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The Climate of the Matanuska Valley

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PREFACE

This study was made possible only through the unselfish service of the cooperative weather observers listed in table 1 and the Weather Bureau and Soil Conservation officials who conceived and implemented the network in 1941. Special mention should be given Max Sherrod at Matanuska No. 12, and Irving Newville (deceased) at Matanuska No. 2, both original colonists and charter observers with more than 10 years of cooperative weather observing to their credit. Among the many individuals who have furnished information and assistance in the preparation of this study should be mentioned Don L. Irwin Director of the Alaska Agricultural Experiment Station; Dr. Curtis H. Dearborn, Horticulturist and present weather observer at the Matanuska Agricultural Experiment Station; Glen Jefferson, Regional Director, and Mac A. Emerson, Assistant Regional Director, U. S. Weather Bureau; and Alvida H. Nordling, my assistant in the Anchorage Climatological Section.

ROBERT F. DALE.

FEBRUARY 1955.

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Robert F. Dale

February 1955

CONTENTS

THE CLIMATE OF THE MATANUSKA VALLEY

1. INTRODUCTION

The discovery of placer gold in the Talkeetna Mountains brought a small gold rush to the Matanuska Valley in 1898, and in the next 10 years gold and coal mining activities resulted in a gradual settlement of the Valley [9]. In 1916 the Alaska Railroad was built through the Valley, and with homesteading farmers settling near it, agriculture increased in importance. The climate of the Matanuska Valley was described briefly by M. B. Summers [10] in 1925 using 4 to 5 years of climatological data from the Matanuska Agricultural Experiment Station and from Chickaloon, a coal mining village about 35 miles northeast of the Experiment Station. Although at that time the development of Alaskan agriculture had made the most progress in the Fairbanks area of the Tanana Valley, Summers believed that climatic conditions were more favorable for farming in the Matanuska and Susitna Valleys where winters were milder and growing seasons longer. Colonization efforts by the Alaska Railroad attracted more settlers to the Valley after 1929; however, the greatest impetus given the Valley was its colonization under the Federal Emergency Relief Administration program of 1935. Detailed plans for the colony were formed rapidly in early 1935 and the colonists were moved to the Matanuska Valley in April and May of the same year [9].

A weather station had been established in July 1917 at the Matanuska Agricultural Experiment Station, and thus about 15 years of climatological data were available to the FERA planners when the Valley was selected as the site of the proposed colony in the fall of 1934. Experience of the colonists in various areas of the Valley soon revealed differences from the climate recorded at the Experiment Station, but it was not until July 1941 that the Weather Bureau in cooperation with the Soil Conservation Service [1] established four additional temperature and precipitation stations. Ten more stations, recording precipitation only, were established in August and September 1941 in cooperation with the General Land Office [2] and the 15 weather stations were designated Matanuska No. 1, No. 2, . . . No. 15. The original locations are shown in figure 2. Matanuska No. 15 was converted to a temperature and precipitation station, but the other 9 precipitation-only stations were discontinued within the first year. In response to interest evidenced in early results from the network of climatological stations in the Matanuska Valley, Heller [4] in November 1944 analyzed the data obtained the first 3 years; and Stone [9] included information gained from a summary of the climatological data through 1946 in his comprehensive work on the Matanuska Valley Colony.

This study is based primarily on about 34 years of record from the Matanuska Agricultural Experiment Station (No. 14) and an average of more than 11 years of record for Matanuska No. 2, No. 9, No. 12, No. 15, Wasilla (No. 13), and Eklutna (established at the Anchorage Hydroelectric Power Plant in May 1941). Records from Matanuska No. 16 and Eklutna Project, both established in 1951, and the aviation weather station at Palmer 2NW, established in 1948 and moved to the Palmer Airport in 1951, have also been considered in this study. Names and periods of record of all weather observers in the Valley from July 1941 through 1954 are listed in table 1.

2. GENERAL FEATURES

The farming area of the Matanuska Valley is located in a roughly rectangular area about 10 to 12 miles wide and extending from the Chugach Mountains on the east to an indefinite boundary 15 to 20 miles to the west (figs. 1 and 2). The Valley is bordered on the southwest by an arm of

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[1] The Soil Conservation Service, W. A. Rockie, in charge, Alaska Project, Pacific Northwest Region, Spokane, Wash., furnished weather instrumental equipment for the Matanuska Valley Climatological network. The actual implementation of the network was by John J. Keyser, official in charge, Anchorage Weather Bureau Office.

[2] Standard 8-inch precipitation gages furnished by the Weather Bureau, with stations established by Dr. M. F. Burrill, Economic Geographer, General Land Office, Washington, D. C.

Table 1.—*Cooperative climatological observers in the Matanuska Valley and period of record.*

Station	Observer	Period of Record
Eklutna	Frank M. Reed	May 12, 1941 to May 31, 1941.
	T. Bergt	June 1, 1941 to June 30, 1941.
	Charles A. Wilson	July 1, 1941 to Aug. 31, 1944.
	Raymond Henricks	Sept. 1, 1944 to Feb. 28, 1955.
Eklutna project	Max Weinstock	Nov. 1, 1951 to Apr. 30, 1953.
	Arnold Johnson	May 1, 1953 to Dec. 20, 1954.
	Bureau of Reclamation, power plant operators	Dec. 20, 1954 to date.
Matanuska No. 1	L. M. Bergan	Sept. 7, 1941 to Sept. 30, 1942.
Matanuska No. 2 (Palmer 4SSE)	I. Newville	July 14, 1941 to Jan. 10, 1952.
	Lee L. McKinley family	Apr. 1, 1952 to June 30, 1953. Nov. 11, 1954 to date.
Matanuska No. 3	Mrs. LeRoy Hamann	Sept. 4, 1941 to Dec. 31, 1941.
Matanuska No. 4	Mrs. C. V. King, Jr.	Aug. 13, 1941 to June 30, 1942.
Matanuska No. 5	Robert Klem	Aug. 9, 1941 to Nov. 30, 1941.
	James Klem	July 12, 1942 to May 30, 1943.
Matanuska No. 6	Mrs. Lee Marshall	Sept. 1, 1941 to Sept. 28, 1943.
Matanuska No. 7	Carl H. Meier	Sept. 4, 1941 to Mar. 31, 1942.
	Vivien Meier	July 10, 1942 to Nov. 30, 1943.
Matanuska No. 8	Walter Menck	Sept. 6, 1941 to June 30, 1942.
Matanuska No. 9 (Palmer 5NW)	Mrs. Neil Miller	July 13, 1941 to Oct. 12, 1942.
	Charles Wilson	June 19, 1943 to Sept. 22, 1950.
	Ray Cather	Oct. 17, 1950 to date.
Matanuska No. 10	Mrs. C. Quarnstrom	Aug. 12, 1941 to Aug. 31, 1942.
Matanuska No. 11	Mrs. Robert Risley	Aug. 12, 1941 to Sept. 30, 1941.
Matanuska No. 12 (Palmer 1N)	Max Sherrod	July 13, 1941 to date.
Matanuska No. 13 (Wasilla)	N. A. Browne	Aug. 6, 1941 to Dec. 31, 1943.
	James Pendleton	Oct. 18, 1944 to Apr. 21, 1948.
	L. Nelson	Apr. 22, 1948 to Jan. 25, 1950.
	J. C. Baldwin	Jan. 25, 1950 to July 19, 1951.
Matanuska No. 14 (Matanuska Agricultural Experiment Station)	Frederick Rader	July 1, 1917 to July 31, 1918.
	U. S. Exp. Station*	Aug. 1, 1918 to June 30, 1933.
	Don L. Irwin	July 1, 1934 to Mar. 31, 1942.
	Mary Ebert	Apr. 1, 1942 to Nov. 30, 1945.
	Floyd King	Dec. 1, 1945 to Nov. 30, 1948.
	Bernard King	Dec. 1, 1948 to Oct. 31, 1950.
	C. H. Dearborn	Dec. 1, 1950 to date.
Matanuska No. 15	J. R. Griffith	July 1, 1942 to May 31, 1947.
	Eugene Reid	June 1, 1947 to Aug. 31, 1952.
Matanuska No. 16 (Wasilla 3S)	Harold Dinkel	July 19, 1951 to date.
Palmer 2NW	Mrs. Irene M. Beylund	Nov. 20, 1948 to Jan. 31, 1951.
Palmer Airport	Mrs. Hazel Green	Feb. 1, 1951 to Apr. 30, 1952.
	A. K. Dickow	May 1, 1952 to date.

* Personnel not identified.

the Pacific Ocean and lies less than 40 miles northwest of Prince William Sound; however, the Chugach Mountains to the south and east, with peaks ranging from 7,000 to 10,000 feet, form an effective coastal barrier to all flow of moist Pacific air except from the southwest over Cook Inlet. Therefore, maritime air masses are generally well modified by the time they reach the Valley, and precipitation is only a little greater than that in interior Alaska, averaging 16 to 20 inches a year in the central Valley area. The Alaska Range and Talkeetna Mountains to the north and the Chugach Mountains to the east protect the Valley from the extreme winter cold of the interior areas, and, even in midwinter, thawing temperatures are common under occasional invasions of warm maritime air from the southwest and south.

The country is part of a large plain which borders the upper end of Cook Inlet, and is composed of a step-like series of benches and terraces descending from the foot of the Talkeetna Mountains on the north down to the tidal flats of Knik Arm on the south. This general pattern is broken by morainic ridges of coarse material, dunes, lakes, peat bogs, and alluvial bottomlands. Almost all of the agricultural area and all of the weather stations in the Valley are at elevations less than 500 feet above sea level. The soils of the Valley generally have developed from wind-sorted, silty, very fine, sandy materials laid over a base of water-sorted, coarse, glacial drift. The thickness of the fine materials—silt loam, fine sandy loams, and fine sand—overlying the gravel, cobble, and sand varies from more than 6 feet in the Palmer area to very thin deposits in and west of the Wasilla area [7]. Although there is no permafrost in the agricultural areas, the subsoil is too cold for deep extension of plant roots. The Valley floor is wooded with white spruce, birch, and aspen on the better drained and relatively warm sandy soils, cottonwood and willow in cool moist sites, and black spruce in the poorly drained areas. The ground cover consists of ferns, currants, high- and low-brush cranberries, wild rose, horsetail, bluetop, and dwarf dogwood.

In the winter months the mean atmospheric circulation pattern [16] shows northeasterly flow of continental air prevailing over the Valley; as a result, there is little precipitation or cloudiness, and the precipitation is almost wholly in the form of snow. With the short periods of sunlight at latitude 61.5° N. the winters are long and mod-

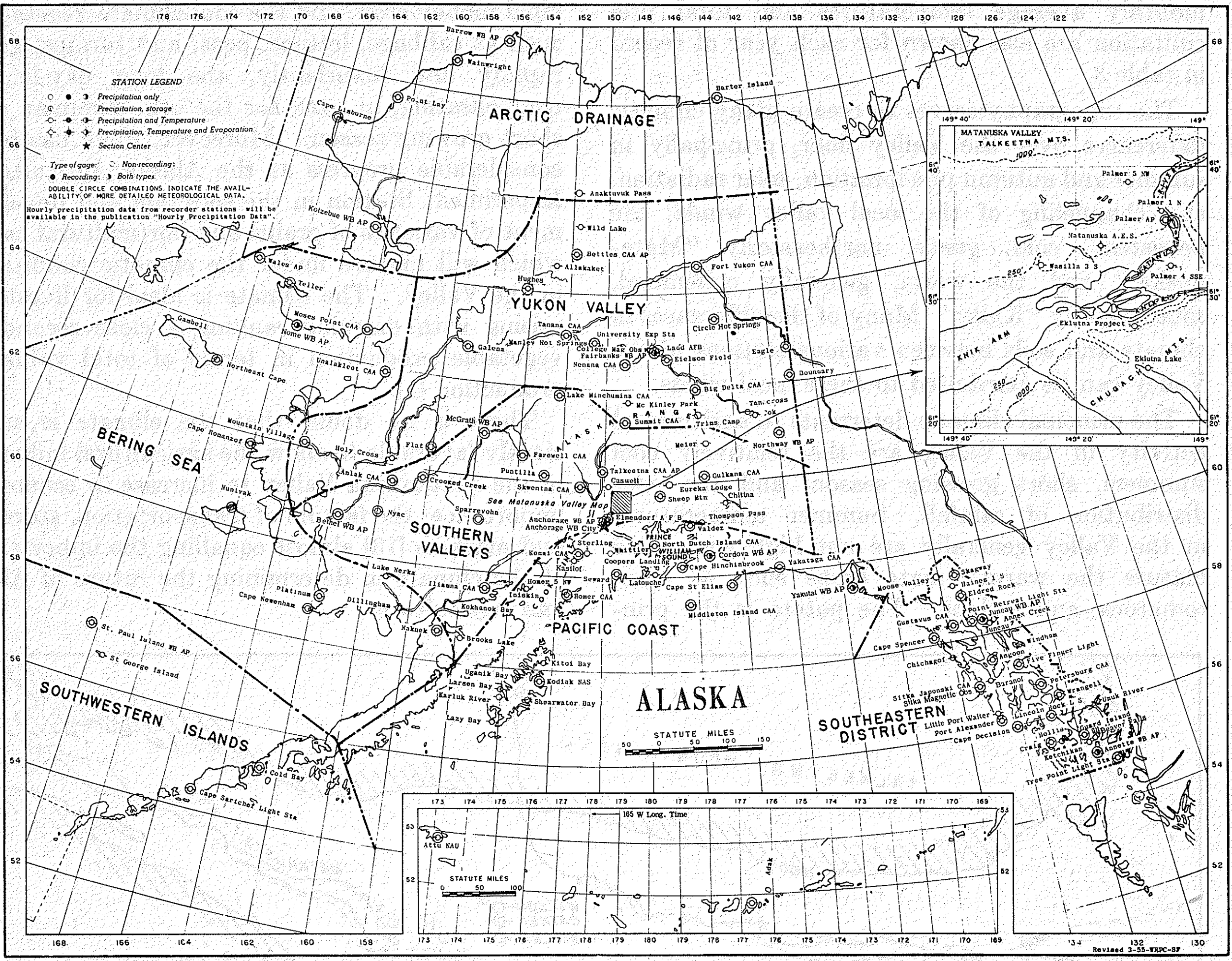

FIGURE 1.—Location of the Matanuska Valley in Alaska.

erately cold. January temperatures at the Matanuska Agricultural Experiment Station average about 13° F., or about the same as mean January temperatures in northeastern South Dakota, southern Minnesota, and central Wisconsin. The ground is usually snow covered from November through March except where the fields are blown bare by the cold gusty northeasterly winds, known locally as "Matanuskas." The prevailing flow changes slowly to easterly in April with the spring breakup beginning in late March or April. Spring is the driest and sunniest period of the year and, except for the 2- to 3-week period of breakup, the most pleasant. Under prevailing southwesterly circulation in the summer months cloudiness and precipitation increase; days are relatively warm and nights cool. July temperatures average about 58° F., about the same as those in the San Francisco area and almost 10° lower than July mean temperatures in northern Minnesota, Wisconsin, and Michigan. Days are long, and twilight continues all night at the summer solstice. The period from the last occurrence of freezing temperatures in the spring to the first occurrence in the fall averages about 100 days in the Valley with the average first occurrence of freezing temperatures ranging from August 29 at Wasilla and No. 15 to September 12 at No. 12. Generally in late October the first snow falls and, with rapidly shortening days, mean temperatures drop below the freezing point.

Table 2 provides a tabular summary of the temperature and precipitation means and extremes for the central Valley area throughout the year. The Climatological Summary is based on all available record at the Matanuska Agricultural Experiment Station from 1917 through 1952. For an idea of the variation from year to year, monthly average temperatures and total precipitation are also shown for each year of record in table 3.

The topography serves to create many climatic differences over the Valley floor, principally in summer and autumn precipitation, solar radiation, and channeling of the local valley winds: the persistent, cold, gusty, northeasterly "Matanuska," and the warm, generally ephemeral, southeasterly "Knik." Many of the differences in climate and soils between various sections of the Valley can be attributed to these local winds.

The principal climatic deterrents to agricultural activity in the Valley are the relatively cool summers, short growing season, and the poor distribution of rainfall. Summer temperatures in the Valley generally are not high enough to mature the warm-climate crops such as corn, tomatoes, and melons. The potato is the principal money crop; and the cool-climate vegetables such as cabbage, lettuce, peas, and turnips, grow rapidly and luxuriantly, the long day-length compensating, in part, for the cool summers and short growing season. Moreover, there has been considerable progress at the Alaska Agricultural Experiment Station in the selection and development of varieties of grains and horticultural crops which will mature under the climatic conditions in the Valley. The climate is ideal for livestock raising with dairying ranking a close second to vegetable production in terms of total value of production [1].

There is no doubt that the climate is sufficiently favorable to allow the agricultural industry in the Matanuska Valley to increase in economic importance; the factors of transportation, storage, and markets [13] almost equalling the importance of the climate in determining the future of Alaskan agriculture.

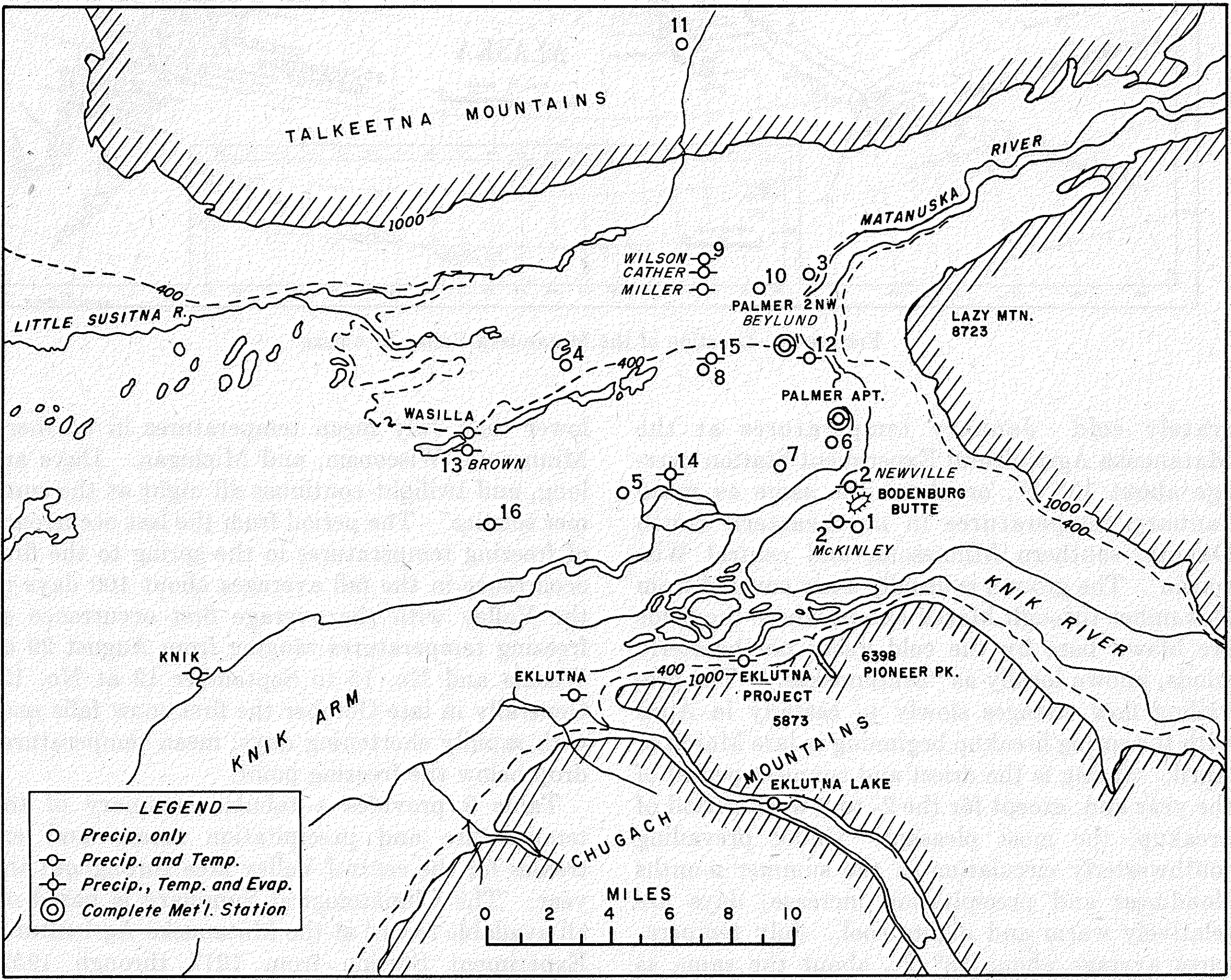

FIGURE 2.—Location of cooperative stations in Matanuska Valley, Alaska.

Table 2.—*Climatological summary, Matanuska Agricultural Experiment Station, Alaska, 1917–52*

	Temperature								Precipitation															Mean Number of Days					
	Means			Extremes												Snow, Sleet, Hail									Maximum temperature		Minimum temperature		
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days	Mean total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hours	Year	Mean total	Maximum monthly	Year	Maximum in 24 hours	Year	Maximum depth on ground	Year	Prevailing wind direction	Precipitation 0.01 or more	70° or above	32° or below	32° or below	0° or below	Month
(1)	32	32	32	32		32		32	32	32		32		32		32	32		32		32		32	32	32	32	32	32	(1)
Jan.	21.4	3.7	12.6	51	1945	−40	1947	1,618	0.94	2.89	1937	0.14	1920	0.92	1937	9.5	21.4	1944	9.0	1952	29	1951	NE	6	0	23	30	14	Jan.
Feb.	27.3	9.3	18.3	56	1943	−41	1947	1,308	.69	3.16	1932	T	1919	.84	1932	7.0	36.0	1932	8.5	[2] 1932	46	1932	NE	5	0	17	27	8	Feb.
Mar.	33.6	15.1	24.4	54	[2] 1930	−22	1925	1,259	.51	1.42	1930	.00	1932	.80	1931	6.5	23.8	1930	15.0	1930	14	1922	NE	5	0	12	29	4	Mar.
Apr.	45.5	26.9	36.2	66	1940	−16	1944	864	.43	1.64	1937	.00	[2] 1919	1.10	1937	2.3	17.5	1937	10.0	1937	18	1951	E	3	0	2	23	1	Apr.
May	57.8	35.7	46.8	83	1947	8	1945	567	.65	2.31	1931	T	1951	.83	1940	.3	5.3	1945	5.0	1945	1	[2] 1937	SW	5	1	(3)	9	0	May.
Jun.	66.4	43.7	55.1	91	1936	27	1947	297	1.31	4.62	1949	.16	1948	1.61	1949	.0	.0	----------	.0	----------	0	----------	SW	7	9	0	1	0	June.
July	67.7	47.4	57.6	85	1951	31	1934	233	2.01	3.91	1917	.55	1927	1.56	1926	.0	.0	----------	.0	----------	0	----------	SW	12	11	0	(3)	0	July.
Aug.	64.9	45.9	55.4	83	[2] 1923	27	1947	298	2.84	6.37	1944	.45	1940	1.20	1930	.0	.0	----------	.0	----------	0	----------	E	14	7	0	(3)	0	Aug.
Sep.	56.7	38.5	47.6	75	1934	16	1946	522	2.58	7.55	1925	.51	1941	2.48	1925	.2	7.0	1930	6.0	1930	(3)	1923	E	12	(3)	0	6	0	Sep.
Oct.	44.0	28.5	36.3	69	1923	−4	1935	890	1.72	4.61	1936	.39	1943	1.32	1921	3.5	18.0	1945	11.0	1945	11	1945	NE	9	0	3	21	(3)	Oct.
Nov.	30.0	15.0	22.5	58	1936	−22	[2] 1918	1,281	.93	3.71	1931	.04	1921	1.50	1931	6.9	23.2	1928	10.0	1937	15	1928	NE	6	0	17	28	5	Nov.
Dec.	21.5	5.5	13.5	55	1934	−34	1917	1,597	.98	3.81	1934	.04	1922	1.30	1934	9.2	27.5	1936	14.0	1925	18	1925	NE	6	0	23	30	11	Dec.
Year	44.7	26.3	35.5	91	June '36	−41	Feb. '47	10,734	15.59	7.55	Sept. '25	.00	Mar. '32 [2] Apr. '19	2.48	Sept. '25	45.4	36.0	Feb. '32	15.0	Mar. '30	46	Feb. '32	NE	90	28	97	204	43	Year.

[1] Average length of record (years). [2] Also other years. [3] Less than one-half. T=Trace.

TABLE 3.—*Monthly and annual average temperature and total precipitation, Matanuska Agricultural Experiment Station, Alaska, 1917–52*

Year	Average Temperature												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1917	------	------	------	------	------	------	55.3	56.6	45.3	32.6	13.8	—5.6	------
1918	10.6	12.4	15.9	33.2	44.4	55.6	60.2	54.0	48.3	34.7	16.2	14.2	33.3
1919	8.8	21.3	23.0	37.8	47.0	53.6	58.1	54.6	46.8	33.3	14.9	8.4	34.0
1920	4.5	27.4	16.5	29.2	44.2	52.4	55.2	53.0	44.3	33.2	19.8	13.5	32.8
1921	4.6	12.4	26.8	36.2	45.6	56.3	55.8	55.1	46.3	33.8	18.9	14.2	33.8
1922	13.8	14.4	17.6	35.0	45.2	54.4	55.6	53.2	45.2	40.7	22.6	12.6	34.2
1923	6.0	23.7	22.2	38.0	48.0	56.6	60.8	61.0	50.4	45.0	27.2	11.0	37.5
1924	16.0	17.2	33.4	28.4	47.1	56.5	56.6	54.6	45.5	29.8	28.6	8.0	35.1
1925	1.9	9.4	24.0	36.6	47.6	53.5	58.4	57.0	49.9	43.2	32.2	11.6	35.4
1926	30.0	19.8	38.8	44.5	51.6	56.8	------	56.6	50.8	41.4	29.0	14.6	------
1927	11.4	21.8	22.8	28.9	46.4	54.6	59.5	54.6	46.6	32.2	9.5	11.9	33.4
1928	17.4	25.6	20.8	36.5	46.6	55.6	57.0	54.4	44.7	35.4	26.2	24.0	37.0
1929	19.4	25.2	20.8	32.6	48.4	55.4	56.0	54.4	52.3	36.8	29.1	7.2	36.5
1930	11.4	6.0	21.8	35.0	45.3	53.4	58.2	57.0	44.8	32.4	20.0	26.8	34.3
1931	24.4	25.4	25.3	38.8	45.1	55.6	57.8	57.6	47.2	33.2	26.5	8.7	37.1
1932	—1.8	5.0	27.8	39.4	------	------	------	55.6	47.2	40.6	17.6	15.2	------
1933	------	13.0	21.6	36.6	47.9	54.0	------	------	------	------	------	------	------
1934	------	------	------	------	------	------	58.6	57.1	51.6	39.6	24.0	19.0	------
1935	------	------	------	------	------	------	58.4	54.4	47.4	32.4	20.5	16.4	------
1936	17.5	13.7	21.4	36.2	46.8	63.5	61.9	57.8	46.4	41.2	30.0	9.6	37.2
1937	19.4	8.8	24.6	35.5	46.1	54.8	56.8	53.0	50.0	41.0	22.7	13.2	35.5
1938	11.2	19.9	25.6	41.2	47.1	53.0	56.0	57.0	50.8	41.7	24.2	20.6	37.4
1939	12.2	20.4	22.8	37.0	46.0	54.8	57.4	52.6	47.0	29.6	18.4	20.5	34.9
1940	20.2	25.9	27.5	44.4	48.6	55.6	58.1	55.8	47.4	37.2	23.7	20.4	38.7
1941	12.0	28.4	33.5	42.1	47.0	56.4	56.2	59.0	48.6	30.9	18.0	17.2	37.4
1942	24.2	30.2	25.5	39.8	51.4	56.3	59.4	56.5	52.0	37.8	14.9	1.2	37.4
1943	7.1	25.4	24.0	37.8	48.2	57.6	56.9	55.0	47.9	39.6	31.8	26.6	38.2
1944	17.4	28.6	24.6	34.4	47.2	56.4	57.0	55.6	47.9	37.5	23.9	18.7	37.4
1945	25.7	24.4	24.1	33.0	43.8	53.0	56.0	53.2	44.8	33.7	13.2	13.0	34.8
1946	17.7	17.8	15.8	33.4	45.3	53.5	57.2	53.0	46.0	37.4	14.2	2.7	32.8
1947	—4.0	19.0	31.0	36.1	46.2	52.5	56.8	52.6	45.2	34.7	27.0	23.0	35.0
1948	16.8	13.2	22.8	33.7	48.1	56.4	56.6	53.0	45.4	36.2	15.4	4.6	33.5
1949	12.2	6.7	31.4	33.5	45.9	51.8	55.8	55.4	------	36.2	26.0	6.4	------
1950	3.8	9.2	29.7	------	------	53.7	57.1	58.2	48.2	33.3	------	------	------
1951	------	12.2	15.8	39.1	48.1	54.2	59.4	55.7	48.0	31.7	24.2	8.8	------
1952	4.7	21.0	25.3	35.3	43.1	54.0	57.9	54.7	47.1	38.8	33.8	19.6	36.3

Year	Total Precipitation												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1917	------	------	------	------	------	------	3.91	0.67	2.12	1.69	0.55	0.12	------
1918	0.72	0.61	0.34	1.41	1.10	0.64	.82	4.27	2.34	.54	.77	1.60	15.16
1919	.58	T	.09	.00	.27	.87	2.00	2.23	1.90	1.62	.46	1.42	11.44
1920	.14	1.76	.72	.06	.49	1.77	2.50	1.90	.58	.66	.67	.43	11.68
1921	.83	.08	.75	1.25	.81	1.10	1.57	3.93	1.80	3.57	.04	2.26	17.99
1922	1.45	.59	1.17	.80	.28	.92	3.27	2.41	1.54	1.77	1.01	.04	15.25
1923	1.47	.80	.47	.32	.21	.35	1.10	1.05	3.75	1.91	.97	.54	12.94
1924	.79	.41	.26	.92	.83	.71	.61	4.18	2.08	1.86	.07	.98	13.70
1925	.53	.17	.32	.20	.07	2.20	.70	3.06	7.55	1.88	.55	1.08	18.31
1926	.66	.10	.12	.05	.29	.65	3.57	2.32	2.21	1.36	.35	1.72	13.30
1927	.93	.95	.92	.37	.51	.75	.55	1.94	1.69	1.32	.10	1.22	11.25
1928	.55	1.23	1.34	.44	.29	1.33	1.71	2.05	3.29	.63	2.06	1.15	16.07
1929	1.07	1.88	.98	.53	.77	.52	2.51	2.09	2.69	2.48	1.05	.31	16.88
1930	.87	.46	1.42	.57	1.12	2.72	2.08	6.21	5.42	1.49	2.18	1.24	25.78
1931	.85	.39	1.08	.22	2.31	.72	1.42	2.11	1.44	3.36	3.71	1.32	18.93
1932	1.45	3.16	.00	.00	------	------	------	4.12	2.72	1.52	.17	.85	------
1933	1.16	.87	.23	.09	1.04	1.05	------	------	------	------	------	------	------
1934	------	------	------	------	------	------	1.77	5.09	1.54	.70	.14	3.81	------
1935	------	------	------	------	------	------	2.09	3.18	1.72	3.08	2.01	.54	------
1936	.68	.48	.65	T	.02	.50	2.88	1.72	.91	4.61	3.18	1.53	17.16
1937	2.89	.47	T	1.64	.72	1.60	1.16	3.81	1.24	1.06	1.29	.14	16.02
1938	.29	.85	.73	.04	.02	.71	1.26	2.10	1.64	1.58	.91	.48	10.61
1939	.44	.43	.50	.02	1.07	1.50	3.75	2.59	4.81	2.22	.53	.77	18.13
1940	.53	.07	.14	.66	1.54	1.23	1.15	.45	4.20	1.06	.11	1.34	12.48
1941	.31	.95	.20	.88	.97	2.10	1.94	.51	.51	1.48	.62	.60	11.07
1942	.36	.93	.64	.75	.47	1.07	2.45	3.05	4.53	1.47	.10	.30	16.12
1943	.66	.42	.62	.17	.51	1.84	1.59	4.42	3.69	.39	2.33	1.50	18.14
1944	2.00	.43	.33	.08	.74	1.84	2.28	6.37	3.58	1.51	.23	1.74	21.13
1945	.26	.85	1.04	.04	.79	1.87	2.86	3.92	2.88	3.48	.54	.05	18.58
1946	.44	1.20	.23	.15	1.71	.96	1.47	2.78	.78	1.52	.88	.48	12.60
1947	1.04	.23	.27	.13	.53	.41	.99	2.35	4.47	.84	1.05	.29	12.60
1948	1.38	.51	.67	.24	.17	.16	2.76	2.19	2.40	2.31	.96	.57	14.32
1949	1.86	.62	.18	.52	.03	4.62	2.35	3.11	------	.62	.28	1.53	------
1950	1.44	.00	.07	------	------	1.82	1.44	1.45	.68	.40	------	------	------
1951	------	.53	.05	1.00	T	2.99	2.90	3.33	3.19	1.34	.25	.80	------
1952	1.43	.29	.24	.05	.54	.52	3.06	2.53	1.97	2.88	1.60	.65	15.76

3. TEMPERATURE

Temperature data from the Matanuska Valley weather stations show considerable differences over the Valley floor, and conform to a general pattern. The differences between the mean daily maximum for each month at No. 14[3] and those at Eklutna, No. 2, No. 9, and No. 12 were computed using the same period of record for No. 14 which was available for each of the other stations; the differences for the mean daily minimum temperature also were computed. These differences are shown in figure 3, the abscissa, or line of zero departure, representing in figure 3A and 3B, respectively, the mean daily maximum and minimum temperatures at No. 14. The differences were then applied to the 1921–52 temperature normals at No. 14 to obtain for the other stations the adjusted mean daily maximum and minimum normals which are shown in table 4 and plotted for January, April, July, and October in figure 4. To give a more complete picture of the areal temperature distribution in the Valley, adjusted normals were also computed for Eklutna Project, No. 15, No. 16, and Wasilla although the length of record is somewhat shorter for these stations; the adjusted normals for No. 16 and Eklutna Project are based on just 3 years of record and are therefore only rough estimates of the true temperature normals for those stations.

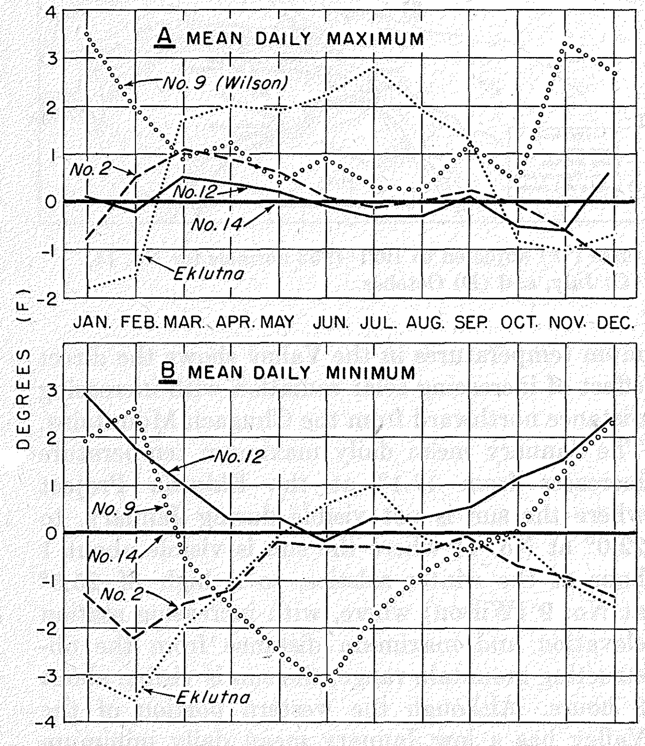

FIGURE 3.—(A) Differences between mean daily maximum temperatures at No. 14 and those at No. 2, No. 9, No. 12, and Eklutna based on common periods of records. (B) Differences for mean daily minimum temperatures.

TABLE 4.—*Mean daily maximum and minimum temperatures adjusted to No. 14 temperature normals 1921–52*

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean Daily Maximum (° F.)													
Eklutna	20.2	25.5	35.8	47.8	59.9	68.8	70.6	67.0	58.3	43.7	28.8	21.6	45.8
No. 2	21.2	27.5	35.2	46.7	58.6	66.7	67.7	65.1	57.2	44.5	30.3	21.0	45.1
No. 9 (Wilson)	25.5	29.0	35.0	47.0	58.4	67.5	68.1	65.3	58.2	44.9	34.2	25.0	46.5
No. 12	22.1	26.8	34.6	46.2	58.2	66.5	67.5	64.8	57.1	44.0	30.2	23.0	45.1
No. 14	22.0	27.0	34.1	45.8	58.0	66.6	67.8	65.1	57.0	44.5	30.8	22.3	45.1
Mean Daily Minimum (° F.)													
Eklutna	1.1	5.7	13.8	26.1	35.7	44.4	48.3	45.8	38.1	28.6	14.9	6.1	25.7
No. 2	2.8	7.0	14.3	26.0	35.6	43.5	47.0	45.5	38.4	28.0	15.0	4.9	25.7
No. 9 (Wilson)	6.0	11.8	15.3	25.7	33.3	40.6	45.5	45.0	38.2	28.7	17.2	8.5	26.3
No. 12	7.0	11.0	16.8	27.5	36.1	43.6	47.6	46.2	37.0	29.8	17.4	8.6	27.6
No. 14	4.1	9.2	15.8	27.2	35.8	43.8	47.3	45.9	38.5	28.7	15.9	6.2	26.5

The greatest temperature differences across the Valley are found in the winter months as typified by January in figure 4A. The southeastern side of the Valley, shaded by the Chugach Mountains from any direct sunlight and with its radiation inversion least disturbed by the northeasterly air drift and turbulent winds out of the Matanuska River Valley, is the coldest area in the Valley. The 3 years of record at Eklutna Project resulted in a January mean daily minimum temperature 6.5° lower than that for the same 3 years at No. 14 and 9.4° lower than the adjusted mean daily minimum temperature at No. 12 about 10 miles north of Eklutna Project. There are, of course, local frost pockets in the Valley in which lower temperatures may occur: at No. 13 (Wasilla) the station was located near the railroad depot in a low spot between the railroad and highway grades from 1941–43 and again in 1948–49, in which periods the January mean daily minimum temperature averaged 6.5° lower than the January mean daily minimum at No. 14 and 3.1° lower than the adjusted mean daily minimum temperature based on the other Wasilla locations. The railroad depot location was not used in computing the Wasilla temperature normals shown in figure 4.

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[3] Hereafter, for ease of reference, numbers only are used in referring to the Matanuska Valley weather stations.

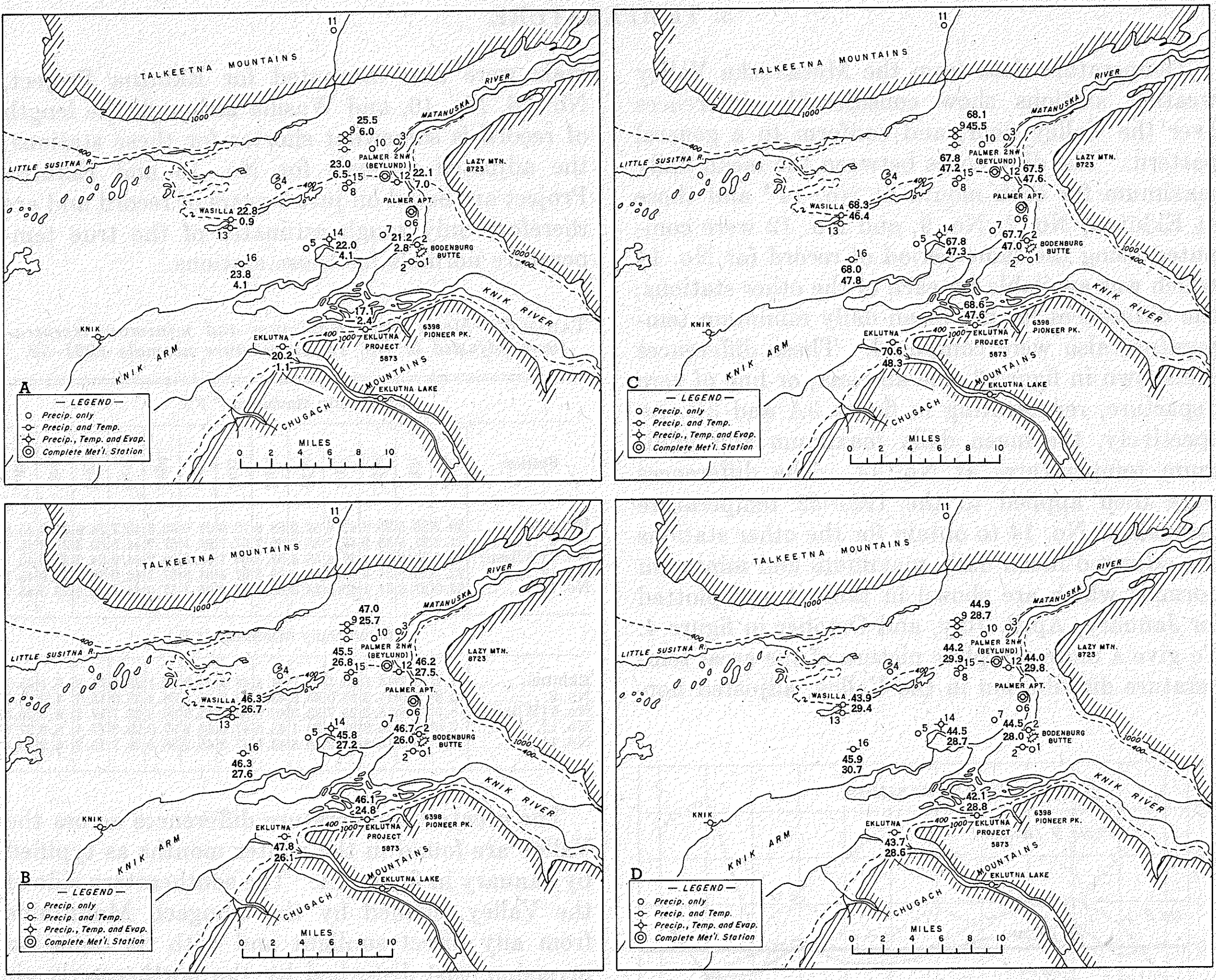

Figure 4.—Mean daily maximum and minimum temperatures (°F) adjusted to 1921–1952 normals for No. 14, for (A) January, (B) April, (C) July, and (D) October.

The highest January mean daily minimum temperatures in the Valley are found in the northeastern portion and are attributed primarily to the turbulence of the prevailing northeasterly Valley winds which mix the warmer air aloft with the cooler surface layers. With the exception of the better-developed Matanuska wind cases, the northeasterly Valley winds decrease in intensity and turbulence with distance from the Valley mouth resulting in stronger surface inversions and lower minimum temperatures in the western portion represented by Wasilla. Wasilla and Eklutna, with considerably shorter records than No. 14, have recorded the lowest extremes in the Valley with −50° and −47° respectively, both established in the late January and early February 1947 cold period.

The distribution of January mean daily maximum temperatures in the Valley shows the direct effect of increasing solar radiation with increasing distance northward from the Chugach Mountains. The January mean daily maximum temperature increases from 17.1° at the Eklutna Project where the sun is not visible during January, to 22.0° at No. 14 where the sun is visible about 1 hour at the winter solstice, to a high of 25.5° at No. 9 (Wilson) where, with increasing station elevation and maximum distance from the obstructing mountain range, the sun is visible about 3 hours. Although the western portion of the Valley has a low January mean daily minimum temperature it is also subject to longer sunshine with resultant higher mean daily maximum temperatures than in the southeastern portion and the greatest diurnal temperature range in the Valley. The smallest diurnal variation is observed at No. 12 where the mixing effect of the Valley winds is believed to be the major factor in keeping minimum temperatures relatively high and maximum temperatures low.

With increasing day length and sun elevation, transition to prevailing easterly and southeasterly flow, and increasing temperatures, the extreme temperature differences between stations observed in the winter months decrease in the spring as is shown in figure 3 and figure 4B. The April mean daily maxima exhibit a difference between the lowest at No. 15 and the highest at Eklutna of only 2.3°. As the sun's elevation and azimuth angles increase, the Chugach Mountains, which rise immediately behind Eklutna, receive and undoubtedly reflect considerable solar radiation and also protect the station from local turbulent winds, permitting temperatures to climb higher at Eklutna than at any other station. Although differences between the mean daily minima have also decreased considerably in April the same pattern experienced in January seems to exist: higher minima in a roughly northeast-southwest line through the central Valley area, and lower minima in the southern, southeastern, and northern portions of the Valley. With change from northeasterly to southeasterly flow, wind speeds and resultant mixing effect decrease in the northeastern portion of the Valley, and No. 9 in figure 3 shows the greatest decrease in minimum temperatures relative to those at No. 14.

In July (figs. 3 and 4C), under long hours of sunlight, the Eklutna area continues as the warmest in the Valley: daily maxima average almost 3° above those at No. 14. No. 9, least subject to winds in the summer months and at a slightly higher elevation than other stations, has the lowest mean minimum in the Valley; and the pattern of temperature differences between No. 14 and Eklutna and No. 14 and No. 9 are then completely reversed from that in January. The upward trend in the No. 9 temperature difference curve (fig. 3), or the marked warming relative to No. 14, is attributed to increasing cloud cover in July and August, and resulting decreased radiational cooling. As might be expected, departures from normal cloudiness may cause considerable deviation from the mean differences shown in figure 3— a clear night will not only result in lower temperatures than observed on a cloudy night but also greater temperature differences over the Valley.

In October the prevailing flow has backed to northeasterly; and although October, like April, shows little temperature difference over the Valley, the winter temperature pattern has been established (fig. 4D). Even in October mean daily maxima and minima in the southern and southeastern portion are the lowest in the Valley.

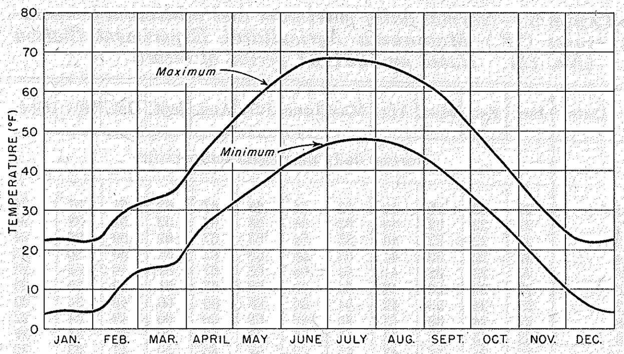

FIGURE 5.—Normal daily maximum and minimum temperature, for Matanuska Agricultural Experiment Station (No. 14) based on 1921–1952 period of record (table 5).

The annual march of normal daily maximum and minimum temperatures for No. 14, based on the period 1921–52 (table 5), is shown in figure 5. The curves were eye-fitted to the monthly normal daily maximum and minimum temperatures using the daily average maxima and minima from January through March 1921–40 for No. 14 and 1942–52 for No. 12 to help "shape" the January-March portion. Normal temperatures for other stations in the Valley may be estimated by applying the temperature differences in figure 3 to the No. 14 temperature curves in figure 5.

With the Valley located at the head of an arm of the Pacific Ocean, considerable temperature variation is both possible and likely during the winter months. Southwesterly flow over Cook Inlet or strong southerly and southeasterly flow over the Chugach Mountains and down the Knik River Valley as a warm chinook-type wind will bring warm air into the Valley. Temperatures rise above the freezing point on an average of 8 days a month in both December and January at No. 14, and temperatures of 50° or more have been recorded in each of the winter months. Even at Eklutna temperatures rise to or above the melting point on an average of 7 days in January. Conversely, temperatures as low as —20° to —25° may be expected at No. 14 some time during each winter; however, these low temperatures usually are of short duration. Minimum temperatures of 0° or below occur on an average of 14 days in January and an average total of 43 days a year at

TABLE 5.—*Normal daily maximum and minimum temperatures (°F.) Matanuska Agricultural Experiment Station (No. 14). Based on 1921–52 period of record*

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Normal daily maximum temperature											
1	22	22	32	39	52	64	68	67	62	51	37	24
2	22	22	32	40	52	64	68	67	62	51	37	24
3	22	22	32	40	53	64	68	67	62	50	36	24
4	22	22	32	41	53	65	68	67	61	50	36	23
5	22	23	32	41	54	65	68	67	61	49	35	23
6	22	23	32	42	54	65	68	67	61	49	35	23
7	22	24	33	42	54	65	68	66	60	48	34	22
8	22	24	33	43	55	66	68	66	60	48	34	22
9	22	25	33	43	55	66	68	66	60	48	34	22
10	22	25	33	43	56	66	68	66	59	47	33	22
11	22	26	33	44	56	66	68	66	59	47	33	22
12	22	26	33	44	56	66	68	66	58	46	32	22
13	22	27	33	45	57	67	68	66	58	46	32	22
14	22	27	33	45	57	67	68	65	58	45	31	22
15	22	28	33	46	58	67	68	65	57	45	31	22
16	22	28	33	46	58	67	68	65	57	45	30	22
17	22	29	33	47	58	67	68	65	56	44	30	22
18	22	29	34	47	59	67	68	65	56	44	30	22
19	22	29	34	47	59	67	68	65	56	43	29	22
20	22	30	34	48	59	67	68	65	55	43	29	22
21	22	30	34	48	60	68	68	64	55	42	28	22
22	22	30	35	49	60	68	68	64	55	42	28	22
23	22	30	35	49	61	68	68	64	54	41	28	22
24	22	31	35	50	61	68	68	64	54	41	27	22
25	22	31	36	50	62	68	68	64	53	40	27	22
26	22	31	36	50	62	68	67	64	53	40	26	22
27	22	31	37	51	62	68	67	63	52	40	26	22
28	22	31	37	51	63	68	67	63	52	39	26	22
29	22	-----	38	51	63	68	67	63	52	39	25	22
30	22	-----	38	52	63	68	67	63	51	38	25	22
31	22	-----	39	-----	64	-----	67	63	-----	38	-----	22
Mean	22.0	27.0	34.1	45.8	58.0	66.6	67.8	65.1	57.0	44.5	30.8	22.3
	Normal daily minimum temperature											
1	4	5	14	21	32	41	46	47	43	34	22	10
2	4	5	15	22	32	41	46	47	43	34	22	10
3	4	5	15	22	32	41	47	47	42	33	21	9
4	4	5	15	23	32	41	47	47	42	33	21	9
5	4	5	15	23	33	42	47	47	42	33	20	8
6	4	5	15	24	33	42	47	47	41	32	20	8
7	4	6	15	24	33	42	47	47	41	32	19	8
8	4	6	15	25	33	42	47	47	41	32	19	8
9	5	6	15	25	34	43	47	47	40	32	18	7
10	5	7	15	26	34	43	47	47	40	31	18	7
11	5	7	15	26	34	43	47	47	40	31	18	7
12	4	8	15	27	35	43	47	47	39	31	17	7
13	4	8	15	27	35	43	47	47	39	30	17	6
14	4	9	15	27	35	44	47	46	39	30	16	6
15	4	9	15	28	36	44	48	46	39	29	16	6
16	4	10	15	28	36	44	48	46	38	29	15	6
17	4	11	15	28	36	44	48	46	38	29	15	6
18	4	11	15	29	36	44	48	46	38	28	15	5
19	4	12	15	29	37	45	48	46	38	28	14	5
20	4	12	15	29	37	45	48	46	37	27	14	5
21	4	12	15	29	37	45	48	46	37	27	14	5
22	4	13	16	29	37	45	48	45	37	26	13	5
23	4	13	16	30	38	45	48	45	36	26	13	5
24	4	13	16	30	38	46	48	45	36	26	12	5
25	4	13	17	30	38	46	48	45	36	25	12	5
26	4	14	17	30	39	46	47	45	35	25	12	5
27	4	14	18	31	39	46	47	44	35	24	11	4
28	4	14	18	31	39	46	47	44	35	24	11	4
29	4	-----	19	31	40	46	47	44	34	23	11	4
30	4	-----	19	32	40	46	47	44	34	23	10	4
31	4	-----	20	-----	40	-----	47	43	-----	22	-----	4
Mean	4.1	9.2	15.8	27.2	35.8	43.8	47.3	45.9	38.5	28.7	15.9	6.2

No. 14. The spells of thawing temperatures in the winter are often accompanied by rain which, with below freezing ground temperatures, causes a glaze condition credited by agriculturists as one of the chief reasons for winter killing of perennial forage crops. A continuation of the warm weather when the soil surface has been blown clear of snow sometimes thaws the ground to depths of 2 to 4 inches which upon freezing breaks the roots of taprooted plants [5].

The mean daily maximum temperatures rise above the freezing point about the first week in March and the mean daily minima about the first week in May. The annual march of temperatures (fig. 5) shows a tendency for the lowest temperatures to occur in January and early February, then rapidly increasing temperatures in February, a leveling off in March, and rapidly increasing temperatures again in April. Breakup, or ground thawing, begins in late March and early April and proceeds fairly rapidly on well-drained south slopes but may continue through the month of May in some poorly drained areas. Agricultural

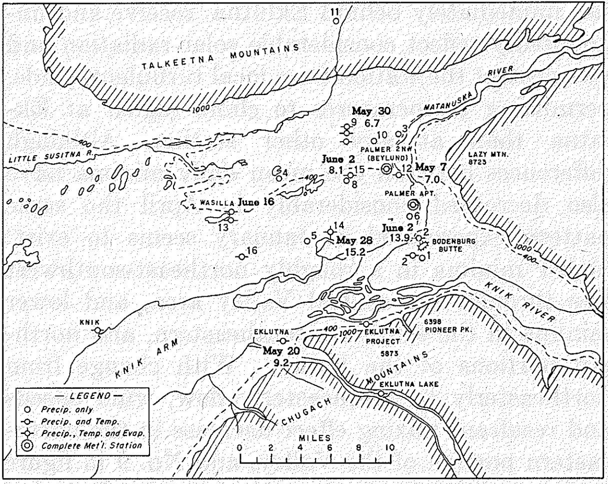

FIGURE 6.—Average date of last freezing temperatures in spring with standard deviation. (No standard deviation was computed for Wasilla which has only 5 years of freeze record.)

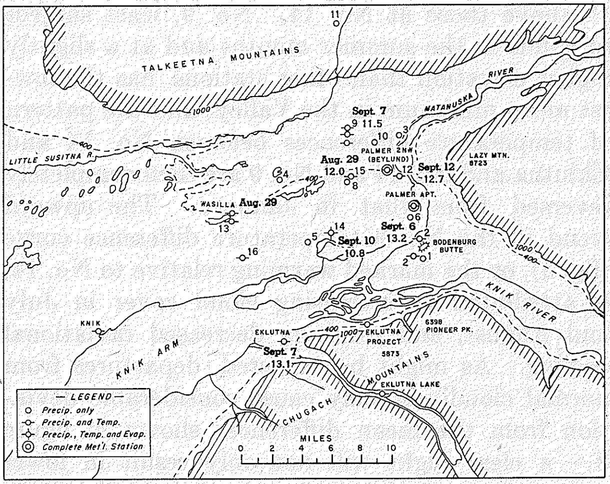

FIGURE 7.—Average date of first freezing temperatures in Fall with standard deviation. (No standard deviation was computed for Wasilla which has only 5 years of freeze record.)

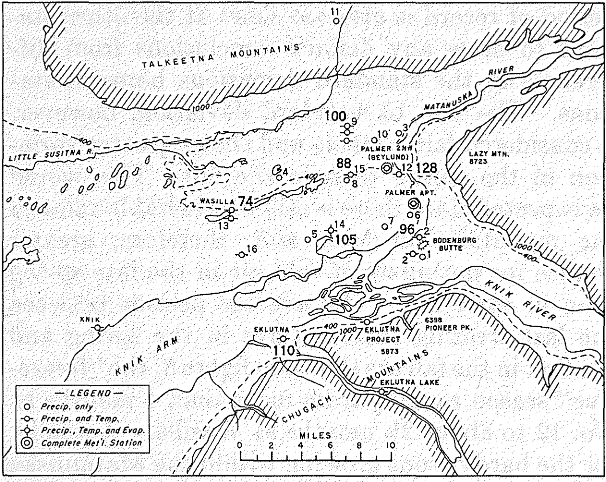

FIGURE 8.—Average length (days) of freeze-free season.

practices have also been used to speed the breakup. For example, Max Sherrod, observer at No. 12, plows as soon as he can get in the field, generally about mid-April when only a thin surface layer may be thawed. The increased absorption of solar radiation and aeration produced by this practice, together with a favorable soil texture of sandy loam and a very favorable climatic location, helps to make the Sherrod Gardens one of the earliest garden areas in the Valley with planting ordinarily carried out in middle to late April.

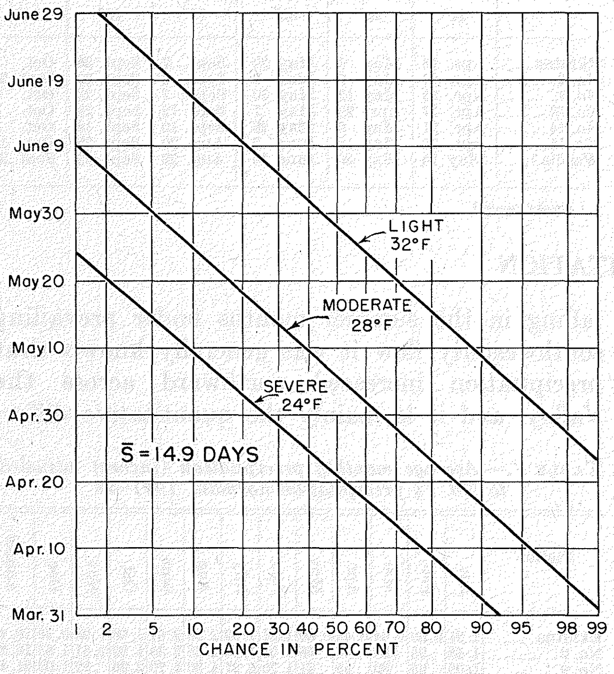

FIGURE 9.—Chance of indicated freeze after any date in spring at the Matanuska Agricultural Experiment Station (No. 14), based on 1917–1952 period of record.

Although July is the warmest month of the year at all stations in the Valley the highest temperatures may occur in June, and even in May, when there is usually less cloudiness and more chance of an extended period of sunshine than in July. At No. 14, temperatures have reached 80° or higher in about one-third of the Junes and in about half of the Julys of record but have reached 90° or above in only one June and never in July. The highest temperature recorded in the Valley is 91°, established at No. 14 in June 1936 and equaled at Eklutna on June 21, 1953. Temperatures reach 70° or higher on an average of 1 day in May, 9 days in June, 11 days in July, and 7 days in August, yet the record high for May is the same as that in August, 83°, and only 2° below the July extreme. July minima of 40° or lower occur almost every year, but minima of 35° or less have occurred in only 3 Julys in the period of record (1917–52); the record July low of 31° occurred on July 10, 1934.

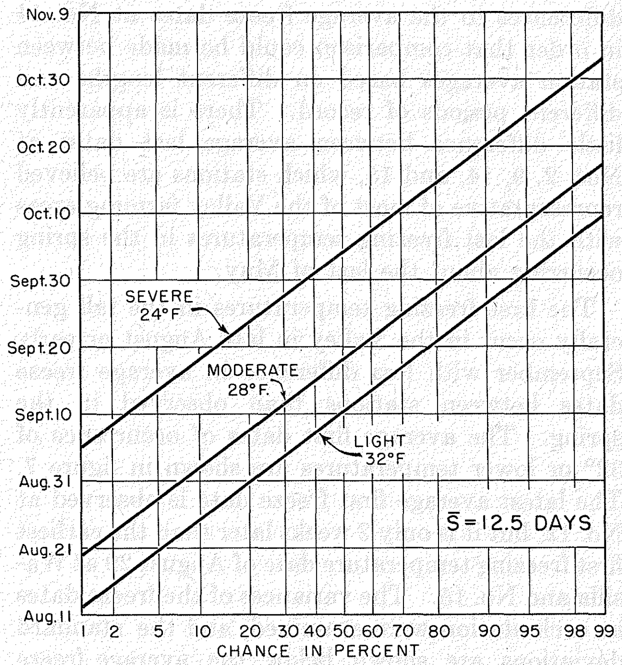

FIGURE 10.—Chance of indicated freeze before any date in fall at the Matanuska Agricultural Experiment Station (No. 14), based on 1917–1952 period of record.

With rapidly decreasing sunshine, temperatures at all stations fall rapidly in September, mean daily minima crossing the freezing line about October 7, mean temperatures about October 25, and mean daily maxima about the middle of November.

The average last dates of freezing temperatures in the spring show great differences between stations in the Valley. The slight turbulence caused by air drift down the Matanuska River Valley as it spills up and over the bluff at No. 12 results in the earliest average last date of freezing temperatures in the spring at that station, May 7, more than a month before the average last freeze date in the Wasilla area and about 2 weeks before the average last freeze date at Anchorage and Eklutna. Average freeze dates are shown in figure 6. All freeze dates were adjusted by a method of differences to the average freeze dates at No. 14 in order that comparison could be made between station averages based on different lengths and different periods of record. There is apparently little difference between average last dates at Nos. 2, 9, 14, and 15, which stations are believed representative of most of the Valley farming areas with the last freezing temperatures in the spring occurring about the last of May.

The first freezing temperatures in the fall generally occur in the Valley in late August or early September with less difference in average freeze dates between stations than observed in the spring. The average first dates of occurrence of 32° or lower temperatures are shown in figure 7. The latest average first freeze date is observed at No. 12, but it is only 2 weeks later than the earliest first freezing temperature date of August 29 at Wasilla and No. 15. The variances of the freeze dates at each station were examined, and the standard deviations are shown below the average freeze dates in figures 6 and 7. Since only 5 years of freeze record were available for Wasilla, standard deviations are not shown for that station, and the period of record is also too short at the other stations to draw any definite conclusions from differences in the standard deviations between stations. The No. 14 standard deviation, however, is considered fairly stable and shows greater variation in the spring than in the fall. This would be expected since there is still considerable snow in the mountains in May and, therefore, greater chance for outbursts of cold air in the late spring than in early fall. The average periods between the last freezing temperatures in the spring and the first in the fall are shown in figure 8, the "freeze-free" season ranging from more than 4 months at No. 12 to about 2½ months at Wasilla. Actually, for the hardy crops growing within the Matanuska Valley the first occurrence of 32° generally does little damage except to potatoes. Average first and last dates of 32°, 28°, and 24° are shown in table 6. Accumulated frequency curves showing the chance of freeze dates in spring and fall for 32°, 28°, and 24° for No. 14 are shown in figures 9 and 10. The curves were prepared on normal probability paper using an average of the three standard deviations for 32°, 28°, and 24° dates: $\bar{s}=14.9$ days for spring dates and 12.5 days for fall dates.

TABLE 6.—*Average first and last dates of 24°, 28°, and 32° F., adjusted to Matanuska No. 14 period of record, 1921–52*

Station	Last occurrence in spring			First occurrence in fall		
	24°	28°	32°	32°	28°	24°
Eklutna	Apr. 18	May 6	May 20	Sept. 7	Sept. 26	Oct. 5
No. 2	Apr. 23	May 9	June 2	Sept. 6	Sept. 20	Sept. 29
No. 9	Apr. 25	May 12	May 30	Sept. 7	Sept. 23	Oct. 5
No. 12	Apr. 17	Apr. 29	May 7	Sept. 12	Sept. 28	Oct. 8
No. 14	Apr. 21	May 6	May 28	Sept. 10	Sept. 18	Oct. 4
No. 15	Apr. 21	May 16	June 2	Aug. 29	Sept. 23	Oct. 10
Wasilla [1]	May 10	May 20	June 16	Aug. 29	Sept. 23	Sept. 28

[1] 4-year record.

4. PRECIPITATION

Normal monthly and annual precipitation amounts for the Valley stations, adjusted by ratio to the 1921–52 period of record at No. 14, are shown in table 7. Precipitation records for all locations of the Wasilla station were pooled to increase the length of record as were the Wilson and Cather locations for No. 9. The annual precipitation normals are plotted in figure 11. Although the average precipitation amounts for No. 16 and Eklutna Project have been entered on the chart for comparison, it is emphasized that 3 years of precipitation record hardly warrant the computation of an estimate of the normal precipitation. With maximum precipitation amounts falling in the summer months under prevailing southwesterly flow it was generally known that precipitation increased northward across the Valley, and it is mainly the quantitative differ-

TABLE 7.—*Average monthly precipitation (inches) adjusted to No. 14 precipitation normals, 1921–52*

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Eklutna	1.21	0.69	0.64	0.45	0.80	1.31	1.92	2.90	2.61	1.68	1.28	0.95	16.44
No. 2	1.48	.95	.80	.44	.56	1.01	1.66	2.38	2.38	1.90	1.61	1.65	16.82
No. 9	1.05	.95	.80	.55	.81	1.70	2.21	4.30	4.79	2.26	.89	1.09	21.40
No. 12	1.11	.71	.75	.50	.63	1.27	1.98	3.25	2.98	1.90	1.06	1.03	17.17
No. 14	.99	.68	.52	.42	.66	1.34	1.97	2.92	2.70	1.80	.97	.99	15.96
No. 15	1.35	.82	.80	1.09	.72	1.38	2.03	3.30	3.14	1.91	1.07	1.34	18.95
Wasilla	1.23	.91	.98	.64	.73	1.52	2.02	3.26	3.50	2.01	1.22	1.21	19.23

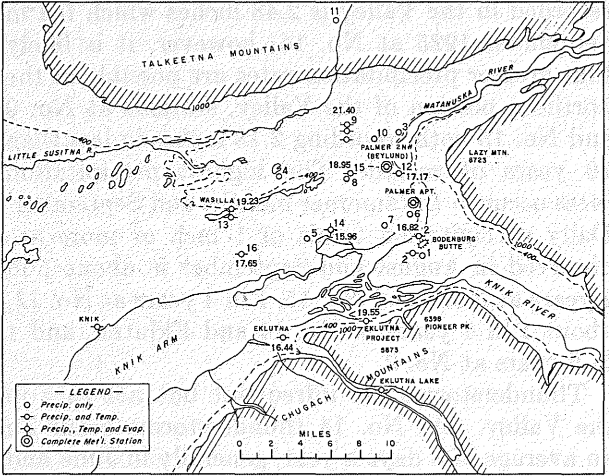

FIGURE 11.—Average annual precipitation (inches) adjusted by ratio to 1921–1952 period of record at No. 14.

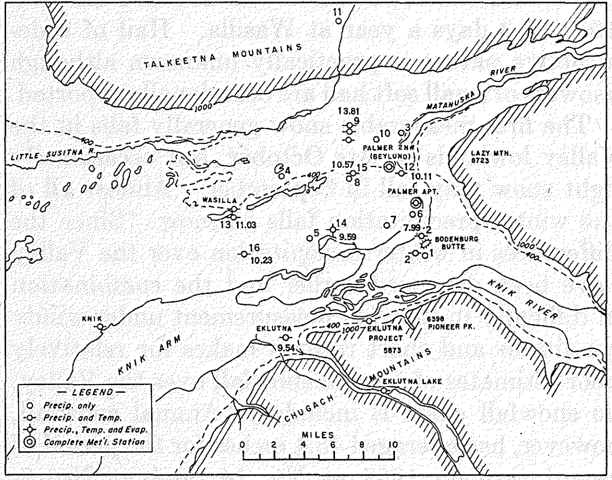

FIGURE 12.—Average warm-season precipitation (inches), May–September.

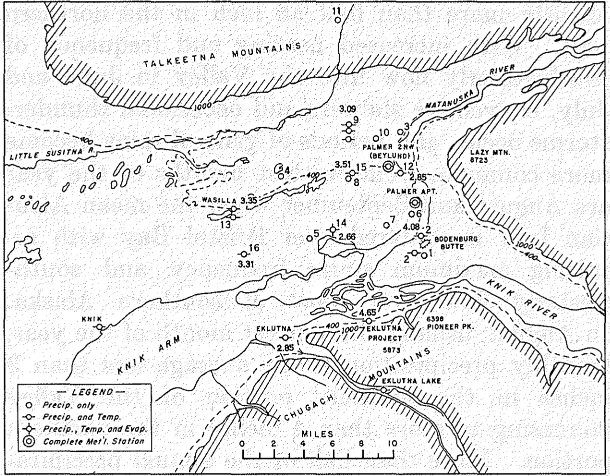

FIGURE 13.—Average winter precipitation (inches), December–February.

ences in the precipitation totals over the Valley which were brought out by establishment of the Valley network.

Precipitation amounts range from an annual accumulation of about 16 inches in the southern portion of the Valley to more than 21 inches at No. 9. The apparent dry area in the central Valley, as represented by No. 14, is believed due partially to orographic effects of the surrounding mountains causing slightly greater precipitation amounts around the perimeter of the Valley, and partly to the inherent difficulty in the measurement of snowfall at the more open stations in the windy areas of the Valley. In figure 12, showing the normal precipitation in the warm season (May–September), no dry area is evident in the central Valley, the only precipitation distribution tendency being the gradual increase with rising elevation northward. However, in figure 13, showing the precipitation received in the 3 winter months, a dry tongue extends southwestward from No. 12 to the northern end of Knik Arm with the lowest winter precipitation in the Valley recorded at No. 14. The heaviest winter precipitation is recorded in the southeastern portion of the Valley which is most protected from the strong Matanuska winds. The fact that the location of No. 14 is the most open of any station in the Valley suggests at least a portion of the smaller precipitation totals in the Matanuska wind path is due to difficulty in obtaining a proper estimate or catch of snowfall in the precipitation gage under drifting conditions. On the other hand, it is possible that the dry area is real, and that the increased winter precipitation in the southeastern portion of the Valley is partially due to "backwash" action—situations in which the air flow changes from southwesterly to more westerly and northwesterly flow which pushes the moist air trapped in the upper Knik Arm area against the Chugach Mountains, thus causing greater precipitation along the south and east sides of the Valley than in the central portion.

Winters are relatively dry, but the driest period of the year occurs in the spring months, usually in April when the mean position of the Aleutian Low is over Kodiak and the light easterly flow of dry air prevails over the Valley. Less than half an inch of precipitation is received in April at stations in the southern half of the Valley and slightly more than half an inch in the northern half. With increased heating and frequency of southwesterly flow into the Valley in June and July, convective showers and occasional thunderstorms occur, and periods of general rains become more common. The wettest months of the year are August and September when the mean Aleutian Low is centered over Bristol Bay with resulting maximum storm frequency and southwesterly flow over most of southern Alaska. In August, usually the wettest month of the year, monthly precipitation totals average less than 3 inches in the southern portion of the Valley increasing to more than 4 inches in the northern portion. More than half of the annual precipitation in the Valley falls in the 4-month period from July through October. The dry spring and wet summer and fall is the reverse of the precipitation distribution desired for grain and hay crops and that generally enjoyed in stateside agricultural areas.

There seems to be little variation in frequency or number of days with rain over the Valley, the precipitation differences arising primarily from increased amounts per storm in the northern portions of the Valley with about the same number of rainy days. The average number of days with 0.01 inch or more precipitation ranges from 3 or 4 days in April, the driest month, to about 14 days in August. The rains occur as light showers in the spring, becoming more frequent and persistent as the summer progresses until in August and September periods of drizzle lasting several days are common.

From weighing-precipitation-gage records at No. 14 (1936–43) and at No. 2 and No. 12 (1942–44 at both stations), it appears that in the rainy season the rains are most likely in early morning hours with the probability of rain decreasing to a minimum in the late afternoon and evening. In the 8 Augusts from 1936 to 1943 at No. 14 rain fell in the hour ending at 6 a. m., on 35 days, which is 14 percent of the days in August; the frequency of rainfall decreased after the forenoon to a minimum in the evening, rain occurring in each of the hours ending at 8 p. m., 9 p. m., and 11 p. m. on 24 days, about 10 percent. Although the hourly precipitation records for No. 2 and No. 12 are available only from 1942 through 1944 [17] and show a higher frequency of precipitation than No. 14's record, both stations show about the same diurnal pattern of precipitation as that observed at No. 14. The greatest 24-hour precipitation recorded in the Valley is 2.48 inches which fell in September 1925 at No. 14; however, it is likely that greater precipitation rates are possible in the northern portion of the Valley, stations at No. 9 and No. 15 both recording 2.18 inches in less than 10 years of record. The highest precipitation rates occur in the summer months and September. Daily precipitation totals of 1 inch or more are observed in August and September in about 1 in 2 years at No. 9 and No. 15, 1 in 3 years at No. 12, about 1 in 4 years at No. 14 and Eklutna, and 1 in 6 years at No. 2.

Thunderstorms are infrequent but not rare in the Valley. At No. 14 thunderstorms occur on an average of 3 days a year, generally in June and July. Although the records are much shorter for the other Valley stations, thunderstorms have occurred on an average of 1 day a year at Eklutna, No. 9, and No. 12; 2 days a year at No. 2 and No. 15; and 3 days a year at Wasilla. Hail of a destructive nature is practically unknown although showers of small soft hail are occasionally reported.

The first measurable snow generally falls in the Valley lowlands in late October, but occasionally light snow may fall in September. Almost all of the winter precipitation falls as snow. Since the differences in winter precipitation over the Valley have been discussed earlier and the combination of difficulty in snowfall measurement under windy conditions and short records makes for relatively poor estimates of normal snowfall over the Valley, no snowfall chart is included. Annual snowfall, however, has averaged 45.4 inches for the period of record through 1952 at No. 14; and at No. 2, generally the most sheltered station in the agricultural areas, the annual and seasonal snowfall from 1942 through 1951 averaged 49.2 inches. The greatest monthly snowfall usually occurs in January at all stations, January totals averaging from more than 12 inches at No. 2 and No. 12 to about 10 inches at Eklutna, No. 14, and Wasilla; all averages adjusted to the No. 14 record.

Although snow generally lies in the southeastern portion of the Valley most of the winter, snow cover in the remainder of the Valley is subject to drifting and often almost complete removal by the force of the local Valley winds. At No. 12, 17 inches of snow had accumulated on the ground by January 16, 1952; Matanuska winds on the 17th and 18th completely stripped all 17 inches of snow from cleared areas piling the snow in huge drifts in roads and brush and around buildings. On a day with high northeast winds the blowing snow is carried high in the air, and a considerable portion of the snow on the ground in the path of the Matanuska wind is undoubtedly blown completely from the Valley. At No. 14 the snow on the ground accumulates to a median monthly maximum depth of 4 inches in November, about 7 inches in January, and then slowly decreases to about 2 inches in April. In the southeastern portion of the Valley, least subject to drifting, although the record is much shorter, the median monthly maximum snow depth (above which the snow can be expected to accumulate about 1 in 2 years) at Eklutna is 4 inches in November, 19 inches in January, and 8 inches in April; and at No. 2 is 3 inches in November, 12 inches in January, and 6 inches in April. The maximum snow depths of record have generally occurred in either January or February and range between 2 and 3 feet for all stations except No. 14, which, with a longer period of record, has a maximum snow depth of 46 inches. The snow cover is usually gone from the cultivated lands in the Matanuska Valley by mid-April but may continue well into May in wooded areas and drifts.

5. DROUGHT

As one would expect from the seasonal precipitation pattern the probability of periods without precipitation is considerably greater in the spring than in the summer and early fall. The chances of experiencing 3, 5, and 7 consecutive days without measurable amounts of rain at No. 14 are shown in figure 14. The daily frequencies were "smoothed" by a 5-day running average. Although there may be minor variations in the expectancy of consecutive days without rain in the various sections of the Valley, it is believed that the drought frequency curves are generally representative of the entire Valley. The chart shows that the chances for three or more consecutive days without rain beginning on June 1 in the Valley are about 60 percent. The probability of the occurrence of three or more straight days without rainfall beginning on any specified day then decreases to about 37 percent on July 1, 26 percent on August 1, and about 24 percent on September 1. The probability of three or more day periods of rainless weather then increases to about 55 percent by the end of October. Similarly, the chance of a week without rain beginning on June 1 is about 28 percent and decreases to a minimum frequency of about 5 percent on September 1, or only about once in 20 years did a run of 7 dry days begin on September 1; the probability then increases to about 30 percent by the end of October.

With these frequency curves one can see the difficulties involved in hay curing and grain harvesting in the Matanuska Valley. To combat the reversed harvest weather pattern there is an increasing amount of barn-curing of hay and silage cutting of forage crops. A number of farmers seed oat-pea mixtures in late June; the hay crop is then cut late in September when the probability of dry periods is increasing [6]. The spring deficiency of precipitation generally is not as serious as the fall excess and, in fact, is conducive to an earlier and more rapid spring breakup than might be experienced under heavier spring rainfall. The spring precipitation deficiency is also offset by irrigation practices on a number of farms in the Valley.

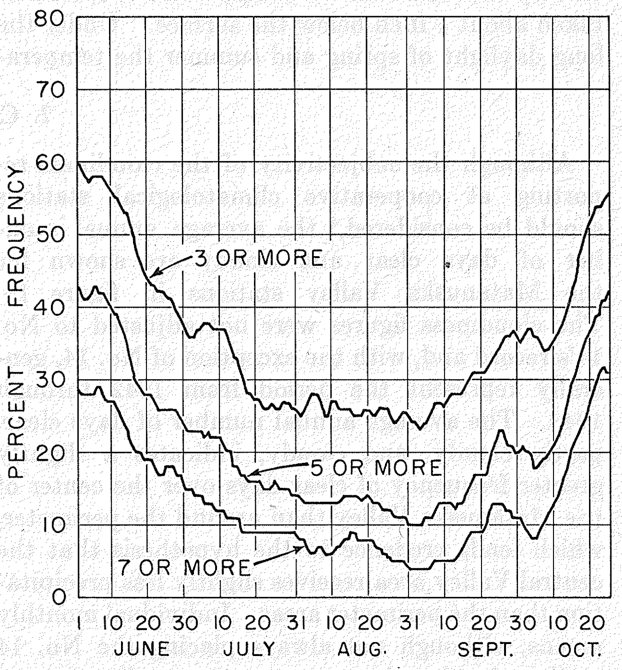

FIGURE 14.—Percent frequency of consecutive days without measurable precipitation starting on indicated day, at the Matanuska Agricultural Experiment Station, (No. 14). Based on period of record, 1919–1950. (After [2].)

6. EVAPORATION

Evaporation measurements have been taken at No. 14 (Matanuska Agricultural Experiment Station) since August 1, 1929, when a standard Weather Bureau pan and anemometer were installed. The average monthly evaporation and wind movement for the period 1929–52 are shown in table 8 with the years of record indicated for each monthly average. Only months of complete evaporation records were used. The averages show the trend which might be expected from the monthly precipitation distribution and drought expectancy curves, the evaporation being highest in the spring and decreasing through the summer. The maximum evaporation in any one complete month was 5.60 inches in July 1947 and the least, 1.34 inches in September 1929. Since ice, forming in the pan, generally prevents complete evaporation measurements in May and also October, the length of record for these 2 months consists of only 1 complete month in May and 2 incomplete months in October which averaged 27 days.

TABLE 8.—*Average monthly evaporation and wind movement at Matanuska Agricultural Experiment Station, 1929–52*

	May	June	July	August	September	October
Average evaporation (inches)	4. 86	4. 29	4. 17	2. 91	1. 78	0. 92
Average length of record, years	1	10	13	18	12	2
Average wind speed (m. p. h.)	4. 3	3. 5	2. 7	2. 4	3. 0	4. 2
Average length of record, years	5	14	13	18	14	7

A floating Six's-type maximum and minimum thermometer was installed in the evaporation pan on July 23, 1953 with the temperature of the water taken about 1 inch below the surface. Under the long daylight of spring and summer the temperature of the water in the 1953 and 1954 seasons was generally considerably higher than the air temperature: in May 1954 the water average daily maximum temperature was 8.5° above the air average daily maximum, and the water daily average minimum 3.7° above the air daily average minimum. In June 1954 the average water maxima and minima were 9.9° and 9.0°, respectively, above those of air; and in July, with increasing cloudiness, the differences had decreased to 5.7° and 6.5°, respectively, the temperature differences between the water and air average daily minima becoming greater than the differences between water and air average daily maxima in late summer and fall with the decrease in daytime insolation and outward long-wave radiation at night due to the increase in cloudiness.

7. CLOUDINESS

Although the subjectivity of the cloudiness reporting at cooperative climatological stations should be considered,[4] the average annual number of days clear and cloudy are shown for the Matanuska Valley stations in figure 15. The cloudiness figures were not adjusted to No. 14's record and, with the exception of No. 14, generally represent the period from 1942 through 1948. The average annual number of days clear, partly cloudy, and cloudy, indicates a slightly greater frequency of clear days over the center of the Matanuska Valley than around the perimeter, which lends credence to the hypothesis that the central Valley area receives slightly less precipitation than the perimeter areas. Individual monthly means, although not always placing the No. 14 station in the clearest area, generally showed slightly less cloudiness in the central Valley, and even though the cloudiness figures are a subjective statistic it is believed unlikely that the observers around the perimeter of the Valley would have uniformly different reporting criteria than those in the central Valley. At No. 14 the averages are 112 clear days a year, 79 partly cloudy days, and 168 cloudy days; at Anchorage the averages are 71, 90, and 204 days, respectively.

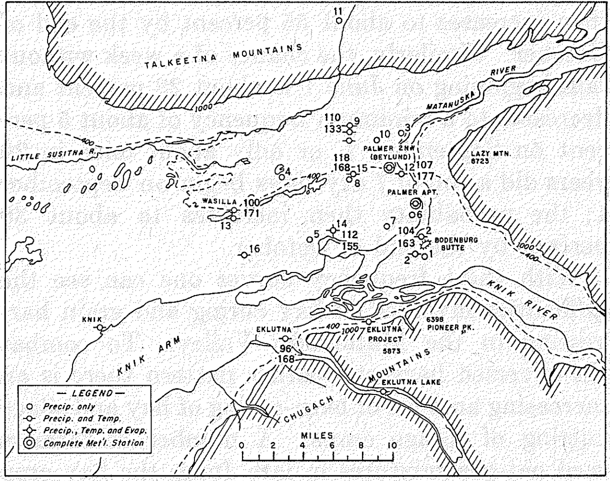

FIGURE 15.—Average annual number of days clear (top number) and days cloudy.

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[4] Cloudiness reporting was discontinued at climatological stations in 1949.

8. SOLAR RADIATION AND DAY LENGTH

No sunshine records are available for the Valley although it is believed that it receives slightly more sunshine than the Anchorage area. An Eppley pyrheliometer and Brown recorder were installed at No. 14 in May 1954 and should afford some interesting statistics with which to compare the solar radiation received in the Valley with that received in stateside agricultural areas.[5]

Although the record is too short for any comparison of average radiation values, it is interesting to note that half of the days in late June 1954 showed solar radiation amounts in the high 600's (langleys) and on June 26, 1954, a count of 706 langleys (gm cal/cm^2); even though the sun is at a lower angle than at more southern latitudes and is therefore less intense in its zenith, these radiation figures show that the longer periods of sunshine provide a total insolation equaling or exceeding that enjoyed by many stateside stations. The June and July 1954 weekly solar radiation means were roughly comparable with those of stations in the northwestern and northeastern United States.

There is a tremendous annual variation in day length and amount of possible sunshine in the Matanuska Valley. Between stations in the Valley, too, there are considerable differences in both day length and possible sunshine. Since the Valley is shaded from the sun by the Talkeetna Mountains on the north and the Chugach Mountains to the east and south, and since the sun is at a very low elevation through much of the year, the times of sunrise and sunset vary for each station in the Valley and are also considerably different from "sea level" times of sunrise and sunset. During the winter solstice the sun rises above a sea level horizon at 9:19 a. m. at an azimuth angle of 142° and sets at 2:49 p. m., giving an official day length of 5.5 hours. But, at No. 14 the sun is visible for only about an hour when it reaches an elevation angle of 5° at noon, while the extreme southern portion of the Valley, the Knik River area, receives no direct sunlight in midwinter. Although sea level twilight begins about 6:19 a. m. and ends at 5:37 p. m., the mountains reduce twilight period also and there is little light at No. 14 before 8 a. m. or after 4 p. m. Day lengths increase rapidly in the spring, and during the growing season outside activities can be carried on through most of the 24 hours: at the summer solstice sea level sunrise and sunset are at 2:15 a. m. and 9:48 p. m., respectively, resulting in a day length of 19.5 hours and twilight lasting all night; the sun rises above a sea level horizon at an azimuth angle of 32°, or about north-northeast, but does not rise above the Talkeetna Mountains until it reaches an azimuth of about 54°, reaches a maximum elevation angle of 51° at noon, and disappears behind the local timbered terrain at an azimuth angle of about 312° with sea level sunset at 328°.

The long day lengths help to offset the cool summers, and plant growth is much more rapid than in the northern States under higher temperatures but shorter day lengths. The long day lengths pose photoperiod problems in plant adaptation; biennials may produce seeds the first year, and some new plant varieties or strains have been developed to increase Valley yields.

9. LOCAL WINDS

Local wind conditions have been mentioned frequently as they affect temperature variation and the measurement of precipitation in the Matanuska Valley. Not only are the local winds of indirect importance as they affect the temperature and precipitation distribution but they also cause considerable soil erosion, property damage, and personal discomfort. The well-known "Matanuska" and "Knik" winds, technically, are not valley or glacier winds, but are winds caused by strong pressure gradient when the gradient becomes properly alined with the respective river valleys. The synoptic situation most favorable for Matanuska wind occurrences in the winter is also favorable for the formation of a cold air mass over the Copper River Valley; the cold pool of air, dammed by the divide between the Tazlina and Matanuska River drainages under strong easterly to northeasterly gradient flow, spills over into the Matanuska Valley in surges resulting in cold gusty winds over much of the Valley. Valley and glacier winds [3] also occur, and, although probably much more common than the extreme gradient-produced Matanuska and Knik winds, they are of less direct economic importance. It is believed, however, that both the Matanuska and the light valley

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[5] Solar radiation data for Matanuska Agricultural Experiment Station are, currently published with data from all other solar radiation stations in the monthly Climatological Data, National Summary, Asheville, N. C.

winds cause eddies near the bluff of the Matanuska River at No. 12 which are largely responsible for the comparatively warm winter nights and long freeze-free season at that station.

The speed of an extreme Matanuska wind at its central axis in the eastern Valley has not been measured, but the highest observed 1-minute wind speed at Palmer 2NW was 48 m. p. h. on January 23, 1951. An idea of the speed of a strong Matanuska wind is afforded by the totalizing anemometer on the evaporation pan support at No. 14 which recorded a total of 601 miles on April 4, 1945, an average hourly wind speed of 25 m. p. h. for the 24 hours at an elevation of about 2 feet above the ground. Strong northerly winds were also recorded at Anchorage on April 4 with a 5-minute maximum wind of 43 m. p. h. and gusts over 70 m. p. h. which did considerable damage to windows and roofs; at Elmendorf Field a pressure tube anemometer recorded a peak gust of 100 m. p. h. The observer at the Palmer Airport estimated winds to reach 80 m. p. h. in the Matanuska windstorm of January 25–26, 1953 [14] but there were no measured wind speeds recorded in the Valley in this storm; several roofs were blown off; a hay shed and garage were demolished in the Matanuska Valley; wind sandblasted neon signs in Palmer, driving some sand particles clear through the glass with breakage occurring when small pebbles carried by the wind hit the glass. In the same January 25–26 Matanuska, a fastest mile wind of 60 m. p. h. was recorded at Anchorage, the fastest ever observed at that station in January, with a maximum observed gust of 72 m. p. h. Considerable freeze damage to water pipes and drainage systems resulted from the unusually high Matanuska winds and subzero temperatures. Matanuska winds may remove most, if not all, of the protective winter snow cover from fields in portions of the Valley and cause considerable soil erosion.

Knik winds occur more frequently than Matanuskas but are of shorter duration and more local in effect. The highest Knik winds probably occur over the immediate stream bed of the Knik River near and below the Knik bridge where the low-level wind stream is occasionally reported so strong that it is difficult to drive cars over the bridge; yet there may be little or no wind several hundred feet from the approaches of the bridge. During the winter of 1935–36, while piling for false work was being driven on the Knik bridge, a Knik wind blew the pile driver off the false work into the river [6]. Well-developed or extreme Knik wind situations which affect most of the Matanuska Valley occur on only about 2 or 3 days a year causing considerable soil erosion and damage. An extreme example of a Knik wind occurred on October 23, 1954 [15], when a strong pressure gradient, channeled in the valley, produced winds in the southern portion of the Matanuska Valley which must have been on the order of 100 m. p. h. Large spruce trees were snapped off or uprooted in the Knik River area, and a house at Mile 38 on the Glenn Highway, which is just south of the Knik River bridge, was demolished with slight injury to the family.

Wind conditions in the Valley, therefore, have always been of utmost interest, and in the original planning of the climatic network it was hoped to learn the intensity, geographic extent, usual duration, direction, and frequency of the local winds, the Matanuska and the Knik. To study

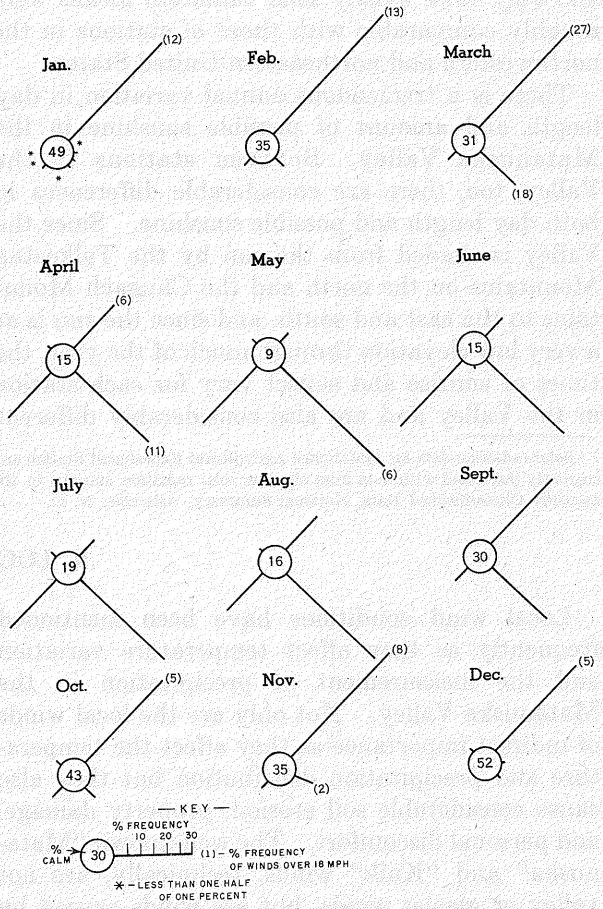

FIGURE 16.—Wind roses, Beylunds, Palmer 2NW, for period November 1948–January 1951. Number in parenthesis shows percentage of winds from that direction greater than 18 m. p. h.

the wind conditions 4 sets of wind equipment consisting of wind towers 20 feet high, Friez 1/60 contacting anemometers and Dozier mileage counters, and nonrecording wind vanes were installed at No. 2, No. 9, No. 12, and No. 14. With the exception of almost continuous records of daily miles of wind at No. 2 and No. 12 from December 1942 through July 1946 the wind records obtained from the totalizing anemometers were fragmentary and furnished little assistance to the study of the local winds. The average hourly wind speeds for No. 2 and No. 12 are shown in table 9 with the Anchorage 31-year average for comparison. Although the No. 2 and No. 12 monthly average wind speeds are based on only 3–4 years of record, the averages indicate that wind speeds are considerably lower at No. 2 than at No. 12 in the winter and higher in the summer.

TABLE 9.—*Hourly average wind speeds (m. p. h.)*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
No. 2	2.6	3.7	3.5	4.6	5.6	4.9	4.5	4.4	3.7	3.6	2.8	2.3	3.9
No. 12	6.1	5.9	4.7	5.3	3.9	3.0	2.6	2.4	2.6	4.6	5.7	5.1	4.3
Anchorage	5.2	5.8	5.8	5.5	6.1	6.0	5.4	5.1	5.3	5.4	5.1	4.9	5.5

The establishment of a second-order aviation weather station in the Palmer area in November 1948 furnished wind speed and direction data 3 times daily, 8 and 11 a. m. and 5 p. m., from November 1948 to the present and permitted the preparation of wind speed and direction frequencies. The station was first located at Beylund's residence, about 2 miles northwest of Palmer, and was in the path of the Matanuska wind. Since the wind conditions reported here were not representative of those observed at the Palmer Airport, less than 3 miles to the southeast, the second-order station was moved to the airport in February 1951. Although this move made both aviation weather station records short (about 3 years each), it made wind speed and direction data available on a thrice daily basis for two strategic points in the Valley. The wind roses for Palmer 2NW and the Palmer Airport are shown in figures 16 and 17 with wind speeds above 18 m. p. h. shown in parentheses at the ends of the lines. Although there is an evident bias toward the intercardinal directions at Palmer 2NW, the bias detracts little from the obvious predominance of the northeasterly and Matanuska winds in the winter and the change to southeasterly and Knik winds in the summer. The wind rose for the Palmer Airport, apparently located in an eddy near the confluence of the northeasterly and southeasterly wind flow channels, shows prevailing southeasterly and Knik winds in the spring and summer but more evenly distributed wind directions and lower wind speeds than observed at Palmer 2NW. The frequency of northeasterly winds during the winter months is greatly reduced from that at Palmer 2NW, and the Matanuska winds necessarily come from the more northerly directions at Palmer Airport than at Palmer 2NW.

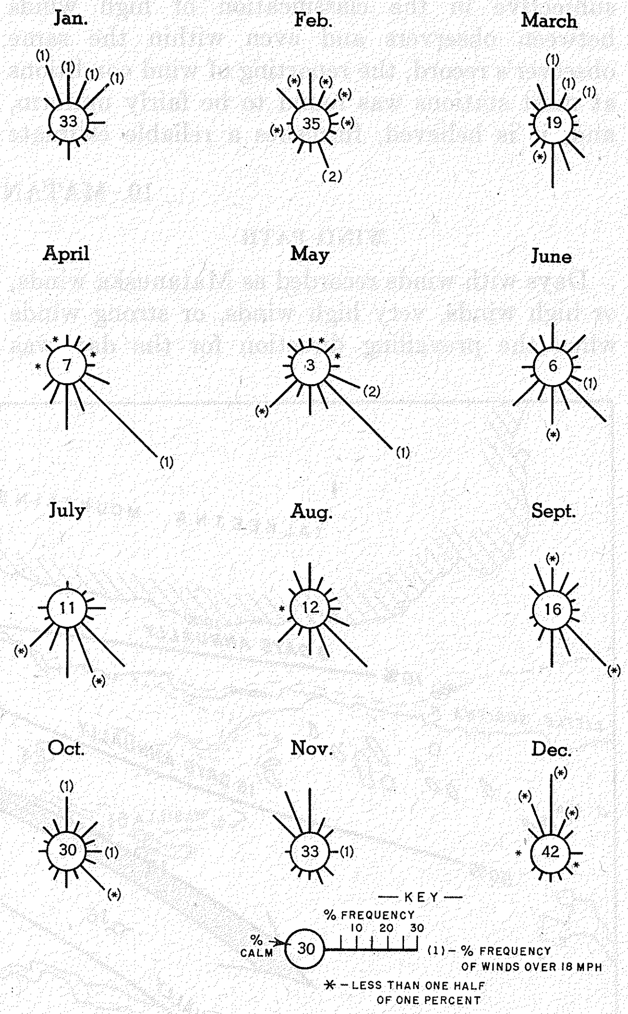

FIGURE 17.—Wind roses, Palmer Airport, for period February 1951–February 1954.

Since both the totalizing anemometers at No. 2 and No. 12 and the short station records of daytime wind speeds and direction at Palmer 2NW and Palmer Airport provide insufficient data for a detailed study of the wind condition, a study was made of the occurrences and duration of the local wind conditions from descriptive information or remarks entered on the Form 1009, Monthly Record of Climatological Observations. Although these basic observational data have the disadvantage of being more or less subjective in the classification of high winds between observers and even within the same observer's record, the reporting of wind conditions at most stations was found to be fairly uniform, and, it is believed, furnishes a reliable estimate of the path and characteristics of the Matanuska and Knik winds.

Matanuska No. 2 and No. 12 were selected as "control" stations for the Knik and Matanuska winds, respectively, since preliminary studies indicated these stations reported the majority of the respective winds. Since the format of the Form 1009 was changed, decreasing the emphasis of wind reporting effective with the January 1949 forms, the records used in the following wind analysis were generally those from July 1941 through December 1948.

10. MATANUSKA WINDS

WIND PATH

Days with winds recorded as Matanuska winds, or high winds, very high winds, or strong winds when the prevailing direction for the day was recorded as north or northeast, were listed for each station in the Valley regardless of the length of record. The number of days with Matanuska winds for each station was then compared to the

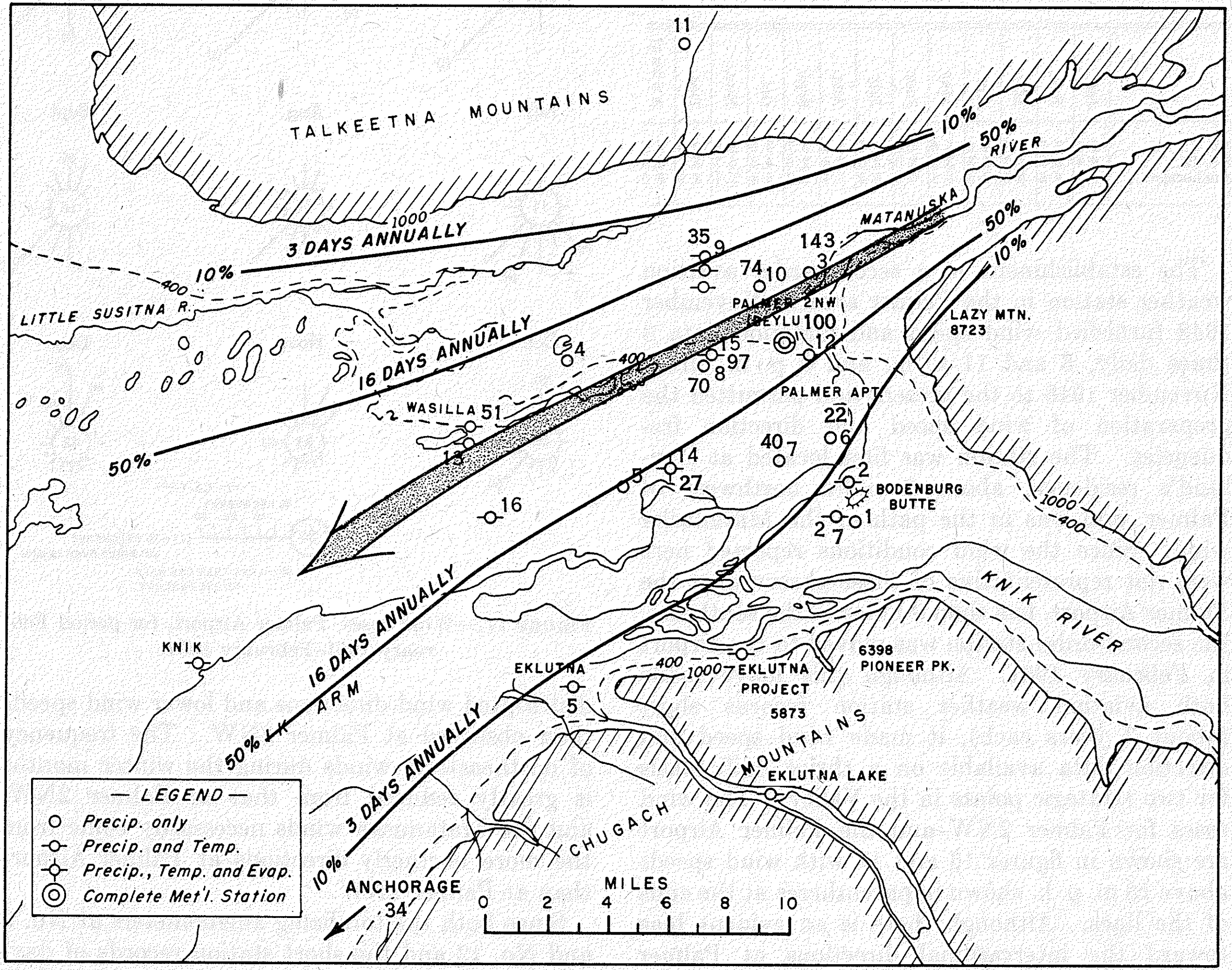

FIGURE 18.—Percentage of number of days of "Matanuska" winds reported at No. 12, and Matanuska wind path (July 1942–December 1948).

number reported over the same period at No. 12, the control station, and the comparison expressed as a percentage of the number of days of Matanuska winds reported at No. 12. For example, Matanuska winds were reported at No. 2 on 16 days in the period from October 1941 through December 1948, and in the same period Matanuska winds were reported at No. 12 on 224 days; therefore, only 7 percent of the number of days of Matanuska winds reported at No. 12 were recorded at No. 2. These percentages are shown for each station in figure 18 and the sketched 10 and 50 iso-percentile lines indicate the path of the Matanuska wind. Although not included on the map, Anchorage (Merrill Field) experienced about one-third of the days of Matanuska winds reported at No. 12. As an indication of the accuracy of the subjective wind reporting at the control station, it is interesting to note that *no* Matanuska winds were reported at No. 2 which were not reported at No. 12.

The percentages define the Matanuska wind stream fairly well in the eastern portion of the Valley, and information gained from new stations since 1948 seems to corroborate the path shown. Although the observational forms in use after December 1948 do not include the prevailing wind direction and no percentages were computed for these records, enough cases of Matanuska winds were found to show that the new location of No. 9 at the Cather Children's Home, about one-quarter mile south of Wilson's, shows a much greater frequency of Matanuska winds, probably approaching that at No. 12. The 4-month record (September-December 1941) at No. 3 shows a greater frequency of Matanuska winds than experienced at No. 12, and, although the record is extremely short, No. 3 is believed to be near the center of the path of the Matanuska wind. No. 12 is within the southern edge of the most frequent Matanuska wind path, and the present location of No. 9 is on the northern edge with the most common Matanuska wind streams then approximately 4 miles across at the eastern side of the Valley. It is in this eastern area that the full force of the Matanuska wind is felt.

The Matanuska wind path extends west-southwest over the lake chain in the Wasilla area, but the network of stations in the western portion of the valley is too meager to place any definite limits on the boundary of the wind stream. The 51 percent at Wasilla is believed to be great enough, considering the slightly decreased strength of the Matanuska wind with increasing distance from the Matanuska River Valley mouth, and the subjective nature of the reports, to place the station near the center of the wind stream. Records since 1951 indicate about half of the Matanuska winds reported at No. 12 were experienced at No. 16 which station was also placed within the 50 percentile path. In figure 18 the lines of 10 and 50 percent frequency correspond to about 3 and 16 days, respectively, with Matanuska winds each year. Although the heavy arrow shows the axis or most frequent path of the Matanuska wind, the wind does not always follow the same channel but varies somewhat with the direction of the gradient flow. It may blow only along the northern portion of the Valley affecting only No. 9, and on other days, when the flow is more northeasterly, the wind will affect stations at No. 12 and No. 14 but not No. 9. In most cases, however, when the Matanuska winds are experienced at the southeastern stations—Palmer Airport and No. 2—usually it is not so much the channel or path of the wind which has changed but the width, depth, and strength of the wind, and Matanuska winds are experienced throughout the Valley.

SYNOPTIC SITUATION

A study of the synoptic situation during reported Matanuska winds was hampered by the fact that the Northern Hemisphere Map series [12] was not yet available for the months between June 1939 and October 1945. Of the eight joint occurrences of Matanuska winds at No. 12 and No. 2, representing occasions of well-developed Valley-wide Matanuska winds, Northern Hemisphere maps were available for only 3 of the occurrences or 5 days. The synoptic maps for all 5 days showed the same basic pattern: a Low in the eastern Gulf of Alaska and high pressure over the interior with strong pressure gradient along and south of the Alaska Range. The five Low and High centers are plotted in figure 19 with the gradient flow in all five situations shown as an arrow. Similarly, the positions of the Lows and Highs were plotted for 22 days when Matanuska winds were reported at No. 12, No. 9, and No. 15, or the stations most frequently within the path of the Matanuska wind. The envelopes of these points, figure 20, show the Gulf Low in approximately the same position with slightly more scattering due to the increased number of observations and less limited conditions. A plotting of the High and Low centers for cases where Matanuska winds

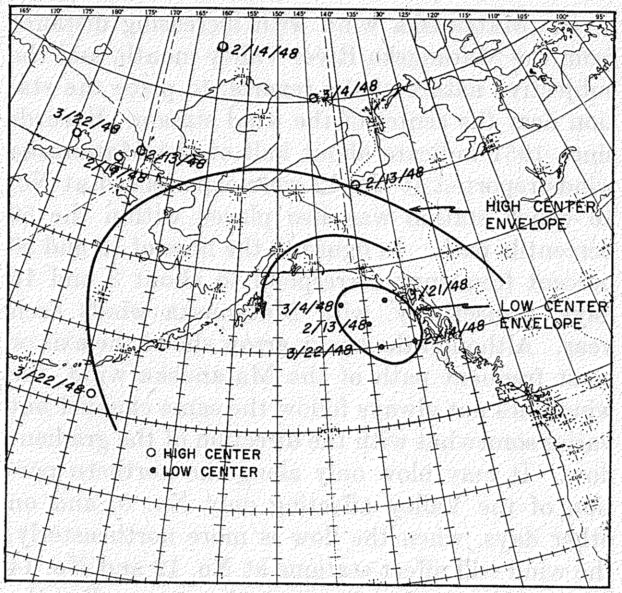

FIGURE 19.—Envelopes of low and high centers for days with Matanuska winds at both Palmer 1N (No. 12) and Palmer 4SSE (No. 2).

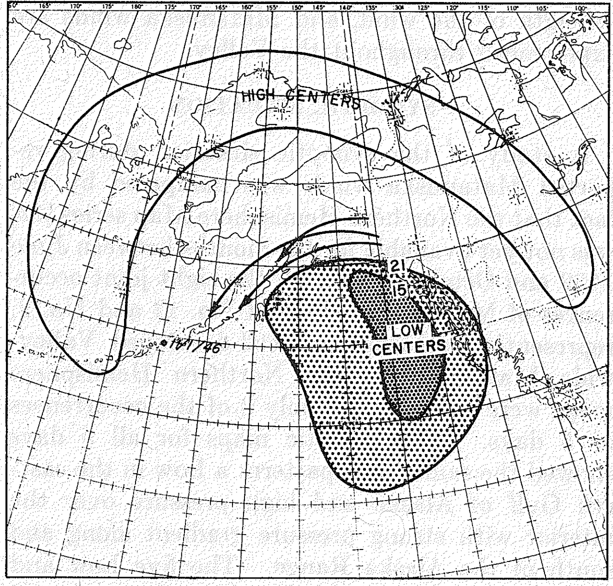

FIGURE 20.—Envelopes of low and high centers for 22 days with Matanuska winds at Palmer 1N (No. 12), Palmer 5NW (No. 9), and Palmer 4W (No. 15).

were experienced at either or both No. 9 and No. 15 but *not* at No. 12 provided a different pattern, however, as shown in figure 21, with a more westward position of the Low; the Lows also tended to be elongated east-west with a tendency for double centers providing for more easterly gradient over the Valley. Typical trajectories are shown by the arrows. Matanuska winds produced by this synoptic pattern will affect only the northern portions of the Valley, but the wind path may back as the Low moves eastward in the Gulf. Figures 19 and 20 show only the synoptic pattern and not the gradient strength which would of course be a necessary consideration in forecasting Matanuska wind occurrences.

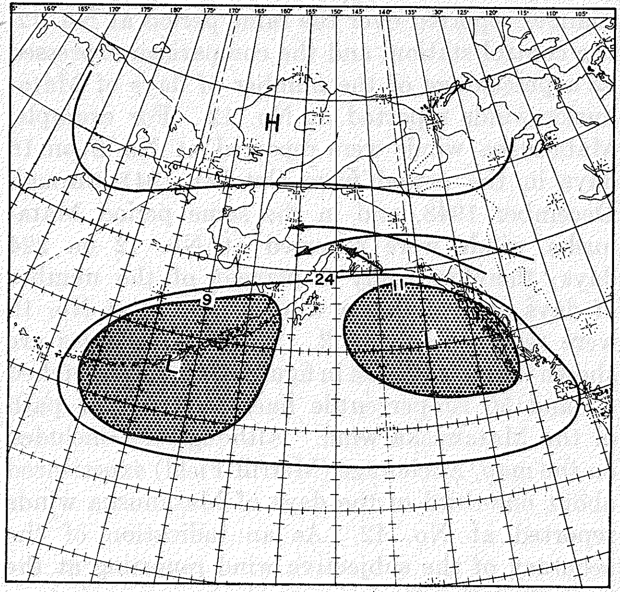

FIGURE 21.—Envelopes of high and low centers during 19 days of Matanuska winds at Palmer 5NW (No. 9) and/or Palmer 4W (No. 15) but not at Palmer 1N (No. 12).

FREQUENCY AND DURATION

Frequency and duration statistics of the Matanuska wind were compiled for No. 12 since that station has the longest and most consistent record of Matanuska winds. Matanuska winds have been observed in every month but are infrequent from May through August. With the movement of the mean position of the Aleutian Low from the northern Bering Sea in August to the Kodiak area in October, and with the concurrent cooling of the Copper River plateau, the number of occurrences of Matanuska winds increases in September and October, Matanuskas being experienced at No. 12 on an average of about 4 days in each of the months from October through April. The average number of days with reported Matanuska winds at No. 12 for each month are shown

TABLE 10.—*Average number of days with Matanuska winds at No. 12 (Palmer 1N), July 1941–December 1948*

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
3	6	4	4	<½	0	<½	1	2	3	5	4	32

in table 10. Matanuska winds occurred at least once in all but 4 of the 52 months, October through April, 1941–48. The greatest number of days with Matanuska winds in any month was in February 1944 when high northeasterly winds were recorded on 13 days during the month.

Out of a total of 120 separate occurrences of the Matanuska wind recorded at No. 12 in the period August 1941 through December 1948, the beginnings and endings of the wind conditions were sufficiently well recorded to obtain wind duration in hours for 101 of the reported cases. The wind duration data were compiled for each month and, although there appeared to be a tendency for the Matanuska wind to persist longer in the winter months than in the other three seasons, a Chi-square test, table 11, showed *no significant differences* in duration of the Matanuska wind between seasons. There were only four occurrences of Matanuska winds in the summer months which was an insufficient number to allow the summer season to be considered in the test.

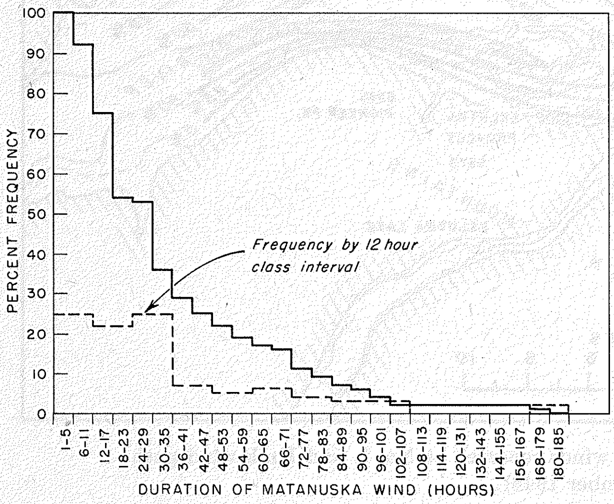

FIGURE 22.—Percent frequency that duration of Matanuska wind will equal or exceed indicated number of hours, based on 101 occurrences recorded at Palmer 1N (No. 12), August 1941–December 1948.

TABLE 11.—*Contingency table of duration occurrences of Matanuska winds at No. 12 by seasons*

Duration in hours	Winter	Spring	Fall	Total
<24	14	11	18	43
24 to 47	12	8	12	32
≥48	8	8	6	22
Total	34	27	36	97

χ^2=.879

The duration-frequency data for the 4 seasons, therefore, were pooled, and a cumulative frequency of the persistence of Matanuska winds equaling or exceeding a given time period is shown in figure 22. Almost half of the Matanuska winds continued for less than 24 hours, and about 9 out of 10 continued for less than 72 hours. The longest recorded duration of the Matanuska wind at No. 12 was 178 hours (January 30–February 6, 1944) and the shortest duration was 3 hours (October 23, 1943); there were seven occurrences of durations of about 4 hours each which were recorded in all seasons. None of the four Matanuska winds recorded in the summer months persisted longer than 24 hours.

It is emphasized that the foregoing statistics on the frequency and duration of the Matanuska wind are based on the reported occurrences at No. 12, and if data were available for the center of the wind stream *at all times* the wind frequency undoubtedly would prove greater and the duration longer.

11. KNIK WINDS

WIND PATH

Days with recorded Knik winds, or high winds, very high winds, or strong winds when the prevailing direction for the day was given as southeast or east, were listed for all stations in the Valley. The number of Knik winds at each station, regardless of length of record, was then compared to that at No. 2, the control station, for the same period of record, and the comparisons, or ratios, expressed in percent are shown in figure 23. For example, from November 1941 through December 1948, 81 days of Knik winds were recorded at No. 12, and in this same period a total of 362 days with Knik winds were recorded at No. 2; thus, about 22 percent of the number of days with Knik winds recorded at No. 2 were reported at No. 12. As an indication of the accuracy and completeness of the subjective reporting at No. 2, the control station, it is interesting to note that on each of the 81 days on which Knik winds were reported at No. 12 Knik winds were also reported at No. 2 except for 3 days, and on 2 of these days Knik winds were reported on adjacent days. Since Newville, observer at No. 2, reported Knik winds when dust clouds were observed on the lower Knik River bar, in addition to those actually experienced at his station, it is believed that the count of Knik winds at No. 2

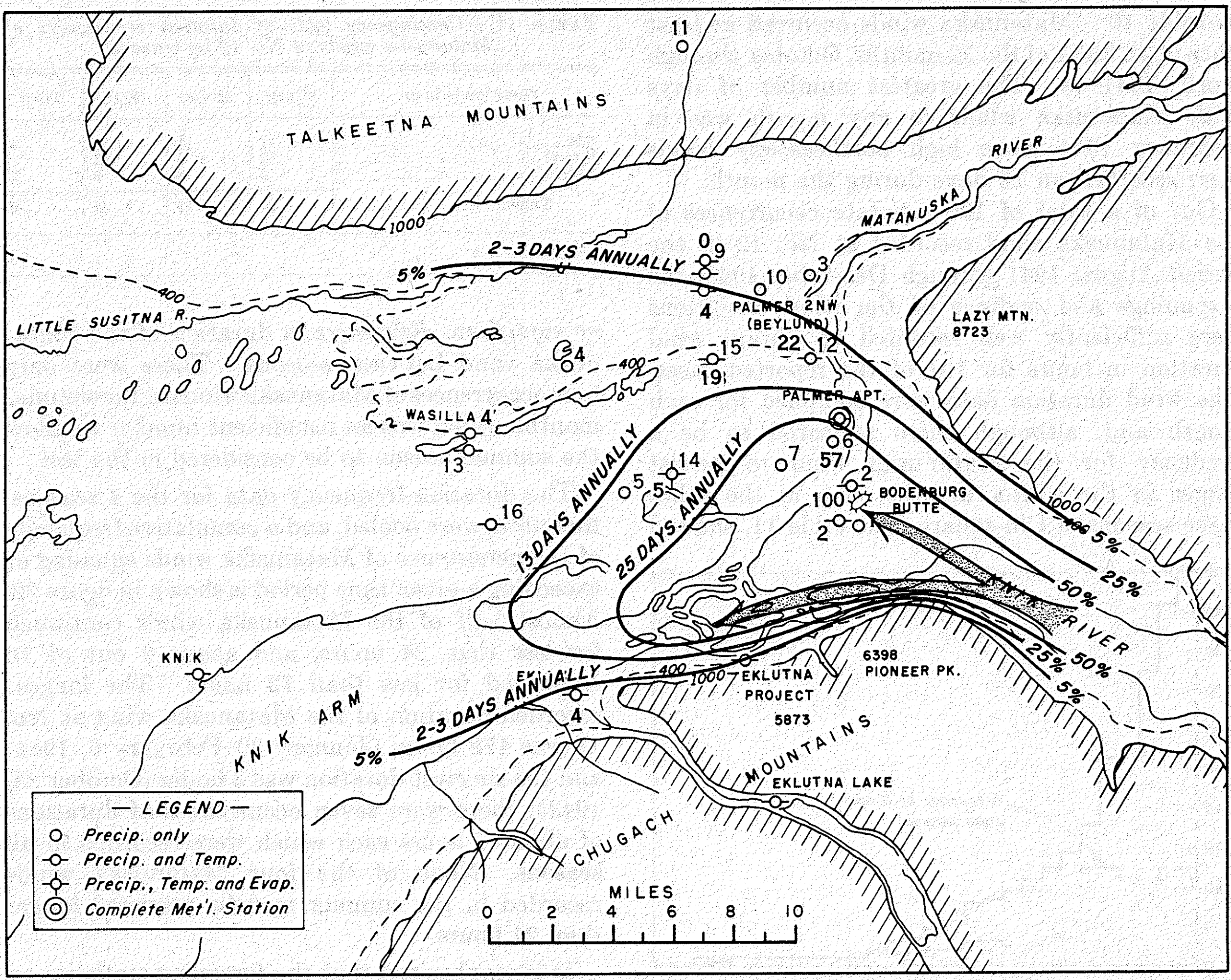

Figure 23.—Percentage of number of days of Knik winds reported at No. 2, and Knik wind path (July 1942–December 1948).

approaches the true frequency of the wind condition; however, the 100-percent figure assigned to the control station, then, is misleading, and the percentage of Knik winds actually experienced at No. 2 is unknown. The figure of 5 percent at No. 14 is probably biased considerably below the true frequency at that station since Knik winds were not sufficiently described on the observational forms for tabulating, and the only wind records used were twice-daily wind speed observations taken at 8 a. m. and 4 p. m. from April 1942 through December 1944. Thus, many Knik winds could have occurred between the observations.

In figure 23 the approximate path of the Knik wind is shown by the 5, 25, and 50 iso-percentile lines representing, respectively, 3, 13, and 25 days annually with Knik winds. The most frequent path of the Knik wind is down the Knik River with the width of the wind path limited primarily to the width of the river bed. This most frequent occurrence of the Knik wind is evidenced by clouds of dust on the lower Knik River flats but causes little damage and is generally felt only at the Knik River bridge and a few farms immediately adjacent to the river in the vicinity of the bridge; it requires little gradient and is generally spent by the time it reaches Knik Arm. Unlike the Matanuska wind the Knik wind is usually of short duration, relatively shallow, and does not maintain itself as a stream across the Valley. Under strong southerly to southeasterly gradient, however, Knik winds become stronger and more extensive, affecting most of the southeastern quadrant of the Valley about 10–15 days a year. Dr. Lee McKinley, at whose farm the No. 2 station is presently located, and who commutes by small plane daily between Anchorage and No. 2 whenever weather permits, estimated the top of the Knik wind stream over the Knik River at between 1,000 and 1,500 feet.

He also indicated that except for the strongest occurrences the Knik wind does not have the turbulence of the Matanuska wind stream and, since his private runway is oriented southeast-northwest, he has encountered little difficulty in landing in Knik winds of 20–30 m. p. h.

SYNOPTIC SITUATION

Northern Hemisphere maps [12] were available for only 20 days when Knik winds were reported at both No. 2 and No. 12. The Low and High centers were plotted in the same manner described for Matanuska wind occurrences; envelopes enclosing these centers are shown in figure 24. All cases of high southeasterly to easterly winds in the Matanuska Valley showed basically the same pattern—a low index situation with a north-south elongated Low centered near Dutch Harbor, high pressure over the eastern Gulf and Canada, and strong southerly to southeasterly flow over a long Pacific trajectory. Therefore, rather than the Knik wind gaining its warmth as a typical chinook wind, to which cause the higher temperatures have commonly been attributed, the Knik is essentially a warm wind because of its long Pacific trajectory. Certainly, however, the downslope or chinook effect serves in further increasing the temperatures, and under strong southerly flow in the winter months temperatures in the Matanuska Valley are often higher than those at Pacific Coastal stations.

Table 12.—*Average number of days with Knik winds*

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Length of record
No. 2	3	4	3	6	9	6	3	2	5	3	3	3	50	10 years.
No. 12	1	1	<½	<½	3	3	1	<½	1	1	1	<½	12	7 years.

Since reports of Knik winds at No. 12 were a necessary condition for the selection of the cases on which figure 24 is based, it follows that the synoptic pattern is typical of the stronger Knik wind situations which affect the southeastern quadrant of the Valley about 10 to 15 days a year; however, the gradient would, of course, be a necessary consideration in forecasting the extent and intensity of the Knik winds in the Valley.

FREQUENCY AND DURATION

Knik winds were reported in all but 14 of the months from November 1941 through December 1951 or in almost 90 percent of the months. Knik winds may occur in any month but are most frequent in May when the mean sea level pressure map [16] showing a Low centered just north of Unimak Island, corresponds more closely than that of any other month to the synoptic situation associated with Knik winds. The average number of days with recorded Knik winds at No. 2 and No. 12 are shown in table 12. The length of record was extended through 1950 at No. 2 through use of the observer's personal records [8] on which he recorded supplementary wind information.

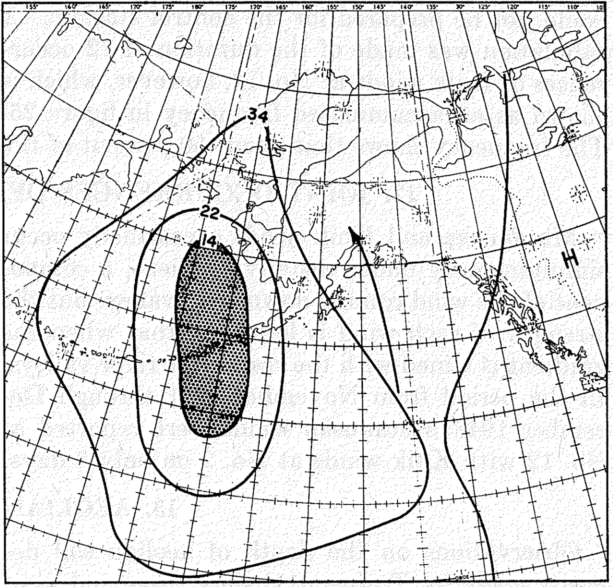

Figure 24.—Envelopes of high and low centers for 20 days when Knik winds were reported at both Palmer 4SSE (No. 2) and Palmer 1N (No. 12).

Times of beginning and ending of Knik winds were recorded at No. 12 but not at No. 2. Therefore, a frequency of the duration of Knik winds

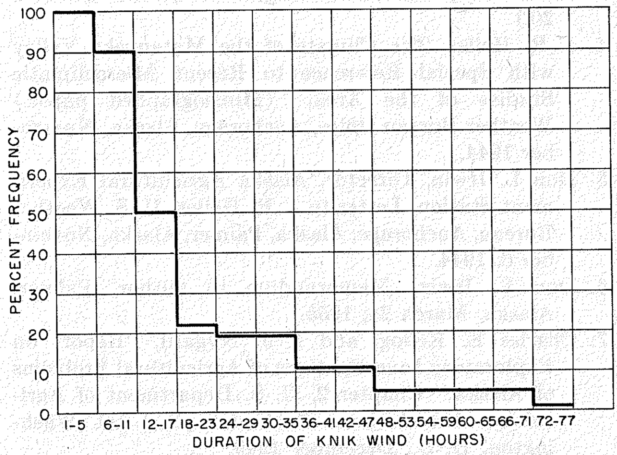

Figure 25.—Percent frequency that duration of Knik wind will equal or exceed indicated number of hours, based on 72 occurrences recorded at Matanuska No. 12, August 1941–December 1948.

could not be prepared for the control station. A tabulation was made of the duration of 72 occurrences of Knik winds at No. 12, however, which is shown as an accumulated frequency in figure 25. The frequency shows that about 50 percent of the Knik winds lasted less than 12 hours, 80 percent less than 24 hours, and 95 percent less than 48 hours. The longest wind duration was about 72 hours on May 20–23, 1947, which wind caused considerable soil erosion at No. 12.

12. JOINT OCCURRENCES OF MATANUSKA AND KNIK WINDS

Matanuska and Knik winds occasionally occur simultaneously under easterly gradient, a component of the wind coming down each valley, but the strength of each wind is less than that when the gradient is alined with the respective river valleys. In the period from November 1941 through December 1948 Matanuska winds were reported at No. 12 with Knik winds at No. 2 on only 8 days, and only on 3 of these days could the occurrences be determined as simultaneous. It is far more common for the Knik wind to precede the Matanuska wind as the Low (fig. 24) moves east-northeastward from the eastern Aleutians to the eastern Gulf (fig. 20) and the flow backs from southerly to northeasterly.

13. AEOLIAN SOIL DEPOSITS

Observations on the depth of aeolian soil deposits made by Trainer [11] show loess and sand deposits up to a maximum of 40 feet on the river bluff about 1 mile north of No. 12 with loess deposits thinning rapidly to the southwestward with the central axis of maximum deposit over the area of somewhat rough topography between No. 12 and No. 14 along the southern edge of the Matanuska wind stream. In the Knik River area Trainer's observations show maximum deposits in a dune area from Jim Creek (about 4 miles east of Bodenburg Butte) extending about a mile northwestward from the Knik River toward Bodenburg Butte, gradually thinning to the east bank of the Matanuska River. Loess deposits show an increase along the immediate west bank of the Matanuska River. The longer tailing of the Matanuska-induced aeolian deposits indicates the greater strength of the Matanuska wind.

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