RECONNAISSANCE SURVEY: TRACE METALS CONCENTRATION IN WIND RIVER GLACIERS

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ABSTRACT

A reconnaissance investigation of Bull Lake and Knife Point glaciers in the Wind River Range, Wyoming, has yielded data on the aerosol deposition of trace metals in the youngest layers of snow and ice. The study provides minimal background data for preindustrial period aerosol deposition in this region of Wyoming. Site selection for sampling is critical and several sampling techniques are reviewed. Dating of the different snow/ice layers is uncertain. Chemical analysis reveals little evidence that local power plants or trona industries have much influence on atmospheric deposition on the sampled glacier. Trace metal concentrations ranged from 0.1 ug/l to 200 ug/l. Our data indicate copper, zinc, and lead enrichment, relative to mean crustal abundance. Measurements show the terminus of Knife Point glacier has receded 228 meters since 1963. Stratigraphic measurements suggest some ice may be over 1000 years old.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PAGE

INTRODUCTION

The chemical composition of modern aerosols is influenced by continental dust, volcanism, sea spray, and anthropogenic emissions. These aerosols play a major role in the geochemical cycling of some elements. Many of the enriched trace elements are biologically active and may have significant environmental effect. Their source and fate have been given much attention in recent years (Galloway, J. N., and S. J. Eisenreich 1980; Lantzy and Mackenzie 1979).

Some attention has also been focused on wilderness areas and national parks that by statute must be protected from significant air quality deterioration. Atmospheric deposition provides evidence of deterioration. Recent studies in the Rocky Mountains show that precipitation in some areas evidences significant deterioration of air quality and that adjacent wilderness or primitive areas are sensitive to such a deterioration (Turk 1983; Yuhnke 1984; Stuart 1984).

Little data exist of actual measurements in the wilderness areas because they are inaccessible and automatic samplers are for the most part, prohibited. In addition, because the precipitation has such dilute concentrations of elements there is danger of escape of these elements or of contamination during transport over long distances to specialized laboratories.

Glaciers act as reservoirs for many sedimentary processes. They have been shown to provide a record of changes in the input of materials from the atmosphere (Mayewski 1980). Trace metal analysis of deposition can be used to calculate enrichment and assess the impact of anthropogenic activities on atmospheric particulate compositions. Enrichment factors are calculated from the concentration ratio of the trace element to a standard (such as Al or Na) in atmospheric deposition divided by the trace element/standard ratio in crustal material (Lantzy and Mackenzie 1979). Trace element concentrations in snow melt samples from the Wind River Range exceed concentrations for remote areas such as Antarctica and Greenland by one to two orders of magnitude, and exceed concentrations in the Wyoming Range, the western boundary of the Green River Basin, by factors of 1.3 - 7.8 (see proposal).

No systematic study of any of the present glacial regimens in the Wind River Range has been reported. No published information is available on the flow dynamics, present extent of ice, or moraine descriptions and characteristics (Richmond 1985; Mears 1985; Love 1985; Montagne 1985; Frost 1985). According to Richmond, Mears, and Frost, most, if not all, the Wind River glaciers are presently undergoing rapid ablation, and it is suspected that the permanent addition of new snow may be slight.

PROPOSAL

We proposed to core and dig snow/ice pits at two locations in Knife Point glacier in the Wind River Range to determine:

1. The background level (pre 1900?) of particulate trace metal composition before large scale industrialization and metals refining in the west. These samples would come from locations where it can be determined that the ice is older than about 1900.
2. Historical trends in deposition if stratigraphy can be identified demonstrating snow/ice of the last century remains.
3. Enrichment and interference factors based on trace element concentration changes with depth.
4. To access the relative contribution of anthropogenic mobilization of trace metals from the Green River Basin.

To accomplish this we planned to do chemical analysis of all samples from each location. By comparing total chemical composition of successive snow/ice layers, we hoped to determine if or when the total concentrations "level out" as a function of depth. A static concentration may indicate a background level, the source of which would be weathering of crustal materials. Historical trends might be indicated by depth, deposition from volcanism, and organic detritus layers such as one resulting from extreme ablation during the period 1937-1942 (Richmond 1985), and radioactive fallout. Enrichment factors and basin anthropogenic mobilization were hoped to be determined by comparison of various elemental concentrations (Na, F, and trace metals).

Further we intended to begin a systematic description of the sampled glacier, including subsequent analysis of historic photos, data, and discussions with informants, to determine approximate ablation rates as well as other aspects of the glacier's regimen. In addition, we hoped to sample the 1984-85 snowpack at several locations to preserve the continuity of snow composition data started by the U.S.F.S. in 1983 but suspended due to budget cuts.

The following narrative describes what we have accomplished to date (July 1988). The remote wilderness location, mountaineering problems, denial of helicopter access, and risk associated with packing outfits strongly influenced the investigation. See Recommendations for Future Studies.

FIELD RECONNAISSANCE

The project area is located in the northwest corner of the Fremont Peak South Quadrangle in the Wind River Range (Fig. 1). On the northeast side of the continental divide, the 4000 meter high crest provides both a natural snowfence for the drifting of snow blown by southwest winds, and shady protection from the late afternoon summer sun. Two glaciers arise from protected cirques and cols, the northwest one is known as Bull Lake Creek glacier, the southeast Knife Point glacier. Although Knife Point glacier was originally selected for sampling based upon U.S.G.S. air photographs, overflights, and the nearest potential access by pack horses, field examination proved the glacier too costly in man hours of labor and the upper part too dangerous to use for the study. Field reconnaissance of the adjacent Bull Lake Creek glacier showed a portion of its accumulation zone to provide safer access and a textbook example of a stratigraphic snow section suitable for sampling. The portion studied of Bull Lake Creek glacier is considerably smaller. On both Knife Point glacier and Bull Lake Creek glacier, minor geomorphic work was accomplished. The initial field work took place from August 2-15, 1985, overflights and additional field work occurred from August 21-25, 1986, September 2-5, 1987, and August 12-23, 1988.

SITE SELECTION

For chemical analysis of the yearly snow layers, the study required an uninterrupted and undisturbed stratigraphic sequence of snow deposition. These conditions would normally occur high up on the glacier below the bergschrund but above the firn limit, the approximate line above which winter snows do not melt completely away. Theoretically the snow should grade downward into ice layers, and snow pits dug in this area would therefore provide a continuous sequence of datable samples.

The three snow pit sites were selected at an elevation of 3,800 meters (12,200'). The mean annual temperature at this site is approximately -14 degrees C. This temperature was calculated from the mean annual temperature of Pinedale, Wyoming, (2.02 degrees C) by applying the dry adiabatic lapse rate. Three snow pit locations were excavated in a downslope line in an eastern portion of Bull Lake Creek glacier that revealed a comparatively undisturbed stratigraphic snow/ice sequence in the accumulation zone. No vertical interstices were discovered during excavation of the pits.

The pits were dug through the snow above the 1985 firn line and ultimately penetrated the glacier ice beneath. The deepest of these was 4.2 meters.

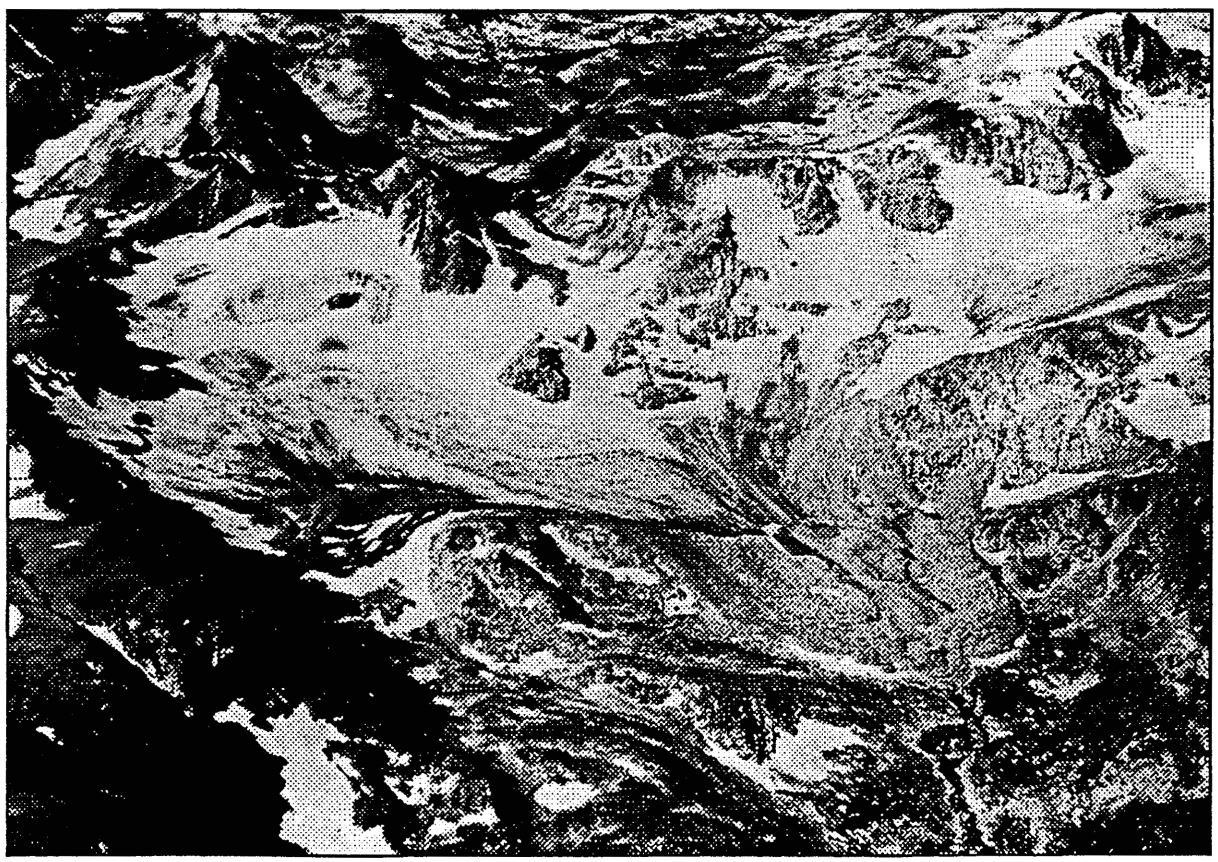
The three major pit locations were deliberately chosen in the potential avalanche runout zone below a gentle col (Fig. 2). It was hoped that via avalanches the accumulation of a winter's snow might be considerably greater and thus less subject to melting completely away during a hot summer. In the field there was no indication within the snow stratigraphy that any avalanches had occurred, though overflights in both 1985 and 1986 showed them to have run on this slope. These avalanches were all of the surface slough type which involve only the previous winter's snows, and no indications of any deep slab avalanche activity was evident. In August of 1986 past avalanche activity was examined on the surface of the 1986 snows and was evidenced primarily in the form of scattered rock debris originating from above the bergschrund. Three smaller pits were excavated down-glacier in ice whose stratigraphic age is approximate, but probably dating about 1941, 1819, and 1806. The sample from Knife Point glacier (No. 14210) probably dates between 1600 and 2000 years before present. Two additional old ice samples (No. 14211 and 14212) were obtained from the lower section for control purposes.

STRATIGRAPHY

Glacier Surface Stratigraphy

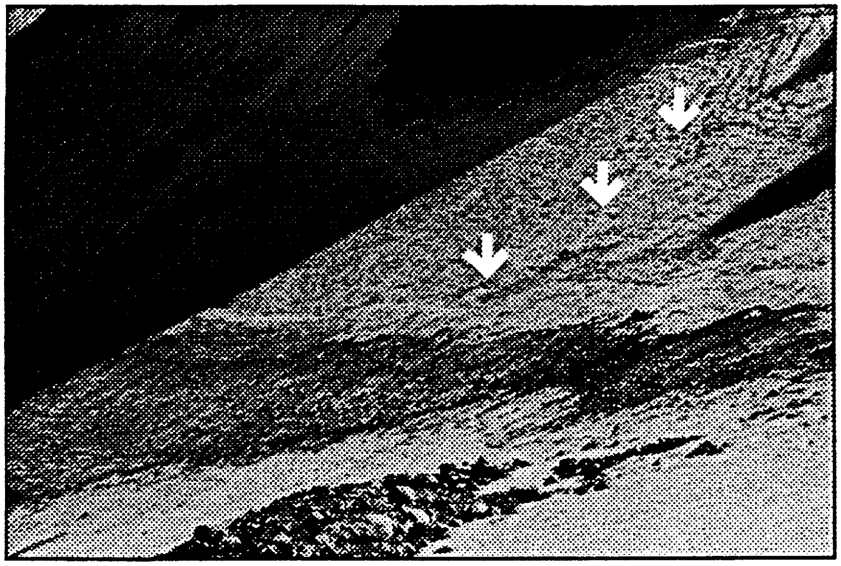
Critical to dating the sampled layers is the identification of a comparatively undisturbed stratigraphic snow sequence. Because the Wind River glaciers are among the southernmost of the temperate glaciers in the U.S., cumulative winter snowfalls compact and melt down to a relatively thin layer during the summer.

The summer thaw layers that are on the top of the previous winter's snows we termed "meltdown" layers. Like varves, therefore, a single year's accumulation may be ideally represented



Post, 1963

Figure 1. Area of snow/ice sampling with Knife Point glacier on the left and Bull Lake Creek glacier on the right. Austin Post U.S.G.S. Tacoma. Photo K631-78.



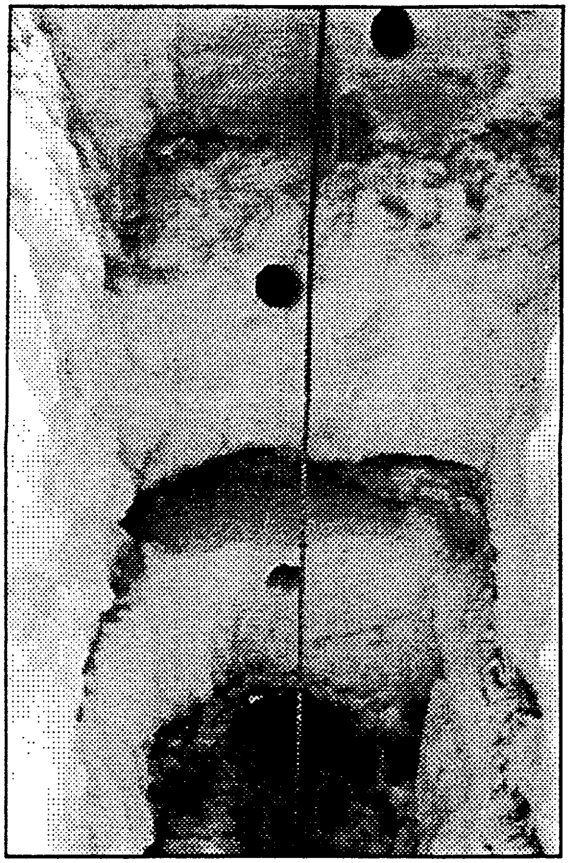
Love, 1985
Figure 2. Pit locations shown by arrows on Bull Lake Creek glacier. Note upper and lower firn lines.

by two layers, the summer thaw on top of the remaining winter's snow accumulation (Fig. 3). The rate of snow concentration or disappearance based on sublimation is not known.

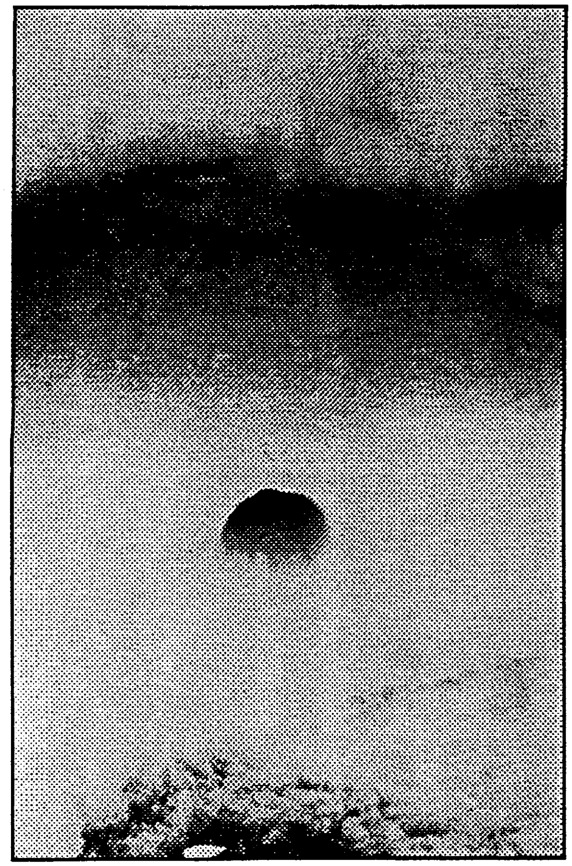
On the snow surface but especially in the excavated trenches, meltdown or summer thaw can be seen as a layer of higher density snow or ice, and is marked by fewer bubbles or air spaces between ice granules. These meltdown layers are accompanied by particles concentrated from within the melted snow, and occasionally they contain insects. Beneath the thaw layers is a much thicker zone of less metamorphosed snow representing the unmelted portion of that winter's snow. It appears as dense ice granules with high porosity (Fig. 4).

Analysis of the samples taken from these meltdown layers reflects the increased concentrations of metals as compared with the samples taken immediately above or below them (Contrast sample Nos. 14218 and 14226) [Appendix A]. When the summer meltdown proceeds so completely as to combine several year's snow accumulation, metal concentrations may wildly exceed those of snow samples above and below. In addition, the nature of the meltdown process provides through meltwater the mechanism for metal mobility in both vertical and horizontal directions. Field examination suggests water tends to flow along the established meltdown horizons within the snow stratigraphy above the firn line, and that horizontal mixing is possibly more of a factor in mobility than vertical mixing. It is not known how this affects the retention of trace metals.

For some parameters it is obviously advantageous to the analyst to sample snows of highest elemental concentrations, i.e. the meltdown layers. However, the meltdown layers are concentrated by sublimation, melting, additional dry deposition, etc., and may actually represent the meltdown of



Love, 1985
Figure 3. Sampling Pit 2. Dark summer melt layers on top of previous winter's snow. Glacier ice at the bottom. Sample holes are 8 cm across.



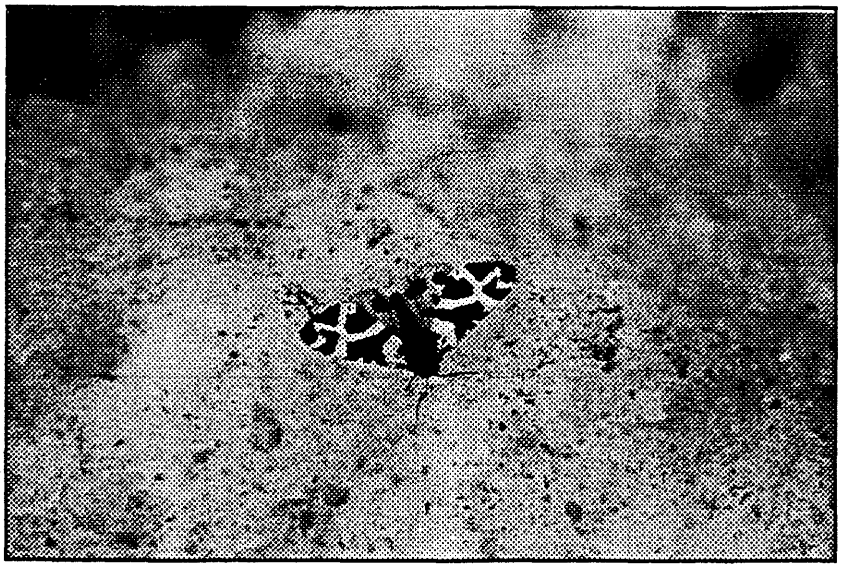
Love, 1985
Figure 4. Pit 2. Varve-like dark layers of summer meltdown.

several years. Comparison of data from these layers to subsurface snow layers may not be valid.

Great caution was exercised in interpreting how many summers a single meltdown or thaw layer represented. Many meltdown layers were much thicker or much dirtier than others. We interpreted these to represent the result of particularly hot summers during which several winter snow accumulations melt completely and combine to form a particularly thick and dirty meltdown layer overlying older snow layers.

A heavy summer melt therefore may concentrate impurities from one or more winter snows into the lower layer. The process takes place only when one year's firn limit recedes above the previous year's firn limit, and essentially "stores" at least some of the aerosol and particulates in the snow layers beneath.

Thus it would seem that a meltdown layer could represent a minimum of one summer, but may represent the loss of 2 or more years of winter snows. The process concentrates the remaining particulates and changes the snow chemistry for those years. In one meltdown complex on Knife Point glacier the accumulation of insects, mostly grasshoppers, approached 270 per square meter, and had potential for C-14 dating. It suggests either a spectacular event of insect deposition or the accumulation of them from a great many meltdown layers. This latter alternative implies a series of hot summers or winters with low snowfall. Our experience with the discovery of insects on the surface snow of 1985 was approximately one grasshopper-sized insect per 30 meters of traverse, or a density many orders of magnitude lower than that found in some of the prehistoric meltdown layers. There were no grasshoppers seen in 1985, but a variety of moths and butterflies (Fig. 5).



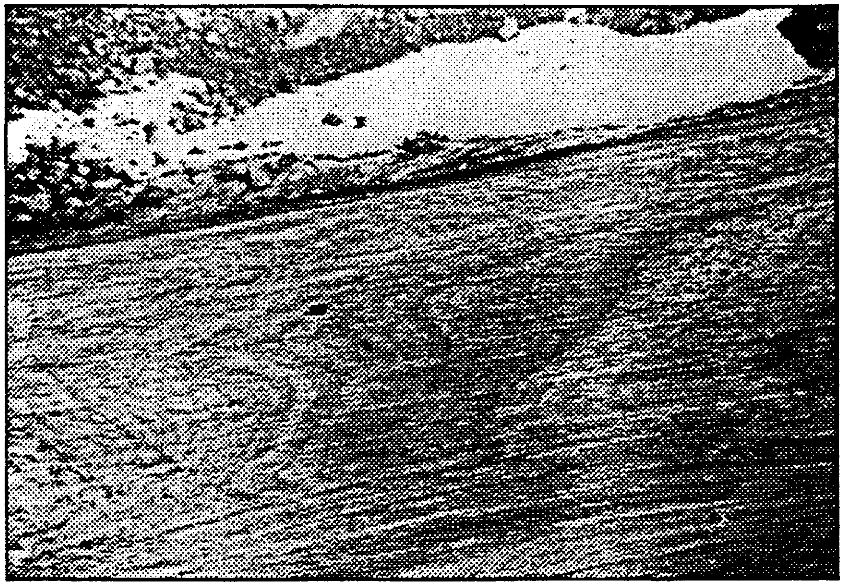
Love, 1985

Figure 5. Stranded moth on surface meltdown of 1985 snow.

In 1986, most large insects were dragonfly varieties, but a hatch of small flying ants had also become trapped and were much more common on the snow surface than dragonflies.

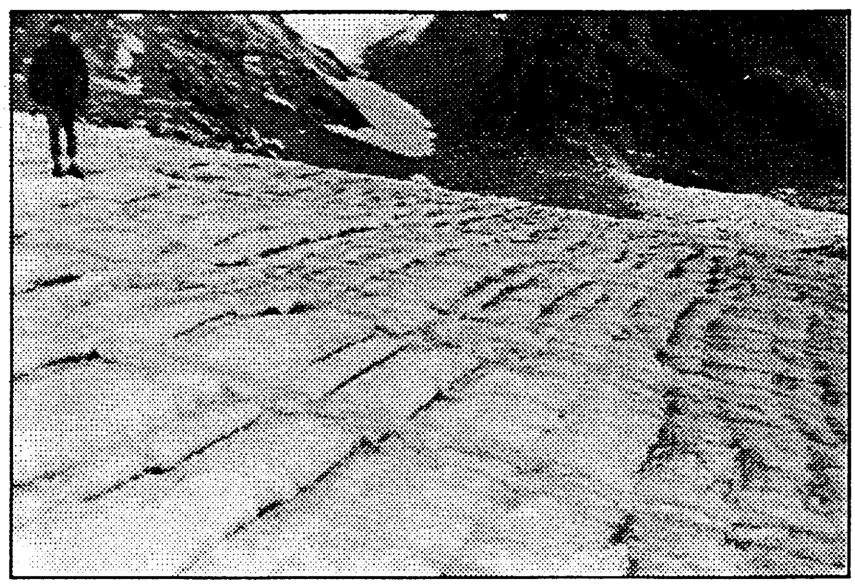
The relative thicknesses and spacing of the meltdown layers exposed farther downstream on the glacier surface seem to lend appearances similar to tree rings, closely spaced meltdowns signifying either low snow accumulation and hot summers, or both, and thicker, cleaner layers signifying heavy winter snow accumulation and cool summers, or both (Fig. 6).

The firn limit can be a mappable down-glacier border of the blanket-like meltdown layer and the whole represents the net snow accumulation for that year (although a heavy summer meltdown may eliminate the entire unit). Normally, the winter's accumulation layer slowly metamorphoses and eventually becomes part of the glacier after continued burial by subsequent winter snows. The edge of this unit is exposed by melting on the glacier downstream and is clearly visible in both Bull Lake Creek and Knife Point glaciers (Fig. 2). Similarly, they are visible in other Wind River glaciers as well.



Love, 1985

Figure 6. Knife Point glacier showing ice stratigraphy and flow patterns. Group of 12 people on ice for scale.



Love, 1985

Figure 7. Knife Point glacier showing uniformity of preserved meltdown layers. Note subtle meltdown layers between darker ones.

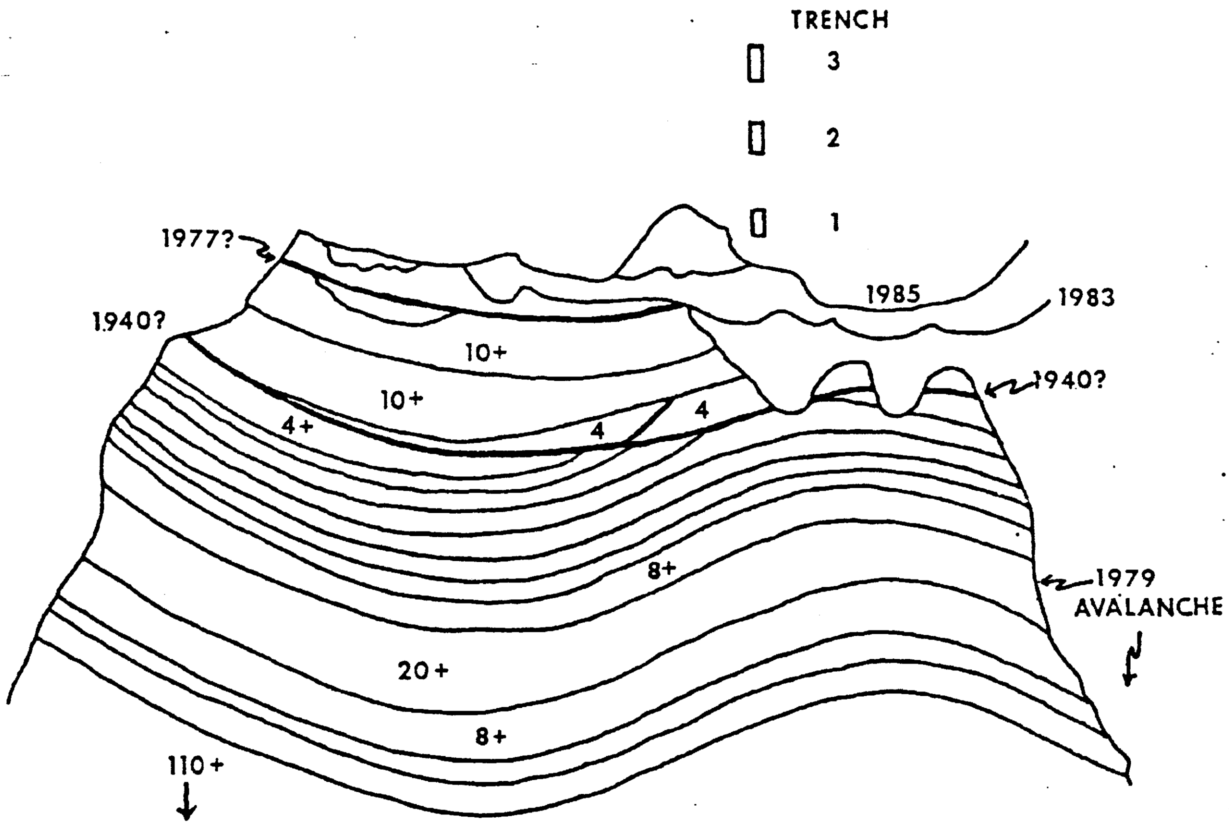


Figure 8. Sketch of firn lines and major stratigraphy from 1985. Locations of snow trenches are shown. Numbers between major strata indicate minimum number of melt lines.

Individual layers exposed in the glacier ice below the firn line as well as within the excavated pits lower down on the glacier showed surprising uniformity of thickness, as though the net accumulation of precipitation could be uniformly compressed into 20 to 40 cm thick layers. Rarely were they thicker; thinner ones were more common (Fig. 7).

Examination of both Knife Point and Bull Lake Creek glaciers showed several firn limits (Fig. 8). Their exposure depended on two major factors: the uneven snow accumulation during the winter, and the uneven meltback of that snow during the summer. Snow from several winters could be seen emerging from beneath the 1985 firn limit on Bull Lake Creek glacier (Fig. 2). By tracing these various years' firn limits to the stratigraphy in the excavated pits, and sketch-mapping their cross cutting relationships down the glacier, a tentative sequence of meltdown layers can be reconstructed into the past. It becomes clear, with mapping, that there may be "hidden" meltdown layers and meltdown complexes (Figure 8). Thus, dating the snow and ice layers backward in time is probably accurate for only the first few years into the past and might be correlated with known weather data. Farther into the past, dating the layers becomes progressively speculative. Correlation of sequences of meltdown layers in Bull Lake Creek glacier with other nearby glaciers was not attempted during this fieldwork.

Plotting the annual snow accumulations and mean summer temperatures of Lander and Pinedale for the years 1915-1986 indicate reasonable correlation between the reporting stations. Heavy snow accumulations and low summer temperatures in both Lander and Pinedale suggest years of probable glacier accumulation. (See Appendix B, 1971-1975).

The summer temperature profiles are of limited use in approximating the reduction in summer snowcover on the glaciers themselves. Certain summer temperature profiles suggest that more melting should be taking place but in fact if there is cloud cover, melting is greatly reduced. In the field, the glacial meltwater streams greatly reduce their flow within fifteen minutes of clouds obscuring the sun. In 1985, August had a fairly low average temperature of 12.8 degrees C in Pinedale. Our early morning temperatures in camp when we took them were consistently -4.5 degrees C, but the meltdown was very nearly complete for the snows of 1985 and 1984. By contrast, the heavy snows of 1983 did not melt away in spite the following comparatively hot summer and fall, including the hottest August average temperature in 15 years (16.7 degrees C). Therefore a hot summer in Pinedale may not necessarily be indicative of heavy snow melt in the mountains.

It is our opinion that melting of snow in the Wind River Range may be more closely connected with the degree of summer cloud cover than monthly average temperatures. What role sublimation and relative humidity play in snow/ice reduction was not investigated nor was there time to examine what mix of local weather factors influence the melting process of snow on the glaciers.

Snow Pit Excavation and Stratigraphy

Three major snow pits, labeled 1, 2 and 3 upslope, were all excavated with steel shovels and mattocks into the accumulation zone of Bull Lake Creek glacier (Fig. 2). The surface slope angle in the pit alignment was 25 degrees, although the glacier/snow surface ranged from 31 degrees on the southeast to 26 degrees to the northwest.

In the accumulation zone penetrated by the three major pits, the winter snow layers measured from 10 cm to 2 m thick between clearly defined meltdown

Love, 1985

Figure 9. Pit 1 snow/ice interface and stratigraphy. Note meltdown lines within the ice parallel to the surface of the ice.

layers (Fig. 3). In all three pits the interface with the glacier ice was abrupt, the metamorphosis of ice granules into higher density ice occurring over a 5 to 10 cm vertical interval depending on location. This suggests that at several times in the last few years, no snow may have existed on the surface of the glacier in the lowest of the three pits, pit 1 (Fig. 9).

By contrast, at the same elevation of approximately 3800 meters (12,200'), examination of snow layers in the wall of a well-opened 15 meter deep crevasse in the upper reaches of Knife Point glacier did not reveal a snow/ice interface. The winter snow layers here were considerably thicker than those on the surface of Bull Lake Creek glacier, but sampling the wall of a crevasse such as this was too dangerous.

Other bergschrunds and crevasses were examined but all were discarded as sampling sites based on dangerous access or conditions (falling rock, collapsing cornices, vertical faces, etc.). They would, however, have provided excellent stratigraphic sections and samples with less visible danger of contamination by meltwater.

Since the pit excavation required some days to accomplish, sampling had to proceed at the same time as excavation to obtain 1985 and older snow samples before the respective firn lines retreated upslope from the pits. We observed the progressive retreat of the 1985, 1984, and 1983 snow layers. Based on the observed rate of retreat, snows of 1985 and 1984 probably melted completely away from the snow pit area of the glacier before the end of August. We do not know if either layer was preserved nearer the bergschrund to ultimately become one of the "varved" layers of glacier ice. Note that 1985 was a year of comparatively low snowfall when compared with those recorded since 1978 (Table 1). The data is incomplete for the precipitation winter ending in May of 1978.

TABLE 1: Precipitation at Pinedale, Wyoming in cm.

Rank of Snowfall Years

Driest	1981	107.18
	1980	131.56
	1985	136.91
	1984	172.72
	1982	183.14
	1986	209.94
	1979	210.45
Wettest	1983	229.62

Rank of Total Sept. - May. Precipitation

Driest	1977	13.89
	1985	15.29
	1975	15.80
	1973	18.77
	1976	19.03
	1979	19.33
	1974	19.73
	1980	20.68
	1981	21.89
	1982	23.91
	1986	24.21
	1984	26.73
Wettest	1983	33.37

The snow layers in the pits are correlated by years counting back from 1985. The 1985 and 1984 snow layers were observed to melt up slope beyond the excavations. Of interest is that during a known dry year, 1985, not only did the 1985 snowfall melt away, but also the remaining 1984 year, one whose precipitation pattern is of average snowpack of the years recorded, but whose water content is second highest. The snowfall of 1983 was particularly heavy and in all three pits, the third layer down was always the thickest of the upper sequence.

By contrast, 1986 seems to have been a healthy year for snow accumulation on the two glaciers. The distribution of snow remaining on the glaciers from 21 August to 25 August was also very different from the previous year and suggested deposition patterns from the northeast.

In the area of the snow pits on Bull Lake Creek glacier, 1986 snow remaining ranged from 60cm to 200cm in thickness, and the majority of both glacier surfaces remained covered. Only the terminous of Knife Point glacier had begun to emerge by August 25, 1986. The average September temperature was 7.1, one of Pinedale's coldest, suggesting further ablation retardation.

The terminous of Knife Point glacier did not ablate or advance substantially over its position of 1985, although meltwater stream positions did alter.

A layer we interpreted to correspond to a pair of the 1980 Mount St. Helens ashfalls was found in all of the pits. Known ashfalls were reported at various locations around Wyoming two or three days after the eruptions of May 19 and June 12, 1980. During that time interval a heavy spring snowstorm occurred in the Wind Rivers and probably buried the first ash deposition. In all the trenches, the pair of ash? layers was encased in a particularly heavy ice meltdown and were a few centimeters apart.

This may account for the slight separation of the dust lines. The ice layer was always directly below the thick snowfall of 1983. This would suggest that the snows of 1981 and 1982 had melted away or amalgamated into a meltdown layer containing the two ashes. The upper ash layer was embedded a few centimeters below the upper surface of the ice while the lower ash occurred six to ten centimeters above the bottom of the meltdown. Curiously, the analysis and comparison of the particulates from these "ash" layers with particulates from other meltdown layers were inconclusive and did not confirm that it was Mount St. Helens ash. We had hoped in 1986 that further samples would be collected and analyses performed, but the 1986 snow cover prevented that. For the present report however, it is assumed that the pair of particulate layers dates to post May 19 and post June 12 of 1980.

Alternatively, the dusty brown layers might be deposited during dust storms during dry years, during prolonged periods of forest/brush fires in upwind forests, or during unusual meteorologic conditions or events. The range of alternative explanations has not yet been explored. The brown layer could be seen in the snow stratigraphy within the upper crevasses of Knife Point glacier as well.

The snowfall for 1980 is the second lightest in recent years (Table 1) and it might be expected to have melted completely away similar to the snowfalls of 1985 and 1984. Similar to the heavy snowfall of 1983, 1979 was a particularly heavy snowfall year though the water content was not particularly high. This suggests that the 1982, 1981, and 1980 layers are amalgamated or melted down onto the 1979 snowpack, a conclusion independently reached in the field and based upon the position of the probable Mt. St. Helens ash.

Based on snowfall patterns, the remaining recent years that are the best candidates to be missing from the stratigraphy are 1977 and 1975 (with data missing for the 1978 winter). Based upon the Pinedale weather data, proposed missing snow stratigraphy might be as follows:

1985	
1984	Both amalgamated as meltdown on top of 1983
1982	
1981	
1980	All amalgamated as meltdown on top of 1979
1977	Amalgamated as meltdown on top of 1976
1975	Amalgamated as meltdown on top of 1974
1973	Potentially amalgamated onto the top of 1972

Admittedly speculative, the approximate dates attributed to the stratigraphic snow sections follow the above proposal.

FIELD SAMPLING PROCEDURES

We originally intended to core or dig snow pits to sample successive snow/ice layers. Coring the glacier was abandoned based on the following:

1. Conversations with Bruce Koci (1984) of the Polar Ice Coring Office indicated they did not have a non-contaminating auger.
2. The specially constructed auger described by Boutron (1983) was not available.
3. Construction of a clean auger would have been prohibitively expensive.
4. Sampling from snow pit walls had been successfully shown to produce reliable data (Boutron 1984).

To minimize contamination problems, superclean sampling procedures similar to those developed for trace metal analysis in Antarctica were used for the collection of samples (Boutron 1979b). Exacting clean-room preparations were not followed because that equipment was not available to us. It should be noted however, that Boutron and Patterson's (1979b) methods were developed for sampling Greenland and Antarctic snows which are one to three orders of magnitude less concentrated in trace metals than Wind River Range snows.

At each site in the Wind Rivers, a pit was hand dug using metallic shovels. The sampler then put on a clean-room jump suit, particle mask and class 100 polyethylene gloves. The sampling face was cut back approximately 10 cm with a critically cleaned polyethylene shovel. Rinsing of tools and equipment with distilled water took place before any contact with the snow face and between sample collection. From coolers already carried to the site, the sample tubes were lifted and uncapped and carried, using the polyethylene gloves, into the pit for sampling.

Snow samples were then collected by one of the following methods:

1. The critically cleaned sample tubes were pushed horizontally into the clean pit face, and the samples removed intact inside the tube.
2. The sample tubes were inserted into a critically cleaned PVC pipe of sufficient wall thickness to support the sample tubes, and both were then pushed into the pit face. In several instances the PVC corer was pounded into the face using a steel hammer against an epoxy coated wooden block placed at the exposed end of the PVC pipe. The PVC pipe had cutting surfaces machined into the pipe to allow for easy insertion by rotating the pipe. The pipe, sampling tube and sample were removed intact. The sampling tube and sample were then removed from the tube by using a critically cleaned polyethylene plunger.
3. For certain samples, as noted, the snow was simply scooped up using the sample tube edge from the pit wall or the surface of the snow layer, all of which were exposed by the cleaned shovel. This method probably risked the least contamination.
4. For most ice samples, the sample tube was held below the face chipped to a clean surface with the critically cleaned porcelain chipper, then pieces of the ice layer to be sampled were chipped so they fell directly into the sample tube.
5. For certain samples, as noted, an ice axe cleaned off the face to be sampled. The pick end then fractured pieces held against the face by a clean polyethylene-gloved hand, and these were placed into the sample tube. The gloved hand did not touch the ice axe.

Once a sample was collected, the filled sample tubes in each case were then capped individually with airtight caps, returned to original coolers and buried in the snow until the time to transport them to where packhorses could carry them out. The returning packhorses brought in dry ice so that after repacking, the samples could be kept frozen until the time of laboratory analysis. Three of the 36 sample tubes were damaged or contaminated at the time of collection and were deemed unusable. Unfortunately, another three of the remaining 33 samples collected were broken in the coolers en route by packhorse. Analyses were conducted on these, and they are so noted.

Pit 1 Sampling and Stratigraphy Notes

The excavation of pit 1 was made prior to the retreat up-slope of the firn snow from the years 1985 and 1984. An extension of this pit down the ice slope was made by chopping out a 25 cm wide trench to establish the connection of the snow/ice stratigraphy in pit 1 with the firn limits and meltdown stratigraphy in Figure 8. The heavily pebbled layer at the bottom of pit 1 correlates with the heavy meltdown line in the upper part of Figure 8.

Five samples were collected from Pit 1 in accordance with the outlined procedures. However, at the time of sampling no cleanroom suit was used because they could not go over the necessary heavy clothing. The ice samples were chipped off directly into the sample tubes. The porcelain pick was washed with distilled water between samples. An asterisk, marking a sixth sample is included here because it correlates with the stratigraphy in Pit 1 but was collected a few meters away where the layer was better exposed.

From the surface, the following snow layers could be distinguished.

Year(?)	Sample No.	Stratigraphic Thickness	Abbreviated Description
1985		8 cm	Firn snow. Top snow layer.
1984		10 cm	Firn snow. Second snow layer down.
1983		41 cm	Firn snow. Third snow layer down.
1982? 1980?	14237 14206	21 cm	Top of glacier ice. Ice layer with 1981? clear cut laminations, brown color and particles at bottom (Mt. St. Helens ash?) extending into the lower 6 cm of bubbly firn snow. Sample 14237 collected above the brown layer, sample 14206 collected in the brown layer.
1979?		7 cm	Second ice layer down, bubbly ice.
1978?	14237	18 cm	Third ice layer down. Hard clear ice at top; 13 cm bubbly ice below. Meltwater from ice face may have touched some ice pieces.
1977? 1976?	14236	18 cm	Fourth ice layer down. Two layers: upper is 5 cm hard ice, 12 cm bubbly ice below. Sample tube broken in transit. Potential contamination.
1975? 1974?	14235	13 cm	Fifth ice layer down. Homogeneous moderately bubbly ice.
1973? 1972?	14238	20 cm	Sixth ice layer down. Clear ice, few bubbles. (Sample made away from pit on glacier face and is just above the heavy meltdown characterized by pebbles. See below.)
1971?		-	Pebble layer suggests heavy meltdown, outcrops on glacier 25 m down slope.

Pit 2 Sampling and Stratigraphy Notes

The excavation of Pit 2 was made 23 meters directly up the 25 degree slope from Pit 1 to a depth of 1.95 meters. Before the end of the sampling period, the 1985 firn limit had retreated upslope.

Eight samples were collected from Pit 2. The face of Pit 2 was originally formed by and shaved down with a mattock, then the snow stratigraphy cleaned off to a depth of 10 cm with the rinsed polyethylene shovel. The lower ice face was rechipped in the areas for sampling with the rinsed porcelain chisel. All tools and samples were handled with polyethylene rubber gloves. The ice samples were chipped off into the sample tubes. The porcelain pick was washed with distilled water between samples.

From the surface, the following snow layers could be distinguished.

Year(?)	Sample No.	Stratigraphic Thickness	Abbreviated Description and Notes
1985	14227	-	Melted away. (Sample made adjacent tot 10 meters away.)
1984	14228	38 cm	Firn snow. Top snow layer but previous winter (1984) down. Sample made directly with sample tube. Possible (slight) contamination from the meltdown layer below due to horizontal sample in tilted layer.
1983	14219	66 cm	Firn snow down to top of brown layer. Second snow layer down. Used corer but possible contamination from back end of corer during extraction.
1982? 1981?	14216	10-15 cm	Third layer down. Icy surface meltdown containing brown dirt line 1980? separated by 3 cm from lower brown line (Mt. St. Helens ash?). Sampled upper brown section directly with sample tube after cleaning off with rinsed plastic shovel.
1980?	14220		Third layer down. Lower ice section described above. Cleaned off surface, then chipped out pieces into sample tube with porcelain chipper.
1979?	14229	36 cm	Firn snow. Third snow layer down. Used corer but possible contamination from back end of corer due to failure of pounding block.
1978?	14230	30 cm	Top of glacier. Hard clear ice at top 15 cm; 15 cm bubbly ice below. Used porcelain chipper which failed repeatedly. Handled a few pieces with polyethylene gloves.
1977? 1976?	10 cm		Hard clear ice.

Pit 3 Stratigraphy and Sampling

Pit 3 was excavated 21 meters directly up the slope from Pit 2 to a depth of 4.27 meters (see Fig. 10).

The snow sequence here was considerably thicker than at either pit 1 or 2. The presumed Mount St. Helens ash layer was also present in precisely the same stratigraphic position as in the other two pits. It again suggests strongly that the snows of 1981 and 1982 have amalgamated into the 1980 layer. Importantly, even in this pit the snow/ice interface is quite sharp, again suggesting that prior to the snow sequence, the glacier surface in this area may have been exposed. Of the above layers, fifteen samples were taken, many of them duplicates in order to test the chemical analytical methods, the various sampling methods, and in one case, the quantity of deliberate contamination. The face of Pit 3 was originally formed by and shaved down with mattocks and iron shovels. The snow stratigraphy was then cleaned off to a depth of 10 cm with the rinsed polyethylene shovel. The lower ice face was rechipped in the areas for sampling with the porcelain chisel which was washed with distilled water between sampling. All tools and samples were handled with polyethylene rubber gloves. The ice samples were chipped to directly fall into the sample tubes, thus avoiding contamination via handling. Three sample tube failures occurred during the initial sampling procedure in Pit 3. One sample tube was broken, but capped and left in its sample hole in the second snow layer down (1984). Two other sample tubes were contaminated during the sampling procedure and capped and left in sample holes of the third snow layer down (1983). These tubes were deliberately left in sampling position in order to determine by reexamination in subsequent years, if possible, how much surface melting of the snow layers might take place. If little or no melting takes place, how soon they may be incorporated in the surface of the glacier ice may give an indication of the rate of glacier recharge.

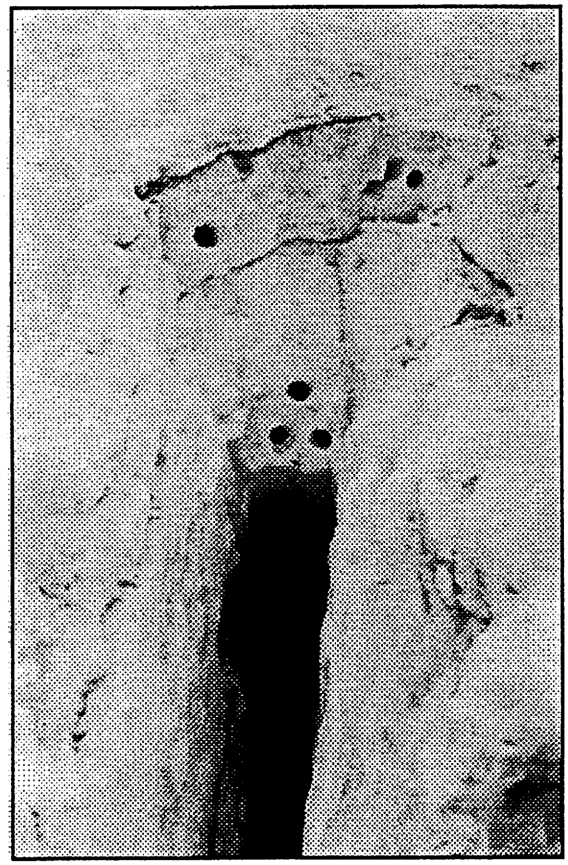


Figure 10. Pit 3. Multiple quality control sampling holes in snow layers; 1985, 1984, 1983.

From the surface, the following layers could be distinguished.

Year(?)	Sample No.	Stratigraphic Thickness	Abbreviated Description and Notes
1985	14233	25 cm	Firn snow. Separate pit made adjacent to pit 3 for surface sample. Used broken sampler. Couldn't get full sample. Possible contamination from axe head and PVC bar.
	14231		Pit same as above but shaved off surface with plastic shovel. Scooped up snow using sampling tube. Doubt any contamination.
	14234		Surface meltdown sampled 10 m northwest of pit by cooping 30 cm x 30 cm area using the sample tube. Doubt any contamination.
1984	14214	48 cm	Firn snow. Second snow layer down. Used steel axe against PVC sampler corer as pounding base, resulting in possible contamination at one end of the sample from the steel or the red paint on the steel.
	14208		Duplicate sample of above but composite of two attempts. PVC corer broke at one end. Sample in tube made by combining snow from two adjacent holes in the same layer. Possible contamination from axe head pounder or broken PVC.
1984	14207		Surface meltdown of second snow layer down. Uncovered meltdown layer by removing carefully the 1985 snow with the cleaned plastic shovel. Scooped up 30 cm x 30 cm meltdown using the sample tube. Doubt any contamination.
1983	142221	30 cm	Firn snow. Third snow layer down. Possible contamination from steel axe or red paint on the axe.
	14209		Duplicate of above.
1983	14232		Duplicate of above. Chopped out the overlying snow down to near this level, then scraped off remainder using the rinsed plastic shovel. Sampled directly into sample tube by chipping with porcelain chisel. Doubt any contamination.
1982? 1981? 1980?	14213	10 cm	Meltdown ice composed of two distinctive parts: an upper brown ice separated by a few cm of clear ice, then a lower brown ice (Mt. St. Helens ash?). Sample collected from the ice layer using porcelain chisel with ice falling directly into sample tube. Upper two layers of ice. Doubt any contamination.
	14218		Duplicate of above. Sample collected from lower portion of meltdown ice layer using steel hatchet with ice falling directly into sample tube. Test for quantity and type of contamination from this sampling method.

Year(?)	Sample No.	Stratigraphic Thickness	Abbreviated Description and Notes
1979?	142261	63 cm	Coarse firn snow; one cm ice stringers within. Fourth snow layer down. Sample collected by shaving snow into sample tube from a wall surface cleaned off with the rinsed plastic shovel. Doubt any contamination.
	14224		Duplicate of above.
1978?	14221	25 cm	Top ice layer of glacier. Upper 11 cm is clear ice, lower 14 cm is bubbly whitish ice. Chipped pieces out using rubber hammer and porcelain pick; wore polyethlyene gloves. Possible contamination from glue on rubber hammer handle label.
1977?		20 cm	Clear ice. Second ice layer down. Used steel axe to free pieces, then shaved them down with porcelain chisel and holding them with polyethylene gloves. Possible contamination by glue on label of rubber hammer.

OLDER ICE SAMPLING AND STRATIGRAPHY NOTES

In solid glacier ice, the original summer thaw layers become visually discernable higher density ice. The ice may range from clear to very dirty, depending on the dust content of the original winter's snowfall and subsequent dry deposition. These are separated by layers of bubbly ice, which represent the metamorphosed remnants of winter snow.

Bull Lake Creek Glacier

Four other samples of Bull Lake Creek glacier ice were collected outside of Pits 1, 2, and 3. The reason for sampling other layers rests on the need to have "older" ice for background data. The actual date of each of the layers of ice is open to interpretation. In each case, shallow pits were dug into the glacier surface to expose fresh ice stratigraphy. Sample No. 14238 (1975?) has been included in the samples from Pit 1 since the correlation with Pit 1 was so close. See above. Three other samples could only be dated approximately by the number of meltdown layers correlated from the base of Pit 1. In each case, the samples may have been compromised by having used an ice axe to free the samples, and by not having worn cleanroom garb. Analyses revealed high Fe and Al concentrations. Great care was taken during sampling however, so that no contact with the ice by clothing or tools other than the ice axe took place. See further discussion under laboratory analyses.

These smaller pits revealed ice stratigraphy that could not always be seen on the surface of the glacier. Four small trenches made on the surface of the glacer between obvious "dirty" meltdown lines revealed in each case from 4 to 8 "varved" ice layers. These ranged from 10 cm to 40 cm thick. A random surface count in the lower part of this glacier revealed some 28 smaller "varved" ice layers sandwiched between 9 "dirty" meltdown lines, or a ratio of roughly 3 "varved" ice layers for each heavy meltdown. Since these latter were surface observations only, undoubtedly an unknown number "varved" ice layers were missed.

Various firn lines are exposed in the upper part of the glacier. Four surface snow layers could be counted. Stratigraphically beneath them but exposed on the surface, about 20 surface meltdown lines could be easily counted in the glacier ice down to the small pit made for Sample 14215 (Figure 8). However, based on the thickness of the "varved" ice layers exposed in the small exploratory trenches, at least 40 years could be represented. Thus the "best guess" minimum date for Sample 14215 was calculated to be 44 years into the past from 1985. The estimated date of the winter snow producing the sample would be close to 1941. It is probably somewhat older based on an interpretation of how many meltdown years have been sandwiched into certain of the heavy meltdown lines and exactly how many of the "varved" ice layers are invisible from the surface.

Sample No.	Approximate Date of Layer	Notes
14215	1941?	Approximate Ice layer age determined by mapping. Sample chopped out using ice axe with pieces falling directly into the sample tube.
14211	1700 - 1819?	Ice layer age determined by mapping and calculation. Sample chopped out using ice axe with pieces falling directly into the sample tube.
14212	1700 - 1806?	Ice layer age determined by mapping and calculation. Sample chopped out using ice axe with pieces falling directly into the sample tube.

For samples 14211 and 14212, the ages are much less secure because so many meltdown lines separate them from Pits 1, 2, and 3. (See Fig. 8). Some 41 heavy meltdown lines containing 166 layers visible on the surface separate samples 14215 (1941?) and 14211. Sample 14211 is separated from 14212 by 13 "varved" ice layers counted in a shallow trench on the glacier surface connecting the two sample areas. Although very speculative, it means that a minimum date for snowfall forming the upper prehistoric sample is about 1819, the other, 1806. Without a doubt, both dates must be considerably older, perhaps by a factor of two. Because of the "hidden" years contained in the heavy meltdown lines and the fact that the varved layers could not be revealed by trenching the whole glacier, the two samples could be as old as 1650-1700. In either case, the samples should reflect preindustrial aerosol depositional conditions.

In order to explore potential radioactive fallout deposition, a GeoMetrics Inc., Portable Gamma Ray Scintillometer GR 101A, was passed carefully four times over all the ice and snow stratigraphy up section from the 1941? layer. It was hoped that this might be a potential method for locating specific years. No remnant radioactivity from atmospheric deposition was detected by this method. However, since only gamma radiation could be detected and the daughter products of the various bomb tests were not known, our results should be considered inconclusive. Boulders on the ice emitted higher than background levels of radiation, but none of the meltdown layers had enough local weathering products to produce the same results. Using this method for detecting radioactivity as a field dating method for snow/ice layers seems limited.

Knife Point Glacier

Knife Point glacier is considerably larger than Bull Lake Creek glacier. The calculated length is about 1.8 km (6,000'), according to the Fremont Peak South quadrangle map based on 1966 photo coverage. The glacier originates at an elevation of 3780 meters (12,400') and flows down to a terminus at approximately 3380 meters (11,080'). The toe of the glacier has receded considerably from the terminal moraine (Fig. 1).

The air photographs of Knife Point glacier taken by Austin Post (U.S.G.S., Tacoma) in 1963 show the toe of Knife Point glacier calving off into a meltwater lake (Fig. 1). A boulder in another of these photographs can be seen near the very end of the ice on the shore of the lake. The taped distance from the boulder to the 1985 ice terminous was 231 meters, or an average meltback of about 10 meters a year since 1963. If this linear rate of melting is extrapolated over the length of the glacier, and ignoring other parameters of glacier ablation and climate fluctuations, it would suggest that Knife Point glacier could disappear in the next 180 years. If other ablation parameters are taken into account, Knife Point glacier could disappear in much less time, perhaps during the next century. The resulting effect of the gradual loss of this glacier and presumably others nearby on the future water volume of the Wind River could interest interstate water pacts.

Sample 14210 was collected several hundred meters up section from the toe of Knife Point glacier adjacent to a heavy meltdown line containing insects (Figure 1). The approximate dating of this sample is even more speculative because of the lack of field time available to study adequately the stratigraphy of the glacier. Preliminary counting of heavy meltdown lines from air photographs taken during a preflight of the region revealed 115 on a small but measurable exposed portion of the ice. If the glacier distance these 115 lines cover is extrapolated down the glacier to where the ice sample was taken, a speculative minimum date of 400-450 heavy meltdown lines is calculated. If each of the heavy meltdown lines contains 4 - 8 "varved" ice layers as those on Bull Lake Creek glacier, then the ice may be at least 1600 - 2000 years old (If this number of meltdown lines is extrapolated over the remaining downstream glacier ice, at least some ice may exist that is between 2500 and 3000 years old.). The sample of insects was insufficient to use for dating by C-14 that section of the glacier. The ice sample was chopped out of the wall of an excavation made in the surface of the glacier to expose fresh ice.

Potential contamination exists in having used an ice axe for the excavation and polyethylene gloves in the handling of certain ice chips.

Sample No.	Approximate Date of Layer	Notes
14210	0 - 400 A.D.	Ice layer immediately above a meltdown layer containing insects, 350 meters from the toe of the glacier. Potential contamination from use of ice axe and polyethylene gloves.

SURVEYED LINES

The following research was not funded or included in the original proposal. It was initiated at the writer's expense and because of the obvious benefits to this project. In an attempt to research the relative activity of both Knife Point or Bull Lake Creek glaciers, one line each of PVC 1.27 cm pipes was surveyed across them. The survey points were set at 20 m intervals, drilled by hand auger into the ice and a 76 cm long, white PVC pipe pounded down the drill hole until the top was flush with the ice surface. Deviations from this plan were noted. The purpose was to set lines that through resurveying in future years would allow glacier flow and meltdown from the original flush surface to be measured, and thus obtain a preliminary view of their respective glacial regimens.

The line across Bull Lake Creek glacier began at a point on bedrock below the ice terminus to the southeast and was aligned on the left vertical face a sketched peak on the western horizon. The zero point is marked by a cross chiseled into the rock. The 220 meter line stretches diagonally from below the terminous to the upper firn line (See Figure 1) across an ice surface sloping at about 26 degrees. The field check in August, 1986, rediscovered the zero point but there was simply too much snow covering virtually all of the glacier's surface to relocate even one stake of the surveyed line. Similarly, a snowstorm on September 5, 1987, covered the entire glacier and precluded relocating the surveyed line.

The line across Knife Point glacier began on a 7 meter high bedrock point jutting out from the edge of a lower lateral moraine and is aligned with the left edge of a prominent pinnacle on the southwestern horizon. The zero point is marked by a cross chiseled into the rock. The 300 meter line crosses the ice at such an angle that several directions of the presumed direction of flow might be measured (See Figure 1). The ice surface along the line slopes in several directions depending on location. The degree of slope is nowhere more than about 7 degrees. The approximate pattern of flow can be seen in Figure 6.

It is clear that on both glaciers, rocks are sliding down the surface of the ice more rapidly than the ice is moving, and thus some of the survey points may be endangered. None of the rocks appears to be net heat sinks and to be melting into the ice. Rather, they tend to rest on low pedestals of unmelted ice and to slide off them down-glacier. This seems identical to Fryxell's (1933) discovery on Teton glacier.

LABORATORY METHODS

Critical cleaning procedures specified by Boutron (1979b) and Boutron and Patterson (1983) were followed in principle for all sample tubes or equipment that would ultimately come into contact with the samples. Deviations from those procedures follow.

Sampling tubes were tenite butylrate with polyethelene caps. The tubes were cut to length, rinsed with reagent ethanol and diethyl ether to remove any organics, then washed thoroughly with lab detergent and rinsed with distilled water. The sample tubes and equipment (all new) were then immersed 24 hours in a bath of 1:3 JT Baker instra-grade HCl/ reagent grade water, rinsed thoroughly, immersed 24 hours in a bath of 1:3 JT Baker instra-grade HNO_3/reagent grade water and rinsed again. Careful attention was paid to the quality of water used in the acid baths and rinses. Conductance values of this water averaged 0.6 u mho.cm at 25 degrees C. The items were then immersed in 0.4 umho.cm water for 24 hours, followed by four flush rinses with 0.4 umho.cm water. Experiment showed that HNO_3 concentration in rinse water was less than 10 ug/l after four rinses (Birnbaum 1985). Certain clean room preparations were not followed because none were available. It should again be noted, however, that Boutron and Patterson (1979b) developed these methods for Greenland and Antarctic snows, which are 1-3 orders of magnitude less concentrated in elements than Wind River Range snows.

Samples were melted at room temperature. pH and alkalinity determinations were completed within 12 hours. Analytical methods indicated in the proposal were employed with the following exceptions.

The method used for NO_3 analysis was the Keeney still reduction because values were out of range for ion chromatography relative to other anions. NH_3, conductivity and Kjeldahl N were not determined because NO_3 contamination was found.

QUALITY CONTROL

Normal EPA certified laboratory quality control measures were employed for anions and cations. This involved bracketing samples with standards, running duplicate samples, blanks and "spiking" samples with known standard additions. At least ten percent of all samples were standards, duplicates or spikes (total quality control samples were 30%).

Special quality control measures were taken for the trace metals. The sample was carefully transferred to at least three graphite furnace cups. Analyses were run in duplicate on each cup to insure precision and non-contamination. At least six determinations were done on each sample for each trace metal.

After initial cleaning, a container blank was made by partly filling a sample tube with our highest quality water. This container blank was then analyzed as a normal sample. All anion/cation concentrations in the container blank were not detected with the exception of NO_3 (50 ug/l). All trace element concentrations were less than detection limits.

Contamination

Despite the efforts outlined above it was noted very early that approximately two thirds of the samples were contaminated with very small amounts(less than 10mg/l) of NO_3. The data indicate

1. The close correlation with H ion concentrations indicates the source of contamination was probably HNO_3.
2. Although the nitrate contamination was less than 10 mg/l, ion balance calculations show that NO_3 as HNO_3 could also be responsible for pH depressions.
3. The data indicate no other parameters are affected by this contamination problem.

It appears as if the tenite butylrate plastic used for sampling tubes does not rinse uniformly and additional research into the suitability of this material for sampling is needed.

RESULTS AND DISCUSSION

The data are presented in Appendix A. Legends follow each page. Page 1 contains the complete data set, Page 2 presents the mean values for the top snow & ice layers and includes the surface melt layers. Mean values for the top four subsurface snow layers are also shown. No dating is presented because of the obvious imprecision. A discussion of dating was presented in the sampling and stratigraphic notes section.

Results shown on Page 2 are grouped into four areas depending on where each sample was taken. Those groups are: 1) 4 snow layers identified in each pit, 2) ice layers in snow pits, 3) an ice layer sampled outside the pits, and 4) old ice sampled near the ablation area of both Knife Point and Bull Lake Creek glaciers.

Measured concentrations of trace metals ranged from 1-170 ug/l for Al, 0.1 - 3.4 ug/l for Cu, 2 - 120 ug/l for Fe, 0.5 - 20 ug/l for Pb, 0.4 - 37 ug/l for Mn, 0.7 - 23 ug/l for Zn. These values compare very well with Wyoming snow samples taken in 1983-1984. [See proposal]

Good agreement is seen in samples taken side by side within the same snow pit for quality control purposes. Examples are nos. 233 and 231; 214 and 208; 222 and 209; 226 and 224. The elements Ca, Mg, Si, Al and Fe are usually associated with crustal sources and show the highest variance. Less agreement is found in surface melt layer samples. Examples are Nos. 213 and 218.

Comparison with Other Temperate Glacier Data

There are few published values on glacial snow samples in the Rocky Mountains. Mayewski (1980) investigated shallow core glacial chemistry on the Athabasca glacier in central Alberta and reported values ranging from 9.9 ug/l to 178 ug/l for iron, 1.9 ug/l to 6.6 ug/l for PO_4 and 24 to 102 ug/l for SiO_2. These values agree reasonably well with our own. We report four Si numbers that are an order of magnitude higher. It is noteworthy, however, that each of those occur in the surface melt layers. Fe values in sample nos. 235, 238, 215, 211 are suspected to be erroneously high because the sampling technique involved using an ice axe after a porcelain chipper failed. Agreement with data collected by Blanchard (1985) in northwest Colorado is very good.

Most other reported data from the French and Swiss alps.

The most comprehensive comparison can be made with Boutron (1984a) and Briat (1978). Again, measured concentrations in the Wind River Range appear to be in excellent agreement with the upper end of our range for Cu, Pb, Mn, and Zn being somewhat higher than the alpine values. (See Enrichment Factors discussion)

Mayewski (1983) also reported values in fresh Himalayan snows that unfortunately offer comparison only for Fe, SiO_2 and Cl. For Fe Mayewski reported 30 - 670 ug/l, silica 110-2200 ug/l, and for Cl 14-173 ug/l. This data compares reasonably well with Wind River values, however the Fe concentrations in our samples are somewhat lower. This may be the result of a local weathering phenomenon.

Hinkley (1980) reported chemical concentrations of samples taken at Kahiltna glacier, Alaska. A comparison is possible for Pb, K, and Ca. He reported the following ranges: Pb: 0.11 - 0.53 ug/l; K: 4 - 45 ug/l; Ca: 3 - 32 ug/l. These values are considerably lower than ours with the higher concentrations roughly equivalent to our lower concentrations. This is likely due to the remote location of the Alaska site and lack of proximity to any industry. It should also be noted that Hinkely's site is at a much higher latitude and at lower elevation.

Comparison with Other United States Precipitation Data

Comparison with precipitation collected in Minnesota indicates that Wind River precipitation is one fourth to three fourths as concentrated in Al, Fe, Pb, and Mn (Eisenreich 1981). However, Zn is an order of magnitude lower. Eisenreich and Lazrus (1970) reported Zn, Pb, Cu concentrations an order of magnitude higher with Mn twice as concentrated in precipitation samples from 32 stations nationwide.

Comparison with Antarctic and Greenland Snows

Boutron (1979a, 1982, 1984b) and others (Herron 1977, Patterson 1969) have investigated trace metal concentrations in both recent snow and ice cores taken in Antarctica and Greenland. In general we report concentrations for Pb, Mn, and Zn of 1-2 orders of magnitude higher than Greenland. For the elements Cu, Pb, Mn, and Zn we report concentrations 1-2, 2-3, 2-3, 1-3 orders of magnitude higher than Antarctica respectively.

The difference between the concentrations we report and those reported by Boutron (1979b) and Herron (1977) are most likely due to several factors:

1. The proximity of the Wind River sampling site to anthropogenic emissions in the American west. The Wind River site is located at 43 degrees N. latitude. Nriagu (1979) reports that most anthropogenic emissions occur in the northern hemisphere at a latitude of 45 degrees N.
2. The remoteness of the Greenland site, which is located at 70 degrees N. latitude. Few anthropogenic emissions are located this far north. Further, the Greenland site is north of the polar front barrier (Boutron 1984).
3. The pristine character of the Antarctic snows. This is due to the fact that it is located in the southern hemisphere (74 degrees S.) where less than 10% of the anthropogenic emissions occur and is protected by the polar convergence (Boutron 1979). Boutron (1979a) also reports that industrial pollution has had no significant effect on the background atmospheric composition of the southern hemisphere.

Si/Fe Ratios

It is generally accepted that unpolluted continental aerosols have a Si/Fe ratio of approximately 10, while those influenced by anthropogenic sources range around 3 (Rahn 1976, Mayewski 1980). Other researchers have found this value to be closer to 6.5 for the western United States (Flocchini 1981). In the Wind River samples the mean of the top four surface snow melt layers and the top four subsurface layers yields a Si/Fe ratio of 10.8. Ice samples yield a mean ratio of 19 (rejecting those contaminated by sampling with the ice axe). This yield must be interpreted with caution however because of the wide data spread. However, the indication is that the glacial chemistry is not strongly influenced by local emission sources of particulates.

Enrichment Factors

To determine if an element is enriched by anthropogenic emissions Zoller (1974) and Lantzey and Mackenzie (1978) proposed the use of enrichment factors, defined as

$$\boxed{EF = \frac{Cx_p/CAl_p}{Cx_c/CAl_c}}$$

where Cx_p concentration of x in particulates

CAl_p concentration of Al in particulates

Cx_c concentration of x in average crustal rock

CAl_c concentration of Al in average crustal rock

Al is generally used as the reference element when comparing crustal enrichment while sodium is used to compare oceanic enrichment. An EF value close to unity implies a crustal source and insignificant enrichment. EF values greater than 10 are considered to be enriched and suggest there are elemental sources other than crustal weathering and/or there is a release mechanism to the atmosphere for those elements (Lantzey and Mackenzie 1979).

Enrichment factors for the mean top four layers are shown below.

Table 2: Enrichment Factors

	Fe	Na	Mg	K	Ca	Mn	F	Cu	Zn	Pb
EF	1.5	2.7	5.8	6.3	9.1	13	23	100	170	830

For Fe, Na, K, Mg, and Ca, calculated enrichment factors are less than ten and are most likely not enriched. Cu, Zn and Pb on the other hand show higher enrichment factors and may be the result of long range transport from smelting operations. Pb has been shown to be the predominant trace metal in particles emitted from a copper smelter in Salt Lake City (Parungo 1982). Evidence of high Pb deposition in this area has also been found by other researchers (Flocchini 1981; Hale 1984). Pb, Zn, and Cu are also reported to be enriched in copper smelting emissions (Small 1981; Germani 1981; Eatough 1981). Mn and F are more difficult to interpret. F values are almost all at the limit of detection and we therefore hesitate to interpret these low values as enriched. Mn is close enough to the threshold value of ten that enrichment in our opinion would have to be supported by other data.

Historical Trends

No clear trend is seen for trace metals comparing ice and snow concentrations. This may result from on-site contamination or from complex glacial transport processes.

Mean enriched trace metal concentrations in subsurface snow layers correlate well with a trough at layer three (Fig. 11). This observed pattern in the third snow horizon may substantiate observations by others of a decrease in atmospheric deposition due to the fluctuations in smelter emissions (Oppenheimer 1985; Eldred 1983).

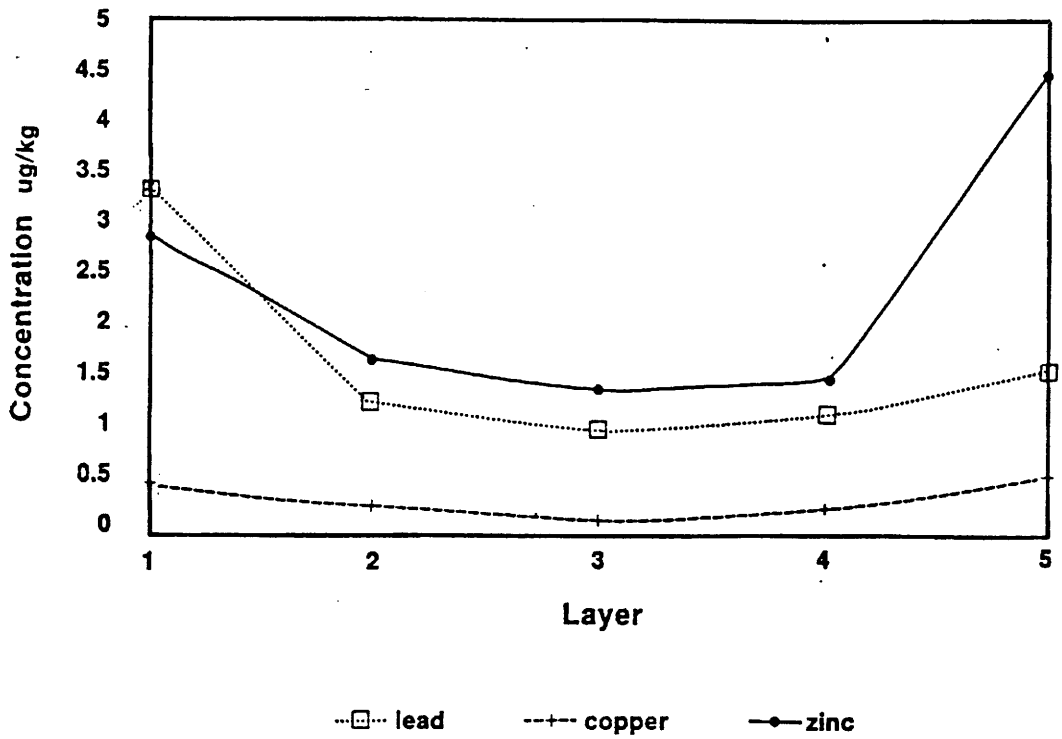


Figure 11. Enriched trace element concentrations.

Local Sources

Air pollution sources in the Green River Basin upwind from our sampling site are primarily restricted to coal fired powër plants, trona (sodium carbonate) refining, fertilizer manufacturing, and natural gas processing facilities.

Se, Ti, and V are trace elements identified as showing high emission rates in fly ash (Andren 1975), high plume to background ratios (Wangen 1981) or highest outlet fly ash concentrations in coal fired power plants (Klein 1975). No Se or V was found in Wind River glacier samples at the limits of detection: 0.2 ug/l and 5 ug/l respectively. Ti analysis was not performed.

Trona refining in the southern Green River Basin emits large quantities of particulates which normally range from a few tenths of one percent to greater than 50 percent by weight sodium. Further, a conservative trace element found in high concentration in trona refining particulates is F (Love, D., 1981) [Data on hi-vol filter analyses from 1977 - 1984 General Chemical Corporation (formerly Allied Chemical Corporation), available from Western Wyoming College Water Quality Laboratory, Rock Springs, Wyoming]. Neither Na or F was found to be present in glacial samples in (significant concentrations). Further, Na and F concentration ratios in glacial samples are inconsistent. Because Na has been found in high concentrations in background particulates in the upper Colorado River Basin (Eatough, 1981), its absence in glacial samples suggests that local fugitive dust plays a minor role in high altitude deposition at this site. Other trace metals found in relatively high abundance in trona refining hi-vol samples are Cr, Ni, Mn, and Zn (Schnauber, 1986). Cr and Ni were not determined. Mn and Zn were determined and found to be enriched. Other processes enrich Mn and Zn, however, and since Na and F values were low, we find little evidence to support the hypothesis that trona refining contributes substantially to aerosol composition in the Wind River Range.

It is interesting to note that an atmosphere diffusion study done for the U.S.F.S. on four new emission sources within the Green River Basin states "Coherent plumes (from the basin) are not expected to surmount the mountains or to impact any other wilderness area." (USFS 1983). This was thought to be due to the large elevation difference and the associated large kinetic energy required to carry particulates out of the basin. "The wind speeds associated with such kinetic energies are expected to be so great as to not be observed normally in the study area."

CONCLUSIONS

1) Surface melt layers are richest in all elements studied except SO_4. This is thought to be the result of dry deposition throughout the year, additional precipitation such as summer rain, concentration of elements particularly those associated with particulates by melting and sublimation. Sublimation has been shown to predominate (Grabczak, 1983). Surface melt layers have higher elemental concentrations and a larger range of values. Subsurface snow samples display greater consistency in the data, but lower elemental concentrations.
2) Little evidence was found of local power plant or trona refining emissions influencing the chemistry of atmospheric deposition on the sampled glacier. Si/Fe ratios confirm there is little to suggest a significant local emission source influencing deposition.
3) Most elements in snow and glacial ice samples taken in the Wind River Range are very dilute. Critical cleaning, use of ultra-pure acids and special sampling techniques are required.
4) Our data indicate Fe, Na, K, Mg, and Ca are not enriched and are probably from crustal sources. The data indicate Cu, Zn, and Pb are enriched. This may support the theory of long range transport of smelter emissions.
5) The historical pattern of trace element concentrations may support observations by others of SO_4 deposition at monitor sites remote from emission sources which they attribute to fluctuations in smelter emissions (Oppenheimer, 1985).
6) Knife Point Glacier has melted back approximately 230 meters since 1963.

RECOMMENDATIONS FOR FUTURE STUDIES

1. Infrared photography and a helicopter could be used to record meltdown lines for a given glacier. It is difficult to safely obtain photographs of particular glaciers from the most advantageous angles in a small plane.
2. If possible, all snow samples should be scooped out of the snow face using the sample tube edge to avoid any contamination. The method of pounding the PVC tube into the snow greatly risks contamination from the smaller PVC pipe used to pull the corer back out as well as contamination from the pounding block, the pounding hammer, and the plunger pushing the sample and sample tube out of the corer. The PVC corer tended to contract slightly with the cold with the result that the sample tube becomes stuck in the corer. Exposure in the sun for a few moments expands it again.
3. If the PVC coring tube is used for sampling procedures in snow too compact to scoop with a sample tube, the PVC need not have cutting surfaces machined on the "cutting" edge.
4. A cleaned plexiglass pounding block should be used to hammer against when pounding in the PVC coring tube, and the smaller PVC pipe extractor has to be kept scrupulously clean during extraction of the corer.
5. If cleanroom garb is to be used, it needs to be considerably outsized to cover the bulky clothing necessary at that altitude to keep warm. Special problems occur with the feet, since crampons must be worn at most times outside of the pit floor. The polyethylene gloves do not keep the hands warm while working with ice and snow.
6. Additional research into the suitability of poly isobutyrate plastic for non-contamination needs to be pursued.

RECOMMENDATIONS FOR FURTHER RESEARCH

1. The summer temperature profiles need somehow to be correlated with the reduction in summer snowcover of the glaciers themselves. This could be approximated if Landsat photo resolution is high enough, but the annual (summer) aerial photo coverage may be limited. A documentation of various governmental agencies overflights may help provide some of the more detailed information on snowmelt and glacier retreat. Certain extensive private photo collections may be the only other way to gain information on relative snow accumulation and melt.

2. The role of cloud cover and relative humidity/sublimation rates should be carefully studied for this area to determine parameters of glacier melting. Certain summer temperature profiles suggest that more melting should be going on, but if there is heavy cloud cover that season, perhaps surprisingly little melting is actually taking place. The long term effects on stream flow of glacier melting in the Wind River Range should be studied.
3. There is a need to duplicate the data in the same glacier, in order to cross check the accuracy of both our field techniques and our laboratory analyses.
4. For a small glacier such as Bull Lake Creek Glacier, it is conceivable that a well-funded, well-equipped expedition might chop a trench completely down the glacier's length, thereby determining precisely how many meltdown layers it contains. With adequate stratigraphic recording, these could be compared with other small glaciers nearby, including two other segments of Bull Lake Creek Glacier itself. In the case of Bull Lake Creek glacier, one would have to dig snow pits or perhaps a trench even further up the glacier, perhaps just below the bergschrund in order to get the most complete snow sequence available. Some of the missing stratigraphic snow years may be preserved in the upper region for two reasons. First, the cirque headwall acts as a windfence for snow deposition and the snowpack is thicker therefore. Second, the upper section tends to be in the shadow of the cirque headwall which retards melting. Not unlike a standard dendrochronology, it might be possible to construct a baseline for past climate by sampling a series of small glaciers.
5. There is a need to examine the snow/ice interface more closely to measure the rate at which snow metamorphoses to ice under this climatic regimen.
6. It would be important to positively identify the particulates because the snowfall/summer melt regimen for 1980, 1981 and 1982 might give a sense of time scale to meltdown complexes.
7. For the purposes of this final report, only the closest weather station, that of Pinedale and Lander have been used. It would be preferable to use several, such as Jackson, Big Piney, Dubois, and Eden/Farson. In this way the missing data for the year 1978 could be extrapolated for Pinedale, and the snowpack data analyzed much more accurately and further back into the past.
8. Additional indicator elements that were not included in this study should be analyzed. Among those are Ti, Cr, and Ni.

9. Additional elements and compounds such as sulfur and oxygen isotopes and certain organics (chlorinated hydrocarbons) should be analyzed in an effort to more precisely date glacial samples.
10. A systematic study of the retreat of the Wind River glaciers should be pursued.

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APPENDIX A

DATA: ELEMENTAL CONCENTRATIONS IN SNOW/ICE
WIND RIVER RANGE GLACIER - THOMPSON/LOVE

all concentrations in micrograms per kilogram

Samp #	Layer	Desc	Na	K	Mg	Ca	Cl	F	SO4	SiO2	P	Al	Cu	Fe	Pb	Mn	Se	V	Zn ug/kg
	Snow																		
234	1	p3 L1sm	40	200	220	630	80	17	29	2000	<1	82	3.4	18	10.0	37.0	<0.2	<5	8.9
233	1	p3 L1a	37	40	25	25	74	<10	150	320	<1	14	0.5	29	5.7	2.2	<0.2	<5	3.1
231	1	p3 L1b	28	40	57	81	80	10	300	300	4	50	0.8	68	3.5	2.2	<0.2	<5	3.1
227	1	p2 L1	27	10	30	84	120	<10	210	88	<1	5	0.1	28	1.1	1.9	<0.2	<5	2.0
207	2	p3 L2sm	32	180	140	520	79	16	<10	1300	1	47	1.9	21	6.5	17.0	<0.2	<5	7.3
214	2	p3 L2a	15	30	37	39	45	11	37	<20	2	14	0.1	16	0.6	0.6	<0.2	<5	0.8
208	2	p3 L2b	15	31	46	58	12	12	38	120	<1	23	0.4	37	2.4	1.0	<0.2	<5	1.4
228	2	p2 L2	10	50	34	91	66	<10	<10	260	<1	8	<0.1	8	0.7	2.6	<0.2	<5	2.5
232	3	p3 L3sm	29	150	110	230	84	14	<10	1100	<1	130	3.0	120	20.0	9.6	<0.2	<5	1.3
222	3	p3 L3a	10	20	75	50	43	<10	<10	<20	<1	2	<0.1	6	0.9	0.4	<0.2	<5	1.6
209	3	p3 L3b	13	30	19	45	51	13	52	160	3	9	0.2	14	1.4	0.5	<0.2	<5	0.9
219	3	p2 L3sm	12	50	44	96	64	11	<10	410	<1	[illegible]	0.2	9	0.8	3.4	<0.2	<5	1.3
225	3	p2 L3	12	10	10	70	41	<10	<10	<20	<1	1	<0.1	2	<0.5	0.7	<0.2	<5	0.7
213	4	p3 L4sma	170	330	190	410	250	16	<10	1800	<1	160	4.0	41	14.0	15.0	<0.2	<5	33.0
218	4	p3 L4smb	310	270	110	180	450	12	52	750	<1	110	7.0	50	11.0	5.1	<0.2	<5	23.0
226	4	p3 L4a	10	30	23	46	77	<10	<10	26	5	21	<0.1	29	1.5	0.9	<0.2	<5	1.1
224	4	p3 L4b	12	20	16	45	53	<10	<10	26	3	76	0.3	16	0.9	0.6	<0.2	<5	0.7
216	4	p2 L4sm	22	50	130	140	56	12	<10	650	<1	71	1.8	29	8.7	5.8	<0.2	<5	5.8
220	4	p2 L4sm	50	80	47	96	84	10	<10	340	<1	27	0.7	66	3.1	4.2	<0.2	<5	3.9
229	4	p2 L4	10	30	18	73	43	<10	10	23	5	9	0.1	16	1.1	1.3	<0.2	<5	2.2
217	4	p1 L4sm	20	20	110	67	54	10	<10	56	<1	6	<0.1	4	0.5	1.0	<0.2	<5	2.2
	Ice																		
221	1	p3 TI	23	40	32	99	97	10	90	<20	8	160	0.5	20	1.7	0.9	<0.2	<5	2.8
230	1	p2 TI	32	30	12	110	85	<10	65	<20	<1	2	0.2	2	0.5	0.9	<0.2	<5	4.7
206	2	p2 I2	110	60	47	170	260	12	60	340	<1	11	0.2	6	0.6	3.7	<0.2	<5	4.4
223	2	p3 I2	97	70	37	24	120	10	62	200	<1	20	0.8	13	2.7	4.0	<0.2	<5	4.4
237	3	p1 I3	120	50	39	170		10		300	<1	35	1.4	41	2.8	3.4	<0.2	<5	7.5
236	4	p1 I4	55	40	28	110	92	<10	<10	110	<1	16	0.9	19	2.0	1.8	<0.2	<5	4.5
235	5	p1 I5	180	120	78	260	240	16	62	790	5	170	3.3	150	12.0	6.3	<0.2	<5	13.0
238	6	p1 I6	88	80	48	180	140	12	28	490	23	130	1.0	150	6.3	5.7	<0.2	<5	3.9
	Ice																		
215	16	OI	96	90	130	320	130	18	170	620	28	120	1.7	170	8.1	9.3	<0.2	<5	8.8
	Old Ice																		
211		OI	31	70	55	97	66	14	52	340	14	94	0.3	130	3.3	5.2	<0.2	<5	8.3
212		OI	75	30	17	87	120	<10	37	<20	<1	7	<0.1	9	1.2	2.0	<0.2	<5	5.5
210		OI KP	58	60	36	51	82	13	88	280	9	65	0.3	7	1.4	2.0	<0.2	<5	5.7

p=sampling pit followed by number

L=sampled layer followed by number (top down)
depth to sampled layer variable

a,b= samples taken side by side in the same layer

I=Ice layer followed by number

OI=Old Ice

KP=sample taken from Knife Point Glacier

sm=surface meltdown

TI=Top Ice

samples 211,215,235,238 taken with ice axe

Mean surface melt layer concentrations (top four melt layers)

Layer	Desc	Na	K	Mg	Ca	Cl	F	SO4	SiO2	P	Al	Cu	Fe	Pb	Mn	Se	V	Zn ug/kg
1	L1M	33	77	33	205	89	7	172	677	1	38	1.2	36	5.1	10.8	0	0	4.3
2	L2M	18	73	64	177	51	10	19	420	1	23	0.6	20	2.6	5.3	0	0	3.0
3	L3M	15	52	52	98	57	9	10	334	1	30	0.7	30	4.6	2.9	0	0	1.2
4	L4M	76	104	81	132	133	8	8	459	2	60	2	31	5.1	4.2	0	0	9.0
	Mean of ice layer concentrations (top four layers)																	
1-4	L1-4M	72	42	33	110	130	7	55	160	1	41	0.6	17	1.7	2.5	0	0	4.7

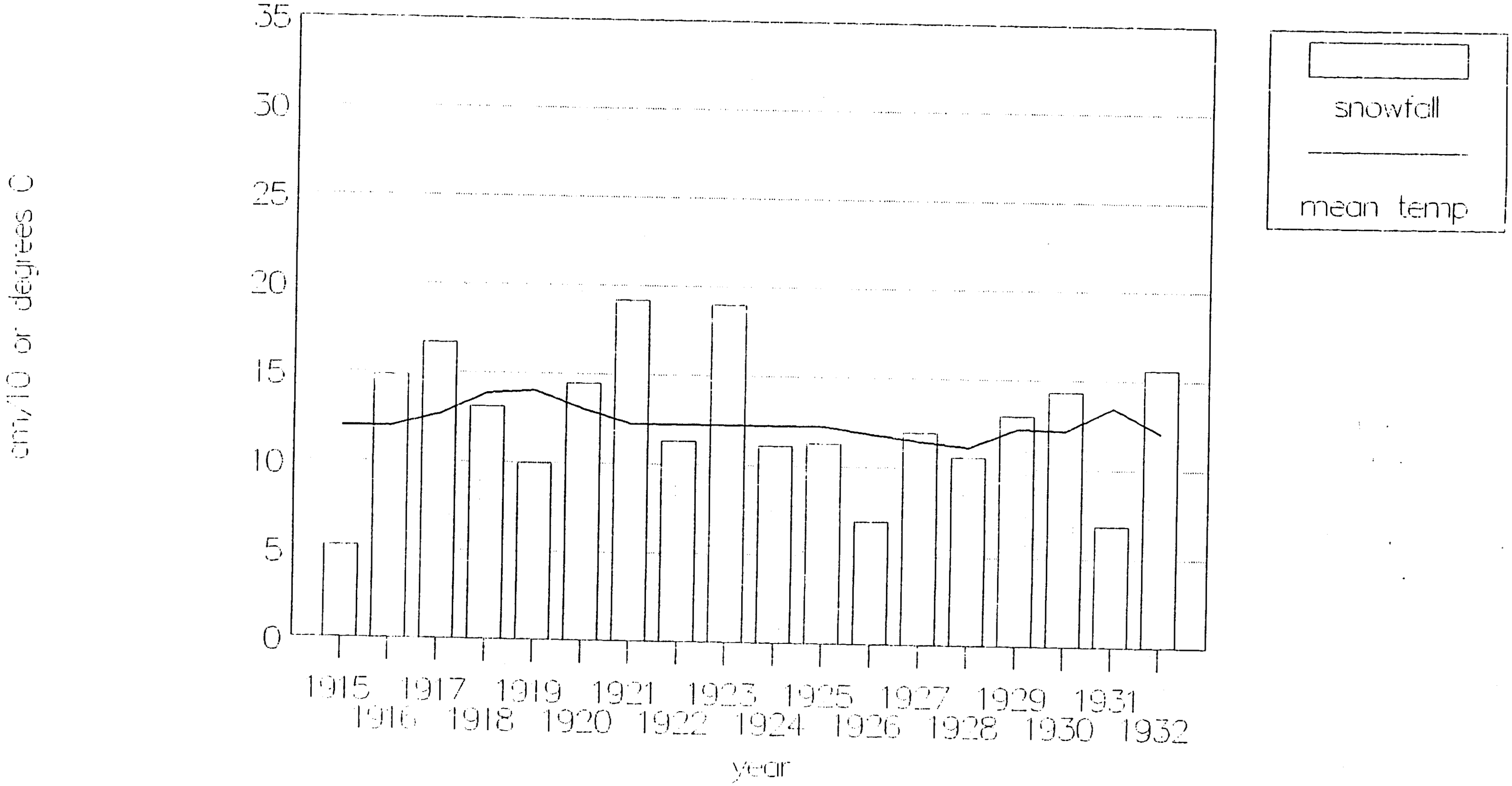
Mean sub-surface snow layer concentrations

Layer	Desc	Na	K	Mg	Ca	Cl	F	SO4	SiO2	P	Al	Cu	Fe	Pb	Mn	Se	V	Zn ug/kg
1	l1ssM	31	31	31	63	91	3	220	236	1	23	0.5	42	3.4	2.1	0	0	2.7
2	l2ssM	13	37	39	63	41	8	25	127	1	15	0.2	20	1.2	1.4	0	0	1.6
3	l3ssM	12	20	20	55	45	4	17	53	1	11	0.1	7	0.8	0.5	0	0	1.1
4	l4ssM	11	27	56	55	58	0	3	25	4	35	0.1	20	1.2	0.9	0	0	1.3

APPENDIX B

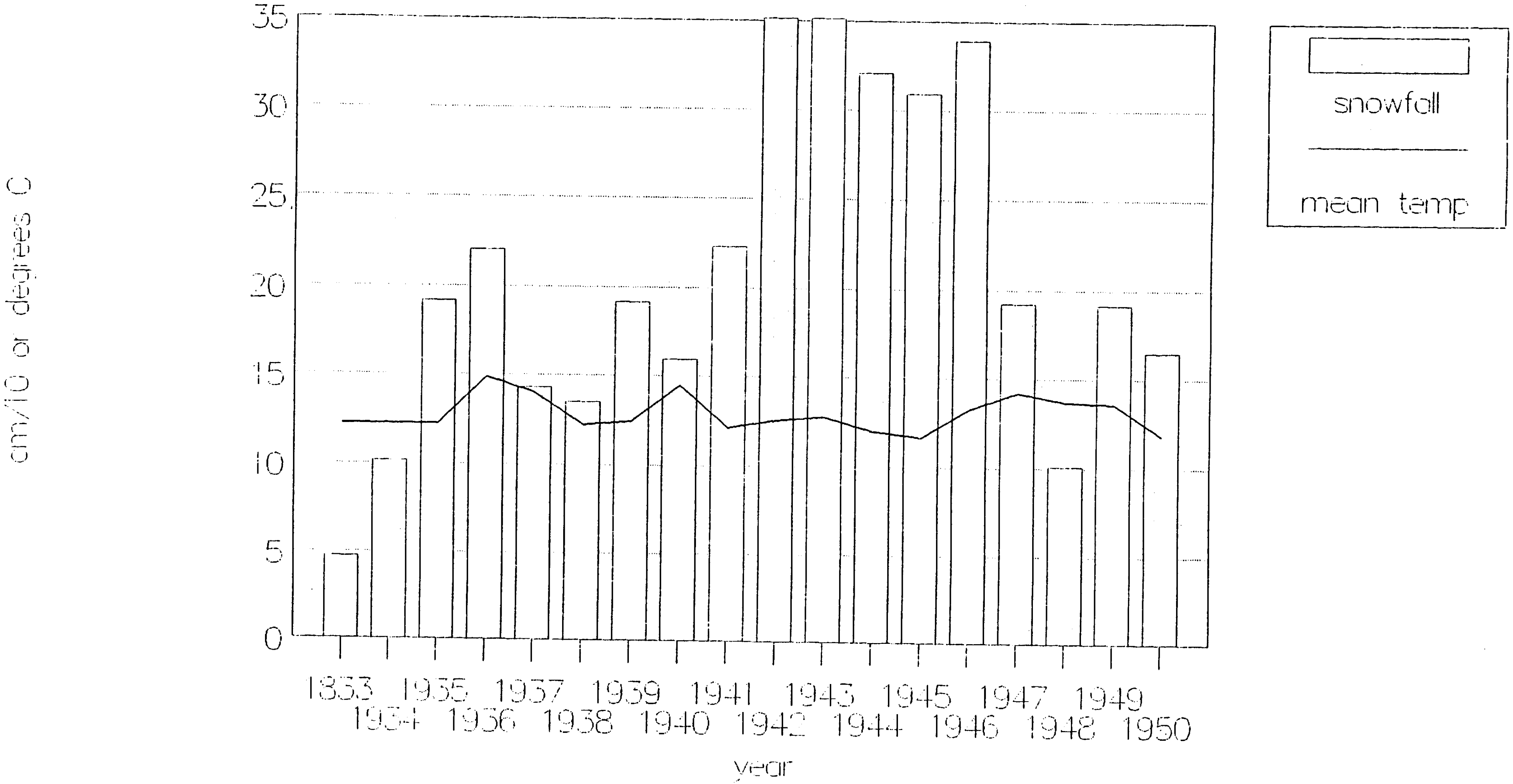
PINEDALE

Snowfall & Mean Summer Temperature



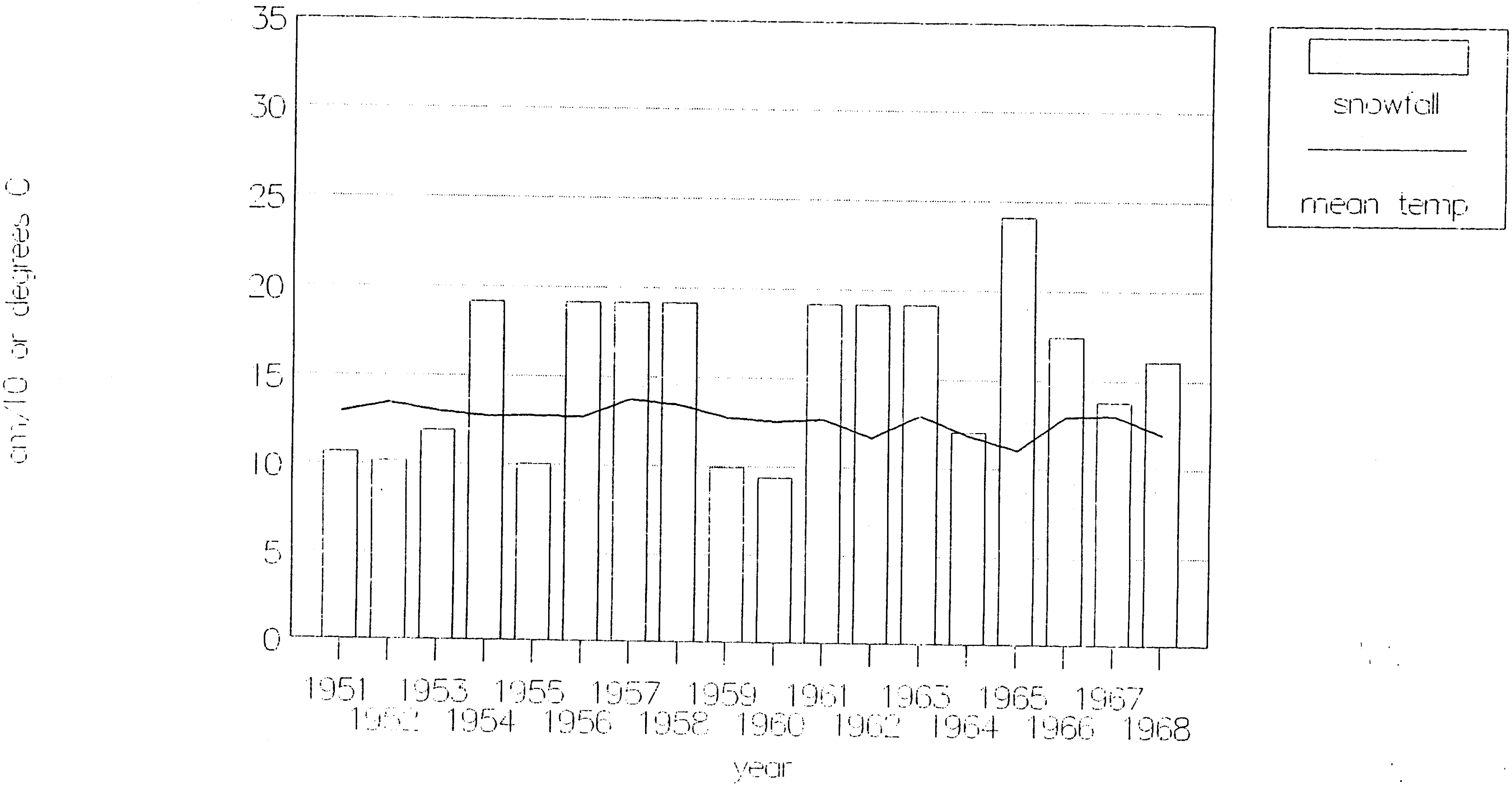
PINEDALE

Snowfall & Mean Summer Temperature



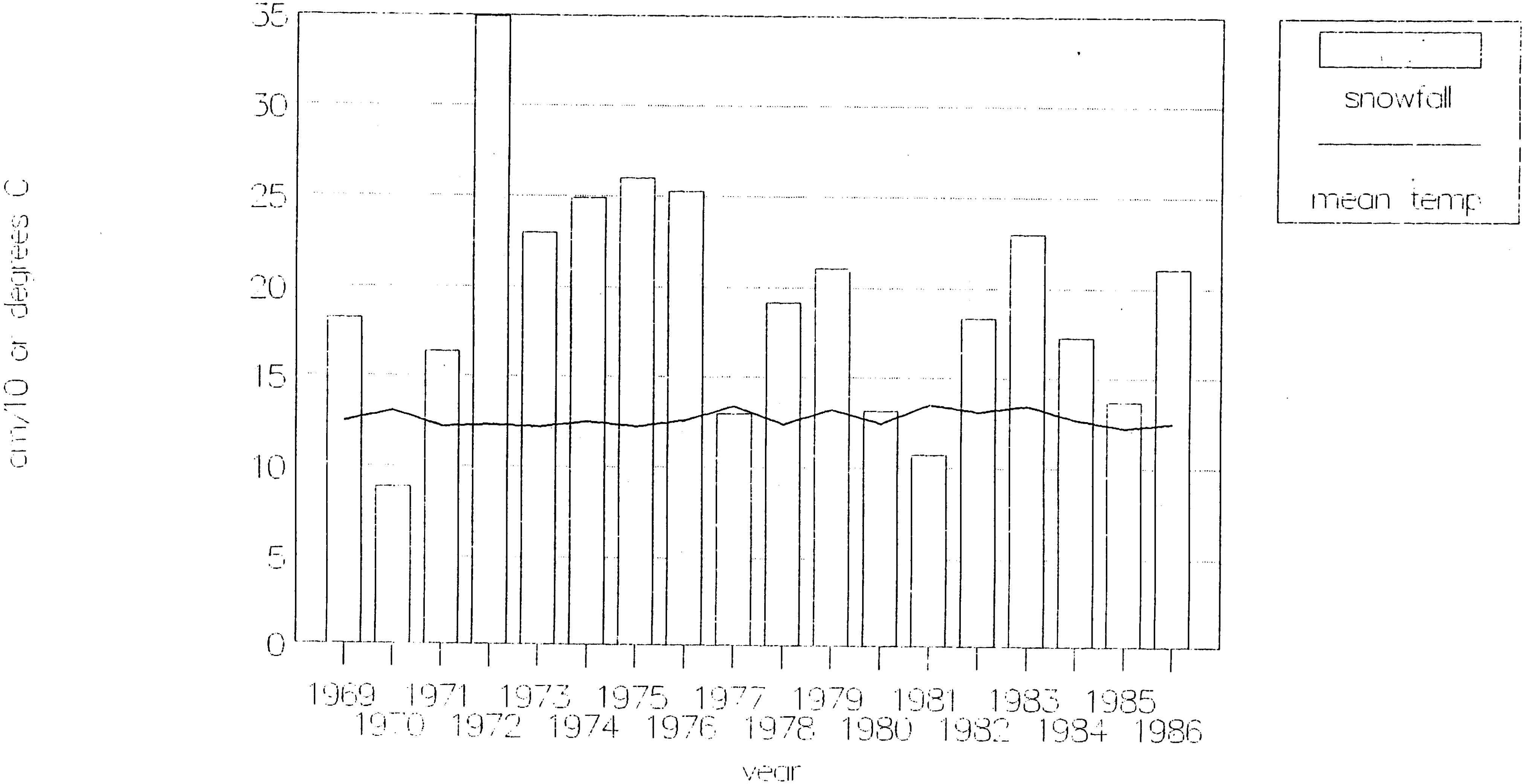
PINEDALE

Snowfall & Mean Summer Temperature



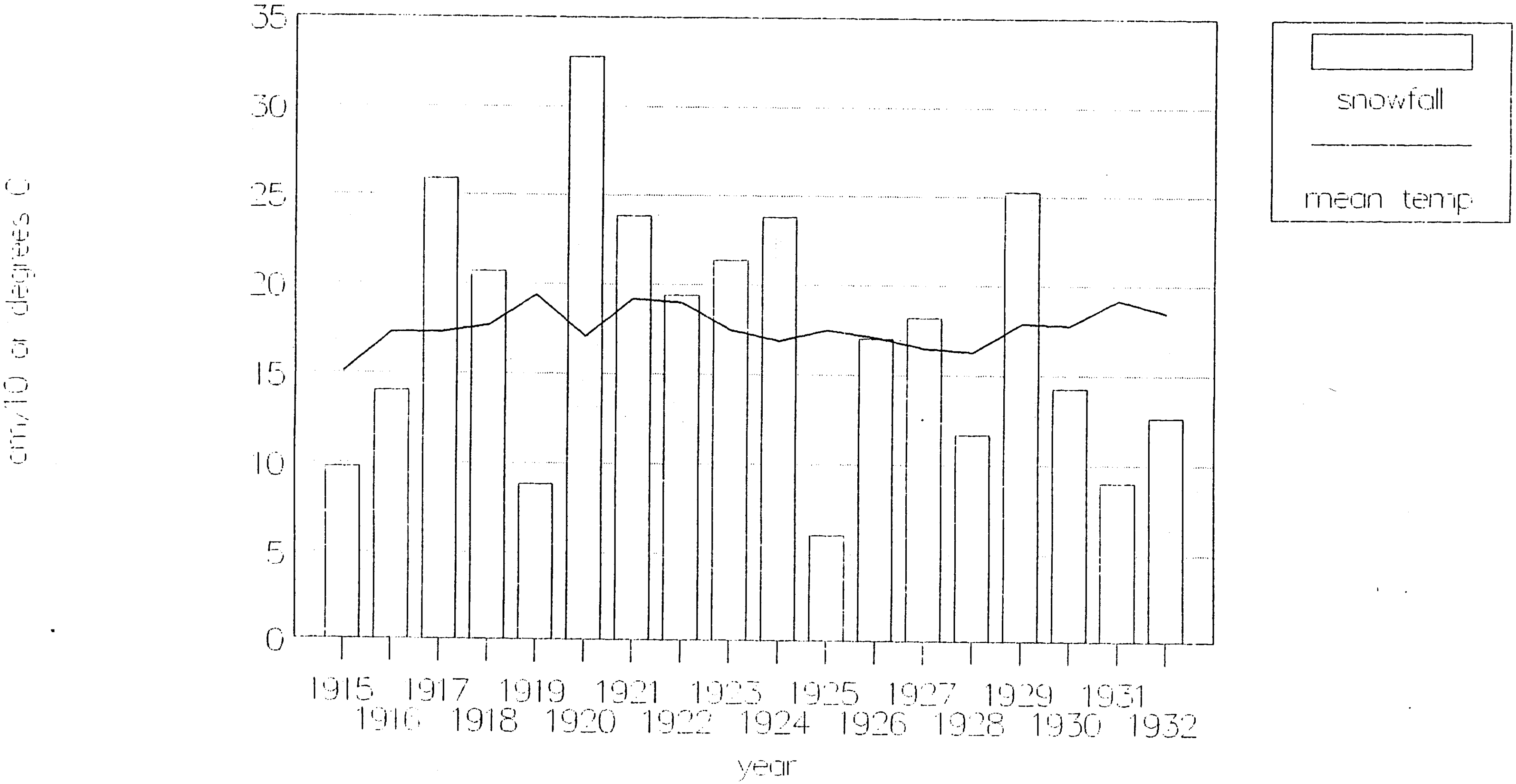
PINEDALE

Snowfall & Mean Summer Temperature



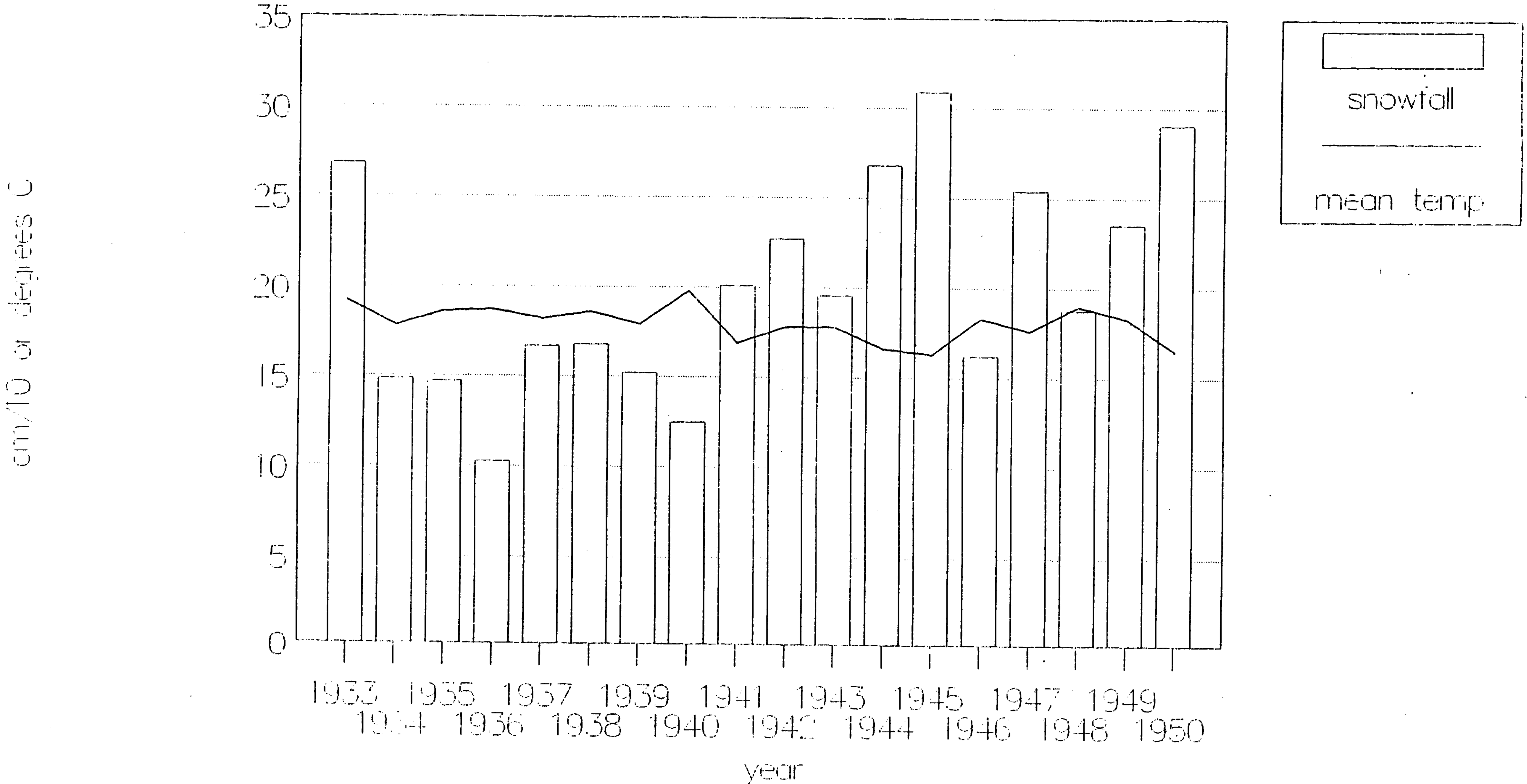
LANDER

Snowfall & Mean Summer Temperature



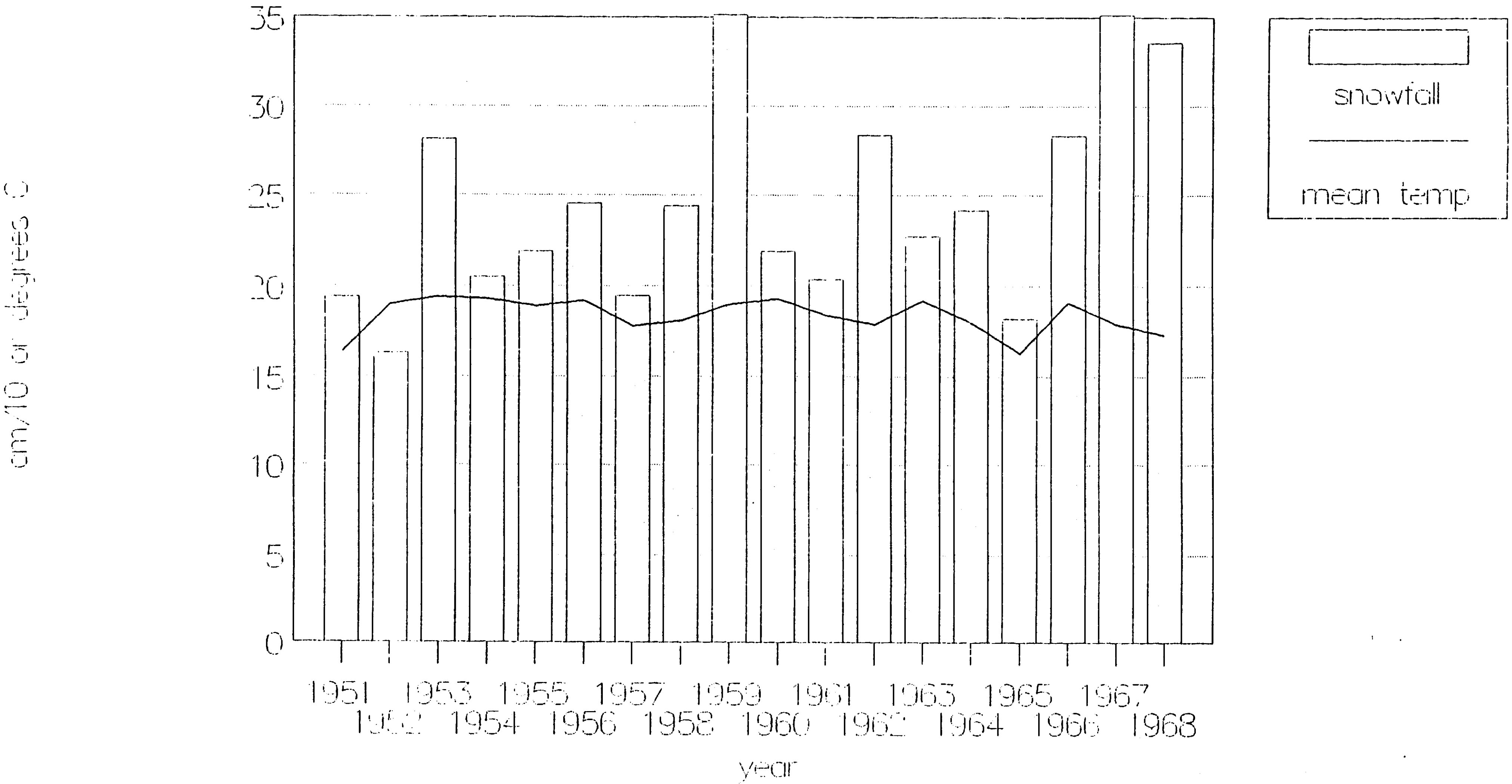
LANDER

Snowfall & Mean Summer Temperature



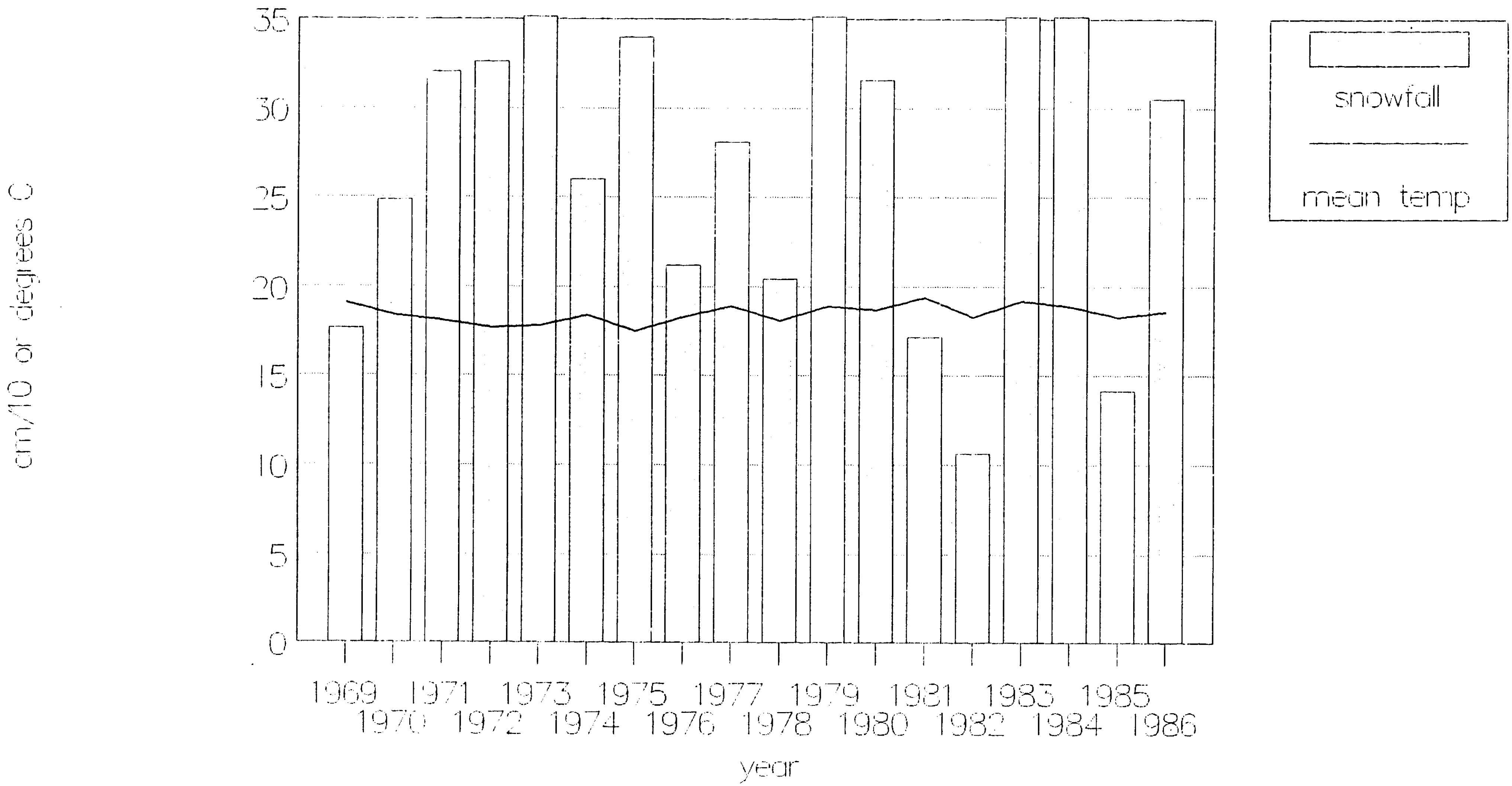
LANDER

Snowfall & Mean Summer Temperature



LANDER

Snowfall & Mean Summer Temperature



Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1986			1985			1984			1983		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	4.27		14.0	3.61		16.8	7.57		16.6	3.35		15.2
Aug	2.72		14.4	0.53		12.8	2.49		15.2	6.45		16.7
Sep	2.87	2.54	7.1	5.84	10.16	7.1	5.41		7.8	4.67		10.3
Oct	2.54		3.9	1.42	10.16	2.8	1.30	12.45	0.3	2.82	.51	5.6
Nov	2.44	43.18	-4.7	4.57	76.71	-8.4	1.47	22.86	-5.2	5.23	45.97	-3.8
Dec	T	T	-10.6	0.79	17.53	-9.7	0.81	25.91	-12.5	3.53	50.55	-13.1
Jan	3.25	44.70	-12.2	0.43	6.35	-9.7	0.97	18.54	-12.6	0.15	.25	-10.0
Feb	1.55	30.73	-8.4	3.94	53.34	-7.1	0.91	18.80	-12.6	1.47	24.13	-9.6
Mar	2.74	35.81	-5.6	0.66	6.10	-1.7	1.24	30.73	-6.9	0.91	10.16	-4.1
Apr	0.64	3.30	3.9	3.56	19.81	2.5	0.74	7.62	3.6	4.01	34.29	0.2
May	8.74		9.7	3.00	10.41	6.6	2.44		7.8	3.94	6.86	7.2
June	1.65		12.8	1.45		14.4	2.13		12.2	3.61		11.2
Sept - May Totals:												
	24.77	160.26		24.21	210.57	12.5	15.29	136.91	12.2	26.73	172.72	12.7
End	1987			1986			1985			1984		

Begin	1982			1981			1980			1979		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	5.59		15.3	1.75		15.6	3.05		15.5	0.53		15.4
Aug	3.63		16.1	1.55		15.3	2.77		12.6	3.18		14.1
Sep	8.89	12.45	9.7	0.51	.51	11.4	2.36		10.0	0.58		11.3
Oct	1.47	3.81	3.1	5.16	12.45	2.9	1.40	4.57	4.5	1.35	1.27	5.3
Nov	2.03	24.89	-5.6	2.03	22.35	-1.4	1.98	24.13	-3.0	1.32	17.27	-6.0
Dec	1.57	18.80	-9.6	2.69	30.73	-7.8	1.40	13.72	-3.3	0.33	4.32	-5.8
Jan	0.84	12.70	-7.5	2.57	30.48	-10.3	1.50	22.35	-4.0	4.83	58.67	-10.7
Feb	1.50	24.38	-8.4	1.07	12.45	-10.4	0.58	8.38	-4.8	1.52	25.40	-6.8
Mar	3.78	38.61	-1.8	2.92	37.34	-3.9	2.08	20.32	-0.3	1.88	20.06	-5.0
Apr	5.03	36.83	-0.3	2.77	16.51	-0.7	1.73	4.57	4.4	1.02	4.57	2.0
May	8.26	57.15	5.5	4.19	11.43	6.3	8.86	9.14	7.2	7.85		7.3
June	3.76		11.6	3.00	8.89	11.4	0.64		11.9	0.84		11.7
Sept - May Totals:												
	33.37	229.62	13.5	23.91	183.14	13.1	21.89	107.18	13.6	20.68	131.56	12.5
End	1983			1982			1981			1980		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1978 Ppt.	Snowfall	Temp.	1977 Ppt.	Snowfall	Temp.	1976 Ppt.	Snowfall	Temp.	1975 Ppt.	Snowfall	Temp.
July	1.35		15.6	3.40		15.8	1.14		15.9	2.82		17.3
Aug	1.57		12.9	4.80		13.3	3.78		13.1	2.31		13.0
Sep	3.58	17.78	9.2	1.78		9.8	3.71		10.2	1.73		8.8
Oct	0.07	T	4.6	U	U	U	0.25		3.3	3.94	33.02	3.1
Nov	3.76	45.85	-6.4	U	U	U	0.28	2.54	-1.7	1.12	21.59	-5.1
Dec	3.28	44.96	-14.0	U	U	U	0.20	2.54	-6.3	1.22	40.64	-6.6
Jan	2.82	48.26	-15.3	U	U	U	1.85	50.80	-9.3	0.58	17.78	-9.5
Feb	1.83	27.69	-10.2	U	U	U	0.15	7.62	-5.0	2.64	91.44	-8.6
Mar	0.53	5.84	-3.9	U	U	U	2.39	40.64	-4.6	0.99	27.94	-7.9
Apr	1.35	5.84	1.1	U	U	U	0.74	13.97	3.6	2.36	17.78	1.6
May	2.11	11.94	7.0	3.99	10.16	6.2	4.32	11.43	6.3	4.45	2.54	8.8
June	1.42	2.29	12.1	0.34		11.8	0.76		14.6	4.27		11.2
Sept - May Totals:	19.33	210.45	13.2	U	U	12.4	13.89	129.54	13.4	19.03	252.73	12.6
End	1979			1978			1977			1976		

Begin	1974 Ppt.	Snowfall	Temp.	1973 Ppt.	Snowfall	Temp.	1972 Ppt.	Snowfall	Temp.	1971 Ppt.	Snowfall	Temp.
July	1.73		15.8	5.44		14.7	0.71		14.3	2.46		13.9
Aug	1.17		12.6	1.47		13.7	4.90		14.3	2.23		15.7
Sep	0.00		8.8	5.21	20.32	8.8	2.21		7.9	2.54		7.4
Oct	3.10	15.24	4.9	2.03	22.86	4.8	4.32	13.97	3.8	5.38	24.13	3.3
Nov	0.05	1.27	-2.4	2.82	38.10	-4.6	2.31	30.48	-4.8	1.14	20.32	-5.5
Dec	1.07	26.16	-8.7	3.15	76.20	-8.2	0.43	27.94	-12.0	2.72	91.44	-13.1
Jan	2.13	69.85	-11.5	0.94	30.48	-12.8	2.31	50.80	-13.5	4.47	172.72	-11.6
Feb	1.63	73.66	-9.2	0.81	24.13	-9.2	1.02	29.21	-11.1	1.07	17.78	-8.7
Mar	2.21	50.80	-4.2	1.09	26.67	-2.4	2.26	46.99	-6.7	1.68	22.86	-2.3
Apr	2.87	15.24	-1.7	1.65	10.16	2.7	1.65	15.24	-1.0	2.64	U	2.3
May	2.74	7.62	5.2	2.03		7.1	2.26	15.24	6.8	2.16		7.6
June	3.02		9.8	0.71		13.0	1.91		11.6	7.37		12.7
Sept - May Totals:	15.80	259.84	12.2	19.73	248.92	12.6	18.77	229.87	12.2	23.80	349.25m	12.3
End	1975			1974			1973			1972		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1970 Ppt.	Snowfall	Temp.	1969 Ppt.	Snowfall	Temp.	1968 Ppt.	Snowfall	Temp.	1967 Ppt.	Snowfall	Temp.
July	4.95		15.4	1.96		14.6	1.85		14.9	2.92		15.7
Aug	4.17		15.2	2.59		14.8	7.87		12.8	1.85		14.8
Sep	2.77		U	1.30		10.4	2.34		8.8	2.46		11.9
Oct	2.24	17.78	0.6	2.51	2.54	-0.6	1.48		3.3	1.98	1.52	4.7
Nov	1.65	17.78	-4.0	U	U	U	3.96	37.34	-5.8	1.27	14.99	-2.8
Dec	1.40	24.89	-10.9	1.07	U	-7.6	4.32	43.94	-11.1	2.11	38.10	-12.3
Jan	2.13	45.21	-8.7	1.70	33.02	-8.9	2.84	23.62	-9.0	0.89	17.78	-11.6
Feb	1.19	22.35	-8.5	0.58	12.70	-6.6	2.51	59.69	-10.7	1.45	29.46	-7.8
Mar	1.37	15.24	-6.2	0.79	12.70	-5.2	0.64	5.08	-8.6	1.07	21.34	-3.8
Apr	3.12	20.32	1.3	2.31	27.94	-1.3	0.86	12.70	3.8	1.65	29.97	-0.8
May	2.44		7.2	2.69		6.6	1.19		9.7	9.50	7.62	5.3
June	1.09		11.3	3.86		12.2	6.27		10.1	7.37		11.4
Sept - May Totals:	18.31	163.57	12.1	12.95m	88.90m		20.14	182.37	12.5	22.38	160.78	12.0
End	1971			1970			1969			1968		

Begin	1966 Ppt.	Snowfall	Temp.	1965 Ppt.	Snowfall	Temp.	1964 Ppt.	Snowfall	Temp.	1963 Ppt.	Snowfall	Temp.
July	0.66		16.6	3.18		15.6	1.47		16.3	0.94		14.9
Aug	2.24		13.7	2.79		12.6	1.73		12.4	4.04		14.4
Sep	4.29		11.1	5.20	9.73	5.7	0.15		8.6	4.72		11.6
Oct	0.50	U	U	0.99		6.7	0.36		4.5	1.88	10.16	6.7
Nov	0.53	U	-1.7	2.77	51.82	-1.3	2.06	40.13	-4.8	1.24	23.37	-2.2
Dec	1.70	36.58	-9.8	1.50	30.48	-9.9	3.63	53.34	-10.3	0.99	16.51	-7.9
Jan	1.78	35.56	-8.2	0.45	9.14	-12.4	1.68	33.53	-8.7	1.40	27.94	-11.8
Feb	1.22	22.86	-9.2	0.74	14.73	-12.0	1.60	32.00	-9.3	1.30	25.91	-11.9
Mar	0.69	13.72	-4.2	1.47	32.51	-5.9	0.76	12.95	-11.4	0.43	5.08	-8.2
Apr	1.83	29.46	1.0	1.52	25.91	0.7	2.16	29.46	1.9	4.57	11.68	0.6
May	6.63	T	4.8	4.06		8.4	6.71	39.62	5.5	2.79		6.6
June	8.43		9.8	5.05		10.5	5.59		10.3	6.68		10.1
Sept - May Totals:	19.17	138.18m	13.1	18.70	174.32	13.0	19.11	241.03	11.1	19.32	120.65	11.9
End	1967			1966			1965			1964		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1962			1961			1960			1959		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	2.57		13.9	0.97		15.5	1.85		15.7	1.29		15.7
Aug	0.33		12.8	2.59		15.3	1.45		12.7	3.71		13.2
Sep	1.27		8.9	4.24		6.4	3.20		10.4	3.53	5.08	8.4
Oct	1.09		5.4	U	U	U	5.84		3.3	0.18	T	3.5
Nov	T	T	-1.3	U	U	U	2.62	28.45	-5.2	0.58	7.62	-2.6
Dec	0.08	1.52	-5.5	U	U	U	U	U	U	0.36	12.95	-6.4
Jan	U	U	-11.6	U	U	U	0.00	0.00	-10.1	0.15	12.19	-11.3
Feb	U	U	-4.8	U	U	U	0.43	U	-6.9	2.95	23.62	-11.9
Mar	U	U	-4.2	U	U	U	0.86	U	-4.7	0.74	10.41	-4.4
Apr	U	U	0.9	U	U	U	0.05	U	0.7	2.72	21.84	2.4
May	4.70?	0.0?	7.6	4.70?	?	7.8	1.30		6.3	0.99	T	6.2
June	2.39?	T?	11.1	2.39?	T?	11.3	0.43		13.7	2.13		11.6
Sept - May Totals:												
	----	----	13.0	----	----	11.7	14.30m	----	12.7	12.20	93.71	12.6
End	1963			1962			1961			1960		

Begin	1958			1957			1956			1955		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	1.70		14.6	2.13		16.1	U		U	1.91		15.8
Aug	1.70		15.9	4.19		15.8	0.07		12.9	2.11		15.1
Sep	1.93		10.2	2.72		10.4	U		U	2.79		9.5
Oct	T		4.7	3.05	U	3.0	U	U	U	1.24	U	4.6
Nov	1.75	15.49	-2.9	2.06e	U	U	U	U	U	1.45	U	-5.2
Dec	1.60	35.56	-7.4	2.51e	U	U	U	U	U	2.39	U	-7.7
Jan	0.48	12.70	-10.7	U	U	U	1.88	U	U	2.92	U	-10.4
Feb	1.19	U	-8.7	U	U	U	1.24e	U	U	1.02	30.48	-13.8
Mar	0.13	U	-5.8	U	U	U	1.40	U	-3.9	1.24	27.94	-6.9
Apr	4.62	34.29	1.4	U	U	U	2.41	U	2.2	U	U	U
May	3.76	1.27	5.2	U	U	U	8.84	T	7.9	U	U	U
June	2.95		13.8	1.57		13.3	2.44		12.8	0.71		12.8
Sept - May Totals:												
	15.46	99.31m	12.8	----	----	13.5	----	----	13.8	13.05m	----	----
End	1959			1958			1957			1956		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1954 Ppt.	Snowfall	Temp.	1953 Ppt.	Snowfall	Temp.	1952 Ppt.	Snowfall	Temp.	1951 Ppt.	Snowfall	Temp.
July	3.71		U	1.27		17.0	1.02		16.1	4.32	T	16.4
Aug	1.80e		U	1.78		13.8	4.57	T	14.9	3.94	T	14.2
Sep	2.34		9.5	0.20	T	9.6	0.51		U	0.25		9.6
Oct	1.02	U	4.3	1.91		4.5	0.00		U	1.78	T	3.3
Nov	T	T	-0.2	0.76		-2.1	2.54e	25.40	-9.8	0.53	7.62	-7.0
Dec	0.25	10.16	-8.8	0.76e	7.62	-9.6	1.02	22.86	-11.3	4.83	40.64	-11.7
Jan	0.61	21.59	-12.3	0.50	10.16g	-8.7	1.40	30.48	-7.4	1.52	22.86	-13.6
Feb	0.66	22.86	-10.9	0.00	0.00g	U	0.76	15.24	-9.1	1.52	15.24	-11.8
Mar	1.02	45.72	-8.3	4.32	U	U	2.03	25.40	-4.9	1.02	15.24	-9.7
Apr	1.12	U	0.4	T	T	U	1.78	7.62g	-0.3	1.02	U	-1.1
May	3.45	T	7.5	3.05	U	U	2.03	U	4.9	0.25	U	5.2
June	2.77		10.8	3.53e		U	3.30	T	11.7	U	U	13.5
Sept - May Totals:	10.47	100.33m	12.8	11.50	----	----	12.07	119.38m	13.25	12.72	101.60m	11.1m
End	1955			1954			1953			1952		

Begin	1950 Ppt.	Snowfall	Temp.	1949 Ppt.	Snowfall	Temp.	1948 Ppt.	Snowfall	Temp.	1947 Ppt.	Snowfall	Temp.
July	2.74		14.2	1.24	T	16.1	0.71		15.6	0.86		18.2
Aug	1.02		13.1	0.58		15.6	2.92		14.3	5.59		15.6
Sep	4.27		9.2	2.46		10.2	1.68		11.6	2.77		11.8
Oct	1.22	4.32	5.8	7.16	5.08	2.2	1.70		4.3	2.44	T	6.1
Nov	1.91	18.54	-4.9	1.27	T	1.6	1.63	T	-6.4	1.63	19.81	-5.4
Dec	1.52e	15.24	-6.8	3.07	U	-8.8	3.10	U	-12.6	0.64	9.14	-7.3
Jan	2.54	33.02	-12.7	4.17	43.18*	-11.9	2.59	U	-16.6	1.35	17.78	-8.6
Feb	1.52	10.16	-8.3	0.91	55.88g	-9.2	1.88	U	-12.3	0.74	9.65	-8.1
Mar	0.25	7.62	-8.0	2.54	33.02g	-5.6	0.84	U	-4.1	2.06	33.27	-6.1
Apr	3.30	17.78	-0.1	3.51	20.32g	0.7	0.13	U	4.1	2.31	3.81	1.9
May	U	U	U	3.43	7.62	5.0	8.28	T	8.6	3.00	7.62	7.8
June	U	U	U	1.80	T	10.9	6.71	T	12.6	6.63		13.4
Sept - May Totals:	16.53m	106.68m	10.1m	28.52	----	11.9	21.83	----	13.6	16.94	101.08	13.7
End	1951			1950			1949			1948		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1946 Ppt.	Snowfall	Temp.	1945 Ppt.	Snowfall	Temp.	1944 Ppt.	Snowfall	Temp.	1943 Ppt.	Snowfall	Temp.
July	0.94		16.4	1.17		15.6	0.94		14.9	1.02		15.6
Aug	1.78		15.4	4.24		14.6	0.00		13.3	3.38	T	14.8
Sep	2.16		9.1	3.02	T	7.9	2.03		9.6	1.22		10.2
Oct	6.40	37.08	1.3	0.64	1.52	5.1	0.61	2.54	5.2	4.24	25.40	5.0
Nov	1.32	17.27	-5.1	4.95	60.96	-6.0	3.71	46.99	-4.1	0.97	12.70	-1.4
Dec	2.64	35.05	-6.0	6.17	83.82	-11.7	3.23	53.34	-9.2	3.66	60.96	-9.1
Jan	1.04	16.51	-12.1	2.95	48.26	-12.9	0.94	15.24	-8.8	1.91	31.75	-11.9
Feb	1.45	21.84	-7.4	2.13	30.48	-10.6	4.65	77.47	-8.7	3.12	52.07	-10.4
Mar	0.84	9.14	-3.4	5.44	62.23	-3.7	2.90	47.75	-5.6	4.50	74.93	-6.7
Apr	4.45	42.67	1.3	0.41	1.27	4.2	4.37	66.04	-1.3	4.22	60.96	0.9
May	7.06	12.70	8.6	2.92	50.80	5.6	3.15	T	7.1	3.51	2.54	7.7
June	2.84		11.2	2.67		12.3	6.05		8.7	6.71		10.3
Sept - May Totals:	27.36	192.26	14.2	28.63	339.34	13.3	25.59	309.37	11.7	27.35	321.31	12.0
End	1947			1946			1945			1944		

Begin	1942 Ppt.	Snowfall	Temp.	1941 Ppt.	Snowfall	Temp.	1940 Ppt.	Snowfall	Temp.	1939 Ppt.	Snowfall	Temp.
July	2.18		15.8	2.90		15.4	1.27		16.4	3.63		15.8
Aug	0.28		14.1	2.41		14.7	0.86		15.2	0.36		13.8
Sep	1.78	T	10.4	3.10	T	6.7	6.43		11.1	2.82		9.9
Oct	1.75	15.24	4.1	4.88	16.26	2.1	3.07	20.32	4.7	0.51	T	3.8
Nov	6.25	93.98	-2.9	1.98	25.40	-2.9	2.01	33.27	-6.0	T	T	-0.9
Dec	4.72	78.74	-9.3	4.72	104.14	-8.0	2.59	43.18	-9.5	0.61	10.16	-5.3
Jan	7.47	124.46	-11.4	4.37	71.12	-13.8	1.83	30.48	-12.4	4.04	67.31	-12.8
Feb	2.13	35.56	-8.8	1.83	30.48	-14.7	1.40	43.18	-8.4	4.42	69.85	-7.3
Mar	4.65	77.47	-7.9	1.42	17.78	-8.5	1.14	19.05	-4.7	0.79	5.59	-2.7
Apr	4.01	96.52	4.8	1.93	25.40	1.8	6.35	30.99	1.2	3.30	6.35	2.7
May	1.55	7.62	6.2	9.32	116.84	5.0	1.73	2.54	8.4	2.11	T	9.9
June	2.59	15.24	10.5	0.64		10.0	6.96		11.8	1.85		15.2
Sept - May Totals:	34.31	544.83	12.8	33.55	407.42	12.6	26.55	223.01	12.2	18.60	159.26	14.5
End	1943			1942			1941			1940		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1938 Ppt.	Snowfall	Temp.	1937 Ppt.	Snowfall	Temp.	1936 Ppt.	Snowfall	Temp.	1935 Ppt.	Snowfall	Temp.
July	U	U	U	10.57		16.2	5.72		18.1	U	U	U
Aug	U	U	U	0.15		16.3	1.55		16.2	U	U	U
Sep	U	U	U	1.37	T	12.1	1.91		10.1	U	U	U
Oct	U	U	U	2.51	0.25	5.9	2.36	0.50	4.1	U	U	U
Nov	U	U	U	1.78	25.54	-3.2	0.25	4.32	-1.2	U	U	U
Dec	U	U	U	4.88	69.60	-9.3	3.28	50.29	-7.4	U	U	U
Jan	2.29	38.10	-10.4	U	U	U	1.22	20.57	-17.1	6.07	67.56	-10.2
Feb	U	U	U	0.79	13.21	-7.6	2.90	30.48	-12.2	8.33	94.49	-9.7
Mar	0.21	3.81	-4.4	1.47	19.56	-3.6	1.32	11.94	-6.3	4.75	58.42	-6.3
Apr	0.71	T	3.9	1.19	4.57	1.9	1.50	13.46	-0.8	2.62e		U
May	3.12		8.5	3.35	2.54	7.3	2.62		8.3	0.79e		U
June	2.18	1.27	10.3	U		U	4.29	11.43	11.5	5.21		15.1
Sept - May Totals:												
	----	----	----	17.34m	135.27m	----	17.36	142.99	14.0	22.56*	220.47*	14.9
End	1939			1938			1937			1936		

Begin	1934 Ppt.	Snowfall	Temp.	1933 Ppt.	Snowfall	Temp.	1932 Ppt.	Snowfall	Temp.	1931 Ppt.	Snowfall	Temp.
July	U	U	U	U	U	U	2.26		14.3	0.74		16.1
Aug	U	U	U	U	U	U	2.64		12.3	1.27		14.6
Sep	U	U	U	U	U	U	0.36		10.0	0.94	T	9.6
Oct	U	U	U	U	U	U	1.42	10.16	2.7	2.13	5.08	4.2
Nov	U	U	U	U	U	U	3.30	7.11	-2.0	0.76	10.92	-5.6
Dec	U	U	U	1.78	28.45	-5.6	3.99	29.97	-14.8	1.32	13.21	-10.4
Jan	U	U	U	0.76	12.19	-7.5	U	U	U	1.17	19.05	-13.6
Feb	U	U	U	1.88	42.16	-2.8	U	U	U	1.40	18.54	-9.3
Mar	U	U	U	1.12	19.05	1.0	U	U	U	0.86	5.33	-6.4
Apr	U	U	U	U	U	U	U	U	U	4.06e	40.64e	U
May	U	U	U	U	U	U	U	U	U	4.32e	43.18e	U
June	U	U	U	U	U	U	U	U	U	6.96	T	U
Sept - May Totals:												
	----	----	----	5.54*	101.85*	----	9.07*	47.24*	----	16.96	155.95	9.2m
End	1935			1934			1933			1932		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1930 Ppt.	Snowfall	Temp.	1929 Ppt.	Snowfall	Temp.	1928 Ppt.	Snowfall	Temp.	1927 Ppt.	Snowfall	Temp.
July	4.19		15.8	1.35		16.0	2.77		14.4	1.80		14.4
Aug	11.33		14.3	2.24		15.3	1.40		12.2	2.49		12.0
Sep	1.93		8.4	5.92	15.24	7.7	0.07		9.3	8.46	12.70	8.2
Oct	4.72	8.89	2.0	2.34	5.08	3.8	4.39	33.02	3.4	1.27	2.54	3.8
Nov	0.36	6.60	-3.5	0.20	3.81	-4.2	1.35	13.97	-2.9	2.62	29.21	-0.8
Dec	0.25	T	-7.2	0.43	4.83	-5.6	0.94	15.75	-10.8	1.60	27.43	-12.1
Jan	0.20	5.08	-7.3	2.74	36.83	-18.1	0.79	9.65	-12.8	0.91	10.92	-7.5
Feb	0.36	8.38	-4.2	2.39	28.19	-6.2	1.42	17.53	-13.1	0.79	10.41	-9.7
Mar	0.53	8.89	-3.4	2.44	39.37	-5.3	2.87	34.29	-5.6	0.81	3.05	-4.1
Apr	2.31	30.48	2.2	2.34		4.8	1.42	3.05	-1.1	0.69	10.16	-0.7
May	2.16	T	6.7	8.15	10.16	5.7	0.56	2.54	5.7	1.93		8.8
June	0.64		13.6	2.57		10.3	0.79		10.0	5.64		8.9
Sept - May Totals:	12.81	68.32	13.5	26.95	143.51	12.2	13.81	129.80	12.3	10.62	106.42	11.2
End	1931			1930			1929			1928		

Begin	1926 Ppt.	Snowfall	Temp.	1925 Ppt.	Snowfall	Temp.	1924 Ppt.	Snowfall	Temp.	1923 Ppt.	Snowfall	Temp.
July	4.06		14.8	U	U	U	U	U	U	U	U	U
Aug	3.53		13.6	2.69		U	U	U	U	U	U	U
Sep	3.33		6.7	7.92		U	U	U	U	U	U	U
Oct	0.07		3.9	U	U	U	6.53	U	U	U	U	U
Nov	2.62	30.48	-1.2	U	U	U	U	U	U	U	U	U
Dec	0.84	16.51	-10.2	0.97	12.95	-6.3	3.07	44.20	-13.7	1.30	20.32	U
Jan	0.66	12.95	-10.2	1.32	13.46	-10.7	1.80	30.48	-12.1	1.07	16.00	-12.9
Feb	1.63	32.51	-9.1	0.69	11.43	-6.9	0.51	8.89	-7.8	0.18	1.78	-5.3
Mar	0.94	19.81	-6.2	1.02	13.97	-4.6	1.75	20.32	-1.5	2.91	45.72	-7.7
Apr	1.68	7.62	0.2	2.44	12.45	3.7	3.12	9.14	3.3	2.36	27.43	0.7
May	2.46		4.4	2.41	5.08	7.4	2.92		U	U	U	U
June	3.18		11.4	2.16		12.3	4.65		U	U	U	U
Sept - May Totals:	14.23	119.88	11.5	16.77m	69.34m	11.9	19.70m	113.03*		7.82*	111.25*	
End	1927			1926			1925			1924		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1922			1921			1920			1919		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	1.88		U	0.89		U	1.35		15.9	U		U
Aug	8.33		U	U	U	U	2.06		15.2	0.79		15.1
Sep	1.09		U	U	U	U	U	U	U	2.11		11.4
Oct	2.13	15.24	U	1.96	U	U	U	U	U	2.87		0.1
Nov	1.93	27.94	U	U	U	-4.3	2.57	U	U	3.35	30.48	-6.0
Dec	2.44	30.99	U	4.22	50.55	U	U	U	-8.8	2.03	34.29	-11.9
Jan	2.90	43.18	-9.6	2.06	19.56	-16.0	U	U	-10.1	1.02	12.70	-8.8
Feb	1.17	22.35	U	2.46	27.94	-14.7	1.04	13.97	-8.8	1.80	22.86	-7.9
Mar	2.72	43.18	U	U	U	U	U	U	U	1.70	19.05	-6.7
Apr	0.97	6.86	U	1.96	15.24	-2.1	U	U	U	2.06	25.40	U
May	3.23	T	U	2.08		7.2	3.23	T	U	1.42		7.3
June	U	U	U	1.14		U	3.00		U	1.47		11.7
Sept - May Totals:	18.58	189.74	----	14.74*	113.29*	----	----	-----		18.36	144.78	10.7m
End	1923			1922			1921			1920		

Begin	1918			1917			1916			1915		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	5.94		15.7	U	U	U	2.46		17.4	2.92		14.0
Aug	1.65		13.6	2.34		14.1	5.21		14.4	0.43		15.2
Sep	2.92	T	10.8	5.69	2.54	10.4	0.02	0.02	8.9	8.89		8.5
Oct	3.99	4.83	5.2	0.91	10.16	3.7	3.40	31.24	3.4	T	T	3.7
Nov	0.64	7.11	-4.7	2.44	20.32	0.3	0.30	5.08	-4.3	0.58	4.57	-3.4
Dec	0.41	3.30	-8.5	2.74	27.18	-4.9	3.86	46.99	-11.7	1.55	19.05	-10.4
Jan	T	T	-8.4	1.68	19.05	-9.3	2.67	18.29	-14.2	4.47	55.12	-16.4
Feb	3.33	49.53	-9.9	3.28	41.91	U	3.28	31.75	-10.1	2.79	25.40	-8.2
Mar	1.73	20.83	-4.8	0.46	T	-3.0	0.91	10.67	-10.6	3.45	34.29	-3.3
Apr	2.57	13.97	4.2	1.24	10.16	0.3	0.94	16.76	-1.7	0.48	2.54	0.7
May	0.86		9.1	2.21	T	6.1	6.10	4.57	5.7	2.16	7.62	3.1
June	0.25		14.0	1.19		15.4	0.25	1.27	10.5	0.33		10.0
Sept - May Totals:	16.45	99.57	10.2m	20.65	131.32	13.9	21.48	166.64	8.8m	24.37	148.59	12.7
End	1919			1918			1917			1916		

Precipitation and Temperature Data in metric for Pinedale, Wyoming, elevation 2190m (7186').

Begin	1914 Ppt.	Snowfall	Temp.
July			
Aug			
Sep			
Oct			
Nov			
Dec			
Jan			
Feb	0.76	10.41	-6.0
Mar	1.85	26.67	-2.6
Apr	1.22	T	6.8
May	5.94	15.24	5.0
June	3.15	T	10.2
Sept - May Totals:	9.77*	52.32*	12.0

Pindale winter snowfall from Sept. to May, and summer average temperatures from June to Sept.

Year	Snowfall	Temp	ppt/av.ppt ratio	ppt/med.ppt ratio
1915	52.32*	11.98	.27	.32
1916	148.59	12.68	.78	.90
1917	166.64	12.67e	.87	1.10
1918	131.32	13.88	.69	.80
1919	99.57	14.04e	.52	.61
1920	144.78	13.07e	.76	.88
1921	------	-----	----	----
1922	113.29*	-----	.59	.70
1923	189.74	-----	.99	1.15
1924	111.25*	-----	.58	.68
1925	113.03*	-----	.59	.69
1926	69.34m	11.85	.36	.42
1927	119.88	11.50	.63	.73
1928	106.42	11.20	.56	.65
1929	129.80	12.25	.68	.79
1930	143.51	12.20	.75	.87
1931	68.32	13.48	.36	.42
1932	155.95	12.08e	.82	.95
1933	47.24*	-----	.25	.29
1934	101.85*	-----	.53	.62
1935	------	-----	----	----
1936	220.47*	14.88	1.15	1.34
1937	142.99	14.03	.75	.87
1938	135.27m	-----	.71	.82
1939	------	12.45	----	----
1940	159.26	14.48	.83	.97
1941	223.01	12.15	1.17	1.36
1942	407.42	12.58	2.13	2.48
1943	544.83	12.78	2.85	3.62
1944	321.31	12.03	1.68	1.96
1945	309.37	11.70	1.62	1.88
1946	339.34	13.30	1.78	2.06
1947	192.26	14.20	1.01	1.17
1948	101.08	13.73	.53	.62
1949	------	13.63	----	----
1950	165.10	11.85	.86	1.00
1951	106.68m	12.98e	.56	.65
1952	101.60m	13.49e	.53	.62
1953	119.38	13.03	.63	.73
1954	------	-----	----	----
1955	100.33m	12.80	.53	.61
1956	------	-----	----	----
1957	------	13.78	----	----
1958	------	13.50	----	----
1959	99.31m	12.78	.52	.60
1960	93.71	12.60	.49	.57
1961	------	12.73	----	----
1962	------	11.73	----	----
1963	------	13.00	----	----

Pindale winter snowfall from Sept. to May, and summer average temperatures from June to Sept. Continued.

Year	Snowfall	Temp	ppt/av.ppt ratio	ppt/med.ppt ratio
1964	120.65	11.85	.63	.73
1965	241.03	11.05	1.26	1.47
1966	174.32	12.98	.91	1.06
1967	138.18m	13.05	.73	.84
1968	160.78	11.98	.84	.98
1969	182.37	12.48	.95	1.11
1970	88.90m	13.07e	.47	.54
1971	163.57	12.08	.86	1.00
1972	349.25	12.30	1.83	2.13
1973	229.87	12.20	1.20	1.40
1974	248.92	12.48	1.30	1.51
1975	259.84	12.23	1.36	1.58
1976	252.73	12.60	1.32	1.54
1977	129.54	13.38	.68	.79
1978	------	12.38	----	----
1979	210.45	13.23	1.10	1.28
1980	131.56	12.45	.69	.80
1981	107.18	13.53	.56	.66
1982	183.14	13.13	.96	1.11
1983	229.62	13.45	1.20	1.40
1984	172.72	12.70	.90	1.05
1985	136.91	12.23	.72	.83
1986	210.57	12.50	1.10	1.28
1987	160.26			

Temperature average for June, July, August, and September for those years without any estimates is 674.52/ 53 years

Years not represented are 18, or 18+53=71 18/71/=25.35% so roughly one fourth of the years aren't represented.

Average snowfall in cm is 8618.57/45 years = 191.52 cm per year for the years where a complete record is available.

Precipitation data uses only 45 of 72 years, the 27 not included have either no data, or as much as two months not represented. Thus 37.5% of the years "recorded" are not represented. Snowfall is not the same as precipitation.

Lowest average summer temperature:	11.05	(1965)
Highest average summer temperature:	14.88	(1936)
Lowest winter snowfall:	68.32cm	(1931)
Highest winter snowfall:	544.83cm	(1943)

Rank of year's snowfall in Pinedale for whole measured years.

Heaviest snow year

Year	Snowfall	Temp	ppt/av.ppt ratio	ppt/med.ppt ratio
1943	544.83	12.8	2.85	3.62
1942	407.42	12.6	2.13	2.48
1972	349.25	12.3	1.83	2.13
1946	339.34	13.3	1.78	2.06
1944	321.31	12.0	1.68	1.96
1945	309.37	11.7	1.62	1.88
1975	259.84	12.2	1.36	1.58
1976	252.73	12.6	1.32	1.54
1974	248.92	12.5	1.30	1.51
1965	241.03	11.1	1.26	1.47
1973	229.87	12.2	1.20	1.40
1983	229.62	13.5	1.20	1.40
1941	223.01	12.2	1.17	1.36
1979	210.45	13.2	1.10	1.28
1986	209.94	12.5	1.10	1.28
1947	192.26	14.2	1.01	1.17
1923	189.74	----	.99	1.15
1982	183.14	13.1	.96	1.11
1969	182.37	12.5	.95	1.11
1966	174.32	13.0	.91	1.06
1984	172.72	12.7	.90	1.05
1917	166.64	12.7e	.87	1.10
1950	165.10	11.6	.86	1.00
1971	163.57	12.1	.86	1.00
1968	160.78	12.0	.84	.98
1987	160.26		.84	.98
1940	159.26	14.5	.83	.97
1932	155.95	12.1e	.82	.95
1916	148.59	12.7	.78	.90
1920	144.78	13.1e	.76	.88
1930	143.51	12.2	.75	.87
1937	142.99	14.0	.75	.87
1985	136.91	12.2	.72	.83
1980	131.56	12.5	.69	.80
1918	131.32	13.9	.69	.80
1929	129.80	12.3	.68	.79
1977	129.54	13.4	.68	.79
1964	120.65	11.9	.63	.73
1927	119.88	11.5	.63	.73
1953	119.38	13.0	.63	.73
1981	107.81	13.5	.56	.66
1928	106.42	11.2	.56	.65
1948	101.08	13.7	.53	.62
1919	99.57	14.0e	.52	.61
1960	93.71	12.6	.49	.57
1931	68.32	13.5	.36	.42

Rank of other years of Pinedale snowfall * = three months or more of Sept. - May data missing. m = one or two months of Sept. - May data missing.

Year	Snowfall	Temp	ppt/av.ppt ratio	ppt/med.ppt ratio
1936	220.47*	14.9	1.15	1.34
1922	113.29*	----	.59	.70
1925	113.03*	----	.59	.69
1924	111.25*	----	.58	.68
1934	101.85*	----	.53	.62
1915	52.32*	12.0	.27	.32
1933	47.24*	----	.25	.29
1967	138.18m	13.1	.73	.84
1938	135.27m	----	.71	.82
1951	106.68m	13.0e	.56	.65
1952	101.60m	13.5e	.53	.62
1955	100.33m	12.8	.53	.61
1959	99.31m	12.8	.52	.60
1970	88.90m	13.1e	.47	.54
1926	69.34m	11.9	.36	.42

No snowfall data for

Year	Temp
1921	----
1935	----
1939	12.5
1949	13.6
1954	----
1956	----
1957	13.8
1958	13.5
1961	12.7
1962	11.7
1963	13.0
1978	12.4

Preipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1986 Ppt.	Snowfall	Temp.	1985 Ppt.	Snowfall	Temp.	1984 Ppt.	Snowfall	Temp.	1983 Ppt.	Snowfall	Temp.
July	2.26		20.4	2.54		23.2	3.91		22.9	0.51		21.1
Aug	1.63		21.0	0.18		19.5	3.07		22.4	0.81		23.3
Sep	1.12		12.9	4.42	19.30	11.8	2.64	8.89	12.8	1.27	4.83	16.1
Oct	7.19	30.23	7.7	0.41	5.59	7.4	1.47	26.42	5.3	1.45	3.05	9.4
Nov	2.79	44.45	-0.4	3.94	82.04	-7.9	1.22	22.10	0.1	8.56	123.70	-2.1
Dec	0.56	13.46	-7.3	4.11	71.12	-8.8	0.18	5.84	-6.4	1.52	30.23	-14.4
Jan	2.01	35.81	-8.4	0.76	12.45	-5.6	1.43	23.11	-8.8	2.41	45.72	-8.8
Feb	4.39	83.06	-2.2	2.64	35.05	-4.1	0.66	11.94	-4.2	2.59	44.20	-6.4
Mar	5.72	67.82	0.1	1.24	14.48	6.7	1.22	21.84	2.2	2.03	41.40	-0.5
Apr	3.45	44.45	10.4	5.46	36.58	7.2	2.11	21.34	9.1	9.17	115.32	4.6
May	6.02	T	14.2	2.55	28.70	11.4	2.11		15.1	0.69	2.79	13.3
June	3.53		18.8	0.69		20.1	4.32		18.6	3.07		17.3
Sept - May Totals:												
		319.28		25.53	305.31	18.6	13.04	141.48	18.3	30.05	411.24	18.9
End	1987			1986			1985			1984		

Begin	1982 Ppt.	Snowfall	Temp.	1981 Ppt.	Snowfall	Temp.	1980 Ppt.	Snowfall	Temp.	1979 Ppt.	Snowfall	Temp.
July	3.71		21.4	2.24		21.8	0.79		22.3	0.46		21.5
Aug	0.81		22.9	2.34		20.9	0.69		19.2	5.84		19.2
Sep	9.73	83.57	12.9	1.55		16.8	0.17		15.5	0.03		17.7
Oct	2.08	7.87	6.8	1.55	0.51	6.5	3.58	22.61	8.4	1.22	13.46	9.9
Nov	1.50	28.45	-1.4	0.13	4.57	3.2	1.79	28.19	-0.4	1.45	25.40	-3.3
Dec	3.66	57.40	-7.6	0.13	4.32	-2.7	0.56	10.41	1.3	2.77	51.82	-3.9
Jan	0.20	3.30	-3.2	1.12	20.57	-5.5	1.70	38.10	-1.9	2.41	66.55	-10.0
Feb	1.24	12.19	-2.2	0.25	7.11	-3.7	0.69	15.49	-2.7	1.37	26.92	-3.7
Mar	5.38	61.21	-2.3	1.18	18.80	2.1	5.03	39.62	4.1	3.81	64.52	0.3
Apr	8.48	109.98	3.3	1.93	19.56	5.2	2.82	17.27	9.1	4.27	32.00	7.2
May	7.67	56.90	9.2	3.96	30.73	11.1	8.13	T	11.3	8.43	35.31	11.2
June	2.79		16.4	3.43		16.1	0.10		18.2	0.13		17.8
Sept - May Totals:												
	39.94	420.87	19.2	11.80	106.17	18.3	24.47	171.69	19.4	25.76	315.98	18.7
End	1983			1982			1981			1980		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1978 Ppt.	Snowfall	Temp.	1977 Ppt.	Snowfall	Temp.	1976 Ppt.	Snowfall	Temp.	1975 Ppt.	Snowfall	Temp.
July	2.08		21.0	6.35		21.5	2.67		22.5	0.74		21.9
Aug	0.64		19.2	1.19		18.5	1.02		19.4	0.25		19.3
Sep	2.97	7.62	15.2	0.46		15.4	1.37		15.4	0.96		14.4
Oct	1.65	11.94	8.9	2.31	9.40	8.9	4.24	33.78	6.4	3.48	40.39	8.2
Nov	5.46	98.55	-6.3	1.65	32.51	0.0	1.02	24.89	0.9	1.93	37.85	-1.8
Dec	3.10	64.52	-12.7	0.84	19.56	-3.2	0.51	15.49	-3.7	2.01	50.04	-4.7
Jan	1.91	40.39	-17.1	1.50	23.62	-8.1	1.35	23.11	-8.9	0.69	12.45	-7.1
Feb	0.13	2.79	-6.5	1.27	23.11	-5.6	0.28	6.60	-0.4	2.08	42.42	-2.7
Mar	1.41	23.62	1.0	1.07	10.41	3.5	8.38	132.08	-0.8	1.09	19.30	0.2
Apr	4.29	72.64	6.7	3.25	T	7.4	3.73	42.16	8.2	2.97	3.30	6.7
May	7.62	76.96	10.8	13.11	85.60	9.4	2.82	2.79	11.8	5.31	6.10	12.6
June	2.11	6.60	17.2	0.41		16.9	1.68		20.2	5.00		15.8
Sept - May Totals:	28.54	405.63	18.9	25.46	204.21	18.1	23.70	280.90	18.9	20.52	211.85	18.3
End	1979			1978			1977			1976		

Begin	1974 Ppt.	Snowfall	Temp.	1973 Ppt.	Snowfall	Temp.	1972 Ppt.	Snowfall	Temp.	1971 Ppt.	Snowfall	Temp.
July	1.19		22.5	5.33		20.3	1.12		19.4	0.69		20.2
Aug	1.68		18.4	0.84		21.1	2.57		19.6	0.69		22.6
Sep	2.72	16.76	13.4	11.89	T	12.1	0.23		13.8	5.77	25.65	11.9
Oct	5.13	8.64	8.9	3.73	40.89	8.9	5.99	48.51	6.6	9.09	101.35	5.0
Nov	0.48	10.16	1.1	1.88	34.29	-0.1	2.26	38.35	-2.3	1.04	23.62	-2.8
Dec	1.68	24.38	-6.9	1.65	31.50	-3.6	3.71	69.09	-10.8	0.91	16.76	-5.8
Jan	1.88	26.92	-6.2	1.09	18.29	-7.7	2.26	65.28	-12.6	2.74	47.50	-6.9
Feb	1.09	20.57	-5.1	2.51	46.48	-2.7	0.71	23.11	-10.2	1.40	27.18	-2.5
Mar	3.00	58.17	-0.1	1.42	32.51	2.2	7.67	125.73	-3.1	0.97	11.68	4.9
Apr	4.27	88.14	2.7	5.97	55.37	6.5	10.21	167.64	1.2	5.49	72.39	6.3
May	11.28	86.11	8.9	0.79	0.51	10.8	2.31	19.30	11.4	5.23		11.1
June	4.78		14.5	0.76		19.1	0.56		17.6	1.78		17.8
Sept - May Totals:	31.53	339.85	17.5	30.93	259.84	18.4	35.35	557.01	17.8	32.64	326.13	17.7
End	1975			1974			1973			1972		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1970 Ppt.	Snowfall	Temp.	1969 Ppt.	Snowfall	Temp.	1968 Ppt.	Snowfall	Temp.	1967 Ppt.	Snowfall	Temp.
July	1.02		21.7	0.20		21.9	0.80		20.9	2.30		20.6
Aug	T		22.7	0.60		22.8	7.70		18.1	0.30		20.7
Sep	1.68	17.02	11.9	T		17.7	1.20		13.8	3.50		15.9
Oct	3.78	52.32	5.1	3.70	12.40	3.2	0.40	1.30	8.8	0.50	3.60	8.9
Nov	1.91	19.05	0.2	2.50	19.80	1.1	1.20	20.80	-0.9	4.20	53.30	-2.2
Dec	0.97	22.86	-5.9	1.30	14.50	-3.6	1.80	31.90	-8.1	2.80	66.80	-9.4
Jan	0.91	17.53	-3.1	0.20	4.80	-4.2	0.30	5.10	-3.7	0.40	6.10	-9.2
Feb	1.14	32.00	-3.3	T	T	0.9	0.30	11.90	-2.2	1.50	25.10	-4.1
Mar	2.16	41.15	0.3	5.60	102.40	-1.3	2.30	54.10	-1.4	4.20	67.30	2.4
Apr	13.26	114.81	5.0	6.50	94.50	2.7	5.90	48.50	8.3	6.20	100.30	3.7
May	12.57	3.81	10.5	1.20	T	12.4	2.60		13.9	5.50	13.20	9.7
June	T		17.7	5.80		17.2	13.40	3.00	13.8	9.90		16.2
Sept - May Totals:												
	38.38	320.55	18.1	21.00	248.40	18.4	29.40	176.60	19.1	28.80	335.70	17.3
End	1971			1970			1969			1968		

Begin	1966 Ppt.	Snowfall	Temp.	1965 Ppt.	Snowfall	Temp.	1964 Ppt.	Snowfall	Temp.	1963 Ppt.	Snowfall	Temp.
July	0.70		23.7	4.20		21.1	0.90		23.4	0.10		21.6
Aug	4.50		19.7	0.50		19.5	0.40		19.3	1.40		21.0
Sep	1.80	T	16.3	6.70	59.90	8.6	1.40		14.2	0.50		17.5
Oct	5.50	67.30	6.2	0.90		11.1	0.90	7.60	9.2	0.90	6.10	12.0
Nov	1.30	16.80	1.2	1.10	13.20	3.7	1.00	21.30	0.3	0.30	4.60	2.4
Dec	1.00	18.50	-4.1	1.10	30.50	-3.4	0.20	1.00	-3.9	1.50	32.80	-7.1
Jan	0.60	13.20	-3.0	0.70	23.60	-5.2	0.50	9.40	-1.3	1.10	21.10	-6.4
Feb	3.00	54.40	-4.3	0.80	17.80	-4.3	2.10	39.90	-4.4	3.00	62.50	-5.7
Mar	1.90	45.20	2.6	2.20	47.50	1.7	1.10	25.90	-4.6	2.00	38.40	-2.9
Apr	6.40	94.00	5.2	5.60	87.10	4.4	4.10	36.10	7.4	7.50	72.40	5.1
May	10.10	62.20	10.0	2.00	3.60	13.7	8.00	40.60	9.8	8.70	3.80	11.9
June	12.90		14.2	3.30		16.8	5.30		15.8	5.30		15.1
Sept - May Totals:												
	31.60	371.60	17.9	21.10	283.20	19.1	19.30	181.80	16.3	25.50	241.70	18.0
End	1967			1966			1965			1964		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1962 Ppt.	Snowfall	Temp.	1961 Ppt.	Snowfall	Temp.	1960 Ppt.	Snowfall	Temp.	1959 Ppt.	Snowfall	Temp.
July	4.40		20.2	1.00		21.7	0.71		22.7	0.38		21.6
Aug	0.10		19.8	1.10		22.0	T		20.1	0.18		21.6
Sep	1.40	6.10	15.2	4.00	10.20	10.3	2.67		16.1	3.07	5.84	13.7
Oct	2.80		10.9	7.60	98.00	5.8	4.95	16.76	8.4	3.35	32.51	6.6
Nov	0.50	5.30	2.9	2.30	54.40	-4.9	3.56	48.51	-0.8	2.03	43.43	-2.5
Dec	0.60	11.40	-2.3	0.50	8.40	-7.9	0.97	25.15	-6.6	1.73	27.94	-3.4
Jan	2.90	45.20	-13.9	3.40	67.30	-13.0	0.30	6.40	-5.5	1.83	32.26	-7.8
Feb	0.80	10.70	1.2	1.00	16.00	-4.1	3.00	53.60	-1.6	1.35	24.64	-7.1
Mar	4.30	75.70	0.8	1.40	22.10	-0.4	1.70	19.80	2.3	0.89	19.30	0.1
Apr	8.60	72.90	5.1	4.90	7.10	8.4	2.20	33.30	5.4	2.72	33.02	7.4
May	1.50		13.1	9.00		12.2	5.60		12.1	1.98	T	12.5
June	9.80		16.7	1.20		16.3	1.20		19.4	1.47		18.2
Sept - May Totals:	23.40	227.30	19.2	43.10	283.50	17.9	24.95	203.52	18.4	18.95	218.94	19.3
End	1963			1962			1961			1960		

Begin	1958 Ppt.	Snowfall	Temp.	1957 Ppt.	Snowfall	Temp.	1956 Ppt.	Snowfall	Temp.	1955 Ppt.	Snowfall	Temp.
July	2.59		18.7	1.70		21.2	0.94		21.3	2.77		22.3
Aug	1.88		21.5	2.59		21.1	0.99		19.6	0.79		22.3
Sep	0.38	T	15.4	4.47	9.14	13.4	0.25		16.2	3.30	13.72	15.3
Oct	0.25		9.7	2.41		7.9	1.60	1.78	9.4	1.45	15.49	9.8
Nov	3.86	81.79	-0.4	5.28	82.55	-3.9	3.02	48.77	-1.6	1.98	13.72	-2.9
Dec	0.84	12.70	-3.2	0.36	8.13	-1.7	0.84	14.73	-3.4	3.84	50.55	-4.5
Jan	1.93	36.58	-6.4	0.41	8.64	-5.0	0.38	4.32	-9.6	1.70	22.10	-5.6
Feb	2.16	48.51	-6.1	0.84	12.45	0.5	0.10	0.76	0.3	1.12	20.06	-8.4
Mar	5.51	87.63	0.5	2.49	46.74	-1.4	2.74	16.51	1.7	1.57	28.45	0.4
Apr	3.15	48.01	6.3	6.25	75.69	5.1	13.87	102.62	3.3	4.98	53.34	5.6
May	7.24	51.56	9.4	13.26	0.76	14.3	15.32	5.08	10.8	9.25	27.94	12.9
June	1.12		18.9	3.66		16.7	6.32		15.6	T		19.5
Sept - May Totals:	25.32	366.78	19.0	35.77	244.10	18.1	38.12	194.57	17.8	29.19	245.37	19.2
End	1959			1958			1957			1956		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1954 Ppt.	Snowfall	Temp.	1953 Ppt.	Snowfall	Temp.	1952 Ppt.	Snowfall	Temp.	1951 Ppt.	Snowfall	Temp.
July	2.29		23.8	0.33		23.1	1.85	T	20.6	2.24		20.6
Aug	0.36		20.8	1.88		20.9	1.17	T	20.4	1.22		19.4
Sep	0.46	T	16.2	0.25		16.6	0.03		17.3	2.69	T	13.0
Oct	1.98	16.76	7.3	2.85	4.32	9.8	0.76	6.86	10.1	3.68	4.06	6.3
Nov	0.38	10.67	3.9	2.16	29.46	2.9	1.63	26.42	-3.1	0.41	10.92	-0.7
Dec	0.08	2.03	-3.5	1.14	25.40	-3.8	0.56	9.40	-4.8	0.69	18.03	-6.7
Jan	0.13	1.78	-5.1	1.17	17.02	-2.7	1.68	24.13	-0.1	T	T	-5.9
Feb	5.54	111.25	-7.3	0.33	3.30	2.4	4.37	86.11	-4.3	3.00	62.48	-4.3
Mar	1.70	32.00	-3.3	4.70	83.06	-2.3	2.95	35.05	1.6	3.23	56.64	-2.8
Apr	3.81	44.45	5.2	2.69	36.83	8.2	7.14	60.71	3.7	5.21	9.65	8.3
May	3.00	T	12.5	1.63	5.33	11.8	7.16	32.26	8.5	11.25	1.27	11.8
June	4.90	T	15.7	0.23		16.5	1.30	T	17.1	2.90		17.8
Sept - May Totals:	17.08	218.94	18.9	16.92	204.72	19.3	26.28	280.94	19.4	30.16	163.05	19.0
End	1955			1954			1953			1952		

Begin	1950 Ppt.	Snowfall	Temp.	1949 Ppt.	Snowfall	Temp.	1948 Ppt.	Snowfall	Temp.	1947 Ppt.	Snowfall	Temp.
July	1.78	T	18.6	1.47	T	21.4	2.51		21.1	0.51		21.4
Aug	0.28		19.4	0.23		21.2	0.91		20.7	1.37		20.2
Sep	11.73	T	12.7	1.60	T	14.7	1.85		16.9	1.60	T	15.5
Oct	0.41	2.79	10.7	7.92	70.61	4.2	2.11	7.62	8.1	5.36	32.26	9.6
Nov	1.91	27.18	-0.6	0.03	0.25	5.9	3.12	52.58	-1.7	2.26	33.78	-3.0
Dec	0.36	8.64	-0.1	2.18	41.66	-6.2	1.50	22.36	-7.6	1.30	21.34	-4.2
Jan	0.46	8.13	-6.4	0.97	12.95	-7.9	4.19	61.21	-16.9	2.36	34.29	-6.9
Feb	1.63	29.21	-2.3	0.46	8.64	-0.2	0.99	12.19	-7.6	1.91	19.81	-6.7
Mar	2.84	37.08	-1.2	1.50	24.13	0.0	4.78	51.31	0.5	2.79	46.23	-3.1
Apr	4.24	24.64	4.8	4.90	35.56	5.4	2.51	13.72	9.1	1.98	T	6.7
May	11.10	10.67	11.2	8.66	70.36	7.7	7.11	14.48	12.1	1.52	T	12.4
June	4.45	45.47	12.7	6.30	26.16	15.1	3.35		15.7	5.08		17.4
Sept - May Totals:	34.68	193.81	16.4	34.52*	290.32	16.5	28.16	235.47	18.3	21.08	187.71	19.0
End	1951			1950			1949			1948		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1946 Ppt.	Snowfall	Temp.	1945 Ppt.	Snowfall	Temp.	1944 Ppt.	Snowfall	Temp.	1943 Ppt.	Snowfall	Temp.
July	1.19		22.2	0.33		20.8	2.69		19.0	0.20		21.1
Aug	0.99		20.2	1.40		19.4	T		19.2	0.36		20.3
Sep	3.66	3.56	13.6	4.11	14.73	11.8	5.89	30.48	13.8	1.24		14.7
Oct	7.29	53.59	4.2	1.04	7.87	9.8	1.22	10.16	9.0	2.69	21.59	8.8
Nov	1.85	22.10	-1.1	5.03	59.18	-1.2	3.71	41.91	-3.7	1.35	9.14	1.7
Dec	0.30	4.32	-1.0	0.30	5.59	-8.1	1.40	19.81	-11.7	2.26	26.16	-6.5
Jan	0.53	5.84	-7.0	0.79	13.21	-4.3	0.94	13.46	-6.6	2.39	30.73	-11.6
Feb	0.97	14.22	-7.4	0.10	0.76	-1.6	1.35	15.49	-4.4	2.72	42.42	-8.7
Mar	2.03	32.51	0.7	2.77	32.51	3.9	3.30	22.61	0.5	6.45	69.09	-3.0
Apr	7.11	44.96	4.9	1.19	T	9.9	12.75	149.61	0.8	13.34	59.44	5.0
May	9.53	25.91	12.2	7.90	28.19	9.3	4.62	2.78	11.7	4.80	9.40	12.1
June	17.48	46.74	13.1	4.24		17.1	4.88	2.54	13.0	5.13		14.3
Sept - May Totals:												
	50.75*	253.75	17.6	23.23	162.04	18.3	40.06*	308.85	16.3	37.24	267.97	16.6
End	1947			1946			1945			1944		

Begin	1942 Ppt.	Snowfall	Temp.	1941 Ppt.	Snowfall	Temp.	1940 Ppt.	Snowfall	Temp.	1939 Ppt.	Snowfall	Temp.
July	0.71		21.8	2.90		20.4	0.69		22.6	0.89		21.9
Aug	0.20		19.8	5.05		19.2	1.32		21.0	0.51		19.5
Sep	4.27	4.32	13.8	4.42	2.54	11.4	4.39		16.6	1.63		14.8
Oct	8.64	16.00	7.6	6.48	31.50	5.7	0.81		10.0	0.79	2.29	8.8
Nov	5.97	58.93	-1.4	2.18	16.00	1.7	4.29	45.12	-4.3	0.00		2.2
Dec	0.28	5.33	-2.6	1.91	26.92	-3.8	1.09	12.19	-4.9	0.18	1.78	-0.3
Jan	2.64	21.59	-5.4	1.40	16.00	-11.9	0.38	3.81	-6.2	1.30	13.72	-9.9
Feb	0.86	8.13	-0.4	3.10	32.00	-10.2	1.68	16.00	-3.7	2.67	28.45	-3.7
Mar	2.39	25.65	-3.5	2.03	21.08	-0.6	6.81	61.72	-1.1	2.59	24.64	3.7
Apr	7.39	16.51	9.9	3.43	9.91	8.4	13.51	55.37	5.1	8.74	54.10	6.4
May	4.62	27.69	9.9	10.77	71.12	9.8	2.49	6.60	13.2	3.12		13.6
June	2.54	11.43	15.1	0.10		15.6	4.67		16.6	0.91		19.1
Sept - May Totals:												
	39.70*	195.58	17.8	35.72	227.07	17.8	35.45	200.81	16.9	21.02	124.98	19.8
End	1943			1942			1941			1940		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1938			1937			1936			1935		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	1.98		20.3	7.09		20.8	5.79		23.0	0.74		22.1
Aug	1.42		19.3	0.30		21.1	2.77		19.2	0.89		20.1
Sep	1.65		16.8	0.28	2.29	15.6	2.44	7.62	13.7	1.24		15.3
Oct	3.12	14.99	9.3	2.51	1.27	9.4	6.99	16.26	6.9	0.74	2.54	7.7
Nov	4.57	49.28	-4.3	1.45	16.26	0.1	0.89	11.18	-0.1	1.24	16.51	-1.7
Dec	1.12	15.24	-4.4	2.57	26.42	-5.4	0.81	12.70	-4.0	1.24	13.21	-6.1
Jan	0.71	8.13	-3.8	1.60	12.45	-5.5	0.99	12.95	-17.2	0.66	7.37	-5.2
Feb	3.05	35.56	-10.7	0.36	3.05	-1.9	0.84	7.62	-4.7	1.45	18.29	-11.1
Mar	1.27	11.43	-1.8	4.22	39.88	1.1	3.63	34.29	-0.3	3.35	36.32	0.9
Apr	2.03	17.53	8.1	7.32	45.97	6.8	6.55	42.42	5.2	3.53	8.38	6.9
May	7.11	T	13.6	4.55	20.06	10.6	5.66		12.9	2.11		14.6
June	2.03		15.2	0.36		18.0	9.35	21.59	15.4	4.50		19.0
Sept - May Totals:	24.63	152.16	17.9	24.86	167.65	18.6	38.15*	166.63	18.2	15.56	102.62	18.7
End	1939			1938			1937			1936		

Begin	1934			1933			1932			1931		
	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.	Ppt.	Snowfall	Temp.
July	3.43		22.2	2.51		22.5	0.36		21.4	5.33		22.1
Aug	0.94		20.3	4.24		18.7	0.41		20.3	1.50		19.9
Sep	4.24	10.92	11.7	0.38		15.2	T		15.1	4.39	5.33	15.5
Oct	1.83		10.8	0.03		10.3	5.13	28.96	5.1	4.11	6.60	8.6
Nov	1.80	28.70	1.8	2.18	25.91	2.8	0.30	2.79	2.6	1.96	18.29	-2.7
Dec	0.51	8.38	-5.4	T	T	1.1	1.70	16.26	-12.4	T	0.25	-10.4
Jan	0.13	1.52	-5.2	0.03	0.51	-1.3	1.07	13.46	-5.6	2.36	28.96	-12.4
Feb	4.24	36.07	-2.3	1.98	25.65	-2.6	0.97	12.45	-8.8	0.15	2.29	3.4
Mar	1.27	9.40	0.4	2.34	26.67	4.1	2.13	16.76	2.4	1.12	11.43	-1.2
Apr	7.39	48.41	4.6	7.87	60.71	8.0	10.34	102.36	3.4	5.92	48.01	6.2
May	15.04	3.56	7.9	2.34	8.89	16.2	9.60	74.93	9.9	3.56	5.33	11.8
June	0.43		16.7	2.29		17.1	0.05		20.3	2.36		17.2
Sept - May Totals:	36.45	146.96	18.6	17.15	148.34	17.8	31.24	267.97	19.2	23.57	126.49	18.5
End	1935			1934			1933			1932		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1930 Ppt.	Snowfall	Temp.	1929 Ppt.	Snowfall	Temp.	1928 Ppt.	Snowfall	Temp.	1927 Ppt.	Snowfall	Temp.
July	4.75		21.3	0.97		21.8	0.94		20.0	0.94		19.8
Aug	11.05		19.4	0.72		21.9	0.61		18.3	1.24		16.7
Sep	0.25		14.1	4.62	10.16	12.0	0.05		13.9	8.00	2.54	12.8
Oct	5.99	3.81	6.6	3.45	27.69	7.6	9.19	70.10	6.4	1.22	3.56	8.7
Nov	0.03	0.51	0.8	3.68	33.02	-7.2	6.48	66.55	-2.6	0.56	5.59	2.8
Dec	0.25	3.56	-5.8	0.58	10.16	-1.6	0.41	4.32	-11.7	1.65	17.78	-9.9
Jan	T	T	-4.0	1.37	13.21	-16.1	0.38	5.59	-11.9	0.79	7.87	-4.9
Feb	1.96	21.34	-1.5	1.17	11.43	1.2	1.73	21.59	-11.0	3.78	43.69	-5.4
Mar	2.16	21.59	0.6	3.30	28.45	-0.7	3.45	25.15	0.2	1.14	11.94	1.3
Apr	4.62	38.86	6.4	0.25		10.3	10.85	49.53	4.7	2.26	24.13	4.3
May	5.59	0.51	11.0	14.48	8.64	10.4	4.67	9.65	10.3	5.18	T	13.1
June	1.12		19.1	0.30		16.4	0.33		15.7	7.52		13.1
Sept - May Totals:	20.85	90.18	19.2	32.90	142.76	17.8	37.21	252.48	17.9	24.58	117.10	16.3
End	1931			1930			1929			1928		

Begin	1926 Ppt.	Snowfall	Temp.	1925 Ppt.	Snowfall	Temp.	1924 Ppt.	Snowfall	Temp.	1923 Ppt.	Snowfall	Temp.
July	5.23		20.2	3.99		21.1	0.10		19.8	5.74		21.8
Aug	1.78		19.6	0.74		18.8	0.41		19.1	0.58		19.0
Sep	1.37	T	11.1	2.39	8.64	13.7	1.12	4.06	13.0	14.33	T	13.6
Oct	1.30	7.11	8.4	4.52	29.72	3.1	4.62	2.03	7.5	10.41	61.98	2.8
Nov	0.33	3.30	2.1	2.36	26.42	-1.9	0.23	2.29	1.7	1.65	12.70	-5.0
Dec	2.18	24.13	-7.5	2.21	25.15	-4.2	3.73	41.91	-11.6	1.22	15.24	-8.3
Jan	0.79	8.38	-6.0	2.69	30.23	-9.8	0.10	1.02	-6.2	1.63	15.75	-11.0
Feb	3.05	36.58	-2.7	0.66	6.60	-2.8	T	T	1.4	0.53	5.33	-3.4
Mar	1.45	9.40	-0.1	3.78	40.39	0.0	0.46	3.05	3.0	5.92	67.06	-4.8
Apr	8.59	86.61	5.0	1.85	3.30	8.1	1.45	0.51	7.8	3.96	29.46	4.7
May	3.81	6.60	10.0	5.72		12.6	2.57	5.59	12.7	15.39	30.48	10.2
June	5.72		16.6	0.58		17.4	1.22		16.3	0.13	T	15.7
Sept - May Totals:	22.87	182.11	16.5	26.18	170.45	17.1	14.28	60.46	17.5	55.04	238.00	16.9
End	1927			1926			1925			1924		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1922 Ppt.	Snowfall	Temp.	1921 Ppt.	Snowfall	Temp.	1920 Ppt.	Snowfall	Temp.	1919 Ppt.	Snowfall	Temp.
July	0.23		20.0	0.97		20.4	0.13		20.1	3.61		22.8
Aug	2.64		21.4	0.76		19.2	0.58		18.7	0.79		20.3
Sep	0.05		16.3	0.33	T	19.7	3.33		13.6	2.57		15.4
Oct	5.00	40.64	7.9	1.27		10.2	11.30	87.63	5.8	11.79	77.22	0.6
Nov	3.99	34.80	-5.9	1.09	11.94	2.7	3.81	42.42	-7.3	5.59	65.79	-6.6
Dec	0.08	0.76	-5.8	4.24	42.42	-7.6	2.01	23.62	-8.9	1.45	14.48	-9.9
Jan	1.04	9.91	-2.3	2.87	30.73	-13.7	0.71	7.62	-6.2	2.74	27.43	-6.6
Feb	1.96	20.57	-9.7	1.02	10.16	-8.8	0.51	5.08	-2.3	4.98	59.69	-6.6
Mar	4.78	47.75	-2.1	1.52	15.24	-1.3	1.75	18.54	3.4	1.63	8.89	-2.2
Apr	6.05	53.34	5.1	9.27	80.77	3.2	6.93	53.34	4.1	7.95	75.18	1.8
May	4.83	5.84	11.4	4.32	2.54	11.0	14.12	T	12.2	4.32		10.9
June	2.18		15.7	0.97		18.4	6.53		17.5	0.94		15.8
Sept - May Totals:	27.78	213.61	17.5	25.93	193.80	19.0	44.47	238.25	19.2	43.02	328.68	17.1
End	1923			1922			1921			1920		

Begin	1918 Ppt.	Snowfall	Temp.	1917 Ppt.	Snowfall	Temp.	1916 Ppt.	Snowfall	Temp.	1915 Ppt.	Snowfall	Temp.
July	1.52		19.5	T		22.1	0.84		21.6	1.91		17.2
Aug	0.69		18.3	0.79		17.9	0.69		18.8	2.64		18.0
Sep	2.62		13.3	0.13		14.3	0.33	T	13.1	10.95	T	12.2
Oct	1.02	T	9.3	2.06	22.61	5.9	4.98	44.20	4.7	0.23		9.2
Nov	2.36	23.62	-3.2	2.79	12.70	2.2	2.08	21.34	-4.8	0.25	2.54	1.2
Dec	2.87	30.99	-6.2	1.07	12.19	-1.0	3.48	37.08	-11.0	3.84	49.02	-5.1
Jan	0.00		-5.4	2.59	25.91	-8.4	1.88	20.32	-10.3	2.62	28.96	-13.0
Feb	1.45	19.05	-4.8	1.83	21.34	-4.1	2.26	23.11	-4.7	1.02	10.16	-4.7
Mar	0.33	3.56	2.9	2.97	35.56	5.3	1.83	29.46	-2.8	4.11	33.02	3.6
Apr	2.36	5.84	7.1	6.65	55.88	2.6	6.15	50.80	3.3	1.57	7.62	6.4
May	0.76	5.59	13.0	5.03	20.57	9.7	13.36	32.51	7.7	3.84	9.14	8.7
June	0.86		18.9	3.33		19.6	0.33		14.7	0.48		15.7
Sept - May Totals:	13.77	88.65	19.4	25.12	206.76	17.7	36.35	258.82	17.3	28.43	140.46	17.3
End	1919			1918			1917			1916		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1914 Ppt.	Snowfall	Temp.	1913 Ppt.	Snowfall	Temp.	1912 Ppt.	Snowfall	Temp.	1911 Ppt.	Snowfall	Temp.
July	1.27		20.7	2.62		19.1	2.44		19.2	2.62		18.2
Aug	0.38		19.1	0.25		20.7	1.32		17.8	0.56		17.7
Sep	T		14.1	3.62		12.9	9.86		8.7	0.56		13.4
Oct	1.07		8.4	4.34		4.7	11.79		4.7	1.85		4.5
Nov	0.00		3.1	1.30		1.1	0.84		1.8	1.73		-2.9
Dec	0.79	8.89	-9.3	2.67		-11.9	1.02		-6.2	2.13		-11.0
Jan	1.12	13.21	-7.1	0.20	1.52	-4.7	1.24		-6.3	0.91		-7.8
Feb	1.12	9.65	-0.7	1.93	20.83	-5.2	3.78		-12.1	4.42		-6.4
Mar	3.45	38.10	0.8	0.46	3.56	2.6	3.15		-2.4	3.94		-8.8
Apr	3.53		10.8	13.61	28.19	5.6	5.66		7.0	4.17		5.1
May	7.98	27.94	9.4	0.89	4.06	12.2	3.05		11.9	6.65		9.6
June	9.53	T	13.0	0.46		16.0	2.54		16.7	3.45		15.9
Sept - May Totals:	19.06	97.79m	15.1	29.02	58.16m	17.5	40.39		17.4	26.36		15.4
End	1915			1914			1913			1912		

Begin	1910 Ppt.	Snowfall	Temp.	1909 Ppt.	Snowfall	Temp.	1908 Ppt.	Snowfall	Temp.	1907 Ppt.	Snowfall	Temp.
July	1.70		20.6	0.79		20.3	1.02		19.3	1.30		18.9
Aug	0.91		17.9	3.38		20.1	3.86		17.1	1.75		17.3
Sep	3.07		13.9	1.93		13.6	1.68		13.7	1.47		13.4
Oct	0.94		8.6	1.40		7.2	11.61		4.9	1.02		8.9
Nov	T		1.9	3.61		0.7	1.08		-1.2	1.24		-0.3
Dec	T		-3.0	5.23		-15.7	2.62		-7.2	2.90		-7.1
Jan	0.58		-2.2	5.23		-11.2	1.09		-4.2	1.50		-6.7
Feb	5.89		-7.5	0.99		-11.0	1.93		-4.2	3.86		-5.1
Mar	0.64		2.3	1.50		6.1	5.94		-0.8	3.78		-0.7
Apr	2.24		5.2	3.30		9.1	5.11		2.9	3.99		7.5
May	2.36		11.1	4.85		11.3	2.90		8.3	9.30		9.1
June	5.18		16.9	1.17		17.7	1.63		16.1	3.81		13.3
Sept - May Totals:	15.72		16.6	28.04		17.5	33.96		17.5	29.06		15.9
End	1911			1910			1909			1908		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1906 Ppt.	Snowfall	Temp.	1905 Ppt.	Snowfall	Temp.	1904 Ppt.	Snowfall	Temp.	1903 Ppt.	Snowfall	Temp.
July	2.57		18.4	1.19		18.4	3.33		18.0	0.53		18.5
Aug	3.20		18.3	1.45		19.2	0.61		18.6	0.48		19.1
Sep	1.70		14.1	2.82		14.4	0.99		13.8	6.55		10.9
Oct	5.18		6.6	3.86		3.7	4.60		7.9	1.45		8.1
Nov	1.04		-0.7	4.62		-1.3	0.03		2.2	0.03		1.1
Dec	2.34		-1.6	1.40		-10.9	1.24		-4.7	2.39		-5.3
Jan	1.22		-7.0	1.60		-8.3	0.58		-6.7	1.42		-6.4
Feb	0.30		0.2	0.64		-3.4	0.61		-7.6	1.60		-1.4
Mar	2.49		3.1	9.04		-6.8	2.72		2.8	3.99		1.0
Apr	3.02		5.2	5.82		2.5	6.48		5.7	2.67		6.8
May	6.78		7.9	8.86		10.6	7.95		8.9	11.40		10.6
June	3.18		13.4	0.36		13.9	2.24		14.9	5.82		14.7
Sept - May Totals:	24.07		15.8	38.66		16.2	25.20		16.7	31.50		16.3
End	1907			1906			1905			1904		

Begin	1902 Ppt.	Snowfall	Temp.	1901 Ppt.	Snowfall	Temp.	1900 Ppt.	Snowfall	Temp.	1899 Ppt.	Snowfall	Temp.
July	0.74		17.4	T		21.9	1.30		18.4	1.17		19.0
Aug	0.15		18.7	1.47		20.0	0.64		18.2	0.20		17.4
Sep	1.91		12.3	0.33		12.1	5.21		12.4	1.37		14.8
Oct	2.79		7.9	1.09		8.7	1.85		7.8	3.99		5.3
Nov	0.15		0.4	0.56		2.2	0.84		1.0	T		3.1
Dec	0.64		-5.2	4.75		-5.7	2.29		-3.1	2.39		-6.8
Jan	0.64		-5.0	0.46		-7.3	0.41		-4.7	T		-2.1
Feb	2.08		-8.9	0.51		-1.6	2.39		-8.4	2.69		-7.8
Mar	5.72		-1.1	1.96		0.6	0.97		1.1	0.79		3.1
Apr	6.12		5.2	3.63		5.4	7.90		5.3	18.26		6.0
May	4.72		9.4	3.12		12.2	7.95		14.0	1.30		13.1
June	5.05		16.0	2.36		16.4	4.75		14.6	0.99		18.8
Sept - May Totals:	24.77		16.2	16.41		16.2	29.81		17.2	30.79		17.0
End	1903			1902			1901			1900		

Precipitation and Temperature Data in metric for Lander, Wyoming, elevation 1696m (5563').

Begin	1898 Ppt.	Snowfall	Temp.	1897 Ppt.	Snowfall	Temp.	1896 Ppt.	Snowfall	Temp.	1895 Ppt.	Snowfall	Temp.
July	1.70		18.9	3.07		18.3	7.62		20.0	0.48		20.6
Aug	1.57		18.7	2.64		18.3	1.24		18.2	2.64		18.2
Sep	0.91		13.0	0.38		14.6	2.74		12.1	4.42		12.6
Oct	5.64		4.1	2.59		7.2	1.88		6.4	2.54		6.2
Nov	0.64		-1.1	1.12		1.4	2.06		-3.8	5.84		-3.8
Dec	1.75		-9.2	3.28		-8.9	T		-2.6	T		-7.4
Jan	2.24		-5.9	0.84		-11.9	0.58		-9.4	0.61		-4.1
Feb	1.45		-12.7	T		-2.3	2.82		-5.0	0.66		-1.6
Mar	4.19		-2.9	6.93		-2.7	3.51		-1.9	6.68		-2.0
Apr	1.24		3.6	2.74		6.4	2.90		6.1	3.05		4.1
May	5.46		9.2	15.29		9.0	3.18		14.2	4.45		9.4
June	2.08		14.6	7.67		15.4	2.16		15.7	0.30		17.3
Sept - May Totals:	23.52		16.5	33.17		16.5	19.67		16.7	28.25		16.9
End	1899			1898			1897			1896		

Begin	1894 Ppt.	Snowfall	Temp.	1893 Ppt.	Snowfall	Temp.	1892 Ppt.	Snowfall	Temp.	1891 Ppt.	Snowfall	Temp.
July	2.77		19.3	0.30		19.4	5.21		19.1			
Aug	0.28		19.3	2.34		17.7	2.18		18.1			
Sep	5.82		15.5	0.74		12.7	0.15		15.0			
Oct	0.08		7.7	1.42		6.4	2.62		6.8			
Nov	0.94		2.7	1.45		-1.3	2.92		0.9			
Dec	0.08		-6.4	1.93		-2.9	4.06		-9.0			
Jan	1.73		-7.6	1.24		-7.9	0.05		-3.1	1.91		-8.4
Feb	0.54		-6.9	2.34		-10.8	4.17		-7.1	1.14		-3.4
Mar	2.97		-0.6	8.36		0.0	3.40		-1.8	3.18		1.3
Apr	14.50		7.9	1.91		6.4	5.44		2.8	10.57		3.0
May	3.35		10.6	3.10		12.3	3.99		9.4	8.74		8.2
June	4.83		13.5	1.30		15.6	2.67		15.6	3.00		14.1
Sept - May Totals:	30.01		16.2	22.49		17.4	26.80		16.4	28.54m		16.6
End	1895			1894			1893			1892		

Lander winter snowfall from Sept. to May, and summer average temperatures from June to Sept.

Year	Snowfall	Temp	Ppt/av.ppt ratio	Ppt/med.ppt ratio
1914	58.15m	17.5		
1915	97.79m	15.1	.43	.45
1916	140.46	17.3	.61	.65
1917	258.82	17.3	1.13	1.19
1918	206.76	17.7	.90	.95
1919	88.65	19.4	.39	.41
1920	328.68	17.1	1.43	1.51
1921	238.25	19.2	1.04	1.10
1922	193.80	19.0	.85	.89
1923	213.61	17.5	.93	.98
1924	238.00	16.9	1.04	1.10
1925	60.46	17.5	.26	.28
1926	170.45	17.1	.74	.78
1927	182.11	16.5	.79	.84
1928	117.10	16.3	.51	.54
1929	252.48	17.9	1.10	1.16
1930	142.76	17.8	.62	.66
1931	90.18	19.2	.39	.42
1932	126.49	18.5	.55	.58
1933	267.97	19.2	1.17	1.23
1934	148.34	17.8	.65	.68
1935	146.96	18.6	.64	.67
1936	102.62	18.7	.45	.47
1937	166.63	18.2	.73	.77
1938	167.65	18.6	.73	.77
1939	152.16	17.9	.66	.70
1940	124.98	19.8	.55	.58
1941	200.81	16.9	.88	.92
1942	227.07	17.8	.99	1.05
1943	195.58	17.8	.85	.90
1944	267.97	16.6	1.17	1.23
1945	308.85	16.3	1.35	1.42
1946	162.04	18.3	.71	.75
1947	253.75	17.6	1.11	1.17
1948	187.71	19.0	.82	.86
1949	235.47	18.3	1.03	1.08
1950	290.32	16.5	1.27	1.34
1951	193.91	16.4	.85	.89
1952	163.05	19.0	.71	.75
1953	280.94	19.4	1.23	1.29
1954	204.72	19.3	.89	.94
1955	218.94	18.9	.96	1.10
1956	245.37	19.2	1.07	1.13
1957	194.57	17.8	.85	.90
1958	244.10	18.1	1.06	1.12
1959	366.78	19.0	1.60	1.69
1960	218.94	19.3	.96	1.01
1961	203.52	18.4	.89	.94
1962	283.50	17.9	1.24	1.31

Lander winter snowfall from Sept. to May, and summer average temperatures from June to Sept.

Year	Snowfall	Temp	Ppt/av.ppt ratio	Ppt/med.ppt ratio
1963	227.30	19.2	.99	1.05
1964	241.70	18.0	1.05	1.11
1965	181.80	16.3	.79	.84
1966	283.20	19.1	1.24	1.30
1967	371.60	17.9	1.62	1.71
1968	335.70	17.3	1.46	1.55
1969	176.60	19.1	.77	.81
1970	248.40	18.4	1.08	1.14
1971	320.55	18.1	1.40	1.48
1972	326.13	17.7	1.42	1.50
1973	557.01	17.8	2.43	2.56
1974	259.84	18.4	1.13	1.20
1975	339.85	17.5	1.48	1.56
1976	211.85	18.3	.92	.98
1977	280.90	18.9	1.23	1.29
1978	204.21	18.1	.89	.94
1979	405.63	18.9	1.77	1.87
1980	315.98	18.7	1.38	1.46
1981	171.69	19.4	.75	.79
1982	106.17	18.3	.46	.49
1983	420.87	19.2	1.84	1.94
1984	411.24	18.9	1.79	1.89
1985	141.48	18.3	.62	.65
1986	305.31	18.6	1.33	1.41
1987	319.28		1.39	1.47

1304.30 years 72 (Not inc. 1914) Av.temp. = 18.12

Rank of year's snow fall in Lander, Wyoming. Average snowfall is 229.25cm.
Median snowfall is 217.16

	Year	Snowfall	Temp	ppt/av.ppt ratio	ppt/med.ppt ratio
Highest					
	1973	557.01	17.8	2.43	2.56
	1983	420.87	19.2	1.84	1.94
	1984	411.24	18.9	1.79	1.89
	1979	405.63	18.9	1.77	1.87
	1967	371.60	17.9	1.62	1.71
	1959	366.78	19.0	1.60	1.69
	1975	339.85	17.5	1.48	1.56
	1968	335.70	17.3	1.46	1.55
	1920	328.68	17.1	1.43	1.51
	1972	326.13	17.7	1.42	1.50
	1971	320.55	18.1	1.40	1.48
	1987	319.28		1.39	1.47
	1980	315.98	18.7	1.38	1.46
	1945	308.85	16.3	1.35	1.42
	1986	305.31	18.6	1.33	1.41
	1950	290.32	16.5	1.27	1.34
	1962	283.50	17.9	1.24	1.31
	1966	283.20	19.1	1.24	1.30
	1953	280.94	19.4	1.23	1.29
	1977	280.90	18.9	1.23	1.29
	1944	267.97	16.6	1.17	1.23
	1933	267.97	19.2	1.17	1.23
	1974	259.84	18.4	1.13	1.20
	1917	258.82	17.3	1.13	1.19
	1947	253.75	17.6	1.11	1.17
	1929	252.48	17.9	1.10	1.16
	1970	248.40	18.4	1.08	1.14
	1956	245.37	19.2	1.07	1.13
	1958	244.10	18.1	1.06	1.12
	1964	241.70	18.0	1.05	1.11
	1921	238.25	19.2	1.04	1.10
	1924	238.00	16.9	1.04	1.10
	1949	235.47	18.3	1.03	1.08
	1963	227.30	19.2	.99	1.05
	1942	227.07	17.8	.99	1.05
	1960	218.94	19.3	.96	1.01
	1955	218.94	18.9	.96	1.01
	1923	213.61	17.5	.93	.98
	1976	211.85	18.3	.92	.98
	1918	206.76	17.7	.90	.95
	1954	204.71	19.3	.89	.94
	1978	204.21	18.1	.89	.94
	1961	203.52	18.4	.89	.94
	1941	200.81	16.9	.88	.92
	1943	195.58	17.8	.85	.90
	1957	194.57	17.8	.85	.90
	1951	193.81	16.4	.85	.89
	1922	193.80	19.0	.85	.89
	1948	187.71	19.0	.82	.86

Cont.

Rank of year's snow fall in Lander, Wyoming

Cont.

Year	Snowfall	Temp	ppt/av.ppt ratio	ppt/med.ppt ratio
1927	182.11	16.5	.79	.84
1965	181.80	16.3	.79	.84
1969	176.60	19.1	.77	.81
1981	171.69	19.4	.75	.79
1926	170.45	17.1	.74	.78
1938	167.65	18.6	.73	.77
1937	166.38	18.2	.73	.77
1952	163.05	19.0	.71	.75
1946	162.04	18.3	.71	.75
1939	152.16	17.9	.66	.70
1934	148.34	17.8	.65	.68
1935	146.56	18.6	.64	.67
1930	142.76	17.8	.62	.66
1985	141.48	18.3	.62	.65
1916	140.46	17.3	.61	.65
1932	126.49	18.5	.55	.58
1940	124.98	19.8	.55	.58
1928	117.10	16.3	.51	.54
1982	106.17	18.3	.46	.49
1936	102.62	18.7	.45	.47
1915	97.79	15.1	.43	.45
1931	90.18	19.2	.39	.42
1919	88.65	19.4	.39	.41
1925	60.46	17.5	.26	.28

Lowest