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Vulnerability and Resiliency of Boreal-Taiga Ecosystems to Wildfire in a Changing Climate

Bourgeau-Chavez-02/03

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Institutional Collaborations

Problem and Research Goals

- Wildfire and permafrost degradation are the most prevalent disturbance factors in boreal North America and evidence indicates that climate change is exacerbating both variables with wildfire occurring more often, across larger areas in more extreme conditions.

- In 2014 Northwest Territories of Canada wildfire consumed 3.4 million hectares

  - record breaking year of fire, extreme drought

  - Uplands, peatlands, even emergent
    wetlands burned in all seasons

  - Wildfire across taiga shield and boreal and
  taiga plains in permafrost and non-permafrost

GOAL: improve our understanding
of the controls and impacts of climate
change on boreal-taiga ecosystems

  - *2014 fires serve as a microcosm of these effects within the ABoVE study domain*

2014 Photo from Environment and Nat. Resurces - GNWT

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Study Questions Addressed

2015 Wildfires near Hearne Lake, NWT

QUESTION 1: What are the controls on spatial and temporal variations in fire severity?

QUESTION 2: Do fire effects vary across different ecological zones and permafrost conditions?

QUESTION 3: Are there pre-season indicators of extreme fire years?

ABoVE Science Questions & Objectives

Tier 2 Science Questions addressed:

- (3.2) *What processes are contributing to changes in disturbance regimes and what are the impacts of these changes*?

- (3.5) *How are flora responding to changes in biotic and abiotic conditions and what are the impacts on ecosystem structure?*

- (3.3) *What processes are controlling changes in the distribution and properties of permafrost and what are the impacts of these changes*?

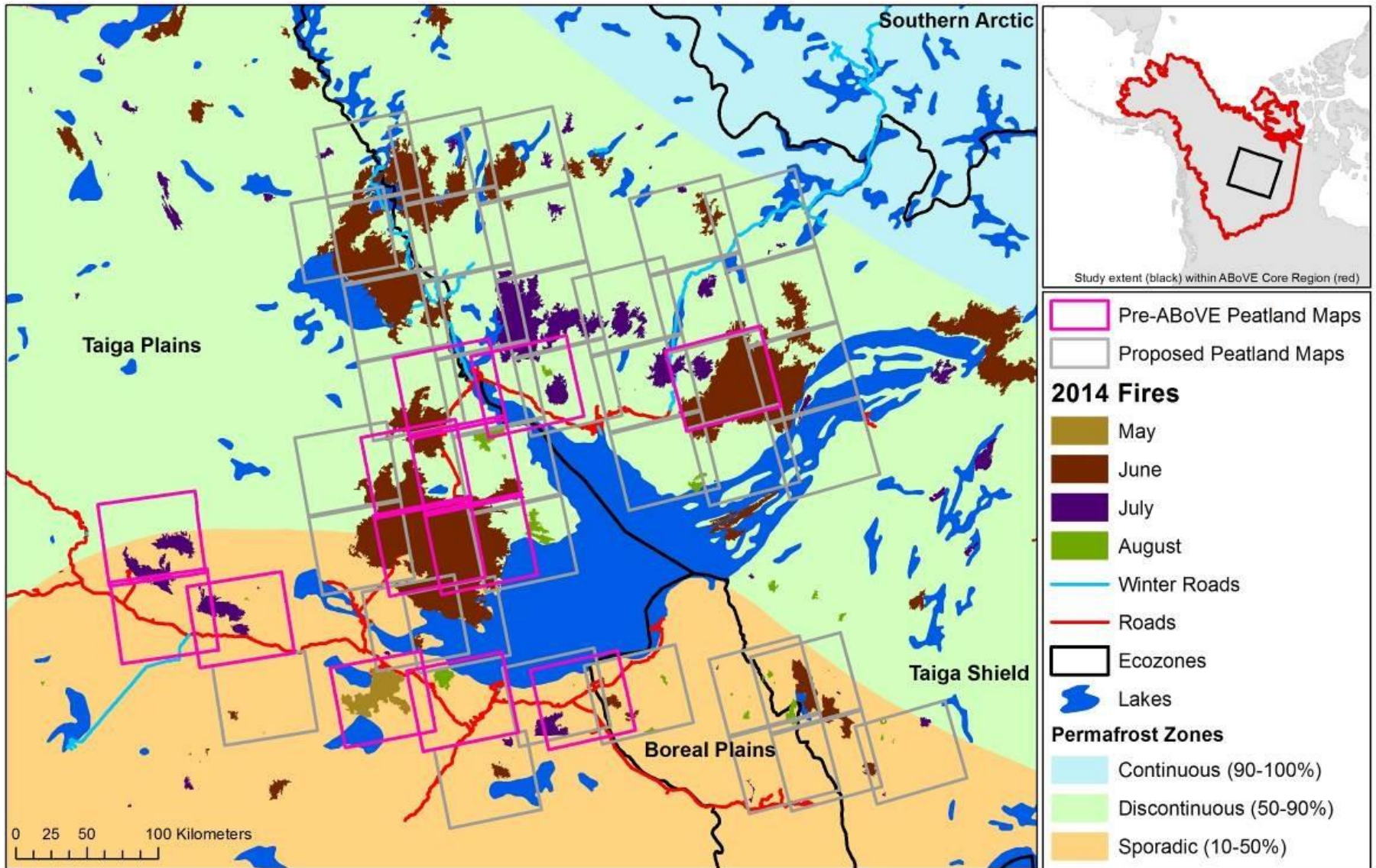Tier 2 Science Objectives:

- Ecosystem Dynamics
  - (1) Interactions with disturbances and permafrost
  - (3) Vegetation, hydrology, disturbance interactions
- Ecosystem Service
  - (5) Climate Regulation

NASA Funded Rapid Response NWT 2014 Wildfire Effects Study (Pre-ABoVE)

- Measure the effects of wildfire on the landscape with particular focus on peatlands

  - Field data and remote sensing of burn severity

  - Field data and mapping of pre-burn peatland types

  - Field data and satellite radar imagery to study post-fire soil moisture patterns

  - Field data on revegetation (sprouting and seeding)

Fens

Bogs

Burned Fen on Taiga Shield

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Southern Arctic

Taiga Plains

Study extent (black) within ABoVE Core Region (red)

Pre-ABoVE Peatland Maps

Proposed Peatland Maps

2014 Fires
May
June
July
August
Winter Roads
Roads
Ecozones
Lakes

Permafrost Zones
Continuous (90-100%)
Discontinuous (50-90%)
Sporadic (10-50%)

Taiga Shield

Boreal Plains

0 25 50 100 Kilometers

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Field Studies

- Preselected burned and validation points distributed in peatlands across the study area to collect:
  - Burn severity   -Re-vegetation   -fuel loading
  - Soil moisture   -Permafrost depth   -ecosystem types

- Field efforts are coordinated with collaborators (Wilfred Laurier, University of Alberta, GNWT, others)
  - Summer 2015 shared field methods and collected data for other teams
  - Matt Coyle Geomatics Analyst from GNWT spent a week in the field with us learning how we collect post-burn data

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Summer 2015 Field Data (Pre-ABoVE)
Sampled 100 x 100 m sites

- Selection Criteria
  - Ecozone
  - Peatland type
  - Burn date
  - Access
- 41 unburned sites (*Green*)
- 30 burned sites (*Magenta*)
  - 23 Taiga Plain and 7 Taiga Shield burn severity and regeneration site
 - 10 Taiga Plain and 7 Taiga Shield soil moisture sites
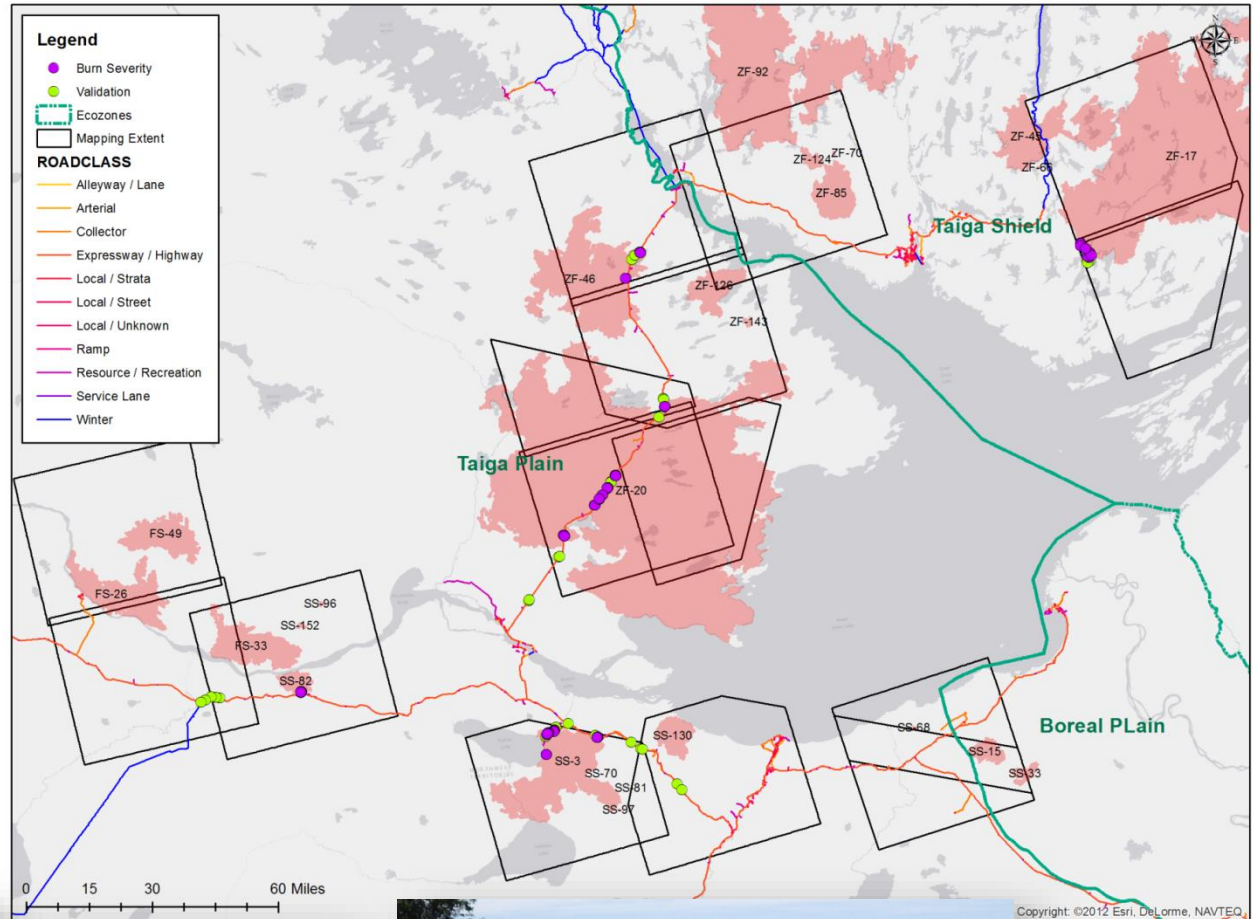
2016-2018 Field Schedule

- 3 year Field campaign
  - 56 person days from MTRI/Year
  - 56 person days from MTU/Year

- Early Summer Collection
  - Vegetation and Recruitment
  - Burn Severity
  - Soil Moisture

- Collaborator Collections
  - April Snow depth
  - Late-Season depth to permafrost

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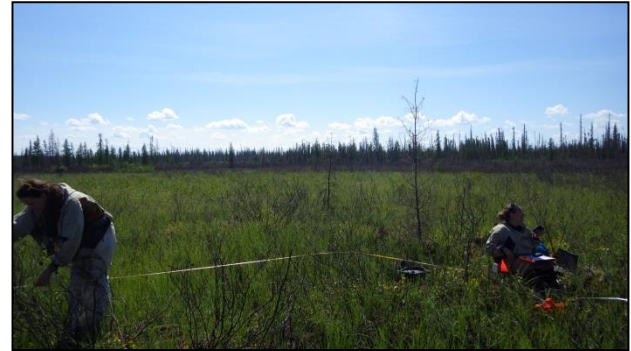
Spaceborne Remote Sensing

- PALSAR (L-Band) and Radarsat-2 (C-band)
  - Peatland Mapping
  - Soil Moisture
- ERS (C-Band) & Sentinel
  - Peatland Mapping
  - Soil Moisture

- SMOS and SMAP (L-band)
  - Soil Moisture
- Landsat
  - Peatland Mapping
  - Burn Severity Mapping
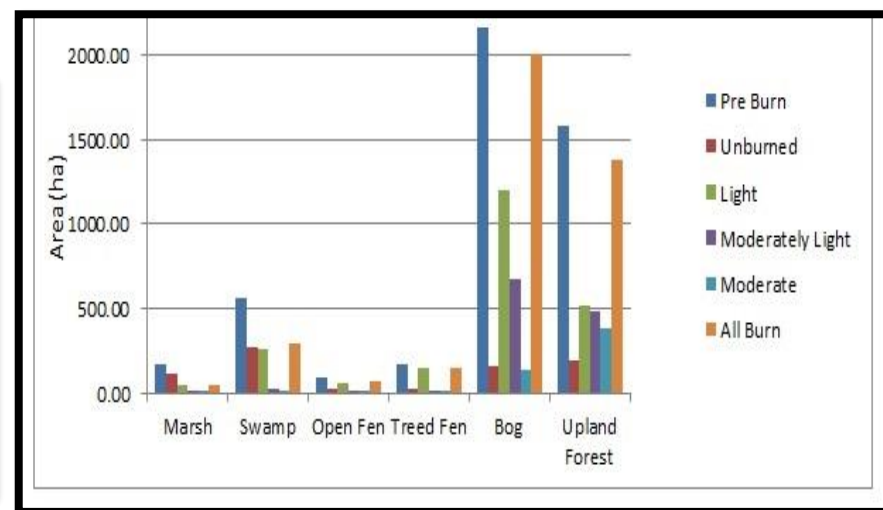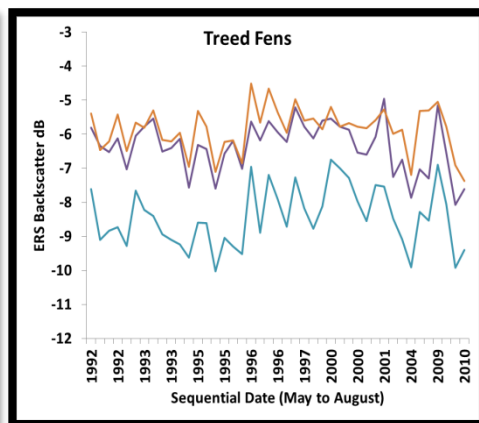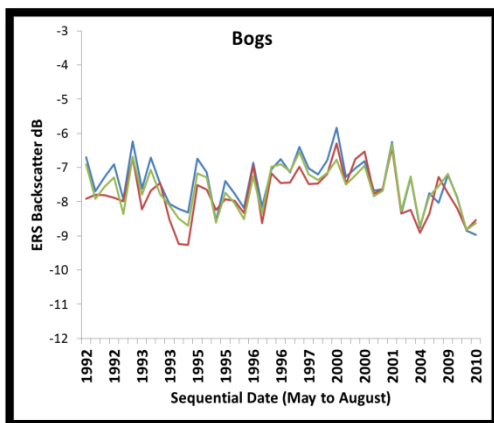
High Resolution Remote Sensing

- NGA DigitalGlobe Imagery (pre- and post-burn)
  - for site selection and Landcover delineation (training data)

- No aerial imagery in current plan *but* UAVSAR, AVIRIS or AIRMOSS would be of interest

Expected Products

- Pre-fire maps of Peatland types for Fires of NWT
  - Preliminary maps completed
- Burn Severity maps of Peatlands from Landsat
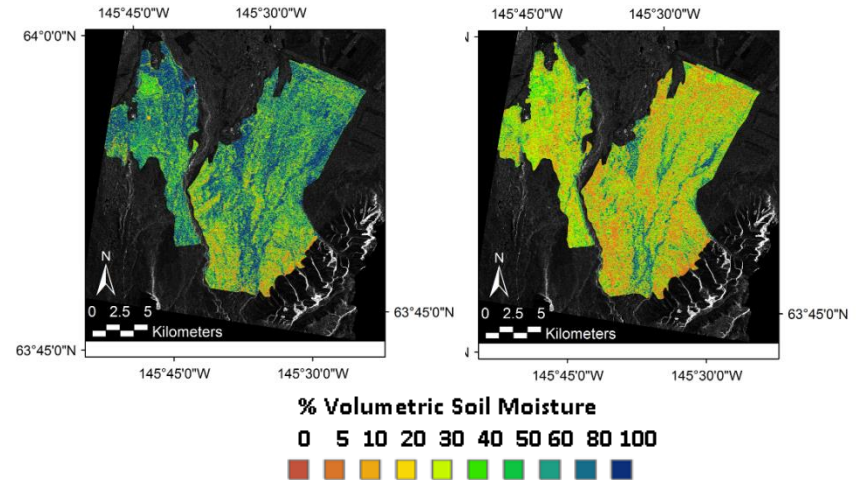- Algorithms for Soil moisture mapping
  - SAR
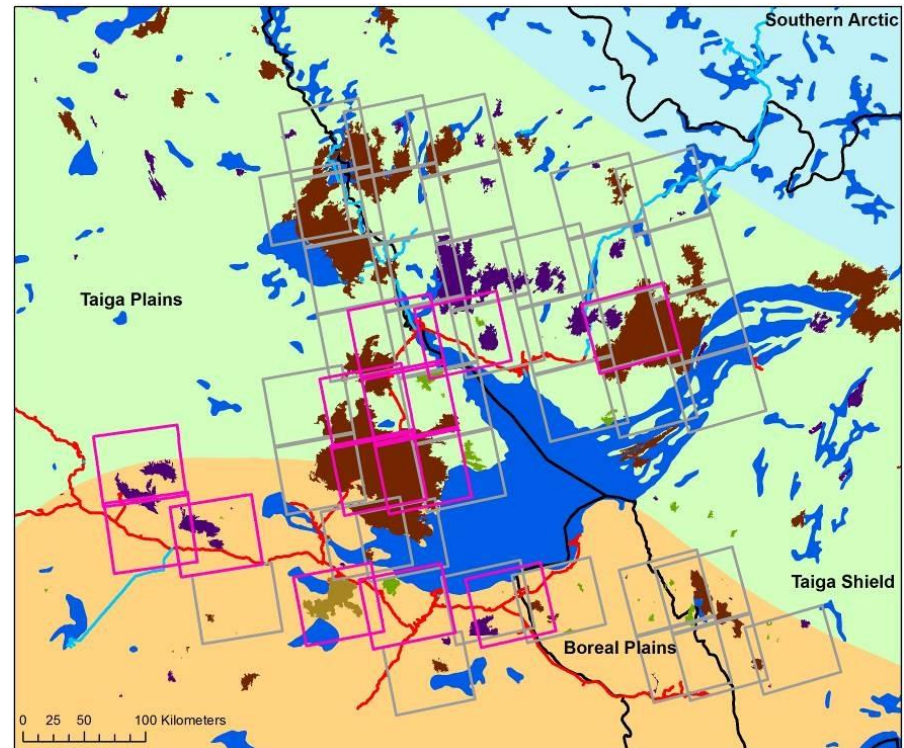
- Database of field data on
  - Fuel loading
  - post-fire regeneration
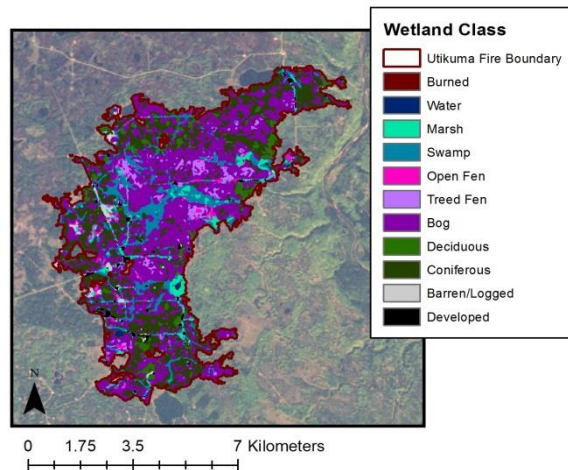 - permafrost depths
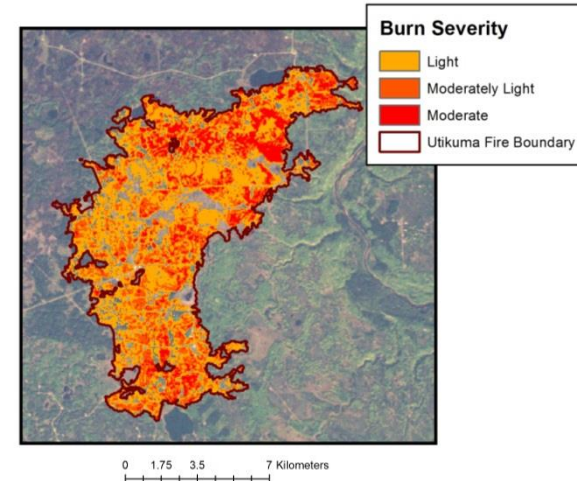
Geospatial Data Products
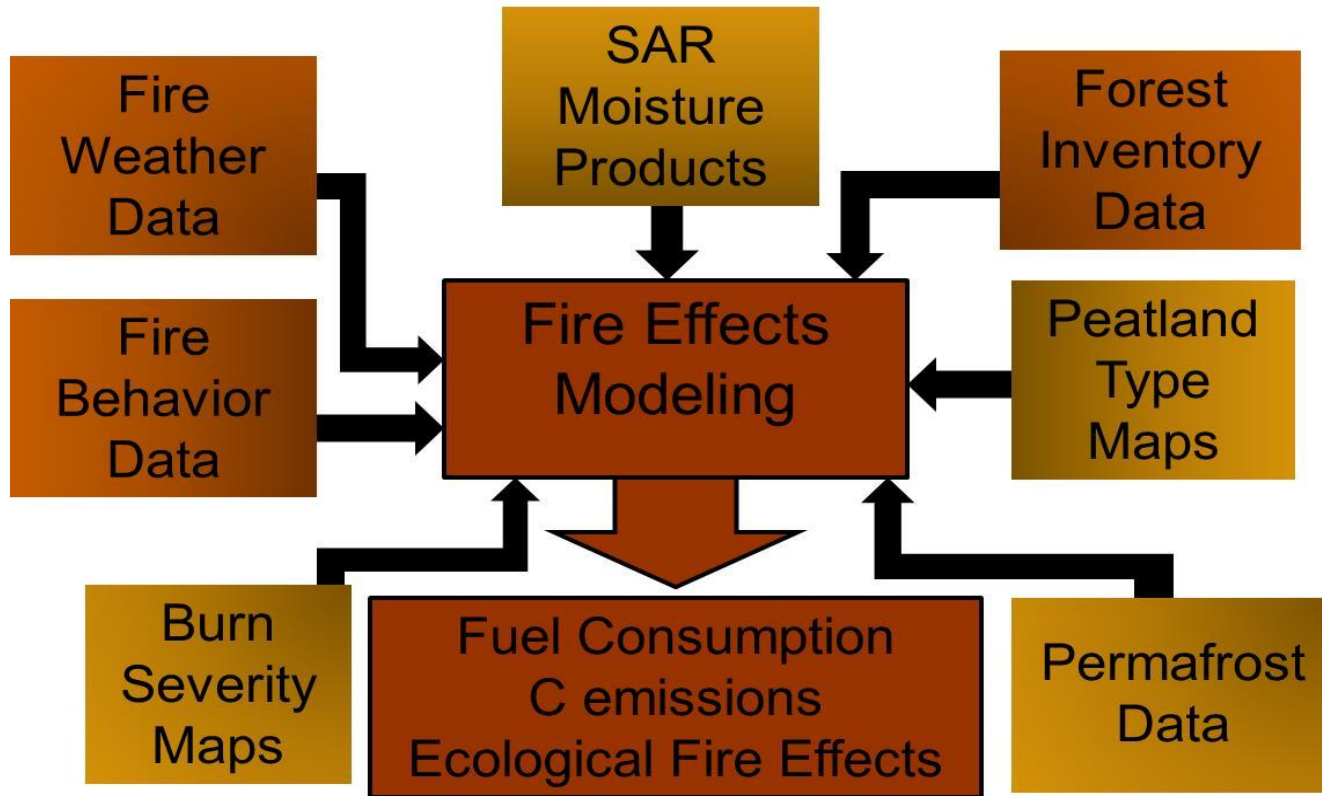
Modis Fire Progression Maps
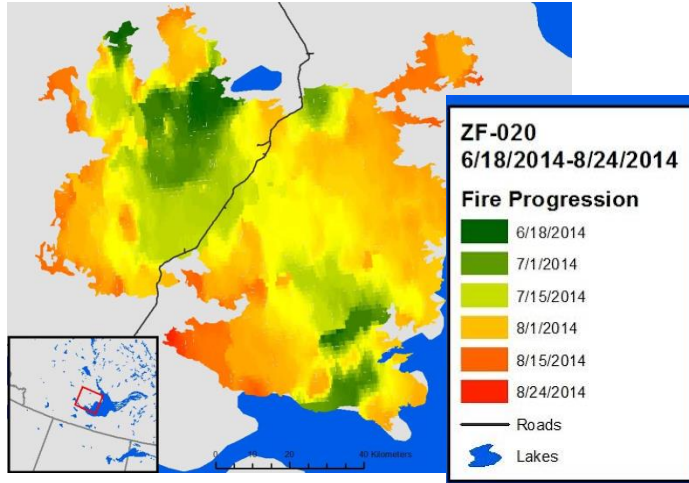
Radarsat-2 Soil Moisture

SAR-Optical Fusion Peatland Type Maps

Landsat Burn Severity

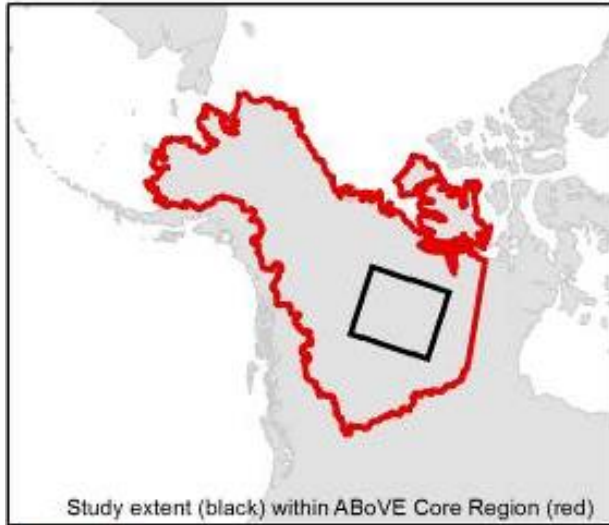ARCTIC BOREAL VULNERABILITY EXPERIMENT

Modeling Approaches - CanFIRE

- Geotiff image data, JPEG, and Shp files shared via ABoVE Data Cloud
- ISO 19115-2 for metadata content

Geographic Focus and Mapping

Study extent (black) within ABoVE Core Region (red)

- Geographic data stored as Geotiff, Shp files
  - Albers Equal Area
- Pre-fire trends in soil moisture status from radar (2009-2017)
- Fire and vegetation regeneration studies (2014-2018)
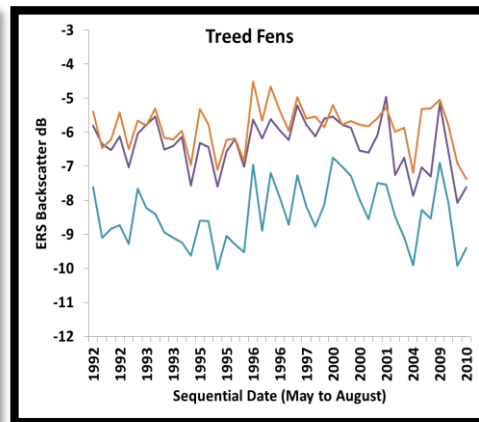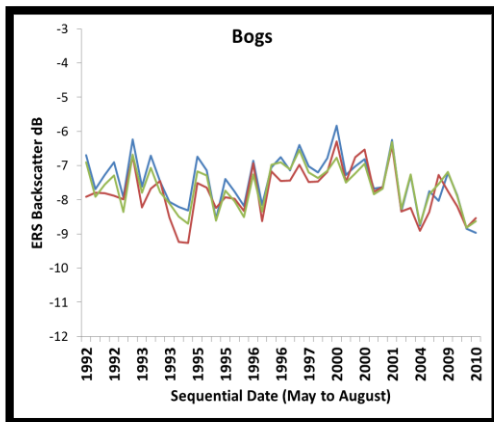
Stakeholder Involvement

- Collaborating with GNWT Center for Geomatics

  - Data share

  - Applying algorithm of CCRS to detect change from past Landsat data using the ABoVE Cloud

  - Links to current monitoring

- Discussions with local First Nations and Chiefs

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