SOME SMALL-SCALE FEATURES OF THE TRACK OF HURRICANE IONE

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1. INTRODUCTION

Ione was named on the 14th of September 1955. Previously, on September 10, the existence of a tropical disturbance near 11° N., 45° W. had been suspected. The next day reconnaissance aircraft located a center at 15° 35′ N., 50° 35′ W. Thereafter the developing storm moved west-northwestward at about 10 knots until the 17th when it was north of the Bahamas. During the 17th it turned gradually and moved north-northwest at 13 knots until it entered the coast of North Carolina on the morning of the 19th. During the 19th Ione stopped, recurved, and moved out into the North Atlantic. On the 21st Ione lost her name and disappeared into an extra-tropical deep Low off Newfoundland.

For some 35 hours, from the 18th at 1945 EST until the 20th at 0643 EST, the eye of Ione was under surveillance of the new radar installation at Hatteras, N. C. For part of that time the center was in an area of many surface observing stations. It was here that several oscillations and finally recurvature took place. This study will examine some of the small-scale features of the vacillations in this segment of the track of Ione.

2. ANALYSIS OF DATA

Several radar stations reported fixes on Ione. These fixes were made by Navy and Air Force installations as well as by the Weather Bureau. Because of the greater proximity of the Hatteras radar[1] station to the area of interest in this paper, all the fixes from this station are presented in figure 1 exactly as they were plotted by Mr. Vaughn Rockney of the Weather Bureau who made most of the eye observations at the radar site. Figure 2 is an analysis of the track of the radar fixes of the eye of Ione. The positions in figure 1 are augmented in a few places by examination of a time lapse movie made simultaneously.

It can be seen from figures 1 and 2 that prior to 0630 EST of the 19th the movement was mainly north-northwest at 14 knots; from 0630 to 1130 EST it was nearly stationary while several oscillations took place; and from 1130 to 1830 EST it was mainly north-northeast at 10 knots. From 1930 to 2230 EST more oscillations occurred and subsequent to 2230 EST Ione accelerated east-northeastward. During the period from 0430 to 1330 EST the eye was very close to the observing stations on the North Carolina coast at Morehead City, Cherry Point, New Bern, Kinston, Wilmington, and Hatteras. Also during this period any deepening or filling of the storm was very slight, so that any pressure changes recorded at the stations most likely reflect features of general movement of the storm.

Figure 3 is a collection of pressure profiles at some of the stations in the vicinity of the storm center. These profiles are reduced to one horizontal time scale, but the vertical scale is only relative, the reference having been shifted for each station to separate the traces. Pressure readings taken by the cooperative observer at Morehead City were at irregular intervals and since no barograph trace is available the profile cannot be presented.

An examination of the profiles shows:

1. Large pressure falls at all stations in advance of the center until 0630 EST on the 19th.
2. Only slight pressure changes at all stations from 0630 to 1130 EST on the 19th.
3. Large pressure rises at stations behind the center after 1130 EST.

Surface isobaric analyses of sequence reports, light ships, and ships at sea were made in the Analysis Center each hour during the progress of Ione through the North Carolina coastal area. These analyses were revised where necessary after receipt by mail of all additional hourly reports from the stations which were unable to transmit them by teletypewriter. Copies of the hourly analyses, with the track from figure 2 superimposed, are presented in figure 4. Plotted at each station is the 1-hour pressure change during the hour preceding map time.

The hourly isobaric analyses agree closely with the radar fixes. The hourly tendencies, wind changes, and synchronous pressure fluctuations on the original barograms agree closely with the movements indicated by the radar fixes.

The sea level isobars at 0430, 0530, and 0630 EST show the pressure center of Ione south-southeast of Cherry Point (NKT) and Morehead City and as near to the radar fixes as can be determined by the surface network. One-hour pressure falls were large and increasing ahead of the center at Cherry Point and New Bern (EWN).

[1] Model SPIM, wave length 10 cm., beam width 3°, peak power 750,000 watts, antenna size 8 ft., pulse length 5 microseconds.

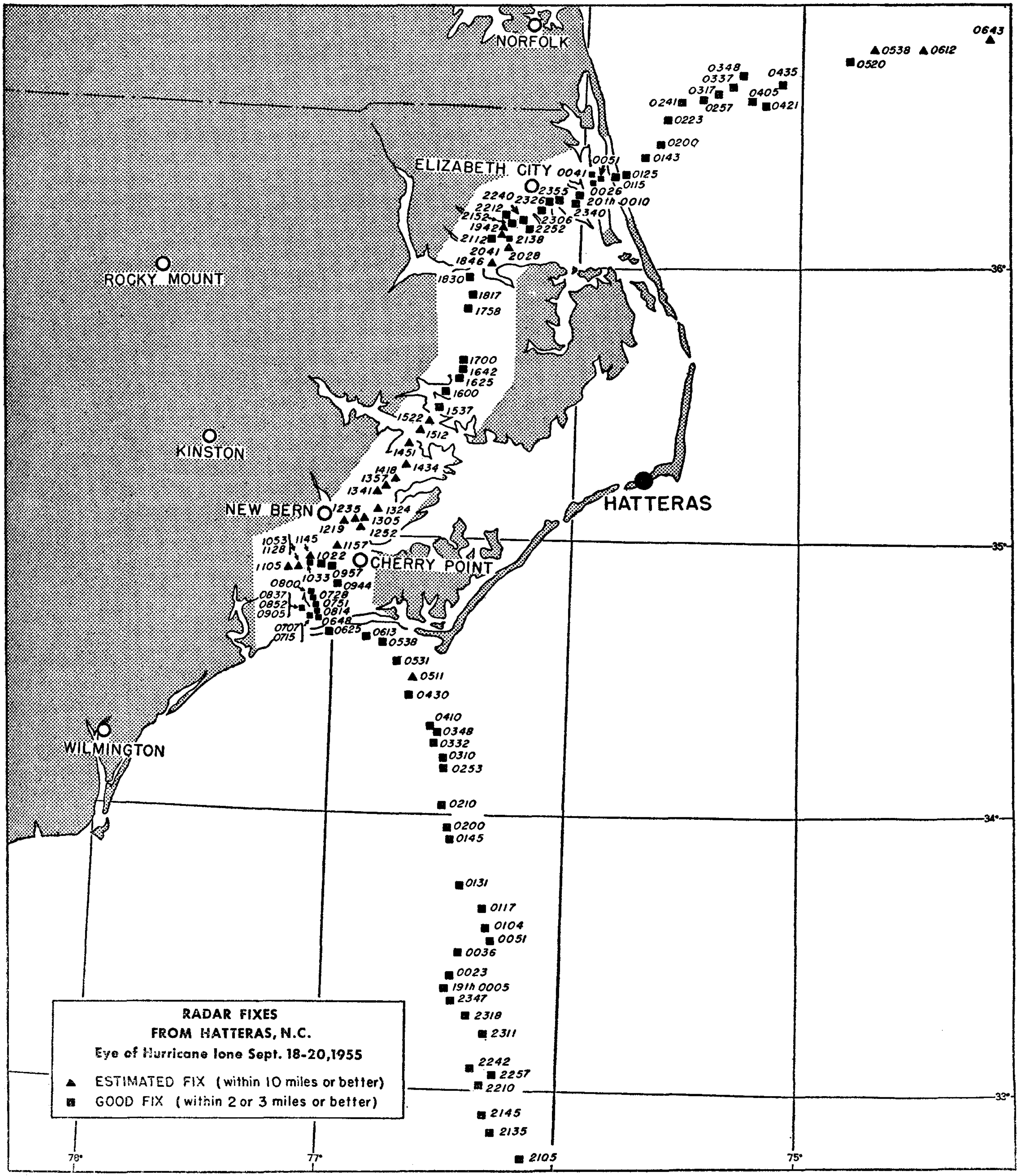


Figure 1.—Positions of the eye of hurricane Ione as determined by Hatteras radar, September 18, 19, 20, 1955. Eastern Standard Time.

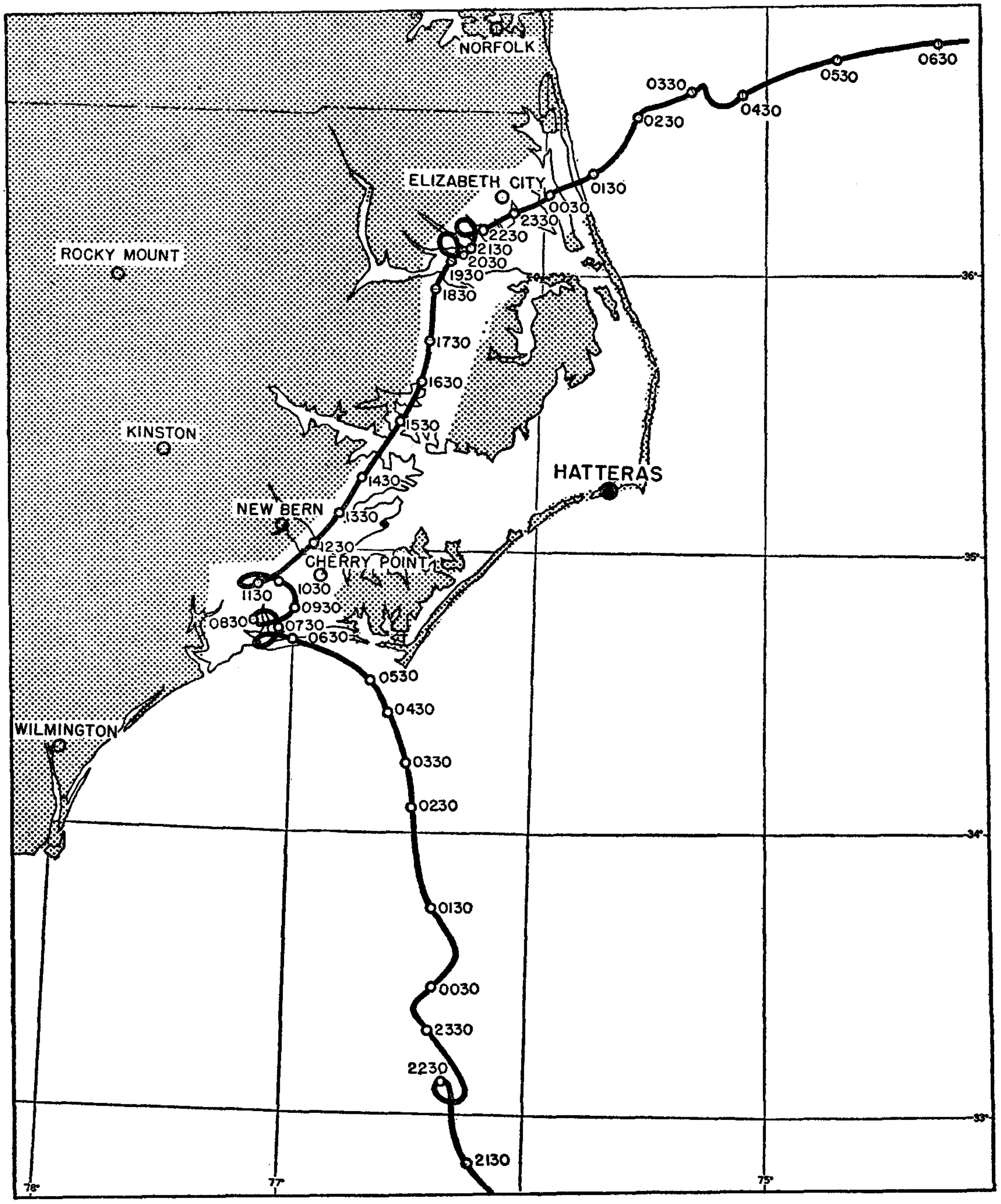


FIGURE 2.—Apparent track of hurricane Ione as determined by Hatteras radar fixes September 18, 19, 20, 1955. Points are indicated for position at thirty minutes after each hour. Eastern Standard Time.

As it moved north-northwest toward Cherry Point, winds increased to a maximum gust of 93 knots (107 m. p. h.) at 0530 EST. At 0630 EST the wind veered from north-northeast to east-northeast at Cherry Point as the center moved westward south of the station.

At 0730 EST the pressure rose at Cherry Point and fell less rapidly at New Bern as the center moved more slowly and away from Cherry Point. At 0830, 0930, and 1030 EST pressure changes were slight as the center continued making its loop. The wind at Cherry Point slowly turned toward east-southeast while at Morehead City the wind increased from the southwest.

At 1130 EST the wind at Cherry Point went to southwest and pressure rises at Cherry Point and New Bern began to increase just prior to 1230 EST as the center accelerated north-northeastward.

In general, during the entire time while Ione was being watched by the radar at Hatteras the center did not differ from the radar fix by any discernible distance.

3. RADAR AND TROPICAL STORMS

There is more than one method of observing a storm by radar. A study of the echo pattern can be made to determine the position of the open eye in the cloud and rain shield, or the motion of small separate cells can be tracked to determine the center of the streamline pattern. The first method was utilized at Hatteras.

In a tropical storm the cloud and rain eye is believed to be most nearly concentric with the center of rotation. In a moving storm this is the to right of the isobaric center while the center of the streamlines is to the left of the isobaric center. Sir Napier Shaw [1,2] demonstrated geometrically that the distance between the rotation center and the center of the streamlines is proportional to the translational velocity of the storm and inversely proportional to the angular velocity of its rotation.

If s is the distance in nautical miles between the rotation center and the center of streamline pattern, V the translational velocity in knots, and ω the angular velocity of rotation in radians per hour, then [1,2]

$$s=\frac{V}{\omega}$$

Thus when a storm is nearly stationary and has a high rotational velocity, as was the case with Ione during the morning of the 19th, the various centers should be almost coincident.

In Ione during the period of time studied here the speed of translation was under 15 knots. The angular velocity can be estimated from the winds and radius of the storm at 4 radians per hour or less. Thus the maximum estimated distance for s must be less than 4 miles—less than the magnitude of error involved using synoptic pressure and wind considerations to fix the center.

Therefore any attempt to show the separation of the eye from the wind field and pressure pattern could not be particularly fruitful in the case of Ione. However, now that meteorological observers are armed with the more accurate weapon of radar, future observations of faster moving storms can furnish material for further investigation of Shaw's model of a normal cyclone.

In a study of the Florida hurricane of September 14–15, 1945, Wexler [3] found that the displacement of the paths of pressure and radar centers may have agreed with Shaw's explanation when the storm was north of the radar site, but showed a puzzling change in sign south of the radar site.

Hatakeyama et al. [4] present an observational case of a fast moving storm. In this typhoon (Lorna) the translational velocity was great enough to demonstrate the relative displacement (about 15 miles) of the streamline center and cloud center from the pressure center.

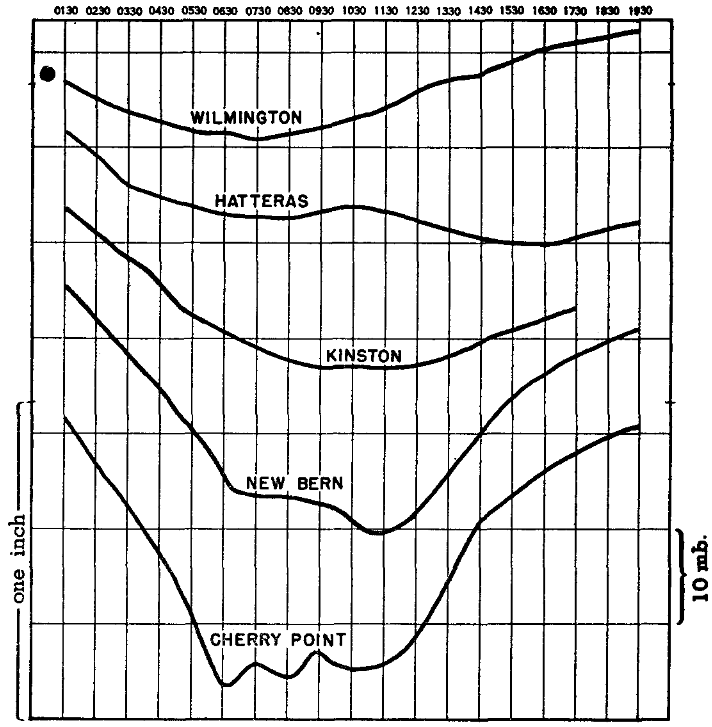


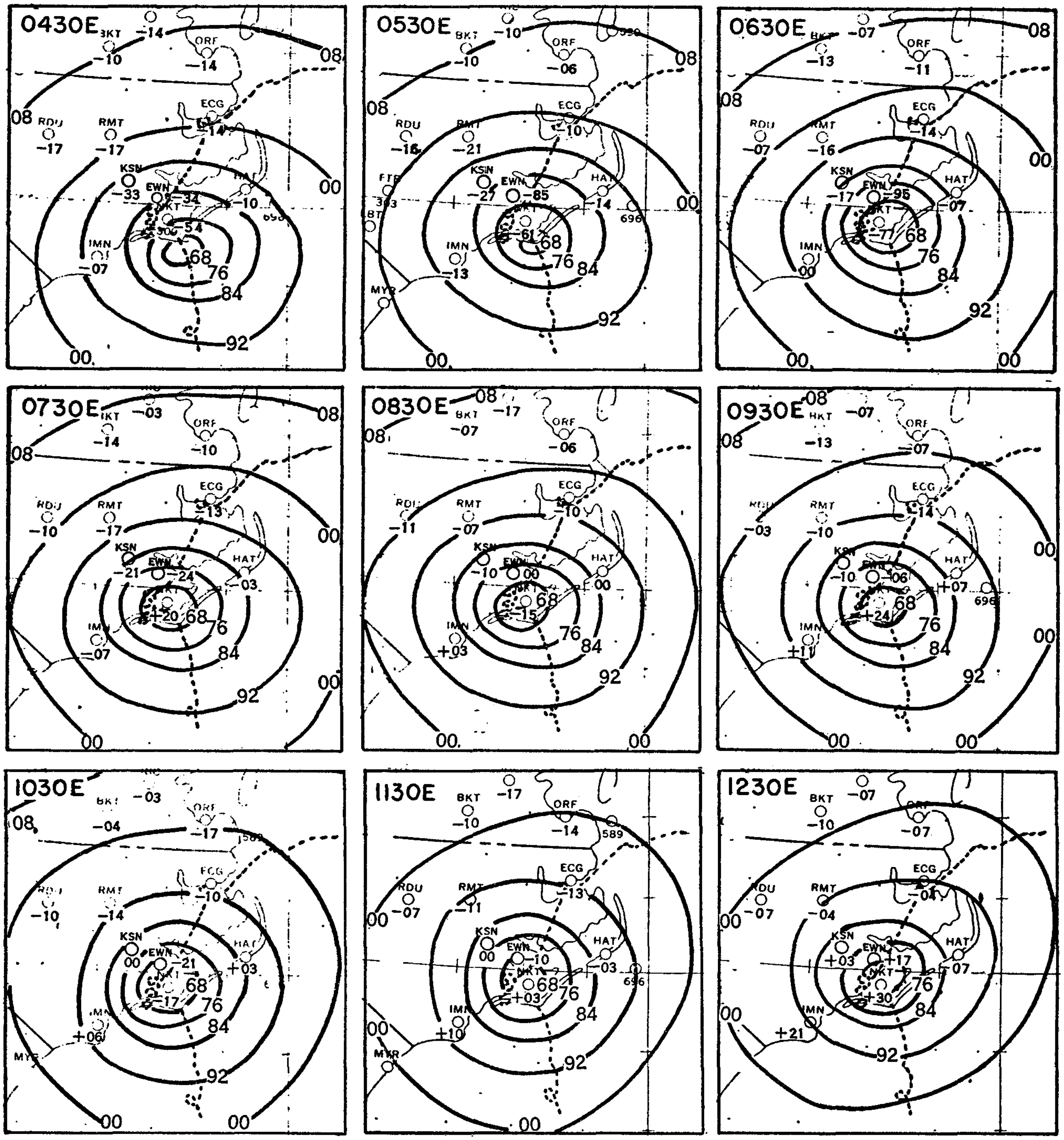
FIGURE 3.—Comparative pressure profiles for various stations near the center of hurricane Ione, September 19, 1955. Eastern Standard Time.

4. CONCLUSIONS

1. Ione made at least two sets of oscillations during the time it was within range of the Hatteras radar.
2. In a slow moving storm and one in which the rotational velocity is high, the position of the eye as determined by radar, of the type used at Hatteras, is almost identical with the position indicated by a synoptic isobaric analysis. However, in a fast moving storm and one in which the angular velocity is low, Shaw's computations for a normal cyclone should be considered.

ACKNOWLEDGMENTS

The writers are indebted to Mr. Vaughn Rockney for his generous assistance with radar information, to the senior members of NWAC for advice and consultation, and to the hardy meteorological observers who continued to log regular reports as Ione passed almost directly over them.



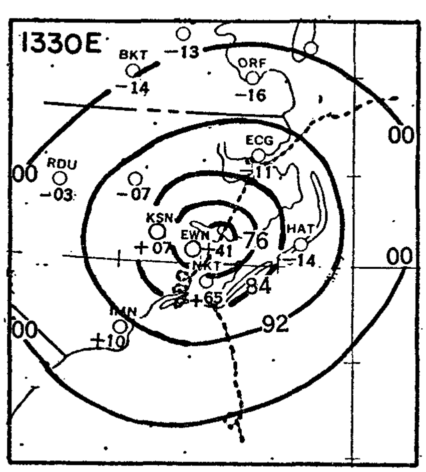


FIGURE 4.—Hourly analyses with 1-hour pressure changes in tenths of millibars near the center of hurricane Ione, September 19, 1955. Isobars at 8-mb. intervals are copied from hourly analyses of data from all stations indicated plus some ships at sea and light ships. Eastern Standard Time. (Track same as in fig. 2.) Hatteras=HAT, Cherry Point=NKT, New Bern=EWN, Kinston=KSN, and Wilmington=IMN.

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4. H. Hatakeyama, I. Imai, and Y. Masuda, "On Some Radar Observations of Typhoon 'Lorna'," *Proceedings of the UNESCO Symposium on Typhoons, 9–12 November 1954*, Tokyo, 1955, pp. 121–128.

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