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UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU

MICROCLIMATOLOGY OF OGOTORUK VALLEY
Interim Report No. 2.

June 15, 1961

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Robert O. Weedfall
Weather Bureau Research Station
Las Vegas, Nevada

Prepared for the U. S. Atomic Energy Commission as
part of Project Chariot Environmental Study Program

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TABLE OF CONTENTS

	<u>Page</u>
Table of Contents.....	i
List of Tables.....	ii
Introduction.....	1
Operations.....	1
Instrumentation.....	1
Wind.....	2
Sea Ice.....	2
Precipitation.....	2
Temperature.....	3
References.....	5
Tables.....	6-16
Map of Station Network.....	17
Appendix	

LIST OF TABLES

Table

1. Chariot Site Wind Direction Percentages, Oct. 1960--May 1961.
2. Comparison Between Coastal and Inland Wind at Chariot Site.
3. Comparison Between Wind at Chariot Site and Point Hope.
4. Relation Between "Ogotruk Wind" and Open Water.
5. Summary of Ice Reports in Chukchi Sea.
6. Chariot Site Precipitation, Snowfall, and Snow Depths.
7. Snow Depths at Environmental Stations.
8. Highest and Lowest Temperatures at Chariot Site and Nearby Locations.
9. Chariot Site Mean Maximum and Mean Temperatures Compared to Nearby Locations.
10. Mean Temperatures at Micrometeorological Network.
11. Lowest Minimum Temperatures, Winter of 1960-61.

INTRODUCTION

This report covers the micrometeorological study of the Ogotoruk Valley during the period from October 1960 through April 1961 and is a continuation of material included in "Microclimatology of the Ogotoruk Valley" Preliminary Report No. 1, dated December 15, 1960. For brevity in the current document frequent references will be made to the Preliminary Report.

OPERATIONS

It was impractical and considered to be largely unnecessary to maintain daily observations of the valley climate in the microscale during winter because little, if any, vegetable growth was possible and most animal life was restricted to sheltered burrows in which measurements would not have normally been made. Large scale weather changes were observed from the base camp from October 1960 through March 15, 1961 by Holmes and Narver caretakers and produced information on wind, pressure, temperature, humidity and other weather phenomena. About 15 trips up the valley were made during this period to read soil thermometers at the micrometeorological stations. Some of these were not completed because of the harsh weather, mechanical breakdowns, etc. Daily readings, when possible, at the various stations were resumed about March 25, 1961 by U. S. Weather Bureau personnel.

INSTRUMENTATION

Air temperature and relative humidity at the base camp were measured by a recording 7-day hygrothermograph. Soil temperatures were measured by Palmer thermometers, which were completely installed at all levels by October 15, 1960. Three-channel thermographs were installed near Test Holes "C" and "D" and produced a continuous record of the temperature variation at 3 levels, one of which was at about 122 cm above the surface. Processing of these data has not been completed.

Precipitation was recorded only for the base camp during this period from the standard 8-inch cylindrical gage. Although precipitation readings were taken at the network stations, these readings were valueless because additional wind-blown snow collected in these gages. Although great care was taken to eliminate the blowing snow in the base camp gage, even those readings must be considered to be very rough.

Wind speed and direction are measured three or more times daily at the base camp by means of an anemometer fully described in the Preliminary Report (1). U. S. Weather Bureau personnel installed a contacting anemometer and vane at Station A34.12 at a 15-foot height on March 24, 1961. This instrument, using battery power, is wired to a 9-pen Esterline-Angus recorder.

During the winter, sunshine intensity was measured by a Belfort Pyrhellograph at the base camp only. These data are not included in this report.

Upper winds were measured infrequently during the winter by optically tracking helium-filled pilot balloons. These data will be combined with regular and frequent soundings being made in the current season in a separate report.

SURFACE WIND

A Monthly Regional Weather Summary has been included as an Appendix in this report, and gives a monthly wind rose for this year and last year, starting with October 1960 and including April 1961. From this and from Table 1, it is seen that a northerly direction is still the preferred and predominate direction.

Table 2 compares this northerly coastal wind with the tussock level wind recorded at A34.12, 6½ miles inland, from May to October 1960. These data show that when the "Ogotoruk Wind" is blowing, the direction is nearly the same, even at the head of the Valley. It is anticipated that future readings from the relocated instrument near the ponds will show better speed correlation than was apparent last summer.

Table 3 is a comparison of Charlot Site's north wind with that at Point Hope, showing that in most cases Charlot's north winds are stronger at speeds above 10 knots and that there is more variability in direction at Point Hope at speeds below 10 knots. Data not shown but which include about 10 cases during the last year indicate that with a strong southeasterly flow the wind is much stronger at Point Hope, probably because of its more exposed position in the Chukchi Sea.

Table 4 shows the relation between the "Ogotoruk Wind" and open water, before the final freeze, which occurred on February 6, 1961. When the "Ogotoruk Wind" blows, the ice is blown out to sea, and open water will exist for a period of from several hours to several days.

SEA ICE

Table 4 also notes that thin ice appeared in the Chukchi Sea 3 weeks earlier this year, the first thick ice (3-5 inches) 2 weeks earlier, and the final freeze-up about 9 days earlier this year than last. Table 5 is a summary of ice conditions in the Chukchi Sea from the time of the final freeze to the beginning of the break-up on April 30, 1961. The conditions observed are also contained in a report (3) prepared by the U. S. Navy Hydrographic Office which adds that on any given day there will always be a certain amount of small leads existing in the ice cover; coastal leads beyond the belt of fast ice (2-10 miles wide) frequently occur in winter when the winds are strong offshore; and in late autumn, when the ice is still thin, and in late spring when it is breaking up, this coastal lead occurs along the immediate coastline.

PRECIPITATION

Table 6 shows the precipitation, snowfall, and greatest snow depth for Charlot, Kotzebue, and Cape Lisburne from September 1960 through April 1961. For more detailed comparisons on a monthly basis, it is suggested that reference be made to the Monthly Regional Summaries included in the Appendix of this report. Table 7 gives the accumulated snow depths at the various micrometeorological stations by 2 week periods beginning on September 15, 1960.

TEMPERATURE

Table 8 compares the highest and lowest recorded monthly temperatures, and Table 9 compares the mean maximum and mean monthly temperatures at Charlot Site, Kotzebue, and Cape Lisburne. These tables show that warmer than usual weather prevailed during December 1960 and January 1961, with record highs being set at Kotzebue in both months. October and November 1960, and February and March 1961 were all colder than normal at Kotzebue and last year's readings at Charlot. April was warmer than last year and had much more precipitation. It is interesting to note that the coldest temperature recorded at Charlot was minus 45°F., and occurred on March 16, 1961, the day the U.S.W.B. observers returned to the Site. A more detailed review and comparison with a possible synoptic explanation of why these extreme variations occurred are given in the monthly Regional Weather Summary in the Appendix.

Regarding the micrometeorological temperature network, readings were taken an average of once every two weeks from November 1960 through March 1961 by caretaker personnel. U. S. Weather Bureau personnel resumed nearly daily readings in late March 1961. Table 10 gives only the mean of the max-min readings because during these colder months diurnal temperature variation is practically non-existent and advection of warmer or colder air plus radiative cooling are the main factors governing temperature change. Five readings made between November 8 and December 25 were averaged together, and four readings between December 25 and March 4 were averaged. These averages at five levels, 5, -5, -10, -20, and -50 cm. may be compared with the average of 21 readings taken during April 1961. In general, the pattern at -50 cm. shows surprising similarity, with less similarity being shown at the levels closer to the surface. The main reason for this seems to be the irregular and shifting snow cover over these soil thermometers, as snow is an excellent insulator. This property of snow is more strikingly illustrated in some soil temperature readings taken in winter at Antarctica (2) where removal of 4-5 foot snow drifts caused an average temperature drop of 16°F. at -10 cm. and 8°F. drop at -50 cm.

Although only moderate similarity exists between the patterns at 5 and -5 cm. for these three periods, what little that does exist resembles, in general, the mean minimum of the daily readings taken last summer, and follows the theoretical premise that the lower elevations of the valley, inland and away from the warming effect of the sea, are the coldest. This is not surprising, as the mean minimum temperatures during the summer months are an indication of night-time radiation cooling, and so are these readings, since the months of November through February can be considered almost as one long night in this part of the world.

The warmer readings along the creek at stations A34.3 and A34.8 could be due to (1) less exposure to cold winds than the slopes, (2) more ice and less rocks in the soil than higher on the slopes, and (3) the insulating effect of deeper snowdrifts in the immediate vicinity.

Table 10 further shows, as is to be expected, that in the colder months it stays warmer at the lower depths. This is even more obvious from Table 11 in which the lowest temperature for the winter at each station and depth is recorded. Reference to Table 20 in the Preliminary Report (1) shows that in August it stays colder at the lower depths, with the beginning of the permafrost at, or close to the -50 cm. depth. April, being a transition month, should and does show some irregularity.

However, numerous inconsistencies and irregularities are apparent in these soil temperature data. In some cases it has been possible to show an error on the part of the observer or thermometer. Insofar as possible these cases have been corrected. Some readings during the winter months were faulty due to poor installation of the thermometers. The late delivery of the balance of these Palmer thermometers necessitated their installation into frozen ground last October, and the only feasible way was digging a small hole and covering the thermometer with the frozen ground. Airholes resulted at a few of these installations and the probes were bare or exposed to air when some thawing occurred in late March. This necessitated immediate reinstallation. However, there are some apparent inconsistencies between temperatures at various depths and times which can be explained only by the non-homogeneity of the soil and the resulting variability of heat conduction. The interpretation of these data is not complete at the time of this report.

R E F E R E N C E S

1. Microclimatology of Ogotoruk Valley, Preliminary Report No. 1, December 15, 1960.
2. Soil Temperatures at Cape Hallett, Antarctica, 1958; Benes, Norman S., Monthly Weather Review, June 1960, pg. 223.
3. Letter, AEC, dated May 17, 1961, Subject: Summary of Ice Conditions in Southern Chukchi Sea, John F. Philip.

	<u>Calm</u>	<u>W</u>	<u>WNW</u>	<u>NW</u>	<u>NNW</u>	<u>N</u>	<u>NNE</u>	<u>NE</u>	<u>ENE</u>	<u>E</u>	<u>ESE</u>	<u>SE</u>	<u>SSE</u>	<u>S</u>	<u>SSW</u>	<u>SW</u>	<u>WSW</u>
Oct. 60	0	1	0	0	4	60	4	2	0	3	8	4	9	3	0	0	1
Nov. 60	0	0	0	2	8	60	10	1	0	3	4	3	0	2	1	3	1
Dec. 60	0	1	0	2	2	59	11	1	1	5	6	3	3	3	0	0	1
Jan. 61	0	0	0	0	3	57	22	0	1	4	8	4	0	0	0	0	1
Feb. 61	0	0	0	1	2	88	8	0	0	0	0	0	0	0	0	0	0
Mar. 61	0	1	0	1	1	82	11	0	0	0	5	0	0	0	0	0	0
Apr. 61	1	0	0	0	0	55	9	3	3	6	9	7	4	2	0	0	0
May 61	3	0	1	1	4	38	17	2	0	1	4	13	4	2	4	6	1

Table 1. Charlot Site Wind Direction Percentages. Taken from Wind Observations at Base Camp Station A34.0(Continuation of Table 3 in Preliminary Report No. 1 dated Dec. 15, 1960.)

Base Camp Mean Wind SpeedPond Station A34.12 Wind Direction and Speed

<u>Speeds 0-10 knots,</u>	<u>N & NNE</u>	<u>North</u>	<u>NE & E</u>	<u>SE & S</u>	<u>SW & W</u>	<u>NW</u>
Cases:	25	14	3	3	0	5
Mean Speeds:	8.7.....	4.9				
	8.7.....		3.0			
	7.3.....			2.7		
	8.6.....					5.4
<u>Speeds 11-20 knots,</u>	<u>N & NNE</u>					
Cases:	69	51	11	0	0	7
Mean Speeds:	16.4.....	7.9				
	15.1.....		5.2			
	15.0.....					7.7
<u>Speeds 21-30 knots,</u>	<u>N & NNE</u>					
Cases:	57	53	1	0	0	3
Mean Speeds:	25.9.....	11.4				
	25.0.....		8.0			
	28.3.....					12.0
<u>Speeds above 30 knots:</u>	<u>N & NNE</u>					
Cases:	10	10	0	0	0	0
Mean Speeds:	35.5.....	16.2				

Table 2. Comparison between Coastal and Inland Wind at Chariot Site. These comparisons are for the period May to October 1960 when simultaneous recordings were available. The base camp anemometer was at about 22 feet whereas the pond station anemometer was at about 2 feet above the surface. The direction correlation was good, especially for strong winds.

Charlot Wind SpeedSpeeds 0-10 knots, N & NNE

Cases: 41
 Mean Speeds: 8.5
 10.0
 7.9
 7.7
 7.7

Speeds 11-20 knots, N & NNE

Cases: 194
 Mean Speeds: 17.1
 16.4
 15.3
 15.3
 17.4

Speeds 21-30 knots, N & NNE

Cases: 127
 Mean Speeds: 26.2
 25.1
 23.0
 22.0
 27.4

Speeds 31-40 knots, N & NNE

Cases: 57
 Mean Speeds: 35.9
 36.9
 35.5

Speeds Above 40 knots, N & NNE

Cases: 10
 Mean Speeds: 44.3
 49.2

Point Hope Wind Direction and Speed

<u>N-NNE</u>	<u>NE-E</u>	<u>ESE-S</u>	<u>SSW-W</u>	<u>WNW-NNW</u>
--------------	-------------	--------------	--------------	----------------

10	4	7	10	10
7.1	12.5	7.0	5.0	10.2

71	72	16	4	31
10.5	7.1	3.1	4.8	14.9

71	40	1	1	14
18.7	11.7	6.0	4.0	16.4

25	28	0	0	4
28.5	34.3			24.0

4	6
38.8	45.3

Table 3. Comparison Between Wind At Charlot Site and Point Hope. Above data were assembled from simultaneous readings from May 1960 through April 1961.

<u>Date</u>	<u>Mean Temp</u>	<u>Wind Dir.</u>	<u>Wind Speed</u>	<u>Comments on State of Sea, etc.</u>
12/10/60	21	SSE	10.3	Slush ice forming during day.
12/11/60	5	N	13.0	Sea frozen solid by early morning.
12/20/60	8	N	16.7	100-foot lead just offshore.
12/21/60	9	N	22.7	Sea open.
12/30/60	9	S	10.0	Sea was frozen at daybreak (0700B)
1/1/61	-3	N	28.3	Sea open.
1/2-1/4		Gusts to 60		Sea obscured by blowing snow.
1/5/61	-5	N	16.3	Sea still open.
1/6/61	-6	NNE	8.3	Sea half covered with ice.
1/7/61	-10	NNE	17.0	Sea frozen.
1/11-1/14				Sea obscured by blowing snow. Gusts to 70.
1/15/61	-14	N	23.3	Sea open.
1/20/61	32	E	20.0	Sea frozen. Wind shifted to east after five days of northerly winds.
1/25/61	25	N	23.3	Sea ice moving south.
1/26/61	27	ESE	10.7	Sea frozen again.
2/1/61	-7	N	31.7	Sea ice blown out past horizon.
2/3/61	-20	N	22.0	Sea still open.
2/4-2/5		N	37-42	Sea obscured by Blowing Snow. Gusts above 50 both days.
2/6/61	-12	N	21.0	Sea frozen.

Table 4. Relation Between "Ogotoruk Wind" and Open Water. (See Table 6 in Preliminary Report for Comparison with previous winter). Thin ice first appeared 11/24/60 and lasted several days, whereas it did not appear until 12/10/59 the previous season, although ice floes had appeared as early as 10/31/59. The sea became frozen solid (3-5 inches) for the first time on 12/11/60 compared to 12/25/59. As seen from above, various periods of open water existed, depending on the intensity of the "Ogotoruk Wind", until 2/6/61 when, in spite of a northerly wind averaging 21.0 knots, the sea became frozen for the last time until the spring breakup. It finally became frozen 2/15/60 the previous season. Detailed sea and ice reports for the general area from Kotzebue to Cape Lisburne from 2/4/61 to 4/15/61 appear in Table 5 of this report.

- 2/4/61 Open water existed from Point Hope to just beyond Cape Krusenstern. 50% pack ice with big leads began 30 miles out. Kotzebue Sound was 100% pack ice. From Point Hope to the northeast beyond Cape Lisburne was 60% rough ice.
- 2/11/61 From Point Hope to Kotzebue was 100% solid new ice. All leads and open water were now frozen over with smooth ice 3-5 inches thick. Several miles offshore, Point Hope and Cape Lisburne had 60-80% rough ice.
- 2/18/61 No change from previous week except the new ice was somewhat deeper -- about 8-10 inches thick. A number of leads 2-3 miles across and 5-7 miles long existed in the vicinity of 67°N and 166°W (directly west of Kotzebue).
- 2/25/61 New ice was now 12 inches thick. No change in leads from last week. From Cape Thompson to Point Hope, 100-500 yards of shore ice existed, then 2-5 miles of open water; otherwise ice was 100% solid.
- 3/4/61 Solid ice was over entire area. Leads west of Kotzebue became badly broken-up ice.
- 3/11/61 The $\frac{1}{2}$ mile wide lead which extended from Point Hope to Kivalina on 3/7 5-10 miles offshore was now frozen with 4-8 inches of young ice. From Kivalina to Kotzebue the ice was solid and fairly smooth.
- 3/18/61 Solid ice was along shore to 20 miles out; fairly smooth from Kotzebue to Point Hope, but fairly rough from Point Hope to Cape Lisburne.
- 3/25/61 All ice east of 166°W was solid and fairly smooth, with 2-3 inches of undisturbed snow. Quite a lot of pressure-driven ice was along the shore at Charlot Site, with 2 leads 3 miles south extending to the southeast 3-4 miles. These $\frac{1}{2}$ mile leads closed to $\frac{1}{8}$ mile on 3/27.
- 4/1/61 Most of area appeared as if ice had been broken up and then frozen together again, except it was solid and smooth in Kotzebue vicinity. In Charlot Site vicinity, the young offshore ice was 2-10 inches thick, with occasional open water.
- 4/8/61 No reports except for one lead $\frac{1}{2}$ mile wide noticed 5 miles off Kivalina.
- 4/15/61 The offshore ice in Charlot Site area seemed to be young ice one day and a lead the next. Numerous leads were off the coast at Point Hope. Ice in Kotzebue vicinity was still solid and smooth.

Table 5. Summary of Pilots' Ice Reports for the Chukchi Sea Received by the U. S. Weather Bureau Station at Kotzebue, Alaska.

<u>Precipitation</u> <u>(Liquid Equivalent)</u>	<u>Sept</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>
Charlot 1960-61	1.58	1.16	.12	.02	.03	.00	.31	.55
Kotzebue 1960-61	2.85	1.53	.44	.47	.26	.08	.15	.83
Cape Lisburne	1.83	1.83	.43	.93	.09	T		
<u>Snowfall</u>								
Charlot 1960-61	3.2	6.6	11.5	0.5	1.6	0.0	2.0	5.5
Kotzebue 1960-61	5.4	4.3	11.6	8.9	3.2	1.2	3.6	14.9
Cape Lisburne	4.7	9.2	4.3	9.3	4.1	T		
<u>Greatest Snow Depth</u> <u>on Ground (Inches)</u>								
Charlot 1960-61	1	4	2	2	2	2	3	6
Kotzebue 1960-61	1	3	7	14	15	10	13	22
Cape Lisburne	3	4	6	13	15	14		

Table 6. Charlot Site Precipitation, Snowfall, and Snow Depths Compared with Nearby Locations. (Continuation of Tables 7 and 8 in Preliminary Report No. 1).

	<u>A34.0</u>	<u>.1</u>	<u>.2</u>	<u>.3</u>	<u>.4</u>	<u>.5</u>	<u>.6</u>	<u>.7</u>	<u>.8</u>	<u>.9</u>	<u>.10</u>	<u>.11</u>	<u>.12</u>
9/15/60	T	T			T	T	T	T	T	T	T	T	T
9/20	1	1	1	1	1	2	2	2	1	1	2	4	2
9/25	0	T	T	0	0	0	T	T	0	0	T	T	0
9/30	0	1	T	T	T	1	1	1	T	0	0	T	T
10/5	0	0	0	0	0	0	0	T	0	0	0	0	T
10/11	1	1	1	1	1	1	1	1	1	1	1	1	1
10/21	3	2	2	3	4	4	4	4	3	3	5	4	4
10/28	2	2	2				4	3	2			4	3
11/8	2	2	3	2	2	2	3	3	3	2	4	3	3
11/16	2	3	3	2	2	2	3	3	3	2	4	3	3
11/26	2	2	4		2	3							
12/12	2	2	4	3	2	3	3	3	3	3	4	3	3
12/18	2	2	3	3	2	2	3	3	3	2	4	1	2
12/25	2	2	3	3	2	2	3	3	3	2	5	2	2
12/31	2	2	3	3	2	2							
1/9/61	2	2	2	3	2	1							
1/20				3			2	3	3	2	3	2	2
1/28	2	2	2	3	2	1	2	3	10	2	3	2	2
2/12	2	2	2	3	2	1	2	3	10	2	3	2	2
2/21	2	2	2	3	2	1	2	3	10	2	3	2	2
3/31	3-5	1-2	6	6-8	0	4-8	6	5-6	32	3-6	32	5-7	8-12
4/30	3-10	0	5-10	5-10	6-11	2-6	2-4	3-10	36	4-18	32	2-4	4-12

Table 7. Snow Depths in Inches at Environmental Stations. The larger amounts of snow observed at A34.10 from 10/21/60 through 12/25 and at A34.8 from 1/28/61 through 2/21 reflect wind drifting rather than greater amounts of snowfall. The depth ranges shown for March 31 and April 30 reflect the variability of depths around each plot. Depths for earlier dates were mean values.

	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>
<u>Highest Recorded Temperatures</u>								
Charlot 1960-61	47	41	29	37	39	4	30	39
Kotzebue 1960-61	55	43	27	36	39	10	38	38
Cape Lisburne	43	40	22	39	41	-1		
Kotzebue Record - Highest	63	51	38	36	39	35	34	46
- Lowest	17	-8	-36	-47	-43	-48	-48	-44
<u>Lowest Recorded Temperatures</u>								
Charlot 1960-61	16	2	-19	-21	-26	-26	-45	-12
Kotzebue 1960-61	23	4	-21	-14	-24	-33	-36	-20
Cape Lisburne 1960-61	20	1	-12	-17	-21	-29		

Table 8. Highest and Lowest Temperatures Recorded at Charlot Site and Nearby Locations. (Continuation of Table 13 in Preliminary Report No. 1).

	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>
<u>Mean Maximum Temperatures</u>								
Cape Lisburne	35.1	23.6	5.7	9.5	6.1	-11.5		
Chariot 1960-61	37.6	22.8	6.6	11.7	7.3	-8.9	-7.4	14.5
Kotzebue 1960-61	43.4	27.6	11.4	18.6	12.7	-5.8	1.7	22.0
<u>Mean Temperatures</u>								
Cape Lisburne	32.9	20.7	2.2	2.9	2.0	-14.9		
Chariot 1960-61	32.4	18.7	2.0	6.0	2.5	-13.1	-13.6	6.8
Kotzebue 1960-61	37.6	22.3	6.8	12.0	6.6	-12.9	-6.2	11.5

Table 9. Chariot Site Mean Maximum and Mean Temperatures Compared to Nearby Locations. (Continuation of Table 12 in Preliminary Report No. 1).

	<u>A34.0</u>	<u>A34.1</u>	<u>A34.2</u>	<u>A34.3</u>	<u>A34.4</u>	<u>A34.5</u>	<u>A34.6</u>	<u>A34.7</u>	<u>A34.8</u>	<u>A34.9</u>	<u>A34.10</u>	<u>A34.11</u>	<u>A34.12</u>
<u>11/8 to</u> <u>12/25/60</u>													
5 cm		9.1	10.9	11.1	7.7	8.7	5.8	3.9	6.7	6.1	-	7.9	8.6
-5 cm	13.3	11.2	13.6	16.4	11.4	10.0	10.4	10.4	7.3	9.6	21.5	13.1	10.8
-10 cm	14.8	12.6	13.8	17.3	11.8	12.4	6.7	12.1	7.8	13.0	20.4	12.7	12.9
-20 cm	18.4	14.0	13.0	19.8	12.6	14.0	11.8	14.2	12.2	11.6	23.4	13.4	15.1
-50 cm	18.3	14.7	20.2	23.4	12.9	15.1	16.7	14.7	17.9	17.4	22.4	17.6	19.5
<u>12/25/60 to</u> <u>3/4/61</u>													
5 cm	-5.8	-5.5	-3.6	-7.8	-2.3	-1.4	-7.4	-10.5	-4.9	-11.9	-	-6.9	-
-5 cm	0.1	-1.1	-2.1	4.3	-1.0	0.5	-3.3	-3.8	-0.4	-2.8	12.0	0.0	-1.0
-10 cm	0.6	1.1	-1.4	0.8	-0.5	1.6	-3.1	-2.4	0.8	0.0	11.5	-0.8	-0.6
-20 cm	4.5	2.0	-0.1	5.0	2.9	4.0	-1.4	-1.4	4.4	-2.1	15.3	-1.1	2.4
-50 cm	3.5	1.6	2.6	8.1	1.5	4.6	1.6	0.6	9.5	3.9	10.5	8.3	6.5
<u>April 1961</u>													
5 cm	9.1	5.7	6.5	10.3	13.8	9.1	10.7	6.4	6.1	7.5	8.5	7.8	5.3
-5 cm	7.9	8.3	7.4	13.7	6.5	8.2	9.7	5.1	3.9	6.4	8.5	10.1	5.8
-10 cm	6.3	8.1	3.5	6.9	4.5	9.0	5.9	4.7	4.7	6.3	8.3	8.9	7.3
-20 cm	7.7	8.5	1.5	5.4	6.7	8.8	6.4	4.7	5.2	2.4	10.1	7.1	3.9
-50 cm	4.7	5.8	5.7	8.1	3.3	6.9	3.7	2.8	8.7	1.9	8.5	6.5	5.4

Table 10. Mean Temperatures at the Micrometeorological Station Network. The pattern of warmer temperatures at greater depths was changing in April when surface warming began to be effective. The readings were somewhat erratic in April because of the heavy snowfall during the month, which resulted in varying accumulation at the station network. For example, A34.1 looks lower than it should be as the ground was bare at the end of the month, while A34.4 seems higher, and this station had 6-11 inches of snow in the immediate vicinity at the end of the month. Stations A34.8, 9 and 10 had over 15 inches of snow at that time. The patterns of readings at -5 cm, while similar to those at 5 cm, are a little more erratic, as are those at -10 and -20 cm. The high readings at A34.10, at all levels, are obviously due to this deeper snow accumulation. Some of the irregularities in the temperature patterns are apparently from air pockets which formed due to installation difficulty in frozen ground last October.

	<u>A34.0</u>	<u>A34.1</u>	<u>A34.2</u>	<u>A34.3</u>	<u>A34.4</u>	<u>A34.5</u>	<u>A34.6</u>	<u>A34.7</u>	<u>A34.8</u>	<u>A34.9</u>	<u>A34.10</u>	<u>A34.11</u>	<u>A34.12</u>
5 cm	-25	-28	-28	-28	-22	-27	-32	-34	-21	-31	-	-33	-32
-5 cm	-11	-16	-15	-6	-15	-14	-20	-15	-13	-19	4	-10	-10
-10 cm	-9	-13	-13	-9	-14	-13	-18	-13	-4	-13	4	-14	-11
-20 cm	-5	-10	-18	-4	-10	-5	-15	-11	-3	-13	7	-12	-9
-50 cm	-3	-9	-17	0	-7	-4	-6	-7	5	-4	-2	-5	0

Table II. Lowest Minimum Temperatures, Winter of 1960-61. It is interesting to note that the lowest temperature in each level is at a station located on the east side of the valley, either A34.2, 6 or 7. Practically all of these extreme lows occurred in March, the same month that A34.0 recorded a minus 45°F at the standard instrument shelter height of about 122 cm. This time of year the sun is at the equinox, and some solar heating is beginning to make itself felt. Thus, it is suggested that possibly the late sunrise on the east side of the valley may have resulted in the extreme lows being there.

Map of Station Network

A P P E N D I X

REGIONAL WEATHER SUMMARY

Chariot Site and Vicinity
by Month

October 1960 to April 1961

OCTOBER

	1960			1959			Kotz.
	Char.	Kotz.	Lisb.	Char.	Kotz.	Lisb.	Normal
Mean Max. Temp.	22.8	27.6	23.6	26.9	27.7		30.2
Mean Min. Temp.	14.6	17.0	17.7	15.7	16.2		20.7
Highest Recorded	41	43	40	45	46		
Lowest Recorded	2	4	1	-4	-6		
Precip.(liquid)	1.16	1.53	1.83	.46	.53		.58
Snowfall(inches)	6.6	4.3	9.2	5.0	1.9		5.6
Greatest Depth	4	3	4	2.5	1		
Avg.Wind(knots)	21.9	11.5		13.7	8.0		11.8

October 1960

The final series of unusual storms whose tracks were northward through the Bering Straits along the northern coastline of Alaska ended by October 5, but gave precipitation totals of over an inch to all 3 locations during the first 5 days of the month. For the balance of the month the storm tracks followed a more southerly route, as the typical winter high pressure area asserted its dominance over the ice cap earlier than usual and resulted in mostly a northerly flow of air over the region, which in turn kept the mean temperatures of both Kotzebue and Chariot below last year's figures, and in the case of Kotzebue, below normal.

N O V E M B E R

Chariot Wind Rose
November 1960

Chariot Wind Rose
November 1959

	1 9 6 0			1 9 5 9			Kotz.
	Char.	Kotz.	Lisb.	Char.	Kotz.	Lisb.	Normal
Mean Max. Temp.	6.6	11.4	5.7	11.2	14.6		12.9
Mean Min. Temp.	-2.7	2.2	-1.2	0.3	3.5		2.1
Highest Recorded	29	27	22	33	27		
Lowest Recorded	-19	-21	-12	-15	-17		
Precip.(liquid)	.12	.44	.43	.57	.24		.43
Snowfall(inches)	1.5	11.6	4.3	7.5	2.7		7.8
Greatest Depth	2	7	6	5	4		
Avg.Wind(knots)	19.9	13.3		23.0	11.9		12.1

November 1960

From November 1-15, intense high pressure existed on the polar ice cap, and maintained a north to south pressure gradient over northwest Alaska. In the latter half of the month, this high pressure receded somewhat, and the track of the major storms across the southern Bering Sea moved further north. Several times some of this low pressure broke off from the main storm to the south, redeveloped north of the Bering Straits, and moved eastward along the northern Alaskan coast, giving slight amounts of precipitation to the Chariot Site. By November 30, high pressure had again built up over the ice pack.

The mean temperatures at Chariot again continued lower than last years monthly figures, and precipitation and snow were much less. This reflects somewhat colder northerly flow from the ice pack, but the Kotzebue data suggests that the month was near normal in the mean.

DECEMBER

Chariot Wind Rose
December 1960

Chariot Wind Rose
December 1959

	1960			1959			Kotz.
	Char.	Kotz.	Lisb.	Char.	Kotz.	Lisb.	Normal
Mean Max. Temp.	11.7	18.7	9.5	-11.1	-8.7		3.3
Mean Min. Temp.	0.2	5.3	-0.4	-20.1	-20.9		-10.6
Highest Recorded	37	36	39	9	22		
Lowest Recorded	-21	-14	-17	-37	-34		
Precipitation(liq.)	.02	.47	.93	T	.33		.35
Snowfall(inches)	.5	9.1	9.3	T	3.9		6.1
Greatest Depth	2	14	13	5	6		
Avg.Wind(knots)	19.7	13.2		19.5	7.9		11.2

December 1960

The month started with the typical pattern of high pressure over the polar ice cap and a deep low over the Aleutians, but by the 7th the paths of the lows had moved northward and were penetrating central Alaska and dissipating or moving inland much weaker. The northeasterly gradient over the Chariot Site gave way to more of an easterly or southeasterly flow on the 8th, 10th, and 14th, with some light precipitation. By the 15th a long wedge of high pressure had built up inland along the west coast of Canada, reinforced by a high pressure ridge at all levels aloft, and this gave rise to a long fetch of warm, relatively dry east-southeasterly flow across all of western Alaska. This resulted in a period of unseasonably high temperatures with lower relative humidities at Chariot--the extreme high reaching 37°F on the 16th. Kotzebue had a record 36°F and the warmest December ever recorded.

Temperature anomalies were noted over the whole of North America during this 2 week period. On the east side of the Rockies a cold northerly flow existed, with Arctic air extending from Point Barrow to Miami, Florida, 3000 miles to the south. By the 21st, a deep low in the Bering Sea moved slowly southeastward and gradually weakened this continental high pressure ridge, and by the 24th high pressure had again built up over the polar ice cap, giving colder more normal weather for the balance of the month to most of northwestern Alaska.

JANUARY

Chariot Wind Rose
January 1961

	1961		
Char.	Kotz.	Lisb.	

Mean Max. Temp.	7.3	12.7	6.1
Mean Min. Temp.	-2.3	0.5	-2.0
Highest Recorded	39	39	41
Lowest Recorded	-26	-24	-21

Precip. (liquid)	.03	.26	.09
Snowfall (inches)	1.6	3.2	0.9
Greatest Depth	2	15	15
Avg. Wind (knots)	21.6	10.6

Chariot Wind Rose
January 1960

	1960		
Char.	Kotz.	Lisb.	Kotz. Normal

Mean Max. Temp.	-4.4	2.4	-8.8	0.6
Mean Min. Temp.	-18.0	-12.3	-17.1	-13.7
Highest Recorded	32	29	18	
Lowest Recorded	-38	-40	-30	

Precip. (liquid)	.10	.58	.50	.47
Snowfall (inches)	2.8	6.7	5.0	5.5
Greatest Depth	5	11	19	
Avg. Wind (knots)	24.3	10.0		13.3

January 1961

Moderate high pressure over the polar ice cap gave a cold northerly flow to the Chariot Site the first 16 days, with weak fast-moving storms or lows moving eastward through the southern Bering Sea. The latter half of the month was similar to the previous month's anomalous pattern, in which a blocking high built up over the Canadian Rockies, forcing slow-moving weak lows to move over Alaska and giving most of Alaska a warmer southerly flow. By the end of the month a more normal pattern was re-established, with high pressure again over the ice cap.

F E B R U A R Y

Chariot Wind Rose
February 1961

Chariot Wind Rose
February 1960

	1 9 6 1			1 9 6 0			Kotz.
	Char.	Kotz.	Lisb.	Char.	Kotz.	Lisb.	Normal
Mean Max. Temp.	-8.9	-5.8	-11.5	9.7	9.1	8.2	2.5
Mean Min Temp	-17.3	-20.0	-18.3	-1.8	5.4	-1.6	-11.9
Highest Recorded	4	10	-1	34	33	35	
Lowest Recorded	-26	-33	-29	-19	-33	-26	
Precip.(liquid)	.00	.08	T	.12	.46	.71	.32
Snowfall(Inches)	0.0	1.2	T	1.9	5.7	7.1	4.9
Greatest Depth	2	10	14	6	17	28	
Avg.Wind(knots)	23.0	5.3		20.9	12.0		12.4

February 1961

This month was unusually cold. The Chariot Site was under the influence of the polar high the entire period, with northerly winds predominating, no precipitation, and an average of only 1/10 cloud cover per day.

MARCH

Chariot Wind Rose
March 1961

Chariot Wind Rose
March 1960

	1961			1960			Kotz.
	Char.	Kotz.	Lisb.	Char.	Kotz.	Lisb.	Normal
Mean Max. Temp.	-7.4	1.7		9.2	13.6	8.5	6.6
Mean Min. Temp.	-19.7	-14.1		-5.2	-2.8	-3.0	-9.7
Highest Recorded	30	38		29	31	33	
Lowest Recorded	-45	-36		-28	-17	-30	
Precip. (liquid)	.31	.15		.04	T	.21	.27
Snowfall (inches)	2.0	3.6		0.5	T	2.1	6.0
Greatest Depth	3	13		6	18	30	
Avg. Wind (knots)	19.5	8.4		15.4	9.6		11.4

March 1961

The Chariot Site was again cold and under mostly a northerly flow this month, with high pressure over the polar ice cap and also in the Bering Sea for several extended periods. On the 6th, a deep low which penetrated the Alaskan coast in the Bristol Bay area south of the Chariot Site dumped 1.5 inches of snow over the Site, otherwise the storm tracks of the lows were further south in the Bering Sea, and just gave smaller amounts of snow on several occasions.

A P R I L

Charlot Wind Rose
April 1961

Charlot Wind Rose
April 1960

	1961			1960			Kotz. Normal
	Char.	Kotz.	Lisb.	Char.	Kotz.	Lisb.	
Mean Max. Temp.	14.5	22.0		9.4	18.0	6.0	22.3
Mean Min. Temp.	-0.9	1.0		-7.0	-5.4	-4.5	5.2
Highest Recorded	39	38		44	46	29	
Lowest Recorded	-12	-20		-21	-23	-19	
Precip. (liquid)	.55	.83		.27	.31	.37	.36
Snowfall (inches)	5.5	14.9		2.9	5.5	3.7	3.4
Greatest Depth	6	22		8	22	34	
Avg. Wind (knots)	19.6	11.4		20.3	7.0		11.7

April 1961

The storm tracks of the low pressure areas began their northward migration early this year, as was evidenced by the number of rainy and snowy days at the Charlot Site, and which is reflected in the increased precipitation totals and decreased northerly wind flow. On two occasions, on the 10th and the 17th, lows moved northward through the Bering Straits northeastward over the Site. In general, the month was the transition to Arctic summer-type weather. Kotzebue's temperatures were near normal.

M A Y

Chariot
Wind Rose
May 1961

Chariot
Wind Rose
May 1960

	1 9 6 1			1 9 6 0			
	Char.	Kotz.	Lisb.	Char.	Kotz.	Lisb.	Kotz. Normal
Mean Max. Temp.	42.0	42.6		38.9	40.2	33.2	36.3
Mean Min. Temp.	26.9	27.6		26.0	28.8	25.0	22.8
Highest Recorded	63	64		53	60	46	
Lowest Recorded	14	16		15	22	16	
Precip. (liquid)	.15	.36		.73	.57	.59	.33
Snowfall (inches)	1.3	0.4		2.0	2.2	3.0	1.0
Greatest Depth	4	14		2	17	34	
Avg. Wind (knots)	12.9	7.7		13.1	13.0		10.3

May 1961

This month was quite similar to May 1960, except there was considerably less precipitation. The month was quite typically an Arctic transition month, with weak storms or low pressure areas in the Bering Sea moving slowly eastward. The decrease in average wind speed from the preceding months is indicative of the decrease in pressure gradients and the approach of the Arctic summer. The decrease in precipitation this year was probably due to the fact that fewer of these weak lows moved northward through the Bering Straits.