Quantifying CO₂ fluxes across a gradient of permafrost thaw in boreal Alaska

Eugénie S. Euskirchen¹, Colin Edgar¹, Mark Waldrop², Merritt R. Turetsky², Jennifer W. Harden², A. David McGuire⁴

¹University of Alaska Fairbanks, Institute of Arctic Biology, Fairbanks, AK, USA, ²U.S. Geological Survey, Menlo Park, CA, USA, ³University of Guelph, Department of Integrative Biology, Guelph, ON, Canada, ⁴Alaska Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, University of Alaska Fairbanks, Fairbanks, AK, USA

Background

- Changes in vegetation and soil properties following permafrost degradation and thermokarst development may cause changes in net carbon uptake, either by stimulating primary productivity due to changes in vegetation composition or by stimulating soil microbial decomposition.
- To better understand these dynamics, we established three sites in interior Alaska across a gradient of permafrost in which permafrost varies in presence and stability.
- These sites include a black spruce ecosystem with cold soils and stable permafrost, a permafrost collapse scar with thermokarst formation, and a moderately rich fen lacking near surface permafrost.

Pathways of Change

- Eddy covariance measurements at the black spruce and thermokarst sites take place year round, while those at the fen take place from March – November.
- The collapse scar bog is ~40 – 50 years old.
- Autochambers measure CO₂ and CH₄ fluxes at the black spruce and thermokarst sites.

Study Area & Measurements

- Data suggests the conversion of black spruce forest to thermokarst bog features in this landscape will increase ET by ~13%, or 23 mm y⁻¹.

Summary

- The black spruce site is a net sink of CO₂, and begins to take up CO₂ as soon as temperatures increase in the spring, while the thermokarst bog has the exact opposite response, and begins respiring more.
- The thermokarst bog showed a large degree of interannual variability between 2011 and 2012.
- Changes in albedo and the associated energy fluxes should also be considered in addition to the biogeochemical feedbacks.
- There are clear differences in the water balance and evapotranspiration between the ecosystems.

Acknowledgements: Funding was provided by the U.S. Geological Survey. Glenn Scott provided valuable field assistance.