INFLUENCE OF THE LANDSCAPE CONDITION ON THE THERMAL STATE OF PERMAFROST ON THE INTERIOR ALASKA AND KOLYMA LOWLAND.

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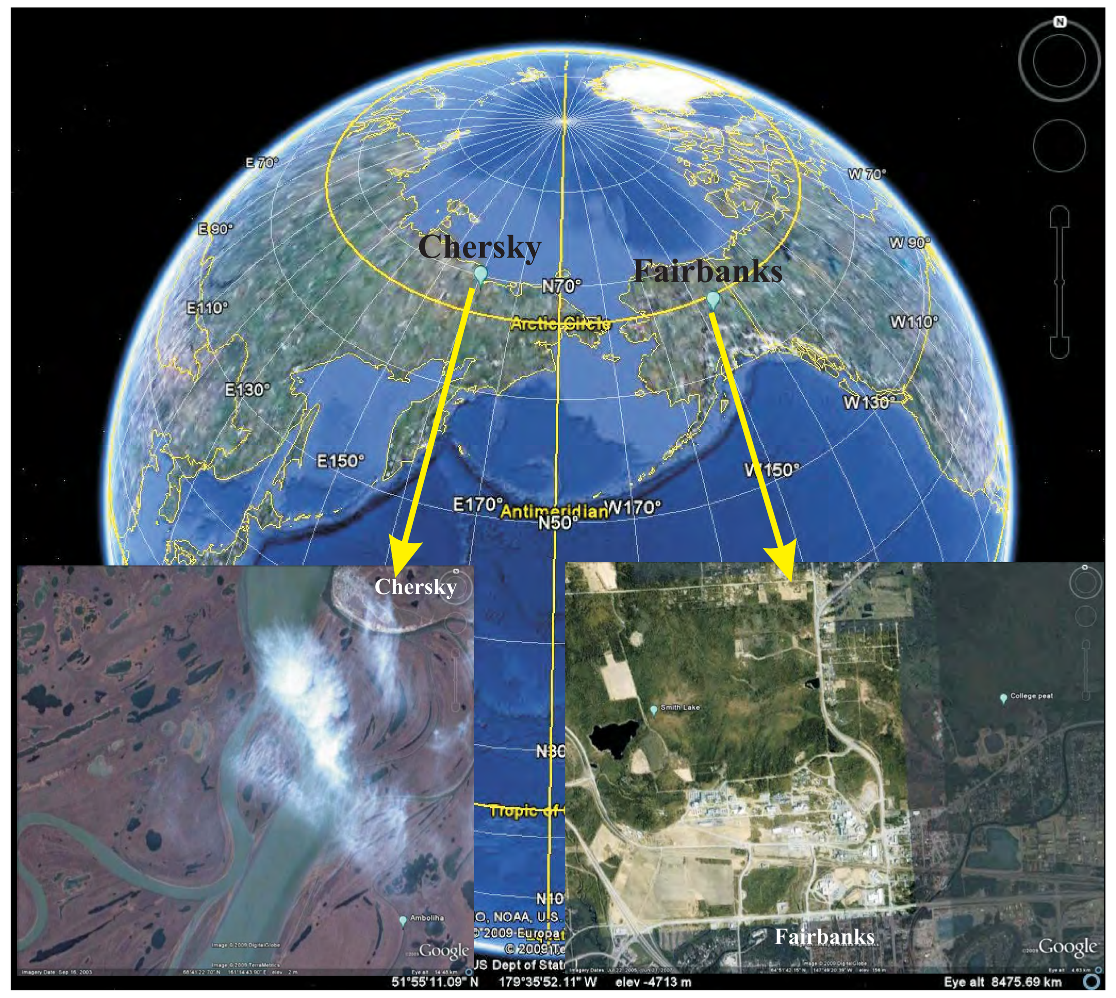
ABSTRACT

Permafrost exerts a significant influence on northern socioeconomic and biological systems, and the thermal state of permafrost is exquisitely sensitive to climate and other environmental changes. Permafrost temperature is an integrated parameter and depends not only on the air temperature, but also on the heat transfer conditions at the ground surface. Landscape conditions is one of the most important factors can influence permafrost temperature through the snow cover redistribution and vegetation.

Since 2005th the global network of boreholes for permafrost temperature observation was established under umbrella of International Permafrost Association (IPY project Thermal state of Permafrost). Global trend to the permafrost temperature increasing was noticed as a result of this monitoring. However, the above-mentioned trend operates at different scales in different sites.

Current research was aimed on the influence of landscape condition (modern state and its natural dynamic) on the thermal state of permafrost.

LOCATION OF INVESTIGATION SITES



Observations have been carried out at the 3 sites, situated in the interior Alaska (Fairbanks area) at the 64.87°N 147.75°W (College Peat) and 64.87°N 147.86°W (Smith Lake) and Kolyma valley (Chersky area) - Ambolikha site situated at the 68.638°N 161.391°E.

NATURAL CONDITIONS OF THE RESEARCH SITES

Fig. 1. Landscape conditions on the Fairbanks area sites: Smith Lake 4 (top) and College Peat (bottom)

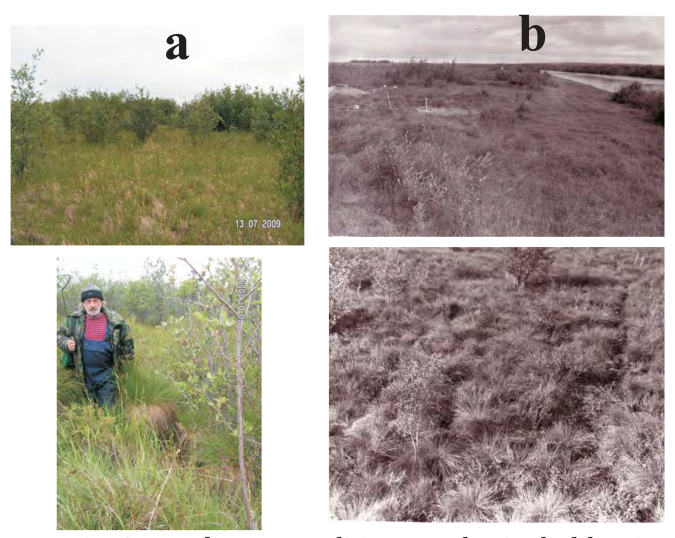


Fig. 2. Landscape conditions on the Amboliha site recently (2a) and at 1980 (2b). Vegetation (top) and micro relief (bottom)

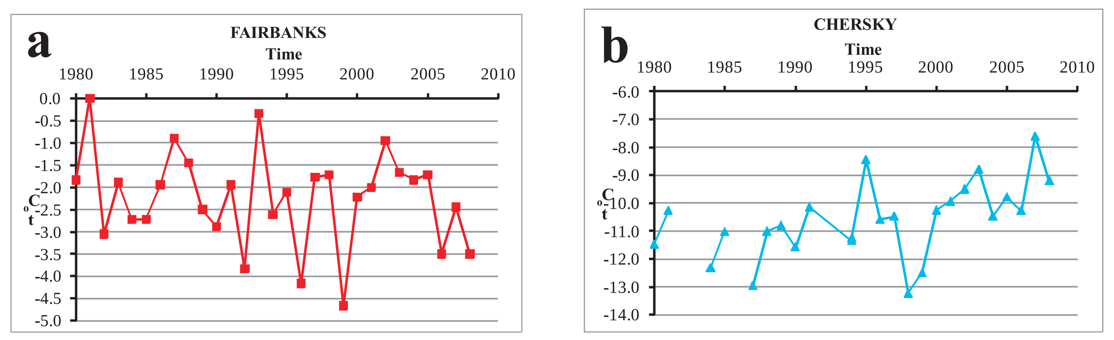


Fig. 3. Mean annual air temperature dynamics at the Fairbanks (a) and Chersky (b)

At the Fairbanks area both investigations sites are located in the forest conditions (fig 1). Vegetation represented by the black spouse, birch and rare larches. Mean annual air temperature does not change significantly over the last 30 years and varies in the range from -1 to -3°C (see fig. 3a). Mean value is -2.9°C (www.climate.gi.alaska.edu).

Amboliha site is locates on the bank of Amboliha channel in the Kolyma floodplain. Vegetation is mainly shrubs (fig. 2a top). Air temperature since 1980 it increased from -12 to -9°C (fig. 3b).

All research sites are characterized by tussocks micro relief and modern frost cracks formation. At the Fairbanks area tussocks are 30-40 cm high (fig. 1).Amboliha site is characterized by the active modern sedimentation. Tussocks high are up to 60 cm here (fig. 2a bottom). Comparison of modern landscape description and survey had been done at 1980 shows growing of the tussocks from 20-30 cm (fig. 2b bottom) to the present size and shrubs spreading(fig 2a and 2b top).

RESULTS AND DISCUSSION

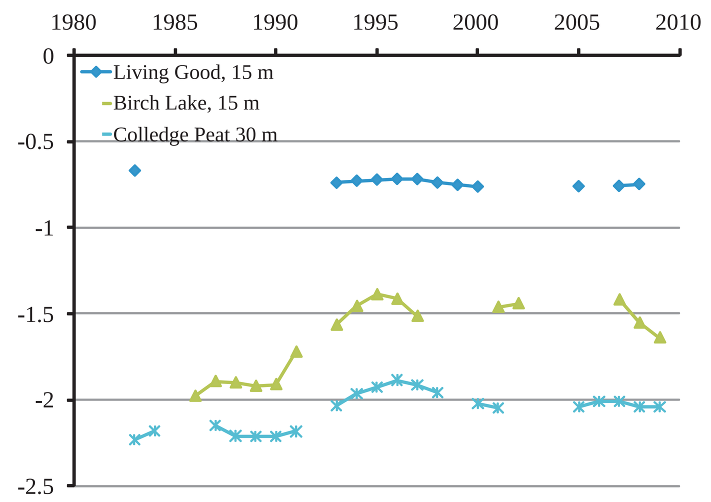


Fig. 4. Comparison of mean annual temperature dynamics on the College Peat site and another Interior Alaska observatories.

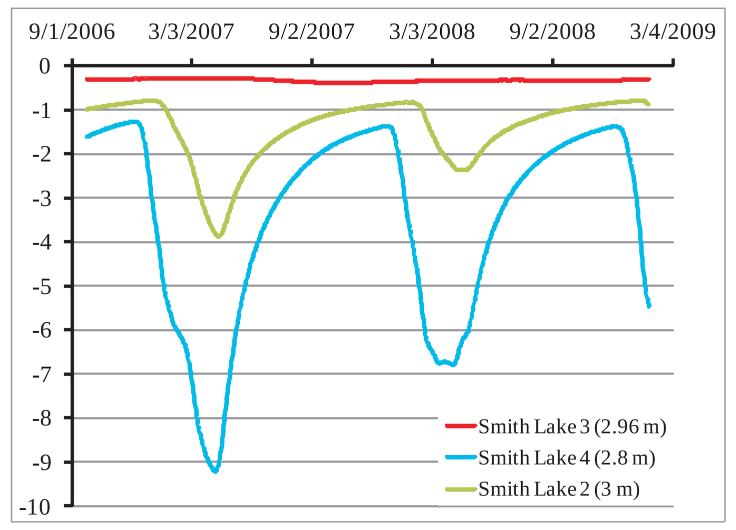


Fig. 5.Temperature dynamics at the investigated site Smith Lake 4 and surrounding sports.

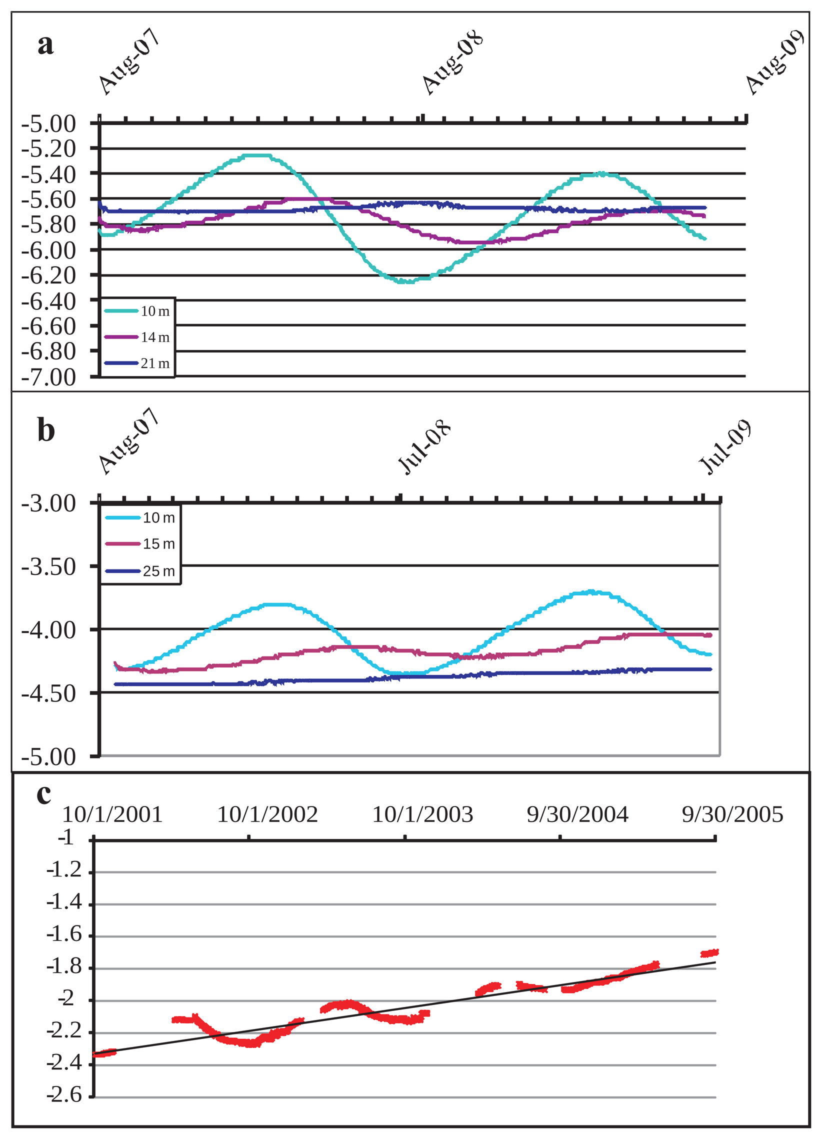


Fig. 9. Temperature dynamics within the Chersky area at the sites Amboliha (a); Omolon river mouth (b) and Pleistocene Park ©

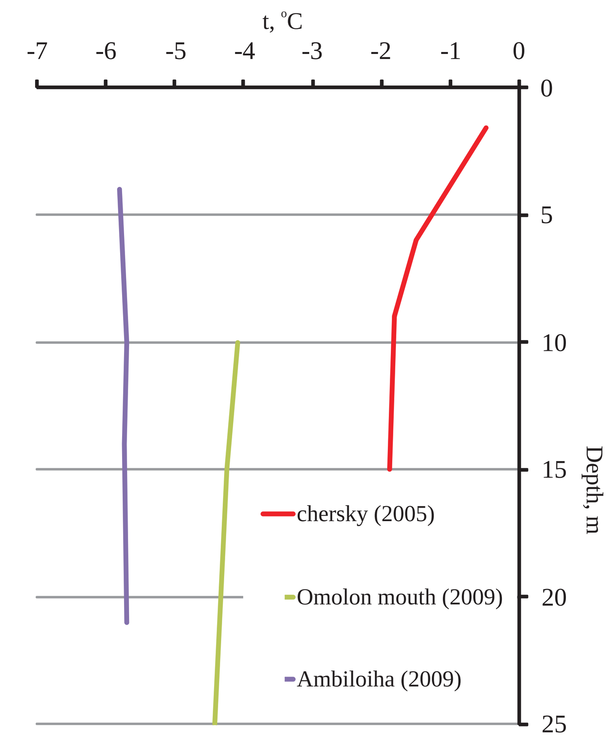


Fig. 6. Mean annual temperature versus depth at the Chersky area: Chersky (Pleistocene park) site; Omolon river mouth and Amboliha (investigated site)

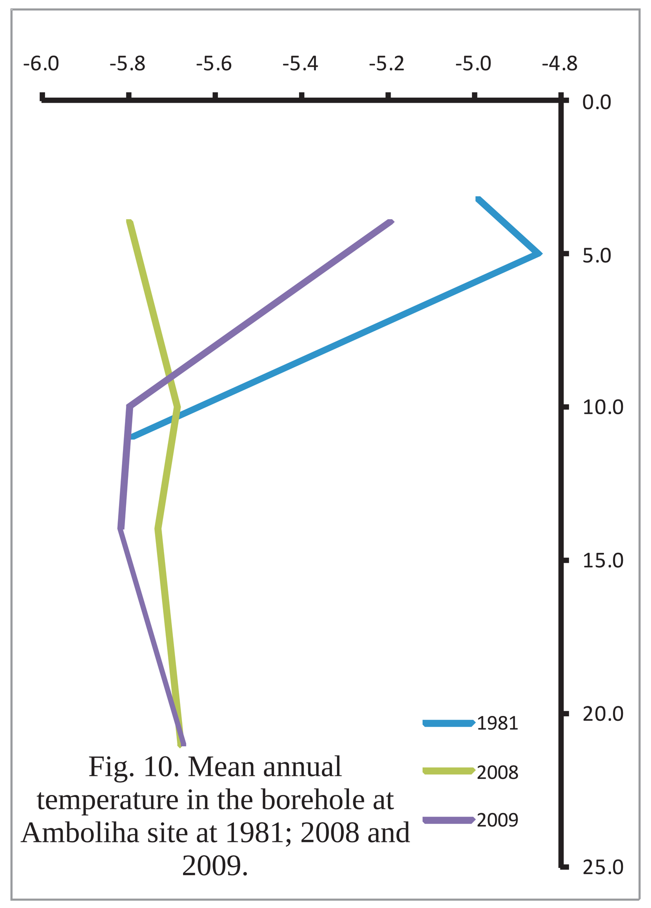


Fig. 10. Mean annual temperature in the borehole at Amboliha site at 1981; 2008 and 2009.

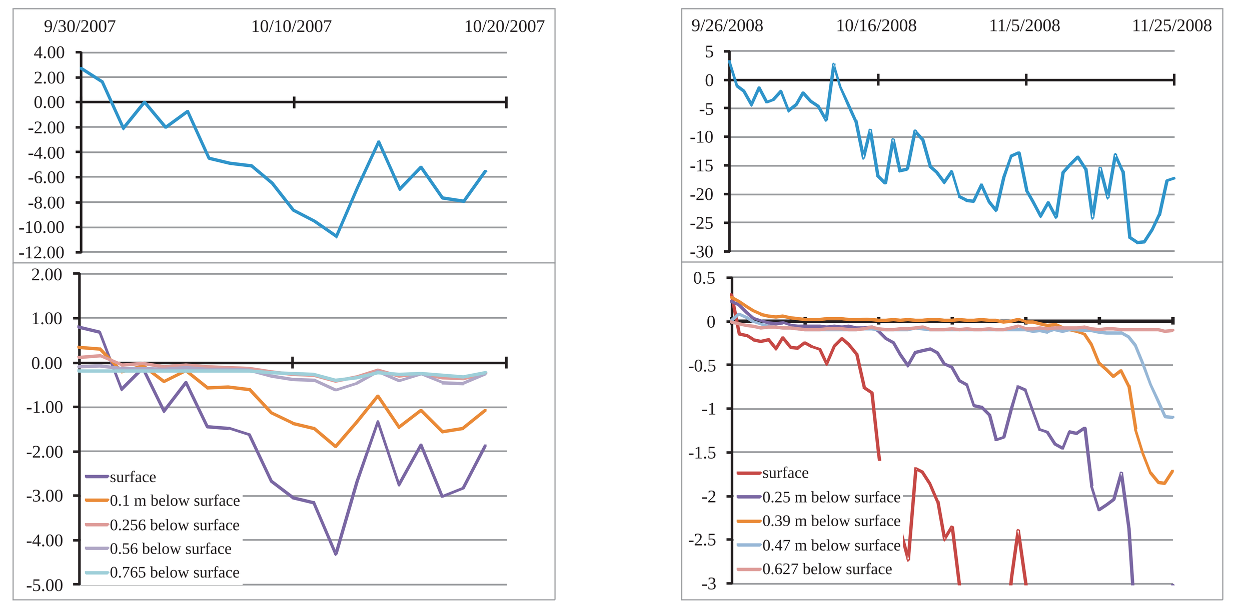


Fig. 7. Peculiarities of snow cover and freezing of active layer at the College Peat (left panel) and Smith Lake 4 (right panel) sites.

All research sites characterized by the lower values of mean annual ground temperature in comparison with regional background values. Difference in the mean annual ground temperature at the research sites and surrounding territory is shown on the figures 4 and 5. Such

Although air temperature has a positive trend over the last 30 years in Chersky area (fig. 3b) thermal state of permafrost was stable here until the end of 1990s. Only during the last decade increasing of the mean annual ground temperature was recorded at the all observation sites on the Kolyma lowland

except Amboliha site (see fig. 9). Comparison of modern observations and data of measurements had been done at 1981 does not show any significant changes of the mean annual ground temperature (fig 10). And active layer thickness decreased twice (from 1.2 to 0.6 m). It might be explained by the landscape changes take place at this spot. Growing of tussocks leads to the above mentioned peculiarities of snow cover influence on the thermal regime. Additionally, spreading of willow shrubs prevent radiation heating of the surface during the summer period.

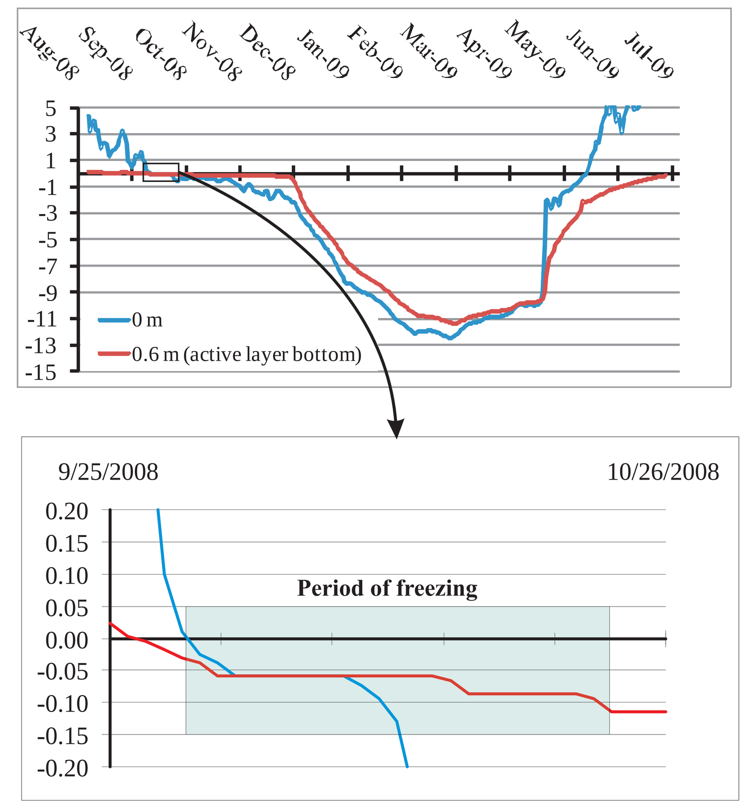


Fig. 8. Temperature dynamics on the surface and bottom of active layer at the Amboliha site

At the beginning of winter season when air temperature becomes negative and snow cover thickness does not exceed tussocks high (fig. 7) sides of tussocks are open to the direct influence of cold air. It leads to fast active layer freezing with consequent cooling of the upper horizons of permafrost. Within the investigated types of landscapes complete freezing of active layer takes time from 10 to 30 days (fig. 7 and 8).

CONCLUSIONS

The following conclusions can be done:

1) Specific types of landscape, characterized b the tussocky micro relief and shrub type of vegetation cause decreasing of mean annual ground temperature.

2) Landscape changes, possible induced by the climate changes, can compensate air temperature increasing and keep thermal state of permafrost stable

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