Multivariate Time series analysis of CO2 flux from soil in temperate deciduous forest

Shoichi Sowa[1]; teturo Shinagawa[2]; Masao Takano[3]; Takeshi Ohta[2]

[1] System, Earth and Planetary Sci, Nagoya Univ; [2] Bioshere Resources Sci, Bioagricultural Sciences, Nagoya Univ; [3] Dep. Earth and Planetary Sci., Nagoya Univ.

Intensive studies on the elemental processes of the global carbon cycle have been accumulated, however, the mechanism of soil respiration have not been fully understood yet. It is considered that temperature and water content in soil may be main controlling factors on the CO2 out flux from soil. Previous studies usually analyzed the time series data of CO2 flux, soil temperature and water content with applying ad-hoc functions to connect these items. In this study we adopted a simple and straight-forward method of time series analysis to describe the effect of soil temperature and water content of soil to soil respiration in a temperate deciduous forest.

We observed CO2 flux, soil temperature, and soil water content in a secondary forest at Nagoya University. Eight auto switching chambers were settled in a line between two big trees and a digital recorder recorded the variation in CO2 concentration for 5 minutes after each chamber was closed with IRGA (infra-red gas analyzer) and CO2 flux was calculated from the increasing rate of CO2 concentration. Soil temperature was measured with thermistor sensor and water content with TDR (time domain reflectmetry), which were settled 5 cm below the surface of the ground, respectively, and recorded 10 minutes interval. The observation continued from April 2003 to September 2005.

Time series data were rearranged into 2 hours interval and divided into three frequency band component, i.e. yearly band, daily band and middle band with running mean filters. We applied multivariate time series analysis to each band component data and obtained three sets of transfer function; temperature effect to CO2 flux, water content effect to CO2 flux and auto-regressive function of CO2 itself. The orders of transfer functions were determined at the minimum of AIC (Akaike's information criteria).

As a result the theoretical synthetic data with the transfer functions of soil temperature, water content and autoregressive process fitted CO2 flux data well in the middle and daily band. The daily variation in soil temperature well explained daily CO2 flux variation, and the effect of precipitation to CO2 flux was also well described by the transfer function of soil water content. The auto-regressive component had considerable intensity and it might describe the effect of the variation in biomass and activity of microbes and/or the stocks and flux of organic matter in soil.