Old dissolved inorganic carbon in the Mackenzie River Basin: A smoking gun for the degradation of aged organic matter?

ROBERT G. HILTON[1], EDWARD TIPPER[2], VALIER GALY[3], MARK H. GARNETT[4], MATHIEU DELLINGER[1], MELISSA SCHWAB[5], SUZANNE TANK[6], CHARLOTTE L. BRYANT[4], PHILIPPA ASCOUGH[4], TIM EGLINTON[5]

[1]Durham University, UK, r.g.hilton@durham.ac.uk; [2]University of Cambridge, UK; [3]Woods Hole Oceanographic Institution, USA; [4]NERC Radiocarbon Facilty, UK; [5]ETH Zurich, Switzerland; [6]University of Alberta, Canada

Soils of the northern high latitudes contain 1035 ± 150 x 10^{15} gC as organic matter in the upper three meters, higher than the carbon content of the atmosphere. A large proportion of this organic carbon (OC) is found in regions hosting permafrost and is thousands of years old. Thawing of frozen soils due to on-going and future warming may promote organic matter degradation and release greenhouse gases. The fluxes remain uncertain, but they are thought to be large enough to negate the drawdown of anthropogenic CO_2 by the growth of the terrestrial biosphere and act as a positive feedback to warming. Areas of active soil erosion could enhance this process, and thus river networks may release CO_2 from aged OC.

To better understand and quantify the processing of aged organic matter in Arctic Rivers, we measure the radiocarbon (^{14}C) activity of dissolved inorganic carbon (DIC) in the Mackenzie River and its Arctic tributaries from samples collected in 2013 and 2017. The DIC pool of large rivers mainly reflects inputs of HCO_3^- from carbonate weathering by sulphuric and carbonate acids, as well as that supplied from silicate weathering via the atmosphere. In addition, respiration of OC in soils and rivers inputs to the DIC pool.

In the Mackenzie River we find that DIC is ^{14}C-depleted when compared to large tropical rivers. We use dissolved ions (Ca^{2+}, SO_4^{2-}) to help constrain the DIC inputs and find evidence for mixing of ^{14}C-dead DIC from carbonate weathering with ^{14}C-depleted DIC from respiration. The latter is 10^2-10^3 ^{14}C years old. This reflects a relatively young component of the riverine particulate OC pool, but is much older than the dissolved OC carried in the river. Our results suggest degradation of old organic matter is already extensive in the Mackenzie Basin, and it likely contributes importantly to the CO_2 evasion from this large river.