Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS24-P01 Room:Convention Hall Time:May 23 18:15-19:30

Dissolved iron concentration in rivers throughout Japan and GIS analysis of its geographical factors

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Being an essential element, iron can be a limiting factor for marine production. Iron is abundant in earth's surface but dissolved iron is only bio-available. It has been generally believed that forest is vital as a source of dissolved iron, where iron is complexed with humic substances, but few studies have been reported to demonstrate it. In the present study, we firstly show dissolved iron concentration in rivers throughout Japan on the basis of an existing database of river chemistry and a field survey of ourselves. In addition, the geographical factors that regulate river dissolved iron concentration are analyzed by using GIS. The results showed that a wide range exists in dissolved iron concentration among rivers throughout Japan as much as two orders of magnitude with some regionality. Dissolved iron concentration did not have any relationship with forest area coverage; it appears that forest ecosystem itself does not act as a source of dissolved iron. The level of dissolved iron was adequately explained by soil types of Histosols (peaty) and Gleysols (very wet) in river basin and by the gentleness of land surface. The GIS analyses suggest that an important factor to generate dissolved iron is flat lands, where reductive conditions could prevail.

Keywords: dissolved iron, marine production, forest as a possible iron source, river export, geographical factors, GIS analysis

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Humic Substances Affect Growth of the Marine Phytoplankton Cultures

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Humic substances are major components of dissolved organic matter in aquatic systems and known to have a substantial influence on the trace metal speciation, and thus the bioavailability of trace elements. Using newly developed chemically defined medium, we investigated the iron requirements and effects of humic substances on the growth of axenic phytoplankton cultures. Calculated EDTA bound iron species had positive effects on the growth of marine plankton cultures. It is suggested that the composition and concentration of humic substances affect the growth of marine phytoplankton by controlling the iron availability.

Keywords: Marine phytoplankton, Humic substance, Iron, Culture experiment

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Input-output budgets and internal fluxes of dissolved materials in tropical rainforest catchment of Malaysian Borneo

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The neutralisation of dissolved materials from rainfall to streams in catchments is poorly understood in tropical rainforests with complex biogeochemical and hydrological processes. To investigate the status of neutralisation process and factors controlling streamwater chemistry, input-output budgets and internal fluxes of dissolved materials have been observed in the Baru forested catchment near the Danum Valley Field Centre (DVFC), Sabah, Malaysian Borneo.

The study catchment is covered by 'lowland dipterocarp rainforest'. We collected streamwater from the bottom of the Baru catchment for 3 years and 9 months, from April 2008 to December 2011. To examine the effect of the plant-soil system on the streamwater chemistry, soil solutions were collected several times during 4 months from May to August 2010 using a tension lysimeter (porous cup), and the vertical ion fluxes via the rainfall, the throughfall, the litter and the soil layer were determined using an ion-exchange resin column (IER column) for 2 years, which were divided into four periods from March 2009 to February 2011. Soil solutions using a porous cup were used to examine the temporal change of the concentrations, whereas the vertical fluxes determined by the IER column clarified the vertical distribution of ion fluxes through the plant-soil system; we used IER data to calculate the vertical fluxes from the rainfall to the soil.

In streamwater, the pH was relatively high, and over one year, it fluctuated temporally within a small range between 6.5 and 7.6. The streamwater pH was not directly correlated with water discharge, which controlled most other dissolved materials in the streamwater. The pH did not change over time with strong acid (NO_3^- and SO_4^{2-}); rather, it was affected by the dissolved organic carbon (DOC) and HCO_3^-/DOC in this tropical stream. In the plant-soil system, the mean precipitation pH value of 5.3 declined to 4.8 in the surface soil solution and increased to 5.9 in the subsoil and 7.1 in streamwater. A principal component analysis of the soil solution and the streamwater chemistry revealed that the solute pH value declined due to the high concentration of NO_3^- in the surface soil and increased due to low NO3- and high base cations in the streamwater.

The annual vertical fluxes of almost all ions rapidly increased from the canopy to the surface soil. The NO_3^-, NH_4^+ and K^+ fluxes markedly decreased from the surface soil to the stream, whereas the Na+, Ca2+ and Mg2+ fluxes remained high in the subsoil and the stream. We concluded that significant chemical weathering between the subsoil and the stream played an important role in the relatively high and stable streamwater pH value and ANC because exports of Na^+, Ca^{2+} and Mg^{2+} to the stream greatly exceeded the input via atmospheric deposition and because HCO_3^- was significantly correlated with SiO_2 and base cations over the year. In this tropical rainforest catchment, the streamwater had a low acid sensitivity to the fluctuation of NO_3^- or SO_4^{2-} leaching due to the constant high HCO_3^- leaching derived from chemical weathering, whereas DOC, including organic acids, may cause temporal variations in water acidification. A comparison with other studies suggested that regional variations in the streamwater pH of tropical forest might be controlled by the leaching balance of base cations and SO_4^{2-}, which were derived from the chemical weathering.

Keywords: Tropical rain forest, Catchment study, Stream water, Soil solution, Atmospheric deposition

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Origin and composition of organic matter in a brackish lagoon by elemental and isotopic techniques

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Blue Carbon, captured and sequestrated by marine organisms, has attracted attention as one of the major sink of the carbon emitted by anthropogenic activity. Coastal shallow ecosystems such as seagrass meadows and intertidal flats are recently proposed to be particularly important for Blue Carbon; however, the scientific validation has only just begun. A large amount of terrestrial carbon flows into estuaries, consequently being buried in coastal zones. Also, estuaries have high biological productivity due to riverine nutrient load, resulting in significant amount of autochthonous organic matter supply into water column by primary producers. Therefore, various organic matter compositions, having different origin and bioavailability, are mixed in shallow waters. In this study, we estimate the origin and composition of organic matter in a brackish lagoon using elemental, isotopic and optical techniques, to help evaluation of carbon storage at shallow water ecosystems.

Our study site, the Furen Lagoon, is located at the high latitude in Japan. Several rivers flow into the lagoon and pastures are dominant in the catchment area, causing eutrophication because of the livestock wastes. Seagrass meadows occupy 67 % of the total area of the lagoon. To evaluate the autochthonous and allochthonous organic matter components, we collected samples in the lagoon and rivers along the salinity gradient. POC (particulate organic matter) and PON (particulate organic nitrogen) concentrations, as well as carbon and nitrogen isotopic signatures were analyzed. The relative contribution of four sources (terrestrial POM, coastal POM, lagoon POM, and seagrass) to total POM were estimated using a mixing model of three variables (N/C, d13C, d15N). The origin and composition of DOM were evaluated by concentration, elemental ratio (C/N) and absorption spectrum. The autochthonous phytoplankton POM was indicated to be dominant in the lagoon with a salinity range of 10 to 25. The terrestrial POM occupied 60 % at the river mouth, but decreased with increasing salinity. Supply of DOM increased with chlorophyll a concentration in the lagoon. Since C/N ratio declined along with increasing DOM, DOM supplied in the lagoon would be mainly derived from phytoplankton. These results suggest that the lagoon can be the sink of carbon due to high autochthonous production and deposition of terrestrial carbon.

Keywords: stable isotope mixing model, elemental ratio, estuary, particulate organic matter, dissolved organic matter

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Spectral characteristics of chromophoric dissolved organic matter in the western North Pacific

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Chromophoric dissolved organic matter (CDOM) ubiquitously occurs in marine environments and plays a significant role in the marine biogeochemical cycles. Basin scale distributions of CDOM have recently been surveyed in the global ocean and indicate that quantity and quality of oceanic CDOM are mainly controlled by in situ production and photo-degradation. However, factors controlling the spectral parameters of CDOM at UV region (i.e., S275-295 and SR) have not been well documented. To evaluate the factor controlling the spectral characteristics of CDOM at UV region in open ocean, we determined the quantitative and qualitative characteristics of CDOM in the subarctic and subtropical surface waters (5-300 m) of the western North Pacific. Absorption coefficients at 320 nm in the subarctic region were significantly higher than those in the subtropical region throughout surface waters, suggesting that magnitudes of photobleaching were different between two regions. The values of S275-295 and SR were also significantly higher in the subtropical region compared with the subarctic region. The dark microbial incubation showed biodegradation of DOM little effected on S275-295, but slightly decreased SR. On the other hand, increases and unchanging was observed for S275-295 and SR during photo-irradiation incubations respectively. These experimental results indicated that photobleaching of CDOM mainly produced qualitative differences in CDOM at UV region between the subarctic and subtropical surface waters. The results of this study imply that S275-295 can be used as a tracer of photochemical history of CDOM in open ocean.

Keywords: Marine biogeochemistry, Dissolved organic matter, Spectral characteristics, Photobleaching

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Contribution of heterotrophic bacteria for degradation process of organic carbon in the ocean

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Proliferation of phytoplankton is the most important events that stimulate, upkeep and sustain all the biochemical processes in the oceanic ecosystems. This event contributes largely to biological pump facilitating carbon dioxide sequestration in the ocean. About half of the photosynthetically produced organic matter is consumed by heterotrophic microorganisms in the surface layers. Active growth and proliferation of these heterotrophs facilitate the build-up of biomass that is available to higher trophic levels via microbial loop. In addition, heterotrophic mineralization of organic matter in the surface layers is pivotal for recycling inorganic nutrients. Therefore, the interactions between phytoplankton and heterotrophic bacteria are central to the carbon cycle in the ocean.

The advent of culture-independent molecular approaches has facilitated the phylogenetic description microbial communities in the ocean. Several investigations during the last three decades, have described marine microbial communities through sequencing of phylogenetic marker genes directly from the environmental DNA samples. In addition, total bacterial production has been routinely measured by the incorporation of radiolabeled substrates. Yet, the fundamental questions that persist are 1) which phylogenetic groups account for total bacterial production? and 2) what is the relative contribution of each? Answers to these are substantially important to our understanding of the food web dynamics and biogeochemical cycles in the ocean.

To answer these questions, I have developed a novel method, named bromodeoxyuridine immunocytochemistry-fluorescence in situ hybridization (BIC-FISH) which method enable to measure the phylotyp-specific bacterial growth without using radiolabeled tracers. This combined method of two different techniques can measure single-cell activity or growth rate and, can identify its phylotype. The BIC is a technique to detect BrdU-incorporating (therefore actively growing) cells with the use of fluorescently labeled antibody. In this presentation, I introduce the interaction between heterotrophic bacterial and spring diatom blooms in the western North Pacific Ocean, and discuss about ecological roles of heterotrophic bacteria for degradation of organic matters produced by phytoplankton in the ocean.

Keywords: Marine bacteria, Community structure, Phytoplankton, Ocean carbon cycle

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Linking temperature sensitivity of decomposition with substrate quality and microbial physiology

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Carbon dioxide production via microbial degradation of organic matter (OM) may significantly accelerate anticipated global warming depending on its temperature sensitivity. Thus the controls on the degradation temperature sensitivity have been a topic of scientific debate in both terrestrial and marine systems. A leading hypothesis in the terrestrial literature (called enzyme kinetic or carbon quality hypothesis) suggests that the degradation of low-quality substrate (SOM with complex molecular structure) is more temperature sensitive than that of high-quality, simple substrate in accord with Arrhenius kinetic theory. Supporting evidence, however, relies largely on respiration-based indices of substrate quality. Furthermore, the enzyme-substrate reactions that drive SOM degradation may be regulated by microbial physiology (e.g., direct temperature effect on microbial community) and/or constrained by protective effects of soil architecture (e.g., micro-aggregate formation via organo-mineral interaction).

We thus tested the kinetic hypothesis by directly assessing the carbon molecular structure of low-density fraction (LF) which represents readily accessible, mineral-free SOM pool. Using five mineral soil samples of contrasting SOM concentrations, we conducted 30-days incubations (15, 25, and 35 oC) to measure microbial respiration and quantified easily-soluble C as well as microbial biomass C pools before and after the incubations. The respiration Q10 was significantly correlated with the abundance of aromatic plus alkyl-C relative to O-alkyl-C groups in LF but not in bulk soil fraction or with the indirect C quality indices based on microbial respiration or biomass. The laboratory warming did not significantly change the size of microbial biomass C or the three types of soluble C pools despite two- to three-fold increase in respiration. These results suggest that the enhanced microbial maintenance respiration (reduced C-use efficiency) upon warming especially in the soils rich in recalcitrant LF might lead to the apparent equilibrium between SOM solubilization and microbial C uptake. Our results showed physical fractionation coupled with direct assessment of molecular structure as an effective approach and supported the enzyme-kinetic interpretation of widely observed C quality-temperature relationship for short-term degradation. Factors controlling the Q10 of long-term SOM degradation are more complex due to protective effect of mineral matrix and thus remain as a central question.

Keywords: soil organic matter, microbial degradation, NMR, density fractionation, kinetic theory, Q10

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Detecting 15N records in paleo-laminaria specimen; Evidence of herrings derived DIN to the west coast of Hokkaido, Japan

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We suggested the possibility of the evidence of nitrogen supply impact along the west coast of Hokkaido, Japan, derived a large quantities of herrings from the end of the 19th century to the early of the 20th century, by detecting 15N recorded in long-term paleo-laminaria specimens. This result may support the ” nutrients transport hypothesis by herring ” based on empirical results until now.

We had started to monitor of nutrients concentrations in the west coast of Hokkaido from 1989, the no data before 1988 were achieved unfortunately. So we would have to make effort to research the good indicator of nutrients conditions in the past time. In general, attached seaweeds such as laminaria are primary producer in the coastal zone of marine environments, which synthesize body components by absorbing nutrients for the spot, therefore they reflected the integrating nutrients environment for the spot in a past environments. This may suggest that the past nutrients environment can be presumed by analyzing the body components.

We had obtained the long-term paleo-laminaria specimens which had inhabited at the sea areas around Hokkaido before 1880 to 2011 (for the past 133 years) and they were conserved as specimens at the Herbarium, Graduate School of Science, Hokkaido University (SAP) in the Hokkaido University Museum. On the other hand, the living laminaria, which inhabits at the same sites, where those paleo- laminaria had been collecting as long as possible. The nutrient conditions between the present and the past of the west coast of Hokkaido, Japan were compared by analyzing 15N of the algal body components, which were used as an indicator of the origin of DIN.

15N of the laminaria which had inhabited the sea areas surrounding Hokkaido after 1980s showed 5˜6 per mill order which was the range of a general 15N of primary producer utilizing nitrogen in the sea water, while it showed the high value of 10 per mill order around the wide coastal area of the Sea of Japan, Hokkaido between 1880 and 1920. Although these results could not be explained by only an isotope fractionation or deterioration of specimens, inflowing of anthropogenic nitrogen, and denitrification, the possible high concentrations of DIN which had different origin of the present and the other sea areas were utilized by laminaria.

Once herring, Clupea pallasii fishery had supported the economy and culture of Hokkaido. Herring catches in the Sea of Japan between 1880 and 1920 reached about 500 to 1000 times of the present catches and occupied more than 90% of only in the Sea of Japan. The 15N of the laminaria deteted by this study showed a similar trend to the herring catches of only in the Sea of Japan. Therefore we thought a possibility that DIN originated from a large amount of herrings in those days distributed in the west coast of Hokkaido and laminaria had absorbed these nutrients. This result may support the ” nutrients transport hypothesis by herring” based on empirical results until now, we suggested the possibility of the evidence of nitrogen supply impact along the west coast of Hokkaido, Japan, derived a large quantities of herrings from the end of the 19th century to the early of the 20th century, by detecting 15N recorded in long-term paleo-laminaria specimens.

Keywords: laminaria, 15N, west coast of Hokkaido, herrings, DIN

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Spatio-temporal variation of phosphate concentration at river mouths in the Lake Hachiro watershed, Akita, Japan

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[Aim] The present study was conducted to elucidate spatio-temporal variation of phosphate (PO4) concentration at river mouths of 5 main rivers entering to Lake Hachiro.

[Materials and Methods] Study sites were at river mouths of 5 main rivers (MTN, BBM, IKW, TYK, BFM) entering to Lake Hachiro at Akita prefecture, Japan. Surface and bottom (about 10 cm from the riverbed) of river water at each site was sampled once a month from May to December in 2012. River sediments were also collected from the top 10 cm of the riverbed at the same time of the water sampling. Dissolved gases in stream water were collected to measure N2O and CH4 concentration. Water and sediment samples were placed on ice, transported back to the laboratory, and refrigerated until denitrification assays and water analysis. Sediment incubation was conducted to evaluate the effect of temperature (10, 25 deg C) and oxic or hypoxic conditions on PO4 release from the sediments. Fractionation of sediment phosphorus (soluble and loosely bound P, Al-P, Fe-P, reductant soluble P, and Ca-P) was also determined at each site. Phosphorus concentrations in the various solutions were determined using the molybdenum blue method. The denitrification assays of the sediments were determined using the acetylene inhibition technique, which inhibits the final step in the conversion of N2O gas into N2 gas. To determine the difference among sites in the amount of organic C available to the denitrifying organisms, we defined denitrification potential (DP) as the denitrification rate that occurred under anaerobic conditions with abundant NO3- at 25 deg C.

[Result and Discussion] Riverine PO4 concentrations had a large spatio-temporal variation, which increased from summer to autumn at three rivers (IKW, TYK, BFM). PO4 concentrations in bottom water tended to be higher than that in surface water, which indicated part of PO4 was from the riverbed during summer and autumn. In contrast, NO3- concentrations decreased likely by denitrification of which DP was higher in the three rivers, causing lower DIN/DIP ratios in river water during the summer. Higher dissolved CH4 concentrations in the bottom water indicated the riverbed was under anoxic condition in summer at the three river mouths. The results of the sediment incubation clearly demonstrated that PO4 was released from the sediments at 25 deg C with hypoxic condition, especially from the three river's sediments. Fe-P contents in the sediments also had a spatial variation among sites and correlated positively with PO4 concentration in the river water. In conclusion, Fe-P in the river sediments had a large impact on the river water and would result in the spatio-temporal variations of PO4 concentration in river mouths in the Lake Hachiro watershed.

Keywords: phosphorus, river sediment, eutrophication, denitrification, Fe-P

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Relationship between the coastal Blue Carbon and atmospheric CO_2

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The mitigation of atmospheric CO_2 is an urgent task for future climate change, and has been required to be applied to several initiatives. UNEP reported that the Blue Carbon, which is the carbon captured by marine living organisms, could be a new initiative for future climate change. Especially, coastal regions are expected to be long-term atmospheric CO_2 storage because the persistent Blue Carbon such as seagrasses is estimated to sequestrates in the sediment for millennia.

However, the contribution of the Blue Carbon to atmospheric CO_2 has not been clarified quantitatively. Rather, the coastal vegetation has been basically recognized as an atmospheric CO_2 source in according to the former measurements in Mangroves or Salt marshes. But, the comprehensive measurement and analysis of the complex coastal carbon flow, which is necessary in order to evaluate the relationship between the Blue Carbon and atmospheric CO_2, has been few. Besides, there were few measurements in Seagrasses where the vegetation uses the dissolved inorganic carbon (DIC) in water.

In this study, the relationship between the Blue Carbon and atmospheric CO_2 was analyzed by the measurement in two seagrasses. The measurement sites were the Furen lagoon and the Fukido reef, which locate in boreal and subtropical regions, respectively. These sites were selected in order to expose the latitudinal difference. The measured carbon flows were 1): the air-water CO_2 flux, 2): the net ecosystem production (NEP), 3): carbon discharge from land. The air-water CO_2 flux was measured by three methods; the eddy covariance method, the bulk formula method and the floating chamber method. The NEP and the carbon discharge from land were determined from the DIC of the water samples. However, the NEP at the Fukido reef was determined from the grow rate of the seagrass due to the problem of the precision. At the Furen lagoon, the measurements were mainly performed in summer (August) and winter (November). Additionally, the measurement of the bulk formula method and the NEP were performed from June to November in 2011. At the Fukido reef, the measurements were performed in summer (August) in 2011.

The results of the measurement are summarized below. The air-water CO_2 flux at the Furen lagoon indicated atmospheric CO_2 influx and efflux in summer and winter, respectively. The annual average indicated atmospheric CO_2 influx both in 2010 and 2011. The air-water CO_2 flux at the Fukido reef indicated atmospheric CO_2 influx but the flux shifted to efflux during the latter half of the measurement period. The NEP at the Furen lagoon showed clear diurnal change and indicated the autotrophic condition in summer. Contrary, the NEP in winter showed small fluctuations, and the average indicated the heterotrophic condition. In 2011, the autotrophic and heterotrophic conditions were indicated from June to September and from October to November, respectively. At the Fukido reef, the grow rate of the seagrass indicated the autotrophic condition. The carbon discharge from land was confirmed both at the measurement sites.

Atmospheric CO_2 influx and efflux were seemed to occur under the autotrophic and heterotrophic conditions at the measurement sites, respectively. The analysis of the carbon equilibrium system revealed that the site changed from an atmospheric CO_2 source to a sink due to the decrease of CO_2 partial pressure by the NEP. Because the NEP determined in this study was smaller than that in the former references, other seagrasses might have larger atmospheric CO_2 influx than our measurement site.

This study indicated that the Blue Carbon in Seagrasses could contribute to the mitigation of atmospheric CO_2 directly. Therefore, the funds for recovery and reservation of seagrass vegetations by carbon credits such as REDD+ is expected by the further study of the coastal Blue Carbon.

Keywords: Recovery and Reservation of coastal vegetations, Initiative for climate change, Carbon flow in coastal regions, Seagrasses, Eddy covariance

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Influence of surface flow on nitrogen discharge processes from a forested watershed

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It was generally thought that surface flow did not occur in forested watershed because of large infiltration capacity of forest soil. However, in recent years, some studies showed that surface flow was generated in plantations of v. The purpose of this study is to clarify the mechanisms of surface flow and its influence on nitrogen discharge from plantation of Japanese cypress.

We collected rainfall, throughfall, surface flow, soilwater (10cm, 30cm), groundwater, springwater and streamwater in a forested watershed planted with Japanese cypress in Shiga prefecture in biweekly. Four plots on the lower slope and two plots on the upper slope were selected to collect the samples. 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.

The amount of collected sample of surface flow was the largest in the samples and its suggested occurrence of surface flow, however, the amount of samples collected on a unit area by surface flow was extremely small compared to soilwater and throughfall. Therefore, influence of surface flow on nitrogen discharge was small in this watershed while dissolved nitrogen concentrations in surface flow were the highest in the samples.

This study was partly supported by a grant from Water Resources Environment Technology Center.

Keywords: forested watershed, surface flow, nitrogen discharge processes

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Difference of water quality of rivers between the affected by polluted air from urban area and the environed by mountain

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The source area of Arakawa river in Saitama prefecture and the source area of Fujigawa river in Yamanashi is common. It is high mountain district located in Western part of Kanto district. However, there is a big difference of water quality between the both rivers. Especially nitrate concentration in Fujigawa river is lower than that of Arakawa river.

This difference of water quality suggested the shielding effect of high mountains on the transportation of polluted air containing nitrate and the other pollutants from the Tokyo area.

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Observation of vertical profiles of nitrogen oxides and ozone in two forest sites at the foot of Mt Fuji

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We have developed two monitoring systems for nitrogen oxide, NO, nitrogen dioxides, NO_2, and ozone, O_3, in the atmosphere in Fujiyoshida and Hokuroku forest observation sites at the foot of Mt. Fuji. The air was sampled from four vertical height locations from above the forest canopy to 2 m above the ground. The total interval time was 15 minutes. The 15-minutes interval measurements of NO, NO_2 and O_3 were repeated continuously during about a week at the both sites in the summer 2012 and has successfully measured vertical profiles of NO, NO_2 and O_3. The concentration of ozone increased gradually with the height, but the concentrations of NO and NO_2 did not changed obviously. We will discuss the details at the meeting.

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

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Seasonal pattern of nitrogen uptake by Sasa dwarf bamboo in a cool-temperate forest in northern Hokkaido

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Nitrogen (N) is an essential element, so uptake of inorganic N by plants would influence N dynamics in forest ecosystems. Generally the amount of N that circulates within the ecosystem is considered to be far larger than that leached out from the ecosystem. In addition, nitrate concentration in stream water has been reported to be high in winter season than in growing season owing to low N uptake by plants in winter, however no study quantified the N uptake. Especially we focused on understory Sasa bamboo, which is the typical understory vegetation in northern Hokkaido and being thought to be important in biogeochemical processes. Sasa is an evergreen perennial plant, which has green leaves during winter under snowpack, hence it may be different in activity such as uptake compared with deciduous species. In this study, we spread ^{15}N tracer four times a year and measured the uptake by collecting Sasa in order to determine the pattern of N uptake by Sasa.

We conducted our study in a cool-temperate forest in Teshio Experimental Forest of Hokkaido University in northern Hokkaido. Sasa (*Sasa senanensis*) covered the forest floor entirely. We conducted the survey four times in a year (November 2011, January, May, and July 2012) and set four treatment; $^{14}NH_4$, $^{15}NH_4$, $^{14}NO_3$, $^{15}NO_3$. In each date and treatment, we established the 1-m$*$1m plot. In total 16 plots was established. Soil surrounding each plot was trenched to 30 cm depth and plate was installed to cut off the connection of rhizomes and roots with outside plot. NH_4Cl and $NaNO_3$ were used in NH_4 and NO_3 plots, respectively. We established five quadrates of 20$*$20cm in each plot and 128ml of 1mM NH_4Cl and $NaNO_3$ were evenly spread using syringe within the quadrates. In NH_4 plots, 8mg of nitrapirin was contained in the solution to block nitrification. Surface 10 cm of soil was collected using auger one day and one month after the treatment and collected Sasa roots by washing with water. ^{15}N content in dried and milled samples was measured, compared according to the season. We discuss the seasonal pattern of N uptake by Sasa.

Keywords: 15N tracer, nitrate, ammonium, root, *Sasa senanensis*

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(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS24-P15 Room:Convention Hall Time:May 23 18:15-19:30

Changes in biochemical characteristics of extractable organic matter during litter decomposition

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Litter decomposition is an important process maintaining productivity in terrestrial ecosystems. Litter decomposition begins on the surface of litter rather than the inside of litter, and quality change of extractable organic matter is rapid than that of bulk litter. However, little is known about the characteristics of organic matter on the litter surface and its changes in litter decomposition. The objective of this study is to clarify the differences in changes in quality of extractable organic matter during litter decomposition. Especially, in this presentation, we report the changes in biochemical characteristics of extractable organic matter during litter decomposition. In the early stages of decomposition of Quercus litter, variable distribution of molecular weight was observed for extractable organic matter, and it changed considerably with decomposition. Other species also showed similar pattern of molecular weight distribution. In this presentation, we also report the changes in biomoleculars of organic matter extracted from microorganims as well as other plant species.

Keywords: litter decomposition, soil organic matter, extractable organic matter, molecular weight distribution, amino acid

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The processes of transformation and emission of nitrite in the forest soil

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The processes of transformation and emission of nitrite in the forest soil

Keywords: Forest soil, Nitrite, Nitrous oxide, Nitric oxide, 15N tracer

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Nitrogen mineralization rates in forest soils in Japanese archipelago - Soil chemical properties -

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1.Introduction

The nitrogen (N) dynamics in forest soils in the Japanese archipelago varies widely because it extends for 3000 km and the climatic zone ranges from cool-temperate to subtropical region. Also, changes in N dynamics due to the climate change are expected to differ from region to region. Therefore, it is necessary to understand the mechanisms and factors which control the biogeochemical responses to the environmental changes. In this study, we selected more than 30 sites from the Japanese archipelago and measured the soil N mineralization rates by field and laboratory incubation. Also, we measured the physical and chemical soil properties, and the relationships between such properties and N mineralization rates will provide a map of N mineralization rates in Japan. In this meeting, we will show the basic information of soils from 34 sites in regards to the chemical and physical properties.

2.Materials and methods

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 in depth. Soil pH(H_2O) (fresh soil:water = 1:2.5) and water soluble cation (Ca^{2+}, Mg^{2+}, K^+, Na^+, $NH_4{}^+$, Al^{3+}), anion (Cl^-, $NO_3{}^-$, $SO_4{}^{2-}$), and organic carbon (WSOC) were measured.

3.Results and discussion

pH(H_2O) increased from the surface to deeper soil layers. The variation range was remarkably wide; the minimum value of 0-10 cm soil was 3.5 (Ashiu site) and the maximum value was 8.0 (Fuji-Hokuroku site), and the range became smaller in the deeper the soil layers. In contrast, the concentrations of water soluble $NO_3{}^-$ and Ca^{2+} were high in the surface layer and decreased in the deeper layers. Concentrations of water soluble Cl^- and Na^+ were significantly high in the site near the sea (Akita and Yona site).

The ion balance (total cation - total anion) was positive at almost all site, which indicated that the anion was in deficit. The positive correlation between the ion balance and WSOC suggested that the organic acid compensated the anion deficit. The slope between WSOC and the ion balance differed among sites, and the slope was higher in the site of low soil pH(H_2O) suggesting that the organic acid was more dissolved in such sites. From the soil chemical properties, it indicated that the water soluble substrates interacted with soil pH(H_2O).

Keywords: nitrogen mineralization rate, nitrification rate, forest soil, soil chemical properties, Japanese archipelago

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Deer-induced degradation of understory vegetation affects N retention and loss in forested watershed

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Recently, ecosystem degradation by large herbivorous mammals becomes a serious issue worldwide. Loss of plant biodiversity and decreasing in biomass at the forest understory may result in the changes in streamwater chemistry and nutrient loss from forest ecosystem, but the knowledge remains still limited. In central Japan, over-grazing of forest understory vegetation by Japanese sika deer has been pronounced since 2000's. The main goal of this study was to elucidate the relationship between nitrogen (N) retention by understory vegetation and annual N loss, and discuss the effects of deer-overgrazing on N cycling by comparing a 13 ha watershed surrounded by the deer-excluded fence to its adjacent 19 ha control watershed, in cool-temperate forest in Ashiu, Japan.

We have collected streamwater samples monthly at 4 first-order streams (0.3˜2.3 ha) and 1 second-order stream (13˜19 ha) within each watershed, and analyzed nitrate concentration by ion chromatography since June 2006 when the fence was established. The rate of streamwater discharge was obtained from a Parshall flume by measuring water level. Annual loss of nitrate was calculated by multiplying stream flow by the concentration. As for the understory vegetation, number of species, vegetation cover, and Shannon's *H'* as an indicator of biodiversity were observed in two 800 m^2 plots established in the lower slope and upper slope within each watershed. Nitrogen uptake by understory vegetation was determined by cutting all plant species, including herbaceous species, ferns and tree seedlings, within 145 1 m^2 quadrats randomly established throughout fenced and unfenced watersheds and measuring dry weights and N contents by NC analyzer. Nitrogen uptake by vegetation was calculated by multiplying the dry weights by N contents for annual herbs and current year leaves and branches of woody tree seedling. For perennial and evergreen species, N uptake was estimated by dividing the product of dry weights and N contents by average leaf longevities. Then we made the coverage-biomass and coverage-N uptake regression equation. Also, coverage of each dominant 13 species appeared in our study watersheds was observed by line transect method, and the spatial distribution of their coverage was analyzed by generalized linear model (GLM) based on topographical information (slope, aspect, curvature, wetness index) and a categorical variable representing the spatial extent of the watersheds calculated from 10m-resolution digital elevation model (DEM) data. We then estimated watershed-scale biomass and N uptake of understory vegetation.

In the fenced watershed, number of species, vegetation cover, and Shannon's *H'* of understories remarkably increased at the lower-stream slope and slightly increased at the upper-ridge slope, while in the unfenced watershed, they showed little change or slightly decreased at the both slopes. The nitrate concentration of stream water was lower during plant growing season (May to October) than during dormant season (November to April) in both watersheds, but it decreased year by year in some streams within the fenced watershed since the fence was established. Averages of annual N loss during 2009 to 2011 was 2.36 kgN ha^{-1} in the fenced watershed and 4.87 kgN ha^{-1}, and its difference was 2.51 kgN ha^{-1}. Nitrogen uptake by understory vegetation was estimated to be 5.5 kgN ha^{-1} in the fenced, and 3.3 kgN ha^{-1} in the unfenced, which indicated that loss of N uptake induced by deer over-grazing can directly influence hydrological N loss. In conclusion, despite the small amount of biomass of the forest understory vegetation, the loss of this ecosystem component by deer over-browsing can lead to an increase in nitrate loss to streamwater. Our finding also suggests that understory vegetation recovered from deer grazing can retain nitrate effectively.

Keywords: deer-overgrazing, understory vegetation, nitrogen retention, nitrogen loss, nitrate nitrogen, forest ecosystem

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MIS24-P19 Room:Convention Hall Time:May 23 18:15-19:30

Nitrate discharge from an N-rich forest in central Japan: A preliminary isotopic diagnose of rainfall events

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Tracing nitrate (NO3-) losses from highly polluted forests is directed to understanding ecosystem N cycles in response to anthropogenic N inputs. Stable isotopes of NO3- (d15N, d18O and D17O) are well-suited tools to differentiate atmospheric-deposited and soil-derived NO3- leached into streams of forested catchments, thus provide diagnostic evidences on the plant-soil N status and forest N saturation. However, our understanding of the mechanisms that regulate the temporal and hydrological variability of stream NO3- isotopes is rather limited. It has not been well characterized how the source and flux of stream NO3- will change across rain events, and how stream NO3- isotopes record the response of short-term soil NO3- dynamics to rainfall and/or direct hydrological losses of soil NO3-.

A high-temporal resolution collection and flow monitoring of the headwater stream was conducted across two rainfall events in 2011 in an N-rich forest of Karasawayama, the northern Kanto district of Japan. All samples were analyzed for NO3- concentration ([NO3-]) and part of samples has been analyzed for stable isotopes (d15N, d18O and D17O). Using the flow rate and [NO3-] of regular flows, annual NO3- discharge was estimated. In the same way, total NO3- discharge in the whole event was calculated using event-based flow and event-based [NO3-]. Then using D17O of stream NO3-, atmospheric-derived NO3- (atm-NO3-) can be differentiated in annual and event NO3- discharge. According the differences of soil-derived NO3- and atm-NO3- in regular and event discharges, it can be quantified how much soil NO3- was washed out by the rain event.

The D17O of stream NO3- ranged between 0.8-1.5 permil, showing no substantial difference between event-based and regular flows. On average, 5.0-5.8% of stream NO3- was derived directly from precipitation. Annually, 3.0-4.0 kg-N in total 60?80kg-N discharge was directly from precipitation. This annual discharge did not include influences from rain events. Actually, in a rain event, ca.95% of NO3- is soil-derived, in which only 18?30% was discharged in the regular pathway, 70-82% of soil NO3- was flushed out by rain water. For regular flow, d15N and d18O of stream NO3- co-varied with a slope closing to 1:1 and did not change with [NO3-], suggesting little influence from denitrification and the mixing of atm-NO3-. However, according to the event of September, the temporal variations of D17O and fatm were weak and the fatm was actually low, simple atm-NO3- mixing could not explain the d18O fluctuations (by 4-12 permil). Altered soil nitrification/denitrification dynamics, not the mixing of atm-NO3- (fatm), were suspected fluctuating the d18O but keeping a low D17O signal of stream NO3- during the rain event.

Keywords: N saturation, N deposition, Nitrate leaching, Stable isotopes, 17O anomaly, Rainfall event

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Emissions of nitrous oxide and methane in temperate forests with different nitrogen status in central Japan

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Nitrous oxide (N2O) and methane (CH4) are strong greenhouse gases, which contribute about a fourth to current warming effect globally. Compared with other sources, importance of forest ecosystems has been less quantified. With the increase of anthropogenic N deposition, it is urgent to evaluate the emissions of these gases from N-saturated forests. In general, forest soil has been recognized as a net sink of CH4 and as a source of N2O, but more works are needed because forests differ greatly in N status, which may play an important role in regulating the gas emissions. Soil nitrification, which is a dominant process of N2O emission, often increases with the increase in N status. To the contrary, increased inorganic N availability may inhibit the oxidation of CH4 by soil microbes.

In this study, emission rates of N2O and CH4 were measured monthly in an N-saturated forest (Tamakyuryo, Tokyo; from May-2012 to Jan-2013) and singly in two relatively N-limited forests (in Fukushima and Izu; Aug-2012) in central Japan. The temperature, contents of water and inorganic N in soil were simultaneously determined. In situ net nitrification rate was measured for soil in the forest of FM-Tama. According to the analysis in Aug-2012, the N2O emission rate averaged 18.3 mg-N m-2 h-1 at Tamakyuryo, which was 4.5 times higher than those of other forests. The CH4 emission rate averaged 58.7 mg-CH4 m-2 h-1 at Tamakyuryo, which was significantly lower than those of other forests (67.8mg-CH4 m-2 h-1 for the forest in Fukushima and 95.8 mg-CH4 m-2 h-1 for the forest in Izu). Moreover, a positive correlation was found between the rate of N2O emission and the net nitrification rate, and the emission rate of N2O varied with the soil temperature. Consequently, it can be inferred that nitrification can be a major process of N2O production, and N enrichment in forest will obviously stimulate soil N2O emission.

Keywords: Nitrous oxide, methane, nitrogen saturation, nitrification, temperate forest

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MIS24-P21 Room:Convention Hall Time:May 23 18:15-19:30

Measurement of concentrations and isotope ratios of nitrite in acidic forest soils

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Nitrite in acidic forest soils has been ignored because nitrite concentration is quite low in most of the cases. However, Stevens and Laughlin (1997) clearly showed that the conventional method for the extraction of soil inorganic N such as the use of KCl and K2SO4 solutions cannot work for nitrite determination due to the oxidation of nitrite to nitrate during the extraction. We reevaluate their method with alkali salty solution (pH=12) to prevent nitrite from being oxidized during the extraction with several Japanese temperate forest soils with low pH. We found that high nitrite concentration can be found occasionally, which affects the stable isotope measurement of nitrate if nitrite is not carefully removed from the samples. We will show our preliminary data on the concentrations and isotope ratios of nitrite and nitrate to discuss the importance of nitrite in forest ecosystems as an intermediate compounds in many nitrogen transformations such as nitrification, (a)biotic denitrification and nitrosation.

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Extractable amino sugar-like N in forest soils

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Amino sugar can be an important available N form in soils for soil microbes, although our knowledge on the dynamics of amino sugar in soils is quite limited. Many studies measured the concentrations of hydrolyzable amino sugar, which can be several percent of the total hydrolyzable nitrogen in the soil, the concentrations of readiliy available form of amino sugar such as dissolved free amino sugar and extractable amino sugar are seldom measured. We modified a classic ”diffusion method” (Mulvaney and Khan 2001) to measure the amino sugar-like N in the soil extract (H2O and K2SO4 extracts) to see the potential importance of this unmeasured nitrogen pool in the soil. We found that the concentration of extractable amino sugar-like nitrogen is as same as the inorganic nitrogen, which implies that this pool can be an important available nitrogen pool for soil microbes. We will discuss the characteristics of this new nitrogen pool based on the concentrations and its nitrogen isotope ratio.

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Optical characterization of DOM in a temperate forest ecosystemsby fluorescence

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Better understanding of the dynamics of dissolved organic matter (DOM) in forest ecosystems is quite important to understand the ecosystem functions of the forests as well as the availability of DOM supplied from forest to the ecosystems downwards. Recently optical characterization of DOM becomes popular in ocean and freshwater ecosystems because of its easiness of operation. However the optical information of the DOM is still limited in terrestrial, especially forest ecosystems and we applied the optical characterization to the DOM collected from precipitation, throughfall, soil solutions, groundwater and streamwater to trace the fate of DOM along with the waterpath running through a forest ecosystems. We found that the quality of DOM is rather stable with quite variable concentration of dissolved organic carbon (DOC). We will discuss the production and consumption processes of DOM in a forest ecosystems based of DOC concentrations and optical information.

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Carbon allocation in Japanese cedar forests with different nitrogen deposition in northern Kanto district

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Recently nitrogen deposition to forest ecosystems is increasing by human activity which causes forest decline, nutrient deficiency and soil acidification. In Japan, some Japanese cedar forests have high nitrogen loss and considered as nitrogen saturated condition. Trees allocate assimilated carbon into leaves, stems, roots and reproductive organs and their proportion can vary as affected by nitrogen deposition. However information about carbon allocation in Japanese cedar forests is limited. In this study, we evaluated pattern of carbon allocation in Japanese cedar forests with high and low nitrogen deposition in Ibaraki Prefecture.

The study areas are Tsukuba with high nitrogen deposition and Katsura with low nitrogen deposition. Study plots (600-675m2) was established and Diameter at breast height and tree height were measured annually for 3-4 years. Litterfall was collected by littertraps and separated into leaves, branches, male cones and seed cones. Soil respiration was measured monthly by chamber method. Sum of fine root production and respiration of roots was estimated as soil respiration minus littefall. Coarse wood biomass production was estimated by expansion factor for the species. The reported value of carbon use efficiency was used to estimate respiration of stem, leaves and reproductive organs. Gross primary production and carbon allocation to wood, leaves, reproductive organs and roots were estimated.

Aboveground net primary production was 8.2 MgCha-1 yr-1 and 6.3 MgCha-1 yr-1 in Tuskuba and Katsura, respectively, with a 1.29-fold difference. Nitrogen utilized for aboveground biomass production was 72.5 kgha-1 and 29.1 kg N ha-1yr-1 in Tsukuba and Katsura, respectively, with a 2.5-fold difference. Nitrogen uptake in Tsukuba with high nitrogen deposition is higher but the difference of ANPP is much smaller. Gross primary production was 22.2 MgC ha-1 yr-1 and 19.3 MgCha-1 yr-1 in Tuskuba and Katsura, respectively, with a 1.15-fold difference. Carbon allocation of stems, leaves, reproductive organs and roots was 37%, 24%, 14% and 21%, respectively in Tsukuba and 41%, 18%, 6%, and 35% in Katsura. Allocation to stems was not different between two forests but that to leaves, reproductive organs and roots was different.

Keywords: Japanese cedar, Nitrogen saturation, Carbon allocation

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Silicon cycle in moso bamboo forests in central Japan

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Silicon (Si) plays an important role in processes of soil formation in terrestrial and aquatic ecosystems. Among various plants, the gramineous plants are classified as silicon-accumulators [1, 2]. Therefore, graminoid dominated vegetation such as bamboo forests is considered to have a large pool of biogenic amorphous silica ($SiO_2 * nH_2O$) named as phytolith. Through the death of the plant, the phytolith contributes to an amorphous Si pool in the upper soil layers and constitute an important component in soil systems [3]. However, the researches on Si biogeochemical cycles in bamboo stands are a few. The purpose of this study is to evaluate Si dynamics in moso bamboo (*Phyllostachys pubescens*) forests spreading around eastern Asia, and to understand a role of them in Si biogeochemical cycle in forest ecosystem.

A study on the organic pool and biological cycle of Si was conducted at 15 * 15 m quadrats in three moso bamboo stands in central Japan. To evaluate Si accumulation and supply, we sampled each organ of living bamboo and litter fall. Biomasses of culms, branches, leaves were calculated from all bamboos' DBH in each quadrat using moso bamboo-specific allometry equations [4]. The biomasses of rhizomes and roots, which were taken on Dec 2009, were calculated for five 50 * 50 cm subplots with 30 cm of soil depth, and for five soil core samples (0-30 cm depth), respectively. Si concentrations of each organ were determined by combination method of gravimetry and ICP-AES after wet digestion with nitric acid [5]. Litter falls were collected using five litter-traps with 50 * 50 cm once a month from Aug 2008 to Jul 2009. Si accumulations and annual Si supply per area in each bamboo organ were determined by multiplying the Si concentrations in each organ by corresponding mass in each site. Turnover time (year) of Si was calculated by dividing total Si accumulation (above- and under-ground) by annual Si supply to forest floor through litter fall.

Si accumulations in three sites were 200-360 kg/ha above ground and 180-460 kg/ha in underground. The Si underground accumulations corresponded to 46-59% of the whole. Bamboo roots in the surface horizon (0-10 cm depth) existed 54-60% of the whole root biomass. Si supply was 77-324 kg/ha/yr, and their 72-88% were leaf litters. The amount of supply as phytolith (SiO_2) by bamboo litter fall was estimated about 140-700 kg/ha/yr, and it was comparable to phytolith supply in grass vegetation and much more than those in coniferous or broadleaved vegetation [6]. The turnover time of Si showed a range of 1.3-12 years from the results of this research.

From our research, we indicated that the huge biogenic Si source comparable or more than those in aboveground parts exists in the underground parts in moso bamboo stands. In addition, moso bamboo stands circulate much quantity of Si as amorphous silicic acid comparing with other forest vegetation, and should play an important role in Si biogeochemical cycles.

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Keywords: biogenic Si, phytolith, biogeochemistry, biomass, turnover

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Carbonized wood for atmospheric mercury, passive sampler

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We report the result on the accumulation of mercury by carbonized wood.

Keywords: carbonized wood, mercury, passive sampler