Soil respiration in deciduous forests with different disturbance history

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Soil respiration is an important pathway of the carbon cycle in forest ecosystems. Topsoil stripping (thereinafter, TSS) is a promising practice for weed control for sapling growth. However, few studies clarified effects of TSS on soil respiration. We monitored soil respiration in naturally-regenerating forests after windthrown disturbance having different management history, including the topsoil-intact site and the topsoil-removed site. We evaluated effects of topsoil on the soil respiration.

Keywords: Topsoil stripping, leaf litter, root, soil organic matter, spatial variation

Measurement of soil CO_2 and CH_4 fluxes in tropical peat swamp forests using atuotmated multi-chamber systems

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Large carbon has been stored in organic soil in tropical peat swamp forests, which has various types. We measured soil CO_2 and CH_4 fluxes two tropical peat swamp forests using automated multi chamber system, which consists of 16 chambers. Difference of two tropical peat swamp forests is depth of ground water level (GWL). GWL in CMC site is lower and that in MLM site is higher.
Both CO_2 and CH_4 fluxes were strongly regulated by GWL. CO_2 flux in both sites increased with decreasing GWL. However, CO_2 fluxes in CMC site became plateau below -0.3 m of GWL.
On the contrast, CH_4 in both sites decreased with decreasing GWL. In CMC site, CH_4 is almost zero below -0.3 m of GWL.

Carbon and nitrogen isotopic features of the bivalve Corbicura japonica and Corbicura leana in the Harai River (Mie Prefecture, central Japan) –preliminary report

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In order to eventually reveal factors controlling distribution and abundance of the bivalve Unionidae group in the Harai River, the branch of the Kushida River, Mie Prefecture, central Japan, the bivalve *Corbicura* as alternatives were analyzed for carbon and nitrogen isotope ratios. Dissolved components of water samples and isotopic compositions of suspended particulate matter were also analyzed. Sample collection was performed in summer (July 28th, 29th and August 8th) and autumn (October 24th and 25th) in 2016; *Corbicura* samples were collected at 4 sites (*C. leana* from the two upstream sites and *C. japonica* from the two downstream estuary sites), water samples at 15 localities and particulate matter at 5 localities. In summer, PO_4^{3-} increased downstream from 0.03 to 0.12 ppm. In October, concentrations of PO_4^{3-} and NO_3^- increased downstream. Concentrations of these nutrients were significantly higher than the midstream water of the Kushida River (less than 0.01 ppm for PO_4^{3-} and 2 ppm for NO_3^-, respectively) (Sugitani et al., 2014). While carbon and nitrogen isotope ratios of *Corbicura* ranged relatively widely from -25.5 to -22.2 and from 5.6 to 10.4 per mil, respectively, samples of each population (n=10) clustered closely with each other. Additionally, seasonal variation can be seen, though small. Data of two populations of *C. leana* and one population of *C. japonica* comprised an array showing a negative correlation between carbon and nitrogen isotope ratios. Population of *C. japonica* collected from the lowermost locality was distributed outside of this array and shows a positive correlation between carbon and nitrogen isotope ratios. Distribution of *C. japonica* samples in this study was significantly lower in carbon and nitrogen isotope ratios than those reported by Kasai and Nakata (2005), who analyzed *C. japonica* and *C. leana* in the Kushida River and demonstrated that terrestrial organic matter was significantly important even for *C. japonica* diet. On the other hand, distribution of *C. leana* samples in this study was lower in nitrogen isotope ratios, while similar or higher in carbon isotope ratios than those reported by Kasai and Nakata (2005). The results of this study suggest that corbicura diet could vary significantly, depending on localized food sources. We are going to continue periodic samplings and analyses to reveal dynamics of food sources of *C. japonica* and *C. leana* and its relation to environmental factors.

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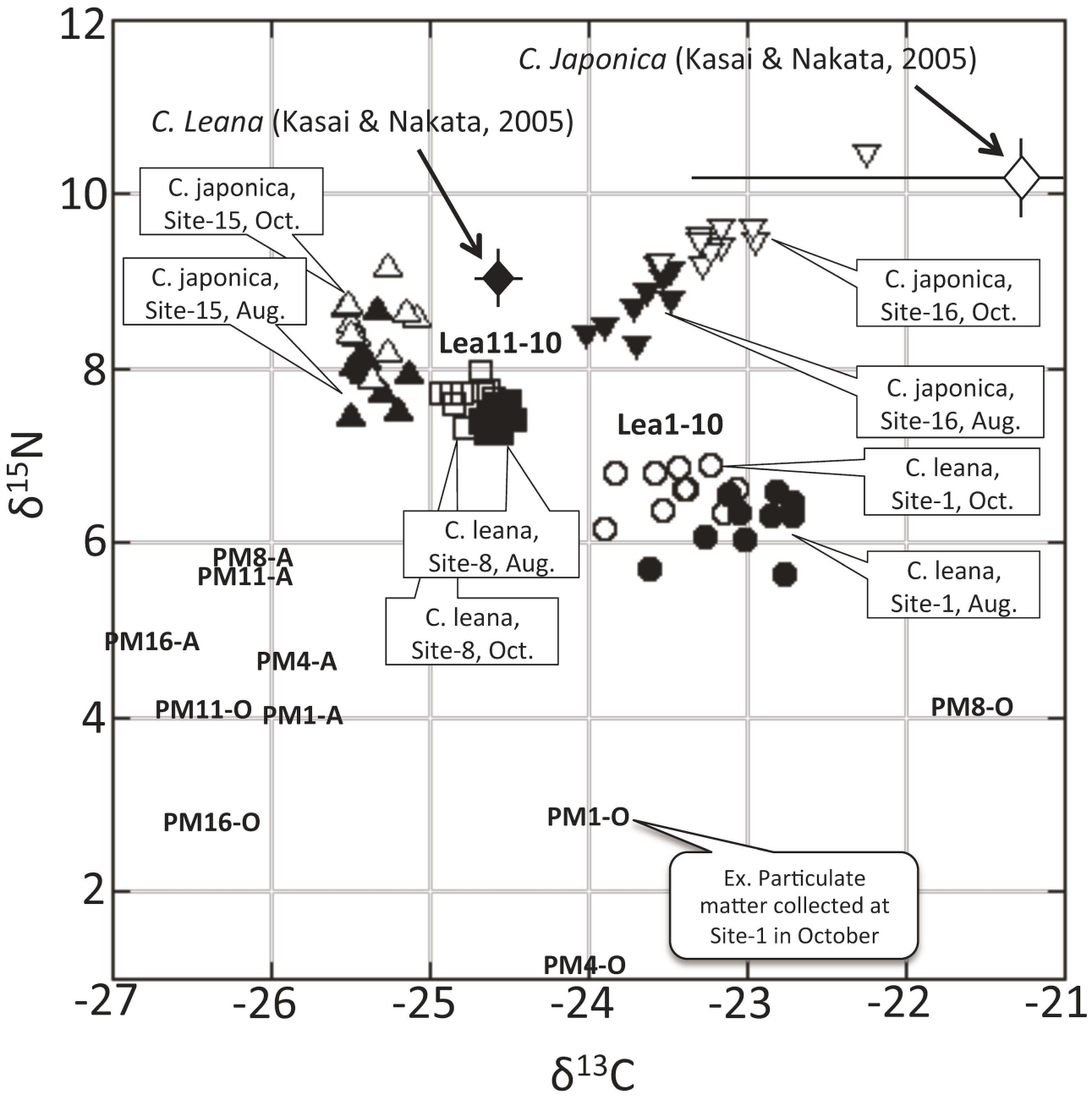
Keywords: Corbicura, food sources, carbon and nitrogen isotopic ratios, Harai River



Carbon budget in an urban forest

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Urban green areas, although being decreased in its space, have multi-functions in the urban area and would bring us benefit in the human health and safety. The carbon uptake in the urban green areas should be also benefit in GHG reduction. This study introduces our micrometeorological observations in a large park (Shirogane park) in Tokyo. The park locates in residential- and commercial area with compact mid-rise buildings near the center of Tokyo. The park was covered with forest canopy whose mean height was 14 m. Our 8-years-continued observation with eddy covariance method clarified the carbon budget in the park forest canopy. The maximum uptake of carbon was 8 gC/m^2/day in Jun above the forest canopy. The annual NEP was 820 gC/m2/year from the eddy covariance, although 360 gC/m2/year from the allometry method.

Keywords: carbon budget, urban park, eddy covariance method

Effect of hydro-thermal condition in active layer of permafrost to larch tree transpiration and forest evapotranspiration at eastern Siberia

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To improve our understanding of water cycle in eastern Siberia boreal forest, two observation sites at a larch dominated forest were compared. The dominant species in these forests is larch making the upper canopy, and mixed with mainly birch and willow, although composing ratio differs at each forest. Atmospheric condition was similar in the two sites, but soil properties such as soil texture, seasonal thawing ratio and soil water content was different. We use datasets of larch tree transpiration based on sap-flow measurement and forest evapotranspiration based on tower flux observation. Environmental factors explaining temporal variation of the larch transpiration and forest evapotranspiration were extracted by a path analysis. Remarkable difference between sites was found in influence of the soil temperature and water. Generally soil temperature affects positively to root water uptake in layer of the fine root concentration. In one site with soils of high water permeability, soil temperature of some depths has negative correlation to the water fluxes possibly via deepening active layer which accelerates soil water infiltration. Such relation was not found in the other site with high water holding capacity through the active layer. Vertical profile of the soil water due to difference of the soil texture and seasonal thawing ratio is an important factor on distinctive response of two forests.

Keywords: forest evapotranspiration, permafrost active-layer, larch, Siberia

Artificial sap flow measured by heat field deformation and heat ratio methods in the laboratory

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Recently, newly developed sap flow techniques, that is heat ratio method (HR, Burgess et al., 2001) and heat field deformation method (HFD, Nadezhdina et al., 2012), have been available in Japan. However thermal dissipation method (TD, Granier, 1985) has been widely used in Japan (e.g., Kumagai et al., 2014), and there are quite a few numbers of studies measuring sap flow of trees in a forest by HFD and HR. Iida et al. (2015; 2016) applied TD, HR and HFD for a mature tree of Japanese cedar (*Cryptomeria japonica*) during a year, and confirmed their availability to detect diurnal changes in sap flow. This preliminary measurement was carried out in the Japanese cedar stand located in Mt. Tsukuba: the condition of comparisons cannot be controlled. Shinohara et al. (2016) has established the equipment to generate the stable water flow with the variable intensities within a stem by using a vacuum pump, and compared TD measurements with the artificial flow. Our primal objective is, by using the equipment in the laboratory (Shinohara et al., 2016), to compare the HR and HFD measurements with controlled sap flow.

We sampled four stems from four Japanese cedars planted in the nursery of Forestry and Forest Products Research Institute, Japan. Their ages are 12 years, tree height was from 9.0 to 10.0 m and diameter at breast height was from 10.9 to 12.5 cm. The width of active sapwood was about 3 to 4 cm. We used sensors of HR and HFD manufactured by ICT international Pty Ltd (type SFM1 and HFD8, respectively) and another HR measurement system developed by Kominami et al. (2016). Outputs of HR and HFD showed clear correlations with the vacuum pressure, indicating the basic availability of these methods to measure activities of sap flow for Japanese cedar as suggested by Iida et al. (2015; 2016). At the presentation, we will show the radial and azimuthal variations in sap flow generated by the equipment (Shinohara et al., 2016) and will analyze the effect of some corrections related to calculations of heat pulse velocity for HR. We will also provide the results of comparisons between the artificial sap flux density and that calculated by the equation proposed for HFD (Nadezhdina et al., 2012).

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Keywords: artificial sap flow, calibration, heat field deformation method, heat ratio method

Influence of human disturbances on long-term CO_2 exchange over a larch forest

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Larch forest is an important research object for evaluating ecosystem response against future global warming because it is a representative vegetation type for high latitudinal northeast Eurasia where greater temperature rise due to climate change is anticipated. In Japan, Larch is a common tree type of plantation that has been planted widespread over northeastern Japan especially after World War II. Quantifying the influence of the forest management on carbon budget in larch forests have significance on the securement of forests as a source of CO_2 absorption. Thus, National Institute for Environmental Studies (NIES) has implemented long-term monitoring program of CO_2 exchange over larch forests. We established the Fuji Hokuroku Flux Observation Site in the foothills of Mt. Fuji as an alternative base for monitoring, and began observations in January 2006. The site is dominated by larch trees of more than 50 year-old. 30% thinning was conducted at the site in spring of year 2014 and 2015. The characteristics of CO2 exchange were affected from the human disturbance. We will introduce the results of carbon fluxes and related parameters for the sites.

Keywords: CO2, Flux, Disturbance

Some findings from on-going construction of database for functional traits of Sugi and Hinoki

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Recent increases in air temperature and extreme climatic events strongly arise the needs for assessing the impact of climatic change on forestry. This is particularly an emergent requirement in artificial forests of Sugi (*Cryptomeris japonica*), since this species is more sensitive to drought and has already exhibit symptoms of water stress in the forests of southwest Japan.
An accurate assessment requires the use of species' specific traits as parameters in the models, which could then simulate realistic forest dynamics. However, for afforestation species, few studies have measured their ecophysiological traits with the intention of using them in the models, and thereby a reliable set of parameters for a targeted species is not readily available. On the other hand, for this half century, Japanese researchers have extensively studied physiology, stand structure and carbon cycle of major afforestation species, which now form a huge stock of information. Reviewing such studies to reveal the means and the ranges of given traits, factors responsible for the ranges, and the relationship between traits will significantly contribute to the improvement of the accuracy of assessment. We are now surveying vast literature on Sugi and Hinoki cypress (*Chamaecyparis obtusa*) that have published so far and constructing a database of their functional traits. Here, we report some findings obtained from our database consisted of data collected by more than 100 papers.
The recent spread of portable gas-exchange measurement system and the development of the study of leaf traits syndromes had provided relatively abundant data on leaf physiology (e.g. photosynthesis, leaf nitrogen content, stomatal conductance) and leaf morphology (SLA, LMA) in Sugi and Hinoki. In both species, photosynthetic capacity that were measured under different condition (light, nitrogen availability, water application, month, leaf age, leaf location in the crown) varied more than 10 folds, which ranged 0.34 - 12.69 μmol m^{-2} s^{-1} in Sugi and 0.37 - 9.85 μmol m^{-2} s^{-1} in Hinoki. Stomatal conductance also showed more than 10 folds difference, while area-based leaf nitrogen content and SLA varied only 2 - 4 folds, suggesting that the stomatal conductance is responsible for the large variation in photosynthesis. Relatively few studies measured seasonal changes in these parameters, although they could have large influence on the model prediction. Therefore, in this study, we also attempt to reveal the phonological characteristic of these traits by meta-analysis.

Keywords: Sugi, Hinoki, Functional traits, database, impact assessment of climatic change, forestry

Seasonal changes in the photosynthetic capacity and chlorophyll fluorescence in canopy leaves of *Quercus crispula* in a cool-temperate forest

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In recent years, climate change has occurred around the world. To explore and predict the cause of such climate change, it is indispensable to elucidate the behavior of carbon cycles on the earth. To estimate gross primary production (GPP) of terrestrial ecosystems, one of the largest carbon flux, is an urgent task of mankind. Solar-Induced Fluorescence (SIF) is expected to represent GPP and to include photosynthetic physiological information on vegetation. However, it remains unclear what regulate the SIF at the canopy scale across the growing season. I examined the effect of seasonal photosynthetic capacity (V_{cmax25}) and leaf area index on SIF and SIF yields at the leaf and canopy scale, using the fluorescence-photosynthesis model (van der Tol et al., 2014) and retrieved canopy SIF data in a cool-temperate deciduous forest at Tomakomai Experimental Forest, Hokkaido, Japan. I conducted gas exchange measurements for canopy leaves of Quercus crispula Blume and calculated V_{cmax25} once a month, from June to October in 2016. Using the seasonal changes in V_{cmax25}, air temperature, photosynthetically active radiation (PAR), SIF at the leaf scale was simulated. Additionally, seasonal changes in leaf area index (LAI) was estimated from enhanced vegetation index (EVI) of Hemispherical Spherical spectroRadiometer. My results show that the seasonal variation of V_{cmax25} had little impacts on simulated SIF (4.9 % in averege of growing season) compared to xed V_{cmax25}. In addition, simulated SIF at the leaf scale was strongly correlated to APAR (r^2 = 0.99), which indicates that SIF is emitted according to absorbed light photon. As a result of comparing the SIF simulated at the canopy level and the retrieved SIF, r^2 = 0.91 for SIF and r^2 = 0.64 for SIF yield (canopy SIF / APAR), both of which were highly correlated. This values were higher than the comparison of the SIF simulated at the leaf scale and the retrieved SIF (r^2 = 0.73 for SIF, r^2 = 0.34 for SIF yield). Thus, SIF retrieved at the canopy scale had stronger relationship with SIF simulated at the canopy scale than with that at the leaf scale, which indicates the amount of leaves affects canopy SIF. I also examined the relationship between retrieved SIF yield (SIF / APAR) and LAI. As a result, SIF yield was found to have a high correlation with LAI (r^2 = 0.65). My results suggests that seasonal changes in SIF is more affected by LAI and APAR while physiological factors had little impacts on SIF.

Keywords: Remote Sensing, Solar-Induced Fluorescence (SIF), Leaf Area Index (LAI), Carbon cycle, Non-Photochemical Quenching (NPQ)

Multi-layer measurement of upward and downward solar-induced chlorophyll fluorescence in a cool-temperate deciduous broadleaf forest

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Strong representation of Sun-Induced Fluorescence (SIF) for the ecosystem-level photosynthesis activity has been confirmed by satellite studies [*Frankenberg et al*., 2011; *Joiner et al.,* 2013] and by field studies [*Porcar-Castell*, 2011, *Yang et al*., 2015]. However, the lack of taking care of SIF emission below the tree canopy top may underestimate the contribution of sub-canopy and the understory species to total ecosystem CO_2dynamics.
To examine the potential contribution of SIF emission from lower part of tree ecosystem to total ecosystem SIF emission, the downward SIF from tree canopy and upward SIF from understory were calculated from the spectrum data in a cool temperate forest in in central Japan (36˚08′N, 137˚25′E, 1420 m a.s.l.) as well as the upward SIF from canopy top, and the fractional ratios among them are compared on half-hourly and daily bases from 2006 to 2007. The top canopy is dominated by Oak and Birches, and the sub-canopy layer and shrub layers are dominated by *Acer*, *Hydrangea* and *Viburnum species*. The understory is dominated by an evergreen dwarf bamboo *Sasa senanensis*, and covered partially by the seedlings of oak and maple, and herbaceous species [*Muraoka and Koizumi*, 2005]. The SIF was estimated from the spectrums of downward and upward irradiances measured at two heights of 18m and 2m above ground by HemiSpherical Spectro-Radiometer, consisting of the spectroradiometer (MS700, Eko inc., Tokyo, Japan) with the FWHM of 10 nm and wavelength interval of 3.3 nm. The SIF around 760nm (O_2-A band: SIF_{760}) was calculated according to the Fraunhofer Line Depth principle with the additional arrangements.
The SIF emission intensity was kept in the order as canopy upward > canopy downward > understory upward for most of growing season, except for the spring time when the snow was just melted and the Sasa bamboo kept green leaves at the forest floor. On the other hand, the relative intensities among three SIF emissions seem to change temporally. The lower upward/downward SIF ratio and lower understory/overstory SIF ratio in spring and autumn may have showed the phonological trend in foliage volume and chemistry in deciduous forest. On annual average, 43% higher upward SIF from overstory to that from understory showed high contribution of sunlit tissue and leaves in top canopy. The fractional ratio of overstory upward SIF to total of overstory and understory upward SIF of 70% is lower than the overstory ratio to total in NPP of 83% (Ohtsuka et al., 2007) and that in APAR of 82%. Large contribution of understory in upward SIF may indicate that current satellite and field observations may miss the contribution of sub-top crown foliage to ecosystem photosynthesis (GPP).

Keywords: Remote sensing, Carbon dynamics, Forest structure

Simulation of the forest dynamics and material cycle after typhoon disturbance using the Spatially Explicit Individual-Based Dynamics Global Vegetation Model (SEIB-DGVM)

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Typhoon, one of the major disturbances in temperate coastal areas, drastically affects forest dynamics and material cycling. After the typhoon, large number of gaps was formed, and canopy density was reduced, light transmission was enhanced. The primary productivity, hydrological characteristics, carbon and nutrient cycling, vegetation regeneration, community succession, species composition and structure, ecosystem stability were also severely affected (Sano et al., 2010; Lin et al., 2011; Kauffman et al., 2010). Therefore, the research of forest dynamics and material cycling after disturbance is critically important. Dynamic global vegetation model (DGVM) has been developed to simulate vegetation dynamics, energy and material cycles under the climate change (e.g. LPJ, CLM-DGVM, SEIB-DGVM, etc.). Especially, SEIB-DGVM has a great advantage that can represent the three-dimensional forest structure based explicitly with local competition among individual trees on the virtual forest stand (Sato et al., 2007; Guan et al., 2014). To understand the disturbance effect on the forest ecosystem, here we simulate the vegetation dynamics and carbon cycles by SEIB-DGVM in deciduous mixed forest, formerly Larch plantation until typhoon destruction, in Tomakomai Flux Research site with validation to the field measured data.

The study site was Tomakomai Flux Research Site in the Tomakomai National Forest in southern Hokkaido, Japan (42°44’13.1”N, 141°31’7.1”E, 125m above sea level). After Typhoon No.5 in 1954, during 1957-1959, the site was planted several tree species: Japanese larch (*Larix Kaempferi Sarg.*), Birch (*Betula ermanii* and *B. platyphylla*), Japanese elm (*Ulmus japonica*), Spruce (*Picea jezoensis*). Dominant understory species were Fern (*Dryopteris crassirhizoma*, *D. austriaca*), Pachysandra terminalis and Hydrangea petiolaris. In 2004, typhoon SONGDA landed Japan, 90% of the trees were blew down at Tomakomai Flux Research Site. (Hirano et al., 2017). Mean annual temperature and mean annual precipitation from 2005 to 2015 at this site were 6.38℃and 1408.18mm respectively. The climatic data are download from the Japan Meteorological Agency. The validation eddy flux and biomass data are taken by previous studies (Sano et al., 2010 etc.).

The SEIB-DGVM simulates the establishment, the competition with others, and the death of individual tree on spatial explicit 30m X30m virtual forest stand. Since this research focuses on simulate forest dynamics after typhoon, we cut off the fire component to exclude the interference of the fire. To get the carbon storages equilibrium, the model was spun-up for 1000 years, repeatedly using 30 years’ climate data from 1901 to 1930 with constant atmospheric CO_2 concentration in 1900. After spin-up, we set four continuous simulation periods: 1901-1959 as historical period with AMeDAS-based climate, 1959-2004 as plantation one with AMeDAS based climate, 2004-2016 as disturbance one with Eddy flux tower-based climate; 2016-2100 as future one with MIROC-AR5 based climate. We will show the preliminary results on simulated time courses in carbon fluxes (GPP, NPP, R_{eco}, NEP), carbon storages, and composition of species diversity especially between woody and grass PFTs . The destruction of canopy trees may reduce the competition for the understory trees and the formation of gaps case new allocation such as light, carbon and soil nutrients to accelerate the entry of invasive species into natural forest. The PFT diversity of ecosystems increased with the recovery of community.

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Keywords: Gap formation, Age class, Carbon cycle, Water cycle, Species composition

Bayesian calibration of a process-based model for estimating the growth of Japanese cedar plantations

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In Japan, there is increasing concern about the effects of climate change on the growth or decline of old Japanese cedar (*Cryptomeria japonica*) plantations. Process-based simulation models can provide information on the short- and long-term responses of tree plantations to changing climate, which is useful for policy making and broad discussion among stakeholders. In many cases, however, it is difficult to obtain all of the model parameters from direct measurements. The recently developed Bayesian calibration scheme has the potential to provide a set of appropriate parameters for a model based on monitoring data archives. This study tested the applicability of Bayesian calibration to the parameterization of a process-based model for estimating the growth of Japanese cedar plantations.
The process-based model Biome-BGC was used with the default parameters (evergreen needle leaf forest). The 20 eco-physiological trait parameters (*e.g.*, turnover rate, allocation, C:N ratio of tree organs, etc.) in Biome-BGC were calibrated simultaneously. For the Bayesian calibration, we used monitoring data for Japanese cedar plantations, including the monthly averaged data for the net ecosystem exchange (NEE) and soil respiration for 2001–2003 in the Kahoku Experimental Watershed in northern Kumamoto Prefecture, and growth and yield data for three experimental sites in Kyushu, Japan.
The simulations of NEE and soil respiration were improved after a small number of iterations (*i.e.*, <1000) in the Bayesian calibration, compared with the default values. A newly added parameter on the turnover rate of fine roots also improved the simulation of soil respiration. The variation in the biomass increment among the three experimental sites was smaller in the simulation than observations, even after the calibration. The next step is to improve the choice and combination of observation data (*e.g.*, gross primary production and respiration) and the calibration procedure (*i.e.*, hierarchal calibration).

Keywords: Cryptomeria japonica, Biome-BGC, Bayesian calibration

