Development of the Active Layer, Tuktoyaktuk Peninsula and Richard's Island area, Western Arctic, Canada

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ABSTRACT

During the 1979 field season, a large number of measurements of active layer thickness were obtained at a number of locations in the Tuktoyaktuk Peninsula/Richard's Island area, N.W.T., by probing the ground surface with a stainless steel rod until the firm resistance of frozen soil was met. The various data sets were analyzed to determine the effect of late snow cover, microrelief, soil type and slope orientation on active layer development.

Generally, thaw in the study area began sometime in May but active layer development in areas covered by remnant snow was delayed by at least two to three weeks, dependant on the extent of late snow cover. The effect of this delay in initial thawing was not observable in late summer active layer thicknesses for the Illisarvik southeast slope transect. Final snow melt on the Illisarvik southeast slope and an associated short lived period of rapid thaw, in the previously snow covered area, resulted in a water saturated downslope active layer.

Active layer thicknesses in areas surrounding late snow cover are dependant on a number of factors including soil type, soil moisture, vegetation type and abundance, microrelief and slope orientation within each area. Generally, a thicker active layer is encountered in sandy soils and unvegetated areas with a moderate and thin active layer associated with clay soil and peat soil, respectively.

The time required for propagation of daily maximum soil temperature through the active layer results in a delay between the time of daily maximum solar radiation (i.e. maximum ground surface temperature) and the period of daily maximum thaw. In early summer (June 17 to June 23), when the active layer was relatively thin, maximum diurnal thaw was recorded between 2000 hours and 0500 hours.

In hummocky terrain, late summer frost table was a crude mirror image of surface topography. This is caused by: the higher conductivity of silty clay soil beneath the hummock versus peaty soil in the interhummock depression, greater evaporation of soil moisture from interhummock peat soil, greater net direct radiation received on hummock tops, higher ice content in interhummock depression soils, and possible vegetational differences between the hummock top and the interhummock depression. On larger scale relief features (i.e. pingos), direct radiation affects active layer development in that south facing slopes tended to have a thicker active layer than north facing slopes while east and west facing slopes had intermediate average active thicknesses.

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INTRODUCTION

Nearly 50% of Canada is covered by continuous or discontinuous permafrost. Permafrost may be defined as any earth surface material which has a mean annual temperature below $0^{o}C$ for two or more consecutive years. The active layer is the seasonally thawed zone marking the upper surface of permafrost. Biological and most geomorphological processes are confined to this upper thawed zone. As such, knowledge of active layer processes is essential in the planning of northern development.

In the summer of 1978 and 1979 the author was employed by the Geologic Survey of Canada under the supervision of Dr. J. Ross Mackay of the University of British Columbia. The location of employment was the Tuktoyaktuk Peninsula/MacKenzie Delta area where Dr. MacKay has been carrying out studies of the active layer for over 25 years. In the summer of 1979, during the author's off work hours, a detailed field study of active layer development was initiated towards completion of B. Sc. honours thesis at Dalhousie University. This study was carried out firstly, to examine initial active layer development associated with remnant snowbank melt. Secondly, to study the effect of microrelief and slope orientation on active layer development.

A number of different study sites were visited during the summer, with time of study at each site usually less than two weeks, Thus, due to the nature of employment, detailed study of individual sites throughout the entire summer was not possible. Continuity in the field study was obtained by observing initial active layer development at each early summer study site. Active layer thickness was determined by using a metal probing rod. The ground surface was probed, along the transects selected at each study site, until the firm resistance of "frozen" ground was encountered. In this paper the top of ice bonded soil is considered as the base of the active layer.

Transects, with 0.5m spacing between probe stations, were established across late snowbanks at the Illisarvik site and Kikoak site. Probing was carried out two to three times a day in anitcipation of recording diurnal variations in amounts of thaw. Diurnal variations of temperature profiles in the active layer have previously been recorded (Batson, 1977) (Fisher, 1977).

Active layer development in relation to surface topography was also studied during the summer. Fisher (1978) presents two supposedly conflicting theories concerning the relationship between active layer thickness and ground surface topography. In one (originally proposed for hummocky terrain) the frost table is the inverse of surface topography (MacKay, 1958). In the second, the frost table follows ground surface contours (Brown and Johnson, 1965). In the present study, active layer thickness and surface topography were recorded at 10cm intervals, along transects across ice wedges and in hummocky terrain. Transects were established on pingos and across collapsed ice wedges to study macrorelief and slope orientation effects.

STUDY AREA

Thaw depth data was collected at a number of study sites on the Tuktoyaktuk Peninsula and Richard's Island area of the western Arctic of Canada (Figure 1). Access to the study sites was by helicopter with logistic support

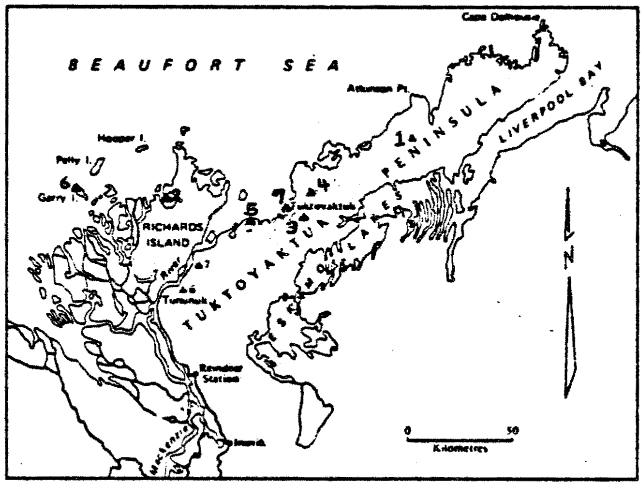


Figure 1: Location map (see Table 1)

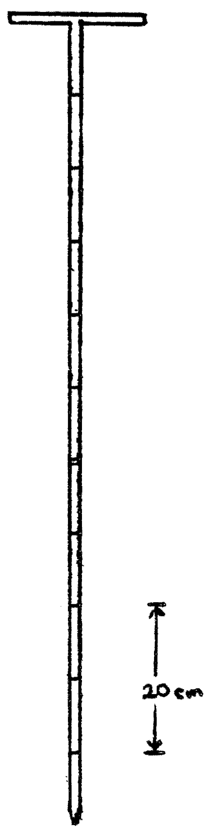


Figure 2: Sketch of stainless steel probing rod

in Tuktoyaktuk. The names given to the various sites are working names and are not official unless otherwise indicated. The total study time ranges from three days at the Banook site to 21 days, during two visits, at the Illisarvik site.

TABLE 1

Reference #	Study Site	Study Dates
1	Kikoak	June 4-10
2	Illisarvik	June 14-26, Aug. 13-22
3	Banook	June 28-30
4	I.O.L.	July 2-5
5	Pingo Lake	July 20-22
6	Garry Island	August 7-10
7	Tuktoyaktuk	June 13 & 26, July 17 & 28 August 23

PHYSIOGRAPHY

The Tuktoyaktuk Peninsula and Richard's Island area is a low lying Pleistocene Coastal Plain underlain by sands, silts and gravels. It experienced Pleistocene glaciation, as evidenced by a blanket of stony clay till, but was not glaciated during the late Wisconsin (Mackay et.al., 1972). Permafrost thickness varies from 400m to over 600m in the study area (Mackay, 1979).

Maximum relief in the study locations is found on pingos, ice cored hills and the banks of drained lakes. Surface slopes up to 15 degrees are common, with some slopes on pingos exceeding 45 degrees (Mackay, 1979).

No major drainage systems are present on Tuktoyaktuk Peninsula and many lakes have an internal drainage. Richard's Island is bounded by channels of the MacKenzie River but otherwise has largely internal drainage. Drainage between lakes may occur through ice wedge polygon systems. (Mackay, 1979).

DATA COLLECTION

Thaw depth values were obtained by probing the ground with a steel rod or probe. The probe is a 1.1m stainless steel rod, graduated at 10cm intervals (Figure 2). The probing end of the rod is tapered to a blunt point from a maximum width of approximately 0.7cm.

Similar probes have been used previously for a quick and fairly accurate measure of active layer thickness (Mackay, 1958) and (Brown and Johnson, 1965). Several small sample pits, which were excavated to "frozen" (or hard) ground throughout the summer, confirmed the probe results to within approximately one centimeter.

The local topography, on a more or less detailed scale, was measured using a transit and tape. A steel tape was used for distance measurement while a Wild RK-1 model plane table alidade and a stadia rod, graduated at 1cm intervals, was used for determining the elevation. Vegetation type and density as well as selected soil samples were collected and are presented as required throughout the text.

The probe results and the small excavation pits measure the depth to frozen (i.e. ice bonded) ground horizon, which is marked by an increase in soil hardness (and a change in other physical properties). The horizon which marks the frozen/unfrozen boundary may not be the exact horizon defined by the $0^{o}C$ isotherm. Unfrozen water may exist in soils at temperatures below $0^{o}C$ (Figure 3). The $0^{o}C$ isotherm should be fairly close to the frozen soil/unfrozen boundary except for certain fine grained soils. Clay soil has a relatively high unfrozen water content at sub-zero temperatures. A probe in clay may penetrate partially frozen material which is colder than $0^{o}C$ (Mackay, 1977). A consistent succession of probe measurements will result in a measured thaw profile which very closely follows the contour of the $0^{\circ}C$ isotherm (Figure 4: Mackay, 1977).

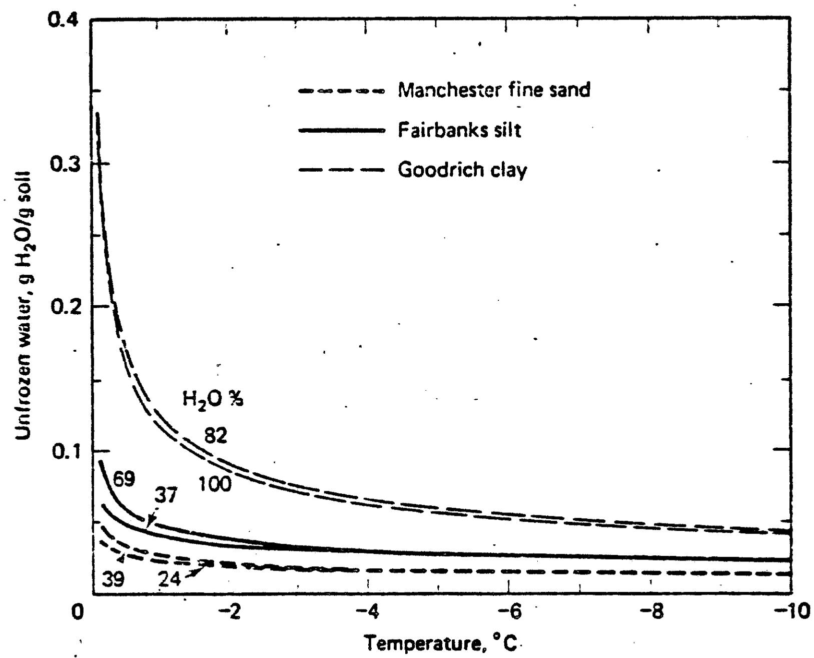


Figure 3: *Unfrozen water contents versus temperature for three soils (Reproduced from Anderson et.al., 1978).*

In test pits excavated in hummocky terrain (clayey silt soil) a transition zone of partially frozen soil was not observed. Soil just above the "frost table" was easily removed by hand. At the frost table the frozen clayey silt soil ("lithified") could only be sampled with a chipping action of a shovel. It is possible that a very thin transition zone of unconsolidated soil below $0^{\circ}C$ may have been present but unrecognized. In any case, it is important to locate the frozen soil/unfrozen soil boundary, marking changes in the physical properties of soil.

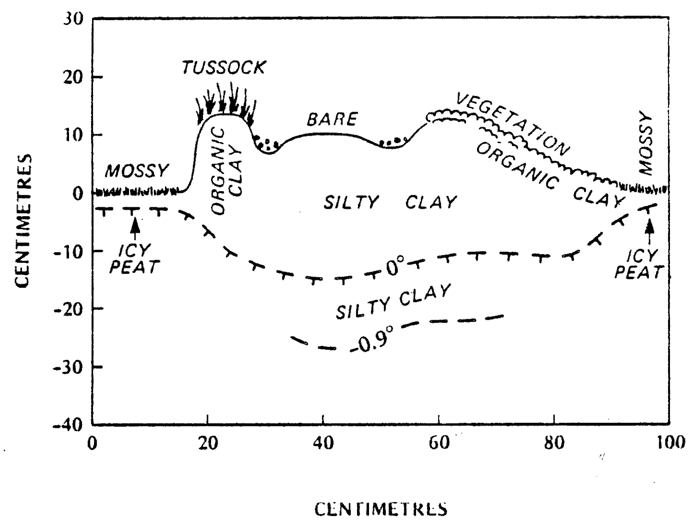


Figure 4: *Cross section of a mud hummock north of Inuvik. The -0.9° isotherm marks the zone of firm resistance to the probe. (Reproduced from Mackay, 1977).*

STUDY SITE DESCRIPTIONS

Active layer thickness was measured along a number of short transects throughout the summer. Depending on the particular study site, transects ranged from six meters to 154m in length. Sample spacing varied from 10cm intervals to two meter intervals.

Illisarvik Sites

A major portion of the study was carried out at a site near the drained lake "Illisarvik". The location of a number of transects on various terrain are show in Plate 1.

a) Southeast Facing Slope: On June 14, a 26m transect was established on the southeast facing slope shown in Plate 2. The transect crossed mud hummocks on the upper slope and a portion of a nivation hollow on the lower slope. The 7m to 13m portion of the course was initially covered with up to 25 centimeters of snow. Probing was carried out at half meter intervals, two or three times daily. In addition, the active layer thickness was probed and the topography measured at 10 centimeter intervals on June 24 and August 13.

b) Lineated Hummock Course: Many of the hummocks on the southeast facing slope are quite elongated or lineated in the down-slope direction. A 13 meter north-south transect was established across the lineated hummocks (Plate 3). The active layer thickness was probed at 10cm intervals on June 24 and August 13. Ground surface topography was also measured at 10cm intervals.

c) North Facing Slope Course: The north facing slope is adjacent to a small lake (Plate 1). The 15m course begins in upper hummocky terrain and ends on poorly drained peaty material just above lake level. Probing, at half meter intervals, was carried out on June 19, June 23 and August 17.

Pingo Course: A north south course was set up on a pingo west of "Illisarvik" lake (Plate 4). On August 19,

Plate 1: *Photograph from a helicopter showing the location of some Illisarvik sites. 1) Southeast facing slope and lineated hummock courses. 2) North facing slope. 3) Polygon courses.*
Note: The drained lake "Illisarvik" and the Pingo course are off to the bottom right of the photo.

Plate 2: *Photo of southeast facing slope, taken after most of the late snowbank had melted. Coloured flags show daily probe stations. The line AB marks the approximate location of the lineated hummock course.*

Plate 3: *Lineated hummock course with the stadia rod lying along the crest of a hummock and orange flags marking the tops of successive parallel hummocks along the 13 meter transect. Shaded areas indicate interhummock depressions.*

pingo

Plate 4: *Areal photo of the pingo west of the drained lake "Illisarvik".*

thaw depths were probed at one metre intervals along the course. Thaw measurements were obtained from local high and local low areas at each station in hummocky terrain.

Kikoak Site

The Kikoak Site transect was established on a drained lake bottom (Plate 5). Four meters of the west facing slope on the edge of the sand spit was snow covered when the transect was established on June 4. Active layer thickness was probed at half meter intervals, two to three times a day, from June 4 to June 10. The upper portion of the transect was located on a sand spit and consisted of a well drained sparsely vegetated sandy soil. The lower portion of the transect was poorly drained and had a continuous surface vegetation mat. Below the vegetation mat is a 5cm - 15cm thick sand, in places very peaty. Beneath this a buried peat soil can be traced to the frost table and into frozen ground (Sample 10-6-79-4: Appendix II).

Kikoak lake drained, probably catastrophically, sometime between 1950 and 1957 (Mackay, pers. comm.). The post drainage history, under sub-areal conditions, is most likely responsible for the observed soil profile on the lower slope. The buried peat is believed to be the original lake bottom sediment. The overlying sand layer was wind blown from the freshly exposed upper slope sand spit. This is in analogue to the early post drainage history of the Illisarvik Lake which was drained during the 1978 field season. The freshly exposed lake bottom soil was mainly peat except for the southwest corner which had a sandy soil. By the early summer of 1979, up to 30cm of wind blown sand had been deposited above the peat at the western end of the lake. By late summer of 1979, surface vegetation had begun to encroach western limit of transect

<u>Plate 5</u>: *Orange flags mark the Kikoak Site transect. The three flags to the left (east) mark the edge of the sand spit with the flags to the right (west) marking the mid-slope and lower slope areas. The late snowbank is no longer covering the mid-slope area at the time the photo was taken.*

<u>Plate 6</u>: *North slope of Pingo #10 and the surrounding drained lake flat of Pingo Lake. The south slope of Pingo #10 has a similar grassy vegetation.*

upon the lake bottom and within a few years will stabilize the presently exposed soil.

Pingo Lake Site

a) Pingo #10: A north-south and an east-west transect was established on July 21 over a small pingo and on surrounding lake flats at the Pingo Lake site (Plate 6). The probe measurements were taken every meter.

b) Collapsed Ice Wedges: A number of short transects (north-south and east-west) were set up across collapsed ice wedges near Pingo Lake (Plate 7). Topography and active layer thickness were measured at 10cm intervals.

I.O.L.: A north-south transect over "Satellite" pingo at the I.O.L. site was established on July 2 (Plate 8). Active layer measurements were taken every 2m except within the tension crack where measurements were taken every 1 meter. This data was collected during working hours and is used with permission of Dr. MacKay.

Garry Island: A 40m north-south transect across a low hill was probed at 1m intervals. Hummocky terrain was pronounced on the north facing slope portion of the transect but was absent on the lower south facing slope portion. In the hummocky terrain, a probe was taken on the hummock top and interhummock depression nearest the probe station.

Tuktoyaktuk: A six meter transect was established on June 13 behind a beach berm at Tuktoyaktuk. Probing, at 10cm spacing, was carried out periodically throughout the summer during each resupply visit to Tuktoyaktuk.

Plate 7: *High center polygons bordered by "collapsed" ice wedges. The Pingo Lake flat, observed in the upper right of the photograph, is to the right (south) of the photo area.*

Plate 8: *North slope of "Satellite" Pingo with orange flags marking the transect across the pingo. The transect crosses predominantly grassy vegetation on the north slope, as seen in the photograph, whereas the south slope has a complete ground birch and dwarf willow cover.*

THAW ASSOCIATED WITH MELTING OF A SNOWBANK ON A LOW ANGLE SLOPE

The Kikoak west facing slope transect (June 4-10), and Illisarvik southeast facing slope transect crossed late snowbank remnants. Thus, at the initiation of daily observation, different portions of the courses had different active layer thicknesses depending on their position relative to the remnant snowbank. It was hoped to characterize the early summer thaw associated with these remnant snowbanks.

As may be expected, the non-snow covered portions of the courses had a certain initial active layer thickness which was variable depending on the time of initial observation, soil type, vegetation influences and other factors. The snow covered portions of the slope generally had no active layer although it is possible in certain situations to have unfrozen soil beneath a thin (less than 20cm remnant snow cover.

An active layer may develope beneath a thin remnant snowbank (less than 20cm) due to penetration of incoming short wavelength radiation. This effect was not observed to any great extent directly on the Kikoak west facing slope transect but was observed adjacent to the mid-slope portion of the Kikoak transect. In addition, thaw beneath a remnant snowbank was similarly observed at the Banook Site. At Kikoak, on June 5, two 2m by 2m areas were cleared of snow and probed to determine active layer development. Results showed an average thaw depth of 5cm with up to 30cm unfrozen soil beneath 20cm of snow. Maximum thaw occurred in a 10cm by 15cm patch of bare sand. The snowbank above this patch had a 3cm to 5cm basal ice layer indicating "ripe" snow conditions. By the morning of June 6 there was a 1cm to 2cm frozen crust where the snow had been cleared. Similar frozen crusts were recorded during morning probes of the lower slope course. By the evening of June 7, maximum active layer thickness was reduced indicating a freezeback once the insulating snow cover was removed. The insulating effect of the snow cover is that of absorption of outgoing long wavelength radiation thus preventing radiation cooling.

To study the day by day development of the active layer, the daily active layer measurements were averaged over the entire course. The use of average thaw data should not be misunderstood to imply that the thaw rate (and hence, active layer thickness) is constant for the entire course over a certain period of time. Figure 5b shows the actual measurements of daily active layer thickness for the Kikoak west facing slope transect.

It is immediately observable that active layer thickness is highly variable at each probe station along the transect. Some abnormally high increases in active layer thickness over a 24 hour period (in excess of 10cm) for the upper slope may reflect the penetration of the probe through a pocket of very dry sand (i.e. non-ice bonded). The occasional freezebacks indicated in 5b may reflect slight changes in probe locations at each probe station in lieu of true freezeback. That is to say, the frost table is not a planar feature and probes taken a few centimeters apart yield slightly different active layer thicknesses. On a larger scale (25cm probe spacing), the frost table is quite irregular even at the end of the observation period. These irregularities probably reflect slight variations in soil profile, soil moisture, microrelief and surface vegetation.

To properly evaluate some of these factors, thaw depth data were examined in subgroups relating to distance away from remnant snowbank, microrelief and soil type. The topographic effects are discussed more fully in the section on microrelief where a detailed frost table configuration is presented. Limited soil type and moisture content were obtained and are discussed where applicable. It is near impossible to adequately record and interpret vegetation changes on a small scale but possible vegetational influence is considered on a gross scale.

Kikoak West Facing Slope

A plot of time versus active layer thickness for the Kikoak west slope transect shows the differences observed for the subgroups which were selected according to position relative to the initial remnant snowbank. The upper slope portion of the transect had the thickest active layer on June 4 and also experienced the largest thaw during the June 4 to June 10 observation period (Figures 5 and 6). During the same time period the lower slope section had the smallest increase in active layer thickness. By June 10 (end of study period) the mid-slope portion of the transect had an average active layer thickness equal to that of the lower slope section despite being covered by approximately 20cm of snow, on June 4, with a virtually non-existant active layer.

The thicker active layer for the upper slope may be attributed to a number of factors. Firstly, the surface vegetation is very sparse (Appendix III), allowing more direct incoming radiation to be absorbed by the sandy soil. Secondly, although soil densitites were not obtained, thermal conductivity of the dry sandy upper slope soil is probably at least twice that of the "peaty" soil of the lower slope. This would allow a more rapid transfer of energy to the frost table. Also, the upper slope frozen soil sample had a lower ice content than the lower slope frozen sample (Appendix II). Less heat is required, per unit thickness of thaw, to overcome the latent heat involved in the ice-water phase change, allowing thicker active layer development on the upper slope. In

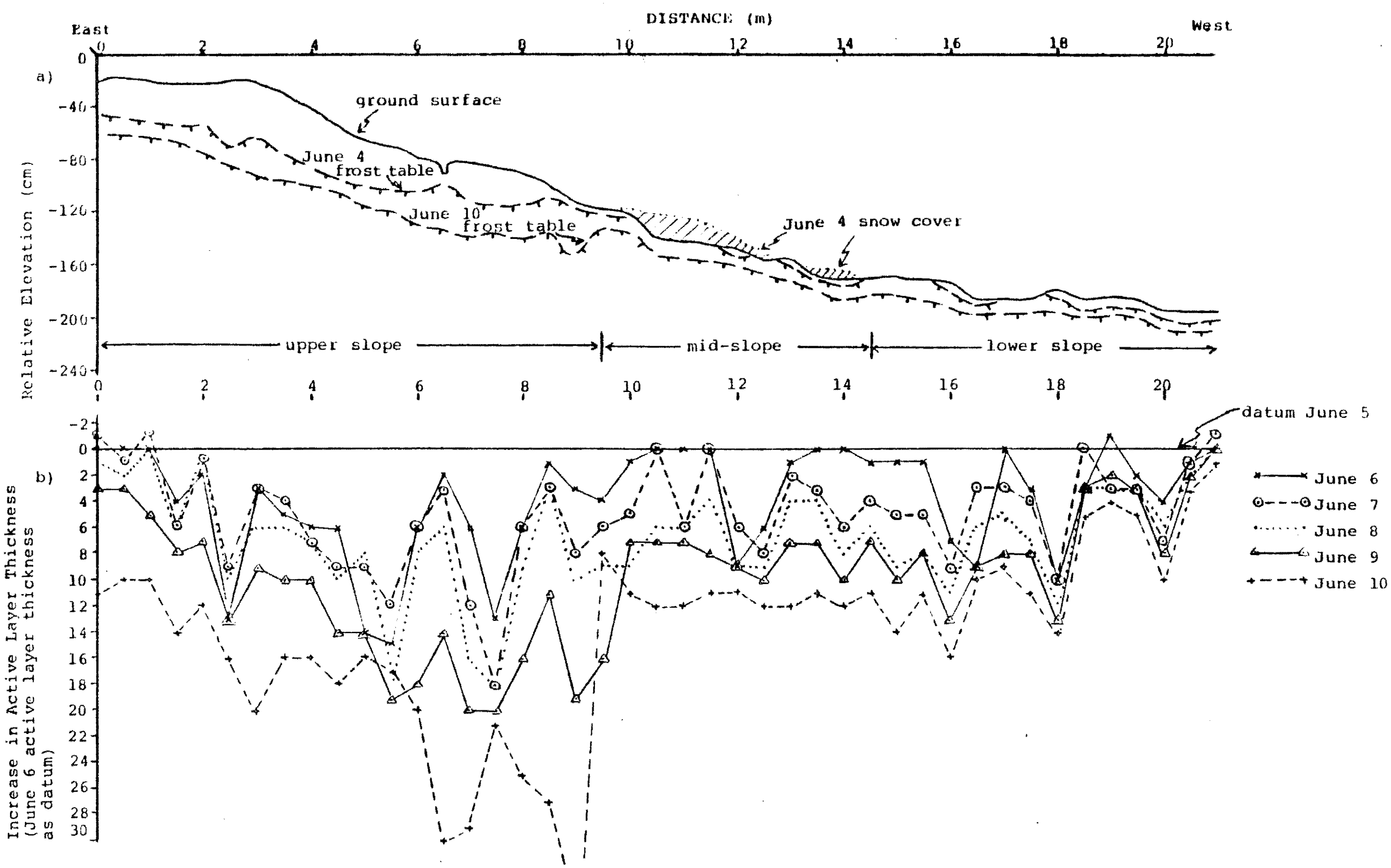


Figure 5: Kikoak West Facing Slope: a) Cross-section showing the position of the frost table at the beginning and end of the observation period. b) Variability in active layer thickness at individual probe stations (Appendix I).

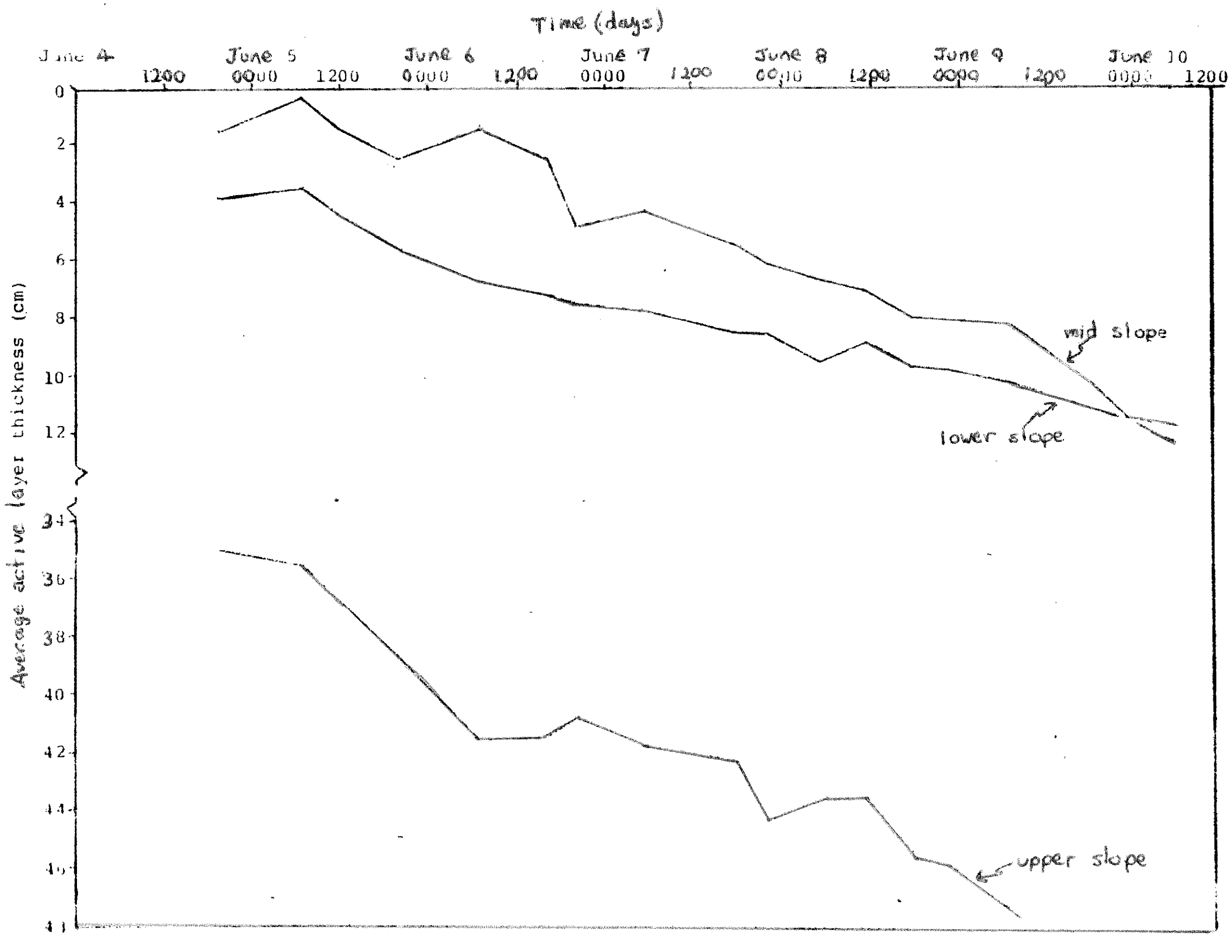


Figure 6: Increase in active layer thickness versus time for the Kikoak west slope transect

contrast, the lower slope portion of the course had a higher unfrozen moisture content (in the active layer) and a higher frozen moisture (ice) content below the frost table. The high water content in the active layer is the result of upslope snowbank melt and soil thaw, and in-situ soil thaw. The ice content in the frozen soil probably reflects soil moisture conditions of the previous fall, prior to freeze-back although some change in ice content of soil may occur throughout the summer (Mackay, 1980). Both of these soil moisture conditions influence the relatively thin active layer observed.

The importance of ice content in the thawing of frozen soil has already been discussed for the upper slope soil. The effect of soil moisture in the active layer is ambiguous. The thermal conductivity of a soil (with constant dry density) increases as the soil moisture content increases (Harlan and Nixon, 1978). Lachenbruch (1970) has shown that heat transfer by convection can be an important factor when groundwater flow is high. Any increase in heat transfer by these two mechanisms are counter balanced by heat loss accompanying evaporation of soil moisture in the open active layer system.

The lower slope soil profile consists of a lower peat layer and an upper sandy layer of variable thickness below a continuous, 1cm to 2cm thick, surface turf or "vegetation mat". This was determined by excavating a number of local topographic highs and lows adjacent to the lower slope portion of the transect (Figure 7). Surface vegetation may act to reflect direct incoming radiation (Brown, 1965). This feature of the lower slope vegetation mat, in addition to the insulating effect of its definite 1cm to 2cm thickness, acts to reduce the heat transfer deeper into the ground. On June 9th, the frost table was invariably 2cm to 3cm below the top of the buried peat layer, regardless of the thickness of the overlying sandy layer. This active layer configuration (Figure 7) is a result of the different thermal conductivities of the two soil types. The sand layer with higher thermal conductivity is completely thawed, regardless of its thickness, allowing heat transfer to the underlying peat. The buried peat soil, with lower conductivity acted as an insulator allowing a maximum of 3cm thaw even in areas where it is relatively close to the ground surface. Areas with a thicker sand layer also had positive microrelief and thus, it is possible that greater energy input from direct radiation contributed to the complete thaw of the thicker sand layer.

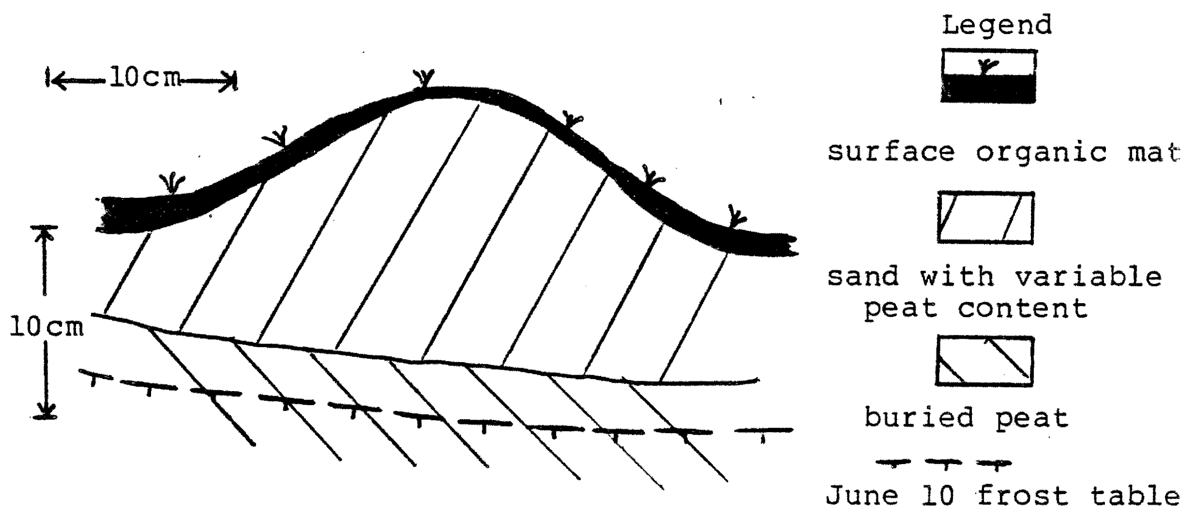


Figure 7: *Cross section of soil profile from the Kikoak Site lower slope based on five excavation pits.*

During the observation period the mid-slope area (initially snow covered) experienced a greater increase in thaw than the lower slope. A more rapid thaw is expected because of the initial absence of an insulating active layer once the remnant snowbank had melted. It is also possible that the mid-slope has a soil profile similar to the upper slope (i.e. sandy) but unfortunately, no excavations were carried out in order to test this hypothesis.

Illisarvik Southeast Facing Slope

The average increases in active layer thickness were also calculated for the June 13th to June 26th period at the Illisarvik southeast course. An average active layer thickness versus time, for various data sub groups, is presented in figure 8. Figure 9 shows the position of the frost table at the beginning and end of the June observation period, the detailed frost table configuration on June 24 and August 13 and the actual thaw increase at individual probe stations. The half meter sample spacing used in the daily June thaw mearurements is too large to record the true nature of the active layer in hummocky terrain. The 10cm detailed probe sample spacing (June 24 and August 13) revealed small scale variations in the frost table configuration.

Thawing on the mid-slope section can be divided into two phases (Figure 8). The first was a period of very rapid thaw immediately following the final melting of snow cover. The last remaining snow was melted and an average thaw of 3.5cm was recorded during an 18 hour period on June 16. Maximum daily temperatures on June 15 and June 16, the period of rapid thaw, were markedly higher than those recorded on the first two days of observation (Appendix IV). The upper slope and lower slope area probably experienced similar snow melt and rapid initial thaw in response to four days of abnormally high daily maximum temperature (June 8 to June 11: Appendix IV), just prior to the observation period (i.e. no initial rapid thaw recorded in these areas).

Environmentally, this rapid thaw phase may be quite signigicant. Water released into the active layer (from final snowbank melt and thaw of ground ice in the soil) will percolate downslope along the frost table. This lubricates the base of the active layer possibly to the extent that reduced soil strength may result in slope failure. Slope failure is, of course, related to other

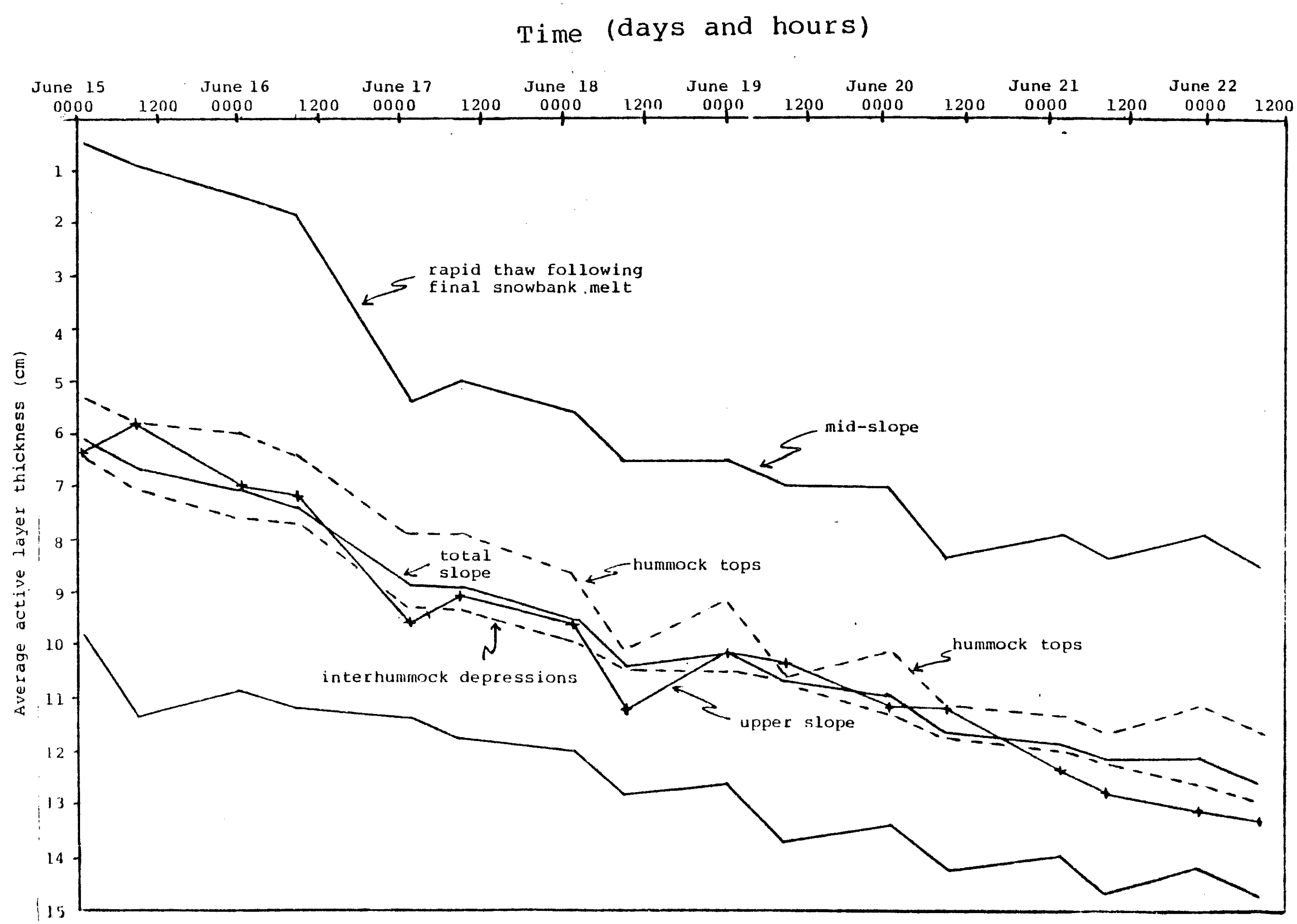


Figure 8: Average active layer thickness for various data subgroups of the Illisarvik southeast facing slope transect daily data set (Appendix I).

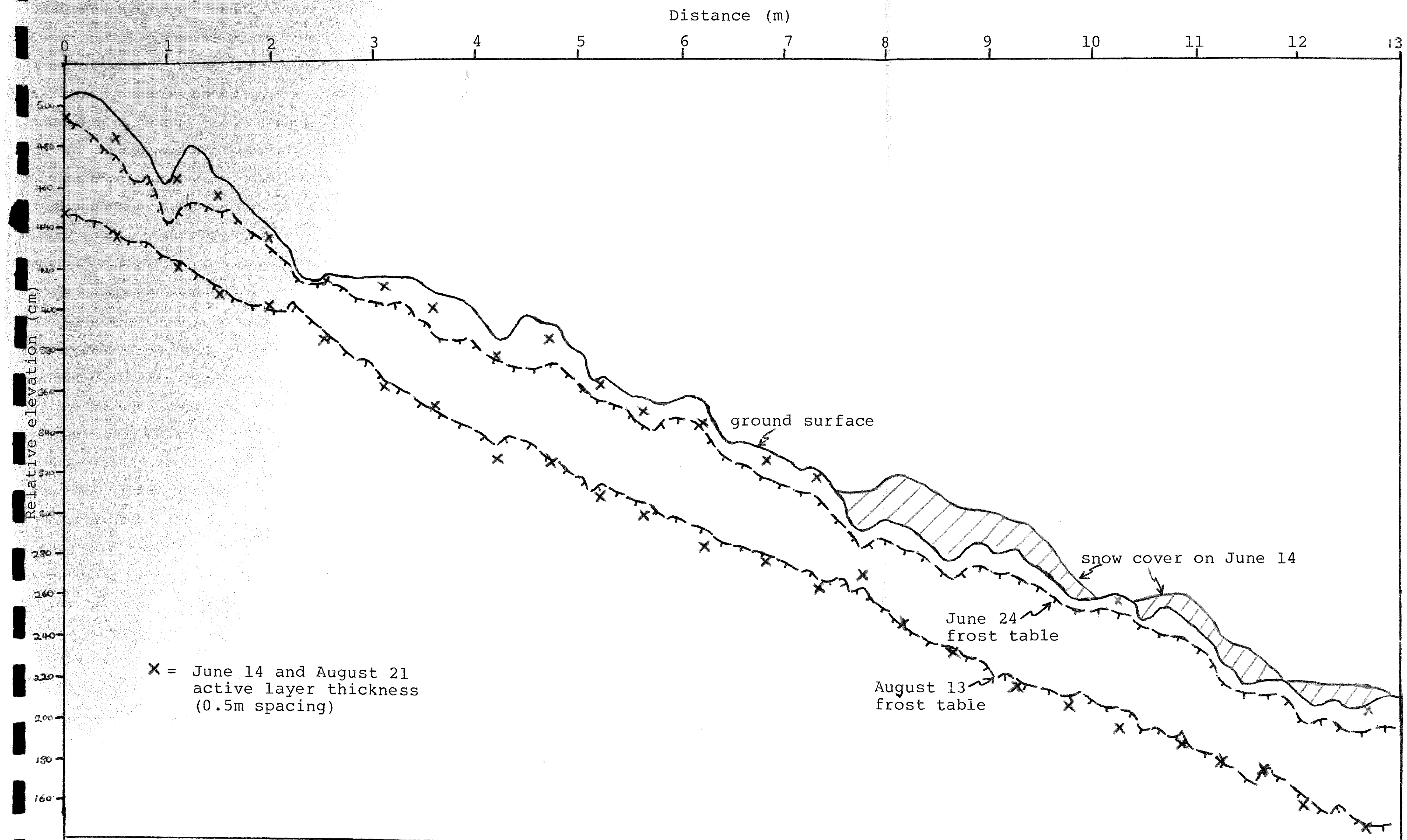


Figure 9: Illisarvik southeast slope transect. Note that although 0.5m spacing measurements (daily thaw data) are accurate, they do not record irregularities in the frost table configuration (even in late summer).

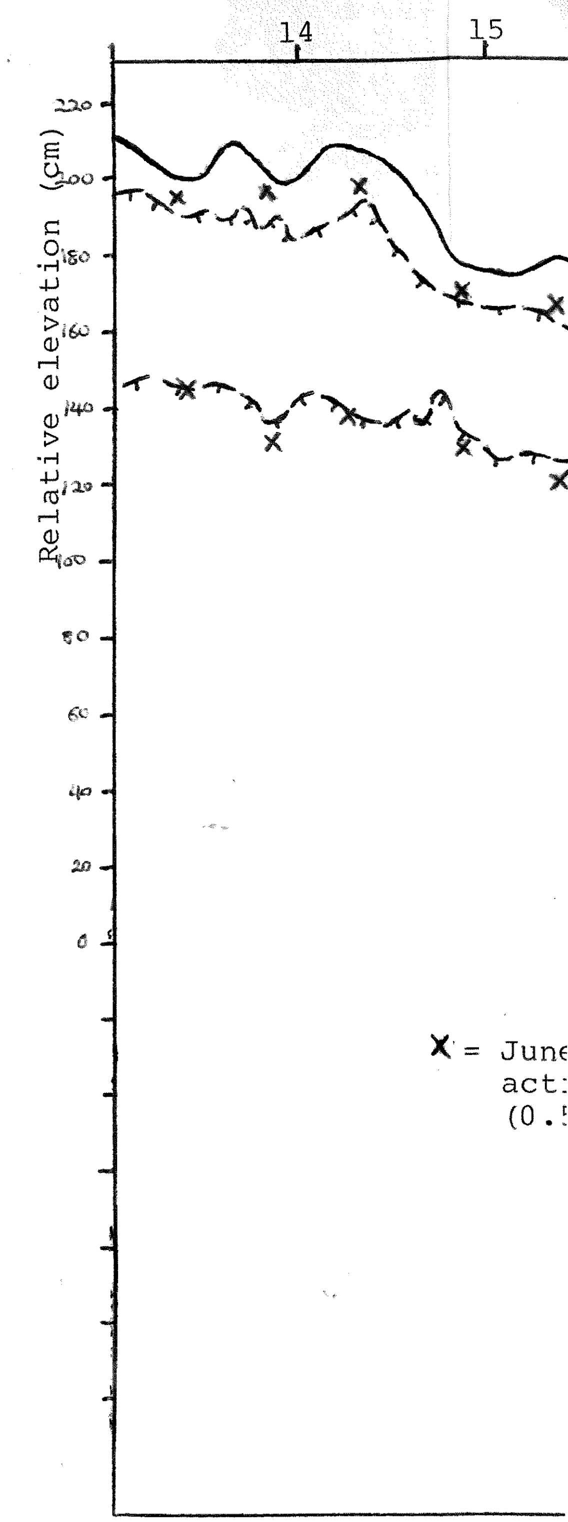


Figure 9:

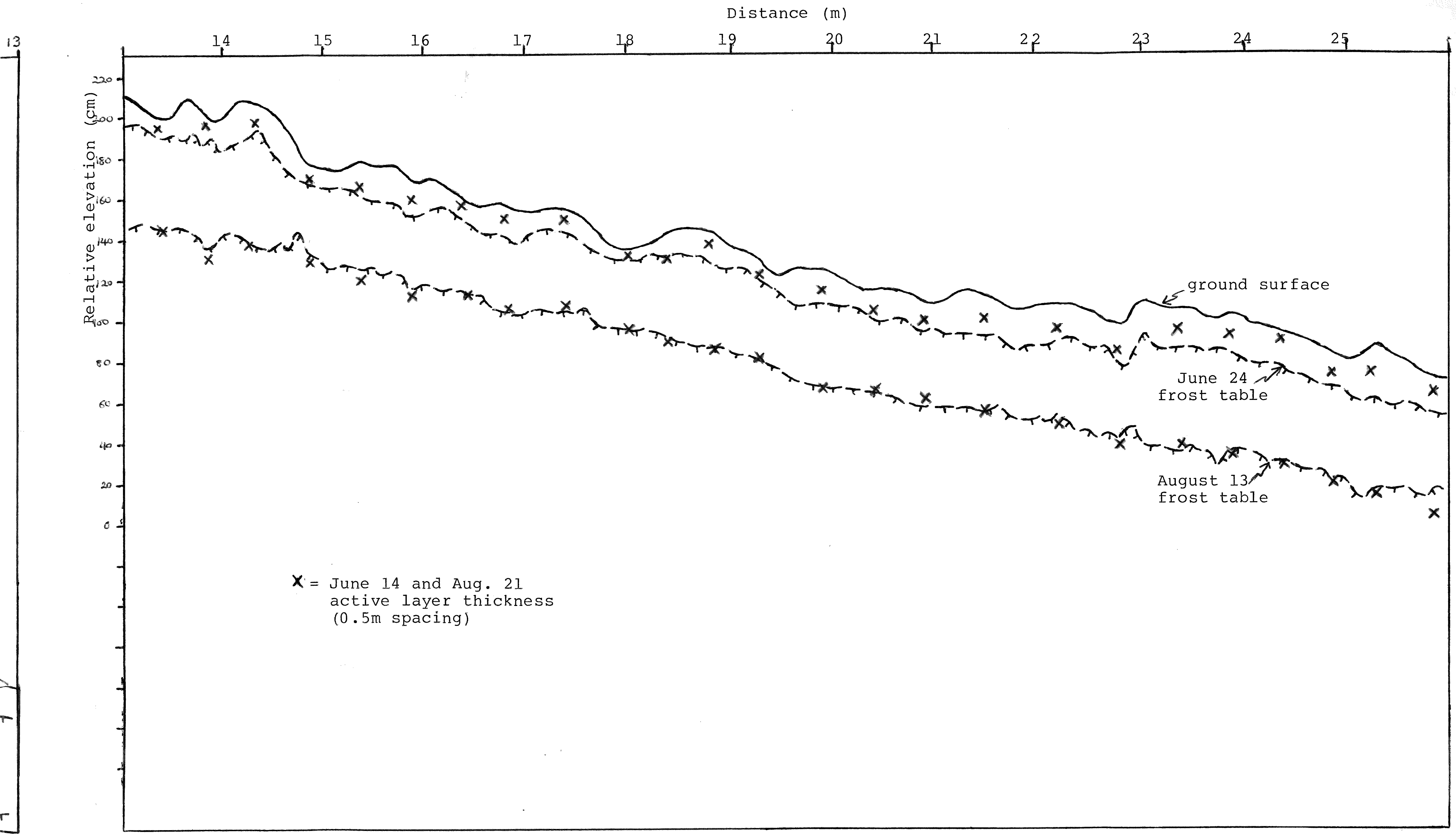


Figure 9: (continued)

factors such as the angle of the slope, active layer thickness, soil type and abundance, and type of vegetation cover. Once the active layer slump has exposed bare mineral soil, successive seasonal failure will probably occur until the slope is restabilized.

After the initial rapid thaw phase, the rate of thaw decreased in the mid-slope area. The insulating effect of a certain thickness of active layer (after initial thaw) may explain the decrease in the mid-slope thaw rate during the second phase. The upper slope experienced the largest thaw increase during the observation period (excluding the rapid initial thaw phase for the mid-slope area) despite having a thicker insulating active layer at the onset of observation. This may reflect: a transition in soil type across the mid-slope into the lower slope area, the higher angle of the upper slope and low soil moisture content in the upper slope active layer. These factors are somewhat intertwined since Arctic soil type is largely related to drainage conditions (i.e. soil moisture content) which are in turn affected by the slope of the ground surface.

Lower soil moisture for the upper slope active layer could explain the larger thaw increase observed here if the zero curtain effect, as proposed by Harlan and Nixon (1978), is a major factor in the mid-slope area. The zero curtain effect is a time delay mechanism in soil warming due to the latent heat associated with the ice-water and water-water vapor phase changes (Figure 10).

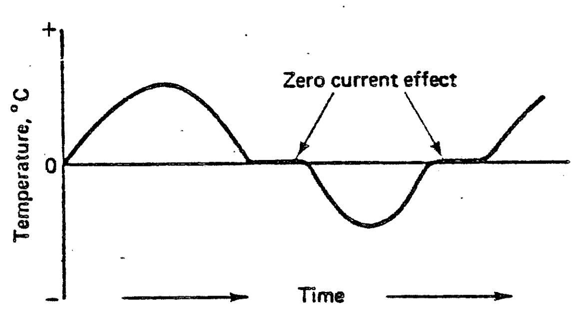


Figure 10: *Ground thermal regime illustrating the zero curtain effect due to latent heat (Reproduced from Harlan and Nixon, 1978).*

Similarly, downslope percolation of soil moisture from the melting remnant snowbank could explain the lowest thaw rate which was observed on the lower slope. However, limited moisture analysis of soil samples for the upslope and downslope area collected on June 25 (Appendix II) do not support this hypothesis. Unfortunately, no soil samples were taken in the mid-slope area. Soil moisture conditions just above the frost table were similar for both the upslope and downslope samples although the lower slope frost table is closer to the ground surface (Appendix II). Soil moisture conditions for the entire course would have to be monitored throughout the observation period to ultimately confirm or reject the time delay hypothesis.

Differences between the soil composition of the upslope and downslope areas may also have contributed to the differences in the amount of June thaw. The mid-slope area, arbitrarily determined on the basis of June 14 snow cover, is a transition zone between true hummocky terrain and the upper portion of a nivation hollow. A 20cm thick peaty layer below 10cm of gray clayey silt was encountered in a soil sample pit from the lower slope excavated on August 22. Such a profile would explain the large initial active layer (thaw of upper clay prior to the observation period) and the low increase in active layer thickness during the observation period (thaw of buried peaty soil). The lateral continuity of this soil profile was not determined, but since the hummocky terrain is not very pronounced, lateral variations in soil profile may be slight. The lack of abundant high broad leaf vegetation (good reflectors of direct incoming radiation) on the lower slope, compared with ground birch and dwarf willow cover on the upper slope, may have also contributed to the greater lower slope initial active layer thickness by allowing more incoming radiation to be absorbed at the ground surface.

By mid August there was no significant difference in active layer thickness for the different slope areas. The lower slope area actually had the greatest average thaw ($\bar{X}$ thaw: 58cm) but it was not statistically greater than either the upper slope ($\bar{X}$ thaw; 54cm) or mid-slope ($\bar{X}$ thaw; 53cm) areas. Thus, late snow cover may delay early summer thaw but has little effect on late summer active layer thickness. The hummock versus interhummock thaw difference is not immediately observable from the half-meter probe spacing data set but in general, hummock tops experienced greater thaw than interhummock depressions. This concept is dealt with in more detail in the section on microrelief where the 10cm probe spacing data is examined.

In the model proposed by Fisher (1977), thaw rates should decrease exponentially throughout the summer as the active layer increases in thickness. If this is the case, a linear extrapolation of June thaw rates will result in estimates of late summer (August) active layer thickness larger than those observed in the field. This was not the case for the Illisarvik southeast slope where linear extrapolation of June thaw rates produced estimates of active layer thickness (for August 13) which were smaller than actually observed (Figure 11). This is in spite of the fact that ice content in samples taken beneath hummocks (and hence, energy required to thaw a unit thickness of soil) increased with depth (June 25 versus August 22 soil samples; Appendix II).

This apparent excess in late summer active layer thickness may result from a depressed thaw rate in early summer, associated with early summer high soil moisture content (Appendix II), and the zero curtain effect as discussed above. Alternatively, the abnormally high July and early August daily maximum temperatures (Appendix IV) observed in 1979 could explain the deviations from Fisher's model.

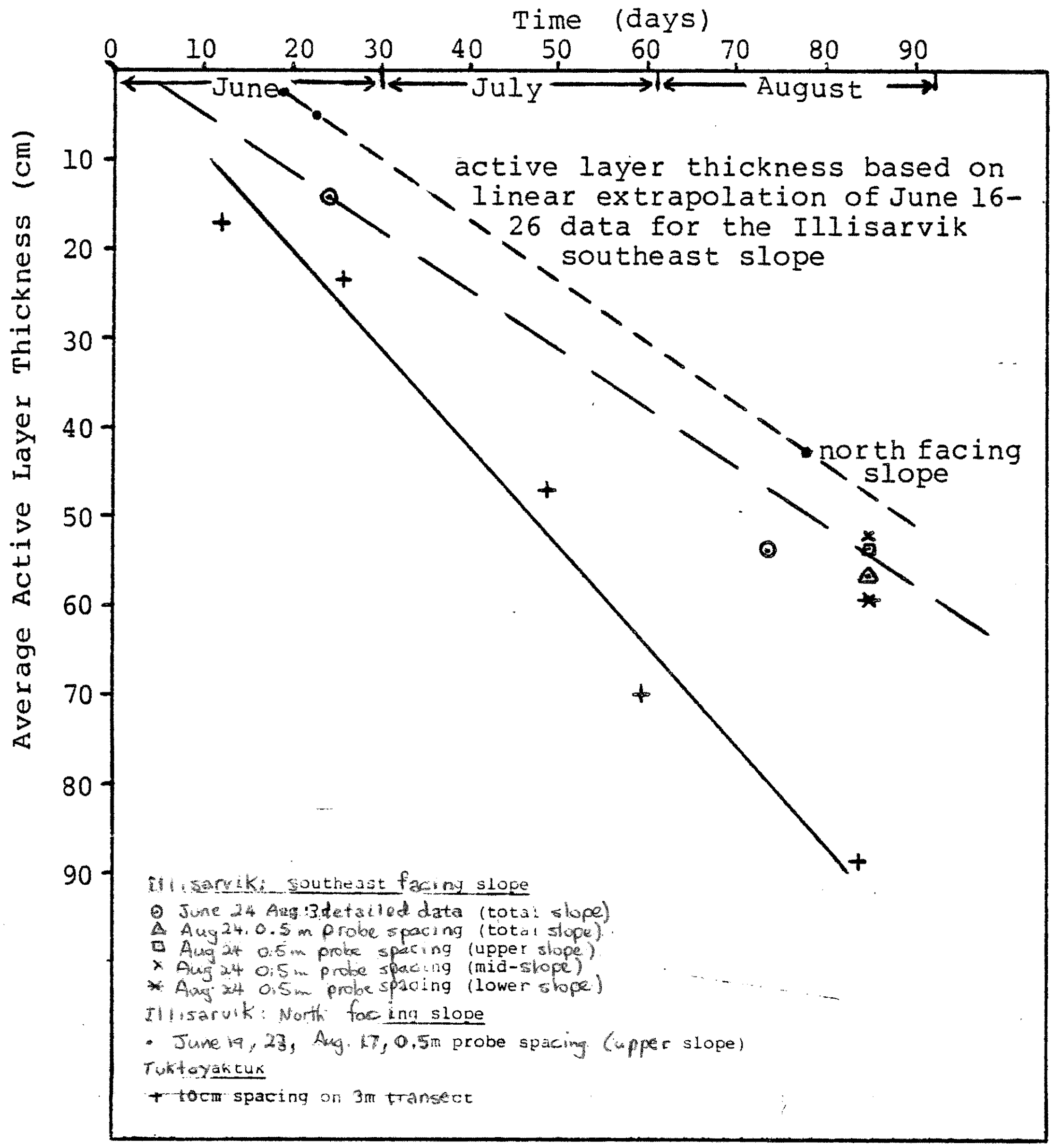


Figure 11: *Time versus average thaw depth for the Illisarvik southeast slope and north facing slope transects and the Tuktoyaktuk transect.*

The apparent agreement of late summer measurements of active layer thickness with estimates based on linear extrapolation of early thaw rates at Illisarvik are confirmed by measurements of average thaw depths at a three meter course in Tuktoyaktuk recorded throughout the summer (Figure 11). A linear thaw rate is indicated even in late August although a decrease in thaw rates prior to freeze-back (sometime in September for 1979) is necessary by definition.

In summary, late snowbank melt delays active layer development in those areas covered by the snow. Snowbank melting and rapid, but short-lived, initial active layer development (after the snow melt) provide excess soil moisture downslope. After initial rapid thaw, in previously snow covered terrain, active layer development is dependant on factors such as soil type and water/ice content, ground surface relief and surface vegetation. Dependant on how far into the summer late snow cover persists, the underlying soil will not necessarily have a thinner late summer active layer. Although an exponential decrease in thaw rates throughout the mid-summer may occur (Fisher, 1977), one must be careful in using generalized time versus depth to frost table calculations for predicting active layer thicknesses. In fact, active layer thickness at any given locality is highly variable at any given time. Also, the development of the active layer is a unique response to the climatic conditions of the particular year in question.

DIURNAL VARIATIONS IN THAW RATES

Heat energy is required for the ice to water phase change associated with the thaw of soils in permafrost areas. In nature this energy must be imparted to the earth surface at the ground/air interface. Mathematical calculations on the energy transfer between the ground surface and the overlying air mass have been attempted (Abbey et.al., 1978). Many of these models consider a true boundary layer being set up at the base of the air mass. A true boundary layer is not observed in nature and many factors such as surface vegetation effects (Brown, 1965), local climatic effects, variable soil moisture conditions and the effects of direct incoming radiation from the sun complicate such models.

Abbey et. el., (1978) reported a 69% correlation between air temperature and net incoming radiation and suggests that air temperature, measured in cumulative ^{O}C/day, may be used as a measure of net radiation. There is an association of air temperature and net radiation because the warming of the air mass is the result of direct radiation and radiation reflected at the ground surface.

The amount of energy imparted to the ground surface can, however, exceed that explained by the temperature of the overlying air mass. French (1970) has reported soil temperatures (up to $14^{O}C$), taken 1cm below the ground surface, well in excess of the air temperature at the time of the measurement. These soil temperatures are attributed to the direct effects of incoming radiation.

Once the ground surface has been heated, this heat must be transferred through the active layer in order to induce thaw of frozen soil at the frost table. It is generally accepted that conduction is the primary method of this transfer and that convection can ususlly be regarded as minimal (Harlan and Nixon, 1978). However, French (1970) suggests convection of heat may be important within a few meters of the ground surface.

Heat transfer, through the active layer, by conduction occurs at a rate dependant on the thermal conductivity and thermal diffusivity of the soil in question as well as the geothermal gradient present in the active layer. In the present study changes in the geothermal gradient, throughout the active layer, were not obtained and as a result the precise rate of heat transfer could not be determined.

Batson (1974) has observed that soil temperatures, down to the frost table, fluctuate with changes in daily maximum and minimum temperatures and that variations in soil temperatures have a time delay, or lag effect, with respect to air temperatures (Figure 12). Unfortunately,

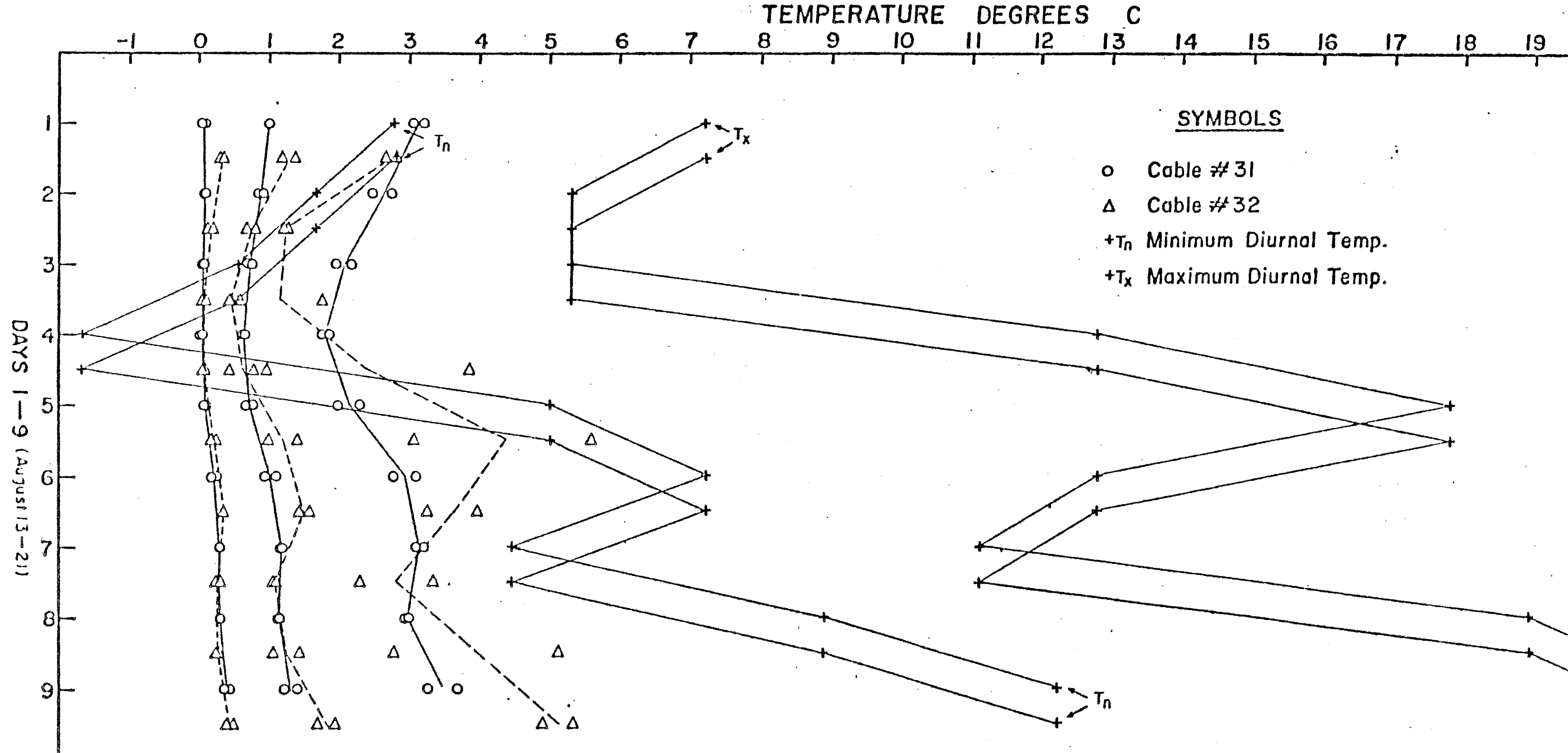


Figure 12. Temperature plots on South Side (Cable #31) and North Side (Cable #32) of willow patch at Garry Island. See Plates II–#2 & #3. (Reproduced from Batson, 1974)

Frost table thermistors 0,10,20
Cable #31 (47 cm below ground surface, cm above frost table)
Cable #32 (31 cm below ground surface, cm above frost table)

TABLE II

Kikoak west facing transect				Illisarvik southeast facing slope transect		
Date	Average thaw rate (cm/hour)			Date	Average thaw rate (cm/hour)	
	1	2	3		4	5
				June 14, 15	0.05	
June 5		0.14		June 15		0.03
June 5, 6			0.12	June 15, 16	0.04	
June 6	0.05			June 16		0.09
June 6		0.13		June 16, 17	0.00	
June 6, 7			0.02	June 17		0.09
June 7	0.04			June 17, 18	0.13	
June 7		0.52		June 18		0.01
June 7, 8			-0.06	June 18, 19	0.06	
June 8	0.11			June 19		0.02
June 8		0.26		June 19, 20	0.08	
June 8, 9			0.08	June 20		0.02
June 9	0.12			June 20, 21	0.04	
June 9		0.21		June 21		0.01
June 9, 10			0.15	June 21, 22	0.04	
				June 22		0.01
				June 22, 23	0.03	
				June 23		0.03
				June 23, 24	0.03	

1. 0600-1700 hours
2. 1700-2100 hours
3. 2100-0600 hours
4. 2000-0500 hours
5. 0500-2000 hours

Table II: Average diurnal thaw rates for the Kikoak west facing slope transect and the Illisarvik southeast facing slope transect.

Batson's soil temperatures were recorded only once a day, such that diurnal variations could not be detected. Abbey (1978) reports that average peak intensity of ground heat flux lagged the peak radiation by two hours. Fisher (1978) recorded detail variations in soil temperature, on July 28 and July 29, at a depth of 20cm and 40cm below the ground surface. At 20cm depth a $3^{O}C$ fluctuation in soil temperatures was reported with a 6 hour time delay between maximum soil temperature and the time of maximum incoming radiation. The results at 40cm depth were not as conclusive although near maximum soil temperatures were recorded from 2200 hours to 0500 hours.

By monitoring thaw depths two to three times a day, at the Kikoak west facing slope and the Illisarvik southeast facing slope, it was hoped to record any diurnal variations in active layer increases. Figure 6 and figure 8 are plots of average thaw depth for each data set of probe values for the Kikoak and Illisarvik southeast slope transects, respectively. Average thaw rates for the time between successive data sets are presented in Table II. The logistics of using average thaw depths is discussed in the previous section (Figure 5b).

A visual examination of figures 6 and 8 shows a trend of larger and smaller incremental increases in active layer thickness, dependant on the time of day during which thaw measurements were obtained. At Illisarvik, where detailed topography was measured, this trend is evident for both hummocks and interhummock depressions. At Kikoak course (June 4 to June 10) there appears to be a five to ten hour time delay between the time of maximum thaw and the time of maximum incoming radiation, with maximum thaw occuring between 1700 hours and 2100 hours. For the June 18 to June 23 Illisarvik southeast slope data, maximum thaw takes place during the 2000 hour to 0500 hour time period, indicating a time delay of 8 hours to 17 hours. A statistical comparison of the thaw rates (from Table II), using student's t test, concludes that the maximum thaw does occur during the above stated periods with a .05 significance for the Kikoak data and a .01 significance for the Illisarvik data.

The greater time lag observed at the Illisarvik site can be explained by an increase in the time required for the temperature wave to propagate through the thicker active layer observed at Illisarvik (compared to the mid-slope and lower slope at Kikoak). French (1970) has previously reported on diurnal temperature wave propagation through the active layer (Figure 13). Also, much of the Kikoak course was underlain by sandy soil which has a higher thermal conductivity (and hence, faster heat transfer) than the clay and peat soil observed at the Illisarvik southeast slope.

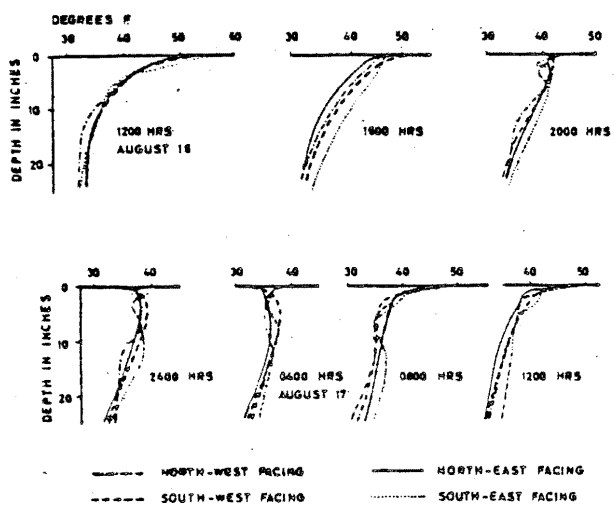


Figure 13: *Late summer temperatures in the active layer, 18-19 August 1968. (Reproduced from French, 1970)*

In some cases (i.e. Illisarvik lower slope) a small decrease in active layer thickness, or freezeback, is indicated for the 0500 hour to 2200 hour time period.

Dr. J.R. Mackay (pers. comm.) suggests this freezeback phenomenon may reflect an irregularity in the probing method. However, a large amount of freezeback was definitely noted (see page 14) adjacent to the Kikoak transect indicating that freezeback can occur over a relatively short time period. Also, one would not expect probing irregularities to result in a fairly consistant trend for six consecutive days, (i.e. Illisarvik southeast slope transect). It is not known if this 0500 hour to 2000 hour period marks the time of minimum soil temperature near the frost table because soil temperature profiles were not obtained.

A major deviation from the time lag thaw model was observed on June 16 when the maximum daily thaw rate, for the entire Illisarvik dats set, occurred during the 0500 hour and 2200 hour time period. This period of maximum thaw is biased by rapid initial thaw (following snowbank melt) on the mid-slope area in response to a relatively high daily maximum temperature on June 16. Other deviations from the model are also observed (i.e. Illisarvik upper slope) but these are the exception rather than the rule.

Previous reports on the time lag between maximum incoming radiation and soil warming at depth (French, 1970; Batson, 1974; and Fisher 1977), provide a basis for the concept of diurnal variations in active layer increases as presented above. Possible irregularities in the probing method, suggested by freezeback, question the validity of this model. Future studies involving accurate temperature profiles and energy balance calculations in conjunction with detailed active layer measurements may confirm the hypothesis of a time lag in daily maximum thaw with respect to daily maximum incoming radiation.

Microrelief (Hummocky Terrain)

Fisher (1977) summarizes two earlier, supposedly conflicting, theories concerning the configuration of the frost table (base of the active layer) with respect to the ground surface relief (Figure 14). One model (Mackay, 1958) was originally proposed for hummocky terrain and suggests that the frost table is an inverse of surface topography. Brown and Johnson (1965) believe that the frost table follows the ground surface contour.

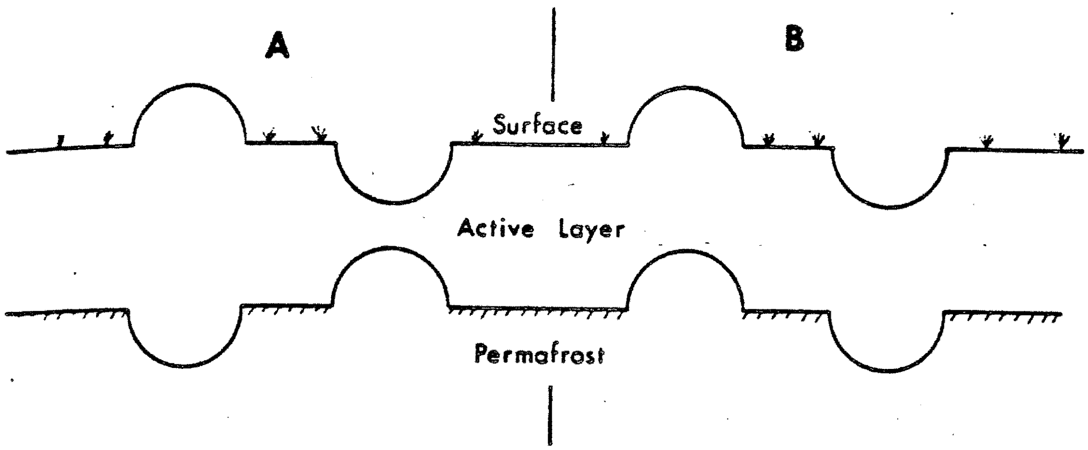


Figure 14: Idealized shapes of the active layer (A after Mackay, 1958; B after Brown and Johnson, 1965). (Reproduced from Fisher, 1977).

Mackay's original data (Mackay, 1958) show detailed variations of the frost table. Brown and Johnson (1965) based their model on 36 probe measurements on a two meter by two meter grid, thus overlooking detailed changes of the frost table. Based on a five meter spacing of probe measurements, Fisher (1977) favors the Brown and Johnson (1965) model although noting irregularities in active layer thickness may occur in hummocky terrain.

The lateral dimensions of hummocks are usually less than one meter. Thus, spacing of probe measurements in

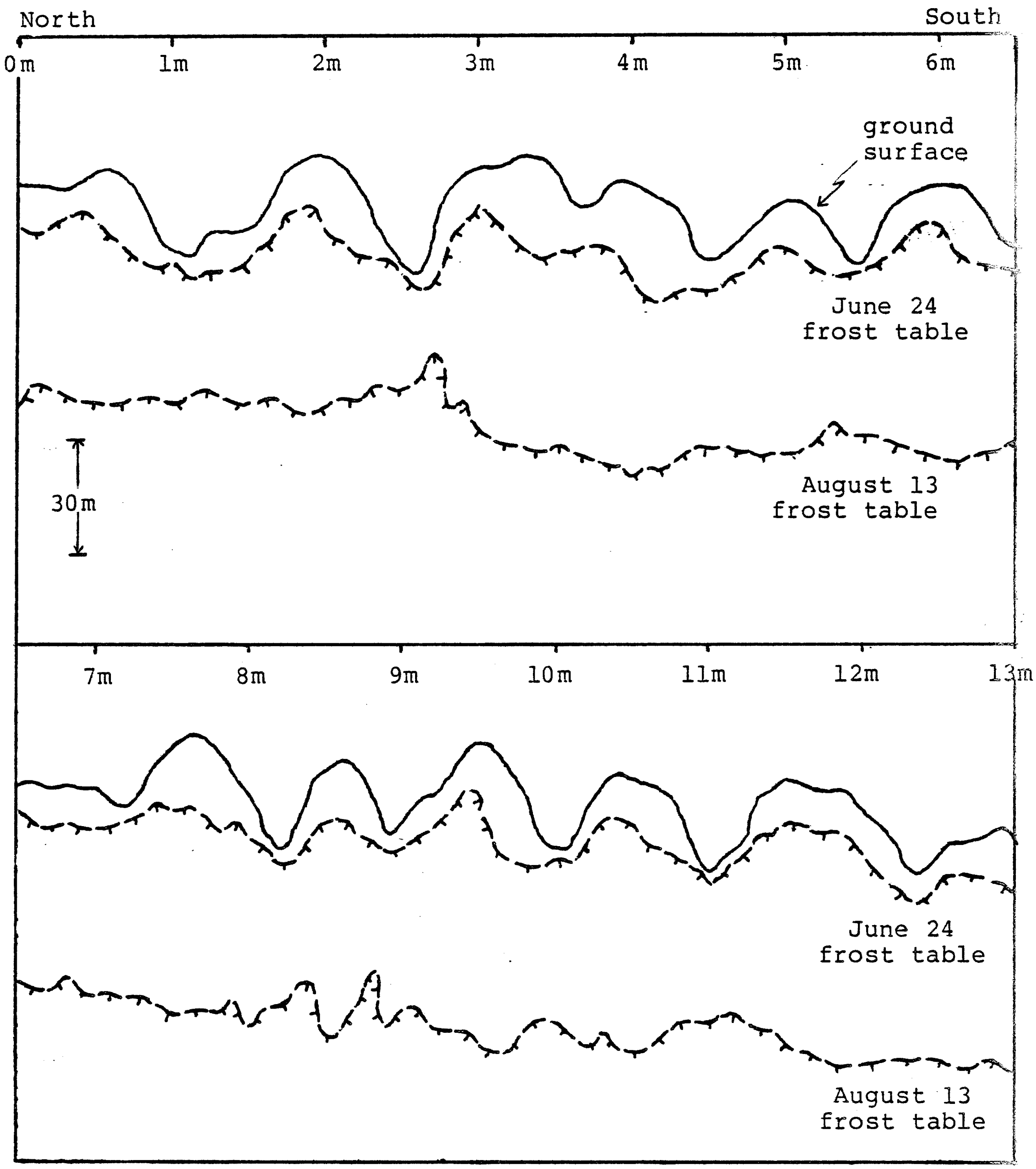


Figure 15: *Lineated hummock transect from the Illisarvik southeast facing slope.*

hummocky terrain should be less than one meter in order to adequately describe active layer thickness in these areas. At the Illisarvik site, a six meter north-south transect (lineated hummock transect) and a 25 meter transect (southeast facing slope transect) were studied with a 10 centimeter spacing probe measurements and surface topography measurements (Figures 9 and 15). Such closely spaced probe measurements show that the frost table is an irregular surface rather than a planar feature. Variations in the frost table are more detailed than those recorded by the southeast slope daily data (Figure 9) which had a 0.5m spacing.

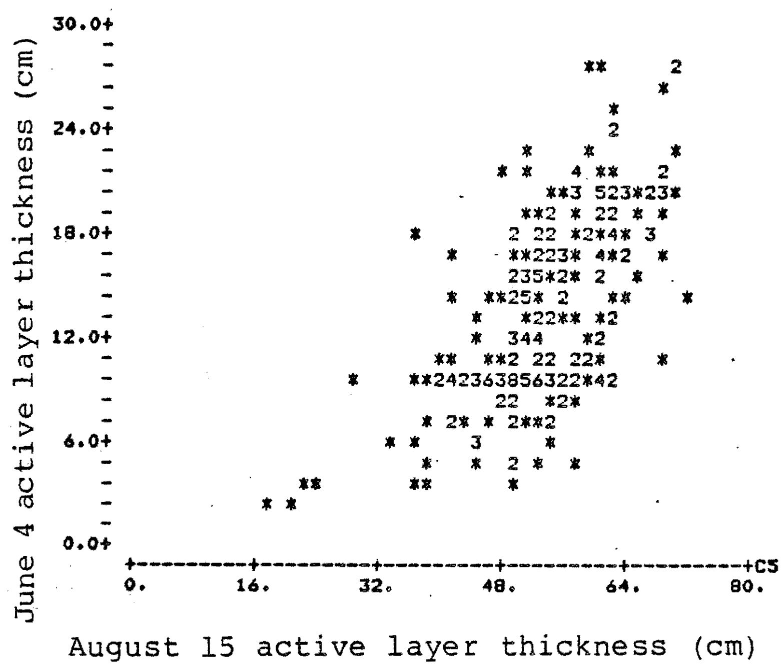


Figure 16: *Correlation of June thaw with August thaw for the Illisarvik lineated hummock transect.*

The June 24th active layer is thicker under hummocks than it is under adjacent interhummock depressions. At this time, the frost table tends to follow surface topography due to the fact that extensive thaw development has yet to occur. A .65 correlation between the June and August thaw data for the lineated hummock transect indicates that probe stations with a relatively thick early summer active layer also have a relatively thick late summer active layer (Figure 16). As discussed in the previous section, numerous factors may be responsible for thaw depth at each individual probe station. Many of these factors, such as, soil moisture and vegetation cover are variable throughout the summer and may explain the wide scatter observed. By August 15, a continued higher rate of thaw under hummocks, especially for the lineated hummock transect, results in a frost table configuration that is an inversion of surface topography (Figures 9 and 15). This inversion is not as pronounced for the southeast slope transect. Here the frost table is a smoother surface but it does rise beneath intra-hummock depressions. The inversion may not be as pronounced due to the fact that the southeast slope transect does not always cross over the central portion of each hummock, thus not recording maximum thaw.

At Garry Island, active layer thickness was measured for 33 individual hummocks and adjacent interhummock depressions. A single active layer measurement on the hummock top, another in the adjacent interhummock depression and the local relief of the hummock were recorded at each probe location. Of the 33 sample sites, 22 were located on a north facing slope and 12 on a south facing slope. The results, summarized in figure 17, support the Illisarvik data in that the frost table is an inversion, or crude mirror image, to surface topography. Active layer thickness is similar beneath hummocks on both the north and south slope. In general, interhummock depressions on the south slope have a thicker active layer than those on the north facing slope.

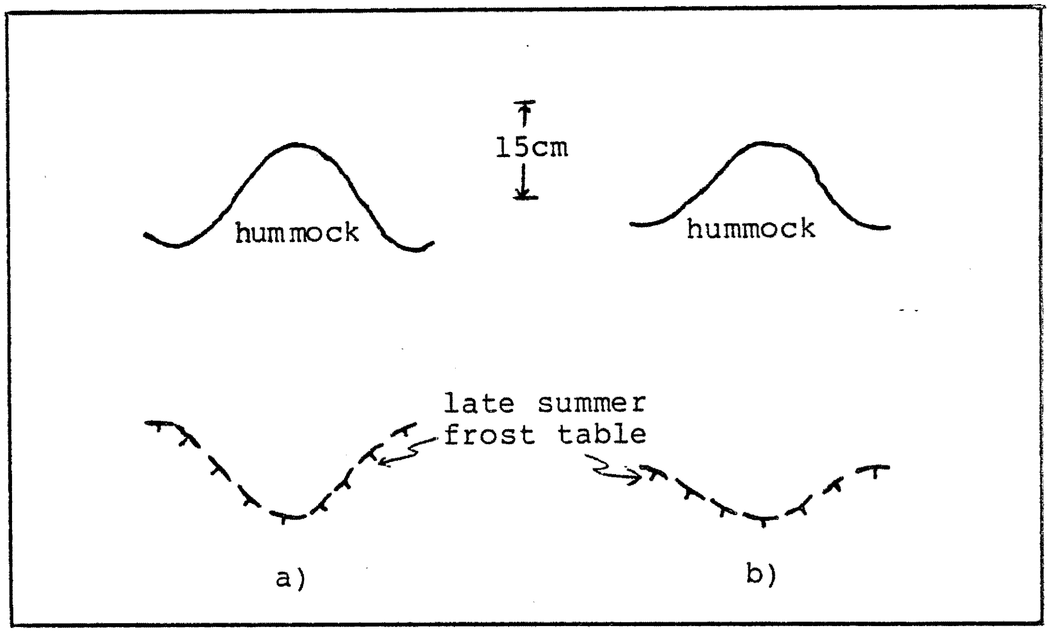
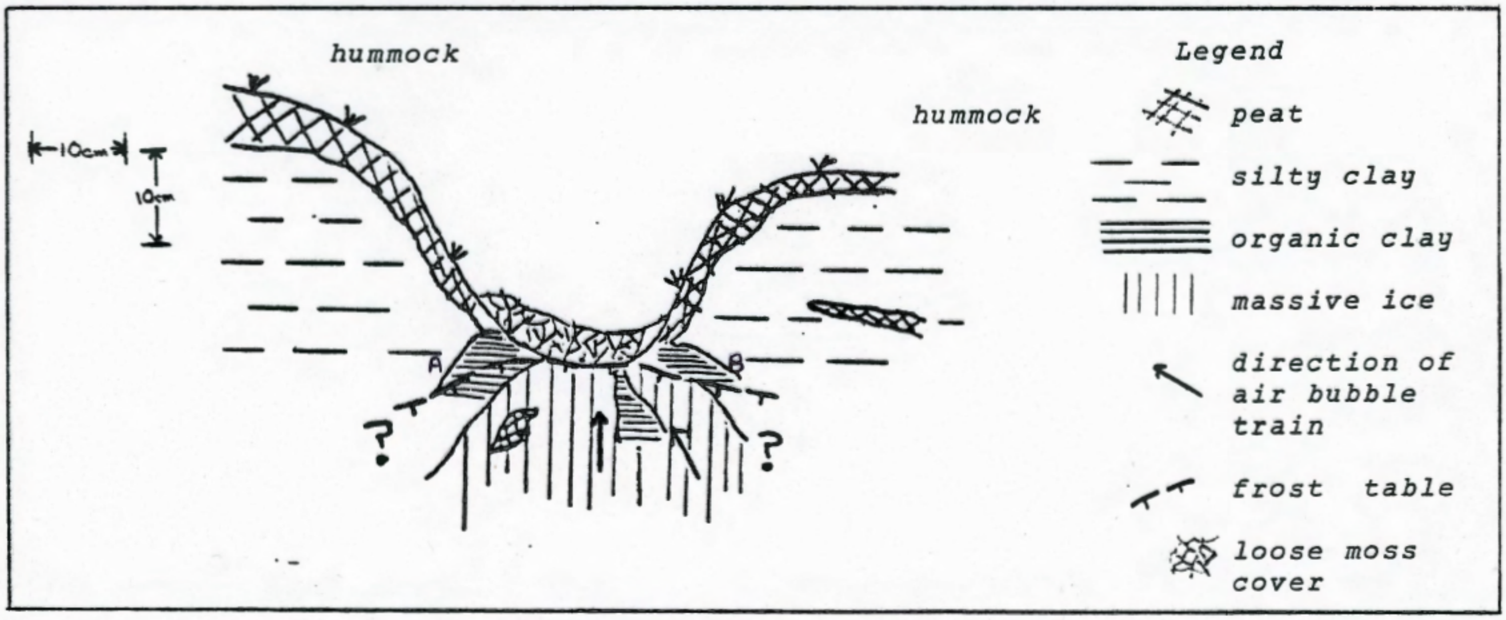


Figure 17: Idealized active layer thickness in hummocky terrain: a) on a north facing slope (8^{o} slope) b) on a south facing slope (7^{o} slope) (see text).

Mackay (1958) proposed that differences in soil composition and soil moisture content between the hummock and interhummock areas may be responsible for the thaw differences observed. The interhummock peat soil (Appendix II) would have a lower thermal conductivity and thus a thinner active layer. A greater moisture content in the unfrozen peat, as opposed to that of the clayey silt hummock soil, would consume energy because of the latent heat associated with evaporation.

The unfrozen soil moisture content of interhummock peat was not recorded but they were quite damp to the touch. The ice contents of frozen interhummock samples were at least five times higher than those in adjacent hummocks (Appendix II). In fact, a June excavation near the Illisarvik southeast slope transect revealed massive ice (contains air bubble trains) in the inter-hummock depression just below a loose vegetation cover (Figure 18: Plate 9). This ice may be the result of a

Plate 9: Massive ice beneath an interhummock depression on the upper Illisarvik southeast facing slope (see figure 18).



<u>Figure 18</u>: Cross-section of excavated (June 25) interhummock depression revealing massive ice (upper slope on Illisarvik southeast facing slope).

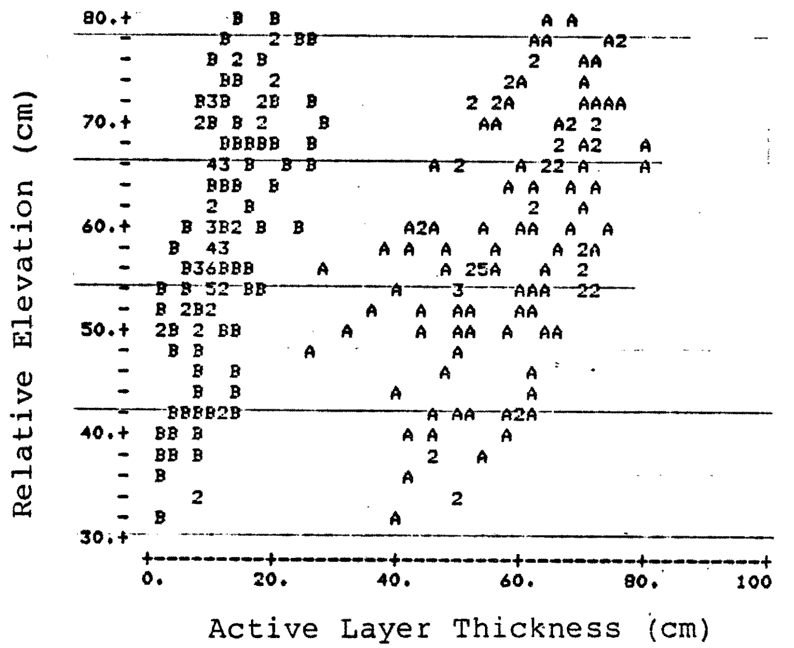


Figure 19: *Relative elevation (microrelief) versus active layer thickness for the Illisarvik lineated hummock detailed data set. A) June 24 data. B) August 13 data.*

late season rain storm the previous fall, after an impervious frozen crust had formed at the ground surface.

The latent heat required to thaw soil with higher ice content along with the effects of soil composition and moisture discussed by Mackay (1958), may explain, in large part, the active layer development in hummocky terrain. There is, however, another factor which has not yet been considered; the greater heating of the hummock surface by direct radiation.

A plot of local topography versus active layer thickness (Figure 19) would seem to suggest that local high areas (receiving greater direct radiation) have the thickest active layer, However, the true differential net radiation effect is difficult to test. This is because hummock tops and interhummock depressions (local high and low areas respectively) are characterized by differences in soil type, vegetation cover, soil moisture and ice content as outlined above. It may be argued that variation in active layer thickness with microrelief, observed in Figure 19, merely reflects these differences. The increased scatter for the August data suggest a greater effect of factors other than microrelief. Sufficient quantative data, required to isolate the microrelief effect by factor analysis, were not obtained. Thus, analysis of the entire data set is not very definitive.

However, if data for the south facing hummock slopes (which receive greater direct radiation) are compared with north facing hummock slopes (Figures 13 and 20),

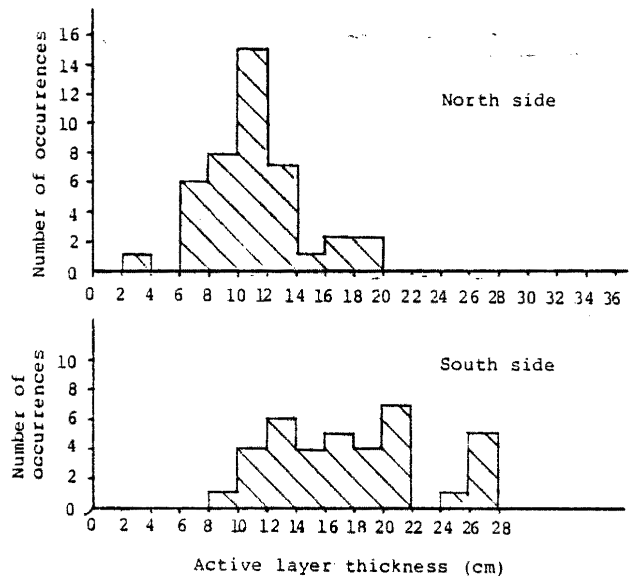


Figure 20: *Histogram of June active layer thickness on south and north sides of hummocks from the lineated hummock transect.*

significantly greater early summer active layer thicknesses are found on the south facing slopes (99% confidence). Thus, differential amounts of direct solar radiation can affect thaw depths on a microscale and, in conjunction with the material differences outlined earlier, produce the thicker active layer observed beneath hummocks.

A generalized thaw model for hummocks is presented in Figure 21. A larger thaw rate under the hummock, for

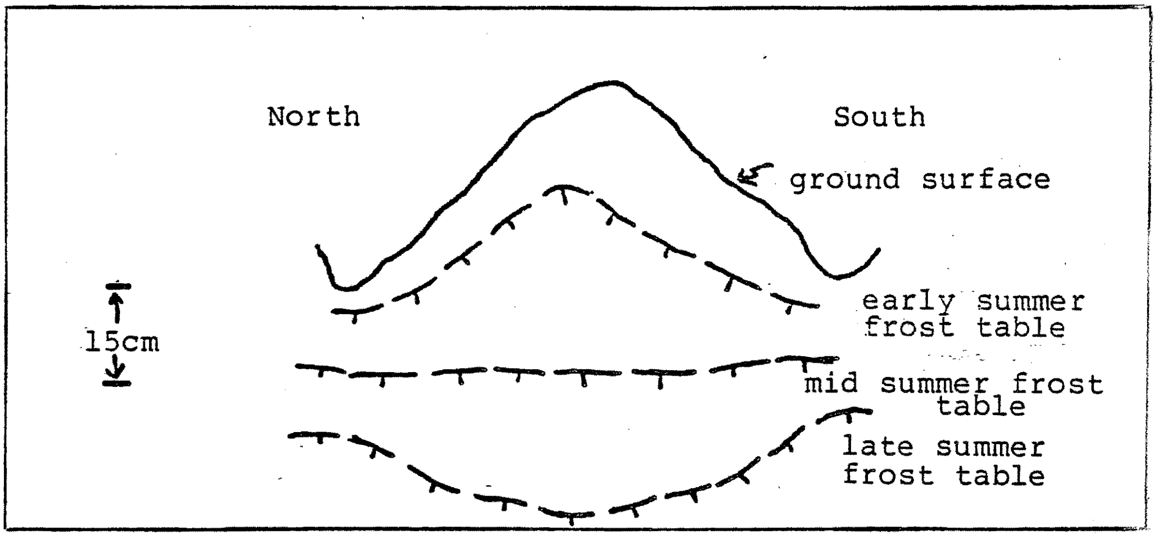


Figure 21: *Idealized active layer development beneath a hummock. Note that any given time, a probe measurement of active layer thickness will be highly variable depending on the probe location.*

TABLE III

Hummocks	Interhummock Depressions
- relatively high conductivity of silty clay soil beneath a thin organic surface layer	- low conductivity of peaty soil
- relatively low soil moisture content	- high evaporation of soil moisture from organic material
- low ice content in frozen soil	- high ice content in frozen soil
- local positive ground surface relief resulting in relatively greater amounts of net solar radiation received	- local negative ground surface relief resulting in decreased net solar radiation received

Table III: *Differences between hummocks and interhummock depressions which may be responsible for the thicker active layer recorded beneath hummocks (see text for details)* reasons summarized in Table III, eventually causes an inversion of the frost table with respect to surface topography. The inversion becomes more pronounced throughout the summer until freezeback begins. The freezeback period was not studied and is of interest for future active layer studies in the area.

Macrorelief (Slope Orientation)

It has already been shown that greater incoming radiation is partially responsible for increased thaw beneath hummocks. The effect of incoming radiation on depth of thaw has also been tested for features with larger relief than hummocky terrain. Transects were set up across collapsed ice wedges at Pingo Lake. Also, thaw depth measurements were recorded across pingos (Satellite Pingo at I.O.L., Pingo #10 at Pingo Lake, and a pingo just west of the drained lake "Illisarvik") and on other non-pingo large scale north and south facing slopes (southeast facing slope and north facing slope transects at Illisarvik).

The low topographic areas of the collapsed ice wedges, which receive less direct radiation, have a much thinner active layer than the surrounding areas. Typically, the south facing side of the collapsed ice wedges have greater thaw depths than the north facing side (Figure 22). This is an indication of the greater amount of incoming radiation received on south facing side. In this case, the frost table tends to follow the surface topography because the relief across the collapsed ice wedges is much greater than the ultimate active layer thickness. Tension cracks on the top of pingos are similar in dimension (but not origin) to the collapsed ice wedges. These too have a thin

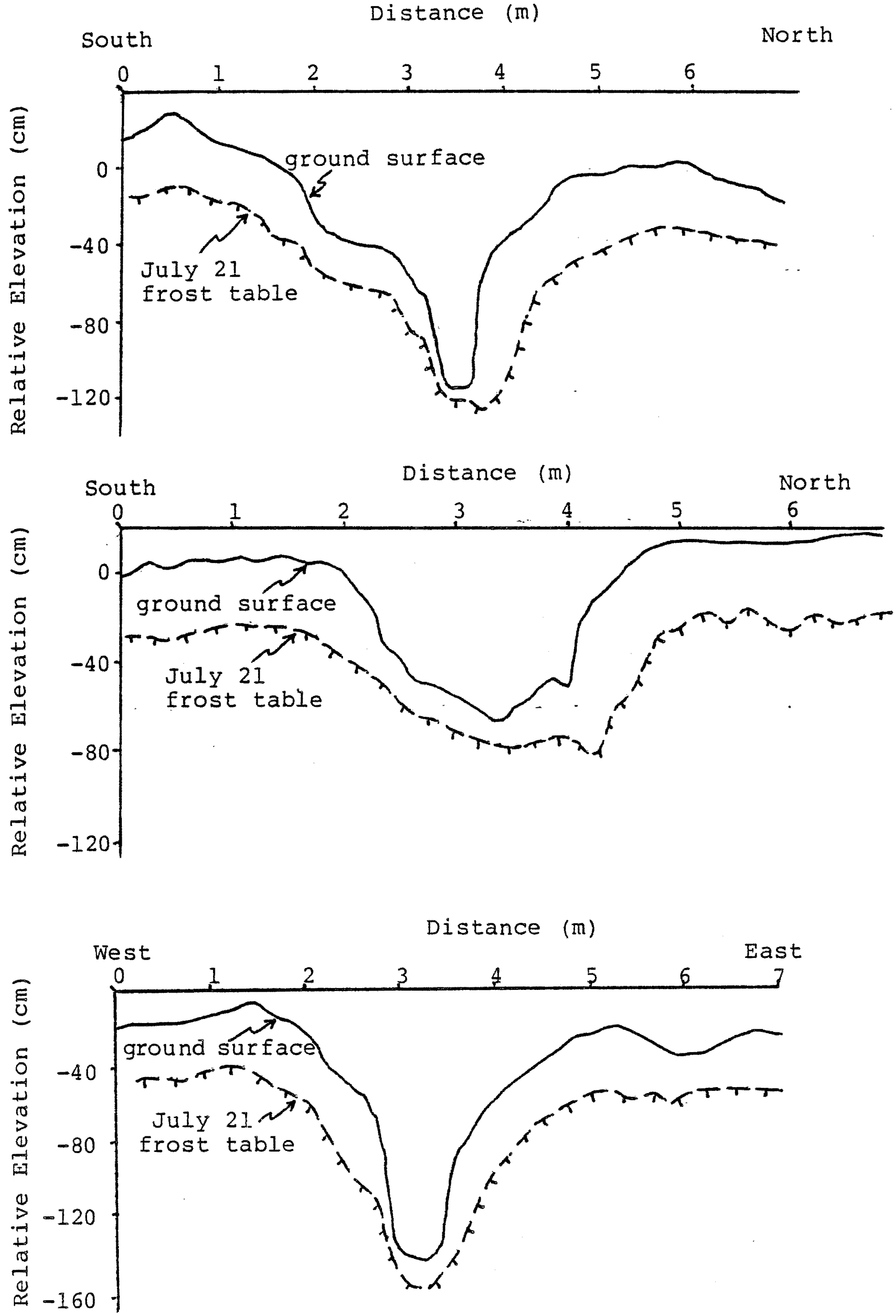


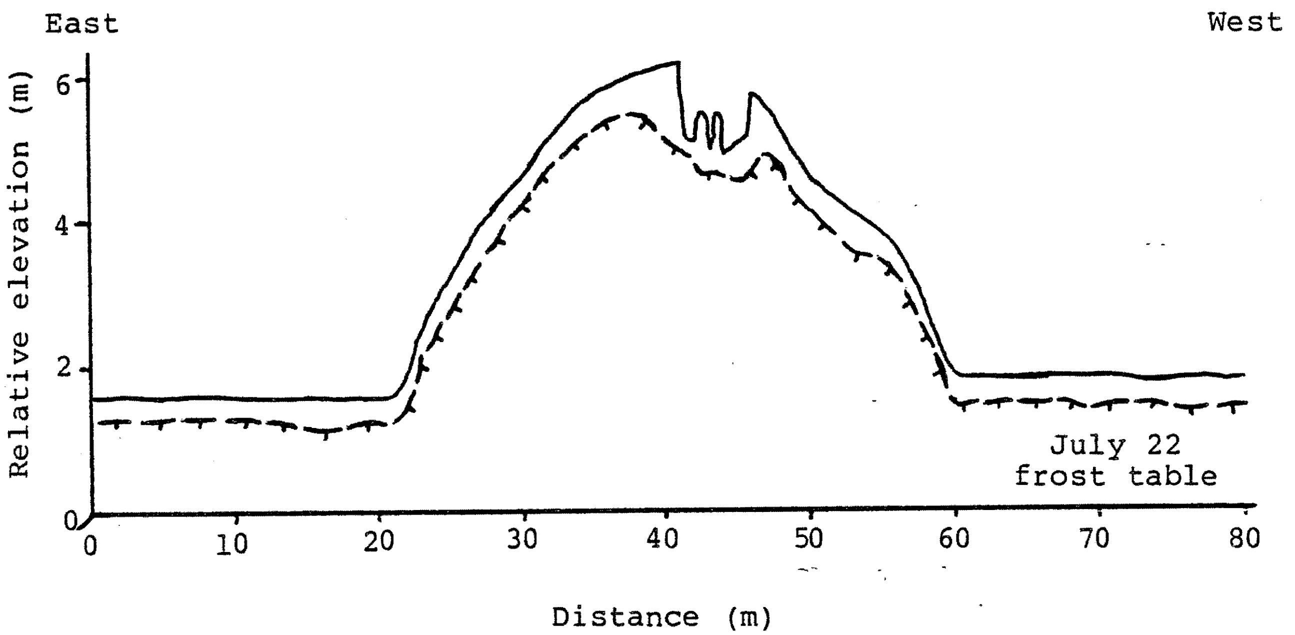
Figure 22: *Selected transects across "collapsed" ice wedges at the Pingo Lake Site (See Plate 7).*

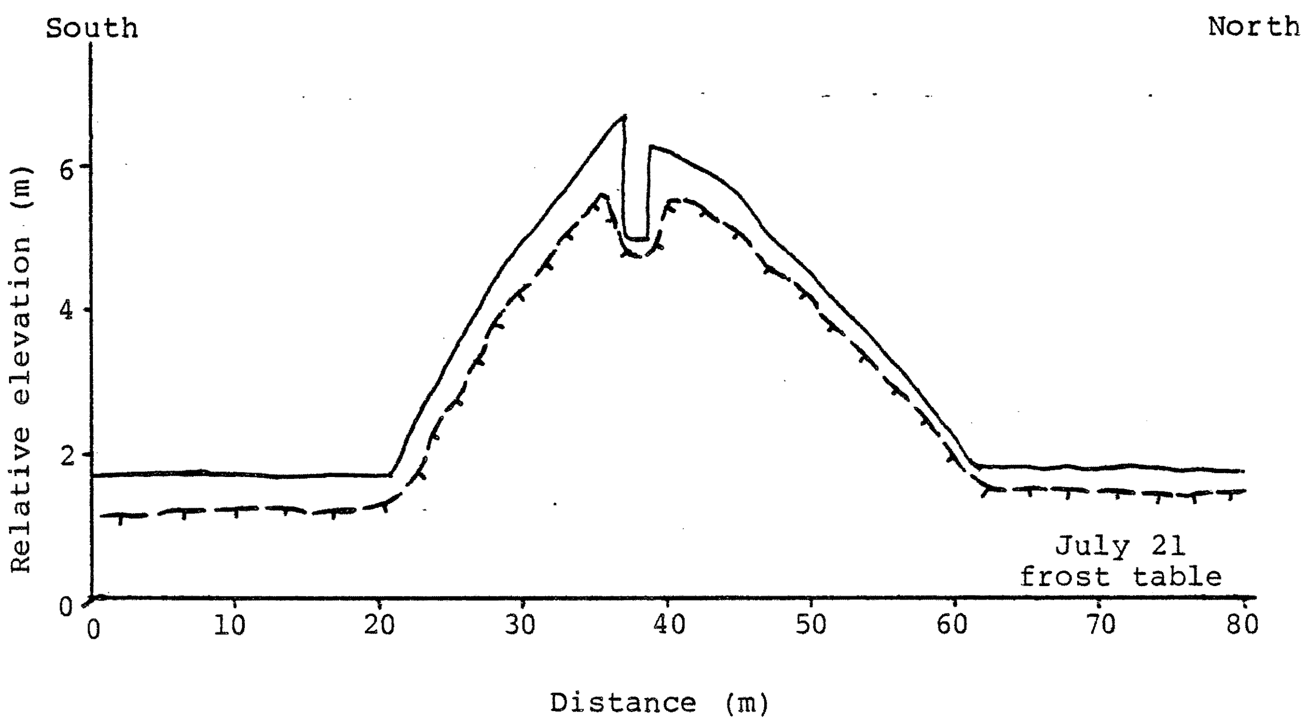
active layer in low areas and a thicker active layer on the south facing side than on the north facing side.

On east-west transects across the collapsed ice wedges, the west facing side tended to have a thicker active layer than the east facing side although both sides received similar amounts of direct radiation. Fisher (1977) has proposed that greater thaw depths observed on a west facing slope is a result of coincident daily maximum temperature and the time of maximum direct radiation on the west slope (both in late afternoon).

Pingos provide an excellent location to test the effect of direct radiation on thaw depths. Pingo #10 at Pingo Lake is a young pingo (pingo growth commenced after 1950; Mackay, 1979) and has grassy vegetation on both the north and south facing slopes thus eliminating differential vegetational influences (Appendix III). The ground surface is fairly regular without hummocky terrain and thus eliminates microrelief effects (Figure 23). On July 21, the active layer on the south facing slope of Pingo #10 (average thaw of 53cm) was signigicantly thicker, with a 95% confidence interval, than that on the north facing slope (average thaw of 37cm) (Figure 24). This can be attributed to more direct solar radiation (and associated soil warming) received on the south slope, resulting in thicker active layer development.

An average active layer thickness of 46cm and 47cm, on the east and west facing slopes of Pingo #10 respectively, are approximately midway between active layer thicknesses recorded on the north and south facing slopes. This is in agreement with the fact that these slopes receive more direct radiation than the north facing slope and less than that received by the south facing slope. Also, the east and west facing slopes receive equal amounts of solar radiation, thus one could expect





<u>*Figure 23:*</u> *North-south and east-west transects across Pingo #10. Note: The apparent thicker active layer on the drained lake flat is due to the vertical exaggeration in the sketch.*

similar active layer thicknesses on these slopes.

Thaw measurements were also taken 20m onto the surrounding lake flats (now a marsh; Appendix III) to the north and south of the pingo. The lake flat south of the pingo had an average active layer thickness 13cm greater than that for the lake flat north of the pingo (48cm versus 35cm). Although drainage conditions may be a factor (south lake flat is much wetter; Appendix III), the thaw difference is almost certainly related to the fact that the pingo acts to shade the north lake flat from the mid-day sun thus reducing the net direct radiation received. If this were the case, one would expect the north-south lake flat thaw difference to be accentuated closer to the pingo. Indeed, if data from the base of the pingo to 10 m onto the lake flat is considered alone, the lake flat to the south of the pingo had an average thaw 17cm greater than that for the lake flat to the north of the pingo.

On August 19, a north-south transect across a pingo just west of Illisarvik lake (Plate 4) was established. Significantly greater (85% confidence interval) thaw depths on the south facing slope of the pingo, supporting the Pingo Lake data, were recorded. Factors other than net solar radiation received may be partially responsible for the thaw difference. The south facing slope did not have complete hummocky terrain whereas the north facing slope was completely covered by hummocks. The non-hummocky portion of the south slope also had vegetational differences (lack of dwarf willow and ground birch; Appendix III) which may have had an effect on the thicker south slope active layer observed.

The north-south transect across Satellite Pingo (July 5, I.O.L. Site) provides data for comparison of a third north facing slope and south facing slope pair. In late June, the average thaw for the south slope was

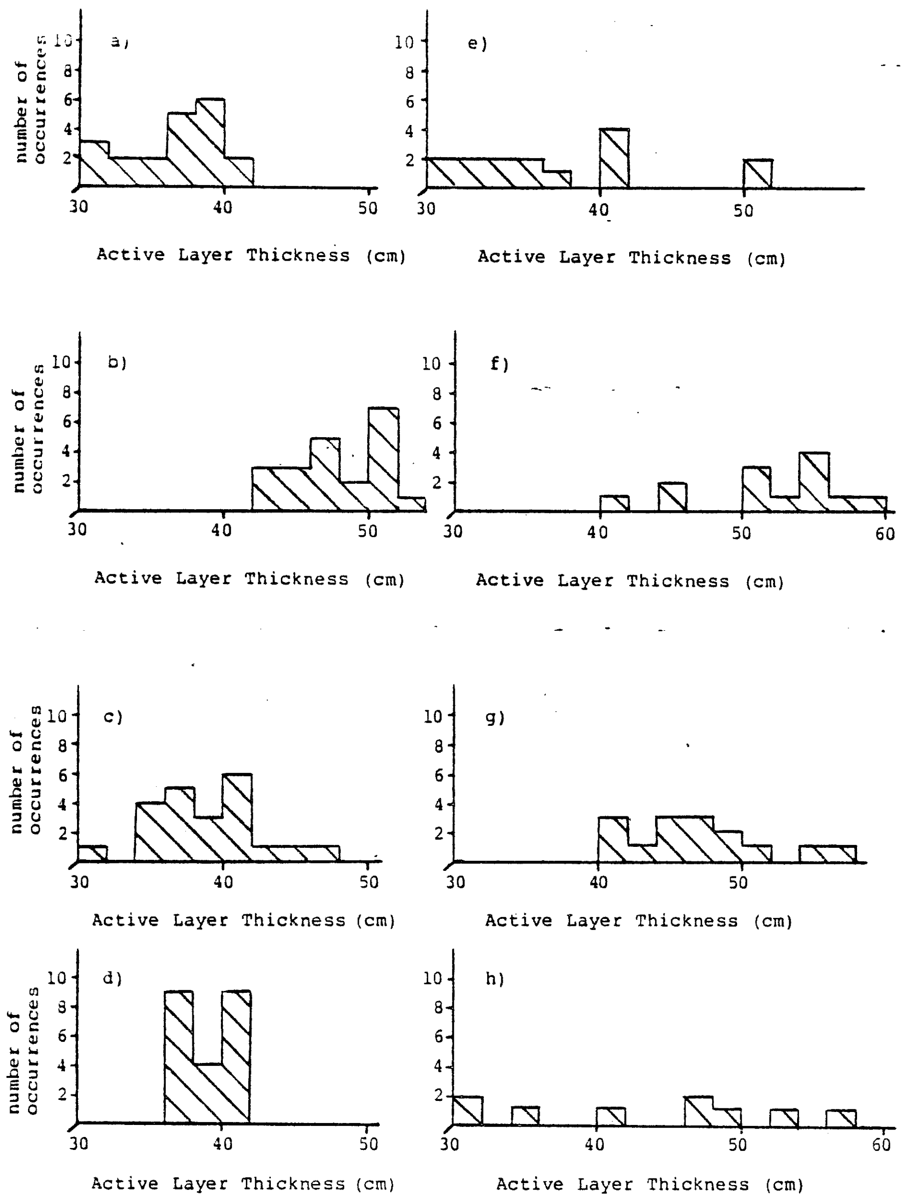


Figure 24: *Active layer thicknesses for pingo #10: a, b, c, and d are probe measurements on the lake flat north, south, east and west of the pingo, respectively. Graphs e, f, g, h are probe measurements from the north, south, east and west facing pingo slopes, respectively.*

slightly larger than that for the north slope but the difference was not statistically significant (Figure 25). The fact that much of the north facing slope had grassy vegetation (Plate 8) while the south slope had complete dwarf willow or ground birch cover may explain the relatively thick active layer on the north slope. Since these measurements were taken in early summer it is also possible that by late summer the thaw on the south facing slope would be significantly greater than that on the north facing slope.

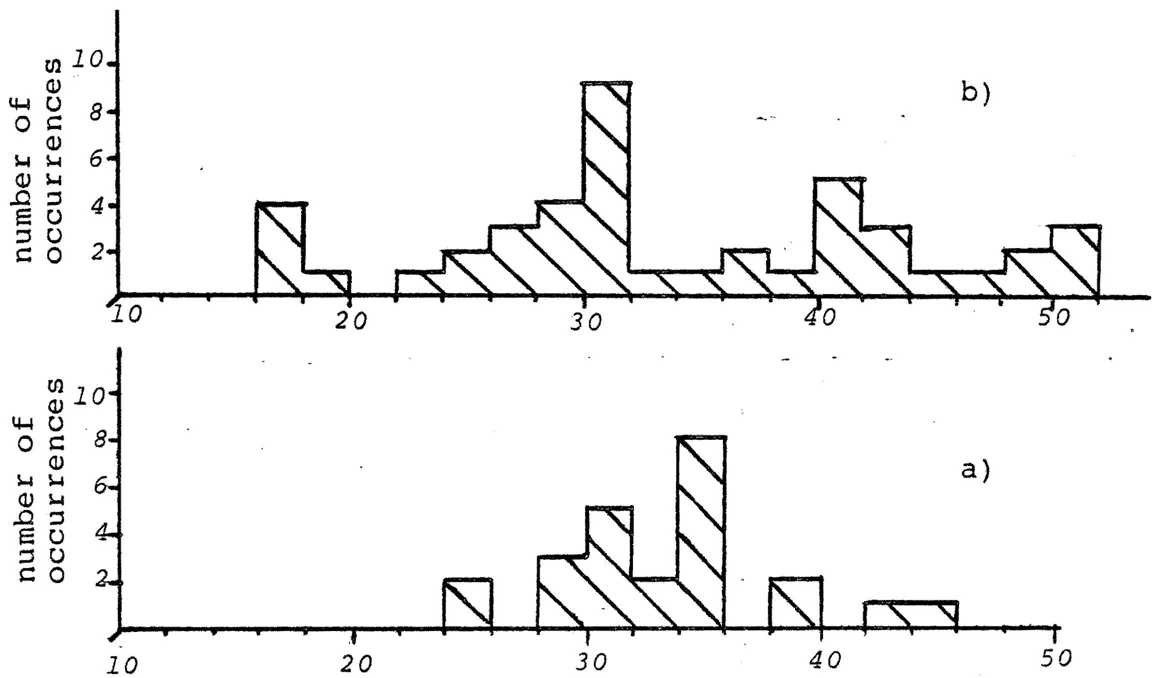


Figure 25: *July 5 active layer thickness for Satellite Pingo; a) north facing slope. b) south facing slope.*

In addition to the pingo data, thaw depths for the Illisarvik southeast facing slope and a nearby north facing slope (Plate 1) were also compared. Both slopes had hummocky terrain and were partially snow covered at the June observation period. Both thaw depths were compared in mid June and mid August. Thaw depths were greater at the southeast facing slopes for both observation periods (Figure 11). This was true for corresponding hummocks and interhummock depressions on each slope.

To summarize, there is ample evidence to suggest that a greater amount of direct radiation received on south facing slopes will result in a thicker active layer on these slopes. The differential thaw for north and south facing slopes will be accentuated throughout the summer. Vegetational and microrelief differences on slopes of various orientation and microclimatic factors may outweigh this effect in certain cases.

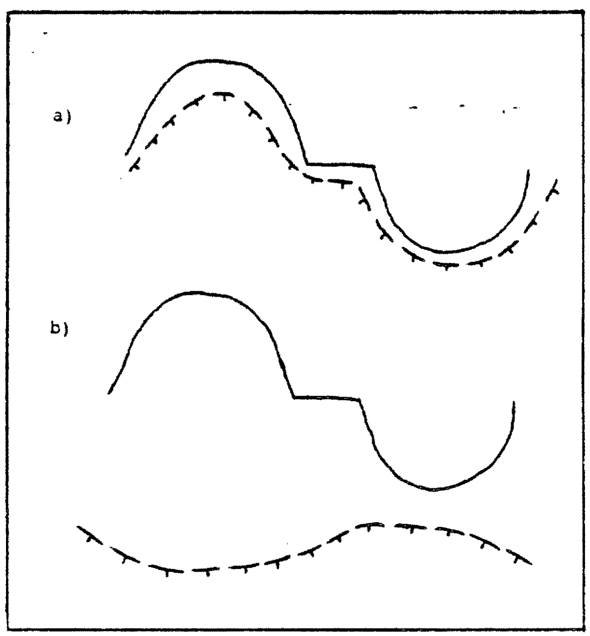


Figure 26: *Idealized active layer development associated with changes in local relief; a) local relief exceeds active layer thickness. b) active layer thickness exceeds local relief.*

In areas where the local relief exceeds active layer thickness, the frost table will naturally follow the surface topography although negative relief areas will have a thinner active layer than areas of positive relief (Figure 26). The thicker active layer associated with areas of positive relief are believed to be primarily the result of greater exposure (of these areas) to direct solar radiation. Similarly, on a smaller scale, greater exposure of positive relief features (e.g. hummocks) to direct solar radiation may result in a thicker active layer development beneath areas of positive relief such that the frost table becomes an inverse to the surface topography.

SUMMARY AND CONCLUSIONS

The field work undertaken in this project examined active layer development in a number of different situations. This study has: 1) resolved an earlier misunderstanding concerning active layer development associated with local topography, 2) confirmed observations of previous workers regarding the effect of slope orientation and soil type on active layer thickness, 3) reached some new conclusions on a) active layer development associated with late snow cover b) diurnal variations of increases in active layer thickness.

1) In hummocky terrain, greater thaw beneath hummocks (versus interhummock depressions) results in a highly variable active layer thickness such that the frost table is a crude mirror image of surface topography. Positive relief of the hummock, and differences in soil profile and soil water/ice content between the hummock and interhummock depression are factors responsible for the variable active layer thickness.

If active layer thickness exceeds local relief, then larger amounts of direct radiation received on areas of positive relief (not necessarily hummocks) may result in a slight inversion of the frost table with respect to surface topography. If active layer thickness is exceeded by local relief the frost table will naturally follow surface topography (e.g. across pingos) although localized areas of negative relief will still have a thinner active layer than areas of positive relief.

2) Slope orientation has an effect on active layer development. South facing slopes will usually have the thickest active layer because they receive greater amounts of direct solar radiation. North facing slopes are expected to have the thinnest active layer with east and west facing slopes having intermediate active layer thicknesses. Although the differential net radiation effect begins as soon as winter is over, the differences in active layer thicknesses may not be pronounced until mid or late summer. Differences in active layer thicknesses due to slope orientation may be overshadowed by the effects of local vegetation, microrelief, late snow cover and soil type.

3) Late snow cover acts to delay initial active layer development dependant on the extent of the snow. Considerable active layer development is possible beneath snow cover less than 20cm thick although freezeback may occur if the snow is disturbed. Snow melting and rapid initial thaw, following snow melt in the previously snow covered area, will increase the soil moisture content of the active layer in areas immediately downslope from the late snowbank. By late summer, the active layer thickness in areas with late snow cover will not be appreciably different from that in surrounding areas dependant on how far into the summer late snow

cover persists.

Variations in the daily increase of early summer active layer thickness indicate a time delay or lag effect in maximum daily thaw with respect to the period of daily maximum solar radiation. Between June 17 and 23, maximum thaw was recorded during the 2200 to 0500 hour time period on the Illisarvik southeast facing transect. Previous work on the propagation of surface heat (caused by absorption of direct solar radiation) through the active layer would seem to support this concept of diurnal variations in thaw rates, although unknown inconsistancies in the probing method may be partially responsible for this phenomenon.

Acknowledgements

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APPENDIX I

Kikoak west facing slope transect and
Illisarvik southeast facing slope transect
daily active layer measurements.

APPENDIX I

Kikoak west facing slope data

Distance (m)	June 4 8:00P.M.	June 5 6:45A.M.	June 5 11:45A.M.	June 5 8:00P.M.	June 6 6:45A.M.	June 6 4:00P.M.
	Active layer thickness (cm)					
0.0	27	30	28	27	29	30
0.5	30	30	31	30	30	30
1.0	31	31	31	30	31	30
1.5	33	32	33	32	36	37
2.0	32	41	41	41	43	44
2.5	53	47	55	55	60	56
3.0	43	47	46	50	50	49
3.5	47	47	48	46	52	52
4.0	44	43	47	43	48	48
4.5	40	40	38	45	46,fc	47
5.0	36	35	36	45	49	47
5.5	36	33	37	42	48	43
6.0	29	31	30	36	37	36
6.5	10	13	12	14	15,fc	12
7.0	32	27	31	32	33	48
7.5	30	30	32	40	43	41
8.0	23	24	23	27	30	27
8.5	8	10	8	11	11	12
9.0	3	2	3	4	5	8
9.5	5	2	1	3	6	6
10.0	4s,3	3s,0	3s,0	3s,0	2s,0	3
10.5	19s,0	19s,0	22s,0	18s,0	19s,0	17s,0
11.0	17s,0	16s,0	10s,0	14s,6,fc	14s,0	11s,4
11.5	14s,0	14s,0	14s,0	13s,0	13s,0	10s,0
12.0	2s,5	0	4	5	9,fc	7

f.c. = frozen crust observed at ground surface (commonly 0.5cm-2cm)
s = thickness of late snow cover

Kikoak west facing slope data

	Active layer thickness (cm)					
Distance (m)	June 6		June 7		June 8	
	8:00P.M.	5:00A.M.	5:45P.M.	9:45P.M.	5:00A.M.	11:30A.M.
0.0	29	29	29	30	31	30
0.5	30	31	30	30	32	31
1.0	31	30	30	31	31	31
1.5	37	38	36	37	36	37
2.0	43	42	43	45	43	43
2.5	57	56	55	57	57	55
3.0	49	50	52	61	53	52
3.5	52	51	52	52	53	54
4.0	47	50	49	50	50	50
4.5	48	49	49	50	50	52
5.0	45	44	46	45	43	44
5.5	45	45	48	50	51	50
6.0	36	37	39	48	39	40
6.5	17	16,fc	20	19	19,fc	23
7.0	39	40	41	43	44	45
7.5	40	48	48	48	48	48
8.0	26	30	31	32	33	34
8.5	15	13,fc	15	14	13,fc	17
9.0	8	10,fc	10	12	12,fc	13
9.5	10	8,fc	10	10	11,fc	10
10.0	8	5,fc	3	7	9,fc	6
10.5	13s,3	17s,0	4s,0	2	6,fc	7
11.0	8s,4	7s,6,fc	6	6	6,fc	7
11.5	7s,0	6s,0	4	4	4,fc	4
12.0	8	7,fc	9	9	10,fc	7

Kikoak west facing slope data

Distance (m)	Active layer thickness (cm)					
	June 8		June 9			June 10
	5:30P.M.	10:00P.M.	4:45A.M.	6:00P.M.	11:00P.M.	6:30A.M.
0.0	31	32	33	36	40	40
0.5	32	34	33	37	40	40
1.0	32	33	36	37	40	41
1.5	37	37	40	40	45	46
2.0	47	46	48	50	51	53
2.5	57	57	60	60	62	62
3.0	53	53	56	55	56	67
3.5	57	57	57	60	61	63
4.0	52	52	53	57	59	59
4.5	51	52	54	58	59	58
5.0	47	47	49	50	53	51
5.5	52	54	52	51	52	50
6.0	48	47	49	51	53	51
6.5	24	27	27	28	31	43
7.0	45	45	48	49	52	57
7.5	49	50	50	50	51	51
8.0	36	38	40	52	45	49
8.5	20	29	21	29	33	37
9.0	16	19	21	27	28	40
9.5	12	11	18	15	12	10
10.0	9	5	7	10	12	11
10.5	4	10	7	8	10	12
11.0	4	10	7	8	0	12
11.5	8	5	7	9	10	10
12.0	8	9	8	10	10	11

Kikoak west facing slope data

Distance (m)	June 4 8:00P.M.	June 5 6:45A.M.	June 5 11:45A.M.	June 5 8:00P.M.	June 6 6:45A.M.	June 6 4:00P.M.
	Active layer thickness (cm)					
12.5	0	0	3	4	6,fc	7
13.0	3	2,fc	2	3	3,fc	3
13.5	2s,1	2s,0	2s,0	1	0	3
14.0	2s,2	2s,0	1s,1	3	0	5
14.5	0	0	1	1	1	3
15.0	0	0	0	2	1	3
15.5	0	0	1	1	1	3
16.0	3	0	6	7	7,fc	7
16.5	1	0	1	3	9,fc	7
17.0	0	1	0	2	1	3
17.5	0	0	0	2	3,fc	3
18.0	4	0	2	4	10,fc	9
18.5	7	7,fc	7	5	10,fc	9
19.0	6	8,fc	6	8	7	10
19.5	7	7,fc	9	10	9	10
20.0	7	4,fc	7	10	8	8
20.5	10	9,fc	8	9	10	11
21.0	6	11,fc	10	10	11	10

Kikoak west facing slope data

	Active layer thickness (cm)					
Distance (m)	June 6		June 7		June 8	
	8:00P.M.	5:00A.M.	5:45P.M.	9:45P.M.	5:00A.M.	11:30A.M.
12.5	8	8,fc	9	8	6,fc	10
13.0	3	4,fc	5	4	9,fc	10
13.5	3	2	6	8	4,fc	6
14.0	5	6	8	8	8,fc	6
14.5	7	4	5	5	6,fc	9
15.0	3	5,fc	7	6	9,fc	6
15.5	4	5,fc	5	5	8,fc	9
16.0	10	9,fc	10	10	11,fc	5
16.5	6	3,fc	5	6	6,fc	10
17.0	3	4,fc	5	6	6,fc	6
17.5	4	4,fc	5	6	7,fc	6
18.0	10	10	10	11	12,fc	10
18.5	8	7,fc	10	10	10,fc	10
19.0	10	11,fc	11	9	11,fc	11
19.5	10	10,fc	10	10	10,fc	10
20.0	9	11,fc	10	10	10,fc	10
20.5	10	10,fc	10	10	11,fc	10
21.0	10	10,fc	10	10	10,fc	12

Kikoak west facing slope data

Active layer thickness (cm)

Distance (m)	June 8		June 9			June 10
	5:30P.M.	10:00P.M.	4:45A.M.	6:00P.M.	11:00P.M.	6:30A.M.
12.5	11	9	10	10	12	12
13.0	10	10	10	11	13	12
13.5	7	10	9	12	16	14
14.0	8	8	7	10	11	11
14.5	10	10	10	11	11	12
15.0	5	5	7	11	9	11
15.5	10	9	10	11	11	14
16.0	8	9	8	11	10	11
16.5	12	12	13	15	16	18
17.0	9	9	9	10	10	10
17.5	8	8	9	9	9	10
18.0	11	12	13	13	14	14
18.5	10	10	10	11	10	12
19.0	10	10	10	10	12	12
19.5	10	10	10	11	12	13
20.0	10	10	11	13	12	13
20.5	11	11	11	11	10	11
21.0	10	10	10	10	11	11

APPENDIX I

Illisarvik southeast facing slope data

	Active layer thickness(cm)					
Distance (cm)	June 14	June 15		June 16		June 17
	7:30P.M.	5:30A.M.	8:00P.M.	6:30A.M.	9:45P.M.	4:45A.M.
0	9	7	9	9	10	10
50	11	12	14	16	14	15
110	4	7	6	6	13	13
150	8	4	8	9	13	10
200	4	4	4	5	7	7
250	2	4	4	4	4	3
310	3	4	7	6	7	8
360	8	6	7	6	12	9
420	8	3	4	4	6	7
470	8	6	8	9	9	9
520	2	4	3	2	9	9
560	6	4	3	5	3	5
620	8	6	8	8	9	9
680	4	4	8	5	8	9
730	2	3	7	6	8	8
770	18s,o	18s,0	7s,0	7s,0	1	1
810	22s,0	20s,0	8s,0	9s,0	2	2
860	23s,0	23s,0	14s,0	14s,0	7	6
920	11s,0	9s,0	2	3	6	6
970	8s,0	6s,0	7s,0	8s,0	3	3
1020	2	3	4	3	6	7
1080	5s,0	5s,0	4s,0	4s,0	8	5
1120	3s,0	3s,0	1	3	6	8
1160	7s,0	7s,0	1	1	2	2
1200	1	2	2	4	5	7
1270	7s,0	6s,0	6s,0	4s,0	9	7

f.c. = frozen curst observed at ground surface (commonly 0.5cm-2cm)
s = thickness of late snow cover

Illisarvik southeast facing slope data

Distance (cm)	June 17	June 18		June 19		June 20
	10:00P.M.	4:45A.M.	8:15P.M.	5:00A.M.	9:00P.M.	4:45A.M.
	Active layer thickness (cm)					
0	7	9	10	8	10	10
50	17	20	17	18	17	18
110	13	11	14	11	12	12
150	9	15	10	10	13	17
200	8	7	8	7	7	7
250	2	4	3	4	3	2
310	7	10	9	9	15	10
360	15	16	13	17	15	15
420	8	8	9	9	9	10
470	8	9	9	10	10	9
520	10	10	15	14	16	13
560	5	4	4	5	5	5
620	9	9	9	10	9	10
680	10	9	10	10	11	10
730	9	10	10	10	10	10
770	3	3	3	4	3	5
810	2	3,fc	3	4	3	6,fc
860	5	10	6	7,fc	7	9,fc
920	7	8	9	9,fc	10	10,fc
970	3	4,fc	5	4,fc	4	6,fc
1020	7	6	7	8	7	9
1080	7	8	10	5	10	10
1120	7	7	8	8,fc	9	9,fc
1160	4	5,fc	3	5	5	9
1200	5	7	6	8,fc	6	7,fc
1270	10	9,fc	10	10,fc	10	11,fc

Illisarvik southeast facing slope data

Distance (cm)	June 20 10:00P.M.	June 21 5:00A.M.	June 21 7:00P.M.	June 22 4:45A.M.	June 22 7:00P.M.	June 23 4:45A.M.
	Active layer thickness (cm)					
0	10	10	10	9	10	10
50	20	20,fc	21	21	23	23
110	13	14,fc	14	16	15	14
150	14	16	17	17	17	18
200	8	8,fc	8	9	8	9
250	3	2,fc	3	3	3	3
310	16	17	17	17	17	17
360	18	18	18	18	19	19
420	10	10	10	10	9	9
470	9	10,fc	10	10	10	10
520	16	14	15	15	13	15
560	7	7	7	8	8	8
620	10	10	10	10	10	10
680	11	10	12	12	12	12
730	11	12	12	11	13	13
770	3	3	4	5	4	4
810	3	5	4	5	5	7
860	9	9,fc	9	9	9	9
920	10	10,fc	9	11	11	11
970	5	7,fc	5	6	7	7
1020	8	8,fc	9	10	9	10
1080	11	11	11	11	12	12
1120	9	9	10	10	9	10
1160	10	11	4	5	5	5
1200	7	8,fc	10	10	9	10
1270	11	10,fc	11	11	12	12

Illisarvik southeast facing slope data

Active layer thickness (cm)

Distance (cm)	June 23 6:30P.M.	June 24 4:45A.M.	June 25 5:00A.M.	June 26 4:00A.M.	August 21 6:00A.M.
0	11	10	11	12	58
50	24	24	25	28	59
110	16	15	20	20	50
150	18	18	20	20	56
200	8	9	8	10	40
250	4	3	3	3	32
310	18	18	17	18	53
360	18	19	17	19	58
420	10	10	10	10	56
470	10	11	11	11	66
520	16	16	17	16	57
560	9	9	14	20	51
620	11	11	11	17	61
680	13	14	14	16	55
730	14	14	15	15	55
770	4	3	3	3	22
810	6	6	6	6	49
860	9	10	10	10	44
920	12	12	13	15	65
970	6	7	8	9	57
1020	10	10	10	11	69
1080	13	13	16	17	64
1120	10	10	10	10	53
1160	6	5	5	7	45
1200	10	10	10	10	53
1270	14	15	17	16	60

Illisarvik southeast facing slope data

Distance (cm)	June 14	June 15		June 16		June 17
	Active layer thickness (cm)					
	7:30P.M.	5:30A.M.	8:00P.M.	6·30A.M.	9:45P.M.	4:45A.M.
1330	3	6	8	8	10	6,fc
1380	3	6	4	6	8	10
1430	8	9	10	9	9	10
1480	10	9	10	9,fc	10	9,fc
1530	10	9	9	9,fc	10	10
1580	10	10	10	11,fc	9	10
1630	5	5	6	7	5	6
1670	7	9	10	10	10	11
1730	5	9,fc	8	9,fc	9	9
1790	3	8,fc	4	7,fc	3	8
1830	9	9,fc	8	8,fc	8	8
1870	9	7,fc	11	10,fc	10	10
1920	11	10,fc	10	9,fc	9	10
1930	11	9,fc	10	10	12	12
2030	10	10,fc	9	10,fc	10	10,fc
2080	10	12	10	10,fc	10	10
2140	12	13	13	13,fc	14	14
2210	12	12	13	12,fc	12	11
2270	14	12	13	12,fc	11	12
2330	11	15	10	12,fc	15	13
2380	10	9	10	11	11	11
2430	7	12	11	11,fc	13	13
2480	12	14	12	11,fc	13	12
2510	11	18	19	20,fc	20	20
2580	12	17	16	17,fc	15	16

Illisarvik southeast facing slope data

Distance (cm)	Active layer thickness (cm)					
	June 17	June 18		June 19		June 20
	10:00P.M.	4:45A.M.	8:15P.M.	5:00A.M.	9:00P.M.	4:45A.M.
1330	7	8	8	10	8	9
1380	15	12	10	10,fc	15	17
1430	10	10	12	10	12	12,fc
1480	11	10	11	11,fc	12	12,fc
1530	10	10,fc	10	11,fc	11	13,fc
1580	14	10,fc	14	15	17	17
1630	7	9	8	8	7	8
1670	11	11	12	13	13	14
1730	9	10	10	10,fc	9	10,fc
1790	5	7,fc	4	7,fc	7	10,fc
1830	7	10,fc	8	10,fc	9	10,fc
1870	11	12,fc	11	13,fc	13	13,fc
1920	10	10	10	10	11	10
1930	13	14,fc	13	14,fc	14	16,fc
2030	10	10,fc	10	10,fc	10	10,fc
2080	10	13,fc	11	13,fc	11	14,fc
2140	15	17	16	18,fc	14	17,fc
2210	12	15	14	15,fc	16	13,fc
2270	13	15	15	17,fc	17	19,fc
2330	16	16,fc	15	16,fc	17	17
2380	11	12	12	13,fc	13	13
2430	14	14,fc	14	14	15	15,fc
2480	13	15,fc	13	15,fc	15	16,fc
2510	20	21	21	21,fc	21	21,fc
2580	16	17	17	17,fc	17	17,fc

Illisarvik southeast facing slope data

	Active layer thickness (cm)					
Distance (cm)	June 20	June 21		June 22		June 23
	10:00P.M.	5:00A.M.	7:00P.M.	4:45A.M.	7:00P.M.	4:45A.M.
1330	9	9,fc	9	9	9	10
1380	16	17,fc	18	19	19	19
1430	13	11,fc	12	14	15	15
1480	12	12,fc	13	14	13	14
1530	12	13,fc	14	13	13	15
1580	17	15	18	19	19	20
1630	9	8,fc	9	8	8	9
1670	14	14	14	16	15	16
1730	10	8,fc	10	10	10	10
1790	4	7,fc	4	6	4	5
1830	10	10,fc	9	9	10	9
1870	13	12,fc	10	12	14	14
1920	9	10,fc	12	10	10	10
1930	16	16,fc	16	16	17	17
2030	11	11,fc	10	11	11	11
2080	17	14,fc	11	13	13	14
2140	15	18,fc	18	18	18	19
2210	16	15,fc	15	15	15	15
2270	16	20,fc	19	19	20	20
2330	15	17,fc	19	20	20	20
2380	15	16,fc	16	16	17	18
2430	16	17	17	17	18	18
2480	16	16,fc	17	16	17	17
2510	21	22,fc	22	22	23	22
2580	18	19	18	19	19	19

Illisarvik southeast facing slope data

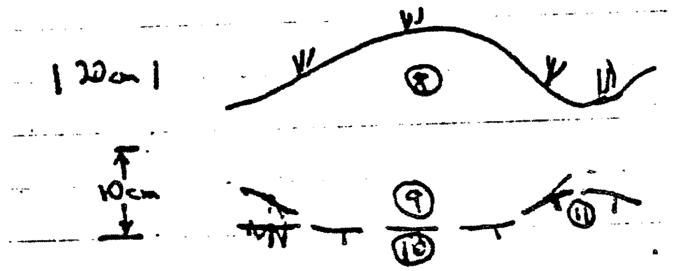
Distance (cm)	June 23 6:30P.M.	June 24 4:45A.M.	June 25 5:00A.M.	June 26 4:00A.M.	August 21 6:00A.M.
1330	9	9	10	10	54
1380	20	20	20	20	71
1430	16	15	17	18	70
1480	15	14	16	15	51
1530	15	16	15	18	56
1580	20	20	20	27	58
1630	10	10	10	10	48
1670	17	17	18	19	54
1730	10	10	10	10	48
1790	4	4	3	5	40
1830	10	9	11	11	50
1870	14	14	16	15	59
1920	10	10	9	10	51
1930	17	17	17	19	59
2030	11	12	11	13	50
2080	13	15	15	20	51
2140	19	19	20	20	60
2210	15	16	14	17	60
2270	21	21	20	22	61
2330	20	20	20	26	69
2380	17	18	18	23	67
2430	19	19	19	20	65
2480	17	17	18	19	66
2510	25	25	26	30	71
2580	20	20	20	20	71

APPENDIX II

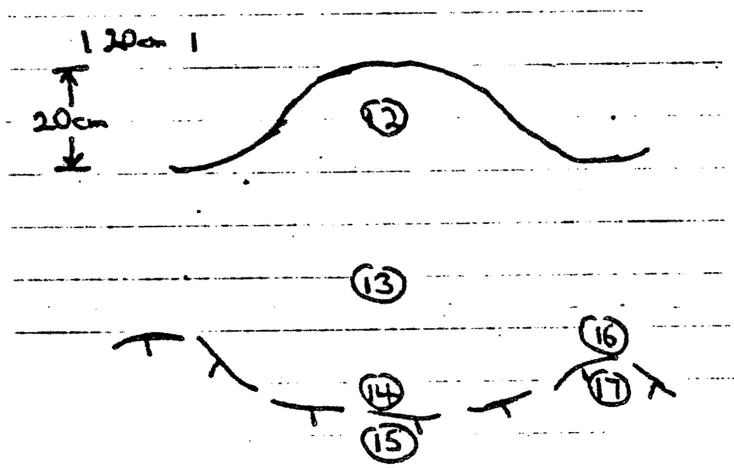
Water content from Kikoak west facing slope and Illisarvik southeast facing slope.

SAMPLE #	LOCATION	WATER CONTENT	DESCRIPTION
1(10-6-79-1)	Kikoak, upper slope	4.2%	frozen sand
2(10-6-79-2)	Kikoak, upper slope	7.3%	unfrozen sand
3(10-6-79-3)	Kikoak, lower slope	240.3%	unfrozen peat
4(10-6-79-4)	Kikoak, lower slope	133.6%	frozen peat
5(25-6-79-1)	Illisarvik, lower slope	231.6%	unfrozen silty peat
6(25-6-79-2)	Illisarvik, lower slope	44.8%	frozen silty clay
7(25-6-79-3)	Illisarvik, lower slope	675.0%	frozen peat
8(25-6-79-4)	Illisarvik, upper slope	33.5%	unfrozen silty clay
9(25-6-79-5)	Illisarvik, upper slope	214.7%	unfrozen silty clay
10(25-6-79-6)	Illisarvik, upper slope	26.0%	frozen silty clay
11(25-6-79-7)	Illisarvik, upper slope	1564.0%	peaty ice
12(22-8-79-1)	Illisarvik, upper slope	23.2%	unfrozen silty clay
13(22-8-79-2)	Illisarvik, upper slope	23.0%	unfrozen silty clay
14(22-8-79-3)	Illisarvik, upper slope	24.4%	unfrozen silty clay
15(22-8-79-4)	Illisarvik, upper slope	75.6%	frozen silty clay
16(22-8-79-5)	Illisarvik, upper slope	60.9%	unfrozen peaty silt
17(22-8-79-6)	Illisarvik, upper slope	203.6%	frozen icy peat
18(22-8-79-7)	Illisarvik, lower slope	31.7%	unfrozen silty clay
19(22-8-79-8)	Illisarvik, lower slope	31.6%	unfrozen silty clay
20(22-8-79-9)	Illisarvik, lower slope	89.6%	frozen silty clay
21(22-8-79-7)	Illisarvik, lower slope	298.8%	unfrozen peat
22(22-8-79-8)	Illisarvik, lower slope	563.8%	icy organic clay

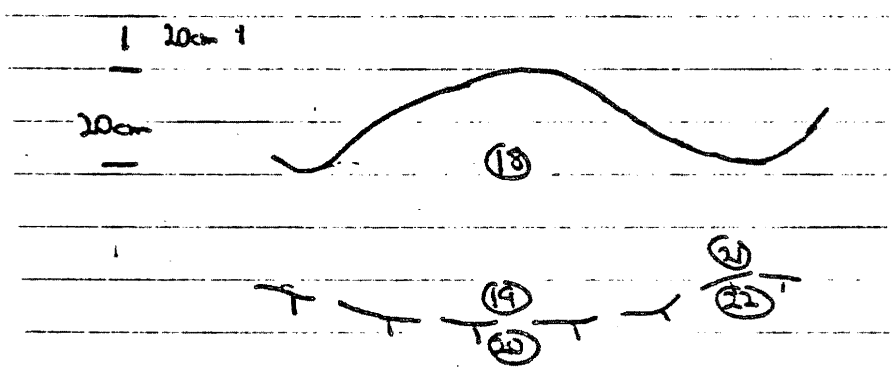
Sketches of soil sample locations



Approximately one meter south of upper slope portion of Illisarvik southeast slope transect (June 25)



Approximately one meter south of upper slope portion of Illisarvik southeast slope transect (August 22)



Just south of lower slope portion of Illisarvik southeast slope transect (August 22)

APPENDIX III

Gross description of vegetation cover

Kikoak west facing slope transect

0m - 9m: (east)	-	20% exposed sand
	-	vegetation is sparse (i.e. no continuous turf cover), low lying and includes; lichens, reindeer moss, labrador tea and grasses in order of decreasing abundance.
9m - 14m:	-	continuous low lying vegetation cover including cassiope, heather, labrador tea, cranberry, empetrum, lichens, mosses and sparse grasses.
14m-20m (west)	-	continuous vegetation cover with 0.5cm - 2cm thick surface organic mat ("turf")
	-	vegetation includes; heather, cloudberry, heather, sedges, bearberry, and labrador tea with occasional ground birch.

Illisarvik site; southeast facing slope transect

0m -8m: (northeast)	30%	heather and unidentified low lying vegetation (concentrated on hummocks)
	30%	mosses (concentrated in interhummock depressions)
	10%	crowberry
	10%	labrador tea
	10%	loupins, avens, lichens and grasses
	5%	dwarf willow (20-40cm high)
	5%	ground birch ($<$20cm high)
8m - 19m:	30%	heather, avens and unidentified low lying vegetation (concentrated on hummocks)
	30%	mosses (concentrated in interhummock depressions)
	20%	grasses
	15%	colt's foot
	5%	loupins
19m - 25m (southeast)	50%	mosses
	20%	grasses
	10%	sedges
	10%	loupins
	10%	heather, avens and other unidentified low lying vegetation

Illisarvik site; north facing slope transect

0m - 7m: (south)
- upper slope with hummocky terrain
  - 40% mosses (concentrated in interhummock depressions)
  - 30% heather, avens and other unidentified low lying vegetation
  - 10% dwarf willow ($<$40cm high)
  - 10% grasses (up to 45cm high)
  - 5% sedges
  - 5% colt's foot

7m - 14m: (north)
- poorly drained lower transect (near "Scotia Lake" water level)
  - 40% sedges
  - 30% mosses
  - 10% crowberry
  - 10% ground birch ($<$10cm high)
  - 5% cloudberry
  - 5% heather and other low lying vegetation

Illisarvik site; lineated hummock transect

- 30% heather, avens and other unidentified low lying vegetation (concentrated on hummocks)
- 30% mosses (concentrated in interhummock depressions)
- 15% colt's foot
- 10% grasses
- 5% loupins
- 10% unidentified

Illisarvik site; North-south transect across the pingo west of Illisarvik Lake

0m - 38m: (north)
- 70% cover of high bushes up to 50cm high (85% dwarf willow, 15% ground birch)
- also complete ground cover of low lying vegetation (30% mosses, 10% grasses, 40% heather and unidentified plants)

38m - 55m: - near complete cover of high bushes (50cm - 70cm high) (80% dwarf willow, 20% ground birch)
- also, complete low lying vegetation cover (70% mosses, 20% grasses, 10% fern-like plants and unidentified plants)

55m - 63m: - similar to 38m - 55m section except upper bush cover is 80cm to 100cm high

63m - 80m: (south)
- 40% heather and other low lying vegetation
- 15% crowberry
- 15% blueberry
- 10% grasses
- 10% mosses
- 8% loupins and lichens
- 2% dwarf willow

<u>Pingo Lake site; north-south transect across pingo #10</u>

0m - 22m: (south) - 60% sedges, 40% grasses on a "floating" organic bog

22m - 37m: - near complete grass vocer (20-70cm high) with minor mosses ($<1\%$) and dwarf willow ($<1\%$)
- some exposed soil from 33m - 37m

37m - 39m: - in tension crack (mainly grassy vegetation up to 1m high)

39m - 66m: - same as 22m - 37m section

66m - 80m: (north) - water saturated lake flat (but not a "floating bog") 80% sedges and 20% grasses

<u>Pingo lake site; east-west transect across pingo #10</u>

0m - 21m: (east) - water saturated firm lake flat (i.e. not a "floating bog") 90% sedges, 10% grasses (50-100cm high)

22m - 42m: - complete grassy vegetation usually 30cm maximum height

42m - 45m: - tension crack: 75% grasses (up to 1m high) 5% sedges, 20% mosses and bare peat

45m - 58m: complete grassy vegetation with average height of 70cm

58m - 80m: (west) - sedges and grasses (50-80cm high) on a firm lake flat

Garry Island site:

north facing slope: 30% mosses
25% crowberry
20% tussocks ($<$30cm high)
15% ground birch ($<$10cm high)
10% lichens and colt's foot

upper south facing slope (hummocky)

- similar to north facing slope except 50% dwarf willow (up to 50cm high)

lower south facing slope (non-hummocky)

- 40% mosses, 30% sedges and grasses ($<$20cm high), 20% crowberry,
- 10% lichens, colt's foot and other unidentified plants

I.O.L. Site: Satellite Pingo

0 - 6m (South)
- complete high bush cover: 70% dwarf willow (60-100cm high), 30% ground birch (20-30cm high).
- ground cover: 40% moss, 20% dead leaves, 10% grasses, 10% labrador tea, 10% cranberry, 10% crowberry.

8 - 14m
- 60% mosses, 20% ground birch (< 30cm high), 10% grasses, 5% dwarf willow, 5% labrador tea.

16 - 28m
- near complete high bush cover: 80% ground birch (< 60cm high), 10% dwarf willow (< 70cm high).
- ground cover: 40% cranberry, 20% mosses, 15% grasses, 15% labrador tea, 8% crowberry, 2% colt's foot.

30 - 50m
- near complete high bush cover: 90% ground birch 70-100cm high), 10% dwarf willow (110cm+ high).
- ground cover: predominantly dead leaves but also 20% grasses, 5% colt's foot.

50 - 56m
- 60% grasses, 30% mosses, 10% lichens.

56 - 87m
- 100% dwarf willow cover.
- ground cover: 90% dead leaves, 5% grasses, 5% small white flower.

87 - 106m
- tension crack: 60% mosses, 20% small white flower(?), 10% grasses, 10% exposed peat.

108 - 144m
- 75% mosses and lichens, 20% grasses, 5% fire weed.

144 - 154m (North)
- complete high bush cover: 95% ground birch (50-70cm high), 5% dwarf willow.
- ground cover: 50% mosses, 20% dead leaves and twigs, 15% grasses, 10% small white flower, 5% lichens.

APPENDIX IV

Meterological summary for stations at Illisarvik, Tuktoyaktuk and Inuvik.

ILLISARVIK [1]

	MAY				JUNE		
Day	Air Temperature		Precipitation	Day	Air Temperature		Precipitation
	Max (°C)	Min (°C)	(mm)		Max (°C)	Min (°C)	(mm)
1				1	12	-3	
2				2	6	-3	
3				3	7	-4	
4				4	9	-2	
5				5	1	-4	
6				6	4	-5	
7			1.5e	7	9	-3	
8			0.5e	8	11	-2	
9	Start of record			9	16	-1	
10	-1	-8		10	23	3	
11	-7	-11		11	15	2	
12	-5	-15		12	8	1	
13	-4	-16		13	4	-2	
14	-1	-13		14	2	-2	
15	3	-13		15	10	-2	
16	0	-8		16	10	-2	
17	-2	-6		17	6	-3	
18	-2	-6		18	6	-2	
19	-2	-7		19	6	-2	
20	4	-6		20	5	-3	
21	2	-3	1.0	21	10	-4	0.5
22	-2	-6		22	4	0	2.3
23	1	-6		23	7	-2	
24	-2	-5		24	19	-1	1.5
25	0	-6		25	3	1 q	1.3
26	3	-8		26	3	0	6.1
27	10	-2	0.8	27	7	-1	
28	8	-2		28	13	1	
29	3	-1	4.6	29	11	2e	
30	-1	-3		30	18	2	
31	4	-4					

e = estimate
m = missing data

1 Collected by J. Anderson, Snow & Ice Div., Environment Canada

ILLISARVIK

JULY				AUGUST			
Day	Air Temperature Max (^{O}C)	Air Temperature Min (^{O}C)	Precipitation (mm)	Day	Air Temperature Max (^{O}C)	Air Temperature Min (^{O}C)	Precipitation (mm)
1	23	7		1	m	m	
2	26	4		2	m	m	m
3	26	10		3	m	m	m
4	23	m		4	m	m	m
5	m	m	0.3	5	m	m	m
6	m	m	1.5	6	m	m	m
7	m	m		7	m	m	m
8	m	m	0.5	8	m	m	
9	9	3		9	m	m	
10	23	6	3.3	10	m	m	
11	9	3		11	m	m	
12	10	3		12	m	m	
13	18	3		13	m	m	
14	23	10		14	m	m	
15	26	8		15	m	m	
16	18	8		16	m	m	m
17	22	8		17	m	m	m
18	20	9		18	m	m	m
19	19	8		19	m	m	m
20	20	10		20	m	m	
21	25	10		21	15	7	1.5
22	26	14		22	8	6	2.0
23	27	12		23	8	4	2.0
24	19	12		24	8	2	
25	27	13		25	10	4	
26	15	5		26	6	3	0.8
27	16	5		27	9	4	0.3
28	19	8		28	10	4	0.3
29	m	m		29	7	3	
30	m	m		30	5	2	
31	m	m		31	6	1	0.3

ILLISARVIK

SEPTEMBER

Day	Air Temperature Max (^{o}C)	Min (^{o}C)	Precipitation (mm)
1	4	2	4.8
2	5	2	0.3
3	8	2	1.3
4	4	3	
5	4	3	0.3
6	9	2	
7	10	4	
8	8	3	
9	5	3	
10	3	0	
11	5	1	
12	4	-4	0.8
13	0	-4	0.3
14	-1	-4	
15	2	-3	0.5
16	2	0	0.8
17	0	-3	
18	2	-4	0.5
19	8	-4	

End of Record

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY

SOMMAIRE CLIMATOLOGIQUE

STATION TUKTOYAKTUK PROVINCE [illegible] YEAR / ANNÉE 1979 MONTH / MOIS MAY/MAI TIME ZONE / FUSEAU HORAIRE C LISTING NUMBER / NUMÉRO DE LISTE 2203910 GEOG. NUMBER / NUMÉRO GEOG. 125

DAY / JOUR	TEMPERATURE °C / TEMPÉRATURE °C: Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % / Humidité Relative (%): Max.	Min.	PRECIPITATION S.I. UNITS / PRÉCIPITATION UNITÉS S.I. — 6-HOURLY TOTALS / TOTAL DE 6 HEURES: 1200Z mm	1800Z mm	0000Z mm	0600Z mm	24-HOURLY TOTALS / TOTAL DE 24 HEURES: Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm	Snow Depth 12Z / Épaisseur de neige 12Z cm	DAYS WITH / JOUR AVEC: Freezing Temp. / Temp. de congélation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog / Brouillard <1 km	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / (Chasse-Poussière ou Chasse-Sable Élevée)	Blowing Snow / Chasse-Neige Élevée	Wind / Vent: 50 or more km/h / 50 km/h ou plus	62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal: Direction 36 Points	Speed / Vitesse km/h
01	0.8	-5.5	-2.4	20.4	M	M								23	1											M	M		
02	-0.5	-9.5	-5.0	23.0	M	M								20	1											M	M		
03	2.5	-7.5	-2.5	20.5	M	M								18	1											M	M		
04	1.8	-3.7	-1.0	19.0	M	M								17	1											M	M		
05	1.5	-4.8	-1.7	19.7	M	M								14	1											M	M		
06	-3.5	-10.0	-6.8	24.8	M	M								13	1											M	M		
07	-5.2	-16.0	-10.6	28.6	M	M				T		T	T	12	1											M	M		
08	-2.0	-6.2	-4.1	22.1	M	M	1.0	.4	.4	T	T	1.8	1.8	13	1			1		1	1					M	M		
09	-3.7	-13.7	-8.7	26.7	M	M	T	.3	.2		T	.5	.5	14	1			1		1	1					M	M		
10	-3.0	-8.0	-5.5	23.5	M	M	T	.2	T			.2	.2	14	1					1	1					M	M		
11	-6.5	-13.3	-9.9	27.9	M	M		T	T	T		T	T	14	1											M	M		
12	-7.5	-10.8	-9.2	27.2	M	M	T	1.0	T			1.0	1.0	14	1					1	1					M	M		
13	-5.3	-15.1	-10.2	28.2	M	M								14	1											M	M		
14	-7.0	-15.3	-11.2	29.2	M	M								14	1							1				M	M		
15	0.4	-12.6	-6.1	24.1	M	M								13	1							1				M	M		
16	3.4	-4.6	-0.6	18.6	M	M								10	1											M	M		
17	-1.4	-7.2	-4.3	22.3	M	M								9	1											M	M		
18	-2.0	-4.7	-3.4	21.4	M	M	T					T	T	9	1											M	M		
19	-2.6	-7.4	-5.0	23.0	M	M		.2	T			.2	.2	8	1					1	1					M	M		
20	2.6	-5.5	-1.5	19.5	M	M								8	1											M	M		
21	3.6	-2.0	0.8	17.2	M	M	T	T			T		T	6	1											M	M		
22	-1.2	-4.9	-3.1	21.1	M	M	T	T				T	T	5	1											M	M		
23	-0.2	-6.1	-3.2	21.2	M	M			T	T	T	T	T	5	1			1								M	M		
24	-1.4	-3.6	-2.5	20.5	M	M	T	T	T	T		T	T	5	1											M	M		
25	-1.2	-4.7	-3.0	21.0	M	M	T	T				T	T	5	1											M	M		
26	2.5	-7.1	-2.3	20.3	M	M								5	1											M	M		
27	13.9	-2.3	5.8	12.2	M	M				2.4	2.4	T	2.4	5	1		1				1					M	M		
28	4.2	-1.0	1.6	16.4	M	M	2.0	T			T	2.0	2.0	5	1			1		1	1					M	M		
29	4.1	-0.6	1.8	16.2	M	M		2.6	T		2.6		2.6	T	1		1				1	1				M	M		
30	0.3	-3.0	-1.4	19.4	M	M	2.0	T	T			2.0	2.0	T	1					1	1					M	M		
31	2.0	-3.1	-0.6	18.6	M	M	T	T			T	T	T	T	1							1				M	M		
TOTAL FOR MONTH / TOTAL DU MOIS															31		2	4		7	9	4				M	M	Maximum	

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	TEMPERATURE °C / TEMPÉRATURE °C: Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	EXTREMES / EXTRÊMES: Maximum / Maximale	Date	Minimum / Minimale	Date
Mean / Moyenne	-0.3	-7.1	-3.7	13.9	27	-16.0	7
Normal / Normale	-1.1	-8.2	-4.6				
Departure / Écart	0.8	1.1	0.9				

	DEGREE DAYS / DEGRÉS JOURS: Below / au-Dessous 18.0°C	Below / au-Dessous 0.0°C	Above / au-Dessus 0.0°C	Above / au-Dessus 5.0°C	Above / au-Dessus 10.0°C	PRECIPITATION S.I. UNITS / PRÉCPITATION UNITÉS S.I.: Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm
TOTAL	673	125	10			5.0	7.7	12.7
Normal / Normale	M	M	M	M	M	3.0	4.1	7.1
% of Normal / % de la Normale	M	M	M	M	M	167%	188%	179%

GREATEST / HAUTEUR MAXIMALE: Rain / Pluie mm	Date	Snow / Neige cm	Date	Pcpn / Préc. mm	Date
2.6	29	2.0	28*	2.6	29

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY / SOMMAIRE CLIMATOLOGIQUE

STATION TUKTOYAKTUK PROVINCE NWT. YEAR / ANNÉE 1979 MONTH / MOIS JUNE/JUIN TIME ZONE / FUSEAU HORAIRE C LISTING NUMBER / NUMÉRO DE LISTE 2203910 GEOG. NUMBER / NUMÉRO GEOG. 125

DAY / JOUR	Temperature °C / Température °C: Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % / Humidité Relative (%): Max.	Min.	Precipitation S.I. Units / Précipitation unités S.I. — 6-Hourly Totals / Total de 6 heures: 1200Z mm	1800Z mm	0000Z mm	0600Z mm	24-Hourly Totals / Total de 24 heures: Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm	Snow Depth 122 / Épaisseur de neige 122 cm
01	10.5	-2.8	3.9	14.1	M	M								T
02	7.6	-1.2	3.2	14.8	M	M								
03	5.5	-2.5	1.5	16.5	M	M								
04	11.2	-0.7	5.3	12.7	M	M								
05	2.8	-3.0	-0.1	18.1	M	M								
06	3.5	-5.1	-0.8	18.8	M	M								
07	8.1	-3.1	2.5	15.5	M	M								
08	11.3	-2.1	4.6	13.4	M	M								
09	19.0	1.5	10.3	7.7	M	M								
10	24.0	4.0	14.0	4.0	M	M								
11	17.0	2.5	9.8	8.2	M	M			T	T	T		T	
12	6.7	1.0	3.9	14.1	M	M				.2	.2		.2	
13	6.3	-0.5	2.9	15.1	M	M				T	T	T	T	
14	2.4	-1.5	0.5	17.5	M	M	T	T	T		T	T	T	T
15	6.0	-2.5	1.8	16.2	M	M								
16	13.6	-0.5	6.6	11.4	M	M								
17	6.8	-1.0	2.9	15.1	M	M								
18	5.0	-2.1	1.5	16.5	M	M								
19	7.5	-1.2	3.2	14.8	M	M								
20	6.2	-1.0	2.6	15.4	M	M								
21	11.8	-2.2	4.8	13.2	M	M				T	T		T	
22	6.1	1.1	3.6	14.4	M	M	1.8	1.0			2.8		2.8	
23	6.1	0.0	3.1	14.9	M	M								
24	19.2	1.0	10.1	7.9	M	M				1.2	1.2		1.2	
25	12.1	1.6	6.9	11.1	M	M	.6		.5		1.1		1.1	
26	4.8	0.9	2.9	15.1	M	M		.2	4.0	1.2	5.4	T	5.4	
27	7.0	0.3	3.7	14.3	M	M								
28	11.6	1.4	6.6	11.4	M	M								
29	14.4	3.4	8.9	9.1	M	M								
30	15.1	2.6	8.9	9.1	M	M								
**														

DAY / JOUR	Days with / Jour avec: Freezing Temp. / Temp. de congélation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog <1 km / Brouillard	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / (Chasse-Poussière ou Chasse-Sable Élevée)	Blowing Snow / Chasse-Neige Élevée	Wind / Vent: 50 or more km/h / 50 km/h ou plus	62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal: Direction 36 Points	Speed / Vitesse km/h
01	1											M	M		
02	1							1				M	M		
03	1							1				M	M		
04	1											M	M		
05	1							1				M	M		
06	1											M	M		
07	1											M	M		
08	1											M	M		
09												M	M		
10												M	M		
11												M	M		
12			1				1					M	M		
13	1											M	M		
14	1			1								M	M		
15	1											M	M		
16	1											M	M		
17	1											M	M		
18	1											M	M		
19	1											M	M		
20	1											M	M		
21	1											M	M		
22			1				1					M	M		
23	1											M	M		
24			1				1					M	M		
25			1				1					M	M		
26			1				1					M	M		
27												M	M		
28												M	M		
29												M	M		
30												M	M		
Total for month / Total du mois	18		5	1			5	3				M	M	Maximum	

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	Temperature °C / Température °C: Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Extremes / Extrêmes: Maximum / Maximale	Date	Minimum / Minimale	Date
Mean / Moyenne	9.6	-0.4	4.6	24.0	10	-5.1	6
Normal / Normale	9.1	0.2	4.7				
Departure / Écart	0.5	-0.6	-0.1				

	Degree Days / Degrés jours: Below / au-Dessous 18.0°C	Below / au-Dessous 0.0°C	Above / au-Dessus 0.0°C	Above / au-Dessus 5.0°C	Above / au-Dessus 10.0°C	Precipitation S.I. Units / Précipitation unités S.I.: Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm
TOTAL	400		140	37	4	10.7	T	10.7
Normal / Normale	M	M	M	M	M	10.2	3.3	13.5
% of Normal / % de la Normale	M	M	M	M	M	105%	%	79%

Greatest / Hauteur maximale: Rain / Pluie mm	Date	Snow / Neige cm	Date	Pcpn / Préc. mm	Date
5.4	26	T	13*	5.4	26

TAB 41 (S.I.)

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ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY

SOMMAIRE CLIMATOLOGIQUE

STATION TUKTOYAKTUK PROVINCE NWT. YEAR / ANNÉE 1979 MONTH / MOIS JULY/JUIL TIME ZONE / FUSEAU HORAIRE C LISTING NUMBER / NUMÉRO DE LISTE 2203910 GEOG. NUMBER / NUMÉRO GEOG. 125

DAY / JOUR	TEMPERATURE °C / TEMPÉRATURE °C			Degree Days Below 18.0°C / Degrés Jour au-dessous de 18.0°C	Relative Humidity % / Humidité Relative (%)		PRECIPITATION S.I. UNITS / PRÉCIPITATION UNITÉS S.I. — 6-HOURLY TOTALS / TOTAL DE 6 HEURES				24-HOURLY TOTALS / TOTAL DE 24 HEURES			Snow Depth 12Z / Épaisseur de neige 12Z	DAYS WITH / JOUR AVEC											Wind / Vent		Peak Wind / Vent Maximal	
	Maximum / Maximale	Minimum / Minimale	Mean / Moyenne		Max.	Min.	1200Z	1800Z	0000Z	0600Z	Rain / Pluie	Snow / Neige	Pcpn. / Préc.		Freezing Temp. / Temp. de congelation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog <1 km / Brouillard	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / (Chasse-Poussière ou Chasse-Sable Élevée)	Blowing Snow / Chasse-Neige Élevée	50 or more km/h / 50 km/h ou plus	62 or more km/h / 62 km/h ou plus	Direction 36 Points	Speed km/h / Vitesse
							mm	mm	mm	mm	mm	cm	mm	cm															
01	25.3	8.3	16.8	1.2	M	M																				M	M		
02	21.0	6.4	13.7	4.3	M	M																				M	M		
03	24.9	12.2	18.6		M	M																				M	M		
04	21.3	13.5	17.4	.6	M	M																				M	M		
05	17.4	5.0	11.2	6.8	M	M																				M	M		
06	11.0	5.5	8.3	9.7	M	M			.5	.5	1.0		1.0				1				1					M	M		
07	9.1	5.5	7.3	10.7	M	M	1.0	T	2.2	T	3.2		3.2				1				1					M	M		
08	14.5	3.6	9.1	8.9	M	M																				M	M		
09	10.1	4.7	7.4	10.6	M	M			.2		.2		.2				1				1					M	M		
10	24.3	7.5	15.9	2.1	M	M																1				M	M		
11	22.5	4.1	13.3	4.7	M	M			1.0	1.0	2.0		2.0				1				1					M	M		
12	9.3	3.4	6.4	11.6	M	M	T				T		T													M	M		
13	16.1	5.0	10.6	7.4	M	M																				M	M		
14	23.4	10.7	17.1	.9	M	M																				M	M		
15	23.2	11.0	17.1	.9	M	M																				M	M		
16	17.8	12.7	15.3	2.7	M	M																				M	M		
17	21.5	7.5	14.5	3.5	M	M																				M	M		
18	19.4	11.3	15.4	2.6	M	M																				M	M		
19	18.9	9.5	14.2	3.8	M	M																				M	M		
20	20.7	11.1	15.9	2.1	M	M																				M	M		
21	23.5	14.0	18.8		M	M																				M	M		
22	25.2	15.5	20.4		M	M																				M	M		
23	26.8	17.0	21.9		M	M																				M	M		
24	23.6	15.0	19.3		M	M																				M	M		
25	24.6	14.0	19.3		M	M																				M	M		
26	19.0	8.2	13.6	4.4	M	M																				M	M		
27	15.0	8.4	11.7	6.3	M	M																				M	M		
28	21.2	9.3	15.3	2.7	M	M																				M	M		
29	13.0	9.3	11.2	6.8	M	M																1				M	M		
30	13.0	7.5	10.3	7.7	M	M																				M	M		
31	18.2	8.3	13.3	4.7	M	M	T	T	.3	T	.3		.3				1				1					M	M		
																										M	M		
TOTAL FOR MONTH / TOTAL DU MOIS																	5				5	2				M	M	Maximum	

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	TEMPERATURE °C / TEMPÉRATURE °C			EXTREMES / EXTRÊMES			
	Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Maximum / Maximale	Date	Minimum / Minimale	Date
Mean / Moyenne	19.2	9.2	14.2	26.8	23	3.4	12
Normal / Normale	14.9	5.8	10.3				
Departure / Écart	4.3	3.4	3.9				

	DEGREE DAYS / DEGRÉS JOURS — Below / au-Dessous 18.0°C	Below / au-Dessous 0.0°C	Above / au-Dessus 0.0°C	Above / au-Dessus 5.0°C	Above / au-Dessus 10.0°C	PRECIPITATION S.I. UNITS / PRÉCIPITATION UNITÉS S.I. — Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm
TOTAL	127		440	285	142	6.7		6.7
Normal / Normale	M	M	M	M	M	21.6	.3	22.1
% of Normal / % de la Normale	M	M	M	M	M	31%	%	30%

GREATEST / HAUTEUR MAXIMALE — Rain / Pluie mm	Date	Snow / Neige cm	Date	Pcpn / Préc. mm	Date
3.2	6		*	3.2	6

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY / SOMMAIRE CLIMATOLOGIQUE

STATION TUKTOYAKTUK PROVINCE NWT. YEAR / ANNÉE 1979 MONTH / MOIS AUG/AOUT TIME ZONE / FUSEAU HORAIRE C LISTING NUMBER / NUMÉRO DE LISTE 2203910 GEOG. NUMBER / NUMÉRO GEOG. 125

DAY JOUR	Temperature °C Maximum Maximale	Temperature °C Minimum Minimale	Temperature °C Mean Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % Max.	Relative Humidity % Min.	Precipitation 6-hourly totals 1200Z mm	1800Z mm	0000Z mm	0600Z mm	24-hourly totals Rain Pluie mm	Snow Neige cm	Pcpn. Préc. mm	Snow Depth 122 / Épaisseur de neige 122 cm
01	20.0	9.7	14.9	3.1	M	M								
02	21.2	11.5	16.4	1.6	M	M			T	T	T		T	
03	15.5	9.2	12.4	5.6	M	M		T	.2	9.0	9.2		9.2	
04	13.3	8.0	10.7	7.3	M	M	2.4	1.6			4.0		4.0	
05	8.7	4.8	6.8	11.2	M	M		.4			.4		.4	
06	11.5	5.5	8.5	9.5	M	M								
07	16.0	7.4	11.7	6.3	M	M								
08	22.8	8.9	15.9	2.1	M	M								
09	20.0	12.8	16.4	1.6	M	M				1.4	1.4		1.4	
10	22.0	9.9	16.0	2.0	M	M								
11	23.0	12.9	18.0		M	M								
12	18.9	12.1	15.5	2.5	M	M								
13	16.8	9.5	13.2	4.8	M	M	T	T			T		T	
14	20.5	12.3	16.4	1.6	M	M								
15	25.0	13.7	19.4		M	M								
16	23.5	12.8	18.2		M	M								
17	15.6	7.8	11.7	6.3	M	M	.6	T			.6		.6	
18	14.0	7.5	10.8	7.2	M	M			.8	T	.8		.8	
19	13.3	8.5	10.9	7.1	M	M	T				T		T	
20	20.9	8.7	14.8	3.2	M	M								
21	18.0	7.5	12.8	5.2	M	M	.8	.2			1.0		1.0	
22	10.6	7.9	9.3	8.7	M	M	2.0	4.0	1.0		7.0		7.0	
23	10.0	6.8	8.4	9.6	M	M		2.0	2.0	1.0	5.0		5.0	
24	8.2	3.4	5.8	12.2	M	M								
25	12.9	5.7	9.3	8.7	M	M				1.0	1.0		1.0	
26	12.2	6.5	9.4	8.6	M	M		T	T	T	T		T	
27	8.5	6.0	7.3	10.7	M	M	T				T		T	
28	12.2	6.5	9.4	8.6	M	M		T			T		T	
29	9.7	6.3	8.0	10.0	M	M								
30	6.6	4.8	5.7	12.3	M	M								
31	11.8	2.8	7.3	10.7	M	M				T	T		T	

DAY JOUR	Freezing Temp. / Temp. de congelation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog <1 km / Brouillard	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / Chasse-Poussière ou Chasse-Sable Élevée	Blowing Snow / Chasse-Neige Élevée	Wind / Vent 50 or more km/h / 50 km/h ou plus	62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal Direction 36 Points	Speed / Vitesse km/h
01												M	M		
02												M	M		
03			1				1					M	M		
04			1				1					M	M		
05			1				1					M	M		
06												M	M		
07												M	M		
08												M	M		
09			1				1					M	M		
10												M	M		
11												M	M		
12								1				M	M		
13								1				M	M		
14												M	M		
15												M	M		
16												M	M		
17			1				1					M	M		
18			1				1					M	M		
19												M	M		
20												M	M		
21			1				1					M	M		
22			1				1					M	M		
23			1				1					M	M		
24												M	M		
25			1				1					M	M		
26								1				M	M		
27												M	M		
28												M	M		
29												M	M		
30												M	M		
31												M	M		
TOTAL FOR MONTH / TOTAL DU MOIS			10				10	3				M	M	Maximum	

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	Temperature °C Maximum Maximale	Minimum Minimale	Mean Moyenne	Extremes / Extrêmes Maximum Maximale	Date	Minimum Minimale	Date
Mean / Moyenne	15.6	8.3	12.0	25.0	15	2.8	31
Normal / Normale	12.2	5.2	8.7				
Departure / Écart	3.4	3.1	3.3				

	Degree Days / Degrés Jours Below / au-Dessous 18.0°C	Below / au-Dessous 0.0°C	Above / au-Dessus 0.0°C	Above / au-Dessus 5.0°C	Above / au-Dessus 10.0°C	Precipitation S.I. Units / Précipitation Unités S.I. Rain Pluie mm	Snow Neige cm	Pcpn. Préc. mm
TOTAL	188		371	216	86	30.4		30.4
Normal / Normale	M	M	M	M	M	28.2	.5	28.7
% of Normal / % de la Normale	M	M	M	M	M	108%	%	106%

Greatest / Hauteur Maximale	Rain Pluie mm	Date	Snow Neige cm	Date	Pcpn Préc. mm	Date
	9.2	3		*	9.2	3

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY / SOMMAIRE CLIMATOLOGIQUE

STATION TUKTOYAKTUK PROVINCE NWT. YEAR / ANNÉE 1979 MONTH / MOIS SEPT/SEPT TIME ZONE / FUSEAU HORAIRE C LISTING NUMBER / NUMÉRO DE LISTE 2203910 GEOG. NUMBER / NUMÉRO GEOG. 125

DAY / JOUR	Temperature °C Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % Max.	Min.	Precipitation 6-Hourly Totals 1200Z mm	1800Z mm	0000Z mm	0600Z mm	24-Hourly Totals Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm	Snow Depth 122 / Épaisseur de neige 122 cm
01	7.2	4.8	6.0	12.0	M	M	1.0	1.8	2.2	T	5.0		5.0	
02	7.2	4.8	6.0	12.0	M	M	.2			T	.2		.2	
03	15.7	5.0	10.4	7.6	M	M	.6				.6		.6	
04	10.0	6.9	8.5	9.5	M	M								
05	7.8	5.6	6.7	11.3	M	M		.6	2.0		2.6		2.6	
06	7.8	5.0	6.4	11.6	M	M	T	1.6	T		1.6		1.6	
07	10.3	4.9	7.6	10.4	M	M								
08	8.8	5.4	7.1	10.9	M	M								
09	7.1	4.8	6.0	12.0	M	M			T	.4	.4		.4	
10	6.4	3.6	5.0	13.0	M	M								
11	7.1	3.2	5.2	12.8	M	M								
12	7.8	-1.3	3.3	14.7	M	M	T	1.4	T	1.0	2.2	.2	2.4	
13	0.8	-3.2	-1.2	19.2	M	M	T		T	T		T	T	T
14	1.3	-2.5	-0.6	18.6	M	M	T					T	T	T
15	4.0	-1.2	1.4	16.6	M	M				1.0	1.0		1.0	
16	5.3	1.5	3.4	14.6	M	M	T	T	.4	.2	.6		.6	
17	2.7	-0.2	1.3	16.7	M	M	.4	T	.6	1.0	1.0	1.0	2.0	
18	1.3	-0.8	0.3	17.7	M	M	1.0		1.0	T		2.0	2.0	2
19	7.5	-1.0	3.3	14.7	M	M			.4		.4		.4	T
20	11.0	2.0	6.5	11.5	M	M								
21	4.3	-0.2	2.1	15.9	M	M								
22	4.5	0.0	2.3	15.7	M	M								
23	10.5	0.0	5.3	12.7	M	M								
24	10.8	3.1	7.0	11.0	M	M								
25	4.7	2.0	3.4	14.6	M	M								
26	8.0	2.7	5.4	12.6	M	M								
27	5.0	2.0	3.5	14.5	M	M		T	.2	.2	.4		.4	
28	3.2	0.3	1.8	16.2	M	M			T	T	T	T	T	
29	0.5	-2.4	-1.0	19.0	M	M								
30	-1.1	-4.6	-2.9	20.9	M	M								
**														

DAY / JOUR	Days with / Jour avec: Freezing Temp. / Temp. de congélation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog <1 km / Brouillard	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / (Chasse-Poussière ou Chasse-Sable Élevés)	Blowing Snow / Chasse-Neige Élevée	Wind / Vent 50 or more km/h / 50 km/h ou plus	62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal Direction 36 Points	Speed / Vitesse km/h
01			1				1					M	M		
02			1				1					M	M		
03			1				1					M	M		
04												M	M		
05			1				1					M	M		
06			1				1					M	M		
07												M	M		
08												M	M		
09			1				1					M	M		
10												M	M		
11												M	M		
12	1		1	1		1	1					M	M		
13	1											M	M		
14	1											M	M		
15	1		1				1					M	M		
16			1				1					M	M		
17	1		1			1	1	1				M	M		
18	1					1	1					M	M		
19	1		1				1					M	M		
20												M	M		
21	1							1				M	M		
22	1							1				M	M		
23	1							1				M	M		
24												M	M		
25								1				M	M		
26												M	M		
27			1				1					M	M		
28												M	M		
29	1											M	M		
30	1											M	M		
**															
TOTAL FOR MONTH / TOTAL DU MOIS	12		12	1		3	13	5				M	M	Maximum	

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	Temperature °C / Température °C Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Extremes / Extrêmes Maximum / Maximale	Date	Minimum / Minimale	Date
Mean / Moyenne	6.3	1.7	4.0	15.7	3	-4.6	30
Normal / Normale	4.6	0.0	2.3				
Departure / Écart	1.7	1.7	1.7				

	Degree Days / Degrés Jours Below / au-Dessous 18.0°C	Below / au-Dessous 0.0°C	Above / au-Dessus 0.0°C	Above / au-Dessus 5.0°C	Above / au-Dessus 10.0°C	Precipitation S.I. Units / Précipitation Unités S.I. Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm
TOTAL	420	5	125	24		16.0	3.2	19.2
Normal / Normale	M	M	M	M	M	9.9	4.1	14.0
% of Normal / % de la Normale	M	M	M	M	M	162%	78%	137%

Greatest / Hauteur Maximale: Rain / Pluie mm	Date	Snow / Neige cm	Date	Pcpn / Préc. mm	Date
5.0	1	2.0	18	5.0	1

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY / SOMMAIRE CLIMATOLOGIQUE

STATION INUVIK A PROVINCE NWT. YEAR / ANNÉE 1979 MONTH / MOIS MAY/MAI TIME ZONE / FUSEAU HORAIRE M LISTING NUMBER / NUMÉRO DE LISTE 2202570 GEOG. NUMBER / NUMÉRO GEOG. 115

DAY / JOUR	Temperature °C / Température °C: Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % / Humidité Relative (%): Max.	Min.	Precipitation S.I. Units / Précipitation unités S.I. — 6-Hourly Totals / Total de 6 heures: 1200Z mm	1800Z mm	0000Z mm	0600Z mm	24-Hourly Totals / Total de 24 heures: Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm
01	5.0	-2.4	1.3	16.7	M	M							
02	3.8	-6.9	-1.6	19.6	M	M							
03	6.8	-3.3	1.8	16.2	M	M							
04	7.4	-0.8	3.3	14.7	M	M							
05	7.4	-1.2	3.1	14.9	M	M							
06	1.0	-7.1	-3.1	21.1	M	M							
07	-1.6	-10.2	-5.9	23.9	M	M		T	T	T		T	T
08	-1.4	-6.8	-4.1	22.1	M	M	.4	.8	.6	.6	T	3.0	2.4
09	-2.6	-7.2	-4.9	22.9	M	M	T	T			T	T	T
10	1.3	-12.7	-5.7	23.7	M	M							
11	-1.1	-10.5	-5.8	23.8	M	M							
12	-1.8	-8.3	-5.1	23.1	M	M	T	T				T	T
13	1.7	-10.3	-4.3	22.3	M	M			T			T	T
14	5.7	-8.7	-1.5	19.5	M	M							
15	13.2	-4.7	4.3	13.7	M	M							
16	13.5	-0.2	6.7	11.3	M	M							
17	3.8	-3.7	0.1	17.9	M	M	T	T	T		T	T	T
18	0.4	-3.0	-1.3	19.3	M	M	T	T				T	T
19	8.2	-3.6	2.3	15.7	M	M							
20	15.4	2.5	9.0	9.0	M	M		T			T		T
21	11.7	1.6	6.7	11.3	M	M							
22	7.3	-1.8	2.8	15.2	M	M		T				T	T
23	5.1	-3.7	0.7	17.3	M	M	T	T		T		T	T
24	5.1	-3.5	0.8	17.2	M	M	T	T	T			T	T
25	11.1	-3.4	3.9	14.1	M	M		T	T			T	T
26	16.5	2.5	9.5	8.5	M	M							
27	15.7	1.1	8.4	9.6	M	M				.6	.6		.6
28	8.0	-0.1	4.0	14.0	M	M	7.2	.2			.4	7.0	7.4
29	7.5	1.1	4.3	13.7	M	M		T	T	T	T	T	T
30	3.0	-1.8	0.6	17.4	M	M	T	T			T	T	T
31	7.5	-1.6	3.0	15.0	M	M	T	.2				.2	.2

DAY / JOUR	Snow Depth 12Z / Épaisseur de neige 12Z cm	Days with / Jour avec: Freezing Temp. / Temp. de congélation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog <1 km / Brouillard	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / (Chasse-Poussière ou Chasse-Sable Élevés)	Blowing Snow / Chasse-Neige Élevée	Wind / Vent: 50 or more km/h / 50 km/h ou plus	62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal: Direction 36 Points	Speed / Vitesse km/h
01	5	1													140	37
02	5	1													140	41
03	5	1													130	50
04	4	1													100	35
05	4	1													120	37
06	3	1													110	37
07	3	1														
08	3	1			1		1	1								
09	4	1			1											
10	4	1														
11	4	1														
12	3	1														
13	3	1														
14	2	1														
15	2	1														
16		1														
17		1			1				1							
18	T	1														
19	T	1														
20	T															
21																
22		1														
23	T	1														
24	T	1														
25		1														
26																
27				1				1								
28	4	1		1			1	1								
29															320	37
30	T	1			1										310	41
31	T	1					1	1								
TOTAL FOR MONTH / TOTAL DU MOIS		26		2	4		3	4	1						Maximum: 130	50

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	Temperature °C / Température °C: Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Extremes / Extrêmes: Maximum / Maximale	Date	Minimum / Minimale	Date
Mean / Moyenne	6.0	-3.8	1.1	16.5	26	-12.7	10
Normal / Normale	3.9	-5.7	-0.8				
Departure / Écart	2.1	1.9	1.9				

	Degree Days / Degrés Jours: Below / au-Dessous 18.0°C	Below / au-Dessous 0.0°C	Above / au-Dessus 0.0°C	Above / au-Dessus 5.0°C	Above / au-Dessus 10.0°C	Precipitation S.I. Units / Précipitation unités S.I.: Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm
TOTAL	524	43	76	15		1.0	10.2	10.6
Normal / Normale	M	M	M	M	M	5.1	14.0	17.5
% of Normal / % de la Normale	M	M	M	M	M	20%	73%	61%

Greatest / Hauteur maximale: Rain / Pluie mm	Date	Snow / Neige cm	Date	Pcpn / Préc. mm	Date
.6	27	7.0	28	7.4	28

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY / SOMMAIRE CLIMATOLOGIQUE

STATION INUVIK A PROVINCE NWT. YEAR / ANNÉE 1979 MONTH / MOIS JUNE/JUIN TIME ZONE / FUSEAU HORAIRE M LISTING NUMBER / NUMÉRO DE LISTE 2202570 GEOG. NUMBER / NUMÉRO GEOG. 115

DAY JOUR	TEMPERATURE °C / TEMPÉRATURE °C Maximum Maximale	Minimum Minimale	Mean Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % / Humidité Relative (%) Max.	Min.	PRECIPITATION S.I. UNITS / PRÉCIPITATION UNITÉS S.I. 6-HOURLY TOTALS / TOTAL DE 6 HEURES 1200Z mm	1800Z mm	0000Z mm	0600Z mm	24-HOURLY TOTALS / TOTAL DE 24 HEURES Rain Pluie mm	Snow Neige cm	Pcpn. Préc. mm	Snow Depth 12Z / Épaisseur de neige 12Z cm	DAYS WITH / JOUR AVEC Freezing Temp. / Temp. de congelation	Thunderstorms Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail Grêle	Snow Neige	Precipitation Précipitation	Fog Brouillard <1 km	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand (Chasse-Poussière ou Chasse-Sable Élevés)	Blowing Snow / Chasse-Neige Élevée	Wind Vent 60 or more km/h / 60 km/h ou plus	62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal Direction 36 Points	Speed Vitesse km/h
01	17.7	-0.1	8.8	9.2	M	M									1														
02	14.6	1.0	7.8	10.2	M	M	.5	2.0			2.5		2.5				1				1								
03	13.5	-2.3	5.6	12.4	M	M	T				T		T		1														
04	17.2	4.5	10.9	7.1	M	M																							
05	13.0	1.5	7.3	10.7	M	M																						30	37
06	11.6	-3.5	4.1	13.9	M	M									1														
07	18.9	2.6	10.8	7.2	M	M																							
08	16.6	4.9	10.8	7.2	M	M																							
09	21.6	6.2	13.9	4.1	M	M																							
10	25.4	12.7	19.1		M	M																						180	37
11	17.9	6.1	12.0	6.0	M	M			T	T	T		T															320	44
12	12.0	3.1	7.6	10.4	M	M	T	T	T	T	T		T																
13	8.9	0.7	4.8	13.2	M	M	2.8	4.4	T		7.0	.2	7.2				1			1	1							330	37
14	7.0	-0.4	3.3	14.7	M	M	.3	1.0	T		.2	1.1	1.3		1		1			1	1								
15	16.9	1.0	9.0	9.0	M	M																							
16	23.3	7.1	15.2	2.8	M	M																							
17	16.6	3.8	10.2	7.8	M	M																						30	33
18	12.2	1.4	6.8	11.2	M	M																							
19	16.7	4.2	10.5	7.5	M	M				.2	.2		.2				1				1								
20	14.6	5.4	10.0	8.0	M	M	T		T		T		T																
21	20.0	0.4	10.2	7.8	M	M																							
22	17.2	2.8	10.0	8.0	M	M	T	.2	T		.2		.2				1				1								
23	12.7	0.8	6.8	11.2	M	M																							
24	20.8	4.1	12.5	5.5	M	M			T	1.2	1.2		1.2				1				1							240	33
25	18.7	10.4	14.6	3.4	M	M	.8				.8		.8				1				1								
26	12.6	3.5	8.1	9.9	M	M	T	4.8	2.0	T	6.8		6.8				1				1							300	41
27	13.2	1.2	7.2	10.8	M	M																							
28	16.1	7.0	11.6	6.4	M	M				T	T		T																
29	17.2	8.5	12.9	5.1	M	M			T	T	T		T																
30	22.2	5.7	14.0	4.0	M	M																							
**																													
TOTAL FOR MONTH / TOTAL DU MOIS															4		8			2	8							Maximum 320	44

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	TEMPERATURE °C / TEMPÉRATURE °C Maximum Maximale	Minimum Minimale	Mean Moyenne	EXTREMES/EXTRÊMES Maximum Maximale	Date	Minimum Minimale	Date
Mean Moyenne	16.2	3.5	9.9	25.4	10	-3.5	6
Normal Normale	16.0	3.7	9.8				
Departure Écart	0.2	-0.2	0.1				

	DEGREE DAYS / DEGRÉS JOURS Below au-Dessous 18.0°C	Below au-Dessous 0.0°C	Above au-Dessus 0.0°C	Above au-Dessus 5.0°C	Above au-Dessus 10.0°C	PRECIPITATION S.I. UNITS / PRÉCIPITATION UNITÉS S.I. Rain Pluie mm	Snow Neige cm	Pcpn. Préc. mm	GREATEST / HAUTEUR MAXIMALE Rain Pluie mm	Date	Snow Neige cm	Date	Pcpn Préc. mm	Date
TOTAL	244		296	149	39	18.9	1.3	20.2	7.0	13	1.1	14	7.2	13
Normal Normale	M	M	M	M	M	10.7	2.3	13.0						
% of Normal / % de la Normale	M	M	M	M	M	177%	57%	155%						

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY / SOMMAIRE CLIMATOLOGIQUE

STATION INUVIK A PROVINCE NWT. YEAR/ANNÉE 1979 MONTH/MOIS JULY/JUIL TIME ZONE/FUSEAU HORAIRE M LISTING NUMBER/NUMÉRO DE LISTE 2202570 GEOG. NUMBER/NUMÉRO GEOG. 115

DAY JOUR	Temperature °C Maximum Maximale	Temperature °C Minimum Minimale	Temperature °C Mean Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % Max.	Relative Humidity % Min.	6-Hourly Totals 1200Z mm	6-Hourly Totals 1800Z mm	6-Hourly Totals 0000Z mm	6-Hourly Totals 0600Z mm	24-Hourly Totals Rain Pluie mm	24-Hourly Totals Snow Neige cm	24-Hourly Totals Pcpn. Préc. mm	Snow Depth 12Z / Épaisseur de neige 12Z cm	Freezing Temp. / Temp. de congelation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog / Brouillard <1 km	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / Chasse-Poussière ou Chasse-Sable Élevée	Blowing Snow / Chasse-Neige Élevée	Wind / Vent 50 or more km/h / 50 km/h ou plus	Wind / Vent 62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal Direction 36 Points	Peak Wind / Vent Maximal Speed / Vitesse km/h
01	22.1	11.5	16.8	1.2	M	M																							
02	23.4	12.3	17.9	.1	M	M																							
03	24.8	10.5	17.7	.3	M	M																							
04	26.6	12.4	19.5		M	M																							
05	21.5	10.6	16.1	1.9	M	M			.8	.4	1.2		1.2				1				1							330	37
06	17.6	9.2	13.4	4.6	M	M	.3	3.2	1.8		5.3		5.3				1				1								
07	15.1	6.2	10.7	7.3	M	M				T	T		T																
08	18.6	7.5	13.1	4.9	M	M			T	T	T		T																
09	18.2	7.8	13.0	5.0	M	M	T	1.6	T		1.6		1.6				1				1								
10	24.9	13.1	19.0		M	M																							
11	21.8	6.6	14.2	3.8	M	M				T	T		T															300	44
12	12.1	5.0	8.6	9.4	M	M	2.0	T			2.0		2.0				1				1								
13	21.7	2.2	12.0	6.0	M	M																							
14	23.9	8.0	16.0	2.0	M	M																							
15	25.8	12.6	19.2		M	M																							
16	25.3	13.0	19.2		M	M																							
17	24.8	10.7	17.8	.2	M	M																							
18	25.2	11.7	18.5		M	M																							
19	21.8	11.8	16.8	1.2	M	M	T				T		T																
20	25.6	11.7	18.7		M	M																							
21	26.1	13.4	19.8		M	M																						100	41
22	27.2	13.0	20.1		M	M																						160	39
23	27.9	17.7	22.8		M	M				T	T		T										1					160	37
24	27.6	14.9	21.3		M	M	.2	2.8			3.0		3.0				1				1								
25	30.3	15.7	23.0		M	M																							
26	24.5	15.3	19.9		M	M																							
27	23.1	8.8	16.0	2.0	M	M																						80	31
28	23.4	13.1	18.3		M	M																						330	33
29	19.3	10.3	14.8	3.2	M	M																							
30	20.0	10.7	15.4	2.6	M	M																							
31	23.5	11.0	17.3	.7	M	M																						30	33
TOTAL FOR MONTH / TOTAL DU MOIS																	5				5		1					Maximum 300	44

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	Temperature °C Maximum Maximale	Temperature °C Minimum Minimale	Temperature °C Mean Moyenne	Extremes/Extrêmes Maximum Maximale	Date	Extremes/Extrêmes Minimum Minimale	Date
Mean Moyenne	23.0	10.9	17.0	30.3	25	2.2	13
Normal Normale	19.2	7.4	13.3				
Departure Écart	3.8	3.5	3.7				

	Degree Days Below au-Dessous 18.0°C	Below au-Dessous 0.0°C	Above au-Dessus 0.0°C	Above au-Dessus 5.0°C	Above au-Dessus 10.0°C	Precipitation Rain Pluie mm	Snow Neige cm	Pcpn. Préc. mm
TOTAL	56		526	371	218	13.1		13.1
Normal Normale	M	M	M	M	M	34.0	.3	34.3
% of Normal % de la Normale	M	M	M	M	M	39%	%	38%

Greatest / Hauteur maximale	Rain Pluie mm	Date	Snow Neige cm	Date	Pcpn Préc. mm	Date
	5.3	6		*	5.3	6

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY

SOMMAIRE CLIMATOLOGIQUE

STATION INUVIK A PROVINCE NWT. YEAR ANNÉE 1979 MONTH MOIS AUG/AOUT TIME ZONE FUSEAU HORAIRE M LISTING NUMBER NUMÉRO DE LISTE 2202570 GEOG. NUMBER NUMÉRO GEOG. 115

DAY JOUR	TEMPERATURE °C TEMPÉRATURE °C Maximum Maximale	Minimum Minimale	Mean Moyenne	Degree Days Below 18.0°C Degrés jour au-dessous de 18.0°C	Relative Humidity % Humidité Relative (%) Max.	Min.	PRECIPITATION S.I. UNITS 6-HOURLY TOTALS TOTAL DE 6 HEURES 1200Z mm	1800Z mm	0000Z mm	0600Z mm	PRÉCIPITATION UNITÉS S.I. 24-HOURLY TOTALS TOTAL DE 24 HEURES Rain Pluie mm	Snow Neige cm	Pcpn. Préc. mm	Snow Depth 12Z Épaisseur de neige 12Z cm	DAYS WITH / JOUR AVEC Freezing Temp. Temp. de congelation	Thunderstorms Orages	Rain or Drizzle Pluie ou Bruine	Freezing Pcpn. Précipitation verglaçante	Hail Grêle	Snow Neige	Precipitation Précipitation	Fog <1 km Brouillard	Smoke or Haze Fumée ou Brume Sèche	Blowing Dust or Sand (Chasse-Poussière ou Chasse-Sable Élevés)	Blowing Snow Chasse-Neige Élevée	Wind Vent 50 or more km/h 50 km/h ou plus	62 or more km/h 62 km/h ou plus	Peak Wind Vent Maximal Direction 36 Points	Speed km/h Vitesse
01	23.9	8.3	16.1	1.9	M	M				.2	.2		.2				1				1								
02	23.3	11.0	17.2	.8	M	M				.8	.8		.8				1				1								
03	20.1	8.4	14.3	3.7	M	M		T		.6	.6		.6				1				1								
04	14.4	9.4	11.9	6.1	M	M	.3	2.3	.2		2.8		2.8				1				1							310	37
05	10.6	5.1	7.9	10.1	M	M		T			T		T																
06	15.7	3.0	9.4	8.6	M	M				T	T		T																
07	17.6	8.6	13.1	4.9	M	M	4.2	.4			4.6		4.6				1				1								
08	23.5	8.8	16.2	1.8	M	M																							
09	24.1	12.0	18.1		M	M																							
10	25.0	9.4	17.2	.8	M	M																							
11	26.6	13.1	19.9		M	M																							
12	24.8	10.4	17.6	.4	M	M																							
13	28.6	12.7	20.7		M	M																							
14	28.1	14.7	21.4		M	M																							
15	28.6	15.3	22.0		M	M																							
16	28.3	15.4	21.9		M	M				14.6	14.6		14.6			1	1				1							270	41
17	22.8	13.8	18.3		M	M		T			T		T																
18	19.4	10.7	15.1	2.9	M	M		.2	.4	.2	.8		.8				1				1								
19	19.7	11.5	15.6	2.4	M	M	T				T		T																
20	24.2	10.7	17.5	.5	M	M																							
21	20.2	9.4	14.8	3.2	M	M	.2	.4	T	.2	.8		.8				1				1							320	56
22	12.2	9.0	10.6	7.4	M	M	T	1.4	1.8	.8	4.0		4.0				1				1								
23	15.5	8.5	12.0	6.0	M	M	T	T	T	T	T		T																
24	12.7	7.2	10.0	8.0	M	M	.2				.2		.2				1				1								
25	20.9	10.0	15.5	2.5	M	M				T	T		T															300	31
26	16.4	10.9	13.7	4.3	M	M		T		.6	.6		.6				1				1								
27	12.6	8.0	10.3	7.7	M	M	1.0	1.2	2.0		4.2		4.2				1				1								
28	12.7	6.3	9.5	8.5	M	M	.6	1.8	1.0	.4	3.8		3.8				1				1								
29	12.8	2.6	7.7	10.3	M	M																							
30	10.7	6.6	8.7	9.3	M	M																						50	41
31	10.1	4.6	7.4	10.6	M	M	M	M	.2	2.4	2.6		2.6				1				1					M	M		
										TOTAL FOR MONTH TOTAL DU MOIS						1	14				14					M	M	Maximum 320	56

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	TEMPERATURE °C TEMPÉRATURE °C Maximum Maximale	Minimum Minimale	Mean Moyenne	EXTREMES/EXTRÊMES Maximum Maximale	Date	Minimum Minimale	Date
Mean Moyenne	19.6	9.5	14.6	28.6	13*	2.6	29
Normal Normale	15.5	5.0	10.3				
Departure Écart	4.1	4.5	4.3				

	DEGREE DAYS DEGRÉS JOURS Below au-Dessous 18.0°C	Below au-Dessous 0.0°C	Above au-Dessus 0.0°C	Above au-Dessus 5.0°C	Above au-Dessus 10.0°C	PRECIPITATION S.I. UNITS PRÉCPITATION UNITÉS S.I. Rain Pluie mm	Snow Neige cm	Pcpn. Préc. mm
TOTAL	122		451	296	151	40.6		40.6
Normal Normale	M	M	M	M	M	38.4	4.3	46.2
% of Normal % de la Normale	M	M	M	M	M	106%	%	88%

GREATEST / HAUTEUR MAXIMALE Rain Pluie mm	Date	Snow Neige cm	Date	Pcpn Préc. mm	Date
14.6	16		*	14.6	16

TAB 41 (S.I.)

ATMOSPHERIC ENVIRONMENT SERVICE – DEPARTMENT OF THE ENVIRONMENT – CANADA

SERVICE DE L'ENVIRONNEMENT ATMOSPHERIC – MINISTERE DE L'ENVIRONNEMENT – CANADA

CLIMATOLOGICAL SUMMARY

SOMMAIRE CLIMATOLOGIQUE

STATION INUVIK A PROVINCE NWT. YEAR / ANNÉE 1979 MONTH / MOIS SEPT/SEPT TIME ZONE / FUSEAU HORAIRE M LISTING NUMBER / NUMÉRO DE LISTE 2202570 GEOG. NUMBER / NUMÉRO GEOG. 115

DAY / JOUR	TEMPERATURE °C / TEMPÉRATURE °C Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	Degree Days Below 18.0°C / Degrés jour au-dessous de 18.0°C	Relative Humidity % / Humidité Relative (%) Max.	Min.	PRECIPITATION S.I. UNITS / PRÉCIPITATION UNITÉS S.I. 6-HOURLY TOTALS / TOTAL DE 6 HEURES 1200Z mm	1800Z mm	0000Z mm	0600Z mm	24-HOURLY TOTALS / TOTAL DE 24 HEURES Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm	Snow Depth 12Z / Épaisseur de neige 12Z cm
01	9.7	6.4	8.1	9.9	M	M	M	7.6	3.4	T	11.0		11.0	
02	10.0	2.9	6.5	11.5	M	M								
03	11.6	6.6	9.1	8.9	M	M								
04	8.5	6.3	7.4	10.6	M	M		T	T	.2	.2		.2	
05	7.2	5.7	6.5	11.5	M	M	.2	.2	T		.4		.4	
06	11.8	3.1	7.5	10.5	M	M	T	T			T		T	
07	10.0	0.6	5.3	12.7	M	M		T	T		T		T	
08	12.6	7.3	10.0	8.0	M	M								
09	7.6	5.2	6.4	11.6	M	M	T	.2	T		.2		.2	
10	7.3	4.2	5.8	12.2	M	M								
11	11.7	4.2	8.0	10.0	M	M		T			T		T	
12	8.2	-0.9	3.7	14.3	M	M		.6	.3	T	.9	T	.9	
13	0.1	-3.3	-1.6	19.6	M	M		T	T	T		T	T	
14	0.2	-2.6	-1.2	19.2	M	M	T	T	1.4	1.6		3.6	3.0	
15	2.0	-2.0	0.0	18.0	M	M	1.1	1.6	.2	T	T	3.4	2.9	4
16	5.9	1.0	3.5	14.5	M	M	T		T	T	T		T	T
17	1.0	-0.7	0.2	17.8	M	M	.2	1.0	.6	2.6	T	4.6	4.4	T
18	1.7	-2.4	-0.4	18.4	M	M	.6	.8	.6			3.2	2.0	4
19	11.0	-3.7	3.7	14.3	M	M				T	T		T	5
20	12.5	1.9	7.2	10.8	M	M			T		T		T	
21	13.6	1.5	7.6	10.4	M	M								
22	12.4	2.3	7.4	10.6	M	M								
23	14.5	2.0	8.3	9.7	M	M								
24	15.7	3.0	9.4	8.6	M	M								
25	9.1	1.7	5.4	12.6	M	M	T	T			T		T	
26	8.2	3.2	5.7	12.3	M	M								
27	7.1	2.0	4.6	13.4	M	M	T		T	T	T		T	
28	5.4	1.9	3.7	14.3	M	M	T	T	T	T	T		T	
29	2.0	-1.0	0.5	17.5	M	M	T	T	T		T	T	T	
30	-0.5	-2.8	-1.7	19.7	M	M								
**														

DAY / JOUR	DAYS WITH / JOUR AVEC Freezing Temp. / Temp. de congelation	Thunderstorms / Orages	Rain or Drizzle / Pluie ou Bruine	Freezing Pcpn. / Précipitation verglaçante	Hail / Grêle	Snow / Neige	Precipitation / Précipitation	Fog < 1 km / Brouillard	Smoke or Haze / Fumée ou Brume Sèche	Blowing Dust or Sand / (Chasse-Poussière ou Chasse-Sable Élevée)	Blowing Snow / Chasse-Neige Élevée	Wind / Vent 50 or more km/h / 50 km/h ou plus	62 or more km/h / 62 km/h ou plus	Peak Wind / Vent Maximal Direction 36 Points	Speed / Vitesse km/h
01			1				1					M	M		
02														50	41
03								1							
04			1				1								
05			1				1							350	39
06								1							
07															
08															
09			1				1								
10															
11								1							
12	1		1				1								
13	1														
14	1					1	1								
15	1					1	1								
16															
17	1					1	1	1							
18	1					1	1								
19	1														
20															
21															
22															
23															
24															
25								1							
26															
27															
28								1							
29	1														
30	1														
**															
TOTAL FOR MONTH / TOTAL DU MOIS	9		5			4	9	6				M	M	Maximum 50	41

MONTHLY SUMMARY / SOMMAIRE MENSUEL

	TEMPERATURE °C / TEMPÉRATURE °C Maximum / Maximale	Minimum / Minimale	Mean / Moyenne	EXTREMES / EXTRÊMES Maximum / Maximale	Date	Minimum / Minimale	Date
Mean / Moyenne	7.9	1.8	4.9	15.7	24	-3.7	19
Normal / Normale	6.8	-1.3	2.7				
Departure / Écart	1.1	3.1	2.2				

	DEGREE DAYS / DEGRÉS JOURS Below / au-Dessous 18.0°C	Below / au-Dessous 0.0°C	Above / au-Dessus 0.0°C	Above / au-Dessus 5.0°C	Above / au-Dessus 10.0°C	PRECIPITATION S.I. UNITS / PRÉCPITATION UNITÉS S.I. Rain / Pluie mm	Snow / Neige cm	Pcpn. / Préc. mm
TOTAL	393	4	151	41		12.7	14.8	25.0
Normal / Normale	M	M	M	M	M	10.9	11.4	21.1
% of Normal / % de la Normale	M	M	M	M	M	117%	130%	118%

GREATEST / HAUTEUR MAXIMALE Rain / Pluie mm	Date	Snow / Neige cm	Date	Pcpn / Préc. mm	Date
11.0	1	4.6	17	11.0	1

TAB 41 (S.I.)