# Utilization and transformation of terrestrial carbon in northern landscapes

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High-latitude terrestrial systems are particularly vulnerable to climate change and present significant uncertainties to predictions of future sources and sinks for carbon on land. We are investigating carbon utilization and transformation in northern landscapes at two DOE sites, NGEE Arctic and SPRUCE. Production and loss of dissolved organic carbon (DOC) is an important mechanism for ecosystem carbon loss that results in considerable export off the Arctic landscape, reducing or eliminating carbon sinks. At the NGEE-Arctic site (Barrow, Alaska), we have determined the $^{14}C$-age and chemistry of DOC from surface and peat pore water from 17 drainages sampled in July and September 2013. DOC ages ranged from modern to ~5600 years and increased with depth, from July to September, and with increasing DOC, DIC, and DON concentrations. In September, sites with older DOC in deep pore waters also had highly depleted $\delta^{13}C$ of dissolved $CH_4$, suggesting a link between DOC source and methanogenesis pathways. Spectral analysis suggested a shift in DOC chemistry with depth and sampling month, but we found little evidence for a connection between DOC age and chemistry. To elucidate the response of boreal wetlands to changing climate, we are collaborating with SPRUCE to identify 1) microbial communities producing and consuming $CH_4$ and interactions with N-fixers, 2) the source of carbon used for production of $CO_2$ and $CH_4$, and 3) how these respond to ecosystem warming treatments. Isotopic analysis of $CO_2$ and $CH_4$ from surface chambers indicate that the source for the emitted carbon is mostly recent, with most $^{14}C$ values between 30 and 50‰ for $CO_2$ (i.e., carbon that was photosythetically fixed in the last decade) and 50- 90‰ for $CH_4$ (i.e., carbon that was photosynthetically a decade or two ago). Respired $^{14}CO_2$ values decreased during the growing season, to values consistent with current year photosynthate. $^{14}CH_4$ followed a similar trend over the growing season, but was more variable earlier in the summer when fluxes were small. While deep peat heating did occur at SPRUCE in 2014, it appears that surface C fluxes were more influenced by seasonal surface effects. This suggests that under the current climate, microbes shift towards increased use of new photosynthates over the growing season and, on average, emitted $CH_4$ is roughly a decade older than emitted $CO_2$. These results illustrate the critical importance of future $^{14}C$ measurements in isolating ecosystem patterns and processes that contribute to terrestrial carbon balance across the landscape.

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