

Thermal State of Permafrost in Alaska and Russia

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PROJECT SUMMARY

The thawing of permafrost that is already occurring at the southern limits of the permafrost zone can generate dramatic changes in ecosystems and in infrastructure performance. There exists no global database that defines the thermal state of permafrost within a specific time interval. This project provides the US contribution to the International Polar Year Thermal State of Permafrost (IPY/TSP) project that measures temperatures in a large number of globally distributed boreholes in order to provide a "snapshot" of permafrost temperatures in both time and space. The Alaskan and Russian borehole temperature data sets will also provide the baseline to reconstruct past surface temperatures, to assess the future rates of change in near-surface permafrost temperatures and permafrost boundaries, and to provide spatial data for validation of climate scenario models and temperature reanalysis approaches.

Project Goals:

The overarching goal of our research is to obtain a deeper understanding of the temporal (interannual and decadal time scales) and spatial (north to south and west to east) variability and trends in the permafrost temperatures in the North of Eurasia and Alaska to develop more reliable predictive capabilities for the projection of these changes into the 21st century.

To achieve this goal the following tasks were proposed:

1. Obtain standardized temperature measurements in permafrost regions of Alaska and Russia
2. Work towards establishing a sustainable network of boreholes for long-term temperature observation in Russia and Alaska
3. Develop a joint Alaska-Russian permafrost temperature database and report initial results at the Ninth International Conference on Permafrost (NICOP) (June 2008, Fairbanks)

DEVELOPMENT OF BOREHOLE NETWORK FOR PERMAFROST TEMPERATURE OBSERVATIONS

Objective 1: Upgrade, maintain and acquire data from the Alaskan network of permafrost observatories.

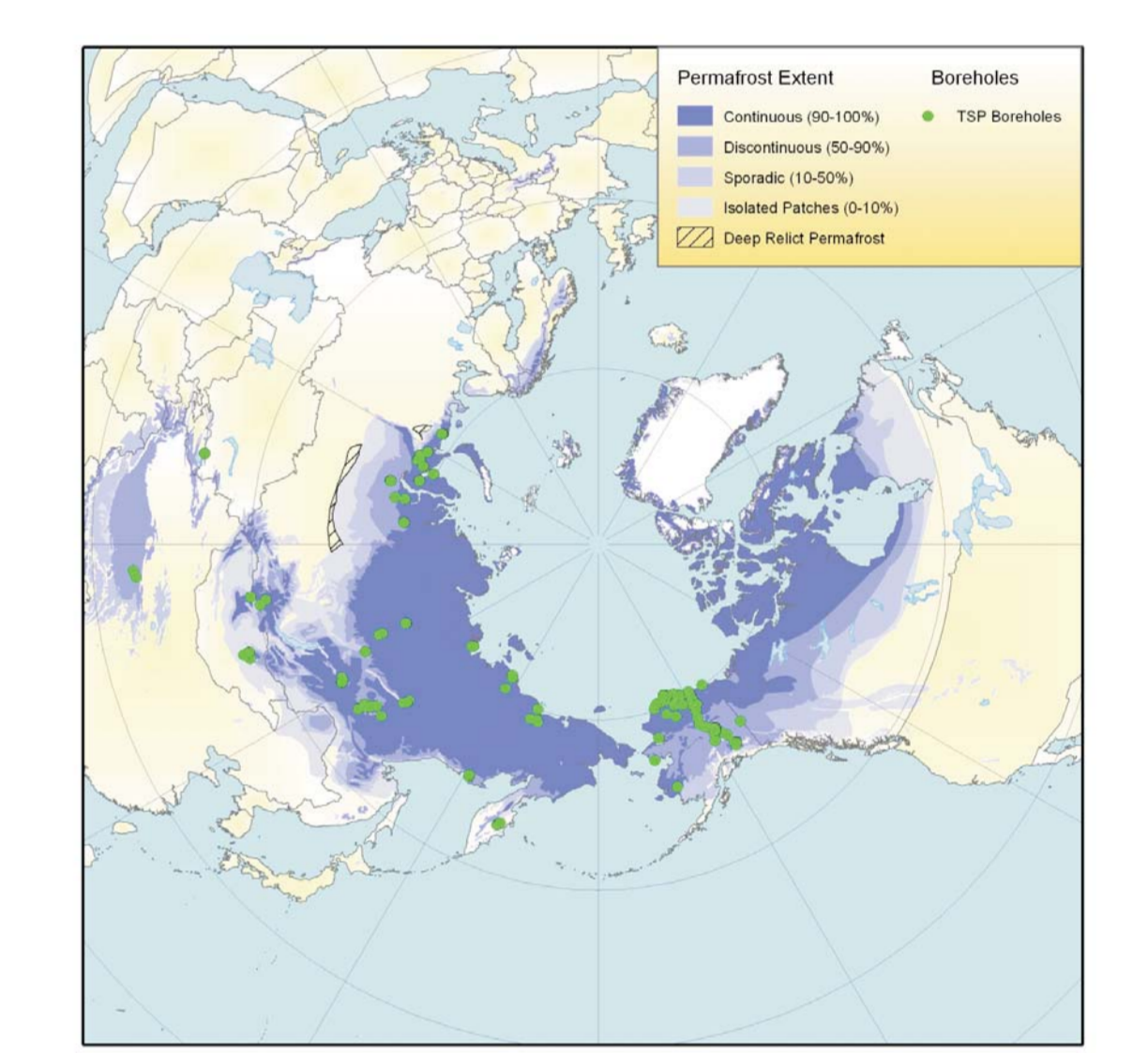
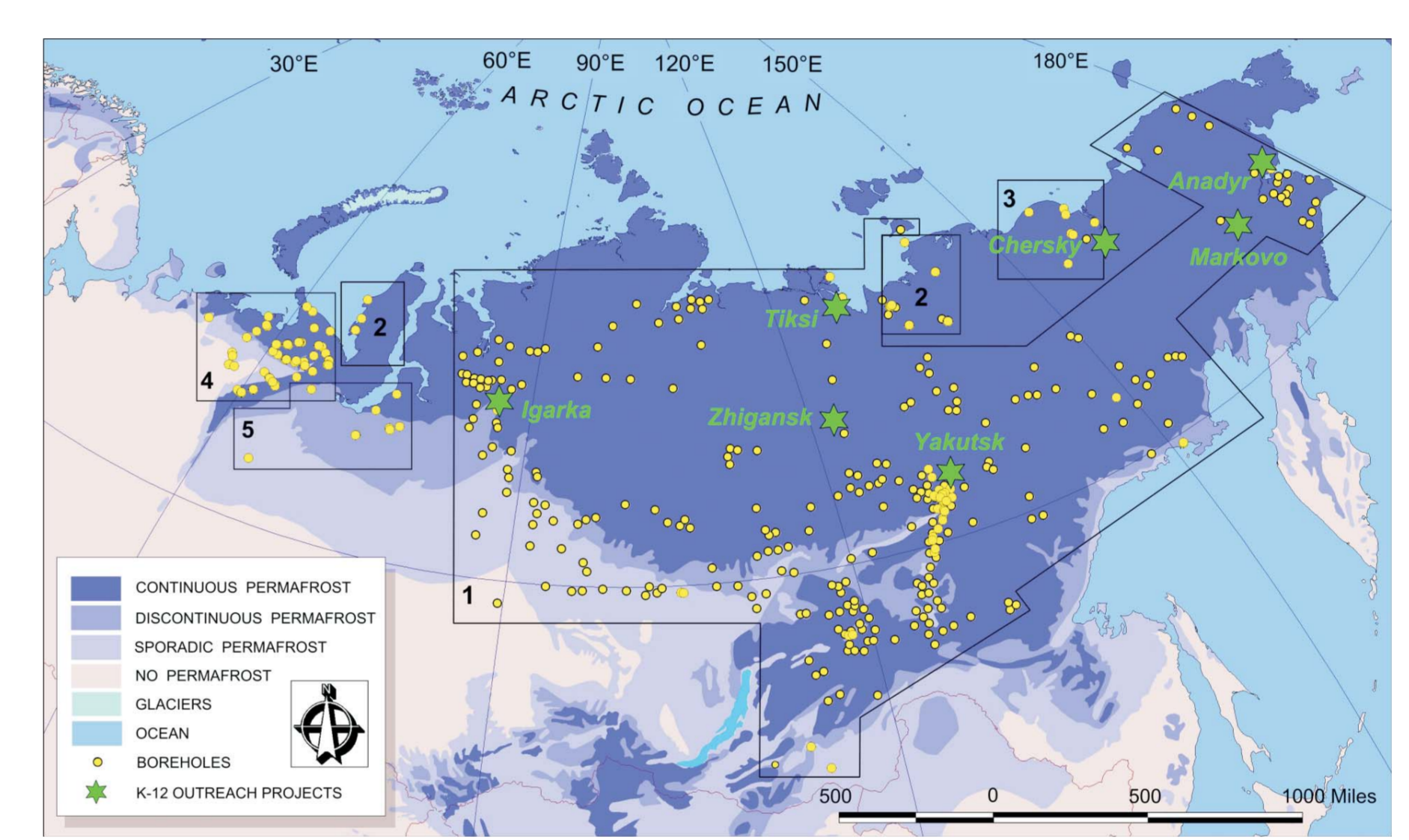
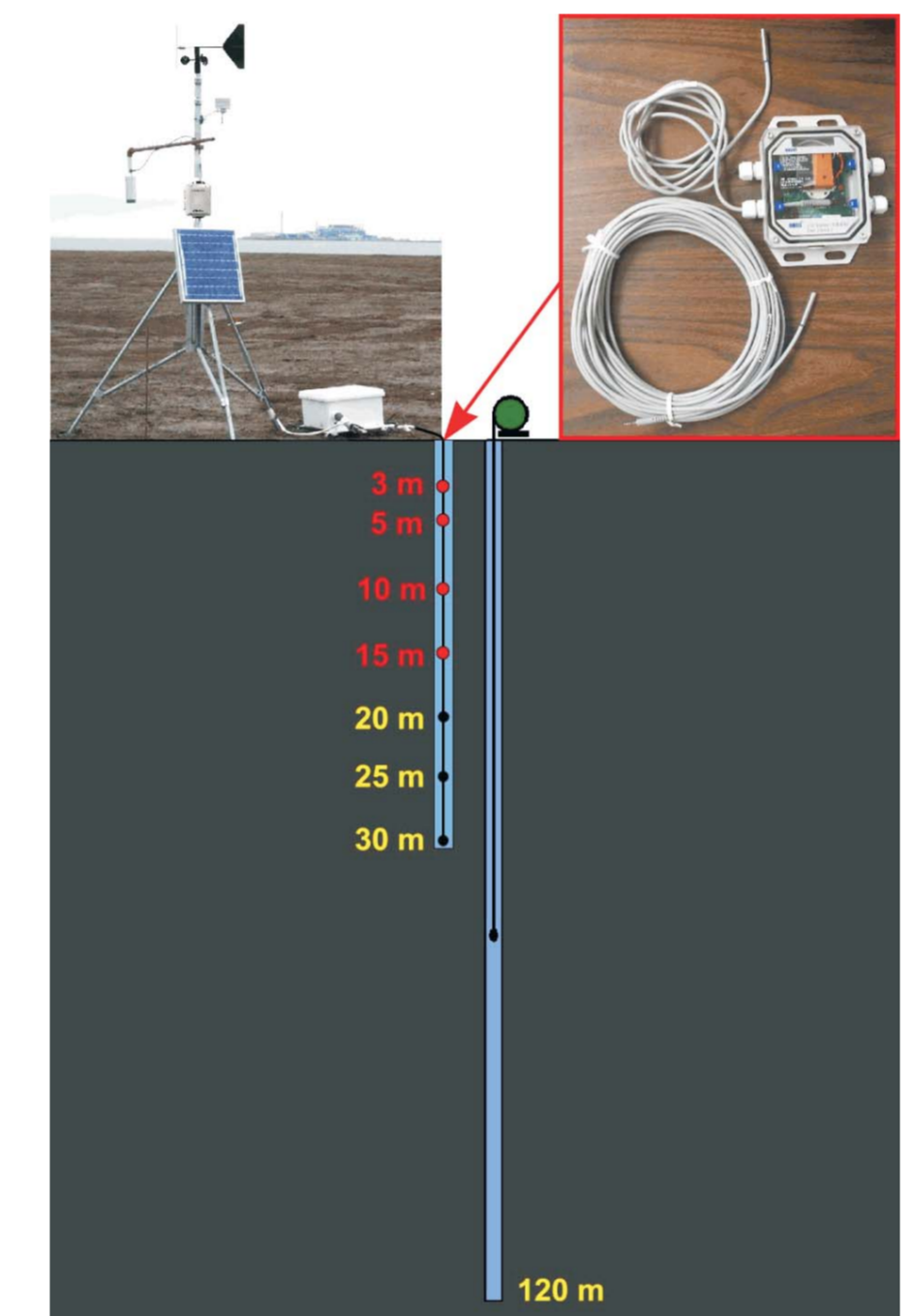
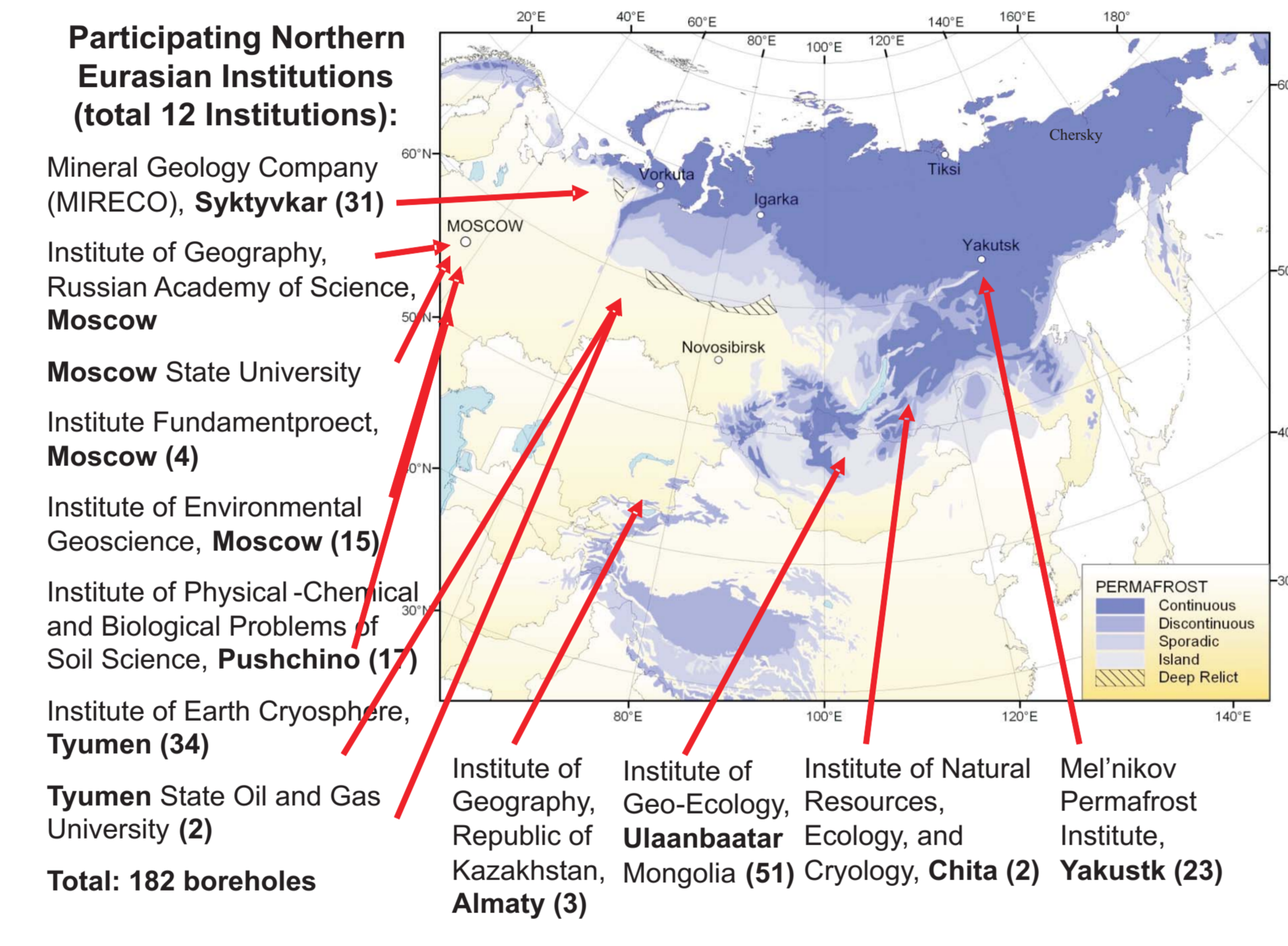
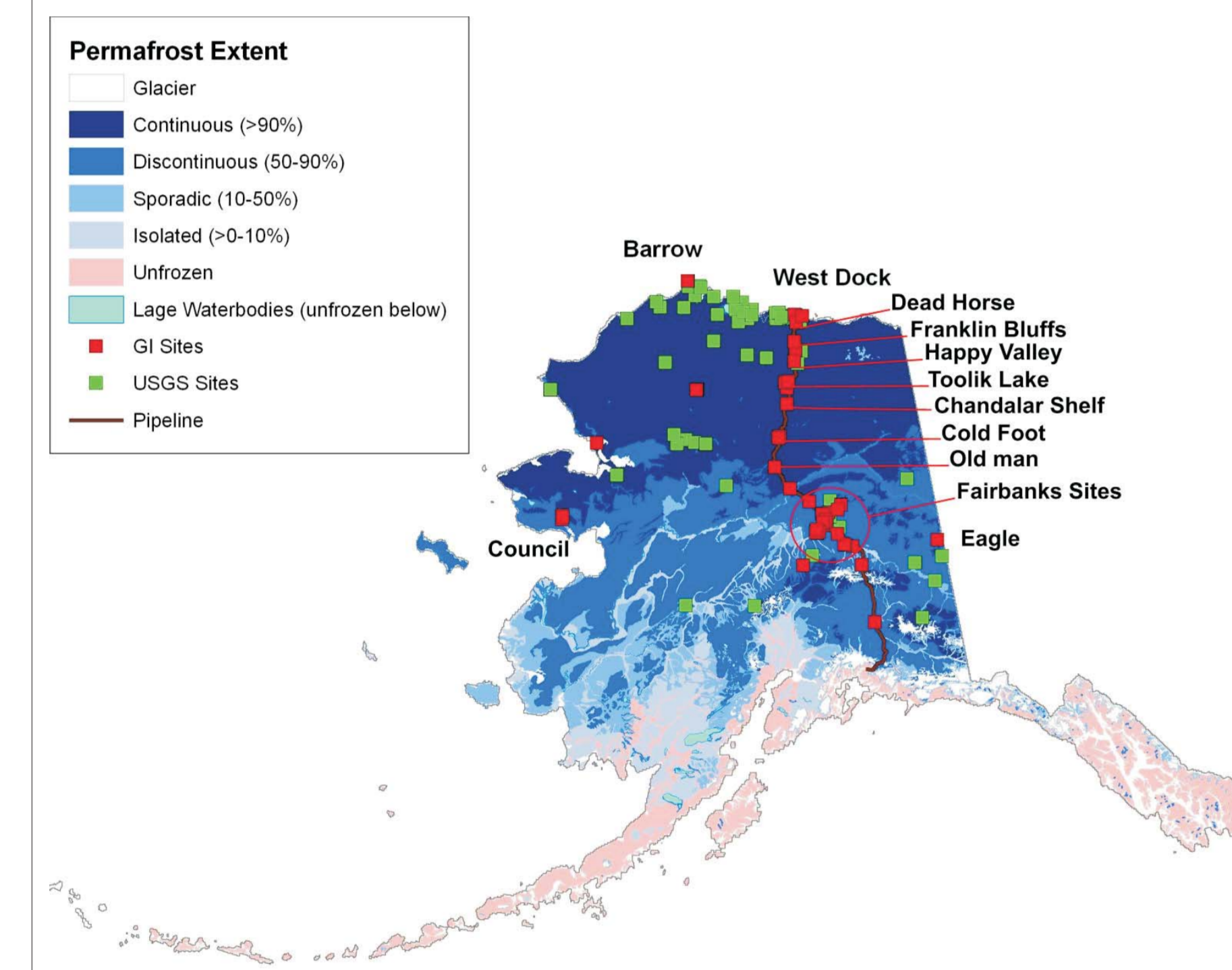
During the time of the project, temperature has been measured in all Alaskan boreholes with the long-term continuous records that go back to the late 1970s. In addition, measurements were resumed in 7 existing deep boreholes where observations were discontinued in the 1980s. 12 new permafrost boreholes were added to the existing network during the IPY time frame.

Objective 2: Develop a sustainable network of permafrost observatories in Russia and participate in the acquisition of a comparable set of data from regional observatories in Russia.

a. Collaboration with partners in Russia. Memorandums of agreement were signed with 11 Russian partners' organizations representing Russian Academy of Sciences, Russian Universities and Industrial organizations at the level of Directors of these organizations.

b. Protocol of geothermal measurements development. In order to standardize all investigation within the frame of the Project, the "Manual for monitoring and reporting data permafrost borehole temperatures" was developed. It allows better permafrost data collection and interpretation. This protocol was discussed among all participants and the final version was produced.

c. Boreholes inventory and instrumentation. A large number of existing boreholes have been identified for possible measurements ("candidate sites"). Currently observational network includes 194 boreholes situated in Alaska (63); European part of Russia (46); Western Siberia (35); Northern (13), Central (7) and Southern (12) Yakutia; Baikal region (10); Chukotka and Magadan region (3) and Kamchatka (5). Most of the boreholes (154) are less than 30 m deep (surface, shallow or intermediate in according to GTN-P classification) and instrumented for continuous observations. Some of them (40) are 50 – 200 m deep and measured once or twice per year. Additionally, 155 shallow boreholes (less than 10 m deep) were instrumented near many schools in Alaska as a part of Permafrost Outreach Program.



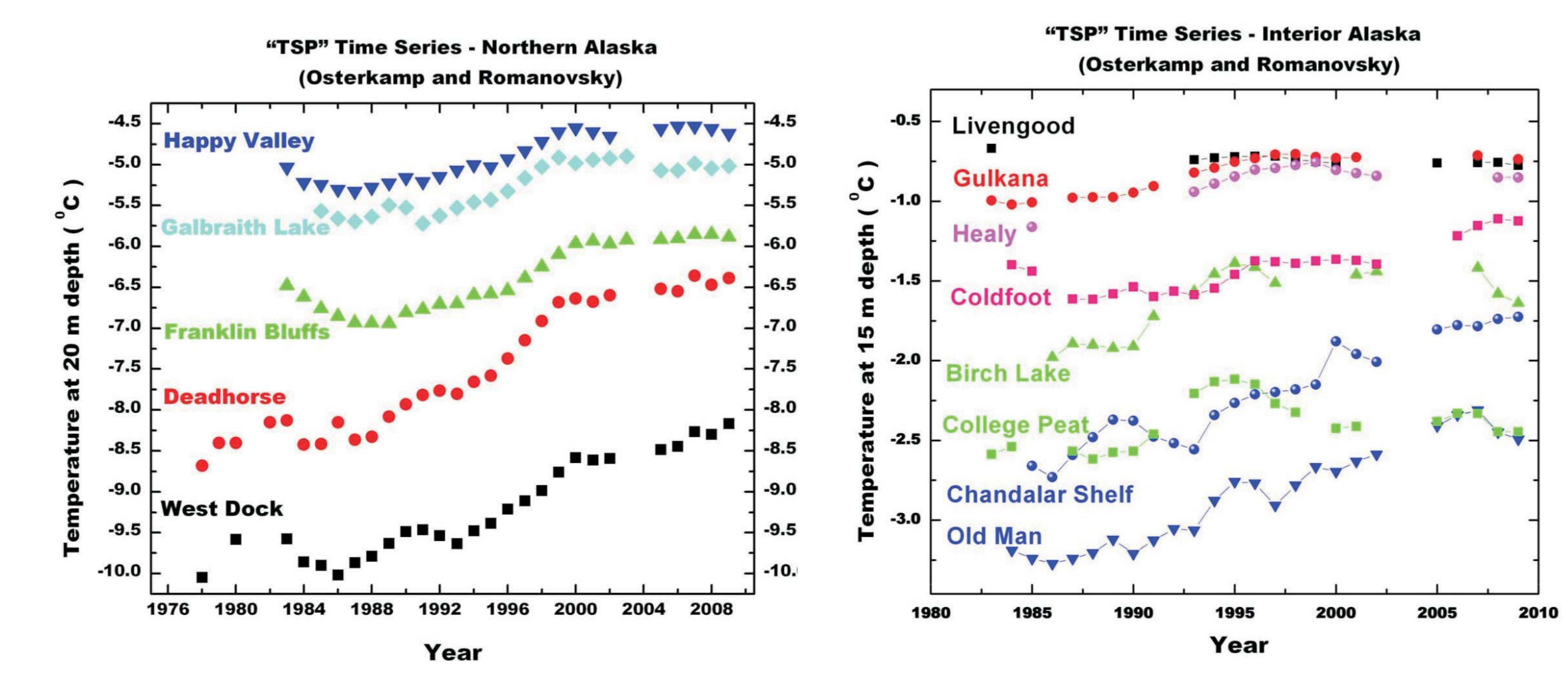
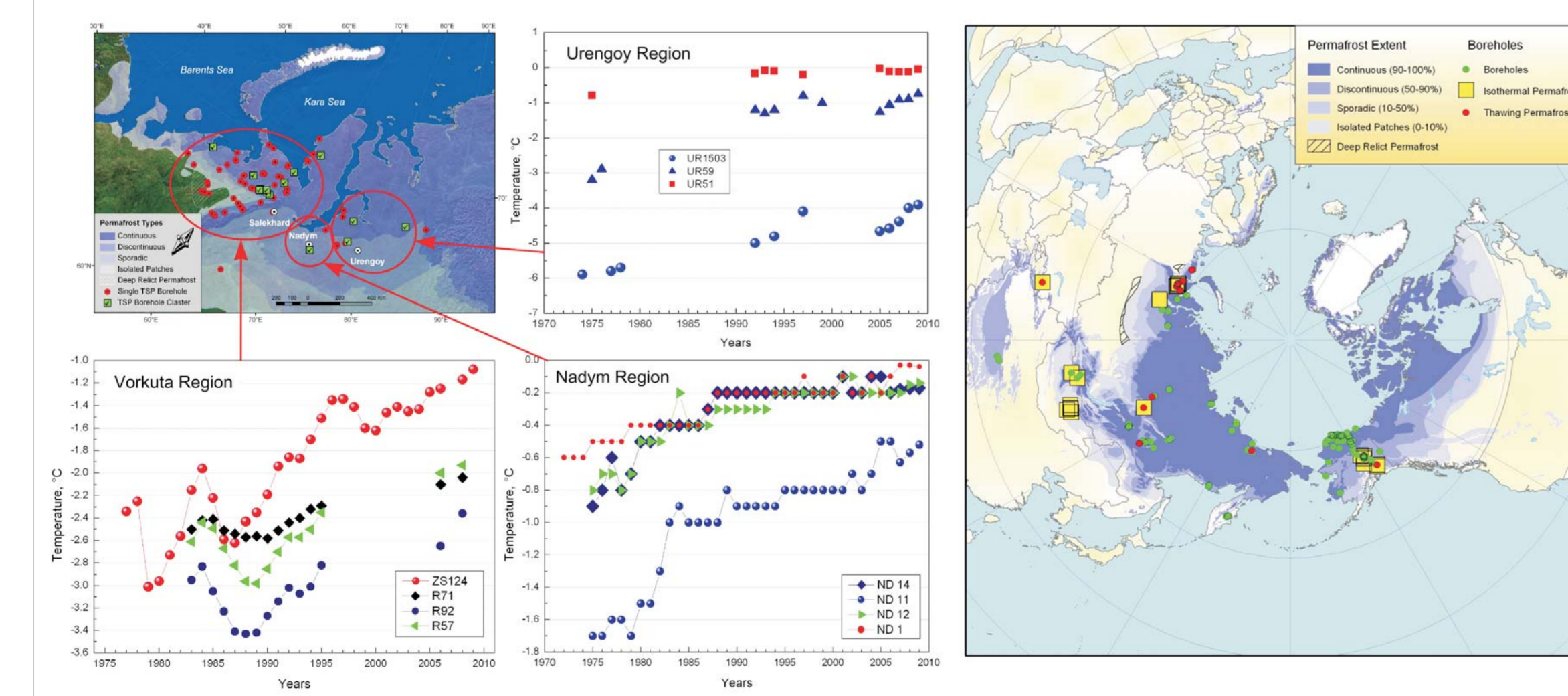
Results of measurements are available for download from the **Cooperative Arctic Data and Information Service (CADIS)** website.



Objective 3: Encourage the development of a new generation of arctic researchers and permafrost specialists. Several young scientists (Pot Doc, PhD and undergraduate students) are involved in our research both at the UAF and in Russian partner's organizations.

CONCLUSIONS:

- Based on the comparison of historical and recently obtained data the following conclusions can be made:
- Most of the permafrost observatories in Russia and Alaska show substantial warming of permafrost during the last 20 to 30 years (Figures 1 and 2). The magnitude of warming varied with location, but was typically from 0.5 to 2°C at the depth of zero annual amplitude.
 - This warming occurred predominantly between the 1970s and 1990s. There was no significant observed warming in permafrost temperatures in the 2000s in most of the research areas; some sites (especially in the Alaskan Interior) even show a slight cooling during the late-1990s and early-2000s and then in 2006-2009. Warming has resumed during the last two to three years at some locations, predominantly along the Arctic Ocean coasts both in Alaska and in Russia.
 - Considerably less or no warming was observed during the same period in the north of East Siberia.
 - Permafrost is already thawing in specific landscape settings within the southern part of the permafrost domain in the European North, in northwest Siberia, and at some locations in Interior Alaska. Formation of new closed taliks and an increase in depth of pre-existing taliks has been observed in this area during the last 20 to 30 years.

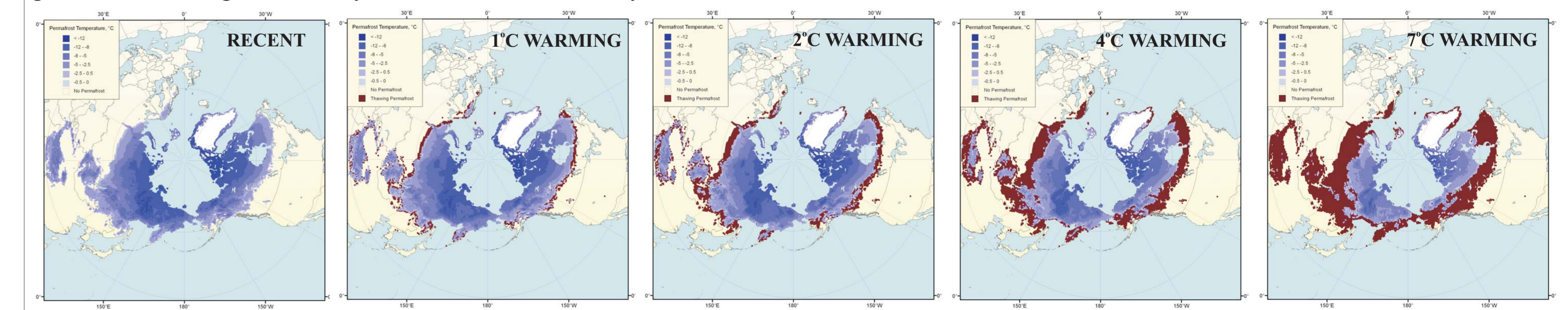


INTERACTIONS WITH OTHER AON PROJECTS.

Close relations with Circumarctic Active Layer Monitoring project (CALM) were established. Some of key boreholes are associated with CALM sites.

USING THE DATA OF THE PROJECT FOR MODELING

Results of observations were used for permafrost dynamic models validation. Permafrost temperature reanalysis provides a valuable tool to study past changes in permafrost temperature, which helps to place recent changes into a long-term perspective. An implemented spatially-distributed permafrost model shows that if warming in air temperatures continues to occur as predicted by most climate models, widespread thaw of late-Holocene permafrost may be in progress by the mid-21st century. If warming continues, some Late Pleistocene permafrost will begin to thaw by the end of the 21st century.



ACKNOWLEDGMENTS

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