Proof of Concept for Atmospheric Profiling with the High Definition Sounding System (HDSS)

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Objective

- Measure outflow layer jets and inner core ‘roots’:
  - pattern,
  - strength,
  - structure and
  - orientation

- Relate to:
  - Hurricane intensity change and size: $V_{\text{max}}$, $P_{\text{min}}$, $R_{\text{max}}$
  - Boundary layer and inner-core structure

- Provide \textit{BALANCED} initialization of TC models

Approach

- Utilize aircraft-based, in-situ, new-generation atmospheric profiling dropsondes:
  - Global Hawk UAV: AVAPS-II minisonde
  - WB-57: HDSS/XDD-2014

- Synthesize with state-of-the-art remote sensors:
  - Global Hawk- CPL, SHIS, HAMSR, HIRAD, HIWRAP
  - WB-57- HIRAD, HIWRAP

- Synthesize with satellite-derived Atmospheric Motion Vectors (AMVs)
HYPOTHESIS

TC Life Cycle, including Rapid Intensification (RI) and Rapid Decay (RD), is associated with environmentally-forced and inner-core convectively-forced outflow jet evolution:

I. TC development- Single Equatorward-directed Jet
II. Intensification and RI: Dual Equatorward and Poleward Jets
III. Mature & decay (ET): Primarily, single Poleward-directed Jet
Edouard 2014
Global Hawk UAV
AVAPS Minisondes
Synoptic Forcing
Phase I

Edouard
200 mb
15 Sept 00Z

Phase II

Edouard
200 mb
17 Sept 00Z

(Sonde plots courtesy Scott Braun, NASA Goddard)
(Rapid-Scan AMVs courtesy CIMMS)
Edouard
200 mb
19 Sept 00Z

Phase III
Gonzalo 2014
WB-57F
HDSS/ XDD sondes
Convective Forcing
Gonzalo
17 Oct 12Z
Phase II
Microwave 91GHz Tb SSMIS

HIRAD 4GHz Tb
15 Oct

HIRAD image courtesy Dan Cecil, NASA Marshall
Gonzalo 2014
WB-57F
HDSS/ XDD
Multiple sondes observe consistent upper level structure at slow- and fast-fall rate
Outflow WIND Profiles: Different profiles in different storms
The HDSS sondes were dropped between 2045z and 2145z on 11/20. Here we will compare the HDSS results with those of the Brownsville (BRO) and Corpus Christi (CRP) radiosondes from 00z 11/21. The maps below show the dropsonde groupings and their locations.
Plots show temperature (left), wind speed (middle), and RH (right) comparisons for HDSS dropsondes from the drop #1-6 grouping, which was closest to the Corpus Christi radiosonde (CRP).
Plots show temperature (left), wind speed (middle), and RH (right) comparisons for HDSS dropsondes from the **drop #7-8 grouping**, which was furthest west and a bit closer to the **Brownsville radiosonde (BRO)** than the **Corpus Christi radiosonde (CRP)**.

The radiosonde data is at 1Hz, while the HDSS data is at 2Hz for the temperature and RH and 4Hz for the wind speed. Radiosonde ascent begins at 23 UTC and takes 80 min to reach 20 km, whereas XDD descent begins at 2120-2150 UTC and takes 12 or 20 min (fast-fall or slow-fall) to reach the surface.
XDD Deployed

SQUALL LINE

Nov/19/2013 07:01:16
WB-57 FWD

69th Interdepartmental Hurricane Conference
3-5 March, 2015  Jacksonville, FL
Outflow Layer Analysis

Achievements and Key Findings


- Outflow layer jets appear to precede intense inner core convection
  - Thin peripheral outflow jets are forced by environmental features:
    - Leslie
      - Subtropical jets
      - Upper cold lows
      - Tropical Upper Tropospheric Troughs (TUTTs)
    - Thick inner-core outflow jets associated with convective bursts:
      - Nadine and Pre-Gabriel

- Here-to-for unknown outflow jet fine-structure may lead to instabilities which enhance outflow layer mixing not yet adequately modelled.

- Outflow jets appear to have diurnal modulation.