a graduate student of the University of Alaska, were in the field from June 1 to September 1. The two field parties made, respectively, a detailed ablation study and a study of the surface motion.

Liberal helicopter support was furnished by the U.S. Army, Fort Greely, Alaska. The U.S. Air Force Arctic Aeromedical Laboratory, Fort Wainwright, Fairbanks, the Civil Engineering Department and the Geophysical Institute of the University of Alaska, the U.S. Geological Survey, Fairbanks, and the U. S. Weather Bureau, Anchorage, Alaska generously provided scientific equipment.

Ablation and meteorological studies

Larry Mayo led the party that concentrated on detailed mapping of ablation and accumulation, and recording local weather and net total radiation. Seventy-nine ablation poles and twenty-five snow pits were used to measure ablation and accumulation on the 3.5-mile-long glacier. Continuous weather observations were made for 3 months. The main weather station was located near the centre line of the glacier at an altitude of 4,800 feet. Every 12 hours measurements were made of wind, precipitation, and ablation on snow, ice, and morainal surfaces. Continuous records were made of temperature, humidity, and net total radiation. A Suomi-type, net total radiometer and a Brown recording potentiometer were powered by a Universal 1.5 kw. portable gasoline generator. A second weather station for continuous temperature measurements was at an altitude of 5,600 feet on the glacier.

Motion studies

Seventy-five of the ablation stakes were used in the surface motion study. This part of the program was led by Eugene Moores and consisted of the following: (1) an overall program of locating weekly, monthly, and bimonthly the position of all 75 stakes, (2) short-interval studies consisting of daily observations of seven stakes and 2-day observations of 32 stakes, (3) resurvey of the tranverse profiles established in 1960, (4) extension of the triangulation net, and (5) locating stakes in the tributaries feeding the main ice streams. The short-interval studies concentrated on an area below the ice fall extending across the width of the glacier, including two stakes on different blocks at the top of the ice fall. Differential motion between ice streams was also investigated.

Geophysical measurements

Gravity measurements were made along one longitudinal and three transverse lines on the glacier. The measurements were made by Paul Sellmann, Department of Geology, University of Alaska, with co-operation of Ned Ostenso, University of Wisconsin.

TROY L. PÉWÉ

HOURLY AIR AND NEAR-SURFACE SOIL TEMPERATURES AT RESOLUTE, N.W.T.*

Introduction

Since 1959 the Geographical Branch of the Canada Department of Mines and Technical Surveys has been pursuing a program of enquiry into problems of periglacial geomorphology at Resolute, N.W.T. (74°43'N., 95°59'W.)[1,2]. This area was considered suitable because it is in an active periglacial region, where geomorphological processes are reduced to as near a mechanical process as can be found in nature, since there is an almost complete absence of vegetation.

The study of soil temperature in the active layer of permafrost has formed a significant part of the program. In the past freeze-thaw cycles have received special consideration as continued freezing and thawing of the mantle has been considered instrumental in its disintegration. The Resolute program also included the study of freeze-thaw cycles and in the course of this study temperature data were collected at five levels at 4-minute intervals during the period from October 1959 to September 1960 inclusive.

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In this paper hourly air and near-surface soil data are being analysed as a preliminary to a larger study to be published later. It is realized that a 1-year record does not provide a stable frequency distribution, but as no similar set of data exists for a high arctic area, it is presented here.

Instruments and site

The basic instrument used was a Leeds and Northrup Type G Speedomax automatic recorder, which was housed in a heated wing of the Ionosphere Station. Thermocouples made of standard copper and constantan 18-gauge wire were installed at two distant sites. The first site was about 60 metres north of the Ionosphere Station at an altitude of 12.5 metres above sea-level and 210 metres inland from the shore of Resolute Bay. Thermocouples were installed at three levels: in a standard Stevenson screen, on the surface of the ground, and at a depth of 2.5 cm. The limestone bedrock at this site is overlain with shattered rock and gravel to a depth of approximately 2 metres and is representative of the raised beaches in the region. The second site was approximately 15 metres to the southeast, and two thermocouples were installed there in a pocket of clay at depths of 10 cm. and 20 cm., respectively.

The active layer, which overlies the permafrost and annually thaws in the summer and freezes in the winter, is approximately 0.6 metres thick in this area. The effect of snow cover is not discussed because of incomplete data. However, it is known that the first site is essentially bare for the greater part of the winter, as the wind keeps the raised beaches free from snow. The second site, on the other hand, has a continuous snow cover from October to May, generally less than 0.5 metres deep.

Data

The frequency distribution of mean hourly temperatures is a climatic parameter of considerable importance, but one rarely reported due to limited installations or the laborious task of analysing data. The mean hourly temperature is here defined as the average of the fifteen 4-minute-interval readings.

Table 1 presents monthly means of hourly temperatures, with standard deviations and degrees of skewness for both sites, involving readings in the screen (air), on the ground surface, and at depths of 2.5 cm., 10 cm., and 20 cm., respectively.

In summer temperatures follow the normal diurnal variation in response to the daily insolation curve. Ranges are small, however, because of continuous daylight, and the relatively weak air circulation prevailing at this time of year. The temperatures at the ground surface fluctuate more widely than they do at levels above or below, and have accordingly the largest standard deviation. The standard deviations at all five levels in summer are of the same order of magnitude, as the balance of heat has achieved summer equilibrium and the ground is not frozen.

The standard deviations are greater in winter than in summer. This period is the "polar" night, with continuous darkness for approximately 3 months. The supply of incoming heat has been largely cut off, resulting in an interruption of the usual diurnal variation. Longley[3,4] has shown that variation in temperature at Resolute at this time can be attributed to random variations. Thomas[5] states that since the atmosphere is usually completely stable, with a marked temperature inversion, an increase in wind speed from any direction will bring a temperature rise as turbulent mixing brings heat down from aloft. Changes in temperature tend to occur rapidly, with periods of prolonged cold alternating with warmer periods that result from incursions of warm air from the Atlantic Ocean associated with cyclonic activity in the Davis Strait area.

It will be noted that the standard deviations are less in January and February than in either November or December. This is the result of the balance of heat approaching the winter eqilibrium following rapid cooling after the disappearance of the sun in November. A reverse process is seen in

April air and ground surface temperatures, when rapid warming occurs after the return of the sun and the re-establishment of the diurnal temperature variation. Standard deviations are high for this period as rapidly increasing daily insolation totals steadily push temperatures upward. It is not until June, however, that the snow at the second site melts and temperatures at both the 10-cm. and 20-cm. level begin to rise to their summer maxima.

The frequency curves show a negative skewness in winter when there is a greater dispersion of temperature below the mean than above it. The position is reversed in summer, with greater dispersions above than below the mean. The negative skewness of the May temperatures at the first site is anomalous and results from the rapid increase in temperature towards the freezing point (32°F.) in late May. As with the standard deviations, this negative skewness is prolonged to June at depths of 10 cm. and 20 cm.

Fig. 1 shows hourly soil temperatures in percentages for the months of January and July 1960 — months with no daylight and no darkness, respectively. The January temperature curves show many peaks for air, at ground surface, and the depth of 2.5 cm., reflecting the non-cyclic variation of air temperature in winter. The July temperature curves at these levels, on the other hand, follow the normal pattern of diurnal variation, and have only one mode.

The January and July frequency distribution curves for 10 cm. and 20 cm. reflect the fact that the second site is snow covered in winter, as the curves are more leptokurtic than those from the first site with little or no snow cover. There is, however, little difference in the form of the hourly temperature curves for July at all levels, apart from the ground surface curve, which shows considerable variation in surface temperatures due to the effects of climatic elements, such as insolation and precipitation. Table 2 shows yearly means of hourly temperatures for the sites,

Table 1. Monthly means, standard deviations and skewness.

	Site I									Site II					
	Air			Ground surface			2.5 cm.			10 cm.			20 cm.		
Month	$\overline{X}$	σ	Skewness	$\overline{X}$	σ	Skewness	$\overline{X}$	σ	Skewness	$\overline{X}$	σ	Skewness	$\overline{X}$	σ	Skewness
October 1959	0.8	11.7	−0.41	0.9	11.8	−0.64	3.3	9.8	−0.95	5.9	8.5	−1.1	6.4	7.8	−0.99
November	− 4.9	12.4	−0.10	− 6.3	12.9	−0.21	− 4.8	10.1	−0.36	− 1.5	9.3	−0.35	− 1.5	8.7	−0.24
December	−16.6	13.2	−0.36	−18.2	12.9	−0.09	−16.4	9.9	−0.09	− 6.9	5.0	−0.36	− 6.9	4.4	−0.20
January 1960	−24.6	11.1	0.32	−26.4	10.9	0.36	−24.7	9.0	0.77	−13.6	3.6	−0.17	−13.5	3.2	−0.19
February	−23.9	9.8	0.83	−26.2	9.5	0.91	−25.4	7.1	0.89	−16.5	2.9	1.24	−15.8	2.7	1.33
March	−29.6	6.8	0.53	−29.9	6.7	0.23	−28.8	4.3	0.42	−17.3	1.6	0.75	−16.9	1.4	0.86
April	−12.6	11.5	0.73	−10.9	13.2	0.57	−13.3	9.7	0.87	−12.2	2.6	0.69	−12.4	2.1	0.29
May	17.9	7.6	−0.40	21.0	8.8	−0.20	16.4	7.5	−0.60	2.1	4.2	−0.93	1.5	4.2	−0.79
June	34.7	4.4	0.48	41.9	9.7	0.80	36.1	5.8	0.83	27.9	12.5	−0.58	26.1	11.6	−0.96
July	40.3	5.4	0.01	46.9	9.8	0.80	42.6	4.6	0.59	44.7	5.0	0.66	43.1	4.1	0.73
August	38.1	3.8	0.47	40.1	5.6	0.70	38.7	3.3	0.46	41.3	3.9	−0.15	40.0	3.4	−0.53
September	23.7	6.7	0.22	24.5	7.0	0.09	25.9	6.0	−2.0	27.2	6.8	−0.09	27.0	6.7	−0.09

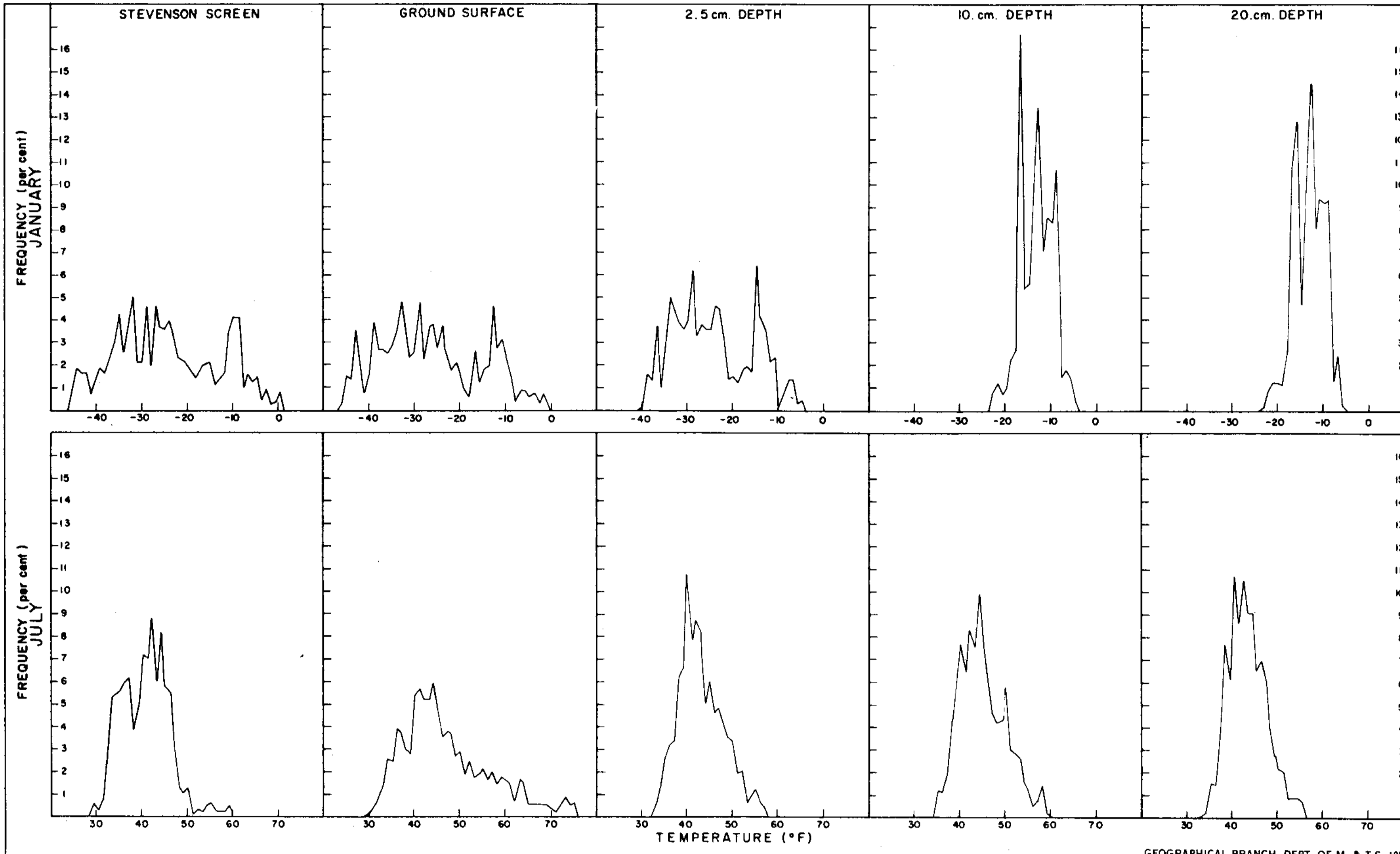

Fig. 1. **Hourly soil temperatures for January and July 1960 in percentages of frequency.**

Table 2. Yearly mean, standard deviation, and degree of skewness of hourly means.

		$\overline{X}$	σ	*Skewness*
Site	Air	3.6	26.7	0.20
	Ground surface	4.8	29.3	0.25
I	2.5 cm.	4.1	27.0	0.26
Site	10 cm.	6.8	23.4	−0.82
II	20 cm.	6.4	22.1	−0.96

with standard deviations and degrees of skewness.

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MAXIMUM POSTGLACIAL MARINE SUBMERGENCE IN SOUTHERN MELVILLE PENINSULA, N.W.T.*

In a recent article[1] the author discussed the limit of postglacial marine submergence in the northern part of Melville Peninsula. It was suggested that the marine limit in the area, as determined by a number of observations using four different criteria, varied between 450 and 500 feet. Of these four criteria only two, the lowest altitude at which undisturbed ground moraine and perched boulders occurred, were found to be particularly useful. Similar techniques were used during the summer of 1959 to determine the limit of postglacial submergence in the southern part of the peninsula. The observations there are limited to four altitudes in the Prince Albert Hills east of Lefroy Bay and to seven altitudes on the shores of the peninsula between Haviland Bay and Gore Bay. Two additional altitudes, one obtained by Burns[2] near the mouth of Jenness River (the only observation on the east coast south of 68°N.) and the other by Mathiassen[3] between Gore and Haviland bays, comprise all the available information. The location and altitude of each observation is plotted on the map, Fig. 1.

In southern, as in northern Melville Peninsula the altitudes of the lowest undisturbed ground moraine and perched boulders were the most easily applied and most reliable indicators of the marine limit. The presence of marine shells in raised deposits was found to be of little use for determining the limit. Although shells were usually

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