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DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

ATLANTIC TROPICAL CYCLONE CLASSIFICATIONS FOR 1974

Donald C. Gaby, Donald R. Cochran,
James B. Lushine, Samuel C. Pearce,
Arthur C. Pike, and Kenneth O. Poteat

Washington, D.C.
April 1975

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UNITED STATES DEPARTMENT OF COMMERCE
Frederick B. Dent, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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National Environmental Satellite Service
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ABSTRACT. Estimates of the locations and maximum sustained winds (classifications) of all named tropical cyclones in the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico during 1974 were made using the technique developed by Dvorak. This technique was applied to pictures from the SMS-1 (Stationary Meteorological Satellite) and ATS-3 (Advanced Technology Satellite) geostationary satellites. These estimates were compared with other data to establish the measure of accuracy achieved. The results are presented together with comments on expected future performance.

I. INTRODUCTION

For the past four hurricane seasons, the Miami Satellite Field Services Station (SFSS) of the National Environmental Satellite Service (NESS), collocated with the National Weather Service's National Hurricane Center (NHC), has provided "classifications" of all tropical cyclones in the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Classification includes fixing the location of the storm, making an estimate of the maximum sustained wind speed, and describing certain characteristics of the storm such as the trend of development and signs of probable future change. These classifications together with information from other sources are used by the NHC to formulate their advisories and warnings. Over the years, the ability of the satellite meteorologists to make good estimates of tropical cyclone locations and maximum wind speeds has increased steadily because of improvements in the classification system, better imagery and processing, and experience. This brief memorandum presents the results obtained at Miami for the 1974 hurricane season.

II. ESTIMATES OF MAXIMUM SUSTAINED WIND SPEED

Estimates of the maximum sustained wind speed were made using the technique developed by Dvorak (1973). Some slight modifications to the technique were made by adjusting it for use with the more frequent pictures from geostationary satellites. Almost all of the classifications reported here were made using SMS-1 (Stationary Meteorological Satellite) pictures while the satellite was located above the Equator at 45°W for the recent GARP[1] Atlantic Tropical Experiment (GATE) effort. A few were made while SMS-1 was moving westward late in the season; estimates also were made using ATS-3 (Advanced Technology Satellite) pictures for storms located over the extreme western Caribbean Sea or the Gulf of Mexico. Visible spectrum pictures with 4-km resolution were used in daylight hours,and 8-km resolution infrared pictures were used at night. Classifications were provided operationally at times specified by the NHC.

Any evaluation of performance is made difficult because there is no actual "ground truth" (i.e., no one knows exactly where the storm was or what the actual wind strength was). Our evaluations were made in two different ways. First, comparisons were made against data given in the NHC's "best tracks" (fig. 1). During postanalysis, these data are determined by the hurricane specialists giving careful consideration to all data available.[2] Typically, these data will include reconnaissance aircraft observations, ship reports, rawinsonde and pibal observations from land stations, and satellite observations. We consider that these best track data are the closest available approximation to the truth; but the data themselves are, to some extent, dependent data. Second, where feasible, comparisons were made against the

[1] Global Atmospheric Research Program

[2] NHC official tracks will be published in the April or May 1975 issue of the Monthly Weather Review. Unpublished summaries of maximum winds or minimum pressures for each storm are available from NHC.

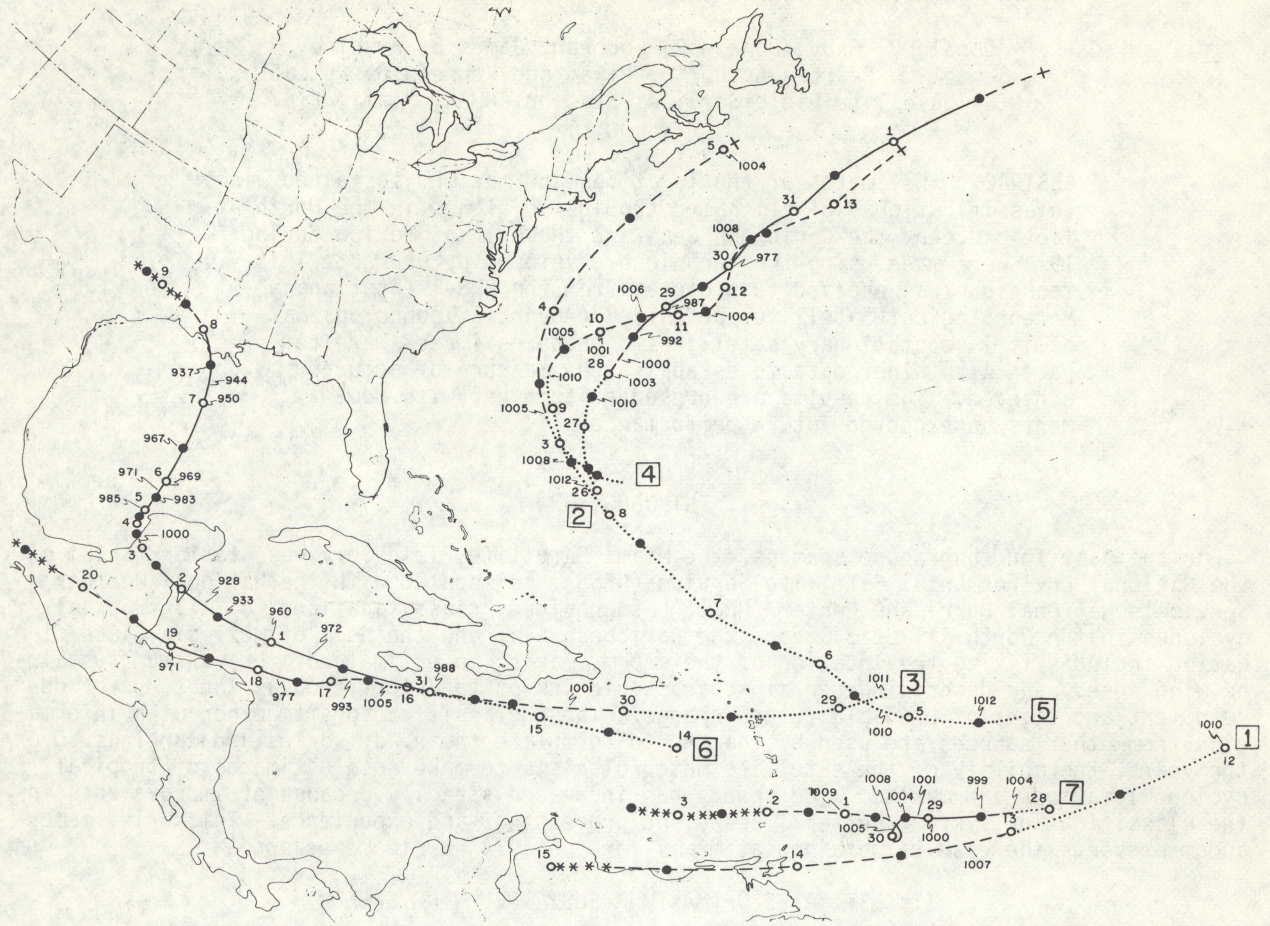


Figure 1.--NHC official tracks, 1974. See tables 1 and 3 for the names of the storms and their corresponding numbers.

maximum winds. These winds acquired by interpreting the minimum central pressures obtained by the reconnaissance aircraft using an average of the relationships derived by Kraft (1956) and the Joint Typhoon Warning Center (JTWC 1952). (See fig. 2.) We recognize that the satellite meteorologist working operationally and exposed to all of the data could have his judgment biased by the reconnaissance data, but we believe that this is not, in fact, a significant influence for the following reasons. The aircraft winds are demonstrably unreliable as indicators of the maximum sustained winds (Gaby 1974, Sheets 1972, and Sheets and Grieman 1975), and rarely is the current central pressure known to the satellite meteorologist at the time he renders his judgment.

Table 1 provides a comparison of the SFSS estimates of maximum sustained wind with the NHC best track or advisory data. There is a slight tendency to call the maximum winds lower than the best track or advisory data; however, this difference is small, averaging about one-half the average incremental difference between current intensity (C.I.) numbers shown in table 2.

Figure 3 shows a comparison of the SFSS estimates of maximum sustained winds with winds obtained by interpreting the minimum sea level pressures as shown on the best tracks chart (fig. 1). The central pressure values were taken directly from the official tracks except that the value of 971 mb for Fifi should be at 0902 GMT. Another measurement of 982 mb, just prior to landfall of Fifi at 1910 GMT, also is included. Although figure 3 represents less than one-third of the total comparisons, the results are not greatly different from those for all storms given in table 1. Again, a tendency for SFSS to estimate the maximum winds somewhat too low is indicated, but by amounts less than one-half the average incremental difference shown in table 2. [The pressure-"T-number" relationship shown in NOAA Technical Memorandum NESS 45 (Dvorak 1973) also may be compared directly to the observed pressure values obtained by reconnaissance.]

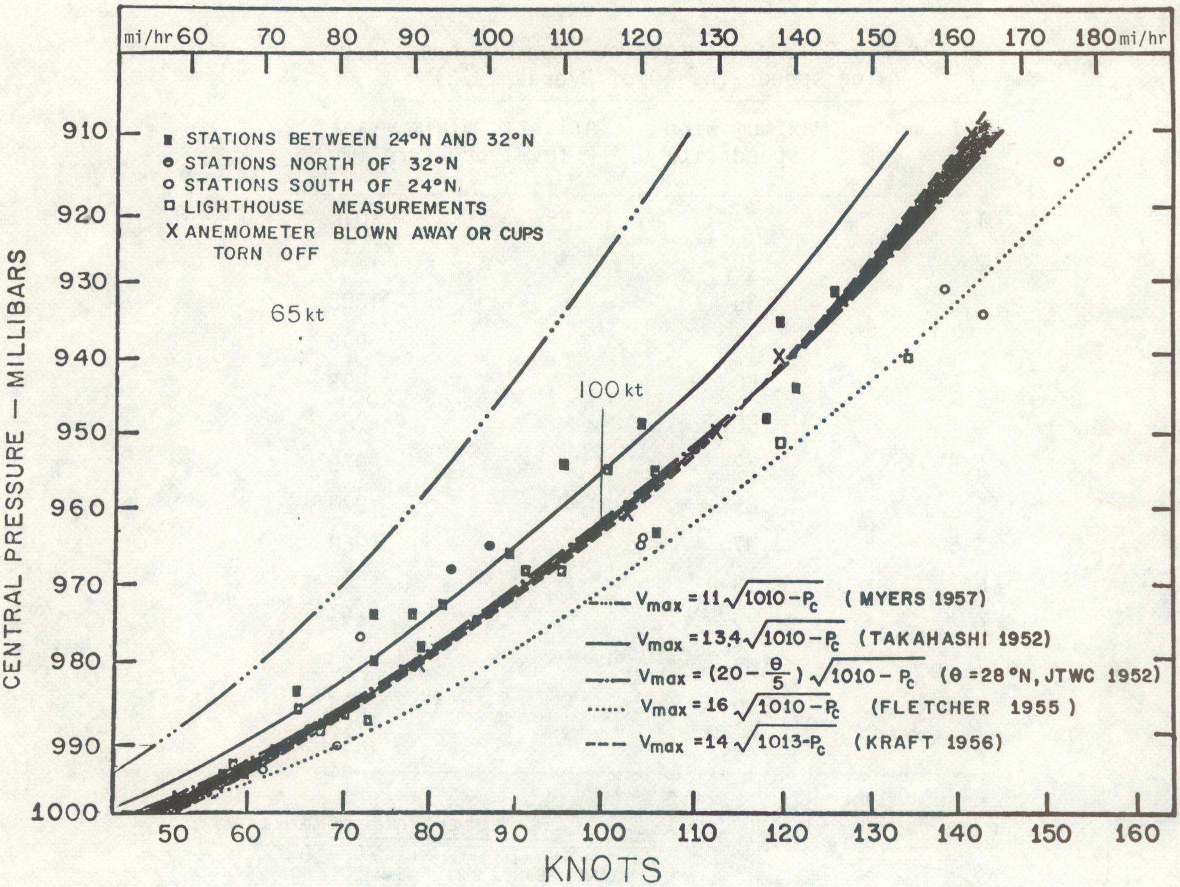


Figure 2.--Operational chart of maximum sustained surface winds versus central pressures in tropical cyclones (from Holliday 1969)

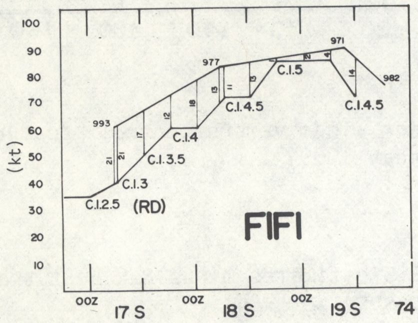
Table 1.--Maximum sustained wind-speed comparisons, SFSS estimates minus NHC best tracks data (no overland cases)

Storm, no.*	No. of cases	Average absolute difference	Average difference (SFSS-NHC)	σ of difference	Range of difference
		(kt)	(kt)	(kt)	(kt)
Alma, 1	11	8.5	-7.6	10.1	-20 to +5
Becky, 2	28	8.8	-5.8	10.4	-25 to +10
Carmen, 3	36	7.2	+2.1	8.7	-15 to +17
Dolly, 4	6	6.7	-6.7	5.8	-14 to 0
Elaine, 5	37	6.6	-5.8	5.3	-15 to +5
Fifi, 6	15	11.9	-11.9	7.5	-25 to 0
Gertrude, 7	15	11.7	-11.0	11.7	-30 to +5
All combined	148	8.4	-5.2	9.6	-30 to +17

*See the corresponding numbers within squares in figure 1.

Table 2.--C.I. numbers versus maximum sustained wind speeds (p. 10 of Dvorak 1973)

C.I. no.	Maximum wind speed (kt)	Atlantic minimum sea level pressure (mb)
1.5	25	1010
2	30	1007
2.5	35	1003
3	40	998
3.5	50	993
4	60	988
4.5	72	979
5	85	970
5.5	97	960
6	110	948
6.5	122	934
7	135	920
7.5	150	906
8	170	891



	CARMEN	FIFI	CARMEN & FIFI
	(kt)	(kt)	(kt)
MEAN (ABS.)	9.2	12.2	10.1
MEAN	-8.5	-12.2	-9.6
STD. DEV.	7.7	6.8	7.6
RANGE	-19 to +7	-21 to -1	-21 to +7
CASES	28	12	40

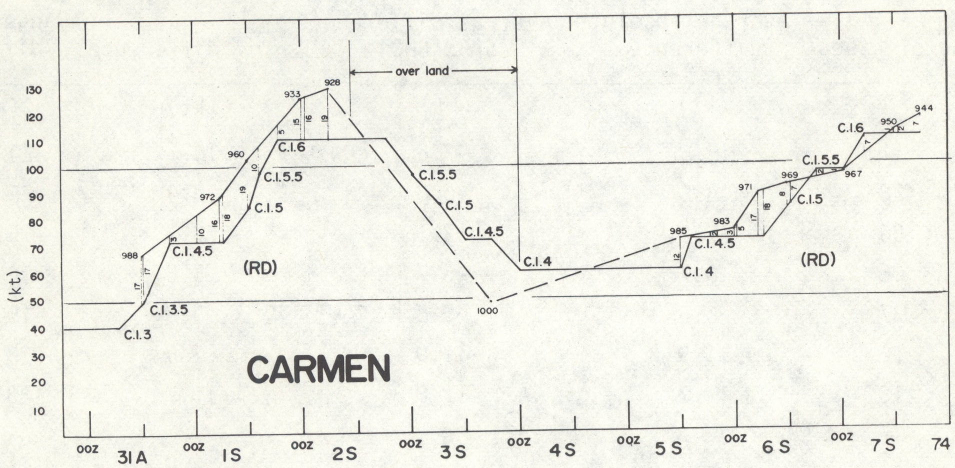


Figure 3.--Maximum sustained wind speed comparisons (Dvorak 1973), SFSS estimates from C.I. numbers minus wind speeds derived from minimum central pressures (no overland cases). Absolute is ABS.; standard deviation, STD. DEV.; rapid development (RD); A, August 1974; S, September 1974; and Z, GMT.

Table 3.--Position comparisons, SFSS and aircraft reconnaissance versus NHC official tracks (positions during reconnaissance periods only; aircraft and satellite fixes weighted equally)

Storm, no.*	No. of cases	Average difference	σ of difference	Range of difference
		(n.mi.)	(n.mi.)	(n.mi.)
Alma, 1	7	20.7	8.3	10-36
Becky, 2	27	18.2	15.6	0-60
Carmen, 3	126	17.0	12.9	0-60
Dolly, 4	10	22.9	18.4	6-70
Elaine, 5	39	22.6	19.5	0-84
Fifi, 6	64	15.0	10.5	0-46
Gertrude, 7	40	22.6	22.9	3-106
All combined	313	18.4	15.5	0-106

*See the corresponding numbers within squares in figure 1.

III. ESTIMATES OF LOCATION

Any evaluation of the accuracy of the SFSS storm locations made by direct comparison against the best tracks might be influenced by the individual weighting of the data since the best track locations are fixed subjectively by the person establishing them. We believe that, based upon the considerable aerial reconnaissance experience of several of our staff, the satellite storm "fixes" are at least as accurate as the aircraft reconnaissance fixes. This was demonstrated in earlier comparisons of both aircraft and satellite fixes to the best tracks (Gaby 1972). Accordingly, an evaluation was made by treating all fixes, both satellite and aircraft, as being of equal quality and then comparing them against the NHC best tracks. (Although the best tracks are dependent upon both types of fixes and other data, it would make little difference for this comparison just how the tracks are drawn.) Table 3 has the results.

IV. COMMENTS AND FUTURE PROSPECTS

The SFSS is supported by a small photographic laboratory staffed with experienced electronic and photographic technicians. The duty meteorologist usually matches the geographic overlay grid for the picture used for any particular classification, or he checks the gridding. Then, an optimum contrast photographic enlargement is made for the individual storm. Finally, the meteorologist has the photographic negative or a positive transparency with which to detect the maximum detail and more subtle features. In addition, he is able to examine a time-lapse motion picture loop of the storm just before his classification is done. Refinements are being made constantly to the operational procedures.

Looking to the future, we have every reason to believe that better results will be obtained with the coming series of satellites, SMS/GOES.[3] Although the first of the series, SMS-1, was used during the 1974 season, it was used under difficult and often trying conditions, an unfavorable viewing angle, moving the satellite out of position during the season, and inadequate geographic grids. For 1975 and subsequent years, we expect to have the SMS/GOES favorably situated to view the more important western parts of the Atlantic hurricane belt and to have a complete set of matching geographic grids. Grid information automatically implanted on the images is expected to improve our ability to fix the location of storms at night.

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[3]Geostationary Operational Environmental Satellites

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