

# Temperature variations describing the Arctic environment using the European North as an example

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This research analyses peculiarities of changes in the regional temperature characteristics in the northern Europe for the last one thousand years based on indirect data - geothermal, dendrochronological, historical, and meteorological data.

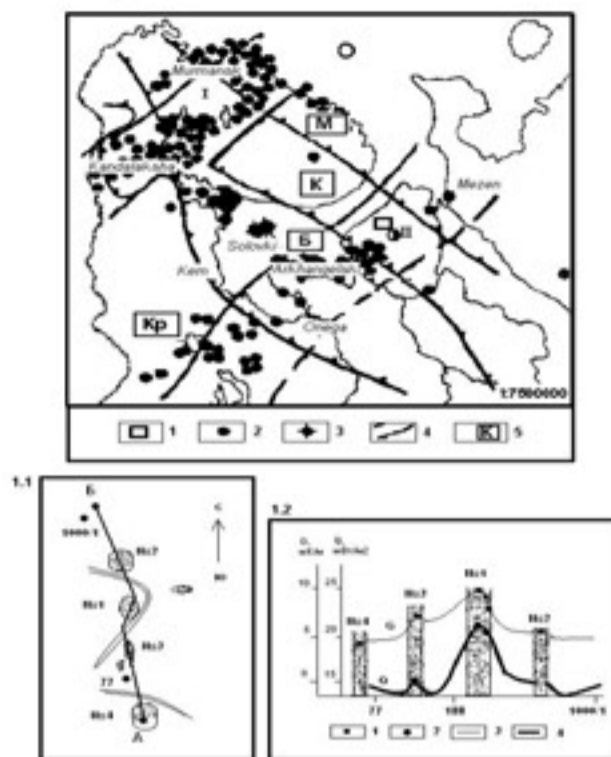


Fig. 1. A map of paleoclimate research area

**Conventional symbols:**

1 - Zolotitsa kimberlite field:

1.1 - Location of tube and bore-hole of one of the ore deposits on the Winter coast of the White sea, structures: N 1 - Pioneer, N 2 - Lomonosov, N 3 - Karpinsky, N 4 - Snegurochka. The same site of dendrochronological research.

1.2 - Character of geothermal parameters change in a section A-B (see 1.1) of structures of the Winter Coast:

1, 3 - geothermal gradient meanings in tube and behind its contour, accordingly;  
 2, 4 - thermal flow density in a tube and in containing rock, accordingly.

**Block tectonics and seismicity:**

2 - fixed centers of earthquakes in earthcrust;

3 - earthquakes of magnitude 6;

4 - megablocks limiting breaks; transblock zones (I - Hibinskaya; II - Baltic-Mezen);

5 - basic megablocks and their indexes: M - Mezen; K - Kola; B - Belomorsky; Kr - Karelian.

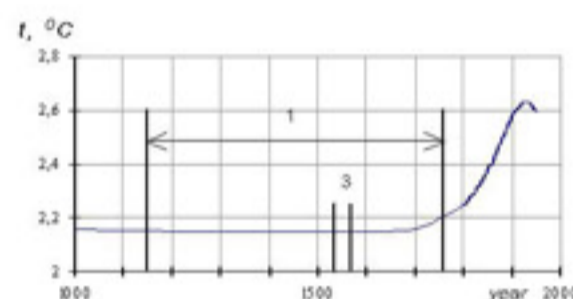


Fig. 2. The reconstruction of temperature of a terrestrial surface on the geothermal data, bore-hole 1000/1, 1000-1949;

**Conventional signs:** 1 - Little Ice Age; 3 - interval of time of the lowest temperatures of Little Ice Age

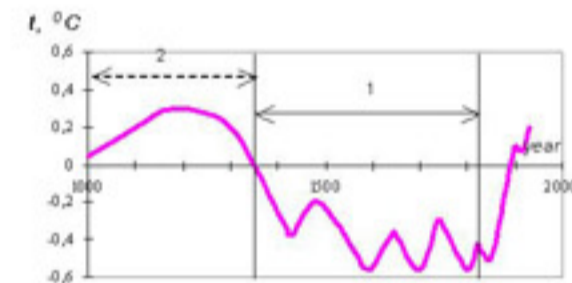


Fig. 3. The reconstruction of temperature of air temperature in Western Europe and in east of Northern America on dendrochronological and historical data, 1000-1930 (Balobaev, Duchkov, 1994);

**Conventional signs:** 1 - Little Ice Age; 2 - Medieval warm period

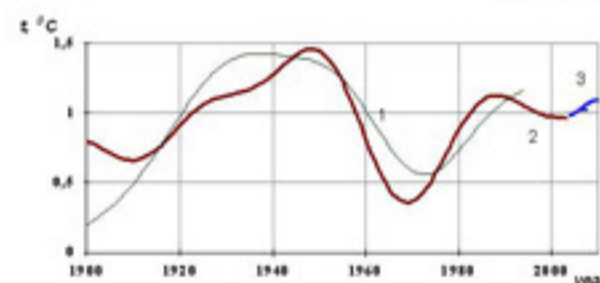


Fig.4 Comparison results of a low-frequency filtration (border 30 years) of temperatures received at the reconstruction the indirect data and at processing the meteorological data.

- (1) Meanings of meteorological air temperatures on station of Arkhangelsk
- (2) Meanings of air temperature on dendrochronological data, area of Zolotitsa field (the materials are collected before the beginning of industrial working of the deposit).
- (3) **Prognosis:** air temperature increase till 2010, from the natural cyclic (30-40 years and 80-100 years) of climate.

According to geothermal reconstructions it is possible to allocate the Little Ice Age, the maximum of which lies around 1540-1560. The end of this period is recorded at approximately 1850. The last warming of non-anthropogenic character was recorded in 1920-1950, contemporary warming since 1970 years.

This trend is proved by dendrochronological reconstructions and until 2003 for the same territory.

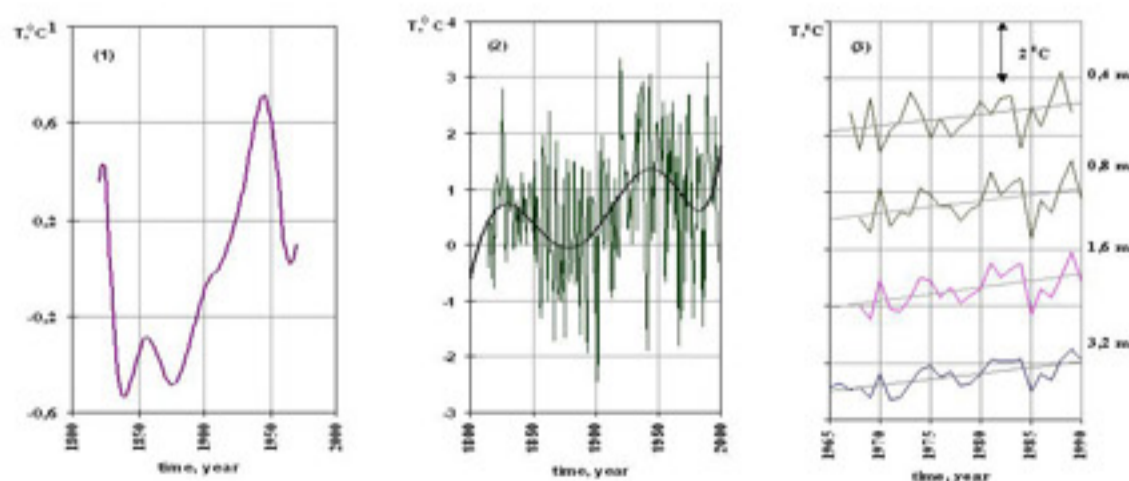


Fig. 3. Graphs of annual temperatures according to the meteorological data.

**in air,** data processed with polynomial function: (1) Northern Europe, 1820-1970 (Kucherova, 1994), average of stations: Oslo, Bergen, Trondheim, Stockholm, St.-Petersburg, Arkhangelsk, Ust-Zylma; (2) Arkhangelsk station, 1813-1998;

**at different depths in the soil:** (3) Arkhangelsk station, 1965-1990 (average mean: 0,4 m = 4,6 °C; 0,8 m = 4,6 °C; 1,6 m = 4,6 °C; 3,2 m = 4,6 °C), processed with linear trend.

The analysis of low frequency (Potter-filtered) components of meteorological air temperatures from the investigated region from the 19-20th centuries has distinguished a dominant component of 30-40 and 80-100 years for the European North, with contemporary warming since the year 1970 and correlation with ground temperatures.

The obtained results suggest, that climate in the Arctic and adjacent regions will continue to be dominated by natural century-scale cycles, superimposed by the contemporary warming trend of air temperatures