

Yukon Weather Centre Ret'd



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Climate Change in the Yukon, Some Observations

by

Michael Purves
Meteorologist Ret'd
Yukon Weather Centre
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ABSTRACT

Surface and upper air observations from the Yukon are examined for evidence of climate change.

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Introduction

Climate change is a hot topic in the world, and with good reason. Many articles have been written in academic papers and in the popular press about the occurrence and effects of changing climate in the world. The Yukon is presented as one area on our planet showing rapid changes in the climate record.

Several datasets of Yukon climate observations have been examined to look for evidence of these changes, and to get an idea of some of the problems in assessing the data.

Data Sources

The monthly, daily and upper air climate archives for Yukon stations have been examined using the climate manager program (Purves and Trojan, 1995). The data were provided by Environment Canada and the Yukon Forest Service. The data were extracted using the Yukon Weather Centre's Climate Manager programs, and were ingested into Microsoft Excel where they were graphed and simple linear equations were calculated.

The stations in the Yukon were examined for the length and continuity of their record. From over 150 stations with daily climate records in the Yukon, four were chosen: Dawson, Mayo, Watson Lake and Whitehorse. These stations had the longest and most complete datasets. However, even their records were not continuous. Surface observations from Dawson, Watson Lake and Whitehorse were obtained from a combination of three related stations. Although Mayo has only one station id throughout its eighty year history, it had a small shift in position in February, 1969.

In some cases, the effect of using data from a neighbouring station could be estimated, but in other cases, it could not be.

Only one station, Whitehorse, has upper air records. These are available from 1960.

Method

The precipitation and temperature data were obtained from the monthly records: Summer was defined as being May 1 to August 31; Winter was defined as being November 1 to the last day in February. The year of the winter considered was taken to be that for November. Changes in temperature are given in degrees Celsius per Century (d/c). Changes in precipitation are given in percent per century or in millimetres per century (mm/c). The change in percent is calculated using the regression coefficients calculated by Excel. Given the regression equation:

$$\text{Pcp Amt} = A + B \cdot \text{Years}$$

the percent change per century is simply:

B*100

Several common problems occurred when processing the data. These involved missing data, changes in instrumentation and changes in station locations.

Missing monthly data occurred when one or more daily records were unavailable in the month. In this case, the daily records were examined. If one day was missing, its absence was ignored, and the seasonal average was computed. If several days were missing, up to ten, then the twenty year average for these days was computed, centred on the missing day, and these averages were used in place of the missing data. Rarely, an entire month was missing. In this case, the twenty year average for the month was used.

Instrumentation issues were most noticeable in the upper air record. In the years around 1974, it appears that the hygistor was replaced by a different model. The changes in humidity before and after this date are very noticeable and prevent the use of these data before 1975. This change has affected calculations of parameters such as precipitable water and various stability indices and reducing the effective period of record by 16 years.

The issue of changes in station location were dealt with in two ways. For temperature data, the difference in the mean temperatures between the two stations were calculated and were used to adjust the temperatures in one station to be similar to the other. For precipitation, the mean precipitation from the two stations were calculated and were used to derive a factor to adjust one station. The temperature and precipitation data used for these calculations were taken only for those days that were present in both stations' records.

Discussion on Data Used

The data used in the analysis of temperature and precipitation will be grouped together and discussed by station. In the case of a few missing observations, the twenty year average was calculated for the month in question, centred on the year of the missing observations. If the missing year was too close to the beginning or end of the record, then either the first or last twenty year averages were calculated. The calculated average was then used to replace the missing observations. In cases where observations from one station were used to replace those of another, averages for the season in question were calculated using days that were in the record of both stations. As many observations as were available, up to twenty year's worth, were used. The observations from the second station were then adjusted to correspond to the average of the first station. I.e., if the second station average temperatures were 0.5 C warmer than those of the first station, then the observations from the second station were reduced by 0.5 C and used for the missing values of the first station. Precipitation amounts were adjusted by a factor based on the ratio of the averages from the two stations.

Dawson Temperature and Precipitation.

Data from three stations were combined to provide a dataset of over 100 years. These stations are: Dawson, 2100400; Dawson A, 2100402; and, Dawson, 2100LRP. The latter is the automatic station at the Dawson airport. Extracts from the Canadian Climate Centre's Station catalogue are given in Table 1. and illustrate changes in the history of these stations. Fortunately, these stations had periods of overlapping observations, so direct comparisons could be made between them. The stations 2100400 and 2100LRP had their observations adjusted to correspond to those of 2100402. The adjustments were made as follows:

2100400 and 2100402 had overlapping observations between 1976 and 1978. There were 369 matching summer maximum temperatures during this period. The mean daily maximum temperature for 2100400 was 20.8 deg. C. while for 2100402 it was 20.5. There were also 369 observations of precipitation: 2100400 had a total of 354.9 mm., while 2100402 had a total of 319.1 mm. Observations of precipitation from 2100400 were multiplied by 0.90 to adjust them to reflect values we would expect from 2100402. Temperature observations from 2100400 were reduced by 0.3 degrees.

For the winter period, there were 301 days with matching observations of daily minimum temperature. Station 2100400 had a daily mean of -26.0 while 2100402 had a mean of -27.5 deg. C. There were also 301 days with matching observations of precipitation. Station 2100400 had a total of 164.3 mm. while station 2100402 had a total of 185.5 mm. Observations of precipitation from 210400 were multiplied by 1.13 to adjust them to values we would expect from 2100402. Temperature observations from 2100400 were reduced by 1.5 degrees.

For annual precipitation, there are useful data from 1902 to 2001. The year 1913 was missing 77 observations, so it was not included. September, 1912, was missing seven days. These were replaced with their twenty year averages for these days. July 8, 1915 was missing, and this day given a value of zero. The entire month of July 1927 was missing; its twenty year average was used. In 1977, we had to use observations from station 2100402. Stations 2100400 and 2100402 had 974 matching observations in the period 1976-1978. Station 2100400 had a total off 673.2 mm, and station 2100402 had 688.9 mm. The amounts recorded by station 2100400 were increased by 2% to reflect what we would expect from station 2100402.

2100402 and 2100LRP had 806 days with where both stations reported a daily maximum temperature in summer. 2100402's average was 19.8 deg. C. and 2100LRP had an average of 19.5. Data from 2100LRP were used for the summers of 2004 and 2005. These values were adjusted up by 0.3 deg. C. to correspond to values for 2100402. These two stations had 249 days where they both had summer precipitation records between 1996 and 2004. (Note: an observation of zero was considered to be a record, but an 'M' was not.) For these 249 matching days, 2100LRP recorded 313.4 mm. of precipitation while 2100402 had 252.5 mm. This requires that the observations from 2100LRP be multiplied by a factor of 0.81. In as much as these two stations are at the same site, this discrepancy is troubling, and it may be due to the instruments used by the automatic station to measure precipitation. The August 2004 precipitation from 2100LRP was missing, and so that year was not used. The summer

precipitation for 2005 from 2100LRP was only 45 mm. which seems like a very small amount, and so it was not used either.

For winter temperatures, there were 928 matching observations. Station 2100LRP had a mean winter daily minimum of -26.7 while station 2100402 had a mean winter daily temperature of -26.1 . An adjustment of 0.6 degrees was used to adjust the winter 2004 and 2005 temperatures from 2100LRP to correspond to what we would expect at 2100402. For winter precipitation, there were 33 days with matching records. However, station 2100LRP showed 33 zeroes, while 2100402 shows a total of 24.4 mm. For this reason, the observations from 2100LRP for the winter of 2005 were not considered.

There were too many missing observations from both 2100402 and 2100LRP after 2001 to obtain any reliable estimates of annual precipitation.

Mayo Temperature and Precipitation.

Data for Mayo were from just one station: 2100700. Extracts from the Canadian Climate Centre's Station catalogue are given in Table 2. and illustrate changes in the history of this station. There was a slight change in its position on 1 February, 1969, but otherwise the station has remained fairly constant. There are no comparison observations to be had between observations at the two sites, so it is impossible to say what difference this move might have on the long term regression equations.

For winter temperatures, three winters had missing data: 1926, 1994 and 1995. December 1926 was missing entirely, as was the calendar year 1995. Summer 1936 was missing data for nine days in May; these days were given their twenty year averages. 1995 was missing both temperature and precipitation.

Winter precipitation was missing for 1926, 1946, 1994 and 1995. 18 days were missing in February, 1947, and were given their twenty year average. Summer precipitation was missing 1995. There were eight missing days in June, 1936. These eight days were assigned their twenty year average values.

For the annual precipitation amounts, the record is from 1927 to 2005. The year 1995 is missing. Eight days in June 1936 were given their twenty year average, as were 18 days in February, 1947, and April 1989.

Watson Lake Temperature and Precipitation.

Data for Watson Lake were obtained from three stations: Watson Lake A, 2101200; Watson Lake (AUT), 2101204; and, Watson Lake YTG, 2101222. The record spans from 1938 to 2006. As with Dawson, matching observations were used to compute the differences between the stations so that adjustments could be made. For Watson Lake, the observations from 2101204 and 2101222 were adjusted to reflect those of 2101200. For the case of winter precipitation, there were no data from either 2101204 or 2101222. The winters of 1993, 1994 and 1998 were missing.

For winter temperatures, data from 2101204 were used to supply data for winter 2005. There were 306 days with matching winter temperature observations between 2101200 and 2101204. The mean winter temperature for 2101200 was -22.1 while for 2101204 it was -23.3 , a full 1.2 degrees colder. Station 2101222 was used for the winter of 1994. It had 47 days matching observations with 2101200. The mean temperature for 2101222 was -24.2 while for 2101200 it was -25.9 .

The annual precipitation was calculated for the years 1939 to 2005. Several years were missing: 1993, 1994, 1995 and 1999. 1998 was used with the twenty year average for December. 2005 was used with October data from station Watson Lake (AUT), 2101204. No adjustment was made for this amount. As well, March, 1942 was missing and its twenty year average was used in its place.

Whitehorse Temperature and Precipitation.

Data for Whitehorse were obtained from three stations: Whitehorse A, 2101300; Whitehorse Riverdale, 2101400; and, Whitehorse WSO, 2101415. Climate data for Whitehorse A. were not collected from Jan 8, 1996 until May 1, 1998. The Yukon Weather Centre moved approximately 1 km along the Alaska Highway to its new office. Three days later, staff began recording climate data at the new site. There are no overlapping data for the two sites, but staff at the weather centre monitored hourly temperatures from both Whitehorse A and Whitehorse WSO and noted no difference. This visual inspection is not the same as a rigorous comparison, but it is, unfortunately, all we have. Nor do we have any way of comparing precipitation data. For the purposes of this study, data from 2101415 were used without adjustment. For the few days in January 1996, and the month of November 1997, we used data from station 2101400. There are many years of overlap with stations 2101300 and 2101400. As with other datasets, we calculated averages for each station on days that were recorded by both. The observations from 2101400 were then adjusted to represent observations from 2101300. In general, the winter precipitation at the airport is about 90% of that in Riverdale; winter temperatures are 0.3 to 0.4 deg. C lower. We did not need to use 2101400 for the summer data.

For annual precipitation, station 2101300 was used, except for the years 1996 and 1997 and the first four months of 1998. Whitehorse WSO, 2101415 was used for all of 1996, and parts of 1997 and Jan-Mar, 1998. Whitehorse Riverdale, 2101400, was used November 1997, and April 1998. Data from 2101415 were used without adjustment, but data from Whitehorse Riverdale were adjusted to account for differences in the monthly twenty year averages from those of Whitehorse A.

Snow on Ground

Snow on the Ground measured on 28 February is available at our five stations from 1955 to 2006. Each station, however, is missing some data for at least one year, and all stations, except Mayo, are using data from neighbouring stations. It was not possible to estimate the differences in snow depths at the neighbouring stations because there were no data

overlaps, as there were for temperature and precipitation. The availability of the data is listed here:

- **Dawson.** Data from 1955 to 1975 were taken from Dawson, 2100400. From 1976 to 2004, data from Dawson A, 2100402 were used. Data from Dawson (AUT), 2100LRP were used for the last year, 2006. There were no data for February 2005.
- **Mayo.** Only data from 1995 are missing, and all data are from the one station, Mayo, 2100700.
- **Watson Lake.** Data are missing for the years 1995 and 1999. Data from Watson Lake YTG, 2101222 were used for the year 1994, and data from Watson Lake (AUT.), 2101204 were used for the year 2006. Otherwise, all data came from 2101200.
- **Whitehorse.** Data for Whitehorse were missing for the years 1996-1998. Data for these three years are taken from station 2101415, Whitehorse WSO. No adjustments were made to these data.

Mean Hourly Wind Speeds

Mean hourly wind speed averages are calculated for Winter, Summer and Annual periods. Dawson, Mayo, Watson Lake and Whitehorse each have records from 1953 to 2005. Dawson, however, has only records for only partial days and is split between two stations, Dawson, 2100400, and Dawson A, 2100402, with no overlap between them. Mayo also has records for only part of the days until 1974, although it is all from one station. For these reasons, only data from Watson Lake and Whitehorse were considered. All stations were missing data for the year 1991. Watson Lake was missing 21 days in December, 1999. These missing observations were given values equal to their twenty year average. Some years were missing a few observations, but these absences were ignored.

Whitehorse Sunshine

Of the four stations, only Watson Lake and Whitehorse had sunshine data and, of the two, the record from Whitehorse is the longer, nearly forty years. The record from Watson Lake was barely over twenty years, and so it is not considered. In the hourly sunshine record for Whitehorse, several days were missing. The year 1983 is missing Aug 18-27. These days were given their twenty year average. July 9, 1984 was missing; since it was a cloudy day, it was ignored. June 10, 1988 was missing. The hourly aviation data showed mainly scattered cloud for most of the day, so it was given an additional eight hours. Finally, May 31, 1972 was missing. As the day progressed, it became cloudy with showers so it was given six hours.

Yukon Summer Lightning

Data from the Yukon Forest Service lightning detector network are available from 1986. Several changes were made to the network in the early 1990s (Kepke, 1993). This network was taken over by Environment Canada around the year 2000. It is difficult to say how the upgrades have affected the counting of strikes. Nevertheless, these data are presented as they are.

Results

The results are presented by the dataset analyzed.

Mean Daily Minimum in Winter.

- **Dawson.** (See Figure 1.) The data record covers every winter from 1900 to 2005 inclusive. Station 2100402 was used from 1973 to 2003 inclusive, with 2100400 being adjusted and used before that, and station 2100LRP being adjusted for the last two years. The data show two major periods of warming. The first, from 1902 to 1925, had an increase of 10.9 d/c. The second and more significant, from 1964 to 2005, had an increase of 18.0 d/c. There was a period of cooling from 1940 to 1964 with a decrease of 14.5 d/c. Over the period of record, Dawson shows an overall increase of 2.6 d/c. The change over the last 40 years, 16.4 d/c, is very significant and has been noted by many people in terms of their own life experience that winters are not as cold as they used to be.
- **Mayo.** (See Figure 2.) The data cover every year, except three, from 1925 to 2005 inclusive. The three missing winters were: 1926, 1994 and 1995. There were no observations for December 1926, nor for the calendar year of 1995. In addition, the temperature for December 24, 2005 was missing. No adjustment was made for this one missing day. As in the case of Dawson, there was a period of strong cooling. In the case of Mayo, it was from 1943 to 1975 and was at a rate of 16.4 d/c. Over the past forty years, there has been strong warming, at the rate of 17.8 d/c. The mean daily minimum temperature for winter for Mayo, over the entire period of record is up 2.9 d/c. Dawson, measured for the same period, had warming of 3.0 d/c. The mean minimum temperature averaged for the winters 1966 to 1977 was -29.3 . For the years 1996 to 2005 the average was -23.2 . This 6 degree increase is impressive in itself, but it should be considered in light of the change in latitude required to produce such a change in temperature. For that estimate, the mean minimum temperature for the winters 1966 to 1975 were examined for Fort Nelson B.C. The Fort Nelson temperature was -24.0 . In other words, if people in Mayo couldn't wait thirty years for the milder weather to reach them, they would have had to move south of Fort Nelson, a move of 5 degrees latitude south.
- **Watson Lake.** (See Figure 3.) As with the other Yukon stations, Watson Lake shows a cooling trend from 1943 to 1968. In this case, the cooling occurred at a rate of 14.8 d/c. This is comparable to that found in Dawson and Mayo. There was also a period of warming from 1966 to 2005. This warming was measured as 11.7 d/c. Over the entire period of record, the warming has been at a rate of 0.8 d/c. Dawson, measured for the same period, had warming at a rate of 3.8 d/c.
- **Whitehorse.** (See Figure 4.) Whitehorse A has data for the mean daily minimum for winters from 1942 to 2005. Data from station 2101415 were used from January 11, 1996 to Feb 28, 1998. These values were not adjusted. Data from 2101400 were used for Jan 8-10, 1996 and the month of November 1997. The January temperatures were raised 0.4 degrees and the November temperatures by 0.3 deg. to represent values at 2101300. Whitehorse showed a cooling trend of -16.9 d/c for the winters 1943-1973 incl. Over the past forty years, there has been strong warming at 13.8 d/c. Overall,

Whitehorse shows daily minimum temperatures in winter rising 3.8 d/c. When we use matching years, Dawson shows an increase of 5.2 d/c.

Mean Daily Maximum in Summer.

- **Dawson.** (See Figure 5.) The data record covers all but three summers from 1901 to 2005 inclusive. (The missing summers are 1913, 1927 and 1933.) Data from station 2100402 were used for summer 1973 to 2003 with 2100400 being adjusted and used before that and 2100LRP adjusted for the last two years. As with the winter temperatures, the summer temperatures show two periods of significant warming and one of cooling. The first period of summer warming was from 1901 to 1923 with an increase of 4.0 d/c and the second period of warming from 1966 to 2005 with an increase of 4.1 d/c. There was a period of cooling from 1941 to 1964 of 7.8 d/c. Over the entire period, the rate of warming of the mean summer daily temperature is 0.8 d/c.
- **Mayo.** (See Figure 6.) Only one station was used, with a period of record from 1926 to 2005. As with the case of Winter, the year 1995 was missing. Nine days in May 1936 were also missing. The values for these missing days were replaced with the twenty year average for these days from 1926 to 1946. As in the case of Dawson, there was a period of cooling, from 1941 to 1964. For Mayo, the cooling was measured at a rate of 4.9 d/c. This was less than that in Dawson, where it was 7.8 d/c. The period of warming from 1966 to 2005 is measured at 2.9 d/c. Overall, for the full period of record, the warming is measured at 1.3 d/c. Dawson, for the same period, (although Dawson is missing 1926 and 1933), has warming of 1.7 d/c.
- **Watson Lake.** (See Figure 7.) Watson Lake has a period of record from 1939 to 2005, with only one year is missing: 1993. Station 2101222 was used to provide data for the summer of 1994, and 2101204 was used for the summer of 2005. Watson Lake also shows a cooling trend from 1954 to 1974 with a rate of cooling of 6.9 d/c. This rate is in between that of Dawson and Mayo for their cooling periods, although the cooling period in Watson Lake occurs about ten years later. For the past forty years, the warming trend was 2.8 d/c. This is less than the rate at Dawson, but similar to that of the rate at Mayo. Over the entire period, Watson Lake shows no real difference, about -0.1 d/c. For a similar period, Dawson had an increase of 1.9 d/c.
- **Whitehorse.** (See Figure 8.) Whitehorse A has data for the mean daily maximum in summer from 1942 to 2005 inclusive. Data for the summers of 1996 and 1997 were obtained from 2101415, with no adjustment. As with the other stations, there is a period of cooling with warming thereafter. For the years 1954 to 1974, the cooling was 5.5 d/c. The period of cooling was similar to that of Watson Lake, but the rate of cooling was slightly less. Over the past forty years, the increase is measured as 3.5 d/c, and over the entire period of record, there has been an increase of 1.0 d/c. Dawson shows an increase of 2.5 d/c for the years matching the Whitehorse period of record.

Total Winter Precipitation.

- **Dawson.** (See Figure 9.) The data record covers every winter from 1901 to 2003. Two stations were used: observations from station 2100400 were adjusted and used until 1976 and then 2100402 was used for the remainder. The observations from 2100LRP were not available for 2004, did not appear to be reliable for 2005 and there was no way to compare them to observations from 2100402. While there are some signs of wetter and drier periods over the length of the record, the record generally shows decreasing amounts of precipitation amounting to a decrease of 30.3 mm/c, a rate of 28% over the last century. Over the past forty years, the precipitation is down 15 mm, or about 14%.
- **Mayo.** (See Figure 10.) The period of record for this evaluation is from the winter of 1925 to 2005. Data from four winters were missing: 1926, 1946, 1994 and 1995. Unlike Dawson, which shows no strong trends during the record, Mayo shows a very strong increase in winter precipitation from 1933 to 1966, amounting to an increase of 560%/c. Just in this 33 year period, the precipitation nearly tripled. For the same period, Dawson shows only an increase of about 20%/c. There was a large drop between 1966 and 1968, and then a rise of nearly 100%/c for the years from 1968 to 2005. We can see the effect a couple of years can make: counted from 1966 to 2005 the increase is only 16%/c. Over the entire period, Mayo shows no real change to up only about 1%/c. If Dawson is examined for the period 1925 to 2003, minus the years 1926, 1946, 1994 and 1995, it would have a decrease of about 34%/c.
- **Watson Lake.** (See Figure 11.) Watson Lake has a period of record for winter precipitation that covers 1938 to 2005, with three years missing: 1993, 1994 and 1998. Watson Lake shows a trend towards much wetter weather in the decade 1941 to 1951. Precipitation in this decade almost doubled. This rapid increase was followed by an extended drying trend from the years 1951 to 1985, which saw the precipitation cut in half. Over the past forty years, Watson Lake shows an increase of 68%/c, but using the entire period of record, Watson Lake shows a trend towards drier winters, with a decrease in precipitation of 44%/c or 64 mm/c. For the same years, Dawson shows a decrease of 17%/c.
- **Whitehorse.** (See Figure 12.) In general, the winter precipitation has been decreasing in Whitehorse. Over the period of record, 1942 to 2005, it has been diminishing at a rate of 29%/c (22 mm/c). Over just the past forty years, however, the rate is only down 4%/c. Dawson, when using the period 1942 to 2005, had a decrease of 40%/c.

Total Summer Precipitation.

- **Dawson.** (See Figure 13.) The period of record is from 1902 to 2003 with four years missing: 1913, 1915, 1927 and 2002. Data from station 2100400 were used until 1975 and then data from station 2100402 were used for the remainder. Station 2100LRP was missing data from August 2004, and they not used for that year. Data from station 2010LRP appeared to be unreliable for 2005, and so they were not used for that year either. The first thirty years of record seem drier than the remainder. Overall, summer precipitation seems to be up about 37%/c (44 mm/c).
- **Mayo.** (See Figure 14.) Mayo has records of summer precipitation from 1926 to 2005, except for the year 1995. There were eight days missing in May 1936. These days were given their mean values, averaged over the period 1926 to 1936. There do

appear to be some periods of wetter and drier summers; overall there is an increase of 24%/c (32 mm/c). This compares with an increase of 38%/c at Dawson. For a period from 1926 to 2003, Dawson has an increase of 26%, nearly the same as for Mayo.

- **Watson Lake.** (See Figure 15.) Watson Lake has data for summer precipitation from 1939 to 2005. Two months were missing, and a twenty year average was used to fill the missing months. These months were August 1993 and May 1994. The record shows fluctuations in the amount of summer precipitation, but overall there is an increase of 39%/c (64 mm/c). When we use matching years of 1933 to 2003, Dawson shows an increase of 29%/c and Watson Lake an increase of 37%/c.
- **Whitehorse.** (See Figure 16.) As for the summer temperatures, the period of record is from 1942 to 2005, and data from 2101415 were used with no adjustment for the summers of 1996 and 1997. As with the other stations, there are wide year to year swings in summer precipitation amounts. Over the past forty years, precipitation is down 8%/c, but over the period of record, it is up 14%/c (16 mm). Dawson, using the years of the Whitehorse period of record (although Dawson goes only till the summer of 2001) has an increase of 20%/c.

Total Annual Precipitation.

- **Dawson.** (See Figure 17.) The period of record is from 1902 to 2001, and data from two stations were used. Data from Dawson A, 2100400 were used to 1977 and were increased to reflect values at 2100402. The data show wide fluctuations from year to year, but a slight decrease is noted overall of about 5 %/c, or about 17 mm/c.
- **Mayo.** (See Figure 18.) The period of record for Mayo is from 1927 to 2005. The year 1995 is missing entirely, and twenty year averages were used for June 5-12 1936; for February 1-18 1947; and for April 1989. Of the four stations, Mayo alone shows a trend of increasing precipitation, up 20%/c or 54 mm/c.
- **Watson Lake.** (See Figure 19.) Over the 67 year history, Watson Lake shows a small decline of 7%/c or 31 mm/c.
- **Whitehorse.** (See Figure 20.) Whitehorse, too, shows a small decrease over its 63 year history, having a decline of 4%/c, or 10 mm/c.

Snow on Ground for February 28

- **Dawson.** (See Figure 21.) Snow on Ground Data for the years 1955 to 2006 show a strong decrease over the years, amounting to 64 %/c or 46 cm/c (see Figure 18). The average depth for the first twenty years is 67 cm. For the last twenty years, it is 53 cm. It is impossible to say what effect the change in station location has had on the snow depth data.
- **Mayo.** (See Figure 22.) Mayo Snow on Ground data for 28 Feb. is available from 1955 to 2006, except for the year 1995. This record also shows a strong and steady decrease, amounting to 114%/c (or 76 cm/c). The average over the first twenty years is 61 cm; by the final twenty years, the average is down to 38 cm.
- **Watson Lake.** (See Figure 23.) Watson Lake also shows a decrease in snow depth for February 28. For the first twenty years, the average was 74.7 cm; for the last

twenty years the average was down to 59.6 cm. Using all the data, the decrease comes to 63 %/c (49 cm/c).

- **Whitehorse.** (See Figure 24.) Whitehorse Snow on Ground data for 28 Feb. for the years 1955 to 2006 show a decrease of 53 %/c (17 cm/c). There was a noticeable increase in snow depths in the late 1960s and 1970s. The twenty year average depth in the years ending in 1986 was 36.9 cm. In the twenty years ending in 2006, the twenty year average was down to 22.5 cm.

Days Below -40 C.

- **Dawson.** (See Figure 25.) Although the data from Dawson do show some long term cycles in the number of days with temperatures below -40C, over the full period of record there is no apparent trend.
- **Mayo.** (See Figure 26.) Mayo also has indications of long term cycles, but over the eighty years of record, there is an indication of about 6 fewer very cold days per century.
- **Watson Lake.** (See Figure 27.) Over the past 65 years in Watson Lake, there is an overall trend towards fewer very cold days, about three over the record, or 4.5 per century.
- **Whitehorse.** (See Figure 28.) Whitehorse also has fewer very cold days; about 2/12 fewer over the 63 years of record. This works out to be about four days per century.

Mean Hourly Wind Speeds

- **Watson Lake.** (See Figures 29 to 31.) Watson Lake shows a significant decrease in mean hourly wind speeds, being down 6 km/h/century in Winter, 7.5 km/h/century in Summer, and 7 km/h/century when averaged over the entire year. This is a reduction of one half over the last fifty years for Winter, and about one third over the last fifty years overall.
- **Whitehorse.** (See Figures 32 to 34.) Whitehorse also shows a decrease in mean hourly wind speeds, although not as great as for Watson Lake. The decreases for Whitehorse are: 4 km/h/century in Winter; 6 km/h/century in Summer; and, and about 5 km/h/century over the year. These are drops in the 12 to 20% range over the last fifty years.

Whitehorse Sunshine

Whitehorse winters are sunnier, up 39 hours or about 20% over the 37 years of record. The summer, on the other hand, is not as sunny. Sunshine is down about 44 hours over the 39 summers with data, a drop of only about 4%. Measured over the entire year, sunshine is up about 30 hours over the 38 years of record, an increase of less than 2% of the average annual total. (See Figures 35 to 37.)

Yukon Lightning

Yukon lightning strikes are available from 1986 to the present. (See Figure 38.) Only data from the month of May, 2004 are missing. These were replaced with the average May total, some 488 strikes. The effect of these 488 strikes on the total for the summer, some 38,000 strikes, is negligible. The number of summer lightning strikes has increased dramatically over the years, with an increase of 424%/c. Much of this is due to the strong lightning year of 2004, which also saw a record area of forest burned. Ignoring this year, the increase is still high, being 204%/c. How much, if any, of this increase is due to changes in the network is unclear.

Fine Fuel Moisture Codes

Finally, changes in the average June values for four of the Canadian Forest Service's Fire Weather Indices were examined for the years 1953 to 2006 for the four stations. The Canadian Forest Fire Danger Rating System provides for the assessment of relative fire potential solely on the basis of weather observations. The FWI System's six components individually and collectively account for the effects of fuel moisture and wind on ignition potential and probable fire behavior in the form of relative numeric ratings. (Canadian Forest Service, 1996.)

The Fine Fuel Moisture Code (FFMC) is a numeric rating of the moisture content of litter and other cured fine fuels. This code is an indicator of the relative ease of ignition and the flammability of fine fuel. (See Figures 39 to 42.)

For the four stations considered, Dawson showed no trend over the 54 year period, Mayo showed an increase of 4.5 points per century, while both Watson Lake and Whitehorse showed a decrease of the same amount, namely 4.5 points per century.

Initial Spread Index

The Initial Spread Index (ISI) is a numeric rating of the expected rate of fire spread. It combines the effects of wind and the FFMC on rate of spread without the influence of variable quantities of fuel. (See Figures 43 to 46.)

Dawson showed a small increase over the period, equalling about 0.8 points per century. Mayo had an increase of 2.6 points per century, while both Watson Lake and Whitehorse had decreasing ISIs of -5.4 and -5.2 points per century. These decreases are a consequence of lighter winds and lower FFMCs.

Drought Code

The Drought Code (DC) is a numeric rating of the average moisture content of deep, compact organic layers. This code is a useful indicator of seasonal drought effects on forest fuels and

the amount of smoldering in deep duff layers and large logs. This code is a measure of wet and dry spells. (See Figures 47 to 50.)

Each of the four stations showed an increase in Drought Codes: Dawson up 20 points per century, Mayo up 98, Watson Lake up 65 and Whitehorse up 147 points per century. The decreases in winter precipitation at Dawson, Watson Lake and Whitehorse would cause some of those increases.

Fire Weather Index

The Fire Weather Index (FWI) component itself combines the ISI and Build Up Index (BUI) to indicate the potential intensity of a fire on level terrain in a stand of mature pine. (See Figures 51 to 54.)

Dawson and Mayo show very slight increases in the FWI (1.6 and 2.4 points/century resp.), whereas Watson Lake and Whitehorse show decreases of 9 and 10.2 points/century. These are most likely due to the decrease in wind speeds at these two stations.

Winter 1000-500 MB Thickness

Some statistics were derived from the upper air records from Whitehorse UA, which has records for the years 1961 to 2004 and the hour 00 U.T.C. The 1000-500 MB thickness is a measure of the mean temperature in the lower half of the atmosphere, not just at a particular level. The data for Whitehorse were generally complete, missing an occasional observation. The winter of 1997, however, was missing 46 observations. No attempt to fill in the missing gaps was made; the data were plotted with no adjustments.

The data, see Figure 55, show a decrease until 1971, followed by increasing thickness through the remainder of the period. The change over the entire period is 129 m/century. Looking at the years since 1971, this increases to an increase of 165 m/century.

Summer 1000-500 MB Thickness

The data for Whitehorse summer 1000/500 MB thickness were generally complete, missing an occasional observation. The summers of 1991 and 1999, however, were missing 37 and 31 observations respectively, while the summers of 1993 and 1994 were missing completely. No attempt to fill in the missing gaps was made; the data were plotted with no adjustments.

The data, see Figure 56, show considerable change from year to year. Over the entire period, the change is up 17 m/century. This trend is similar to that for Whitehorse mean maximum temperatures in summer.

Summer Clarke Index

The Clarke Index compares the thickness of the upper tropospheric air mass between 500 millibars and 250 millibars with that of the lower troposphere between 500 millibars and 1000

millibars. The higher level thickness is subtracted from the lower level thickness, with the difference relating to the stability of the entire air mass column. An unstable air mass is represented by relatively cold air aloft (small thickness value) and warm air below (large thickness value) yielding a large numerical difference. (Clarke, Purves, 1991.)

The mean Clarke Index was calculated for each summer. (See figure 57.) As with the summer 1000/500 MB thickness, the years 1993 and 1994 were missing, and the summers of 1991 and 1999 were missing over 30 observations each. No attempts were made to compensate for these gaps; the data were plotted as calculated.

The trend, over the years from 1961 to 2004, shows increasing instability, with a rate of 3.5 points per century. This increased instability leads to increasing lightning activity. A Clarke Index of 70 implies a probability of lightning of 10%; a Clarke Index of 74 implies a probability of lightning of 25%. (Purves, 1993.)

Whitehorse Precipitable Water

The precipitable water was calculated for each day using soundings taken at 00Z, and averaged over the year. Precipitable water is the amount of water that would be on the ground if all the water vapour in the atmosphere above a point were condensed and brought to the surface. These data were in general available for each day, although most years were missing data for one to five days. Five years were missing between 30 and 60 days: namely 1991, 1994, 1997, 1998 and 1999. The missing days were replaced with their twenty year averages.

The interesting aspect of this graph, see Figure 58, is the discrepancy in the trend between 1973 and 1974, and again between 1995 and 1996. Before 1974, the precipitable water averaged 8 mm. From 1974 to 1995, it averaged 9.2 mm, and from 1996 on, it averaged 8.7 mm. Although I have been unable to ascertain this, it seems that changes in instrumentation may be responsible for these abrupt discrepancies. For this reason, stability indices involving moisture were not examined.

Mean Annual 850 MB Wind Speed

The mean annual wind speed at 850 MB was calculated for each year, using data from soundings at both 00 and 12 U.T.C. (See Figure 59.)

The data show decreasing wind speeds from 1961 to 1977, with increasing wind speeds from 1978 to the present. The average increase over the entire period of record is 1.9 kts/century. Over the period since 1977, the increase is 5.5 kts/century. This is in marked contrast with the surface winds at Whitehorse, which are becoming lighter over time.

Date of Yukon River Break Up at Dawson

Finally, the date of the break-up of the Yukon River at Dawson is examined. (See Figure 60.) The time of the ice going out has been recorded since 1896, (Mac's Fireweed and Appendix

1.) These dates have been converted to the appropriate Julian Day and plotted. They show a trend towards earlier break-up dates of 5.4 days/century.

Conclusion

There is strong evidence of climate change in the Yukon in the set of weather data available for the territory. Overall, winters and summers are warmer, with winters showing the greatest change. Each of the four stations had a period of strong cooling approximately between 1940 and 1970. This was followed by even stronger warming. Dawson and Mayo had stronger warming than Watson Lake and Whitehorse. Over the past forty years, the warming was 18 deg.C/century at Dawson and Mayo, with 12 deg. C/century at Watson Lake and 14 at Whitehorse. Dawson, with a longer record, showed strong warming from 1902 to 1925.

Summer mean maximum temperatures show a similar pattern to winter mean minimum temperatures, with a period of cooling from 1940 to about 1970. For Dawson and Mayo, this period of cooling, 1941 to 1964 was about ten years before the cooling period in Watson Lake and Whitehorse. The warming trend over the past forty years is between 3 and 4 deg. C/century. Dawson shows the strongest warming of the four stations.

Winters, for the most part, are drier, although there are considerable differences between the four stations. Summers are wetter, although the change in Whitehorse is small. Over the year, there is a small decrease in precipitation, except for Mayo, which shows a small increase.

There is a remarkable decrease in snow depth for the 28 February.

It seems that for Whitehorse at least, winters are sunnier. For Whitehorse and Watson Lake, winds are not as strong. Summer lightning across the Yukon is more frequent. The Yukon River is breaking-up earlier.

Forest Fire indices were also examined. Watson Lake and Whitehorse had decreases in the Fine Fuel Moisture Codes, while Dawson showed no trend and Mayo's trend was up. The Initial Spread Index was up in Dawson and Mayo, but down quite strongly in Watson Lake and Whitehorse. All four stations showed increasing Drought Codes, with the strongest increase in Whitehorse and the least in Dawson. Finally, the Fire Weather Index was slightly higher in Dawson and Mayo (up two points) and down about ten points in Whitehorse and Watson Lake.

The upper air records for Whitehorse show trends similar to the surface observations for the mean temperatures between 1000 and 500 MB as measured by the change in 1000/500 MB thickness. There is a period of cooling from 1961, the start of records, to 1971. This is followed by strong warming until the present. Summer thicknesses also show a trend towards higher values, but the changes in winter thicknesses are greater than those in summer.

The atmosphere over Whitehorse, as measured by the Clarke Index, is becoming more unstable over time. This correlates with the increased lightning reported over the territory.

Winds aloft over Whitehorse, measured at 850 MB, have become stronger over the period of record. This contrasts the winds at the surface, which have been decreasing over the past 50 years.

This study has shown problems with the climate record datasets. Many stations have only very spotty records, and some stations have moved frequently. If there are no overlapping observations with those stations in their old and new locations, it is impossible to estimate the effect of the move on the data.

There may also be problems with changes in instruments affecting the values of the parameters measured. This is strongly indicated in the hygistor data in the Whitehorse Upper Air data, and seems to be a problem in precipitation data measured at some automatic weather stations.

Furthermore, there are considerable year to year variations in the data, and these variations can cause different results to be calculated depending on whether or not they are included in the sample. There also appear to be longer term trends embedded in the record, and these too can have a marked effect on long term trend calculations. For example, there was a period of cooling from the 1940s to the 1970s, with the cooling trend occurring earlier at the two northern stations than the two in the south. Some people may find this cooling surprising. Is it part of a long term cycle, or is it due to other factors? For example, it could be due to a shift in the "cold pole" with the centre of the cold arctic air moving closer to or farther away from the Yukon. It is not possible, with our limited data, to answer this question.

While the Yukon is generally free from the effects of urbanization, there are possible problems with winter minimum temperatures at Whitehorse airport. On very clear cold nights, wood smoke from houses in the Hillcrest subdivision can be seen drifting down and across the airport. This can effect the change in the air temperature, but its effect can not be reliably estimated from the climate data record.

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Appendix 1

A Dawson City / Yukon Tradition

The Ice Guessing contest, aka The Ice Pool has been happening in Dawson City since 1896 when the garbage that had been thrown on the frozen Yukon River over the winter months was seen to start moving in the spring and that was the sign that the ice was going out.

Things have changed since then. For the past several decades there has been a Tripod erected on the frozen river. A wire is connected to the Tripod and is run to a clock secure in a box and firmly mounted on a wall on the shore. The clock stops when the ice moves the Tripod and trips the wire. Someone sees that the ice is moving and immediately phones the Volunteer Fire Department and they in turn ring the fire siren. Then the people flock to the river bank.

IODE has been running this contest for about 60 years. At one time people got paid for at least some of their efforts but these days it's a strictly volunteer affair. Our good friends The Yukon Order of Pioneers use their skills to put up the Tripod, built with donated lumber and donated wire that leads to the clock - also donated!! People all over town, along the Klondike Highway and in Whitehorse sell Ice Guessing Tickets for us until April 25th and then volunteers help sort the tickets.

IODE is a women's charitable organisation that has been active in Dawson since 1914. The proceeds after expenses are split 50-50 with the winning guesser and IODE (which puts the money to good works improving the quality of life for children, youth and those in need).

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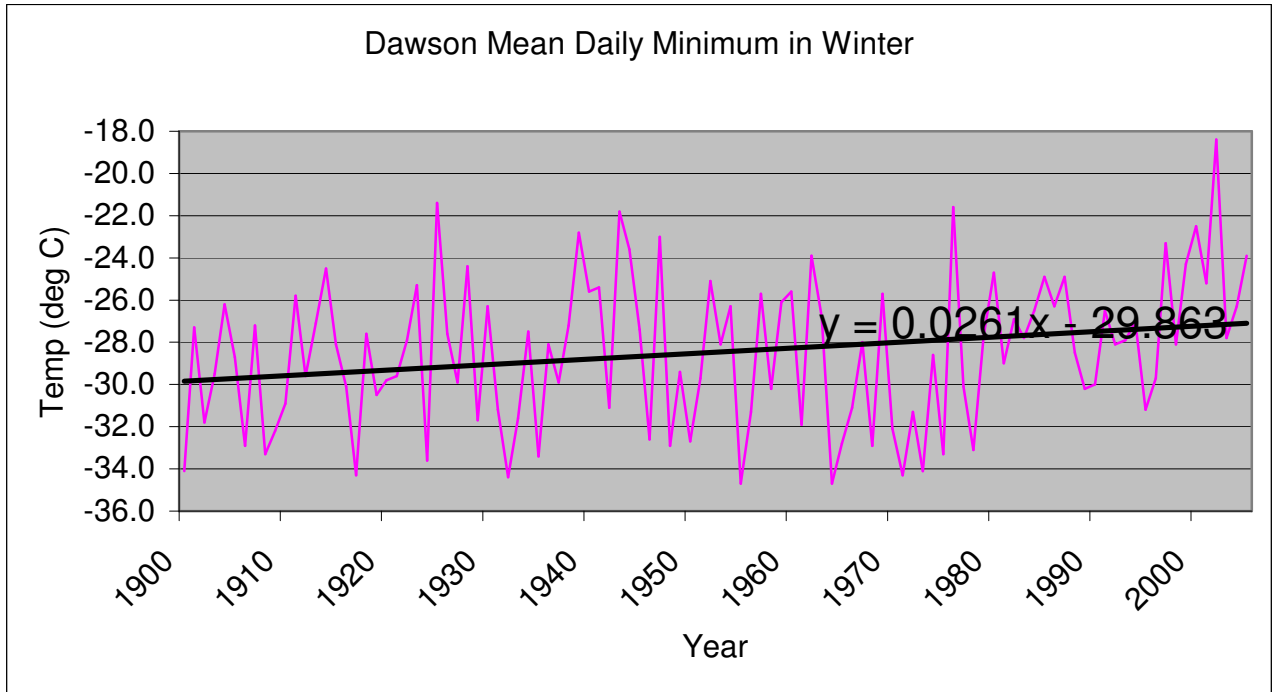


Figure 1. Dawson Mean Daily Minimum in Winter.

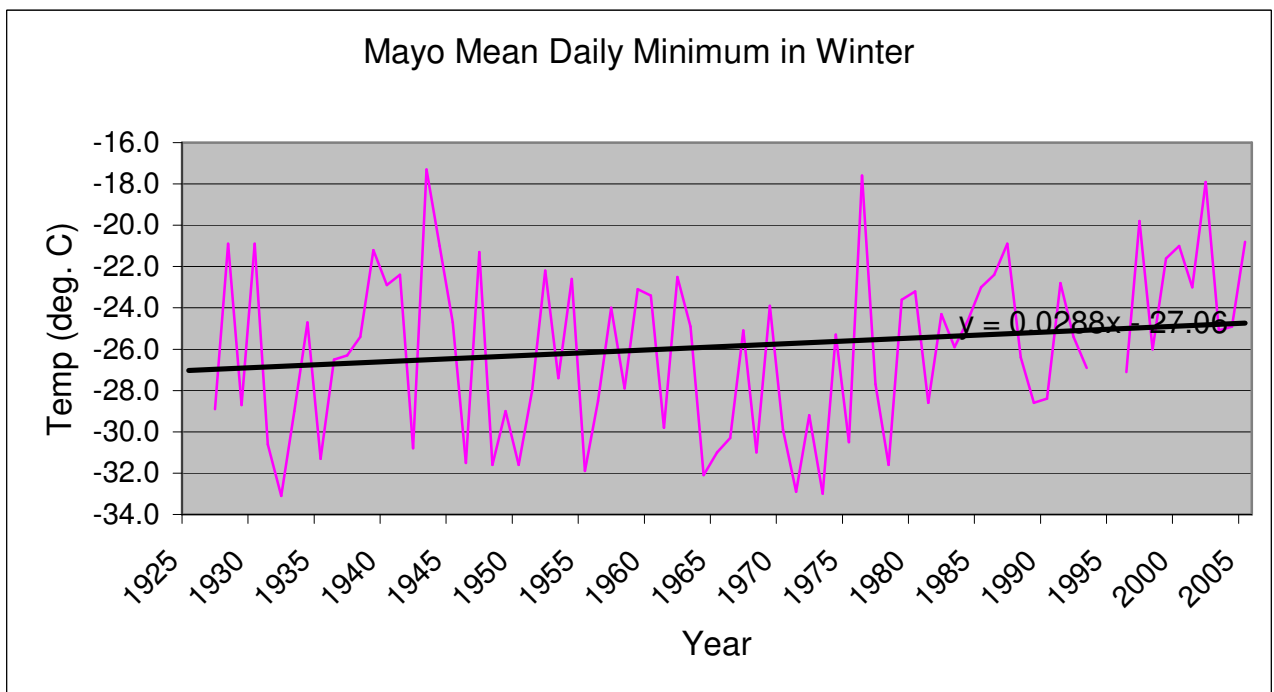


Figure 2. Mayo Mean Daily Minimum in Winter.

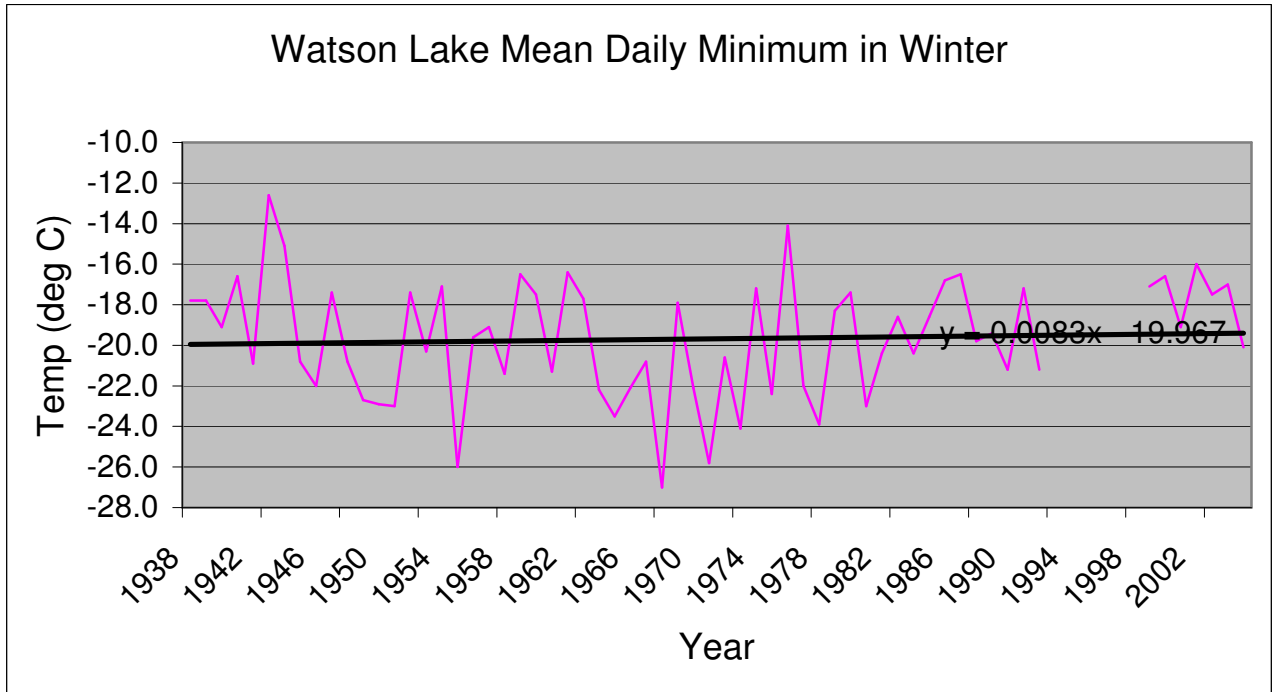


Figure 3. Watson Lake Mean Daily Minimum in Winter.

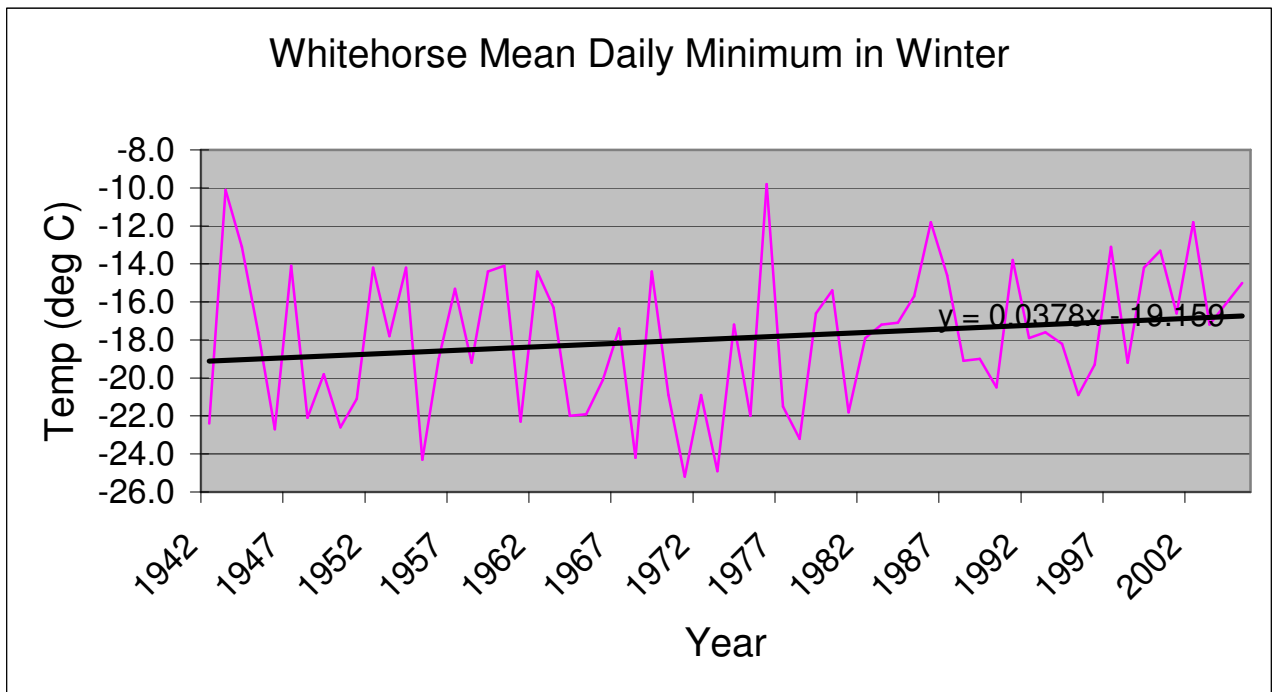


Figure 4. Whitehorse Mean Daily Minimum in Winter.

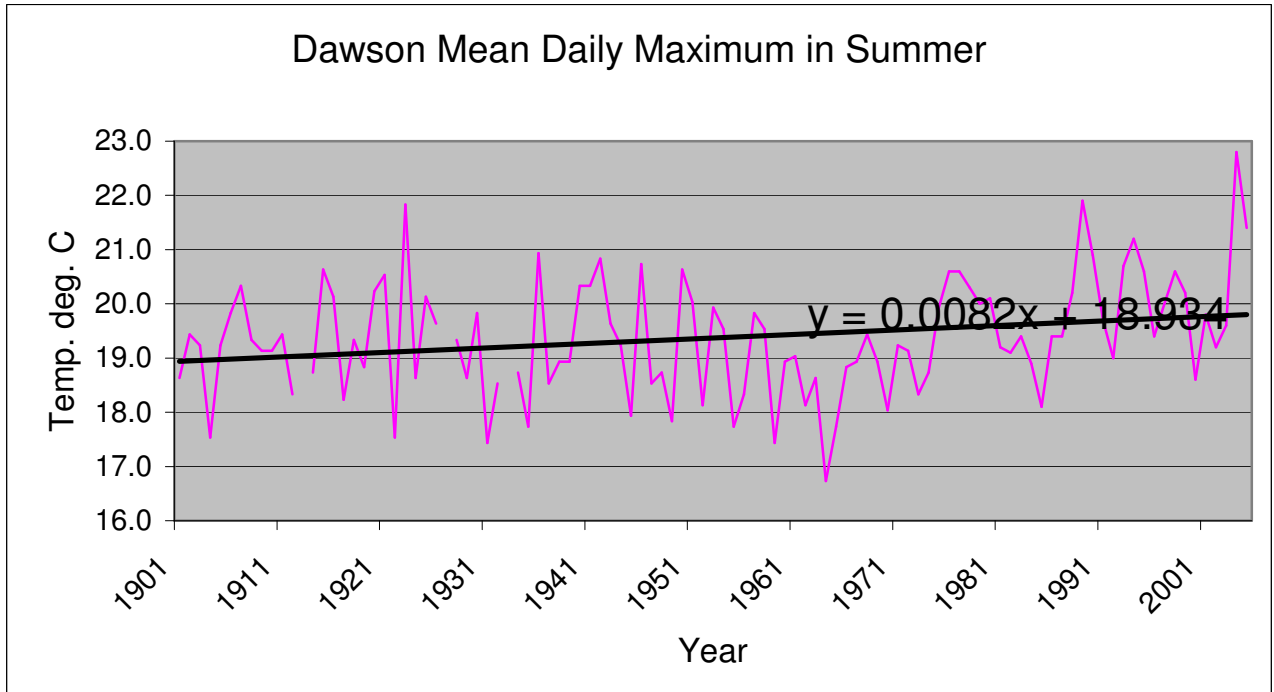


Figure 5. Dawson Mean Daily Maximum in Summer.

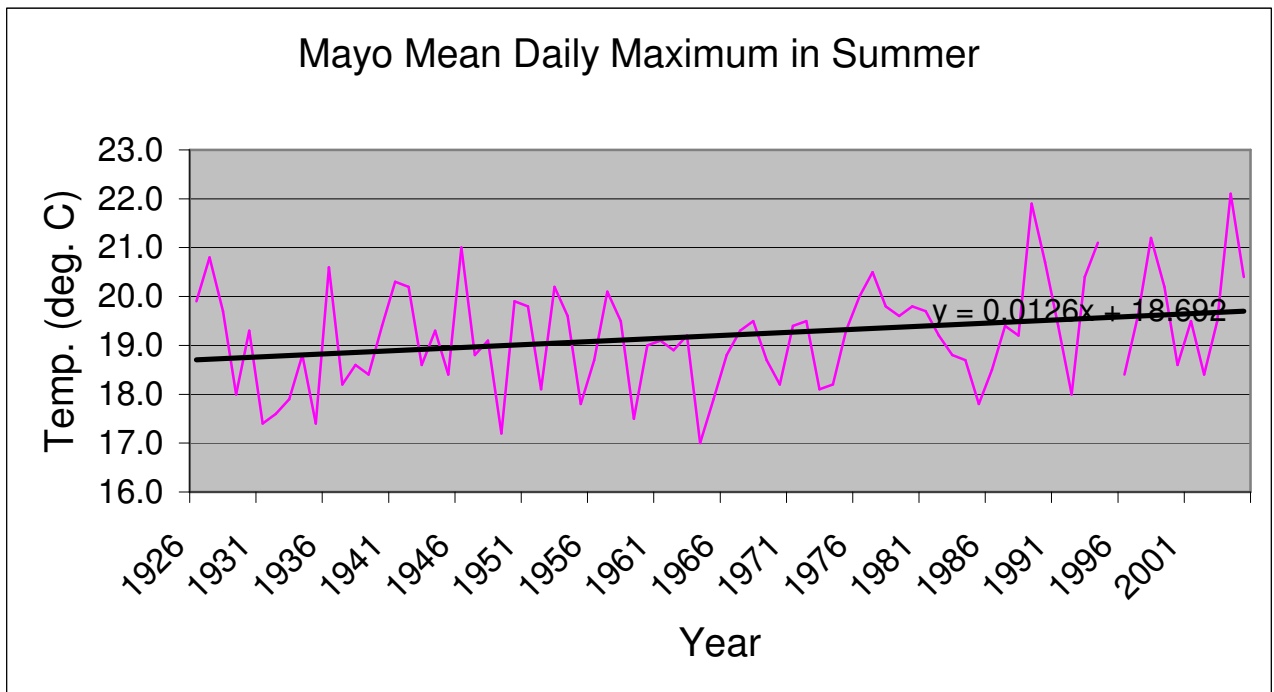


Figure 6. Mayo Mean Daily Maximum in Summer.

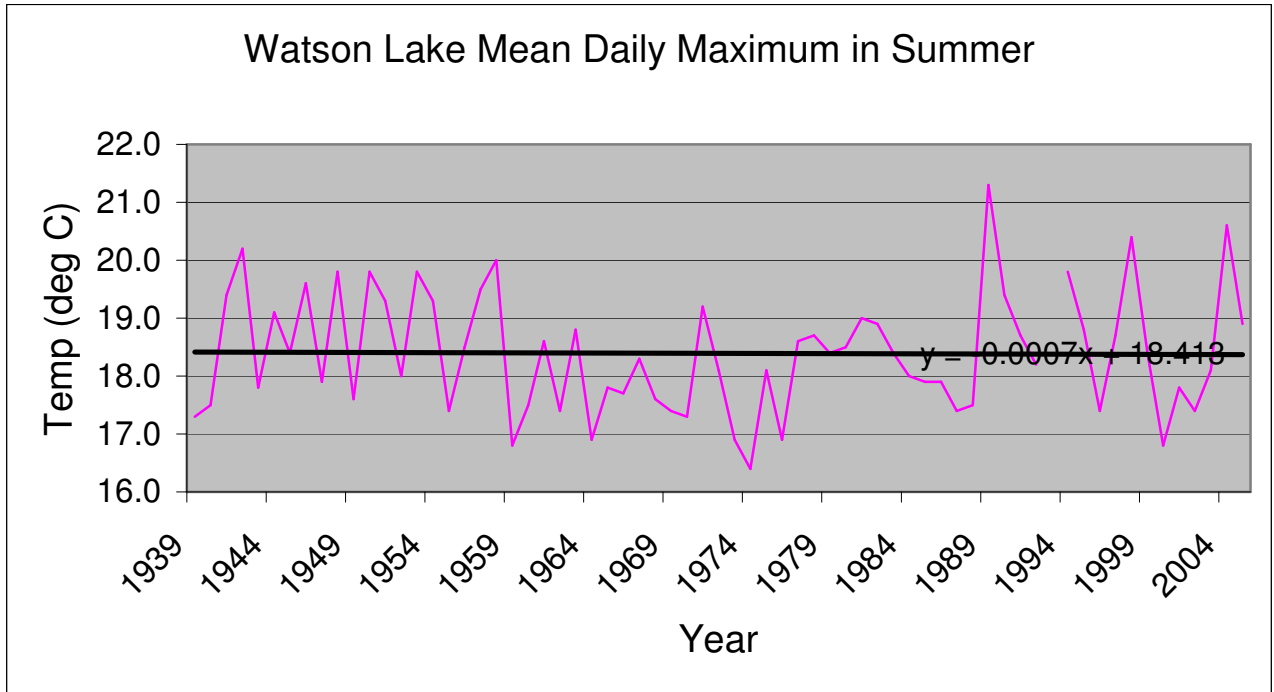


Figure 7. Watson Lake Mean Daily Maximum in Summer.

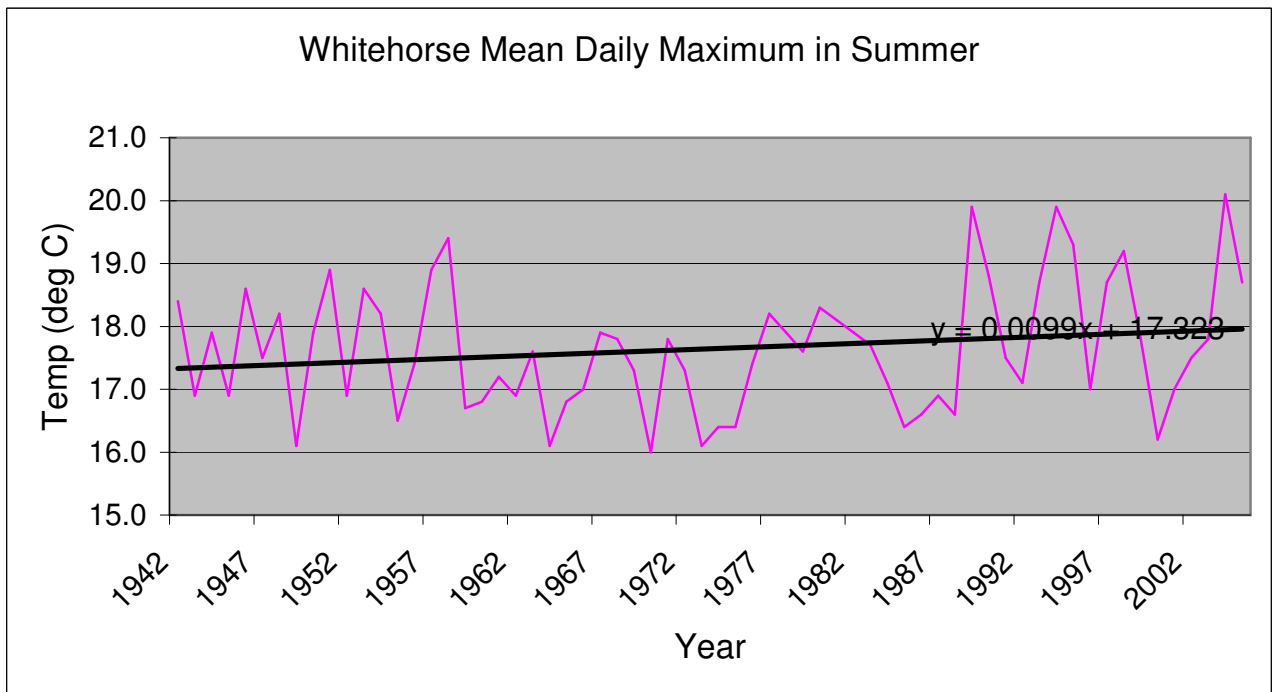


Figure 8. Whitehorse Mean Daily Maximum in Summer.

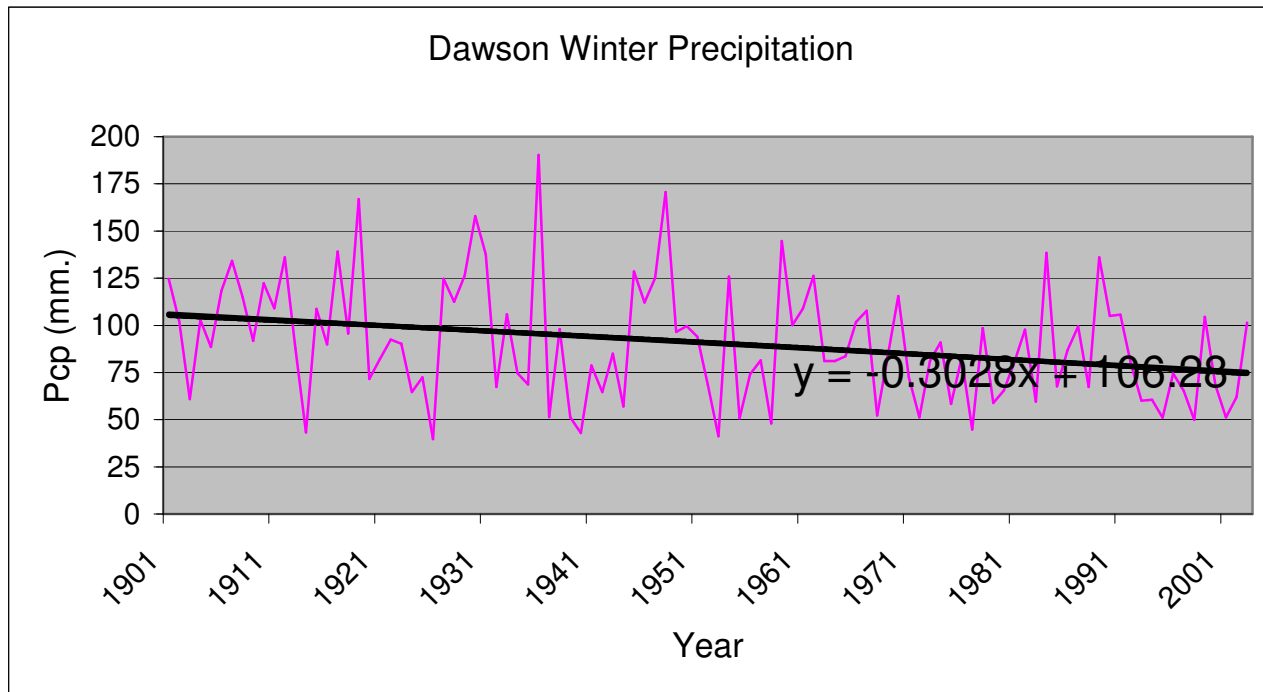


Figure 9. Dawson Winter Precipitation.

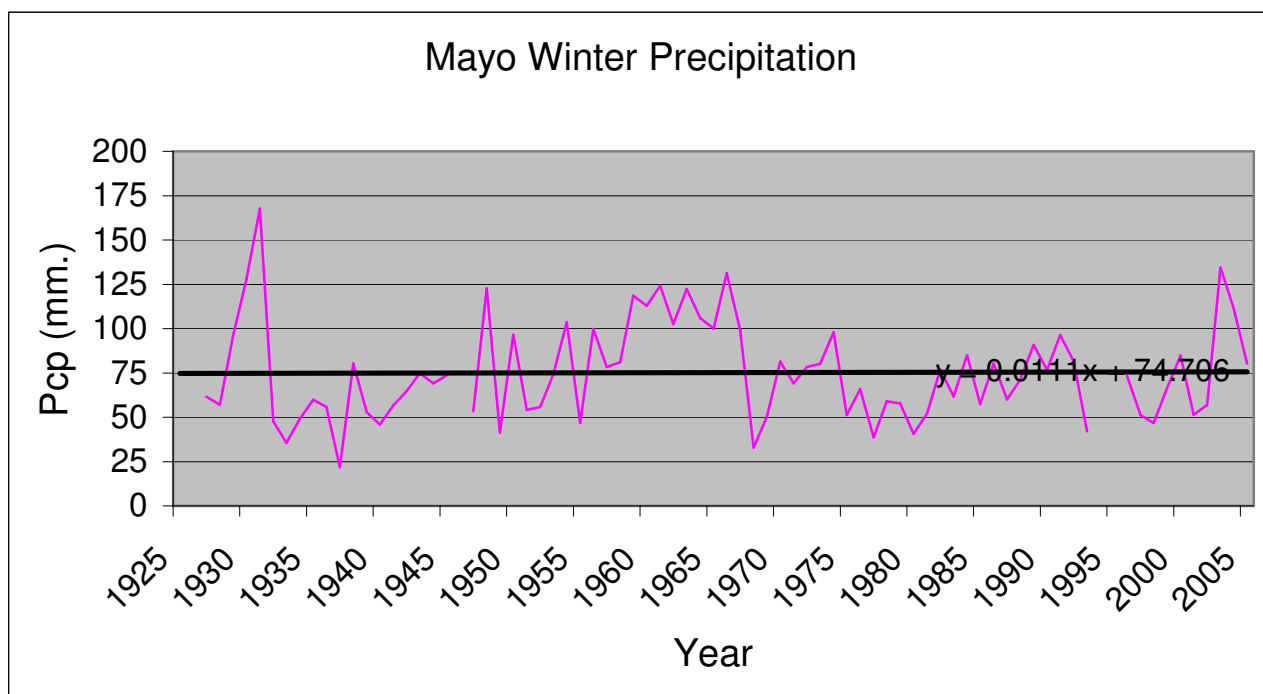


Figure 10. Mayo Winter Precipitation.

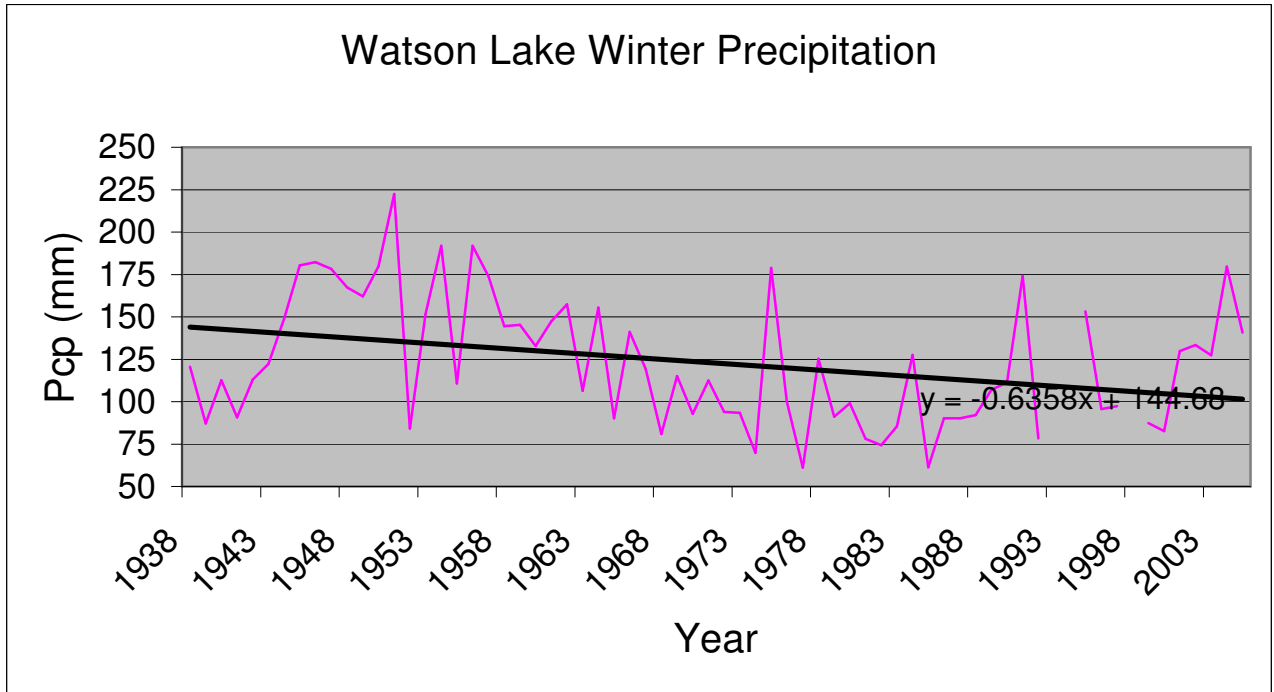


Figure 11. Watson Lake Winter Precipitation.

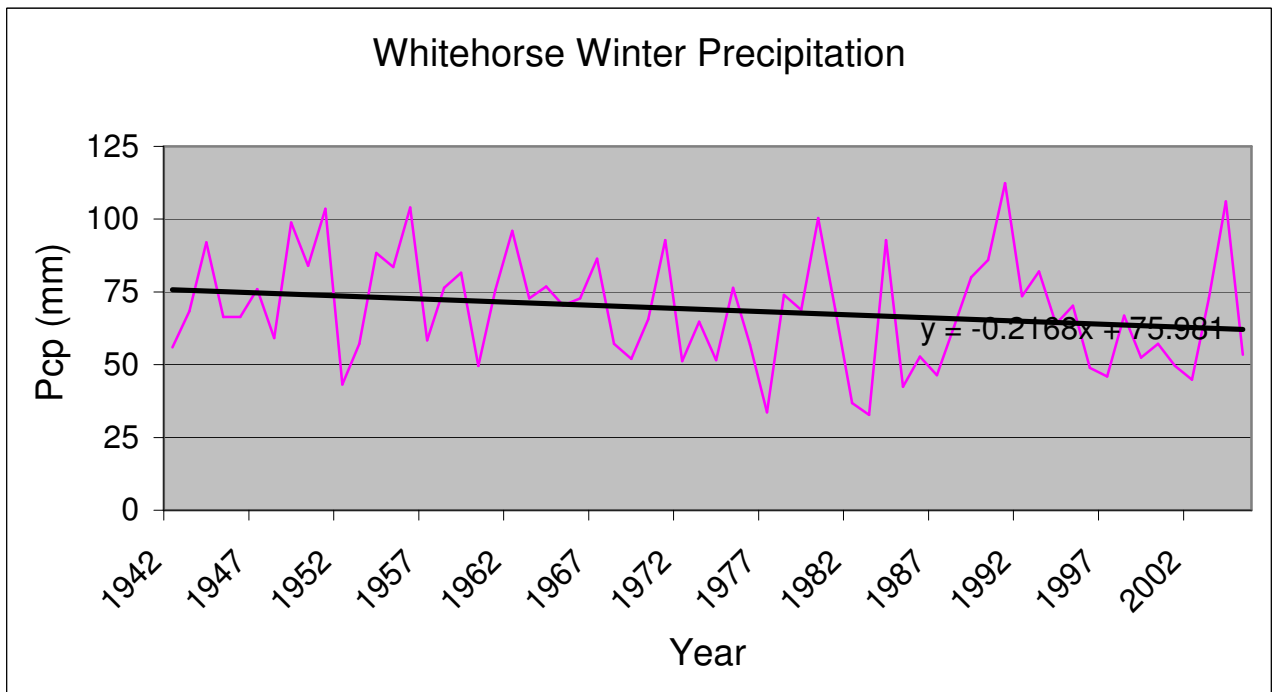


Figure 12. Whitehorse Winter Precipitation.

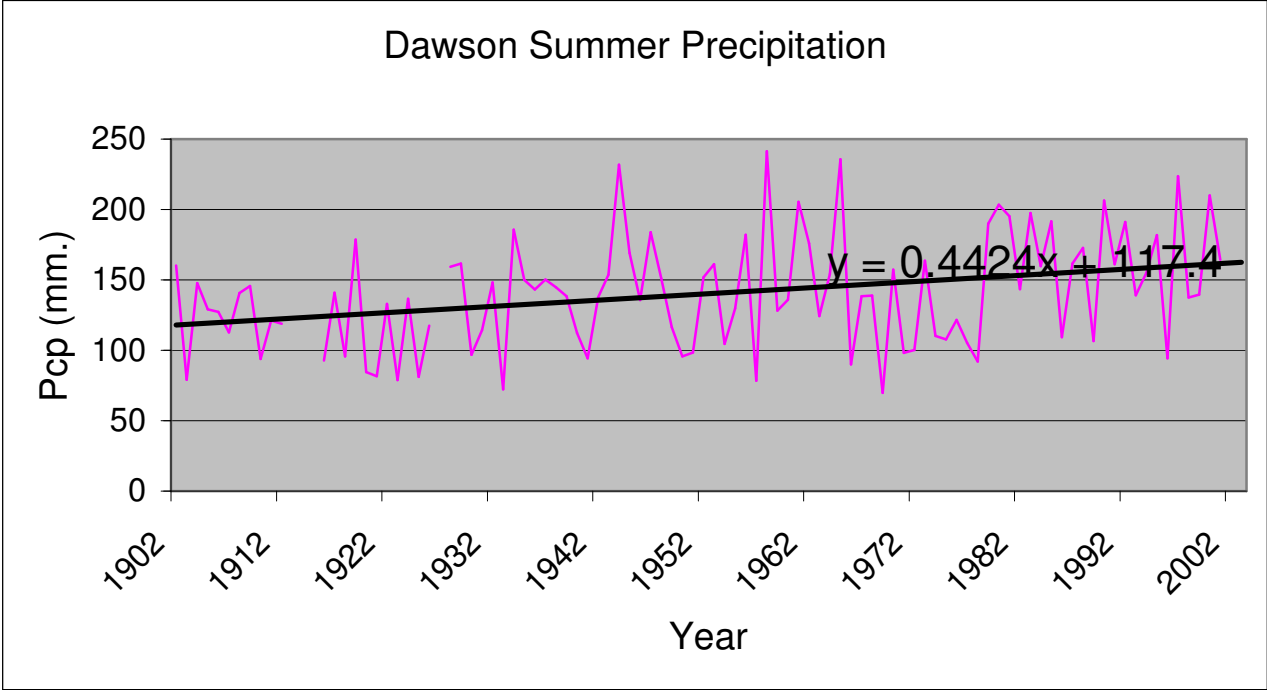


Figure 13. Dawson Summer Precipitation.

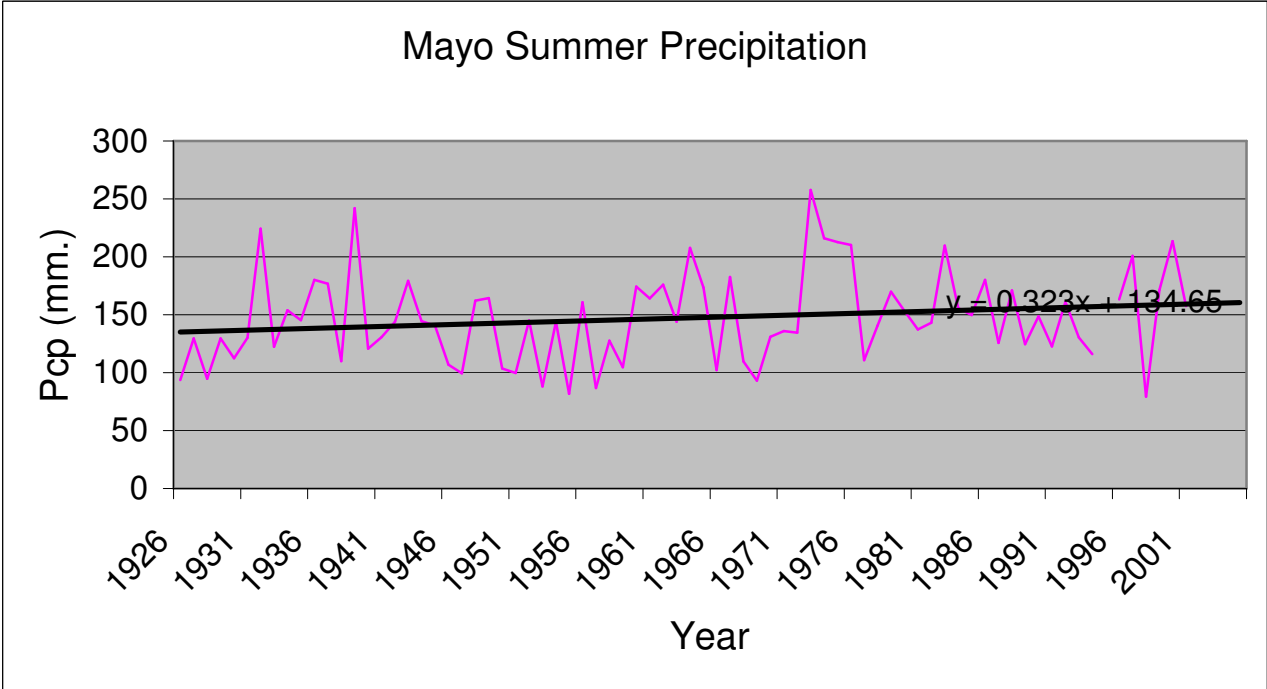


Figure 14. Mayo Summer Precipitation.

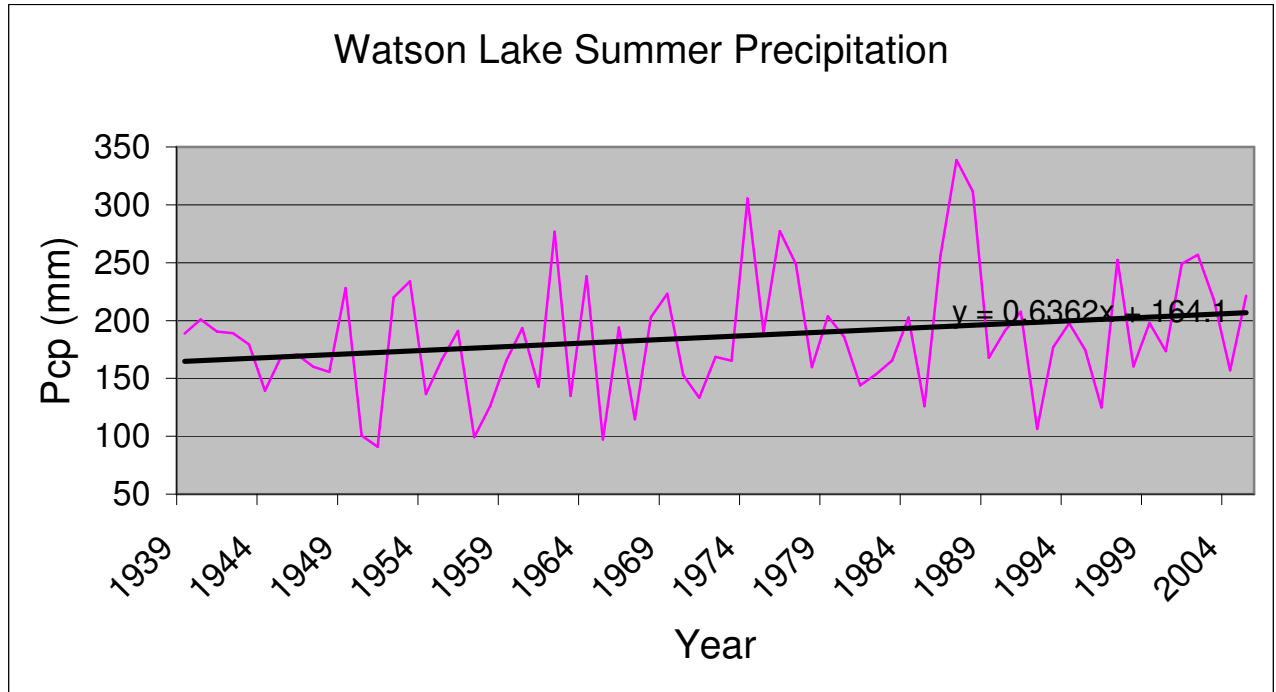


Figure 15. Watson Lake Summer Precipitation.

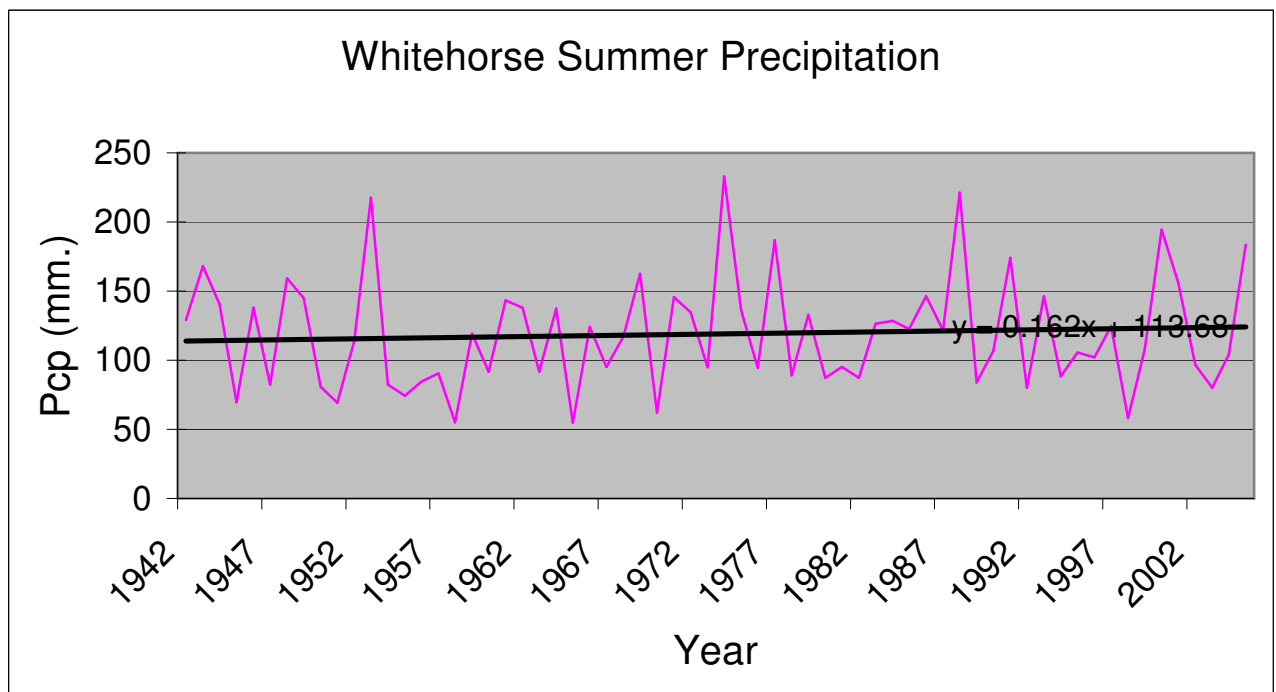


Figure 16. Whitehorse Summer Precipitation.

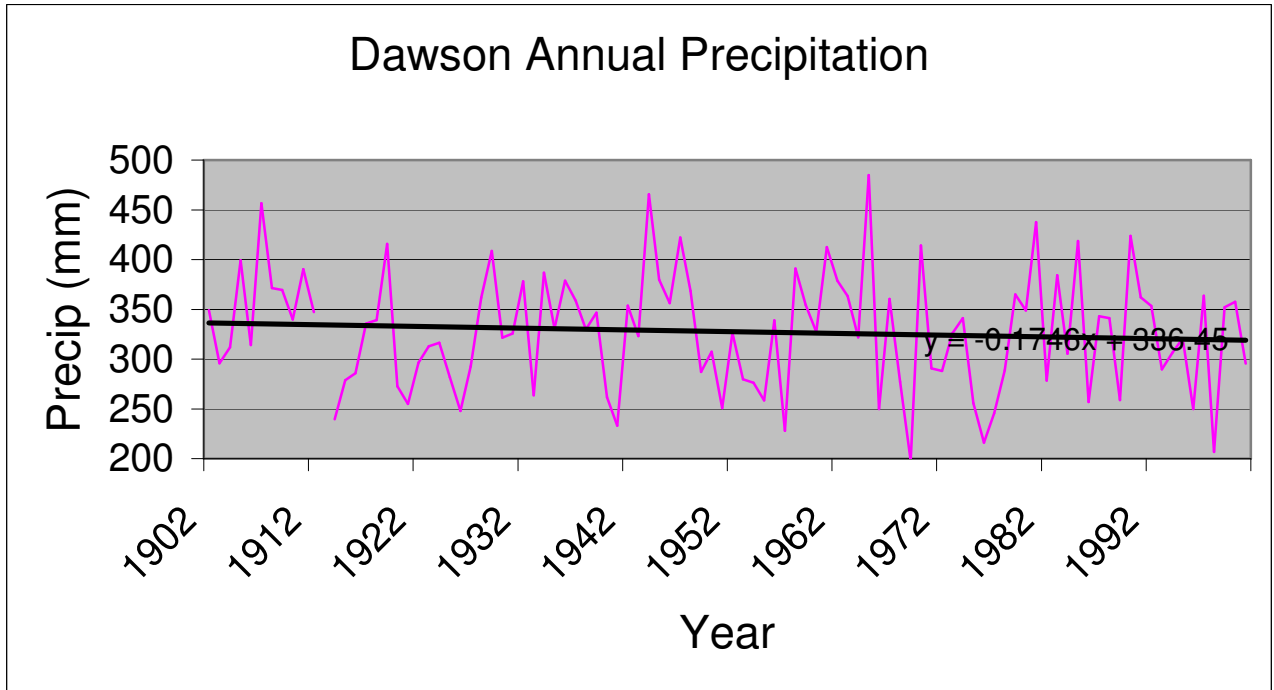


Figure 17. Dawson Annual Precipitation.

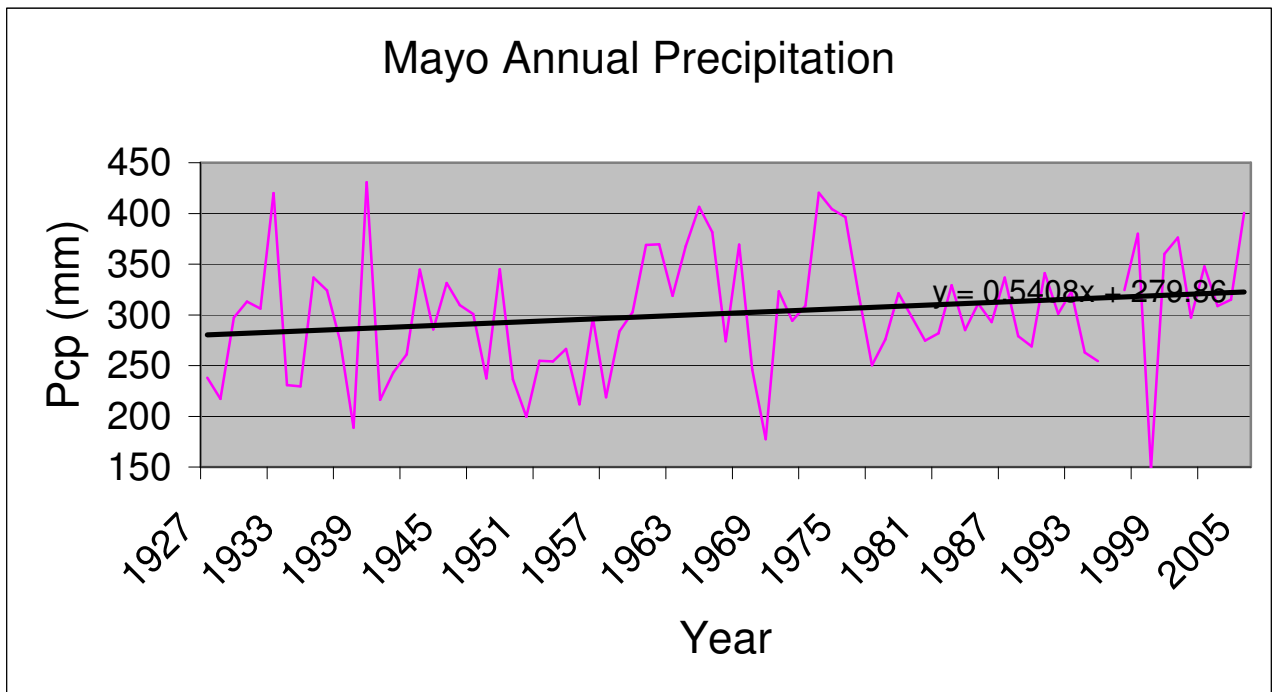


Figure 18. Mayo Annual Precipitation.

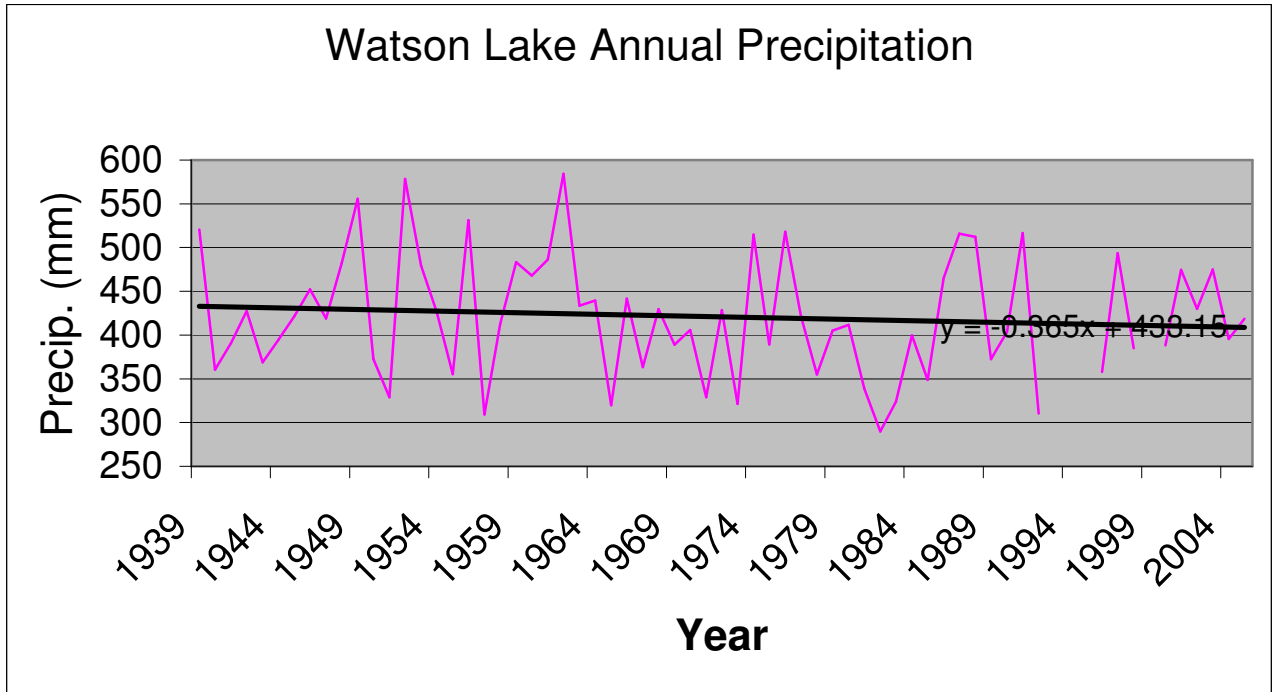


Figure 19. Watson Lake Annual Precipitation.

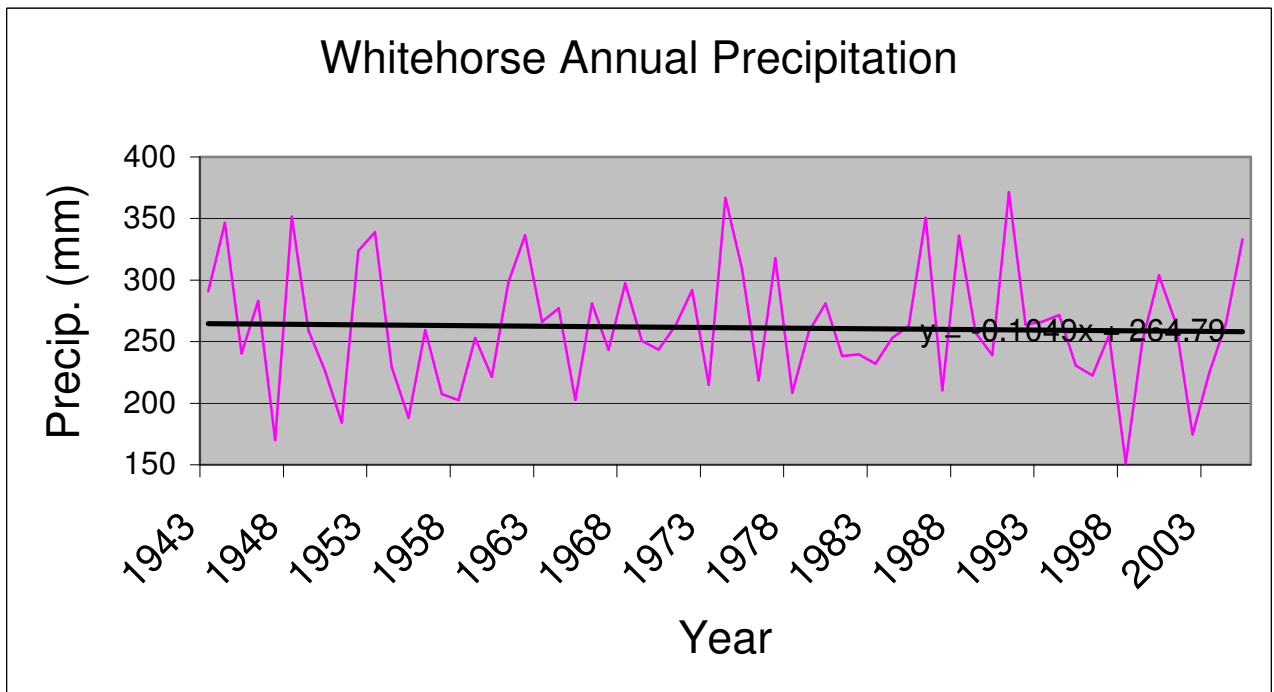


Figure 20. Whitehorse Annual Precipitation.

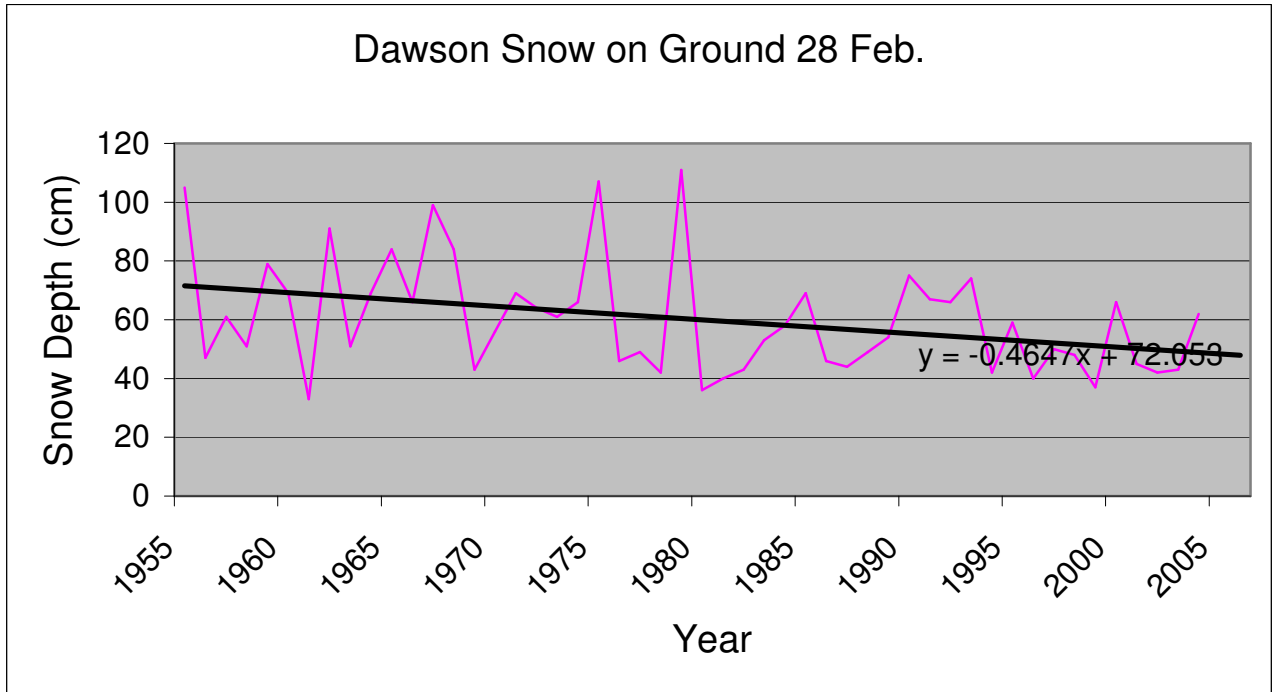


Figure 21. Dawson Snow on Ground.

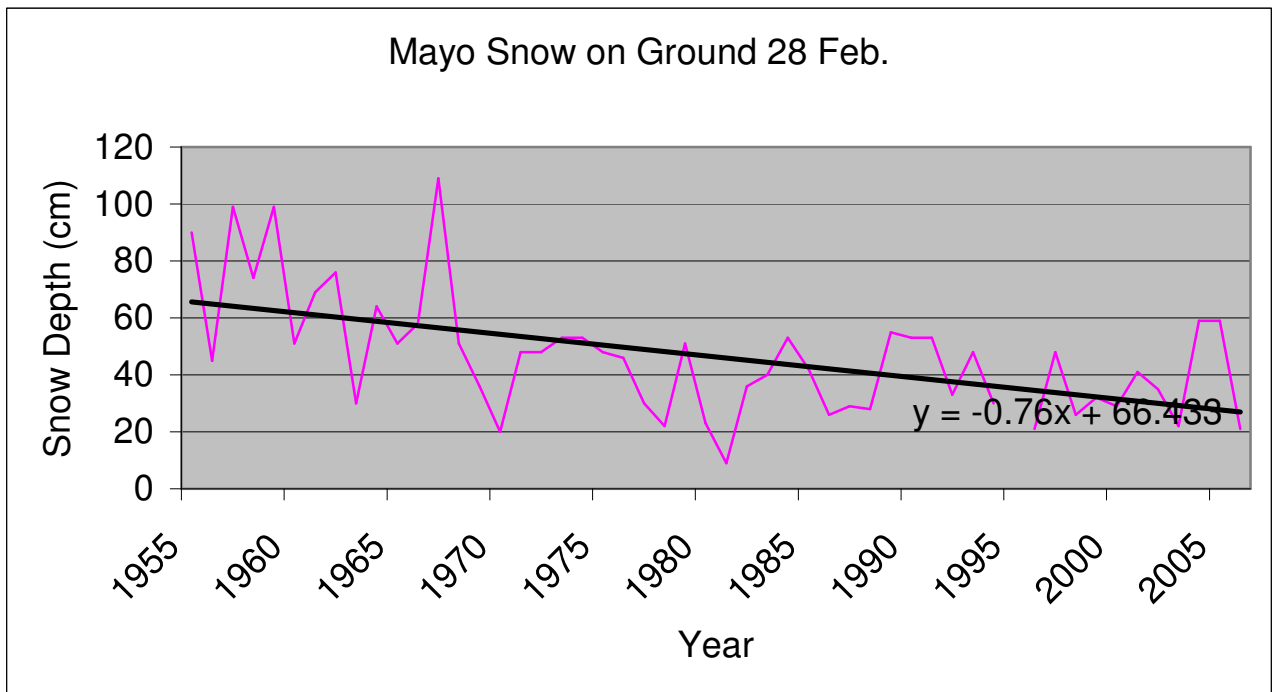


Figure 22. Mayo Snow on Ground.

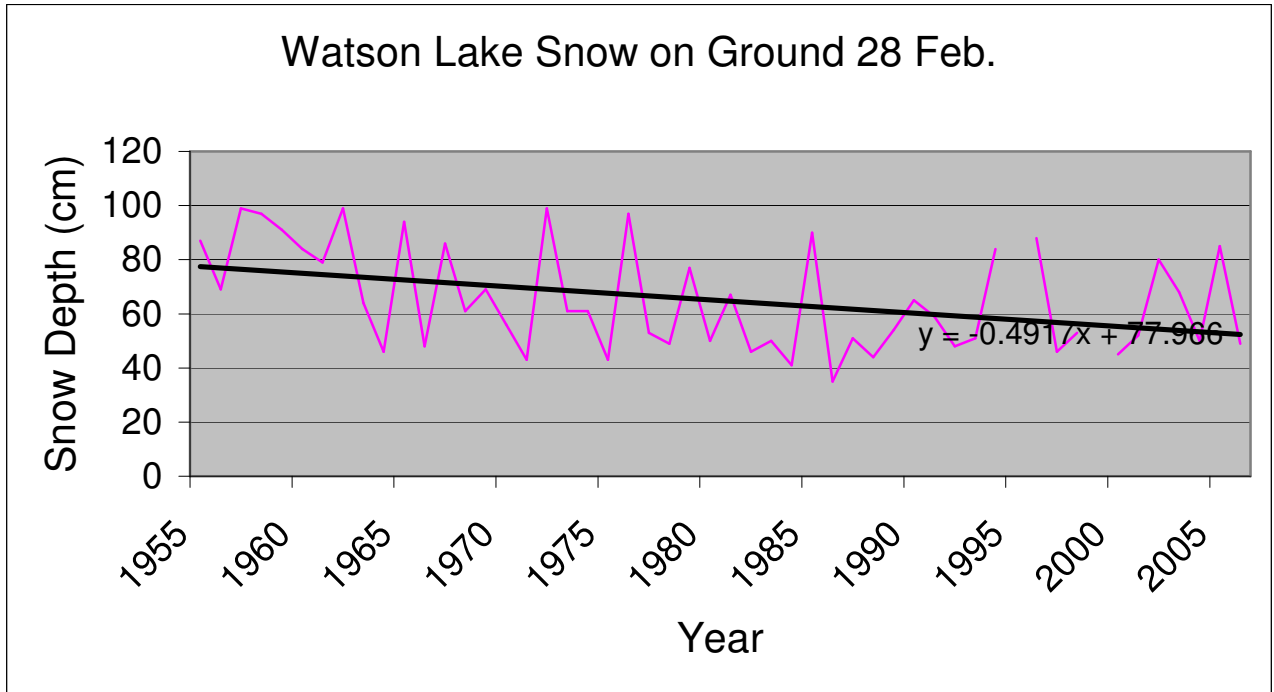


Figure 23. Watson Lake Snow on Ground.

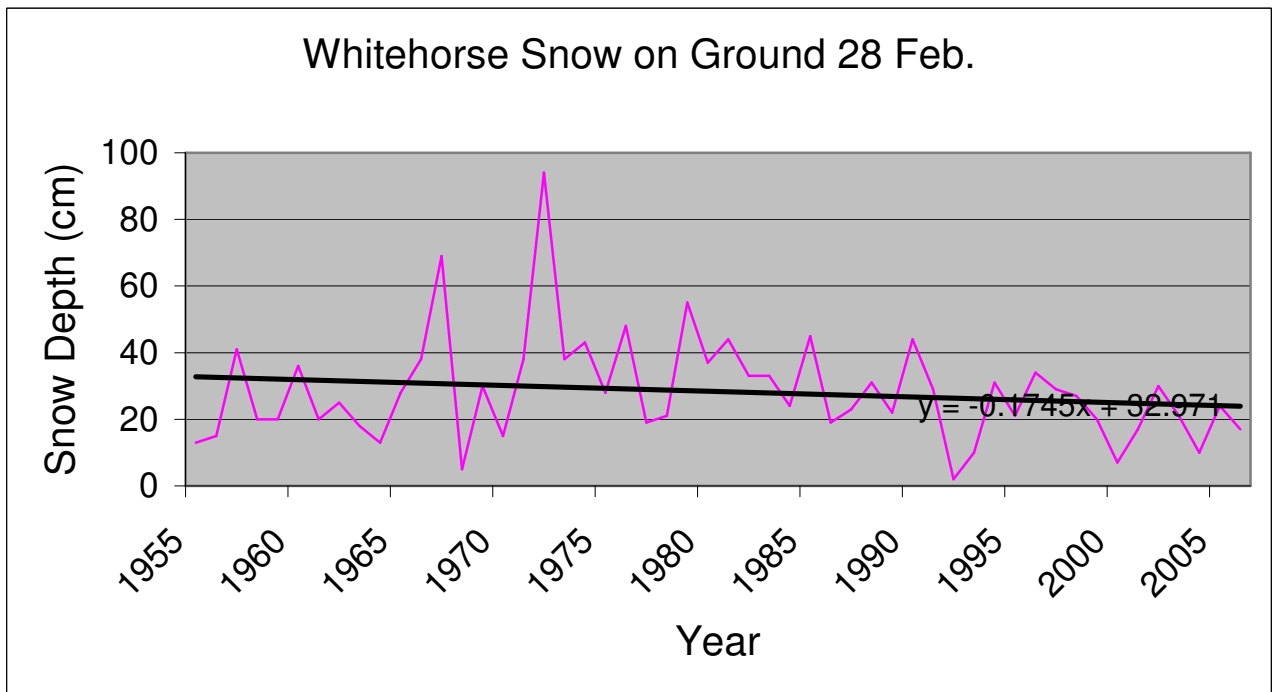


Figure 24. Whitehorse Snow on Ground.

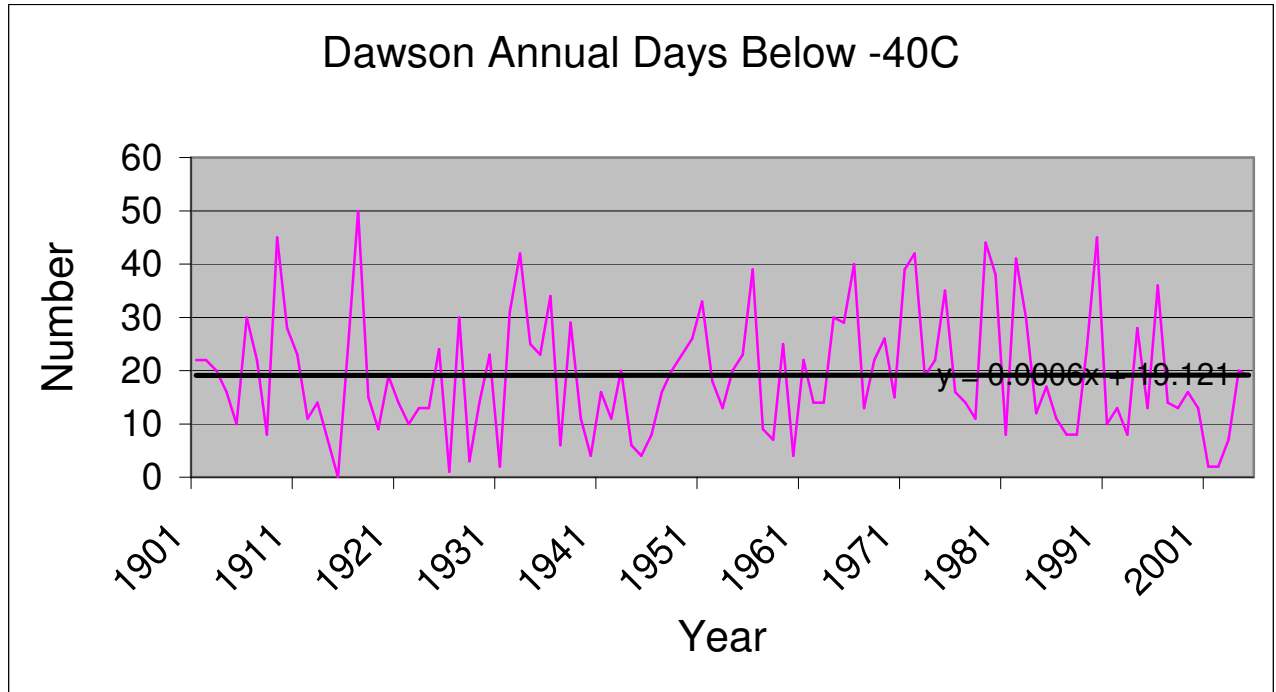


Figure 25. Dawson Annual Days Below -40C.

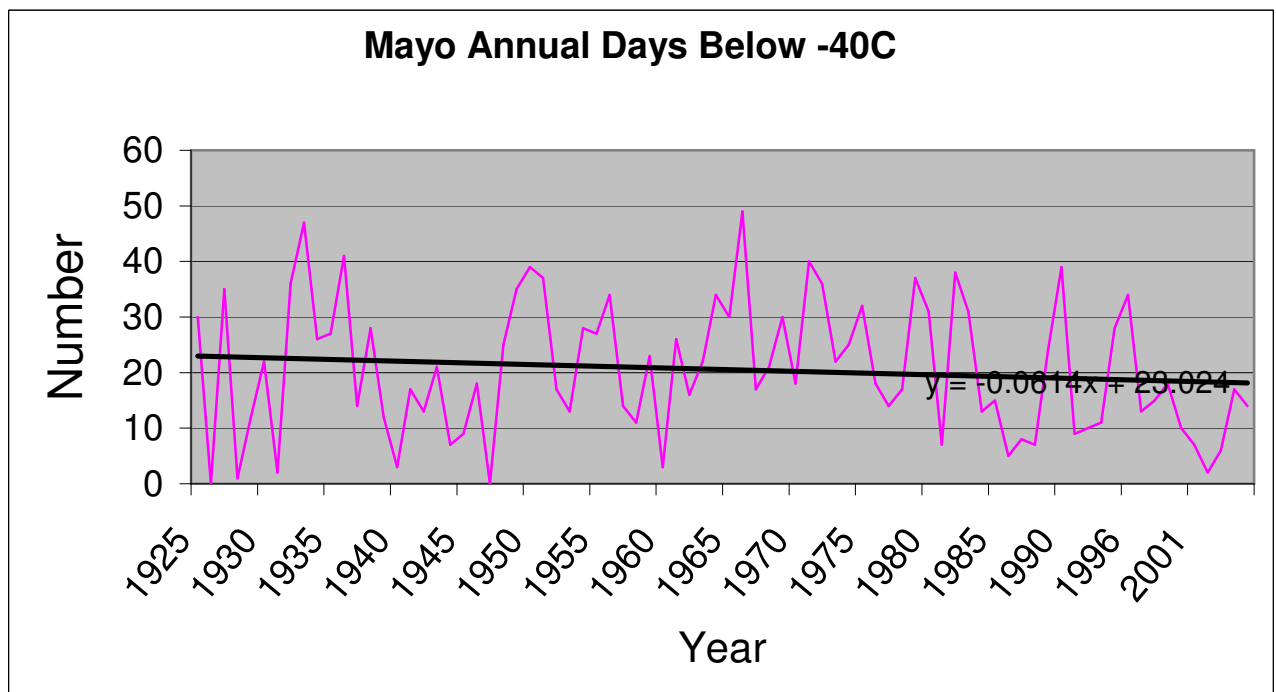


Figure 26. Mayo Annual Days Below -40C.

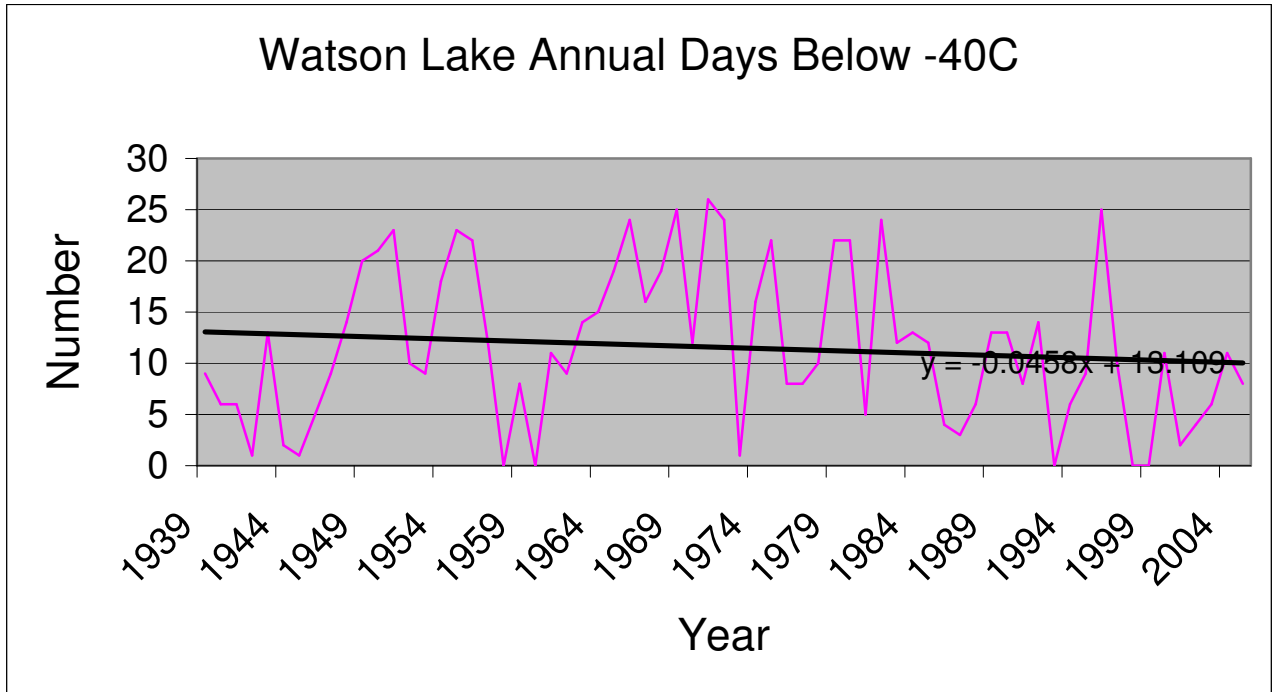


Figure 27. Watson Lake Annual Days Below -40C.

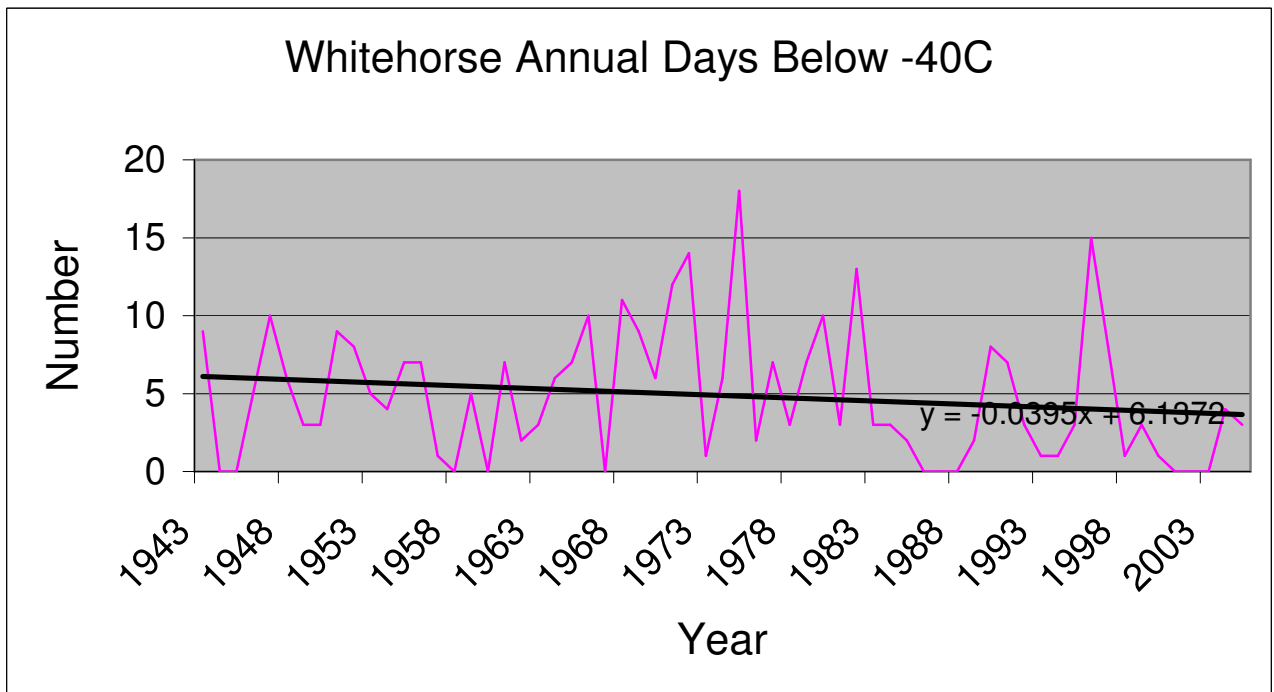


Figure 28. Whitehorse Annual Days Below -40C.

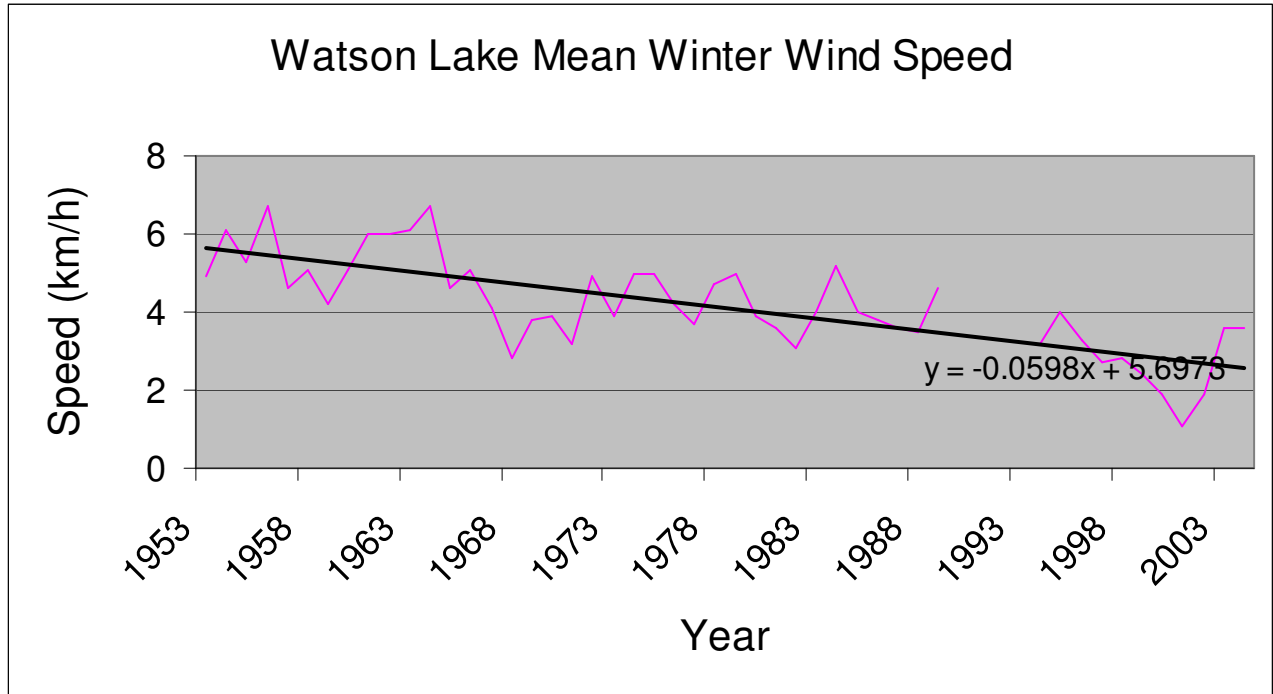


Figure 29. Watson Lake Mean Hourly Wind Speed in Winter.

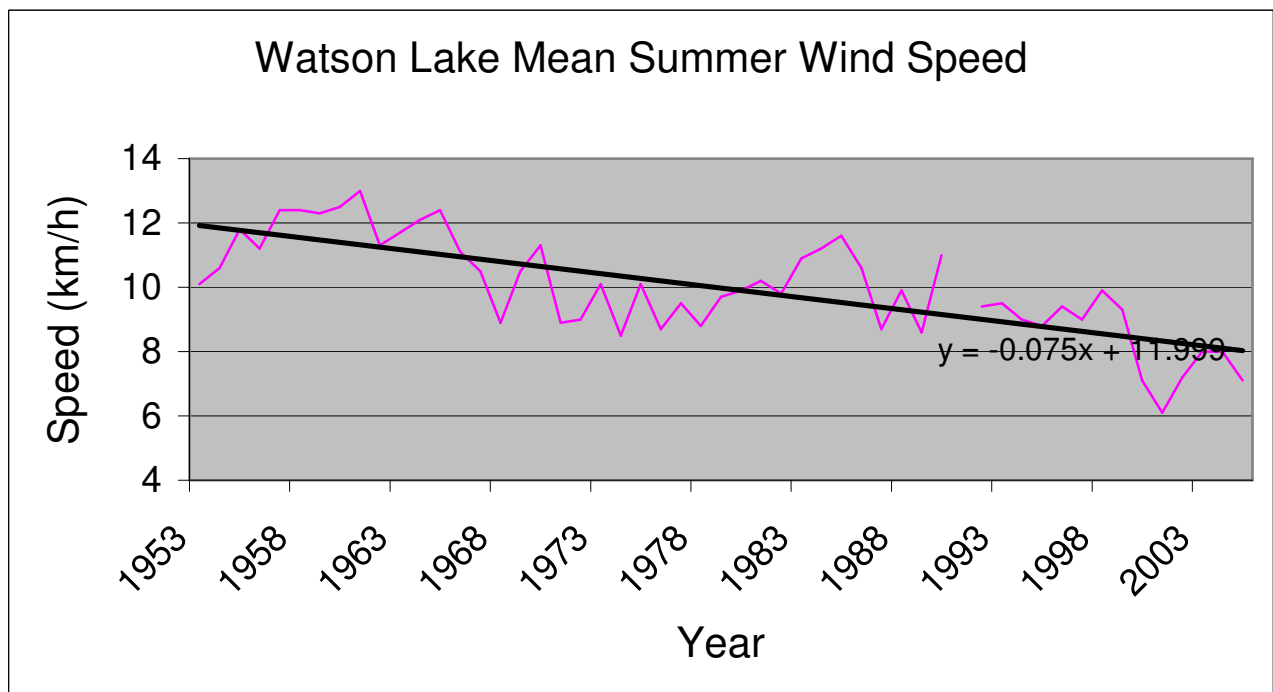


Figure 30. Watson Lake Mean Hourly Wind Speed in Summer.

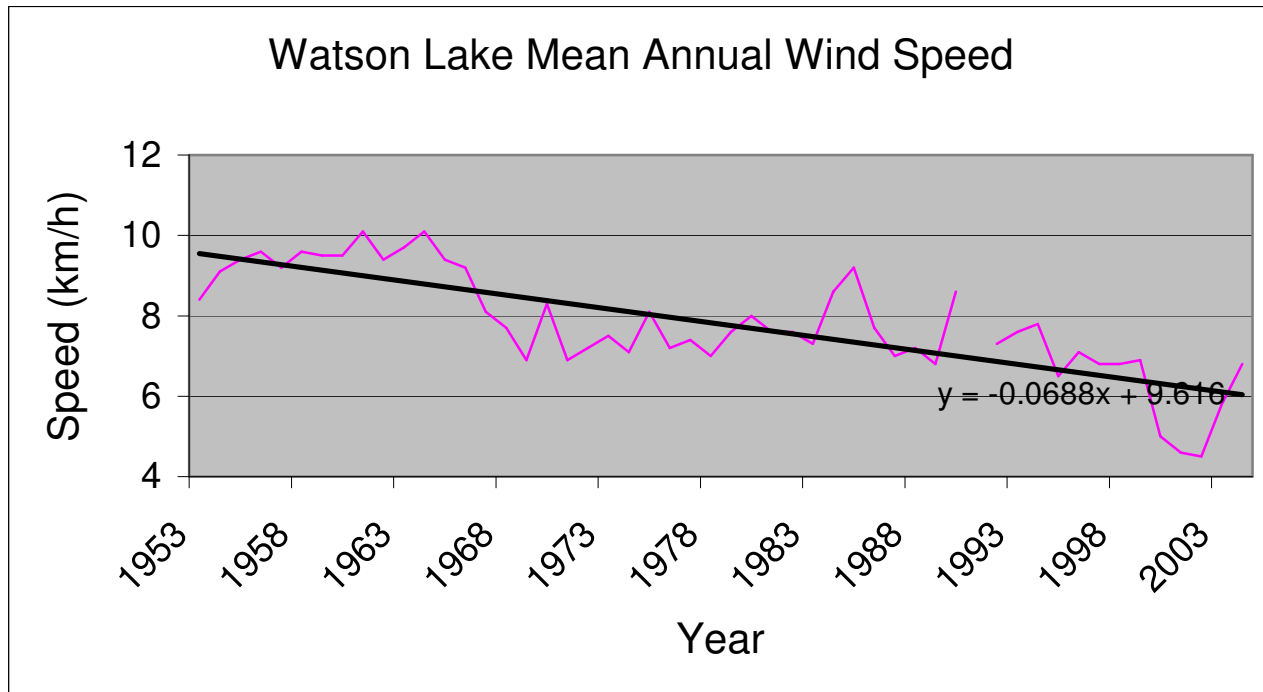


Figure 31. Watson Lake Mean Annual Hourly Wind Speed.

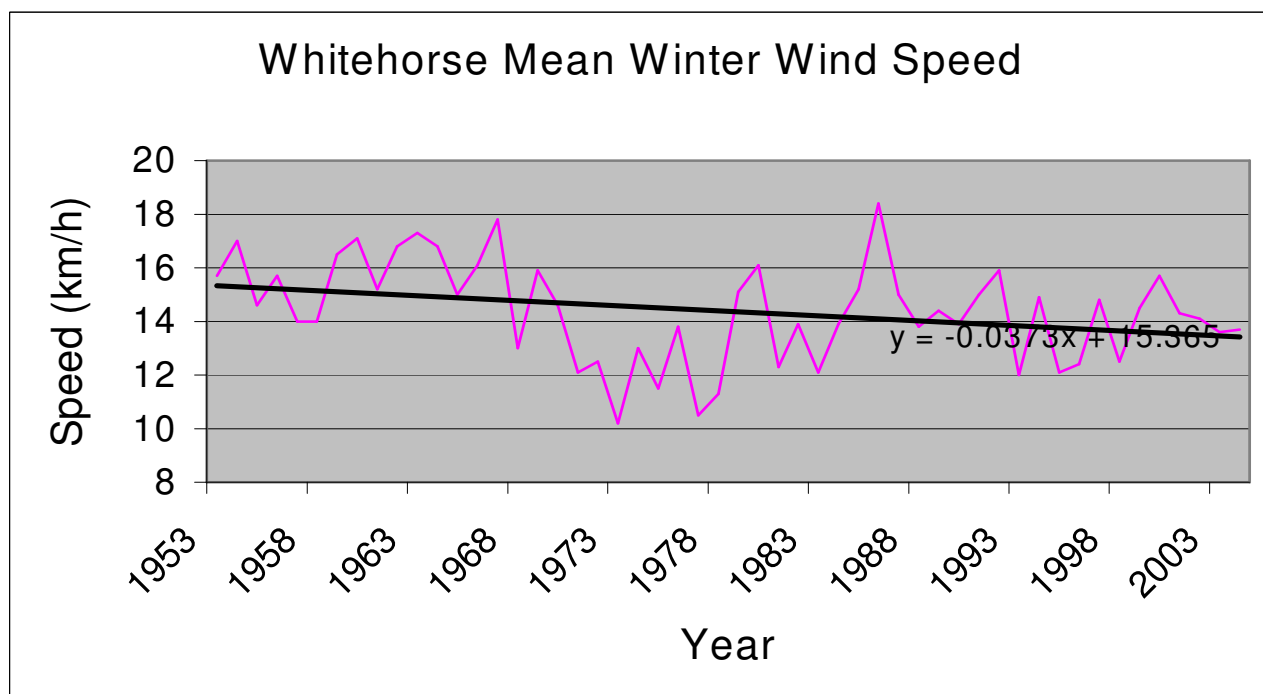


Figure 32. Whitehorse Mean Hourly Wind Speed in Winter.

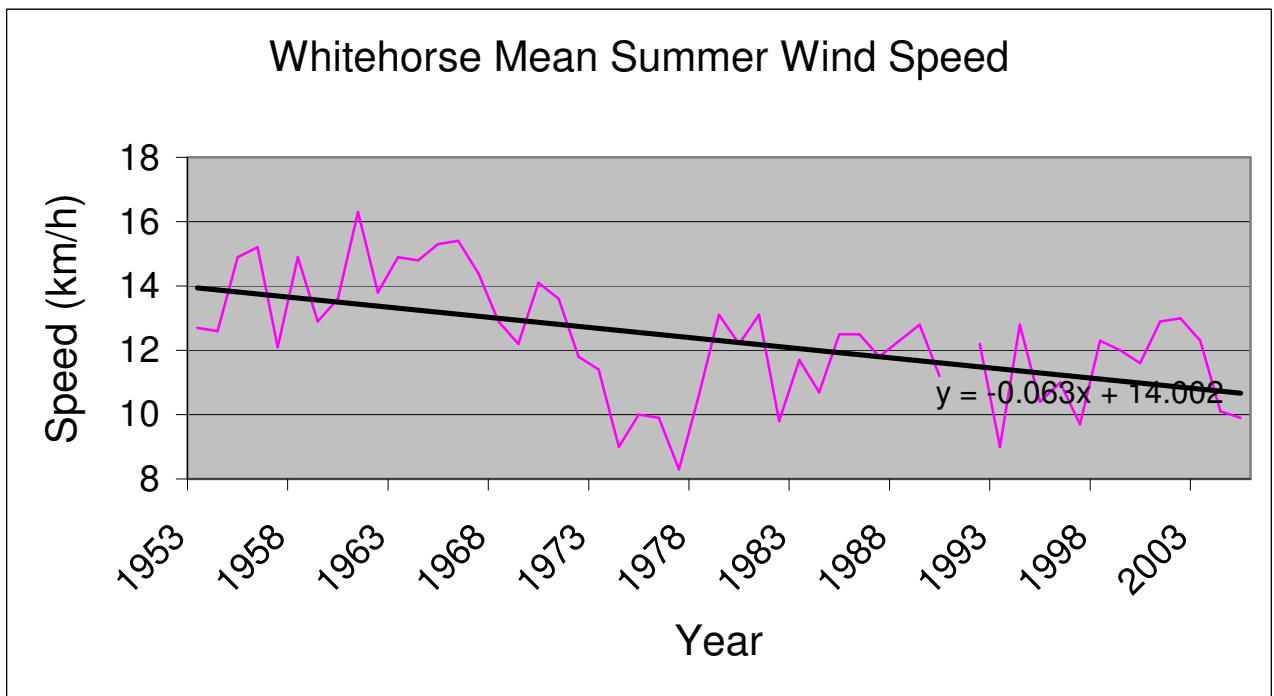
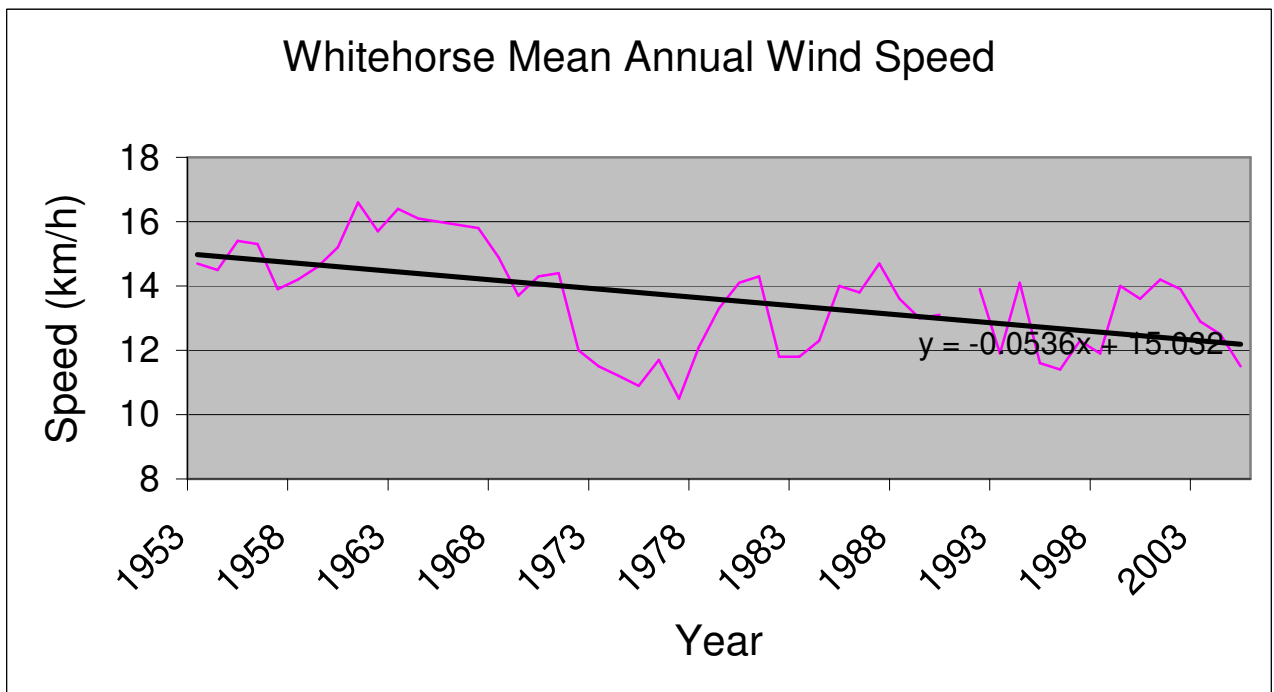


Figure 33. Whitehorse Mean Hourly Wind Speed in Summer.

Figure 34. Whitehorse Annual Mean Hourly Wind Speed.



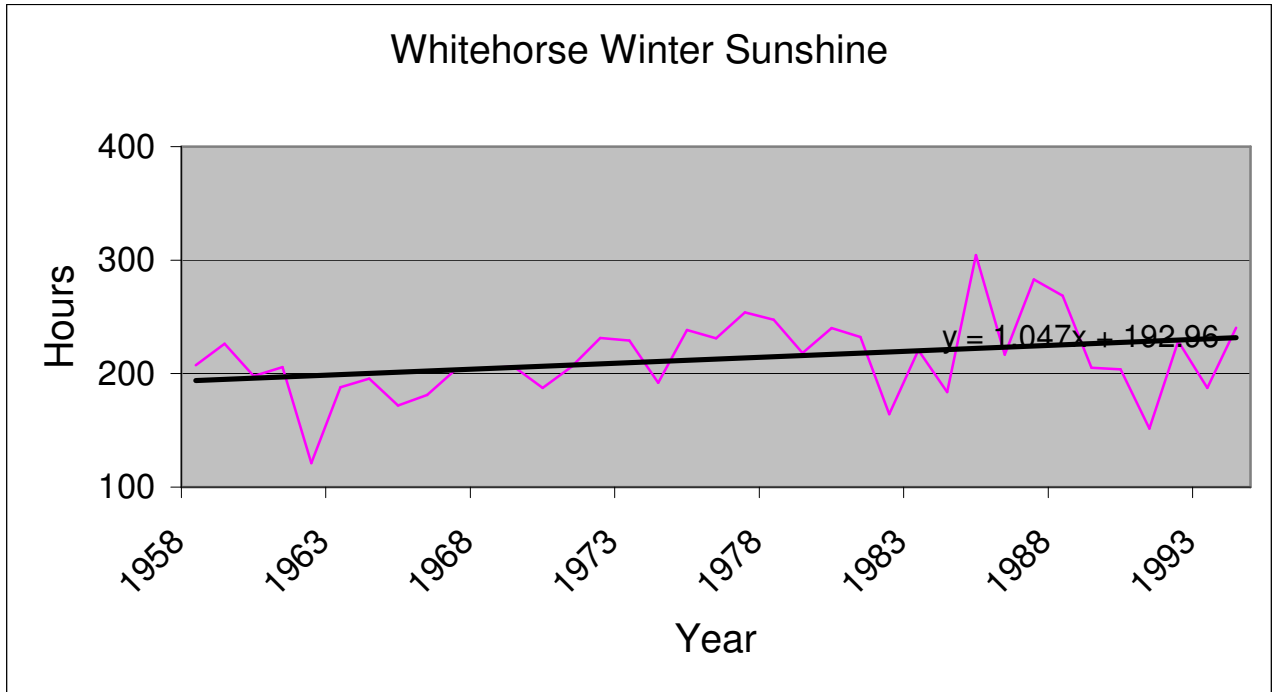


Figure 35. Whitehorse Total Winter Sunshine.

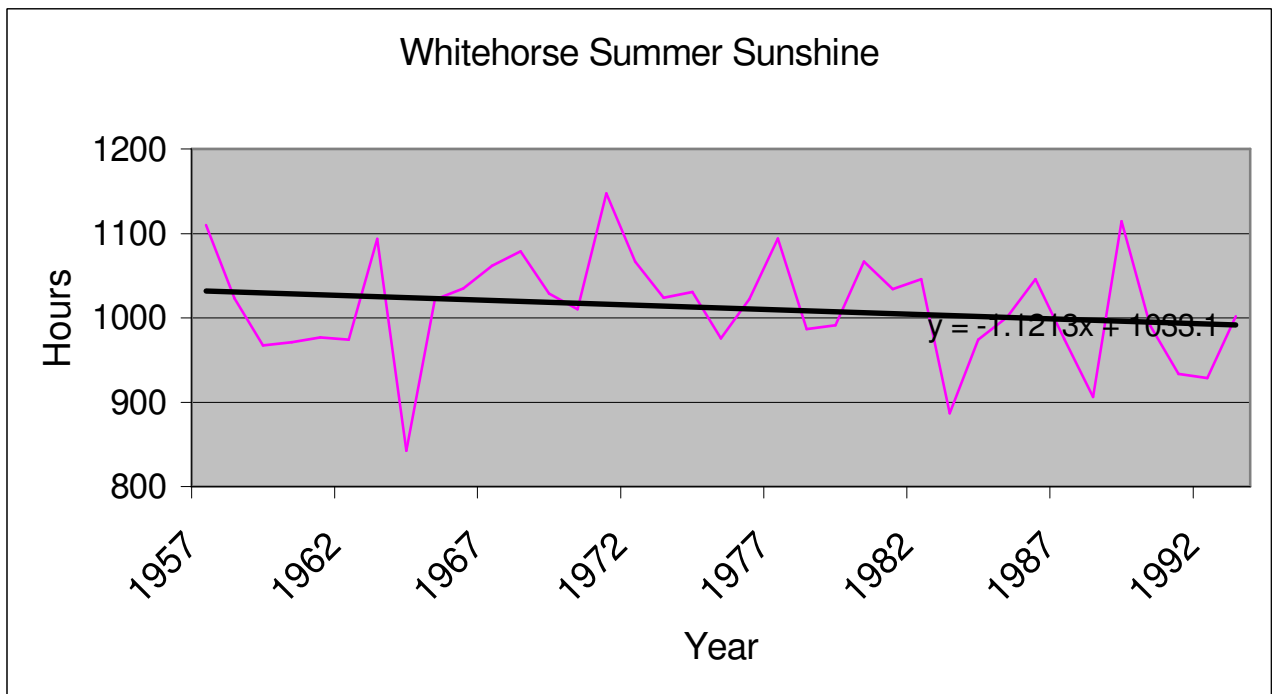


Figure 36. Whitehorse Total Summer Sunshine.

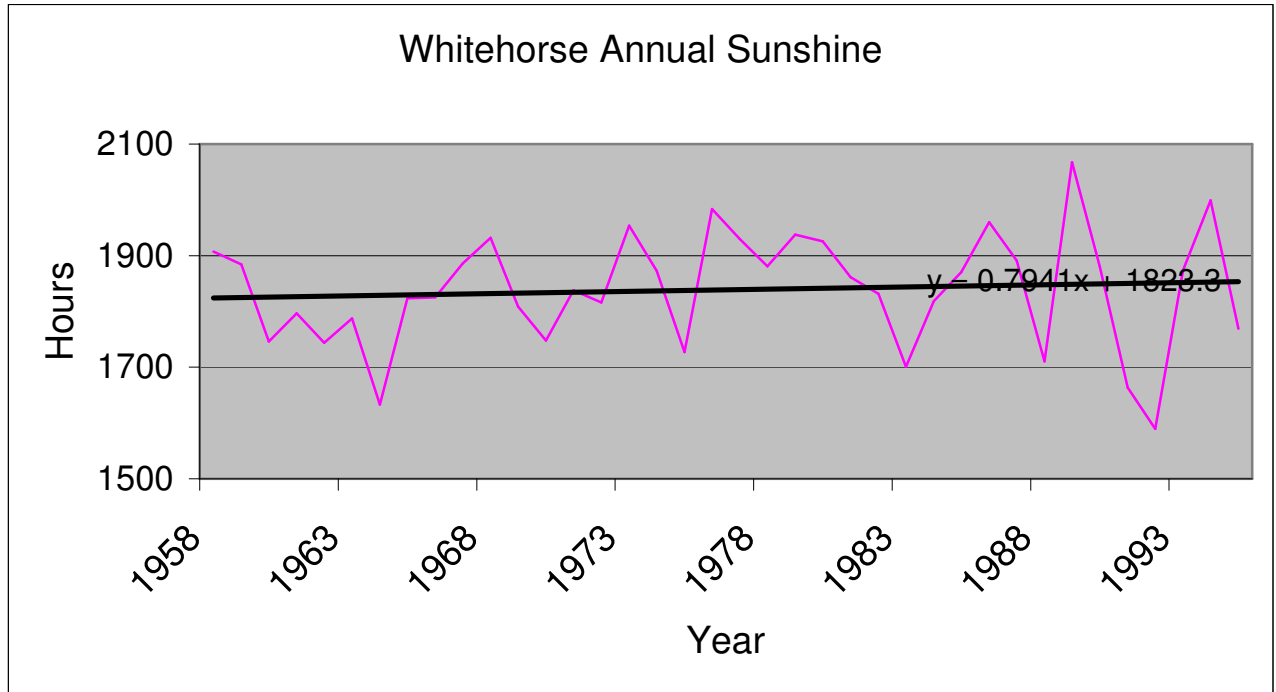


Figure 37. Whitehorse Total Annual Sunshine.

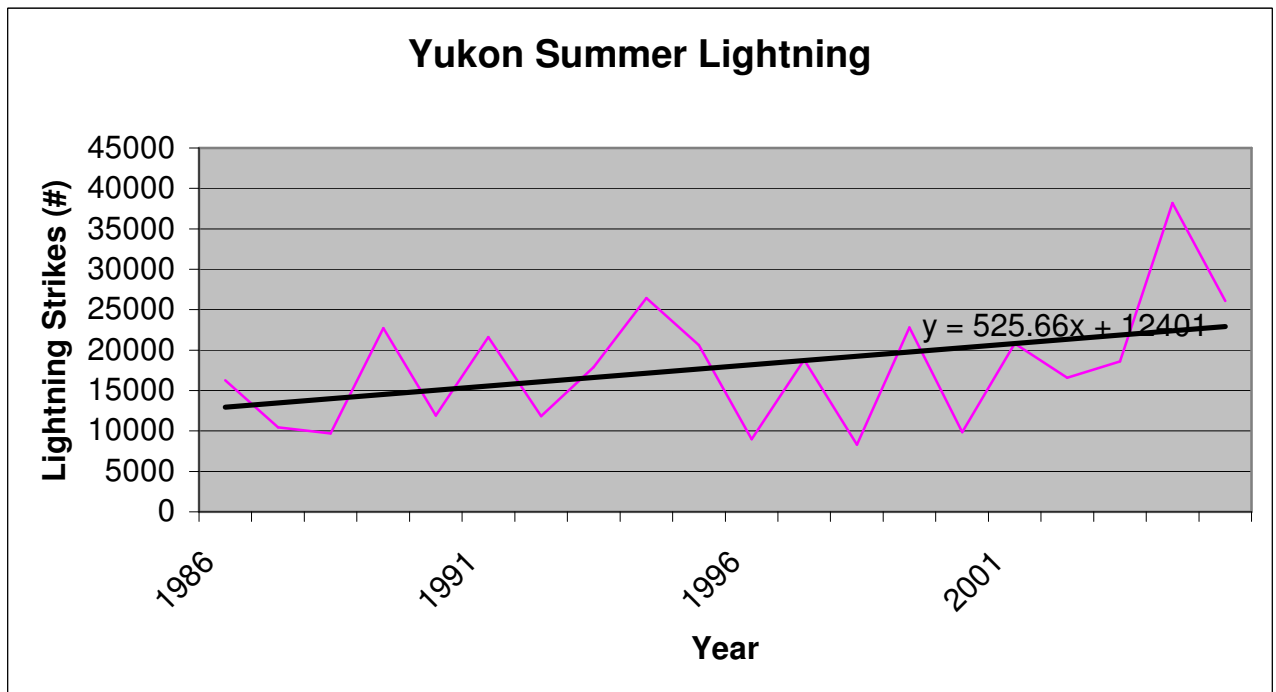


Figure 38. Yukon Summer Lightning

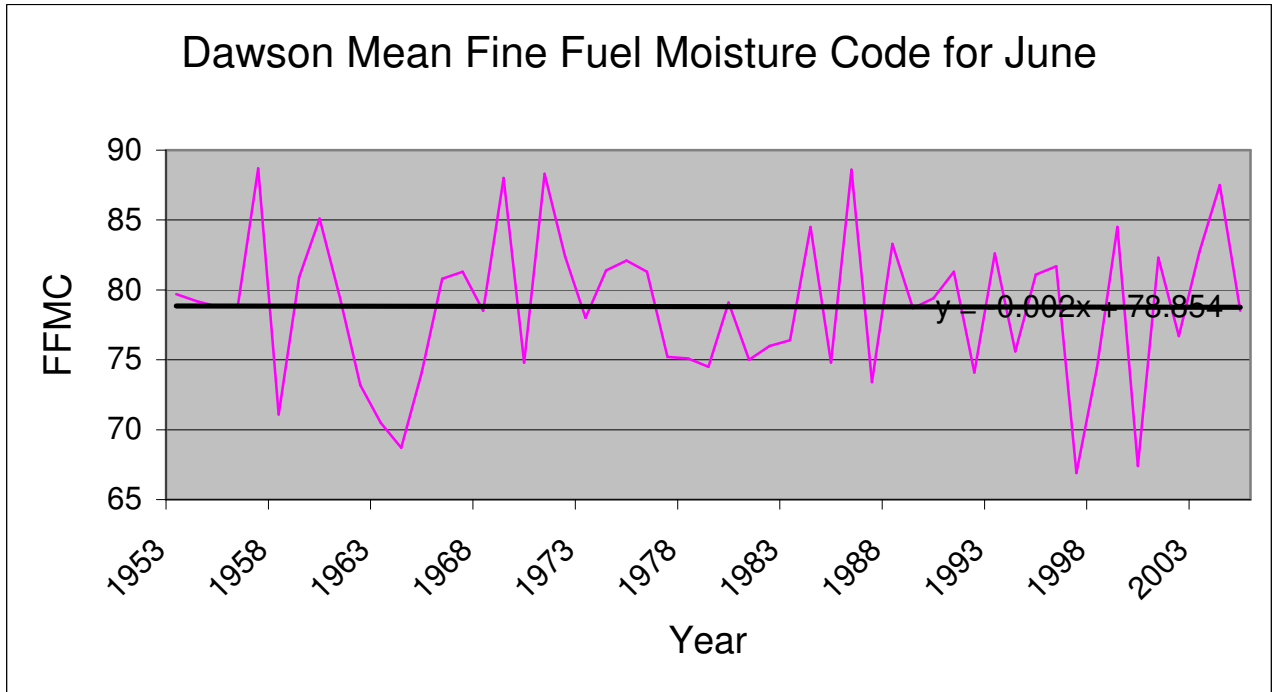


Figure 39. Dawson Mean Fine Fuel Moisture Code for June.

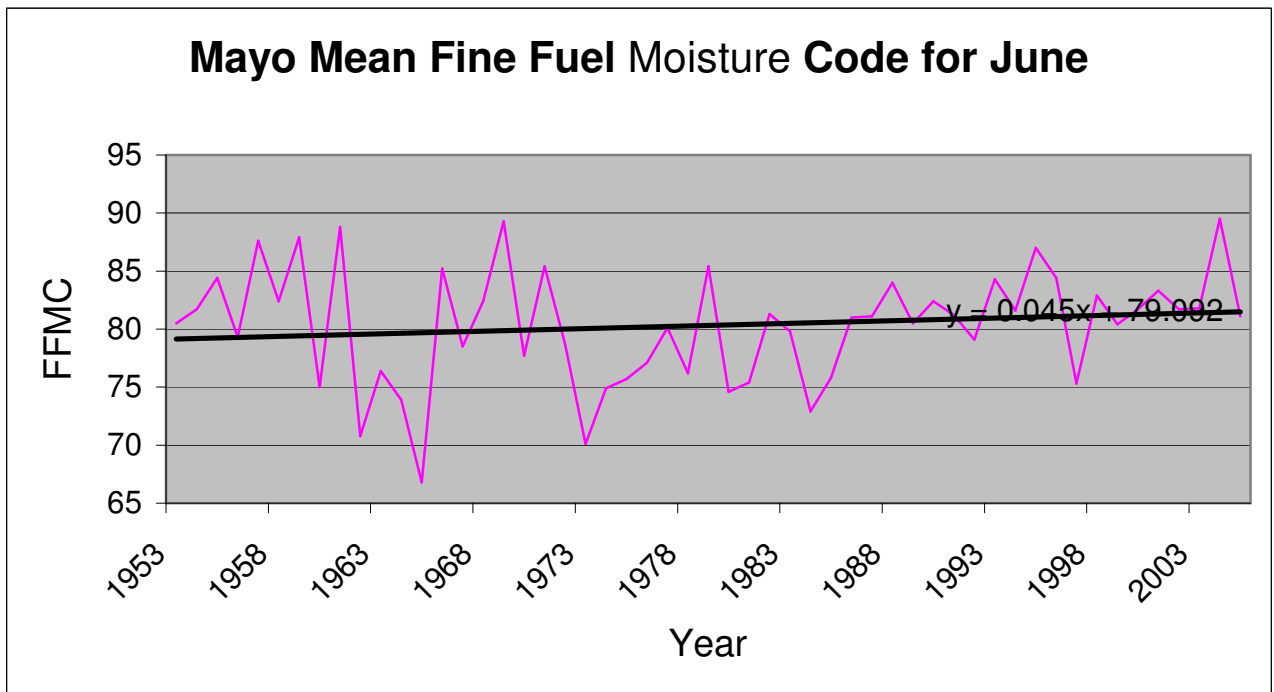


Figure 40. Mayo Mean Fine Fuel Moisture Code for June.

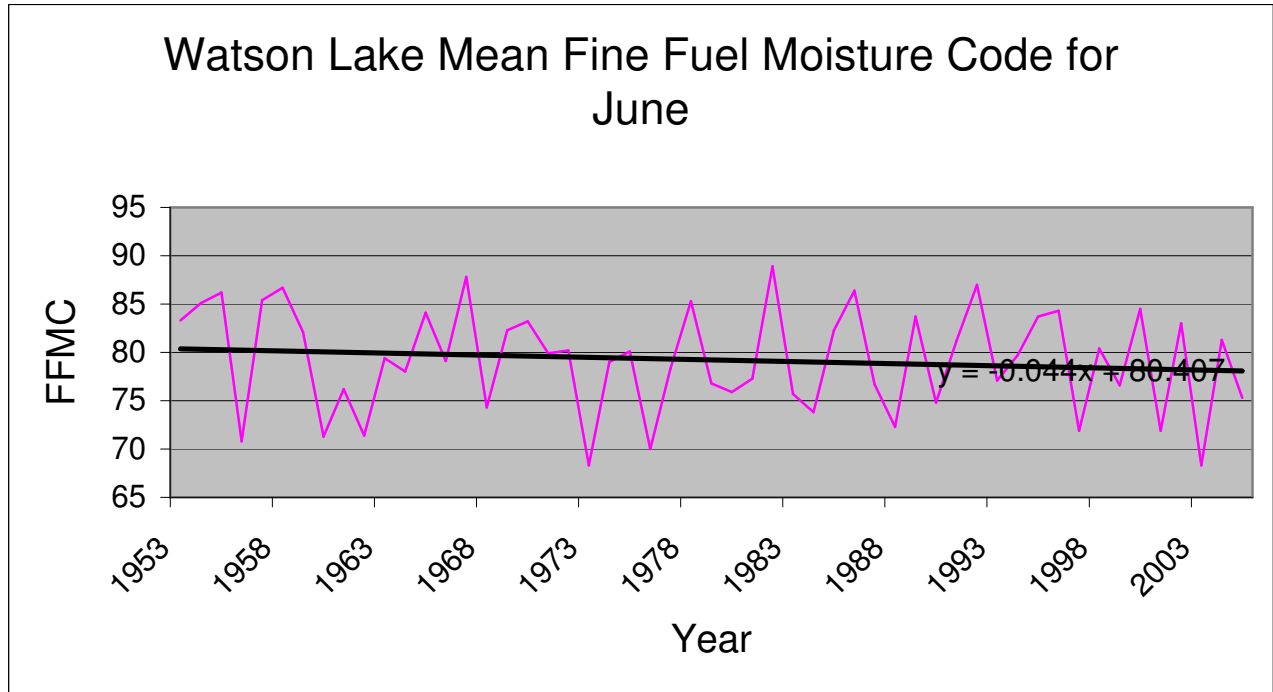


Figure 41. Watson Lake Mean Fine Fuel Moisture Code for June.

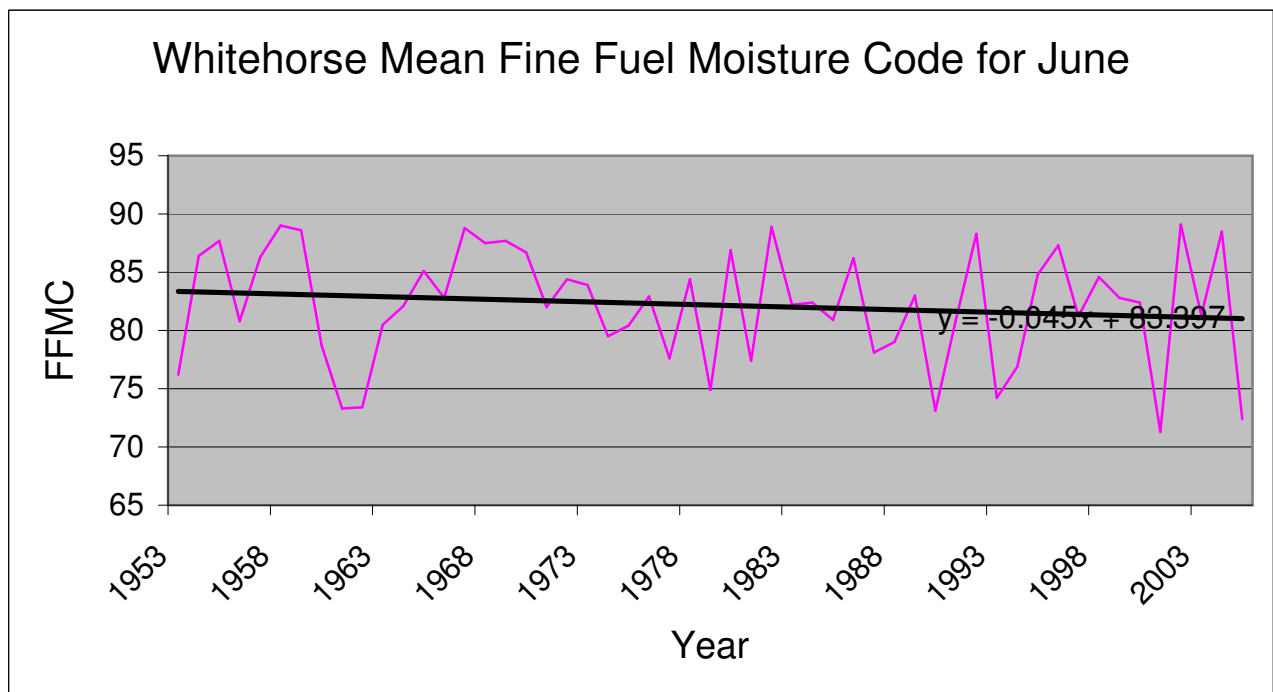


Figure 42. Whitehorse Mean Fine Fuel Moisture Code for June.

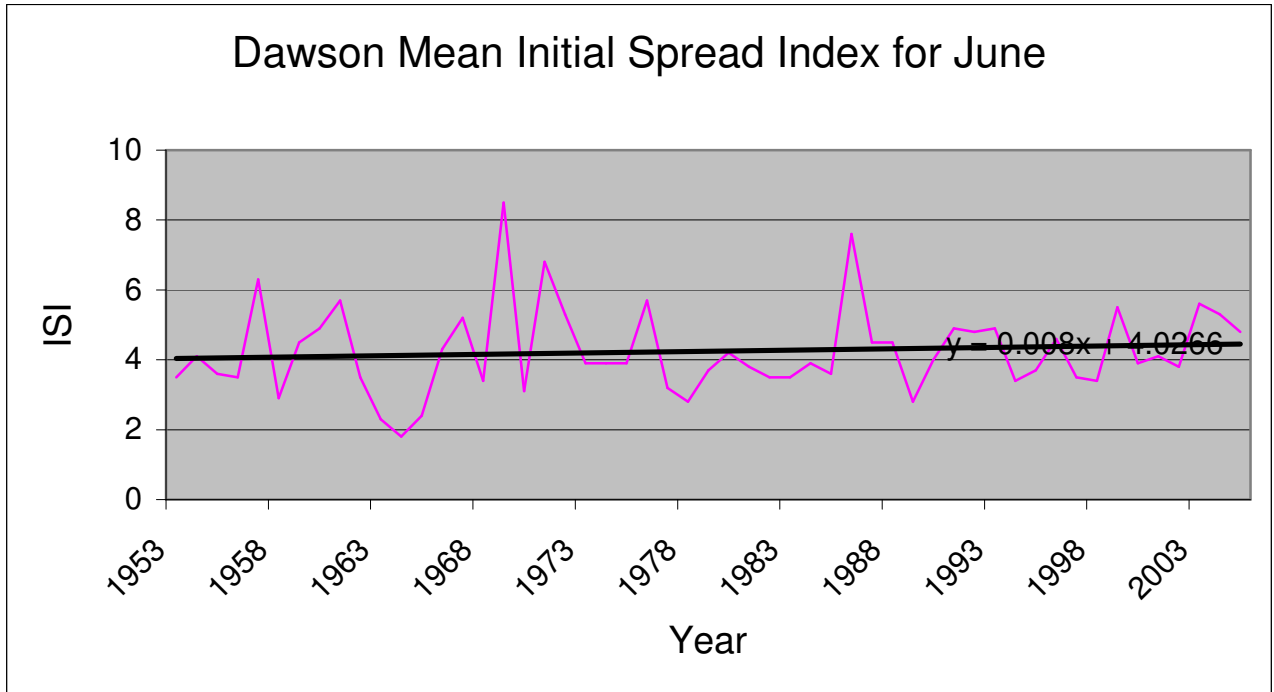


Figure 43. Dawson Mean Initial Spread Index for June.

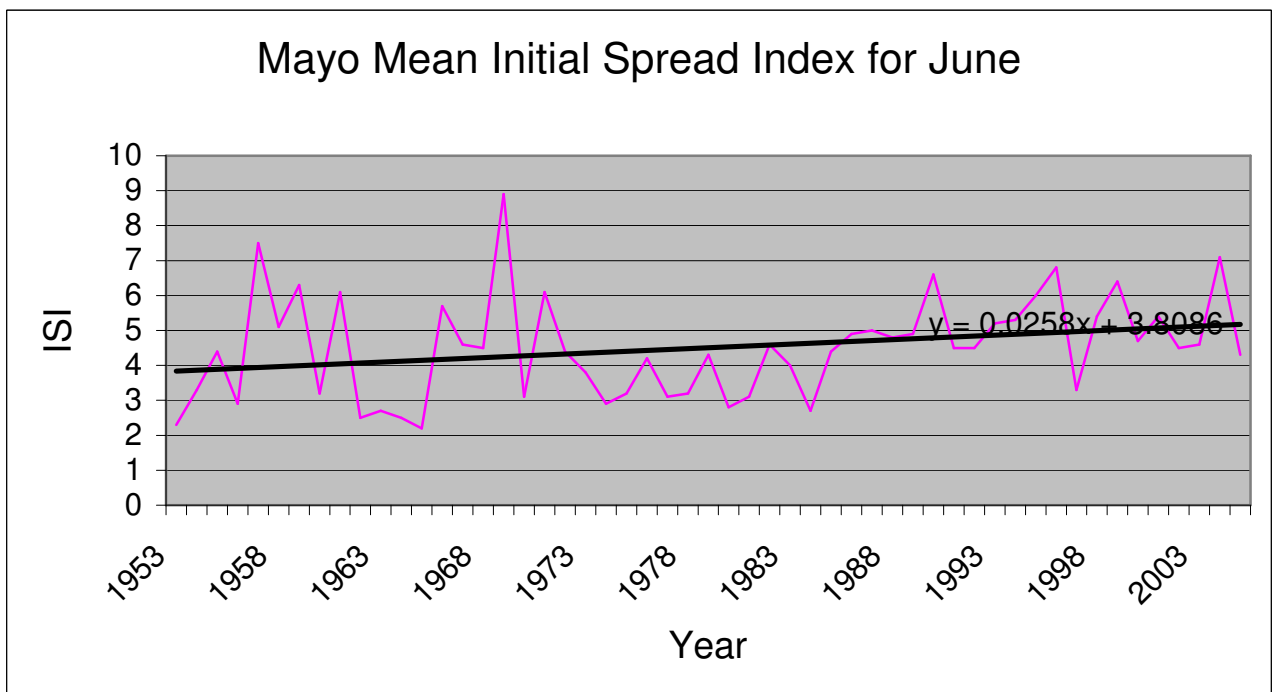


Figure 44. Mayo Mean Initial Spread Index for June.

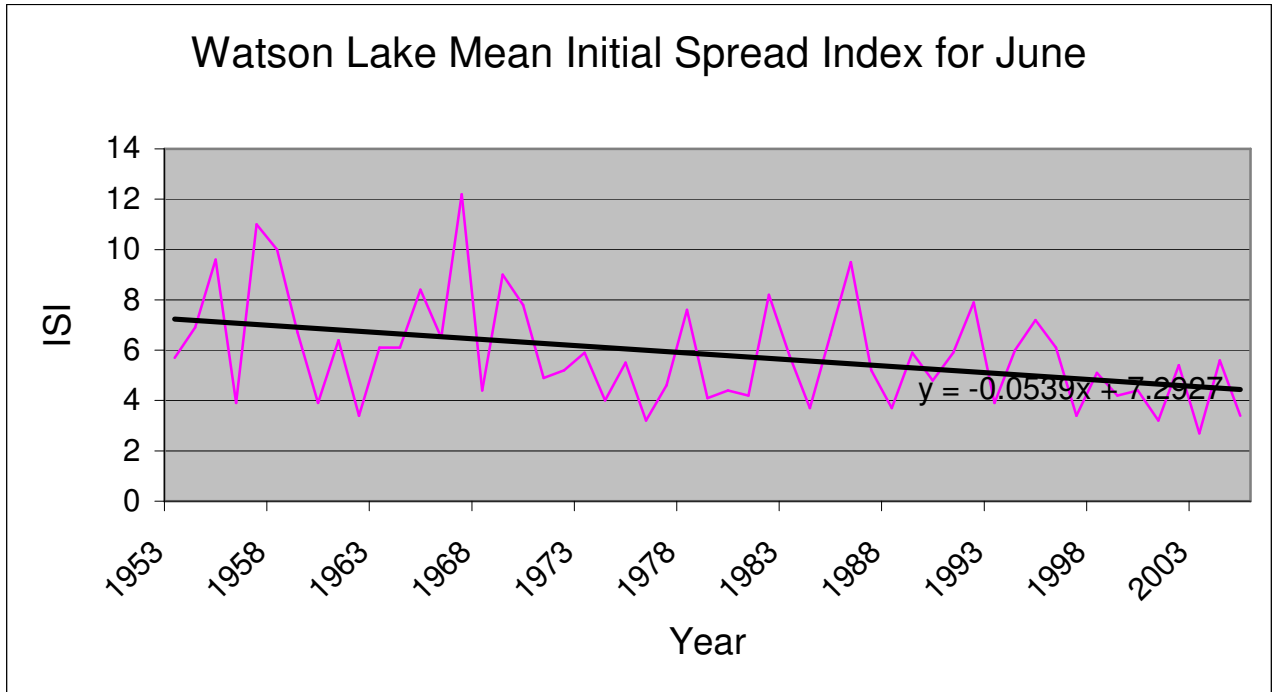


Figure 45. Watson Lake Mean Initial Spread Index for June.

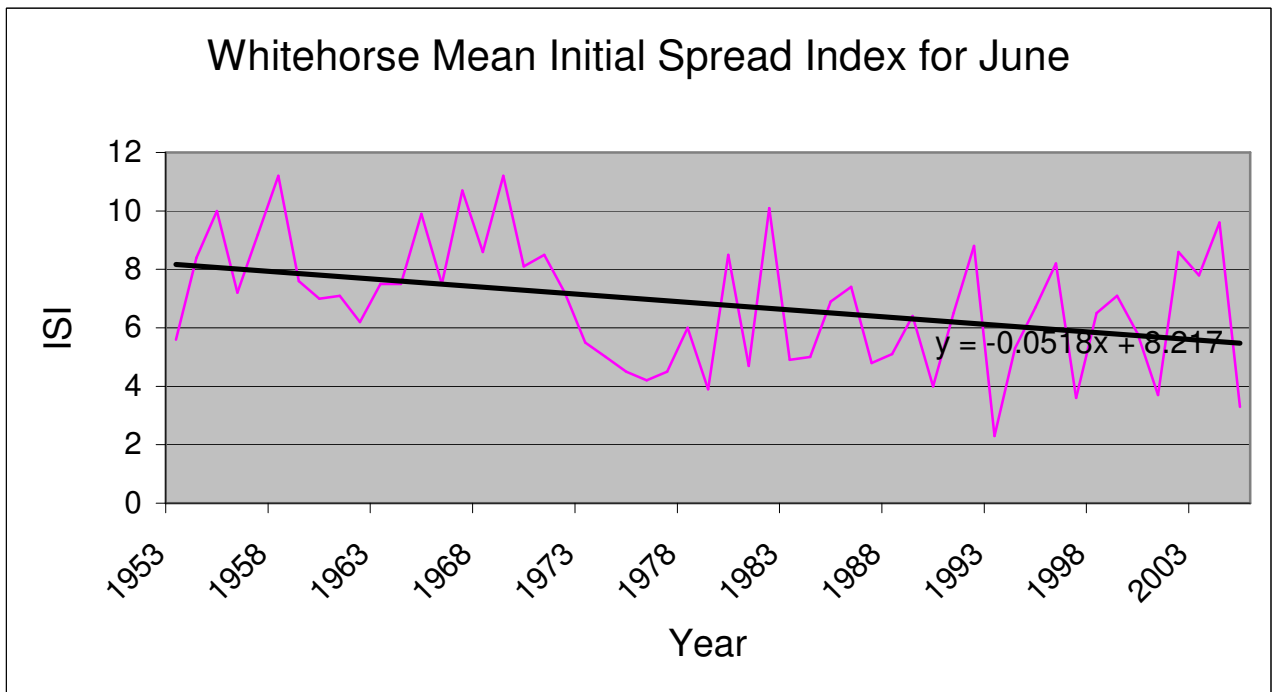


Figure 46. Whitehorse Mean Initial Spread Index for June.

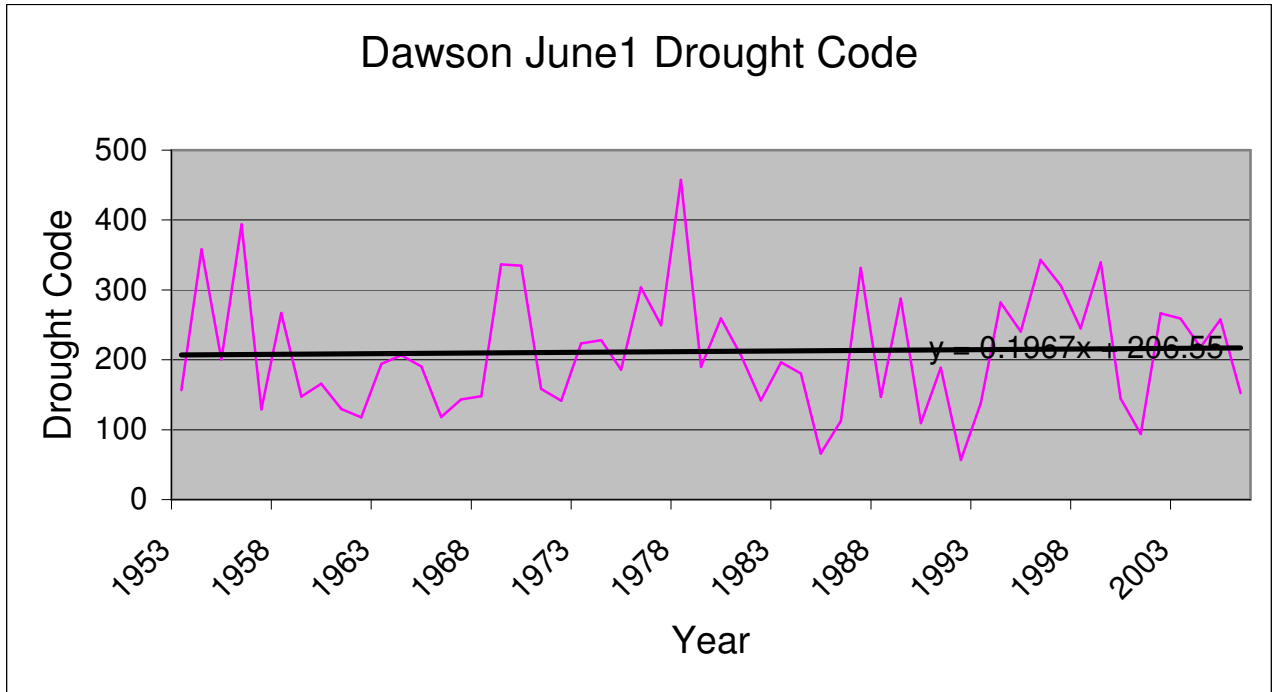


Figure 47. Dawson Drought Code for June 1.

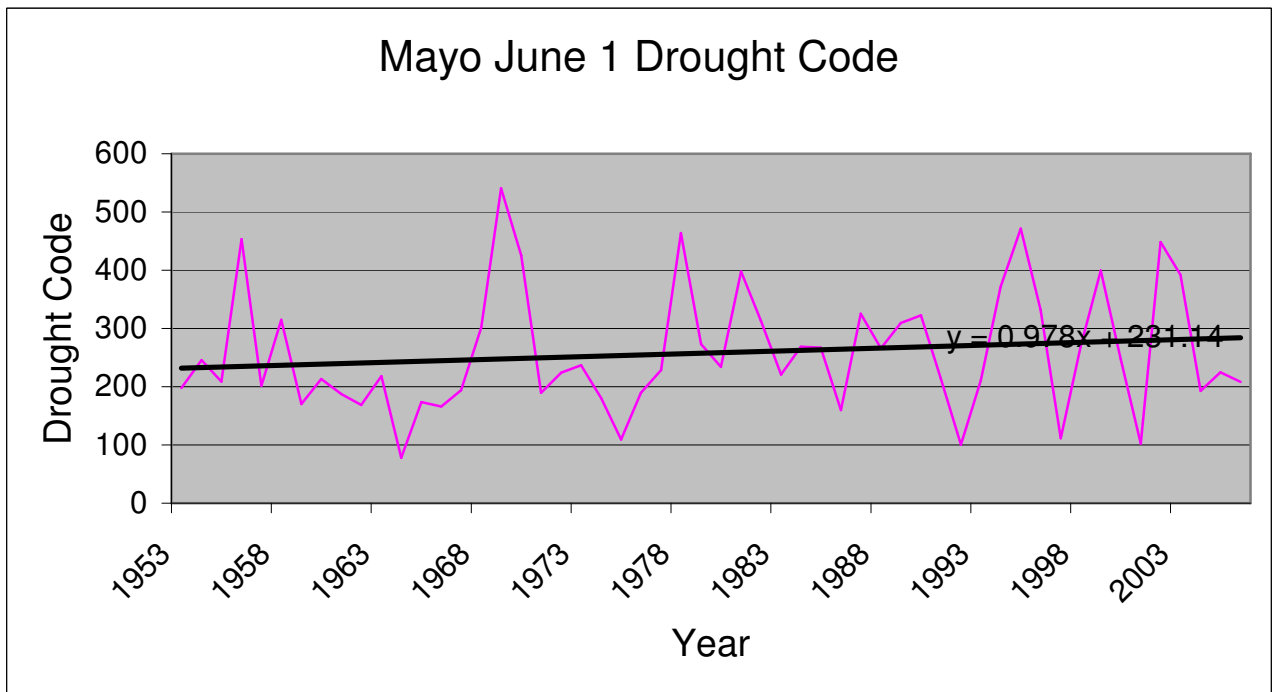


Figure 48. Mayo Drought Code for June 1.

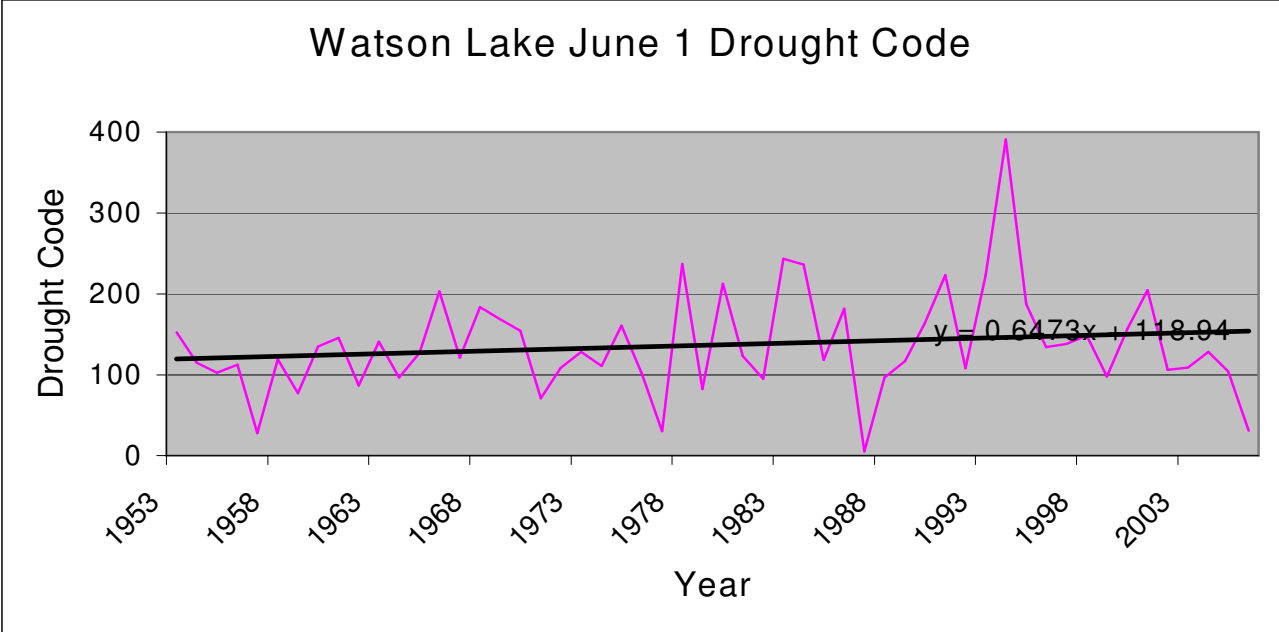


Figure 49. Watson Lake Drought Code for June 1.

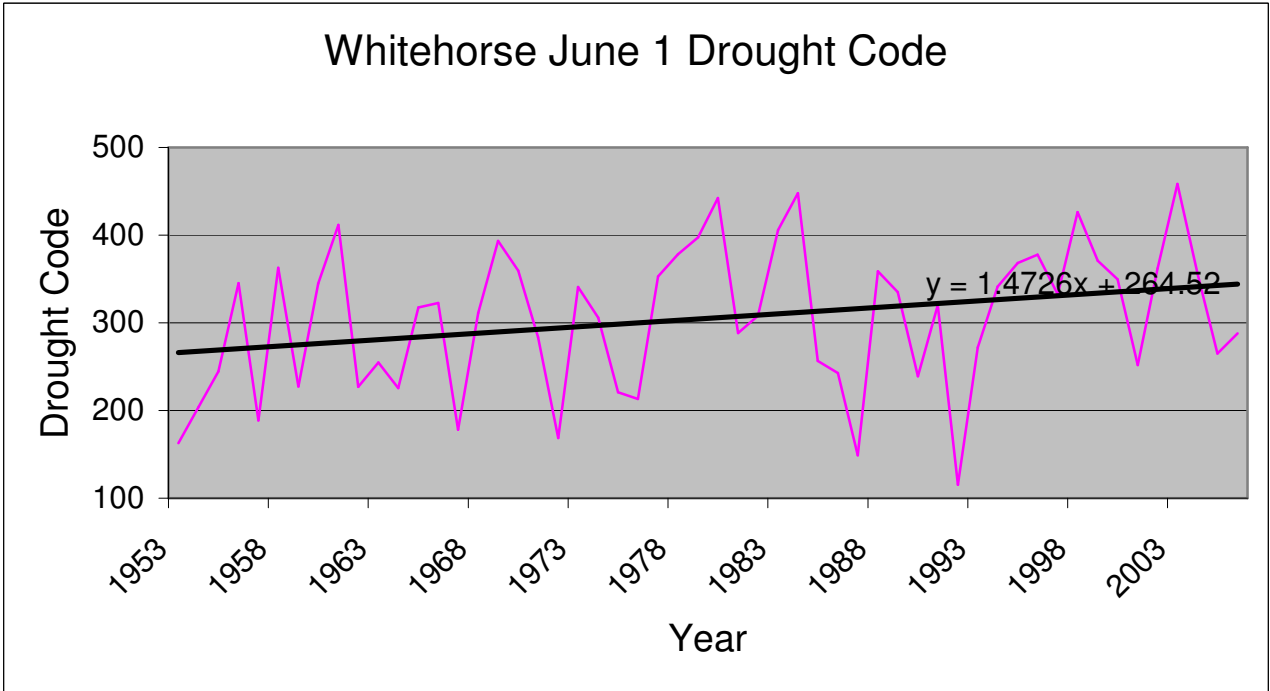


Figure 50. Whitehorse Drought Code for June 1.

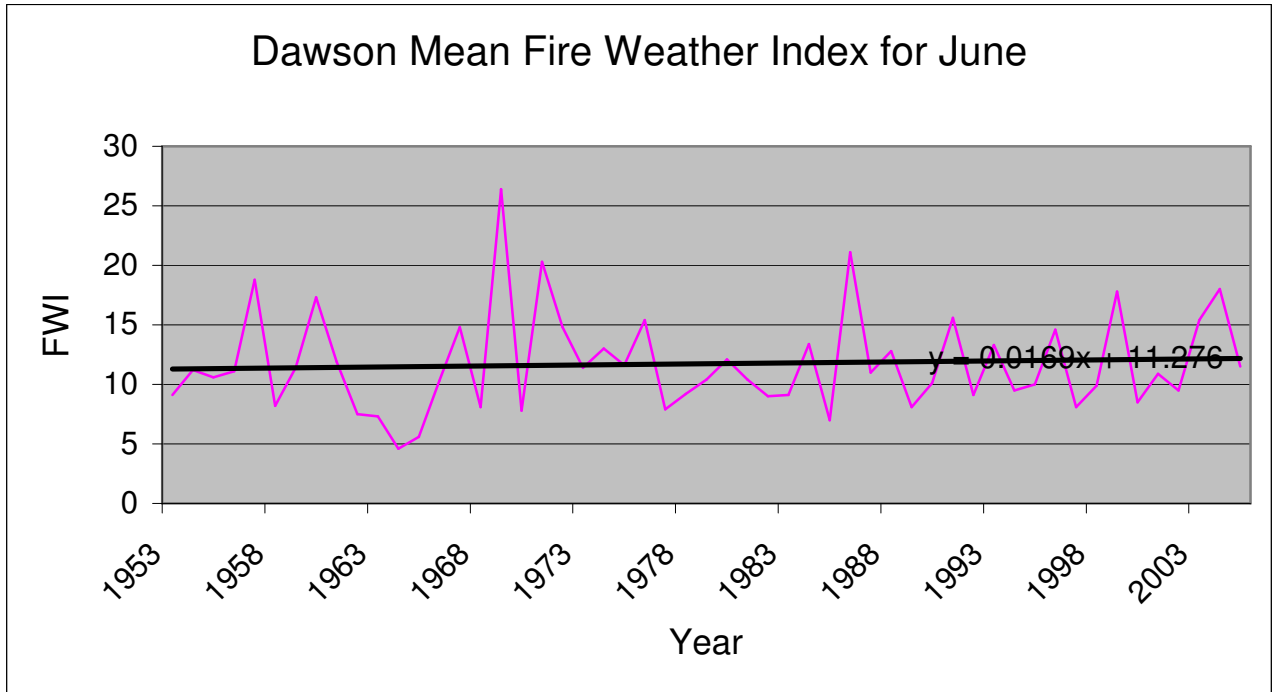


Figure 51. Dawson Mean Fire Weather Index for June.

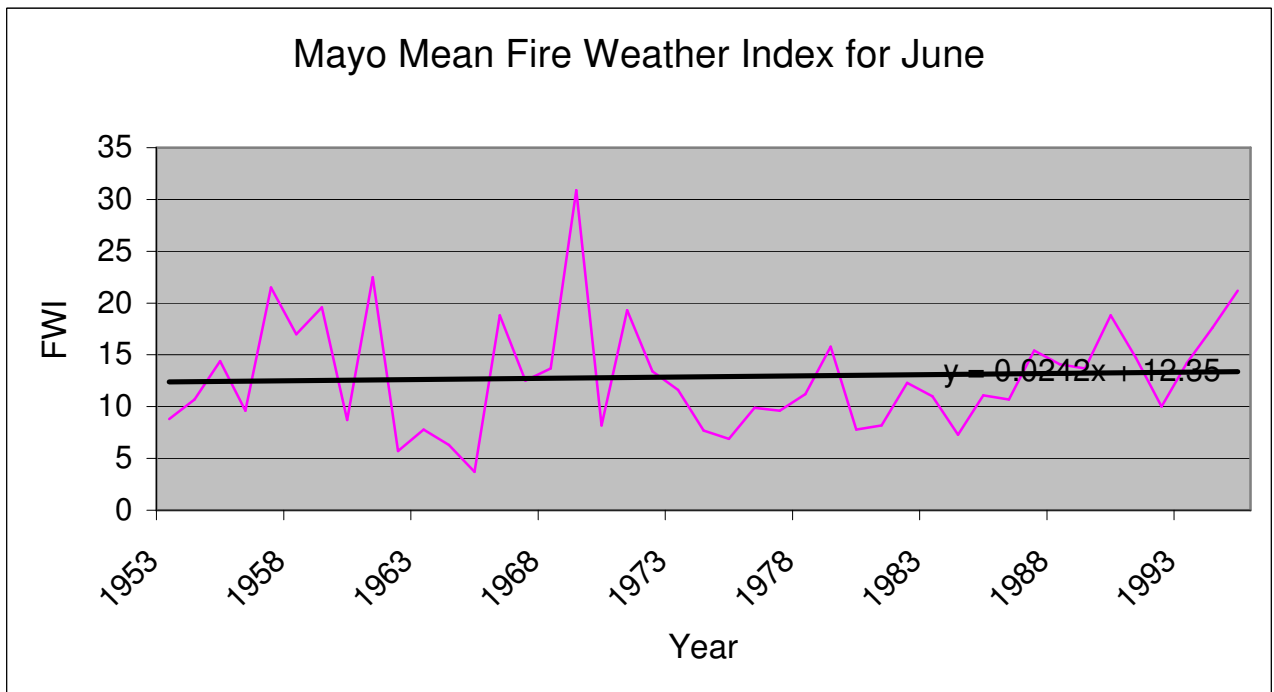


Figure 52. Mayo Mean Fire Weather Index for June.

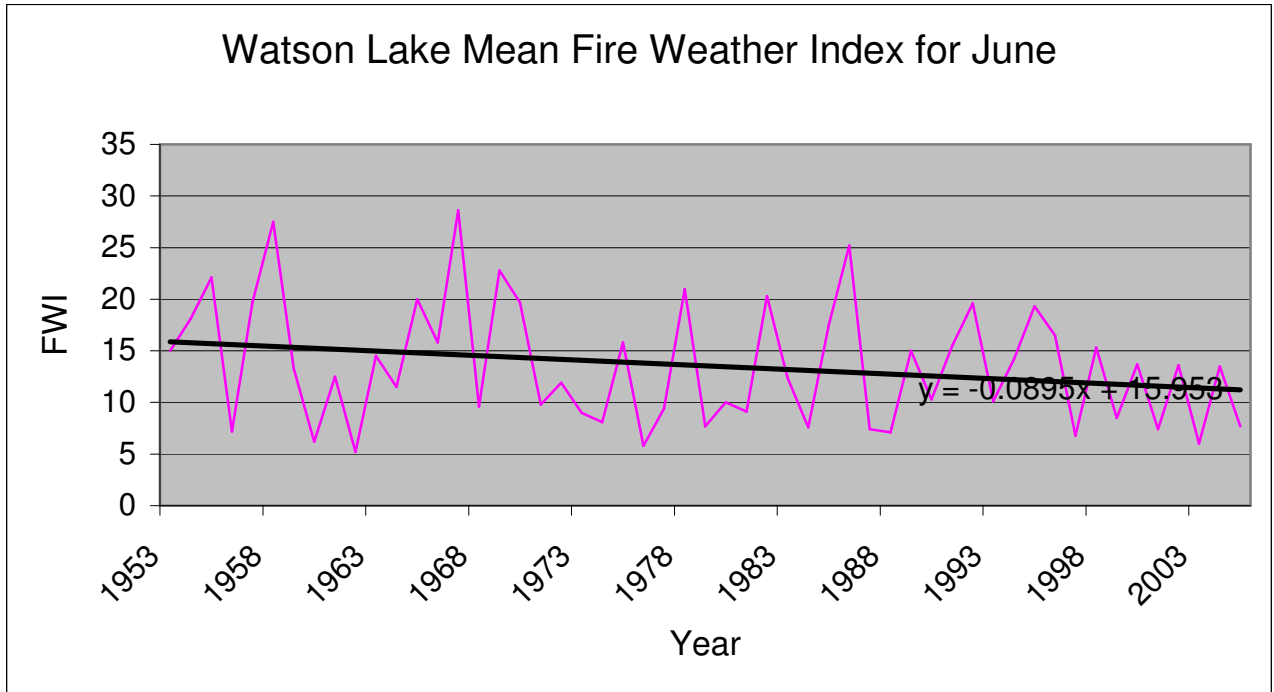


Figure 53. Watson Lake Mean Fire Weather Index for June.

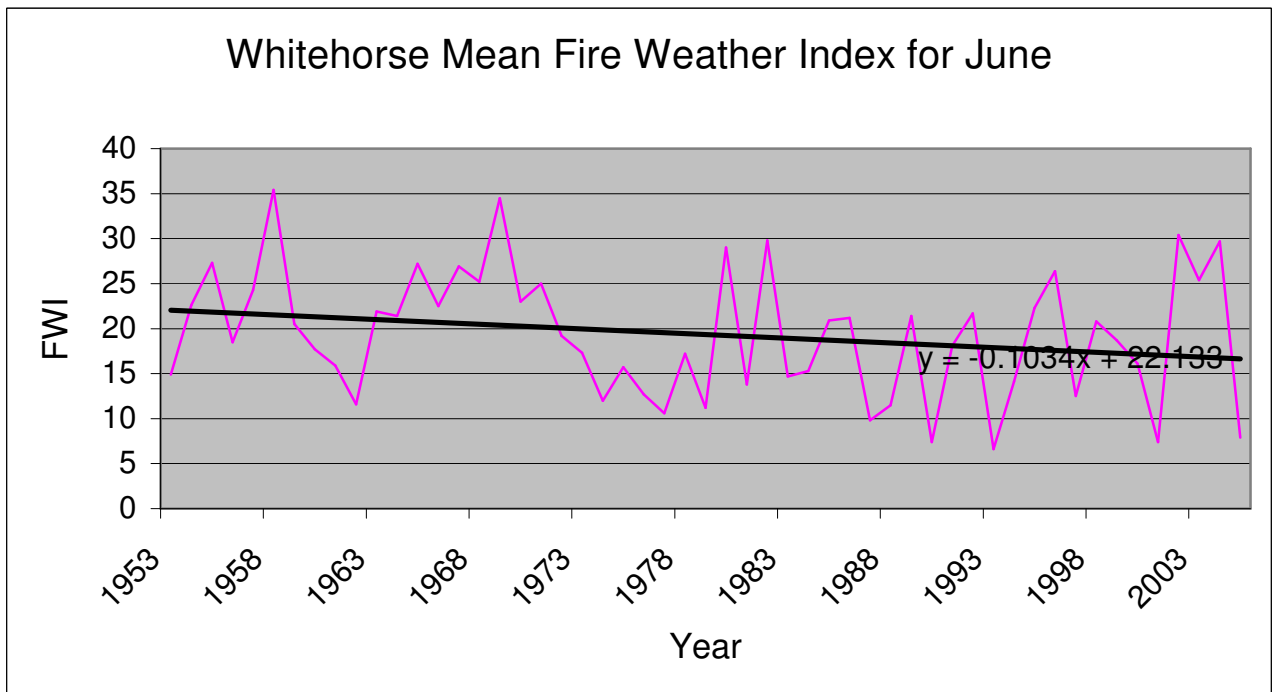


Figure 54. Whitehorse Mean Fire Weather Index for June.

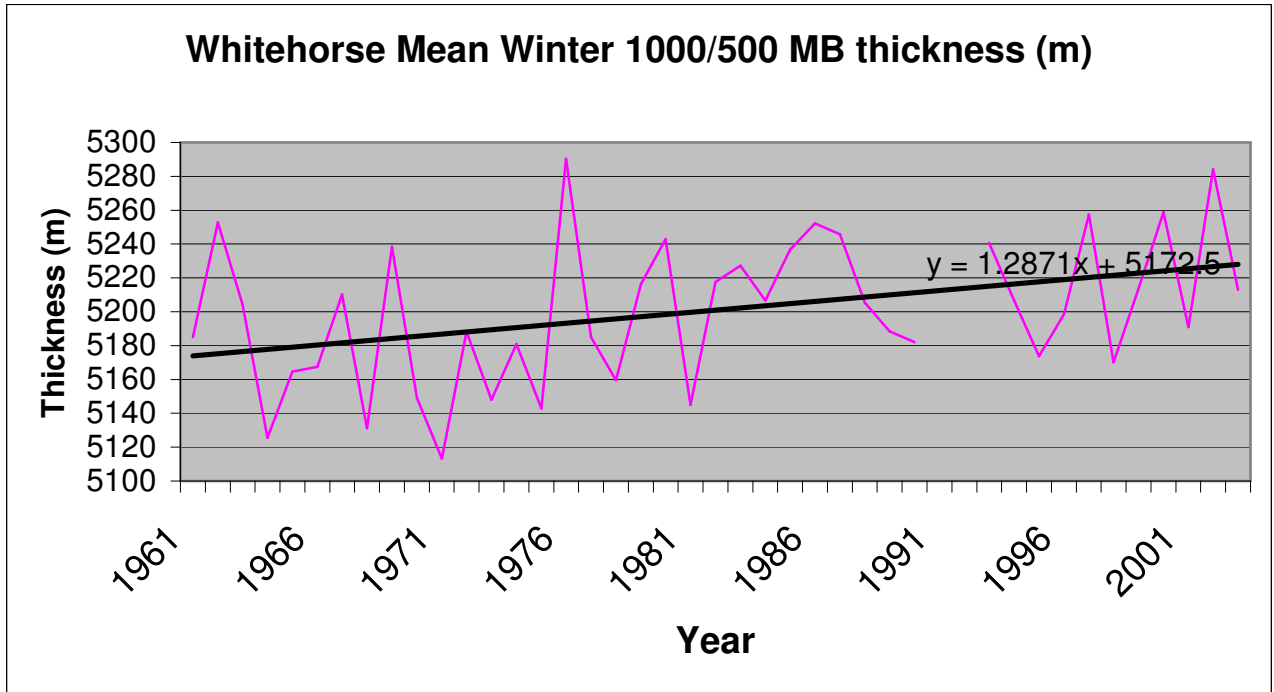


Figure 55. Whitehorse Mean Winter 1000/500 MB Thickness.

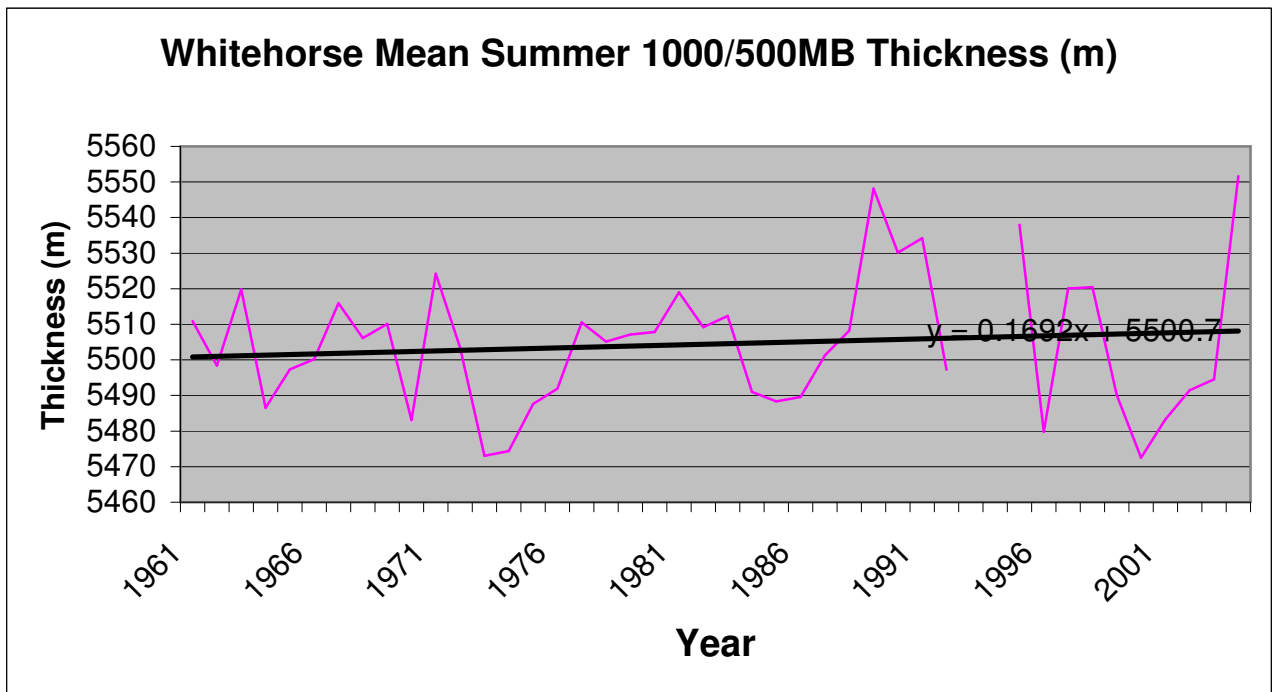


Figure 56. Whitehorse Mean Summer 1000/500 MB Thickness

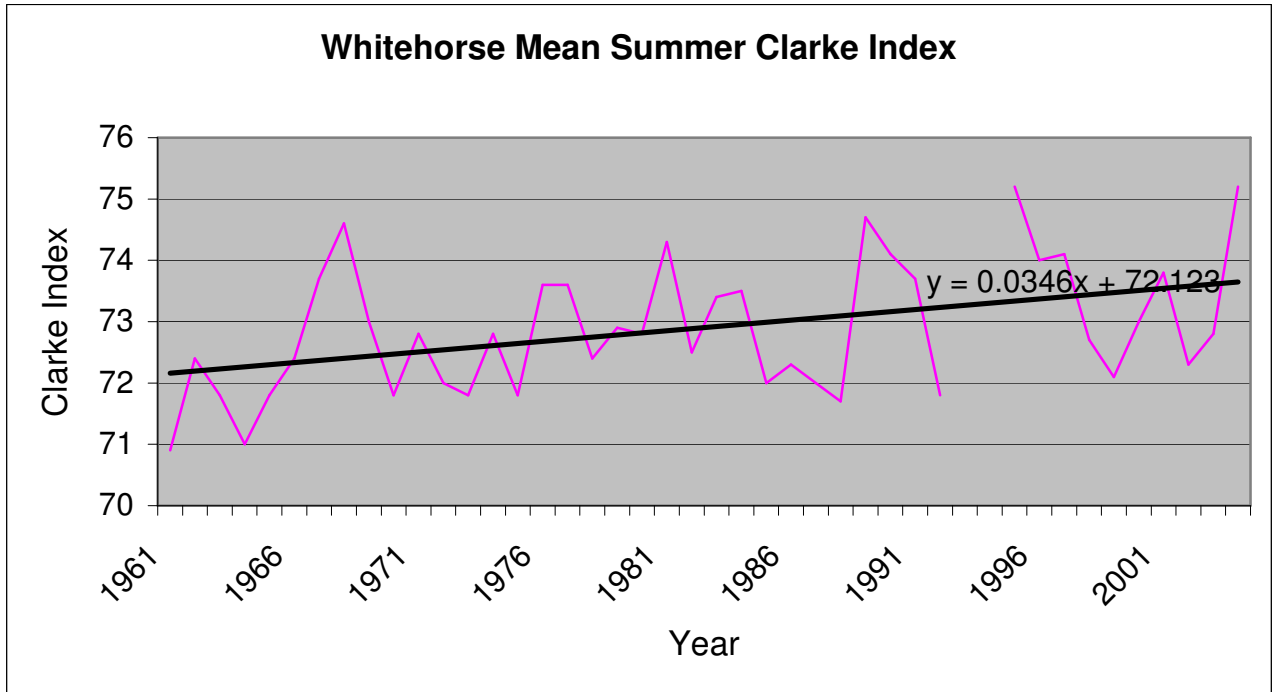


Figure 57. Whitehorse Mean Summer Clarke Index

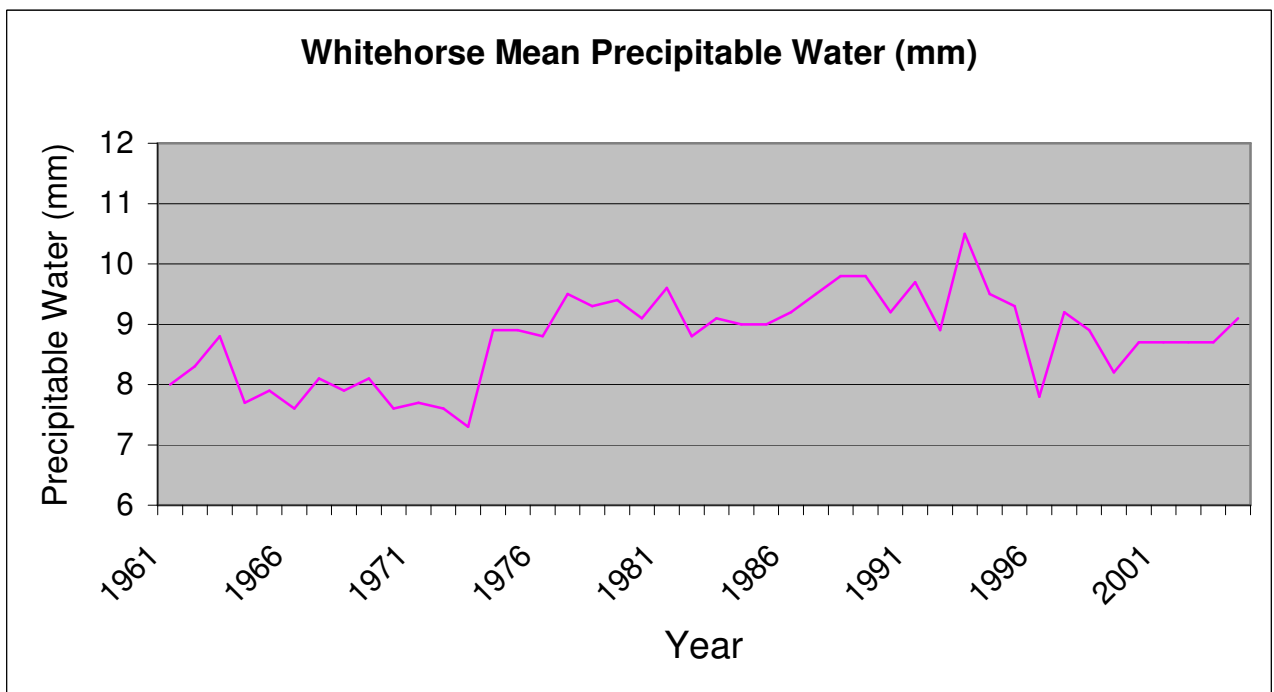


Figure 58. Whitehorse Mean Precipitable Water

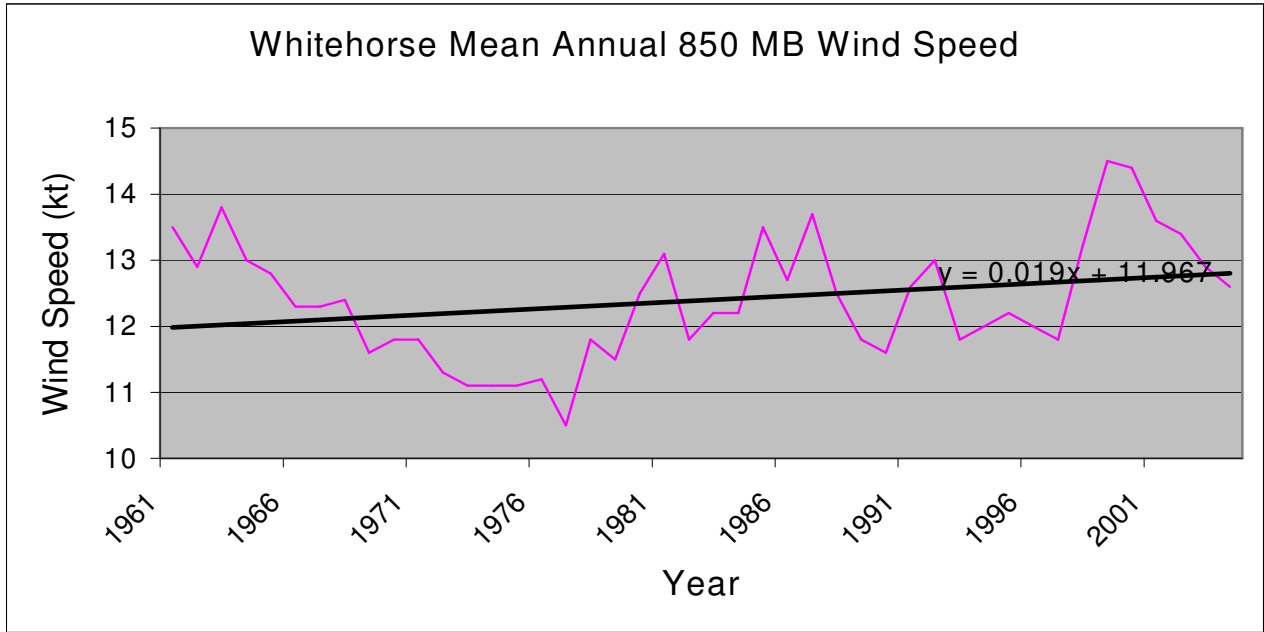


Figure 59. Whitehorse Mean Annual 850 Mb Wind Speed.

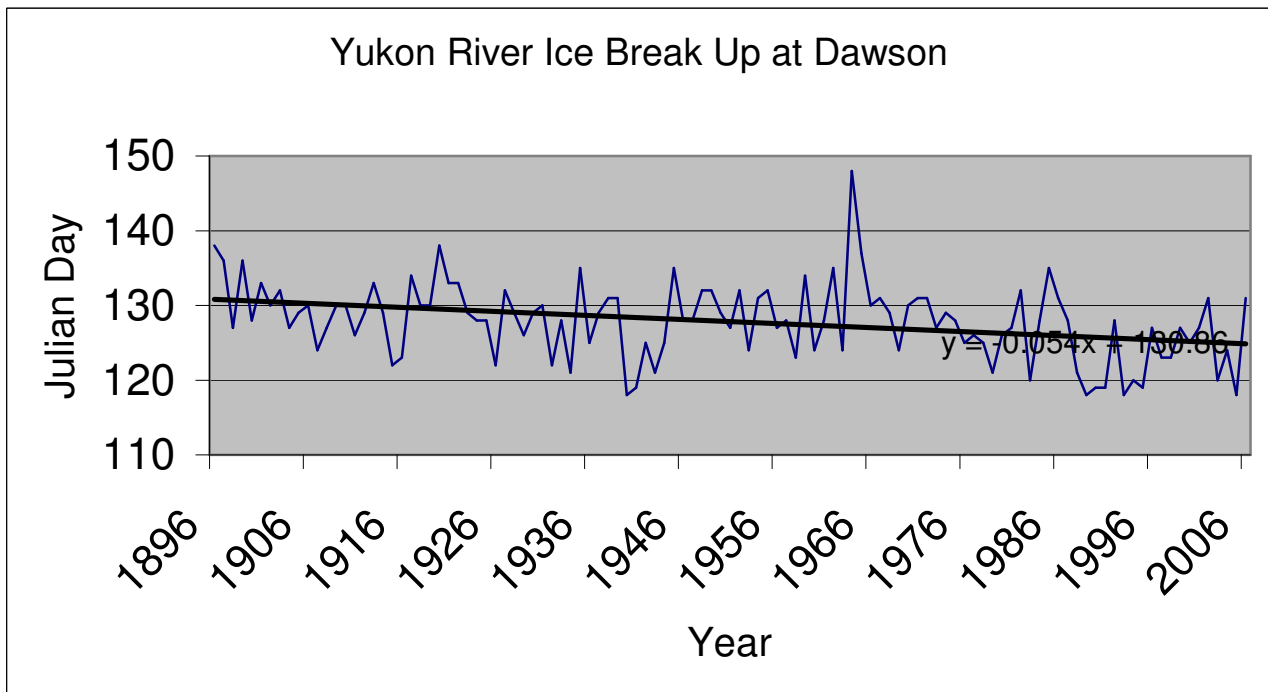


Figure 60. Date of Yukon River Break Up at Dawson.

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STATION CATALOGUE		PROV.	LAT.	LONG.	ELEV.	NAME (S=SUMMER W=WINTER)	START YR-MO	END YR-MO	SNOW SURVEY	EVAPORATION	PRECIPITATION	TEMPERATURE	HOURLY	SYNOPTIC	PERIOD WITH NO CHANGE	IN PROGRAM LOCATION OR	CLIMATE STATION NAME
2100400	DAWSON	YT	64 04	139 26			1897-07-01	1897-12-01									
2100400	DAWSON	YT	64 04	139 26			1898-11-01	1899-02-01									
2100400	DAWSON	YT	64 04	139 26			1900-10-01	1901-08-01									
2100400	DAWSON	YT	64 04	139 26			1901-08-01	1937-04-01	X	D	@	@					
2100400	DAWSON	YT	64 04	139 26			1937-04-01	1937-12-01	X	D	@	@	B				
2100400	DAWSON	YT	64 04	139 26			1937-12-01	1953-08-01	X	D	@	@					
2100400	DAWSON	YT	64 04	139 26			1953-08-01	1953-09-01	X	@	@						
2100400	DAWSON	YT	64 04	139 26			1953-09-01	1954-07-01	X	D	@	@					
2100400	DAWSON	YT	64 04	139 26			1954-07-01	1960-02-01	X	D	@	@	B				
2100400	DAWSON	YT	64 04	139 26			1960-02-01	1960-03-01	X	@	@	B					
2100400	DAWSON	YT	64 04	139 26			1960-03-01	1965-09-01	X	X	@	@	B				
2100400	DAWSON	YT	64 04	139 26			1965-09-01	1966-12-01	X	X	@	X	B				N
2100400	DAWSON	YT	64 04	139 26			1966-12-01	1976-01-01	X	X	@	X					N
2100400	DAWSON	YT	64 04	139 26			1976-01-01	1976-02-01		@							
2100400	DAWSON	YT	64 03	139 26	0320		1976-02-01	1979-01-01		@	@						
2100402	DAWSON A	YT					1956-10-10	1976-01-01									
2100402	DAWSON A	YT	64 03	139 08	0369		1976-01-01	1976-04-01	X	D	@	X					N
2100402	DAWSON A	YT	64 03	139 08	0369		1976-04-01	1986-04-01	X	D	@	X	X				N
2100402	DAWSON A	YT	64 03	139 08	0369	W	1986-04-01	1988-11-17	X	D	X	X	X				N
2100402	DAWSON A	YT	64 03	139 08	0370	W	1988-11-17	1994-06-03	X	D	X	X	X				N
2100402	DAWSON A	YT	64 03	139 08	0370		1994-06-03	1997-09-11		D	X	X	X				N
2100402	DAWSON A	YT	64 03	139 08	0370		1997-09-11	1998-04-01		D	X	X	X				N
2100402	DAWSON A	YT	64 03	139 08	0370	S	1998-04-01			D	X	X	X				N
2100LRP	DAWSON	YT	64 03	139 08	0370		1988-01-13	1992-04-13		H							W
2100LRP	DAWSON	YT	64 03	139 08	0370		1992-04-13	1995-09-29		H	H						P
2100LRP	DAWSON	YT	64 03	139 08	0370		1995-09-29			H	H						P

Table 1. Dawson Station History.

STATION CATALOGUE									
CLIMATE STATION NAME	PROV.	LAT.	LONG.	ELEV.	NAME (S=SUMMER W=WINTER)	START YR-MO	END YR-MO	PERIOD WITH NO CHANGE IN PROGRAM LOCATION OR	SYNOPTIC
2100700+MAYO LANDING	YT	63 36	135 53			1924-10-01	1937-04-01	X D @ @	W
2100700+MAYO LANDING	YT	63 36	135 53			1937-04-01	1937-10-01	X D @ @	W
2100700+MAYO LANDING	YT	63 36	135 53			1937-10-01	1953-09-01	X D @ @	W
2100700+MAYO LANDING	YT	63 36	135 53			1953-09-01	1953-10-01	X @ @	W
2100700+MAYO LANDING	YT	63 36	135 53			1953-10-01	1966-10-01	X D @ @	W
2100700+MAYO LANDING	YT	63 36	135 53			1966-10-01	1967-09-01	X D @ X	N W
2100700+MAYO LANDING	YT	63 36	135 53			1967-09-01	1967-10-01	X @ X	N W
2100700+MAYO	YT	63 36	135 53			1967-10-01	1967-12-01	X D @ X	N W
2100700+MAYO	YT	63 36	135 53			1967-12-01	1968-10-01	X D @ X	N W
2100700+MAYO	YT	63 36	135 53			1968-10-01	1968-11-01	X @ X	N W
2100700+MAYO	YT	63 36	135 53			1968-11-01	1969-02-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1969-02-01	1971-04-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1971-04-01	1971-05-01	X @ X	N W
2100700+MAYO A	YT	63 37	135 52			1971-05-01	1971-09-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1971-09-01	1971-10-01	X @ X	N W
2100700+MAYO A	YT	63 37	135 52			1971-10-01	1972-04-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1972-04-01	1972-05-01	X @ X	N W
2100700+MAYO A	YT	63 37	135 52			1972-05-01	1972-09-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1972-09-01	1972-10-01	X @ X	N W
2100700+MAYO A	YT	63 37	135 52			1972-10-01	1973-04-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1973-04-01	1973-05-01	X @ X	N W
2100700+MAYO A	YT	63 37	135 52			1973-05-01	1973-09-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1973-09-01	1973-10-01	X @ X	N W
2100700+MAYO A	YT	63 37	135 52			1973-10-01	1974-07-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52			1974-07-01	1975-06-01	X D @ X	N W
2100700+MAYO A	YT	63 37	135 52	0504		1975-06-01	1985-05-01	X D @ X X	N W
2100700+MAYO A	YT	63 37	135 52	0504		1985-05-01	1985-06-14	X D @ X X	N W
2100700+MAYO A	YT	63 37	135 52	0504		1985-06-14	1986-04-01	X D @ X X	N W
2100700+MAYO A	YT	63 37	135 52	0504		1986-04-01	1987-09-30	X D X X X	N W
2100700+MAYO A	YT	63 37	135 52	0504		1987-09-30	1988-09-30	X D X X X	N W
2100700+MAYO A	YT	63 37	135 52	0504		1988-09-30	1988-10-01	X D X X	N W
2100700+MAYO A	YT	63 37	135 52	0504		1988-10-01		D X X X	N P

Table 2. Mayo Station History.

		SNOW SURVEY----->: A																			
		EVAPORATION----->: I																			
STATION CATALOGUE		RATE OF PRECIPITATION----->: S R U R																			
		PRECIPITATION----->: O S A P																			
		TEMPERATURE----->: I U D P Q																			
		HOURLY----->: L N I E U N R																			
		SYNOPTIC----->: S A O R : T A I E																			
		PERIOD WITH NO CHANGE : : : : W T : H T Z : O L P G																			
		IN PROGRAM LOCATION OR : : : : I E : I I O A : W I H I																			
CLIMATE STATION NAME	PROV.	LAT.	LONG.	ELEV.	NAME (S=SUMMER W=WINTER)	START YR-MO	END YR-MO	:	:	:	:	:	:	:	:	:	:	:	:	:	
		START YR-MO END YR-MO : : : : D P : E N E R : R Y R N																			
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1938-10-01	1938-11-01	X D @ @													W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1938-11-01	1942-02-01	X D @ @	B												W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1942-02-01	1942-04-01		@ @												W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1942-04-01	1960-11-01	X D @ @	B												W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1960-11-01	1964-12-01	X D @ X	B												N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1964-12-01	1966-12-01	X D @ X	B						@						N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1966-12-01	1969-06-01	X D @ X							@						N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1969-06-01	1969-10-01	X D @ X							S			@			N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1969-10-01	1981-07-01	X D @ X X	D	S			@								N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1981-07-01	1986-04-01	X D @ X X	D A S			@									N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1986-04-01	1988-03-31	X D X X X	D A S			@									N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1988-03-31	1990-09-30	X D X X X		A S											N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1990-09-30	1993-08-31	X D X X X			S										N W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1993-08-31	1993-09-01	X D		X			S								W	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1993-09-01	1993-10-15	X D X X X			S										P	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1993-10-15	1993-10-18	H G X X X			S										P	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1993-10-18	1997-08-21	H G X X X													P	
2101200 WATSON LAKE A	YT	60 07	128 49	0690	1997-08-21		H G X X X													P	
2101200 WATSON LAKE (AUT)	YT	60 07	128 49	0690	1938-10-01	1938-11-01	X D @ @													W	
2101222 WATSON LAKE (YTG)	YT	60 04	128 43	0701	(From the Environment Canada Website)																
2101204 WATSON LAKE (AUT)	YT	60 07	128 49	0690	(From the Environment Canada Website)																

Table 3. Watson Lake Station History.

=====											
SNOW SURVEY----->: A											
EVAPORATION----->: I											
+-----+ RATE OF PRECIPITATION----->: S R U R											
STATION CATALOGUE											
+-----+ PRECIPITATION----->: : O S A P											
TEMPERATURE----->: : I U D P Q											
HOURLY----->: : : L N I E U N R											
SYNOPTIC----->: : : : : S A O R T A I E											
PERIOD WITH NO CHANGE : : : W T H T Z O L P G											
IN PROGRAM LOCATION OR : : : I E I I O A W I H I											
CLIMATE STATION NAME	PROV.	LAT.	LONG.	ELEV.	NAME (S=SUMMER W=WINTER)	START YR-MO	END YR-MO	START YR-MO	END YR-MO	SYNOPTIC	
=====											
2101245+WHITEHORSE RSB	YT										
2101245+WESTERN REGION RSB WHITEHORSE	YT	60 43 135 04	0702	1989-01-01	1998-07-16					P	
2101245+PACIFIC REGION RSB WHITEHORSE	YT	60 43 135 04	0709	1998-07-16	1999-01-01					P	
2101245+WHITEHORSE RSB	YT	60 43 135 04	0709	1999-01-01						P	
2101290 WHITEHORSE	YT			1900-07-01	1900-08-01	@ @				W	
2101290 WHITEHORSE	YT	60 45 135 00		1904-11-01	1907-12-01	@ @				W	
2101290 WHITEHORSE	YT	60 45 135 00		1909-01-01	1911-01-01	@ @				W	
2101290 WHITEHORSE	YT	60 43 135 03	0636	1940-09-01	1942-03-01	X D @ @				W	
2101290 WHITEHORSE	YT	60 43 135 03	0636	1959-02-01	1960-07-01	@ @				W	
2101300 WHITEHORSE A	YT			1901-11-21	1942-04-01						
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1942-04-01	1942-06-01	X D @ @	B			W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1942-06-01	1942-07-01	X	@ @	B		W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1942-07-01	1946-05-01	X X @ @	B			W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1946-05-01	1957-03-01	X X @ @	B		@	W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1957-03-01	1959-08-01	X X @ @	B	S	@	W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1959-08-01	1961-10-01	X X @ @ X B	S	@		W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1961-10-01	1965-03-01	X X @ X X B	S	@		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1965-03-01	1966-12-01	X X @ X X B	S	@ @		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1966-12-01	1970-07-01	X X @ X X	S	@ @		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1970-07-01	1974-07-01	X X @ X X	S H	@ @		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1974-07-01	1977-07-01	X X @ X X	A S H	@ @		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1977-07-01	1985-12-31	X X @ X X	A S H	@ @	@	N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1985-12-31	1986-04-01	X X @ X X	A S H	@ @		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1986-04-01	1990-12-31	X X X X X	A S H	@ @		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1990-12-31	1991-01-01	X X X X X	A S H	@		N W	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1991-01-01	1996-01-02	X X X X X	A S	@		N P	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1996-01-02	1997-08-21	X X X X X	A S	@		N P	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1997-08-21	1997-12-01	X X X X X	A S	@		N P	
2101300 WHITEHORSE A	YT	60 43 135 04	0703	1997-12-01	2000-03-09	X X X X X	A S	@		N P	
2101300 WHITEHORSE A	YT	60 43 135 04	0706	2000-03-09		X X X X X	A S	@		N P	
2101350 WHITEHORSE INSTRUMENT STORAGE	YT	40 00 50 00	0000	2000-03-14	*****					P	
2101400 WHITEHORSE RIVERDALE	YT	60 42 135 02		1959-02-01	1966-01-01	@ @				W	
2101400 WHITEHORSE RIVERDALE	YT	60 42 135 02		1966-01-01	1966-02-01	@ @				W	
2101400 WHITEHORSE RIVERDALE	YT	60 42 135 02		1966-02-01	1970-08-01	@ @				W	
2101400 WHITEHORSE RIVERDALE	YT	60 43 135 01	0643	1970-08-01	1973-08-01	@ @				W	
2101400 WHITEHORSE RIVERDALE	YT	60 43 135 01	0643	1973-08-01	1973-09-01	@ @				W	
2101400 WHITEHORSE RIVERDALE	YT	60 43 135 01	0643	1973-09-01		@ @				P	
2101405 WHITEHORSE UA	YT	60 43 135 04	0704	1991-01-01	1996-01-11				H	@	P
2101405 WHITEHORSE UA	YT	60 44 135 04	0707	1996-01-11					H	@	P
2101415 WHITEHORSE WSO	YT	60 44 135 05	0707	1996-02-01		@ @					

Table 4. Whitehorse Station History.