Cold Regions Research Centre

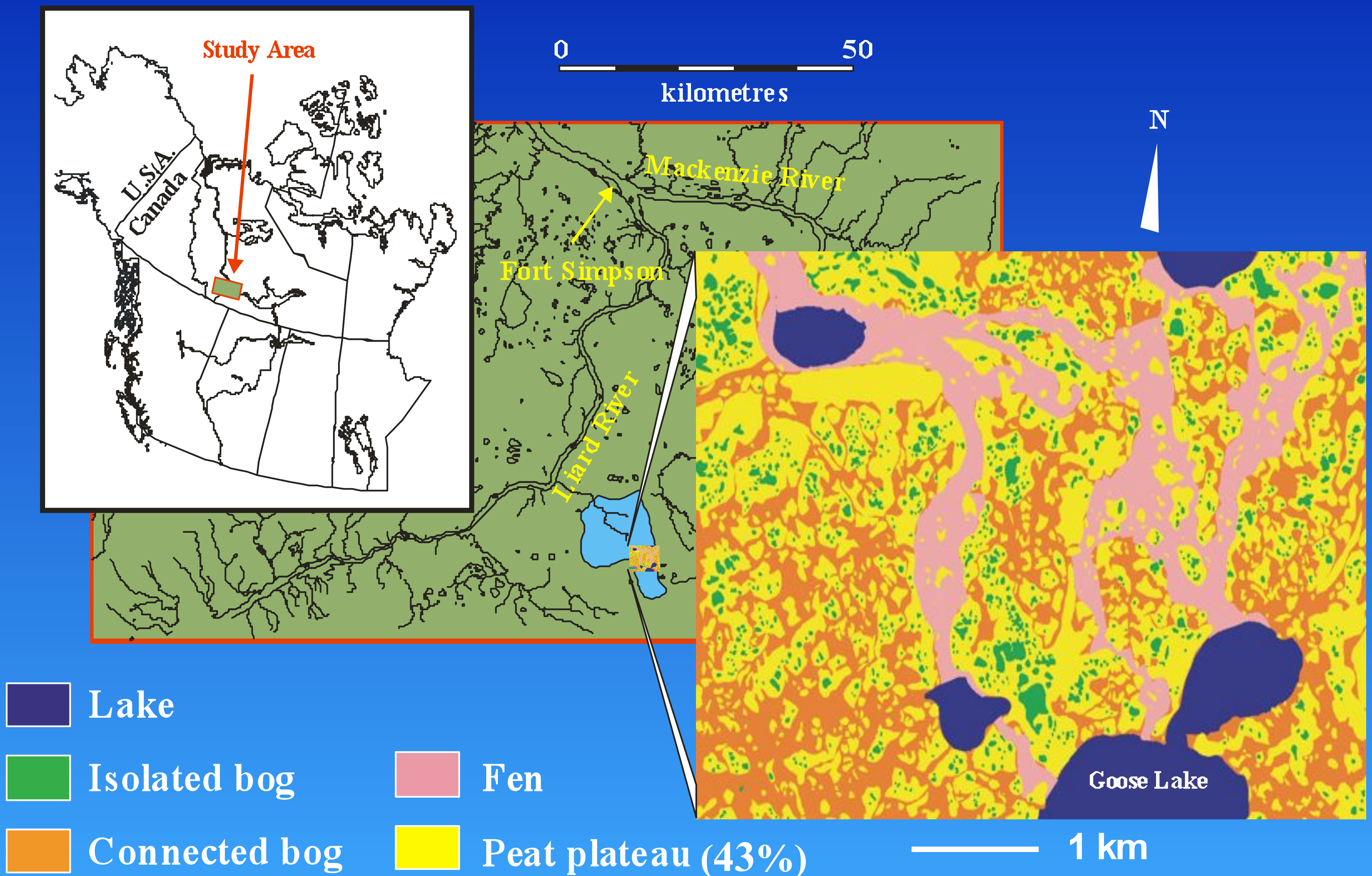
IP3 progress at Scotty Creek

Joint Annual Workshop of the IP3 & WC2N Networks, Lake Louise, Alberta, Canada, 14-17 October, 2009

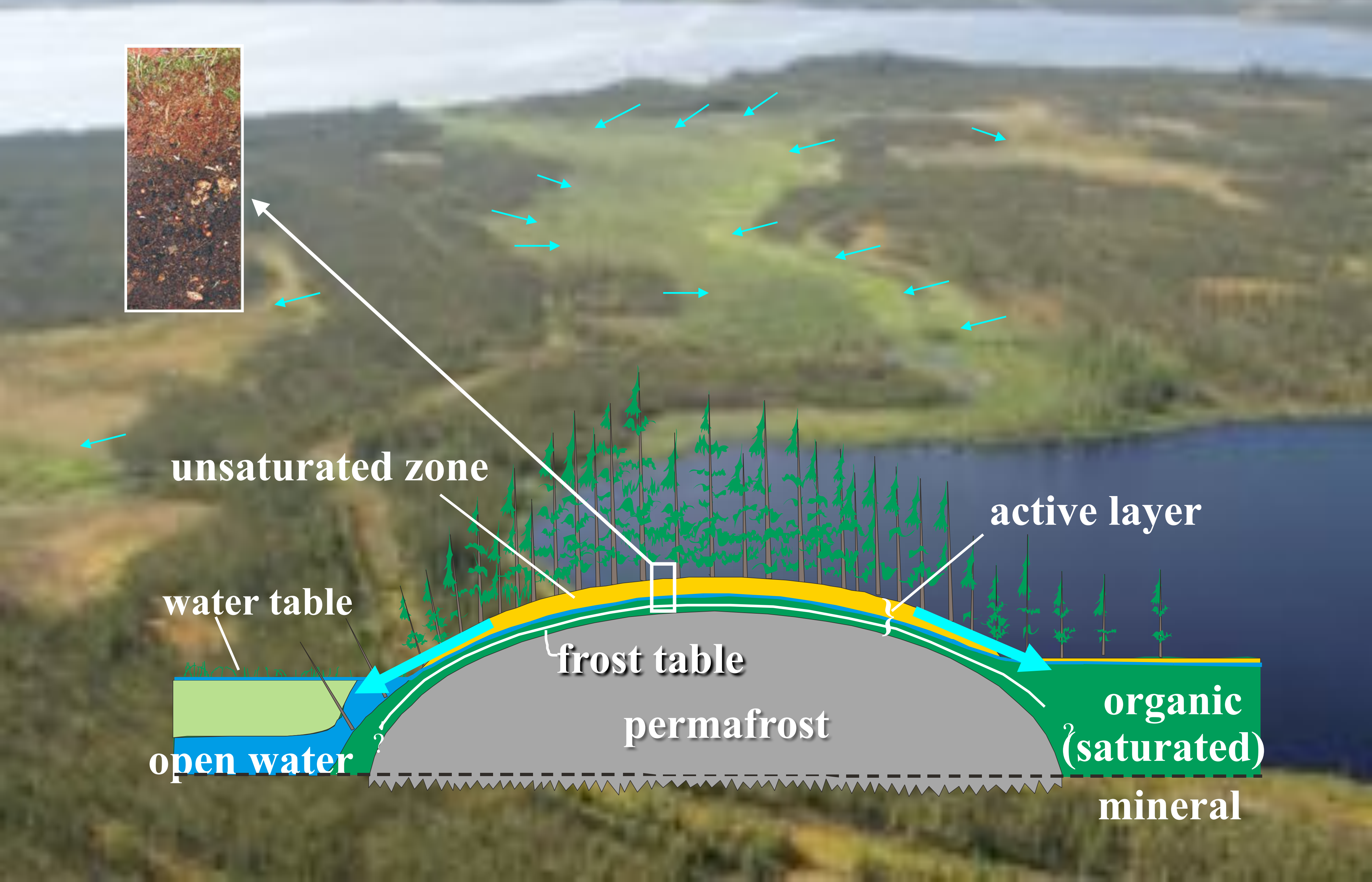
Wilfrid Laurier University

University of Calgary

Scotty Creek, Northwest Territories

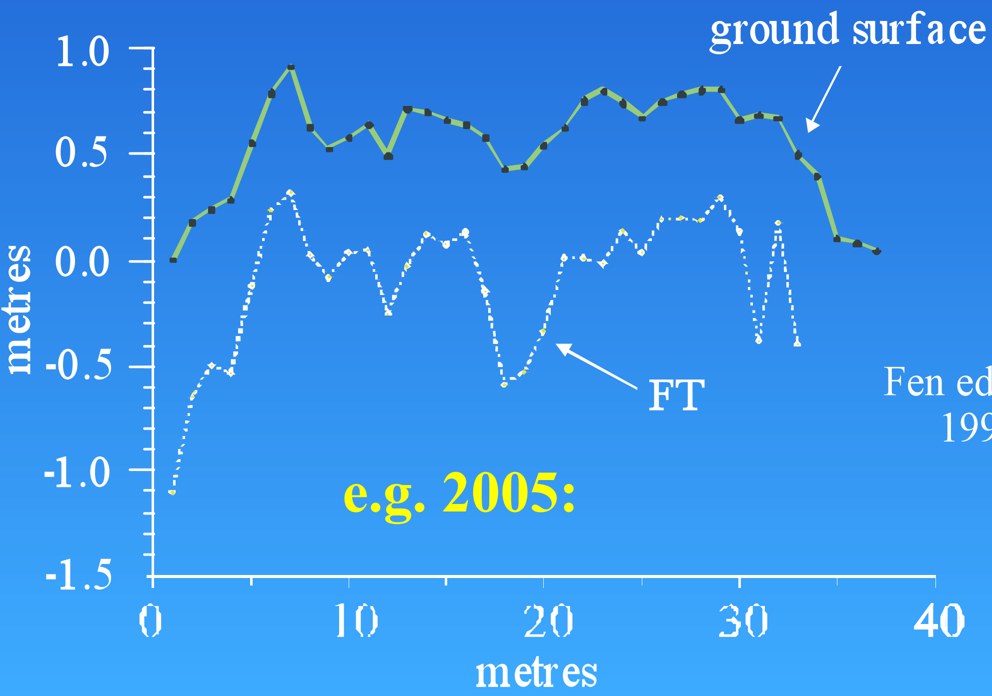


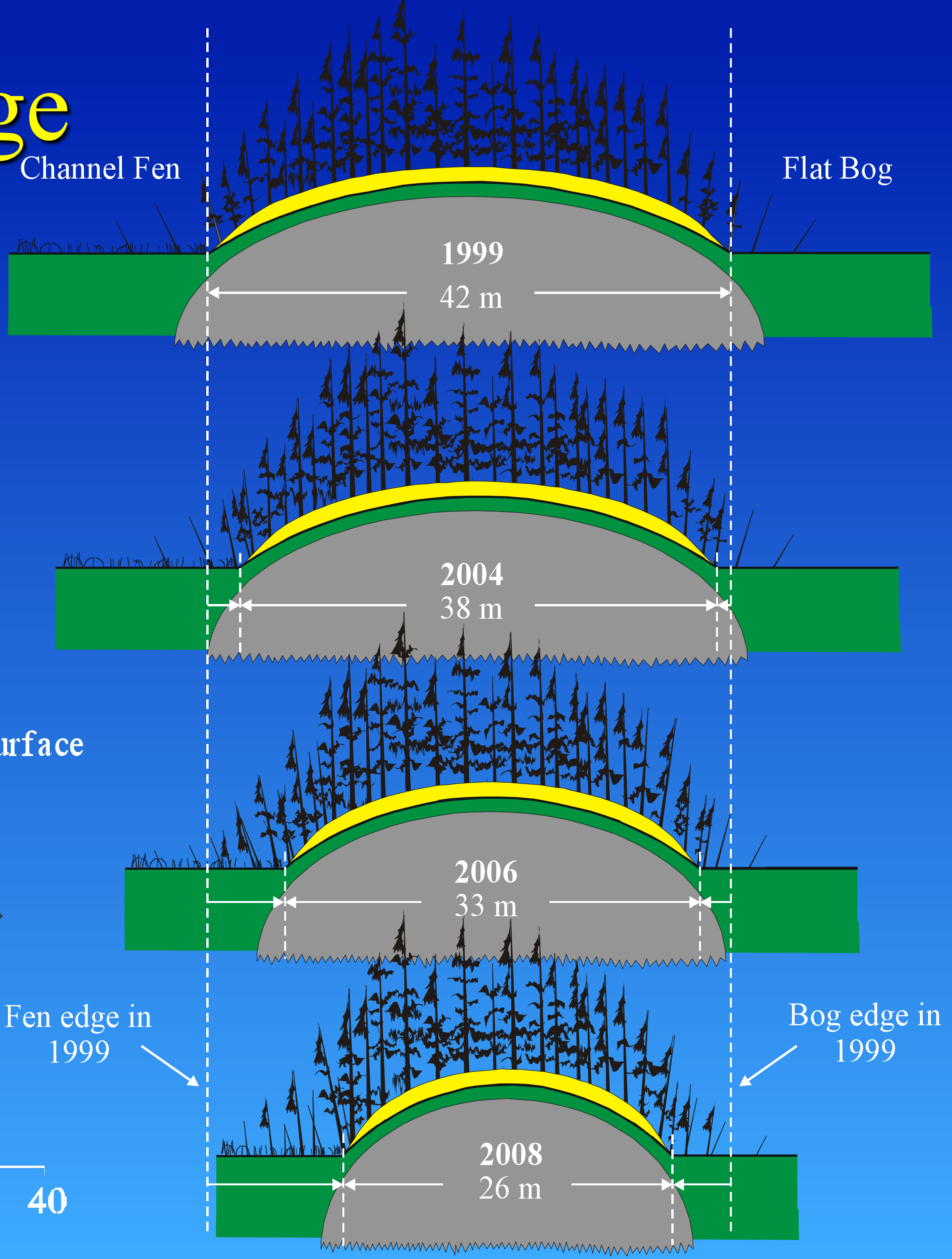
Hillslope Runoff



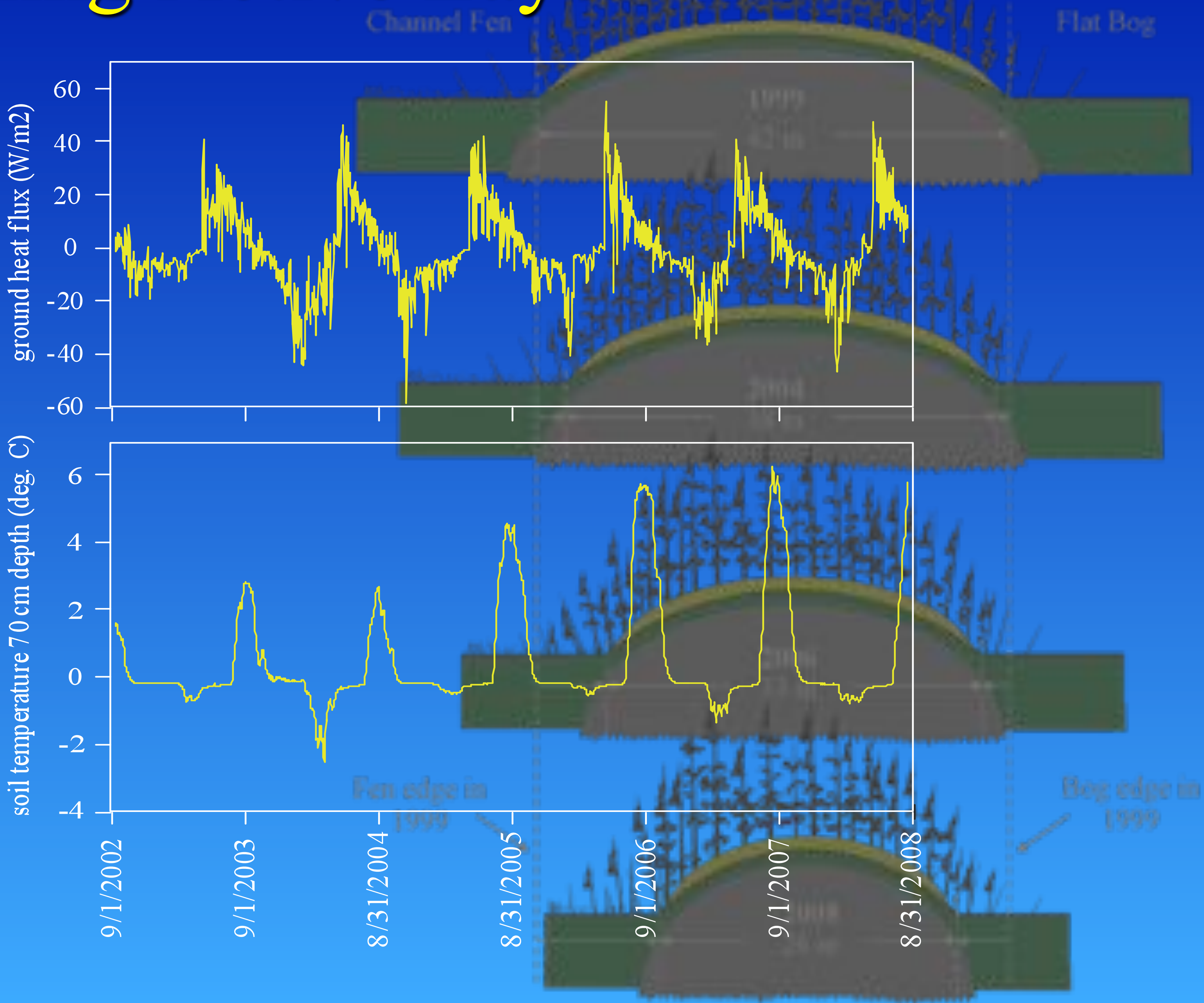
Shifting Boundaries

Plateau Shrinkage

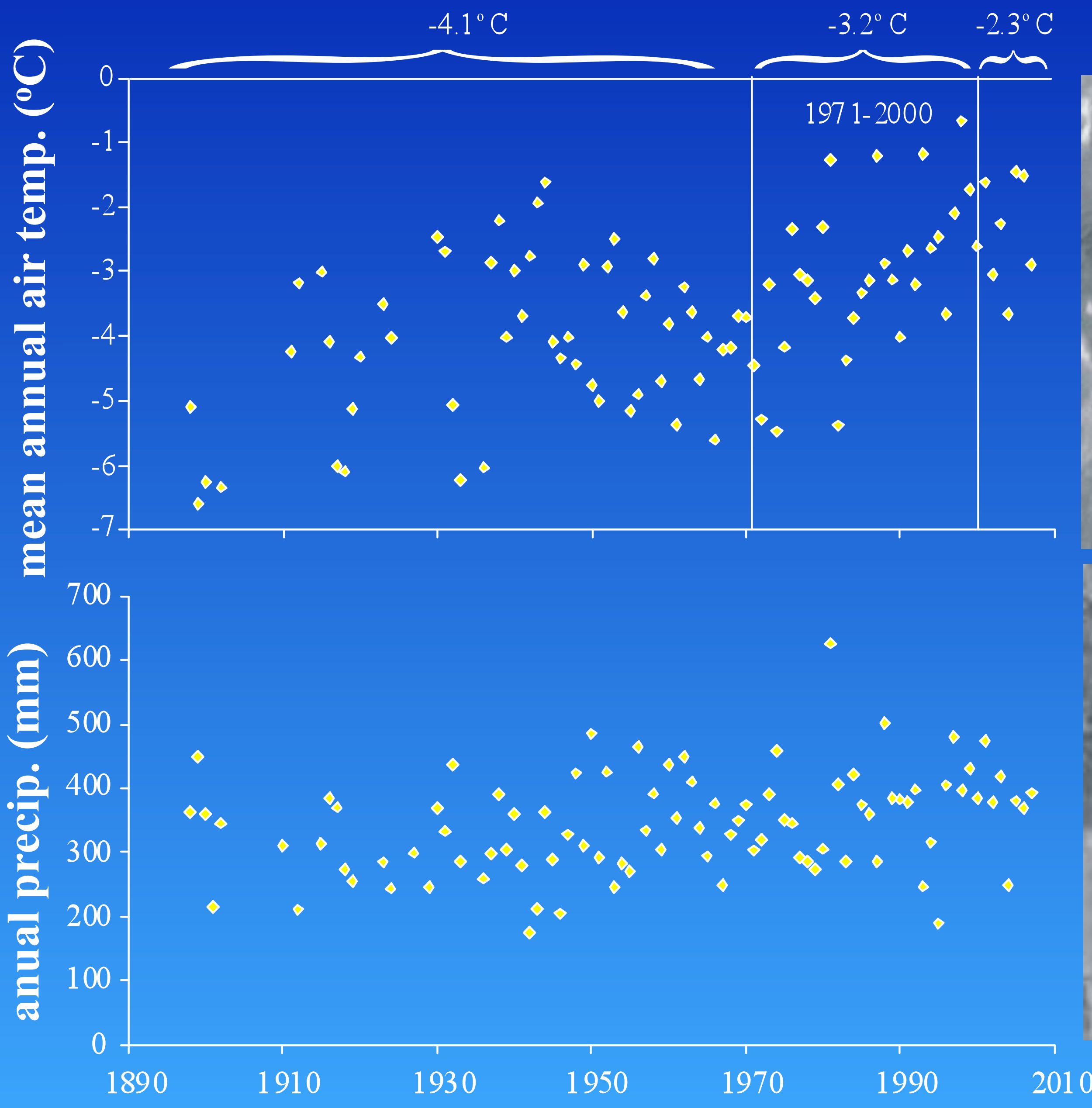


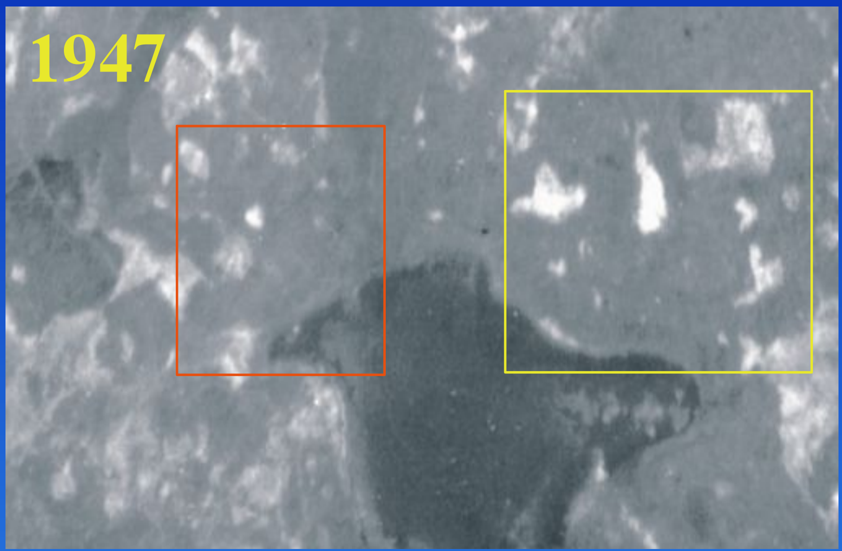


Warming Active Layer

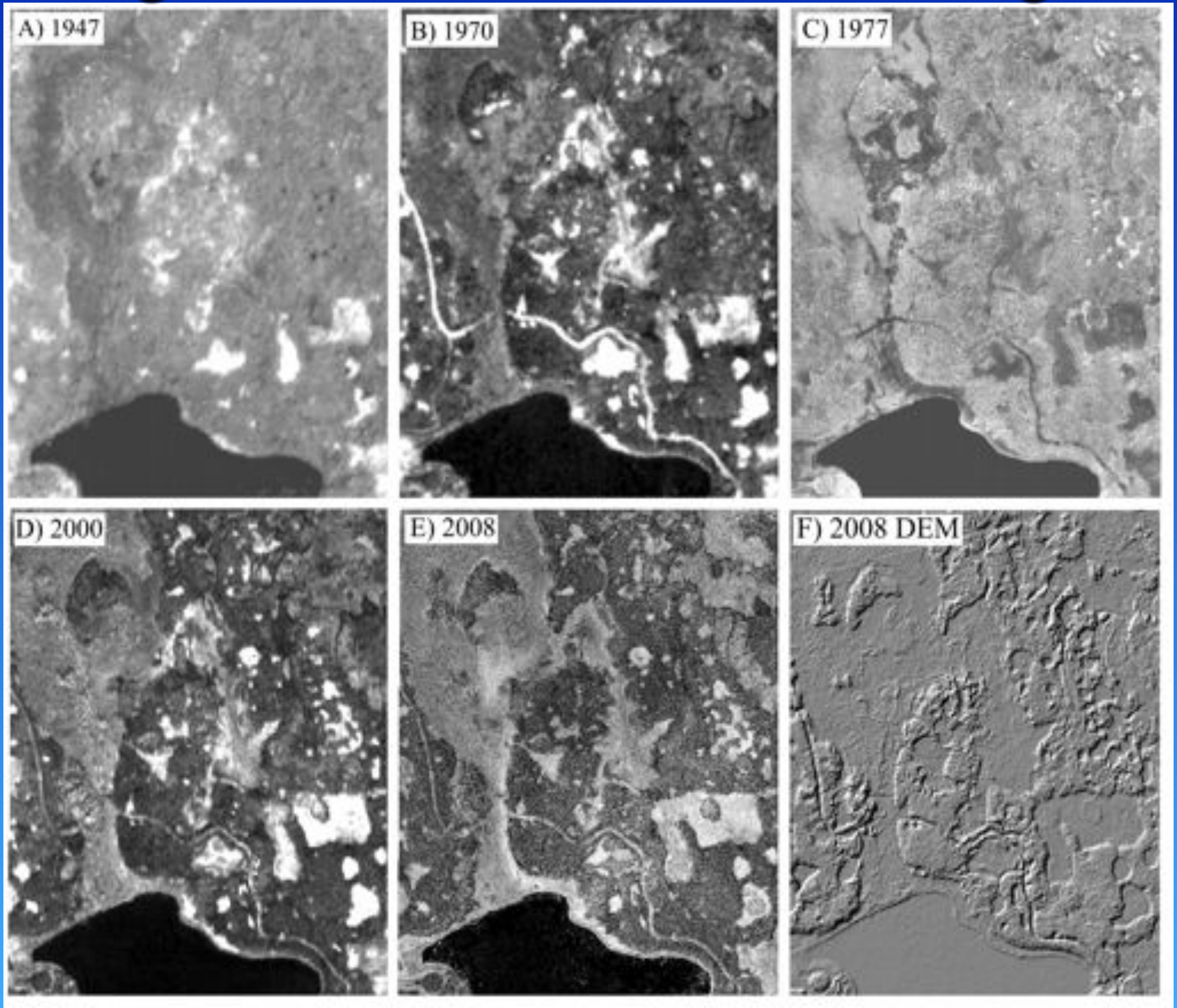


Permafrost Melt 1947 - 2000

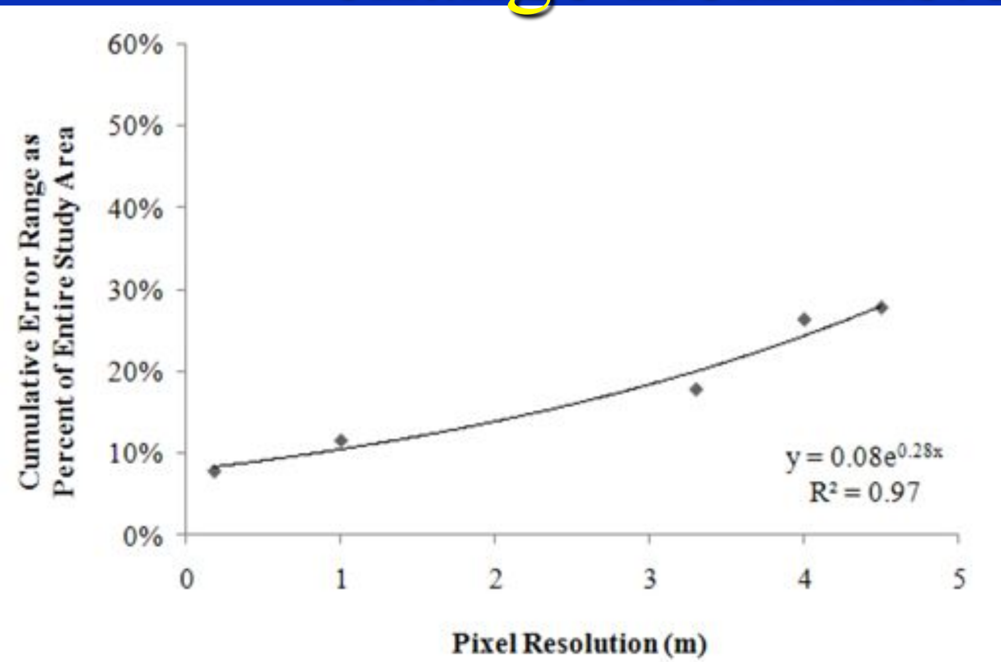




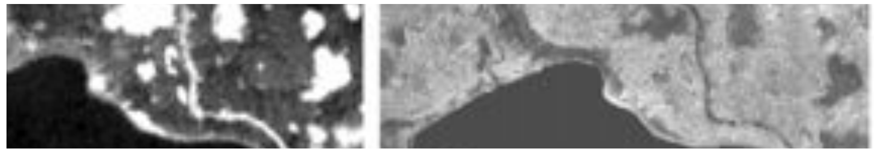
Quantifying errors in permafrost plateau change from historic remote sensing data

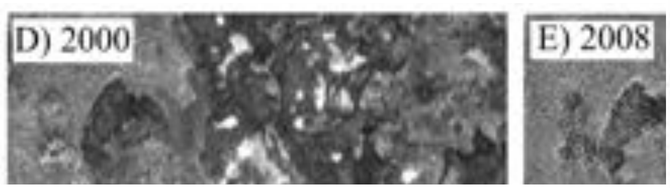


Quantifying errors in permafrost plateau change from historic remote sensing data

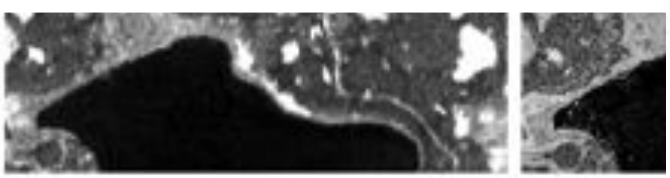


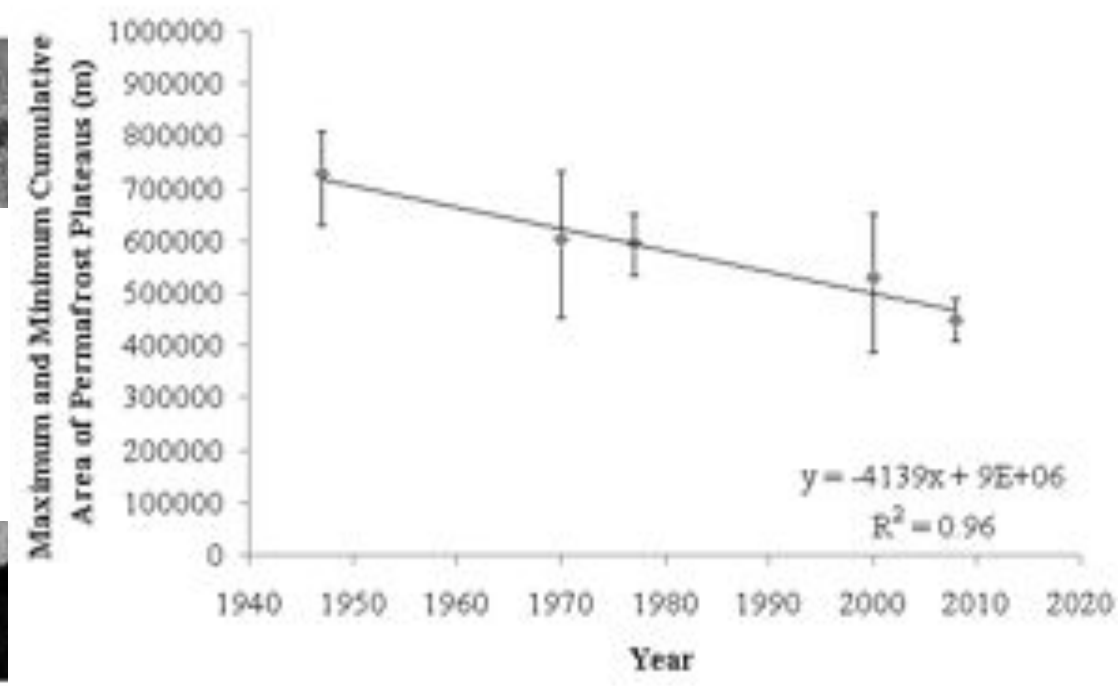
Positive and negative cumulative error (based on a number of criteria) with pixel resolution (left). Despite low resolutions and high error, 1970 and 2000 imagery provide increased confidence in change (below)



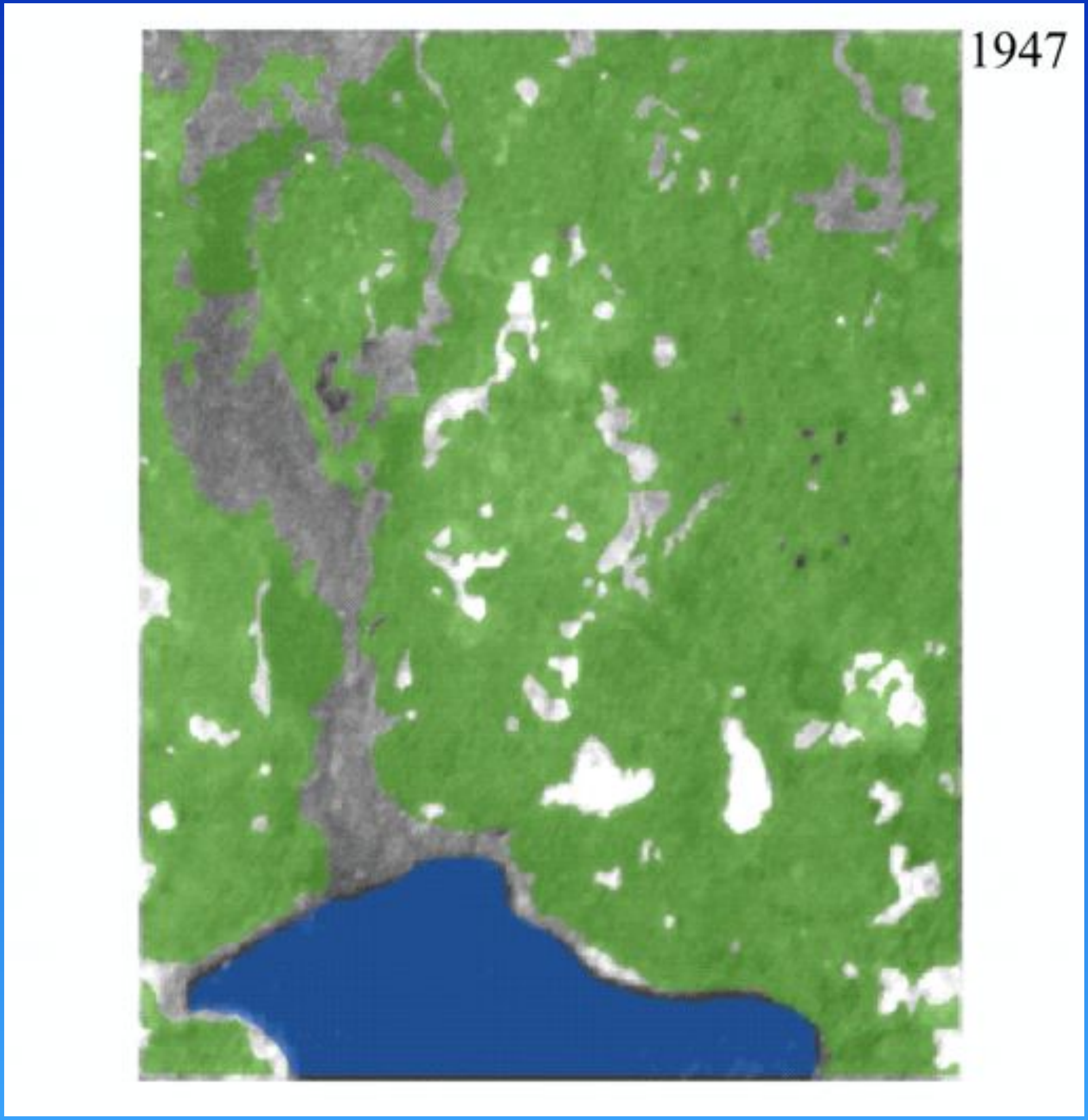


Based on linear permafrost loss of ~ 1% per year, and a pixel resolution of 1 m or less, 26 years are required between images to confidently show change (approx. same amount of time between 1970 and 2008 images).



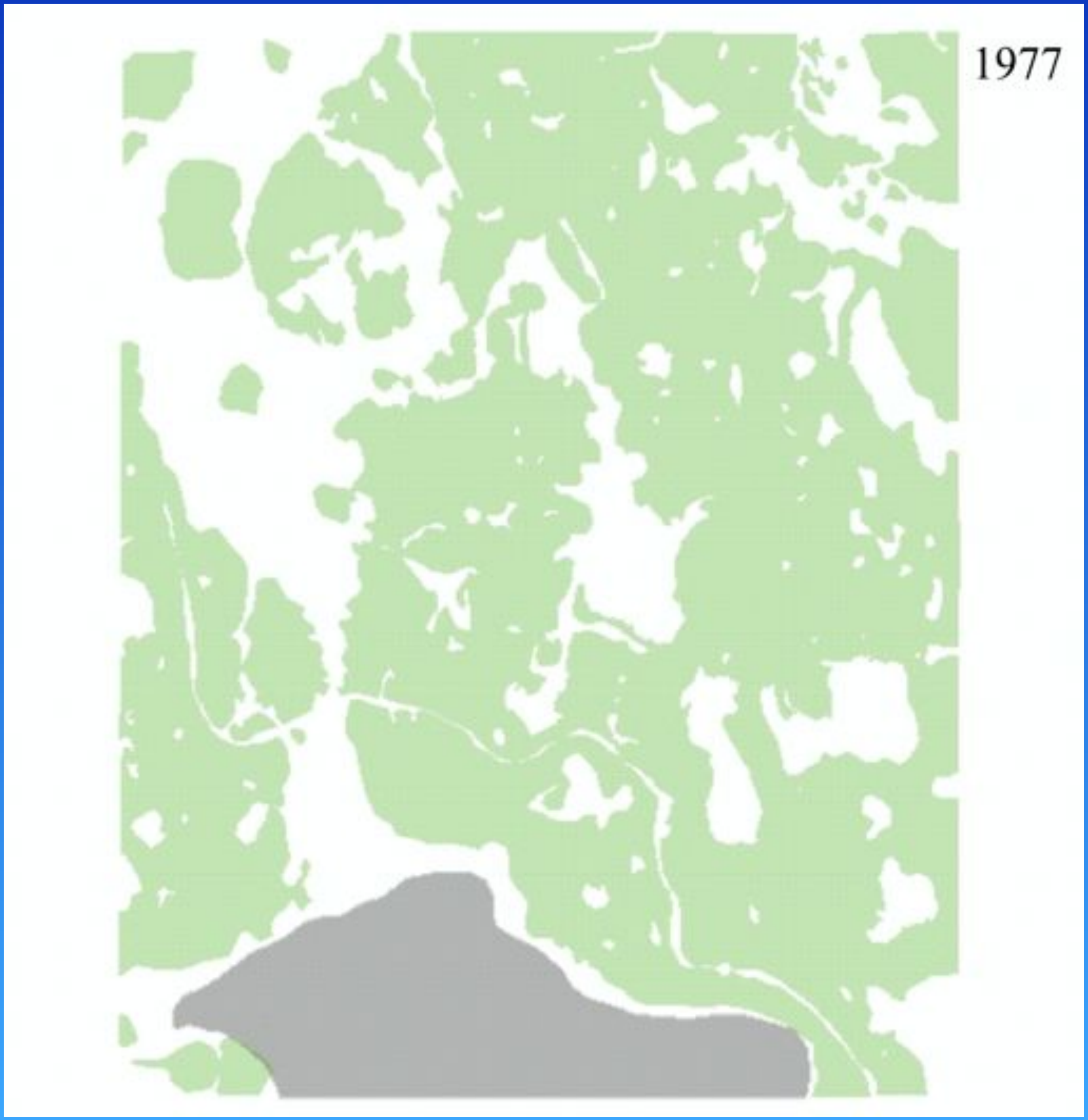


Change in permafrost cover



1947 = 72%
1970 = 60%
1977 = 59%
2000 = 52%
2008 = 40%

Change in permafrost cover



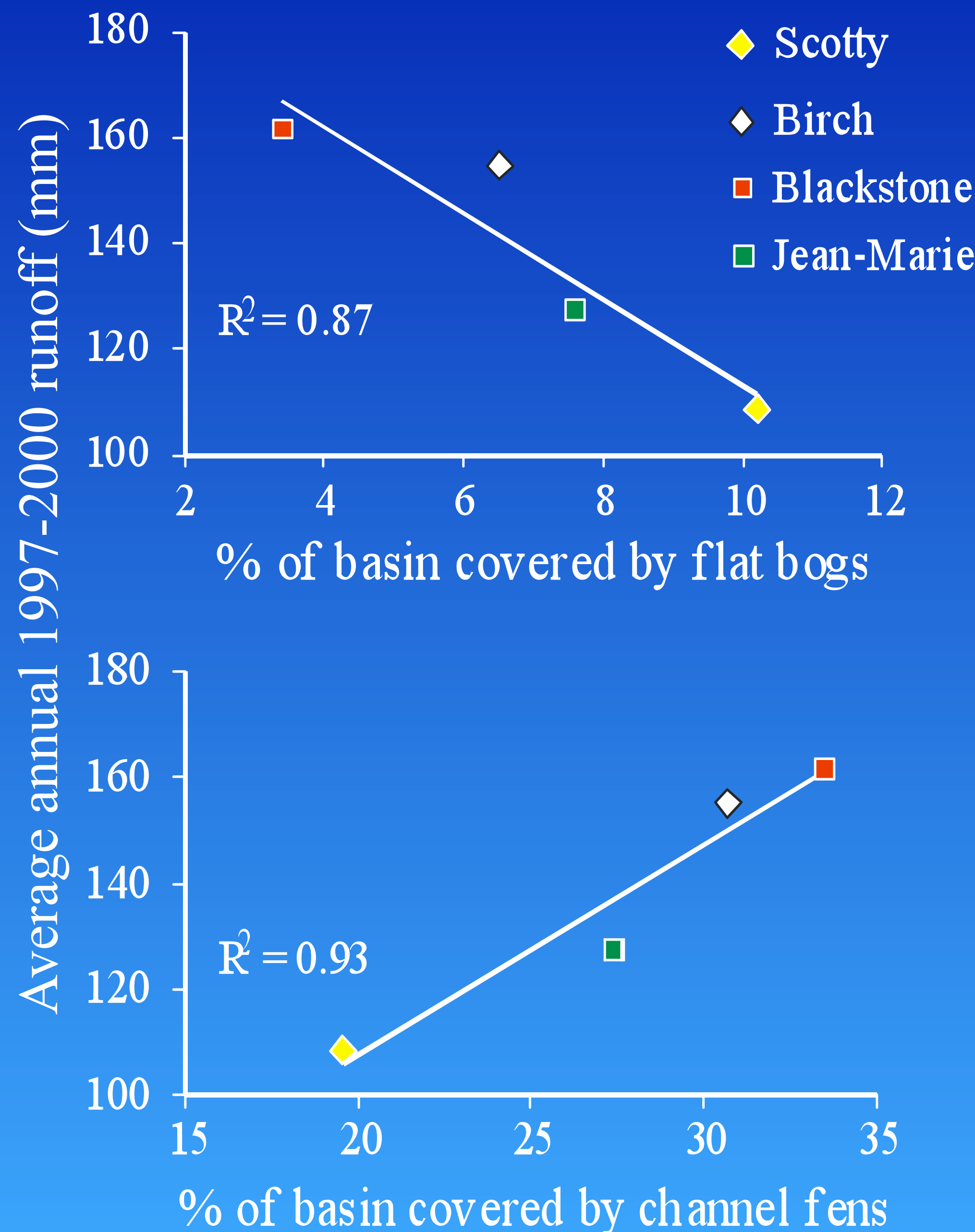
Basin Runoff Related to Cover Type

Four River Basins (150-1300 km^2)

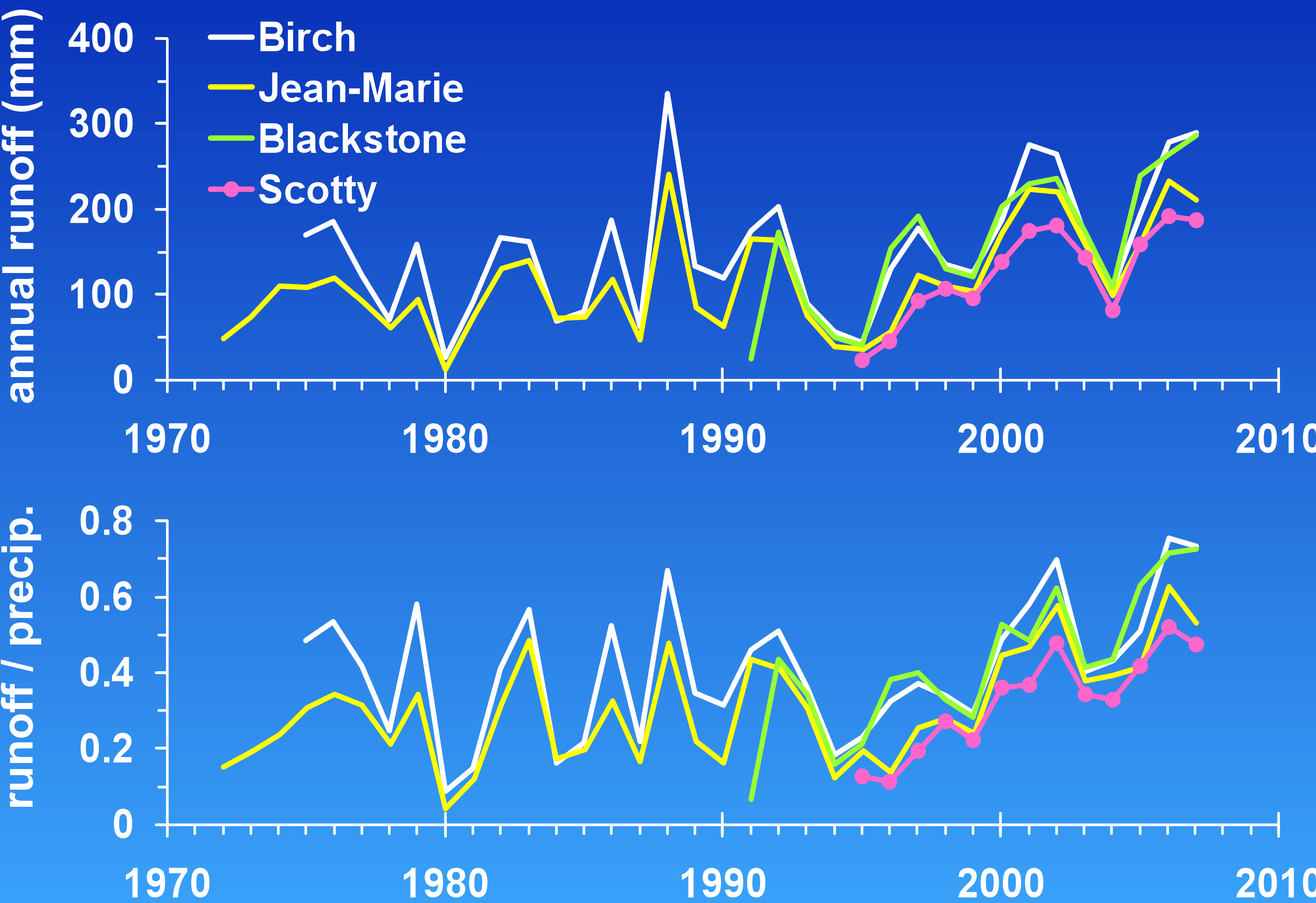
- **Scotty Creek**
- **Birch River**
- **Blackstone River**
- **Jean-Marie River**

Different percentage of land-cover types

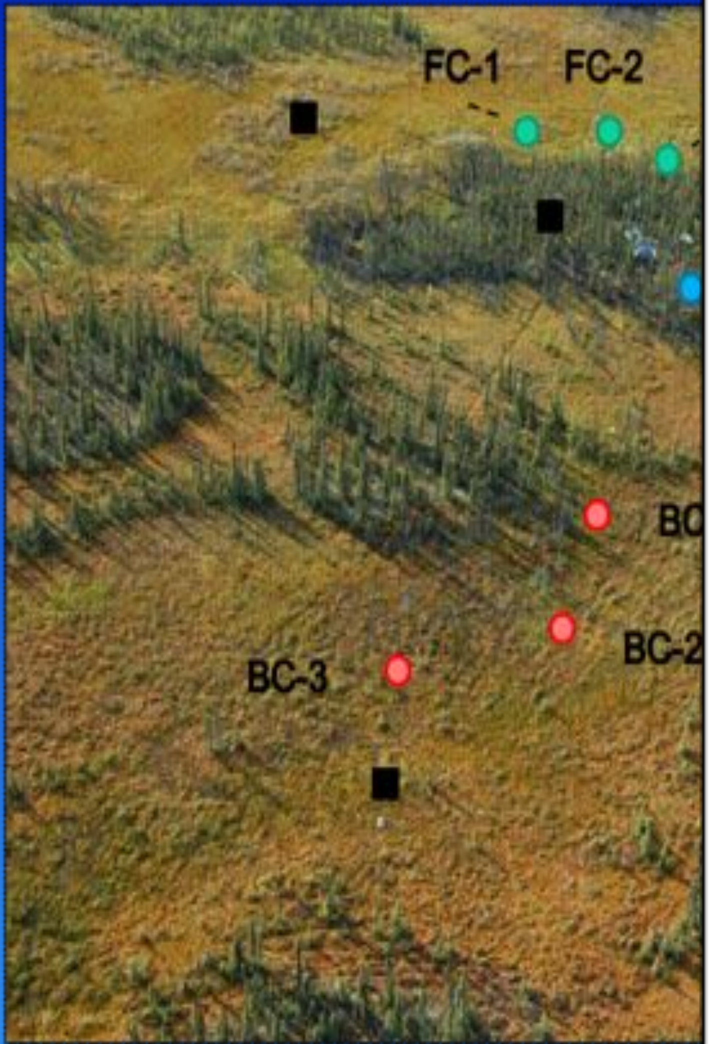
- **bogs (storage)**
- **fens (routing)**



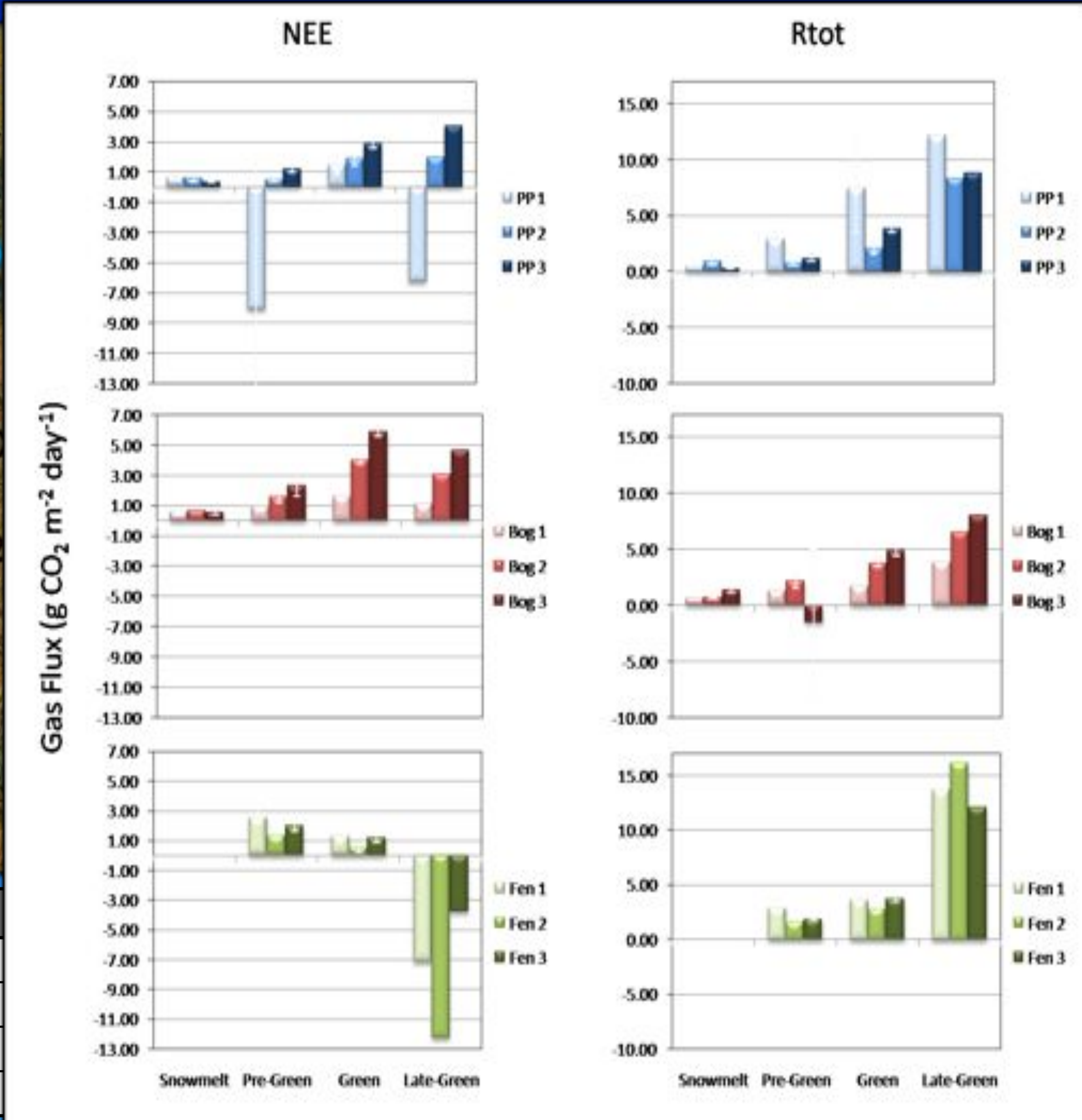
Will basin runoff respond to permafrost melt?



Examining CO_2 Gas Flux in Permafrost Terrain (Scotty Creek, NWT)



Season	Dates
Snowmelt	April 26 – April 30
Pre-Green	May 1 – May 10
Green	May 11 – June 6
Late-Green	August 23

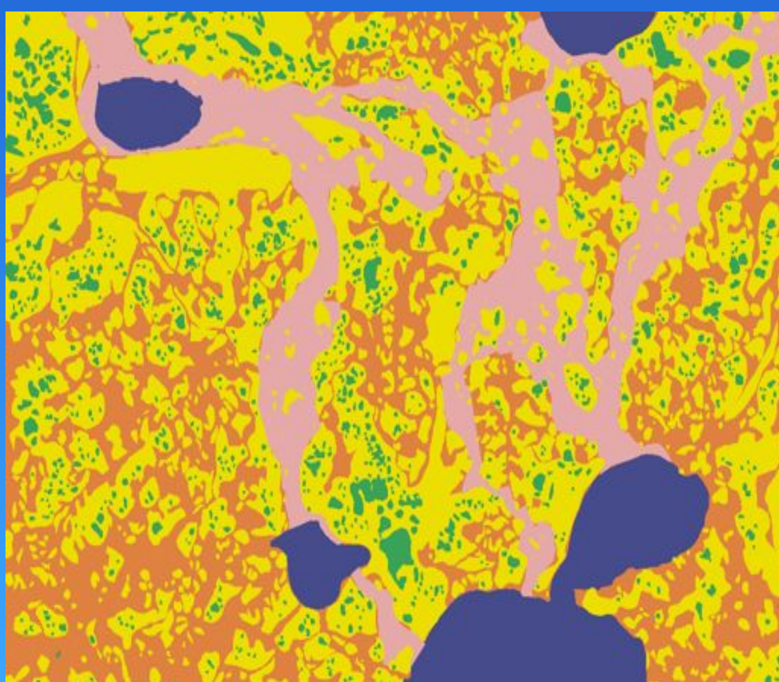


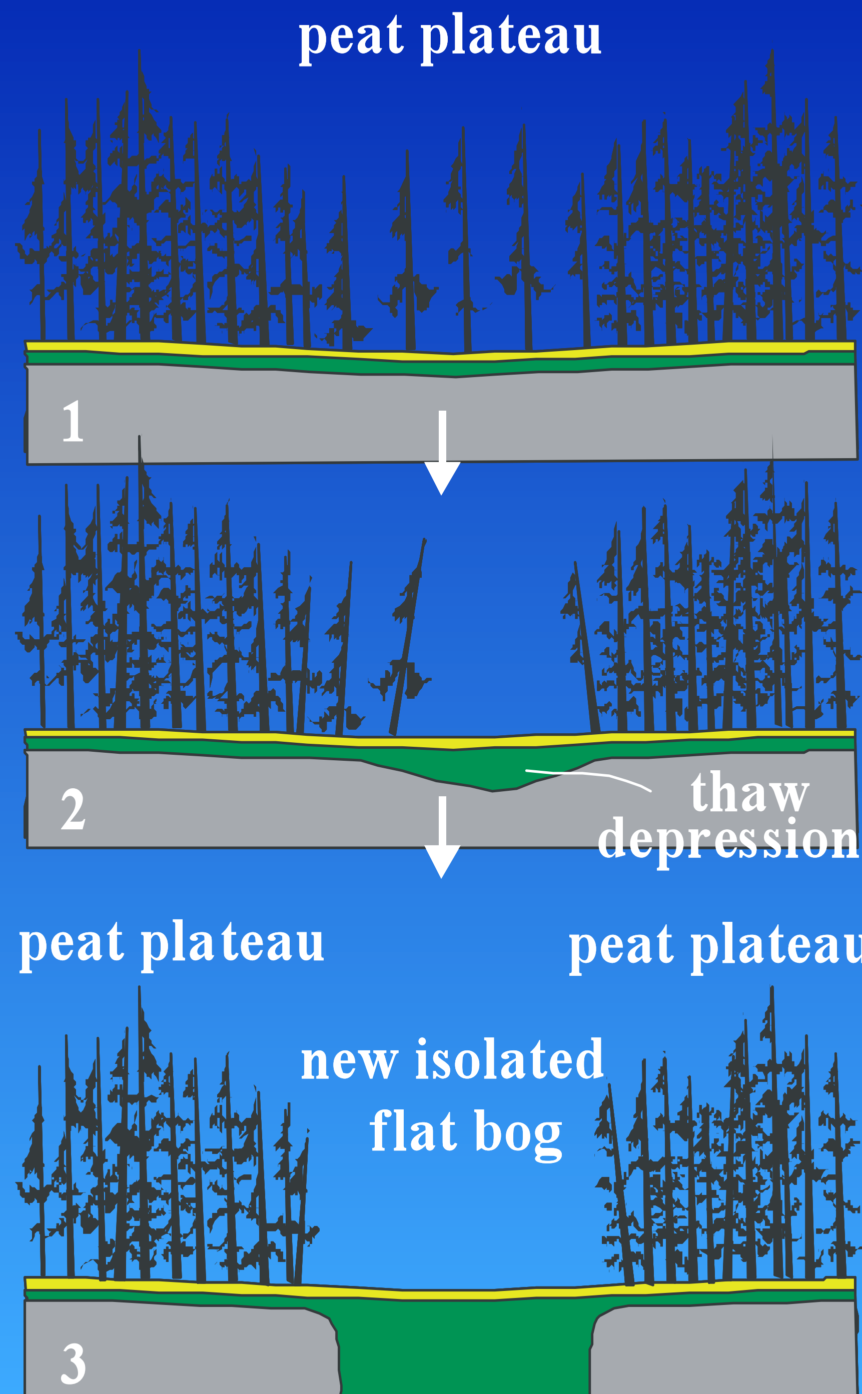
Conceptual Model of Permafrost Melt

unsaturated, thawed peat

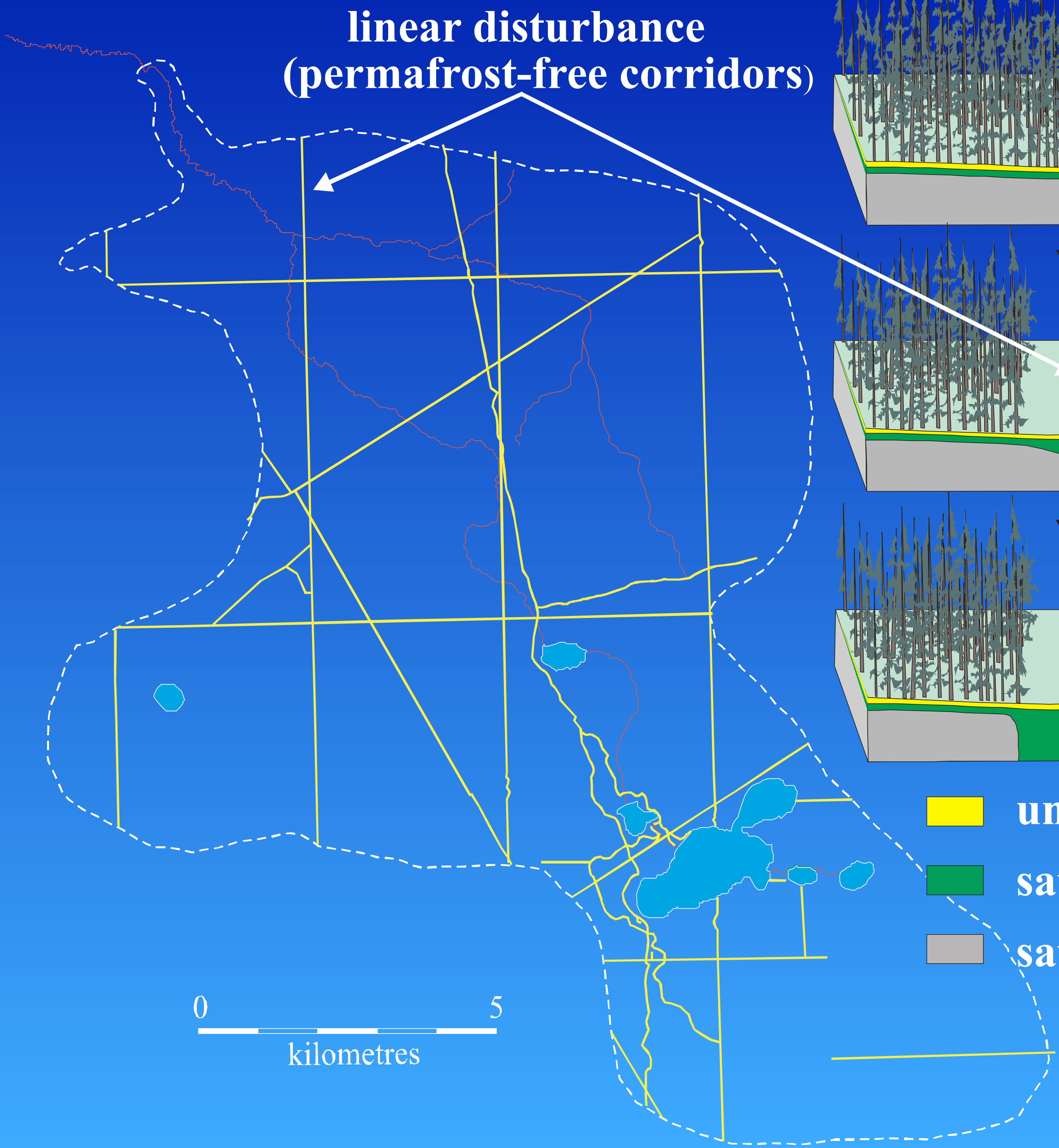
saturated, thawed peat

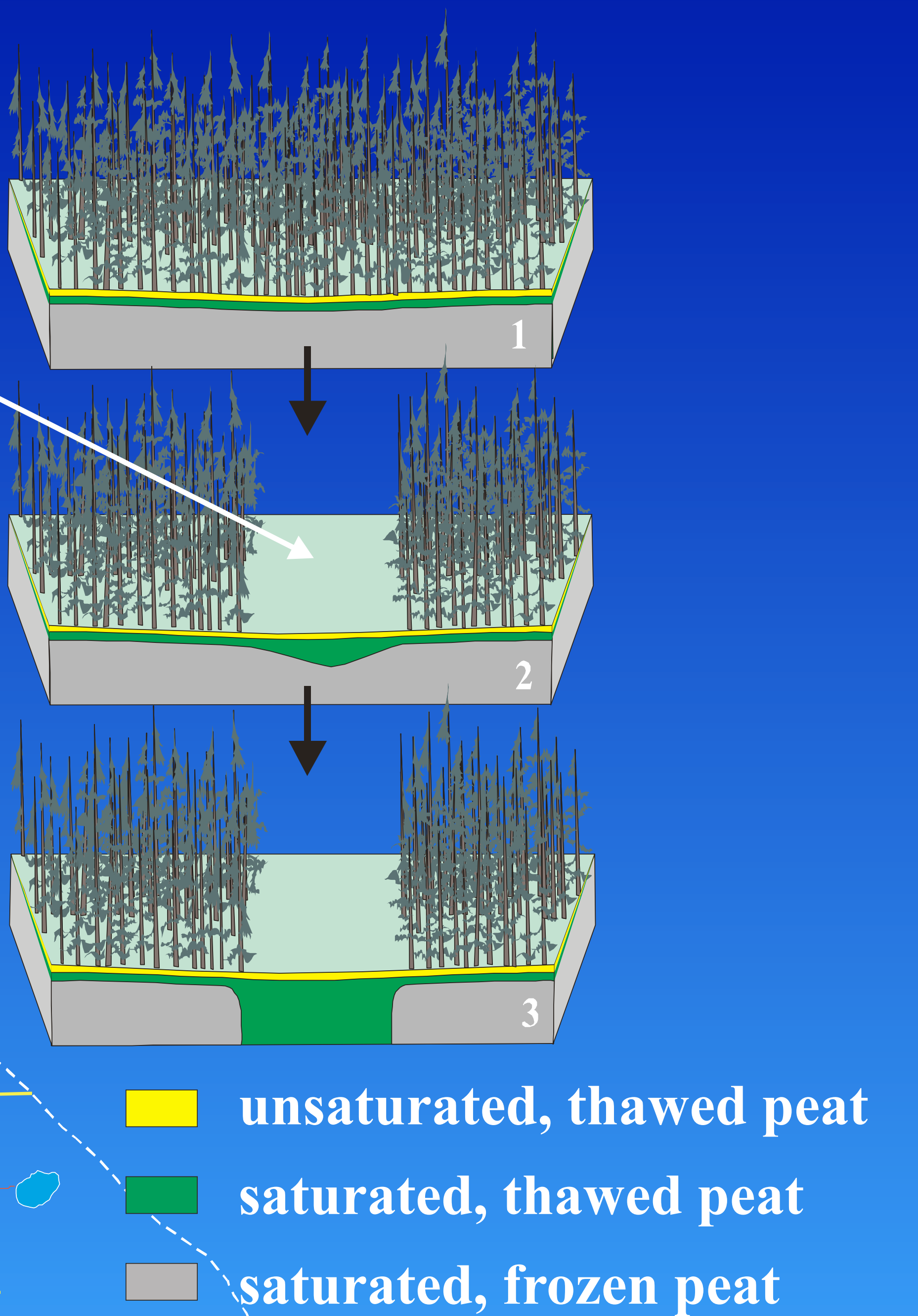
saturated, frozen peat



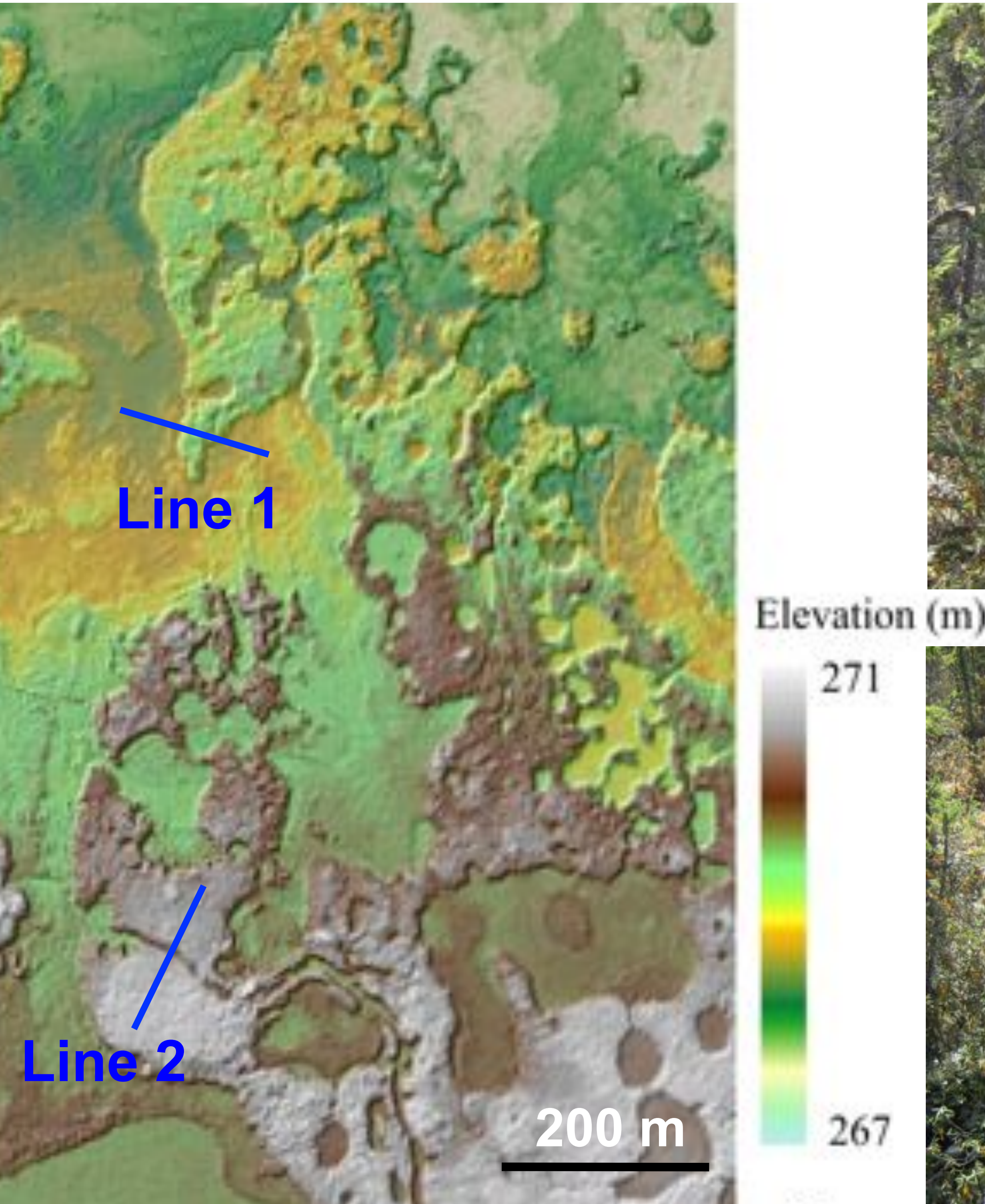


Linear Wetlands





Electrical Resistivity Imaging of Permafrost



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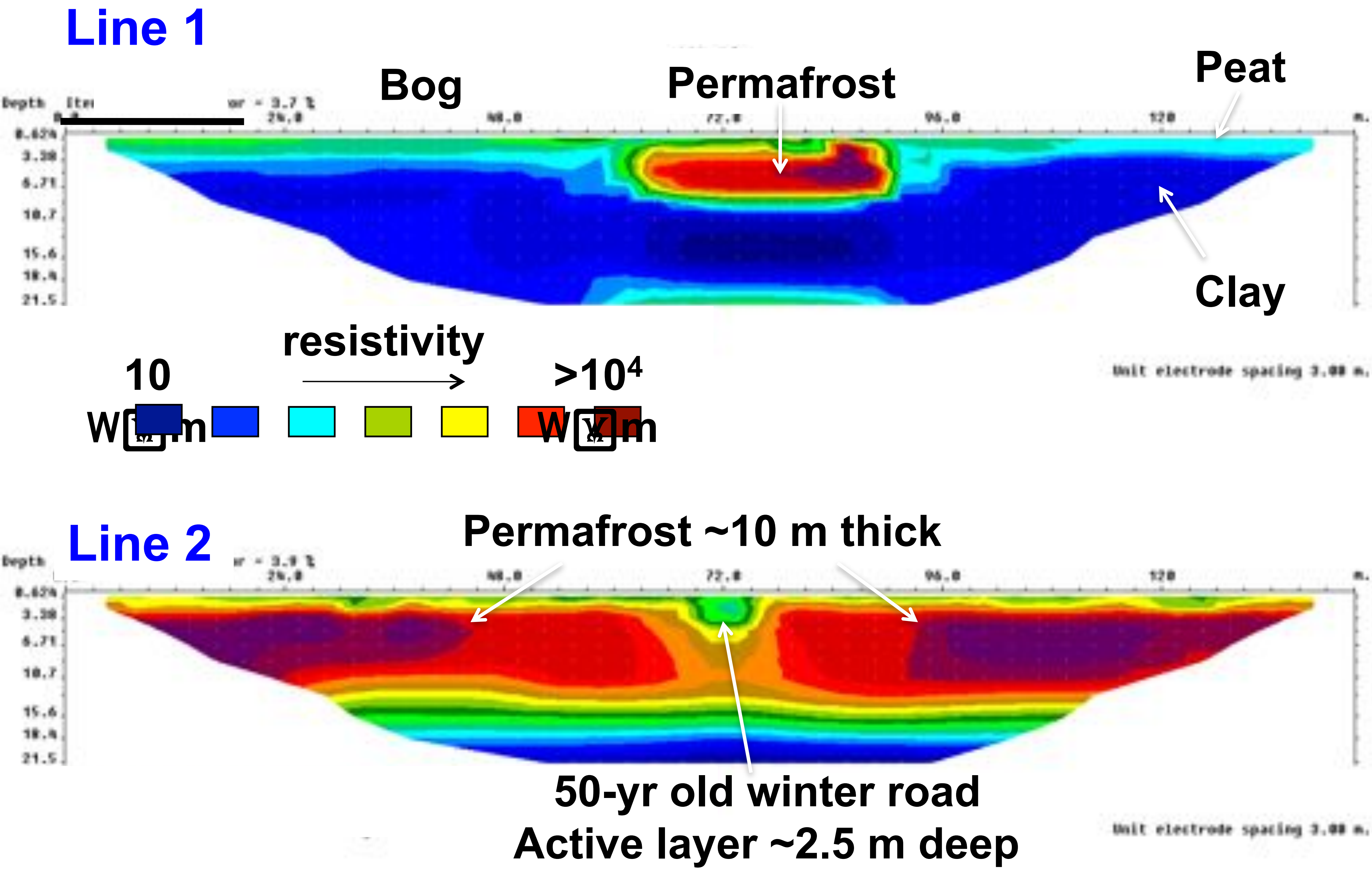
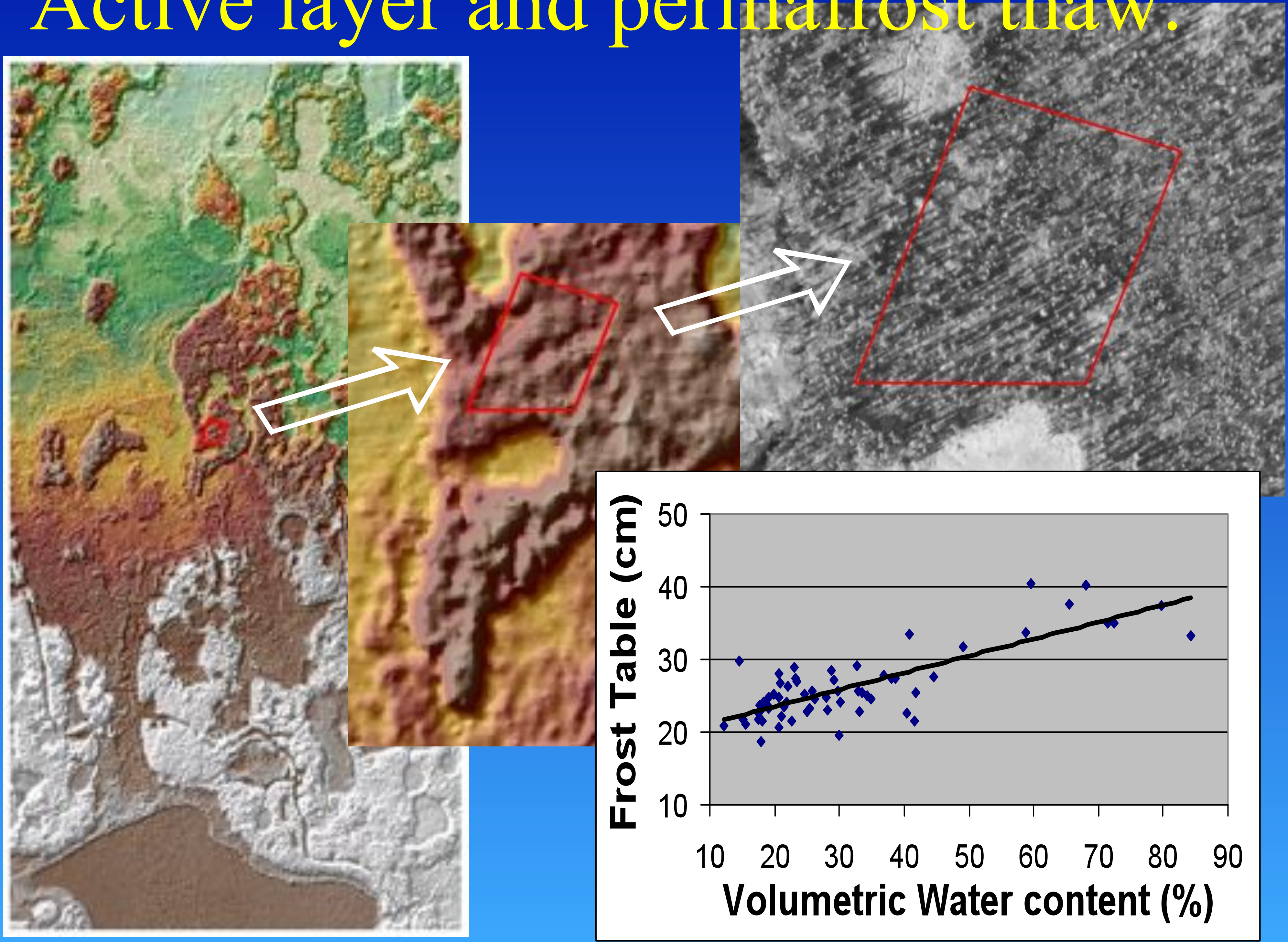
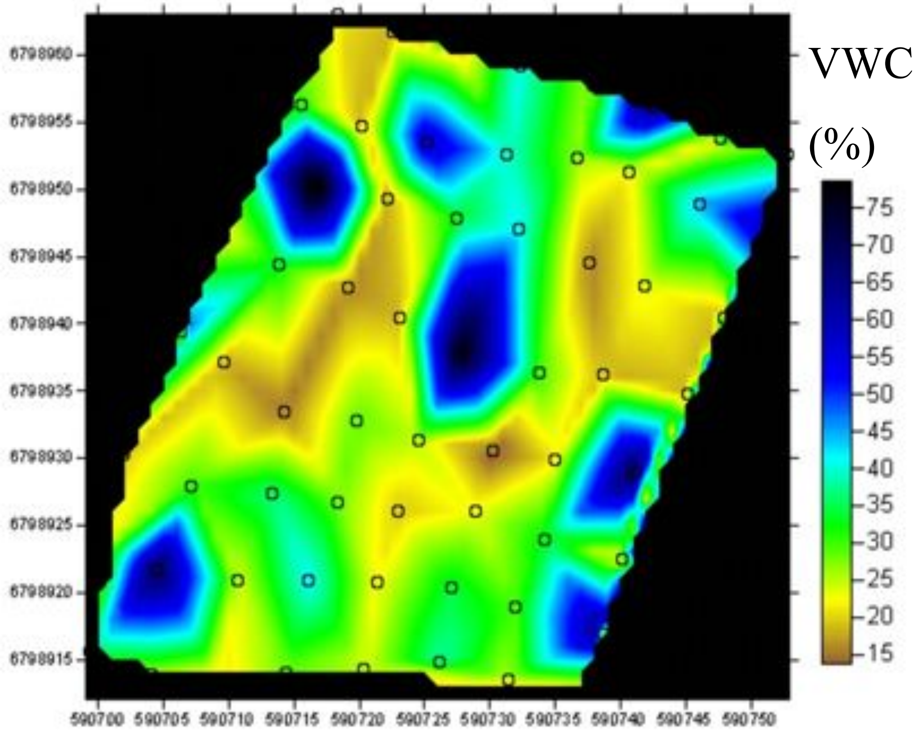
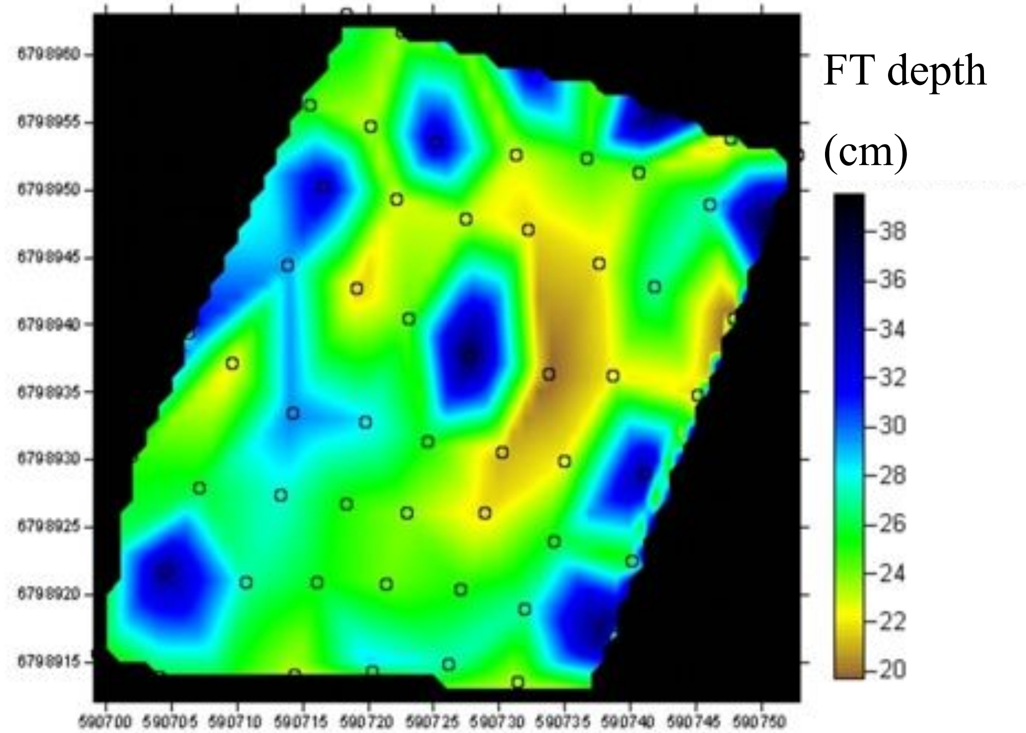
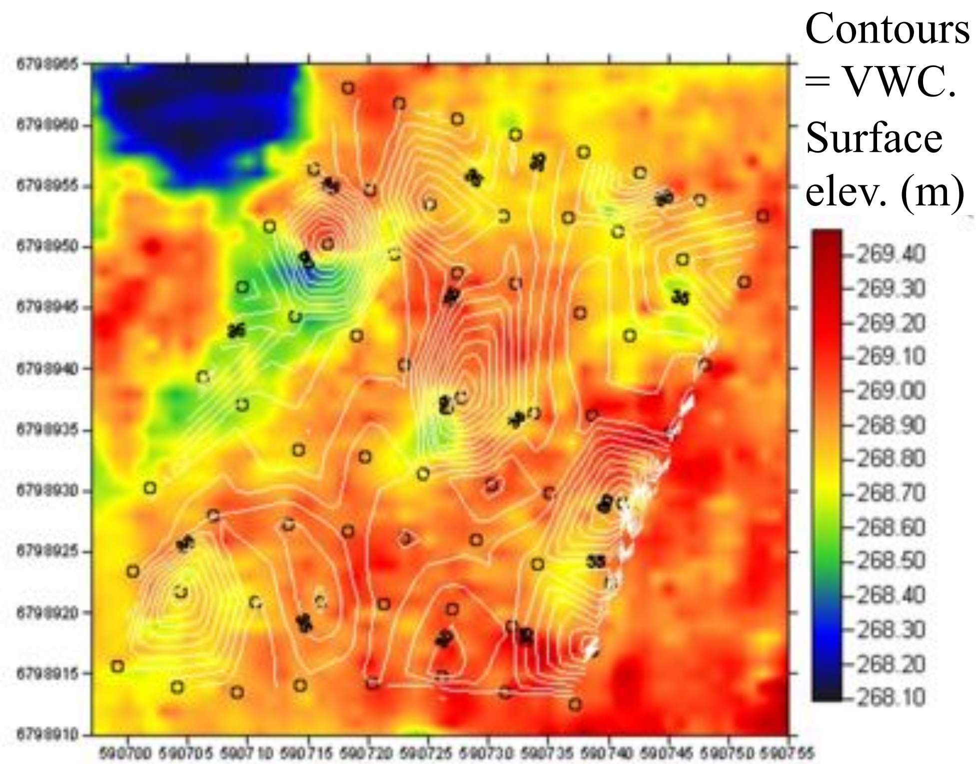


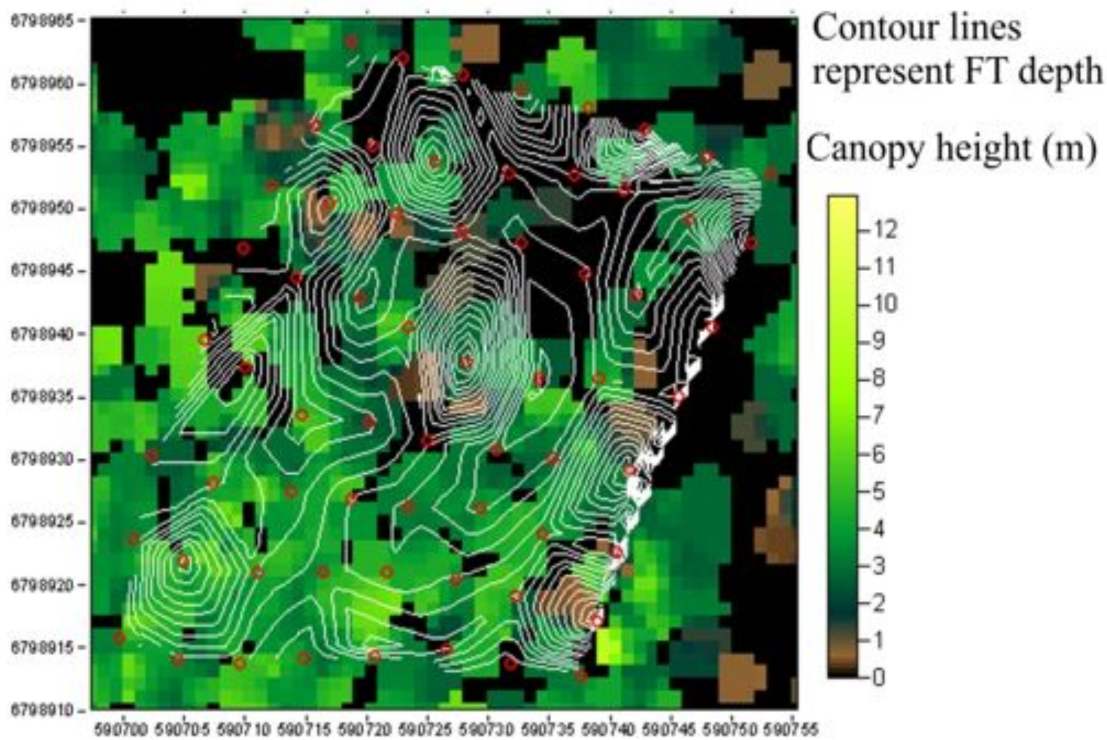
Active layer and permafrost thaw:



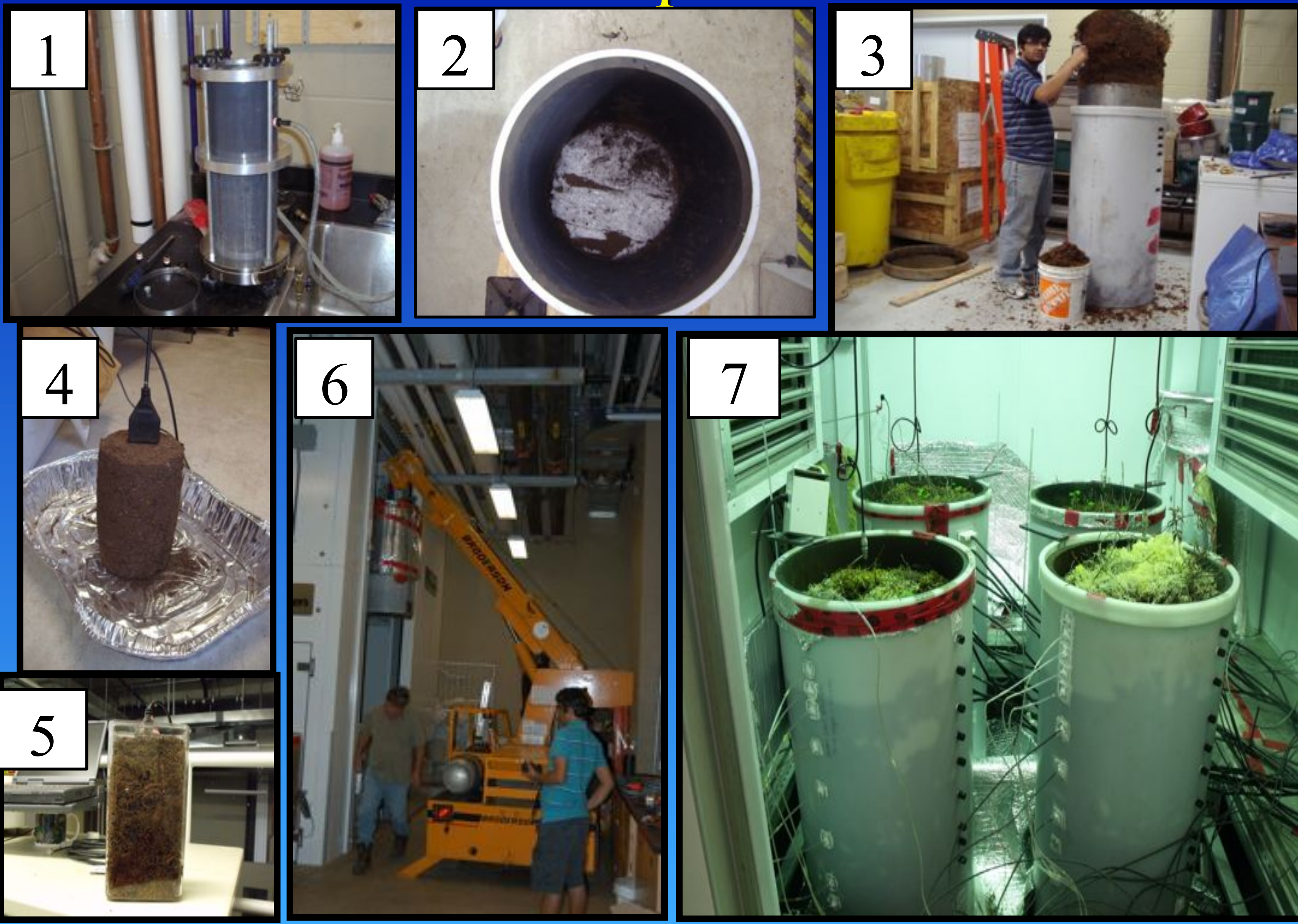

VWC
(%)
75
70
65
60
55
50
45
40
35
30
25
20
15


FT depth
(cm)
38
36
34
32
30
28
26
24
22
20

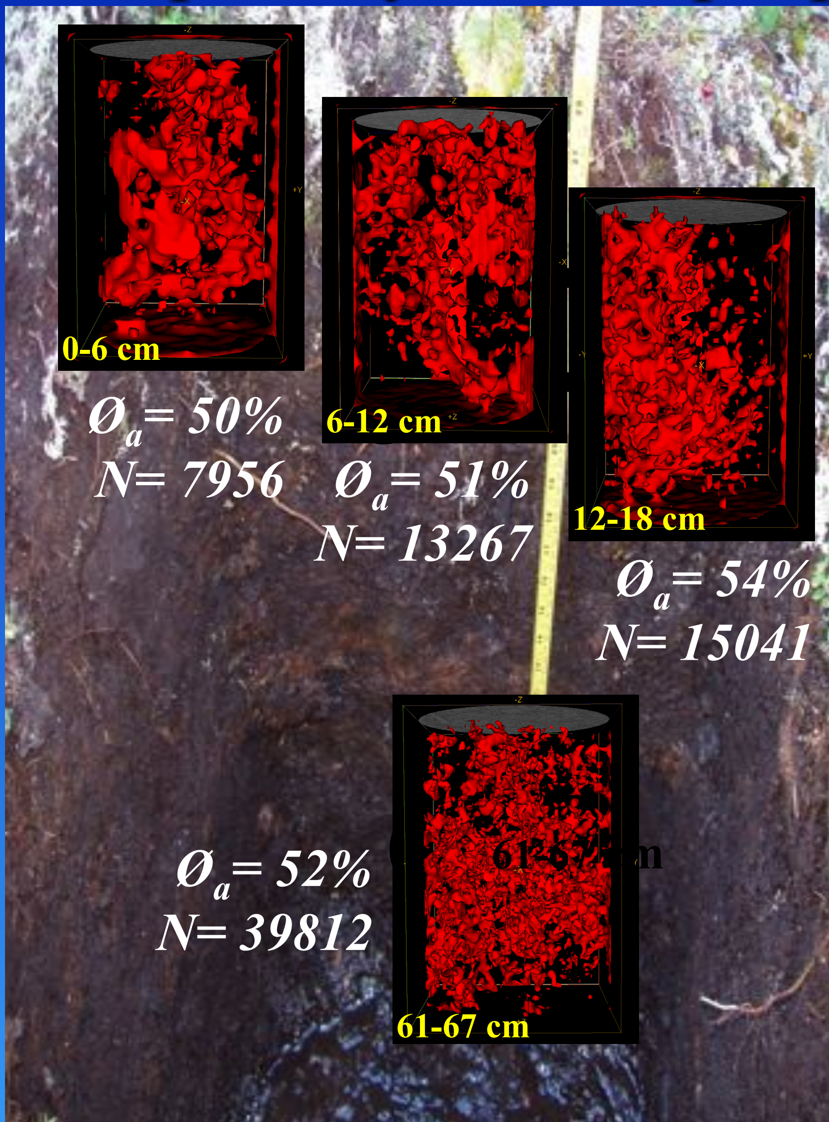

Contours
= VWC.
Surface
elev. (m)
269.40
269.30
269.20
269.10
269.00
268.90
268.80
268.70
268.60
268.50
268.40
268.30
268.20
268.10


Contour lines
represent FT depth
Canopy height (m)
12
11
10
9
8
7
6
5
4
3
2
1
0

Soil Mesocosm Experiments: UWO



Examining the influence of pore size and geometry on peat hydraulic properties using 3-D CT analysis

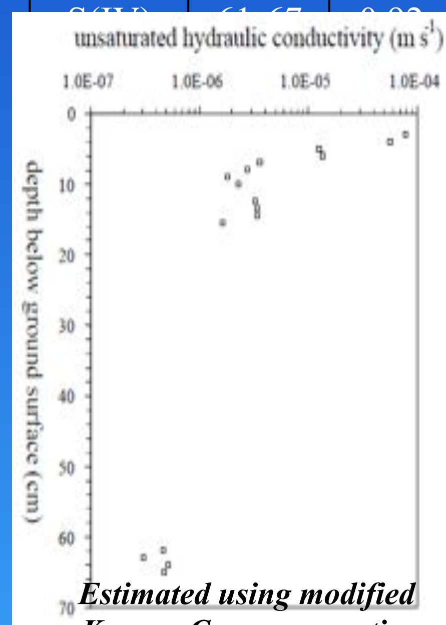


Red: air-filled pores

sub-sample	depth (cm)	$Ø_T$ (%)	θ (cm^3/cm^3)	ρ_b (gr/cm^3)	vP (-)	K (m/s) (Permeameter)
S(I)	0-6	0.955	0.385	0.035	H2	4×10^{-6}
S(II)	6-12	0.863	0.427	0.054	H3	2×10^{-6}
S(III)	12-18	0.933	0.402	0.071	H3	5.7×10^{-7}
S(IV)	61-67	[illegible]	0.437	0.115	H5	4.7×10^{-7}

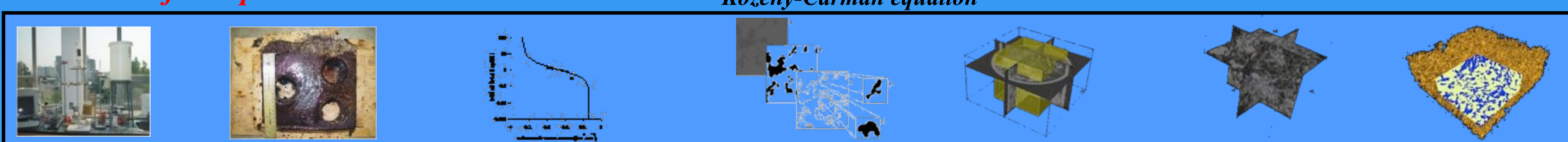
vP= von Post number

Constant pressure head: -40cm



Estimated using modified Kozeny-Carman equation

The large reduction of K_{unsat} with depth, under a constant pressure head, is controlled by air-filled pore hydraulic radius, tortuosity, air-filled pore density and the fractal dimension due to decomposition and compression of the organic matter.



On-going work:

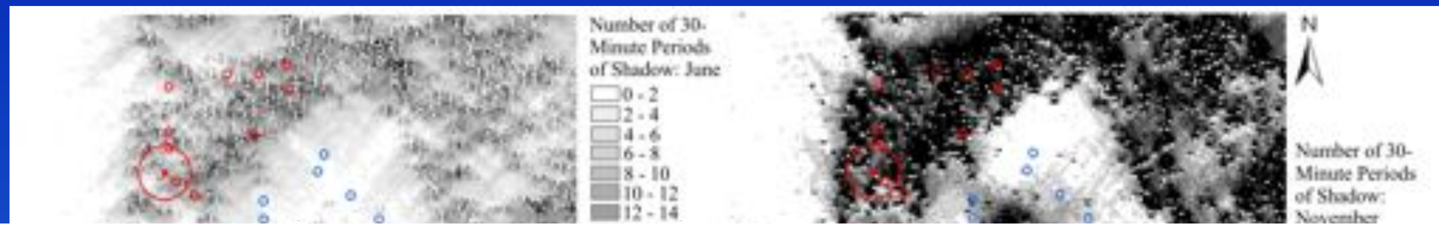
1) Identify the key factors controlling the rates and patterns of preferential thaw leading to permafrost degradation,

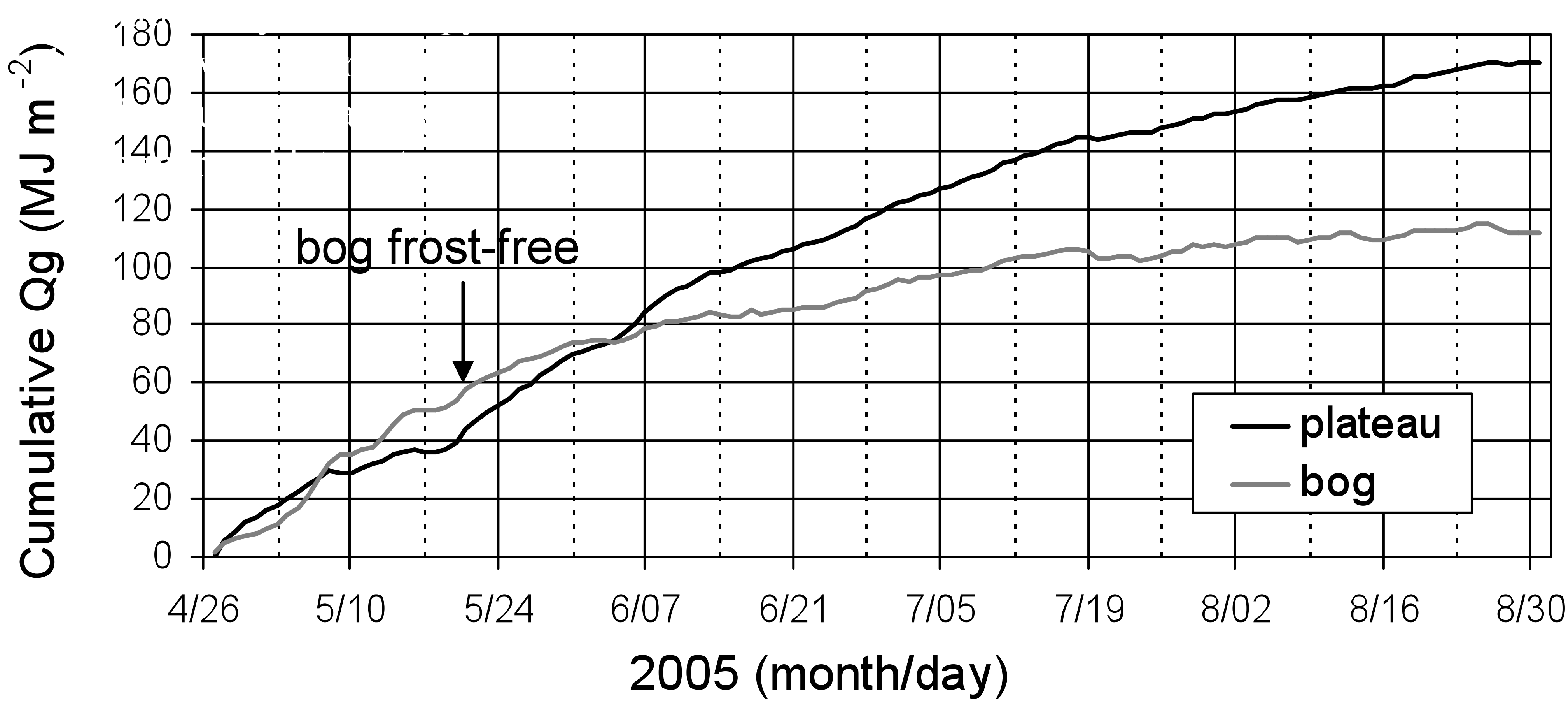
2) Develop a new model that simulates the permafrost response to climate warming and human disturbance,

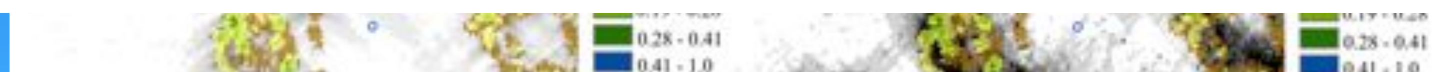
3) Develop conceptual & mathematical models of key hydrological processes, and

4) Couple the hydrological and permafrost models to predict the spatial distribution of permafrost, and the river flow regime under scenarios of climate warming and human disturbance.

Ground surface energetics and subsurface thermal regime of permafrost plateau and a peat bog







June, 2005

November, 2005