Quinton-01: Consortium for Permafrost Ecosystems in Transitions

Oliver Sonnentag, PhD

Département de géographie
Université de Montréal

3rd ABoVE Science Team Meeting *19 & 20 January, 2017*

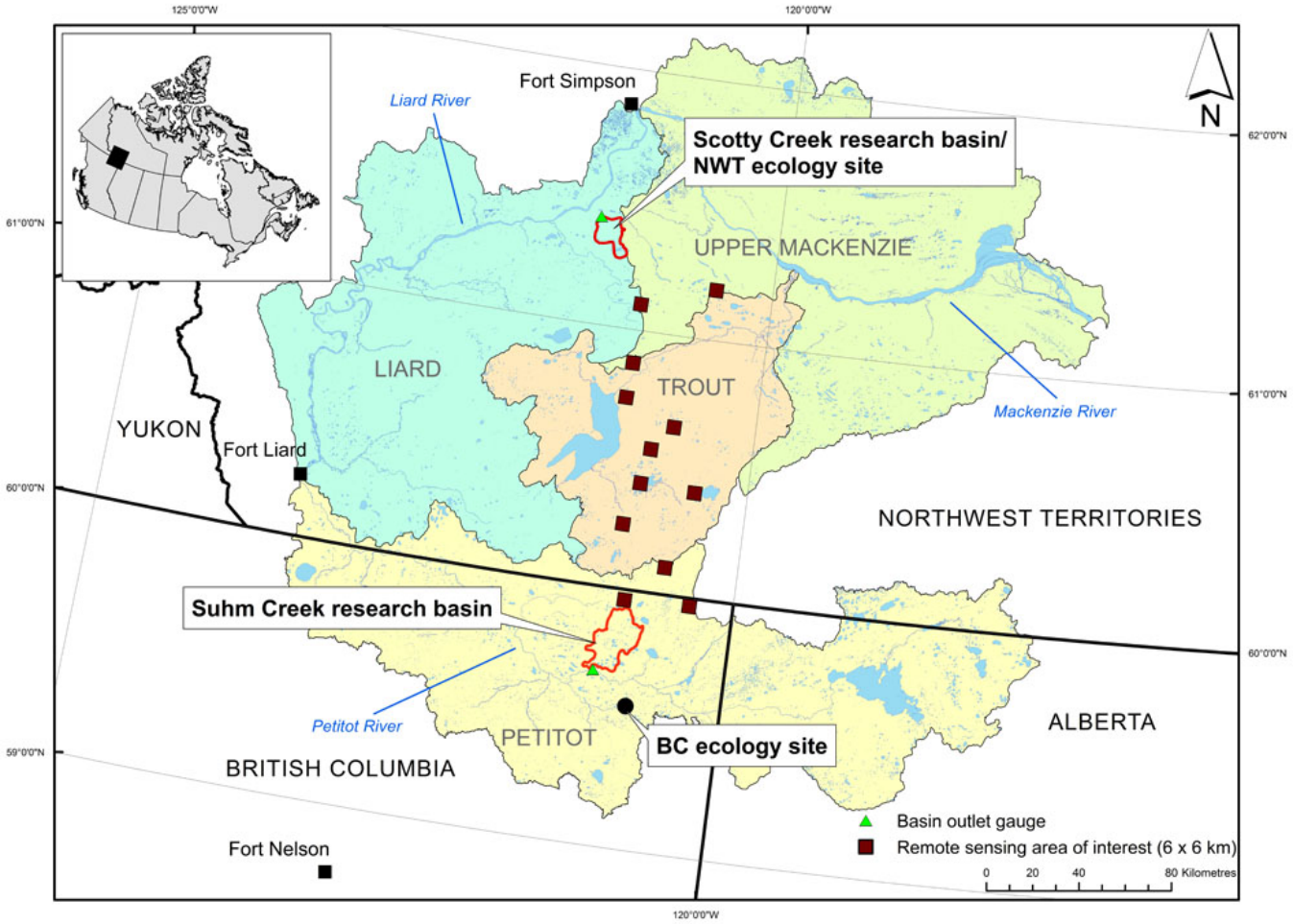
CPET: background

- Southern Taiga Plains: one of the most rapidly warming regions on Earth, experiencing unprecedented human disturbance.
- Both factors have led to widespread permafrost thaw that has altered the hydrological cycle and transformed ecosystems.
- *CPET* science activities:
  - investigates hydrological and ecological changes resulting from permafrost thaw,
  - develops and mobilises knowledge of these changes,
  - develops predictive modelling tools, and
  - provides interactive training on these tools to our partners in industry, government and communities, including First Nations.

CPET: structure

- **Investigators**: J. Baltzer, A. Berg, J. Craig, W. Quinton
- **Collaborators**: S. Tank, K. Devito (both U. Alberta), R. Shincariol (Western U.), O. Sonnentag (U. Montréal), M. Hayashi (U. Calgary)
- **PDFs**: J. Mai, E. Abdeian, C. Pappas, J. Adams
- **Graduate Students**: 6 PhD, 8 M.Sc.
- **Governments**: NWT & BC
- **Agencies**: NSERC, GeoScience BC, BC Hydro, Water Survey of Canada, TransAlta
- **First Nations**: Dehcho FN, Liidlii Kue, Fort Nelson, Jean-Marie River, Sambaa K'e
- **Industry**: Nexen Energy
- **NGO**: Ducks Unlimited

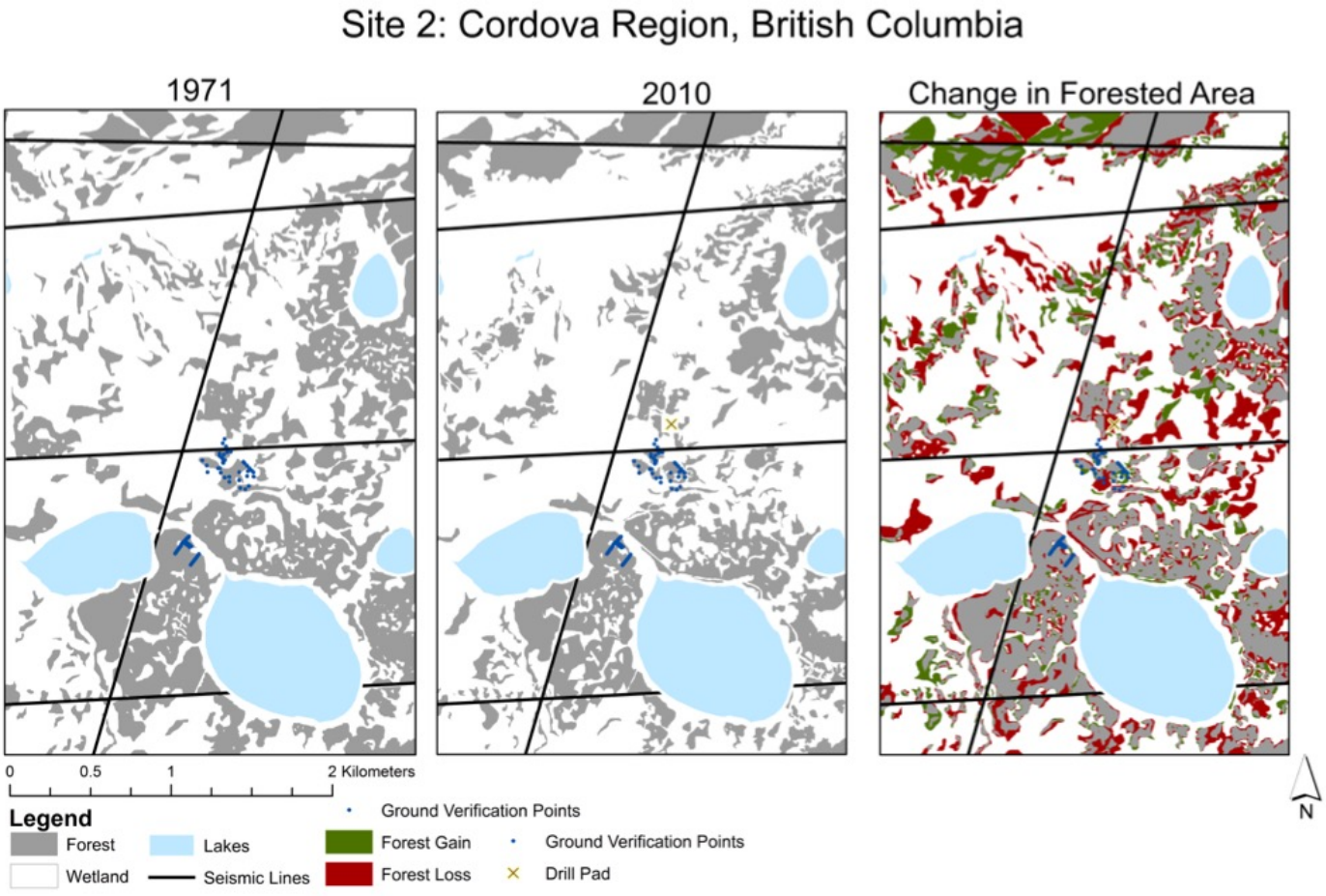
CPET: the southern limit of permafrost



Map indicating locations of 12 Areas of Interest (AOI) in the southern NWT and northeastern BC boreal peatland region: Baltzer, Berg, Quinton, Sonnentag

CPET: Land cover change results

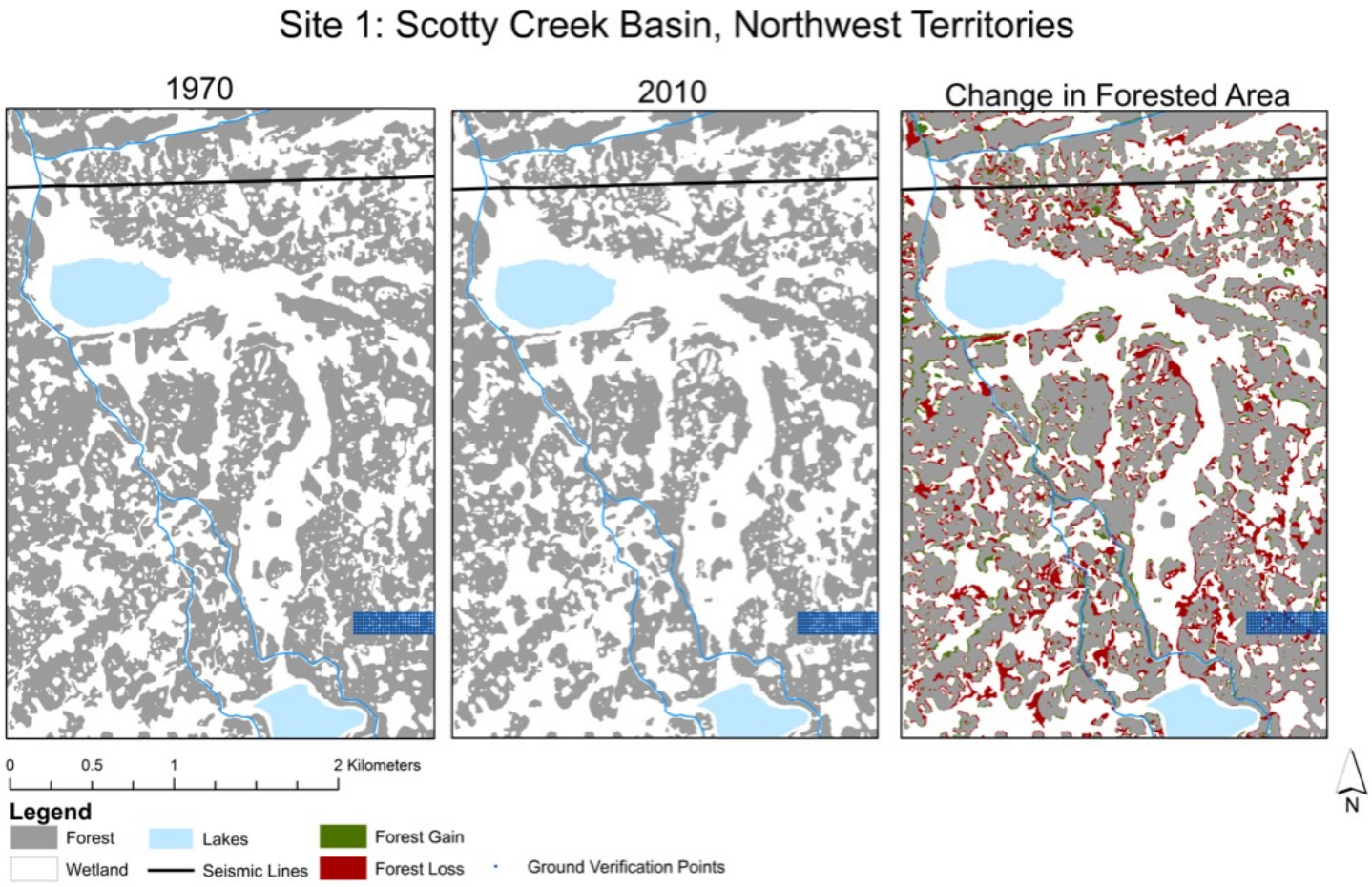
A significant (p<0.05) net decrease in forested area of 6.9% (152,939m^2) occurred between 1971 and 2010.



Land cover change over a 10 km^2 subset of AOI 11, BC (59°46'N, 120°42'W)

CPET: Land cover change results

A significant (p<0.05) net decrease in forested area of 11.6% (547,846m^2) occurred between 1970 and 2010.



Land cover change over a 10 km^2 subset of Scotty Creek Basin, NWT (61°18'N, 121°18'W)

CPET: northern end member

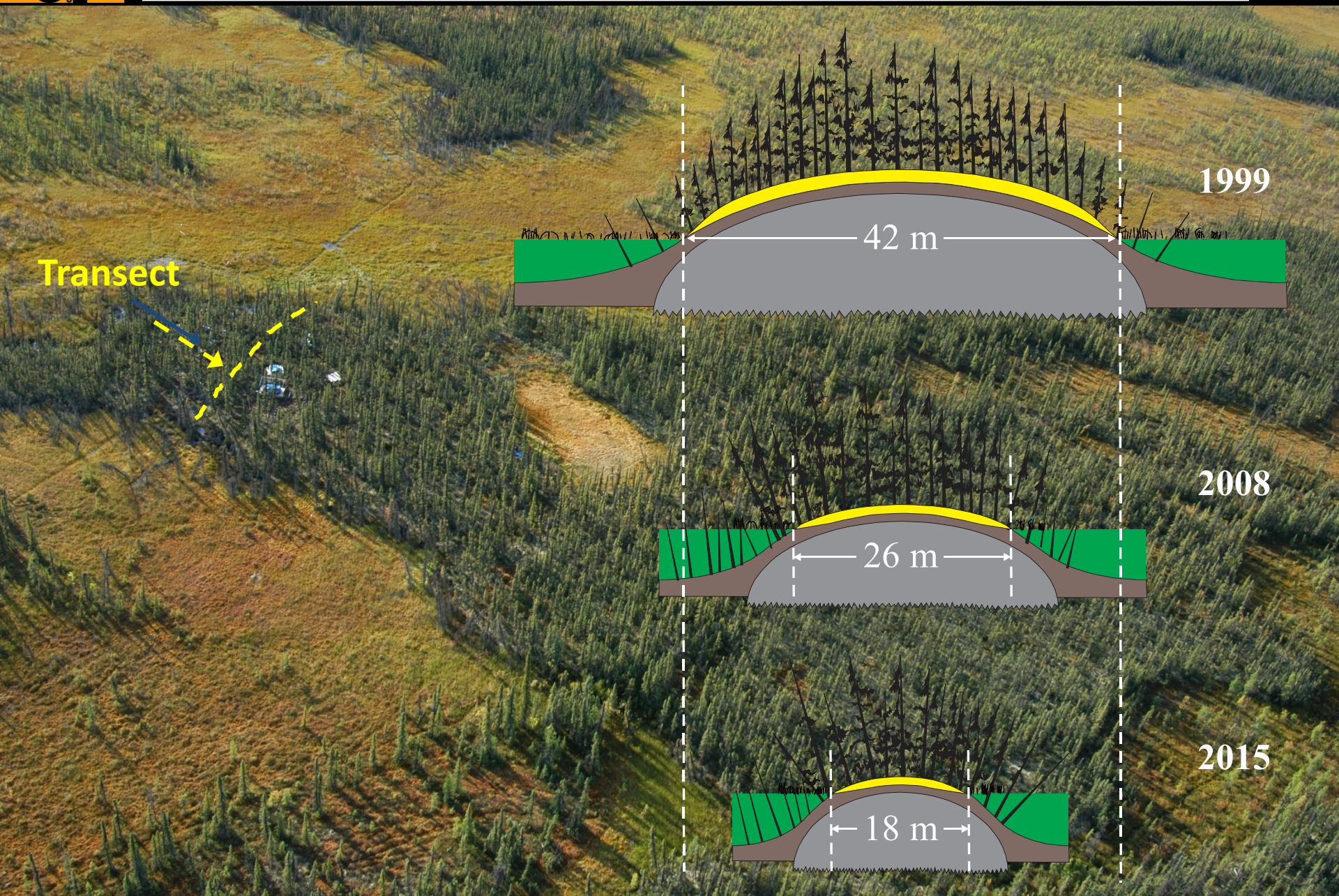
CPET: Scotty Creek

- Renewed infrastructure *2017 & 2018* (CANet)
  - *3-km of boardwalk, stable AC power, accommodates 14+*
- Local capacity building & community engagement.
  - High school field courses, coordination with Aboriginal initiatives, partnership agreements, convergence with TEK
- ~1000 person days per year
- State-of-the-art research infrastructure
- Long-term monitoring & focused experiments
  - streamflow, water table and permafrost dynamics, water chemistry, snow surveys, vegetation composition and structure, etc.

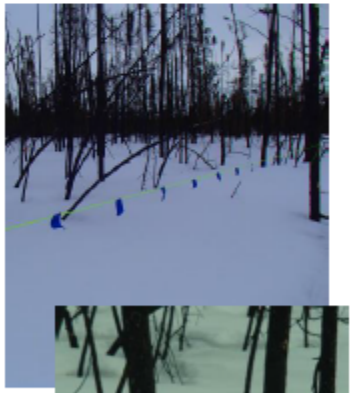
CPET: Scotty Creek

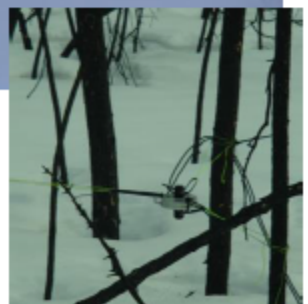
- Comprehensive, high-quality data archives (1994-)
- CTFS-ForestGEO: global network of forest research plots to study forest function and diversity

CPET: Scotty Creek permafrost dynamics



Fire disturbance studies:





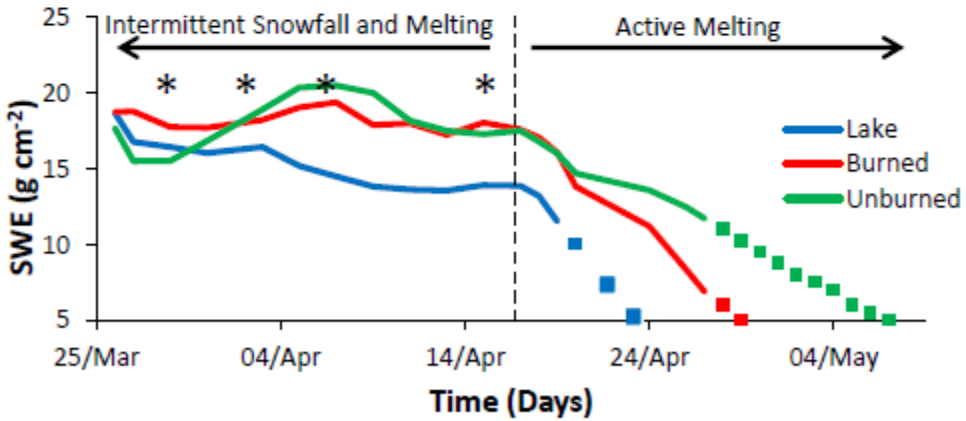


Figure 1. Comparison of the average SWE on a lake surface, burned and unburned plateau, from the March 26th March to May 9th 2015. The solid line values are from manual measurements, the coloured dashed line were estimated

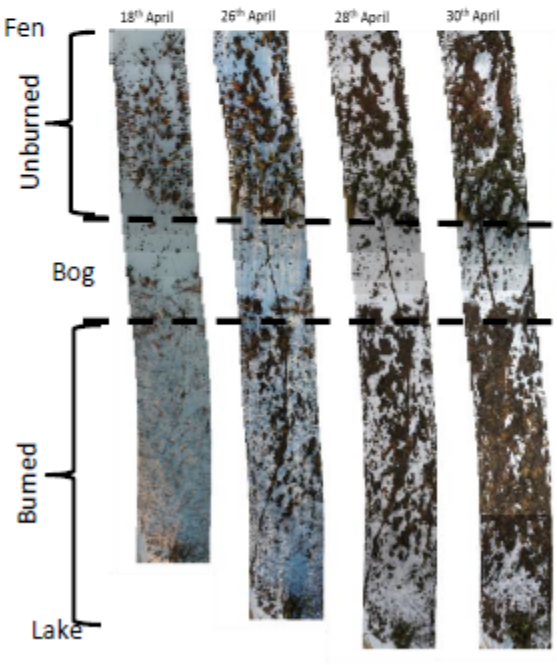
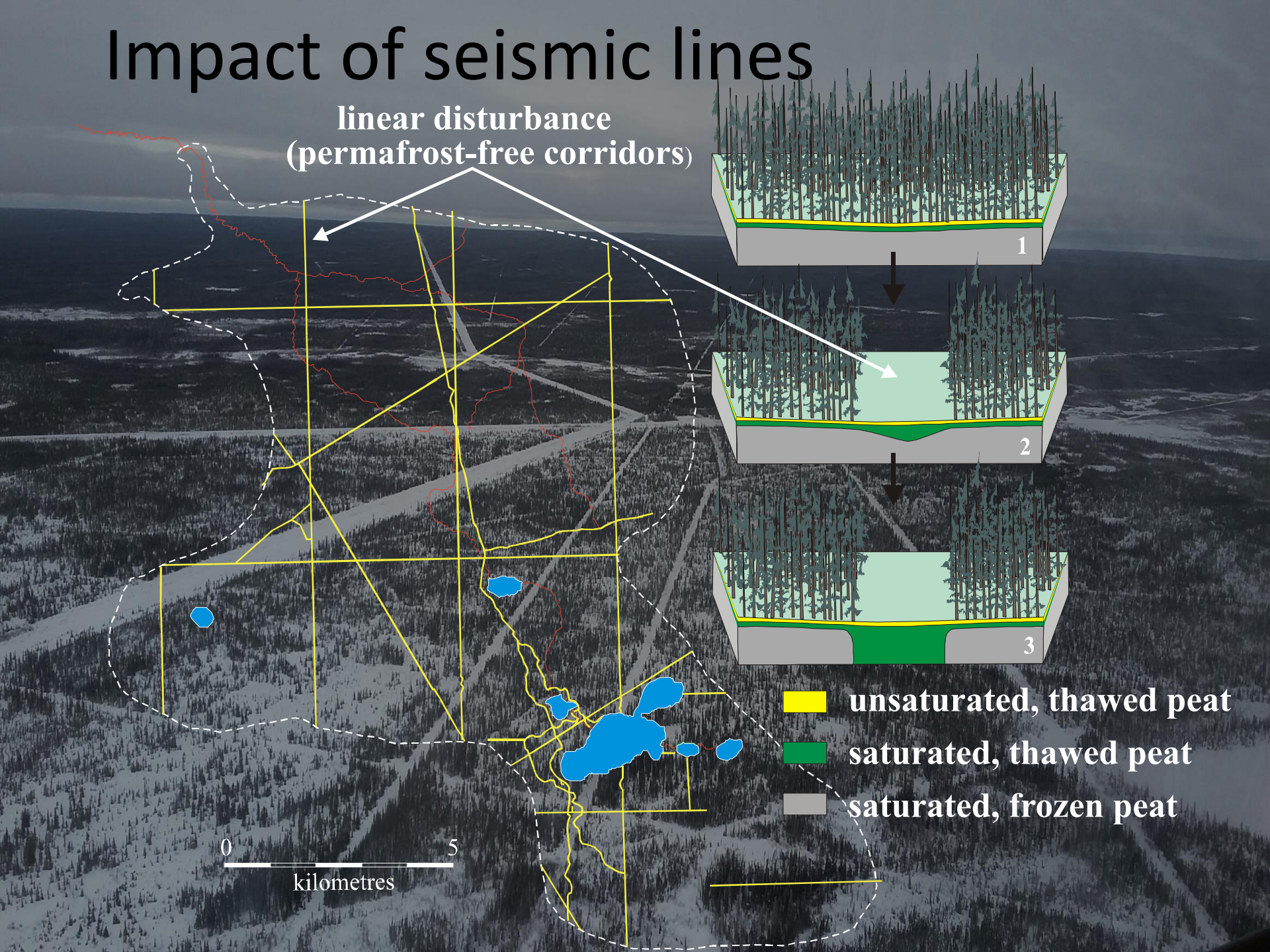
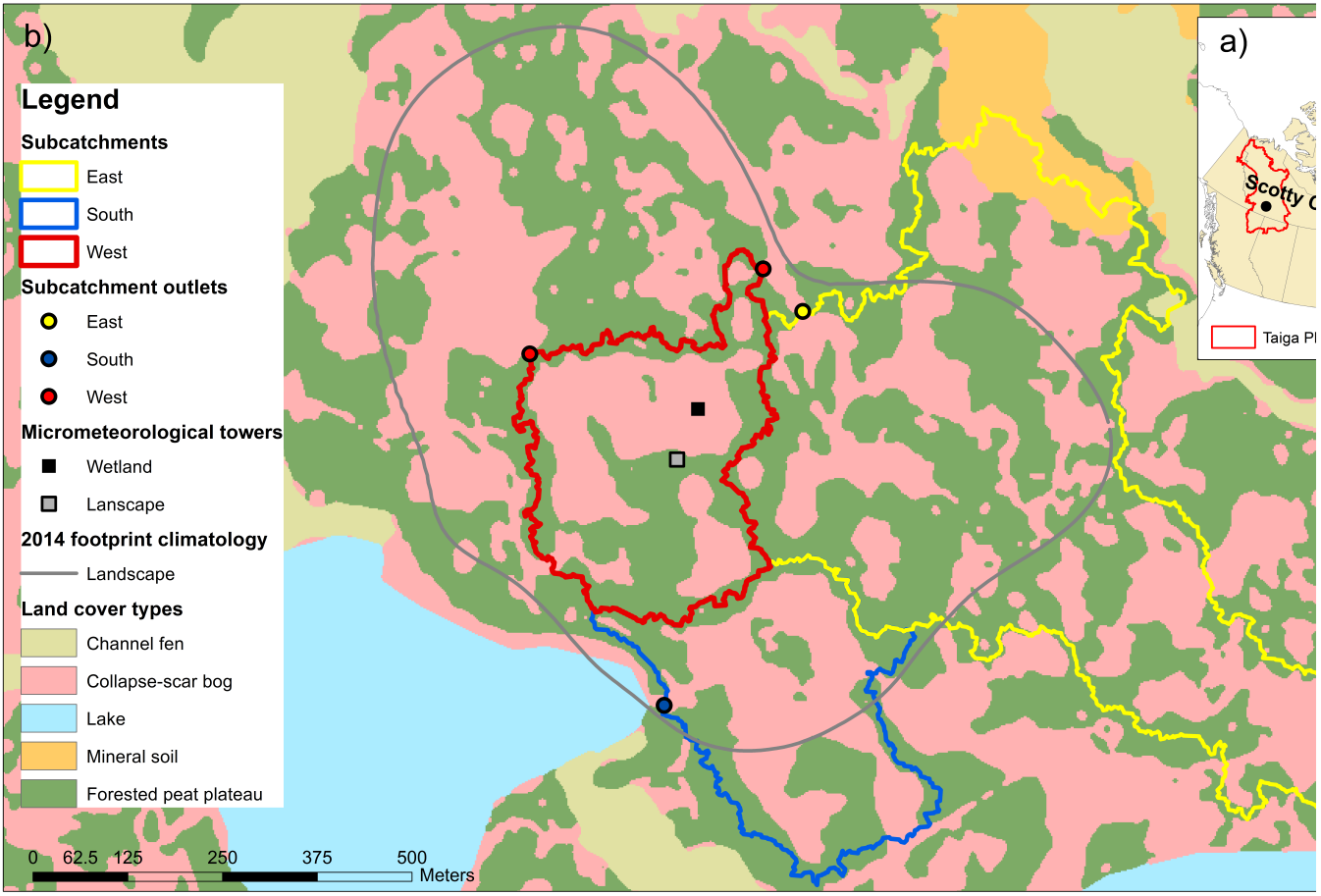


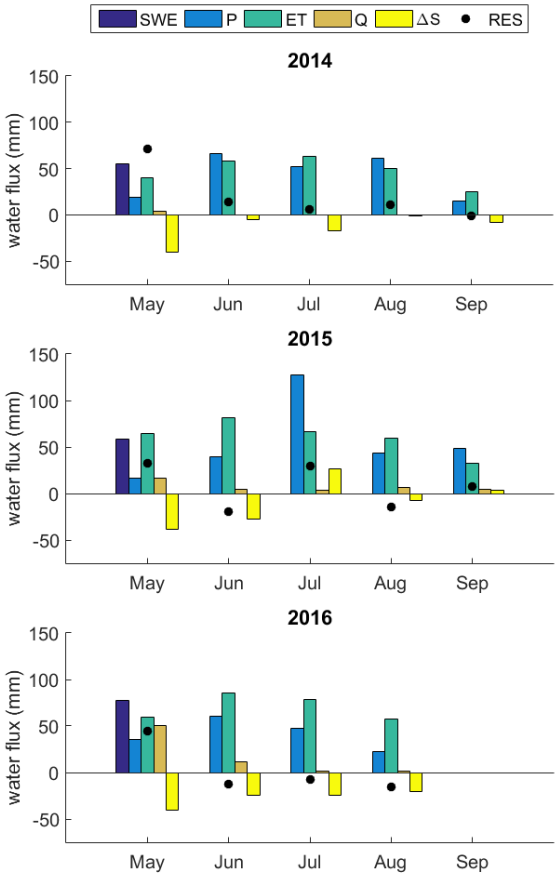
Figure 2. Example of mosaiked images of the

Impact of seismic lines

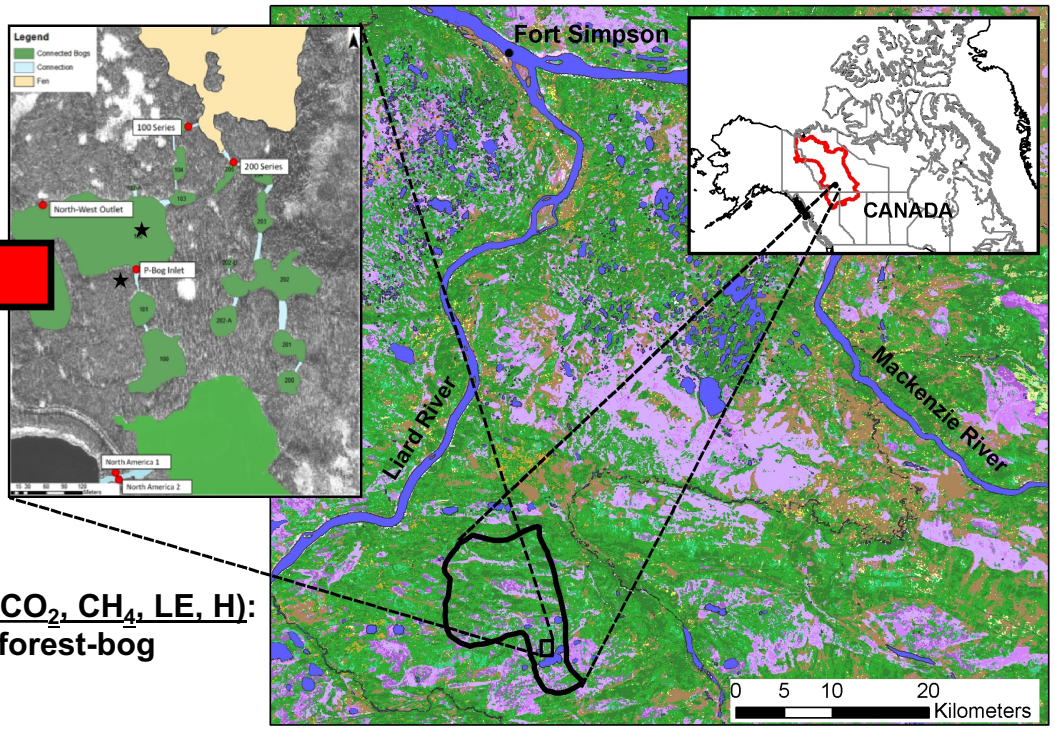


CPET: Scotty Creek hydrology





CPET: Scotty Creek eddy covariance



NAD83 UTM Zone 10N; Natural Resources Canada - Centre for Topographic Information (2009)

Nested eddy covariance systems (CO_2, CH_4, LE, H):
15 m (landscape-scale): boreal forest-bog
1.9 m (ecosystem-scale): bog

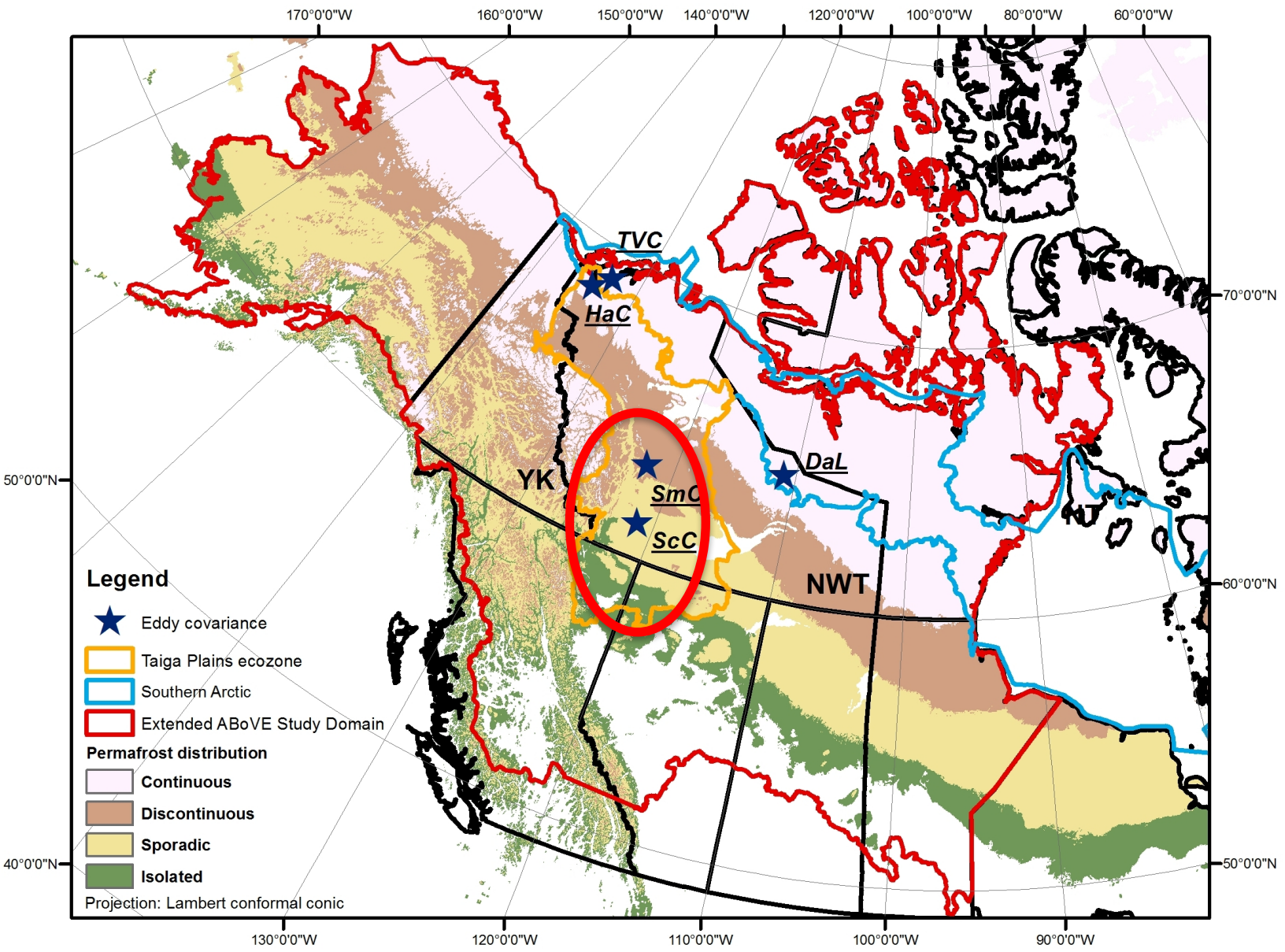
Southern portion of the 152 km^2-watershed: forested peat plateaus with permafrost (38%), and permafrost-free bogs (27%), fens (26%) and lakes (9%)

CPET: eddy covariance recent results

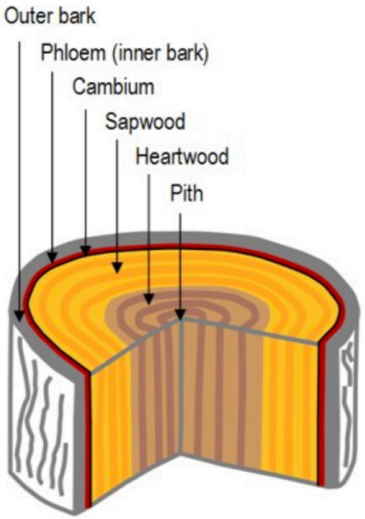
Recent findings (e.g., *Geophysical Research Letters*, *Agricultural and Forest Meteorology*, *Global Change Biology*)

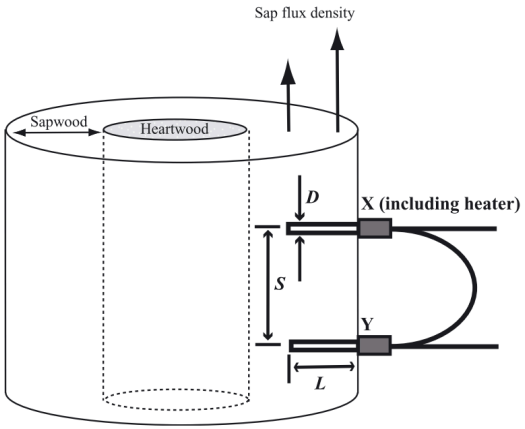
- Permafrost thaw and wildfire: equally important drivers of boreal tree cover changes
- Regional atmospheric cooling and wetting effect of permafrost-thaw induced boreal forest loss
- Net warming effect of increasing landscape methane emissions from thawing permafrost during this century
- Thawing permafrost only marginally affects landscape carbon dioxide sink strength

Eddy covariance across the NWT

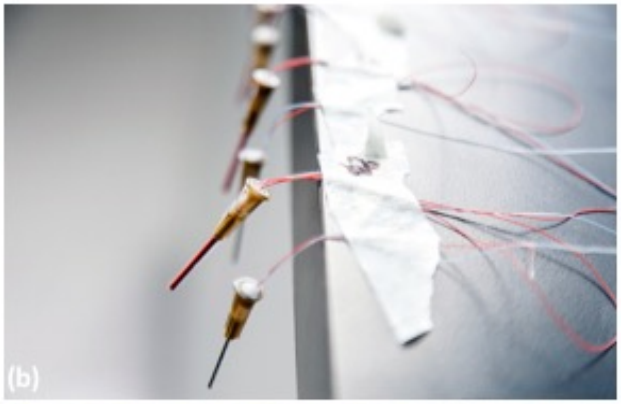


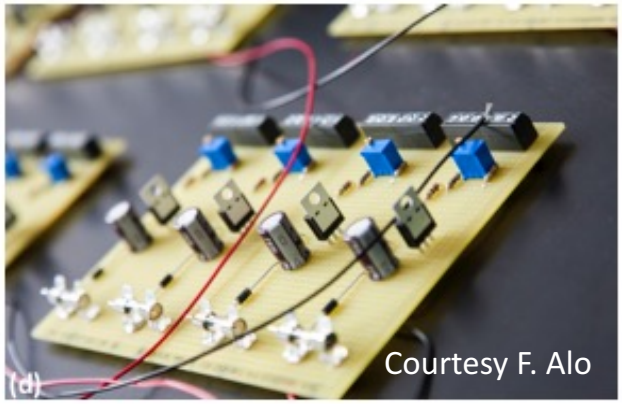
16 Methods –(b) Thermal dissipation sap flux density





Granier, 1987
Iida and Tanaka, 2010





Self-manufactured thermal dissipation (Granier) sap flux density probes: each sensor consists of a pair of 20 mm long, 2 mm diameter probes inserted in the conductive xylem (sapwood) about 10 cm apart. The upper probe is constantly heated and the temperature difference between the two probes is recorded (Granier, 1987).