Future hurricane robotic observation platforms

Pat Fitzpatrick and Yee Lau

Mississippi State University

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Liquid Robotics, Inc.

- Wave Gliders
- GlobalHawks
- Dropsonde drone (“Coyote”)

Funded by the Sandy Supplemental Internal Competition for Instruments and Observing Systems under NOAA Grant NA14OAR4830128

Two papers published in Maritime Technology Society journal

One of three WGs on R/V Tommy Munro

Pre-deployment, Biloxi, MS

Aug. 25, 2014

Launched 37 km offshore

A WG about to be launched

Areas Wave Gliders Have Been Used in the North American Scientific Community

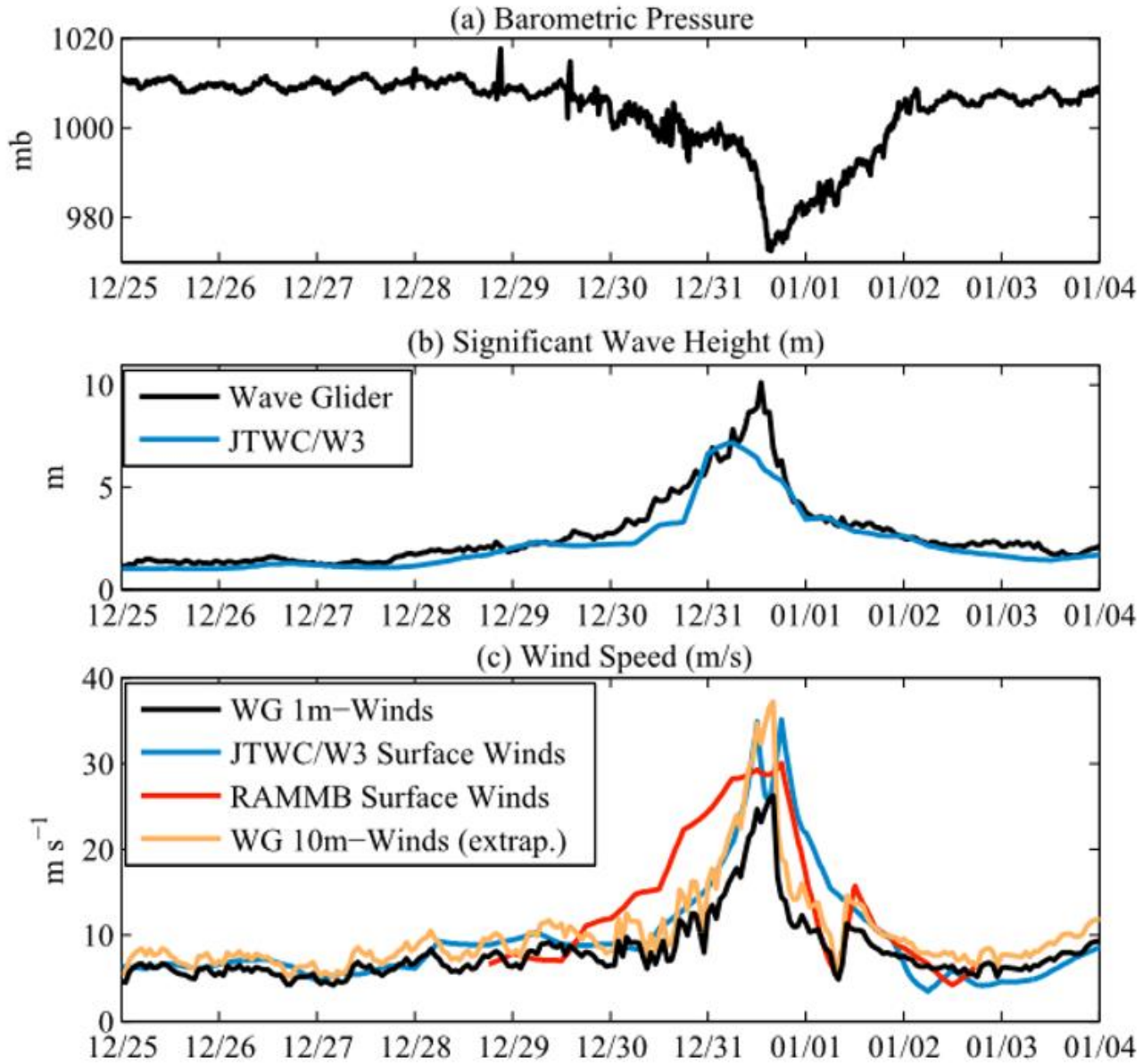
- Oceanography
- Satellite Validation
- Ocean Acidification
- Hurricane Monitoring
- Mothership/Gateway
- Acoustic Ship Monitoring
- Seismic
- Fish Tracking
- Marine Mammal Acoustics
- Shark Tracking
- Fish Finding
- Survey

Devices Integrated Onto Wave Gliders

- Airmar WX200 Weather*
- Seabird GPCTD*
- Teledyne RDI Workhorse Monitor ADCP – 300/600kHz*
- Turner C3*
- Datawell Wave Height*
- VEMCO Vr2C*
- LI-COR LI-820 CO2
- MAPCO2
- Honeywell Durafet II pH
- Wet Labs Eco Puck
- SeaFET pH
- WHOI Micromodem*
- Benthos Transducer*
- Sonardyne 6G*
- Inertial Navigation Unit
- MBARI Comms Hot Spot
- WHOI DMON
- SCRIPPS HARP
- Inmarsat
- NDBC DART
- PME Thermistor
- MacArtney Winch

*LRI Supported Products

Hurricane Freda (2012) in Pacific Ocean



MSU Wave Glider program

G10

42040: 8/28-8/29
42039: 9/2-9/5
42036: 9/15-9/23; 10/11-11/21
42099: 11/28-11/29

G11 (renamed G14 on 9/11)

42040: 9/1-9/5

G12 (discontinued 10/24, duties assumed by GOM1)

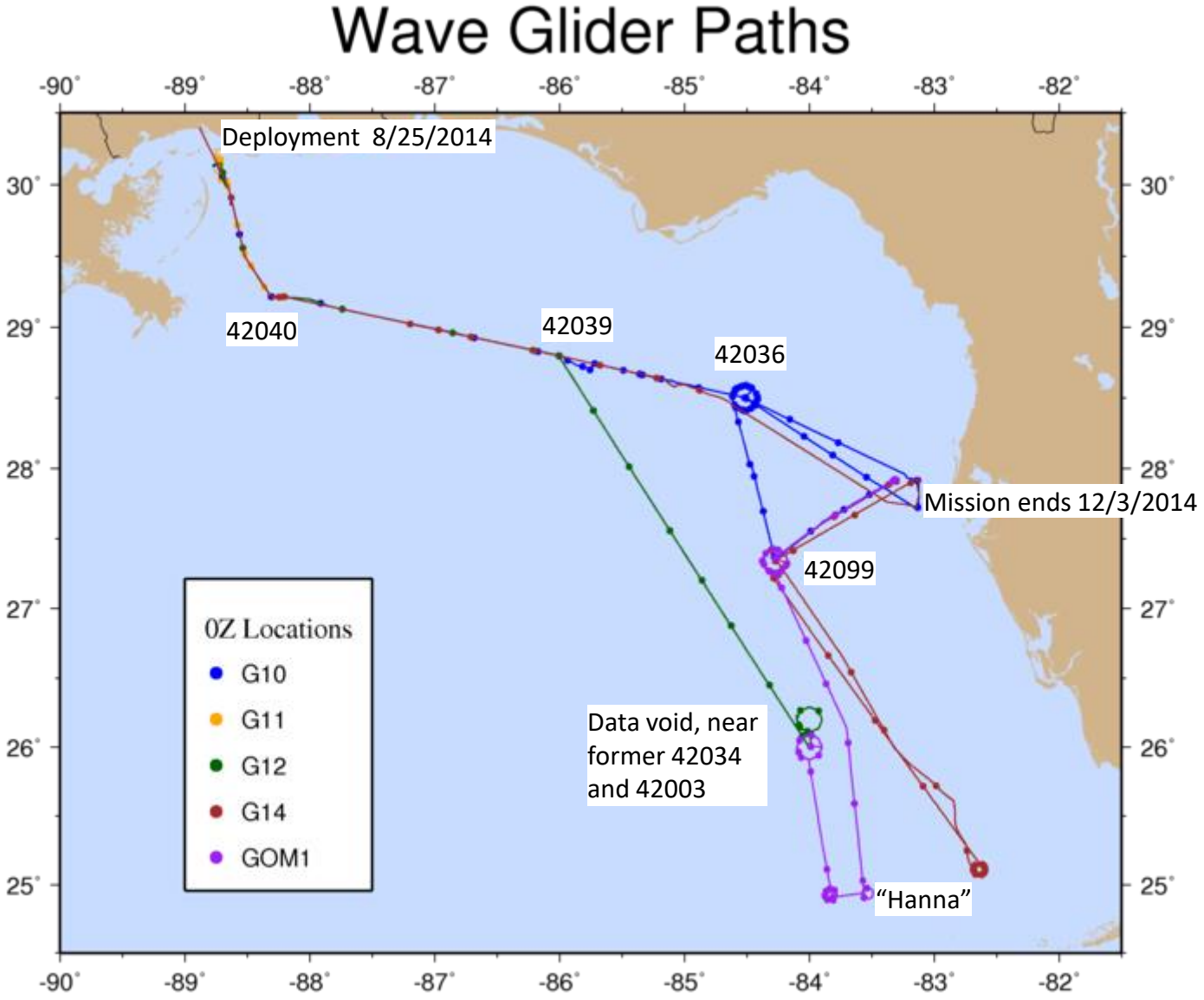
42039: 9/1-9/2
84W, 26N: 9/9-10/23

G14

42040: 9/14-9/19
42099: 10/10-10/21
“Hanna” 82.6W 25.1N: 10/25-11/18
42099: 11/28-11/29

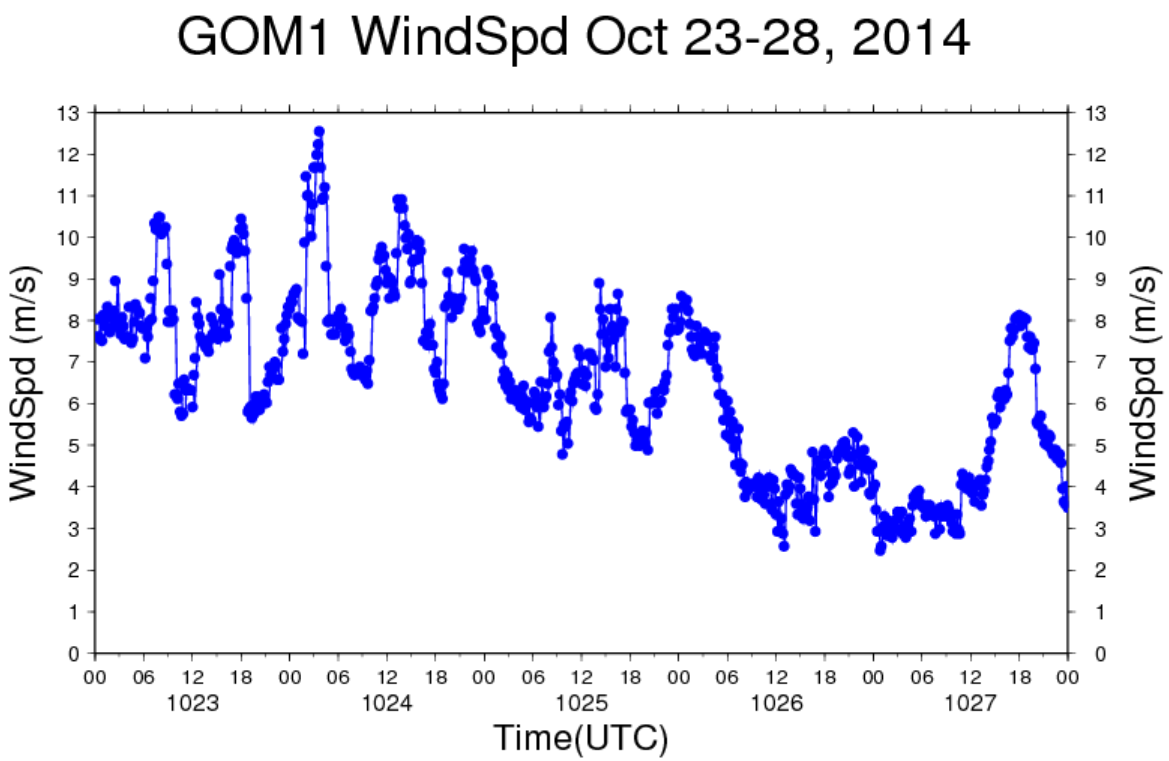
GOM1

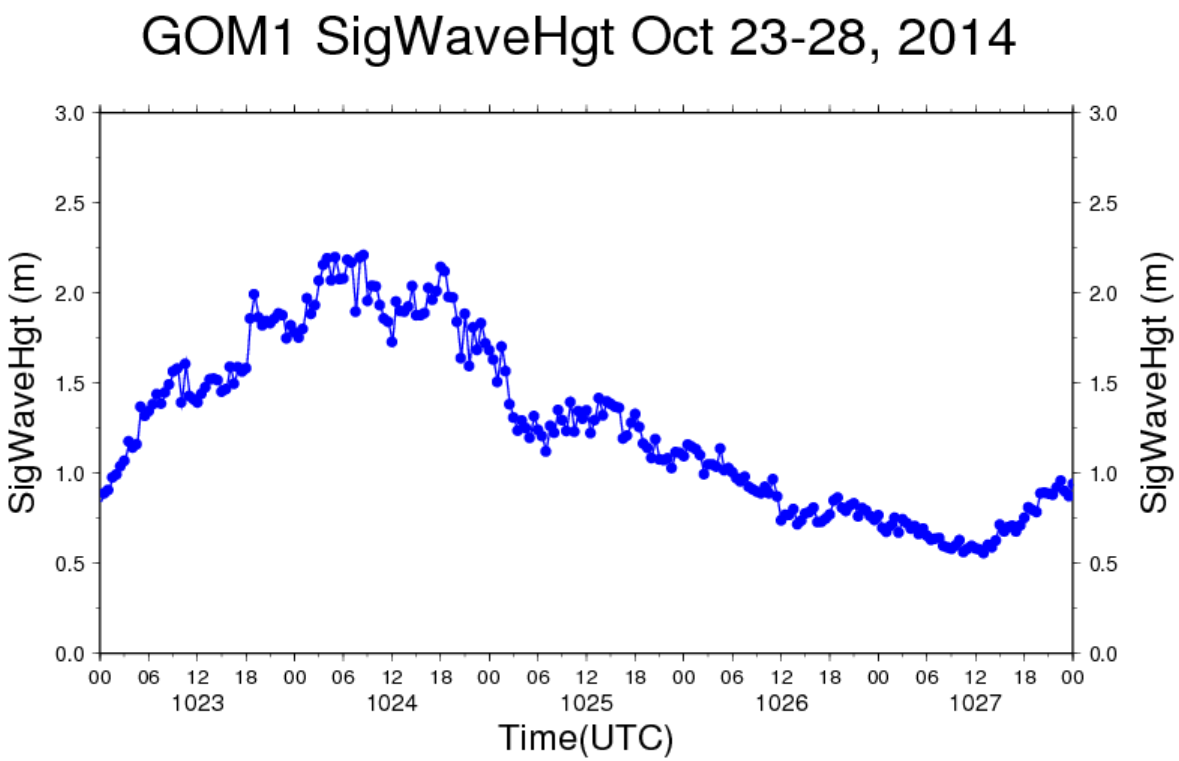
84N, 26W: 10/14-10/21
“Hanna” 83.8W 24.9N: 10/23-10/31
“Hanna” 83.5W 24.9N: 11/1-11/3
42099: 11/9-11/29



“Hanna” connotes northern fringe of tropical system

Northern fringe of Hanna lifecycle during 2014 field program





Front and circulation interaction

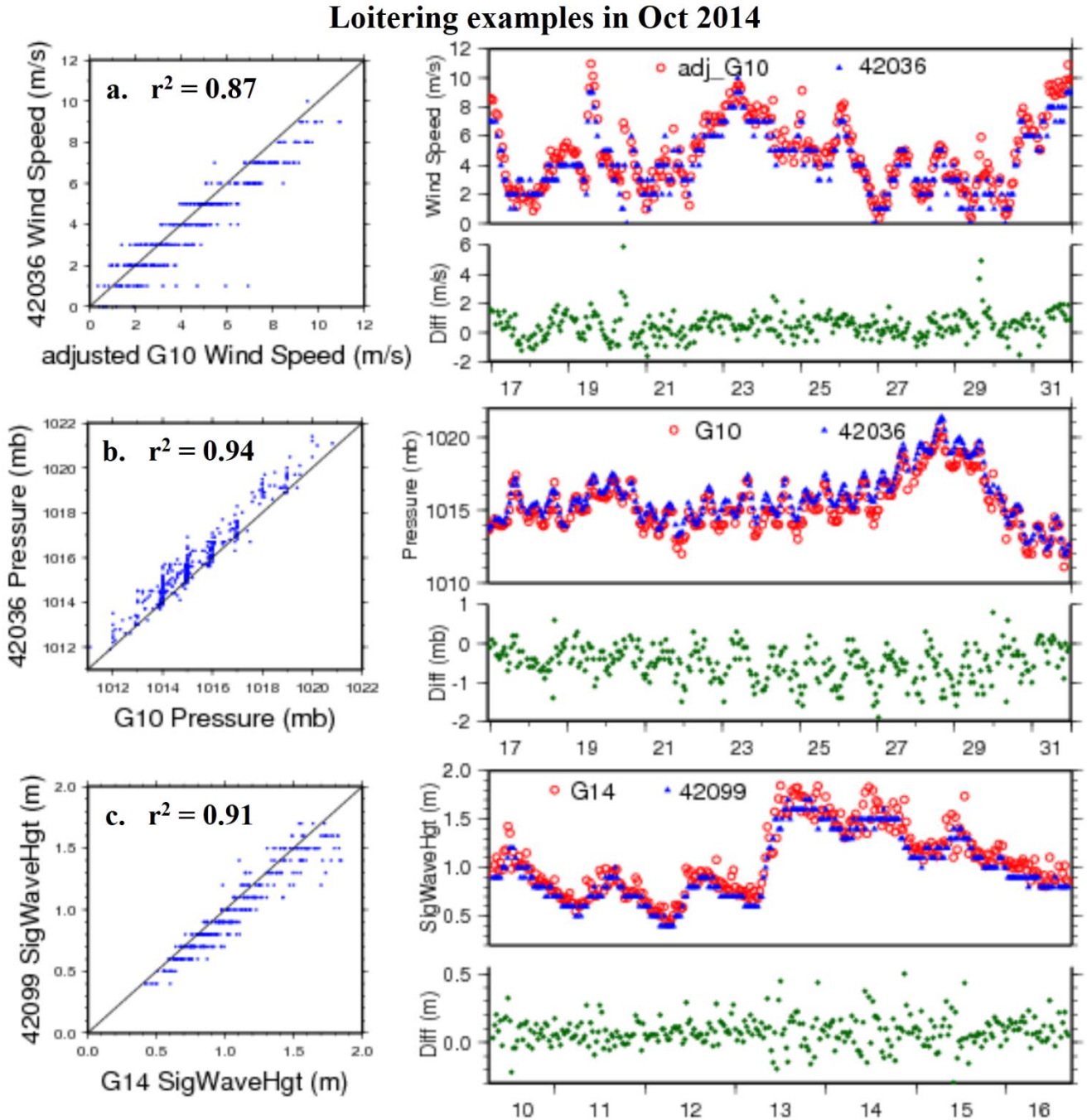
Front dissipates

Genesis then landfall

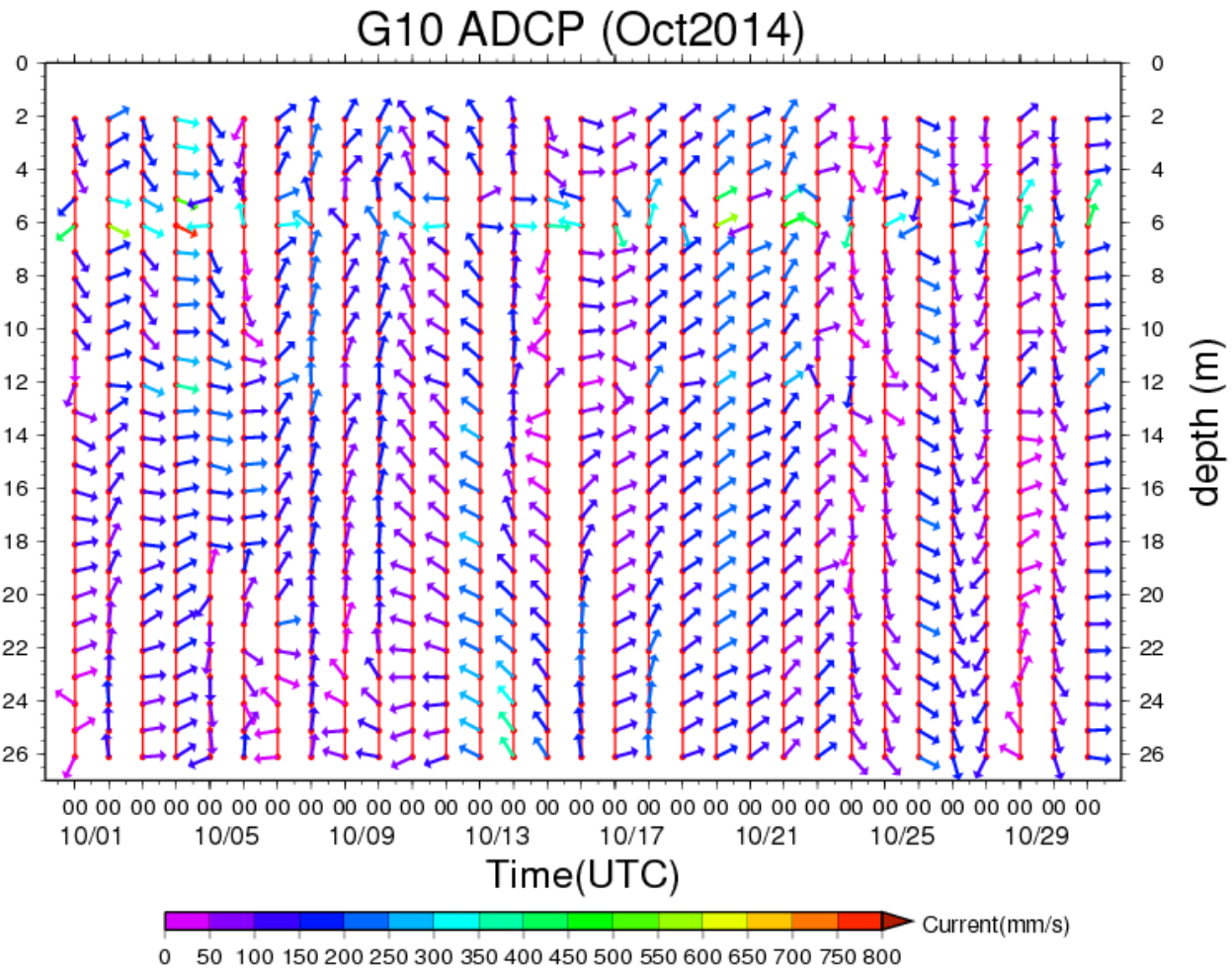
Bias Err = 0.48 m/s
Abs Err = 0.76 m/s

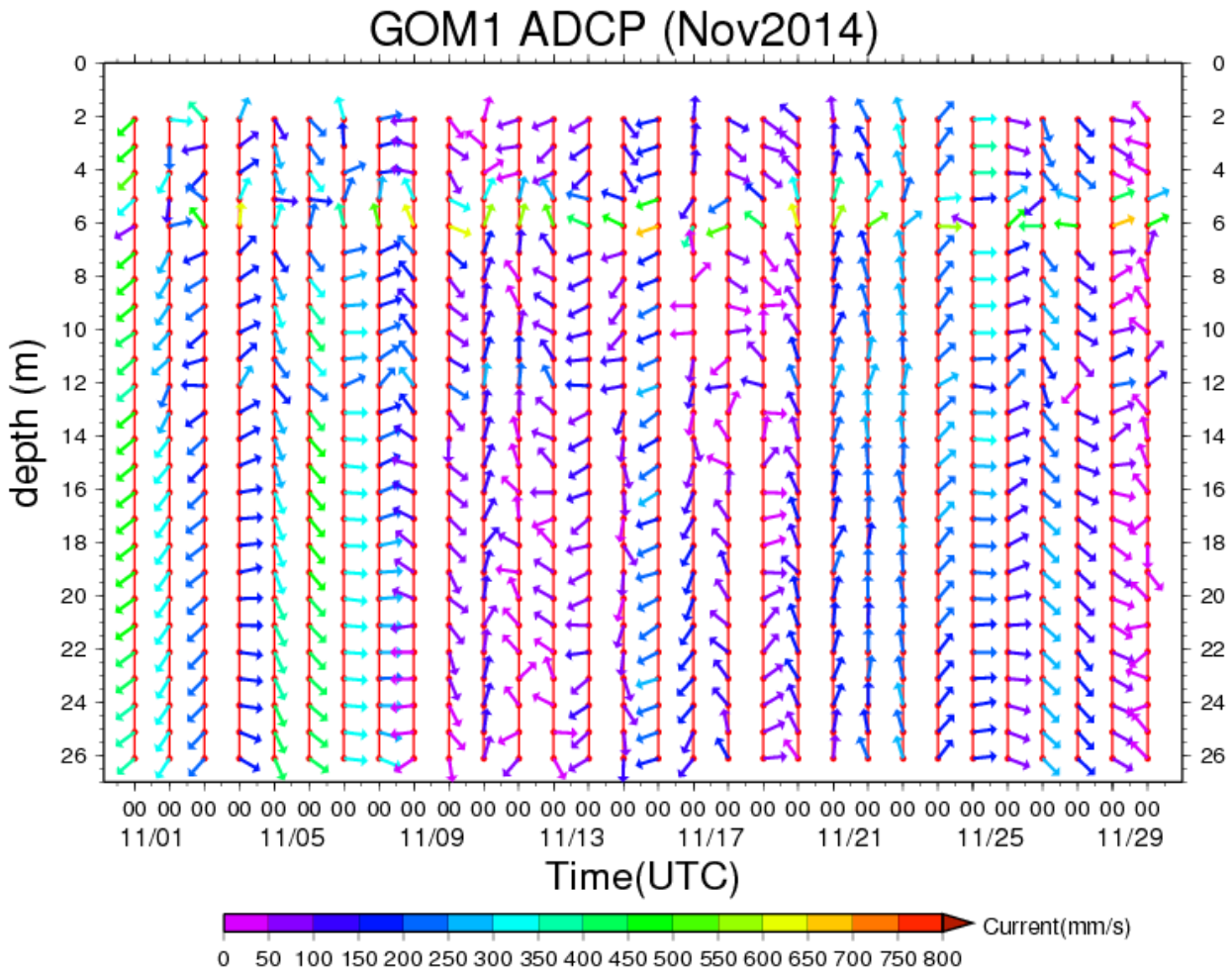
Bias Err = -0.51 mb
Abs Err = 0.55 mb

Bias Err = 0.08 m
Abs Err = 0.10 m



Example monthly plots of ADCP at 00Z – no validation possible

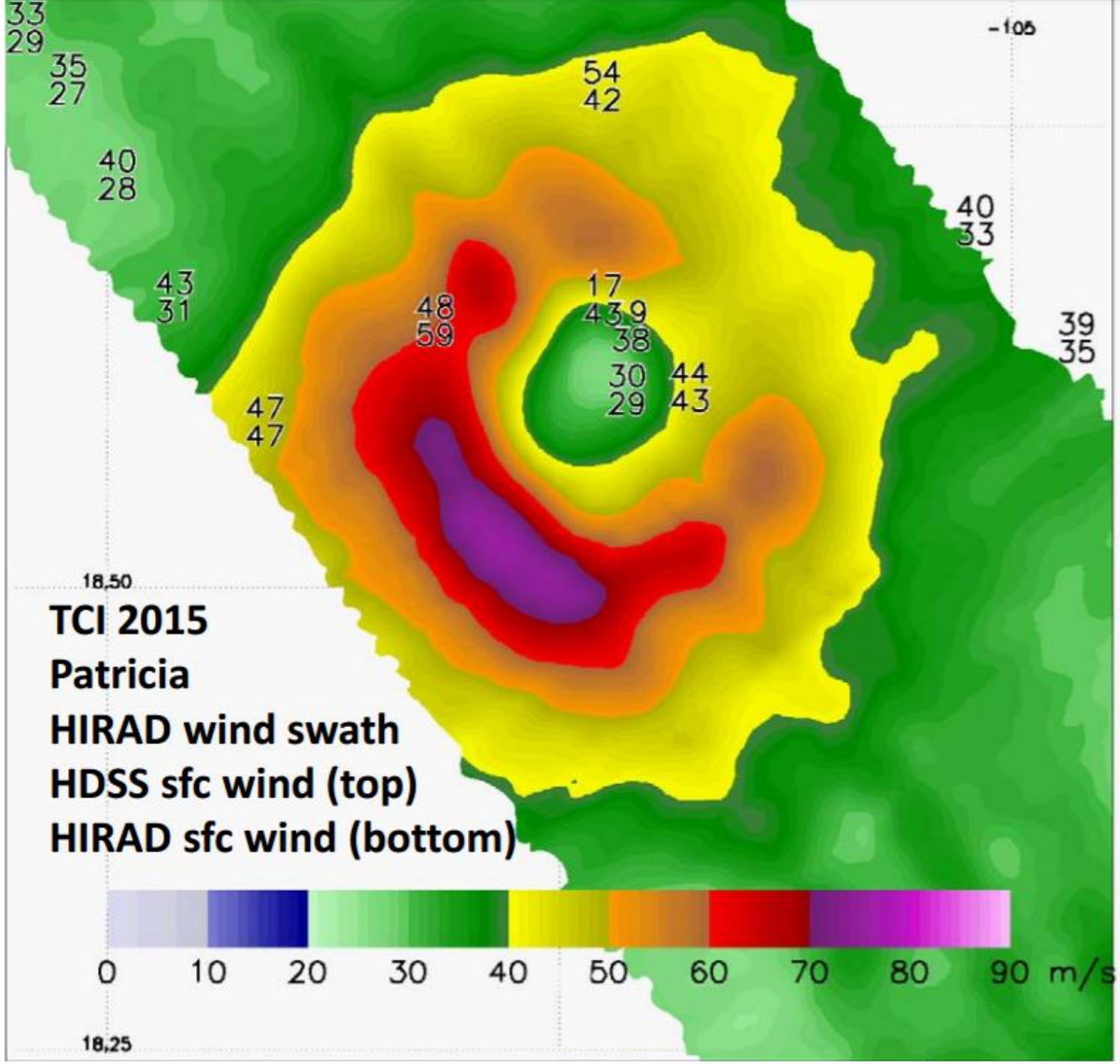




Real-time data available every 30 min

NASA's Global Hawk


Dropwindsonde
High Altitude Lightweight Dropsonde (Vertical profiles of temp, humidity, pressure & winds)
LIP
Lightning Instrument Package (Lightning and Electrical Storm observation)
HIWRAP
High Altitude Imaging Wind and Rain Profiler (Horizontal wind vectors and ocean surface winds)
HAMSR
High Altitude MMIC Sounding Radiometer (Temp, H2Ov, Cloud liquid & ice distribution)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47
47
40
33
39
35
-105
18,50
18,25
TCI 2015
Patricia
HIRAD wind swath
HDSS sfc wind (top)
HIRAD sfc wind (bottom)
0 10 20 30 40 50 60 70 80 90 m/s

SHOUT 2016 Summary

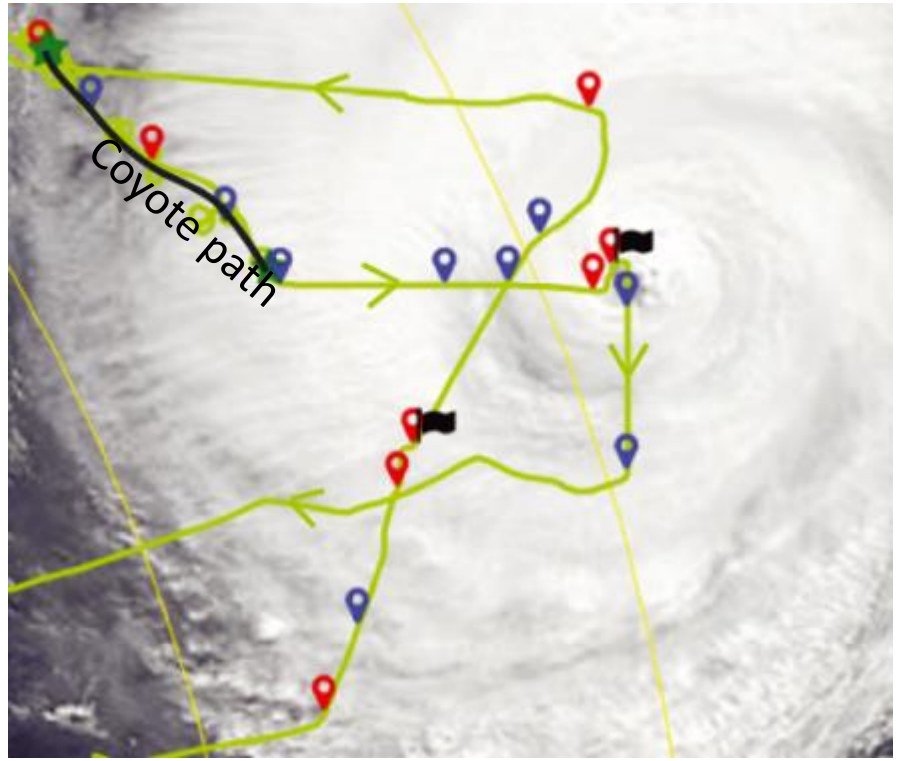
- ❑ Five Storms (2 landfalls), 9 flights in 7 weeks:
  - 2 Gaston,
  - 2 Hermine (1 pre-landfall)
  - 2 Karl,
  - Record 3 Matthew (back-to-back-to-back, one landfall)
  - 1 Matthew/ Nicole

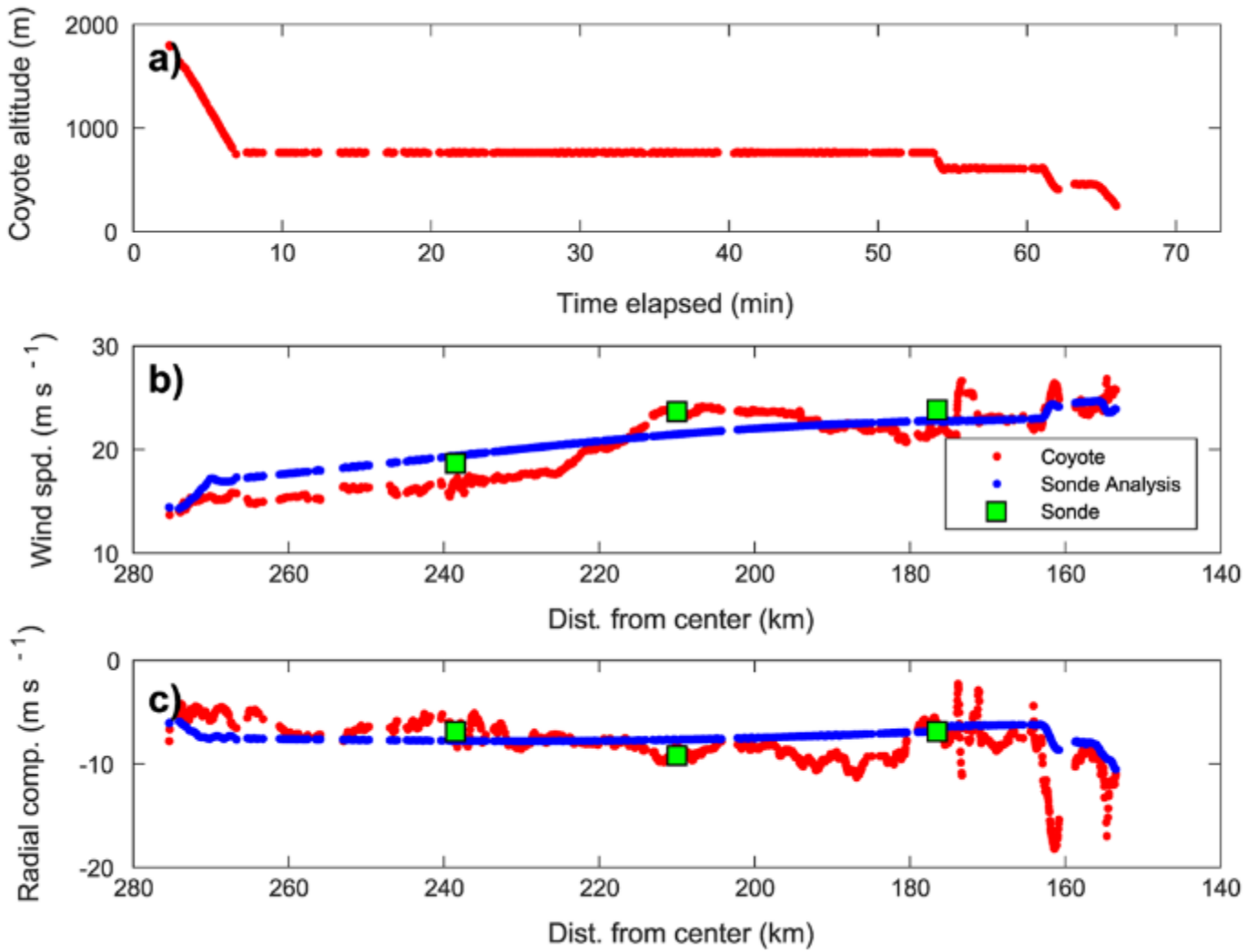
- ❑ 214 Flight Hours (23.8 hr/flt)
- ❑ 647 sondes (72 sondes/flt)
  - 97% in real time to GTS
  - 95% passed HWRF and ECMWF QC
- ❑ Record 90 sondes in pre-Hermine flight

NOAA's "mini-drone" called a Coyote

Table 1. Coyote Missions in Hurricane Edouard

Date	Coyote Flight Times (UTC)	Locations and Heights Targeted	Hurricane Intensity Wind (kt)/Pressure (hPa)
16 September 2014	1433–1500 (27 min)	Eye and eyewall (900–1500 m)	105/955
17 September 2014	1508–1616 (68 min)	Clear air and rainband in inflow layer (~760 m)	80/957




a)
Coyote altitude (m)
2000
1000
0
0
10
20
30
40
50
60
70
Time elapsed (min)
b)
Wind spd. (m s -1)
30
20
10
280
260
240
220
200
180
160
140
Dist. from center (km)
Coyote
Sonde Analysis
Sonde
c)
Radial comp. (m s -1)
0
-10
-20
280
260
240
220
200
180
160
140
Dist. from center (km)

Video links

https://www.youtube.com/watch?v=0_X05oIUmDo

https://www.youtube.com/watch?v=SjtlTj7xe7Y&feature=youtu.be

https://www.youtube.com/watch?v=aQo3NEYGSLw

https://scied.ucar.edu/dropsonde-video-nasa-global-hawk

https://www.youtube.com/watch?v=44qpI3p-9xg