

## CHAPTER V - APPLIED TROPICAL CYCLONE RESEARCH SUMMARY

The following articles delineate the extent of the research program at Naval Environmental Prediction Research Facility (NAVENVPREDRSCHFAC) dedicated to supporting the operations at JTWC. There are three major research departments at NAVENVPREDRSCHFAC, each contributing to the overall program; research on current and future tropical cyclone models is performed in the Numerical Modeling Department, the Tactical Applications Department conducts statistical applications studies, and the Satellite Processing and Display Department develops computer interactive techniques.

### THE NAVY TWO-WAY INTERACTIVE NESTED TROPICAL CYCLONE MODEL (NTCM)

(Fiorino, M., NAVENVPREDRSCHFAC)

Two techniques for incorporating persistence into the NTCM forecast were tested on 157 independent cases from the 1982 and 1983 WESTPAC seasons. The first method uses the bias-corrector strategy in which the winds around the storm are modified to force the storm to initially move with the observed current motion. The bias-corrector is a pre-processing technique because the forecast track is affected before the model integration. The second method uses the post-processing technique of COSMOS. In this method, the 72-hour forecast position is retained and a combination of persistence and a straight line between the initial position and 72-hour point is used to fill in for the 24- and 48-hour positions. Superior results were obtained with the post-processing method. The median forecast errors at 24, 48, and 72 hours were 90, 201, and 296 nm compared to 102, 225, and 312 nm for the pre-processing method. Although the bias-corrector degraded the median 72-hour forecast error of the NTCM, it was effective in reducing the speed bias.

One-Way influence boundary conditions have been built into the NTCM. The initialization of the large-scale flow and the vortex were also modified to accommodate the change to the lateral boundary conditions. Experiments are underway to determine how the time variation of the flow at the boundaries affects the forecast track. The new version of the NTCM with one-way boundaries will be ready for the 1985 WESTPAC season.

### TROPICAL CYCLONE SYNOPTIC ANALYSIS DISPLAY SYSTEM

(Tsui, T., NAVENVPREDRSCHFAC)

A new SPADS software is under development for the purpose of demonstrating that the existing computer softwares can be adapted for SPADS and be streamlined

together to provide tropical cyclone forecasters a means to investigate immediate synoptic situation changes. This new SPADS system will be able to process satellite IR, VIS, and microwave data as they become available and translate these digital data into meteorological information which is to be merged with the FNOC wind/height field analysis. To maximize the utility of the system, the modified wind/height field should be updated every three hours so the forecasters could detect the most recent changes in the synoptic-scale flow influencing the tropical cyclone movement.

### TROPICAL CYCLONE OBJECTIVE DECISION-TREE FORECASTING AID

(Elsberry, R. L. and J. Chan, NAVPGSCOL)

In view of the short tour length and limited forecast experience of many JTWC TDO's, an objective approach to the tropical cyclone track forecasting decision making process is desired. Forecasters need assistance in determining when, where, and how to use the objective aids. A research effort is now underway to study the performance of different tropical cyclone forecast aids for various cyclone characteristics under different environmental conditions. Each of the factors, including center fix errors, affecting the accuracy of objective forecast aids will be incorporated into a decision tree to assist the forecaster in following a logical and reasonable path in selecting appropriate aids in any given situation. In FY85, NTCM will be used as a test case to prove the concept.

### JTWC CLIMATOLOGICAL DATA SET

(Tsui, T., NAVENVPREDRSCHFAC)

The JTWC tropical cyclone data base has been updated and expanded. The data base resides on FNOC computer disks on a storm-by-storm basis containing fix data, best track information, and official and objective aid forecasts. All three data sets have a separate but consistent data format. The data period begins at 1966 for the fix data, 1945 for the best track information, and 1967 for the official and objective aid forecasts. Currently, the last year included in this data set is 1983.

### A STATISTICAL METHOD FOR 1 to 3 DAY TROPICAL CYCLONE TRACK PREDICTION

(Matsumoto, C. R. and W. M. Gray, Colorado State University)

Growing out of the Colorado State University's own research effort, a new

method of incorporating climatology, persistence and synoptic data to forecast the 1 to 3 day tropical cyclone motion has been developed in an attempt to improve the accuracy of track prediction. Cyclones are stratified based on their position relative to the 500 mb subtropical ridge to better define the environmental influences on the cyclones. The 72-hr track forecast is segmented into three 24-hr time steps to permit the application of updated persistence and synoptic data relative to the new cyclone position as the 24-hr displacements are stepped forward to the desired forecast projection. Since the initial results warrant further investigations, NAVENVPREDRSCHFAC will evaluate the program under a simulated operational environment in FY85.

#### TROPICAL CYCLONE HAVEN STUDIES

(Brand, S. NAVENVPREDRSCHFAC)

With the completion of seven new hurricane haven studies, the Hurricane Havens Handbook for the North Atlantic Ocean provides 22 port and harbor evaluations. In addition, the haven study for Pearl Harbor has been completed and published. Requests for copies for official use may be directed to Commanding Officer, Attn: Technical Library, Naval Environmental Prediction Research Facility, Monterey, CA 93943-5106. Registered qualified users may request copies from Director, Defense Technical Information Center, Cameron Station, Alexandria, VA 22314. Others may purchase copies from National Technical Information Service, U. S. Department of Commerce, Springfield, VA 22151.

NAVY TACTICAL APPLICATIONS GUIDE (MTAG), Vol. 6

(Fett, R., NAVENVPREDRSCHFAC)

An effort is now underway to develop a series of examples demonstrating the use of high quality satellite data for analysis and forecasting in the tropics. Both polar orbital and geostationary satellite data are used to study the evolution of certain weather effects or of a particular weather phenomenon at a given time. These examples are intended for publishing in the NTAG Volume 6, Part I, Tropical Weather Analysis and Forecast Applications, and Volume 6, Part II, Tropical Cyclone Weather Analysis and Forecast Applications. This NTAG Volume 6 is scheduled to be published in 1988.

#### STATISTICAL TROPICAL CYCLONE FORECASTING AIDS FOR THE SOUTHERN HEMISPHERE

(Keenan, T., Bureau of Meteorology, Australia)

Statistical models for forecasting Southern Hemisphere tropical cyclones have been adapted and developed. From a limited

sample test, it is apparent that the Australian aids provide a level of assistance similar to the JTWC aids. The forecast errors of the Australian statistical aids range from 111 to 148 nm for 24-hr forecast and from 215 to 252 nm for 48-hr forecast. The classical regression technique turns out to be the best aid. This regression technique is derived from prescreened data sets which consist of 1000, 850, 700, 500, and 300 mb height fields, climatology predictors and persistence predictors. All the Australian aid programs reside on JTWC disk files in the FNOC computer system. Forecasters can activate these aids by providing date-time-group, previous and current storm locations and intensities.

#### SATELLITE BASED TROPICAL CYCLONE INTENSITY FORECASTS

(Cook, J. and T. Tsui, NAVENVPREDRSCHFAC)

An objective spiral analysis technique for tropical cyclone intensity forecasting has been installed on the Satellite Data Processing And Display System (SPADS). Through the satellite IR image displayed by SPADS, the technique first accepts a user described outline of a major cloud band of the tropical cyclone. The technique then objectively finds the best fitting spherical logarithmic spiral to the cloud band, and performs multiple Fourier analyses of the radiance field along orthogonal spirals to the band. By using these Fourier coefficients along with climatology and persistence predictors, tropical cyclone intensity forecasts can be deduced from regression equations. Independent tests show that the spiral technique possesses remarkably better skill in estimating the current intensity (6 kts RMS errors) than the Dvorak technique (15 kts RMS errors). Also, the spiral technique has a reliable 12-hr intensity forecasting skill (14 kts RMS errors).

#### CHARACTERISTICS OF NORTH INDIAN OCEAN TROPICAL CYCLONE ACTIVITY

(Lee, C. S. and W. M. Gray, Colorado State University)

A detailed individual case analysis is made of each of the North Indian Ocean (NIO) tropical cyclones which occurred during the 1979 First GARP GlobalExperiment (FGGE) period. Each NIO tropical cyclone's characteristics from genesis to decay are discussed. These tropical cyclones are found to form almost exclusively within the monsoon trough. Low-level equatorial westerly winds and Southern Hemisphere influences appear more important for the NIO tropical cyclones than for monsoon trough tropical cyclone formations in other regions. However, their basic structure, intensity change, and movement characteristics are very similar to tropical cyclones occurring in the other regions. A NAVENVPREDRSCHFAC technical report of this study will be published in early 1985.

TROPICAL CYCLONE READINESS CONDITION  
SETTING PROGRAM

(Brand, S. NAVENVPREDRSCHFAC and Jarrel, J.,  
Science Applications, Inc.)

A procedure for setting tropical cyclone readiness conditions with a high degree of reliability has been developed. The methodology utilizes a large number of computer-simulated forecasts for actual tropical cyclones since 1899 that passed near Key West, FL and Guantanamo Bay, Cuba. Wind probabilities were computed from these

forecasts assuming present-day official forecast error characteristics, and then compared to hindsight estimates of actual winds. These data were used to establish tropical cyclone condition thresholds at desired levels of confidence as related to wind probability. Sample nomographs with 95% threshold confidence values have been developed for hurricane readiness conditions at Key West and Guantanamo Bay. In the coming year, the readiness condition setting program will be adapted for five Pacific sites (Subic Bay, Buckner Bay, Yokosuka, Guam, and Pearl Harbor). In addition, this program will be developed for the afloat units in the Pacific area.