NOTES AND CORRESPONDENCE

A Preliminary Analysis of Factors Affecting the Frequency of August Southeastern North Pacific Tropical Storms and Hurricanes Since the Advent of Satellite Observations

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(Manuscript received 22 April 1975; in revised form 7 July 1975)

ABSTRACT

Satellite-augmented observations of tropical storm and hurricane frequencies in the southeastern North Pacific during recent Augusts (1966–1974) were compared to various environmental factors. On a regional scale, a relatively strong mean 700 mb ridge from the Gulf of Mexico to Baja California was found to accompany high storm frequency. The linear correlation coefficient between storm frequency and a measure of the strength of this ridge amounted to 0.77. On a larger scale, the 700 mb Subtropical Westerlies Index (20°N to 35°N) for west longitudes from 0° to 180° had a somewhat stronger relation to storm frequency ($r=0.86$). Average August sea surface temperature in the vicinity of storm formation was poorly correlated with storm frequency. This suggests that the unfailingly warm August water temperatures in this area—always exceeding 27°F—were not a limiting factor in storm development.

1. Introduction

The southeastern portion of the North Pacific is a region of frequent tropical cyclone activity (Crutcher and Quayle, 1974). In recent years satellite observing techniques have provided a uniform, high quality source of data on storm formation and movement. Storm frequencies utilizing such data for 1966 to 1974 have been summarized by Baum (1975). A first look at some factors that might affect these frequencies would appear to be useful. Obviously conclusions drawn from the study of a 9 year period must be considered tentative.

2. Analysis and results

The present study is confined to August, the month with the greatest frequency of tropical storms and hurricanes during recent years in the area of interest. Figure 1 illustrates the mean 700 mb height distribution in the three Augusts of highest storm frequencies (1968, 1972, and 1974; see Fig. 2a). Superimposed are the differences of this pattern from the mean height in the two years with few August storms (1969 and 1973), expressed in units of standard deviations of August mean heights. The solid black circle in Fig. 1 locates the center of the area of climatologically greatest storm frequency during August (Crutcher and Quayle, 1974). A relatively strong mean 700 mb ridge, extending from the Gulf of Mexico to Baja California, prevailed when southeast Pacific storms were frequent. The location of the center of positive departure to the northeast of the area of storm formation is similar to the results of Ballenzweig (1958) for Caribbean and Lesser Antilles storms.

An index of the strength of the Gulf of Mexico–Baja California ridge, the average of August mean 700 mb heights at 25°N, 85°W and 20°N, 100°W, is plotted versus time in Fig. 2b. Comparison with Fig. 2a reveals a rather remarkable agreement between variations in the strength of the ridge and the frequency of tropical storms and hurricanes in the southeastern North Pacific; the linear correlation coefficient is 0.77. An evaluation of the statistical significance of this result, however, is clouded by the way in which the independent variable was chosen.

Simpson *et al.* (1969) concluded that impulses from the Caribbean played a significant role in east Pacific tropical storm formation. Thus it appears that the Gulf of Mexico-Baja California ridge, through control of the easterlies to its south, regulates the number and perhaps the nature of impulses crossing Central America to the east Pacific. An alternative interpretation of the correlation is possible, namely, that frequent tropical storm and hurricane development in the southeastern North Pacific may bring about a stimulation of the low latitude meridional circulation near North America, including a strengthening of the Gulf of Mexico–Baja California tropospheric ridge. Although both effects are probably

operative, an examination of synoptic maps during the three Augusts with most frequent storms suggests that the former predominates. In two of these cases tropical storm genesis in the east Pacific continued for 5 to 12 days following an abrupt decline of 5-day mean 700 mb heights in the Gulf of Mexico; the third case was inconclusive.

Correlation of storm frequency over the southeastern North Pacific with a broadscale measure of the subtropical flow produced a somewhat surprising result. The flow measure was the August Subtropical Westerlies Index at 700 mb for the Western Hemisphere—the geostrophic wind speed between latitudes 20°N and 35°N averaged over west longitudes from 0° to 180°. The resulting correlation coefficient was 0.86, somewhat greater than the aforementioned regional correlation, and significant at the 1% level. The sense of the correlation is that storms are most frequent with weak easterlies between 20°N and 35°N (Figs. 2a, c). Since these weak easterlies result from relatively high mean 700 mb heights along 20°N (see Fig. 1), they are probably associated with relatively strong 700 mb easterlies south of 20°N. It will be interesting to see whether subsequent data substantiate the apparent importance of the large-scale flow.

It is tempting to speculate that global trends in tropical cyclone frequencies (Milton, 1974) may arise in part from such a large-scale control as discussed above. However, a cursory survey of Atlantic storm data for the study period reveals little correlation with the Subtropical Westerlies Index on this time scale. Furthermore, during a recent period (1951–1962) when the August Subtropical Westerlies Index was available for both Eastern and Western Hemispheres, the two indices were negatively correlated ($r=-0.18$).

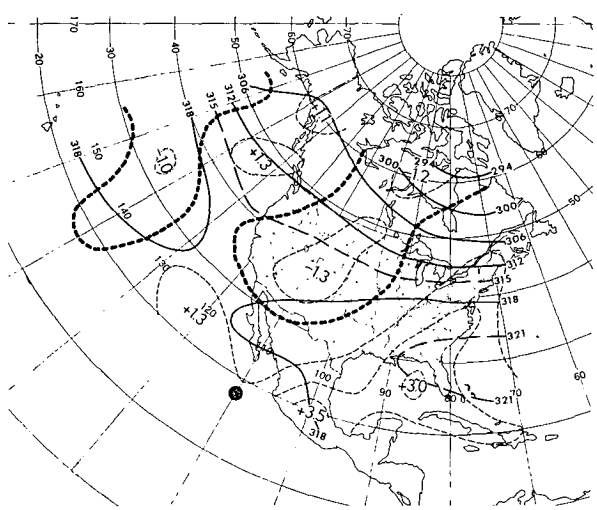

FIG. 1. Mean 700 mb height contours (dam) in the three Augusts with relatively frequent tropical storms and hurricanes in the southeastern North Pacific, 1966–1974. Dashed lines are differences of this pattern from the mean heights in the two years with few August storms in the same period. The difference unit is local standard deviation of August mean height, 1945–67. Large dot locates climatological maximum of August storm frequency.

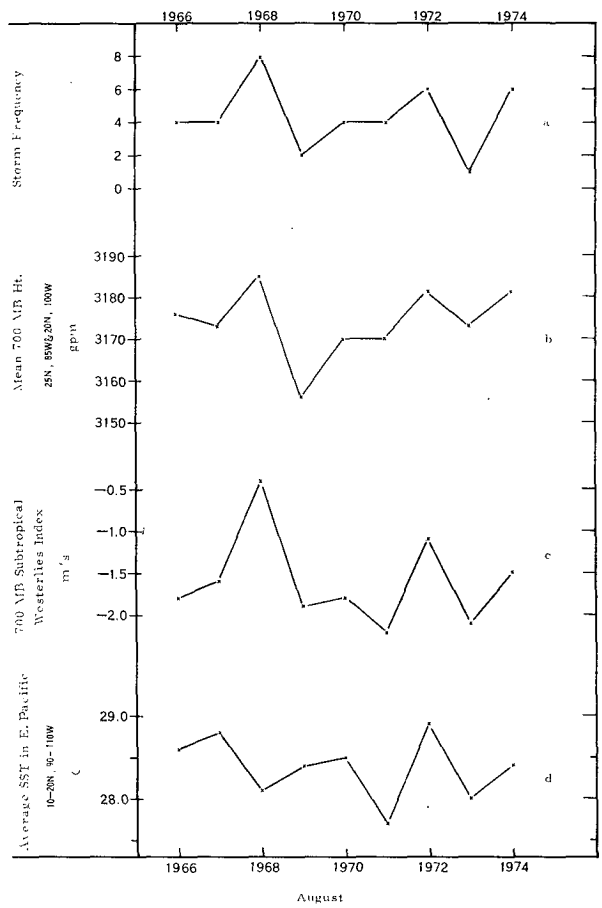

FIG. 2. Eastern Pacific tropical storm and hurricane frequency and selected environmental parameters for August, 1966–74.

Finally, storm frequency was related to a local parameter, the mean sea surface temperature in the area of storm formation. On the basis of 1968–1974 data, this was taken to be the eastern Pacific portion of the area encompassed by 10° to 20° north latitude and 90° to 110° west longitude. The average sea surface temperature in this area was computed from data read at a 5 degree latitude-longitude grid on monthly mean maps (National Marine Fisheries Service, 1966 to 1974). The resulting correlation, 0.20, was not significant at the 5% level. This is not too surprising in view of the unfailingly warm mean temperatures in this area during the study period—always exceeding the 26–27°C climatological constraint noted by Palmén (1948). Of course, the low correlation may also reflect the variable quality of the sea surface temperature data, and the manner in which the temperature parameter was computed.

3. Conclusions

When consideration is confined to recent years with satellite-augmented data, the frequency of August tropical storms and hurricanes in the southeastern North Pacific is found to be related to both the regional and the hemispheric mid-tropospheric circulation at low latitudes. On the other hand, the usually small variations in local surface temperatures about the quite-warm average appear unrelated to storm frequency in this area.

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