

Weather Note

SOUNDING IN THE DEVELOPING EYE OF TROPICAL STORM ALMA

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On August 28, 1962 at 1000 GMT, tropical storm Alma, the first of the 1962 season, was located at 34.5° N., 76.8° W. or some 20 mi. southwest of Morehead City, N.C. Alma was moving on a northeasterly course at about 15 m.p.h.

At 1139 GMT a radiosonde and rawin target was released from the Cape Hatteras, N.C. Weather Bureau observation station for the routine 1200 GMT upper air observation. This upper air sounding continued from 1139 GMT until it terminated at 1307 GMT. At the start of the raob, rain was falling at the surface and this ended at 1210 GMT. A thunderstorm, or series thereof, was observed at the surface from 1045 GMT and ended at 1240 GMT or approximately during the first two-thirds of the period of the upper air observation. Alma's surface center passed by very closely to the east of the station at 1135 GMT as the surface observations during this period indicate (see table 1A). Surface reports from the Diamond Shoals Light Ship (table 1B) show that the center quite probably passed to the northwest of that station between 0600 and 1200 GMT and lend some support to the above statement.

Here the routineness of the events transpiring ended. A close scrutiny of the Hatteras sounding disclosed an

interesting bit of meteorological history. For the third time* in the past two decades it appeared that a Weather Bureau radiosonde had been released near the center of a tropical storm, and returned interesting and possibly valuable upper air data from *inside* the eye. From an analysis of the rawinsonde data, radar weather observations, and the sounding itself, it became apparent that the balloon, after release, had been carried into the eye

*A radiosonde was released in the eye of a hurricane as it passed over Tampa, Fla., at 0600 EST on October 19, 1944 and again at 0100 EST on October 8, 1946.

TABLE 1.—(A) Cape Hatteras, N.C., surface observations (aviation form) from 0900 GMT through 1500 GMT, August 28, 1962

| | | | |
|-------|-----------------|-------------------|------------------------|
| 0857Z | M8@4RF | 061/75/74<15/ | 758 17XX PRESFR |
| 0957Z | S M6@2R+F | 034/74/73<18/ | DSNT LTGIC SW PRESFR |
| 1056Z | S E8@3TR-F | 990/75/75↑15/ | PCPN 80 |
| 1105Z | W3X1/2TR+F | ↓30+42/ | TB45 T SE MOVG NW PCPN |
| 1115Z | W3X1/2TR+F | ↓30+41/ | 2.09 PRESFR |
| 1158Z | S E15① 90①1TR-F | 980/70/69 ↓24+32/ | T OVHD MVMNT UNK |
| 1256Z | S 90① U①7 | 997/73/70 ↓13+21/ | T OVHD MVMNT UNK |
| 1356Z | E10①7 | 024/75/72 ↓19+27/ | PRIMP 4/0557 E/09 |
| 1453Z | E10①7 | 044/76/72 ↓16+22/ | T E MOVG S PCPN 1.63 |
| | | | PRIMP 2/0635 E/36 BLUE |
| | | | SKY VIS IN BINOV C W |
| | | | RADAT 44008 RE10 TE40 |
| | | | PRESRR |
| | | | PRESRR /264 17XX |

TABLE 1.—(B) Diamond Shoals Light Ship (35.1° N., 75.3° W.) surface observations (transposed into aviation form) from 0000 GMT through 1800 GMT, August 28, 1962

| | | | |
|-------|------------|-----------------|------------------|
| 0000Z | ⊕ 3/8 RW | 139/69/67 ↑20 | 709 XXXX SQUALLS |
| 0600Z | ⊕ <1/16 RW | 993/74/74 ↑5 35 | 710 XXXX |
| 1200Z | ⊕ 1 | 088/75/74 >20 | 219 XXXX BINOV C |
| 1800Z | ⊕ 10 | 119/76/72 →70 | 109 XXXX |

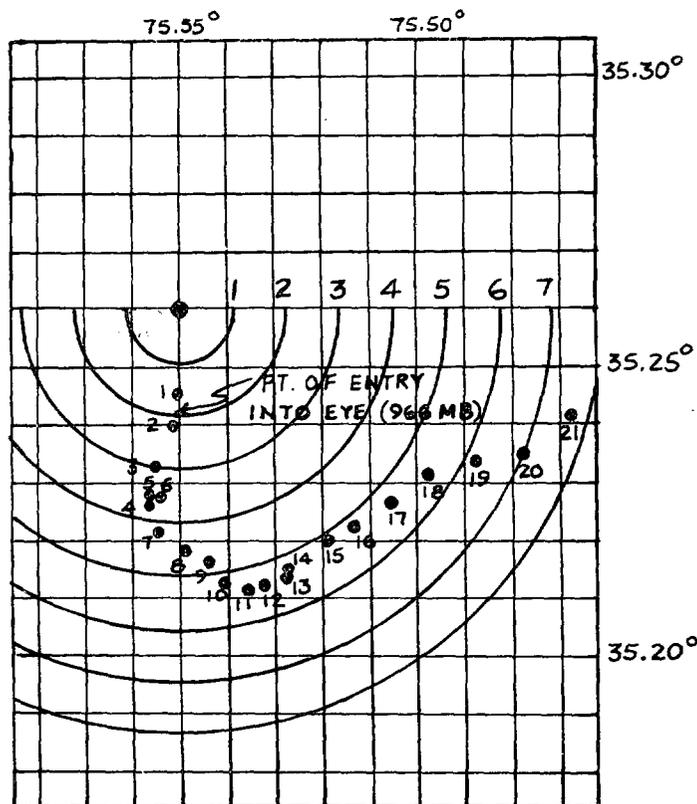


FIGURE 1.—Plot of Cape Hatteras, N.C., 1200 GMT, August 28, 1962 radiosonde balloon positions at 1-min. intervals from radar azimuth angles and distances. Each ring equals 1 km. Release time 1139 GMT.

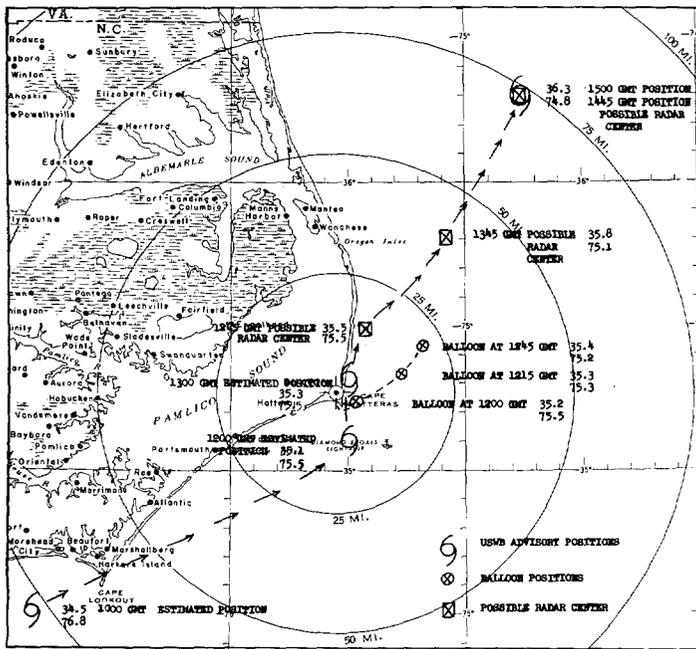


FIGURE 2.—Track of tropical storm Alma from 0900 through 1500 GMT on August 28, 1962. Based on U.S. Weather Bureau advisories, with radar positions of Hatteras radiosonde balloon and Hatteras radar possible centers.

of the still-developing Alma. By plotting the positions of the radiosonde balloon using the radar azimuth angles and measured distances from the observation point (fig. 1), a position at 35.2° N., 75.5° W. was derived. This was within 0.2° or 12 n.mi. of the storm's estimated position (35.1° N., 75.5° W.) at 1200 GMT (fig. 2).

Radar weather observations taken by the 10-cm. set at Hatteras showed definite evidence of spiral banding at distances of from 140 to 125 mi. from the northeast through the southeast of the station on the 1146 GMT observation but no definite center was then apparent. By 1245 GMT a possible center was observed on a bearing of 038° at 15 mi. or at 35.5° N., 75.5° W. This possible center was subsequently tracked for three more hours (fig. 2). Although no definite center was observed by radar until the radiosonde observation was almost completed the fact that the possible center of the storm was observed only 15 mi. north-northeast of the station at 1245 GMT lends considerable support to the point that some sort of weak, developing center passed just to the east of Hatteras as the surface observations at Hatteras and the Diamond Shoals Light Ship would indicate. Also the balloon at 1245 GMT was observed to be on a bearing of 065° at 37,500 m. (22 mi.) distance at a height of 18,660 m. (61,204 ft.). This position (35.4° N., 75.2° W.) would place it within 0.3° or 18 n.mi. of the possible center observed by radar, a remarkably close position considering the height. This would give rather strong support to the idea that the balloon remained in the center through the entire tropospheric column as the

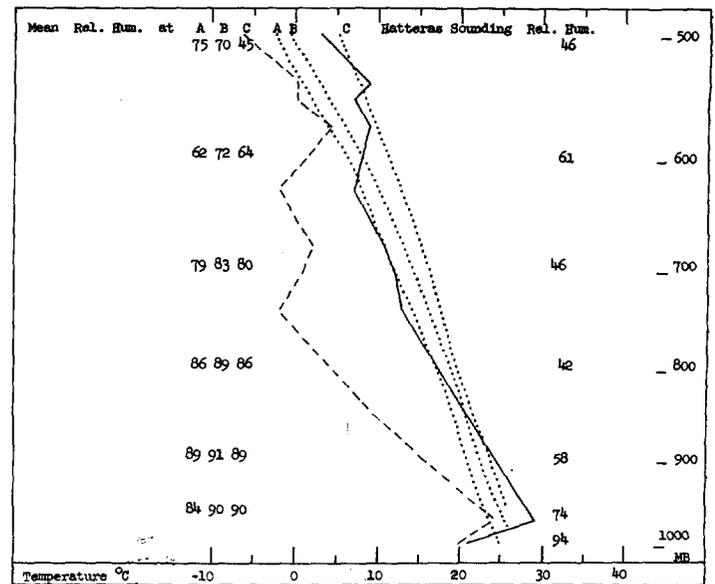


FIGURE 3.—Cape Hatteras, N.C. 1200 GMT, August 28, 1962 radiosonde sounding (solid line), dew point curve (dashed line), and C. L. Jordan's mean hurricane eye soundings (dotted). A—weak, B—moderate, C—intense.

warmth of the temperatures of the sounding would indicate.

Upon looking at the Hatteras sounding (fig. 3) one can ascertain that it was certainly not a saturated or even near saturated run as one might expect so close to the center of a storm of tropical nature and with moderate rain falling when the balloon was released.

A close look at the Hatteras sounding showed a remarkably strong inversion from the surface (997 mb.) $+21^{\circ}$ C. to the 966-mb. level $+29^{\circ}$ C. The relative humidity dropped from 94 to 74 percent, which appeared significant in view of the moderate rain falling at the surface. From these indications it became apparent that the radiosonde had entered the eye at the 966-mb. level. Further substantiation of this idea came with the remarkable drying out of the sounding with height from 966 mb. to 570 mb.

From a stability viewpoint, if we compute the Showalter stability index, we derive the quite stable figure of $+12$. With the unstable indexes expected about and presumably extending some distance from the center of a tropical storm this figure becomes quite significant.

Another look at the sounding reveals a temperature of $+3^{\circ}$ C. at the 500-mb. level. Clearly this must indicate that the balloon had remained in the eye from the 966-mb. level to at least the 500-mb. level. A freezing level of 19,300 ft. is also observed which is in itself a rarity except when compared to dropsondes in the eyes of tropical storms, hurricanes, etc.

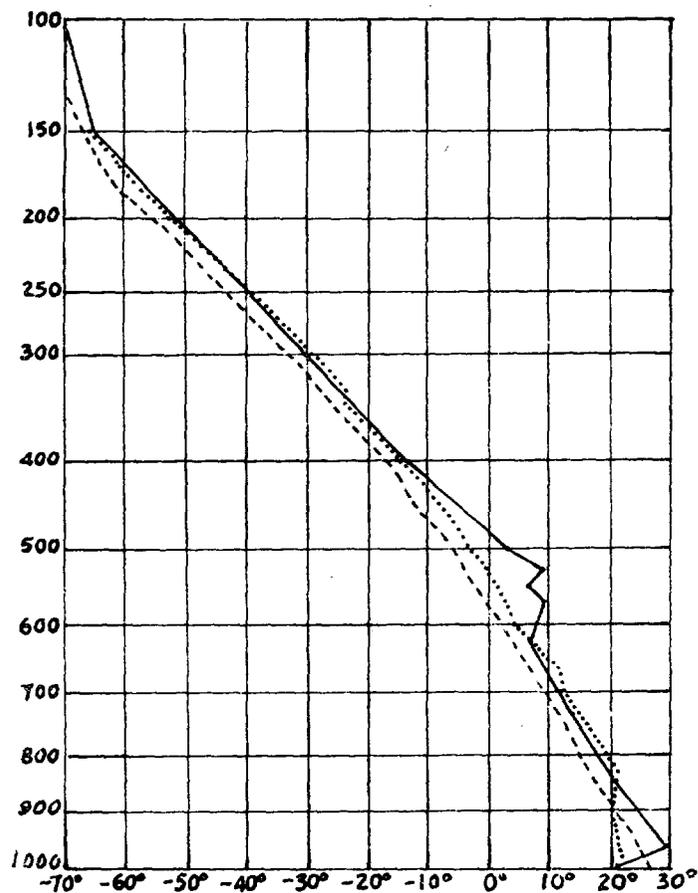


FIGURE 4.—Entire Cape Hatteras 1200 GMT August 28, 1962 sounding (solid line) and the mean August sounding for the West Indies Area (dashed line) after C. L. Jordan [2]. Sounding made at Tampa, Fla. in hurricane eye, 0600 GMT, October 8, 1946 is dotted.

An interesting comparison was made with Jordan's [1] computations of mean temperature and humidity in the eye of hurricanes classified as intense, moderate, and weak on the basis of surface pressures. From a *temperature* standpoint Alma was comparable to the intense class at the 900-mb. level, the weak class from 800 mb. through 700 mb., weak to moderate class at 600 mb., and somewhat greater than the moderate class at 500 mb.

From the *humidities* reported, in comparison to Jordan's classes Alma was extremely weak from 900 mb. through 700 mb.; at the 600-mb. level the weak class was approached, while at 500 mb. the intense class was indicated.

For further comparison figure 4 shows the Hatteras sounding plotted against the mean August sounding for the West Indies area as derived by Jordan [2] and the Tampa, Fla. sounding at 0600 GMT on October 8, 1946, taken in the eye of a hurricane. From this comparison showing the anomalous warmth of the Hatteras sounding, it becomes readily apparent that the balloon in all probability ascended from the 966-mb. level to the top of the troposphere in the developing eye of Alma.

In conclusion, a close analysis of the Cape Hatteras, N.C. surface, rawinsonde, radar weather observation, and radiosonde data for 1200 GMT, August 28, 1962, support the contention that shortly after release the balloon was carried into the developing eye of tropical storm Alma at about the 966-mb. level where it remained and ascended to at least the 500-mb level and most probably to the top of the troposphere. This idea is also supported by the quite stable Showalter stability index of the sounding, by a comparison with mean hurricane soundings in regard to temperatures and humidities in the eye, and by a comparison with mean August soundings for the West Indies area and the Tampa, Fla. hurricane eye sounding of October 1946.

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REFERENCES

1. C. L. Jordan, "Mean Soundings for the Hurricane Eye," *National Hurricane Research Project Report No. 13, 1957, 10 pp.* (see pp. 2-5).
2. C. L. Jordan, "A Mean Atmosphere for the West Indies Area," *National Hurricane Research Project Report No. 6, 1957, 17 pp.* (see p. 3).