2007　Global COE Program　Next Generation Research Initiative
Research report

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Title :　**Study on GHG dynamics in a tropical forest ecosystem using stable isotope measurements**

Objective and focuses

Methane (CH_4) and Nitrous Oxide (N_2O) are key greenhouse gas, and their infrared radiative heating effects are much greater than that of carbon dioxide on a mole-per-mole basis. Soil functions as both a main source and a main sink for CH_4 and N_2O. In anoxic environments, CH_4 is produced by methanogenic bacteria. Both N_2O production and consumption occur in anoxic soil by denitrification. In contrast, CH_4 is usually oxidized by methanotrophic bacteria and N_2O is usually produced by nitrification in oxic soils. However, much uncertainty regarding the mechanisms of such GHG production and consumption in soils still leads to uncertainty in estimating the global budget of these gases. Although there are many reports on these GHG gas dynamics in temperate regions, observation data of various environments in tropical regions are still needed. In particular, little data has been obtained in tropical forests in Asia.

Our objectives were to understand what the controlling factors of GHG production and consumption in tropical forest are.

Research fields and Methods

1. Pasoh Forest Reserve (Malaysia)

We measured 3 spices of GHG (CH_4, CO_2, N_2O) flux at Pasoh Forest Reserve in the Malaysian peninsular (2°59' N, 102°18' E). We measured gas flux from the forest floor and GHG gas concentrations in soil gas. Carbon and Nitrogen concentrations in soil, stable isotope ratio of soil C were also analyzed. We set 34 chambers across the forest site (120m×220m). Field measurements were conducted in August 2006, March and December 2007, and March 2008.

2. Peatland forest site (Central Kalimantan, Indonesia)

Our field research was conducted at 3 sites in Central Kalimantan, Indonesia. A natural wetland forest site, a wetland forest site with artificial control of water table level for prevent the decomposition of peat, and a forest site formed

after irrigation, cutting, and burning were selected.

Dissolved CH_4, CO_2, NO_3^- and SO_4^{2-}, organic carbon concentrations were analyzed. Stable carbon isotopic composition of CH_4 and CO_2 were also analyzed. Sampling was conducted in February and September 2007.

Results and future direction

1, Pasoh forest reserve

Generally dry oxic soil can consume CH_4 because CH_4 oxidation in soil can exceed CH_4 production. In Pasoh, CH_4 consumption was larger in the dry period than the rainy period and negatively correlated to the soil's water condition. CH_4 production during the wet season that we can observe in temperate forest (in the Japanese site) was not detected even in the wettest season. CH_4 consumption rates were almost the same level as those in the temperate forest. In the driest season, large CH_4 emissions were sometimes observed, suggesting the contribution of CH_4 production by termites. Although N_2O emissions were usually undetected, a large emission of N_2O was observed just after rainfall. Our results suggest that more factors affect these GHG dynamics in tropical rain forests when compared to those in temperate forests. Further measurement including isotopic composition of these gases will provide much further information.

2, Peatland forest in Central Kalimantan, Indonesia

Redox conditions in porewater of peatland forest sites in Indonesia were much more oxic than those of peatland wetland in Japan. In general, decomposition of organic matter in submerged anoxic condition causes highly reducing condition (low Eh condition) and CH_4 production can occur only under -200mV (Eh). At all our sites in Kalimantan, Eh of porewater in peatland forest does not go below zero, suggesting that a relatively oxic condition was kept there even with much undecomposed organic matter and dissolved organic matter. Dissolved gaseous CH_4 and CO_2 were much lower than peatland wetland in Japan and this suggests that the decomposition of organic matter was at a low level in the Indonesian peatland sites. In the future, we will focus on the difference of in quality of the organic matter between tropical peatland forests and temperate peatland forests.