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A long-term monitoring of the carbon uptake by Japanese forests via micrometeorological observation network

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1. Introduction

To curb global warming, the profound knowledge of carbon uptake and the carbon cycle processes in the terrestrial ecosystem are the most important and urgent issues. Therefore, it requires the extensive observation in the field and the improvement of the database about the carbon budget and its functions in forests from various types in different regions.

The global long-term monitoring network of the terrestrial ecosystems (FLUXNET) and its regional network among Asian nations (AsiaFlux), which was established in 2000 and has been organized mainly by the Japanese researchers, focus on the carbon budget to address this issue. This study reports results from forest carbon exchange under the forest tower flux observation network in Japan, FFPRI FluxNet.

2. Methods

Six observation towers, FFPRI FluxNet, are located at SAP (Deciduous forest in Sapporo, Hokkaido), API (Deciduous forest in Appi, Iwate), KWG (Deciduous forest in Kawagoe, Saitama), FJY (Coniferous forest in Fujiyoshida, Yamanashi), YMS (Mixed broadleaved forest in Yamashiro, Kyoto), and KHW (Coniferous forest in Kahoku, Kumamoto).

Flux and the micrometeorological elements such as wind velocity, air temperature, and carbon dioxide concentration above the canopy have been observed. The closed-type gas analyzer has been used for the eddy covariance technique. The data quality has been controlled among sites. The elements such as net ecosystem productivity (NEP), ecosystem respiration (RE), gross primary productivity (GPP), and the other related micrometeorological elements were compiled into the database which is available on our web site.

3. Results

The seasonal changes in NEP at SAP and API, which have cool and snow covered winter, showed constant CO_2 release in winter and large CO_2 uptake from May to August as the forest canopy closure. Meanwhile, the NEP in coniferous sites in FJY and KHW showed CO_2 absorption throughout the year, and drop from June to August as the high air temperature and the reduction of the solar radiation due to the rainy season.

The following two examples are the change in NEP associated with the natural forest disturbances. In 2004, SAP forest had hard hit by a typhoon. After this wind disturbance, the summer NEP dropped by 50%, while the winter NEP unchanged. In the annual bases, the estimated RE increased conspicuously, however the GPP decreased slightly despite of approximately 50% of trees around the tower were uprooted or stem-collapsed, eventually changed the forest completely as the carbon source. In August in 2007, API experienced severe insect damage by *Syntypistis punctatella* and the forest canopy lost their entire leaves. The NEP changed drastically from positive to negative after the damage, and the annual NEP decreased to 1/3 from the previous year, which attributed to reduction of GPP and steady RE. However, the decrease in NEP had recovered in the next year.

Among the different forest type and its climatic condition, the NEP observed in each sites ranged from 3 to 4.5 t[C]$ha^{-1}y^{-1}$ except YMS, which was located in the oligotrophic soil condition. Our results showed that the forest released 74 to 88% of the totally absorbed carbon (GPP) as RE and the remaining 12 to 26% of GPP was NEP.

Keywords: tower flux observation, NEP, Ecosystem respiration, GPP