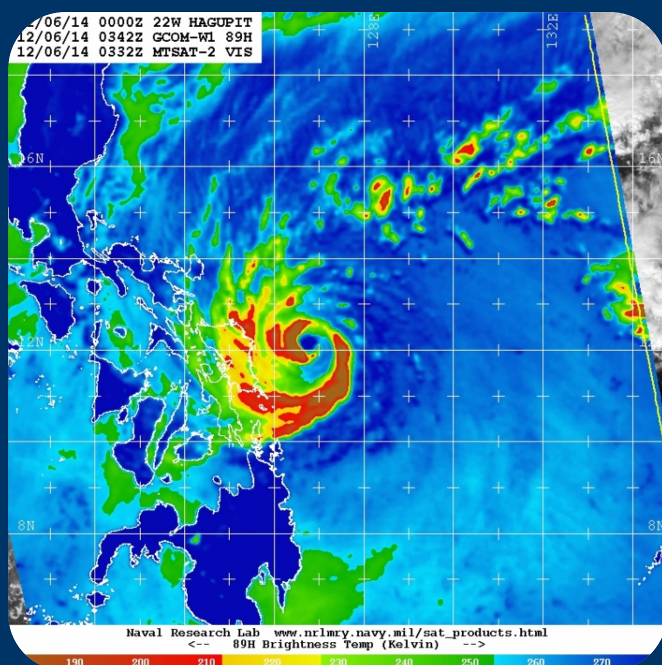
# Annual Tropical Cyclone Report
# 2014

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**Cover:** GCOM-W1 89h image of Typhoon 22W (HAGUPIT), 06 December 2014, as it approaches the central island of Samar, Philippines. Image courtesy of the Naval Research Laboratory (NRL). http://www.nrlmry.navy.mil/TC.html

## Executive Summary


The Annual Tropical Cyclone Report (ATCR) is prepared by the staff of the Joint Typhoon Warning Center (JTWC), a jointly manned United States Air Force/Navy organization under the operational command of the Commanding Officer, Joint Typhoon Warning Center.

The original JTWC was established on 1 May 1959 when the Joint Chiefs of Staff directed Commander-in-Chief, US Pacific Command (USCINCPAC) to provide a single tropical cyclone warning center for the western North Pacific region. USCINCPAC delegated the tropical cyclone forecast and warning mission to Commander, Pacific Fleet. A subsequent USCINCPAC directive further tasked Commander, Pacific Air Force to provide for tropical cyclone (TC) reconnaissance support to the JTWC. Currently, JTWC operations are guided by USPACOM Instruction 0539.1 and Pacific Air Forces Instruction 15-101.

This edition of the ATCR documents the 2014 TC season and details operationally or meteorologically significant cyclones noted within the JTWC Area of Responsibility. Details are provided to describe significant challenges and/or shortfalls in the TC warning system and to serve as a focal point for future research and development efforts. Also included are tropical cyclone reconnaissance statistics and a summary of tropical cyclone research or tactics, techniques and procedures development that members of JTWC were involved in.

The western North Pacific Ocean returned to below average activity again, with only 23 TCs observed compared to the long term average of 31. However, 7 of the 23 cyclones attained super typhoon intensity. Despite the low number of cyclones, the onset of El Nino conditions shifted the genesis region eastward, causing major DoD installations to experience strong cyclone impacts. Okinawa had two direct strikes and two additional passages within 300 miles. Guam had three cyclones pass within 300 miles. Department of Defense bases in South Korea were impacted by one cyclone and mainland Japan was impacted by four.

The Southern Hemisphere activity remained below the long term average of 28, with 14 cyclones in the southern Indian Ocean / western Australia region and 10 in the South Pacific / eastern Australia region. The northern Indian Ocean experienced normal activity of five cyclones, with two in the Arabian Sea and three in the Bay of Bengal. The most significant cyclones in the northern Indian Ocean were Tropical Cyclone 03B (Hudhud) in the Bay of Bengal and 04A (Nilofar) in the Arabian Sea, both reached peak intensities of 115 knots.

Weather satellite data remained the mainstay of the TC reconnaissance mission to support the JTWC. Air Force satellite analysts exploited a wide variety of conventional and microwave satellite data to produce over eleven thousand position and intensity estimates (fixes), primarily using the USAF Mark IVB and the USN FMQ-17 satellite direct readout systems. Geo-located microwave satellite imagery overlays available via the Automated Tropical Cyclone Forecast (ATCF) system from Fleet Numerical Meteorology and Oceanography Center and the Naval Research Laboratory Monterey, CA were also used by JTWC to make TC fixes.

JTWC also continues to utilize radar derived TC position information from numerous U.S. owned/operated weather radars as well as from international sources. However, budget challenges have delayed the replacement of the WSR-88D Doppler Weather Radar at Kadena AB.

JTWC continued to collaborate with TC forecast support and research organizations such as the Fleet Numerical Meteorology and Oceanography Center (FNMOC), Naval Research Laboratory, Monterey (NRLMRY), Naval Post Graduate School, the Office of Naval Research, Air Force Weather Agency (AFWA), and NOAA Line Offices for continued development of TC reconnaissance tools, numerical models and forecast aids.

The Technical Services Team (formally TECHDEV) continued significant collaboration with the research and development community. Among a variety of promising projects (described in Chapter 5 of this report), Technical Services implemented the Weighted Analog Intensity (WANI) application developed at the Naval Postgraduate School. This intensity aid uses the JTWC track forecast to match the top ten analogs from the JTWC best track archive. A weighted consensus intensity forecast and intensity spread guidance are created from these ten historical cyclones.

Behind these efforts are the dedicated team of men and women, military and civilian at JTWC. Special thanks to the entire JTWC N6 Department for their continued outstanding IT support and the administrative and budget staff who worked tirelessly to ensure JTWC had the necessary resources to accomplish the mission despite extremely volatile financial times.

A Special thanks also to: FNMOC for their operational data and modeling support; the NRLMRY and ONR for its dedicated TC research; the National Oceanic and Atmospheric Administration National Environmental Satellite, Data, and Information Service for satellite reconnaissance support; Dr. John Knaff, Mr. Jeff Hawkins, Dr. Mark DeMaria, and Mr. Chris Velden for their continuing efforts to exploit remote sensing technologies in new and innovative ways; Mr. Charles R. “Buck” Sampson, Ms. Ann Schrader, and Mr. Mike Frost for their outstanding support and continued development of the ATCF system.

# JTWC Personnel 2014

N1 Staff
CDR Mike Cornelius, *Executive Officer*
AGDC Enrique Acosta, *Senior Enlisted Advisor*
Ms. Kerri Kanbara, *Administrative Officer*
Mr. Roberto Macais, *Administrative Assistant*

N4 Staff
Ms. Kehau Koa, *Budget Analyst*
LSC Arcyria Lockley, *Logistics and Supply*

N6 Staff
Mr. Joshua Nelson, *Information Technology Officer*
Mr. Angelo Alvarez, *System Administrator*
Mr. Andrew Rhoades, *Information Assurance Officer*
Mr. Albert Leyendecker, *System Administrator*
IT1 Jeffery Gross, *Information Technology*
IT2Isaac Wilson, *Information Technology*

J3 Staff
Mr. Robert Falvey, *Director*
LT Chad Geis, *Operations Officer*
LT Thomas Mills, *Operations Officer*
Mr. Edward Fukada, *Technical Advisor*
Mr. Matt Kucas, Chief Technical Services
Mr. Brian Strahl, Technical Development and Research Coordinator
Mr. James Darlow, Technical Services

Command Duty Officers (CDO)
AG1 Nadine McBee
AG1 Cecil Jordan
AGC Christopher McKinstry
LT Chris Chitwood
LT Denie Kiger
LT Dominique Krieger
LT Nicholas Kutchak
LT Justin Van Es

Typhoon Duty Officers (TDO)
LT Joshua Carter
LT Thai Phung
Mr. Matt Kucas
Mr. Stephen Barlow
Mr. Brian Strahl
Mr. Richard Ballucanag
Mr. Aaron Lana

Satellite Operations
Capt Brenda Arincorayan*, OIC Satellite Operations*
TSgt Jeffrey Quast, *Analyst/NCOIC*
TSgt Ricky Frye, *Analyst/NCOIC*
SSgt Donald Chappotin*, Analyst*
SSgt Brittany Bermea, *Analyst*
SrA Karen Long, *Analyst*
SrA Kolby Rapp, *Analyst*

SrA Terrance Schalin, *Analyst*
Mr. James Darlow, *Analyst*
Mr. Dana Uehara, *Analyst*

Geophysical Technician (GT)
AG1 Jamaine Parks
AG2 Jack Tracey
AG2 Heather Johnston
AG2 Christian Wilcox
AG3 Bristol Rigby
AG3 Jake Wilson
AG3 Christopher Hoole
AGAN Janie Sherrock

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## Chapter 1 Western North Pacific Ocean Tropical Cyclones

### Section 1 Informational Tables

Table 1-1 is a summary of TC activity in the western North Pacific Ocean during the 2014 season. JTWC issued warnings on 23 cyclones. Table 1-2 shows the monthly distribution of TC activity summarized for 1959 - 2014 and Table 1-3 shows the monthly average occurrence of TC's separated into: (1) typhoons and (2) tropical storms and typhoons. Table 1-4 summarizes Tropical Cyclone Formation Alerts issued. The annual number of TC's of tropical storm strength or higher appears in Figure 1-1, while the number of TC's of super typhoon intensity appears in Figure 1-2. Figure 1-3 illustrates a monthly average number of cyclones based on intensity categories. Figures 1-4 and 1-5 depict the 2014 western North Pacific Ocean TC tracks and intensities.

**Table 1-1**

**WESTERN NORTH PACIFIC SIGNIFICANT TROPICAL CYCLONES FOR 2014 (01 JAN 2014 - 31 DEC 2014)**

| TC | NAME* | PERIOD** | | WARNINGS ISSUED | EST MAX SFC WINDS KTS |
|---|---|---|---|---|---|
| 01W | LINGLING | 18 JAN / 0000Z | 19 JAN / 2100Z | 8 | 30 |
| 02W | KAJIKI | 30 JAN / 1800Z | 01 FEB / 1800Z | 9 | 35 |
| 03W | FAXAI | 28 FEB / 0000Z | 05 MAR / 1200Z | 23 | 80 |
| 04W | FOUR | 22 MAR / 0000Z | 22 MAR / 1800Z | 4 | 25 |
| 05W | PEIPAH | 03 APR / 0000Z | 10 APR / 0600Z | 30 | 35 |
| 06W | TAPAH | 27 APR / 1200Z | 01 MAY / 0600Z | 16 | 70 |
| 07W | HAGIBIS | 14JUN / 0600Z | 18 JUN / 0000Z | 12 | 40 |
| 08W | NEOGURI | 03 JUL / 0000Z | 10 JUL / 1200Z | 31 | 140 |
| 09W | RAMMASUN | 10 JUL / 1200Z | 19 JUL / 0000Z | 35 | 140 |
| 10W | MATMO | 17 JUL / 1200Z | 23 JUL / 1200Z | 25 | 85 |
| 11W | HALONG | 28 JUL / 1200Z | 10 AUG / 0000Z | 51 | 140 |
| 12W | NAKRI | 02 AUG / 0600Z | 03 AUG / 1800Z | 7 | 40 |
| 07E | GENEVIEVE | 07 AUG / 0600Z | 11 AUG / 1800Z | 19 | 140 |
| 13W | FENGSHEN | 07SEP / 0000Z | 09 SEP / 1200Z | 11 | 65 |
| 14W | FOURTEEN | 07SEP / 0600Z | 08SEP / 0000Z | 4 | 30 |
| 15W | KALMAEGI | 10 SEP / 1800Z | 16 SEP / 1800Z | 25 | 80 |
| 16W | FUNG-WONG | 17 SEP / 1200Z | 23 SEP / 1200Z | 25 | 50 |
| 17W | KUMMURI | 24 SEP / 1200Z | 28 SEP / 0000Z | 19 | 55 |
| 18W | PHANFONE | 28 SEP / 1800Z | 06 OCT / 0600 | 31 | 135 |
| 19W | VONGFONG | 02 OCT / 1800Z | 14 OCT / 0000Z | 46 | 155 |
| 20W | NURI | 31 OCT / 0000Z | 06 NOV / 0000Z | 25 | 155 |
| 21W | SINLAKU | 26 NOV / 0600Z | 29 NOV / 1800Z | 15 | 55 |
| 22W | HAGUPIT | 01 DEC / 0000Z | 12 DEC / 0000Z | 45 | 155 |
| 23W | JANGMI | 28 DEC / 0000Z | 31 DEC / 0000Z | 13 | 45 |

* As designated by the responsible RSMC

** Dates are based on the issuance of JTWC warnings on system.

## Table 1-2

### DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959 - 2014

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total ≥64kt | Total 34-63kt | Total ≤33 kt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | TOTALS | |
| 1959 | 0 | 1 | 1 | 1 | 0 | 1 | 3 | 8 | 9 | 3 | 2 | 2 | | 31 | |
| | 0 0 0 | 0 1 0 | 0 1 1 | 1 0 0 | 0 0 0 | 0 0 1 | 1 1 1 | 5 1 2 | 4 2 3 | 2 1 0 | 2 0 0 | 2 0 0 | 17 | 7 | 7 |
| 1960 | 1 | 0 | 1 | 1 | 1 | 3 | 3 | 9 | 5 | 4 | 1 | 1 | | 30 | |
| | 0 0 1 | 0 0 0 | 0 0 1 | 1 0 0 | 0 1 0 | 2 1 0 | 2 1 0 | 8 1 0 | 0 4 1 | 4 0 0 | 1 0 0 | 1 0 0 | 19 | 8 | 3 |
| 1961 | 1 | 1 | 1 | 1 | 4 | 6 | 5 | 7 | 6 | 7 | 2 | 1 | | 42 | |
| | 0 1 0 | 0 1 0 | 1 0 0 | 0 1 0 | 2 1 1 | 1 1 4 | 3 2 0 | 3 1 3 | 5 1 0 | 3 2 2 | 1 0 1 | 1 0 0 | 20 | 11 | 11 |
| 1962 | 0 | 1 | 0 | 1 | 3 | 0 | 8 | 8 | 7 | 5 | 4 | 2 | | 39 | |
| | 0 0 0 | 0 1 0 | 0 0 0 | 1 0 0 | 2 0 1 | 0 0 0 | 5 1 2 | 7 0 1 | 3 1 3 | 3 1 1 | 3 0 1 | 0 2 0 | 24 | 6 | 9 |
| 1963 | 0 | 0 | 1 | 1 | 0 | 4 | 5 | 4 | 4 | 6 | 0 | 3 | | 28 | |
| | 0 0 0 | 0 0 0 | 0 0 1 | 1 0 0 | 0 0 0 | 3 1 0 | 3 1 1 | 3 0 1 | 2 2 0 | 5 1 0 | 0 0 0 | 2 1 0 | 19 | 6 | 3 |
| 1964 | 0 | 0 | 0 | 0 | 3 | 2 | 8 | 8 | 8 | 7 | 6 | 2 | | 44 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 2 0 1 | 2 0 0 | 6 1 1 | 3 5 0 | 5 2 1 | 3 3 1 | 4 2 0 | 1 0 1 | 26 | 13 | 5 |
| 1965 | 2 | 2 | 1 | 1 | 2 | 4 | 6 | 7 | 9 | 3 | 2 | 1 | | 40 | |
| | 1 1 0 | 0 2 0 | 0 1 0 | 1 0 0 | 1 0 1 | 3 1 0 | 4 1 1 | 3 2 2 | 5 3 1 | 2 0 1 | 1 1 0 | 0 1 0 | 21 | 13 | 6 |
| 1966 | 0 | 0 | 0 | 1 | 2 | 1 | 4 | 9 | 10 | 4 | 5 | 2 | | 38 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 2 0 0 | 1 0 0 | 3 1 0 | 5 3 1 | 5 3 2 | 1 1 2 | 1 2 2 | 1 0 1 | 20 | 10 | 8 |
| 1967 | 1 | 0 | 2 | 1 | 1 | 1 | 8 | 10 | 8 | 4 | 4 | 1 | | 41 | |
| | 0 1 0 | 0 0 0 | 1 1 0 | 1 0 0 | 0 1 0 | 1 0 0 | 3 3 2 | 3 4 3 | 5 3 0 | 2 1 1 | 4 0 0 | 0 1 0 | 20 | 15 | 6 |
| 1968 | 0 | 1 | 0 | 1 | 0 | 4 | 3 | 8 | 4 | 6 | 4 | 0 | | 31 | |
| | 0 0 0 | 0 0 1 | 0 0 0 | 1 0 0 | 0 0 0 | 2 0 2 | 1 2 0 | 3 4 1 | 4 0 0 | 5 1 0 | 4 0 0 | 0 0 0 | 20 | 7 | 4 |
| 1969 | 1 | 0 | 1 | 1 | 0 | 0 | 3 | 3 | 6 | 5 | 2 | 1 | | 23 | |
| | 1 0 0 | 0 0 0 | 0 1 0 | 1 0 0 | 0 0 0 | 0 0 0 | 2 1 0 | 2 1 0 | 2 0 4 | 4 1 0 | 1 1 0 | 0 1 0 | 13 | 6 | 4 |
| 1970 | 0 | 1 | 0 | 0 | 0 | 2 | 3 | 7 | 4 | 6 | 4 | 0 | | 27 | |
| | 0 0 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 1 0 | 0 2 1 | 4 2 1 | 2 2 0 | 3 2 1 | 1 3 0 | 0 0 0 | 12 | 12 | 3 |
| 1971 | 1 | 0 | 1 | 2 | 5 | 2 | 8 | 5 | 7 | 4 | 2 | 0 | | 37 | |
| | 0 1 0 | 0 0 0 | 0 1 0 | 2 0 0 | 2 3 0 | 2 0 0 | 6 2 0 | 3 1 1 | 5 1 1 | 3 1 0 | 1 1 0 | 0 0 0 | 24 | 11 | 2 |
| 1972 | 1 | 0 | 1 | 0 | 0 | 4 | 5 | 5 | 6 | 5 | 2 | 3 | | 32 | |
| | 1 0 0 | 0 0 0 | 0 0 1 | 0 0 0 | 0 0 0 | 2 2 0 | 4 1 0 | 3 2 0 | 4 1 1 | 4 1 0 | 2 0 0 | 2 1 0 | 22 | 8 | 2 |
| 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 6 | 3 | 4 | 3 | 0 | | 23 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 4 3 0 | 2 3 1 | 2 0 1 | 4 0 0 | 0 3 0 | 0 0 0 | 12 | 9 | 2 |
| 1974 | 1 | 0 | 1 | 1 | 1 | 4 | 5 | 7 | 5 | 4 | 4 | 2 | | 35 | |
| | 0 1 0 | 0 0 0 | 0 1 0 | 0 1 0 | 1 0 0 | 1 2 1 | 2 3 0 | 2 3 2 | 3 2 0 | 4 0 0 | 2 2 0 | 0 2 0 | 15 | 17 | 3 |
| 1975 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 6 | 5 | 6 | 3 | 2 | | 25 | |
| | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 1 | 0 0 0 | 0 0 0 | 0 1 0 | 4 1 1 | 4 1 0 | 3 2 1 | 2 1 0 | 0 2 0 | 14 | 8 | 3 |
| 1976 | 1 | 1 | 0 | 2 | 2 | 2 | 4 | 4 | 5 | 0 | 2 | 2 | | 25 | |
| | 1 0 0 | 0 1 0 | 0 0 0 | 1 1 0 | 2 0 0 | 2 0 0 | 2 2 0 | 1 3 0 | 4 1 0 | 0 0 0 | 1 1 0 | 0 2 0 | 14 | 11 | 10 |
| 1977 | 0 | 0 | 1 | 0 | 1 | 1 | 4 | 2 | 5 | 4 | 2 | 1 | | 21 | |
| | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 1 | 0 1 0 | 3 0 1 | 0 2 0 | 2 3 0 | 3 1 0 | 2 0 0 | 1 0 0 | 11 | 8 | 2 |
| 1978 | 1 | 0 | 0 | 1 | 0 | 3 | 4 | 8 | 4 | 7 | 4 | 0 | | 32 | |
| | 0 1 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 0 3 0 | 3 1 0 | 3 4 1 | 3 1 0 | 4 1 2 | 1 2 1 | 0 0 0 | 15 | 13 | 4 |
| 1979 | 1 | 0 | 1 | 1 | 2 | 0 | 5 | 4 | 6 | 3 | 2 | 3 | | 28 | |
| | 1 0 0 | 0 0 0 | 1 0 0 | 1 0 0 | 0 1 1 | 0 0 0 | 2 2 1 | 2 0 2 | 3 3 0 | 2 1 0 | 1 1 0 | 1 1 1 | 14 | 9 | 5 |
| 1980 | 0 | 0 | 1 | 1 | 4 | 1 | 5 | 3 | 7 | 4 | 1 | 1 | | 28 | |
| | 0 0 0 | 0 0 0 | 0 0 1 | 0 1 0 | 2 2 0 | 0 1 0 | 3 1 1 | 2 0 1 | 5 1 1 | 2 2 0 | 1 0 0 | 0 1 0 | 15 | 9 | 4 |
| 1981 | 0 | 0 | 1 | 1 | 1 | 2 | 5 | 8 | 4 | 2 | 3 | 2 | | 29 | |
| | 0 0 0 | 0 0 0 | 1 0 0 | 0 1 0 | 0 1 0 | 2 0 0 | 2 3 0 | 2 5 1 | 4 0 0 | 1 1 0 | 2 1 0 | 2 0 0 | 16 | 12 | 1 |
| 1982 | 0 | 0 | 3 | 0 | 1 | 3 | 4 | 5 | 6 | 4 | 1 | 1 | | 28 | |
| | 0 0 0 | 0 0 0 | 2 1 0 | 0 0 0 | 1 0 0 | 1 2 0 | 2 2 0 | 5 0 0 | 3 2 1 | 3 0 1 | 1 0 0 | 1 0 0 | 19 | 7 | 2 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 6 | 3 | 5 | 5 | 2 | | 25 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 3 0 0 | 2 3 1 | 1 1 1 | 3 2 0 | 3 2 0 | 0 2 0 | 12 | 11 | 2 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 7 | 4 | 8 | 3 | 1 | | 30 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 4 1 0 | 2 3 2 | 1 3 0 | 5 4 1 | 3 0 0 | 1 0 0 | 16 | 13 | 3 |
| 1985 | 2 | 0 | 0 | 0 | 1 | 3 | 1 | 7 | 5 | 5 | 1 | 2 | | 27 | |
| | 0 2 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 2 0 1 | 1 0 0 | 5 2 0 | 3 2 0 | 4 1 0 | 0 1 0 | 1 1 0 | 17 | 9 | 1 |
| 1986 | 0 | 1 | 0 | 1 | 2 | 2 | 2 | 5 | 2 | 5 | 4 | 3 | | 27 | |
| | 0 0 0 | 1 0 0 | 0 0 0 | 1 0 0 | 1 1 0 | 1 1 0 | 2 0 0 | 4 1 0 | 2 0 0 | 3 2 0 | 2 2 0 | 2 1 0 | 19 | 8 | 0 |
| 1987 | 1 | 0 | 0 | 1 | 0 | 2 | 4 | 4 | 7 | 2 | 3 | 1 | | 25 | |
| | 1 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 1 1 0 | 4 0 0 | 3 1 0 | 5 1 1 | 2 0 0 | 1 2 0 | 1 0 0 | 18 | 6 | 1 |
| 1988 | 1 | 0 | 0 | 0 | 1 | 3 | 2 | 5 | 8 | 4 | 2 | 1 | | 27 | |
| | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 1 1 1 | 1 1 0 | 2 3 0 | 2 6 0 | 4 0 0 | 2 0 0 | 0 1 0 | 14 | 12 | 1 |
| 1989 | 1 | 0 | 0 | 1 | 2 | 2 | 6 | 8 | 4 | 6 | 3 | 2 | | 35 | |
| | 0 1 0 | 0 0 0 | 0 0 0 | 1 0 0 | 2 0 0 | 1 1 0 | 2 3 1 | 3 3 2 | 2 2 0 | 6 0 0 | 3 0 0 | 1 0 1 | 21 | 10 | 4 |
| 1990 | 1 | 0 | 0 | 1 | 2 | 4 | 4 | 5 | 5 | 5 | 4 | 1 | | 32 | |
| | 1 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 1 1 0 | 2 1 1 | 2 2 0 | 5 0 0 | 4 1 0 | 2 3 0 | 3 1 0 | 1 0 0 | 21 | 10 | 1 |
| 1991 | 0 | 0 | 2 | 1 | 1 | 1 | 4 | 8 | 6 | 3 | 6 | 0 | | 32 | |
| | 0 0 0 | 0 0 0 | 1 1 0 | 0 1 0 | 1 0 0 | 1 0 10 | 4 0 0 | 3 3 2 | 4 2 0 | 3 0 0 | 3 3 0 | 0 0 0 | 20 | 10 | 2 |
| 1992 | 1 | 1 | 0 | 0 | 0 | 3 | 4 | 8 | 5 | 6 | 5 | 0 | | 33 | |
| | 1 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 2 1 0 | 2 2 0 | 4 4 0 | 4 1 0 | 5 1 0 | 3 1 1 | 0 0 0 | 21 | 11 | 11 |
| 1993 | 0 | 0 | 2 | 2 | 1 | 2 | 5 | 8 | 5 | 6 | 4 | 3 | | 38 | |
| | 0 0 0 | 0 0 0 | 0 1 1 | 0 0 2 | 0 1 0 | 1 0 1 | 3 2 0 | 6 1 1 | 4 1 0 | 3 2 1 | 1 1 2 | 3 0 0 | 21 | 9 | 8 |
| 1994 | 1 | 0 | 1 | 0 | 2 | 2 | 9 | 9 | 8 | 7 | 0 | 2 | | 41 | |
| | 0 0 1 | 0 0 0 | 1 0 0 | 0 0 0 | 1 0 1 | 0 2 0 | 3 4 2 | 6 3 0 | 4 4 0 | 5 1 1 | 0 0 0 | 1 1 0 | 21 | 15 | 5 |
| 1995 | 1 | 0 | 0 | 0 | 1 | 2 | 3 | 7 | 7 | 8 | 2 | 3 | | 34 | |
| | 0 0 1 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 2 0 | 2 1 0 | 4 2 1 | 4 1 2 | 5 1 2 | 0 2 0 | 0 1 2 | 15 | 11 | 8 |
| 1996 | 1 | 1 | 0 | 2 | 2 | 0 | 7 | 10 | 7 | 5 | 6 | 3 | | 44 | |
| | 0 0 1 | 0 0 1 | 0 0 0 | 0 1 1 | 1 1 0 | 0 0 0 | 6 1 0 | 4 3 3 | 6 1 0 | 2 1 2 | 1 3 2 | 1 1 1 | 21 | 12 | 11 |
| 1997 | 1 | 0 | 0 | 2 | 3 | 3 | 4 | 8 | 4 | 6 | 1 | 1 | | 33 | |
| | 0 1 0 | 0 0 0 | 0 0 0 | 1 1 0 | 1 2 0 | 3 0 0 | 3 1 0 | 6 1 1 | 3 1 0 | 4 1 1 | 1 0 0 | 1 0 0 | 23 | 8 | 2 |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 8 | 6 | 3 | 4 | | 27 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 2 | 2 1 0 | 4 1 3 | 2 1 3 | 0 3 0 | 1 1 2 | 9 | 8 | 10 |
| 1999 | 1 | 1 | 0 | 3 | 0 | 1 | 5 | 9 | 6 | 2 | 3 | 3 | | 34 | |
| | 0 1 0 | 0 1 0 | 0 0 0 | 2 1 0 | 0 0 0 | 1 0 0 | 1 1 3 | 4 2 3 | 2 4 0 | 1 1 0 | 1 1 1 | 0 0 3 | 12 | 12 | 10 |
| 2000 | 0 | 0 | 0 | 0 | 4 | 0 | 8 | 9 | 6 | 3 | 3 | 1 | | 34 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 1 2 | 0 0 0 | 2 3 3 | 4 3 2 | 4 1 1 | 2 1 0 | 1 1 1 | 1 0 0 | 15 | 10 | 9 |
| 2001 | 0 | 1 | 0 | 1 | 1 | 2 | 6 | 7 | 5 | 3 | 3 | 4 | | 33 | |
| | 0 0 0 | 0 0 1 | 0 0 0 | 0 0 1 | 0 1 0 | 2 0 0 | 4 1 1 | 3 3 1 | 5 0 0 | 3 0 0 | 1 2 0 | 2 2 0 | 20 | 9 | 4 |
| 2002 | 1 | 1 | 1 | 1 | 2 | 3 | 6 | 8 | 3 | 5 | 1 | 1 | | 33 | |
| | 0 1 0 | 1 0 0 | 0 0 1 | 0 0 1 | 1 0 1 | 3 0 0 | 3 2 1 | 4 3 1 | 1 2 0 | 3 0 2 | 1 0 0 | 1 0 0 | 18 | 8 | 7 |
| 2003 | 1 | 0 | 0 | 1 | 3 | 2 | 2 | 5 | 3 | 6 | 3 | 1 | | 27 | |
| | 0 1 0 | 0 0 0 | 0 0 0 | 1 0 0 | 1 1 1 | 1 1 0 | 2 0 0 | 4 1 0 | 3 0 0 | 2 1 3 | 3 0 0 | 0 1 0 | 17 | 6 | 4 |
| 2004 | 0 | 1 | 1 | 1 | 3 | 5 | 2 | 9 | 3 | 3 | 2 | 2 | | 32 | |
| | 0 0 0 | 0 1 0 | 0 1 0 | 1 0 0 | 2 1 0 | 5 0 0 | 1 1 0 | 6 2 1 | 1 1 1 | 3 0 0 | 2 0 0 | 0 2 0 | 21 | 9 | 2 |
| 2005 | 1 | 0 | 1 | 1 | 0 | 1 | 4 | 6 | 5 | 3 | 2 | 1 | | 25 | |
| | 1 0 0 | 0 0 0 | 1 0 0 | 1 0 0 | 0 0 0 | 1 0 0 | 1 3 0 | 6 0 0 | 4 1 0 | 2 0 1 | 1 1 0 | 0 1 0 | 18 | 6 | 1 |
| 2006 | 0 | 0 | 1 | 0 | 1 | 1 | 3 | 8 | 5 | 4 | 2 | 2 | | 27 | |
| | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 1 0 0 | 0 1 0 | 2 1 0 | 3 4 1 | 3 0 2 | 2 1 1 | 2 0 0 | 1 0 1 | 14 | 8 | 5 |
| 2007 | 0 | 0 | 1 | 0 | 1 | 0 | 3 | 6 | 5 | 5 | 6 | 0 | | 27 | |
| | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 2 1 0 | 3 2 1 | 2 2 1 | 3 2 0 | 3 1 2 | 0 0 0 | 15 | 8 | 4 |
| 2008 | 1 | 0 | 0 | 1 | 4 | 1 | 2 | 5 | 6 | 3 | 3 | 1 | | 27 | |
| | 0 1 0 | 0 0 0 | 0 0 0 | 1 0 0 | 3 1 0 | 1 0 0 | 2 0 0 | 1 4 0 | 3 3 0 | 0 3 0 | 0 3 0 | 1 0 0 | 12 | 15 | 0 |
| 2009 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 5 | 7 | 4 | 4 | 1 | | 28 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 2 0 0 | 1 1 0 | 1 1 1 | 3 2 0 | 4 1 2 | 3 1 0 | 1 1 2 | 0 0 1 | 15 | 7 | 6 |
| 2010 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 5 | 4 | 4 | 1 | 1 | | 19 | |
| | 0 0 1 | 0 0 0 | 0 0 1 | 0 0 0 | 0 0 0 | 0 0 0 | 2 0 0 | 2 3 0 | 3 1 0 | 2 2 0 | 0 0 1 | 0 0 1 | 9 | 6 | 4 |
| 2011 | 0 | 0 | 0 | 2 | 2 | 3 | 4 | 4 | 7 | 1 | 1 | 3 | | 27 | |
| | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 2 | 1 1 0 | 0 2 1 | 2 1 1 | 2 1 1 | 2 5 0 | 0 0 1 | 0 0 1 | 0 1 2 | 7 | 11 | 9 |
| 2012 | 0 | 1 | 1 | 0 | 1 | 4 | 4 | 5 | 3 | 5 | 2 | 1 | | 27 | |
| | 0 0 0 | 0 0 1 | 0 1 0 | 0 0 0 | 1 0 0 | 2 2 0 | 3 1 0 | 4 1 0 | 2 1 0 | 2 3 0 | 1 0 1 | 0 1 0 | 15 | 10 | 2 |
| 2013 | 1 | 1 | 0 | 0 | 0 | 4 | 3 | 5 | 8 | 7 | 3 | 1 | | 33 | |
| | 0 1 0 | 0 0 1 | 0 0 0 | 0 0 0 | 0 0 0 | 1 3 0 | 1 2 0 | 2 2 1 | 4 3 1 | 6 0 1 | 1 1 1 | 0 0 1 | 15 | 12 | 6 |
| 2014 | 2 | 0 | 1 | 2 | 0 | 1 | 4 | 2 | 5 | 1 | 3 | 2 | | 23 | |
| | 0 1 1 | 0 0 0 | 1 0 0 | 1 1 0 | 0 0 0 | 0 1 0 | 3 1 0 | 1 1 0 | 2 2 1 | 1 0 0 | 2 1 0 | 1 0 1 | 12 | 8 | 3 |

1) If a tropical cyclone was warned on prior to the last two days of a month, it was attributed to the first month, regardless of how long the system lasted.

2) If a tropical cyclone began on the last day of the month and ended on the first day of the next month, that system was attributed to the first month. However, if a tropical cyclone began on the last day of the month and continued into the next month for only two days, it was attributed to the second month.

| TABLE 1-3 WESTERN NORTH PACIFIC TROPICAL CYCLONES | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TYPHOONS (1945 - 1958)** | | | | | | | | | | | | | |
| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
| MEAN | 0.4 | 0.1 | 0.3 | 0.4 | 0.7 | 1.1 | 2 | 2.9 | 3.2 | 2.4 | 2 | 0.9 | 16.4 |
| CASES | 5 | 1 | 4 | 5 | 10 | 15 | 28 | 41 | 45 | 34 | 28 | 12 | 228 |
| **TYPHOONS (1959 - 2014)** | | | | | | | | | | | | | |
| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
| MEAN | 0.2 | 0.1 | 0.2 | 0.4 | 0.7 | 1.1 | 2.5 | 3.4 | 3.3 | 2.9 | 1.5 | 0.6 | 16.9 |
| CASES | 11 | 3 | 11 | 24 | 41 | 59 | 140 | 191 | 182 | 163 | 85 | 36 | 946 |
| **TROPICAL STORMS AND TYPHOONS (1945 - 1958)** | | | | | | | | | | | | | |
| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
| MEAN | 0.4 | 0.2 | 0.5 | 0.5 | 0.8 | 1.6 | 2.9 | 4 | 4.2 | 3.3 | 2.7 | 1.2 | 22.3 |
| CASES | 6 | 2 | 7 | 8 | 11 | 22 | 44 | 60 | 64 | 49 | 41 | 18 | 332 |
| **TROPICAL STORMS AND TYPHOONS (1959 - 2014)** | | | | | | | | | | | | | |
| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
| MEAN | 0.5 | 0.2 | 0.4 | 0.6 | 1.1 | 1.8 | 3.9 | 5.5 | 4.9 | 4.0 | 2.5 | 1.2 | 26.6 |
| CASES | 27 | 12 | 24 | 36 | 64 | 99 | 216 | 307 | 276 | 222 | 139 | 68 | 1490 |

| TABLE 1-4<br>TROPICAL CYCLONE FORMATION ALERTS FOR THE<br>WESTERN NORTH PACIFIC OCEAN 1976 - 2014 | | | | | |
|---|---|---|---|---|---|
| YEAR | INITIAL TCFAS | TROPICAL CYCLONES WITH TCFAS | TOTAL TROPICAL CYCLONES | PROBABILITY OF TCFA WITHOUT WARNING* | PROBABILITY OF TCFA BEFORE WARNING |
| 1976 | 34 | 25 | 25 | 26% | 100% |
| 1977 | 26 | 20 | 21 | 23% | 95% |
| 1978 | 32 | 27 | 32 | 16% | 84% |
| 1979 | 27 | 23 | 28 | 15% | 82% |
| 1980 | 37 | 28 | 28 | 24% | 100% |
| 1981 | 29 | 28 | 29 | 3% | 97% |
| 1982 | 36 | 26 | 28 | 28% | 93% |
| 1983 | 31 | 25 | 25 | 19% | 100% |
| 1984 | 37 | 30 | 30 | 19% | 100% |
| 1985 | 39 | 26 | 27 | 33% | 96% |
| 1986 | 38 | 27 | 27 | 29% | 100% |
| 1987 | 31 | 24 | 25 | 23% | 96% |
| 1988 | 33 | 26 | 27 | 21% | 96% |
| 1989 | 51 | 32 | 35 | 37% | 91% |
| 1990 | 33 | 30 | 31 | 9% | 97% |
| 1991 | 37 | 29 | 31 | 22% | 94% |
| 1992 | 36 | 32 | 32 | 11% | 100% |
| 1993 | 50 | 35 | 38 | 30% | 92% |
| 1994 | 50 | 40 | 40 | 20% | 100% |
| 1995 | 54 | 33 | 35 | 39% | 94% |
| 1996 | 41 | 39 | 43 | 5% | 91% |
| 1997 | 36 | 30 | 33 | 17% | 91% |
| 1998 | 38 | 18 | 27 | 53% | 67% |
| 1999 | 39 | 29 | 33 | 26% | 88% |
| 2000 | 40 | 31 | 34 | 23% | 91% |
| 2001 | 34 | 28 | 33 | 18% | 85% |
| 2002 | 39 | 31 | 33 | 21% | 94% |
| 2003 | 31 | 27 | 27 | 13% | 100% |
| 2004 | 35 | 32 | 32 | 9% | 100% |
| 2005 | 26 | 25 | 25 | 4% | 100% |
| 2006 | 23 | 22 | 26 | 4% | 85% |
| 2007 | 27 | 26 | 27 | 4% | 96% |
| 2008 | 23 | 23 | 28 | 0% | 82% |
| 2009 | 26 | 22 | 28 | 15% | 79% |
| 2010 | 24 | 18 | 19 | 25% | 95% |
| 2011 | 32 | 26 | 27 | 19% | 96% |
| 2012 | 31 | 26 | 27 | 16% | 96% |
| 2013 | 36 | 31 | 33 | 14% | 94% |
| 2014 | 32 | 23 | 23 | 28% | 100% |
| MEAN | 35 | 28 | 30 | 21% | 93% |
| CASES | 1354 | 1073 | 1152 | | |
| * Percentage of initial TCFAs not followed by warnings. | | | | | |

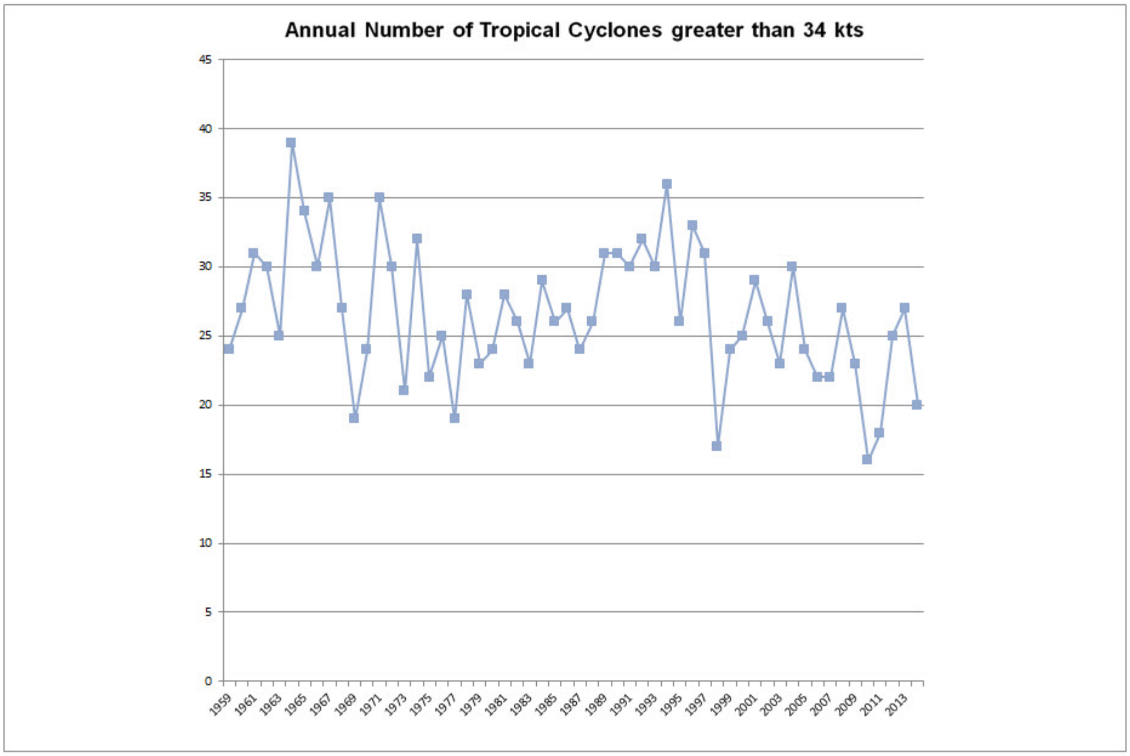



**Figure 1-1.** Annual number of western North Pacific TCs greater than 34 knots intensity.

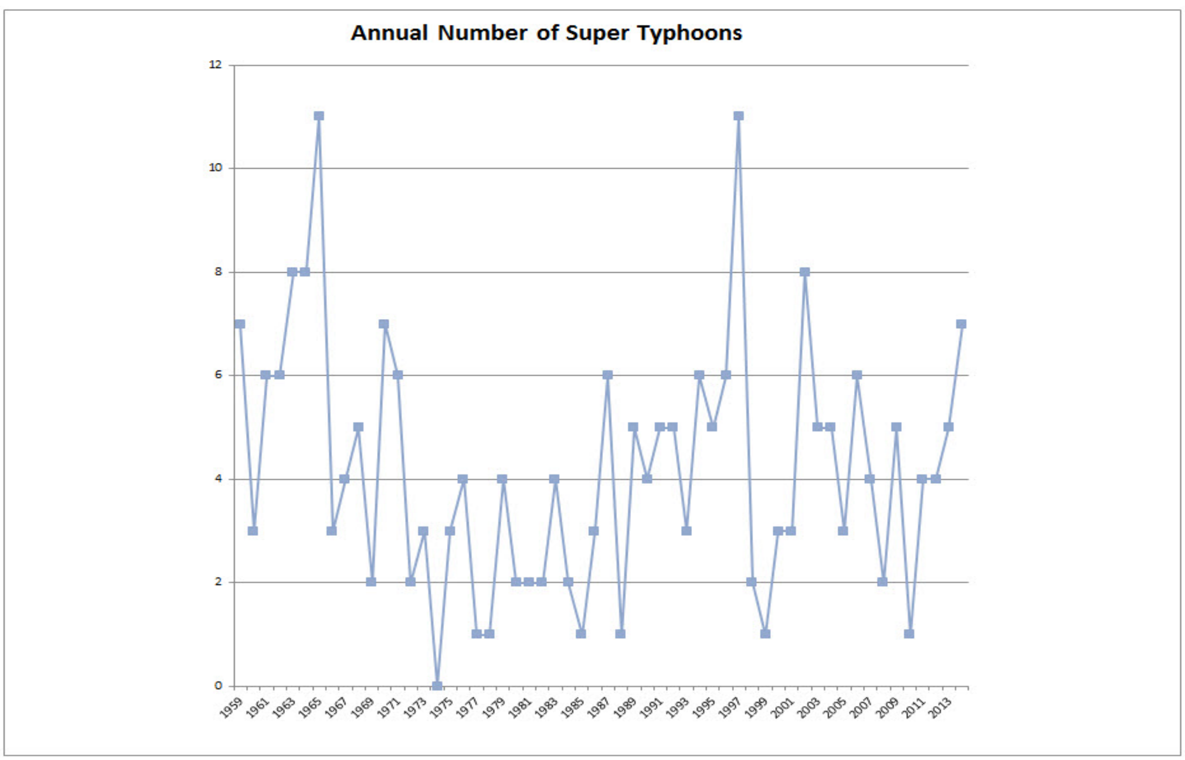
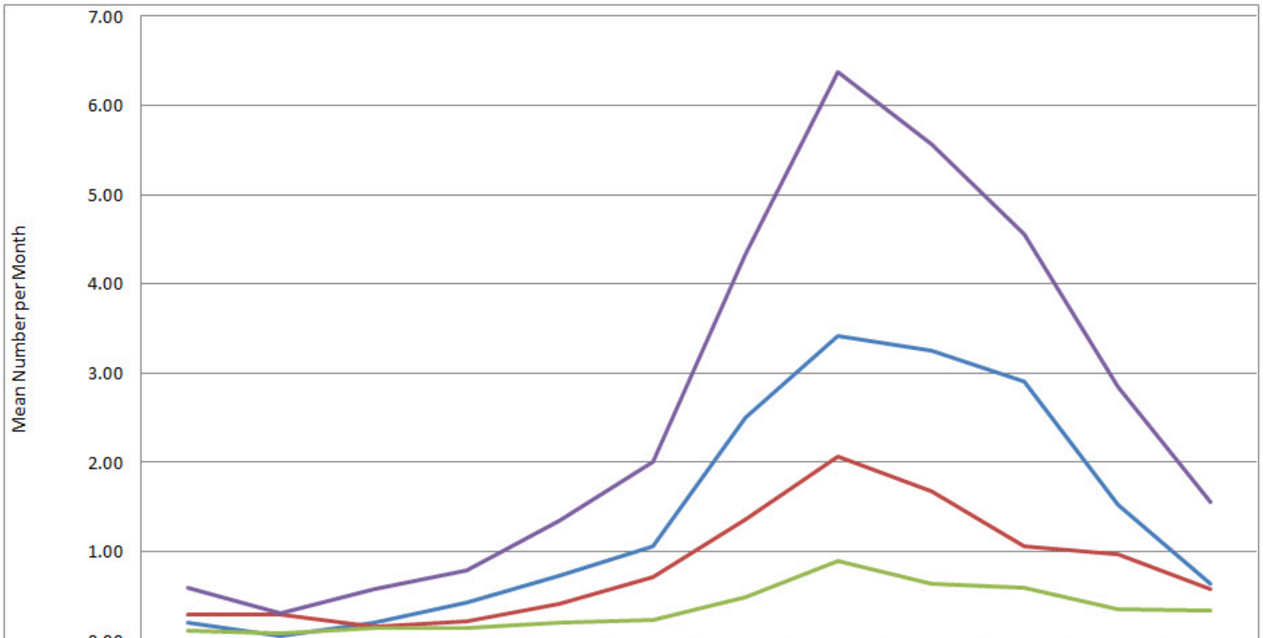



**Figure 1-2.** Annual number of western North Pacific TCs greater than 129 knots intensity.




| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TY AVG | 0.20 | 0.05 | 0.20 | 0.43 | 0.73 | 1.05 | 2.50 | 3.41 | 3.25 | 2.91 | 1.52 | 0.64 |
| TS AVG | 0.29 | 0.29 | 0.16 | 0.21 | 0.41 | 0.71 | 1.36 | 2.07 | 1.68 | 1.05 | 0.96 | 0.57 |
| TD AVG | 0.11 | 0.09 | 0.14 | 0.14 | 0.20 | 0.23 | 0.48 | 0.89 | 0.64 | 0.59 | 0.36 | 0.34 |
| All AVG | 0.59 | 0.30 | 0.57 | 0.79 | 1.34 | 2.00 | 4.34 | 6.38 | 5.57 | 4.55 | 2.84 | 1.55 |

**Figure 1-3.** Average number of western North Pacific TCs (all intensities) by month 1959-2014.

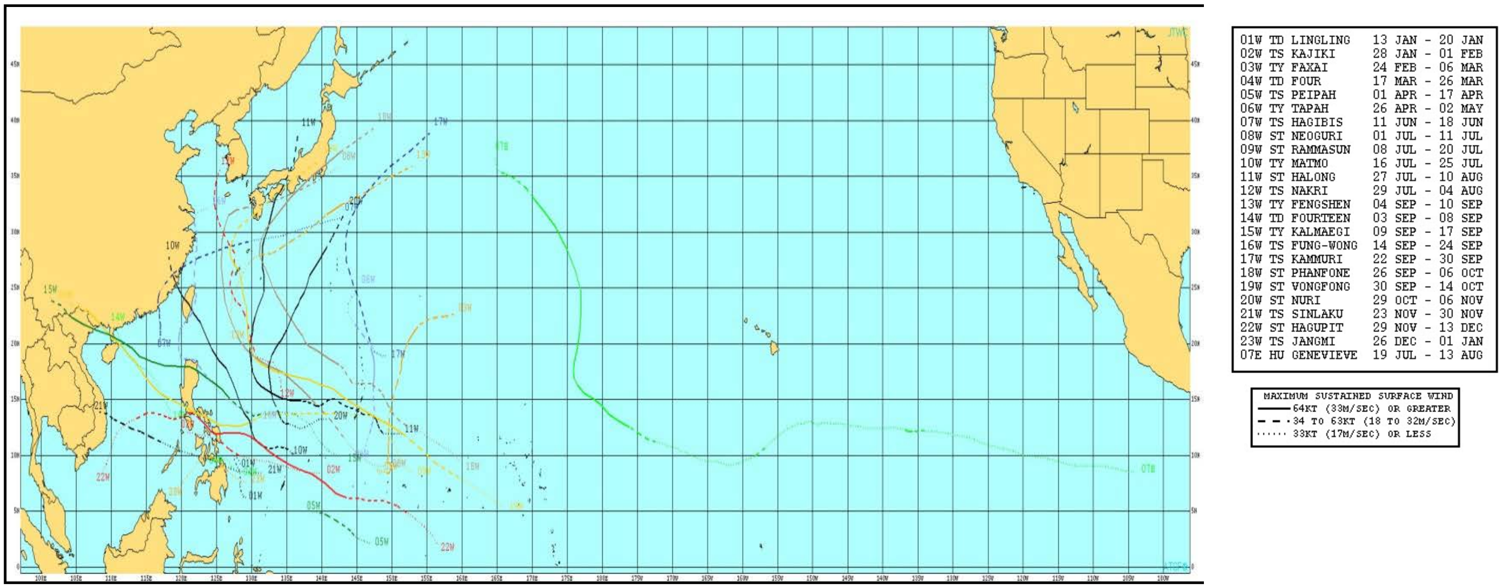



**Figure 1-4.** Western North Pacific Tropical Cyclones 01W – 23W and 07E.

## Section 2 Cyclone Summaries

This section presents a synopsis of each cyclone that occurred during 2014 in the western North Pacific Ocean. Each cyclone is presented, with the number and basin identifier used by JTWC, along with the name assigned by Regional Specialized Meteorological Center (RSMC) Tokyo.

Dates are also listed when JTWC first designated various stages of pre-warning development: LOW, MEDIUM, and HIGH (concurrent with TCFA). These classifications are defined as follows:

"Low" formation potential describes an area that is being monitored for development, but is unlikely to develop within the next 24 hours.

"Medium" formation potential describes an area that is being monitored for development and has an elevated potential to develop, but development will likely occur beyond 24 hours.

"High" formation potential describes an area that is being monitored for development and is either expected to develop within 24 hours or development has already started, but warning criteria have not yet been met. All areas designated as "High" are accompanied by a Tropical Cyclone Formation Alert (TCFA).

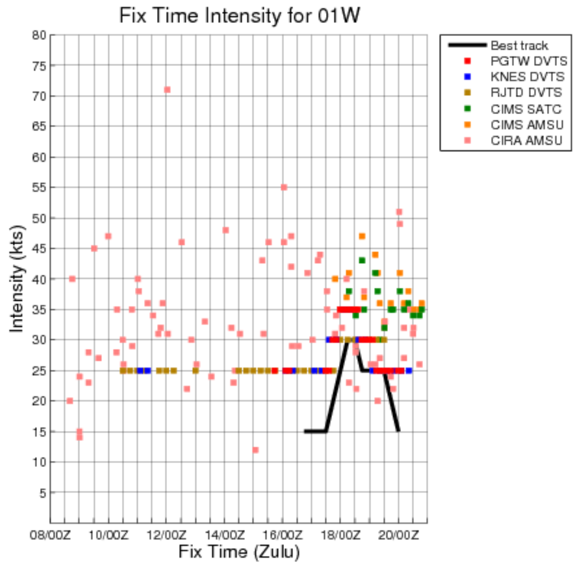
Initial and final JTWC warning dates are also presented with the number of warnings issued by JTWC. Landfall over major land masses with approximate locations is presented as well.

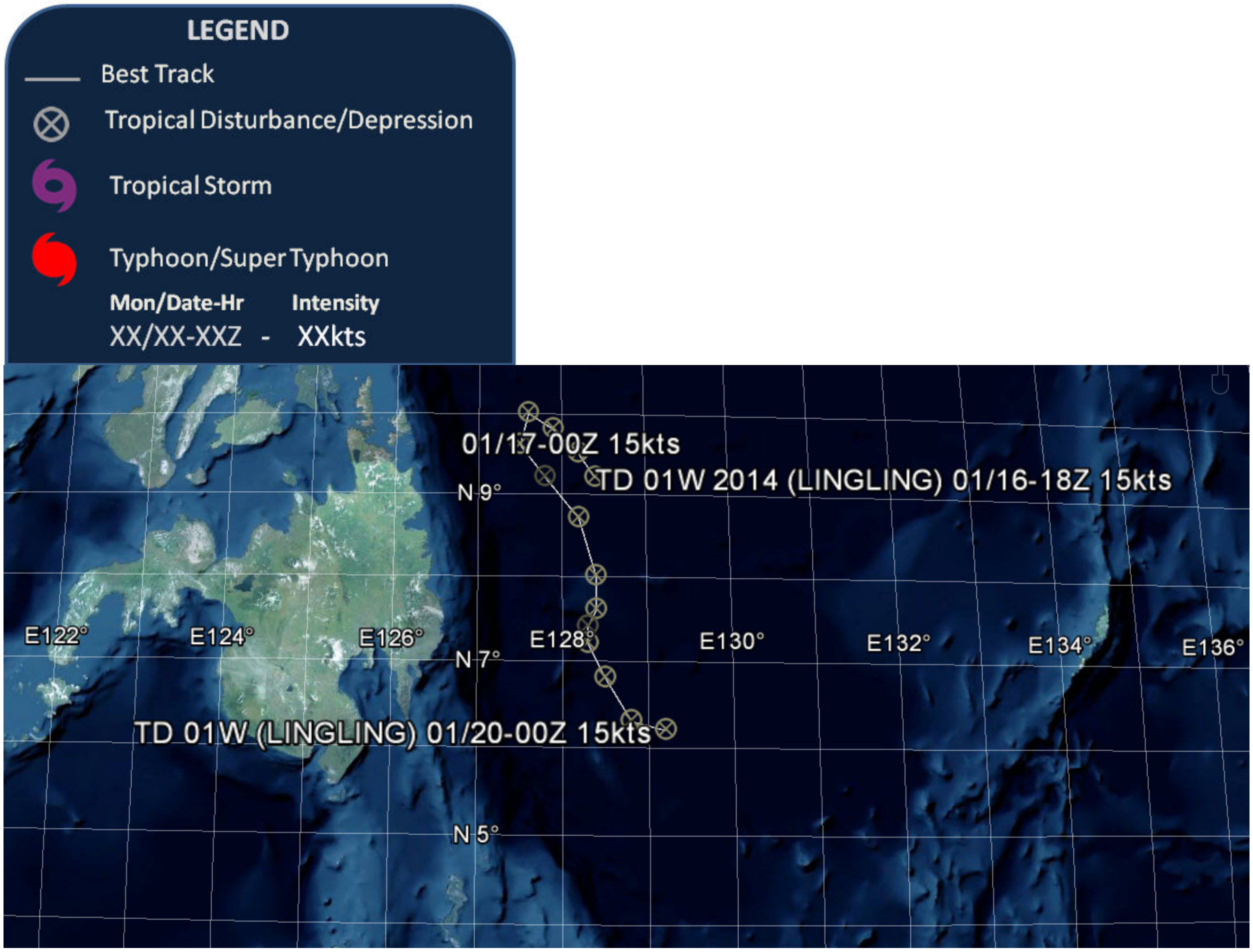
The JTWC post-event reanalysis best track is also provided for each cyclone. Data included on the best track are position and intensity noted with cyclone symbols and color coded track. Best track position labels include the date-time, track speed in knots, and maximum wind speed in knots. A graph of best track intensity and fix intensity versus time is presented. The fix plots on this graph are color coded by fixing agency.

In addition, if this document is viewed as a pdf, each map has been hyperlinked to the appropriate keyhole markup language (kmz) file that will allow the reader to access and view the best-track data interactively on their computer using Google Earth software. Simply hold the control button and click the map image. The link will open, allowing the reader to download and open the file.
Users may also retrieve kmz files for the entire season from:
http://www.usno.navy.mil/NOOC/nmfc-ph/RSS/jtwc/best_tracks/2014/2014s-KMZs/JTWC_BestTrack_Climatology_2014.kmz

# 01W TROPICAL DEPRESSION LINGLING

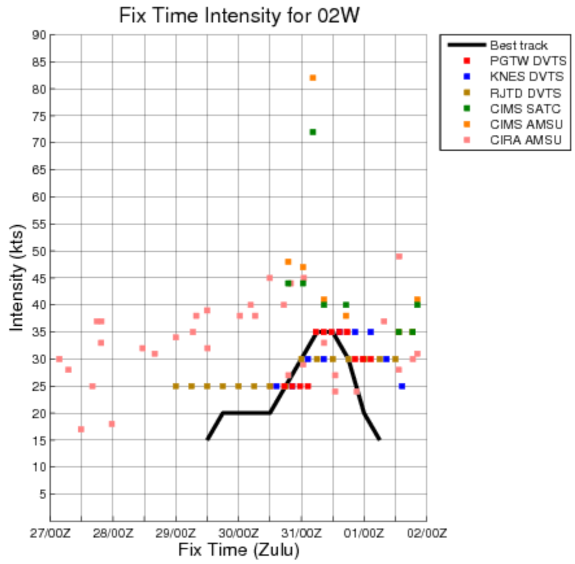
| | |
|---|---|
| ISSUED LOW: | 15 JAN/ 0600Z |
| ISSUED MED: | 16 JAN/ 0600Z |
| FIRST TCFA: | 16 JAN/ 1500Z |
| FIRST WARNING: | 18 JAN/ 0000Z |
| LAST WARNING: | 19 JAN/ 1800Z |
| MAX INTENSITY: | 30 |
| WARNINGS: | 8 |

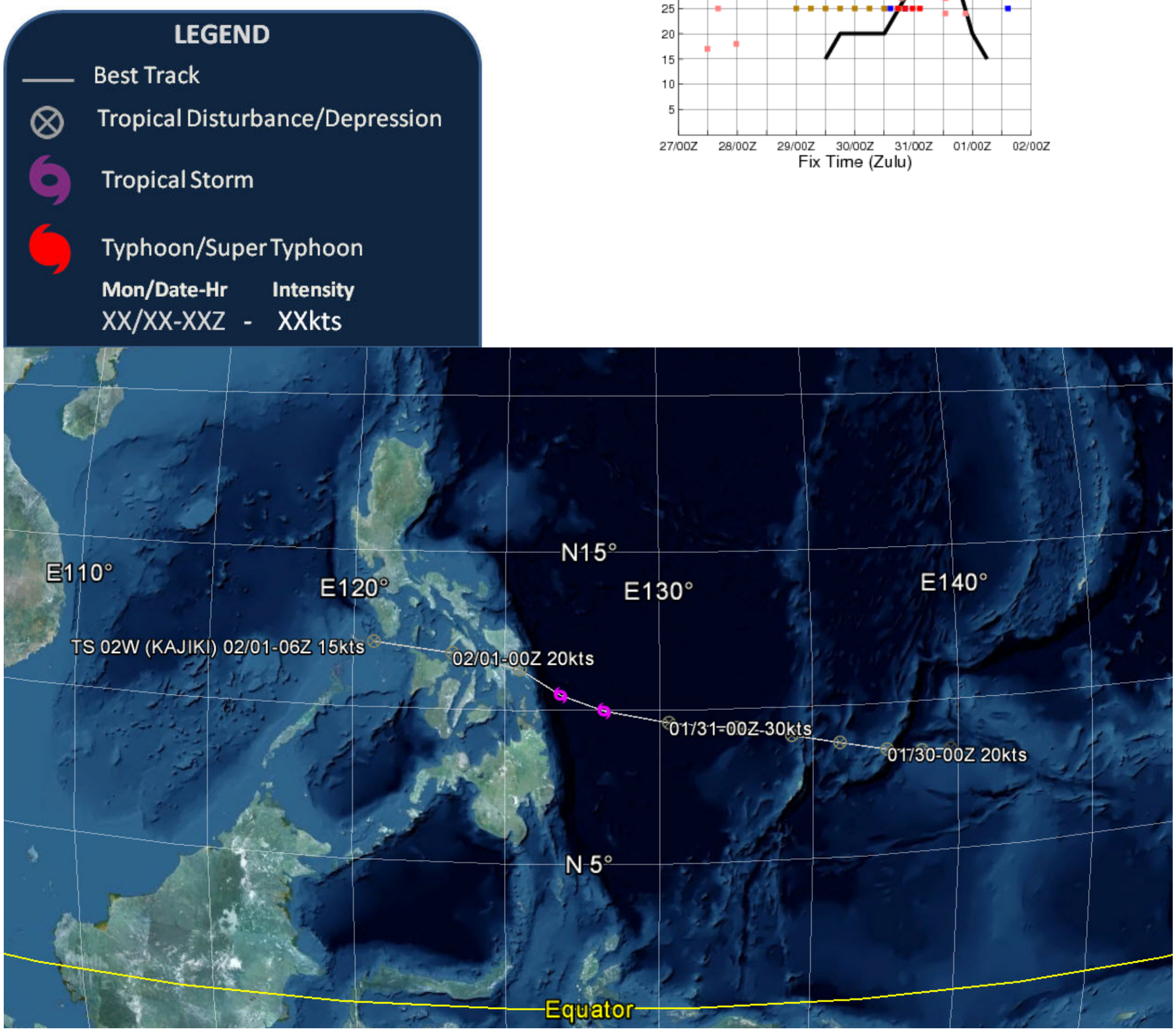


## 02W TROPICAL STORM KAJIKI

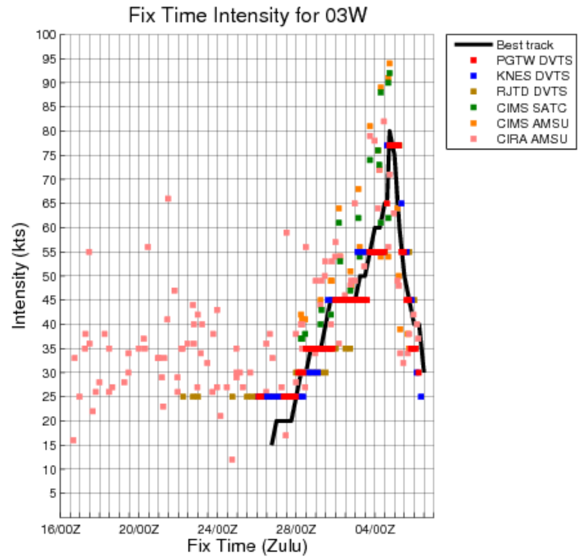
| | |
|---|---|
| ISSUED LOW: | 28 JAN/ 1400Z |
| ISSUED MED: | 29 JAN/ 0300Z |
| FIRST TCFA: | 29 JAN/ 0530Z |
| FIRST WARNING: | 30 JAN/ 1800Z |
| LAST WARNING: | 01 FEB/ 1800Z |
| MAX INTENSITY: | 35 |
| WARNINGS: | 9 |

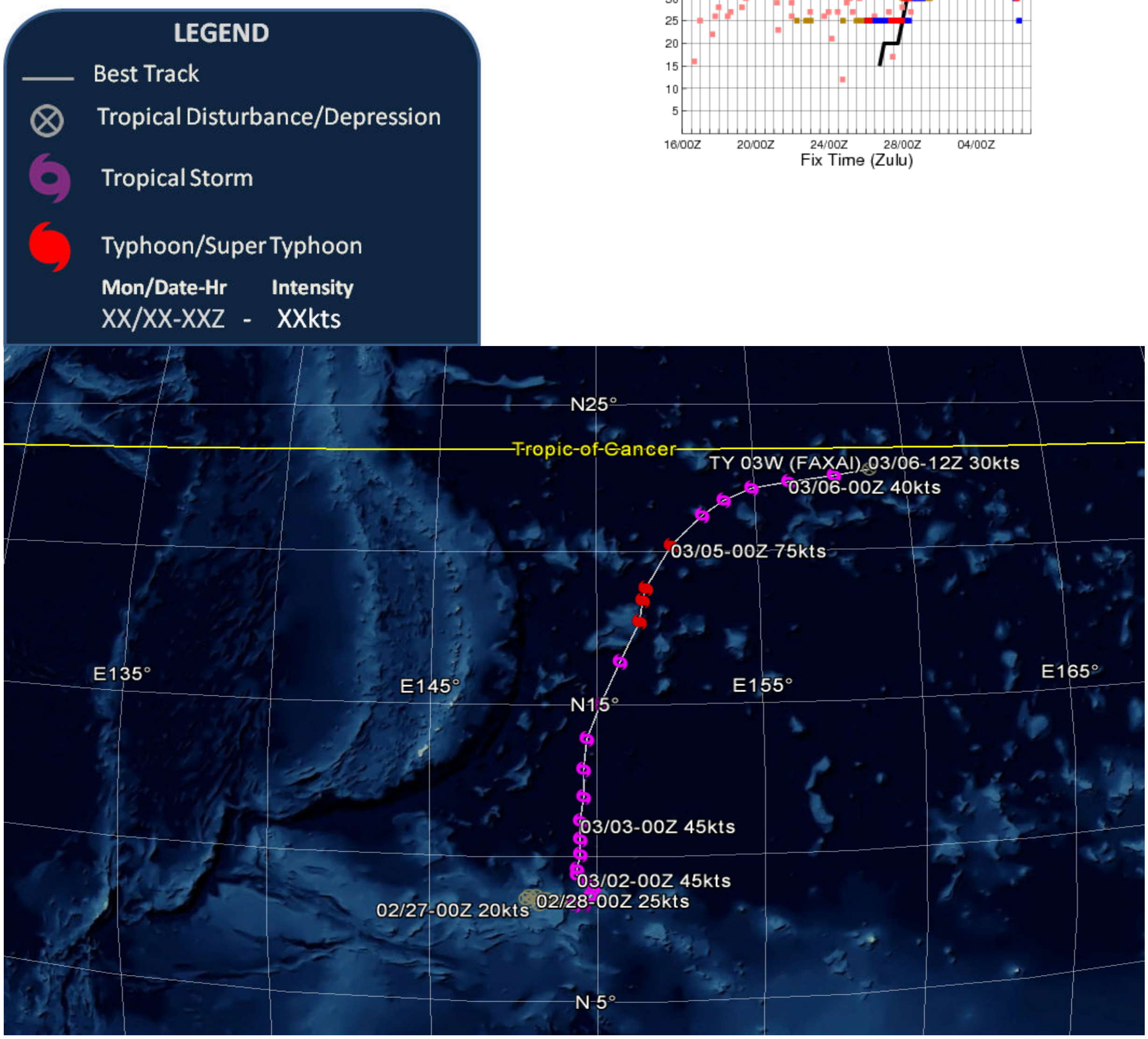


# 03W TYPHOON FAXAI

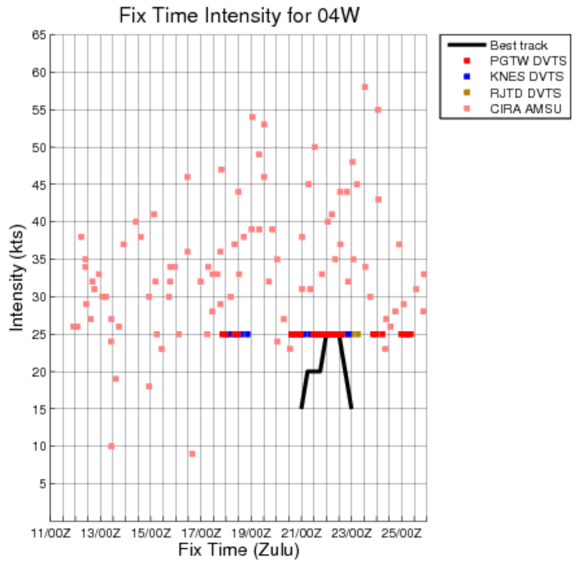
| | |
|---|---|
| ISSUED LOW: | 17 FEB/ 0600Z |
| ISSUED MED: | 25 FEB/ 2000Z |
| FIRST TCFA: | 26 FEB/ 0530Z |
| FIRST WARNING: | 28 FEB/ 0000Z |
| LAST WARNING: | 05 MAR/ 1200Z |
| MAX INTENSITY: | 80 |
| WARNINGS: | 23 |

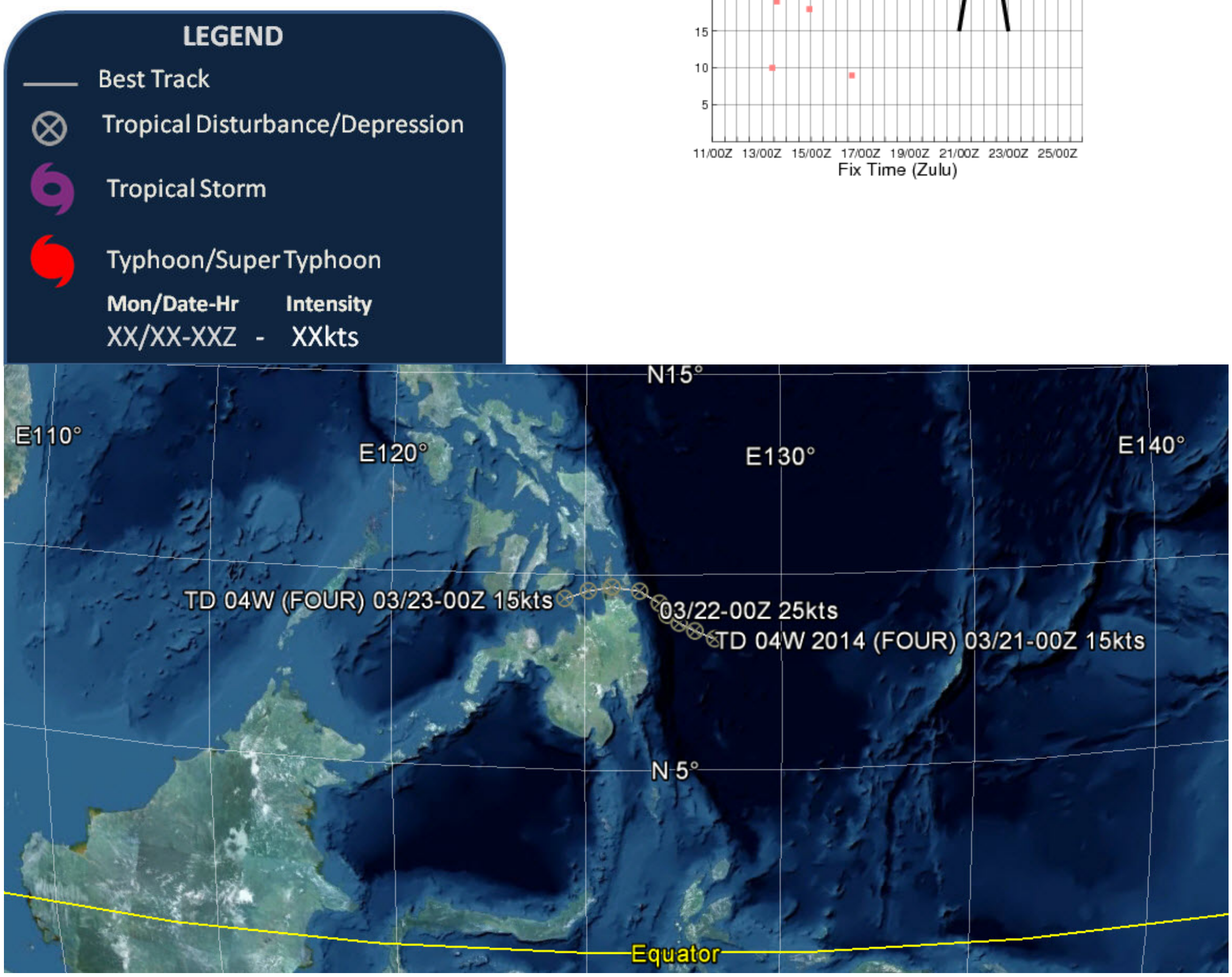


## 04W TROPICAL DEPRESSION FOUR

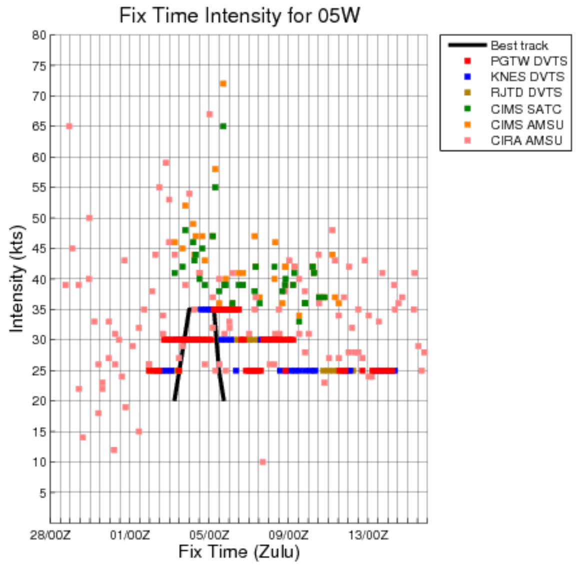
| | |
|---|---|
| ISSUED LOW: | 18 MAR/ 1500Z |
| ISSUED MED: | 20 MAR/ 1500Z |
| FIRST TCFA: | 20 MAR/ 2200Z |
| FIRST WARNING: | 22 MAR/ 0000Z |
| LAST WARNING: | 22 MAR/ 1800Z |
| MAX INTENSITY: | 25 |
| WARNINGS: | 4 |

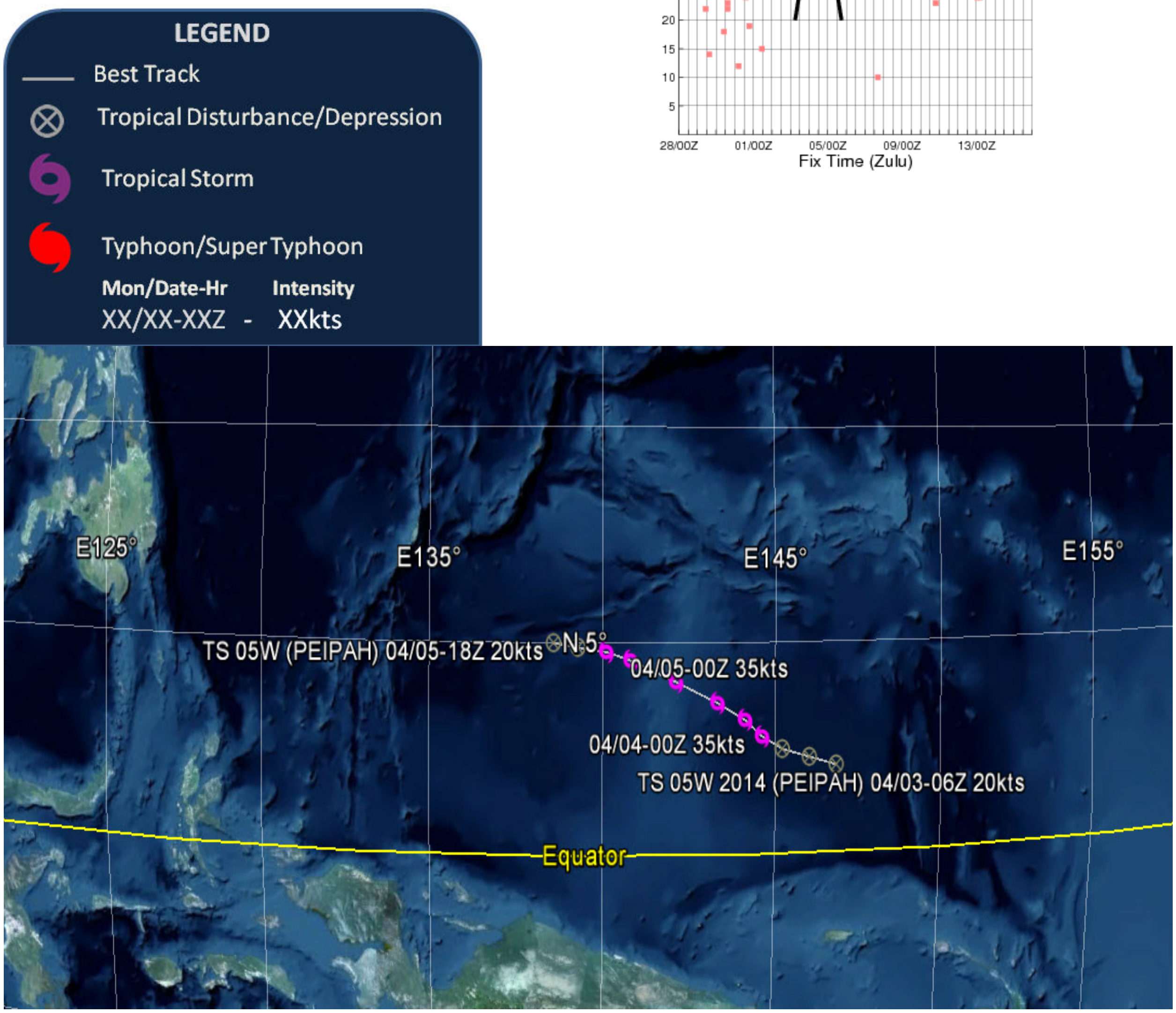


## 05W TROPICAL STORM PEIPAH

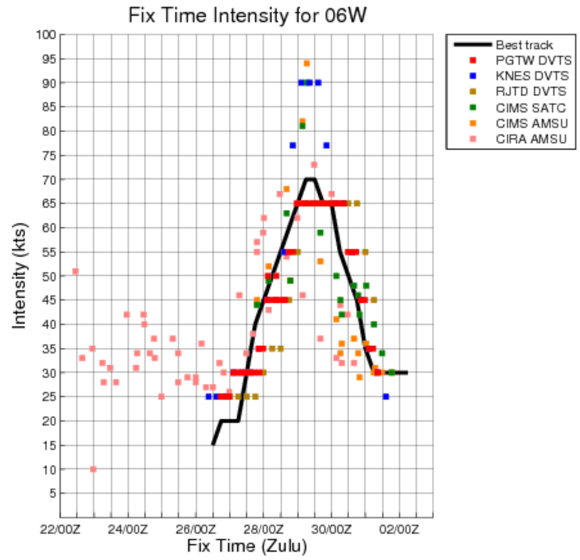
| | |
|---|---|
| ISSUED LOW: | 29 MAR/ 0830Z |
| ISSUED MED: | 02 APR/ 0600Z |
| FIRST TCFA: | 02 APR/ 2000Z |
| FIRST WARNING: | 03 APR/ 0000Z |
| LAST WARNING: | 10 APR/ 0600Z |
| MAX INTENSITY: | 35 |
| WARNINGS: | 30 |

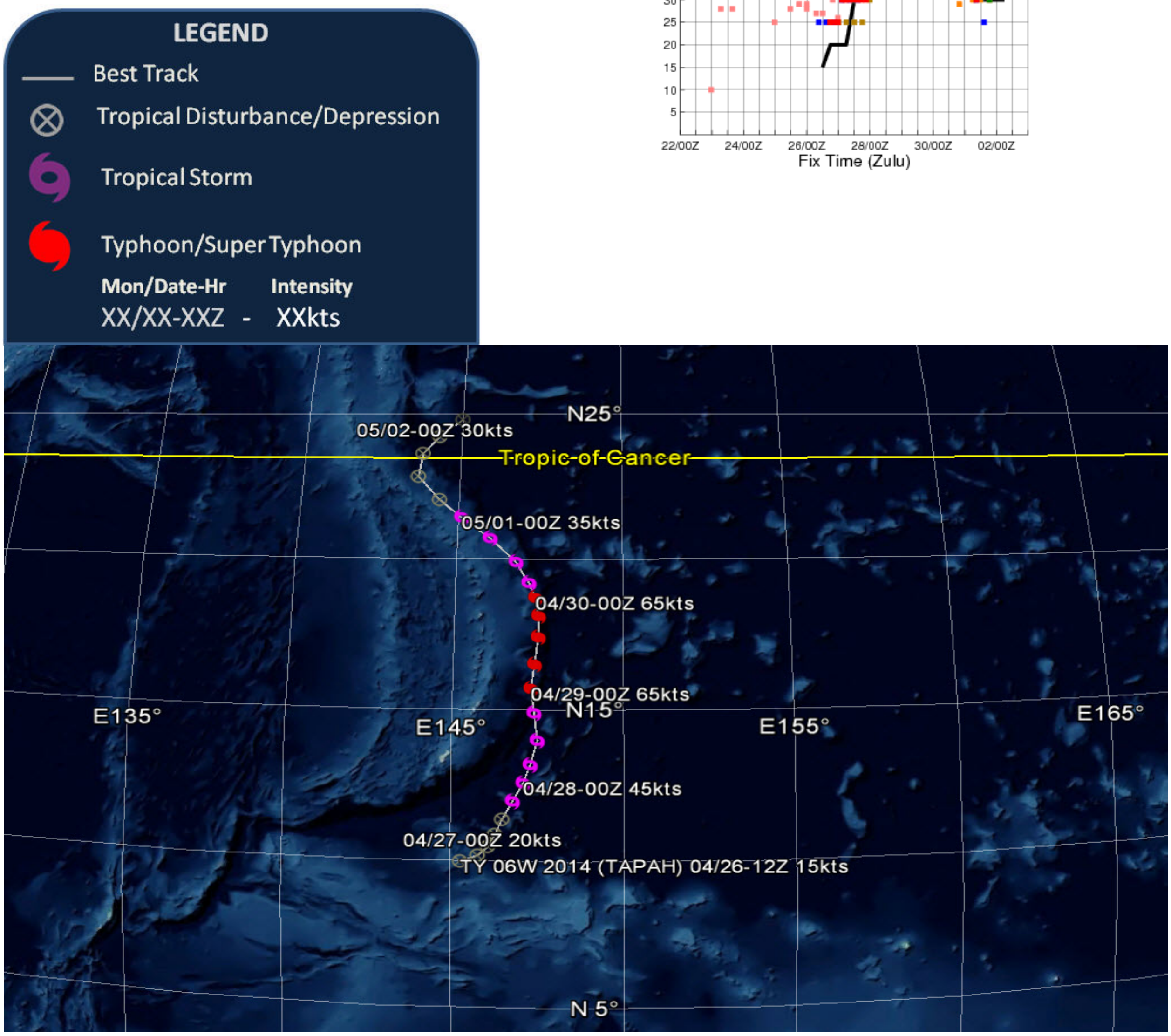


## 06W TYPHOON TAPAH

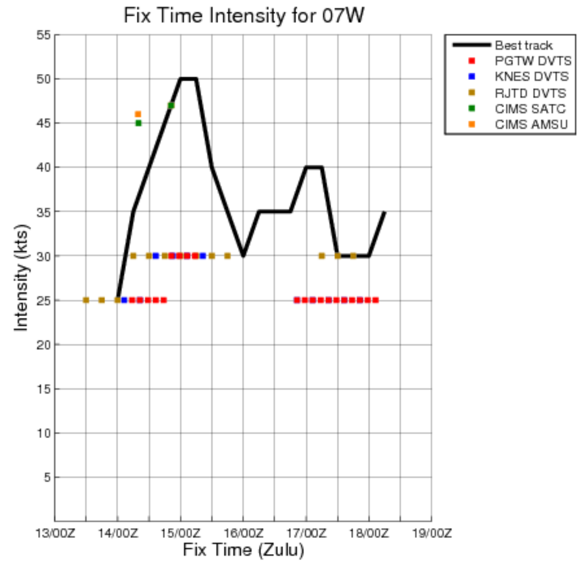
| | |
|---|---|
| ISSUED LOW: | 23 APR/ 2230Z |
| ISSUED MED: | 26 APR/ 1430Z |
| FIRST TCFA: | 27 APR/ 0230Z |
| FIRST WARNING: | 27 APR/ 1200Z |
| LAST WARNING: | 01 MAY/ 0600Z |
| MAX INTENSITY: | 70 |
| WARNINGS: | 16 |

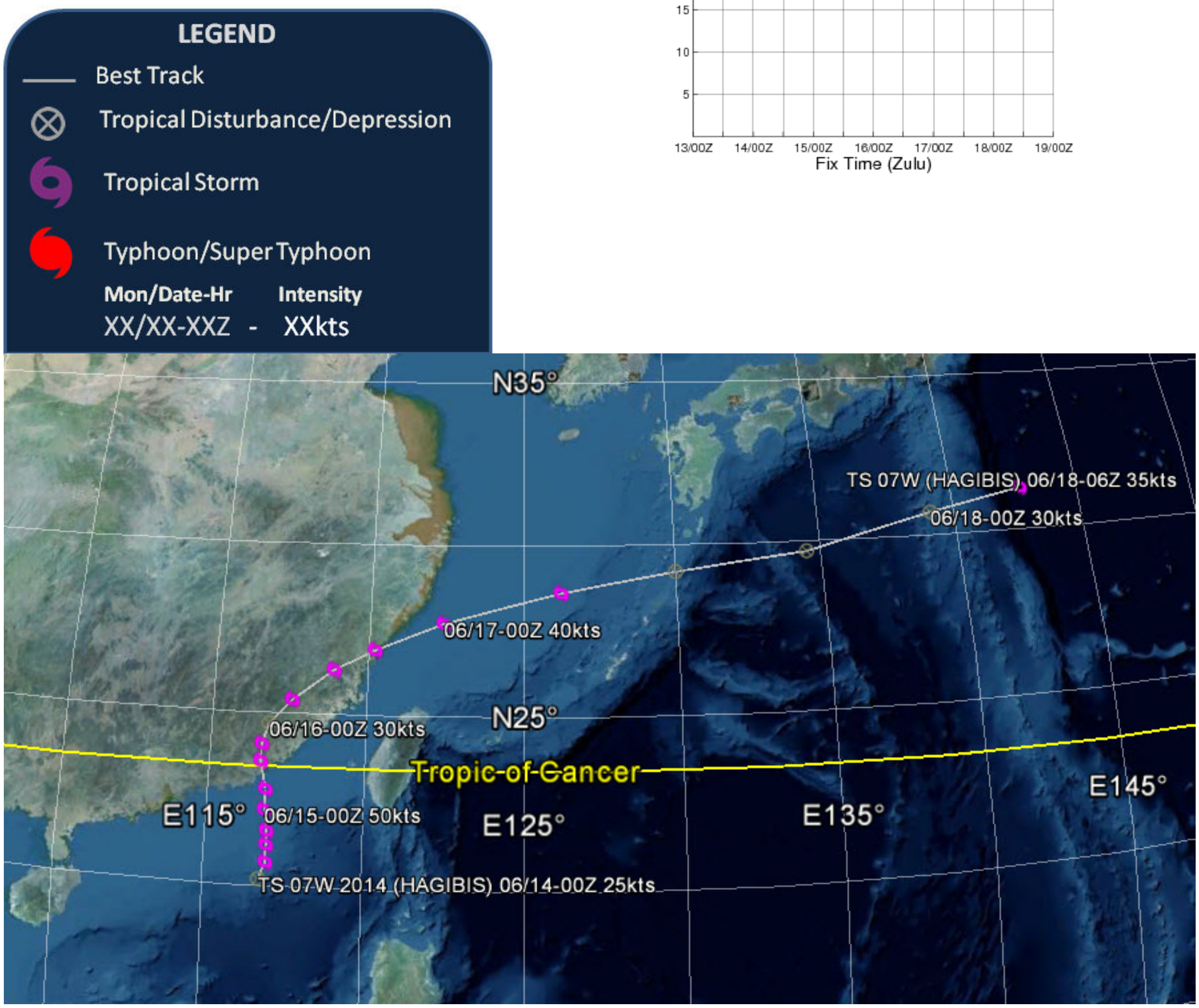


## 07W TROPICAL STORM HAGIBIS

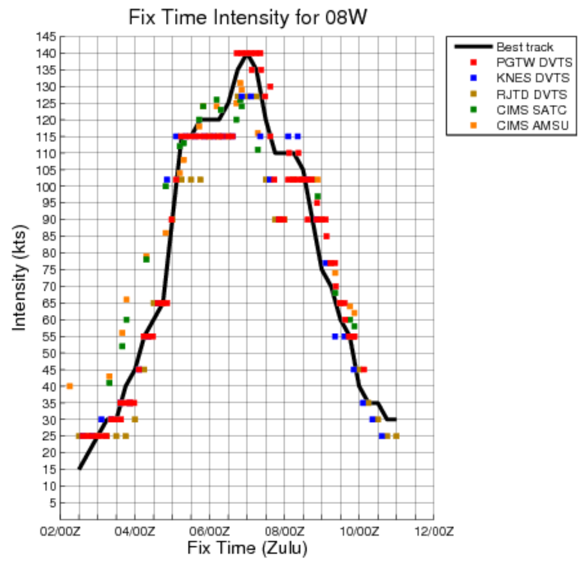
| | |
|---|---|
| ISSUED LOW: | 11 JUN/ 2300Z |
| ISSUED MED: | 13 JUN/ 1900Z |
| FIRST TCFA: | 14 JUN/ 0200Z |
| FIRST WARNING: | 14 JUN/ 0600Z |
| LAST WARNING: | 18 JUN/ 0000Z |
| MAX INTENSITY: | 40 |
| WARNINGS: | 12 |

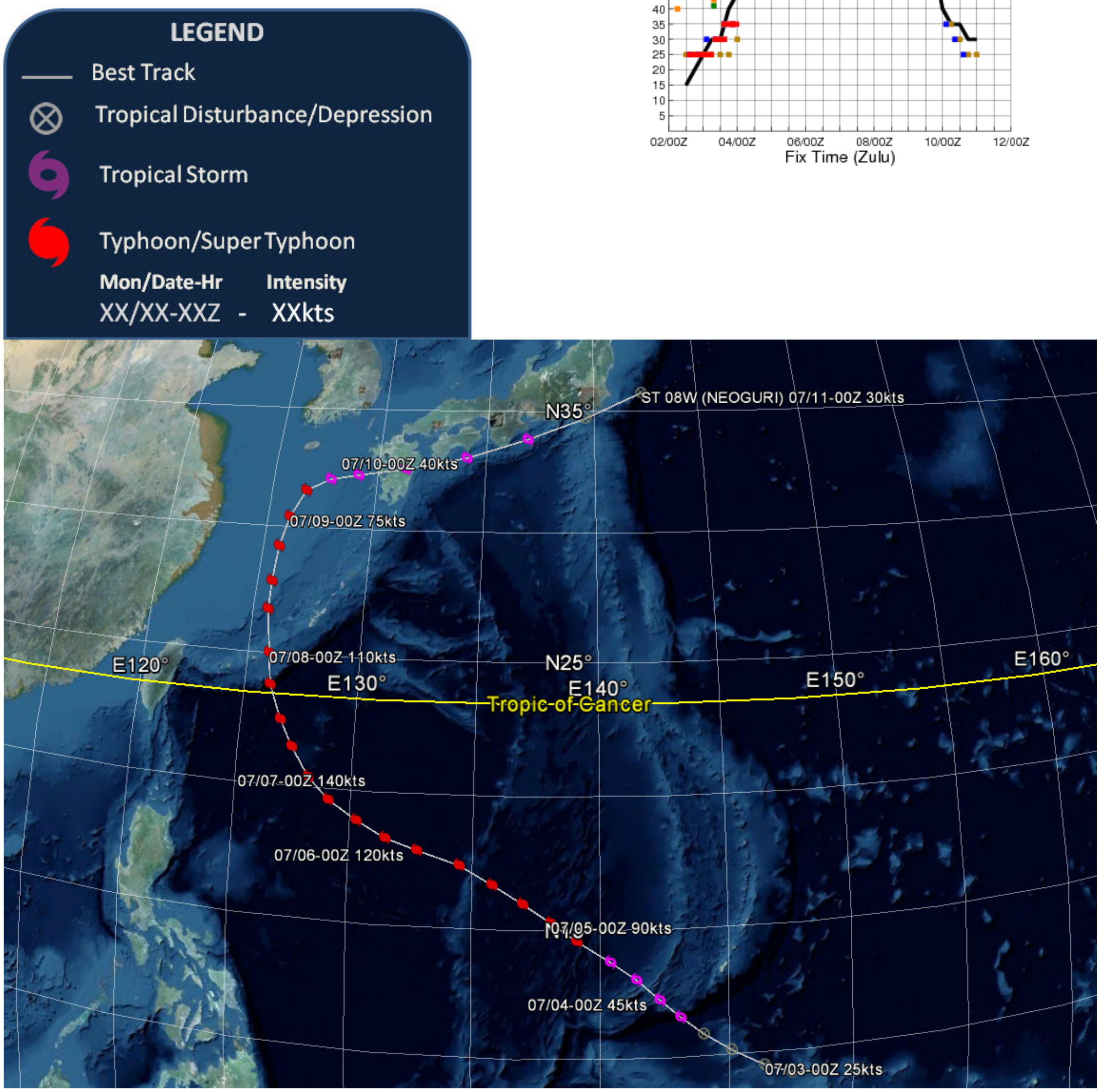


## 08W SUPER TYPHOON NEOGURI

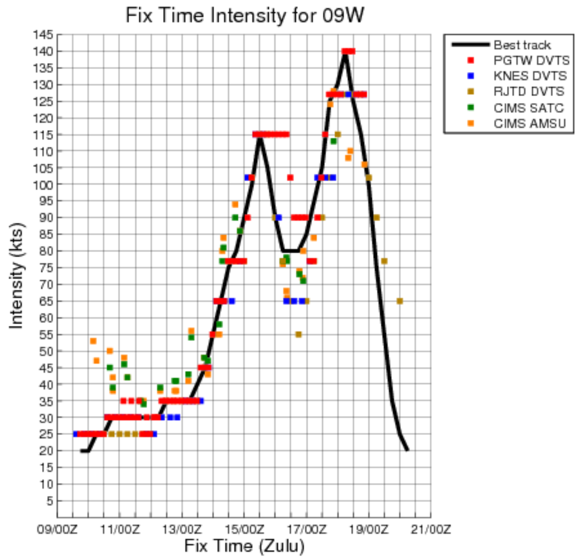
| | |
|---|---|
| ISSUED LOW: | 30 JUN/ 2200Z |
| ISSUED MED: | 01 JUL/ 2000Z |
| FIRST TCFA: | 02 JUL/ 2000Z |
| FIRST WARNING: | 03 JUL/ 0000Z |
| LAST WARNING: | 10 JUL/ 1200Z |
| MAX INTENSITY: | 140 |
| WARNINGS: | 31 |

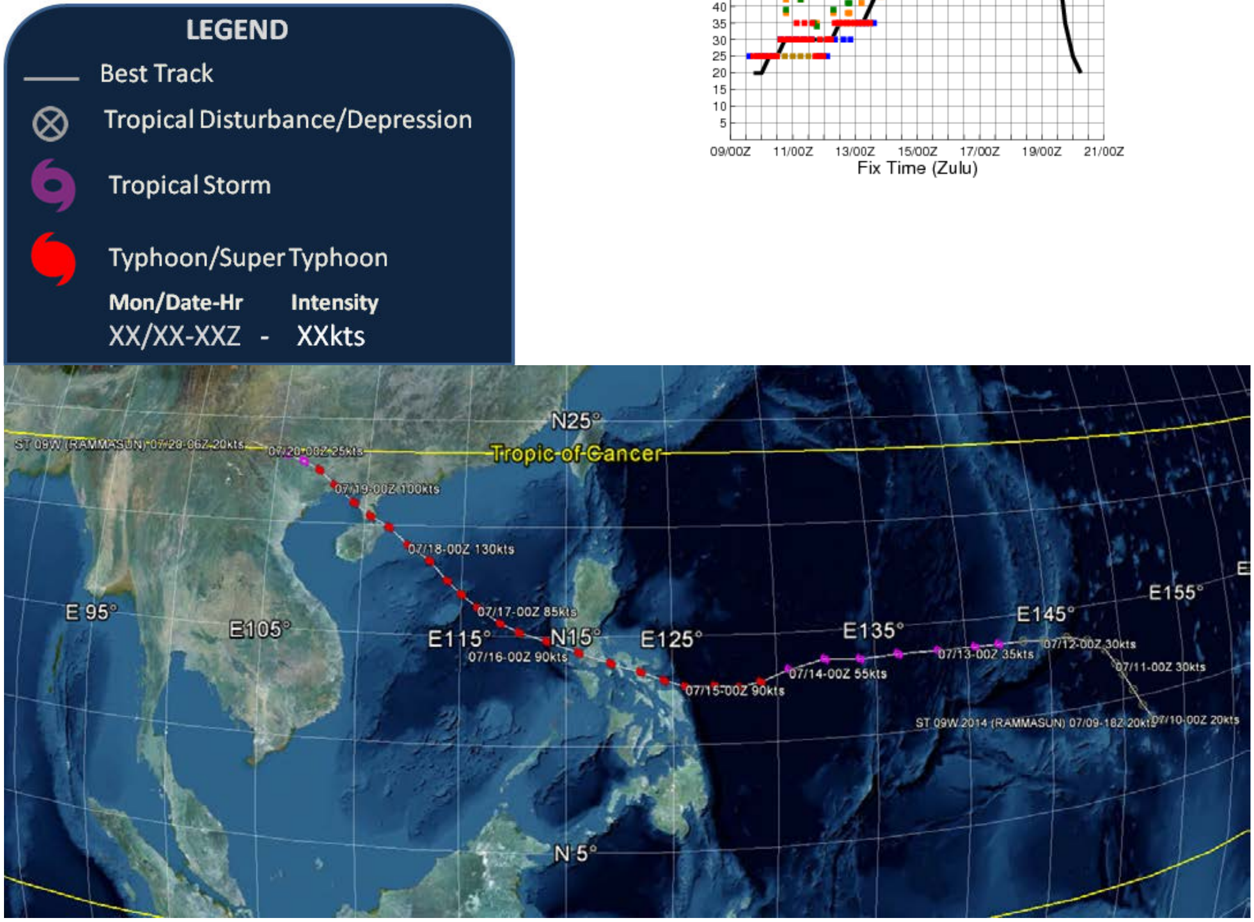


## 09W SUPER TYPHOON RAMMASUN

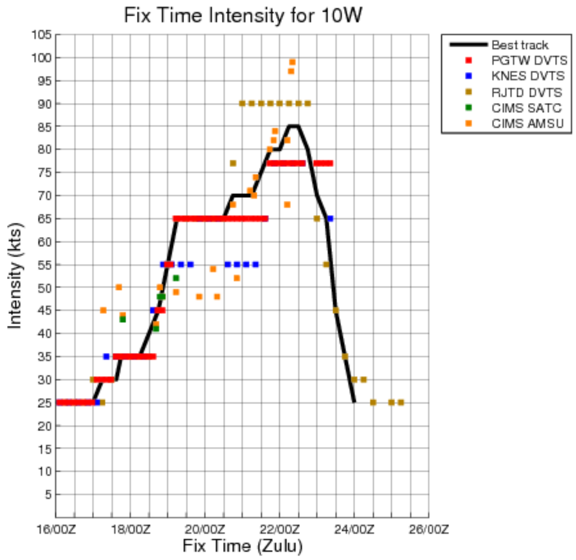
| | |
|---|---|
| ISSUED LOW: | 09 JUL/ 0600Z |
| ISSUED MED: | 10 JUL/ 0130Z |
| FIRST TCFA: | 10 JUL/ 0730Z |
| FIRST WARNING: | 10 JUL/ 1200Z |
| LAST WARNING: | 19 JUL/ 0000Z |
| MAX INTENSITY: | 140 |
| WARNINGS: | 35 |

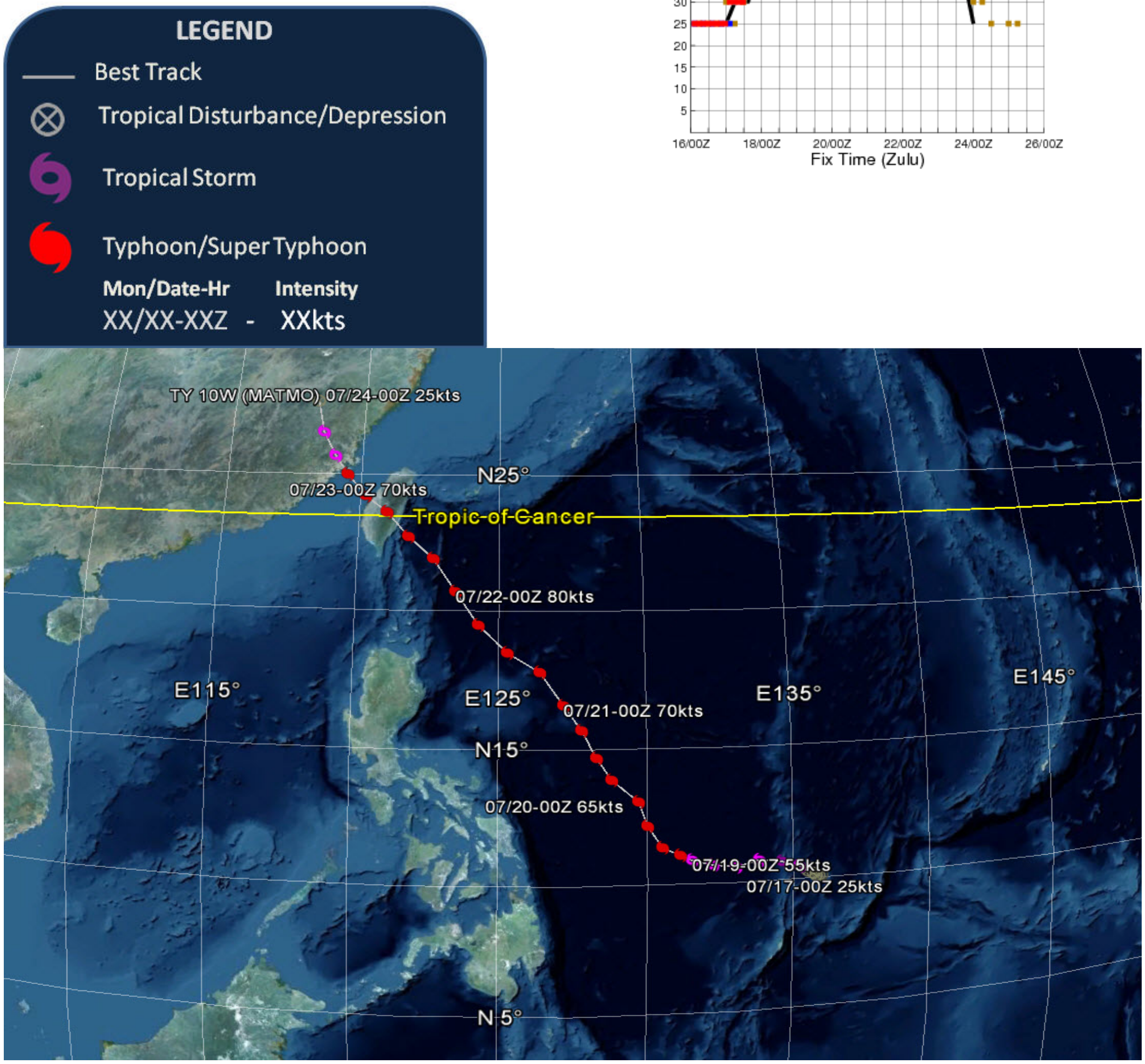


## 10W TYPHOON MATMO

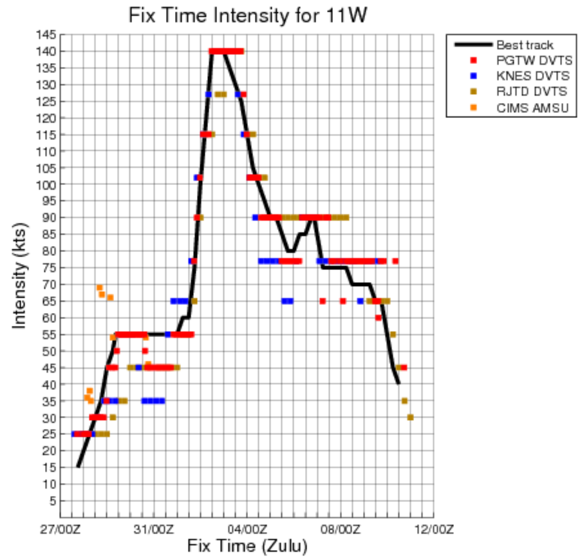
| | |
|---|---|
| ISSUED LOW: | 14 JUL/ 0600Z |
| ISSUED MED: | 16 JUL/ 0600Z |
| FIRST TCFA: | 16 JUL/ 1130Z |
| FIRST WARNING: | 17 JUL/ 1200Z |
| LAST WARNING: | 23 JUL/ 1200Z |
| MAX INTENSITY: | 85 |
| WARNINGS: | 25 |

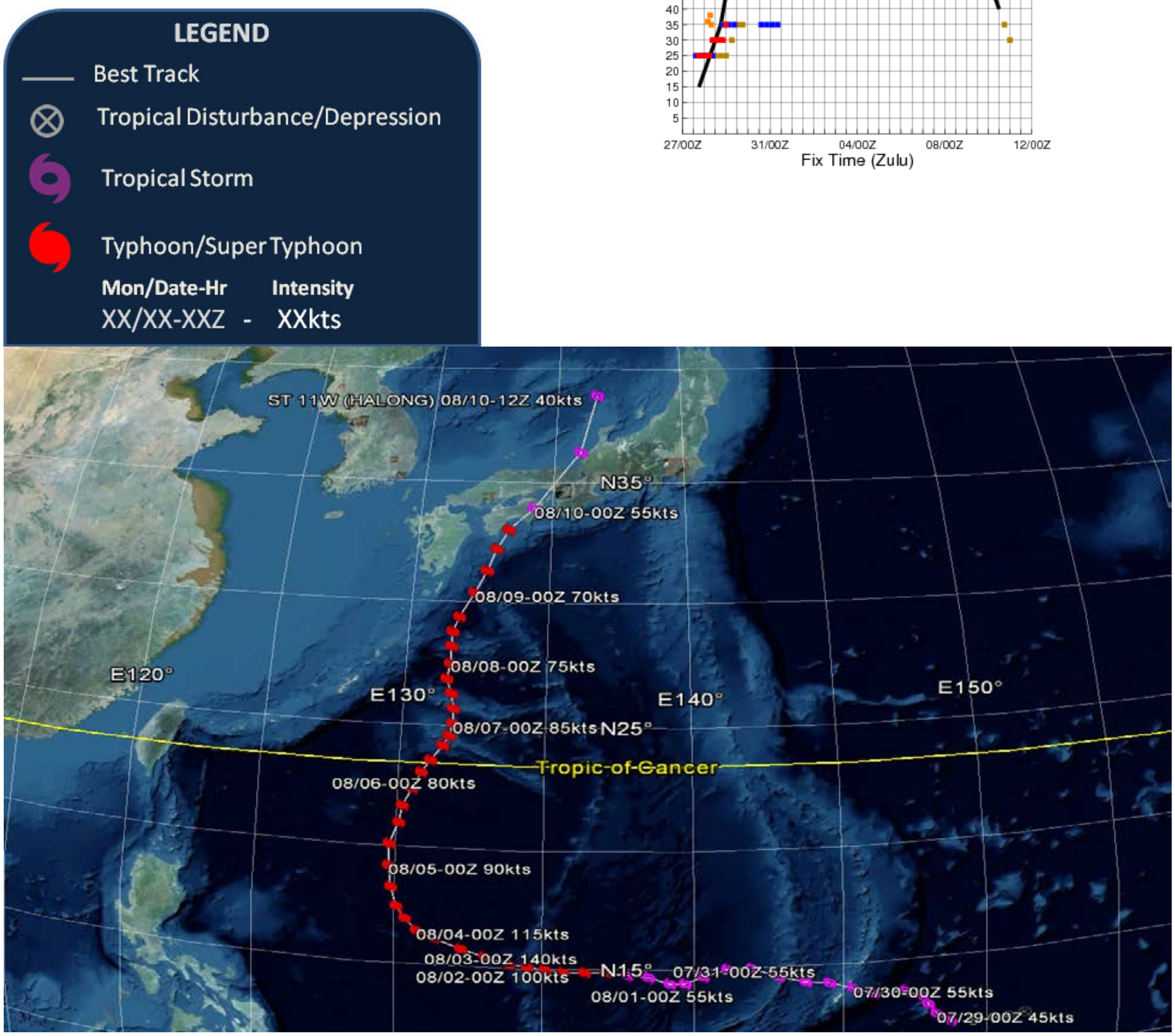


## 11W SUPER TYPHOON HALONG

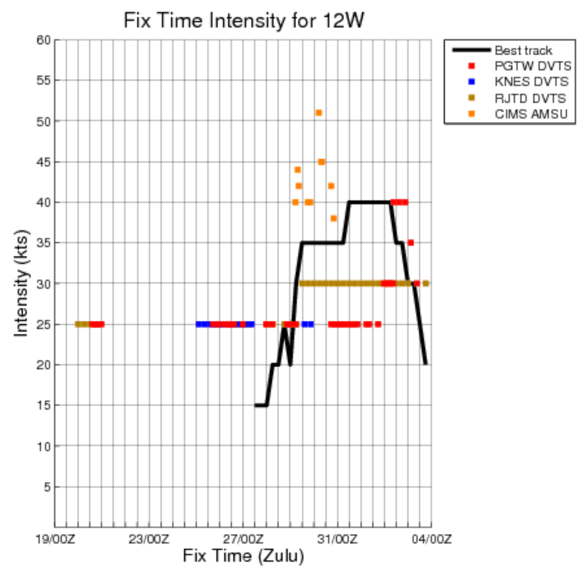
| | |
|---|---|
| ISSUED LOW: | 26 JUL/ 0600Z |
| ISSUED MED: | 27 JUL/1730Z |
| FIRST TCFA: | 28 JUL/ 0100Z |
| FIRST WARNING: | 28 JUL/ 1200Z |
| LAST WARNING: | 10 AUG/ 0000Z |
| MAX INTENSITY: | 140 |
| WARNINGS: | 51 |

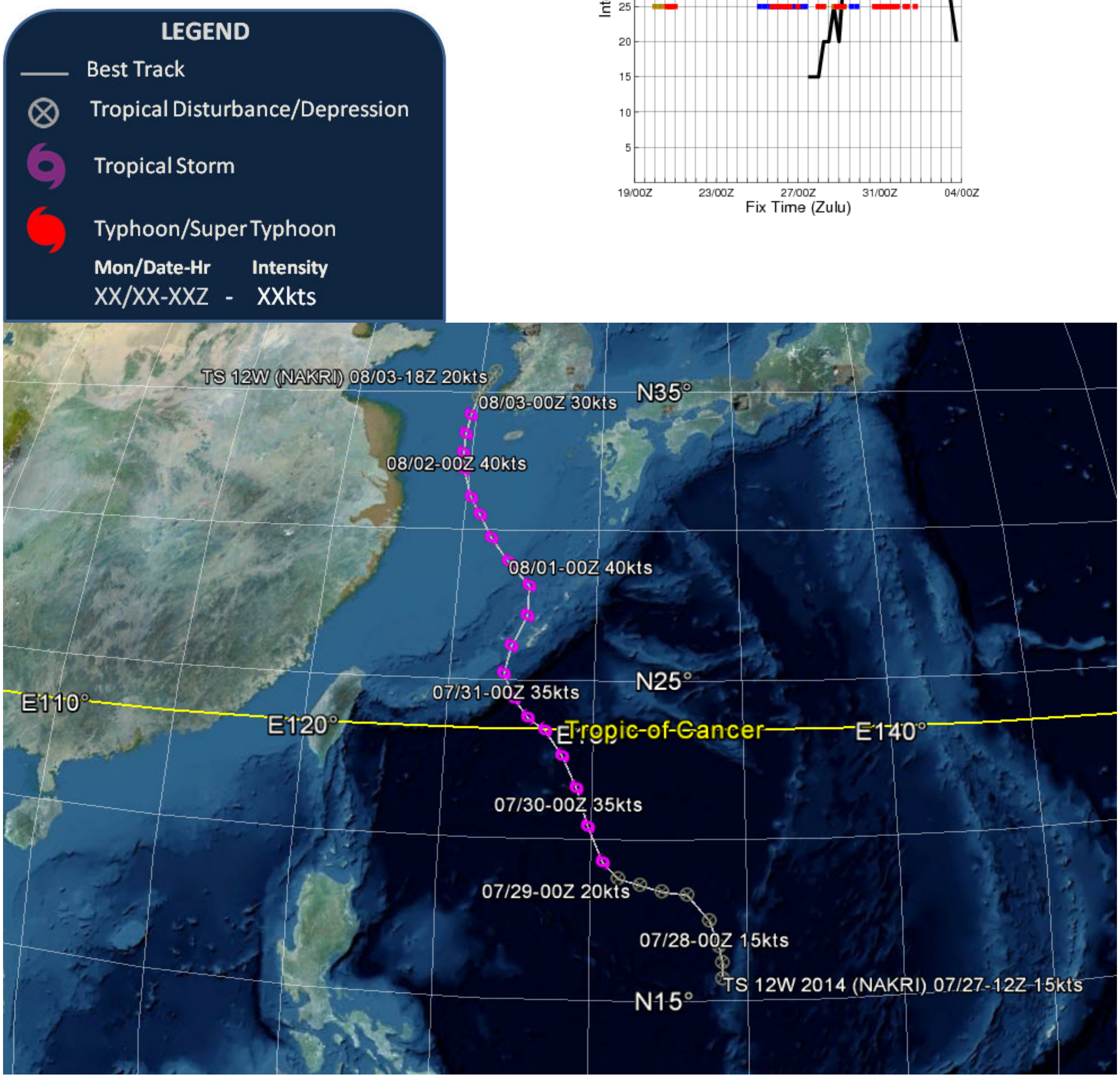


## 12W TROPICAL STORM NAKRI

| | |
|---|---|
| ISSUED LOW: | 19 JUL/ 0600Z |
| ISSUED MED: | 19 JUL/ 1400Z |
| FIRST TCFA: | 02 AUG/ 0530Z |
| FIRST WARNING: | 02 AUG/ 0600Z |
| LAST WARNING: | 03 AUG/ 1800Z |
| MAX INTENSITY: | 40 |
| WARNINGS: | 7 |

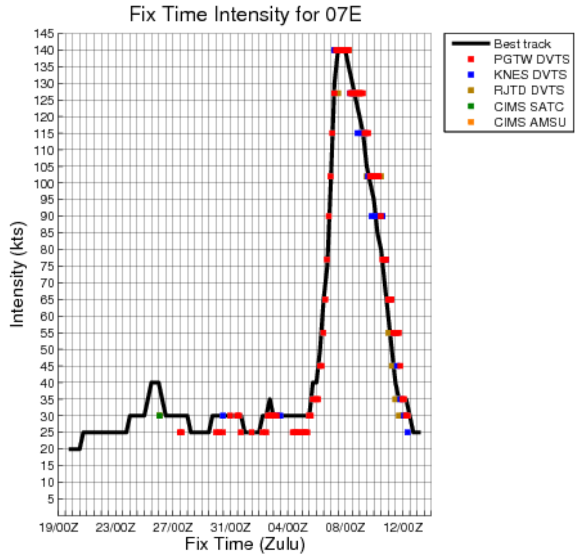


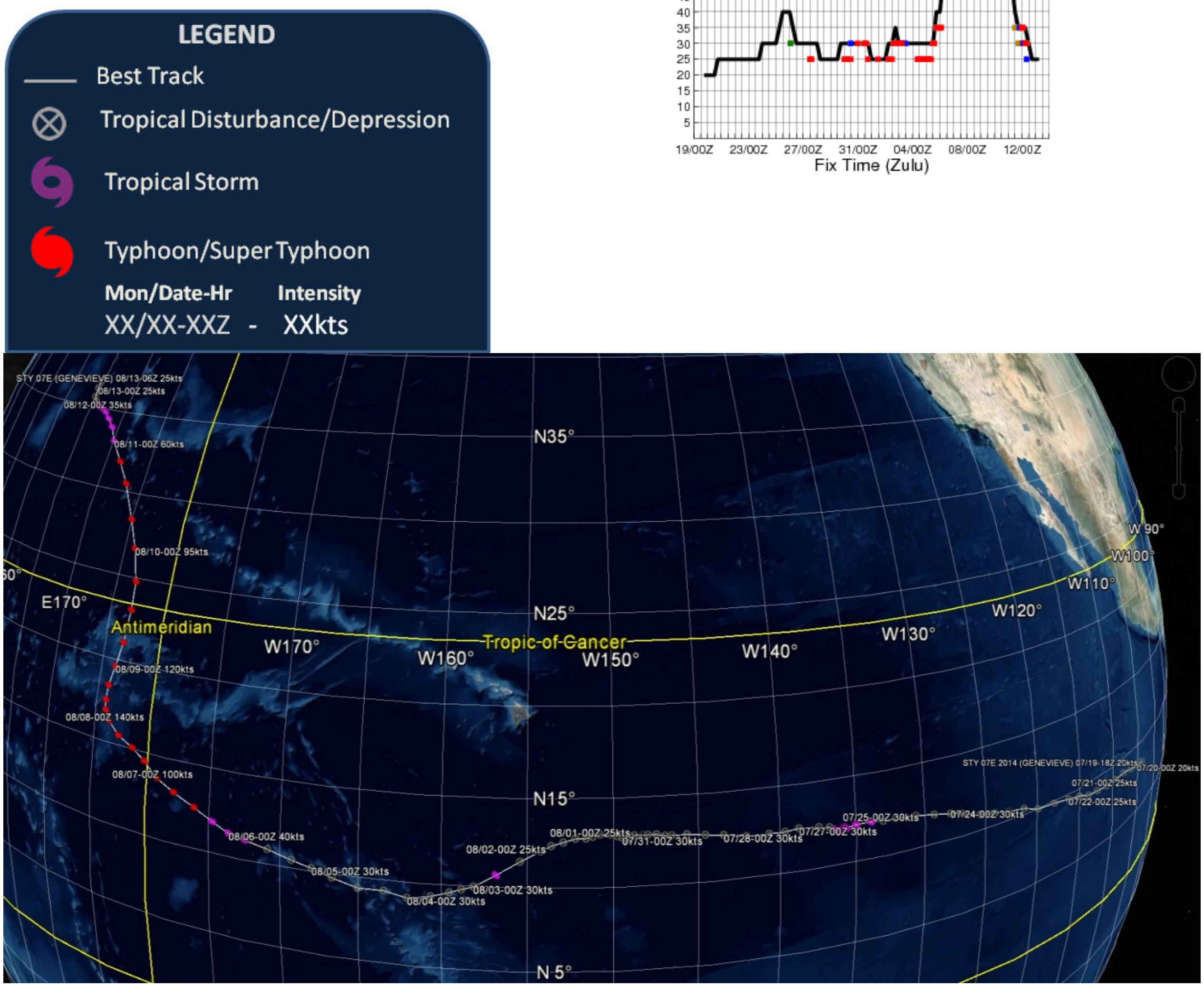



# 07E SUPER TYPHOON GENEVIEVE

(Assumed from CPHC 07 AUG/ 0600z)

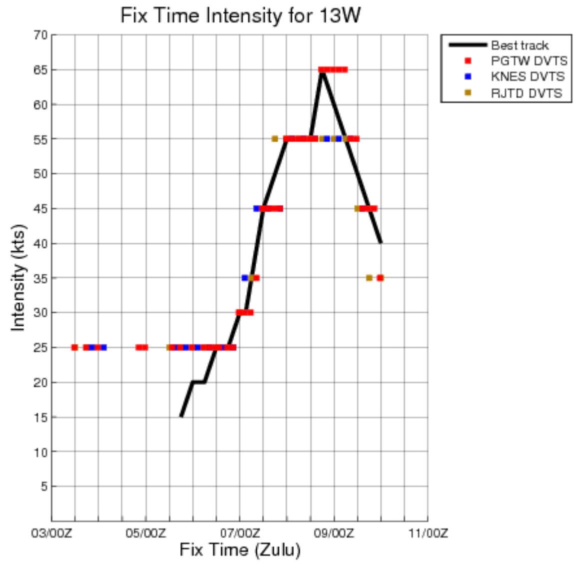
| | |
|---|---|
| ISSUED LOW: | N/A |
| ISSUED MED: | N/A |
| FIRST TCFA: | N/A |
| FIRST WARNING: | 07 AUG/ 0600Z |
| LAST WARNING: | 11 AUG/ 1800Z |
| MAX INTENSITY: | 140 |
| WARNINGS: | 19 |

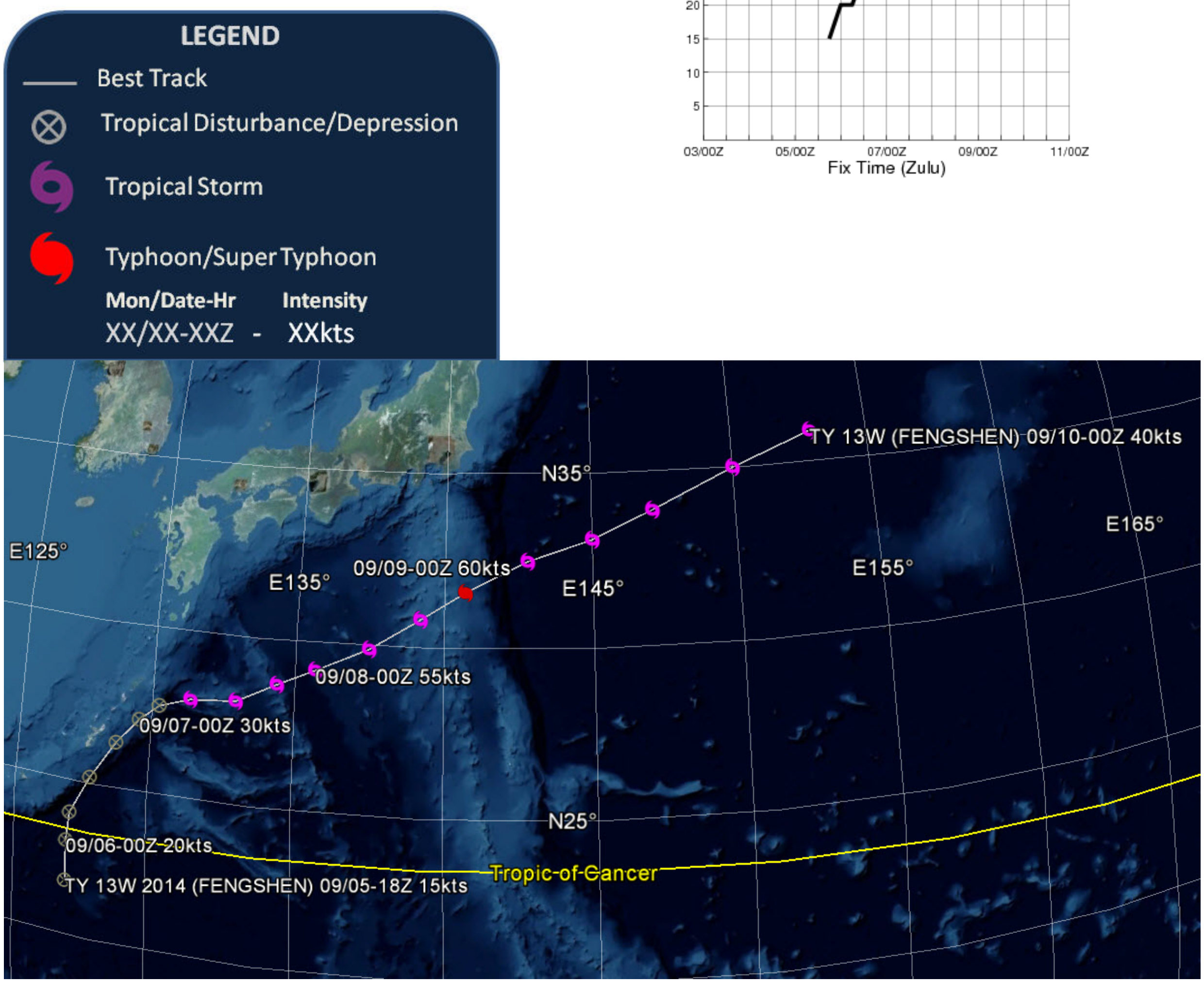


## 13W TYPHOON FENGSHEN

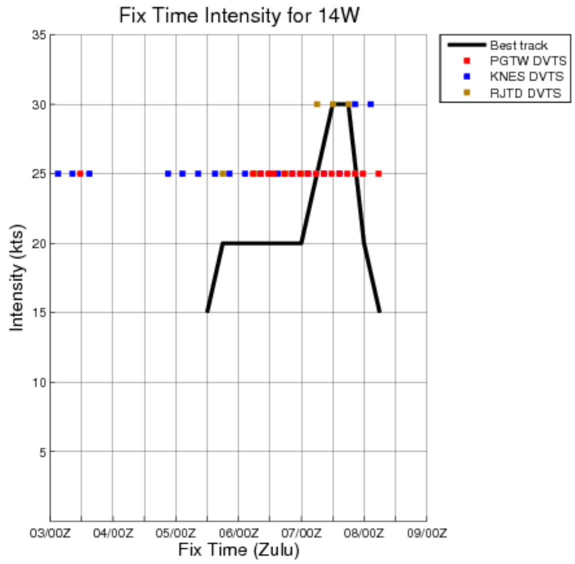
| | |
|---|---|
| ISSUED LOW: | 03 SEP/ 0600Z |
| ISSUED MED: | 04 SEP/ 2200Z |
| FIRST TCFA: | 06 SEP/ 0200Z |
| FIRST WARNING: | 07 SEP/ 0000Z |
| LAST WARNING: | 09 SEP/ 1200Z |
| MAX INTENSITY: | 65 |
| WARNINGS: | 11 |

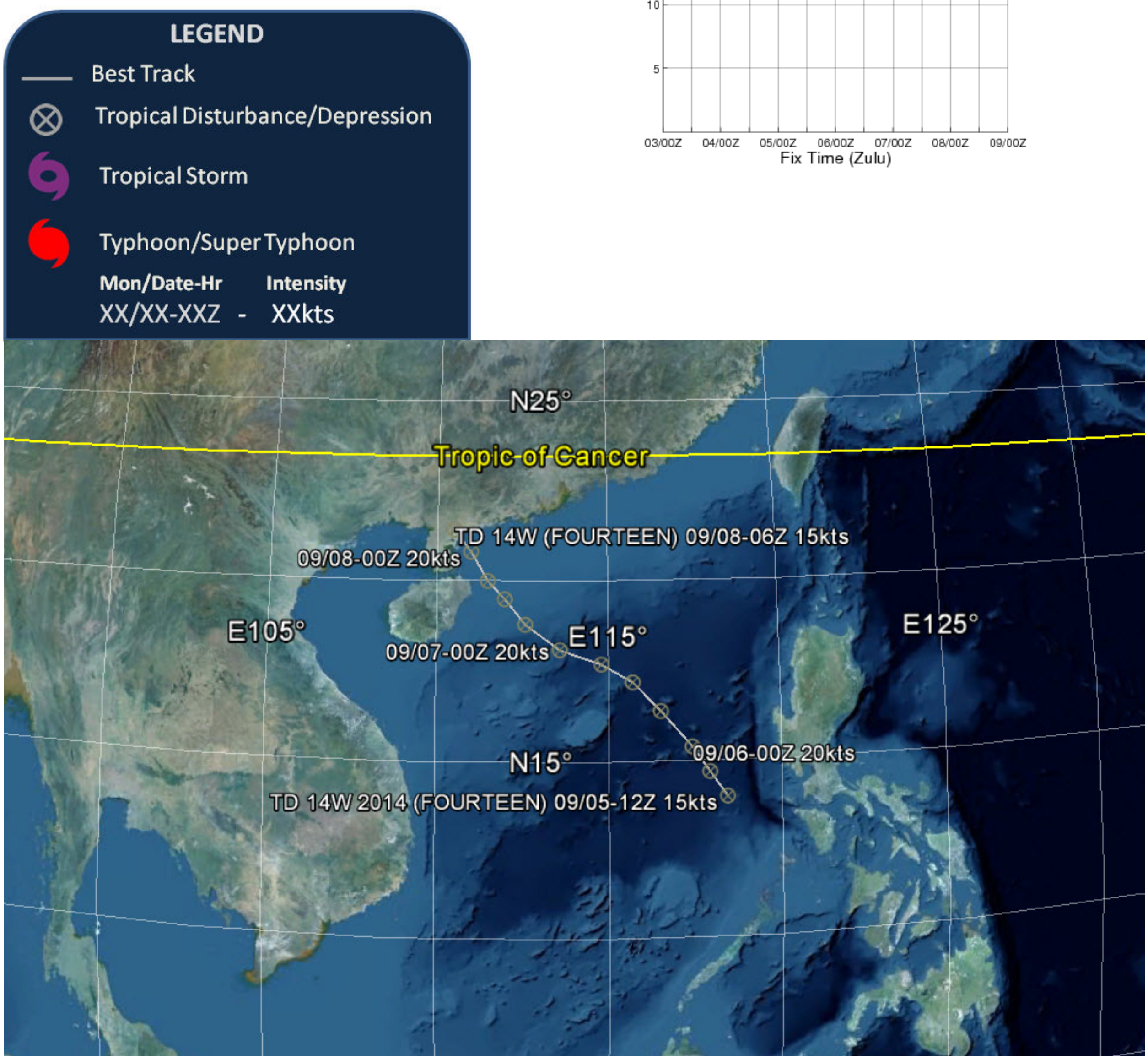


## 14W TROPICAL DEPRESSION FOURTEEN

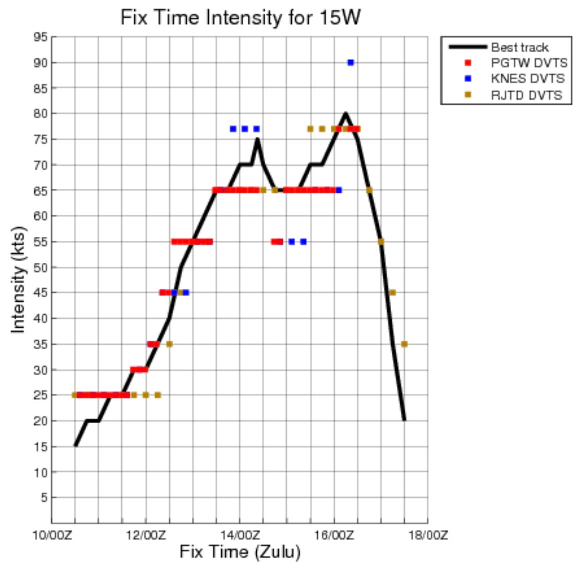
| | |
|---|---|
| ISSUED LOW: | 31 AUG/ 1300Z |
| ISSUED MED: | 05 SEP/ 2030Z |
| FIRST TCFA: | 06 SEP/ 0730Z |
| FIRST WARNING: | 07 SEP/ 0600Z |
| LAST WARNING: | 08SEP/ 0000Z |
| MAX INTENSITY: | 30 |
| WARNINGS: | 4 |

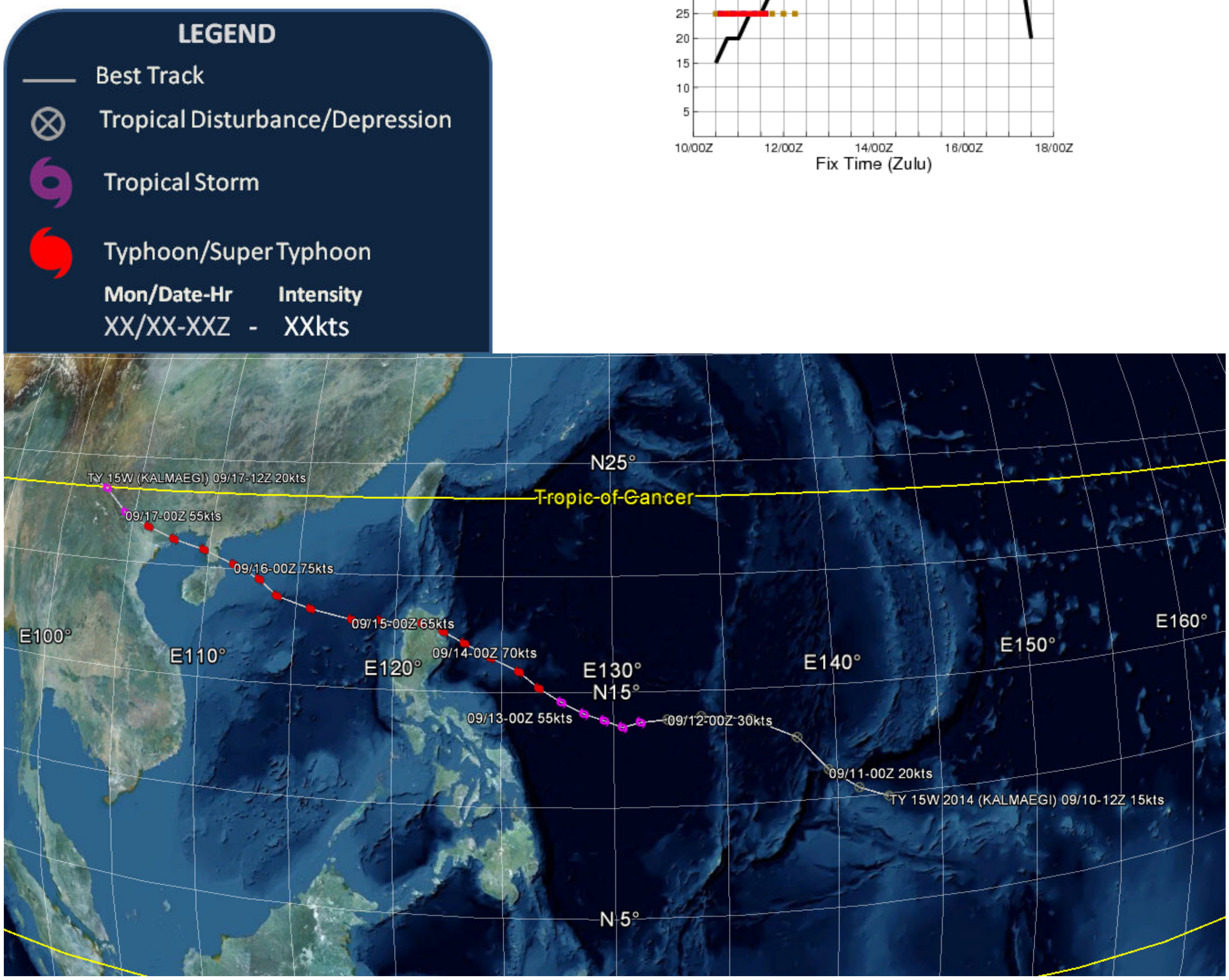


# 15W TYPHOON KALMAEGI

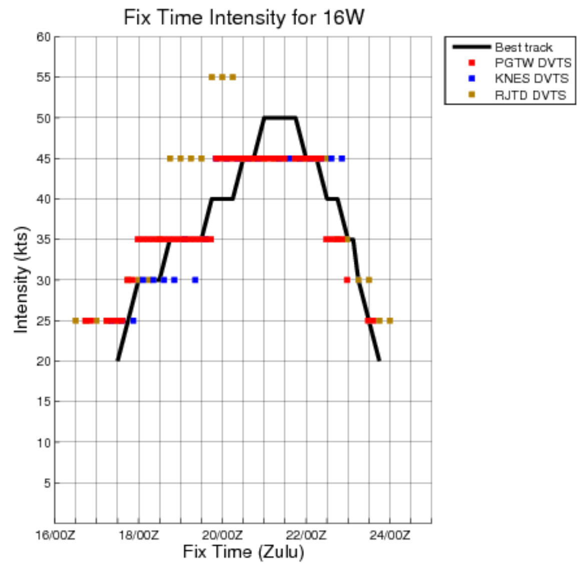
| | |
|---|---|
| ISSUED LOW: | 10 SEP/ 0600Z |
| ISSUED MED: | 10 SEP/ 1400Z |
| FIRST TCFA: | 10 SEP/ 1700Z |
| FIRST WARNING: | 10 SEP/ 1800Z |
| LAST WARNING: | 16 SEP/ 1800Z |
| MAX INTENSITY: | 80 |
| WARNINGS: | 25 |

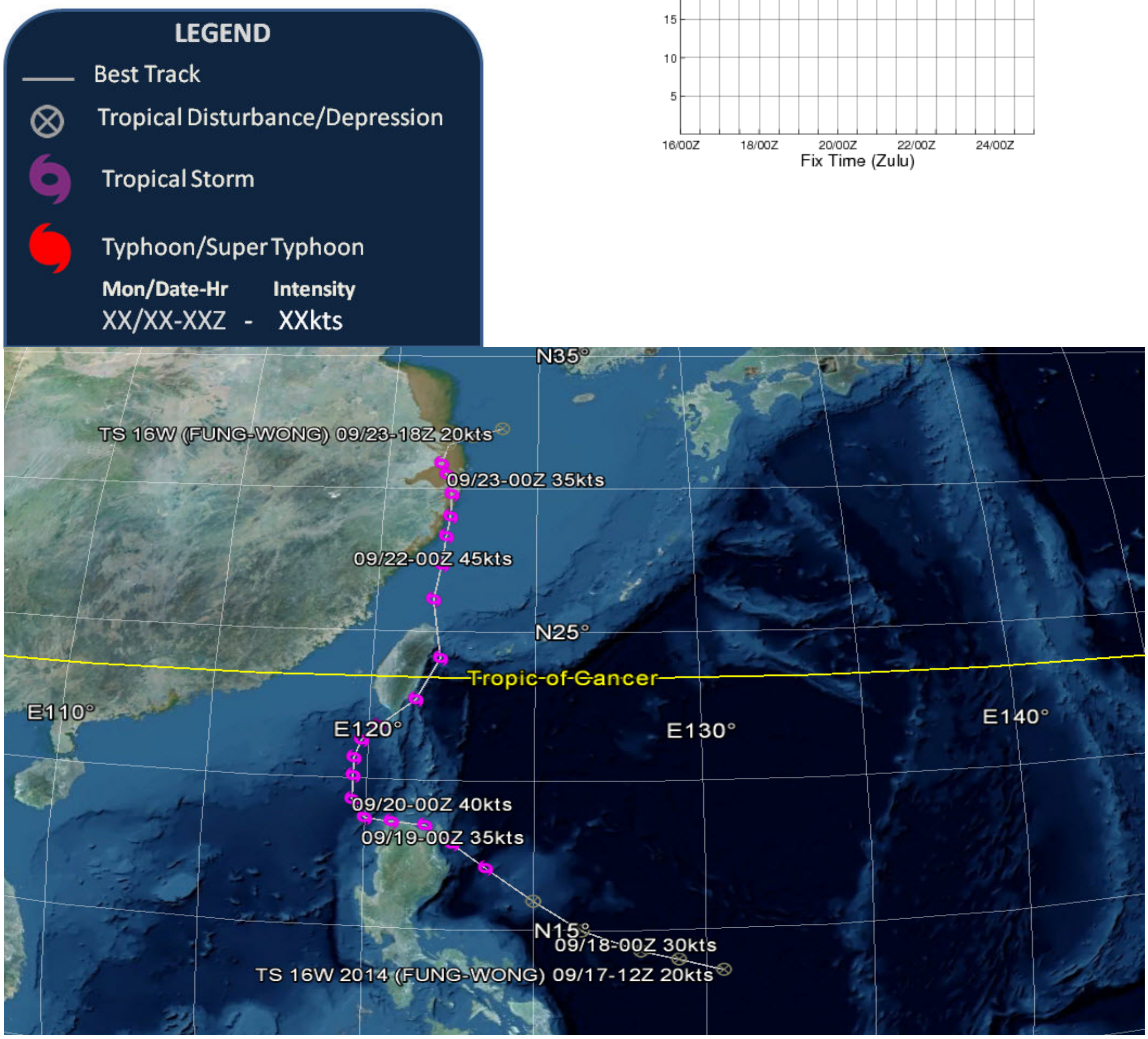


## 16W TROPICAL STORM FUNG-WONG

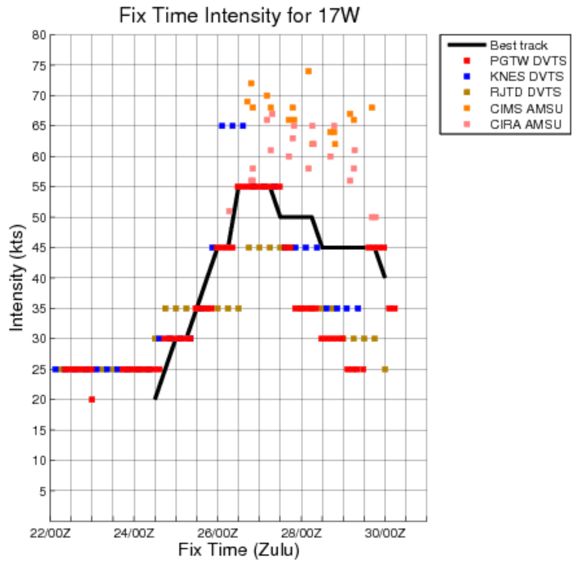
| | |
|---|---|
| ISSUED LOW: | 15 SEP/ 0130Z |
| ISSUED MED: | 15 SEP/ 2300Z |
| FIRST TCFA: | 16 SEP/ 2000Z |
| FIRST WARNING: | 17 SEP/ 1200Z |
| LAST WARNING: | 23 SEP/ 1200Z |
| MAX INTENSITY: | 50 |
| WARNINGS: | 25 |

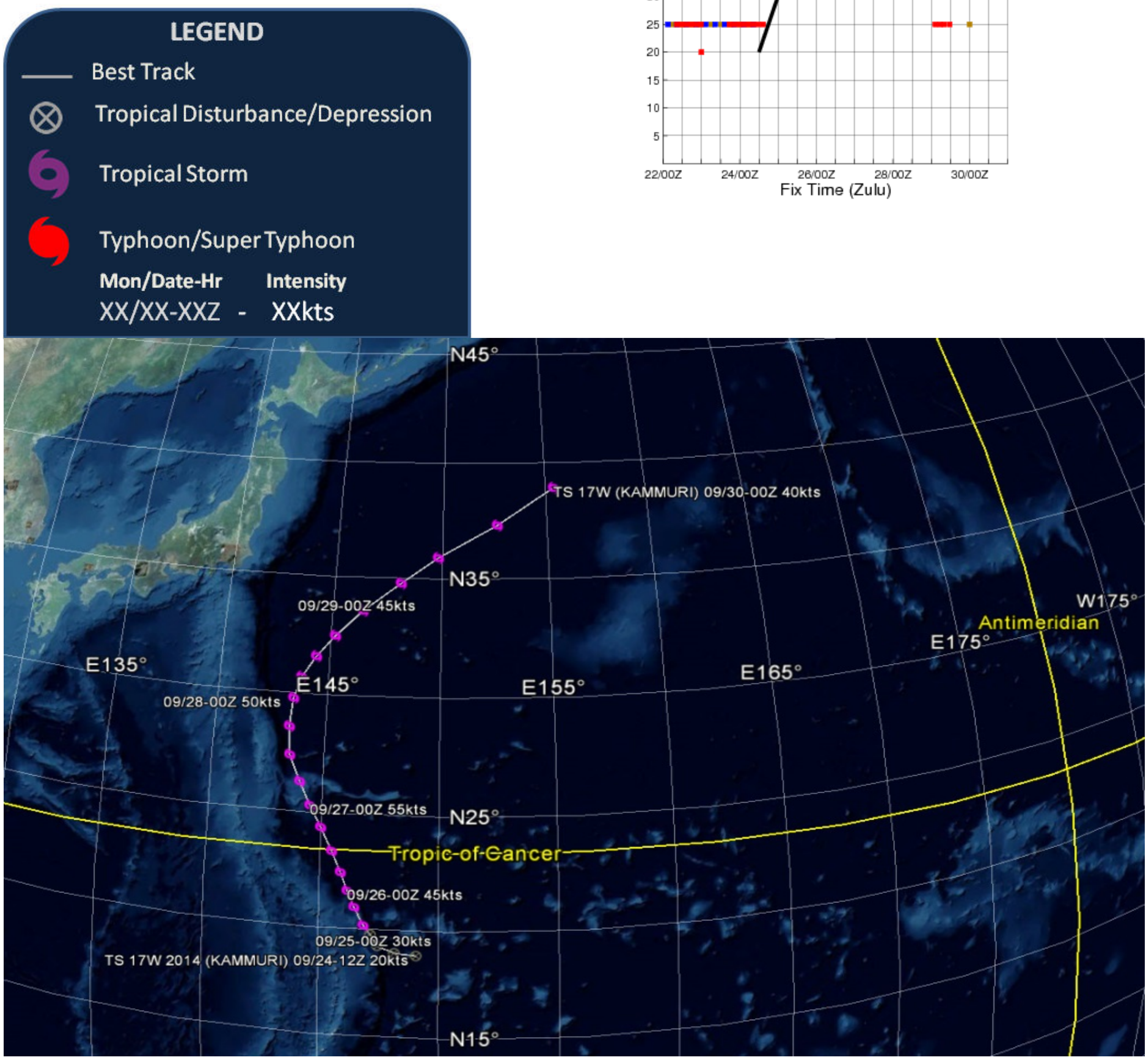


# 17W TROPICAL STORM KUMMURI

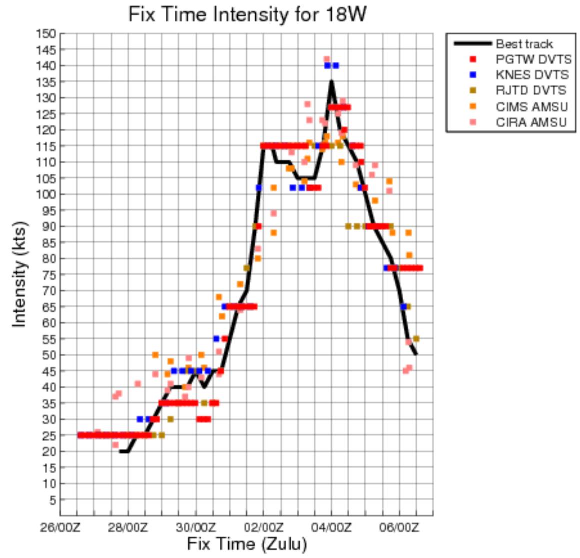
| | |
|---|---|
| ISSUED LOW: | 21 SEP/ 1200Z |
| ISSUED MED: | 22 SEP/ 0600Z |
| FIRST TCFA: | 22 SEP/ 1900Z |
| FIRST WARNING: | 24 SEP/ 1200Z |
| LAST WARNING: | 28 SEP/ 0000Z |
| MAX INTENSITY: | 55 |
| WARNINGS: | 19 |

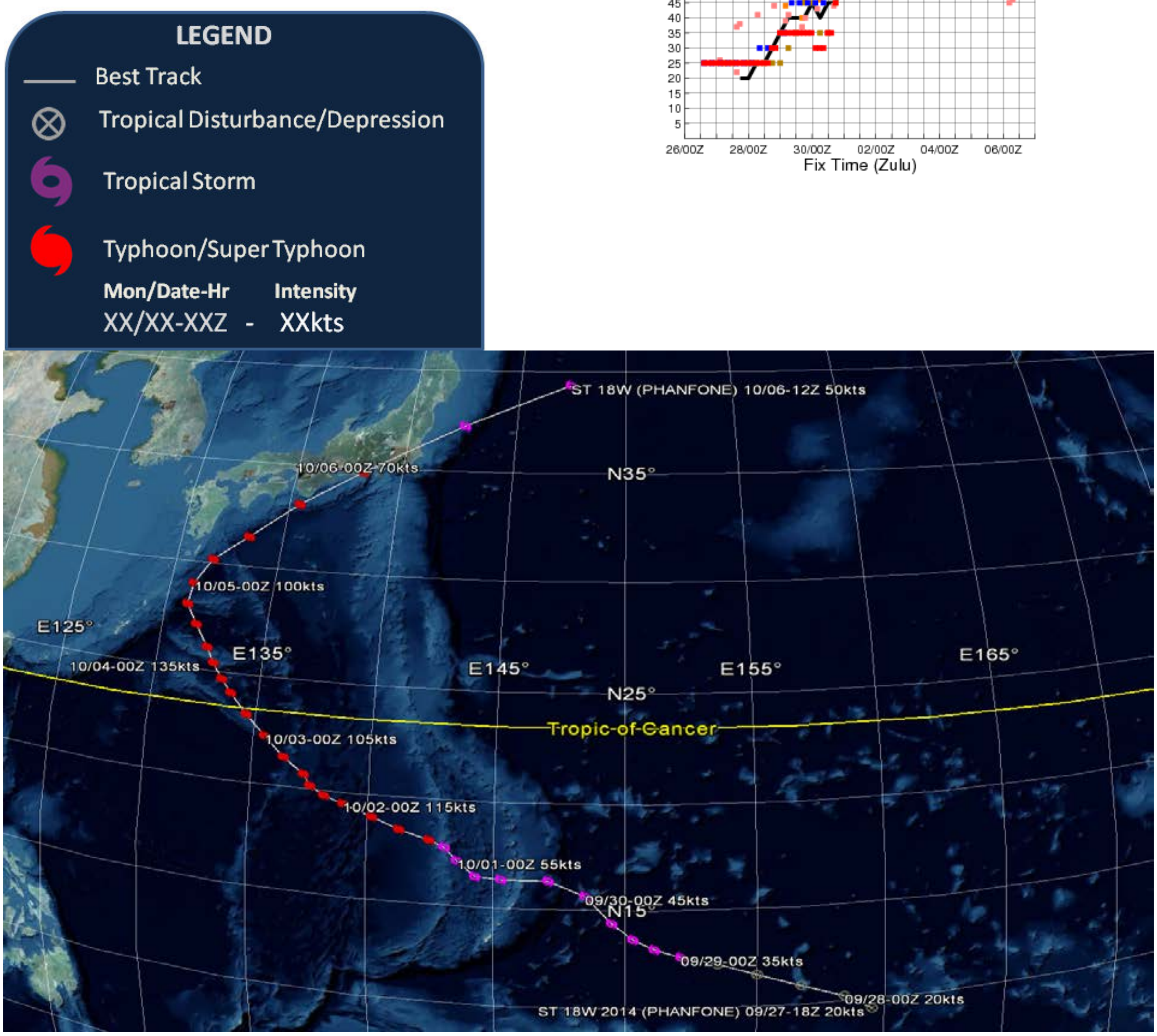


## 18W SUPER TYPHOON PHANFONE

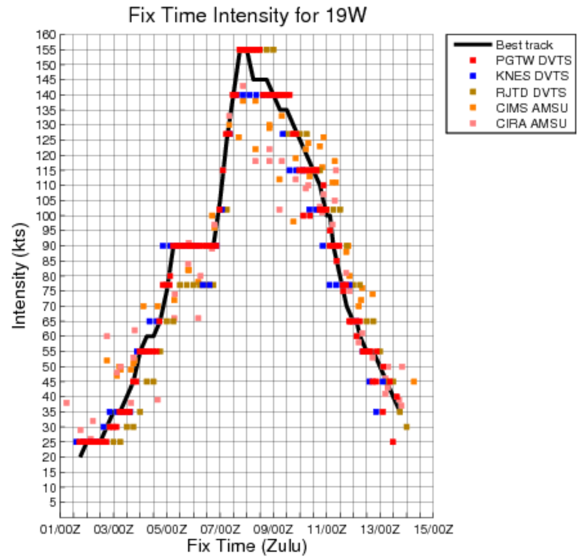
| | |
|---|---|
| ISSUED LOW: | 26 SEP/ 1500Z |
| ISSUED MED: | 26 SEP/ 1800Z |
| FIRST TCFA: | 26 SEP/ 2230Z |
| FIRST WARNING: | 28 SEP/ 1800Z |
| LAST WARNING: | 06 OCT/ 0600 |
| MAX INTENSITY: | 135 |
| WARNINGS: | 31 |

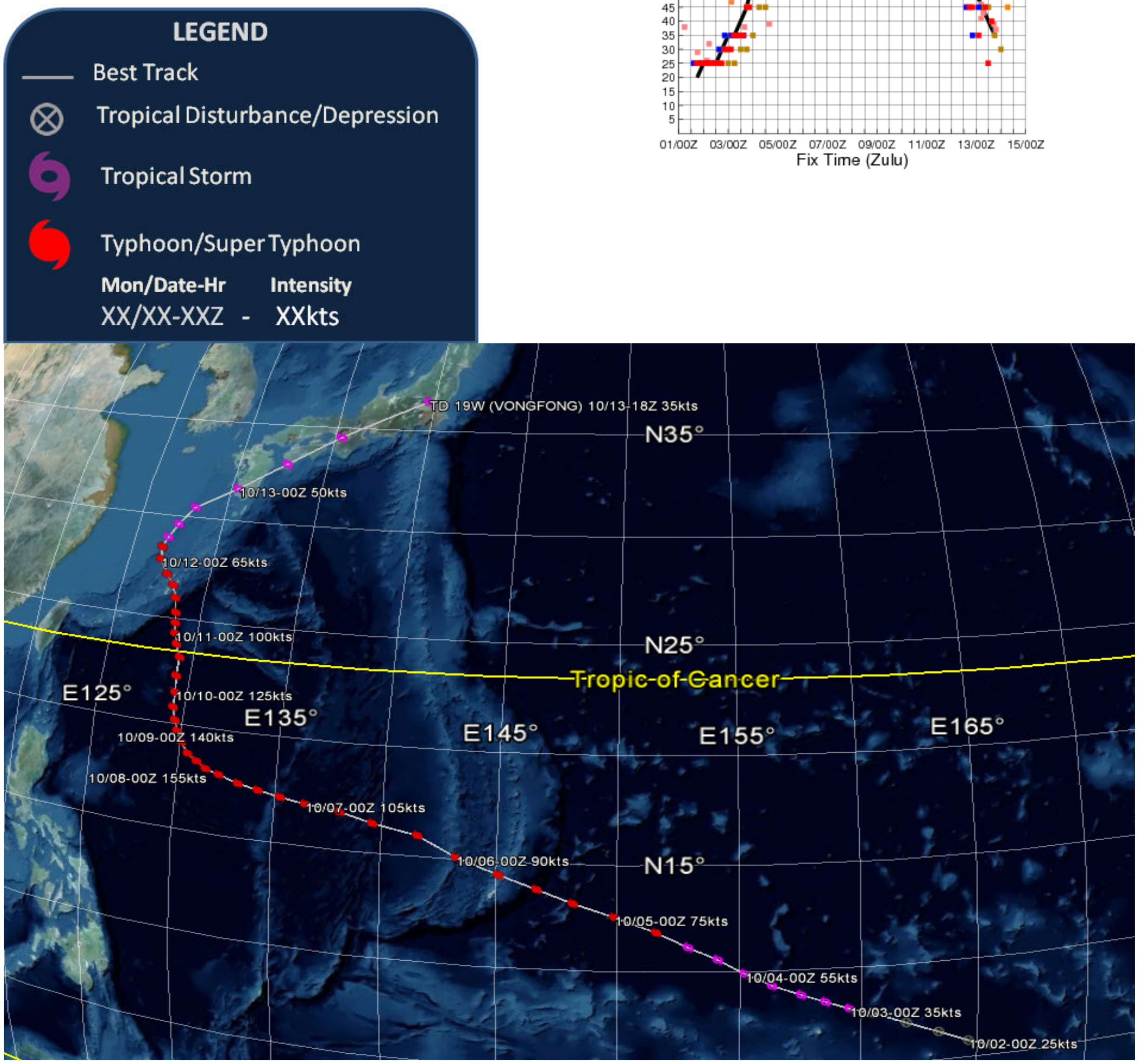


# 19W SUPER TYPHOON VONGFONG

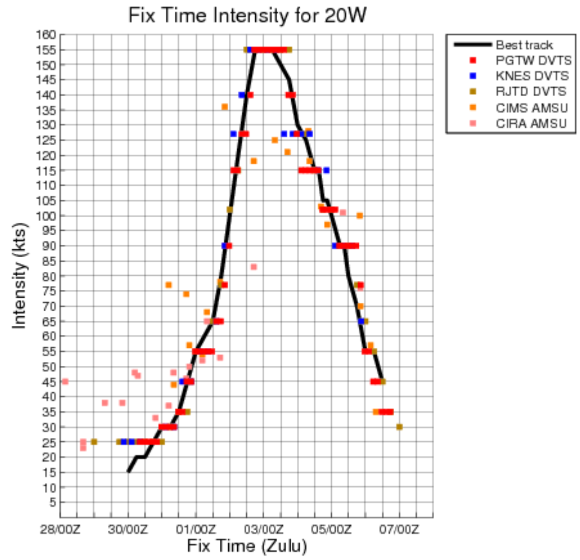
| | |
|---|---|
| ISSUED LOW: | 01 OCT/ 1700Z |
| ISSUED MED: | N/A |
| FIRST TCFA: | 02 OCT/ 0300Z |
| FIRST WARNING: | 02 OCT/ 1800Z |
| LAST WARNING: | 14 OCT/ 0000Z |
| MAX INTENSITY: | 155 |
| WARNINGS: | 46 |

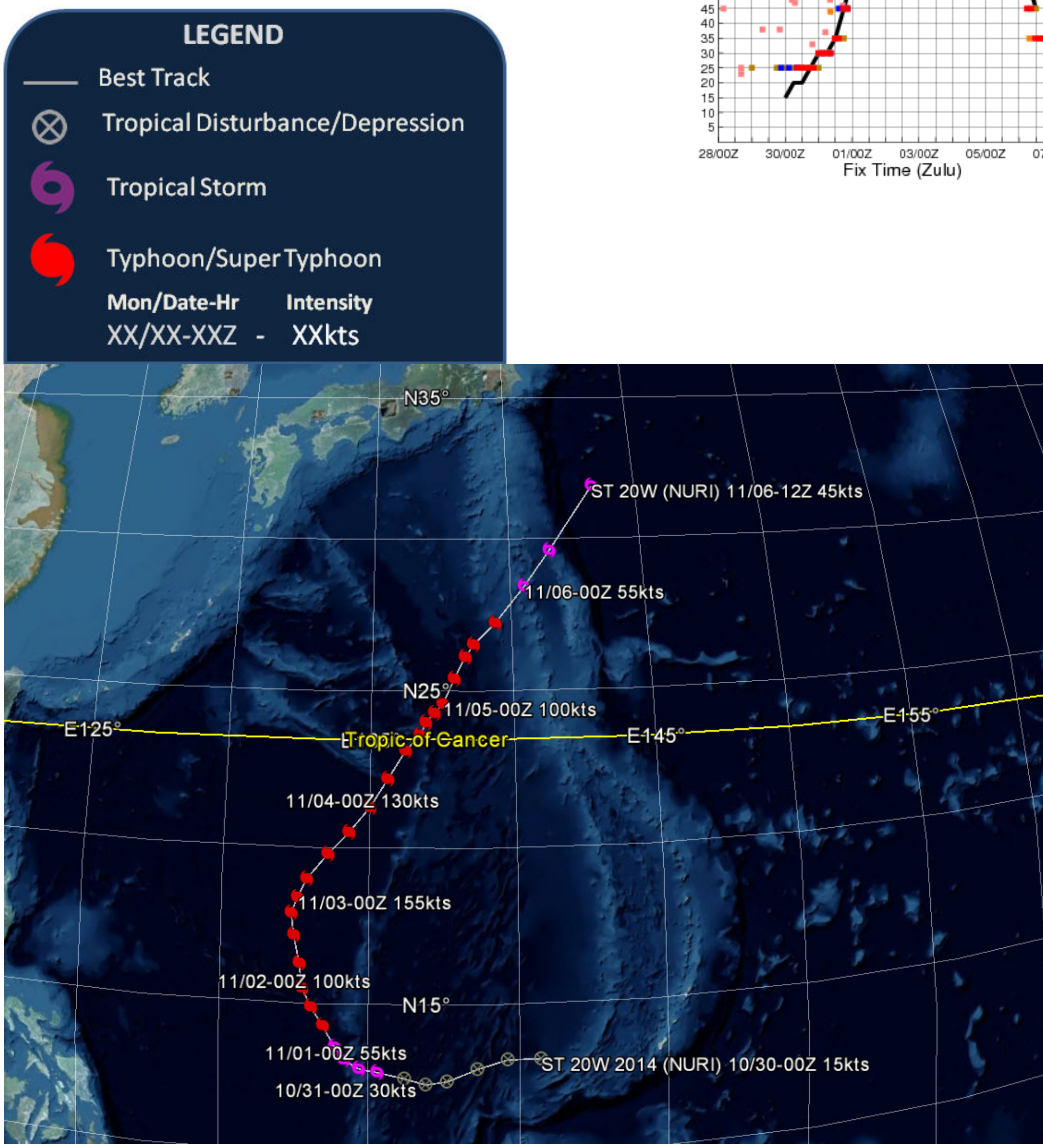


## 20W SUPER TYPHOON NURI

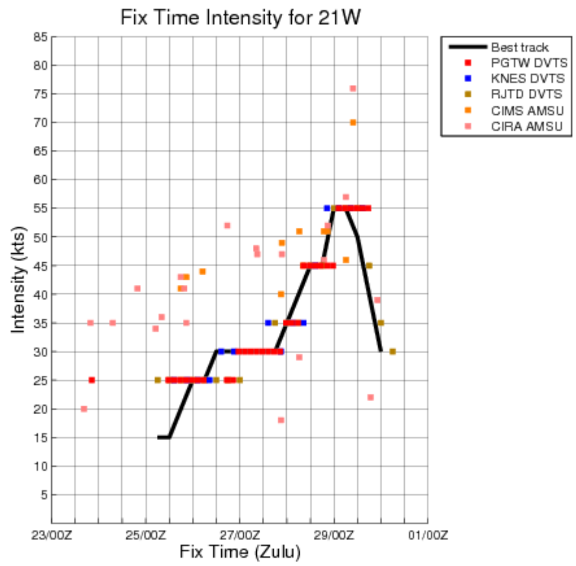
| | |
|---|---|
| ISSUED LOW: | 28 OCT/ 0600Z |
| ISSUED MED: | 30 OCT/ 0600Z |
| FIRST TCFA: | 30 OCT/ 0900Z |
| FIRST WARNING: | 31 OCT/ 0000Z |
| LAST WARNING: | 06 NOV/ 0000Z |
| MAX INTENSITY: | 155 |
| WARNINGS: | 25 |

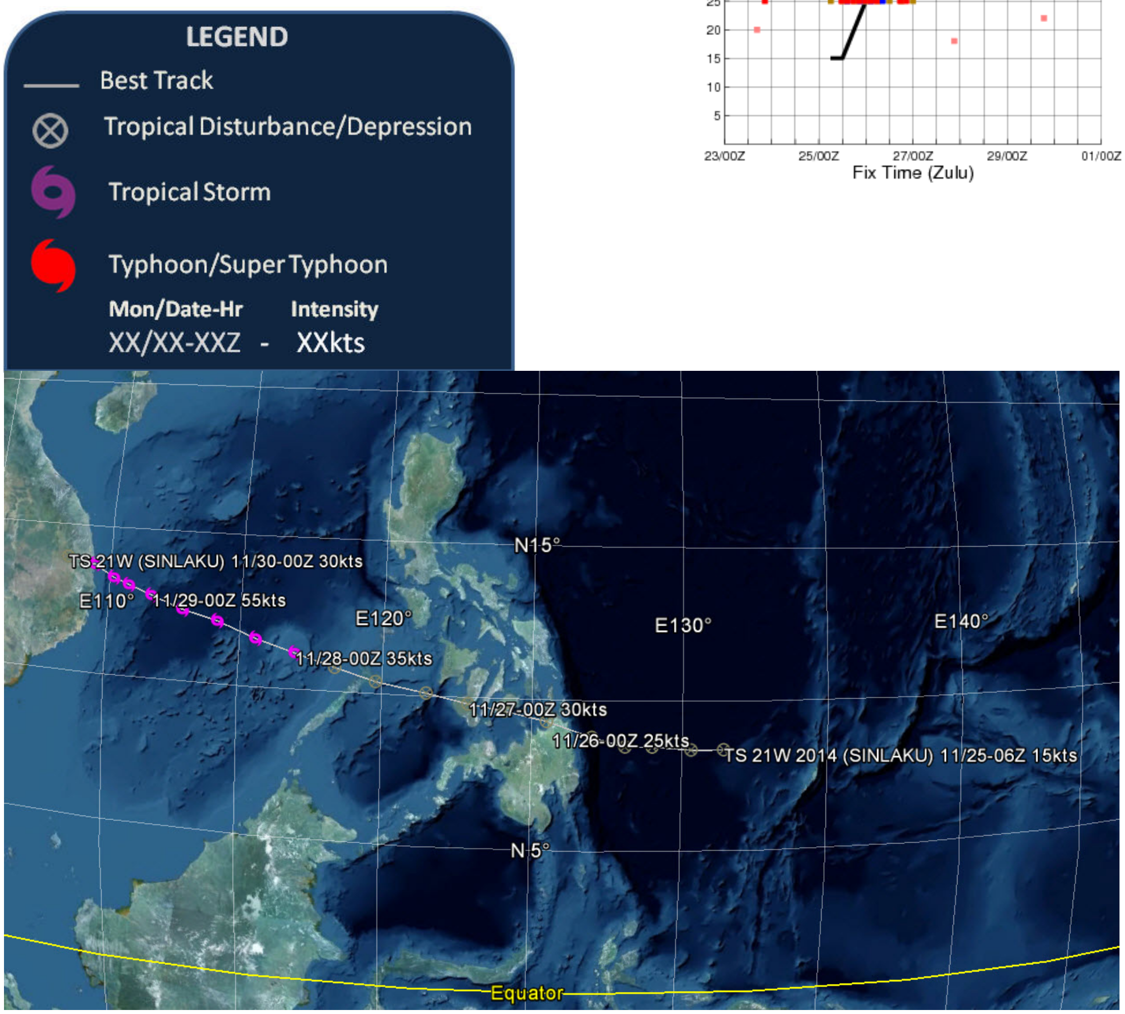


# 21W TROPICAL STORM SINLAKU

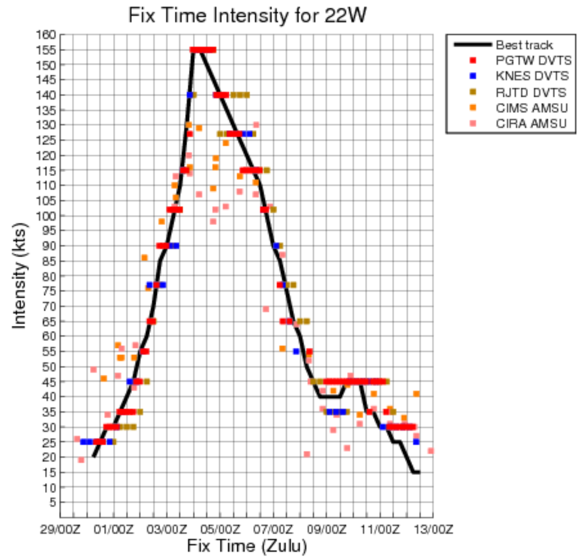
| | |
|---|---|
| ISSUED LOW: | 25 NOV/ 0600Z |
| ISSUED MED: | N/A |
| FIRST TCFA: | 26 NOV/ 0500Z |
| FIRST WARNING: | 26 NOV/ 0600Z |
| LAST WARNING: | 29 NOV/ 1800Z |
| MAX INTENSITY: | 55 |
| WARNINGS: | 15 |

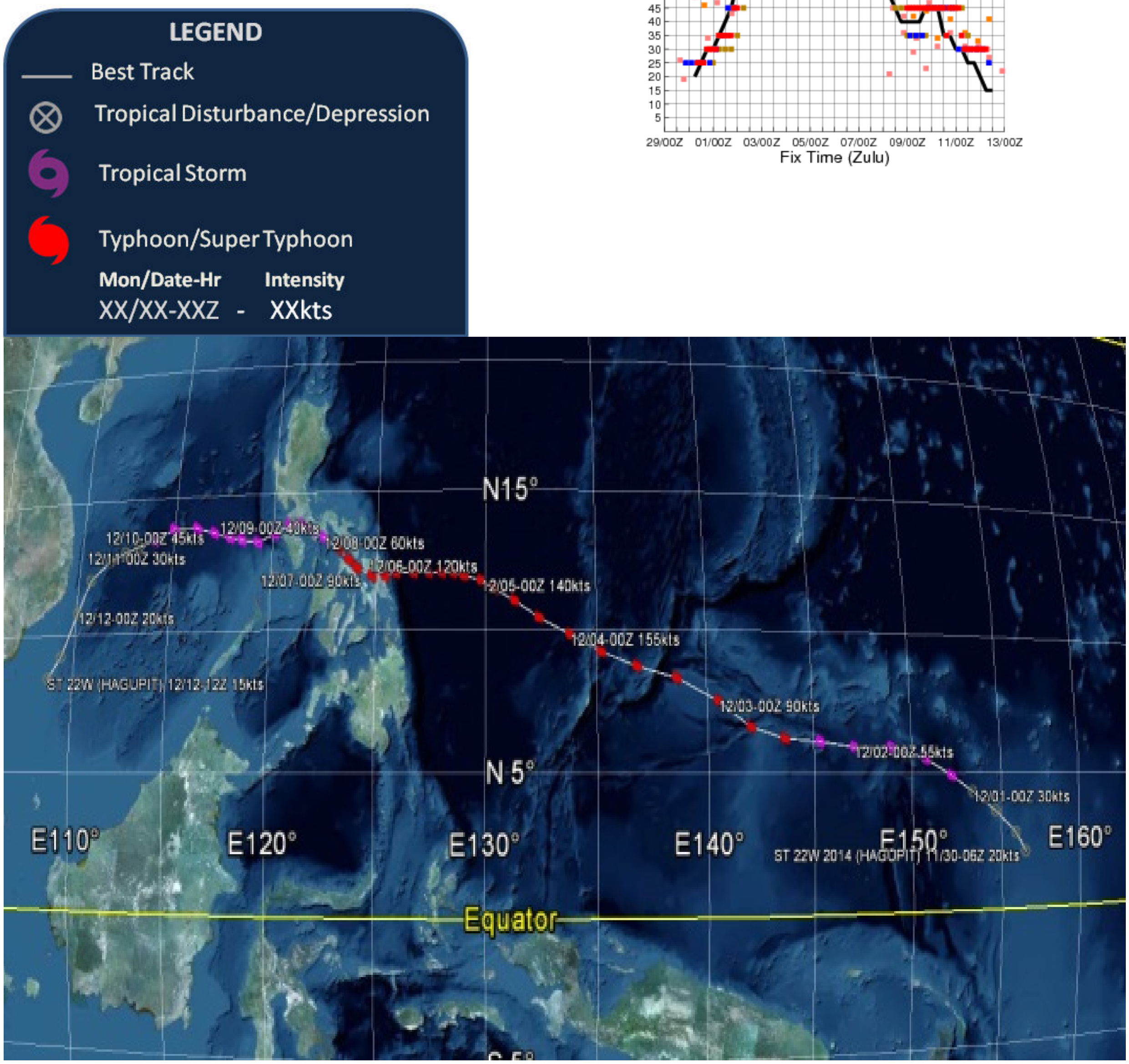


## 22W SUPER TYPHOON HAGUPIT

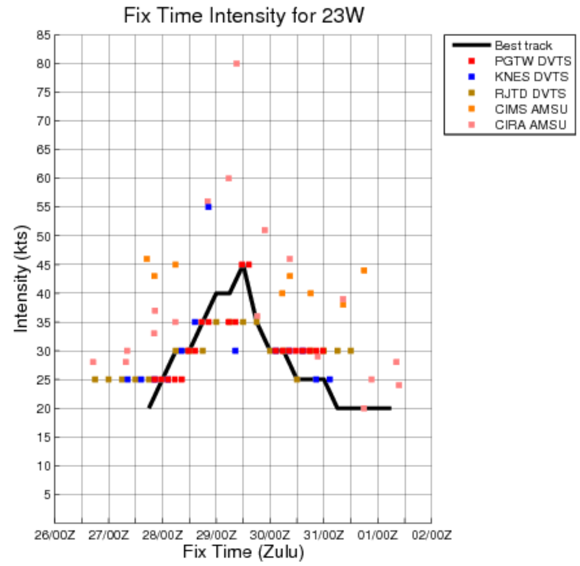
| | |
|---|---|
| ISSUED LOW: | 30 NOV/ 0600Z |
| ISSUED MED: | 13 NOV/ 1300Z |
| FIRST TCFA: | 30 NOV/ 1800Z |
| FIRST WARNING: | 01 DEC/ 0000Z |
| LAST WARNING: | 12 DEC/0000Z |
| MAX INTENSITY: | 155 |
| WARNINGS: | 45 |

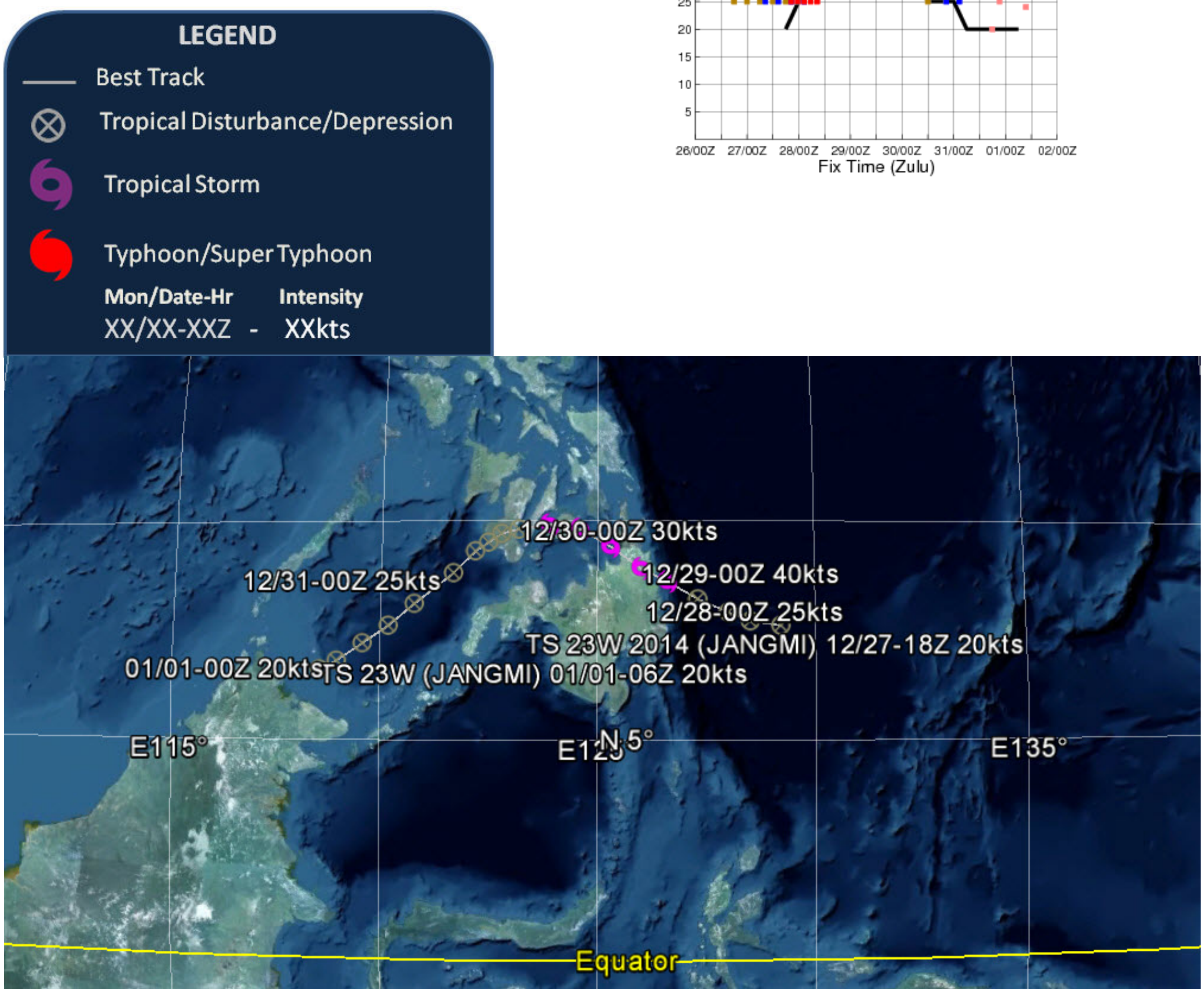


# 23W TROPICAL STORM JANGMI

| | |
|---|---|
| ISSUED LOW: | 27 DEC/ 0600Z |
| ISSUED MED: | 27 DEC/ 1830Z |
| FIRST TCFA: | 27 DEC/ 1930Z |
| FIRST WARNING: | 28 DEC/ 0000Z |
| LAST WARNING: | 31 DEC/ 0000Z |
| MAX INTENSITY: | 45 |
| WARNINGS: | 13 |



## Section 3 Detailed Cyclone Reviews

# Tropical Storm 12W (Nakri)

Tropical Storm (TS) 12W (Nakri) formed as a prototypical monsoon depression over the east Philippine Sea in late July 2014. The system slowly intensified while meandering poleward (Figure 1-5) toward Okinawa and the other Ryukyu Islands.

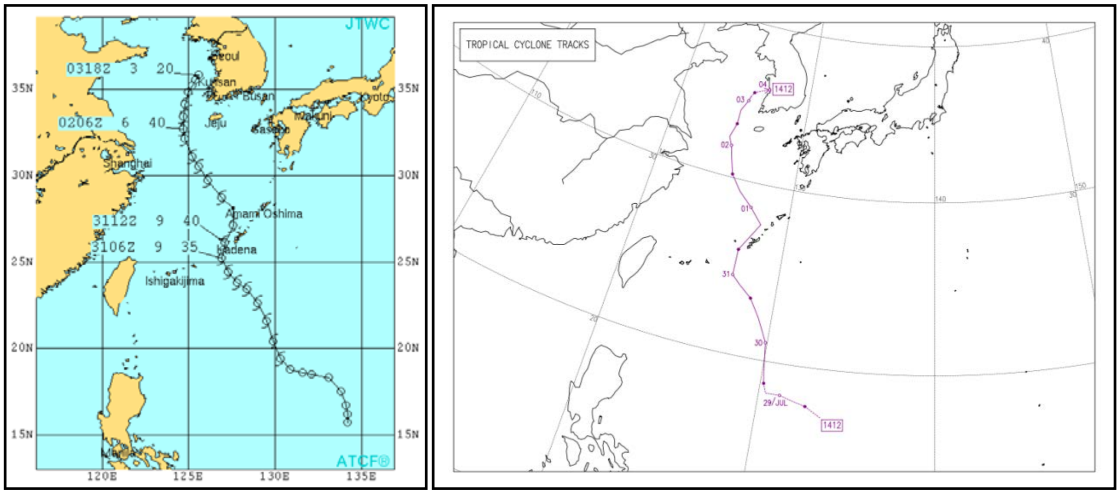



**Figure 1-5:** TS 12W (Nakri) best track (JTWC left and JMA right).

Monsoon depressions present unique difficulties to tropical forecasters, satellite analysts and METOC personnel due to their non-tropical cyclone characteristics:

- Large cyclonic circulations (average size using outer most closed isobar ~ 600 nm diameter) that develop within the monsoon trough
- A loosely organized cluster of deep convective elements, which may form an elongated band of deep convection in the eastern semicircle
- Low-level wind distribution that features a core of light winds which may be surrounded by a band of gales or a highly asymmetric wind field
- Lack of a distinct cloud system center, rendering the conventional Dvorak intensity estimate technique unusable
- Multiple small, weak mesovortices that rotate cyclonically about a centroid
- Monsoon depressions that develop in the western North Pacific Ocean often acquire persistent central convection and accelerated core winds, marking their transition into conventional tropical cyclones

Currently, it's JTWC's policy not to issue tropical cyclone warnings on monsoon depressions until they consolidate into tropical cyclones, i.e., they have acquired "persistent central convection and accelerated core winds" as defined in the AMS Glossary of Meteorology. JTWC's primary mission to issue warnings on tropical cyclones is unequivocally stated in *USPACOMINST 0539.1, Tropical Cyclone Operations in U.S. Pacific Command*. This instruction also outlines the purpose of Tropical Cyclone Conditions of Readiness (TCCOR) as "preparedness postures assumed by military activities threatened by tropical cyclones." Although a strong monsoon depression can induce wind speeds on the order of TCCOR thresholds, it will remain in “non-warning” status as long as its structural characteristics more closely resemble a monsoon depression than a tropical cyclone. This can generate considerable and unnecessary confusion as DoD METOC personnel recommend preparations for tropical cyclone-like local impacts in the absence of a tropical cyclone warning.

According to Lander (2004), “two-thirds of western North Pacific tropical cyclones derive from monsoon depressions,” which eventually “acquire persistent central deep convection and are often classified as tropical storms on the first warning due to the presence of extensive areas of gales.” This implies a significant change where “the size of the monsoon depression is an important consideration because the large vortex structure of the monsoon depression must somehow be transformed to have a small inner core of intense winds and precipitation” (Beattie, 2013). As will be discussed later in this review, research concerning this transformation is limited. Consequently, there are wide-ranging opinions regarding the best practices for operational analysis and forecasting of monsoon depressions and their potential transition into tropical cyclones.

Unlike the majority of western North Pacific monsoon depressions, TS 12W never fully transitioned into a tropical cyclone, i.e., it never acquired persistent central convection and accelerated core winds, except for a brief period of time (based on subjective analysis of scatterometer data). Not surprisingly, Dvorak intensity estimates remained relatively low, ranging from T1.0 (25 knots) to a peak of T2.0 (30 knots). JTWC leadership made the initial decision to not issue tropical cyclone warnings based on previously cited policy, and instead closely coordinated with the 17$^{th}$ Operational Weather Squadron to issue weather watches and warnings for Okinawa for resource protection purposes. Due to the expansive, strengthening wind field with peripheral storm-force wind gusts exceeding 50 knots, the system had a major impact on DoD assets, particularly on Okinawa, where peak surface wind gusts exceeded 50 knots well in advance of the arrival of the storm center. At Kadena Air Base, maximum sustained surface winds of 40 knots gusting to 51 knots were observed (Captain Klick, 18 OSS Wx Flight Commander, personal communication).

TS 12W continued to track slowly poleward toward the Korean Peninsula while maintaining 35 to 40 knot maximum sustained surface winds displaced well away from the center of circulation. On 02 Aug 0600Z, JTWC initiated tropical cyclone warnings based on ASCAT scatterometer data (Figure 1-6), which provided, for the first time, evidence of a contracting, symmetric wind field with a radius of maximum winds of 80 to 100 nm (more typical of a tropical cyclone).

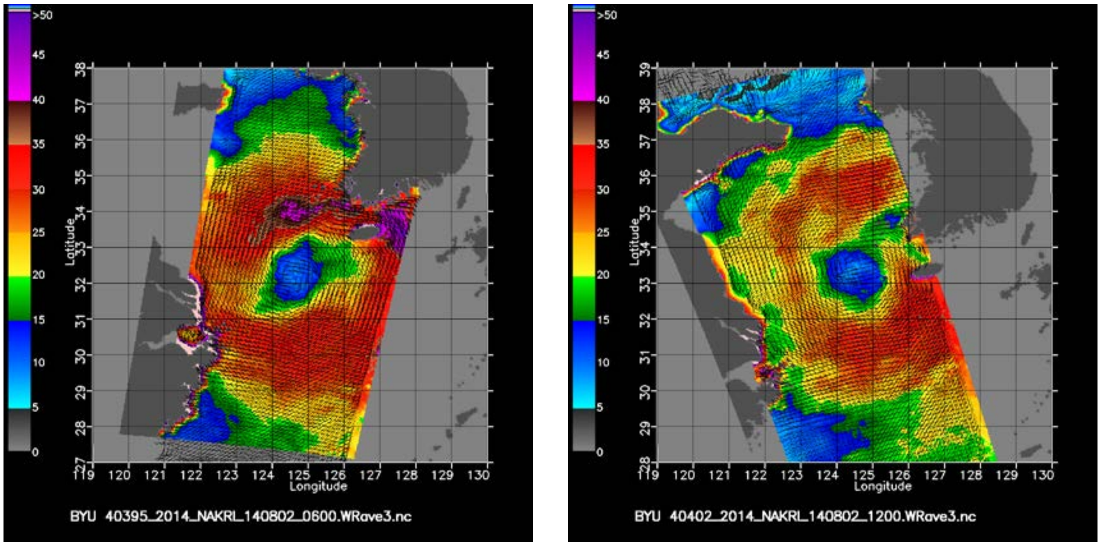



**Figure 1-6:** BYU high-resolution ASCAT scatterometer imagery (based on 02 Aug / 0107Z (left) and 02 Aug / 1224Z (right) ASCAT data).

Figure 1-7 shows the evolution of the expansive wind field and peripheral gale-force winds that impacted the Ryukyu Islands as well as the asymmetric weak wind core, with a radius of maximum winds (RMW) exceeding 100nm. As the monsoon depression tracked north of the Ryukyu Islands, the wind core became more symmetric (see 02 Aug / 0107Z and 02 Aug / 1224Z images) and the RMW contracted to less than 100nm for a brief period of time before the system made landfall over the Korean Peninsula.

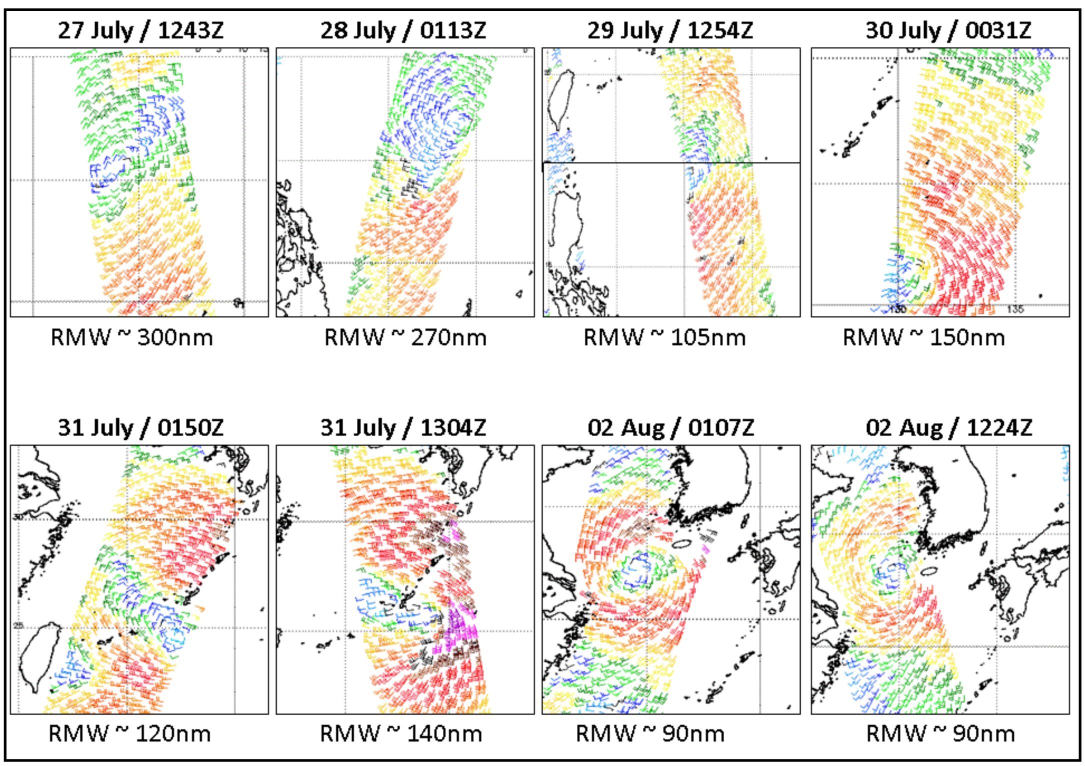



**Figure 1-7:** Evolution of 12W's wind field, reflected in a time-series of ASCAT scatterometer imagery (with author's subjective estimate of RMW) (data source: NOAA NESDIS).

As TS 12W approached the southwest coast of South Korea, the expansive wind field weakened rapidly, as expected, due to frictional effects resulting from interaction with land as well as increasing vertical wind shear. 12W dissipated prior to making landfall.

In addition to the expansive wind field, 12W exhibited minimal centralized convection throughout its lifecycle, a classic characteristic of monsoon depressions. The lack of central convection is evident in the following three figures, which show several ASCAT scatterometer images from Figure 1-7 with nearly coincident microwave images. Note that the central core of the system is marked by a 100-nm radius red circle centered on the JTWC best track position.

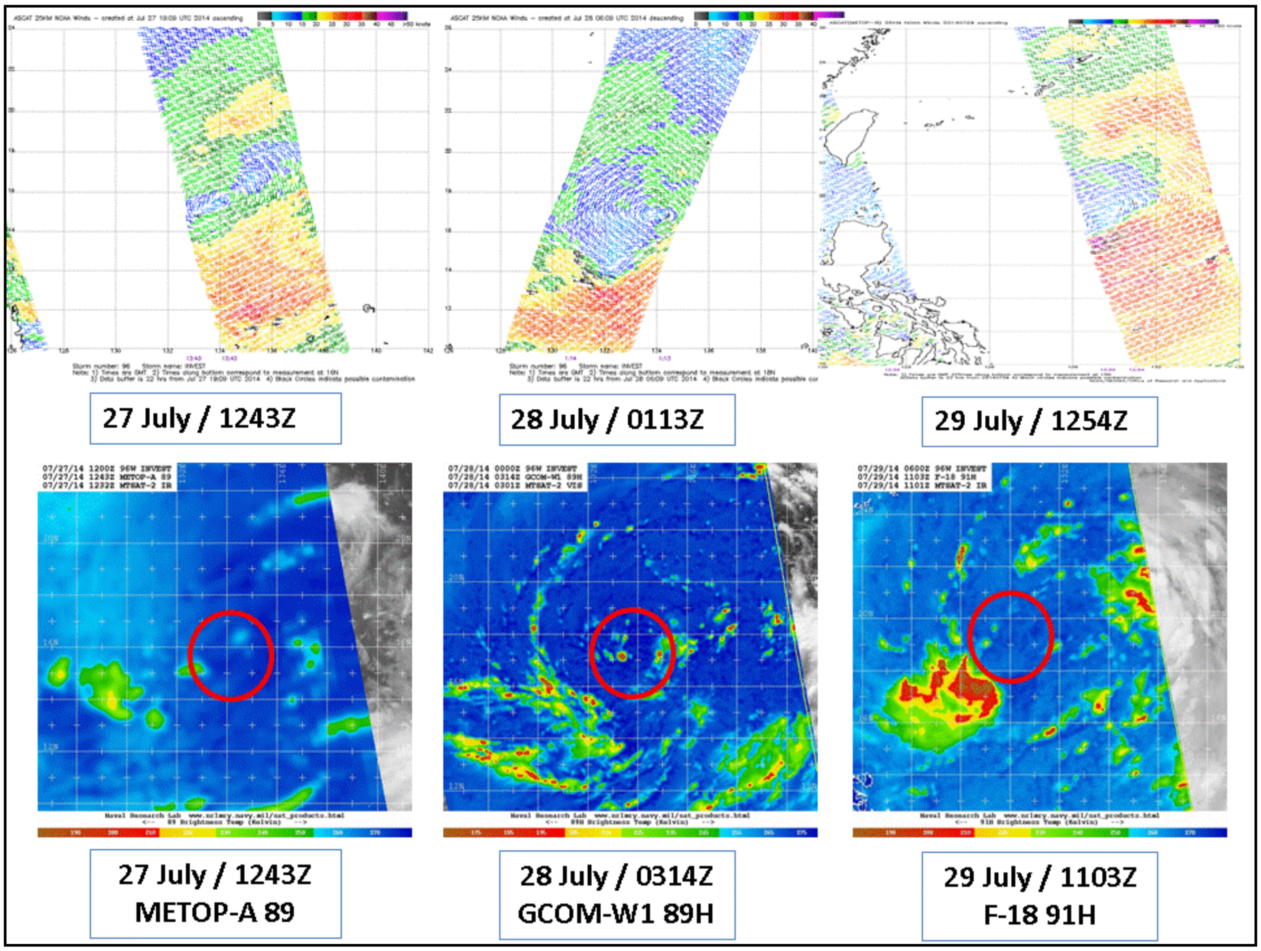



**Figure 1-8:** Comparison of 12W's surface wind field (ASCAT data) and nearly coincident microwave satellite imagery during the 27 to 29 July period (data sources: NOAA NESDIS (top), NRL TC page (bottom)).

During the early phase of development, from 27 through 29 July, deep convection associated with 12W formed primarily along the periphery of the system while core convection (within the red circle) remained sparse and disorganized (Figures 1-8,1-9, and 1-10). The convective structure, while uncharacteristic of a tropical cyclone, was essentially consistent with Beattie's (2013) description of a typical monsoon depression: "…ring of convection was broader in the southwest and northeast quadrants of the circulation, especially when those regions of convection were embedded in the leading edge of the equatorial westerly flow converging with the trade easterlies prior to monsoon depression formation.”

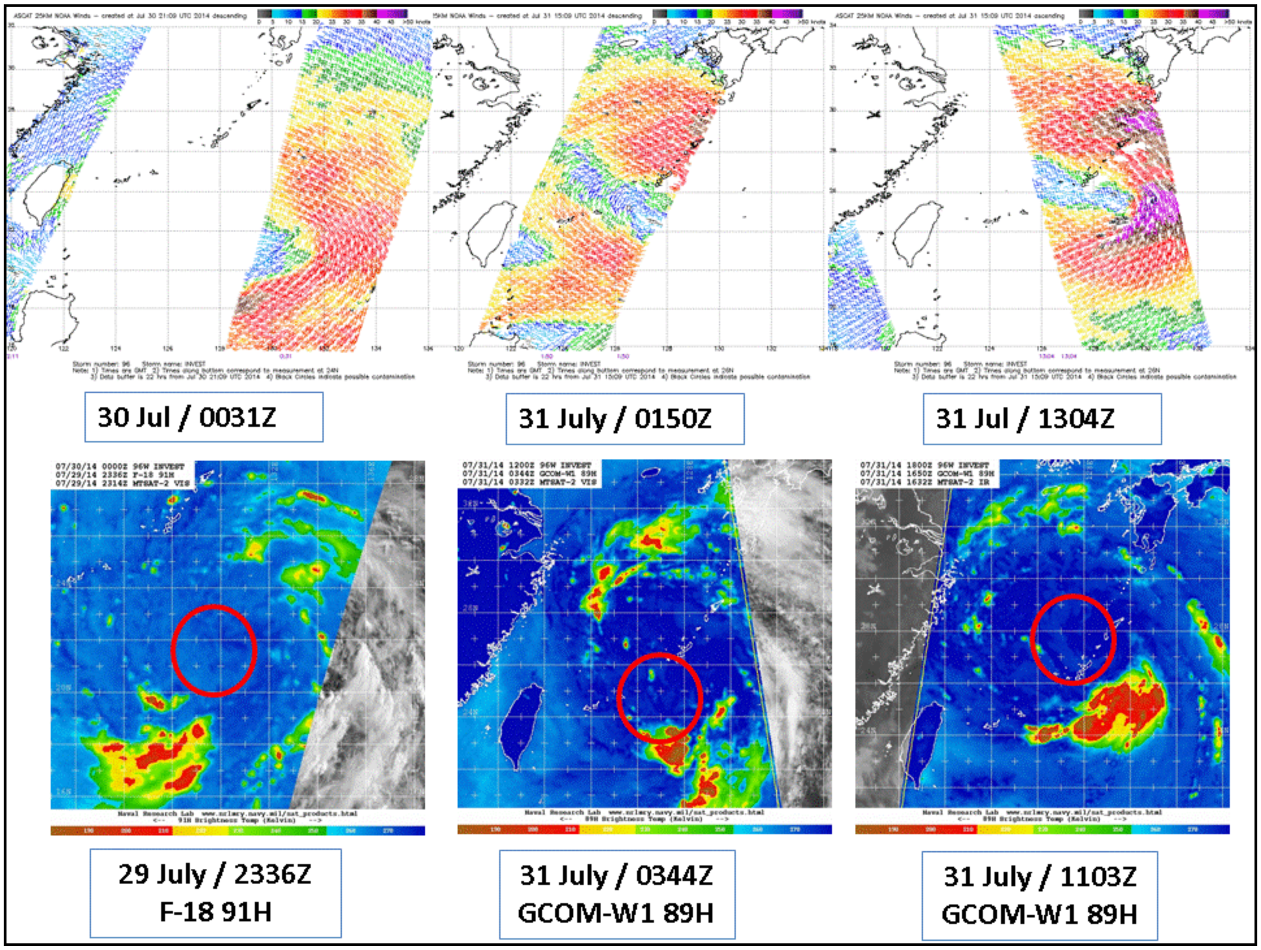



**Figure 1-9:** Comparison of surface wind field (ASCAT data) and nearly coincident microwave satellite imagery during the 30 to 31 July period (data sources: NOAA NESDIS (top), NRL TC page (bottom)).

From 30 through 31 July, broad convective banding remained confined to the periphery of the system (Figure 1-9). Imagery indicates that an area of intense deep convection initially developed along the southwestern flank (29 July / 2336Z) of the system and rotated gradually to the southeast quadrant (31 July / 1103Z). This convection appears to have been associated with a surge of strong convergent flow measuring 40 to 45 knots. These strong peripheral winds are not unusual with monsoon depressions as “the special characteristics of the monsoon depression are the higher winds and deep convection that are wrapped around a broad region of minimum pressure and minimum cloudiness” (Beattie, 2013). Despite the presence of the band of strong gale-force winds, 12W did not exhibit tropical cyclone characteristics.

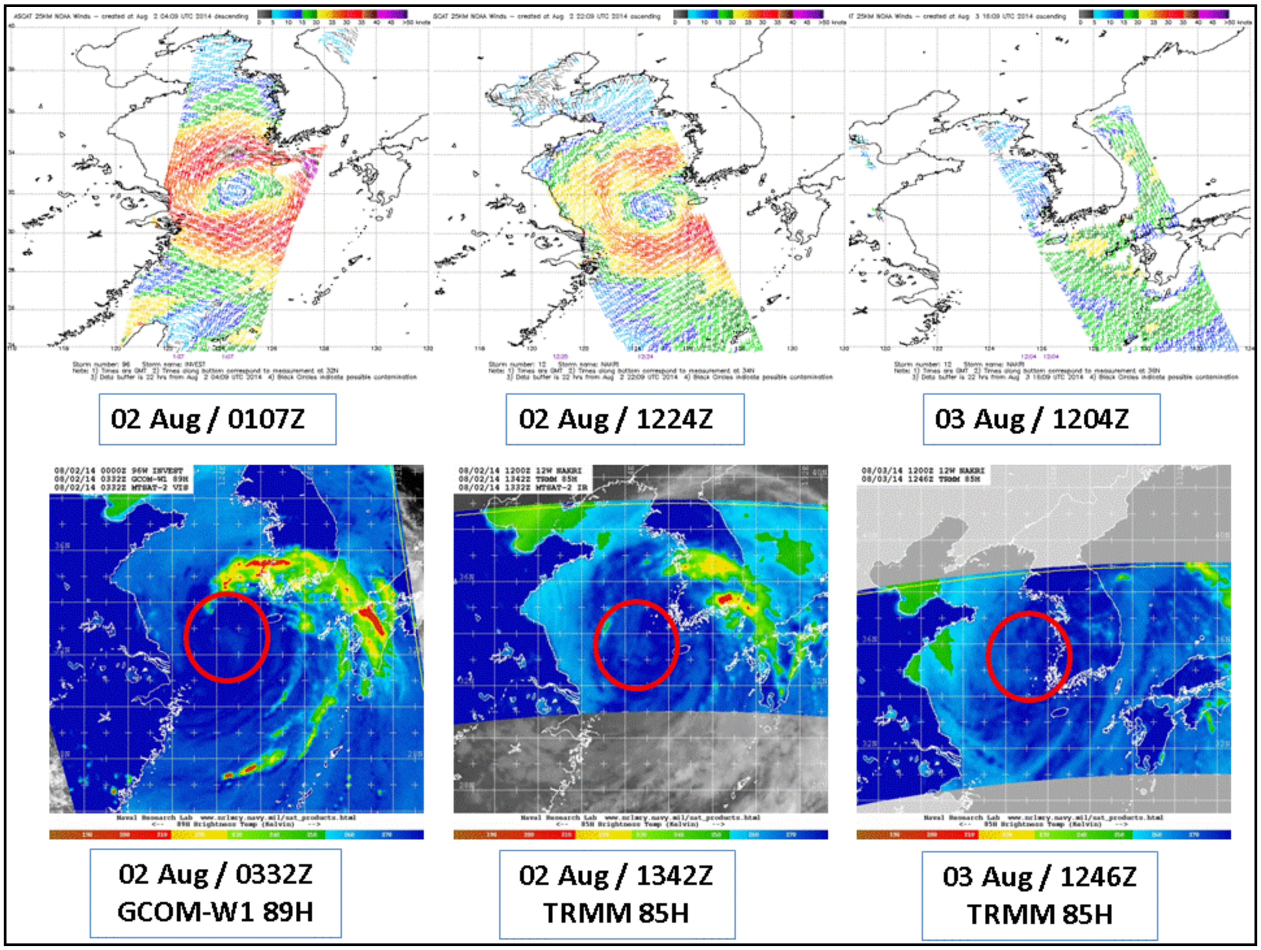



**Figure 1-10:** Comparison of surface wind field (ASCAT data) and nearly coincident microwave satellite imagery during the 02 to 03 August period (data sources: NOAA NESDIS (top), NRL TC page (bottom)).

On 02 Aug, TS 12W developed extensive deep convective banding, which wrapped broadly around the northern portion of the low-level circulation. At this point, 12W appeared to begin transitioning into a tropical cyclone as the core winds contracted. Analysis at 02 Aug / 0107Z indicated a 90nm RMW, which persisted until at least 02 Aug / 1224Z according to ASCAT data. Given the improved convective banding and shrinking RMW, as well as resource protection concerns, the senior JTWC forecaster strongly recommended initiating tropical cyclone warnings as the system approached the Korean Peninsula. JTWC leadership concurred and the 17th Operational Weather Squadron Lead Forecaster and the 607th Weather Squadron Director of Operations were immediately notified and briefed on the reasoning for initiating tropical cyclone warnings. However, post-storm review concluded that the system more likely remained a monsoon depression during this period.

JTWC received some criticism for delaying TC warnings early in TS 12W's lifecycle despite the strength of the system's peripheral wind field. However, as demonstrated in this review, 12W was an unusually persistent monsoon depression that perhaps never fully transitioned into a tropical cyclone, and therefore did not fulfill the requirements for issuing warnings outlined in USPACOM Instruction 0539.1. JTWC and DoD forecast partners ensured that US Government resources were protected, in this case, through careful collaboration and the timely dissemination of local weather watches and warnings. "Artificially" declaring this and other monsoon depressions as tropical cyclones and issuing warnings could mislead local forecasters who, upon receiving a TC warning, may consequently expect the more accurate position estimates and forecast closest-points-of-approach associated with classic tropical cyclones. Such assumptions and misunderstandings can lead to suboptimal TCCOR and sortie actions.

As noted earlier, current research on monsoon depressions is lacking. Beattie (2012) notes that "little is known about the processes that influence the formation, structure, and development of the monsoon depressions in the western North Pacific." There is neither a peer-reviewed adaptation of the Dvorak technique, nor a clear alternative to the Dvorak technique, for assessing monsoon depression intensity. Additionally, there is no documented procedure for identifying the transition from a monsoon depression to a tropical cyclone. Until the necessary research is conducted and new methodologies are developed for monsoon depressions, there will continue to be "differences of opinion about monsoon depressions and monsoon gyres in relation to tropical cyclone formation and as to the outer wind structure (or size) of the tropical cyclone that might result" (Beattie, 2013).

Improving monsoon depression analysis and forecast procedures and associated resource protection will require expanding research, canvassing DoD METOC customers for feedback on JTWC's existing procedures, and regularly training DoD local forecasters on the unusual nature of these systems. Specifically, forecasters should understand the broad nature of a monsoon depression's wind field, the lack of convective organization and the often-observed presence of multiple mesovortices within the broad central circulation. All of these features introduce significant uncertainty to position analyses, track predictions and closest point-of-approach projections. Additionally, these forecasters must recognize that monsoon depressions can produce severe weather in the subtropics just like other non-tropical cyclone phenomena such as monsoon gyres, waves in the easterlies, shear lines, upper-level lows, subtropical cyclones, and midlatitude cyclones / fronts. Watches and warnings for these non-tropical cyclone events should be standardized, straightforward, and fully consistent with existing TCCOR protocols, enabling seamless resource protection regardless of storm classification.

References:

Beattie, J. C., and R. L. Elsberry, 2012: Western North Pacific monsoon depression formation. *Weather and Forecasting*, **27**, 1413-1432.

Beattie, J. C., and R. L. Elsberry (2013), Horizontal structure of monsoon depressions in the western North Pacific at formation time, Geophys. Res. Lett., **40**, 983–987.

Lander, M. A., 2004: Monsoon depressions, monsoon gyres, midget tropical cyclones, TUTT cells and high intensity after recurvature: Lessons learned from the use of Dvorak's techniques in the world's most prolific tropical-cyclone basin. *Extended Abstract 7A.5, 26th Conf. on Hurricanes and Tropical Meteorology*, Amer. Meteor. Soc., Miami, FL.

Dvorak, Vernon F., 1984, Tropical Cyclone Intensity Estimates Using Satellite Data, NOAA Technical Report NESDIS 11, Washington DC

# Chapter 2 North Indian Ocean Tropical Cyclones

This chapter contains information on northern Indian Ocean TC activity during 2014 and the monthly distribution of TC activity summarized for 1975 - 2014. North Indian Ocean tropical cyclone best tracks appear following Table 2-2.

## Section 1 Informational Tables

Table 2-1 is a summary of TC activity in the north Indian Ocean during the 2014 season. Five cyclones occurred in 2014, with two systems reaching an intensity greater than 64 knots. Table 2-2 shows the monthly distribution of Tropical Cyclone activity for 1975 - 2014.

**Table 2-1**

**NORTH INDIAN OCEAN SIGNIFICANT TROPICAL CYCLONES FOR 2014**

**(01 JAN 2014- 31 DEC 2014)**

| TC | NAME* | PERIOD** | | WARNINGS ISSUED | EST MAX SFC WINDS KTS |
|---|---|---|---|---|---|
| 01B | ONE | 04 JAN / 0600Z | 05 JAN / 1800Z | 7 | 40 |
| 02A | NANAUK | 10 JUN / 0000Z | 13 JUN / 0600Z | 14 | 55 |
| 03B | HUDHUD | 08 OCT / 0000Z | 12 OCT / 1200Z | 19 | 115 |
| 04A | NILOFAR | 25 OCT / 1200Z | 30 OCT / 1800Z | 22 | 115 |
| 05B | FIVE | 06 NOV / 0000Z | 07 NOV / 1800Z | 8 | 35 |

* As designated by the responsible RSMC

** Dates are based on Issuance of JTWC warnings on system.

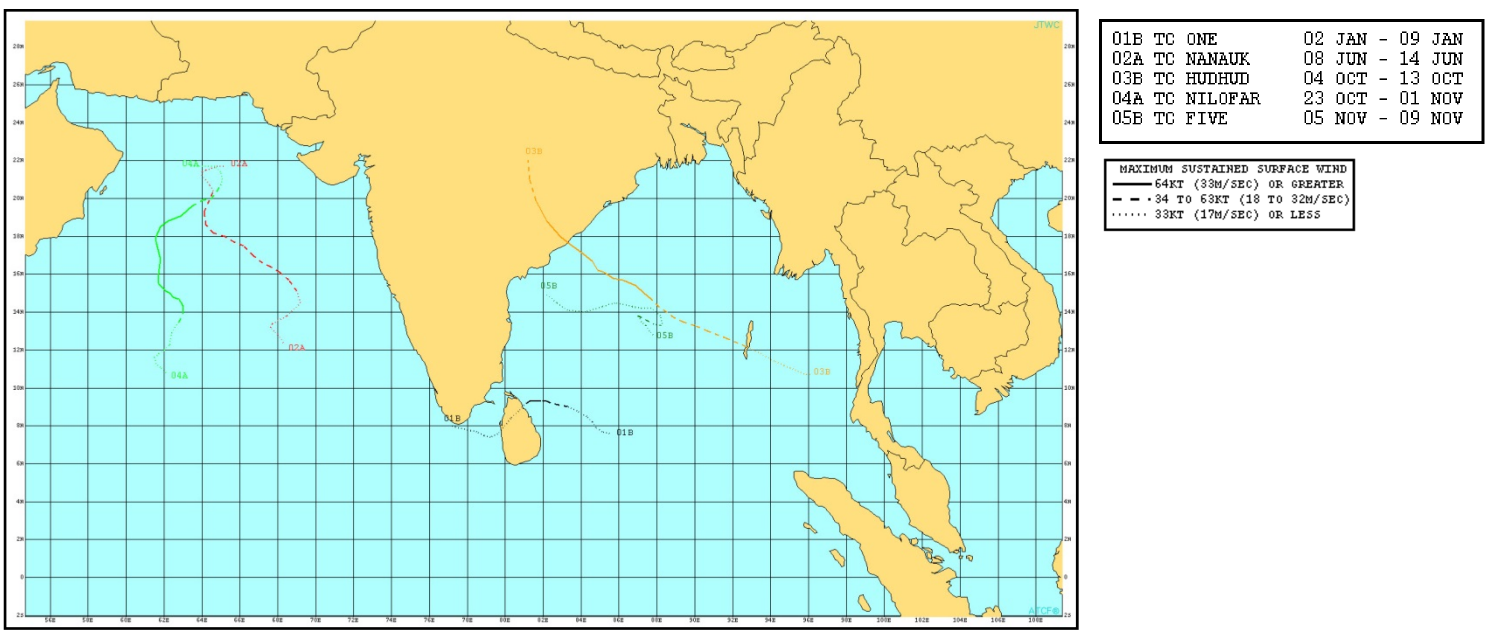



**Figure 2-1.** North Indian Ocean Tropical Cyclones.

## Table 2 - 2
## DISTRIBUTION OF NORTH INDIAN OCEAN TROPICAL CYCLONES FOR 1975 - 2014

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total ≥64kt | Total 34-63kt | Total ≤33 kt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | TOTALS | |
| | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | | 6 | |
| 1975 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 2 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 2 0 | 0 0 0 | 3 | 3 | 0 |
| | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | | 5 | |
| 1976 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 0 0 0 | 0 1 0 | 0 | 5 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | | 5 | |
| 1977 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 1 1 0 | 1 | 4 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | | 4 | |
| 1978 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 2 0 0 | 0 0 0 | 2 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 1 | 2 | 0 | | 7 | |
| 1979 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 1 1 | 0 1 0 | 0 1 1 | 0 0 0 | 1 | 4 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | 2 | |
| 1980 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 0 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | | 3 | |
| 1981 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 1 0 0 | 1 0 0 | 2 | 1 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | | 5 | |
| 1982 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 1 0 0 | 0 0 0 | 2 | 3 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | | 3 | |
| 1983 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 1 0 | 0 1 0 | 0 0 0 | 0 | 3 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | | 4 | |
| 1984 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 2 0 0 | 0 0 0 | 2 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | | 6 | |
| 1985 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 1 0 | 0 1 0 | 0 | 6 | 0 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | | 3 | |
| 1986 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 0 0 | 0 | 3 | 0 |
| | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 2 | | 8 | |
| 1987 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 1 0 | 0 2 0 | 0 | 8 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 1 | | 5 | |
| 1988 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 1 1 0 | 0 1 0 | 1 | 4 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | | 3 | |
| 1989 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 1 | 2 | 0 |
| | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | 4 | |
| 1990 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 1 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 1 | 0 1 0 | 1 | 1 | 2 |
| | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | | 4 | |
| 1991 | 0 1 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 2 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 1 | 3 | 3 | 2 | | 13 | |
| 1992 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 2 0 | 0 1 0 | 0 0 0 | 0 0 1 | 0 2 1 | 2 1 0 | 0 2 0 | 3 | 8 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | | 2 | |
| 1993 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 2 0 0 | 0 0 0 | 2 | 0 | 0 |
| | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | | 5 | |
| 1994 | 0 0 0 | 0 0 0 | 0 1 0 | 1 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 0 0 0 | 1 | 4 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | | 4 | |
| 1995 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 2 0 0 | 0 0 0 | 2 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 2 | 2 | 0 | | 8 | |
| 1996 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 1 2 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 1 0 | 2 0 0 | 0 0 0 | 4 | 4 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | | 4 | |
| 1997 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 1 0 | 0 1 0 | 0 0 0 | 2 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 1 | 2 | 1 | | 8 | |
| 1998 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 1 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 2 0 0 | 1 0 0 | 5 | 3 | 0 |
| | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | | 5 | |
| 1999 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 2 0 0 | 0 0 0 | 0 0 0 | 3 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | | 4 | |
| 2000 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 1 0 0 | 0 1 0 | 1 | 3 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | | 4 | |
| 2001 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 0 | 0 0 1 | 0 0 0 | 1 | 2 | 1 |
| | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | | 5 | |
| 2002 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 1 0 | 0 | 5 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | 3 | |
| 2003 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 1 0 | 2 | 1 | 0 |
| | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | | 5 | |
| 2004 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 1 0 0 | 0 0 0 | 1 | 4 | 0 |
| | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | | 7 | |
| 2005 | 0 1 1 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 1 0 | 0 2 0 | 0 | 6 | 1 |
| | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | | 6 | |
| 2006 | 0 1 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 2 0 | 0 0 0 | 0 1 0 | 0 0 0 | 1 | 5 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | | 6 | |
| 2007 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 1 2 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 1 0 0 | 0 0 0 | 3 | 3 | 0 |
| | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | | 7 | |
| 2008 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 1 1 | 0 2 0 | 0 1 0 | 1 | 5 | 1 |
| | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | | 5 | |
| 2009 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 1 0 | 0 1 0 | 1 | 4 | 0 |
| | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | | 5 | |
| 2010 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 1 0 | 1 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 0 1 0 | 0 0 0 | 3 | 2 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 3 | 1 | | 6 | |
| 2011 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 3 0 | 1 0 0 | 1 | 5 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | | 4 | |
| 2012 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 2 0 | 0 1 0 | 0 1 0 | 0 | 4 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | | 6 | |
| 2013 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 1 0 0 | 2 1 0 | 1 0 0 | 4 | 2 | 0 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | | 5 | |
| 2014 | 0 1 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 0 0 | 0 1 0 | 0 0 0 | 0 0 0 | 2 0 0 | 0 1 0 | 0 0 0 | 2 | 3 | 0 |
| (1975-2014) | | | | | | | | | | | | | | | |
| MEAN | 0.2 | 0.1 | 0.0 | 0.2 | 0.7 | 0.6 | 0.1 | 0.0 | 0.3 | 1.1 | 1.4 | 0.6 | | 5.1 | |
| CASES | 7 | 2 | 1 | 7 | 28 | 22 | 3 | 1 | 13 | 42 | 55 | 23 | | 204 | |

1) If a tropical cyclone was warned on prior to the last two days of a month, it was attributed to the first month, regardless of how long the system lasted.
2) If a tropical cyclone began on the last day of the month and ended on the first day of the next month, that system was attributed to the first month. However, if a tropical cyclone began on the last day of the month and continued into the next month for only two days, it was attributed to the second month.

**Section 2 Cyclone Summaries**

Each cyclone is presented, with the number and basin identifier assigned by JTWC, along with the RSMC assigned cyclone name. Dates are also listed when JTWC first designated Low and Medium[1] stages of development:

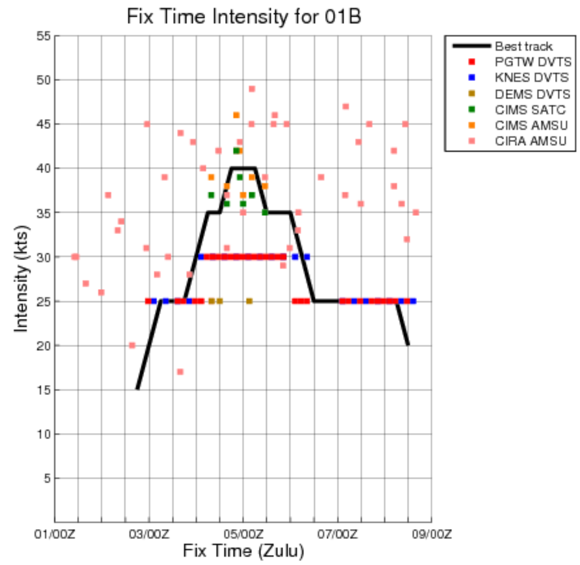
The first Tropical Cyclone Formation Alert (TCFA) and the initial and final warning dates are also presented with the number of warnings issued by JTWC. Landfall over major landmasses with approximate locations is presented as well.

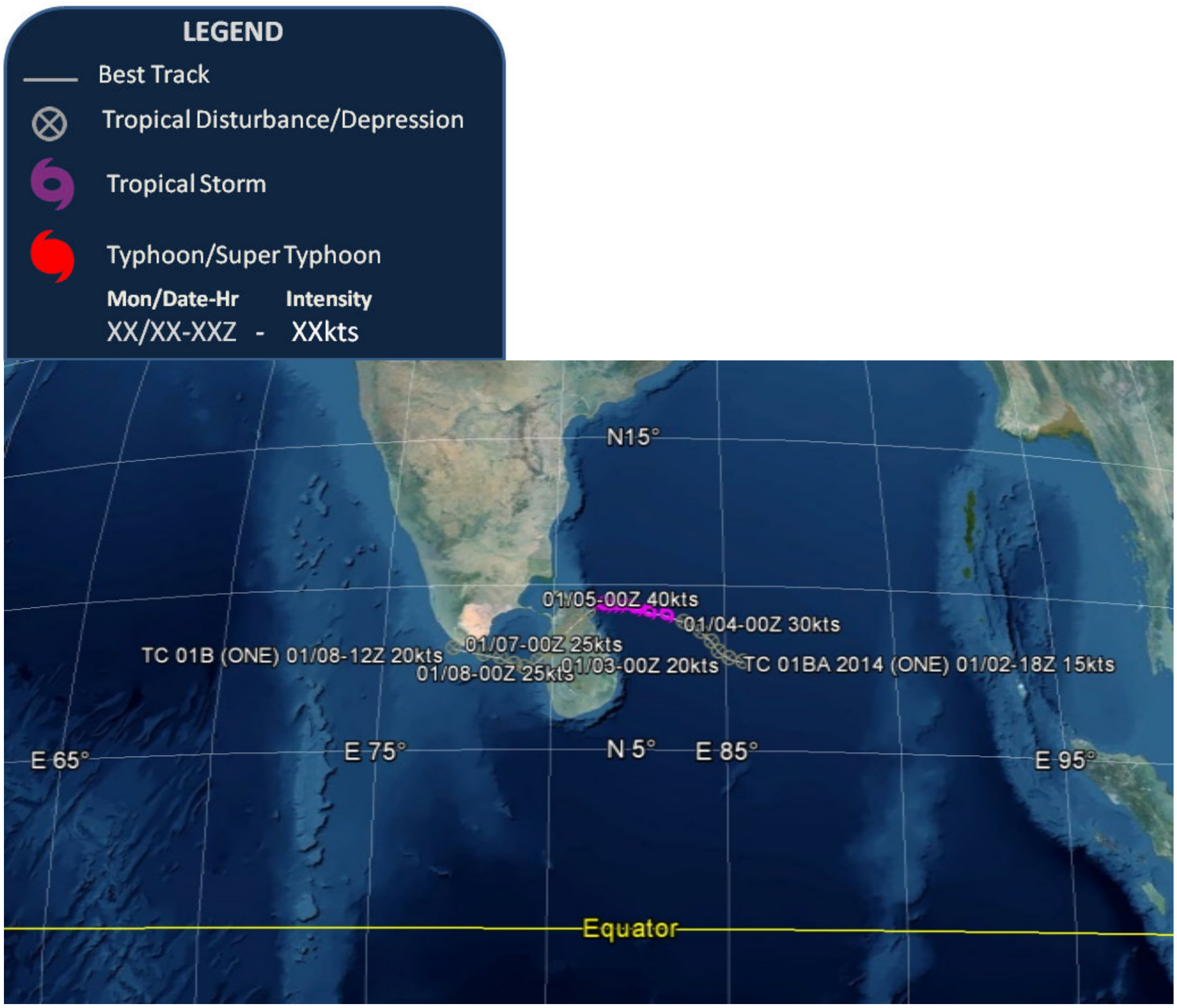
The JTWC post-event reanalysis best track is also provided for each cyclone. Data included on the best track are position and intensity noted with cyclone symbols and color coded track. Best track position labels include the date-time, track speed in knots, and maximum wind speed in knots. A graph of best track intensity versus time is presented. Fix plots on this graph are color coded by fixing agency.

In addition, if this document is viewed as a pdf, each map has been hyperlinked to the appropriate keyhole markup language (kmz) file that will allow the reader to access and view the best-track data interactively on their computer using Google Earth software. Simply hold the control button and click the map image; the link will open allowing the reader to download and open the file.
Users may also retrieve kmz files for the entire season from:
http://www.usno.navy.mil/NOOC/nmfc-ph/RSS/jtwc/best_tracks/2014/2014s-KMZs/JTWC_BestTrack_Climatology_2014.kmz

## 01B TROPICAL CYCLONE ONE

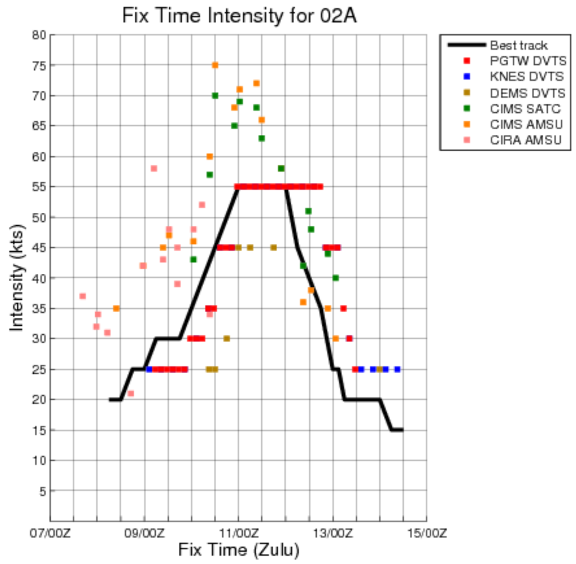
| | |
|---|---|
| ISSUED LOW: | 02 JAN/ 1900Z |
| ISSUED MED: | 03 JAN/ 1800Z |
| FIRST TCFA: | 04 JAN/ 0300Z |
| FIRST WARNING: | 04 JAN/ 0600Z |
| LAST WARNING: | 05 JAN/ 1800Z |
| MAX INTENSITY: | 40 |
| WARNINGS: | 7 |

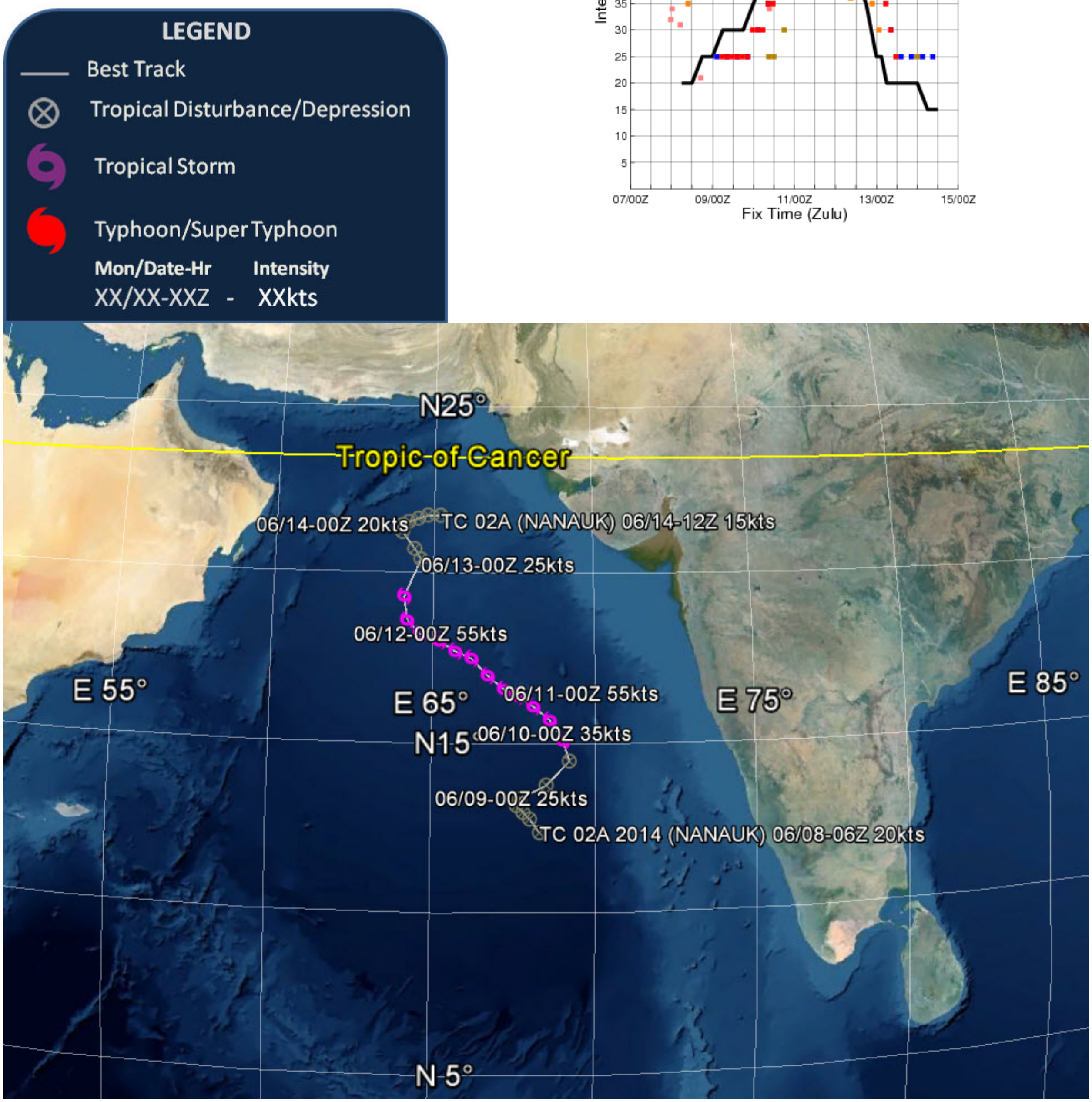


# 02A TROPICAL CYCLONE NANAUK

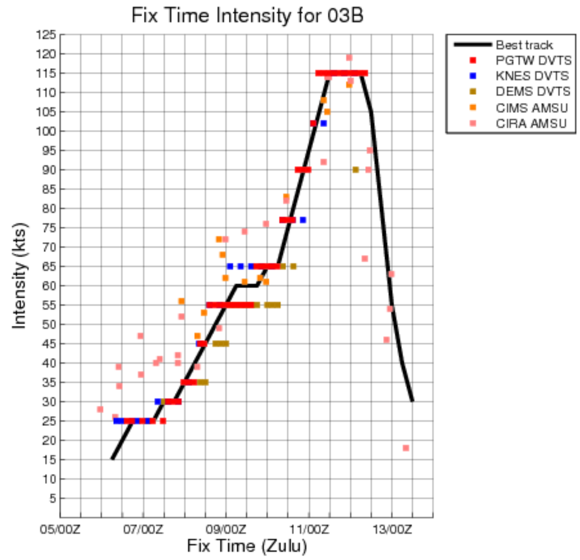
| | |
|---|---|
| ISSUED LOW: | 08 JUN/ 1400Z |
| ISSUED MED: | 08 JUN/ 1800Z |
| FIRST TCFA: | 09 JUN/ 1330Z |
| FIRST WARNING: | 10 JUN/ 0000Z |
| LAST WARNING: | 13 JUN/ 0600Z |
| MAX INTENSITY: | 55 |
| WARNINGS: | 14 |

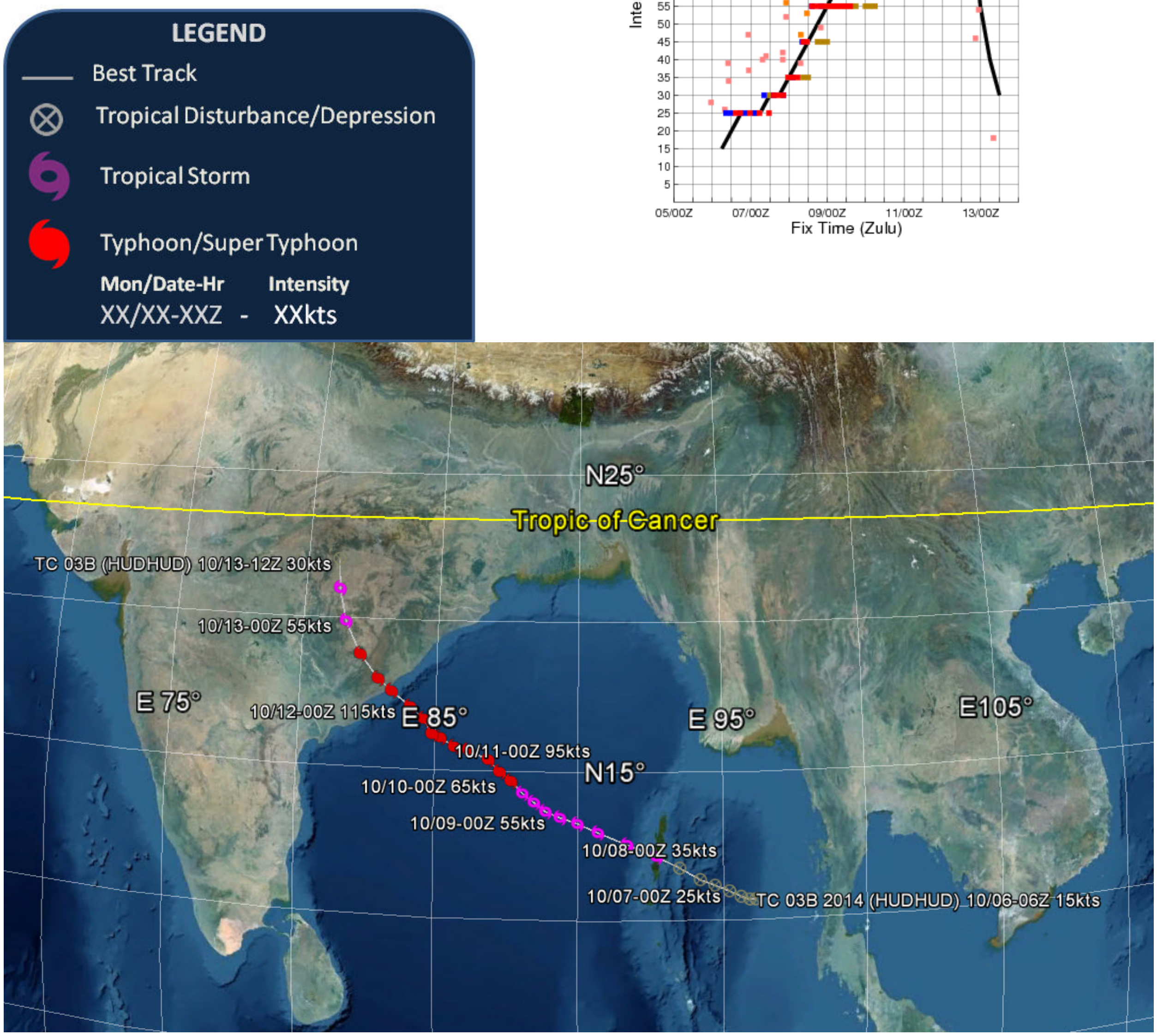


<u>**03B TROPICAL CYCLONE HUDHUD**</u>

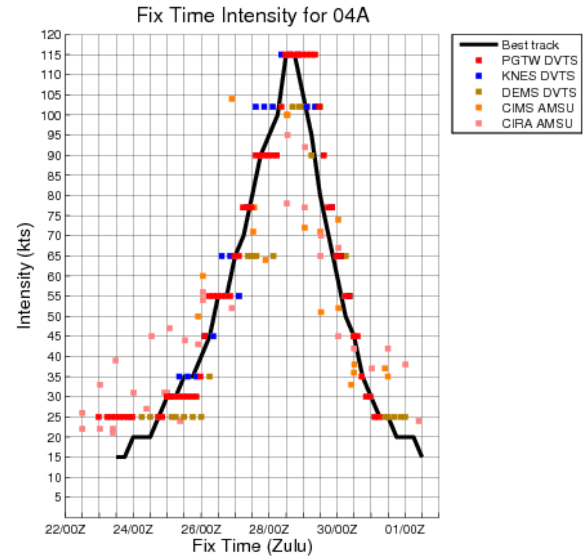
ISSUED LOW: 06 OCT/ 1800Z
ISSUED MED: 07 OCT/ 0300Z
FIRST TCFA: 07 OCT/ 1330Z
FIRST WARNING: 08 OCT/ 0000Z
LAST WARNING: 12 OCT/ 1200Z
MAX INTENSITY: 115
WARNINGS: 19

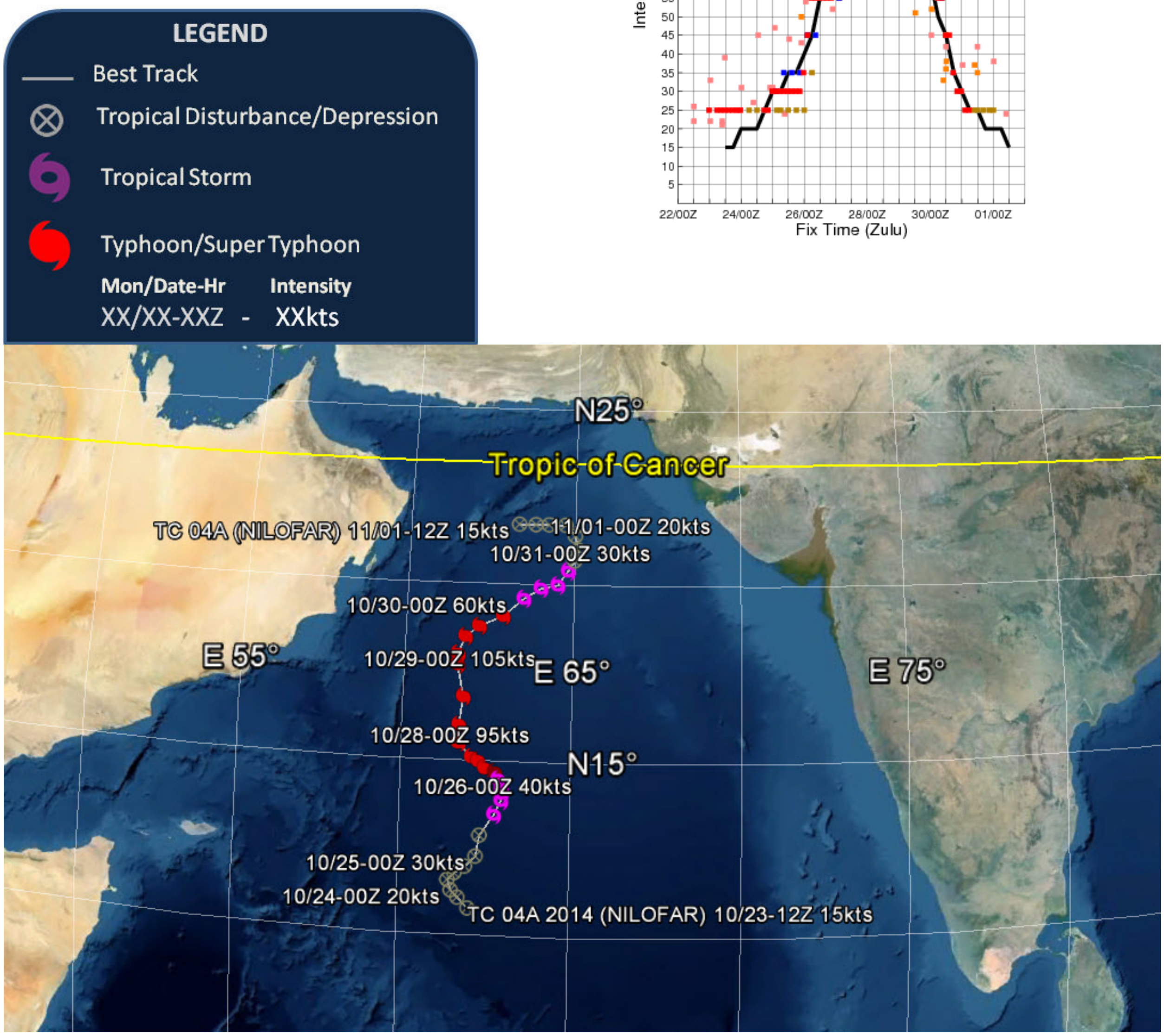


## 04A TROPICAL CYCLONE NILOFAR

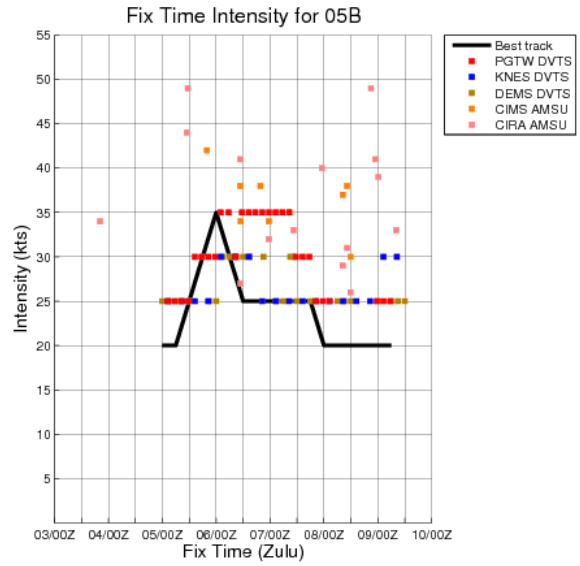
| | |
|---|---|
| ISSUED LOW: | 23 OCT/ 0000Z |
| ISSUED MED: | 24 OCT/ 0600Z |
| FIRST TCFA: | 24 OCT/ 2200Z |
| FIRST WARNING: | 25 OCT/ 1200Z |
| LAST WARNING: | 30 OCT/ 1800Z |
| MAX INTENSITY: | 115 |
| WARNINGS: | 22 |

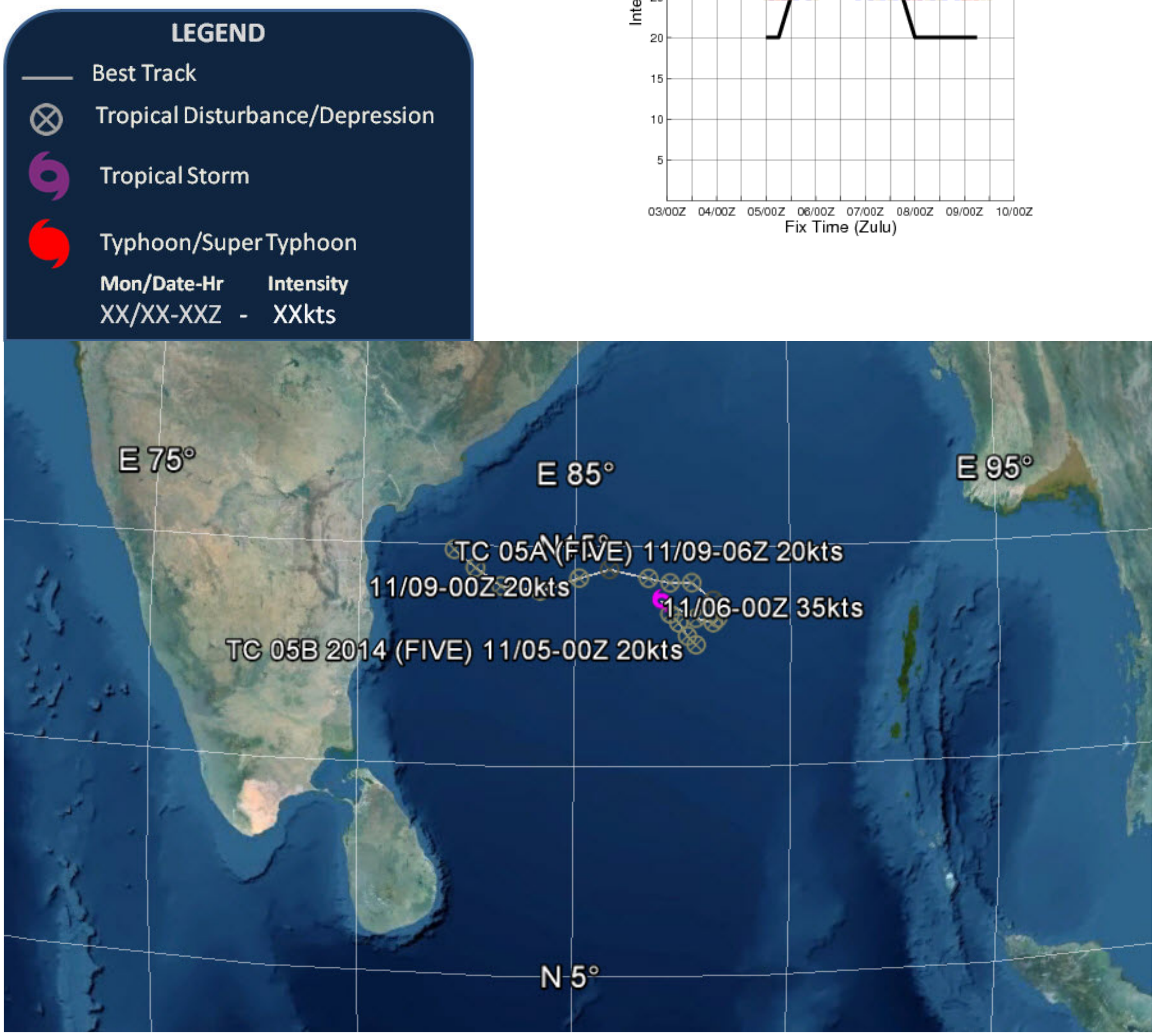


## 05B TROPICAL CYCLONE FIVE

| | |
|---|---|
| ISSUED LOW: | 04 NOV/ 1800Z |
| ISSUED MED: | 05 NOV/ 1000Z |
| FIRST TCFA: | 05 NOV/ 2000Z |
| FIRST WARNING: | 06 NOV/ 0000Z |
| LAST WARNING: | 07 NOV/ 1800Z |
| MAX INTENSITY: | 35 |
| WARNINGS: | 8 |



## Chapter 3 South Pacific and South Indian Ocean Tropical Cyclones

This chapter contains information on South Pacific and South Indian Ocean TC activity that occurred during the 2014 tropical cyclone season (1 July 2013 – 30 June 2014) and the monthly distribution of TC activity summarized for 1975 - 2014.

### Section 1 Informational Tables

Table 3-1 is a summary of TC activity in the Southern Hemisphere during the 2014 season.

**Table 3-1**

**SOUTHERN HEMISPHERE TROPICAL CYCLONES FOR 2014**

**(01 JULY 2013- 30 JUNE 2014)**

| TC | NAME* | PERIOD** | | WARNINGS ISSUED | EST MAX SFC WINDS KTS |
|---|---|---|---|---|---|
| 01S | ONE | 27 OCT/ 0000Z | 28 OCT/ 0000Z | 3 | 40 |
| 02S | ALESSIA | 22 NOV/ 0600Z | 27 NOV/ 1800Z | 7 | 45 |
| 03S | AMARA | 16 DEC/ 1800Z | 23 DEC/ 1200Z | 15 | 130 |
| 04S | BRUCE | 17 DEC/ 1800Z | 24 DEC/ 1200Z | 15 | 140 |
| 05S | CHRISTINE | 28 DEC/ 0600Z | 30 DEC/ 1800Z | 11 | 100 |
| 06S | BEJISA | 29 DEC/ 0600Z | 06 JAN/ 1800Z | 16 | 115 |
| 07P | IAN | 05 JAN/ 1800Z | 13 JAN/ 1800Z | 17 | 130 |
| 08S | COLIN | 09 JAN/ 1800Z | 15 JAN/ 1200Z | 13 | 120 |
| 09S | DELIWE | 16 JAN/ 1200Z | 18 JAN/ 0000Z | 5 | 50 |
| 10P | JUNE | 17 JAN/ 1200Z | 19 JAN/ 0600Z | 5 | 45 |
| 11P | DYLAN | 29 JAN/ 0000Z | 31 JAN/ 0000Z | 5 | 45 |
| 12P | EDNA | 04 FEB/ 1200Z | 03 FEB/ 1800Z | 4 | 55 |
| 13S | EDILSON | 05 FEB/ 0000Z | 07 FEB/ 1800Z | 7 | 55 |
| 14S | FOBANE | 06 FEB/ 1800Z | 14 FEB/ 0600Z | 16 | 60 |
| 15S | GUITO | 18 FEB/ 1800Z | 22 FEB/ 0600Z | 9 | 65 |
| 16P | KOFI | 28 FEB/ 0600Z | 03 MAR/ 1800Z | 8 | 50 |
| 17P | GILLIAN | 08 MAR/ 1200Z | 11 MAR/ 0000Z | 16 | 140 |
| 18P | LUSI | 9 MAR/ 1800Z | 13 MAR/ 1800Z | 9 | 70 |
| 19P | HADI | 10 MAR/ 0600Z | 11 MAR/ 0600Z | 3 | 40 |
| 20P | MIKE | 19 MAR/ 0600Z | 19 MAR/ 1800Z | 2 | 35 |
| 21S | HELLEN | 28 MAR/ 1800Z | 01 APR/ 0000Z | 8 | 130 |
| 22S | IVANOE | 04 APR/ 1200Z | 06 APR/ 1200Z | 5 | 45 |
| 23P | ITA | 04 APR/ 1800Z | 14 APR/ 0600Z | 20 | 140 |
| 24S | JACK | 18 APR/ 1800Z | 22 APR/ 0600Z | 8 | 90 |

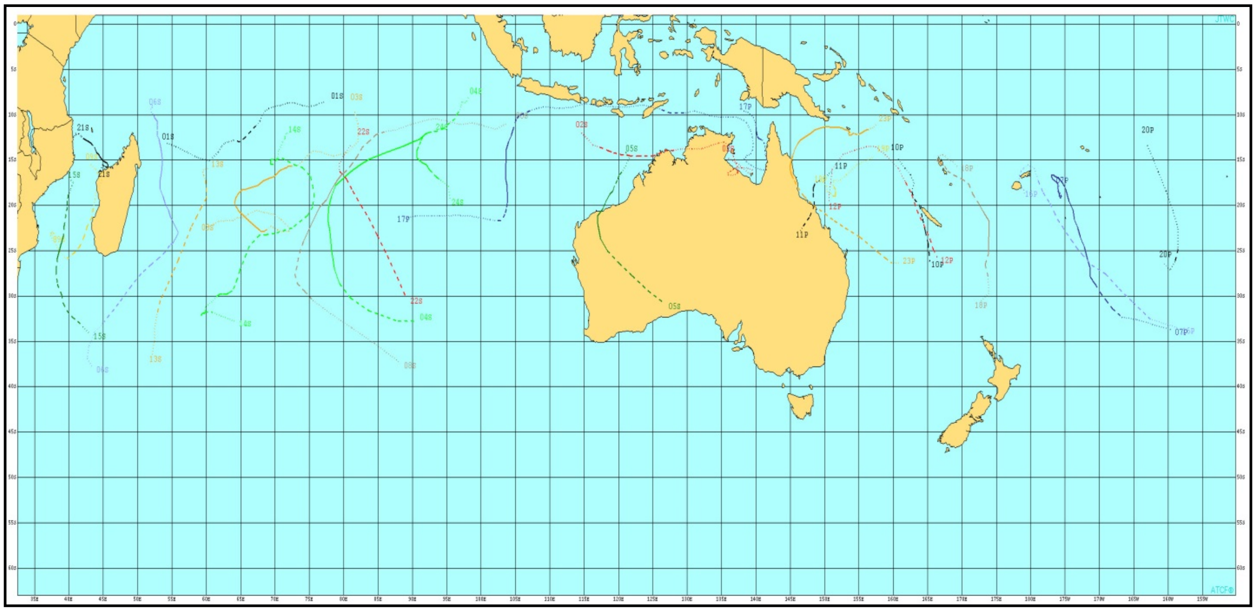
* As designated by the responsible RSMC

** Dates are based on the issuance of JTWC warnings on the system.

Table 3-2 provides the monthly distribution of Tropical Cyclone activity summarized for 1975 - 2014.

| Table 3-2 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTRIBUTION OF SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES FOR 1958 - 2014 | | | | | | | | | | | | | |
| **YEAR** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **TOTALS** |
| **1958 - 1977 AVERAGE*** | | | | | | | | | | | | | |
| - | - | - | - | 0.4 | 1.5 | 3.6 | 6.1 | 5.8 | 4.7 | 2.1 | 0.5 | - | 24.7 |
| **1981 - 2014** | | | | | | | | | | | | | |
| 1981 | 0 | 0 | 0 | 1 | 3 | 2 | 6 | 5 | 3 | 3 | 1 | 0 | 24 |
| 1982 | 1 | 0 | 0 | 1 | 1 | 3 | 9 | 4 | 2 | 3 | 1 | 0 | 25 |
| 1983 | 1 | 0 | 0 | 1 | 1 | 3 | 5 | 6 | 3 | 5 | 0 | 0 | 25 |
| 1984 | 1 | 0 | 0 | 1 | 2 | 5 | 5 | 10 | 4 | 2 | 0 | 0 | 30 |
| 1985 | 0 | 0 | 0 | 0 | 1 | 7 | 9 | 9 | 6 | 3 | 0 | 0 | 35 |
| 1986 | 0 | 0 | 1 | 0 | 1 | 1 | 9 | 9 | 6 | 4 | 2 | 0 | 33 |
| 1987 | 0 | 1 | 0 | 0 | 1 | 3 | 6 | 8 | 3 | 4 | 1 | 1 | 28 |
| 1988 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 5 | 3 | 1 | 2 | 0 | 21 |
| 1989 | 0 | 0 | 0 | 0 | 2 | 1 | 5 | 8 | 6 | 4 | 2 | 0 | 28 |
| 1990 | 2 | 0 | 1 | 1 | 2 | 2 | 4 | 4 | 10 | 2 | 1 | 0 | 29 |
| 1991 | 0 | 0 | 1 | 1 | 1 | 3 | 2 | 5 | 5 | 2 | 1 | 1 | 22 |
| 1992 | 0 | 0 | 1 | 1 | 2 | 5 | 4 | 11 | 3 | 2 | 1 | 0 | 30 |
| 1993 | 0 | 0 | 1 | 1 | 0 | 5 | 7 | 7 | 2 | 2 | 2 | 0 | 27 |
| 1994 | 0 | 0 | 0 | 0 | 2 | 4 | 8 | 4 | 9 | 3 | 0 | 0 | 30 |
| 1995 | 0 | 0 | 0 | 0 | 2 | 2 | 5 | 4 | 5 | 4 | 0 | 0 | 22 |
| 1996 | 0 | 0 | 0 | 0 | 1 | 3 | 7 | 6 | 6 | 4 | 1 | 0 | 28 |
| 1997 | 1 | 1 | 1 | 2 | 2 | 6 | 9 | 8 | 3 | 1 | 3 | 1 | 38 |
| 1998 | 1 | 0 | 0 | 3 | 2 | 3 | 7 | 9 | 6 | 6 | 0 | 0 | 37 |
| 1999 | 1 | 0 | 1 | 1 | 1 | 6 | 6 | 8 | 7 | 2 | 0 | 0 | 33 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 5 | 7 | 6 | 0 | 0 | 27 |
| 2001 | 0 | 1 | 0 | 0 | 1 | 1 | 4 | 6 | 2 | 5 | 0 | 1 | 21 |
| 2002 | 0 | 0 | 0 | 2 | 4 | 1 | 4 | 5 | 4 | 2 | 3 | 0 | 25 |
| 2003 | 0 | 0 | 1 | 0 | 2 | 5 | 5 | 7 | 5 | 2 | 1 | 1 | 29 |
| 2004 | 0 | 0 | 0 | 1 | 1 | 3 | 6 | 3 | 7 | 1 | 1 | 0 | 23 |
| 2005 | 0 | 0 | 1 | 1 | 2 | 2 | 7 | 7 | 4 | 2 | 0 | 0 | 26 |
| 2006 | 0 | 0 | 0 | 1 | 2 | 1 | 6 | 5 | 5 | 3 | 0 | 0 | 23 |
| 2007 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 5 | 6 | 6 | 1 | 1 | 24 |
| 2008 | 1 | 0 | 0 | 0 | 3 | 4 | 7 | 5 | 6 | 3 | 0 | 0 | 29 |
| 2009 | 0 | 0 | 0 | 1 | 2 | 2 | 7 | 4 | 8 | 3 | 0 | 0 | 27 |
| 2010 | 0 | 0 | 0 | 0 | 2 | 4 | 5 | 6 | 5 | 2 | 0 | 0 | 24 |
| 2011 | 0 | 0 | 0 | 1 | 1 | 2 | 6 | 7 | 2 | 2 | 0 | 0 | 21 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 4 | 5 | 6 | 2 | 1 | 1 | 2 | 21 |
| 2013 | 0 | 0 | 0 | 1 | 1 | 4 | 7 | 5 | 2 | 3 | 1 | 0 | 24 |
| 2014 | 0 | 0 | 0 | 1 | 1 | 4 | 5 | 4 | 6 | 3 | 0 | 0 | 24 |
| **(1981 - 2014)** | | | | | | | | | | | | | |
| MEAN | 0.3 | 0.1 | 0.3 | 0.7 | 1.5 | 3.2 | 5.9 | 6.2 | 4.8 | 3.0 | 0.8 | 0.2 | 26.9 |
| CASES | 9 | 3 | 9 | 23 | 52 | 109 | 200 | 210 | 163 | 101 | 26 | 8 | 913 |
| * (GRAY, 1978) | | | | | | | | | | | | | |

1) If a tropical cyclone was warned on prior to the last two days of a month, it was attributed to the first month, regardless of how long the system lasted.
2) If a tropical cyclone began on the last day of the month and ended on the first day of the next month, that system was attributed to the first month. However, if a tropical cyclone began on the last day of the month and continued into the next month for only two days, it was attributed to the second month.



| | |
|---|---|
| 01S TC ONE | 20 OCT - 30 OCT |
| 02S TC ALESSIA | 19 NOV - 30 NOV |
| 03S TC AMARA | 14 DEC - 29 DEC |
| 04S TC BRUCE | 14 DEC - 25 DEC |
| 05S TC CHRISTINE | 26 DEC - 01 JAN |
| 06S TC BEJISA | 27 DEC - 07 JAN |
| 07P TC IAN | 04 JAN - 14 JAN |
| 08S TC COLIN | 06 JAN - 16 JAN |
| 09S TC DELIWE | 13 JAN - 22 JAN |
| 10P TC JUNE | 15 JAN - 19 JAN |
| 11P TC DYLAN | 27 JAN - 31 JAN |
| 12P TC EDNA | 31 JAN - 06 FEB |
| 13S TC EDILSON | 03 FEB - 08 FEB |
| 14S TC FOBANE | 03 FEB - 17 FEB |
| 15S TC GUITO | 16 FEB - 23 FEB |
| 16P TC KOFI | 24 FEB - 04 MAR |
| 17P TC GILLIAN | 06 MAR - 29 MAR |
| 18P TC LUSI | 07 MAR - 14 MAR |
| 19P TC HADI | 06 MAR - 14 MAR |
| 20P TC MIKE | 17 MAR - 20 MAR |
| 21S TC HELLEN | 26 MAR - 05 APR |
| 22S TC IVANOE | 03 APR - 06 APR |
| 23P TC ITA | 01 APR - 15 APR |
| 24S TC JACK | 17 APR - 22 APR |

MAXIMUM SUSTAINED SURFACE WIND
——— 64KT (33M/SEC) OR GREATER
– – · 34 TO 63KT (18 TO 32M/SEC)
······ 33KT (17M/SEC) OR LESS

**Figure 3-1.** Southern Hemisphere Tropical Cyclones.

## Section 2 Cyclone Summaries

Each cyclone is presented, with the number and basin identifier assigned by JTWC, along with the RSMC assigned cyclone name. Dates are also listed when JTWC first designated various stages of development.

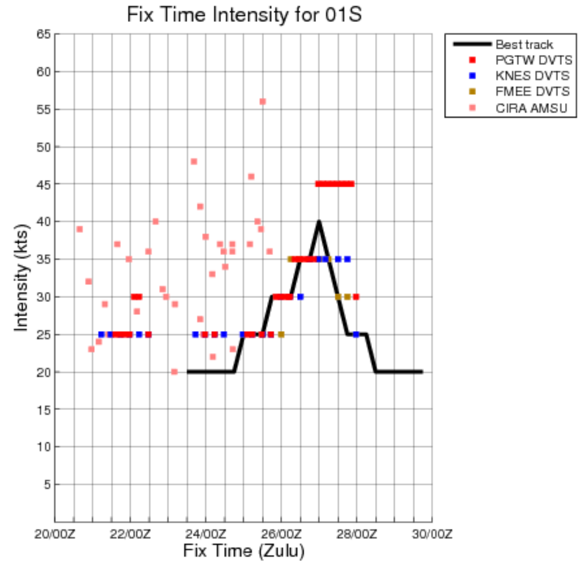
The first Tropical Cyclone Formation Alert (TCFA) and the initial and final warning dates are also presented with the number of warnings issued by JTWC. Landfall over major landmasses with approximate locations is presented as well.

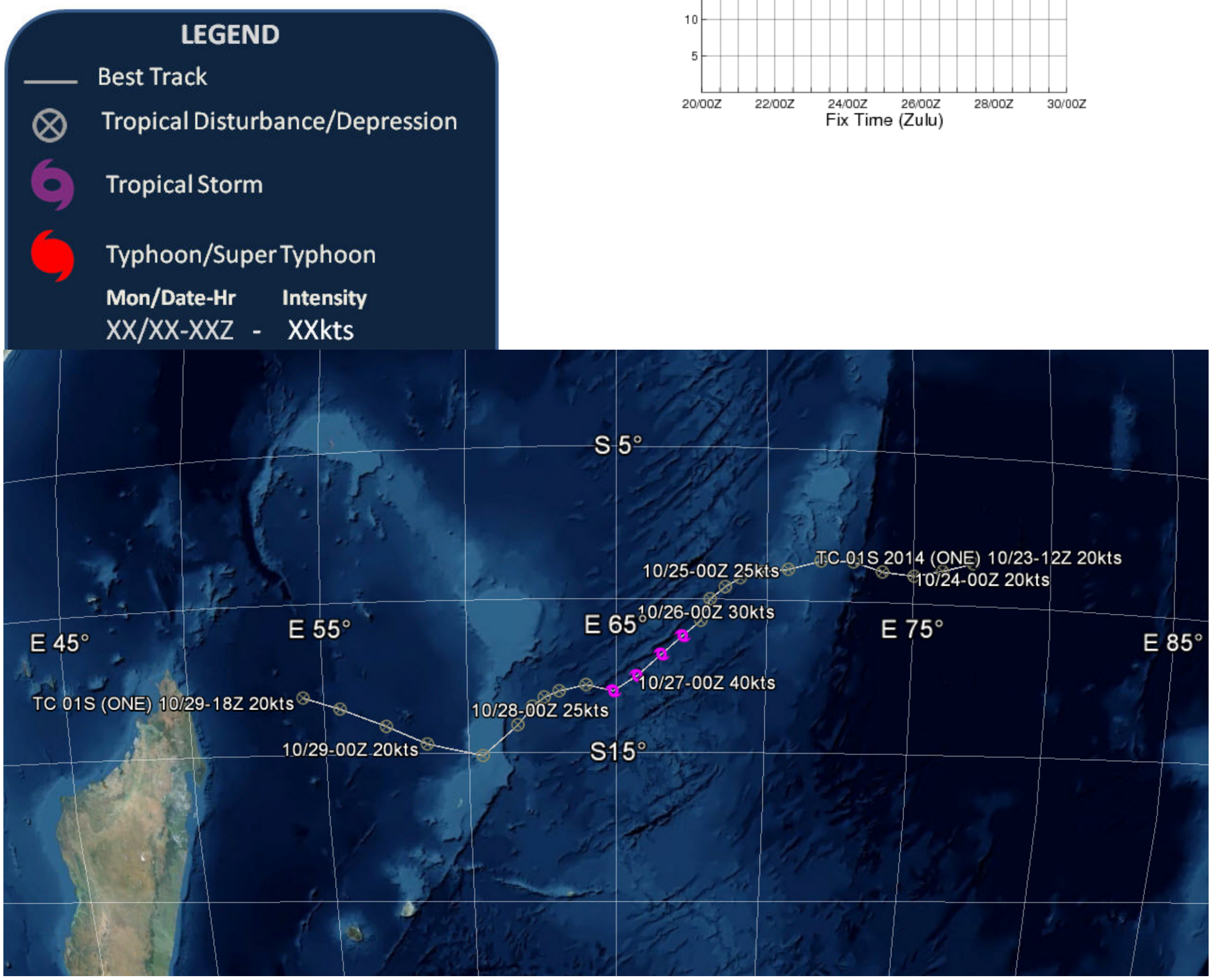
Data included on the best track are position and intensity noted with cyclone symbols and color coded track. Best track position labels include the date-time, track speed in knots, and maximum wind speed in knots. A graph of best track intensity versus time is presented. Fix plots on this graph are color coded by fixing agency.

In addition, if this document is viewed as a pdf, each map has been hyperlinked to the appropriate keyhole markup language (kmz) file that will allow the reader to access and view the best-track data interactively on their computer using Google Earth software. Simply hold the control button and click the map image; the link will open allowing the reader to download and open the file.
Users may also retrieve kmz files for the entire season from:
http://www.usno.navy.mil/NOOC/nmfc-ph/RSS/jtwc/best_tracks/2014/2014s-KMZs/JTWC_BestTrack_Climatology_2014.kmz

# 01S TROPICAL CYCLONE ONE

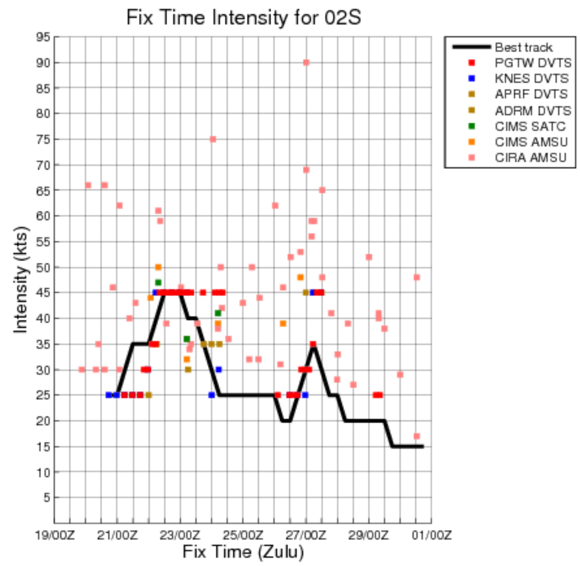
| | |
|---|---|
| ISSUED LOW: | N/A |
| ISSUED MED: | N/A |
| FIRST TCFA: | 25 OCT/ 2300Z |
| FIRST WARNING: | 27 OCT/ 0000Z |
| LAST WARNING: | 28 OCT/ 0000Z |
| MAX INTENSITY: | 40 |
| WARNINGS: | 3 |

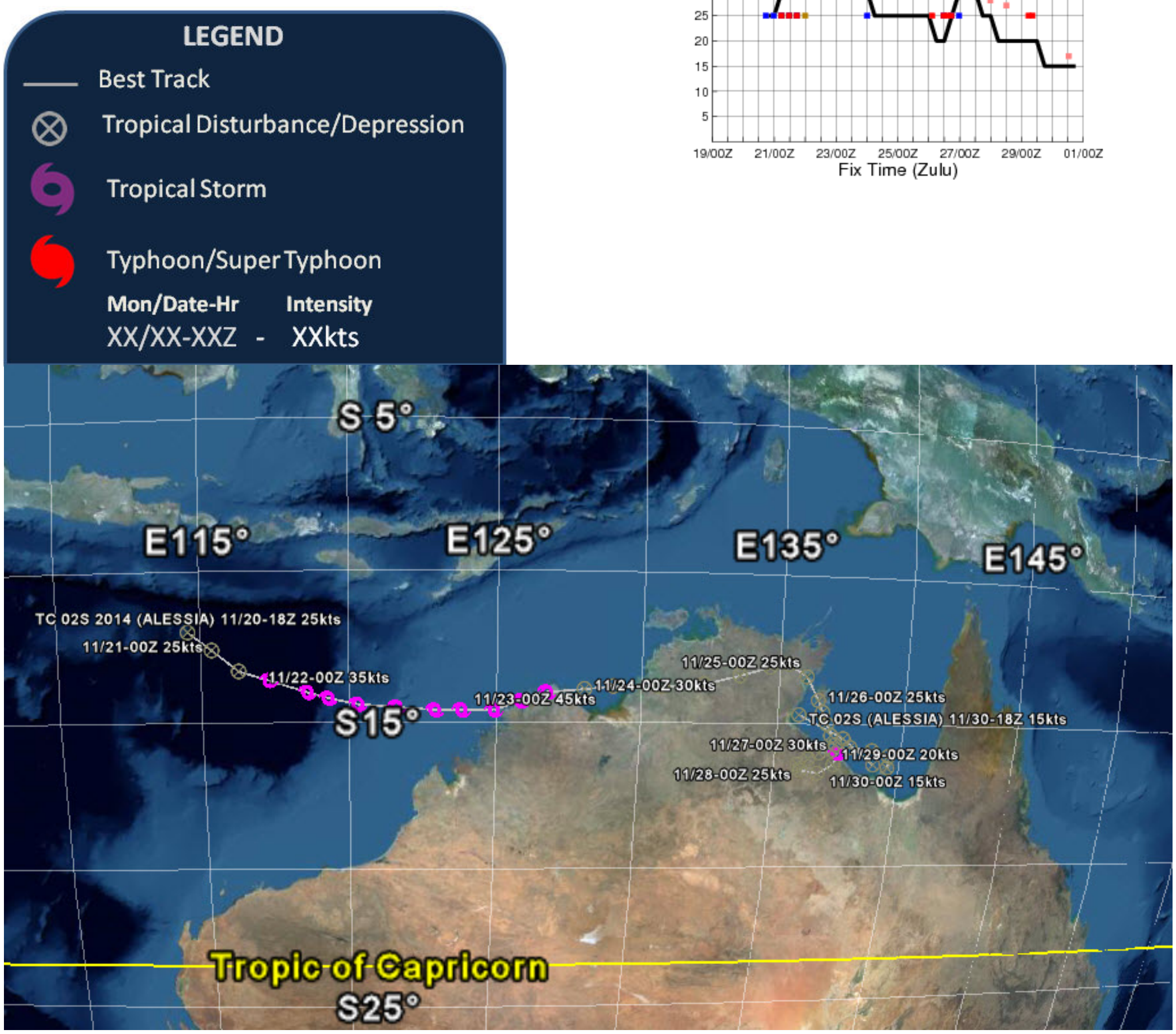


## 02S TROPICAL CYCLONE ALESSIA

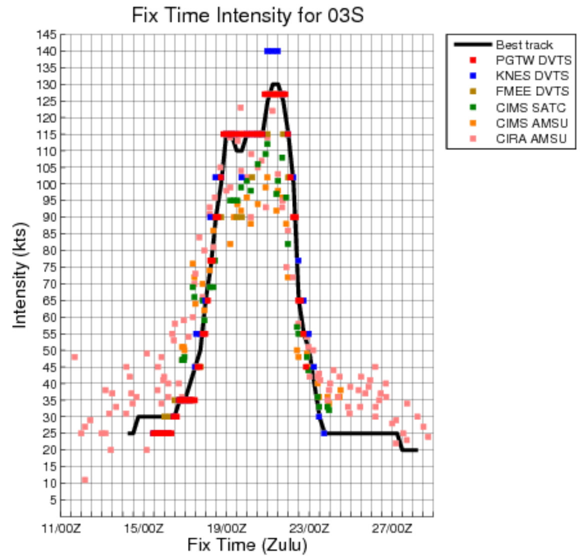
| | |
|---|---|
| ISSUED LOW: | 20 NOV/ 0630Z |
| ISSUED MED: | 20 NOV/ 1800Z |
| FIRST TCFA: | 20 NOV/ 1800Z |
| FIRST WARNING: | 22 NOV/ 0600Z |
| LAST WARNING: | 27 NOV/ 1800Z |
| MAX INTENSITY: | 45 |
| WARNINGS: | 7 |

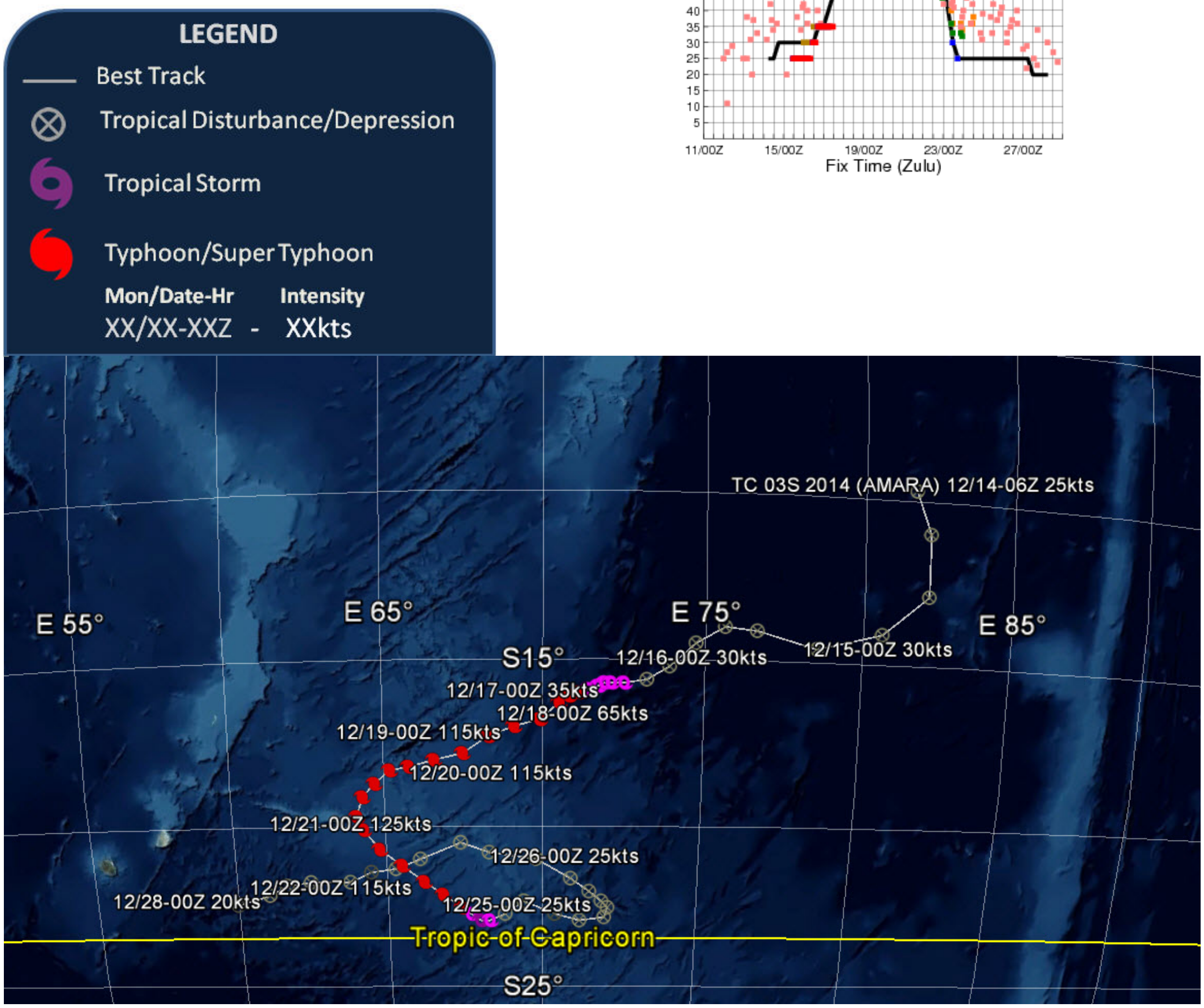


# 03S TROPICAL CYCLONE AMARA

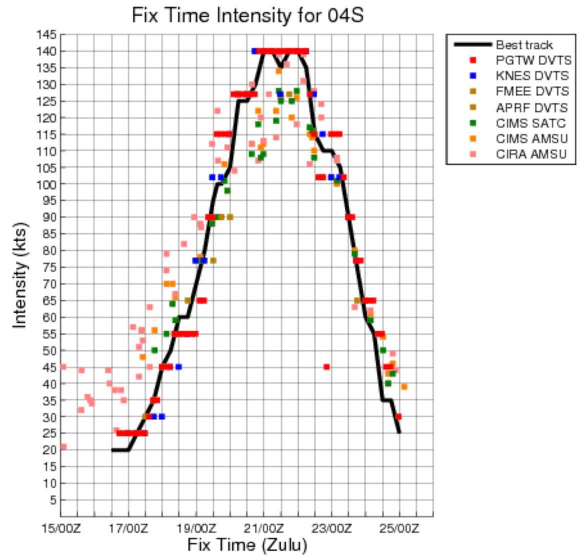
| | |
|---|---|
| ISSUED LOW: | 13 DEC/ 1400Z |
| ISSUED MED: | 14 DEC/ 0700Z |
| FIRST TCFA: | 15 DEC/ 1500Z, |
| FIRST WARNING: | 16 DEC/ 1800Z |
| LAST WARNING: | 23 DEC/ 1200Z |
| MAX INTENSITY: | 130 |
| WARNINGS: | 15 |

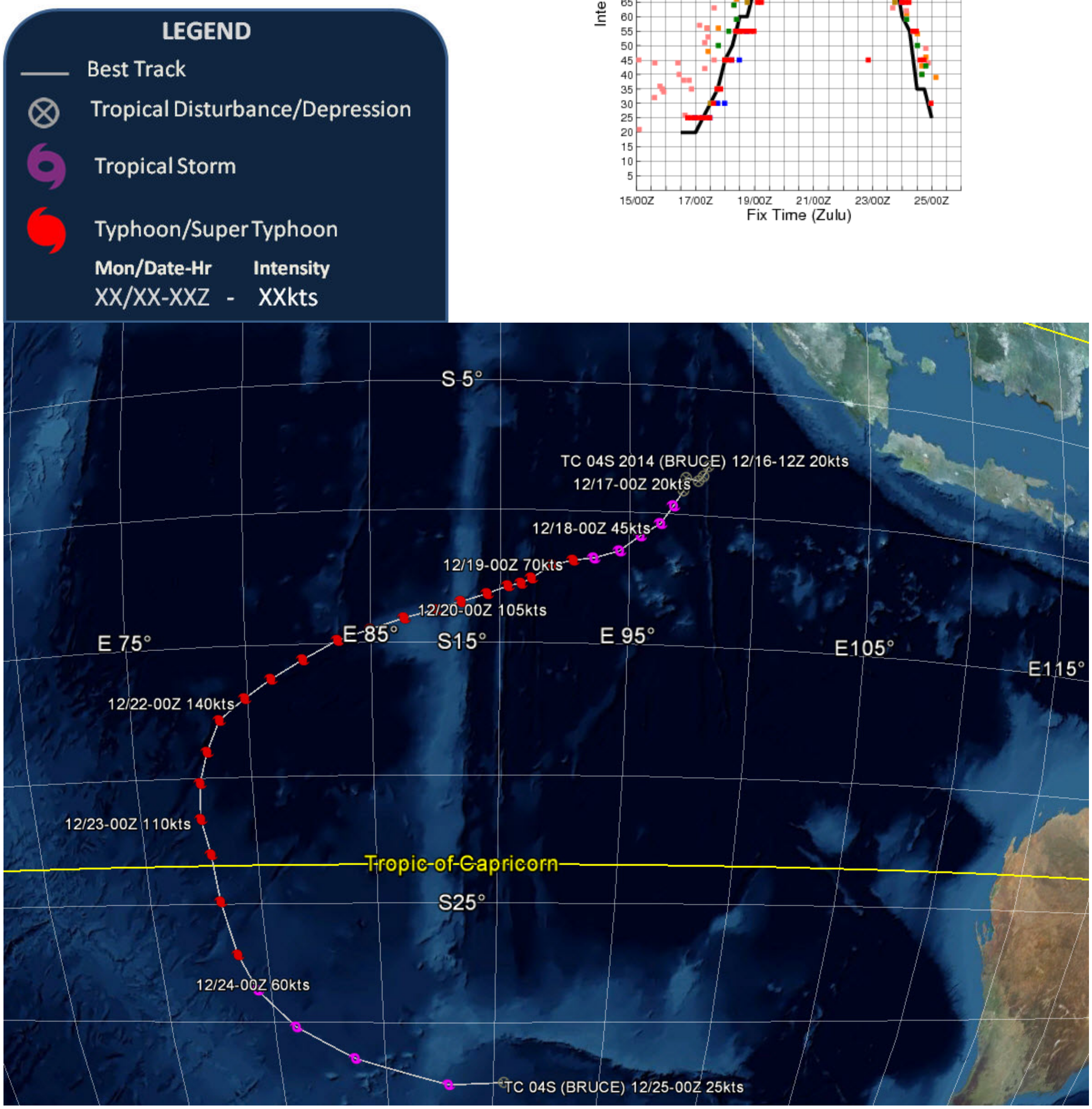


# 04S TROPICAL CYCLONE BRUCE

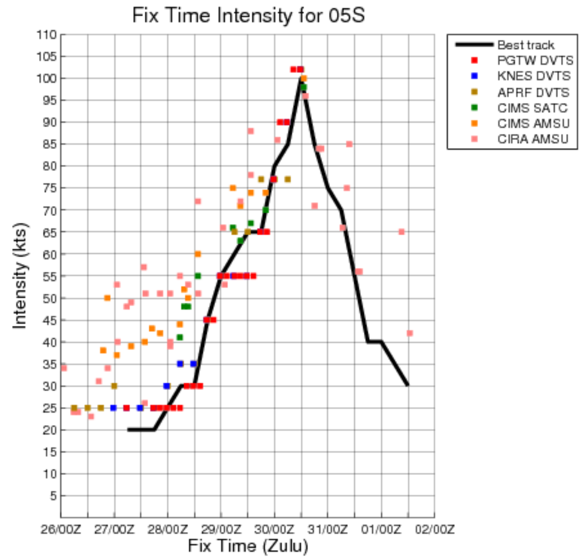
ISSUED LOW: 15 DEC/ 1500Z
ISSUED MED: 16 DEC / 1500Z
FIRST TCFA: 17 DEC/ 0300Z
FIRST WARNING: 17 DEC/ 2100Z
LAST WARNING: 24 DEC/ 1200Z
MAX INTENSITY: 140
WARNINGS: 15

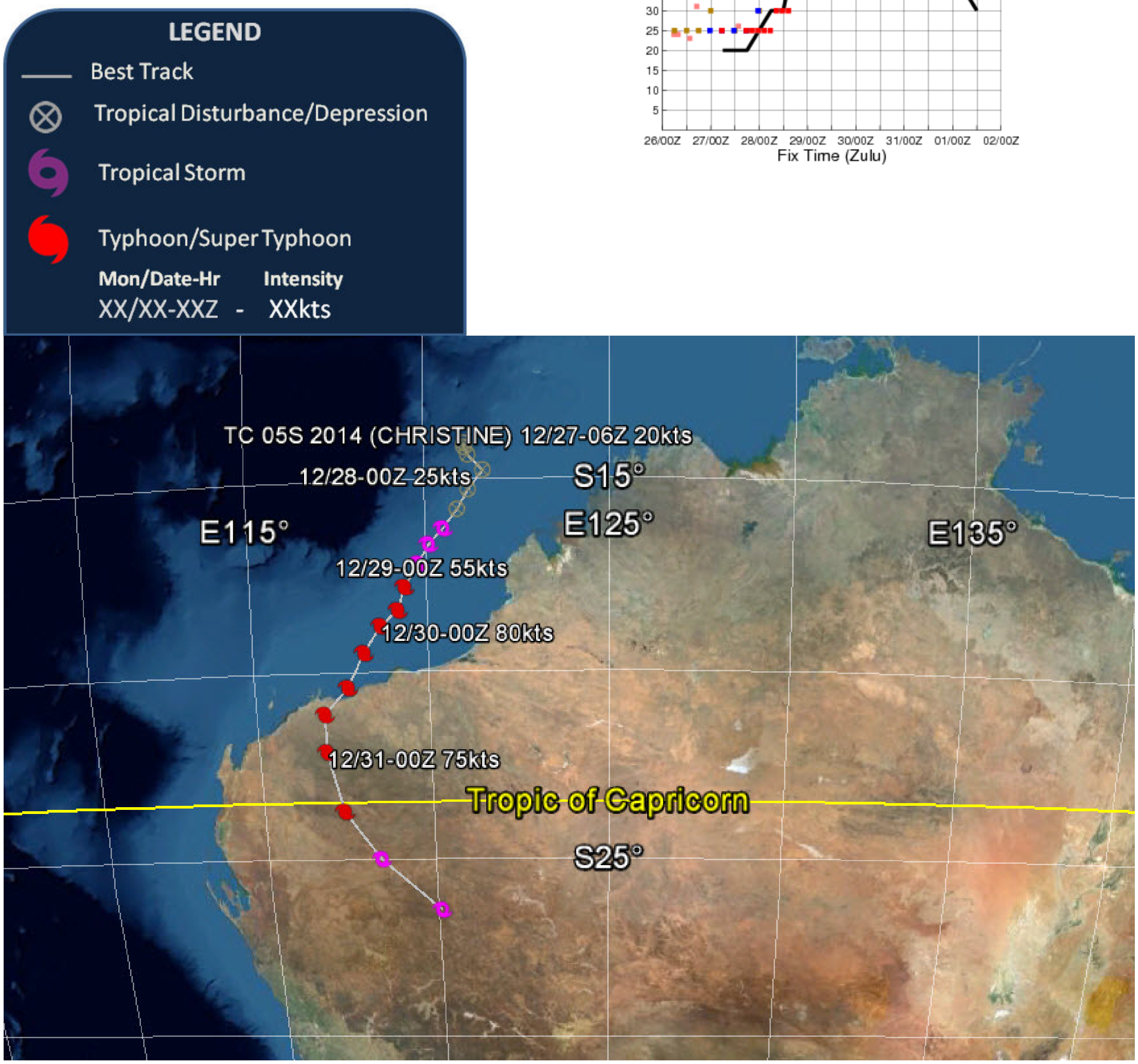


# 05S TROPICAL CYCLONE CHRISTINE

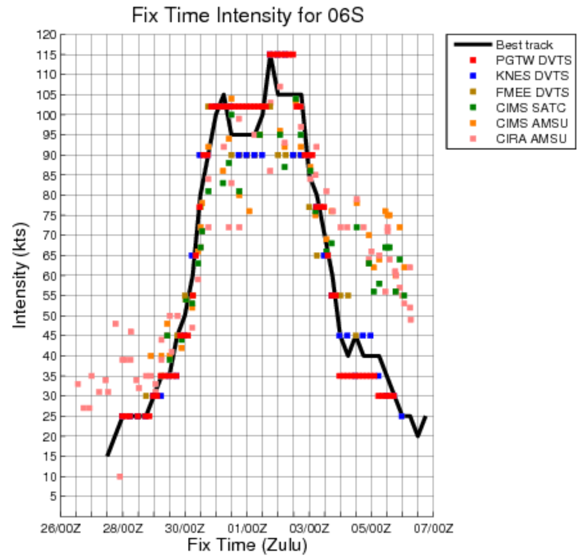
| | |
|---|---|
| ISSUED LOW: | 26 DEC/ 0530Z |
| ISSUED MED: | 26 DEC/ 1800Z |
| FIRST TCFA: | 27 DEC/ 0730Z |
| FIRST WARNING: | 28 DEC/ 0600Z |
| LAST WARNING: | 30 DEC/ 1800Z |
| MAX INTENSITY: | 100 |
| WARNINGS: | 11 |

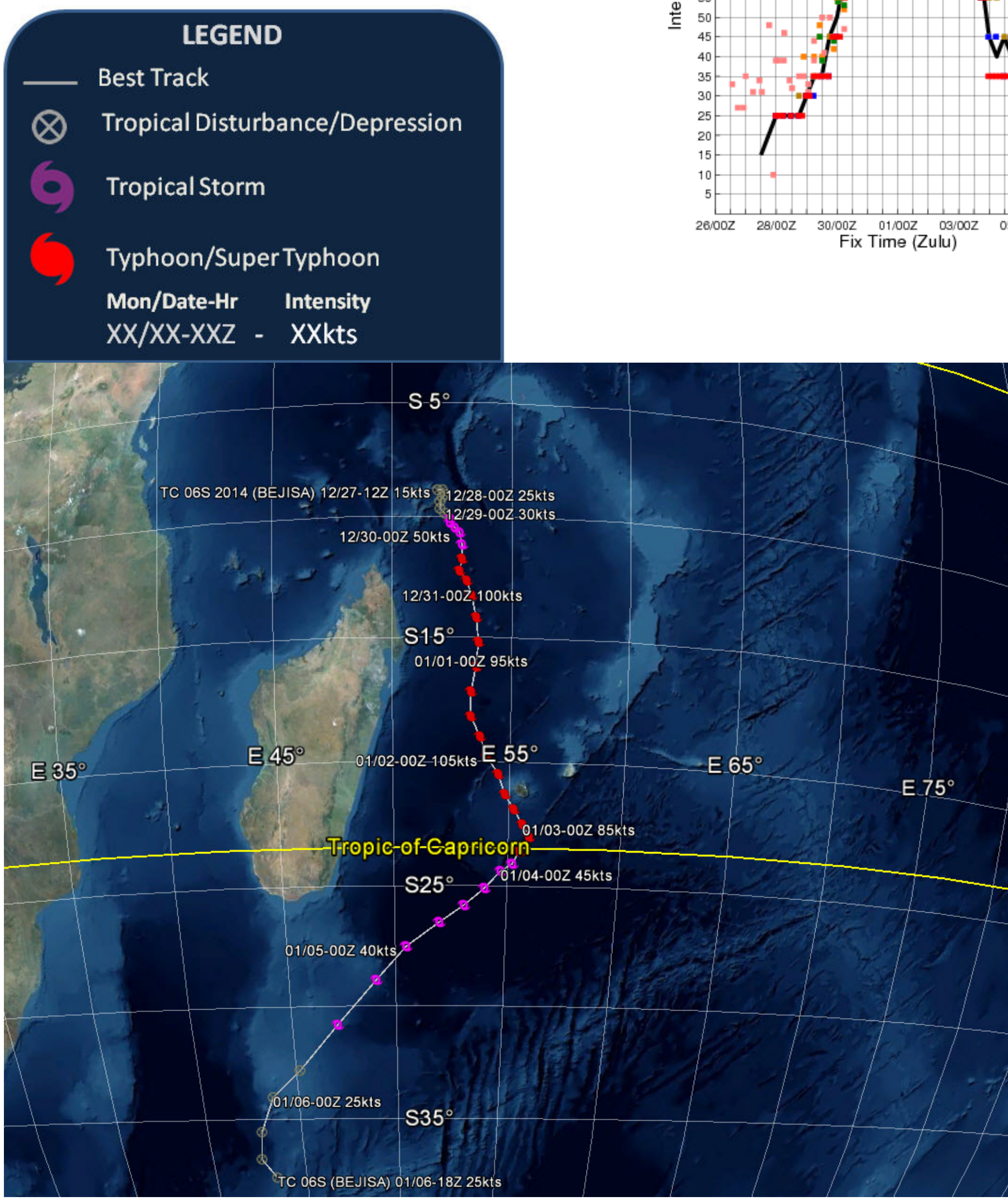


# 06S TROPICAL CYCLONE BEJISA

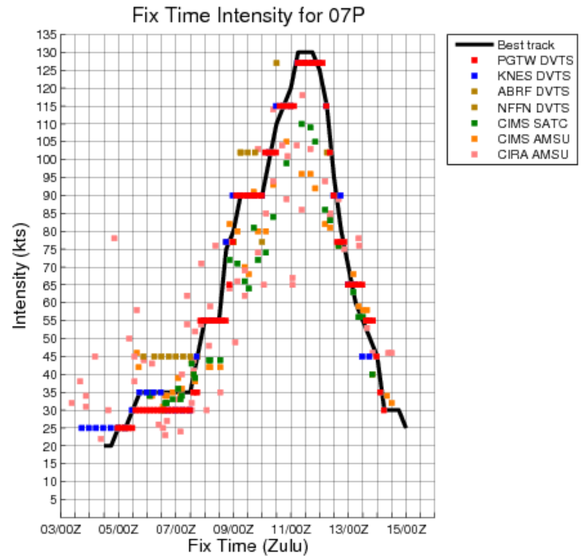
| | |
|---|---|
| ISSUED LOW: | 27 DEC/ 1800Z |
| ISSUED MED: | 28 DEC/ 1000Z |
| FIRST TCFA: | 29 DEC/ 0200Z |
| FIRST WARNING: | 29 DEC/ 0600Z |
| LAST WARNING: | 06 JAN/ 1800Z |
| MAX INTENSITY: | 115 |
| WARNINGS: | 16 |

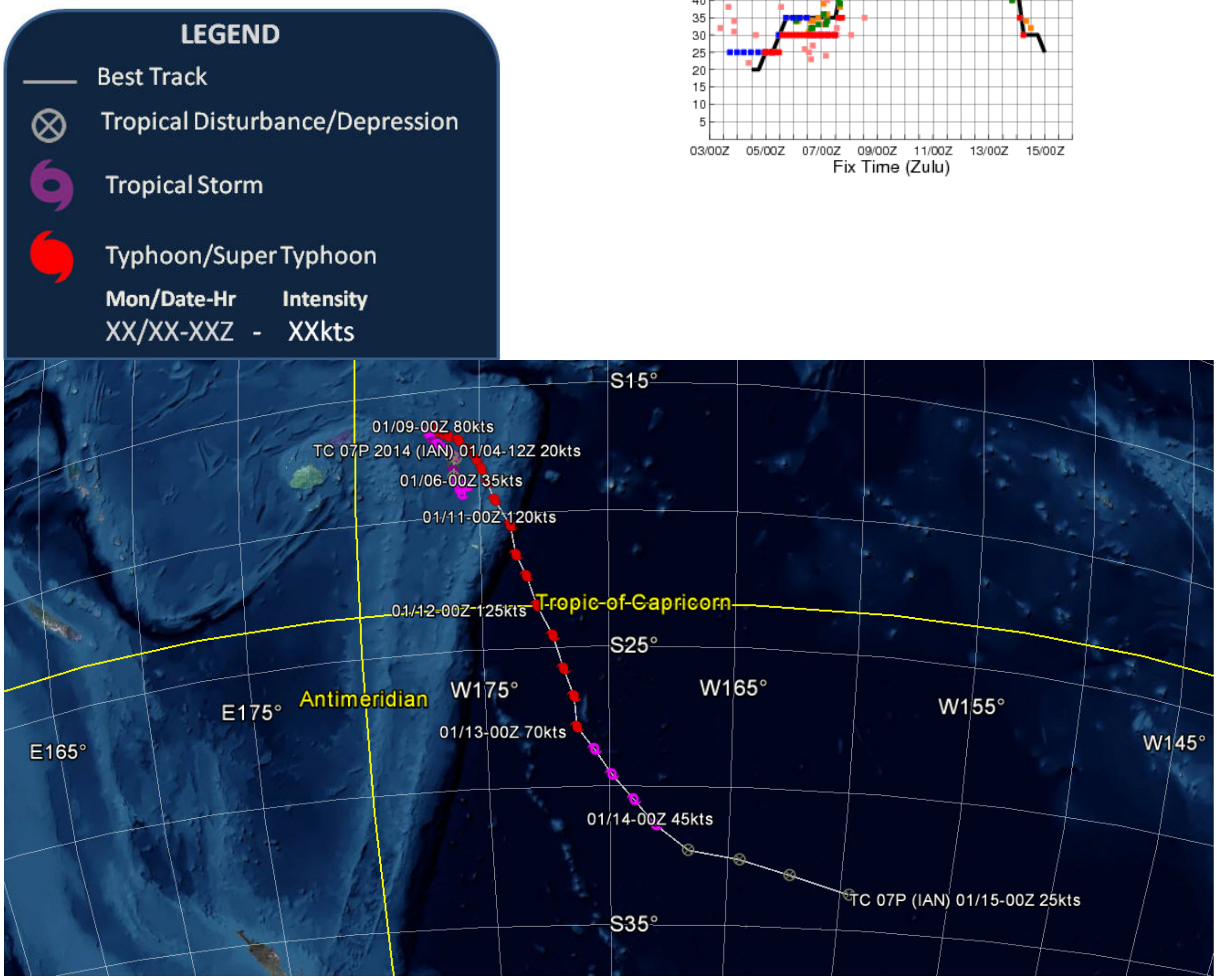


## 07P TROPICAL CYCLONE IAN

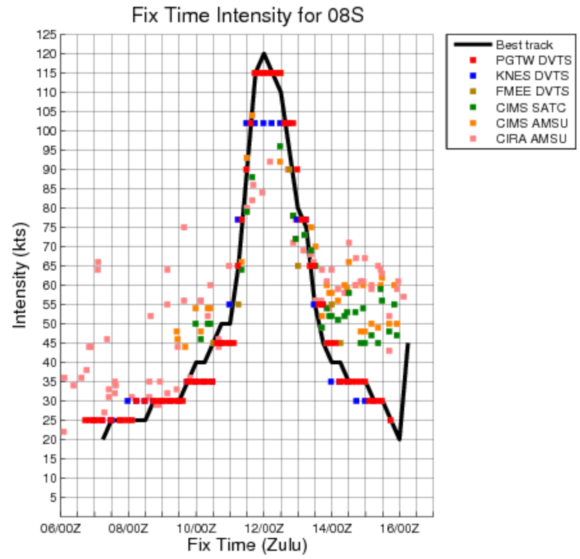
| | |
|---|---|
| ISSUED LOW: | 04 JAN /1200Z |
| ISSUED MED: | 04 JAN/ 2300Z |
| FIRST TCFA: | 05 JAN/ 0230Z |
| FIRST WARNING: | 05 JAN/ 1800Z |
| LAST WARNING: | 13 JAN/ 1800Z |
| MAX INTENSITY: | 130 |
| WARNINGS: | 17 |

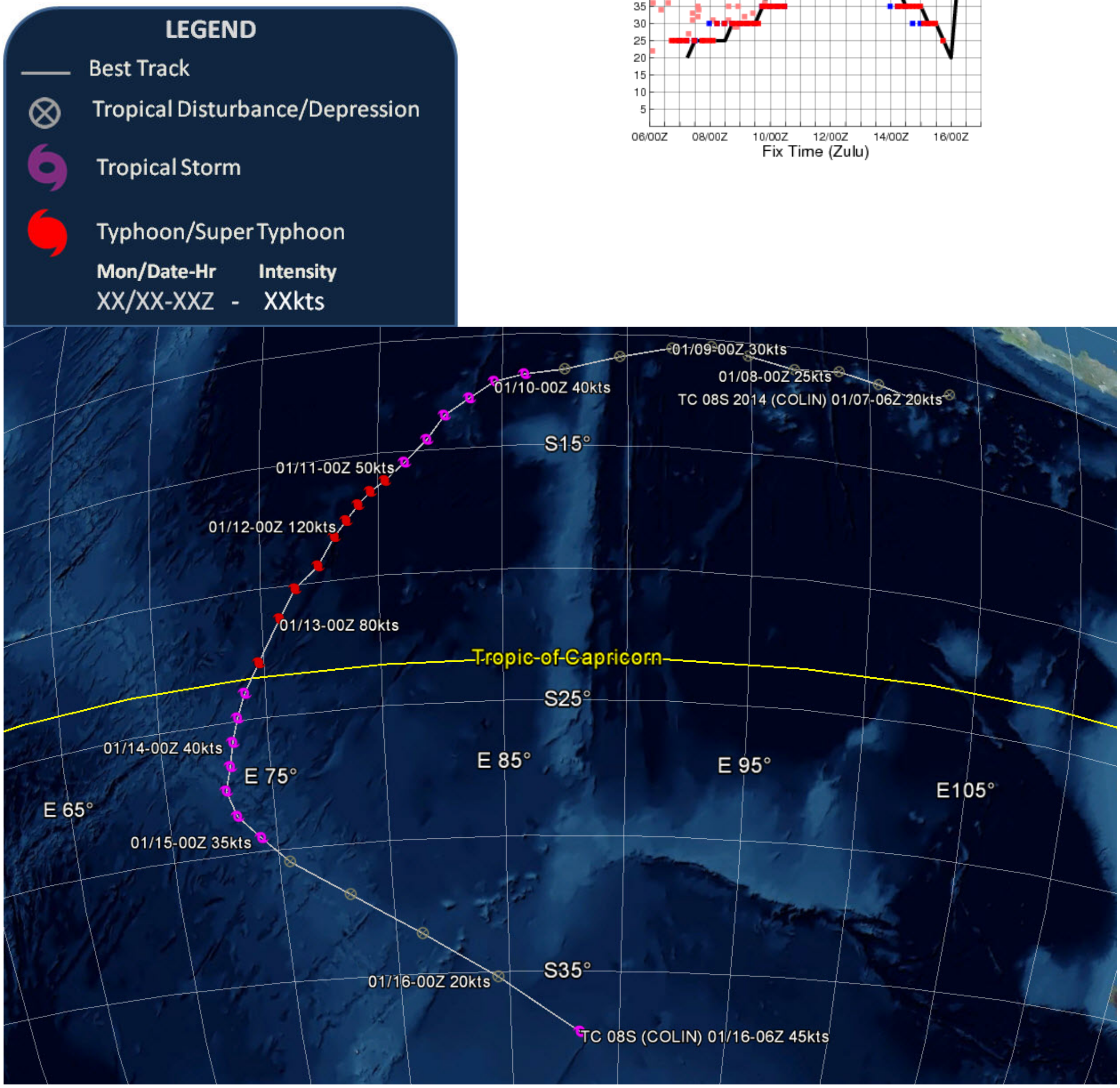


# 08S TROPICAL CYCLONE COLIN

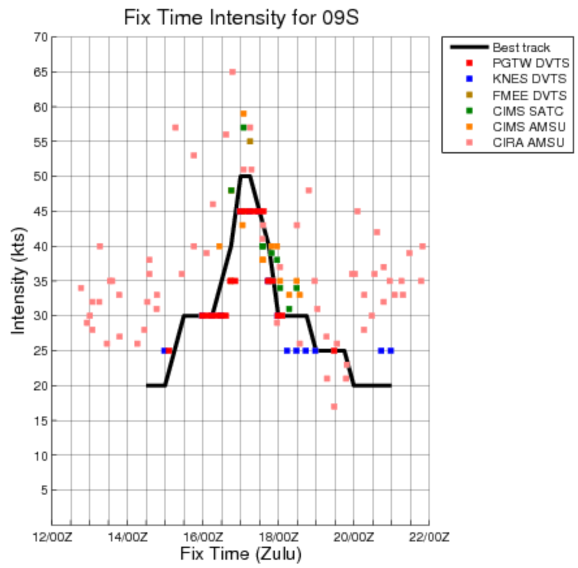
| | |
|---|---|
| ISSUED LOW: | 06 JAN/ 1800Z |
| ISSUED MED: | 07 JAN/ 0300Z |
| FIRST TCFA: | 08 JAN/ 2200Z |
| FIRST WARNING: | 09 JAN/ 1800Z |
| LAST WARNING: | 15 JAN/ 1200Z |
| MAX INTENSITY: | 120 |
| WARNINGS: | 13 |

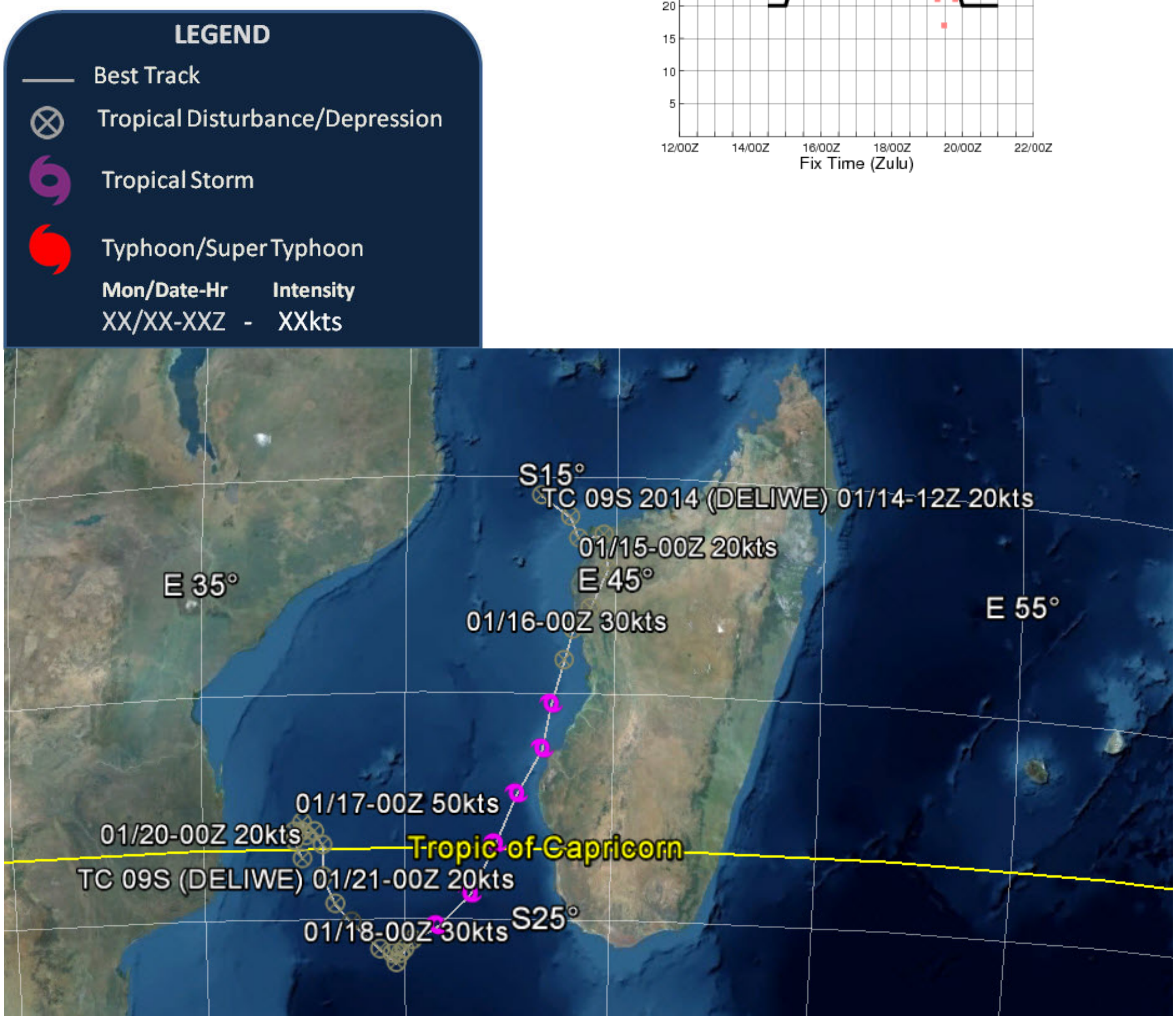


# 09S TROPICAL CYCLONE DELIWE

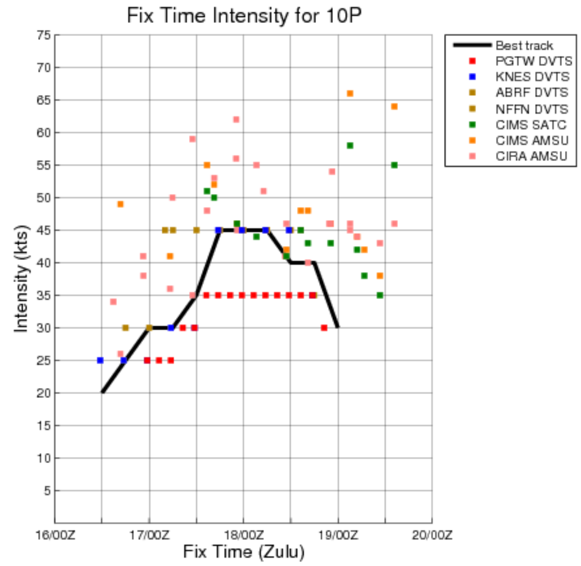
| | |
|---|---|
| ISSUED LOW: | 15 JAN/ 0030Z |
| ISSUED MED: | Skipped |
| FIRST TCFA: | 15 JAN/ 2000Z |
| FIRST WARNING: | 16 JAN/ 1200Z |
| LAST WARNING: | 18 JAN/ 0000Z |
| MAX INTENSITY: | 50 |
| WARNINGS: | 5 |

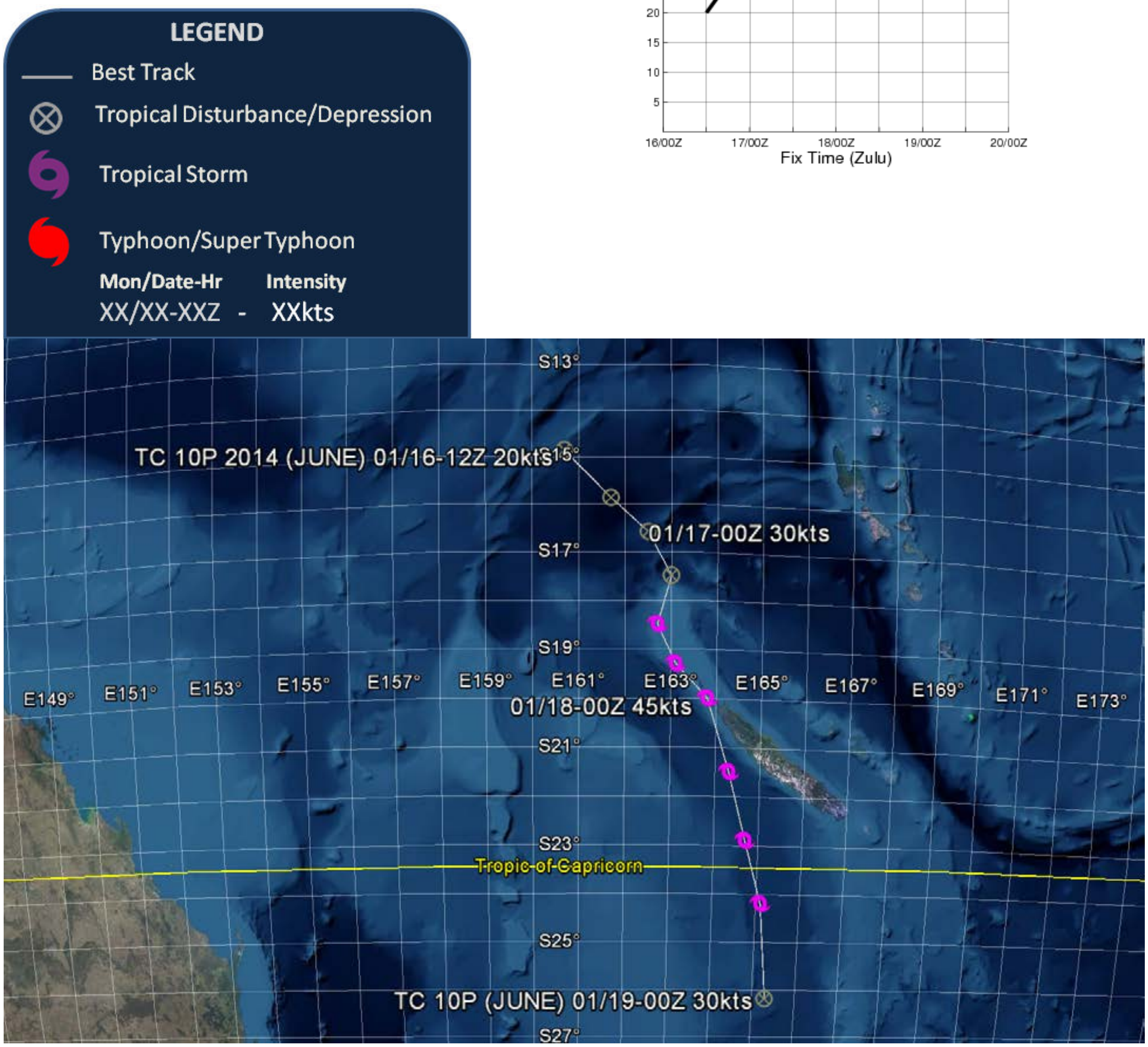


# 10P TROPICAL CYCLONE JUNE

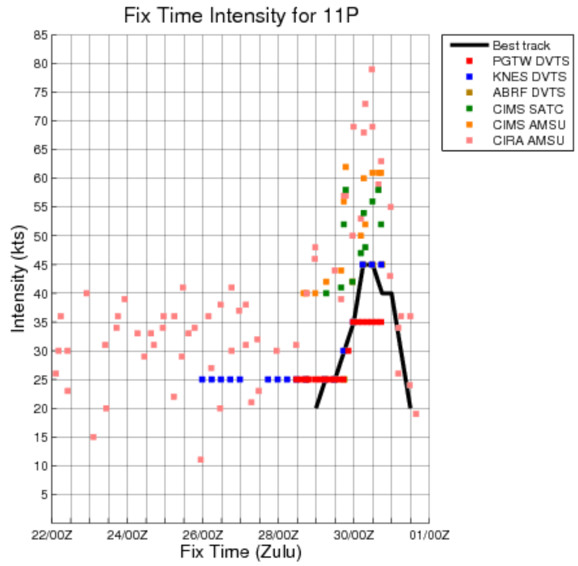
| | |
|---|---|
| ISSUED LOW: | 16 JAN/ 0600Z |
| ISSUED MED: | 16 JAN/ 1500Z |
| FIRST TCFA: | 17 JAN / 0300Z |
| FIRST WARNING: | 17 JAN/ 1200Z |
| LAST WARNING: | 19 JAN/ 0600Z |
| MAX INTENSITY: | 45 |
| WARNINGS: | 5 |

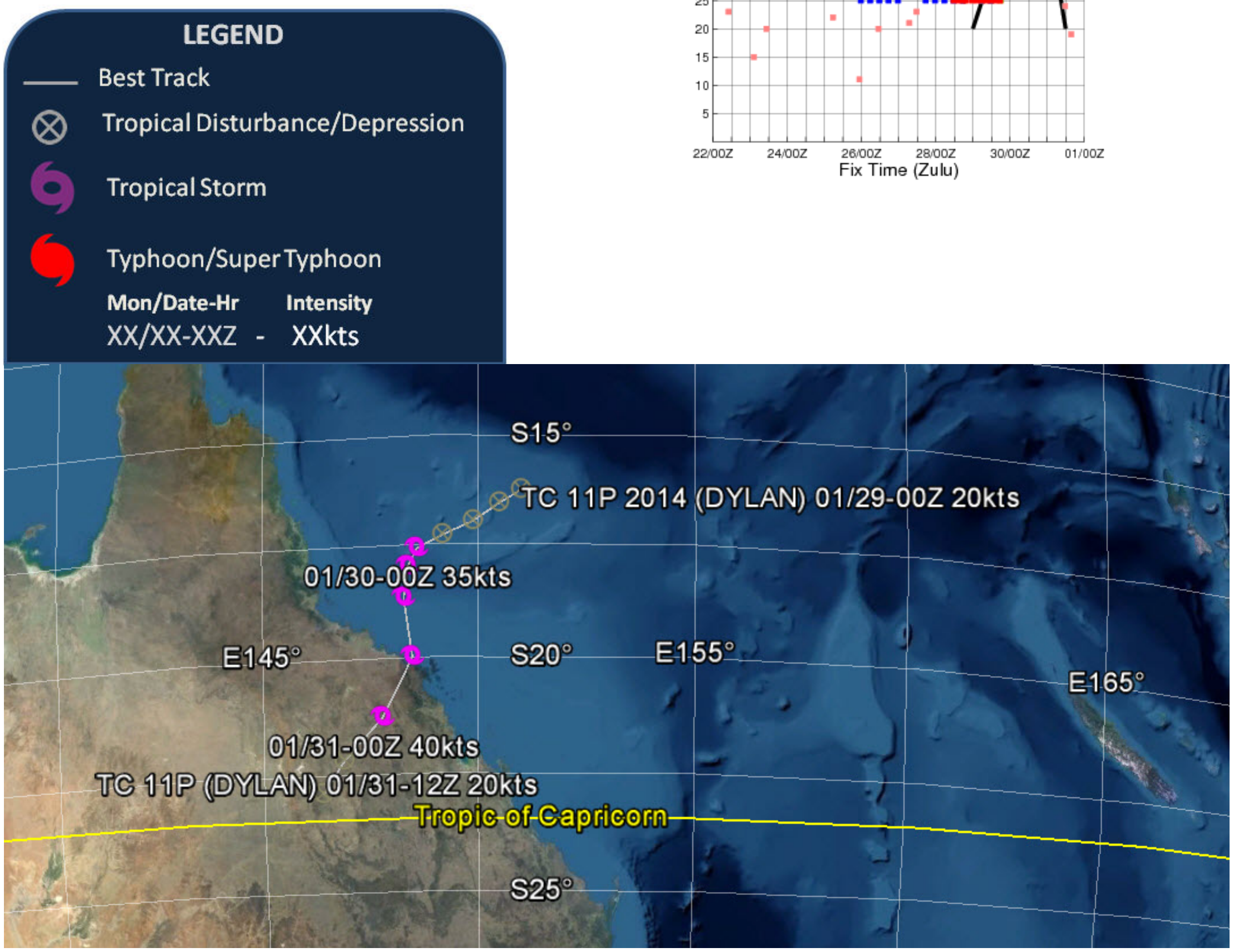


## 11P TROPICAL CYCLONE DYLAN

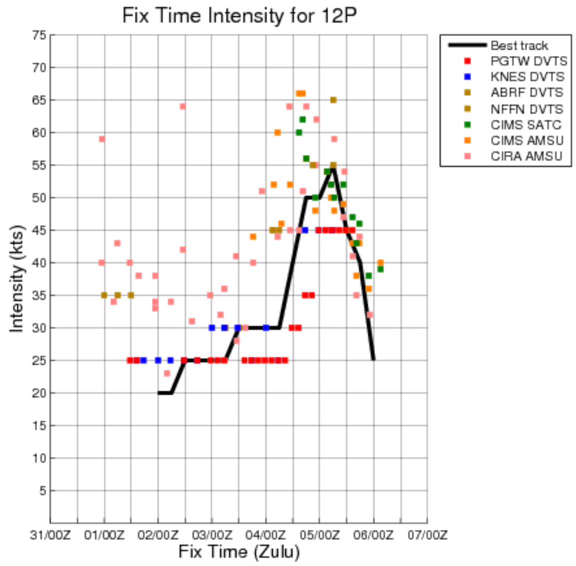
| | |
|---|---|
| ISSUED LOW: | 24 JAN/ 0000Z |
| ISSUED MED: | 27 JAN/ 0600Z |
| FIRST TCFA: | 28 JAN / 0300Z |
| FIRST WARNING: | 29 JAN/ 0000Z |
| LAST WARNING: | 31 JAN/ 0000Z |
| MAX INTENSITY: | 45 |
| WARNINGS: | 5 |

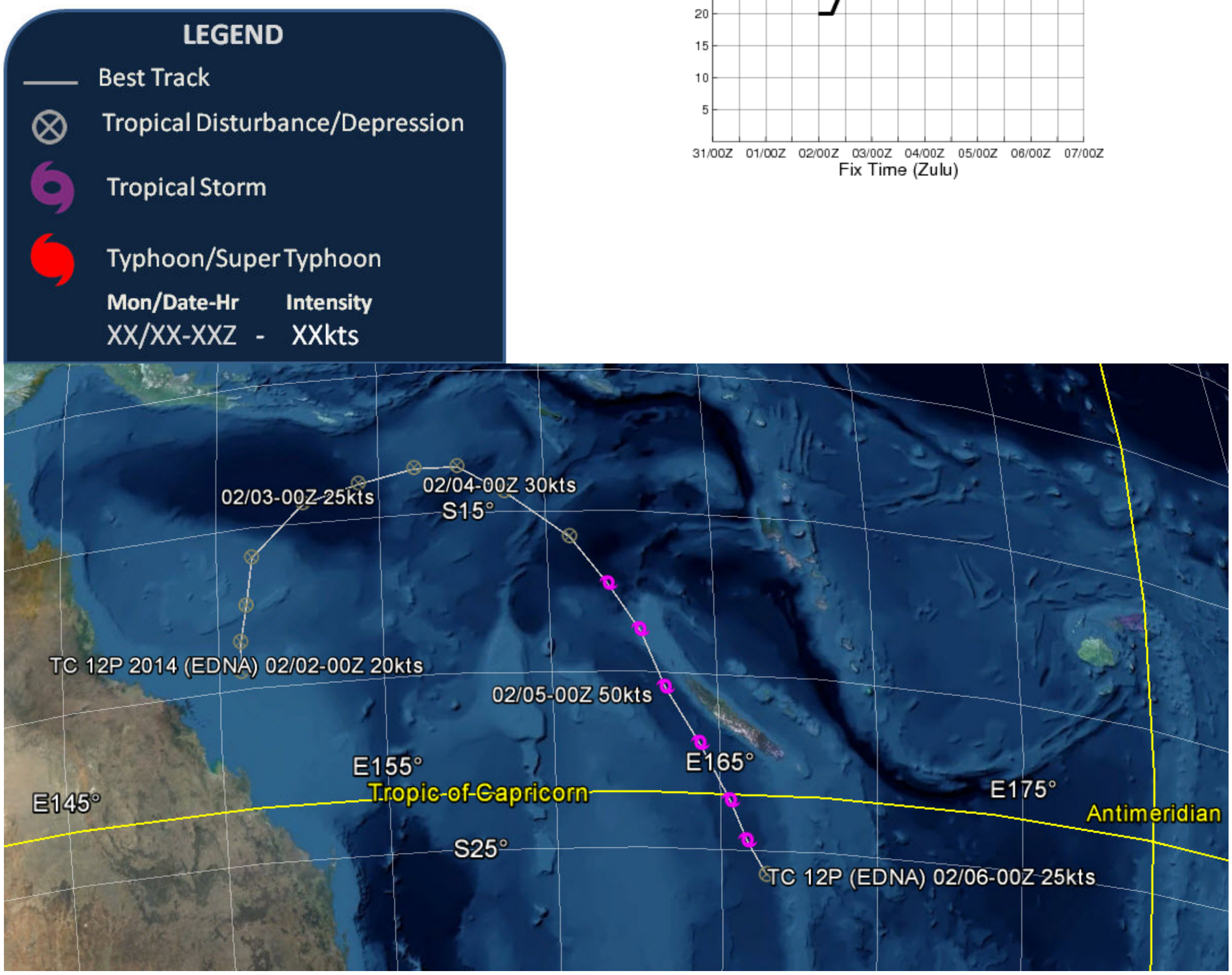


## 12P TROPICAL CYCLONE EDNA

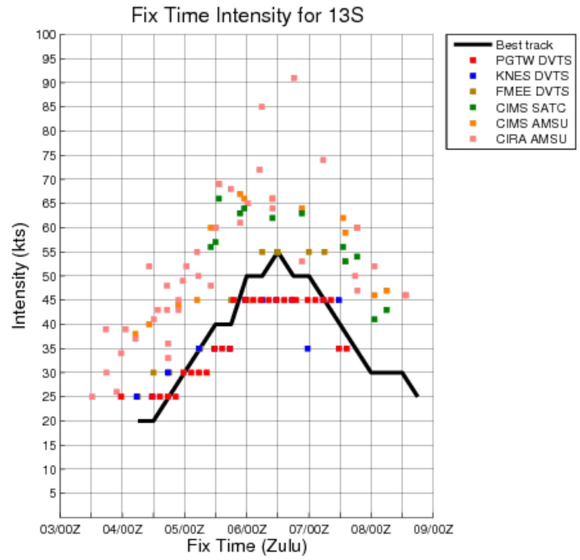
| | |
|---|---|
| ISSUED LOW: | N/A |
| ISSUED MED: | 01 FEB/ 0600Z |
| FIRST TCFA: | 03 FEB / 2300Z |
| FIRST WARNING: | 04 FEB/ 1500Z |
| LAST WARNING: | 03 FEB/ 2300Z |
| MAX INTENSITY: | 55 |
| WARNINGS: | 4 |

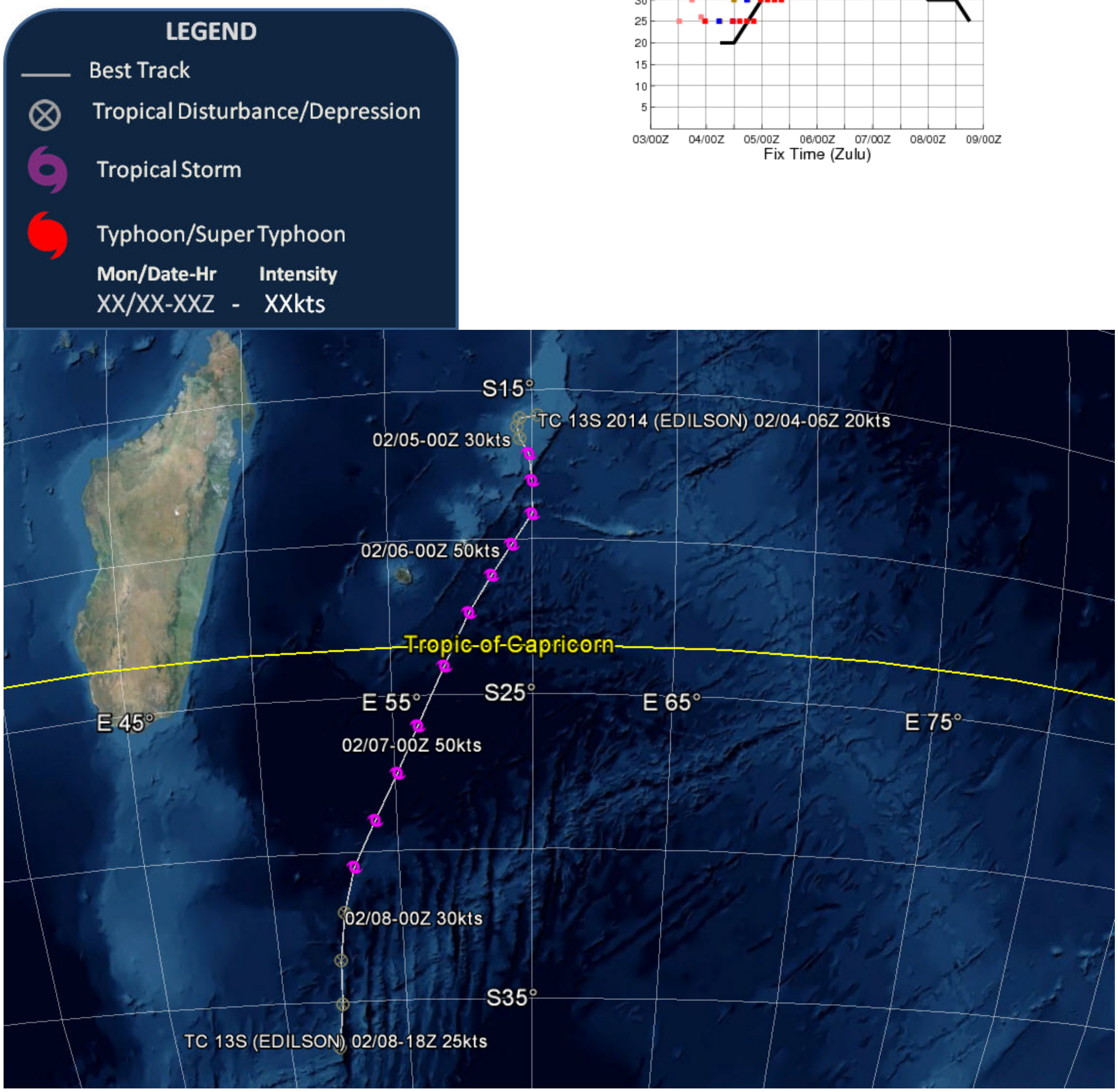


## 13S TROPICAL CYCLONE EDILSON

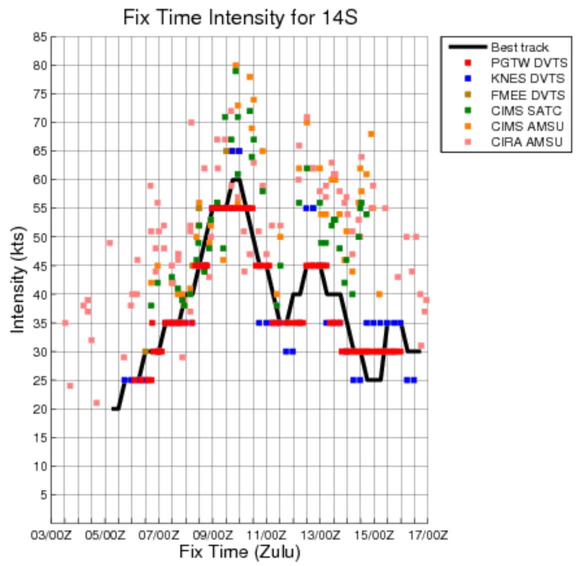
| | |
|---|---|
| ISSUED LOW: | 03 FEB/ 1800Z |
| ISSUED MED: | 04 FEB/ 0400Z |
| FIRST TCFA: | 04 FEB / 1530Z |
| FIRST WARNING: | 05 FEB/ 0000Z |
| LAST WARNING: | 07 FEB/ 1800Z |
| MAX INTENSITY: | 55 |
| WARNINGS: | 7 |

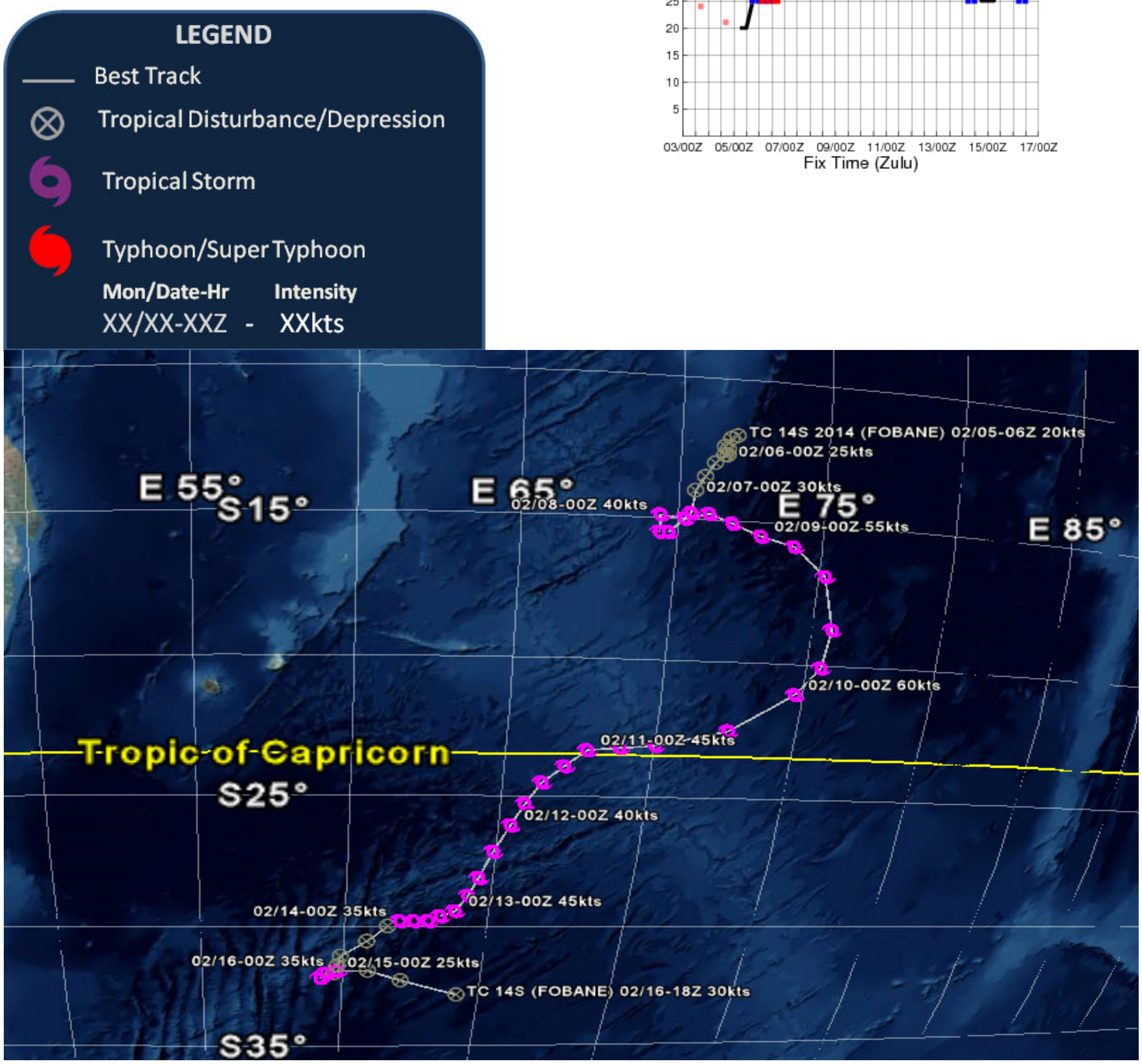


## 14S TROPICAL CYCLONE FOBANE

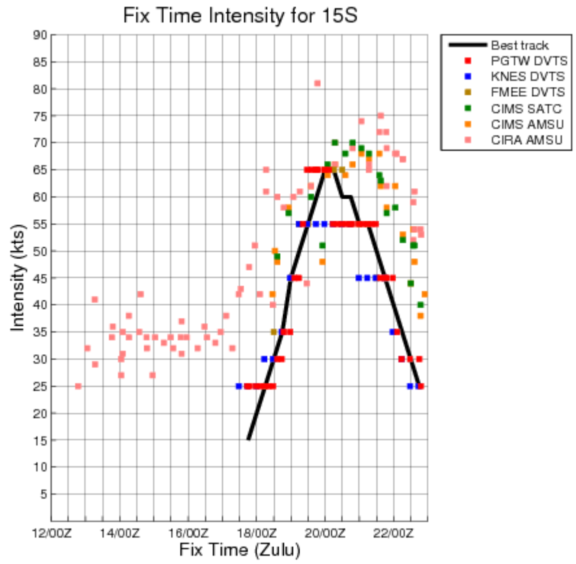
| | |
|---|---|
| ISSUED LOW: | 03 FEB/ 2000Z |
| ISSUED MED: | 04 FEB/ 1800 |
| FIRST TCFA: | 05 FEB/ 2330Z |
| FIRST WARNING: | 06 FEB/ 1800Z |
| LAST WARNING: | 14 FEB/ 0600Z |
| MAX INTENSITY: | 60 |
| WARNINGS: | 16 |

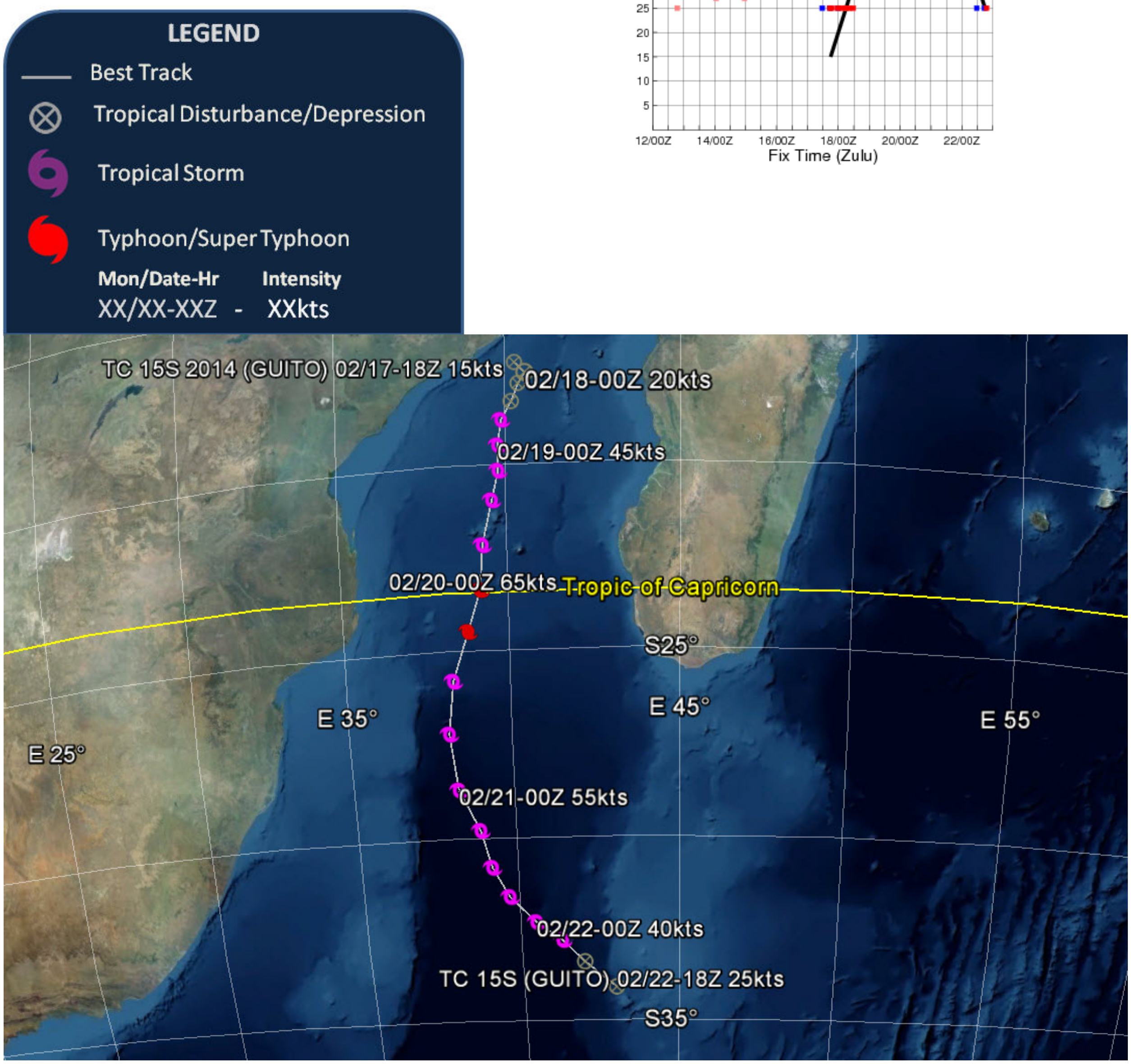


## 15S TROPICAL CYCLONE GUITO

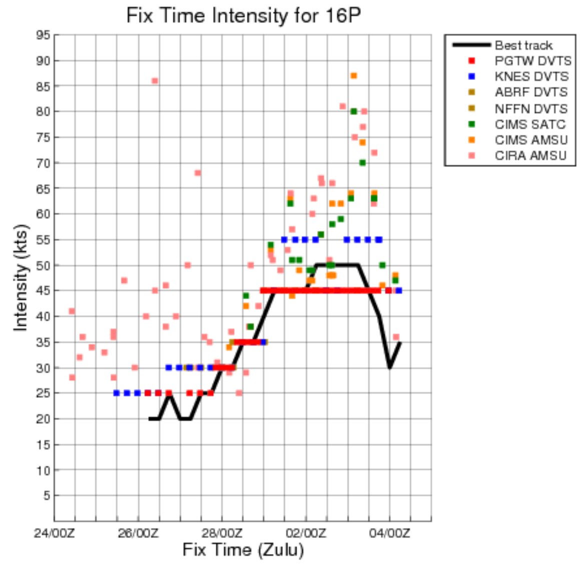
| | |
|---|---|
| ISSUED LOW: | 15 FEB/ 1800Z |
| ISSUED MED: | 16 FEB/ 0300Z |
| FIRST TCFA: | 17 FEB / 1800Z |
| FIRST WARNING: | 18 FEB/ 2100Z |
| LAST WARNING: | 22 FEB/ 0600Z |
| MAX INTENSITY: | 65 |
| WARNINGS: | 9 |

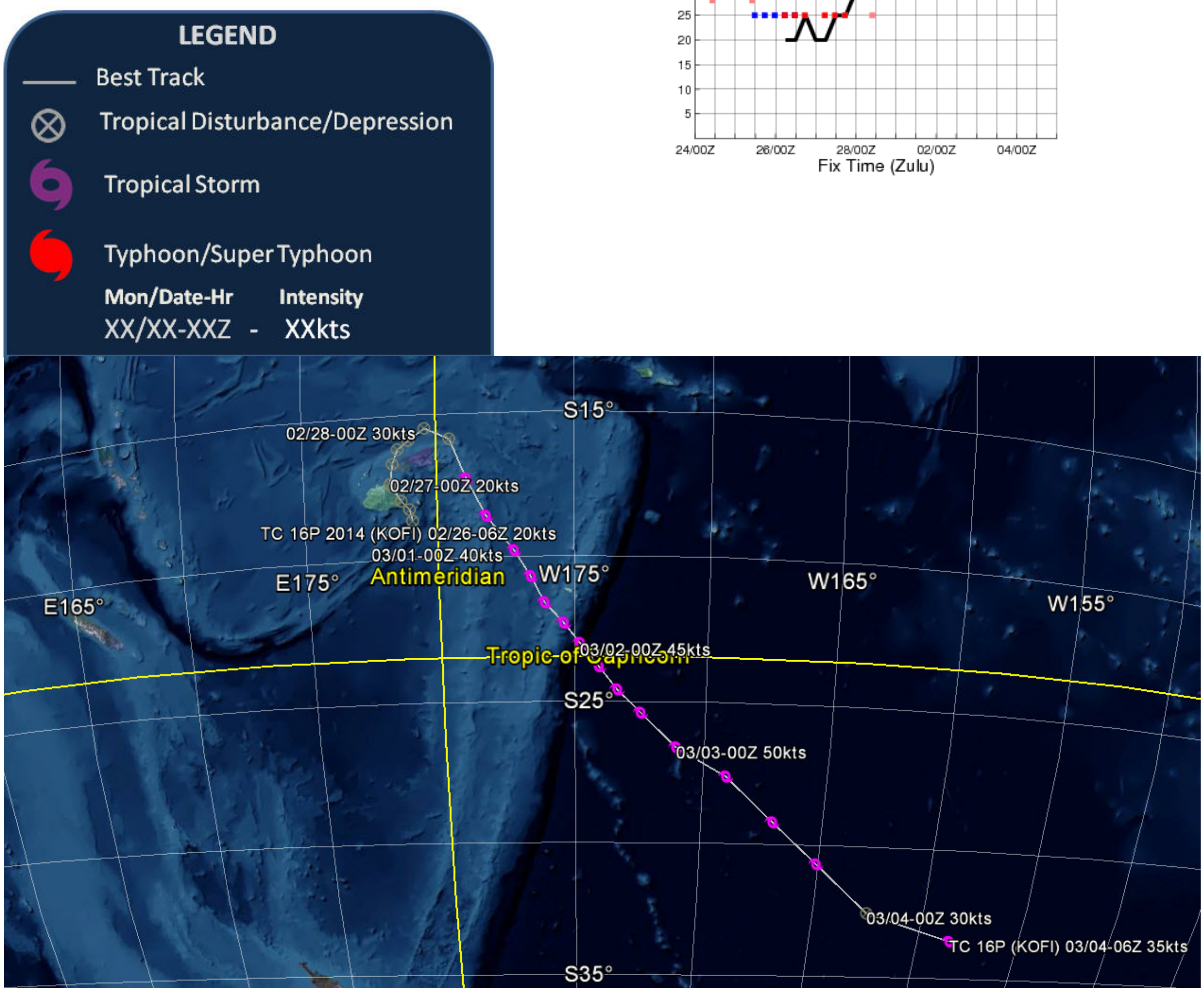


# 16P TROPICAL CYCLONE KOFI

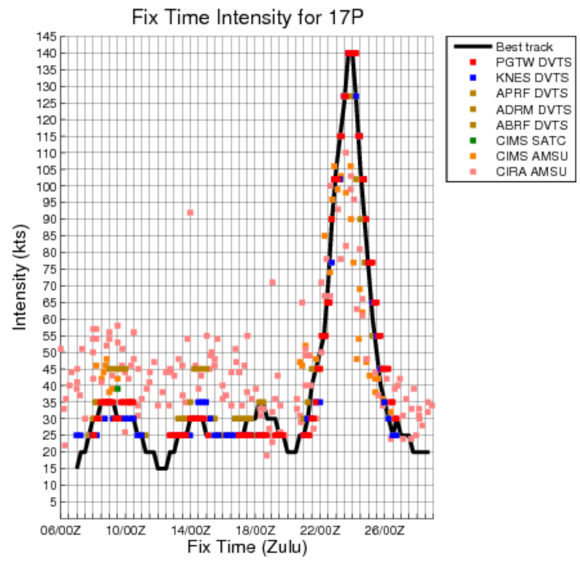
| | |
|---|---|
| ISSUED LOW: | 25 FEB/ 0000Z |
| ISSUED MED: | 25 FEB/ 0600Z |
| FIRST TCFA: | 27 FEB / 2100Z |
| FIRST WARNING: | 28 FEB/ 0600Z |
| LAST WARNING: | 03 MAR/ 1800Z |
| MAX INTENSITY: | 50 |
| WARNINGS: | 8 |

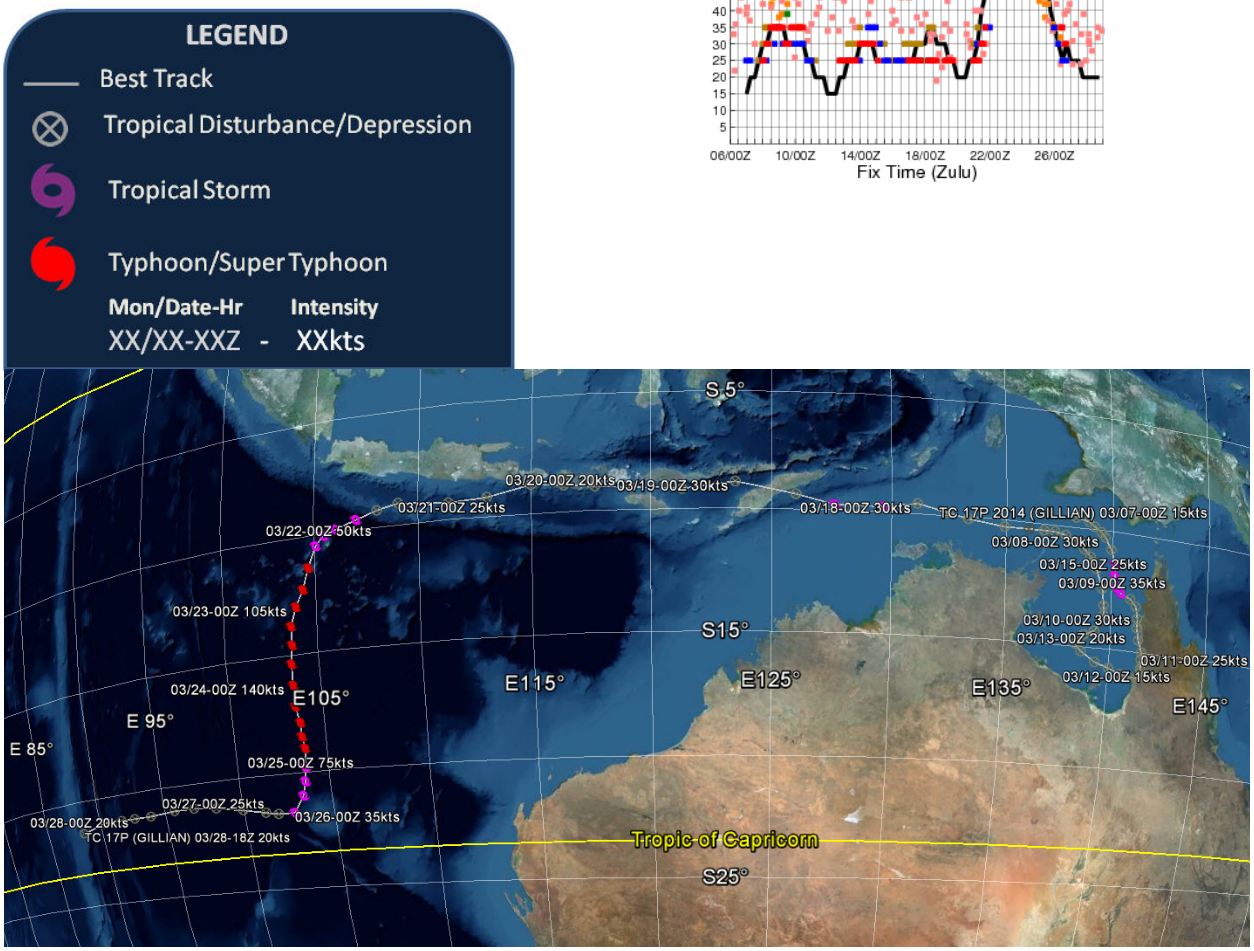


## 17P TROPICAL CYCLONE GILLIAN

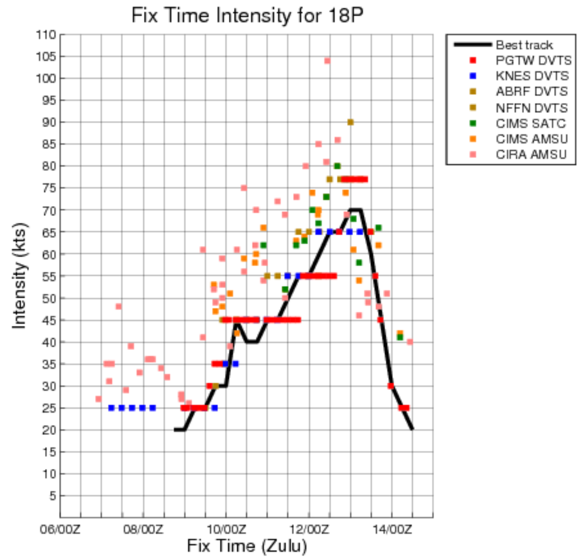
| | |
|---|---|
| ISSUED LOW: | N/A |
| ISSUED MED: | N/A |
| FIRST TCFA: | N/A |
| FIRST WARNING: | 08 MAR/ 1200Z |
| LAST WARNING: | 11 MAR/ 0000Z |
| MAX INTENSITY: | 140 |
| WARNINGS: | 16 |

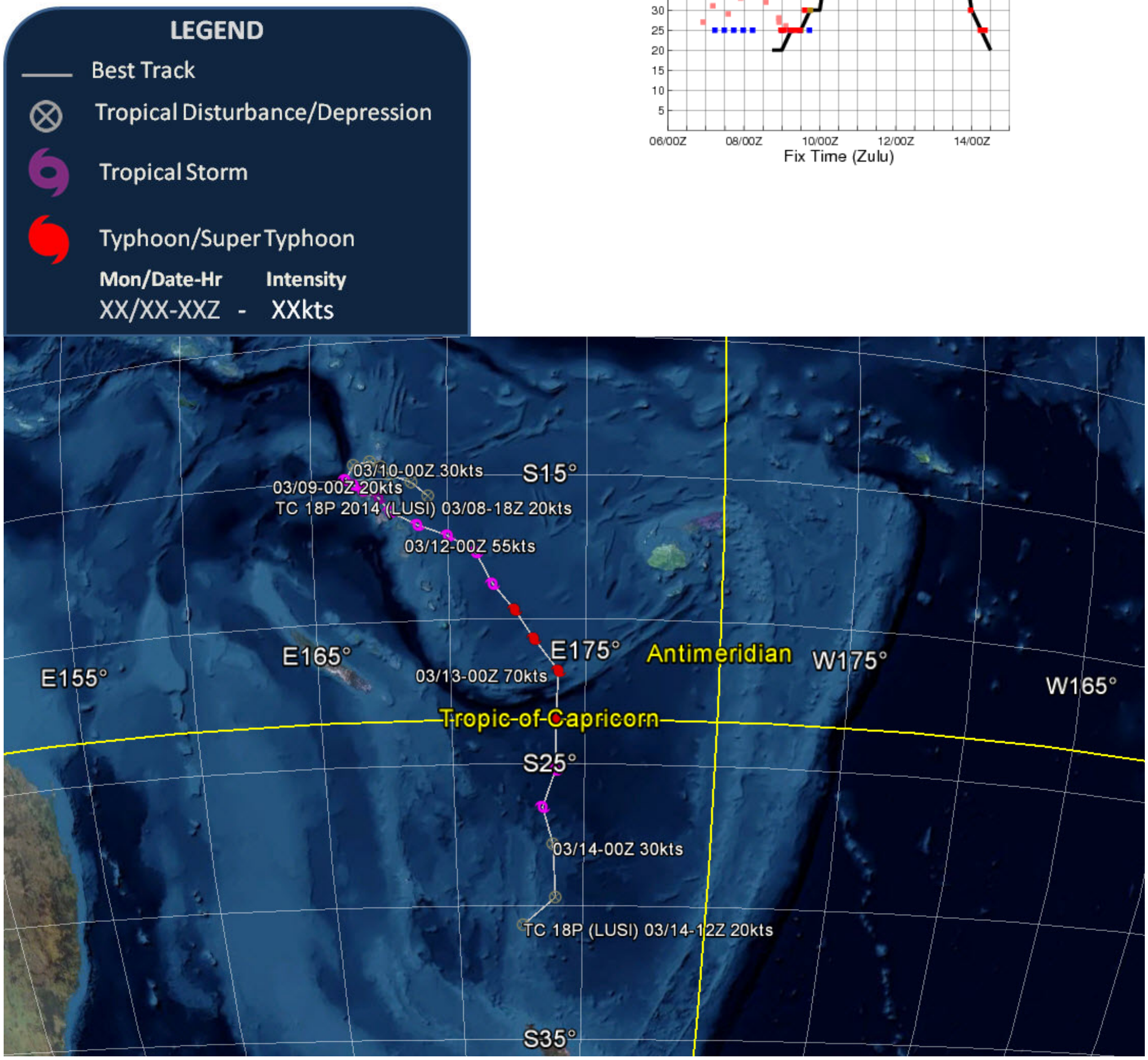


# 18P TROPICAL CYCLONE LUSI

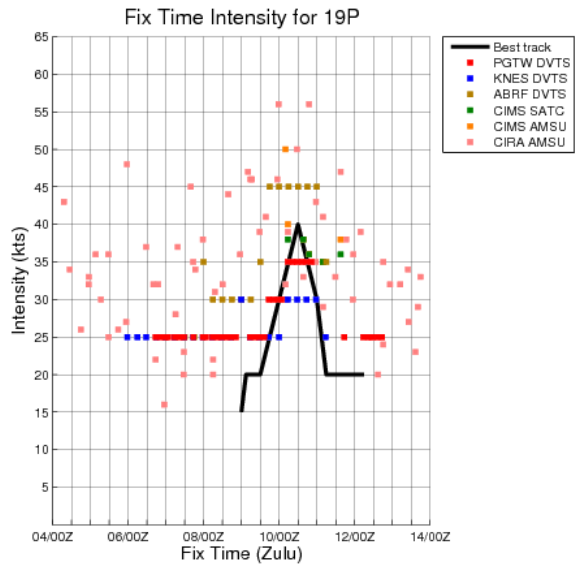
| | |
|---|---|
| ISSUED LOW: | 08 MAR/ 1500Z |
| ISSUED MED: | 09 MAR/ 0200Z |
| FIRST TCFA: | 09 MAR / 0900Z |
| FIRST WARNING: | 9 MAR/ 1800Z |
| LAST WARNING: | 13 MAR/ 1800Z |
| MAX INTENSITY: | 70 |
| WARNINGS: | 9 |

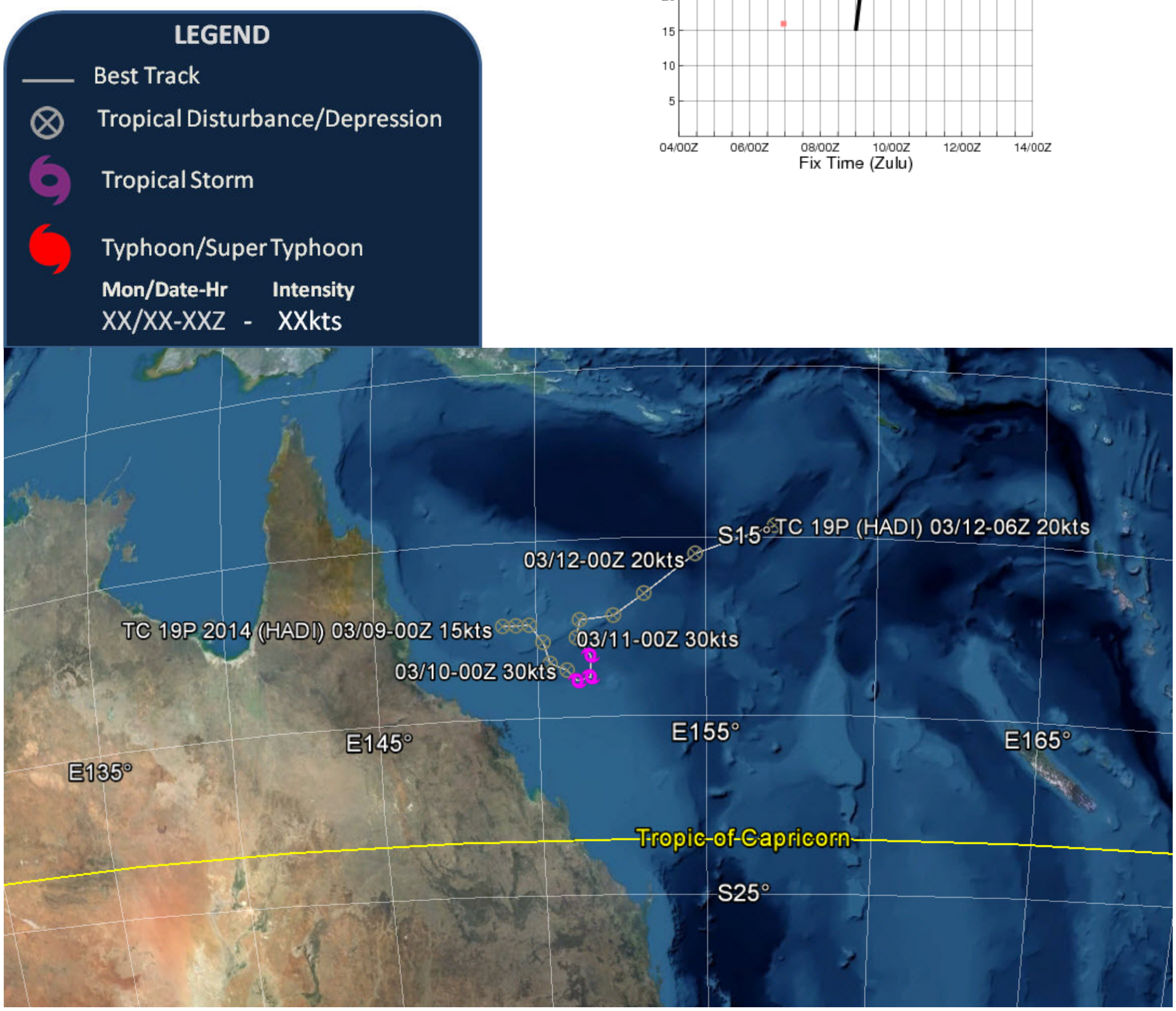


# 19P TROPICAL CYCLONE HADI

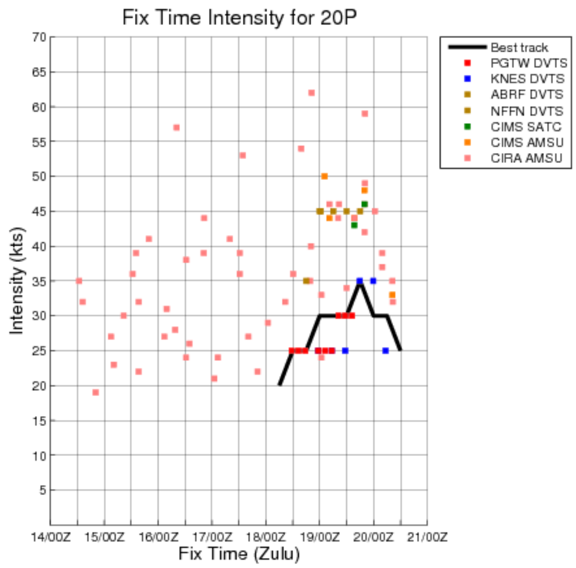
| | |
|---|---|
| ISSUED LOW: | 05 MAR/ 0600Z |
| ISSUED MED: | 06 MAR/ 1330Z |
| FIRST TCFA: | 07 MAR/ 0200Z |
| FIRST WARNING: | 10 MAR/ 0600Z |
| LAST WARNING: | 11 MAR/ 0600Z |
| MAX INTENSITY: | 40 |
| WARNINGS: | 3 |

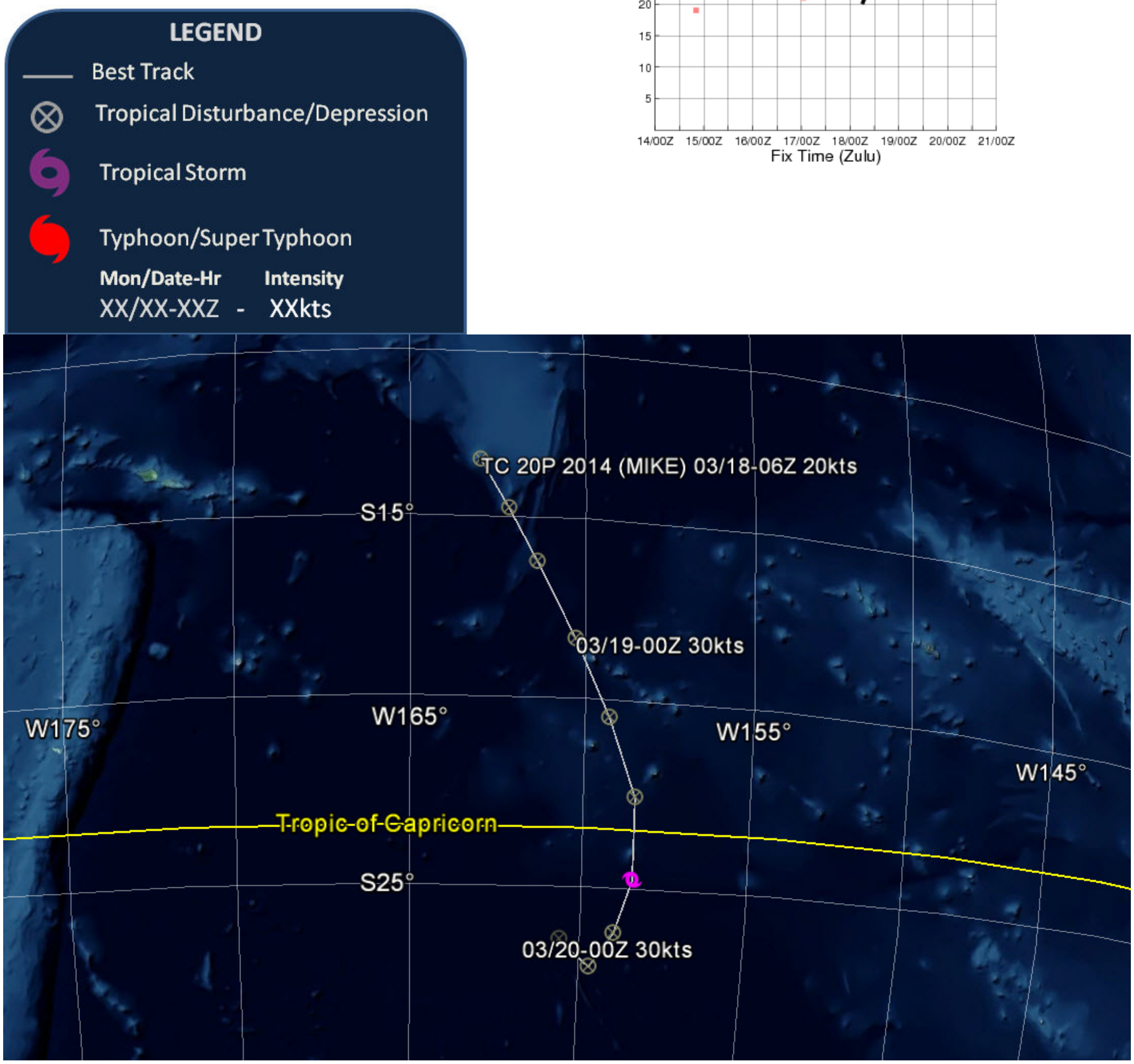


# 20P TROPICAL CYCLONE MIKE

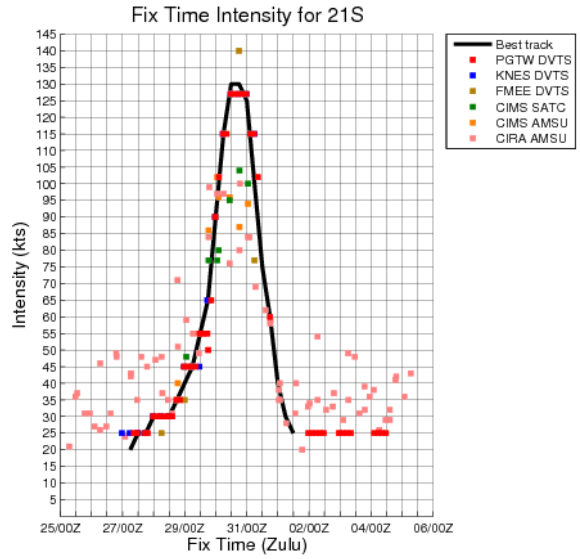
ISSUED LOW: 18 MAR/ 0600
ISSUED MED: 18 MAR/ 1500Z
FIRST TCFA: 19 MAR / 0230Z
FIRST WARNING: 19 MAR/ 0600Z
LAST WARNING: 19 MAR/ 1800Z
MAX INTENSITY: 35
WARNINGS: 2

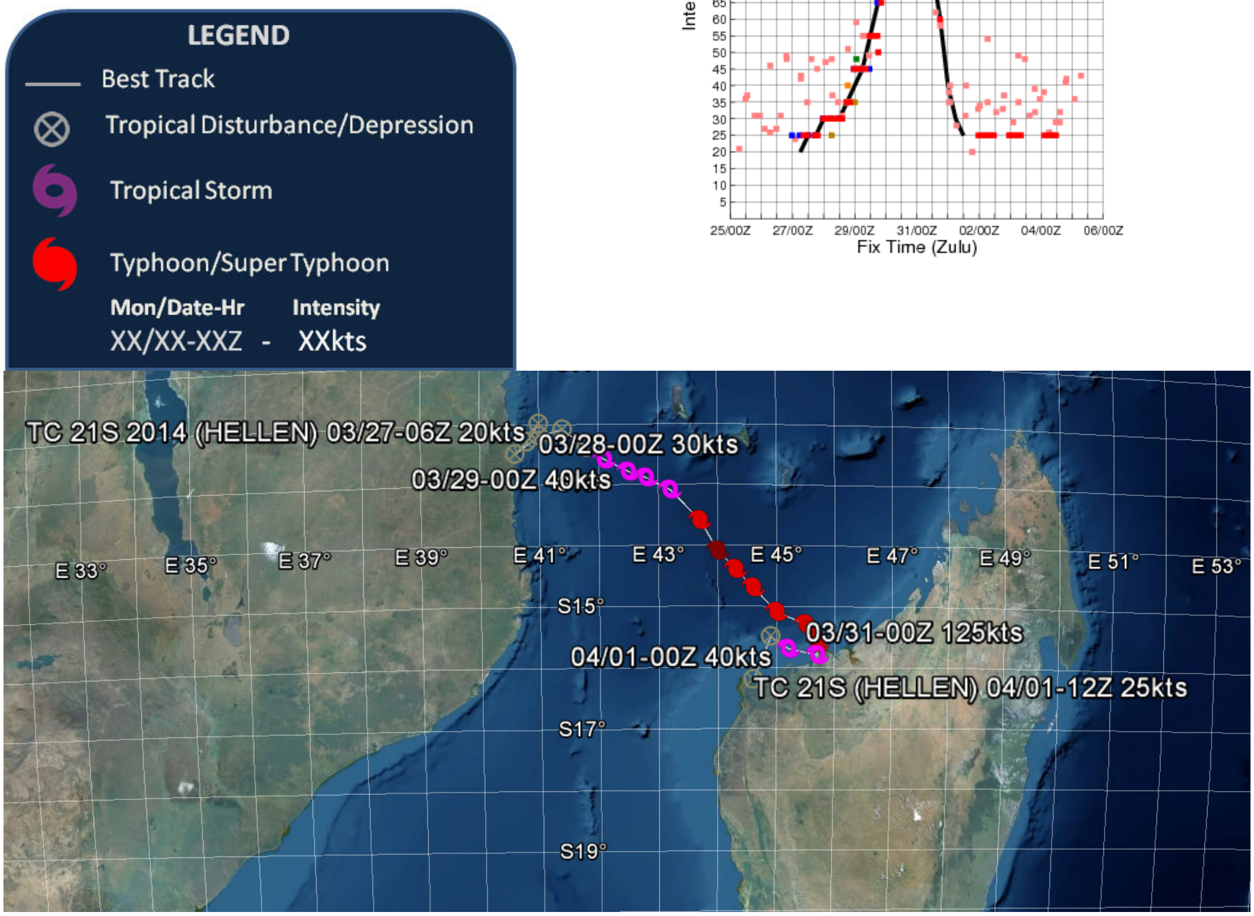


## 21S TROPICAL CYCLONE HELLEN

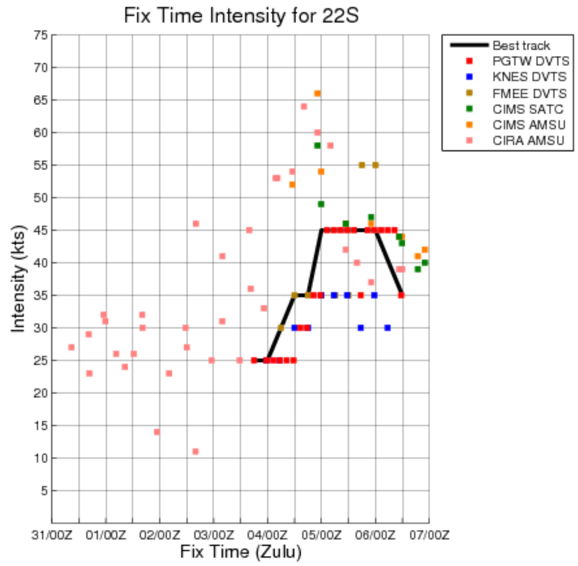
| | |
|---|---|
| ISSUED LOW: | 25 MAR/ 2130Z |
| ISSUED MED: | 26 MAR/ 0630Z |
| FIRST TCFA: | 26 MAR/ 2000Z |
| FIRST WARNING: | 28 MAR/ 1800Z |
| LAST WARNING: | 01 APR/ 0000Z |
| MAX INTENSITY: | 130 |
| WARNINGS: | 8 |

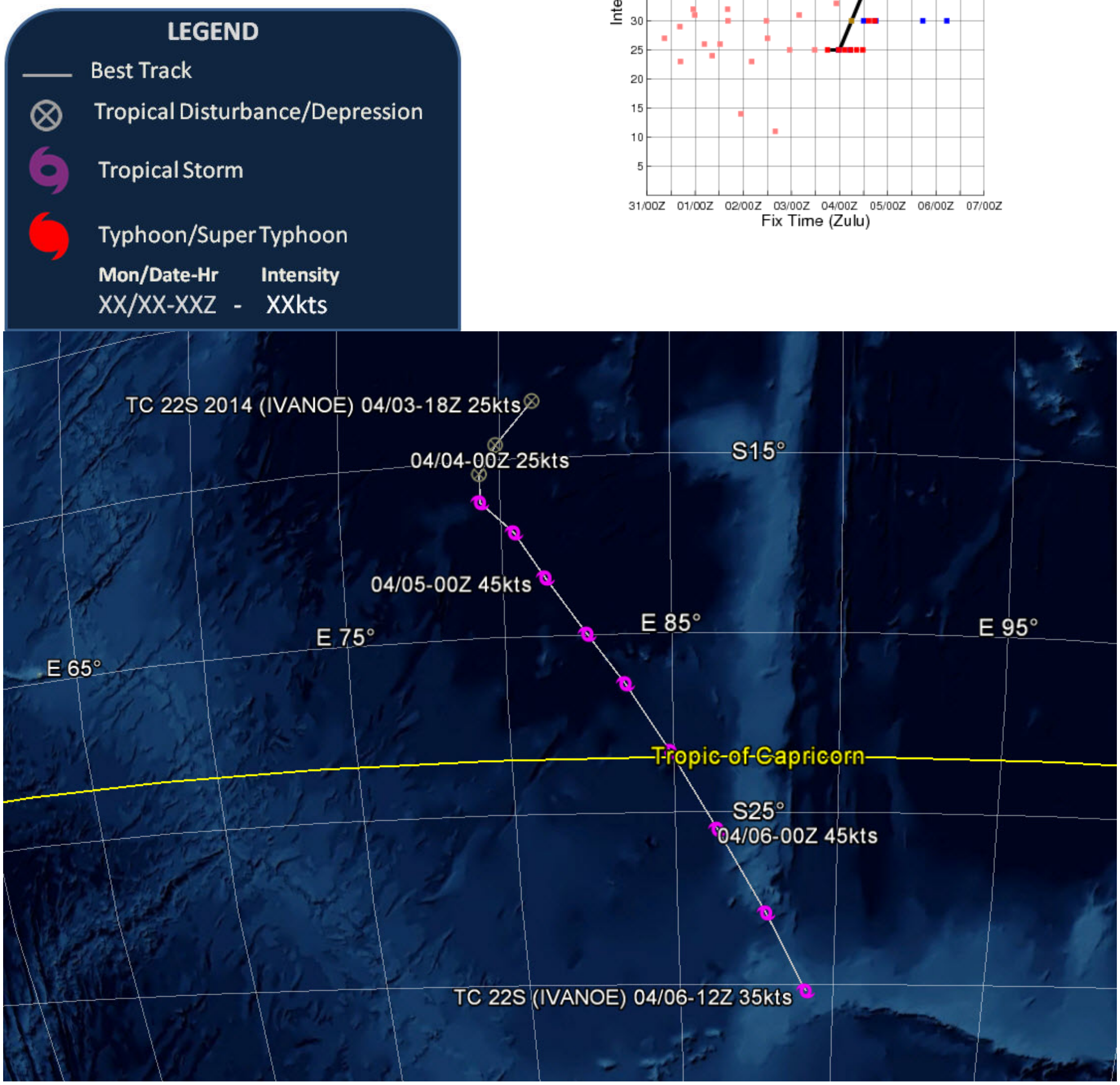


## 22S TROPICAL CYCLONE IVANOE

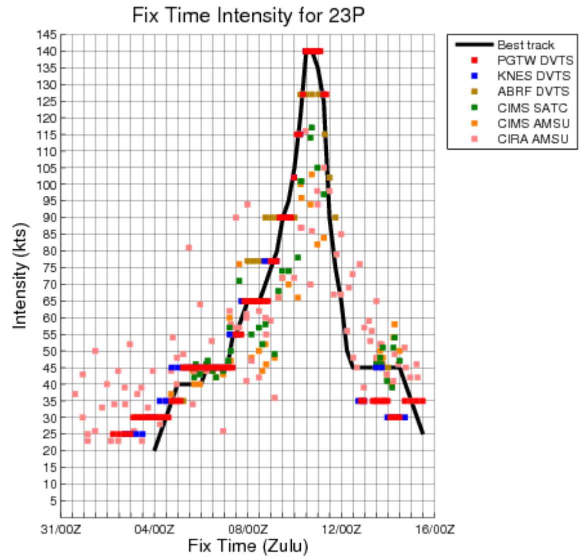
| | |
|---|---|
| ISSUED LOW: | 01 APR/ 0600Z |
| ISSUED MED: | 03 APR/ 1800Z |
| FIRST TCFA: | 04 APR / 0400Z |
| FIRST WARNING: | 04 APR/ 1200Z |
| LAST WARNING: | 06 APR/ 1200Z |
| MAX INTENSITY: | 45 |
| WARNINGS: | 5 |

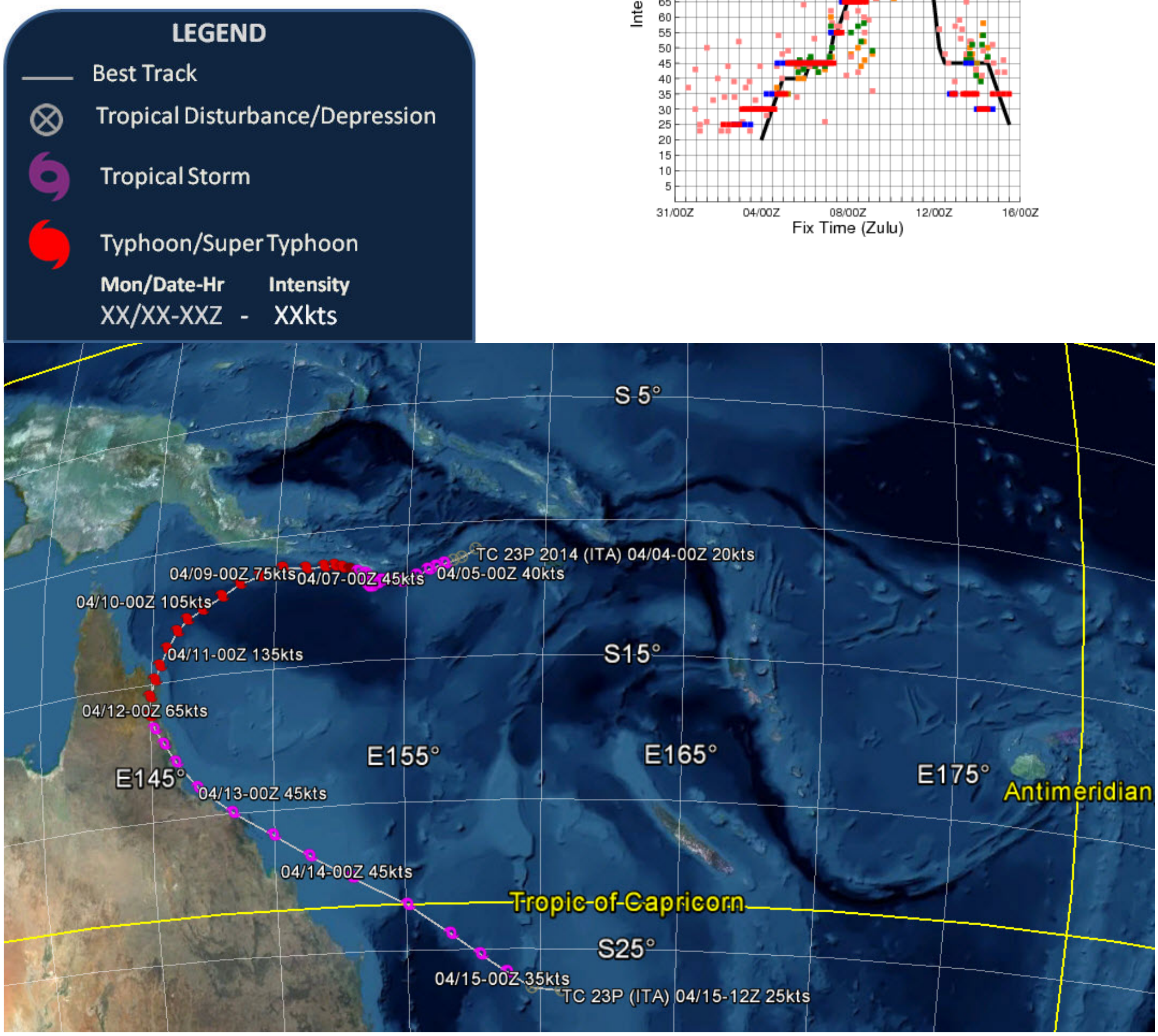


# 23P TROPICAL CYCLONE ITA

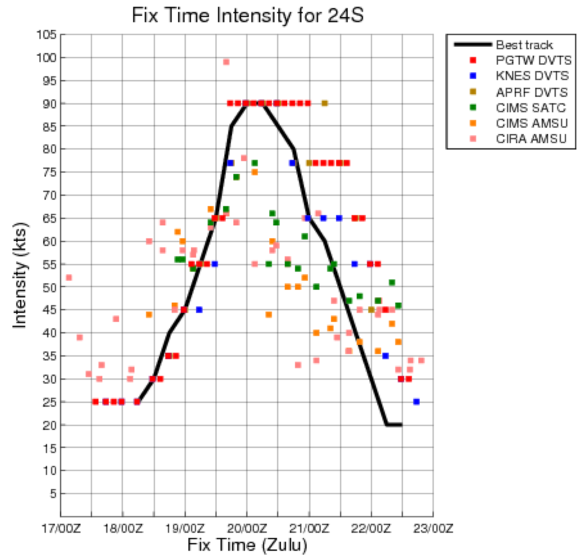
| | |
|---|---|
| ISSUED LOW: | 01 APR/ 0600Z |
| ISSUED MED: | 02 APR/ 0600Z |
| FIRST TCFA: | 03 APR / 0330Z |
| FIRST WARNING: | 04 APR/ 1800Z |
| LAST WARNING: | 14 APR/ 0600Z |
| MAX INTENSITY: | 140 |
| WARNINGS: | 20 |

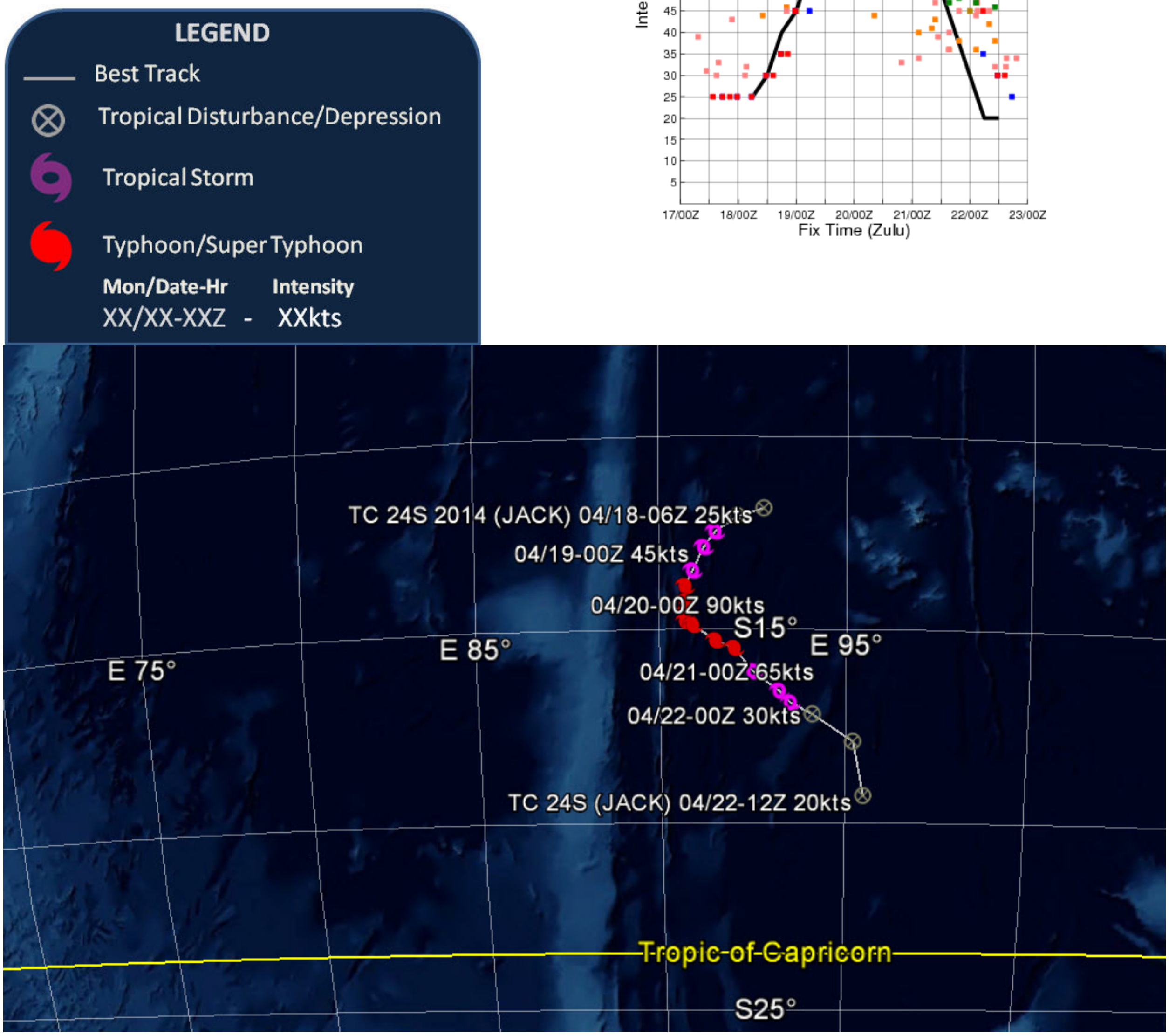


## 24S TROPICAL CYCLONE JACK

ISSUED LOW: 16 APR/1800Z
ISSUED MED: 17 APR/ 1800Z
FIRST TCFA: 18APR/ 1400Z
FIRST WARNING: 18 APR/ 1800Z
LAST WARNING: 22 APR/ 0600Z
MAX INTENSITY: 90
WARNINGS: 8



**Chapter 4 Tropical Cyclone Fix Data**

## Section 1 Background

Weather satellite data continued to be the mainstay for the TC reconnaissance mission at JTWC. JTWC satellite analysts produced 12,561 position and intensity estimates. A total of 8260 of those 12,561 fixes were made using microwave imagery, amounting to well over 65 percent of the total number of fixes. The USAF primary weather satellite direct readout system, Mark IVB, and the USN FMQ-17 continued to be invaluable tools in the TC reconnaissance mission. Section 2 tables depict fixes produced by JTWC satellite analysts, stratified by basin and storm number. Following the final numbered storm for each section, is a value representing the number of fixes for invests considered as Did Not Develop (DND) areas. DNDs are areas that were fixed on but did not reach warning criteria. The total count of DND fixes was 1099 for all basins, which accounts for approximately 9% of all fixes in 2014.

## Section 2 Fix summary by basin

**TABLE 4-1**

**WESTERN NORTH PACIFIC OCEAN FIX SUMMARY FOR 2014**

| Tropical Cyclone | Name | Visible/Infrared | Microwave/Scatterometry | Total |
|---|---|---|---|---|
| 01W | Lingling | 36 | 142 | 178 |
| 02W | Kajiki | 32 | 66 | 98 |
| 03W | Faxai | 73 | 156 | 229 |
| 04W | N/A | 64 | 97 | 161 |
| 05W | Peipah | 97 | 179 | 276 |
| 06W | Tapah | 67 | 115 | 182 |
| 07W | Hagibis | 39 | 71 | 110 |
| 08W | Neoguri | 74 | 162 | 236 |
| 09W | Rammasun | 81 | 149 | 230 |
| 10W | Matmo | 74 | 133 | 207 |
| 11W | Halong | 112 | 253 | 365 |
| 12W | Nakri | 100 | 210 | 310 |
| 07E | Genevieve | 49 | 129 | 178 |
| 13W | Fengshen | 49 | 114 | 163 |
| 14W | N/A | 39 | 62 | 101 |
| 15W | Kalmaegi | 61 | 107 | 168 |
| 16W | Fung-wong | 57 | 149 | 206 |
| 17W | Kammuri | 60 | 163 | 223 |
| 18W | Phanfone | 81 | 202 | 283 |
| 19W | Vongfong | 101 | 272 | 373 |
| 20W | Nuri | 65 | 177 | 242 |
| 21W | Sinlaku | 47 | 98 | 145 |
| 22W | Hagupit | 103 | 226 | 329 |
| 23W | Jangmi | 38 | 89 | 127 |
| **DND** | | **184** | **273** | **457** |
| **Totals** | | **1783** | **3794** | **5577** |
| **Percentage of Total** | | **31.97%** | **68.03%** | **100** |

| TABLE 4-2<br><br>NORTH INDIAN OCEAN (BAY OF BENGAL/ARABIAN SEA)<br>FIX SUMMARY FOR 2014 | | | | |
|---|---|---|---|---|
| **Tropical Cyclone** | **Name** | **Visible/Infrared** | **Microwave/Scatterometry** | **Total** |
| 01B | N/A | 47 | 63 | 110 |
| 02A | Nanauk | 50 | 98 | 148 |
| 03B | Hudhud | 62 | 138 | 200 |
| 04A | Nilofar | 78 | 174 | 252 |
| 05B | N/A | 36 | 77 | 113 |
| **DND** | | **191** | **276** | **467** |
| **Totals** | | **464** | **826** | **1290** |
| **Percentage of Total** | | **35.97%** | **64.03%** | **100** |

| TABLE 4-3<br><br>SOUTH PACIFIC & SOUTH INDIAN OCEAN<br>FIX SUMMARY FOR 2014 | | | | |
|---|---|---|---|---|
| **Tropical Cyclone** | **Name** | **Visible/Infrared** | **Microwave/Scatterometry** | **Total** |
| 01S | N/A | 66 | 67 | 133 |
| 02S | Alessia | 63 | 74 | 137 |
| 03S | Amara | 76 | 227 | 303 |
| 04S | Bruce | 80 | 182 | 262 |
| 05S | Christine | 45 | 101 | 146 |
| 06S | Bejisa | 81 | 207 | 288 |
| 07P | Ian | 79 | 184 | 263 |
| 08S | Colin | 76 | 181 | 257 |
| 09S | Deliwe | 56 | 126 | 182 |
| 10P | June | 21 | 46 | 67 |
| 11P | Dylan | 33 | 81 | 114 |
| 12P | Edna | 35 | 87 | 122 |
| 13S | Edilson | 40 | 101 | 141 |
| 14S | Fobane | 90 | 231 | 321 |
| 15S | Guito | 43 | 106 | 149 |
| 16P | Kofi | 47 | 82 | 129 |
| 17P | Gillian | 157 | 332 | 489 |
| 18P | Lusi | 45 | 84 | 129 |
| 19P | Hadi | 45 | 137 | 182 |
| 20P | Mike | 19 | 51 | 70 |
| 21S | Hellen | 78 | 92 | 170 |
| 22S | Ivanoe | 21 | 65 | 86 |
| 23P | Ita | 108 | 175 | 283 |
| 24S | Jack | 42 | 101 | 143 |
| **DND** | | **578** | **550** | **1128** |
| **Totals** | | **2024** | **3670** | **5694** |
| **Percentage of Total** | | **35.55%** | **64.45%** | **100** |

**Chapter 5 Technical Development Summary**

## Section 1: Operational Priorities

The top operational priority of the Joint Typhoon Warning Center is sustained development and support of The Automated Tropical Cyclone Forecast System (ATCF). ATCF is the DOD's primary toolkit for analyzing and forecasting tropical cyclones (TCs), and is the principal software platform through which emerging research transitions into JTWC operations. Without ATCF, JTWC could not generate TC formation alerts or warnings. The systems tracks all TC activity and invest areas, automatically processes objective forecasting aids, produces TC formation alert, warning text and graphical products, and provides core capabilities for analyzing TCs and their environment. Additionally, ATCF provides JTWC Contingency of Operations Plan (COOP) backup capabilities to FWC-Norfolk and analytic support to FWC-San Diego for tasks such as setting TCCOR, forecasting on-station wind speed, designating OTSR "MODSTORM" locations, and preparing diverts and advisories. JTWC upgraded to the latest version of ATCF (v5.7) in June 2014. This upgrade incorporated new data displays such as composite microwave imagery overlays and radar, and a host of other improvements to the efficiency of data processing and filtering. Additional details of ATCF enhancements, delivered and proposed for future release, are discussed in Section 2.

JTWC has also prioritized integrating a state-of-the-art platform to facilitate visualization and evaluation of meteorological data. In 2015, the Commander, US Navy Meteorology Oceanography Command authorized acquisition of the National Weather Service (NWS) Advanced Weather Interactive Processing System (AWIPS-II) as the Navy's next-generation weather display and analysis system. JTWC technical services staff is facilitating incorporation of the AWIPS-II system into operations by developing standard operating procedures and site-specific applications. An initial operating capability (IOC) is scheduled in 2016. Although AWIPS II promises a generational leap in data synthesis capabilities, it cannot currently replicate ATCF functionality.

## Section 2: Research and Development Priorities

The top 5 JTWC R&D priorities, as outlined in the 2015 annual report of the Office of the Federal Coordinator for Meteorological Services and Supporting Research – Tropical Cyclone Working Group are:

1. Deterministic and probabilistic forecast guidance for tropical cyclone intensity change, particularly the onset, duration, and magnitude of rapid intensification events and eyewall replacement cycles, as well as over-water rapid weakening events
2. Techniques to improve the utility and exploitation of microwave satellite, ocean surface wind vectors, and radar data for fixing tropical cyclones (e.g. develop a "Dvorak-like "technique using microwave imagery), or for diagnosing RI, ETT, ERC, etc.
3. Improved and extended (out to 7 days) deterministic and probabilistic forecast track guidance to assist forecasters in the Identification, and then reduction of, the occurrence of guidance and official track outliers, focusing on both large speed errors (e.g., accelerating recurvers and stalling storms) and large direction errors (e.g., loops), and on specific forecast problems,

including interactions between upper-level troughs and tropical cyclones, track forecasts near/over land--especially elevated terrain, and extratropical transition.

4. Statistically based real-time guidance on guidance to assist in the determination of official track and intensity forecasts. This could include multi-model consensus approaches, single- or multi-model ensembles
5. Enhancements to the operational environment to increase forecaster efficiency, by expediting analysis, forecast, coordination, and/or communication activities. In particular, transitioning of successful guidance products to integrated operational forecast systems such as the ATCF or AWIPS.

## Section 3: Technical Development Projects

JTWC personnel have initiated and scheduled numerous efforts to address the operations and research and development priorities presented in Sections 1 and 2 of this report.

### 1. Tropical cyclone intensity change

#### a. Intensity Consensus (S5YY & S5XX)

JTWC made minor revisions to the primary intensity consensus aids, S5YY and S5XX, based on inputs from NRL's review of 2013 performance. LGEM forecasts were temporarily removed from the western North Pacific tropical cyclone intensity consensus, S5YY, due to an ongoing numerical calculation issue. Additionally, NRL sensitivity tests indicated that incorporating the SHIPS-RI short-range rapid intensification aid, RI30, increases tropical cyclone intensity consensus forecast skill. Therefore, this aid was added to the S5YY consensus in early 2015.

The following table lists the ATCF objective aid identifiers for the current primary members of JTWC's operational intensity forecast consensuses: S5YY (intensity, western North Pacific basin) and S5XX (intensity, Indian Ocean and Southern Hemisphere basins).

| S5YY | S5XX |
|---|---|
| DSHN (SHIPS) | AVS5 (STIPS) |
| DSHA (SHIPS) | JGS5 (STIPS) |
| GFDN | NVS5 (STIPS) |
| COTI | UKS5 (STIPS) |
| CHII | WBS5 (STIPS) |
| HWFI | AFS5 (STIPS) |
| RI30 | GFNI |
| | COTI |
| | CHII |

**Table 5-1:** Primary objective aids comprising the operational JTWC tropical cyclone intensity (S5YY and S5XX) consensuses (as of Spring 2015).

### b. Expansion of SHIPS-RI routine in ATCF:

NRL expanded the SHIPS Rapid Intensification Index (SHIPS-RII) to all JTWC forecast basins in 2014. The index provides the probability of 30-knot intensification during a 24-hour forecast period for active tropical cyclones (Kaplan et al. 2010). The index is generated in ATCF and available for forecaster interrogation during each forecast cycle.

### c. Weighted Analog Intensity Technique

JTWC initiated an operational assessment of the Weighted Analog Intensity Prediction (WANI) technique (Tsai and Elsberry 2014). The WANI method provides intensity forecast skill and spread guidance for designated TC tracks based on situation-dependent analogs in the multi-decadal, historical best track dataset. Track and intensity analogs are selected by comparing the time of year, track speed and direction, and initial intensity of the designated TC track with storms in the historical record. A weighted average of these past cyclone intensities (i.e., their best track intensities) is calculated; analog data that more closely match the current JTWC forecast track and initial intensity receive more weight. The resultant mean intensity value is the Weighted Analog Intensity (WANI) forecast. Additionally, the ten analog intensities are used to calculate an intensity forecast range, which is expected to contain the verifying best track intensities roughly 70% of the time.

Verification statistics from the 2014 western North Pacific TC season indicate that WANI performance was on-par with the S5YY multi-member consensus and JTWC subjective intensity forecasts, particularly at 96 and 120 hours (Figure 5-1).

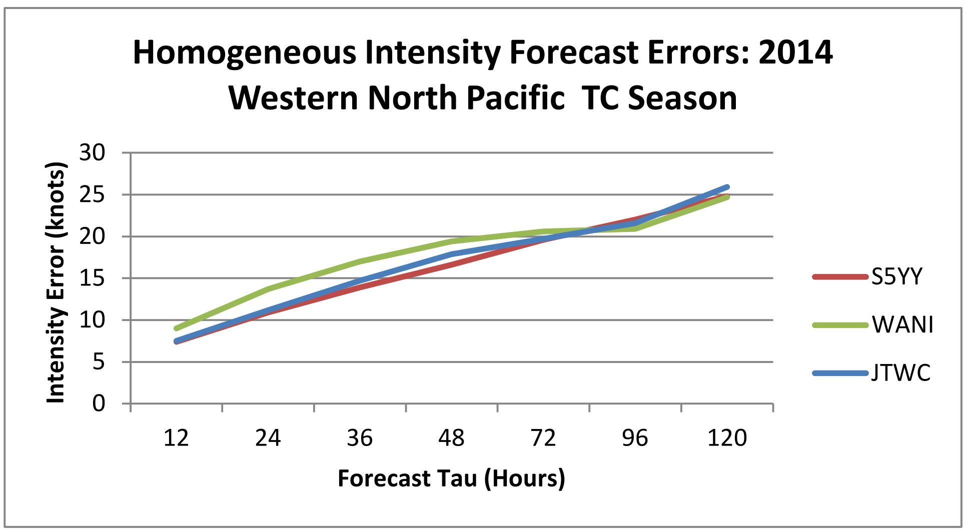



**Figure 5-1:** Comparison of intensity forecast performance: JTWC subjective forecasts, S5YY intensity consensus, and WANI intensity forecast average errors. The number of cases at each forecast tau are 379, 355, 330, 299, 238, 186, and 138, respectively.

## 2. Application of environmental satellite data

### a. RapidScat data integration

JTWC Satellite Analysts and forecasters began applying scatterometer data from the RapidScat sensor onboard the International Space Station for operational tropical analysis. Partners at the Naval Research Laboratory, Fleet Numerical Meteorology and Oceanography Center, and NOAA have worked diligently to process these data and provide them to JTWC through web servers and ATCF.

### b. OSVW intensity estimates

The satellite operations department began producing and recording tropical cyclone intensity and 34-kt wind radii estimates from ASCAT scatterometer data. These data are expected to improve both subjective and objective best track intensity estimates, particularly during scenarios in which the Dvorak technique is prone to larger errors.

## 3. Improved and extended track forecast guidance

### a. CONW

COAMPS-TC run with NAVGEM lateral boundary conditions (COTC) replaced COAMPS-TC run with GFS lateral boundary conditions (CTCX) in JTWC's official track consensus, CONW. Otherwise, the track consensus remained unchanged in 2014, with the members listed in table 5-2.

| CONW |
|---|
| NVGI |
| EGRI |
| JGSI |
| GFNI |
| AVNI |
| ECMI |
| COTI |
| JENI |
| HWFI |
| AEMI |

**Table 5-2:** Primary objective aids comprising the operational JTWC tropical cyclone track (CONW) consensus (as of Spring 2015).

### b. Evaluation of seven-day forecasting capability

Since implementing 5-day warnings, JTWC 4- and 5-day TC track accuracy has improved approximately 25%. JTWC believes that steady improvements in numerical weather prediction and new technologies may now make it feasible to provide statistically skillful forecast guidance out to 7 days, providing decision makers even more advance notice of potential TC threats. A feasibility study for seven-day track and intensity forecasting found that the quantity of track forecast guidance diminishes after five days, and six- and seven-day forecast guidance for intensity and structure is even more limited. Thus, the current phase of the seven-day forecasting study focuses solely on gathering and developing additional seven-day forecast data for further evaluation. New data sources under consideration include the ECMWF medium-range ensemble mean vortex track for track forecasting and a seven-day Weighted Analog Intensity forecasting technique for intensity forecasting.

### c. Acquisition and evaluation of ECMWF ensemble

A statistical evaluation of the European Centre for Medium-Range Weather Forecasting (ECMWF) tropical cyclone ensemble indicated very encouraging track forecast performance during the 2014 western North Pacific TC season. Based on the findings of that evaluation, JTWC has begun processing the EC ensemble mean vortex tracker for operational application during calendar year 2015. If the tracker is found to positively impact the track consensus during end-of-year testing, it will be incorporated into CONW during calendar year 2016.

### d. Model testing

JTWC continues to process and evaluate forecast data from multiple numerical models discussed in the 2013 ATCR, including ACCESS-TC, AFWA MEPS, FIM9, Arpege, TWRF, and ECMWF ensemble track clusters.

### e. Model upgrades

The UK Met Office global model received a significant upgrade in 2014, including the incorporation of a new dynamical core and an increase horizontal resolution from approximately 25 km to approximately 17 km in the mid-latitudes (UK Met Office 2015). Numerous upgrades to other numerical modeling systems in use at JTWC are occurring in calendar year 2015, including:

- COAMPS-TC (June 2015): FNMOC implemented version 5.2, which includes an upgraded vortex initialization scheme, modified terrain, and improved drag coefficient formulation. Retrospective testing indicates increased mean track forecast accuracy at tau 72-120, reduced track directional bias, and a smaller bias toward under-forecasting the intensity of strong cyclones (FNMOC COAMPS-TC 2015).

- GFS (January 2015): NCEP introduces numerous improvements to the Global Forecast System, including an increase in horizontal grid resolution from approximately 27 km to approximately 13 km for the first 240 hours of the model simulation (NWS TIN 14-46).

- GEFS (October 2015): The upgraded NCEP Global Ensemble Forecast System will feature an increase in horizontal grid resolution from approximately 55 km to approximately 33 km for the first 192 hours of the model forecast, and increase in vertical resolution from 42 to 64 levels, and incorporation of an Ensemble Kalman Filter (EnKF) data assimilation scheme (Hou et al 2015).

- NAVGEM (June 2015): The latest version (NAVGEM 1.3) features an increase in horizontal grid resolution from approximately 37 km to approximately 31 km, an increase in the number of vertical levels from 50 to 60, an upgraded physics package, and the capability to assimilate data from several additional satellite platforms (FNMOC NAVGEM 2015).

- GFDN (July 2015): FNMOC upgrades GFDN to the latest operational version of the GFDL model code, including a horizontal resolution increase to 1/18$^{th}$ degree in addition to vortex initialization and model physics improvements described in the GFDL discussion below.

- GFDL (June 2015): Improvements to the vortex initialization and model physics are implemented. The improvements reduced tropical cyclone intensity forecast errors during the testing phase (NWS TIN 15-26). The GFDL deterministic model and 10-member ensemble ran on experimental HFIP computer resources and forecasts were made available to JTWC for evaluation beginning in July 2014. GFDL modeling has expanded to all JTWC forecast basins for 2015.

- GFDL ensemble (Summer 2015): Ensemble members increase from 10 to 12 (GFDL 2015).

- HWRF (June 2015): The HWRF model becomes operational for tropical cyclones occurring in the western North Pacific, Southern Pacific, and Indian Ocean, and the system's simultaneous modeling capability increases from 5 to 7 cyclones. HWRF model package upgrades include a horizontal resolution increase in all three domains to 18/6/2 km, a modified vortex initialization scheme, and improved physics (NWS TIN 15-25).

- MEPS ensemble (July 2015): AFWA implements a rolling ensemble capability, running one member of the 12-member, 20 km ensemble every two hours (557 WW 2015).

### f. Two-week subjective TC formation outlooks

JTWC, in collaboration with NOAA organizations, the Naval Postgraduate School, the University of Albany, the Australia Bureau of Meteorology, and the Taiwan Central Weather Bureau, again provided input to the week one and two tropical cyclone forecasts produced by NOAA/NWS's Climate Prediction Center's (CPC) weekly Global Tropics Hazards (GTH) Assessment. This assessment, published weekly by Wednesday at 0000Z, is available directly from CPC's GTH website (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/), and is also accessible from a hyperlink provided on JTWC's public webpage.

Expanding upon the successful GTH prediction effort, JTWC has implemented an experimental, in-house procedure to predict tropical cyclone formation within the area-of-responsibility during a two-week forecast period. JTWC forecasters have regularly, but informally, identified candidate areas for tropical cyclone formation in the extended range (one to two weeks) through inspection of dynamic model fields and other data sources. This experimental two-week forecasting procedure formalizes extended-range prediction by cataloging suspect areas and collating associated track, intensity, and formation probability data. The goals of this project are to provide skillful extended-range forecast guidance for JTWC customers, improve early identification of candidate areas for tropical cyclone formation, and mitigate inaccuracies sometimes noted in objective forecast guidance during the first few warning cycles for a newly-formed tropical cyclone.

Candidate areas for tropical cyclone formation identified during the experimental two-week forecast process are designated as "preinvests." Technical Services issues preinvest forecasts every administrative workday, typically Monday through Friday, at 0000Z. A geographical formation region (box-shaped), potential tropical cyclone formation (first warning) timeframe, and subjective formation confidence (percentage) are included in each preinvest forecast. Extended range prediction tools are thoroughly reviewed for TC genesis signals during the preinvest forecasting process. Preliminary track and intensity forecast data, if available, are provided to forecasters for each preinvest area. These data will be incorporated into the Automated Tropical Cyclone Forecast system (ATCF) during CY 2015 and 2016.

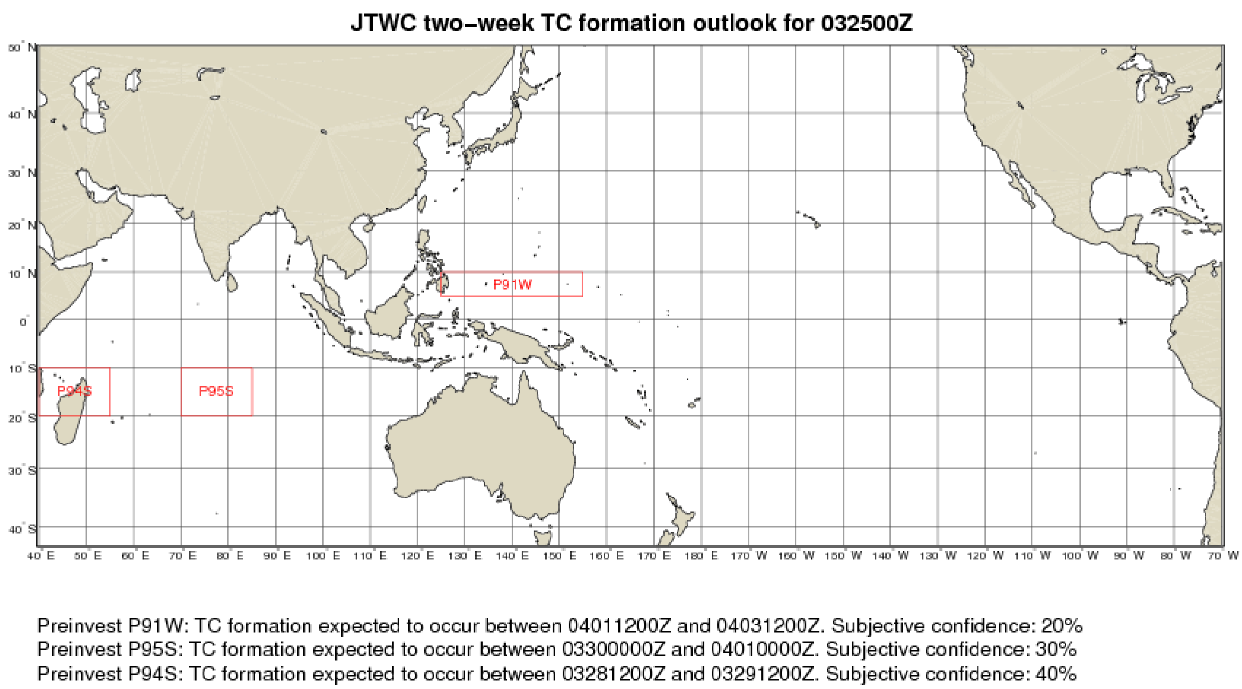



**Figure 5-2:** Example experimental, two-week tropical cyclone formation outlook graphic showing the projected location, timing, and probability of development for several "preinvest" areas.

## 4. Statistical based TC track confidence guidance

### a. Evaluation of situation-dependent error swath based on GPCE

JTWC personnel and partners at NRL are developing techniques to improve and expand upon existing track forecast confidence guidance. These efforts include incorporating situation-dependent uncertainty (GPCE) into the TC warning graphic 34-knot danger area (NRL lead) and relating GPCE uncertainty to historical forecast errors (JTWC lead). Both efforts aim to improve battlespace maneuverability and safety by increasing available sea space in highly certain forecast scenarios and accurately highlighting danger areas in highly uncertain forecast scenarios.

**Enhancements to the operational environment**

### b. Geospatial data display tool

JTWC is developing a geospatial data interface for hand-analyzed tropical streamlines and other tropical cyclone datasets. The interface uses the Google Maps Javascript API, which does not require specialized geospatial display software to function on the user's computer. Forecasters and meteorological technicians can simply access and display the interface and associated datasets through their web-browsers (Figure 5-3).

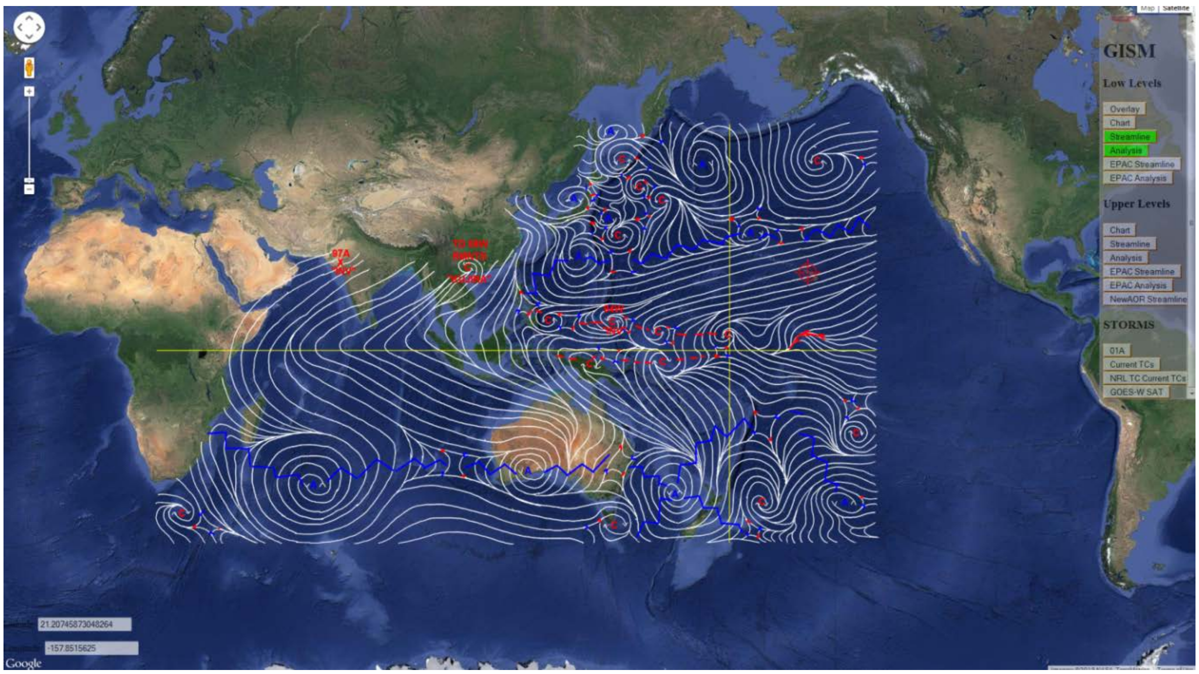



**Figure 5-3:** Example Google Maps Javascript API interface image showing JTWC's hand-analyzed tropical streamline data

## 5. Other projects

### a. Climatology packages

JTWC composed detailed reviews of historical tropical cyclone activity impacting various DoD installations throughout the organization's area of forecast responsibility. These climatology packages detail the track and intensity characteristics of TCs that pass near each installation, and include analyses of basin-wide activity as well as a comparison of El Niño and La Niña years. The climatology packages will be made available in .ppt, .pdf, and .kmz formats to JTWC customers through the Navy Enterprise Portal, Oceanography (NEP-Oc) webpage.

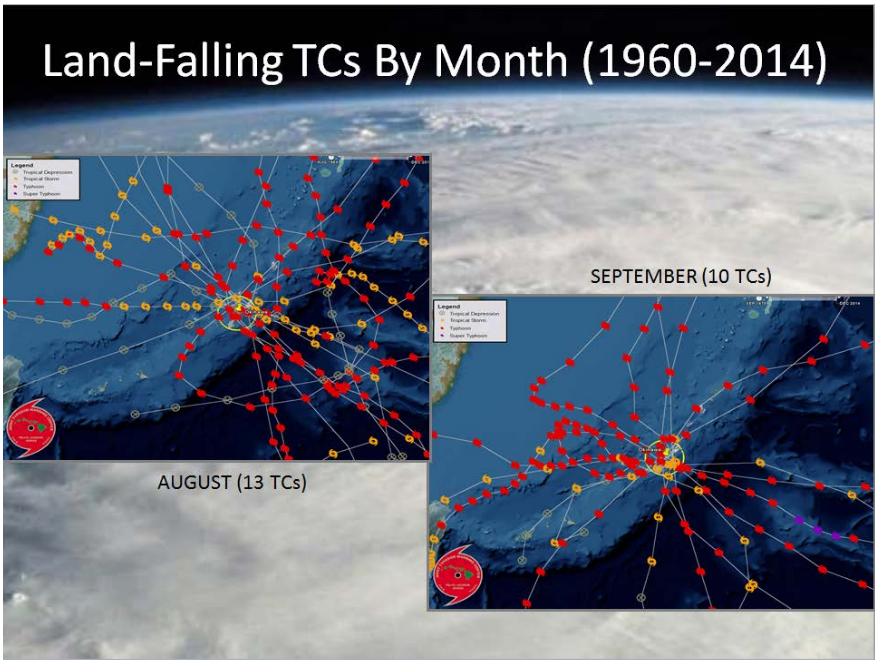



**Figure 5-4:** Example image from the asset climatology packages developed at JTWC. This graphic shows the tracks of all TCs that made landfall in Okinawa in August and September during the 1960 through 2014 period (image source: Google Earth software).

## Section 4: Scientific and technical exchanges

Participating in national and international-level meetings and conducting technical exchanges with members of the scientific community is essential to the success of JTWC's strategic development efforts. Budgetary restrictions in place during 2014 curtailed JTWC's participation in these events, prompting cancellation of the biennial Tropical Cyclone Conference and the ATCF requirements meeting. The following is a list of JTWC's 2014 conference attendance and technical exchange meetings.

- Hosted technical exchanges with Naval Postgraduate School representative Dr. Russell Elsberry. JTWC continues to evaluate multiple forecasting tools and techniques developed by Dr. Elsberry and his colleagues, including ensemble track clusters, weighted intensity analog forecasts, and extended-range TC formation and track forecasts from model ensembles.

- Hosted technical exchange with Australian Bureau of Meteorology Centre for Australian Weather and Climate Research (CAWCR) representative Dr. Noel Davidson. Dr. Davidson discussed several areas of innovative, ongoing research at CAWCR, including near real-time analysis of the Okubo-Weiss-Zeta (OWZ) parameter derived from ACCESS model fields. These OWZ data can differentiate tropical disturbances with elevated potential to develop into tropical cyclones (Tory et al 2013). A leading OWZ researcher, Dr. Kevin Tory (also from CAWCR), has graciously provided these data to JTWC for evaluation during the past year.

- Hosted technical exchange with Naval Research Laboratory representatives Dr. Carolyn Reynolds and Dr. James Doyle. Dr. Reynolds and Dr. Doyle updated JTWC staff on the current status and future plans for the NAVGEM and COAMPS-TC forecast models, respectively.

- Hosted technical exchange with University of Rhode Island representative Dr. Isaac Ginis. Dr. Ginis discussed the 2014 GFDL forecast model upgrade and shared some recent research findings regarding TC-ocean interaction.

- Served in working groups for the WMO Eighth International Workshop on Tropical Cyclones (IWTC-VIII), which convened in Jeju, South Korea, in December 2014. The team composed and contributed two original summaries of operational intensity and extratropical transition forecasting procedures to IWTC subject matter rapporteurs.

- Participated in the NCEP 6th Annual Ensemble Users Workshop.

- Presented JTWC subtropical cyclone operational procedures and analysis methods at 31st Annual American Meteorological Society Hurricane Conference.

- Participated in the 2014 NCEP Production Suite Review.

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## Chapter 6 Summary of Forecast Verification

Verification of warning position and intensities at 24-, 48-, and 72-, 96-, 120-hour forecast periods are made against the final best track. The (scalar) track forecast, along-track and cross track errors (illustrated in Figure 6-1) were calculated for each verifying JTWC forecast. These data are included in this chapter. This section summarizes verification data for the 2014 season, and contrasts it with annual verification statistics from previous years.

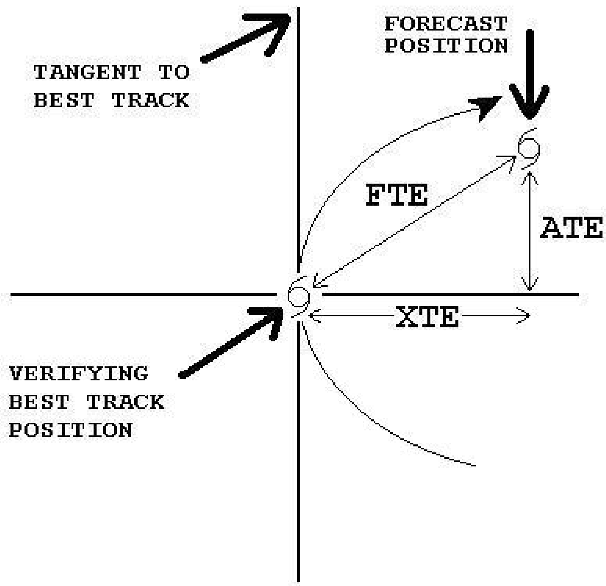


**Figure 6-1.** Definition of cross-track error (XTE), along track error (ATE), and forecast track error (FTE). In this example, the forecast position is ahead of and to the right of the verifying best track position. Therefore, the XTE is positive (to the right of track) and the ATE is positive (ahead of the best track). Adapted from Tsui and Miller, 1988.

## Section 1 Annual Forecast Verification

**TABLE 6-1**
**MEAN FORECAST ERRORS (NM) FOR WESTERN NORTH PACIFIC TROPICAL CYCLONES FROM 1959 - 2014**

| | 24-Hour | | | | | 48-Hour | | | | | 72-Hour | | | | | 96-Hour | | | | | 120-Hour | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year (Note) | Cases | TY Mean Error | TC Mean Error (3) | Cross Track Mean Error (2) | Along Track Mean Error (2) | Cases | TY Mean Error | TC Mean Error (3) | Cross Track Mean Error (2) | Along Track Mean Error (2) | Cases | TY Mean Error | TC Mean Error (3) | Cross Track Mean Error (2) | Along Track Mean Error (2) | Cases (1) | TY Mean Error | TC Mean Error (3) | Cross Track Mean Error (2) | Along Track Mean Error (2) | Cases (1) | TY Mean Error | TC Mean Error (3) | Cross Track Mean Error (2) | Along Track Mean Error (2) |
| 1959 | | 117 | | | | | 267 | | | | | | | | | | | | | | | | | | |
| 1960 | | 177 | | | | | 354 | | | | | | | | | | | | | | | | | | |
| 1961 | | 136 | | | | | 274 | | | | | | | | | | | | | | | | | | |
| 1962 | | 144 | | | | | 287 | | | | | 476 | | | | | | | | | | | | | |
| 1963 | | 127 | | | | | 246 | | | | | 374 | | | | | | | | | | | | | |
| 1964 | | 133 | | | | | 284 | | | | | 429 | | | | | | | | | | | | | |
| 1965 | | 151 | | | | | 303 | | | | | 418 | | | | | | | | | | | | | |
| 1966 | | 136 | | | | | 280 | | | | | 432 | | | | | | | | | | | | | |
| 1967 | | 125 | | | | | 276 | | | | | 414 | | | | | | | | | | | | | |
| 1968 | | 105 | | | | | 229 | | | | | 337 | | | | | | | | | | | | | |
| 1969 | | 111 | | | | | 237 | | | | | 349 | | | | | | | | | | | | | |
| 1970 | | 98 | 104 | | | | 181 | 190 | | | | 272 | 279 | | | | | | | | | | | | |
| 1971 | | 99 | 111 | 64 | | | 203 | 212 | 118 | | | 308 | 317 | 177 | | | | | | | | | | | |
| 1972 | | 116 | 117 | 72 | | | 245 | 245 | 146 | | | 382 | 381 | 210 | | | | | | | | | | | |
| 1973 | | 102 | 108 | 74 | | | 193 | 197 | 134 | | | 245 | 253 | 162 | | | | | | | | | | | |
| 1974 | | 114 | 120 | 78 | | | 218 | 226 | 157 | | | 256 | 348 | 245 | | | | | | | | | | | |
| 1975 | | 129 | 138 | 84 | | | 279 | 288 | 181 | | | 442 | 450 | 290 | | | | | | | | | | | |
| 1976 | | 117 | 117 | 71 | | | 232 | 230 | 132 | | | 336 | 338 | 202 | | | | | | | | | | | |
| 1977 | | 140 | 148 | 83 | | | 266 | 283 | 157 | | | 290 | 407 | 228 | | | | | | | | | | | |
| 1978 | | 120 | 127 | 71 | 87 | | 241 | 271 | 151 | 194 | | 459 | 410 | 218 | 296 | | | | | | | | | | |
| 1979 | | 113 | 124 | 76 | 81 | | 219 | 226 | 138 | 146 | | 319 | 316 | 182 | 214 | | | | | | | | | | |
| 1980 | | 116 | 126 | 76 | 86 | | 221 | 243 | 147 | 165 | | 362 | 389 | 230 | 266 | | | | | | | | | | |
| 1981 | | 117 | 124 | 77 | 80 | | 215 | 221 | 131 | 146 | | 342 | 334 | 219 | 206 | | | | | | | | | | |
| 1982 | | 114 | 113 | 70 | 74 | | 229 | 238 | 142 | 162 | | 337 | 342 | 211 | 223 | | | | | | | | | | |
| 1983 | | 110 | 117 | 73 | 76 | | 247 | 260 | 164 | 169 | | 384 | 407 | 263 | 259 | | | | | | | | | | |
| 1984 | | 110 | 117 | 64 | 84 | | 228 | 232 | 131 | 163 | | 361 | 363 | 216 | 238 | | | | | | | | | | |
| 1985 | | 112 | 117 | 68 | 80 | | 228 | 231 | 138 | 153 | | 355 | 367 | 227 | 230 | | | | | | | | | | |
| 1986 | | 117 | 126 | 70 | 85 | | 261 | 261 | 151 | 183 | | 403 | 394 | 227 | 276 | | | | | | | | | | |
| 1987 | | 101 | 107 | 64 | 71 | | 211 | 204 | 127 | 134 | | 318 | 303 | 186 | 198 | | | | | | | | | | |
| 1988 | 353 | 107 | 114 | 58 | 85 | 255 | 222 | 216 | 103 | 170 | 183 | 327 | 315 | 159 | 244 | | | | | | | | | | |
| 1989 | 585 | 107 | 120 | 69 | 83 | 458 | 214 | 231 | 127 | 162 | 343 | 325 | 350 | 177 | 265 | | | | | | | | | | |
| 1990 | 551 | 98 | 103 | 60 | 72 | 453 | 191 | 203 | 110 | 148 | 334 | 299 | 310 | 168 | 225 | | | | | | | | | | |
| 1991 | 673 | 93 | 96 | 53 | 69 | 570 | 187 | 185 | 97 | 137 | 467 | 298 | 287 | 146 | 229 | | | | | | | | | | |
| 1992 | 890 | 97 | 107 | 59 | 77 | 739 | 194 | 205 | 116 | 143 | 610 | 295 | 305 | 172 | 210 | | | | | | | | | | |
| 1993 | 744 | 102 | 112 | 63 | 79 | 596 | 205 | 212 | 117 | 151 | 469 | 320 | 321 | 173 | 226 | | | | | | | | | | |
| 1994 | 920 | 96 | 105 | 56 | 76 | 762 | 172 | 186 | 105 | 131 | 623 | 244 | 258 | 152 | 176 | | | | | | | | | | |
| 1995 | 521 | 105 | 123 | 67 | 89 | 409 | 200 | 215 | 117 | 159 | 315 | 311 | 325 | 167 | 240 | | | | | | | | | | |
| 1996 | 868 | 85 | 105 | 56 | 76 | 707 | 157 | 178 | 89 | 134 | 604 | 252 | 272 | 137 | 203 | | | | | | | | | | |
| 1997 | 905 | 86 | 93 | 55 | 76 | 783 | 159 | 164 | 87 | 134 | 665 | 251 | 245 | 120 | 202 | | | | | | | | | | |
| 1998 | 354 | 127 | 124 | 58 | 98 | 257 | 263 | 239 | 127 | 178 | 189 | 392 | 370 | 201 | 274 | | | | | | | | | | |
| 1999 | 433 | 88 | 106 | 59 | 74 | 300 | 150 | 176 | 102 | 119 | 191 | 225 | 234 | 139 | 155 | | | | | | | | | | |
| 2000 | 605 | 75 | 81 | 45 | 57 | 467 | 136 | 142 | 80 | 98 | 363 | 205 | 209 | 118 | 144 | | | | | | | | | | |
| 2001 | 627 | 66 | 73 | 42 | 49 | 512 | 114 | 122 | 75 | 78 | 395 | 169 | 180 | 110 | 120 | 191 | | 289 | 169 | 200 | 139 | | 420 | 237 | 299 |
| 2002 | 657 | 50 | 66 | 37 | 47 | 535 | 94 | 116 | 67 | 79 | 421 | 144 | 166 | 88 | 120 | 260 | | 232 | 107 | 183 | 201 | | 292 | 131 | 230 |
| 2003 | 602 | 59 | 73 | 41 | 52 | 495 | 119 | 128 | 68 | 94 | 397 | 186 | 186 | 89 | 147 | 238 | | 241 | 107 | 197 | 173 | | 304 | 126 | 249 |
| 2004 | 766 | 52 | 70 | 41 | 48 | 646 | 94 | 122 | 69 | 84 | 537 | 180 | 173 | 95 | 121 | 328 | | 206 | 111 | 147 | 242 | | 274 | 147 | 195 |
| 2005 | 507 | 41 | 61 | 38 | 38 | 407 | 81 | 102 | 59 | 72 | 316 | 138 | 156 | 76 | 120 | 168 | | 213 | 106 | 164 | 111 | | 263 | 122 | 200 |
| 2006 | 512 | 47 | 62 | 39 | 40 | 405 | 85 | 104 | 61 | 73 | 327 | 133 | 151 | 77 | 112 | 206 | | 216 | 115 | 155 | 141 | | 309 | 167 | 222 |
| 2007 | 343 | 45 | 61 | 24 | 42 | 260 | 72 | 100 | 58 | 69 | 189 | 89 | 148 | 83 | 102 | 105 | | 189 | 107 | 127 | 63 | | 215 | 117 | 155 |
| 2008 | 354 | 45 | 66 | 38 | 46 | 261 | 104 | 120 | 75 | 78 | 192 | 201 | 198 | 110 | 140 | 138 | | 300 | 163 | 219 | 87 | | 447 | 246 | 313 |
| 2009 | 498 | 46 | 66 | 35 | 47 | 395 | 102 | 123 | 65 | 90 | 303 | 179 | 183 | 102 | 130 | 227 | | 258 | 145 | 183 | 174 | | 298 | 158 | 213 |
| 2010 | 253 | 57 | 59 | 33 | 42 | 192 | 101 | 101 | 63 | 65 | 140 | 157 | 160 | 95 | 102 | 92 | 154 | 223 | 134 | 147 | 54 | 154 | 279 | 174 | 179 |
| 2011 | 455 | 56 | 61 | 36 | 43 | 365 | 85 | 93 | 54 | 66 | 290 | 117 | 129 | 74 | 91 | 177 | 159 | 177 | 103 | 121 | 164 | 233 | 252 | 150 | 163 |
| 2012 | 535 | 48 | 50 | 30 | 34 | 439 | 87 | 89 | 52 | 61 | 340 | 121 | 127 | 67 | 93 | 248 | 160 | 163 | 82 | 123 | 178 | 218 | 224 | 105 | 176 |
| 2013 | 448 | 39 | 46 | 29 | 31 | 332 | 65 | 74 | 47 | 49 | 232 | 96 | 102 | 61 | 71 | 152 | 156 | 156 | 92 | 105 | 87 | 248 | 240 | 142 | 161 |
| 2014 | 406 | 49 | 49 | 29 | 34 | 362 | 81 | 82 | 48 | 56 | 258 | 119 | 123 | 71 | 85 | 200 | 164 | 167 | 102 | 111 | 146 | 218 | 227 | 147 | 146 |
| Avg (1978-2014) | 569 | 84 | 93 | 53 | 65 | 458 | 163 | 173 | 99 | 121 | 359 | 254 | 260 | 146 | 183 | 195 | 159 | 216 | 117 | 156 | 140 | 214 | 289 | 155 | 207 |
| 5yr Avg | 419 | 50 | 53 | 31 | 37 | 338 | 84 | 88 | 53 | 59 | 252 | 122 | 128 | 74 | 88 | 174 | 159 | 177 | 103 | 121 | 126 | 214 | 244 | 144 | 165 |

(1) JTWC extended warning period from 72hrs to 120hrs in 2001. 96-hour and 120-hour data is not available prior to 2001.
(2) Cross-track and along-track errors were adopted by the JTWC in 1986. Right angle errors (used prior to 1986) were recomputed as cross-track errors after-the fact to extend the data base.
(3) Mean forecast errors for all warned systems in Northwest Pacific.

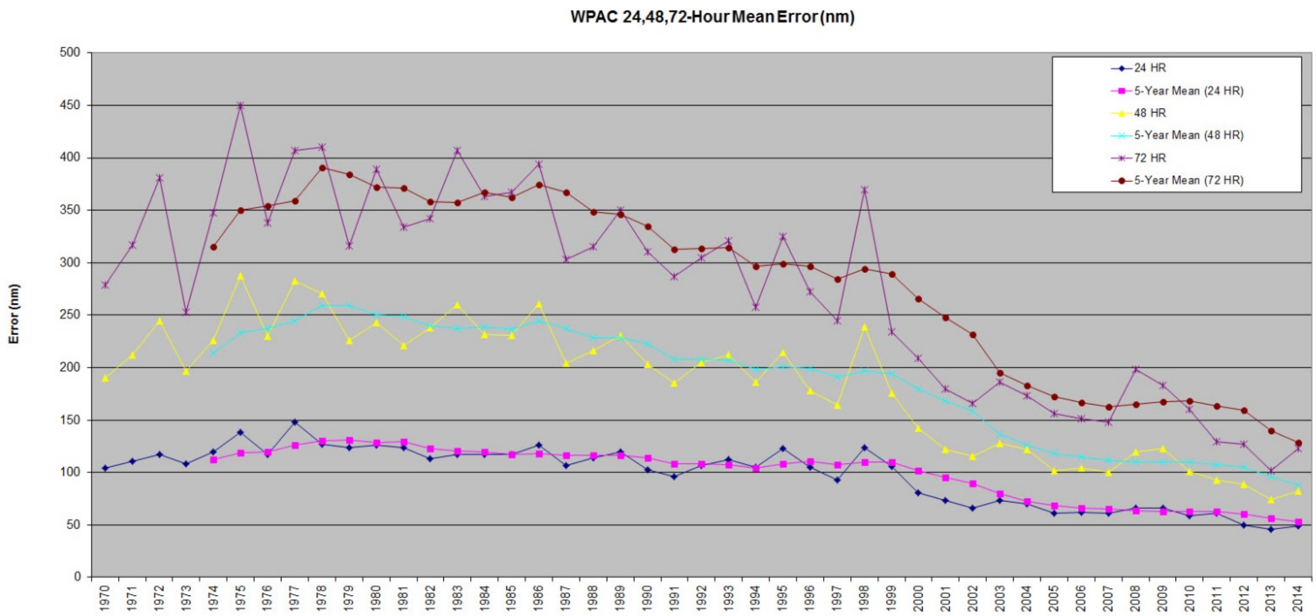


**Figure 6-2.** Graph of JTWC forecast errors and five year running mean errors for the western North Pacific at 24, 48, and 72 hours.

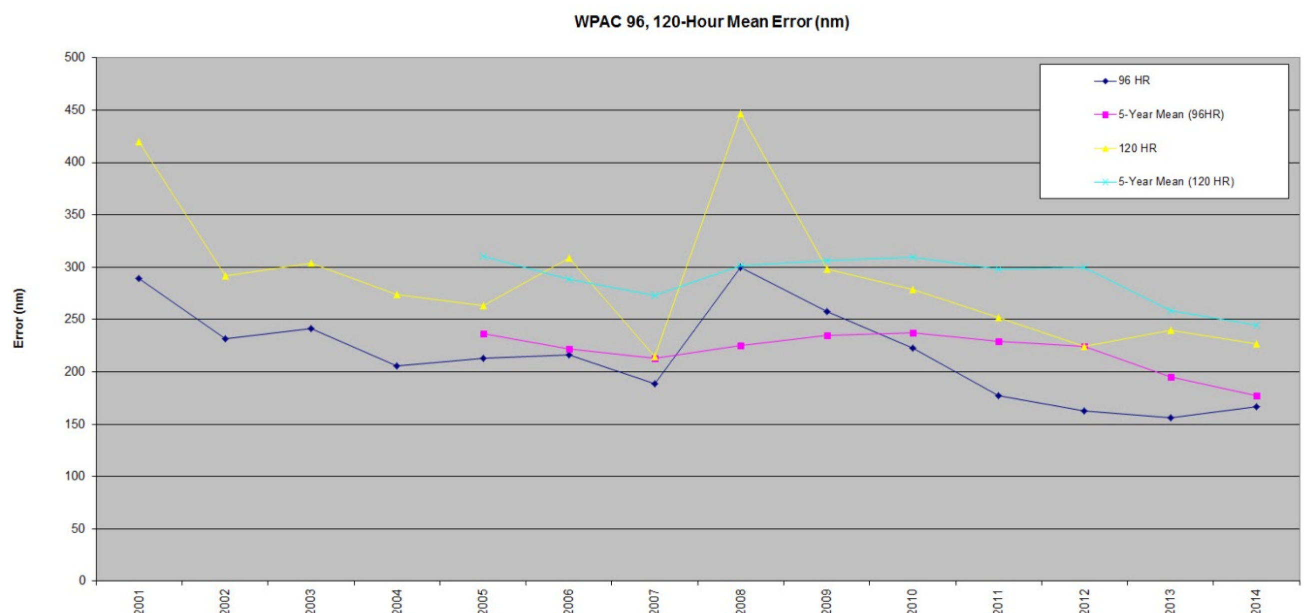


**Figure 6-3.** Graph of JTWC forecast errors and five year running mean errors for the western North Pacific at 96 and 120 hours.

## Table 6-2
## MEAN FORECAST TRACK ERRORS (NM) FOR NORTH INDIAN OCEAN
## TROPICAL CYCLONES FROM 1985-2014

| | 24-HOUR | | | | 48-HOUR | | | | 72-HOUR | | | | 96-HOUR | | | | 120-HOUR | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR (Notes) | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error |
| 1985 | 30 | 122 | 102 | 53 | 8 | 242 | 119 | 194 | 0 | | | | | | | | | | | |
| 1986 | 16 | 134 | 118 | 53 | 7 | 168 | 131 | 80 | 5 | 269 | 189 | 180 | | | | | | | | |
| 1987 | 54 | 144 | 97 | 100 | 25 | 205 | 125 | 140 | 21 | 305 | 219 | 188 | | | | | | | | |
| 1988 | 30 | 120 | 89 | 63 | 18 | 219 | 112 | 176 | 12 | 409 | 227 | 303 | | | | | | | | |
| 1989 | 33 | 88 | 62 | 50 | 17 | 146 | 94 | 86 | 12 | 216 | 164 | 11 | | | | | | | | |
| 1990 | 36 | 101 | 85 | 43 | 24 | 146 | 117 | 67 | 17 | 185 | 130 | 104 | | | | | | | | |
| 1991 | 43 | 129 | 107 | 54 | 27 | 235 | 200 | 89 | 14 | 450 | 356 | 178 | | | | | | | | |
| 1992 | 149 | 128 | 73 | 86 | 100 | 244 | 141 | 166 | 62 | 398 | 276 | 218 | | | | | | | | |
| 1993 | 28 | 125 | 87 | 79 | 20 | 198 | 171 | 74 | 12 | 231 | 176 | 116 | | | | | | | | |
| 1994 | 44 | 97 | 80 | 44 | 28 | 153 | 124 | 63 | 13 | 213 | 177 | 92 | | | | | | | | |
| 1995 | 47 | 138 | 119 | 58 | 32 | 262 | 247 | 77 | 20 | 342 | 304 | 109 | | | | | | | | |
| 1996 | 123 | 134 | 94 | 80 | 85 | 238 | 181 | 127 | 58 | 311 | 172 | 237 | | | | | | | | |
| 1997 | 42 | 119 | 87 | 49 | 29 | 201 | 168 | 92 | 17 | 228 | 195 | 110 | | | | | | | | |
| 1998 | 55 | 106 | 84 | 51 | 34 | 198 | 135 | 106 | 17 | 262 | 188 | 144 | | | | | | | | |
| 1999 | 41 | 79 | 59 | 38 | 22 | 184 | 130 | 116 | 10 | 374 | 309 | 177 | | | | | | | | |
| 2000 | 24 | 61 | 47 | 26 | 16 | 85 | 69 | 37 | 1 | 401 | 399 | 38 | | | | | | | | |
| 2001 | 41 | 61 | 40 | 37 | 31 | 115 | 71 | 71 | 22 | 166 | 44 | 154 | | | | | | | | |
| 2002 | 30 | 84 | 41 | 63 | 18 | 137 | 92 | 83 | 10 | 185 | 92 | 133 | | | | | | | | |
| 2003 | 37 | 108 | 66 | 69 | 31 | 196 | 115 | 132 | 7 | 354 | 210 | 252 | | | | | | | | |
| 2004 | 46 | 81 | 53 | 52 | 36 | 140 | 95 | 85 | 9 | 173 | 144 | 86 | | | | | | | | |
| 2005 | 67 | 62 | 41 | 40 | 49 | 116 | 71 | 73 | 18 | 118 | 35 | 109 | | | | | | | | |
| 2006 | 19 | 64 | 37 | 44 | 13 | 92 | 58 | 60 | 0 | | - | - | | | | | | | | |
| 2007 | 38 | 61 | 38 | 36 | 23 | 94 | 56 | 65 | 10 | 140 | 92 | 93 | | | | | | | | |
| 2008 | 59 | 70 | 46 | 44 | 38 | 99 | 71 | 55 | 24 | 127 | 94 | 127 | | | | | | | | |
| 2009 | 25 | 93 | 42 | 74 | 10 | 206 | 79 | 169 | 1 | 387 | 102 | 373 | | | | | | | | |
| 2010 | 63 | 52 | 31 | 33 | 42 | 90 | 67 | 44 | 22 | 170 | 116 | 84 | 11 | 332 | 175 | 259 | 6 | 587 | 154 | 545 |
| 2011 | 46 | 56 | 38 | 34 | 35 | 96 | 59 | 63 | 23 | 118 | 59 | 87 | 12 | 108 | 44 | 95 | 4 | 156 | 65 | 118 |
| 2012 | 19 | 67 | 38 | 42 | 7 | 51 | 34 | 31 | 3 | 30 | 22 | 15 | 0 | | | | 0 | | | |
| 2013 | 99 | 49 | 27 | 37 | 75 | 80 | 37 | 66 | 52 | 102 | 61 | 69 | 32 | 138 | 68 | 109 | 17 | 207 | 104 | 167 |
| 2014 | 59 | 40 | 27 | 26 | 40 | 55 | 36 | 36 | 25 | 76 | 52 | 45 | 16 | 136 | 101 | 84 | 8 | 182 | 139 | 112 |
| Avg (1985-2014) | 48 | 92 | 65 | 52 | 31 | 156 | 107 | 91 | 17 | 241 | 164 | 137 | 14 | 179 | 97 | 137 | 7 | 283 | 116 | 236 |
| 5Yr Avg | 57 | 53 | 32 | 34 | 40 | 74 | 47 | 48 | 25 | 99 | 62 | 60 | 14 | 179 | 97 | 137 | 7 | 283 | 116 | 236 |

(1) JTWC extended warning period from 72hrs to 120hrs in 2010. 96-hour and 120-hour data is not available prior to 2010.

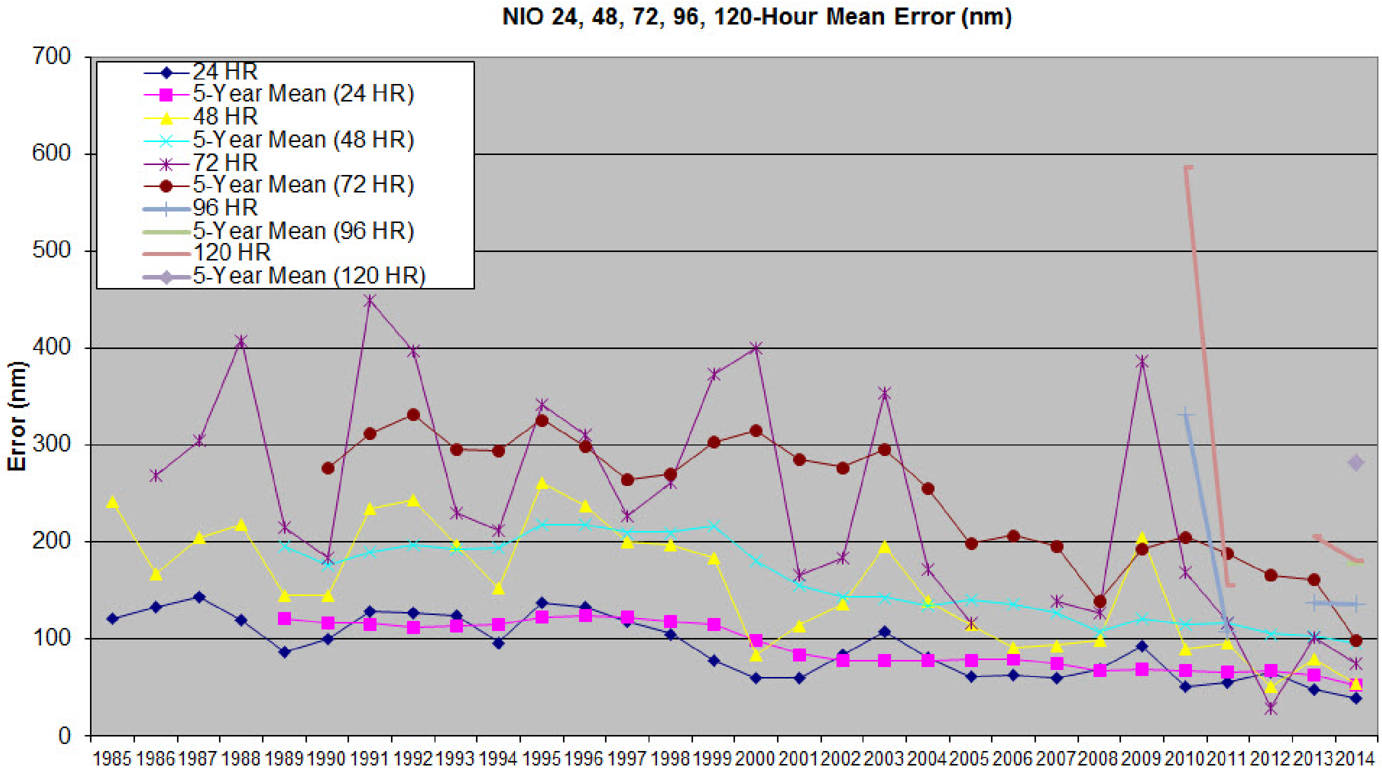


**Figure 6-4.** Graph of JTWC forecast errors and five year running mean errors for the north Indian Ocean at 24, 48, 72, 96, and 120 hours. (Note: No 96 HR, 120 HR data for 2012)

## TABLE 6-3
## MEAN FORECAST ERRORS (NM) FOR SOUTHERN HEMISPHERE TROPICAL CYCLONES 1985 - 2014

| | 24-Hour | | | | 48-Hour | | | | 72-Hour | | | | 96-Hour | | | | 120-Hour | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year (Notes) | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error | Cases | Mean Error | Cross Track Mean Error | Along Track Mean Error |
| 1985 | 257 | 134 | 79 | 92 | 193 | 236 | 132 | 169 | | | | | | | | | | | | |
| 1986 | 227 | 129 | 77 | 86 | 171 | 262 | 164 | 169 | | | | | | | | | | | | |
| 1987 | 138 | 145 | 90 | 94 | 101 | 280 | 138 | 153 | | | | | | | | | | | | |
| 1988 | 99 | 146 | 83 | 98 | 48 | 290 | 144 | 246 | | | | | | | | | | | | |
| 1989 | 242 | 124 | 73 | 84 | 186 | 240 | 136 | 166 | | | | | | | | | | | | |
| 1990 | 228 | 143 | 74 | 105 | 177 | 263 | 152 | 178 | | | | | | | | | | | | |
| 1991 | 231 | 115 | 69 | 75 | 185 | 220 | 129 | 152 | | | | | | | | | | | | |
| 1992 | 230 | 124 | 64 | 91 | 208 | 240 | 129 | 177 | | | | | | | | | | | | |
| 1993 | 225 | 102 | 57 | 74 | 176 | 199 | 114 | 142 | | | | | | | | | | | | |
| 1994 | 345 | 115 | 68 | 77 | 282 | 224 | 134 | 147 | | | | | | | | | | | | |
| 1995 | 222 | 108 | 55 | 82 | 175 | 198 | 108 | 144 | 53 | 291 | 190 | 169 | | | | | | | | |
| 1996 | 298 | 125 | 67 | 90 | 237 | 240 | 129 | 174 | 46 | 277 | 133 | 221 | | | | | | | | |
| 1997 | 499 | 109 | 72 | 82 | 442 | 210 | 135 | 163 | 150 | 288 | 175 | 248 | | | | | | | | |
| 1998 | 305 | 111 | 52 | 85 | 245 | 219 | 108 | 169 | 81 | 349 | 171 | 261 | | | | | | | | |
| 1999 | 322 | 113 | 64 | 80 | 245 | 226 | 132 | 159 | 59 | 286 | 164 | 198 | | | | | | | | |
| 2000 | 313 | 72 | 45 | 47 | 245 | 135 | 86 | 84 | 58 | 180 | 139 | 94 | | | | | | | | |
| 2001 | 147 | 84 | 44 | 61 | 113 | 148 | 86 | 105 | 11 | 248 | 197 | 133 | | | | | | | | |
| 2002 | 200 | 82 | 43 | 60 | 146 | 133 | 75 | 93 | 5 | 102 | 41 | 91 | | | | | | | | |
| 2003 | 279 | 74 | 37 | 57 | 221 | 127 | 68 | 90 | 37 | 123 | 54 | 99 | | | | | | | | |
| 2004 | 277 | 77 | 45 | 52 | 233 | 142 | 89 | 92 | 47 | 210 | 102 | 162 | | | | | | | | |
| 2005 | 214 | 70 | 44 | 44 | 170 | 116 | 77 | 72 | 41 | 199 | 117 | 136 | | | | | | | | |
| 2006 | 191 | 65 | 37 | 46 | 140 | 116 | 69 | 79 | 32 | 201 | 101 | 151 | | | | | | | | |
| 2007 | 186 | 74.9 | 41 | 52 | 131 | 147 | 80 | 105 | 3 | 173 | 146 | 73 | | | | | | | | |
| 2008 | 269 | 61 | 38 | 40 | 211 | 106 | 64 | 72 | 27 | 97 | 53 | 65 | | | | | | | | |
| 2009 | 166 | 74 | 42 | 51 | 118 | 128 | 74 | 89 | 14 | 114 | 89 | 54 | | | | | | | | |
| 2010 | 206 | 66 | 40 | 45 | 161 | 109 | 67 | 57 | 125 | 149 | 76 | 109 | 89 | 207 | 117 | 145 | 64 | 276 | 159 | 191 |
| 2011 | 164 | 53 | 32 | 34 | 127 | 81 | 50 | 54 | 88 | 109 | 62 | 76 | 54 | 173 | 114 | 107 | 31 | 274 | 205 | 151 |
| 2012 | 187 | 58 | 33 | 41 | 145 | 99 | 53 | 72 | 117 | 149 | 71 | 116 | 91 | 202 | 96 | 162 | 64 | 272 | 149 | 192 |
| 2013 | 216 | 49 | 28 | 34 | 175 | 80 | 45 | 54 | 140 | 114 | 63 | 78 | 103 | 138 | 72 | 101 | 69 | 166 | 76 | 131 |
| 2014 | 180 | 53 | 28 | 39 | 132 | 90 | 47 | 65 | 95 | 133 | 64 | 102 | 69 | 162 | 83 | 122 | 50 | 198 | 98 | 147 |
| Avg (1985-2014) | 235 | 95 | 54 | 67 | 185 | 177 | 100 | 123 | 61 | 190 | 110 | 132 | 81 | 176 | 96 | 127 | 56 | 237 | 137 | 162 |
| 5Yr Avg | 187 | 59 | 34 | 41 | 143 | 98 | 56 | 65 | 97 | 128 | 71 | 89 | 81 | 176 | 96 | 127 | 56 | 237 | 137 | 162 |

(1) JTWC extended warning period from 72hrs to 120hrs in 2010. 96-hour and 120-hour data is not available prior to 2010.

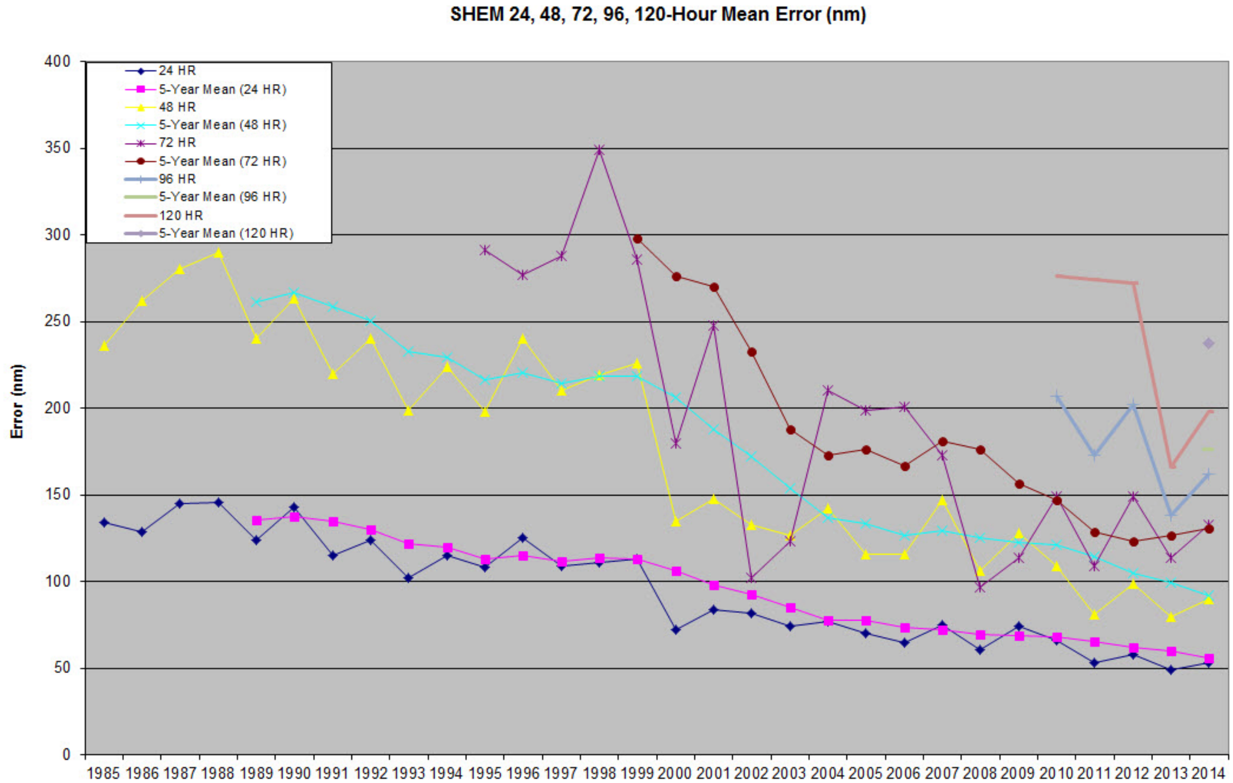


**Figure 6-5**. Graph of JTWC forecast errors for the Southern Hemisphere at 24, 48, 72, 96, and 120 hours.

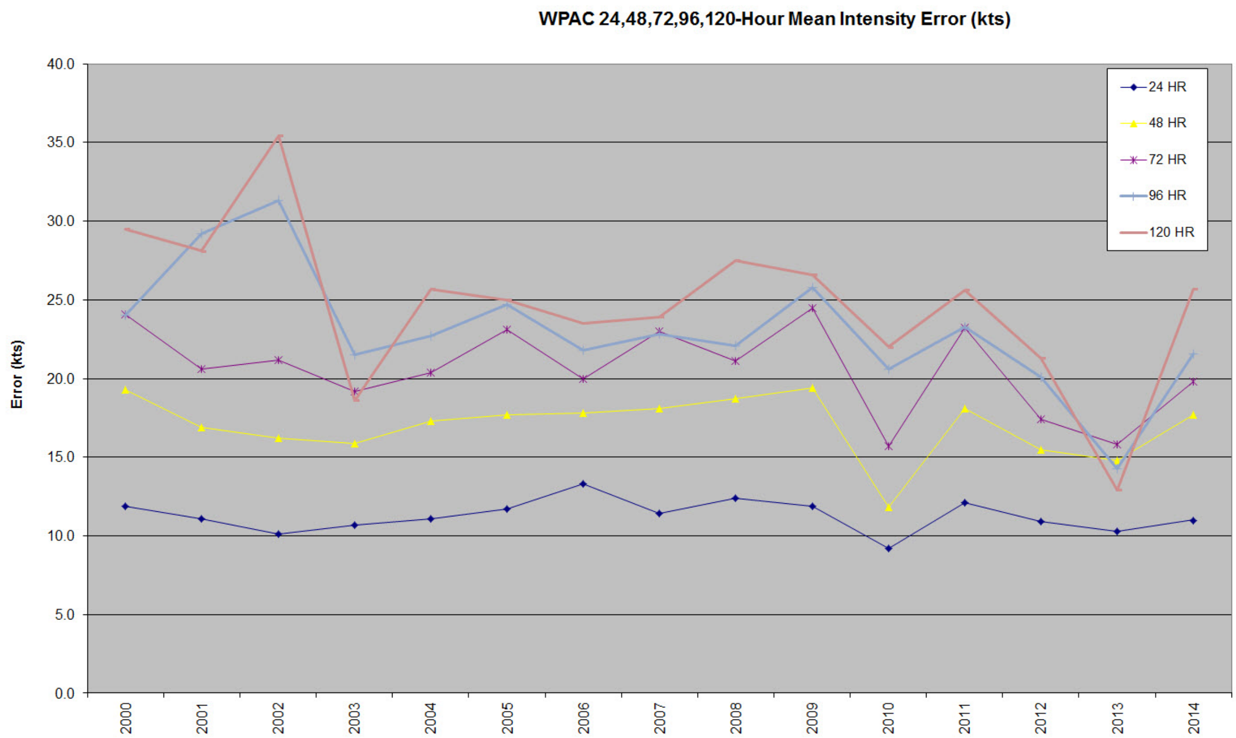


**Figure 6-6**. Graph of JTWC intensity forecast errors for the western North Pacific at 24, 48, 72, 96, and 120 hours.

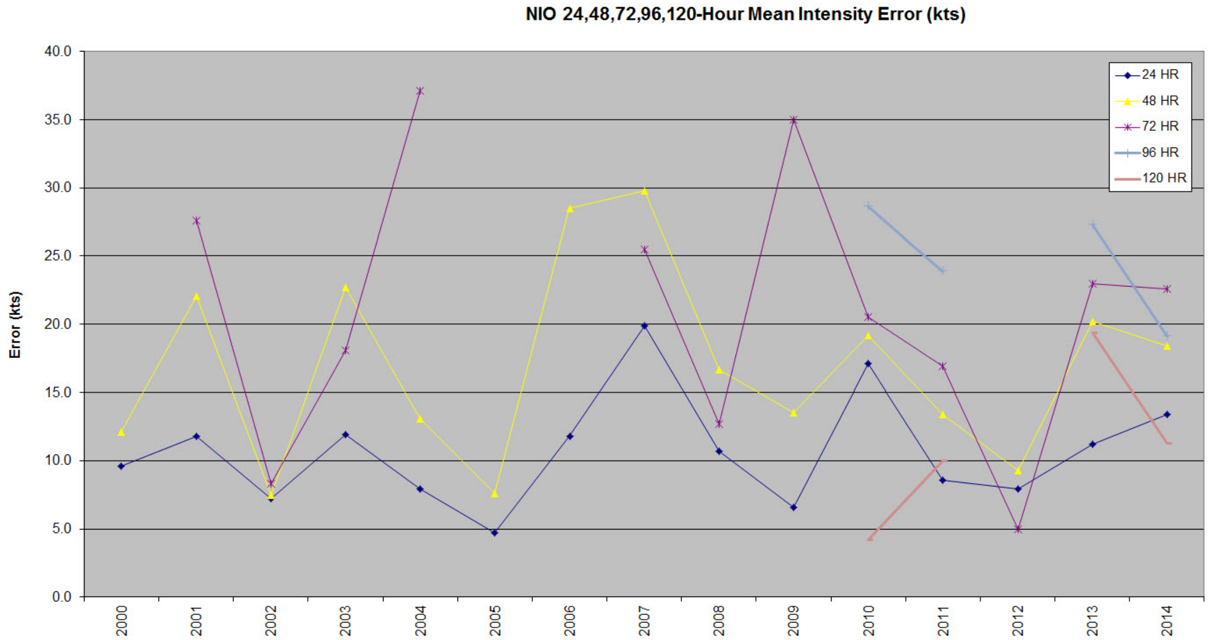


**Figure 6-7**. Graph of JTWC intensity forecast errors for the North Indian Ocean at 24, 48, 72, 96, and 120 hours. (Note: No 96 HR, 120 HR data for 2012)

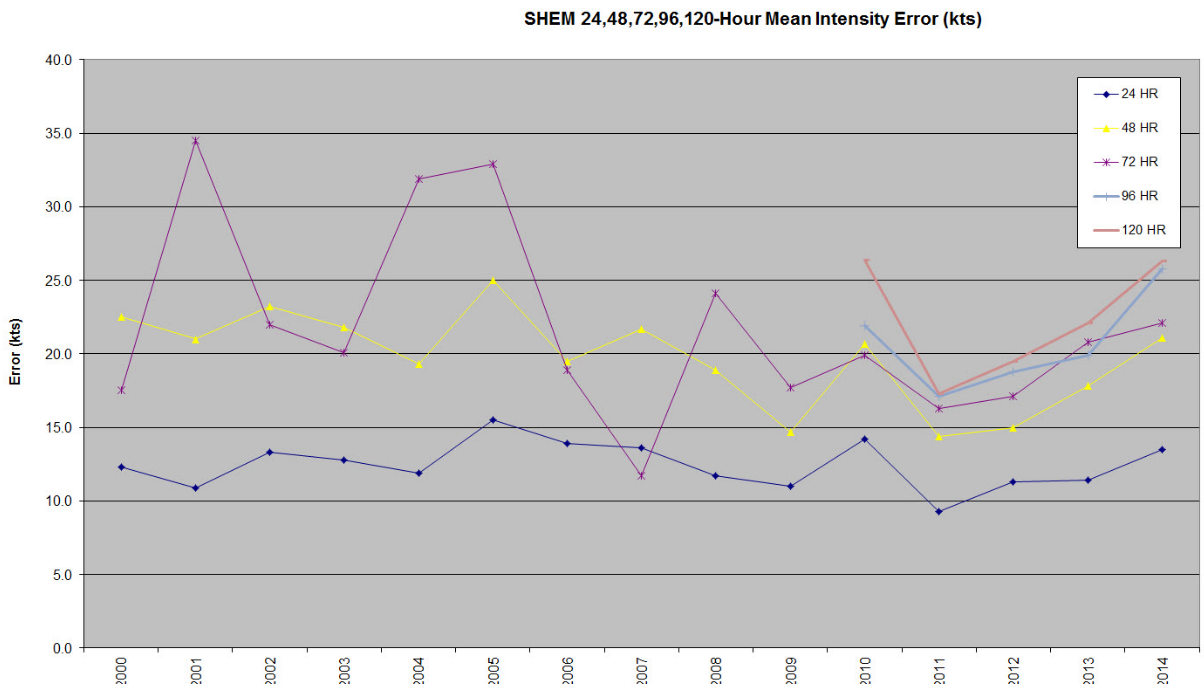


**Figure 6-8**. Graph of JTWC intensity forecast errors for the Southern Hemisphere at 24, 48, 72, 96, and 120 hours.