Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-01 Room:301B Time:May 25 09:00-09:15

Quantifying warming effect due to urbanization based on comparative measurements of the surface energy budget

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Land use changes from natural ecosystems to urban built-up have strong influence on local climates. The urban heat island has received much attention as an important environmental problem. However, detailed mechanisms have not be clear enough. In this study, we conducted comparative measurements of the surface energy balance at an urban built-up and a forest, and evaluated factors contributing surface warming due to the land use change based on a methodology called temperature decomposition.

We measured the energy balance at the urban built-up in Sakai,Osaka and at a cypress plantation (Kiryu Experimental Watershed) in Shiga. Sensible and latent heat fluxes were measured using the eddy covariance method. The ground heat flux for the urban area was estimated using the objective hysteresis model with relevant plot-scale experiments. In this study, we evaluated the urbanization effect from the forest plantation to the urban in terms of changes in surface temperatures associated with surface albedo, aerodynamic resistance, Bowen ratio, and ground heat flux.

In daytime, the urbanization increased net surface temperatures by 5.5 K in the summer (June to August 2014) and 3.8 K in the winter (January, February, and December 2014). The daytime warming was mostly contributed by increased surface resistance due to the urbanization in the summer (4.4 K) and the winter (3.7 K). In the urban built-up, the decreased surface roughness due to a high building density restricted the heat transfer redistribution into the atmosphere. Consequently, we found that the decreased surface resistance was the most effective factor to warm the urban surface temperatures in daytime. In nighttime, the urban surface temperature was higher than those in the forest in the summer (1.9 K) and the winter (2.5 K). Change in ground heat flux most strongly contributed to the nighttime warming in the summer (4.2 K) and the winter (5.2 K). In the urban built-up, a lot of incoming energy was stored in buildings and impervious roads in daytime. This energy was radiated and warmed up the urban surface in nighttime. The estimated net increases in the surface temperature were lower than those estimated using the bulk model in daytime and nighttime. The discrepancy could be caused by uncertainties associated with estimated radiative fluxes, energy imbalance of turbulent fluxes, and no consideration of anthropogenic heat in the urban built-up.

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ACG30-02 Room:301B Time:May 25 09:15-09:30

A decline of a Japanese oak by sulfuric acid of an air pollutant, and reproduction by charcoal

OMORI, Teiko[1*]

[1]FOMER TOHO UNIVERSITY

A fossil fuel generates sulfuric acid by combustion.Sulfuric acid becomes an air pollutant, moves by wind and adheres to trees.Sulfuric acid which adhered to trees is dropped on a root by rain, and acidifies soil.If soil acidifies, a metal ingredient will dissolve.The dissolved metallic ion is absorbed into the trees.The phosphoric acid in trees combines with metallic ion.The combined phosphoric acid becomes inactivate and trees wither.The combined phosphoric acid becomes inactivate and trees wither.If the tannin contained in trees combines with a metal ion,it loses the insect control effect.Rain water becomes alkaline solution by charcoal.An alkaline solution changes metal ion into hydroxide.Trees cannot absorb metal hydroxide.As a result, trees are saved.If charcoal is scattered on the tree of the declined Japanese oak, it dropped a seed after 3 years and budded after 4 years.

Keywords: air pollutant, acidifies soil, acidifies soil, tannin, metallic phosphate

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ACG30-03 Room:301B Time:May 25 09:30-09:45

Long-term warming effect on soil respiration in warm-temperate evergreen broad-leaved forest in Kyusyu

TERAMOTO, Munemasa[1*] ; LIANG, Naishen[1] ; TAKAGI, Masahiro[2] ; ZENG, Jiye[1]

[1]Center for Global Environmental Research, National Institute for Environmental Studies, [2]Faculty of Agriculture, University of Miyazaki

Soil respiration is composed of heterotrophic respiration and plant root respiration, and is the second largest carbon flux in the terrestrial ecosystem. As the heterotrophic respiration increases exponentially with soil temperature, its positive feedback to the global warming has become a concern.

In the middle of December 2008, a multi-channel automated chamber measurement system was installed at the Tano forest science station of Miyazaki University, which is a warm-temperate broad-leaved forest site in Kyusyu. We prepared 10 trenched plots with 5 of them artificially warmed by +2.5^{o}C by infrared heaters 1.6 m above the surface for long-term measurement of warming effect on soil respiration.

The average value of soil respiration in control and warmed plots were, respectively, 3.45 μmol CO_2 m^{-2} s^{-1} and 3.53 μmol CO_2 m^{-2} s^{-1} in 2009, 3.81 μmol CO_2 m^{-2} s^{-1} and 4.07 μmol CO_2 m^{-2} s^{-1} in 2010, 3.31 μmol CO_2 m^{-2} s^{-1} and 3.81 μmol CO_2 m^{-2} s^{-1} in 2011, 3.02 μmol CO_2 m^{-2} s^{-1} and 3.79 μmol CO_2 m^{-2} s^{-1} in 2012, 3.08 μmol CO_2 m^{-2} s^{-1} and 3.33 μmol CO_2 m^{-2} s^{-1} in 2013. The annual warming effect increased soil respiration by 5.4% in 2009, 9.9% in 2010, 18.4% in 2011, 29.5% in 2012, and 11.5% in 2013. The warming effect showed an increasing trend until 2012, but decreased in 2013 due to fewer amount of rainfall in summertime, which caused a much lower moisture in soil.

Keywords: soil respiration, global warming, chamber, forest soil

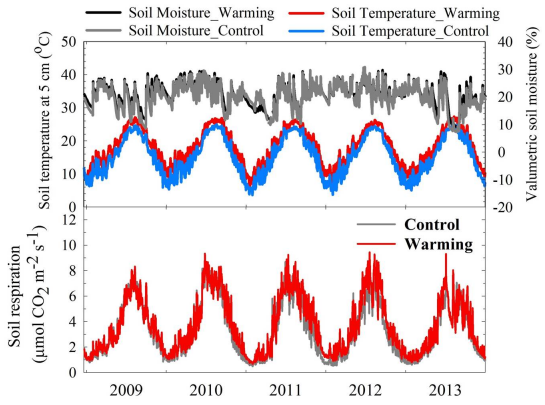

Fig 1. Seasonal variation of soil temperature, soil moisture and CO_2 efflux of each treatment.

Japan Geoscience Union Meeting 2015
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ACG30-04 Room:301B Time:May 25 09:45-10:00

Control of Soil Carbon Dynamic of Southeast Asian Ecosystems

LIANG, Naishen[2*] ; TERAMOTO, Munemasa[2] ; TANG, Zhenghong[3] ; FLETCHER, Christine D.[4]

[1]NIES, [2]NIES, [3]XTBG, [4]FRIM

The tropical ecosystems have been estimated to be a large carbon source (1.3 Pg C yr^{-1}) due to deforestation and forest degradation, even the global terrestrial carbon sink has been large (1.1 Pg C yr^{-1}) in recent decades. Reducing Emissions from Deforestation and Forest Degradation (REDD) is an effort to create a financial value for the carbon stored in forests, offering incentives for tropical region to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. The ultimate goal of this study is to update REDD mechanism through improved forest management by evaluation of effects of logging and land-use change on soil carbon emission of tropical forests. This study was conducted in a lowland primary forest at Pasoh Forest Reserve (2^o58'N, 102^o18'E; 75˜150m a.s.l.) and a mountainous tropical forests at Temenggor concession area (5^o33'N, 101^o36'E; 800˜900m a.s.l.) in Peninsular Malaysia. About 50˜65% biomass was harvested and soil temperature increased about 3oC with SMS, resulting value of the carbon stock lost about 2,577 US$ ha^{-1} following the first year of logging. On the other hand, under low-impact harvest condition, only about 1,773 US$ ha^{-1} was lost following the first year of logging. Result suggests that this low-impact harvest system would achieve about 804 US$ ha^{-1} of REDD credit partially contributed from mitigating soil degradation of about 169 US$ ha^{-1}.

Keywords: Automated chamber, LULUC, moisture, soil carbon, tropical ecosystem

Japan Geoscience Union Meeting 2015
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ACG30-05 Room:301B Time:May 25 10:00-10:15

Spatial variations in larch and soil nitrogen isotope ratio along forest-grassland gradient in northern Mongolia

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The underlying processes that affect the Nitrogen isotope ratio of plant and soil,which is known as a good indicator of N dynamics and shows dependency on climate, is not yet clearly understood.

In this study, we compare the nitrogen isotope ratio of single plant species (Larix sibirica Ledeb.) and soils along the forest-grassland gradient of a forest-steppe ecotone in Mongolia. Larch needles and soils were sampled during the growing season (May- August) from 2004-2012 at several sites in seven study areas.

The results showed the clear spatial pattern in needle, soil nitrogen isotope ratios, and its difference ($\Delta\delta^{15}$N)along forest-grassland gradient and the pattern corresponded to humus type (mor/mull). $\Delta\delta^{15}$N also had significant correlations with needle δ^{13}C and C/N ratio of bulk soil, suggesting the $\Delta\delta^{15}$N change relates to water, light conditions and soil N availability. Isotope mass-balance model was applied to investigate the processes affecting the spatial pattern of $\Delta\delta^{15}$N.

Keywords: ecotone, Mongolia, nitrogen isotope ratio, plant and soil

Japan Geoscience Union Meeting 2015
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ACG30-06 Room:301B Time:May 25 10:15-10:45

Seasonal variation in ratio of soil respiration to ecosystem respiration at Takayama estimated from d18O measurement

MURAYAMA, Shohei[1*] ; SAWADA-TAKAMURA, Chikako[2] ; SAIGUSA, Nobuko[3] ; ISHIDOYA, Shigeyuki[1] ; WATANABE, Tsutomu[4] ; ITO, Akihiko[3] ; MORIMOTO, Shinji[5] ; KONDO, Hiroaki[1] ; MAEDA, Takahisa[1] ; MURAOKA, Hiroyuki[6] ; USAMI, Tetsuyuki[1] ; AOKI, Shuji[5] ; NAKAZAWA, Takakiyo[5]

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Forest ecosystems are one of the important reservoirs in the global carbon cycles. However, environmental factors governing variation in carbon dioxide (CO_2) flux between the atmosphere and the forest ecosystems have not been fully understood, which leads to very large uncertainty in future predictions of response of forest ecosystems to climate change. For more precise prediction of the future global carbon budgets, better understandings of each process in the carbon cycle in the ecosystem are necessary. A stable oxygen isotopic ratio (δ^{18}O) in CO_2 is a unique tracer reflecting not only the carbon cycle but also the hydrological cycle. Using difference of isotopic fractionation in ^{18}O between photosynthetic and respiratory processes and between soil and leaf respiratory processes, gross CO_2 fluxes in each of the processes have been estimated in some previous studies at relatively short time scales from diurnal to a few months. In this study, isotopic measurements of not only CO_2 in the atmosphere and soil air but also soil water and atmospheric water vapor were made at a cool-temperate deciduous forest, Takayama (TKY; 36^{o}08'N, 137^{o}25'E, 1420 m a.s.l.) in the growing seasons during 2006-2009. From the obtained data, δ^{18}O values in CO_2 emitted due to soil (R_s) and leaf respirations and total ecosystem respiration (R_{ec}) during the nighttime were calculated. Then, seasonal variation in relative contribution of R_s to R_{ec} was estimated form mass balance equations. The obtained result was compared with variation in the ratio of R_s to R_{ec} estimated from soil chamber and eddy covariance flux measurements. The result from the δ^{18}O measurements showed that the ratio of R_s to R_{ec} increased from about 0.5 in late spring to almost 1 in early autumn though the estimated ratios were very scattered. Such a seasonal pattern was similar to that estimated from the flux measurements. In our presentation, factors governing the seasonal variation will also be discussed by comparison with the results simulated for TKY using a process-based ecosystem model (VISIT) and a multi-layer canopy model (MINCER).

Keywords: oxygen isotope, forest ecosystem, ecosystem respiration, soil respiration

Japan Geoscience Union Meeting 2015
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ACG30-07 Room:301B Time:May 25 11:00-11:15

Long-term observation of CO2 flux over a larch forest in northern foot of Mt. Fuji

TAKAHASHI, Yoshiyuki[1*] ; SAIGUSA, Nobuko[1] ; IDE, Reiko[1] ; HIRATA, Ryuichi[1]

[1]Center for Global Environmental Research, National Institute for Environmental Studies

Larch forest is representative vegetation type of widespread region in northeast Eurasia where vulnerability to climate change is expected to be significant. Since length of growing season of the vegetation is affected by temperature, evaluation of climate change feedback in the carbon exchange process in the ecosystem has great importance. National Institute for Environmental Studies has been operating long-term observation of CO_2 flux over a larch plantation at the Fuji Hokuroku flux observation site in northern foot of Mt. Fuji since 2006. We have accumulated 9-year records of observational data set. The observation is to be continued until 2025. In this presentation, we will investigate year-to-year variation of CO_2 exchange and its relationship with environmental factors based on the observational data.

Keywords: carbon dioxide, flux, forest ecosystem, climate change, long-term monitoring, micrometeorology

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ACG30-08 Room:301B Time:May 25 11:15-11:30

Effects of waterlogging on carbon isotope discrimination of Larix gmelinii during photosynthesis

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The carbon isotope discrimination during photosynthesis reflects various environmental factors, such as VPD, solar radiation, soil moisture, salinity, air pollution and so on. It has been used to estimate environmental condition, or calculation of carbon isotope mass balance equation to know a flow of carbon. It is well known that soil moisture is one of the major factors controlling carbon isotope discrimination: discrimination decreased under drought condition due to a decrease of stomatal conductance. On the other hand, there is almost no research on carbon isotope discrimination under extremely wet condition. Larix gmelinii is one of the major species of larch trees, which constitute eastern Siberian Taiga. In 2007, extreme wet event has been reported near Yakutsk. In this research, pot experiment with Larix gmelinii saplings was conducted to obtain carbon isotope discrimination during photosynthesis under waterlogging condition which may happen more frequently in the future. Under waterlogging condition, both photosynthesis rate and stomatal conductance of all three larch saplings used for experiment decreased, while only one sapling among three showed clear decrease in carbon isotope discrimination. Although the decrease in carbon isotope discrimination was not so clear, needles on current year stem, which seemed to be formed with C fixed during the experiment, showed slightly higher δ^{13}C in waterlogging treatment than that in control. This result suggests that waterlogging condition makes stomatal conductance decreased.

Keywords: carbon isotope discrimination, photosynthesis, stomatal conductance, waterlogging, larch, experiment

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ACG30-09 Room:301B Time:May 25 11:30-11:45

Effects of the expansion of vascular plants in Sphagnum-dominated bog on carbon balance

HIRANO, Takashi[1*] ; YAMADA, Hiroyuki[1] ; TAKADA, Masayuki[2] ; FUJIMURA, Yoshiyasu[3] ; FUJITA, Hiroko[4] ; TAKAHASHI, Hidenori[5]

[1]Research Faculty of Agriculture, Hokkaido University, [2]Faculty of Humanity and Environment, Hosei University, [3]Nippon Koei, [4]Field Science Center for Northern Biosphere, Hokkaido University, [5]Hokkaido Institute of Hydro-Climate

Peatland ecosystems have accumulated a huge amount of soil organic carbon for millennia. However, it is reported that the soil carbon has become vulnerable because of global warming and land-use change. Such disturbances potentially enhance oxidative peat decomposition, and consequently a large amount of CO_2 is emitted into the atmosphere. In Sarobetsu Mire in northern Hokkaido, which has the largest *Sphagnum*-dominated bog in Japan, vascular plants, *Sasa*, have invaded into *Sphagnum* bog because of the change of the hydrological environment, which was due to drainage for agriculture. To understand the effects of the expansion of *Sasa*-dominated area in *Sphagnum* bog on carbon balance, we measured CO_2 flux using the eddy covariance technique at a *Sphagnum*-dominated area (B site) and a *Sasa*-dominated area (T site) and compared CO_2 balance between the two sites.

Flux measurement was conducted during the four snow-free seasons from mid-April through early November in 2007 to 2010. Eddy sensors of CO_2 (LI7500, Licor) and wind speed (CSAT3, Campbell) were installed at the heights of 2.0 and 2.3 m, respectively, at B and T sites. The outputs from the sensors were recorded with a datalogger (CR1000, Campbell) at 10 Hz. Net ecosystem CO_2 exchange (NEE) was calculated on a half-hourly basis as a sum of eddy CO_2 flux and CO_2 storage change calculated from CO_2 concentration measured by LI7500. NEE was partitioned into gross primary production (GPP) and ecosystem respiration (RE) using an empirical conventional method.

Both GPP (gross ecosystem photosynthesis) and RE were larger at T site than B site. In 2008 with dry summer, cumulative NEE for 6.5 months of the snow-free season was -129 and -179 gC m^{-2}, respectively, at T site and B site. The negative NEE values indicate that the two peatland ecosystems functioned as CO_2 sinks in the season. In addition, sink strength was higher at T site. In 2010 with hot, wet summer, however, cumulative NEE was -238 and -159 gC m^{-2}, respectively, at T site and B site. Although NEE increased largely at B site, it decreased at T site. *Sphagnum* moss grew more under the hot and moist environment, which increased GPP more than RE. In contrast, although growth and resultant GPP also increased at T site, RE increased more than GPP because of high temperature. This result suggests that net CO_2 uptake will decrease by the invasion of *Sasa* plants under the warming environment in the near future.

Keywords: Peatland, CO2 flux, Eddy covariance technique, Global warming

Japan Geoscience Union Meeting 2015
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ACG30-10 Room:301B Time:May 25 11:45-12:00

Detection of vegetation phenology across Japan by using digital time-lapse cameras

IDE, Reiko[1*] ; OGUMA, Hiroyuki[1] ; NAKAJI, Tatsuro[2] ; NASAHARA, Kenlo[3] ; ICHII, Kazuhito[4] ; NAGAI, Shin[4] ; ISHIDA, Akito[5] ; NAKAMURA, Kazuhiko[6] ; FUJIWARA, Akio[6] ; WATANABE, Ryuichi[7]

[1]National Institute for Environmental Studies, [2]Hokkaido University, [3]University of Tsukuba, [4]Japan Agency for Marine-Earth Science and Technology, [5]Kyoto Prefectural University, [6]University of Tokyo, [7]Shinsyu University

Many recent studies have reported earlier timings of leaf flush and later timings of leaf fall around the world with progress of recent global warming. Seasonal change (phenology) of vegetation is an indicator for the climate change, and also is one of the important parameters for terrestrial ecosystem models to estimate the carbon balance. For detection of the long-term changes in vegetation across wide areas, remote sensing technique is expected as a useful tool. However, due to the limitations of spatial resolution and observing frequency, it is difficult to detect the species specific environmental responses by satellite. Therefore, we collected high temporal and spatial resolution images by using digital time-lapse cameras. The purpose of this study is to detect phenology at a community or a species level for various types of vegetation across Japan, and to analyze the relationships between phenology and temperature.

We used the images of live camera archives such as "Phenological Eyes Network (PEN)", "Internet Nature Information System" of the Ministry of the Environment, "Mt. Hiei live camera" of Kyoto Prefectural University, "Cyberforest" of Tokyo University and so on, which were taken in 2002-2014. Images of approximately 120 site·year at 20 sites across Japan were analyzed. The areas of interest for vegetation a community or a tree within the images were selected for analysis. RGB digital counts in each pixel in the areas were extracted and Green Ratio Index (GR= G/ (R + G + B)), which varies seasonally reflecting leaf greenness, was calculated at daily step. The time series of GR showed the maximum rate of change on the timings of leaf flush and leaf coloring, consequently, the dates of start/end of green leaves (SOG/EOG) were estimated. Furthermore, we investigated the relationships of the inter-annual variations between SOG/EOG and the temperature at each site.

The estimated SOG/EOG showed large variations across both years and areas, although earlier or later phenological trend during 2002-2014 was not recognized so far. Nationwide earlier SOG in 2002, 2004 and 2009, and later EOG in 2005, 2010 2012 were found. When the green leaved season started earlier than other years, it tended to end relatively later. Vice versa, when the green leaved season started later than other years, it tended to end relatively earlier. Such tendency of earlier or later SOG sometimes differed from the districts even in the same year. SOG or EOG of each community or species had high correlations with the mean temperature during respectively March-April or September at each sites. The impact of the climate change was discussed from the view point of species-specific and site-specific temperature sensitivities of the estimated SOG/EOG.

For assessment of the impact of climate change on vegetation, we need to observe the phenology at more sites for longer term. We plan to install more cameras and to analyze much more data including the uploaded images on the Internet. In addition, it is necessary to keep updating the existing camera systems and to administrate the observation networks sustainably.

Keywords: Time-lapse camera, Phenology, RGB, temperature sensitivity

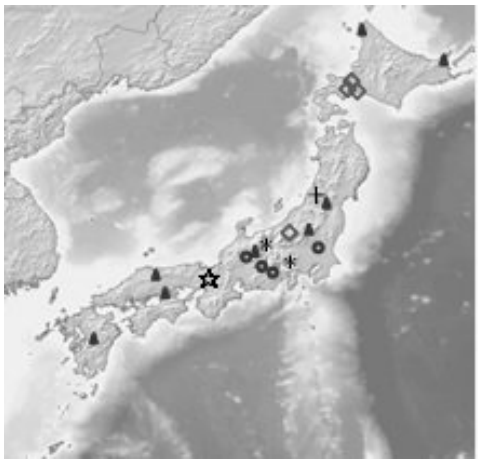

Fig.1 Study sites of PEN(○), Internet Nature Information System(▲), Cameras of National Institute for Environmental Studies(◇), Mt.Hiei live camera(☆), Cyberforest(*),and Mt Chokai live camera(+).

Japan Geoscience Union Meeting 2015
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ACG30-11 Room:301B Time:May 25 12:00-12:15

Development of Above Ground Biomass estimation method using satellite data in Japan

BORJIGIN, Habura[1*] ; HAYASHI, Masato[1] ; SAIGUSA, Nobuko[1] ; YAMAGATA, Yoshiki[1]

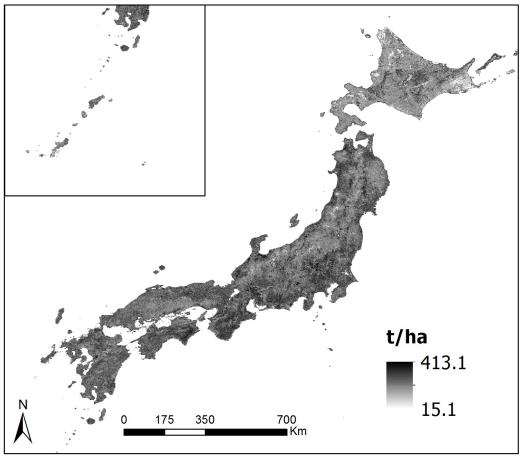
[1]National Institute for Environmental Studies

As a measurement method of Forest Above Ground Biomass, getting basic information of tree category, height and DBH from fieldwork, then calculate the volume, multiply expansion factor and wood density to get the result is widely used. This method can measure the forest above ground biomass correctly, however it is hard for us to make wall-to-wall map when monitoring large area of land. Satellite Remote Sensing is an effective way to estimate large area of forest distribution. In this study, our purpose is to investigate forest above ground biomass in the whole terrestrial land of Japan using ground truth data (fieldwork data from forest above ground biomass) and satellite data. We mainly used MODIS reflectance data from 2000 to 2009, Land Surface Reflectance data, Vegetation Index, LAI then using Random Forest method to estimate biomass.

We divided ground truth data to two groups, one group (90%) used as building Random Forest learning model. After the learning model was built, another group of data (10%) was used for estimating above ground biomass. Then we did the regression analysis between the estimation result and ground truth data. Accuracy assessment was carried out by calculation of coefficient of determination and RMSE from regression analysis. The results showed R2 is 0.6, RMSE is 26.37 (t ha-1). Estimation accuracy from deciduous forest and evergreen forest, R2 is 0.4 and 0.53, RMSE is 24.29 (t ha-1) and 27.34 (t ha-1), respectively. Evergreen forest showed an higher accuracy. Also, we found out that low biomass (<100 t ha-1) and high biomass (>200 t ha-1) showed bigger estimation error. We compared the estimation result (acquired from forest above ground biomass of whole Japan) to prefectural data and forest registration, the comparison results showed coefficient of determination is 0.95, slope is 1.68 times, which is much lower than verification result (1.86 times) from Forestry and Forest Products Research Institute.

In this study, we confirmed that combine satellite data and fieldwork data, using Random Forest machine learning model, the large area of forest above ground biomass can be effectively estimated. In future study, compare the Random Forest to other models then get more accurate estimation is one of our goals. Also, carbon emission from deforestation, typhoon and other disturbance caused forest biomass change should be considered as well.

Keywords: Satellite data, MODIS, Above Ground Biomass, RandomForest



Japan Geoscience Union Meeting 2015
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ACG30-12 Room:301B Time:May 25 12:15-12:30

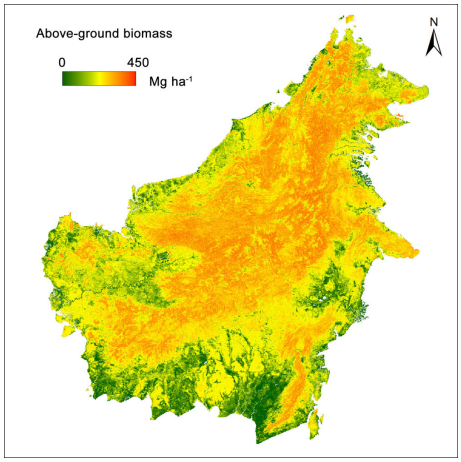
Forest resources monitoring using spaceborne LiDAR over Borneo

HAYASHI, Masato[1*] ; BORJIGIN, Habura[1] ; SAIGUSA, Nobuko[1] ; YAMAGATA, Yoshiki[1] ; HIRANO, Takashi[2]

[1]National Institute for Environmental Studies, [2]Research Faculty of Agriculture, Hokkaido University

Forests serve as a primary reservoir of terrestrial carbon. Recently, the technology for forest resources monitoring at large-scale is required for the purpose of understanding the global carbon cycle or supporting REDD+ scheme. Satellite remote sensing can provide the most practical mean for the large-scale observation, and spaceborne LiDAR is particularly expected. This sensor transmits a laser pulse from space to the Earth's surface, and records the time-varying return signal intensity as a waveform. The waveform makes it possible to analyze vertical structure near the surface. ICESat/GLAS was the only spaceborne LiDAR so far, which was operated by NASA from 2003 to 2009. However, there are some future plans of spaceborne LiDAR, such as ICESat-2, GEDI, and MOLI, and they are expected to be used for forest monitoring. This study aims to clarify the potential of spaceborne LiDAR to quantitatively observe forest biomass at large-scale. We targeted Borneo as a study area, where is one of the most important areas for REDD+ because the forest area in the island has been rapidly decreasing in recent years. First, we measured above-ground biomass (AGB) by the Bitterlich method at 37 plots, where corresponded with the GLAS footprints. And, we used the field measured data as the training data to develop an empirical model for estimating AGB from the GLAS waveform parameters. As a result of cross-validation, the accuracy of this model (root-mean-square error) was 32.1 Mg ha^{-1}. Next, we applied the developed model to the 127,862 points GLAS data over Borneo to assess the forest resources in the island. As a result, some features were found as follows: (1) the average AGB in Borneo was 183.1 Mg ha^{-1}, (2) the AGB of evergreen broadleaved forest was nearly two times larger than that of mangrove forest or shrub land, and (3) the total AGB in Borneo was 9.81 Gt. Next, we developed a wall-to-wall map of forest biomass over Borneo using MODIS satellite image (see figure), because GLAS observed at only discrete points. These results indicate that spaceborne LiDAR is a suitable sensor for forest resources monitoring at large-scale.

Keywords: Forest biomass, Spaceborne LiDAR, ICESat/GLAS, Borneo



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ACG30-13 Room:301B Time:May 25 14:15-14:30

Development of Sun-Induced Chlorophyll Fluorescence database based on ecosystem tower measurement

KATO, Tomomichi[1*] ; TSUJIMOTO, Katsuto[2] ; NASAHARA, Kenlo[3] ; AKITSU, Tomoko[3] ; NAGAI, Shin[4] ; ONO, Keisuke[5] ; SAITOH, Taku M.[6] ; MURAOKA, Hiroyuki[6] ; NODA, Hibiki[7] ; SAIGUSA, Nobuko[7] ; IDE, Reiko[7] ; TAKAHASHI, Yoshiyuki[7]

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Terrestrial ecosystems, forest, grassland and so on, absorbs atmospheric CO2 as a greenhouse gas by photosynthesis, and are thought to mitigate global warming. Estimation of geographical extent of their photosynthesical activity is very crucial for the understanding of global climate change in future. However, conventional vegetation indices (for ex, NDVI, EVI, etc.) representing the greenness of ecosystem, reduce the accuracy for photosynthesis estimation in the particular situations: for ex., the overestimation in evergreen forest in winter and in drought.

Chlorophyll fluorescence is emitted from chloroplast to release the overflown energy of incident sunlight (so-called as Sun-Induced Fluorescence; SIF). Recently, Several studies proved that SIF could be utilized for photosynthesis estimation at the ecosystem spatial scale (Zarco-Tejada et al., 2013, AFM, etc.) as shown by the strong correlationship between SIF and gross primary production (GPP). On the other hand, the availability of SIF is reduced due to small number of ground-based measurement thought highly evaluated potential of them.

This study compiles the SIF derived at five different ecosystems at tower-based flux stations in Japan: paddy field in Mase, grassland in Tsukuba university, deciduous broad-leaf and evergreen needleleaf forests in Takayama, deciduous needleleaf forest in Fujihokuroku. The SIF is calculated in the O2-A band around the wavelength of 760 nm by Fraunhofer line depth (FLD) method. We will compare the SIF to eddy GPP flux during 2005-2013 and show the preliminary analysis on the availability of the SIF for the estimation of ecosystem photosynthesis.

Keywords: Ecosystem Photosynthesis, Remote Sensing, Flux measurement, Satellite measurement

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-14 Room:301B Time:May 25 14:30-14:45

Estimation of water storage and evaporation at seasonal wetlands in Namibia by satellite remote sensing

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North-central Namibia, classified as a semi-arid region, forms vast seasonal wetlands during the rainy season. Especially the seasonal ponds near the local farmers' house (*ondombe*) are assumed as important water resources for agriculture. Local farmers mainly have cultivated only pearl millet (*Pennisetum glaucum*), but nowadays they require the introduction of rice cropping in the seasonal ponds to mitigate the risk of poor harvests.

To introduce sustainable rice cropping, evaluation of available water resource and water budget in the seasonal ponds is required. However, there has been few such researches due to the difficulty of the hydrological monitoring because the seasonal ponds are distributed widespread area, and the water storage in the seasonal ponds fluctuate even during a few days. Thus we utilized satellite remote sensing together with field measurement to estimate the chronological water storage and evaporation in the seasonal ponds.

Study site covers north-central Namibia and the part of southern Angola (16:29:43S-19:05:20S, 14:24:59E-17:00:53). Also we set three test sites (each site is 5.4 km by 5.4 km) in the study site for field measurement. First we prepared three different types of satellite data (AMSR-E and AMSR2, MODIS, Landsat ETM+) from 2002 to 2013. We integrated these data by new data fusion technique (database unmixing; Mizuochi *et al*., 2014, *Remote Sensing*) to detect water covered area with temporally and spatially high resolution. Second, we made a field laser measurement in 11 typical seasonal ponds to generate regression model between water covered area and water storage in the seasonal ponds. Then we translated water covered area detected by satellite remote sensing into water storage based on the regression model. Finally, we estimated evaporation from seasonal ponds derived from satellite data, comparing with precipitation data obtained by field observation to reveal the hydrological features in this region.

As the result of database unmixing, the spatial resolution was improved from original resolution of AMSR-E and AMSR2 (25 km) to Landsat ETM+ resolution (30 m). Temporal resolution was also dramatically improved: original Landsat ETM+ provided only 1.8% available data through the study period, whereas database unmixing provided 88.5% available Landsat-like data through the study period. The laser measurement provided 110 samples which shows the relationship between water covered area and water storage in seasonal ponds. Based on these samples we generated regression model, and eventually translated water covered area detected by database unmixing into chronological water storage data from 2002 to 2013. Both the integral water storage and maximum value of water storage for each year reflected the precipitation situation of each year. For example, in the rainy season between 2012 and 2013, which was reported as the severe drought once in 30 years, the water storage was significantly less than the other year's water storage. While in the rainy season between 2008 and 2009, during which the flooding occurred in the surrounding rivers, both the annual integral water storage and maximum water storage were high. By comparing evaporation estimated by the satellite data with the precipitation data in three test sites, it was shown that the evaporation from the seasonal ponds was several to ten percent of the amount of water input by the precipitation. This result shows that both water infiltration into the ground and evaporation from the soil surface are important process to express this region's water budget.

This study not only revealed this region's water storage and water evaporation but also proposed new approach for hydrological monitoring with high spatiotemporal resolution in seasonal wetlands. Further researches should be done in the future on improvement of the algorithm or validation of these result.

Keywords: semi-arid, seasonal pond, database unmixing, laser measurement

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-15 Room:301B Time:May 25 14:45-15:00

Process-based modeling for mountain pasture dynamics in unusual warm and long snow-free wintertime

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Alpine plant ecosystems are known as a carbon source mainly in colder periods when soil respiration is exceeding gross primary productivity. However, there is still little information about the specific impact of snow cover and thus the response of these ecosystems to climate warming and accompanying snow cover shortening is unclear. Here, we coupled a multi-layer atmosphere-SOiL-VEGetation model (SOLVEG) with a detail snow scheme, a grass growth scheme, and a soil microbiology scheme to investigate managed grassland-snowcover dynamics. The employed grass growth module can simulate key processes under cold environment such as leaf formation, elongation and death, tillering, carbon allocation, and acclimation on temperature on photosynthetic activity and frost damages. We applied the modified SOLVEG to pre-alpine grassland sites in TERestrial ENvironmental Observatories (TERENO) networks in Germany for a year with an exceptional small amount of snowfall (2013-2014). The modified model reproduced temporal changes in observations of surface energy and CO_2 fluxes, soil temperature and moisture, and aboveground biomass. Our simulations and measurements demonstrate that grasses at lower elevation continuously assimilate atmospheric CO_2 even in the middle of winter season. On the other hand, dead leaf biomass increases due to frosts over cold snow-free days. As a result, snow-free wintertime carbon uptake was not as large as expected (13% of the annual carbon uptake), and it almost balanced with wintertime soil respiration. However, under temperature rise conditions, grass ecosystems act as a strong sink of CO_2 from winter to early spring (25% of the annual carbon uptake) due to a decrease of frost damages of foliage. Future climate developments may enhance the importance of wintertime carbon uptake of typical mountain grass species in the world.

Keywords: managed grassland dynamics, snow-free period, land surface model, photosynthesis, frost damage, European Alps

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-16 Room:301B Time:May 25 15:00-15:15

Model-Aided Analysis of FACE Effects on Rice Canopy Photosynthesis, Transpiration, and Water Use Efficiency

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Sustainable agricultural practice requires promising crop productivity with efficient water use. Given the projected increase in atmospheric CO_2 concentration [CO_2], our understanding on the CO_2 effects on rice productivity (i.e., photosynthesis) and water use (i.e., transpiration) on a leaf scale improved in the last few decades, particularly with Free-Air CO2 Enrichment (FACE) experiments that enable a simulation of a future agricultural field with high [CO_2]. However, very few information is yet available as to how the investigation on a leaf-level response of photosynthesis and transpiration to [CO_2] is translated to the whole canopy photosynthesis and transpiration (Shimono et al., Glob. Change Biol., 2013; Yoshimoto et al., Agric. For. Meteorol., 2005). This is partly due to the limited size of a FACE ring where it is difficult to apply top-down measurements, such as the eddy covariance technique. In this study, we quantified the effect of [CO_2] on rice canopy photosynthesis, transpiration and water use efficiency, using a multi-layer model with the model parameters obtained from single-leaf photosynthesis and transpiration measurements. With the model parameters carefully determined, we delineated the effects of [CO_2] on the canopy photosynthesis and transpiration through the changes in physiological and micrometeorological conditions for a better understanding on future rice productivity and water use.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-17 Room:301B Time:May 25 15:15-15:30

Improving the soil sub-model of the process-based terrestrial ecosystem model to apply tropical swamp forests

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We applied conventional model (Vegetation Integrative Simulator for Trace Gases; VISIT) to tropical peat forest data obtained from Palangkaraya (PDF) site in Kalimantan but it cannot simulate carbon balance accurately. Especially, ecosystem respiration (RE) showed opposite seasonal variation with observed RE because of misunderstanding of soil respiration process. Soil respiration process in conventional ecosystem model is controlled by only soil temperature and soil water content. In contrast, CO2 release from peat is regulated by not only these components but also water table. Soil respiration data obtained from PDF site shows that the response of soil respiration to wetness is also different from that in conventional model. In order to improve the response of soil respiration, we modify soil submodel of the model. Ground water level is simulated by tank model. We modify soil respiration function using the relationship between ground water level and soil respiration.

Keywords: carbon balance, ground water level, Central Kalimantan

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-18 Room:301B Time:May 25 15:30-16:00

Global estimation of soil nitrous oxide emission using a semi-empirical model

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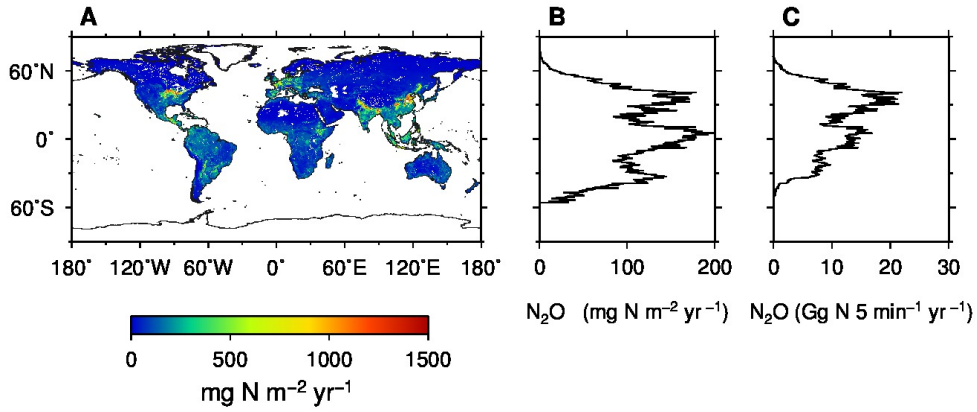
Nitrous oxide (N_2O) flux is one of the major greenhouse gas fluxes from terrestrial ecosystems. N_2O is generally released from soil surface to the atmosphere. In this study, a semi-empirical model was developed through modifying a model for soil CO_2 flux (Raich et al. 2002), and the global distribution of N_2O flux from soil was examined. The model consists of the functions of nitrogen, air temperature, and precipitation and the parameters of the functions were determined using a global dataset of N_2O emission (Stehfest and Bouwman 2006). The model was applied at a spatial resolution of 5-minute and at a monthly time resolution.

The preliminary calculation revealed that the total amount of N_2O emission was 14 Tg N yr^{-1}, and the monthly flux showed a clear seasonality, and was highest in August and lowest in February. The dry natural land is the major source of N_2O emission while the dry cultivated land was the second major source. Latitudinally, the flux was high around 30 — 40 degreeN and 10 degreeS — 10 degreeN. These results were still based on limited data, especially for wet ecosystems, and will be updated in future.

Keywords: soil, nitrous oxide, model, nitrogen



Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-19 Room:301B Time:May 25 16:15-16:30

Variability in aboveground woody biomass in miombo woodland under fire disturbances

SAITO, Makoto[1*] ; LUYSSAERT, Sebastiaan[2] ; POULTER, Benjamin[3] ; WILLIAMS, Mathew[4] ; CIAIS, Philippe[2] ; BELLASSEN, Valentin[5] ; RYAN, Casey[4] ; YUE, Chao[2] ; CADULE, Patricia[2] ; PEYLIN, Philippe[2]

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Miombo woodland is a savanna that spreads extensively over Africa, but it subjects to frequent fires (fire return intervals of 1-3 years) that are probably caused by human activities, such as cultivation, deforestation, and fuel wood collection. These activities result in degradation of miombo woodland. The degradation of large areas of miombo woodland involves the risks of rapid change in the current stable state of ecosystems to an alternative state and of increasing fire frequency and intensity. This study combined a process-based ecosystem model ORCHIDEE-FM with a fire regime model SPITFIRE to quantify the relative importance of fire regime and climate change in regulating aboveground woody biomass in miombo woodland under current and near-future climate conditions. The model was developed based on observations of resprouting and tree topkill rates in individual tree size classes for varying fire intensity. The model demonstrated that fire has a large impact on aboveground woody biomass and vegetation structure in miombo woodland. Aboveground woody biomass in miombo woodland significantly varies with fire regime with fire intensity and fire return interval. A shorter fire return interval and higher fire intensity results in a greater reduction of aboveground woody biomass by reducing the mean tree size. Although fire return interval in miombo woodland depends on human activities, fire intensity depends on the amount of grass fuel and on the season. For the current fire regime in miombo woodland, adaptive fire management is necessary to maintain today's aboveground woody biomass by controlling moderate fire intensity and frequency under current climate conditions. Under near-future climate with elevated CO_2 concentration and warmer climate, miombo woodland is perhaps more tolerant of fire disturbances by increase in the resprouting capacity and growth rate of woody plants.

Keywords: savanna, miombo, fire, aboveground woody biomass

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG30-20 Room:301B Time:May 25 16:30-16:45

Arctic terrestrial model intercomparison and its site-specific difference - physical process and biogeochemical cycle.

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GRENE-TEA Model Intercomparison Project (GTMIP) is one of the modeling group's activities in the terrestrial research project of the GRENE Arctic Climate Change Research Project (GRENE-TEA). One of the challenges for Arctic model development is scarcity of site observation data available for validation of the models. GTMIP stage 1, site simulations at GRENE-TEA observation sites using the common driving data which was elaborately combining reanalysis and site observation data, assesses the inter-model variations and the site-specific differences, investigates their attributions to the implemented processes and their complexity of the models, and propose possible improvement of physical and biogeochemical processes for modeling of the Arctic terrestrial (excl. glaciers and ice sheets).

So far, 16 terrestrial process models participate in GTMIP stage 1: a permafrost model (FROST), physical snow models (SMAP and SNOWPACK), land surface models (2LM, HAL, JULES, MATSIRO with several versions, and SPAC-Multilayer), physical and biogeochemical soil dynamics model (PB-SDM), terrestrial biogeochemical models (BEAMS, Biome-BGC, STEM1 and VISIT), dynamic global vegetation models (LPJ and SEIB-DGVM coupled with a land surface model (Noah-LSM) or standalone), and a coupled hydrological and biogeochemical model (CHANGE). Driving and validation data were produced for the four GRENE-TEA observation sites; Fairbanks (USA), Kevo (Finland), Tiksi (Russia) and Yakutsk (Russia), which have different characteristics in snow accumulation, permafrost condition, vegetation and continentality. The 30plus-year forcing data is primarily prepared from reanalysis data to compensate missing values and limitation in the coverage period of the observation data. First, we made 30 minutes-interval forcing dataset (level 0.2) based on ERA-Interim. Air temperature and precipitation are corrected with CRU and GPCP respectively. Then, the site specific data (level 1.0) was created by fitting the level 0.2 data to the observation data at a site to inherit the characteristics of the site with enough temporal coverage for driving models. Target period was set from 1980 to 2013 (34 years). Model outputs are compared and evaluated in terms of the metrics in the five categories: energy budget, snowpack (annual maximum snow depth, snowpack duration etc.), phenology, subsurface thermal and hydrological condition (ground temperature profile, active layer/seasonal freezing thickness etc.) and carbon budget.

Physical models reproduced mean annual latent heat flux better, especially at Fairbanks and Yakutsk, than biogeochemical models that tend to show larger values than the observed, and great inter-model variability at Kevo. While dedicated snow models are good at reproducing maximum snow depth except for Tiksi, those models with invariant snow density show relatively lower value than the observation. At Tiksi, a tundra site on an Arctic coast, all the models overestimate snow depth. Annual gross primary production is reproduced well at Yakutsk. However at Fairbanks, the inter-model variation is large. Annual net ecosystem production (NEP) does not have such large inter-model variation at all sites examined. However, at Fairbanks, model outputs relatively overestimate to the observation value. On the contrary, NEP is underestimated at Yakutsk. Causes and attributions of the variability in reproducibility of the models will be discussed further.

Keywords: Circum-Arctic region, Terrestrial process model

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ACG30-21 Room:301B Time:May 25 16:45-17:00

A design for the new Earth System Model with terrestrial carbon/nitrogen cycle processes

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Changes in the natural environment that are the result of human activities are becoming evident, and these changes are interrelated and can not be investigated without interdisciplinary collaboration between scientific fields. In order to understand the interrelated mechanism within the Earth's environment and to evaluate/project the anthropogenic impact on it, Earth system models (ESMs) have been developed by incorporating the biogeochemical processes of terrestrial/marine ecosystems into atmosphere-ocean general circulation models. These models have joined the Coupled Model Intercomparison Project (CMIP) and contributed to the assessment report of IPCC. We finished a process of reviewing our modeling and scientific activities up to the IPCC 5th assessment report, and we have started to design a new generation of ESMs. In this presentation, we briefly summarize the scientific/modeling tasks with ESM, and illustrate the design of the new ESM we are now developing.

Keywords: terrestrial ecosystems, carbon cycle, nitrogen cycle, Earth system models, Climate change projection, Biogeochemistry