Long-term warming effect on soil carbon fluxes in a red pine forest in Tsukuba

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Globally, soil contains about 3000 Gt of organic carbon. Annually, about 98 GtC is released to the atmosphere from soil as CO_2 (soil respiration, R_s). R_s consists of root respiration and heterotrophic respiration (R_h), and R_h contributes to more than the half of soil respiration. On the other hand, upland soil uptakes CH_4. Therefore, soil (especially forest soil) is a large source for CO_2 and sink for CH_4. Long-term response of those soil carbon fluxes to warmer environment is a key for mitigation and adaptation for future climate change. However, long-term continuous monitoring data for those soil carbon fluxes are totally limited.

To examine the long-term response of R_h to global warming in Asian monsoon forests, we set multi-channel automated chamber measurement system in a red pine forest in Tsukuba in February 2006. We prepared 12 trenched chambers (90 cm ×90 cm ×50 cm) to continuously measure R_h. Half of those trenched chambers were artificially warmed by infrared heaters 1.6 m above the soil surface (+2.5˚C), and influence of soil warming on R_h was examined by comparing control plots and warming plots. In July 2009, we added 8 chambers to measure R_s. Further, we started continuous measurement of soil CH_4 flux in June 2019 using the same chamber measurement system by connecting control unit with CH_4 analyzer (915-0011, Los Gatos Research, Inc., USA).

Remarkable exponential relationships between soil temperature and soil CO_2 effluxes (R_s and R_h) were confirmed every year. In addition, soil CO_2 effluxes were observed to be related with soil moisture especially in summer period from July to September. On the other hand, we found that soil CH_4 was negatively related with soil moisture. Those observations suggest that soil temperature is the primary factor controlling soil CO_2 effluxes, whereas soil moisture is the main factor controlling soil CH_4 uptake in our study site.

Keywords: Soil respiration, CH4, Chamber, Global warming

