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Seasonal variation in ratio of soil respiration to ecosystem respiration at Takayama estimated from d18O measurement

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Forest ecosystems are one of the important reservoirs in the global carbon cycles. However, environmental factors governing variation in carbon dioxide (CO_2) flux between the atmosphere and the forest ecosystems have not been fully understood, which leads to very large uncertainty in future predictions of response of forest ecosystems to climate change. For more precise prediction of the future global carbon budgets, better understandings of each process in the carbon cycle in the ecosystem are necessary. A stable oxygen isotopic ratio (δ^{18}O) in CO_2 is a unique tracer reflecting not only the carbon cycle but also the hydrological cycle. Using difference of isotopic fractionation in ^{18}O between photosynthetic and respiratory processes and between soil and leaf respiratory processes, gross CO_2 fluxes in each of the processes have been estimated in some previous studies at relatively short time scales from diurnal to a few months. In this study, isotopic measurements of not only CO_2 in the atmosphere and soil air but also soil water and atmospheric water vapor were made at a cool-temperate deciduous forest, Takayama (TKY; 36^{o}08'N, 137^{o}25'E, 1420 m a.s.l.) in the growing seasons during 2006-2009. From the obtained data, δ^{18}O values in CO_2 emitted due to soil (R_s) and leaf respirations and total ecosystem respiration (R_{ec}) during the nighttime were calculated. Then, seasonal variation in relative contribution of R_s to R_{ec} was estimated form mass balance equations. The obtained result was compared with variation in the ratio of R_s to R_{ec} estimated from soil chamber and eddy covariance flux measurements. The result from the δ^{18}O measurements showed that the ratio of R_s to R_{ec} increased from about 0.5 in late spring to almost 1 in early autumn though the estimated ratios were very scattered. Such a seasonal pattern was similar to that estimated from the flux measurements. In our presentation, factors governing the seasonal variation will also be discussed by comparison with the results simulated for TKY using a process-based ecosystem model (VISIT) and a multi-layer canopy model (MINCER).

Keywords: oxygen isotope, forest ecosystem, ecosystem respiration, soil respiration