Forest photosynthesis from leaf to region, and from present to future: long-term and multidisciplinary research in Japan.

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Carbon cycle and budget, tree water use and hydrological cycle, and primary production are among the major forest ecosystem functions, and there is no doubt that they play key roles in the Earth system and biodiversity. Recent global needs to these themes involves to link such observations with regional and global climate observations in order to find and predict their interactive changes which influence societal security. Promoting our collaborative long-term observations and in-situ experiments would be useful to identify the major observational parameters, methodology and data analysis for our understandings and prediction of environmental changes in regional scale. The GEO Carbon and GHG initiative, as part of the GEO 2017-2019 Work Programme, aims at providing integration across different parts of the system, intends to facilitate the cooperation among existing initiatives/networks/programmes, and promotes the interoperability of data, to fill in the missing pieces to obtain a comprehensive, globally coordinated, carbon and GHGs observation and analysis system. In this poster, a case study at a “super-site” of a forest ecosystem in central Japan will be introduced to address one of the tasks of this GEO Carbon and GHG initiative dealing with the optimization of observational networks. Sharing the data, knowledge and experience gained in this super-site would help seeking essential carbon cycle variables and hence to develop an improved observation design which promotes interdisciplinary and linked observations of in-situ and satellite methodologies.

Long-term observation of CO2 flux at a cool-temperate deciduous broadleaf forest named “Takayama site”, located in a mountainous landscape in central Japan (TKY site) revealed that net ecosystem production (NEP) shows remarkable seasonal change from spring to summer, and to autumn, with different magnitude of the maximum NEP in summer over multiple years. In order to clarify its plant ecophysiological mechanisms we monitored phenology of single leaf level photosynthesis and canopy leaf area index for several years. Our cross-scale observations and model analysis showed that inter-annual variations in leaf expansion and senescence in spring and autumn, respectively, as well as the inter-annual variation of weather in summer affected activity of forest canopy photosynthesis (Gross Primary Production: GPP). Open-field warming experiments on canopy tree foliage suggested that warmer spring and autumn induce earlier leaf expansion and delayed leaf senescence, and 10% higher photosynthetic capacity of leaves. Model simulation also suggested about 20% increase of NEP in this forest in late 21st century.

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