Role of fire and permafrost in governing boreal carbon dynamics

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Permafrost
- Distribution
- Traits

Scale

Fire
- Regime
Experimental Design

Site Transect

- Total Carbon Stocks
- Total Carbon Combustion Rates
- Landscape Variables
Drivers of Carbon Recovery and Combustion

Stock - Drainage
- Xeric
- Mesic
- Subhygric

Combustion - Drainage
- Xeric
- Mesic
- Subhygric

Total Carbon (Kg C/m²) vs. Stand Age (yrs)
Pan-Regional Data
Pan-Regional Carbon

Bar chart showing carbon stock and combustion for different regions and stages of forest development:
- **Young** stages: SK, NWT, AK
- **Intermediate** stages: SK, NWT, AK
- **Mature** stages: SK, NWT, AK

- **Stocks** are represented by blue bars.
- **Combustion** are represented by red bars.

The y-axis represents carbon stock in kg C/m², ranging from 0 to 16 kg C/m².
Permafrost
- Distribution
- Traits

Scale
Recovery Time
Regionally Variable

Fire
- Regime
Experimental Design

Permafrost Core

{ Seasonal Thaw (20-50 cm)
{ Transition zone (50-80 cm)
{ Permafrost zone (80-110 cm)
{ Basal Permafrost zone (>110 cm)

Incubation Set-up

Mason jar with cellophane
Nalgene filtering Unit
10 g sample
Glass wool and glass filter
Long-Term Carbon Release

Sustained recovery in seasonal thaw layer production

Sustained productivity in all permafrost layers
Long-Term Nitrogen Release

Trends reflective of sustained carbon productivity

- Seasonal Thaw
- Transition
- Permafrost
- Basal

NO₃⁻ (mg/L)

Week 1, Week 2, Month 1, Month 2, Month 3, Month 4, Month 5, Month 6, Month 7, Month 8, Month 9, Month 10, Month 11, Month 12, Month 13

Time
Experimental Design

**Depth**
- 70+ cm Permafrost Interface
- 30 cm Biologically Active Zone

**Time**
- July Max Biological Activity
- Sept Max Permafrost Thaw

**Thaw State**
- Permafrost Plateau
- Active Thaw
CO$_2$ Trends

**a) Active Thaw**
- Control
- Sept: Active
- Sept: Deep
- July: Active

**b) Permafrost Plateau**

Ecosystem Respiration (umol CO$_2$ m$^{-2}$ s$^{-1}$)

Sampling Points

Jul-17, Aug-17, Sep-17, Jun-18, Jul-18, Aug-18, Sep-18
CH$_4$ Trends

a) Active Thaw

- Control
- Sept : Active
- Sept : Deep
- July : Active

b) Permafrost Plateau

Methane Flux (mg CH$_4$ m$^{-2}$ d$^{-1}$)

Sampling Points

Jul - 17  Aug - 17  Sep - 17  Jun - 18  Jul - 18  Aug - 18  Sep - 18
Permafrost
- Distribution
- Traits

Scale
- Nested time variability
- Vertical spatial variability
- Lateral spatial variability

Fire
- Regime
Final Thoughts
Pan-Regional Carbon
Pan-Regional Stand Age

Northern Boreal Age
- Young: 38%
- Intermediate: 17%
- Mature: 45%

Southern Boreal Age
- Young: 72%
- Intermediate: 14%
- Mature: 14%