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温暖化実験による冷温帯落葉広葉樹林の光合成特性と土壌呼吸の環境応答の解明
Canopy photosynthetic and soil respiratory responses to rising temperature in a cool-temperate deciduous forest

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Prediction of possible influences of global warming on terrestrial ecosystem structure and functions is one of an urgent research tasks in environmental sciences. This paper overviews our challenging research by open-field warming experiments on forest canopy photosynthetic productivity and on soil respiration in a cool-temperate deciduous broadleaf forest at Takayama AsiaFlux and JaLTER site, located on a mountainous landscape in central Japan. Canopy warming experiment is conducted by three open-top canopy chambers (OTCC) on branches of a mature tree of Quercus crispula, one of the dominant canopy species in the forest. The OTCC increased mean daytime air temperature by about 2 degree-C, with midday maximum of about 5 degree-C throughout the growing seasons. Soil warming treatment, with 3 degree-C higher than the control area, was made by installing electric heating cables below the soil surface.

Warming treatment at the canopy-top led (1) expansion of canopy photosynthetically active season in about 10 days by 3-5 days earlier leaf budbreak and expansion and about 5 days delay of leaf senescence, and (2) slightly higher chlorophyll content and photosynthetic capacity of oak leaves. Warming treatment of forest soil showed (1) higher soil respiration throughout the seasons, resulting in 15% higher CO2 efflux from the soil during the growing season, but (2) the temperature response of soil respiration acclimated to the higher temperature condition characterized by lower slope of the response curve. We also examined the possible effects of growing period length on forest canopy and understory vegetation ecosystem CO2 budget under future climate conditions by using canopy-phenology ecosystem carbon cycling combined model. Our simulation indicated that annual total ecosystem GPP, RE and NEP was greater under the future condition than under the current condition by 9-12 %, 9-13% and 12-17%.

Our study demonstrates that open-field warming experiments provide us with useful and insightful knowledge on the ecophysiological responses of both canopy and soil processes to rising temperature, and their critical roles in predicting future changes of forest carbon cycle processes in cool-temperate region in Japan where ecosystem structure, functions and services are subjected to influence of the climate change.

キーワード: 温暖化, 森林, 光合成, 土壌呼吸, フェノロジー
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