Aquatic carbon and GHG export from a permafrost catchment; identifying source areas and primary flow paths.

K.J. Dinsmore (kjdi@ceh.ac.uk), M.F. Billett, J.S. Lessels, L. Street, P.A. Wookey, R. Baxter, J.-A.Subke, I .Washbourne, J.F. Dean, M. Cooper, D. Tetzlaff

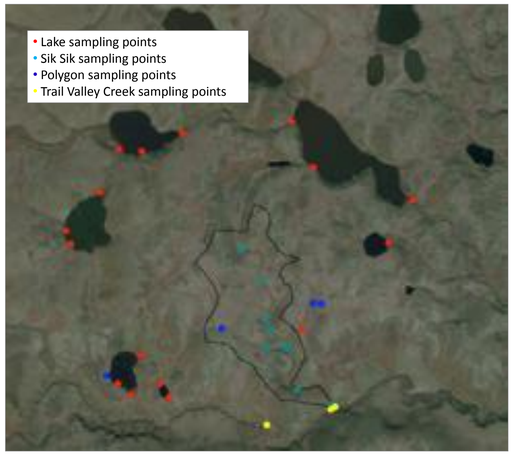
Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
enquiries@ceh.ac.uk
www.ceh.ac.uk

1. Background – The HYDRA project

The HYDRA project ("Permafrost catchments in transition: hydrological controls on carbon cycling and greenhouse gas budgets") aims to understand the fundamental role that hydrological processes play in regulating landscape-scale carbon fluxes, and predict how changes in vegetation and active layer depth in permafrost environments influence the delivery and export of aquatic carbon.

2. Catchment

- Research is based in the Trail Valley Creek (TVC) catchment (68° 44' N, 133° 38'W), 55 km NNE of Inuvik, NWT, Canada
- The project focuses specifically on the smaller, ~ 1 km^2'Siksik' sub-catchment with additional aquatic sampling in 6 of the surrounding lakes.

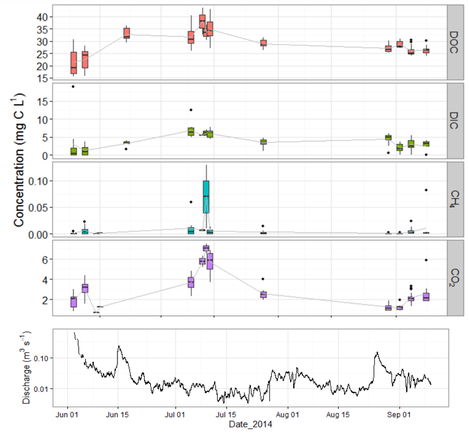


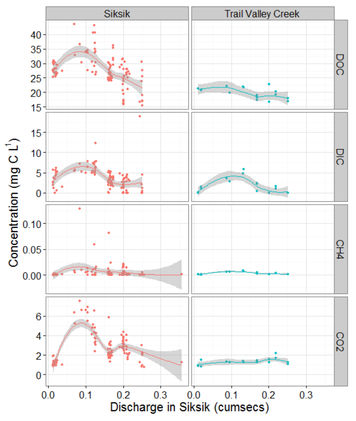
3. Methods

- Aquatic GHG concentrations (CO_2, CH_4 and N_2O) are calculated using the headspace method with water collection for analysis of DOC, DIC and a range of auxiliary chemical parameters.
- The field seasons ran from June to September 2013 and 2014.
- Evasion calculations were made sporadically throughout the field seasons and will be used to back calculate gas transfer values for comparison to literature and model based estimates.

4. Temporal variability in C and GHG concentrations

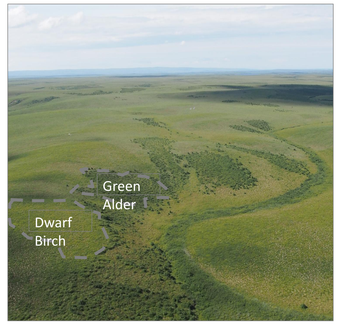
- Concentrations in all species peak during the July sampling period, it's yet unclear whether this is a result of increasing productivity in the catchment or simply a result of lower discharge (also lowest in July).
- The concentration-discharge relationships are non-linear yet show a general dilution pattern with concentrations decreasing with increasing discharge.
- Non-linearity in the discharge-concentration relationship is primarily due to a single sample date, most likely the low flow period immediately after the spring flood suggesting source depletion.

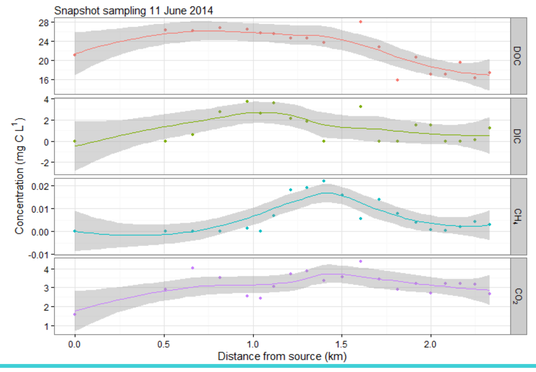




5. Snapshot sampling and sub-catchment analysis

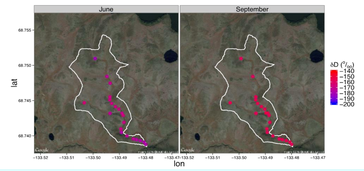
- In addition to repeat measurements at the 8 sampling points along the main Siksik channel, two campaigns were carried out including an additional 13 sampling points giving very high resolution in the spatial data.
- Peak DOC and DIC appears approximately 0.5-1.0 km from stream source; CO_2 and CH_4 both peak lower in catchment ~1.5 km from source, immediately downstream of a tributary originating in a polygon system.
- Further analysis will use catchment characteristics such as sub-catchment vegetation community, NEE and thaw depth to explain the aquatic inputs





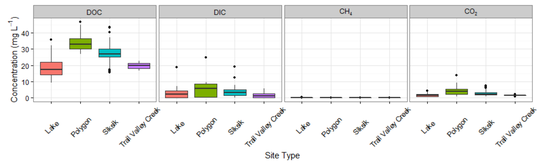
6. Flow path dynamics/sources within catchment

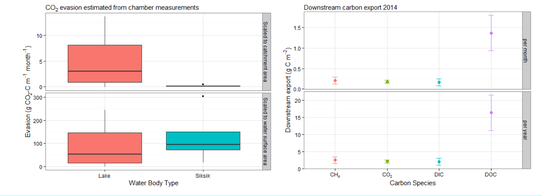
- A combination of cation concentrations and stable water isotopes are used to trace water flow pathways through the catchment and identify water source areas.
- For further information on flow path analysis see poster B43B-0238 presented by J.S. Lessels.



7. Comparison of water body types

- Highest C concentrations found in polygons; similar patterns seen between site types in DOC, DIC and CO_2 suggesting similarities in sources.
- Evasion estimated from chamber measurements suggests similar fluxes from lakes and the Siksik stream however due to the small areal coverage of the streams their contribution to total catchment emissions is low.
- Chambers likely to underestimate evasion from fast moving water so further analysis will compare these to evasion calculated from gas transfer coefficients.
- Evasion from lakes appears to be the largest aquatic flux, with downstream and evaded CO_2 of a similar magnitude





8. Preliminary Conclusions

Whilst there is a significant amount of analysis still to complete:

- Aquatic carbon appears to be primarily allochthonous in origin.
- CO_2 evasion from the lake surfaces, and downstream export of DOC, appear to be the major aquatic fluxes.

Hydrological Controls on Carbon Cycling and Greenhouse Gas Budgets (HYDRA)

For further information: http://arp.arctic.ac.uk/projects/hydrological-controls-carbon-cycling-and-greenhous/

NERC SCIENCE OF THE ENVIRONMENT