BNZ LTER: Climate-driven changes in Alaska's disturbance regimes affect ecological memory to drive abrupt landscape transitions and alter feedbacks to the climate system

- The frequency and size of fires has increased significantly in the past 60 years; paleoecological evidence suggests a transition to a novel, unprecedented fire regime.

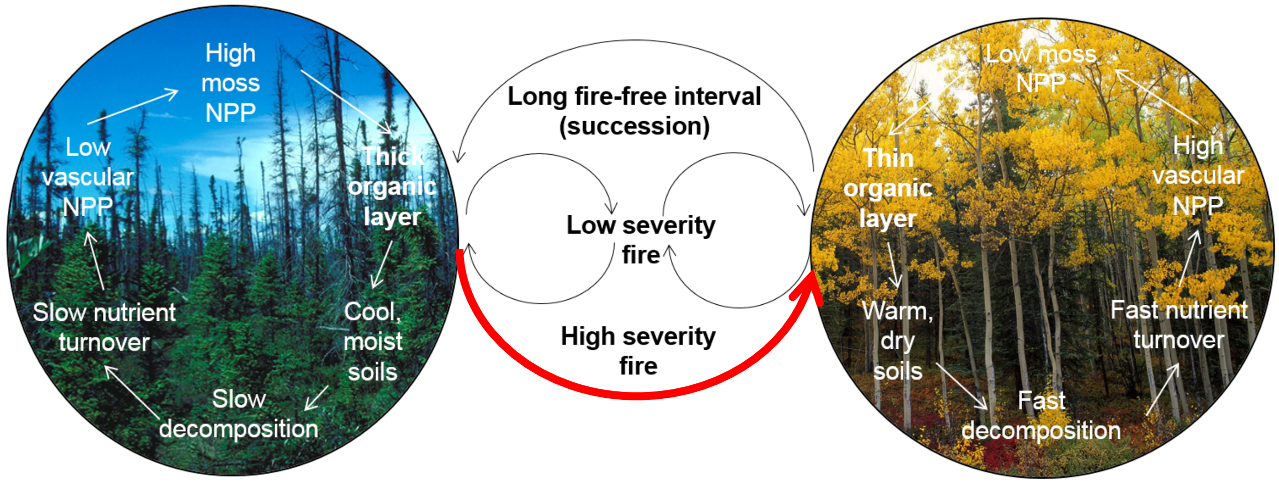
- Permafrost is warming/thawing rapidly, particularly in response to wildfire, resulting in dramatic changes in vegetation, NEE, and surface hydrology

- There has been an increase incidence of native and invasive insect and pathogen outbreaks that are influencing stand structure, successional dynamics and likely response to fire.
- Changes in climate-disturbance interactions are influencing the availability (abundance, distribution, access) of subsistence resources to rural and urban communities

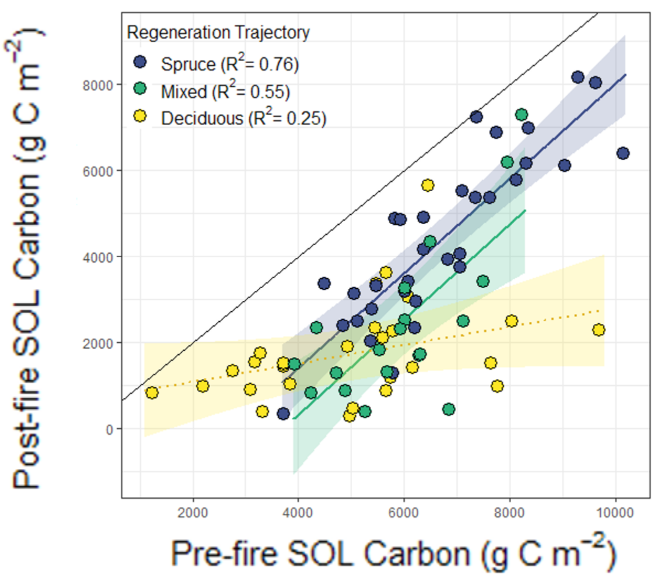
Changing disturbance regimes are influencing information and material legacies and disrupting the feedbacks that have conferred resilience. Ecosystems are shifting to new states.

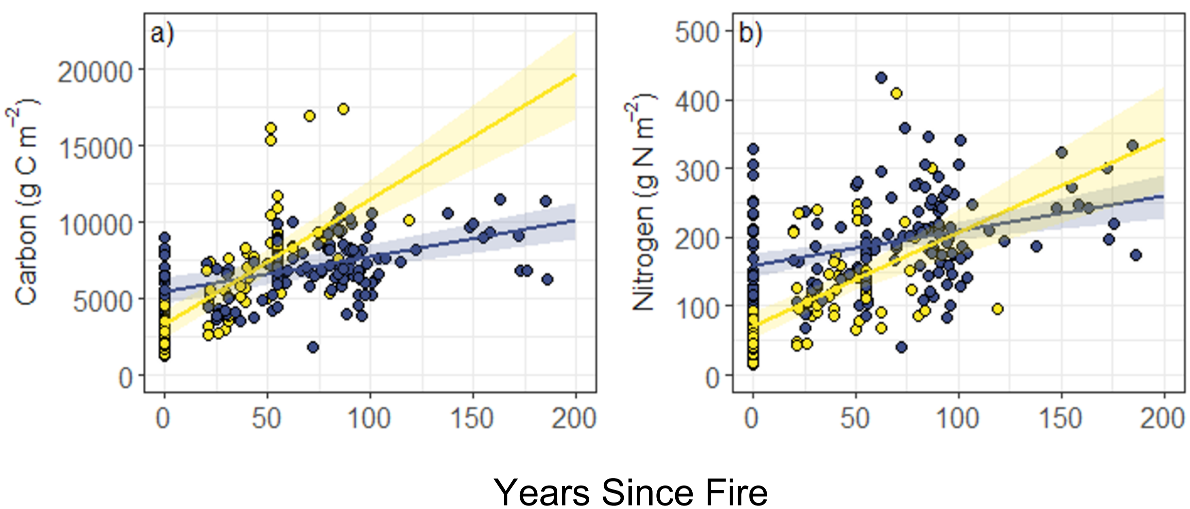
High severity fires burning through organic horizons to mineral soil favor the establishment of hardwoods over conifers. Predictions are that a substantial component of the black spruce landscape could be converted to hardwoods over the next 50-100 years.

Black Spruce



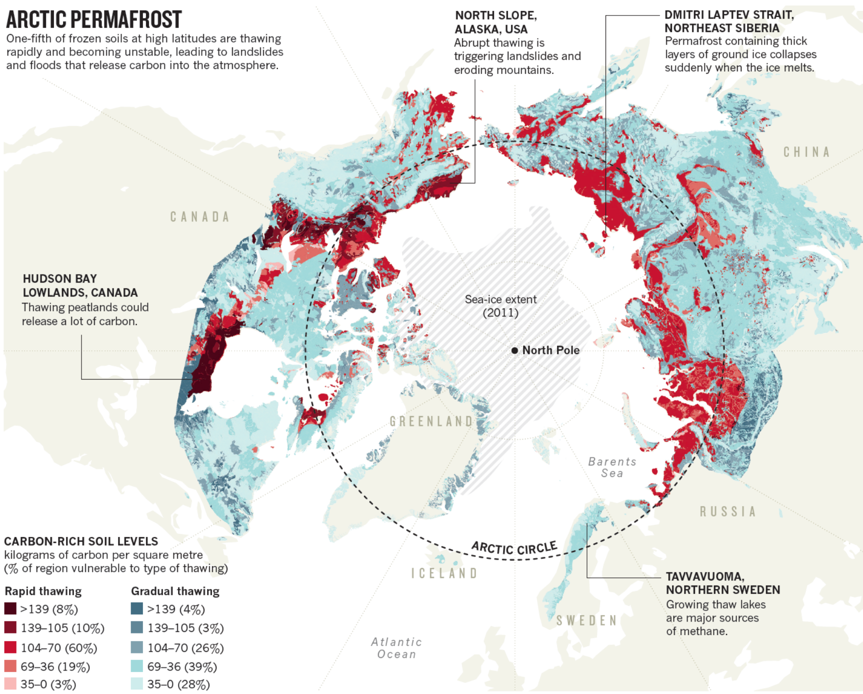
Hardwoods





Permafrost thaw & collapse is accelerating – resulting in dramatic changes in vegetation, hydrology, landscape structure and trace gas exchanges with the atmosphere.

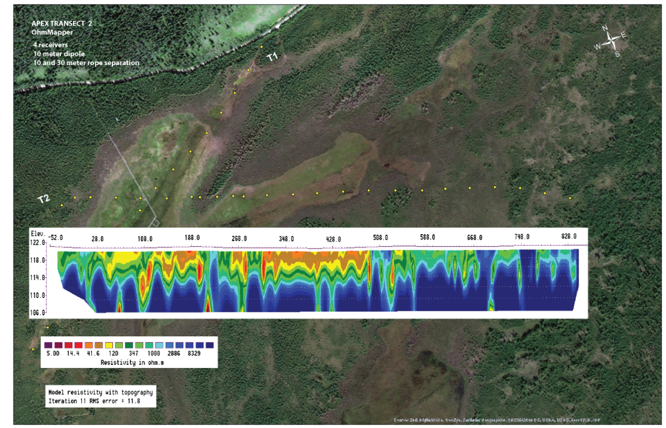
Mapping vulnerability of abrupt thaw and risk to rural communities and infrastructure



Turetsky, M. et al. 2019. Permafrost collapse is accelerating carbon release. Nature 569: 32-34.

Coupled biogeophysical models incorporating permafrost thaw do a poor job in capturing abrupt change

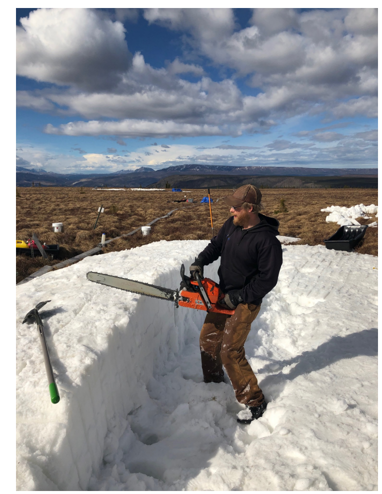
Drivers/spatial patterns of gradual and abrupt thaw: ~ f(climate, climate x fire, climate x ground ice)



Consequences of thaw:

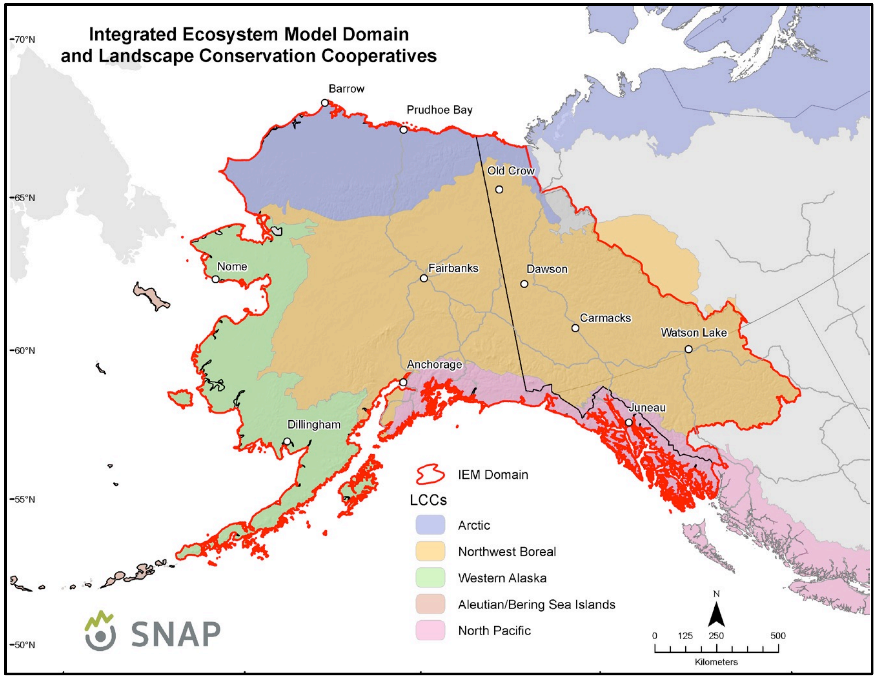
Global change experiments: simulate winter warming – $^{14}CO_2$ to assess loss of old permafrost C

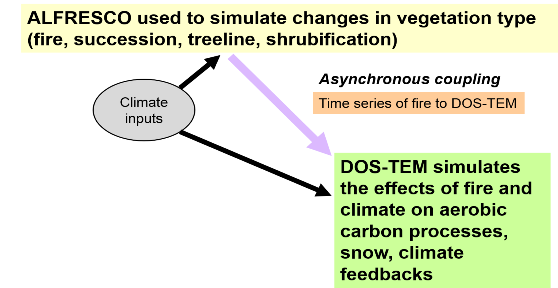
Collapse scar gradients: studying vegetation change & soil/watershed biogeochemistry, e.g., C sources for CH4 fluxes, N_2O production, plant N uptake.

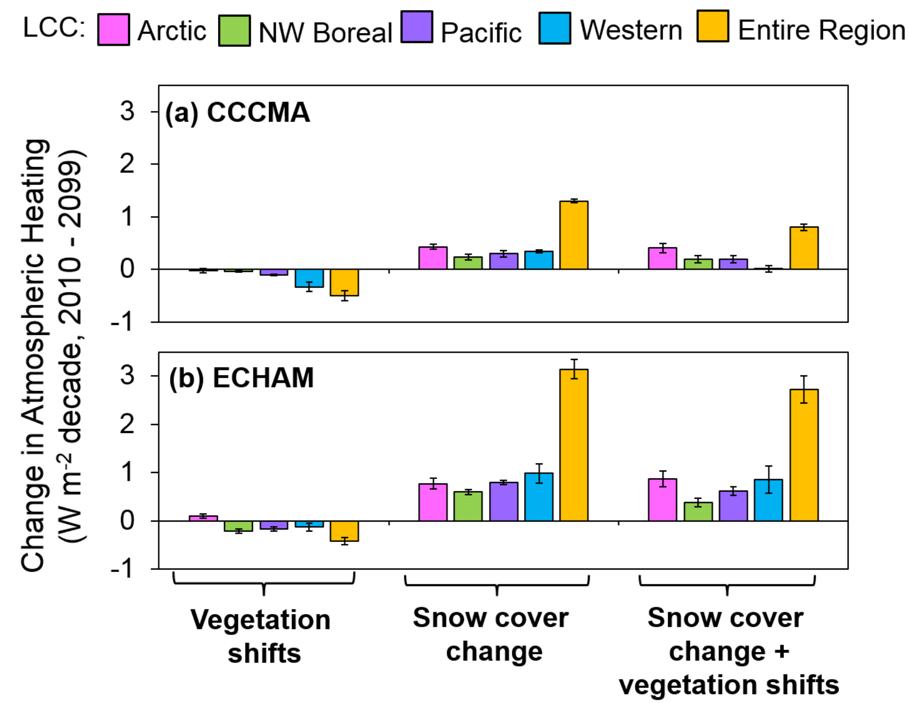


Incorporating thaw predictions into risk assessment using modeling

Positive climate feedbacks driven by increases in the snow-free season (reduced albedo) substantially outweigh negative feedbacks from increases in NPP and deciduousness following fire.







https://csc.alaska.edu/projects/integrated-ecosystem-model-iem-alaska-and-northwest-canada

Euskirchen, E. S., et al. 2016. Consequences of changes in vegetation and snow cover for climate feedbacks in Alaska and northwest Canada. Environmental Research Letters 11.

McGuire, A. D., et al. 2018. Dependence of the evolution of carbon dynamics in the northern permafrost region on the trajectory of climate change. PNAS. 115:3882-3887.

Schuur, E. A. G., et al. 2015. Climate change and the permafrost carbon feedback. Nature 520:171-179.