

Climatic Changes in Indiana

STEPHEN S. VISHER, Indiana University

Changes of climate have occurred repeatedly here in the long past, and presumably will occur in the future. The following discussion is partly an abstract of the chapter on climatic changes in "Climate of Indiana,"¹ where more details are presented, with several additional graphs. Here, however, some new material is presented.

Several sorts of climatic changes certainly have occurred in Indiana:

(1) At certain times in the remote geologic past, this area had a warm climate, as shown by the presence of many corals; at other times it was cold, as evidenced by the presence of a continental ice sheet deposit covering most of the State. (2) At times this area has been arid enough to permit the accumulation of widespread salt beds. At present it has a humid climate. The rock formations laid down under the sea, and also those accumulated in vast, almost-sea-level swamps, especially during the time of coal accumulation, are indications that at times in the past, surface moisture was even more abundant than at present. (3) At present, Indiana is not a windy state. The presence of extensive deposits of loess along the southwestern margin of the State and of extensive former sand dune areas in the northwestern eighth of the State suggest, however, that at some other times, the wind has been a more active agency than it is at present. (4) The alternation of glacial and interglacial epochs during the Pleistocene, one of the outstanding and especially puzzling aspects of the changes of climate, occurred in Indiana, where evidences of three glacial advances have been found, with two interglacial epochs. (5) Since the melting away of the late Wisconsin Ice Sheet, which disappeared from northern Indiana some 20,000 years ago, there have been a number of significant climatic oscillations. Studies of the pollen and other plant remains of Indiana peat bogs have shown that the vegetation varied from century to century, and that a milder, drier period preceded the present one.² There is some good evidence that this major mild drier period ended about 4,000 years ago, and that the modern period of increasing dryness and mildness commenced about a century ago.³

¹ Visher, *Climate of Indiana*, Indiana University Science Series, 511 pp., Bloomington, Ind., 1944.

² Potzger, J. E., and Friesner, R. C.: Plant Migration in Indiana. *American Midland Naturalist*, 22:351-368, 1939, and several earlier studies of Indiana bogs by these men or their students; also papers by Markle and Welch, in *Proc. Ind. Acad. Sci.*, Vols 25 to 45.

³ Matthes, F. E.: On the fluctuations of existing mountain glaciers and salt lakes. *Trans. American Geophys. Union*, 1939, pp. 518-522. (In his chapter on Glaciers in Meinzer (ed.): *Hydrology*, New York, 1942, Matthes concludes that

SOME EARLY WEATHER RECORDS NEAR INDIANA

The U. S. Weather Bureau was established in 1871; there are comparatively few Indiana records of rainfall and temperature prior to that date. Scattered records in and near Indiana during the half-century before 1871 indicate, however, that some years were exceptionally wet, that others were relatively dry, while others were unusually cold or warm.

Dayton, Ohio, only a few miles from Indiana's border, had its rainiest year of record in 1846, when 62.96 inches was recorded. Cincinnati received 65.18 inches in 1847. St. Louis, Missouri, received 65.36 inches in 1848. The rainfall of southwestern Ohio and southern Indiana was exceptionally copious during 1846 to 1860. Indiana rainfall records for 1858 are available for New Harmony, 48.7 inches (the maximum on record, except 1880), and for Richmond, 56.7 (exceeded only by 1855—56.8 inches). These totals are about 40 per cent more than Richmond's average. No Indiana rainfall records for 1846-1848 are now available.

Four curves by Hoyt of the variation in precipitation, 1880-1935, as shown by ten-year progressive averages for a region somewhat larger than Indiana centering in northeastern Indiana show that for the year as a whole, the fluctuation was sharply downward from 1880 until about 1901 when, on the average, the curve rose till 1930. For the months December to April, the rise which commenced about 1902 ended about 1912, since which period there has been a moderate decline. For the months May to August, inclusive, there has been a decline since about 1900. For the autumn months, however, there was an irregular rise from about 1910 to the end of this record, 1935.

At Chicago the coldest 20 year period of 1871-1940 was 1885-1904; the warmest was 1920-1939; the coldest individual year was 1875, the warmest was 1933. At St. Louis from 1845-1945, the coldest period centered at 1875, the warmest at 1939. For the United States as a whole, as well as for parts of the country, the years 1940-1946 have been less warm, and less dry than those of the 1930's.⁴

SOME INDIANA TRENDS

Precipitation. The curves for stations near Indiana or for large regions including Indiana lead to the expectation that the precipitation fluctuation in Indiana has been considerable. Bar graphs of the annual total rainfall at Indianapolis for 1871-1940 and of the rainfall of April to August, inclusive, at Indianapolis, 1883-1940, display a moderate but irregular fluctuation, without any clear evidence of trends. However when an analysis of the data is made by more refined methods, some evidence of trends appear. Figure 1, by Kincer, shows the fluctuations in Indiana's precipitation, 1875-1936, by the method of five-year moving

from about 4,000 years ago until about 1850 there was a colder, wetter period, during which many mountain glaciers accumulated. Since 1850 glaciers have been declining, rapidly since 1920.)

⁴Kincer, J. B.: Our Changing Climate. *Trans Am. Geophys. Union*, Vol. 27:342-47, June, 1946.

averages of the annual totals. This graph shows that the five years ending in 1929, 1908, 1892, and 1883 were especially wet while the five years ending in 1903 was only moderately less dry than the period 1930-40.

The precipitation departures in Indiana for each of the months were studied by the late Larry Page who found that for the average of 1916-1935, February and July were much drier than for the average of 1896-1915, but that April and September had much more rainfall. The other months had averages for the latter twenty years which were close to those for the first 20.

Temperature. Although the fluctuations in precipitation are more significant in Indiana than those of the monthly or annual average temperatures, because they are more critical and larger, there is especial popular interest in temperature changes. Between 1887 and 1940 the first 30 years displayed less extreme departures from the normal than is true

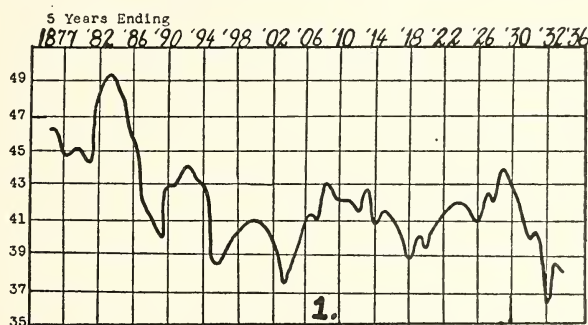


Fig. 1. Fluctuation in Indiana's average annual precipitation by five-year moving averages. (after Kincer.)

for the years 1917-1940. During 1887-1916 no clear trend is evident. From 1916 to 1940, however, a considerable upward trend occurred.

Figure 2 shows that the chief changes in temperature between the average for two halves of the 40-year period, 1896-1935, was that February became much warmer and May became considerably colder. The other months changed but little.

Figure 3, two interesting original graphs, show the variation in the mean winter and summer temperatures at Indianapolis from 1871 to 1940 averaged by five-ten- and 20-year periods. The 20-year curve for the summer months shows a slight decline until 1920 and then a rise. The 20-year curve of average winter temperatures shows a slight decline to about 1900 and then a rise. The ten-year average curves for the winter show only slight fluctuation until about 1915, but a distinct rise since then. For the summer, the ten-year average curve shows a much greater variation, with a sharper drop in the early years. (to 1885) and a sharper rise, 1925 to 1940. The curves for five-year average temperatures show several curious alternations of rise and fall. Although since about 1917 the summer and winter curves have risen and fallen together, as they did also

for the second five years of the period 1871-1940, in a number of other five-year periods, they were in opposition instead of parallel.

Hence when the year as a whole is averaged, or summer or winter, the fluctuation from year to year in average Indiana temperature is rather irregular. Annual and seasonal averages are not, however, the

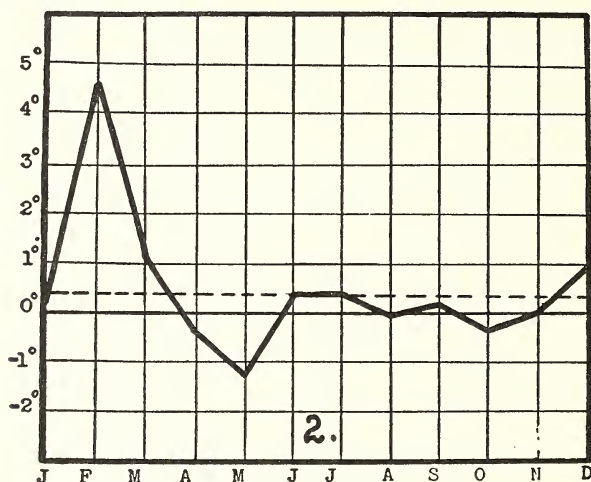


Fig. 2. Differences in average monthly temperatures, 1896-1915 as compared with 1916-1935. (after L. Page.)

temperature conditions that are readily evident; instead, the extremes are impressive. Three brief spells were exceptionally cold during the first 20 years of Weather Bureau record (1871-1890), but most of the records for lowest temperatures were established in 1917-1918, with a few others set in 1936. The duration of subzero weather in 1940 was also notable.

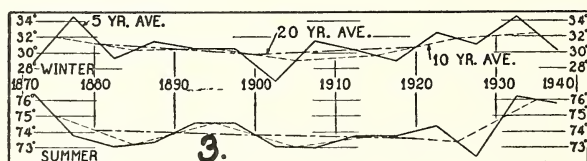


Fig. 3. Variation in the mean winter and summer temperatures at Indianapolis 1871-1940, averaged by five, ten, and twenty-five year periods.

On the other hand, the data on high temperatures shows that most high temperatures records were established in the 1930's. Between February 19, 1936 and January 2, 1940, for example, no official temperature of zero was recorded at Indianapolis. Never before since the Weather Bureau station was established in 1871 have three consecutive winters passed without a zero temperature at Indianapolis. The nearest approach to three consecutive winters with no zero was, however, in 1889-1892, which had only two zero days in three years.

The annual number of days with temperatures of 90° or higher at Indianapolis has varied greatly from year to year. In 1877 no day was that warm, but in 1936 there were 53 such days. The annual average number of such days is 17. During 1871-1890, however, there were an average of 13; the next 12 years had an average of twice as many (26); the next eight years averaged 12; and the next nine years again averaged twice as many (24). The decade, 1921-1930, averaged 17, and the next nine years, 30. Thus there has been a curious alternation of groups of years, the hot ones in this special respect having about twice as many days with 90° or higher as occurred in the cooler groups. The groups of years are, however, not of equal length and within each group there are one or more years which departed widely from the average for the group. Hence the predictive value of this sequence is not at all high as applied to a single future year. An average increase is shown despite the fact that several early years were warmer than most recent ones and several years of 1900-1929 were cooler than most of the early years.

SUMMARY

During the long geologic past, Indiana has experienced several great changes of climate; numerous fossil corals indicate that it has been almost tropically warm; at another time it was almost covered for many thousands of years by a great ice sheet; it has been so dry that extensive salt beds accumulated; it has been covered repeatedly by the sea and once by great marshes in which our valuable coal beds accumulated. These great changes of climate occurred gradually, requiring thousands or millions of years.

Since white people came to Indiana, there has been continued fluctuation in temperature and rainfall. Many people believe that Indiana is becoming warmer and drier. But when the records are carefully studied, it is seen that while some early years were colder and wetter than most recent ones, others were exceptionally warm and dry. Indeed almost all recent records have been matched or closely approached years ago and vice versa. However 1930-1936 were relatively warm years on the average, although the winters of 1936 and 1940 were exceptionally cold. Some early years were much wetter than 1930-1936, but the driest summer of record in central Indiana was that of 1895 and the wettest one was that of 1929. As to snowfall, the whole of southern Indiana had an average fall of 41 inches in 1917 but less than 2 inches in 1919.

In brief, while Indiana experiences sharp changes in temperature, rainfall, and snowfall, these changes are mostly irregular changes of weather. The changes of the average conditions which are called climate are slight during the lifetime of a person. The tendency to remember the highly exceptional conditions that occurred long ago, and to forget the conditions which prevailed most of the time, makes reliance upon memory far less dependable than reliance upon careful records. There is no good evidence that Indiana is becoming systematically, regularly, drier or warmer. Instead, there are irregular oscillations; for example the years since 1936 have been notably less warm and less dry than those of 1930-1936.