A Climatology of Landfalling Hurricane Central Pressures Along the Gulf of Mexico Coast

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October 19, 2009
Outline & Motivation for Study

- Analyze the climatological characteristics of landfalling Gulf of Mexico hurricanes specifically for wave and surge modeling:
  - 10-m wind ($U_{10}$), Wind stress ($\tau$), drag coefficient ($C_D$), central pressure ($C_p$), peripheral pressure ($P_o$), and central pressure deficit ($\Delta P$)
  - Central Pressure ($C_p$) - directly observed measure of TC max intensity

- Discuss the historical observations of $C_p$ related to Gulf Coast hurricanes
  - Return periods and along-shore variability of $C_p$ over different sections of Gulf Coast

- Analyze the changes in $C_p$ prior to, and during, landfall
  - 12-hr change in Gulf hurricane $\Delta P$ and $C_p$
Methodology

✔ Examine 6-hr $C_p$ observations from HURDAT
  – Assess best period of record for analysis

✔ Correlate Pre-Landfall & Landfall $C_p$ with $\Delta P$
  – Analyze by sub-region along Gulf Coast

✔ Assess along-shore variability:
  – $C_p$ return periods
  – Correlate pre-landfall and landfall $\Delta P$ for different sections of Gulf Coast
Conclusions

✓ Significant along-shore variability in $C_p$ return period
  – Lowest in the central Gulf Coast region (LA & MS)
    • Period of record strongly affects results
  – Broad confidence limits!

✓ Correlation of 12-hr change in Pressure Differential ($\Delta P$) and $C_p$
  – Pre-landfall $C_p$ has higher correlation than landfall $C_p$
  – Highest correlations found for LA and FL Panhandle
  – Best correlations using data since 1980

HURDAT Since 1851

All Observations Including Missing Pressures: 37,854 points

Observations w/ Pressures: 12,095 points
HURDAT Pressure Counts 1900-2005

Availability of Pressure Observations by Decade


Frequency:
- Pressures
- NoPressures

NOAA/NESDIS National Climatic Data Center:
11th Int’l Workshop on Wave Hind-casting and Forecasting & 2nd Coastal Hazards Symposium
Gulf Coast Zones

Zone A

Zone B

Zone C
Availability of Pressure Observations by Decade and Zone

Frequency

No Pressures  Pressures

150 N Mile Gulf Coast $C_p$ (1900-2005)
90 N Mile Gulf Coast $C_p$ (1900-2005)
Along Coast $C_p$ Return Periods

![Graph showing Along Coast $C_p$ Return Periods](image-url)
C_p Return Periods for Zone B:
90 N Mile Offshore Extent
50 & 100 N Mile Lateral Extensions

Zone B (Central Gulf): 90 N Mile CPI with 50 N Mile overlap

Zone B (Central Gulf): 90 N Mile CPI with 100 N Mile overlap

100-year = 920 mb
100-year = 904.8 mb
100-year = 916.2 mb
100-year = 900 mb
CPI Return Periods for Zone B:
150 N Mile Offshore Extent
50 & 100 N Mile Lateral Extensions

Zone B (Central Gulf): 150 N Mile CPI with 50 N Mile overlap
- 100-year = 913.7 mb
- 100-year = 895.6 mb

Zone B (Central Gulf): 150 N Mile CPI with 100 N Mile overlap
- 100-year = 910.4 mb
- 100-year = 892.3 mb
Cₚ Return Periods (150 N Mi offshore)
Zone C: Texas & Western Gulf Coast

CPI Return Periods for Zone C (Texas & Western Gulf Coast)

- 106-yr Record (1900-2005)
- 65-yr Record (1941-2005)
- 41-yr Record (1965-2005)
- 30-yr Record (1976-2005)

Key Pressures:
- 939.6 mb
- 934.1 mb
- 924.7 mb
- 918.7 mb

Central Pressure Index (mb)

0 100 200 300 400 500
Western Gulf Coast (Zone C) Return Periods and 90% Confidence Intervals
Satellite Era 40-year Period (1965-2005)
Texas: $C_p$ vs. $\Delta P$

Data coverage: 1964-2008
Florida Panhandle: $C_p$ vs. $\Delta P$

Data coverage: 1964-2008
Louisiana: $C_p$ vs. $\Delta P$

Data coverage: 1964-2008
LA, MS & AL: $C_p$ vs. $\Delta P$

Data coverage: 1964-2008
All Gulf Coast Hurricanes

Data coverage: 1959-2008

with Camille  without Camille
Gulf Coast
1980-2008 Data Only

![Graph showing the relationship between pre-landfall pressure and 12-hour change in central pressure deficit before landfall. The equation of the line is $y = 3.32E-01x - 3.21E+02$ with $R^2 = 7.91E-01$.](image)
TC Intensity Changes Along Gulf Coast
48-hr \( \Delta C_p \) Landfalling Hurricanes

**Data coverage: 1979-2008**
Concluding Remarks

✓ Future Work
  – EOF analysis Atlantic basin MSLP
    • with Ocean Weather, Inc. and USACE/CHL
  – Correlate EOFs of MSLP with hurricane activity, tropical Atlantic SST and wind shear (850-200 hPa)

✓ International Best Track Archive for Climate Stewardship (IBTrACS)
  – Comprehensive Global Best Track Dataset
  – Version 2 released in July 2009
  – Includes updated files through the end of 2008
http://www.ncdc.noaa.gov/oa/ibtracs

IBTrACS

News

WMS, WFS and KML access to IBTrACS now available

Vision

Providing tropical cyclone best track data in a centralized location to aid our understanding of the distribution, frequency, and intensity of tropical cyclones worldwide.

Introduction

The intent of the IBTrACS project is to overcome data availability issues, and to freely disseminate this new global dataset. This was achieved by working directly with all the Regional Specialized Meteorological Centers and other international centers and individuals to create a global best track dataset, merging storm information from multiple centers into one product and archiving the data for public use.

One of the goals of the project is for the data processing methods to remain open, such that desired user feedback on data quality is more easily collected. Also, data provenance is completely recorded so all observations and corrections, either through rigorous quality control or user feedback, may be tracked. Data are then provided in various formats given the diversity of the tropical cyclone (TC) data user community.
Thank you!