

Cryosphere and related hazards in High Mountain Asia in a changing climate

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Temporal and Spatial Variability of Permafrost in the High Mountain Asia During the Last Millennia: Implication to the Permafrost-Related Hazards.

Permafrost Distribution in Central Asia



Permafrost Distribution in Central Asia

Traditionally, alpine permafrost area of the Central Asia is divided into altitudinal sub-zones of continuous, discontinuous and sporadic permafrost (*Gorbunov, 1978, 1988*).

The total area of permafrost within each of these sub-zones is:

- *Continuous* *not less than 90%*
- *Discontinuous* *90% - 30%*
- *Island (Sporadic)* *not more than 30%*
- *Isolated patches* *about 1%*

Permafrost Temperatures Change

Mongolian Altai 1973 - 2015

Trend: 0.1 - 0.2°C/decade (*Sharkhuu, 2016*).

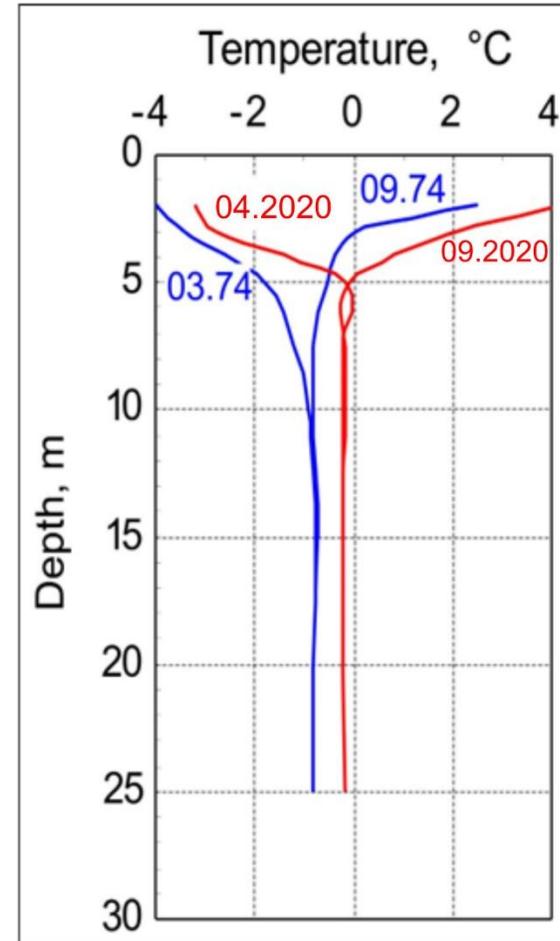
Tien Shan 1973-2020

Trend: 0.1 - 0.25°C/decade (*Marchenko, 2007, 2020*).

Qinghai-Tibet Plateau 1985 - 2018

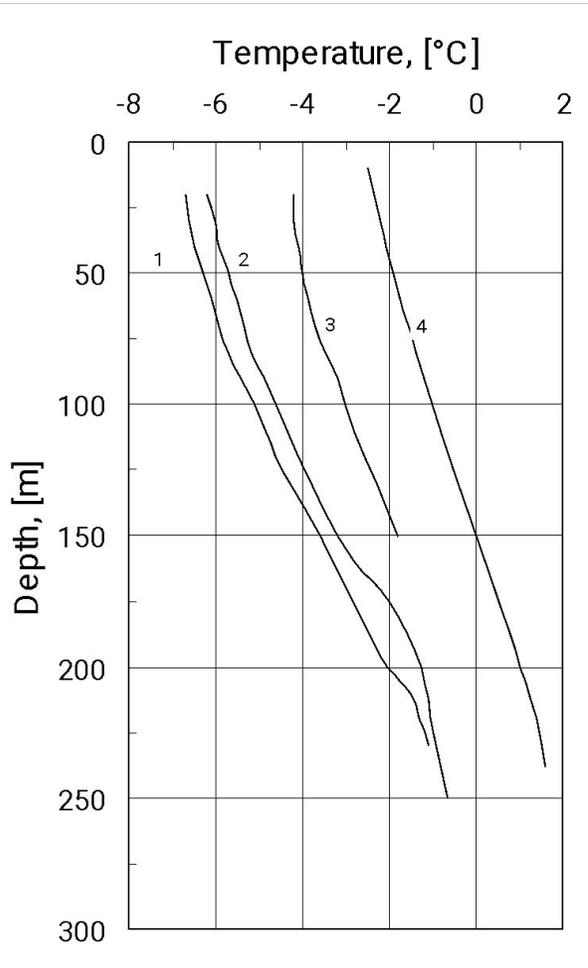
Trend: 0.13 - 0.22°C/decade (*Jin et al., 2019*).

Permafrost Temperature in the northern Tian Shan

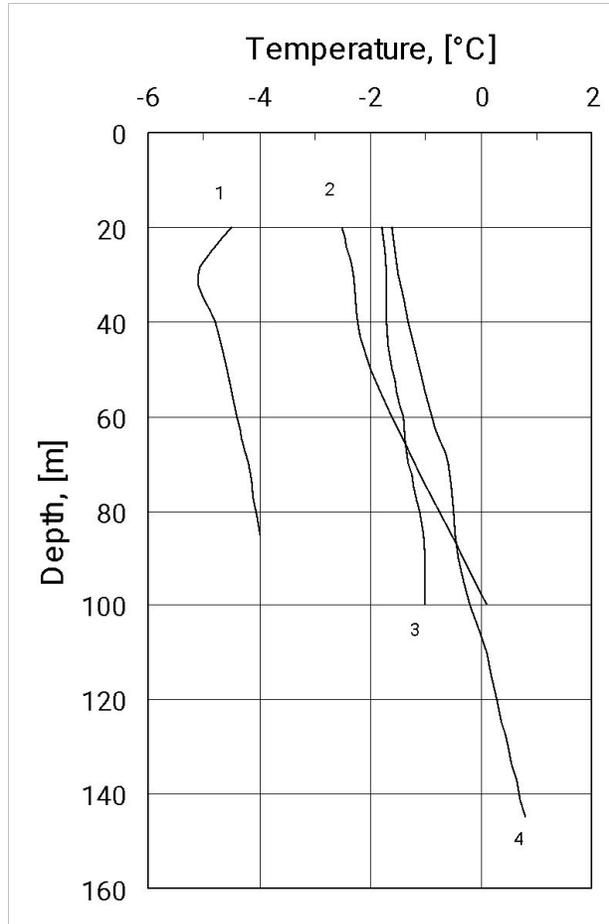


Ground temperature profiles in Holocene moraine at altitude 3300 m a.s.l., Northern Tien Shan.

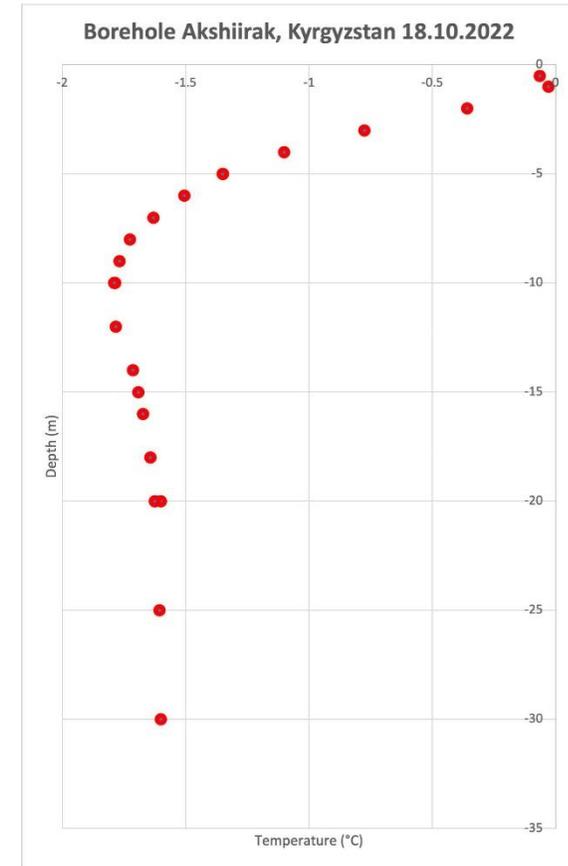
Permafrost Temperature in the inner Tian Shan



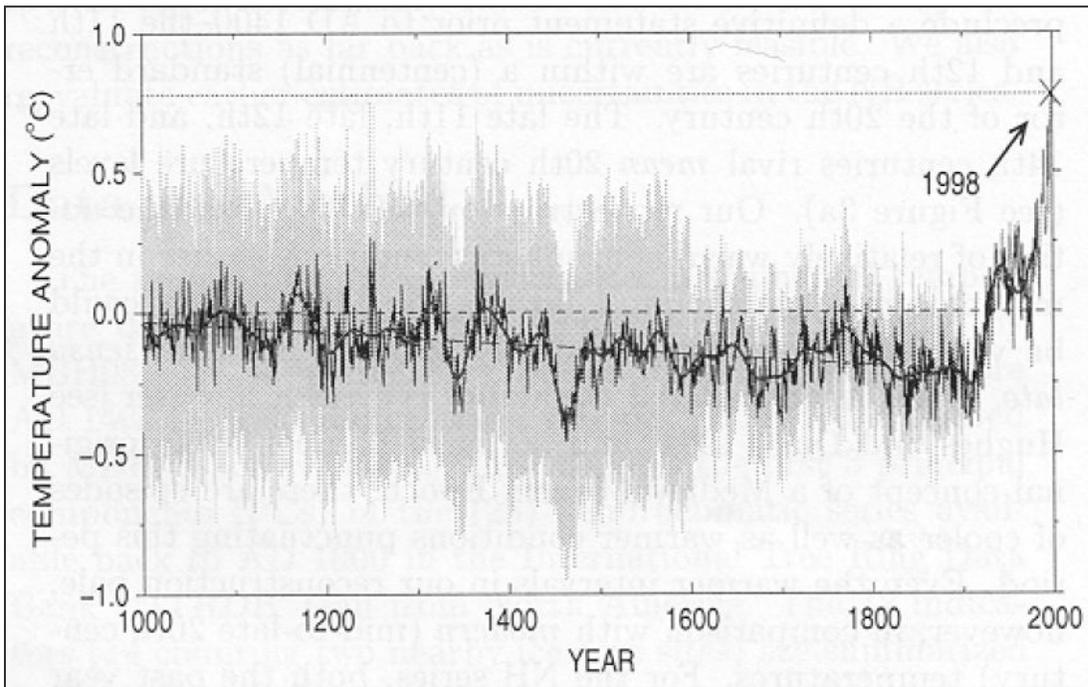
1993 Data
Alpine Lab.



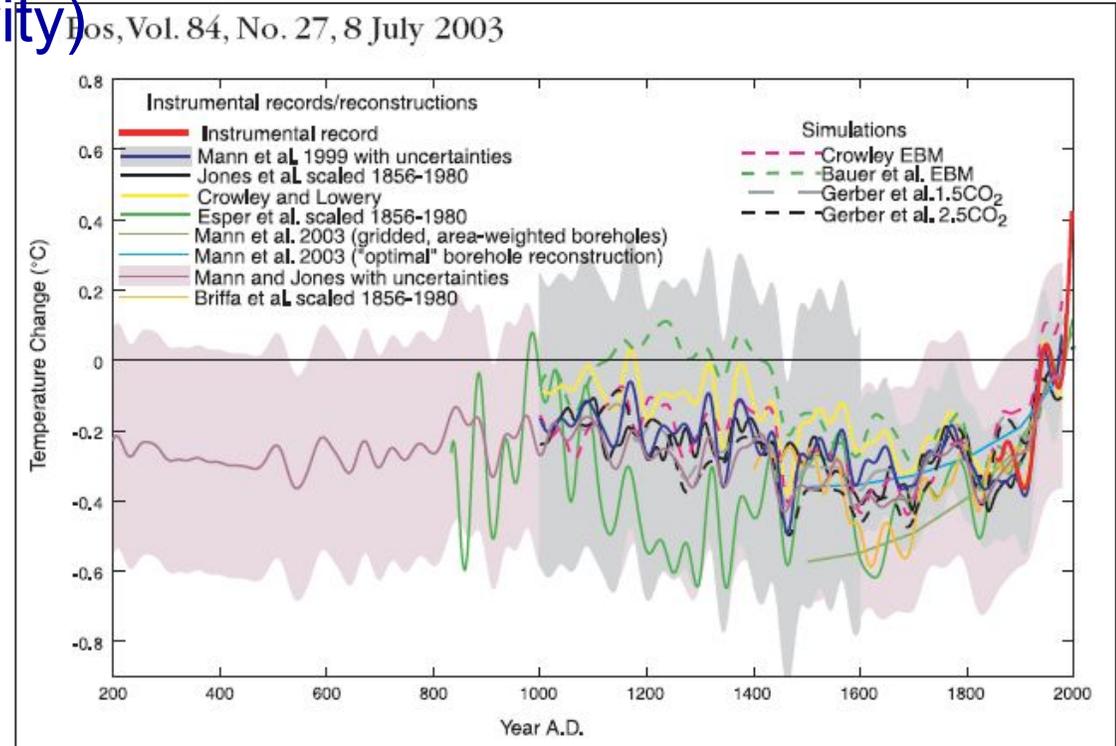
Kazakhstani



2022 Data provided by Professor M. Hoelzle and team



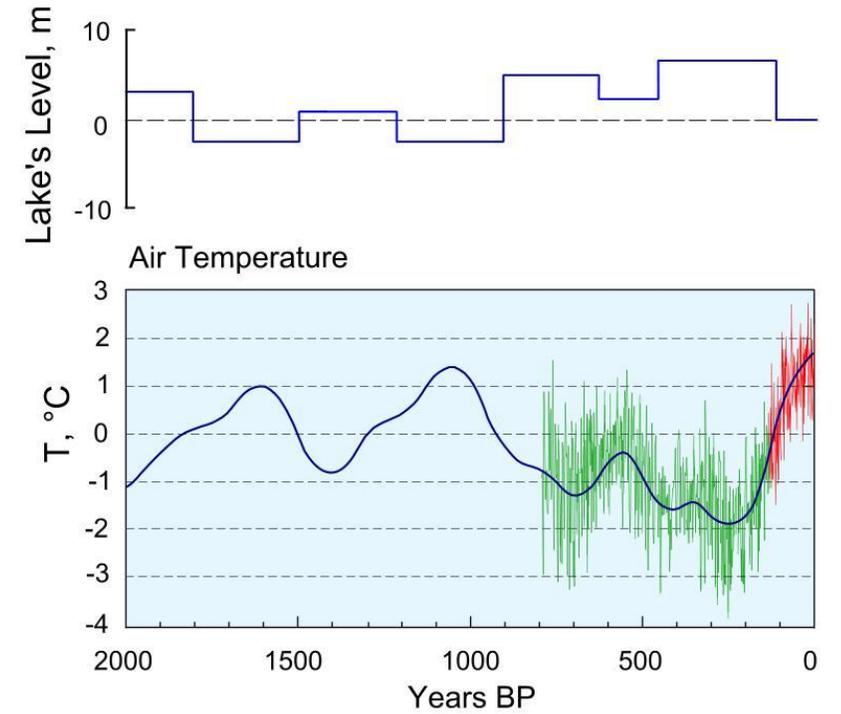
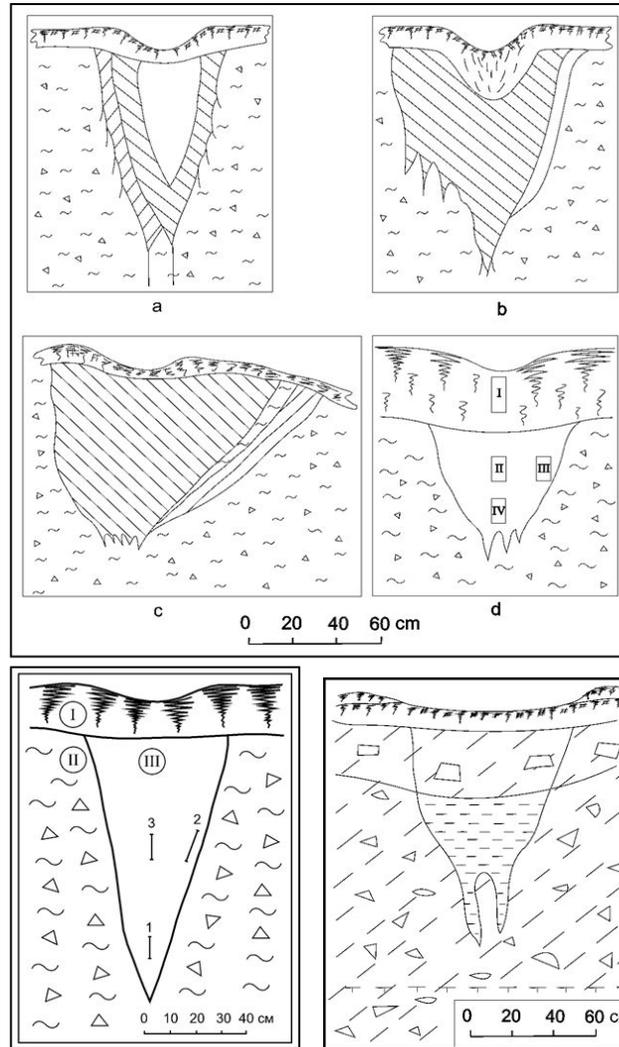
The upper boundary conditions were set up as the mean monthly air temperatures and snow cover properties (thickness, density and thermal conductivity)



Jones, P. D. and M. E. Mann. 2004.
CLIMATE OVER PAST MILLENNIA
Moberg, 2015.

Mann, M. E., Bradley, R.S. and M.K. Hughes. 1999. Northern Hemisphere Temperatures During the Past Millennium: Inferences, Uncertainties, and Limitations.

Proxy data using for soil temperature reconstruction



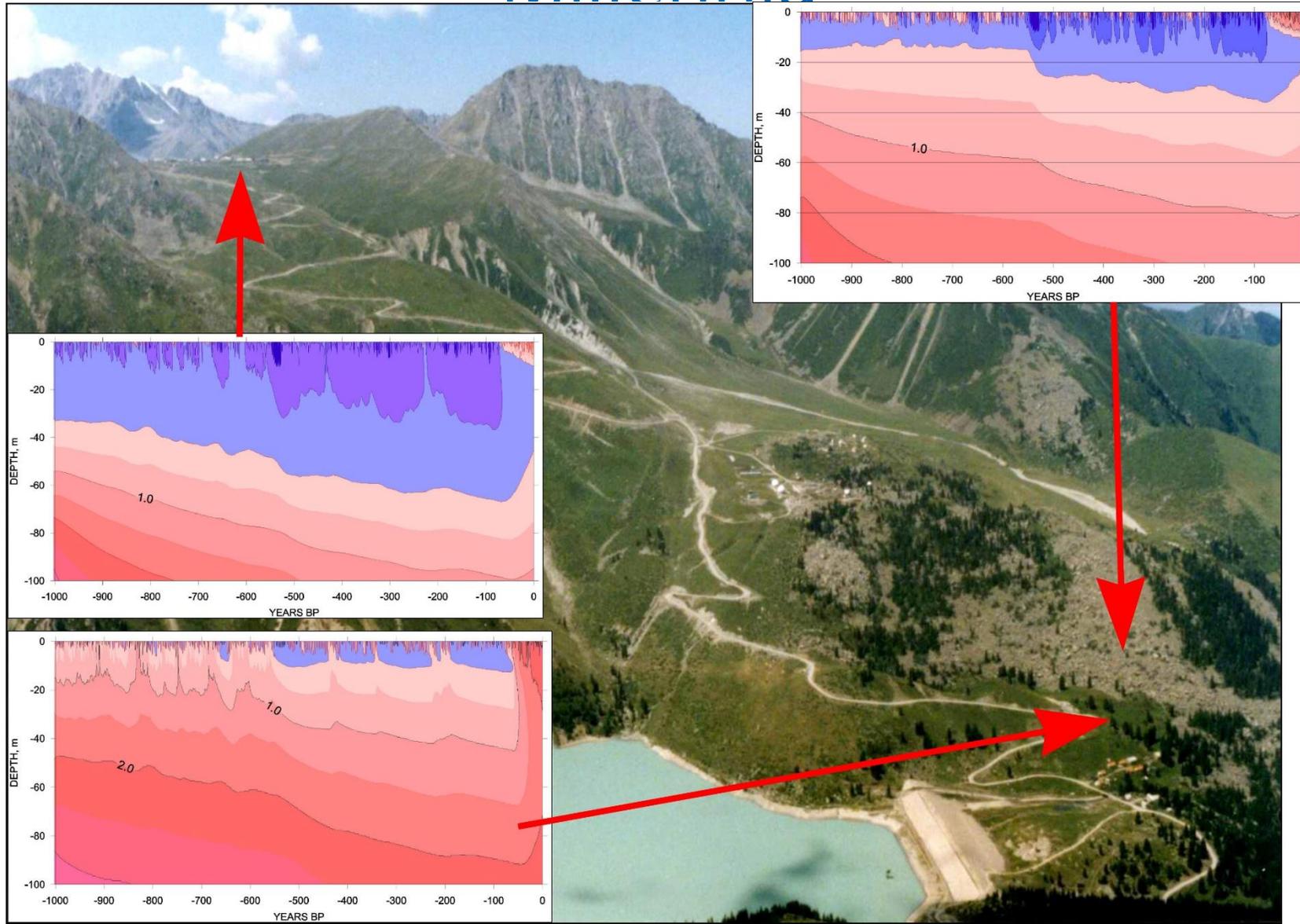
Solomina et al., 2005

Different Surface Types



1 – fine-grained soils, 2 – blocky materials or coarse debris, and 3 – bed rock

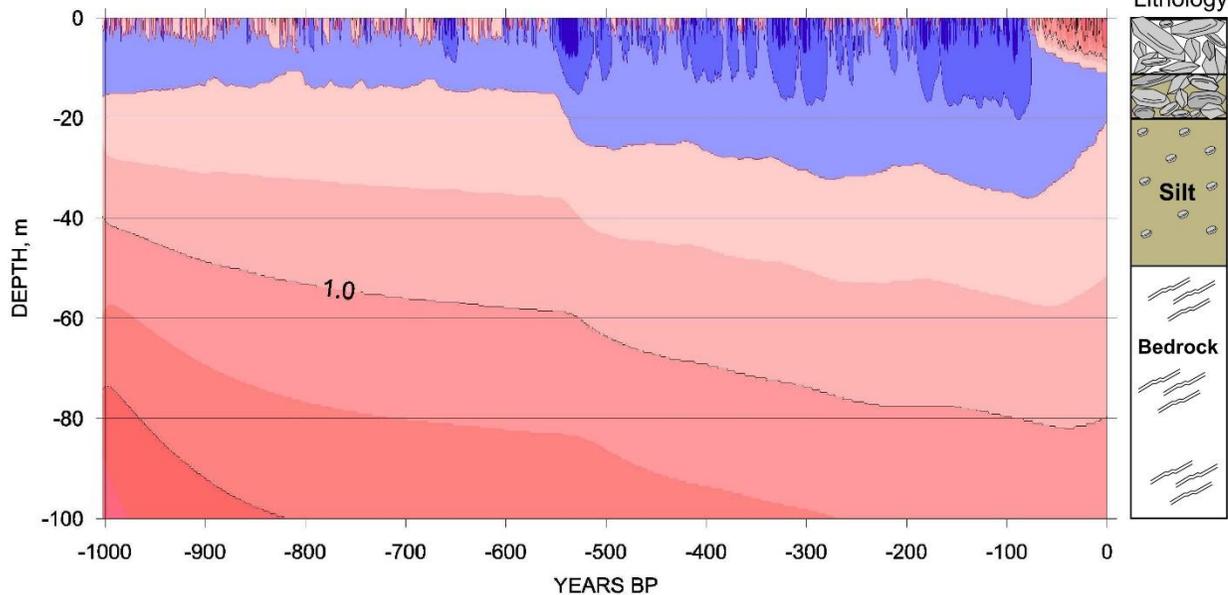
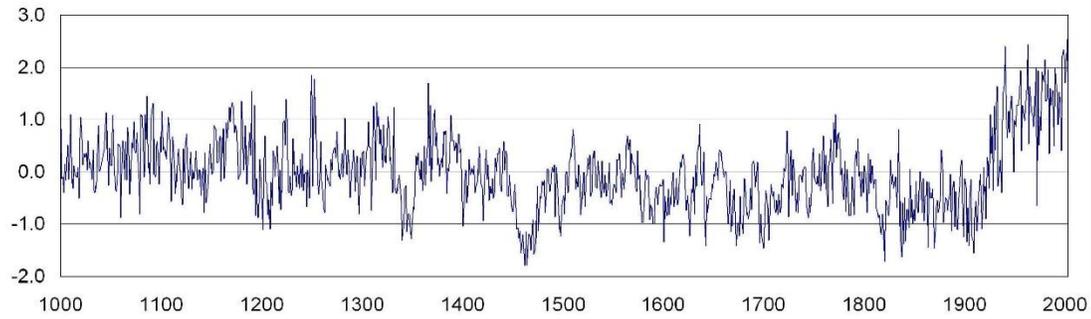
Reconstructed Ground Temperature During the Last Millennium



Reconstructed Temperature inside of Blocky Materials



EVOLUTION OF MEAN ANNUAL AIR TEMPERATURE



2,500 m ASL

Rock Glaciers is a Special Song



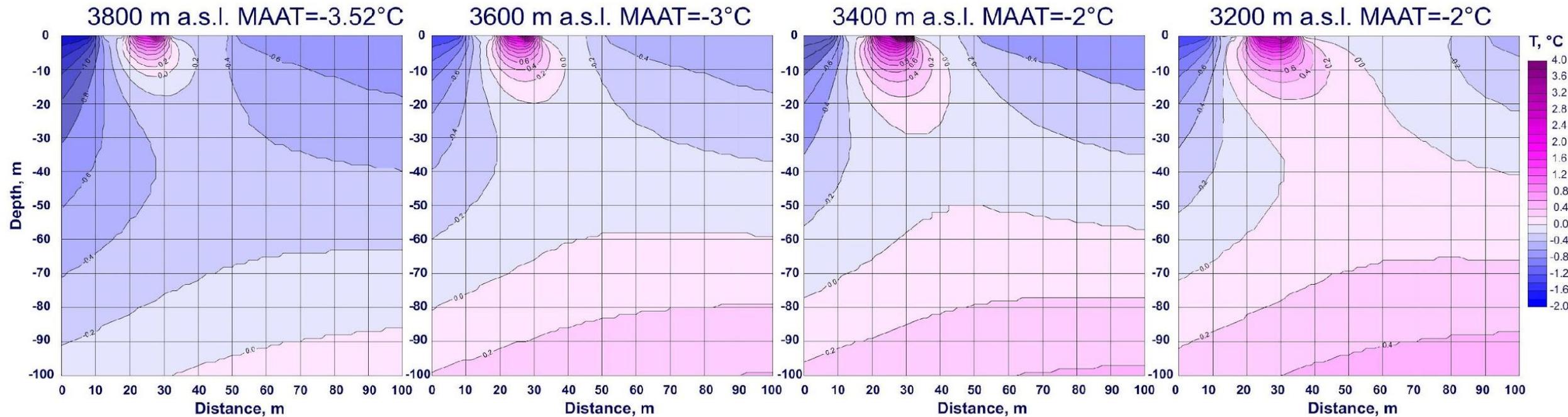
Implication to the Permafrost-Related Hazards



1997, Glacier Lake #6,
Manshok



Result of River Talik Simulation as an Application to the Glacier Lakes Outburst.





Thank you

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