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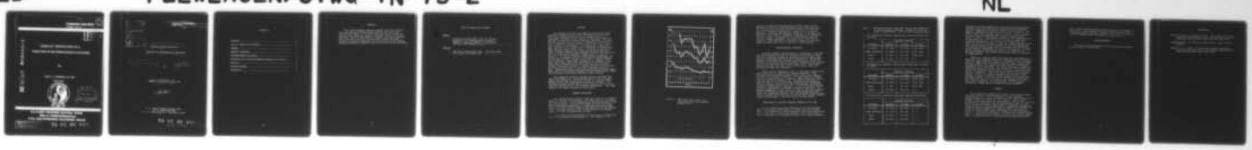

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FORECAST VERIFICATION AS A FUNCTION OF RECONNAISSANCE PLATFORM

by

LCDR E. J. HARRISON, JR., USN

MAY 1975

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ABSTRACT

This study examines tropical cyclone forecast accuracy as a function of reconnaissance platform upon which the forecast was based. It is shown that for the two years of data studied, forecasts based on aircraft fixes are the most accurate. Both 24- and 48-hour forecast accuracy is presented, although it must be realized that 48-hour forecast accuracy is heavily dependent on the accuracy of the recurvature/non-recurvature decision made at the time of the forecast.

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GENERAL

The western North Pacific oceanic region spawns more tropical cyclones annually than any other place on earth. This fact, combined with the large concentration of Department of Defense (DOD) assets in this area, makes the problem of forecast accuracy extremely important. A vital decision must be made by military commanders on whether or not to evacuate or sortie from a base or port when a tropical cyclone is approaching. This decision is based on many factors, but in every case, confidence in the official JTWC forecast plays a major role. Since the inception of JTWC, forecast accuracy has generally improved over the years to the current average accuracy of about 100-200-300 nm for the 24-48-72-hr forecasts respectively, as seen in Figure 1. It appears unlikely that further improvement can be realized without increases in tropical cyclone location (fix) accuracy. Many recent studies (e.g., Neumann 1975) have shown that significant improvement in objective forecasts can be realized with more exact initial positions. Current technology, however, severely restricts the accuracy of satellite fixes for all but well developed cyclones. Thus, improved aircraft navigational and meteorological equipment such as the Airborne Weather Reconnaissance System (AWRS) is the logical short-term solution to this problem.

The impact of tropical cyclone forecast accuracy has been well documented. Brand and Blelloch (1974) estimated annual DOD savings of $12.9 million for the western North Atlantic for a 20% improvement in forecast accuracy. An estimated annual DOD savings of $24.3 million for this area could be realized with a 40% forecast improvement. This same rationale of course extends to the Pacific.

WARNING PROCEDURE

The official JTWC warning is the end result of a complex series of events and decisions. The first step is, of course, to obtain the fix. To be adequate for warning purposes, a fix must occur within a certain time frame of 3 1/2 to 2 hours before scheduled warning time. Fixes obtained earlier are essentially too old for accurate extrapolation to the warning time, and fixes obtained later do not allow the forecaster sufficient time to prepare the warning.

When a fix has been plotted, the warning or initial position is determined by extrapolation. For example, a fix

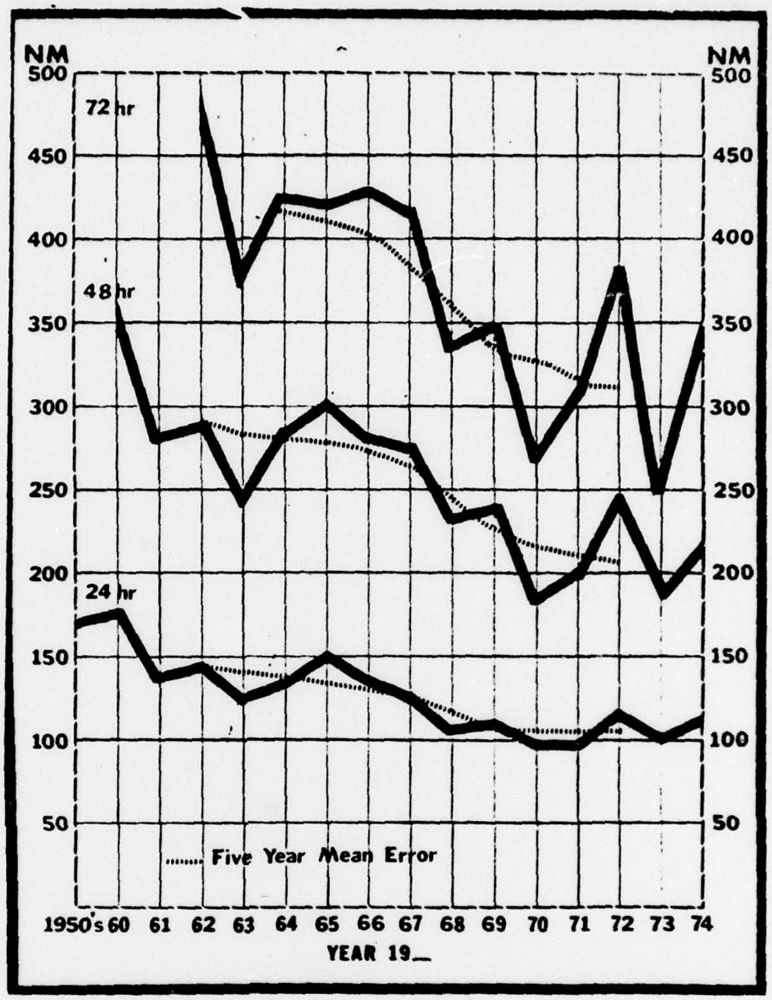

Figure 1. JTWC mean vector error (nm). Five year mean error shown by dashed line.

obtained at 0930Z is extrapolated to 1200Z using the fix position and the 12-hr old preliminary best track position. The computerized objective forecast programs are then run using all available information. Based on the objective forecasts, a preliminary forecast track out to 72 hours is derived. This track is carefully examined by the forecaster for consistency, compatability with climatology, and the current synoptic situation, and subjectively modified as required. JTWC warnings are normally transmitted 1/2 hour before warning time (e.g., 1130Z for a 1200Z warning).

RECONNAISSANCE PROCEDURE

Aircraft weather reconnaissance is performed in the JTWC area of responsibility by the Air Force 54th Weather Reconnaissance Squadron located at Andersen Air Force Base, Guam. Satellite data are provided by the Detachment 1, 1st Weather Wing Air Force DMSP site located at Nimitz Hill, which, in addition to providing direct coverage, coordinates the efforts of the other western North Pacific DMSP sites. Land radar positioning data from both civil and Air Force sites are provided to JTWC when available.

Under current directives, JTWC is required to obtain four fixes daily on all significant tropical cyclones. The Selective Reconnaissance Program (SRP) allows these fixes to be levied on aircraft, satellite, or radar based on factors such as cyclone position, intensity, threat potential, timeliness of satellite coverage, etc. The SRP was designed to optimize the use of all available reconnaissance platforms, and its primary intent was to reduce the burden on dwindling aircraft reconnaissance resources. In 1974, variable warning times were introduced to further increase flexibility. By allowing warnings to vary within 2 hours of the fixed synoptic times of 0000Z plus every six hours, many satellite fixes which were previously outside the time envelope could be used. Further details and statistics on the SRP and variable warning times may be found in the 1974 Annual Typhoon Report.

COMPARISON OF POSITION FORECAST ERRORS BY FIX TYPE

Table 1 depicts position forecast errors for warnings based on aircraft, DMSP satellite, radar, and other fixes. The "other" category is mainly warnings based on extrapolation or synoptic data. These cases usually occur either when a levied aircraft fix is missed and there is no timely satellite

Table 1. Forecast Position Error (nm) for various categories of reconnaissance platforms. Number of cases are shown in parentheses. 1973 and 1974 composite data.

a. All forecasts (Tropical Depressions, Tropical Storms and Typhoons)

PLATFORM	FORECAST INTERVAL		
	WARNING	24 HOUR	48 HOUR
Aircraft	18 (466)	111 (410)	207 (261)
DMSP Satellite	25 (358)	119 (248)	226 (126)
Radar	17 (61)	125 (36)	228 (22)
Other	43 (93)	151 (43)	---

b. Forecasts for typhoons (when maximum winds were 35 knots or more).

PLATFORM	FORECAST INTERVAL		
	WARNING	24 HOUR	48 HOUR
Aircraft	16 (323)	106 (299)	200 (229)
DMSP Satellite	20 (205)	103 (162)	228 (111)
Radar	15 (39)	115 (26)	210 (20)
Other	36 (29)	122 (11)	---

c. Forecasts for tropical storms and tropical depressions.

PLATFORM	FORECAST INTERVAL		
	WARNING	24 HOUR	48 HOUR
Aircraft	22 (133)	120 (95)	---
DMSP Satellite	32 (111)	146 (62)	---
Radar	21 (14)	152 (10)	---
Other	48 (53)	160 (30)	---

coverage, or when geographical restraints preclude aircraft reconnaissance and there is no timely satellite coverage. The main comparison is between aircraft and satellite. For example, although the radar fixes are more accurate in the mean, storms within radar range are usually being affected by land with the commensurately larger forecast errors shown in Table 1. The numbers missing in all three portions of the table are a result of too few cases to make their inclusion meaningful. In addition, no comparisons are shown for 72-hour forecasts. Such long range forecast errors are a direct result of the accuracy of the recurvature/non recurvature decision made when the warnings are issued and are relatively independent of initial fix accuracy. A significant portion of the 48-hour error is also due to this decision; however, the 48-hour errors are shown for the sake of completeness.

Table 1.a. depicts error statistics for all forecasts and shows that forecast errors for warnings based on aircraft fixes are lower than those based on satellite. As mentioned earlier, radar fixes are usually made on storms nearing land, and such systems will always be more difficult to forecast, regardless of fix accuracy. The cases depicted in Table 1.b. illustrate that when a storm has an eye, or a well developed center, the warning position error is about the same for the two major platforms. This also holds true for the forecast errors. Table 5.c. clearly indicates the ability of the aircraft to more accurately locate centers in the less well developed storms. This ability is particularly important in the formative stages, as it allows the forecaster to get a much better handle on the past movement of the surface circulation center and the potential future movement.

SUMMARY

The information summarized in Table 1 has several important implications. The most obvious is that aircraft reconnaissance is vitally important for developing storms and storms without eyes (Section c of Table 1). The 24-hour forecast error difference of approximately 22% for this category is extremely significant from an operational point of view. Since constant aircraft surveillance is impossible because of available assets, careful planning is required to optimize the reconnaissance platform mix. Aircraft fixes early in the formative stages allow better description of the developing structure and wind distribution. The Selective Reconnaissance Program, coupled with the variable warning time option, allow later aircraft fixes to be alternated with timely satellite data. When a storm develops an eye, and is not a threat to DOD assets, every attempt is made to maximize use of the satellite, with occasional aircraft fixes levied to check on current intensity and horizontal wind distribution.

ACKNOWLEDGEMENT

The statistics presented in this report were compiled by AG3 Alana L. Bryant, USN.

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