Permafrost temperature monitoring, Yukon and Western Arctic Canada

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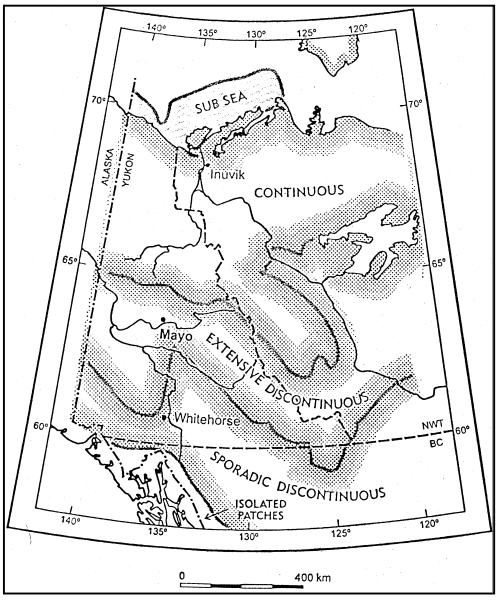
This presentation concentrates on work in the Yukon and Western Arctic. This work is funded mostly by NSERC and the Polar Continental Shelf Project (PCSP). I also receive a fair amount of support in kind, particularly from the Aurora Research Institute and from Yukon College's Northern Research Institute. The most fundamental support comes from Carleton University, which gives me the time needed to do this kind of work.

The research program is situated in three principal areas:

- Sporadic discontinuous permafrost (Takhini River valley, southern Yukon Territory)
- Widespread discontinuous permafrost (Mayo, central Yukon Territory)
- Continuous permafrost (Western Arctic)



As shown in the GCOS presentation that Whitehorse, Mayo, and Inuvik are part of the global climate data gathering system, so there is a good chance that climate data will be available from these stations for the long term. From the ground temperature perspective, there is already considerable interest in the Western Arctic.

There are four basic principle that drive the research program:

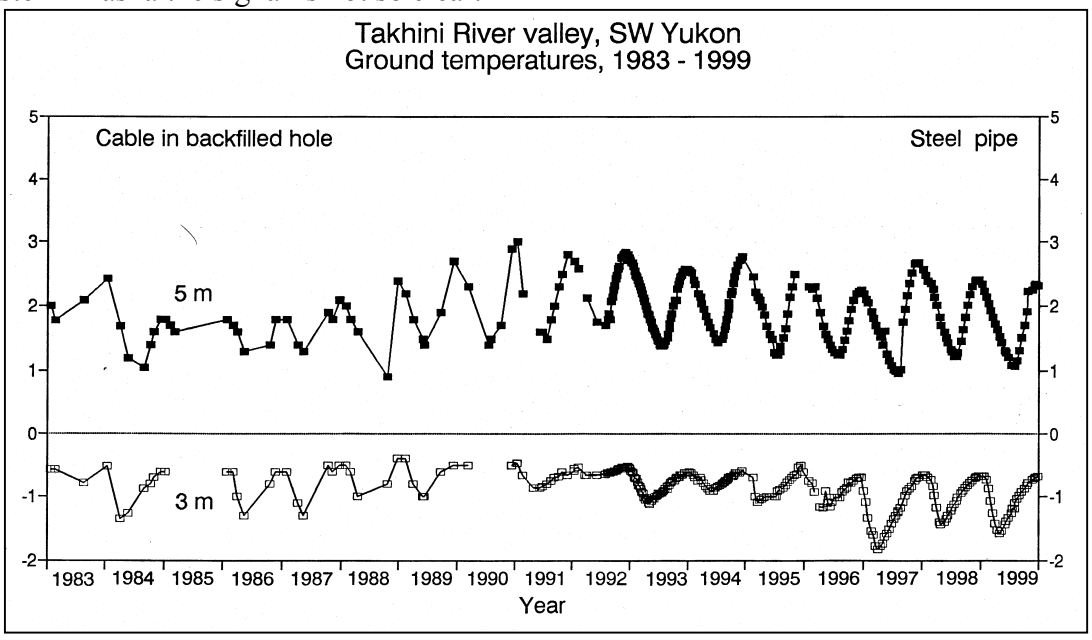
1. Because a significant part of my research funding is from NSERC, all of my data collection (monitoring) is aimed at answering specific research questions. There may be long-term data collection and archives, but all of the data collected is to supply answers for specific questions about permafrost behavior, with specific models in mind.
2. For an independent researcher like me to work in Northern Canada, it is absolutely critical that there be community involvement, or at least that local people are on side in terms of the research program.
3. Simple and robust measurements are best: this will guarantee long-term success. Rather than having sophisticated instrumentation at these sites, we have equipment that can survive encounters with wild animals or disgruntled

individuals, and that can be read easily by people that have not had a substantial post-secondary education. Data acquisition is a backup to the manual measurements.

4. Particularly in the university sector, a long-term personal commitment is essential. In the university, no one can tell you what your research program is going to be, so long-term work depends on personal commitment. In the government sector, some institutional long-term support is also required, while in the private sector, institutional, government and personal commitments are all required.

For each of the three areas where we work, I will give examples of what we do and illustrate the four principals.

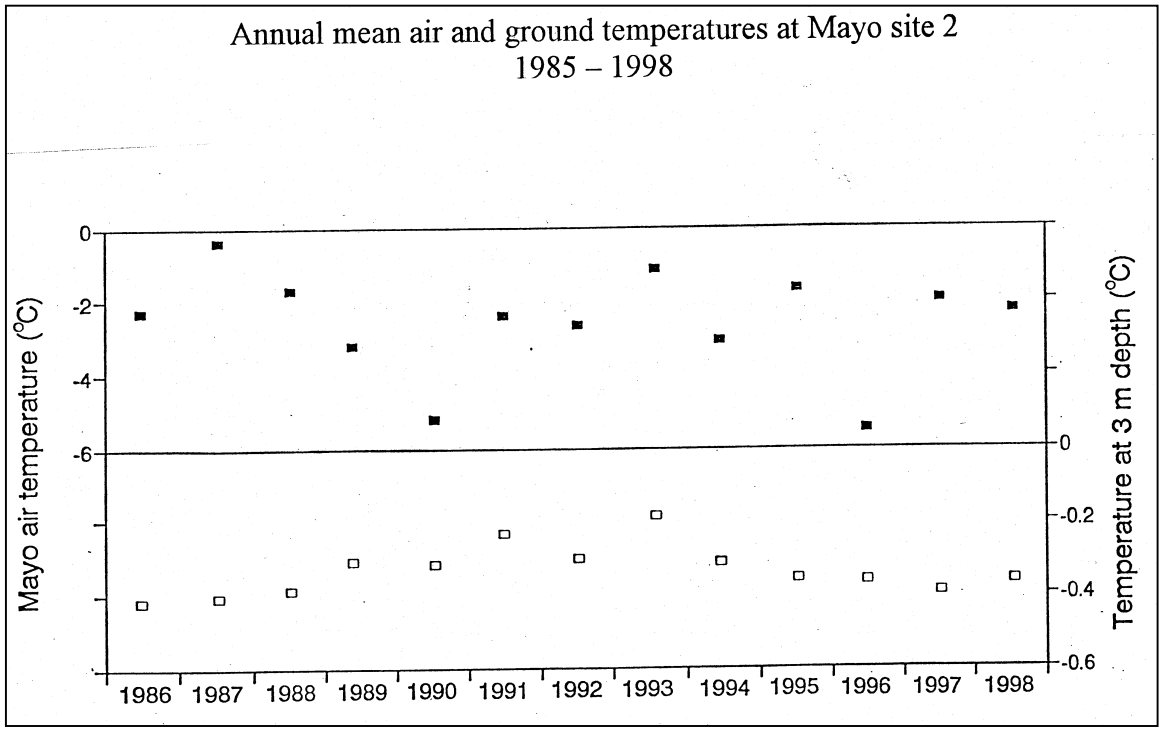
The first of these is Takhini River valley. The research questions that have been driving the data collection have been associated with the response of permafrost to a large change in surface conditions associated with forest fire (published in 1998); and the experimental manipulation of snow cover to try and establish permafrost at sites where snow cover is cleared in wintertime. Currently, data are collected primarily by Diana and Karen White (1996-2000). They have come out from Whitehorse on a fortnightly basis. Since 1982 (when the project began, about ten other Whitehorse residents have been involved. The actual data collection is relatively simple, consisting of manual thermistor readings of cables in steel pipes in the ground. There are five sites in this area, including one with stable permafrost and one with degrading permafrost. At some sites there are HOBO loggers as a backup for those times that people can't make it out to the sites. Currently, some people are also involved in snow shoveling. The long-term nature of this work is exemplified by the fact that data collection began at these sites in 1982, when Mike Smith was interested in the long-term effect of climate change on permafrost in this area. The data shown are from two sites in the Takhini Valley, with data commencing in January 1983 and continues to January 2000. Since 1990 we have data once every two weeks, and in 1997 we replaced the original cable with a new cable installed in steel pipe. There is a slight amplification of the annual wave because of this. In this area, we have not seen the same change in ground temperature that was reported for Alaska by Dr. Romanovsky, although they do report that for eastern Alaska the signal is not so clear.



Mayo

In the Mayo area, we have explored many research questions, the overall theme of which has been permafrost aggradation and degradation under natural conditions. Most of this area is underlain by permafrost, but there is significant local spatial and temporal variability. Currently, my local assistant is Ross Cooper, who has been qorking with me for three years (1997-2000). He is currently in grade 10 at the local high school, and is one of the brightest people I have ever met. Since 198217 Mayo residents have participated in this research, with the result that the village is on side and has helped out in many ways. As in the Takhini Valley, field activities are straightforward, involving manual thermistor readings, measurements of snow depth, CR10 and HOBO loggers used as a backup, and simple measurements of ground movement. Data collection was initiated in 1982.

Below are shown the time series of mean annual air temperature from the Mayo weather station (solid symbols) and mean annual ground temperature at 3 m depth at a site with aggrading permafrost. Similar fluctuations are evident, including the cooling trend of the last decade. The ground temperature trend is not attributable directly to the air temperature trend, since in the last decade the snow cover has been considerably less than it was in the 1980s.

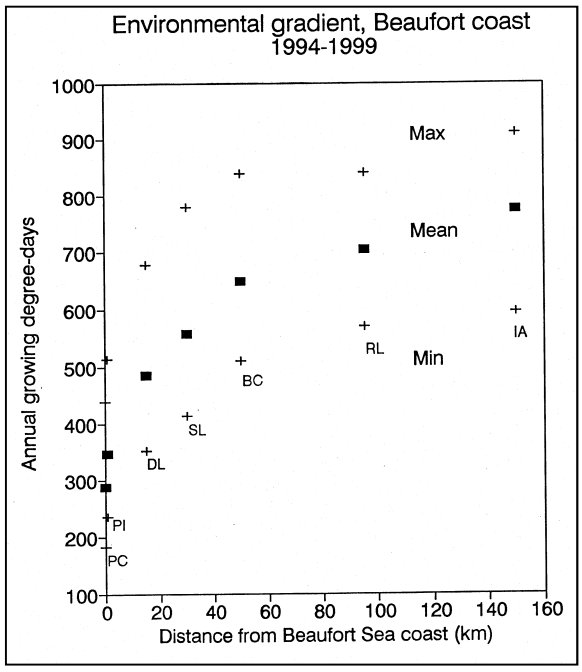


Western Arctic

Research questions in the Western Arctic have included systematic regional variation in permafrost conditions, including systematic change of permafrost with air temperature between Inuvik and the coast. A considerable amount of time in the Western Arctic is spent in collaborative research with Ross Mackay at Illisarvik and Garry Island, where we are continuing observations made over 20 years. The Illisarvik site celebrated its 20th birthday in 1998. Consequently, there is a large amount of material currently in preparation for publication documenting the changes in conditions at Illisarvik over the first 20 years. In the Western Arctic we are reliant in many ways on the support of the Inuvik research center, in particular Les Kutny, who has made measurements for us on a regular basis. We also rely on Doug Joe, who lives in the community and goes out with us whenever we go out on the land; he is a very helpful person who contributes to the research program in many ways.

As above, field activities are straightforward, involving manual thermistor readings, measurements of snow depth, CR10 and HOBO loggers used as a backup, and simple measurements of ground movement. The measurement systems for ground movement are usually arranged so that the measurements can be made with tape measures or small calipers. This work continues the work of Dr. Mackay, so some of the monitoring time series are decades in length.

Just as an example, the data here shows the changing environmental conditions between Inuvik (150 km inland) and Pelly Island on the Beaufort Sea coast. This particular plot is of the number of growing degree-days, and so is an index of summer conditions. Over the five years of data collection there has been significant variability, with the largest variability occurring 40-50 km from the coast. Variability here is about 1/3 greater than either inland or at the coast, and snow cover variation is greater here as well. This indicates that the thermal response of the ground may be more pronounced in this area.



My recommendation to the workshop is to look to the example of Dr. Mackay, to see how he has managed to keep a research program going for decades: he has had very well defined questions, and he has collected data in a manner that ensured retrieval. 2001 will be his 50th season in the fieldL that is ann example that we can all learn from.