ANL Terrestrial Ecosystem Science SFA:

CHARACTERIZING ORGANIC MATTER LABILITY IN ALASKAN TUNDRA SOILS USING MID-INFRARED SPECTROSCOPY

Zhaosheng Fan, Argonne National Laboratory, zfan@anl.gov
Roser Matamala, Argonne National Laboratory
Julie Jastrow, Argonne National Laboratory
Chao Liang, Argonne National Laboratory
Francisco Calderon, USDA-ARS
Gary Michaelson, University of Alaska Fairbanks
Chien-Lu Ping, University of Alaska Fairbanks
Umakant Mishra, Argonne National Laboratory
Scott Hofmann, Argonne National Laboratory

The permafrost region contains large amounts of soil organic carbon (SOC) that is preserved in a relatively un-decomposed state due to cold and often wet conditions, yet the potential lability of this SOC is still largely unknown. Traditional methods of assessing SOC lability (e.g., laboratory incubation studies) are labor intensive and time consuming. Fourier-transform mid-infrared spectroscopy (MidIR) provides a low-cost means to quickly estimate SOC quantity and quality based on the wealth of spectral information. The Argonne National Laboratory TES SFA explored the possibility of linking MidIR spectra with SOC lability in Arctic tundra soils. Soils from four sites on the North Slope of Alaska were used in this study: a low-centered polygon in the Coastal Plain (CP), a high-centered polygon in a lowland drainage area near Sagwon Hills (HC), a frost boil in an upland area near Sagwon Hills (SH), and a frost boil in an upland area near Happy Valley (HV). Active-layer organic and mineral soils and upper permafrost soils from the four sites were incubated for 60 days at -1, 1, 4, 8 and 16 °C. Incubated soils were allowed to drain to field capacity. Total SOC concentration and MidIR spectra of bulk soil samples were obtained before and after the incubations. Carbon dioxide (CO_2) production was measured throughout the incubations. SOC quality was independently characterized before incubation by quantifying several SOC fractions. We evaluated whether MidIR spectra could be calibrated by using multivariate partial least squares modeling to predict total SOC, CO_2 production, and the SOC fractions. Our results indicate that MidIR can be used to quickly and reliably estimate tundra SOC concentration and is a potentially power tool to quickly and reasonably estimate CO_2 production during short-term incubations. Future studies will determine whether this approach can be used to predict CO_2 production in longer term incubations designed to evaluate the intrinsic decomposability of permafrost-region soils. Our results also indicate that MidIR can be used to estimate measurable SOC fractions, which may be used to initialize, calibrate, and/or validate SOC pools of ecosystem and Earth system models.