



Thermal State of Permafrost (TSP)

Gradient of Seasonal Thaw Depth along the Yamal Transect

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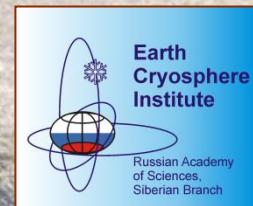
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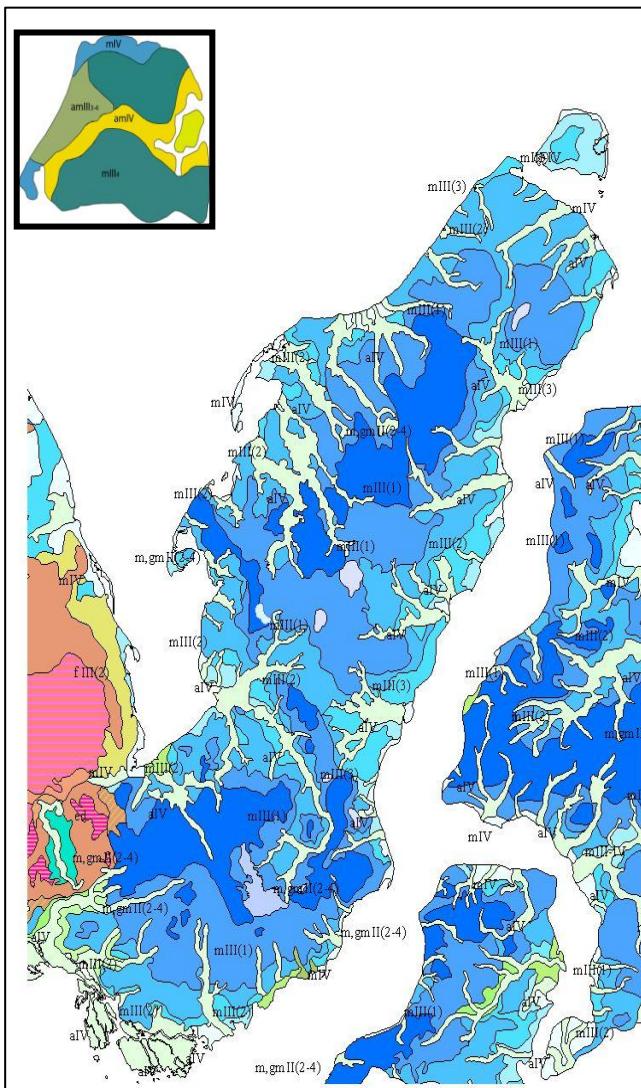


LCLUC-Yamal Transect physiography





Quaternary geology



Average air temperature

-13,3°C

-10,3°C

-9,7°C

-8,1°C

-7,0°C

Tundra portion of the Transect covers the distance of 1540 km from Laborovaya ($67^{\circ}42'23''\text{N}$, $67^{\circ}59'55''\text{E}$) to FJL Hayes Island ($80^{\circ}35'56''\text{N}$, $57^{\circ}54'20''\text{E}$):

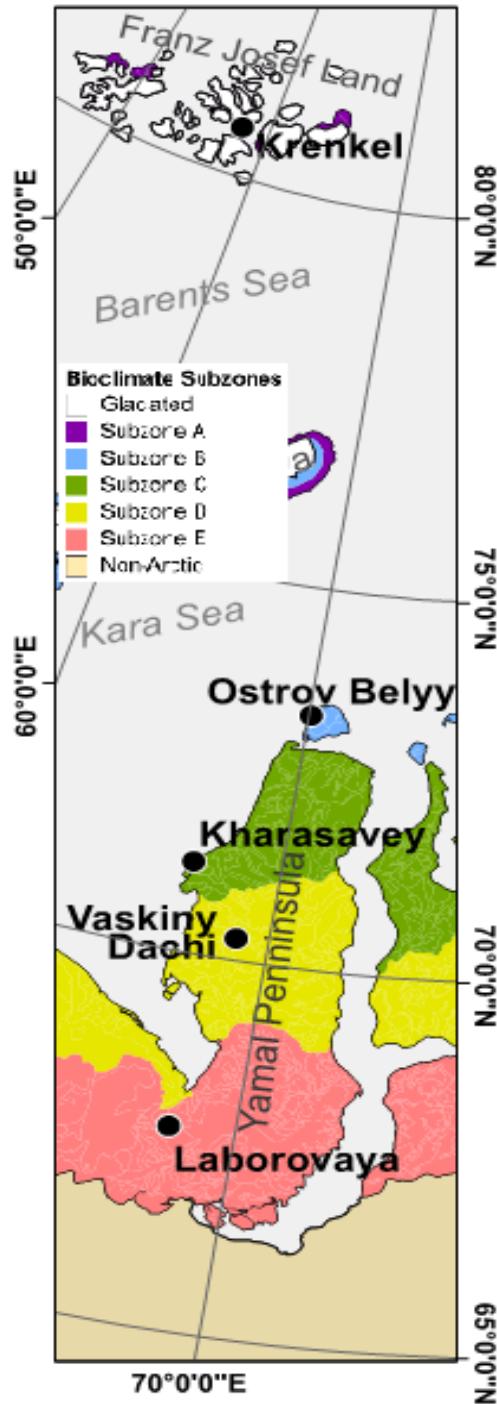
LOCATIONS	DISTANCE E, km
Laborovaya – Vaskiny Dachi	290
Vaskiny Dachi – Kharasavey	125
Kharasavey – Bely Island	260
Bely Island – Hayes Island (Krenkel)	865

Bioclimatic subzones of the Yamal transect

Bely Island 2009-2011



Vaskiny Dachi 1993-2011



Hayes Island 2010



Kharasavey 2008



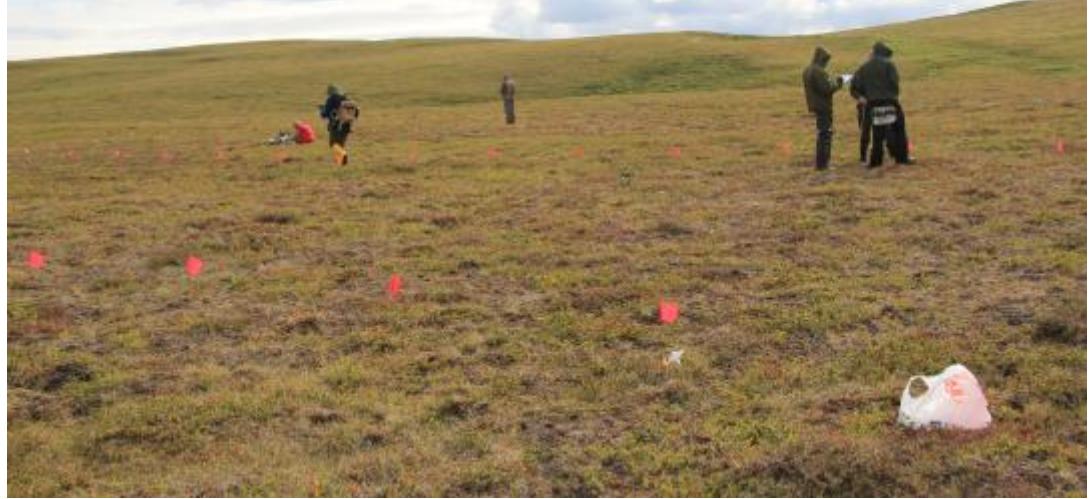
Laborovaya 2007-2009



Laborovaya location



Laborovaya-1



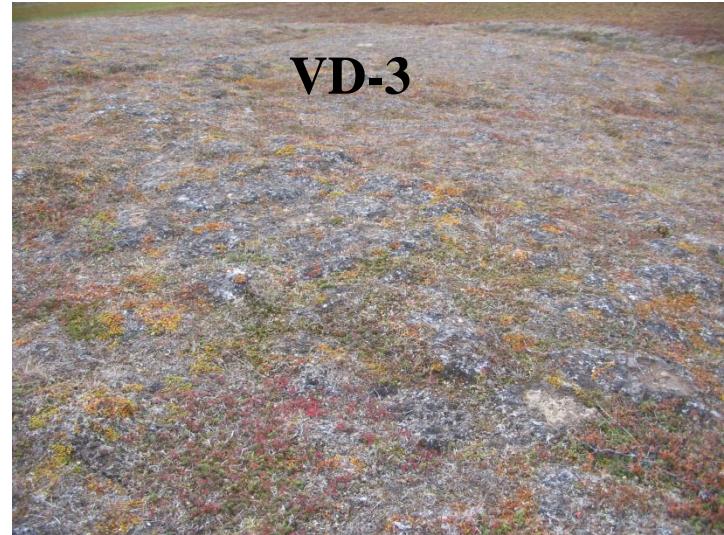
Laborovaya-2

Vaskiny Dachi location

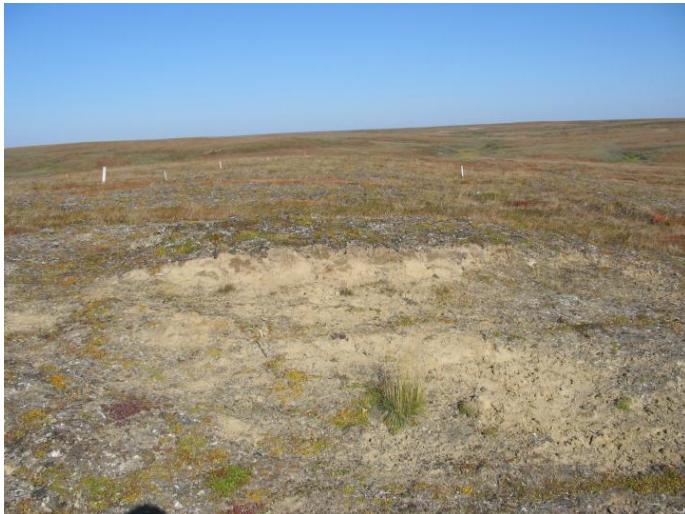
VD-1



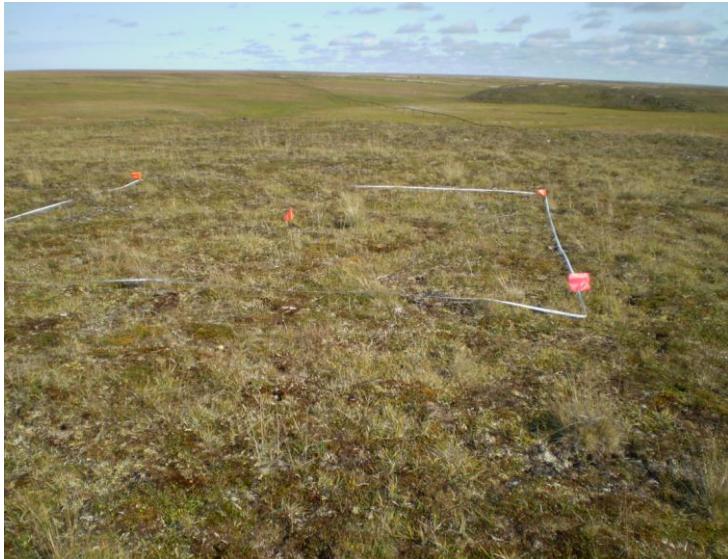
VD-3



VD-CALM



Kharasavey location

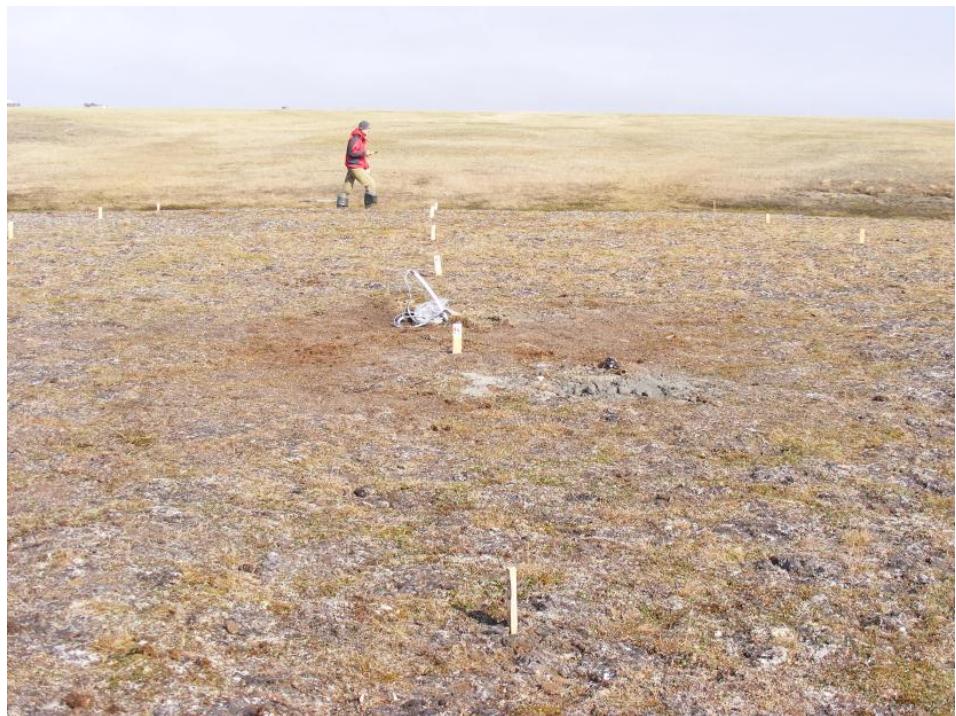


Kharasavey-1



Kharasavey-2

Bely Ostrov location



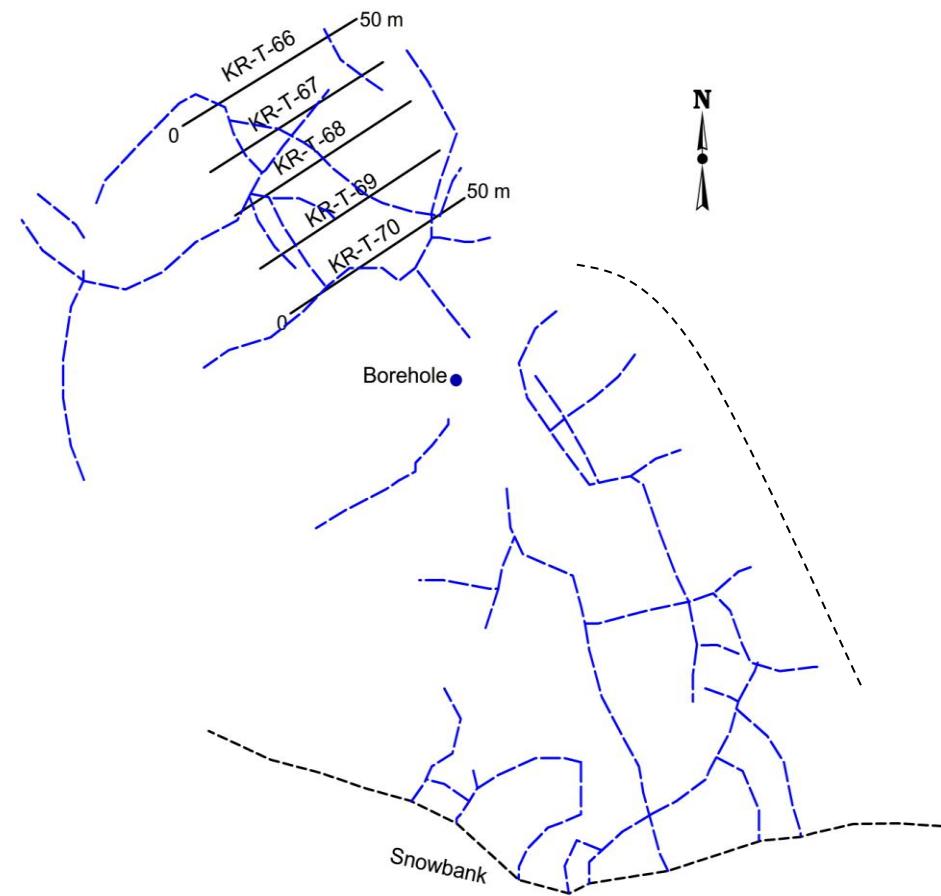
BO-1



BO-2

Krenkel location

Krenkel-1



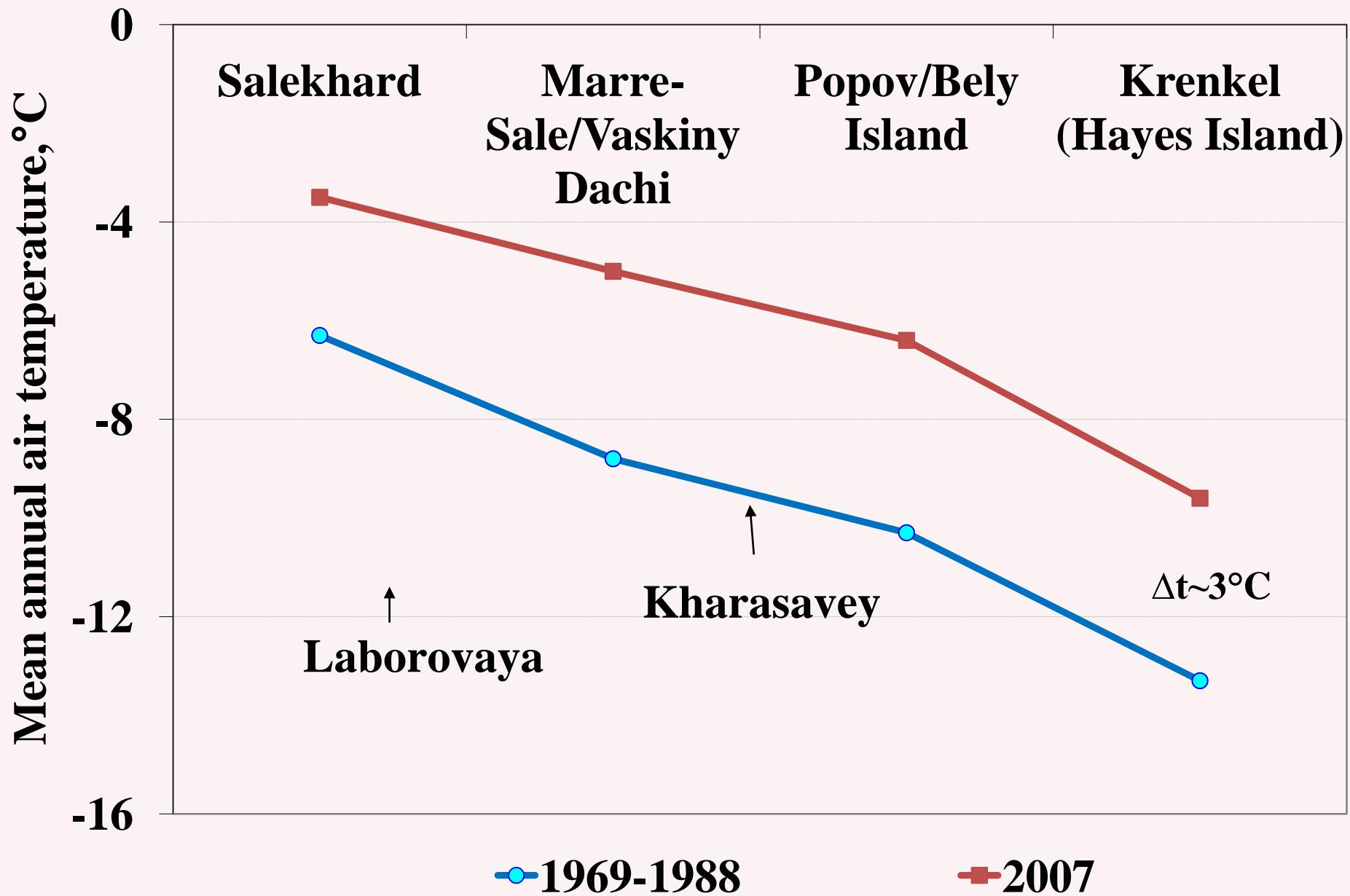
ACTIVE-LAYER DEPTH

METHODS

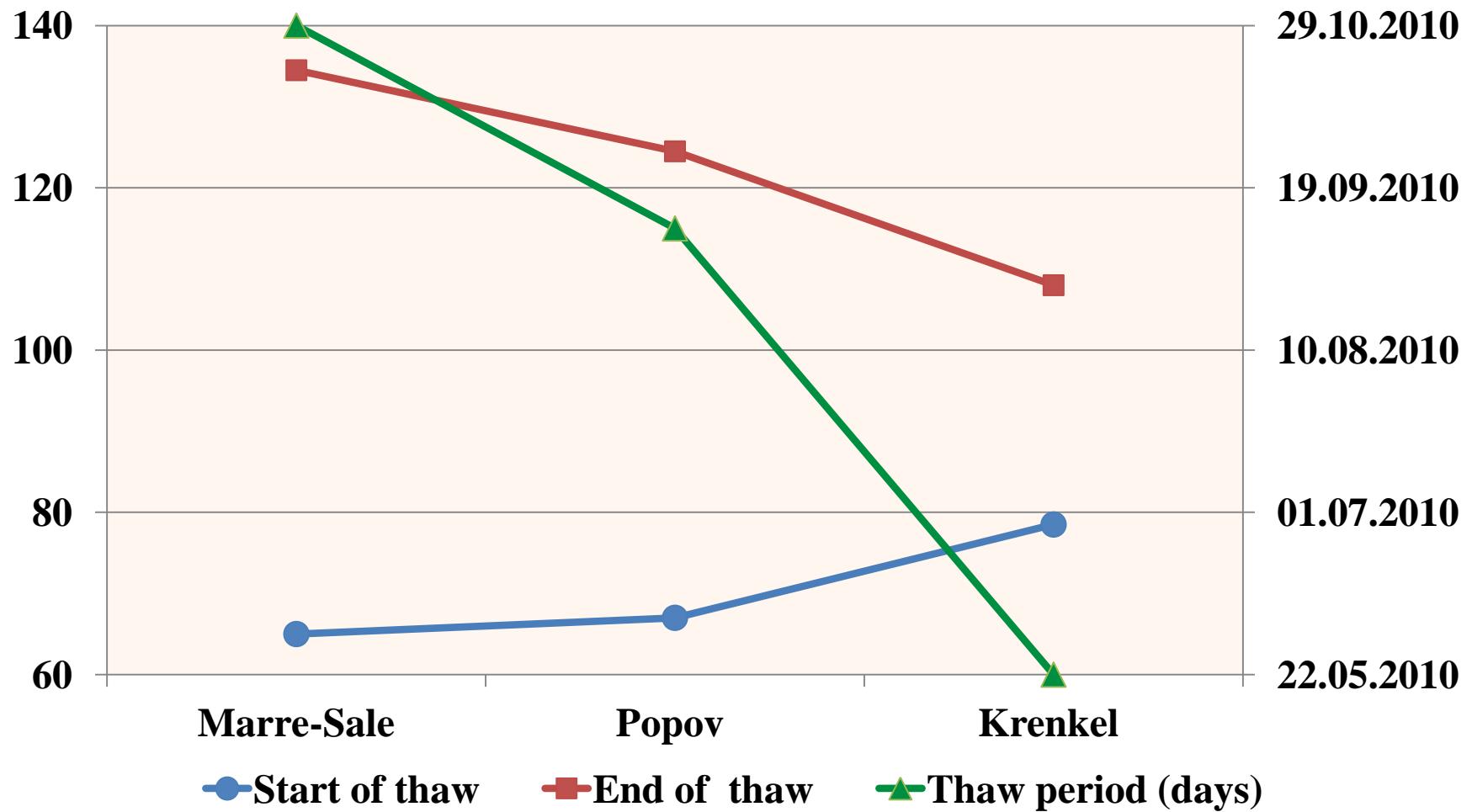
- Metal probe: single measurement
- Metal probe: serial measurements
- Ground temperature measurements
- Modeling
 - Calculating rate of thaw
 - Calculating maximum thaw
- Analysis of ALD controls



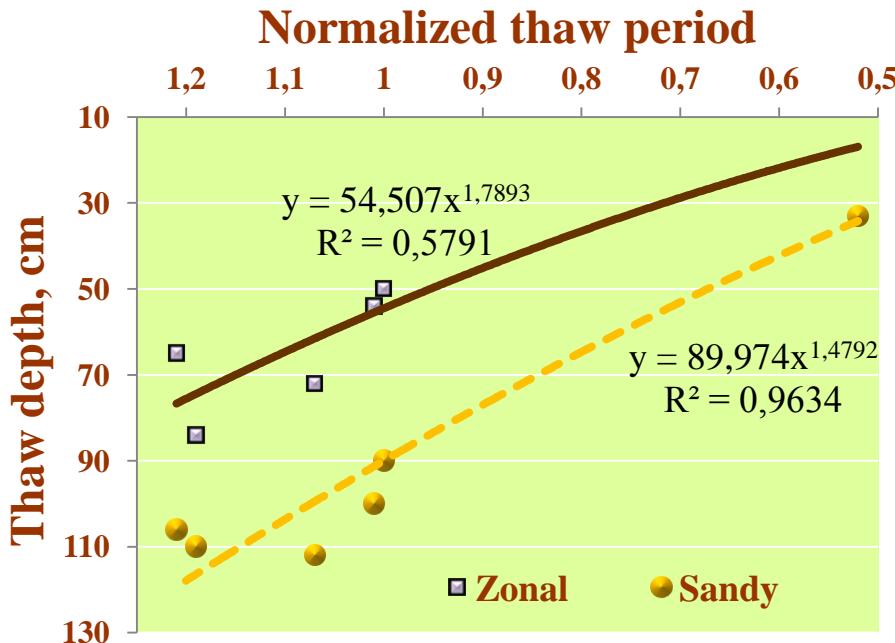
Weather stations



Climatic parameters in 2010

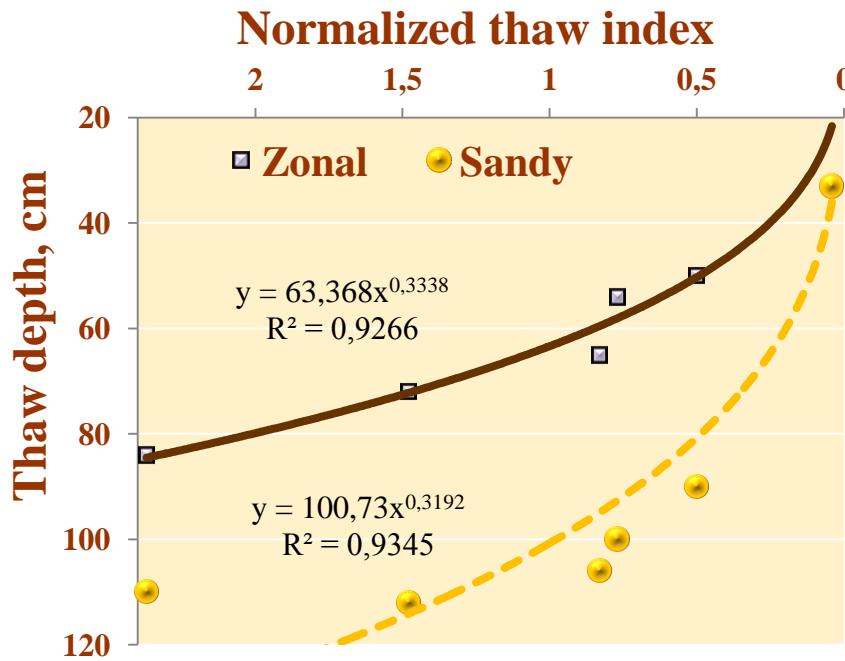
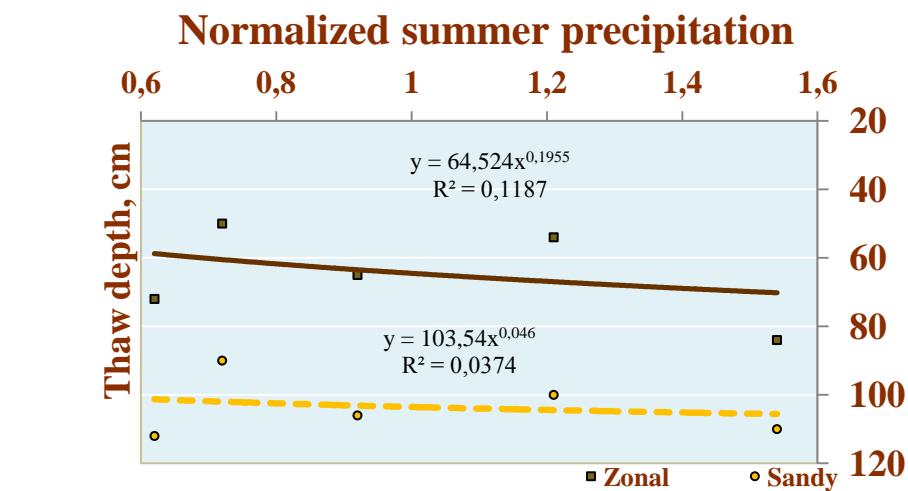


ACTIVE-LAYER DEPTH GRADIENT

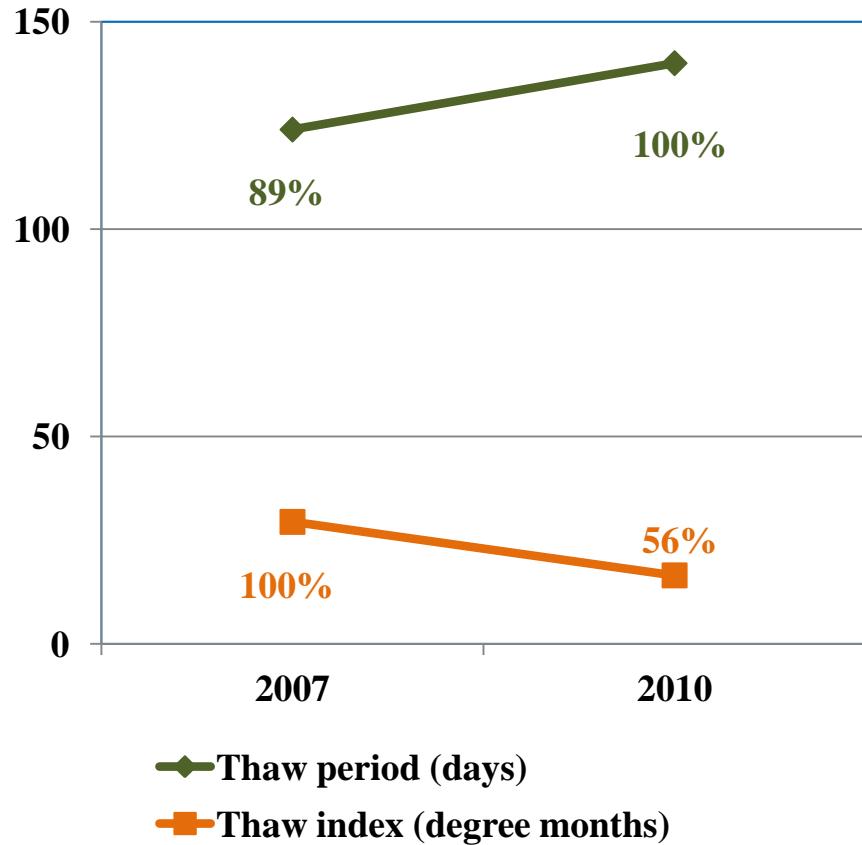
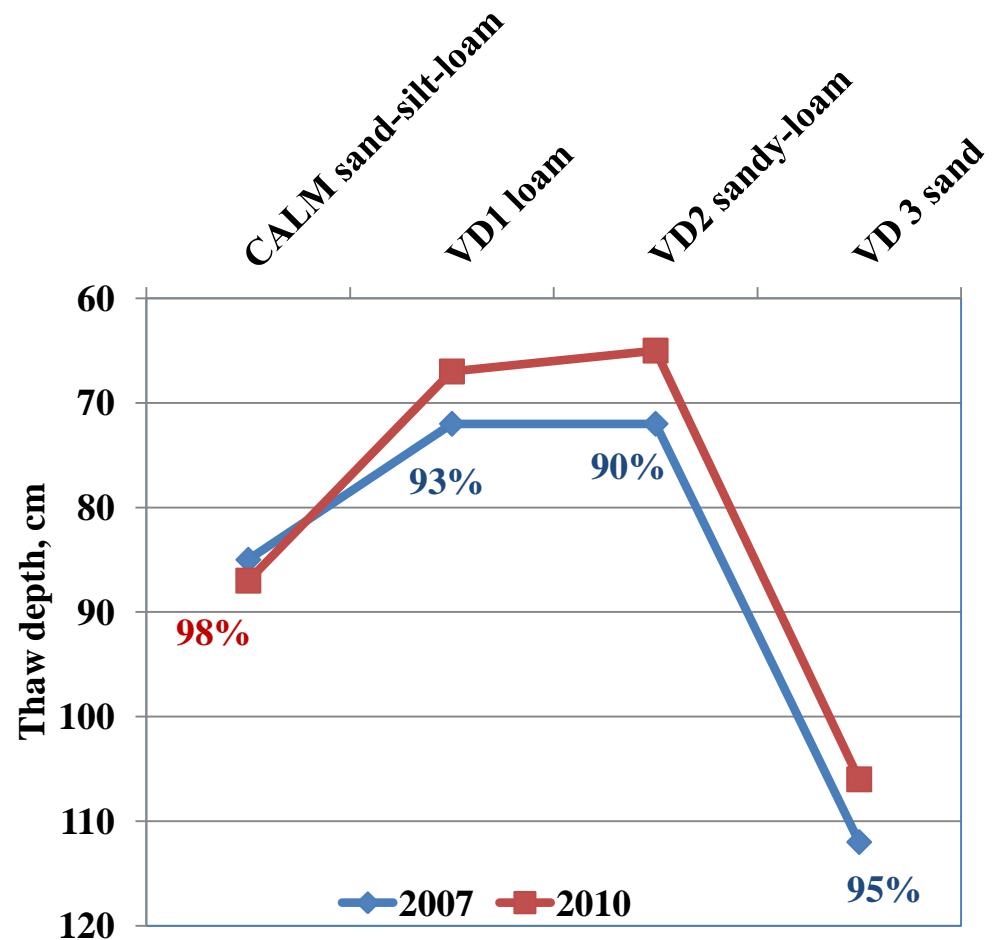


To operate with non-dimensional quantities we divided each parameter into an average value of the data array to obtain “normalized” values

$$x_{norm} = x_i / \bar{x}$$

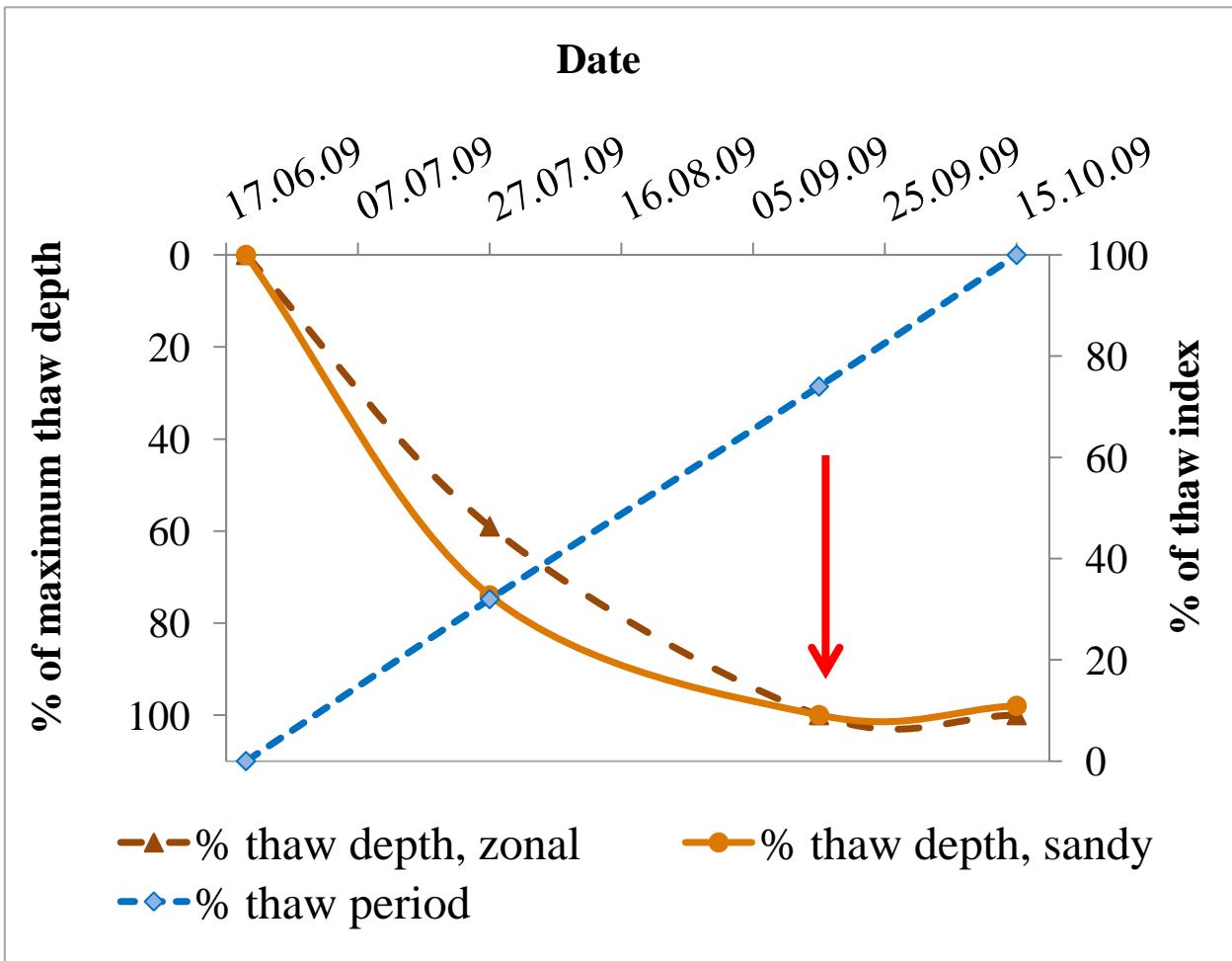


ACTIVE-LAYER DEPTH REGIME at 4 sites of Vaskiny Dachi



ACTIVE-LAYER DEPTH REGIME

Bely Island



The curve indicates that upward freezing starts after September 15 (with the average daily temperature down to $+3^{\circ}\text{C}$). This is shown by the bend of the curve based on the measurement data from October 15 and the thaw depth reduction on the same date as compared to the records from September 15.

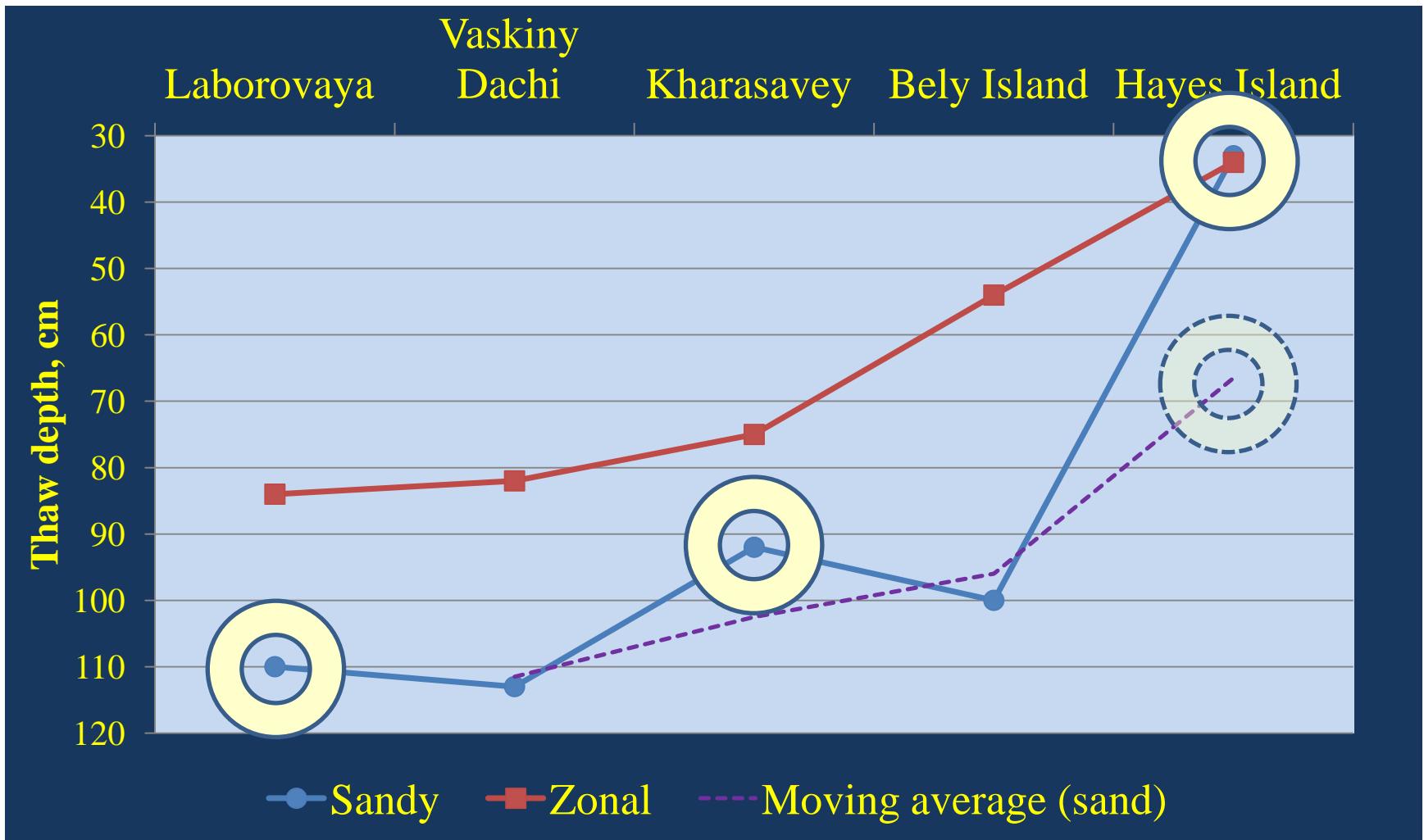
It can be seen from the thaw index line calculated as thaw index at the specific date (TI_i) related to maximum thaw index, in percent ($TI_i / TI_{max} \cdot 100$) that maximum thaw is achieved after about 75% of the thaw index passed.

ACTIVE-LAYER DEPTH DISTRIBUTION

Across polygonal structures at Hayes Island

Where	n	Range	Average	StDev
Sandy grid, total	58	26-36	31,9	2,6
Polygon center, total	16	29-33	31,9	1,2
micro-polygon	8	32-33	32,4	0,5
micro-trough	8	29-33	31,5	1,5
Polygon rim, total	9	34-36	34,9	0,6
micro-polygon	5	34-36	34,8	0,9
micro-trough	4	35	35,0	0,0
Polygon trough, moss-covered	8	26-32	28,5	1,9

Seasonal thaw depth gradient



Conclusions

- The zonal change of climatic controls influences the seasonal thaw depth directly and indirectly. In similar terrains the average thaw depth noticeably declines from the south to the north.
- The thaw depths associated with the particularities of local natural conditions within each bioclimatic subzone may differ by 30-40 cm, the same as when moving to the north for 1500 km at the farthest limits of tundra bioclimatic zone.
- Thaw stops and upfreezing starts when the air temperature reduces to 3-4°C, or about 75% of the duration of the thaw period.

Thank you for your attention

