

## The revised Northeast and North Central Pacific hurricane database (HURDAT2) - Chris Landsea – April 2022

The National Hurricane Center (NHC) and the Central Pacific Hurricane Center (CPHC) conduct post-storm analyses of each tropical cyclone in their respective areas of responsibility over the North Pacific Ocean to determine the official assessment of the cyclone's history. (NHC's area extends from the North and Central America west coast westward to 140°W and CPHC's area extends from 140 to 180°W. These analyses make use of all available observations, including those that may not have been available in real-time. NHC and CPHC have traditionally disseminated the tropical cyclone historical database in a format known as HURDAT (short for HURricane DATAbase – Davis et al. 1984). This report updates the original HURDAT documentation to reflect significant changes to both the format and content for the tropical cyclones and subtropical cyclones of the Northeast and North Central Pacific basin. *(Note for April 2022: Radius of Maximum Wind added into HURDAT2 for the first time beginning with the 2021 hurricane season.)*

The original HURDAT format substantially limited the type of best track information that could be conveyed. The format of this new version - HURDAT2 (HURricane DATa 2<sup>nd</sup> generation) - is based upon the “best tracks” available from the b-decks in the Automated Tropical Cyclone Forecast (ATCF – Sampson and Schrader 2000) system database and is described below. Reasons for the revised version include: 1) inclusion of non-synoptic (other than 00, 06, 12, and 18Z) best track times (mainly to indicate landfalls and intensity maxima); 2) inclusion of non-developing tropical depressions; and 3) inclusion of best track wind radii.

An example of the new HURDAT2 format for Hurricane Rick from 2021 follows:

```

EP172021,           RICK,           15,
20211022, 1200, , TD, 12.7N, 100.3W, 30, 1007, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 50
20211022, 1800, , TS, 12.9N, 100.8W, 35, 1005, 40, 40, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 40
20211023, 0000, , TS, 13.2N, 101.1W, 45, 1001, 40, 40, 0, 40, 0, 0, 0, 0, 0, 0, 0, 0, 0, 30
20211023, 0600, , TS, 13.7N, 101.2W, 60, 995, 50, 50, 30, 40, 0, 20, 0, 0, 0, 0, 0, 0, 15
20211023, 1200, , HU, 14.4N, 101.4W, 75, 983, 50, 50, 30, 40, 30, 20, 0, 0, 15, 0, 0, 0, 15
20211023, 1800, , HU, 14.9N, 101.8W, 80, 979, 50, 50, 30, 50, 30, 20, 0, 30, 15, 0, 0, 15, 15
20211024, 0000, , HU, 15.1N, 101.8W, 80, 978, 50, 50, 30, 50, 30, 20, 0, 30, 15, 0, 0, 15, 10
20211024, 0600, , HU, 15.4N, 101.6W, 80, 980, 50, 50, 30, 50, 30, 20, 20, 30, 15, 10, 0, 15, 10
20211024, 1200, , HU, 15.7N, 101.5W, 75, 980, 60, 60, 40, 50, 30, 30, 20, 30, 15, 15, 0, 15, 10
20211024, 1800, , HU, 16.0N, 101.4W, 75, 980, 60, 70, 50, 60, 30, 30, 20, 30, 15, 15, 0, 15, 10
20211025, 0000, , HU, 16.5N, 101.5W, 80, 979, 70, 70, 50, 60, 30, 30, 30, 30, 20, 20, 15, 15, 15
20211025, 0600, , HU, 17.2N, 101.8W, 90, 977, 70, 70, 50, 50, 30, 30, 20, 30, 20, 20, 15, 15, 15
20211025, 1100, L, HU, 17.9N, 102.0W, 90, 977, 70, 70, 50, 50, 30, 30, 20, 30, 20, 20, 15, 15, 15
20211025, 1200, , HU, 18.1N, 102.1W, 85, 980, 70, 70, 50, 50, 30, 30, 20, 30, 20, 20, 15, 15, 15
20211025, 1800, , TS, 19.0N, 102.5W, 50, 997, 40, 40, 0, 0, 20, 0, 0, 0, 0, 0, 0, 0, 0, 20

```

There are two types of lines of data in the new format: the header line and the data lines. The format is comma delimited to maximize its ease in use. The header line has the following format:

```

EP172021,           RICK,           15,
1234567890123456789012345678901234567

```

EP (Spaces 1 and 2) – Basin

EP – Northeast Pacific

CP – North Central Pacific

17 (Spaces 3 and 4) – ATCF cyclone number for that year

2021 (Spaces 5-8, before first comma) – Year

RICK (Spaces 19-28, before second comma) – Name, if available, or else “UNNAMED”

15 (Spaces 34-36) – Number of best track entries – rows – to follow

Notes:

1) Basin: This designation refers to whether the cyclone formed (typically via tropical depression status) in the North Pacific east of 140°W (“EP”) or between 140 and 180°W (“CP”). Note that on occasion, systems would form east of 140°W, obtain an “EP” cyclone number, move westward, further develop and get “named” as a tropical storm while located between 140 and 180°W. Hurricane Iniki in 1992 (EP18) is an example of such a system.

2) Cyclone number: In HURDAT2, the order cyclones appear in the file is determined by the date/time of the first tropical or subtropical cyclone record in the best track.

3) Name: Tropical cyclones forming in the North Central Pacific have been given names back to the beginning of this database. Tropical cyclones were not formally named in the Northeast Pacific before 1960 and are thus referred to as “UNNAMED” in the database. Systems that were added into the database after the season (such as AL20 in 2011) also are considered “UNNAMED”. Non-developing tropical depressions – first were introduced into the dataset in 1988 - formally were given names (actually numbers, such as “TEN”) that were included into the ATCF b-decks starting in 2005. Non-developing tropical depressions before 2005 are also referred to as “UNNAMED”.

The remaining rows of data in the new format are the data lines. These have the following format:

```
20211025, 1100, L, HU, 17.9N, 102.0W, 90, 977, 70, 70, 50, 50, 30, 30, 20, 30, 20, 20, 15, 15, 15  
123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345
```

2021 (Spaces 1-4) – Year

10 (Spaces 5-6) – Month

25 (Spaces 7-8, before 1<sup>st</sup> comma) – Day

11 (Spaces 11-12) – Hours in UTC (Universal Time Coordinate)

00 (Spaces 13-14, before 2<sup>nd</sup> comma) – Minutes

L (Space 17, before 3<sup>rd</sup> comma) – Record identifier (see notes below)

L – Landfall (center of system crossing a coastline)

P – Minimum in central pressure

I – An intensity peak in terms of both pressure and maximum wind

S – Change of status of the system  
T – Provides additional detail on the track (position) of the cyclone  
HU (Spaces 20-21, before 4<sup>th</sup> comma) – Status of system. Options are:  
TD – Tropical cyclone of tropical depression intensity (< 34 knots)  
TS – Tropical cyclone of tropical storm intensity (34-63 knots)  
HU – Tropical cyclone of hurricane intensity (> 64 knots)  
EX – Extratropical cyclone (of any intensity)  
SD – Subtropical cyclone of subtropical depression intensity (< 34 knots)  
SS – Subtropical cyclone of subtropical storm intensity (> 34 knots)  
LO – A low that is neither a tropical cyclone, a subtropical cyclone, nor an extratropical cyclone (of any intensity)  
DB – Disturbance (of any intensity)

17.9 (Spaces 24-27) – Latitude

N (Space 28, before 5<sup>th</sup> comma) – Hemisphere – North or South

102.2 (Spaces 31-35) – Longitude

W (Space 36, before 6<sup>th</sup> comma) – Hemisphere – West or East

90 (Spaces 39-41, before 7<sup>th</sup> comma) – Maximum sustained wind (in knots)

977 (Spaces 44-47, before 8<sup>th</sup> comma) – Minimum Pressure (in millibars)

70 (Spaces 50-53, before 9<sup>th</sup> comma) – 34 kt wind radii maximum extent in northeastern quadrant (in nautical miles)

70 (Spaces 56-59, before 10<sup>th</sup> comma) – 34 kt wind radii maximum extent in southeastern quadrant (in nautical miles)

50 (Spaces 62-65, before 11<sup>th</sup> comma) – 34 kt wind radii maximum extent in southwestern quadrant (in nautical miles)

50 (Spaces 68-71, before 12<sup>th</sup> comma) – 34 kt wind radii maximum extent in northwestern quadrant (in nautical miles)

30 (Spaces 74-77, before 13<sup>th</sup> comma) – 50 kt wind radii maximum extent in northeastern quadrant (in nautical miles)

30 (Spaces 80-83, before 14<sup>th</sup> comma) – 50 kt wind radii maximum extent in southeastern quadrant (in nautical miles)

20 (Spaces 86-89, before 15<sup>th</sup> comma) – 50 kt wind radii maximum extent in southwestern quadrant (in nautical miles)

30 (Spaces 92-95, before 16<sup>th</sup> comma) – 50 kt wind radii maximum extent in northwestern quadrant (in nautical miles)

20 (Spaces 98-101, before 17<sup>th</sup> comma) – 64 kt wind radii maximum extent in northeastern quadrant (in nautical miles)

20 (Spaces 104-107, before 18<sup>th</sup> comma) – 64 kt wind radii maximum extent in southeastern quadrant (in nautical miles)

15 (Spaces 110-113, before 19<sup>th</sup> comma) – 64 kt wind radii maximum extent in southwestern quadrant (in nautical miles)

15 (Spaces 116-119, before 20<sup>th</sup> comma) – 64 kt wind radii maximum extent in northwestern quadrant (in nautical miles)

15 (Spaces 122-125) – Radius of Maximum Wind (in nautical miles)

Notes:

1) Record identifier: This code is used to identify records that correspond to landfalls or to indicate the reason for inclusion of a record not at the standard synoptic times (0000, 0600, 1200, and 1800 UTC). For the years 1989 onward, international landfalls (but not for U.S.' Hawaii) are denoted with the "L" identifier. The landfall identifier (L) is the only identifier that will appear with a standard synoptic time record. The

remaining identifiers (see table above) are only used with asynoptic records to indicate the reason for their inclusion. Inclusion of asynoptic data is at the discretion of the Hurricane Specialist who performed the post-storm analysis; standards for inclusion or non-inclusion have varied over time. Identification of asynoptic peaks in intensity (either wind or pressure) may represent either system's lifetime peak or a secondary peak.

2) Time: Nearly all HURDAT2 records correspond to the synoptic times of 0000, 0600, 1200, and 1800. Recording best track data to the nearest minute became available within the b-decks beginning in 1992 and some tropical cyclones since that year have the landfall best track to the nearest minute.

3) Status: The low status is for cyclones that are not tropical cyclone or subtropical cyclones, nor extratropical cyclones. These typically are assigned at the beginning of a system's lifecycle and/or at the end of a system's lifecycle. For the disturbance status, the location given is the approximate position of the lower tropospheric vorticity center, as the surface center is not present for this stage.

4) Maximum sustained surface wind: This is defined as the maximum 1-min average wind associated with the tropical cyclone at an elevation of 10 m with an unobstructed exposure. Values are given to the nearest 5 kt and are assigned for every cyclone at every best track time. From 1949 through 1969 the maximum wind values are only crudely estimated (values of "25", "45", and "75" are very commonly used), reflecting in part the rudimentary information available in the pre-satellite era for intensity analysis.

5) Central Pressure: These values are given to the nearest millibar. Originally, central pressure best track values were only included if there was a specific observation that could be used explicitly. Missing central pressure values are noted as "-999". Beginning in 1988 for "EP" and 2001 for "CP", central pressures have been analyzed and included for every best track entry, even if there was not a specific in-situ measurement available.

6) Wind Radii – These values have been best tracked since 2004 and are thus available here from that year forward with a resolution to the nearest 5 nm. Best tracks of the wind radii have not been done before 2004 and are listed as "-999" to denote missing data. Note that occasionally when there is a non-synoptic time best track entry included for either landfall or peak intensity, that the wind radii best tracks were not provided. These instances are also denoted with a "-999" in the database.

7) Radius of Maximum Wind: These values have been best tracked only starting in 2021. Before 2021, the missing data are denoted as "-999".

#### General Notes:

The database goes back to 1949, but it is far from being complete and accurate for the entire duration. Uncertainty estimates of the best track parameters are available from Torn and Snyder (2012) and Landsea and Franklin (2013) for the Atlantic, but may be relevant for the Northeast and North Central Pacific best tracks as well. The lack of completeness in the dataset before the satellite era (beginning around 1970) is well-recognized (e.g., Blake et al. 2008) and any long-term variability and trends so derived must be treated very cautiously. It should be noted that records for the most intense eastern North Pacific hurricanes are particularly uncertain and likely low biased during the 1970s through 1987. (1988 was the first years that NHC began forecasting and best tracking for the Northeast Pacific.)

References:

Blake, E. S., E. J. Gibney, D. P. Brown, M. Mainelli, J. L. Franklin, T. Kimberlain, and G. R. Hammer, 2009: Historical Climatology Series 6-5: Tropical Cyclones of the Eastern North Pacific Basin, 1949-2006. *Historical Climatology Series 6-5*.

Davis, M. A. S., G. M. Brown, and P. Leftwich, 1984: A Tropical Cyclone Data Tape for the Eastern and Central North Pacific Basins, 1949-1983: Contents, Limitations, and Uses. *NOAA Technical Memorandum NWS NHC 25*, <http://www.nhc.noaa.gov/pdf/NWS-NHC-1984-25.pdf>

Landsea, C. W., and J. L. Franklin, 2013: How 'good' are the best tracks? - Estimating uncertainty in the Atlantic hurricane database. *Mon. Wea. Rev.*, **141**, 3576-3592. <http://www.aoml.noaa.gov/hrd/Landsea/landsea-franklin-mwr2013.pdf>

Sampson, C. R., and A. J. Schrader, 2000: The Automated Tropical Cyclone Forecasting System (Version 3.2). *Bull. Amer. Meteor. Soc.*, **81**, 1231-1240. [https://journals.ametsoc.org/downloadpdf/journals/bams/81/6/1520-0477\\_2000\\_081\\_1231\\_tatcfs\\_2\\_3\\_co\\_2.xml](https://journals.ametsoc.org/downloadpdf/journals/bams/81/6/1520-0477_2000_081_1231_tatcfs_2_3_co_2.xml)

Torn, R. D., and C. Snyder, 2012: Uncertainty of tropical cyclone best-track information. *Wea. Forecasting*, **27**, 715-729. [https://journals.ametsoc.org/downloadpdf/journals/wefo/27/3/waf-d-11-00085\\_1.xml](https://journals.ametsoc.org/downloadpdf/journals/wefo/27/3/waf-d-11-00085_1.xml)