Mobilized permafrost carbon is concentrated in particulate matter and ebullition methane in Northern Quebec thaw lakes

REGINA GONZALEZ MOGUEL[1] PETER DOUGLAS[2]
ADRIAN M. BASS[3] MARTIN PILOTE[4] MARK H GARNETT[5]

[1]McGill University, regina.gonzalezmoguel@mail.mcgill.ca
[2]McGill University, peter.douglas@mcgill.ca
[3]University of Glasgow, adrian.bass@glasgow.ac.uk
[4]Environment and Climate Change Canada, martin.pilote@canada.ca
[5]NERC Radiocarbon Lab, mark.garnett@glasgow.ac.uk

Permafrost thaw can potentially mobilize millennial aged carbon across the Arctic and Subarctic, with significant implications for carbon cycle feedbacks to climate change. Widespread permafrost degradation has been recorded in Northern Quebec (Canada) over the past 30 years, but it remains unclear to what extent old carbon is being mobilized, transported, and mineralized to methane (CH_4) and carbon dioxide (CO_2) in aquatic systems. To answer this, we measured the radiocarbon age of dissolved and ebullition CH_4, ebullition CO_2, dissolved inorganic carbon (DIC), dissolved organic carbon (DOC), particulate organic carbon (POC), and surficial sediment carbon from one river and three thaw lakes associated with peatlands, and two rivers and two thaw lakes associated with mineral soils.

In peatland lakes, carbon older than permafrost formation in the area (>300 yrs BP) is a major component of sedimentary carbon (~3630 yrs BP), POC (~1360 yrs BP), and ebullition CH_4 (~1395 yrs BP), but comprises a smaller component of DOC (~880 yrs BP) and dissolved CH_4 and CO_2 (modern to 700 yrs BP). Similarly, the peatland river transports relatively old POC (~2830 yrs BP) and DIC (~1030 yrs BP), but younger DOC (~335 yrs BP). In the mineral lakes, surficial sediments (~1000 yrs BP) and POC (~630 yrs BP) contained carbon dating to the period of local permafrost formation (~1050–300 yrs BP), but DOC, DIC, and all CH_4 pools were primarily modern in age. Similarly, DOC and DIC in the non-peatland rivers was modern, but POC was older (~670 yrs BP).

These results indicate old deep peat and permafrost organic carbon has been mobilized into Northern Quebec aquatic systems. The results also suggest that the geological setting strongly influences the fate of old carbon in these systems, with old carbon in peatland lakes and rivers forming a larger component of mobilized carbon and greenhouse gas emissions than in mineral soil regions.