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A tower for measuring CO_2 flux in a cool-temperate deciduous broad-leaved forest

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■RESEARCH TOPIC

What Influences the Annual Variations in the Carbon Fixation Capacity of Forest Ecosystems

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Ohtsuka T., Saigusa N., Koizumi H., "On linking multiyear biometric measurements of tree growth with eddy covariance-based net ecosystem production", *Global Change Biology*, **2009**

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What Influences the Annual Variations in the Carbon Fixation Capacity of Forest Ecosystems

Japan has seen a succession of summers extremely hot and winters extremely mild that people can feel the harmful effects of global warming. Abnormal meteorological conditions that are believed to be caused by global warming, such as big typhoons, localized concentrated heavy rain, and extremely light rain, occur more frequently. In 2007, the Intergovernmental Panel on Climate Change (IPCC) published a forecast that the average temperature in 2100 would be 1.8℃ to 4℃ higher than from what it is today. The main cause for this increase is the increase in carbon dioxide emissions due to the use of fossil fuels, and therefore, reducing these emissions is an urgent requirement on an international scale. Japan has many forests and there is a need to scientifically ascertain the extent to which carbon dioxide is absorbed by the forest ecosystems. For approximately ten years, Professor Hiroshi Koizumi and his colleagues at the Faculty of Education and Integrated Arts and Sciences have been studying the annual variations in the amount of carbon dioxide absorbed by a cool-temperate deciduous broad-leaved forest located in the Takayama Experimental Site of Gifu University's River Basin Research Center in Takayama City, Gifu Prefecture.

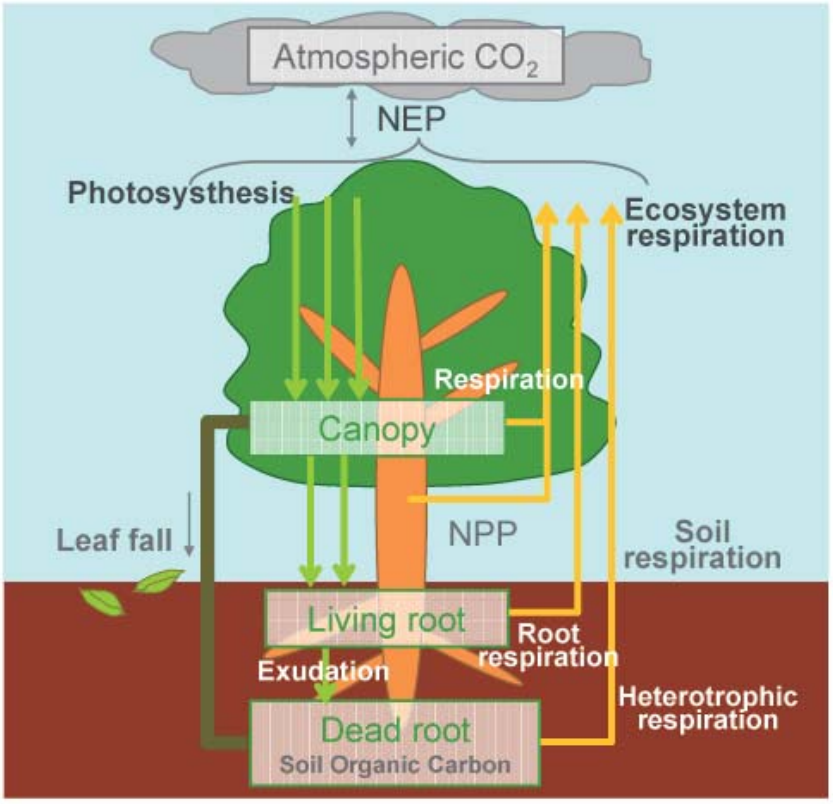

Diagram of CO_2 dynamics in the forest

Cool-temperate deciduous broad-leaved forests mainly consistes of trees such as the Mizunara oak and the Japanese Beech that develop new leaves during spring and shed them during autumn. They are extremely common in Chubu, Kanto, Tohoku, and Hokkaido, and it is thought that they account for approximately 20% of Japan's forest area. Professor Koizumi and his colleagues built an observation tower in the Takayama Experimental Site that was taller than all the trees in the site, and beginning in 1993, they continuously measured the "amount of carbon dioxide absorbed by the forest from the atmosphere during the day" and the "amount of carbon dioxide emitted from the forest into the atmosphere at night" for the next 15 years. In addition, they collected data such as the "trunk and branch growth," which is determined by measuring the diameter of the trunk 1.3 meters above the ground(DBH), the "leaf production," which is estimated by measuring the amount of fallen leaves, and the "decomposer respiration rate," which is estimated from the soil respiration rate and the respiration rate of the plant roots in the forest.

However, although I referred simply to the carbon dioxide dynamics in the forest, there are various kinds of adsorption and emission compartments (Figure). For example, the amount of carbon dioxide absorbed by the forest overall, including the soil, is called the Net Ecosystem Production (NEP). The NEP can be positive or negative depending on the activities of the living organisms comprising the forest ecosystem. The amount of carbon dioxide fixed by plants in the forest (trees and forest floor plants) is called the Net Primary Production (NPP). Professor Koizumi says, "when we analyzed eight years of data from 1999, we found, among other results, that NPP could more than double or halve year by year, that annual variations in leaf production were comparatively small, and conversely that annual variations in trunk and branch growth were large." He also discovered that "annual variations in the heterotrophic respiration rate, estimated from changes in the soil temperature, are small," "there is a positive correlation between trunk and branch growth, and NEP," and "no correlation can be seen between leaf production and NEP or the heterotrophic respiration rate and NEP."

Professor Koizumi sums up his results by quoting in the following manner: "from our series of analyses, we have for the first time understood scientifically that NEP fluctuates substantially each year and that the size of the fluctuation is affected by the patterns of annual variation in the activities of the vegitation, which is a producer." He is enthusiastic about continuing his research and expanding its scope to grasslands, rice paddies, etc., in order to determine the extent to which the ability of ecosystems to absorb carbon dioxide can contribute to the reduction and forecasting of global warming.

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