

## A metabolic model of stable isotope dynamics

ISHII, Reiichiro<sup>1\*</sup> ; NOGUCHI, Maki<sup>1</sup> ; WADA, Eitaro<sup>1</sup>

<sup>1</sup>JAMSTEC

Carbon and nitrogen stable isotope analysis have been a powerful tool used for identifying food-web structures. Our recent study suggested that the ratios of trophic fractionation of carbon and nitrogen isotopes ( $\Delta\delta^{15}\text{N}/\Delta\delta^{13}\text{C}$ ) throughout food chain are similar in various ecosystems (Wada et al. 2013), although the general mechanisms determining isotopic incorporation rates and discrimination factors are poorly understood.

Here, we developed a mechanistic model of the isotopic fractionation in metabolic processes that are common to animals composing most grazing food chains. Particularly, we calculate fluxes of carbon and nitrogen stable isotopes within an organism by following fluxes of molecules involved in some of physiological reactions: the synthesis of amino acids and their carbon skeletons, the rates of which are governed by energy-producing systems such as glycolysis, the TCA cycle, and oxidative phosphorylation, that is, the ratio of the rate of amino-acid syntheses to that of energy-yielding processes. The active metabolic pathways above are assumed to be changed by the conditions of supply (diet quantity and quality) and demand (growth rate).

The model result suggests that the instant isotopic composition of animals are sensitive to the change of their diet composition and growth rate, but on the other hand, the isotopic composition converges as the integrating period becomes long. With further temporal scaling-up, in turn, the isotopic compositions of animal body reflect the spatio-temporal variability due to their life history, migration and foraging patterns. This gives mechanistic insight to what information we can acquire from the observation.

## Tracing environmental history of macroalgae by the use of radiocarbon and stable isotope ratio analyses

SATO, Naomi<sup>1\*</sup> ; FUKUDA, Hideki<sup>1</sup> ; MIYAIRI, Yosuke<sup>1</sup> ; YOKOYAMA, Yusuke<sup>1</sup> ; NAGATA, Toshi<sup>1</sup>

<sup>1</sup>Atmosphere and Ocean Research Institute, the University of Tokyo

In the bays located along the Sanriku coastal area (northeast Japan), where the Kuroshio and Oyashio mix in a complex manner, environmental conditions (e.g. water temperature, irradiation and nutrients) may largely change depending on which current predominantly enters into the bays. Changes in environmental conditions, in turn, may exert a large influence on growth of and interactions between organisms residing there. However, knowledge is limited regarding relationships between shifts in hydrographic conditions and physiological responses of organisms to environmental variability. The purpose of this presentation is to report our attempt to trace environmental history of individual macroalgae (*wakame*, *Undaria pinnatifida*), a widespread benthic primary producer and an important aquaculture product in the Sanriku area, by a combined use of radiocarbon and stable isotope ratio analyses. The key concept was to use distinct <sup>14</sup>C abundance between the two water currents, i.e., <sup>14</sup>C abundance of dissolved inorganic carbon in the Oyashio water is lower than that in Kuroshio water due to upwelling of old deep water. We assumed that <sup>14</sup>C abundance profile of pinnate blades of macroalgae (blades near the top are older than those near the bottom) reflects a temporal change in dissolved inorganic carbon <sup>14</sup>C (hence, shift in water current) via photosynthetic fixation. We also analyzed carbon and nitrogen stable isotope ratios ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) of the blades to gain insights into changes in physiological state of the macroalgae during their growth.

We collected sporophytes of *U. pinnatifida* cultured between October 2012 and March 2013 at two stations (one located near the bay center and the other located near the river mouth) in Otsuchi Bay. One individual (length, ca. 190 cm) was collected at each station. For each individual, a tip of each pinnate blade was cut, treated with HCl, reduced to graphite, and served for determination of radiocarbon composition ( $\Delta^{14}\text{C}$ ) profile using an accelerator mass spectrometer.  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  of the corresponding samples were also measured using a stable isotope ratio mass spectrometer.

$\Delta^{14}\text{C}$  of pinnate blades of the saprophyte collected near the bay center varied between 0 and 40 permil.  $\Delta^{14}\text{C}$  values were high for the blades located at the upper and lower parts of the macroalgae, whereas they were low for the blades situated at the middle part. These results indicate that the sporophyte experienced the intrusion of the Oyashio water during the period of the development of the middle blade. Similar to the pattern in  $\Delta^{14}\text{C}$ ,  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values were also lowest at the middle part, although the position of the minimum was skewed toward bottom relative to the position of the  $\Delta^{14}\text{C}$  minimum. There was a significant positive correlation between  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ , suggesting that the variation in stable isotope ratios reflected macroalgal physiological responses and associated shifts in isotope fractionation. Collectively, these results were interpreted as an indication that the physiological state of the saprophyte was altered with a time lag after the intrusion of the Oyashio water into the bay. In contrast,  $\Delta^{14}\text{C}$  profile of pinnate blade was complex for a saprophyte collected near the river mouth. For this individual, there was no clear pattern in distribution of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  among blades. Complex variations in isotopic compositions for this individual might be ascribed to the influence of inflow river water.

Keywords: macroalgae, Sanriku coast, water current, radiocarbon, stable isotope

## Accumulation of humic-like fluorescent dissolved organic matter in the Japan Sea interior

TANAKA, Kazuki<sup>1</sup> ; KUMA, Kenshi<sup>2</sup> ; HAMASAKI, Koji<sup>3</sup> ; YAMASHITA, Youhei<sup>4\*</sup>

<sup>1</sup>Graduate School of Environmental Science, Hokkaido University, <sup>2</sup>Faculty of Fisheries Science, Hokkaido University, <sup>3</sup>Atmosphere and Ocean Research Institute, The University of Tokyo, <sup>4</sup>Faculty of Environmental Earth Science, Hokkaido University

Marine dissolved organic matter (DOM) is the largest reduced carbon reservoir in ocean. Most marine DOM is produced by marine biota and is resistant to rapid microbial degradation. Thus, it is crucial to know the dynamics of recalcitrant DOM for determining whether the marine DOM reservoir is stable or not. Even though there have been several hypotheses regarding with the recalcitrant mechanism of marine DOM, the microbial production of recalcitrant DOM (defined as microbial carbon pump) has been considered as the main process. Humic-like fluorescent DOM (FDOM<sub>H</sub>) has found to produce during microbial incubation. Even though FDOM<sub>H</sub> has known to easily degrade by sunlight, linear relationships between fluorescence intensity of FDOM<sub>H</sub> and indicators of microbial remineralization, e.g., apparent oxygen utilization (AOU), have been observed throughout the ocean. These experimental and observational results imply that FDOM<sub>H</sub> is a product of microbial carbon pump. Another important source of FDOM<sub>H</sub>, especially in coastal environments and marginal seas, is riverine supply. Even though the major fractions of FDOM<sub>H</sub> have been considered to be photo-degraded in coastal environments, substantial contribution of terrestrial FDOM<sub>H</sub> into ocean interior has been suggested. Thus, in addition to accumulation of in situ produced FDOM<sub>H</sub>, recalcitrant terrestrial FDOM<sub>H</sub> might occur in deep ocean, especially in marginal seas. However, it is not clear whether recalcitrant autochthonous and/or terrestrial FDOM<sub>H</sub> is accumulated in deep ocean of marginal seas or not.

We determined vertical profiles of FDOM<sub>H</sub> at 5 stations in the Japan Sea and 5 stations in the western North Pacific using excitation emission matrix fluorescence with parallel factor analysis (EEM-PARAFAC). Seawater samples from surface to bottom waters of the Japan Sea and the western North Pacific were collected during T/S Oshoro-maru (C184) and R/V Taisei-Maru (KT-11-17) cruises, respectively. Two FDOM<sub>H</sub> were obtained after EEM-PARAFAC and assigned as traditional terrestrial and marine (microbial) FDOM<sub>H</sub>, respectively. In the Japan Sea, levels of both FDOM<sub>H</sub> were lowest in surface waters, gradually increased with depth below surface waters, and were highest in waters distributed depths greater than 2000 m that were corresponding to the lower part of Japan Sea Proper Water (JSPW), i.e., lower part of the Japan Sea Deep Water (JSDW) and the Japan Sea Bottom Water (JSBW). Levels of both FDOM<sub>H</sub> were linearly correlated with AOU in the JSPW, suggesting that both FDOM<sub>H</sub> were produced in situ in the JSPW. Interestingly, levels of both FDOM<sub>H</sub> in the JSPW were similar or slightly higher compared with those in deep waters of the western North Pacific, even though AOU in the JSPW were significantly lower than those in deep waters of the western North Pacific. Such distributional characteristics of FDOM<sub>H</sub> in the JSPW imply that FDOM<sub>H</sub> is accumulated in the interior of the Japan Sea. We will discuss possible origin and accumulation mechanism of FDOM<sub>H</sub> in the Japan Sea interior.

Keywords: Japan Sea, Dissolved Organic Matter, Humic-like fluorescence

## Sources of hydroxyl radical photochemically produced in headwater streams from nitrogen-saturated forest

CHIWA, Masaaki<sup>1\*</sup>; HIGASHI, Naoko<sup>1</sup>; OTSUKI, Kyoichi<sup>1</sup>; KODAMA, Hiroki<sup>2</sup>; MIYAJIMA, Tohru<sup>2</sup>; TAKEDA, Kazuhiko<sup>3</sup>; SAKUGAWA, Hiroshi<sup>3</sup>

<sup>1</sup>Kyushu University Forest, <sup>2</sup>Graduate School of Science and Engineering, Saga University, <sup>3</sup>Graduate School of Biosphere Science, Hiroshima University

Hydroxyl radical ( $\cdot\text{OH}$ ) is the most oxidative reactant among the active oxygen species and oxidation reactions with  $\cdot\text{OH}$  are involved in important biogeochemical processes. In this study  $\cdot\text{OH}$  photoformation rate ( $R_{\text{OH}}$ ) was determined in headwater stream samples from nitrogen (N)-saturated forests, 1) to quantify the sources of  $\cdot\text{OH}$  in headwater streams and 2) to evaluate the nitrate ( $\text{NO}_3^-$ )-induced enhancement of  $\cdot\text{OH}$  formation in stream water caused by N saturation in forested watersheds. Stream water fulvic acid extracted from the forested watersheds was used to quantify the contribution of dissolved organic matter (DOM) to  $R_{\text{OH}}$ . The results showed that almost all (97%; 81-109%)  $R_{\text{OH}}$  sources in our headwater stream samples were quantitatively elucidated; the photolysis of  $\text{NO}_3^-$  (55%; 34-75%), nitrite [N(III)] (2%; 0.5-5.2%), and DOM-derived  $\cdot\text{OH}$  formation, from which photo-Fenton reactions (18%; 12-26%) and the direct photolysis of fluorescent dissolved organic matter (FDOM) (22%; 10-40%), was successfully separated. FDOM, which accounted for 53% (24-96%) of DOM in total organic carbon bases, was responsible for  $\cdot\text{OH}$  formation in our headwater streams. High  $\text{NO}_3^-$  leaching caused by N saturation in forested watersheds increased  $R_{\text{OH}}$  in the headwaters, indicating that N-saturated forest could significantly change photoinduced and biogeochemical processes via enhanced  $\cdot\text{OH}$  formation in downstream water.

Keywords: hydroxyl radical, dissolved organic matter, nitrate, photo-Fenton reaction, stream, photoinduced processes

## Effects of clear-cutting on the loss of ion and DOC from cool-temperate forested watershed in northern Japan

FUKUZAWA, Karibu<sup>1\*</sup> ; SHIBATA, Hideaki<sup>1</sup> ; TAKAGI, Kentaro<sup>1</sup> ; NOMURA, Mutsumi<sup>1</sup>

<sup>1</sup>FSC, Hokkaido University

Nitrate and dissolved organic carbon (DOC) concentrations in stream water before and after clear-cutting of trees and subsequent strip-cutting of understory vegetation, dwarf bamboo (*Sasa* spp.) were investigated to understand the effect of these disturbances on biogeochemical processes in forested watershed in Teshio Experimental Forest in northern Japan. Trees of 8 ha watershed except riparian zone were clear-cut in January-March of 2003. *Sasa* was strip-cut in October of 2003 and larch seedlings were planted on the cut line immediately after the *Sasa* cutting. Stream water was sampled every two or three weeks from 2002 to 2013. Tree-cutting did not cause a significant increase of nitrate concentration in stream water during the growing season after the cutting. Subsequent *Sasa*-cutting caused significant increase of stream nitrate concentration to ca. 15 micro mol L<sup>-1</sup>. At the cut site, it has been reported that *Sasa* compensated the decrease in tree fine root biomass. Thus, we suggest that nitrogen uptake by *Sasa* was very important in mitigating nitrogen leaching after tree-cutting, and the decline of this nitrogen uptake after *Sasa*-cutting lead to marked nitrate leaching to the stream. However, after that stream nitrate concentration fluctuated in the range of <0.1 to >20 micro mol L<sup>-1</sup> depending on date and year, and was especially high in 2007 throughout the year. It did not get back to pre-cutting level. Cation (K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>) concentration and pH fluctuated much depending on the flow rate and changes by both cutting were not observed. On the other hand, ammonium was detected in 2007 and synchronized with increase in nitrate concentration. DOC concentration in stream water was not changed after both cuttings of tree and *Sasa* and had clear seasonal pattern that peaked in late summer. Stream DOC concentration increased in growing period with low runoff from late May to August and then decreased after runoff increased in fall, indicating that dilution by the runoff reduce stream DOC concentration after late summer. However, DOC concentration remained low during winter when runoff was stably low, suggesting that high temperature also promote DOC production in soil during the early summer. DOC loss from ecosystem was not influenced by the cutting of trees and *Sasa* in this watershed owing to the adsorption to the soil at the cut area. These results indicate the response to cutting is different between NO<sub>3</sub><sup>-</sup> and DOC due to the different source area of these solutes in the watershed with cool climate and the gentle basin topography.

Keywords: nitrate, DOC, cation, *Sasa*, stream discharge

## Microbial contributions to biochemical commonalities of decaying organic matter

HOBARA, Satoru<sup>1\*</sup> ; AE, Noriharu<sup>1</sup> ; HASEGAWA, Yuki<sup>1</sup> ; OGAWA, Hiroshi<sup>2</sup> ; SATOU, Takayuki<sup>3</sup> ; IMAI, Akio<sup>3</sup> ; BENER, Ronald<sup>4</sup>

<sup>1</sup>Rakuno Gakuen University, <sup>2</sup>The University of Tokyo, <sup>3</sup>National Institute for Environmental Studies, <sup>4</sup>The University of South Carolina

Natural organic matters including dead organisms are decayed (decomposed) under various environmental conditions, but some parts of them, residues, remain for long time. Organic matter residues are major components of organic matter in soil and marine ecosystems, and play important functions and roles. The residues are originated from various organisms, organs, and cellular components, and in various stages of organic matter decay. Recently, it has been suggested that organic matter produced by microorganisms increase its percentage in residues during decay process. However, researches are limited especially on the quality of the produced organic matter and its producing processes. In this research, we investigate biochemical differences between original organic matters and organic residues and biochemical changes of organic matter during decaying process to clarify microbial contributions to the organic matter residues. Biochemical molecular compositions of original organic matters was more variable than those of organic residues in soil and water: for example, glycine:lysine (Gly/Lys) ratio and glucosamine:galactosamine (GlcN/GalN) ratio of original organic matters varies widely with origins, while those of decayed residues indicates considerably narrower ranges for both ratios. An incubation test, litterbag experiment, in a terrestrial ecosystem showed a clear trend that Gly/Lys ratio increased and GlcN/GalN ratio decreased during decay for all three species litter. These changes were also observed for litterbag experiments conducted in water, suggesting that it might be uniformly-observed biochemical directivity for decaying organic matter. In addition, amino acids and amino sugars are biomolecules, which increase during decaying processes, suggesting that this directivity results from microbial products. Another biochemical directivity was observed for molecular weight distribution of decaying organic matters, suggesting that organic residues derived from microbial products contribute to biochemical directivities and commonalities of decaying organic matter in various environmental conditions.

Keywords: Organic matter decay, Soil, Ocean, Amino acids, Amino sugars, Molecular weight distribution

## Spatial modelling of water, nitrogen and sediment for systematic conservation of multiple ecosystem services

FAN, Min<sup>1\*</sup> ; SHIBATA, Hideaki<sup>2</sup>

<sup>1</sup>Graduate School of Environmental Science, Hokkaido University, <sup>2</sup>Field Science Center for Northern Biosphere, Hokkaido University

Spatial modelling and analysis of multiple ecosystem service (ES) under land use and climate changes provides useful support for decision making in sustainable planning, management and policies of large landscapes. This study aimed to integrate the GIS modelling approach of spatial explicit ESs (water yield, and retention of nitrogen (N) and sediment) into system conservation model under various land use and climate changes in Teshio river watershed located in northern Hokkaido, Japan. In this study, we applied hydrology and material flow model (Soil and Water Assessment Tools, SWAT model), land use change model (CLUF) and system conservation model (Marxan). The multiple scenario includes three different land use maps in past (1976), current (2006) and future (2036), and three climate change scenarios (short-term (2010-2039), mid-term (2040-2069), and long-term (2070-2099)).

Our results indicated that various land use and climate change scenarios showed different impact on ES and system conservation in the watershed. The forest land use change significantly affected on magnitudes and spatial patterns in water yield, sediment and N retention. It was suggested that south western and northern part of the studied watershed should be conserved to match the given conservation targets of multiple ESs (0.3 and 0.5 of maximum ES values). The protection area to satisfy each ES conservation target increased with increase of differences between each ES and maximum ES values under land use and climate changes. Our results indicated that the land distribution and area of optimal ES protection for multiple ESs were totally different from those for single ES. The conservation area for multiple ESs was more compact than those for single ES. The proposed approach in this study provided useful information to assess the responses of ESs and system conservation under the land use and climate changes. The system conservation area of ES protection for multiple ESs provided an effective trade-off tool between environmental protection and agriculture expansion.

Keywords: Ecosystem services, SWAT, Marxan, Land use and climate change

## Spatial variability of mineralization and nitrification in soil nitrogen along the hillslope in Japanese cedar forest

KATO, Hiroyu<sup>1\*</sup> ; OHTE, Nobuhito<sup>1</sup> ; ISOBE, Kazuo<sup>1</sup> ; ODA, Tomoki<sup>1</sup> ; MURABAYASHI, Sho<sup>2</sup> ; URAKAWA, Rieko<sup>1</sup> ; SENOO, Keishi<sup>1</sup>

<sup>1</sup>University of Tokyo, graduate school of agricultural and life sciences, <sup>2</sup>University of Tokyo, faculty of agriculture

**Introduction** Precise understandings of mechanism of nitrogen (N) cycle is one of the most important subjects for ecosystem conservation in forests and rivers. Especially, the responses of N mineralization and nitrification to environmental changes are especially important due to their role in entire N cycling. Previous studies suggest that nitrification and mineralization have spatial variation in forest, which are controlled by the geophysical condition such as topography and water condition. The aim of this study is to clarify the mechanisms behind the spatial variety of nitrification and mineralization rate in soil along the hillslope.

**Methods** The field observations and soil samplings were conducted at Fukuroyamasawa Experimental Watershed (Catchment Area 0.8ha) which belongs to the University of Tokyo, Chiba forest. Dominant vegetation on the slope consisted of *Cryptomeria japonica* plantation. Along the hillslope (entire length: 110m), soil samples were collected at organic layer (O-layer) and mineral layer (0-10cm) at 10m intervals. After measuring water content and pH, the  $\text{NO}_3^-$  and  $\text{NH}_4^+$  concentration of soil extract (by 2M KCl solution) were measured. The net mineralization and nitrification rate were measured by laboratory incubations (28 days). Then, the gross mineralization and nitrification rate were determined using the  $^{15}\text{N}$  pool-dilution method.

**Results** Soil moisture content was higher at the down slope part. Similarly, the pH value was higher at down slope part. The pool size of  $\text{NO}_3^-$  was significantly low at the up slope part, and gradually increased along the slope toward the lower portion. On the other hand, the pool size of  $\text{NH}_4^+$  did not have visible pattern along the slope. Moreover, there was not significant spatial variations in net and gross mineralization rate over the hillslope while net and gross nitrification had significant spatial pattern with higher rate at the down slope part.

**Discussion** Difference in the spatial patterns of mineralization and nitrification suggested that nitrification is more sensitive to the geophysical conditions such as the soil moisture content. We are attempting to explain the mechanisms of these spatial patterns from the spatial distributions of related microbial communities in the next step of this study

## Nitrogen mineralization rates in forest soils in the Japanese archipelago measured by field incubation

URAKAWA, Rieko<sup>1\*</sup> ; OHTE, Nobuhito<sup>1</sup> ; SHIBATA, Hideaki<sup>2</sup> ; ODA, Tomoki<sup>1</sup> ; WATANABE, Tsunehiro<sup>2</sup> ; FUKUZAWA, Karibu<sup>2</sup> ; INAGAKI, Yoshiyuki<sup>3</sup> ; TATENO, Ryunosuke<sup>4</sup> ; OYANAGI, Nobuhiro<sup>5</sup> ; HATTORI, Daichi<sup>6</sup> ; NAKATA, Makoto<sup>6</sup> ; HISHI, Takuo<sup>7</sup> ; FUKUSHIMA, Keitaro<sup>4</sup> ; NAKANISHI, Asami<sup>4</sup> ; TODA, Hiroto<sup>8</sup>

<sup>1</sup>Graduate School of Agricultural and Life Sciences, University of Tokyo, <sup>2</sup>Field Science Center for Northern Biosphere, Hokkaido University, <sup>3</sup>Forestry and Forest Products Research Institute, <sup>4</sup>Field Science Education and Research Center, Kyoto University, <sup>5</sup>Environmental Science Research Niigata, <sup>6</sup>Graduate School of Science and Technology, Niigata University, <sup>7</sup>Graduate School of Agriculture, Kyushu University, <sup>8</sup>Graduate School of Agriculture, Tokyo University of Agriculture and Technology

### 1. Introduction

To predict the effect of climate change on nitrogen dynamics in the forest ecosystem, it is necessary to investigate nitrogen mineralization and nitrification at various locations allowing for modeling of nitrogen dynamics in soils. In this study, we selected 20 sites from the Japanese archipelago and conducted field incubation for measuring net nitrogen mineralization and nitrification. We also considered whether parameters obtained from laboratory incubation were applicable in the field by comparing the ratios between field and laboratory incubations (Urakawa et al., 2013).

### 2. Method

We conducted buried bag method to investigate field net nitrogen mineralization and nitrification rate. In autumn 2012, we established an experimental plot (20 \*20 m) at each site, and at each plot, five soil sampling locations were established. At each sampling location, mineral soil samples were collected from 0-10, 10-30, 30-50 cm depths. Soil samples were sieved (4 mm mesh) to remove roots and gravel, and composited soils from five plots into one sample at each depth. After collecting soils for the initial extraction, buried bags were made and buried in the plots again. We collected them in spring, summer, and autumn 2013, and measured net nitrogen mineralization and nitrification for three seasons (autumn 2012 - spring 2013, spring - summer, summer - autumn). Soil samples were extracted with 2M-KCl solution (1:10) and concentrations of ammonium nitrogen and nitrate nitrogen were measured by colorimetric method. Net nitrogen mineralization and nitrification amount of each season were summed to evaluate the annual amount.

Simultaneously with the field incubation, inorganic nitrogen leaching was investigated by resin column method. Resin columns containing ion exchange resin was installed at depths of 0 and 50 cm. Inorganic nitrogen absorbed by ion exchange resin was extracted with 1M-KCl and concentration of inorganic nitrogen was analyzed by colorimetric method.

### 3. Results and Discussion

Annual net nitrification in 0-50 cm layer ranged widely from 40 to 140 kgN ha<sup>-1</sup> y<sup>-1</sup>. Nitrification amount in 10-50 cm layer was comparable to that in surface soil layer (0-10 cm) due to large bulk density and thickness, while nitrification in 0-10 cm layer accounted for about a half of that of all soil layers.

There was a significant positive correlation between nitrification measured by field and laboratory incubation. This suggests that estimation of field nitrification using parameters obtained from laboratory incubation is possible.

### 4. Reference

Urakawa et al. (2013) Characteristics of nitrogen mineralization rates and controlling factors in forest soils in Japanese archipelago, 2013 AGU Fall Meeting, San Francisco, 9-13 December 2013

Keywords: forest soil, nitrogen mineralization, nitrification, field incubation, nitrogen leaching, ion exchange resin

## Analysis of transportation and consumption processes of atmospheric nitrate in forested watershed by using oxygen isotop

KUGO, Tatsuro<sup>1\*</sup> ; OSAKA, Ken'ichi<sup>1</sup> ; NAKAMURA, Takashi<sup>2</sup> ; II, Yumi<sup>1</sup> ; IWAI, Misako<sup>1</sup> ; NISHIDA, Kei<sup>2</sup> ; NAGAFUCHI, Osamu<sup>1</sup>

<sup>1</sup>University of Shiga Prefecture, <sup>2</sup>ICRE University of Yamanashi

Some studies reported that atmospheric nitrogen deposition into terrestrial ecosystem has recently increased due to increase of anthropogenic emission of nitrogen compound into atmosphere. However, dynamics of atmospheric nitrogen deposition in forested watersheds is not clearly understood. Moreover, that leads our poor understanding of influence of increasing atmospheric nitrogen deposition on nitrogen cycle in forested ecosystem and nitrogen discharge from forested ecosystem. The purpose of this study is to clarify the mechanisms of transportation and consumption of atmospheric nitrate deposition in forested ecosystems. We collected rainfall, throughfall, surface water, soilwater (10cm, 30cm), groundwater, spring water and streamwater at a forested watershed planted with Japanese cypress in central Japan at biweekly. Samples were analyzed for total nitrogen, dissolved nitrogen, nitrate, ammonium, nitrite, and oxygen isotope of nitrate. Isotope analysis was conducted at ICRE in University of Yamanashi. We also collected soil at several month intervals, and measured nitrate, ammonium in soil and net mineralization rate, and net nitrification rate. We are planning to present transportation rate of nitrogen compounds and atmospheric nitrate through the forested watersheds and discuss the interaction between nitrogen cycle and atmospheric nitrate deposition in forested ecosystem.

Keywords: oxygen isotope of nitrate, transportation and consumption processes of nitrogen, forested watershed

## The effect of soil freeze-thaw on nitrogen transformation through the root litter changes

HOSOKAWA, Nanae<sup>1\*</sup> ; WATANABE, Tsunehiro<sup>2</sup> ; FUKUZAWA, Karibu<sup>2</sup> ; TATENO, Ryunosuke<sup>3</sup> ; SHIBATA, Hideaki<sup>2</sup>

<sup>1</sup>Graduate School of Environmental Science, Hokkaido University, <sup>2</sup>Field Science Center for Northern Biosphere, Hokkaido University, <sup>3</sup>Field Science Education and Research Center, Kyoto University

Soil freeze-thaw cycles are considered to alter soil nitrogen (N) cycle through physical disturbances of soil, changes in root litter quality, inhibition of microbial N immobilization and others. However, these mechanisms have not been well elucidated yet. Plant litter is important substrate for N mineralization by soil microbes. It has been reported that root litter mass is quantitatively comparable to those of leaf litter in various forest ecosystems. Previous studies suggested that physical disruption of root litter by freeze-thaw cycle in winter affect soil N dynamics through the change in substrate availability. In this study we aimed to clarify that effect of root litter on the rates of soil N mineralization and nitrification under various conditions of soil freeze-thaw.

This study was conducted at Shibeche experimental forest, Kyoto University located in Eastern Hokkaido, Japan. The study site is dominated by Natural oak (*Quercus crispula*) with dense dwarf bamboo (*Sasa niponica*) as understory vegetation. Soil is Humic Andosol. In July 2013, we collected 0-10cm mineral soil and fine root (<2mm) of oak in the 2500 cm<sup>2</sup> square plot. The collected soil was sieved to 2mm to remove coarse gravel and coarse organic matter. Fine roots for incubations were separated manually from the organic matter. The fine roots were added to 25g soil as 0, 5 and 15 mg g soil<sup>-1</sup>, respectively. The soil were exposed to three different freeze-thaw treatments: +5 °C ~-5 °C, -5 °C ~0 °C, -5 °C constant and +5 °C constant for 7days in low temperature incubator. After these freeze-thaw treatments, the soil were incubated at +5 °C for 2 days. For the samples exposed at +5 °C ~-5 °C and -5 °C constant were also incubated at +5 °C for 7 days and at +10 °C for 2 and 7 days. Each treatment had four replications. Soils were extracted using potassium chloride (KCl) before and after incubations, and were measured for ammonium (NH<sub>4</sub>) and nitrate (NO<sub>3</sub>) concentrations in the extracts. Net production rates of NH<sub>4</sub> and NO<sub>3</sub> were calculated as differences of NH<sub>4</sub> and NO<sub>3</sub> contents in soil between before and after the incubations. After the freeze-thaw treatment, roots were extracted using distilled water, and were measured for dissolved organic nitrogen (DON) in the extracts.

Root litter addition significantly increased the net NH<sub>4</sub> production incubated at 5 °C for 2 days after all freeze-thaw treatments (15 mg added >0mg added) with maximum at -5 °C ~0 °C treatment followed by -5 °C constant treatment. However, these effect were not observed in higher incubation temperature (10 °C) and longer incubation period (7days), rather dominated by N immobilization in those treatments. Similarly, the root litter additions significantly increased the net NO<sub>3</sub> production rate (nitrification rate) incubated at 5 °C for 2 days after all freeze-thaw treatments (15 mg added >0mg added) with maximum at +5 °C ~-5 °C treatment. However, these effect were not observed in higher incubation temperature (10 °C) and longer incubation period (7days) as same as the effects to the NH<sub>4</sub> production. The DON supply by water extraction from root litter tended to be large at -5 °C ~0 °C treatment.

These results indicated that increases of soil freeze-thaw cycles with root litter addition increased the net NH<sub>4</sub> production and nitrification. It was suggested that DON supply from root litter by soil freeze-thaw cycle related to these impacts. These effect seems to be remarkable in shorter period (2 days) and lower temperature (5 °C incubation). Furthermore, net NH<sub>4</sub> production, the sum of net NH<sub>4</sub>+NO<sub>3</sub> productions and DON supply from root rate were higher at -5 °C ~0 °C treatment than those at +5 °C ~-5 °C treatments, implying that magnitude (temperature ranges) of freeze-thaw cycle was not simple explain variables to impact of freeze-thaw on the microbial NH<sub>4</sub> production and nitrification activities.

## Estimation of trace gas fluxes in the forest of Mount Fuji using the multi layer model

NIJIMA, Kohei<sup>1\*</sup>; HIDA, Yuki<sup>1</sup>; WADA, Ryuichi<sup>1</sup>; MOCHIZUKI, Tomoki<sup>2</sup>; TANI, Akira<sup>2</sup>; NAKAI, Yuichiro<sup>3</sup>; TAKANASHI, Satoru<sup>3</sup>; NAKANO, Takashi<sup>4</sup>; TAKAHASHI, Yoshiyuki<sup>5</sup>; MIYAZAKI, Yuzo<sup>6</sup>; UEYAMA, Masahito<sup>7</sup>

<sup>1</sup>Teikyo University of Science, <sup>2</sup>University of Shizuoka, <sup>3</sup>FFPRI, <sup>4</sup>Yamanashi Institute of Environmental Science, <sup>5</sup>National Institute for Environmental Studies, <sup>6</sup>Hokkaido University, <sup>7</sup>Osaka Prefecture University

We measured vertical profiles of nitrogen oxide, NO, nitrogen dioxides, NO<sub>2</sub>, ozone, O<sub>3</sub>, and VOC in the atmosphere in Fujiyoshida and Hokuroku forest observation sites at the foot of Mt. Fuji in summer 2012. The concentration of ozone increased gradually with the height, but the concentrations of NO and NO<sub>2</sub> did not changed obviously. VOCs showed characteristic vertical profiles. We calculated O<sub>3</sub> fluxes at parts of in and under the canopy, and around the surface layer as  $-2.6 \pm 3.2 \text{ nmol m}^{-2} \text{ s}^{-1}$ ,  $0.2 \pm 2.9 \text{ nmol m}^{-2} \text{ s}^{-1}$ ,  $-8.7 \pm 5.2 \text{ nmol m}^{-2} \text{ s}^{-1}$ , respectively.

Keywords: forest, atmosphere, nitrogen oxides, ozone, VOC, vertical profile

## Localization of delta-34S value distribution in tree ring of Japanese cedar and evaluation on the S deposition history

ISHIDA, Takuya<sup>1\*</sup> ; TAKENAKA, Chisato<sup>1</sup> ; TAYASU, Ichiro<sup>2</sup>

<sup>1</sup>Nagoya univ., <sup>2</sup>Kyoto univ.

Anthropogenic sulfur emissions have been changed with human activities and affected sulfur dynamics in terrestrial ecosystems. Therefore, the information on sulfur deposition change should be important for understanding of the effects of anthropogenic sulfur on its dynamics. The stable sulfur isotope ratios ( $\delta^{34}\text{S}$ ) in tree rings are a useful archive for the history of sulfur deposition (Kawamura et al. 2006), since the  $\delta^{34}\text{S}$  of various origins have specific values and there is few isotopic fractionation through absorption of sulfur by plant. However, only few studies have been conducted about the  $\delta^{34}\text{S}$  in tree ring, and factors affecting the  $\delta^{34}\text{S}$  in tree ring have not been understood.

The aim of this study is to clarify the localization of  $\delta^{34}\text{S}$  distribution in tree ring. We also perform the evaluation of sulfur deposition history at locations received heavy anthropogenic sulfur deposition using tree ring.

The investigation was carried out at two study sites, Yokkaichi (YOK) and Inabu (INA) in central Japan. Both study sites have different histories of sulfur deposition. YOK had been affected by quite high anthropogenic sulfur deposition during 1960s. INA is located about 60 km NE of main urban area (Nagoya City). Three disk samples were obtained from Japanese cedar (*Cryptomeria japonica*) stump in 2013 at YOK and in 2012 at INA. The stumps at YOK were 63-year-old cut down in 2012 and those at INA were 170-year-old cut down in 2007. In addition, at INA, three 40-year-old living stems were cut down in 2013 at INA and the disk samples were obtained. After washing and dried, the tree ring samples were divided into 5 year increments from bark toward the pith, and ground using power mill. The ground samples were digested with  $\text{HNO}_3$  and  $\text{H}_2\text{O}_2$  on a hot plate and after filtration  $\text{BaCl}_2$  was added to obtain the  $\text{BaSO}_4$ . The  $\delta^{34}\text{S}$  values (VCDT) were measured using EA-IRMS.

To evaluation the localization of  $\delta^{34}\text{S}$  in sapwood, heartwood and pith, the data from the stump and the living wood samples at INA were compared. These samples showed the different localization of  $\delta^{34}\text{S}$  against the age. There were no difference of  $\delta^{34}\text{S}$  between the sapwood (living wood) and the heartwood (stump) at the same age. However, the  $\delta^{34}\text{S}$  values of the pith (living wood) were higher than those of heartwood (stump). This result indicated that the specific composition of sulfur compound might be consisted in pith and the  $\delta^{34}\text{S}$  of the pith should be unsuitable for evaluation of sulfur deposition history.

The  $\delta^{34}\text{S}$  values in ring at YOK declined from the late 1950s to early 1970s and then increased again. This trend was almost homologized in ring at INA and air  $\text{SO}_2$  concentration at near the YOK. In contrast, the minimum value of at YOK (-7.3 ‰) was lower than that at INA (-1.6 ‰). These results should be reflected by the deposition history of anthropogenic sulfur with low  $\delta^{34}\text{S}$  value at each site.

Keywords: Tree ring, Sulfur isotope, Morphology, Sulfur deposition

## Distribution of radiocesium in a small forest at Namie town in Fukushima Prefecture

OGATA, Hiroko<sup>1\*</sup>; KUROSHIMA, Hiroto<sup>1</sup>; OKOCHI, Hiroshi<sup>1</sup>; TOKONAMI, Shinji<sup>2</sup>; SORIMACHI, Atsuyuki<sup>3</sup>; HOSODA, Masahiro<sup>4</sup>; IGARASHI, Yasuhito<sup>5</sup>; KATAOKA, Jun<sup>1</sup>; OHSUKA, Shinji<sup>6</sup>

<sup>1</sup>Waseda University, <sup>2</sup>Hirosaki University, <sup>3</sup>Fukushima Medical University, <sup>4</sup>Hirosaki University Graduate School, <sup>5</sup>Meteorological Research Institute, <sup>6</sup>Hamamatsu Photonics K.K.

Fresh leaf/needle, litter, surface soil, stream water and bottom sand were monthly collected in a deciduous broadleaf forest and an evergreen needleleaf forest in Fukushima Prefecture during non-snowfall period. The concentration of radiocesium (<sup>134</sup>Cs and <sup>137</sup>Cs) was measured by commercially available NaI(Tl) scintillation detector.

The air dose rate at a broadleaf forest (5.64  $\mu$ Sv/h) was higher than that at a needleleaf forest (4.11  $\mu$ Sv/h) in November 2012. The average concentration of radiocesium in each sample was also higher at broadleaf forests than at needleleaf forests. The order of the concentration of radiocesium was litter > surface soil > fresh leaf/needle > bottom sand at both sites, indicating that radiocesium was accumulated in litter. Radiocesium was not detected in precipitation, throughfall, and stream water.

Surface soil samples at each sampling point were taken using a scraper plate in April and December 2013. Samples were taken with 0.5 cm increments for the depth of 0-5 cm and 1.0 cm increments for the depth of 5-10 cm. The maximum concentration was found at the surface at the broadleaf forest in April and December 2013. The maximum concentration was also found at the surface at the needleleaf forest in April 2013 but at 1-1.5 cm in December 2013, indicating that the radiocesium in surface soil penetrated deeply at the needleleaf forest. These differences were likely caused by the soil type and the composition of tree species at the sampling points.

A photostimulable phosphor (PSP) image plate was used to record a two-dimensional image of radioactivity distribution on the leaf/needle and root of the broadleaf tree samples. We used the CR<sup>x</sup>25P (General Electric Company). The image of the needleleaf sample of Japanese cedar showed some high intensity spots on the needles, indicating the presence of radioactive dusts attached onto the plant's surface. On the other hand, the image of the broadleaf showed uniform distribution, suggesting that contamination with radiocesium occurred internally.

In the presentation, we will also report about the runoff processes of the radiocesium with the stream bottom sand.

## Monitoring of atmospheric mercury pollution using a leaf camphor tree ( *Cinnamomum camphora* (L.) Sieb. )

CHIKAMASA, Takaya<sup>1\*</sup> ; KAMIYAMA, Naoko<sup>1</sup> ; SATAKE, Kenichi<sup>1</sup>

<sup>1</sup>Faculty of Geo-environmental Science, Rissho University

Source of mercury is divided into two anthropogenic sources such as incineration and sludge of fossil fuel and natural sources, such as by volcanic activity. Mercury discharged from these sources is present in the gaseous atmosphere mainly. On the other hand, trees are accumulated by adsorption or absorption in the leaves and bark of contaminants in the atmosphere. I am thought to absorb atmospheric pollution from the pores in the case of accumulation by the leaves. I was aimed at performing mercury pollution monitoring of air by measuring the mercury content in the leaves in this study. The absorption in the two years up fallen leaves from the deployment of new buds and evergreen broad-leaved tree, using the camphor tree( *Cinnamomum camphora* (L.) Sieb. ) accumulation is expected to indicators of mercury pollution in the atmosphere. I was monitoring for the full year, including the winter an increase in use of fossil fuels is expected by this. It was possible sampling points you ' ve covered as being human influenced due to its proximity to urban areas, in Rissho University campus is located in Kumagaya, Saitama Prefecture. In addition, a point of performing region comparison was a sampling Kirryu City in Gunma, Ogose town in Saitama, Ueno Park in Tokyo, Sarue Park in Tokyo and Katsuura City in Chiba.

### 1. Changes in mercury concentration due to dry and weight change due to drying temperature of leaf

After drying for five hours, respectively 70 °C leaves, at 130 °C, it was found that 60 minute in 70 °C , it is 10 minute at 130 °C to constant weight. Mercury concentration at each temperature was 33.4ngg<sup>-1</sup> at 70 °C, 33.0ngg<sup>-1</sup> at 130 °C.

### 2. Mercury concentration in the leaves within the site-specific mercury concentration in leaves

I was measuring the mercury concentration of each site by dividing the top, middle, at the bottom toward the petiole from the tip of the leaf camphor tree. As a result, mercury concentration was 62.0ngg<sup>-1</sup> at the top, 67.0ngg<sup>-1</sup> at middle, 66.5ngg<sup>-1</sup> at the bottom. In addition, I compared the mercury concentration in leaves in removing the mercury deposited in the leaf and total mercury concentration in the leaves. It is a leaf inside was revealed that much of the mercury contained in the leaves.

### 3. Changes in mercury concentration in the leaves by the time series variation

I investigated the time series changes in mercury concentration accumulated in the leaves by the use of leaves of different leaf age.

Keywords: mercury, camphor tree, environment

MIS21-P16

Room:Poster

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## Restoration of Soil Physical Properties by No-tilled Management in Tropical Sugarcane.

MORI, Yasushi<sup>1\*</sup> ; ARAI, Miwa<sup>2</sup> ; KANEKO, Nobuhiro<sup>2</sup> ; SWIBAWA, Gede<sup>3</sup> ; NISWATI, Ainin<sup>3</sup>

<sup>1</sup>Okayama Univesity, <sup>2</sup>Yokohama National University, <sup>3</sup>Univresity of Lampung

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Keywords: Non-till, Sugarcane, Infiltration

## A study of soil organic matter stabilization using physical fractionation, isotopic, and spectroscopic approaches

WAGAI, Rota<sup>1\*</sup> ; ASANO, Maki<sup>1</sup> ; HAYAKAWA, Chie<sup>1</sup> ; INOUE, Yudzuru<sup>2</sup> ; KAJIURA, Masako<sup>1</sup> ; HIRADATE, Shyuntaro<sup>1</sup> ; YAMAGUCHI, Noriko<sup>1</sup> ; INAGAKI, Yoshiyuki<sup>7</sup> ; UCHIDA, Masao<sup>3</sup> ; TAKEICHI, Yasuo<sup>4</sup> ; SUGA, Hiroki<sup>5</sup> ; JINNOU, Muneaki<sup>4</sup> ; ONO, Kanta<sup>4</sup> ; TAKAHASHI, Yoshio<sup>5</sup>

<sup>1</sup>National Institute for Agro-Environmental Sciences (NIAES), <sup>2</sup>Kyushu University, <sup>3</sup>National Institute of Environmental Studies (NIES), <sup>4</sup>High Energy Accelerator Research Organization (KEK), <sup>5</sup>Hiroshima University, <sup>6</sup>TOYAMA Co. Ltd., <sup>7</sup>Forestry and Forest Products Research Institute

Volcanic-ash soil (Andisol) is unique among the world soil types due to the strong physical stability of organo-mineral aggregate structure at micro and submicron scales (Asano and Wagai, 2013, Geoderma) and its high capacity to store organic matter (OM) even in upland surface horizons under warm, moist climate regime where microbial heterotrophic activity is high. Several hypotheses have been proposed to account for these features of Andisol including (i) strong interaction of OM with dissolved metals (Al, Fe) and/or short-range-order (SRO) minerals that are quite abundant in this soil type, and (ii) preservation of recalcitrant compounds such as char.

Here we present some highlights from the 3-year project (GR091, NEXT Program, JSPS) examining the mechanisms of soil OM stabilization with a focus on organo-mineral interactions at various spatial and temporal scales using multiple analytical methods and experimental approaches. After careful consideration of the degree of soil aggregate disruption levels, we physically fractionated Andisol surface horizon sample based on particle size and density. Chemical composition of each physical fraction was assessed by elemental analysis, selective dissolution of inorganic phases, and solid-state <sup>13</sup>C-NMR. The origin and degree of microbial alteration of OM was estimated from C and N stable isotope ratios while the turnover time of C was assessed by radiocarbon measurements. Physical features of soil mineral and organo-mineral aggregate surfaces were characterized by specific surface area (N<sub>2</sub>-BET), XPS, and microscopic methods. We also conducted tracer experiments to further assess the residence time of the OM in each density fractions. Based on these results, we will discuss the progression of organo-mineral associations from fresh plant detritus to the aggregates of varying structure and stability for the studied Andisol.