Modeling the effects of fire severity on boreal forest ecosystems in Interior Alaska

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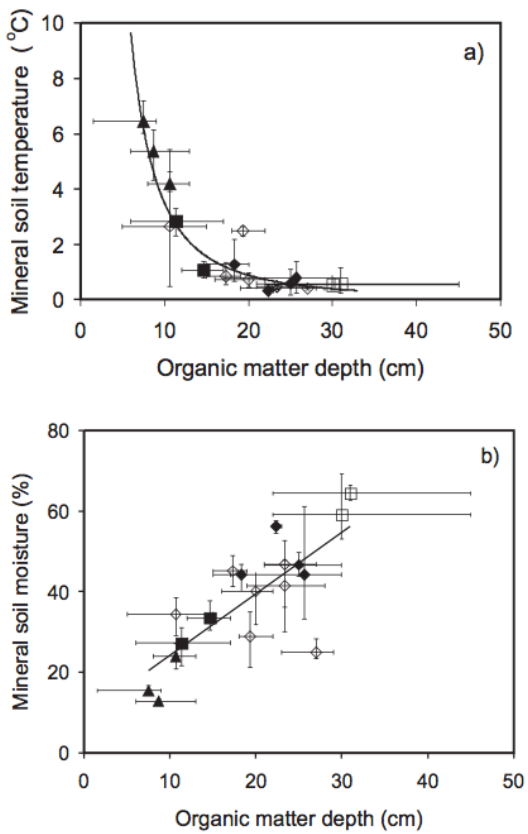
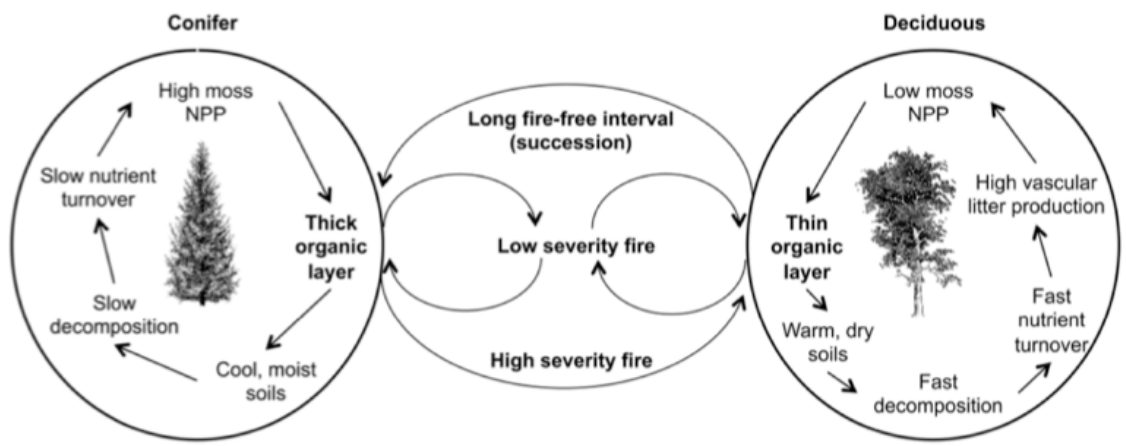
Introduction

The organic layer is of fundamental importance in boreal ecosystems for its influence in soil thermal and hydrologic regimes that determine (1) active layer dynamic and permafrost stability, (2) environmental conditions for regeneration.

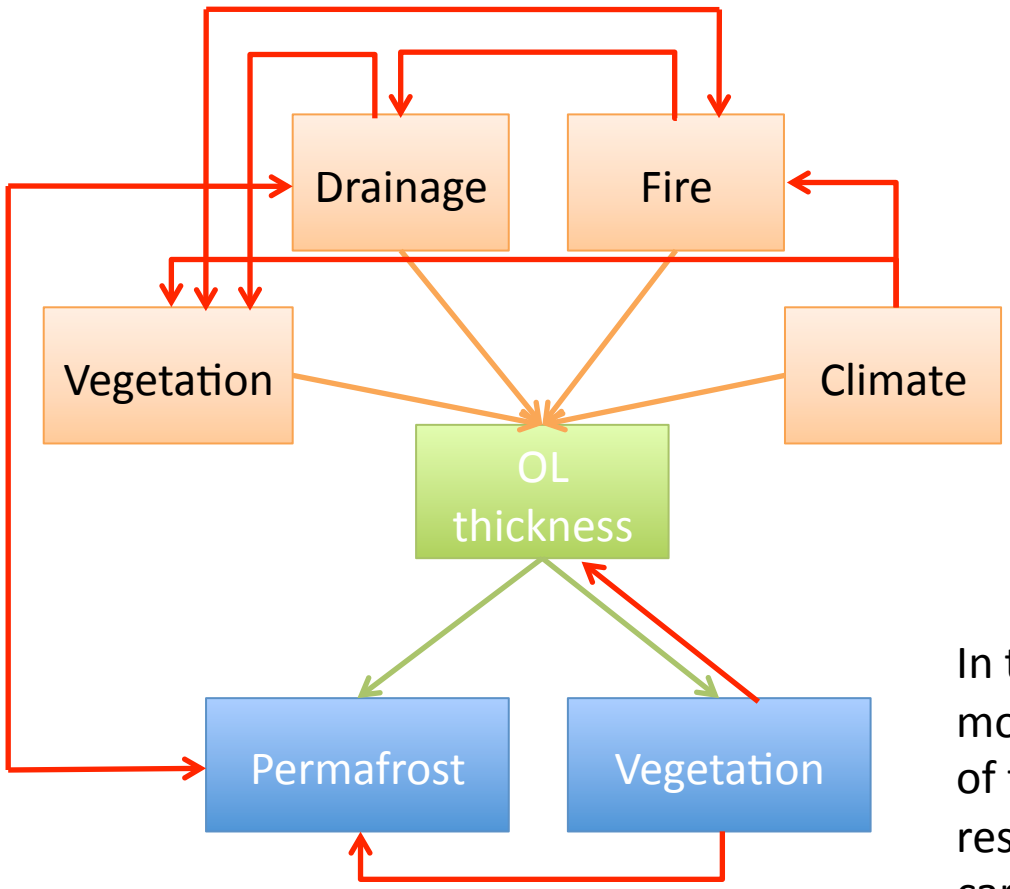


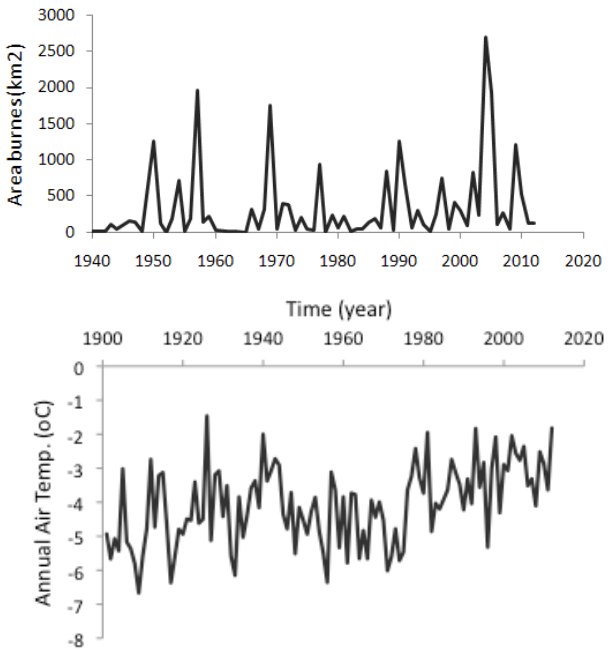
(Kasischke and Johntsone 2005)



(Johnstone et al. 2010)

Introduction





In the present study, we used a process-based modeling approach to examine the response of the organic layer depth to fire and how this response influences permafrost stability, carbon cycling and vegetation composition.

Mat. &Meth.: Observations

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Recent acceleration of biomass burning and carbon losses in Alaskan forests and peatlands

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The set of observation :

- 178 sites dominated by **black spruce** in Alaska
- Data collected from 31 fire events between 1983 and 2005.

Courtesy: IARCC

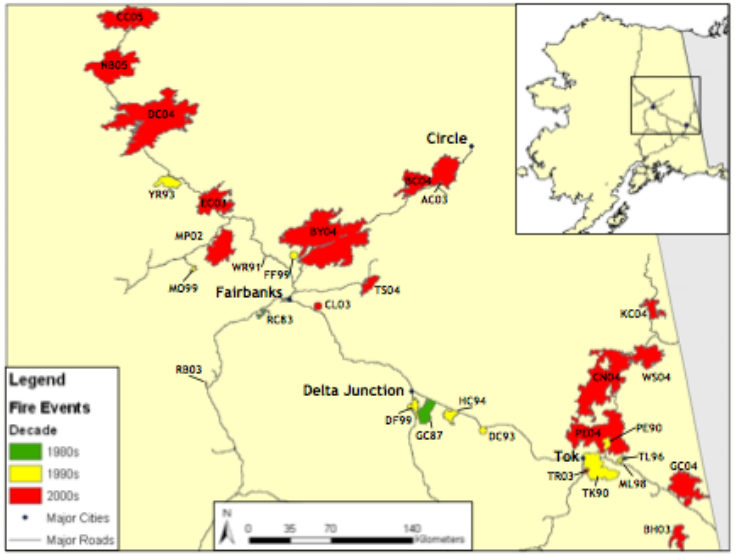
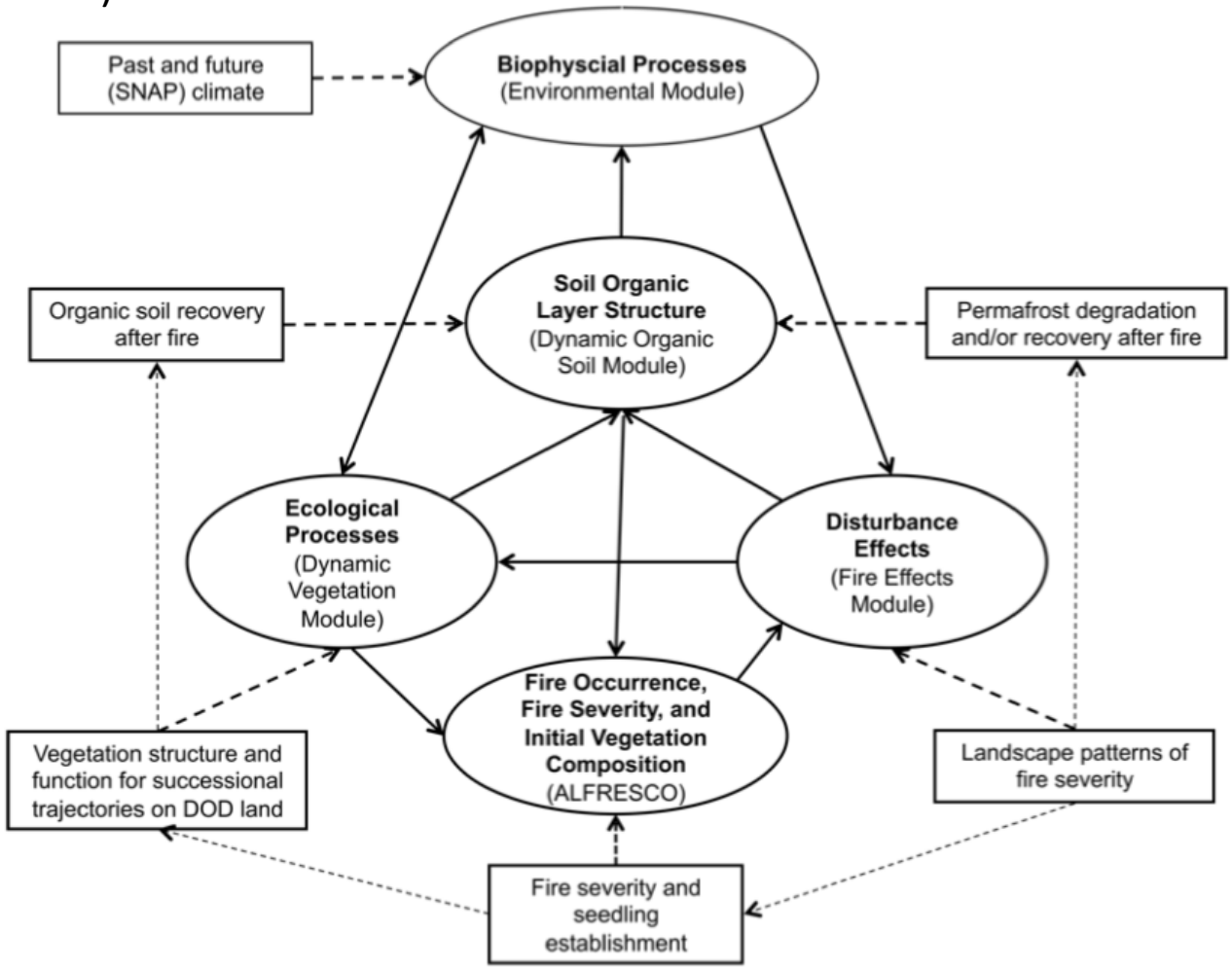


Figure S2. Map of fire perimeters sampled in this study, coded by decade. Full fire names and characteristics are provided in Tables S2 and S5.

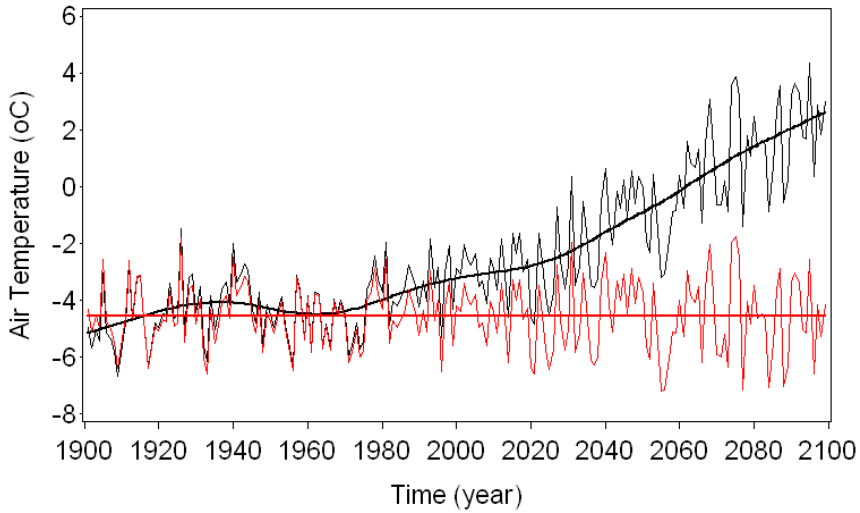
Mat. &Meth. – Model devel.

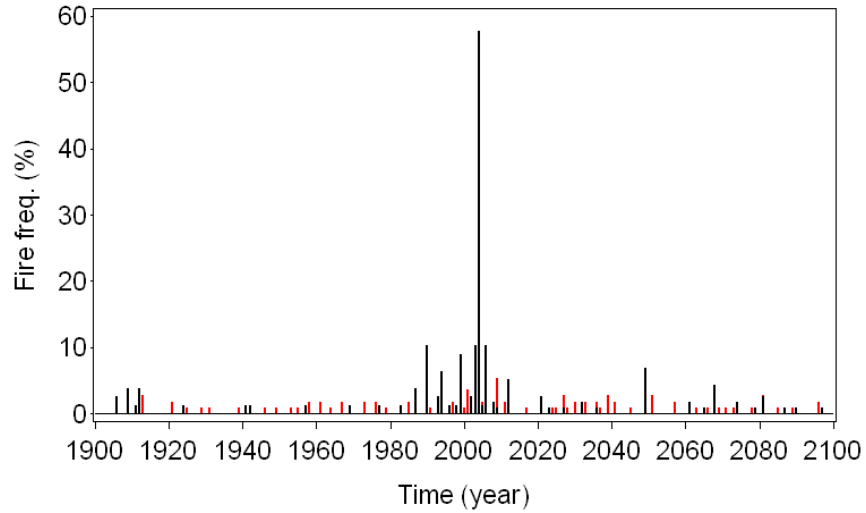
The Terrestrial Ecosystem Model, **TEM** (Raich et al. 1991, McGuire et al. 1992, Euskirchen et al. 2009, Yi et al. 2009)



Mat. &Meth. – Simulation

Assessing the relative impact of future warming and fire intensification on carbon balance and permafrost vulnerability.

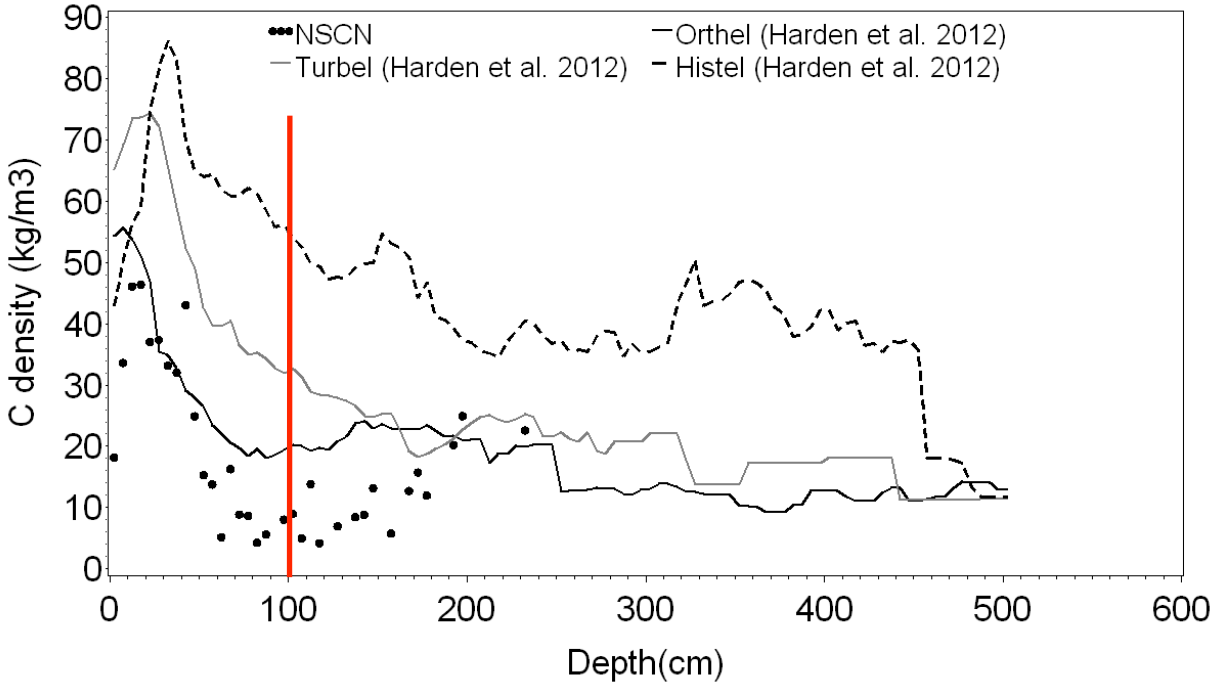




	Fire Intens. (FI)	No Fire Intens. (noFI)
Warming (W)	✓	✓
No Warming (NoW)	✓	✓

Mat. &Meth. – Simulation

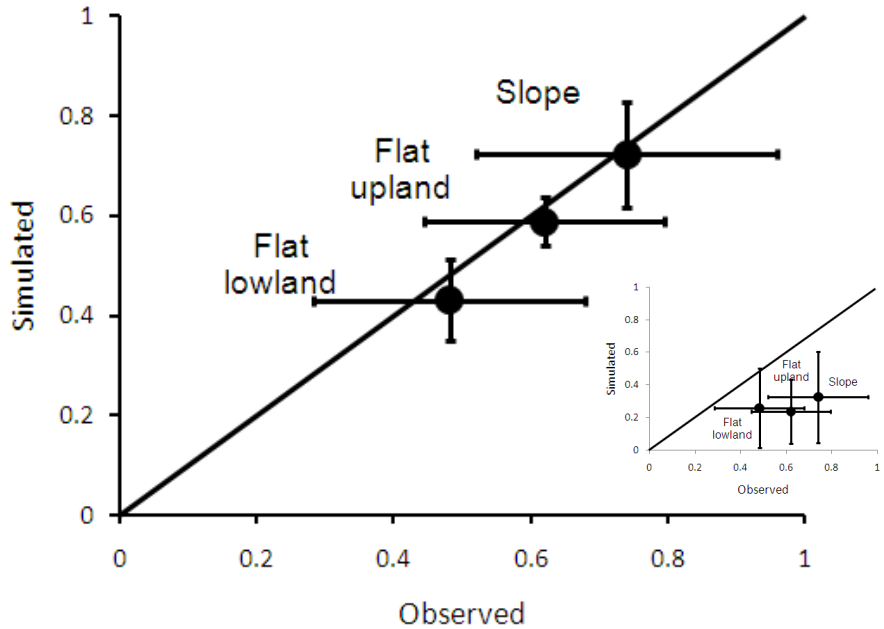
Integration soil carbon deeper than 1m to better represent the potential effect of deeper active layer on soil C balance.



Result: Model verification

- ✓ Simulated relative OL reduction are significantly correlated with observations (n=76, p<0.01).
- ✓ The model reproduce the effect of local drainage on fire severity to the soil organic layer.

Relative OL reduction



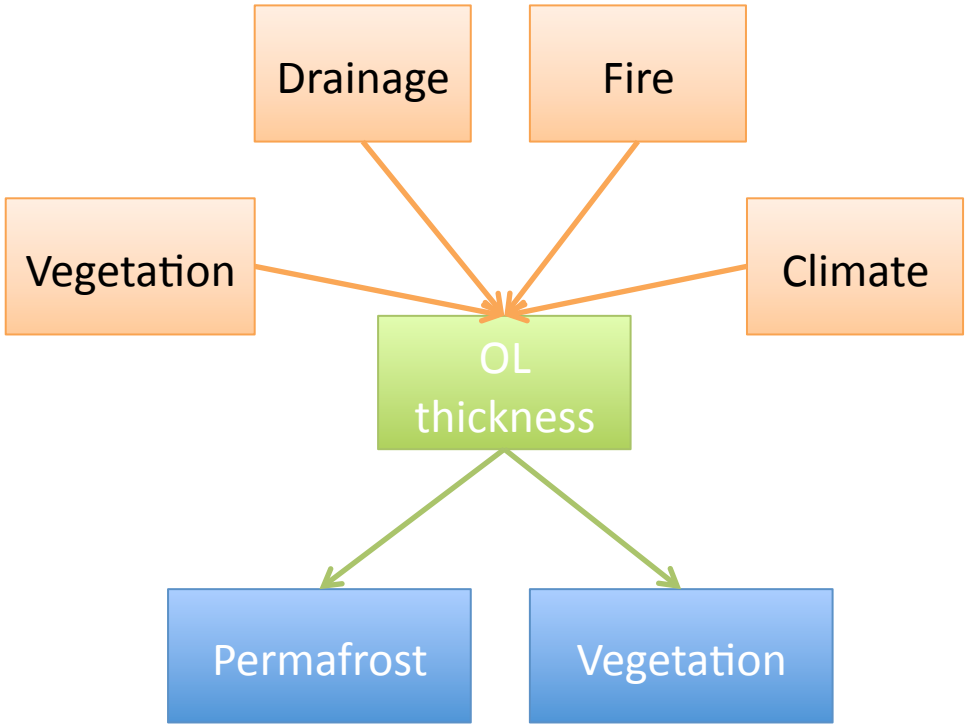
Conclusion

Model development

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

The integration of deep C (> 1m deep) is necessary to better represent soil C balance in regions susceptible to permafrost degradation.

Conclusion



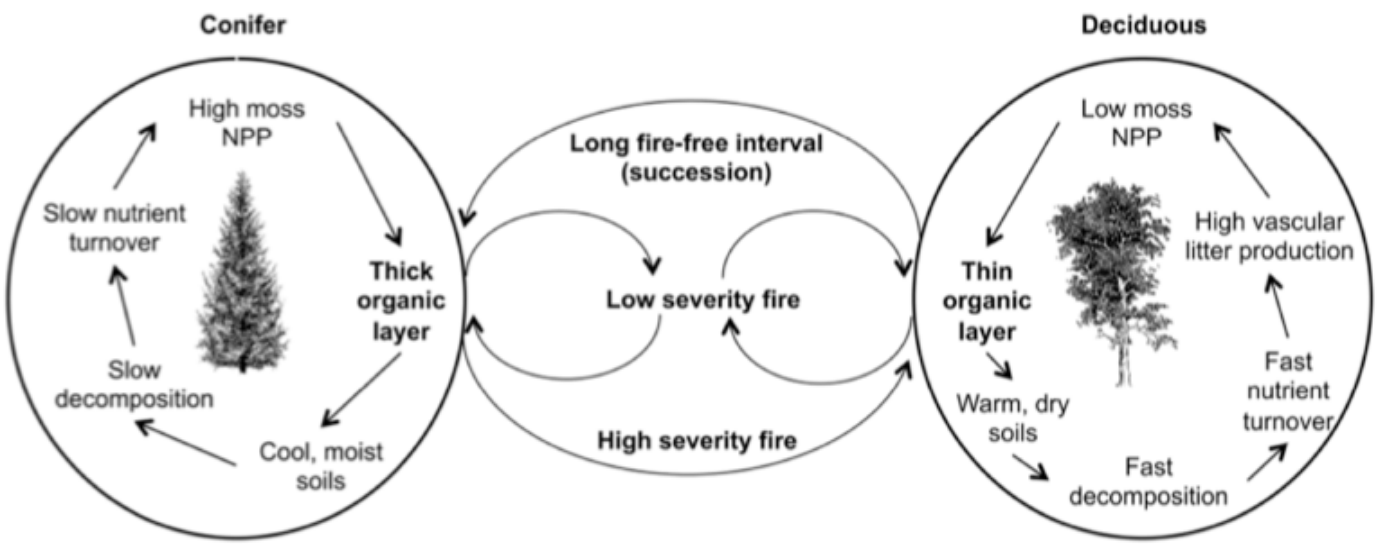
The impact of the co-existing warming and fire intensification in black spruce boreal forest induce:
(1) A decrease of the organic layer depth.
(2) A degradation of the permafrost.

These two responses induce significant carbon loss in black spruce forest.

Conclusion

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.



(Johnstone et al. 2010)

Conclusion

Thank you!

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