



NCAR/NSF GV New Automated Dropsonde System Overview



***MPEX Meeting
13 December 2012***

***National Center for Atmospheric Research
Earth Observing Lab
Boulder, CO
Terry Hock***

GV Dropsonde Team

ISF - Terry Hock, Dean Lauritsen, Nick Potts, Clayton Ardent, Chip Owens

DFS - Jim Ranson, Cindy Bradley

RAF - Steve Raumbuler, Mark Lord, Kurt Zrubek, Chris Webster

CDS - Charlie Martin, Xuanyong Xu, **FPS** - Brigitte Baeuerle

5 EOL Facilities

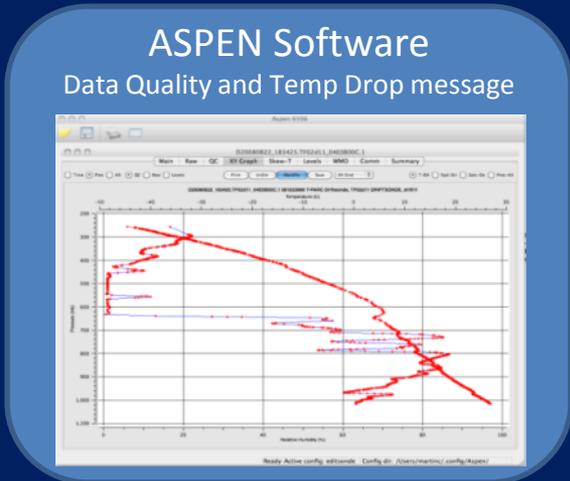


NCAR Dropsonde Technology

Complete end to end solution



- ### Atmospheric Profiling
- Research quality sensors
 - Fast sample rate- high vertical resolution
 - Pressure
 - Temperature
 - Humidity
 - Winds



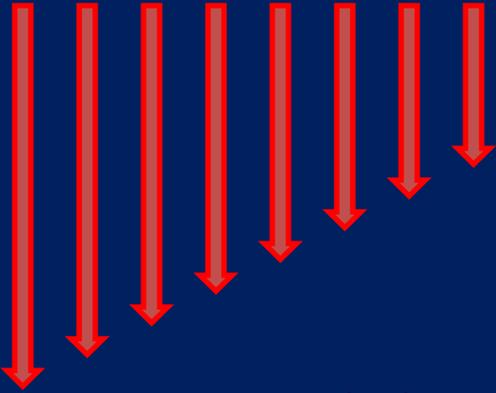
- Capability of rapid launch, up to 8 sondes in the air simultaneously.
- Launch Platforms
 - Manned Aircraft Systems
 - Global Hawk UAS
 - Long duration balloons (Driftsonde)

G-V Design Criteria for New System

Technology developed for the NASA Global Hawk
applied to the NSF/NCAR G-V System

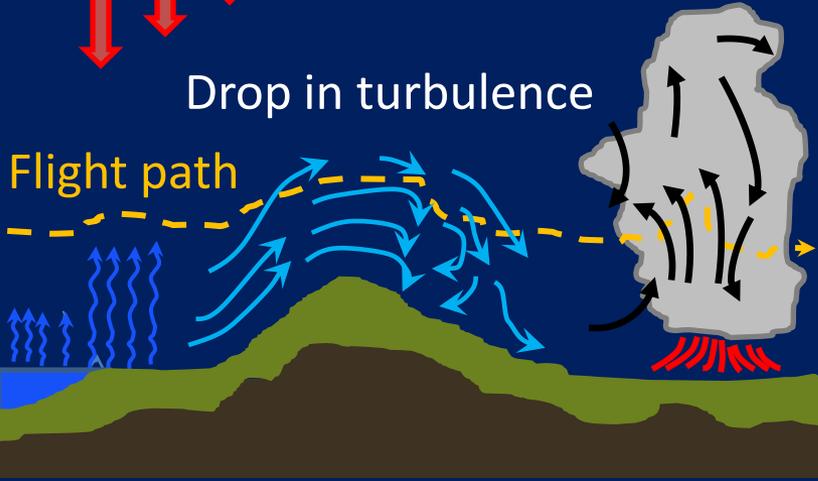


Curtain of sondes every ~15km
(rapid deployment up to 8 sondes)



Drop in turbulence

Flight path



No flight limitations

Operator safety



Automatic
Launcher

Mini Dropsonde (<6oz)



Capacity: 50 Mini Dropsondes

Optional dedicated
Dropsonde operator



Remote Operation

Ability to reload
launcher
during flight





Summary of Capabilities



	New GV Dropsonde System
Automated launcher	✓
No flight restrictions to operator thus no limiting criteria for drops during flight.	✓
Automated sonde prep/sounding	2-button operation
Rapid Launches	~ 2 minute
Remote operation via AGS software	Multiple seat locations on G-V
Total Number of dropsonde in air simultaneously	8 Channel System
Dropsonde	Mini Dropsonde (167 grams)
Dropsondes capacity /flight	50 ++
Launcher located in baggage compartment	✓
FAA Certification	✓



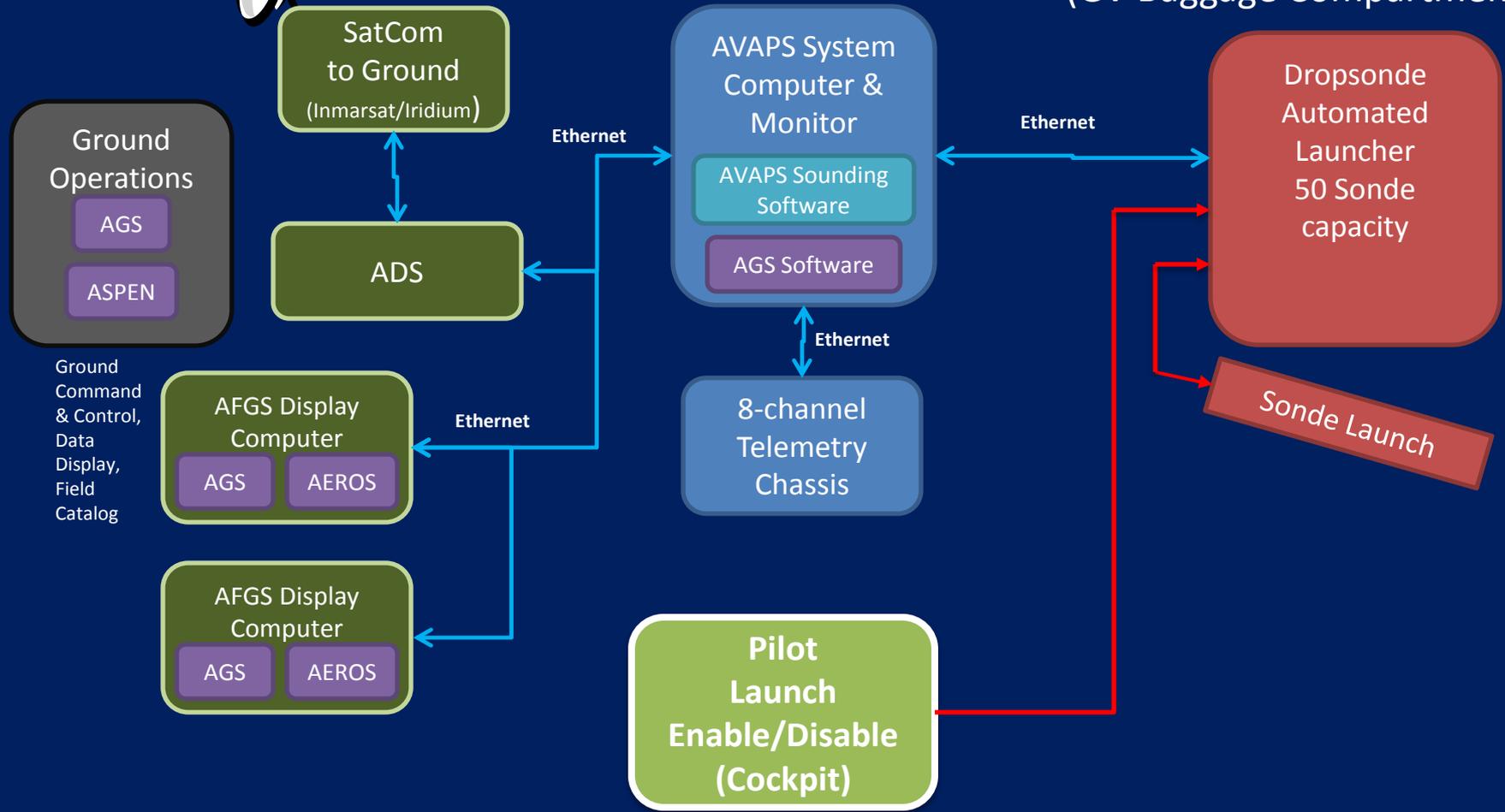
GV Dropsonde System Overview



AVAPS Flight/Ground System (AFGS)

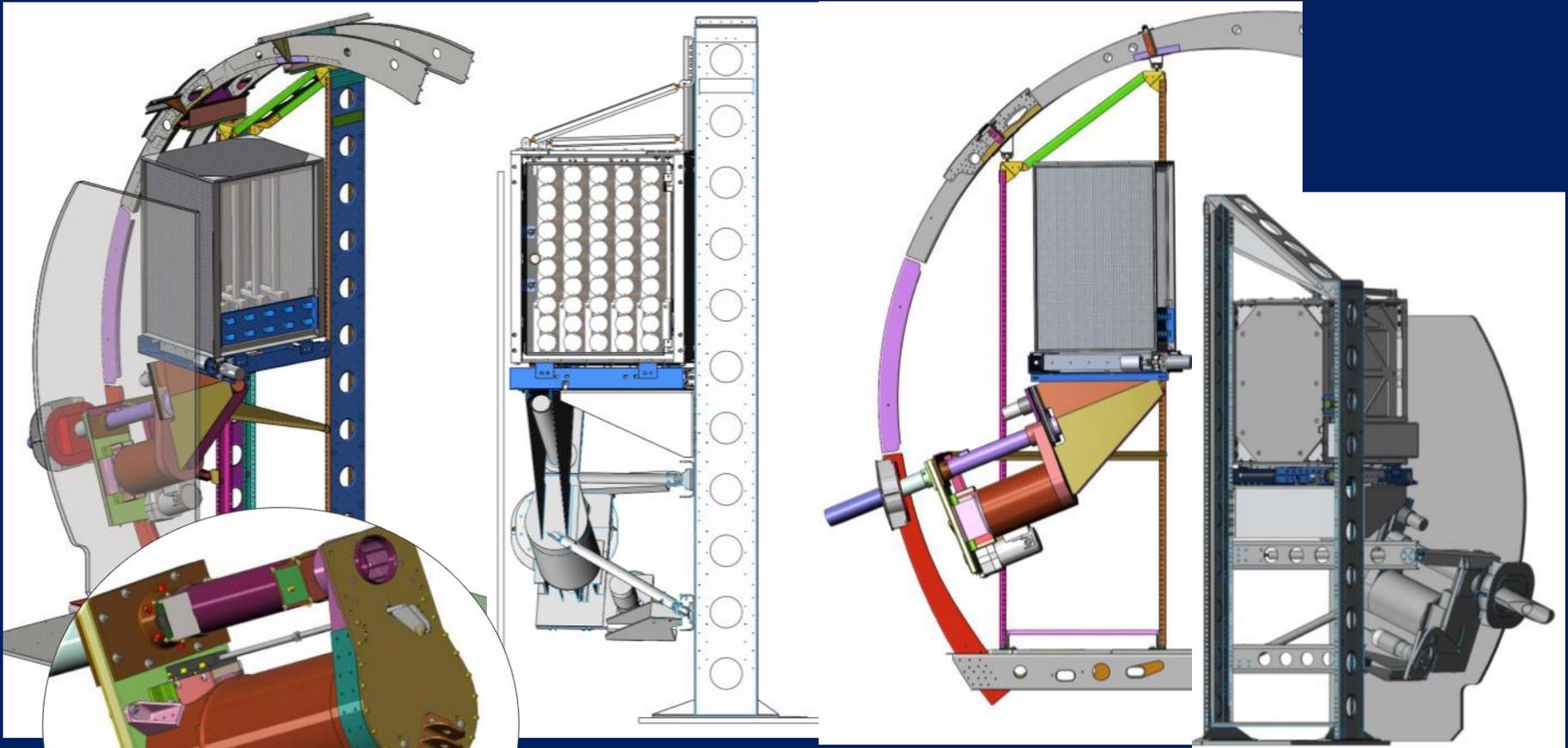
AVAPS Operator Station

Sonde Storage Container & Launcher (GV Baggage Compartment)





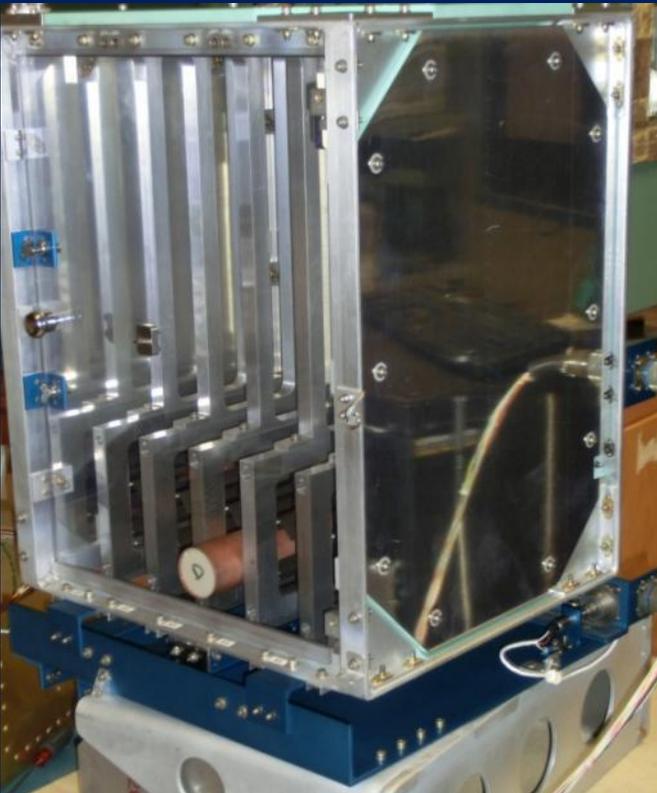
Sonde Storage & Ejection System



Launcher all designed by EOL DFS & RAF
Manufactured by DFS Machine Shop

New GV Automated Launcher

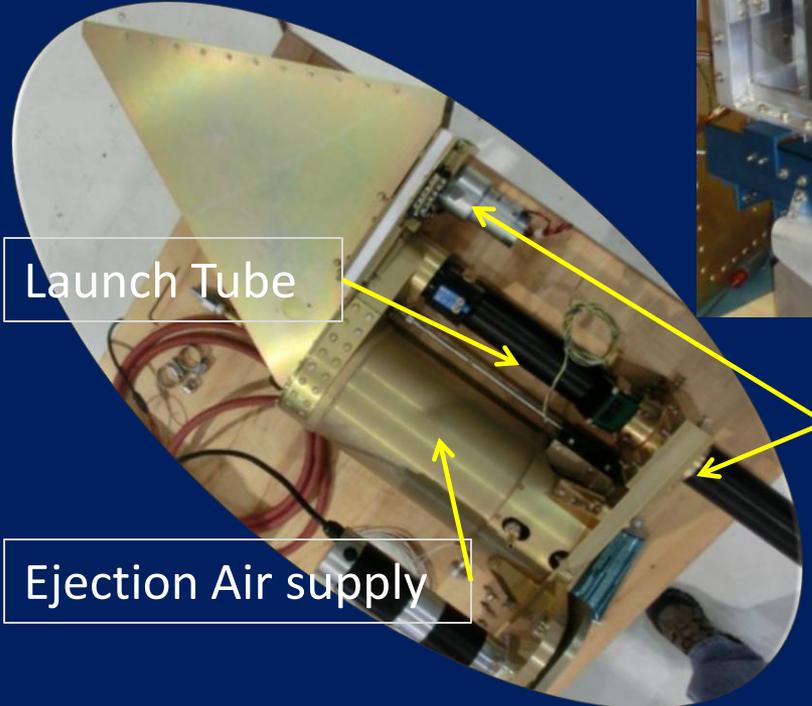
Sonde Storage Container
5 columns of 10 sondes each
Capacity 50 Mini Dropsondes



Launcher Control
Electronics



Sonde Ejection System



Launch Tube

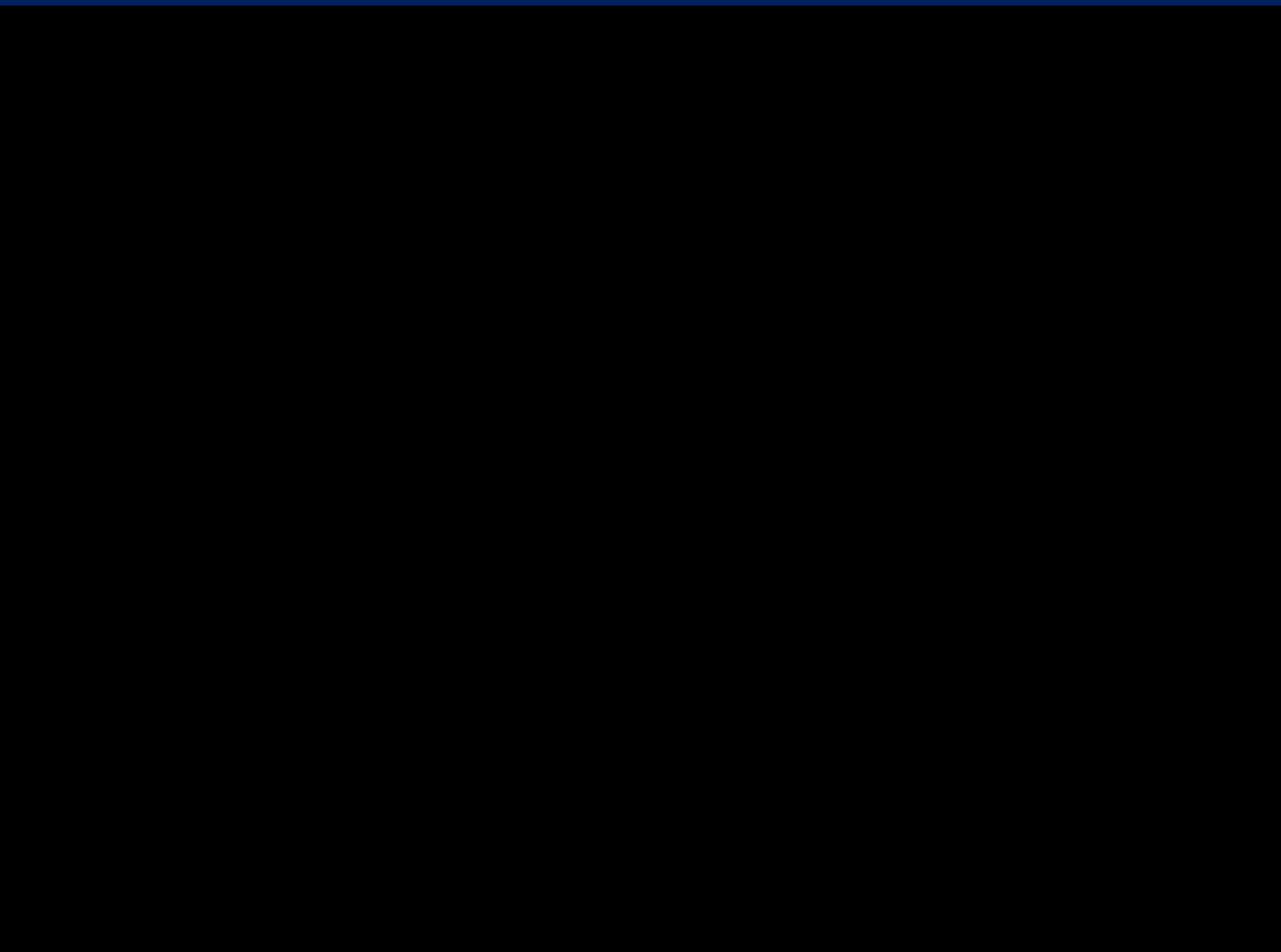
Automatic
Gate valves

Ejection Air supply





Dropsonde Storage System



Sonde Storage
Capacity:
50 sondes

Sonde storage can be
reloaded during flight

Sonde Carriage
unit
Loads sonde into
Ejections System



Sounding Time Line



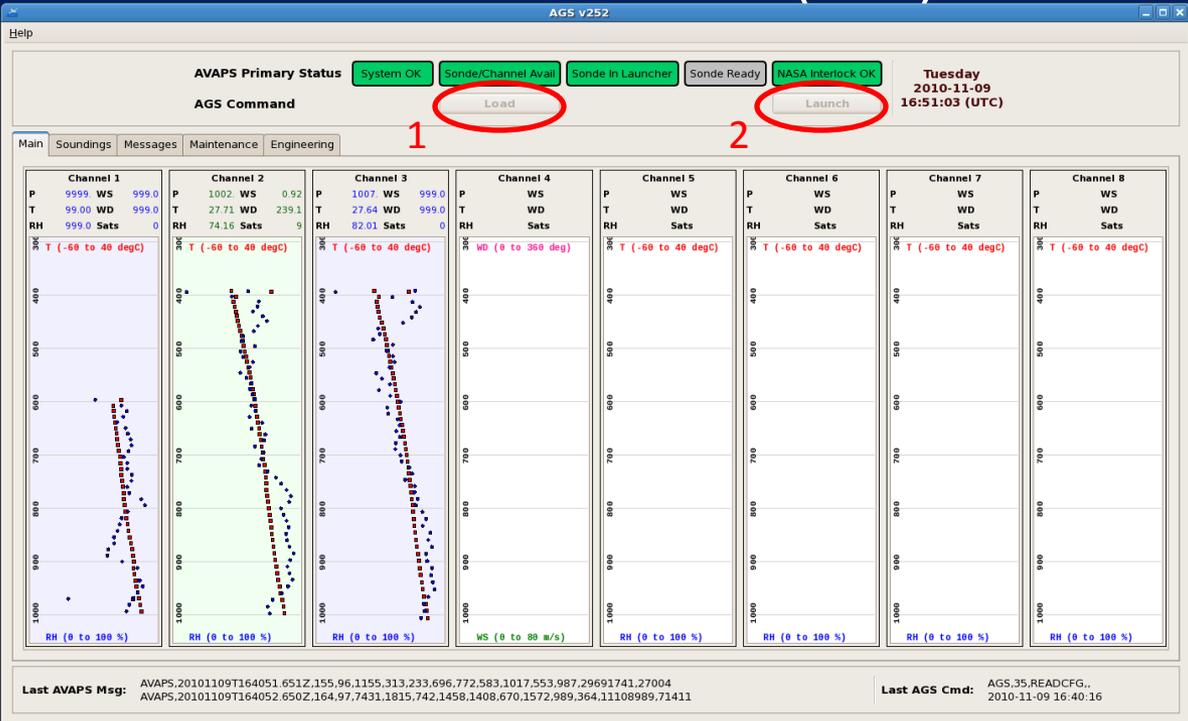
Task	Time	Location
Initialize & load sonde for launch	2 minutes	G-V Aircraft
Dropsonde Fall Time	~15 minutes @ 45,000 ft.	G-V Aircraft
Data transfer at completion of drop	~3 minutes	G-V Aircraft
ASPEN Processing	10-25 minutes	Ground Ops Center
Process data by student?		Ground Ops Center
Send data to GTS		Ground Ops Center
Send data files to Field Catalog		Ground Ops Center
Total Time per Sounding	30 – 45 minutes per drop	



Operational Remote Software



AVAPS Ground Software (AGS)



- 2 Button Sounding Interface
- 1) Load sonde
 - 2) Launch sonde

AGS on any computer

- Flight Computers
- Ground Computers
- System does not need dedicated Dropsonde operator

- Remote interface will be via the existing datagram protocol developed for the Global Hawk deployment.
- Data feeds will integrate into the existing Aeros database structure and display.
- Pilot over-ride for launch.



NCAR GPS Dropsondes (MIST, Mini, AVAPS II/Vaisala RD-94)



Research quality measurements

- Pressure – Temperature – Humidity
- Winds speed/direction
- High vertical resolution
- Multiple sonde in air simultaneously

Performance Specs

- Fall speed ~11 m/s at sea surface
- Fall Time: ~15 Min from 45K ft.
- PTU Sensors Measurement rate every **500 msec** (Vaisala RS-92 PTU module)
 - Vertical resolution : ~ 6 meters @ surface
 - Pressure
 - 0.1 mb resolution
 - 0.5 mb repeatability
 - Temperature
 - 0.1° resolution
 - 0.2° repeatability
 - Humidity
 - 1% resolution
 - 2% repeatability
- Winds Measurement rate every **250 msec**
 - Horizontal Winds 0.1 m/s resolution
 - Vertical resolution : ~ 3 meters @ surface
- Stable parachute design



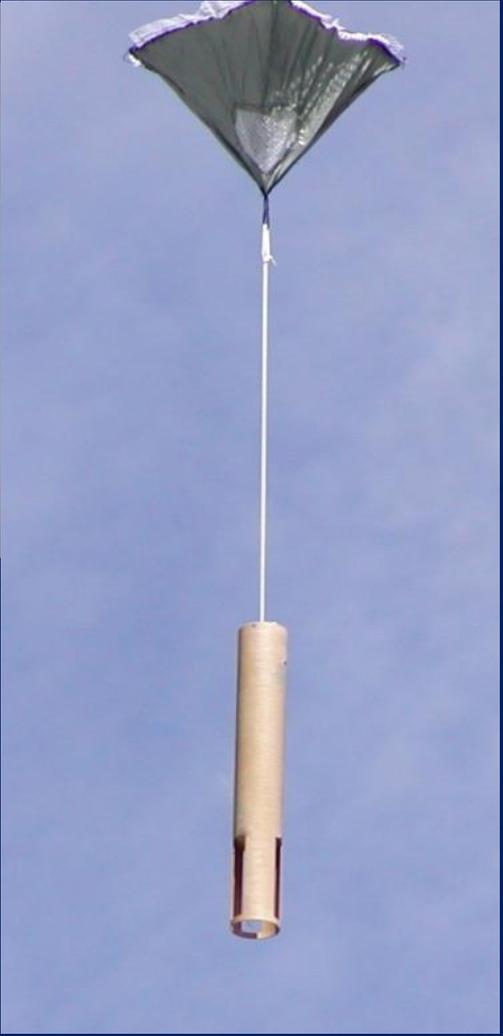
AVAPS II **Mini**

Mini sonde Size:

- Mass: 165 grams
- Length: 30.5 cm
- Diameter: 4.7 cm

AVAPS II Sonde Size:

- Mass: 320 grams
- Length: 40.6 cm
- Diameter: 7 cm



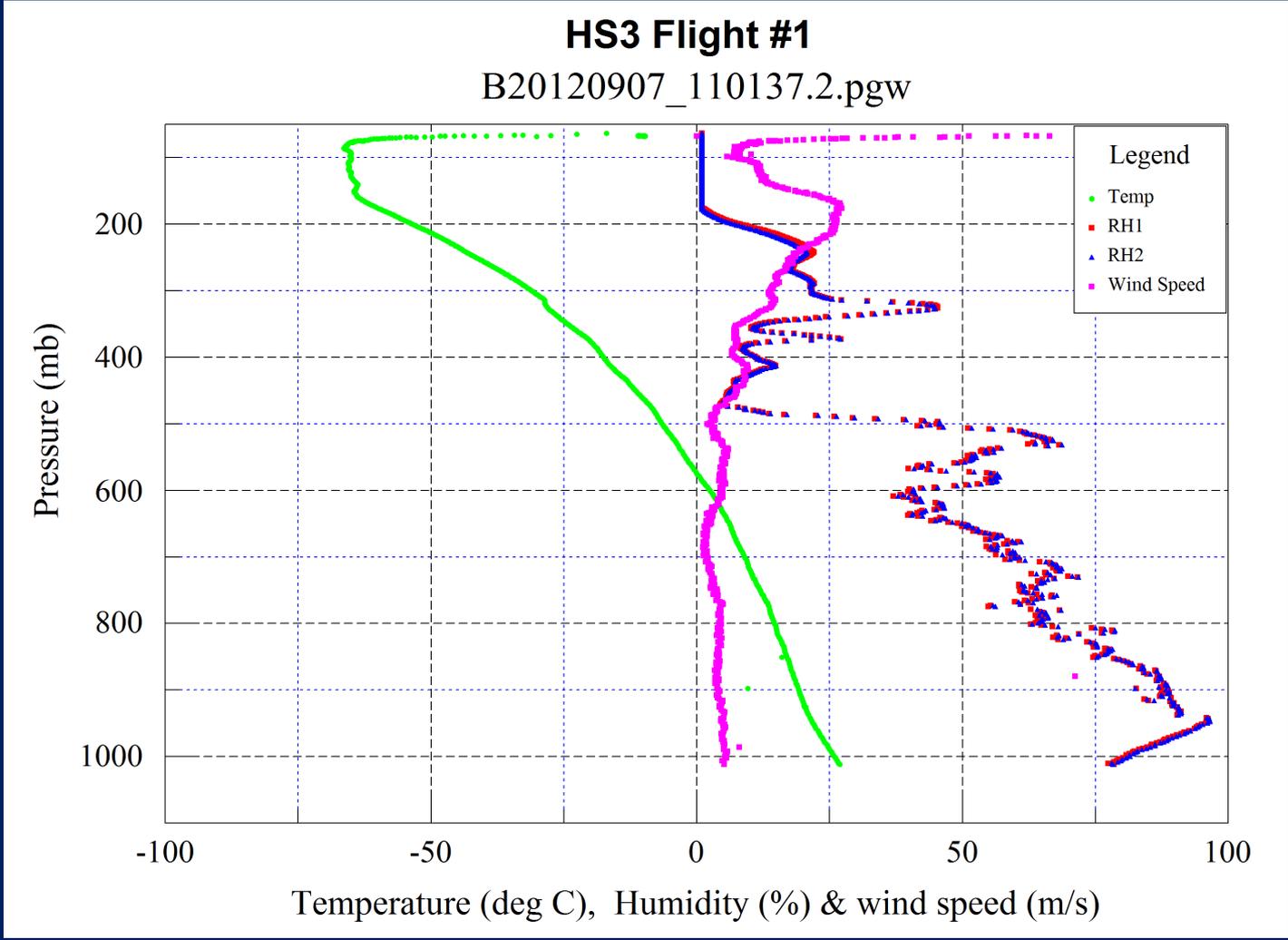


NCAR Mini Dropsonde

(Same sonde used on NASA Global Hawk)



Hurricane Leslie from NASA AV-6 Global Hawk



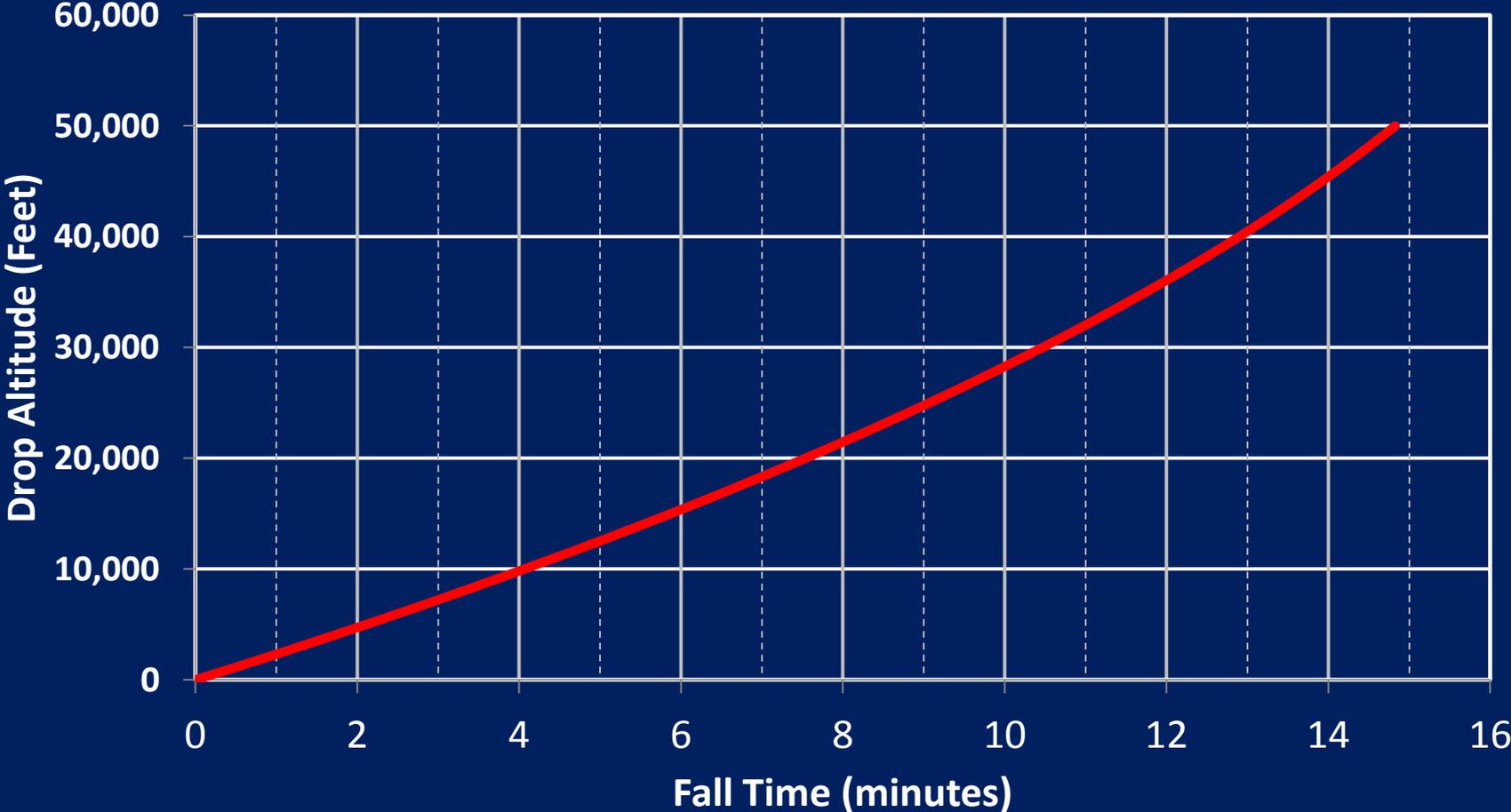
Raw Data Plot, no Quality Control



Sonde Fall Time



Fall Time vs Altitude

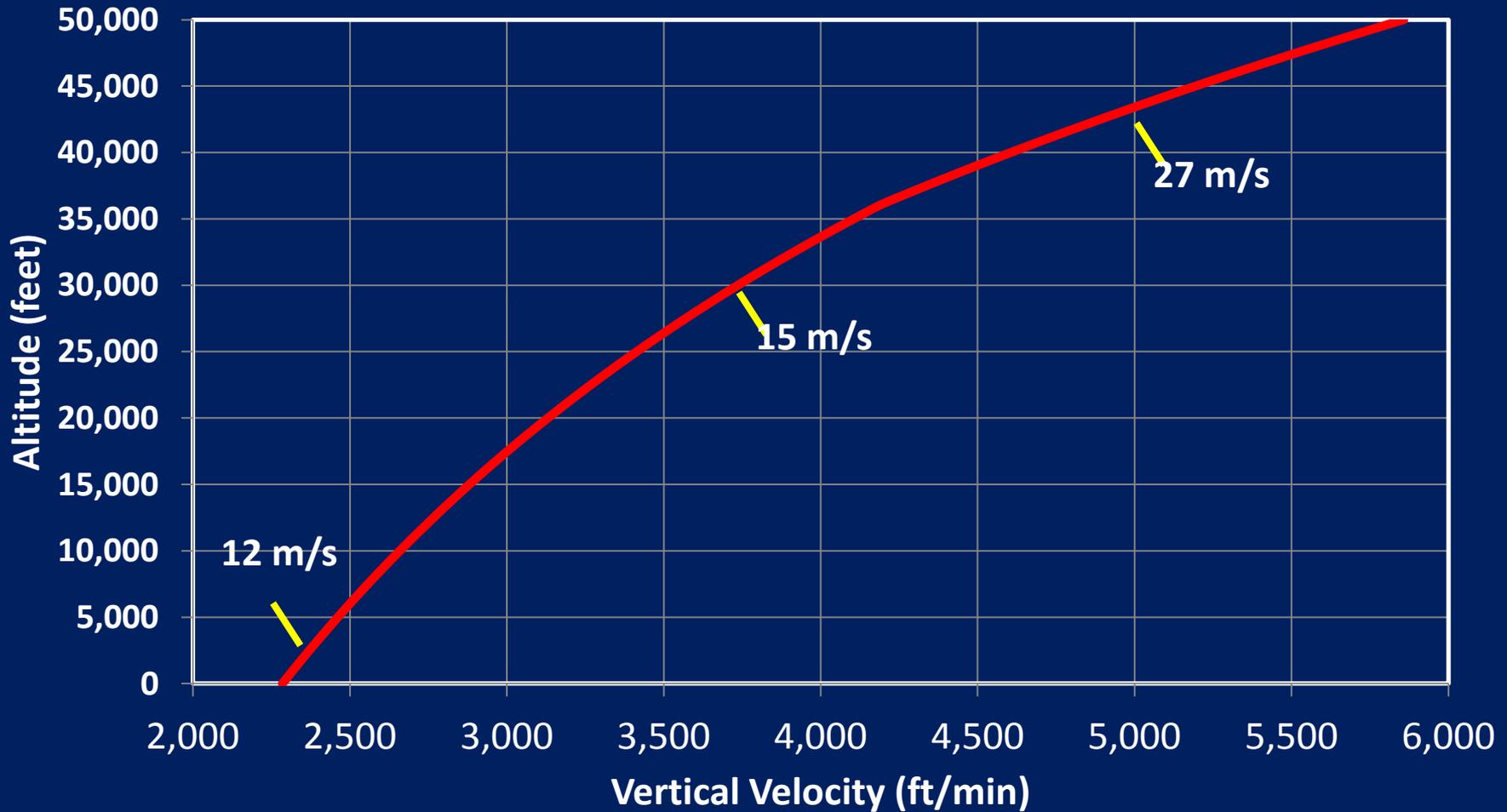




Sonde Fall Velocity



Descent Velocity vs Altitude

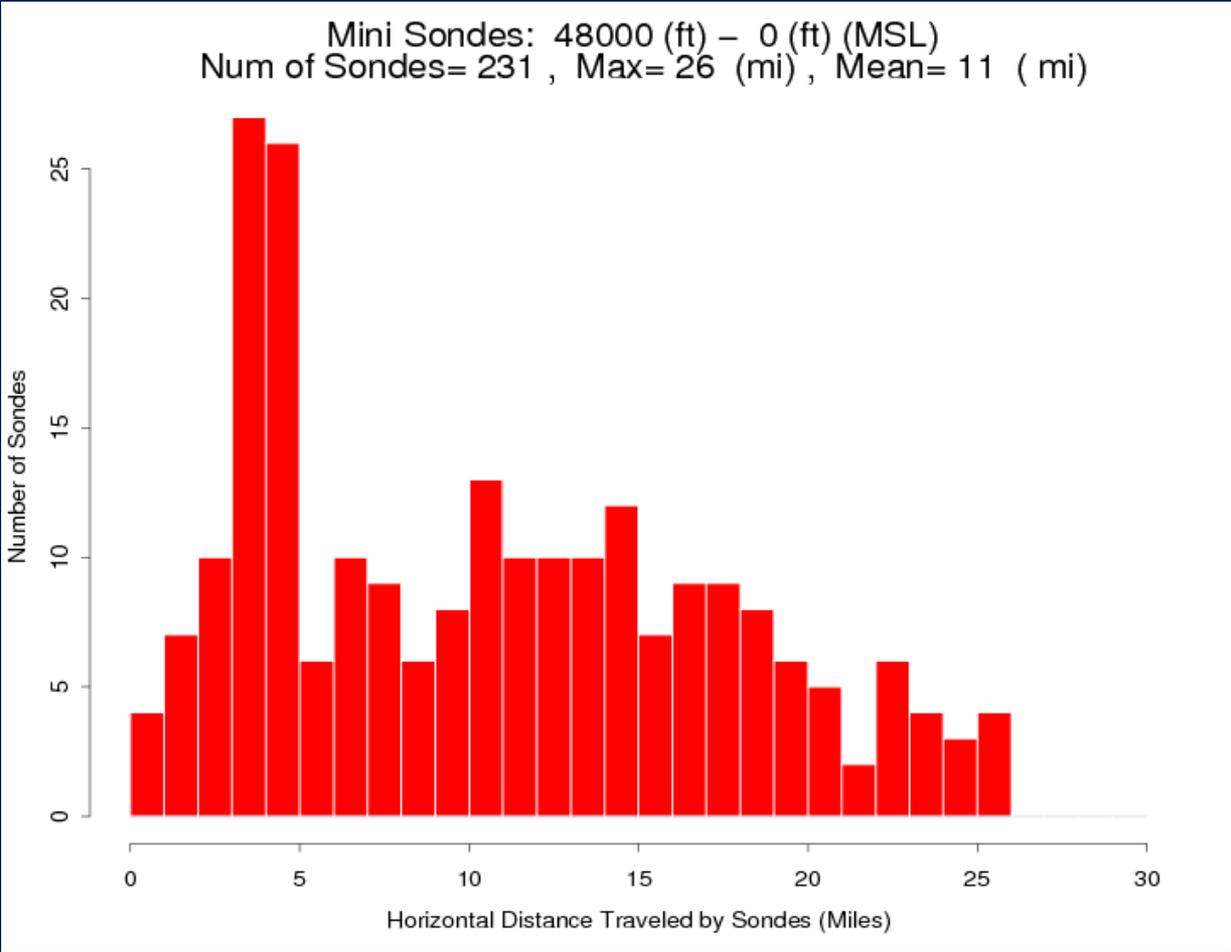




Horizontal Distance traveled between Launch & impact Locations

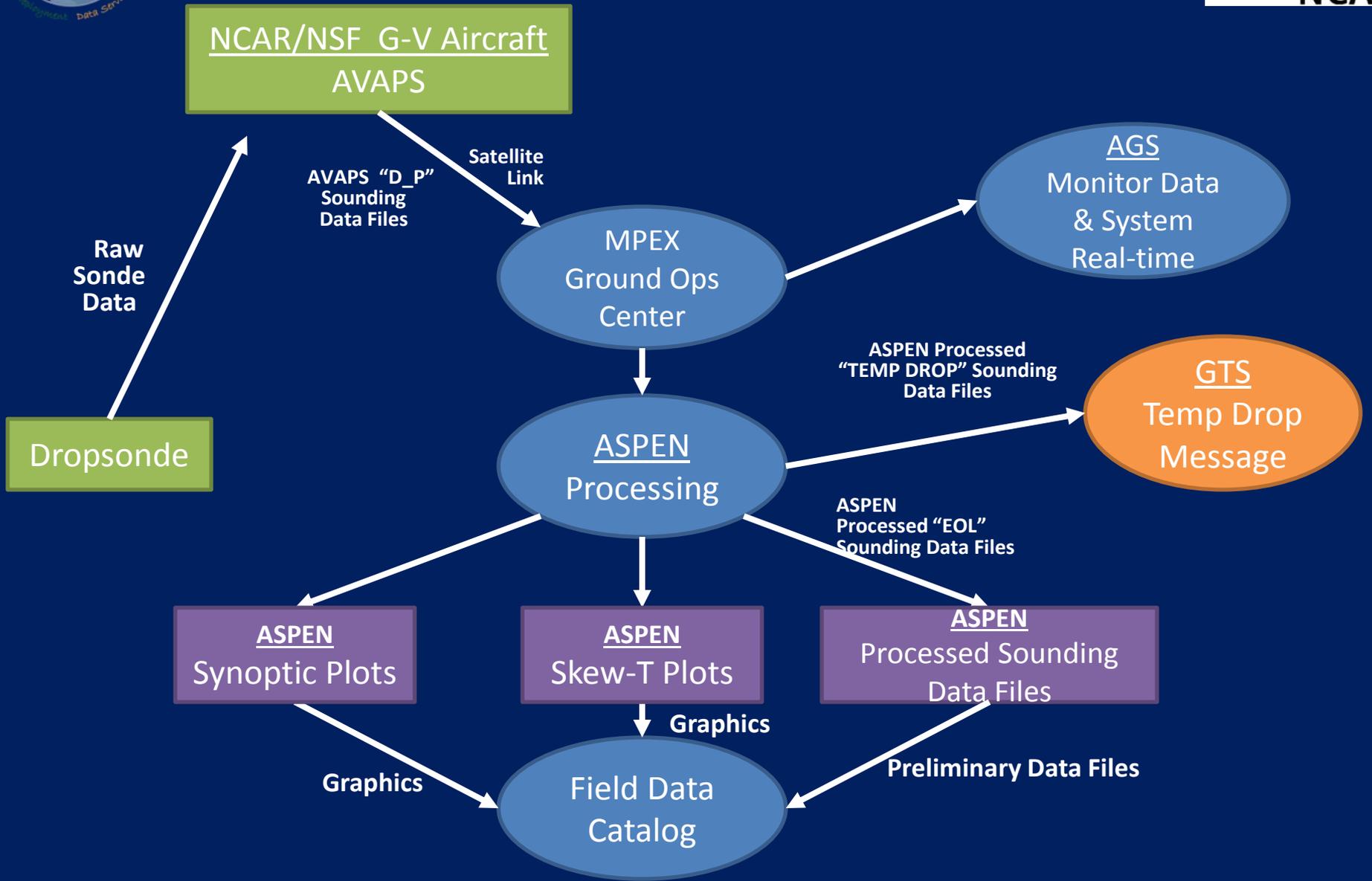


Mini sondes released from Global Hawk during WISAR
(Altitude range adjusted from 48,000 ft. to sea level)





MPEX – Soundings Data Flow





ASPEN- Tabular QC'ed Data



Aspen 3.1 - 7506

D20110304_084959_recomp4_P.1

Main Raw **QC** XY Graph Skew-T Levels WMO Comm Summary

D20110304_084959_recomp4_P.1 102015193 GH - WISPAR, GH - Science Flight 2 Global Hawk, NASA 872 (AV-6)

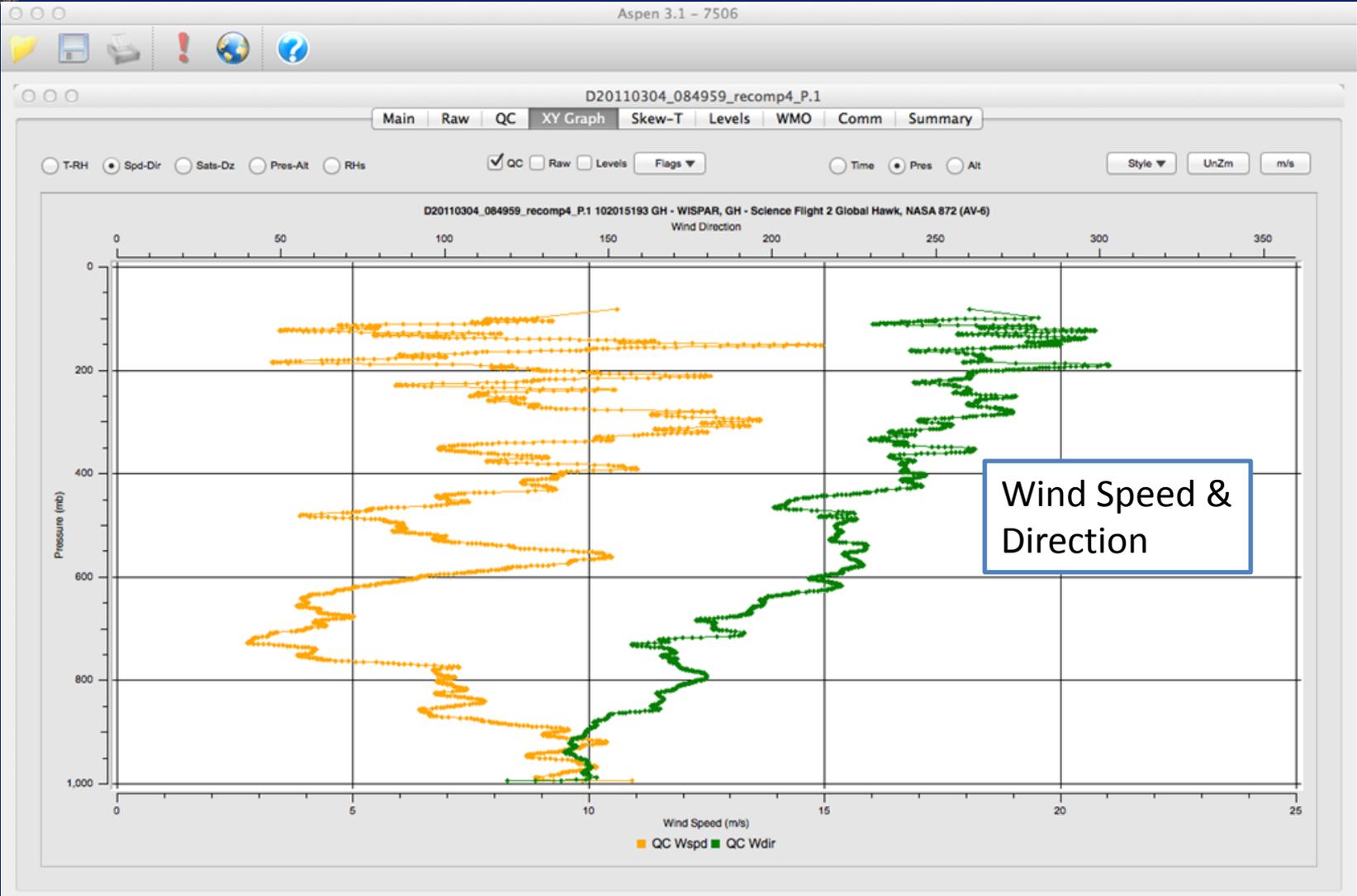
Time (s)	Pres (mb)	Tdry (C)	RH (%)	Spd (m/s)	Dir (deg)	Alt (m)	Dz/dt (m/s)	Lat (deg)	Lon (deg)
117.00	140.2	-44.2	1.0	9.6	291.5	13698.8	-27.1	51.6733	-145.2537
117.25				9.7	291.3				
117.50	140.5	-44.2	1.0	9.8	291.0	13685.3	-27.1	51.6733	-145.2536
117.75				9.9	290.8				
118.00	140.8	-44.1	1.0	10.0	290.5	13671.8	-27.0	51.6733	-145.2535
118.25				10.1	290.3				
118.50	141.1	-44.1	1.0	10.2	290.0	13658.3	-26.9	51.6733	-145.2535
118.75									
119.00	141.3	-44.1	1.0	10.4	289.5	13644.8	-26.9	51.6733	-145.2534
119.25				10.5	289.3				
119.50	141.6	-44.0	1.0	10.6	289.1	13631.4	-26.8	51.6733	-145.2534
119.75				10.6	288.8				
120.00	141.9	-44.0	1.0	10.7	288.6	13618.0	-26.8	51.6733	-145.2533
120.25				10.8	288.3				
120.50				10.9	288.1			51.6732	-145.2532
120.75				11.0	287.9				
121.00	142.5	-44.0	1.0	11.1	287.7	13591.2	-26.7	51.6732	-145.2532
121.25				11.1	287.4				
121.50	142.8	-43.9	1.0	11.2	287.2	13577.9	-26.7	51.6732	-145.2531
121.75				11.3	287.0				
122.00	143.0	-43.9	1.0	11.3	286.8	13564.6	-26.7	51.6732	-145.2530
122.25				11.3	286.6				
122.50	143.3	-43.9	1.0	11.4	286.3	13551.2	-26.7	51.6732	-145.2529
122.75				11.4	286.1				
123.00	143.6	-43.9	1.0	11.4	285.7	13537.9	-26.7	51.6732	-145.2529
123.25				11.4	285.4				
123.50	143.9	-43.9	1.0	11.4	285.0	13524.5	-26.7	51.6732	-145.2528
123.75				11.4	284.6				
124.00	144.2	-43.9	1.0	11.3	284.1	13511.2	-26.7	51.6731	-145.2527
124.25				11.3	283.7				
124.50	144.5	-44.0	1.0	11.2	283.2	13497.9	-26.7	51.6731	-145.2526
124.75				11.2	282.7				
125.00	144.8	-44.0	1.0	11.1	282.1	13484.6	-26.7	51.6731	-145.2526
125.25				11.1	281.6				
125.50	145.0	-44.0	1.0	11.0	281.1	13471.3	-26.8	51.6731	-145.2525
125.75									
126.00	145.3	-44.0	1.0	10.9	280.1	13457.9	-26.8	51.6731	-145.2524
126.25				10.8	279.6				
126.50	145.6	-44.0	1.0	10.8	279.2	13444.4	-26.8	51.6731	-145.2523
126.75				10.7	278.8				

Ready

ACTIVE CONFIG: editsonde CONFIG DIR: /Users/martinc/.config/Aspen/



ASPEN – X-Y Data Plot

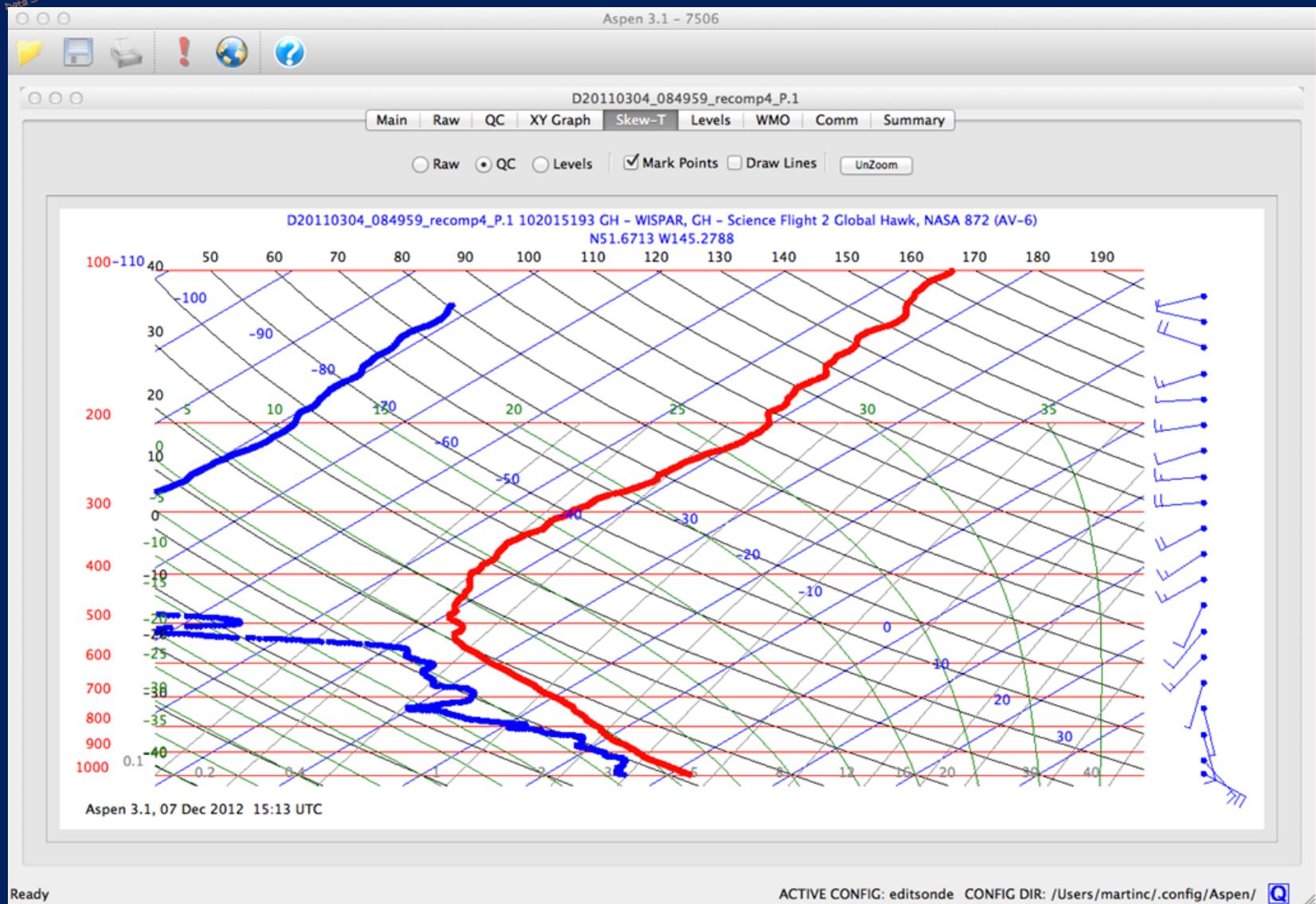


Ready

ACTIVE CONFIG: editsonde CONFIG DIR: /Users/martinc/.config/Aspen/



ASPEN – Skew-T Plot





ASPEN – Temp Drop Significant and Mandatory Levels



Aspen 3.1 – 7506

D20110304_084959_recomp4_P.1

Main Raw QC XY Graph Skew-T Levels WMO Comm Summary

D20110304_084959_recomp4_P.1 102015193 GH - WISPAR, GH - Science Flight 2 Global Hawk, NASA 872 (AV-6)

Click on a level to disable/enable it. Disabled Levels are highlighted in red.

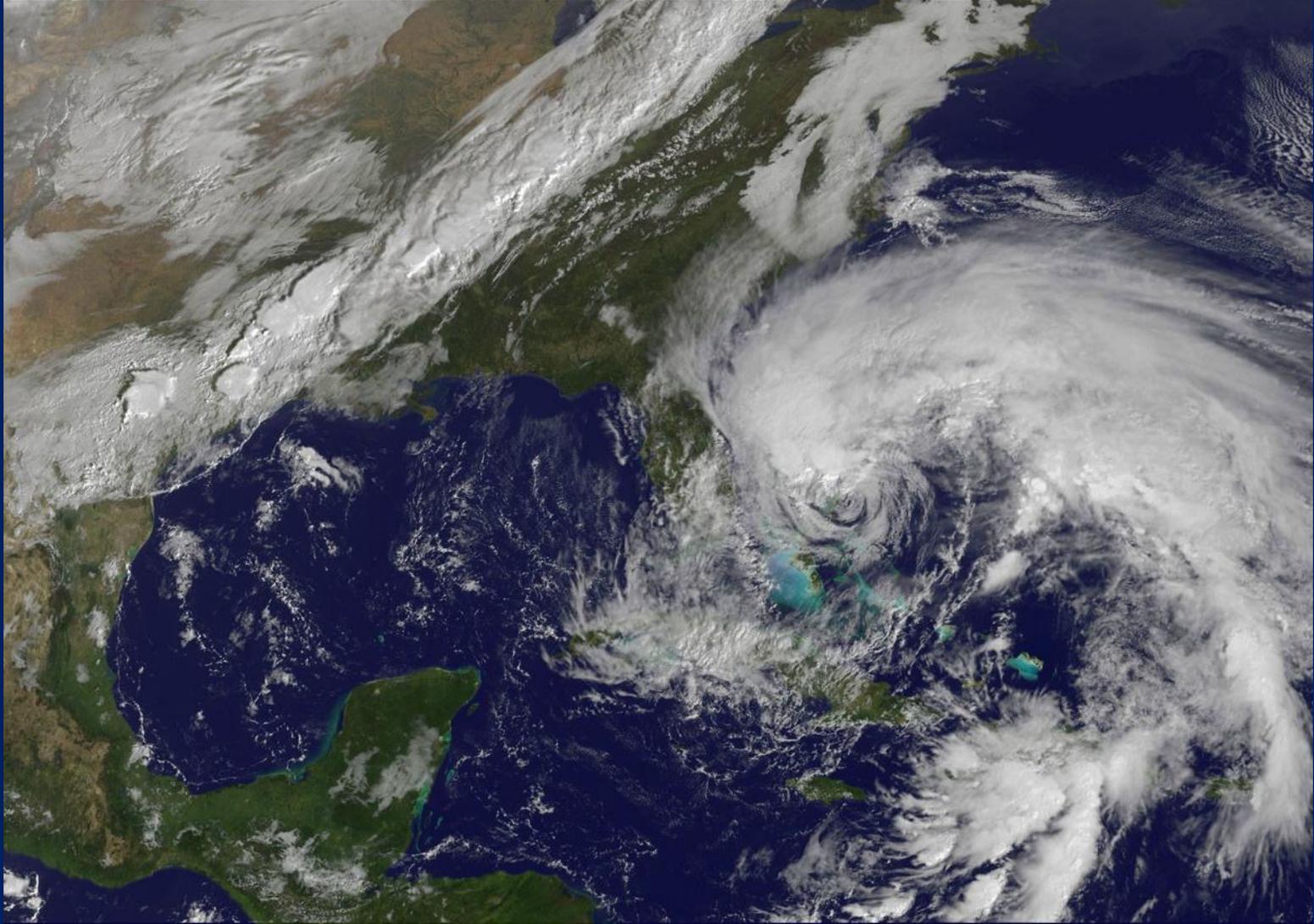
n	Type	Time (s)	Pres (mb)	Tdry (C)	RH (%)	Dir (deg)	Spd (m/s)	Alt (m)
0	Extrapolated Altitude	-1.0	70.0					18266
1	62626 REL Location	-1.0	82.5					
2	Uppermost Thermodynamic	-1.0	82.5	-53.5				
3	Uppermost Winds	-1.0	82.5			260.2	10.6	
4	GDL Wind Speed	10.0	87.1			271.3	22.1	
5	GDL Wind Speed	19.2	91.1			263.2	4.5	
6	GDL Wind Direction	25.5	93.7			288.7	6.2	
7	GDL Wind Direction	37.8	98.9			286.3	9.3	
8	GDL Temperature	38.5	99.2	-46.6				
9	Standard	40.2	100.0	-46.6		272.7	8.5	15951
10	GDL Wind Direction	44.2	101.9			251.4	7.8	
11	110-100mb Temperature	60.5	109.9	-46.6				
12	110-100mb Winds	60.5	109.9			231.2	7.6	
13	GDL Wind Direction	63.5	111.4			237.3	5.7	
14	GDL Wind Direction	68.2	113.9			278.6	5.3	
15	Uppermost Thermodynamic	74.0	116.8	-45.6	1.0			
16	GDL Wind Direction	75.8	117.7			263.6	5.5	
17	GDL Wind Speed	85.5	122.9			298.7	3.5	
18	GDL Temperature	88.0	124.2	-44.1	1.0			
19	GDL Wind Direction	98.2	129.8			256.5	7.8	
20	GDL Temperature	107.5	134.9	-45.1	1.0			
21	GDL Wind Direction	111.5	137.1			295.5	7.2	

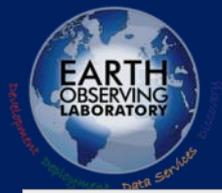
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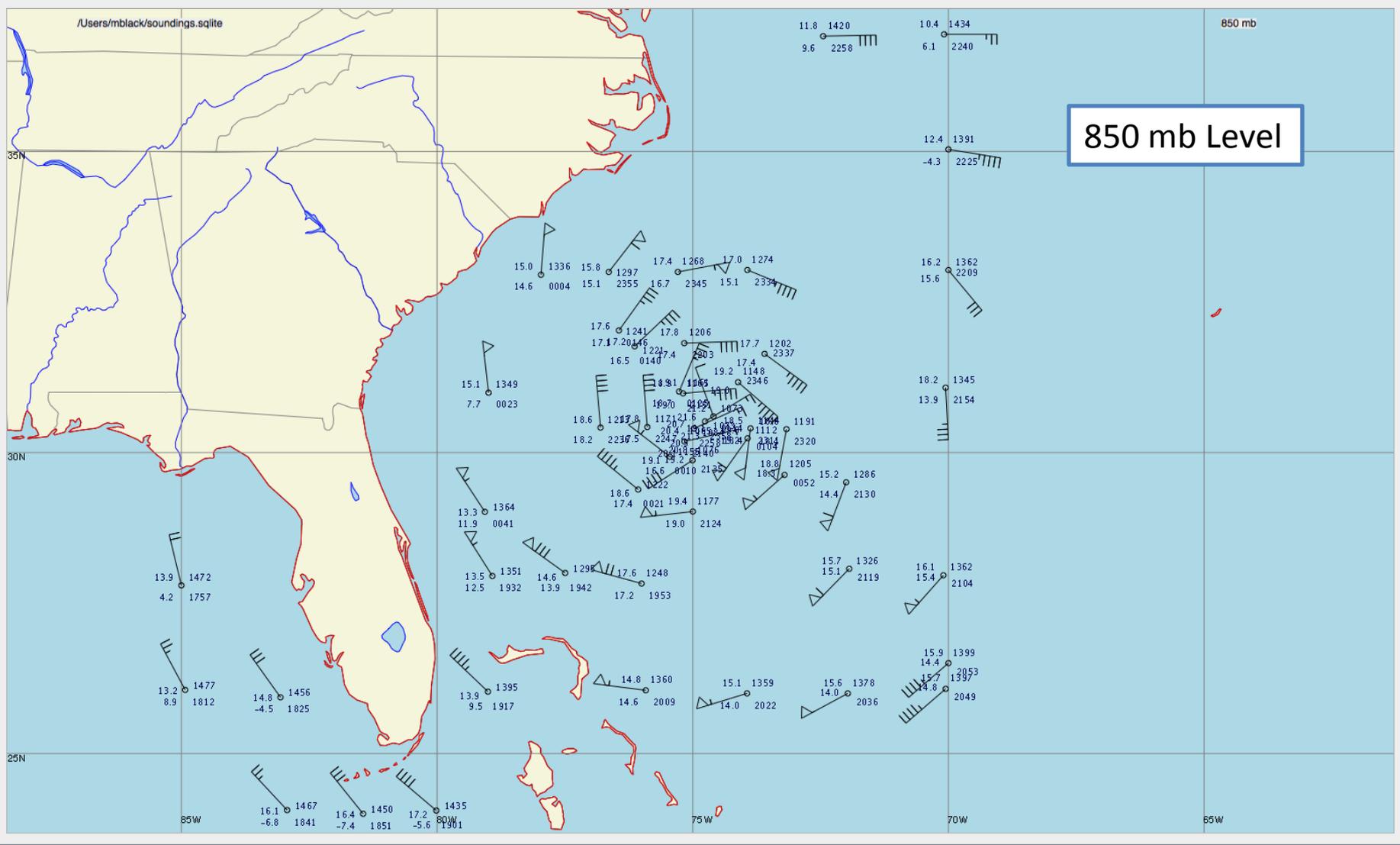


Hurricane Sandy





Hurricane Sandy NOAA/AOC Drops ASPEN Synoptic Plot





G-V Dropsonde Project



Project Management & Documentation

- System is based upon the Global Hawk System
 - NASA HS3 2011, NASA HS3 2012, NOAA WISPAR
- Dedicated Project Manager
- Project Charter Document
- Technical Requirements Document
- Gantt Chart / Project Time Line
- Timeline July 2011 – March 2013 (21 months)
- EOL Staff FTE: ~4.5 yrs
(Techs, Eng, Mechanics, Management)



Current Schedule & Status

- Completion of Sonde storage and Ejection Assembly – Oct 2012
- Core Software Development – June to Dec 2012
- Lab System Testing and preliminary G-V Integration – Nov to Dec 2012
- GV Installation and ground aircraft testing – Jan 2013
- Flight Tests – Feb 2013
- First Deployment - May - June 2013

MESOSCALE PREDICTABILITY EXPERIMENT (MPEX)