Watershed-Scale Experiment on the Carbon Cycle of Larch Plantation

Carbon Cycle and Larch Growth

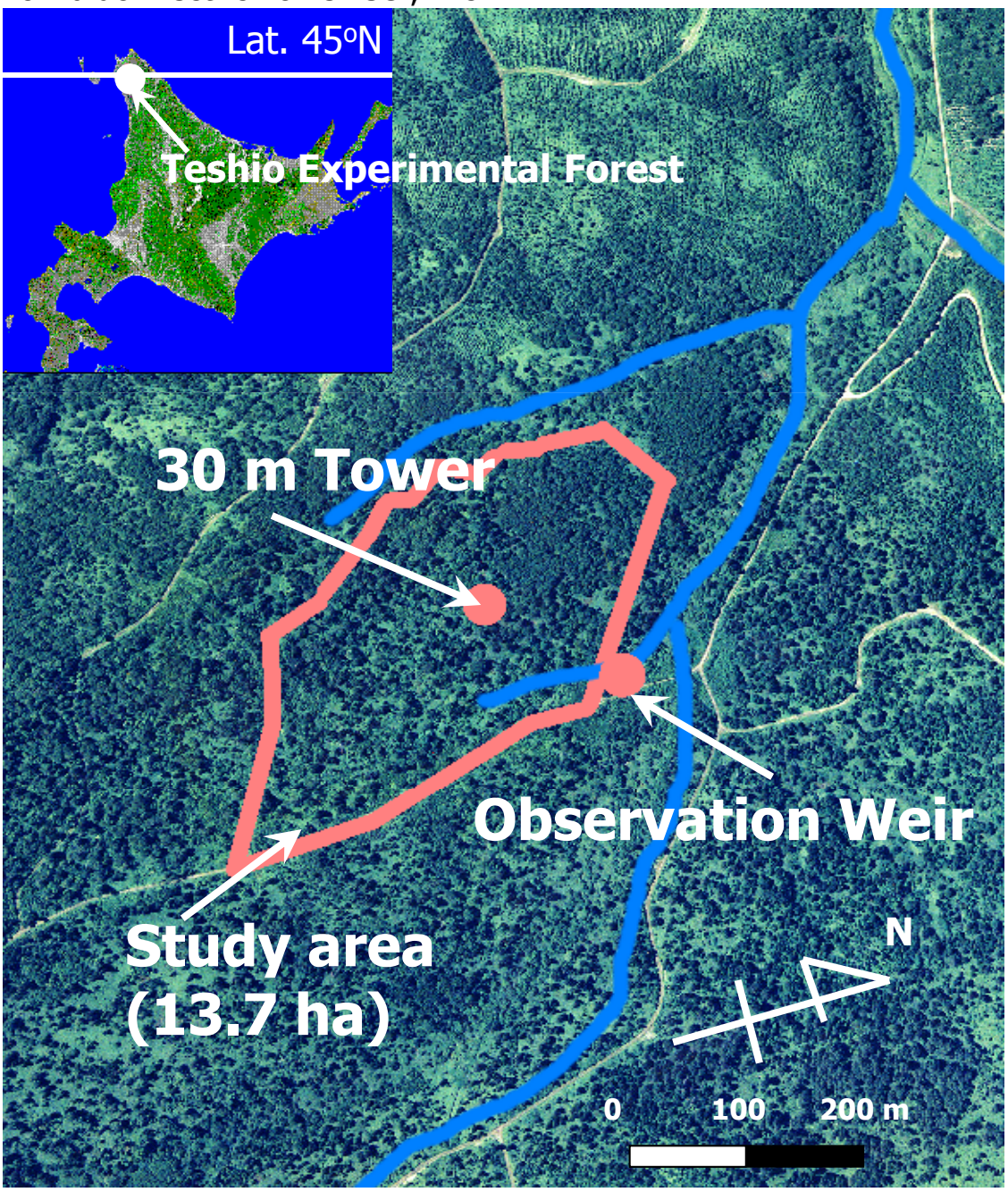
CC—LaG Experiment

Carbon Cycle and Larch growth Experiment

LaG

Since 2001

- National Institute for Environmental Studies
- FSC for Northern Biosphere, Hokkaido University
- Hokkaido Electric Power CO., Inc.



Study site

Teshio Experimental Forest, Field Science Center for Northern Biosphere, Hokkaido University（45º 03'N, 142º 07'E, a.s.l. 66m ）

Main Project

P0 Carbon dynamics monitoring in a young larch plantation

Sub Projects

P1 Biomass research of a cool-temperate forest

P2 Carbon dynamics monitoring in a cool-temperate forest

P3 Effect of regeneration managements on the carbon sequestration

P4 Watershed-scale carbon/water/nutrient dynamics

P5 Evaluation of regional carbon budget

Monitoring terms

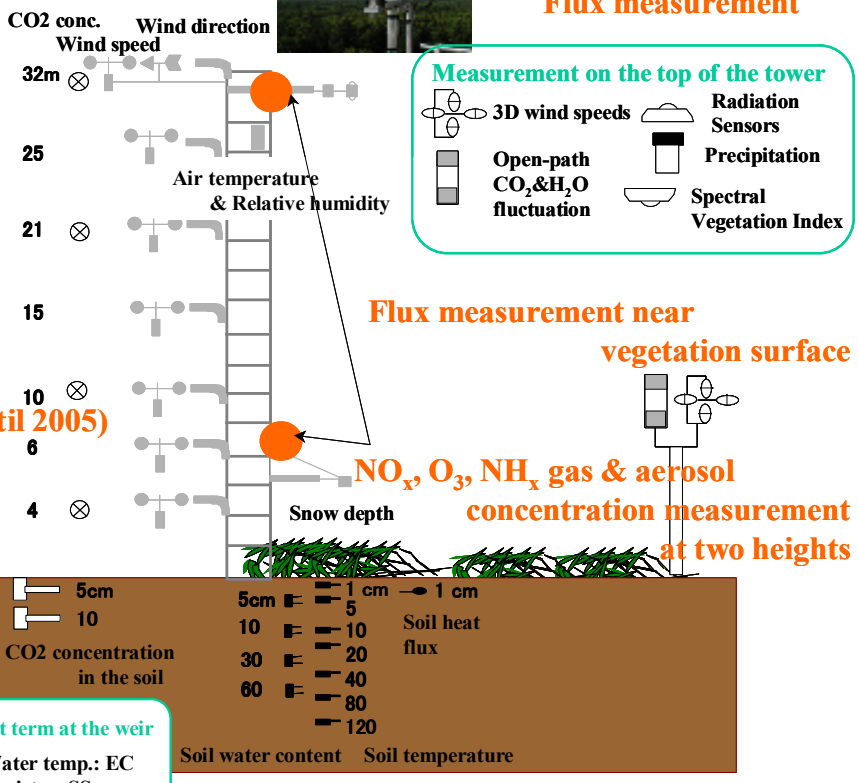
Biomass & Spectral vegetation index measurement using remote sensing

Biomass & matter flow surveys

- Biomass, Leaf Area
- Snow survey
- Water chemistry of Through fall and Rain fall
- Deposition amount
- Water chemistry of soil water

Soil & Sasa (& larch; until 2005) CO_2 flux using chamber

Flux measurement



Measurement on the top of the tower

- 3D wind speeds
- Radiation Sensors
- Precipitation
- Open-path CO_2&H_2O fluctuation
- Spectral Vegetation Index

Flux measurement near vegetation surface

NO_x, O_3, NH_x gas & aerosol concentration measurement at two heights

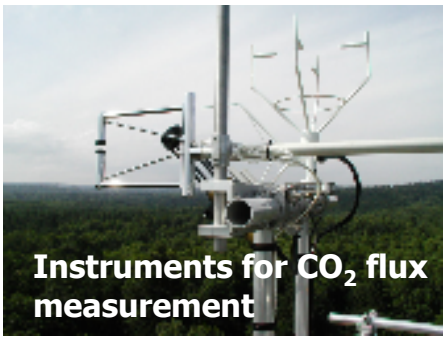
Measurement term at the weir

- Runoff: Water temp.: EC
- Water chemistry: SS

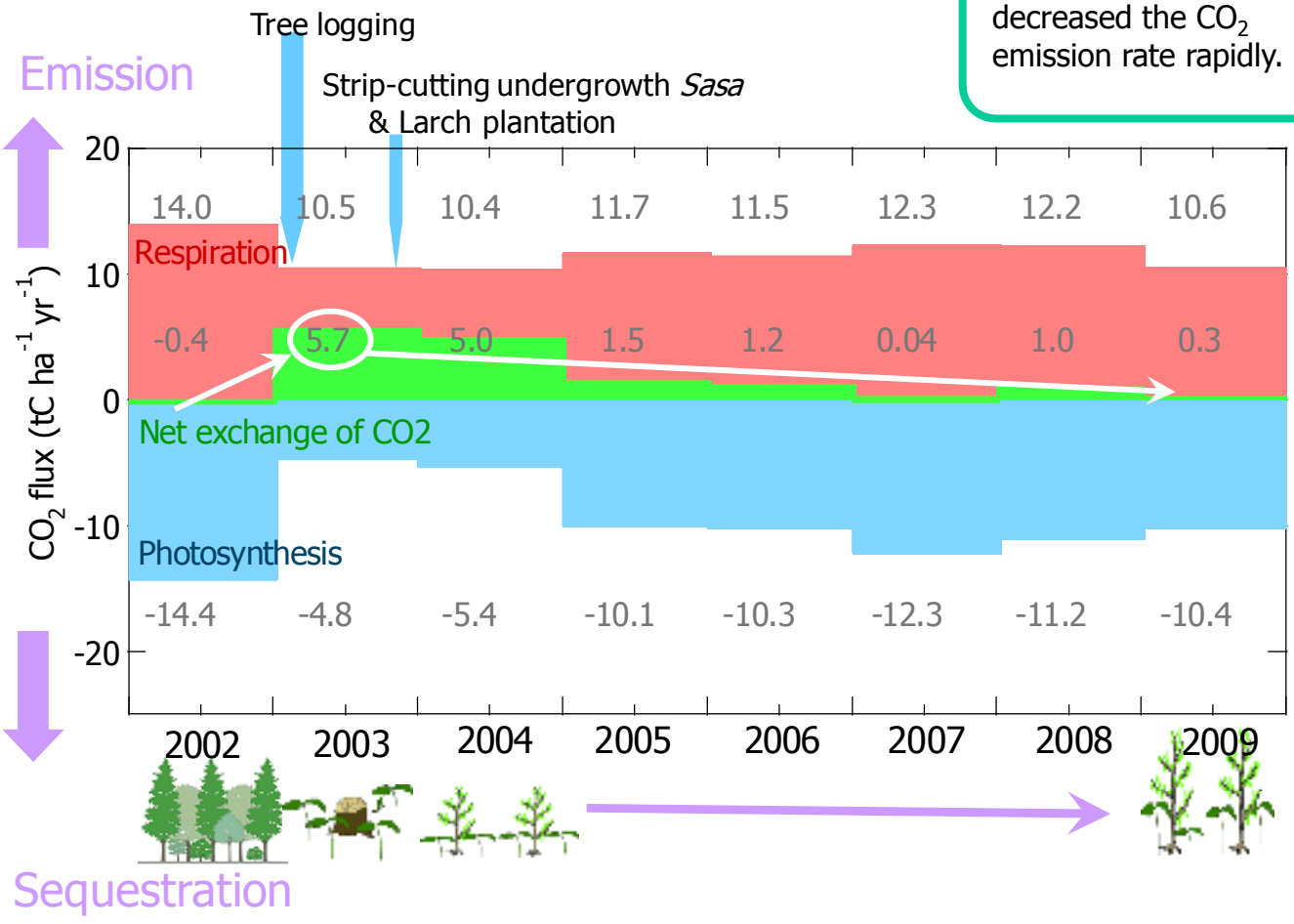
Study on the CO_2 sequestration capacity of forest

CO_2 flux can be evaluated by measuring vertical wind velocity and CO_2 concentration continuously with high frequency.

Our principal aim is to evaluate the effect of deforestation and afforestation on the ecosystem carbon budget by monitoring the CO_2 flux under the series of these activities.



8 years observation shows that the defore-station decreased the photosynthetic capacity and increased the net CO_2 emission rate from the ecosystem. However, the increase in the *Sasa* photosynthesis decreased the CO_2 emission rate rapidly.



We will continue this monitoring in order to evaluate the effect of tree growth on the carbon sequestration capacity of this ecosystem.

Study on the hydro-biogeochemical cycles of forested watershed

We also evaluates the water balance of this forested watershed by observing rainfall, snowfall, evapotranspiration and water runoff of the stream.

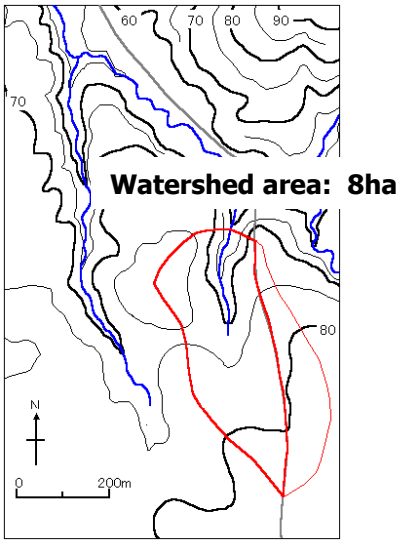
Additionally, we evaluates the carbon and nutrient outputs by the stream water by periodic collection and chemical analyses of the water.

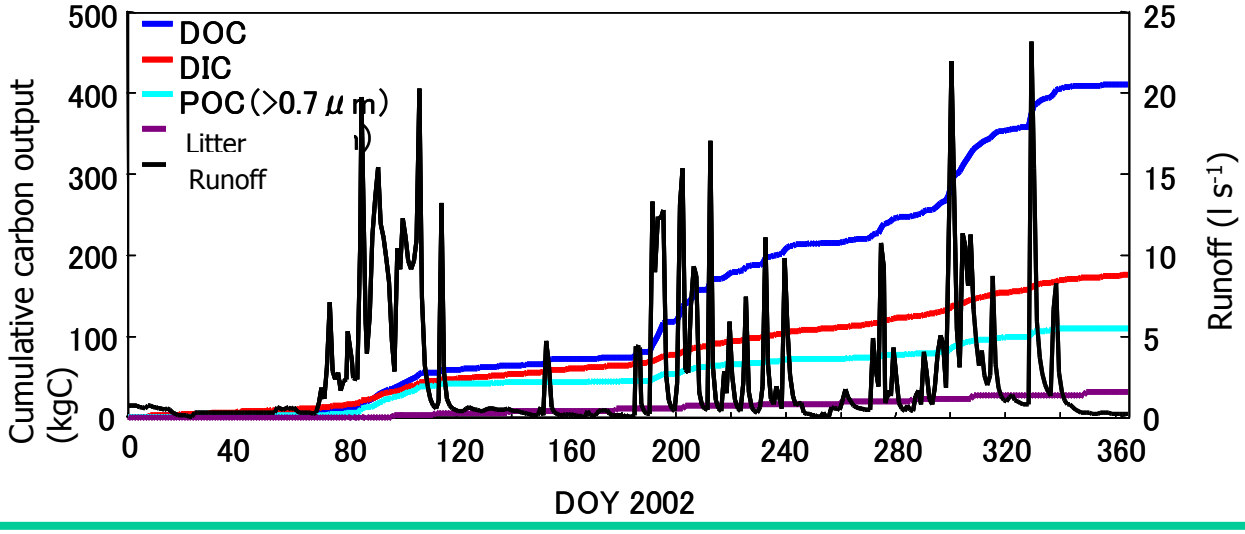

Observation weir and litter trap


Litter trap and rain collector

Rain water & litter are collected periodically and the chemical components are analyzed.


Dry and wet deposition collector





Observation in the mixed forest shows that

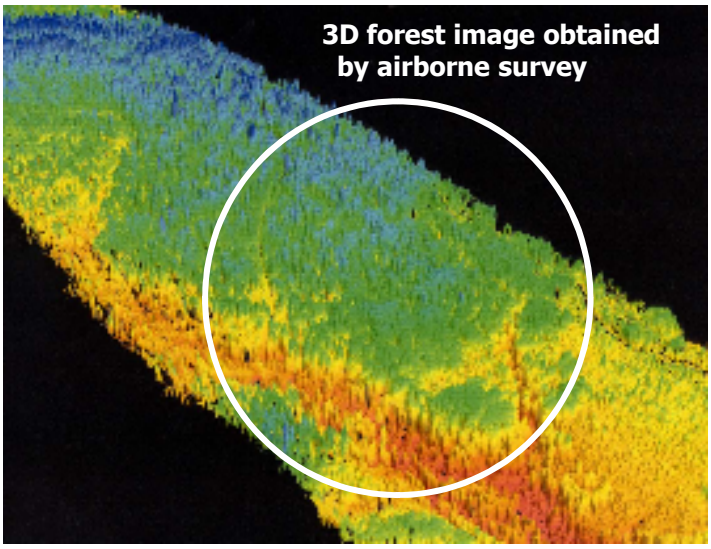
ca. 80% of the input water was flowed out by the stream.

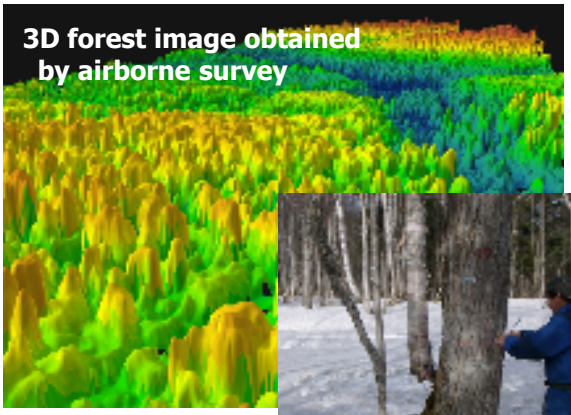
ca. 20% of the fixed carbon was flowed out by the stream water.

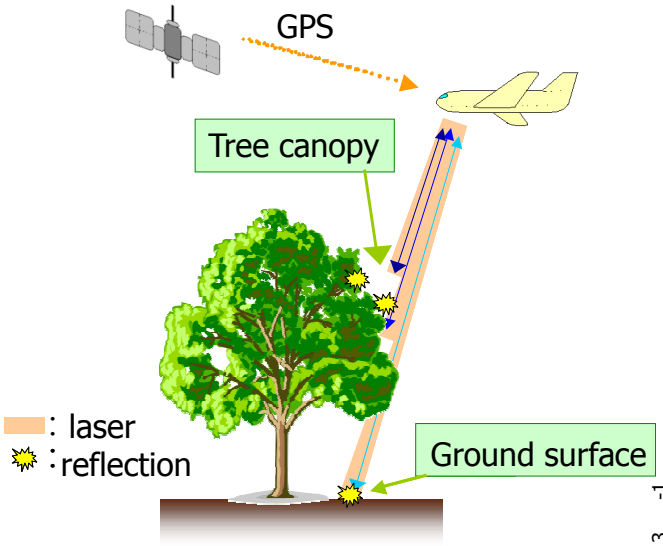
Study on the large scale forest biomass estimation by airborne surveys

Airborne laser survey detects 3D structure of forests by shooting laser from airborne and sensing the reflection.

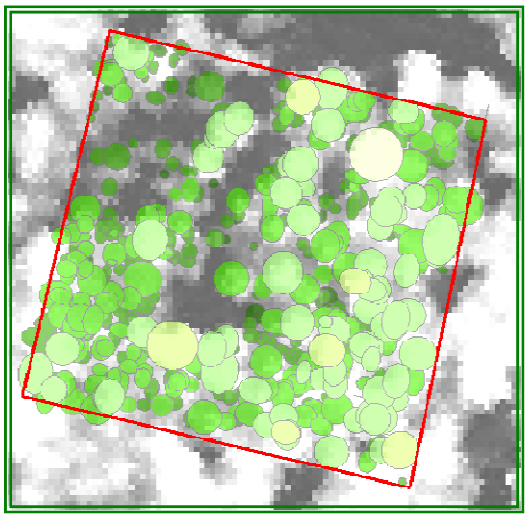
We are developing the estimation method of large scale forest biomass by relating the airborne data with the ground survey data.



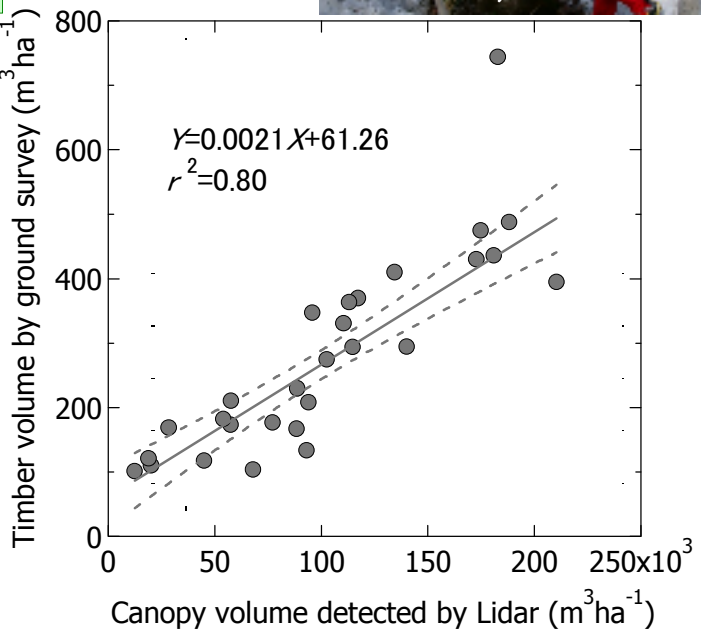




Schematic diagram of airborne laser survey



Layering airborne 3D data (Grey-white) and ground surveyed canopy crown map (Green).



Relationship between ground surveyed timber volume and canopy volume detected by Lidar.

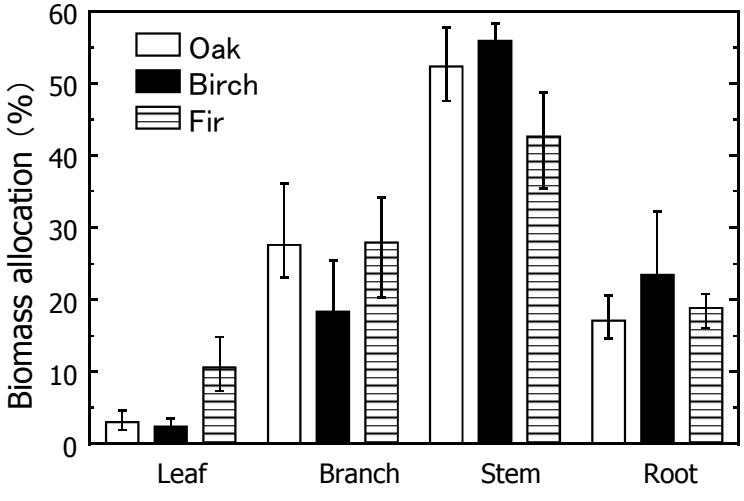
We are also conducting traditional biomass survey for major tree species in the cool-temperate zone, in order to elucidate the carbon allocation in a tree. It takes much time but is important basic data in order to consider the allocation of fixed carbon by tree photosynthesis.

Washing roots for weighing

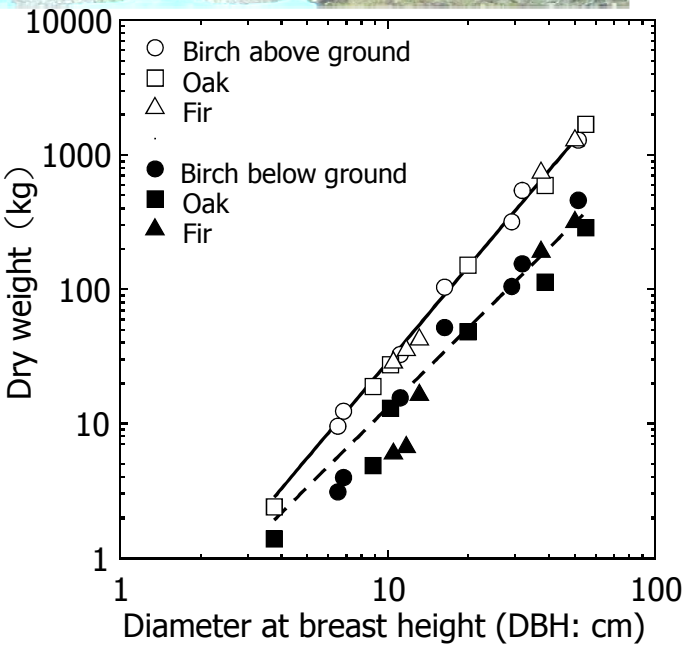
Separation of leaf and branch

Washing and categorizing roots

Tree cutting



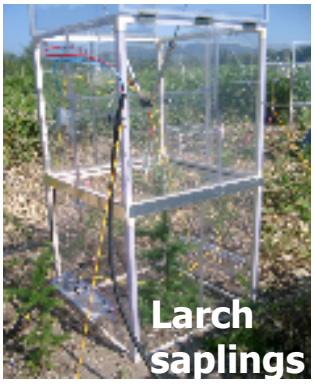
Biomass allocation for major tree species in northern Hokkaido

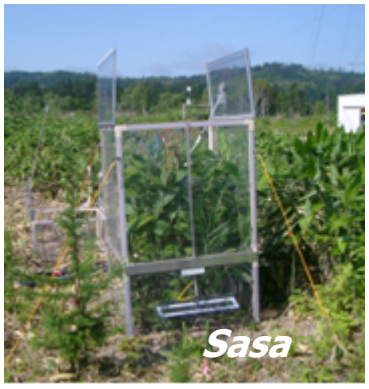


Relationship between DBH and the dry weight.

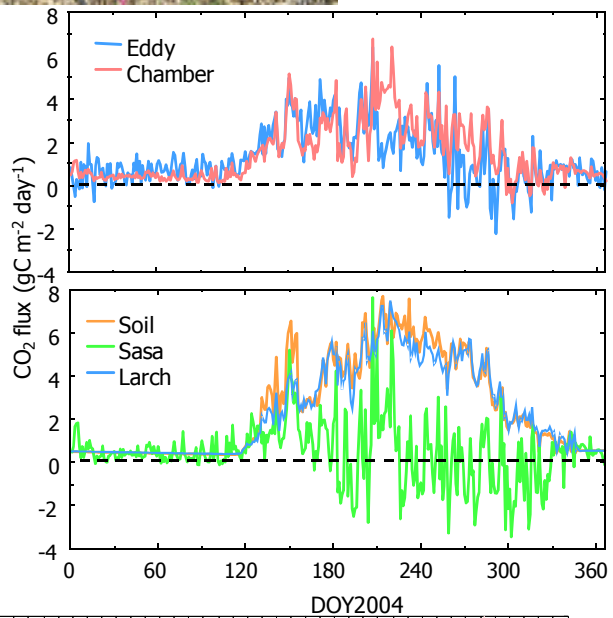
Study on the CO_2 exchange rate of ecosystem components

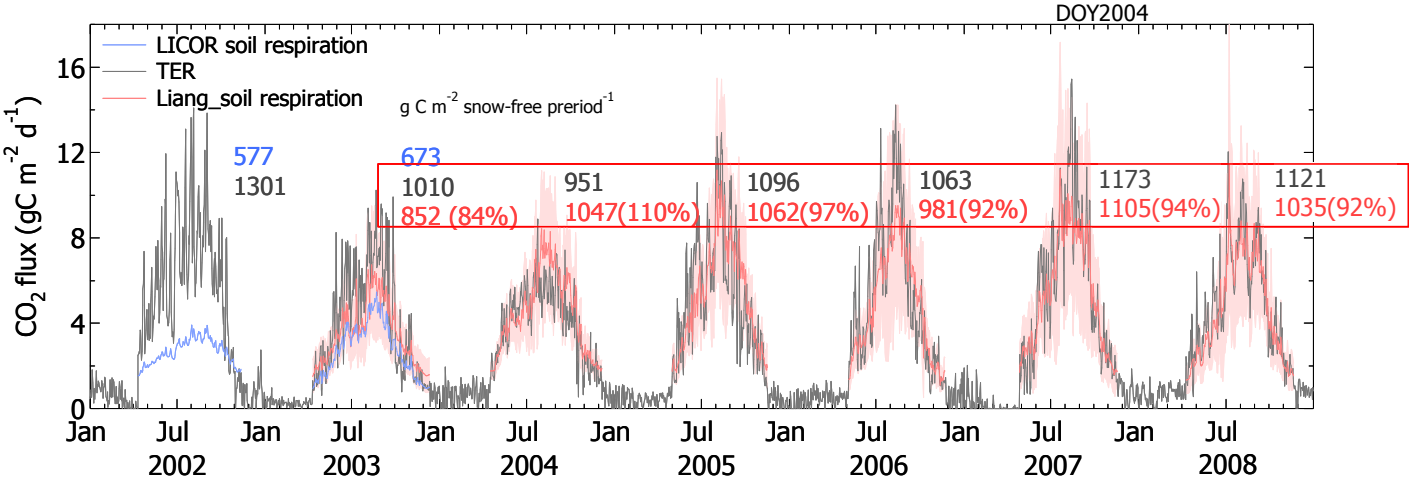
Continuous chamber measurement elucidate the CO_2 exchange rate of each ecosystem component (i.e. soil, *Sasa*, larch) . Open and close of each chamber lid are automatically regulated. When a measurement starts, the lid close and the change rate of CO_2 concentration in the chamber is logged by data-logger.





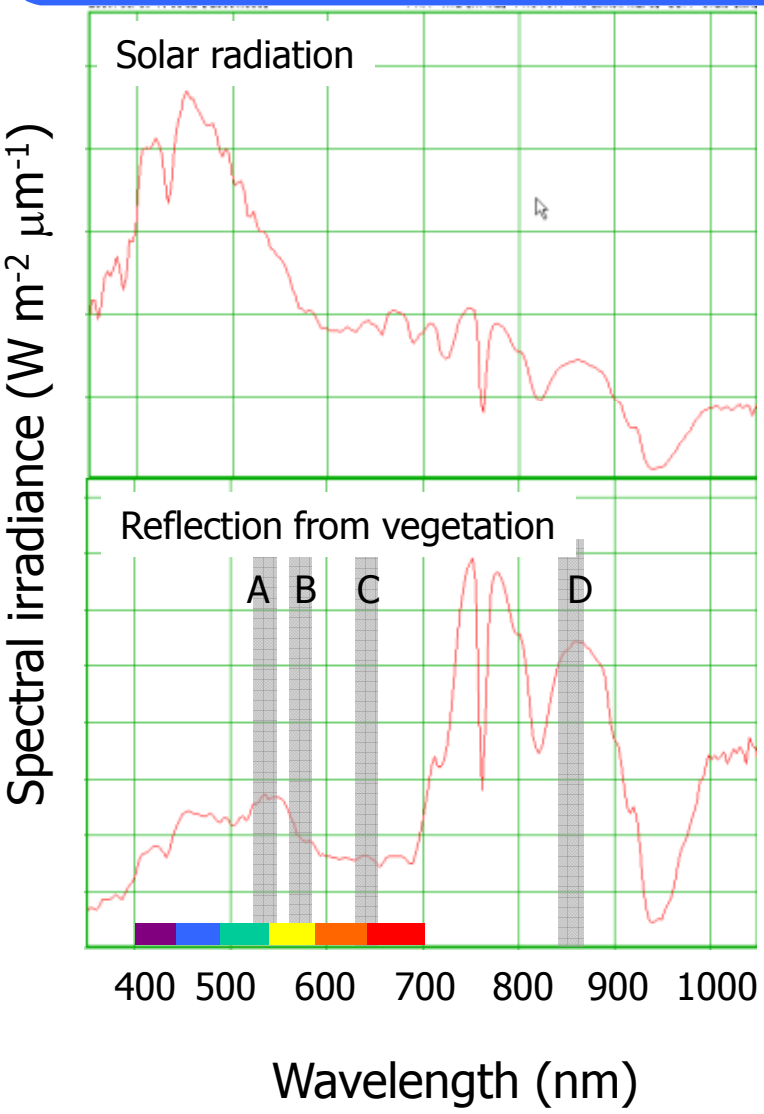
Results obtained during 1 year after larch plantation shows that the soil is large carbon source of this ecosystem and larch has little CO_2 sequestration capacity. *Sasa* community tend to be a carbon sink during the late summer, however the annual budget was still positive (i.e. carbon source).





Study on the spectral vegetation indexes

Surface vegetation has its own characteristics for radiation reflection and some combination of the reflected radiation bands are proposed to explain the photosynthetic activity of vegetation. We are relating the real CO_2 fluxes to several spectral vegetation indexes, in order to estimate carbon fluxes more precisely by remote sensing from space.



For example,

NDVI=(D-C)/(D+C)

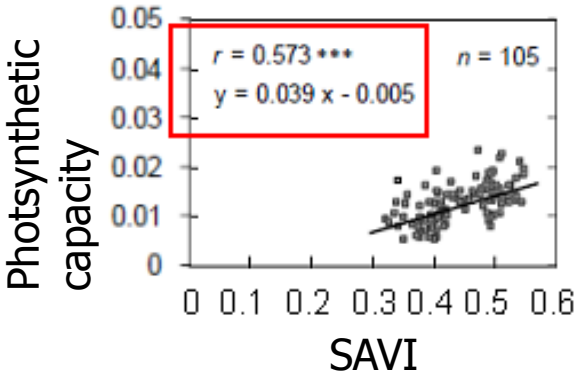
SAVI=1.5*((D-C)/(D+C+0.5))

PRI=(A-B)/(A+B)

NDVI:normalized difference vegetation index

SAVI :soil-adjusted vegetation index

PRI :photochemical reflectance index



Best correlation was observed between SAVI and photosynthesis capacity for this site.

●Features

1. Clear-cutting of a natural forest & plantation of larch saplings

- 13.7 ha clear-cutting
- Effect of clear-cutting on the matter flow
- Effect of plantation on the matter flow

Flux measurement

2. Snowy region

- Snow depth ≈1.5 m
- Comprehensive understanding of hydro-biogeochemical cycle of a forest in snowy region

3. Watershed-scale monitoring

●Schedule

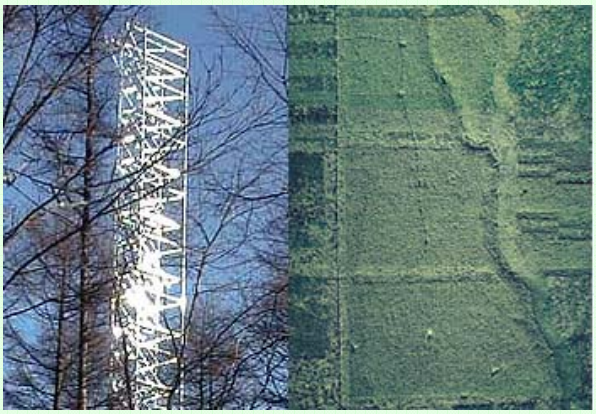
Observation on mixed-forest

13.7 ha clear-cutting (Jan.-Mar. 2003)

Hybrid larch (*Larix gmelinii*× *L. kaempferi*) plantation (ca. 30,000 saplings) (Oct. 2003)

Tie up with Tomakomai Flux Research site and Fuji Hokuroku Flux observation site

Comprehensive study on carbon sequestration rate of larch forests



Papers on this project

- Koike, T., et al. (2001) Basic data of the study site for CO_2 flux monitoring of a young larch plantation located in the border between northern Japan and far east Russia-Current status of a mature mixed conifer-hardwood forest stand -. *Eurasian Journal of Forest Research* 2: 65-79.
- Takagi, K., et al. (2005) Deforestation effects on the micrometeorology in a cool-temperate forest in northern Japan. *Journal of Agricultural Meteorology* 60, 1025-1028.
- Takagi, K., et al. (2005) Dynamic carbon dioxide exchange through snowpack by wind-driven mass transfer in a conifer-broadleaf mixed forest in northernmost Japan. *Global Biogeochemical Cycles,* 19, GB2012.
- Fukuzawa, K., et al. (2006) Effects of clear-cutting on nitrogen leaching and fine root dynamics in a cool-temperate forested watershed in northern Japan. *Forest Ecology and Management*, 225, 257-261.
- Fukuzawa, K., et al. (2007) Vertical distribution and seasonal pattern of fine-root dynamics in a cool-temperate forest in northern Japan: implication of the understory vegetation, *Sasa* dwarf bamboo. *Ecological Research*, 22, 485-495.
- Tsuji, H., et al. (2008) Summer relative humidity in northern Japan inferred from δ18O values of the tree-ring in (1776-2002 AD)-Influence of the paleoclimate indices of atmospheric circulation. *Journal of Geophysical Research*, 113, D18103.
- Nakaji, T., et al. (2008) Utility of spectral vegetation indices for estimation of light conversion efficiency in coniferous forests in Japan. *Agricultural and Forest Meteorology*, 148, 776-787.
- Takagi, K., et al. (2009) Change in CO_2 balance under a series of forestry activities in a cool-temperate mixed forest with dense undergrowth. *Global Change Biology*, 15, 1275-1288.
- Hayashi, K., et al. (2009) Ammonia emission from a young larch ecosystem afforested after clear-cutting of a pristine forest in northernmost Japan. *Water, Air and Soil Pollution*, 200, 33-46.