Fuf	35.09	-111.76	TeENF	2005-2006	(Dore et al., 2008)
US-Fwf	35.45	-111.77	GraC3	2005-2006	(Dore et al., 2008)
US-Goo	34.25	-89.97	GraC3	2002-2006	(Benjamin et al., 2017)
US-Ho1	45.2	-68.74	TeENF	1996-2004	(Hollinger et al., 1999)
US-IB2	41.84	-88.24	GraC3	2004-2007	(Allison et al., 2005)
US-Ivo	68.49	-155.75	GraC3	2003-2006	(McEwing et al., 2015)
US-Los	46.08	-89.98	TeDBF	2001-2005	(David et al., 2003)
US-Me3	44.32	-121.61	TeENF	2004-2005	(Campbell and Law, 2005)
US-Me4	44.5	-121.62	TeENF	1996-2000	(Campbell and Law, 2005)
US-MMS	39.32	-86.41	TeDBF	1999-2005	(Schmid et al., 2000)
US-MOz	38.74	-92.2	TeDBF	2004-2006	(Gu et al., 2006)
US-NC2	35.8	-76.67	TeENF	2005-2006	(Noormets et al., 2010)
US-NR1	40.03	-105.55	BoENF	1999-2003	(Monson et al., 2002)
US-Oho	41.55	-83.84	TeDBF	2004-2005	(Noormets et al., 2008)
US-PFa	45.95	-90.27	MF	1996-2003	(Berger et al., 2001)
US-SO2	33.37	-116.62	TeDBF	1997-2006	(Lipson et al., 2005)

US-SO4	33.38	-116.64	TeDBF	2004-2006	(Luo et al., 2007)
US-SP1	29.74	-82.22	TeENF	2000-2005	(Powell et al., 2008)
US-SP3	29.75	-82.16	TeENF	1999-2004	(Powell et al., 2008)
US-Syv	46.24	-89.35	MF	2002-2006	(Desai et al., 2005)
US-Ton	38.43	-120.97	TeDBF	2001-2006	(Xu and Baldocchi, 2003)
US-UMB	45.56	-84.71	TeDBF	1999-2003	(Schmid, 2003)
US-Var	38.41	-120.95	GraC3	2001-2006	(Xu and Baldocchi, 2004)
US-WBW	35.96	-84.29	TeDBF	1995-1999	(Baldocchi and Vogel, 1996)
US-WCr	45.81	-90.08	TeDBF	1999-2006	(Desai et al., 2005)
US-Wi1	46.73	-91.23	TeDBF	2003	(Noormets et al., 2008)
US-Wi2	46.69	-91.15	TeENF	2003	(Noormets et al., 2008)
US-Wi4	46.74	-91.17	TeENF	2002-2005	(Noormets et al., 2008)
US-Wrc	45.82	-121.95	TeENF	1998-2006	(Paw et al., 2004)
VU-Coc	-15.44	167.19	TrEBF	2001-2004	(Roupsard et al., 2008)

* Mix forests, treated as 50% TeDBF and 50% TeENF

References

- Acosta, M., Pavelka, M., Montagnani, L., Kutsch, W., Lindroth, A., Juszczak, R. and Janouš, D. (2013) Soil surface CO₂ efflux measurements in Norway spruce forests: Comparison between four different sites across Europe — from boreal to alpine forest, *Geoderma*, 192, 295–303
- Allison, V. J., Miller, R. M., Jastrow, J. D., Matamala, R., Zak, D. R. (2005) Changes in soil microbial community structure in a tallgrass prairie chronosequence, *Soil Science Society of America Journal*, 69(5), 1412-1421.
- Amiro, B., Orchansky, A., Barr, A., Black, T., Chambers, S., Chapin III, F., Goulden, M., Litvak, M., Liu, H., McCaughey, J., McMillan, A., Randerson, J. (2006) The effect of post-fire stand age on the boreal forest energy balance, *Agricultural and Forest Meteorology*, 140(1-4), 41-50.
- Ammann, C., Spirig, C., Leifeld, J. and Neftel, A. (2009) Assessment of the nitrogen and carbon budget of two managed temperate grassland fields, *Agriculture, Ecosystems and Environment*, 133(3–4), 150–162
- Anthoni, P. M., Knohl, A., Rebmann, C., Freibauer, A., Mund, M., Ziegler, W., Kolle, O. and Schulze, E.-D. (2004) Forest and agricultural land-use-dependent CO₂ exchange in Thuringia, Germany, *Global Change Biology*, 10(12), 2005–2019
- Aubinet, M., Chermanne, B., Vandenhaute, M., Longdoz, B., Yernaux, M., Laitat, E. (2001) Long term carbon dioxide exchange above a mixed forest in the Belgian Ardennes. *Agricultural and Forest Meteorology* 108(4), 293-315.
- Araujo, A., Nobre, A., Kruijt, B., Elbers, J., Dallarosa, R., Stefani, P., Von Randow, C., Manzi, A., Culf, A., Gash, J., et al., (2002) Comparative measurements of carbon dioxide fluxes from two nearby towers in a central Amazonian rainforest: The Manaus Iba site. *Journal of Geophysical Research: Atmospheres* 107 (D20), LBA–58.
- Arain, M. A., Restrepo-Coupe, N. (2005) Net ecosystem production in a temperate pine plantation in southeastern Canada, *Agricultural and Forest Meteorology*, 128(3-4), 223-241.
- Baker, B., Guenther, A., Greenberg, J., Goldstein, A., Fall, R. (1999) Canopy fluxes of 2-methyl-3-buten-2-ol over a ponderosa pine forest by relaxed eddy accumulation: field data and model comparison, *Journal of Geophysical Research: Atmospheres*, 104(D21), 26107-26114.
- Baldocchi, D. D., Vogel, C. A. (1996) Energy and CO₂ Flux densities above and below a temperate broad-leaved forest and a boreal pine forest, *Tree Physiology*, 16(1-2), 5-16.
- Bernhofer, C., Gay, L., Granier, A., Joss, U., Kessler, A., Kostner, B., Siegwolf, R., Tenhunen, J. D., Vogt, R., (1996) The hartx-synthesis: an experimental approach to water and carbon exchange of a scots pine plantation. *Theoretical and Applied Climatology*, 53 (1-3), 173–183.
- Benjamin R. K. Runkle, James R. Rigby, Michele L. Rebac, Saseendran S. Anapallid, Joydeep Bhattacharjee, Ken W. Krauss, Lu Liang, Martin A. Locke, Kimberly A. Novick, Ruixiu Suid, Kosana Suvocareva and Paul M. White (2017) Delta-flux: an eddy covariance network for a climate-smart lower Mississippi basin, *Agricultural and Environmental Letters*, 2(1), 170003 - 170003.
- Berger, B. W., Davis, K. J., Yi, C., Bakwin, P. S., Zhao, C. L. (2001) Long-term carbon dioxide fluxes from a very tall tower in a northern forest: flux measurement methodology, *Journal Of Atmospheric and Oceanic Technology*, 18(4), 529-542.
- Bergeron, O., Margolis, H. A., Black, T. A., Coursolle, C., Dunn, A. L., Barr, A. G., Wofsy, S. C. (2007) Comparison of carbon dioxide fluxes over three boreal black spruce forests in Canada, *Global Change Biology*, 13(1), 89-107.
- Béziat, P., Ceschia, E., Dedieu, G. (2009) Carbon balance of a three crop succession over two cropland sites in South West France. *Agricultural and Forest Meteorology* 149 (10), 1628–1645

- Black, T., Hartog, G. d., Neumann, H., Blanken, P., Yang, P., Russell, C., Nesic, Z., Lee, X., Chen, S., Staebler, R., et al., (1996) Annual cycles of water vapour and carbon dioxide fluxes in and above a boreal aspen forest. *Global Change Biology*, 2 (3), 219–229.
- Bonal, D., Bosc, A., Ponton, S., Goret, J.-Y., Burban, B., Gross, P., Bonnefond, J.-M., Elbers, J., Longdoz, B., Epron, D., Guehl, J.-M. and Granier, A. (2008) Impact of severe dry season on net ecosystem exchange in the Neotropical rainforest of French Guiana, *Global Change Biology*, 14(8), 1917–1933
- Campbell, J., Law, B. (2005) Forest soil respiration across three climatically distinct chronosequences in Oregon, *Biogeochemistry*, 73(1), 109-125.
- Chen, S., Chen, J., Lin, G., Zhang, W., Miao, H., Wei, L., Huang, J. and Han, X. (2009) Energy balance and partition in Inner Mongolia steppe ecosystems with different land use types, *Agricultural and Forest Meteorology*, 149(11), 1800–1809.
- Chiesi, M., Maselli, F., Bindi, M., Fibbi, L., Cherubini, P., Arlotta, E., Tirone, G., Matteucci, G. and Seufert, G. (2005) Modelling carbon budget of Mediterranean forests using ground and remote sensing measurements, *Agricultural and Forest Meteorology*, 135(1–4), 22–34
- Davis, K. J., Bakwin, P. S., Yi, C., Berger, B. W., Zhao, C., Teclaw, R. M., Isebrands, J. G. (2003) The annual cycles of CO₂ and H₂O exchange over a northern mixed forest as observed from a very tall tower, *Global Change Biology*, 9(9), 1278-1293.
- Delpierre, N., Berveiller, D., Granda, E. and Dufrêne, E. (2016) Wood phenology, not carbon input, controls the interannual variability of wood growth in a temperate oak forest, *New Phytologist*, 210(2), 459–470
- Desai, A. R., Bolstad, P. V., Cook, B. D., Davis, K. J., Carey, E. V. (2005) Comparing net ecosystem exchange of carbon dioxide between an old-growth and mature forest in the upper Midwest, USA, *Agricultural and Forest Meteorology*, 128(1-2), 33-55
- Dietiker D, Buchmann N, Eugster W (2010) Testing the ability of the DNDC model to predict CO₂ and water vapour fluxes of a Swiss cropland site. *Agriculture, Ecosystems and Environment* 139: 396–401
- Dore, S., Kolb, T. E., Montes-Helu, M., Sullivan, B. W., Winslow, W. D., Hart, S. C., Kaye, J. P., Koch, G. W., Hungate, B. A. (2008) Long-term impact of a stand-replacing fire on ecosystem CO₂ exchange of a ponderosa pine forest, *Global Change Biology*, 14(8), 1801-1820.
- Dušek, J., Čížková, H., Stellner, S., Czerný, R. and Květ, J. (2012) Fluctuating water table affects gross ecosystem production and gross radiation use efficiency in a sedge-grass marsh, *Hydrobiologia*, 692(1), 57–66
- Fischer, M. L., Billesbach, D. P., Berry, J. A., Riley, W. J., Torn, M. S. (2007) Spatiotemporal variations in growing season exchanges of CO₂, H₂O, and sensible heat in agricultural fields of the southern great plains, *Earth Interactions*, 11(17), 1-21.
- Fischer, M. L., Torn, M. S., Billesbach, D. P., Doyle, G., Northup, B., Biraud, S. C. (2012) Carbon, water, and heat flux responses to experimental burning and drought in a tallgrass prairie, *Agricultural and Forest Meteorology*, 166-167, 169-174.
- Garbulsky, M.F., Penuelas, J., Papale, D., Filella, I. (2008) Remote estimation of carbon dioxide uptake by a Mediterranean forest. *Global Change Biology*, 14, 2860–2867
- Glenn, A. J., Flanagan, L. B., Syed, K. H., Carlson, P. J. (2006) Comparison of net ecosystem CO₂ exchange in two peatlands in western Canada with contrasting dominant vegetation, sphagnum and carex, *Agricultural and Forest Meteorology*, 140(1-4), 115-135.
- Gower, S. T., Vogel, J. G., Norman, J. M., Kucharik, C. J., Steele, S. J., Stow, T. K. (1997) Carbon distribution and

- aboveground net primary production in aspen, jack pine, and black spruce stands in Saskatchewan and Manitoba, Canada, *Journal of Geophysical Research: Atmospheres*, 102(D24), 29029-29041.
- Granier, A., Ceschia, E., Damesin, C., Dufrene, E., Epron, D., Gross, P., Lebaube, S., Le Dantec, V., Le Goff, N., Lemoine, D., et al. (2000) The carbon balance of a young beech forest. *Functional Ecology* 14 (3), 312–325.
- Grünwald, T. and Bernhofer, C. (2007) A decade of carbon, water and energy flux measurements of an old spruce forest at the Anchor Station Tharandt, *Tellus B: Chemical and Physical Meteorology*, 59(3), 387–396
- Grünzweig, J., Lin, T., Rotenberg, E., Schwartz, A., Yakir, D. (2003) Carbon sequestration in arid-land forest. *Global Change Biology* 9 (5), 791–799.
- Gu, L., Meyers, T., Pallardy, S. G., Hanson, P. J., Yang, B., Heuer, M., Hosman, K. P., Riggs, J. S., Sluss, D., Wullschlegel, S. D. (2006) Direct and indirect effects of atmospheric conditions and soil moisture on surface energy partitioning revealed by a prolonged drought at a temperate forest site, *Journal of Geophysical Research*, 111(D16),
- Guan, D.-X., Wu, J.-B., Zhao, X.-S., Han, S.-J., Yu, G.-R., Sun, X.-M. and Jin, C.-J. (2006) CO₂ fluxes over an old, temperate mixed forest in northeastern China, *Agricultural and Forest Meteorology*, 137(3–4), 138–149.
- Hollinger, D. Y., Goltz, S. M., Davidson, E. A., Lee, J. T., Tu, K., Valentine, H. T. (1999) Seasonal patterns and environmental control of carbon dioxide and water vapour exchange in an ecotonal boreal forest, *Global Change Biology*, 5(8), 891-902.
- Howard, E. A., Gower, S. T., Foley, J. A., and Kucharik, C. J. (2004) Effects of logging on carbon dynamics of a jack pine forest in Saskatchewan, Canada, *Global Change Biology*, 10, 1267–1284.
- Humphreys, E., Black, T., Ethier, G., Drewitt, G., Spittlehouse, D., Jork, E., Nesic, Z., Livingston, N. (2003) Annual and seasonal variability of sensible and latent heat fluxes above a coastal douglas-fir forest, British Columbia, Canada, *Agricultural and Forest Meteorology*, 115(1-2), 109-125.
- Humphreys, E. R., Black, T. A., Morgenstern, K., Cai, T., Drewitt, G. B., Nesic, Z., Trofymow, J. (2006) Carbon dioxide fluxes in coastal douglas-fir stands at different stages of development after clearcut harvesting, *Agricultural and Forest Meteorology*, 140(1-4), 6-22.
- Jacobs CJM, Jacobs AFG, Bosveld FC et al. (2007) Variability of annual CO₂ exchange from Dutch grasslands. *Biogeosciences*, 4, 803–816.
- Kato, T., Tang, Y., Gu, S., Hirota, M., Du, M., Li, Y. and Zhao, X. (2006) Temperature and biomass influences on interannual changes in CO₂ exchange in an alpine meadow on the Qinghai-Tibetan Plateau, *Global Change Biology*, 12(7), 1285–1298
- Katul, G., Leuning, R., Oren, R. (2003) Relationship between plant hydraulic and biochemical properties derived from a steady-state coupled water and carbon transport model, *Plant, Cell and Environment*, 26(3), 339-350.
- Kilinc, M., Beringer, J., Hutley, L. B., Tapper, N. J. and McGuire, D. A. (2013) Carbon and water exchange of the world's tallest angiosperm forest, *Agricultural and Forest Meteorology*, 182–183, 215–224.
- Knohl, A., Schulze, E.-D., Kolle, O. and Buchmann, N. (2003) Large carbon uptake by an unmanaged 250-year-old deciduous forest in Central Germany, *Agricultural and Forest Meteorology*, 118(3–4), 151–167
- Kwon, H.J., Oechel, W.C., Zulueta, R.C., Hastings, S.J. (2005) Effects of climate variability on carbon sequestration among adjacent wet sedge tundra and moist tussock tundra ecosystems, *Journal of Geophysical Research: Biogeosciences*, 111(G3), 2005-2012.
- Lagergren, F., Lindroth, A., Dellwik, E., Ibrom, A., Lankreijer, H., Launiainen, S., Møller, M., Kolari, P., Pilegaard, K., and Vesala, T. (2008) Biophysical controls on CO₂ fluxes of three Northern forests based on long-term eddy covariance data, *Tellus B*, 60, 143–152

- Lee HC, Hong JK, Cho CH, Choi BC, Oh SN, Kim J. (2003) Surface exchange of energy and carbon dioxide between the atmosphere and a farmland in Haenam, Korea. *Korean Journal of Agricultural and Forest Meteorology* 5(2): 61–69.
- Leuning, R., Cleugh, H. A., Zegelin, S. J. and Hughes, D. (2005) Carbon and water fluxes over a temperate Eucalyptus forest and a tropical wet/dry savanna in Australia: measurements and comparison with MODIS remote sensing estimates, *Agricultural and Forest Meteorology*, 129(3–4), 151–173.
- Lipson, D. A., Wilson, R. F., Oechel, W. C. (2005) Effects of elevated atmospheric CO₂ on soil microbial biomass, activity, and diversity in a chaparral ecosystem, *Applied and Environmental Microbiology*, 71(12), 8573-8580.
- Liu, H., Randerson, J. T., Lindfors, J., Chapin, F. S. (2005) Changes in the surface energy budget after fire in boreal ecosystems of interior Alaska: an annual perspective, *Journal of Geophysical Research*, 110(D13)
- Luo, H., Oechel, W. C., Hastings, S. J., Zulueta, R., Qian, Y., Kwon, H. (2007) Mature semiarid chaparral ecosystems can be a significant sink for atmospheric carbon dioxide, *Global Change Biology*, 13(2), 386-396.
- Marcolla, B., Pitacco, A., Cescatti, A. (2003) Canopy architecture and turbulence structure in a Coniferous forest. *Boundary-Layer Meteorology*, 108, 39–59
- Marcolla, B., Cescatti, A., Manca, G., Zorer, R., Cavagna, M., Fiora, A., Gianelle, D., Rodeghiero, M., Sottocornola, M. and Zampedri, R. (2011) Climatic controls and ecosystem responses drive the inter-annual variability of the net ecosystem exchange of an alpine meadow, *Agricultural and Forest Meteorology*, 151(9), 1233–1243
- McCaughey, J., Pejam, M., Arain, M., Cameron, D. (2006) Carbon dioxide and energy fluxes from a boreal mixedwood forest ecosystem in Ontario, Canada, *Agricultural and Forest Meteorology*, 140(1-4), 79-96.
- McEwing, K. R., Fisher, J. P., Zona, D. (2015) Environmental and vegetation controls on the spatial variability of CH₄ emission from wet-sedge and tussock tundra ecosystems in the arctic, *Plant and Soil*, 388(1-2), 37-52.
- Miao, H., Chen, S., Chen, J., Zhang, W., Zhang, P., Wei, L., Han, X., Lin, G. (2009) Cultivation and grazing altered evapotranspiration and dynamics in Inner Mongolia steppes. *Agricultural and Forest Meteorology*, 149(11), 1810–1819
- Monson, R. K., Turnipseed, A. A., Sparks, J. P., Harley, P. C., Scott-Denton, L. E., Sparks, K., Huxman, T. E. (2002) Carbon sequestration in a high-elevation, subalpine forest, *Global Change Biology*, 8(5), 459-478.
- Montagnani, L., Manca, G., Canepa, E., Georgieva, E., Acosta, M., Feigenwinter, C., Janous, D., Kerschbaumer, G., Lindroth, A., Minach, L., Minerbi, S., Mölder, M., Pavelka, M., Seufert, G., Zeri, M. and Ziegler, W. (2009) A new mass conservation approach to the study of CO₂ advection in an alpine forest, *Journal of Geophysical Research*, 114(D7), D07306
- Moors, E. J. (2012) Water use of forests in the Netherlands, PhD-thesis, Vrije Universiteit Amsterdam., the Netherlands.
- Moureaux, C., Debacq, A., Bodson, B., Heinesch, B., Aubinet, M., (2006) Annual net ecosystem carbon exchange by a sugar beet crop. *Agricultural and Forest Meteorology* 139, 25-39.
- Nagy, Z., Pinter, K., Czobel, S., Balogh, J., Horvath, L., Foti, S., Barcza, Z., Weidinger, T., Csintalan, Z., Dinh, N. Q., Grosz, B., and Tuba, Z. (2007) The carbon budget of semi-arid grassland in a wet and a dry year in Hungary, *Agriculture, Ecosystems and Environment*, 121, 21–29
- Noormets, A., Desai, A., Cook, B., Euskirchen, E., Ricciuto, D., Davis, K., Bolstad, P., Schmid, H., Vogel, C., Carey, E., Su, H., Chen, J. (2008) Moisture sensitivity of ecosystem respiration: comparison of 14 forest ecosystems in the upper great lakes region, USA, *Agricultural and Forest Meteorology*, 148(2), 216-230.
- Noormets, A., McNulty, S. G., DeForest, J. L., Sun, G., Li, Q., Chen, J. (2008) Drought during canopy development has lasting effect on annual carbon balance in a deciduous temperate forest, *New Phytologist*, 179(3), 818-828.

- Noormets, A., Gavazzi, M. J., McNulty, S. G., Domec, J., Sun, G., King, J. S., Chen, J. (2010) Response of carbon fluxes to drought in a coastal plain loblolly pine forest, *Global Change Biology*, 16(1), 272-287.
- Papale, D., Migliavacca, M., Cremonese, E., Cescatti, A., Alberti, G., Balzarolo, M., et al. (2015). Carbon, water and energy fluxes of terrestrial ecosystems in Italy. In *The Greenhouse Gas Balance of Italy* (pp. 11–45). Berlin: Springer.
- Paw U, K., Falk, M., Suchanek, T., Ustin, S., Chen, J., Park, Y., Winner, W., Thomas, S., Hsiao, T., Shaw, R., King, T., Pyles, R., Schroeder, M., Matista, A. (2004) Carbon dioxide exchange between an old-growth forest and the atmosphere, *Ecosystems*, 7(5), 513-524.
- Pilegaard, K., Ibrom, A., Courtney, M. S., Hummelshøj, P. and Jensen, N. O. (2011) Increasing net CO₂ uptake by a Danish beech forest during the period from 1996 to 2009, *Agricultural and Forest Meteorology*, 151(7), 934–946
- Powell, T. L., Gholz, H. L., Clark, K. L., Starr, G., Cropper, W. P., and Martin, T. A. (2008) Carbon exchange of a mature, naturally regenerated pine forest in north Florida, *Global Change Biology*, 14, 2523–2538
- Prescher, A.-K., Grünwald, T., Bernhofer, C., (2010) Land use regulates carbon budgets in eastern Germany: From NEE to NBP. *Agricultural and Forest Meteorology*, 150, 1016-1025.
- Rebmann, C., Zeri, M., Lasslop, G., Mund, M., Kolle, O., Schulze, E.-D., and Feigenwinter, C. (2010) Treatment and assessment of the CO₂-exchange at a complex forest site in Thuringia Germany, *Agricultural and Forest Meteorology*, 150, 684–691
- Reichstein M., Falge E., Baldocchi D., et al. (2005) On the separation of net ecosystem exchange into assimilation and ecosystem respiration: review and improved algorithm., *Global Change Biology*, 11 (9) 1424-1439
- Rambal, S., Joffre, R., Ourcival, J. M., Cavender-Bares, J. and Rocheteau, A. (2004) The growth respiration component in eddy CO₂ flux from a *Quercus ilex mediterranean* forest, *Global Change Biology*, 10(9), 1460–1469
- Richardson, A. D., Jenkins, J. P., Braswell, B. H., Hollinger, D. Y., Ollinger, S. V., Smith, M. (2007) Use of digital webcam images to track spring green-up in a deciduous broadleaf forest, *Oecologia*, 152(2), 323-334.
- Roupsard, O., Dausat, J., Nouvellon, Y., Deveau, A., Feintrenie, L., Saint-andré, L., Mialet-Serra, I., Braconnier, S., Bonnefond, J.-M., Berbigier, P., Epron, D., Jourdan, C., Navarro, M., Bouillet, J.-P. (2008) Cross-validating Sun-shade and 3D models of light absorption by a tree-crop canopy. *Agricultural and Forest Meteorology* 148, 549-564.
- Saito, M., Miyata, A., Nagai, H., Yamada, T. (2005) Seasonal variation of carbon dioxide exchange in rice paddy field in Japan. *Agricultural and Forest Meteorology*, 135 (1–4), 93–109.
- Sakai, R. K., Fitzjarrald, D. R., Moraes, O. L. L., Staebler, R. M., Acevedo, O. C., Czikowsky, M. J., Da Silva, R., Brait, E., and Miranda, V. (2004) Land-use change effects on local energy, water, and carbon balances in an Amazonian agricultural field, *Global Change Biology*, 10, 895–907
- Saleska, S. R., Miller, S. D., Matross, D. M., Goulden, M. L., Wofsy, S. C., Da Rocha, H. R., De Camargo, P. B., Crill, P., Daube, B. C., De Freitas, H. C., et al. (2003) Carbon in amazon forests: unexpected seasonal fluxes and disturbance-induced losses. *Science* 302 (5650), 1554–1557.
- Schmid, H. P. (2003) Ecosystem-atmosphere exchange of carbon dioxide over a mixed hardwood forest in northern lower Michigan, *Journal of Geophysical Research*, 108(D14), 4417.
- Schmid, H., Grimmond, C.S.B., Cropley, F., Offerle, B., Su, H.B. (2000) Measurements of CO₂ and energy fluxes over a mixed hardwood forest in the mid-western United States, *Agricultural and Forest Meteorology*, 103(4), 357-374.
- Suni, T., Rinne, J., Reissell, A., Altimir, N., Keronen, P., Rannik, Ü., Maso, M. D., Kulmala, M. and Vesala, T. (2003) Long-term measurements of surface fluxes above a Scots pine forest in Hyytiälä, southern Finland, 1996–2001, *Boreal Environment Research*, 8, 287–301

- Syed, K. H., Flanagan, L. B., Carlson, P. J., Glenn, A. J., Van Gaalen, K. E. (2006) Environmental control of net ecosystem CO₂ exchange in a treed, moderately rich fen in northern Alberta, *Agricultural and Forest Meteorology*, 140(1-4), 97-114.
- Tedeschi, V., Rey, A., Manca, G., Valentini, R., Jarvis, P. G. and Borghetti, M. (2006) Soil respiration in a Mediterranean oak forest at different developmental stages after coppicing, *Global Change Biology*, 12(1), 110–121
- Valentini, R., De Angelis, P., Matteucci, G., Monaco, R., Dore, S. and Mugnozza, G. E. S. (1996) Seasonal net carbon dioxide exchange of a beech forest with the atmosphere, *Global Change Biology*, 2(3), 199–207
- Valentini, R., Matteucci, G., Dolman, A., Schulze, E.-D., Rebmann, C., Moors, E., Granier, A., Gross, P., Jensen, N., Pilegaard, K., et al. (2000) Respiration as the main determinant of carbon balance in european forests. *Nature* 404 (6780), 861–865.
- van der Molen, M. K. van der, Huissteden, J. van, Parmentier, F. J. W., Petrescu, A. M. R., Dolman, A. J., Maximov, T. C., Kononov, A. V., Karsanaev, S. V. and Suzdalov, D. A. (2007) The growing season greenhouse gas balance of a continental tundra site in the Indigirka lowlands, NE Siberia, *Biogeosciences*, 4(6), 985–1003
- von Randow, C., Manzi, A. O., Kruijt, B., De Oliveira, P., Zanchi, F., Silva, R., Hodnett, M., Gash, J., Elbers, J., Waterloo, M., et al. (2004) Comparative measurements and seasonal variations in energy and carbon exchange over forest and pasture in south west Amazonia. *Theoretical and Applied Climatology* 78 (1-3), 5–26.
- Wilkinson, M., Eaton, E., Broadmeadow, M., Morison, J. (2012) Inter-annual variation of carbon uptake by a plantation oak woodland in south-eastern England. *Biogeosciences* 9 (12), 5373–5389.
- Wohlfahrt, G., Hammerle, A., Haslwanter, A., Bahn, M., Tappeiner, U. and Cernusca, A. (2008) Seasonal and inter-annual variability of the net ecosystem CO₂ exchange of a temperate mountain grassland: Effects of weather and management, *Journal of Geophysical Research*, 113(D8), D08110.
- Xu, L., Baldocchi, D. D. (2003) Seasonal trends in photosynthetic parameters and stomatal conductance of blue oak (*quercus douglasii*) under prolonged summer drought and high temperature, *Tree Physiology*, 23(13), 865-877.
- Xu, L., Baldocchi, D. D. (2004) Seasonal variation in carbon dioxide exchange over a Mediterranean annual grassland in California, *Agricultural and Forest Meteorology*, 123(1-2), 79-96.
- Yamamoto, S., Murayama, S., Saigusa, N., Kondo, H., (1999) Seasonal and inter-annual variation of CO₂ flux between a temperate forest and the atmosphere in japan. *Tellus B.*, 51 (2), 402–413.
- Yan, Y., Zhao, B., Chen, J. Q., Guo, H. Q., Gu, Y. J., Wu, Q. H., and Li, B. (2008) Closing the carbon budget of estuarine wetlands with tower-based measurements and MODIS time series, *Global Change Biology*, 14, 1690–1702