CYCLONIC AND FRONTAL ACTIVITY IN OHIO DURING THE SUMMER OF 1953

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The summer of 1953 was an unusually dry one in most of southern United States and parts of the midwest. The state of Ohio had one of its driest summers in several decades in 1953. A cross section of the state's weather may be seen in the statistics for Cleveland, Columbus, and Cincinnati, these stations being located in the north, central, and south parts of the state respectively. An average of the normal precipitation for these three stations during the period June 1 to September 30 is 13.39 inches. In 1953 the average precipitation for these stations was 10.04 inches for the summer (Clim. Data, 1953), 26 percent below normal. Individual stations may frequently have a commensurate or greater variation from one year to the next; but when several stations in the same part of the country show a similar variation in one season, a variation in warm season climate is indicated.

Several authors (Winston, 1953; Klein, 1953a; Klein, 1953b) have noted that a pronounced anticyclonic circulation associated with the subtropical high pressure cell dominated the upper air over southern United States much of the summer and was immediately associated with the drought of that summer. A contributory cause was the prevailing direction of the upper air winds which was such as to restrict clashes between Continental Polar and Maritime Tropical air masses over the United States.

This study is not concerned with the upper air. Instead, the emphasis here is on the surface situation as shown by weather maps. It is felt that a consideration of day by day surface weather might lead to a fuller understanding of the warm season climate of the area in question.

In order better to see the summer of 1953 in its proper perspective, a comparison of cyclonic activity during that summer and one or two during which precipitation was near normal or above should be helpful. It is the purpose of this paper to make such a comparison.

The summers of 1947 and 1956 are used for comparison. The year 1947 had the wettest summer in Ohio in the past decade, the average rainfall for the three stations being 16.26 in. from June 1 to September 30 (Clim. Data, 1947), or 21 percent above the long term average. The summer of 1956 is included as an additional comparative year, the rainfall that summer being within 3 percent of the long term average (Clim. Data, 1956).

The stations selected for the study each have a length of record of over 40 years. The comparison of summer precipitation for a given year with an average utilizes long term averages as of 1953. The area of primary concern is the State of Ohio. Although political boundaries and climatic regional boundaries seldom coincide, the writer does not feel that this fact renders invalid a study of the climate of a politically defined area. There is no attempt made here to suggest that the conditions discussed are peculiar only to Ohio nor to any particular climate type.

Paths of Cyclones

Of primary consideration in a comparative study such as this are the storm tracks or paths followed by cyclones during the years in question. Although the area of principal attention remains as defined, cyclones may often be centered

outside that area and still affect it. Hence, figures 1, 2, and 3, show all cyclones occuring in eastern North America between latitudes 30° N and 60° N and east of longitude 90° W. Many of the northernmost cyclones would not affect Ohio; they are included in the interest of a more complete picture. These maps were compiled from monthly maps of cyclone tracks (Mo. Wea. Rev., 1947, 1953, 1956). Figure 4 summarizes the three maps of cyclone paths. Inasmuch as the number of cyclones is variable from year to year, the graph shows the *percentage* of cyclones crossing the 85th meridian in each of several zones, four degrees of latitude

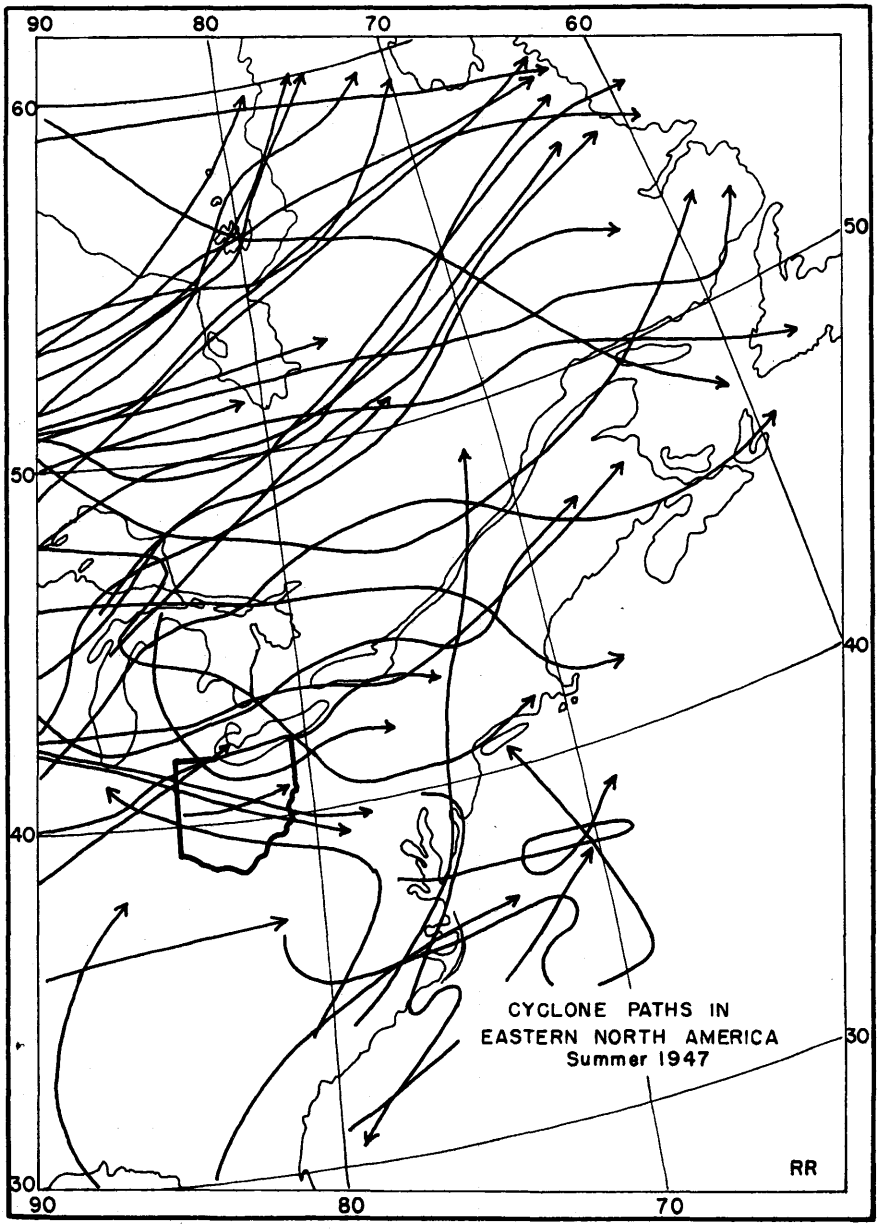

FIGURE 1

in width. Of the variety of choices of latitude units possible, a four degree unit was chosen because it approximates Ohio's latitudinal width. Similarly, since Ohio's north and south boundaries lie within one half of a degree of the 42° and 38° parallels respectively, this four degree unit formed the numerical basis for the selection of the other latitude units.

It will be seen from the graph that 1947 and 1956 have a maximum in or just north of Ohio. In 1953 this maximum is less pronounced and is farther poleward while the major concentration is along the south edge of Hudson Bay. The

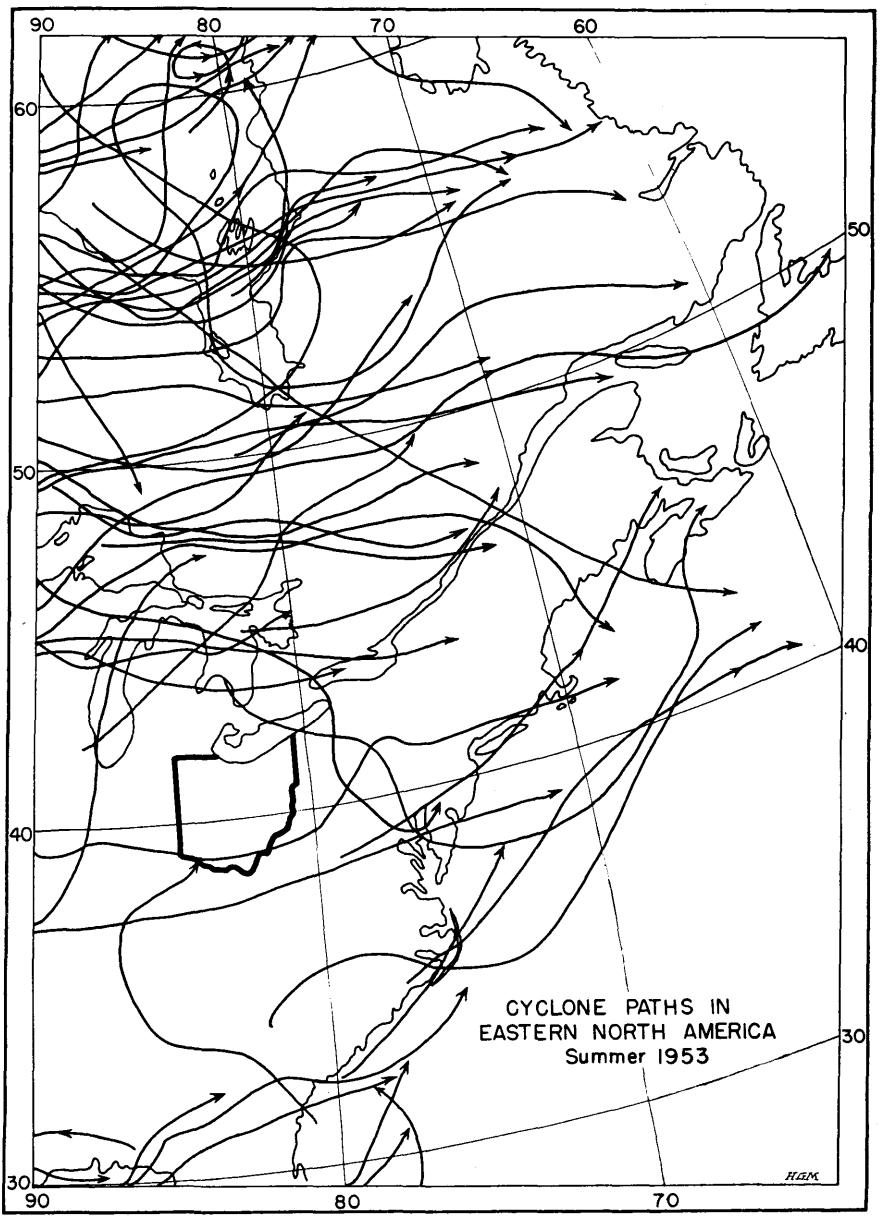

FIGURE 2

years 1947 and 1953 are alike in having two maxima, but those of 1947 are closer to Ohio and more nearly equal. The pronounced single maximum of 1956 would seem to suggest an even wetter summer in Ohio than 1947. The first three months of the warm season averaged above normal precipitation, but the markedly reduced rainfall at all three stations in September had its effect on the four months total.[1] It may also be noted that there was a greater percentage of cyclones at Ohio's

[1]It may be noted here that the upper air situation of September, 1956 has been likened to that of September, 1953 (Hawkins, 1956).

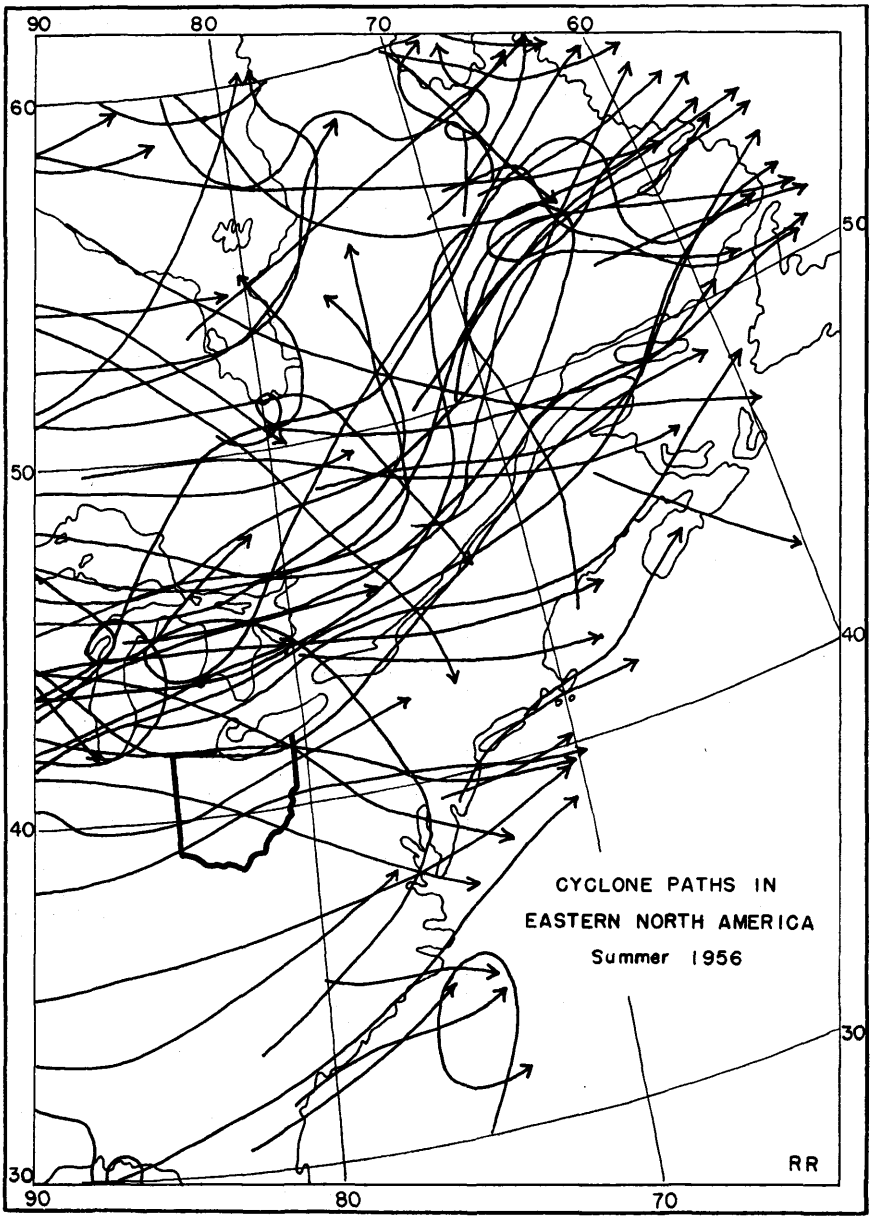

FIGURE 3

latitude in both of the wet years than during the dry year. In short, it would seem that coincident with the occurrence of a drier-than-average summer there was a comparative dearth of cyclonic activity in or near Ohio. If we can assume that, in general, the amount of precipitation decreases as distance from the low center increases, the above consideration of surface weather suggests that Ohio in 1953 was drier than the other two years partly because of the greater remoteness of most of that summer's cyclones.

Precipitation Types

It is common to find cyclonic precipitation considered along with frontal precipitation as opposed to that due to other causes such as convection, etc. This is, of course, in recognition of the fact that much precipitation which occurs with the passage of a cyclone is more directly due to its associated fronts than to

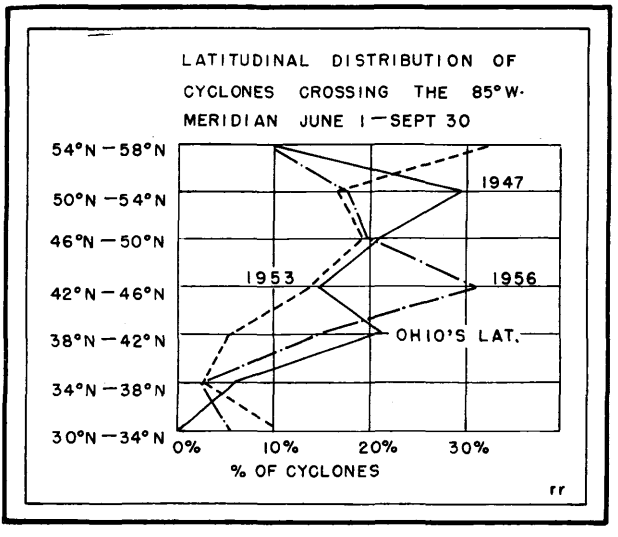

FIGURE 4

the low center itself. In like manner frontal and cylonic precipitation are considered jointly in this study, and the terms frontal and cyclonic are used interchangeably. It is recognized that not all warm season precipitation is necessarily due to fronts and cyclones, that some may be due to other causes. It is in fact possible that the differences in summer rainfall mentioned at the beginning of this paper are, for example, differences in the amount of convective rainfall. It therefore becomes necessary to determine how much of the summer rainfall in Ohio is associated with fronts and cyclones and how much is due to other causes. Since this study is concerned primarily with the former type, no attempt will be made to identify as to cause rainfall that is not frontal or cyclonic. It will be referred to hereafter simply as "other."

The problem of differentiating between frontal and other rainfall may seem straight forward enough at first; however, in the course of considering all rainfall that occurs at a number of stations—especially during the summer months—problems do arise. In studying the dates on which rainfall occurred at these stations and daily weather maps for the same dates, it was noted that the majority of rainy days were days when a front or a cyclone was in the near vicinity of the station. A rather broad interpretation of the word frontal is used herein, partly because of the aforementioned fact, and partly because it is felt that a thorough pursuance of the matter is a separate study in itself. The word frontal will be used hereafter to refer to precipitation occurring within the general limitations

set out below. Experiments employing arbitrary distance limits from cyclones or fronts proved unsatisfactory and were discarded.

On the Daily Weather Map of recent years, the main map and two of the smaller maps may be used to obtain a fairly continuous picture of surface weather. By combining the information on the large map with that on the small map showing the synoptic situation 12 hours earlier, a sequence of frontal movements can be obtained. Another small map shows areas where precipitation occurred during the 24 hours prior to the time of the large map. In many cases the striking coincidence between the *pattern* and location of the precipitation area and the area through which fronts moved during the period in question seems to indicate the cause of the precipitation. Admittedly the picture is often not as clear cut as is desirable; naturally occurring phenomena often leave much to be desired in this respect. Locations near the margins of affected areas require arbitarary decisions. However, where the station in question lies within an uninterrupted area of precipitation, which area has experienced a frontal passage or cyclonic activity during the same time interval, all precipitation at the station is herein classified frontal.

TABLE 1

Amount and type of precipitation June 1 to September 30

FRONTAL PRECIPITATION	1947	1953	1956
Cleveland	16.82	11.61	13.03
Columbus	15.28	7.36	10.85
Cincinnati	11.49	5.79	10.88
Average	14.53	8.25	11.59
% of Average Total	89	86	84
OTHER PRECIPITATION	1947	1953	1956
Cleveland	1.64	.21	1.55
Columbus	2.51	2.12	.84
Cincinnati	1.05	1.74	4.28
Average	1.73	1.36	2.24
% of Average Total	11	14	16

As pointed out earlier, the coincidence between precipitation dates and frontal activity dates is considerable at the stations here discussed. The actual amounts as shown in table 1 illustrate this more specifically. It will be seen that during each of the three years considered, for each of the three stations the amount of frontal precipitation is markedly greater than that which is classified as other. These figures were arrived at by checking each day that precipitation occurred at each station (Clim. Data, 1947, 1953, 1956) against the daily weather map (Daily Wea. Map, 1947, 1953, 1956) and classifying the precipitation as frontal or other as outlined above. The significant difference in the precipitation amounts is the one between 14.53 or 11.59 on the one hand, and 8.25 on the other, an average of 3 to 6 inches less frontal precipitation in the dry summer. Insofar as the other category is concerned, the three Ohio stations averaged only 0.4 inches less in 1953 than in 1947, and 0.9 inches less than in 1956. It would thus seem indicated that the difference in the amount of the other precipitation is, relatively speaking, unimportant here. It is interesting to note that despite the admittedly broad interpretation put on these two categories, the percentages are remarkably close for the three years considered.

The writer was interested in knowing whether there was any difference in the velocity of cyclones during a wet summer as compared to those of a dry summer. Using the aforementioned maps of cyclone tracks in the Monthly Weather Review, an average velocity was computed for each cyclone crossing the 85th meridian between 30° N and 50° N during the summer; and the several figures were com-

bined to obtain an average for the whole summer. A comparison of the averages for the two summers revealed no significant differences, the actual difference between two summers being about 1 m.p.h. Similarly the relative depth of cyclones during two of the summers were compared utilizing Daily Weather Maps. Average pressure gradients for the several cyclones of each summer were obtained by combining distance in miles from the low centers to the associated high pressure centers with the pressure difference across this distance. The average pressure gradient computed for the summer cyclones of 1947 differed from that computed for 1953 by one-tenth of a millibar in 100 miles, hardly a significant figure.

SUMMARY

In comparing cyclonic activity during the several summers here considered, the following points were noted:

1. During the dry summer in Ohio, a majority of the cyclone paths were markedly farther north of the state than during either of the wetter summers.
2. Cyclonic and associated frontal precipitation as herein defined was clearly the dominant type at the three stations considered during both dry and wetter summers.
3. A study of the surface weather maps for these summers therefore suggests that 1953 was drier because more of the effective cyclonic and frontal activity in eastern North America occurred north of Ohio during that summer.
4. No appreciable difference in velocity or relative depth of cyclones in the years considered was noted.

A comment seems in order concerning the percentage of total summer precipitation here described as being associated with frontal or cyclonic activity. Some may feel that the percentage is too high, that more of the summer precipitation is due to other causes such as convectional activity. Others may feel that the percentages should be still higher, that were upper air cyclonic effects taken into consideration an even higher percentage of the precipitation would be so categorized. The latter point of view is not debated here as the emphasis in this study was on weather as shown by surface maps. As regards the other point of view, more definitive criteria for classifying precipitation as to origin and a broader statistical coverage both in years and number of stations should show whether they are representative or not. It is believed that even with the above refinements, cyclonic or frontal precipitation will be found to be clearly dominant.

ACKNOWLEDGMENT

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