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WEATHER NOTE

An Apparent Relationship Between the Sea-Surface Temperature of the Tropical Atlantic and the Development of African Disturbances Into Tropical Storms

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ABSTRACT

An analysis of sea-surface temperatures over the tropical Atlantic for the past 5 yr shows a correlation between the number of tropical storms formed between July 10 and September 20 and the ocean temperatures over a wide area centered near 10°N and 35°W.

In a recent article by Carlson (1969) it was suggested that the frequency of tropical storm formation from African disturbances is dependent upon the sea-surface temperatures over the tropical Atlantic west of the African Continent. Evidence in support of this included a comparison of the August 1968 sea-surface temperatures over the tropical North Atlantic with those of August 1966. The earlier year was one in which several African disturbances developed into tropical storms, whereas 1968 was a notably inactive hurricane season. In the more active season, the August sea temperatures were 1° to 2°F higher than those of August 1968 in the area between longitude 30° and 40°W and latitude 5° and 20°N.

The hurricane season of 1969 was noted for being one of the most active in recent years, especially with respect to the number of African disturbances that became tropical storms or hurricanes, a total of seven between July 10 and September 20. We have obtained the machine-analyzed mean sea temperature data from the U.S. Fleet Numerical Weather Facility at Monterey, Calif., for the month of August 1969. Our own hand analyses of sea-temperature data have indicated that these machine analyses may be quite useful in examining relative temperature variations in the Tropics provided that the analyses represent an average over an extended period of time. Although the Tropics contain relatively few ship reports, a minimum of one or two reports are likely to be found within each 10° longitude square at any given observation period, while the composite analyses consist of about 60 such observation periods (Wolff 1969). Of course, such analyses are comparable from year to year only if the data density and method of analyses remain the same.

Figure 1 contains sea-temperature analyses for the 3 mo, August 1969, August 1968, and August 1966. The departure isotherm patterns show that August 1969 was clearly warmer than August 1966 over the tropical Atlantic Ocean; in the vicinity of 35°W, the tropical Atlantic was 2° to 3°F higher in August 1969 than the same area during August of the inactive season of 1968. For focusing attention on this area of maximum departure, subsequent tabulations will refer primarily to an area box located between 10° and 20°N and between 30° and 40°W.

Table 1 is a version of the sea-temperature data for the past five Augusts (1965–1969), showing the area average and area maximum values over this box. The years of data are listed from bottom to top in the table, in order of the increasing number of African disturbances to develop into tropical storms or hurricanes in the interval between July 10 and September 20 of that year.[1] It is evident that there is some degree of correlation between storm growth and sea temperature for these 5 yr. Were it not for a narrow intrusion of relatively cool water that extended into the northern part of the box, August 1969 would have yielded the warmest average of the past 5 yr (as the values in the third column of table 1 suggest) rather than taking second place to August 1967 when only four disturbances grew into tropical storms. The two most inactive seasons were also the coldest of the five.[2]

Recent studies such as those of Namias (1969) and Perlroth (1969) have also been concerned with the effects of sea temperatures on the development of Atlantic hurricanes. However, this note attempts only to relate the sea-surface temperature field lying in the path of (African) tropical disturbances to the propensity for growth of these disturbances beyond the wave stage into tropical storms. Examination of monthly mean circulation maps for the past 5 yr, as furnished to us by the Extended Forecast Division of the U.S. Weather Bureau, showed very little consistency between the behavior of the general circulation at low levels *in the Tropics* and the development of tropical storms. For illustrating this, the last five columns of table 1 include respectively the monthly mean 1000-mb geopotential height in the afore-mentioned area box, the

[1] The vast majority of tropical storms that form during this period develop from disturbances with origins appearing to be over the continent of Africa. These storms can be identified on the basis of their tracks as given by the U.S. Weather Bureau (now the National Weather Service) in its yearly summary of hurricanes in the *Monthly Weather Review*.

[2] Figures for August 1970 show 78.6 average temperature and 80.2 maximum temperature for the area box. The number of developing disturbances was 3.

TABLE 1.—*Version of the sea-temperature data for five Augusts (1965–1969) in the area box 10° to 20°N and 30° to 40°W*

Year	Average sea temperature	Maximum sea temperature	No. of storms, July 10–Sept. 20	Average 1000-mb height (m) in box	Average 700-mb height (m) in box	Average 700- to 1000-mb thickness (m) in box	Zonal height gradient (m) at 1000 mb along 20°N between 20° and 30°W	Meridional height gradient (m) at 1000 mb along 45°W between 20° and 30°N
1969	79.0	81.7	7	146	3195	3049	27	53
1966	78.9	80.8	5	158	3206	3048	31	56
1967	79.4	81.0	4	148	3198	3050	29	55
1965	78.7	80.0	3	156	3194	3038	30	44
1968	78.1	79.9	2	157	3199	3042	26	43

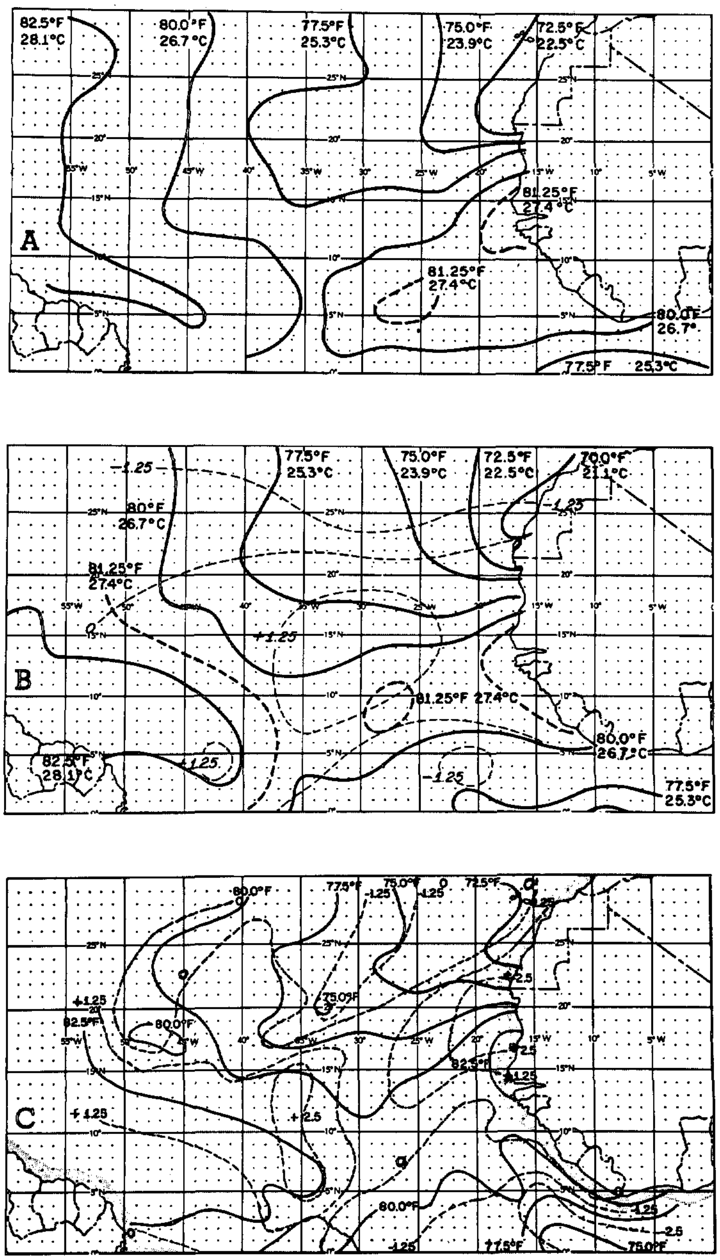

FIGURE 1.—Mean sea surface temperature field (°C and °F) for (A) August 1968, (B) August 1966, and (C) August 1969 (labeled °F only). The light dashed lines (labeled in °F) in (B) and (C) represent departure isotherms of that month from August 1968.

700-mb height averaged over the same area, the mean thickness in this area, the 1000-mb zonal height gradient along latitude 20°N between 20° and 30°W (a measure of the strength of the northeasterlies along the African coast), and the 1000-mb meridional geopotential height gradient along longitude 45°W between 20° and 30°N (a measure of the strength of the trades). Except for the 1000- and 700-mb thickness being somewhat less in the 2 coldest months, the only relationship worthy of mention is that the strength of the trades was somewhat reduced in the two inactive seasons. Oddly enough, the strength of the northeast trades along the coast of Africa does not appear to be greater in the years when the southward intrusion of cold water west of Africa was more pronounced. As suggested by Namias (1969), seasonal variations of sea-surface temperature in the Tropics may be influenced by anomalies in the circulation at higher latitudes which can affect the amount of cloudiness and insolation over a considerable area. Indeed, a comparison of the monthly composite satellite cloud pattern (prepared by the Walter A. Bohan Co., Parkridge, Ill.) for August 1967 with that of August 1968 shows a notably greater amount of cloud over the eastern tropical Atlantic in the latter (inactive) year.

If the sea-temperature anomaly in the tropical Atlantic proves to be persistent for periods of several months, it may become useful as a predictor of hurricane activity for that season.

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