NOAA “Hurricane Hunters” Flight Testing of Air-Launched UAS

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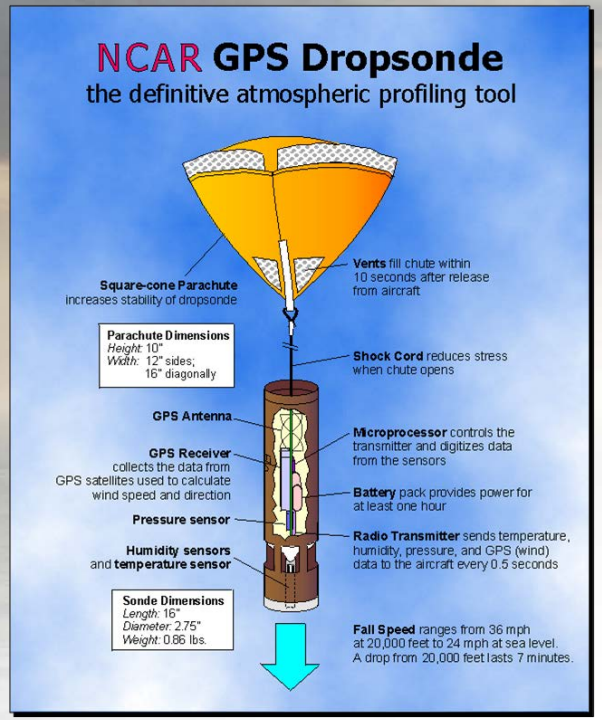
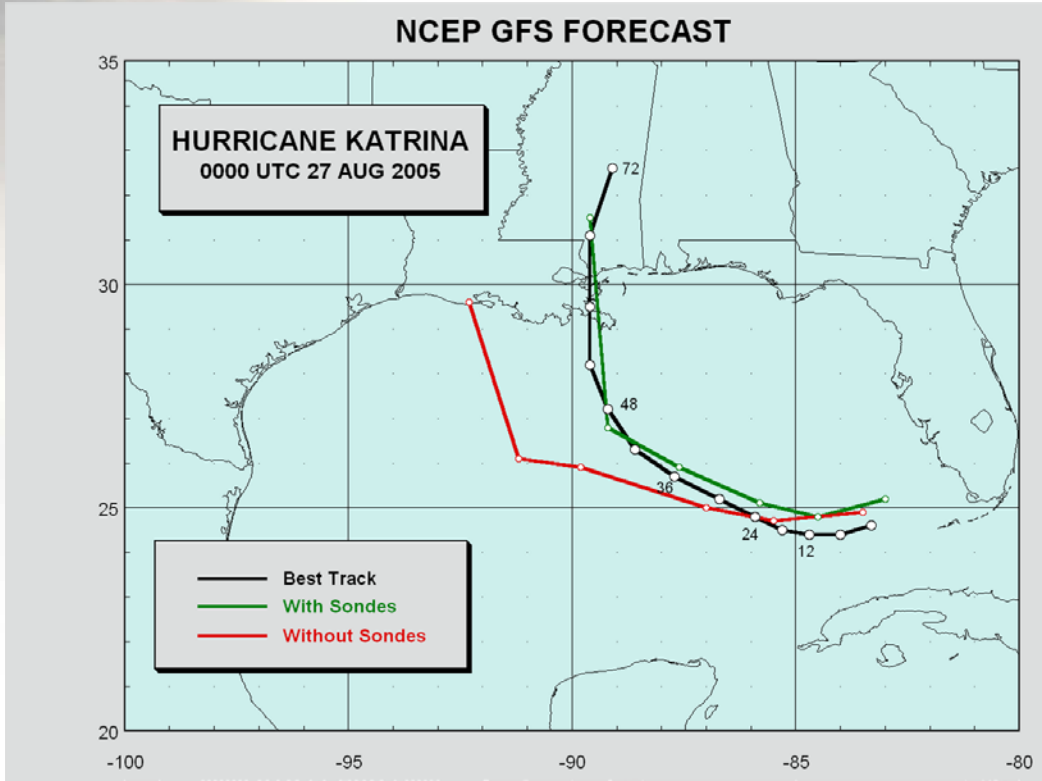
Introduction

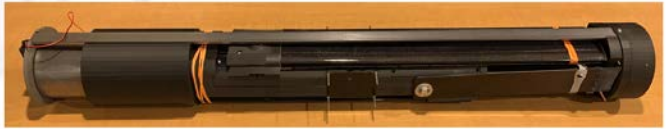
- NOAA flies WP-3D aircraft into tropical cyclones to collect data
- Data limited to meteorological observations from aircraft and dropsondes
- Need identified to collect more continuous data- UAS

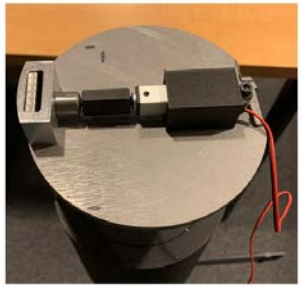
Dropsondes

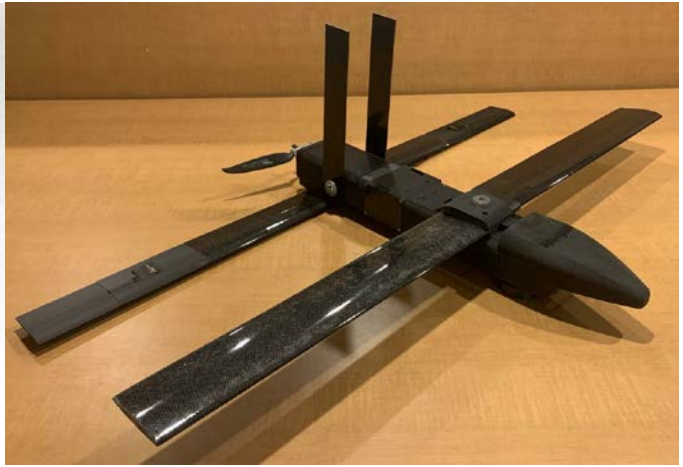

NCAR GPS Dropsonde
the definitive atmospheric profiling tool
Square-cone Parachute
increases stability of dropsonde
Parachute Dimensions
Height: 10"
Width: 12" sides;
16" diagonally
Vents fill chute within
10 seconds after release
from aircraft
Shock Cord reduces stress
when chute opens
GPS Antenna
GPS Receiver
collects the data from
GPS satellites used to calculate
wind speed and direction
Pressure sensor
Humidity sensors
and temperature sensor
Microprocessor controls the
transmitter and digitizes data
from the sensors
Battery pack provides power for
at least one hour
Radio Transmitter sends temperature,
humidity, pressure, and GPS (wind)
data to the aircraft every 0.5 seconds
Sonde Dimensions
Length: 16"
Diameter: 2.75"
Weight: 0.86 lbs.
Fall Speed ranges from 36 mph
at 20,000 feet to 24 mph at sea level.
A drop from 20,000 feet lasts 7 minutes.

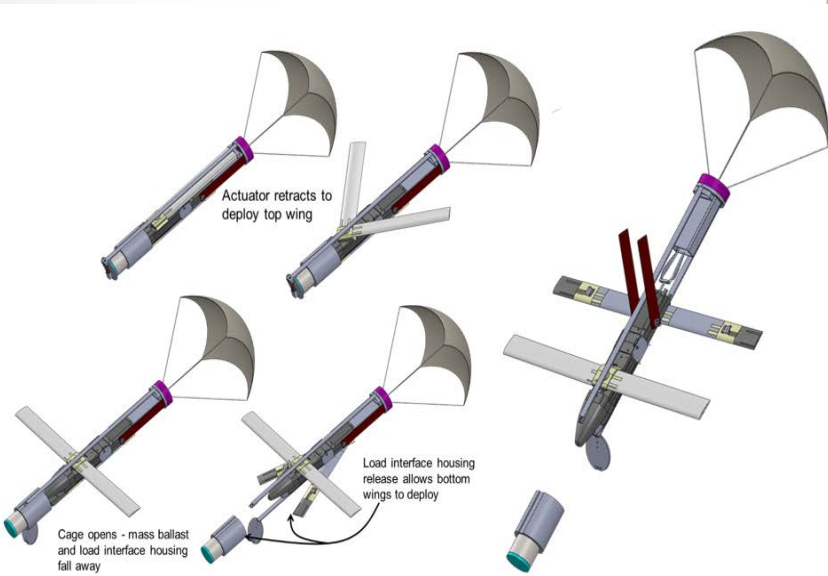

NCEP GFS FORECAST
HURRICANE KATRINA
0000 UTC 27 AUG 2005
72
48
36
24
12
Best Track
With Sondes
Without Sondes
35
30
25
20
-100
-95
-90
-85
-80

UAS







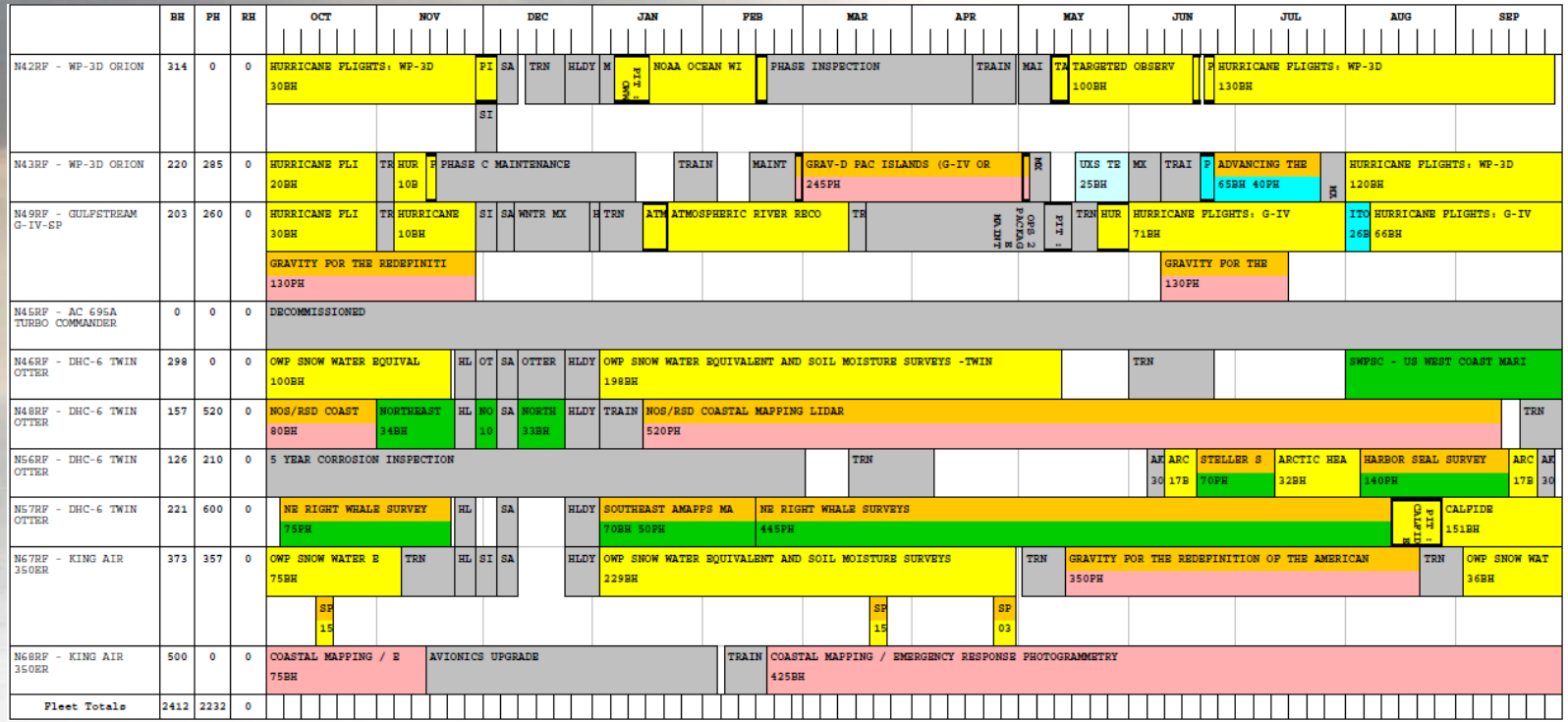

Actuator retracts to deploy top wing
Load interface housing release allows bottom wings to deploy
Cage opens - mass ballast and load interface housing fall away

UAS

Constraints

- Aircraft Availability
- Cost
- Instrumentation
- Test Conditions

Aircraft Availability



Cost

- UAS designed to be unrecoverable
- Every test article is expendable
- Results in increased cost to test program

Instrumentation

- No TM
- No range

Test Conditions

Test Techniques

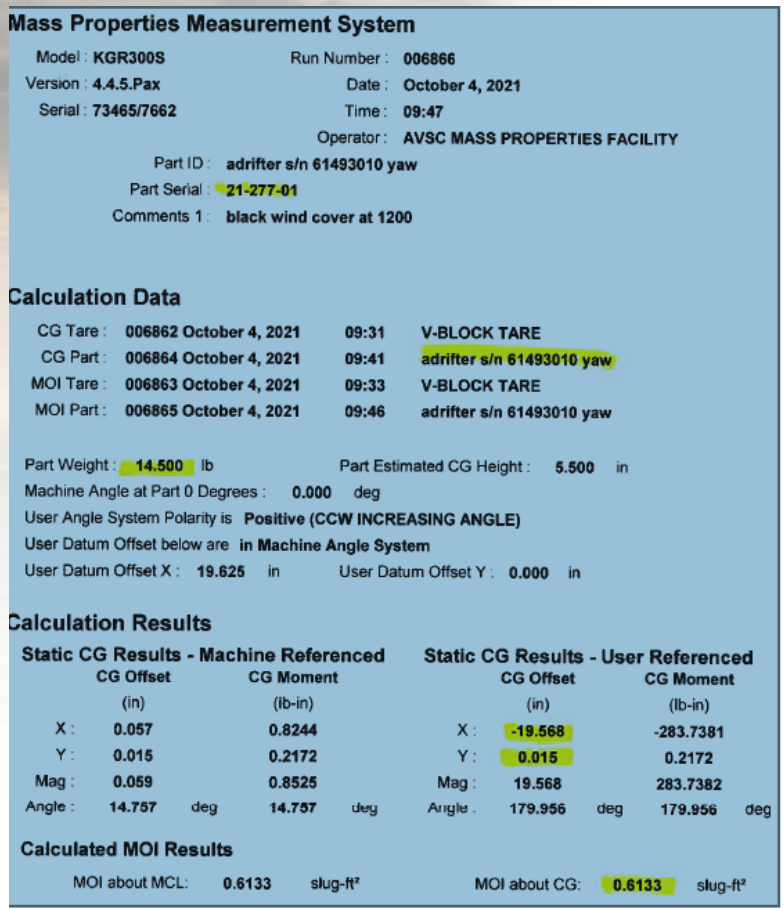
- **Safe Separation**
- **Demonstration Test**
- **Operational Test**

Safe Separation Tools

- Cameras
- MOI
- Witness Tape
- Distance Markings
- Mass Models

Safe Separation

Safe Separation



Mass Properties Measurement System

Model : KGR300S
Version : 4.4.5.Pax
Serial : 73465/7662
Run Number : 006866
Date : October 4, 2021
Time : 09:47
Operator : AVSC MASS PROPERTIES FACILITY
Part ID : adrifter s/n 61493010 yaw
Part Serial : 21-277-01
Comments 1 : black wind cover at 1200

Calculation Data

CG Tare :	006862 October 4, 2021	09:31	V-BLOCK TARE
CG Part :	006864 October 4, 2021	09:41	adrifter s/n 61493010 yaw
MOI Tare :	006863 October 4, 2021	09:33	V-BLOCK TARE
MOI Part :	006865 October 4, 2021	09:46	adrifter s/n 61493010 yaw

Part Weight : 14.500 lb
Part Estimated CG Height : 5.500 in
Machine Angle at Part 0 Degrees : 0.000 deg
User Angle System Polarity is Positive (CCW INCREASING ANGLE)
User Datum Offset below are in Machine Angle System
User Datum Offset X : 19.625 in
User Datum Offset Y : 0.000 in

Calculation Results

Static CG Results - Machine Referenced

	CG Offset (in)		CG Moment (lb-in)	
X :	0.057		0.8244	
Y :	0.015		0.2172	
Mag :	0.059		0.8525	
Angle :	14.757	deg	14.757	deg

Static CG Results - User Referenced

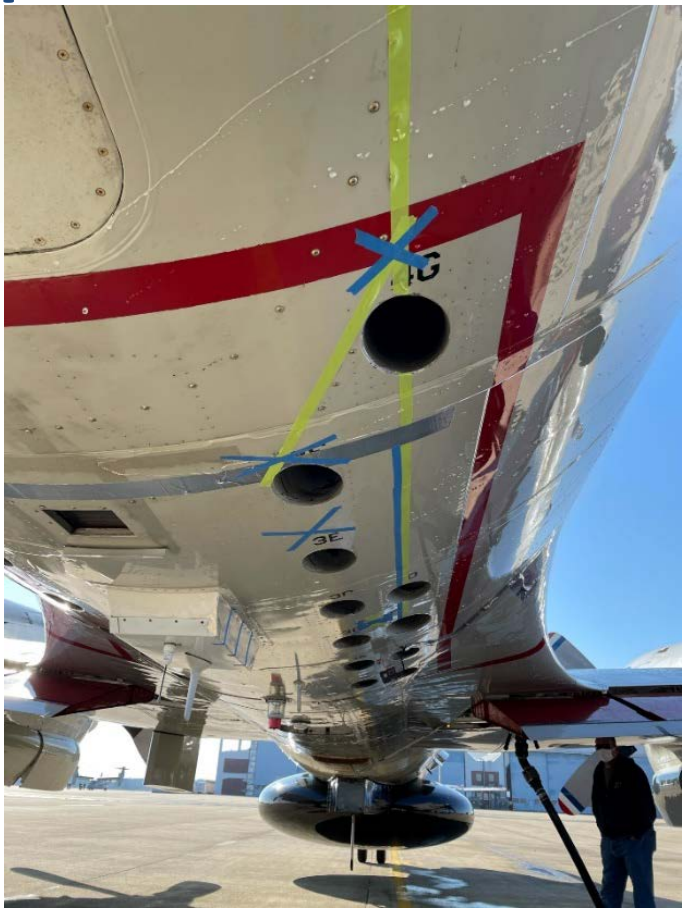
	CG Offset (in)		CG Moment (lb-in)	
X :	-19.568		-283.7381	
Y :	0.015		0.2172	
Mag :	19.568		283.7382	
Angle :	179.956	deg	179.956	deg

Calculated MOI Results

MOI about MCL: 0.6133 slug-ft²
MOI about CG: 0.6133 slug-ft²

Safe Separation

Safe Separation



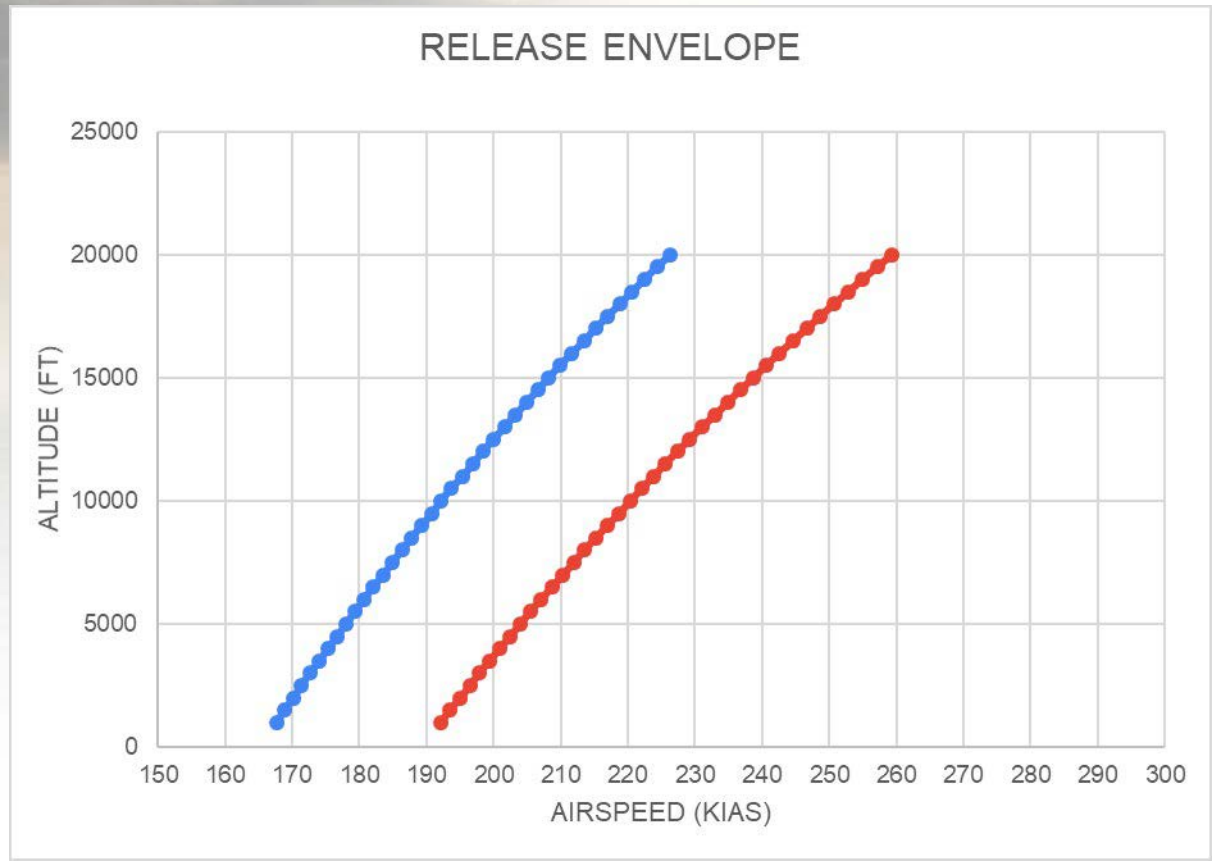
Safe Separation Technique

- Limited time on aircraft = minimal test points to create envelope
- Generally allotted 2 flights totaling 4-6 flight hours
- Tasked with creating release envelope within this constrained environment

Safe Separation Technique

		Low Point	High Point
		92.43	121.41
Density	Altitude	Airspeed	Airspeed_H
0.0023082076	1000	168	192
0.0022745538	1500	169	194
0.0022409000	2000	170	195
0.0022080006	2500	171	196
0.0021751012	3000	173	198
0.0021430006	3500	174	199
0.0021109000	4000	175	201
0.0020795374	4500	177	202
0.0020481747	5000	178	204
0.0020175374	5500	179	206
0.0019869000	6000	181	207
0.0019569500	6500	182	209
0.0019270000	7000	183	210
0.0018977500	7500	185	212
0.0018685000	8000	186	214
0.0018399000	8500	188	215
0.0018113000	9000	189	217
0.0017836500	9500	191	219
0.0017560000	10000	192	220

Safe Separation Technique



Safe Separation Technique

- Natural variation in α occurs from testing at high and low q points
- Accounts for about 5° of pitch change, encompassing entire operational flight regime during hurricane missions

Developmental Test

- Clear-Air Testing
- Compare met-sensor against truth source
- C2 range test
- Endurance

Operational Test

- Testing in the hurricane
- “living test campaign”
- UAS performance in dynamic atmosphere

Questions?