SEASONAL AND INTERANNUAL VARIABILITY IN NET ECOSYSTEM CO_2 EXCHANGE IN SIX FOREST FLUX SITES IN JAPAN

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ABSTRACT

Eddy covariance measurements of CO_2 were taken for five years above six forests distributed from the northern to southernmost main islands of Japan. These forests included cool- and warm-temperate deciduous and coniferous forests. The climate of Japan is characterized by apparent seasonal changes and adequate precipitation affected by the East Asian monsoon. In this report, we compared net ecosystem production (NEP) among forests using the eddy covariance method and analyzed the climatic factors that affect seasonal and inter-annual changes in NEP in relation to forest type. The observed annual NEP from 2000 to 2002 ranged from 286 to 566 $gCm^{-2}yr^{-1}$, and this basically increased with decreasing latitude. The observed maximum 10 days mean NEP was about 1.5 times larger in the deciduous sites, although the growing period was more than 2 times longer in the coniferous sites.

INTRODUCTION

Forest carbon dioxide uptake has been examined in relation to global change. Energy and carbon dioxide flux observations are expected to be valuable in the various forest ecosystems in East Asia, especially those characterized by the monsoon climate, complex terrain and human impacts. In this report, we compare net ecosystem production (NEP) among forest sites using the eddy covariance method and analyze the climatic factors affecting seasonal and inter-annual changes in NEP in relation to forest type.

SITES AND METHODS

Six forest sites distributed from the Japanese main islands of Hokkaido to Kyushu ranging from 43 to 33 °N in latitude were observed: Sapporo site (cool-temperate white birch forest), Appi site (cool-temperate beech forest), Kawagoe site (warm-temperate deciduous broadleaved forest), Fujiyoshida site (cool-temperate pine forest), Yamashiro site (warm-temperate mixed forest on complex terrain), and Kahoku site (warm-temperate Japanese cedar forest on complex terrain). The climate of Japan is generally characterized by apparent seasonal changes and adequate precipitation affected by the East Asian monsoon.

CO_2 flux measurements above the forest canopy were conducted according to the eddy covariance method using a three-dimensional ultrasonic anemometer/thermo-meter (DA600/KAIJO) and closed-path infrared gas analyzer (Li6262/LiCor); the measurement system was similar among sites. The air was sampled at a

rate of around 10Lmin-1 with 30 to 50m teflon tubes with an inner diameter of 6mm. Signals were recorded every 0.1s or 0.2s using a high-speed data logger (DRM3b/TEAC) with a magneto-optical disk. A low-pass filter with a cut-off frequency of 24Hz was also used. Other micro-meteorological elements such as radiation, air temperature, humidity, wind velocity and soil moisture were also measured in and around the observation tower. In the eddy covariance flux calculations, the vertical wind velocity component was separated by axis rotation [*McMillen*, 1988]. The CO_2 flux (Fc) was calculated every 30 minutes by applying spectral correction in the higher frequency range. The CO_2 storage change (Sc) was also measured in all sites then NEP was obtained from -NEE (net ecosystem exchange) = -(Fc+Sc). Data quality control and data selection according to the friction velocity of the observed NEE were also employed, and data gaps were filled with the estimated nighttime and daytime NEE parameterized for each site. Because in complex terrain sites eddy covariance NEE was sometimes difficult to evaluate using the micro-meteorological approach only, the results of soil and foliage chamber measurements were additionally used.

RESULTS AND DISCUSSION

The observed annual NEP from 2000 to 2002 ranged from 286 to 566 $gCm^{-2}yr^{-1}$ [*Nakai et al.,* 2003; *Yasuda et al.,* 1998; *Ohtani et al*., submitted; *Kominami et al.,* 2003], and this basically increased with decreasing latitude. The observed maximum 10 days mean NEP was about 1.5 times larger in the deciduous sites, although the growing period was more than 2 times longer in the coniferous sites. The monthly NEP in the coniferous sites had large inter-annual variation throughout the year, but variation only appeared from April to October in the deciduous sites because of their limited leafing period. Respiration was relatively more consistent than assimilation in all sites, because the summer air temperature (Ta) behaved similarly among years. Inter-annual variation in Ta increased in winter, but in some sites snow cover maintained the soil temperature. The ratio of the maximum to minimum annual NEP from 2000 to 2002 ranged from 1.7 to 1.9 in the deciduous sites, but from 1.1 to 1.3 in the coniferous sites.

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