Developing a spatially-explicit understanding of fire-climate forcings and their management implications across the ABoVE domain

PI: Brendan Rogers

Co-I's: Scott Goetz, Merritt Turetsky, Sander Veraverbeke

Project Code: Rogers-01

Project description: motivation

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Fires have been and are projected to increase in frequency & severity

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AND

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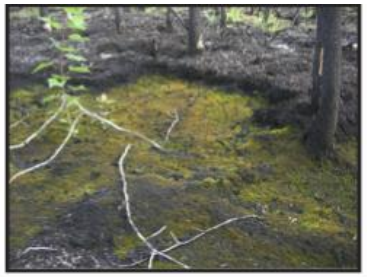

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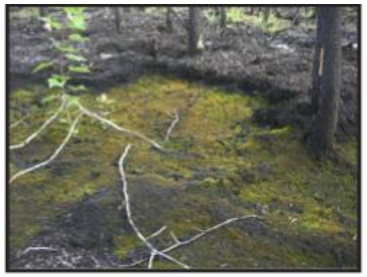
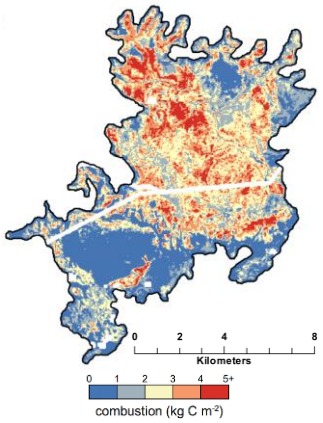
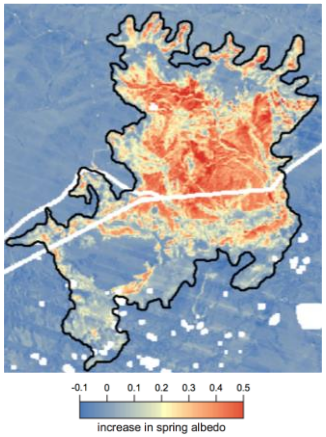
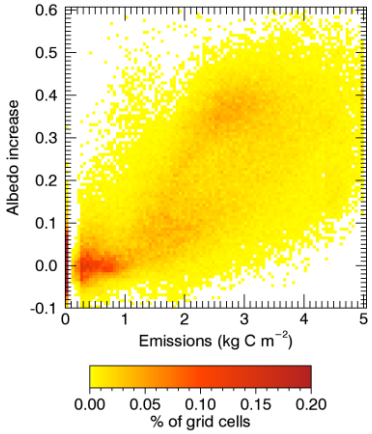


BUT

Our knowledge on the forcings is limited, especially how they vary among and between fires







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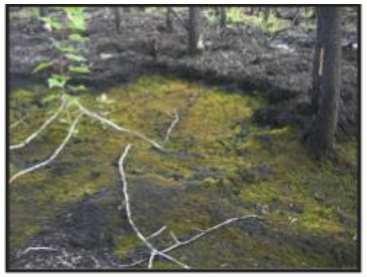

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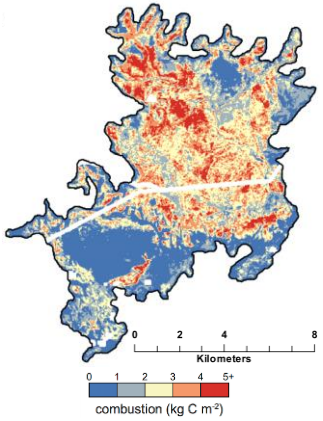

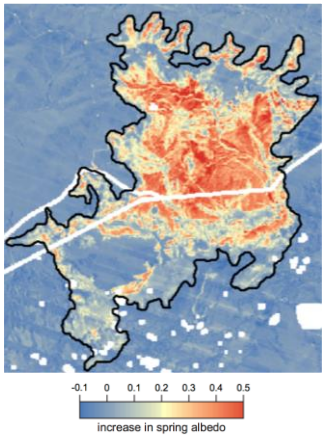

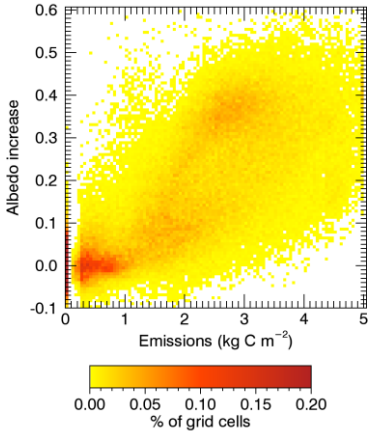

THEREFORE

We will map individual and net fire forcings across the ABoVE domain during 2001 - 2014

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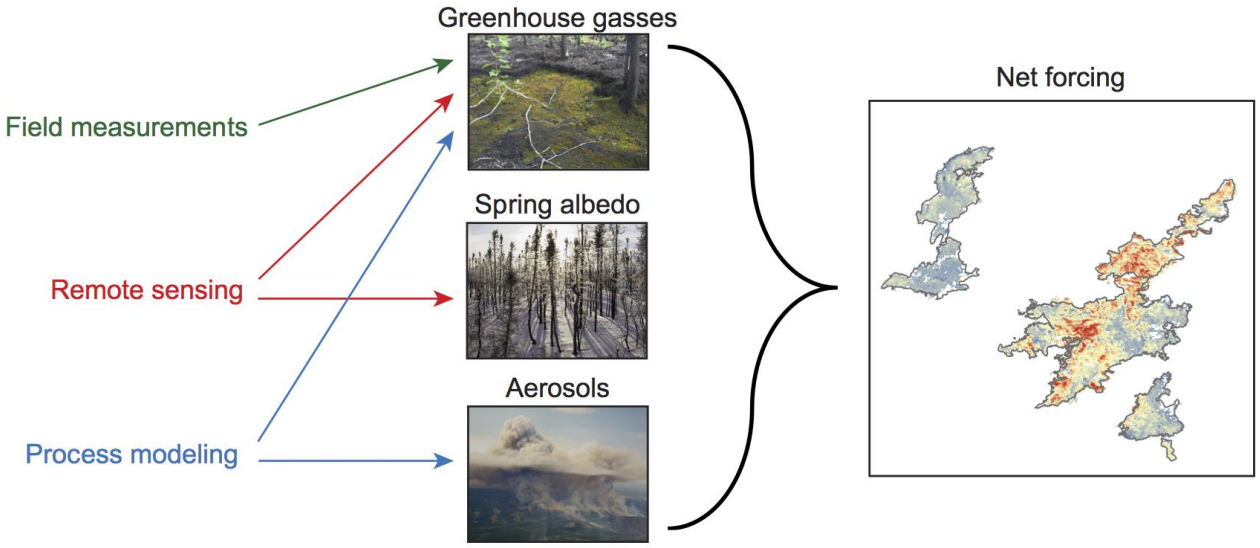

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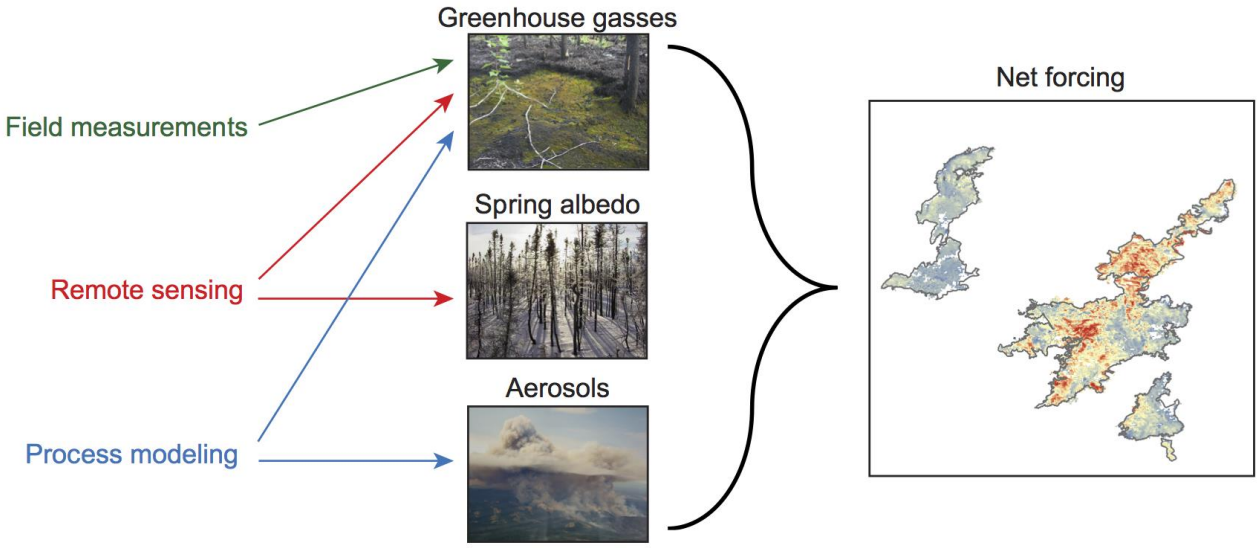

Main *science* question: What controls the warming or cooling impact from fires in the ABoVE domain?

Main *management* question: How can selective fire management help mitigate fire-climate feedbacks?

Project description: RF from combustion

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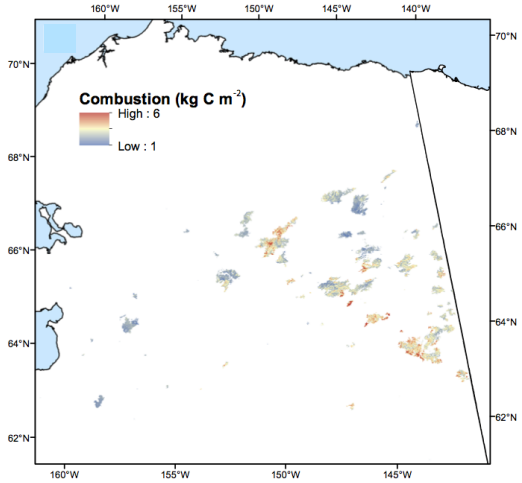
AKFED (Veraverbeke et al. 2015)



Project description: RF from combustion

new field measurements

new fuel types map

prior data from Canada

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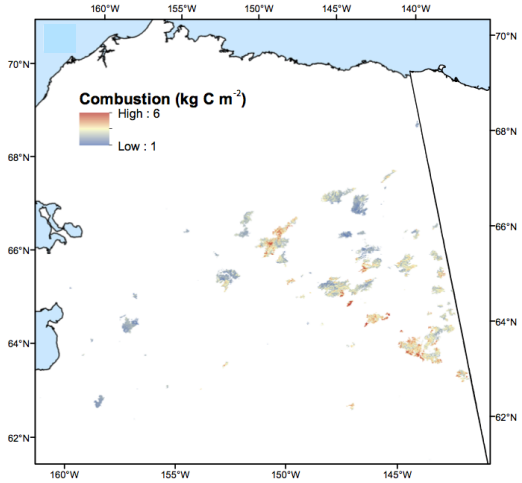

FWIs

Lidar retrievals

expanded domain

smoldering combustion

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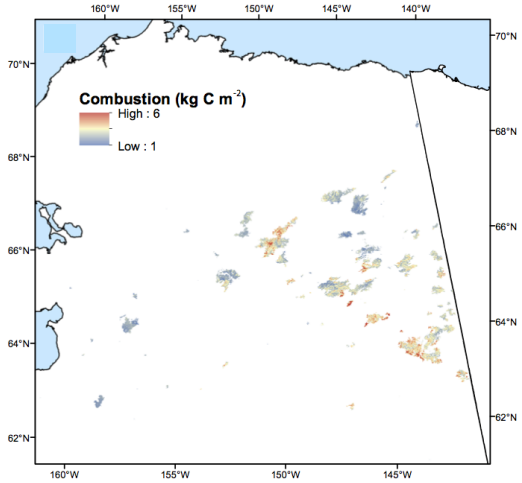

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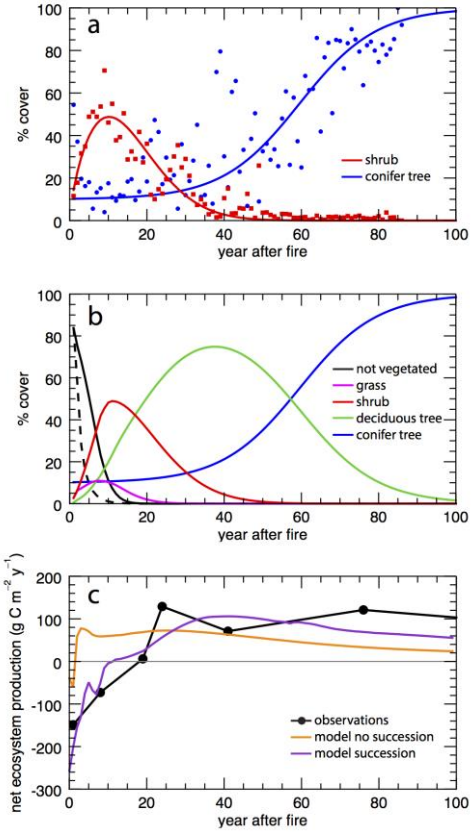

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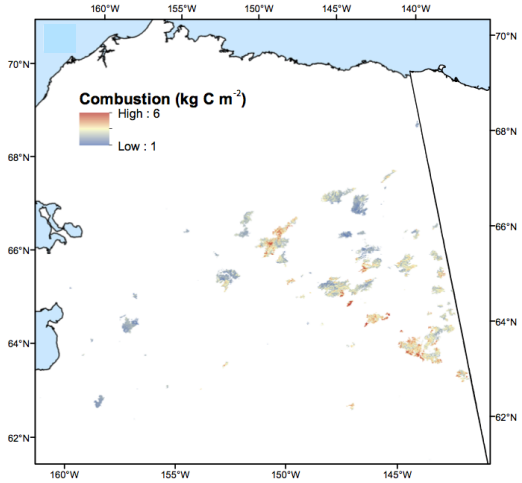

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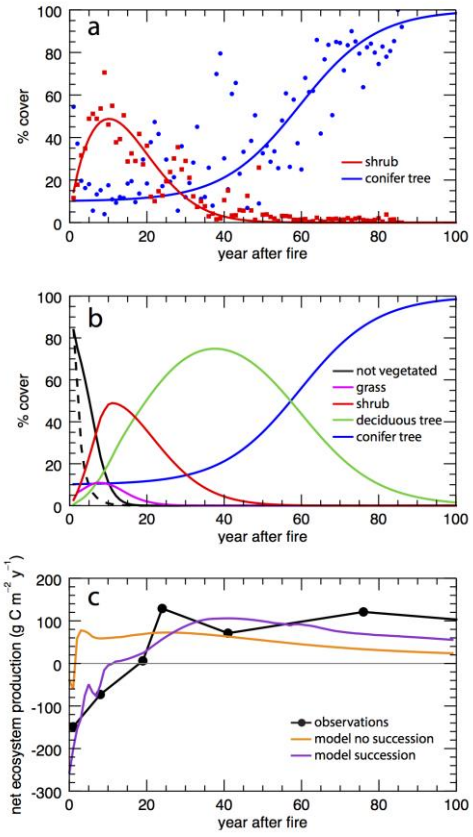

- CO_2 impulse response functions
- box models of N_2O, CH_4 lifetime
- RF equations

Project description: RF from spring albedo

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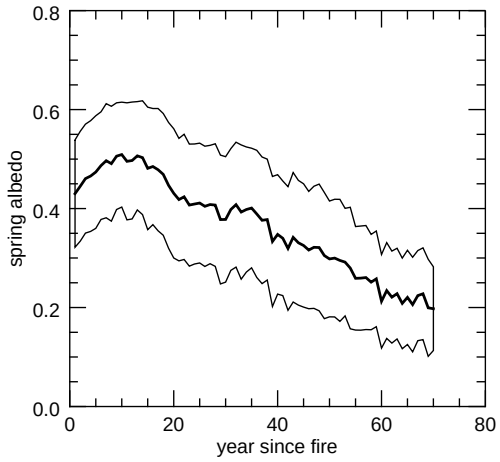
post-fire albedo trajectories



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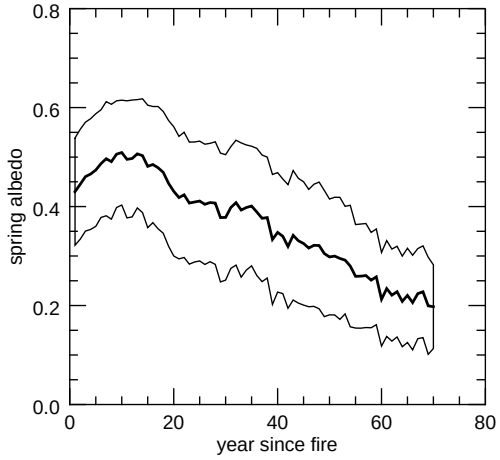

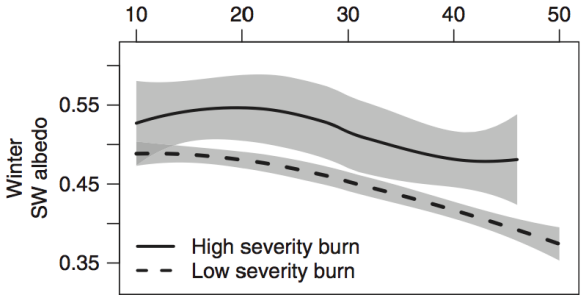

Beck et al. (2011)

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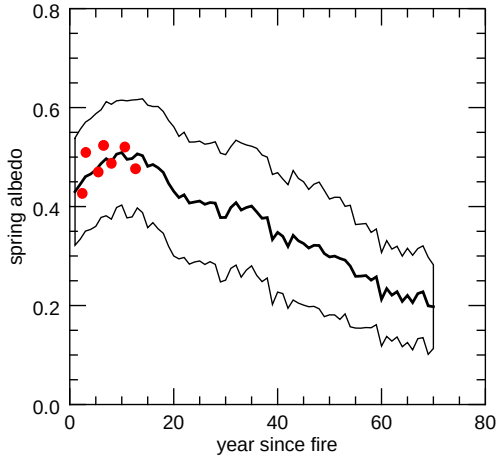

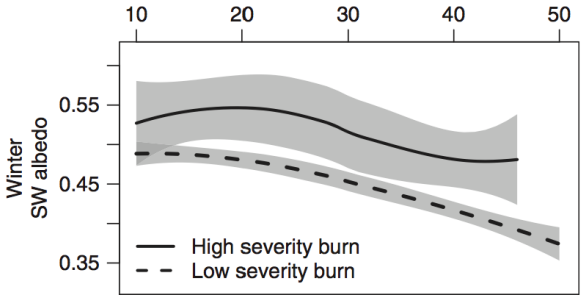

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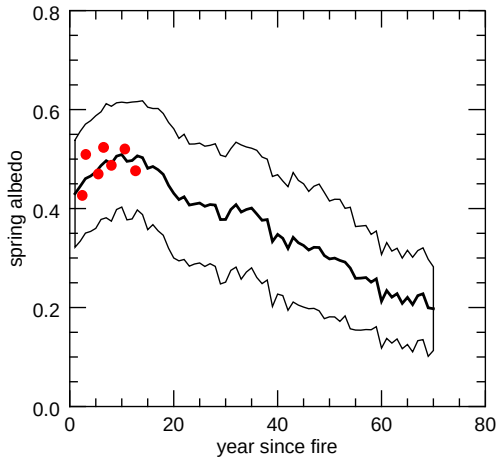
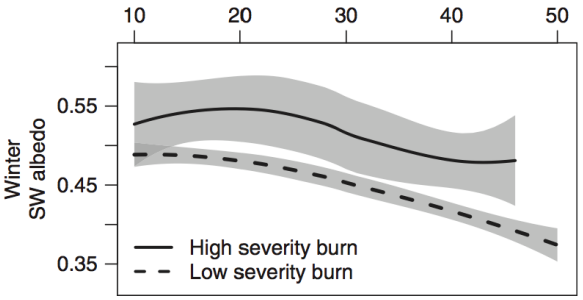
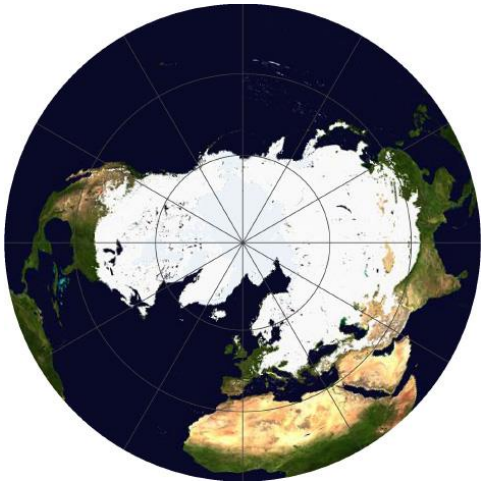




Beck et al. (2011)

current & projected snow cover



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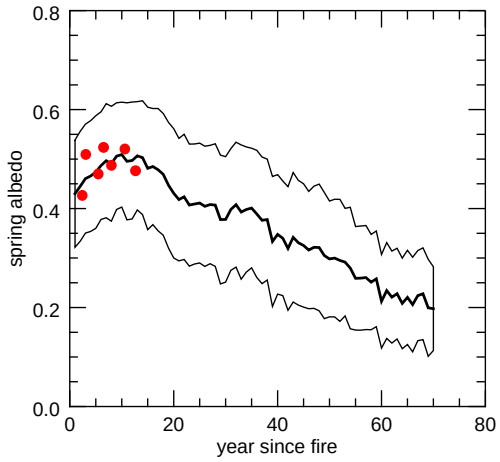

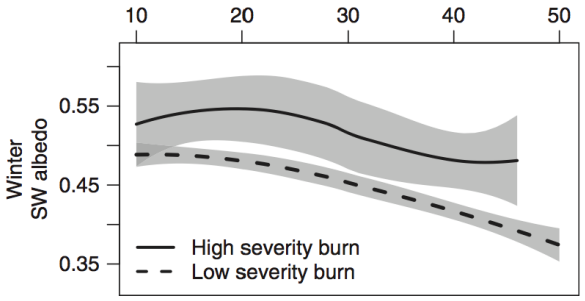

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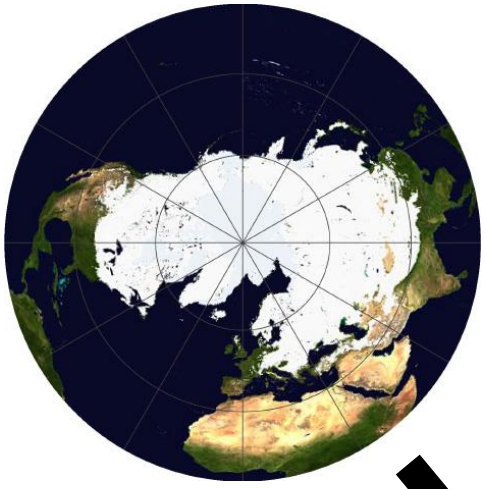
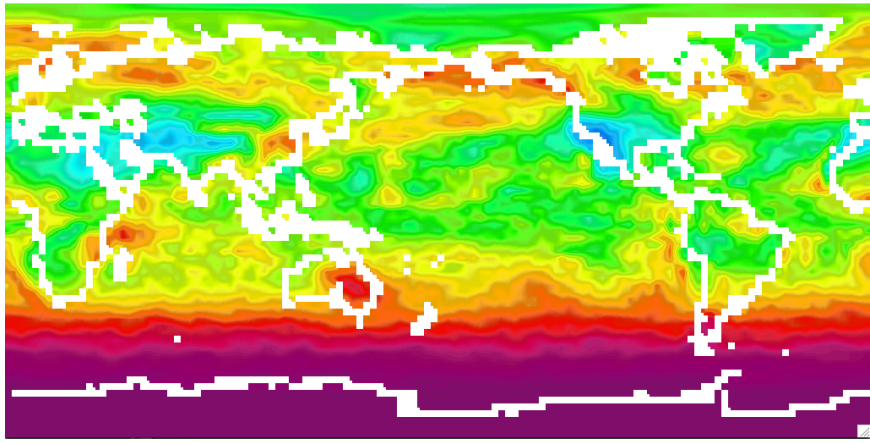


radiative kernels



Shell et al. (2008)

ARCTIC BOREAL VULNERABILITY EXPERIMENT

Project description: RF from aerosols

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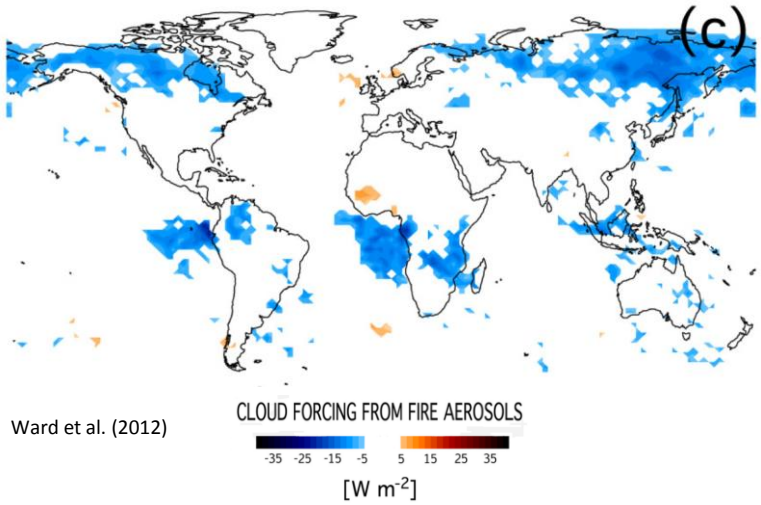
ABoVE-FED + emission factors -> ESM



Ward et al. (2012)

- direct
- indirect
- semi-direct
- BC deposition

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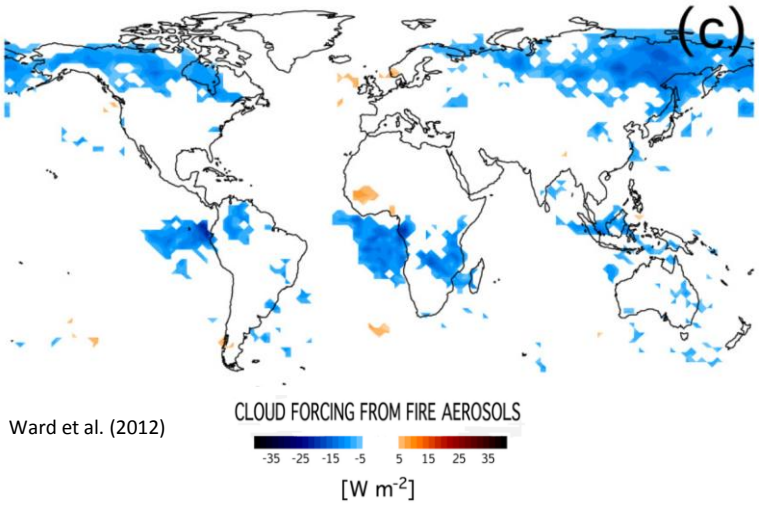

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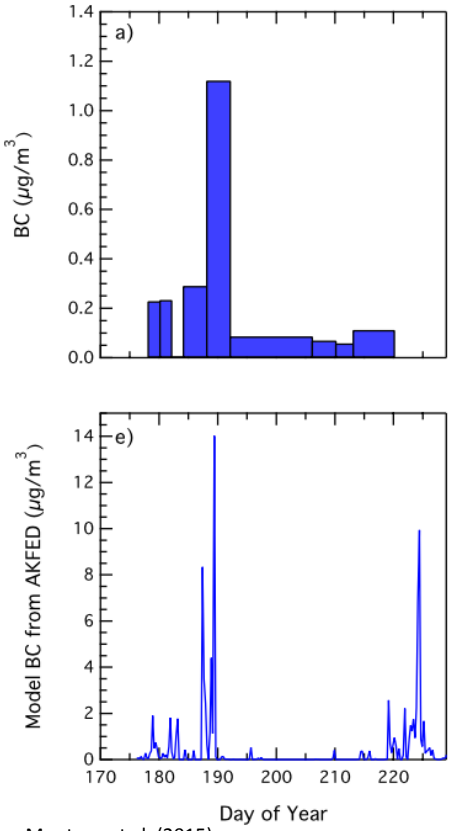
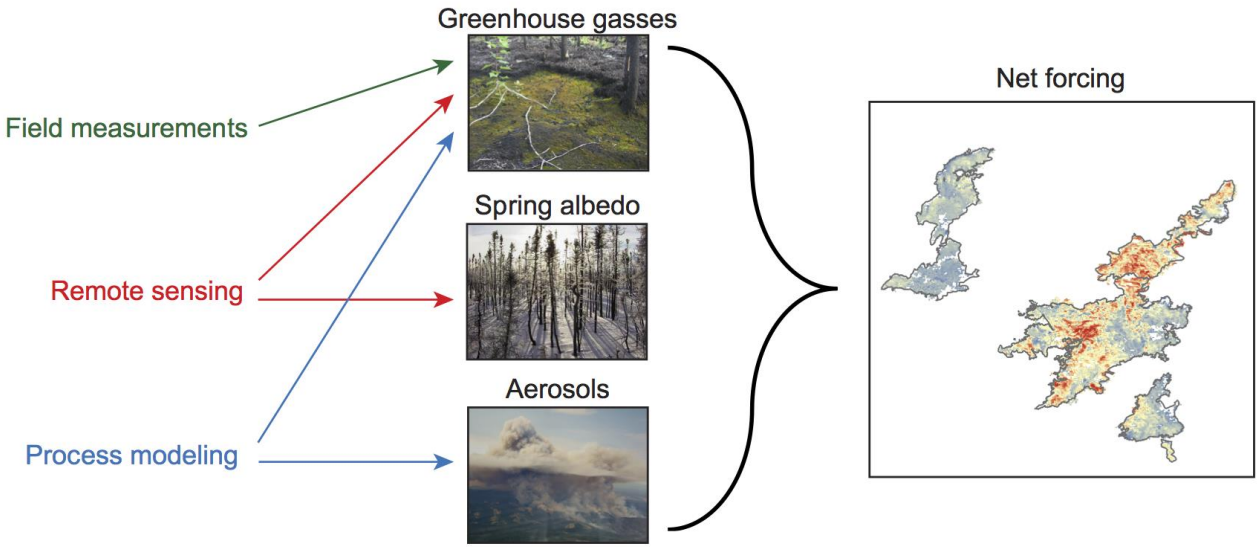
finer-scale WRF-STILT model



Mouteva et al. (2015)

Project description



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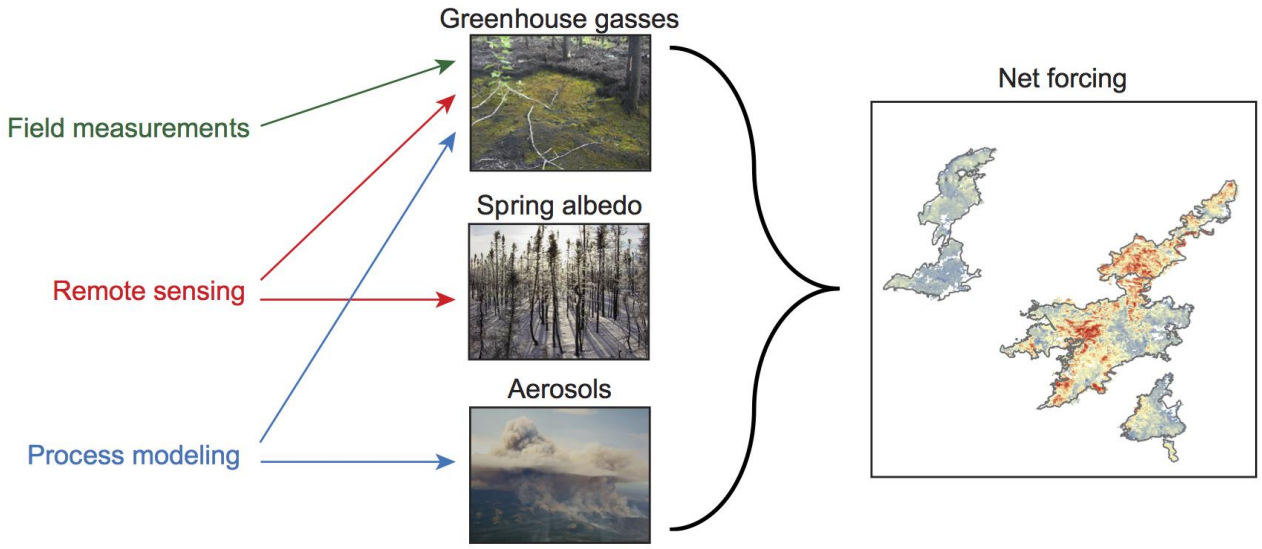

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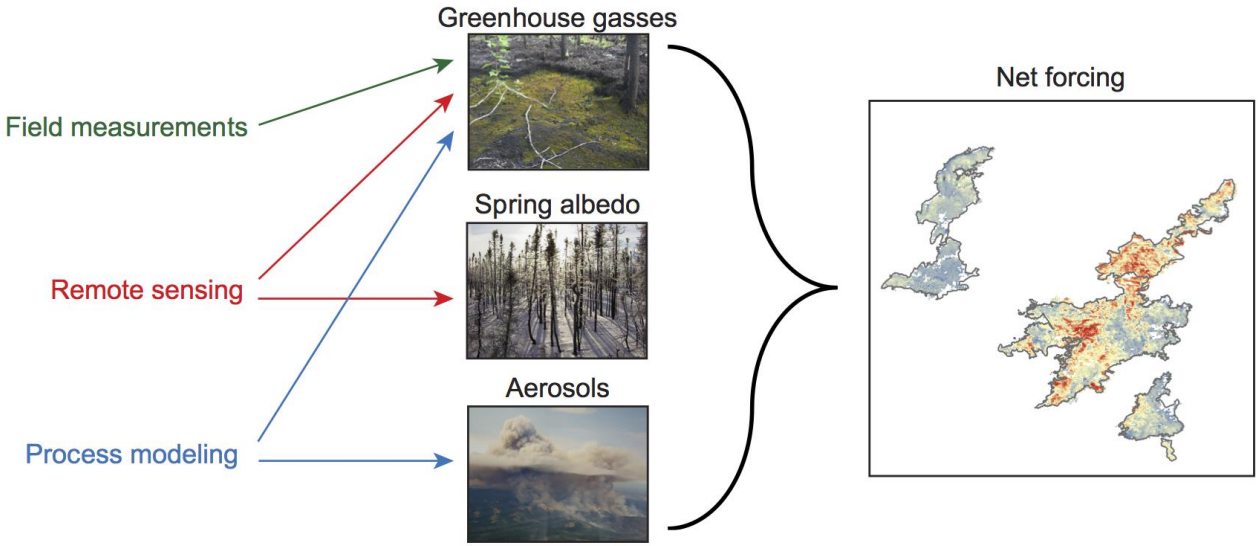

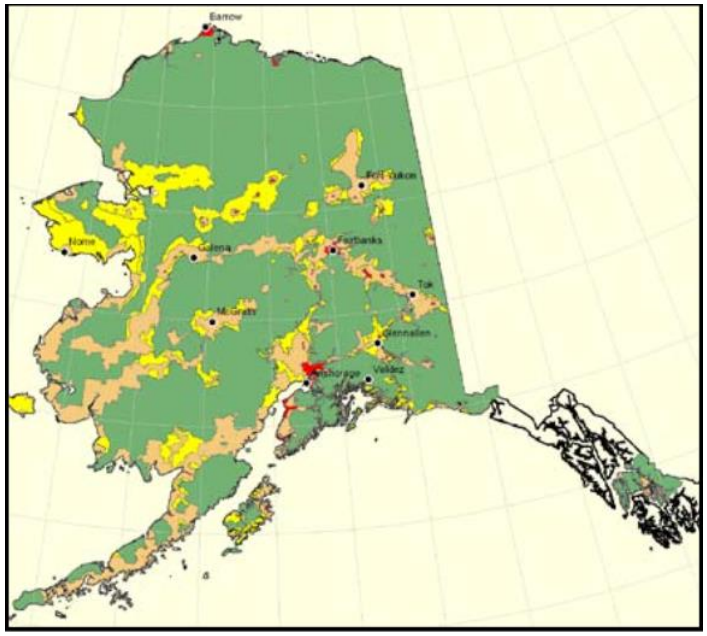

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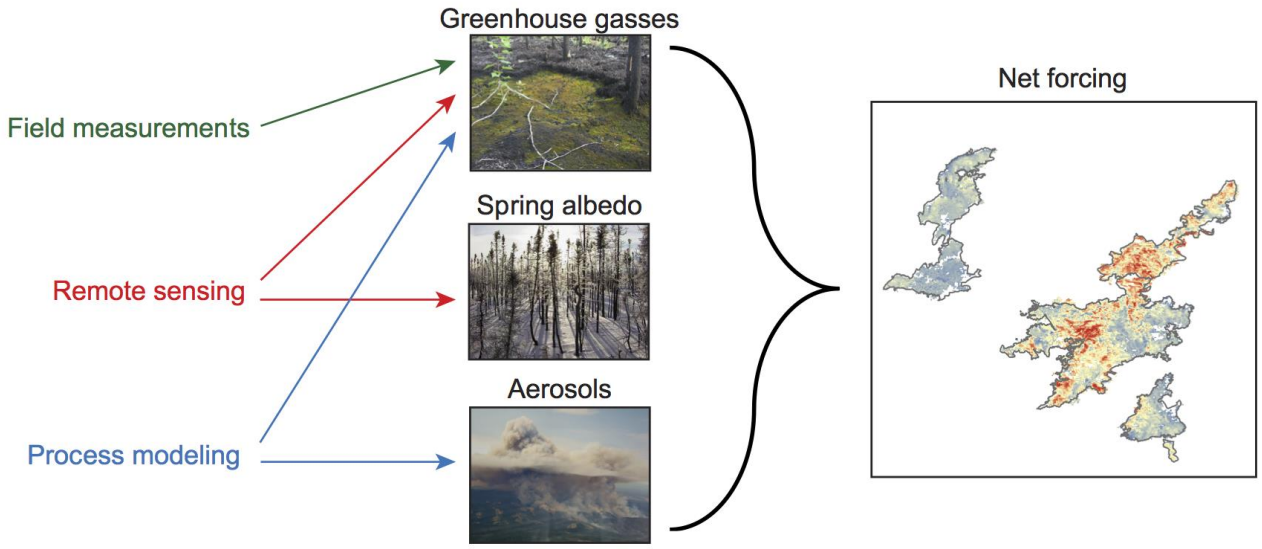


Webinar: Mapping carbon emissions and other fire-climate forcings across Alaska and western Canada: an introduction and call for scientist and manager feedback

Brendan Rogers, Woods Hole Research Center

Tues, Oct 20
1300-1400 AKDT
Register here: https://attendee.gotowebinar.com/register/5908475690306214914

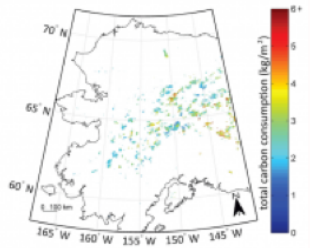
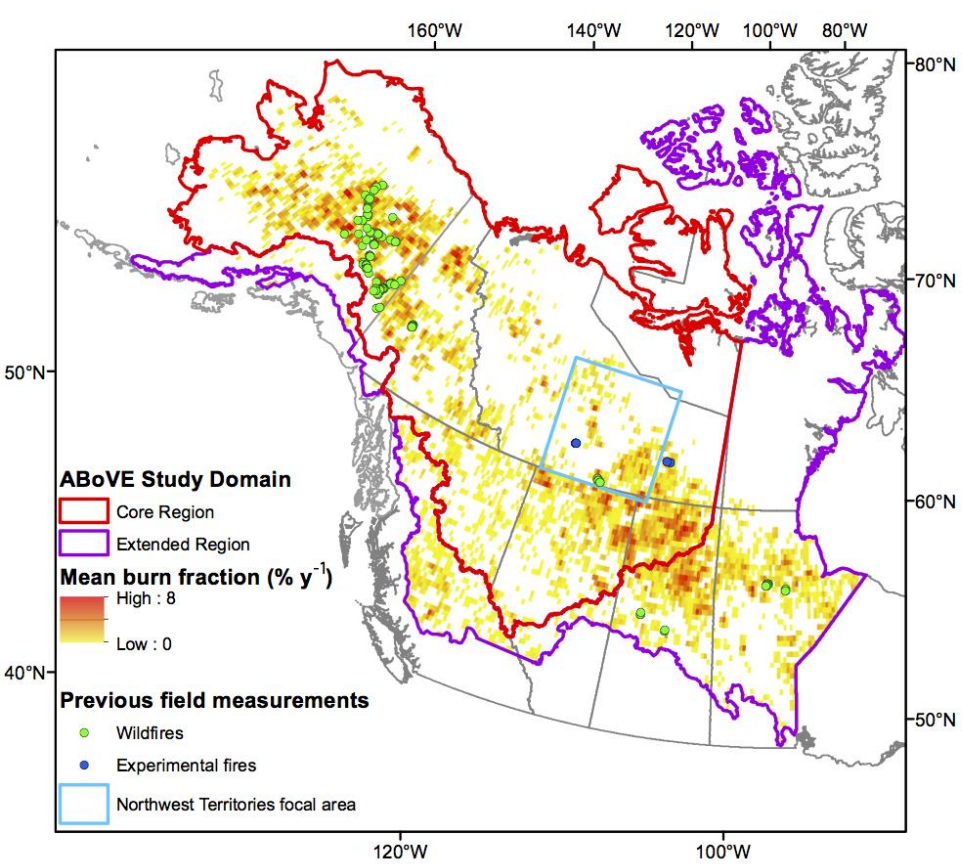
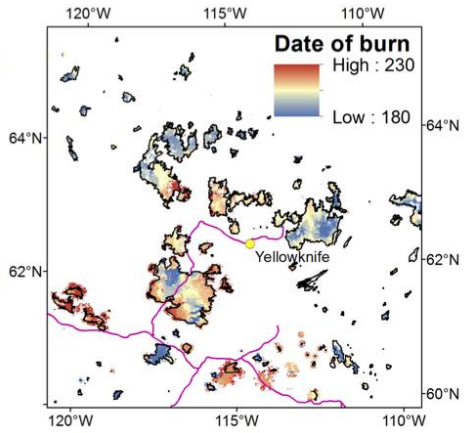
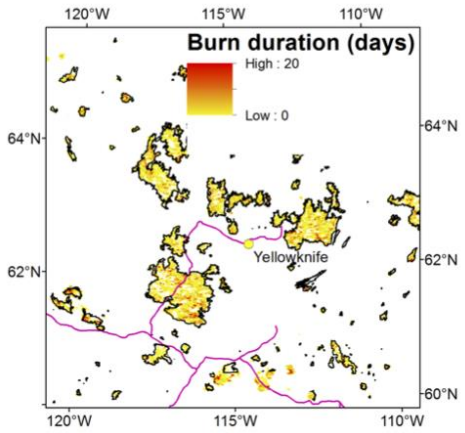


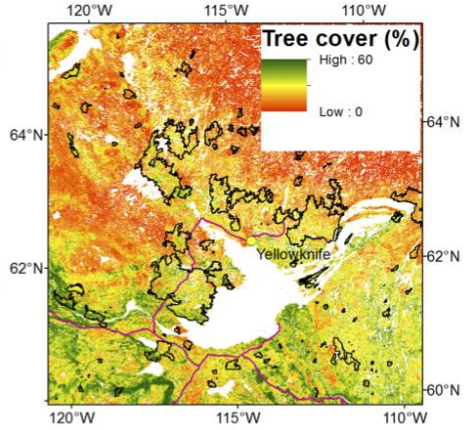
Figure 5. Total pyrogenic carbon consumption estimated from the Alaskan Fire Emissions Database between 2001 and 2012.

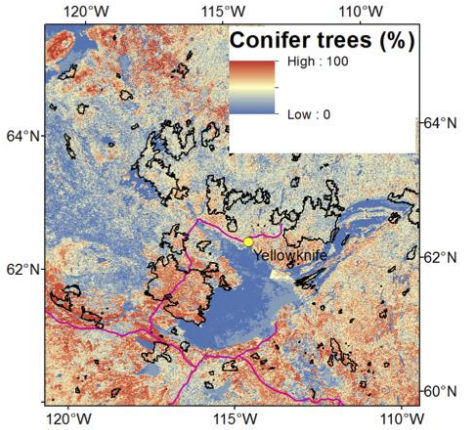
Field campaign











Tier 2 Science Questions and Objectives

Tier 2 Science Questions					
Section 3.1: How are environmental changes affecting critical ecosystem services - natural and cultural resources, human health, infrastructure, and climate regulation - and how are human societies responding?	Section 3.2: What processes are contributing to changes in disturbance regimes and what are the impacts of these changes?	Section 3.3: What processes are controlling changes in the distribution and properties of permafrost and what are the impacts of these changes?	Section 3.4: What are the causes and consequences of changes in the hydrologic system, specifically the amount, temporal distribution, and discharge of surface and subsurface water?	Section 3.5: How are flora and fauna responding to changes in biotic and abiotic conditions, and what are the impacts on ecosystem structure and function?	Section 3.6: How are the magnitudes, fates, and land-atmosphere exchanges of carbon pools responding to environmental change, and what are the biogeochemical mechanisms driving these changes?

Tier 2 Science Objectives: Ecosystem Dynamics			
1. Determine how interactions among vegetation, soil characteristics, hydrology, and disturbances influence surface energy exchange and mediate permafrost vulnerability and resilience to climate change.	2. Determine how and where interactions among microbes, plants, and animals exert control over ecosystem responses to climate change and disturbances.	3. Understand how vegetation attributes and hydrologic conditions interact, and respond and feedback to disturbance.	4. Quantify how changes in the spatial and temporal distribution of snow impacts ecosystem structure and function.
5. Determine the causes of greening and browning trends and their impacts on ecosystem form and function.	6. Elucidate how climate change and disturbances interact with above- and belowground communities and processes to alter carbon biogeochemistry, including release to surface waters and the atmosphere.	7. Determine how the spatial and temporal dynamics in both faunal abundance and characteristics of fish and wildlife habitat co-vary across gradients of climate and disturbance.	

Tier 2 Science Objectives: Ecosystem Services					
1. Assess how future climate warming is likely to affect infrastructure and transportation networks.	2. Determine how changes to disturbance regimes, flora and fauna, permafrost conditions, and/or hydrology influence human health outcomes in the ABR.	3. Evaluate how changes to ecosystems will influence subsistence opportunities.	4. Analyze how changes to natural and cultural resources will impact local communities as well as influence land management policies and practices.	5. Determine the sources of variations in climate feedbacks from Arctic and boreal ecosystems and assess the potential for future changes to climate regulating services at regional to global scales.	6. Determine the degree to which changing environment and altered human activities result in synergistic or antagonistic changes in ecosystem services.

Institutional Collaborations

Institution	Collaborator(s)	Services
(1) USDA Forest Service	Hans Andersen	Lidar data from 2009 & 2014 over Funny River fire
(2) US National Park Service	Jennifer Barnes	Fire severity data, personnel time and travel to stakeholder meetings
(3) US Fish & Wildlife Service	Lisa Saperstein	" "
(4) Env. & Nat. Res., NT	Kris Johnson	Personnel time for webinars, meetings, travel support
(5) Yukon Wildland Fire Management	Michael Smith	" "
(6) Northwest Boreal LCC	Amanda Robertson	Planning and facilitating stakeholder workshops & webinars
(7) UC Irvine	Jim Randerson	Consultation, discount rates for ^{14}C analysis, field equipment
(8) U Alberta	Mike Flannigan	Consultation, CanFIRE data and algorithms
(9) GFDL, NOAA	John Dunne, Dan Ward	Aerosol emission scaling factors, coupled aerosol model output, RF diagnostic scripts

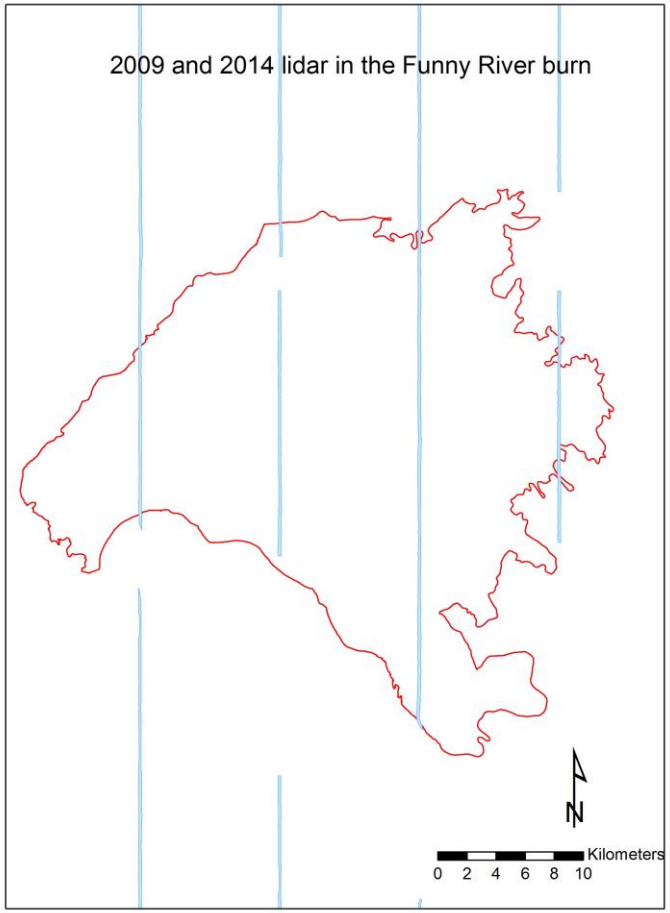
Spaceborne remote sensing

Product	Resolution	Time coverage
ALFD & CNFDB fire perimeters	polygons	1940 - current
Landsat summer surface reflectance	30 m	2001 - present
MODIS snow cover	500 m	2000 - present
MODIS active fires	1 km	2000 - present
MODIS surface reflectance, albedo, BRDF	500 m	2000 - present
MODIS land cover	500 m	2001 - 2012
Tree cover, MODIS and Landsat	500 m, 30 m	2000, 2005
NASA/GEWEX Surface Radiation Budget	~ 1°	2000 - present
NASA Nimbus-7 SMMR and DMSP SSM/I-SSMIS sea ice extent	25 km	2000 - present

Other geospatial data sets

Product	Resolution	Time coverage
DEM	30 m & 500 m	
FCCS fuel maps, AK	30 m	
Species distributions, Canada (Beaudoin et al. 2014)	250 m	
Long-term climate normals (Hijmans et al. 2005)	30 arc-second	
Harmonized World Soil Database v1.2	30 arc-seconds	
NARR	32 km	1979 - present

Airborne remote sensing



Geospatial data products

Product	Resolution	Time coverage
Burned area	500 m	2001 - 2015
Combustion (kgC m^{-2})	500 m (30 m, 250 m)	2001 - 2015
GHG RF	500 m	2001 - 2015
Increase in spring albedo	500 m	2001 - 2011
Spring albedo RF	500 m	2001 - 2011
Aerosol RF	500 m	2001 - 2015
Net RF	500 m	2001 - 2011
RF projections pre-season, during season, & during event	500 m	current