THE GLOBAL TERRESTRIAL NETWORK FOR PERMAFROST (GTN-P)

STATUS AND RECENT RESULTS FROM NORTH AMERICA FOR THE THERMAL MONITORING COMPONENT

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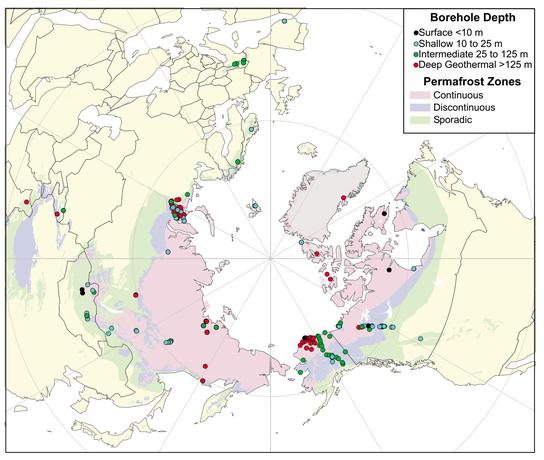
INTRODUCTION

The Global Terrestrial Network for Permafrost (GTN-P) was established in 1999 by the International Permafrost Association (IPA) to provide long-term field observations of active layer and permafrost thermal state that are required to characterize and detect changes in permafrost conditions. The data supplied by the network will enhance our ability to predict the consequences of permafrost degradation and to develop adaptation strategies to respond to these changes. The GTN-P contributes to the World Meteorological Organization's Global Climate Observing System (GCOS) and Global Terrestrial Observing System (GTOS).

The active layer component of the GTN-P, the Circumpolar Active Layer Monitoring Program (CALM), has been in existence for the past 10 years. The efforts of the IPA's ad hoc GTN-P committee over the past five years therefore have focussed on the organization of the thermal monitoring component. This poster reviews the present status of the thermal monitoring component and presents recent selected results from North America.

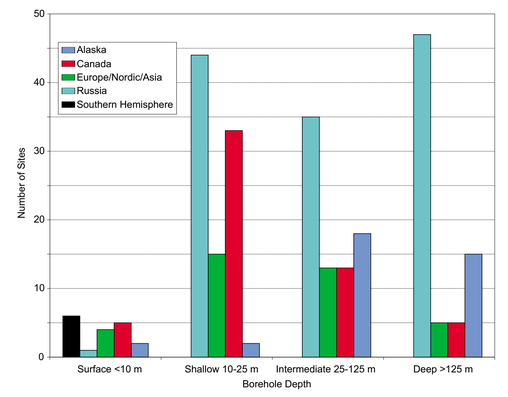


Candidate boreholes for GTN-P for which site descriptions are available.

STATUS OF THE THERMAL MONITORING COMPONENT

The permafrost thermal monitoring program consists of a globally comprehensive network of boreholes for ground temperature measurements. Many of these boreholes were drilled for research, geotechnical, or resource exploration purposes in the last two decades and have been maintained as thermal monitoring sites. An initial survey identified about 370 boreholes from 16 countries which could contribute to the GTN-P. Regional networks include those of the Geological Survey of Canada (GSC) in the Mackenzie region, the University of Alaska's Alaskan transect, the United States Geological Survey's deep boreholes in northern Alaska and the European Community's Permafrost and Climate in Europe (PACE) program of boreholes largely in alpine permafrost. There are also a few sites located in the southern hemisphere in Antarctica and Argentina. An inventory of candidate boreholes and background material is provided on the web site developed by the GSC (www.gtnp.org).

Over the last two years, efforts have focussed on compilation of site metadata (site descriptions) for candidate boreholes. Metadata have been compiled for approximately 70% of the boreholes that were initially identified as candidate sites. Locations of sites in the Northern Hemisphere for which site descriptions are available are shown on the accompanying map. The site descriptions have been compiled in a database and are also accessible through the GTN-P web site. The majority of the boreholes are between 10 and 125 m deep.



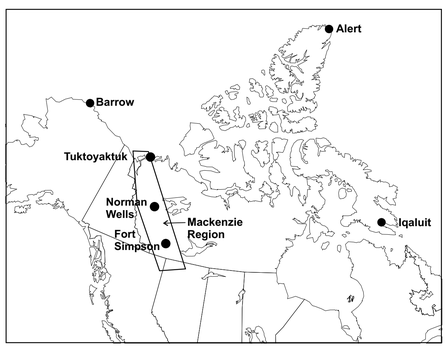
Distribution of candidate boreholes for which site descriptions are available.

Other recent activities and accomplishments include:
i) contribution to the Second Adequacy Report of GCOS
ii) publication of summary paper in EOS
iii) funding acquired from Canadian government for GSC's implementation of Canadian Permafrost Monitoring Network
iv) joint Canada-Denmark project to compile historical permafrost data for Greenland and adjacent Canadian Arctic (funded by Canadian Department of Foreign Affairs and International Trade)
v) establishment of 2 boreholes at Barrow Permafrost Observatory
vi) continuation of European Permafrost Monitoring Network through PACE21

Development of the database structure for management of the thermal data has been initiated and historical data from Canadian monitoring sites is being compiled into this relational database format to test the structure and manipulation routines. Data from sites in other countries have also been submitted and historical database compilation for all sites will take place over the next year. Submission of data on an annual basis, where possible, from network sites will take place similar to that for the CALM program, to build up a long-term database of permafrost thermal data. Summary data will be available through the GTN-P web site.

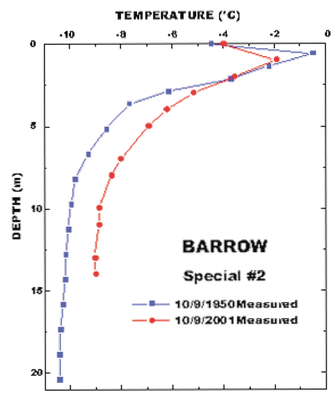
RECENT NORTH AMERICAN RESULTS

A general discussion of preliminary results from GTN-P sites in Canada, Alaska and Russia can be found in Romanovsky et al. (2002). This poster focusses on the thermal data from sites in the North American permafrost zone shown on the map to the right as an initial contribution towards a more comprehensive regional assessment.

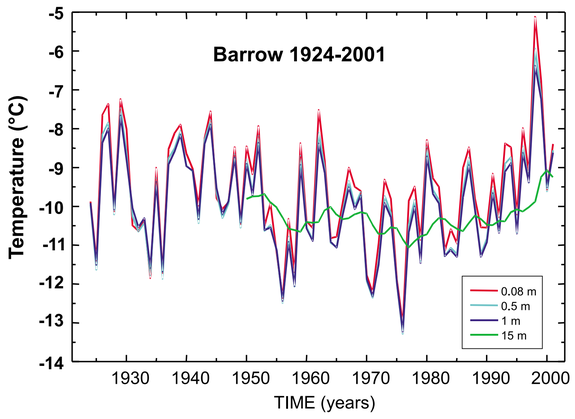


Alaska

Analysis of permafrost temperatures in the upper 20 m from a network of boreholes maintained by the University of Alaska, Fairbanks, indicates that permafrost has warmed over the last 20 to 50 years. At the recently reactivated monitoring site at Barrow, temperatures at a depth of 15 m increased 1°C between 1950 and 2001. At sites along the Trans-Alaska pipeline route, permafrost temperatures increased between 0.6 and 1.5°C at a depth of 20 m between 1983 and 2000 (Romanovsky and Osterkamp, 2001).



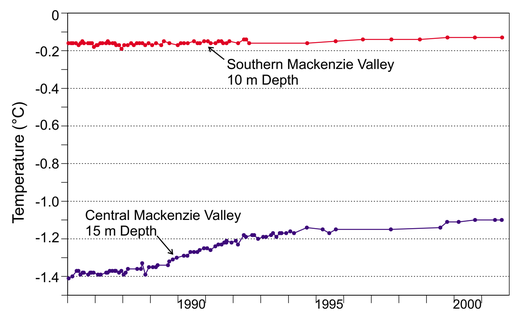
Comparisons between permafrost temperature profiles measured at the same location in 1950 and 2001 (from Romanovsky et al. 2002).



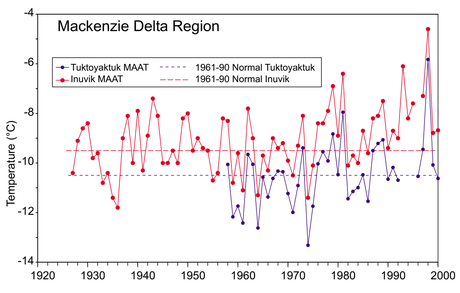
Reconstructed mean annual temperatures in the active layer and near surface permafrost using a model calibrated to the 1950s for the Barrow site and the data from the Barrow meteorological station (from Romanovsky et al. 2002).

Canadian Arctic

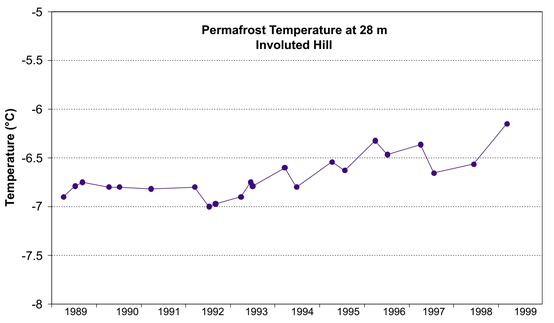
The GSC has operated a network of thermal monitoring sites in the Mackenzie region, Northwest Territories since 1985. At 15 m depth at a site in the central Mackenzie valley, an increase of about 0.03°C per year was observed between 1986 and 2001 in permafrost with a temperature of approximately -1°C. In the southern Mackenzie valley where permafrost temperature is warmer than -0.2°C, there is no apparent trend. In the northern Mackenzie region, in colder permafrost (-7°C), temperatures at a depth of 28 m show an increase of about 0.1°C per year in the 1990s.



Ground temperature at 15 m depth in the central Mackenzie valley near Norman Wells and at 10 m depth in the southern valley near Fort Simpson.

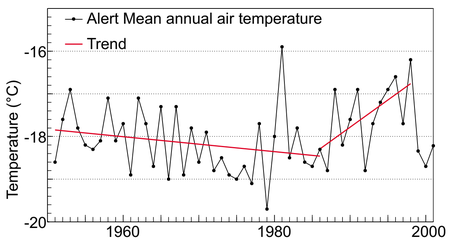


Air temperature records for Environment Canada stations in the northern Mackenzie region.

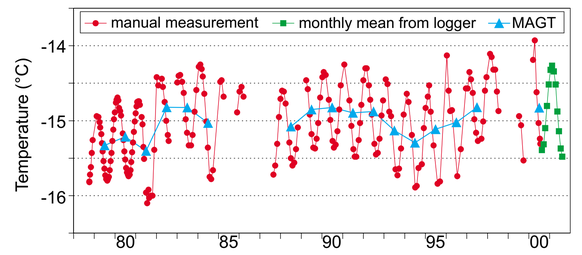


Permafrost temperature at a site in the northern Mackenzie region near Tuktoyaktuk.

At the GSC's high Arctic observatory at Alert, Nunavut, a warming of the permafrost of about 0.15°C per year at a depth of 15 m occurred in the late 1990s.

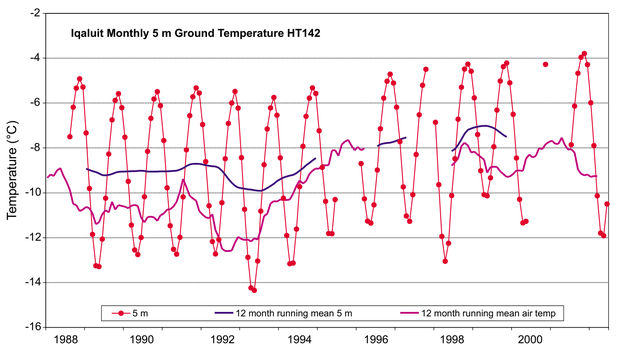


Air temperature record from the Environment Canada station at Alert.



Observed permafrost temperature at Alert between 1978 and 2001 at a depth of 15 m (from Smith et al. 2003). Mean annual ground temperature (MAGT) is also shown.

Some cooling of permafrost was observed from the late1980s to the early 1990s in the eastern Canadian Arctic at a depth of 5 m at Environment Canada's borehole at Iqualuit, Nunavut. This cooling however, was followed by a warming in the late 1990s. This trend is similar to that observed in Northern Quebec, where cooling of about 0.1°C per year was observed from the mid 1980s to the mid 1990s at a depth of 10 m in boreholes maintained by Université Laval (Allard et al. 1995). This was followed by a warming trend starting in 1996 (Brown et al., 2000).



Ground temperature at a depth of 5 m in a borehole at Iqaluit. Air temperature from the Environment Canada station is also shown. Data courtesy of Joe Eley, Environment Canada.

Summary

The long-term observations of permafrost thermal conditions provided by the GTN-P will enable us to address a number of climate change issues in the permafrost regions. The data collected will provide information to scientists studying the cryosphere and also to stakeholders, politicians and other decision makers. Information is also provided that is critical for the evaluation of the impacts of climate change and the development of adaptation measures to reduce these impacts.

Results from North America indicate that warming of permafrost occurred in the latter half of the 20th century in the western Arctic. Warming of permafrost in the Canadian eastern and high Arctic has mainly occurred in the late 1990s. These trends in permafrost temperature are consistent with increases in air temperature since the 1970s in the North American Arctic.

References

Allard, M., Wang, B. and Pilon, J.A. 1995. Recent cooling along the southern shore of Hudson Strait Quebec, Canada, documented from permafrost temperature measurements; Arctic and Alpine Research, 27: 157-166.

Brown, J., Hinkel, K.M. and Nelson, F.E., 2000. The Circumpolar Active Layer (CALM) program: research designs and initial results; Polar Geography, 4: 163-258.

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Romanvisky, V.E. and Osterkamp, T.E. 2001. Permafrost: changes and impacts in Permafrost Response on Economic Development, Environmental Security and Natural Resources, edited by R. Paepe and V. Melnikov, p. 297-315.

Smith, S.L., Burgess, M.M. and Taylor, A.E. 2003. High Arctic permafrost observatory at Alert, Nunavut - analysis of a 23 year data set. Proceedings 8th International Permafrost Conference.

GTN-P web site www.gtnp.org CALM web site http://k2.gissa.uc.edu/~kenhinke/CALM/