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Warming experiment, spectral observation and model analysis for predicting global warming effects on forest carbon cycle

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Estimation of global warming effects on photosynthesis and respiration in forest ecosystems based on mechanistic understanding is one of the most crucial research under the current climate change condition. The knowledge and insights gained by such research would be necessary for our further evaluation of ecological, biogeochemical and societal functions of our ecosystems ranging from local, national land to Asian scales. In Takayama site, Gifu University (Japan), efforts have been made for nearly 20 years to clarify the micrometeorological and ecological understandings on the carbon cycle in a deciduous broadleaf forest located on a mountainous landscape in central Japan. Recently we established a multidisciplinary research named ”Satellite Ecology” to link ecophysiology, micrometeorology and remote sensing to encourage cross-scale observation and mechanistic understanding on the forest ecosystems. In this paper we introduce our new project named ”Satellite Ecology II”, in which in-situ artificial warming experiments for forest canopy tree and soil are established. Here we examine the warming effects on foliage photosynthesis and soil respiration, explore the remote sensing techniques to detect any ecophysiological changes in the canopy, and predict the near-future changes in forest carbon cycle.

Increasing air temperature (+5 degreeC) surrounding a branch of canopy tree, Quercus crispula, by installing an ’Open-Top Canopy Chamber (OTCC)’ resulted in earlier leaf expansion (5 days) and delayed leaf senescence (5 days) than the non-warming branch, and about 10% higher photosynthetic rate in summer. Increasing soil temperature (+3 degreeC) by installing heating cables at 3-5cm below the soil surface resulted in stimulation of soil respiration from spring to late growing season. Preliminary prediction of warming effects on leaf phenology, photosynthesis and respiration of the forest revealed that increasing temperature may enhance the growing season of the deciduous trees and hence both photosynthesis and respiration of entire forest.

Keywords: forest ecosystems, photosynthesis, global warming, carbon cycle