EGU2020-9776
https://doi.org/10.5194/egusphere-egu2020-9776
EGU General Assembly 2020

Characterization of dissolved and particulate organic matter exported during late summer from a glacio-nival river, Zackenberg, Greenland

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With Arctic warming, both gradual and abrupt thaw of permafrost may trigger a positive feedback loop, since large amounts of organic matter (OM) are released into rivers and thus exposed to mineralization along the fluvial continuum. Both dissolved (DOM) and particulate organic matter (POM) mineralization during lateral transport generates greenhouse gases that may fuel further global warming. In addition to glacier retreat, the extent of permafrost thaw is predicted to increase across the Arctic, which will change the release of DOM and POM to aquatic environments. However, the fate of DOM and POM will likely differ during transport in surface waters due to POM-DOM exchange and biodegradation control from organo-mineral interactions. The contrasting behavior between POM and DOM may affect the strength of the permafrost-carbon feedback to climate but is currently afflicted with high uncertainties.

This study characterizes the export of DOM and POM along the fluvial continuum at time of maximum thaw depth and investigates the impacts of permafrost thaw on OM composition and age in the Zackenberg watershed (Northeastern Greenland). In August 2019, streams were sampled twice, before and after a rain event. We collected water and suspended sediments from rivers, the river delta, snow patches and permafrost ice from thermokarst features. Besides *in situ* river chemistry, we analyzed stable water isotopes ($\delta^{18}O$, $\delta^{2}H$) and dissolved organic carbon (DOC) concentrations. The composition of DOM was characterized using absorbance and fluorescence spectroscopy and both DOM and POM were analyzed for radiocarbon ($\Delta^{14}C$).

DOC concentrations increase from 3.1 mg L^{-1} upstream to 15.6 mg L^{-1} after the confluence with the main tributaries, which are characterized by a nival river regime, and decreased to 4.3 mg L^{-1} at the outlet. Optical properties of DOM highlight that low molecular weight microbial-derived organic compounds contribute most to the fluorescent DOM (fDOM) in the upstream part of the

river, likely originating from glacial waters. The contribution of soil and plant derived fDOM increases downstream, and corresponding $\Delta^{14}C_{DOC}$ values increase from upstream (-240‰, i.e. ~2200 yr) to downstream (-30‰, i.e. ~200 yr) resulting from the increasing tributary inputs. Interestingly, POM displays more depleted $\Delta^{14}C$ (older ages) than DOC.

We observed contrasting patterns in river chemistry before and after the rain event with temperature decreasing and pH and EC increasing. $\delta^{18}O$ and $\delta^{2}H$ compositions were less depleted after the rain event, DOC concentrations were lower and DOM displayed a greater contribution of soil and plant derived fDOM. This evidence illustrates the increasing contribution of rain fed streams draining organic-rich top soil and the dilution of the glacial inputs after the rain event. We conclude that, in this glacio-nival Arctic watershed, affected by both permafrost degradation and glacier retreat, old DOM and POM is released and evolves differently in the fluvial continuum.