Geophysical Research Abstracts
Vol. 16, EGU2014-7164, 2014
EGU General Assembly 2014

Preservation of labile organic matter in soils of drained thaw lakes in Northern Alaska

Carsten W. Mueller (1), Janet Rethemeyer (2), Jenny Kao-Kniffin (3), Sebastian Löppmann (4), Kenneth Hinkel (5), and James Bockheim (6)

(1) TU München, Lehrstuhl für Bodenkunde, Freising, Germany (carsten.mueller@wzw.tum.de), (2) University of Cologne, Institute of Geology and Mineralogy, Cologne, 50674, Germany, (3) Cornell University, Department of Horticulture, Ithaca, NY 14853, USA, (4) Lehrstuhl für Geographie und Landschaftsökologie, Ludwig-Maximilians-Universität München, 80333, Germany, (5) University of Cincinnati, Department of Geography, Cincinnati, Ohio, 45221, USA, (6) University of Wisconsin-Madison, Department of Soil Science, Madison, WI 53706, USA

A large number of studies predict changing organic matter (OM) dynamics in arctic soils due to global warming. In contrast to rather slowly altering bulk soil properties, single soil organic matter (SOM) fractions can provide a more detailed picture of the dynamics of differently preserved SOM pools in climate sensitive arctic regions. By the study of the chemical composition of such distinctive SOM fractions using nuclear magnetic resonance spectroscopy (NMR) together with radiocarbon analyses it is possible to evaluate the stability of the major OM pools.

Approximately 50-75% of Alaska's Arctic Coastal Plain is covered with thaw lakes and drained thaw lakes that follow a 5,000 yr cycle of development (between creation and final drainage), thus forming a natural soil chronosequence. The drained thaw lakes offer the possibility to study SOM dynamics affected by permafrost processes over millennial timescales. In April 2010 we sampled 16 soil cores (including the active and permanent layer) reaching from young drained lakes (0-50 years since drainage) to ancient drained lakes (3000-5500 years since drainage). Air dried soil samples from soil horizons of the active and permanent layer were subjected to density fractionation in order to differentiate particulate OM and mineral associated OM. The chemical composition of the SOM fractions was analyzed by 13C CPMAS NMR spectroscopy. For a soil core of a young and an ancient drained thaw lake basin we also analyzed the 14C content.

For the studied soils we can show that up to over 25 kg OC per square meter are stored mostly as labile, easily degradable organic matter rich in carbohydrates. In contrast only 10 kg OC per square meter were sequestered as presumably more stable mineral associated OC dominated by aliphatic compounds. Comparable to soils of temperate regions, we found small POM (< 20 μm) occluded in aggregated soil structures which differed in the chemical composition from larger organic particles. This was clearly shown by increased amounts of aliphatic C in these small POM fractions. As revealed by 13C CPMAS NMR, with advancing soil age increasing aliphaticity was also detected in occluded small POM fractions. By 14C dating we could show the stabilization of younger more labile OM at greater depth in buried O horizons. Additionally the study of the microscale elemental distributions, using nano-scale secondary ion mass spectrometry (NanoSIMS) showed the initial formation of aggregates and organo-mineral interfaces in the studied permafrost soils.