Geophysical Research Abstracts,
Vol. 11, EGU2009-6414, 2009
EGU General Assembly 2009

Thermal State of Permafrost in the Northern Yakutia: Responce on the Modern Climate Changes

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Permafrost continues to receive much attention as observed climate change brings many regions underlain by permafrost to the edge of widespread thawing and degradation. This process can lead both to the local (engineering construction damages, landscape or hydrological condition changes) and global (green hose gases and carbon emission to the atmosphere) negative consequences

To develop a better understanding of the response of permafrost to changes in climate the International Permafrost Association launched under the International Polar Year, the Thermal State of Permafrost (TSP) project(IPY project #50). This program based on the measurements of temperatures in existing and new boreholes in order to develop a snapshot of permafrost temperatures across the entire world permafrost domain. The set of temperature data will serve as a baseline for the assessment of the rate of permafrost temperature changes and changes in permafrost boundaries under the recent climatic changes. Comparison of recently obtained data about permafrost thermal state with historical data allows us to estimate changes of this parameter took place during the last decades. Now boreholes network includes 40 boreholes in Alaska, 100 in Russia, and 13 in Central Asia (Kazakhstan, China and Mongolia). Most of the permafrost observatories show a substantial warming during the last few decades. Geothermal observation in the boreholes on the Yakutian coastal lowlands carried out since 80th years of the last century.

Current research was focused on the investigation of thermal state of upper horizon of permafrost (up to 25 m) in the Yakutian coastal lowlands.

Investigated region covers the area from the Lena delta to Kolyma and characterized by cold continental climate (mean annual air temperature -13.5 to -14˚C) and continuous permafrost distribution up to 700-800 m thick. Active layer thickness is 0.3-0.6 m in some spots up to 1 m.

Recently, the network for continuous geothermal observation was established. It includes 10 boreholes located on the different latitudes, natural zones and landscapes. Existed network allows us to estimate both spatial and temporal changes of the geothermal field.

Method of measurements:

till 2006 – occasional measurements using the thermistor cable

since 2006 continuous observation on selected boreholes using the 4-channel HOBO U12 data loggers and occasional measurements using the thermistor cable.

Modern thermal state of permafrost in this region is following: Mean annual ground temperature on the top of rest of Late Pleistocene accumulative planes varies in the range from -12.3˚C on the latitude 72˚50’ north to -9.9˚C on the latitude 69˚30’ north. Latitudinal zonality here is about 1˚C on the degree of latitude. Within the Alas depression mean annual ground temperature is a little bit warmer (-10˚C on the 71˚40’ north and - 7˚C on the 68˚50’ north).

Comparison of modern observations and published data shows that most significant changes of the geothermal field take place on the Kolyma lowland. Since the 1980th permafrost temperature increase here on 1.5-2˚C. At the

same time thermal state of permafrost in the western part of region is more stable. Also there are some sites where modern landscape changes (vegetation succession) leads to the stabilization of permafrost temperature.

CONCLUSIONS:

The following conclusions about thermal state of permafrost in the investigated region can be done:

Depth of the annual temperature oscillation 10-15 m for depressions and 20 m for hills.

Mean annual ground temperature varies in the range from –12,3˚C to –4,7˚C.

Although the absence of air temperature latitudinal zonation of mean annual permafrost temperature (1˚C on the 1o of latitude) exists.

Permafrost temperature in this region did not changed significantly since the 60th years of XX century. Only in the western part of region changes are noticed. Permafrost here getting warmer on the 1 - 2˚C. But during the last few years trend to permafrost warming in the whole region is noticed.

Within the sites, where dynamic landscape changes (modern cracks formation and tussocks growing) take place permafrost temperature stays stable.

The project is supported by NSF (ARC-0520578 and ARC-0632400).