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1. General Information

Site name (three letter code)	Fuji Hokuroku Flux Observation Site (FHK)
Researcher #1 (e-mail)	[Flux and micrometeorology] Ryuichi Hirata (hirata.ryuichi@nies.go.jp)
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Researcher #2 (e-mail)	[Flux and micrometeorology] Yoshiyuki Takahashi (yoshiyu@nies.go.jp)
Researcher #3 (e-mail)	[Soil respiration] Naishen Liang (liang@nies.go.jp)
Other Researchers (e-mail)	
Observation period	From January 2006 to present
Measurement frequency	Continuous
Infrastructure	Tower: 35 m Electrical power: (AC) Facilities for communication (Internet communication is available) Accommodation (none)
Research fund #1	Global Environmental Monitoring funded by National Institute for Environmental Studies
Research fund #2	Global Environmental Research Coordination System from Ministry of the Environment of Japan (NOU0751, NOU1251, NOU2254)
Research fund #3	Global Environment Research Fund from Ministry of the Environment of Japan (B-3)
Research fund #4	Environment Research and Technology Development Fund from Ministry of the Environment of Japan (2-1705, 2-2006)
URL	https://db.cger.nies.go.jp/gem/en/flux/fuji.html
Other information	

2. Site description

Site name (three letter code)	Fuji Hokuroku Flux Observation Site (FHK)
Country	Japan
Location	Fujiyoshida City, Yamanashi Pref.
Latitude and Longitude (first decimal of second precision), Elevation (geographic coordinates, surveying method)	35.443556°N, 138.764693ºE (1050-1150 m above sea level) Revised 8th Jan. 2025
Slope	3-4 deg
Terrain Type	Flat
Area	150 ha
Fetch	
Climate (Köppen Climate Classification)	Cfa: Temperate – mild with no dry season, hot summer
Mean annual air temperature	8.9 deg C (2006-2023, at a height of 2 m)
Mean annual precipitation	1831 mm (2006-2023)
Vegetation Type	Deciduous needleleaf forest (Japanese larch afforestation)
Dominant Species (Overstory)	Japanese larch (*Larix kaempferi Sarg.*), evergreen needle-leafed species (*Pinus densiflora* and *Abies homolepis*), deciduous broad-leafed species (*Swida controversa, Quercus serrata, Quercus crispula, Betula platyphylla var. japonica, Prunus incisa,* etc.)
Dominant Species (Understory)	Ferns (*Dryopteris crassirhizoma*, *Dryopteris expansa*), bamboo grass (*Sasamorpha borealis*), and other herbs.
Canopy height	20-26 m
Age	Around 70 years old (Planted around 1950)
LAI	Larch: 2.88 m^2 m^{-2} estimated based on the leaf mass abundance (Okano & Arase 2007), and 2.4 m^2 m^{-2} estimated based on 3D portable laser scanner measurement (Maki et al., 2012), Understory: 3.0 m^2 m^{-2} (max) After thinning, the tree LAI was 2.31 in 2016.
Disturbance	As the first thinning, approximately 36% of the larch trees located more than 20 meters away from the observation tower were cut down in May 2014. The second thinning was carried out near the observation tower in March 2015. Between 2014 and 2015, approximately 39% of the larch trees were cut down, reducing the forest density from 409 trees per hectare in 2013 to 249 trees per hectare in 2015. The harvested timber and above-ground residues were removed from the site.
Soil type	Coarse volcanic ash (Urakawa et al., 2015)

3. Measurement Item

3-1. Meteorology

Observation items	Levels / Depth	Instrument
Global solar radiation (incoming)	32 m, 30 m	Pyranometer (32m): MS-402F, Eko, Japan (Jan. 2006 – Apr. 15, 2015); CMP6, Kipp&Zonen, Netherland (Apr. 15, 2015 -), Radiometer (30m): MR-50, Eko, Japan (Jan. 2006 to Nov.16, 2015); NR01, Hukseflux, Netherland (Nov.16, 2015-)
Transmitted solar radiation (below canopy incoming)	2 m (five points) 2 m (two points)	Pyranometer (five points): MS-601, Eko, Japan (Jan. 2006 – Apr. 15, 2015); CMP6, Kipp&Zonen, Netherland (Apr. 15, 2015 -), Radiometer: MR-50, Eko, Japan (Jan. 2006 – Apr. 12, 2018; Jan. 2006 – Apr. 10, 2017); NR01, Hukseflux, Netherland (Apr.12, 2018-; Apr. 10, 2017-)
Global solar radiation (outgoing)	30 m	Radiometer: MR-50, Eko (Jan. 2006 – Nov.16, 2015); NR01, Hukseflux, Netherland (Nov.16, 2015 -)
Transmitted solar radiation (below canopy outgoing)	2 m (two points)	Radiometer: MR-50, Eko (Jan. 2006 – Apr. 12, 2018; Jan. 2006 – Apr. 10, 2017); NR01, Hukseflux, Netherland (Apr.12, 2018-; Apr. 10, 2017-)
Long-wave radiation (incoming)	30 m	Radiometer: MR-50, Eko (Jan. 2006 – Nov.16, 2015); NR01, Hukseflux, Netherland (Nov.16, 2015-)
Transmitted long-wave radiation (below canopy incoming)	2 m (two points)	Radiometer: MR-50, Eko (Jan. 2006 – Apr. 12, 2018; Jan. 2006 – Apr. 10, 2017); NR01, Hukseflux, Netherland (Apr.12, 2018-; Apr. 10, 2017-)
Long-wave radiation (outgoing)	30 m	Radiometer: MR-50, Eko (Jan. 2006 – Nov.16, 2015); NR01, Hukseflux, Netherland (Nov.16, 2015-)
Transmitted long-wave radiation (below canopy outgoing)	2 m (two points)	Radiometer: MR-50, Eko (Jan. 2006 – Apr. 12, 2018; Jan. 2006 – Apr. 10, 2017); NR01, Hukseflux, Netherland (Apr.12, 2018-; Apr. 10, 2017-)
Net radiation	30 m	Radiometer: MR-50, Eko (Jan. 2006 – Nov.16, 2015); NR01, Hukseflux, Netherland (Nov.16, 2015-)
Net radiation	2 m (two points)	Radiometer: MR-50, Eko (Jan. 2006 – Apr. 12, 2018; Jan. 2006 – Apr. 10, 2017); NR01, Hukseflux, Netherland (Apr.12, 2018-; Apr. 10, 2017-)
PPFD (incoming)	32 m	Quantum sensor: LI-190S, LI-COR (Jan 2006 – Apr. 16, 2015); LI-190S, LI-COR encased in a weather-proof external housing with a glass dome (Apr. 16, 2015 -) (Akitsu *et al.*, 2020); ML-020P, Eko, Japan (Jan.2006 – Apr. 15, 2013); SQ-110, Apogee, USA (Apr. 15, 2013 -)
Transmitted PAR (below canopy incoming)	2 m (five points)	Quantum sensor: LI-190S, LI-COR (Jan.2006-Mar.2007); ML-020P, Eko (Mar.2007- Apr. 15, 2013); SQ-110, Apogee, USA (Apr. 15, 2013 -)

Reflected PAR (outgoing)	30 m	Quantum sensor: LI-190S, LI-COR (Jan.2006-Mar.2007); ML-020P, Eko (Mar.2007- Apr. 15, 2013); SQ-110, Apogee, USA (Apr. 15, 2013 -); LI-190S, LI-COR encased in a weather-proof external housing with a glass dome (Apr. 12, 2018 -) (Akitsu *et al.*, 2020)
Reflected PAR (below canopy outgoing)	2 m (three points)	Quantum sensor: LI-190S, LI-COR (Jan.2006-Mar.2007); ML-020P, Eko (Mar.2007- Apr. 15, 2013); SQ-110, Apogee, USA (Apr. 15, 2013 -)
Wind direction	35 m	Three-dimensional sonic anemometer-thermometer: DA-600-3TV, Probe TR-61C, SONIC CORP. (Jan. 1, 2006 – May 9, 2011); DA-650, Probe TR-61C, SONIC CORP. (May 9, 2011 – Nov. 22, 2011); DA-600-3TV, Probe TR-61C, SONIC CORP. (Nov. 22, 2011 – Apr. 18, 2012); DA-700-3TV, Probe TR-61A, SONIC CORP. (Apr. 18, 2012 – Apr. 11, 2016); CSAT3, Campbell Scientific, USA (Apr. 14, 2014-)
	32, 27, 22, 16, 10, 4.5, 2 m	Sonic anemometer: MA-130A, Eko, Japan (Jan.2006-Mar.2007); PGWS-100-3, GILL (Apr.2007-)
Wind speed	35 m	Three-dimensional sonic anemometer-thermometer: DA-600-3TV, Probe TR-61C, SONIC CORP. (Jan. 1, 2006 – May 9, 2011); DA-650, Probe TR-61C, SONIC CORP. (May 9, 2011 – Nov. 22, 2011); DA-600-3TV, Probe TR-61C, SONIC CORP. (Nov. 22, 2011 – Apr. 18, 2012); DA-700-3TV, Probe TR-61A, SONIC CORP. (Apr. 18, 2012 – Apr. 11, 2016); CSAT3, Campbell Scientific, USA (Apr. 14, 2014-)
	32, 27, 22, 16, 10, 4.5, 2 m	Sonic anemometer: MA-130A, Eko, Japan (Jan.2006-Mar.2007); PGWS-100-3, GILL (Apr.2007-)
Air temperature	32, 27, 22, 16, 10, 4.5, 2, 1, 0.5 m	Platinum resistance thermometer and capacitive hygrometer: HMP-45D, Vaisala (Jan. 2006-Apr. 12, 2011); HMP155, Vaisala (Apr. 12, 2011-) coupled with aspirated radiation shield, CPR-AS-21, Climatec, Japan.
Relative humidity	32, 27, 22, 16, 10, 4.5, 2, 1, 0.5 m	Platinum resistance thermometer and capacitive hygrometer: HMP-45D, Vaisala (Jan. 2006-Apr. 12, 2011); HMP155, Vaisala (Apr. 12, 2011-) coupled with a fan-aspirated radiation shield, CPR-AS-21, Climatec, Japan.
Soil temperature	0, 0.02, 0.05 m (three points), 0.15, 0.3, 0.6 m	Platinum resistance thermometer: C-PTWP, Climatec, Japan
Ground heat flux	0.02 m (three points)	Heat flux plate: PHF-01, REBS
Soil water content	0m (three points), 0.1, 0.2 m (two points)	TDR sensor: CS616, Campbell
Barometric pressure	1.5 m	Barometer: PTB210, Vaisala

Precipitation	32 m	Tipping-bucket rain gauge with heater, CYG-52202, R. M. Young
Snow depth	2 m	Sonic ranging sensor: SR50, Campbell
Spectral radiation (incoming) Global, direct/diffuse, transmitted	32, 2 m	Spectroradiometer: MS-700, Eko, Japan wiith shadow band (32 m; PRB-100, PREDE, Japan)
Spectral radiation reflected, transmitted (outgoing)	30m	Spectroradiometer: MS-700, Eko, Japan (Jan. 2006-Apr. 15, 2014); MS-700 with automated masking device to exclude contaminated reflection (Apr. 15, 2014-) (Ide et al.,2016))
Spectral radiation reflected, transmitted (outgoing, below canopy)	2 m	Spectroradiometer: MS-700, Eko, Japan (Jan. 2006-)
CO_2 concentration	35, 32, 27, 22,16,10,4.5,2,1, 0.5 m	Closed-path CO_2/H_2O analyzer: LI-6262, LI-COR (Mar. 2006-Jul. 2010)

3-2. Eddy covariance method　(CO_2)

System	Open- and closed-path systems (CO_2 flux, latent heat flux)
Wind speed	Three-dimensional sonic anemometer-thermometers: DA-600-3TV, Probe TR-61C, SONIC CORP. (Jan. 1, 2006 – May 9, 2011); DA-650-3TV, Probe TR-61C, SONIC CORP. (May 9, 2011 – Nov. 22, 2011); DA-600-3TV, Probe TR-61C, SONIC CORP. (Nov. 22, 2011 – Apr. 18, 2012); DA-700-3TV, Probe TR-61A, SONIC CORP. (Apr. 18, 2012 – Apr. 11, 2016); CSAT3, Campbell Scientific. (Apr. 14, 2014 -)
Air temperature	Platinum resistance thermometer and capacitive hygrometer: HMP45A, Vaisala (Jan. 2006 – May. 9, 2011); HMP155A, Vaisala (May. 9, 2011 -) coupled with aspirated radiation shield, CPR-AS-21, Climatec, Japan.
Water vapor	Open-path CO_2/H_2O analyzer: LI-7500, LI-COR (Jan. 1, 2006 –) Closed-path CO_2/H_2O analyzers: LI-6262, LI-COR (Jan. 1, 2006 – Apr. 11, 2016); LI-7000, LI-COR (Jan. 1, 2012 – Apr. 11, 2016) Platinum resistance thermometer and capacitive hygrometer: HMP45A, Vaisala (Jan. 2006 – May. 9, 2011); HMP155A, Vaisala (May. 9, 2011 -) coupled with aspirated radiation shield, CPR-AS-21, Climatec, Japan.
CO_2	Open-path CO_2/H_2O analyzer: LI-7500, LI-COR (Jan. 1, 2006 –) Closed-path CO_2/H_2O analyzers: LI-6262, LI-COR (Jan. 1, 2006 – Apr. 11, 2016); LI-7000, LI-COR (Apr. 19, 2012–)
Measurement height	35m
Sampling frequency	10 Hz
Averaging time	30 min
Data logger	DR-M3, TEAC, Japan (Jan. 2006 – March 2012); CR-23X, Campbell Scientific, USA (Jan. 2006 – April 2008); CR-3000, Campbell Scientific, USA (May 2008-)
Data storage	Magneto-Optical Disk (TEAC); Data-logger CR-3000, Campbell Scientific, USA
Original data (Raw data or statistics)	Raw data

3-3. Fluxes of non-CO_2 gases

Gas	CH_4
Method	Hyperbolic relaxed eddy accumulation (HREA) method with a laser-based analyzer (GGA-24r-EP, Los Gatos Research Inc., USA), from Aug. 2011 to Sep. 2012 (Ueyama et al., 2013) Automated dynamic closed (non-steady-state through-flow) chambers with a laser-based analyzer (GGA-24r-EP), from Oct. 2012 (Ueyama *et al.*, 2015)
Measurement height	35, 28, 18, 5, and 0.3 m (HREA method), 0 m (chambers)
Data logger	Laptop PC via serial communication
Data storage	

3-4. Soil respiration

Measurement method	Automated dynamic closed chamber method (flow-through, non-steady-state design using IRGA and Integrated Cavity Output Spectroscopy (CH_4/CO_2))
Reference(s) for method (if have)	Teramoto M., Liang N., Takahashi Y., Zeng J., Saigusa N., Ide R., Zhao X., 2019: Enhanced understory carbon flux components and robustness of net CO_2 exchange after thinning in a larch forest in central Japan. *Agricultural and Forest Meteorology*, 274, 106–117. Teramoto M., Liang N., Zeng J., Saigusa N., Takahashi Y., 2017: Long-term chamber measurements reveal strong impacts of soil temperature on seasonal and inter-annual variation in understory CO_2 fluxes in a Japanese larch (*Larix kaempferi Sarg.*) forest. *Agricultural and Forest Meteorology*, 247, 194–206.
Measuring system	A 24-channel automated chamber system (home-made by the investigator)
IRGA Integrated Cavity Output Spectroscopy	Li-820 (Li-Cor) UGGA (LGR)
Flow control	High-precision flow transducer (FSM-V, CKD) and manual flow regulator
Chamber type	Clear PVC chamber
Chamber size	90 cm in length × 90 cm in width ×50 cm in height (8 chambers for soil respiration and 8 chambers for heterotrophic respiration), and 90 cm in length × 90 cm in width × 100 cm in height (8 chambers for net understory CO_2 exchange).
Number of chambers	24
Measuring intervals	The measurement period, during which the chamber lids were closed, was 2.5 min for each chamber with data recorded at 10-s intervals using CR1000 datalogger (Campbell Scientific Inc.) from 2006 to 2009. The measurement period was 5.0 min from 2010 on.
Is the ground covered by snow in winter? (if yes, how about the measurement in winter?	Yes. Missing soil CO_2 efflux data (gaps) during snow covered period were estimated based on Lloyd and Taylor equation for each chamber.
Original data (Raw data or statistics)	Raw data
Air temperature collection (if done, which temperature was used?)	Air temperature inside each chamber was measured using the home-made T-Type thermocouple.
Soil temperature collection (if done, which temperature was used?)	Soil temperature at the depth of 5-cm inside each chamber was measured using the home-made T-Type thermocouple.
Air pressure collection (if done, which sensor was used?)	Air pressure was measured using PX2760 (Omega Engineering).

Understory PPFD collection	6 sensors (SQ225; Apogee Instruments Inc.) at the height of 1 m around plant chambers
Soil moisture collection (if done, which sensor was used?)	6 CS616 (Campbell Scientific Inc.) were used for monitoring soil moisture at the depth of 10 cm in 6 randomly selected chambers (two chambers for each treatment).

3-5. Other

Photosynthesis	Occasionally
Ecological Investigation	Tree heights (every 5 years), stand density (annual), diameter (annual), biomass, LAI
Phenology	Continuous (photos)

4. Note (e. g. calibration information, Publications)

Calibration information

Open-path analyzers were calibrated approximately every two months with standard CO_2 gases and a dew point generator (LI610, LI-COR).

The gain of CO_2 of the closed-path analyzers was checked once a day by flowing two standard CO_2 gases of 320 ppmv and 420 ppmv that were automatically controlled using a programmable data logger (CR23X during 2006-mid-2007 and CR3000 after that, both were made by Campbell Scientific, Logan, UT, USA.

Publications

Okano T., Arase T. 2007: Biomass measurement of larch forest in Fuji Hokuroku Flux Research Site, *Annual Report of Global Environment Monitoring H19*, Center for Global Environmental Research, National Institute for Environmental Studies. (in Japanese)

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Urakawa R., Ohte N., Shibata H., Isobe K., Tateno R., Oda T., Hishi T., Fukushima K., Inagaki Y., Hirai K., Oyanagi N., Nakata M., Toda H., Kenta T., Kuroiwa M., Watanabe T., Fukuzawa K., Tokuchi N., Ugawa S., Enoki T., Nakanishi A., Saigusa N., Yamao Y., Kotani A. 2016: Factors contributing to soil nitrogen mineralization and nitrification rates of forest soils in the Japanese archipelago. *Forest Ecology and Management*, 361, 382-396.

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