Cordilleran Air and Ground Temperature Monitoring

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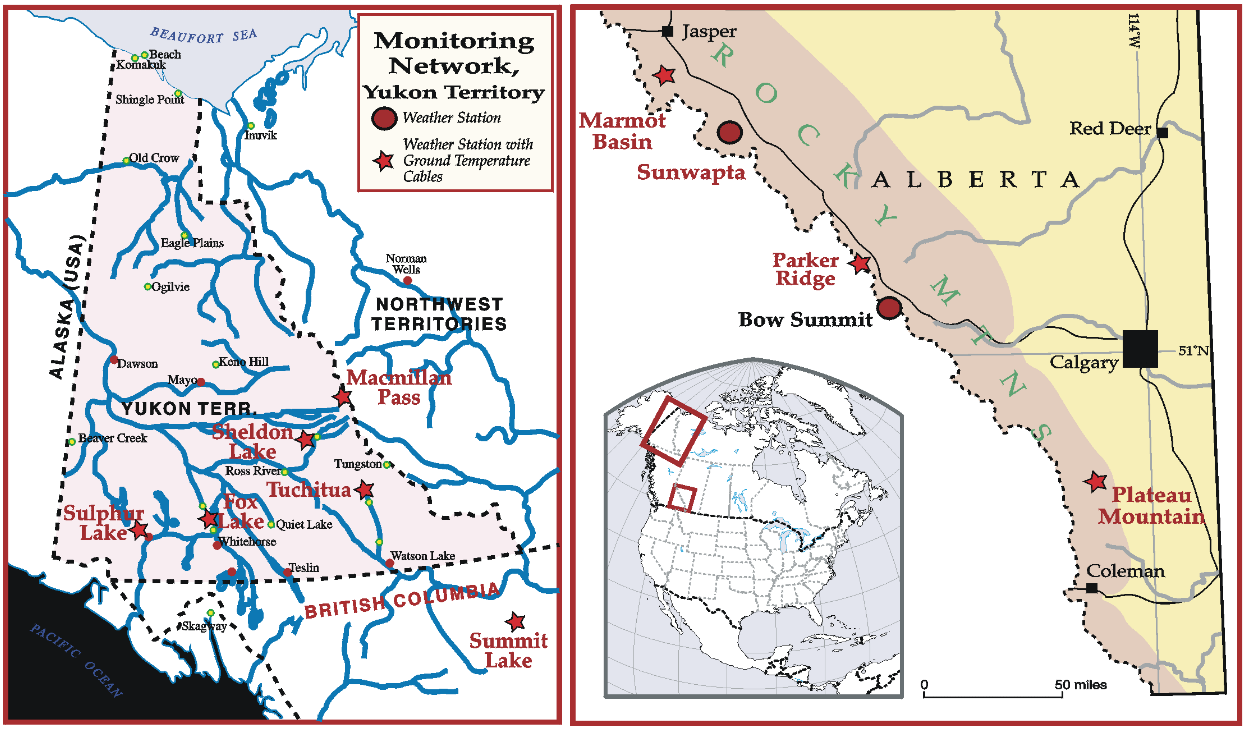
In 1974, Dr. Roger J. E. Brown of the Building Research Division of the National Research Council of Canada drilled a series of five boreholes on Plateau Mountain in Southwest Alberta in order to try to establish the presence or absence of permafrost. The author undertook to monitor the holes once a month, and he also added several weather stations in order to determine the relationship of air temperature and snow cover to the occurrence of permafrost. The ground temperature cables showed the presence of permafrost for the first time in the mountains, and so five more holes were drilled to determine the lower limits of continuous permafrost and to obtain a deeper temperature profile from the top of the mountain, since there was evidence of relict permafrost remaining from the late Wisconsin glaciation. The results were published in the Third International Permafrost Conference Proceedings (1978, vol. 1, 385-391). Before Roger died in 1980, a network of stations with multiple boreholes equipped with both weather stations and ground temperature cables had been emplaced between Marmot Basin Ski area, Jasper, and Plateau Mountain. The results enabled the identification of a climatic method for predicting where permafrost might occur, the climatic conditions under which specific zonal permafrost landforms are active, as well as the distribution of permafrost along this section of the Rocky Mountains. The results were published in a series of papers.

The Geological Survey of Canada sponsored the drilling of five boreholes along the Alaska Highway west of Fort Nelson. These provided information from Northern British Columbia, and in the process, it was possible to document an actual cold air drainage event, which also provided the coldest unofficial air temperature recorded to date in Canada. Additional sites were added in the Yukon Territory, so that by 1987, there was a network of sites operating from Plateau Mountain in the south to the middle of the Yukon Territory. By 1986, enough information had been gathered to permit the construction of a north-south profile of the Eastern Cordillera from Inuvik to northern New Mexico showing the permafrost distribution and temperature (Arctic, vol. 39, 29-38). The key sites are still operating, so there is more than 25 years data for the original study sites. The newer sites were all located where process studies could also be conducted, and this has resulted in the publication of over 50 papers, many coauthored with former graduate students.

The results of these measurements consistently show a decrease in air temperature throughout the region at the permafrost sites over the region. Snow cover has also changed and has partly offset the cooling effect at Marmot Basin. The models of climate-ground temperature interaction reported from lowland arctic permafrost sites, e.g., in Alaska, do not work well in a three dimensional landscape such as mountains at lower latitudes. Thus at Marmot Basin, ponding of

Figure 1: Location of the weather stations & ground temperature cables making up the long term monitoring network



snow meltwater on benches accounts for 60% of the variability in thickness of the active layer, summer precipitation account for 24%, while insolation only explained 16% (Biuletyn Peryglacjalny, #38, 73-93). North of 58` latitude, there is much more asymmetry in the vegetation distribution, and topography and insolation become more important (Erdkunde, vol. 52, 265-285). Nature of the substrate is also of fundamental importance; blocky surfaces (kurums) and peatlands exhibit much colder mean annual temperatures than adjacent mineral soils (Permafrost and Periglacial Processes, vol. 9, 107-120). This complicates mapping permafrost in mountains where peat may accumulate in the valleys and rock glaciers, talus slopes and rock glaciers occur along the steeper slopes. On mountains, e.g., Plateau Mountain, there may even be a dynamic equilibrium with heat entering the ground on some surfaces, then being conducted through the rock to supply heat to the block slopes (Polar Geography, vol. 21, 113-136).

The data obtained at Plateau Mountain has been used to explore the development of modelling permafrost distribution using GIS (Biuletyn Peryglacjalny, #39, In Press). Since this is showing reasonable promise, a more extensive study is being conducted in Jasper National Park. It is also planned to add several more weather stations with ground temperature cables and to integrate this work with micro-meteorological measurements made by colleagues carrying out research in glaciology and ecology. Already, the author has compared the climatic observations at the high mountain sites in southern Alberta to the biodiversity of the vascular flora, and similar work will be forthcoming for the stations further north.

Funding is a problem, and the current lack of government funding will mean that more of the costs will have to be borne by industry. Unfortunately, this may limit the availability of the data to other interested parties. One other trend is for Territories to lease research sites. This means that the research scientist must carry insurance and pay taxes on the sites. An additional financial and operational burden is that approximately 12% of the equipment has to be replaced each year due to vandalism or damage by animals.

In conclusion, I would strongly recommend more government funding tied to use of the resulting data by as diverse a group of scientists as possible. In this way good data can be obtained and duplication of effort can be avoided.