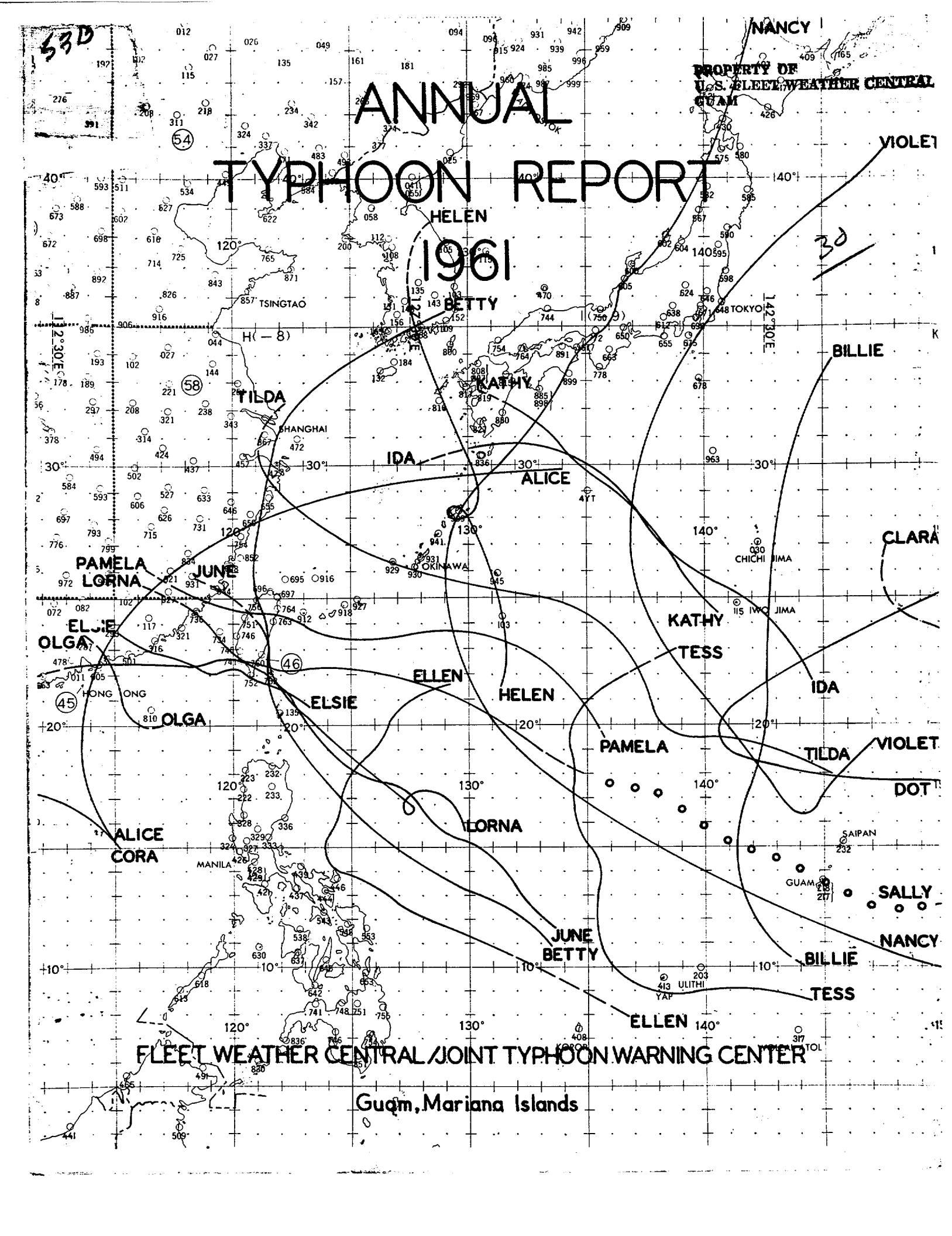
53D
PROPERTY OF
U.S. FLEET WEATHER CENTRAL
GUAM
ANNUAL
TYPHOON REPORT
1961
FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER
Guam, Mariana Islands
NANCY
VIOLET
HELEN
BETTY
TSINGTAO
TOKYO
BILLIE
TILDA
KATHY
SHANGHAI
IDA
ALICE
CLARA
PAMELA
LORNA
JUNE
OKINAWA
CHICHI JIMA
IWO JIMA
ELSIE
OLGA
TESS
ELLEN
HONG KONG
PAMELA
TILDA
VIOLET
DOT
LORNA
ALICE
CORA
MANILA
SAIPAN
GUAM
SALLY
NANCY
JUNE
BETTY
BILLIE
TESS
ULITHI
YAP
ELLEN
120°
130°
140°
142°30'E
112°30'E
40°
30°
20°
10°

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (FROM - TO)
01-01-1995	Annual Typhoon Report	xx-xx-1995 to xx-xx-1995

4. TITLE AND SUBTITLE
1961 Annual Typhoon Report
Unclassified

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Kotsch, William J. ;
Hutchinson, Leonard H. ;

5d. PROJECT NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME AND ADDRESS
Joint Typhoon Warning Center
425 Luapele Road
Pearl Harbor, HI96860-3103

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS
Naval Pacific Meteorology and Oceanography Center
Joing Typhoon Warning Center
425 Luapele Road
Pearl Harbor, HI96860-3103

10. SPONSOR/MONITOR'S ACRONYM(S)
11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APUBLIC RELEASE
,

13. SUPPLEMENTARY NOTES
See Also ADM001257, 2000 Annual Tropical Cyclone Report Joing Typhoon Warning Center (CD includes 1959-1999 ATCRs). Block 1 and Block 3 should be 1961.

14. ABSTRACT
This report is published annually and summarizes Western and Central North Pacific Typhoons. During 1961, no typhoons were reported in the Central North Pacific.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	Public Release	254	Fenster, Lynn lfenster@dtic.mil
Unclassified	Unclassified	Unclassified			19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007

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A1c REX W. METZGER
A2c MICHAEL A. S. EVANS, JR.

1961

ANNUAL TYPHOON REPORT

U. S. FLEET WEATHER CENTRAL/
JOINT TYPHOON WARNING CENTER
COMNAVMARIANAS BOX 12
SAN FRANCISCO, CALIFORNIA

FWC/JTWC:WJK:GU
3140
SER: 92
11 APRIL 1962

FROM: COMMANDING OFFICER, U.S. FLEET WEATHER CENTRAL/
JOINT TYPHOON WARNING CENTER, GUAM, M. I.
TO: CHIEF OF NAVAL OPERATIONS
VIA: COMMANDER IN CHIEF, U.S. PACIFIC FLEET

SUBJ: ANNUAL TYPHOON REPORT, 1961; SUBMISSION OF

REF: (A) OPNAV INSTRUCTION 3140.17C

1. THE ANNUAL TYPHOON REPORT, 1961 IS SUBMITTED HEREWITH IN ACCORDANCE WITH PARAGRAPH 3.A. OF REFERENCE (A).

2. DURING CALENDAR YEAR 1961, A TOTAL OF TWENTY DESTRUCTIVE TYPHOONS THREATENED THE WESTERN PACIFIC AREA, NECESSITATING THE ISSUANCE OF 737 INDIVIDUAL WARNINGS AND THE PLACEMENT OF THE FWC/JTWC, GUAM IN "TYPHOON WARNING STATUS" FOR 165 CALENDAR DAYS.

3. THE COMMANDING OFFICER, FWC/JTWC, GUAM IS PLEASED AND PROUD TO INDICATE THAT DESPITE SEVERE AERIAL RECONNAISSANCE CURTAILMENT SUBSEQUENT TO 1 SEPTEMBER 1961, 24 HOUR TYPHOON FORECASTS WERE IMPROVED 13.2 PERCENT OVER THE PREVIOUS YEAR, AND 48 HOUR FORECASTS WERE IMPROVED BY 13.5 PERCENT. ALSO, THAT AS THE DIRECT RESULT OF JUDICIOUS AND EFFICACIOUS UTILIZATION OF LAND-BASED RADAR REPORTS FROM THE PHILIPPINES, OKINAWA, TAIWAN, AND JAPAN, A TOTAL OF THIRTY-SEVEN AERIAL RECONNAISSANCE MISSIONS WERE "POCKETED," THEREBY SAVING THE DEPARTMENT OF DEFENSE AND THE U.S. TAXPAYER A MOST CONSERVATIVELY ESTIMATED $370,000.00.

WILLIAM J. KOTSCH

COPY TO:

CNO (2)
CINCPAC
CINCPACFLT
CINCLANTFLT
COMNAVMARIANAS
COMNAVPHIL
COMNAVFORJAPAN
COMNAVFORKOREA
COMWESTSEAFRON
COMSEVENTHFLT
COMFIRSTFLT
COMPHIBPAC (2)
COMCRUDESPAC
COMASDEFORPAC
COMINPAC
COMSERVPAC
COMSTS (2)
COMNAVAIRPAC (17)
SUPT NAVPGSCOL (2)
CHIEF, JUSMAG, PHILIPPINES (2)
CHIEF, JUSMAG, THAILAND (2)
CHIEF, MAAG, JAPAN (2)
CHIEF, MAAG, TAIWAN (2)
CHIEF, PMAAG, KOREA (2)

DIR NAVAL WEATHER SERVICE (2)
CO FLEWEACEN PEARL
CO FLEWEACEN ALAMEDA
OIC FLEWEAFAC SANGLEY PT
OIC FLEWEAFAC YOKOSUKA
OIC FLEWEAFAC MIAMI
OIC FLEWEAFAC SAN DIEGO
CO AEWRON ONE (2)
CO AEWRON FOUR
OIC NWRF NORFOLK
NAVREP NWRC ASHEVILLE N.C.
HEADQUARTERS, AWS (5)
HEADQUARTERS, 1ST WW (40)
AFHLO, JHWC, MIAMI
AFPCHLO, BASE WEATHER STATION, HAMILTON AFB, CALIF
HEADQUARTER, 9TH WG (2)
54TH WEATHER RECONN SQDRON (2)
55TH WEATHER RECONN SQDRON
56TH WEATHER RECONN SQDRON (2)
CHIEF, US WEATHER BUREAU (4)
MIC, PSO, USWB HONOLULU (12)
CAF WEATHER CENTRAL, TAIWAN
DIRECTOR, ROYAL OBSERVATORY, HONG KONG
NATIONAL GOVERNMENT OF REPUBLIC OF CHINA
REPUBLIC OF KOREA
JAPAN
SEATO COUNTRIES (10)

FOREWORD

THIS REPORT IS PUBLISHED ANNUALLY AND SUMMARIZES WESTERN AND CENTRAL NORTH PACIFIC TYPHOONS. DURING 1961, NO TYPHOONS WERE REPORTED IN THE CENTRAL NORTH PACIFIC.

THE JOINT METEOROLOGICAL GROUP, PACIFIC COMMAND, THROUGH CINCPACFLT, AS EXECUTIVE AGENT, REDESIGNATED FLEET WEATHER CENTRAL, GUAM AS FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER (FWC/JTWC), GUAM, EFFECTIVE 1 MAY 1959, WITH THE FOLLOWING ADDITIONAL RESPONSIBILITIES:

1. TO PROVIDE WARNINGS TO U. S. GOVERNMENT AGENCIES FOR ALL TROPICAL CYCLONES WEST OF 180 DEGREES LONGITUDE NORTH OF THE EQUATOR TO THE ASIATIC COAST AND MALAYAN PENINSULA.

2. TO DETERMINE TROPICAL CYCLONE RECONNAISSANCE REQUIREMENTS AND ASSIGN PRIORITIES.

3. TO CONDUCT INVESTIGATIVE AND POST ANALYSIS PROGRAMS INCLUDING PREPARATION OF THE ANNUAL TYPHOON REPORT.

4. TO CONDUCT TROPICAL CYCLONE FORECASTING AND DETECTION RESEARCH AS PRACTICABLE.

FUCHU AIR FORCE WEATHER CENTRAL, ASSISTED AS NECESSARY BY FLEET WEATHER FACILITY, YOKOSUKA, WAS DESIGNATED AS ALTERNATE JTWC IN CASE OF FAILURE OF FWC/JTWC, GUAM.

THE JTWC, WHICH IS AN INTEGRAL SECTION OF FWC/JTWC, GUAM, IS STAFFED BY TWO AIR FORCE AND TWO NAVY METEOROLOGISTS AND THREE ENLISTED MEN FROM EACH SERVICE. THE SENIOR AIR FORCE OFFICER HAS BEEN DESIGNATED AS THE DIRECTOR, JTWC.

THE JOINT HURRICANE WARNING CENTER IN HAWAII, A COORDINATED AGENCY COMPOSED OF THE U. S. WEATHER BUREAU, HONOLULU, THE AIR FORCE KUNIA WEATHER CENTER, AND FLEET WEATHER CENTRAL, PEARL HARBOR, IS RESPONSIBLE FOR SURVEILANCE AND ISSUANCE OF WARNINGS IN THE CENTRAL NORTH PACIFIC AREA NORTH OF THE EQUATOR BETWEEN 180 DEGREES AND WEST OF 140 DEGREES WEST. THERE WAS ONE TROPICAL STORM, PAULINE, IN OCTOBER 1961, AND THERE WERE NO TROPICAL DEPRESSIONS WITHIN THIS AREA.

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CHAPTER I

OPERATIONAL PROCEDURES

A. GENERAL

OPERATIONAL PROCEDURES TAKE TWO STEPS, THAT OF ANALYSIS AND FORECAST AIDS, IN THE PREPARATION SEQUENCE PRIOR TO ISSUING THE WARNING. WITHIN THE FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER (FWC/JTWC), THE BASIC ANALYSIS IS THE RESPONSIBILITY OF THE FLEET WEATHER CENTRAL (FWC). MICRO-ANALYSIS, FORECAST AID EVALUATION, AND THE WARNINGS AS DESCRIBED BELOW, ARE THE FUNCTIONS OF THE JOINT TYPHOON WARNING CENTER (JTWC).

B. ANALYSIS - FWC/JTWC:

1. TYPES OF CONTOUR AND/OR STREAMLINE CHARTS:

   A. SURFACE (FIG. 1)
   B. 700 MB
   C. 500 MB
   D. 300 MB
   E. 200 MB
   F. 100 MB

2. CROSS SECTIONS:

   A. CHECKERBOARD OR STIDD DIAGRAM (FIG. 2)
   B. TIME CROSS SECTIONS ANALYZED FOR θ_E (FIG. 3)
   C. SPACE CROSS SECTION (FIG. 4)

3. MICRO-ANALYSIS:

   A. SECTIONAL CHARTS, HOURLY AND 3 HOURLY, AS REQUIRED
   B. RECONNAISSANCE REPORTS (FIG. 5)

4. SPACE MEAN CHART AT 500 MB WITH THE M-1 AND M-2 FIELDS.

5. EASTERLY WAVE CONTINUITY GRAPH (FIG. 6)

C. FORECAST AIDS

THESE ARE LISTED IN ALPHABETICAL ORDER SO AS NOT TO (INFER THAT ANY OTHER ORDER WOULD) ESTABLISH A PRIORITY OF IMPORTANCE.

1. CLIMATOLOGY

ONCE A TROPICAL CYCLONE HAS BEEN DETECTED, THE FIRST STEP IN PREPARING TO ISSUE THE INITIAL WARNING IS TO LAY OUT A TRACK BASED ON CLIMATOLOGY. THIS TRACK IS LAID OUT ON THE TOP ACETATE OF THE WORK CHART DESCRIBED BELOW SO AS TO EXTEND IT 4 OR 5 DAYS AT THE SPEED INDICATED BY CLIMATOLOGY. NEXT, THE TRACK IS MODIFIED IN ACCORDANCE WITH THE EXISTING AND FORECAST UPPER AIR PATTERN, AFTER WHICH THE INITIAL WARNING IS PREPARED AND ISSUED. THE FORECAST TRACK

IS EXTENDED AND MODIFIED WITH TIME, AS RECONNAISSANCE FIXES ARE RECEIVED AND THE SYNOPTIC UPPER AIR PATTERN CHANGES.

THE FINEST COMPILATION OF TYPHOON CLIMATOLOGICAL DATA FOR THE PAST 78 YEARS IS CONTAINED IN THE PUBLICATION OF THE ROYAL OBSERVATORY HONG KONG, "TROPICAL CYCLONES IN THE WESTERN PACIFIC AND CHINA SEA AREA."

2. COMPUTER PRODUCTS

IN 1961, THE PROGNOSIS FUPA 53 AND 56, PRODUCTS OF JNWP, WERE USED EXTENSIVELY. LONG WAVE POSITIONS AND PROGNOSES (FIG. 7) WERE RECEIVED IN NOVEMBER 1961 FROM THE FLEET NUMERICAL WEATHER FACILITY, MONTEREY, CALIFORNIA (FNWF). ALSO, ZONAL INDEX COMPUTATIONS ARE EXPECTED FROM FNWF AND WILL BE EVALUATED DURING THE 1962 SEASON.

IT IS UNDERSTOOD THAT IN ADDITION TO JNWP, NOW NMC, THAT FNWF AND KUNIA AIR FORCE WEATHER CENTRAL WILL PROVIDE TYPHOON COMPUTER POSITION FORECASTS IN 1962. DURING 1961, THOUGH IRREGULARLY RECEIVED, JNWP POSITIONS WERE CONSIDERED FOR TRACK HEADING AND SPIRAL OF MOVEMENT BUT NOT THE COORDINATES FOR WARNINGS.

3. COORDINATION

COORDINATION WITH OTHER AGENCIES IS ROUTINE TO OBTAIN THEIR CONSIDERATIONS PRIOR TO ISSUANCE OF A WARNING. WHEN A CIRCULATION, FOR WHICH WARNINGS ARE BEING ISSUED, IS N OF APPROXIMATELY 20N, FUCHU AIR FORCE WEATHER CENTRAL TRANSMITS COORDINATION FORECASTS TWICE DAILY TO JTWC. COORDINATION WITH OTHER AIR FORCE AND NAVY ACTIVITIES IS ON AN "AS REQUIRED" BASIS DEPENDING UPON THE LOCATION OF A PARTICULAR TROPICAL CYCLONE.

4. STATISTICAL METHODS

SEE CHAPTER V FOR RESEARCH PAPERS ON THE MILLER-MOORE AND ARAKAWA EQUATIONS.

5. STEERING

SEE CHAPTER IV ON THE INDIVIDUAL TYPHOON WRITE-UPS.

THE SPACE MEAN CHART, AS DISCUSSED HEREIN, IS A BRIEF ON HOW IT IS USED AT FWC/JTWC. THE CHART IS CONSTRUCTED FROM THE 500 MB CHART AND HAS THE SINGLE SPACE MEAN, DOUBLE SPACE MEAN, AND DOUBLE SPACE MEAN PLUS THE M-2 FIELD THEREON. DURING THE TYPHOON SEASON THE CHART IS PRODUCED, AS NEEDED, EXCEPT THAT BETWEEN JULY AND NOVEMBER IT IS CONSTRUCTED TWICE DAILY. ONE GREAT ADVANTAGE OF THE CHART IS THAT IT MORE NEARLY PORTRAYS THAT PORTION OF THE ATMOSPHERE UNDER CONSIDERATION ON ONE CHART, THAN DOES ANY OTHER ANALYSIS OR SYSTEM OF PRESENTATION.

THE CHART IS USEFUL FOR STEERING S OF THE RIDGE LINE UNDER THE FOLLOWING CONDITIONS:

A. WHEN THE TYPHOON IS MOVING ALONG THE S PERIPHERY OF A LARGE QUASI-STATIONARY ANTICYCLONE, THE SINGLE SPACE MEAN MAY ACT AS A STEERING TOOL AS FAR AS 8 TO 10N TO THE RIDGE LINE. A TYPICAL EXAMPLE OF THIS SITUATION IS THE TRACK OF NANCY.

B. WHEN THE SYNOPTIC FEATURES ARE PERFORMING CONSISTENTLY, A PROGNOSTIC CHART CAN BE CONSTRUCTED FROM THE SINGLE SPACE MEAN TO BE USED AS A STEERING TOOL FROM 10N TO THE RIDGE LINE. SEVERAL TYPHOONS FULFILLED THIS CATEGORY.

C. THE SINGLE SPACE MEAN MAY BE USED WITH A LESSER DEGREE OF RELIABILITY FROM 15N TO THE RIDGE LINE AT ANY TIME EXCEPT WHEN THE CYCLONE IS UNDER OR NEAR AN INVERTED TROUGH AXIS. AT THIS TIME, THE CYCLONE USUALLY "DRIFTS," FREQUENTLY TO THE W, BUT THE CHART IS NOT RELIABLE AS A STEERING TOOL. THE CIRCULATION MAY ALSO "LOOP" UNDER THESE CONDITIONS. ANALYSIS IS SELDOM SUFFICIENTLY PRECISE TO INTERPRET THESE CIRCUMSTANCES. TILDA IS AN EXAMPLE OF THIS SITUATION, AND THE TYPHOON DRIFTED WESTWARD. LORNA LOOPED WHILE NEAR THE AXIS OF THE INVERTED TROUGH JUST E OF THE PHILIPPINES, 221200Z AUGUST.

THE SPACE MEAN CHART WILL AID IN FORECASTING THE POINT OF RECURVATURE BUT SHOULD BE USED WITH CAUTION FOR ON LARGE TYPHOONS THIS POINT MAY BE A DEGREE OR TWO N OF THAT INDICATED BY THE SPACE MEAN CHART.

AFTER RECURVING, THE CHART IS USED TO FORECAST THE MOVEMENT OF THE TYPHOON SOMEWHAT SIMILAR TO THAT OF FORECASTING THE MOVEMENT OF EXTRATROPICAL SYSTEMS.

IT IS EMPHASIZED THAT THE SPACE MEAN CHART IS ANOTHER TOOL, ONE OF MANY, AND CANNOT BE SUCCESSFULLY USED AS THE SOLE DEVICE FOR MAKING TYPHOON TRAJECTORY FORECASTS.

AN IMPORTANT DERIVATIVE OF THE SPACE MEAN CHART, THE LONG WAVE PATTERNS THAT ARE PRODUCED AND PROVIDED BY FNWF, MONTEREY, AIDS IN DETERMINING THE CONDITIONS OF THE MAJOR ATMOSPHERIC FEATURES IN THE NORTHERN HEMISPHERE AND IS A GUIDE TO THE CHANGES THAT MAY BE EXPECTED THROUGHOUT THE HEMISPHERE. THESE PATTERNS, WHEN USED WITH THE SPACE MEAN CHART THAT COVERS THE WESTERN NORTH PACIFIC, PROVIDE A SUBSTANTIAL BACKGROUND UPON WHICH TO BASE TYPHOON FORECASTS.

6. SURVEILANCE SYSTEMS

SEE CHAPTER II FOR EVALUATIONS OF AERIAL RECONNAISSANCE, LAND RADAR, AND SATILLITES.

7. Wachholz Graph

Refer to report of validity of this graphical correlation of measured and observed eye meteorological parameters to maximum surface wind in Chapter V.

8. Work Chart

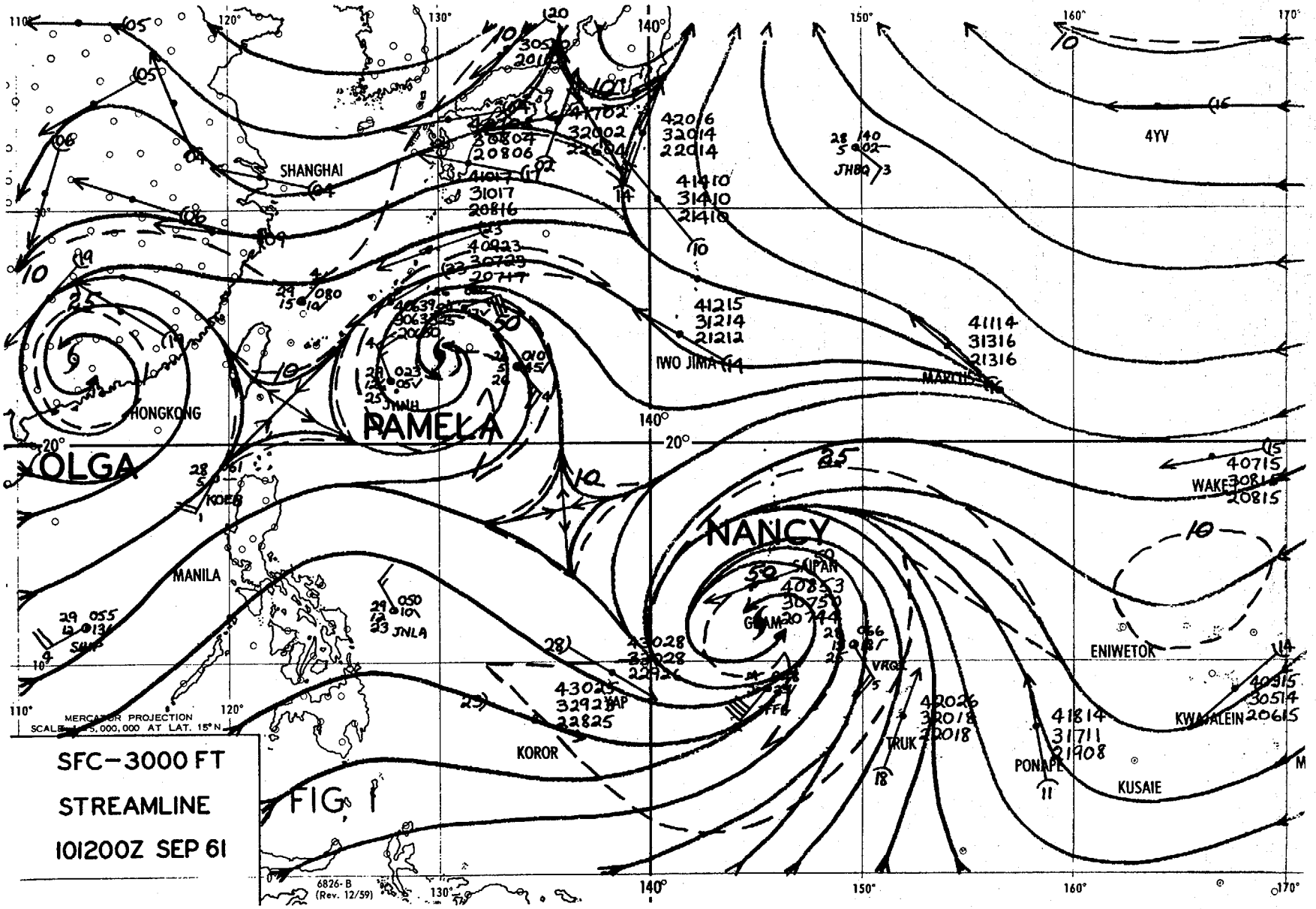
As an operational and recording tool in preparing tropical cyclone warnings, a basic chart from the Pacific Airways Plotting Chart series, plus 3 acetate overlays is used. All aircraft and radar fixes are plotted on the basic chart. Twenty-four hour forecast positions are plotted on the bottom overlay, warning positions are plotted on the second overlay, and the top overlay is utilized as a work sheet.

D. WARNINGS

Warnings are filed and transmitted every 6 hours at synoptic times of 0000Z, 0600Z, 1200Z, and 1800Z. In accordance with CINCPAC IMST 3140.1 C., the message contains the present position of the tropical cyclone being valid for the scheduled transmission time. Therefore, the "present position" of a tropical cyclone is actually a short range forecast position. This position may be based on a reconnaissance fix 30 minutes to perhaps 6 hours old, on surface observations as much as 6 hours old, etc., as confirmed in the warning. It is for this reason that the 0600Z warning, for example, may not agree with the position of the tropical cyclone as indicated by the 0600Z analysis. Amendments are issued when the difference is significant. The numbers of tropical warnings run consecutively when the cyclone is upgraded or downgraded. If warnings are discontinued and the circulation regenerates, the new series of warnings are numbered consecutively from the number of the last warning of the previous series. When necessary, amendments and corrections are issued, and these are numbered the same as the warning which they amend or correct.

The 1961 Verification Summary is contained in Chapter III.

All 24 and 48 hour forecasts, made when a tropical cyclone is of tropical storm or typhoon intensity, are verified against the best 1961 tracks at all latitudes through the last warning issued. In 1959 and 1960 verification was limited to being at or S of 35N.



SFC–3000 FT

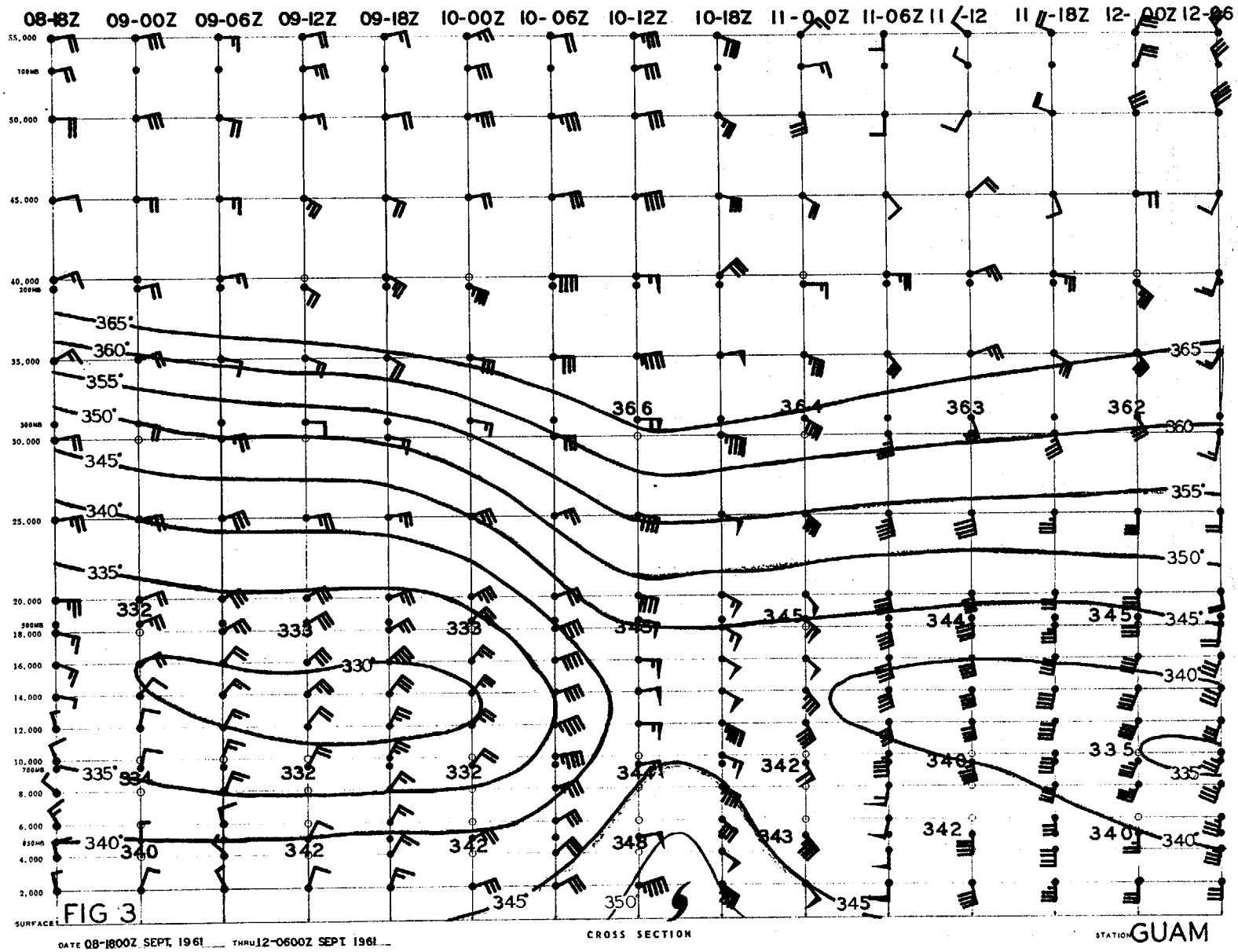
STREAMLINE

101200Z SEP 61

FIG. 1

FIG 2

MAR-FWC 3140-1 (REV. 9/59)


08-18Z
09-00Z
09-06Z
09-12Z
09-18Z
10-00Z
10-06Z
10-12Z
10-18Z
11-00Z
11-06Z
11-12
11-18Z
12-00Z
12-06
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
SURFACE
365°
360°
355°
350°
345°
340°
335°
366
364
363
362
365
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355°
350°
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344
345
345°
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342
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332
333
332
330°
335°
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332
332
342
340
342
342
348
343
342
340
340
345
350
345
FIG 3
DATE 08-1800Z SEPT. 1961 THRU 12-0600Z SEPT 1961
CROSS SECTION
STATION GUAM

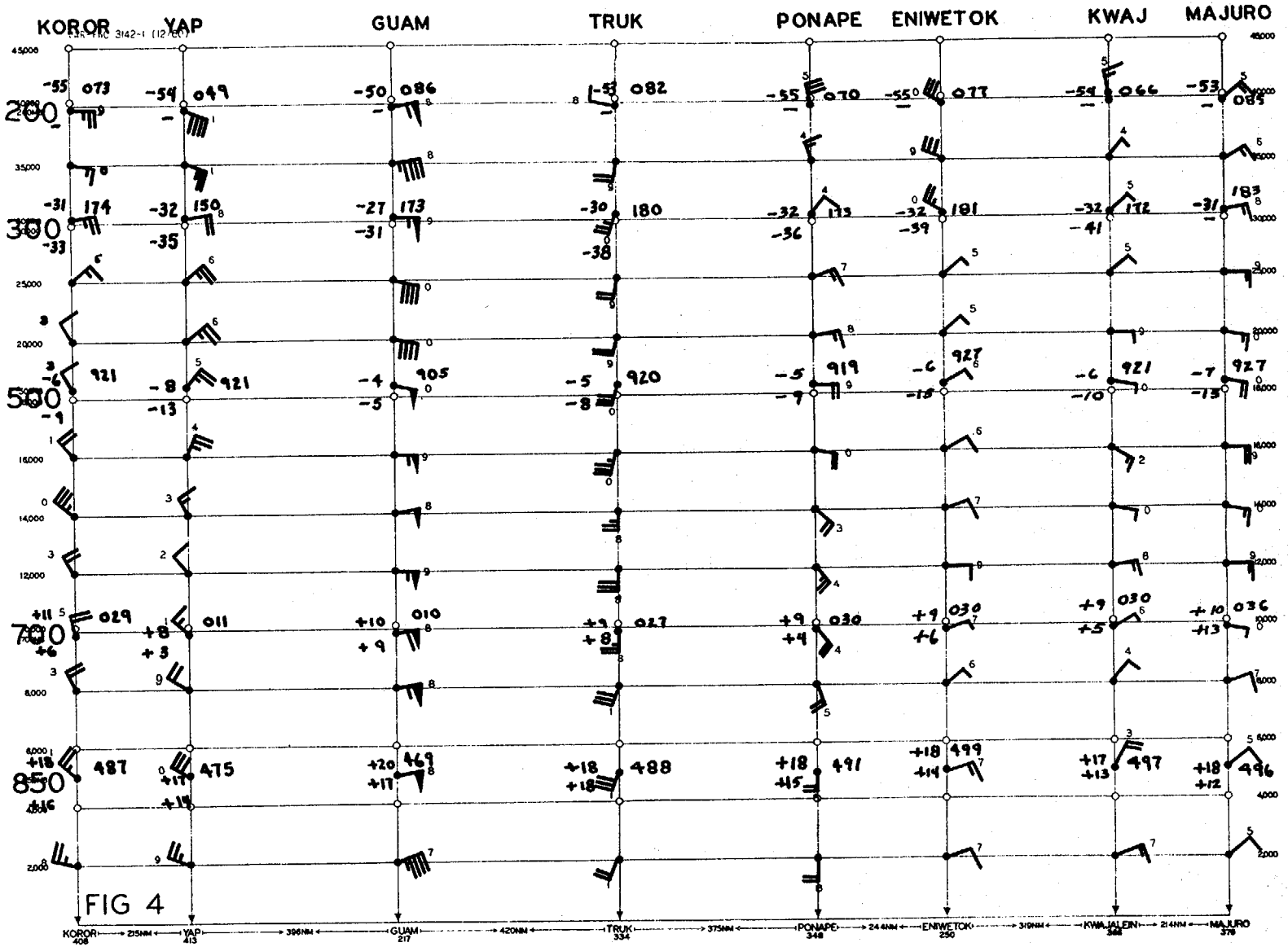


FIG 4

DTG: 10-1200 Z MO: SEPT YR: 1961

CROSS SECTION (KOROR-MAJURO)

SCALE: 1" = 110NM
FWC/JTWC DEC 1960

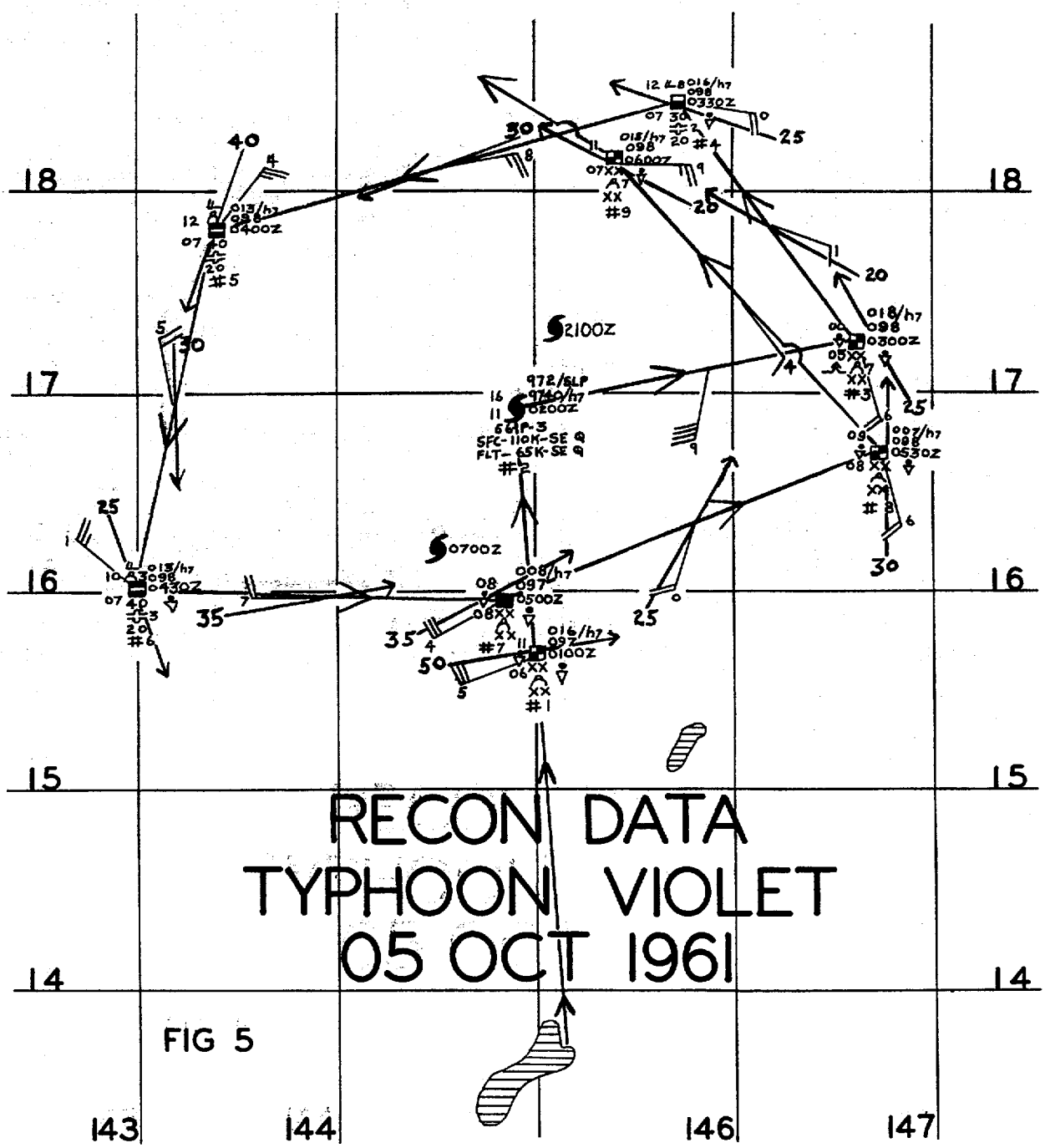

18
17
16
15
14
143
144
146
147
2100Z
0700Z
RECON DATA
TYPHOON VIOLET
05 OCT 1961

FIG 5

EASTERLY WAVE CONTINUITY GRAPH

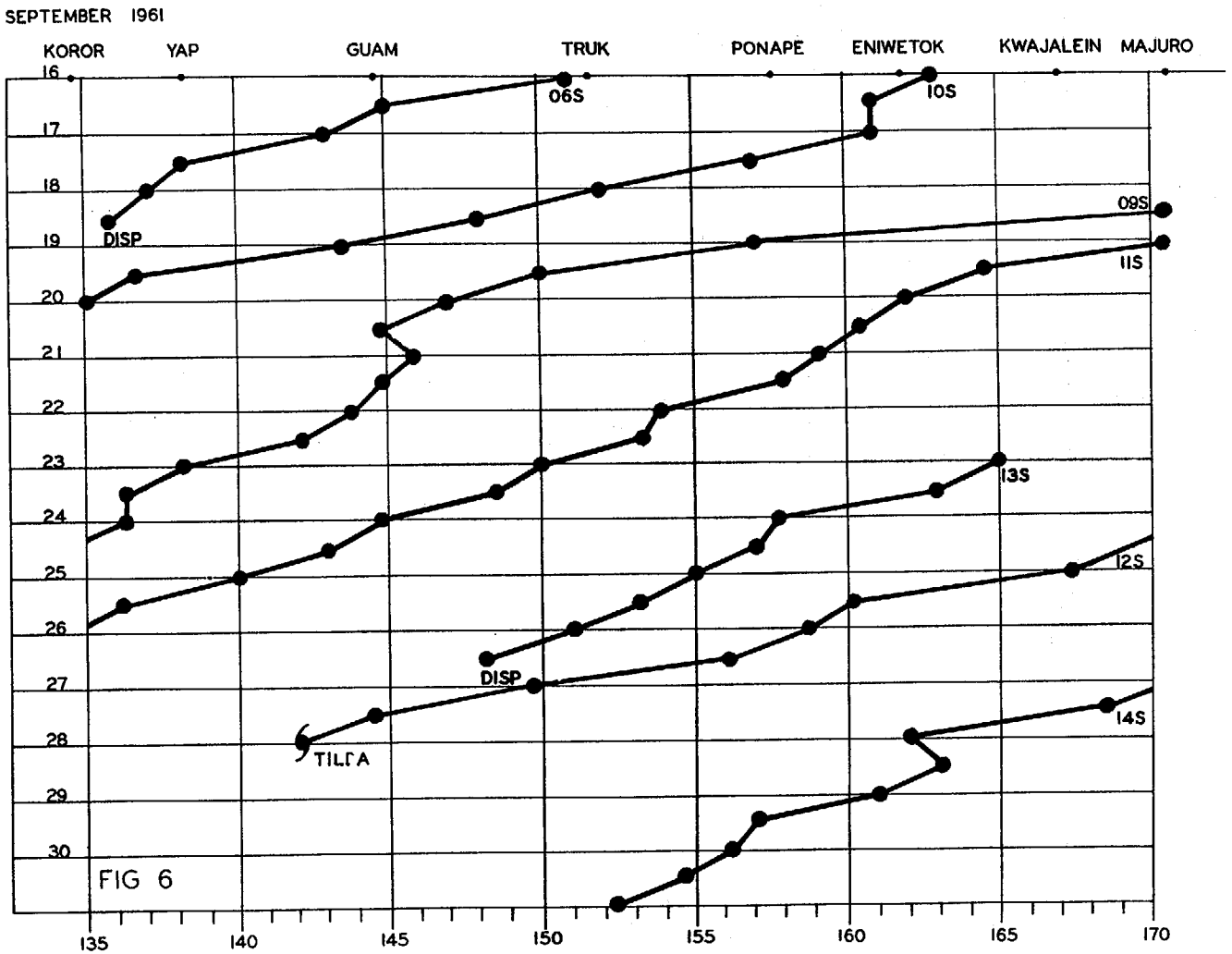


FIG 6

LONG WAVE ANALYSIS AND 48 HR. PROG

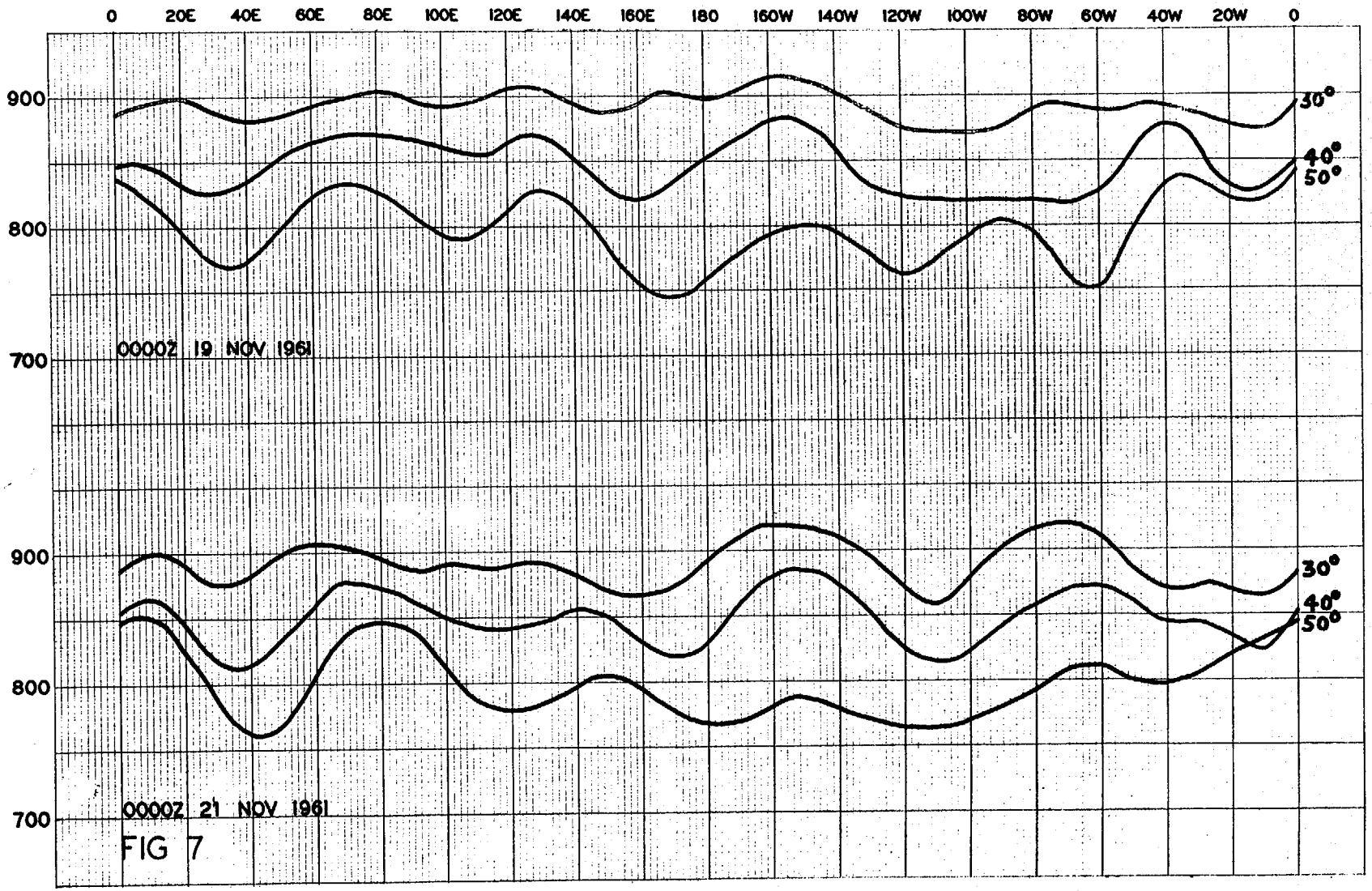


FIG 7

CHAPTER II

SURVEILANCE SYSTEMS

SURVEILANCE SYSTEMS

A. GENERAL

SURVEILANCE QUALITY IS THE KEY TO THE ACCURACY OF EACH WARNING POSITION AT TIME OF ISSUANCE. TYPE, TIMELINESS, CAPABILITIES, AND ACCOMPLISHMENTS OF EACH SYSTEM WILL BE THE SUBJECT MATTER OF THIS CHAPTER.

B. AERIAL WEATHER RECONNAISSANCE

U. S. AIR FORCE, WB-50 AIRCRAFT
56TH WEATHER RECONNAISSANCE SQUADRON, YOKOTO AIR BASE, JAPAN
LT. COL. E. D. WALLACE, COMMANDER
MAJ. R. H. YAW, WEATHER OFFICER
DET. 1 - 56TH WEATHER RECONNAISSANCE SQUADRON, ANDERSEN AIR FORCE BASE, GUAM, M. I.
MAJ. T. J. MAHER, COMMANDER

U. S. NAVY, WV-2 AIRCRAFT (EFFECTIVE 1 JULY 1961)
AIRBORNE EARLY WARNING SQUADRON ONE, NAS, AGANA, GUAM, M. I.
CDR. H. B. KENTON, COMMANDER
LT. M. J. MORAN, WEATHER OFFICER

DUE TO THE EXTREME PAUCITY OF SURFACE AND UPPER AIR METEOROLOGICAL DATA AND INFORMATION IN THE WESTERN PACIFIC AREA (WESTPAC), THE VITALNESS OF AERIAL RECONNAISSANCE TO METEOROLOGICAL ANALYSIS AND FORECAST EFFORT CANNOT BE OVEREMPHASIZED.

THE AVAILABILITY OF ACCURATE AND COMPLETE AERIAL WEATHER RECONNAISSANCE DATA AND INFORMATION IS PARTICULARLY CRITICAL IN CONNECTION WITH THE LIFE CYCLE OF ONE OF NATURE'S MOST DESTRUCTIVE PHENOMENA, THE TYPHOON. THIS IS TRUE FROM THE MOST PRELIMINARY FORMATIVE STAGE TO FINAL DECAY OR TRANSFORMATION TO A SYSTEM EXHIBITING EXTRA-TROPICAL CHARACTERISTICS.

ATTENTION IS INVITED TO THE FACT THAT THE LOCATION AND TRACKING OF TROPICAL DEPRESSIONS/STORMS/TYPHOONS IS MERELY ONE SMALL PHASE OF THE OVERALL REQUIREMENT. THE ABILITY TO DETECT AND ANALYZE VORTEX STRUCTURE, PREDICT FUTURE INTENSITY CHANGES, FORECAST WITH REASONABLE ACCURACY THE VELOCITY AND CHANGES THERETO AND DETERMINE THE PROBABLE AREA OF RECURVATURE DEMANDS ACCURATE AND TIMELY EYE AND PERIPHERAL METEOROLOGICAL DATA.

AERIAL RECONNAISSANCE REQUIREMENTS AND CAPABILITIES FOLLOW:

A. <u>REQUISITE METEOROLOGICAL PARAMETERS FOR MEASUREMENT ON EYE-PENETRATION MISSIONS</u>

1. Temperature, dew-point, wind speed and height of the 700 mb surface by aircraft instrumentation.

2. Lapse rate from the 700 mb level or above to earth's surface with surface temperature and pressure by dropsonde.

3. Location of the pressure center within the eye by use of the radio altimeter.

4. Wind velocity pattern within the eye, wall-cloud configuration, turbulence, and wind shear by observer.

B. Requisite Meteorological Parameters for Measurement on Circumnavigation Missions

1. Same as A1, above

2. Same as A2, above, at pre-selected points

3. 700 mb wind velocity pattern from Doppler (or equivalent) navigational system.

4. Surface wind velocity pattern by observer.

5. Cloud distribution by observer and/or airborne radar.

6. Spot observations in accordance with established standard procedures.

C. Information Provided by FWC/JTWC, Guam, Warnings (based upon requisite meteorological parameters delineated in the preceding paragraphs A and B

1. Existent cyclone intensity and predicted intensity changes.

2. Direction and speed of movement in terms of intensity and past positions of the cyclone.

3. Data for certain statistical predictive formulae in the determination of direction and speed of movement.

4. Distribution of wind speeds in the various cyclone quadrants, strong and weak winds, radius of winds and change of radii.

5. Research data for typhoon structure and behavior.

6. Meteorological data for the development of synoptic forecast systems.

The deletion of any portion of the meteorological data requirements contained in paragraphs A and B above results only in a decrease in the typhoon warning accuracy and the resultant serious meteorological threat to the security of U. S. and allied forces in the Western Pacific area.

The data obtained by eye-penetration and dropsonde techniques are "keys" in intensity analyses and the prediction of future intensity changes for warning purposes. Since the eyes of typhoons vary from a few mi to 200 mi in diameter, it is extremely important that the actual pressure center be precisely determined and that the dropsonde be released at this position. Reports of the eye wind

PATTERN AND THE VISUAL VELOCITY DISTRIBUTION ALSO SERVE TO CONFIRM THE MEASURED PARAMETERS OF TEMPERATURE AND PRESSURE. FROM A SCIENTIFIC STANDPOINT, THERE IS NO SUBSTITUTE FOR A COMPLETELY METEOROLOGICALLY EQUIPPED AIRCRAFT.

IT CANNOT BE STRESSED SUFFICIENTLY THAT COMPLETE METEOROLOGICAL DATA AND INFORMATION OBTAINED BY AERIAL RECONNAISSANCE TECHNIQUES ARE MANDATORY FOR ACCURATE AND EFFICIENT ANALYSES AND PREDICTIONS RELATING TO TROPICAL AREAS, DEPRESSIONS, STORMS, AND TYPHOONS. "FIXES" BY THEATER AIRCRAFT SUPPLY ONLY AN EXTREMELY LIMITED AND UNACCEPTABLE PARTIAL ANSWER TO A HIGHLY COMPLEX PROBLEM. LOCATION IS BUT ONE ASPECT OF THIS PROBLEM. ANALYSES OF CYCLONE CHARACTERISTICS AND INTENSITY, AND PREDICTIONS OF INTENSITY CHANGES AND MOVEMENT ARE EQUALLY, IF NOT MORE, IMPORTANT TO OPERATIONAL FORCES.

THE CAPABILITIES OF THE JOINT TYPHOON WARNING SERVICE IN THE WESTPAC AREA SUFFERED DURING THE 1961 TYPHOON SEASON AS THE DIRECT RESULT OF DRASTICALLY REDUCED USAF PARTICIPATION IN AERIAL WEATHER/TYPHOON RECONNAISSANCE, PARTICULARLY FROM THE STANDPOINT OF EARLY DETECTION OF POTENTIAL OR NASCENT TROPICAL STORMS AND TYPHOONS. LOSS OF THIS RECONNAISSANCE SUPPORT RESULTED IN THE GENERATION OF TWO TROPICAL STORMS, IDA AND KATHY, WITHOUT KNOWLEDGE AND ADEQUATE PRIOR WARNINGS BEING ISSUED BY JTWC. IN ADDITION, THE DETERIORATION OF ANALYSIS AND FORECAST CAPABILITY DUE TO THE PAUCITY OF RECONNAISSANCE CAUSED A DECREASE IN POSITIONAL FORECAST ACCURACY OF AS MUCH AS 30 MI FOR 24 HOUR PREDICTIONS AND 120 MI FOR THE 48 HOUR OUTLOOKS.

VITAL AND INTEGRAL PARTS OF ANY TROPICAL OCEANIC ANALYSIS ARE SYNOPTIC AND INVESTIGATIVE FLIGHTS. SYNOPTIC RECONNAISSANCE OVER THE TROPICAL OCEAN AREAS OF MICRONESIA MEASUREABLY SUPPLEMENT THE SPARSE ISLAND OBSERVING STATIONS TO THE SE AND SW OF GUAM. THESE FLIGHTS PRODUCE SYNOPTIC AND DROPSONDE DATA ENABLING A BETTER METEOROLOGICAL ANALYSIS OF AN AREA 1.5 TIMES THAT OF THE CONTINENTAL UNITED STATES. THIS WAS NOT ACCOMPLISHED DURING THE 1961 SEASON BECAUSE OF THE RESTRICTED INVESTIGATIVE AND SYNOPTIC RECONNAISSANCE. THE NORMAL CAPABILITY OF ADEQUATE ANALYSIS FROM THE STAGES OF CYCLONE TO DEPRESSION TO STORM WAS COMPLETELY LOST.

PRECISION NAVIGATION IS OBVIOUSLY MANDATORY AND REQUIRES LITTLE DISCUSSION. ANY COMPROMISE, IN THIS REGARD, LESSENS THE QUALITY OF THE OBSERVATIONS MADE AND TRANSMITTED, POSES A SERIOUS THREAT TO THE ACCURACY OF THE WARNINGS ISSUED, AND, CONSEQUENTLY, IMPEDES SOUND DECISIONS ON THE PART OF ALL OPERATIONAL CONSUMERS IN THE WESTPAC AREA.

THE PRECEDING DISCUSSION IS EXTRACTED FROM A FWC/JTWC STAFF STUDY WHICH HAS PRODUCED THE FOLLOWING RESULTS:

A. THE 54TH WEATHER RECONNAISSANCE SQUADRON, WITH SIX WB-50 AIRCRAFT, IS BEING REACTIVATED AS OF 18 APRIL 1962 AT ANDERSEN AFB, GUAM, IN LIEU OF DET 1 - 56TH WEATHER RECONNAISSANCE SQUADRON.

B. AIRBORNE EARLY WARNING SQUADRON ONE HAS AUTHORITY TO EQUIP ITS WV-2 AIRCRAFT WITH DROPSONDE CHAMBERS AND DOPPLER TYPE NAVIGATION EQUIPMENT FOR THE 1962 SEASON.

THE WV-2 IS A UNIQUE WEATHER RECONNAISSANCE AIRCRAFT IN THAT ITS APS-20E AND APS-45 RADARS CAN PROVIDE ACCURATE DATA SHOWING THE HORIZONTAL STRUCTURE OF A STORM AREA UP TO 250 MI DISTANCE FROM THE AIRCRAFT. RADAR IS EMPLOYED WHENEVER POSSIBLE ON ALL WEATHER RECONNAISSANCE MISSIONS PERFORMED BY AEWRON ONE. FIXES BY RADAR ARE USED EXTENSIVELY DURING HOURS OF DARKNESS AND AT OTHER TIMES WHEN CLOUD PRESENTATION POSITIVELY DEFINES THE CENTER.

AIRBORNE RADAR LIKE LAND RADAR FURNISHES ONLY A GEOGRAPHICAL POSITION TO LOCATE THE CENTER OF A CYCLONE. DURING DAYLIGHT HOURS, WHEN IT IS CONSIDERED OPERATIONALLY SAFE BY THE WV-2 PLANE COMMANDER, OPTIONAL PENETRATION BY THE WV-2 AIRCRAFT IS ACCOMPLISHED THROUGH THE QUADRANT WHICH CIRCUMNAVIGATION AND RADAR PRESENTATION HAS SHOWN TO BE THE WEAKEST.

THE FOLLOWING SET OF PHOTOGRAPHS DEPICT THE SECOND OF TWO PENETRATIONS OF TYPHOON TILDA PERFORMED BY AN AEWRON ONE AIRCRAFT ON 29 SEPTEMBER 1961. THE FIRST PHOTOGRAPH SHOWS THE AIRCRAFT, REPRESENTED BY THE DOT IN THE CENTER OF THE RADARSCOPE, APPROACHING THE WALL CLOUD. THE SPIRAL BANDS NEAR THE AIRCRAFT ARE EASILY RECOGNIZED, AND THE EYE IS CLEARLY DEFINED. THE WALL CLOUDS NEAR THE AIRCRAFT APPEAR TO BE LESS INTENSE, INDICATING THAT THE AIRCRAFT IS PENETRATING THROUGH THE WEAKEST QUADRANT. PHOTO NUMBER TWO SHOWS THE AIRCRAFT ENTERING THE WALL CLOUD, ENCOUNTERING THE ASSOCIATED TURBULENCE AND TORRENTIAL RAIN. FINALLY, IN PHOTO NUMBER THREE, THE AIRCRAFT HAS ENTERED THE EYE AND IS NOW IN AN AREA OF RELATIVE CALM. THE CLOCK INDICATES THAT ONLY TWO MINUTES HAD ELAPSED DURING THE TRANSIT THROUGH THE WALL CLOUD. IN PHOTO NUMBER FOUR, THE AIRCRAFT IS AT THE CENTER OF THE EYE OBTAINING THE DATA WHICH WILL AID IN FORECASTING THE FUTURE INTENSITY OF THE TYPHOON. PHOTOS FIVE AND SIX SHOW THE AIRCRAFT LEAVING THE EYE BY APPROXIMATELY THE SAME ROUTE IT FOLLOWED IN THE PENETRATION.

IN THE POST FLIGHT SUMMARY, THE TYPHOON WAS DESCRIBED AS FOLLOWS: "EYE PERFECTLY CIRCULAR 14 MI IN DIAMETER. EXTENSIVE WALL CLOUDS ABOVE 40,000 FT, 6 MI THICK. CONSIDERABLE STRATAFORM CLOUDS IN EYE. UNABLE TO SEE SURFACE. MAX SURFACE WINDS 100 KTS WITHIN 20 MI OF EYE. TEMPERATURE ROSE 10° C ON PENETRATION. LIGHT TO MODERATE TURBULENCE AND TORRENTIAL RAIN ENCOUNTERED IN WALL CLOUDS."

AERIAL WEATHER RECONNAISSANCE EFFORTS OF 1961 ARE PRESENTED IN THE FOLLOWING THREE STATISTICAL SUMMARIES.

FIXES MADE IN 1961

	TO 30 JUN	FOR YEAR	BONUS
56TH	79	229	2
VW-1	2	119	13
VAP-61		1	
315TH AIR DIVISION		1	
OTHER USAF			6
OTHER USN			4
CIVILIAN			2
TOTAL FIXES MADE AND USED		377	

FLYING HOURS PER TYPHOON

TYPHOON	56 WRS	AEWRON 1
TESS	155	6
ALICE	60	5
BETTY	142	N/R
CORA	36	N/R
ELSIE	80	27
HELEN	130	51
IDA	50	20
JUNE	112	33
KATHY	39	10
LORNA	80	11
NANCY	121	30
OLGA	N/R	N/R
PAMELA	35	31
SALLY	29	22
TILDA	28	30
VIOLET	80	74
BILLIE	10	79
CLARA	0	65
DOT	49	68
ELLEN	86	82
TOTAL	1322	644
TOTAL TROPICAL CYCLONE FLYING HOURS 2701*	1947	854

N/R - MISSIONS NOT REQUESTED BY JTWC

* - INCLUDES PRECEDING TOTALS BUT NOT THE 56 WRS TROPICAL FIXED TRACKS WHICH WOULD MORE THAN DOUBLE THEIR 1947 HOURS LOGGED

A SERIES OF DROPSONDE PATTERNS WILL BE TESTED IN 1962. EACH OF THESE PATTERNS WILL INCLUDE THE EYE DROP AND WILL LEAD TO A STANDARDIZED PATTERN THAT WILL AUGMENT THE ROUTINE PERIPHERAL DATA AS WELL AS THAT INFORMATION AVAILABLE FROM WITHIN THE EYE.

C. LAND RADAR

AS TYPHOON JUNE APPROACHED TAIWAN ON 6 AUGUST, JTWC ACCEPTED LAND RADAR FIXES ON AN OPERATIONAL BASIS, AS A SURVEILANCE AID, WITH THE FULL KNOWLEDGE OF THEIR INHERENT LIMITATION OF PROVIDING ONLY A GEOGRAPHICAL POSITION. THIS LINEAR DIMENSION HAS RESTRICTED OPERATIONAL VALUE; THEREFORE, JTWC REQUIRES A COMBINATION OF BOTH SYSTEMS, LAND RADAR AND AERIAL RECONNAISSANCE.

SPECIFICALLY, JTWC REQUIRES ONE DAILY AERIAL RECONNAISSANCE PENETRATION WITH DROPSONDE IN CONJUNCTION WITH CONTINUOUS LAND RADAR COVERAGE WHEN THE MISSION CAN BE CONDUCTED SAFELY AS PERMITTED BY TERRAIN FEATURES. THE PRESSURE CENTER AND METEOROLOGICAL INTENSITY PARAMETERS, THUS PROVIDED, COMPLIMENT THE RADAR POSITION WHICH ALONE DOES NOT FURNISH THE NECESSARY DATA TO SUPPORT A COMPLETE FORECAST.

FOR THE REMAINDER OF THE SEASON, A TOTAL OF 37 MISSIONS WERE NOT REQUIRED, THUS "SAVED" AS A RESULT OF USING THE CRITERIA OF ONE FIX PER DAY PLUS ADEQUATE LAND RADAR COVERAGE RATHER THAN THE NORMAL FOUR FIX A DAY REQUIREMENT FOR TYPHOONS BY RECONNAISSANCE AIRCRAFT.

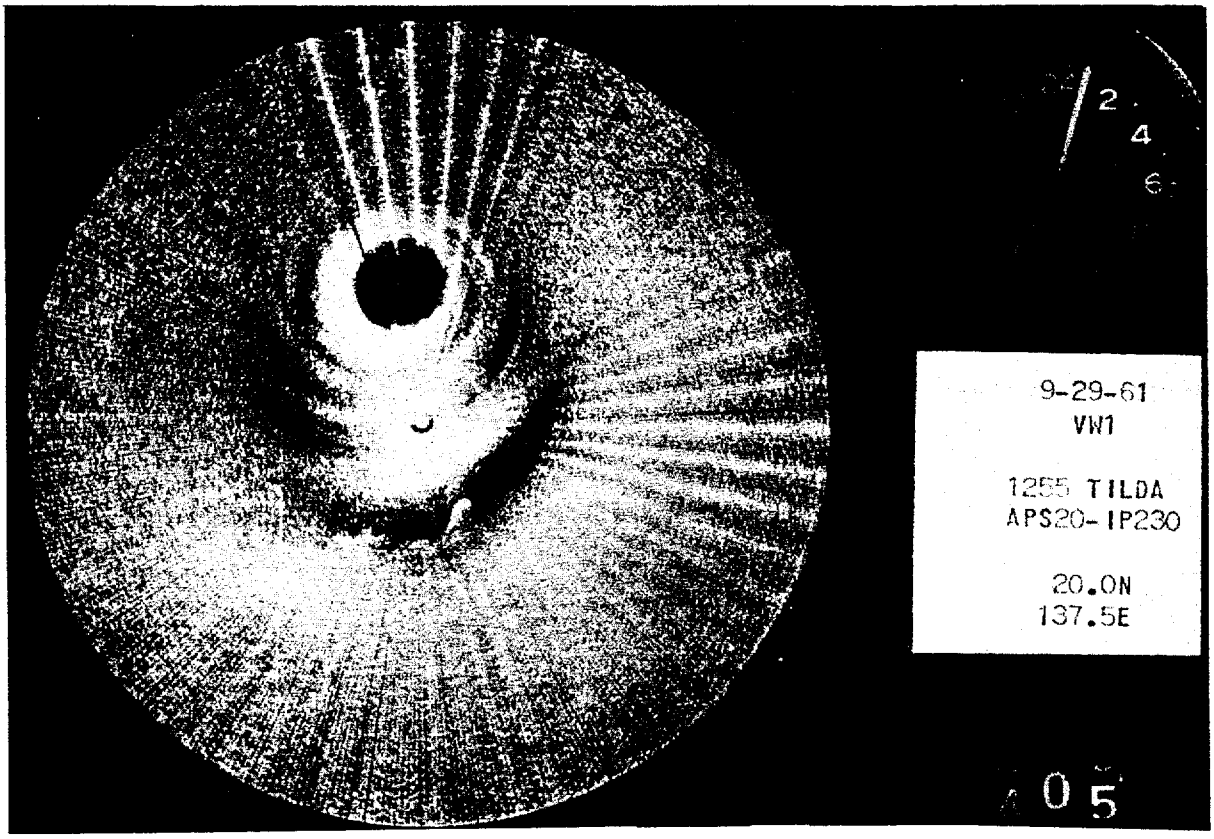
D. SATELLITES

THE TIROS SERIES PROVIDED FWC/JTWC WITH RANDOM NEPHANALYSES OVER THE WESTERN NORTH PACIFIC. SUCH REPORTS HAVE IDENTIFIED THE POSITION OF SIGNIFICANT VORTICES DURING THE PERIOD THAT JTWC WAS ISSUING WARNINGS ON THESE SAME VORTICES. IN 1961, TELEPHONE LIAISON WAS MAINTAINED BY THE METEOROLOGICAL SATELLITE LABORATORY OF THE U. S. WEATHER BUREAU TO CONFIRM OUR POSITION OF THE TROPICAL CYCLONE AT THE TIROS OBSERVATION TIME WHEN JTWC WAS ISSUING WARNINGS AND/OR TO COORDINATE ON TIROS OBSERVATIONS OF DISTAL SYSTEMS WHICH MAY HAVE BEEN NEW OR ADDITIONAL TROPICAL CYCLONES.

THE RANDOM TRACKS OF TIROS DOES NOT PERMIT ITS USE AS A ROUTINE TOOL EXCEPT TO COLLATE THE INFORMATION WHEN AVAILABLE. NIMBUS' ANTICIPATED REGULARITY WILL ELIMINATE TIROS' IRREGULARITY AND IN EFFECT EXTEND THE LAND RADAR FIX COVERAGE. THESE SYSTEMS ARE LIMITED TO FIX COORDINATES AND NEPHANALYSIS AND DOES NOT POSSESS THE VITAL COLLECTION CAPABILITIES FOR THE INTENSIFICATION PARAMETERS THAT ARE AVAILABLE FROM METEOROLOGICALLY EQUIPPED RECONNAISSANCE AIRCRAFT.

A CONTRIBUTION TO RESEARCH IS POSSIBLE, SHOULD THE TIMING BE IN PHASE FOR AN ACTUAL FORMATION PERIOD, IN THAT THE NEPHANALYSIS WOULD ADD MEASURABLY TO THIS UNKNOWN SEQUENCE OF EVENTS. FURTHER IN THE EXCHANGE OF INFORMATION, FWC/JTWC IS SENDING A DAILY MESSAGE COVERING

THE ANALYZED POSITIONS OF EASTERLY WAVES AND INTERTROPICAL ZONE OF CONVERGENCE IN WESTPAC.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VW1
1255 TILDA
APS20-IP230
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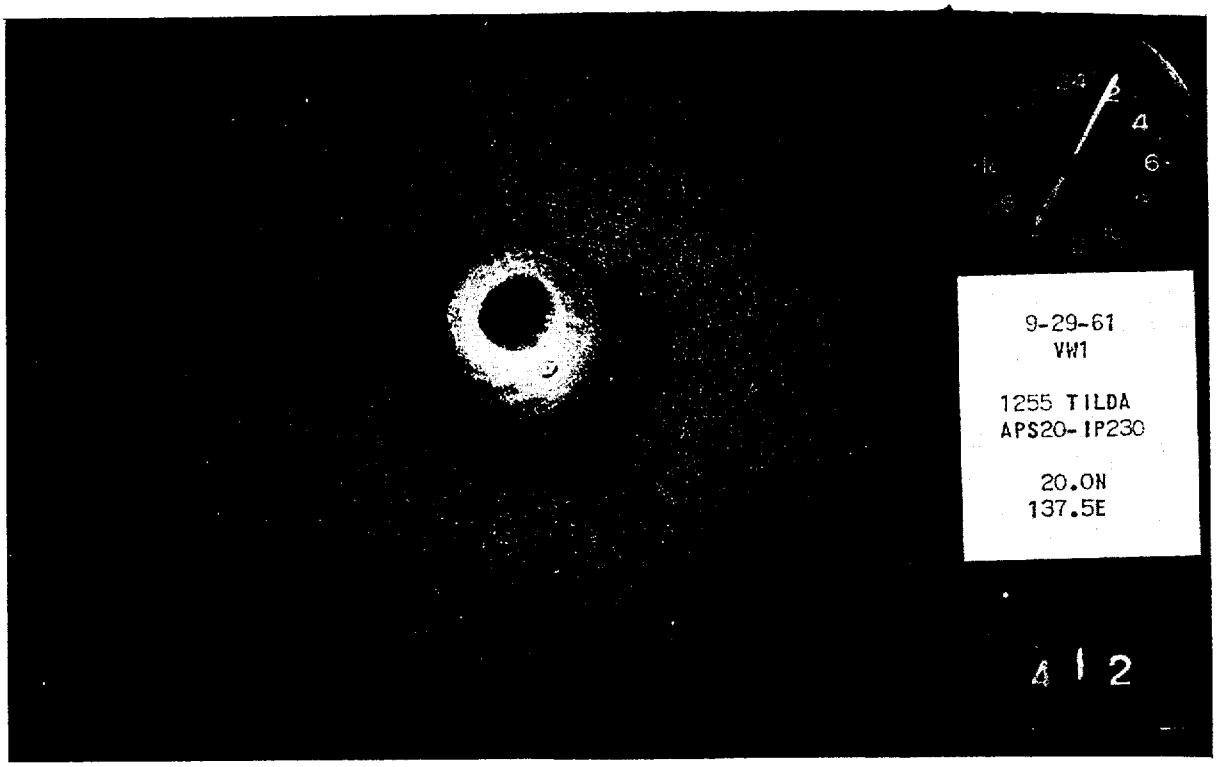
137.5E
405

FIG. 1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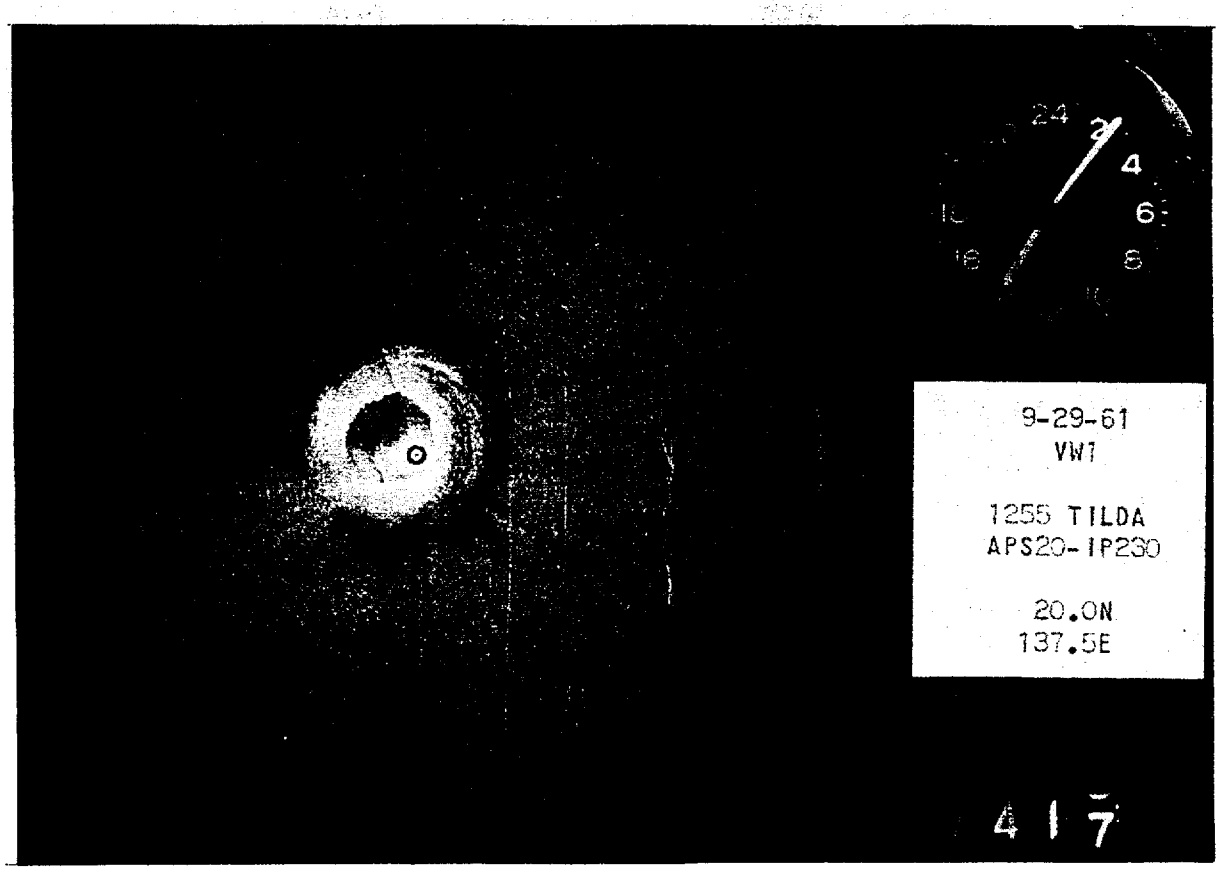
137.5E
412

FIG. 2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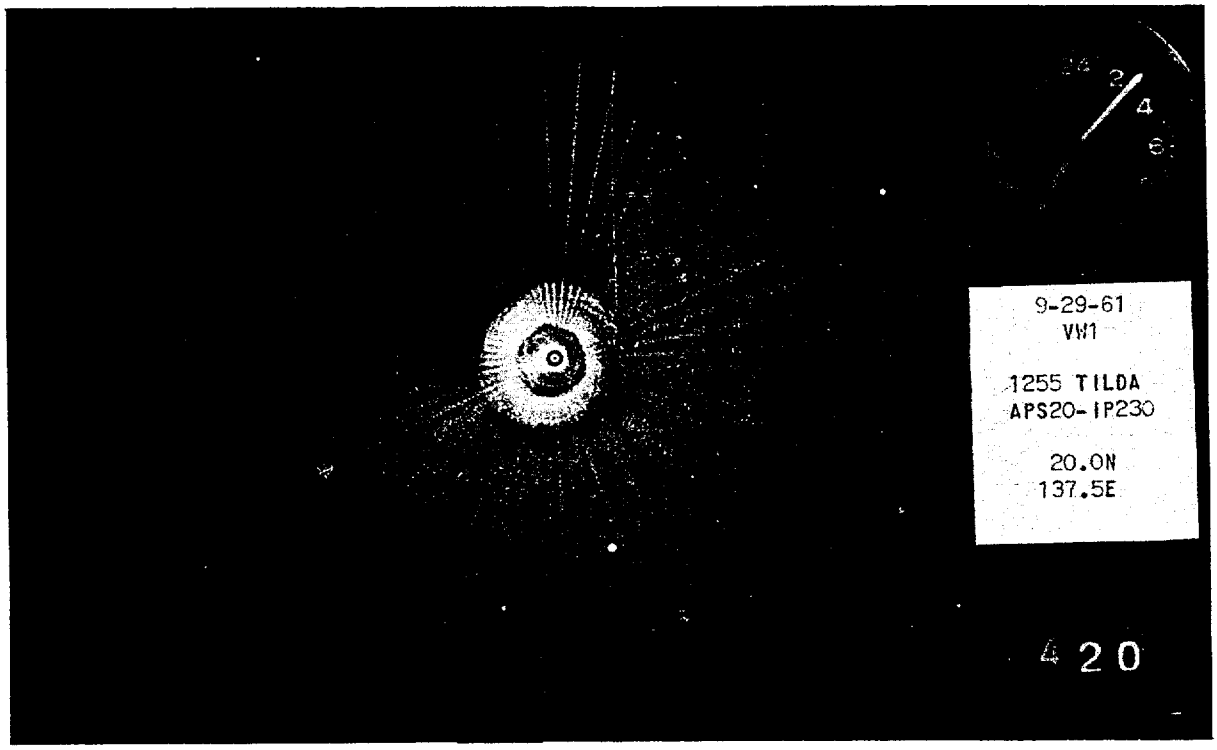
417

FIG. 3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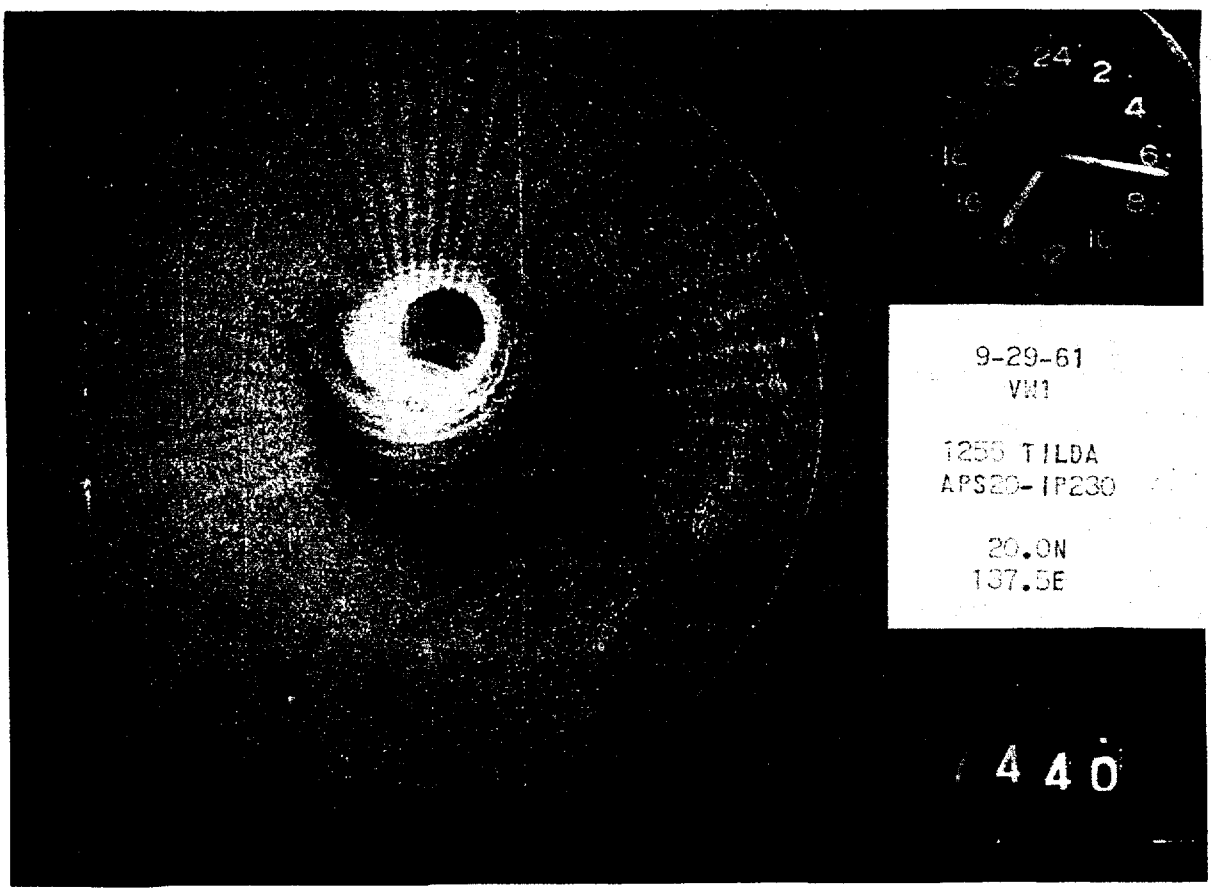
137.5E
420

FIG. 4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VW1
1255 TILDA
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20.0N
137.5E
440

FIG. 5

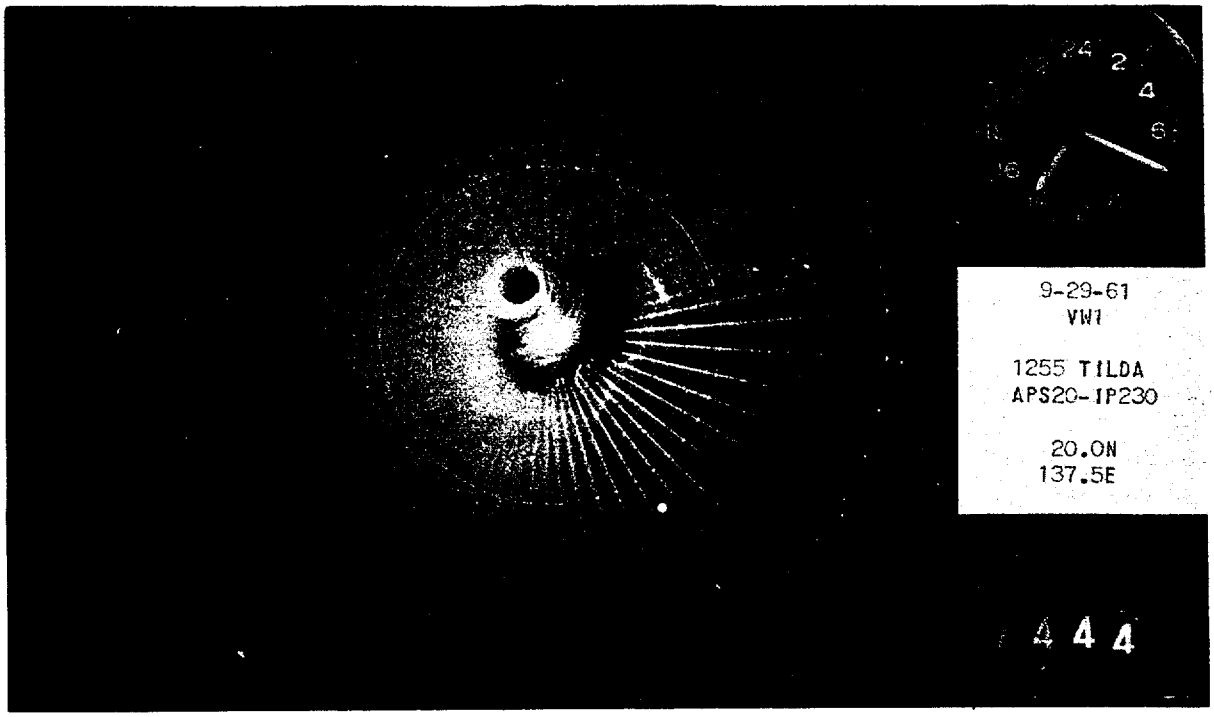

9-29-61
VW1
1255 TILDA
APS20-IP230
20.0N
137.5E
444

FIG. 6

CHAPTER III

SUMMARY OF TROPICAL CYCLONES OF 1961

A. GENERAL

SIXTY NINE (69) TROPICAL DISTURBANCES WERE ANALYZED AND INVESTIGATED AS POTENTIAL CYCLONES DURING THE CALENDAR YEAR 1961 IN THE NORTH PACIFIC OCEAN AREA W OF 180 DEGREES. OF THIS NUMBER, 11 HAD WARNINGS ISSUED AS TROPICAL DEPRESSIONS, AN ADDITIONAL 11 REACHED TROPICAL STORM WARNING STAGE, AND ANOTHER 20 ACHIEVED TYPHOON WARNING STATUS. WARNINGS WERE ISSUED ON 42 TROPICAL CYCLONES.

THE FOLLOWING DATA IS PROVIDED CONCERNING THE 1961 SEASON AND THE TWO PREVIOUS YEARS FOR COMPARISON PURPOSES:

	1959	1960	1961
TOTAL CYCLONES	65	56	69
A. SUSPECT AREAS	32	26	27
B. TROPICAL DEPRESSIONS	7	3	11
C. TROPICAL STORMS	9	8	11
D. TYPHOONS	17	19	20
E. TOTAL NUMBER OF WARNINGS	583	776	737
F. CALENDAR DAYS OF WARNINGS	137	157	165

THE 11 TROPICAL STORMS WERE RITA, SUSAN, VIOLA, WINNIE, DORIS, FLOSSIE, GRACE, MARIE, RUBY, WILDA, AND ANITA.

THE 20 TYPHOONS IN ORDER OF OCCURRENCE WERE TESS, ALICE, BETTY, CORA, ELSIE, HELEN, IDA, JUNE, KATHY, LORNA, NANCY, OLGA, PAMELA, SALLY, TILDA, VIOLET, BILLIE, CLARA, DOT, AND ELLEN. FOR COMPARISON PURPOSES, THE CHART ON THE FOLLOWING PAGE PROVIDES INFORMATION CONCERNING ANNUAL TOTALS AND THE MONTHLY FREQUENCY FOR 1952 THROUGH 1961.

THE SEASONAL DISTRIBUTION OF TYPHOONS CONFORMS TO CLIMATOLOGY FAIRLY WELL, EXCEPT THAT THE TOTAL FOR THE YEAR EXCEEDED THE AVERAGE BY ABOUT TWO. THE AVERAGE TYPHOON FOR 1961 HAD A LIFE OF 5 DAYS, 17 HOURS AND TRAVELED 1497 MI AT AN AVERAGE SPEED OF 11 KTS FROM FIRST TO LAST WARNING. THE 1960 TYPHOONS TRAVELED AT ABOUT THE SAME SPEED, LASTED TWO DAYS LONGER AND TRAVELED AN AVERAGE DISTANCE OF 1930 MI. NANCY, A SEPTEMBER TYPHOON, HOLDS THE 1961 RECORDS FOR LONGEST LIFE, 9 DAYS, 18 HOURS; DISTANCE, 4266 MI; AVERAGE SPEED, 18.2 KTS; FASTEST, 55 KTS BETWEEN 161200Z AND 170000Z; AND MOST INTENSE, 185 KTS BETWEEN 111200Z AND 120600Z.

B. AREAS OF FORMATION AND DEVELOPMENT

A CHART IS PROVIDED SHOWING THE POINTS OF ORIGIN OF ALL TYPHOONS, 1952 THROUGH 1961. THE DATA IS BASED ON ANNUAL REPORTS FOR EACH YEAR, AND OTHER DATA SOURCES MAY VARY SLIGHTLY. AN ADDITIONAL CHART, DESCRIBING POINTS OF FIRST TYPHOON INTENSITY FOR THE SAME PERIOD IS INCLUDED. EACH TRIANGLE IS NUMBERED TO INDICATE A TYPHOON AS FOLLOWS:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
1952						3	1	3	3	5	3	3	21
1953		1			1	1	1	5	2	4	1	1	17
1954					1		1	4	4	2	3		15
1955	1		1	1		1	5	3	3	2	1	1	19
1956			1	1			2	4	5	1	3	1	18
1957	1			1	1	1	1	2	5	3	3		18
1958	1				1	2	5	3	3	3	1	1	20
1959				1			1	5	3	3	2	2	17
1960				1		2	2	8		4	1	1	19
1961			1		2	1	3	3	5	3	1	1	20
AVE.	.3	.1	.3	.5	.6	1.1	2.2	4.0	3.1	3.0	1.9	1.1	18.4

0161 WOULD BE THE FIRST TYPHOON OF 1961, 1352 IS THE THIRTEENTH TYPHOON OF 1952, ETC.

THE CYCLONES INTENSIFIED TO TYPHOON STRENGTH IN THE SOUTH CHINA SEA, ALICE, CORA, AND OLGA, ONE OF WHICH, CORA, ORIGINATED THERE. THE REMAINING CIRCULATIONS DEVELOPED AND INTENSIFIED S OF 25N. AS USUAL, MANY OF THE CYCLONES COMMENCED INTENSIFYING NEAR GUAM (7 WITHIN 500 MI) BUT CREATED HAVOC IN OTHER PARTS OF THE WORLD. THE TWO THAT WERE A POTENTIAL HAZARD TO GUAM WERE NANCY AND VIOLET, THE TWO MOST INTENSE CYCLONES OF THE SEASON. TYPHOON CLARA BECAME A TYPHOON NEAR WAKE ISLAND AND CAN BE CONSIDERED THE ONLY CYCLONE TO DEVELOP IN AN UNUSUAL POSITION FOR THE SEASON.

C. SIZE AND INTENSITY

TYPHOONS VARIED IN SIZE FROM THE SMALL SUCH AS CORA, OLGA, KATHY AND IDA TO THE GIANT, BILLIE. THERE WERE NO "MIDGET" TYPHOONS DETECTED DURING THE YEAR, BUT SEVERAL WERE SMALL ENOUGH TO HAVE ESCAPED DETECTION HAD THEY NOT DRIFTED INTO SHIPPING OR AIR LANES. KATHY WAS DIFFICULT TO FIND ON THE SYNOPTIC CHART, AND POSED SOME PROBLEMS TO RECONNAISSANCE AIRCRAFT SEARCHING FOR IT. TYPHOON BILLIE WAS SO LARGE THAT IT CREATED SEVERE WEATHER CONDITIONS FROM GUAM TO JAPAN, TAIWAN, THE PHILIPPINES AND BACK TO GUAM VIA THE EQUATOR. THE EYE WAS 120 BY 180 MI, AND THE OUTER RADIUS OF 30 KT WINDS WAS ABOUT 750 MI. THE CIRCULATION WAS SIMILAR TO THAT OF CARMEN OF 1960 IN BEHAVIOR AND APPEARANCE. ALTHOUGH CLASSIFIED AS A TYPHOON BECAUSE OF THE SURFACE WIND SPEED, IT IS DOUBTFUL THAT IT WOULD QUALIFY THERMODYNAMICALLY FOR IT LACKED THE CLASSICAL WALL CLOUD AND OTHER FEATURES COMMONLY ASSOCIATED WITH TYPHOONS. TYPHOONS VIOLET AND NANCY HAD MINIMUM SEA LEVEL PRESSURES OF 882 MB REPORTED BY AIRCRAFT RECONNAISSANCE. DROPSONDE EQUIPMENT PROVIDED THIS INFORMATION IN EACH CASE. THE MAXIMUM SURFACE WIND SPEED FROM THE BEST TRACK FOR NANCY WAS 185 KTS AND ONLY 5 KTS LESS FOR VIOLET. TYPHOON OLGA HAD THE SHORTEST LIFE, 2 DAYS 6 HOURS, AND TRAVELED ABOUT 325 MI.

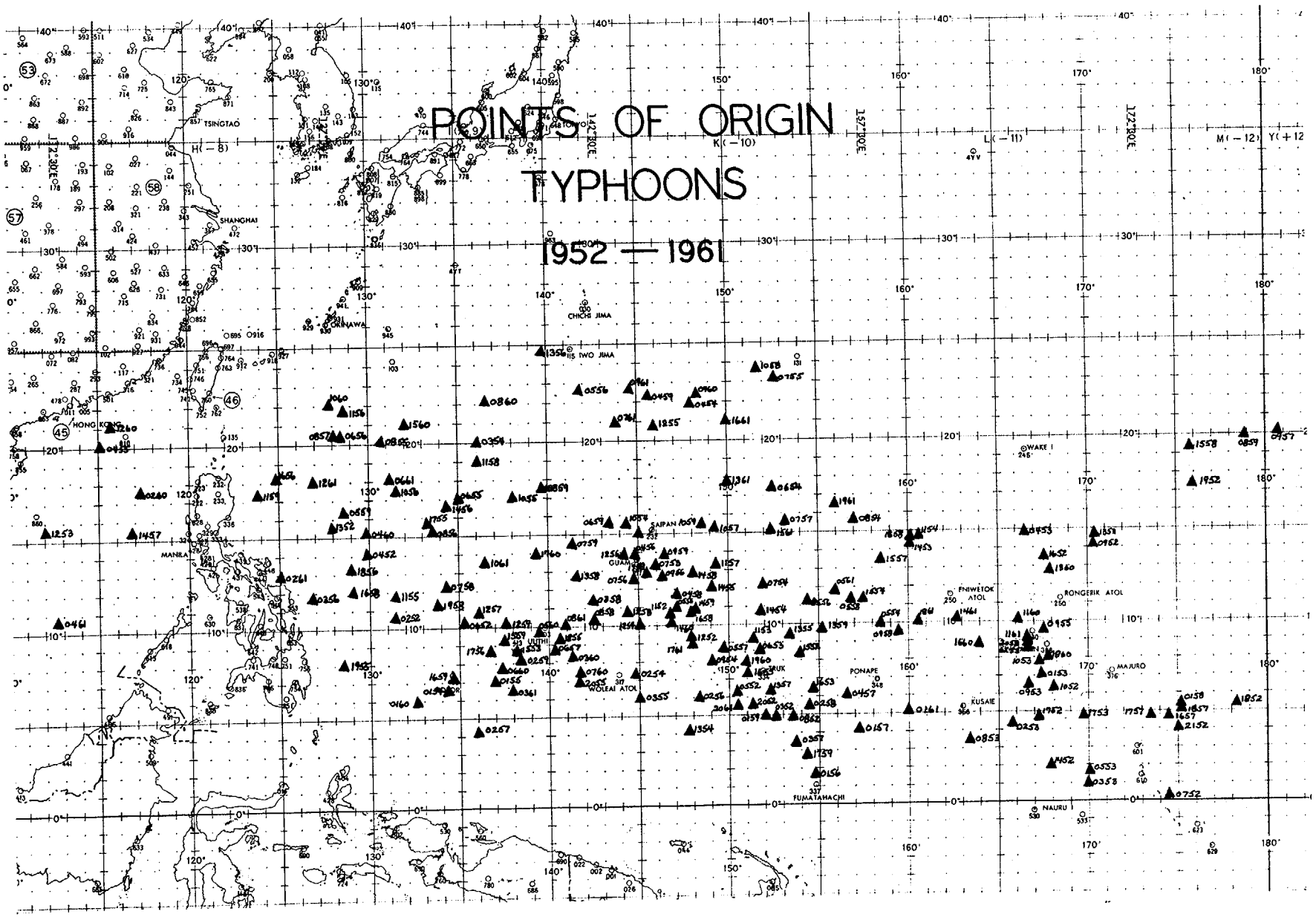
D. MOVEMENT

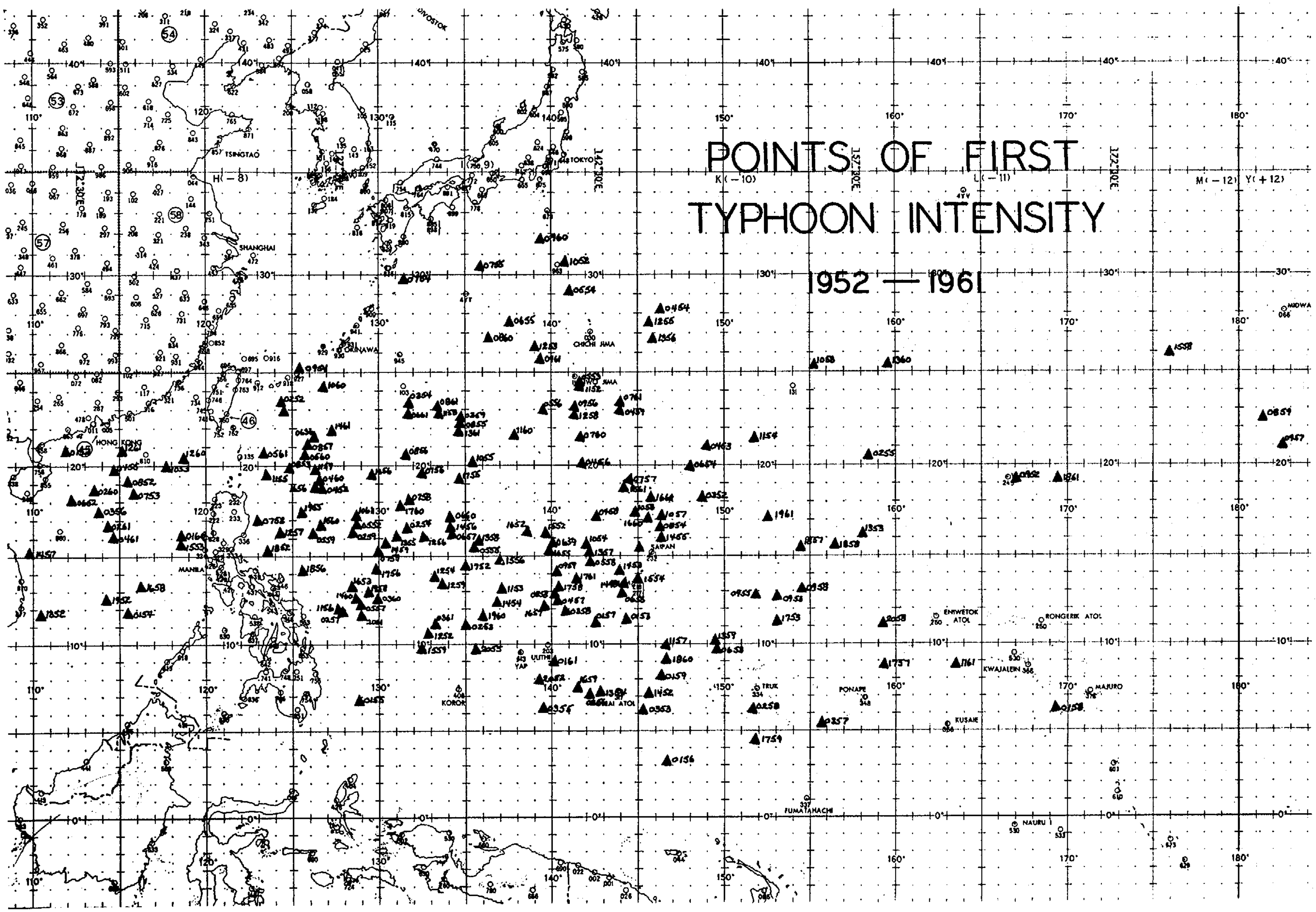
THE SEASONAL TRACKS FOR 1961 AND 1950 COMPARE FAVORABLY IN MANY RESPECTS, EXCEPT THAT THERE WERE ONLY 13 TYPHOONS IN 1950.

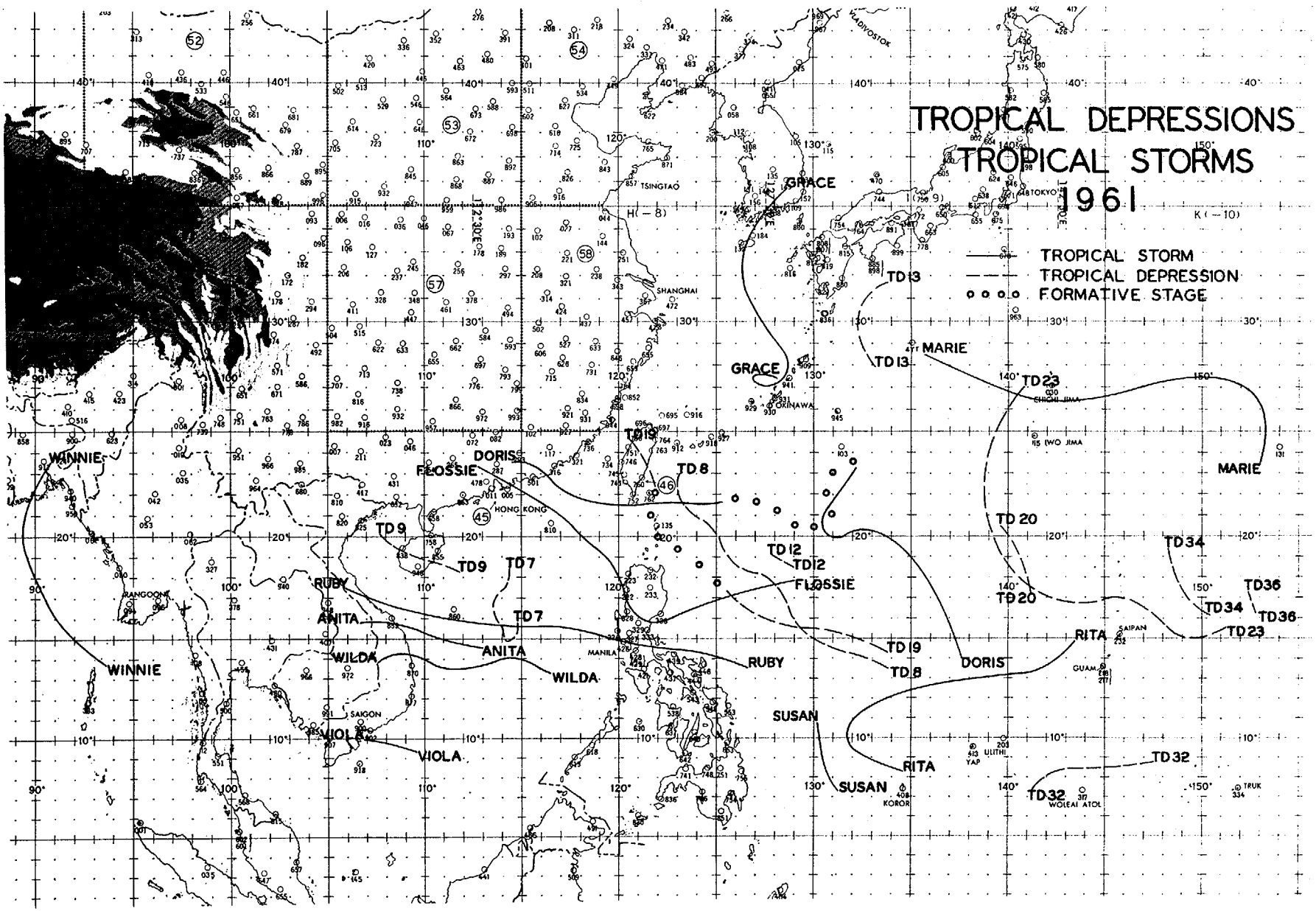
THE 1961 COMPOSITE TYPHOON TRACK CHART REVEALS THAT 9 TYPHOONS DID NOT RECURVE, 3 LOOPED, AND THE TRACKS OF 2 OF THESE, CLARA AND VIOLET, CAN BE CONSIDERED UNUSUAL. CLARA LOOPED IN A CLOCKWISE MANNER, AND VIOLET MOVED SW FOR 300 MI BEFORE TURNING TO THE NW TO COMMENCE BEHAVING IN A RESPECTABLE MANNER. THE FAILURE OF A LARGE NUMBER OF TYPHOONS TO RECURVE SUGGESTS THAT SOME PARTICULAR CIRCULATION FEATURE EXISTED OR CONTINUALLY RECURRED. IN SEVERAL CASES THE ANTICYCLONE AROUND WHICH THE TYPHOON WAS APPARENTLY TRAVELING EXTENDED OVER THE ASIATIC MAINLAND, CAUSING THE TYPHOON TO STRIKE LAND BEFORE RECURVATURE COULD TAKE PLACE. AN ANTICYCLONE MOVED WESTWARD DURING THE LIFE OF

KATHY AND IDA CAUSING A CONTINUED WESTWARD MOVEMENT UNTIL THE TYPHOONS STRUCK LAND. IDA AND HELEN, KNOWN AS THE "TWINS" DEVELOPED A FUJI-WHARA EFFECT, AND IDA EVENTUALLY MOVED ACROSS THE NORTHERN PERIPHERY OF THE CIRCULATION OF HELEN.

NO FULL FLEDGED TYPHOONS TRAVELED ACROSS THE PHILIPPINES DURING THE 1961 SEASON. SIX TYPHOONS CROSSED OR STRUCK LAND ON TAIWAN, AND ONLY 5 TYPHOONS TRAVELED OVER JAPANESE MAINLAND, IF HELEN IS CONSIDERED.


POINTS OF ORIGIN
TYPHOONS
1952 — 1961
TSINGTAO
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
SAIPAN
GUAM
ULITHI
WOLEAI ATOLL
PONAPE
KUSAIE
FUMATAMACHI
NAURU
WAKE I
FNIWETOK ATOLL
RONGERIK ATOLL
MAJURO
122°E
142°E
157°E


POINTS OF FIRST
TYPHOON INTENSITY
1952 — 1961
TSINGTAO
SHANGHAI
TOKYO
OKINAWA
HONG KONG
MANILA
CHICHI JIMA
YAP
KOROR
TRUK
PONAPE
KUSAIE
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN
MAJURO
NAURU
MIDWAY


TROPICAL DEPRESSIONS
TROPICAL STORMS
1961
TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
GRACE
MARIE
WINNIE
FLOSSIE
DORIS
RUBY
ANITA
WILDA
VIOLA
SUSAN
RITA
TD13
TD23
TD8
TD9
TD7
TD12
TD19
TD20
TD34
TD36
TD32
SHANGHAI
TSINGTAO
OKINAWA
HONG KONG
MANILA
SAIGON
RANGOON
GUAM
SAIPAN
YAP
ULITHI
KOROR
WOLEAI ATOL
CHICHI JIMA
IWO JIMA

TROPICAL DEPRESSIONS 1961
POSITION DATA

TROPICAL DEPRESSION SEVEN
25 MAY-28 MAY

DTG	LAT	LONG	DTG	LAT	LONG
250000Z	15.8N	114.8E	270000Z	16.0N	113.8E
250600Z	15.6N	114.9E	270600Z	16.3N	113.7E
251200Z	15.2N	114.8E	271200Z	16.5N	113.5E
251800Z	15.1N	114.7E	271800Z	16.9N	113.7E
260000Z	14.9N	114.4E	280000Z	17.3N	113.9E
260600Z	15.2N	114.2E	280600Z	17.7N	114.3E
261200Z	15.4N	114.0E	281200Z	18.4N	114.2E
261800Z	15.6N	113.9E			

TROPICAL DEPRESSION EIGHT
02 JUN-06 JUN

DTG	LAT	LONG	DTG	LAT	LONG
020600Z	13.5N	133.8E	040600Z	18.6N	125.8E
021200Z	14.2N	132.4E	041200Z	19.6N	125.3E
021800Z	14.5N	130.9E	041800Z	20.5N	124.9E
030000Z	15.4N	129.4E	050000Z	20.8N	124.3E
030600Z	16.5N	128.8E	050600Z	21.0N	123.5E
031200Z	17.5N	128.3E	051200Z	21.6N	123.2E
031800Z	18.0N	127.9E	051800Z	22.3N	123.0E
040000Z	18.2N	126.9E	060000Z	23.0N	123.0E

TROPICAL DEPRESSION NINE
06 JUN-07 JUN

DTG	LAT	LONG	DTG	LAT	LONG
061200Z	18.3N	111.8E	070000Z	19.3N	108.7E
061800Z	18.9N	110.3E	070600Z	20.0N	107.9E

TROPICAL DEPRESSION ONE TWO
24 JUN

DTG	LAT	LONG	DTG	LAT	LONG
240000Z	19.0N	127.9E	241200Z	18.8N	128.6E
240600Z	18.9N	128.3E	241800Z	18.7N	128.9E

TROPICAL DEPRESSION ONE THREE
26 JUN-27 JUN

DTG	LAT	LONG	DTG	LAT	LONG
260000Z	28.0N	133.2E	270000Z	30.5N	132.3E
260600Z	28.5N	132.6E	270600Z	31.0N	132.7E
261200Z	29.1N	132.2E	271200Z	31.4N	133.2E
261800Z	29.8N	132.2E	271800Z	31.7N	133.8E

TROPICAL DEPRESSION ONE NINE
07 AUG-11 AUG

DTG	LAT	LONG	DTG	LAT	LONG
071800Z	14.3N	133.8E	090600Z	17.1N	125.8E
080000Z	14.9N	132.6E	090600Z TO 101200Z NO WARNINGS		
080600Z	15.3N	131.3E	ISSUED		
081200Z	15.4N	129.8E	101200Z	22.6N	121.9E
081800Z	15.7N	128.4E	101800Z	24.6N	120.5E
090000Z	16.3N	127.1E	110000Z-110600Z DISSIPATED		

TROPICAL DEPRESSION TWO ZERO
14 AUG-16 AUG

DTG	LAT	LONG	DTG	LAT	LONG
140600Z	17.6N	141.1E	150600Z	19.7N	140.3E
141200Z	18.2N	140.8E	151200Z	20.1N	140.0E
141800Z	18.8N	140.7E	151800Z	20.4N	139.7E
150000Z	19.2N	140.5E	160000Z-160600Z DISSIPATED		

TROPICAL DEPRESSION TWO THREE
24 AUG-29 AUG

DTG	LAT	LONG	DTG	LAT	LONG
241200Z	15.5N	151.2E	270000Z	18.3N	140.1E
241800Z	15.2N	150.6E	270600Z	19.6N	139.3E
250000Z	14.9N	149.9E	271200Z	21.0N	138.9E
250600Z	14.8N	149.2E	271800Z	22.5N	138.8E
251200Z	15.7N	148.2E	280000Z	24.0N	138.9E
251800Z	16.8N	147.0E	280600Z	25.2N	139.3E
260000Z	17.0N	145.6E	281200Z	25.9N	139.8E
260600Z	16.7N	144.1E	281800Z	26.6N	140.2E
261200Z	16.9N	142.7E	290000Z	27.0N	140.9E
261800Z	17.4N	141.3E	290600Z	DISSIPATED	

TROPICAL DEPRESSION THREE TWO
20 OCT-23 OCT

DTG	LAT	LONG	DTG	LAT	LONG
200600Z	08.8N	147.5E	211800Z	08.4N	142.9E
201200Z	08.7N	146.8E	220000Z	08.3N	142.4E
201800Z	08.5N	145.9E	220600Z	08.1N	141.9E
210000Z	08.5N	145.2E	221200Z	07.8N	141.5E
210600Z	08.6N	144.4E	221800Z	07.6N	141.3E
211200Z	08.5N	143.6E	230000Z-230600Z DISSIPATED		

TROPICAL DEPRESSION THREE FOUR
31 OCT-01 NOV

DTG	LAT	LONG	DTG	LAT	LONG
310600Z	16.2N	150.4E	010000Z	18.5N	148.4E
311200Z	16.8N	149.7E	010600Z	19.3N	148.2E
311800Z	17.6N	148.9E			

TROPICAL DEPRESSION THREE SIX
06 NOV

DTG	LAT	LONG	DTG	LAT	LONG
060600Z	16.3N	152.8E	061200Z	17.1N	152.4E

TROPICAL STORMS 1961
POSITION DATA

TROPICAL STORM RITA
14 JAN-20 JAN

DTG	LAT	LONG	DTG	LAT	LONG
141200Z	08.3N	134.7E	171200Z	12.3N	134.6E
141800Z	08.8N	133.4E	171800Z	12.6N	135.3E
150000Z	09.1N	132.5E	180000Z	12.8N	136.1E
150600Z	09.3N	132.2E	180600Z	12.9N	137.0E
151200Z	09.5N	132.0E	181200Z	13.0N	137.9E
151800Z	09.9N	131.8E	181800Z	13.1N	138.8E
160000Z	10.1N	131.8E	190000Z	13.1N	139.7E
160600Z	10.5N	131.9E	190600Z	13.2N	140.5E
161200Z	10.9N	132.2E	191200Z	13.4N	141.4E
161800Z	11.3N	132.7E	191800Z	13.8N	142.1E
170000Z	11.7N	133.3E	200000Z	14.3N	142.9E
170600Z	12.1N	133.9E	200600Z	14.9N	143.4E

TROPICAL STORM SUSAN
27 FEB-01 MAR

DTG	LAT	LONG	DTG	LAT	LONG
270600Z	07.3N	131.2E	281200Z	09.0N	130.3E
271200Z	07.6N	131.0E	281800Z	09.5N	130.3E
271800Z	07.9N	130.8E	010000Z	09.8N	130.2E
280000Z	08.3N	130.6E	010600Z	10.2N	130.2E
280600Z	08.7N	130.5E	011200Z	10.6N	130.1E

TROPICAL STORM VIOLA
09 APR-10 APR

DTG	LAT	LONG	DTG	LAT	LONG
091800Z	09.3N	109.6E	100600Z	09.9N	107.5E
100000Z	09.7N	108.3E	101200Z	09.9N	106.8E

TROPICAL STORM WINNIE
06 MAY-09 MAY

DTG	LAT	LONG	DTG	LAT	LONG
061800Z	13.8N	93.7E	080600Z	18.0N	90.0E
070000Z	14.1N	93.1E	081200Z	19.1N	89.5E
070600Z	14.5N	92.3E	081800Z	20.3N	89.4E
071200Z	15.1N	91.7E	090000Z	21.5N	89.5E
071800Z	16.0N	91.1E	090600Z	22.5N	90.0E
080000Z	16.9N	90.5E	091200Z	23.5N	90.8E

TROPICAL STORM DORIS
23 JUN-02 JUL

DTG	LAT	LONG	DTG	LAT	LONG
230600Z	14.0N	137.6E	261200Z	23.1N	132.1E
231200Z	15.2N	137.2E	261200Z TO 300000Z NO WARNINGS		
231800Z	16.4N	136.6E	ISSUED		
240000Z	17.6N	136.0E	300000Z	21.7N	125.1E
240600Z	18.6N	135.2E	300600Z	21.6N	124.4E
241200Z	19.5N	134.4E	301200Z	21.7N	123.5E
241800Z	20.1N	133.4E	301800Z	21.6N	122.3E
250000Z	20.2N	132.2E	010000Z	21.4N	120.8E
250600Z	20.0N	131.3E	010600Z	21.9N	118.0E
251200Z	20.0N	130.6E	011200Z	22.3N	117.3E
251800Z	20.4N	130.3E	011800Z	22.6N	116.7E
260000Z	21.3N	130.7E	020000Z	23.2N	116.0E
260600Z	22.3N	131.5E	020600Z	23.5N	114.6E

TROPICAL STORM FLOSSIE
16 JUL-19 JUL

DTG	LAT	LONG	DTG	LAT	LONG
160000Z	17.9N	129.0E	180000Z	18.2N	120.0E
160600Z	17.6N	127.8E	180600Z	19.0N	119.4E
161200Z	17.3N	126.4E	181200Z	19.5N	118.5E
161800Z	16.8N	125.1E	181800Z	20.3N	117.6E
170000Z	16.4N	123.9E	190000Z	21.1N	116.8E
170600Z	16.0N	122.8E	190600Z	21.8N	115.5E
171200Z	15.8N	121.5E	191200Z	22.5N	114.2E
171800Z	16.6N	120.5E	191800Z	23.4N	112.9E

TROPICAL STORM GRACE
21 JUL-25 JUL

DTG	LAT	LONG	DTG	LAT	LONG
210000Z	27.3N	127.9E	230600Z	28.6N	128.3E
210600Z	27.4N	127.6E	231200Z	29.0N	128.1E
211200Z	27.6N	127.2E	231800Z	29.6N	127.8E
211800Z	27.5N	126.7E	240000Z	30.2N	127.4E
220000Z	27.2N	126.9E	240600Z	30.8N	126.9E
220600Z	27.1N	127.6E	241200Z	31.8N	126.5E
221200Z	27.2N	128.2E	241800Z	32.9N	126.3E
221800Z	27.6N	128.5E	250000Z	34.2N	126.9E
230000Z	28.1N	128.5E	250600Z	35.8N	128.6E

TROPICAL STORM MARIE
29 AUG-03 SEP

DTG	LAT	LONG	DTG	LAT	LONG
291800Z	23.8N	153.0E	010600Z	26.5N	144.6E
300000Z	24.9N	153.2E	011200Z	26.4N	143.8E
300600Z	26.1N	153.1E	011800Z	26.3N	142.8E
301200Z	26.9N	152.4E	020000Z	26.4N	142.1E
301800Z	27.3N	151.1E	020600Z	26.5N	141.3E
310000Z	27.3N	149.5E	021200Z	26.8N	140.1E
310600Z	27.2N	148.3E	021800Z	27.2N	138.6E
311200Z	27.1N	147.3E	030000Z	27.7N	137.2E
311800Z	26.9N	146.4E	030600Z	28.4N	135.8E
010000Z	26.8N	145.5E			

TROPICAL STORM RUBY
21 SEP-24 SEP

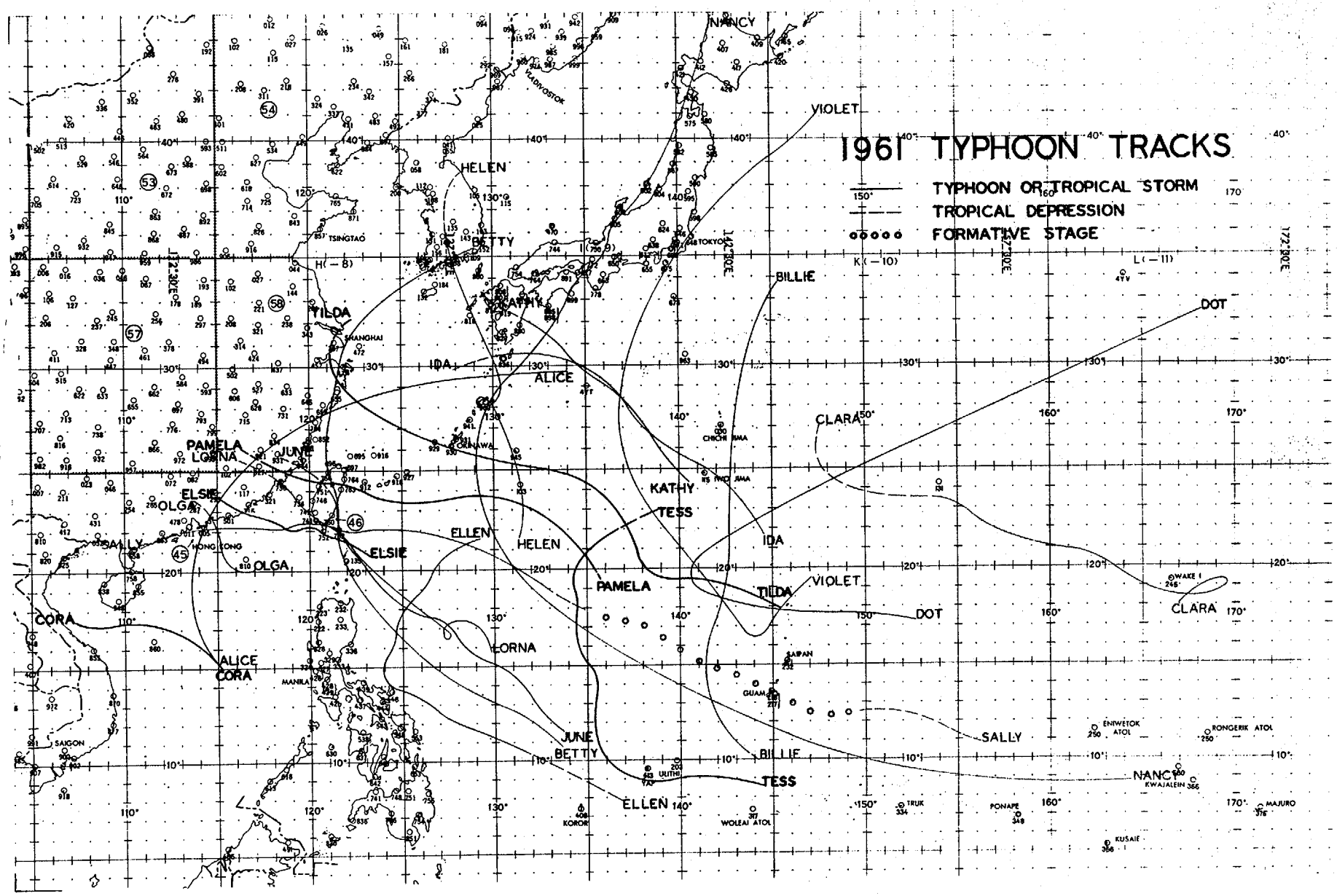
DTG	LAT	LONG	DTG	LAT	LONG
210600Z	13.6N	126.7E	230000Z	15.5N	114.3E
211200Z	14.0N	125.2E	230600Z	15.6N	112.9E
211800Z	14.3N	123.7E	231200Z	15.8N	111.4E
220000Z	14.5N	122.2E	231800Z	16.2N	109.8E
220600Z	15.0N	119.6E	240000Z	16.5N	108.6E
221200Z	15.5N	117.6E	240600Z	16.9N	107.3E
221800Z	15.5N	115.8E	241200Z	17.4N	106.0E

TROPICAL STORM WILDA
11 OCT-13 OCT

DTG	LAT	LONG	DTG	LAT	LONG
110600Z	13.2N	116.4E	121200Z	13.5N	111.5E
111200Z	13.4N	115.9E	121800Z	13.8N	110.2E
111800Z	13.8N	115.4E	130000Z	14.3N	109.1E
120000Z	14.0N	114.4E	130600Z	13.9N	107.6E
120600Z	13.5N	112.8E			

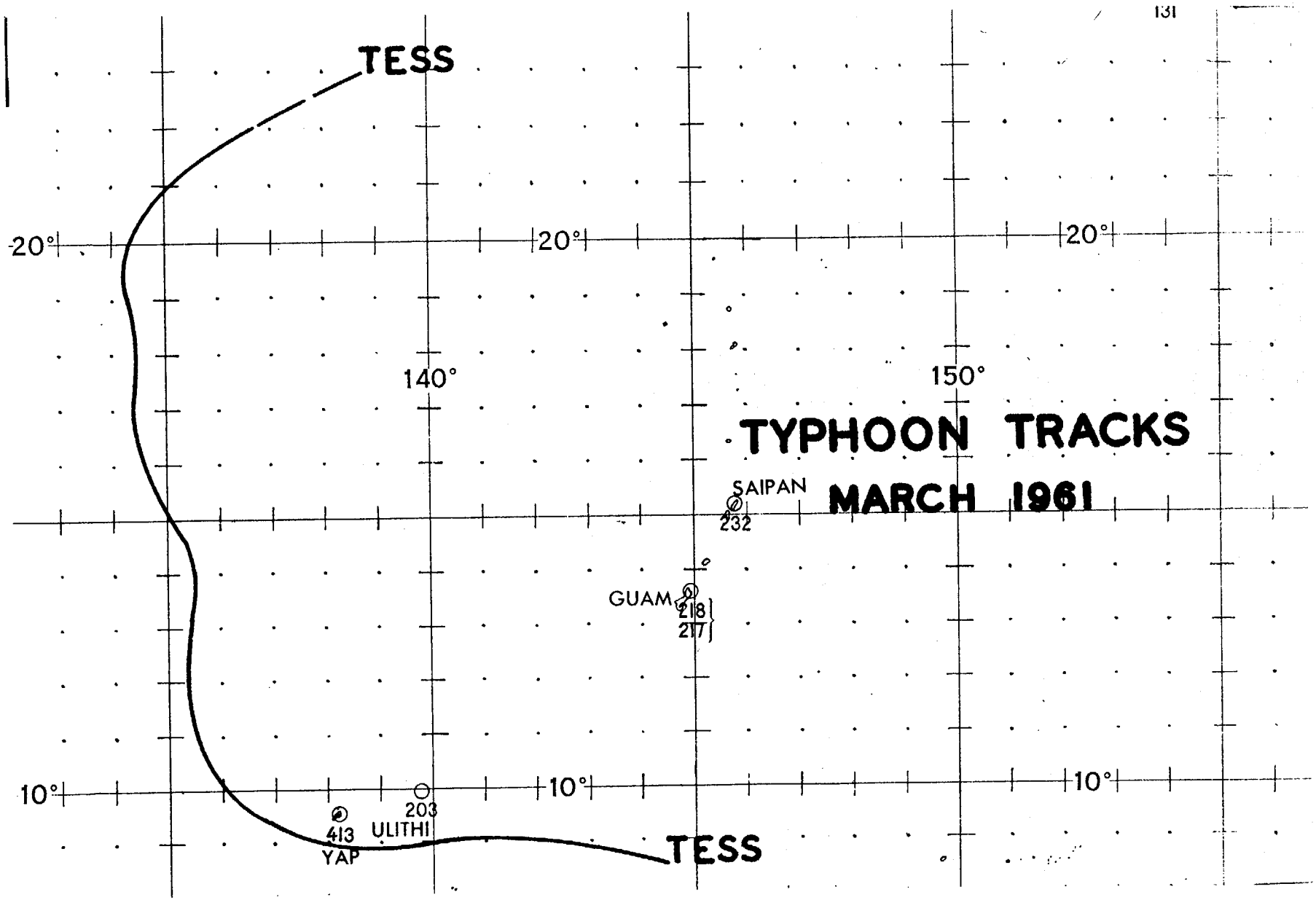
TROPICAL STORM ANITA
19 OCT-20 OCT

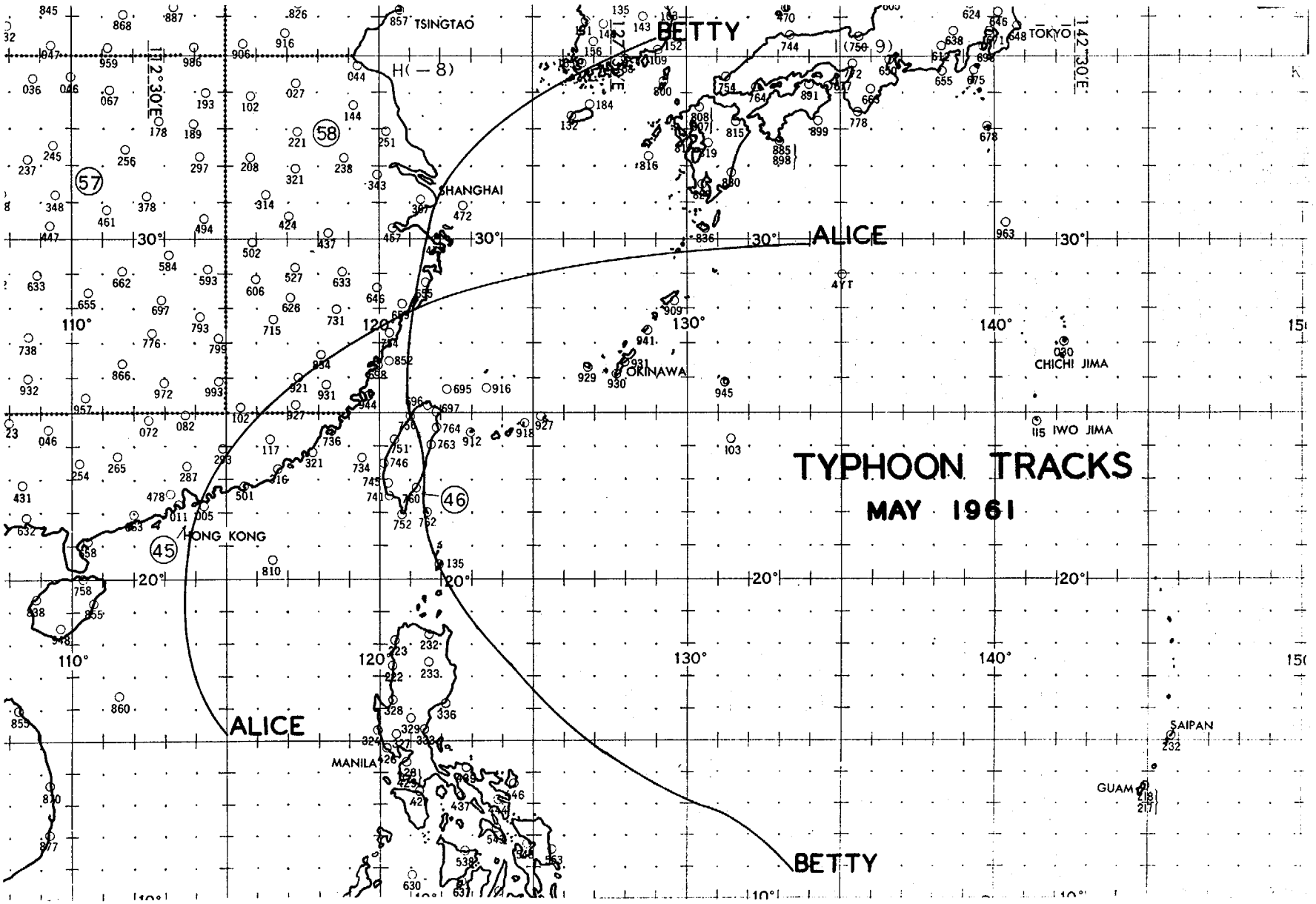
DTG	LAT	LONG	DTG	LAT	LONG
190000Z	14.5N	113.0E	191800Z	15.7N	108.3E
190600Z	14.8N	111.2E	200000Z	15.8N	106.7E
191200Z	15.3N	109.5E			

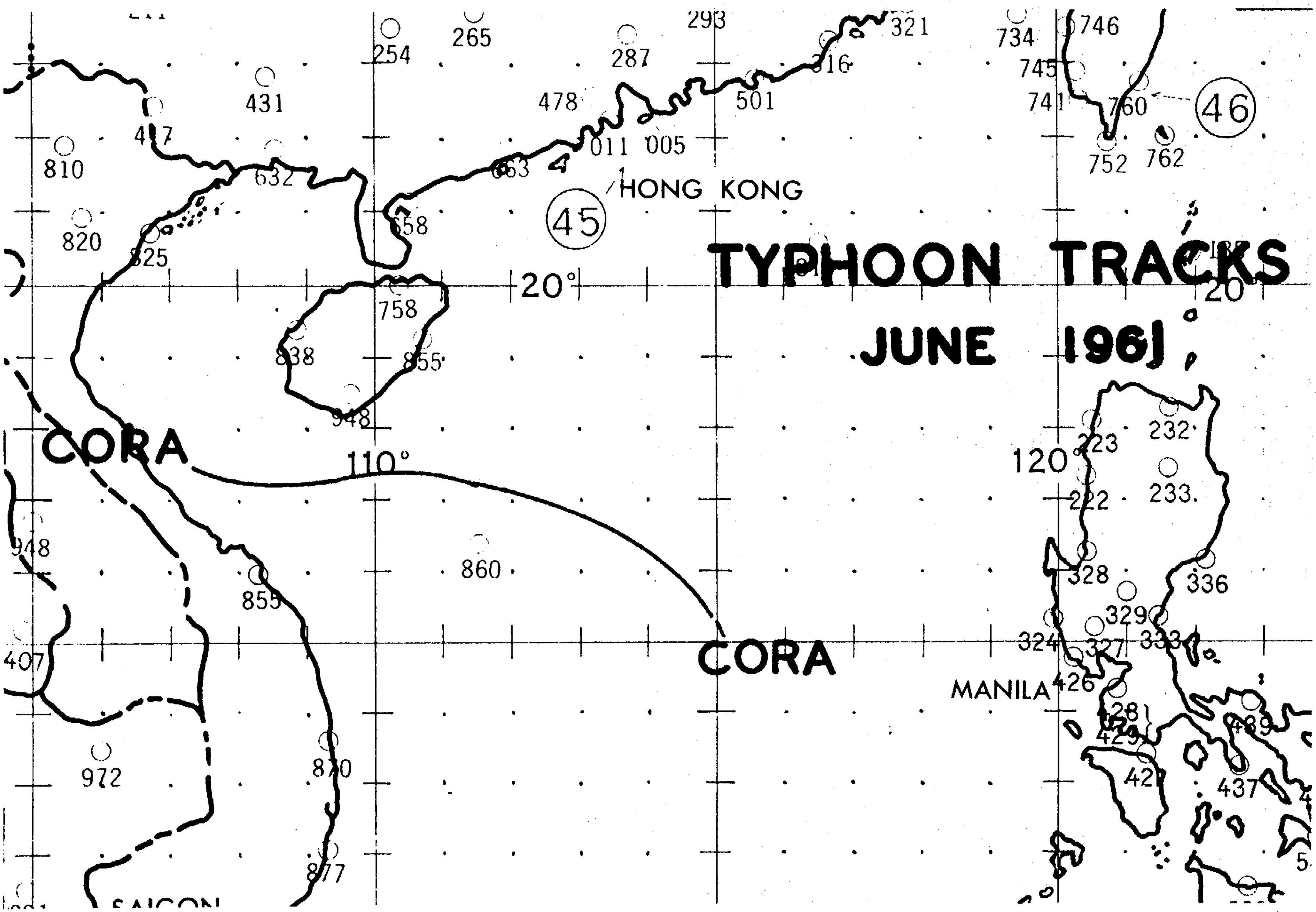

1961 TYPHOON TRACKS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
NANCY
VIOLET
HELEN
BETTY
TILDA
IDA
ALICE
BILLIE
DOT
CLARA
PAMELA
JUNE
KATHY
TESS
ELLEN
ELSIE
OLGA
SALLY
CORA
CORNA
TOKYO
SHANGHAI
HONG KONG
MANILA
SAIGON
GUAM
WAKE I
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN
MAJURO
PONAPE
TRUK
KUSAIE
WOLEAI ATOL
KOROR
UIITHI

1961 TYPHOON TRACKS

TYPHOON TESS	24 MAR - 31 MAR
TYPHOON ALICE	17 MAY - 21 MAY
TYPHOON BETTY	22 MAY - 28 MAY
TYPHOON CORA	22 JUN - 25 JUN
TYPHOON ELSIE	12 JUL - 15 JUL
TYPHOON HELEN	27 JUL - 03 AUG
TYPHOON IDA	28 JUL - 31 JUL
TYPHOON JUNE	01 AUG - 08 AUG
TYPHOON KATHY	15 AUG - 18 AUG
TYPHOON LORNA	20 AUG - 26 AUG
TYPHOON NANCY	07 SEP - 17 SEP
TYPHOON OLGA	08 SEP - 10 SEP
TYPHOON PAMELA	08 SEP - 12 SEP
TYPHOON SALLY	21 SEP - 29 SEP
TYPHOON TILDA	27 SEP - 05 OCT
TYPHOON VIOLET	04 OCT - 10 OCT
TYPHOON BILLIE	23 OCT - 28 OCT
TYPHOON CLARA	26 OCT - 01 NOV
TYPHOON DOT	09 NOV - 15 NOV
TYPHOON ELLEN	05 DEC - 13 DEC


TESS
20°
20°
20°
140°
150°
TYPHOON TRACKS
MARCH 1961
SAIPAN
232
GUAM
218
217
10°
10°
10°
203
ULITHI
413
YAP
TESS


TYPHOON TRACKS
MAY 1961
ALICE
ALICE
BETTY
BETTY
TSINGTAO
SHANGHAI
HONG KONG
MANILA
OKINAWA
CHICHI JIMA
IWO JIMA
TOKYO
SAIPAN
GUAM
H(−8)
(750 9)
112°30'E
127°30'E
142°30'E
110°
120°
130°
140°
30°
20°
10°


TYPHOON TRACKS
JUNE 1961
CORA
CORA
HONG KONG
MANILA
SAIGON
45
46
20°
110°
120°
254
265
287
293
321
734
746
745
741
760
752
762
431
478
501
316
011
005
810
632
663
820
825
658
758
838
855
948
223
232
222
233
948
860
855
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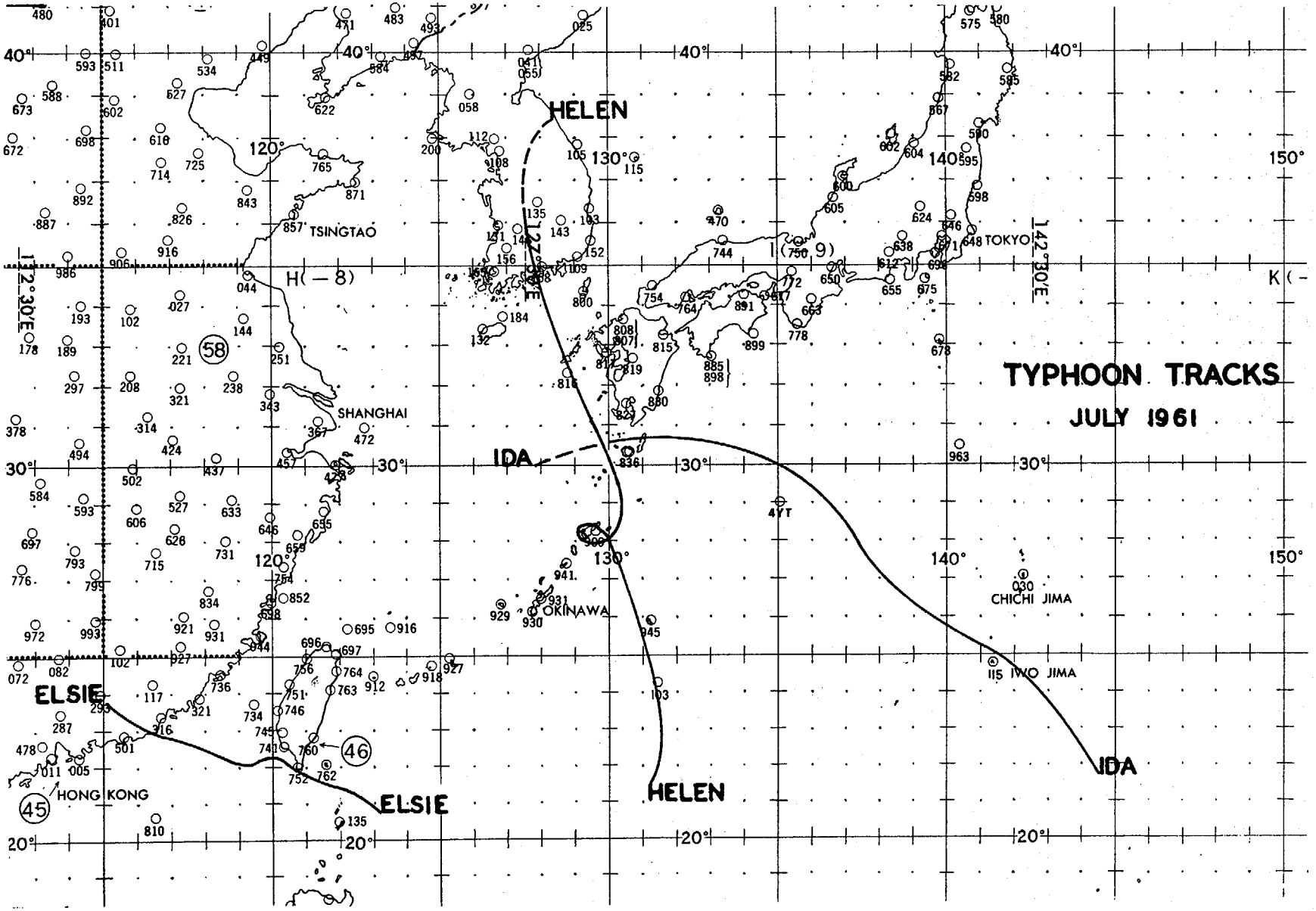
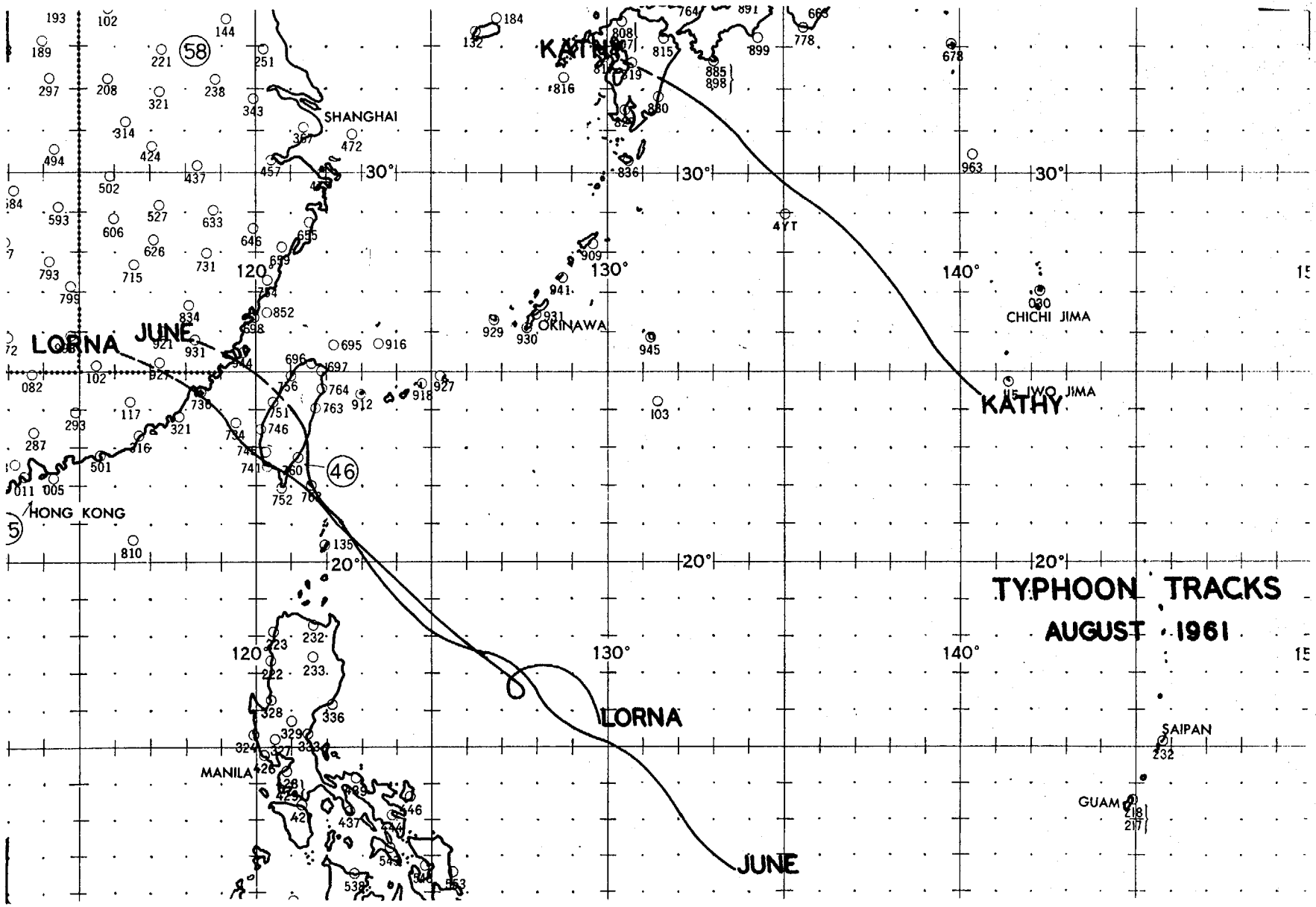
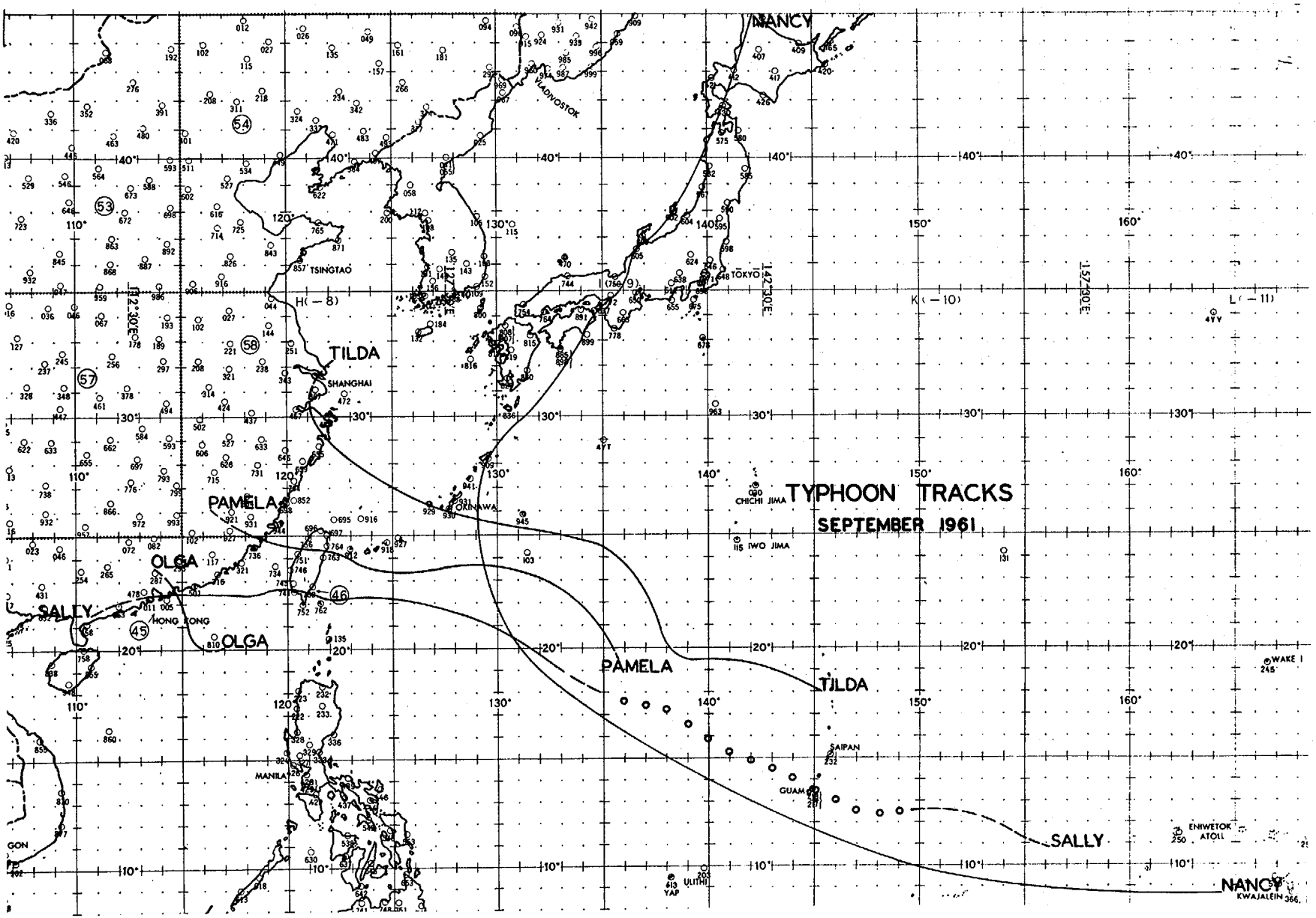
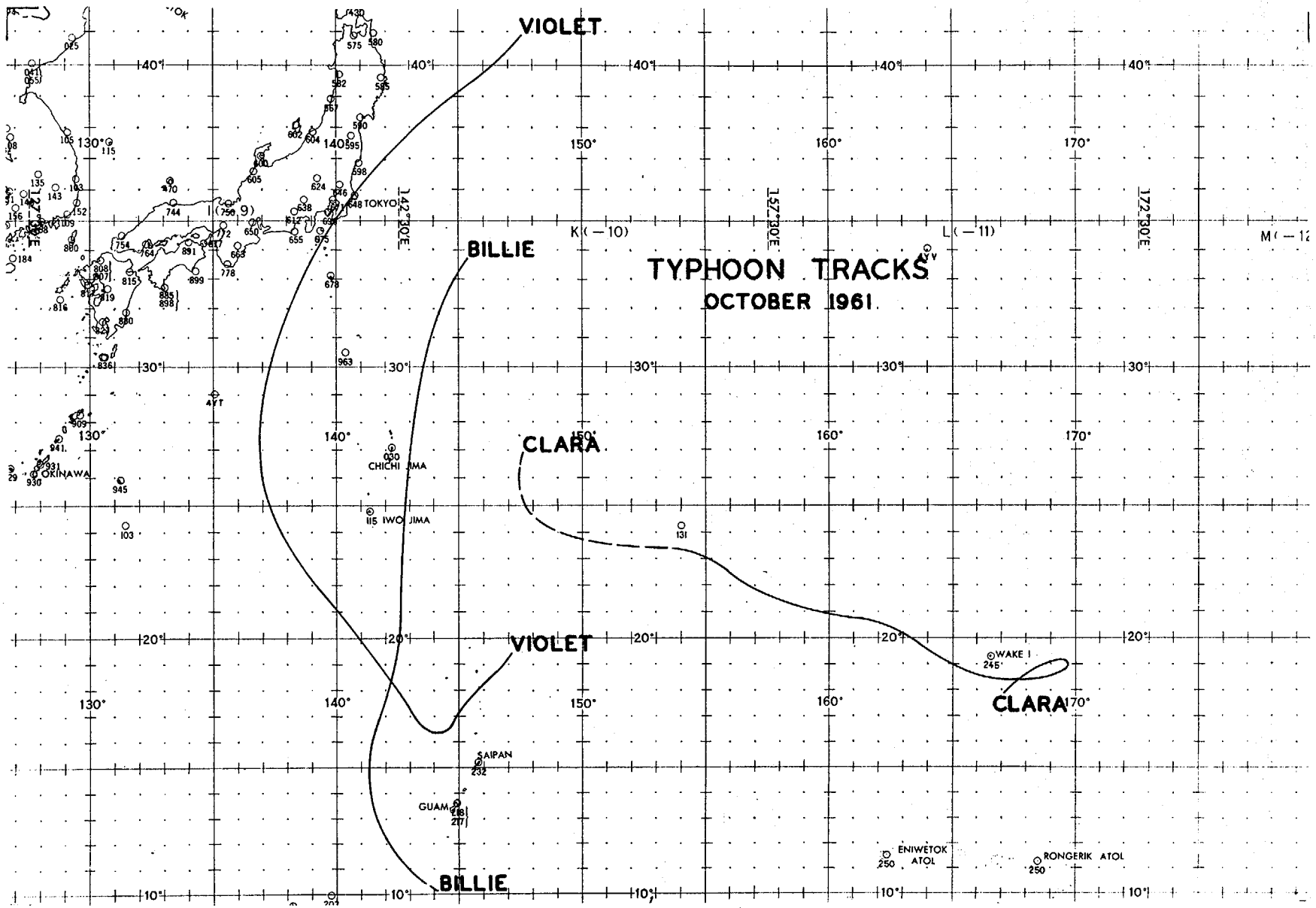
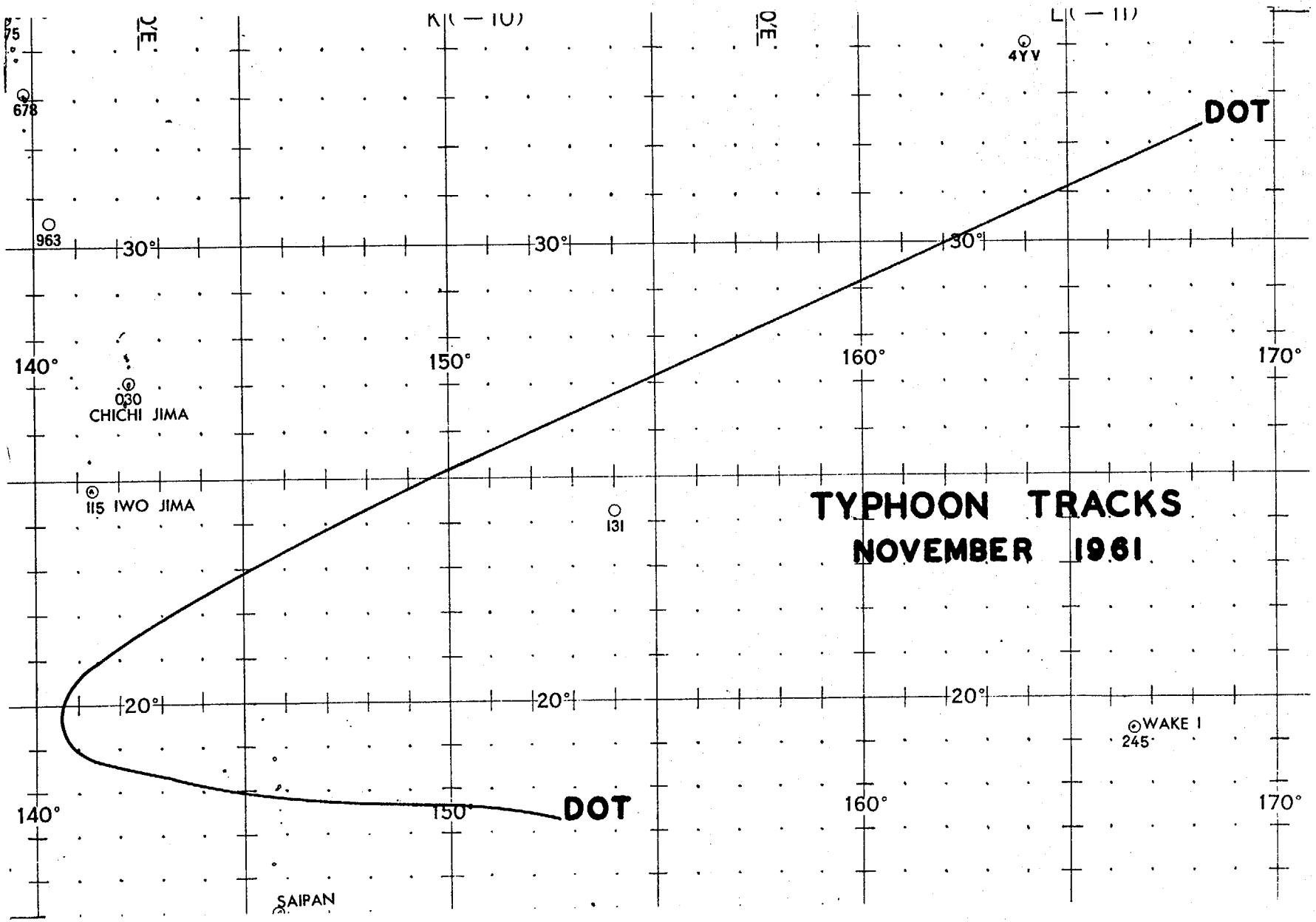
336
329
324
327
333
407
426
281
429
427
439
437
972
870
877

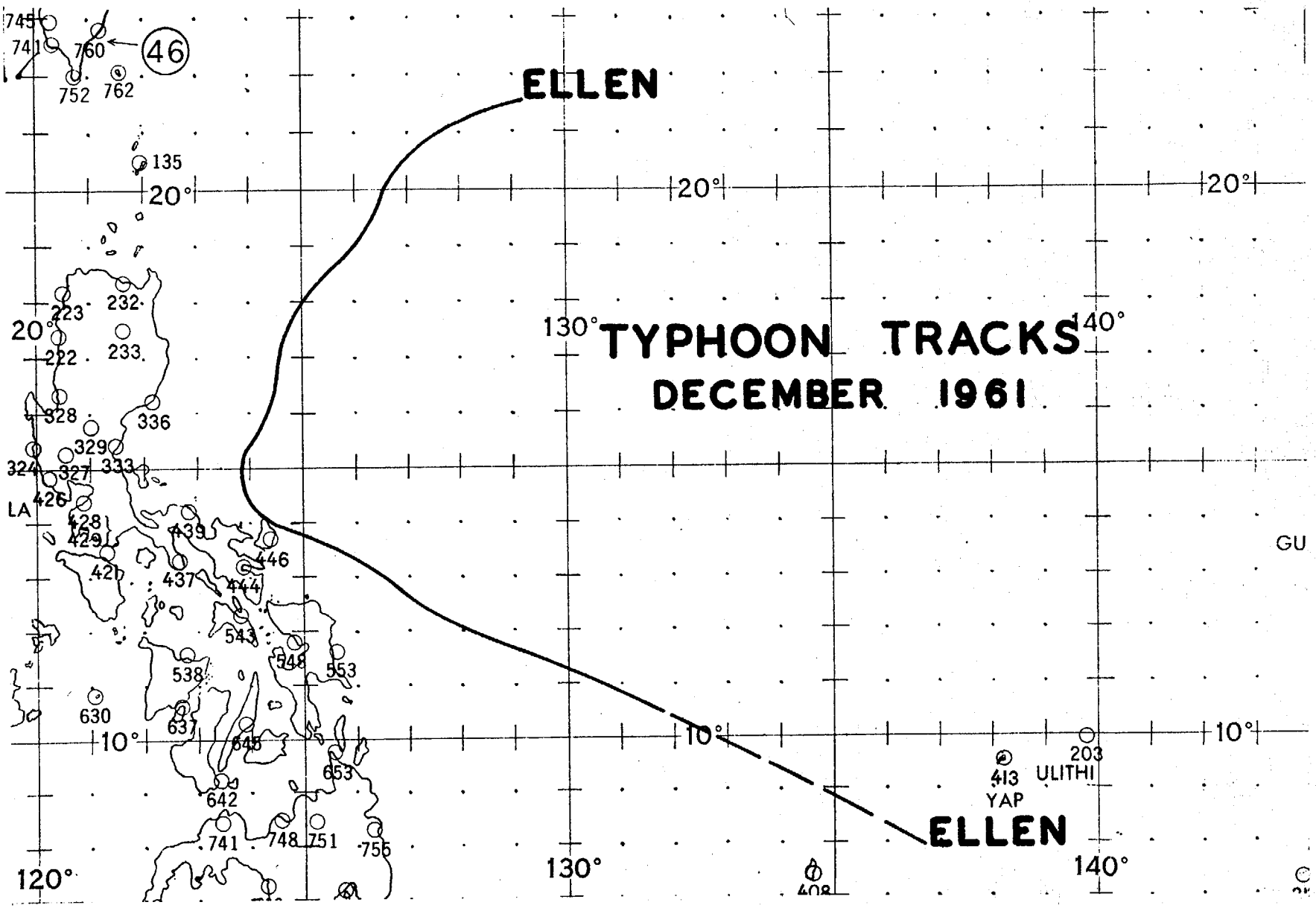

TYPHOON TRACKS
JULY 1961
HELEN
IDA
ELSIE
TSINGTAO
SHANGHAI
HONG KONG
OKINAWA
CHICHI JIMA
IWO JIMA
TOKYO
112°30'E
127°30'E
142°30'E
120°
130°
140°
150°
40°
30°
20°
58
46
45


TYPHOON TRACKS
AUGUST 1961
LORNA
JUNE
KATHY
SHANGHAI
HONG KONG
MANILA
ORINAWA
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
4YT
120°
130°
140°
30°
20°


TYPHOON TRACKS
SEPTEMBER 1961
NANCY
TILDA
PAMELA
OLGA
SALLY
NANCY
TSINGTAO
TOKYO
SHANGHAI
OKINAWA
HONG KONG
MANILA
SAIPAN
GUAM
WAKE I
ENIWETOK ATOLL
KWAJALEIN
VLADIVOSTOK
CHICHI JIMA
IWO JIMA
YAP
ULITHI


TYPHOON TRACKS
OCTOBER 1961
VIOLET
BILLIE
CLARA
VIOLET
BILLIE
CLARA
TOKYO
OKINAWA
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
WAKE I
ENIWETOK ATOL
RONGERIK ATOL
142°30'E
157°30'E
172°30'E
K (−10)
L (−11)
M (−12)


DOT
DOT
TYPHOON TRACKS
NOVEMBER 1961
4YV
678
963
030
CHICHI JIMA
115 IWO JIMA
131
WAKE I
245
SAIPAN
30°
140°
150°
160°
170°
20°


TYPHOON TRACKS
DECEMBER 1961
ELLEN
ELLEN
46
745
741
760
752
762
135
20°
223
232
222
233
328
336
329
324
327
333
426
LA
428
429
439
446
421
437
444
543
538
548
553
630
637
645
653
642
741
748
751
755
120°
130°
140°
10°
GU
203
413
ULITHI
YAP
408

TROPICAL CYCLONES OF 1961

CYCLONE	*PERIOD
01. Tropical Storm RITA	12 Jan - 20 Jan
02. Investigation	19 Jan - 20 Jan
03. Investigation	01 Feb - 02 Feb
04. Tropical Storm SUSAN	27 Feb - 01 Mar
05. Typhoon TESS	22 Mar - 31 Mar
06. Tropical Storm VIOLA	09 Apr - 10 Apr
07. Investigation	04 May - 05 May
08. Investigation	05 May - 06 May
09. Tropical Storm WINNIE	06 May - 09 May
10. Typhoon ALICE	16 May - 21 May
11. Typhoon BETTY	21 May - 28 May
12. Tropical Depression 7	25 May - 28 May
13. Investigation	30 May - 31 May
14. Tropical Depression 8	31 May - 06 Jun
15. Investigation	03 Jun - 05 Jun
16. Tropical Depression 9	06 Jun - 07 Jun
17. Investigation	17 Jun - 18 Jun
18. Investigation	19 Jun - 22 Jun
19. Tropical Storm DORIS	20 Jun - 02 Jul
20. Typhoon CORA	22 Jun - 25 Jun
21. Tropical Depression 12	24 Jun - 25 Jun
22. Tropical Depression 13	25 Jun - 27 Jun
23. Investigation	26 Jun - 29 Jun
24. Investigation	02 Jul - 06 Jul
25. Investigation	04 Jul - 08 Jul
26. Typhoon ELSIE	07 Jul - 15 Jul
27. Investigation	11 Jul - 12 Jul
28. Tropical Storm FLOSSIE	13 Jul - 19 Jul
29. Investigation	18 Jul - 22 Jul
30. Tropical Storm GRACE	20 Jul - 25 Jul
31. Typhoon HELEN	26 Jul - 03 Aug
32. Typhoon IDA	28 Jul - 31 Jul
33. Typhoon JUNE	31 Jul - 08 Aug
34. Tropical Depression 19	01 Aug - 11 Aug
35. Investigation	10 Aug - 11 Aug
36. Investigation	11 Aug - 13 Aug
37. Investigation	12 Aug - 16 Aug
38. Tropical Depression 20	14 Aug - 16 Aug
39. Typhoon KATHY	15 Aug - 18 Aug
40. Investigation	16 Aug - 17 Aug

TROPICAL CYCLONES OF 1961 (CONT'D)

CYCLONE	*PERIOD
41. INVESTIGATION	18 AUG - 20 AUG
42. TYPHOON LORNA	19 AUG - 26 AUG
43. INVESTIGATION	20 AUG - 22 AUG
44. INVESTIGATION	23 AUG - 24 AUG
45. TROPICAL DEPRESSION 23	24 AUG - 29 AUG
46. INVESTIGATION	27 AUG - 29 AUG
47. INVESTIGATION	27 AUG - 28 AUG
48. INVESTIGATION	28 AUG - 29 AUG
49. TROPICAL STORM MARIE	29 AUG - 03 SEP
50. TYPHOON PAMELA	02 SEP - 12 SEP
51. TYPHOON OLGA	03 SEP - 10 SEP
52. TYPHOON NANCY	07 SEP - 17 SEP
53. TROPICAL STORM RUBY	17 SEP - 24 SEP
54. TYPHOON SALLY	20 SEP - 29 SEP
55. TYPHOON TILDA	27 SEP - 05 OCT
56. TYPHOON VIOLET	03 OCT - 10 OCT
57. INVESTIGATION	09 OCT - 10 OCT
58. TROPICAL STORM WILDA	10 OCT - 13 OCT
59. INVESTIGATION	12 OCT - 13 OCT
60. TROPICAL STORM ANITA	19 OCT - 20 OCT
61. TROPICAL DEPRESSION 32	19 OCT - 23 OCT
62. TYPHOON BILLIE	22 OCT - 28 OCT
63. TYPHOON CLARA	26 OCT - 01 NOV
64. TROPICAL DEPRESSION 34	30 OCT - 01 NOV
65. TROPICAL DEPRESSION 36	04 NOV - 06 NOV
66. TYPHOON DOT	08 NOV - 15 NOV
67. INVESTIGATION	15 NOV - 16 NOV
68. INVESTIGATION	24 NOV - 25 NOV
69. TYPHOON ELLEN	04 DEC - 13 DEC

* THE PERIOD SHOWN COVERS THE PERIOD FROM THE DATE THE CYCLONE WAS FIRST ASSIGNED A CYCLONE NUMBER, UNTIL THE FINAL WARNING WAS ISSUED, OR IF NO WARNINGS WERE ISSUED, THE DATE THE CYCLONE DISSIPATED.

1961 TYPHOON DATA SUMMARY

TYPHOON	FROM RECON: MAX OBSVD SFC WND	FROM RECON: MIN SLP (MBS)	FROM RECON: MIN 700MB HGT	FROM RECON: MAX 700MB TEMP(C)	FROM WARNINGS: MAX RADIUS 100KT WND	FROM WARNINGS: MAX RADIUS 50KT WND	FROM WARNINGS: MAX RADIUS 30KT WND
TESS	125	937	8420	21	40	125	250
ALICE	65	985	9730	14	---	100	200
BETTY	100	946	8610	21	30		
CORA	80	987	9800	15	---	125	250
ELSIE	100	974	9420	16	---	175	250
HELEN	100	971	9370	19	---	100	200
IDA	95	990	9560	18	---	150	250
JUNE	110	961	9120	17	---	150	200
KATHY	110	980	9890	20	---	25	150
LORNA	150	947	8880	22	50	175	450
NANCY	200	882	6801	21	100	250	450
OLGA	---	---	----	--	---	75	200
PAMELA	170	914	7440	18	50	125	250
SALLY	60	983	----	--	---	100	300
TILDA	120	917	7980	19	50	150	400
VIOLET	190	882	7130	29	60	175	350
BILLIE	65	961	9290	17	---	250	750
CLARA	75	984	10290	--	---	75	150
DOT	150	922	7960	21	50	100	300
ELLEN	175	945	8520	23	30	100	1000

1961 TYPHOON FORECAST ERRORS
(IN MI)

TYPHOON	24 HR FORECASTS NO. OF CASES	24 HR FORECASTS MEAN ERROR	48 HR FORECASTS NO. OF CASES	48 HR FORECASTS MEAN ERROR
TESS	26	117	22	297
ALICE	14	159	10	378
BETTY	22	142	18	229
CORA	5	113	1	278
ELSIE	8	84	4	173
HELEN	27	119	23	214
IDA	11	250	7	397
JUNE	26	74	22	138
KATHY	8	180	4	164
LORNA	18	120	14	196
NANCY	34	133	30	228
OLGA	5	155	1	353
PAMELA	11	120	7	315
SALLY	11	211	7	574
TILDA	27	137	23	312
VIOLET	24	146	20	312
BILLIE	16	144	12	340
CLARA	20	178	16	361
DOT	24	138	20	304
ELLEN	23	105	19	235

AVERAGE ERROR-24 HR FORECASTS (360 CASES) 136
AVERAGE ERROR-48 HR FORECASTS (280 CASES) 274

CHAPTER IV

INDIVIDUAL TYPHOONS OF 1961

A. TYPHOON TESS (240000Z-310600Z MARCH 1961)

On 21 and 22 March, the winds aloft and surface observations at Truk indicated that a weak tropical cyclone, which originated about 160 mi SE of Ponape on 18 March, had passed just S of Truk at about 211200Z and was intensifying. A reconnaissance aircraft investigated the cyclone on 23 March and reported that a weak circulation existed with maximum surface winds of 15 kts. The circulation was closely observed and on 24 March a reconnaissance aircraft indicated that the system was intensifying, for the maximum observed surface winds had increased to 45 kts. Based on this data, the first warning was issued at 240000Z on Tropical Storm TESS.

At 240000Z TESS was about 300 mi S of Guam, moving towards Yap and intensifying. TESS was upgraded to typhoon intensity at 250000Z and by 251200Z was just S of Yap with maximum surface winds of 75 kts. TESS passed within 30 mi of Yap, and reports from Yap indicated a minimum sea level pressure of 989.0 mbs with peak surface gusts of 50 kts. After passing Yap, TESS began to recurve, and by 271200Z was moving just E of N at 4 kts. By this time TESS had maximum surface winds of 125 kts and no further intensification was anticipated as TESS appeared to be in a trough that was moving through the westerlies; however, the trough passed quickly to the E and at 280600Z TESS began to intensify again and turn towards the NNW. Surface winds reached 135 kts by 281800Z and thereafter TESS began to weaken slowly. After 300600Z TESS began to recurve and rapidly weaken. By 310600Z TESS was moving ENE at 23 kts with maximum surface winds of less than 30 kts, therefore the final warning was issued at this time.

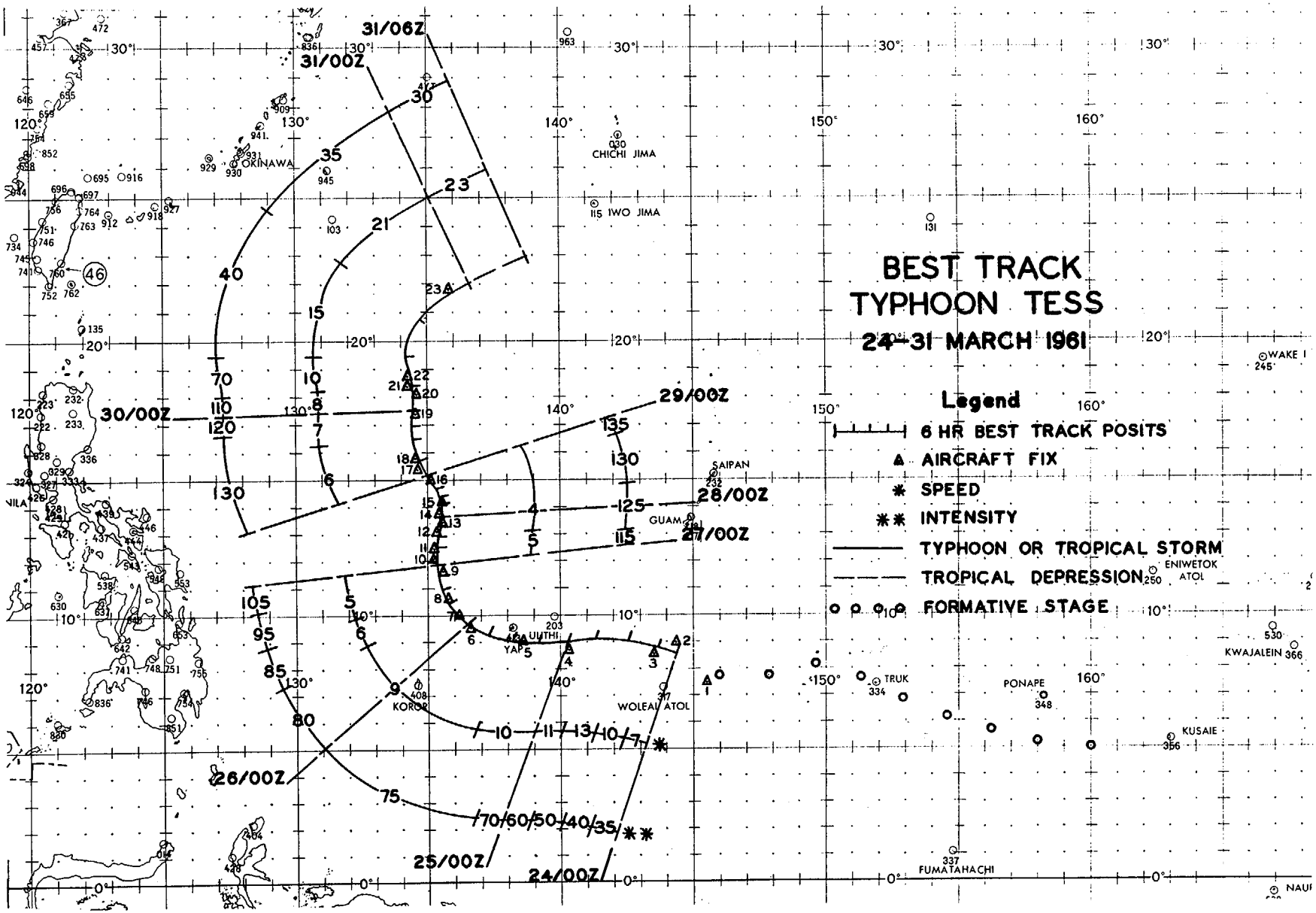
The cyclonic circulation of TESS extended to about the 300 mb level during the period it was a typhoon and at the time of the final warning extended to less than 10,000 ft. TESS followed the track of climatology quite well, and in a period of 7 days and 6 hours traveled 1,450 mi, averaging 8 kts or 200 mi per day. The minimum speed of movement was 4 kts on 27 and 28 March and the maximum speed of movement was 23 kts on 31 March.

An unusual feature of TESS was that on 28 March it appeared that TESS was caught in a trough moving through the westerlies. Weakening was indicated and TESS had begun to move E of N; however, with passage of the trough to the E, TESS began to intensify again and turned to the NNW. Another rarity, TESS was one of 3 typhoons to occur during March in the past 14 years.

A concentric eye was observed by weather reconnaissance at 270740Z at 12.6N 135.2E. The SLP was 940 mb; 700 mb wind, 120 kts; height, 8500 ft; and temperature 21° C.

TESS, beating the season by about four months began her life

CHURNING HARMLESSLY IN THE OPEN SEA OF THE CAROLINE ISLANDS. SHE MAINTAINED A RELATIVE WESTERLY MOVEMENT PASSING 24 MILES SOUTH OF YAP ISLAND ON THE 25TH OF MARCH AT 1200Z. MAXIMUM PEAK GUSTS OF 50 KTS WERE RECORDED AT 2255Z. A TOTAL OF 3.6 INCHES OF RAIN FELL DURING THE PASSAGE, WITH NO RISE IN TIDES. PRELIMINARY REPORTS INDICATED CONSIDERABLE DAMAGE TO TREES AND HOUSING WITH NO CASUALTIES REPORTED. TESS BEGAN RECURVING TO THE NORTH SHORTLY AFTER PASSAGE OF YAP. SHE REMAINED ON THIS NORTHERLY COURSE BLOWING INNOXIOUSLY OVER OPEN SEA FOR THE DURATION OF HER LIFE, BUT MAY HAVE CAUSED DAMAGE TO SEAGOING VESSELS.


BEST TRACK
TYPHOON TESS
24-31 MARCH 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
31/06Z
31/00Z
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
70/60/50/40/35
CHICHI JIMA
IWO JIMA
OKINAWA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOL
ENIWETOK ATOL
TRUK
PONAPE
KUSAIE
KWAJALEIN
WAKE I
FUMATAHACHI

LAND RADAR AND AIRCRAFT FIXES - TYPHOON TESS

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	222300Z	07.6N	145.5E	56-P-10	15	---	10240	1009	09/09	SEMICIRC WALL CLDS W THRU N-E DIA APPROX 40 MI
2	232300Z	09.0N	144.3E	56-P-10	45	30	10220	1005	12/11	SEMICIRC DIA 30 MI WALL CLDS N & W OPEN E & S
3	240636Z	08.7N	143.6E	56-P-02	30	35	10121	1003	13/03	NOT WELL DEFINED ON RADAR
4	242227Z	08.8N	140.2E	56-P-05	65	40	9870	994	17/13	NOT WELL DEFINED 10 MI DIA
5	250715Z	09.1N	138.7E	56-P-01	75	70	9850	984	16/11	CIRC DIA 40 MI WALL CLDS E-N-W
6	252145Z	09.7N	136.6E	56-P-05	80	60	9500	988	15/08	NO WELL DEFINED EYE PATTERN
7	260230Z	10.0N	136.2E	56-P-05	80	60	9410	980	17/11	NO WELL DEFINED EYE PATTERN
8	260745Z	10.6N	135.9E	56-P-02	80	60	9490	974	17/10	CIRC NOT TOO WELL DEFINED DIA 70 MI WALL CLDS N-NE
9	262200Z	11.8N	135.5E	56-P-05	50	90	8930	966	17/13	CIRC DIA 20 MI WELL DEFINED
10	270300Z	12.2N	135.3E	56-P-02	110	110	8760	968	21/14	CIRC DIA 20 MI WELL DEFINED
11	270740Z	12.6N	135.2E	56-P-02	110	120	8510	940	21/07	CIRC DIA 20 MI
12	271500Z	13.1N	135.3E	VW1-R-05	---	---	----	---	-----	DIA 12 MI HVY WALL CLDS ALL QUADS
13	272145	13.5N	135.7E	56-P-05	---	105	8680	974	17/17	ELLIP DIA 12 BY 25 MI NE-SW EYE NOT WELL DEFINED
14	280245Z	13.9N	135.5E	56-P-05	80	120	8610	972	16/16	EYE NOT DEFINED BY RADAR OR VISUAL
15	280920Z	14.1N	135.6E	56-P-02	100	120	8510	946	18/17	30 MI DIA WELL DEFINED WALL CLDS ALL QUADS

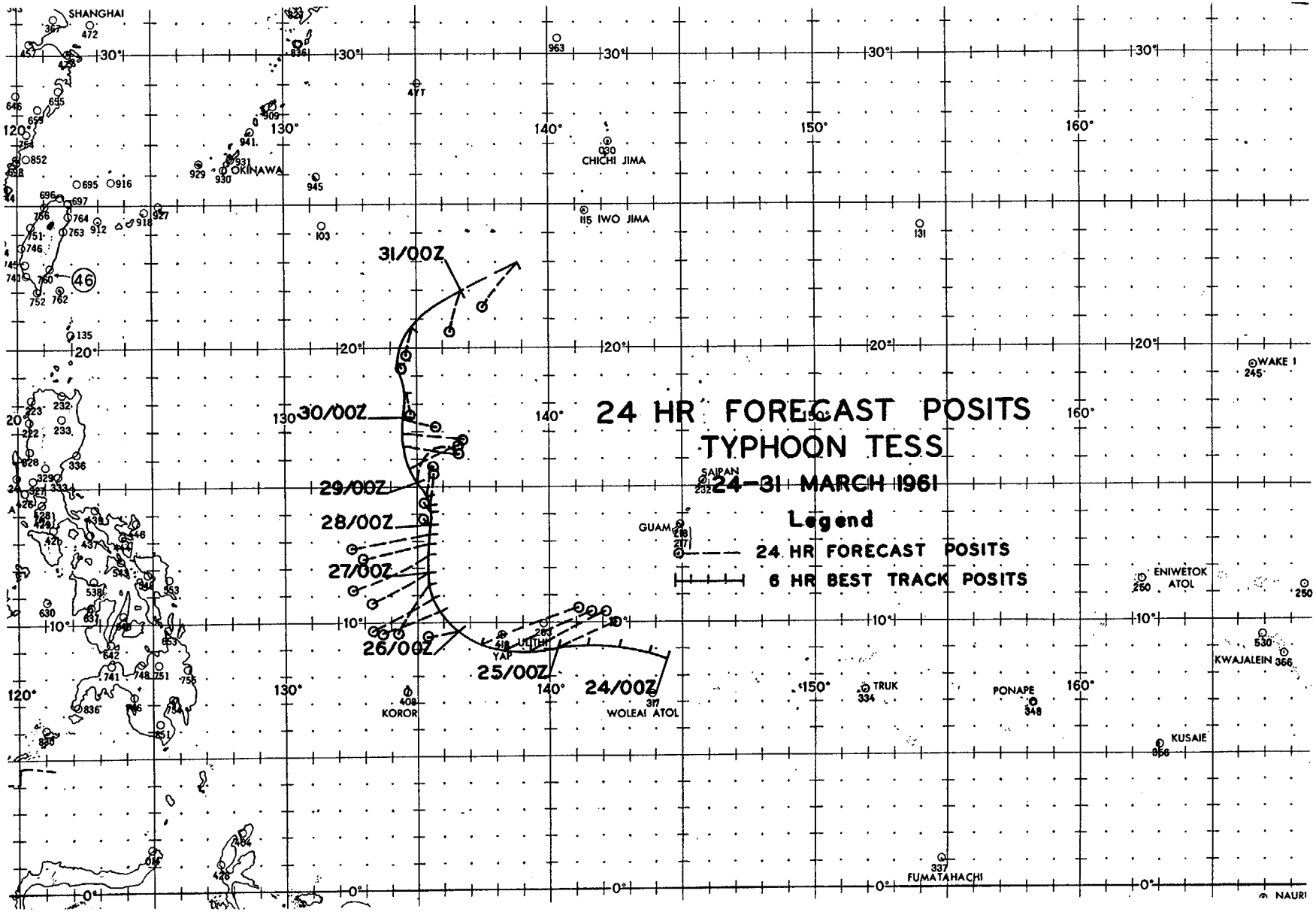
LAND RADAR AND AIRCRAFT FIXES - TYPHOON TESS (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
16	282215Z	15.0N	135.1E	56-P-05	---	122	8420	937	20/16	CIRC DIA 15MI WALL CLDS ALL QUADS
17	290245Z	15.4N	134.8E	56-P-05	100	105	8610	946	19/15	CIRC DIA 20MI WALL CLDS ALL QUADS
18	290745Z	15.9N	134.6E	56-P-05	110	120	8780	951	21/17	CIRC DIA 15MI WALL CLDS ALL QUADS
19	292210Z	17.4N	134.6E	56-P-05	125	110	9020	953	19/14	30X20MI LONG AXIS NW OPEN SE
20	300356Z	18.2N	134.6E	56-P-05	120	100	9140	975	21/15	NOT DEFINED WALL CLDS NE ALL OTHER QUADS OPEN
21	300535Z	18.6N	134.3E	VW1-R-05	---	---	-----	---	-----	CIRC DIA 18MI OPEN SW
22	300755Z	18.8N	134.3E	56-P-10	80	60	9930	987	21/16	EYE NOT DEFINED
23	302230Z	21.8N	135.9E	56-P-10	---	40	10380	1009	10/08	CIRC DIA 40MI OPEN SW-N

TYPHOON TESS 24-31 MARCH 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
240000Z	08.6N	144.3E	-------	-------
240600Z	08.9N	143.6E	-------	-------
241200Z	09.1N	142.6E	-------	-------
241800Z	09.1N	141.3E	-------	-------
250000Z	09.0N	140.1E	065-146	-------
250600Z	09.0N	139.1E	065-185	-------
251200Z	09.0N	138.1E	070-210	-------
251800Z	09.2N	137.2E	070-235	-------
260000Z	09.7N	136.5E	246-74	072-265
260600Z	10.4N	135.9E	251-140	078-272
261200Z	11.0N	135.7E	238-162	086-247
261800Z	11.5N	135.5E	212-140	086-230
270000Z	12.0N	135.4E	246-148	250-303
270600Z	12.5N	135.4E	243-177	249-350
271200Z	12.9N	135.3E	256-141	250-391
271800Z	13.3N	135.4E	260-174	238-352
280000Z	13.7N	135.5E	275-84	252-389
280600Z	14.1N	135.5E	325-26	250-355
281200Z	14.5N	135.4E	360-55	263-240
281800Z	14.8N	135.2E	018-63	268-252
290000Z	15.2N	135.0E	058-105	030-118
290600Z	15.7N	134.7E	073-117	042-188
291200Z	16.3N	134.5E	096-116	050-292
291800Z	17.0N	134.5E	104-127	058-360
300000Z	17.7N	134.6E	118-71	062-435
300600Z	18.5N	134.4E	159-61	068-430
301200Z	19.5N	134.1E	153-23	078-407
301800Z	20.8N	134.6E	186-59	087-382
310000Z	22.1N	136.4E	188-88	139-118
310600Z	23.0N	138.8E	221-110	228-162

AVERAGE 24 HOUR ERROR 117 MI
AVERAGE 48 HOUR ERROR 297 MI


24 HR FORECAST POSITS
TYPHOON TESS
24-31 MARCH 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
31/00Z
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
GUAM
SAIPAN
YAP
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
ENIWETOK ATOL
KWAJALEIN
WAKE I
FUMATAHACHI
NAURU

B. TYPHOON ALICE (170000Z-211200Z MAY 1961)

A VERY WEAK EASTERLY WAVE APPEARED TO HAVE PASSED GUAM AT 081200Z, PROVIDING A SLIGHT WIND SHIFT AND SHOWERS ALONG ITS TRACK. IT WAS ONE OF MANY TO TRAVEL THIS ROUTE AND HAD LITTLE APPARENT SIGNIFICANCE. BY THE TIME IT WAS 110 MI S OF MANILA AT 150600Z A CLOSED CIRCULATION EXISTED, THOUGH SOMEWHAT CONFUSED IN FORM, AND STILL AROUSED NO SUSPICION. BY 170000Z, HOWEVER, THE ASSOCIATED WIND PATTERN WAS SUFFICIENT TO WARRANT ISSUE OF A DEPRESSION WARNING. RECONNAISSANCE AT 170345Z INDICATED WINDS OF 35 KTS AT THE SURFACE, AND AN INDICATED SURFACE PRESSURE OF 988.0 MB. INTENSIFICATION OF TROPICAL DEPRESSION SIX TO TYPHOON STRENGTH WAS RAPID, OCCURRING BETWEEN 170000Z AND 171800Z.

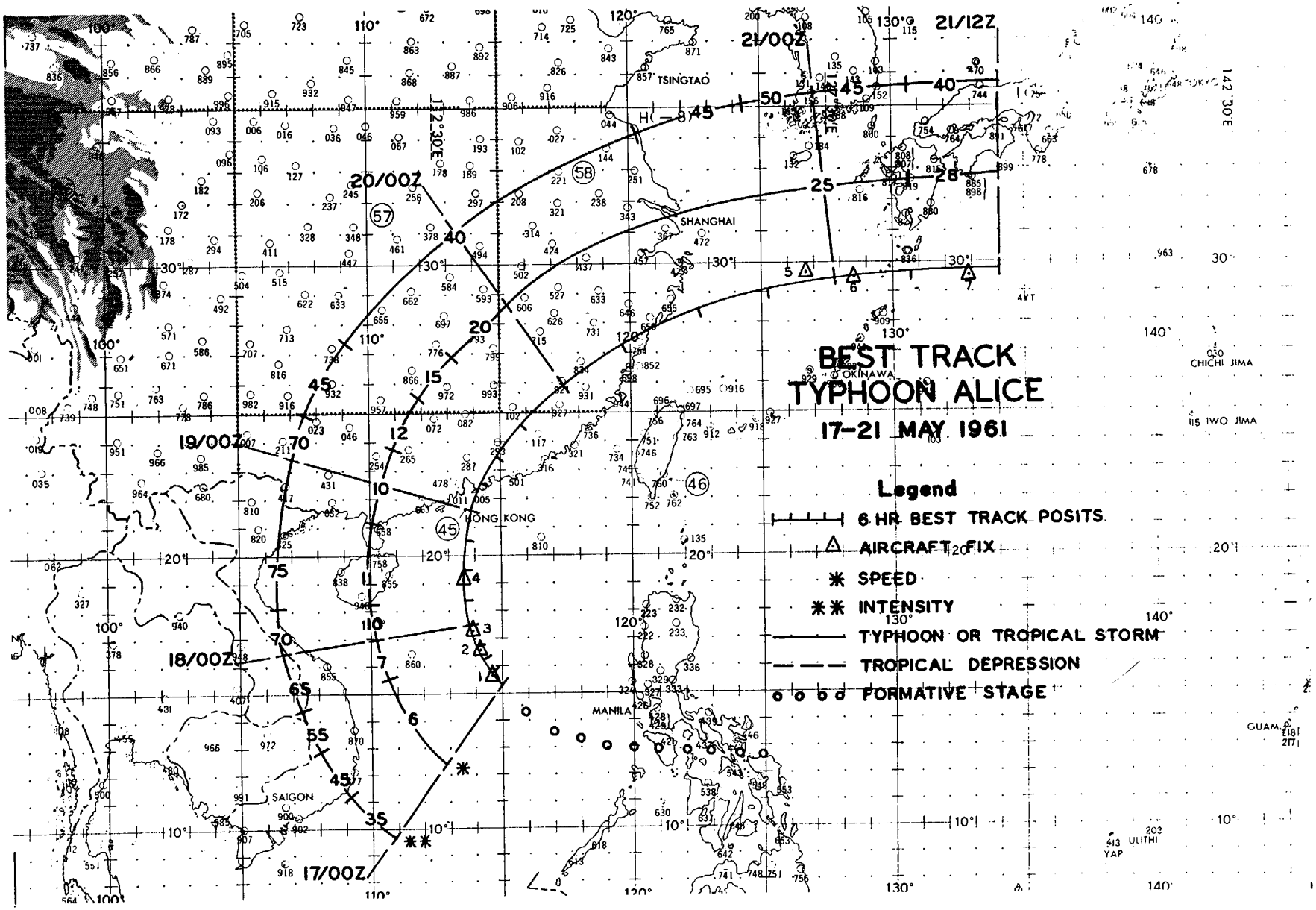
ALICE MOVED NORTHWARD TOWARD HONG KONG, AND INTENSIFIED TO A CIRCULATION WITH 75 KT SFC WINDS BY 180600Z. THE TYPHOON PASSED WITHIN 10 OR 15 MI TO THE W OF THE ROYAL OBSERVATORY AT HONG KONG AT 190500Z. AN UPPER WIND OBSERVATION MADE BY THE OBSERVATORY AT 190400Z, WHEN THE TYPHOON WAS A FEW MILES SW OF THE STATION, INDICATES THE CYCLONE TO HAVE EXTENDED THROUGH 40000 FT AS A CLOSED CIRCULATION.

ALICE DEPARTED THE ASIATIC MAINLAND AT 200800Z, AND WAS 105 MI S OF KAGOSHIMA, KYUSHU, JAPAN AT 210600Z. THE FINAL WARNING WAS ISSUED AT 211200Z WHEN ALICE WAS MOVING E AT 28 KTS. IT WAS IN ITS FINAL STAGES AS A TROPICAL CIRCULATION, RAPIDLY BECOMING EXTRATROPICAL.

WHILE IN THE SOUTH CHINA SEA, ALICE FOLLOWED A SMOOTH TRACK OF RECURVATURE AROUND THE WESTERN SIDE OF THE PACIFIC HIGH, THEN IT MOVED INTO THE WESTERLIES WHILE OVER THE ASIATIC MAINLAND.

ALICE TRAVELED 1660 MI IN 4 AND ONE HALF DAYS AT AN AVERAGE SPEED OF 15.4 KTS OR 368 MI PER DAY. THE CYCLONE MOVED AT A MINIMUM SPEED OF 6 KTS FROM 170000Z TO 171800Z AND AT A MAXIMUM SPEED OF 28 KTS FROM 210600Z TO 211200Z. TYPHOON ALICE WAS AT ITS GREATEST INTENSITY (75 KTS) FROM 180600Z TO 190000Z.

THE AREAS AFFECTED BY ALICE WERE THE SOUTH CHINA SEA, HONG KONG, AND THE ASIATIC MAINLAND. WHILE ALICE WAS IN THE SOUTH CHINA SEA, A PHILIPPINE FISHING VESSEL, DE LA PAZ, WAS SUNK AS A RESULT OF THE HIGH WINDS AND SEAS CREATED BY THE TROPICAL CYCLONE. HONG KONG SUFFERED 4 DEAD AND 20 INJURED; HEAVY RAINS AND STRONG WINDS DESTROYED CROPS ON 321,000 ACRES OF LAND OF THE CHEKIANG PROVINCE ON THE ASIATIC MAINLAND.


BEST TRACK
TYPHOON ALICE
17–21 MAY 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
21/12Z
21/00Z
20/00Z
19/00Z
18/00Z
17/00Z
TSINGTAO
SHANGHAI
HONG KONG
MANILA
SAIGON
OKINAWA
CHICHI JIMA
IWO JIMA
GUAM
YAP
ULITHI
142.30°E
132.30°E

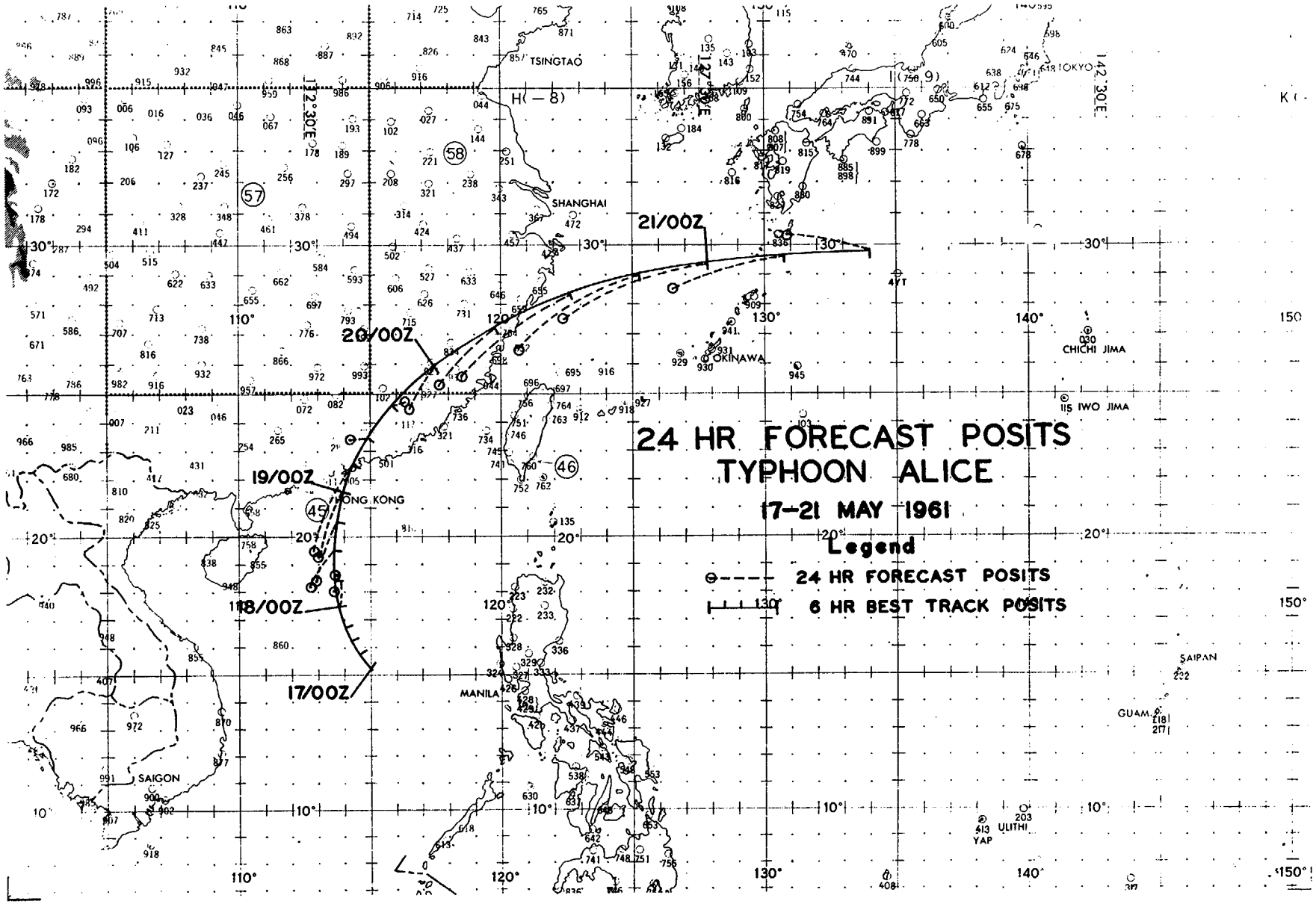
LAND RADAR AND AIRCRAFT FIXES - TYPHOON ALICE

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/Td (°C)	EYE CHARACTERISTICS
1	170345Z	15.5N	114.8E	56-P-02	35	25	9920	988	14/09	CIRC DIA 50 MI WALL CLDS E & N
2	172130Z	16.8N	114.2E	VW1-U-U	---	---	----	---	-----	----------
3	172230Z	17.2N	114.0E	56-P-02	65	60	9730	985	13/09	CIRC DIA 30 MI WALL CLDS OPEN W
4	181000Z	19.1N	113.7E	VW1-R-10	---	---	----	---	-----	EYE WELL DEFINED DIA 38 MI
5	202230Z	29.8N	126.9E	56-P-05	---	50	9860	997	08/08	EYE NOT DEFINED
6	210300Z	29.6N	128.6E	56-P-02	---	45	----	---	-----	EYE NOT DEFINED NO WALL CLDS
7	210910Z	29.7N	133.0E	56-P-05	35	60	9930	998	10/09	DIFFUSE OPEN S & W

TYPHOON ALICE 17-21 MAY 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
170000Z	15.2N	115.0E	-------	-------
170600Z	15.7N	114.7E	-------	-------
171200Z	16.2N	114.4E	-------	-------
171800Z	16.7N	114.2E	-------	-------
180000Z	17.3N	114.0E		-------
180600Z	18.3N	113.8E	195-23	-------
181200Z	19.5N	113.7E	209-94	-------
181800Z	20.5N	113.8E	200-140	-------
190000Z	21.6N	113.9E	200-151	-------
190600Z	22.5N	114.1E	201-200	186-157
191200Z	23.6N	114.8E	244-38	213-286
191800Z	24.7N	115.8E	070-27	213-385
200000Z	25.9N	117.5E	212-103	219-440
200600Z	27.3N	119.9E	232-165	226-576
201200Z	28.3N	122.5E	233-267	233-258
201800Z	29.2N	125.2E	235-288	229-218
210000Z	29.6N	128.0E	247-330	242-443
210600Z	29.8N	130.8E	253-237	250-463
211200Z	29.8N	134.1E	277-168	256-557

AVERAGE 24 HOUR ERROR 159 MI
AVERAGE 48 HOUR ERROR 378 MI


24 HR FORECAST POSITS
TYPHOON ALICE
17–21 MAY 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
21/00Z
20/00Z
19/00Z
18/00Z
17/00Z
TSINGTAO
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
SAIGON
YAP
ULITHI
GUAM
SAIPAN
TOKYO
H(−8)
H(+9)
122°30'E
142°30'E

C. TYPHOON BETTY (220600Z-281200Z MAY 1961)

THE ORIGIN OF TYPHOON BETTY, UNLIKE MANY OTHER TROPICAL CYCLONES, CANNOT BE TRACED EASTWARD IN TERMS OF STATION PASSAGE TO ITS INCEPTION AS A CLOSED VORTEX. AVAILABLE DATA INDICATES THAT BETTY BECAME A CLOSED VORTEX BEFORE 201200Z S OF KOROR. THE 24 HOUR PRESSURE TENDENCY FALLS FROM MAJURO TO KOROR THAT FREQUENTLY PRECEDE THE DEVELOPMENT OF STRONG TROPICAL CYCLONES COMMENCED AT ABOUT 180600Z. THESE FALLS CEASED AT MAJURO AFTER 190600Z, AFTER 210900Z AT GUAM AND AFTER 211200Z AT KOROR. THE 201200Z SURFACE STREAMLINE CHART INDICATED A VORTEX BETWEEN KOROR AND THE EQUATOR WHICH MOVED SLOWLY NW AND PASSED KOROR AFTER 201200Z. PRIOR TO 201200Z ONLY AN E-W ELONGATED PRESSURE TROUGH EXISTED N OF THE EQUATOR FROM W OF KOROR TO KUSAI.

RECONNAISSANCE INTO THE CIRCULATION PROVIDED DATA TO ISSUE A TROPICAL STORM WARNING AT 220600Z, INDICATING 60 KT SURFACE WINDS NEAR THE CENTER. THE FIRST TYPHOON WARNING WAS ISSUED AT 221200Z.

AFTER THE FIRST WARNING BETTY MOVED NW TOWARD TAIWAN AT AN AVERAGE SPEED OF 10 KTS WITH THE RATE OF INTENSIFICATION OF SURFACE WINDS AVERAGING 5 KTS PER 6 HOURS. PEAK INTENSITY OF 130 KTS WAS REACHED AT 251200Z. THE TYPHOON PASSED LESS THAN 10 MI WSW OF BATAN ISLAND, ABOUT 120 MI N OF LUZON, JUST AFTER 252100Z. AT THIS TIME THE SURFACE WIND SPEEDS OF THE CIRCULATION WERE 125 KTS. THE HIGHEST REPORTED WINDS BY OBSERVATION AT BATAN WERE 100 KTS AT 251900Z. THE ANEMOMETER WAS CARRIED AWAY SHORTLY THEREAFTER. THE MINIMUM PRESSURE BY OBSERVATION WAS 957.5 MB AT 252100Z, JUST BEFORE THE CENTER OF THE EYE PASSED BATAN. AIRCRAFT RECONNAISSANCE AT 252320Z INDICATED THE MINIMUM PRESSURE TO BE 950 MB IN THE CENTER OF BETTY, WHICH WAS LESS THAN 20 MI FROM BATAN AT THAT TIME. THE TYPHOON "LANDED" ABOUT MIDWAY OF THE E COAST OF TAIWAN AT 261600Z WITH WIND SPEEDS OF 90 KTS. IT MOVED ACROSS THE ISLAND IN A NNW DIRECTION AT AN AVERAGE SPEED OF 18 KTS. THE LAND MASS EFFECTIVELY DESTROYED THE EYE OF THE TYPHOON AS SUCH, AND REDUCED THE MAXIMUM SURFACE WINDS AROUND BETTY TO 60 KTS. BETTY MOVED IN AN EASTERLY DIRECTION FOR THE FIRST TIME JUST AFTER 270000Z. THE STORM SKIRTED THE ASIATIC MAINLAND UNTIL IT REACHED 32N THEN VEERED SHARPLY NE AND MOVED INTO KOREA JUST N OF CHEJU-DO AT 280800Z. THE LAST WARNING WAS ISSUED AT 281200Z AS IT WAS RAPIDLY BECOMING EXTRATROPICAL. SHORTLY THEREAFTER IT BECAME IMBEDDED AT THE SURFACE IN A RAPIDLY INTENSIFYING EXTRATROPICAL CYCLONE AND LOST ITS IDENTITY.

THE PATH FORMED BY THE MOVEMENT OF BETTY IS FAIRLY TYPICAL OF THE TRACK CREATED AS A RESULT OF THE RIDGE LINE MOVING N DURING THE LIFE CYCLE OF A TYPHOON. THE 500 MB RIDGE MOVED FROM 20N AT 221200Z TO 24N AT 241200Z. A TRANSIENT ANTICYCLONE FORMED JUST WNW OF SHANGHAI ON 25 MAY, CREATING THE EFFECT OF FURTHER NORTHWARD MOVEMENT OF THE RIDGE LINE. THESE FACTORS TENDED TO CAUSE THE CONTINUED NORTHERLY MOVEMENT OF BETTY RATHER THAN RECURVATURE AT 18 TO 20 DEGREES N AS MIGHT HAVE BEEN EXPECTED OTHERWISE. AFTER THE TRANSIENT ANTICYCLONE MOVED EASTWARD OVER JAPAN, BETTY CURVED SHARPLY BEHIND IT AND MOVED TO THE NE.

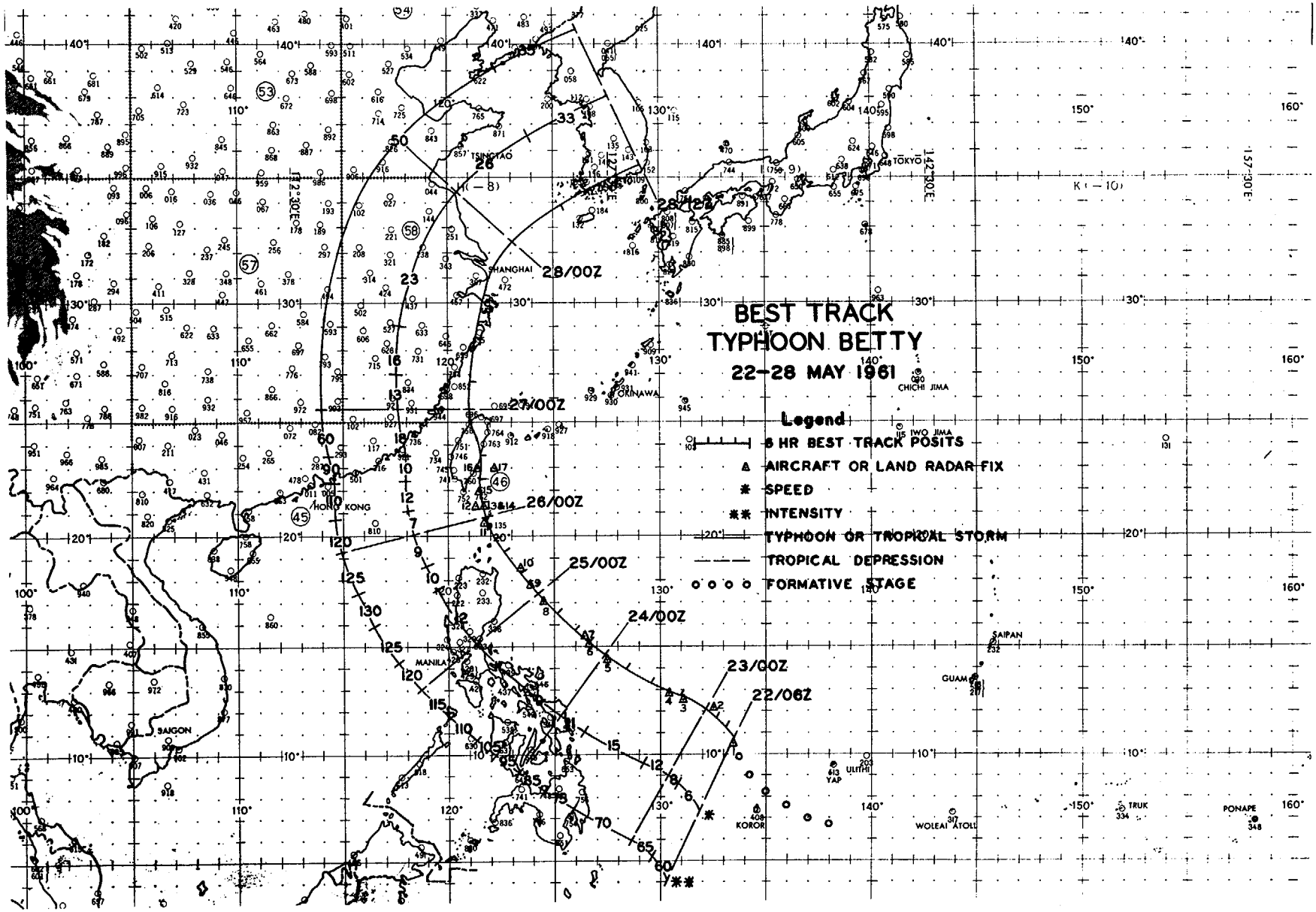
TYPHOON BETTY EXTENDED THOUGH THE 200 MB LEVEL AT 261200Z WHILE NEAR TAIWAN.

EACH YEAR ONE OR TWO UNUSUAL REPORTS OF CONCENTRIC EYES ARE MADE BY THE RECONNAISSANCE OBSERVERS. ONE REPORT WAS MADE ON TYPHOON BETTY AT 230500Z, THE TIME OF THE THIRD RECONNAISSANCE FIX AND IS QUOTED HERE: "VULTURE 0311 BETTY SIX EYE DATA REPORT PSN ONE TWO PT SIX NORTH AT ONE THREE ONE PT ONE EAST AT ZERO FIVE ZERO ZERO ZULU BASIS FOR FIX WIND CENTER FIX BY PENETRATION PSN BY LORAN ACCY 8 MI MAX OBSVD WNDS SFC 75K EAST QUAD MAX FLT LVL WND 55K EAST QUAD 700MB HT 9880FT XMTD SLP 984 MBS FLT LVL 673MB TEMP 11.5 DEGC DEW PT 2 DEGC TURB LIGHT ALL QUAD EYE WITHIN AN EYE DIA CIRCULAR DIA OF OUTER EYE 60 MILES DIA OF INNER EYE 20 MILES SC CLDS IN INNER EYE MOD RAIN ALL QUAD."

THERE ARE SOME INDICATIONS THAT THE WALL CLOUD SURROUNDING THE EYE OF A WELL DEVELOPED TYPHOON IS DETACHED FROM THE SPIRAL BANDS ASSOCIATED WITH THE TYPHOON, IF RADAR PICTURES MAY BE CONSIDERED EVIDENCE. THE POSSIBILITY THEN EXISTS THAT A SPIRAL BAND MAY COMPLETELY SURROUND THE WALL CLOUD FOR SHORT PERIODS OF TIME, THUS FORMING WHAT APPEARS TO BE THE OUTER CIRCULAR CLOUD PATTERN ASSOCIATED WITH THE PHENOMENA KNOWN AS A CONCENTRIC EYE.

TYPHOON BETTY TRAVELED 2025 MI IN THE 6 DAYS 6 HOURS THAT WARNINGS WERE ISSUED, AT AN AVERAGE SPEED OF 13.5 KTS. THE MINIMUM SPEED OF MOVEMENT, 6 KTS OCCURRED BETWEEN 220600Z AND 221800Z. THE MAXIMUM SPEED OF MOVEMENT, 33 KTS, OCCURRED BETWEEN 280600Z AND 281200Z. THE MAXIMUM SURFACE WIND SPEED OF 130 KTS OCCURRED BETWEEN 251200Z AND 251800Z.

THE AREAS AFFECTED BY BETTY WERE BATAN ISLAND, TAIWAN, THE ASIATIC MAINLAND JUST S OF SHANGHAI, AND KOREA. THE ONLY REPORTS AVAILABLE INDICATE EXTENSIVE CROP DAMAGE ON TAIWAN DUE TO FLOODING.


BEST TRACK
TYPHOON BETTY
22-28 MAY 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
23/00Z
22/06Z
TSINGTAO
SHANGHAI
HONG KONG
MANILA
SAIGON
OKINAWA
TOKYO
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOLL
TRUK
PONAPE

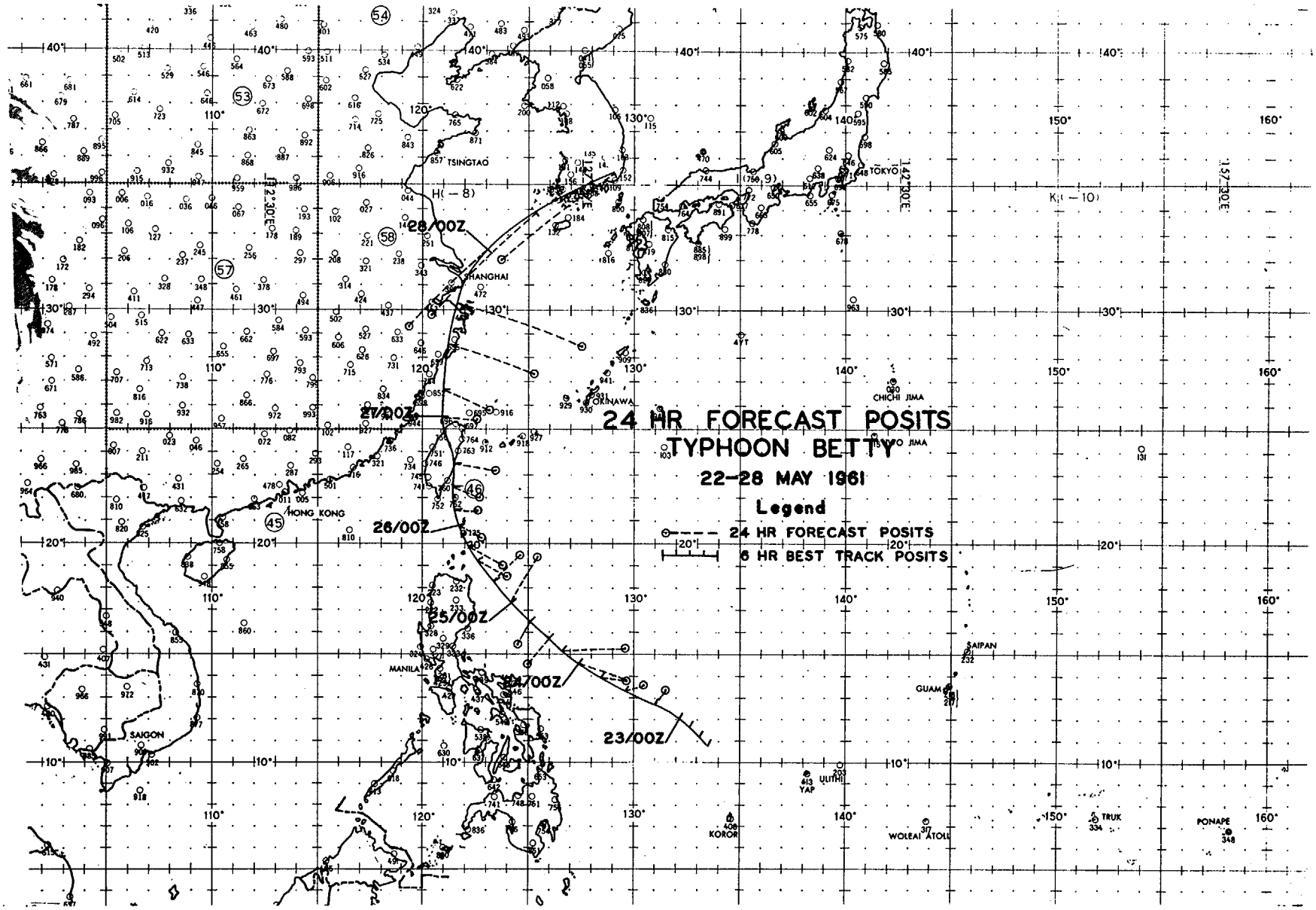
LAND RADAR AND AIRCRAFT FIXES - TYPHOON BETTY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	220451Z	10.6N	133.4E	56-P-05	70	45	9990	990	18/07	CIRC 20MI DIA
2	222106Z	12.1N	132.6E	56-P-15	50	52	9820	982	16/01	CIRC DIA 50MI FILLED WITH SC
3	230500Z	12.6N	131.1E	56-P-08	75	55	9880	984	13/04	DOUBLE EYE DIA INNER EYE 20MI OUTER EYE 60MI
4	230800Z	12.9N	130.4E	56-P-10	70	55	9890	990	08/--	CIRC DIA 20MI
5	232240Z	14.6N	127.6E	56-P-02	60	70	9390	970	16/08	CIRC DIA 50MI OPEN SW HVY WALL CLDS SE
6	240345Z	15.1N	126.8E	56-P-05	100	70	9240	971	15/06	CIRC DIA 60MI
7	240810Z	15.4N	126.5E	56-P-07	100	90	9190	968	17/13	CIRC DIA 25MI
8	242212Z	17.0N	124.6E	56-P-02	60	95	8780	954	17/07	CIRC DIA 40MI WELL DEFINED WALL CLDS ALL QUADS
9	250315Z	17.8N	124.0E	56-P-01	100	95	8610	946	17/06	CIRC DIA 30MI WALL CLDS ALL QUADS WELL DEFINED
10	250907Z	18.4N	123.6E	56-P-02	---	120	8630	947	21/10	CIRC DIA 20MI
11	252320Z	20.5N	121.8E	56-P-02	---	112	8730	950	20/09	CIRC DIA 45MI
12	260310Z	21.2N	121.3E	C-130-R-U	---	---	----	---	-----	DIA 20MI
13	260443Z	21.2N	121.5E	56-P-01	---	105	8760	956	18/16	CIRC DIA 40MI
14	260545Z	21.2N	121.5E	VW1-R-10	---	---	----	---	-----	----------
15	260845Z	21.9N	121.5E	56-P-01	---	90	8830	956	16/12	CIRC DIA 40MI
16	261400Z	23.0N	121.3E	LND/RDR	---	---	----	---	-----	----------
17	261415Z	23.0N	122.1E	LND/RDR	---	---	----	---	-----	----------

TYPHOON BETTY 22-28 MAY 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
220600Z	10.7N	133.5E	-------	-------
221200Z	11.2N	133.2E	-------	-------
221800Z	11.8N	132.8E	-------	-------
230000Z	12.2N	132.2E	-------	-------
230600Z	12.7N	131.0E	031-44	-------
231200Z	13.2N	129.6E	063-60	-------
231800Z	13.9N	128.3E	096-82	-------
240000Z	14.7N	127.5E	113-140	-------
240600Z	15.2N	126.8E	093-160	156-63
241200Z	15.7N	126.0E	221-90	193-70
241800Z	16.4N	125.1E	208-75	191-98
250000Z	17.2N	124.3E	026-136	133-130
250600Z	18.1N	123.6E	033-96	090-170
251200Z	19.1N	122.9E	121-75	127-82
251800Z	19.9N	122.2E	124-101	123-114
260000Z	20.7N	121.8E	123-62	063-334
260600Z	21.3N	121.5E	089-62	060-277
261200Z	22.5N	121.5E	114-80	121-154
261800Z	23.5N	121.4E	105-106	120-179
270000Z	25.3N	120.9E	090-97	110-190
270600Z	26.6N	121.0E	112-122	097-256
271200Z	28.2N	121.3E	106-208	096-325
271800Z	30.4N	121.8E	113-326	105-400
280000Z	32.5N	122.9E	225-270	112-441
280600Z	33.8N	125.5E	228-358	123-415
281200Z	35.4N	129.0E	236-382	131-421

AVERAGE 24 HOUR ERROR 142 MI
AVERAGE 48 HOUR ERROR 229 MI


24 HR FORECAST POSITS
TYPHOON BETTY
22-28 MAY 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
23/00Z
TSINGTAO
SHANGHAI
OKINAWA
HONG KONG
MANILA
SAIGON
TOKYO
CHICHI JIMA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOLL
TRUK
PONAPE

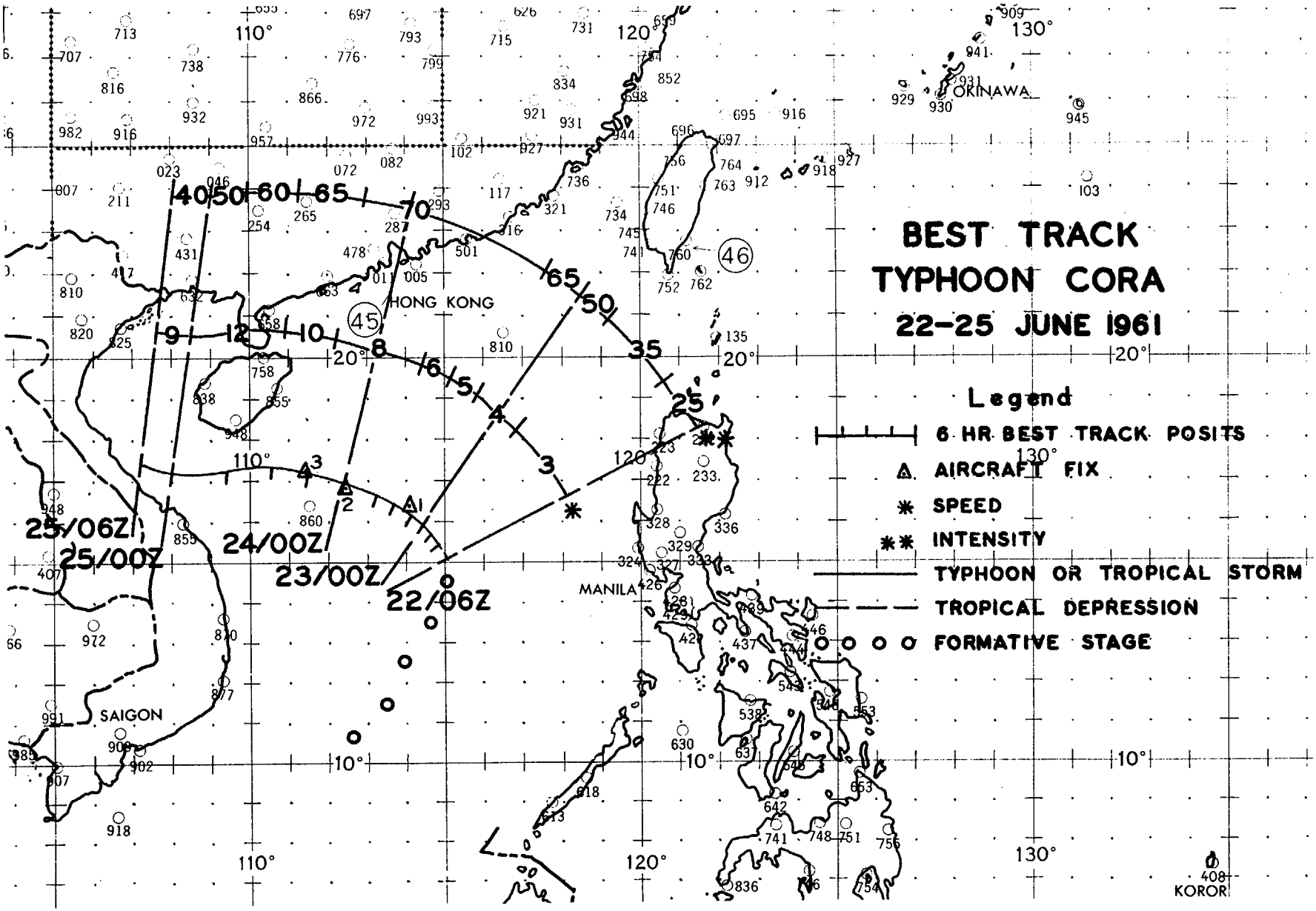
D. TYPHOON CORA (220600Z-250600Z JUNE 1961)

CORA DEVELOPED FROM THE WESTERNMOST OF A SERIES OF 1006 MB LOWS THAT FORMED A TROUGH FROM ABOUT 300 MI E OF SAIGON TO THE ISLAND OF MAJURO ON THE 190600Z SURFACE CHART. AT THIS TIME THE SURFACE PRESSURES ALONG THIS TROUGH BEGAN A SLOW DECREASE THAT RESULTED IN AN AVERAGE PRESSURE OF 1003 MB BY 220600Z, TIME OF THE FIRST WARNING AS A TROPICAL DEPRESSION TO BE LATER KNOWN AS TYPHOON CORA. THE CENTER PRESSURE OF CORA WAS APPROXIMATELY 995 MB AND THE SURFACE WINDS WERE 25 KTS AT THAT TIME.

THE 500 MB PATTERN AT TIME OF THE FIRST WARNING INDICATED THAT CORA EXISTED BETWEEN A WESTERLY FLOW NEAR THE EQUATOR AND AN ANTICYCLONE CENTERED NEAR 30N THAT SLOWLY MOVED S TO 27N DURING THE LIFE CYCLE OF CORA. MOVEMENT OF CORA NORTHWARD ACROSS THIS TROUGH ADDED AN EASTWARD COMPONENT TO THE NORTHERLY MOVEMENT OF THE LOW AT FIRST, AND LATER A WESTERLY COMPONENT THAT FINALLY BECAME THE PREDOMINANT DIRECTION OF MOVEMENT OF CORA AS IT INTENSIFIED TO TYPHOON STRENGTH AND MOVED TOWARD NORTH VIETNAM.

CORA WAS A WEAK TYPHOON WITH AN EYE VARYING FROM 40 TO 80 MI IN DIAMETER, AND HAD POORLY DEFINED WALL CLOUDS. THE FINAL WARNING WAS ISSUED WHEN CORA WAS 45 MI FROM THE POINT AT WHICH IT MOVED INLAND, 75 MI S OF VINH ALONG THE COAST OF VIETNAM.

CORA TRAVELED 500 MI DURING THE 3 DAYS THAT WARNINGS WERE ISSUED AT AN AVERAGE SPEED OF 6.9 KTS OR AT AN AVERAGE MOVEMENT OF 167 MI PER DAY. THE CYCLONE MOVED AT A MINIMUM SPEED OF 3 KTS BETWEEN 220600Z AND 221800Z; AT A MAXIMUM SPEED OF 12 KTS BETWEEN 241200Z AND 250000Z, AND HAD MAXIMUM SURFACE WIND SPEEDS OF 70 KTS BETWEEN 230600Z AND 240600Z. DAMAGE REPORTS WERE NOT RECEIVED BY JTWC, HOWEVER POSSIBLE DAMAGE COULD HAVE OCCURRED TO SHIPPING OR SMALL ISLANDS.


BEST TRACK
TYPHOON CORA
22–25 JUNE 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
HONG KONG
MANILA
SAIGON
OKINAWA
KOROR
25/06Z
25/00Z
24/00Z
23/00Z
22/06Z
110°
120°
130°
20°
10°

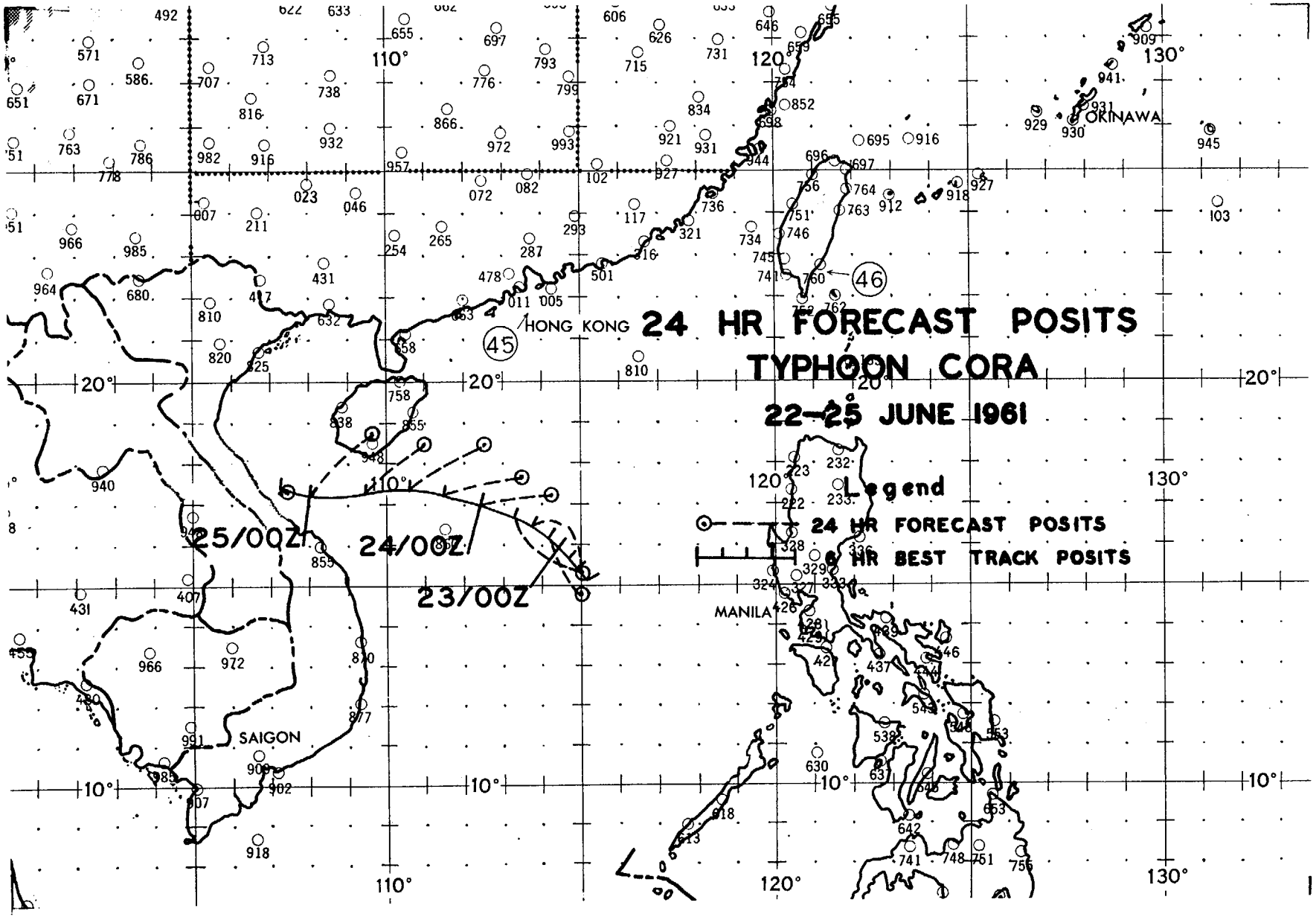
LAND RADAR AND AIRCRAFT FIXES - TYPHOON CORA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	230705Z	16.3N	114.1	56-P-05	80	42	9910	991	13/09	POORLY DEFINED WALL CLD W QUAD CIRC DIA 40MI
2	232355Z	16.9N	112.4E	56-P-01	65	30	9830	989	14/09	CIRC DIA 80MI POORLY DEFINED
3	240315Z	17.1N	111.5E	56-P-1/2	75	45	9800	987	15/08	CIRC DIA 80MI WALL CLDS S & W QUADS OPEN E & N

TYPHOON CORA 22-25 JUNE 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
220600Z	15.2N	115.1E	-------		-------	
221200Z	15.5N	114.9E	-------		-------	
221800Z	15.8N	114.8E	-------		-------	
230000Z	16.0N	114.6E	-------		-------	
230600Z	16.3N	114.2E	-------		-------	
231200Z	16.4N	113.8E	-------		-------	
231800Z	16.7N	113.2E	-------		-------	
240000Z	16.9N	112.3E	-------		-------	
240600Z	17.2N	111.6E	065-	115	-------	
241200Z	17.3N	110.6E	062-	153	-------	
241800Z	17.2N	109.3E	048-	131	-------	
250000Z	17.1N	108.0E	042-	141	-------	
250600Z	17.4N	107.1E	122-	26	054-	278

AVERAGE 24 HOUR ERROR 113 MI
AVERAGE 48 HOUR ERROR 278 MI


24 HR FORECAST POSITS
TYPHOON CORA
22–25 JUNE 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
25/00Z
24/00Z
23/00Z
HONG KONG
MANILA
SAIGON
OKINAWA
45
46
110°
120°
130°
20°
10°

E. TYPHOON ELSIE (121200Z-150600Z JULY 1961)

ELSIE BECAME A CLOSED VORTEX ABOUT 360 MI NE OF TRUK ON THE 031200Z SURFACE CHART WITH A CENTER PRESSURE NOT LOWER THAN 1009 MB, A RATHER HIGH MINIMUM PRESSURE VALUE IN THE TROPICS. THIS WEAK CYCLONE MEANDERED 2300 MI AT AN AVERAGE SPEED OF 10 KTS IN THE EASTERLIES BEFORE A WARNING WAS ISSUED.

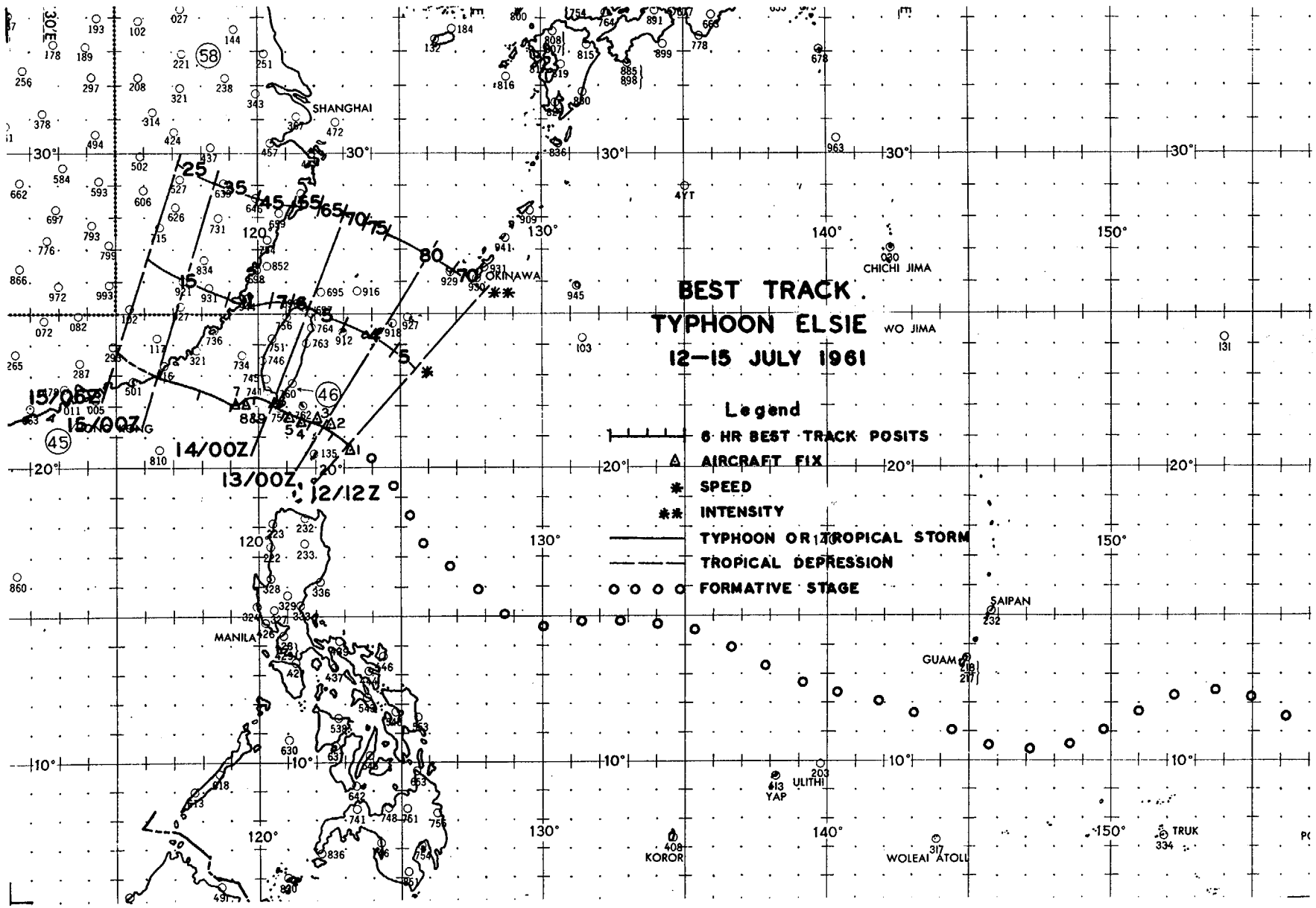
THE FIRST WARNING WAS ISSUED AFTER RECONNAISSANCE HAD DETERMINED THE POSITION OF THE CIRCULATION, AND THE FACT THAT IT HAD WALL CLOUDS. THE SURFACE WIND SPEEDS OF THE TYPHOON INTENSIFIED TO A MAXIMUM OF 80 KTS AND IT CONTINUED TO MOVE TOWARD THE S TIP OF TAIWAN, STRIKING LAND THERE AT 132000Z WITH SUSTAINED SURFACE WINDS OF 70 KTS. THE TRACK AND CONTINUED WESTERLY MOVEMENT OF ELSIE CONFIRMED THE RULE OF THUMB INDICATED BY LT. COLONEL HSU YING-CHIN, IN "THE PROBLEM OF TYPHOON FORECASTING OVER TAIWAN AND ITS VICINITY," THAT IF A STATIONARY LEEWARD INDUCED LOW FORMS NEAR TAICHUNG (46751) AND INTENSIFIES, THE TYPHOON WILL NOT RECURVE. THE INDUCED LOW BEGAN FORMING AS EARLY AS 130000Z AND WAS WELL ESTABLISHED BY TIME OF LAND STRIKE ON TAIWAN. THE TYPHOON DID NOT RECURVE.

ELSIE GRADUALLY WEAKENED AFTER PASSING TAIWAN, MOVED ACROSS THE SOUTHERN APPROACH TO TAIWAN STRAIT AND ENTERED THE ASIATIC MAINLAND 125 MI ENE OF HONG KONG. THE 35 KT SURFACE WINDS THAT EXISTED AT TIME OF LAND STRIKE RAPIDLY WEAKENED TO 15 KTS. THE LAST WARNING WAS ISSUED AT 150600Z WHEN THE CYCLONE WAS 90 MI INLAND, AND 105 MI NE OF HONG KONG.

THE USE OF EXTRAPOLATION, CLIMATOLOGY AND THE 500 MB CHART PROVIDED THE BEST GUIDE FOR FORECASTING THE VELOCITY OF ELSIE. THE 500 MB SPACE MEAN CHART WAS OF LITTLE USE UNTIL 14 JULY, AND THE 200 MB CHART SUGGESTED A MORE SOUTHERLY MOVEMENT THAN THAT WHICH OCCURRED. A TROPICAL CYCLONE OF 23-24 JULY 1944 WAS USED AS A CLIMATOLOGY MODEL.

LIMITED DATA INDICATED THAT ELSIE EXTENDED UPWARD THROUGH THE 40,000 FT LEVEL A FEW HOURS BEFORE PASSING ACROSS THE S TIP OF TAIWAN. THE TYPHOON MOVED 495 MI DURING THE 2 DAYS AND 18 HOURS THAT WARNINGS WERE ISSUED AT AN AVERAGE SPEED OF 7.5 KTS OR 180 MI PER DAY. ELSIE MOVED AT A MINIMUM SPEED OF 4 KTS BETWEEN 121800Z AND 131200Z; AT A MAXIMUM SPEED OF 15 KTS BETWEEN 141800Z AND 150600Z, AND HAD A MAXIMUM SURFACE WIND SPEED OF 80 KTS BETWEEN 121800Z AND 131200Z.

ELSIE CAUSED DAMAGE ON TAIWAN AND THE ASIATIC MAINLAND. STRONG WINDS AND HEAVY RAINS CAUSED SOME CROP DAMAGE, LOSS OF SEVERAL POWER LINES, AND LEFT 345 PERSONS HOMELESS. THE PINGTUNG AREA WAS HARDEST HIT AND ONE MAN WAS REPORTED DROWNED THERE. ONE TAIWANESE MAN WAS ALSO REPORTED DROWNED WHEN HE ATTEMPTED TO CROSS A SWOLLEN STREAM AND FELL INTO THE WATER NEAR HIS HOME IN JUALIEN. INFORMATION IS NOT AVAILABLE CONCERNING DAMAGE ON THE ASIATIC MAINLAND.


BEST TRACK
TYPHOON ELSIE
12–15 JULY 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
SHANGHAI
OKINAWA
CHICHI JIMA
WO JIMA
HONG KONG
MANILA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOLL
TRUK
15/06Z
15/00Z
14/00Z
13/00Z
12/12Z

LAND RADAR AND AIRCRAFT FIXES - TYPHOON ELSIE

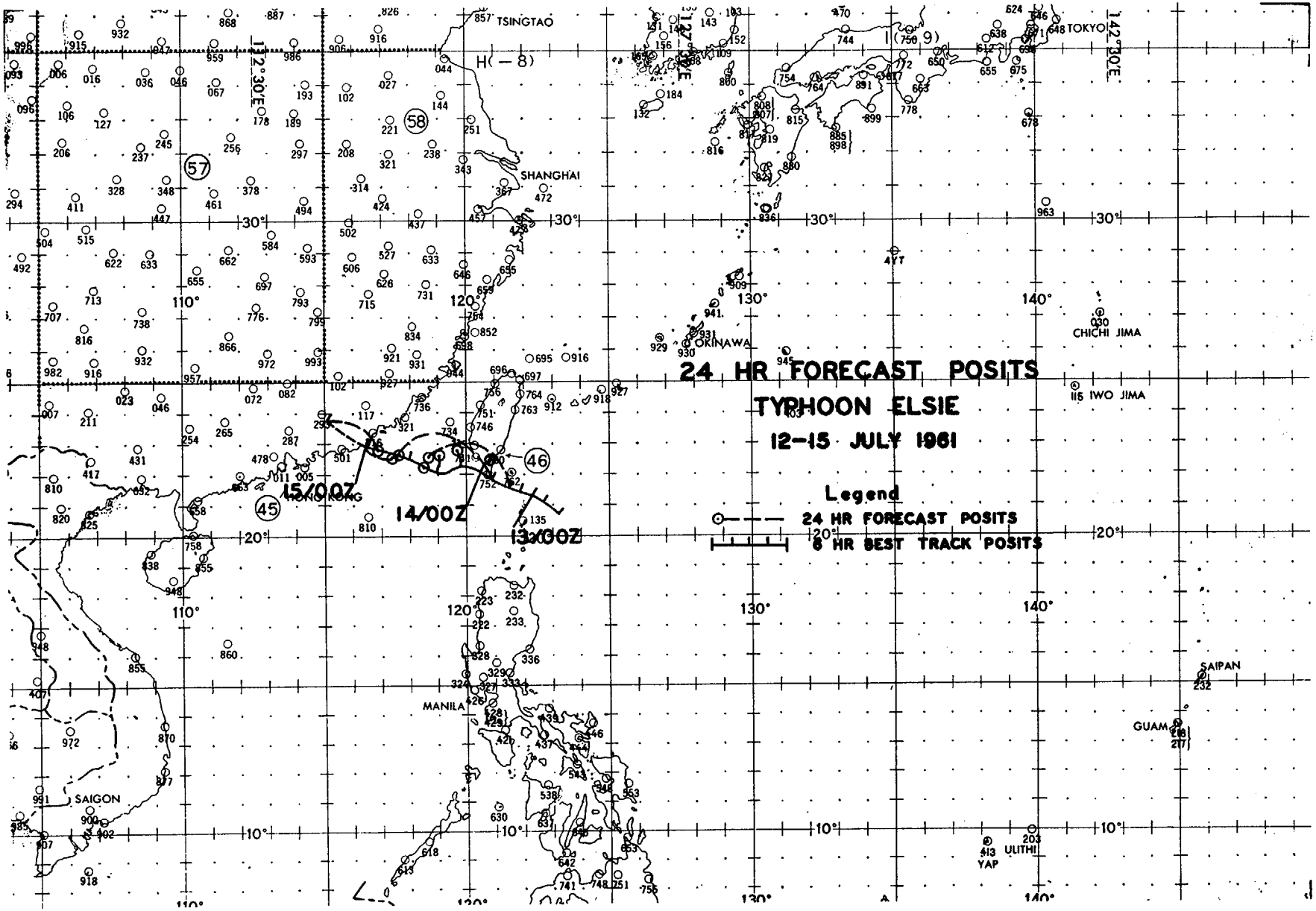
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/Td (°C)	EYE CHARACTERISTICS
1	120810Z	20.7N	123.2E	VW1-R-10	---	---	----	---	-----	DIA 70MI
2	122245Z	21.3N	122.7E	56-P-04	100	75	9680	986	13/13	NOT DEFINED ON RADAR
3	130330Z	21.5N	122.1E	56-P-03	75	40	9420	974	16/11	CIRC 35MI DIA POORLY DEFINED
4	130930Z	21.6N	121.6E	56-P-03	100	60	9430	975	16/16	ELLIP DIA 18MI SSW-NNE & 10MI WNW-ESE WALL CLDS ALL QUADS
5	131530Z	21.7N	121.1E	VW1-R-02	---	---	----	---	-----	DIA 45MI SPIRAL BANDS 160MI DIA ALL QUADS EXCEPT NE
6	132200Z	22.1N	120.7E	56-P-01	90	*60	*18500	---	*01/01	DIA 30MI
7	140400Z	22.0N	119.2E	56-P-05	---	*60	9840	986	12/11	DIA 40MI
8	140937Z	22.0N	119.5E	56-P-15	25	35	9860	990	11/11	NOT WELL DEFINED NO WALL CLDS
9	141610Z	22.0N	119.5E	VW1-R-U	---	---	----	---	-----	NO EYE VISIBLE NORTH SEMICIRC APPEARS CLEAR.

*500MB DATA.

TYPHOON ELSIE 12-15 JULY 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
121200Z	20.8N	123.1E	-------		-------	
121800Z	21.2N	122.7E	-------		-------	
130000Z	21.4N	122.3E	-------		-------	
130600Z	21.6N	121.8E	-------		-------	
131200Z	21.7N	121.4E	290	164	-------	
131800Z	21.8N	120.9E	286	196	-------	
140000Z	22.2N	120.5E	042	23	-------	
140600Z	22.2N	119.8E	339	44	-------	
141200Z	21.9N	119.1E	348	34	288	265
141800Z	22.4N	118.0E	119	31	283	260
150000Z	22.9N	116.4E	121	62	076	89
150600Z	23.9N	115.1E	124	118	105	79

AVERAGE 24 HOUR ERROR 84 MI
AVERAGE 48 HOUR ERROR 173 MI


24 HR FORECAST POSITS
TYPHOON ELSIE
12-15 JULY 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
15/00Z
14/00Z
13/00Z
TSINGTAO
SHANGHAI
TOKYO
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
SAIGON
SAIPAN
GUAM
YAP
ULITHI
112°30'E
127°30'E
142°30'E
110°
120°
130°
140°
10°
20°
30°

F. TYPHOON HELEN (270600Z JULY - 031800Z AUGUST 1961)

A SMALL LOW BOUNDED BY A 1006 MB ISOBAR WAS NOTED AT 8.0N 150.0E ON THE 210600Z SURFACE CHART. THIS CIRCULATION MOVED W AND PASSED 150 MI S OF GUAM JUST AFTER 221800Z, AND THEN PASSED INTO THE LARGE TROUGH THAT EXTENDED FROM THE ASIATIC MAINLAND INTO THE PACIFIC OCEAN TOWARD GUAM. THE TROUGH THEN INTENSIFIED AND A CLOSED CIRCULATION FORMED THAT WAS FIRST OBSERVED ON THE 251200Z SURFACE CHART. THIS CIRCULATION DEEPENED AND FINALLY BECAME TYPHOON HELEN. THE FIRST WARNING WAS ISSUED AT 270600Z CLASSIFYING HELEN AS A STORM BASED ON WEATHER RECONNAISSANCE. HELEN BECAME A TYPHOON AT 280000Z, CONTINUED MOVING SLOWLY NNW TO NEAR 28.0N AND 129.8E WHERE IT LOOPED AND THE SURFACE WIND SPEEDS DECREASED FROM 80 KTS TO 45 KTS. THE LOOP OCCURRED AROUND AMAMI-O-SHIMA (47909), THUS WITH RECONNAISSANCE AND THE LAND STATION, SUFFICIENT DATA WAS AVAILABLE TO RECORD THE DIRECTION AND SPEED OF MOVEMENT. THE CYCLONIC LOOP WAS 20 BY 40 MI, ORIENTED WNW, AND REQUIRED ABOUT 24 HOURS TO COMPLETE. UPON COMPLETION OF THE LOOP, HELEN CONTINUED ALONG A NNW TRACK MISSING KYUSHU BY MOVING 35 MI TO THE W. THE TROPICAL STORM PASSED ONTO KOREA AT 021600Z ABOUT 60 MI WSW OF PUSAN, MOVED UP THE PENINSULA, TURNED TO THE NE AND DEPARTED THE COAST 45 MI SE OF WONSAN AT ABOUT THE TIME OF THE LAST WARNING, 031800Z. HELEN DID NOT REGAIN ITS INTENSITY AFTER LOOPING, BUT CONTINUED TO SLOWLY WEAKEN AND BECAME A TROPICAL DEPRESSION AT 030000Z.

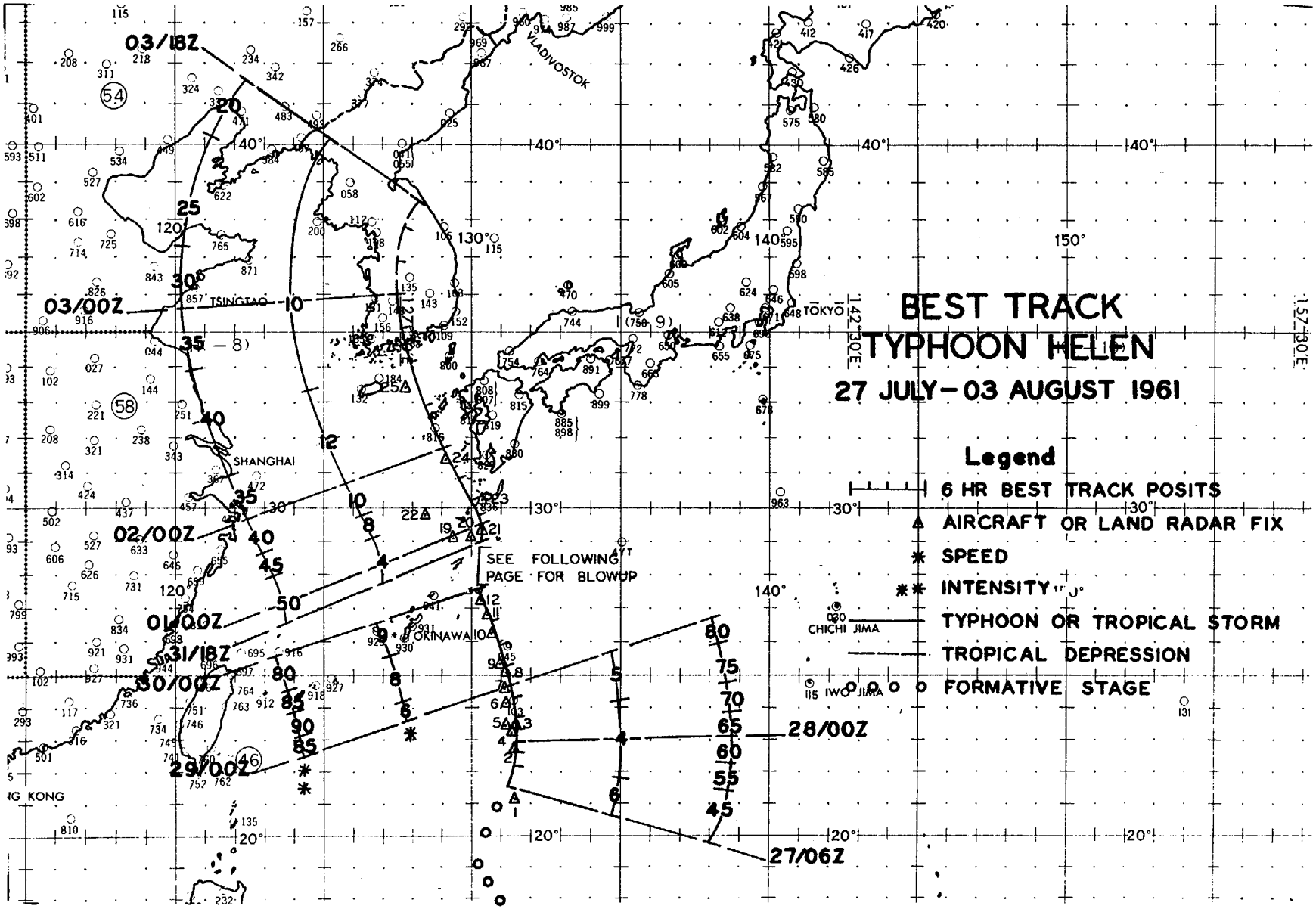
THE SYNOPTIC SITUATION RELATING TO TYPHOON HELEN CAN BEST BE INDICATED BY DESCRIBING THE 500 MB SPACE MEAN CHART AND THE MOVEMENT OF THE ASSOCIATED ANTICYCLONE NE OF HELEN DURING ITS LIFE CYCLE. A SIMILAR SITUATION OCCURRED WITH SEVERAL OTHER CYCLONES AND WILL BE REFERRED TO IN THE NARRATIVE OF OTHER TYPHOONS. THIS DESCRIPTION ALSO SATISFIES THE ACTIVITY THAT TRANSPIRED AT THE 200 MB LEVEL DURING THIS TIME INTERVAL. AT THE TIME OF ISSUE OF THE FIRST WARNING ON HELEN, AN ANTICYCLONE EXISTED NEAR 35N 150E WITH A TROUGH OVER THE ASIATIC MAINLAND ROUGHLY ALONG 110E. BY 280000Z THE ANTICYCLONE HAD MOVED SLIGHTLY E TO 32N 157E. TWENTY-FOUR HOURS LATER A WESTERLY MOVEMENT COMMENCED AND CONTINUED UNTIL THE ANTICYCLONE REACHED 30N 134E AT 040000Z. A SMALL RIDGE OF VARYING INTENSITY EXISTED IN THE SOUTH CHINA SEA DURING THIS PERIOD OF TIME. HELEN MOVED SLIGHTLY W OF N AS IT PASSED AROUND THE WESTERN SIDE OF THE PACIFIC ANTICYCLONE E OF JAPAN.

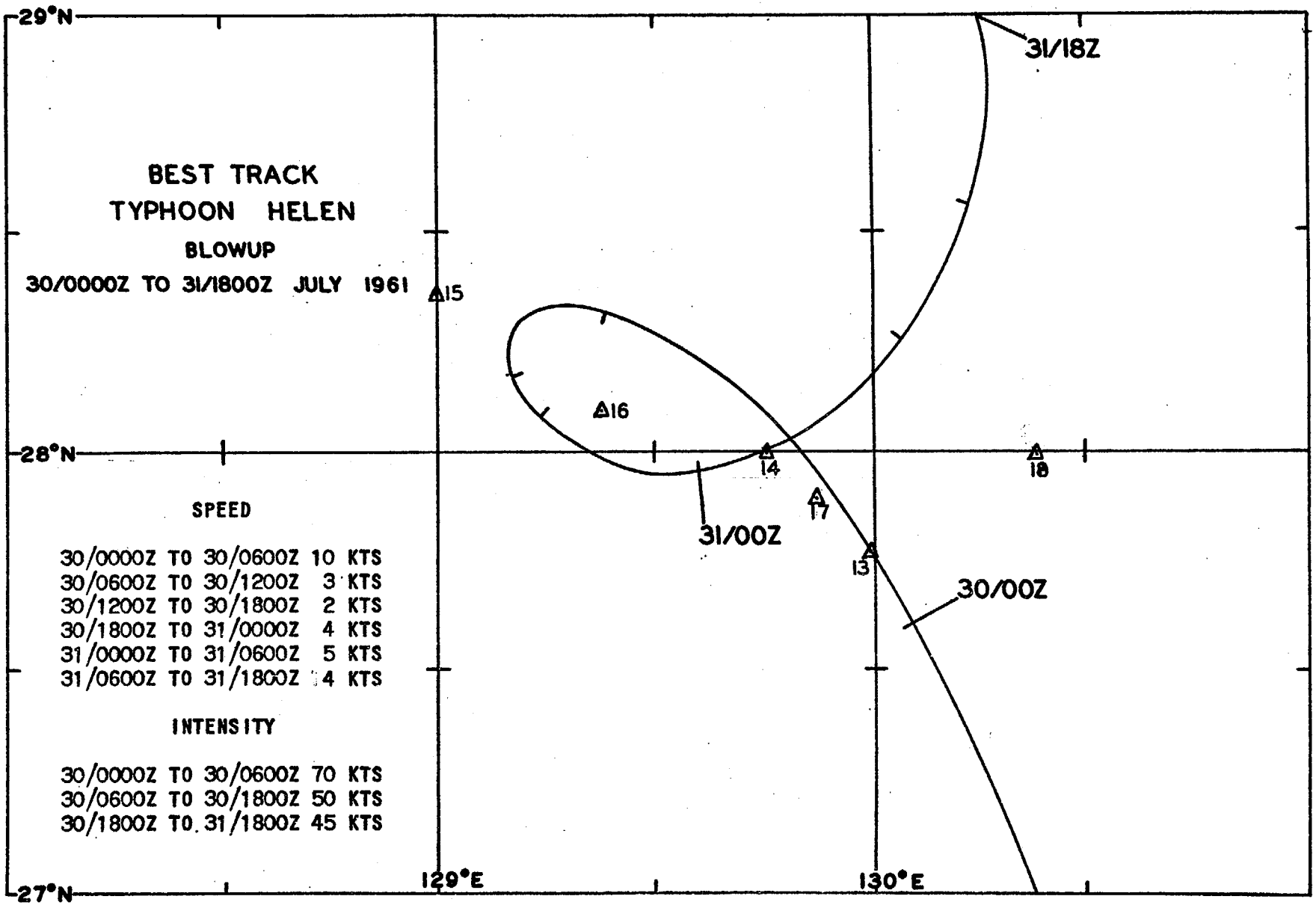
WITH THE EXCEPTION OF THE LOOP, HELEN CREATED NO FORECAST PROBLEMS OF AN UNUSUAL NATURE. THE TWO TYPHOONS, HELEN AND IDA, BETTER KNOWN AS THE TWINS, CREATED FORECAST DIFFICULTIES THAT WILL BE DISCUSSED IN THE IDA NARRATIVE.

TYPHOON HELEN TRAVELED 1195 MI IN 7 AND ONE HALF DAYS AT AN AVERAGE SPEED OF 6.6 KTS OR 159 MI PER DAY, FROM FIRST TO LAST WARNING. THE MINIMUM SPEED WAS 2 KTS BETWEEN 301200Z AND 301800Z; THE MAXIMUM SPEED WAS 12 KTS BETWEEN 020000Z AND 021200Z. THE MAXIMUM

SURFACE WIND WAS 90 KTS BETWEEN 290600Z AND 291200Z.

AMAMI-O-SHIMA AND OTHER ISLANDS NEARBY WERE THE ONLY AREAS AFFECTED BY HELEN, EVEN THOUGH THE TYPHOON WAS NEAR KYUSHU AND EVENTUALLY PASSED ONTO KOREA. THE TYPHOON IS REPORTED TO HAVE INUNDATED ABOUT 2,000 HOUSES, CAUSED TWO DEATHS AND SEVERAL INJURIES ON THESE ISLANDS JUST S OF KYUSHU.


BEST TRACK
TYPHOON HELEN
27 JULY – 03 AUGUST 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
03/18Z
03/00Z
02/00Z
01/00Z
31/18Z
30/00Z
29/00Z
28/00Z
27/06Z
SEE FOLLOWING PAGE FOR BLOWUP
SHANGHAI
TSINGTAO
TOKYO
OKINAWA
CHICHI JIMA
IWO JIMA
VLADIVOSTOK
142.3°E
157.3°E


BEST TRACK
TYPHOON HELEN
BLOWUP
30/0000Z TO 31/1800Z JULY 1961
SPEED
30/0000Z TO 30/0600Z 10 KTS
30/0600Z TO 30/1200Z 3 KTS
30/1200Z TO 30/1800Z 2 KTS
30/1800Z TO 31/0000Z 4 KTS
31/0000Z TO 31/0600Z 5 KTS
31/0600Z TO 31/1800Z 4 KTS
INTENSITY
30/0000Z TO 30/0600Z 70 KTS
30/0600Z TO 30/1800Z 50 KTS
30/1800Z TO 31/1800Z 45 KTS
29°N
28°N
27°N
129°E
130°E
15
16
14
17
13
18
31/18Z
31/00Z
30/00Z

LAND RADAR AND AIRCRAFT FIXES - TYPHOON HELEN

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	270632Z	21.1N	131.5E	VW1-P-02	45	---	----	990	-----	DIA 15 MI
2	272200Z	22.7N	131.5E	56-P-07	70	50	9880	992	16/11	CIRC DIA 50MI
3	280500Z	23.5N	131.5E	VW1-R-02	---	---	----	---	-----	ELLIP 8X12 MI
4	280657Z	23.3N	131.4E	VW1-R-03	---	---	----	---	-----	CIRC DIA 18MI
5	280900Z	23.4N	131.3E	56-P-04	75	45	9700	987	16/13	CIRC DIA 40MI OPEN NE
6	281530Z	24.1N	131.3E	VW1-R-05	---	---	----	---	-----	DIA 27MI OPEN S
7	282200Z	24.4N	131.2E	56-P-00	70	60	9480	978	17/14	OPEN W DIA 25MI
8	290330Z	25.0N	131.3E	56-P-01	75	60	9570	979	16/14	CIRC 20MI DIA
9	290900Z	25.3N	131.0E	56-P-05	80	65	9370	971	17/12	CIRC 20MI DIA OPEN SE TO S
10	291335Z	26.3N	130.8E	VW1-R-04	---	---	----	---	-----	DIA 27MI
11	291830Z	26.8N	130.5E	LND/RDR	---	---	----	---	-----	----------
12	292200Z	27.3N	130.3E	56-P-01	100	65	9510	976	19/15	CIRC WELL DEFINED WALL CLDS
13	300145Z	27.8N	130.0E	56-P-03	100	70	9490	---	19/14	CIRC 40MI DIA WELL DEFINED
14	300400Z	28.0N	129.8E	56-P-01	100	75	9490	976	18/14	CIRC 30MI DIA
15	301600Z	28.4N	129.0E	VW1-R-05	---	---	----	---	-----	WELL DEFINED EYE
16	302230Z	28.1N	129.4E	56-P-1/2	40	30	9890	986	12/10	CIRC 50MI DIA OPEN E-S
17	310330Z	27.9N	129.9E	56-P-1/2	---	30	9890	982	15/13	CIRC DIA 50MI
18	310600Z	28.0N	130.4E	56-P-1/2	65	40	9910	987	17/13	CIRC DIA 50MI
19	311445Z	29.0N	129.5E	VW1-P-20	---	---	----	---	-----	40MI DIA NO WALL CLDS
20	312155Z	29.1N	130.0E	56-P-02	40	30	9890	986	13/12	POORLY DEFINED
21	010854Z	29.2N	130.5E	USN-R-01	---	---	----	---	-----	3 MI DIA WALL CLDS ALL QUADS
22	010930Z	29.8N	128.5E	56-P-05	30	40	9920	988	14/13	POORLY DEFINED

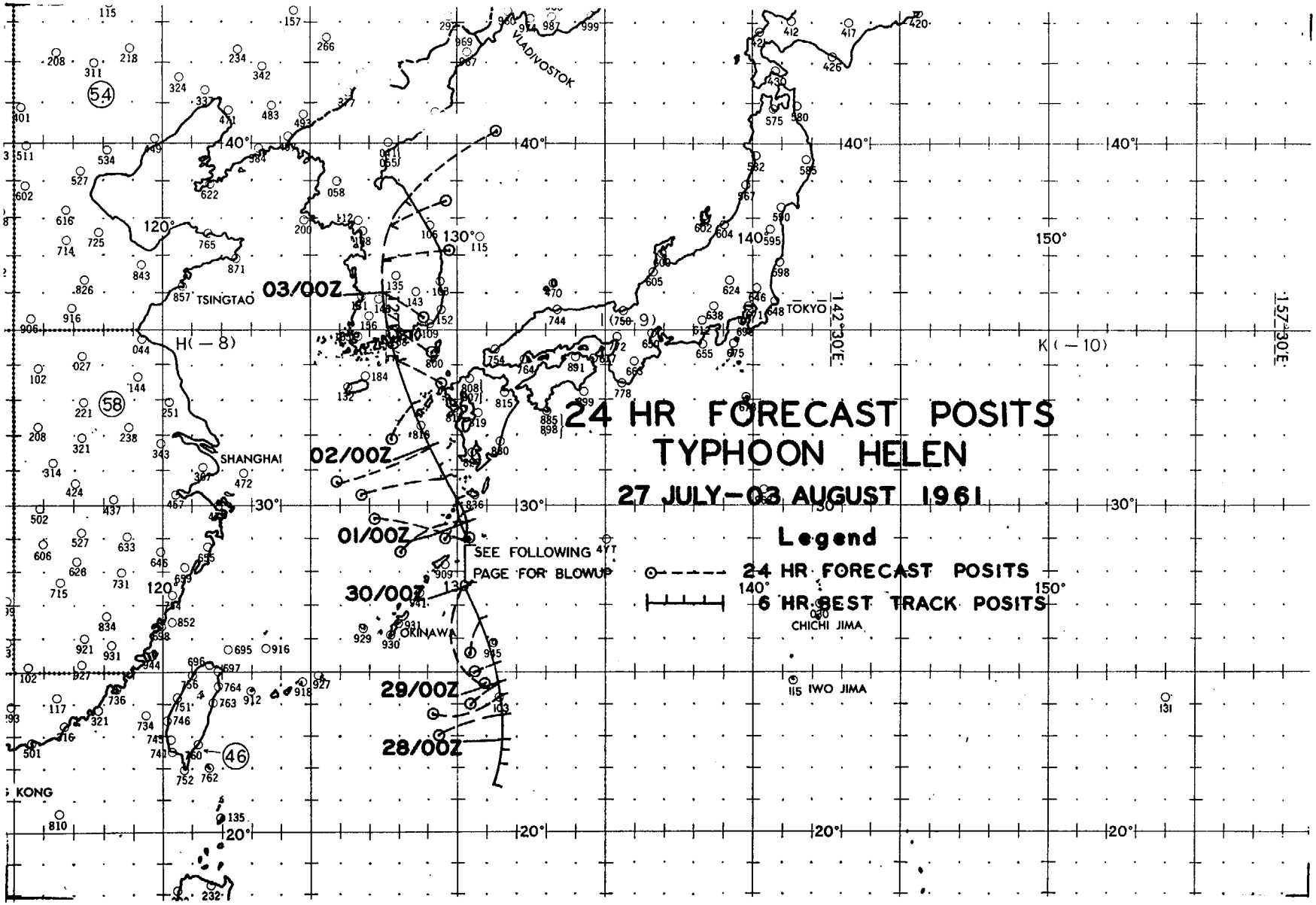
LAND RADAR AND AIRCRAFT FIXES - TYPHOON HELEN (CONT'D)

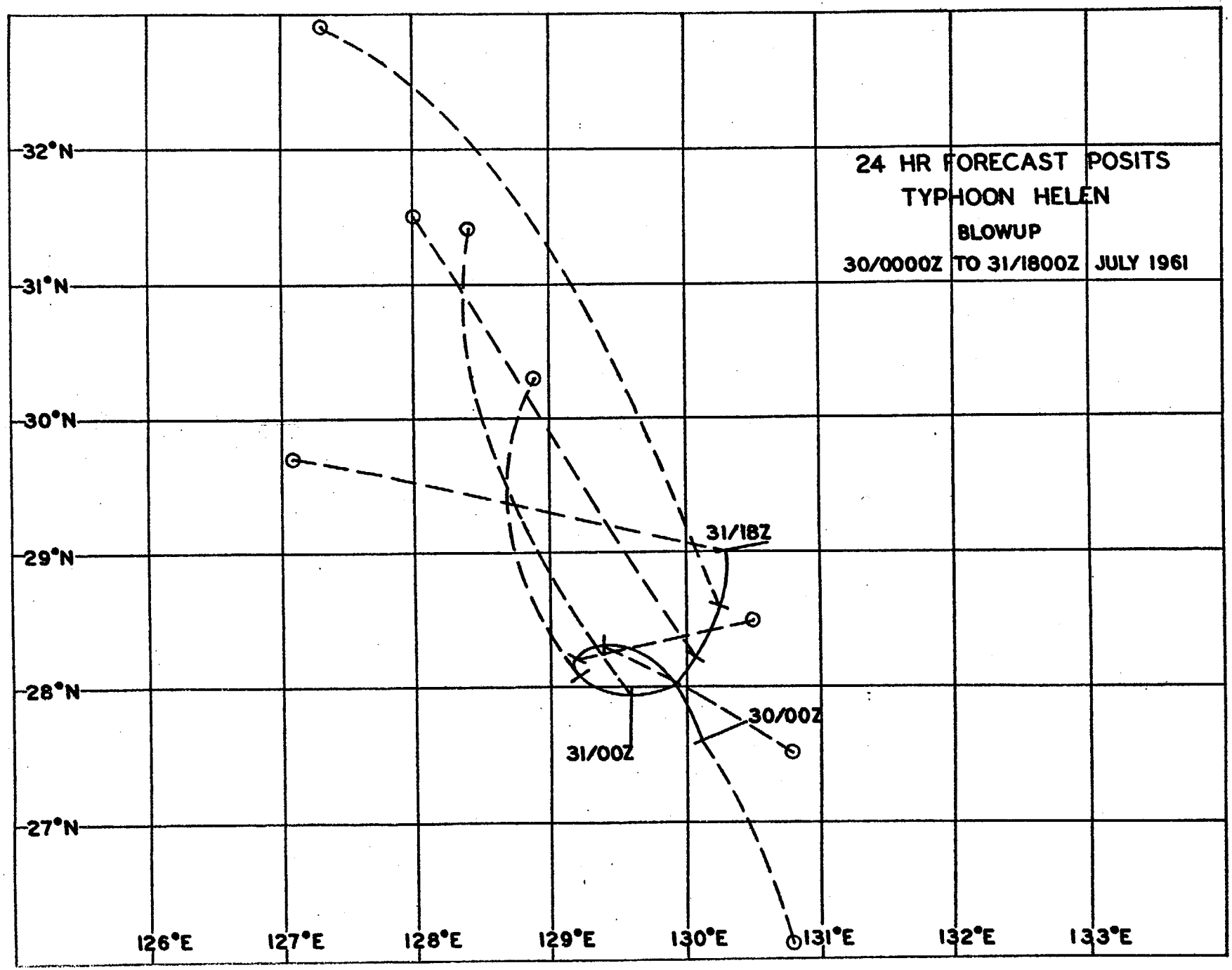
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
23	011200Z	30.1N	130.4E	USN-R-02	---	---	-----	---	-----	DIA 4 MI
24	012130Z	31.4N	129.1E	56-P-02	25	---	9810	983	15/11	VERY DIFFUSE
25	020930Z	33.2N	127.9E	56-P-05	30	30	9770	985	14/12	CIRC 10 MI DIA

TYPHOON HELEN 27 JUL-03 AUG 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
270600Z	21.5N	131.3E	-------	-------
271200Z	22.1N	131.4E	-------	-------
271800Z	22.5N	131.6E	-------	-------
280000Z	22.8N	131.7E	-------	-------
280600Z	23.3N	131.6E	254-127	-------
281200Z	23.7N	131.5E	269-133	-------
281800Z	24.2N	131.4E	260-52	-------
290000Z	24.6N	131.3E	125-46	-------
290600Z	25.3N	131.1E	115-41	268-212
291200Z	25.9N	130.8E	350-70	270-210
291800Z	26.7N	130.5E	345-110	218-75
300000Z	27.6N	130.1E	335-100	206-54
300600Z	28.3N	129.4E	125-78	194-67
301200Z	28.3N	129.2E	080-83	148-170
301800Z	28.1N	129.2E	170-130	144-138
310000Z	27.9N	129.6E	165-210	295-56
310600Z	28.2N	130.1E	154-230	164-156
311200Z	28.6N	130.2E	150-300	164-185
311800Z	29.0N	130.3E	112-110	155-462
010000Z	29.4N	130.2E	068-127	158-481
010600Z	29.8N	130.1E	210-50	146-358
011200Z	30.2N	130.0E	348-68	148-467
011800Z	30.9N	129.7E	257-145	109-257
020000Z	31.8N	129.2E	251-178	234-200
020600Z	32.9N	128.7E	215-78	221-169
021200Z	34.1N	128.1E	230-153	210-175
021800Z	35.1N	127.8E	118-70	224-280
030000Z	36.0N	127.4E	128-88	236-335
030600Z	36.9N	127.2E	088-130	256-130
031200Z	37.9N	127.6E	067-108	260-167
031800Z	38.7N	128.3E	053-185	066-123

AVERAGE 24 HOUR ERROR 119 MI
AVERAGE 48 HOUR ERROR 214 MI


24 HR FORECAST POSITS
TYPHOON HELEN
27 JULY–03 AUGUST 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
03/00Z
02/00Z
01/00Z
30/00Z
29/00Z
28/00Z
SEE FOLLOWING PAGE FOR BLOWUP
VLADIVOSTOK
TSINGTAO
SHANGHAI
OKINAWA
TOKYO
CHICHI JIMA
IWO JIMA
H(−8)
K(−10)
(750 9)
142°30'E
157°30'E
120°
130°
140°
150°
40°
30°
20°


24 HR FORECAST POSITS
TYPHOON HELEN
BLOWUP
30/0000Z TO 31/1800Z JULY 1961
32°N
31°N
30°N
29°N
28°N
27°N
126°E
127°E
128°E
129°E
130°E
131°E
132°E
133°E
31/18Z
30/00Z
31/00Z

G. TYPHOON IDA (280600Z-311800Z JULY 1961)

TYPHOON IDA ORIGINATED TO THE E OF HELEN IN THE TROUGH THAT EXTENDED FROM THE ASIATIC MAINLAND. THE LOW FIRST APPEARED ON THE SURFACE CHART NEAR 21N 144E, ABOUT 850 MI E OF HELEN AT 260600Z. THE CIRCULATION SLOWLY DRIFTED TOWARD IWO JIMA AND GAVE LITTLE INDICATION OF SIGNIFICANT INTENSITY. THE FEW WINDS AVAILABLE HAD A STRENGTH VARYING FROM 5 TO 20 KTS. AT ABOUT 280500Z, FUCHU AIR FORCE WEATHER CENTRAL ADVISED JTWC OF A SHIP REPORT AND AIRCRAFT REPORT THAT INDICATED SURFACE WINDS IN EXCESS OF 40 KTS. THE FIRST WARNING WAS ISSUED ON IDA AS A TROPICAL STORM BASED ON THIS DATA. THE LIFE OF THE "TWINS" (HELEN-IDA) COMMENCED WITH THIS WARNING; IDA BECAME A TYPHOON AT 290000Z, ABOUT 125 MI SE OF IWO JIMA AND PASSED WITHIN 20 MI OF THAT ISLAND TO THE NE. THE LOWEST SLP WAS RECORDED BY IWO JIMA AS 985.5 MB AT 291030Z. SURFACE WINDS REACHED 35 KTS WITH GUSTS TO 57 KTS AT 1112Z. THESE WINDS OCCURRED AFTER THE CENTER PASSED AND WERE FROM THE WNW. THE SURFACE WINDS WERE OF LEAST INTENSITY AROUND THE TYPHOON IN THE LEFT SEMICIRCLE AND STRONGEST IN THE RIGHT FRONT QUADRANT, INDICATED BY SURFACE AND RECONNAISSANCE REPORTS, THEREFORE IWO JIMA HAD COMPARATIVELY LIGHT WINDS WITH THE TYPHOON PASSAGE.

IDA CONTINUED TO INTENSIFY UNTIL 300000Z AND THEN BEGAN TO DISSIPATE, PROBABLY DO TO ITS PROXIMITY TO HELEN. THE TYPHOON MOVED ON A TRACK GENERALLY NW UNTIL AFTER 301800Z, THEN TURNED WESTWARD THEN WSW TO THE N OF HELEN. AT 311800Z, THE TIME OF THE LAST WARNING, IDA WAS IMBEDDED IN THE CIRCULATION OF HELEN AND APPEARED TO BE NO LONGER A SEPARATE CLOSED CIRCULATION. OF THE TWINS, IDA WAS THE WEAKER ONE WHOSE MOVEMENT APPEARED TO BE PARTIALLY CONTROLLED BY HELEN. AS IDA APPROACHED HELEN THE EFFECT UPON IDA BECAME MORE SIGNIFICANT. AT 290000Z, IDA AND HELEN WERE ABOUT 670 MI APART AND IDA WAS INTENSIFYING. BY 300000Z THE TWO TYPHOONS WERE 455 MI FROM EACH OTHER AND IDA WAS WEAKENING EVEN THOUGH GENERAL ATMOSPHERIC CONDITIONS WERE SUITABLE FOR FURTHER INTENSIFICATION WITH THE EXCEPTION OF THE PRESENCE OF HELEN. BY 310000Z IDA WAS 230 MI FROM HELEN AND WAS IMBEDDED IN THE CIRCULATION OF HELEN. IT SHOULD BE NOTED THAT BOTH CIRCULATIONS ACHIEVED MAXIMUM INTENSITY WHILE ABOUT 570 MI APART AT ABOUT THE SAME TIME (HELEN, 90 KTS 290600Z-291200Z, IDA, 80 KTS 291200Z-300000Z), THEN COMMENCED DISSIPATING AS THE TWO APPROACHED EACH OTHER.

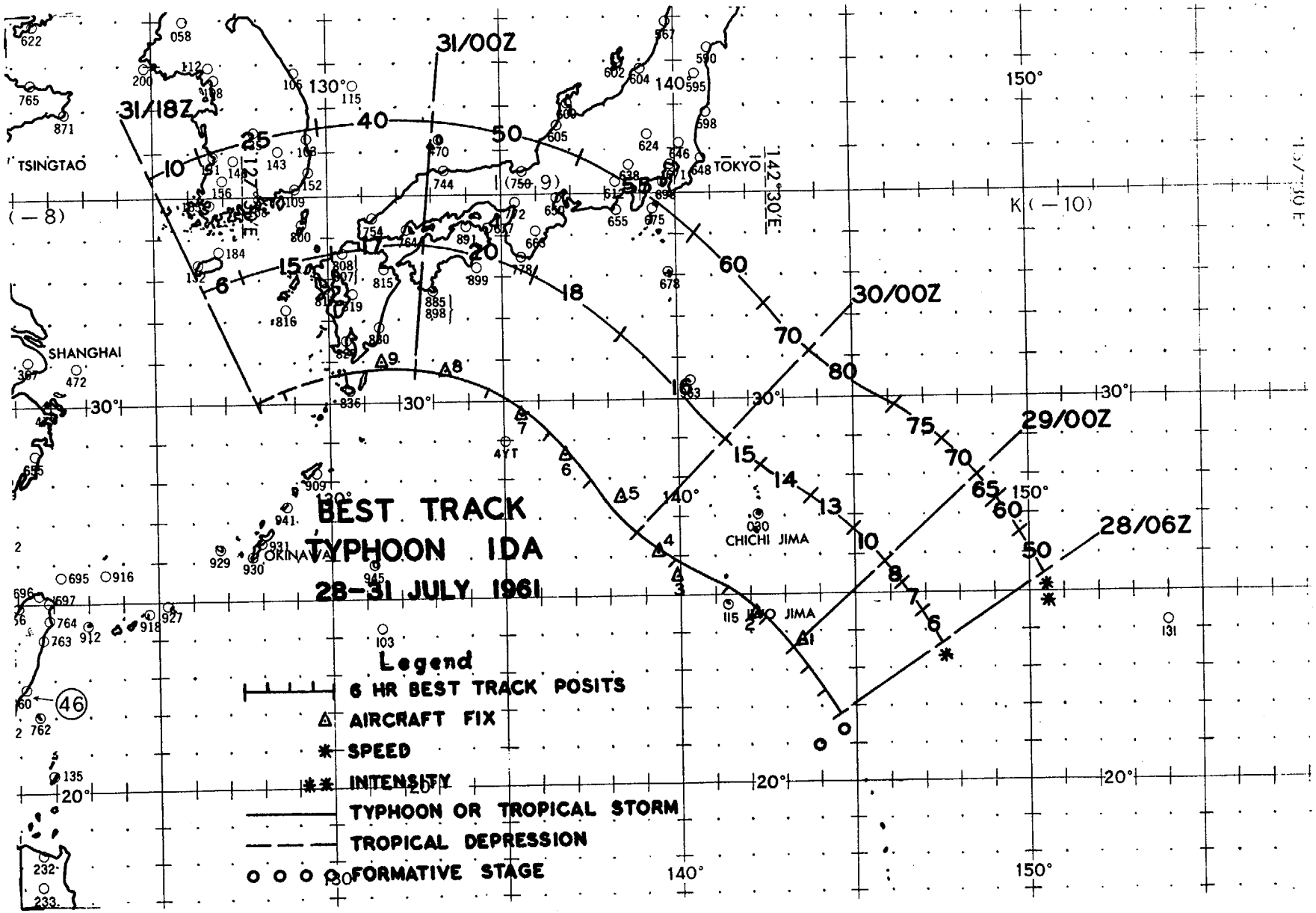
IDA WAS INFLUENCED BY THE HIGH PRESSURE CELL MOVING WESTWARD AS DESCRIBED IN THE HELEN NARRATIVE. THE FUJIWHARA EFFECT WAS CLASSICAL, RESULTING IN THE DISSIPATION AND PARTIAL CONTROL OF THE MOVEMENT OF IDA.

THE FORECAST PROBLEMS AND FORECAST ERRORS (250 MI FOR 11 FORECASTS OF 24 HOURS, 397 MI FOR 7 OUTLOOKS OF 48 HOURS) WERE GREATER ON THIS TYPHOON THAN ANY OTHER OF THE SEASON. THE FUJIWHARA EFFECT WAS IGNORED, EVEN THOUGH IT WAS SUGGESTED BY FAFWC, AND A CONTINUOUS ATTEMPT TO FORECAST THE TYPHOON TO THE RIGHT OF ITS TRACK WAS MADE,

WITH RECURVATURE OR WITH THE EXPECTATION THAT HELEN AND IDA WOULD MOVE FURTHER APART, WITH THE LATTER STRIKING JAPAN.

IDA TRAVELED 1090 MI AT AN AVERAGE SPEED OF 13 KTS IN THE THREE AND ONE HALF DAYS THAT WARNINGS WERE ISSUED. THE MINIMUM SPEED WAS 6 KTS BETWEEN 260600Z AND 281200Z. THE MAXIMUM SPEED WAS 20 KTS BETWEEN 301800Z AND 310000Z. THE MAXIMUM SURFACE WIND SPEED WAS 80 KTS BETWEEN 291200Z AND 300000Z.

IDA CREATED GREATER THAN NORMAL RAINFALL AS IT APPROACHED KYUSHU, AND NO EXTENSIVE DAMAGE REPORTS TO POPULATED AREAS WERE RECEIVED. THE POSSIBILITY OF SHIPPING DAMAGE EXISTS BUT IS UNKNOWN.


BEST TRACK
TYPHOON IDA
28–31 JULY 1961
31/00Z
31/18Z
30/00Z
29/00Z
28/06Z
TSINGTAO
SHANGHAI
TOKYO
CHICHI JIMA
ORINAVA
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE

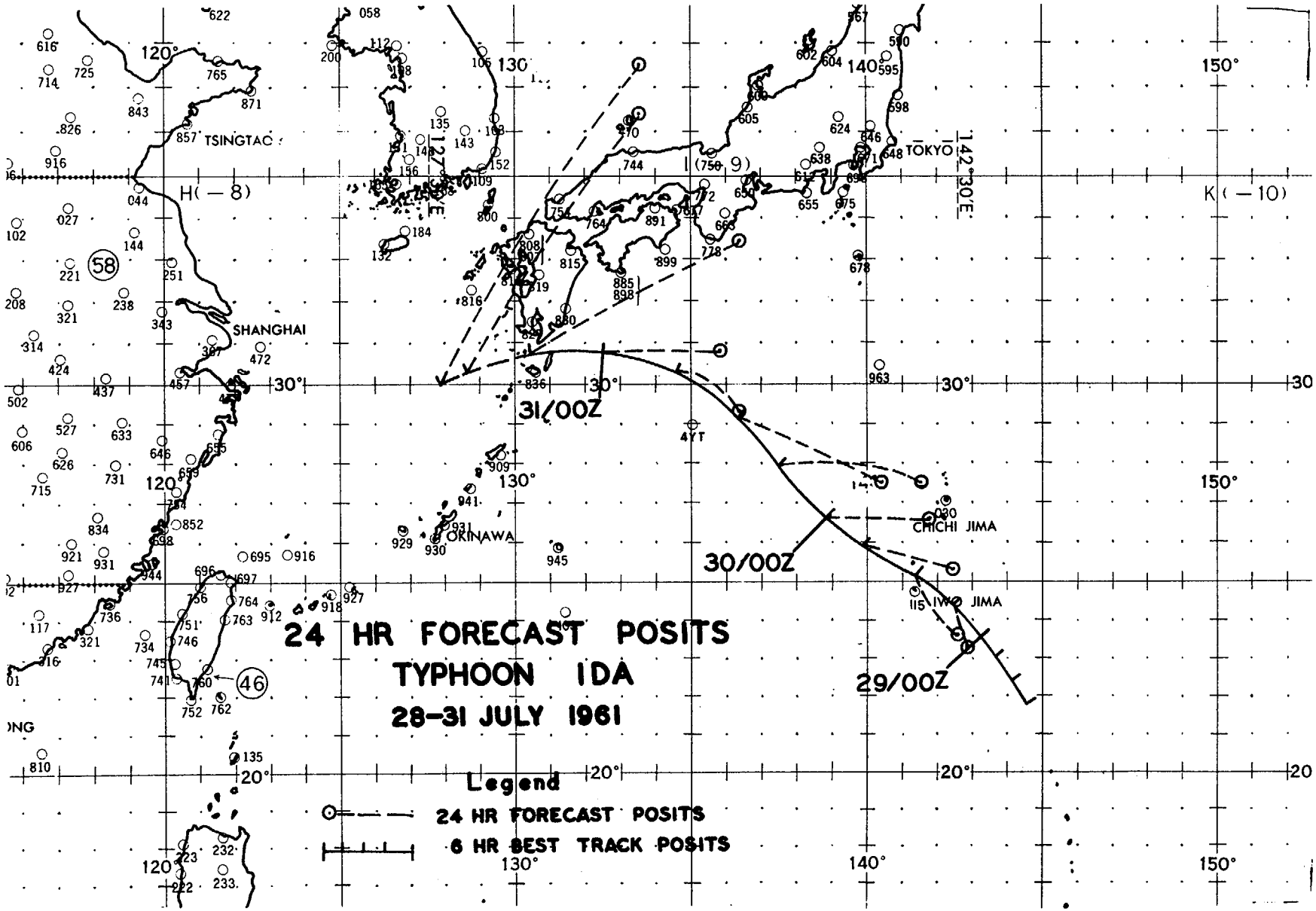
LAND RADAR AND AIRCRAFT FIXES - TYPHOON IDA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/Td (°C)	EYE CHARACTERISTICS
1	282340Z	23.8N	143.4E	56-P-03	90	45	----	---	18/12	40MI DIA WALL CLDS WELL DVLPD
2	290800Z	24.4N	142.2E	56-P-00	70	70	9560	990	17/12	CIRC 25MI DIA OPEN NE
3	291620Z	25.5N	140.0E	VW1-R-10	---	---	----	---	-----	DIA 30MI
4	292135Z	26.1N	139.3E	56-P-05	80	70	9850	997	16/16	NOT DEFINED OPEN N
5	300251Z	27.5N	138.3E	56-P-07	95	---	9900	990	17/17	NOT DEFINED
6	300830Z	28.7N	136.8E	56-P-02	80	45	9950	992	17/09	NOT WELL DEFINED
7	301445Z	29.7N	135.5E	VW1-R-20	---	---	----	---	-----	POORLY DEFINED
8	302130Z	30.8N	133.3E	56-P-01	50	35	9960	993	15/09	POORLY DEFINED
9	310300Z	31.0N	131.6E	56-P-02	45	37	9940	992	14/09	POORLY DEFINED

TYPHOON IDA 28-31 JULY 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
280600Z	21.9N	144.5E	-------	-------
281200Z	22.5N	144.2E	-------	-------
281800Z	23.1N	143.8E	-------	-------
290000Z	23.7N	143.2E	-------	-------
290600Z	24.3N	142.4E	157-78	-------
291200Z	25.3N	141.3E	143-120	-------
291800Z	25.9N	139.9E	112-135	-------
300000Z	26.8N	138.7E	093-180	-------
300600Z	28.0N	137.4E	101-232	128-297
301200Z	29.3N	136.3E	117-247	128-358
301800Z	30.4N	134.7E	130-103	110-317
310000Z	30.9N	132.4E	089-195	092-390
310600Z	30.7N	130.4E	060-420	093-470
311200Z	30.3N	128.7E	031-485	081-530
311800Z	30.0N	128.0E	031-560	059-415

AVERAGE 24 HOUR ERROR 250 MI
AVERAGE 48 HOUR ERROR 397 MI


24 HR FORECAST POSITS
TYPHOON IDA
28-31 JULY 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
31/00Z
30/00Z
29/00Z
TSINGTAO
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
TOKYO
H(-8)
K(-10)
I(750 9)
127° E
142° 30' E
120°
130°
140°
150°
30°
20°

H. TYPHOON JUNE (010600Z-081200Z AUGUST 1961)

AFTER THE DEPARTURE OF IDA FROM THE STAGE, WHILE HELEN WAS PERFORMING A LAST SCENE BY THE WINGS, JUNE APPEARED ON THE CENTER OF THE STAGE AS IF FROM MID AIR ON THE 301200Z SURFACE STREAMLINE CHART AS A CLOSED VORTEX NEAR 10N 141E. COMPARATIVELY LIGHT WINDS AROUND THE CYCLONE AND PREOCCUPATION WITH HELEN AND IDA CAUSED RECONNAISSANCE TO ARRIVE AFTER INTENSIFICATION COMMENCED, FOR THE RECONNAISSANCE AIRCRAFT REPORTED 50 KT WINDS AT 010430Z AND THE FIRST STORM WARNING ON JUNE WAS ISSUED AT 010600Z WITH 50 KT SURFACE WINDS NEAR THE CENTER.

JUNE PROGRESSED TO THE NW AT SPEEDS OF 6 TO 9 KTS AND INTENSIFIED TO TYPHOON STRENGTH AT 020000Z, HAD SURFACE WINDS OF 75 KTS BY 021800Z, THEN THE SURFACE WIND SPEEDS DECREASED BY 5 KTS 12 HOURS LATER. AT 041200Z THE SURFACE WIND SPEEDS DECREASED TO MINIMUM TYPHOON STRENGTH, REMAINED THERE FOR 12 HOURS THEN THE TYPHOON BEGAN A SLOW INTENSIFICATION OF SURFACE WIND SPEEDS TO 100 KTS BY 060600Z. THIS WEAKENING, THEN RE-INTENSIFICATION CORRESPONDS TO THE PARTIAL DISSIPATION OF THE WALL CLOUDS, THE RISE IN SURFACE PRESSURE AND 700 MB HEIGHT, AND THE DECREASE OF 700 MB TEMPERATURE ON 4 AUGUST. THE LAPSE RATE BETWEEN THE 700 MB LEVEL AND THE SURFACE INDICATED A SUBSTANTIAL COOLING AT ALL LEVELS WITH A MAXIMUM OF 7° TO 8° C FROM THE 860 TO THE 800 MB LEVEL BETWEEN 040900Z AND 042300Z. AN AVERAGE OF THE TEMPERATURE FOR EVERY 50 MB FROM THE SURFACE THROUGH 700 MB AT 040900Z INDICATED A TEMPERATURE OF 23.2° C AND A DEW POINT OF 16.6° C. AT 042300Z THE TEMPERATURE AVERAGE BY THE SAME METHOD WAS 19.0° C AND THE DEW POINT WAS 18.5° C. THE SOUNDING WARMED UP AGAIN AFTER 050400Z. THERE APPEARED TO BE SUBSTANTIAL SUBSIDENCE RESULTING IN A DRY LAPSE RATE FROM 763 TO 700 MB AT 040400Z, NO SUBSIDENCE AT 042300Z, THEN THE 060400Z SOUNDING INDICATED SUBSIDENCE TO BE WELL ESTABLISHED AND SUFFICIENT TO PRODUCE A DRY LAPSE RATE FROM 745 TO 700 MB.

JUNE PASSED 35 MI TO THE NE OF BATAN ISLAND AT 052200Z. THE U. S. COAST GUARD LORAN STATION AT BATAN PROVIDED SPECIAL OBSERVATIONS DURING THIS PERIOD, AND REPORTED A MINIMUM SEA LEVEL PRESSURE OF 996.7 MB, AND A SURFACE WIND OF ONLY 12 KTS WITH NO GUSTS, REVEALING THAT THE LEFT QUADRANT AND MOST OF THE LEFT SEMICIRCLE OF JUNE WAS VERY WEAK.

A WEAK SECONDARY LOW APPEARED IN THE TAIWAN STRAITS JUST W OF THE N TIP OF TAIWAN ON THE 060600Z SURFACE CHART. THIS CIRCULATION WAS NEVER WELL DEFINED NOR DID IT APPEAR TO HAVE PRESSURES BELOW 1000 MB OR SURFACE WINDS IN EXCESS OF 30 KTS WHILE A SECONDARY LOW. THE TYPHOON BEGAN WEAKENING AT 061200Z WHILE 40 MI FROM LAND AND ABOUT 65 MI FROM POINT OF PASSAGE OVER THE TAIWAN COAST. THE RUGGED TERRAIN OF THE ISLAND EFFECTIVELY DESTROYED THE WIND CIRCULATION. LEAVING ONLY A WEAK SKELETON OF JUNE BY THE TIME IT PASSED OVER THE COAST AT 070300Z WITH SURFACE WIND SPEEDS OF 50 KTS THAT QUICKLY REDUCED TO 25 KTS. JUNE MOVED INTO THE SECONDARY LOW ON THE W SIDE

OF TAIWAN BETWEEN 071200Z AND 071800Z. THE CYCLONE DEVELOPED 35 KT SURFACE WINDS WHILE OVER THE STRAITS OF TAIWAN, PASSED OVER THE COAST OF THE ASIATIC MAINLAND AT 080000Z, AND HAD WINDS OF ONLY 10 TO 15 KTS WITH A SURFACE PRESSURE OF SLIGHTLY LESS THAN 1000 MB IN THE CENTER WHEN THE LAST WARNING WAS ISSUED AT 081200Z.

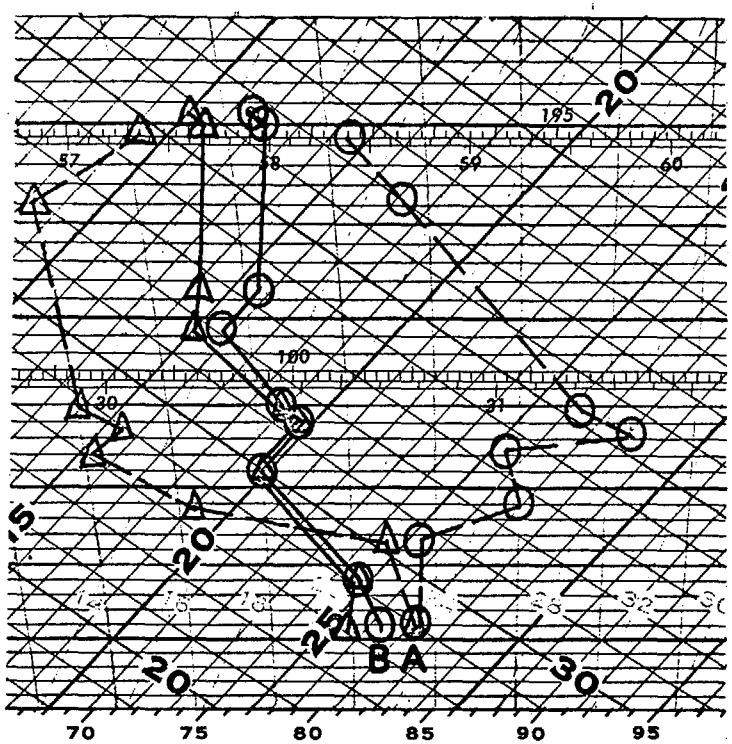
JUNE FORMED TO THE S OF THE RIDGE LINE WHICH WAS NEAR 30N AT THE 200 MB LEVEL. AN ANTICYCLONE AT THAT LEVEL WAS AT 10N 173E, JUST N OF MAJURO, WHICH EXTENDED AS FAR W AS GUAM. JUNE ALSO TRAVELED AROUND THE S AND SW SIDE OF A SURFACE ANTICYCLONE AS IT APPROACHED TAIWAN. THERE WAS EVIDENCE OF A CLOSED CYCLONIC CIRCULATION OVER JUNE ON 7-8 AUGUST TO AT LEAST 45,000 FT, BUT IT IS DIFFICULT TO SAY WITH ANY ASSURANCE THAT THIS CYCLONE WAS A DIRECT RESULT OF JUNE, OR WHETHER OTHER GENERAL CIRCULATION FACTORS WERE INVOLVED.

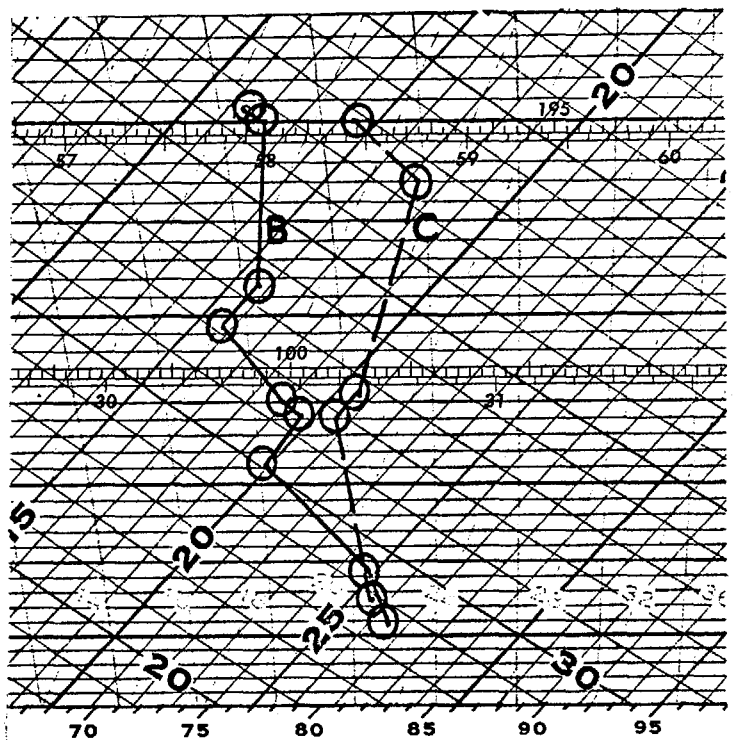
TWELVE LAND RADAR FIXES ON JUNE PROVIDED EXTREMELY ACCURATE POSITIONING OF THE TYPHOON DURING THE FEW HOURS PRIOR TO PASSING OVER THE COASTLINE OF TAIWAN.

NO GREAT DIFFICULTIES WERE INVOLVED IN FORECASTING. THE TYPHOON FOLLOWED THE SINGLE SPACE MEAN CHART REASONABLE WELL, BUT DID NOT FOLLOW THE 200 MB FLOW AFTER 3 AUGUST. THE TRACK MADE BY JUNE SATISFIES CLIMATOLOGY QUITE WELL, AND WITH THE EXCEPTION OF THE SHORT PERIOD OF WEAKENING ON 4 AUGUST VERY LITTLE OF AN UNUSUAL NATURE TRANSPIRED WORTHY OF EXCEPTIONAL NOTICE.

JUNE TRAVELED 1255 MI DURING THE 7 DAYS 6 HOURS THAT WARNINGS WERE ISSUED AT AN AVERAGE SPEED OF 173 MI PER DAY OR 7.2 KTS. THE SLOWEST SPEED OF TRAVEL WAS 3 KTS BETWEEN 061800Z AND 070000Z. THE FASTEST RATE OF TRAVEL WAS 11 KTS BETWEEN 071200Z AND 071800Z. THE HIGHEST SURFACE WINDS, 100 KTS, EXISTED BETWEEN 060600Z AND 061200Z.

THE TYPHOON DELIVERED THE FULL BRUNT OF ITS FORCE TO TAIWAN AND ORCHID ISLAND, JUST E OF THE S TIP OF TAIWAN. DAMAGE IS UNKNOWN ON ORCHID ISLAND, HOWEVER THE TYPHOON PASSED DIRECTLY OVER IT. JUNE DUMPED 21.6 INCHES OF RAIN ON SOUTHERN TAIWAN, TWENTY PERSONS WERE REPORTED DEAD IN THE KAOHSIUNG-TAITUNG AREA, AND ABOUT 15,000 PEOPLE WERE LEFT HOMELESS. ABOUT 5,000 ACRES OF LAND WERE FLOODED ALONG THE LOVE RIVER WHICH OVERFLOWED ITS BANKS. LANDSLIDES BLOCKED HIGHWAYS BETWEEN TAITUNG AND HUALIEN. ABOUT 30 PERCENT OF THE TELEPHONES AT KAOHSIUNG WERE OUT OF ORDER AND TWO SMALL FACTORIES COLLAPSED UNDER THE FORCE OF WINDS AND RAIN. THE CITY OF KAOHSIUNG, HEAVIEST HIT ON TAIWAN WHEN THE LOVE RIVER OVERFLOWED, WAS DECLARED AN EMERGENCY AREA AND NATIONALIST CHINESE TROOPS PERFORMED RESCUE WORK THERE.





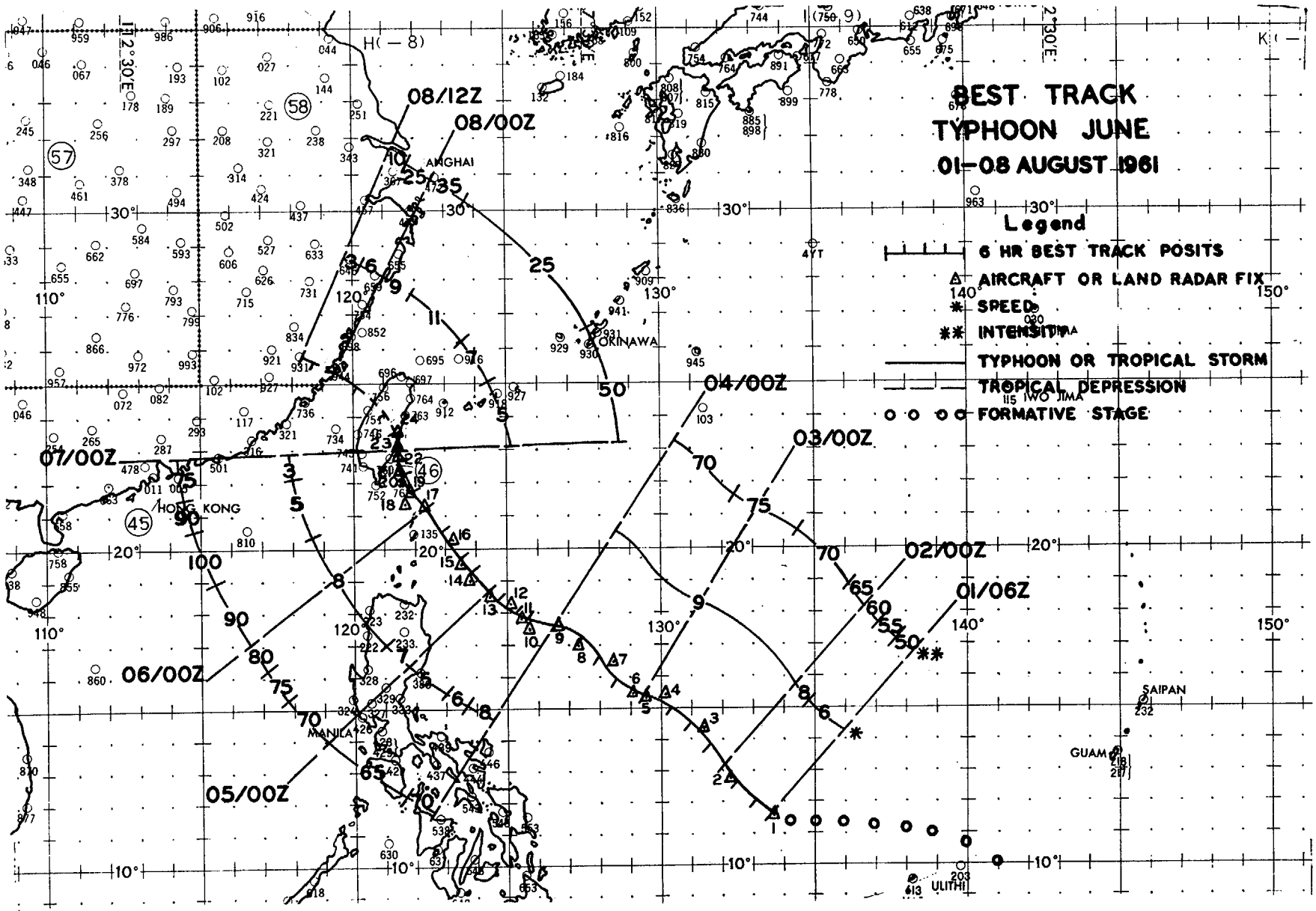
SOUNDING A(DASHED) 040900Z, T AND T_D

SOUNDING B(SOLID) 042300Z, T AND T_D

NOTE: THE 850MB LEVEL, SOUNDING B HAS A θ_E THAT IS 4°C WARMER THAN THE CORRESPONDING LEVEL FOR SOUNDING A.

SOUNDING B(SOLID) 042300Z, T ONLY

SOUNDING C(DASHED) 050930Z, T ONLY


BEST TRACK
TYPHOON JUNE
01–08 AUGUST 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
* SPEED
** INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
08/12Z
08/00Z
04/00Z
03/00Z
02/00Z
01/06Z
01/00Z
06/00Z
05/00Z
SHANGHAI
OKINAWA
HONG KONG
MANILA
SAIPAN
GUAM
ULITHI
IWO JIMA
112°30'E
110°
120°
130°
140°
150°
10°
20°
30°

LAND RADAR AND AIRCRAFT FIXES - TYPHOON JUNE

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	010430Z	11.7N	133.8E	VW1-P-05	50	---	-----	990	------	DIA 45MI OPEN N-E
2	012200Z	12.9N	132.3E	56-P-10	60	50	10000	992	12/09	----------
3	020900Z	14.3N	131.4E	56-P-05	80	55	9960	987	15/07	CIRC 20MI DIA
4	021530Z	15.3N	130.1E	VW1-P-10	50	---	-----	988	15/09	DIA 35MI OPEN N-E
5	022200Z	15.3N	129.6E	56-P-10	110	60	10090	988	15/09	----------
6	030130Z	15.4N	129.1E	56-P-10	110	60	9980	984	15/11	----------
7	030830Z	16.4N	128.4E	56-P-05	100	60	10060	998	14/03	CIRC 20MI DIA WALL CLD SW
8	031630Z	17.0N	127.3E	VW1-R-U	---	---	-----	---	------	NO DEFINITE EYE DIA 50MI
9	032200Z	17.6N	126.8E	56-P-05	70	50	10030	995	14/09	75MI DIA OPEN N & NE
10	040330Z	17.5N	125.8E	56-P-02	85	50	9980	990	15/00	OPEN N & NE
11	040845Z	17.9N	125.6E	56-P-02	100	35	10030	993	14/10	CIRC DIA 65MI OPEN N
12	041540Z	18.1N	125.2E	VW1-R-10	---	---	-----	---	------	ELLIP NW-SE AXIS 35MI LONG
13	042230Z	18.5N	124.5E	56-P-02	90	50	9900	993	12/11	CIRC 35MI DIA WALL CLDS ALL QUADS
14	050400Z	19.0N	123.9E	56-P-02	95	65	9800	988	13/11	CIRC DIA 35MI
15	050930Z	19.4N	123.5E	56-P-06	80	70	9610	981	15/05	CIRC DIA 25MI
16	051530Z	20.2N	123.2E	VW1-R-05	---	---	-----	---	------	DIA 30MI
17	052300Z	21.2N	122.3E	56-P-03	65	50	9420	973	16/08	CIRC 20MI DIA WELL DEFINED WALL CLDS
18	060150Z	21.3N	121.9E	56-P-01	100	70	9250	---	12/12	CIRC 20MI DIA
19	060400Z	21.5N	121.9E	56-P-03	100	75	9230	964	17/07	CIRC 10MI DIA
20	060845Z	22.0N	121.8E	56-P-05	100	100	9120	961	16/06	WELL DEFINED CIRC 25MI DIA
21	061200Z	22.2N	121.6E	LND/RDR	---	---	-----	---	------	----------

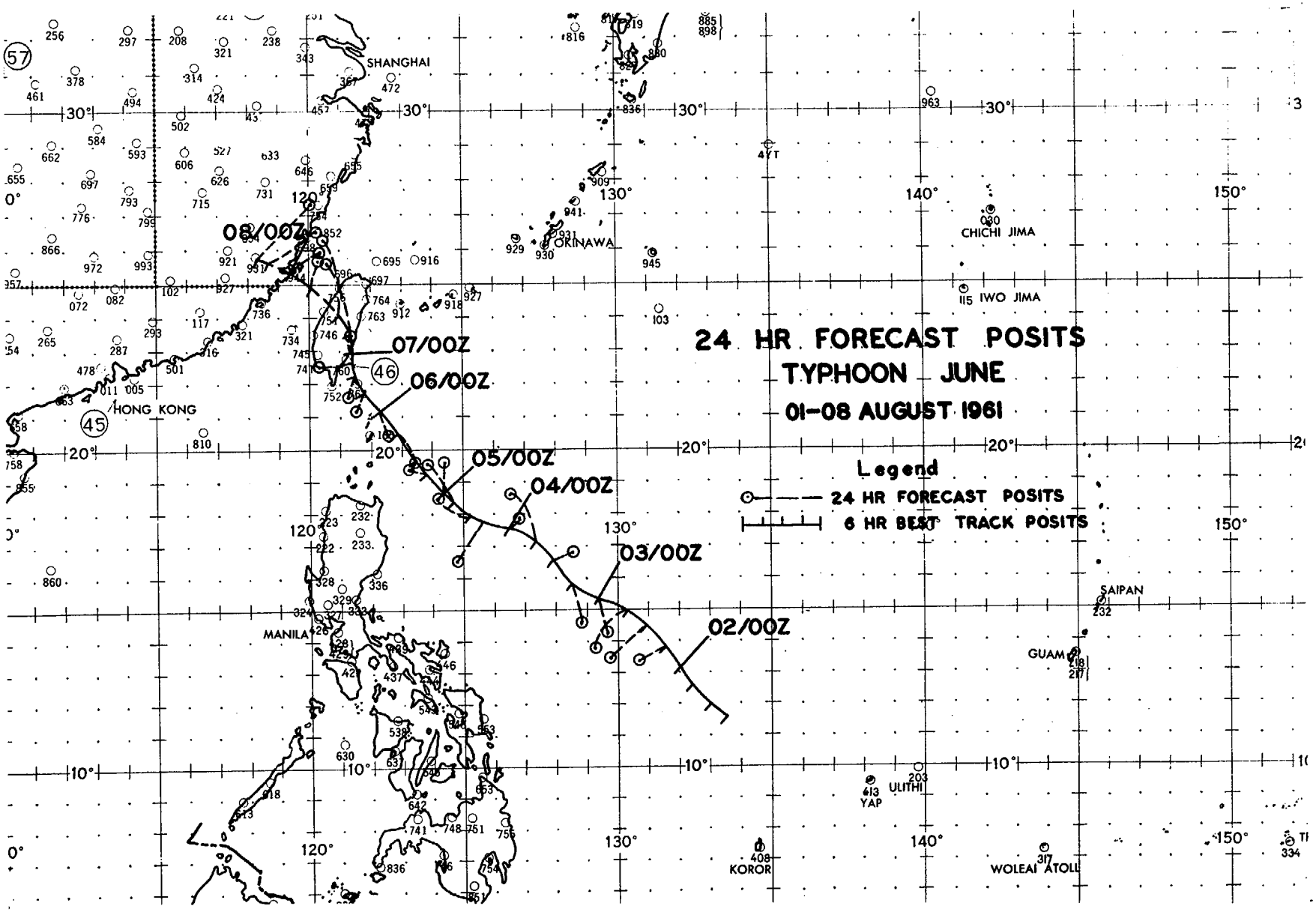
LAND RADAR AND AIRCRAFT FIXES - TYPHOON JUNE (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/Td (°C)	EYE CHARACTERISTICS
22	061800Z	22.7N	121.5E	LND/RDR	---	---	----	---	-----	----------
23	070000Z	23.0N	121.5E	LND/RDR	---	---	----	---	-----	----------
24	070600Z	23.4N	121.4E	LND/RDR	---	---	----	---	-----	----------

TYPHOON JUNE 01-08 AUG 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
010600Z	11.8N	133.6E	-------	-------
011200Z	12.1N	133.1E	-------	-------
011800Z	12.5N	132.6E	-------	-------
020000Z	13.1N	132.2E	-------	-------
020600Z	13.9N	131.7E	238-73	-------
021200Z	14.6N	131.0E	224-89	-------
021800Z	15.0N	130.2E	189-87	-------
030000Z	15.4N	129.3E	158-76	-------
030600Z	15.8N	128.5E	159-72	232-120
031200Z	16.6N	128.0E	049-33	231-148
031800Z	17.3N	127.5E	327-93	226-167
040000Z	17.6N	126.5E	047-31	168-128
040600Z	17.7N	125.7E	215-91	189-107
041200Z	18.0N	125.3E	300-69	214-84
041800Z	18.3N	124.8E	325-90	341-205
050000Z	18.6N	124.4E	003-53	005-133
050600Z	19.2N	123.9E	281-43	089-56
051200Z	19.8N	123.4E	211-37	096-103
051800Z	20.5N	122.9E	330-63	111-96
060000Z	21.1N	122.3E	157-50	055-54
060600Z	21.7N	121.8E	187-35	209-120
061200Z	22.2N	121.6E	193-98	189-145
061800Z	22.7N	121.5E	255-75	206-78
070000Z	23.0N	121.5E	333-25	229-74
070600Z	23.5N	121.4E	340-129	085-126
071200Z	24.2N	121.2E	338-151	072-125
071800Z	24.8N	120.0E	015-58	288-150
080000Z	25.1N	119.2E	049-76	033-159
080600Z	25.4N	118.6E	048-108	015-310
081200Z	25.6N	118.4E	045-130	015-337

AVERAGE 24 HOUR ERROR 74 MI
AVERAGE 48 HOUR ERROR 138 MI


24 HR FORECAST POSITS
TYPHOON JUNE
01-08 AUGUST 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
08/00Z
07/00Z
06/00Z
05/00Z
04/00Z
03/00Z
02/00Z
SHANGHAI
HONG KONG
MANILA
OKINAWA
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOLL
120°
130°
140°
150°
30°
20°
10°
0°

I. TYPHOON KATHY (151000Z-180600Z AUGUST 1961)

THE FIRST KNOWN OBSERVATION OF KATHY WAS MADE BY A USAF WEATHER OFFICER, ANDERSEN AFB, WHO WAS FLYING AS NAVIGATOR ON A C-54 ENROUTE TO JAPAN FROM GUAM. HE SENT THE FOLLOWING REPORT TO JTWC: "SPECIAL WX REPORT X 2340N 14240E VERY LARGE TSTMS X 50 NM IN DIAMETER SFC WIND EST 40 KTS L/V TURBULENCE." THE REPORT ARRIVED AT 150320Z; THE SITUATION WAS EXAMINED AND THE INFORMATION WAS INTERPRETED TO BE WEATHER CONDITIONS ASSOCIATED WITH TROPICAL DEPRESSION 20, THEN CENTERED NEAR 18.5N 139.5E. THE SIGNIFICANCE OF THE REPORT WAS REALIZED WHEN IWO JIMA REPORTED STRONG WINDS AND A PRESSURE OF 998.6 MB AT 150600Z. THIS REPORT WAS VERY LATE IN ARRIVING, ALLOWING KATHY TO PASS IWO JIMA BEFORE JTWC BECAME AWARE OF THE CONDITIONS THERE. KATHY WAS ACTUALLY TRAVELING AROUND TROPICAL DEPRESSION 20.

THE MINIMUM PRESSURE REPORTED AT IWO JIMA WAS 997.0 MB AT 150730Z, WITH MAXIMUM SUSTAINED WINDS OF 42 KTS AND MAXIMUM RECORDED GUSTS OF 61 KTS, HOWEVER THE GUSTS EXCEEDED THIS VALUE AT A LATER TIME BUT POWER FAILURE PRECLUDED RECORDING THE VALUE.

THE FIRST WARNING WAS ISSUED ON KATHY AT 151000Z AS A STORM. THE CIRCULATION CONTINUED TO INTENSIFY UNTIL WINDS OF TYPHOON STRENGTH WERE AROUND IT AFTER 151800Z. AS IT APPROACHED KYUSHU, THE LAND EFFECT DISRUPTED THE ASSOCIATED WIND FIELD AFTER 170600Z. THE SURFACE WIND SPEEDS THEN DECREASED IN INTENSITY FROM 80 KTS TO 60 KTS AND WERE ONLY 25 KTS NEAR THE CENTER AS KATHY PASSED OVER THE KYUSHU COAST LINE SHORTLY AFTER 171800Z. THE LAST WARNING WAS ISSUED AT 180600Z WHILE KATHY WAS OVER THE ISLAND OF KYUSHU.

KATHY REMAINED VERY SMALL IN SIZE THROUGHOUT ITS LIFE. THE LAST CLOSED ISOBAR PROBABLY DID NOT EXCEED 450 MI IN DIAMETER AT ANY TIME NOR DID THE RADIUS OF 30 KT WINDS EXTEND BEYOND A 150 MI RADIUS. THE SMALL SIZE CREATED ANALYSIS DIFFICULTIES, EVEN AS IT APPROACHED LAND.

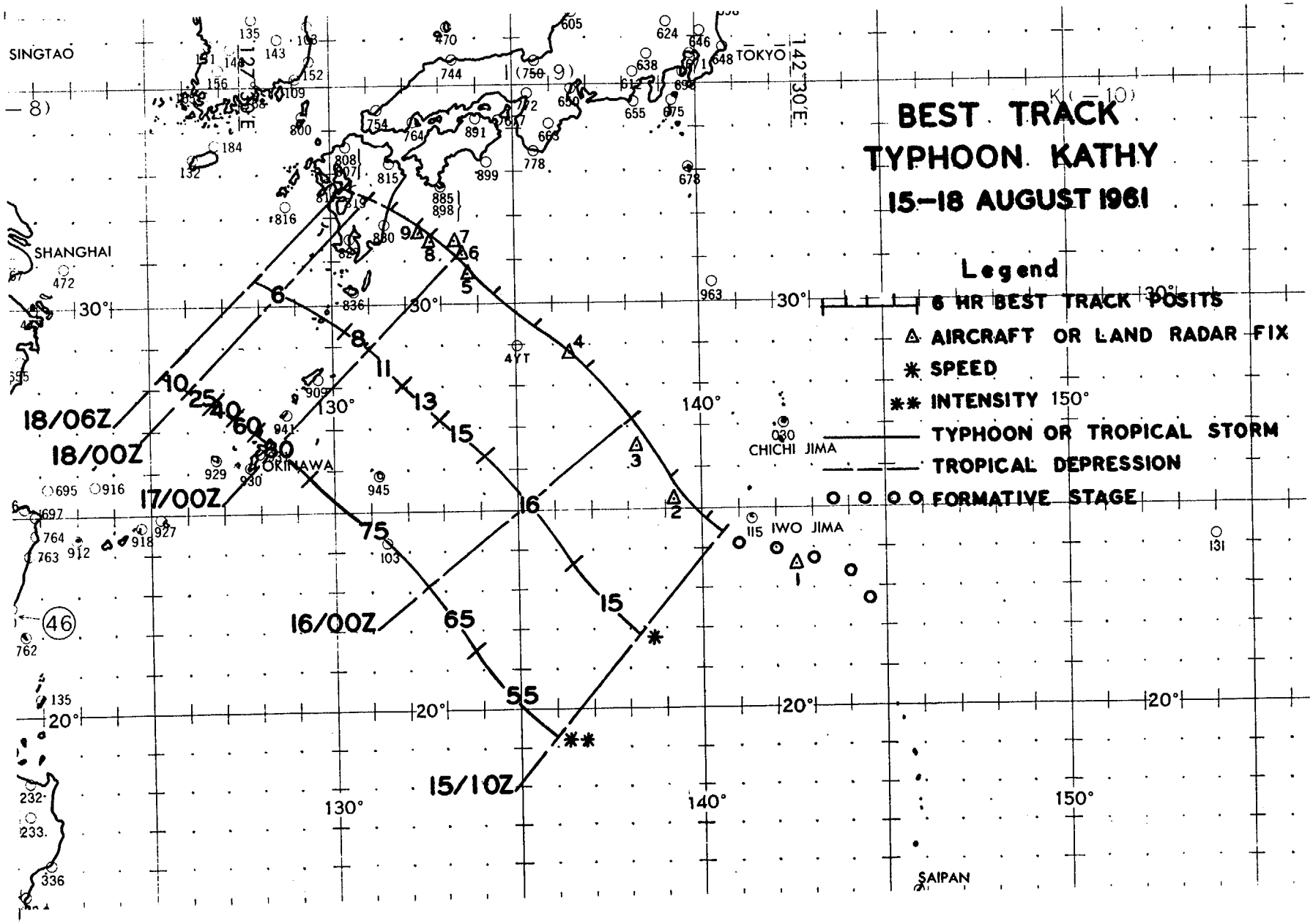
THE TRACK OF KATHY APPROXIMATELY PARALLELED THE 700 MB FLOW, AND WAS ALSO TO THE S THEN SW OF A 500 MB ANTI-CYCLONE THAT MOVED WESTWARD SLIGHTLY DURING THE LIFE CYCLE OF THE TYPHOON. THE 500 MB AND 200 MB RIDGE LINES WERE BETWEEN 33N AND 35N AT THIS TIME. THE WIND FLOW AT THE 200 MB LEVEL COULD NOT BE USED FOR MORE THAN A GENERAL GUIDE TO THE DIRECTION OF MOVEMENT OF THE TYPHOON. A FORECAST USING THESE WINDS WOULD HAVE PREDICTED THE TYPHOON TO MOVE N. THE SINGLE SPACE MEAN CHART WAS AN EXCELLENT TOOL TO FORECAST THE DIRECTION OF TYPHOON MOVEMENT. THE TRACK OF KATHY WAS SIMILAR TO THAT OF IDA OF ONLY A FEW DAYS BEFORE, GEORGIA OF 1955, ALSO FLOSSIE AND HELENE OF 1950 IN BOTH POSITION AND DIRECTION OF MOVEMENT. THIS TYPE OF TRACK IS NOT UNUSUAL BUT IS RELATIVELY RARE.

KATHY MOVED FASTER THAN WAS FORECAST ON THE FIRST FEW WARNINGS. THE TYPHOON CONTINUED ON A NW TRACK AND SLOWED DOWN, BUT THE WARNINGS

ON THE 17TH AND 18TH FORECAST IT TO MOVE MORE NNW AT A FASTER RATE OF MOVEMENT. THE 48 HOUR OUTLOOK WAS ON AN AVERAGE ONLY 164 MI IN ERROR WHILE THE 24 HOUR FORECAST WAS 180 MI IN ERROR. THE MILLER-MOORE 24 HOUR FORECASTS WERE MORE ACCURATE THAN THE WARNING FORECASTS.

KATHY TRAVELED 740 MI DURING THE 2 DAYS AND 20 HOURS THAT WARNINGS WERE ISSUED AT THE RATE OF 261 MI PER DAY, OR AT AN AVERAGE SPEED OF 10.9 KTS. THE TYPHOON MOVED AT A MINIMUM SPEED OF 6 KTS BETWEEN 170600Z AND 180600Z AND AT A MAXIMUM RATE OF SPEED OF 16 KTS BETWEEN 151800Z AND 160600Z. KATHY HAD A MAXIMUM OF 80 KT SURFACE WINDS BETWEEN 161800Z AND 170600Z.

DAMAGE REPORTS WERE NOT RECEIVED BY JTWC, HOWEVER POSSIBLE DAMAGE COULD HAVE OCCURRED TO SHIPPING. THE HIGH WINDS ASSOCIATED WITH KATHY DID CREATE A POWER OUTAGE ON IWO JIMA AS IT PASSED THAT ISLAND, AND OTHER DAMAGE MAY HAVE OCCURRED.


BEST TRACK
TYPHOON KATHY
15–18 AUGUST 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY 150°
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
SINGTAO
SHANGHAI
TOKYO
CHICHI JIMA
IWO JIMA
OKINAWA
SAIPAN
18/06Z
18/00Z
17/00Z
16/00Z
15/10Z
142°30'E
127°E
30°
140°
130°
150°
20°

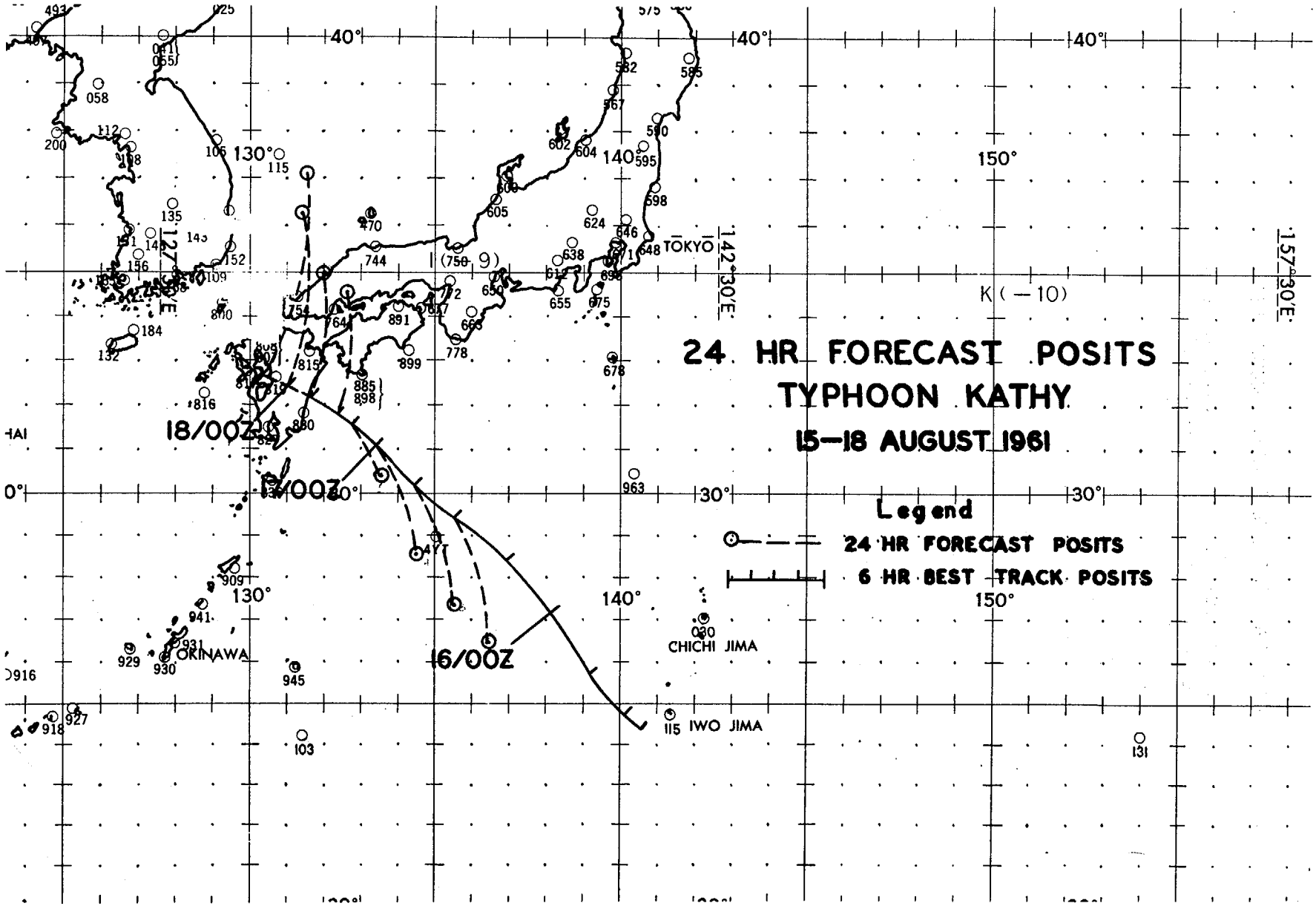
LAND RADAR AND AIRCRAFT FIXES - TYPHOON KATHY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	150300Z	23.7N	142.7E	USAF-P-U	40	---	----	---	-----	50MI DIA
2	151938Z	25.3N	139.2E	VW1-P-30	---	30	10544	---	13/--	NO WALL CLDS
3	152230Z	26.6N	138.2E	56-P-05	15	14	10190	986	11/10	DIFFUSED NO WALL CLDS
4	160830Z	28.9N	136.4E	56-P-03	80	40	9940	986	18/--	OPEN S WELL DEFINED
5	162130Z	30.8N	133.8E	56-P-04	110	60	9930	980	17/11	CIRC DIA 20MI OPEN S
6	170020Z	31.1N	133.6E	56-P-04	100	60	----	1000	18/--	CIRC 40MI DIA
7	170200Z	31.4N	133.3E	56-P-10	85	55	9890	988	20/14	CIRC 40MI DIA
8	170600Z	31.5N	132.8E	LND/RDR	---	---	----	---	-----	----------
9	170900Z	31.7N	132.3E	LND/RDR	---	---	----	---	-----	----------

TYPHOON KATHY 15-18 AUG 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
151000Z	24.6N	140.7E	-------	-------
151200Z	24.8N	140.2E	-------	-------
151800Z	25.9N	139.1E	-------	-------
160000Z	27.2N	138.1E	-------	-------
160600Z	28.4N	136.9E	-------	-------
161200Z	29.4N	135.6E	160-175	-------
161800Z	30.2N	134.3E	160-184	-------
170000Z	31.1N	133.7E	164-154	-------
170600Z	31.5N	132.8E	155-78	-------
171200Z	31.8N	132.2E	013-167	180-263
171800Z	32.2N	131.7E	005-176	180-244
180000Z	32.4N	131.0E	005-232	163-109
180600Z	32.7N	130.3E	010-275	017-40

AVERAGE 24 HOUR ERROR 180 MI
AVERAGE 48 HOUR ERROR 164 MI


24 HR FORECAST POSITS
TYPHOON KATHY
15–18 AUGUST 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
18/00Z
17/00Z
16/00Z
OKINAWA
CHICHI JIMA
IWO JIMA
TOKYO
K (–10)
40°
30°
130°
140°
150°
142°30'E
157°30'E

J. TYPHOON LORNA (201200Z-261200Z AUGUST 1961)

SEVERAL DAYS BEFORE THE FIRST WARNING WAS ISSUED ON LORNA (201200Z) A CONFUSION OF WEAK VORTICES EXISTED OVER THE SOUTH CHINA SEA AND THE PHILIPPINE SEA. THE SURFACE PRESSURE GRADIENT WAS RELATIVELY FLAT THROUGHOUT THE AREA. EASTERLIES PERSISTED OVER THE ENTIRE PHILIPPINE SEA AND EQUATORIAL WESTERLIES EXTENDED ACROSS INDO-CHINA AND THE PHILIPPINES TOWARD GUAM FROM THE EQUATOR TO 15N. THIS CONDITION BEGAN TO MODIFY RAPIDLY ON 19 AUGUST AND THE 200000Z SURFACE CHART DEPICTED THREE SIZEABLE CYCLONES, ONE IN THE SOUTH CHINA SEA, ANOTHER JUST E OF THE PHILIPPINES NEAR 15N 131E THAT BECAME LORNA, WITH A THIRD CYCLONE SITUATED QUITE CLOSE TO GUAM.

WEATHER RECONNAISSANCE AIRCRAFT THAT INVESTIGATED THE CENTER DID NOT INDICATE A WELL ORGANIZED SYSTEM ON THE 19TH, HOWEVER THE FIX MADE ON 20 AUGUST REPORTED 30 KT SURFACE WINDS NEAR THE CENTER WITH AN ORGANIZED CLOUD AND PRESSURE SYSTEM, THUS THE FIRST WARNING WAS ISSUED ON LORNA AS A TROPICAL DEPRESSION WITH 30 KT SURFACE WINDS. THE CYCLONE INTENSIFIED AT THE RATE OF 10 KTS PER 6 HOURS, BECAME A TYPHOON AT 210600Z, CHANGED DIRECTION FROM NW TO W THEN SW, AND LOOPED WITHIN 48 HOURS OF THE FIRST WARNING. THE LOOP WAS ABOUT 25 MI IN DIAMETER, OCCURRING BETWEEN 212100Z AND 221200Z AT AN AVERAGE SPEED OF 4 KTS. THE SURFACE WINDS AROUND THE TYPHOON INCREASED IN SPEED FROM 75 TO 90 KTS DURING THE LOOP AND CONTINUED TO INTENSIFY TO A MAXIMUM OF 120 KTS AS IT MOVED NW TOWARD TAIWAN. LORNA PASSED 45 MI NE OF BATAN ISLAND AT 241030Z, CAUSED THE PRESSURE TO FALL TO A MINIMUM OF 981.9 MB AND CREATED WINDS OF 40 KTS WITH GUSTS TO 65 KTS.

LORNA BEGAN WEAKENING AFTER 241200Z AND BY THE TIME IT PASSED OVER THE COASTLINE OF TAIWAN AT 242200Z THE SURFACE WINDS HAD REDUCED TO 90 KTS. THE TERRAIN EFFECT FURTHER REDUCED THE SURFACE WINDS TO 40 KTS WHILE OVER LAND. AFTER THE TYPHOON PASSED INTO THE STRAITS OF TAIWAN AT 250300Z, THE SURFACE WINDS INCREASED TO 50 KTS. THE TYPHOON MOVED INLAND THIS TIME OVER THE ASIATIC MAINLAND AT 252100Z WITH SURFACE WINDS OF ONLY 35 KTS. THE CIRCULATION QUICKLY DISSIPATED, PRODUCING SURFACE WINDS OF ONLY 20 KTS BY THE TIME OF THE FINAL WARNING AT 261200Z.

LORNA DID NOT FOLLOW ANY FLOW PATTERN THAT WAS DEPICTED BY THE STANDARD LEVEL CHARTS, NOR DID THE SPACE MEAN FLOW PATTERN SATISFY THE COMMON DEFINITION OF A "STEERING" CHART. THE 500 MB RIDGE LINE WAS AT ABOUT 31N, THAT OF THE 200 MB WAS ABOUT 1 DEGREE FURTHER N, WITH THE 700 MB RIDGE LINE FALLING UNDER THAT OF THE 500 MB CHART. LORNA FORMED UNDER THE MIDDLE OF THREE CYCLONES EXISTING IN THE E-W TROUGH ON THE 500 MB CHART; THE DESCRIPTION OF WHICH IS SATISFIED BY THE DISCUSSION OF THE 200000Z SURFACE CHART IN THE INITIAL PARAGRAPH. AN ANTICYCLONE THAT WAS NEAR SHANGHAI ON THE 500 MB AND 200 MB CHARTS, WHEN WARNINGS WERE FIRST ISSUED ON LORNA, MOVED TO THE VICINITY OF TOKYO BY THE TIME OF THE LAST WARNING. THE UPPER AIR CIRCULATION WAS AFFECTED AT LEAST THROUGH THE 40,000 FT LEVEL BETWEEN

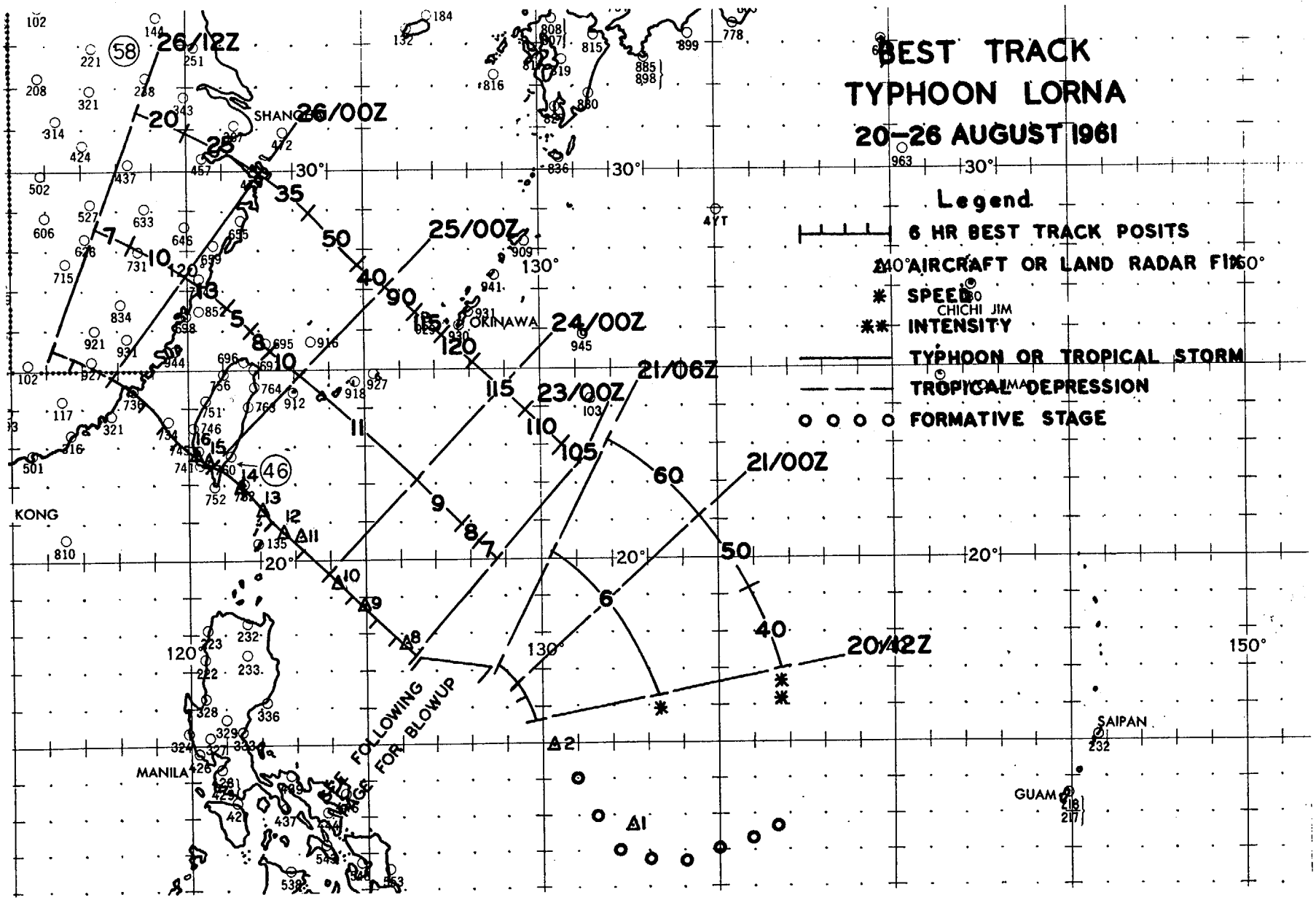
241200Z AND 251200Z.

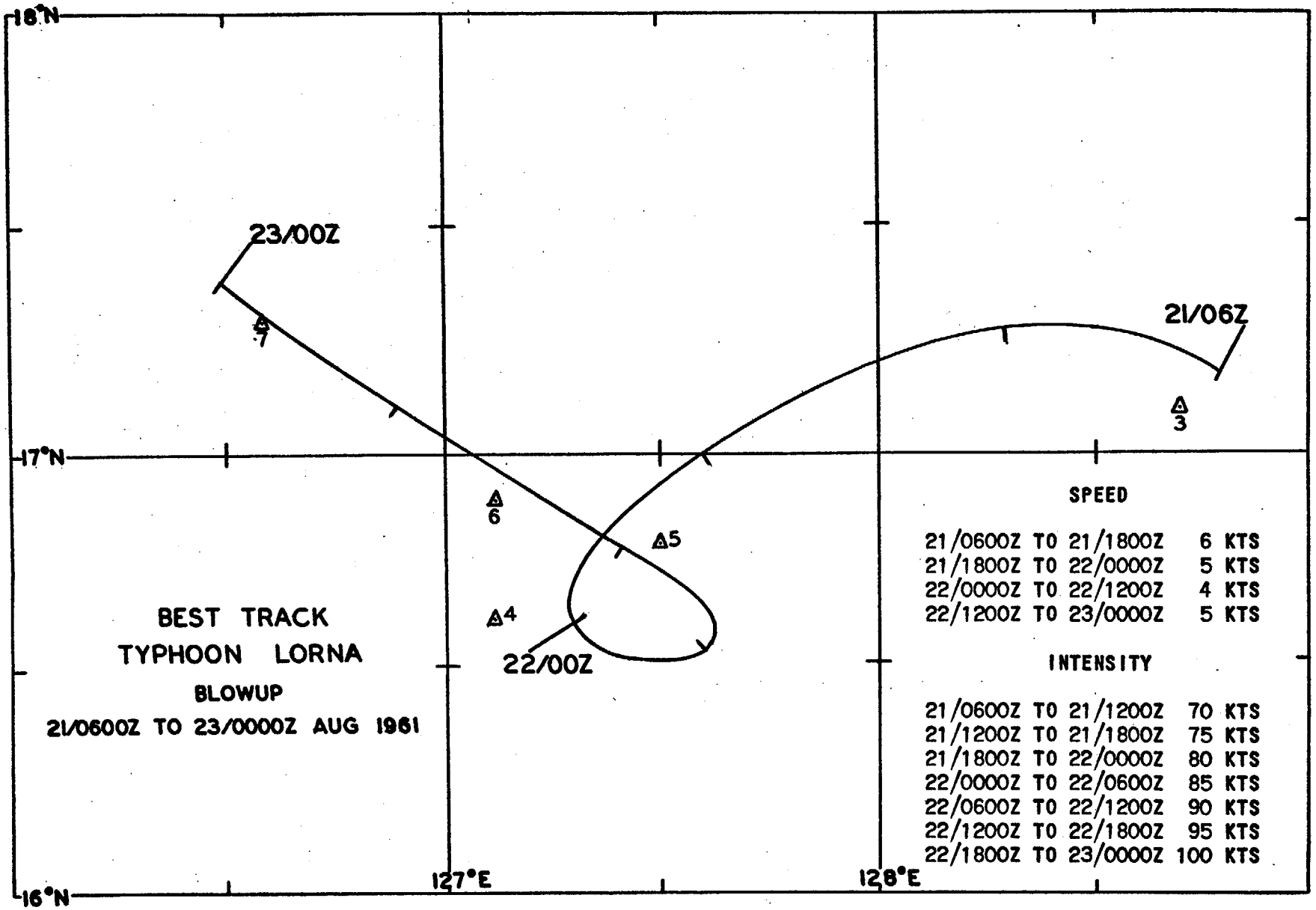
THE 1002 MB ISOBAR (LAST CLOSED ONE AT THE PEAK OF LORNA'S SIZE) ENCLOSED ABOUT 950,000 SQ MI. LORNA WAS A LARGE TYPHOON, BUT NOT THE LARGEST OF THE YEAR.

LORNA TRAVELED 1100 MI DURING THE 6 DAYS THAT WARNINGS WERE ISSUED AT AN AVERAGE SPEED OF 7.6 KTS OR 183 MI PER DAY; IT TRAVELED AT A MINIMUM SPEED OF 4 KTS BETWEEN 220000Z AND 221200Z AND AT A MAXIMUM SPEED OF 11 KTS BETWEEN 240000Z AND 250000Z. THE TYPHOON WAS AT ITS MAXIMUM INTENSITY, PRODUCING SURFACE WINDS OF 120 KTS BETWEEN 240600Z AND 241200Z.

WITH THE EXCEPTION OF THE LOOP, LORNA DID NOT CREATE ANY UNUSUAL FORECAST PROBLEMS.

LIMITED INFORMATION INDICATES THAT MAJOR FLOOD DAMAGE OCCURRED TO VILLAGES AND CROPS WITH THREE PERSONS KNOWN DEAD ON TAIWAN. REPORTS WERE NOT AVAILABLE FOR THE ASIATIC MAINLAND.


BEST TRACK
TYPHOON LORNA
20–26 AUGUST 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
26/12Z
26/00Z
25/00Z
24/00Z
23/00Z
21/06Z
21/00Z
20/12Z
SHANGHAI
OKINAWA
CHICHI JIM
IWO JIMA
4YT
KONG
MANILA
SAIPAN
GUAM
FOLLOWING FOR BLOWUP
120°
130°
140°
150°
30°
20°


18°N
17°N
16°N
127°E
128°E
23/00Z
21/06Z
22/00Z
Δ7
Δ6
Δ5
Δ4
Δ3
BEST TRACK
TYPHOON LORNA
BLOWUP
21/0600Z TO 23/0000Z AUG 1961
SPEED
21/0600Z TO 21/1800Z 6 KTS
21/1800Z TO 22/0000Z 5 KTS
22/0000Z TO 22/1200Z 4 KTS
22/1200Z TO 23/0000Z 5 KTS
INTENSITY
21/0600Z TO 21/1200Z 70 KTS
21/1200Z TO 21/1800Z 75 KTS
21/1800Z TO 22/0000Z 80 KTS
22/0000Z TO 22/0600Z 85 KTS
22/0600Z TO 22/1200Z 90 KTS
22/1200Z TO 22/1800Z 95 KTS
22/1800Z TO 23/0000Z 100 KTS

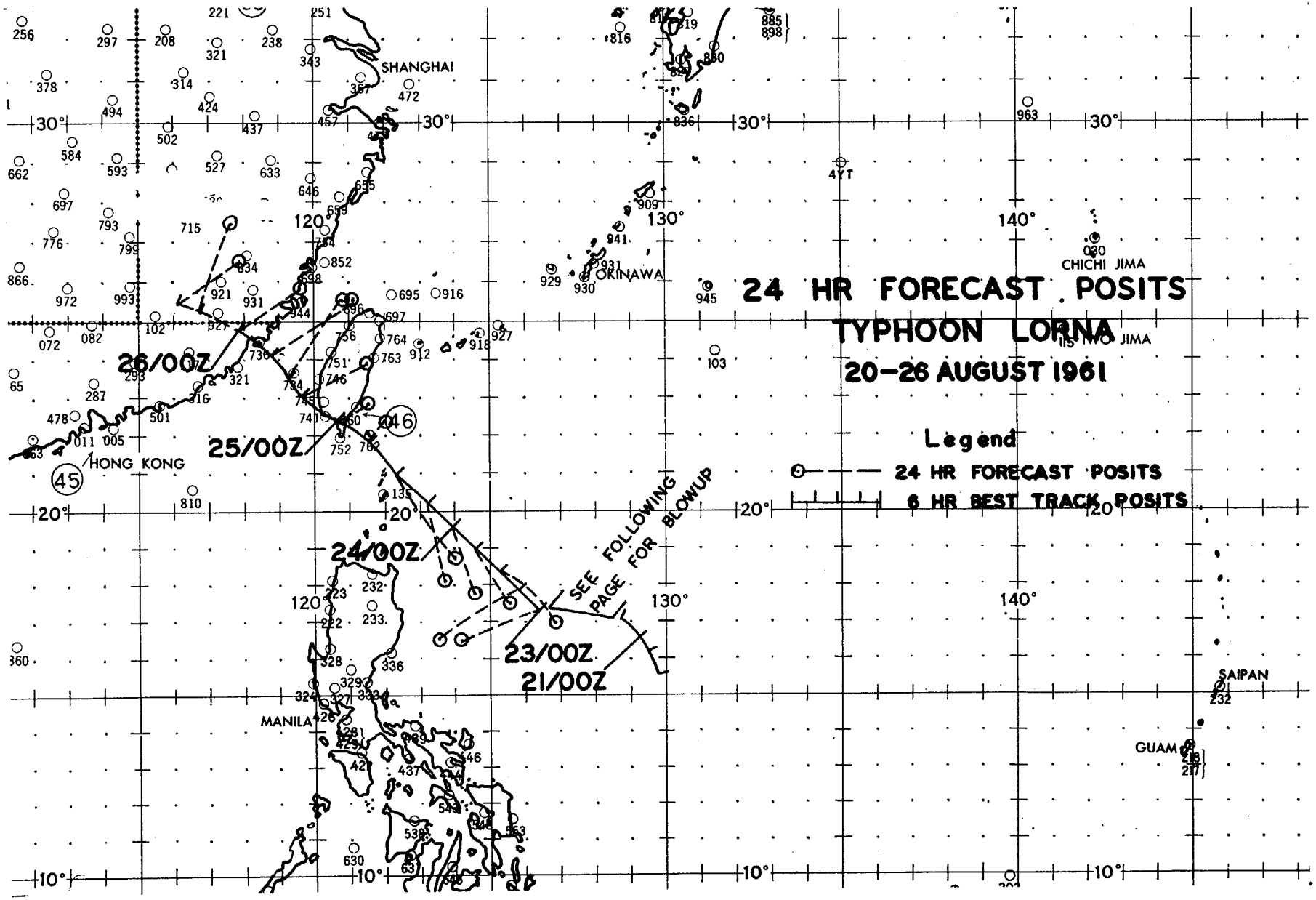
LAND RADAR AND AIRCRAFT FIXES - TYPHOON LORNA

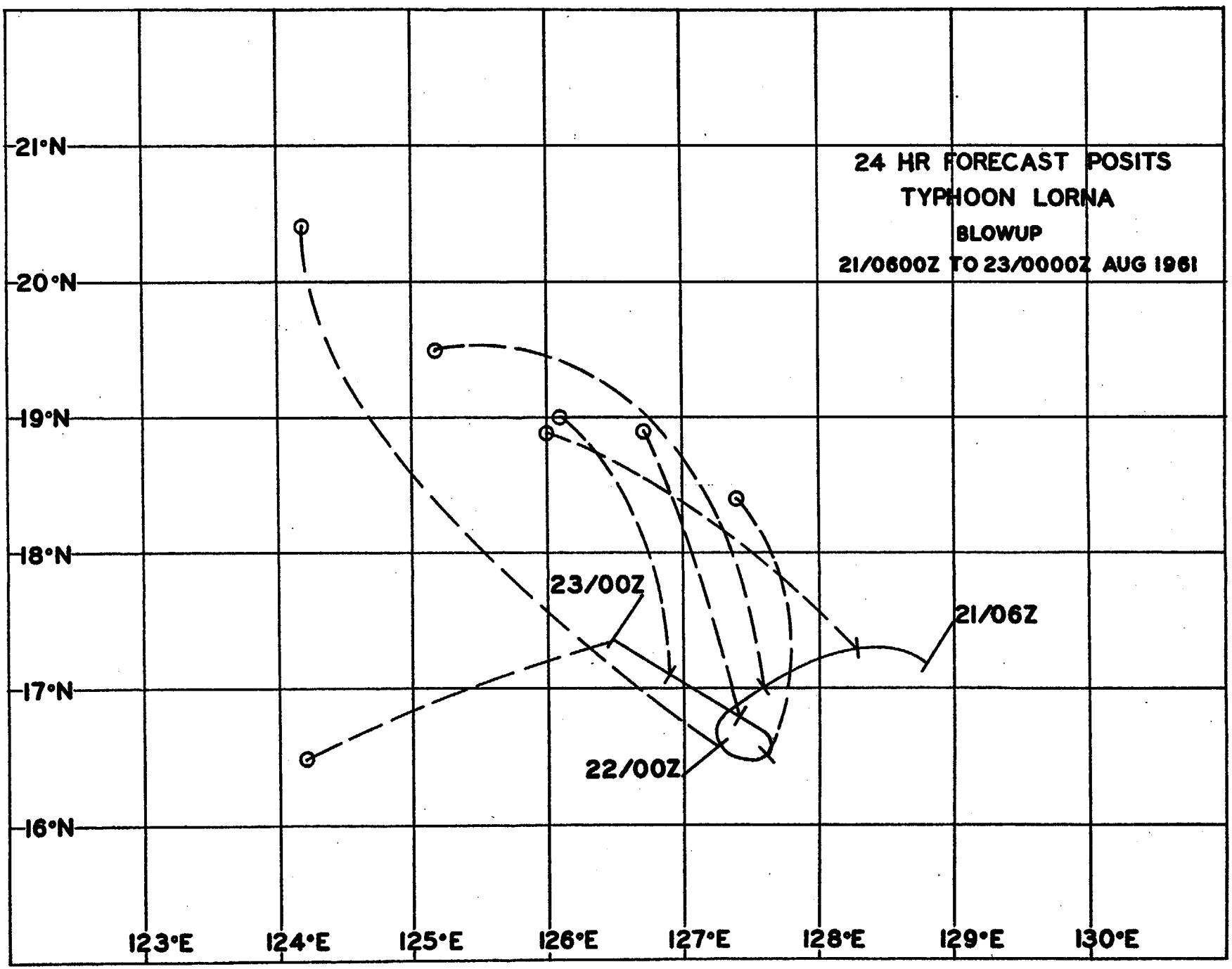
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	190610Z	12.8N	132.7E	56-P-08	25	22	10150	---	08/08	CIRC 20MI DIA
2	200450Z	15.3N	130.0E	VW1-R-05	---	---	----	---	-----	CIRC OPEN N
3	210700Z	17.1N	128.7E	56-P-04	70	25	9910	993	15/14	CIRC 40MI DIA OPEN N-E
4	212145Z	16.6N	127.1E	56-P-05	80	40	9820	980	17/15	ILL DEFINED OPEN N & E
5	220900Z	16.8N	127.5E	56-P-07	150	60	9630	974	18/14	CIRC DIA 30MI OPEN NE
6	221530Z	16.9N	127.1E	VW1-R-10	---	---	----	---	-----	25MI DIA OPEN N
7	222300Z	17.3N	126.6E	56-P-05	110	55	9490	976	18/18	ILL DEFINED OPEN N
8	230900Z	17.8N	126.1E	56-P-07	100	70	9380	970	19/07	CIRC DIA 26MI
9	231600Z	18.8N	125.0E	VW1-R-05	---	---	----	---	-----	CIRC DIA 28MI OPEN SE
10	232215Z	19.4N	124.2E	56-P-02	130	70	9000	947	18/12	DIA 35MI OPEN SE
11	240600Z	20.7N	123.1E	LND/RDR	---	---	----	---	-----	----------
12	240900Z	20.8N	122.8E	56-P-07	150	90	8880	950	22/13	CIRC DIA 15MI
13	241200Z	21.2N	122.1E	LND/RDR	---	---	----	---	-----	----------
14	241800Z	21.9N	121.5E	LND/RDR	---	---	----	---	-----	----------
15	250000Z	22.6N	120.6E	LND/RDR	---	---	----	---	-----	----------
16	250130Z	22.9N	120.1E	LND/RDR	---	---	----	---	-----	----------

TYPHOON LORNA 20-26 AUG 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
201200Z	15.7N	129.9E	-------	-------
201800Z	16.3N	129.6E	-------	-------
210000Z	16.7N	129.3E	-------	-------
210600Z	17.2N	128.8E	-------	-------
211200Z	17.3N	128.3E	-------	-------
211800Z	17.0N	127.6E	-------	-------
220000Z	16.6N	127.3E	-------	-------
220600Z	16.5N	127.6E	358-119	-------
221200Z	16.8N	127.4E	340-133	-------
221800Z	17.1N	126.9E	337-124	-------
230000Z	17.4N	126.5E	247-140	-------
230600Z	17.9N	125.9E	241-157	338-149
231200Z	18.4N	125.4E	135-117	333-143
231800Z	19.0N	124.7E	152-105	325-136
240000Z	19.7N	124.0E	165-109	272-159
240600Z	20.4N	123.2E	167-135	206-182
241200Z	21.2N	122.4E	146-166	149-234
241800Z	21.8N	121.6E	243-36	165-210
250000Z	22.7N	120.7E	072-51	169-230
250600Z	23.1N	119.7E	062-114	167-234
251200Z	23.8N	119.3E	039-141	156-259
251800Z	24.2N	118.9E	054-139	037-142
260000Z	24.9N	117.8E	062-110	152-169
260600Z	25.3N	116.8E	019-140	053-240
261200Z	25.5N	116.1E	056-120	048-252

AVERAGE 24 HOUR ERROR 120 MI
AVERAGE 48 HOUR ERROR 196 MI


24 HR FORECAST POSITS
TYPHOON LORNA
20–26 AUGUST 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
26/00Z
25/00Z
24/00Z
23/00Z
21/00Z
SEE FOLLOWING PAGE FOR BLOWUP
SHANGHAI
HONG KONG
MANILA
OKINAWA
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
4YT
45
46
120°
130°
140°
30°
20°
10°


24 HR FORECAST POSITS
TYPHOON LORNA
BLOWUP
21/0600Z TO 23/0000Z AUG 1961
21°N
20°N
19°N
18°N
17°N
16°N
123°E
124°E
125°E
126°E
127°E
128°E
129°E
130°E
23/00Z
21/06Z
22/00Z

K. TYPHOON NANCY (071200Z-170600Z SEPTEMBER 1961)

AT 070000Z A LOW APPEARED ON THE SURFACE MAP W OF KWAJALEIN ATOLL MARKING THE BEGINNING OF WHAT WAS TO BECOME THE MOST PROLONGED TYPHOON OF THE SEASON. THE FIRST TROPICAL DEPRESSION WARNING WAS ISSUED AT 071200Z AND THE SYSTEM WAS UPGRADED TO A TROPICAL STORM AT 080000Z WHEN IT BECAME OBVIOUS THAT INTENSIFICATION WAS TAKING PLACE. BY THE TIME A RECONNAISSANCE FIX COULD BE MADE, NANCY HAD SURFACE WINDS OF 125 KTS REVEALING THAT SHE WAS AN "EXPLOSIVE DEEPENER" AND HAD PROBABLY REACHED TYPHOON INTENSITY AT 071800Z.

FROM THE TIME OF THE FIRST WARNING NANCY FOLLOWED A SMOOTH WESTERLY TRACK CURVING SLIGHTLY TOWARD THE N. SHE CONTINUED TO INTENSIFY, PASSING 85 MI SSW OF GUAM AT 101800Z WITH MAXIMUM SURFACE WINDS OF 180 KTS. AFTER REACHING THE PEAK INTENSITY OF 185 KTS NANCY STARTED WEAKENING AND BEGAN A MORE PRONOUNCED RECURVATURE, PASSING 40 MI E OF OKINAWA AT 141500Z AND OVER NAZE AT 150000Z. AT THIS TIME MOST FORECASTING RULES INDICATED THAT NANCY WOULD SWING WIDE AROUND JAPAN AND RECURVE INTO THE JAPAN SEA. HOWEVER, BY 151200Z A MARKED CHANGE HAD TAKEN PLACE IN THE UPPER AIR PATTERN AROUND THE TYPHOON. NANCY'S DIAMETER DIMINISHED SIGNIFICANTLY AT THE 500 MB LEVEL AND THE SUBTROPICAL HIGH WHICH HAD BEEN QUASISTATIONARY NEAR 30N 145E SHIFTED 10 DEGREES TO THE E. NANCY THEN ACCELERATED AND RECURVED MORE SHARPLY, BUT UPON ENCOUNTERING THE JAPANESE LAND MASS SHE DEFLECTED BACK TOWARD THE N, PASSING DIRECTLY OVER MUROTO ZAKI AT APPROXIMATELY 160100Z. THE TYPHOON ENTERED HONSHU NEAR OSAKA AT 160430Z, AND BY THIS TIME HAD WEAKENED TO 75 KTS. SHE MADE A RAPID TRANSIT ACROSS HONSHU EMERGING INTO THE JAPAN SEA NEAR NANAO AND CONTINUED NNE TO HOKKAIDO.

THE FINAL WARNING WAS ISSUED AT 170600Z WHEN NANCY HAD CROSSED INTO THE SEA OF OKHOTSK AND HAD OBVIOUSLY LOST HER TROPICAL CHARACTERISTICS. THE MAXIMUM SURFACE WINDS WERE 55 KTS AT THAT TIME.

A TOTAL OF 40 WARNINGS WERE ISSUED, COVERING A PERIOD OF 9 DAYS AND 18 HOURS. NANCY'S SURFACE WINDS REMAINED OVER 100 KTS FOR 8 DAYS, FROM 080000Z TO 160000Z. SHE TRAVELED 4275 MI AT AN AVERAGE SPEED OF 18 KTS. THE MINIMUM SPEED WAS 11 KTS ON 15 SEPTEMBER AND THE MAXIMUM SPEED WAS 55 KTS WHEN NANCY WAS OVER NORTHERN JAPAN. WARNINGS WERE ISSUED ON TYPHOONS OLGA AND PAMELA DURING THE LIFE OF NANCY.

THE DAMAGE CREATED BY TYPHOON NANCY WAS PHENOMENAL. IT TRAVELED ACROSS SOME OF THE MOST DENSELY POPULATED AREAS THAT EXIST, YET THE DEATH TOLL PROBABLY DID NOT EXCEED 225, AND THE DAMAGE WAS SMALL COMPARED TO THAT CREATED BY TYPHOONS OF EARLIER YEARS. EXAMINATION OF AVAILABLE INFORMATION INDICATES THAT PROPARATIONS WERE MADE WELL IN ADVANCE OF THE ARRIVAL OF NANCY FOR PROTECTION AGAINST STRONG WINDS, FLOODING, AND HIGH SEAS. THIS IS PARTICULARLY NOTABLE IN JAPAN, FOR THE PATH OF NANCY WAS SUCH THAT IT AFFECTED ALL OF THAT NATION TO

SOME DEGREE.

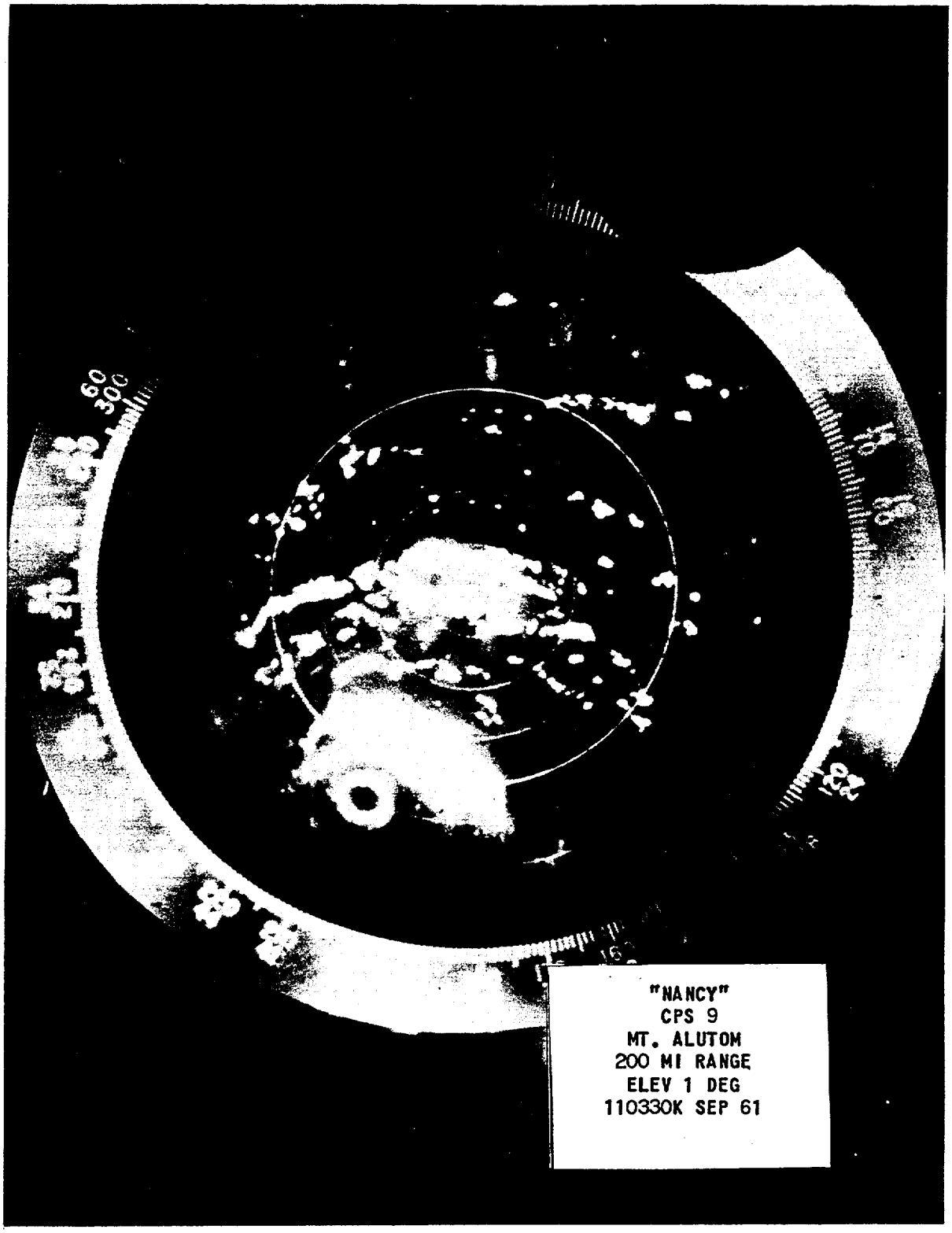
A SUMMARY OF DAMAGE IS PRESENTED HERE:

GUAM: ROADS WERE DAMAGED TO THE EXTENT THAT REPAIRS WERE ESTIMATED TO COST APPROXIMATELY $40,000. ABOUT 50 PERCENT OF CROPS ON THE SOUTHERN END OF THE ISLAND, SUCH AS BEANS, BANANAS, TOMATOES, BREADFRUIT, MELONS, AND CUCUMBERS WERE DESTROYED DUE TO STRONG WINDS AND HEAVY RAIN. THE NORTHERN END OF THE ISLAND SUFFERED LITTLE DAMAGE.

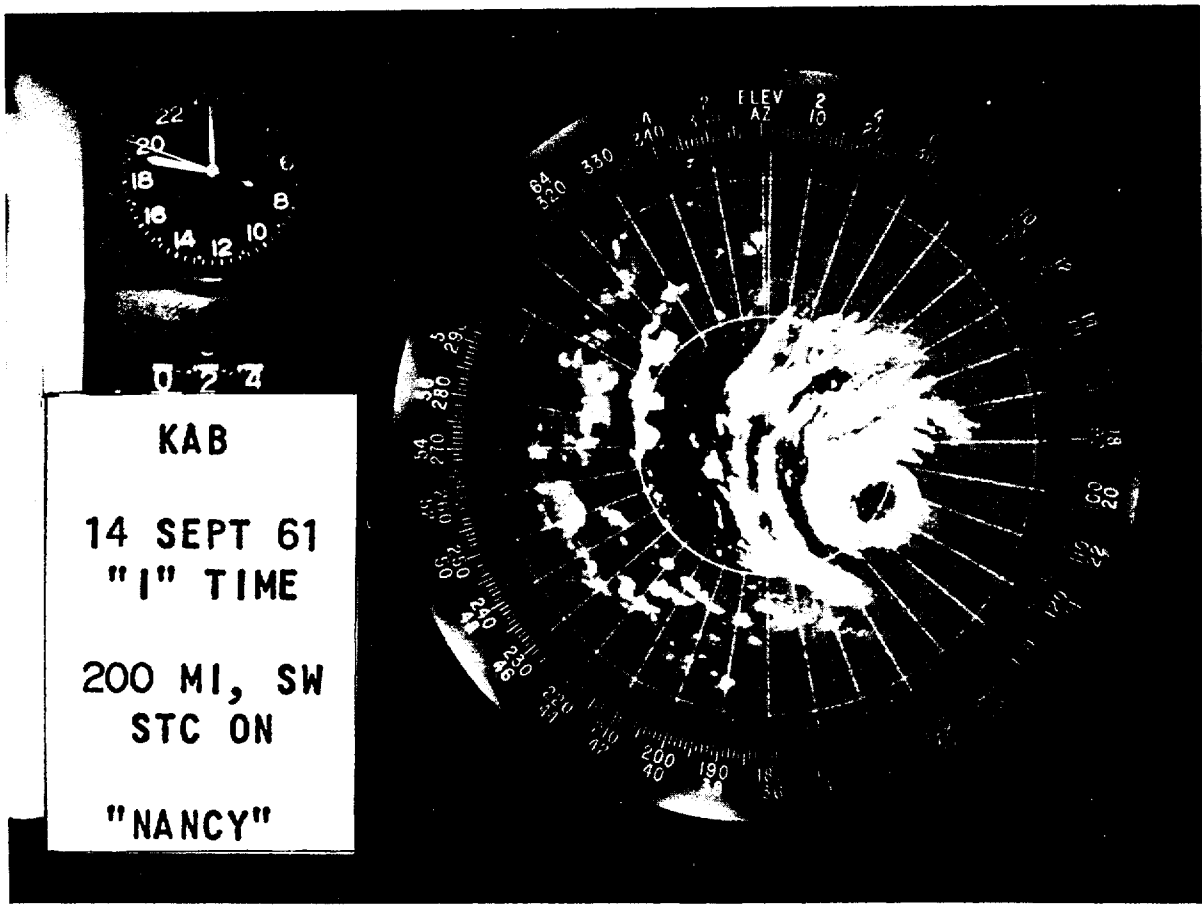
OKINAWA: EXTENSIVE CROP AND STRUCTURAL DAMAGE AND FLOODING OF LOW LYING AREAS OCCURRED BUT NO LOSS OF LIFE.

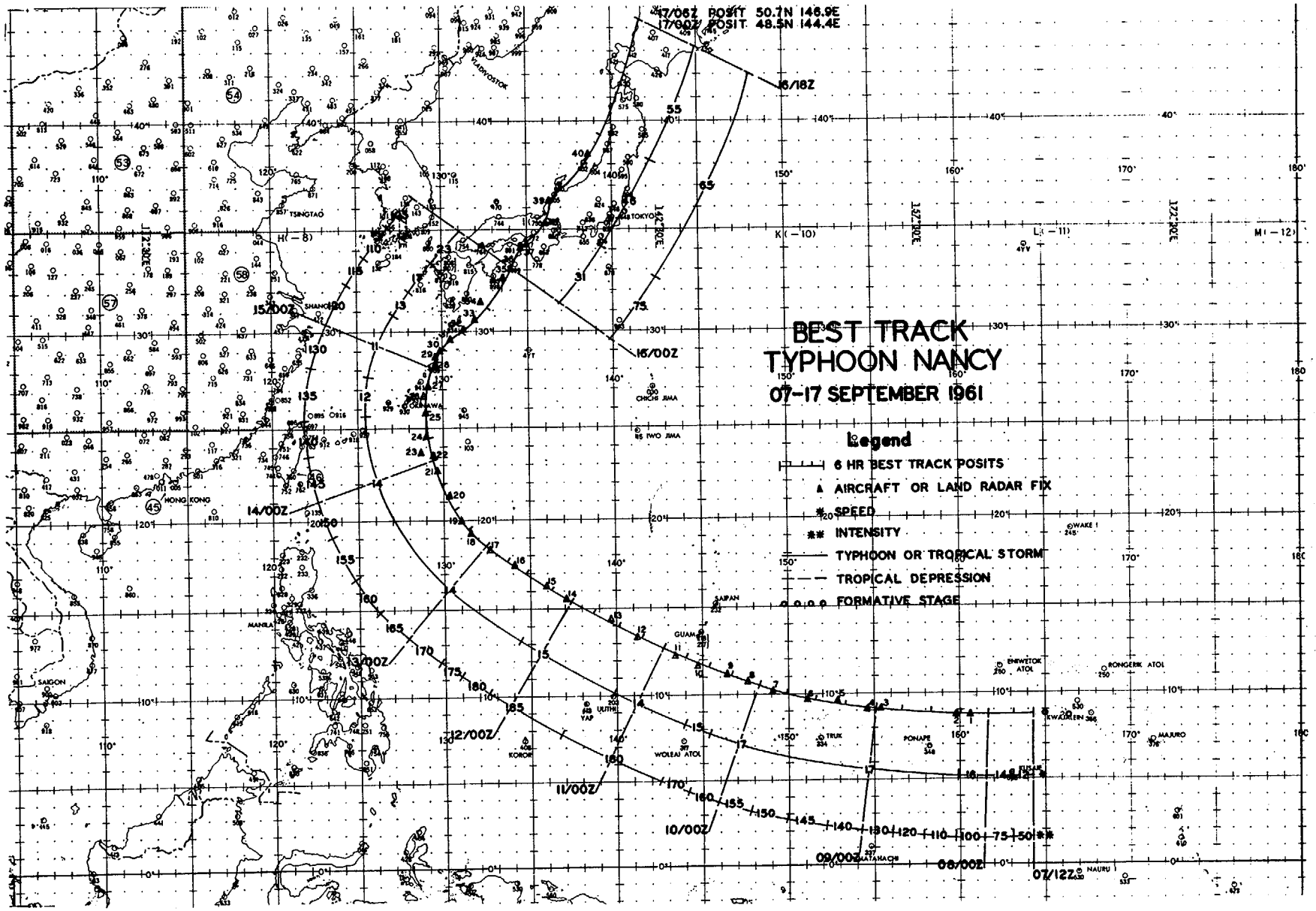
AMAMI-O-SHIMA: ONE PERSON MISSING, ONE SERIOUSLY HURT, AND 152 PEOPLE WERE LEFT HOMELESS. ONE SHIP WAS SUNK, COMMUNICATIONS WERE LOST AND EXTENSIVE FLOODING OF HOMES AND CROPS ALSO OCCURRED.

JAPAN: THERE WERE 172 PERSONS REPORTED DEAD, 18 MISSING, AND 3,184 INJURED. THE JAPAN NATIONAL POLICE REPORTED THAT AS A RESULT OF NANCY, MORE THAN 650,000 PERSONS WERE LEFT HOMELESS, 11,539 HOMES WERE DESTROYED, 32,604 HOMES WERE PARTIALLY DESTROYED, AND 280,078 HOMES WERE FLOODED. MORE THAN 300 SHIPS WERE SUNK, AND MANY DAMAGED. THE FLOODS CAUSED A LOSS OF 566 BRIDGES, CAUSED 1,146 LANDSLIDES AND CUT ROADS AT 2,053 PLACES. JAPANESE OFFICIALS SAID NANCY WAS RATED SIXTH IN THE NUMBER OF PERSONS KILLED BY AN INDIVIDUAL TYPHOON. TYPHOON VERA KILLED 4,464 PERSONS IN NAGOYA ON 26 SEPTEMBER 1959, THE WORST IN JAPANESE HISTORY.


"NANCY"
CPS 9
MT. ALUTOM
200 MI RANGE
ELEV 1 DEG
110330K SEP 61


21.2N 130.3E
9-13-61
VW-1
APS-20
0452-NANCY
"NANCY"


KAB
14 SEPT 61
"I" TIME
200 MI, SW
STC ON
"NANCY"


17/06Z POSIT 50.7N 146.9E
17/00Z POSIT 48.5N 144.4E
16/18Z
16/00Z
15/00Z
14/00Z
13/00Z
12/00Z
11/00Z
10/00Z
09/00Z
08/00Z
07/12Z
BEST TRACK
TYPHOON NANCY
07-17 SEPTEMBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
VLADIVOSTOK
TSINGTAO
SHANGHAI
TOKYO
CHICHI JIMA
IWO JIMA
HONG KONG
SAIGON
MANILA
SAIPAN
GUAM
WAKE I
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN
MAJURO
TRUK
PONAPE
KOROR
WOLEAI ATOLL
NAURU

LAND RADAR AND AIRCRAFT FIXES - TYPHOON NANCY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/Td (°C)	EYE CHARACTERISTICS
1	080230Z	08.8N	160.8E	LND/RDR	---	---	----	---	-----	----------
2	080625Z	08.9N	160.0E	56-P-06	125	60	9580	978	13/09	WALL CLDS ALL QUADS ELLIP 30MI N-S & 20MI E-W
3	082130Z	09.1N	155.5E	56-P-05	130	90	9220	---	16/06	CIRC DIA 10MI
4	090100Z	09.1N	154.8E	56-P-10	150	100	9080	956	18/11	WELL DEFINED CIRC 25MI DIA
5	090706Z	09.5N	153.0E	56-P-05	165	110	8410	928	16/13	CIRC 10MI DIA NO CLDS IN EYE
6	091330Z	09.7N	151.2E	VW1-R-03	---	---	----	---	-----	DIA 8MI
7	092130Z	10.1N	149.2E	56-P-03	180	120	8240	---	17/12	CIRC 8MI DIA WALL CLDS ALL QUADS
8	100230Z	10.8N	147.7E	56-P-02	200	130	7890	925	16/15	CIRC 8MI DIA
9	100705Z	11.2N	146.4E	56-P-02	200	160	7770	916	20/08	CIRC DIA 25MI
10	101345Z	11.7N	144.8E	LND/RDR	---	---	----	---	-----	----------
11	101950Z	12.2N	143.3E	LND/RDR	---	---	----	---	-----	----------
12	110700Z	13.3N	141.2E	56-P-02	200	130	7190	901	20/15	17MI DIA, WELL DEFINED
13	111330Z	14.3N	139.9E	VW1-R-03	---	---	----	---	-----	CIRC 16MI DIA
14	120045Z	15.7N	137.2E	56-P-02	200	150	6801	888	20/17	CIRC 6MI DIA
15	120630Z	16.3N	136.0E	56-P-02	200	130	6990	890	20/18	ELLIP N-S 18MI E-W 12MI
16	121400Z	17.5N	134.1E	VW1-R-03	---	---	----	---	-----	CIRC 25MI DIA
17	122145Z	18.2N	132.8E	56-P-08	180	140	6900	889	18/14	CIRC DIA 10MI
18	130415Z	19.2N	131.5E	56-P-01	150	140	6885	889	21/16	CIRC 25MI DIA
19	130830Z	19.9N	131.0E	56-P-01	120	130	6990	882	18/15	CIRC 15MI DIA
20	131453Z	21.2N	130.3E	VW1-R-05	---	---	----	---	-----	INNER EYE 27MI DIA OUTER EYE 52MI DIA

LAND RADAR AND AIRCRAFT FIXES - TYPHOON NANCY (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
21	132200Z	22.7N	129.7E	56-P-05	160	125	7380	902	17/17	40MI DIA
22	140000Z	23.4N	129.4E	LND/RDR	---	---	----	---	-----	----------
23	140245Z	23.7N	128.8E	56-P-05	150	135	7490	903	19/17	CIRC 50MI DIA
24	140525Z	24.6N	129.0E	LND/RDR	---	---	----	---	-----	----------
25	141115Z	25.9N	129.0E	LND/RDR	---	---	----	---	-----	----------
26	141500Z	26.7N	128.9E	LND/RDR	---	---	----	---	-----	----------
27	141745Z	27.1N	129.1E	LND/RDR	---	---	----	---	-----	----------
28	142320Z	28.1N	129.5E	LND/RDR	---	---	----	---	-----	DIA 33MI
29	150356Z	28.7N	129.6E	56-P-01	120	87	7830	920	18/18	CIRC 60MI DIA WALL CLDS ALL QUADS
30	150600Z	29.0N	130.0E	LND/RDR	---	---	----	---	-----	----------
31	151000Z	29.6N	130.6E	LND/RDR	---	---	----	---	-----	----------
32	151300Z	30.1N	131.2E	LND/RDR	---	---	----	---	-----	----------
33	151500Z	30.5N	131.6E	LND/RDR	---	---	----	---	-----	----------
34	151800Z	31.4N	132.2E	LND/RDR	---	---	----	---	-----	----------
35	152155Z	32.2N	133.1E	LND/RDR	---	---	----	---	-----	----------
36	160000Z	33.1N	133.9E	LND/RDR	---	---	----	---	-----	----------
37	160300Z	34.1N	134.7E	LND/RDR	---	---	----	---	-----	----------
38	160530Z	35.2N	136.1E	LND/RDR	---	---	----	---	-----	----------
39	160700Z	36.3N	136.2E	LND/RDR	---	---	----	---	-----	----------
40	161100Z	38.5N	138.5E	LND/RDR	---	---	----	---	-----	----------

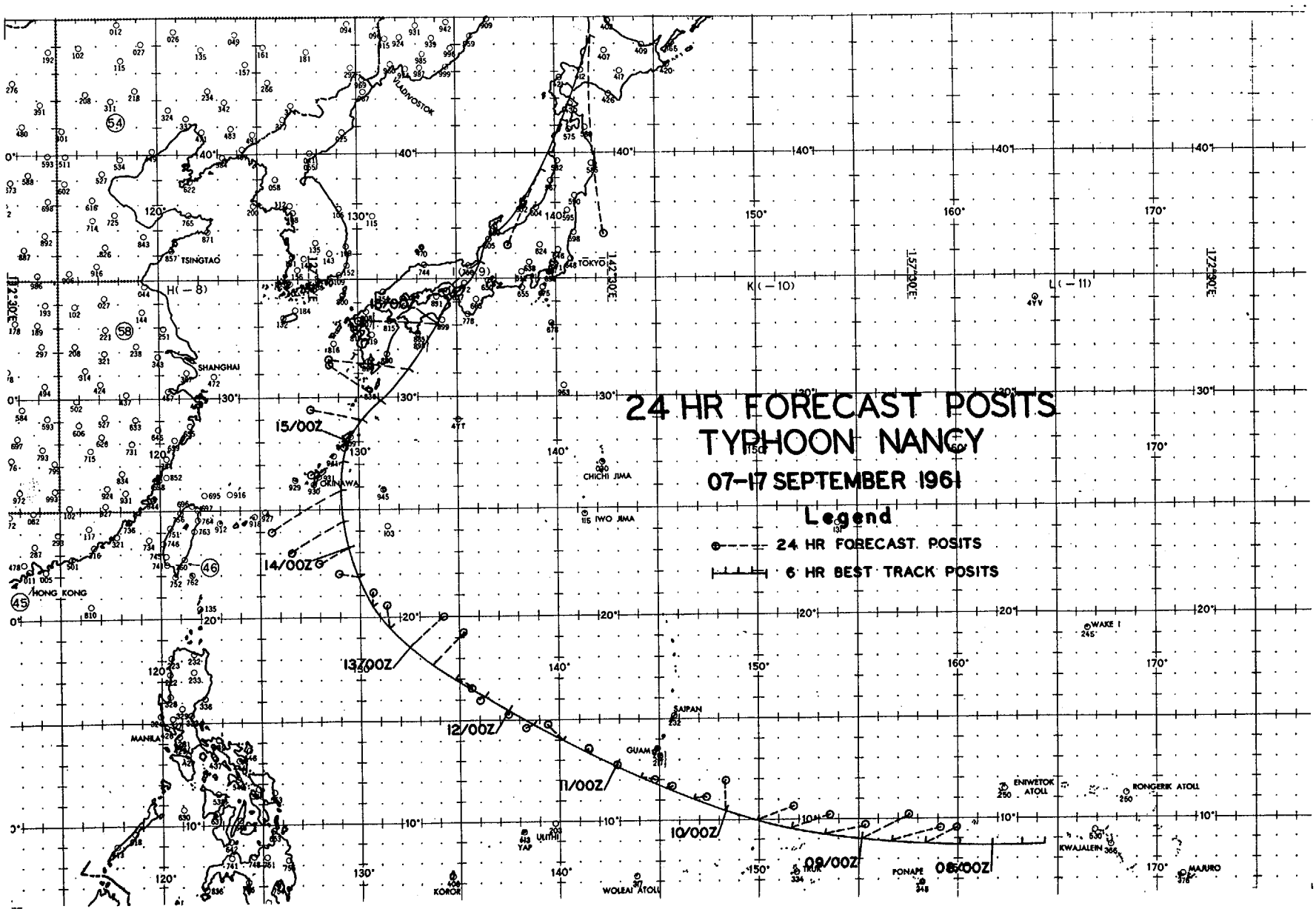
TYPHOON NANCY 07-17 SEP 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
071200Z	08.8N	164.3E	-------		-------	
071800Z	08.8N	163.2E	-------		-------	
080000Z	08.8N	161.8E	-------		-------	
080600Z	08.9N	160.1E	-------		-------	
081200Z	08.9N	158.4E	-------		-------	
081800Z	09.0N	156.8E	-------		-------	
090000Z	09.1N	155.1E	067	167	-------	
090600Z	09.3N	153.3E	076	119	-------	
091200Z	09.6N	151.7E	074	126	-------	
091800Z	10.0N	149.9E	066	116	-------	
100000Z	10.5N	148.3E	357	90	078	281
100600Z	11.0N	146.7E	079	31	086	184
101200Z	11.5N	145.2E	069	27	076	159
101800Z	12.0N	144.0E	360	48	077	154
110000Z	12.6N	142.8E	046	21	324	205
110600Z	13.2N	141.4E	344	23	336	25
111200Z	14.0N	140.1E	313	67	108	37
111800Z	14.8N	138.8E	263	35	112	95
120000Z	15.5N	137.5E	211	23	103	71
120600Z	16.2N	136.1E	213	19	078	70
121200Z	17.0N	134.9E	131	44	031	81
121800Z	17.7N	133.7E	045	121	115	37
130000Z	18.4N	132.3E	048	139	101	56
130600Z	19.4N	131.3E	356	64	118	41
131200Z	20.6N	130.6E	015	31	137	85
131800Z	21.9N	129.9E	297	54	063	120
140000Z	23.2N	129.4E	242	90	068	93
140600Z	24.6N	129.1E	236	167	261	84
141200Z	25.9N	128.9E	238	222	229	123
141800Z	27.2N	129.1E	245	93	243	226
150000Z	28.2N	129.3E	211	25	242	309
150600Z	29.1N	130.0E	283	130	248	316
151200Z	29.9N	131.1E	302	155	255	468
151800Z	31.2N	132.3E	277	200	262	287
160000Z	33.1N	134.0E	271	201	246	294
160600Z	35.5N	136.1E	231	104	251	373

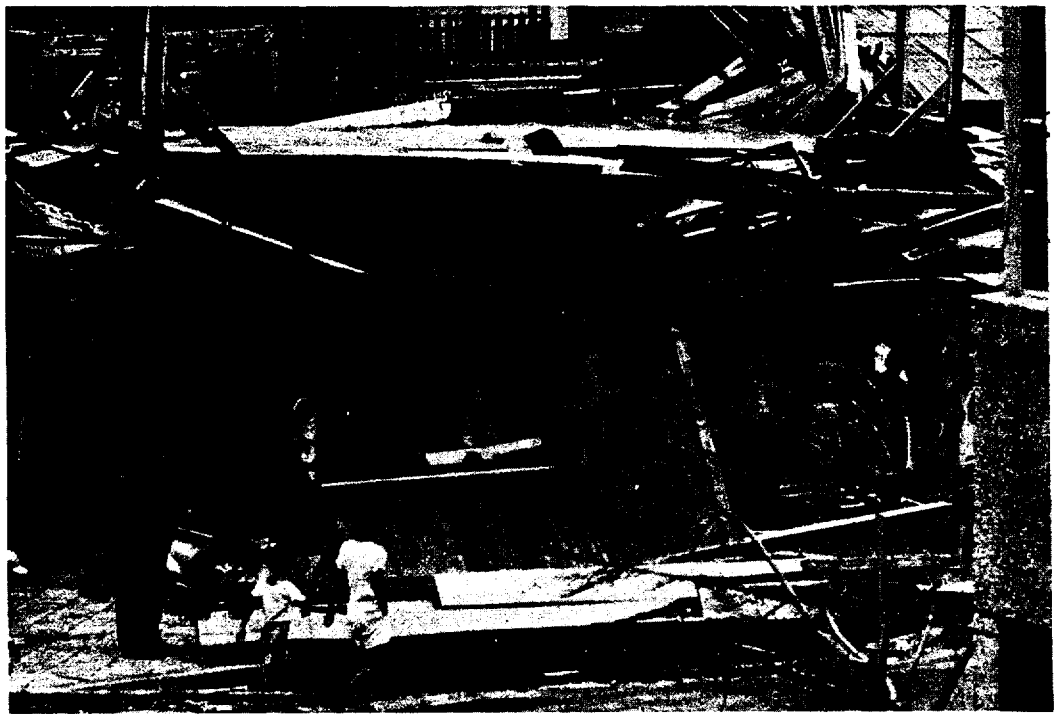
TYPHOON NANCY 07-17 SEP 1961
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
161200Z	39.3N	139.2E	202	194	246	466
161800Z	44.6N	141.8E	177	465	227	660
170000Z	48.5N	144.4E	174	618	208	707
170600Z	50.7N	146.9E	154	494	192	747

AVERAGE 24 HOUR ERROR 133 MI
AVERAGE 48 HOUR ERROR 228 MI

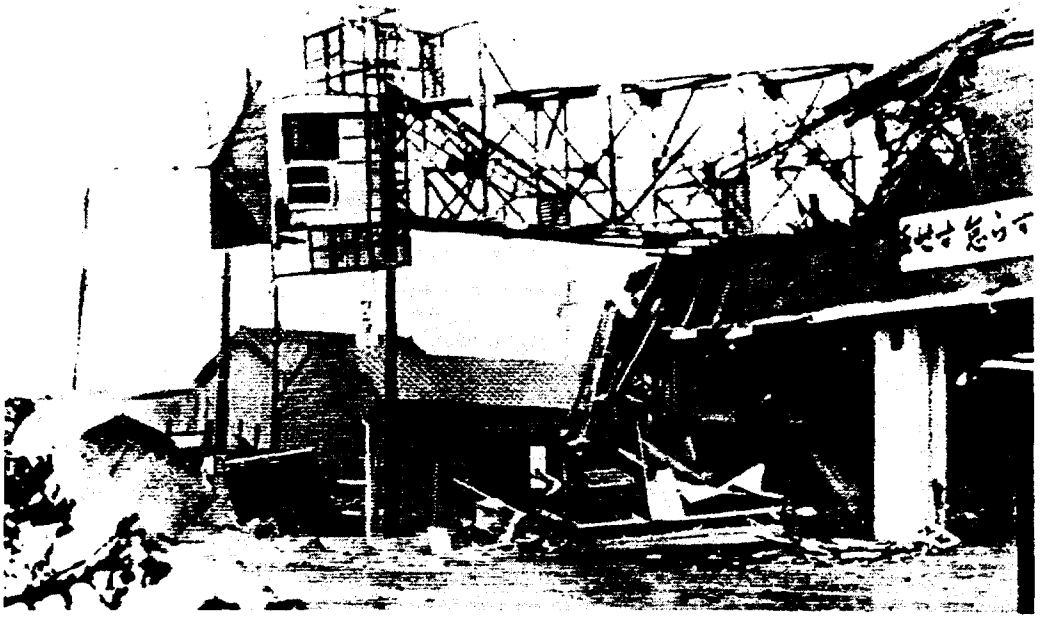

24 HR FORECAST POSITS
TYPHOON NANCY
07-17 SEPTEMBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
15/00Z
14/00Z
13/00Z
12/00Z
11/00Z
10/00Z
09/00Z
08/00Z
VLADIVOSTOK
TSINGTAO
SHANGHAI
TOKYO
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
SAIPAN
GUAM
WAKE I
ENIWETOK ATOLL
RONGERIK ATOLL
KWAJALEIN
MAJURO
PONAPE
TRUK
WOLEAI ATOLL
KOROR
ULITHI
H(−8)
I(−9)
K(−10)
L(−11)

SHIP DAMAGED ON OKINAWA AS A RESULT OF WINDS AND SEAS ASSOCIATED WITH NANCY. SEPTEMBER 1961. (PACIFIC STARS AND STRIPES)



STRUCTURAL DAMAGE, NAHA, OKINAWA. NOTE INVERTED ROOF, CEILING AND SUPPORTS RESTING ON ROOF OF SHOP. SEPTEMBER 1961. (PACIFIC STARS AND STRIPES)

FLOODING CREATED IN TOKYO BY NANCY, EVEN THOUGH THE EYE OF THE TYPHOON WAS MORE THAN 160 MI AWAY. SEPTEMBER 1961. (PACIFIC STARS AND STRIPES)



STEEL FIRE OBSERVATION TOWER BROKEN IN HALF BY NANCY, OSAKA, JAPAN, 16 SEPTEMBER 1961. (AP WIRE PHOTO)

L. TYPHOON OLGA (080000Z-100600Z SEPTEMBER 1961)

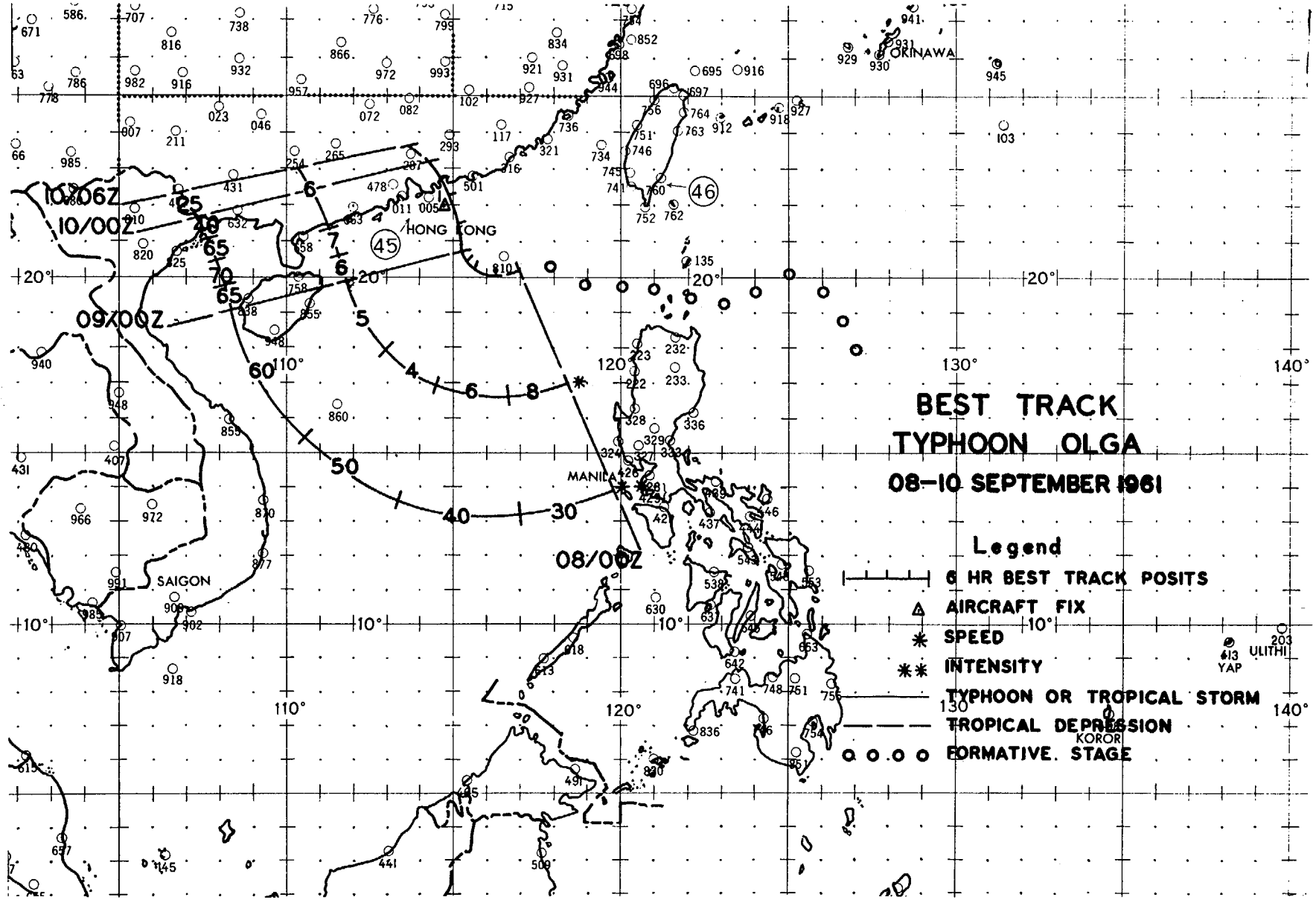
THE FORMATION OF THE LOW WHICH ULTIMATELY BECAME OLGA OCCURRED ALONG THE INTERTROPICAL CONVERGENCE ZONE E OF THE PHILIPPINE ISLANDS. FROM ITS ORIGIN IT DRIFTED SLOWLY WESTWARD WITH NO NOTICEABLE INTENSIFICATION UNTIL IT CROSSED INTO THE SOUTH CHINA SEA. ON 7 SEPTEMBER SHIP REPORTS INDICATED THAT THE SLP WAS BEGINNING TO DROP AND THE PERIPHERAL WINDS WERE INCREASING. THUS AT 080000Z JTWC ISSUED THE FIRST WARNING ON TROPICAL DEPRESSION 27.

THE AREA OF CYCLONIC CIRCULATION CONTINUED TO INCREASE AND BECOME MORE WELL DEFINED. AT 080600Z THE SYSTEM WAS UPGRADED TO A TROPICAL STORM AND ASSIGNED THE NAME OLGA. THE 081200Z 200 MB ANALYSIS INDICATED A MARKED TRANSITION TAKING PLACE IN THE SUBTROPICAL RIDGE. THE ANTICYCLONIC OUTDRAFT WHICH WAS LOCATED NE OF OLGA BROKE DOWN CAUSING THE RIDGE AXIS TO SHIFT TO THE S. IT WAS AT THIS TIME THAT OLGA MADE AN ABRUPT CHANGE FROM HER WESTERLY TRACK AND TURNED TOWARD THE N. THIS TURN WAS FORECAST PERFECTLY BY THE JOINT NUMERICAL WEATHER PREDICTION UNIT, SUITLAND, MD. OF ALL JNWP FORECASTS RECEIVED, THE ONE FOR OLGA VERIFIED CLOSEST TO THE BEST TRACK.

OLGA CONTINUED TO INTENSIFY AND WAS UPGRADED TO A TYPHOON AT 090000Z. AFTER REACHING THE MAXIMUM STRENGTH OF 70 KTS SHORTLY AFTER 090600Z OLGA STARTED TO WEAKEN SLIGHTLY BECAUSE OF HER PROXIMITY TO LAND. SHE ENTERED THE ASIATIC MAINLAND APPROXIMATELY 30 MI NE OF HONG KONG AT 091800Z. AT THE TIME OF HER PASSAGE OVER THE COASTLINE OLGA WAS STILL OF TYPHOON STRENGTH, BUT SHE WEAKENED RAPIDLY, AND THE FINAL WARNING WAS ISSUED AT 100600Z.

ONLY TEN WARNINGS WERE ISSUED ON OLGA, COVERING A PERIOD OF 2 DAYS AND 6 HOURS. SHE TRAVELED 325 MI AT AN AVERAGE SPEED OF 6 KTS. ALTHOUGH SHOWING AN ABRUPT CHANGE OF DIRECTION, OLGA'S TRACK IS NOT MARKEDLY DIFFERENT FROM OTHER TYPHOONS WHICH HAVE OCCURRED NEAR HONG KONG DURING PREVIOUS SEPTEMBERS.

STRONG WINDS AND HEAVY RAIN AFFECTED HONG KONG AND THE ASIATIC MAINLAND DURING THE LIFE OF OLGA AND 5 DEATHS WERE REPORTED AS A RESULT OF LANDSLIDES. A 300 TON FISHING TRAWLER BROKE LOOSE, DRIFTED AWAY AND CAPSIZED. RESCUE PARTIES SAVED ALL ABOARD. AIRLINE AND FERRY SERVICES WERE DISRUPTED, SOME TREES UPROOTED AND THE STREETS OF HONG KONG WERE LITTERED WITH DEBRIS. SOME CROP DAMAGE WAS REPORTED ON THE ASIATIC MAINLAND AND ABOUT 70 PEOPLE TOOK ADVANTAGE OF THE TYPHOON AND SOUGHT REFUGE IN HONG KONG.


BEST TRACK
TYPHOON OLGA
08–10 SEPTEMBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
10/06Z
10/00Z
09/00Z
08/00Z
HONG KONG
MANILA
SAIGON
OKINAWA
YAP
ULITHI
KOROR
110°
120°
130°
140°
20°
10°

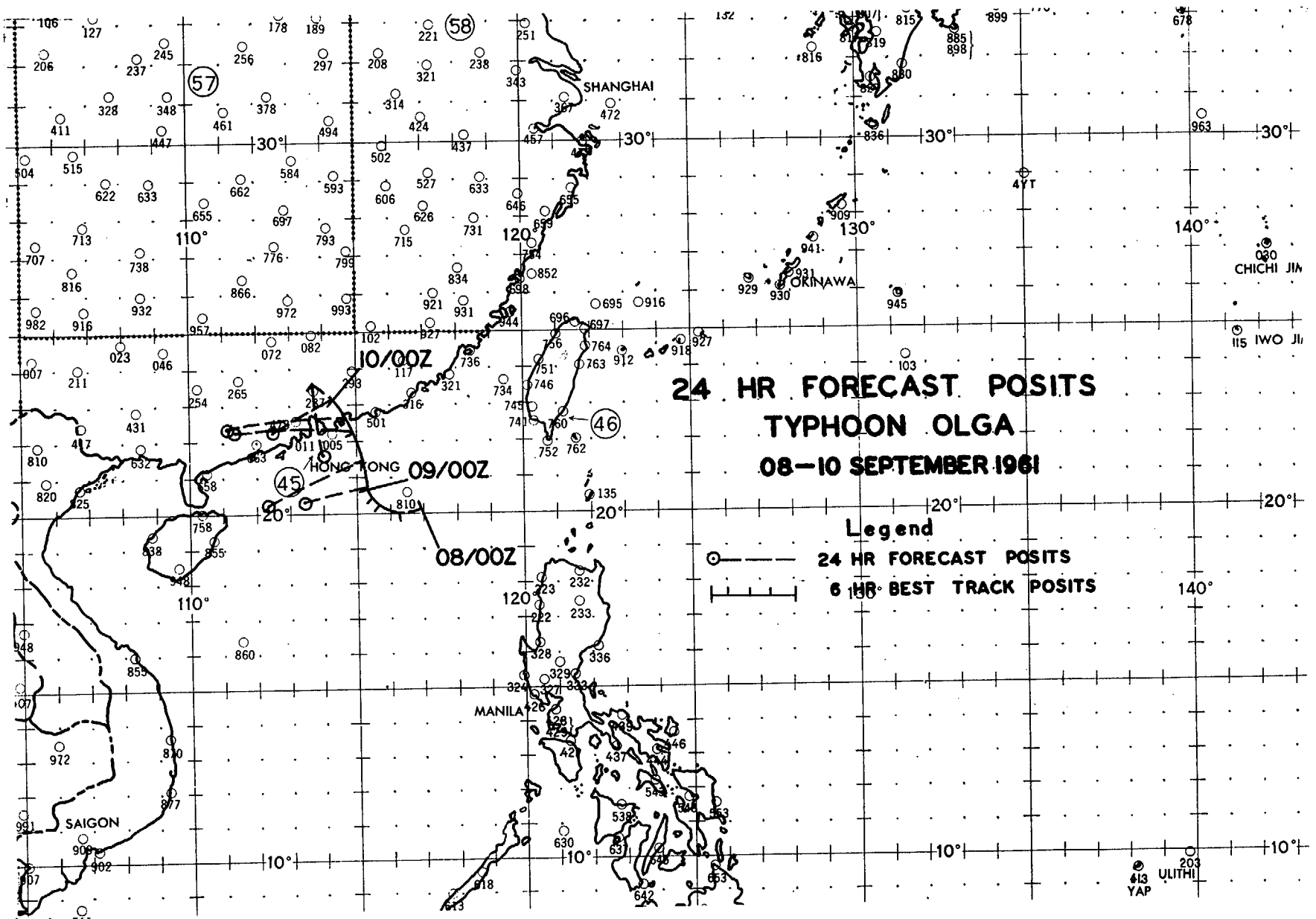
LAND RADAR AND AIRCRAFT FIXES - TYPHOON OLGA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/T_D (^{0}C)	EYE CHARACTERISTICS
1	090930Z	22.0N	114.8E	USN-EST	---	---	-----	---	------	----------

TYPHOON OLGA 08-10 SEP 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
080000Z	20.2N	117.0E	-------	-------
080600Z	20.0N	116.2E	-------	-------
081200Z	20.1N	115.5E	-------	-------
081800Z	20.4N	115.3E	-------	-------
090000Z	20.9N	115.2E	-------	-------
090600Z	21.5N	115.2E	245-188	-------
091200Z	22.2N	114.9E	271-150	-------
091800Z	22.7N	114.7E	262-200	-------
100000Z	23.2N	114.3E	239-116	-------
100600Z	23.6N	113.7E	169-122	239-353

AVERAGE 24 HOUR ERROR 155 MI
AVERAGE 48 HOUR ERROR 353 MI


24 HR FORECAST POSITS
TYPHOON OLGA
08–10 SEPTEMBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
10/00Z
09/00Z
08/00Z
HONG KONG
SHANGHAI
OKINAWA
MANILA
SAIGON
CHICHI JIMA
IWO JIMA
YAP
ULITHI
110°
120°
130°
140°
30°
20°
10°

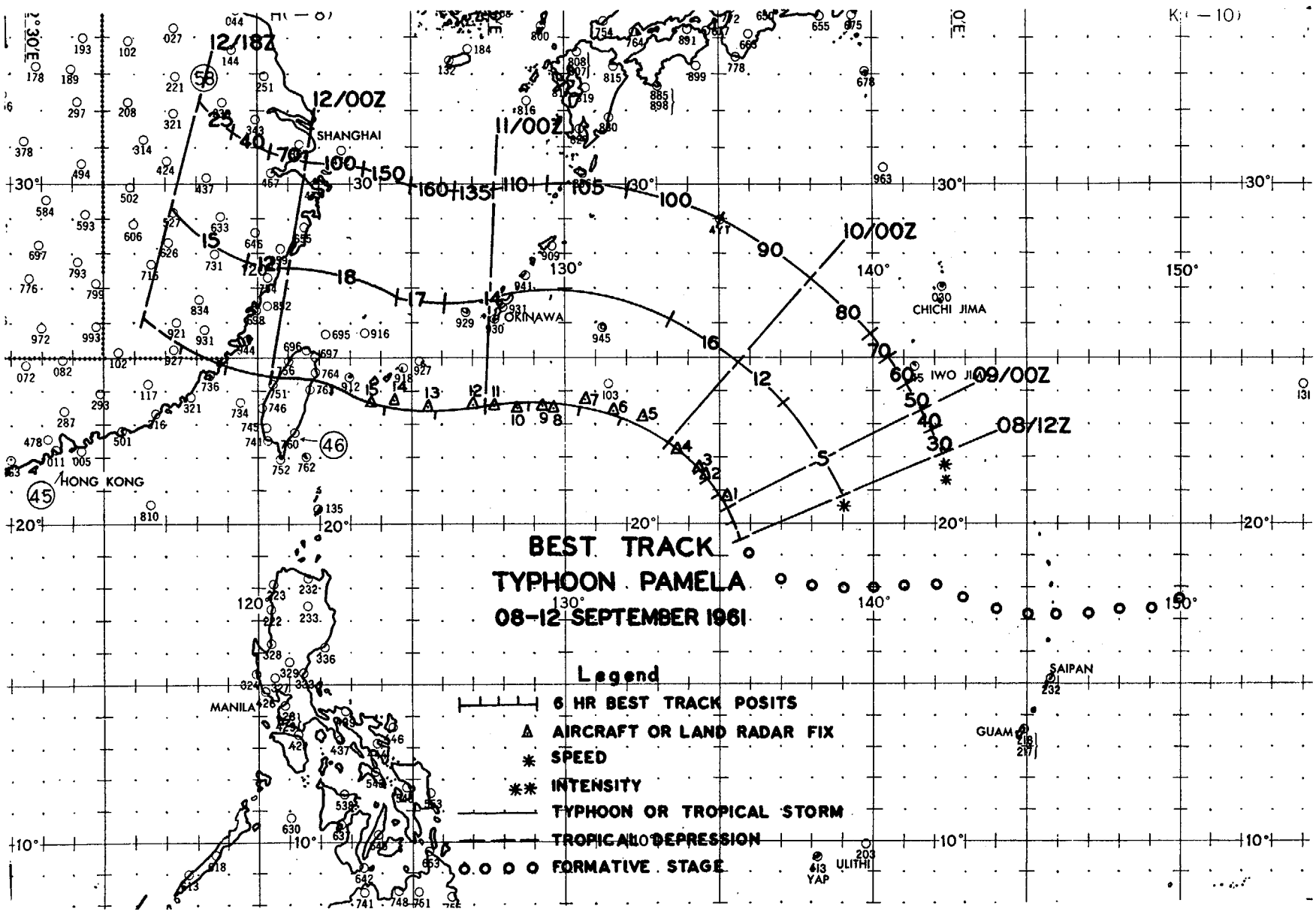
M. TYPHOON PAMELA (081200Z-121800Z SEPTEMBER 1961)

A WEAK CIRCULATION THAT WAS LATER TO BECOME TYPHOON PAMELA FIRST APPEARED ON 4 SEPTEMBER APPROXIMATELY 400 MI NE OF GUAM. IT MOVED SLOWLY W UNTIL 8 SEPTEMBER WHEN IT TURNED TOWARD THE NW AND BEGAN TO INTENSIFY. A TROPICAL DEPRESSION WARNING WAS ISSUED AT 081200Z AND A RECONNAISSANCE AIRCRAFT WAS DISPATCHED TO INVESTIGATE. BASED ON THE INFORMATION CONTAINED IN THE EYE MESSAGE REPORT, THE DEPRESSION WAS UPGRADED TO TROPICAL STORM INTENSITY ON THE 090600Z WARNING.

STARTING A GRADUAL TURN BACK TOWARD THE W, PAMELA CONTINUED TO INTENSIFY. THE FIRST TYPHOON WARNING WAS ISSUED AT 100000Z, HOWEVER, POST ANALYSIS INDICATES THAT PAMELA HAD ACTUALLY REACHED TYPHOON INTENSITY BY 091200Z. PROGRESSING ON A HEADING OF W, PAMELA PASSED 140 MI S OF OKINAWA AND CONTINUED STRAIGHT TOWARD CENTRAL TAIWAN. SHE REACHED HER MAXIMUM INTENSITY OF 160 KTS AT APPROXIMATELY 110900Z WHILE PASSING 65 MI S OF MIYAKO JIMA, THEN WEAKENED SLIGHTLY AND STARTED A SLIGHT DEFLECTION TO THE N. AS PAMELA APPROACHED TAIWAN, A TROUGH DEVELOPED S OF HER AND AT ABOUT 111600Z A LOW APPEARED IN THE TROUGH E OF THE ISLAND'S SOUTHERN TIP. THIS LOW REMAINED QUASI-STATIONARY AND PERSISTED UNTIL APPROXIMATELY 111200Z WHEN PAMELA ENTERED TAIWAN NEAR THE CITY OF KARENKO. THE TRANSIT ACROSS THE ISLAND'S 12,000 FT MOUNTAINS WEAKENED PAMELA TO SLIGHTLY LESS THAN 100 KTS INTENSITY AS SHE CROSSED INTO THE TAIWAN STRAITS. SHE ENTERED THE ASIATIC MAINLAND NEAR T'UNG-A AND CONTINUED STRAIGHT INLAND WEAKENING RAPIDLY. THE FINAL WARNING WAS ISSUED AT 121800Z.

EIGHTEEN WARNINGS WERE ISSUED ON PAMELA COVERING A PERIOD OF 4 DAYS AND 6 HOURS. SHE TRAVELED 1225 MI AT AN AVERAGE SPEED OF 12 KTS. THE MINIMUM SPEED WAS 5 KTS ON 8 AND 9 SEPTEMBER AND THE MAXIMUM SPEED WAS 18 KTS WHEN PAMELA WAS CROSSING TAIWAN.

TYPHOON PAMELA WAS THE 5TH TYPHOON TO STRIKE TAIWAN DURING THE YEAR; IT ALSO CREATED MORE DAMAGE THAN THE OTHERS. NINETY-EIGHT DEATHS, 27 PERSONS MISSING, AND 964 INJURED WERE REPORTED. FIFTY-TWO OF THE DEAD PERISHED AT YILAN, A FISHING PORT IN NORTHEAST TAIWAN. IT WAS ESTIMATED BY POLICE THAT 5,992 HOUSES COLLAPSED AND 12,995 WERE DAMAGED. AN ESTIMATED 50,000 PEOPLE WERE LEFT HOMELESS. DAMAGE WAS ESTIMATED TO BE IN EXCESS OF $4,000,000 TO CROPS, LAND AND HOMES. DAMAGE TO THE ASIATIC MAINLAND WAS NOT AVAILABLE.


BEST TRACK
TYPHOON PAMELA
08-12 SEPTEMBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
12/18Z
12/00Z
11/00Z
10/00Z
09/00Z
08/12Z
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
SAIPAN
GUAM
YAP
ULITHI

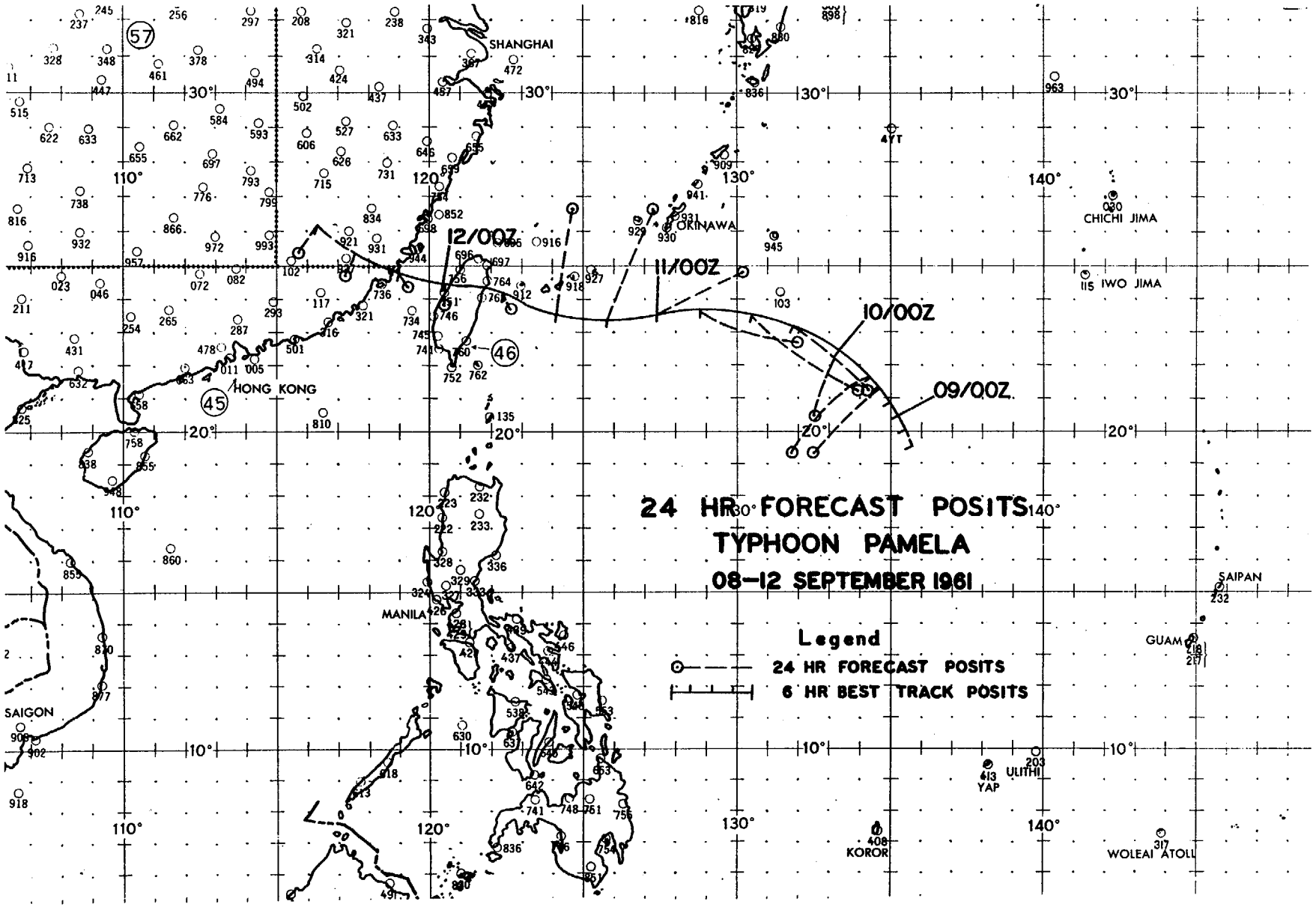
LAND RADAR AND AIRCRAFT FIXES - TYPHOON PAMELA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	090430Z	20.8N	135.2E	VW1-P-05	45	---	----	982	-----	DIA 23 MI SPIRAL BANDS ALL QUADS
2	091440Z	21.5N	134.6E	VW1-R-10	---	---	----	---	-----	CIRC WELL DEFINED 7 MI DIA
3	091903Z	21.7N	134.4E	VW1-R-15	---	---	----	---	-----	DIA 14 MI
4	092200Z	22.2N	133.7E	56-P-04	75	60	9340	970	15/13	DIA 10 MI
5	100330Z	23.1N	132.5E	56-P-03	55	51	9290	---	14/12	POORLY DEFINED CIRC 12 MI DIA
6	100700Z	23.4N	131.6E	56-P-04	90	80	9150	952	17/14	CIRC 18 MI DIA
7	101250Z	23.8N	130.8E	VW1-R-05	---	---	----	---	-----	DIA 17 MI OPEN W
8	101605Z	23.6N	129.7E	VW1-R-04	---	---	----	---	-----	DIA 13 MI WALL CLD 3 MI WIDE
9	101646Z	23.7N	129.3E	LND/RDR	---	---	----	---	-----	12 MI DIA
10	101930Z	23.6N	128.4E	LND/RDR	---	---	----	---	-----	----------
11	102200Z	23.7N	127.8E	56-P-05	100	80	8040	---	18/12	CIRC 8 MI DIA WALL CLDS ALL QUADS
12	110130Z	23.7N	127.0E	56-P-01	130	100	7550	---	17/11	CIRC 6 MI DIA
13	110700Z	23.7N	125.7E	56-P-02	170	140	7440	914	16/16	SEVERE TURBULENCE NE QUAD
14	111100Z	23.8N	124.3E	LND/RDR	---	---	----	---	-----	----------
15	111300Z	23.8N	123.7E	LND/RDR	---	---	----	---	-----	----------

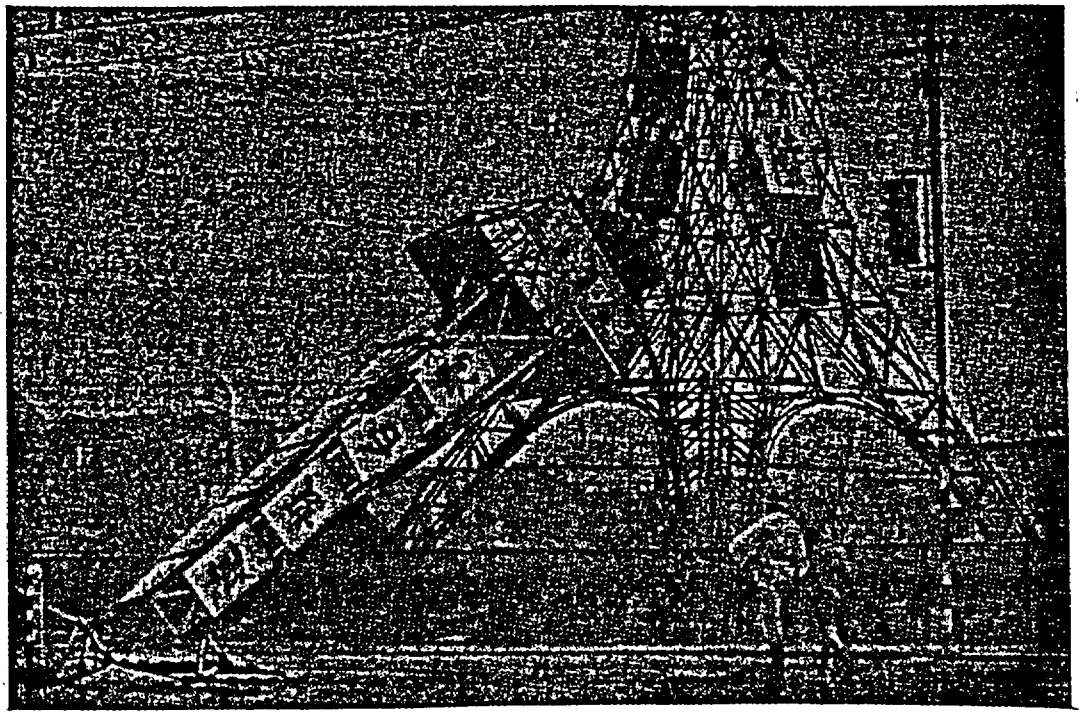
TYPHOON PAMELA 08-12 SEP 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
081200Z	19.6N	135.7E	-------	-------
081800Z	20.1N	135.4E	-------	-------
090000Z	20.6N	135.2E	-------	-------
090600Z	21.0N	135.0E	-------	-------
091200Z	21.3N	134.7E	-------	-------
091800Z	21.7N	134.3E	-------	-------
100000Z	22.5N	133.3E	-------	-------
100600Z	23.3N	131.9E	133-181	-------
101200Z	23.7N	130.4E	127-246	-------
101800Z	23.8N	128.9E	109-180	-------
110000Z	23.7N	127.4E	065-164	-------
110600Z	23.6N	125.9E	020-198	108-359
111200Z	23.7N	124.1E	011-190	103-376
111800Z	24.1N	122.2E	118-27	090-360
120000Z	24.4N	120.3E	169-31	067-360
120600Z	24.6N	119.0E	137-23	043-444
121200Z	25.3N	117.5E	218-33	029-247
121800Z	26.1N	116.1E	203-52	172-59

AVERAGE 24 HOUR ERROR 120 MI
AVERAGE 48 HOUR ERROR 315 MI


24 HR FORECAST POSITS
TYPHOON PAMELA
08–12 SEPTEMBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
12/00Z
11/00Z
10/00Z
09/00Z
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
SAIGON
SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI ATOLL
110°
120°
130°
140°
30°
20°
10°

THIS RUBBLE WAS A BUILDING BEFORE PAMELA STRUCK TAIWAN. SEPTEMBER 1961. (PACIFIC STARS AND STRIPES)



ADVERTISING TOWER SNAPPED OFF IN TAIPER, TAIWAN, BY TYPHOON PAMELA. SEPTEMBER 1961. (PACIFIC STARS AND STRIPES)

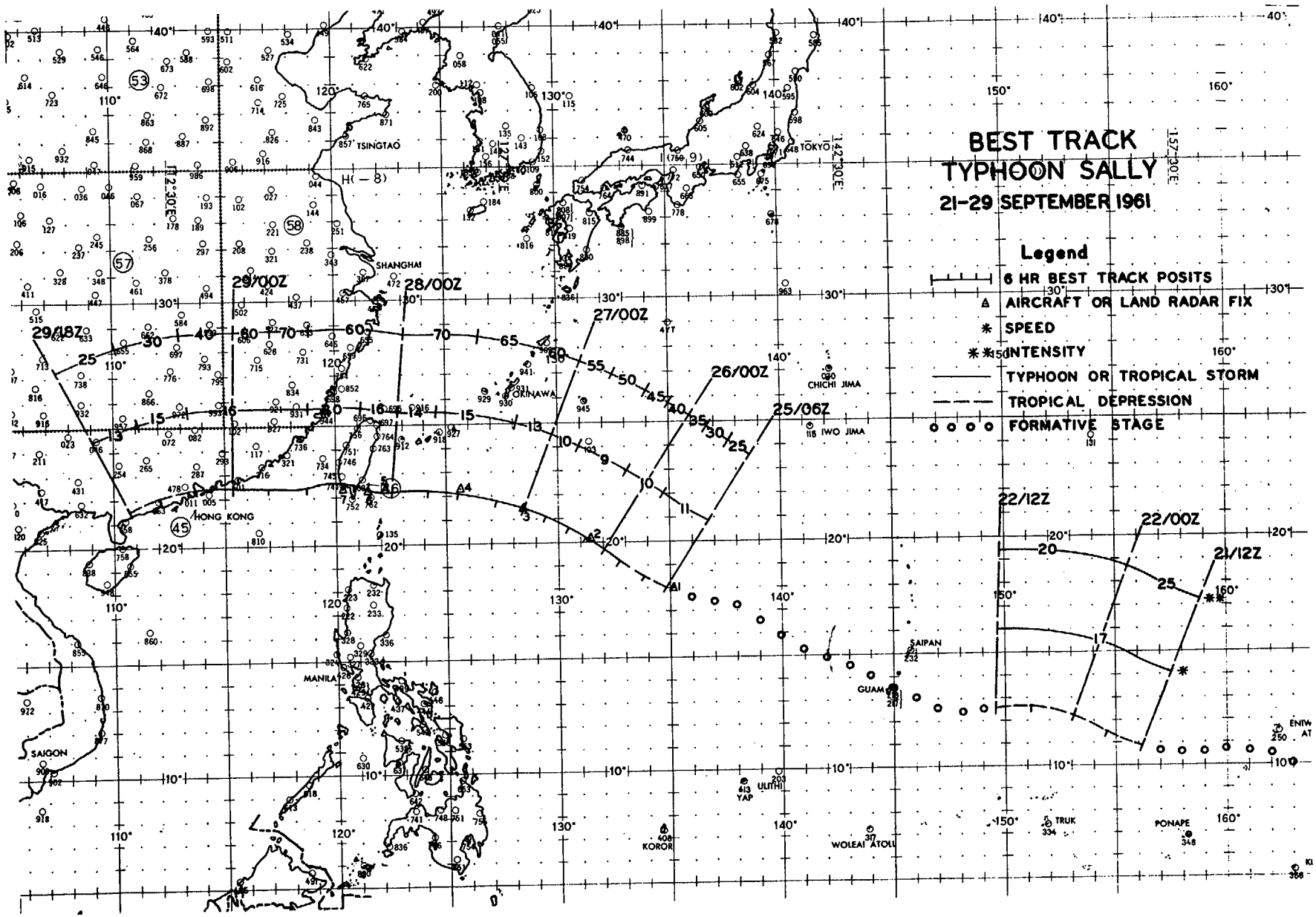
N. TYPHOON SALLY (211200Z-291800Z SEPTEMBER 1961)

THE 191800Z SURFACE CHART WAS THE FIRST TO SHOW THE EXISTENCE OF AN AREA OF LOW PRESSURE SITUATED TO THE E OF ENIWETOK ATOLL. AS THIS LOW MOVED TOWARD THE W, ITS FALLING PRESSURES AND INCREASING RADIUS OF CYCLONIC WINDS GAVE INDICATIONS OF INTENSIFICATION. THE FIRST TROPICAL DEPRESSION WARNING WAS ISSUED AT 212200Z, HOWEVER, SUBSEQUENT RECONNAISSANCE INVESTIGATIONS SHOWED LIGHT WINDS AND NO ORGANIZED CENTER; AND A FINAL WARNING WAS ISSUED AT 221200Z.

AERIAL SURVEILLANCE CONTINUED, BUT NO APPARENT CHANGE WAS NOTED. A PHOTOGRAPH OF THIS SYSTEM SHOWING A WELL DEFINED VORTEX WAS TAKEN AT 240047Z BY TIROS THREE DURING ITS 1056TH ORBIT. THE RECONNAISSANCE FIX OF 250455Z CONFIRMED THIS AND REPORTED 25 KT WINDS AND A 993 MB SLP. THE ISSUANCE OF TROPICAL DEPRESSION WARNINGS WAS RESUMED AT 250600Z. AT THIS TIME THE CENTER WAS MOVING TOWARD THE WNW AT 11 KTS AND INTENSIFYING SLOWLY. THE FIRST TROPICAL STORM WARNING WAS ISSUED AT 260600Z ALTHOUGH POST ANALYSIS SHOWS THAT SALLY ACTUALLY BECAME A TROPICAL STORM AT 251800Z. SHE STARTED A GRADUAL TURN TOWARD THE W AND CONTINUED INTENSIFYING, REACHING TYPHOON STRENGTH AT 270600Z. SALLY REACHED HER MAXIMUM INTENSITY (70 KTS) AT 271200Z AND AT THIS TIME WAS HEADED W TOWARD SOUTHERN TAIWAN. SHE CROSSED THE ISLAND AT APPROXIMATELY 280600Z AND AFTER WEAKENING SLIGHTLY, AGAIN REACHED 70 KTS INTENSITY AS SHE ENTERED THE TAIWAN STRAITS. SALLY CONTINUED MOVING TO THE W UNTIL SHE ENTERED THE ASIATIC MAINLAND PASSING 15 MI N OF HONG KONG. SHE HAD WEAKENED TO ABOUT 40 KTS AT THIS TIME AND CONTINUED TO WEAKEN AS SHE TURNED TOWARD THE WSW. SALLY REMAINED APPROXIMATELY 30 MI INLAND AND MOVED PARALLEL TO THE COASTLINE UNTIL 291800Z WHEN THE FINAL WARNING WAS ISSUED.

SALLY TRAVELLED 2,775 MI FROM THE FIRST TO LAST WARNING, 1,850 MI OF THIS DISTANCE COVERED BY WARNINGS WHILE THE REMAINING 925 MI OCCURRED DURING THE PERIOD THAT WARNINGS WERE NOT ISSUED. SALLY'S MINIMUM SPEED WAS 9 KTS ON 26 SEPTEMBER AND THE MAXIMUM SPEED OF 20 KTS OCCURRED WHILE CROSSING THE ISLAND OF TAIWAN.

INFORMATION CONCERNING DAMAGE BY SALLY WAS EXTREMELY LIMITED. DAMAGE TO CROPS ON TAIWAN AND THE ASIATIC MAINLAND IS KNOWN TO HAVE OCCURRED, HOWEVER THERE IS NO INFORMATION REGARDING LOSS OF LIFE OR SHIPPING AVAILABLE.


BEST TRACK
TYPHOON SALLY
21-29 SEPTEMBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
29/18Z
29/00Z
28/00Z
27/00Z
26/00Z
25/06Z
22/12Z
22/00Z
21/12Z
SHANGHAI
TSINGTAO
TOKYO
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
SAIGON
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOLL
TRUK
PONAPE

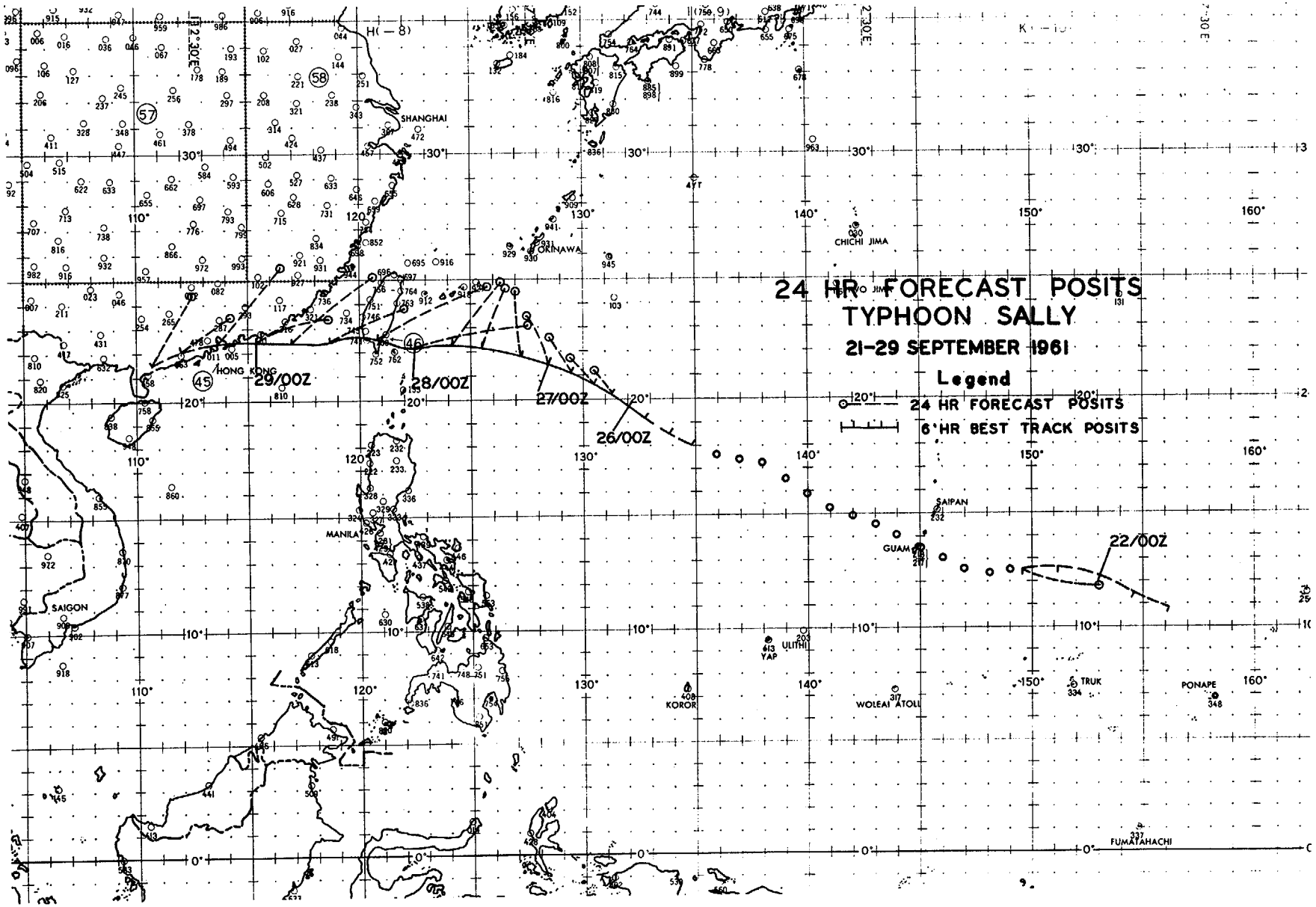
LAND RADAR AND AIRCRAFT FIXES - TYPHOON SALLY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	250455Z	18.0N	135.1E	VW1-P-05	25	---	----	993	-----	----------
2	260545Z	20.3N	131.3E	VW1-P- U	40	---	----	984	-----	EYE 150 MI E-W
3	270020Z	21.5N	128.5E	VW1-P-10	60	---	----	983	-----	EYE 100 MI NW-SE 60 MI NE-SW
4	271130Z	22.3N	125.7E	LND/RDR	---	---	----	---	-----	DIA 40 MI
5	280100Z	22.3N	122.1E	LND/RDR	---	---	----	---	-----	WELL DEFINED
6	280300Z	22.3N	121.4E	LND/RDR	---	---	----	---	-----	ILL DEFINED
7	280800Z	22.3N	120.2E	LND/RDR	---	---	----	---	-----	----------

TYPHOON SALLY 21-29 SEP 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
211200Z	11.0N	156.2E	-------		-------	
211800Z	11.6N	154.7E	-------		-------	
220000Z	12.3N	153.1E	-------		-------	
220600Z	12.7N	151.3E	-------		-------	
221200Z	12.6N	149.7E	-------		-------	
NO WARNINGS ISSUED 221200Z TO 250600Z.						
250600Z	18.1N	134.9E	-------		-------	
251200Z	18.6N	133.9E	-------		-------	
251800Z	19.2N	132.9E	-------		-------	
260000Z	19.8N	132.1E	-------		-------	
260600Z	20.3N	131.2E	-------		-------	
261200Z	20.7N	130.4E	-------		-------	
261800Z	21.1N	129.6E	-------		-------	
270000Z	21.5N	128.6E	-------		-------	
270600Z	21.9N	127.2E	355	158	-------	
271200Z	22.1N	125.7E	017	168	-------	
271800Z	22.3N	124.1E	039	204	-------	
280000Z	22.3N	122.6E	080	289	-------	
280600Z	22.6N	120.9E	064	303	030	404
281200Z	22.5N	118.8E	065	198	044	510
281800Z	22.5N	117.0E	051	249	050	592
290000Z	22.6N	115.2E	076	192	077	627
290600Z	22.5N	113.6E	039	244	062	736
291200Z	22.3N	112.0E	063	136	055	530
291800Z	21.7N	110.8E	029	181	046	621

AVERAGE 24 HOUR ERROR 211 MI
AVERAGE 48 HOUR ERROR 574 MI


24 HR FORECAST POSITS
TYPHOON SALLY
21-29 SEPTEMBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
29/00Z
28/00Z
27/00Z
26/00Z
22/00Z
SHANGHAI
HONG KONG
MANILA
SAIGON
OKINAWA
CHICHI JIMA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOLL
TRUK
PONAPE
FUMATAHACHI

O. TYPHOON TILDA (270600Z SEPTEMBER - 050600Z OCTOBER 1961)

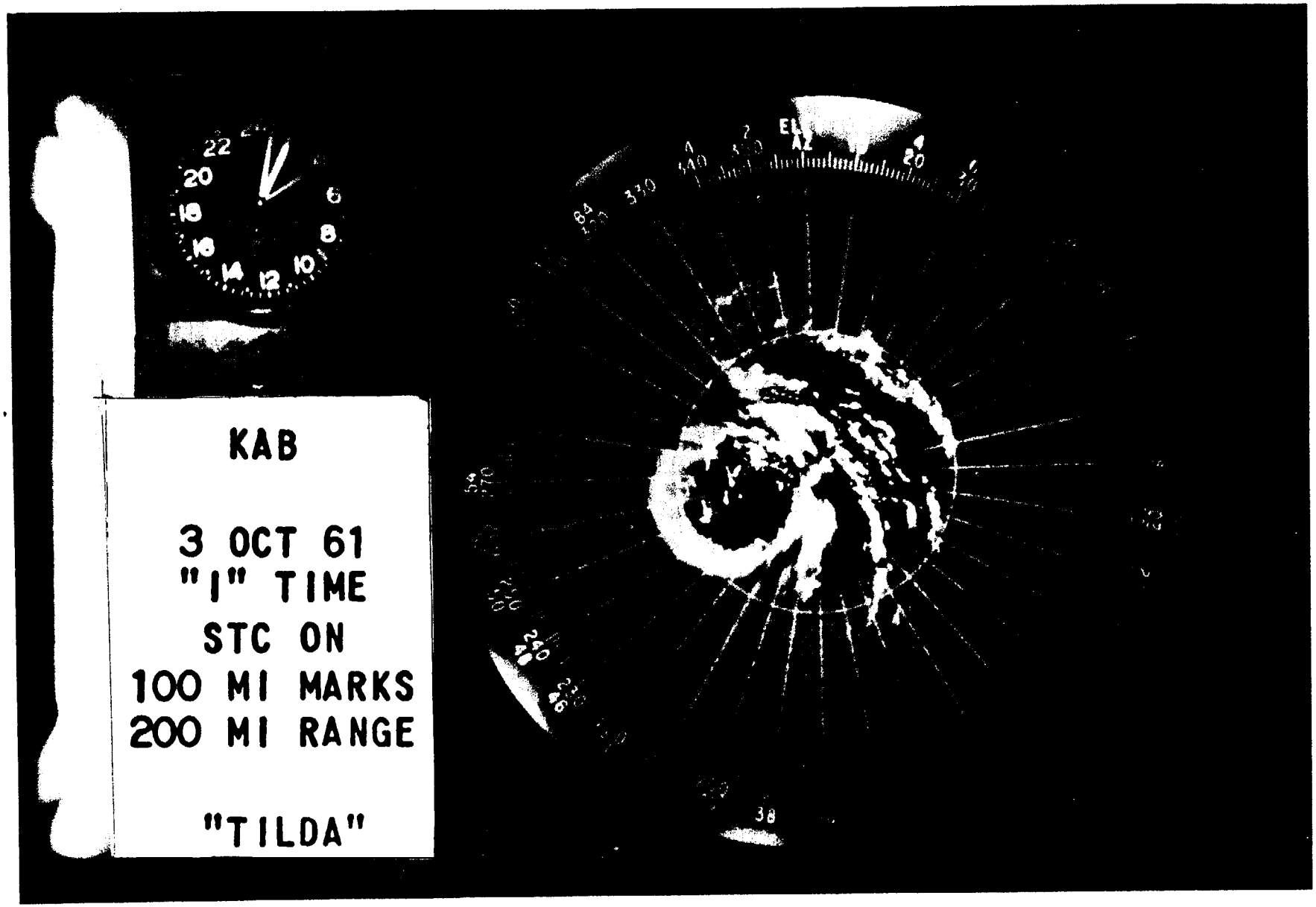
AT 260600Z A SHIP 300 MI E OF GUAM REPORTED NW SURFACE WINDS AND A 1003.5 MB SLP PROVIDING THE FIRST INDICATION OF THE CIRCULATION THAT WAS TO BECOME TYPHOON TILDA. THE CENTER BECAME MORE WELL DEFINED AND MOVED TOWARD THE WNW. THE FIRST TROPICAL DEPRESSION WARNING WAS ISSUED AT 270600Z AND THE SYSTEM WAS UPGRADED TO A TROPICAL STORM AT 271800Z. POST ANALYSIS SHOWS THAT TILDA WAS ALREADY A TROPICAL STORM AT 270600Z AND REACHED TYPHOON INTENSITY AT 271200Z.

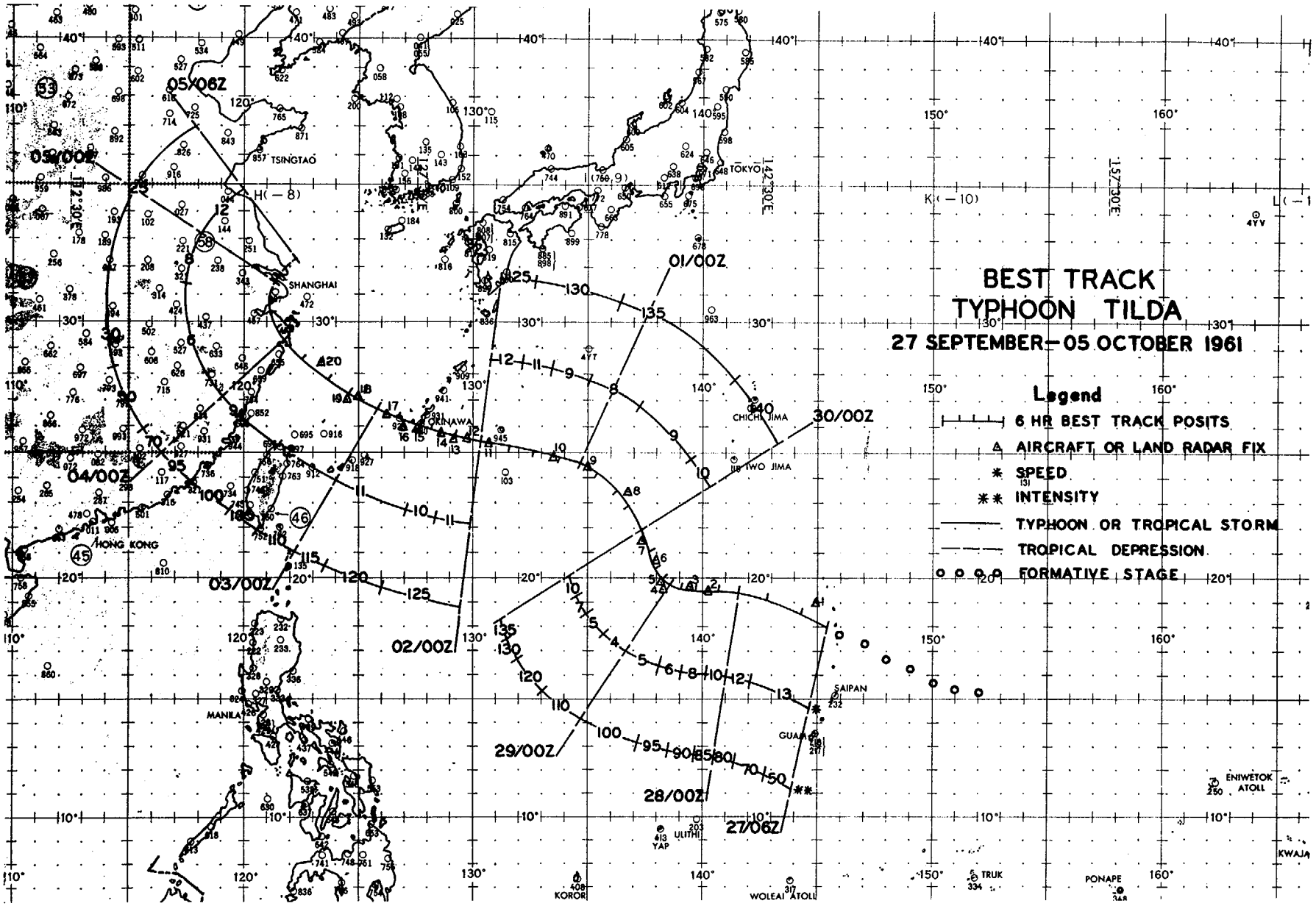
TILDA STARTED A SHARP TURN TOWARD THE N AT 290000Z AND HEADED DIRECTLY TOWARDS CENTRAL JAPAN AND AN AREA OF HIGH PRESSURE WHICH EXTENDED FROM THE SURFACE UP THROUGH 100 MB. IT WAS MANEUVERS SUCH AS THIS THAT CAUSED THE "PACIFIC STARS AND STRIPES" TO HEADLINE TILDA AS "FICKLE" AND STATE THAT SHE "ZIG-ZAGGED" HER WAY THROUGH THE PACIFIC. AS THE HIGH OVER JAPAN STARTED TO WEAKEN AND A BREAK DEVELOPED IN THE RIDGE LINE, TILDA STARTED A TURN BACK TOWARDS THE W. SHE ATTAINED HER MAXIMUM INTENSITY AT THIS TIME, REACHING 140 KTS BETWEEN 300000Z AND 301200Z. A FAST MOVING TROUGH IN THE WESTERLIES PASSED N OF TILDA AT APPROXIMATELY 301200Z, BUT APPARENTLY HAD NO EFFECT ON HER TRACK AS SHE CONTINUED TURNING TOWARD THE W. TILDA COMPLETED HER TURN AT ABOUT 010600Z AND MOVING SLIGHTLY N OF W, PASSED WITHIN 15 MI OF THE SOUTHERN TIP OF OKINAWA AT APPROXIMATELY 021400Z. KADENA WAS DIRECTLY UNDER THE WALL CLOUD AT THE TIME OF TYPHOON PASSAGE AND RECEIVED THE BRUNT OF THE TYPHOON WINDS. THE WINDS WERE 70 KTS SUSTAINED WITH PEAK GUSTS TO 108 KTS. THE SLP REACHED A MINIMUM OF 947.0 MB. NOHA, JUST INSIDE THE WALL CLOUD, HAD SUSTAINED WINDS OF 75 KTS WITH PEAK GUSTS OF 103 KTS AND A MINIMUM SLP OF 942.7 MB. SHE HAD WEAKENED SLIGHTLY, BUT STILL HAD 120 KT SURFACE WINDS AT THIS TIME. AFTER PASSING OKINAWA, TILDA STARTED A GRADUAL TURN TOWARD THE N AND CONTINUED TO SLOWLY DECREASE IN INTENSITY. SHE ENTERED THE ASIATIC MAINLAND APPROXIMATELY 100 MI S OF SHANGHAI AND STARTED TO WEAKEN RAPIDLY. SHE FINALLY CROSSED N OF THE SUBTROPICAL RIDGE LINE AND CAME UNDER THE INFLUENCE OF THE WESTERLIES. SHE THEN RECURVED SHARPLY AND EMERGED FROM THE MAINLAND JUST N OF SHANGHAI AFTER HAVING WEAKENED TO ONLY 25 KTS. THE FINAL WARNING WAS ISSUED AT 050600Z.

TILDA WAS CONSIDERED UNUSUAL BECAUSE OF HER FAILURE TO CONFORM TO CLIMATOLOGY AND HER RELUCTANCE TO FOLLOW NORMAL FORECASTING RULES. SHE TRAVELED 1775 MI IN 8 DAYS AT AN AVERAGE SPEED OF 9.2 KTS. HER MAXIMUM SPEED WAS 13 KTS FROM 270600Z TO 271800Z AND THE MINIMUM SPEED OF 4 KTS OCCURRED DURING THE ERRATIC TURN ON 29 SEPTEMBER 1961.

TILDA CAUSED DAMAGE TO OKINAWA AND POSSIBLY TO THE ASIATIC MAINLAND S OF SHANGHAI. THE TYPHOON WAS RESPONSIBLE FOR THE DEATH OF AT LEAST 11 PEOPLE, MANY INJURED AND DAMAGE IN EXCESS OF 6 MILLION DOLLARS TO CROPS, HOUSING AND EQUIPMENT, BOTH MILITARY AND CIVILIAN ON OKINAWA. A HOUSE IN NAHA WAS BLOWN FROM ITS FOUNDATIONS TO A POINT 300 FEET AWAY, KILLING THE FOUR OCCUPANTS, CERTAINLY AN EXAMPLE OF THE FURY OF TILDA. OPERATION TIEN BING (SKY SOLDIER)

WAS CALLED OFF ON TAIWAN BECAUSE OF THE TYPHOON. THE LEBANESE MERCHANT VESSEL, SHEIK, MANNED BY A GREEK CREW WENT AGROUND ON KITA DAITO SHIMA, 200 MI E OF OKINAWA AS A RESULT OF THE TYPHOON, CAUSING THE LOSS OF LIFE OF THE CAPTAIN AND ENGINEERING OFFICER. THE SHIP BROKE IN TWO BECAUSE OF THE HEAVY SEAS AFTER BEING DRIVEN AGROUND. THIS SHIP WAS JOINED A FEW DAYS LATER BY THE PIONEER MUSE, AS A RESULT OF VIOLET.


KAB
3 OCT 61
"I" TIME
STC ON
100 MI MARKS
200 MI RANGE
"TILDA"


BEST TRACK
TYPHOON TILDA
27 SEPTEMBER–05 OCTOBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT OR LAND RADAR FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
05/06Z
04/00Z
03/00Z
02/00Z
01/00Z
30/00Z
29/00Z
28/00Z
27/06Z
TSINGTAO
SHANGHAI
TOKYO
CHICHI JIMA
IWO JIMA
OKINAWA
HONG KONG
MANILA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOLL
TRUK
PONAPE
ENIWETOK ATOLL
KWAJA

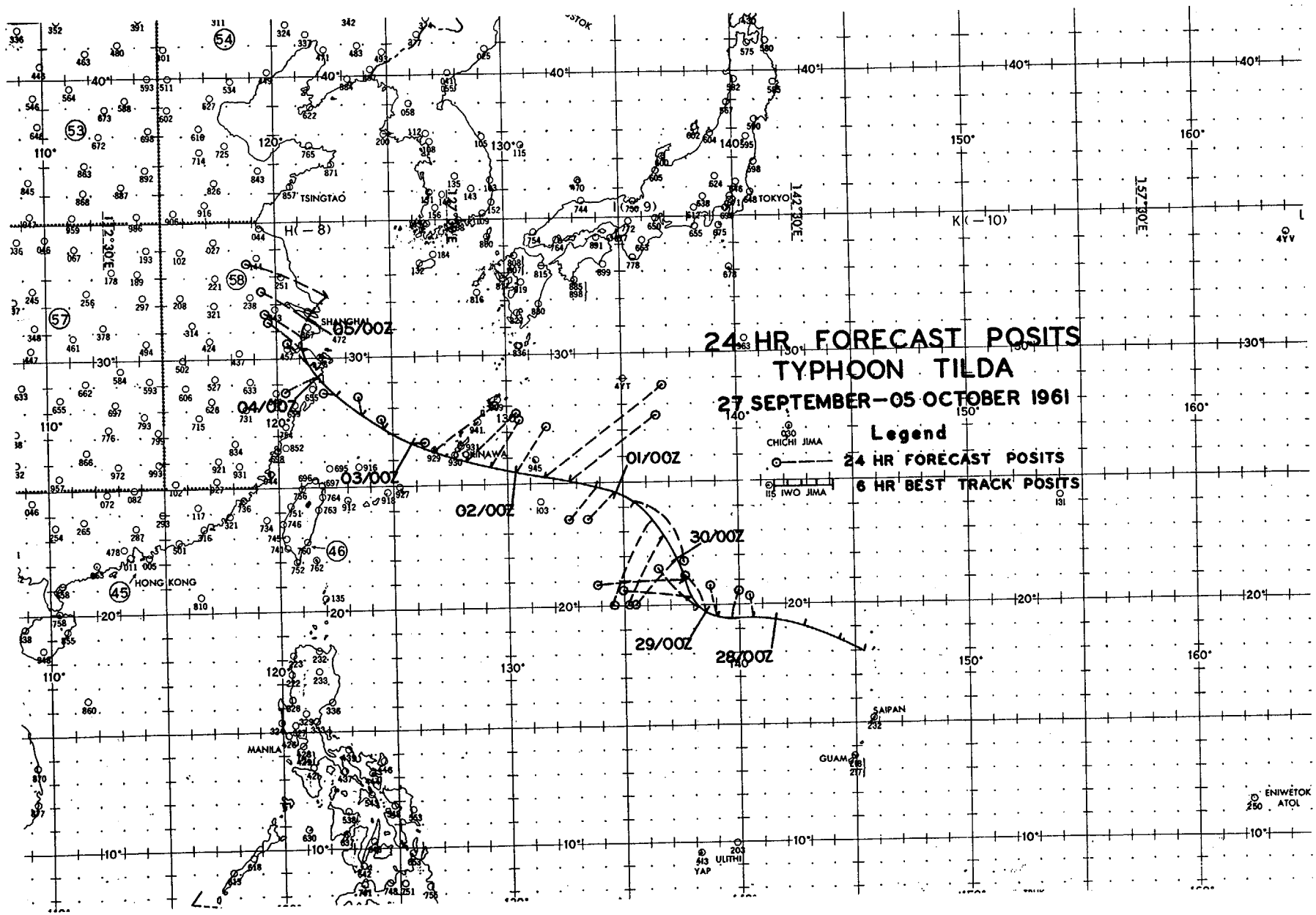
LAND RADAR AND AIRCRAFT FIXES - TYPHOON TILDA

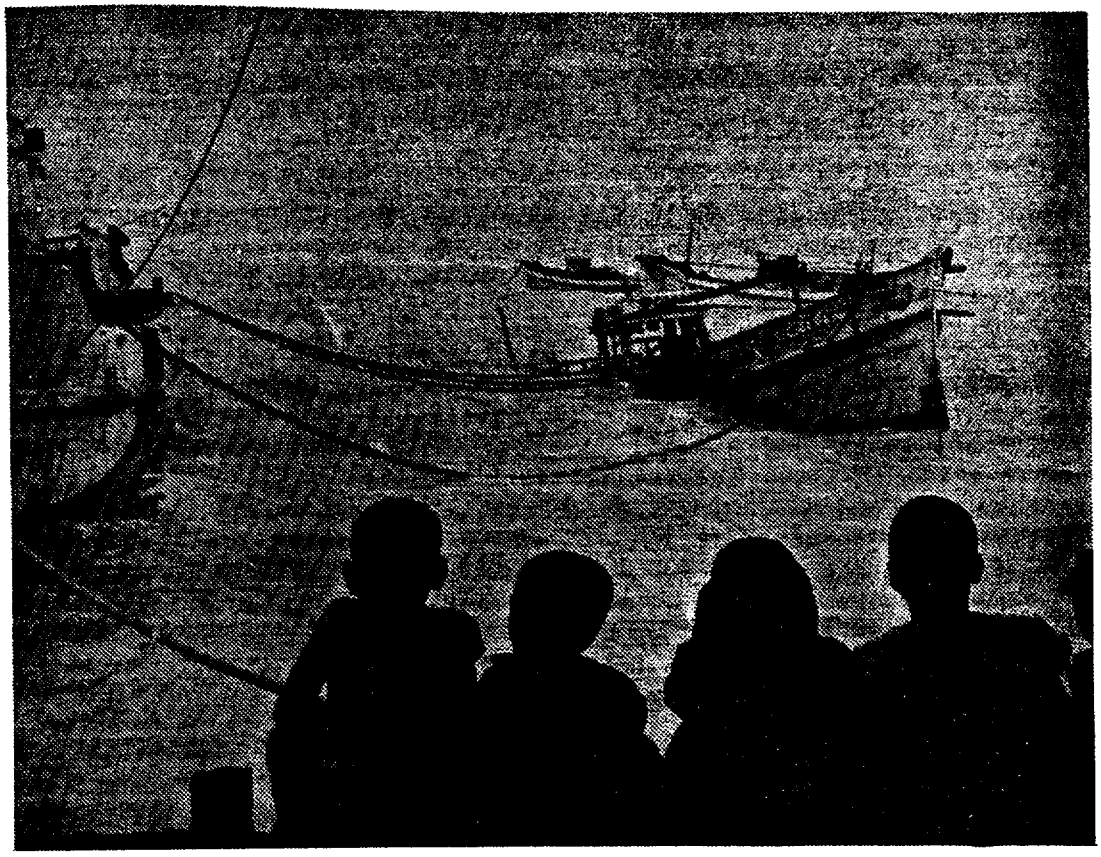
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	270603Z	19.0N	145.0E	VAP61-P-U	---	---	----	---	-----	----------
2	280845Z	19.5N	140.2E	VW1-R-03	---	---	----	---	-----	CIRC 12 MI DIA
3	281333Z	19.7N	139.5E	USOA-R-U	---	---	----	---	-----	15 MI DIA
4	290041Z	19.5N	138.3E	VW1-P-10	---	---	----	---	-----	CIRC 14 MI DIA
5	290420Z	19.8N	138.2E	VW1-P-10	---	---	9055	---	-----	CIRC 14 MI DIA
6	291412Z	20.7N	138.0E	VW1-R-10	---	---	----	---	-----	DIA 13 MI
7	292120Z	21.6N	137.3E	56-P-01	100	---	7980	917	19/17	40 MI DIA
8	300800Z	23.4N	136.9E	VW1-R-05	---	---	----	---	-----	40 MI DIA
9	302135Z	24.5N	135.0E	VW1-R-05	---	---	----	---	-----	CIRC 37 MI DIA
10	010800Z	24.9N	133.5E	VW1-R-05	---	---	----	---	-----	30 MI DIA
11	012210Z	25.3N	130.7E	56-P-03	120	105	8240	935	16/16	CIRC 20 MI DIA
12	020300Z	25.5N	129.8E	LND/RDR	---	---	----	---	-----	----------
13	020600Z	25.6N	129.1E	LND/RDR	---	---	----	---	-----	----------
14	020900Z	25.7N	128.7E	LND/RDR	---	---	----	---	-----	----------
15	021330Z	25.9N	127.6E	LND/RDR	---	---	----	---	-----	DIA 70 MI
16	021700Z	26.0N	127.0E	LND/RDR	---	---	----	---	-----	----------
17	022230Z	26.4N	126.1E	56-P-05	70	120	8470	944	17/17	CIRC 85 MI DIA
18	030300Z	27.1N	125.0E	LND/RDR	---	---	----	---	-----	----------
19	030555Z	27.0N	124.5E	LND/RDR	---	---	----	---	-----	----------
20	031510Z	28.4N	123.2E	VW1-R-10	---	---	----	---	-----	40 MI DIA

TYPHOON TILDA 27 SEP-05 OCT 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
270600Z	18.0N	145.4E	-------	-------
271200Z	18.6N	144.2E	-------	-------
271800Z	19.1N	142.9E	-------	-------
280000Z	19.4N	141.7E	-------	-------
280600Z	19.6N	140.7E	-------	-------
281200Z	19.6N	139.8E	-------	-------
281800Z	19.7N	139.1E	345-74	-------
290000Z	19.8N	138.6E	327-98	-------
290600Z	20.0N	138.3E	210-129	-------
291200Z	20.4N	138.0E	273-169	-------
291800Z	21.1N	137.7E	267-215	287-224
300000Z	22.0N	137.3E	223-165	276-254
300600Z	22.9N	136.8E	207-196	269-296
301200Z	23.7N	136.2E	203-239	242-295
301800Z	24.3N	135.4E	140-192	243-378
010000Z	24.6N	134.7E	222-89	217-311
010600Z	24.8N	133.8E	219-101	211-306
011200Z	25.1N	132.8E	058-256	208-309
011800Z	25.2N	131.7E	052-358	113-292
020000Z	25.4N	130.3E	037-127	236-134
020600Z	25.6N	129.1E	033-139	203-94
021200Z	25.8N	128.1E	050-170	053-720
021800Z	26.1N	126.9E	049-179	057-855
030000Z	26.5N	125.8E	063-27	056-505
030600Z	27.1N	124.7E	343-36	059-633
031200Z	27.8N	123.7E	351-35	068-520
031800Z	28.7N	122.6E	271-35	033-356
040000Z	29.3N	121.9E	245-96	112-41
040600Z	29.8N	121.5E	305-73	343-47
041200Z	30.3N	121.1E	306-97	332-62
041800Z	30.9N	120.9E	302-86	307-104
050000Z	31.6N	121.2E	301-111	260-213
050600Z	32.3N	122.2E	290-195	301-226

AVERAGE 24 HOUR ERROR 137 MI
AVERAGE 48 HOUR ERROR 312 MI


24 HR FORECAST POSITS
TYPHOON TILDA
27 SEPTEMBER–05 OCTOBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
05/00Z
04/00Z
03/00Z
02/00Z
01/00Z
30/00Z
29/00Z
28/00Z
TSINGTAO
SHANGHAI
NAHA
HONG KONG
MANILA
TOKYO
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
YAP
ULITHI
ENIWETOK ATOL
H(−8)
K(−10)
142.5°E
157.5°E



CHILDREN LOOK AT OLD SHIP THAT BATTLED TILDA AND LOST. OCTOBER 1961. (PACIFIC STARS AND STRIPES)

VIOLENT WIND AND HEAVY RAINS BATTER OKINAWA AS TILDA PASSES OKINAWA, OCTOBER 1961. (PACIFIC STARS AND STRIPES)

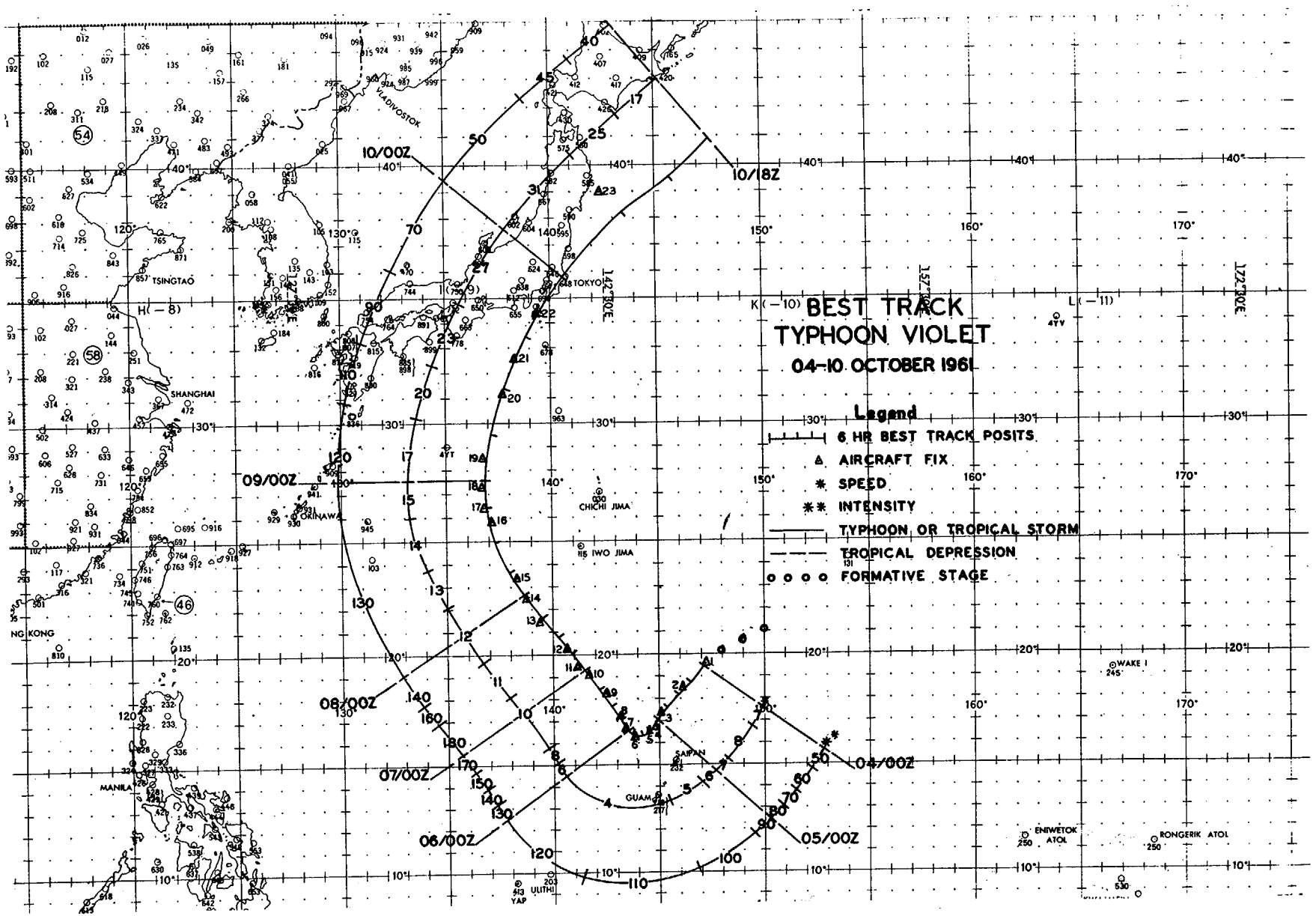
P. TYPHOON VIOLET (040000Z-101800Z OCTOBER 1961)

WHILE TYPHOON TILDA WAS MOVING TOWARD OKINAWA, A SMALL CIRCULATION BEGAN TO APPEAR SW OF MARCUS ISLAND, AND BY 021800Z IT WAS WELL ENOUGH DEFINED TO MERIT A REQUEST FOR AN INVESTIGATION. BASED ON A REPORTED SURFACE WIND OF 45 KTS, THE FIRST TROPICAL STORM VIOLET WARNING WAS ISSUED AT 040000Z.

AT THIS TIME A RIDGE WITH A N-S ORIENTATION WAS LOCATED W OF VIOLET, MIDWAY BETWEEN THE TWO TYPHOONS, VIOLET AND TILDA. AT FIRST VIOLET WAS UNABLE TO TRAVERSE THIS RIDGE WHICH EXTENDED FROM THE SURFACE THROUGH 500 MB. INSTEAD SHE MOVED TOWARD THE SW AND INTENSIFIED, REACHING TYPHOON STRENGTH AT APPROXIMATELY 041200Z. DURING HER INTENSIFICATION PROCESS VIOLET ALSO EXTENDED VERTICALLY, BECOMING DEFINITELY CLOSED AT THE 300 MB LEVEL AT 051200Z. AT THE SAME TIME, A SMALL OUTDRAFT APPEARED ON THE 200 MB MAP IMMEDIATELY SE OF VIOLET AND RESULTED IN THE FORMATION OF A NEUTRAL POINT AT THE SAME LEVEL DIRECTLY OVER THE TYPHOON'S CENTER. VIOLET THEN DECELERATED SLIGHTLY AND STARTED AN ABRUPT TURN TOWARD THE NW AS THE SUBTROPICAL RIDGE SHIFTED TO THE E. VIOLET CONTINUED TO INTENSIFY, REACHING HER MAXIMUM STRENGTH OF 180 KTS FROM 070000Z TO 071200Z. SHE THEN STARTED TO WEAKEN SLIGHTLY AND CONTINUED TO THE NNW, RECURVING THROUGH THE RIDGE LINE AT ABOUT 28N. SHE CONTINUED TO FOLLOW A SMOOTH PARABOLIC TRACK AND CROSSED THE BOSO PENINSULA 30 MI E OF TOKYO AT ABOUT 092200Z. SHE WAS MOVING AT A SPEED OF 27 KTS AT THIS TIME AND STILL HAD MAXIMUM SUSTAINED SURFACE WINDS OF 70 KTS. AFTER HER BRUSH WITH LAND, VIOLET RAPIDLY COMMENCED TO ASSUME EXTRATROPICAL CHARACTERISTICS. THE FINAL WARNING WAS ISSUED AT 101800Z WHEN SHE HAD WEAKENED TO 40 KTS.

VIOLET WAS UNUSUAL IN THAT SHE MOVED STEADILY TOWARD THE SW FOR AT LEAST ONE AND ONE HALF DAYS, BUT OTHER THAN THAT, SHE WAS QUITE NORMAL. SHE TRAVELED 2050 MI IN THE 6 DAYS AND 18 HOURS THAT WARNINGS WERE BEING ISSUED. HER MINIMUM SPEED WAS 4 KTS WHEN SHE MADE THE TURN FROM A HEADING OF SW TO THE NW AND HER MAXIMUM SPEED OF 31 KTS OCCURRED AFTER SHE PASSED TOKYO.

AS VIOLET APPROACHED GUAM FROM THE NE, LITTLE DAMAGE OCCURRED EXCEPT FOR SLIGHT CROP DAMAGE AND SOME NERVOUSNESS AMONG THE OCCUPANTS OF THE ISLAND. AFTER IT COMMENCED MOVING TO THE NW A MERCHANT VESSEL, THE PIONEER MUSE, WAS GROUNDED ON KITA DAITO SHIMA, ONLY A FEW MILES FROM THE SHEIK, AND BROKE IN TWO THE FOLLOWING DAY DUE TO HEAVY SEAS. THE CREW OF THE PIONEER MUSE WAS RESCUED BY THE AMPHIBIOUS ASSAULT SHIP PRINCETON VIA HELICOPTER. ONLY MINOR DAMAGE OCCURRED TO JAPAN IN THE TOKYO AREA, DUE TO GUSTY WINDS. TWO DEATHS WERE ATTRIBUTED TO THE TYPHOON IN JAPAN.


BEST TRACK
TYPHOON VIOLET
04-10 OCTOBER 1961
Legend
6 HR BEST TRACK POSITS.
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
10/00Z
10/18Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/00Z
TSINGTAO
SHANGHAI
TOKYO
OKINAWA
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
WAKE I
ENIWETOK ATOL
RONGERIK ATOL
ULITHI
YAP
MANILA
NG KONG
VLADIVOSTOK
142°30E
157°30E
172°30E

LAND RADAR AND AIRCRAFT FIXES.- TYPHOON VIOLET

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	032130Z	19.5N	147.2E	VW1-P-10	45	---	----	997	-----	POORLY DEFINED
2	040845Z	18.6N	146.1E	VW1-P-10	45	---	----	---	-----	DEFINED BY SPIRAL BANDS
3	042100Z	17.3N	145.1E	56-P-01	85	70	9860	975	15/08	CIRC DIA 25MI WALL CLDS ALL QUADS
4	050200Z	16.9N	144.9E	56-P-03	110	70	9740	972	16/11	DIA 29MI
5	050700Z	16.7N	144.5E	56-P-03	110	62	9560	970	16/11	CIRC DIA 20 MI
6	051245Z	16.2N	143.9E	VW1-R-03	---	---	----	---	-----	DIA 15MI
7	060300Z	16.7N	143.4E	56-P-03	65	65	9000	946	15/10	CIRC 16MI DIA
8	060630Z	17.2N	143.2E	56-P-02	100	75	8670	946	17/12	DIA 5 MI
9	061330Z	18.2N	142.6E	VW1-R-05	---	---	----	---	-----	DIA 11 MI
10	062130Z	19.1N	141.8E	56-P-02	190	170	7340	898	25/19	WALL CLDS ALL QUADS
11	070200Z	19.6N	141.2E	56-P-02	190	160	7260	894	27/21	CIRC 5MI DIA WELL DEFINED
12	070700Z	20.2N	140.8E	56-P-02	190	160	7130	882	29/23	RADAR EYE DIA 10MI
13	071358Z	21.5N	139.4E	VW1-R-10	---	---	----	---	-----	CIRC DIA 9 MI
14	072200Z	22.5N	138.9E	56-P-05	125	115	7350	908	21/15	CIRC DIA 9 MI
15	080400Z	23.4N	138.3E	56-P-02	125	110	7580	916	17/15	WELL DEFINED CIRC DIA 12 MI
16	081330Z	25.9N	137.1E	VW1-R-05	---	---	----	---	-----	CIRC DIA 10 MI
17	081515Z	26.2N	136.9E	VW1-R-05	---	---	----	---	-----	CIRC DIA 8 MI
18	082145Z	27.2N	136.7E	56-P-03	125	115	8010	930	17/16	CIRC DIA 10 MI
19	090300Z	28.5N	136.8E	56-P-02	130	90	8250	940	19/15	CIRC DIA 10 MI OPEN S & W
20	091150Z	31.2N	137.9E	VW1-R-10	---	---	----	---	-----	INDEFINITE 28 MI DIA
21	091500Z	32.7N	138.3E	VW1-R-10	---	---	----	---	-----	CIRC 20 MI DIA

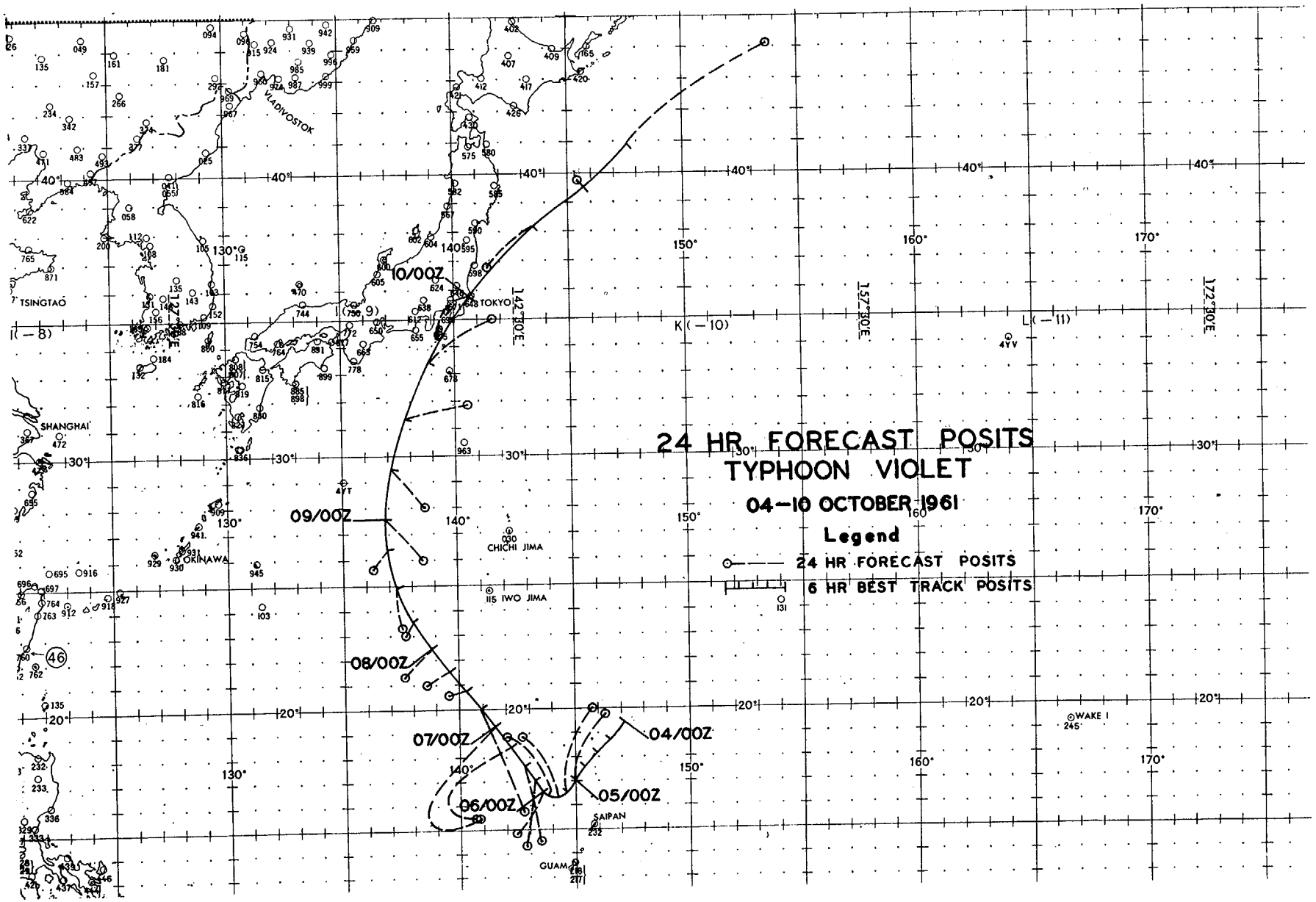
LAND RADAR AND AIRCRAFT FIXES - TYPHOON VIOLET (CONT'D)

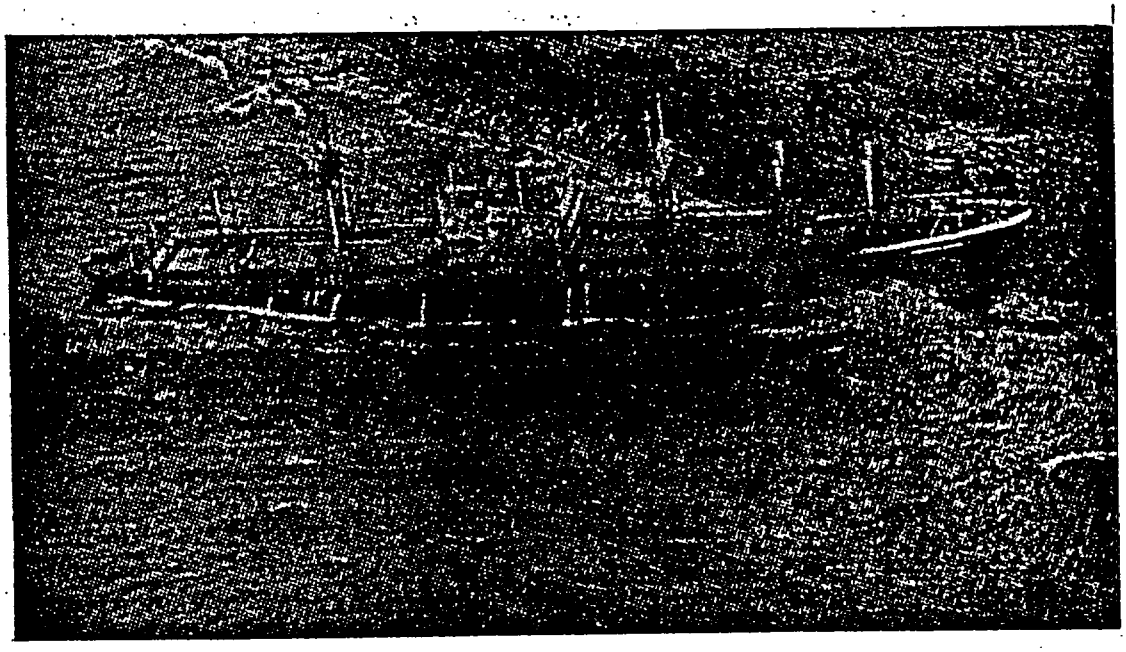
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
22	092130Z	34.3N	139.5E	56-P-01	80	40	9380	973	18/08	NO WALL CLDS
23	100700Z	39.0N	142.3E	56-P-02	100	80	9850	---	16/12	POORLY DEFINED

TYPHOON VIOLET 04-10 OCT 1961
POSITION AND FORECAST VERIFICATION DATA

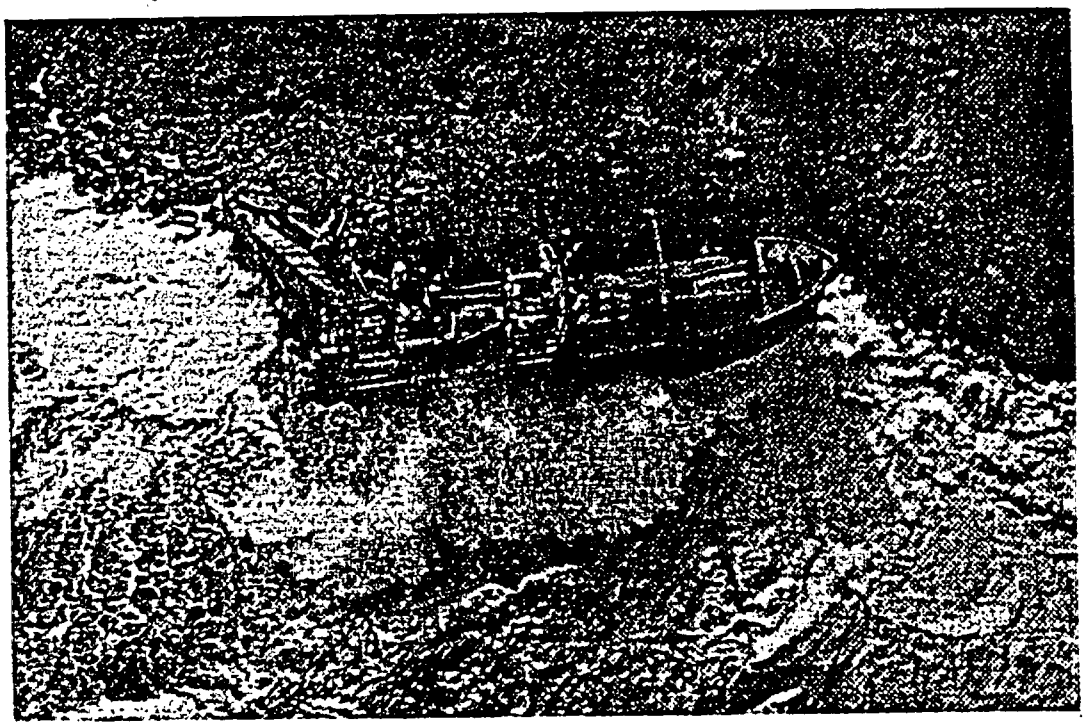
DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
040000Z	19.4N	147.0E	-------	-------
040600Z	18.8N	146.4E	-------	-------
041200Z	18.3N	145.8E	-------	-------
041800Z	17.6N	145.4E	-------	-------
050000Z	17.1N	144.9E	025-175	-------
050600Z	16.6N	144.7E	019-204	-------
051200Z	16.3N	144.1E	333-172	-------
051800Z	16.3N	143.7E	329-180	-------
060000Z	16.5N	143.5E	210-117	015-235
060600Z	17.1N	143.2E	187-170	359-210
061200Z	17.8N	142.8E	172-195	302-145
061800Z	18.6N	142.2E	207-207	294-186
070000Z	19.4N	141.4E	190-235	205-315
070600Z	20.1N	140.9E	157-275	185-365
071200Z	20.9N	140.1E	227-35	171-415
071800Z	21.8N	139.4E	218-65	198-375
080000Z	22.7N	138.7E	210-112	194-442
080600Z	23.8N	137.9E	197-55	171-510
081200Z	25.0N	137.4E	172-110	150-220
081800Z	26.4N	136.8E	223-55	205-290
090000Z	27.8N	136.7E	142-142	200-325
090600Z	29.6N	137.1E	136-120	190-180
091200Z	31.5N	137.8E	078-137	192-325
091800Z	33.6N	138.9E	057-160	194-255
100000Z	35.8N	140.8E	219-112	173-335
100600Z	38.2N	143.3E	049-120	169-340
101200Z	39.7N	145.8E	290-22	050-330
101800Z	41.0N	147.3E	057-335	060-435

AVERAGE 24 HOUR ERROR 146 MI
AVERAGE 48 HOUR ERROR 312 MI


24 HR FORECAST POSITS
TYPHOON VIOLET
04–10 OCTOBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/00Z
VLADIVOSTOK
TSINGTAO
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
TOKYO
SAIPAN
GUAM
WAKE I
142°30'E
157°30E
172°30E



SHIPPING DAMAGE: THE PIONEER MUSE RAN AGROUND OF KITA DIATO SHIMA AS A RESULT OF TYPHOON VIOLET, OCTOBER, 1961. (RELEASED BY PACIFIC STARS AND STRIPES, 14 OCT 61)



SHEIK IS BROKEN IN TWO AFTER RUNNING AGROUND ON KITA DIATO SHIMA, OCTOBER 1961. (RELEASED BY PACIFIC STARS AND STRIPES, 14 OCT 61)

Q. TYPHOON BILLIE (230000Z-280600Z OCTOBER 1961)

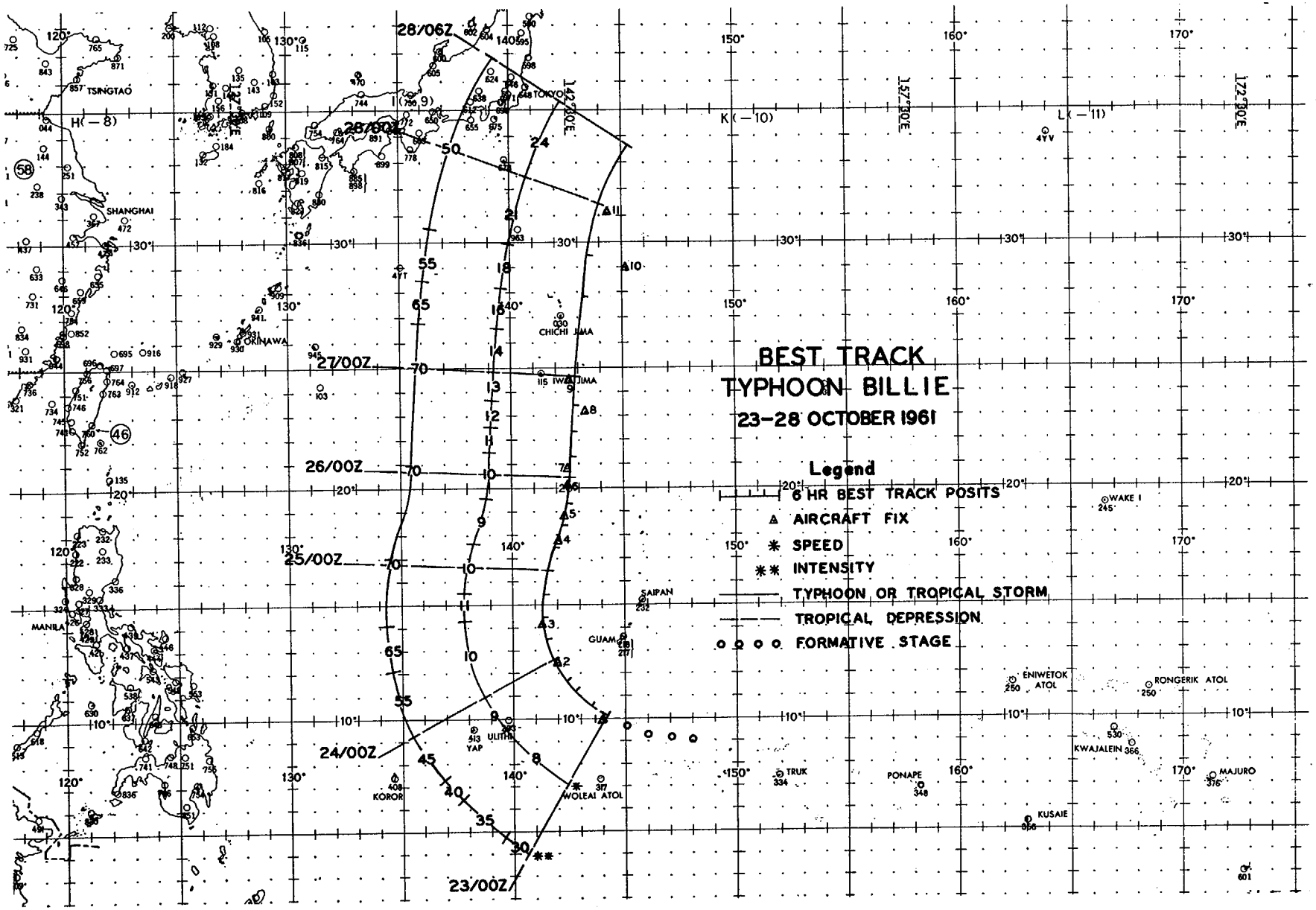
FOR SEVERAL DAYS PRIOR TO 23 OCTOBER AN EXTENSIVE AREA OF LOW PRESSURE HAD BEEN PRESENT SOUTH OF GUAM. AT TIMES IT CONTAINED AS MANY AS THREE WELL DEFINED VORTICES. ONE CENTER FINALLY BECAME PREDOMINANT AND THE ENTIRE SYSTEM STARTED TO INTENSIFY. WHEN THE FIRST TROPICAL DEPRESSION WARNING WAS ISSUED AT 230000Z THE RADIUS OF CYCLONIC WINDS ABOUT THE CENTER EXCEEDED 1000 MI.

AT 231200Z THE SYSTEM WAS UPGRADED TO TROPICAL STORM INTENSITY AND THE NAME BILLIE WAS ASSIGNED. INTENSIFICATION CONTINUED UNTIL 241200Z WHEN THE MAXIMUM SURFACE WIND SPEED OF 70 KTS WAS REACHED. BILLIE'S TRACK UP TO THIS TIME SHOWED THAT SHE HAD TURNED TO THE N FROM A HEADING OF W AND WAS DESCRIBING AN ARC ABOUT GUAM WITH A RADIUS OF ABOUT 200 MI. FOR THE NEXT THREE DAYS BILLIE MOVED IN A NORTHERLY DIRECTION WHILE MAINTAINING THE SAME INTENSITY. HER RADIUS OF CYCLONIC WINDS HAD DECREASED TO APPROXIMATELY 750 MI AND THEN REMAINED NEARLY CONSTANT THROUGHOUT THE REST OF HER TROPICAL LIFE. THE EXTENSIVE AREA ENCOMPASSED BY BILLIE'S CIRCULATION WAS MATCHED BY THE SIZE OF HER EYE WHICH WAS ALSO OF KING SIZE PROPORTIONS. NO OTHER TYPHOON OF 1961 WAS ABLE TO EQUAL HER EYE DIAMETER WHICH AT ONE TIME MEASURED 120 X 180 MI. IN THIS RESPECT AND MANY OTHERS BILLIE WAS VERY SIMILAR TO TYPHOON CARMEN OF AUGUST 1960.

BILLIE PASSED 50 MI E OF CHICHI JIMA AT APPROXIMATELY 270900Z, AND SHORTLY AFTERWARDS WEAKENED TO TROPICAL STORM INTENSITY. SHE ENCOUNTERED THE POLAR FRONT NEAR 32N AT APPROXIMATELY 280000Z AND MERGED WITH A LOW PRESSURE AREA ASSOCIATED WITH IT. THE FINAL TROPICAL WARNING WAS ISSUED AT 280600Z WHEN THE SYSTEM WAS DEFINITELY EXTRATROPICAL BUT STILL HAD 50 KT SURFACE WINDS.

BILLIE TRAVELED 1500 MI OVER A PERIOD OF 5 DAYS AND 6 HOURS, AT AN AVERAGE SPEED OF 12 KTS. THE MINIMUM SPEED WAS 8 KTS ON 23 OCTOBER AND THE MAXIMUM SPEED WAS 24 KTS ON THE 28 OCTOBER.

BILLIE DID NOT PASS OVER ANY LARGE LAND MASSES DURING ITS LIFE, THEREFORE CREATED LESS DAMAGE THAN MIGHT OTHERWISE HAVE BEEN EXPECTED. AS THE TYPHOON NEARED GUAM, A JAPANESE FREIGHTER, THE FUKAZAN MARU, A 7000 TON FREIGHTER LADEN WITH COPPER ORE FROM TOWNSVILLE, AUSTRALIA ENROUTE TO JAPAN, DEVELOPED A LEAK IN ONE OF THE HOLDS AND COMMENCED TO SINK RATHER SLOWLY. THE CREW OF 47 WERE RESCUED BY THE DOLLY TURMAN WITHOUT INCIDENT, WERE TRANSFERRED TO THE USS BRISTER, AND TRANSPORTED TO GUAM. THE TYPHOON CREATED STRONG WINDS AND CONSIDERABLE RAINFALL AT IWO JIMA AND OTHER ISLANDS BUT DAMAGE WAS NOT REPORTED.


BEST TRACK
TYPHOON BILLIE
23-28 OCTOBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
28/06Z
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
23/00Z
TSINGTAO
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
TOKYO
SAIPAN
GUAM
MANILA
YAP
ULITHI
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN
MAJURO
WAKE I
H(−8)
I(−9)
K(−10)
L(−11)
142.5°E
157.5°E
172.5°E

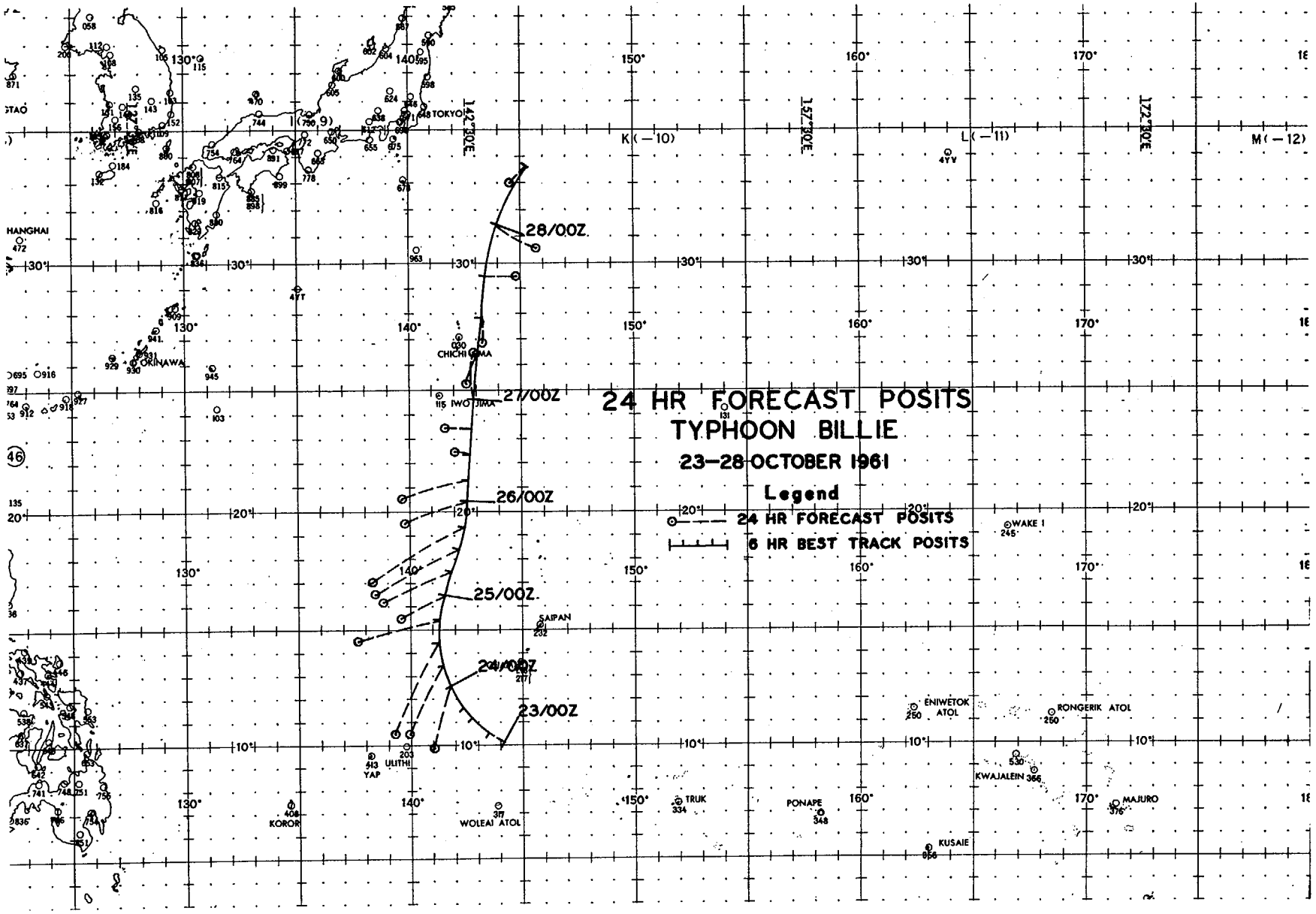
LAND RADAR AND AIRCRAFT FIXES - TYPHOON BILLIE

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/Td (°C)	EYE CHARACTERISTICS
1	222347Z	10.0N	144.0E	VW1-P-15	25	---	----	---	-----	LARGE AREA OF LIGHT AND VARIABLE WINDS
2	232240Z	12.5N	142.0E	VW1-P-10	50	---	9980	990	12/--	40 MI DIA
3	241230Z	14.1N	141.2E	VW1-R-15	---	---	----	---	-----	INDEFINITE
4	250807Z	17.9N	142.1E	VW1-P-10	---	---	----	981	-----	WALL CLDS S QUAD
5	251530Z	18.9N	142.3E	VW1-P-15	---	---	----	974	-----	CIRC 100 MI DIA
6	252316Z	20.2N	142.5E	VW1-P-10	65	---	----	972	-----	152 X 86 MI, ORIENTED 023 DEG
7	260344Z	20.9N	142.4E	VW1-P-05	---	---	9425	961	17/--	180 X 120MI, ORIENTED NNE-SSW
8	261527Z	23.1N	143.2E	VW1-P-05	---	---	9290	---	16/--	RADAR EYE 155 X 105 MI
9	262250Z	24.7N	142.7E	315-P-U	35	20	9530	---	16/--	----------
10	271615Z	29.0N	145.1E	VW1-P-20	---	40	9545	---	16/--	----------
11	272200Z	31.1N	144.3E	315-P-02	40	20	9500	965	13/--	NO DEFINITE EYE, DIA 50 MI

TYPHOON BILLIE 23-28 OCT 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
230000Z	10.2N	144.1E	-------	-------
230600Z	10.7N	143.4E	-------	-------
231200Z	11.2N	142.8E	-------	-------
231800Z	11.8N	142.3E	-------	-------
240000Z	12.6N	141.8E	-------	-------
240600Z	13.5N	141.4E	-------	-------
241200Z	14.5N	141.3E	208-277	-------
241800Z	15.6N	141.4E	250-174	-------
250000Z	16.6N	141.7E	241-241	-------
250600Z	17.6N	141.9E	243-197	-------
251200Z	18.4N	142.2E	240-236	221-594
251800Z	19.3N	142.4E	241-280	252-416
260000Z	20.4N	142.4E	252-157	243-332
260600Z	21.3N	142.6E	252-170	256-356
261200Z	22.5N	142.6E	278-37	238-405
261800Z	23.6N	142.8E	263-61	236-480
270000Z	24.8N	142.9E	183-90	244-291
270600Z	26.3N	143.0E	198-67	242-317
271200Z	27.9N	143.1E	185-62	213-135
271800Z	29.7N	143.4E	109-80	215-152
280000Z	31.8N	143.9E	128-115	093-306
280600Z	33.9N	145.1E	208-64	140-295

AVERAGE 24 HOUR ERROR 144 MI
AVERAGE 48 HOUR ERROR 340 MI

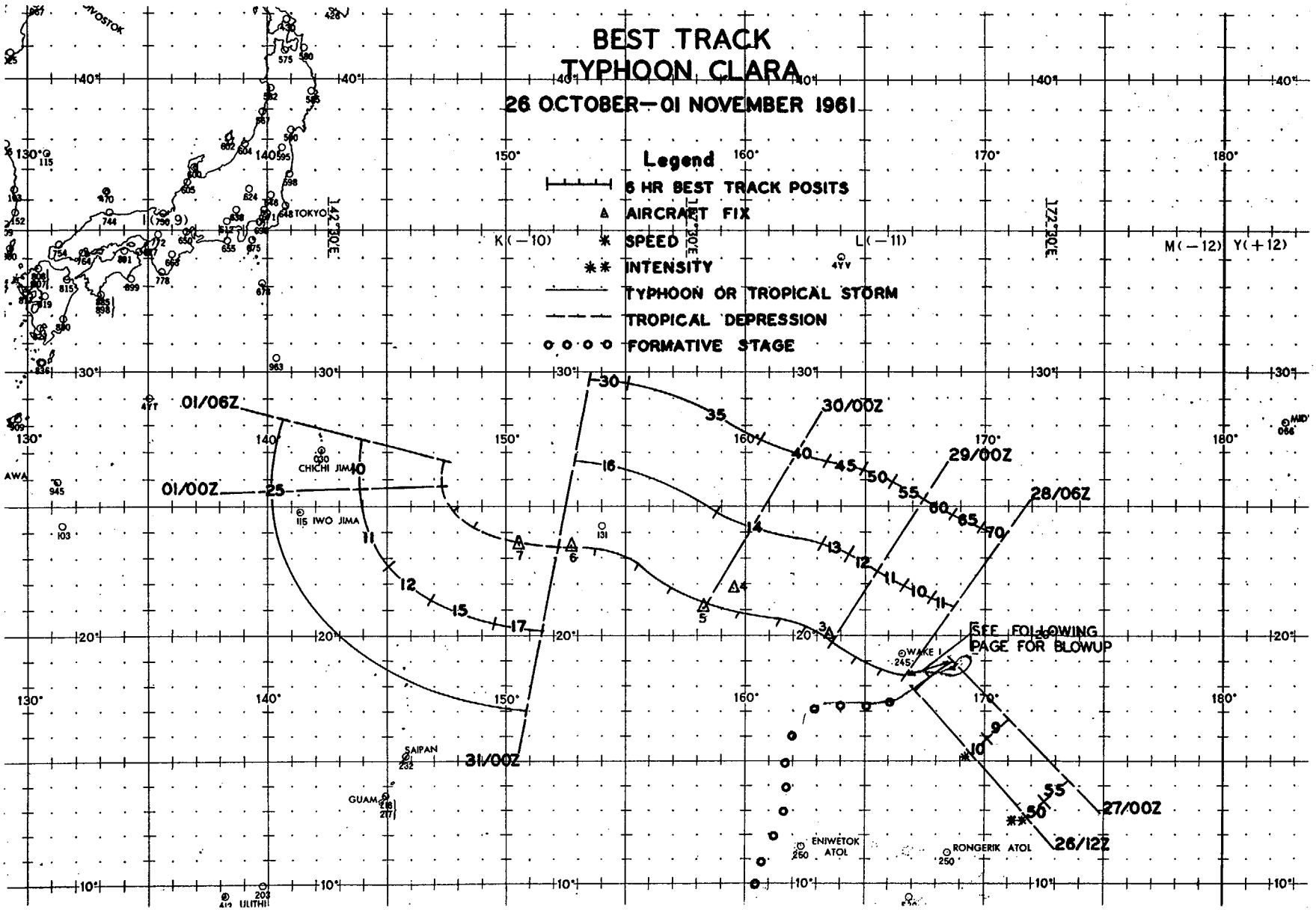

24 HR FORECAST POSITS
TYPHOON BILLIE
23–28 OCTOBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
23/00Z
TOKYO
CHICHI JIMA
IWO JIMA
OKINAWA
HANGHAI
SAIPAN
YAP
ULITHI
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN
MAJURO
WAKE I
130°
140°
150°
160°
170°
30°
20°
10°
I (−9)
K (−10)
L (−11)
M (−12)
142.5°E
157.5°E
172.5°E

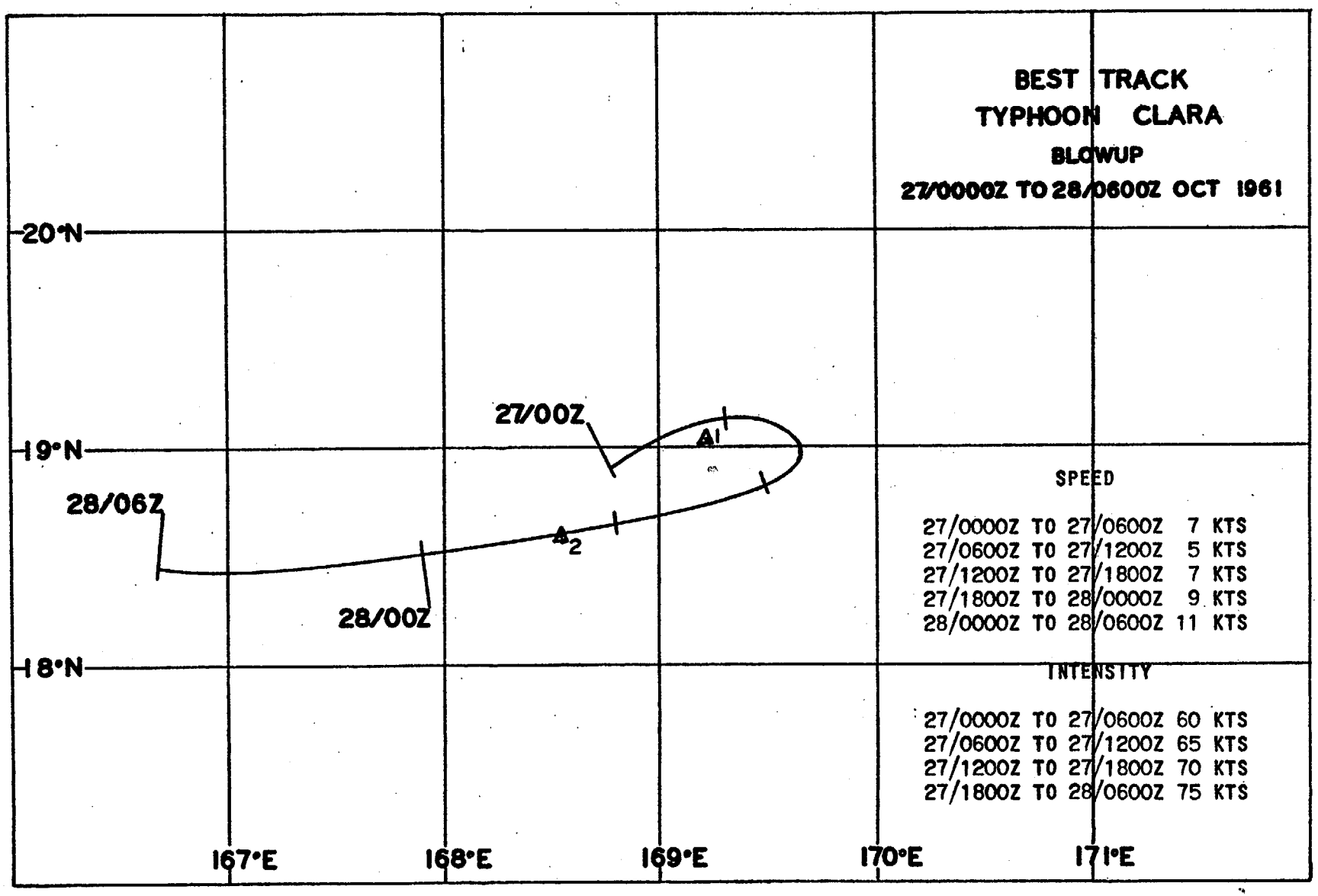
R. TYPHOON CLARA (261200Z OCTOBER - 010600Z NOVEMBER)

THE ORIGIN OF TYPHOON CLARA CAN BE TRACED BACK TO A VORTEX WHICH ORIGINALLY FORMED ALONG THE ITCZ NEAR ENIWETOK ATOLL AND WAS DRIVEN TO THE N BY THE VAST CIRCULATION OF TYPHOON BILLIE. THE FIRST WARNING WAS ISSUED AT 261200Z WHEN SURFACE REPORTS INDICATED THAT THE SYSTEM HAD INTENSIFIED TO TROPICAL STORM STRENGTH AND WAS APPROXIMATELY 100 MI S OF WAKE ISLAND MOVING ENE AT 10 KTS. THIS EASTERLY MOVEMENT WAS PROBABLY CAUSED BY THE COMBINED FORCES OF AN ANTICYCLONE LYING TO THE SW OF CLARA AND AN EXTRATROPICAL CYCLONE SITUATED TO HER NE.

THE ENE MOVEMENT OF CLARA CONTINUED FOR ANOTHER 18 HOURS DURING WHICH TIME SHE INTENSIFIED TO TYPHOON STRENGTH. BETWEEN 270000Z AND 280000Z THE 700 MB LEVEL OVER CLARA UNDERWENT A SIGNIFICANT CHANGE. THE ANTICYCLONE TO THE SW WEAKENED AND QUICKLY DISAPPEARED, WHILE ANOTHER OUTDRAFT WHICH HAD BEEN LOCATED FAR TO THE NW OF CLARA SHIFTED EASTWARD AND REPOSITIONED ITSELF N OF CLARA. BETWEEN 270600Z AND 271200Z CLARA EXECUTED A CLOCKWISE TURN OF 180 DEGREES AND STARTED BACK TOWARDS THE W. SHE RECROSSED HER TRACK AT 280000Z AND PASSED 50 MI S OF WAKE ISLAND AT 280600Z WHILE ON A HEADING OF 270 DEGREES. SHE WEAKENED TO SLIGHTLY LESS THAN TYPHOON STRENGTH AT 281800Z AND STARTED FOLLOWING A LOW AMPLITUDE SINUSOIDAL TRACK TOWARDS THE WNW. CLARA CONTINUED TO GRADUALLY WEAKEN AND DROPPED BELOW TROPICAL STORM INTENSITY WHILE PASSING S OF MARCUS ISLAND AT 301800Z. SHE CONTINUED TO THE W FOR ANOTHER 12 HOURS, THEN STARTED A SWEEPING TURN TO THE N. SHE RAPIDLY BECAME EXTRATROPICAL AFTER ENCOUNTERING THE POLAR FRONT, AND THE FINAL WARNING WAS ISSUED AT 010600Z.

CLARA TRAVELED 1650 MI IN THE 5 DAYS AND 18 HOURS THAT WARNINGS WERE BEING ISSUED. HER MINIMUM SPEED WAS 5 KTS ON 27 OCTOBER AND HER MAXIMUM SPEED WAS 17 KTS ON 31 OCTOBER. SHE WAS ONE OF THREE TYPHOONS THAT LOOPED DURING THE 1961 SEASON, AND THE ONLY ONE TO PERFORM THE MANEUVER IN A CLOCKWISE DIRECTION. DAMAGE REPORTS WERE NOT RECEIVED BY JTWC, HOWEVER POSSIBLE DAMAGE COULD HAVE OCCURRED TO SHIPPING OR SMALL ISLANDS.


BEST TRACK
TYPHOON CLARA
26 OCTOBER–01 NOVEMBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
01/06Z
01/00Z
31/00Z
30/00Z
29/00Z
28/06Z
27/00Z
26/12Z
SEE FOLLOWING PAGE FOR BLOWUP
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
ULITHI
WAKE I
ENIWETOK ATOL
RONGERIK ATOL
TOKYO
K(−10)
L(−11)
M(−12) Y(+12)
172.5°E


BEST TRACK
TYPHOON CLARA
BLOWUP
27/0000Z TO 28/0600Z OCT 1961
20°N
19°N
18°N
27/00Z
28/06Z
28/00Z
A1
A2
SPEED
27/0000Z TO 27/0600Z 7 KTS
27/0600Z TO 27/1200Z 5 KTS
27/1200Z TO 27/1800Z 7 KTS
27/1800Z TO 28/0000Z 9 KTS
28/0000Z TO 28/0600Z 11 KTS
INTENSITY
27/0000Z TO 27/0600Z 60 KTS
27/0600Z TO 27/1200Z 65 KTS
27/1200Z TO 27/1800Z 70 KTS
27/1800Z TO 28/0600Z 75 KTS
167°E
168°E
169°E
170°E
171°E

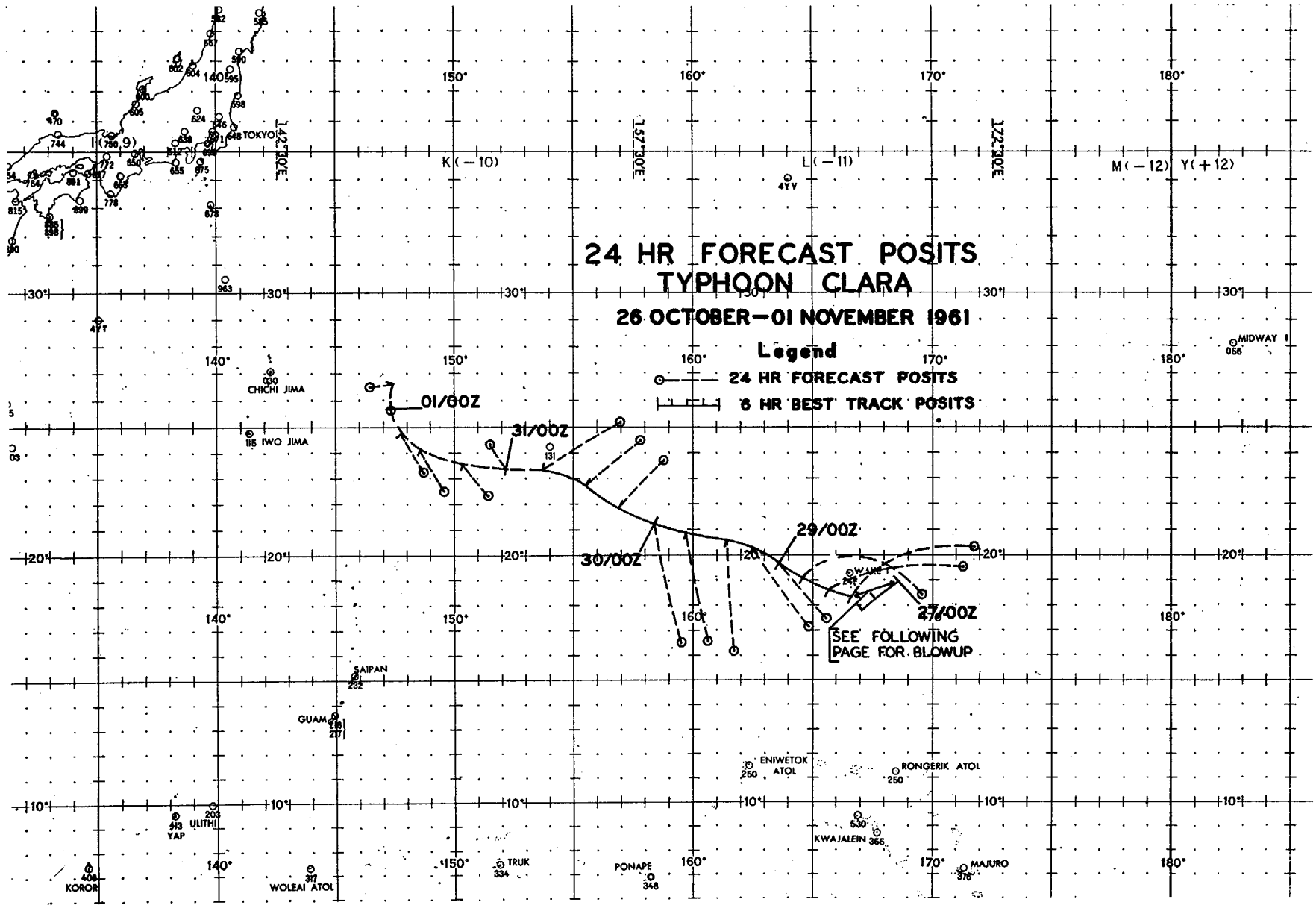
LAND RADAR AND AIRCRAFT FIXES - TYPHOON CLARA

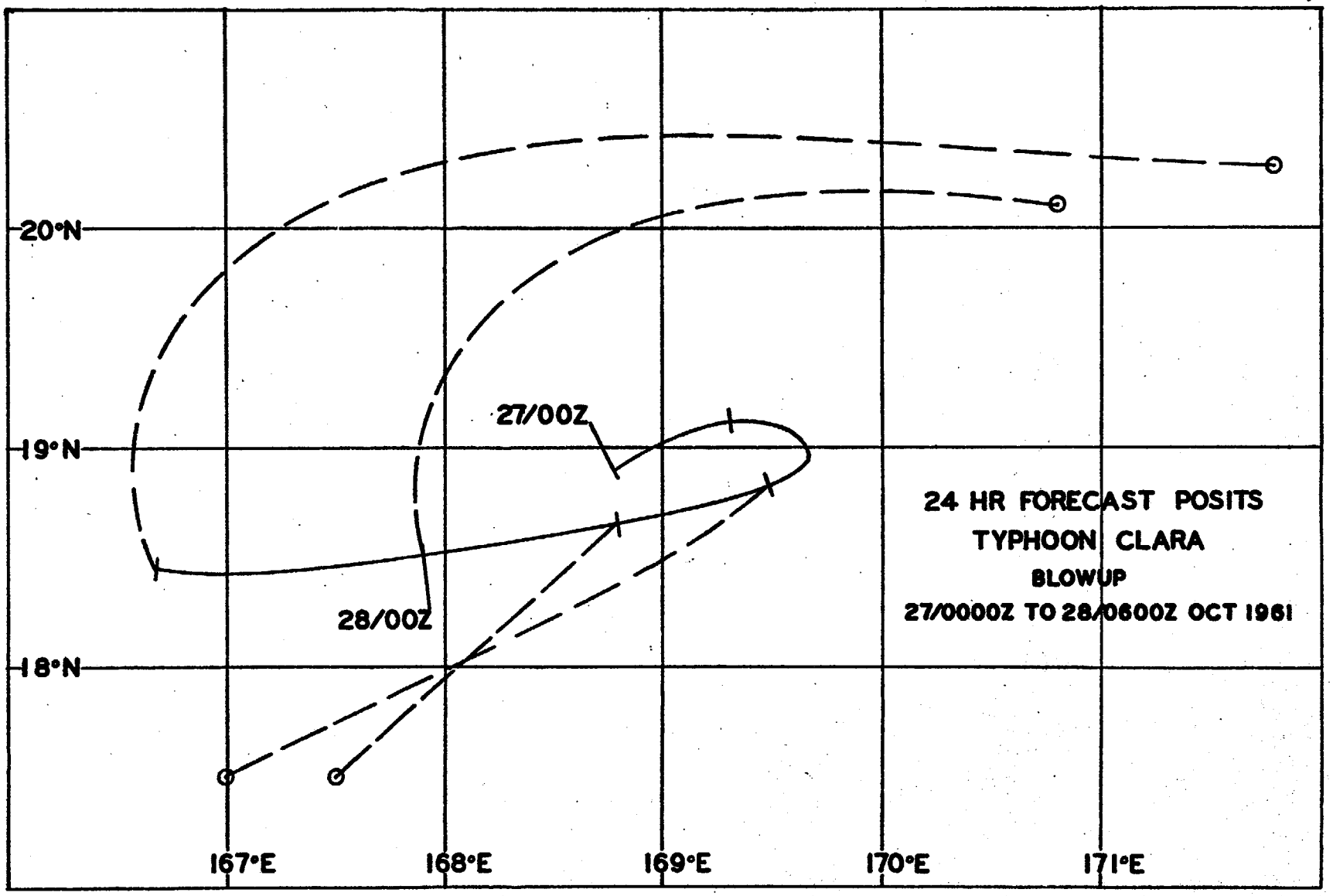
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	270240Z	19.0N	169.2E	VW1-P-U	60	---	-----	---	-----	15 MI DIA OPEN SW & NW
2	271930Z	18.6N	168.6E	VW1-P-05	75	---	-----	984	-----	15 MI DIA OPEN W
3	290230Z	20.1N	163.4E	VW1-P-05	65	---	-----	994	-----	CIRC 15 MI DIA
4	291720Z	21.9N	159.5E	VW1-R-15	---	---	-----	---	-----	----------
5	300039Z	21.1N	158.2E	VW1-P-15	40	---	-----	1003	-----	70 MI DIA OPEN E & N
6	302200Z	23.4N	152.8E	VW1-P-15	30	---	-----	999	-----	20 MI DIA, NO RADAR PRESENTATION
7	310530Z	23.5N	150.5E	VW1-P-U	25	---	10290	---	-----	SCATTERED CB

TYPHOON CLARA 26-OCT-01-NOV 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
261200Z	17.9N	167.1E	-------	-------
261800Z	18.5N	167.9E	-------	-------
270000Z	18.9N	168.8E	-------	-------
270600Z	19.1N	169.3E	-------	-------
271200Z	18.8N	169.5E	241-165	-------
271800Z	18.7N	168.8E	234-102	-------
280000Z	18.5N	167.9E	062-197	-------
280600Z	18.4N	166.7E	069-317	-------
281200Z	18.6N	165.6E	080-325	082-165
281800Z	19.1N	164.7E	097-282	091-245
290000Z	19.8N	163.8E	141-180	085-585
290600Z	20.4N	162.7E	148-239	083-710
291200Z	20.8N	161.4E	173-284	080-325
291800Z	20.9N	159.9E	171-262	109-201
300000Z	21.3N	158.4E	167-277	156-355
300600Z	22.0N	157.0E	054-147	155-428
301200Z	22.9N	155.6E	054-155	165-492
301800Z	23.4N	153.9E	057-207	159-405
310000Z	23.4N	152.2E	337-63	153-410
310600Z	23.6N	150.3E	148-92	050-367
311200Z	24.0N	148.8E	144-95	052-430
311800Z	24.8N	147.8E	149-112	053-462
010000Z	25.8N	147.3E	222-12	353-65
010600Z	26.8N	147.3E	240-53	189-127

AVERAGE 24 HOUR ERROR 178 MI
AVERAGE 48 HOUR ERROR 361 MI


24 HR FORECAST POSITS
TYPHOON CLARA
26 OCTOBER–01 NOVEMBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
01/00Z
31/00Z
30/00Z
29/00Z
27/00Z
SEE FOLLOWING PAGE FOR BLOWUP
TOKYO
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOL
TRUK
PONAPE
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN
MAJURO
WAKE
MIDWAY I
K(−10)
L(−11)
M(−12)
Y(+12)
142.5°E
157.5°E
172.5°E

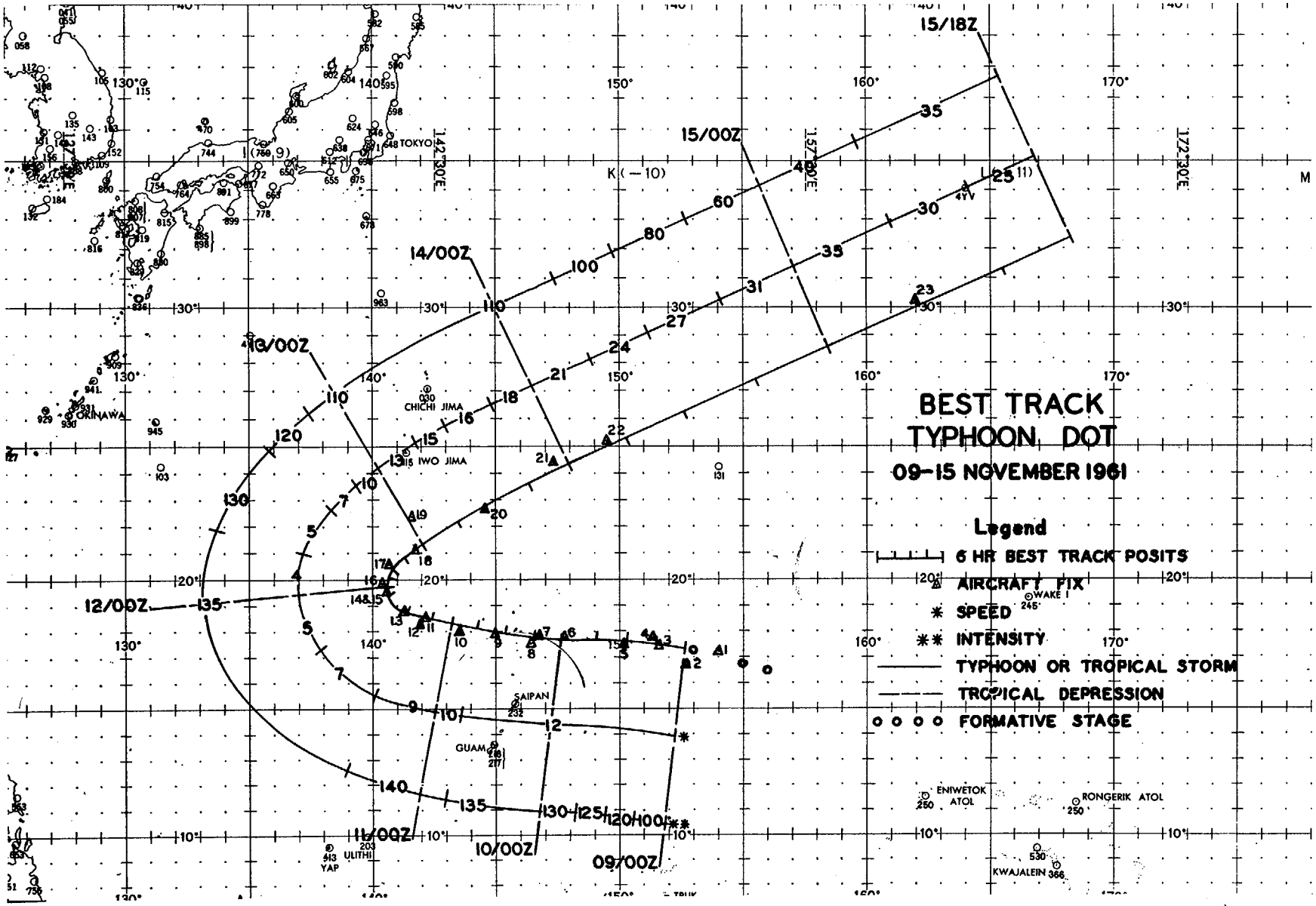

20°N
19°N
18°N
167°E
168°E
169°E
170°E
171°E
27/00Z
28/00Z
24 HR FORECAST POSITS
TYPHOON CLARA
BLOWUP
27/0000Z TO 28/0600Z OCT 1961

S. TYPHOON DOT (090000Z-151800Z NOVEMBER 1961)

On 8 November a series of pilot reports along the Guam-Wake Island track disclosed the existence of an area of severe weather. A subsequent reconnaissance investigation substantiated this and found the source of poor weather to be a fully developed typhoon. The name DOT was assigned and the first warning was issued at 090000Z. It is doubtful that DOT would have been detected even at this advanced stage, had she not formed near a route used by trans-Pacific aircraft. Even at the time the first warning was issued, there was little evidence on any synoptic chart that would support a system of this intensity.

DOT's track for the first two days of her warning life was a nearly straight line towards the W. While she was moving in this direction, the subtropical ridge line started to slope progressively more toward the S. By 110000Z the slope had become quite pronounced, with the ridge axis located 10 degrees N of DOT at the surface and 5 degrees S of her at 200 mb. At this time DOT reached her maximum intensity of 140 kts and started a gradual turn toward the N. She weakened slightly, and at 120000Z showed a sudden increase in curvature, completing a turn of 90 degrees in the next 12 hours. This was apparently caused by a trough passing N of the typhoon and the subsequent southerly movement of the western portion of the ridge line. After this sharp recurvature, DOT continued in another near straight line this time towards the ENE. She followed this track for three days while slowly accelerating. DOT weakened to storm intensity at 141800Z and continued weakening slowly until 151800Z when the final warning was issued.

DOT was characterized by her unusually small size during the formative stages which enabled her to reach typhoon intensity before being detected. Her track of two nearly straight lines meeting at an angle of approximately 150 degrees was also far from normal. She traveled 2425 mi at an average speed of 15 kts during the 6 days and 18 hours of her warning life. The speeds varied from 4 kts on 12 November to 35 kts on 15 November. DOT did not pass over any large land mass while a typhoon. She passed between Pagan and Alamagan Islands at 101000Z causing damage to Alamagan Island that was classed as substantial.


BEST TRACK
TYPHOON DOT
09-15 NOVEMBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
15/18Z
15/00Z
14/00Z
13/00Z
12/00Z
11/00Z
10/00Z
09/00Z
TOKYO
CHICHI JIMA
IWO JIMA
OKINAWA
SAIPAN
GUAM
YAP
ULITHI
WAKE I
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN

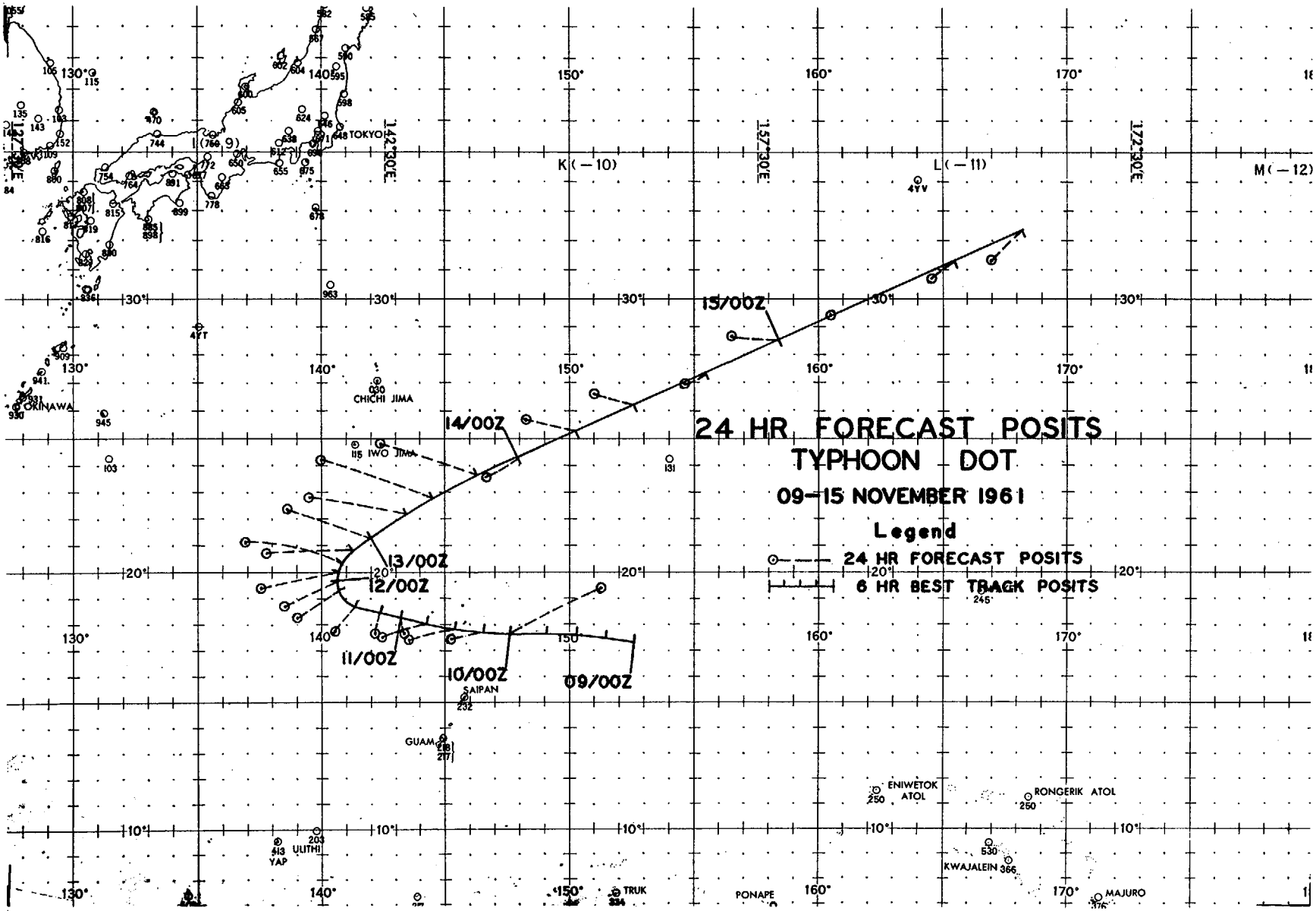
LAND RADAR AND AIRCRAFT FIXES - TYPHOON DOT

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MAX 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	082100Z	17.2N	154.0E	VW1-R-10	---	---	----	---	-----	CIRC 16MI DIA WELL DEVELOPED SPIRAL BANDS ALL QUADS
2	082307Z	16.8N	152.8E	USAF-U-U	---	---	----	---	-----	----------
3	090530Z	17.5N	151.7E	VW1-P-10	125	---	----	982	-----	OVAL 17 X 5MI PERFECT EYE
4	090628Z	17.8N	151.4E	USAF-U-U	---	---	----	---	-----	20MI DIA
5	090810Z	17.6N	150.2E	USAF-R-U	---	---	----	---	-----	20MI DIA
6	100010Z	17.9N	147.9E	VW1-R-03	---	---	----	---	-----	CIRC 19MI DIA
7	100430Z	17.9N	146.9E	VW1-R-02	---	---	----	---	-----	OVAL 19 X 15MI
8	100630Z	17.7N	146.6E	VW1-R-U	---	---	----	---	-----	----------
9	101345Z	17.9N	145.0E	VW1-R-01	---	---	----	---	-----	CIRC 13MI DIA
10	102200Z	18.0N	143.6E	56-P-04	80	117	7960	930	19/13	CIRC 10MI DIA WALL CLDS ALL QUADS
11	110545Z	18.5N	142.1E	VW1-R-05	---	---	----	---	-----	CIRC 22MI DIA, WELL DEFINED
12	110655Z	18.2N	142.0E	56-P-10	100	---	7980	922	16/16	24MI DIA, NOT WELL DEFINED
13	111335Z	18.9N	141.3E	VW1-R-02	---	---	----	---	-----	OVAL NNE-SSW 20X18MI
14	112200Z	19.5N	140.5E	56-P-04	135	100	8270	932	18/15	CIRC 20MI DIA WALL CLDS ALL QUADS
15	120035Z	19.5N	140.5E	VW1-R-02	---	---	----	---	-----	OPEN S SEMICIRC 22MI DIA
16	120400Z	19.9N	140.3E	56-P-04	150	115	8490	931	15/15	CIRC 25MI DIA
17	121400Z	20.6N	140.7E	VW1-R-03	---	---	----	---	-----	CIRC 12MI DIA
18	122200Z	21.2N	141.8E	56-P-02	100	---	8930	958	16/16	NOT DEFINED
19	130445Z	22.3N	142.6E	56-P-05	100	85	9000	960	17/13	NOT DEFINED
20	131200Z	22.8N	144.8E	VW1-R-03	---	---	----	---	-----	CIRC 64MI DIA OPEN E & W

TYPHOON DOT 09-15 NOV 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
090000Z	17.3N	152.8E	-------	-------
090600Z	17.6N	151.6E	-------	-------
091200Z	17.7N	150.3E	-------	-------
091800Z	17.8N	149.1E	-------	-------
100000Z	17.8N	147.9E	062-210	-------
100600Z	17.8N	146.7E	076-93	-------
101200Z	17.9N	145.5E	079-110	-------
101800Z	18.0N	144.2E	077-105	-------
110000Z	18.2N	143.2E	078-155	058-465
110600Z	18.3N	142.3E	193-41	260-129
111200Z	18.8N	141.4E	221-102	260-165
111800Z	19.3N	140.8E	239-118	264-191
120000Z	19.6N	140.4E	247-112	223-143
120600Z	20.0N	140.4E	259-161	233-206
121200Z	20.4N	140.6E	281-210	267-266
121800Z	20.9N	141.2E	270-183	275-353
130000Z	21.5N	142.0E	287-204	265-396
130600Z	22.2N	143.2E	283-203	272-455
131200Z	22.9N	144.7E	286-261	285-448
131800Z	23.7N	146.3E	290-222	265-501
140000Z	24.5N	148.0E	341-203	294-416
140600Z	25.4N	150.1E	284-110	302-367
141200Z	26.4N	152.6E	291-89	308-395
141800Z	27.4N	155.3E	285-65	313-314
150000Z	28.7N	158.5E	275-102	295-216
150600Z	30.1N	162.2E	248-100	250-190
151200Z	31.3N	165.4E	227-41	280-245
151800Z	32.4N	168.1E	225-103	275-225

AVERAGE 24 HOUR ERROR 138 MI
AVERAGE 48 HOUR ERROR 304 MI


24 HR FORECAST POSITS
TYPHOON DOT
09–15 NOVEMBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
15/00Z
14/00Z
13/00Z
12/00Z
11/00Z
10/00Z
09/00Z
TOKYO
CHICHI JIMA
IWO JIMA
ORINAWA
SAIPAN
GUAM
YAP
ULITHI
TRUK
PONAPE
ENIWETOK ATOL
RONGERIK ATOL
KWAJALEIN
MAJURO
142°30'E
157°30'E
172°30'E
K (–10)
L (–11)
M (–12)

T. TYPHOON ELLEN (050600Z-131800Z DECEMBER 1961)

TYPHOON ELLEN'S ORIGIN WAS THE SAME AS THAT OF SEVERAL LATE SEASON CYCLONES WHICH DID NOT DEVELOP TO STORM INTENSITY. IT CAN BE TRACED BACK TO THE VICINITY OF TRUK ISLAND, WHERE THERE WAS SUFFICIENT DATA TO SUPPORT THE EXISTENCE OF A CLOSED CIRCULATION. AS IT MOVED WESTWARD INTO THE "NO DATA" AREA S OF GUAM, ITS PRESENCE COULD ONLY BE SUBSTANTIATED BY PERSISTENCY. MANY SIMILAR CYCLONES HAVE FAILED TO REAPPEAR IN THE YAP-KOROR AREA, BUT THIS WAS NOT THE CASE WITH ELLEN. SHE ARRIVED IN THE WESTERN CAROLINES "ON SCHEDULE" WITH A WELL DEFINED CIRCULATION OF SLIGHT INTENSITY. THE FIRST TROPICAL DEPRESSION WARNING WAS ISSUED AT 050600Z WHEN THE SYSTEM SHOWED SIGNS OF POSSIBLE DEVELOPMENT.

TROPICAL DEPRESSION WARNINGS WERE CONTINUED FOR TWO DAYS WHILE THE SYSTEM BECAME PROGRESSIVELY MORE WELL DEFINED. FINALLY AT 070600Z THE FIRST TROPICAL STORM ELLEN WARNING WAS ISSUED BASED ON A RECONNAISSANCE FIX WHICH REPORTED 45 KT SURFACE WINDS. ELLEN THEN INTENSIFIED RAPIDLY REACHING TYPHOON STRENGTH AT 071200Z AND ATTAINED HER MAXIMUM INTENSITY OF 130 KTS AT 081200Z. SHE HAD BEEN MOVING IN A NEARLY STRAIGHT LINE TOWARD THE WNW UNTIL THIS TIME. SHE PASSED NEAR CATANDUANES ISLAND SHORTLY AFTER 090000Z AND THEN TURNED TOWARDS THE NNE. AFTER THIS TURN, ELLEN'S TRACK BECAME IRREGULAR, SHOWING SEVERAL MINOR HEADING CHANGES WHILE MAINTAINING A CONSTANT 6 KT SPEED OF MOVEMENT. THIS IS CONSIDERED TYPICAL OF A TYPHOON WHICH RECURVES THROUGH THE SUBTROPICAL RIDGE LINE INTO AN AREA OF WEAK ZONAL FLOW. AFTER REINTENSIFYING TO 125 KTS ELLEN STARTED TO WEAKEN, DROPPING BELOW TYPHOON INTENSITY AT 121200Z AND DISSIPATING ENTIRELY SHORTLY AFTER 131800Z.

A TOTAL OF 35 WARNINGS WERE ISSUED COVERING A PERIOD OF 8 DAYS AND 12 HOURS. DURING THIS PERIOD, ELLEN TRAVELED 1400 MI AT AN AVERAGE SPEED OF 7 KTS. HER MAXIMUM SPEED WAS 12 KTS ON 5 DECEMBER AND THE MINIMUM SPEED OF 3 KTS OCCURRED DURING RECURVATURE ON 9 DECEMBER.

ELLEN PASSED WITHIN 10 MI OF THE N TIP OF CATANDUANES ISLAND. THE EYE OF THE TYPHOON WAS 36 MI IN DIAMETER AT THAT TIME, THEREFORE THE COAST GUARD LORAN STATION ON THE ISLAND RECEIVED THE IMPACT OF THE STRONG WINDS ASSOCIATED WITH THE WALL CLOUD TWICE. NEWS RELEASES INDICATED THE PROPERTY DAMAGE TO BE ABOUT $500,000. THE LORAN STATION MADE PREPARATIONS FOR THE PASSAGE ON 7 AND 8 DECEMBER, AND BECAUSE OF THIS, INJURIES TO PERSONNEL WERE MINIMIZED. ONE ENTRY, IN THE LETTER DESCRIBING THE TYPHOON PASSAGE, MADE AT 1800, INDICATES THE FINAL PREPARATIONS PRIOR TO TYPHOON WINDS: "1800, 8 DECEMBER 1961 (N, 33 KTS, 29.58") ALL HANDS MOVED TO SIGNAL-POWER BUILDING. SECURED LOWER STATION EXCEPT FOR POWER (HOT LOCKERS, FUEL AND WATER PUMPS), FRESH WATER, AND FUEL OIL CONNECTIONS. TRUCK PARKED BETWEEN WATER TANKS AND SIGNAL-POWER BUILDING."

A DESCRIPTION OF THE PASSAGE OF THE TYPHOON IS AS FOLLOWS:

A. 2400, 8 DECEMBER 1961 (NE, 45-65 KTS, 29.43") CRACK BETWEEN ROOF JOINT OF SIGNAL ROOM AND POWER ROOM OPENED. LEAKS NECESSITATE MOVING ALL EEE GEAR ON BULKHEAD SHELF OF THE HOT LOCKER TO OTHER SHELVES.

B. 0100, 9 DECEMBER 1961 (N, 45-65 KTS, 29.40") SECURED OUTSIDE TEMPERATURE READINGS DUE TO HIGH WINDS. WATER BEING DRIVEN THROUGH COMMUNICATIONS TRANSMITTING ANTENNA LEAD-IN TERMINAL BOARD AND THROUGH LORAN TRANSMITTER VENT DUCTING INTO THE NORTH END OF BUILDING. ESTABLISHED BUCKET BRIGADE. WATER IS RUNNING ONTO POWER DISTRIBUTION AND SWITCH BOXES BELOW THESE ENTRY POINTS.

C. 0303, 9 DECEMBER 1961 (NNE, 62-85 KTS, 29.22") OBSERVED NO PULSE ON PEDESTAL, USWR AT 10:1 AND TRANSMITTER LINE CURRENT AT 1.9 AMPS. SECURED LORAN TRANSMISSION. REPORTED ANTENNA DOWN. (LATER DISCOVERED THAT ANTENNA WAS NOT DOWN, BUT SEAS HAD WASHED OVER COUPLERS AND SHORTED AND GROUNDED THEM.)

D. 0335, 9 DECEMBER 1961 (UP TO 100 KTS, 29.11") ANEMOMETER IMPELLER GONE. RAIN AND SPRAY DRIVING HORIZONTALLY. NORTH WALL CONTINUES TO LEAK. SIDE DOOR TO SIGNAL ROOM BEGAN POUNDING TO EQUALIZE PRESSURE. ATTEMPTED TO SECURE WITH NAILS AND LINE FROM INSIDE.

E. 0558, 9 DECEMBER 1961 (N, 120 TO 140 KTS EST., 28.80") HOUSEHOLD GENERATOR LOAD VERY ERRATIC. SECURED POWER TO LOWER STATION. (LATER DETERMINED THAT THIS IS TIME WHEN OFFICE BUILDING WAS DESTROYED.) SIDE DOOR CONTINUES TO POUND THOUGH SECURED.

F. 0715, 9 DECEMBER 1961 (N, 120 TO 150 KTS EST., 28.51") LARGE GENERATOR ROOM DOORS BURST OPEN. CLOSED, BARRED, AND NAILED THEM SHUT. ADDED NAILS AND LINE TO SIDE DOOR. STILL SECURE.

G. 0735, 9 DECEMBER 1961 (N, 120 TO 150 KTS EST., 28.17") LIGHT SWITCH IN PASSAGEWAY SHORTED BY WATER FROM ROOF, CAUGHT FIRE AND BURNED ITSELF OUT BEFORE CO2 WAS BROUGHT ON IT. ISOLATED SWITCH AND REPAIRED IT.

H. 0800, 9 DECEMBER 1961 (N, 120 TO 150 KTS EST., 28.15") ALL COMMUNICATIONS ANTENNA DOWN. CONNECTED LORAN RECEIVING ANTENNA TO COMMUNICATIONS RECEIVER. UNABLE TO TRANSMIT.

I. 0915, 9 DECEMBER 1961 (VARIABLE, 30 KTS EST., 28.07") LIGHT WINDS AND RAIN, SKY SLIGHTLY OVERCAST. DISPATCHED TWO TEAMS TO ROUND UP NATIVES WHO DID NOT COME UP TO SIGNAL-POWER BUILDING BEFORE STORM. TEAMS BROUGHT BACK APPROXIMATELY 40 PEOPLE. OBSERVED DAMAGE TO LOWER STATION.

J. 1000, 9 DECEMBER 1961 (LIGHT WINDS, 28.01") LOWEST BAROMETRIC PRESSURE OBSERVED. SEAS ARE BREAKING OVER ENTIRE ANTENNA FIELD.

K. 1130, 9 DECEMBER 1961 (W, 50 TO 70 KTS EST., 28.38") EYE PASSED AND WINDS INCREASED DRIVING RAIN AND SPRAY. OPENED EAST WINDOW TO OBSERVE WAVE ACTION ON ANTENNA FIELD. WAVES ROLLING IN AS FAR AS LORAN RECEIVING HILL. CAN SEE THAT LORAN TRANSMITTING ANTENNA IS STILL UP.

L. 1430, 9 DECEMBER 1961 (W, 130 TO 160 KTS EST.) WIND MUCH STRONGER SECOND HALF. GENERATOR ROOM WEST DOOR BURST OPEN AND TORE OFF. PRESSURE NOW EQUALIZED. DOOR TO GENERATOR EXHAUST HOT ROOM ALSO GONE.

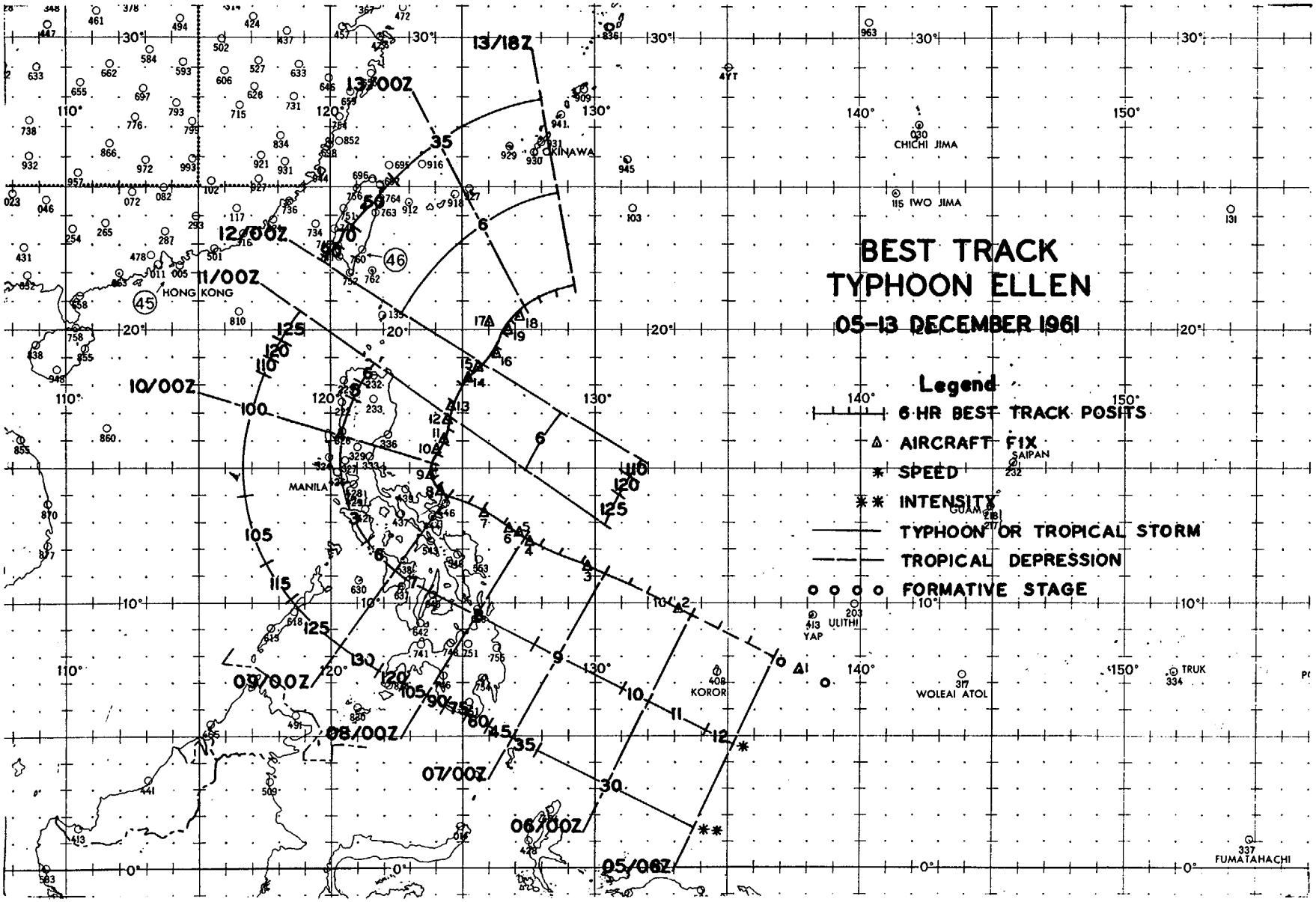
M. 1800, 9 DECEMBER 1961 (W, 30 TO 50 KTS EST., 29.18") BELIEVE TYPHOON PASSED. DUE TO DARKNESS AND GUSTING WINDS, NOT ATTEMPTING OUTSIDE REPAIRS UNTIL DAYBREAK. REMAINING IN SIGNAL-POWER BUILDING OVERNIGHT.

N. 0600, 10 DECEMBER 1961 (W, 8 TO 30 KTS, 29.50") OBSERVED DAMAGE. BEGAN REPAIRING LORAN COUPLERS AND RESTRINGING TRANSMITTING ANTENNAS.

O. 0653, 10 DECEMBER 1961 (W, 10 TO 30 KTS, 29.51") RESUMED COMMUNICATIONS WITH SANGLEY POINT.

P. 1230, 10 DECEMBER 1961 (SW, 10 KTS, 29.62") RESUMED LORAN TRANSMISSIONS.

DAMAGE WAS EXTENSIVE, INCLUDING THE ELECTRICAL, WATER AND SEWAGE SYSTEMS, AND NEARLY ALL BUILDINGS AND VEHICLES. THE DAMAGE WAS DUE TO HIGH WINDS, FLYING OBJECTS, FLOODING AND RAIN. IN MANY CASES SEVERAL FEET OF SAND REMAINED BEHIND TO BE REMOVED LATER.


BEST TRACK
TYPHOON ELLEN
05-13 DECEMBER 1961
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
13/18Z
13/00Z
12/00Z
11/00Z
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/06Z
HONG KONG
MANILA
OKINAWA
CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
YAP
ULITHI
WOLEAI ATOL
KOROR
TRUK
FUMATAHACHI

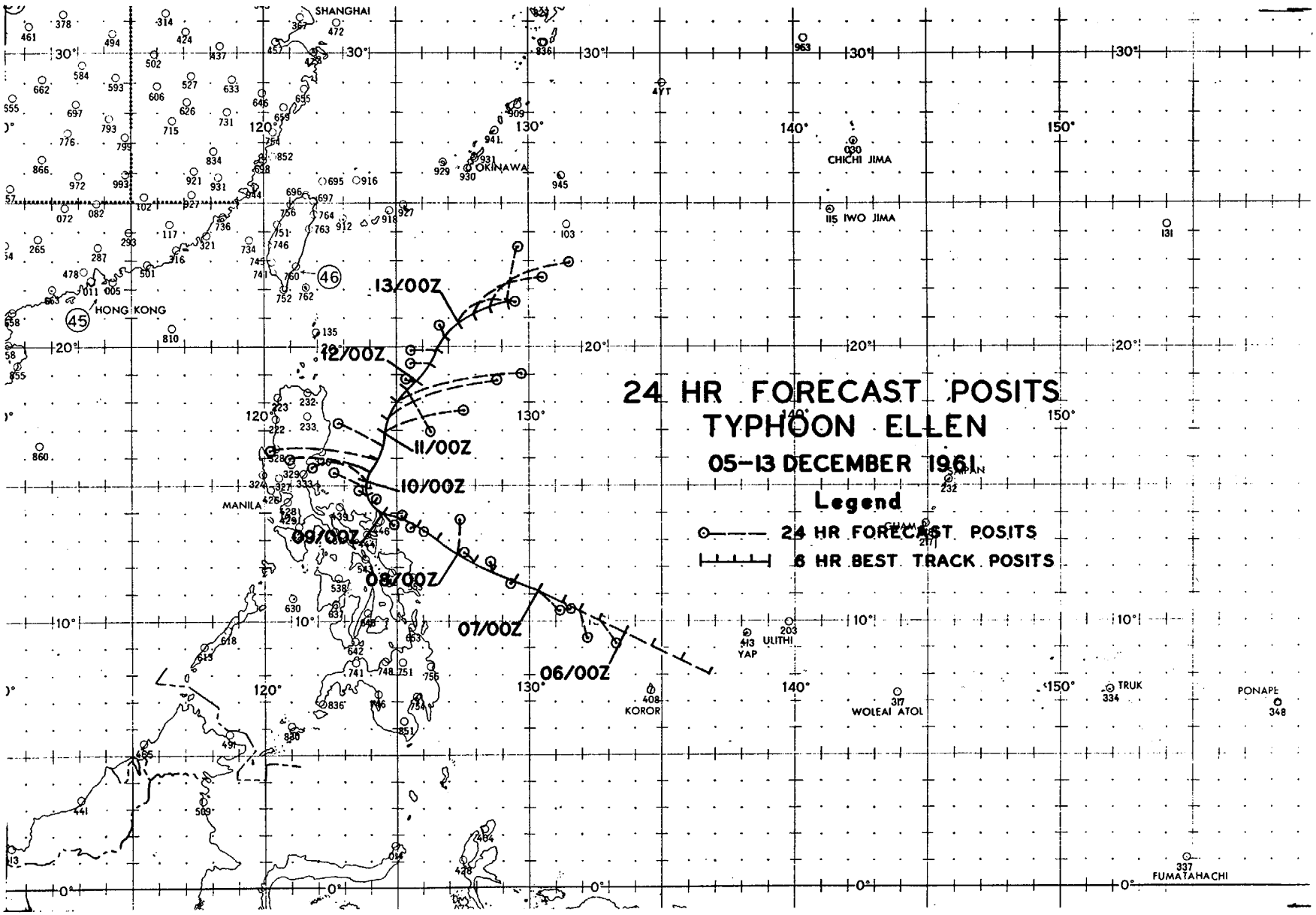
LAND RADAR AND AIRCRAFT - TYPHOON ELLEN

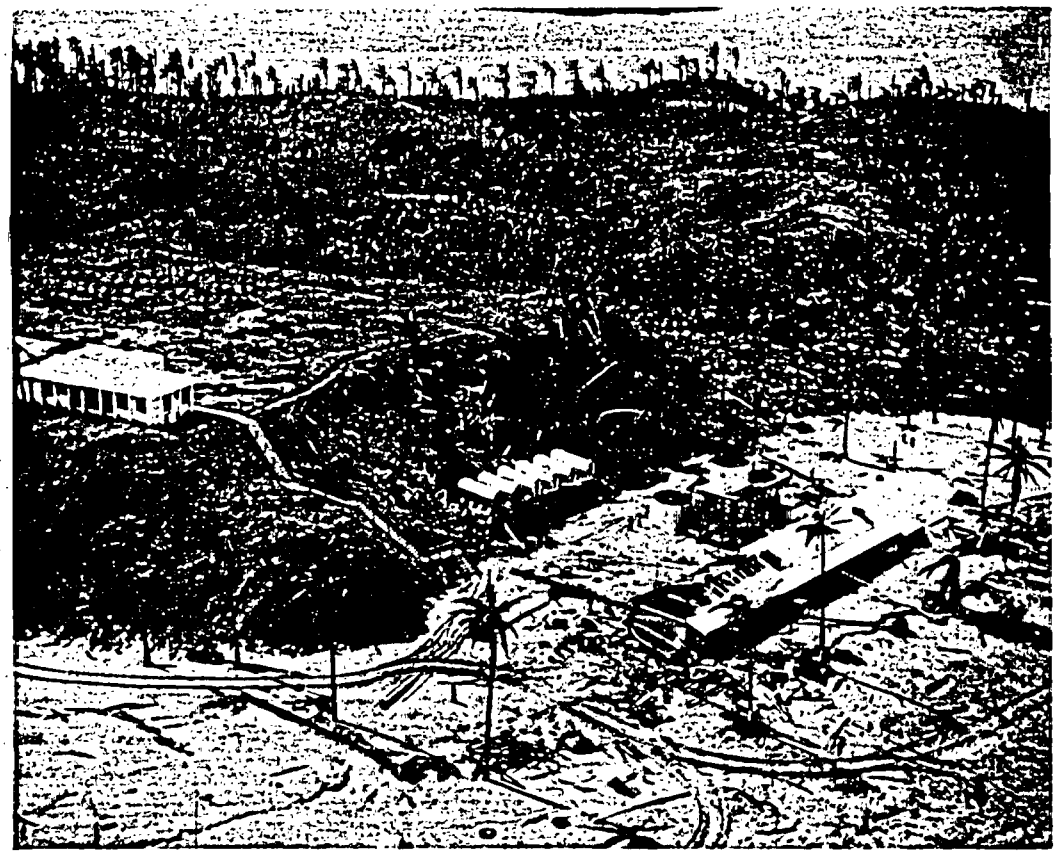
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MAX SFC WND	MIN 700MB WND	MIN 700MB HGT	MIN SLP MBS	700MB T/TD (°C)	EYE CHARACTERISTICS
1	050100Z	07.5N	137.8E	VW1-P-10	22	---	----	---	-----	80MI DIA WELL DEVELOPED FEEDER BANDS
2	060400Z	09.8N	133.1E	VW1-P-05	30	---	9970	995	12/11	CIRC 15MI DIA POORLY DEFINED
3	070316Z	11.4N	129.9E	VW1-P-05	45	---	9980	988	12/12	CIRC 24MI DIA OPEN N & S
4	072245Z	12.4N	127.5E	56-P-05	100	90	9280	---	19/11	CIRC 25MI DIA
5	080056Z	12.7N	127.1E	VW1-R-05	---	---	----	---	-----	CIRC 23MI DIA
6	080400Z	12.9N	126.8E	56-P-05	100	70	9120	---	19/14	NOT WELL DEFINED
7	081200Z	13.5N	125.9E	VW1-R-02	---	---	----	---	-----	CIRC 33MI DIA WALL CLDS ALL QUADS
8	090300Z	14.2N	124.2E	56-P-02	85	90	8520	945	23/23	CIRC 36MI DIA OPEN SE
9	091445Z	14.7N	123.8E	VW1-R-05	---	---	----	---	-----	CIRC 28MI DIA
10	100120Z	15.7N	124.0E	56-P-03	60	70	8930	956	15/02	CIRC 20MI DIA WELL DEFINED
11	101400Z	16.0N	124.3E	VW1-R-03	---	---	----	---	-----	ELLIP NW-SE 35 X 29 MI
12	102230Z	16.9N	124.5E	56-P-02	150	105	8740	---	19/12	ELLIP E-W 25 X 35 MI
13	110300Z	17.2N	124.6E	56-P-01	150	95	8760	---	19/14	CIRC 40MI DIA
14	111400Z	18.1N	125.2E	VW1-R-01	---	---	----	---	-----	EYE SPLIT INTO HALF SEMICIRCLES N HALF CLOSING, S HALF DSPTG
15	112235Z	18.7N	125.8E	56-P-02	140	90	9390	---	16/09	OPEN W & S ORIENTED E-W 25 X 20 MI
16	120430Z	19.2N	126.3E	56-P-02	175	70	9530	980	13/12	NOT DEFINED ON RADAR, SOFT HAIL IN EYE
17	121330Z	20.2N	126.0E	VW1-R-05	---	---	----	---	-----	10MI DIA OPEN S
18	130200Z	20.4N	127.1E	56-P-02	30	20	10300	1009	12/07	NOT DEFINED
19	131312Z	20.0N	126.8E	VW1-P-05	---	---	10290	---	-----	CENTER 25MI E-W 30MI N-S, NO WALL CLDS

TYPHOON ELLEN 05-13 DEC 1961
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
050600Z	08.0N	136.8E	-------	-------
051200Z	08.5N	135.7E	-------	-------
051800Z	09.0N	134.7E	-------	-------
060000Z	09.5N	133.7E	-------	-------
060600Z	10.0N	132.8E	-------	-------
061200Z	10.4N	132.0E	-------	-------
061800Z	10.8N	131.2E	-------	-------
070000Z	11.2N	130.3E	-------	-------
070600Z	11.6N	129.5E	-------	-------
071200Z	11.9N	128.7E	-------	-------
071800Z	12.2N	128.0E	-------	-------
080000Z	12.6N	127.3E	-------	-------
080600Z	13.0N	126.6E	294-37	-------
081200Z	13.5N	125.9E	270-15	-------
081800Z	13.8N	125.2E	310-11	-------
090000Z	14.0N	124.5E	132-28	-------
090600Z	14.3N	124.0E	030-7	287-33
091200Z	14.6N	123.8E	312-20	299-51
091800Z	14.9N	123.7E	298-74	285-68
100000Z	15.2N	123.8E	286-121	241-81
100600Z	15.6N	124.0E	278-176	268-123
101200Z	15.9N	124.3E	274-241	277-155
101800Z	16.3N	124.5E	302-107	284-247
110000Z	16.9N	124.5E	074-192	267-320
110600Z	17.5N	124.7E	076-246	262-411
111200Z	18.0N	125.1E	077-278	269-444
111800Z	18.4N	125.5E	155-96	002-215
120000Z	18.9N	125.9E	272-42	071-498
120600Z	19.3N	126.3E	267-48	072-546
121200Z	19.9N	126.5E	269-46	072-624
121800Z	20.4N	126.8E	339-24	155-162
130000Z	20.8N	127.3E	070-126	051-81
130600Z	21.1N	127.9E	064-158	052-103
131200Z	21.3N	128.5E	060-198	053-145
131800Z	21.5N	129.1E	017-119	051-153

AVERAGE 24 HOUR ERROR 105 MI
AVERAGE 48 HOUR ERROR 235 MI

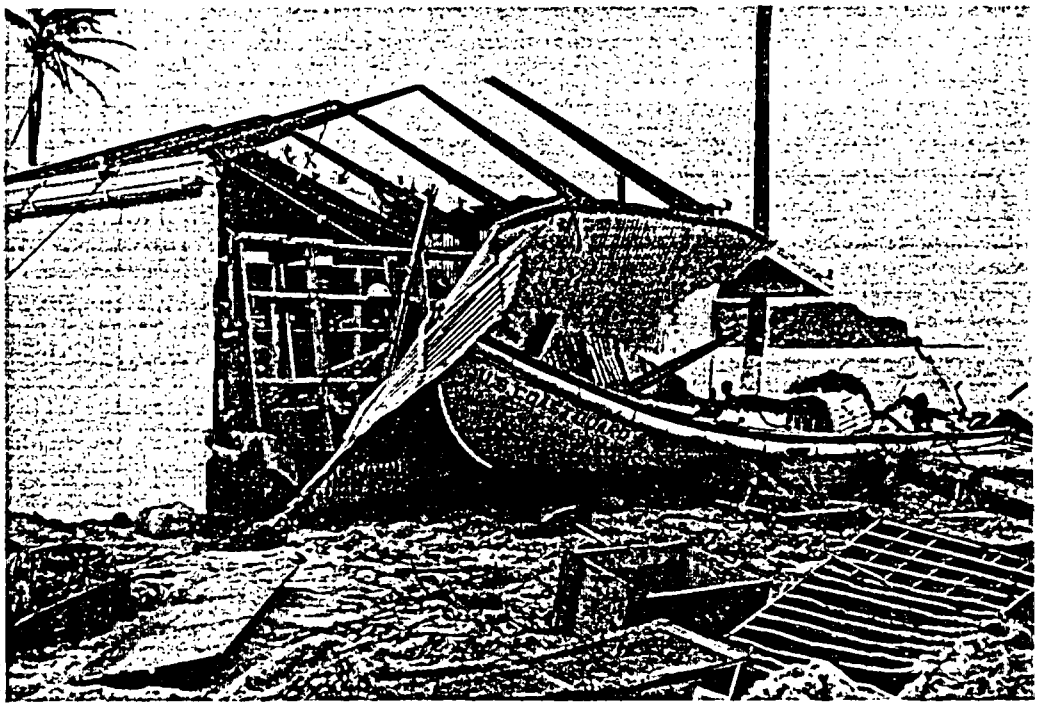

24 HR FORECAST POSITS
TYPHOON ELLEN
05-13 DECEMBER 1961
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
13/00Z
12/00Z
11/00Z
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
SHANGHAI
OKINAWA
CHICHI JIMA
IWO JIMA
HONG KONG
MANILA
YAP
ULITHI
KOROR
WOLEAI ATOL
TRUK
PONAPE
FUMATAHACHI



AERIAL PHOTO SHOWING PART OF DAMAGE CAUSED BY ELLEN TO CGLORSTA, CATANDUANES ISLAND, 9 DECEMBER 1961. (OFFICIAL NAVY PHOTO)

DAMAGE TO LOWER AREA OF CGLORSTA. NOTE DAMAGE TO CONCRETE SLABS. (OFFICIAL NAVY PHOTO)

DAMAGE TO INTERIOR. SAND ON FLOOR WAS BLOWN AND WASHED INTO BUILDING. (OFFICIAL NAVY PHOTO)



DAMAGE TO BUILDING AND BOAT CAUSED BY ELLEN, 9 DECEMBER 1961. (OFFICIAL NAVY PHOTO)

CHAPTER V

RESEARCH

A. GENERAL

RESEARCH AS RELATED TO TROPICAL CYCLONES WAS LIMITED DUE TO THE LACK OF AUTHORIZED PERSONNEL FOR THE 1959, 1960 AND 1961 SEASONS. A TOTAL OF SIX OFFICERS ARE NOW APPROVED FOR 1962; HOWEVER, THE TWO VACANCIES HAVE NOT AS YET BEEN MANNED.

THE "ANNUAL TYPHOON REPORT" IS PREPARED AND PUBLISHED AS A STATISTICAL AND DESCRIPTIVE RECORD AFTER THE SEASON IS OVER IN DECEMBER. THE PUBLICATION DATE VARIES FROM 15 MARCH TO 15 APRIL. THE REMAINDER OF THE TIME THROUGH JUNE IS DEVOTED TO RESEARCH PROJECTS, LEAVE AND TRAINING. WITH THE ANTICIPATED INCREASE OF PERSONNEL, IT IS HOPED THAT MUCH OF THE REPORT CAN BE WRITTEN DURING THE 1962 TYPHOON SEASON, THAT THE METEOROLOGICAL DISCUSSIONS CAN BE EXPANDED AND THAT FUNDS WILL BE AVAILABLE TO ENLARGE THIS REPORT. AN EARLIER PUBLICATION DATE IS NOT ANTICIPATED; HOWEVER, THE PERIOD BETWEEN DECEMBER AND PUBLICATION DATE WILL BE DEVOTED TO PROVIDING A MORE COMPLETE REPORT.

THE PROBLEMS ENCOUNTERED BY JTWC IN THE PAST THREE YEARS HAVE BEEN GREATER IN NUMBER THAN THOSE SOLVED DURING THE RESEARCH PERIOD. THE INCREASE IN MANNING OFFERS AN OPPORTUNITY TO MINIMIZE THESE PROBLEMS.

RESEARCH WILL BE DIVIDED INTO THREE TYPES FOR THE COMING SEASON:

1. SIMPLIFICATION OF FORECAST PROCEDURES
2. IMPROVEMENT OF THE FORECAST TECHNIQUES
3. EXAMINATION OF THE TROPICAL CYCLONE, WHICH WILL INCLUDE A DOCUMENTATION OF THE CYCLONE FROM THE FORMATION TO TYPHOON STAGE, AND TO OBTAIN MORE INFORMATION ABOUT THE STRUCTURE OF THE TYPHOON EYE.

PROJECTS DISCUSSED IN THIS CHAPTER ARE AS FOLLOWS:

1. A TEST OF THE ARAKAWA METHOD OF FORECASTING TYPHOON MOVEMENT AND SURFACE PRESSURE
2. MILLER-MOORE METHOD TESTED AND APPLIED IN THE WESTERN PACIFIC
3. WACHHOLZ COORDINATION CHART

A TEST OF THE ARAKAWA METHOD OF FORECASTING TYPHOON MOVEMENT AND SURFACE PRESSURE

By CHARLES G. WALDRON, LT, USNR

The Arakawa method of typhoon forecasting was developed by Dr. H. Arakawa and the staff of the Meteorological Research Institute, Tokyo, Japan. It is a statistical study based on the Veigas-Miller screening procedure used to develop a similar method of forecasting Atlantic hurricane movement. Three sets of regression equations were developed. One used surface data exclusively, another used 700 mb data, and the third used both. Due to the limited time and personnel available, only one method could be tested for this study. The set of equations using surface data exclusively was chosen because it would be the most useful as an operational forecasting tool. The main advantage in using surface data only is that a forecast can be made every six hours instead of every twelve hours if upper air data is used. In addition, the reliability of a forecasting technique depends directly on the quality and quantity of the reports used in its preparation. The paucity of upper air reports in the Western North Pacific limits the usefulness of an objective forecast using that data. The Miller-Moore method has proven a valuable exception.

The regression equations for the Arakawa method were derived from five years of data covering the period 1956-1960. The pressure pattern was obtained by using a grid of 91 points at intervals of 5 degrees of latitude and of longitude relative to the typhoon center (Fig. 1). The set of equations for 24 hour and 48 hour forecasts computed by the IBM 704 are on the following page. Equations are also available for 12 hour forecasts, but they were not evaluated due to their limited usefulness.

A test was made on the twenty typhoons which occurred in the Western North Pacific during the 1961 season. Positions for latitude and longitude and the 12 and 24 hour previous positions were taken from the typhoon best track charts. The pressures were obtained from 1/15,000,000 mercator projection charts using a grid that was true at 15N. The charts used were ones which had been analyzed during the season. The central pressures and 12 hour previous pressures were obtained by converting best track surface wind speeds using the Wachholz graph. The verifying pressures were obtained by the same method. The forecasts were made only from the 0000Z and 1200Z charts so that the best track Miller-Moore forecast for the same period could be used as a comparison. More Miller-Moore 24 hour forecasts were made from the same data because that method requires only 12 hour previous position vice the 24 hour positions required by Arakawa. No objective 48 hour forecast technique was available for comparison. A total of one hundred and fourteen 48 hour forecasts and one hundred and fifty three 24 hour forecasts were made.

ARAKAWA 24-48 HOUR EQUATIONS

$$LAT_{24} = -112.5 + 2.2797LAT_0 + 0.1284P_{90} + 0.1821P_{26} - 1.254LAT_{-12} - 0.0692P_{52} - 0.1293P_{39}$$

$$LONG_{24} = -589.6 + 1.6812LONG_0 + 0.7209LAT_0 + 0.2443P_{89} + 0.3469P_{21} - 0.7516LONG_{-24} - 0.6155LAT_{-12}$$

$$P_{24} = -1581.9 + 0.8613P_0 + 0.9063P_6 + 1.0163P_{46} + 1.1259P_{21} - 0.3225P_{-24} - 0.3547LONG_{-24} - 0.9921P_{63}$$

$$LAT_{48} = -106.6 + 2.8977LAT_0 + 0.2914P_{40} + 0.2132P_{90} + 0.2034P_{25} - 1.8073LAT_{-12} - 0.5396P_{46} - 0.0613P_{50}$$

$$LONG_{48} = -1037.6 + 1.8948LONG_0 + 2.1311LAT_0 + 0.6461P_{13} + 0.6245P_{89} - 1.0458LONG_{-24} - 1.7983LAT_{-12} - 0.2289P_{17}$$

$$P_{48} = -1790.4 + 0.6493P_0 + 2.6177P_6 + 1.4297P_{46} - 0.5141P_{-12} - 0.6288LONG_{-24} - 1.3597P_{63}$$

P_X = PRESSURE AT GRID POSITION X
LAT_0 = LATITUDE OF TYPHOON CENTER AT CHART TIME
$LONG_0$ = LONGITUDE OF TYPHOON CENTER AT CHART TIME
LAT_{-X} = LATITUDE OF CENTER AT X HOURS PRIOR TO CHART TIME
$LONG_{-X}$ = LONGITUDE OF CENTER AT X HOURS PRIOR TO CHART TIME
P_{-X} = CENTRAL PRESSURE AT X HOURS PRIOR TO CHART TIME

In both the 24 hour and 48 hour forecasts, the longitudinal error was greater than the latitudinal error. The scatter diagram (Fig. 2) of the 24 hour forecasts showed that one-third of the errors fall within the NE quadrant, but the largest ones occur in the SW quadrant. Forecasts which fail to predict recurvature of recurve too slowly produce errors that fall in that quadrant. The 48 hour scatter diagram (Fig. 3) also indicates that more than one-third of the errors are in the NE quadrant. The possibility exists that a correction could be determined to provide a more compact pattern; hovever, since only one year of independent data was tested against the five previous years, further evaluation is indicated before such a correction is made.

The errors for the 24 hour and 48 hour central pressure forecasts showed a bimodal distribution (Fig. 4 and 5). The higher peak on the 24 hour pressure histogram was at zero mb error, and the smaller was at -20 mb. The 48 hour histogram's peaks were of equal height. One was centered at zero mb error and the other at -30 mb. The verification of the pressure forecasts is to be considered less reliable than the position forecast since the former cannot be obtained directly. In addition, the best track position is usually more reliable than the surface wind speed obtained from the same source.

ERRORS OF FORECASTS USING THE ARAKAWA METHOD WITH 1961 BEST TRACK DATA

FORECAST	24 HOUR POSITION (MI)	24 HOUR PRESSURE (MB)	48 HOUR POSITION (MI)	48 HOUR PRESSURE (MB)
MEAN	113	-3	239	-3
STANDARD DIVIATION	74	22	162	26
NUMBER CASES	153	153	114	114

Since the test of this method used best track data, it cannot be compared with the operational forecast made by JTWC, nor can it be compared to the operational Miller-Moore error of 113 miles. The Miller-Moore method yielded an error of 96 miles using the best track data.

The Arakawa method shows promise of becoming a useful operational forecasting tool. Its 24 hour forecast compares favorably with the Miller-Moore method and has the added advantage of being available

EVERY SIX HOURS. THIS METHOD, WHICH PROVIDES 48 HOUR FORECASTS, IS THE FIRST TO BE EVALUATED BY JTWC AND WILL BE A WELCOME ADDITION TO THE LIMITED NUMBER OF LONG-RANGE FORECASTING TECHNIQUES PRESENTLY IN USE.

ARAKAWA GRID

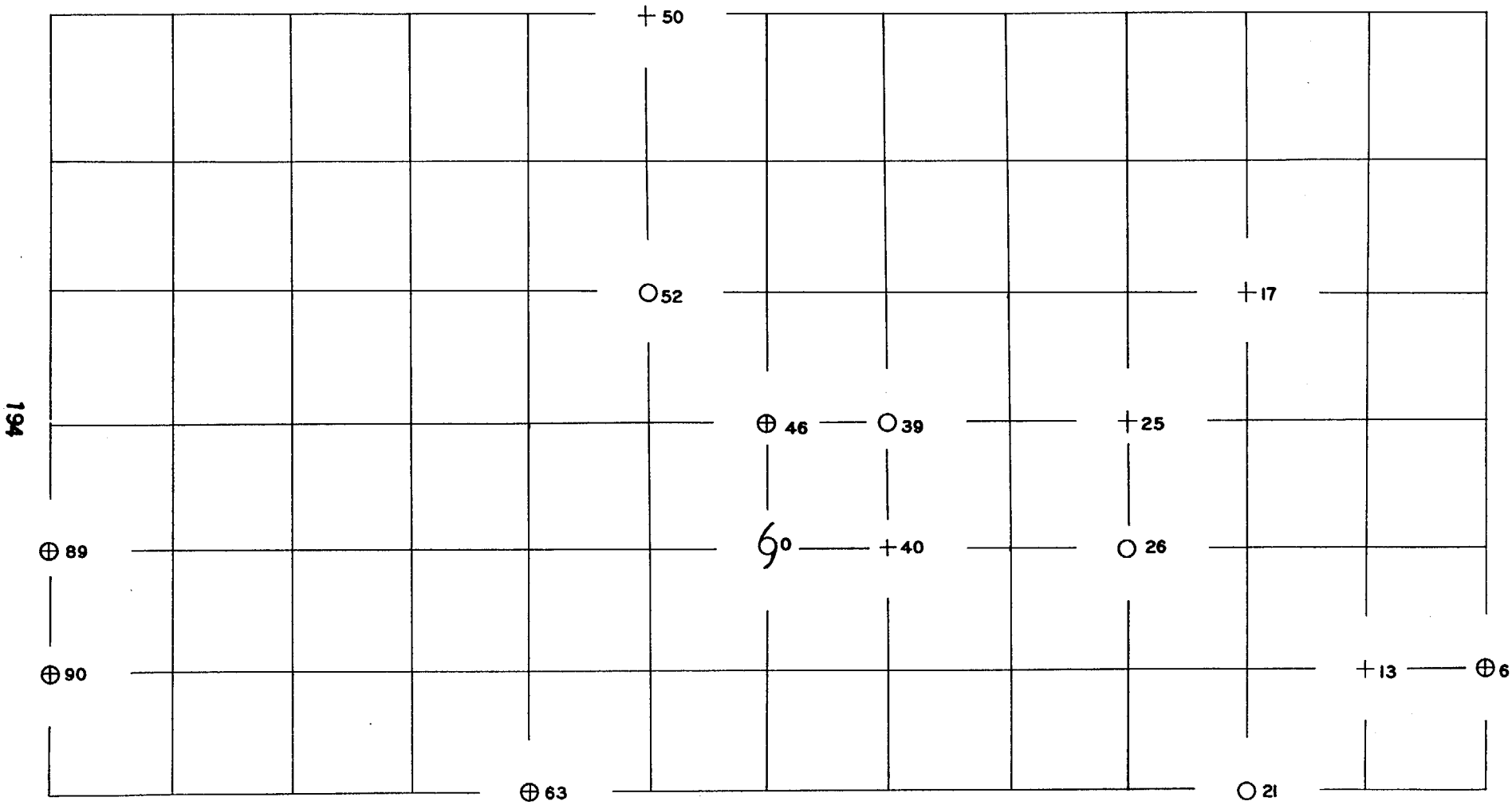


FIG 1

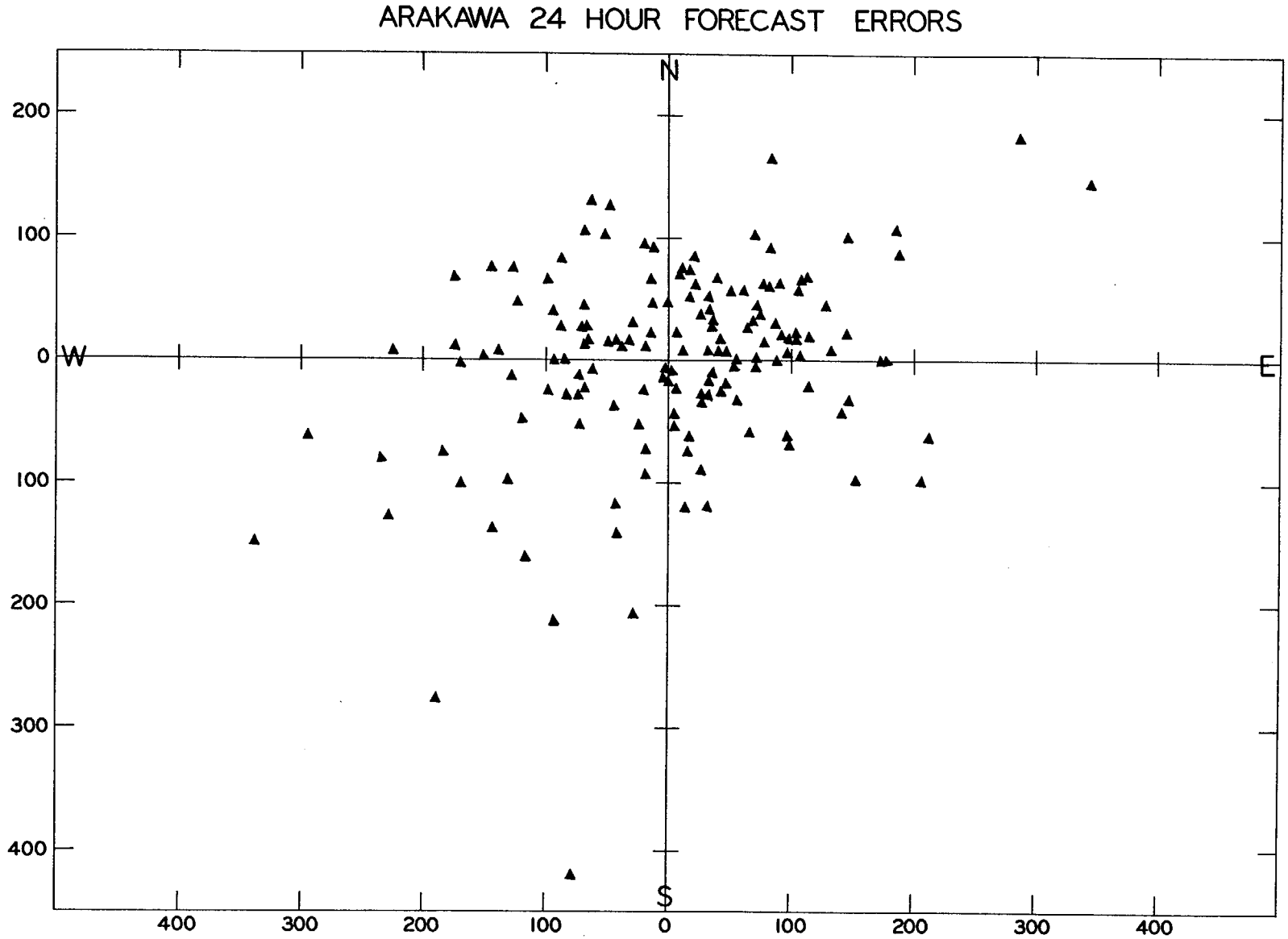

ARAKAWA 24 HOUR FORECAST ERRORS
N
W
E
S
200
100
0
100
200
300
400
400
300
200
100
0
100
200
300
400
MI N,E,S, OR W OF ACTUAL POSITION

FIG 2

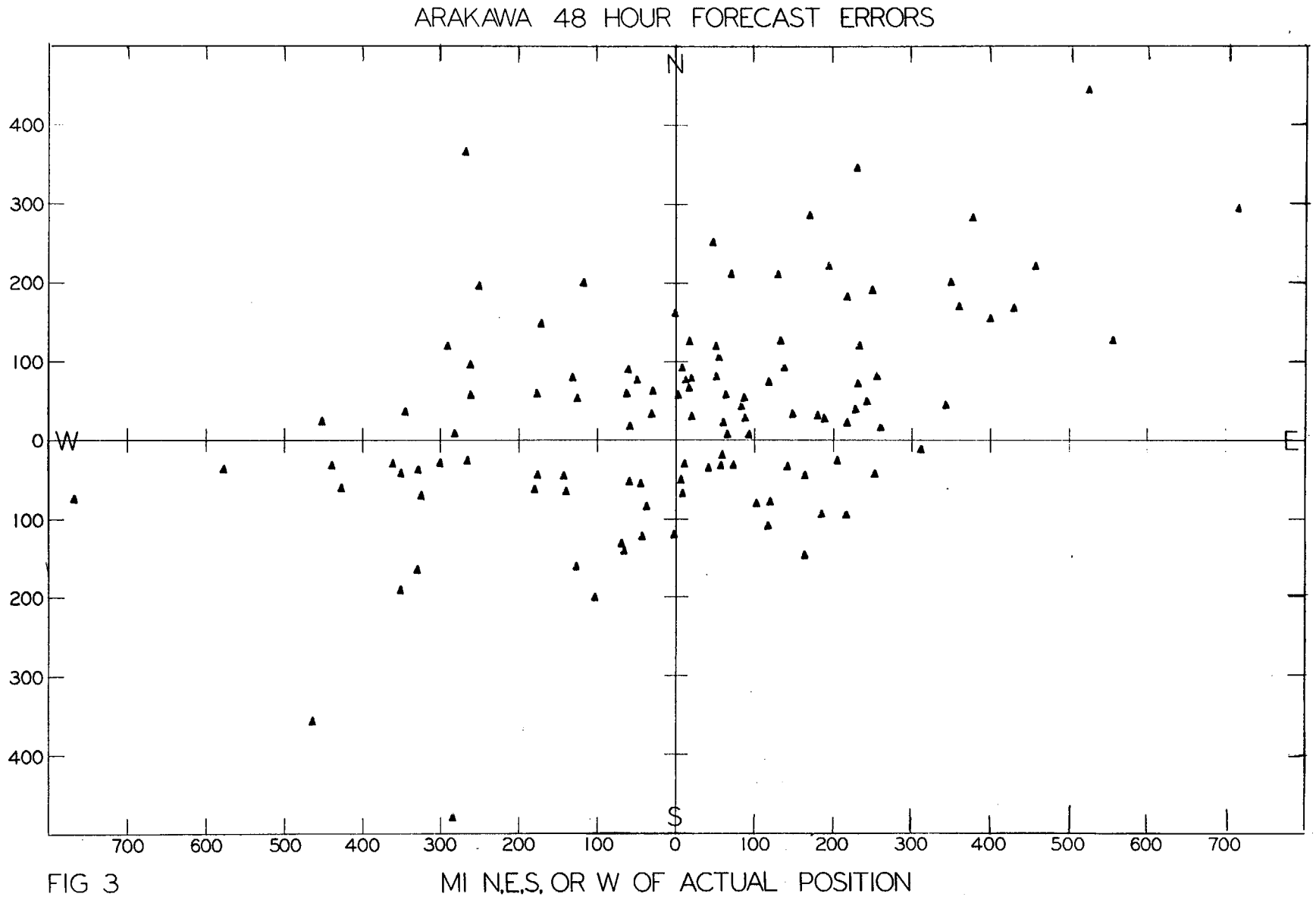

ARAKAWA 48 HOUR FORECAST ERRORS
N
S
W
E
400
300
200
100
0
100
200
300
400
700
600
500
400
300
200
100
0
100
200
300
400
500
600
700
MI N.E.S. OR W OF ACTUAL POSITION

FIG 3

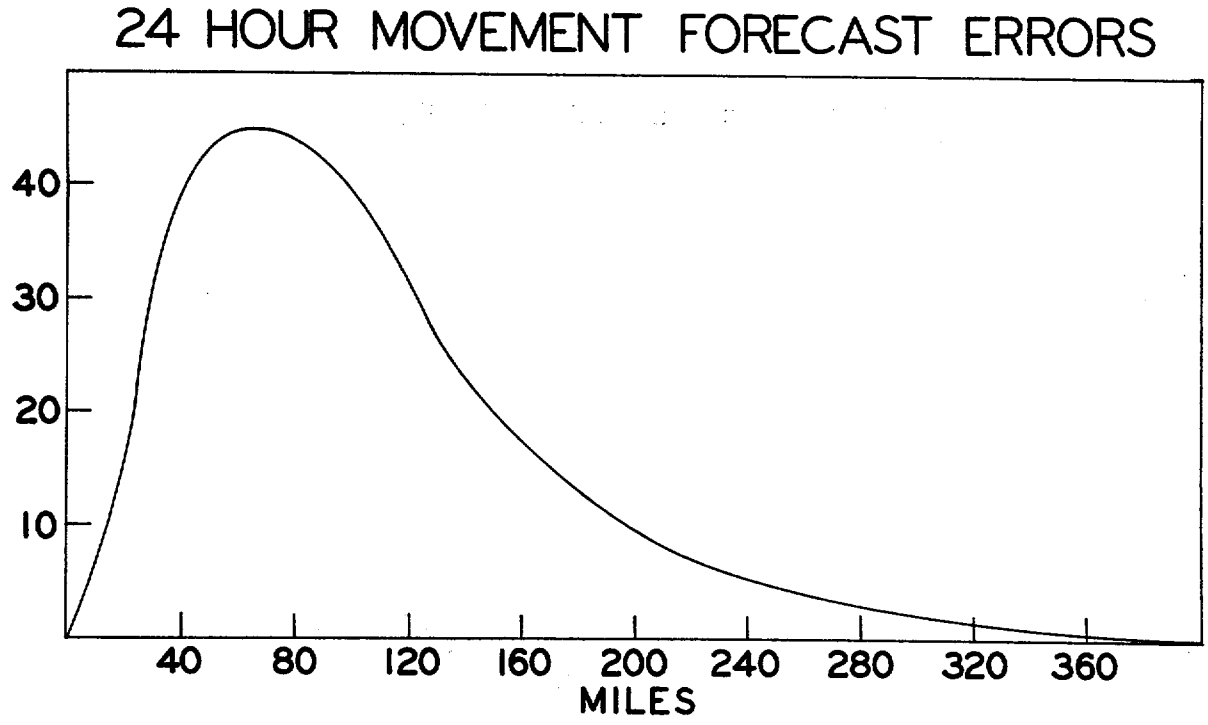
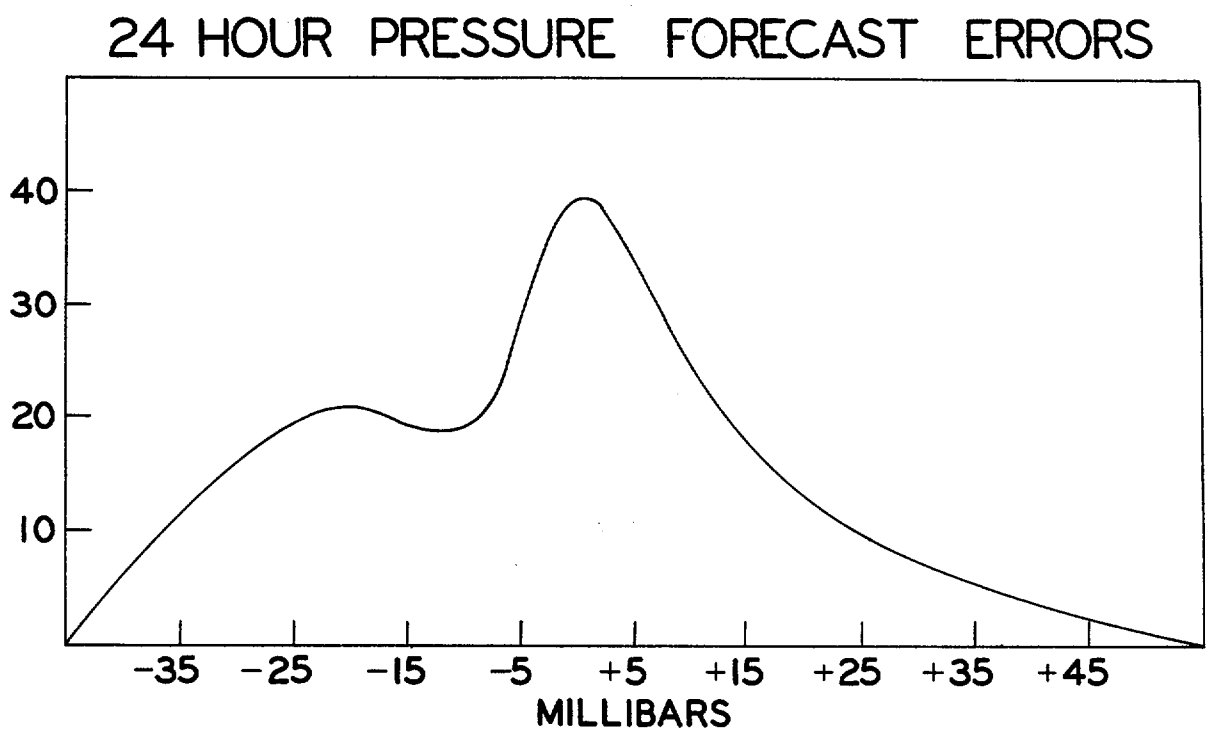

24 HOUR MOVEMENT FORECAST ERRORS
40
30
20
10
40
80
120
160
200
240
280
320
360
MILES

FIG 4


24 HOUR PRESSURE FORECAST ERRORS
40
30
20
10
-35
-25
-15
-5
+5
+15
+25
+35
+45
MILLIBARS

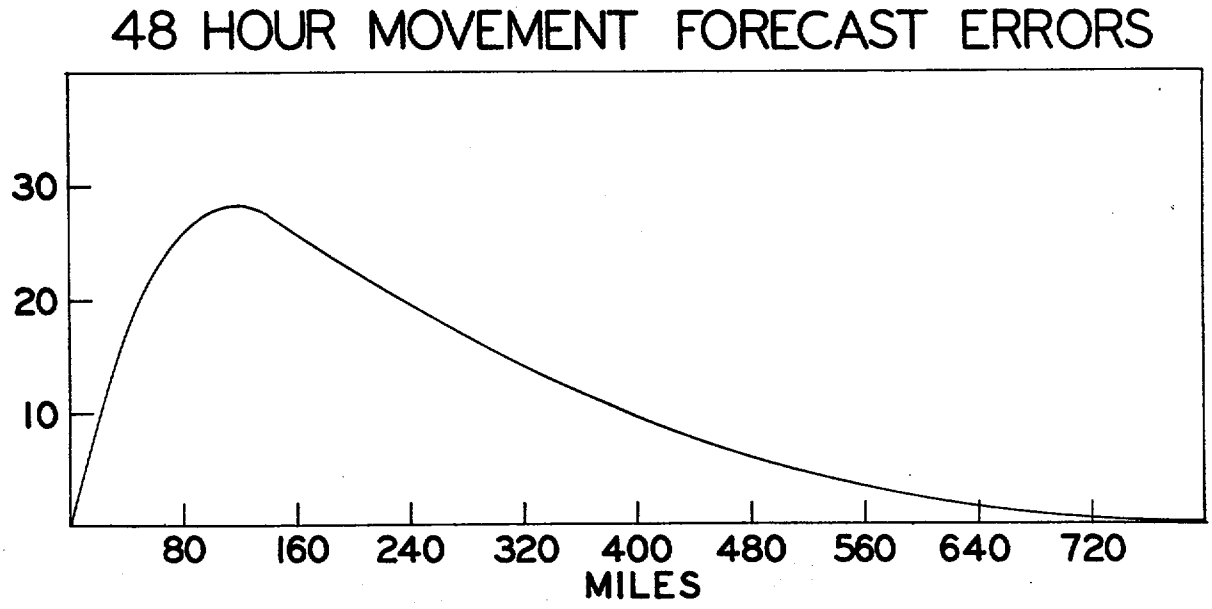
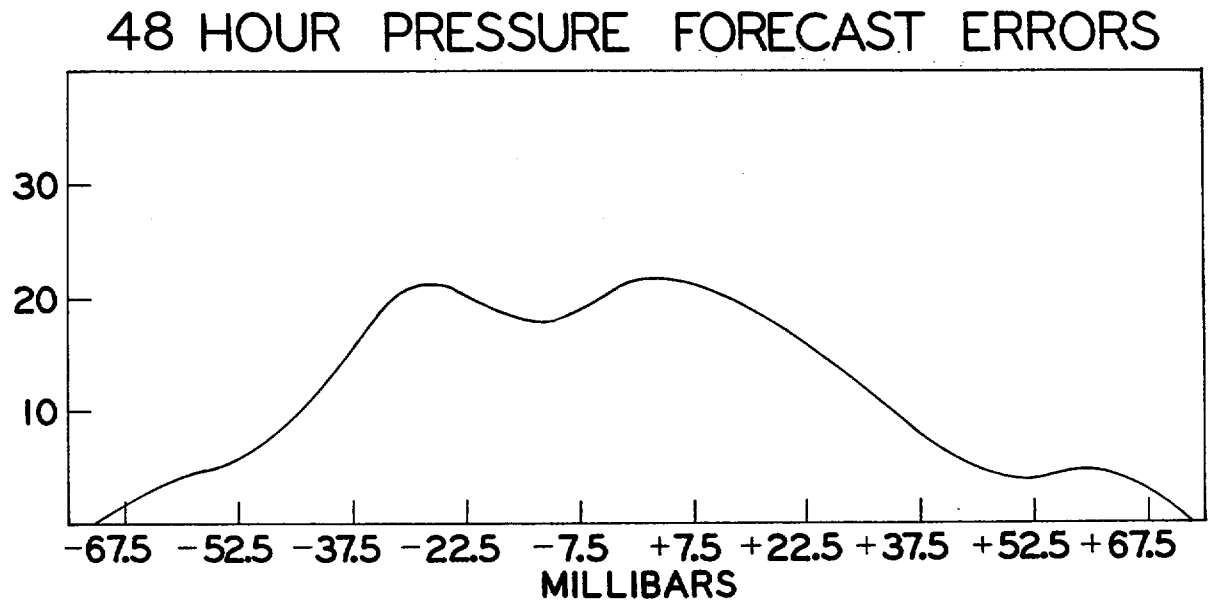

48 HOUR MOVEMENT FORECAST ERRORS
30
20
10
80
160
240
320
400
480
560
640
720
MILES

FIG 5


48 HOUR PRESSURE FORECAST ERRORS
30
20
10
-67.5
-52.5
-37.5
-22.5
-7.5
+7.5
+22.5
+37.5
+52.5
+67.5
MILLIBARS

ARAKAWA 24 HOUR FORECAST ERRORS

TESS

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2600Z	68	14	-	-	67
2612Z	245	-	80	-	234
2700Z	168	-	2	-	168
2712Z	186	69	-	-	172
2800Z	72	29	-	-	67
2812Z	52	15	-	-	49
2900Z	120	20	-	116	-
2912Z	113	-	25	113	-
3000Z	153	-	33	148	-
3012Z	153	-	43	141	-
3100Z	91	-	58	67	-
AVERAGE	129				

ALICE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1900Z	96	-	90	27	-
1912Z	76	31	-	68	-
2000Z	90	-	53	-	72
2012Z	370	-	149	-	335
2100Z	306	-	61	-	294
2112Z	167	75	-	-	144
AVERAGE	184				

BETTY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2412Z	17	-	17	-	-

ARAKAWA 24 HOUR FORECAST ERRORS

BETTY (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2500Z	26	24	-	8	-
2512Z	75	-	74	-	19
2600Z	55	-	51	-	24
2612Z	96	95	-	-	19
2700Z	234	-	212	-	91
2712Z	148	-	141	-	40
2800Z	208	-	206	-	26
2812Z	261	-	126	-	225
AVERAGE	124				

CORA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2412Z	72	3	-	71	-
2500Z	48	17	-	44	-
AVERAGE	60				

ELSIE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1412Z	144	130	-	-	63
1500Z	89	85	-	22	-
AVERAGE	117				

ARAKAWA 24 HOUR FORECAST ERRORS

HELEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2912Z	77	-	75	19	-
3000Z	120	-	120	15	-
3012Z	71	-	5	71	-
3100Z	184	165	-	85	-
3112Z	115	102	-	-	50
0100Z	39	11	-	-	36
0112Z	78	56	-	51	-
0200Z	107	3	-	107	-
0212Z	116	-	61	96	-
0300Z	98	5	-	98	-
0312Z	131	126	-	-	46
AVERAGE	103				

IDA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
3012Z	184	-	98	153	-
3100Z	234	-	97	208	-
3112Z	339	182	-	288	-
AVERAGE	252				

JUNE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0312Z	110	64	-	91	-
0400Z	45	28	-	36	-
0412Z	76	73	-	19	-
0500Z	94	92	-	-	10
0512Z	78	-	11	-	74
0600Z	57	-	36	-	44
0612Z	46	15	-	-	43

ARAKAWA 24 HOUR FORECAST ERRORS

JUNE (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0700Z	92	28	-	-	87
0712Z	138	8	-	-	136
0800Z	16	-	15	-	3
0812Z	86	57	-	63	-
AVERAGE	76				

KATHY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1712Z	75	75	-	11	-
1800Z	122	104	-	71	-
AVERAGE	99				

LORNA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2212Z	124	105	-	-	68
2300Z	128	-	-	47	119
2312Z	80	15	78	-	-
2400Z	123	70	10	-	-
2412Z	110	66	-	-	97
2500Z	116	83	-	-	85
2512Z	130	66	111	-	-
2600Z	53	-	46	21	-
2612Z	67	67	-	-	12
AVERAGE	103				

ARAKAWA 24 HOUR FORECAST ERRORS

NANCY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0912Z	40	31	-	-	26
1000Z	24	22	-	-	11
1012Z	94	-	-	-	94
1100Z	81	45	-	-	67
1112Z	55	-	-	55	-
1200Z	8	-	8	-	-
1212Z	34	8	-	34	-
1300Z	51	41	-	34	-
1312Z	31	-	25	-	20
1400Z	66	-	61	19	-
1412Z	69	-	21	-	66
1500Z	49	49	-	-	-
1512Z	152	75	-	-	128
1600Z	134	47	-	-	124
1612Z	327	-	276	-	186
1700Z	427	-	420	-	76
AVERAGE	103				

OLGA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1000Z	58	51	-	17	-
AVERAGE	58				

PAMELA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1012Z	44	-	29	31	-
1100Z	205	87	-	190	-
1112Z	128	91	-	85	-
1200Z	44	-	34	28	-

ARAKAWA 24 HOUR FORECAST ERRORS

PAMELA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1212Z	193	-	160	-	115
AVERAGE	123				

SALLY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2712Z	14	6	-	12	-
2800Z	139	49	-	129	-
2812Z	147	22	-	146	-
2900Z	40	-	29	27	-
2912Z	40	-	8	-	39
AVERAGE	76				

TILDA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2912Z	224	8	-	-	224
3000Z	197	-	75	-	183
3012Z	196	-	107	-	167
0100Z	47	39	-	26	-
0112Z	175	100	-	148	-
0200Z	214	107	-	189	-
0212Z	118	57	-	106	-
0300Z	97	20	-	94	-
0312Z	222	-	64	212	-
0400Z	120	-	69	100	-
0412Z	68	-	31	59	-
0500Z	35	17	-	-	29
AVERAGE	143				

ARAKAWA 24 HOUR FORECAST ERRORS

VIOLET

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0600Z	150	3	-	-	150
0612Z	166	-	98	-	130
0700Z	96	-	94	-	18
0712Z	52	-	25	45	-
0800Z	106	21	-	105	-
0812Z	88	-	-	88	-
0900Z	101	16	-	98	-
0912Z	123	-	116	-	41
1000Z	201	-	138	-	141
1012Z	196	-	100	-	169
AVERAGE	128				

BILLIE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2500Z	91	-	29	-	84
2512Z	102	40	-	-	92
2600Z	50	47	-	-	11
2612Z	50	8	-	49	-
2700Z	136	45	-	127	-
2712Z	84	45	-	73	-
2800Z	120	-	22	115	-
AVERAGE	90				

CLARA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2812Z	100	62	-	78	-
2900Z	92	67	-	40	-
2912Z	96	60	-	81	-
3000Z	67	52	-	34	-

ARAKAWA 24 HOUR FORECAST ERRORS

CLARA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
3012Z	140	6	-	133	-
3100Z	177	-	-	177	-
3112Z	396	145	-	345	-
0100Z	175	-	-	175	-
AVERAGE	154				

DOT

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1100Z	130	65	-	110	-
1112Z	90	30	-	88	-
1200Z	50	33	-	36	-
1212Z	66	15	-	-	65
1300Z	77	28	-	-	70
1312Z	176	12	-	-	174
1400Z	132	-	12	-	127
1412Z	65	-	7	-	60
1500Z	102	-	24	-	98
1512Z	75	-	27	-	72
AVERAGE	96				

ELLEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0612Z	20	12	-	-	16
0700Z	55	-	5	53	-
0712Z	37	-	16	34	-
0800Z	120	-	118	32	-
0812Z	68	26	-	65	-
0900Z	12	-	10	2	-
0912Z	85	-	-	-	85

ARAKAWA 24 HOUR FORECAST ERRORS

ELLEN (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1000Z	50	-	45	7	-
1012Z	60	-	54	7	-
1100Z	86	64	-	24	-
1112Z	45	6	-	43	-
1200Z	110	17	-	105	-
1212Z	86	37	-	75	-
AVERAGE	64				

ARAKAWA 48 HOUR FORECAST ERRORS

TESS

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2700Z	320	-	36	-	328
2712Z	580	-	38	-	579
2800Z	347	36	-	-	344
2812Z	316	120	-	-	291
2900Z	156	80	-	-	131
2912Z	137	52	-	-	126
3000Z	256	-	43	253	-
3012Z	206	-	97	184	-
3100Z	215	-	146	164	-
AVERAGE	281				

ALICE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2000Z	225	-	201	-	104
2012Z	94	77	-	-	50
2100Z	354	-	42	-	350
2112Z	768	-	75	-	768
AVERAGE	360				

BETTY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2512Z	163	-	108	116	-
2600Z	93	44	-	83	-
2612Z	70	-	55	-	45
2700Z	146	-	131	-	70
2712Z	69	-	67	9	-
2800Z	550	-	480	-	285
2812Z	576	-	358	-	464
AVERAGE	238				

ARAKAWA 48 HOUR FORECAST ERRORS

HELEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	S	ZONAL ERROR E	W
3012Z	94	29	-	88	-
3100Z	88	58	-	64	-
3112Z	161	161	-	-	-
0100Z	331	286	-	172	-
0112Z	71	67	-	16	-
0200Z	60	59	-	2	-
0212Z	218	23	-	217	-
0300Z	252	49	-	243	-
0312Z	94	8	-	94	-
AVERAGE	152				

IDA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	S	ZONAL ERROR E	W
3112Z	568	126	-	555	-
AVERAGE	568				

JUNE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	S	ZONAL ERROR E	W
0412Z	294	221	-	195	-
0500Z	224	212	-	71	-
0512Z	258	252	-	48	-
0600Z	246	211	-	130	-
0612Z	74	63	-	-	30
0700Z	35	31	-	20	-
0712Z	132	120	-	51	-
0800Z	184	127	-	134	-
0812Z	98	82	-	51	-
AVERAGE	172				

ARAKAWA 48 HOUR FORECAST ERRORS

LORNA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2312Z	134	-	-	123	43
2400Z	185	-	-	44	176
2412Z	183	32	181	-	-
2500Z	253	71	231	-	-
2512Z	328	190	250	-	-
2600Z	223	200	-	-	118
2612Z	323	195	-	-	250
AVERAGE	233				

NANCY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1012Z	312	-	11	312	-
1100Z	145	-	34	141	-
1112Z	91	-	85	-	39
1200Z	48	34	-	-	31
1212Z	79	-	31	74	-
1300Z	34	-	30	12	-
1312Z	60	-	19	59	-
1400Z	128	126	-	16	-
1412Z	208	-	161	-	126
1500Z	154	-	140	-	66
1512Z	188	60	-	-	176
1600Z	226	148	-	-	172
1612Z	454	24	-	-	453
1700Z	448	367	-	-	267
AVERAGE	184				

ARAKAWA 48 HOUR FORECAST ERRORS

PAMELA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1112Z	408	201	-	350	-
1200Z	781	295	-	715	-
1212Z	456	168	-	431	-
AVERAGE	548				

SALLY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2812Z	280	182	-	217	-
2900Z	467	279	-	380	-
2912Z	505	222	-	457	-
AVERAGE	417				

TILDA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
3012Z	442	-	33	-	441
0100Z	272	-	25	-	267
0112Z	267	58	-	-	262
0200Z	415	347	-	232	-
0212Z	684	445	-	525	-
0300Z	642	279	-	566	-
0312Z	388	170	-	360	-
0400Z	346	45	-	344	-
0412Z	104	55	-	87	-
0500Z	133	-	79	103	-
AVERAGE	370				

ARAKAWA 48 HOUR FORECAST ERRORS

VIOLET

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0700Z	278	9	-	-	227
0712Z	153	-	65	-	140
0800Z	120	-	120	-	3
0812Z	191	26	-	187	-
0900Z	260	16	-	260	-
0912Z	165	93	-	137	-
1000Z	80	77	-	14	-
1012Z	398	-	191	-	351
AVERAGE	206				

BILLIE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2600Z	330	-	70	-	324
2612Z	109	90	-	-	61
2700Z	151	34	-	149	-
2712Z	169	-	44	164	-
2800Z	242	-	94	216	-
AVERAGE	200				

CLARA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2912Z	54	-	34	42	-
3000Z	85	80	-	20	-
3012Z	65	-	32	58	-
3100Z	270	82	-	256	-
3112Z	425	156	-	400	-
0100Z	236	40	-	228	-
AVERAGE	189				

ARAKAWA 48 HOUR FORECAST ERRORS

DOT

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1200Z	267	120	-	234	-
1212Z	70	8	-	65	-
1300Z	87	60	-	-	64
1312Z	370	-	30	-	362
1400Z	308	29	-	-	300
1412Z	430	-	60	-	427
1500Z	347	-	165	-	330
1512Z	192	-	63	-	180
AVERAGE	259				

ELLEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0612Z	286	95	-	-	263
0700Z	206	-	26	205	-
0712Z	62	23	-	60	-
0800Z	163	-	78	120	-
0812Z	137	75	-	117	-
0900Z	63	18	-	-	60
0912Z	150	-	45	-	144
1000Z	54	-	50	6	-
1012Z	77	-	52	-	60
1100Z	100	95	-	7	-
1112Z	130	107	-	55	-
AVERAGE	130				

MILLER-MOORE METHOD TESTED AND APPLIED IN THE WESTERN PACIFIC

By Elmer A. Erdei, Lt (jg), USN

The Miller-Moore method was discussed in Chapter VII (Research) of the 1960 Annual Typhoon Report. At that time the 1959 data had not been completely evaluated. This series of investigations has provided results that are twofold. First, it apprises the original authors of results based on its use in the Western North Pacific. Secondly, it provides JTWC with a mathematical tool that may be continuously used as a guide to more accurate forecasting.

This method is based on Atlantic Hurricane data and was prepared by B. I. Miller and B. L. Moore. Briefly, the method consists of correlating the storm movement with a mean geostrophic wind and the past 12 hour storm movement. Using 700 mb data, the method involves separate determination of meridional and zonal forecasts of storm movement. The equations as developed by Miller and Moore are:

Initial latitude equal to or less than 27.5°

$$\bar{V} = 0.23v_7 + 0.65P_Y + 2.3 \qquad (1)$$

$$\bar{U} = 0.42u_7 + 0.54P_X - 2.4$$

Initial latitude more than 27.5°

$$\bar{V} = 0.71v_7 + 0.40P_Y + 3.0 \qquad (2)$$

$$\bar{U} = 0.61u_7 + 0.48P_X - 3.8$$

$\bar{U}$ = forecast mean 24 hour zonal speed of center movement (kts)

$\bar{V}$ = forecast mean 24 hour meridional speed of center movement (kts)

v_7 = first approximation: mean 700 mb geostropic wind between five pairs of points 7.5 degrees E and 7.5 degrees W of the storm center and extending from 5 degrees S to 5 degrees N of the center. If southward movement results - no further computation necessary for v_7.

Second approximation: add points at 7.5 degrees N of center to first calculation. If both of the first two approximations are less than 6.5 kts, use the larger - no further computation necessary for v_7.

THIRD APPROXIMATION: SAME AS SECOND BUT ADDING POINTS AT 10 DEGREES N OF CENTER TO SECOND APPROXIMATION. USE THE LARGEST OF THE THREE APPROXIMATIONS.

U_7 = MEAN 700 MB GEOSTROPIC WIND BETWEEN SEVEN PAIRS OF POINTS 5 DEGREES S OF THE INITIAL POSITION OF THE STORM CENTER AND 5 DEGREES N OF THE LATITUDE THAT THE $\overline{V}$ COMPUTATION INDICATES THE CENTER WILL REACH 12 HOURS AFTER CHART TIME.

PY = MEAN MERIDIONAL SPEED OF MOVEMENT OF CENTER FOR THE 12 HOURS PRIOR TO CHART TIME (KTS).

PX = MEAN ZONAL SPEED OF MOVEMENT OF CENTER FOR THE 12 HOURS PRIOR TO CHART TIME (KTS).

U_7 AND V_7 ARE COMPUTED FROM THE LATEST 700 MB CHART ON THE MILLER-MOORE GRID SHOWN HEREIN. HEIGHTS ARE TABULATED FOR EVERY $2\frac{1}{2}$ DEGREES. IN THE CASE OF THE MERIDIONAL COMPONENT, THE AVERAGE HEIGHT DIFFERENCE IS COMPUTED BETWEEN 5 DEGREES N AND S OF THE CENTER; HOWEVER, DEPENDING UPON THE RESULTING NORTHWARD SPEED OF THE STORM, THIS GRID MAY BE EXTENDED TO 7.5 OR 10 DEGREES N OF THE CENTER IN ACCORDANCE WITH THE SPECIFIED CRITERIA. IN THE CASE OF THE ZONAL COMPONENT, THE AVERAGE HEIGHT DIFFERENCE BETWEEN THE TWO HORIZONTAL ROWS IS COMPUTED; THE BOTTOM ROW BEING 5 DEGREES S OF THE INITIAL SURFACE POSITION OF THE STORM AND THE TOP ROW BEING 5 DEGREES N OF THE 12 HOUR MERIDIONAL FORECAST POSITION OF THE CENTER. THE AVERAGE MERIDIONAL AND ZONAL HEIGHT DIFFERENCES ARE THEN REDUCED TO METERS PER DEGREE AND CONVERTED TO GEOSTROPIC WIND (KTS) FOR THE CENTRAL LATITUDE USING THE GRAPH SHOWN HEREIN. $\overline{U}$ AND $\overline{V}$ ARE THEN SOLVED FOR, USING THE EQUATIONS (1) OR (2).

AFTER THE END OF THE 1960 TYPHOON SEASON IT WAS CONCLUDED THAT THIS METHOD COULD BE CORRECTED TO WORK BETTER IN THE WESTERN PACIFIC AREA. RECOMPUTING THE DATA FROM THE 1959 AND 1960 SEASONS PROVIDED A TOTAL OF THREE HUNDRED CASES FROM WHICH TO OBTAIN DATA FOR PX, PY AND TO COMPUTE NEW CONSTANTS.

RESULTS OF TWO YEARS DATA INDICATED THAT TWO CHANGES COULD BE MADE TO IMPROVE THE METHOD FOR THE WESTERN NORTH PACIFIC; FIRST, ADJUST THE MERIDIONAL AND ZONAL CONSTANTS SLIGHTLY, AND SECONDLY, ESTABLISH A DIFFERENT PROCEDURE FOR DETERMINING THE MOST SUITABLE POINT TO COMMENCE USE OF THE SECOND EQUATION.

APPARENTLY THE LATITUDE OF 27.5N, POINT OF CHANGE FROM THE FIRST TO THE SECOND FORMULA IS CONSIDERED TO BE THE AVERAGE LATITUDE OF THE SUBTROPICAL RIDGE LINE. THIS WOULD ALSO APPROXIMATE THE DIVIDING LINE BETWEEN THE INITIAL MOVEMENT BY THE CYCLONE TO THE W AND MOVEMENT TO THE E AFTER RECURVATURE. IN VIEW OF THE DIFFERENT PROBLEMS OF MOVEMENT, TWO EQUATIONS ARE NEEDED. OF COURSE, A MORE IDEAL

METHOD WOULD BE TO HAVE THREE FORMULAS, ONE FOR WESTERLY MOVEMENT, ONE FOR NORTHERLY MOVEMENT, AND ANOTHER FOR EASTERLY MOVEMENT. THIS IDEAL IS IMPOSSIBLE BECAUSE OF THE PROBLEM OF DECIDING WHICH OF THE FORMULAS TO USE. SOME SUCCESS HAS BEEN ACHIEVED IN FORECASTING THE POSITION OF THE RIDGE LINE, THEREFORE THE FIXED FIGURE OF 27.5 AS THE POINT TO CHANGE FORMULAS IS NOT ABSOLUTELY NECESSARY, ALTHOUGH IT IS AN EXCELLENT GUIDE. THUS, THE SECOND FORMULA IS NOW USED JUST AFTER POINT OF RECURVATURE. RECURVATURE IS DEFINED HERE AS THAT POINT AT WHICH THE CYCLONE CEASES MOVEMENT TO THE W OF N AND COMMENCES MOVING TO THE E OF N.

FROM 258 CASES S OF THIS DEFINITION OF POINT OF RECURVATURE, IT WAS DETERMINED THAT THE MERIDIONAL FORECAST ERRORS AVERAGED 1.1 KTS TO THE N, AND THE ZONAL FORECAST ERRORS AVERAGED 2.0 KTS TO THE E. NORTH OF THE POSITION OF RECURVATURE THERE WERE A TOTAL OF 50 CASES. THESE SHOWED THE MERIDIONAL FORECAST ERRORS AVERAGED 0.2 KTS TO THE S, AND THE ZONAL FORECAST ERRORS AVERAGED 1.6 KTS TO THE W.

USING THE ABOVE CORRECTIONS THE FOLLOWING MODIFIED EQUATIONS OF (1) AND (2) WERE DEVELOPED:

AT OR SOUTH OF THE POINT OF RECURVATURE

$$\bar{V} = 0.23v_7 + 0.65P_Y + 1.2 \qquad (3)$$

$$\bar{U} = 0.42u_7 + 0.54P_X - 0.4$$

NORTH OF THE POINT OF RECURVATURE

$$\bar{V} = 0.71v_7 + 0.40P_Y + 3.2 \qquad (4)$$

$$\bar{U} = 0.61u_7 + 0.48P_X - 5.4$$

DURING 1961 EQUATIONS (1), (2), (3) AND (4) WERE USED ON AN OPERATIONAL BASIS TO FORECAST THE MOVEMENT OF TROPICAL LOWS. THE AVERAGE FORECAST ERROR FOR EACH TYPHOON AND FOR THE YEAR IS SHOWN IN THE FOLLOWING TABLE. NOTE THAT THE INFORMATION HERE IS BASED ON OPERATIONAL POSITIONS, NOT ON BEST TRACK DATA. THE AVERAGE ERROR USING EQUATIONS (1) AND (2) FOR BEST TRACK POSITIONS WAS 96 MI.

TYPHOON	NO. OF CASES	MEAN FORECAST ERROR EQUATIONS (1) & (2)	MEAN FORECAST ERROR EQUATIONS (3) & (4)
TESS	12	95	93
ALICE	7	104	116
BETTY	11	94	87
CORA	3	142	89
ELSIE	3	158	114
HELEN	13	92	94
IDA	5	217	156
JUNE	14	133	93
KATHY	4	163	100
LORNA	10	141	108
NANCY	17	120	109
OLGA	3	70	53
PAMELA	7	161	131
SALLY	6	137	96
TILDA	14	138	124
VIOLET	11	149	147
BILLIE	8	104	140
CLARA	9	222	181
DOT	12	144	102
ELLEN	11	74	121
AVERAGE ERROR		129 MI	113 MI

IN VIEW OF THE ABOVE, IT WAS DECIDED TO INCLUDE THE 1961 FORECASTING ERRORS WITH THE DATA FOR 1959 AND 1960. THE EQUATIONS WHICH RESULTED FROM A TOTAL OF THREE YEARS DATA ARE SHOWN BELOW. IT IS PLANNED TO USE THESE ON AN OPERATIONAL BASIS DURING THE 1962 SEASON.

AT OR SOUTH OF THE POINT OF RECURVATURE

$$\overline{V} = 0.23v_7 + 0.65P_Y + 1.1 \qquad (5)$$

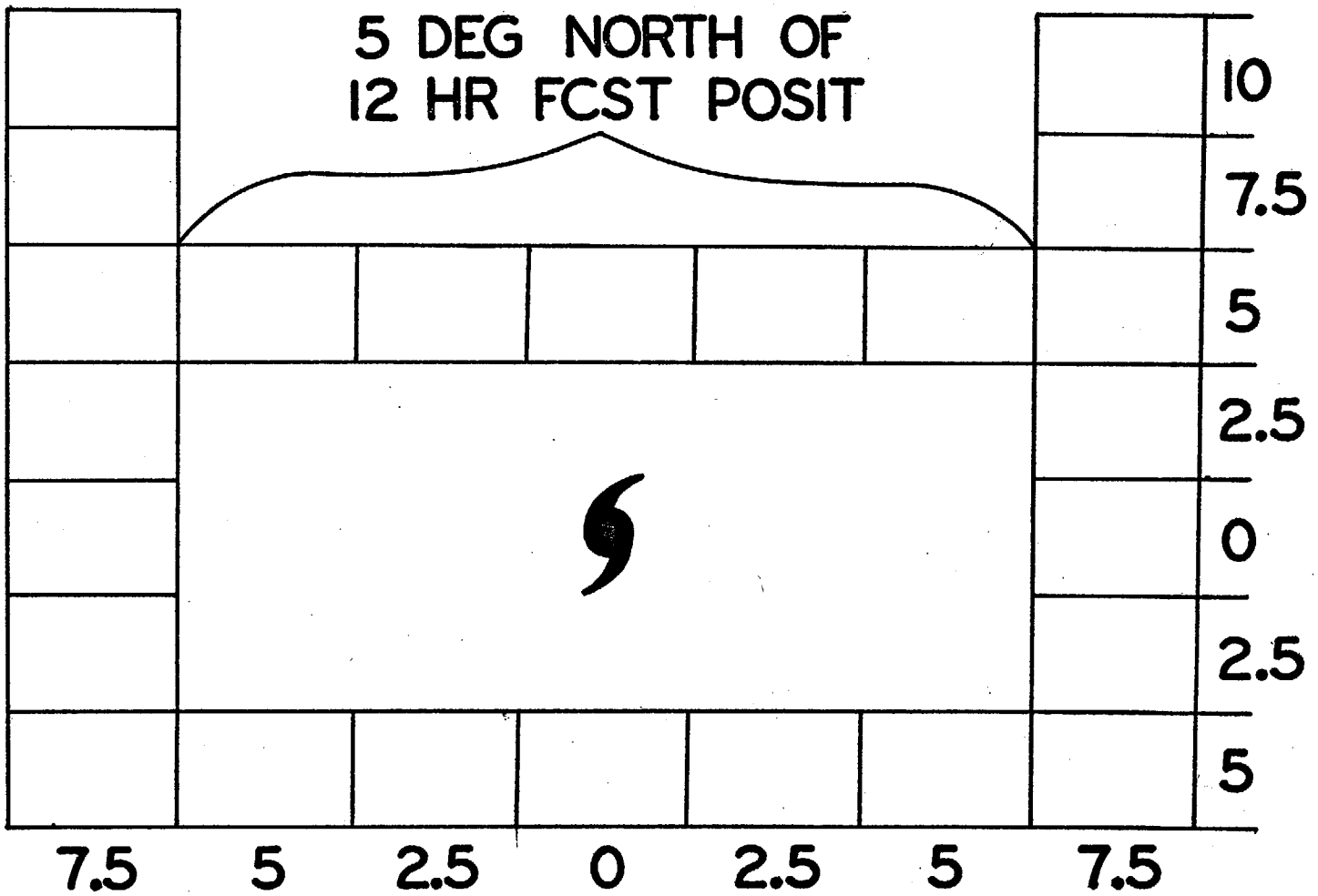
$$\overline{U} = 0.42u_7 + 0.54P_X - 0.2$$

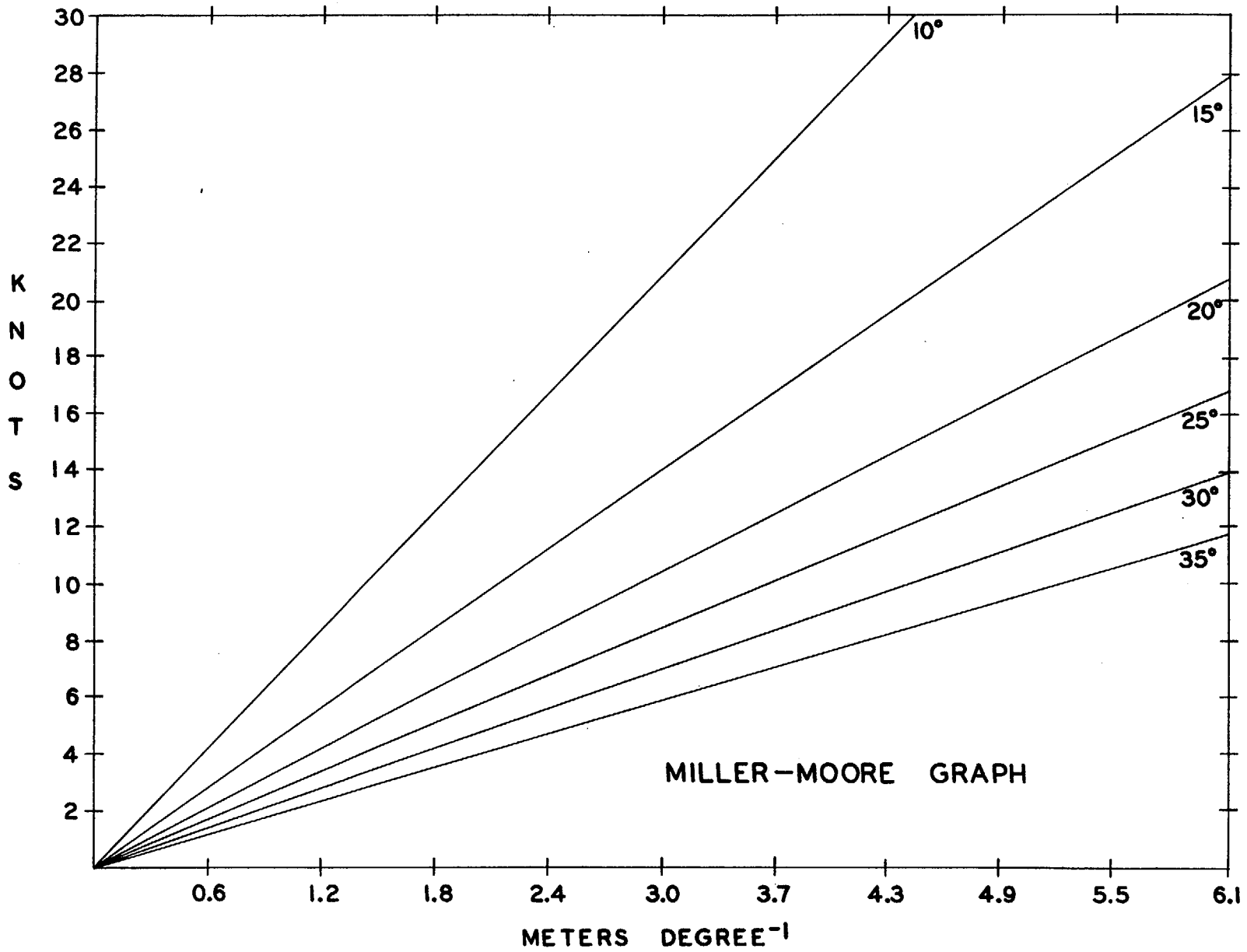
NORTH OF THE POINT OF RECURVATURE

$$\overline{V} = 0.71v_7 + 0.40P_Y + 3.6 \qquad (6)$$

$$\overline{U} = 0.61u_7 + 0.48P_X - 5.7$$

MILLER-MOORE GRID




30
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MILLER–MOORE GRAPH
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
METERS DEGREE^{-1}

MILLER-MOORE 24 HOUR FORECAST ERRORS

TESS

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2512Z	217	158	-	155	-
2600Z	5	-	2	-	3
2612Z	78	-	37	-	71
2700Z	65	-	-	-	65
2712Z	65	62	-	11	-
2800Z	121	93	-	60	-
2812Z	113	62	-	97	-
2900Z	96	96	-	-	-
2912Z	135	65	-	120	-
3000Z	64	-	-	64	-
3012Z	97	25	-	95	-
3100Z	100	-	17	-	98
AVERAGE	96				

ALICE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1812Z	30	-	30	3	-
1900Z	57	-	47	20	-
1912Z	23	-	2	-	23
2000Z	73	-	5	-	73
2012Z	90	74	-	-	56
2100Z	203	65	-	-	192
2112Z	178	172	-	-	47
AVERAGE	93				

BETTY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2312Z	123	60	-	107	-
2400Z	150	-	16	150	-
2412Z	75	5	-	75	-
2500Z	74	48	-	62	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

BETTY (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2512Z	70	-	14	70	-
2600Z	35	30	-	19	-
2612Z	65	64	-	-	15
2700Z	87	-	55	-	75
2712Z	93	-	85	-	43
2800Z	138	-	125	-	52
2812Z	211	-	93	-	173
AVERAGE	102				

CORA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2400Z	108	45	-	98	-
2412Z	107	37	-	102	-
2500Z	197	112	-	161	-
AVERAGE	137				

ELSIE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1400Z	128	97	-	80	-
1412Z	89	77	-	43	-
1500Z	208	75	-	188	-
AVERAGE	142				

HELEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2812Z	76	63	-	-	52

MILLER-MOORE 24 HOUR FORECAST ERRORS

HELEN (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2900Z	29	28	-	16	-
2912Z	34	-	10	33	-
3000Z	38	-	18	33	-
3012Z	59	39	-	43	-
3100Z	170	161	-	-	48
3112Z	122	80	-	-	91
0100Z	69	15	-	66	-
0112Z	45	37	-	-	32
0200Z	58	54	-	20	-
0212Z	73	-	63	41	-
0300Z	55	54	-	10	-
AVERAGE	69				

IDA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2912Z	144	24	-	138	-
3000Z	182	-	21	174	-
3012Z	146	-	13	142	-
3100Z	163	-	3	163	-
3112Z	374	309	-	216	-
AVERAGE	202				

JUNE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0212Z	60	-	46	36	-
0300Z	86	23	-	86	-
0312Z	160	79	-	141	-
0400Z	128	43	-	124	-
0412Z	166	131	-	101	-
0500Z	117	115	-	15	-
0512Z	64	27	-	62	-

MILLER-MOORE 24 HOUR FORECAST ERROR

JUNE (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0600Z	160	7	-	159	-
0612Z	84	56	-	61	-
0700Z	77	76	-	11	-
0712Z	104	72	-	75	-
0800Z	172	38	-	166	-
0812Z	167	77	-	153	-
AVERAGE	119				

KATHY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1612Z	155	-	115	102	-
1700Z	97	56	-	83	-
1712Z	183	163	-	68	-
1800Z	202	192	-	62	-
AVERAGE	159				

LORNA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2200Z	155	148	-	44	-
2212Z	141	135	-	39	-
2300Z	56	-	53	23	-
2312Z	61	-	21	54	-
2400Z	145	-	35	140	-
2412Z	149	-	19	148	-
2500Z	115	-	15	115	-
2512Z	66	56	-	34	-
2600Z	59	54	-	24	-
2612Z	90	48	-	63	-
AVERAGE	104				

MILLER-MOORE 24 HOUR FORECAST ERRORS

NANCY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0900Z	103	40	-	97	-
0912Z	270	23	-	265	-
1000Z	37	-	7	34	-
1012Z	17	-	17	-	3
1100Z	120	7	-	119	-
1112Z	35	10	-	-	35
1200Z	45	45	-	5	-
1212Z	107	65	-	84	-
1300Z	158	55	-	145	-
1312Z	100	-	2	100	-
1400Z	133	-	68	-	122
1412Z	88	-	73	35	-
1500Z	98	70	-	-	70
1512Z	142	73	-	-	103
1600Z	75	-	27	-	69
1612Z	382	-	315	-	202
1700Z	469	-	469	-	-
AVERAGE	140				

OLGA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0912Z	71	-	59	-	38
1000Z	57	15	-	50	-
AVERAGE	64				

PAMELA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1000Z	72	3	-	70	-
1012Z	224	-	8	220	-
1100Z	300	87	-	287	-
1112Z	202	150	-	134	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

PAMELA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1200Z	135	54	-	120	-
1212Z	34	-	17	17	-
AVERAGE	161				

SALLY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2700Z	63	61	-	21	-
2712Z	113	71	-	77	-
2800Z	166	73	-	150	-
2812Z	153	71	-	128	-
2900Z	141	63	-	123	-
2912Z	123	105	-	69	-
AVERAGE	127				

TILDA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2812Z	114	95	-	66	-
2900Z	110	108	-	-	5
2912Z	72	50	-	-	52
3000Z	70	-	62	-	32
3012Z	132	-	78	102	-
0100Z	193	50	-	182	-
0112Z	202	120	-	159	-
0200Z	172	95	-	123	-
0212Z	165	73	-	142	-
0300Z	100	43	-	-	93
0312Z	72	-	26	67	-
0400Z	77	-	32	-	66
0412Z	68	52	-	-	47
0500Z	197	153	-	-	133
AVERAGE	125				

MILLER-MOORE 24 HOUR FORECAST ERRORS

VIOLET

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0512Z	97	78	-	69	-
0600Z	15	-	12	12	-
0612Z	99	-	97	-	13
0700Z	102	-	92	38	-
0712Z	87	-	28	84	-
0800Z	118	23	-	115	-
0812Z	77	-	14	75	-
0900Z	67	-	53	-	38
0912Z	172	-	107	-	127
1000Z	327	-	245	-	210
1012Z	319	123	-	283	-
AVERAGE	135				

BILLIE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2412Z	75	-	43	-	62
2500Z	56	-	13	-	52
2512Z	98	22	-	-	95
2600Z	55	-	-	-	55
2612Z	55	-	-	55	-
2700Z	58	-	50	22	-
2712Z	97	-	58	77	-
2800Z	97	-	88	43	-
AVERAGE	74				

CLARA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2800Z	257	162	-	162	-
2812Z	350	40	-	330	-
2900Z	278	-	35	273	-
2912Z	207	-	34	203	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

CLARA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
3000Z	182	45	-	172	-
3012Z	77	26	-	70	-
3100Z	107	-	25	102	-
3112Z	195	190	-	32	-
0100Z	80	-	30	70	-
AVERAGE	193				

DOT

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1012Z	178	114	-	142	-
1100Z	97	63	-	76	-
1112Z	45	44	-	-	11
1200Z	43	12	-	-	42
1212Z	69	-	8	-	67
1300Z	186	32	-	-	182
1312Z	152	-	29	-	148
1400Z	164	-	42	-	158
1412Z	82	-	28	-	75
1500Z	241	-	54	-	236
1512Z	183	-	68	-	168
AVERAGE	131				

ELLEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0812Z	116	67	-	90	-
0900Z	52	47	-	22	-
0912Z	55	54	-	-	11
1000Z	42	40	-	-	13
1012Z	92	32	-	-	88
1100Z	37	35	-	12	-
1112Z	102	-	13	-	97

MILLER-MOORE 24 HOUR FORECAST ERRORS

ELLEN (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1200Z	83	72	-	40	-
1212Z	83	63	-	44	-
1300Z	92	60	-	60	-
1312Z	76	65	-	28	-
AVERAGE	75				

AVERAGE DISTANCE ERROR-24 HR FORECASTS (175 CASES) . . . . . 119 MI

WACHHOLZ COORDINATION CHART

THIS CHART, WHICH IS INCLUDED AND DISCUSSED IN THIS BOOK, WAS USED IN THE 1960 AND 1961 SEASONS AS A TOOL TO EVALUATE THE EYE DATA REPORTS MADE BY THE AIRBORNE OBSERVER. IT IS AN AID TO DETERMINE THE RELIABILITY OF THE REPORT AND TO PROVIDE A CHECK ON THE OBSERVED SURFACE WIND OR PROVIDE A SURFACE WIND VALUE WHEN NONE WAS OBSERVED. THIS CHART, ALONG WITH THREE SEASONAL CLIMATOLOGY CHARTS, WAS COMPILED BY CAPTAIN EDWARD R. WACHHOLZ, USAF, IN APRIL AND MAY OF 1960 AFTER A SEASON OF FORECASTING TYPHOONS IN 1959 AT FWC/JTWC. THE GRAPHS WERE COMPILED FROM RECONNAISSANCE DATA FOR 1957, 1958 AND 1959 AND WERE INITIALLY TESTED ON 1956 DATA. THESE THREE YEARS PROVIDED THE MOST ACCURATE FLIGHT LEVEL WINDS AS DETERMINED BY THE APN-82 DOPPLER WIND MEASURING EQUIPMENT.

THE WACHHOLZ CHART IS BASED ON THE THEORY THAT ALL TYPHOONS DEVELOP IN HOMOGENEOUS AIR OVER AREAS OF SIMILAR CHARACTERISTICS AND THAT TYPHOONS ARE SIMILAR THERMODYNAMICALLY EXCEPT FOR DIFFERENCES IN INTENSITY. THESE VARIATIONS OF INTENSITY ARE DUE TO THERMAL, LATITUDINAL AND LONGITUDINAL CONSIDERATIONS.

THE CHART (FIG. 1) RELATES MINIMUM 700 MB HEIGHT (FT), MAXIMUM 700 MB TEMPERATURE (^{o}C), AND MINIMUM SURFACE PRESSURE (MB), AS MODIFIED BY LATITUDE, TO MAXIMUM 700 MB WIND SPEED (KTS) AND MAXIMUM SURFACE WIND (KTS). IT IS BASED ON THE FOLLOWING FORMULAE:

$$\text{SFC WIND MAX} = \left[17 - \left(\frac{\theta - 15}{5}\right)\right]\sqrt{372 - \frac{7HM}{28}} \qquad (1)$$

$$\text{700 MB WIND MAX} = 50 + (.5 + \frac{SFCM}{500})\ (SFCM \quad 50) \qquad (2)$$

θ REPRESENTS THE LATITUDE OF THE TYPHOON EYE
7HM IS THE 700 MB MINIMUM HEIGHT OF THE EYE IN FT
SFCM IS THE SURFACE WIND MAX AROUND THE EYE IN KTS

THE BASIS OF THESE FORMULAE IS THE ORIGINAL FORMULA BY DR. ROBERT FLETCHER WHO IS PRESENTLY DIRECTOR OF SCIENTIFIC SERVICES, AIR WEATHER SERVICE. THIS FORMULA IS SHOWN BELOW:

$$\text{SFC WIND MAX} = 16\sqrt{1010 - P_c} \qquad (3)$$

1010 REPRESENTS THE PRESSURE IN MB AT THE "BAR" OF THE TYPHOON AND MAY BE ADJUSTED IF THE "BAR" PRESSURE DIFFERS.
P_c IS THE CENTER PRESSURE OF THE TYPHOON OR HURRICANE IN MB.

NOTE ON THE COORDINATION CHART THAT THE 700 MB-SURFACE WIND RELATIONSHIP IS DIRECT (THEY ARE THE SAME AT 50 AND 250 KTS ONLY) AND THAT THE SURFACE PRESSURE-700 MB HEIGHT IS ALSO DIRECTLY RELATED. WHEN THE SURFACE PRESSURE OR 700 MB HEIGHT IS KNOWN, FIND IT ON THE GRAPH THEN FOLLOW HORIZONTALLY TO THE CORRECT LATITUDE; FROM THERE, EXTEND VERTICALLY TO THE SURFACE WIND OR TO THE 700 MB WIND.

INFORMATION MOST FREQUENTLY USED TO DETERMINE THE SURFACE WIND IS THE 700 MB HEIGHT AND THE 700 MB WIND WHICH ARE ACCURATELY MEASURED BY THE AIRCRAFT. THE SURFACE PRESSURE IS MOST FREQUENTLY OBTAINED FROM DROPSONDE EQUIPMENT AND AVAILABLE AS RAW UNCORRECTED DATA AT TIME OF CHART USE. ITS VALUE VARIED AT TIMES FROM THE CORRECTED PRESSURE AVAILABLE LATER. THE 700 MB TEMPERATURE PARAMETER HAS BEEN FOUND TO BE LEAST USEFUL DUE TO THE FACT THAT IT IS REPORTED IN WHOLE DEGREES, AND A SMALL VARIATION IN TEMPERATURE REPRESENTS A LARGE VARIATION OF OTHER FEATURES IN THE GRAPH. THIS GRAPH WORKS ONLY FOR CIRCULATIONS THERMODYNAMICALLY CLASSIFIED AS TYPHOONS FROM DATA DERIVED FROM WITHIN THE EYE OF THE TYPHOON.

AT THE REQUEST OF HEADQUARTERS AIR WEATHER SERVICE, USAF, AN EVALUATION OF THE GRAPH HAS BEEN MADE, BASED ON INFORMATION AVAILABLE TO JTWC DURING THE 1961 SEASON. THE EVALUATIONS HAVE BEEN DIVIDED INTO TWO SECTIONS. FIRST, RELATING OBSERVED INFORMATION AT A NEARBY LAND OR SHIP STATION TO AN EYE DATA REPORT AND THE SURFACE WIND THAT THE VARIOUS PARAMETERS OF THE EYE DATA REPORT WILL PRODUCE ON THE WACHHOLZ CHART. THE COMPARISONS ARE NOT SIGNIFICANT BECAUSE OF DISTANCE OR TIME VARIATIONS AND LIMITED DATA. THE SECOND EVALUATION CONCERNS THE COMPARISON OF THE OBSERVED PARAMETERS TRANSLATED INTO SURFACE WIND SPEED VALUES WITHIN THE WACHHOLZ CHART ITSELF. IN ADDITION, THE CHART IS EVALUATED AGAINST OBSERVED WINDS OF EACH EYE DATA REPORT.

THE SECOND EVALUATION WAS ACCOMPLISHED IN THE FOLLOWING MANNER:

A. THE REPORTED SEA LEVEL PRESSURE, 700 MB HEIGHT, 700 MB TEMPERATURE AND 700 MB WIND WERE CONVERTED INTO A SURFACE WIND VALUE FOR ALL TYPHOON EYE DATA.

B. EACH CONVERTED PARAMETER AND THE OBSERVED SURFACE WIND WAS COMPARED WITH THE 700 MB WIND CONVERTED TO A SURFACE WIND VALUE ON SCATTER DIAGRAMS.

C. THE DATA WAS SCREENED TO REMOVE EYE DATA REPORTS THAT WERE IN ERROR WHEN COMPARED CHRONOLOGICALLY. FOR EXAMPLE, ASSUME THAT IN ONE REPORT ALL PARAMETERS APPEARED REASONABLE AND IN THE FOLLOWING REPORT THE 700 MB HEIGHT INCREASED IN VALUE, THE SURFACE PRESSURE DECREASED, AND THE REMAINDER OF THE INFORMATION WAS UNCHANGED. THE LATTER REPORT WOULD BE REMOVED FROM THE SAMPLE TO BE EXAMINED. IN THIS MANNER DATA THAT APPEARED TO CONFORM TO THE WACHHOLZ CHART AS WELL AS SOME DATA THAT DID NOT CONFORM WERE REMOVED.

LAND/SHIP OBSERVATIONS COMPARED WITH WACHHOLZ CHART

STATION/WIND KTS	DATE/TIME	WACHHOLZ CHART	ACFT SFC WND	FIX FROM STATION/REMARKS
ULITHI/29	252355Z	T83,H82,W68,P68	80 KTS	TESS, 252145Z MAR, 180 MI W
IWO JIMA/G 57	291112Z	T100,H78,W80,P60	70 KTS	IDA, 290800Z JULY, 48 MI SE
BATANNES/12	060000Z	T58,H94,W80	100 KTS	JUNE, 060150Z AUG, 30 MI NNE
BATANNES/40,G 65	241100Z	T154,H108,W105,P110	150 KTS	LORNA, 240900Z AUG, 54 MI E
NPRE (SHIP)/70	110900Z	T90,H144,W160,P138		PAMELA, 110808Z SEPT, 206 MI ENE, 22.4N 124.3E
TACHIKAWA/25,G 41	092330Z	T104,H70,W95,P70	80 KTS	VIOLET, 092130Z OCT, 100 MI S
YOKOSUKA/48,G 74	092230Z	T104,H70,W95,P70		VIOLET, 092130Z OCT, 62 MI S
YAP ATOLL/G 35	240130Z	T62,H62,P68	50 KTS	BILLIE, 232240Z OCT, 295 MI NE
IWO JIMA/30,G 51	270052Z	T87,H85,W20	35 KTS	BILLIE, 262250Z OCT, 77 MI E
IWO JIMA/29,G 37	132138Z	T88,H87,W120,P87	140 KTS	DOT, 132200Z NOV, 320 MI ESE

NOTE:

G - GUSTS
T - TEMPERATURE, 700 MB CONVERTED TO A SURFACE WIND VALUE, KTS
H - HEIGHT, 700 MB CONVERTED TO A SURFACE WIND VALUE, KTS
W - WIND, 700 MB CONVERTED TO A SURFACE WIND VALUE, KTS
P - REPORTED SEA LEVEL PRESSURE CONVERTED TO A SURFACE WIND VALUE, KTS

D. THE CONVERTED 700 MB OBSERVED WIND WAS SUBTRACTED FROM THE CONVERTED VALUES OF THE 700 MB HEIGHT, SEA LEVEL PRESSURE, 700 MB TEMPERATURE, AND FROM THE REPORTED SURFACE WIND. THIS DIFFERENCE WAS PLOTTED AGAINST NUMBER OF CASES TO PRODUCE A GRAPH OF EACH PARAMETER AS INDICATED. FIGURE 2 REPRESENTS 97 CASES; FIGURE 3, 103 CASES; FIGURE 4, 90 CASES AND FIGURE 5 REPRESENTS 99 CASES. THE VARIATION IN CASES REPRESENTS FAILURE TO REPORT A PARTICULAR PARAMETER BY THE AIRBORNE OBSERVER. FROM THE ORIGINAL UNCORRECTED SAMPLE OF 119 CASES, THE MAXIMUM POSSIBLE NUMBER OF CASES WOULD BE 103.

THE 700 MB WIND, DERIVED FROM THE DOPPLER WIND REPORTING SYSTEM IS THE MOST ACCURATE INFORMATION PROVIDED BY THE OBSERVER AND WAS USED AS THE CONTROL FROM WHICH OTHER REPORTED DATA WOULD VARY. THERE IS A HUMAN ELEMENT INVOLVED IN COLLECTING THE OPTIMUM 700 MB WIND SINCE EYE PENETRATIONS BY SKILLED CREWS ARE USUALLY SAFE ONES, FOR THE AIRCRAFT COMMANDER IN COORDINATION WITH OTHER CREW MEMBERS WILL SELECT THE WEAKEST ZONE OF THE WALL CLOUD TO PENETRATE. THIS IS LIKELY TO BE THE AREA OF LEAST VERTICAL MOTION AS WELL AS LEAST HORIZONTAL MOTION WITHIN THE WALL CLOUD; THUS, THE MAXIMUM OBSERVED 700 MB WIND IS NOT TRULY REPRESENTATIVE OF THE OVERALL CONDITION OF THE WIND AT THAT LEVEL. BECAUSE OF THIS, THE 700 MB HEIGHT IS CONSIDERED TO BE MORE REPRESENTATIVE. IT IS MEASURED WITHIN THE TYPHOON EYE AND THERE ARE FEW PROBLEMS TO SECURING A REASONABLY ACCURATE VALUE THAT REPRESENTS THE OVERALL CONDITION OF THE TYPHOON. A COMPARISON BETWEEN THE 700 MB HEIGHT AND THE 700 MB WIND, BOTH REDUCED TO A SURFACE WIND VALUE, REVEALS 23 CASES BETWEEN PLUS 5 KTS AND MINUS 5 KTS, 25 CASES BETWEEN PLUS 6 AND PLUS 15 KTS INCLUSIVE. THIS DATA PRODUCES A CURVE THAT INCLUDES 65 PERCENT OF CASES BETWEEN MINUS 15 AND PLUS 15 KTS. THE SCATTER DIAGRAM INDICATES THAT 60 PERCENT OF THE DATA WAS WITHIN 10 PERCENT OF THE SPEED VALUE AXIS FOR ALL SPEEDS. THIS IS PROBABLY WITHIN THE LIMITS OF CONSISTENT OBSERVING AND FORECASTING OF TYPHOON INTENSITIES.

A COMPARISON BETWEEN THE REPORTED SURFACE WIND AND THE 700 MB WIND REDUCED TO A SURFACE WIND VALUE INDICATES THAT THE REPORTED WIND WAS FASTER THAN THE COMPUTED WIND, AND THE CURVE IS SKEWED SIMILARLY TO THAT OF THE 700 MB HEIGHT CURVE. THE BOUNDARY OF MINUS 15 TO PLUS 15 KTS INCLUDES 40 PERCENT OF THE DATA, AND 31 PERCENT OF THE DATA WAS WITHIN 10 PERCENT OF THE SPEED VALUE AXIS FOR ALL SPEEDS ON THE SCATTER DIAGRAM.

THE MINIMUM SEA LEVEL PRESSURE CURVE INDICATES THAT THIS PRESSURE PROVIDES A SURFACE WIND SPEED VALUE HIGHER THAN THE 700 MB WIND, 58 PERCENT OF THE DATA BETWEEN MINUS 15 AND PLUS 15 KTS, AND THAT 49 PERCENT OF THE DATA WAS WITHIN 10 PERCENT OF THE SPEED VALUE AXIS FOR ALL SPEEDS ON THE SCATTER DIAGRAM.

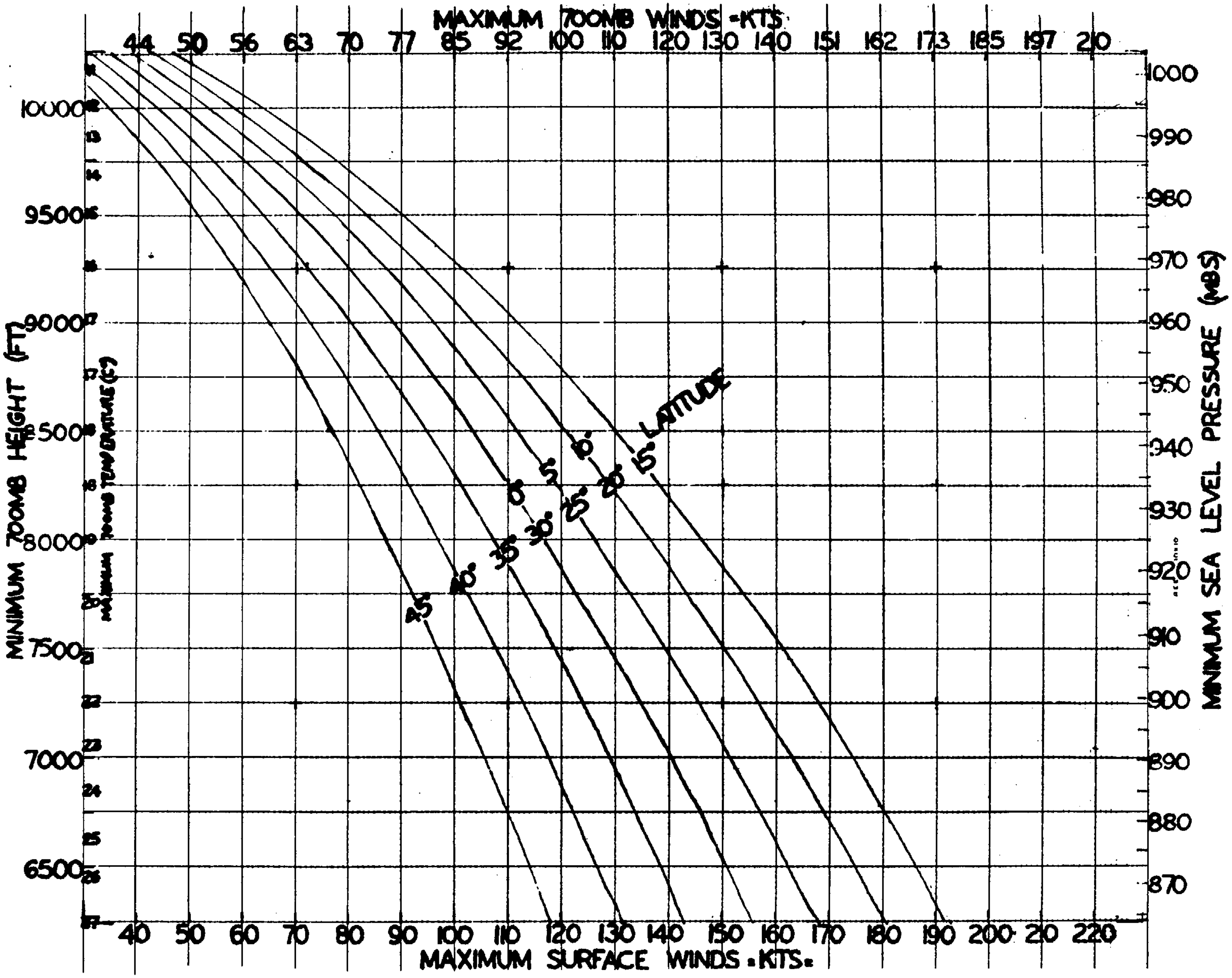
THE 700 MB TEMPERATURE CURVE PROVIDES AN INTERESTING VARIATION FROM THE OTHER CURVES. ONLY 37 PERCENT OF THE DATA RANGES BETWEEN PLUS AND MINUS 15 KTS, 40 PERCENT OF THE DATA IS WITHIN 10 PERCENT

OF THE SPEED AXIS, AND EXPERIENCE INDICATES THE TEMPERATURE TO BE LEAST RELIABLE OF ALL DATA TO PROVIDE A SURFACE WIND VALUE. EXAMINATION OF THE DATA REVEALS THAT WHEN THE TEMPERATURE IS WARMER THAN NORMAL ACCORDING TO THE WACHHOLZ CHART, THE SURFACE WINDS FREQUENTLY INCREASE IN SPEED; THAT IS, THE TYPHOON INTENSIFIES. WHEN THE TEMPERATURE IS COOLER THAN WOULD NORMALLY BE EXPECTED, THE WIND SPEED DECREASES. THIS RELATIONSHIP WILL BECOME A RESEARCH PROJECT OF THE COMING YEAR TO DETERMINE THE SIGNIFICANCE OF THIS INDICATION.

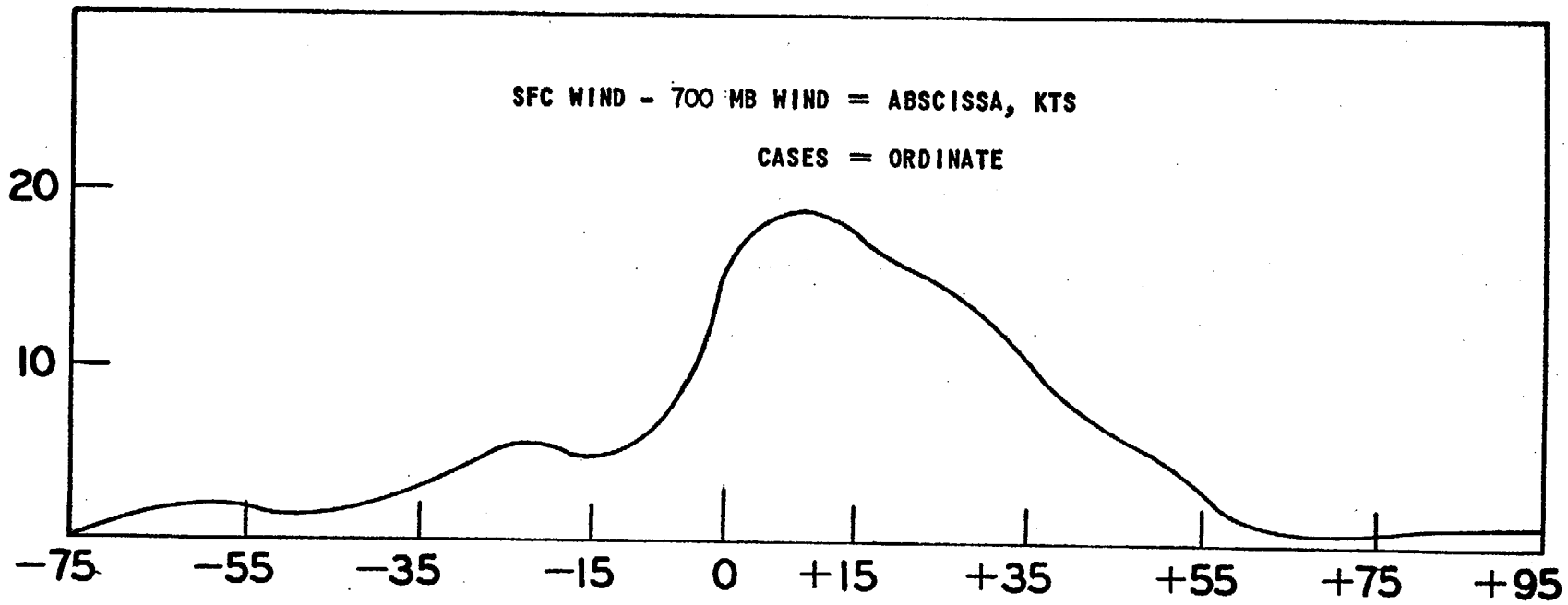
THE QUESTION OF BIAS OF REPORTED DATA HAS ARISEN SEVERAL TIMES CONCERNING THE USE OF THE WACHHOLZ CHART BY JTWC. THIS POSSIBILITY CERTAINLY EXISTS AND CANNOT BE DISCOUNTED. THERE IS SOME SIMILARITY TO THE VARIATION CURVES PRESENTED. THE SCATTER DIAGRAMS AND THE DISTRIBUTION OF THE DATA ON THE VARIATION CURVES DO NOT SUPPORT THE USE BY THE AIRBORNE OBSERVER OF THE WACHHOLZ CHART ITSELF OR ANY OTHER TOOL THAT CONSISTENTLY RELATES SOME OBSERVED PARAMETER TO THE REPORTED SURFACE WIND ON A DAY TO DAY BASIS THROUGHOUT THE YEAR.

EXAMINATION OF AVAILABLE DATA PRODUCES TWO CONCLUSIONS. FIRST, AN AVERAGE OF THE 700 MB WIND, MINIMUM SEA LEVEL PRESSURE AND 700 MB HEIGHT WILL PRODUCE A SURFACE WIND VALUE SLIGHTLY LESS THAN THAT REPORTED BY THE AIRBORNE OBSERVER ON A SEASONAL BASIS. SECOND, THE WACHHOLZ CHART, THE FIRST TO CORRELATE ALL SIGNIFICANT MEASURED PARAMETERS WITHIN THE TYPHOON EYE, IS AN EXCELLENT TOOL FOR USE BY THE TYPHOON DUTY OFFICER AS INDICATED IN THE FIRST PARAGRAPH.

SUFFICIENT DATA IS NOW AVAILABLE FROM THE 1960 AND 1961 SEASONS TO EFFECT SEVERAL MINOR CHANGES TO THE CHART, A PROJECT WHICH CAPTAIN WACHHOLZ INDICATED TO BE DESIRABLE WHEN THIS SUPPORTING DATA BECAME AVAILABLE.



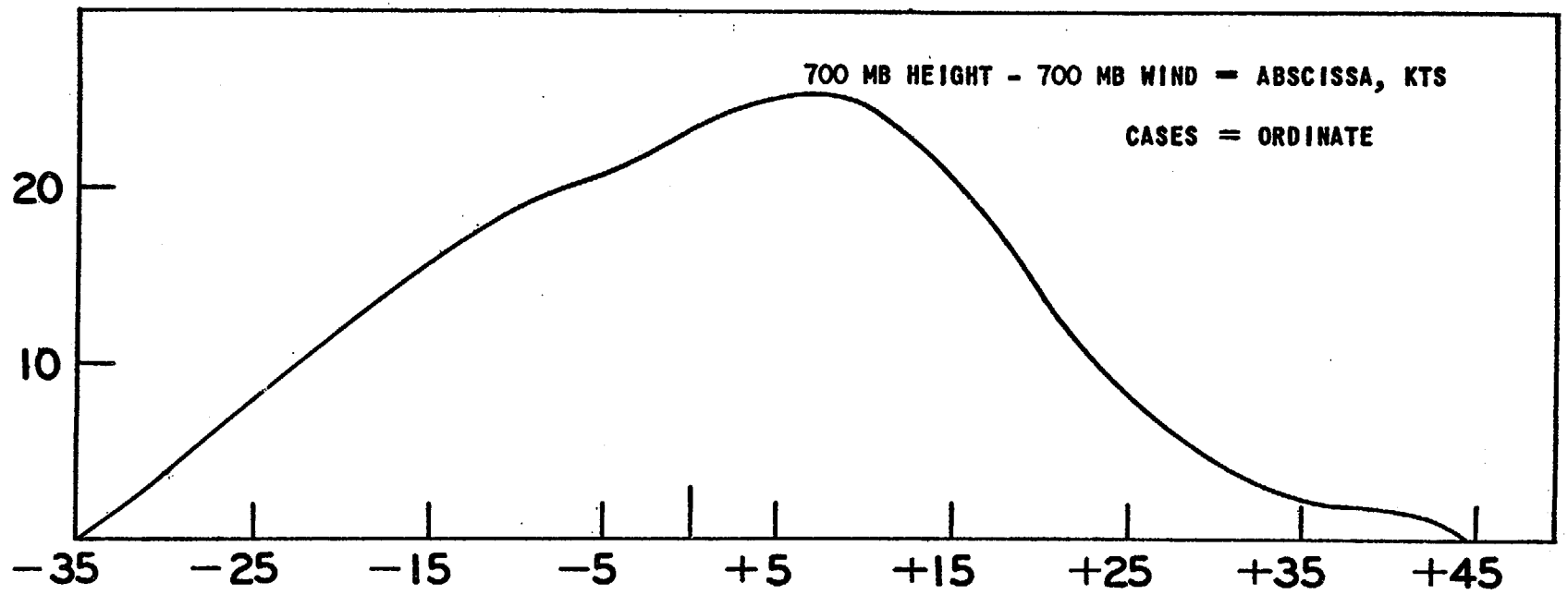
MAXIMUM 700MB WINDS -KTS
44 50 56 63 70 77 85 92 100 110 120 130 140 151 162 173 185 197 210
MINIMUM 700MB HEIGHT (FT)
10000
9500
9000
8500
8000
7500
7000
6500
MINIMUM SEA LEVEL PRESSURE (MBS)
1000
990
980
970
960
950
940
930
920
910
900
890
880
870
LATITUDE
0° 5° 10° 15° 20° 25° 30° 35° 40° 45°
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
MAXIMUM SURFACE WINDS -KTS-



SFC WIND - AS REPORTED BY AIRBORNE OBSERVER

700 MB WIND - CONVERTED TO SURFACE WIND VALUE

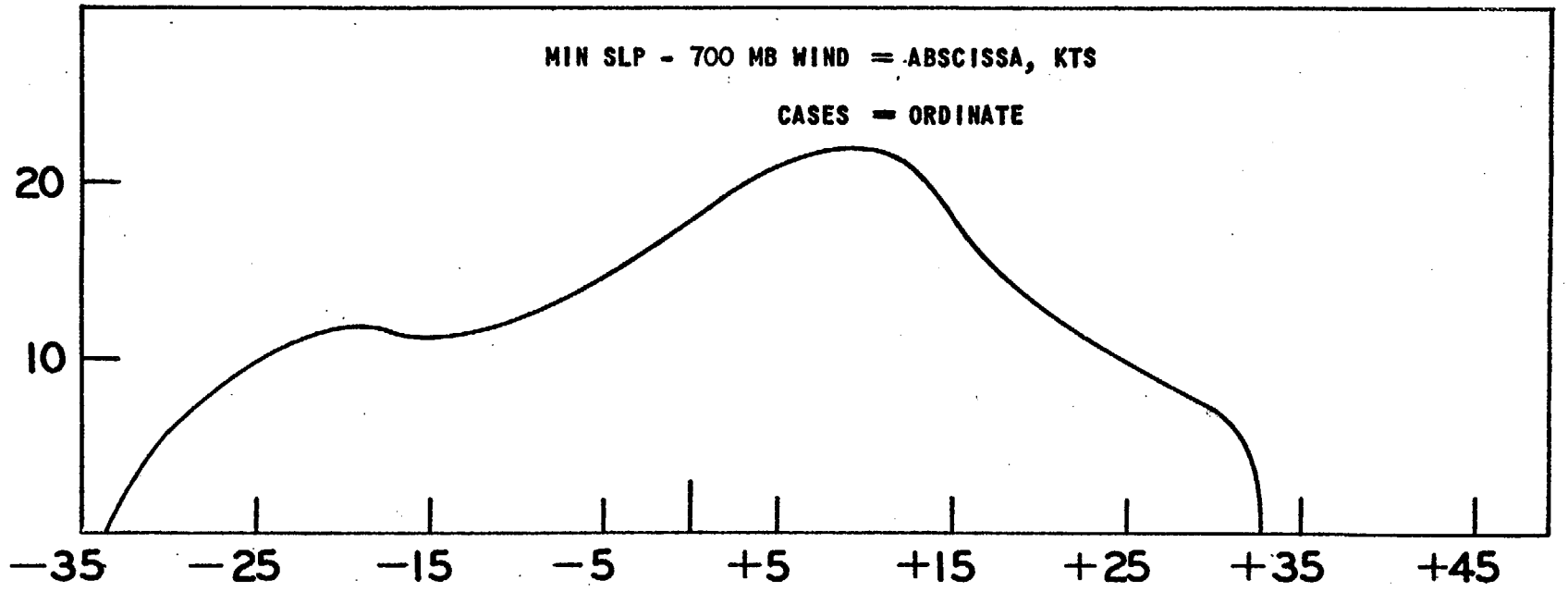
FIG. 2



700 MB HEIGHT - CONVERTED TO SURFACE WIND VALUE

700 MB WIND - CONVERTED TO SURFACE WIND VALUE

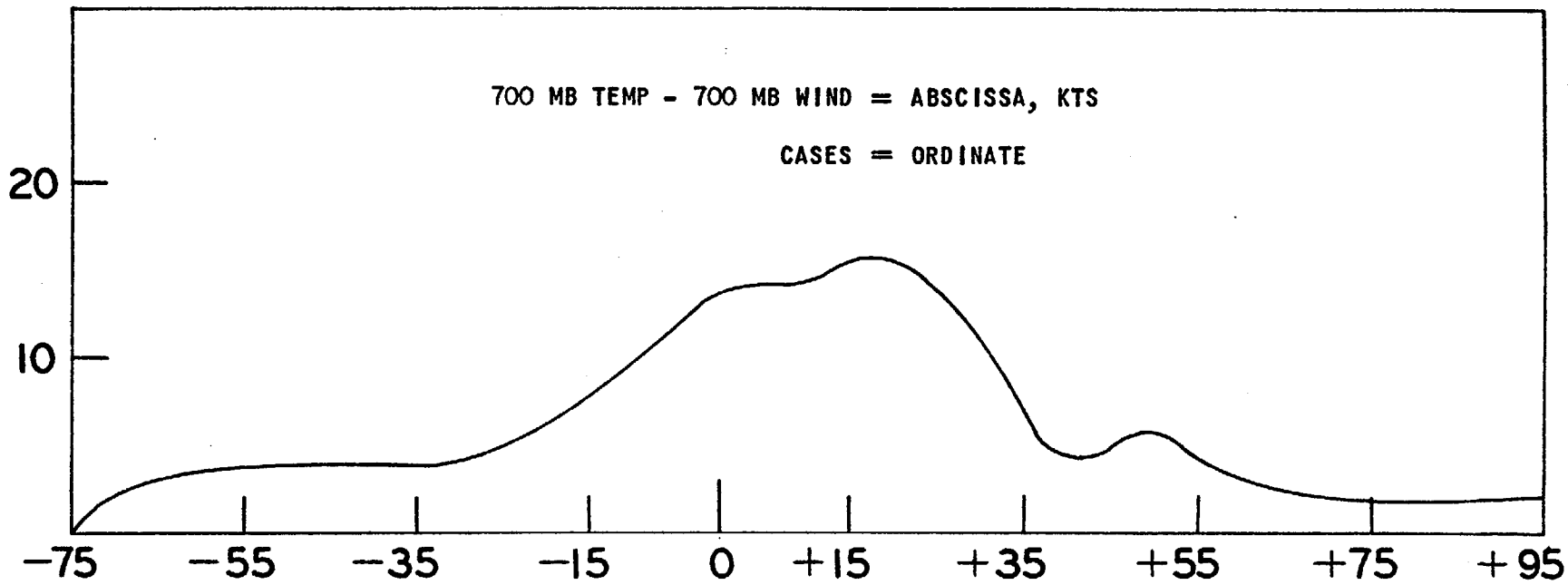
FIG. 3



MIN SLP - CONVERTED TO SURFACE WIND VALUE

700 MB WIND - CONVERTED TO SURFACE WIND VALUE

FIG. 4



700 MB TEMP - CONVERTED TO SURFACE WIND VALUE

700 MB WIND - CONVERTED TO SURFACE WIND VALUE

FIG. 5

APPENDIX A

DEFINITIONS AND ABBREVIATIONS

1. CERTAIN WORDS THAT APPEAR FREQUENTLY IN THIS REPORT ARE ABBREVIATED AS FOLLOWS:

FEET - FT

KNOT(S) - KT(S)

MILLIBAR OR MILLIBARS - MB

NAUTICAL MILES - MI

WEATHER RECONNAISSANCE SQUADRON - WRS

2. POINTS OF THE COMPASS ARE ABBREVIATED: N, SE, WNW, ETC.

3. LATITUDE AND LONGITUDE ARE ABBREVIATED: 30N 140E, ETC.

4. AN INVESTIGATION IS THE TRAVERSE OF A RECONNAISSANCE AIRCRAFT OVER AN AREA CONTAINING A SUSPECTED CIRCULATION THAT HAS BEEN ASSIGNED A CYCLONE NUMBER.

5. A FIX IS THE DETERMINATION OF THE POSITION OF A TROPICAL CYCLONE AT A PRECISE TIME. GENERALLY, THE TERM "FIX" IS USED WHEN THE POSITION OF THE CYCLONE HAS BEEN DETERMINED BY A RECONNAISSANCE AIRCRAFT PENETRATION OR BY AIRBORNE, LAND OR SHIP RADAR. IN THE CASE OF A RECONNAISSANCE AIRCRAFT PENETRATION, THE ACTUAL FIX MAY BE BASED ON ONE OR ALL OF THE FOLLOWING: VISUAL OBSERVATION, RADAR, SURFACE PRESSURE, SURFACE OR UPPER LEVEL WINDS, CONSTANT PRESSURE HEIGHT, AND TEMPERATURE/DEW POINT.

6. A SORTIE IS DEFINED AS A FLIGHT BY ONE AIRCRAFT WITH ONE OR MORE OBJECTIVES, I.E., IT MAY MAKE ONE OR MORE FIXES AND/OR ONE OR MORE INVESTIGATIONS ON ONE OR MORE TROPICAL CYCLONES.

7. THE TERM "TROPICAL CYCLONE" OR "CYCLONE" AS USED IN THIS PUBLICATION HAS TWO DEFINITIONS DEPENDENT UPON USAGE.

A. "TROPICAL CYCLONE" OR "CYCLONE" IS USED TO DESCRIBE A SUSPECTED TROPICAL CYCLONIC CIRCULATION WHICH APPEARS CAPABLE OF INTENSIFICATION, AND TO WHICH HAS BEEN ASSIGNED A "CYCLONE NUMBER" FOR THE PURPOSES OF RECONNAISSANCE AND TO ASSURE THAT RECORDS REGARDING IT ARE NOT CONFUSED WITH THOSE OF ANOTHER CIRCULATION.

B. "TROPICAL CYCLONE" OR "CYCLONE" IS USED IN THE GENERAL SENSE, E.G., "TYPHOON JOAN WAS THE MOST INTENSE TROPICAL CYCLONE OF 1959," OR, "TROPICAL CYCLONES MOST FREQUENTLY DEVELOP DURING AUGUST AND SEPTEMBER."

8. A TROPICAL DEPRESSION IS A TROPICAL CYCLONE WITH A CONFIRMED CYCLONIC CIRCULATION, FOR WHICH WARNINGS ARE BEING ISSUED AND WHOSE SURFACE WIND SPEEDS DO NOT EXCEED 33 KTS. THE NUMBERING OF TROPICAL DEPRESSIONS IS NOT RELATED TO THE NUMBERING OF TROPICAL CYCLONES.

9. THE FOLLOWING DEFINE AND CLARIFY CERTAIN WORDS AND PHRASES THAT APPEAR IN THE TABLES, "LAND RADAR AND AIRCRAFT FIXES," CHAPTER IV.

A. FIX NO. - THIS NUMBER CORRESPONDS TO THE NUMBER OF THE FIX PLOTTED ON THE "BEST TRACK CHART."

B. TIME - THE DATE-TIME GROUP OF THE FIX.

C. LAT. - LATITUDE OF THE FIX.

D. LONG. - LONGITUDE OF THE FIX.

E. UNIT METHOD & ACCY -

(1) UNIT - THE UNIT THAT MADE THE FIX: 56 - 56TH WEATHER RECONNAISSANCE SQUADRON; 315 - 315TH AIR DIVISION; VW1 - VW-1 EARLY WARNING SQUADRON.

(2) METHOD - THE METHOD USED TO MAKE THE FIX: P - PENETRATION; R - RADAR; T - TRIANGULATION.

(3) ACCY - THE ESTIMATED ACCURACY OF THE FIX IN NAUTICAL MILES.

F. MIN SLP MB - THE MINIMUM SEA LEVEL PRESSURE IN MILLIBARS.

G. MAX SFC WND - THE MAXIMUM OBSERVED SURFACE WIND IN KTS.

H. MIN 700 MB HGT - THE MINIMUM 700 MB HEIGHT IN FT.

I. MAX 700 MB WND - THE MAXIMUM 700 MB WIND IN KTS.

J. 700 MB TT/TD (°C) - THE MAXIMUM 700 MB TEMPERATURE AND DEWPOINT IN DEGREES CENTIGRADE.

K. EYE CHARACTERISTICS - SELECTED REMARKS ON THE CHARACTERISTICS OF THE EYE.

SC - STRATO-CUMULUS	DIA - DIAMETER
CIRC - CIRCULAR	ELLIP - ELLIPTICAL
CLD(S) - CLOUD(S)	ELONG - ELONGATED
CTR - CENTER	INDEF - INDEFINITE

ORIEN - ORIENTED

QUAD(S) - QUADRANT(S)

RAD - RADIUS

SFC - SURFACE

WND - WIND

10. A "STIDD DIAGRAM" IS A CHART ON WHICH A CONTINUOUS PLOT OF SURFACE OBSERVATIONS IS MAINTAINED FOR A SERIES OF STATIONS. THE OBSERVATIONS FOR EACH INDIVIDUAL STATION ARE PLOTTED IN EITHER A HORIZONTAL OR VERTICAL LINE.

11. THE "M2 FIELD" IS THE CORRECTION FOR THE CORIOLIS PARAMETER APPLIED TO THE 500 MB DOUBLE SPACE MEAN.

12. THE "BAR" IS THE HEAVY BANK OF CLOUDS THAT APPEARS ON THE HORIZON WITH THE APPROACH OF AN INTENSE TROPICAL CYCLONE.

13. RECURVATURE - THAT POINT AT WHICH THE CYCLONE CEASES MOVEMENT TO THE W OF N AND COMMENCES MOVING TO THE E OF N.

14. SEVERAL COMMANDS, ORGANIZATIONS, AND AREAS THAT APPEAR FREQUENTLY IN THIS REPORT ARE ABBREVIATED AS FOLLOWS:

JMG PACOM - JOINT METEOROLOGICAL GROUP, PACIFIC COMMAND

NMC - NATIONAL METEOROLOGICAL CENTER (FORMERLY JNWP, JOINT NUMERICAL WEATHER PREDICTION)

FWC/JTWC - FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER, GUAM, M. I.

FAFWC - FUCHU AIR FORCE WEATHER CENTRAL, FUCHU AIR STATION, JAPAN

FNWF - FLEET NUMERICAL WEATHER FACILITY, MONTEREY, CALIFORNIA

WESTPAC - WESTERN NORTH PACIFIC AREA

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Typhoon Nancy Hits South Japan, Kills 4

TOKYO (S&S)—Typhoon Nancy swept up the ...

Typhoon Triggers Floods

Typhoon 'Tilda' Clobbers Oki...

Elsie Batters China

PACIFIC STARS AND STRIPES

AN AUTHORIZED PUBLICATION OF THE U.S. ARMED FORCES IN THE FAR EAST

SUNDAY 10c DAILY

Vol. 17, No. 259 AIR EDITION Sunday, Sept. 17, 1961

Tilda En... Taiwan Exercise

By S/SGT. JACK BARR

Taipei Air Station Helps Typhoon Pamela Victims

Weather Plane Penetrates Eye Of Typhoon Nancy

Six Report... Killed; Crop Damage Hea...

NAHA, Okinawa, Oct. 3 (AP)—Typhoon Tilda roared across this U.S. military island Bastion early today, causing damage to communication lines and homes of island residents.

Six persons were reported killed, two of them crew members of a Greek ship piled on to the shore of Minami Daito island, about 200 miles east of Naha. Twenty-seven other crewmen were said to have been rescued by villagers.

The name of the ship and other details were not known immediately.

BLOWN 300 FT.

Nancy Buffets Southern Japan

Nancy Losing Punch; Toll 172

Tess Clocked At 145 MPH

Typhoon On Zig-Zag Course

...ie Loses Punch; ...wan Digging Out

Billie Weakening; New Storm Forms

Storm Floods Taipei, Breaks Heat Wave

213 MPH Winds Hit Taiwan

TYPHOON KILLS

Typhoon Elsie Aims At Taiwan

Typhoon At Sea; Loss Light

TYPHOON NANCY

By JIM LIVSEY JO1

Typhoon Nancy, packing internal winds in excess of 150 knots, slashed within 50 miles of Guam Monday, September 11, before spinning out to sea.

Typhoon Nancy was still hundreds of miles from Guam when the initial Condition Three announcement was made by ComNavMar. A midnight typhoon penetration by a VW-1 "Warning Star" found winds in excess of 130 knots in the now fully developed typhoon.

Top Storm Alert Set On Guam

...To Sinking Japanese Ship

Typhoon Roaring Toward S. Japan

S&S Okinawa Bureau

KADENA AB, Okinawa—Heavy rains and gusts up to 86 m.p.h. whipped Okinawa early Monday as the island braced for violent winds from Typhoon Tilda's 150 m.p.h. punch.

Air Force weathermen here expected winds of 88 m.p.h. by noon Monday as the erratic typhoon swirled west-northwest at 11 m.p.h. They said 58 m.p.h. winds extend 110 miles from the storm's center.

If Tilda remains on her present course, strong winds should slap Okinawa's east coast, according to the Japanese Central Meteorological Agency in Tokyo. The agency also predicted heavy rains in west and south Japan as Tilda nears Japan.

The Joint Typhoon Warning Cen-

(Continued on Back Page, Col. 3)

Tilda Lashes Oki; 6 Killed

CONT'D FROM P. 1

slammed across the Okinawa area late yesterday and early today.

They said the Ryukyuan radio reported nine Okinawans were known dead and that there was considerable damage to crops and to homes of residents on the southern part of the island.

NO DETAILS

The Gabu River which runs through the city of Naha was said to have surged as much

'PAMELA' LASHES FORMOSA--17 DIE

BULLETIN

TAIPEI, Sept. 12 (AP)—Typhoon Pamela smashed across the island of Formosa today, leaving at least 17 persons dead, thousands homeless and inflicting millions of dollars damage before it swirled off toward the mainland.

The death toll may rise as news reports continue to come in. Seven fishermen in a fishing boat off Kyelung were drowned after their vessel sank.

At least 37 persons were injured.

COMMUNICATIONS CUT

Radio telephone and other communication contacts were cut. The offices of the Formosa Central Weather Bureau, at Taipei's Pine Hill Airport, were demolish-

attaches and their dependents were marooned by flash floods.

Pamela was the fifth typhoon to hit Formosa this year and cause severe damage. It struck Taipei with winds as high as 106 M.P.H.

Police reported that 4,330 persons were left homeless in Taipei. More than 145 houses col-

Typhoon June Aims at S. Taiwan

TOKYO (S&S) — Typhoon June continued on a determined path toward southern Taiwan Friday as residents of northern Luzon girded for heavy rains and gusty winds, fringe hazards from 80 m.p.h. center winds.

Formosa, Hard-Hit by 'Pamela', Braces As 'Nancy' Approaches