Hurricane Carmen: August–September 1974—Development of a Wave in the ITCZ[1]

OWEN E. THOMPSON[2]

Graduate Program in Meteorology, University of Maryland, College Park 20740

JOANNA MILLER

General Physical Sciences Program, University of Maryland, College Park 20740

10 November 1975 and 31 December 1975

1. Summary

Hurricane Carmen originated as a disturbance over Africa in the middle of August 1974. From 18 to 24 August, the disturbance was situated over Africa moving slowly toward the western coastline. As the disturbance moved offshore, it perturbed the ITCZ into a wave which crested and separated into two parts about 26 August. The northern portion of the wave continued to develop to later become Hurricane Carmen. From 25 August to 1 September, the storm had an almost uniform speed of drift across the Atlantic with an average drift speed of 556 miles per day or about 10 m s^{-1}. By 1 September, this storm had reached hurricane intensity and passed over the Yucatan Peninsula, turning northward to traverse the Gulf of Mexico and destined for the United States. On 8 September, Carmen's center impinged on the shores of Louisiana. Cut off from the warm waters of the Gulf of Mexico, Carmen rapidly lost intensity. Her remnants then traveled westward as a severe and damaging low pressure system which caused considerable flooding in Texas. According to Hope (1975), Carmen caused $150 million damage and one death in the United States and in excess of $2 million damage in Puerto Rico.

2. Analysis

In Fig. 1, tropical strips of infrared images from the Visible Infrared Spin Scan Radiometer (VISSR) aboard the Synchronous Meteorological Satellite 1 are shown in chronological order at 1200 GMT from 18 August to 8 September, 1974. The period 18–21 August represents the embryonic phase of Hurricane Carmen. A minor wave has formed over the African coastline near 10°N. Hope (1975) refers to this precursor of Hurricane Carmen as an easterly wave while Agee (1972), in a discussion of the formation of tropical storm Anna in 1969 which had a developmental stage very similar to that shown for 18–21 August, calls this type of wave an ITCZ wave. The regions of deep convection products corresponding to the brightest areas are spotty and not well organized except for the fairly prominent vortex situated at 10°W, 13°N on 18 August. Photographs on previous days show that this feature had slowly drifted across Africa as part of extensive activity in the ITCZ. This vortex, drifting toward the African coast during 18–19 August, seems to lose its structure during the 20th and 21st. However, due to its location several degrees north of the longer line of cloudiness at about 8–9°N, this disturbance appears to play an important role in initiating the wave in the ITCZ.

By 23 August, there are definite indications that some of the general cloudiness over a broader area is becoming entrained into the wave. By 24 August, the wave has intensified and has organized a large amount of cloudiness into it with an enhancement of the convection near the trough. By 25 August, what was originally a somewhat irregular perturbation of the ITCZ is now a very massive and clearly defined wave extending from the trough line at approximately 25°W to the ridge at about 48°W. Low-level clouds form a vortex circulation just to the north of the bright cirrus overcast. A surface analysis for this day (see GATE Report No. 17) shows a vortex centered at 15°N, 30°W corresponding to this low level cloud pattern.

From 25 to 28 August, a great deal of development takes place. The wave increases dramatically in amplitude with a corresponding decrease in wavelength. By the 26th, the wave resembles a "breaking" wave on a water surface and on subsequent days the "curl" of the wave separates from the rest of the wave system. A surface analysis for 26 August shows a vortex at 32°W, 16°N corresponding to the bright area seen

[1] Publication No. 140 of the Graduate Program in Meteorology.

[2] Currently on leave at the IBM Thomas J. Watson Research Center as the Wallace J. Eckert Visiting Scientist in Environmental Sciences.

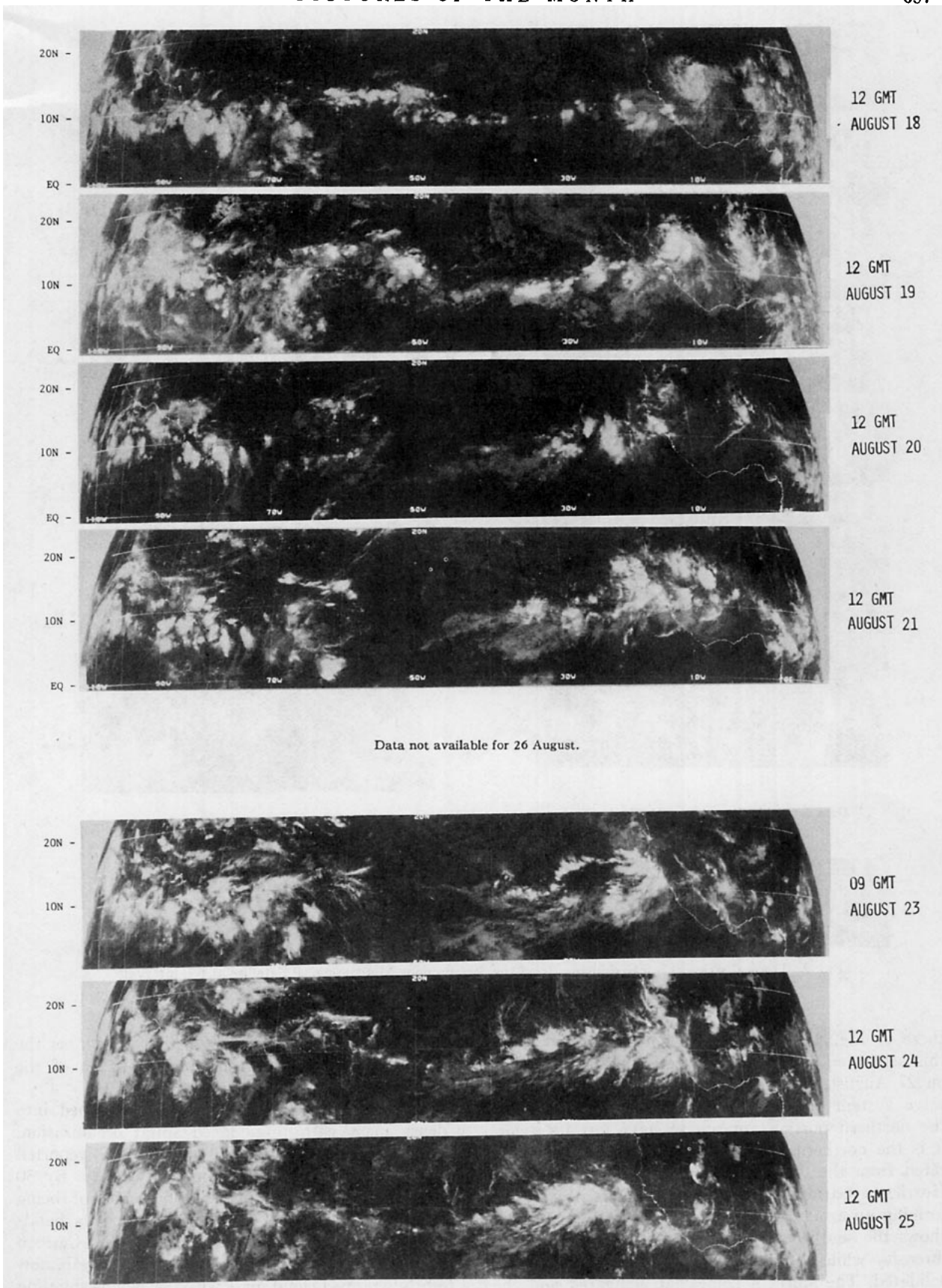
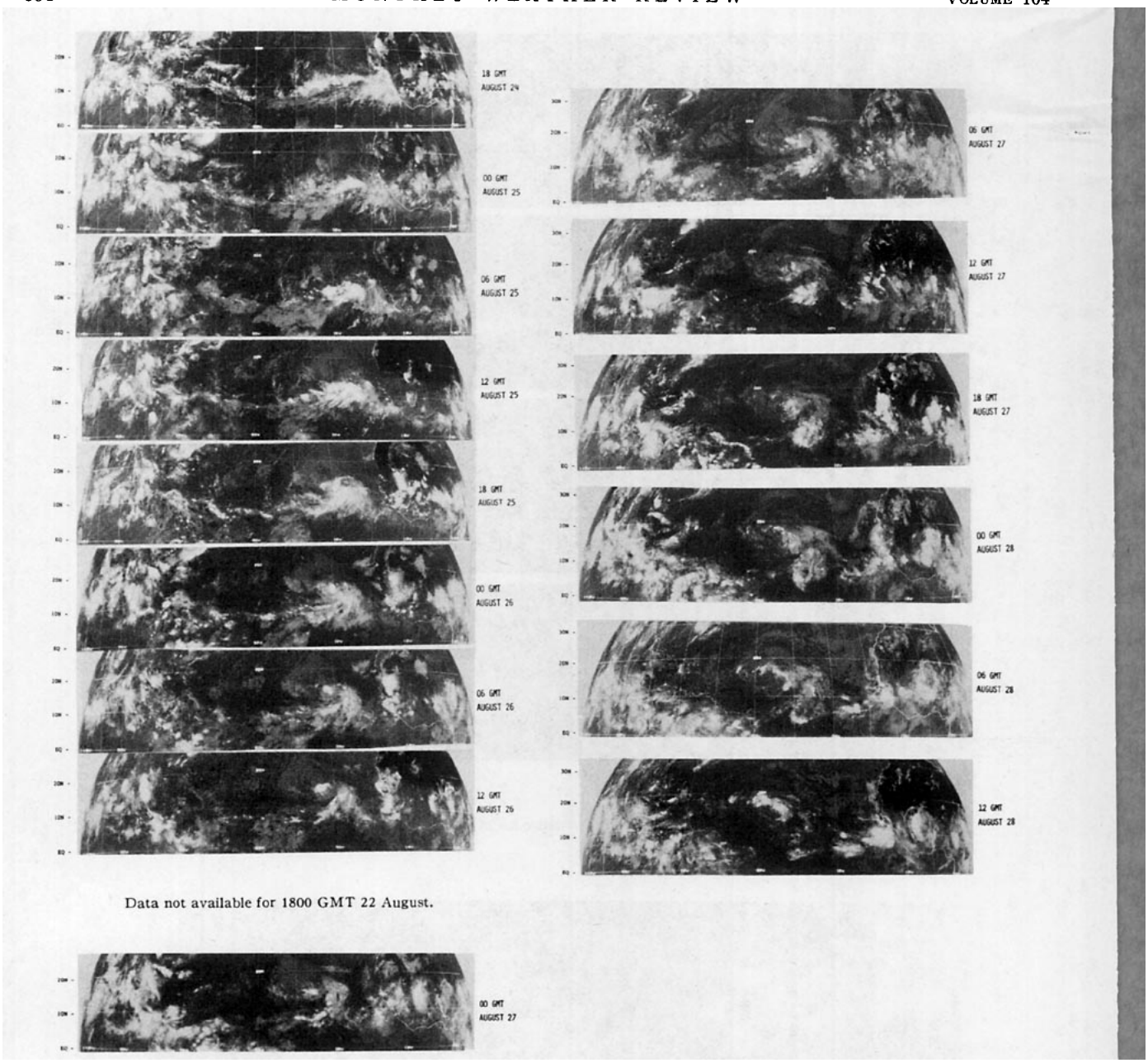


FIG. 1. Tropical strips of infrared images from the Synchronous Meteorological Satellite at 1200 GMT from 18 August to 8 September, 1974.



Data not available for 1800 GMT 22 August.

FIG. 2. Tropical strips of infrared images from the Synchronous Meteorological Satellite at 6 h intervals for 24–28 August 1974.

there in Fig. 1. The low-level flow is drawn about this separated vortex. It is interesting to note that on 27 August, although the southern portion of the wave system exhibits the deepest convection while the northern portion appears to have lost its vigor, it is the northern portion, the low center that separated from the "breaking" wave, that develops into Hurricane Carmen. The low-level clouds are clearly forming up around this low on 27 August. August 28 shows the southern portion of the disturbance losing intensity while the northern part becomes more consolidated. The storm is somewhat elongated and the lower clouds do not have as great an extent as the day before. The development and evolution of the wave are shown at 6 h intervals in Fig. 2.

By 29 August, the convection has deepened into a dense mass with pronounced spiral organization. The National Meteorological Center (NMC) reported Carmen as a tropical depression on this day. By 30 August, the storm has every appearance of being a hurricane. There are well developed cirrus bands and concentric appearance. By 31 August, Carmen seems to have lost some of her intensity. She is now a tightly wrapped cloud mass with low clouds spiraling

about the core. NMC upgraded Carmen to a tropical storm on 30 August and to a hurricane on 31 August.

On 1 September, Carmen regained intensity as her outer bands impinged on the Yucatan Peninsula. Carmen is now classified as a hurricane by NMC and remains so designated until 8 September. On 2 September, Carmen has moved onto the Yucatan Peninsula and her leading edge has encountered the tip of Florida. She is a very tight and compact spiral with a dense overcast that has no breaks. Hope reported that on this day sustained winds reached 130 kt with a central pressure of 928 mb just before landfall. There is a dramatic increase in the extent of the cloudiness from 1–7 September as Carmen drifts across the warm Gulf of Mexico. Hope reported that sustained winds once again reach 130 kt on 5 September. On 7 September, just before landfall on the United States Gulf Coast, Carmen shows an almost perfectly circular overcast with a large amount of cirrus outflow. September 8 is the day that Hurricane Carmen came ashore. Although she may have retained hurricane intensity for a short time while over land, she quickly degraded to a dangerous low pressure system which brought much rain and flooding in Texas. Further discussion of Hurricane Carmen has been given by Hawkins (1975). Readers wishing to inspect surface and 700 mb analyses and SMS visible channel pictures of this system as it passed near the GATE area should refer to GATE (1975), Report No. 17, compiled by Dugdale.

Acknowledgment. Infrared images of the tropical Atlantic were kindly provided by Mr. Ross La Port, National Environmental Satellite Service, NOAA.

REFERENCES

Agee, E. M., 1972: Note on ITCZ wave disturbances and formation of Tropical Storm Anna. *Mon. Wea. Rev.*, **100**, 733–737.

GATE, 1975: Report on the field phase of the GARP Atlantic Tropical Experiment. *GATE Report No. 17*, WMO, Geneva, 179 pp.

Hawkins, H. F., 1975: Study of two hurricanes. Presented at the AMS Ninth Tech. Conf. on Hurricanes and Tropical Meteorology, 27–30 May, Miami, Fla. Abstract in *Bull. Amer. Meteor. Soc.*, **56**, p. 322.

Hope, J. R., 1975: Atlantic hurricane season of 1974. *Mon. Wea. Rev.*, **103**, 285–293.