Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-13 会場:311 時間:4 月 29 日 17:30-17:45

放射性炭素同位体を用いたアラスカ永久凍土における土壌有機炭素収支の推定
Estimate of permafrost organic carbon balance in Alaskan boreal and tundra ecosystems using natural radiocarbon tracer

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The high-latitude regions, where a serious warming is expected, currently store large amounts of soil organic carbon in active-layer soils and permafrost, accounting for nearly half of the global belowground organic carbon pool. Despite the importance of these regions in the present carbon cycle, the soil C fluxes and budget are still only poorly known. Here, we use radiocarbon as the tool for quantifying the C balance of the inputs and decomposition in tundra and boreal soil. We evaluated the C inputs (I) and decomposition rates (k, inverse of turnover time) and net C accumulation (CA), using ^{14}C approaches.

Tundra and boreal soils show different patterns of depth distribution and C storage. Cumulative organic carbon stocks in boreal forest are 5.3 and 19.2 kgCm^{-2}, in surface organic layer (0-25 cm), and deep organic and mineral layers (25-70 cm), respectively. Large annual C input (0.25 kgCm^{-2} yr^{-1}) and relatively slow decomposition (27 years) lead to rapid CA (0.05 kgCm^{-2} yr^{-1}) in surface organic layer in boreal forest. Deep organic and mineral layers including near-surface permafrost show slower rate of input (0.03 kgCm^{-2} yr^{-1}) and turnover (617 years) and CA about 20 times slower (0.003 kgCm^{-2} yr^{-1}) than surface organic layer. Decomposition organic matter (Rh), which in accord with C losses from both surface and subsurface layers, was 0.23 kgCm^{-2}yr^{-1}. This value agreed well with Rh (0.23 kgCm^{-2} yr^{-1}) simulated by process-based models that simulate the biogeochemical and hydrologic cycle, where Rh averaged 45% of ecosystem respiration and 59% of soil respiration.

In contrast, large amount of SOC (36.4 kg m^{-2}) have accumulated over millennia (turnover time: 4540 yrs) below the thin organic layer in tundra. The CA of mineral layer and permafrost is close to zero (0.003 kgCm^{-2} yr^{-1}), and Rh is 0.008 kgCm^{-2} yr^{-1}. Our radiocarbon data show that the most SOC in tundra soil was mode of stabilizing OC by permafrost and steady-state SOC stocks under current C balance.