Canada's Weather Network

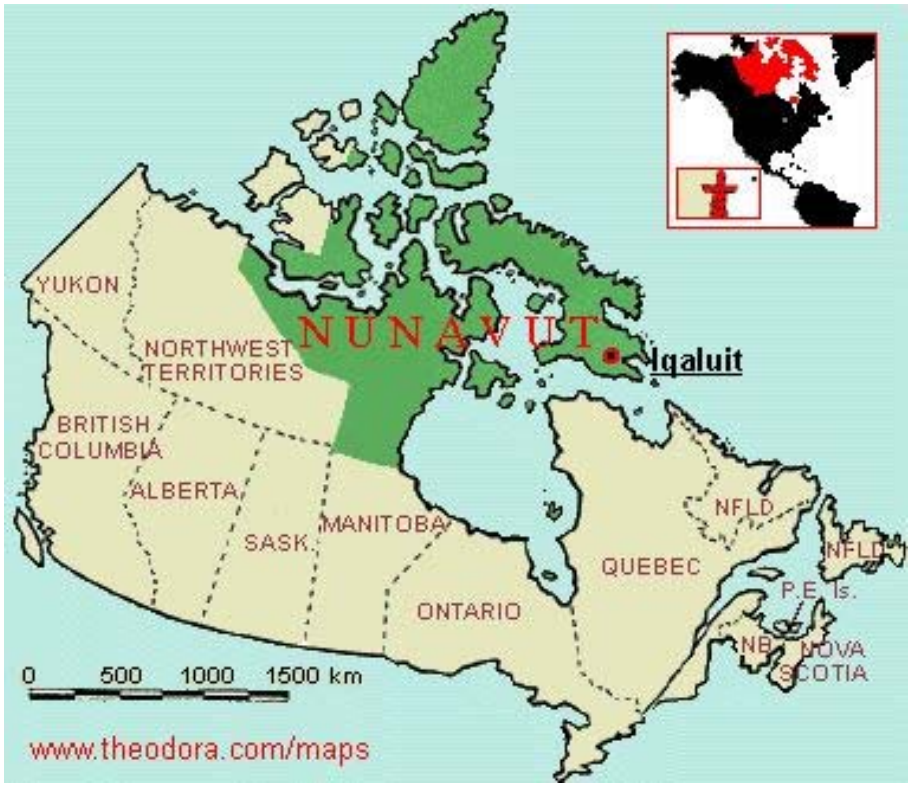
By Dr. Tim Ball

Canada is the second largest country in the world encompassing 9,976,140 sq km. It encloses Hudson Bay, the largest inland ocean sea with a surface area of 480,000 sq km for a combined area of 10,456,140 sq km. There was a total of 1088 World Meteorological Organization (WMO) rated stations, which means a density of one for every 9,610 sq km. However it is extremely variable and the lack of density is troublesome in critical areas.

Province	Land (sq. km)	Water	Total	WMO Stations	Density (sq. km)
Alberta	642,317	19,531	661,848	18	36,769
British Columbia	925,186	19,549	944,735	107	8,829
Manitoba	553,556	94,241	647,797	42	15,423
New Brunswick	71,450	1,458	72,908	18	4,050
Newfoundland	373,872	31,340	405,212	18	22,511
Northwest Territories	1,183,085	163,021	1,346,106	6	56,087
Nova Scotia	53,338	1,946	55,284	24	2,303
Nunavut	1,936,113	157,077	2,093,190	6	348,865
Ontario	917,741	158,654	1,076,395	96	11,212
Prince Edward Island	5,660	0	5,660	8	707
Quebec	1,365,128	176,928	1,542,056	66	23,364
Saskatchewan	591,670	59,366	651,036	52	12,519
Yukon	474,391	8,052	482,443	5	96,488

Table 1; Canadian Provinces area and WMO Weather Station density network.

The worst coverage is for the critical area of Nunavut.



Since it borders on Hudson Bay and Hudson Straits both with no problem is more profound. Now add the inadequate coverage for Yukon Territory and Northwest Territory and Newfoundland and Labrador it is quickly apparent that coverage for most northern Canada is totally inadequate.

The problem goes even further because there are no stations for the Arctic Basin as the Arctic Impact Assessment Report identified, ironically using CRU data.

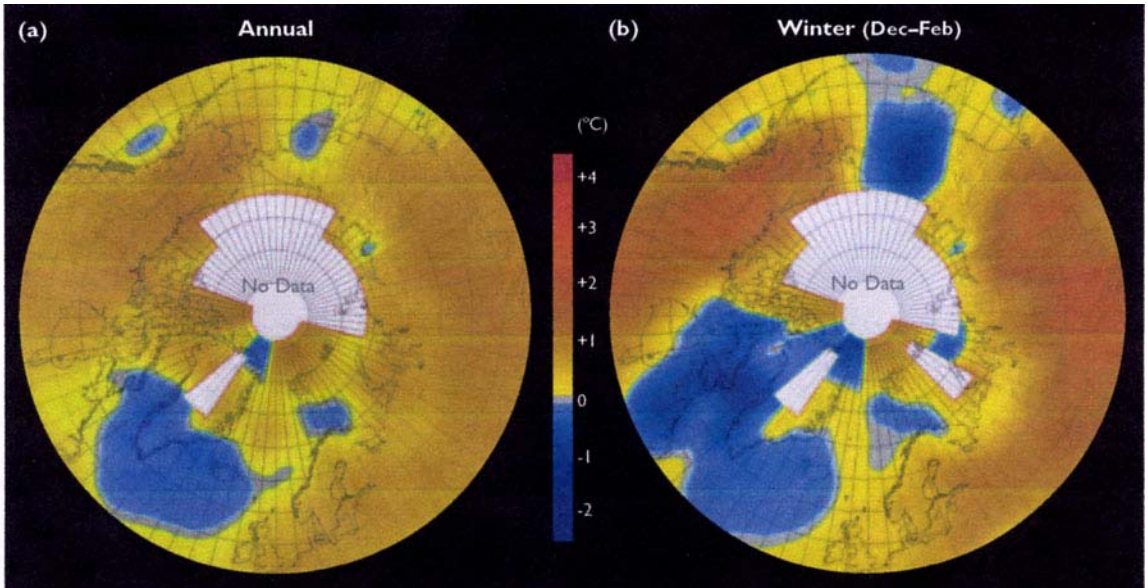
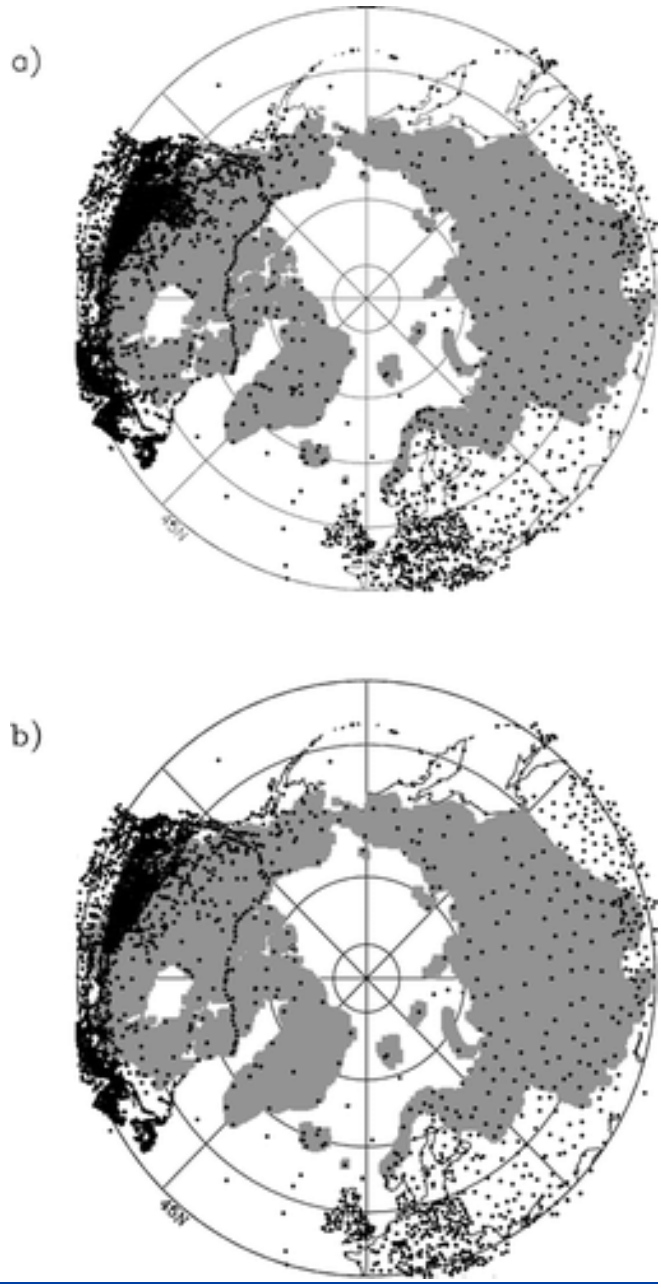


Fig. 1.3. Change in observed surface air temperature between 1954 and 2003: (a) annual mean; (b) winter (Chapman and Walsh, 2003. using data from the Climatic Research Unit, University of East Anglia, www.cru.uea.ac.uk/temperature).

This map shows the northern Canadian region with cold temperatures and Eurasia with warmer temperatures. However, we now know the Eurasian pattern is distorted by the very selective stations used by CRU.

The densities given for the Canadian provinces, which generally lie south of 60°N are averages, but a quick look at the map of the total stations show a concentration in the southern half of each province.

For example, there are only three stations north of 55°N in Quebec. This is important because the boundary between general surplus energy of the tropics and the deficit of the polar regions, traditionally known as the Polar Front, moves north and south within Canada in response to the general migration of the Sun. Its mean summer position is approximately 65°N so the year round area of deficit has virtually no weather stations. The next diagram with caption comes from Rawlins and Wilmott 2003.

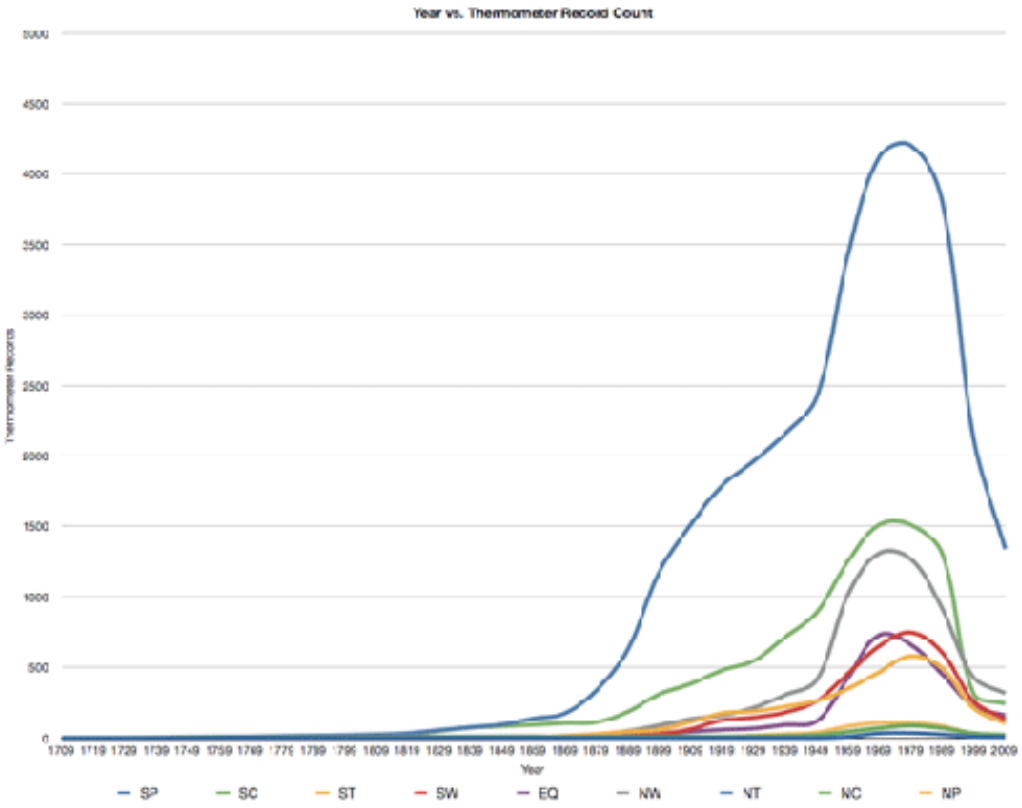


Locations of the monthly air-temperature station records for all Arctic stations (a) and for those Arctic stations with data from the period 1961–1990 (b). The light grey shading delineates the Pan-Arctic drainage basin. The map projection is Lambert's Azimuthal Equal Area (original caption). Source is here.

Second regions of great significance to world weather are the Rocky Mountains and associated parallel mountains such as the Selkirk Range in the Yukon. These mountains generally oriented north and south cut across the critical circulation or Circumpolar vortex generally known as the Westerlies, which includes the Polar Jet Stream. These mountains have significant effect on the planetary waves that form in this vortex and therefore knowledge of the position and movement of the vortex is essential to understanding and especially modeling global climate. There are not enough stations in

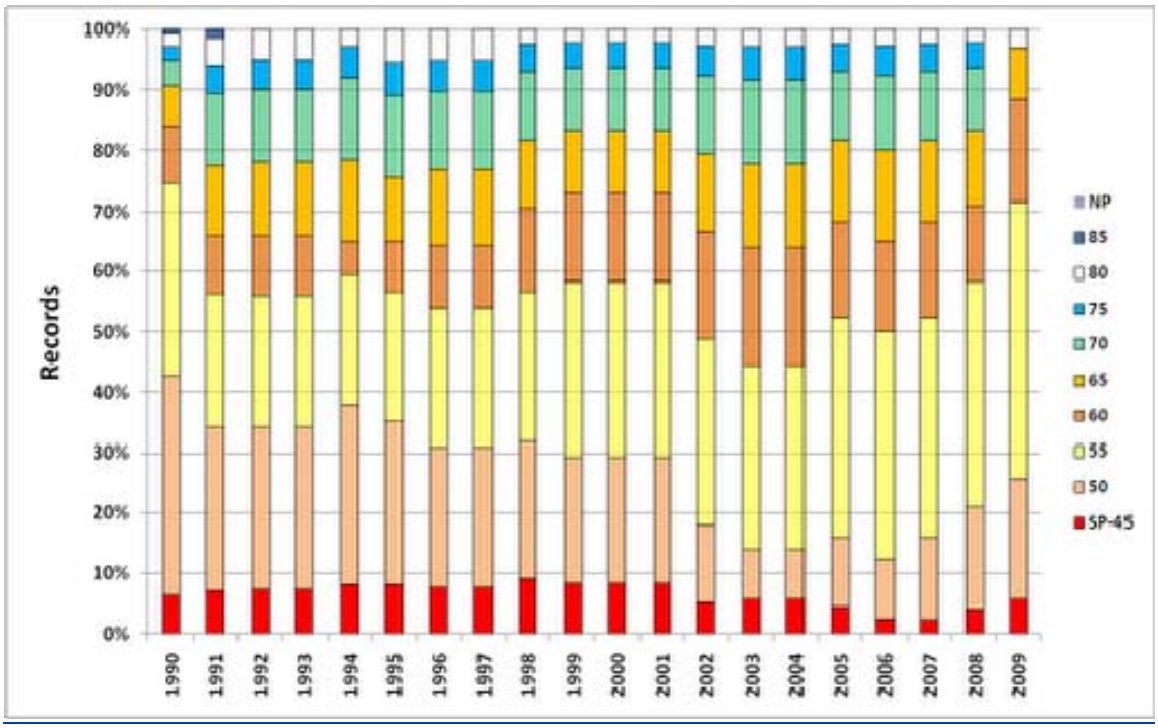
Canada now and especially historically to provide the data required for adequate modeling of the Northern Hemisphere atmosphere.

E.M.Smith has done a very detailed analysis of this limitation summarized in this diagram



The caption he provides says, "*That next to the top green line is the Northern Cold band. The area we are talking about here. From 50N to 70N latitude. We see the thermometer count rise from the 1700s until a sudden Great Dying as the Thermometer Langoliers take their toll.*"

Smith elaborates with a graph showing the changing coverage north of 55°N for the period from 1990 to 2009.



His comments about the graph are; "*Here we see that three northern bands have been gutted entirely. There are now NO thermometers (as of 2009) in the 65-70, 70-75, and 80-85 bands. 1992 saw the 80-85 band die. 2009, the others. Due to the general slaughter of thermometers, that 75-80 band is ONE thermometer.*

That's right. ONE thermometer for everything north of LAT 65. Who needs Northwest Territories, The Yukon Territories, or Baffin Island anyway… GIStemp can just estimate it from the satellite ice map projection synthesis interpolation estimates."

Instrumental records for Canada officially begin with the recordings at the Observatory at the University of Toronto in the early 19th century. Morley Thomas produced a detailed history of Canadian meteorological services recreated up to 1945 in the following sources.

http://www.cmos.ca/wxsvchistory.html

http://www.cmos.ca/wxsvchistory.html#Atmosphere Volume 9 Number 2

http://www.cmos.ca/wxsvchistory.html#Atmosphere Volume 9 Number 3

A summary of the situation up to 1930 outlines the problem with lack of long historical records. *Historical climatological data were published annually after 1871, but very little statistical data, delineating the climate of the country, were available prior to 1900. A beginning was made at expanding meteorological activities into the North before World War I, but it was not until the 1920's that a significant number of observing stations were located there. By 1930 the need for extensive aviation meteorological services was becoming apparent, but the economic depression prevented an expansion of both aviation and meteorological services.*

By the 1920s 36-hour weather forecasts were provided twice a day using 36 Canadian and 5 Newfoundland weather stations. Demand increased as aviation increased but this meant most stations were located at airports on the edge of major cities. This is important because the urban heat island effect (UHIE) is significant in Canadian historical weather data.

Services expanded during the war so that; *The total number of weather reporting stations in Canada remained at about 950 during the war years.*

http://gcmd.nasa.gov/KeywordSearch/Metadata.do?Portal=GCMD&KeywordPath=[Keyword='ADJUSTED+DATA']&NumericId=10347&MetadataView=Text&MetadataType=0&lbnode=mdlb1

Monthly Rehabilitated Precipitation and Homogenized Temperature Data Sets Climate Research Branch (CCRM) - Environment Canada. A database of homogenized and long-term temperature and precipitation time series has been specifically designed for climate change analyses over Canada. Temperature: The data consist of monthly maximum, minimum and mean temperatures for 210 locations across the country. Series extend back to 1895 where possible: however, data availability over most of the Canadian Arctic is restricted to the mid-1940s to present. Homogeneity problems caused by station relocation and changes in observing procedures were addressed using a regression model technique applied with surrounding stations. Monthly adjustments were obtained for identified inhomogeneities (the cause was often retrieved from the station history files) and a database of monthly maximum, minimum and mean temperatures was created.

Two factors led to the decline in stations from 950 in 1945 to 210 today. First the decision that satellites would reduce the need for surface stations and second the shift from a weather service as mandated by law to a climate change agency. The Auditor General reported $6.8 billion spent on climate change between 1998 and 2005. The lack of stations was an immediate problem aggravated by the replacement in many cases with Automatic Weather Observing Stations (AWOS). When NavCanada was formed in 1997 to take over airports they became responsible for the weather stations. They refused to accept the AWOS stations as unreliable, which triggered a parliamentary investigation by Senator Pat Carney.

The 210 are the stations considered for producing global average annual temperature. There was a decline in the total number of weather stations that provided daily temperature and precipitation data from 2900 in 1991 to 2200 in 2000. Milewski and Hogg (2002) Climate Research Branch of the Meteorological Services of Canada study says *"there are about 630 hourly stations, many with more than fifty years of continuous records."* They also reported there were *"almost 600 automated climate stations.* The abstract begins, "*Recent automation of meteorological observations affects homogeneity of the long-term climatological records, which are used to study climate change and variability.*

http://www.cmos.ca/Ao/articles/v400304.pdf

The number of weather stations in Canada has reduced significantly since 1945 but coverage was always inadequate. There are very few stations with records over 60 years in length. Most of them are in southern regions, that is south of 55°N, and are located near large cities. The urban heat island effect (UHIE) is especially pronounced in Canadian cities because of the cold temperatures. Studies in Winnipeg, Montreal, Hamilton and Vancouver all show considerable differences between urban and surrounding rural areas, especially in winter. The lack of records for the subpolar and polar regions is especially problematic because most agencies agree this is where global temperatures changes are detected first.

The number of stations in Canada is inadequate at any time to determine the actual temperature or how it has changed. It is certainly inadequate to serve as the basis for the grids that form the basis of computer models. If we add the inadequacy of the records for Eurasia it is reasonable to say that we are ignorant of weather and climate north of 55°N in the Northern Hemisphere.

ONE thermometer for everything north of LAT 65.That Vstation is Eureka. Eureka according to WIKI has been described as “The Garden Spot of the Arctic” due to the flora and fauna abundant around the Eureka area, more so than anywhere else in the High Arctic.Winters are frigid, but summers are slightly warmer than at other places in the Canadian Arctic.