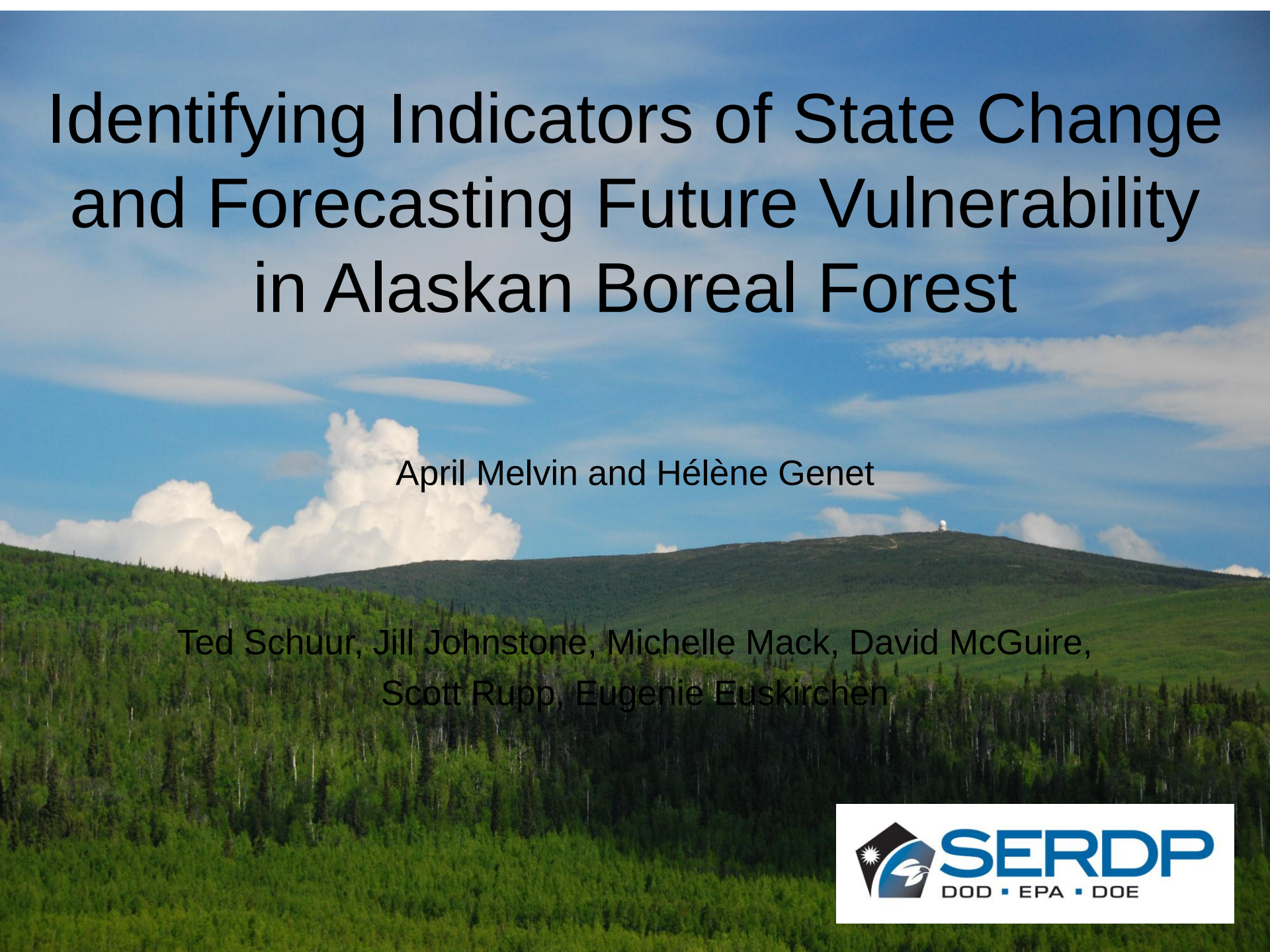
Identifying Indicators of State Change and Forecasting Future Vulnerability in Alaskan Boreal Forest

April Melvin and Hélène Genet

Ted Schuur, Jill Johnstone, Michelle Mack, David McGuire, Scott Rupp, Eugenie Euskirchen

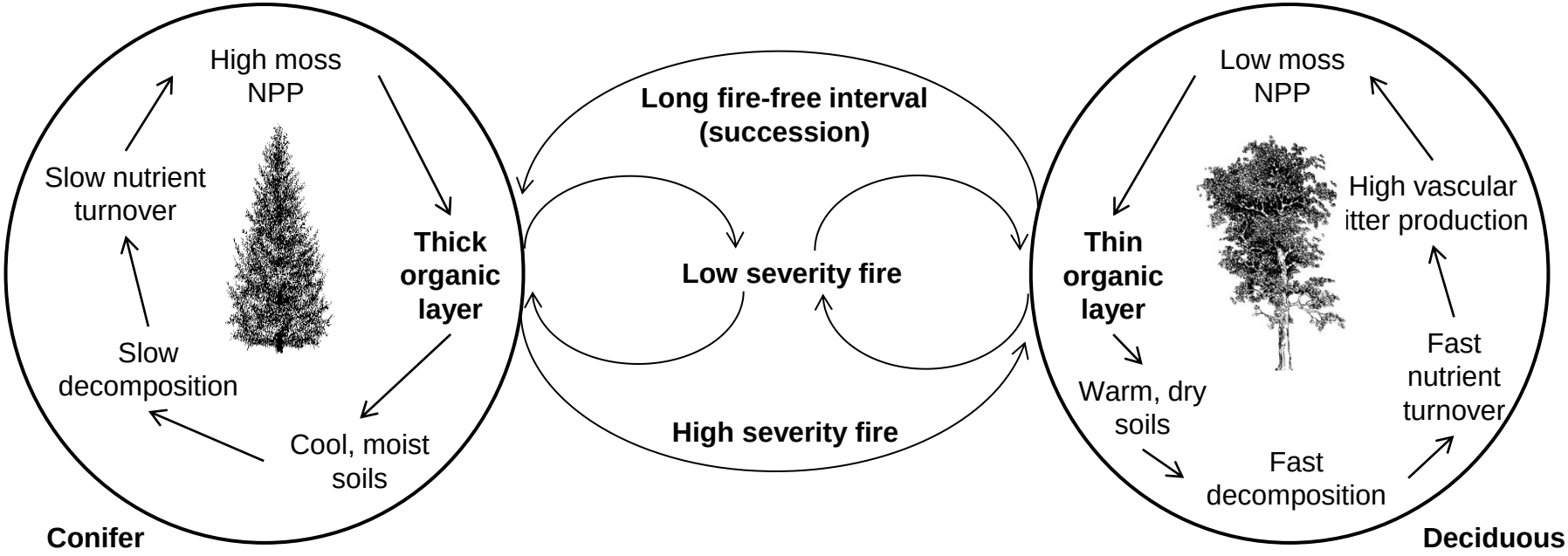


Objectives

- **Objective 1** is to determine mechanistic links among fire, soils, permafrost, and vegetation succession in order to develop and test field-based **ecosystem indicators** that can be used to directly predict ecosystem vulnerability to state change.

- **Objective 2** is to develop models that can **forecast landscape change** in response to projected changes in climate, fire regime, and fire management.

Threshold Dynamics in Boreal Ecosystems



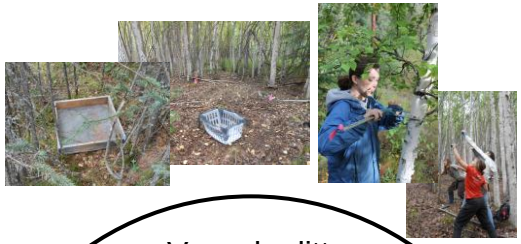
- Models good at estimating changes in organic layer thickness and permafrost vulnerability.
- Don’t simulate changes in forest productivity due to changes in vegetation shift. Limited data about mid-successional stages.

Plant-soil-microbial feedbacks black spruce and birch

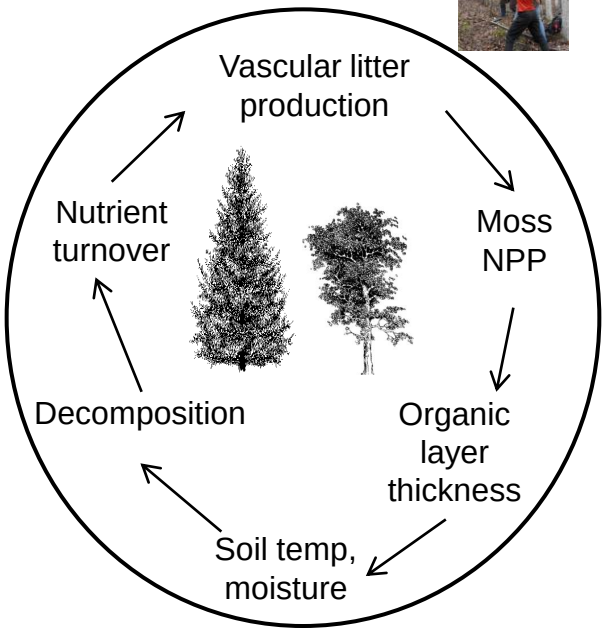
- 3 blocks containing adjacent stands of black spruce and paper birch
- 5 plots (10m x 10m) of each forest type within each block (n = 30 plots)

Plant-soil-microbial feedbacks black spruce and birch


CO_2 flux
Net N mineralization
Soil inorganic N pools



Quantification of litter inputs
Estimation of aboveground biomass



Assess understory vegetation and woody debris

Litter decomposition
Spruce, birch, brown moss, birch stick



Quantification of soil C and N stocks, base cations, P, pH

- Environmental data
- Air temperature, relative humidity, PAR, soil temperature (10cm below OL surface) and soil moisture (10cm into the mineral soil)
- Snow stakes from OL surface to 120cm (aboveground)

Murphy Dome Moss Transplant

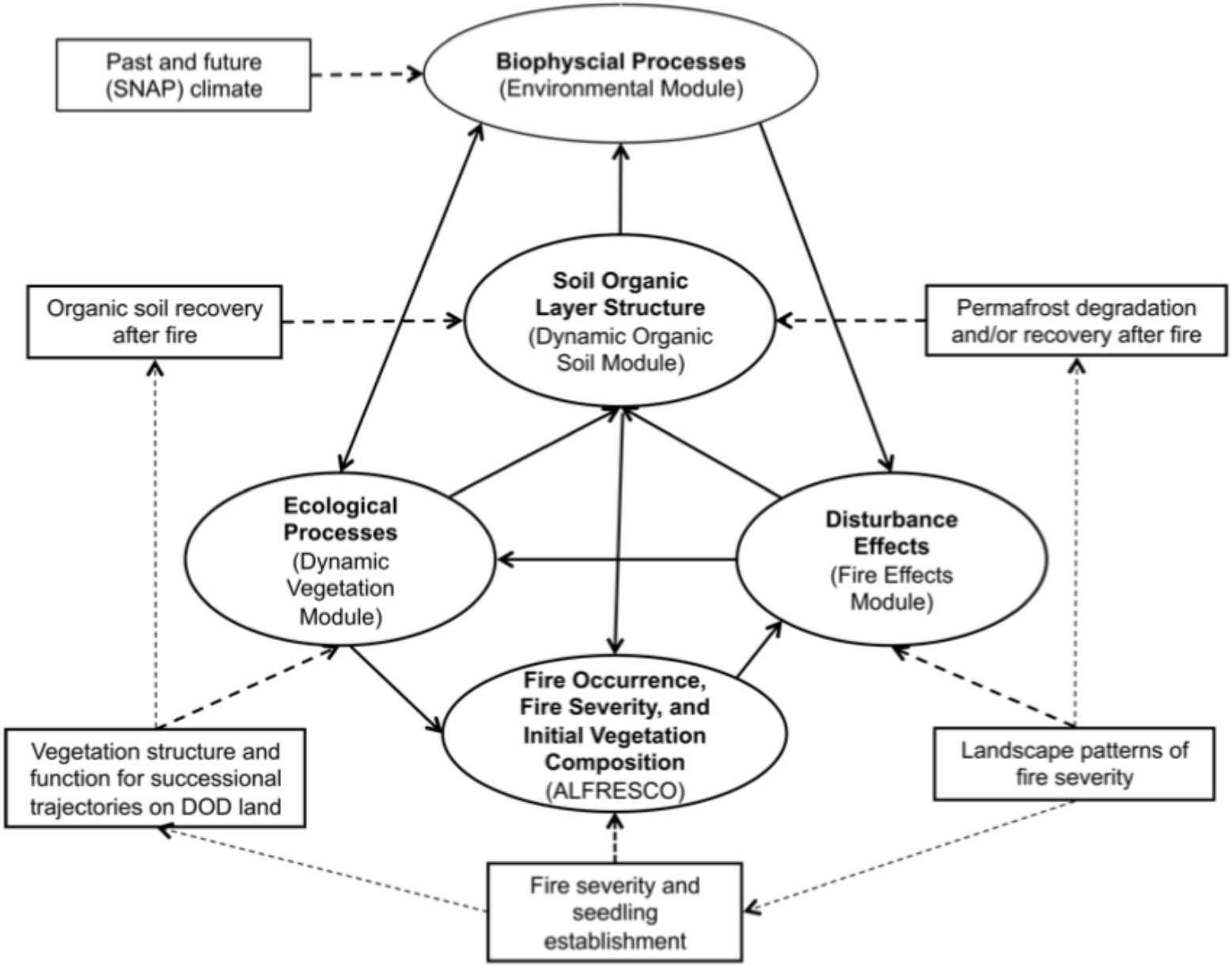
90 Moss cores transplanted (30 per block)
Dominant moss species: *Hylocomium splendens*

3 Transplant treatments:

- Ambient plot litter
- Birch litter addition
- Birch litter exclusion

Unmanipulated control areas

Model Framework



Effect of drainage on post-fire OL

Data assimilation from fire scar observations allowed us to better represent the effect of drainage of the OL dynamic in TEM.

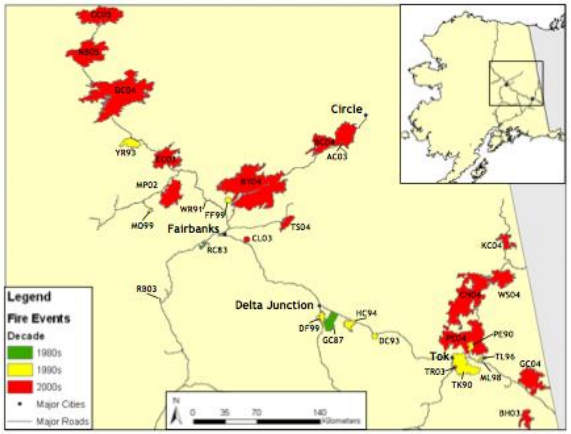
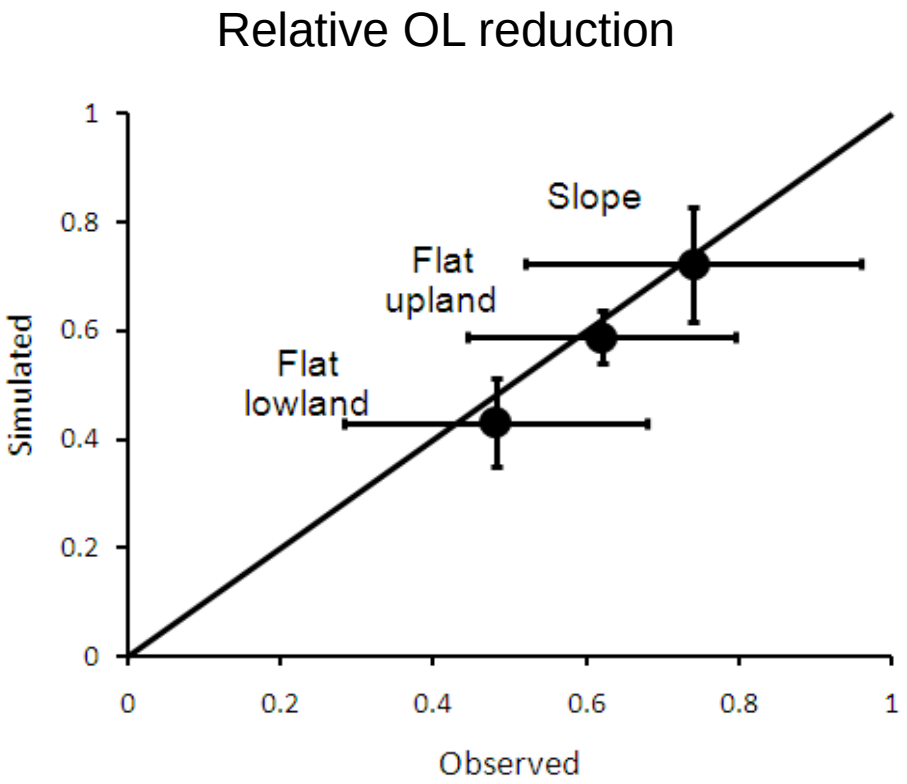
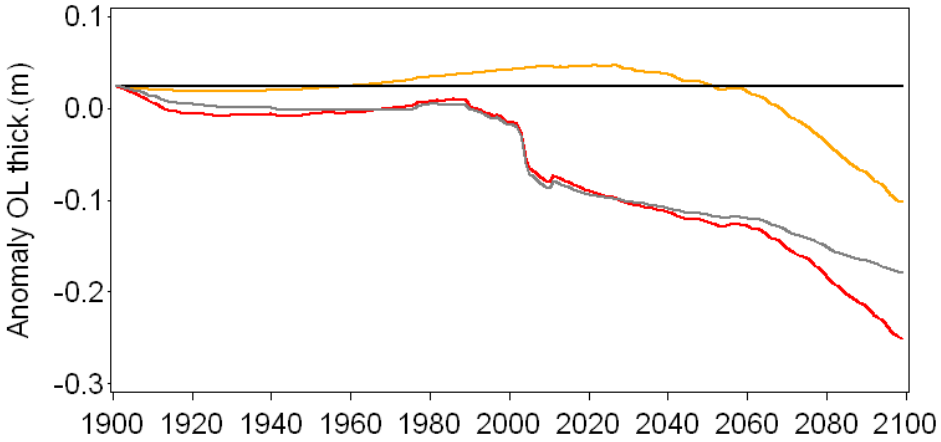


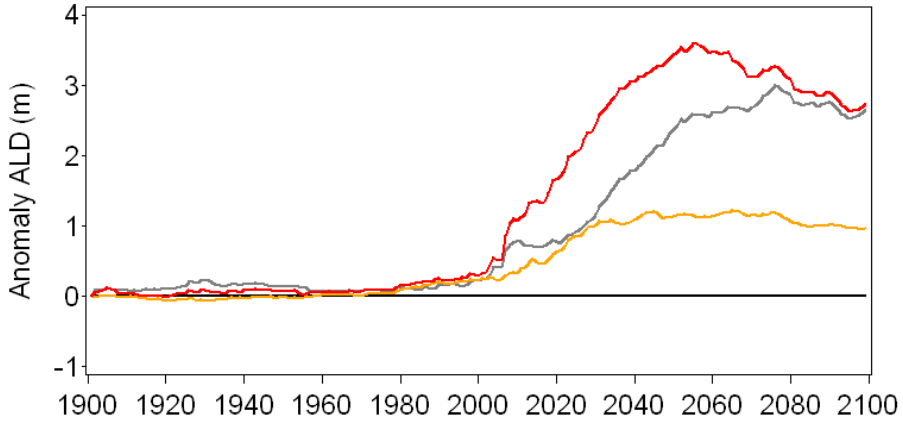
Figure S2. Map of fire perimeters sampled in this study, coded by decade. Full fire names and characteristics are provided in Tables S2 and S5.

(Turetsky et al. 2011)



Effects of fire regime and warming





- ✓ Fire intensification and warming induce a decrease of OL thickness. Their cumulative effects induce a decrease of ~ 20 cm by 2100.
- ✓ The decrease in OL thickness with warming and/or fire intensification induces an increase of the active layer depth.

Equilibrium
Warming
Fire
Warming + Fire

Conclusion

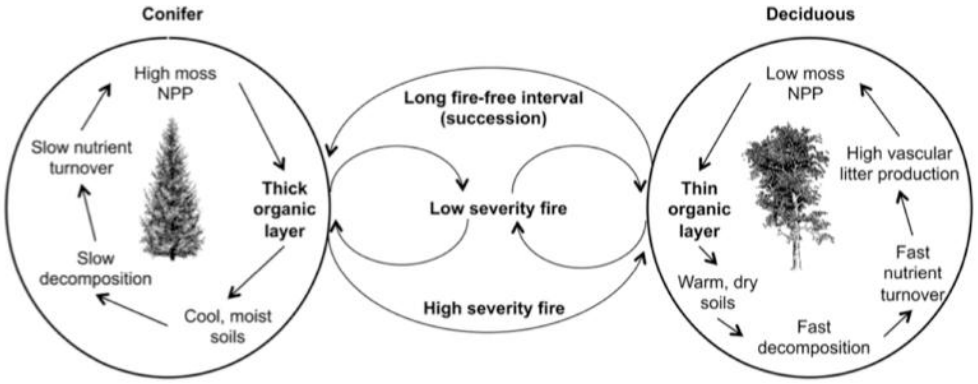
The impact of the co-existing warming and fire intensification in black spruce boreal forest induce:

(1) A decrease of the organic layer depth.

(2) A degradation of the permafrost.

These two responses induce significant carbon loss in black spruce forest. But, a thinner OL and fire intensification in response to future warming should result in a suitable environment for deciduous tree recruitment.

A key question is the degree to which increased productivity of deciduous forest offsets the carbon loss related to permafrost degradation.

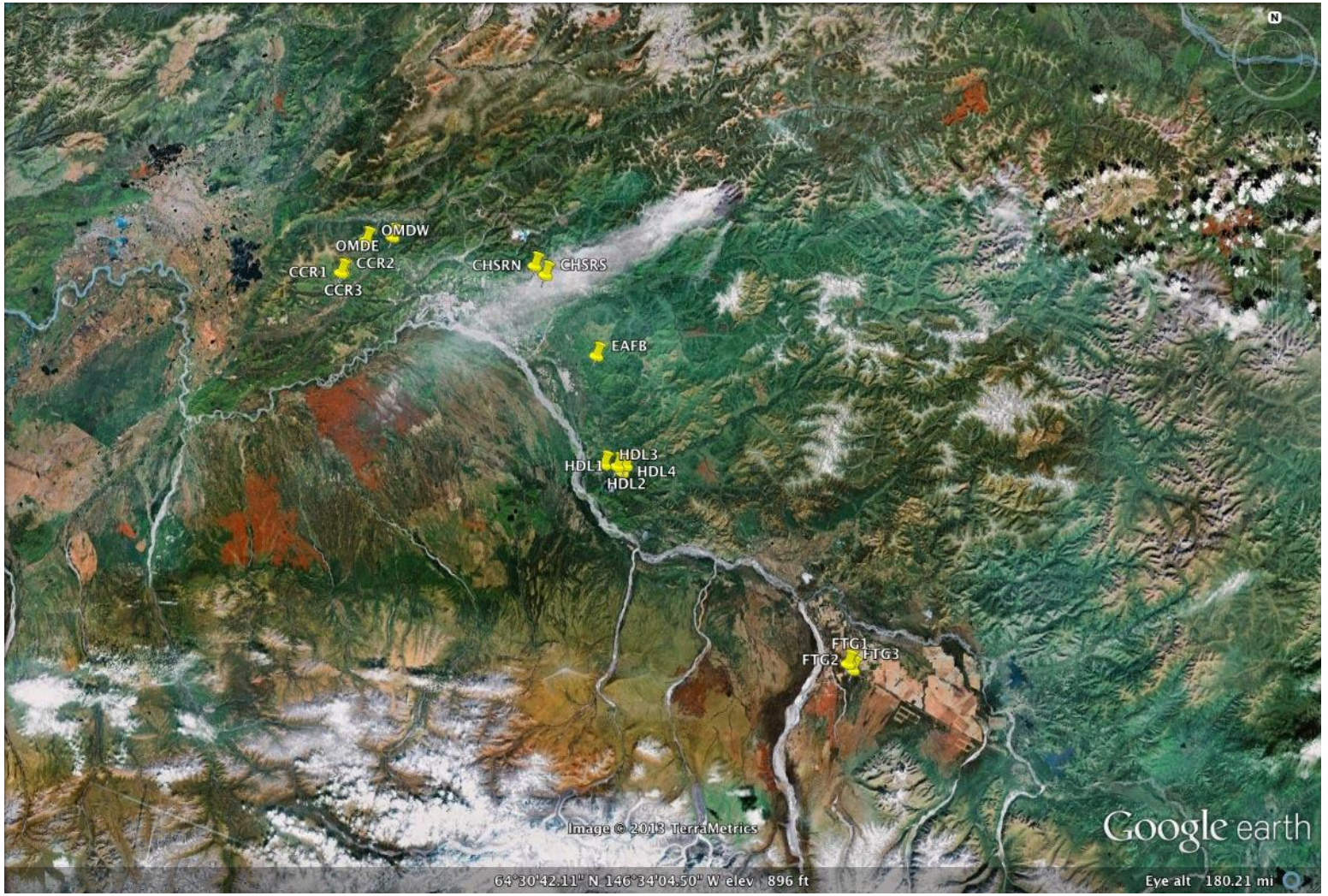


Managed Areas

Objective:

To understand the effects of fire management on the soil organic layer, vegetation, and permafrost.

Managed Areas visited in 2012



- Sampled 16 adjacent managed/control areas
- 14 shearbladed, 2 thinned

Sampling Managed Areas


Questions?