Wildfire Disturbance Working Group

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Contributors:

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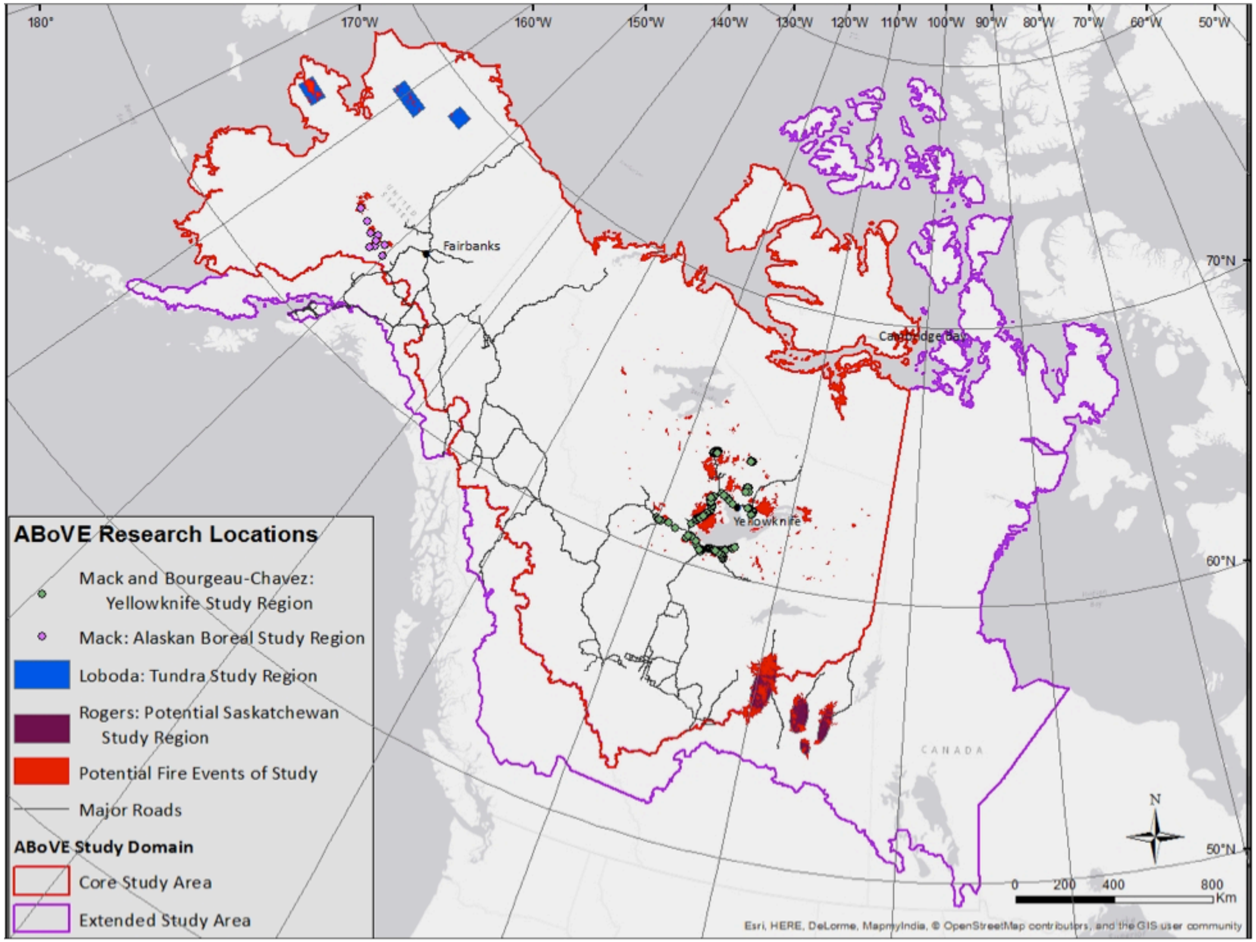
Projects with Primary Discipline in Wildfire Disturbance

[Bourgeau-Chavez (RRNES 2015)](#)
[Bourgeau-Chavez (TE 2014)](#)
[Bourgeau-Chavez (TE 2018)](#) – NWT/Alberta

[Loboda (TE 2012)](#)
[Loboda (TE 2014)](#)
[Loboda (TE 2018)](#) – Alaska

[Mack (TE 2014)](#) – Alaska & NWT
[Rogers (TE 2014)](#) – Saskatchewan & ABoVE Domain-wide
[Schaefer (RRNES 2015, TE 2016)](#) – Alaska, ABoVE Domain
[Veraverbeke (2018)](#) – Circumpolar (Siberia focus)



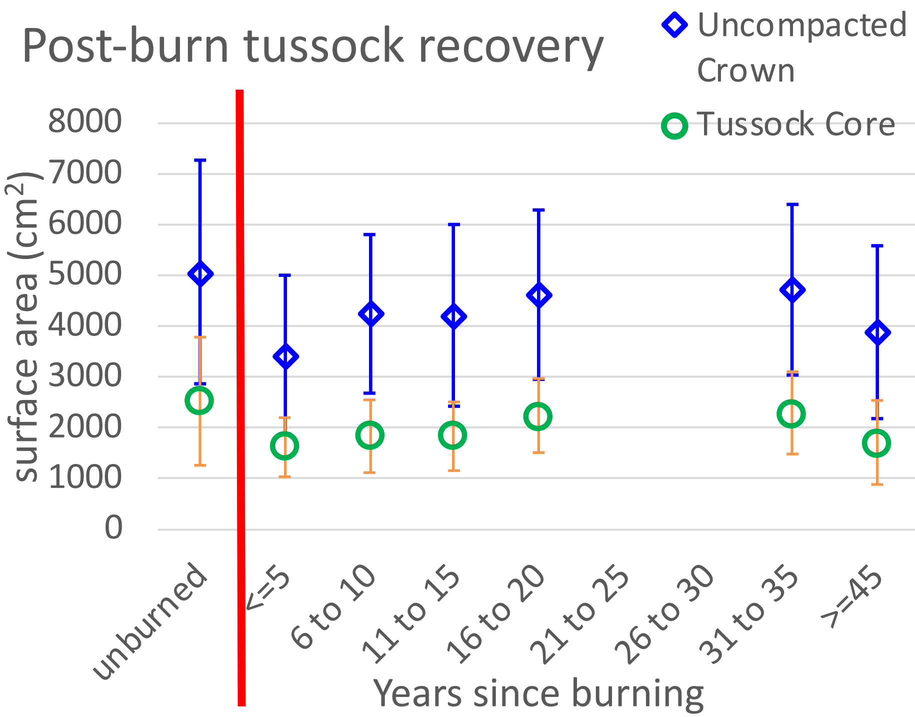
Research Themes

- Understanding effects of wildfire in boreal, taiga and tundra
  - peatlands and uplands
- Understanding fire effects on permafrost and active layer thickness
- Estimating and modeling combustion
- Predicting post-fire successional trajectories through field and remote sensing analysis and modeling
- Modeling climate forcings
- Synthesis of field data
  - Combustion Data Synthesis
  - Regeneration Data Synthesis

Loboda, Jenkins, Chen, He (TE 2014)

Quantifying long-term impacts of single and repeated wildfire burning in North American tundra on organic soil carbon stocks and ecosystem functioning. **(ABoVE Phase 1 project)**

Post fire increase in herbaceous vegetation



Poster:"Building trajectories of tussock tundra post-fire recovery from field observations".

- On average tussock crown surface area is reduced by ~32%
- Similarly tussock cores remain ~10% smaller after 35 years of post-fire recovery compare to unburned conditions
- Reduced surface shading from tussock crowns is a likely contributor to increases in post-fire surface heating → increased soil T → deeper thawing of permafrost

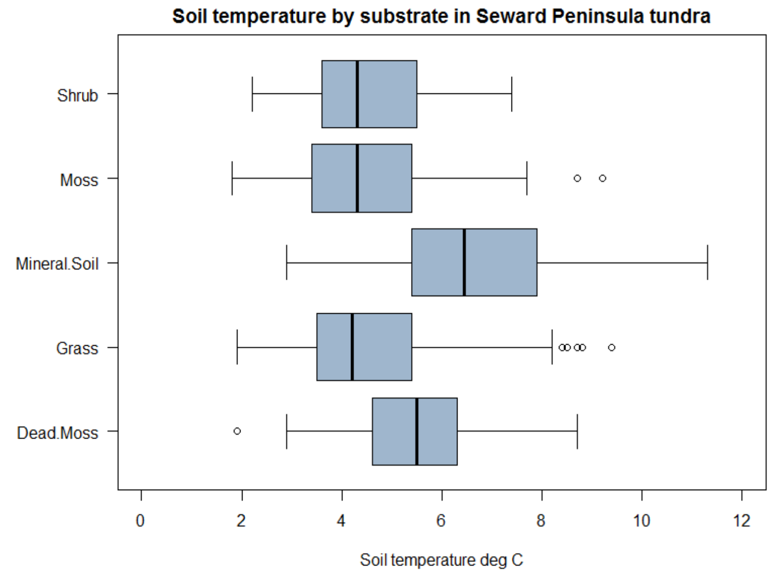
Loboda, Jenkins, Chen, He (TE 2014)

Soil T/ Thaw Depth as a function of repeated burning

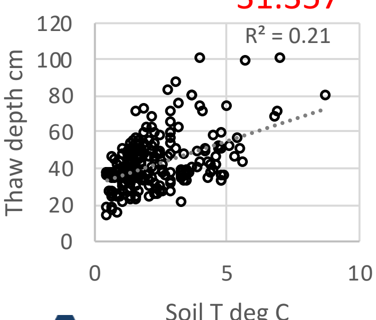
# reburns	Soil T C		Thaw Depth cm	
	μ	σ	μ	σ
unburned	2.33	1.44	42.45	14.76
1	2.89	1.39	39.39	10.73
2	3.52	1.42	47.34	16.26
3	5.10	1.70	52.76	16.79
4	6.55	1.79	73.28	19.74

Increased frequency of re-burning results in higher mean soil temperature and subsequently deeper thawing of the permafrost, but the relationship between the two is changing with increase in frequency of burning ➡ Deeper thawing with higher fire frequency

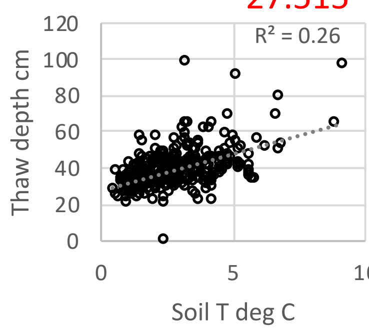
Vegetative cover has a substantial impact on soil temperature



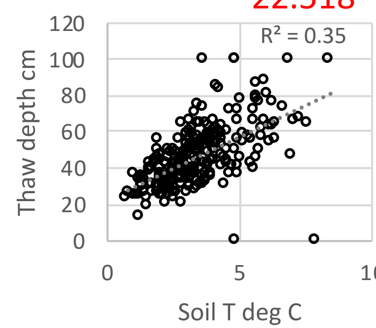
Unburned $y = 4.7639x + 31.357$



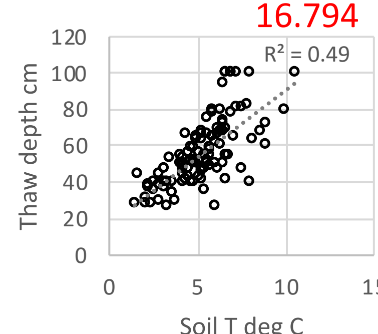
Single burn $y = 4.0668x + 27.515$



Double burn $y = 6.9515x + 22.518$



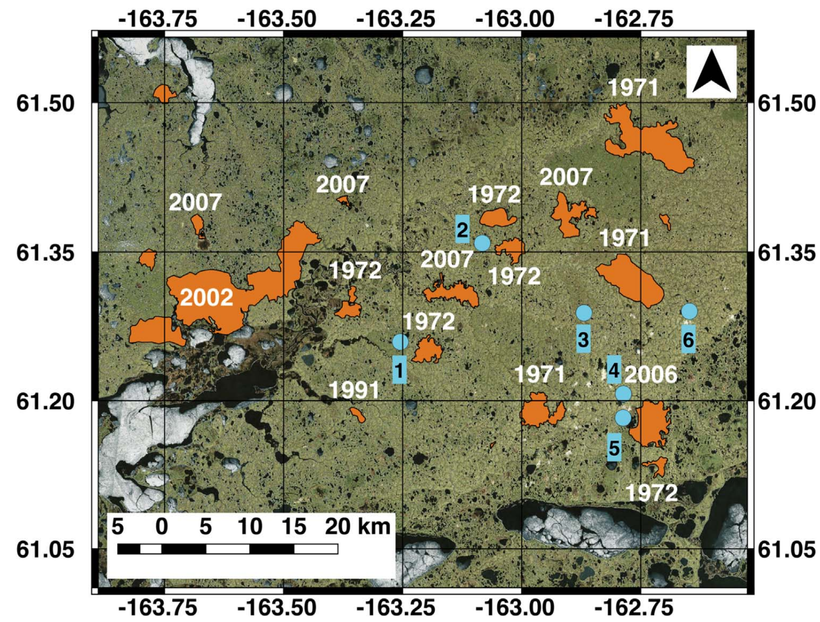
Three+ burns $y = 7.3758x + 16.794$

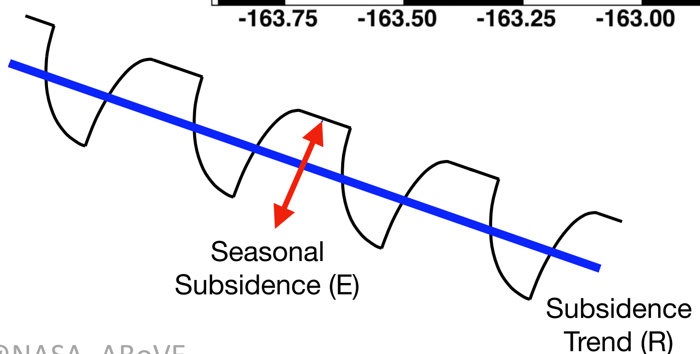


Inference of the impact of wildfire on permafrost and active layer thickness in a discontinuous permafrost region using the remotely sensed active layer thickness (ReSALT) algorithm

R. J. Michaelides, K. Schaefer, H. A. Zebker, A. Parsekian, L. Liu, J. Chen, S. Natali, S. Ludwig, and S. R. Schaefer, ERL, 2019

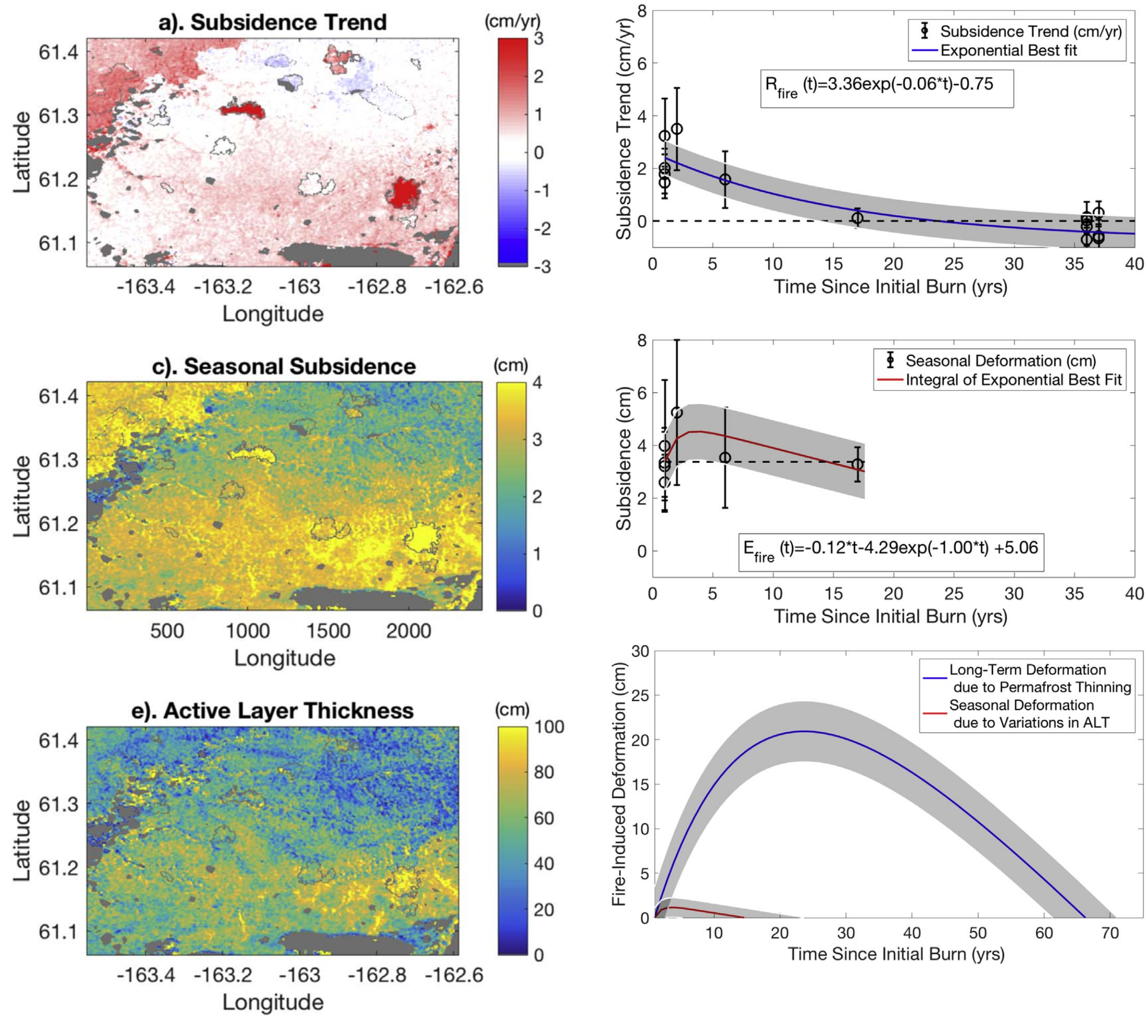
- Using InSAR, we resolve the long-term impact of wildfire on both active layer dynamics and permafrost degradation
- "Space for time swap" to study effect of fire in the YK delta from 1971-2007
- We resolve seasonal subsidence due to active layer thaw, long-term deformation due to post-fire changes in active layer thickness, and long term permafrost thinning





R. J. Michaelides, K. Schaefer, H. A. Zebker, A. Parsekian, L. Liu, J. Chen, S. Natali, S. Ludwig, and S. R. Schaefer, ERL, 2019.

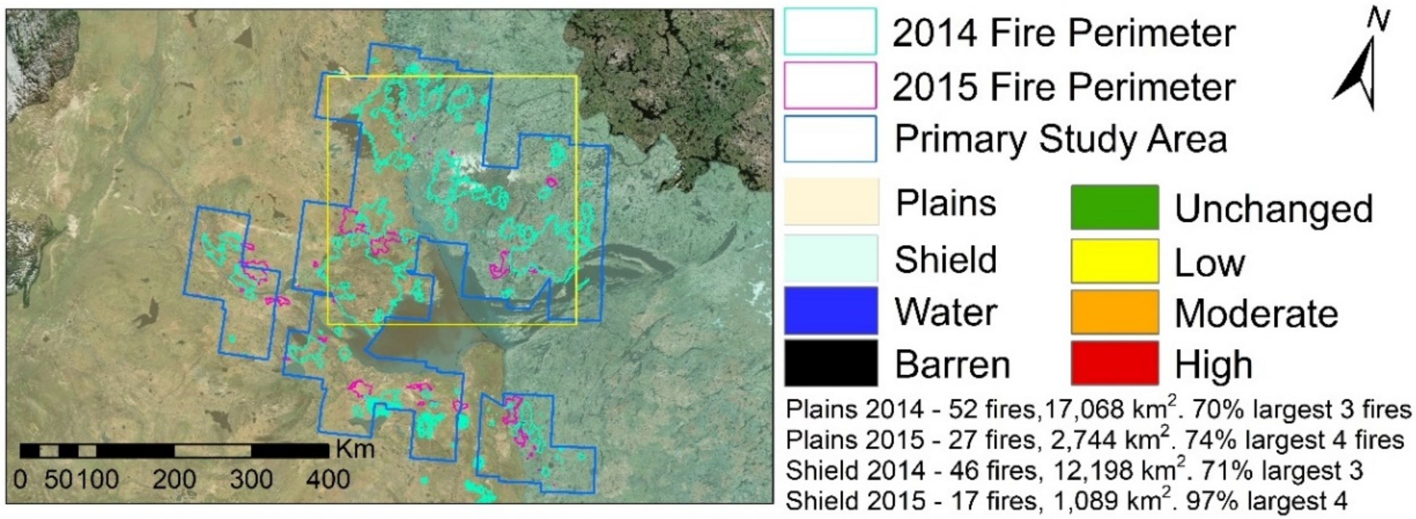
- Wildfire induced a ~5 year process of active layer thickening, followed by a ~15 year gradual recovery to pre-fire active layer thickness
- In parallel, wildfire also induced ~25 year process of permafrost thinning, followed by a ~45 year gradual recovery to pre-fire permafrost thickness
- Observed deformation is consistent with a 4m thinning of the permafrost column



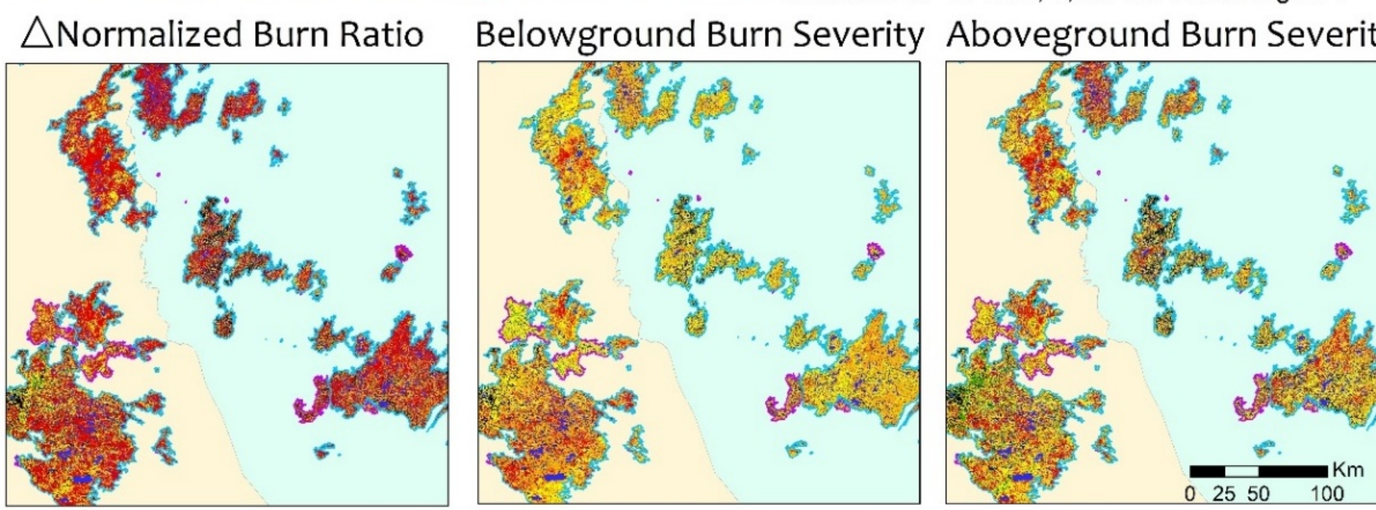
Bourgeau-Chavez (TE 2014)

Understanding the Vulnerability and Resiliency of Boreal-Taiga Ecosystems to Wildfire in a Changing Climate: A study of the 2014 Northwest Territories Wildfires (ABoVE Phase 1)

New Landsat-8 algorithm for retrieving surface organic layer (peat) burn severity – validated for both uplands and peatlands

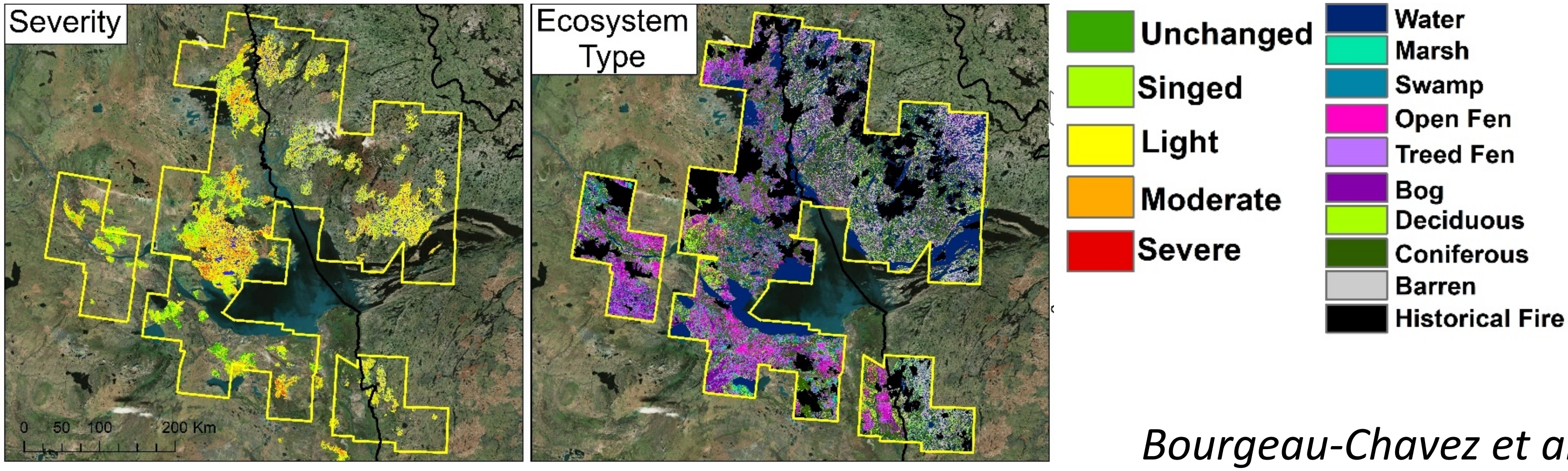


Comparing organic layer (belowground) and canopy (aboveground) burn severity in 2014-15 NWT wildfires on Shield vs. Plains – implications for post-fire succession



French et al. in prep. *Whitman et al. 2017*

What is Burning and How Severely: Intersecting Burn Severity Maps with Peatland – Upland Ecotype Maps

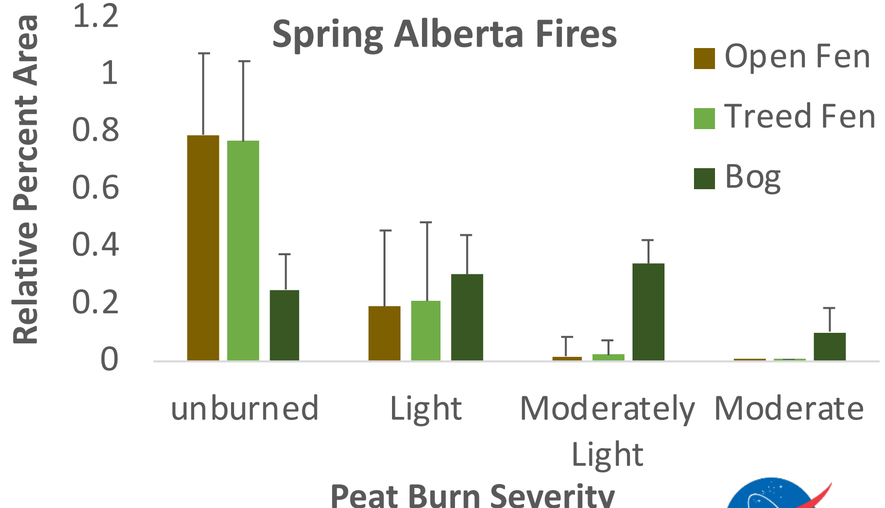


Maps available on DAAC soon; Bourgeau-Chavez et al.

Bourgeau-Chavez et al. in prep.

Combining these 2 maps with field data provides:

- Quantification of peatland vs. upland areas burned and unburned islands
- Information on severity of peat burning in the various ecotypes

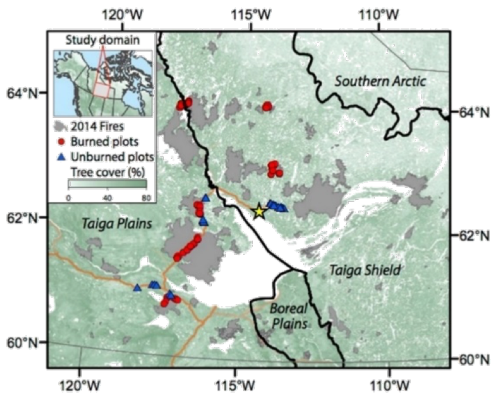


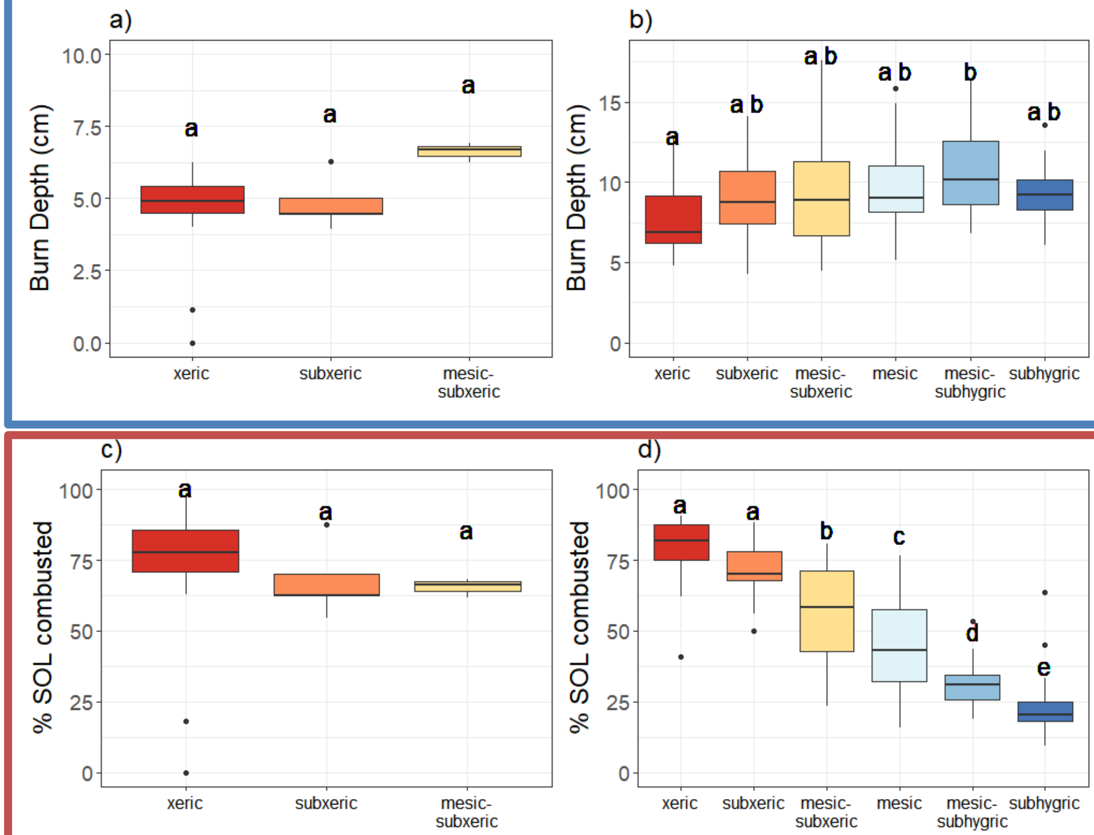
Come see our poster

Soil organic layer combustion in boreal black spruce and jack pine stands of the Northwest Territories, Canada

Walker et al. 2018 International Journal of Wildland Fire

211 burned plots, 7 burn scars





Depth of burn highest in moderately well-drained black spruce stands

% soil organic layer combusted highest in well-drained jack pine stands

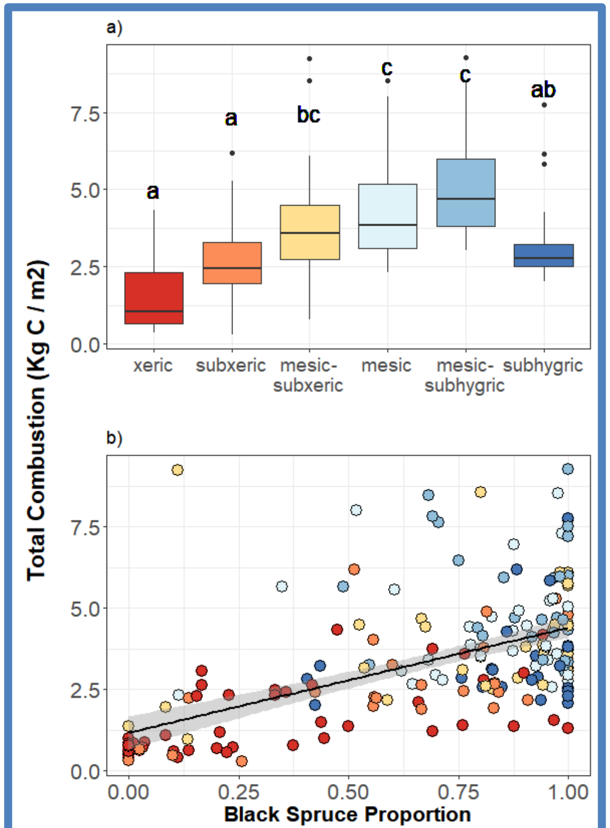
Mack (TE 2014)

Increasing fire severity and the loss of legacy carbon from boreal forest ecosystems.

(ABoVE Phase 1 project)

Cross-scale controls on carbon emissions from boreal forest mega-fires

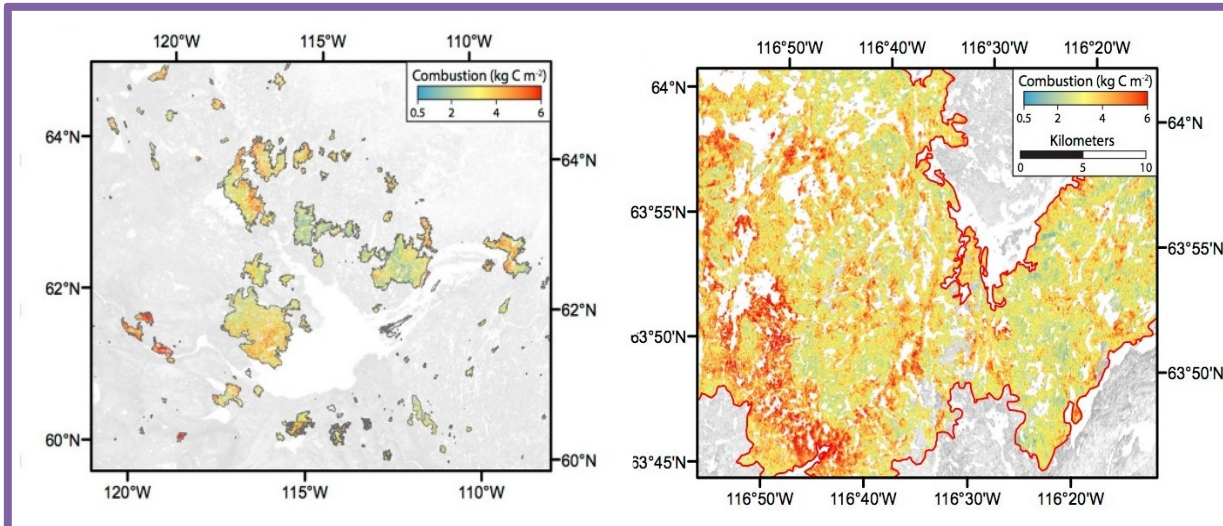
Walker et al. 2018 Global Change Biology



C emissions highest in moderately well-drained black spruce stands

Extrapolate emissions to entire 2014 burned area

Full Model: topographic wetness index, terrain ruggedness, dNBR, relative change in tree cover, percent black spruce, and percent sand in the top 15 cm of soil.

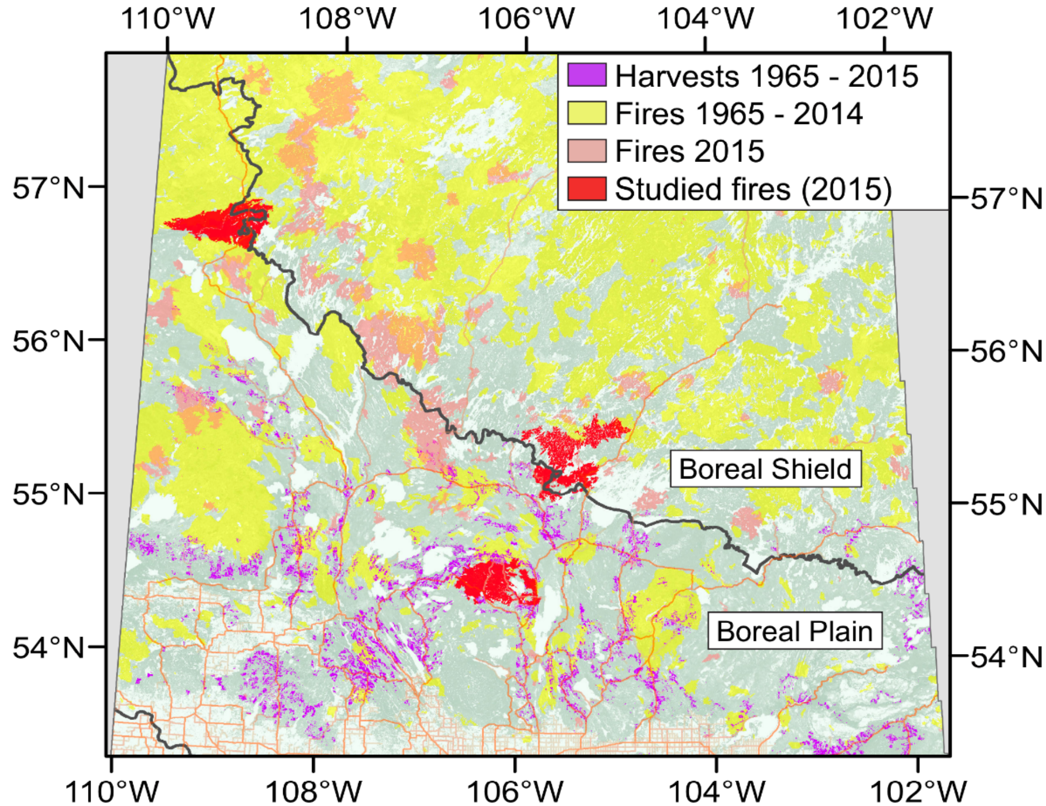


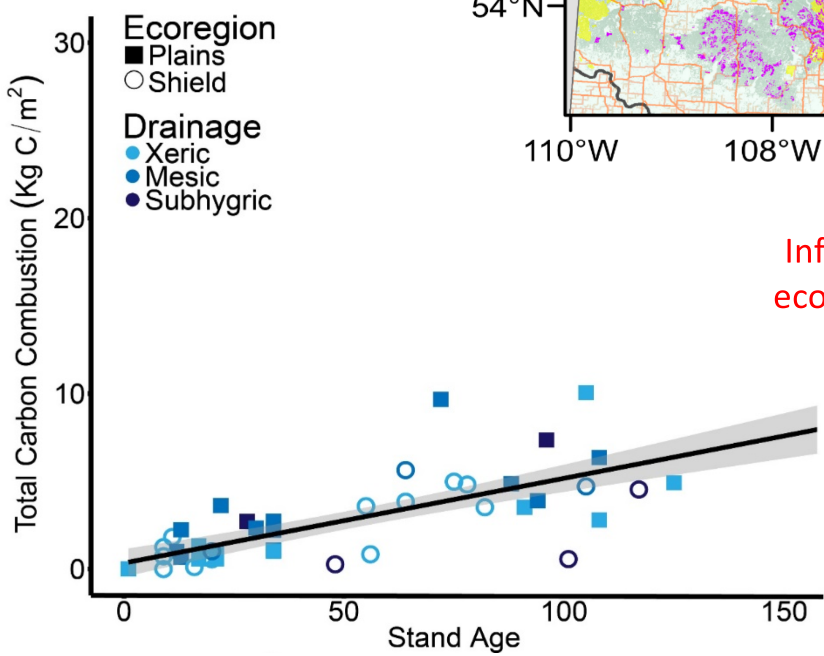
94.3 Tg C emitted from 2.85 Mha

Understanding and Modeling Combustion

Rogers (TE 2014)

- Comparing drivers and combustion levels from the southern boreal to the North (AK and NWT), based on our 2016 field campaign.
- Major differences due to more productive stands, higher fire frequency, and anthropogenic land use (timber harvest) in the southern boreal.



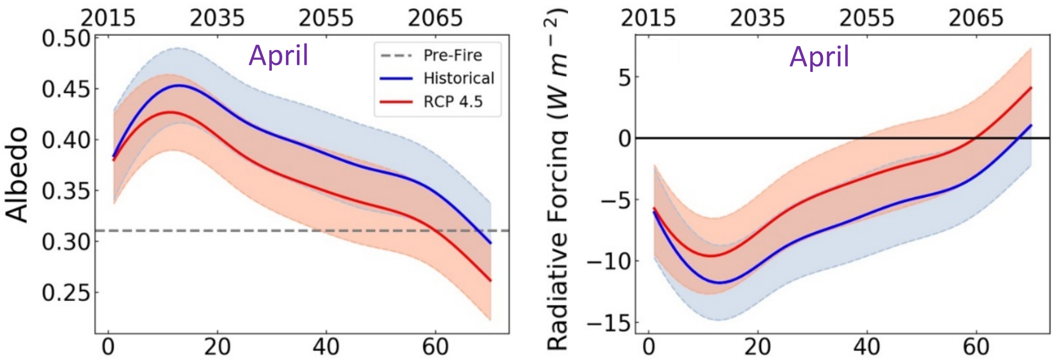


Influence of fire frequency, harvest, and ecosystem characteristics in the southern boreal (Dieleman et al., in prep)

Fire Climate Forcings

Rogers (TE 2014)

Modeling post-fire albedo under current & future climates (Potter et al., submitted shortly)

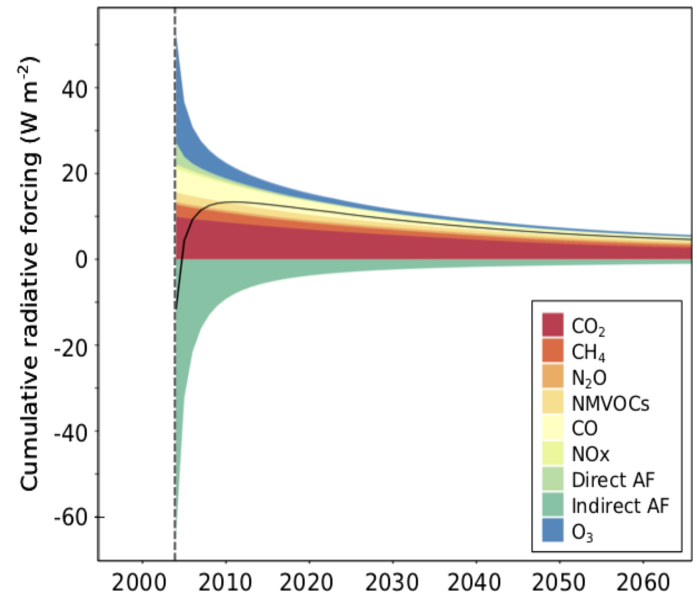


Uses machine learning to model post-fire albedo. Models can be run in current and future climates.

Climate change decreases the negative forcing from post-fire albedo (i.e. warming feedback), primarily b/c of reduced snow cover in winter and spring

Poster: "Spatially-explicit climate forcings from wildfire across the ABoVE domain"

Greenhouse gas forcings (Rogers et al., in prep)



Developed a framework to calculate the forcings from combustion, by linking carbon emissions to forcings from greenhouse gases, ozone and its precursors, and fire aerosols

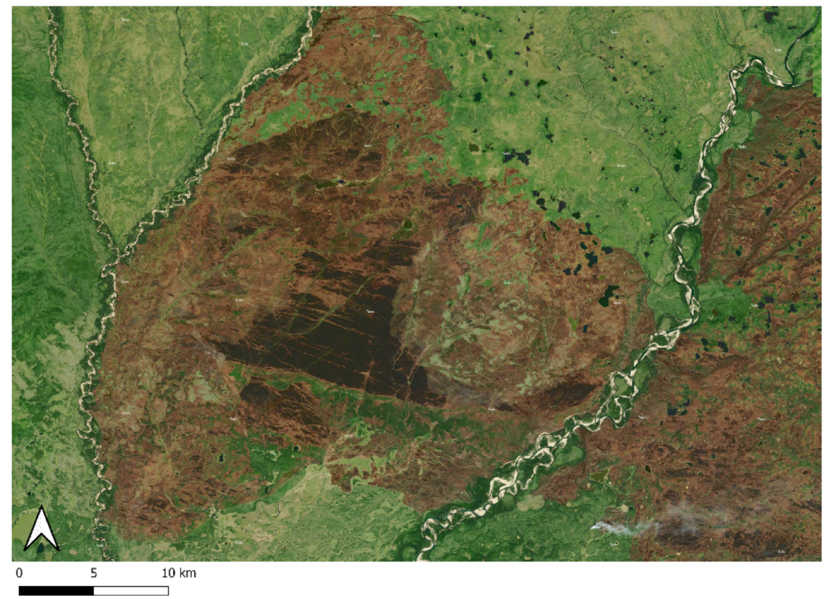
Veraverbeke (2018-2023)

Fires Pushing Trees North

- Key **science questions**:
- *Where, when and how much carbon do fires emit?*
- *How do fires influence forest cover and carbon stocks?*
- *What are the feedbacks between climate, lightning, fires and vegetation, and how do these differ between continents?*

Field and remote sensing analysis

- Circumpolar arctic-boreal, with (field) focus on Siberia
- Field campaign summer 2019 around Yakutsk, Russia.
- ***Measurements***:
- C combustion - Pyrogenic C production
- Post-fire tree recruitment - CBI
- Active Layer Thickness - Stand age



Check out team's poster for more info!

Funded by the Netherlands Organisation for Scientific Research (NWO)

Mack (TE 2014)

Synthesis Work

Regeneration Synthesis — ***Baltzer et al. In prep Nature Climate Change***

Post-fire seedling recruitment from 1534 sites, 58 fires, 10 ecoregions

Black spruce resilience:

- lower in western boreal compared to eastern boreal
- Impacted by pre-fire basal area, site moisture, & depth of residual soil organic layer

Combustion Synthesis — ***Walker et al. In prep Nature Geosciences***

C emissions from 417 sites, 22 fires, 6 ecoregions & Burn depth from 847 sites, 60 fires, 6 ecoregions

- C emissions are controlled by fuel availability, fire-weather seems of low importance in this model

Using combustion synthesis to model combustion across the ABoVE domain — ***Rogers et al. In prep Earth System Science Data***

Model aboveground and belowground C emissions

- Similar drivers of emissions as the field-based model
- Extrapolate emissions across the ABoVE Domain

ABoVE
ARCTIC - BOREAL VULNERABILITY EXPERIMENT

New Wildfire Projects and Articles

- Assessing impact of climate-driven increase in wildfire emissions on air quality and health of urban and indigenous populations in Alaska *Loboda TE-2018*

- Understanding the Interactions between Wildfire Disturbance, Landscape Hydrology and Post-Fire Recovery in Boreal-Taiga Ecosystems *Bourgeau-Chavez TE-2018*

- Environmental characteristics interact with fire to shape boreal forest plant community assembly: the importance of soil moisture and regeneration traits for information legacies *Day et al. In prep Ecology (Mack TE 2014)*

- Losing Legacies, Ecological Release, and Transient Responses: Key Challenges for the Future of Northern Ecosystem Science *Turetsky et al 2017 Ecosystems (Mack TE 2014)*

- Ecological Response to Permafrost Thaw and Consequences for Local and Global Ecosystem Services *Schuur and Mack 2018 Annual Review of Ecology, Evolution, and System. (Mack TE2014)*

- Wildfire severity reduces richness and alters composition of soil fungal communities in boreal forests of western Canada *Day et al. 2019 Global Change Biology (Mack TE 2014)*

- Increasing wildfires threaten historic carbon sink of boreal forest soils *Walker et al in Review Nature (Mack TE 2014)*