A New Historical Database of Tropical Cyclone Position, Intensity, and Size Parameters Optimized for Wind Risk Modeling

Jonathan L. Vigh, Eric Gilleland, Christopher L. Williams, Daniel R. Chavas, Neal M. Dorst, James Done, Greg Holland, Barbara G. Brown

Joint Numerical Testbed Program, RAL/NCAR

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Much thanks to the brave men and women who put their lives at risk to collect these valuable data.
Extended Flight Level Dataset for Tropical Cyclones (FLIGHT+, v1.1) Released to Public Today!

• **Dataset coverage**
  – 273 cyclones
  – Atlantic, Eastern Pacific, Central Pacific, Western Pacific
  – 1999 to 2015
  – 7500 “good” radial legs
    • All typical flight level parameters included
    • SFMR surface winds

• **Dataset characteristics**
  – Standardized data from U.S. Air Force Reserve and NOAA Hurricane Hunter research flights
  – Extensive quality control measures
  – Automatic parsing of radial legs, translation to storm-relative coordinates, azimuthal and radial winds, etc.
  – High resolution data binned to 100-m grid
  – Modern, user-friendly format (NetCDF)
ABOUT THE FLIGHT LEVEL DATASET (FLIGHT+)

The second phase of this RPI-funded project has built a new dataset of standardized flight level data. This dataset covers all Atlantic, Eastern Pacific, and Central Pacific tropical cyclones with flight level data during the period from 1997 to 2015. The dataset also includes flights in certain Western Pacific TCs in 2008 and 2010. The flight level data is provided in both earth-relative and storm-relative coordinates at the highest temporal resolution available (e.g. 30-second, 10-second, or 1-second). Additionally, flight level data has been parsed by radial leg and interpolated to a standardized radial grid. Significant effort has been undertaken to quality control the data. The dataset was released to RPI member companies in August 2014. The dataset was released to the public on 20 April 2016.

Navigate this section

Use the links below to learn more about the data sources have gone into this dataset, to download the combined dataset and accompanying documentation, and to learn more about applications of this dataset.

- Source data and information about versions/a>
- Download the dataset & documentation
- Applications & visualizations
- Dataset Users
- References

http://verif.ral.ucar.edu/tcdata/flight/

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Hurricane Isabel
MSLP: 933 mb
VMAX: 140 kt
No wind radii in Best Track!

Hurricane Charley
MSLP: 947 mb
VMAX: 125 kt
64-kt wind radii: 20 20 10 10 (nm)
34-kt wind radii: 40 75 75 50 (nm)

$15.1 billion damage

Flight Level Wind Speed (earth relative)

Radius of Category 4 winds:
~10.5 miles

Isabe (2003)  FlightID: 20030914U1

Flight Level Wind Speed (earth relative)

Radius of Category 4 winds:
~39 miles
Better data needed to generate more realistic synthetic event sets for modeling wind risk

- Higher spatial resolution
  - HURDAT provides data at 0.1 deg (~6 miles)
- Higher temporal resolution
  - HUDAT is 6-hourly and only attempts to preserve fluctuations on order of a day – many fluctuations get smoothed out
- Better description of wind structure
  - HUDAT rounds vmax to 5 kt and size to 5 nm
  - HURDAT does not include RMW as a best-tracked quantity
  - HURDAT only includes wind radii information back to 2004
  - HUDAT does not include any wind radii for winds higher than hurricane-force
Tropical Cyclone Observations-Based Structure (TC-OBS) Database

- Revised/refined observations-based estimates of track (position), intensity, RMW, and size (wind radii)
- Time-dependent observations-based uncertainty bounds
- Azimuthal mean wind speed
- Spatial/temporal coherence of location of maximum wind
- All parameters provided at 1-hour intervals
- All asynoptic time points included in HURDAT2 are also included (including all landfall times)
- No rounding for positional data precision
- Ancillary parameters that indicate distance to land, translation speed/direction, and whether the cyclone was over land
- Additional wind radii at the Saffir-Simpson category thresholds:
  - 83-kt (Cat1/2), 96-kt (Cat 2/3), 113-kt (Cat 3/4), 137-kt (Cat 4/5)
- All HUDAT parameters included for comparison
General Methodology for Optimal Estimation from Observations

1. Filter/merge step: eliminate duplicatory or conflicting data, keep best observations

2. Traverse data using moving window centered on the target time for estimation

3. Determine # of effective data points using some sort of “goodness” criteria as well as nearness to time of interest

4. From # of effective data points, compute total observational weight, then compute background weight as residual weight

5. Optimally estimate parameter value as a weighted average of observations and background value
Necessary to remove C/W center fixes that are too close in time to avoid forcing the interpolating spline in unphysical directions.
KATRINA (AL122005)

Intensity Parameters

Uncertainty bounds!
Future Work

• Expand FLIGHT+ Dataset further back in time
  – Calculate flight level pressure for all AFRES flights prior to 2004
  – Use HRD’s reprocessed SFMR data
• Use the vmax/rmax/wind radii data contained in the f-decks
  – TAFB/SAB Dvorak fixes, AMSU, CIMSS, CIRA, ADT/ODT, SAR/ASCAT/QSCAT
• Update the QSCAT-R Dataset with quadrant-specific wind radii
  – Use to refine r34, r50, r64, and r83 estimates
• Include surface observations from land/buoys
• Apply/develop a new set of flight->surface reduction factors based on the FLIGHT+ Dataset
  – Explore whether time-dependent SST information and dropsonde profiles can be used to improve flight->surface reduction factors
• Examine the sensitivity of wind hazard risk using TC-OBS vs. HURDAT, case studies of damage for major landfalling storms
• Implement Bayesian and/or boot-strapping-based models to estimate uncertainty
• Estimate the actual uncertainty of the Best Track