SEASONAL CHANGE OF CO_2 FLUX ABOVE A JAPANESE BEECH FOREST

T. Saito[1], Y. Ohtani[2], Y. Mizoguchi[2], T. Morisawa[1]

[1]*Tohoku Research Center, Forestry & Forest Products Research Institute, 92-25, Nabeyashiki, Morioka, 020-0123 Japan;saitota@affrc.go.jp*

[2]*Department of Meteorological Environment, Forestry & Forest Products Research Institute, 1, Matsunosato, Tsukuba, Ibaraki, 305-8687 Japan*

ABSTRACT

Forestry and Forest Products Research Institute erected a CO_2 flux observation tower at a Japanese beech forest, and have measured CO_2 flux with closed-pass eddy covariance method for 5 years. During the observation period, 2003 was the most CO_2 absorbed year, and the amount was 1.9 times larger than 2004, which was the least CO_2 absorbed year. To investigate the cause of the smaller CO_2 absorption in 2004, we referred some meteorological factors in 2003 and 2004. Solar radiation (during green-leaved season) was larger in 2004 than 2003, in contradiction to CO_2 absorption. On the other, air temperature was higher in 2004 than 2003 (both in green-leaved and defoliated season). We assumed that larger respiration in 2004 effected the depression of annual CO_2 absorption. At our research site, annual mean air temperature in 2004 was 0.95 degree centigrade warmer than 2003. The result of this study suggests the tendency that warmer climate may cause less CO_2 absorption in this Japanese beech forest.

INTRODUCTION

Japanese beech (*Fagus crenata* Blume) is one of the most popular tree species distributing north-east district of Japan and mountainous regions of central Japan,and Japanese beech forests are representative vegetation of cool-temperate climatic zone in Japan. So that to evaluate CO_2 absorption by the forests in Japan, CO_2 budget of Japanese beech forests must be clarified. To that purpose, Forestry and Forest Products Research Institute (FFPRI) erected a observation tower at a Japanese beech forest, and have measured CO_2 flux above the forest crown by closed-pass eddy covariance method for 5 years. In this study, we investigate seasonal and inter-annual variation of CO_2 flux above the beech forest and discuss about the climatic difference between the most and the least CO_2 absorbed year.

SITE AND METHODS

We erected a 31m high steel observation tower at a Japanese beech forest located at 40.0 N latitude, 140.9 E longitude, 825m Altitude (named Appi forest meteorological research site) in the north-east district of Japanese Honsyu island. The vegetation height was 18m, and in winter, snow covered the forest floor over 2m depth and all of the trees defoliated. CO_2 flux measurement above the canopy has been conducted throughout the year by closed-pass eddy covariance method, like as our other FFPRI research sites [*Ohtani et al.*,2001; *Nakai et al.*, 2003]. We set a three dimensional ultrasonic anemometer/thermo-meter (DA600/KAIJO) at the top of the tower and continuously drew the sample air into the shed and measured CO_2 concentration with an infrared gas analyzer (Li6262/LiCor). We recorded the signals at every 0.1 seconds and then calculated the CO_2 flux by the eddy covariance method at every 30 minutes. We also measured CO_2 storage under the eddy measurement level with another infrared gas analyzer and computer-controlled 8 level (3m, 9m, 12m, 15m,18m, 20m, 24m and 31m above the ground) air sampling system. We evaluate the net ecosystem CO_2 exchange (NEE) as the sum of the CO_2 flux and the temporal change of CO_2 storage. We also measured some micro-meteorological elements such as solar radiation (at the tower top), air temperature (at 21m above the ground), air pressure, wind velocity and so on.

RESULTS AND DISCUSSION

Daily integrated NEE and Solar radiation at the tower site (Appi site) were shown in Fig. 1. Japanese beech usually foliated in May and defoliated in October, and during green-leaved season, the more solar radiated day tended to absorb the more CO_2 (as indicated negative NEE) by assimilation of the leaves. In defoliated season, most of the days indicated positive NEE (CO_2 emission) and the amount and the variance of NEE were rather small under the snow cover during December to April. As integrated the annual amount of NEE, 2003 was the most CO_2 absorbed year and 2004 was the least CO_2 absorbed year during our observation period. Seasonal amount of NEE with total solar radiation and average air temperature in 2003 and 2004 were shown in Table 1. CO_2 Absorption value of each year was very different (absorption in 2003 was 1.9 times larger than 2004). In green-leaved season, CO_2 absorption in 2003 was 1.7 times larger than 2004. On the other, in defoliated season, CO_2 emission in 2003 was 0.8 times smaller

than 2004. To investigate the cause of the smaller CO_2 absorption in 2004, we referred some meteorological factors in each year. Solar radiation (during green-leaved season) was larger in 2004, in contradiction to CO_2 absorption. On the other, air temperature was higher in 2004 (both in green-leaved and defoliated season). We assumed that larger respiration in 2004 effected the depression of annual CO_2 absorption. At Appi forest meteorological research site, annual mean air temperature in 2004 was 0.95 degree centigrade warmer than 2003. The result of this study suggests the tendency that warmer climate may cause less CO_2 absorption in this Japanese beech forest.

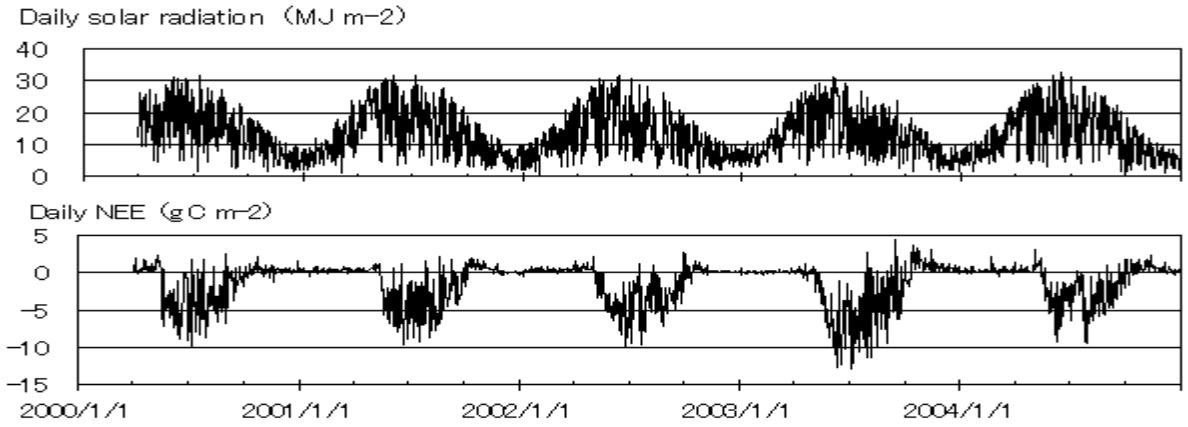

Table 1. Solar radiation, air temperature and NEE at Appi site (in 2003 and 2004)

	Solar radiation (MJ m^{-2})	Air temperature (C)	NEE (g C m^{-2})
	Total	Average	Total
2003 Green-leaved season	2752.6	12.96	-694.71
Defoliated season	1833.8	-1.24	50.40
Whole the year	4586.4	5.91	-644.31
2004 Green-leaved season	2913.5	14.55	-403.81
Defoliated season	1828.9	-0.89	63.92
Whole the year	4742.4	6.86	-339.89

Note: Green-leaved season is May to Oct., Defoliated season is Jan. to Apr. and Nov. to Dec

REFERENCES

Nakai, Y., Kitamura, K., Suzuki, S. and Abe, S. (2003), Year-long carbon dioxide exchange above a broadleaf deciduous forest in Sapporo, Northern Japan, *Tellus 55*B, 305-312

Ohtani, Y., Mizoguchi, Y., Watanabe, T., Yasuda, Y., and Okano, M. (2001), Seasonal change of CO_2 flux above an evergreen needle leaf forest in temperate region, Fujiyoshida, Japan, Proceedings of International workshop for advanced flux network and flux evaluation, 129-132