EIGHTY YEARS OF WEATHER AND CLIMATE AT TOLEDO, OHIO

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Many years ago on a small 40-acre farm in Wood County, two brothers, Emil and Guido Marx, had completed a hard day's work in the field setting out tomato plants. During the course of the evening, with a sharp drop in temperature after a bright sunny day, both were concerned as to whether a frost would ruin the labors of the day. Guido, the younger, stated, "Frost in May seems impossible, but this lake country is queer." After a few moments hesitation he added, "Wouldn't it be wonderful if some scientist could discover some way to predict the weather? Think of the crops it would save." Emil accused his brother of fanciful dreaming and wanting some sort of assistance through witchcraft or a sorcerer to gain this end, but Guido was insistent that if he were a scientist he would work on it in order to save crops and labor. He went on to state, "I predict in 10 years someone will do it."

The next morning the brothers ruefully surveyed the field they had so laboriously planted the preceding day. A heavy white frost covered the field and the precious tomato plants were flat. Fuido stifled an oath. "All our hard work gone for nothing," he said bitterly. Emil shrugged his shoulders and replied, "It has always been the lot of the farmer." "But it shouldn't be" Guido replied angrily, "Someone should discover something."

The little story related above took place about 100 years ago. Since then much progress has been made in weather study and weather forecasting, so that today the young weather scientist not only studies the conditions of the weather at the earth's surface but is able to study the upper atmosphere, two to six miles above the earth. With such knowledge he has been able to make daily forecasts of 24 to 36 hours with considerable accuracy for some time, but now come the 30-day forecasts.

The work of these forecasts was begun in 1941 and first was the basis for 5-day forecasts. The next year some 30-day outlook maps were started, but were not more than in the experimental stage. In February 1950 the first written forecasts appeared. The Associated Press, in reviewing these 30-day written forecasts, states that out of 57 statements made by the weatherman, 45 seemed reasonably accurate when the forecast was compared with what actually occurred. This would prove to be about 80 percent accurate.

The 30-day forecasts differ from the daily forecasts in several important ways. Weathermen do not call them forecasts but rather 30-day outlook summaries. The long-range summaries use only general terms. However, accompanying maps sharply define the areas to which the weatherman is referring. The summaries do not forecast individual storms, nor do they apply to a particular place, like a community, but for the whole nation or large regions. They are based on the atmospheric pattern over a large portion of the earth at from two to six miles high. They predict what effect this slow-moving pattern will have on a large portion of the earth up to 30 days later.

Predictions have been made long enough in advance to give groups of people time to prepare for changes in temperature, rainfall and other weather elements. Coal dealers, overcoat merchants and dealers in summer clothes and electric fans are thus able to time their advertising to meet the anticipated change. Farmers also have been helped in being forewarned in caring for crops and livestock during critical periods. Such progress is possible only after years of weather study with efficient instruments and a development of techniques. Observations used in this study, secured from weather bureau files, cover a period of 80 years beginning with the data of 1871 and including 1950.

LOCATION

Toledo, Ohio is located in the northwestern part of the state at the extreme western end of Lake Erie. It lies approximately 42° N. Lat. and 84° W. Long. well within the belt of prevailing westerlies. It is exposed in all directions as it lies on an extensive plain with no protective physical features. Southward from Toledo lies the floor of post-glacial Lake Maumee at an elevation of 600 feet. To the westward the city lies upon some low beach ridges and sand dunes at elevations slightly over 620 feet. The Maumee River empties into Lake Erie here and divides the city into two parts so that much of it lies but a few feet above the 570-foot level of Lake Erie.

Observations and the recording of weather data have been made at various locations within the city during the years considered. The office quarters were

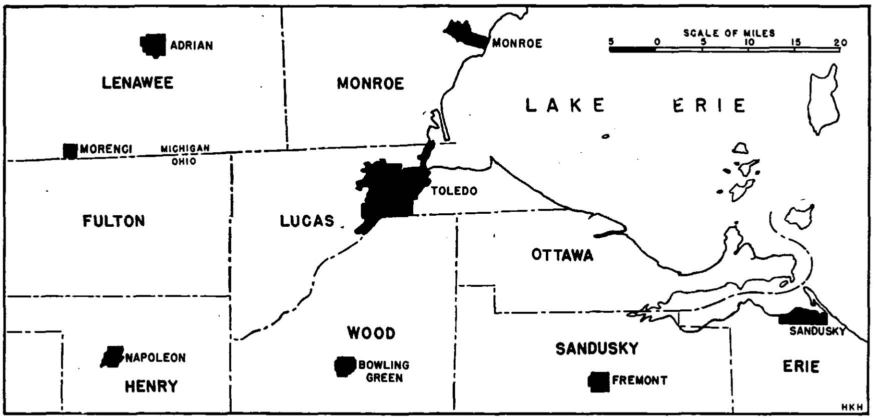

FIGURE 1. Location of Toledo, Ohio, and surrounding cities of Ohio and Michigan with respect to Lake Erie.

first maintained on the first floor of a building near Water Street and Madison Avenue from November 1, 1870, to March 1, 1871. Following the latter date until February 1, 1888, they were in the Chamber of Commerce Building on Summit Street and Madison Avenue. Other locations include: the Government Building, Madison Avenue and St. Clair Street, from February 1, 1888, to July 11, 1906; in the Nicholas Building, Madison Avenue and Huron Street, from July 11, 1906, to June 20, 1932; and in the new Federal Building on Civic Center, near Spielbusch Avenue, from June 20, 1932, to date. On February 1, 1943, instrumental records were made official at Toledo Muncipal Airport near Moline, Ohio (about 6 miles southeast of the city) and continue there. Since February 1, 1943, some comparaative and climatological records are being made at the city office for the city area.

LAKE INFLUENCES

Toledo's location at the western end of Lake Erie places it in a position so that marine influences are felt. Figure 1 shows the geographical position of Toledo and surrounding cities with respect to Lake Erie. All are within a radius of 50 miles from Toledo and all within 40 miles of Lake Erie. From figure 1 it will be seen that Toledo and Monroe lie along the western edge of the Lake while Sandusky lies along the southern edge about 45 miles east of Toledo. The other five cities lie from 15 to 40 miles away from the edge of the Lake.

Two distinct types of climate may be observed between these two groups of cities. Along the edge of the Lake a semimarine type prevails changing to a continental with increasing distance from the Lake. The semimarine type is governed by the force and direction of the wind. When there is little or no wind, the weather becomes continental in character, which means pronounced fluctuation in temperature—hot weather in summer and severe cold in winter. On the other hand, a strong wind from the Lake may immediately transform the weather into a semimarine type.

Data for the selected cities, which were picked at random in order that a group of cities encircle Toledo, may be observed in table 1. These records cover a period of 38–40 years with the exception of Morenci and Monroe, Michigan, which are for a much shorter period. The maximum temperatures of 105° F for Toledo and Sandusky and 106° F for Monroe are slightly lower than those for the other cities, while the minima of −16° F at Toledo and Sandusky and −17° F at Fremont are several degrees higher than the minima for the other cities.

TABLE 1*

CLIMATIC SUMMARY

	Temperature					Killing Frost Average Dates			
	Length of Record	January Average	July Average	Maximum	Minimum	Length of Record	Last in Spring	First in Fall	Growing Season
	Yr.	°F	°F	°F	°F	Yr.			Days
Toledo, Ohio	40	26.9	74.0	105	—16	40	Apr. 20	Oct. 22	185
Sandusky, Ohio	40	27.9	74.0	105	—16	40	Apr. 17	Oct. 28	194
Fremont, Ohio	38	27.1	74.1	110	—17	38	May 1	Oct. 16	168
Bowling Green, Ohio	40	26.6	73.4	110	—22	39	May 7	Oct. 12	158
Napoleon, Ohio..........	40	26.5	73.6	110	—22	37	May 4	Oct. 13	162
Morenci, Michigan	30	25.5	73.5	109	—28	32	May 9	Oct. 5	149
Adrian, Michigan	39	25.3	73.8	108	—26	38	May 6	Oct. 12	159
Monroe, Michigan	22	26.4	73.9	106	—21	22	May 7	Oct. 13	159

* Fisher (1941), Wills (1941).

A similar influence may be seen in the average dates of the last killing frost in spring and the first killing frost in fall. The average date of the last killing frost in spring is from 10 to 22 days earlier at Toledo and Sandusky than at the other cities. Similarly in the fall the first killing frost at Toledo and Sandusky comes from 6 to 23 days later than at the inland cities. Since large bodies of water are less responsive to temperature changes, Lake Erie holds the winter cold longer in spring and the summer heat longer in the fall than the inland areas. This stabilizing influence tends to retard the advance of the spring along its shores, thus holding back the development of vegetation till the likelihood of frost is over. In the fall a reverse process slows up the approach of cold weather till vegetation has matured and is safe from frost. As long as the wind is onshore in the lake areas, the effect is to temper the extremes of heat and cold, thus producing a more equable climate.

Table 1 also shows that the average growing season near the Lake ranges from 159 days at Monroe to 194 days at Sandusky. The growing season at Toledo averages 185 days; the longest was 224 days in 1910, and the shortest 132 days in 1895. The average date of the last freezing temperature in spring is April 21. The date of the last killing frost averages about April 23 and the last light frost about May 14. On the average the first frost in fall occurs on September 27, the first killing frost on October 17, and the first freezing temperature on October 25. The data of Monroe, Michigan, seem to be entirely out of line with Toledo and Sandusky data in this and in other instances. A personal letter from Mr. A. H. Eichmeier, Meteorologist of the United States Weather Bureau station, East Lansing, Michigan has this to say, "Probably the reason for the shorter growing season listed at Monroe is because of the fact that it is a cooperative station and usually at cooperative stations it is necessary to use the last freezing temperature in the spring and first freezing temperature in the fall as observers frequently do not mention frost data, while at first order stations a temperature as low as 27 or 28 might be required before actual killing frost was registered. Also, the record for Monroe is of short duration." The growing season at the insland cities ranges from 149 days at Morenci to 168 days at Fremont. The extreme range in the length of the growing season between the two groups of cities is from 10 to 45 days.

TEMPERATURE

Further temperature conditions may be observed from figure 2 which charts both temperature and precipitation data. The three lines in this graph represent temperature distribution throughout the year. The middle line shows the mean monthly temperature (also see table 2, column 1) to vary from a low of 26.5° F

TABLE 2#

TEMPERATURE DATA: MEANS AND EXTREMES
(Length of Record—77 Years)

	Mean Monthly	Daily Maximum	Monthly Maximum	Year	Record Highest	Year	Daily Minimum	Monthly Minimum	Year	Record Lowest	Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
January	26.5	33.5	40.2	1880	71	1890*	19.5	13.7	1918	—16	1897
February	27.1	34.4	39.4	1882	71	1944	19.8	17.0	1875*	—16	1885
March	35.9	43.9	47.7	1945	83	1910	28.0	27.7	1885	—10	1948
April	47.4	56.1	55.2	1878	89	1915*	38.6	39.6	1874	12	1875
May	59.1	68.3	67.4	1911	95	1911	49.9	52.2	1907	28	1945
June	69.0	78.1	75.4	1933	101	1934	59.9	63.4	1903	38	1929
July	73.6	82.9	79.0	1921	105	1936	64.2	68.0	1891	44	1945
August	71.4	80.5	77.2	1947	103	1918	62.2	66.6	1927	41	1946
September	64.7	73.8	72.4	1881	100	1939	55.7	57.6	1918	29	1942
October	53.3	61.9	61.2	1879	92	1939	44.7	44.8	1925	21	1887
November	40.4	47.6	48.9	1931	80	1950	33.6	33.7	1872	2	1947
December	29.9	36.5	41.4	1889	70	1889	23.8	20.6	1872	—15	1872
Year	49.9	58.1	53.6*	1921	105	July 1936	41.7	46.4	1875	—16	Feb. 1885*

*Also on later dates, months or years. # Coleman (1950).

in January to a high of 73.6° F in July producing a mean temperature range of 47.1° F. The other two lines show the mean daily maximum and the mean daily minimum, the values of which may be seen in columns 2 and 7 respectively of table 2. The mean annual temperature of Toledo is 49.9° F.

Most people are interested in extremes of weather and rightly so; temperature extremes are no exception. The highest temperature ever recorded occurred on July 14, 1936, when a reading of 105° F was registered. The hot spell began on

July 8 and was not broken until July 15. This was not a local condition but the whole country was in its grip. When the heat wave ended, 55 people in the city of Toledo had lost their lives in one way or another attributed to the heat. The total number of heat prostrations was never known since many cases were treated by private physicians and were not reported. Damage reported on streets and

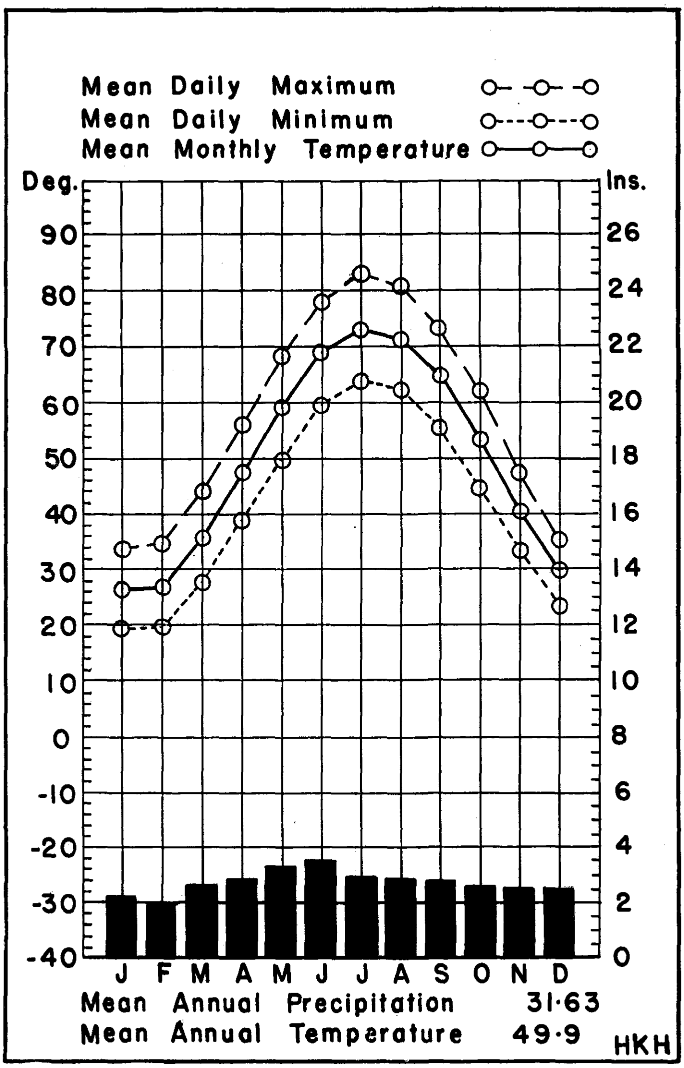

FIGURE 2. Climatic graph and statistics.

highways came from all parts of the city where brick and concrete had been used. On Monroe Street, four miles west of Toledo, the pavement exploded tossing concrete slabs into the air.

The lowest official reading of −16° F on February 11, 1885, and again on January 25, 1897, gives the city an absolute range of 121° F. The temperature drop was gradual over a four-day period before the minimum was reached on

January 25. On the East Side, the mercury stood at −18° F unofficially and at Lawrence Avenue Drug Store it registered −22° F. Although much suffering was reported throughout the city, many were made happy due to the intense cold. The dealers in ice anticipated almost any thickness of ice desired for the next summer's trade. Orders were poured in to the coal dealers throughout the morning and thousands of tons of coal were delivered before the end of the day's business. Other merchants were made happy because the extreme cold created wants that had to be supplied by them. Street cars ran on fairly regular schedules but conductors and motormen suffered with the cold. The conductors did not all

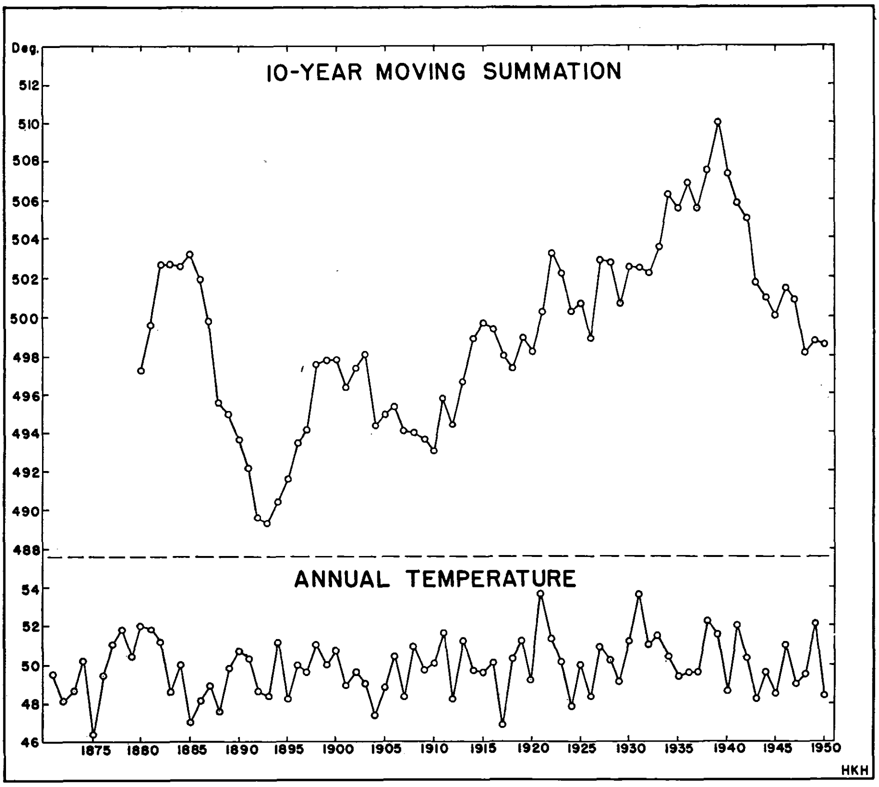

FIGURE 3. The mean annual temperatures at Toledo, Ohio, in the lower portion of graph. The sum of a 10-year period represented by each point in the upper portion of graph.

adhere to the orders to keep on the rear platforms on long runs, but common sense taught them to go inside where many spent an unusual amount of time stirring up the fires in the stoves. The motorman, whose duties would not permit this, got the worst of it.

On the average there are only eleven days a year when the temperature reaches 90° F or higher, and five days when it drops to 0° F or lower. Other temperature data may be seen by further consultation of table 2.

Figure 3 graphically presents the mean annual temperatures throughout the period of observation. This will be observed in the lower portion of the chart. The mean annual temperature of 49.9° F has been exceeded many times and has not been reached almost an equal number of times during these 80 years. Six years have a mean temperature above 52° F and a like number below 48° F. The two years with the highest mean annual temperature of 53.6° F were 1921 and 1931. The two coldest years were 1875, with a mean annual temperature of 46.4° F, and 1916 with one of 46.9° F.

The upper portion of this chart is an attempt to show a trend in temperature. The mean annual temperatures of 10 consecutive years are used in plotting each point in this moving summation. A medium high point was reached in 1885 with the maximum high in 1939. A low point occurred in 1893 with a trend toward another at the present time. One marked irregularity follows the low of 1893, between the years of 1895 and 1904, which is shown in the annual temperatures (lower portion of fig. 3) with a number of these years above the normal of 49.9° F and others but slightly under the normal. This chart shows a rather irregular upward trend from 1893 to 1939, a period of 46 years. The two high points are 54 years apart.

Fuel dealers and their patrons have an intense interest in degree days of heating but on a very different basis; the former on expanding his sales, and the latter in reducing his purchases. To those unfamiliar with the use of the term, a word of explanation is in order. Artificial heating is based on a daily mean temperature of 65° F. If the daily mean drops below this temperature, heating is necessary to keep a comfortable inside temperature. This difference (65° F minus each day's mean) is called number of *degree days*. Table 3 gives the cumulated degree days for each month of the year.

TABLE 3#

MEAN DEGREE DAYS OF HEATING
(Length of Record—77 Years)

January	1193	July	6
February	1070	August	15
March	900	September	107
April	534	October	377
May	230	November	729
June	45	December	1084
	Year	6290	

#Coleman (1950).

PRECIPITATION

Figure 2 also shows the normal distribution of precipitation throughout the year. The general trend is typical of the humid continental type and is characterized normally by abundant precipitation well distributed seasonally and from year to year with serious droughts of infrequent occurrence. The mean annual precipitation is 31.63 inches with a mean June maximum of 3.44 inches and a mean February minimum of 1.95 inches. Other mean monthly values appear in table 4, column 1. This seasonal march shows the summer to have about one and one-half inches more than the winter, the heavier amounts in summer being due to thunderstorms.

The annual precipitation is shown graphically in the lower portion of figure 4. During the 80-year period the annual precipitation has exceeded the average or normal of 31.63 inches 41 times, or 51.25 percent of the time, while it dropped under that average 39 times or 48.75 percent of the time. Figure 5 shows this relationship. This figure shows that there were eight years that the precipitation was five inches or more above normal; four years, more than 10 inches and one year, 1950, over 15 inches above normal. It also reveals that subnormal precipitation of five inches or more occurred 12 times, one year being more than 10 inches below normal. The precipitation has been five inches or more above the normal

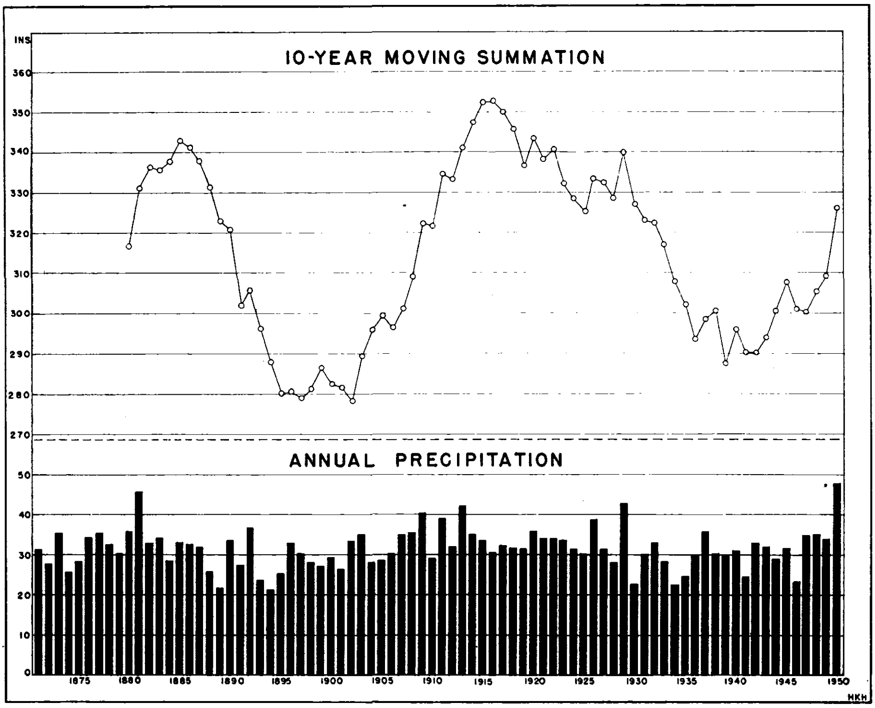

FIGURE 4. The annual precipitation at Toledo, Ohio, in the lower portion of graph. The sum of a 10-year period represented by each point in the upper portion of graph.

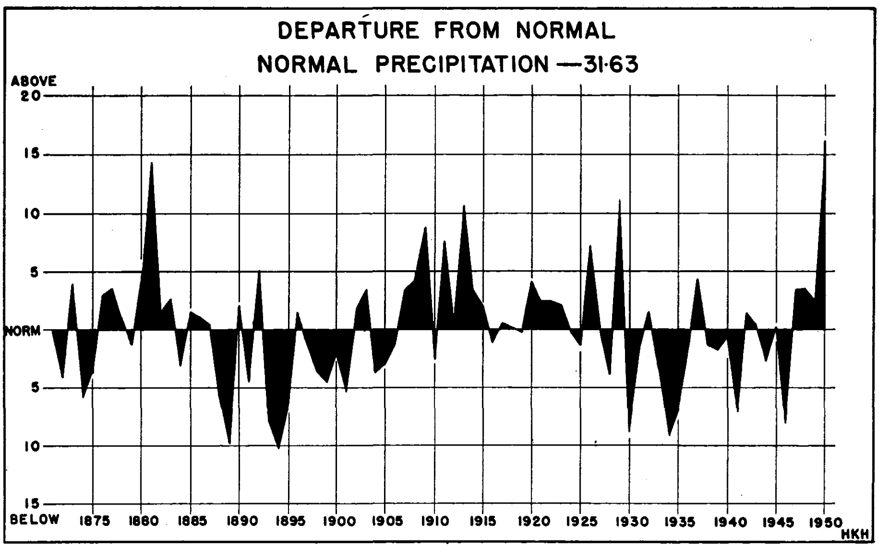

FIGURE 5. Chart showing the departure from the normal precipitation of 31.63 inches (1871–1950).

10 percent of the time and 15 percent of the time it has been five inches or more below normal. This is further evidence of a statement made earlier in this paper, that the precipitation of Toledo does not fluctuate greatly from year to year.

The upper portion of figure 4 is a 10-year moving summation on precipitation with the first point representing the years 1871–1880 inclusive. The general trend between the years 1880–1885 is upward with a maximum being reached in 1885. This corresponds with the moving summation in temperature which reached a peak the same year. During the next 10 years the trend is downward, then leveling off for seven years reaching a low in 1902. The drop during the 10-year period is similar to the drop in temperature but here the similarity ends. Temperature trends are already upward before the precipitation trend has reached its lowest point. By 1902, the time the moving summation reached the lowest point in precipitation, the temperature trend had already recovered more than half that which was lost following the year 1885. From this time on, 1902–1916, the moving.

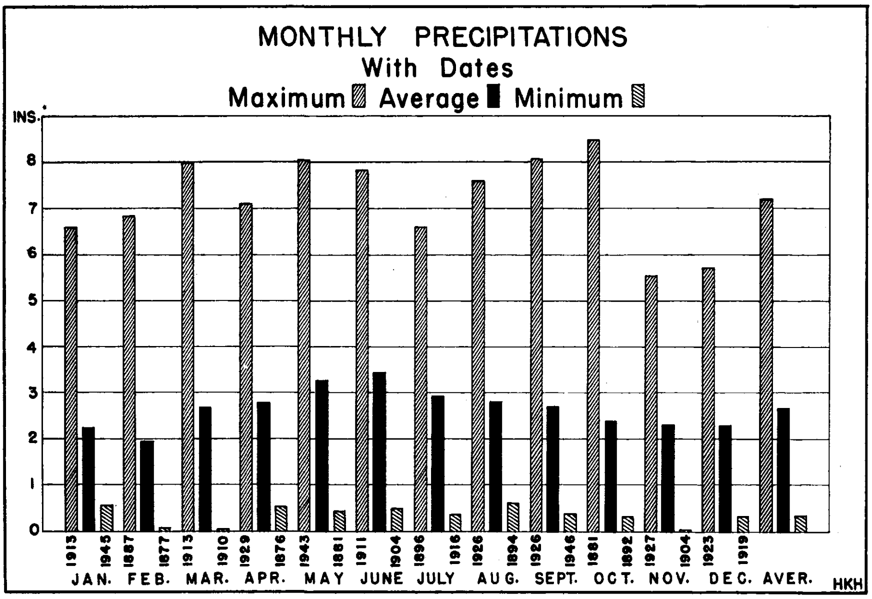

FIGURE 6. Monthly extremes of precipitation compared to the average with date of each.

summation in precipitation had reached its highest point while the temperature summation had changed but little. Between 1916–1939 the general trend in precipitation had been downward reaching its lowest point in 1939; the temperature trend continued upward reaching its highest point the same year. From 1939 to the present, precipitation trends have been upward and temperature trends downward.

Apparently very little in the way of correlation can be made of such trends. The trends which began contrary to the usual relationship between temperature and precipitation has ended quite favorably. Would it be in order to assume that precipitation would occur if the air masses contain sufficient moisture with a general drop in temperature? It would be interesting to make other comparisons in this general region to note whether the same relationship exists between temperature and precipitation as at Toledo.

Figure 6 shows that the difference between the wettest and driest months on record is considerable. The precipitation for the wettest months has varied as much as 13 to 160 times the minimum with the greatest difference occurring in March. Figure 6 shows that every month of the year with the exception of November and December has had at one time precipitation amounting to six inches or more with three months having had over eight inches. The minimum amount is shown to be less than one-half inch for all months at some time except for the months of January and August. The normal monthly precipitation is shown by the black vertical bars in figure 6 and can be readily compared with the maximum and minimum amounts.

The monthly totals of precipitation of one inch or less (a very dry condition) have occurred the following number of times during the period of observation: January, 12; February, 18; March, 4; April, 7; May, 5; June, 3; July, 8; August, 6; September, 11; October, 11; November, 10; December, 9. Thus February is not only the driest month but also has occurred the greatest number of times with a precipitation of one inch or less during this period, an average of one about every four years. The other late summer and winter months also show a dry month every 10 to 12 years.

In spite of the fact that February is the month with the least mean precipitation and the month occurring the greatest number of times with a precipitation of one inch or less, it is not the month with the least ever reported. Table 4, columns 6 and 7, show minimum monthly precipitation and year of occurrence. It shows that two months, March and November, have had less with November, 1904, having had as little as 0.04 of an inch.

Monthly totals for precipitation of more than twice the expected, or average amount, have occurred the following number of times at Toledo during the 80-year period: January, 6; February, 8; March, 4; April, 3; May, 3; June, 2; July, 3; August, 7; September, 7; October, 3; November, 6; December, 3. All months doubled the expected on two or more occasions with June having the least with two, and February the most with eight. The maximum monthly precipitation of 8.49 inches fell in October, 1881. Other maximum monthly values and year of occurrence may be seen in table 4, columns 2 and 3.

Many heavy rains of short duration have fallen at Toledo during the period covered by this study, but two stand out above all others—the one of September 4, 1918, and of August 16, 1920. In the former, 5.98 inches of rain fell within a 24-hour period. This particular storm was not so intense as the latter, in which many new records were established for short periods of time; namely, 0.65 inches for five minutes, 1.25 inches for ten minutes, 1.78 inches for fifteen minutes, 2.87 inches for thirty minutes, 3.58 inches for one hour, 3.65 inches for two hours, and 3.70 inches for three hours. The maximum fall of 3.58 inches for one hour is a state record which has never been broken. The possibility of such severe downpours recurring is about once every 400 years (Sanderson, 1950).

The Toledo Blade of August 16, 1920, refers to this particular storm as follows, "A cloudburst broke over the city shortly after eight o'clock Monday morning and caused damage reaching into millions of dollars." Many of the downtown basements had six to eight feet of water in them and in some instances water was two feet deep for a short time on first floors of stores along Jefferson and Madison avenues. Here the loss was especially heavy as costly merchandise became water soaked or was floated away on the crest of the rushing waves. Jefferson Avenue from Huron to 14th Street was closed as thousands of wooden paving blocks were torn out and "gave the street the appearance of an Irish town after a Sinn Fein-Ulster argument." At the Great Lakes Towing Company office it was estimated that the current in the Maumee River was from five to eight miles an hour approaching the violence of a spring freshet. Three coal steamers which were ready to leave for upper lake ports failed to do so, not daring to attempt the swift current. In the Collingwood and Fulton Street areas, cellar walls began to collapse and thousands of basements were flooded in the west-end residences.

TABLE 4#

PRECIPITATION DATA: MEANS AND EXTREMES
(Length of Record—80 Years)

	(1) Mean Total	(2) Maximum Monthly	(3) Year	(4) Maximum in 24 hours	(5) Year	(6) Minimum Monthly	(7) Year	Snowfall, Sleet, Hail (66 years) (8) Mean Total	(9) Maximum Monthly	(10) Year	(11) Maximum in 24 hours	(12) Year
January	2.23	6.63	1913	1.56	1948	0.51	1945	7.5	26.2	1918	9.8	1885
February	1.95	6.84	1887	2.26	1883	0.08	1877	7.1	25.1	1900	19.0	1900
March	2.58	7.99	1913	2.69	1913	0.05	1910	4.9	17.1	1916	8.4	1888
April	2.78	7.13	1929	2.93	1929	0.55	1876	1.2	9.8	1886	9.0	1886
May	3.24	8.04	1943	3.57	1913	0.45	1881	0.9	4.0	1923	4.0	1923
June	3.44	7.86	1911	3.44	1944	0.51	1904	0.0	0.0		0.0	
July	2.91	6.65	1896	2.47	1929	0.35	1916	0.0	0.0		0.0	
August	2.80	7.64	1926	4.58	1920	0.60	1894	T	T	1949*	T	1949*
September	2.71	8.07	1926	5.98	1918	0.37	1946	T	T	1942*	T	1942*
October	2.38	8.49	1881	3.10	1881	0.32	1892	T	1.2	1925	1.1	1925
November	2.32	5.58	1927	2.68	1871	0.04	1904	1.9	12.0	1932	11.5	1932
December	2.29	5.74	1923	2.04	1885	0.33	1919	6.9	23.5	1895	10.8	1909
Year	31.63	8.49	Oct. 1881	5.98	Sept. 1918	0.04	Nov. 1904	29.8	26.2	Jan. 1918	19.0	Feb. 1900

* Also on later dates, months or years.

Coleman (1950).

SNOWFALL

Records of snowfall for Toledo which cover only a 66-year period have been tabulated for all months of the year excepting June and July (see table 4, columns 8–12 for snowfall data). Snows have been observed as late as May, with a maximum fall of four inches in 1923, and as early as August 1949 and 1950 when traces were reported. The average annual snowfall is 29.8 inches. Greater irregularity occurs with snowfall than with rainfall. Seasonal falls have varied from a minimum of six inches in 1889–1890 to a maximum of 63.7 inches in 1895–1896. December, January and February have had maximum monthly falls of over 23 inches. The heaviest fall occurred during the month of January, 1918 when 26.2 inches fell. There appears to be a tendency however, toward a slight general downward trend in total annual snowfall from the beginning of the century to the present time.

The maximum snowfall within any 24-hour period occurred on February 28, 1900, when a depth of 19 inches was measured. The Toledo Blade of this date reports that the snow began to fall a few minutes after midnight and continued to fall with but few interruptions until near noon on March 1. Fortunately the wind velocity was only eight miles an hour with a temperature of 20° F which did not permit much drifting of the heavy snow. The heaviest part of the storm was during February 28, between 7:00 A.M. and 7:00 P.M. when over 11 inches fell, but did not completely stop until 22 inches had fallen, a record for any single storm which still stands at Toledo.

The problem facing the street commission and other civil groups was a perplexing one. Over 100 extra men were employed to clear crossings in the downtown district and over 200 extra men were hired by the Consolidated Electric Company in an attempt to keep their lines open. The limiting factor was not so much one of men but of shovels and other tools which might be used for clearing purposes. Needless to say, trains and all traffic were delayed many hours and business in general was at a standstill. The only business that did not suffer because of the storm was the shoe stores. They were besieged for hours for overshoes and rubber boots, and available stock became the limiting factor here.

THUNDERSTORMS

Thunderstorms are most frequent during the summer months of the year when heat and moisture are abundant and light winds favor convection. The average number of days with thunderstorms is 35 each year. No month of the year is exempt from them although the number of thunderstorm days increases throughout the spring months reaching a maximum in June and July with an average of seven each, and decreasing throughout the late summer and fall months. Frequently high winds and heavy rains are incident to the passage of these storms.

A rather unique condition exists in relation to the winter thunderstorms which are not common at great distances from Toledo. Usually in early winter a few severe electrical disturbances occur caused by the relatively warm condition of the lower air over the water and the cooler upper air. These displays occur mostly in the latter half of the night when the temperature difference in the air masses is at its greatest.

WINDS

The location of Toledo in the belt of prevailing westerlies exposes it to the influence of winds from all directions and with varying velocities. This is especially marked during the winter when cyclonic storms are most active and wind conditions may change within the space of a few hours.

The prevailing wind direction, over a 70-year period, is from the southwest for all months of the year with a mean hourly speed of 11.3 miles. The highest mean hourly speed of 13.0 miles is reached in March followed closely by April, January, and February, respectively. Lighest winds occur in August with a mean hourly speed of 8.9 miles. Data on the speed of wind in its fastest mile are not very reliable as records are only of seven years duration. These high velocities are reported largely from a westerly direction ranging from 38 miles per hour in July, 1946, to 87 miles per hour in March, 1948. Winds of very high velocities of tornado-like strength have passed through Toledo on earlier occasions. On March 28, 1921, a big wind swept through the city and nearby areas killing 20 persons, injuring over 80 and leaving more than 500 homeless. This twister was said to have been the most devasting since the one long ago that created Fallen Timbers along the Maumee.

SKY COVER

Figure 7 presents the condition of the sky between sunrise and sunset during the 80-year period. A series of four vertical bars are used for each month to indicate this condition on the basis of clear, partly cloudy, cloudy and average sky cover. December has the least sunshine and the greatest amount of cloudy skies with values of 16 and 58 percent respectively. Throughout the winter and the spring months the percentage of days with clear skies steadily increases reaching a maxi-

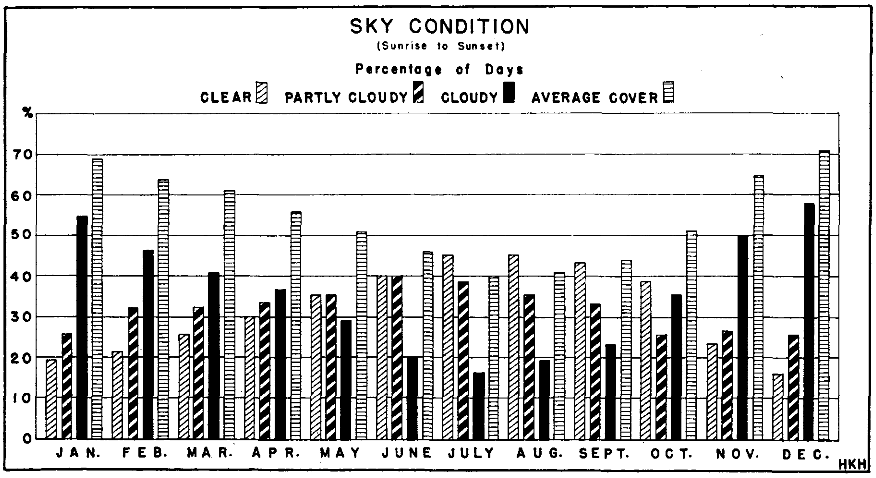

FIGURE 7. Monthly sky condition based on percentage of days Clear, Partly Cloudy, Cloudy, and Average Cover (1871–1950).

mum in July and August of a little over 45 percent. Cloudiness, on the other hand, continues to decrease during the same period reaching a low of 16 percent during the month of July. The bars indicating the partly cloudy days do not fluctuate as widely as those showing clear and cloudy skies. In the late fall and winter approximately 26 percent of the days are partly cloudy with the percentage increasing to 40 by June when the maximum is reached. The bar representing average sky cover is based on the percentage of the sky obscured by clouds from sunrise to sunset. The data presented by this bar differ from the bar showing percentage of cloudy days in that it is a combination of cloudy and partly cloudy conditions insofar as the sky is covered by clouds. During the month of December, 71 percent of its skies are covered by clouds accounting for the dark dreary days of that month. The cover decreases steadily until July, when the skies are freest from clouds with only a 40 percent cover.

OTHER PHENOMENA

There are a few minor observations which may be made that do not always enter into climatological reports in such a way that frequency data can be given. This may include such things as fogs, glaze and humidity conditions. A brief treatment of these phenomena will conclude the present paper.

Heavy or dense fog which limits the visibility to one-quarter of a mile or less are not common to the Toledo area. The records show such fogs occur on the average of seven days a year. These are so distributed that an average of one occurs each month from September through April while the other months of the year average less than one-half day per month. Lighter fogs or hazy conditions do occur more frequently but are not as hazardous to street and highway traffic.

During the winter there are occasions when light rains or misty conditions prevail with temperatures which are critically near the freezing point. This results in traffic snarls and many accidents if a coating of ice forms over streets and highways. Usually such accidents are minor as traffic crawls along at a snail's pace. These conditions result in the street department sending out crews of men to scatter salt over the icy surfaces. Accidents are reduced but the salty slush striking the under surfaces of cars causes considerable damage unless protected by undercoating. Much damage comes from the increased weight on utility lines and poles, trees and shrubbery, and other similar objects which may cause breaks or costly repair bills.

Another condition of the atmosphere which affects the individual and his goods in more ways than one, both in summer and winter, is the moisture content of the air. Data are not available on absolute humidity but records have been kept on relative humidity at 6-hour intervals throughout the day for varying periods of time. The 7:30 o'clock readings for the morning and afternoon have been kept for 62 years; the 1:30 P.M. reading for 20 years and the 1:30 A.M. reading for 11 years.

These readings show that the highest annual average occurs at the 1:30 A.M. hour with the air being 82 percent saturated. A small drop occurs between this reading and the one taken at 7:30 A.M. which is four percent less or 78 percent of saturation. A much greater decrease is noted for the afternoon observations. At 7:30 P.M. the air is 68 percent saturated and is 60 percent saturated at 1:30 P.M. This drop for the afternoon hours is to be expected with increasing temperatures.

There is some difference in the time of the year that the relative humidity reaches its maximum and minimum values at these hours. At the 1:30 A.M. hour, August and September have an average high of 85 percent for both months with a low of 78 percent in April. At 7:30 A.M. an average high of 82 percent is recorded for December and a low of 74 percent for May. For the afternoon periods of observation at 7:30 P.M. and 1:30 P.M., the highest monthly average occurs in December with readings of 76 and 71 percent respectively. The lowest averages occur in July with an average of 59 and 52 percent respectively.

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