THE MEASUREMENT OF CO_2 EFFLUX ON FOREST FLOOR IN DECIDUOUS FOREST, JAPAN - THE CASE IN THE DEEP IMPACTED FOREST BY HUMAN ACTIVITIES

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INTRODUCTION

For more than 1000 years, the forests in mountainous areas of Japan have been distinguished by excessive harvesting and litter collection. Revegetation of these areas over the past 130 years has resulted in the current forest coverage. However, the forest soils are immature and contain very little organic carbon. Therefore, the past human impact likely affects the present carbon cycle and CO_2 efflux at the forest floor. It is important to estimate the carbon cycle and CO_2 efflux at the forest floor in such a heavily affected ecosystem to discuss the relationship between the carbon cycle and land use management. Therefore, we measured the CO_2 efflux at the forest floor in a deciduous forest heavily affected by human activities in Japan and estimated the annual rate.

SITE DESCRIPTION

Observations were taken in the Yamashiro experimental forest situated at 34° 47' N, 135° 50' E, in southern Kyoto Prefecture. The region is covered by deciduous broadleaf secondary forest dominated by oak. In 1999, the total basal area and aboveground biomass of stems with diameter at breast height (DBH) greater than 3 cm were 20.7 $m^2\ ha^{-1}$ and 105.05 t ha^{-1}, respectively. The same authors recorded the average litter fall, mean temperature, warmth index, and annual precipitation for 1999-2002 as 5.16 t $ha^{-1}\ year^{-1}$, 5.5°C, 125.6°C $month^{-1}$, and 1449.1 mm, respectively. The forest soil originates from granite, and has an immature structure. The forest floor at the experimental site was consistent with this regolith, and the organic carbon content was less than 2.75%.

METHODOLOGY

The CO_2 efflux at the forest floor (F_c: mg $CO_2\ m^{-2}\ s^{-1}$) was measured on a ridge (site A) and at the bottom of a valley (site B) from July 2003 to January 2005, and from April 2004 to January 2005, respectively, using a static closed-chamber method. The holizontal distance and the different altitude between these sites are around 100m and 30m, respectively. One automated IRGA enclosed-chamber [*Tamai et al*., 2005a] was placed at each site. To verify the spatial variation in F_c, measurements were taken at random intervals around the automated chamber using a manual IRGA enclosed-chamber [*Nobuhiro et al*., 2003] equipped with eight soil collars in each site. Soil moisture (θ: $m^3\ m^{-3}$) and soil temperature (T_s: °C) were also monitored at a 5-cm depth at these sites beginning in July 2002. In addition, θ and T_s at a 5-cm depth were monitored on a ridge (site C), on a north-facing slope (site D), and on a south-facing slope (site E) from July 2002 to June 2003 to estimate the annual rate of F_c at each site.

RESULTS AND DISCUSSION

The temporal fluctuation in F_c is shown in Fig. 2. *Tamai et al*. [2005b] evaluated the relationship between T_s, θ, and F_c at sites B, C, D, and E as the following equation:

$$F_c = 0.0566 EXP(0.0717 T_s) \frac{\theta}{\theta + 0.1089}$$

The relative differences between the measured F_c and that calculated using the above equation were 25% and 16% at sites A and B, respectively (Fig. 1). Moreover, the calculated and measured F_c at site A in 2004 were 25.9 and 22.5 t CO_2 ha^{-1} $year^{-1}$, respectively. These results indicate that the above equation accurately estimates F_c.

Compared to the calculated annual F_c from July 2002 to June 2003, F_c was relatively small at sites A (19.7 t CO_2 ha^{-1} $year^{-1}$) and C (15.0 t CO_2 ha^{-1} $year^{-1}$), located on the ridge. This occurred because θ tends to be smaller on a ridge than on other parts of a slope. The maximum annual F_c was calculated for site E (26.5 t CO_2 ha^{-1} $year^{-1}$), which faced south. This may be because high amounts of solar energy strike the south-facing slope, causing T_s to be greater than at other sites. The calculated annual F_c at site A from July 2002 to June 2003, and from January to December 2004 were 19.7 and 25.9 t CO_2 ha^{-1} $year^{-1}$, respectively. The difference was relatively large, implying that the long-term estimation of F_c is important. Annual F_c calculated in this study is smaller than those reported by other studies in Japanese forest [*Ohashi et al*., 1999; *Liang et al*., 2004].

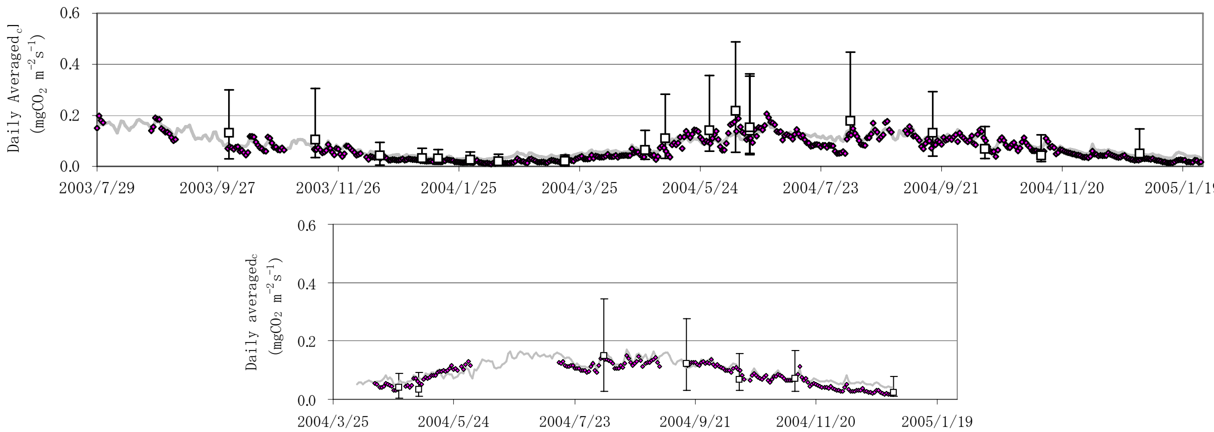

Fig. 1. The fluctuations of CO_2 efflux on the forest floor (F_c) at site A (above) and site B (below). Thick line: Measured F_c with automated chamber, Faint line: Calculated F_c. White square: Averaged F_c measured with manual chamber. Vertical bar: Maximum and minimum F_c measured with manual chamber.

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