

CYCLONIC DISTRIBUTION OF WEATHER ELEMENTS FOR DAVENPORT, IOWA.

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The daily weather forecasts issued by the United States Weather Bureau stations are largely based upon the easterly progress of successive areas of high and low pressure across



Figure 10. Number of Observations in each tract.

the continent. The accuracy of the predictions depends upon the determination of three factors, namely: the probable path of the cyclone or anti-cyclone during the next twenty-

four hours; its probable translational velocity; and the *distribution* of the meteorological elements within the highs and lows.

The purpose of this paper is to describe some of the results obtained from a statistical study of the distribution of the weather elements for Davenport, Iowa. The present work is based upon a method of study devised by Dr. J. A. Udden and described by him in a paper entitled, "On the Cyclonic Distribution of Rainfall."*

The plan consists in constructing a hypothetical cyclonic area

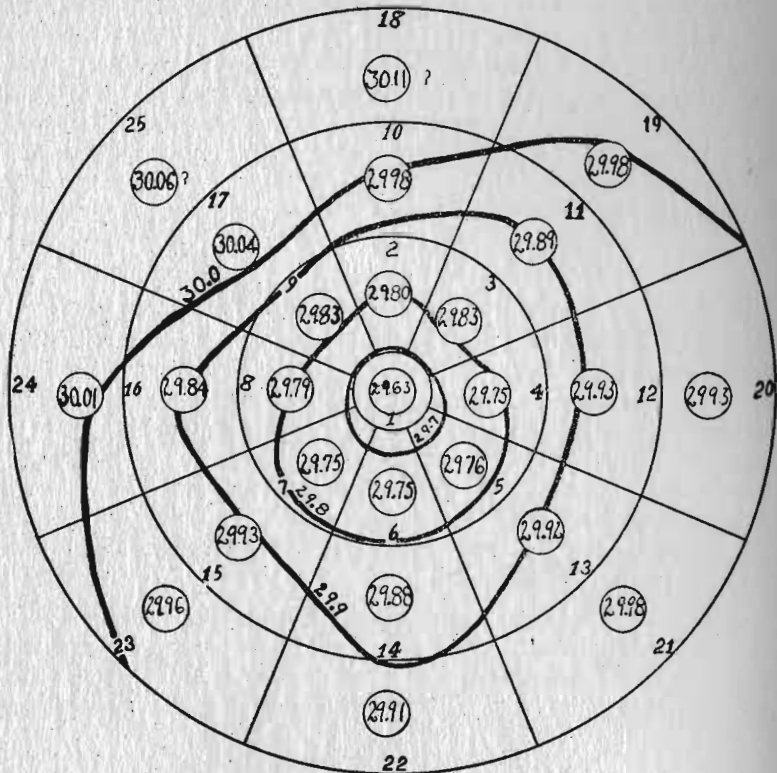


Figure 11. Barometric Pressure

as shown in Fig. 10. Four concentric circles are drawn whose radii measure respectively 100, 400, 700 and 1000 miles in length. Eight radii 45 degrees apart and extending from the outer to the inner circle delimit 25 tracts within the hypothetical cyclone. These are numbered from 1 to 25 in the figure.

*Augustana Library Publications, No. 4, Denkman Memorial Library, Rock Island, Ill.

The next step is simply to determine from a weather map the particular tract of the cyclone in which Davenport lies and to record the simultaneously existing weather conditions. By obtaining a sufficient number of observations it is possible to ascertain the average weather conditions when Davenport is situated in any given area of the cyclone.

The present study is based upon an examination of the

CONSTANCY SCALE

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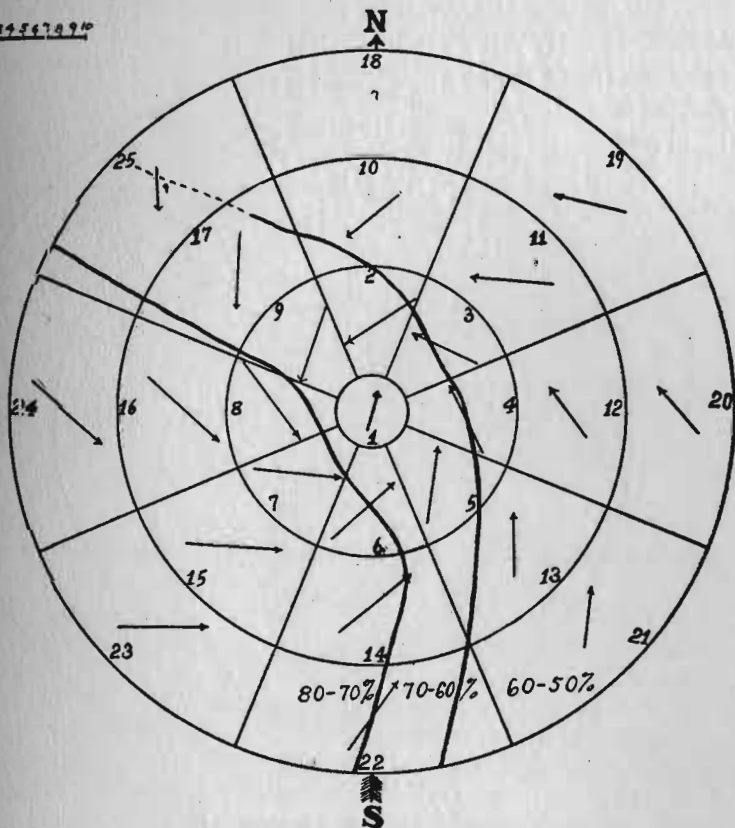


Figure 12. Wind Direction

morning and evening weather maps for a period of about twenty years. A total of 4508 observations have been secured. These are distributed unequally among the 25 tracts of the hypothetical cyclonic area as seen in Fig. 10. The maximum number of observations, namely 521, occurs in tract 15; in this position Davenport lies about 550 miles southwest of the center of the low. The fewest observations, 17 in number, are found in

tract 18, when the center of the low occurs over the Gulf coast. The number of observations in each area is sufficient to give a fairly reliable average of the weather conditions in all tracts except 18 and 25. For this reason the averages in these tracts have been checked by a question mark in the accompanying diagrams.

The number of observations given in figure 10 also show that the center of the low passes north of Davenport about

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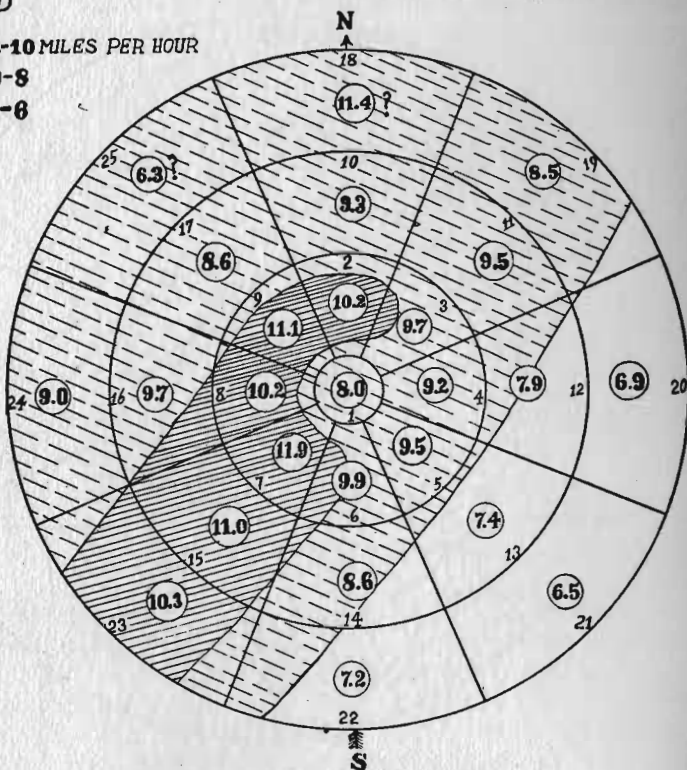
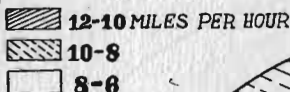


Figure 13. Wind Velocity

twice as frequently as to the south. It passes east and west of the city with about equal frequency. These results evidently depend upon the location of Davenport with reference to the storm tracks traversed by the cyclones.

The distribution of the barometric pressures is shown in figure 11. The numbers within the circles give the average pressure in inches for each tract. The heavy concentric lines represent isobars which conform to the pressure values. In

general the pressure decreases radially toward the center. At the same time it is also evident that the pressure gradient is steepest in the northwest and less toward the southeast. The pressure distribution has a direct bearing on some of the results presented below.

The arrows in figure 12, indicate the prevailing wind directions in the various tracts of the cyclone. They exhibit the general spiral motion of the wind characteristic of cyclones. Upon nearing the center the winds deviate increasingly toward the right. The wind direction in the central tract possesses a southwesterly component of motion. The lengths of the ar-

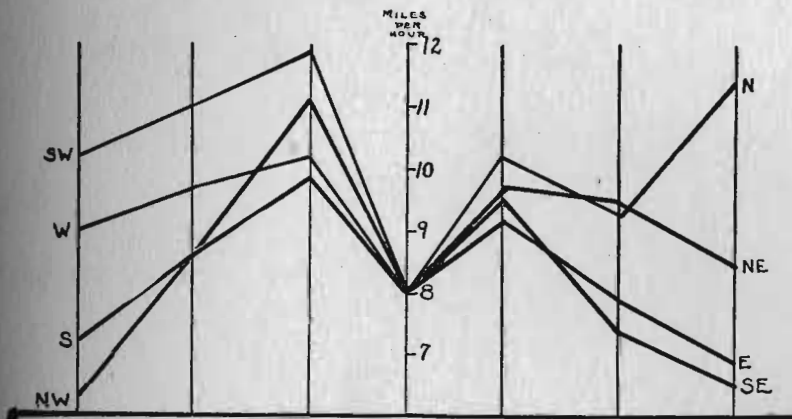


Figure 14. Wind Velocity

rows in figure 12 are proportional to the relative persistence or constancy of the wind in the average direction. The constancy of the wind shows two distinct variations. It increases radially inward to a maximum and drops to its lowest value at the center. This variation is evidently due to a similar radial variation of the wind velocity shown in figure 13. The greater inertia of the higher wind velocities renders them less liable to be deflected by accidental causes. Secondly, the constancy of the wind is greatest in the southwest and decreases toward the northeast. This is shown in figure 12, by the three areas embracing wind directions whose constancy values are, respectively 80-70 per cent; 70-60 per cent; and 60-50 per cent. The high constancy of the wind direction in the southwest is probably due to several causes; the uninterrupted sweep of the wind over the level western prairies; the high wind velocity in this region as shown in figure 13; and

to the relatively stable temperature conditions. The low constancy value in the east and northeast may be accounted for in a similar manner. The presence of the Great Lakes would probably increase the variability; the average wind velocity is low; and the prevailing high temperatures in the east and southeast would introduce an unstable element. (The data in this paragraph are based only on the A. M. observations.)

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 60-50

 50-40

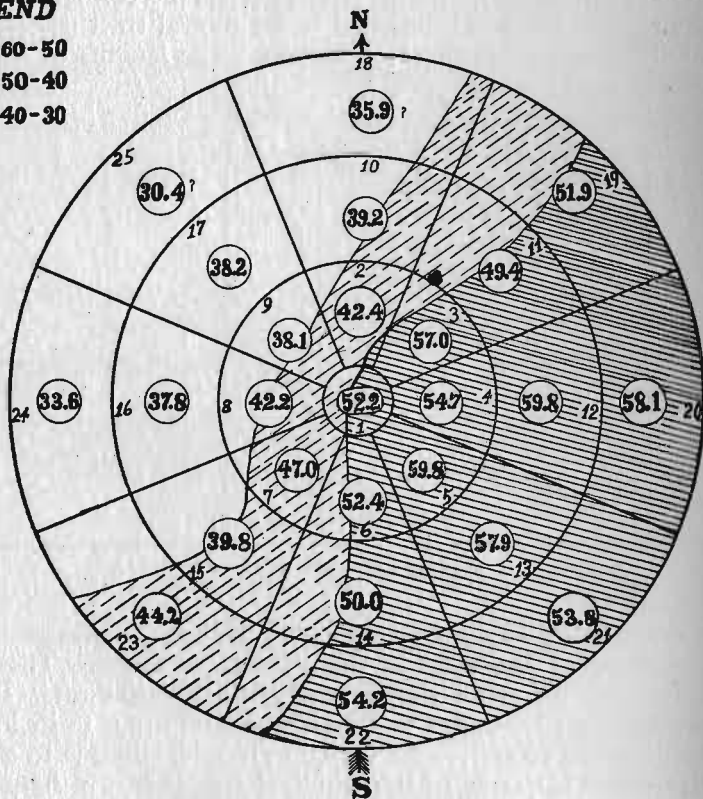
 40-30


Figure 15. Temperature

The distribution of wind velocities within the cyclone is given in figure 13. The average wind velocity in miles per hour for each tract is indicated by the number inscribed in the small circle. The variation in wind velocity may be separated into two components. First: the shaded areas show that the higher wind velocities prevail in the west and northwest while the lower velocities occur to the southeast of the center. This condition is a direct consequence of the pressure distribution

previously described. The high wind velocities in the southwest are probably due to the coincidence in direction of the prevailing westerlies with the westerly cyclonic winds of these tracts. Secondly, the wind velocities increase radially inward to a maximum and drop to a common minimum at the center. This is illustrated more clearly in figure 14, in which the wind velocities are plotted as ordinates. The abscissa is a diameter of the hypothetical low and the ordinates have been erected at

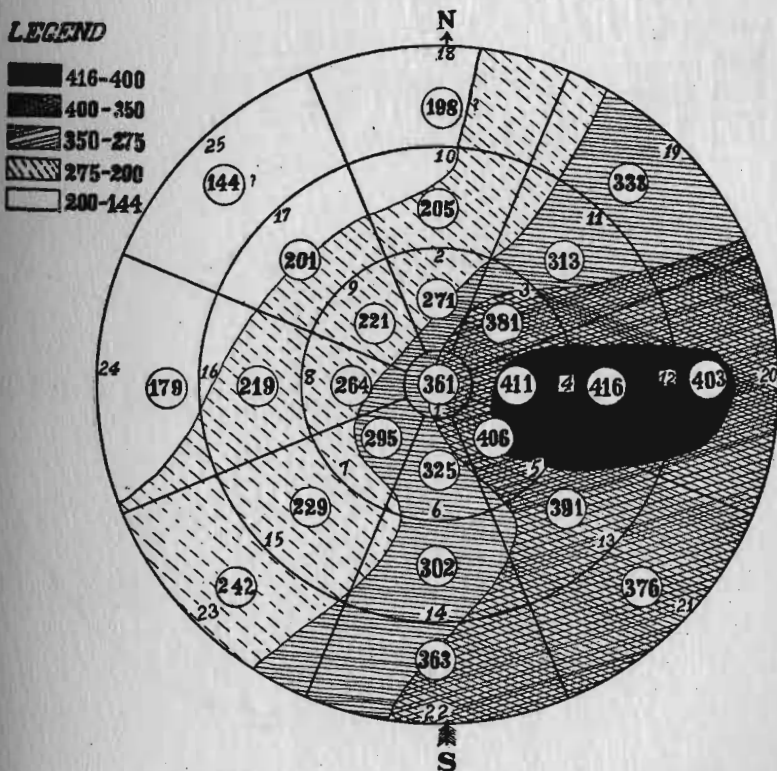


Figure 16. Vapour Pressure

points corresponding to the centers of the tracts along the diameter. A scale of wind velocities in miles per hour is marked off upon the central ordinate. The broken lines indicate the respective radial variations in wind velocity. It is seen that the velocity increases radially to a maximum at the innermost concentric area and then falls to a minimum of 8 miles per hour at the center. These facts are in agreement with the general knowledge of the nature of cyclones.

The distribution of temperatures within the cyclone is shown in figure 15. The average temperatures for the various tracts are inscribed within the small circles. The temperature distribution is also represented graphically by the shaded areas which enclose temperatures ranging from 60-50, 50-40, and 40-30 respectively. The highest temperatures are seen to prevail in the southeast quadrant of the cyclone. This is due to the southerly direction of the winds in that region. The low tempera-

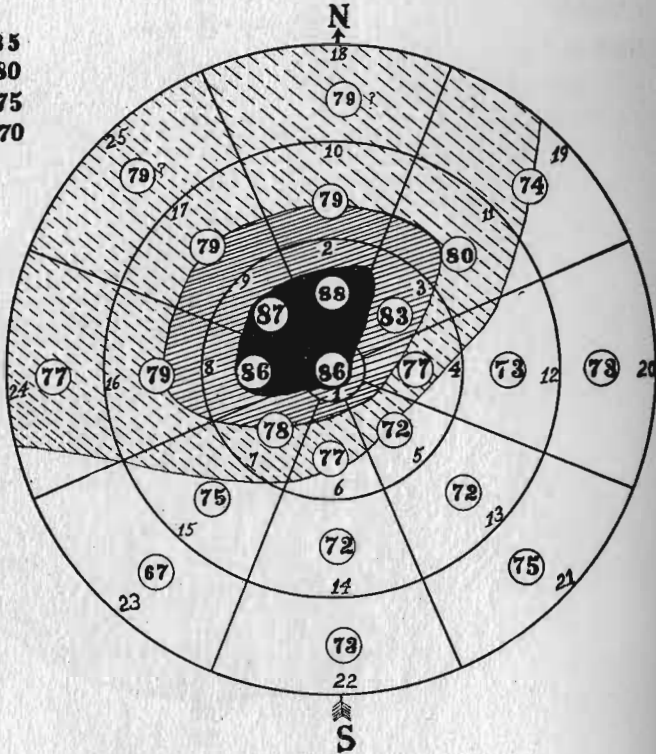
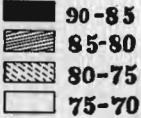
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Figure 17. Relative Humidity

tures in the northwest are produced by the cool winds from the north.

The distribution of vapour pressure is similar to that of the temperature. This is seen by comparing figures 15 and 16. The vapour pressure is greatest in the southeast and least in the northwest. The vapour pressure also increases radially toward the center. The similarity of the vapour pressure and temperature distribution is a necessary consequence of the fact

that the vapour pressure varies directly with the temperature although not at the same rate.

The distribution of the relative humidity, amount of cloudiness and frequency of precipitation are shown in figures 17, 18 and 19 respectively. The relative humidity is expressed in per cent; the amount of cloudiness is given in the usual scale of 1 to 10; and the frequency of precipitation is also expressed in per cent. The three diagrams are strikingly similar. On the whole it is seen that the values of these three quantities

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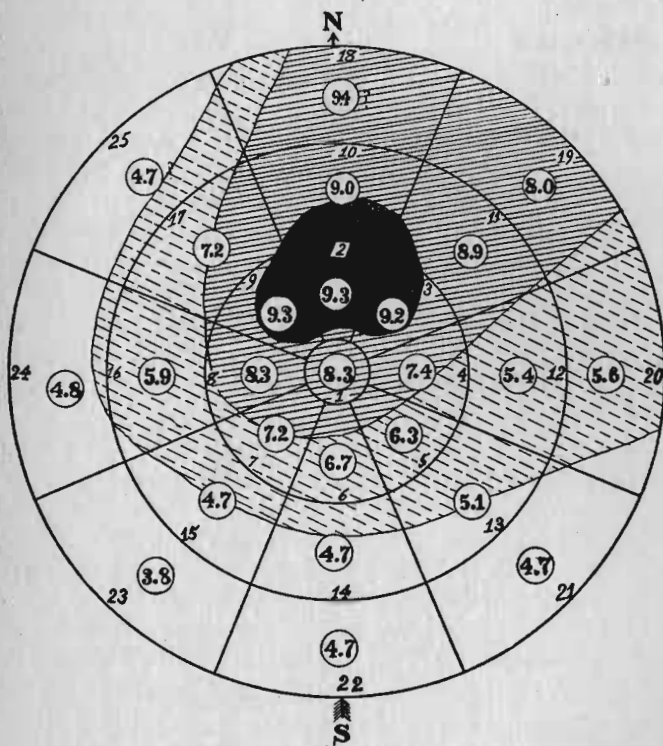
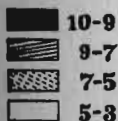


Figure 18. Amount of Cloudiness

are greater in the northern half of the cyclone than in the southern half. The lowest values occur farthest to the southeast of the center. The highest values are found in the dark areas immediately north and slightly west of the center of the cyclone. These areas are relatively small and sharply defined. Judging from the close coincidence in the distribution of the relative humidity, amount of cloudiness and frequency of precipitation, it appears safe to assume that the amount of precipitation fol-

lows a similar distribution. These results seem to stand quite at variance with the statements sometimes found in elementary textbooks on meteorology to the effect that the values of relative humidity, amount of cloudiness and precipitation are highest to the east and southeast of the center of the cyclone.

Several factors probably contribute to the location of the areas of greatest relative humidity, cloudiness and rainfall north of the center of the low. Local conditions evidently of-

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- 60-45%
- 45-30
- 30-15
- 15-0

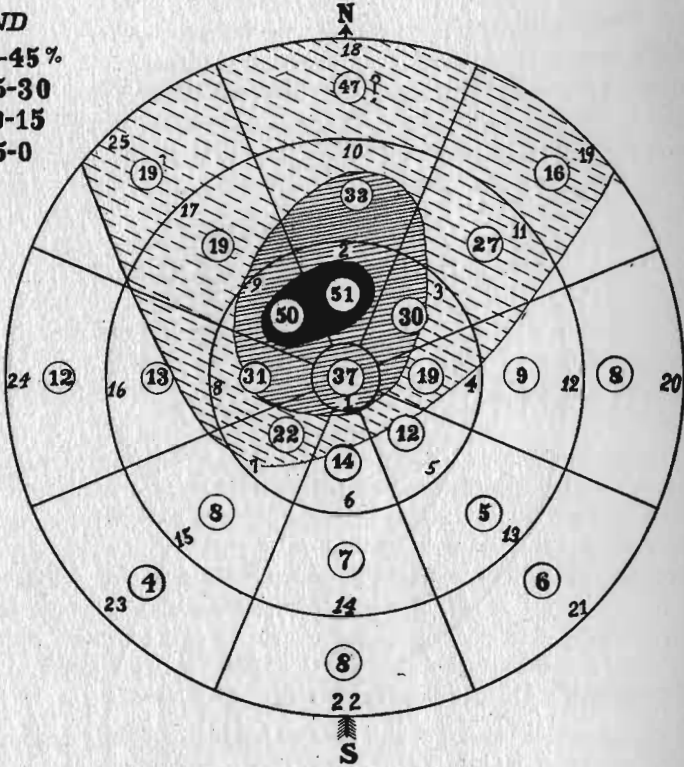


Figure 19. Frequency of Precipitation

fer an important modifying influence. The presence of the Great Lakes to the northeast of Davenport probably constitutes an important cause, also the presence of numerous small lakes, and rivers in Wisconsin and Minnesota. The humidity of the winds sweeping over these areas is probably increased by an appreciable amount. Furthermore the Great Lakes and other bodies of water would tend to decrease the temperature of the northerly winds in the summer time, thus raising the

relative humidity. In the winter time the warmer temperature of the lakes might contribute to the general upward motion of the air in cyclones with the consequent adiabatic cooling.

That the presence of smoke bears a direct relationship to cloudiness seems now to be an established fact. Such a relationship appears to be suggested in figure 18. It is seen that the distribution of maximum cloudiness trends toward the northeast. The action of smoke as a factor in producing this may be stated as follows. Large volumes of smoke are poured into the atmosphere by such manufacturing cities as Gary, Chicago, Milwaukee, Minneapolis and many other cities lying roughly within a quadrant northeast of Davenport. From the figure it is seen that the maximum amount of cloudiness occurs in Davenport when the city is so situated that it lies in the path of the winds blowing over the smoke producing area. On the other hand the quadrants northwest, southwest and southeast of Davenport are relatively free from smoke and the amount of cloudiness registered at Davenport when the winds come from these regions is comparatively low. In order to be reasonably certain that the matter here presented is a real cause of cloudiness it would be necessary to actually count or estimate by an appropriate method the number of particles of dust carried by the atmosphere with the wind from the various directions.

In the preceding paragraphs the author has described in part the cyclonic distribution of weather elements for Davenport, Iowa. The topics considered include: The barometric pressure; wind direction; wind velocity; temperature; vapour pressure; relative humidity; amount of cloudiness and the frequency of precipitation. It is believed that the data here presented are sufficient to show the character and to some extent the value of the method employed, and justify a further application to the method of other localities.

The present description is incomplete. Other matters receiving attention are: the distribution of the various kinds of clouds, thunderstorms, the direction of the higher air strata and the seasonal distribution of the elements. The anti-cyclones are being studied in a similar manner. The results of a more complete survey of the problem will be given in a later paper.

In conclusion the author wishes to acknowledge with gratitude the assistance received from several sources. Mr. J. M. Sherrier, Local Forecaster at Davenport, Ia., has offered helpful suggestions and courteously given access to the records of

that station. Through the kindness of Major H. B. Hersey, official in charge, local office, Chicago, Ill., the author was permitted to examine the evening weather maps of that office. Special thanks are due Mr. C. W. L. Johnson, who has given valuable assistance in the statistical work.
