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Active layer response to contemporary climate variations in coastal Chukotka, NE Russia

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Abstract

Dynamics of active layer, one of the main parameters of the permafrost state, follows regional weather patterns. Compared to neighboring regions, Chukotka remains a white spot for monitoring data and recent trends in climate and permafrost dynamics. We made an update on changes in weather patterns and active layer thickness for 21st century. There is nearly no trend in regional summer warmth in 2000-2015, on the contrary with 1980-90s. Following it, thickening of the active layer have faded on the many sites, likewise in the neighboring regions: Alaska and NE Siberia. Lavrentiya and Lorino are the only exception with the trends of 7 cm per decade owing to location on icy loams. Given the activation of thermoerosion in vicinities of the plot, we suppose it is a feedback to preceding warming.

Keywords: CALM; permafrost table; seasonal thawing; active layer; Chukotka.

Introduction

Long-term ALT studies in Chukotka have already been reported for 20th century (Kotov *et al.*, 1998; Zamolodchikov *et al.*, 2004) and locally using recent data (Tregubov & L'vov, 2014). This contribution encompasses all available data from CALM sites and regular monitoring using different measurement protocol in Chukotka, NE Russia since the beginning of 21st century. We evaluate the active layer response in different landscapes of the region to contemporary climate parameters fluctuations.

Materials and methods

Monitoring sites

ALT monitoring in Chukotka dates back to 1988 when intact tundra and disturbed plots were established at Dionisiy station, 20 km SW of Anadyr (Figure 1, marked as "D"). Later in 1994-2009 there have been 5 CALM sites established on Anadyr lowland (see Figure 1): R9 Onemen, R11 Dionisiya, R45 Kruglaya and Chukotskii Peninsula: R27 Lavrentiya and R41 Lorino. Non-interrupted WMO weather monitoring stations Uelen and Anadyr are located 20-80 km from the study sites.

The sites are located 15-150 m above sea level on moist foothills and in lacustrine depressions in typical tundra on the coast of the Bering Sea. Most common soils are ice-rich loams with gravel inclusions, peats and peaty sandy loams. Sedges, willow-sedge, herb-moss-shrub and sedge-moss associations dominate in vegetation cover.

Table 1. Weather parameters in 2000-2015

	Mean air temperature, °C		Degree-days		Mean summer precipitations, mm
	July	January	Freezing	Thawing	
Anadyr	12.0	-22.6	-3375	1083	130
Uelen	6.8	-19.4	-2861	828	139

Methods

Field measurements of ALT on CALM sites followed the standard technique (Brown *et al.*, 2000), extended with several monthly measurements during summer on Lavrentiya and Lorino sites. Measurements on "Dionisiy" field station followed the Russian technical guide (Gravis *et al.*, 1979), which is similar to CALM protocol and differs only in number of measured nodes within the grid (20-40 instead of 121).

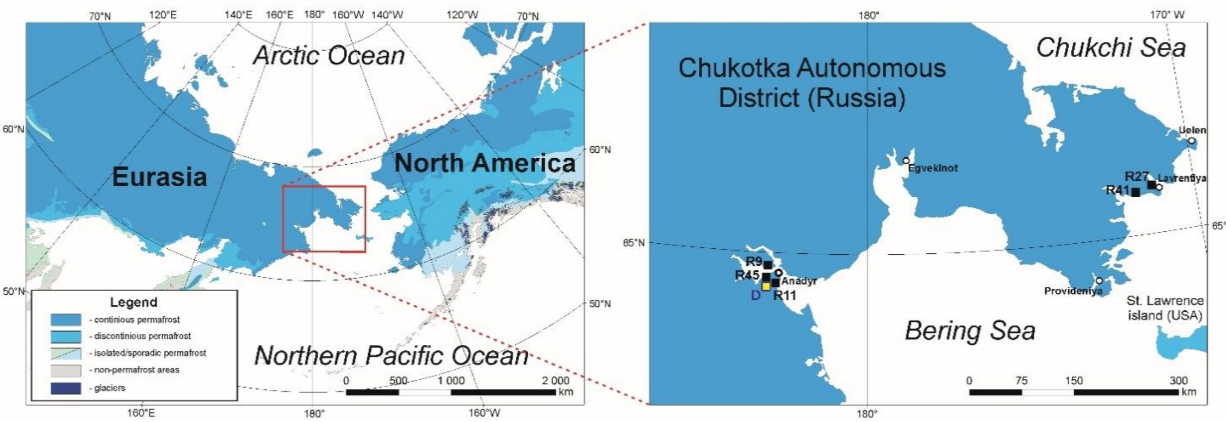

Figure 1. Active layer monitoring sites and weather stations in Chukotka (see explanations in the text)

The ALT datasets for 2000-2015, available online (www2.gwu.edu/~calm/) were analyzed statistically together with relevant weather data.

Results and Discussion

With variations from 600 to 1200°C·day warmth of summer had no pronounced trend (Figure 2). The average ALT for the coastal sites of Chukotka varied from 45 to 66 cm. There was no difference in ALT on sites between Anadyr Lowland and Chukotskiy Peninsula. However, attenuation of ALT growth is visible for the sites on Anadyr Lowland. On the contrary, ALTs in Lavrentiya and Lorino grow at rate of 7 cm per decade.

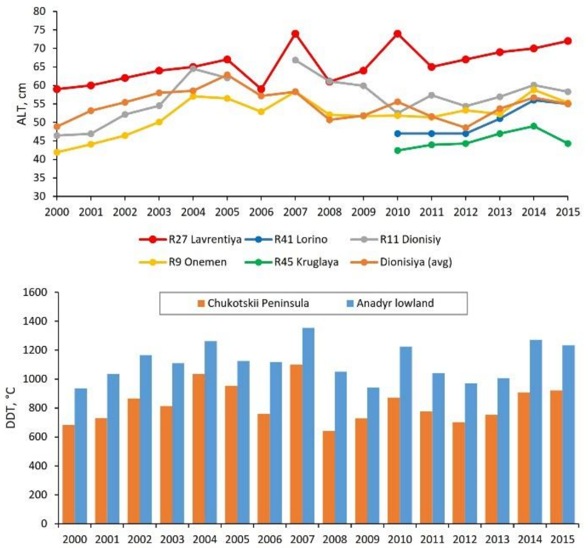

Figure 2. Thawing degree-days and ALT on various sites of Chukotka.

Thawing degree-days strongly correlated with the ALT (r=0.92 for Lavrentiya), so the reasons for discrepancy between the trends are still to be understood. Dynamics of ALT in Chukotka is similar to adjacent regions (NE Yakutia, Alaska), with stabilization in 2000s following rapid growth in 1990s. Lavrentiya and Lorino break this pattern by continuous seasonal thaw deepening. Given the activation of thermoerosion in surroundings we suppose that 1990s warming have initiated permafrost degradation.

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