1. About the data set

Site name (AsiaFlux three letter code)	Appi forest meteorology research site (API)
Period of registered data	From January 1, 2005 to December 31, 2005
This document file name	API_2005_004a.pdf
Corresponding data file name	API_2005_004.csv

Revision information

Date	Details of revision	Renewed file name
31 March 2011	First registration	API_2005_001a.pdf API_2005_001.csv
18 May 2011	Document file is updated: p.9: Publication list is updated	API_2005_001b.pdf
23 June 2011	Second registration: NEE, Re and GPP (all Gap-filled) are added Document file is updated: p.2: Site description is updated	API_2005_002a.pdf API_2005_002.csv
24 November 2011	Document file is updated: p.3: Measurement heights of Ust and Fc are corrected	API_2005_002b.pdf
15 May 2012	Document file is updated: p.9, line2: Publication information is updated.	API_2005_002c.pdf
31 July 2012	Document file is updated: p.1: Details in each revision are added. p.2 and 7: Publication information is updated.	API_2005_002d.pdf
20 April 2017	Third registration: lE is added.	API_2005_003a.pdf API_2005_003.csv
21 August 2017	Forth registration: G data in version 003 is corrected.	API_2005_004a.pdf API_2005_004.csv

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Contact person#3	

2. Site description

Hour line (Time difference from UTC)	Japan Standard Time(JST) (9 hours ahead of UTC)
Location (address)	Hachimantai, Iwate, Japan
Position	40.0001N, 140.9375E (World Geodetic System 1984)
Elevation	825m above sea level (World Geodetic System 1984)
Terrain type	Gentle slope
Slope	5-6 degrees
Area	43.5ha
Fetch	200-600m
Climate	Cool temperate (Köppen climate classification: (Snow-fully humid-warm summer [Dfb])
Mean annual air temperature	5.9 degree (2000-2006; Yasuda *et al,.* 2012)
Mean annual precipitation	2029 mm (2007-2009; Yasuda *et al.,* 2012)
Vegetation Type	Boreal deciduous broadleaf forest
Dominant Species (Overstory)	*Fagus crenata* (Japanese beech)
Dominant Species (Understory)	-
Canopy height	Approx. 20m (in 2009)
Aboveground forest biomass	130-140tCha^{-1} (Hoshino *et al*., in preparation; Yasuda *et al.,* 2012)
Age	70-80years
Mean max. LAI	4.8 (2000-2006; Hoshino *et al*., in preparation; Yasuda *et al.,* 2012)
Soil Type	Andosol (Ishizuka *et al.,* 2006; Hashimoto *et al.,* 2009) Brown forest soil $B_{D(d)}$ (Yasuda *et al.,* 2012)
Other information	

References

ONO Kenji, YASUDA Yukio, MATSUO Tooru, HOSHINO Daisuke, CHIBA Yukihiro, MORI Shigeta (2013) Estimating forest biomass using allometric model in a cool-temperate Fagus crenata forest in the Appi Highlands, Iwate, Japan. Bulletin of Forestry and Forest Products Research Institute, 12(3), 125-141

YASUDA Yukio, SAITO Takeshi, HOSHINO Daisuke, ONO Kenji, OHTANI Yoshikazu, MIZOGUCHI Yasuko, MORISAWA Takeshi (2012) Carbon balance in a cool-temperate deciduous forest in northern Japan: seasonal and interannual variations, and environmental controls of its annual balance, Journal of Forest Research, 17(3): 253-267.

ISHIZUKA Shigehiro, SAKATA Tadashi, SAWATA Satoshi, IKEDA Shigeto, TAKENAKA Chisato, TAMAI Nobuaki, SAKAI Hisao, SHIMIZU Takanori, KAN-NA Kensaku, ONODERA Shinichi, TANAKA Nagaharu, TAKAHASHI Masamichi (2006): High potential for increase in CO_2 flux from forest soil surface due to global warming in cooler areas of Japan. Annals of Forest Science, 63(5):537-546.

HASHIMOTO Toru, MIURA Satoru, ISHIZUKA Shigehiro (2009) Temperature controls temporal variation in soil CO_2 efflux in a secondary beech forest in Appi Highlands, Japan. Journal of Forest Research, 14:44-50

HOSHINO Daisuke *et al*. (in preparation)

3. Registered data

Observation items	Symbol	Unit	Height(s) Depth(s)	Instruments	Note
Date	DATE	-	-	-	yyyymmdd
Time	TIME	-	-	-	hhmm
Precipitation	PPT	NA	NA	NA	(Yasuda *et al*., 2012)
Air temperature	Ta	degrees C	31.0m	HMP45D (VAISALA)	(Yasuda *et al*., 2012)
Relative humidity	Rh	%	31.0m	HMP45D (VAISALA)	See Note [1] (Yasuda *et al*., 2012)
Wind speed	U	$m \cdot s^{-1}$	31.0m	WM30P (IKEDA)	
Wind direction	WD	NA	NA	NA	
Global solar radiation (incoming / downward)	Sd	$W \cdot m^{-2}$	31.0m	CM6F (Kipp & Zonen)	See Note [2] (Yasuda *et al*., 2012)
Reflected solar radiation (upward)	Su	$W \cdot m^{-2}$	31.0m	CM6B (Kipp & Zonen)	See Note [2]
Photosynthetic active photon flux density (downward)	Pd	micromol$\cdot m^{-2} \cdot s^{-1}$	31.0m	LI190 (LI-COR)	See Note [2] (Yasuda *et al*., 2012)
Reflected PAR (upward)	Pu	micromol$\cdot m^{-2} \cdot s^{-1}$	31.0m	LI190 (LI-COR)	See Note [2]
Net radiation	Rn	$W \cdot m^{-2}$	31.0m	CM6F and CM6B (Kipp & Zonen), PIR (Eppley)	See Note [3]
Soil heat flux	G	$W \cdot m^{-2}$	-0.02m	MF-81 (EKO)	Average of 2 points
Sensible heat flux	H	$W \cdot m^{-2}$	31.0m	DA-600-3T (KAIJO)	
Latent heat flux	lE	$W \cdot m^{-2}$	31.0m	DA-600-3T (KAIJO) HMP45A (VAISALA)	
Friction velocity	Ust	$m \cdot s^{-1}$	31.0m	DA-600-3T (KAIJO)	
CO_2 flux	Fc	micromol$\cdot m^{-2} \cdot s^{-1}$	31.0m	DA-600-3T (KAIJO) LI-6262 (LI-COR)	Closed-path system, See 4-4 for QC (Yasuda *et al*., 2012)
Storage change in canopy air layer	Sc	micromol$\cdot m^{-2} \cdot s^{-1}$	31, 24, 20, 18, 15, 12, 9, 3 m	LI-6262 (LI-COR)	See 4-5, (Yasuda *et al*., 2012)
Net ecosystem exchange	NEE	micromol$\cdot m^{-2} \cdot s^{-1}$	-	-	NEE=Fc+Sc Gap filled (Yasuda *et al*.,

					2012)
Ecosystem respiration	Re	micromol·m^{-2}·s^{-1}	-	-	Gap filled (Yasuda *et al.*, 2012)
Gross primary production	GPP	micromol·m^{-2}·s^{-1}	-	-	GPP=-NEE+Re

Note

[1] data of >100% is replaced by 100%
[2] night time data is replaced by 0.0.
[3] 4 elements (Sd, Su, Longwave radiation_downward and Longwave radiation_upward)

Gap filling

NEE	$F_{\mathrm{NEE,day}}=\frac{-\phi Q-P_{\max}+\sqrt{(\phi Q+P_{\max})^2-4\phi Q\,\theta P_{\max}}}{2\theta}+R_{\mathrm{d}}$ Parameters were derived daily, using the 7-day moving window for the 4 weeks after bud burst and before a completely yellow-tinged canopy, and, the 15-day window for the rest of period.
Re	$F_{\mathrm{NEE,night}}=F_{\mathrm{RE},T_{\mathrm{ref}}}\exp\left[E_0\left(\frac{1}{T_{\mathrm{ref}}-T_0}-\frac{1}{T_{\mathrm{a}}-T_0}\right)\right]$ Parameter $F_{RE,T}$ was derived daily using the 21-day moving window, E_0 were determined for each period: growing, snow and defoliation (non-snow) seasons.

References

YASUDA Yukio, SAITO Takeshi, HOSHINO Daisuke, ONO Kenji, OHTANI Yoshikazu, MIZOGUCHI Yasuko, MORISAWA Takeshi (2012) Carbon balance in a cool-temperate deciduous forest in northern Japan: seasonal and interannual variations, and environmental controls of its annual balance, Journal of Forest Research, 17(3): 253-267.

Data format

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

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

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    Date, Time,      PPT,       Ta,       Rh,        U,       WD,       Sd,       Su,       Pd,       Pu, ...........
yyyymmdd, hhmm,       mm,     degC,        %,     ms-1,      deg,     Wm-2,     Wm-2,    (*1),     (*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,     0.94, -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, ...........
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4. Observation and calculation

4-1. Flux observation system and data acquisition

Type of sonic anemometer	DA600-3T (KAIJO)
Type of IRGA	LI-6262, LI-COR
Sampling rate	10Hz
Averaging time	30 min
Flux measurement height #1	31.0m
Zero-plane displacement	
Roughness length	
Calibration information	Once a day using zero and standard CO_2 gases
Other information	

4-2. Flux calculation

Calculation methods		Note
Flow attenuation [*4-6]	applied	
Coordinate rotation [*1-3]	applied	double rotation
Lag removal [*2, 7, 8]	applied	manual

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]	latent heat flux (lE)	
	Experimental approach [*2]		
High frequency loss	Band-pass covariance method [*25]	CO_2 flux (Fc)	
	Experimental approach [*2]		
Low frequency loss (Detrending)	Linear detrend [*16]	sensible heat flux (H), friction velocity (Ust), CO_2 flux (Fc),	
WPL Correction [*17-21]		(Not applied)	
Others [*22-24]			

4-4. Quality control [26-27]

QC methods				Note
Raw data test [26,27]	Spike test [28]		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[26]			Not applied	
Absolute thresholds			Applied	
Others				

4-5. Storage term

Target storage		Note
CO_2	[from the initiation to 2008-06-13] CO_2 profile data (31, 24, 20, 18, 15, 12, 9, 3 m) Sampling interval: 2 minute at each height ([from 2008-06-13 to 2009-11-24] CO_2 profile data (31, 24, 20, 18, 15, 12, 9, 3 m) Sampling interval: 1 minute at each height [from 2009-11-24 to the present] CO_2 profile data (31, 25, 23, 21, 15, 12, 9, 3 m) Sampling interval: 1 minute at each height	(Yasuda *et al*., 2012)

References

YASUDA Yukio, SAITO Takeshi, HOSHINO Daisuke, ONO Kenji, OHTANI Yoshikazu, MIZOGUCHI Yasuko, MORISAWA Takeshi (2012) Carbon balance in a cool-temperate deciduous forest in northern Japan: seasonal and interannual variations, and environmental controls of its annual balance, Journal of Forest Research, 17(3): 253-267.

5. Important event

Date	Events
	Data of Ta, Rh, U, Pd and Pu are not available during winter season.

6. Publications relating to this site

YASUDA Yukio, SAITO Takeshi, HOSHINO Daisuke, ONO Kenji, OHTANI Yoshikazu, MIZOGUCHI Yasuko, MORISAWA Takeshi (2012) Carbon balance in a cool-temperate deciduous forest in northern Japan: seasonal and interannual variations, and environmental controls of its annual balance, Journal of Forest Research, 17(3):253-267.

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Flux calculation

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Flux correction

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Quality control

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