Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

AHW29-01 Room:314 Time:May 2 14:15-14:30

Evaluating the impact of disturbances on the carbon balance of forest ecosystems in Hokkaido by using data and model: fr

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Changes in carbon flux and storage in forest ecosystems are influenced by climate at various temporal and spatial scales, whereas carbon flux and storage are affected instantaneously and heterogeneously by artificial and natural disturbances at the local scale. Disturbance events such as forest fire, damage by insects, and forest harvest drastically change NEP and carbon storage. In this study, we address the effect of disturbance on carbon balance based on two scale; one is site scale and another is local scale.

First, we performed a baseline simulation of carbon dynamics and compared these values with those observed across a wide range of stand ages (old mixed forest and young and middle-aged larch forests). By taking into account seasonal variation in the understory leaf area index, simulated net ecosystem production (NEP), gross primary production, ecosystem respiration, and biomass for the three types of forests were consistent with observed values.

We compared two cases of simulations concerning the carbon balance: one taking account of spatial distribution of disturbance-induced forest age derived from forest inventory data (disturbance case) and another ignoring the disturbance impact (non-disturbance case). NEP was gradually and spatially changed ranging from 0 to 1 t C/ha/y depending on meteorological conditions such as temperature or solar radiation. On the other hand, in the case of disturbance, large NEP ranging from 3 to 5 t C/ha/y were distributed patchwise like hotspots, because forest age of these spots ranging from 20 to 100 years old and then younger than those of the non-disturbance case. In the 1970s, wood harvest and tree planting were intensively conducted in Hokkaido. In the disturbance case during this period, there were many hotspots which show negative NEP.

Keywords: process-based ecosystem model, eddy covariance method

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Examining initialization procedures of terrestrial carbon cycle models

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It has been realized that long-term trends in model simulation is affected by initialization procedure. In terrestrial carbon cycle models, insufficient stabilization can result in artificial trends (lingering sink or source in CO2 flux) in the simulated carbon budget, making it difficult to interpret simulation results and make comparison with observational data. Conventionally, an equilibrium state of terrestrial carbon budget has been obtained through iterative calculations using an appropriate forcing data. This spinning-up method requires high computational cost, typically, at over 90% of total computational cost. On the other hand, terrestrial modeling has another problem related to initialization; actual ecosystems are not always at steady state due to disturbance and environmental change. As a result, different model groups adopt different initialization procedures, raising some problems in inter-model comparison. In this study, I examined how an alternative initialization method (semi-analytical solution) works in a terrestrial carbon cycle model and is effective to reduce computational cost in comparison with the conventional spinning-up. I discuss possibility of better initialization procedures, in terms of idealism, realism, and generality, not only with model researchers but also with filed researchers.

Keywords: terrestrial ecosystem model, initialization, carbon budget

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Interannual variation of carbon allocation in a cool-temperate deciduous forest from 1999 to 2006

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Carbon allocation is the key factor controlling the dynamics of carbon cycle. It determines partitioning of assimilated carbohydrate to components of vegetation, leaves, woody organs, and fine roots. To analyze seasonal and annual scale carbon allocation of forest ecosystems, it is conventional to use the mass-balance approach, which combine individual estimations of flux and biometric observations such as gross primary production, ecosystem respiration, soil respiration, net ecosystem production, leaf and tree biomass, litterfall, and soil organic carbon considering appropriate balances with each components. However, it is often the case that an attribution of fine roots was not fully assessed because it is required significant effort to monitor its dynamics in a long term. Pulse labelling technique allows directly measure allocation of assimilated carbon from foliage to belowground in various tree species. This approach provides detailed aspects of allocation dynamics, but assessing labelled carbohydrate allocated to fine roots is still challenging. Absence of allocation to fine roots limits our knowledge about mechanism of carbon allocation because net primary productivity of fine root (frNPP) potentially account for one-third of the annual total NPP. To compensate limited observation, a model-data integration technique would be a useful tool, in which a process-based biosphere model combined with multi-year biometric observations to inversely estimate plausible allocation to fine roots.

This study investigated the interannual variability of carbon allocation of a cool-temperate forest in the Takayama Forest Research Site, Japan. The multi-year biometric observations are available for most of carbon cycle components at the Takayama site (e.g., woody tissue net primary productivity (wNPP), foliage NPP (fNPP), aboveground and belowground woody biomasses, litterfall, recruitment, and mortality) except fine root NPP (frNPP); only one year data of frNPP is available for 2000?2001. To compensate the limited frNPP measurement, we calculated frNPP from 1999-2006 by a model-data integration technique. In the process of calculation, unnecessary freedom in the simulation of a process-based ecosystem model, Biome-BGC, was constrained as much as possible with multiple biometric observations at the Takayama site. With the observed components of allocation (fNPP and wNPP) in conjunction with the modeled frNPP, we characterized the internnual variability of carbon allocation at the Takayama site by focusing two aspects: (1) allocation priority among leaves, woody components, and fine roots, and (2) controlling climate factors for these allocation components.

Acknowledgments

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Keywords: Allocation, ecosystem modelling

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AHW29-04 Room:314 Time:May 2 15:00-15:15

Net nitrogen input through the atmospheric deposition and irrigation water at a paddy field in central Japan

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The aim of the present study was to evaluate the net nitrogen input through the atmospheric deposition and irrigation water at a paddy field for single cropping of paddy rice in central Japan, where the wet deposition and exchanges of gases and particles (as the difference between the dry deposition and emissions) were measured for the atmospheric deposition. Target species of reactive nitrogen (Nr) were ammonium (NH_4^+) and nitrate (NO_3^-) for the wet deposition, ammonia (NH_3), nitric acid (HNO_3), and nitrous acid (HNO_2) as gases and particulate ammonium (pNH_4) and nitrate (pNO_3) as particles for the atmosphere-rice paddy exchange, and NH_4^+, NO_3^-, and organic nitrogen (OrgN) for the irrigation water.

Monitoring of those processes were conducted for three years from September 2010 to September 2013 at a paddy field in central Japan which was devoted for an experimental site of free-air CO_2 enrichment (FACE). Rainwater samples were collected weekly and the wet deposition was calculated using the Nr concentration and the collected volume of water. The air concentrations of Nr were measured using a filter-pack method at two heights of 6 m and 2 m above the ground surface on a weekly mean basis with day/night separation. A filter-pack consisted of five filter holders to collect the target Nr. The diffusion velocity was calculated using the micrometeorological and eddy covariance data in half-hourly basis and then the weekly-mean values in the daytime and nighttime were calculated. The exchange fluxes were expressed as the product of the difference in air concentration between the two heights multiplied by the diffusion velocity. Cumulative exchange fluxes were also calculated based on the weekly mean exchange fluxes. The flow rate and quality of irrigation water was monitored in the cropping seasons in 2011, 2012, and 2013 at a bay in the paddy field. Each of two inlets and one outlet at the bay was equipped with a flow gaging weir and the water flow was measured continuously. Water was sampled at the weirs every week in principle and the concentrations of Nr were measured, where OrgN was calculated as the difference between the total nitrogen and the sum of NH_4^+ and NO_3^-. The inflow and outflow of Nr by irrigation were then calculated using the flow rate and concentration data.

Annual wet deposition of Nr was 9.5, 8.6, and 5.9 kg N ha^{-1} yr^{-1} for the first, second, and third years, respectively, where NH_4^+ and NO_3^- showed similar contributions quantitatively. In addition, the contribution of OrgN was negligible in the wet deposition. Annual exchanges of Nr between the paddy field and the atmosphere were estimated to around 2-3 kg N ha^{-1} yr^{-1}, where a certain extent of the dry deposition was counterbalanced by the emissions. Ammonia was the most dominant Nr among the target species in the atmosphere. Ammonia also showed the largest dry deposition among Nr; however, a large part of which was canceled by the emissions of NH_3 from the paddy field. The differences between the inflow and outflow for the irrigation water were 10.7, 8.8, and 6.7 kg N ha^{-1} yr^{-1} for the first, second, and third years, respectively, where OrgN accounted for 30-40% of Nr. In total, the net input of Nr to the paddy field through the atmospheric deposition and irrigation water was estimated to approximately 20 kg N ha^{-1} yr^{-1} which corresponds to approximately 30% of a standard application rate of nitrogen fertilizers in this area. However, it is desired that the following processes are also incorporated to complete the evaluation of the nitrogen balance: the biological nitrogen fixation and the dry deposition of nitrogen oxides (nitrogen monoxide and nitrogen dioxide) as inputs; and the denitrification (nitrogen monoxide, nitrous oxide, and dinitrogen) and the leaching of Nr to the groundwater as outputs.

Keywords: reactive nitrogen, nitrogen balance, atmospheric deposition, emission, irrigation, rice paddy field

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AHW29-05 Room:314 Time:May 2 15:15-15:30

The variations of ORP in the paddy soil and effects on the methane emission from a periodically irrigated paddy field.

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Oxidation-Reduction Potential (ORP) in the paddy soil was measured during rice cultivaled season at a periadically irrigated paddy field, and some effects on the methane flux from the paddy soil was investigated. ORP showed rapid decrease when irrigation water was introduced in the paddy field, and lower ORP was shown under the longer flooded condition. From the seasonal-term point of view, lower ORP was shown in later rice season. ORP was suitably modeled as a function of irrigation time. During an irrigation period for four days, higher methane emissions were shown under lower OPR conditions. From the seasonal-term point of view, however, no significant relationship between ORP and methane fluxes. It is suggested that seasonal change of methane flux is affected by seasonal changes of soil temperature and the growth level of rice plants.

Keywords: Rice Paddy, Methane, soil, Oxidation-Reduction Potential

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AHW29-06 Room:314 Time:May 2 15:30-15:45

Carbon emission by open burning from a paddy field and decomposition of the residual biomass in the paddy soil

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Twice sampling surveys of residual biomass above ground surface were conducted before and after the open burning, and carbon contents compared for the estimation of carbon emission by the burning. It is suggested that about 43% of carbon contents of above-ground rice plant was yield out as grain by the harvest, and about 30% of carbon emitted as CO2 by burning. Coarse Organice Matter (COM) in the paddy soil of a single-crop rice field was sampled on a regular schedule for three years. The carbon emission from the COM decomposition of residual biomass was estimated by analyzing of the variations in carbon content of COM. Decrease in COM was accelerated at the warming season between April and June, but it was resisted during rice cultivated season. It is estimated that 70% of COM was decomposed after a year.

Keywords: Organic Carbon, Rice Paddy, Soil, Decomposition, Carbon Dioxide

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AHW29-07 Room:314 Time:May 2 15:45-16:00

Continuous measurement of forest floor CO2 fluxes in a larch forest on the base of Mount Fuji

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Carbon fluxes of forest floor are thought to be important part of forest carbon dynamics. Multi-channel automated chamber system was installed to a larch forest site on the base of Mount Fuji in 2006 for continuous measurement of forest floor CO_2 fluxes. We prepared soil chambers for measuring soil respiration (Rs) and heterotrophic respiration (Rh). Root trenching was applied to separate Rs and Rh. Net ecosystem exchange (NEE) on the forest floor was measured with plant chambers. In 2013, the average efflux of CO_2 was 2.24, 1.81 and 2.11 μmol CO_2 m^{-2} s^{-1} in Rs, Rh and NEE, respectively. Root respiration was estimated to occupy 80.7% of Rs. Plants of forest floor was suggested to absorb about 5.9% of CO_2 in Rs, and it meant that the amount of carbon fixed by those plants was relatively low. There was little rain in summer time (July-August), and forest floor CO_2 fluxes were decreased due to decreased soil moisture. Q_{10} was 2.49 and 2.87 in Rs and Rh, respectively. Soil respiration was estimated to be 8.48 tC ha^{-1} yr^{-1}, and the forest floor was seen as 7.98 tC ha^{-1} yr^{-1} carbon source.

Keywords: soil respiration, chamber, forest floor plants, photosynthesis

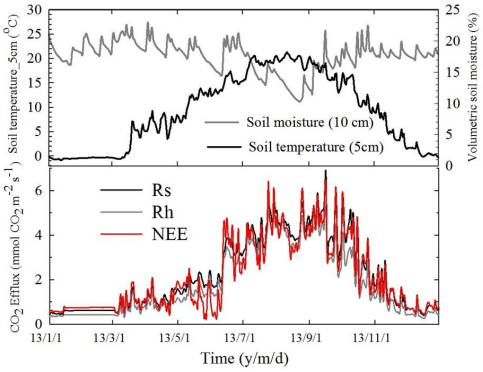

Fig 1. Seasonal variation of soil temperature, soil moisture and CO_2 efflux of each fluxes in 2013.

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AHW29-08 Room:314 Time:May 2 16:15-16:30

Change in carbon dioxide absorption by a deciduous broadleaf forest due to the 2004 typhoon disturbance

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Natural disturbances occur in forests at various scales and frequencies. It has an impact on the amount of carbon dioxide (CO_2) absorption by a forest. In Japan, large-scale disturbance often occurs in forests due to damage caused by strong winds of a typhoon. The 18th typhoon passing in 2004 brought about large-scale damage to forests, mainly in Iburi and Ishikari districts of Hokkaido. The Hitsujigaoka experimental forest (Sapporo forest meteorology research site, SAP) located in the southeastern area of Sapporo also suffered large-scale damage. An investigation related to CO_2 absorption, including flux observation, was conducted before the typhoon disturbance. After a 1-year interruption of the investigation due to facility damage by the typhoon, flux observation was reinitiated. To study the process of regeneration in the forest, the fallen trees were left into site. We report the results of a long-term observation of flux and biomass.

According to flux observation data, the annual carbon budget changed to negative after the disturbance. At present, carbon release is continuing. The supply of a lot of dead trees has caused a large amount of decomposition, which has lead to 1.5-fold heavy increases in ecosystem respiration. Meanwhile, average annual GPP from 2007 to 2012 decreased 5% compared with that before the typhoon.

Yearly maximum LAI including both trees and dwarf bamboo estimated by the attenuation rate of photosynthetically active radiation and the biomass survey was approximately 7 before the disturbance. It decreased to 4 in the following year and increased thereafter. It has been approximately 5.5 since 2007. The main source of total LAI recovery is the LAI of dwarf bamboo, which increased 2-fold. The amount of biomass of trees decreased to 70% after the typhoon, while that of dwarf bamboo increased 1.5-fold. However, biomass of bamboo was approximately 10% of that of trees. Therefore, dwarf bamboo did not fill in gaps due to a decrease in biomass of trees.

Photosynthetic increase due to dwarf bamboo partially compensated for photosynthetic decrease due to trees, and ecosystem respiration increased due to the increase in dead trees. As a result, the forest became the carbon source. To change the status of the forest from the carbon source to a carbon sink, it is necessary for carbon release to decrease with the advancing decomposition of dead trees.

Keywords: deciduous broadleaf forest, dwarf bamboo, CO_2 flux, disturbance

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AHW29-09 Room:314 Time:May 2 16:30-16:45

Evapotranspiration of tropical peat ecosystems

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In Southeast Asia, mainly in Indonesia and Malaysia, peatland is widely distributed, coexisting with swamp forest, over an area of 2.48×10^5 km^2 and accumulates 11-14% of global peat carbon (Page *et al*., 2011). The peatland, however, has been rapidly degraded by deforestation and drainage. As a result, the proportion of forest cover in the peatlands of Peninsular Malaysia, Sumatra and Borneo fell from 77% to 36% from 1990 to 2010 (Miettinen *et al*., 2012). Such human pressures made the huge peat carbon pool vulnerable and raised the risk for the pool to be a large carbon source to the atmosphere chiefly because of peat fires and lowered groundwater level (GWL). The carbon balance of peatland is chiefly controlled by local hydrology, which determines saturation or unsaturation of surface peat. Under unsaturation conditions, peat is aerated, and its soil organic compounds are easily oxidized into carbon dioxide (CO_2). Therefore, drainage to lower GWL necessarily enhances oxidative peat decomposition and its resultant CO_2 emissions. Because tropical peatland is typically ombrotrophic, GWL varies according to residuals (storage change) between precipitation as input and evapotranspiration (ET) and runoff as output. Although precipitation can be also affected by large-scale deforestation, ET and runoff are directly affected by deforestation and drainage, respectively. To predict GWL under human pressures and assess the carbon balance of tropical peatland, therefore, it is crucial to quantify ET and elucidate the effects of disturbances on ET.

We have measured fluxes of sensible heat and latent heat using the eddy covariance technique and determined ET and energy balance at three sites within 15 km on tropical peatlands near Palangkaraya, Central Kalimantan, Indonesia (Hirano *et al*., 2012). The sites are different in disturbance degree: a relatively intact peat swamp forest with little drainage (UF), a heavily drained swamp forest (DF) and a drained burnt swamp forest (DB). Here we show the results of field measurement for four to six years between 2002 and 2009, including El Nino and La Nina events and discuss the effects of disturbances on the energy balance and ET of tropical peat swamp forest.

Because of energy imbalance (84 to 91% on an annual basis), ET was adjusted to close energy balance on a daily basis. Mean annual ET (±1 standard deviation) for the four years from 2004 to 2008 was 1636 ± 53, 1553 ± 117 and 1374 ± 75 mm y^{-1}, respectively, for the UF, DF and DB sites, which account for 67, 64 and 56% of mean annual precipitation of 2435 mm y^{-1}, respectively. Annual ET of the DB site was significantly smaller than those of the other sites, mainly owing to less transpiration due to few trees. This fact indicates that more water is lost by surface and groundwater runoff in the DB site. In addition, annual ET showed a positive linear relationship with annually mean GWL at each site. This significant linearity suggests that annually mean GWL is a robust indicator to assess the annual balances of carbon and water in tropical peat ecosystems (Hirano *et al*., 2012).

Keywords: disturbance, drainage, eddy flux, energy balance, fire

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AHW29-10 Room:314 Time:May 2 16:45-17:00

Withering of Japanese oak by sulfuric acid of an air pollutant. and prevention from withering by charcoal

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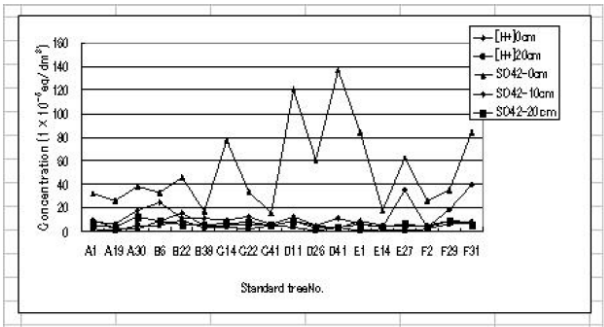
The sulfuric acid which generates by the combustion of a fossil fuel is carried by wind and adheres to trees and only water evaporates and the sulfuric acid concentrates and accumulates.Sulfuric acid is dropped on the root of a tree by rain and it acidi?es the soil.The metal ingredient in the soil becomes a soluble compound.The eluted metal ion is absorbed by trees and it combines with phosphoric acid.The trees become shortage of phosphoric acid and decay.If the tannin contained in Japanese oak combines with metal ion it becomes harmless to insect.Withering of trees originates in acidi?cations of soil.Charcoal can neutralize the acidi?ed soil.The results of an investigation are explained on the basis of consideration from chemical standpoint.

Keywords: air pollutant, charcoal, withering of pine, withering of Japanese oa, tannin, phosphoric acid



sampling: Kanayama,Onuma,Fukusima 10.10.2011
Measuring method :10g/ dried soil + 25g/water,
Filtration after 60minutes, $[H^+]$/pH meter, SO_4^{2-}/Ion chromatography
The relation of the hydrogen ion and sulfuric acid ion concentration in soil (1×10^{-5} eq/dm^3)