Circumpolar Active Layer Monitoring

CALM program:

Long-term monitoring of the active layer/upper permafrost system.

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GTN-P
Global Terrestrial Network for Permafrost

CALM OBJECTIVES

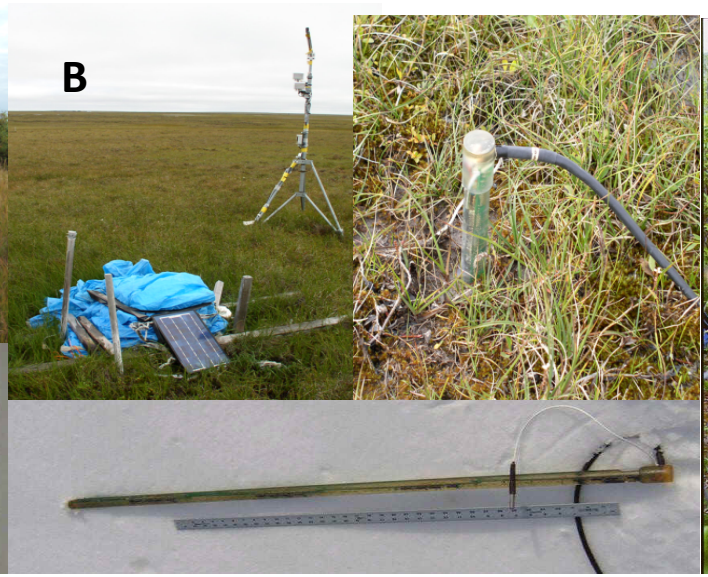
1. Develop and maintain programs of long-term, active layer observations;

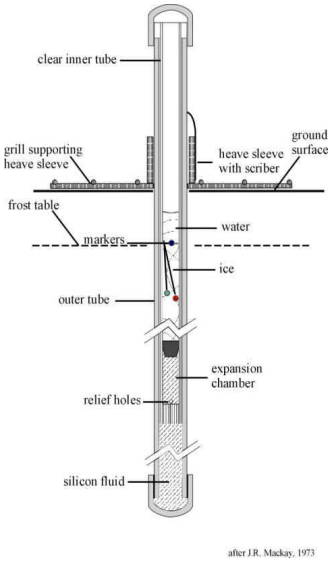
2. Develop standardized active-layer data sets for use in validating hydrologic, ecosystem, permafrost, and climate models;

CALM HISTORY

1989: International Symposium on Geocryological Studies in Arctic Regions, Yamburg, Russia
1991-1997: Initial CALM program launched and managed in association with the International Tundra Experiment (ITEX) program
1995-1998: NSF Arctic Flux Program in northern Alaska
1998- 2003: CALM I **(OPP-9732051)**
2002: First CALM Workshop, Lewes, DE
2004-2009:CALM II **(OPP-0352958)**
2008: Second CALM Workshop, Fairbanks, AK
2009-2014: CALM III **(ARC-1002119)**
2014-2019: CALM IV **(PLR-1304555)**

ACTIVE LAYER MONITORING PROCEDURE





Three methods are used to determine the thickness of the active layer:

Spatial Measurements : A) Mechanical probing using a graduated metal rod; Conducted on regular grids of sampling points ranging from 10×10 m to 1000×1000 m.

Point Measurements: B) Temperature measurements; C) Frost/thaw tubes.

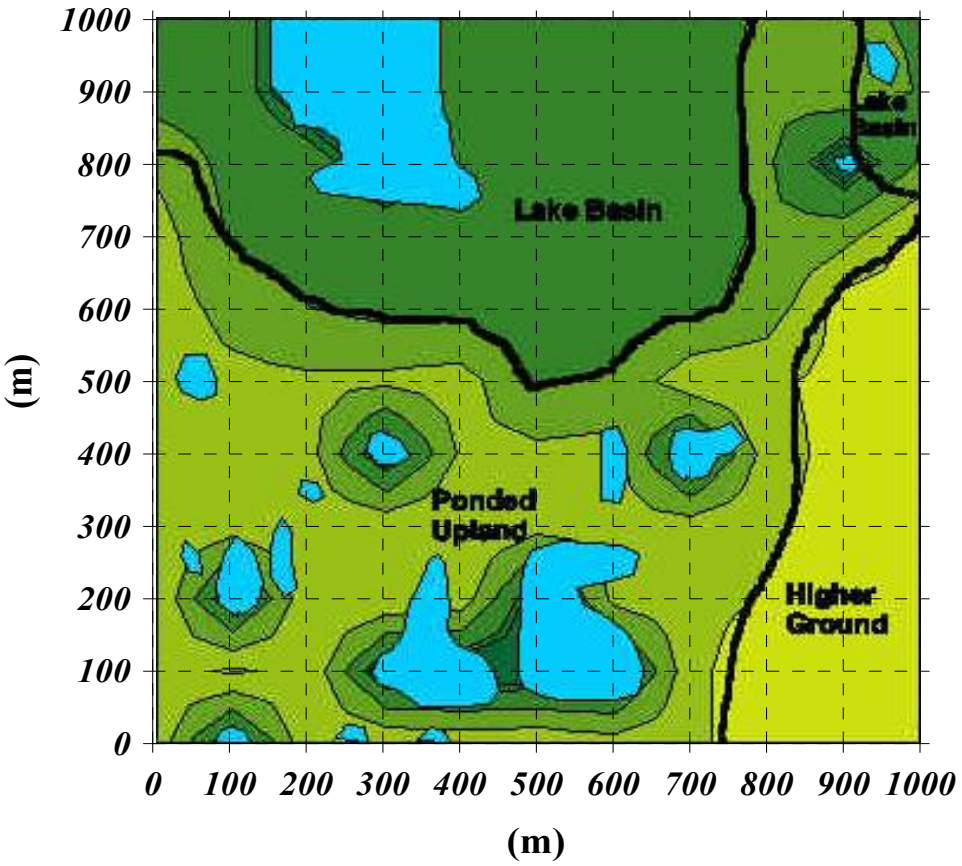
SPATIAL ACTIVE LAYER MEASUREMENTS

Grids are established at undisturbed locations, characteristic of dominant environmental conditions.

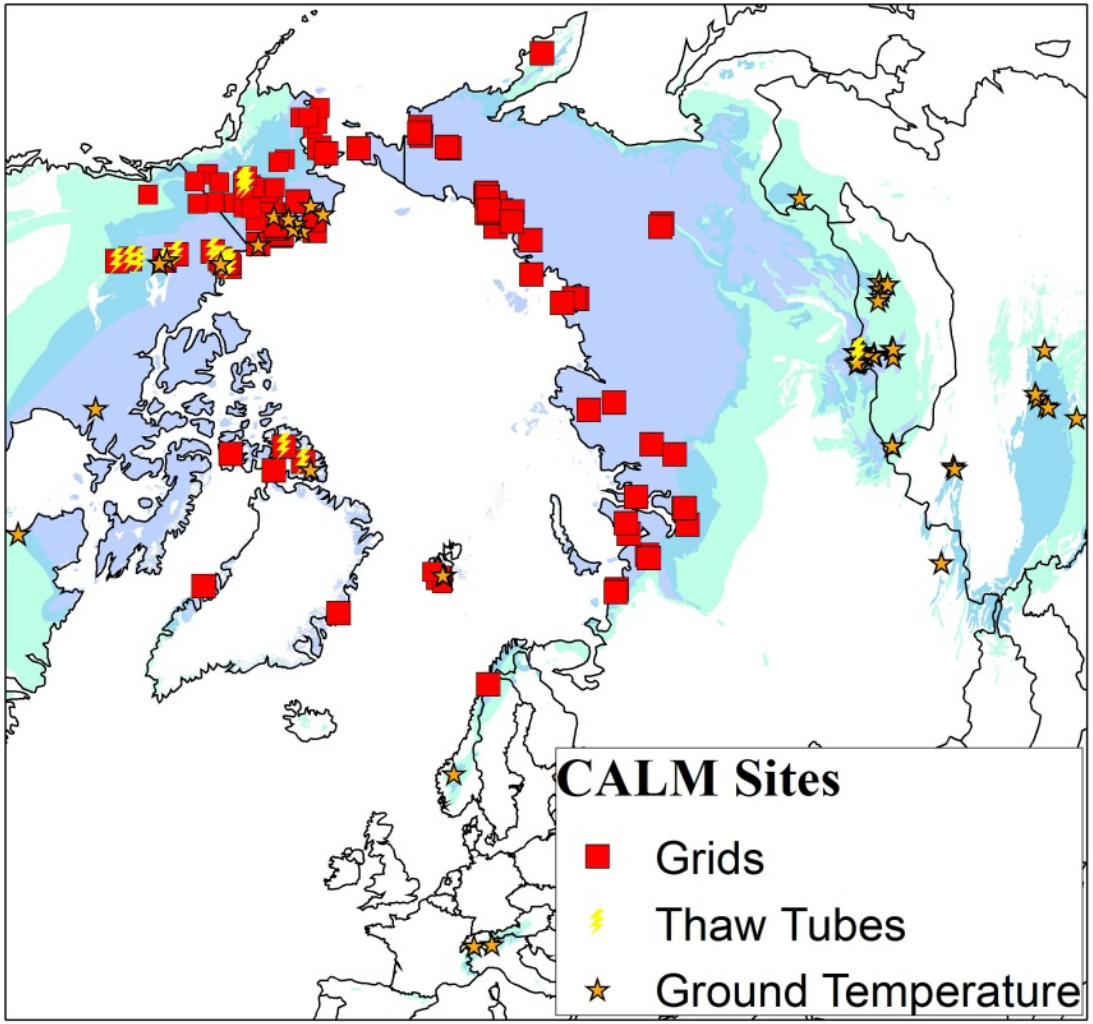
Size of grids varies depending on site geometry, and the level of natural variability of surface and subsurface conditions.

In general, 10×10m to 100×100m size grids are established within relatively homogeneous landscape units. Several sites contain a number of grids representing various landscape units within the area.

The 100×100m to 1000× 1000m grids usually encompass several characteristic landscapes within the area.

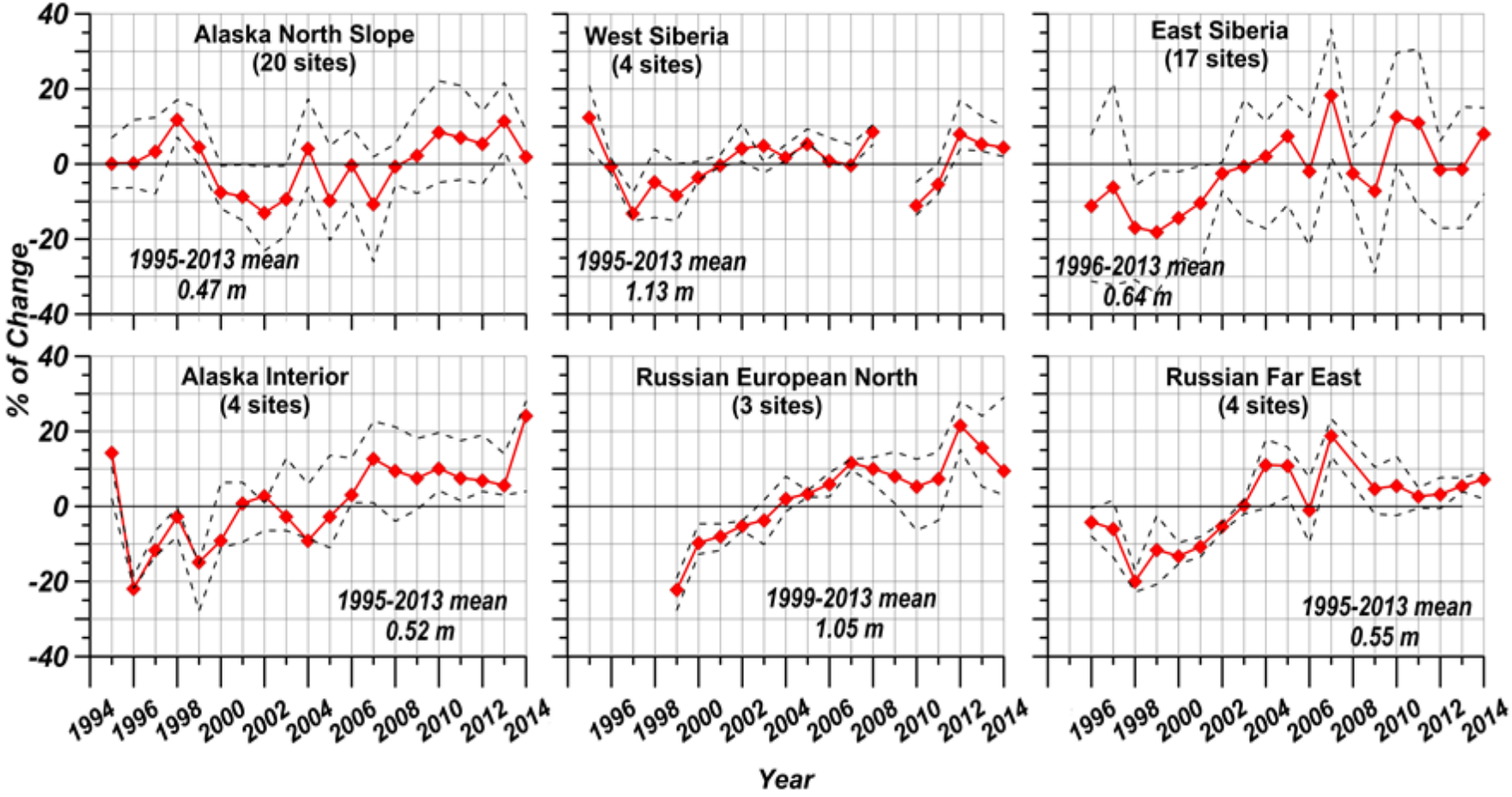


CALM NETWORK
(Northern Hemisphere Component)



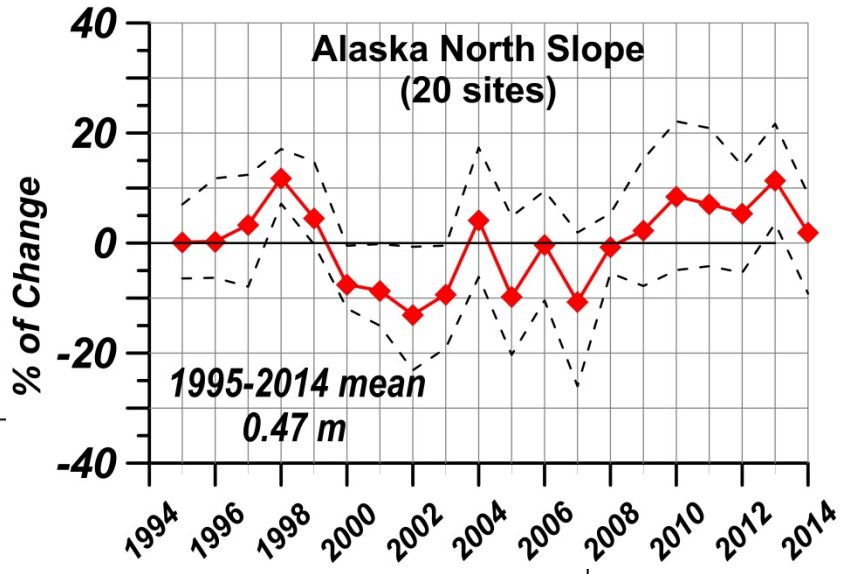
- The CALM network incorporates 234 sites in Arctic and mountainous regions.
- About 115 continuously report data.
- About 70% of the sites are located in Arctic and Subarctic lowlands underlain by continuous permafrost.
- The distribution of sites is not uniform, a circumstance attributable to historical circumstances and logistical constraints.
- Data available at www.gwu.edu/~calm

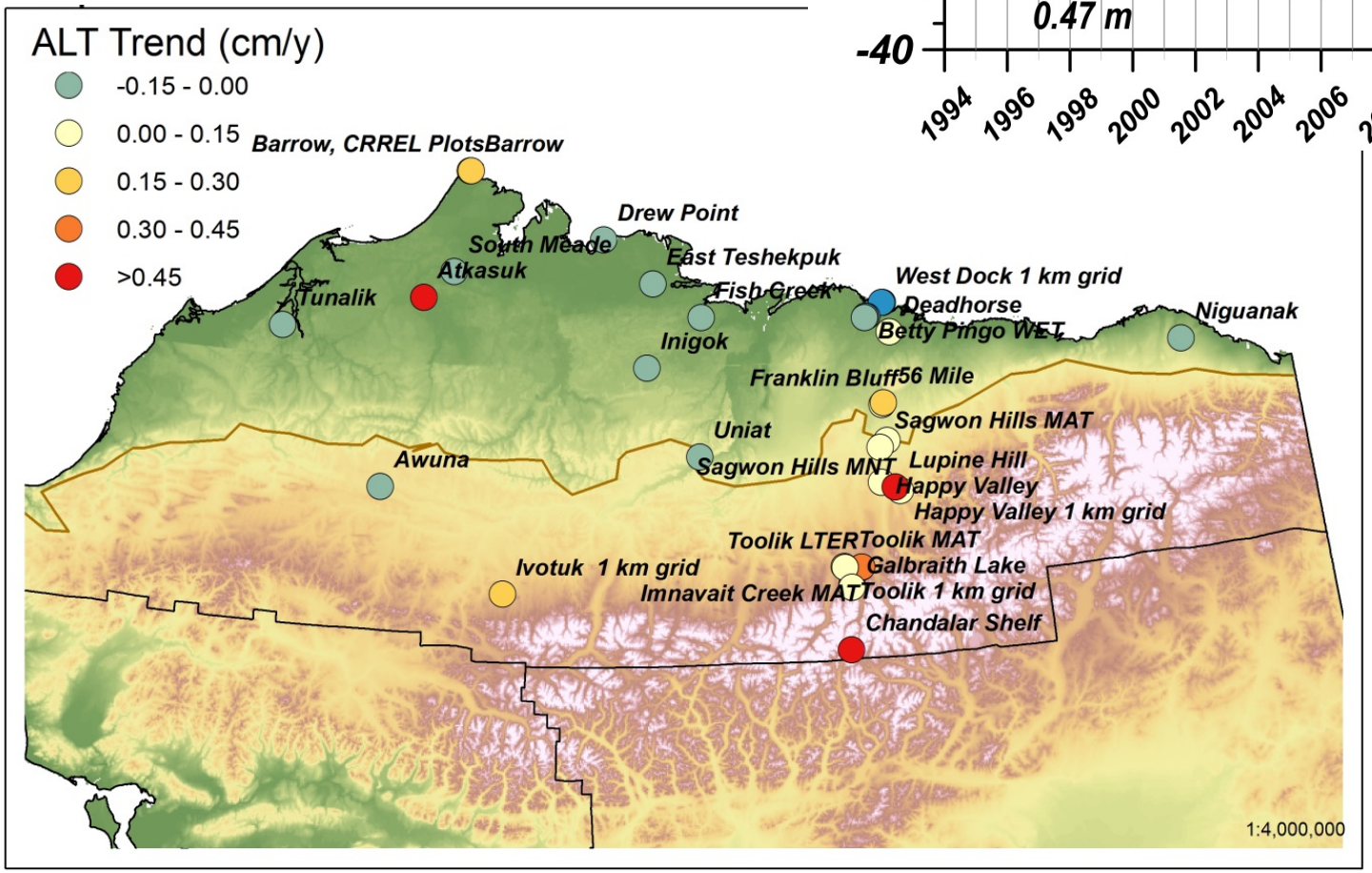
NSF AON CALM (PLR-1304555): 82 Active sites (33 USA (AK); 50 RU)



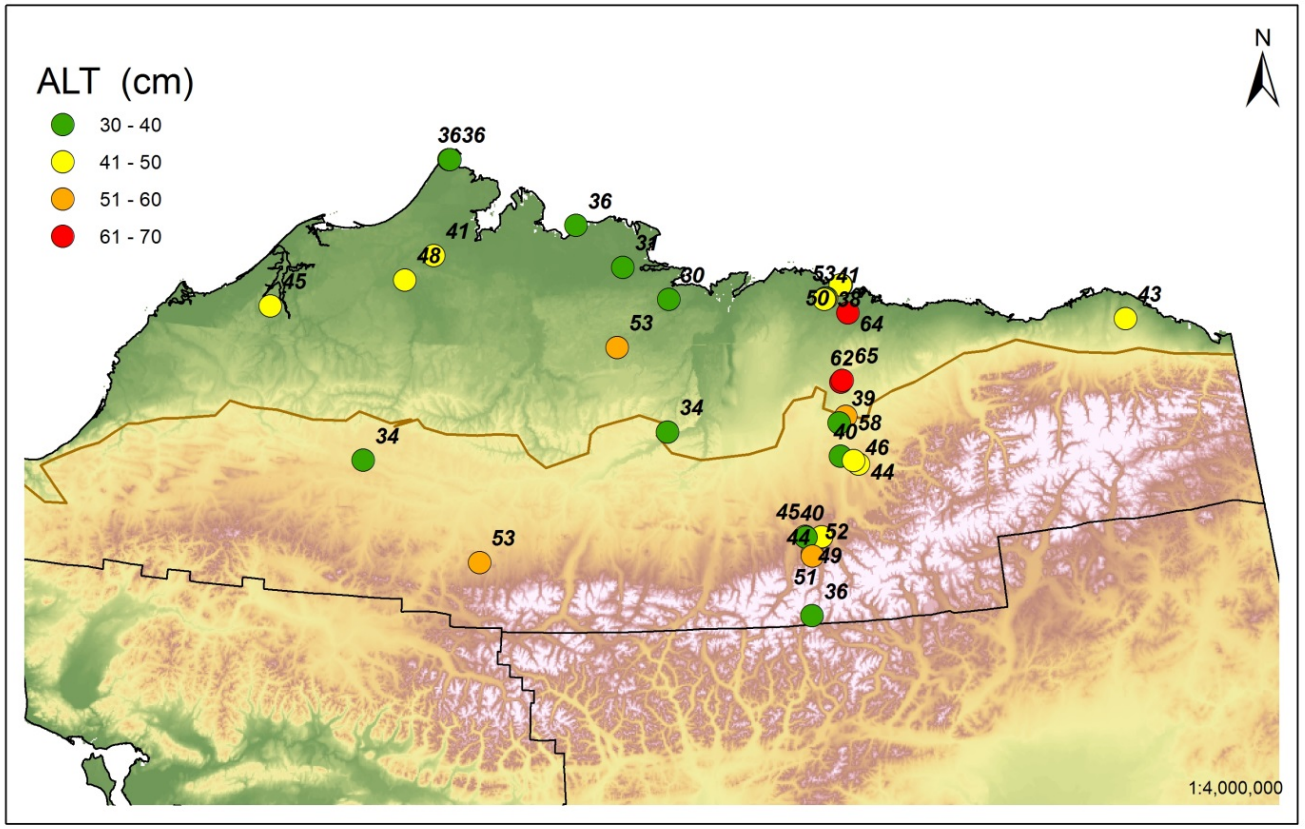
Long-term active-layer change in six different Arctic regions as observed within the Circumpolar Active Layer Monitoring (CALM) project. The data are presented as annual percentage deviations from the mean value for the period of observations.

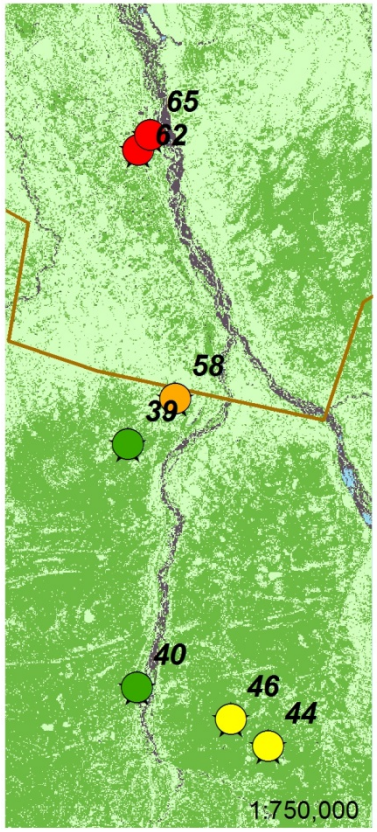
ALT TRENDS (1995-2014)



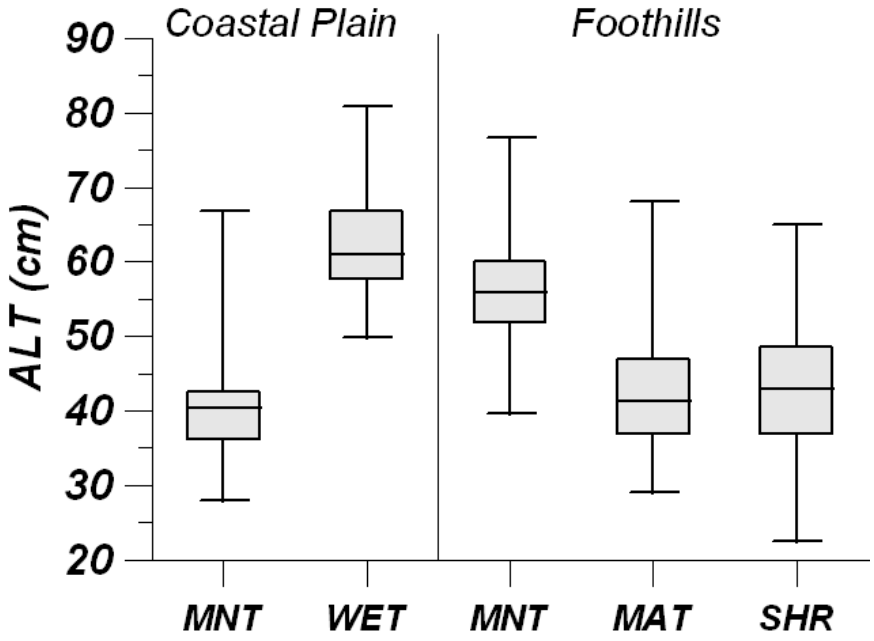


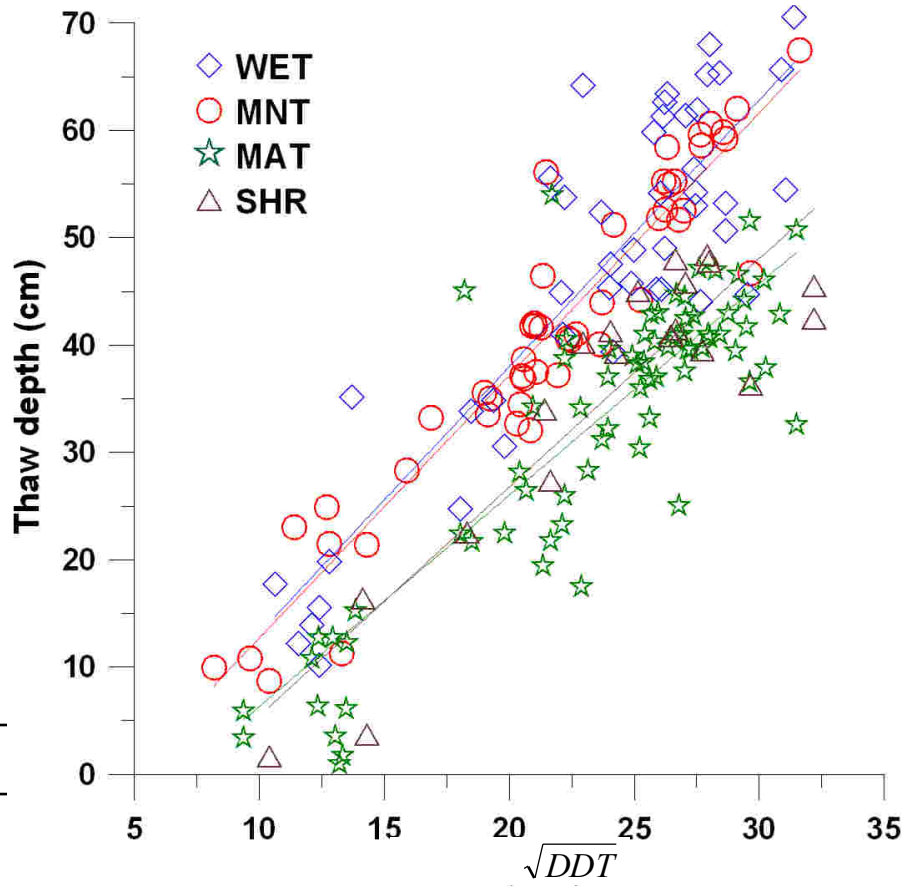
LONG-TERM ALT AVERAGES





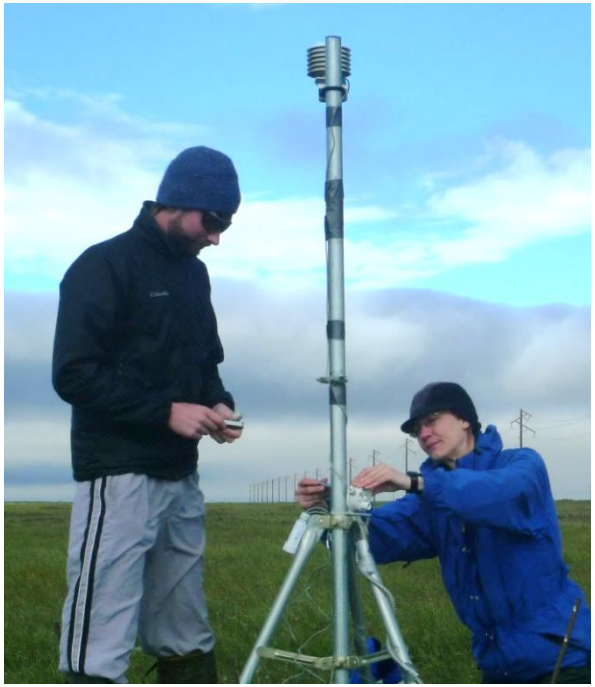
LANDSCAPES-SPECIFIC VALUES OF ALT

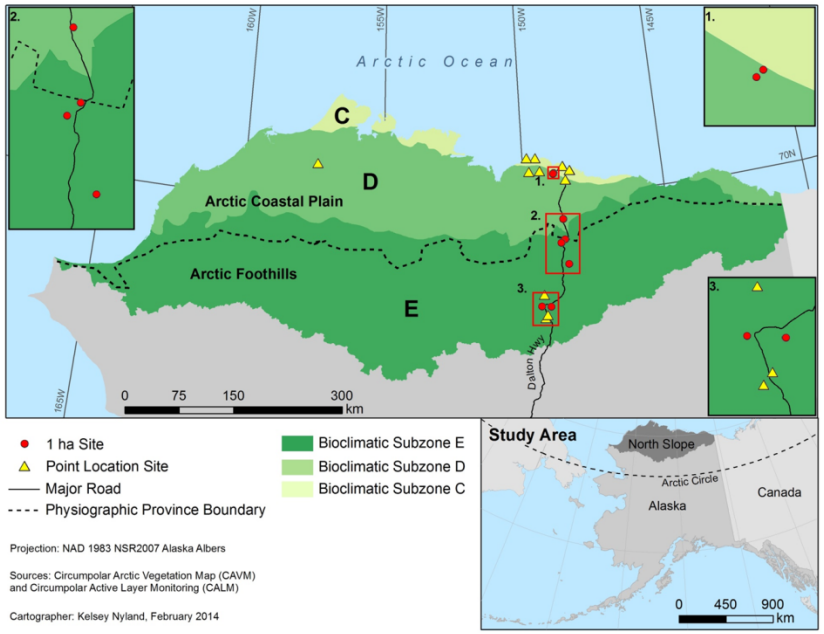




Landcover categories	Coastal Plain	Foothills
Moist nonacidic tundra	40.0	56.4
Moist acidic tundra		40.5
Moist low shrub tundra		43.0
Wet graminoid tundra	62.9	49.1

GROUND SURFACE TEMPERATURE MONITORING



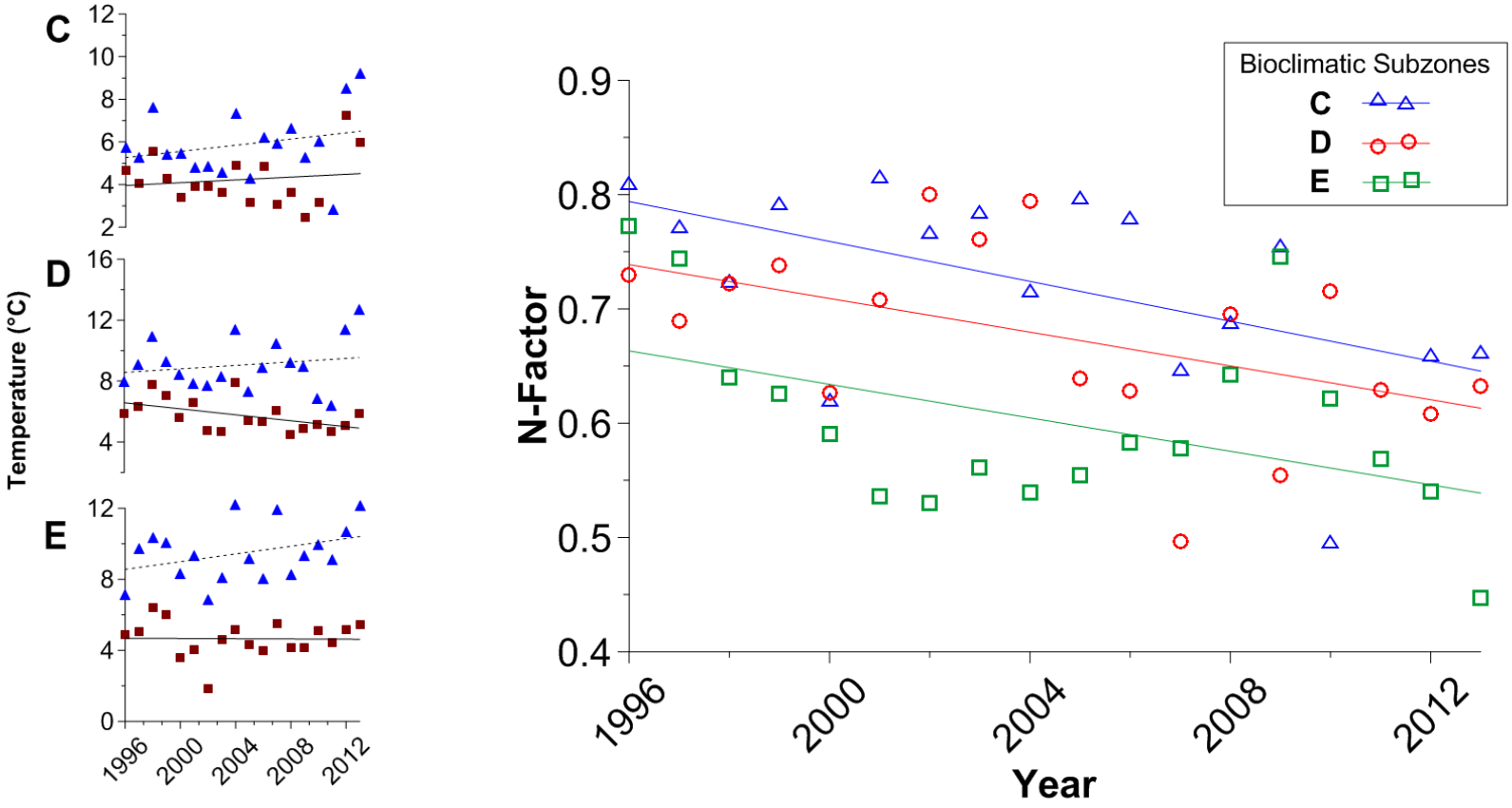


Summer Season Temperature Difference and N-Factors

ΔT°	C	D	E
Barrens		-0.07	-0.41
Moist Nonacidic Tundra	1.51	2.23	3.31
Moist Acidic Tundra			3.64
Shrublands			4.30
Wet Tundra	0.77	3.16	2.58
Cold Acidic Tundra		0.73	

N-Factor	C	D	E
Barrens		1.14	1.11
Moist Nonacidic Tundra	0.73	0.67	0.67
Moist Acidic Tundra			0.61
Shrublands			0.59
Wet Tundra	0.75	0.62	0.71
Cold Acidic Tundra		0.90	

Mean Summer Temperatures and N-Factor Time Series by Bioclimatic Subzone



- Long-term changes in summer N-Factors and temperature differences between the air and soil surface indicate the increase in the thermal insulating properties of vegetation.

- Changes in the insulating properties of vegetation can be attributed to long-term climate-induced changes in biomass. However further investigations are needed.

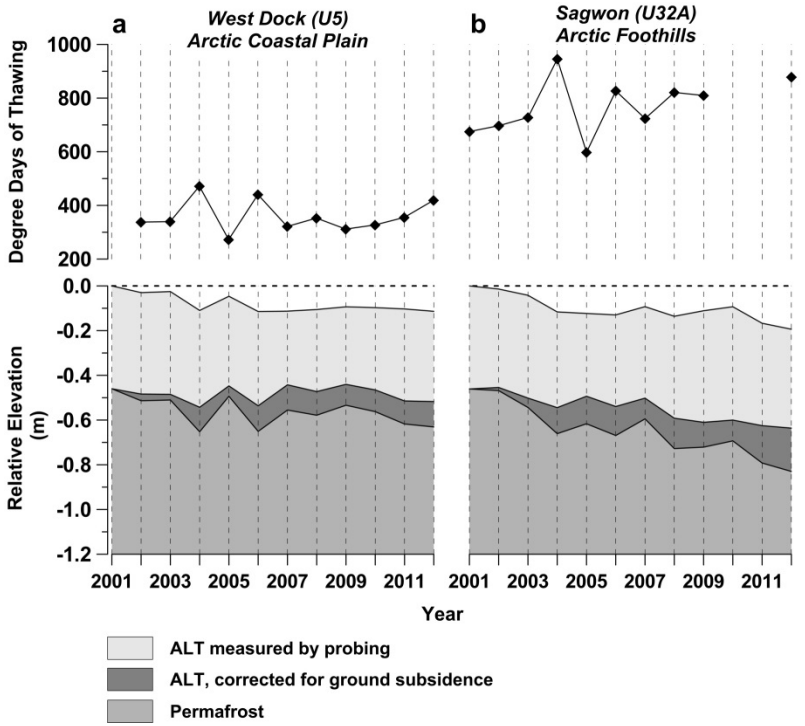
ISOTROPIC THAW SUBSIDENCE

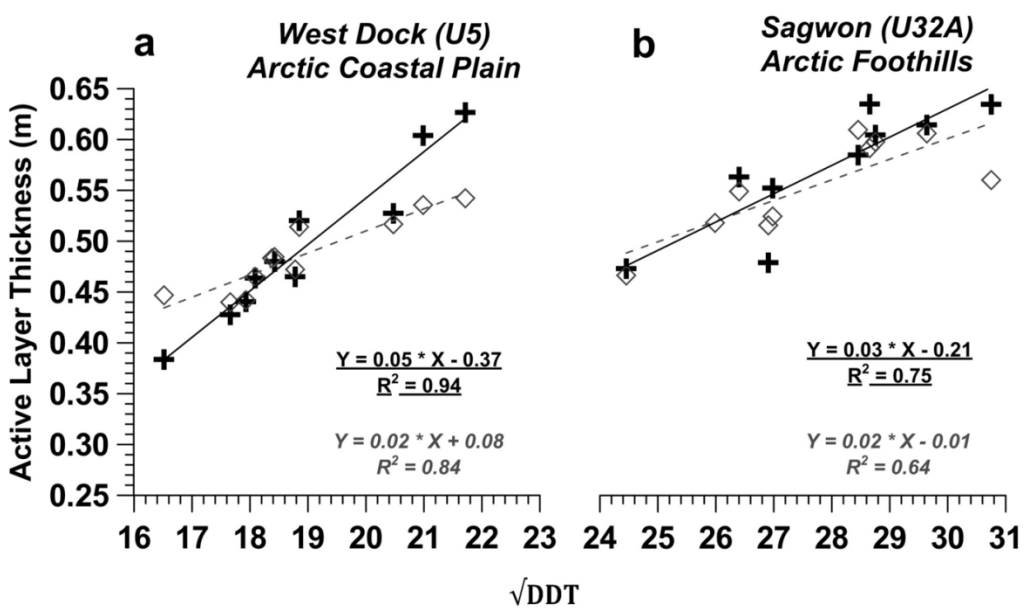
- Frost heave and thaw subsidence are important drivers of geomorphological processes in permafrost and periglacial areas.

- Upward movement of the ground surface can be attributed to migration of water to the freezing front and development of segregation ice.

- Downward movement occurs due to thawing of sub-surface permafrost during summer months.

- ISOTROPIC THAW SUBSIDENCE: Landscape-scale, thaw-induced subsidence that lacks the topographic contrasts associated with thermokarst terrain.

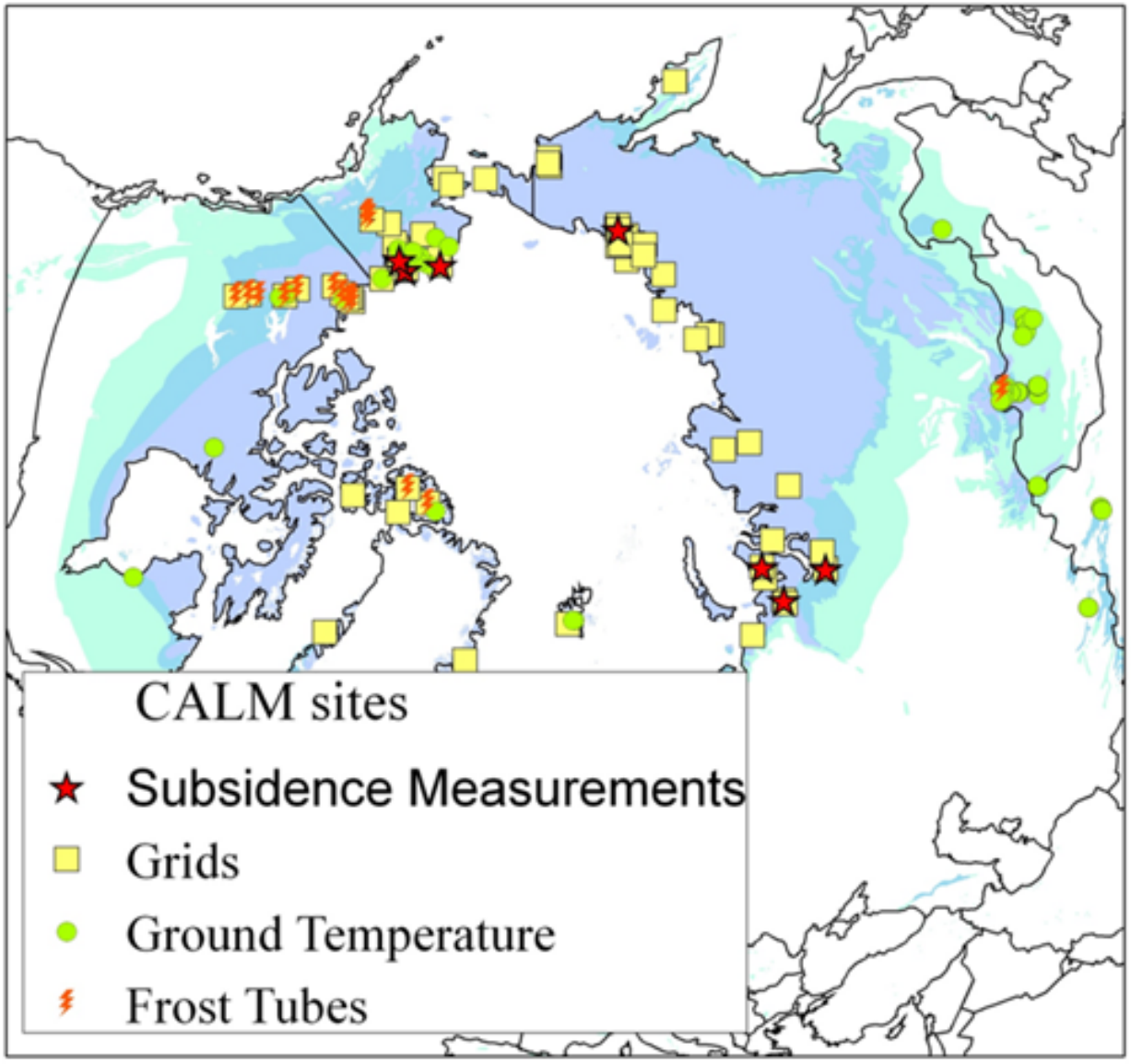


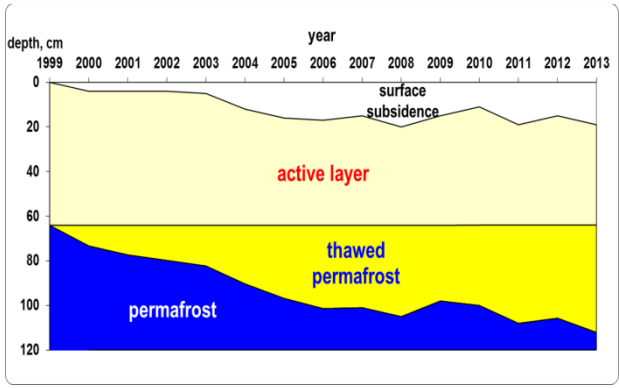


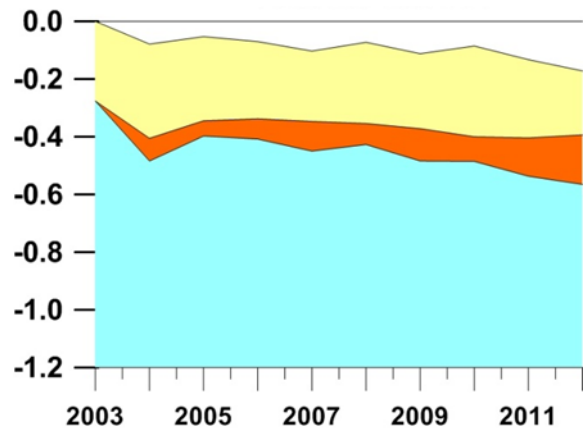
- Entire natural landscapes underlain by ice-rich permafrost are subsiding slowly in response to warming of atmospheric climate, without initiation by localized anthropogenic or geomorphic disturbances.

- The annual contemporary rate of subsidence for the study period, as inferred from the study sites is about 1.0 cm/year in the Coastal Plain and 1.7 cm/year in the Foothills.

Shiklomanov et al 2013


CALM sites
Subsidence Measurements
Grids
Ground Temperature
Frost Tubes


depth, cm
year
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
0
20
40
60
80
100
120
surface subsidence
active layer
thawed permafrost
permafrost


0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
2003
2005
2007
2009
2011

GTN-P: Global Terrestrial Network On Permafrost

Global Climate Observing System

(GCOS)

GCOS global networks →

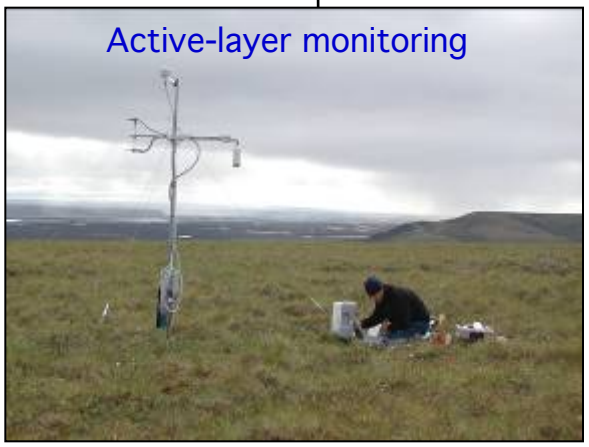
- Global Atmosphere Watch (GAW)
- Global Ocean Observing System (GOOS)
- Global Terrestrial Observing System (GTOS)

Global Terrestrial Networks →

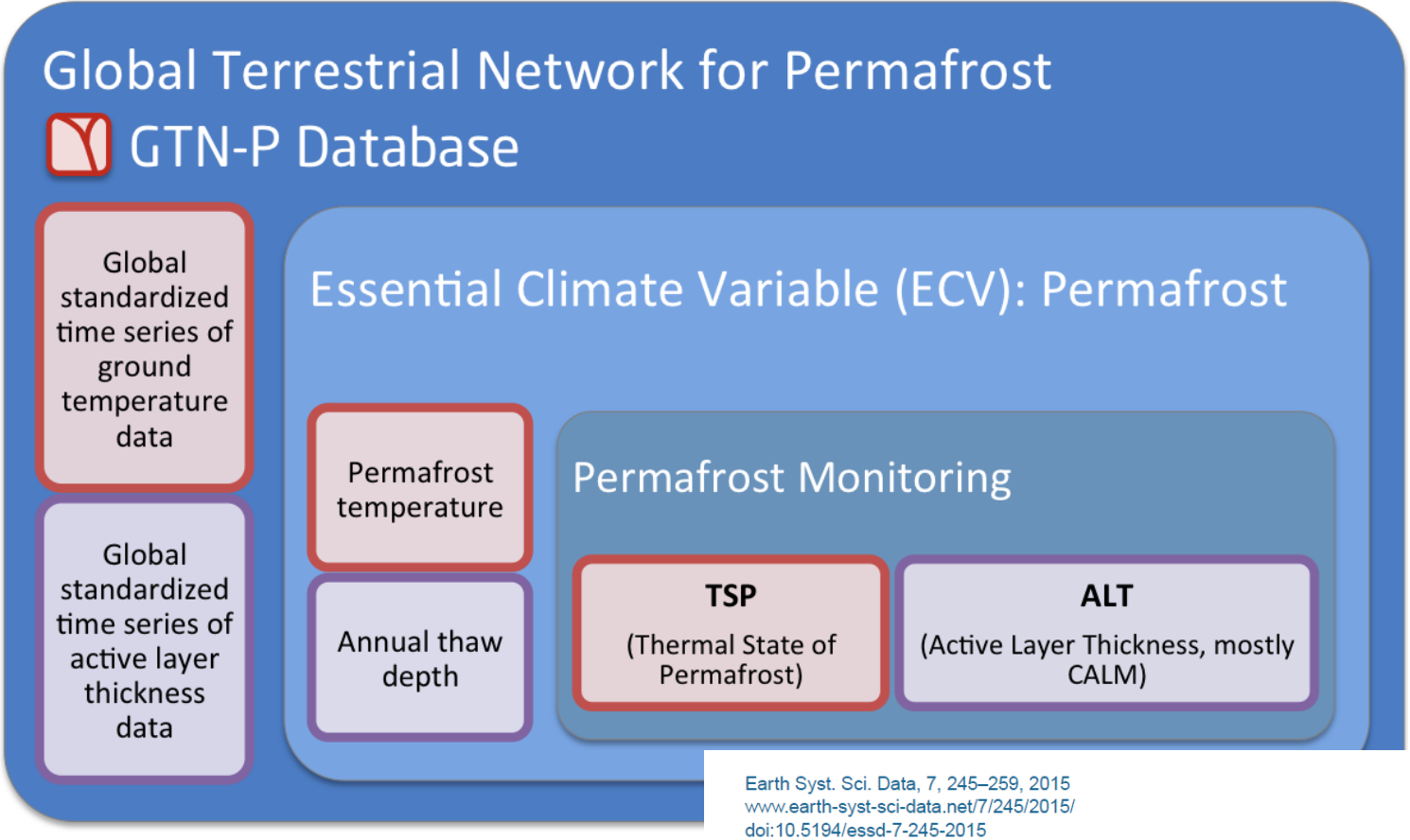
- Ecology (GTN-E)
- Hydrology (GTN-H)
- Glaciers (GTN-G)
- Permafrost (GTN-P)

GTN-P →

Active-layer monitoring



Thermal State of Permafrost



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doi:10.5194/essd-7-245-2015

Open Access Earth System Science Data

The new database of the Global Terrestrial Network for Permafrost (GTN-P)

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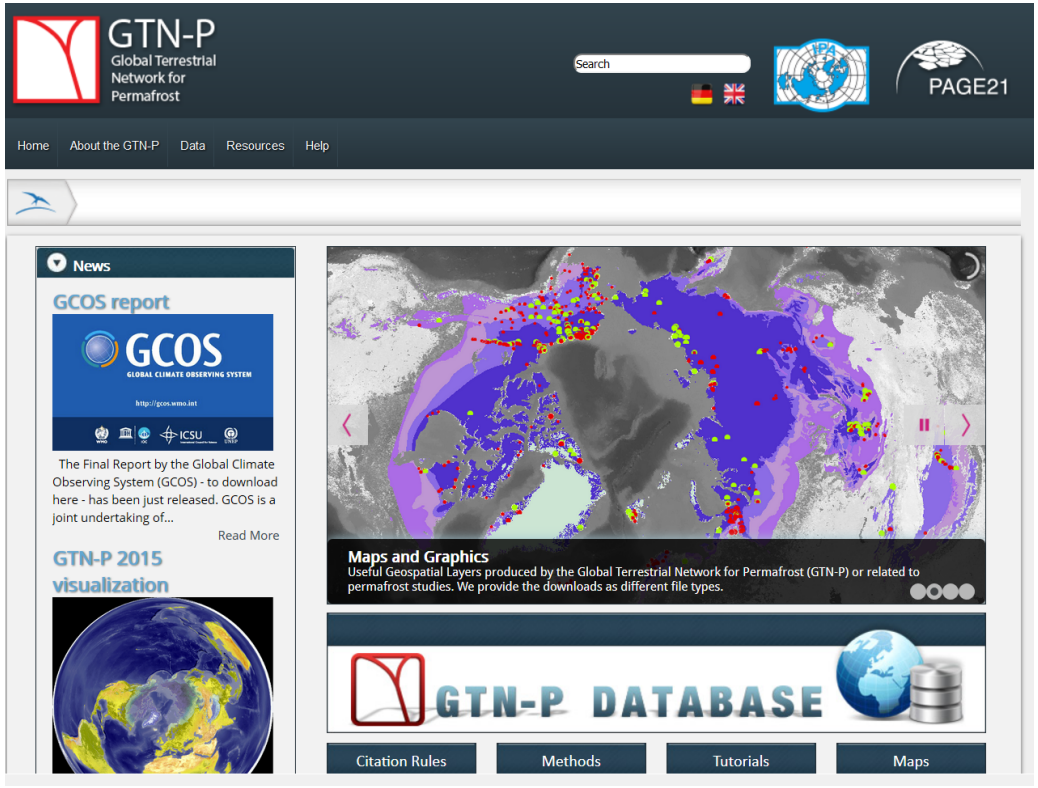

GTN-P data are featured in:

- State of the Climate Report (BAMS)
- Arctic Report Card (NOAA)
- Roshydromet Annual Report
- IPCC, SWIPA, ACIA, UNEP

http://gtnpdatabase.org/