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Methane flux observation over a forest ecosystem by micrometeorological and chamber methods using laser based analyzers

Masahito Ueyama[1*], Ryota TAKEUCHI[1], Yuriko TAKAI[1], Yoshiyuki Takahashi[2], Mioko ATAKA[3], Kenshi Takahashi[4], Yoshiko KOSUGI[3], Ken HAMOTANI[1]

[1]Graduate School of Life and Environmental Sciences, Osaka Prefecture University, [2]Center for Global Environmental Research, National Institute for Environmental Studies, [3]Graduate School of Agriculture, Kyoto University, [4]esearch Institute for Sustainable Humanosphere, Kyoto University

Recent applicability of laser-based analyzers allows the FLUXNET community continuously measure methane flux over various terrestrial ecosystems with high precisions. Such measurements have mainly conducted at ecosystems, such as wetland and agricultural land, which are expected to be an obvious methane source. On the other hand, measurements at forest ecosystems are limited in part due to difficulty in measuring approximately 1-order smaller magnitude of fluxes than those of emission fluxes. In this study, we have conducted a continuous measurement of methane flux over a forest in order to quantify the spatially representative flux, understand processes, and improve our ability to measure the fluxes.

The measurement was conducted at Fujihokuroku Flux Research site in Yamanashi, Japan. A 50-year-old stand of planted Japanese larches dominates on volcanic ash soils, homogeneously. The hyperbolic relaxed eddy accumulation (HREA) method was applied to measure canopy scale fluxes since August, 2011. Five-height vertical methane concentration profile was also measured by same system switched flow lines. The robustness of the HREA method was confirmed by compared CO2 fluxes with the eddy covariance and HREA method. The measured fluxes were corrected for storage terms. The automated dynamic closed chambers were installed at six plots in the forest soil since October 2012. Concentration of methane, CO2, and water vapor were measured by flowing sample air from the HREA and chamber systems to respective laser-based analyzers (GGA-24r-EP and FGGA-24r-EP, Los Gatos Research Inc., USA) after dehydration. The analyzers were conducted two-point calibrations everyday, where there was no detectable change in the sensitivity.

Throughout the measurement period from August 2011 to December 2012, methane uptake was measured by the HREA method. The methane uptake showed a clear seasonal variation roughly coinciding with seasonality in soil temperature near the ground, where sensitivity to soil temperature (Q10) was 1.8. The methane uptake decreased to near zero at winter when the forest floor was covered by snow (approximately 30 cm depth). As previously reported for CO2 fluxes, the annual methane sink strongly changed with the friction velocity (u$*$) filtering correction. The annual sink was 900 mg CH4 m-2 y-1 with the u$*$-filtering correction and 700 mg CH4 m-2 y-1 without the u$*$-filtering correction. Based on the profile system, methane concentration was most depleted near the soil surface, indicating that measured methane sink mostly associated with soil processes. This was also consistent with the chamber measurement, where measured fluxes by the HREA and chamber systems were similar range.

Keywords: Methane flux, HREA method, automated dynamic chamber method, forest, continuous observation, laser-based analyzer