

1. About the data set

Site name (AsiaFlux three letter code)	Sapporo forest meteorology research site (SAP)	
Period of registered data	From January 1, 2009 to December 31, 2009	
This document file name	SAP_2009_001a.pdf	
Corresponding data file name	SAP_2009_001.csv	
Revision information		
Date	Details of revision	Renewed file name
31 Jul y 2014	First registration	SAP_2009_001a.pdf SAP_2009_001.csv
21 February 2017	Second registration: Pd and Pu are updated. H, Ust, Fc, Sc, NEE, Re and GPP are added. Document file is updated.	SAP_2009_002a.pdf SAP_2009_002.csv
Contact person#1	[Flux & Meteorology] Yasuko MIZOGUCHI (pop128@ffpri.affrc.go.jp)	
Contact person#2	[Flux & Meteorology] Katsumi YAMANOI (yamanoi@ffpri.affrc.go.jp)	
Contact person#3		
Contact person#4		

2. Site description

Hour line (Time difference from UTC)	Japan Standard Time (JST) (9 hours ahead of UTC)
Location (address)	Sapporo, Hokkaido, Japan
Position	42.9868N, 141.3853E (World Geodetic System 1984, GPS: Garmin eTrex Legend and map)
Elevation	182m above sea level (World Geodetic System 1984, GPS: Garmin eTrex Legend and map)
Terrain type	Gentle slope
Slope	0-7 degrees
Area	130 ha
Fetch	500-1500m
Climate	Cool temperate (Köppen climate classification: Dfb)
Mean annual air temperature	7.3 degree C (Mizoguchi et al., 2014, Tower site, 9 years (2000-2008) average)
Mean annual precipitation	1253 mm (Mizoguchi and Yamanoi, 2015, 4years (2009-2012) average)
Vegetation Type	Deciduous broadleaf forest
Dominant Species (Overstory)	Japanese white birch (<i>Betula platyphylla</i>), Mizunara oak (<i>Quercus crispula</i>), painted maple (<i>Acer mono</i>), aralia (<i>Kalopanax pictus</i>), Japanese linden (<i>Tilia japonica</i>), Japanese elm (<i>Ulmus davidiana</i> var. <i>japonica</i>)
Dominant Species (Understory)	Dwarf Bamboo (<i>Sasa senanensis</i> , <i>Sasa kurilensis</i>)
Canopy height	Approx. 20m
Breast high diameter	approx. 25 cm (Japanese White Birch)
Age	100years (in 2012)
LAI	approx. 5.7 in max. of 2000 and 2001 (Sato et al. 2004)
Soil Type	Black soil Bl _b (Andosol: WRB classification)
Other information	

References

Mizoguchi Y., Yamanoi K., Kitamuta K., Nakai Y., Suzuki S. (2014) Meteorological observations at the Sapporo forest meteorology research site from 1999 to 2008, Hokkaido, Japan. Bulletin of FFPRI, 13(4): 193-206. (in Japanese with English abstract)
Mizoguchi Y. and Yamanoi K. (2015) Error in the measurement of precipitation in Hitsujigaoka experimental forest: Influence of the difference in instrument type. Bulletin of FFPRI, 14(3): 145-146.(in Japanese)
Sato M., Utsugi H., Abe S., Iida M., Tanouchi H. (2004) The above ground biomass components of boreal deciduous forest in Northern Japan (II). –The estimation of seasonal changes in LAI-. (in Japanese)

3. Registered data

Observation items	Symbol	Unit	Height(s) Depth(s)	Instruments	Note
Date	DATE	-	-	-	yyyymmdd
Time	TIME	-	-	-	hhmm
Precipitation	PPT	mm	2.0m	B071 (Yokogawa)	See Note [1] (Mizozguchi et al. ,2014; Mizoguchi and Yamanoi, 2015)
Air temperature	Ta	degrees C	29.6m	HMP45D (VAISALA)	(Mizozguchi et al. ,2014)
Relative humidity	Rh	%	29.6m	HMP45D (VAISALA)	See Note [2] (Mizozguchi et al. ,2014)
Wind speed	U	$\text{m}\cdot\text{s}^{-1}$	29.6m	CYG5103 (YOUNG)	(Mizozguchi et al. ,2014)
Wind direction	WD	degrees	28.5m	DA600-3T (KAIJO)	(Mizozguchi et al. ,2014)
Global solar radiation (incoming / downward)	Sd	$\text{W}\cdot\text{m}^{-2}$	41.3m	CM-6F (Kipp & Zonen)	See Note [3],[5] (Mizozguchi et al. ,2014)
Reflected solar radiation (upward)	Su	$\text{W}\cdot\text{m}^{-2}$	39.0m	CM-6B (Kipp & Zonen)	See Note [3]
Photosynthetic active photon flux density (downward)	Pd	$\text{micromol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$	41.2m	LI190 (LI-COR)	See Note [3], [6]
Reflected PAR (upward)	Pu	$\text{micromol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$	39.0m	LI190 (LI-COR)	See Note [3], [6]
Net radiation	Rn	$\text{W}\cdot\text{m}^{-2}$	41.3m / 39.0m	CM-6F and CM-6B (Kipp & Zonen), PIR (Eppley)	See Note [4]
Soil heat flux	G	$\text{W}\cdot\text{m}^{-2}$	-0.02m	MF-81 (EKO)	
Sensible heat flux	H	$\text{W}\cdot\text{m}^{-2}$	28.5m		See Section 4
Latent heat flux	IE	NA	NA		
Friction velocity	Ust	$\text{m}\cdot\text{s}^{-1}$	28.5m-	DA600-3T (KAIJO)	See Section 4
CO ₂ flux	Fc	$\text{micromol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$	28.5m	LI-6262 (LI-COR)	Closed-path system See Section 4 (Yamanoi <i>et al.</i> , 2015)
Storage change in canopy air layer	Sc	$\text{micromol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$	29.6, 20.1, 16.3, 10.5, 3.6 m-	LI-6262 (LI-COR)	See Section 4 (Yamanoi <i>et al.</i> , 2015)

Net ecosystem exchange	NEE	$\text{micromol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$			Ust screening (Ust >= 0.31), Gap filled (Yamanoi <i>et al.</i> , 2015)
Ecosystem respiration	Re	$\text{micromol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$			Gap filled (Yamanoi <i>et al.</i> , 2015)
Gross primary production	GPP	$\text{micromol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$			GPP=-NEE+Re

Note

- [1] Observed at Hitsujigaoka meteorological observation field (42.9950N, 141.3906E, 146.5m a.s.l.).
- [2] Data of >100% is replaced by 100%.
- [3] Night time data is replaced by 0.0.
- [4] Summation of 4 elements (Sd, Su, Longwave radiation_downward and Longwave radiation_upward).
- [5] Instrumental error is corrected using the FFPRI standard sensor
- [6] Ageing deterioration is corrected

References

- Mizoguchi Y., Yamanoi K., Kitamuta K., Nakai Y., Suzuki S. (2014) Meteorological observations at the Sapporo forest meteorology research site from 1999 to 2008, Hokkaido, Japan. Bulletin of FFPRI, 13(4): 193-206.(in Japanese with English abstract)
- Mizoguchi Y. and Yamanoi K. (2015) Error in the measurement of precipitation in Hitsujigaoka experimental forest: Influence of the difference in instrument type. Bulletin of FFPRI, 14(3): 145-146.(in Japanese)
- Yamanoi K., Mizoguchi Y., Utsugi H. (2015) Effects of a windthrow disturbance on the carbon balance of a broadleaf deciduous forest in Hokkaido, Japan. Biogeosciences. 12: 6837-6851.

Data format

Data consists of fixed length (8 digits) comma separated format. Missing data is labeled as "-9999.0" or "-9999.00"

Line 1: Symbol (Date, Time, PPT, Ta,)

Line 2: Unit (yyyymmdd, hhmm, mm, degC,)

"hhmm" shows intermediate time of averaging period.

i.e. "1215" labels half-hourly average (or sum) of data from 12:00 to 12:30

Line 3: Comment

Line 4: Data

:

Data example

Date, Time, yyyymmdd, hhmm,	PPT, mm,	Ta, degC,	Rh, %,	U, ms-1,	WD, deg,	Sd, Wm-2,	Su, Wm-2,	Pd, (#1),	Pu, (#1),	.....
File= KWG_2000_001.CSV; Created: 20100326; Gap= -9999.0; (*1): micro-mol m-2 s-1										
20000101, 0015,	0.0,	3.34,	87.19,	1.58,	-9999.0,	0.1,	-9999.0,	0.1,	0.0,	.....
20000101, 0045,	0.0,	3.12,	88.14,	1.44,	-9999.0,	0.0,	-9999.0,	0.1,	0.0,	.....
20000101, 0115,	0.0,	2.36,	90.51,	1.15,	-9999.0,	-0.3,	-9999.0,	0.1,	0.0,	.....
20000101, 0145,	0.0,	2.14,	91.32,	0.83,	-9999.0,	0.0,	-9999.0,	0.1,	0.0,	.....
20000101, 0215,	0.0,	2.28,	88.96,	0.49,	-9999.0,	-0.3,	-9999.0,	0.1,	0.0,	.....
20000101, 0245,	0.0,	2.24,	89.82,	0.35,	-9999.0,	-0.2,	-9999.0,	0.2,	0.0,	.....
20000101, 0315,	0.0,	2.05,	89.49,	1.50,	-9999.0,	0.1,	-9999.0,	0.2,	-0.1,	.....
20000101, 0345,	0.0,	2.41,	87.25,	1.27,	-9999.0,	0.0,	-9999.0,	0.2,	0.0,	.....
20000101, 0415,	0.0,	2.31,	86.83,	1.12,	-9999.0,	-0.2,	-9999.0,	0.1,	0.0,	.....
20000101, 0445,	0.0,	2.84,	83.36,	0.54,	-9999.0,	-0.6,	-9999.0,	0.0,	0.0,	.....
20000101, 0515,	0.0,	2.53,	83.32,	1.23,	-9999.0,	0.2,	-9999.0,	0.2,	0.0,	.....
20000101, 0545,	0.0,	1.59,	87.54,	1.29,	-9999.0,	-0.6,	-9999.0,	0.0,	0.0,	.....
20000101, 0615,	0.0,	1.89,	85.13,	0.84,	-9999.0,	0.4,	-9999.0,	0.3,	0.0,	.....
20000101, 0645,	0.0,	1.77,	82.40,	0.83,	-9999.0,	3.5,	-9999.0,	8.5,	0.4,	.....
20000101, 0715,	0.0,	2.67,	76.83,	1.38,	-9999.0,	45.8,	-9999.0,	71.9,	11.6,	.....
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	

4. Observation and calculation

4-1. Flux observation system and data acquisition

Type of sonic anemometer	DA600-3T (Probe TR-61A) (KAIJO)
Type of IRGA	LI-6262, LI-COR
Sampling rate	5Hz
Averaging time	30min
Flux measurement height #1	28.5m
Zero-plane displacement	
Roughness length	
Calibration information	CO ₂ /H ₂ O gas analyzer was calibrated once a day by flowing standard gases that were automatically controlled.
Other information	

4-2. Flux calculation

Calculation methods		Note
Flow attenuation ^{*4-6}	Not applied	
Coordinate rotation ^{*1-3}	Applied	double rotation
Lag removal ^{*2, 7, 8}	Applied	automatic

4-3. Flux corrections

Correction methods		Target flux	Note
Cross wind correction ^{*9, 10}		sensible heat flux (H)	
Vapor correction		sensible heat flux (H)	
High frequency loss	Band-pass covariance method ^{*12}	CO ₂ flux (Fc)	
	Experimental approach ^{*2}		
Low frequency loss (Detrending)	Linear detrend ^{*16}	sensible heat flux (H), friction velocity (U _{st}), CO ₂ flux (Fc),	
WPL Correction ^{*17-21}		CO ₂ flux (Fc)	
Others ^{*22-24}	Temperature dependency for latent heat Humidity dependency for specific heat Temperature dependency for air density Pressure dependency for air density		

4-4. Quality control ^{*25-26}

QC methods				Note
Raw data test ^{*25,26}	Spike test ^{*27}		Applied	
	Absolute limits		Applied	
	Absolute variance		Applied	
	Higher-moment statistics	skewness	Applied	
		kurtosis	Applied	
	Discontinuities	Harr mean test	Applied	
		Harr variance test	Applied	
	Visual inspection		Applied	
Non steady state test ^{*25}			Not applied	
Absolute thresholds			Applied	
Others				

4-5. Storage term

Target storage		Note
CO ₂	From CO ₂ profile data (29.6, 20.1, 16.3, 10.5, 3.6 m) Sampling interval: 5 minutes at each height -	

References

Yamanoi K., Mizoguchi Y., Utsugi H. (2015) Effects of a windthrow disturbance on the carbon balance of a broadleaf deciduous forest in Hokkaido, Japan. Biogeosciences. 12: 6837-6851. Kitamura K., Nakai Y., Suzuki S., Ohtani Y., Yamanoi K., Sakamoto T. (2012) Interannual variability of net ecosystem production for a broadleaf deciduous forest in Sapporo, northern Japan. Journal of Forest Research, 17(3):323-332 MIZOGUCHI Yasuko, OHTANI Yoshikazu, YASUDA Yukio, TAKANASHI Satoru, NAKAI Yuichiro, IWATA Hiroki (2012) Seasonal and interannual variation in net ecosystem production of an evergreen needleleaf forest, Japan. Journal of Forest Research, 17(3):283-295

5. Important events

Date	Events
20 November 2009	Electric power outage due to facility maintenance

6. Publications relating to this site

- WATANABE Tsutomu, NAKAI Yuichiro, KITAMURA Kenzo, UTSUGI Hajime, TOBITA Hiroyuki, ISHIZUKA Shigehiro (2005) Scaling energy and CO₂ fluxes from leaf to canopy using a Multilayered Implementation for Natural Canopy-Environment Relations (MINCER). *Phyton*, 45:353-360
- NAKAI Yuichiro, KITAMURA Kenzo, SUZUKI Satoru, ABE Shin (2003) Year-long carbon dioxide exchange above a broadleaf deciduous forest in Sapporo, Northern Japan. *Tellus B*, 55(3):305-312
- SUZUKI Satoru, ISHIZUKA Shigehiro, KITAMURA Kenzo, YAMANOI Katsumi, NAKAI Yuichiro (2006) Continuous estimation of winter carbon dioxide efflux from the snow surface in a deciduous broadleaf forest. *Journal of Geophysical Research*, 111:D17101
- KITAMURA Kenzo, NAKAI Yuichiro, SUZUKI Satoru, OHTANI Yoshikazu, YAMANOI Katsumi, SAKAMOTO Tomoki (2012) Interannual variability of net ecosystem production for a broadleaf deciduous forest in Sapporo, northern Japan, *Journal of Forest Research*, 17(3): 323-332..
- KITAMURA Kenzo, NAKAI Yuichiro, SUZUKI Satoru, OHTANI Yoshikazu, YAMANOI Katsumi, SAKAMOTO Tomoki (2012) Interannual variability of net ecosystem production for a broadleaf deciduous forest in Sapporo, northern Japan, *Journal of Forest Research*, 17(3):323-332.
- MIZOGUCHI Yasuko, YAMANOI Katsumi, KITAMURA Kenzo, NAKAI Yuichiro, SUZUKI Satoru (2014) Meteorological observations at the Sapporo forest meteorology research site from 1999 to 2008, Hokkaido, Japan. *Bulletin of FFPRI*, 13(4): 193-206. (in Japanese with English abstract)
- YAMANOI Katsumi, MIZOGUCHI Yasuko, UTSUGI Hajime (2015) Effects of a windthrow disturbance on the carbon balance of a broadleaf deciduous forest in Hokkaido, Japan. *Biogeosciences*. 12: 6837-6851.
- MIZOGUCHI Yasuko, YAMANOI Katsumi (2015) Forty-year meteorological statistics of thee Hitsujigaoka Experimental Forest. *Bulletin of FFPRI*, 14(4): 209-218. (in Japanese with English abstract)

Publication list: http://www2.ffpri.affrc.go.jp/labs/flux/paper_e.html[SAP]

References cited

Flux calculation

- *1 McMillen, R.T., 1988. *Boundary-Layer Meteorology*, 43: 231-245.
- *2 Aubinet M. et al., 2000. *Advances in Ecological Research*, 30: 113-175.
- *3 Wilczak, J.M., Oncley, S.P. and Stage, S.A., 2001. *Boundary-Layer Meteorology*, 99: 127-150.
- *4 Wyngaard, J. C. and Zhang, S. F., 1985. *J. Atmos. Oceanic Tech.*, 2: 548-558.
- *5 Kaimal, J.C. et al., 1990. *Boundary-Layer Meteorol.*, 53: 103-115.
- *6 Shimizu, T. et al., 1999. *Boundary-Layer Meteorol.*, 64: 227-236.
- *7 Leuning, R. and Judd M.J., 1996. *Global Change Biology*, 2: 241-254.
- *8 Information from Li-Cor

Flux correction

- *9 Schotanus, P. et al., 1983. *Boundary-Layer Meteorology*, 26: 81-93.
- *10 Liu, H., Peters, G. and Foken, T., 2001. *Boundary-Layer Meteorology*, 100: 459-468.
- *11 Kaimal J.C. and Gaynor, J.E., 1991. *Boundary-Layer Meteorology*, 56: 401-410.
- *12 Watanabe et al., 2000. *Boundary-Layer Meteorol.* 96, 743-491.
- *13 Massman, W. J., 2000. *Agric. For. Meteorol.* 104, 185-198
- *14 Massman, W. J., 2001. *Agric. For. Meteorol.* 107, 247-251
- *15 Moore, C.J., 1986. *Boundary-Layer Meteorology*, 37: 17-35.
- *16 Moncrieff, J. et al., 2004. Averaging, detrending and filtering of eddy covariance time series. In: X. Lee (Editor), *Handbook of Micrometeorology: A guide for surface Flux Measurements*. Kluwer, Dordrecht, pp. 7-31.
- *17 Webb, E. K., Pearman, G.I. and Leuning, R., 1980. *Quarterly Journal of the Royal Meteorological Society*, 106: 85-100.
- *18 Fuehrer, P.L. and Friehe, C.A., 2002. *Boundary-Layer Meteorology*, 102: 415-457.
- *19 Liebethal, C. and Foken, T., 2003. *Boundary-Layer Meteorology*, 109: 99-106.
- *20 Leuning, R. 2004. Measurements of trace gas fluxes in the atmosphere using eddy covariance: WPL corrections revisited. In: X. Lee (Editor), *Handbook of Micrometeorology: A guide for surface Flux Measurements*. Kluwer, Dordrecht, pp. 119-132.
- *21 Massman, W. 2004. Concerning the measurement of atmospheric trace gas fluxes with open- and closed-path eddy covariance system: The WPL terms and spectral attenuation. In: X. Lee (Editor), *Handbook of Micrometeorology: A guide for surface Flux Measurements*. Kluwer, Dordrecht, pp. 133-160.
- *22 Fischer, G (Editor), 1988. *Landolt-Börnstein, Numerical data and functional relationships in science and technology, Group V: Geophysics and space research, Volume 4: Meteorology Subvolume b: Physical and chemical properties of the air*. Springer, Berlin, Heidelberg, 570pp.
- *23 Stull, R.B., 1988. *An Introduction to Boundary Layer meteorology*. Kluwer Acad. Publ., Dordrecht, Boston, London, 666pp.
- *24 Cohen, E. R. and Taylor, B. N., 1986. The 1986 adjustment of the fundamental physical constants. International Council of Scientific Unions (ICSU), Committee on Data for Science and Technology (CODATA). CODATA-Bulletin, No. 63: 36pp.

Quality control

- *25 Vickers, D. and Mahrt, L., 1997. *Journal of Atmospheric and Oceanic Technology*, 14: 512-526.
- *26 Foken, T. and Wichura, B., 1996. *Agricultural and Forest Meteorology*, 78: 83-105.
- *27 Hojstrup, J., 1993. *Measuring Science Technology*, 4: 153-157.
- *28 Schmid, H. P., 1994. *Boundary-Layer Meteorology*, 67: 293-318.
- *29 Korman, R. and Meixner, F.X., 1990. . *Boundary-Layer Meteorology*, 99: 207-224.