Geophysical Research Abstracts
Vol. 20, EGU2018-3307, 2018
EGU General Assembly 2018


# Comprehensive characterization of DOM composition from High Arctic streams and ponds impacted by permafrost disturbance

Melissa Lafreniere (1), Jun-Jian Wang (2,3), Scott Lamoureux (1), Andre Simpson (2), Yves Gelinas (4), and Myrna Simpson (2)

(1) Geography and Planning, Queen's University, Canada (melissa.lafreniere@queensu.ca), (2) Environmental NMR Centre and Department of Physical and Environmental Sciences, University of Toronto Scarborough, Canada, (3) School of Environmental Science and Engineering and Shenzhen Key Laboratory of Soil and Groundwater Pollution Control, Southern University of Science and Technology, China, (4) GEOTOP and the Department of Chemistry and Biochemistry, Concordia University, Canada

Climate change in the Arctic is having important impacts on the fluvial export and emissions of carbon from permafrost watersheds, which are critical zones for global C cycling because of the abundant C stored in Arctic permafrost soils and the vulnerability of permafrost C to decomposition under climate change. However, little is known about the composition of DOM, or the impacts of changing permafrost conditions on DOM or C dynamics in the rapidly warming High Arctic. In this study, DOM samples collected along the main river channel, and from both disturbed and undisturbed tributaries and ponds at the Cape Bounty Arctic Watershed Observatory (CBAWO), Nunavut (Canada), were analysed using a combination of fluorescence, absorbance, nuclear magnetic resonance (NMR), and carbon isotope techniques. The aims of this comprehensive characterization of DOM were 1) to determine how the age and composition of DOM varied along the river, and between rivers and ponds, 2) to determine how the characteristics of DOM are affected by physical permafrost disturbances (active layer detachments) that formed in this watershed in 2007, and 3) to determine which characteristics or properties are the most sensitive indicators of DOM from different environments.

This study reveals that pond DOM was significantly different from river DOM with respect to nearly every characteristic measured. Pond DOM had higher contributions of old permafrost carbon, and was characterized by lower molecular weight, lower aromaticity, and much higher ancient allochthonous DOM contributions relative to river DOM. The oldest 14C ages (3964 and 4975 years BP) were found in the disturbed ponds suggesting that ancient permafrost organic matter exposed at the surface by the disturbance made large contributions to DOM in these ponds. The difference in the DOM composition between disturbed and undisturbed sites was much less pronounced than the difference observed between the ponds and rivers. None of the fluorescence indices (BIX, HIX or FI) were sensitive to changes in the composition of DOM from disturbed sites. These differences were only apparent in the parallel factor analysis (PARAFAC) components and with the NMR-spectroscopy. The DOM in tributaries and ponds affected by disturbances had 1) lower carbohydrate and higher CRAM (carboxyl-rich alicyclic molecules) and 2) lower terrestrial humic-like and higher oxidized quinone-like fluorescent components, relative to undisturbed sites ($P<0.05$ in all cases), indicating DOM degradation and oxidation is more advanced in disturbed sites.

Overall our results suggest that small Arctic ponds receiving contributions from permafrost DOM may be hot spots of carbon cycling, and may therefore have a positive feedback on warming. Additionally, the research indicates that the impacts of permafrost disturbance on DOM characteristics (and associated positive feedback on climate warming) decrease with increasing distance from headwaters to main channel, and from disturbances to channels. This research supports the need for further comprehensive DOM characterizations from a larger number and wider variety of sites, as well as controlled field experiments, to better understand the impacts of changing climate and permafrost on the structural properties and fate of DOM in High Arctic watersheds.