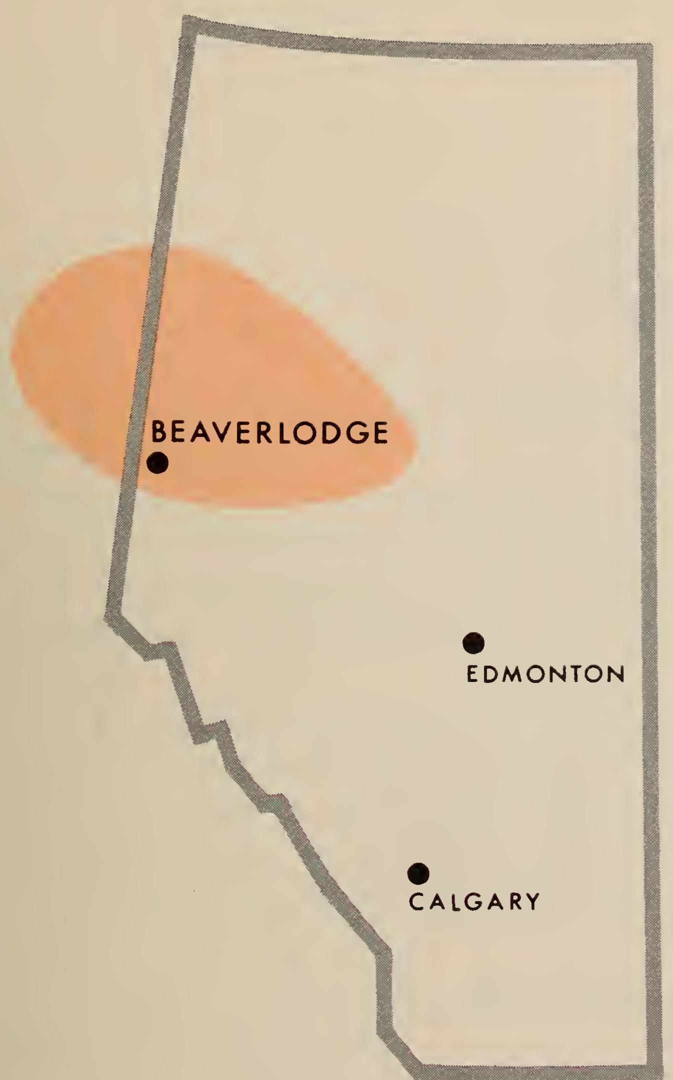


Climate of the Upper Peace River Region

CANADA DEPARTMENT OF AGRICULTURE PUBLICATION 1224 1965

COOL-SEASON CROPS FAVORED

The upper Peace River region is well suited to cool-season crops because:

- Though precipitation is relatively low, it is highest in July and is well distributed throughout the growing season.
- The moderate temperatures during summer help to keep evaporation and transpiration low and are adequate for growth.
- The long summer days promote development and fruiting so that crops usually mature within the short season.
- The cool nights in late summer and early fall promote full filling of the seeds, enhancing their quality.
- The usually deep and stable snow cover protects roots and soil during the winter.

Features that don't favor other crops, retard growth or cause discomfort to humans are:

- Late-spring and early-fall frosts occasionally damage many types of crops.
- Summer droughts sometimes seriously reduce growth and yields.
- The severe winter cold prevents the production of many kinds of plants and is extremely uncomfortable to animals and man.
- The chinook, the warm wind of winter, may injure or kill sensitive plants though it is welcomed by animals and man.
- Lashing west winds in spring and summer periodically injure new growth, suck up vital moisture, and make outdoor activity very unpleasant.

Climate of the Upper Peace River Region

A. C. Carder[1]

Research Station, Beaverlodge, Alberta

The climate of the upper Peace River region is remarkably suitable for various agricultural crops for an inland area at a latitude of 55° to 57° N. The important crops include wheat and coarse grains; alfalfa and various grasses, especially for seed; and rape and flax seed. Some of the crops yield more than in many other parts of Canada, and summerfallowing is not usually needed. With proper management, wheat averages 30 bu. per acre; barley, 45; oats, 65; and flax, 15. Seed of alfalfa averages 200 lb.; of rape, 1,500; and of creeping red fescue, 250.

The agricultural potential of the region is considerable and the above yields point out only one aspect of this. But, as in other northern climates, various features often limit agriculture and it is important to know what these are. Usually they are a short growing season and low temperatures generally, and sometimes insufficient moisture. These and other features are examined below.

This report on the various climatic factors is based on records taken at the Research Station, Beaverlodge, most of them from 1916 to 1960. Recent studies have shown that, except for local variations, the climate throughout the region varies little from that at Beaverlodge. In general, the temperature at Beaverlodge is slightly higher than elsewhere in the region. The precipitation decreases gradually from south to north and is about one inch less annually in the northern part of the region than at Beaverlodge. Lower rates of evaporation, however, offset the differences in precipitation.

The records were taken according to the standards of the Meteorological Branch, Canada Department of Transport. The site was chosen so that the records would not be affected over the years by clearing of land, artificial drainage, shelterbelts, or buildings.

Daily observations, over 800,000 in all, were plotted on graphs so that the weather of any period may be compared with the average or, in some instances, with the extremes. If the climatic factor had been measured for only a few years or if it had varied greatly from day to day, running averages (5) were calculated to show the trends better.

The monthly and annual long-term means are also given (Table 1).

SOME HIGHLIGHTS

The climate is usually peaceful, especially in winter. But in the summer, particularly from mid-June to late August, convectional storms are common; about 10 to 12 thunderstorms usually occur then. These are seldom violent, and damaging rain or hail is rare. Destructive hail may be expected in some part of any square-mile area

[1] Agrometeorologist.

Table 1 Monthly and Annual Weather Records for Beaverlodge

Averages for the numbers of years shown

Period	Mean temperature, ° F		Degree-days above		Precipitation Inches		Evaporation[3] Inches	Bright sunshine Hours daily	Wind Mph
	Air	Soil[1]	42° F	50° F	Total	Snow[2]			
Years of records	45	6	45	45	45	45	8	38	25
January	7.4	20.1			1.31	12.9		2.5	6.6
February	12.8	22.0			1.03	10.0		3.9	6.9
March	21.9	25.9			1.08	10.2		5.0	7.8
April	37.0	34.6	6.3		0.80	4.9		7.1	9.3
May	49.3	49.5	226.5	24.7	1.59	1.0	4.90	8.7	9.7
June	55.6	58.6	410.7	170.4	2.14	0.5	4.85	8.7	8.9
July	60.0	64.0	559.7	311.7	2.44		5.65	9.7	8.0
August	57.6	60.7	485.3	237.3	1.92	0.1	4.39	8.2	7.5
September	49.8	51.0	233.9	35.6	1.62	2.0	2.73	6.1	7.9
October	39.3	38.8	19.1		1.21	5.8		4.4	8.1
November	24.1	30.7			1.19	9.8		2.8	7.0
December	12.7	25.4			1.21	11.3		2.2	6.6
Year	35.6	40.1	1941.5	779.7	17.54	68.5	22.52	5.78	7.86

[1] Four inches below clipped grass sward.
[2] Ten inches of snow taken as 1 inch of rain.
[3] From 4-foot sunken tank.

once in 20 years. Rains of more than 1 inch per hour are highly exceptional, happening about once every 10 years. These storms cause soil erosion on slopes, but appreciably less than the spring snowmelt usually causes. Devastating floods are unknown, but local flooding has occurred in very wet summers and in wet springs after a winter of deep snow.

Droughty conditions are common, but a total crop failure from drought has not occurred since weather records were begun (3). Dust storms did occur in the spring of 1938 but none have occurred since, presumably because of changes in agricultural practices. Tornadoes are unknown but not possible as a small but violent one has passed through a nearby area (8).

Because the region is east of the Rocky Mountains, it is in the path of cold-air masses that occasionally push rapidly far to the south. When these cold fronts come in August they bring damaging frost once in seven years on the average.

Winter storms are rare. Several snow squalls occur each winter when cold fronts move rapidly through the region, but these storms seldom last more than a few hours. Forests help to prevent the snow from drifting. Blizzards are rare, not more than one being expected in 20 years. A serious freezing-rain or ice storm has never been recorded. Persistent heavy fogs do not occur, though thick morning fogs are common in early fall. Mists sometimes precede a slowly moving warm front.

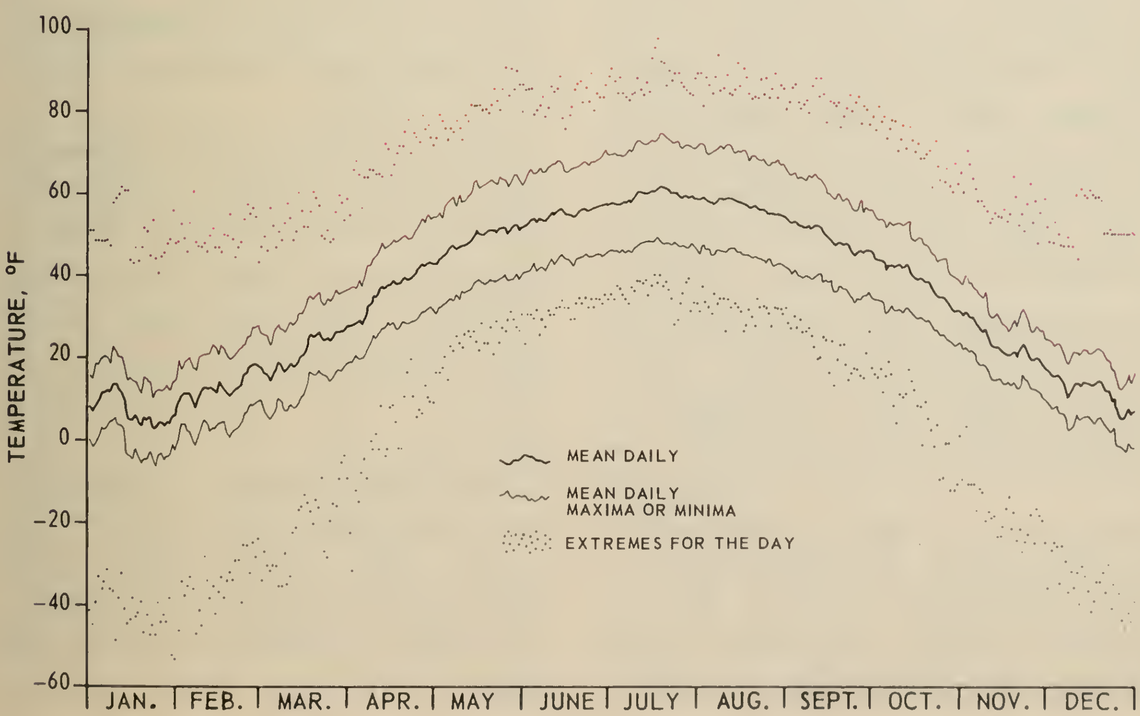
For humans, the greatest causes of discomfort are cold and wind; when these combine, it is most unpleasant to be outdoors. In the summer, wind is the greatest cause of discomfort. The weather is seldom unpleasant because of heat or high humidity.

Agriculturally, the greatest limitation is inadequate moisture in some years. Rainfall through the growing season is usually erratic and most of the snowmelt is lost because the soil is frozen. Warmth also is often below optimum, even in summer. For most cool-season crops the low amount of heat is in part offset by the long days of summer (2). In May and June, high west winds often damage plant foliage and dry out the soil. In winter, chinook winds bare the ground of snow, cause the sap to flow in plants and so promote winter injury and killing. Great winter cold also limits the range of perennial plants adaptable to the region.

AIR TEMPERATURE

The average of the mean daily temperatures is above zero throughout the year (Figure 1). The coldest period is the last half of January and the coldest day, on the average, January 24. The warmest time of the year is mid-July, July 18 being the warmest day. The mean daily temperature may be expected to go above freezing (32° F) about April 7 and fall below freezing about November 1. On the average, it goes above 42° on April 25 and

Figure 1 — Daily temperatures through the year at Beaverlodge, 1916-60.



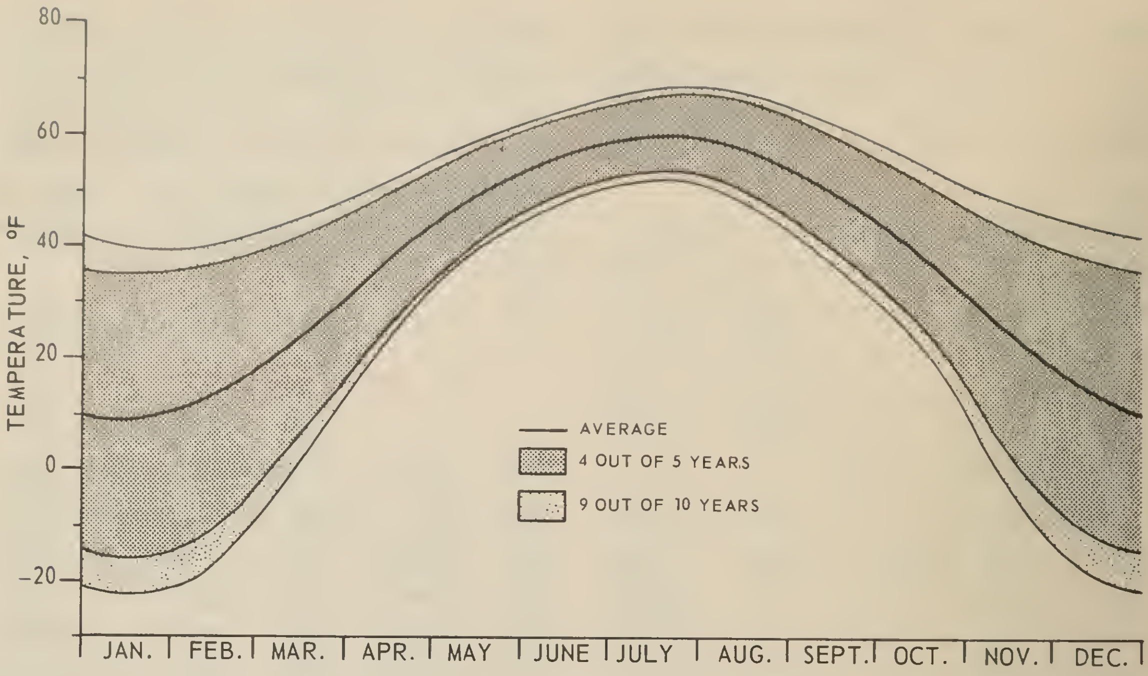


Figure 2 — Chances of various mean daily temperatures through the year on the basis of 1916-60 records (10-day running averages; see text for explanation).

below on October 14. This period is usually considered the growing season (6) and averages 170 days.

The mean daily maximum and minimum temperatures almost parallel the daily means, averaging about 10 degrees above and below them. The daily fluctuation between the mean maximum and the mean minimum is usually greatest in summer because the intensity of sunshine is highest then.

The differences between the daily extremes are much greater in winter than in summer. In January the temperature has varied from 62° to –53°, a range of 115 degrees. Subzero temperatures have occurred as late as April 19 and as early as October 20. Only for a one-month period, from June 20 to July 20, has the Beaverlodge station been free from frost in all years. In July the greatest range has been 69 degrees (29° to 98°). Temperatures over 90° have not occurred before May 25 or after August 16.

Also, during the winter the temperature fluctuates markedly from day to day. The pronounced rise in the average of the mean daily temperatures in early January indicates that a January thaw is common.

That extremes are more common in winter than in summer is shown for periods of 5 and 10 years in Figure 2. For instance, in at least 1 year out of 5 the mean daily temperature on January 15 may be as low as –16° or as high as 35°; in at least 1 year out of 10, –22° or 40°.

Exceptional conditions occur from time to time and may persist for several days. The extreme highs in December and in early January (Figure 1), for example, came in unusually mild spells.

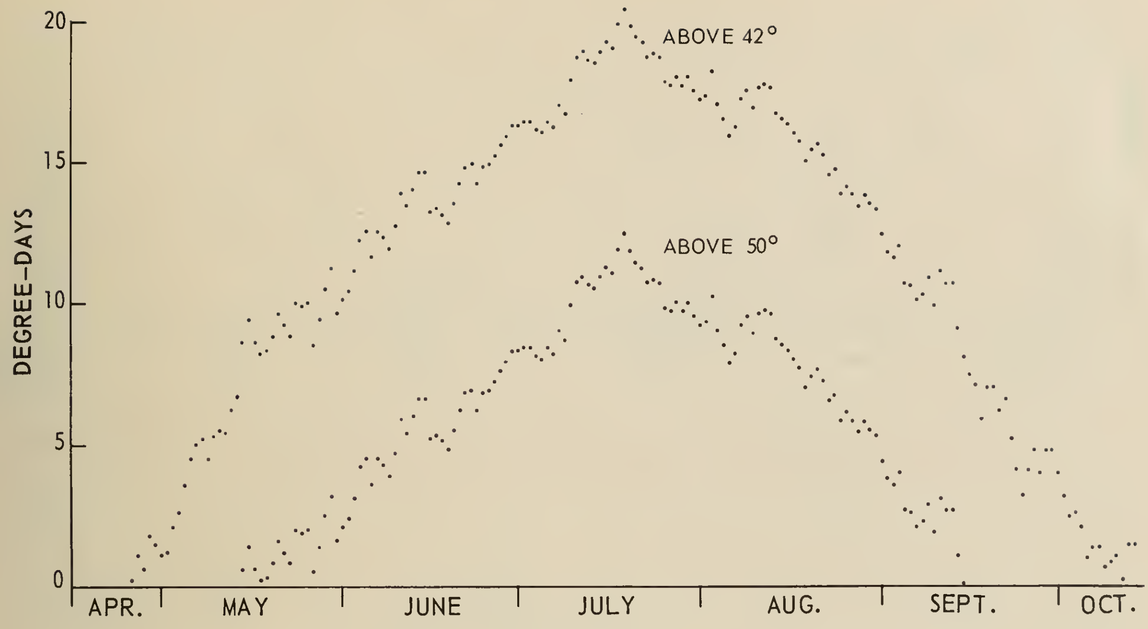


Figure 3 — Average daily degree-days above 42° and 50° F through the year, 1916-60.

DEGREE-DAYS FOR GROWTH

To determine the growing season for cool-season crops, such as wheat, peas, carrots and many others, it is customary to calculate the number of degree-days above 42° F. For example, for a day with a mean temperature of 43° the number of degree-days above 42° is 1; for a day with a mean of 44°, 2; and so on. The average number of these units at Beaverlodge per year is 1,942. The average number of units increases rapidly from late April until July 18 and then decreases equally rapidly until mid-October (Figure 3). The average growing season for these crops is 170 days.

For warm-season crops such as corn and beans the base temperature usually taken is 50°. The average number of degree-days above this base per year is 780. The average number increases rapidly from mid-May to July 18 and then decreases rapidly to mid-September. The average growing season for these crops is 123 days.

FROST-FREE PERIODS

The average periods free of frost (above 32° F) and of killing frost (above 28°) are 101 and 132 days. In spring, the average date of the last killing frost is May 8; of the last frost, May 24 (Figure 4). In the fall the average date of the first frost is September 5; of the first killing frost, September 20. In 1 year out of 10, the last frost in the spring comes on June 11 and the first frost in the fall on August 12. The chances of frost on other dates are shown similarly in Figure 4.

The average date of freeze-up, or the time when work on the land ends because of snow or frost, is November 5. In 4 years out of 5 it comes between October 22 and November 20.

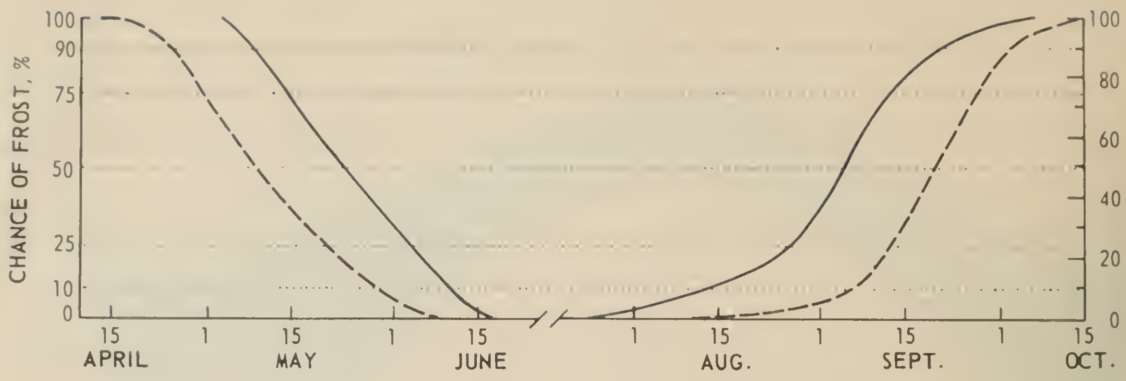


Figure 4 — Chances of frost (32° F, solid line) and of killing frost (28°, broken line) in spring and fall on the basis of 1916-60 records.

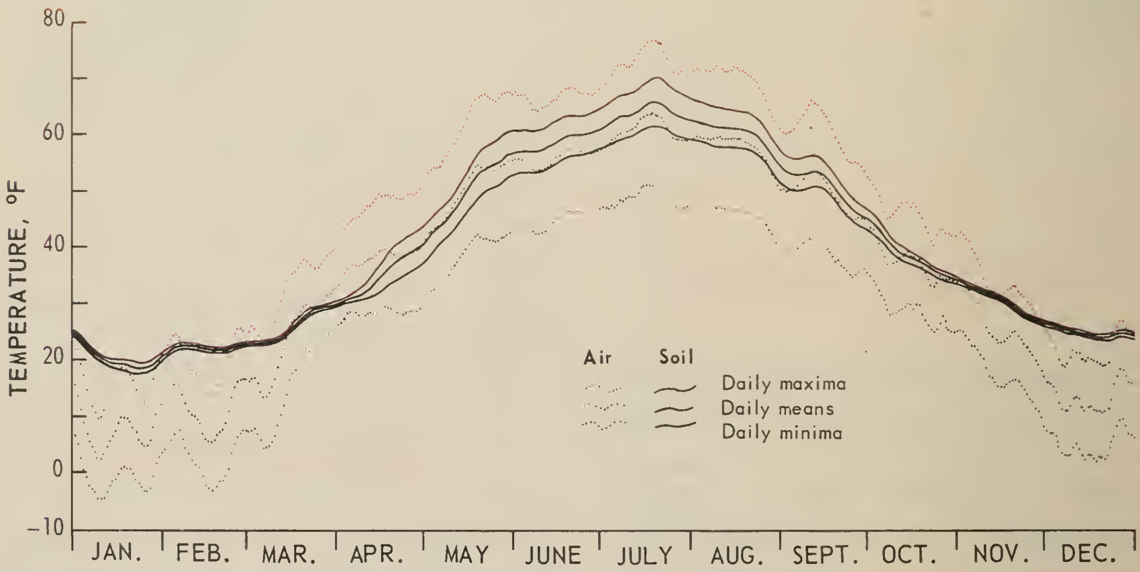


Figure 5 — Average daily soil and air temperatures through the year, 1956-61 (10-day running averages).

The earliest freeze-up recorded was on October 15 and the latest on December 6.

The average date in the spring when the soil has thawed and dried enough to be worked for sowing cereals is April 28 and has ranged from April 8 to May 18.

SOIL TEMPERATURE

The soil temperature at 4 inches deep rises rapidly from an average of 40° F on May 1 to 62° on July 18 (Figure 5). In summer the mean temperature at this depth is usually higher than that of the air. The soil temperature fluctuates much less than the air temperature mainly because the soil gains and loses heat more slowly than the air; in winter the snow cover and lower intensity of sunshine are also important.

In winter, the ground usually being blanketed with snow, the soil temperature averages much higher than that of the air and rarely falls below 20°.

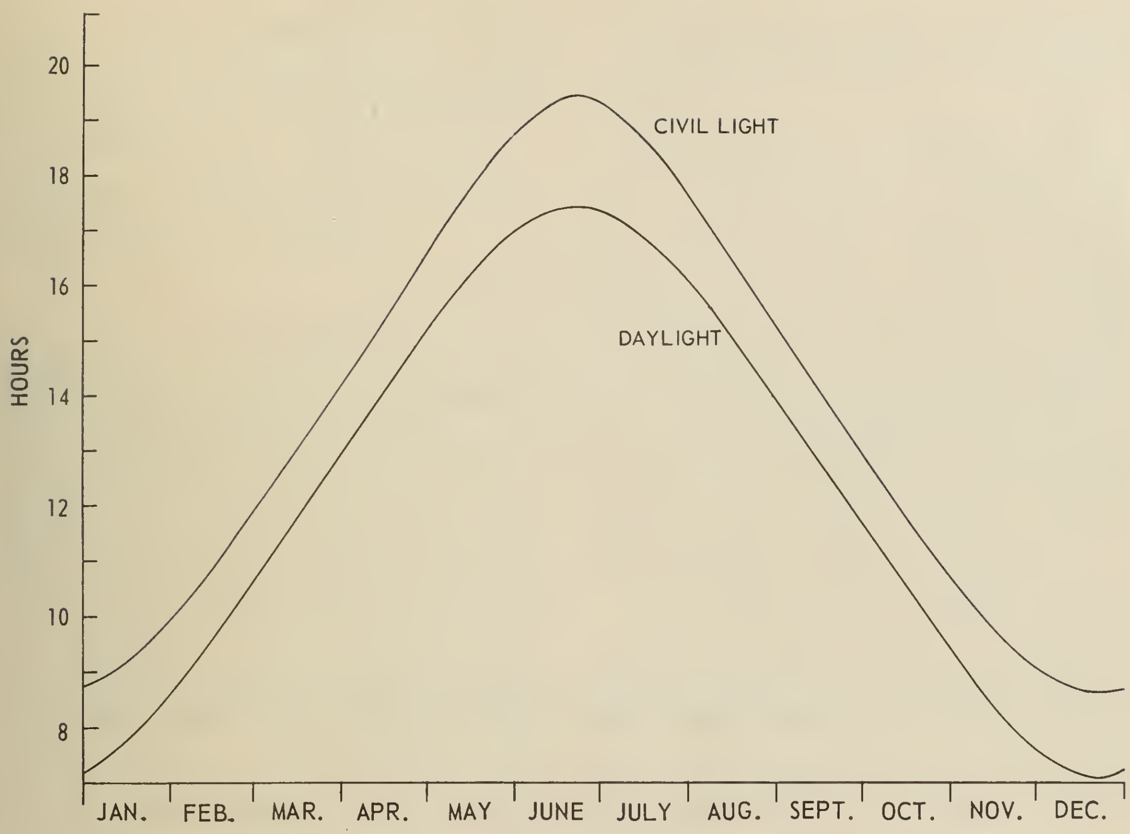


Figure 6 — Daily periods of daylight and civil light through the year.

DAY LENGTH

The hours of daylight and of civil light at Beaverlodge range from 7.1 and 8.7 on December 21 to 17.4 and 19.4 on June 21 (Figure 6). Civil light is the period from when the center of the sun is 6° below the horizon in the morning to when it is in this position in the evening, and daylight is that from sunrise to sunset.

For plants the duration of civil light, or photoperiod, is especially important in northern areas as most grow at light intensities as low as 1 or 2 footcandles. This is the intensity of light on a clear day at the beginning and close of civil light. The twilight, or the sum of the time from sunset to the end of civil light and that from the beginning of civil light to sunrise, is especially long in summer (Figure 6) because of the latitude.

INSOLATION

The average number of hours of bright sunshine ranges from less than 2 on December 21 to about 10 on July 21 (Figure 7). The curves for bright sunshine and for the insolation units[2] are roughly similar to that for daylight. The curves of Figure 7 nearly parallel one another as the factors measured are closely related (1).

Short days and cloudiness (Figure 8) make the winter months gloomy. During Christmas week the sky is overcast 74 percent of the time. In April

[2] Intensity of sunshine, measured with an Eppley pyrheliometer.

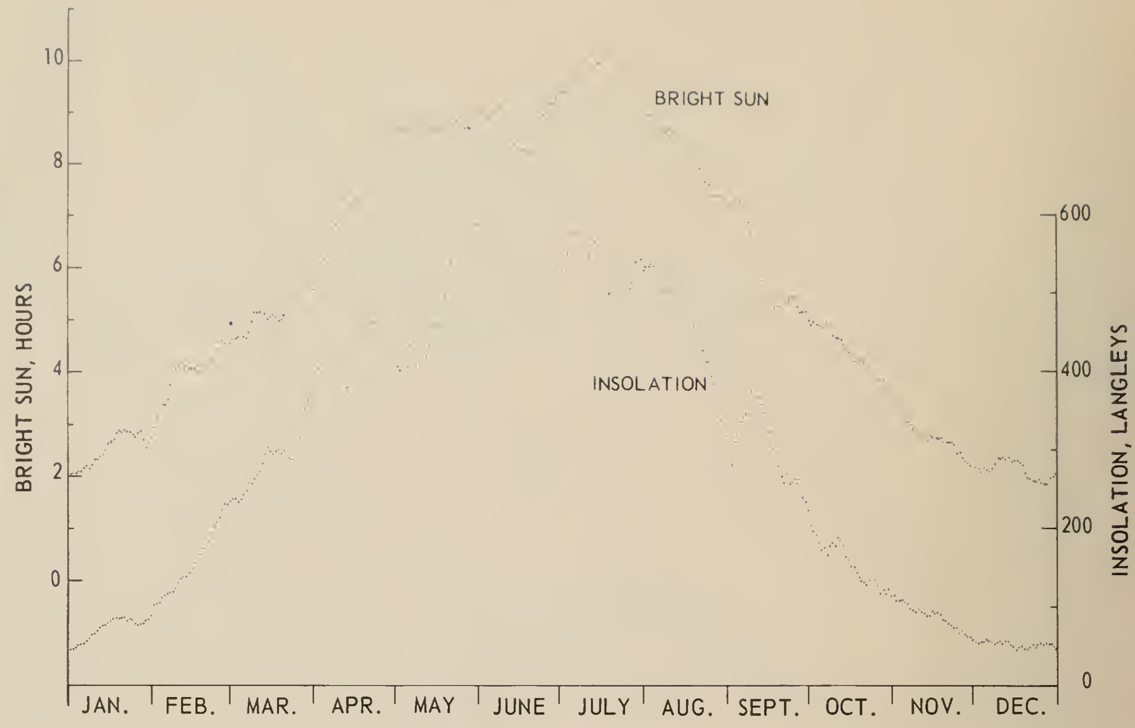


Figure 7 — Hours of bright sun daily, 1923-60, and insolation units (intensity of sunshine), 1961-62 (10-day running averages).

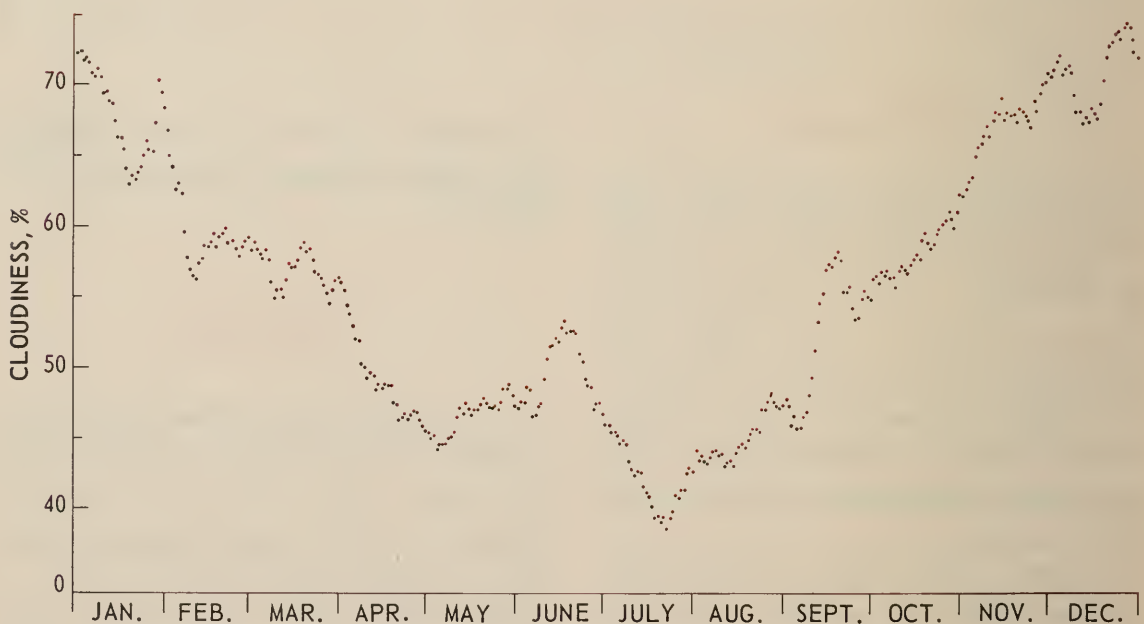


Figure 8 — Average percentages of cloudiness daily through the year, 1923-60 (10-day running averages).

a marked reduction in cloudiness contributes to the marked increase in hours of sunshine shown in Figure 7. At the summer solstice an increase in cloudiness reduces the hours of bright sunshine when they are expected to be greatest. July is the sunniest month of the year, the sky being obscured only an average of 43 percent of the time. In mid-September a rapid increase in cloudiness contributes to the rapid decrease in hours of sunshine.

PRECIPITATION

Much of the precipitation (Figure 9) comes at the times best suited to crop production. The usually dry weather of late April and early May allows planting to proceed with little interruption, and the rains of June and July, in most years, provide enough moisture for crops. Drier weather in late August, September and October favors harvesting. The short dry period in mid-October has sometimes allowed late harvesting of crops that would otherwise have been lost.

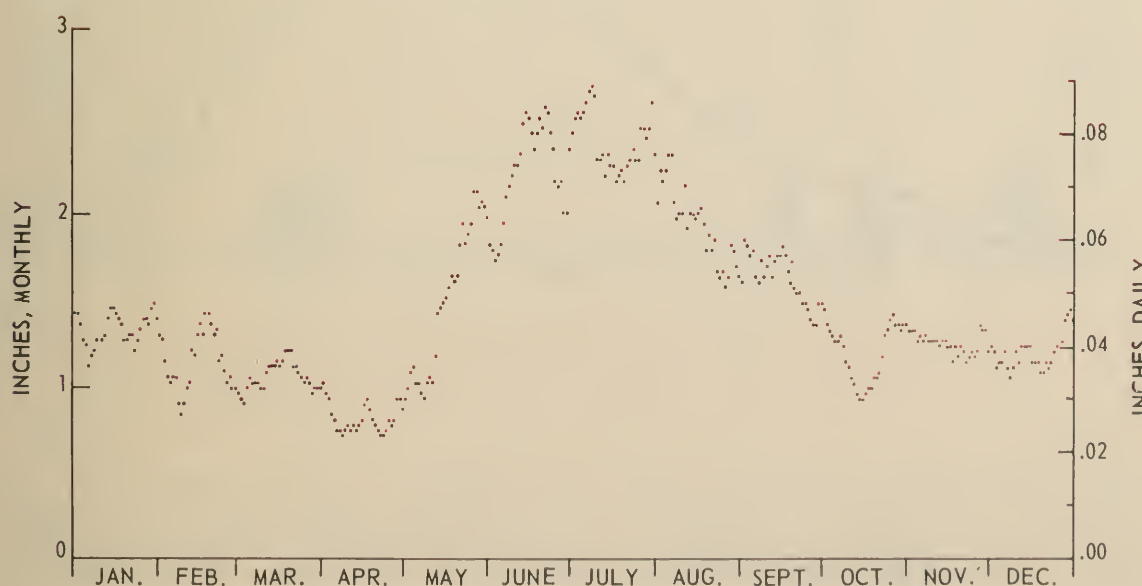
It may seem anomalous that July is both the wettest and the sunniest month of the year (Figures 7, 9). But much of the July rain comes in heavy thunderstorms that quickly form and pass away.

From summer to summer the rainfall is highly irregular. Though July is the rainiest month with an average total of well over 2 inches, droughts often occur then. In at least 1 year out of 10, only 1/10 inch or less of rain comes in July (Figure 10). Even in 1 year out of 5 the total is less than 0.6 inch. But at least once in 5 years the total is more than 4 inches, and once in 10 about 5 inches or more.

June rains are as irregular as those of July and the chances of drought are greater. There are even greater chances of drought in May, for the precipitation is usually much less in this month and most of the snowmelt is lost in runoff.

In winter the precipitation is not great. Though it is more nearly constant than in summer, dry spells often do occur.

Figure 9 — Average monthly and daily precipitation through the year, 1916-60 (10-day running averages).



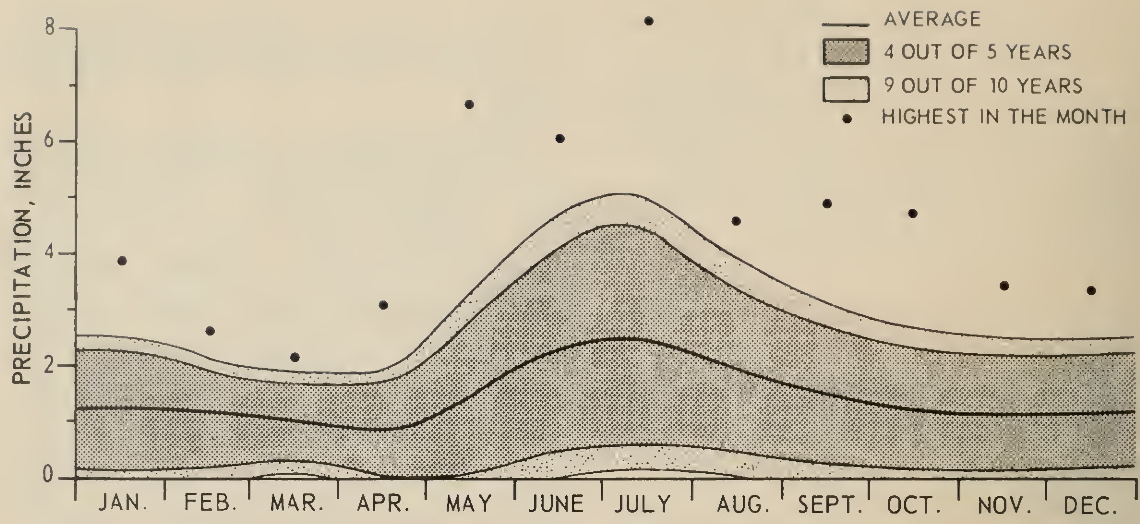


Figure 10 — Chances of various amounts of precipitation through the year, and highest amount in each month, 1916-60 (see text for explanation).

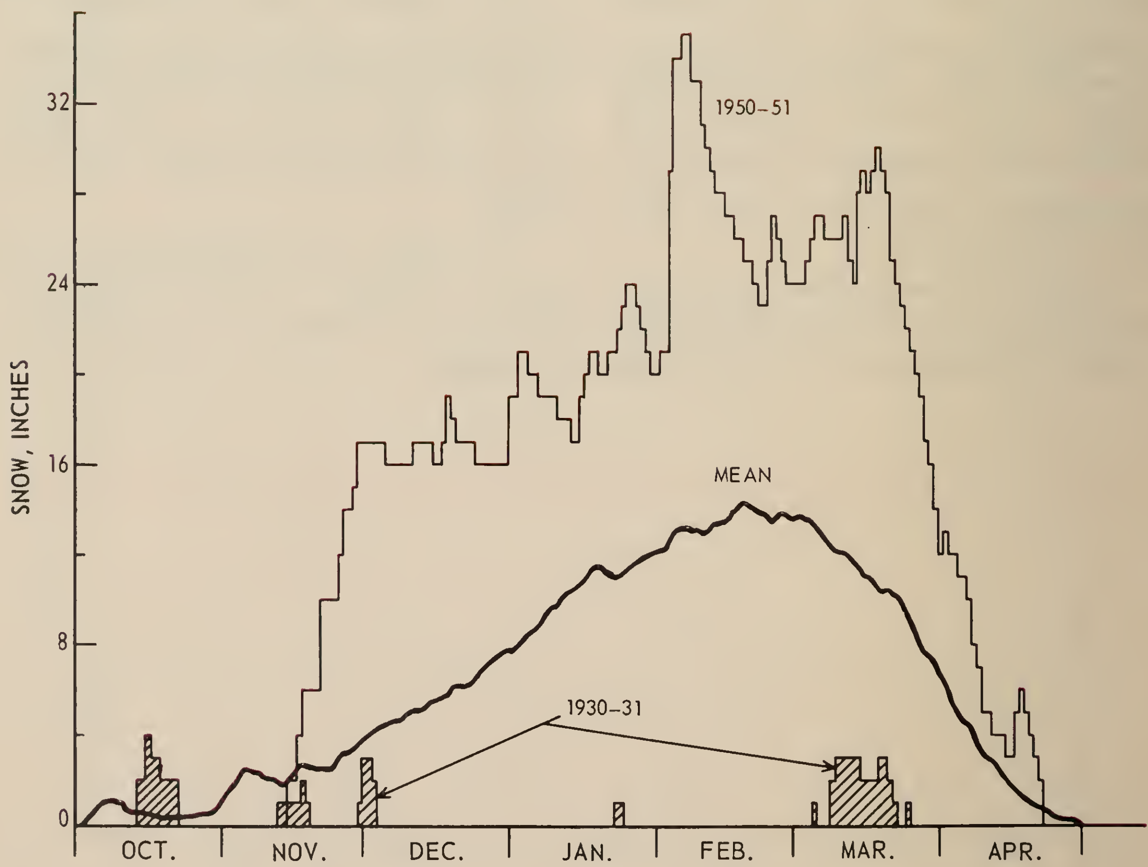


Figure 11 — Average depth of snow daily through the winter, 1936-60, and amounts in the winters of greatest and least snowfall known; 1930-31 amounts compiled from unofficial but reliable sources (see text for explanation).

The amount of precipitation received is rarely the average, especially in summer. The highest rainfall in July, 8.2 inches, came in 1951. For the much drier month of May the highest has been 6.6 inches. The extremes of drought are not given but, between 1916 and 1960, for each of the months there was at some time no precipitation at all or only trace amounts.

In most years, snow covers the ground from early October to the end of April (Figure 11). The depth increases rapidly early in November and then more slowly until there are about 14 inches in late February. From the first of March, both compaction and melting contribute to the rapid decrease.

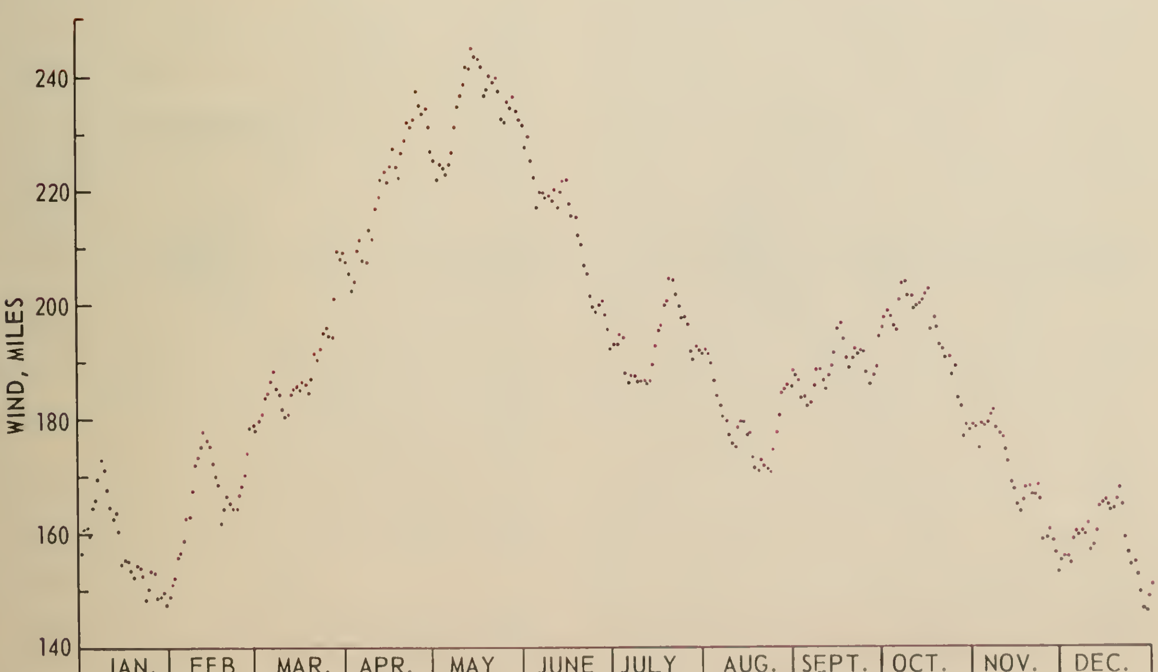
Because of chinook winds and warm periods the depth of snow varies markedly from year to year. In exceptionally mild, open winters the ground may be snow-free for considerable intervals, as in 1930-31 (Figure 11). The winter of 1930-31 was the most open known (4). But as official records of snow depth were not begun until 1935-36, the total snowfall and the deepest snow cover have probably been greater than in 1950-51 (86 and 35 inches). Unofficial but reliable accounts indicate that the corresponding figures for 1919-20 were 121 and 48 inches.

WIND

The daily run-of-wind varies greatly according to time of the year (Figure 12). It is rather calm in winter but windy much of the summer, in the fall and especially in spring. In May and June, lashing west winds often dry out the soil and damage plant foliage. As August is warm, sunny and not very wet (Figures 1, 7, 9), it is a most pleasant month.

In deep winter, December to February, the daily temperature is closely related to run-of-wind (Figures 1, 12). The coldest periods of the year, from December 25 to January 3 and from January 14 to February 1, are the

Figure 12 — Average run-of-wind daily through the year, 1936-60 (10-day running averages).



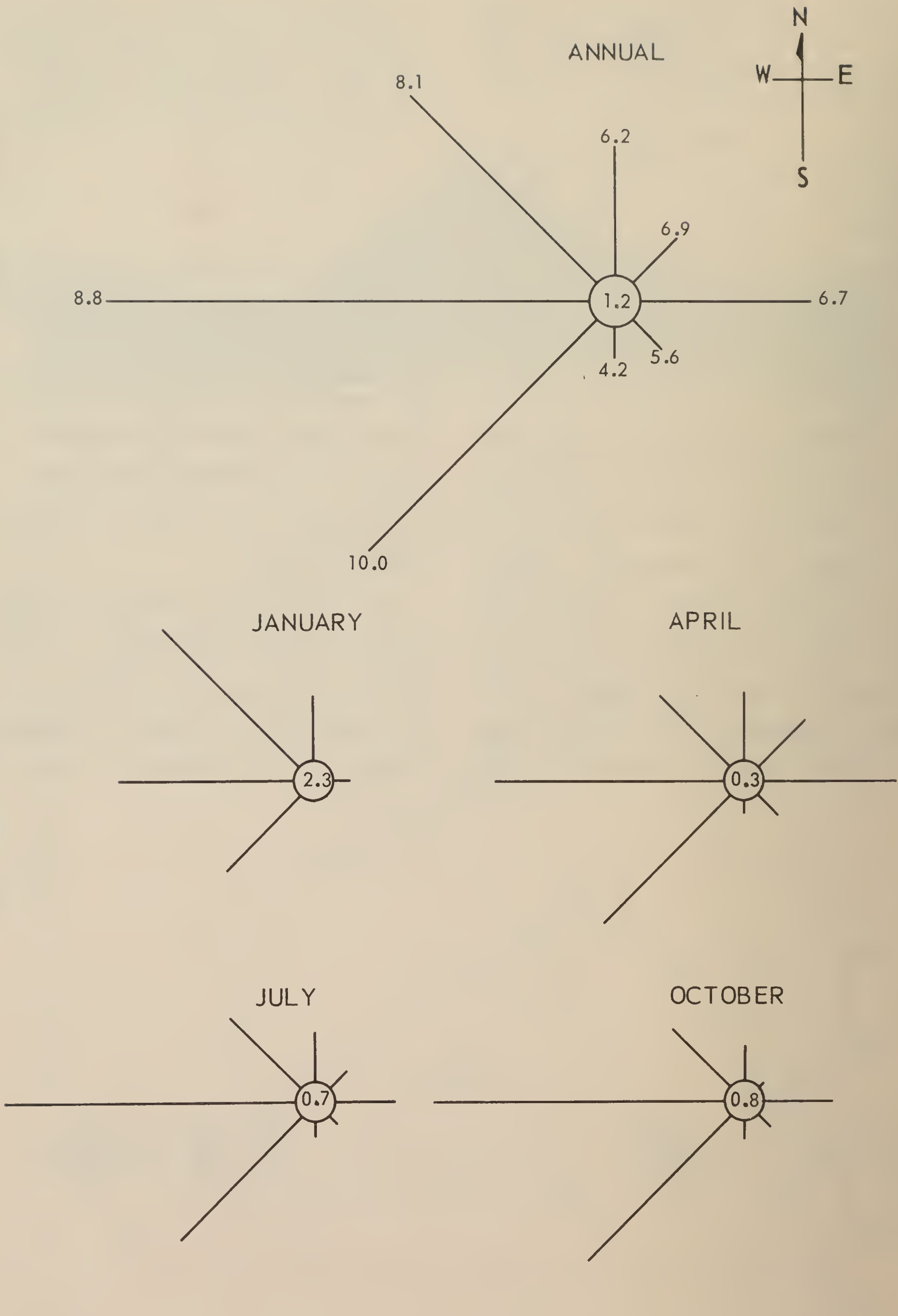


Figure 13 — Average wind values for the year and for months representative of the seasons, 1936-60. Length of ray: total run-of-wind. Number at end of ray: mph. Number in circle: percentage of period calm.

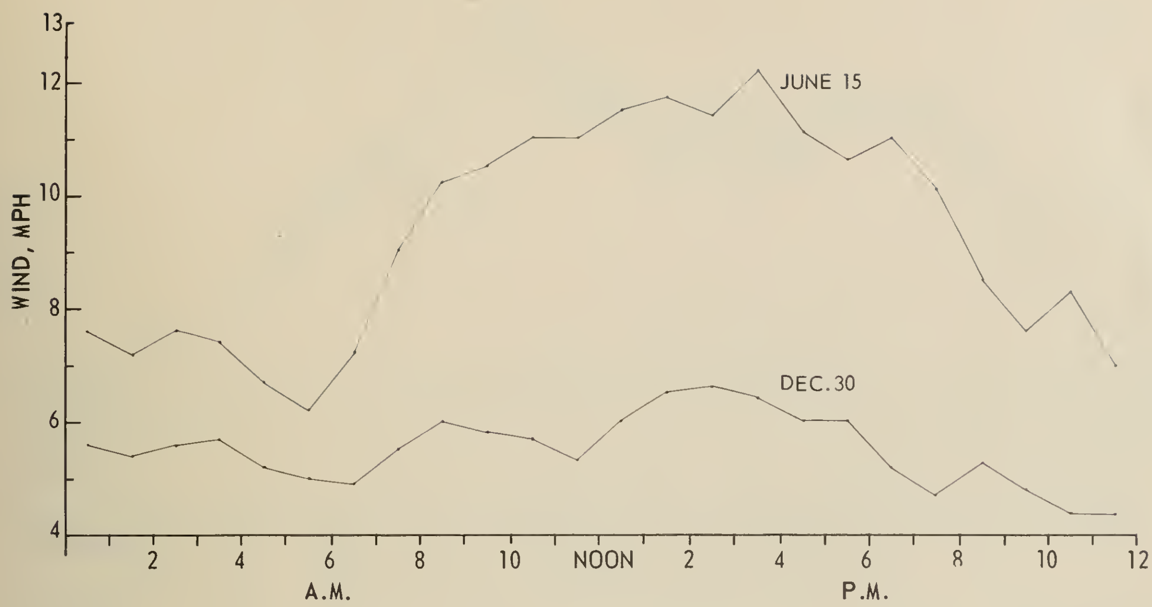


Figure 14 — Velocities of wind through a typical day in early summer and in winter, 1936-60.

calmest. The brief windy periods in winter (Figure 12) are due to strong surges of Pacific air (west winds). These periods of mild west winds are strongest when winter storm tracks shift to the north of the region. Why they shift, apparently at fairly regular times, is not known.

The prevailing wind is the west (Figure 13, upper diagram). In descending order of total run-of-wind for the year, the others rank as follows: southwest, northwest, east, north, northeast, southeast and south. The strongest winds are from the southwest, the direction from which the chinooks come. In descending order of average velocity for the year, the others rank as follows: west, northwest, northeast, east, north, southeast and south. Calm periods are infrequent, the average duration for the year being only 1.2 percent of the total.

The wind direction varies little from season to season. In January, the calmest month, northwest and west winds are the most common. In spring (April), the west and southwest are the most common, the east being next. In summer (July) and in the fall (October), the west and southwest are the most common.

In daylight in June (4 a.m. to 10 p.m. at Beaverlodge), winds of 8 mph or more are common (Figure 14). When the wind is this high, it is impractical to apply sprays to protect crops. On June 15, which is typical of the month, during the windiest time of day (3 to 4 p.m.) the probability that the velocity will be 8 mph or less is 28 percent; during the calmest time, from 5 to 6 a.m., 80 percent. The latter period, however, is very brief.

In winter, winds are not much stronger during daylight than at night. On December 30, which is typical of the season, the highest velocity during daylight (9 a.m. to 5 p.m.) is 6.6 mph; at night, 4.4 mph (Figure 14).

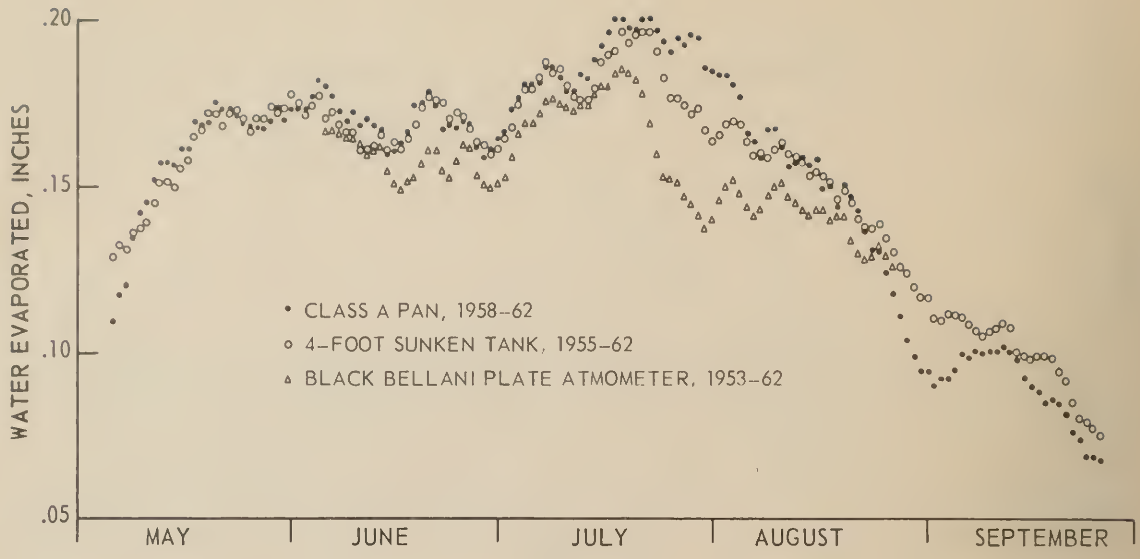


Figure 15 — Average amounts of evaporation daily from May to September by three methods of measurement (running averages).

EVAPORATION

The rate of evaporation is high from mid-May to mid-August and highest in July (Figure 15). Though July is the rainiest month of the year, the rains come mainly in thundershowers and warmth and sunshine are at their peak (Figures 1, 7). The rate of evaporation from the Class A pan of the United States Weather Bureau, when corrected by Kohler's technique (7) to represent evaporation from reservoirs and ponds, is very similar to that from the 4-foot sunken tank of the Canada Department of Agriculture (Figure 15). The records from the black Bellani plate atmometer were converted to inches by Robertson's coefficient of 0.0034 (9). This instrument is more sensitive to changes in insolation and wind than pan or tank evaporimeters.

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