

Real-Time Current Profiles in Support of Offshore Oil and Gas Operations

Archie Todd Morrison III



Woods Hole Group

- Environmental consulting company
- Not to be confused with the Woods Hole Oceanographic Institution
 - But also located in Falmouth, Massachusetts
- Recently acquired (happily) by CLS in Toulouse



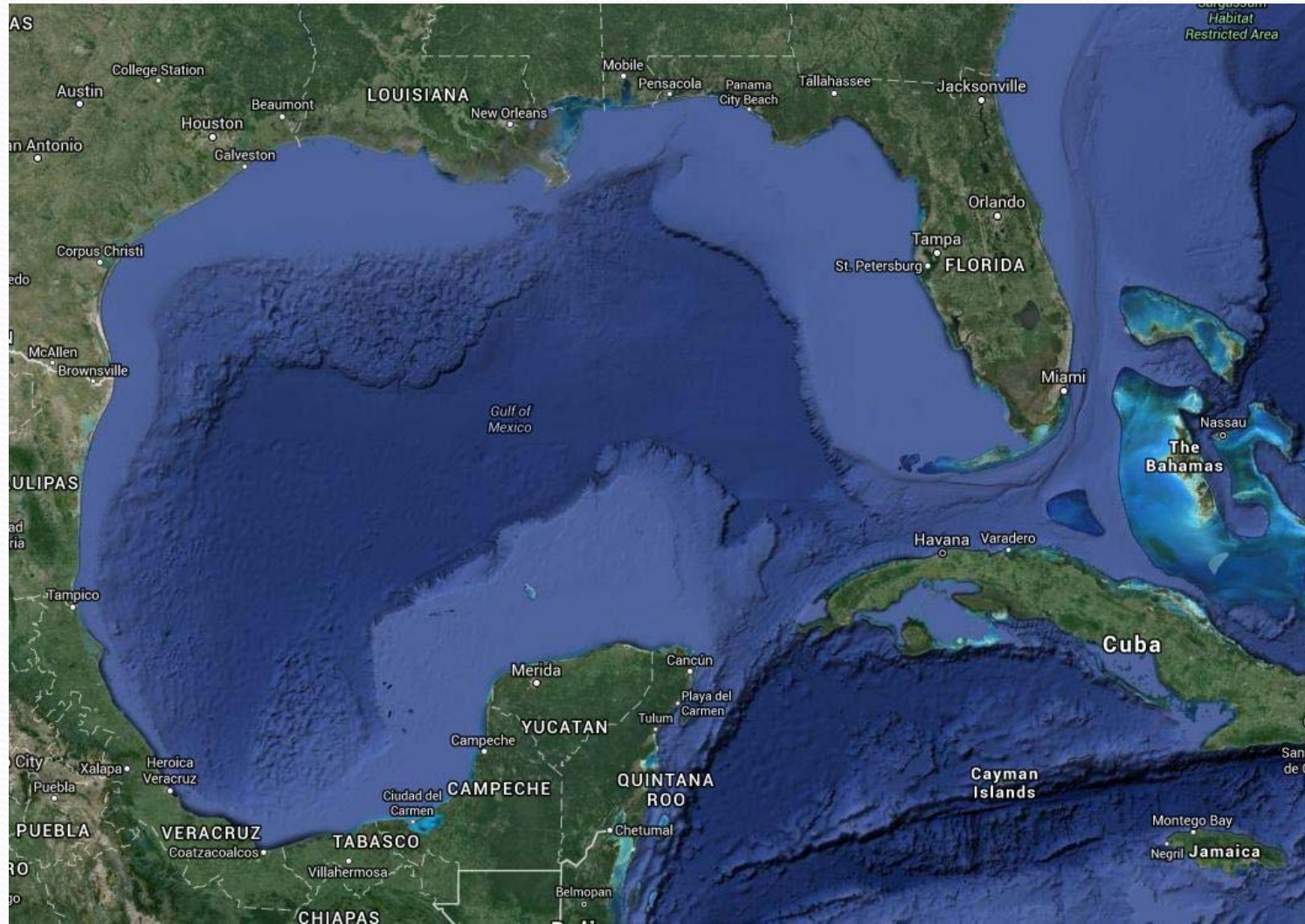


Some Motivation

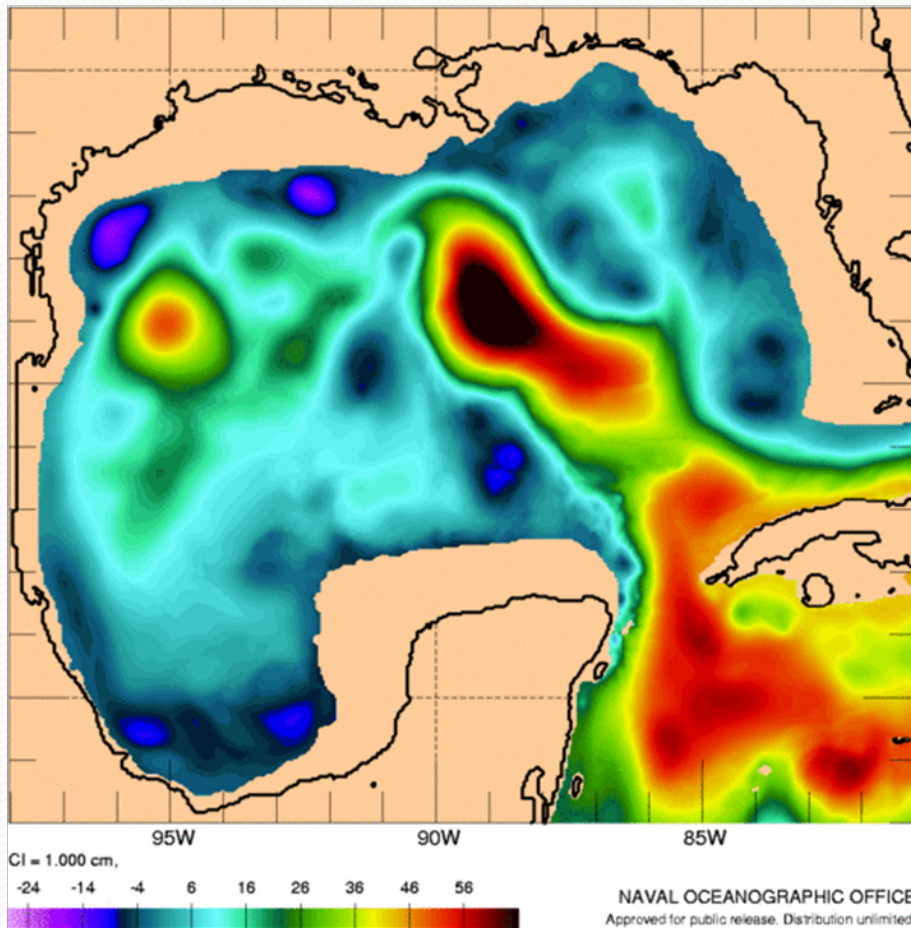
The most exciting phrase
to hear in science,
the one that heralds new discoveries,
is not ‘Eureka!’ (I found it!), but
“That’s funny . . .”

-Isaac Asimov
(among others)

Gulf of Mexico - Bathymetry



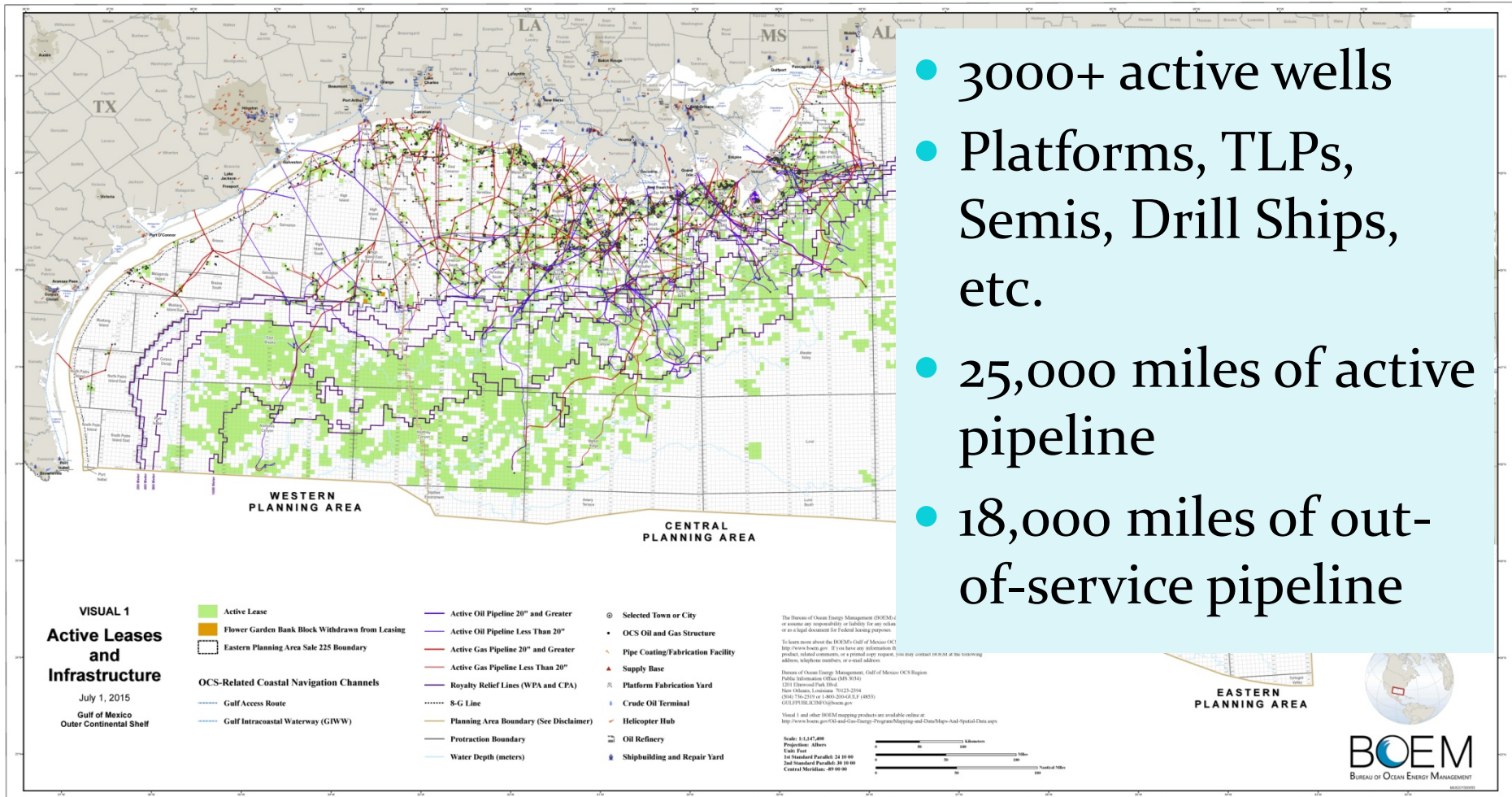
The GoM Loop Current and Loop Current Eddies



- SSH – Sea Surface Height
- Range: 1 meter
- Eddy Yankee separating
- Note older and counter-rotating eddies
- LC and LCE speeds regularly exceed 4 knots!

Lease Blocks – US GoM

- 3000+ active wells
- Platforms, TLPs, Semis, Drill Ships, etc.
- 25,000 miles of active pipeline
- 18,000 miles of out-of-service pipeline



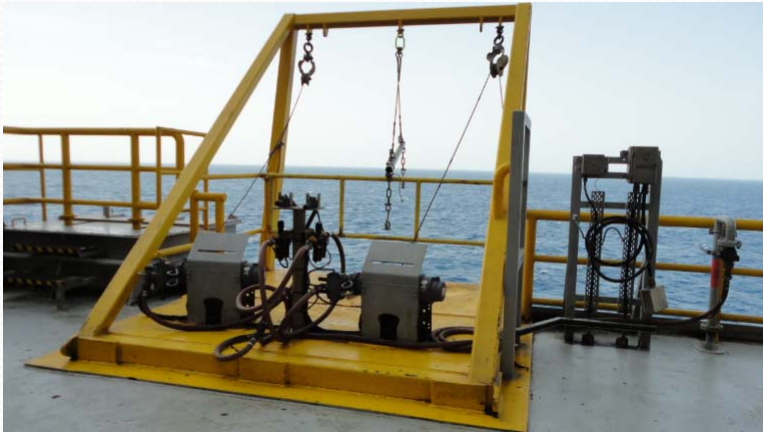
NTLs from MMS/BOEM/BSEE:

- Program began in 2006
- All O&G installations operating in water depths greater than 400 meters or “near” “significant” bathymetry (the Sigsbee Escarpment)
- Speed and direction profiles from near-surface to near-bottom or 1000 meters
- Near-bottom measurement if deeper than 1100 meters
- 20-minute ensembles reported to NDBC in “near-real-time”
- TRDI OO₃₈
 - 1000 m range
 - 600 lb transducer
 - Deck box
 - ~50 conductor cable

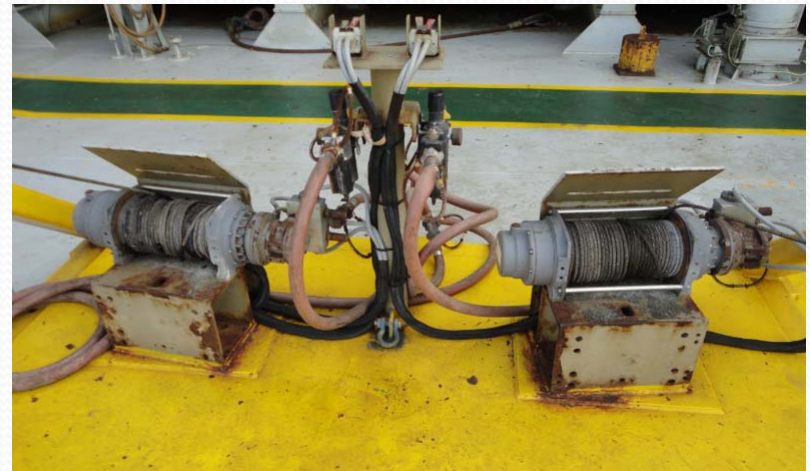
Operational Environment



Early Systems



- Fixed frame
- Expensive, fragile, multi-conductor cable
- Tie wraps
- No equipment protection
- Labor intensive, time consuming, launch and recovery
- Personnel safety issues



Woods Hole Group Innovations



- OO₃₈ UWEA precludes the need for a vulnerable, multi-conductor, external data and power cable
- S/N “Zero”
- The gantry cradle and instrument sled protect the OO₃₈ transducer during operation and maintenance
- WH₃₀₀ tilted mount improves data quality

Woods Hole Group Innovations



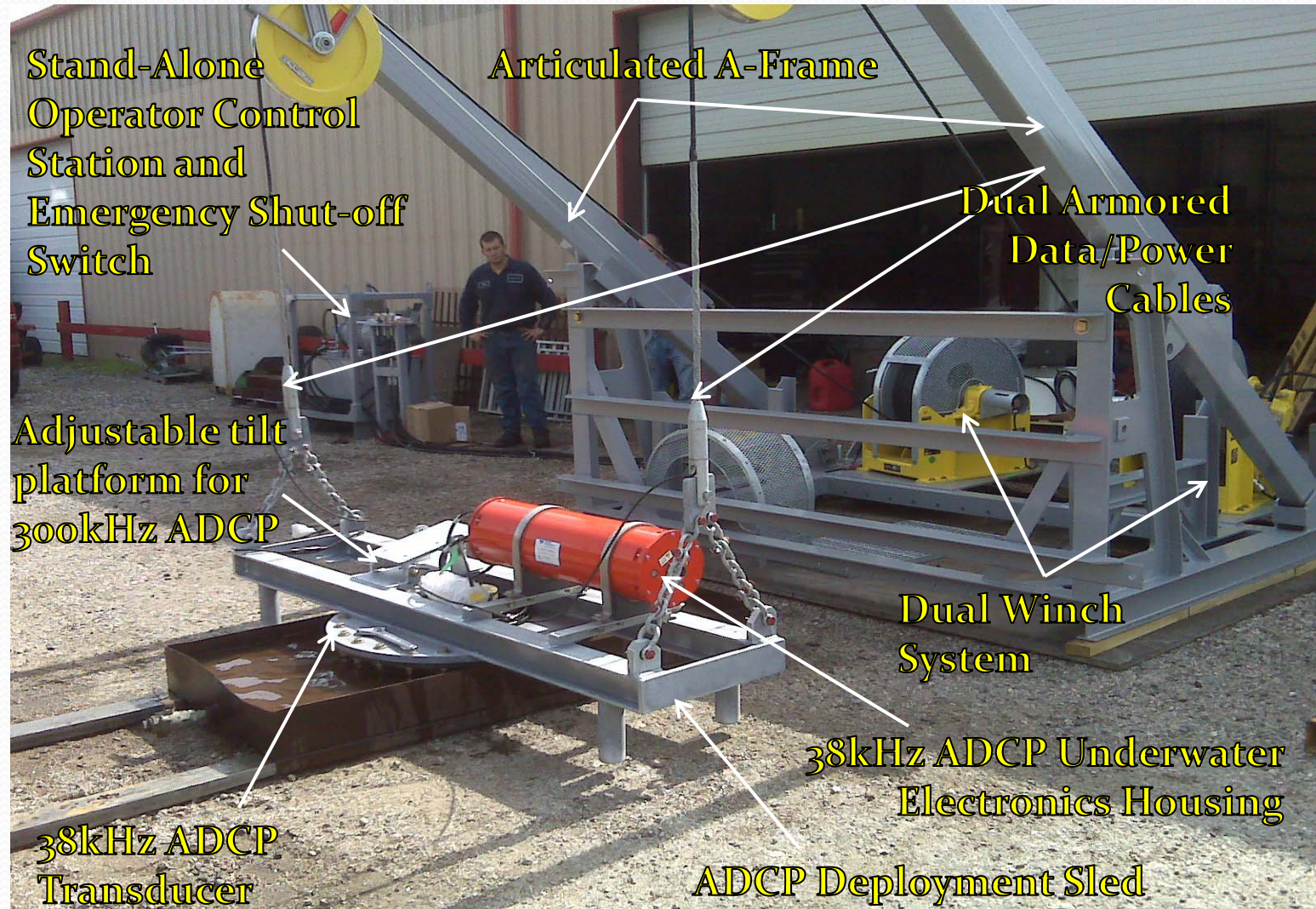
- Electro-mechanical cables carry data and power and support the mechanical load
- Slip rings
- Articulated A-frame separates personnel from the load
- The combination vastly improves personnel safety and launch and recovery times

Woods Hole Group Innovations

- Design keeps personnel away from hazardous areas during operation
- Only two people are required for launch and recovery
- Automatic instrument shutdown during recovery to prevent damage

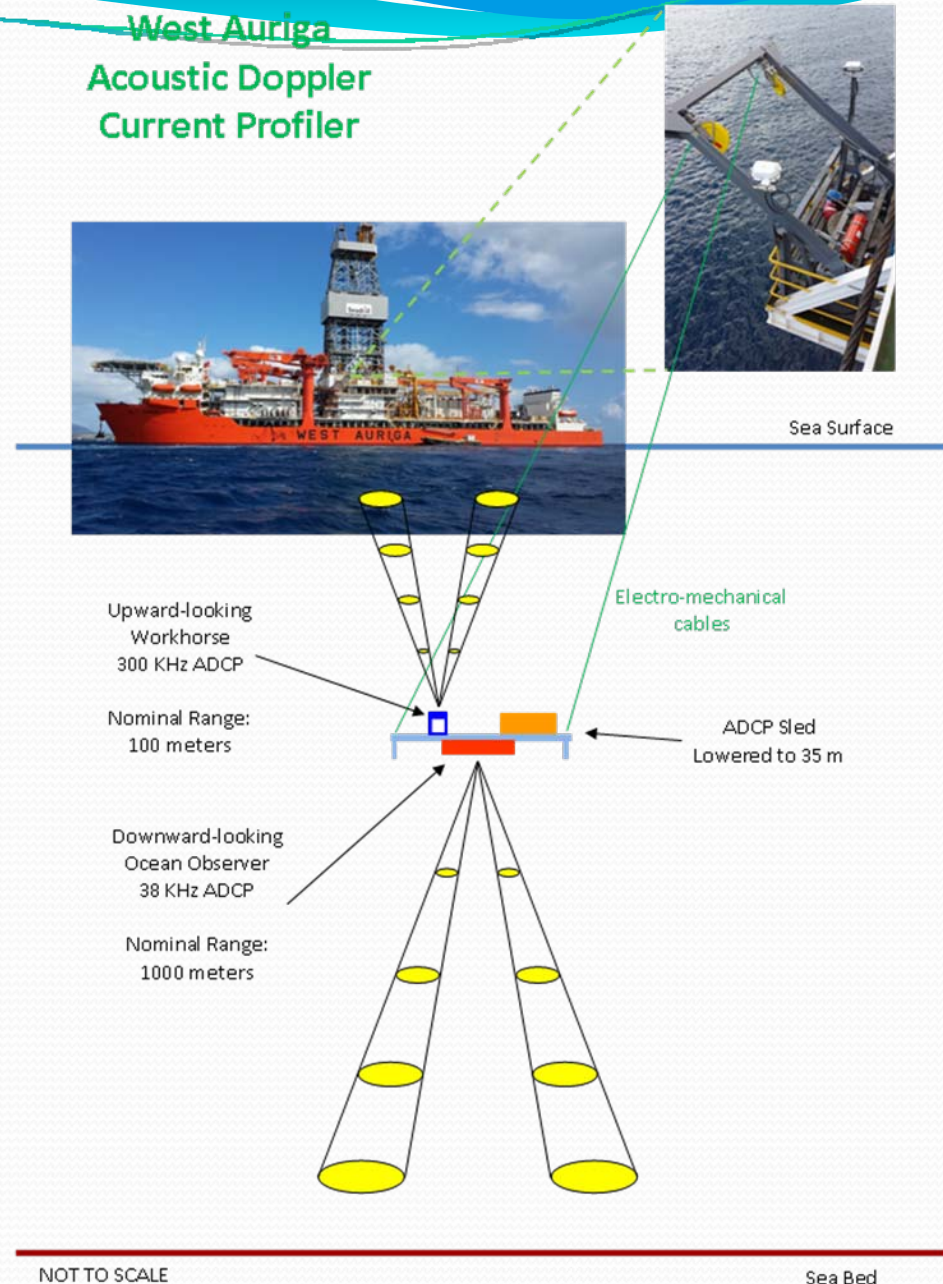


Woods Hole Group Innovations



WHG ADCP Gantry System

- Acoustic Doppler Current Profilers (ADCPs)
- Instrument sled suspended from a gantry
- Upward looking 300kHz ADCP and downward looking 38kHz ADCP make the measurement
- A networked PC delivers the data in near real-time



Level winds and a new cable



Our own winch design – roller and helical drum



Fabrication Complete



Helix Q5000 Semi-Submersible



Installation



CCTV Display

Rig and Site Information

Helix Q5000

Block: MC 777

Well: #4

Heading: 167° True

NDBC ID: 42901

28° 13' 36.768" N

Depth 5625 ft

88° 29' 53.628" W

20-Minute Velocity Profile Start Time (UTC)

2016/04/11 15:00

Selected Near-Surface Velocities

Depth [feet]	Speed [knots]	Dir [deg T]
40	0.5	177
50	0.4	165
60	0.2	185
70	0.2	294
80	NaN	NaN
90	0.7	200
100	0.6	232

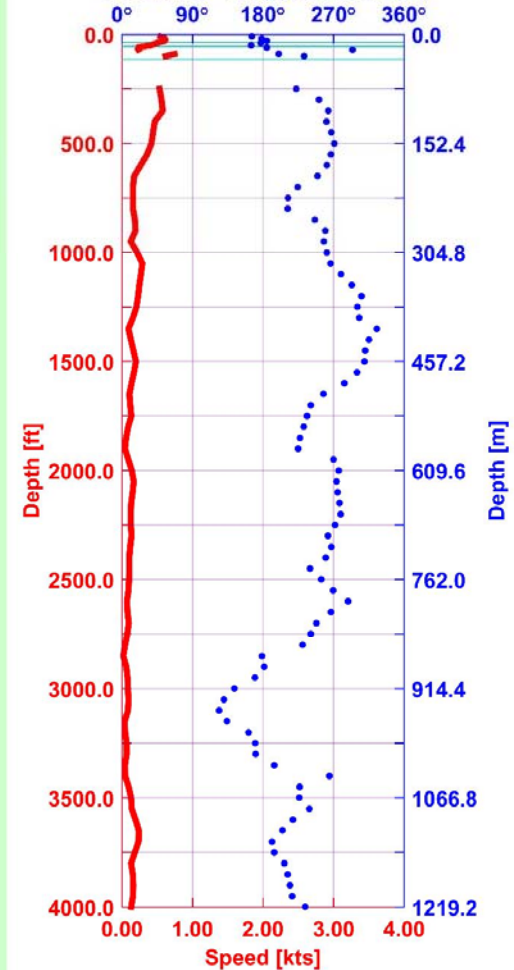
Selected Deep Water Velocities

Depth [feet]	Speed [knots]	Dir [deg T]
250	0.5	222
500	0.4	271
1000	0.2	261
1500	0.2	310
2000	0.1	277
2500	0.1	254
3000	0.1	143

Composite Velocity Profile

2016/04/11 15:00 (UTC)

Direction [° True] (flow towards)




Control Panel and

Speed and Direction Display

MARvelPlot

ADCP Data Display Operation

StopUpdateQuit



Woods Hole Group, Inc.
www.woodsholegroup.com
508-540-8080

Rig and Site Information

Helix Q5000

Block: MC 777

Well: #4

NDBC ID: 42901

Depth: 5625 ftfeet

Date Range for Manual Update

Start Date [YYYY / MM / DD 00 : 00 : 00]

2016 / 04 / 05Set

End Date [YYYY / MM / DD 23 : 59 : 59]

2016 / 04 / 11Set

Plot Span [days from End Date]

7 daysSet

Data Display Properties

Near-Surface Depths

7 70 ft 21.3 m

8 80 ft 24.4 m

9 90 ft 27.4 m

10 100 ft 30.5 m

Speed Limit Selection

3 kts 1.5 m/s

4 kts 2.0 m/s

Deep Water Depths

56 2800 ft 853.4 m

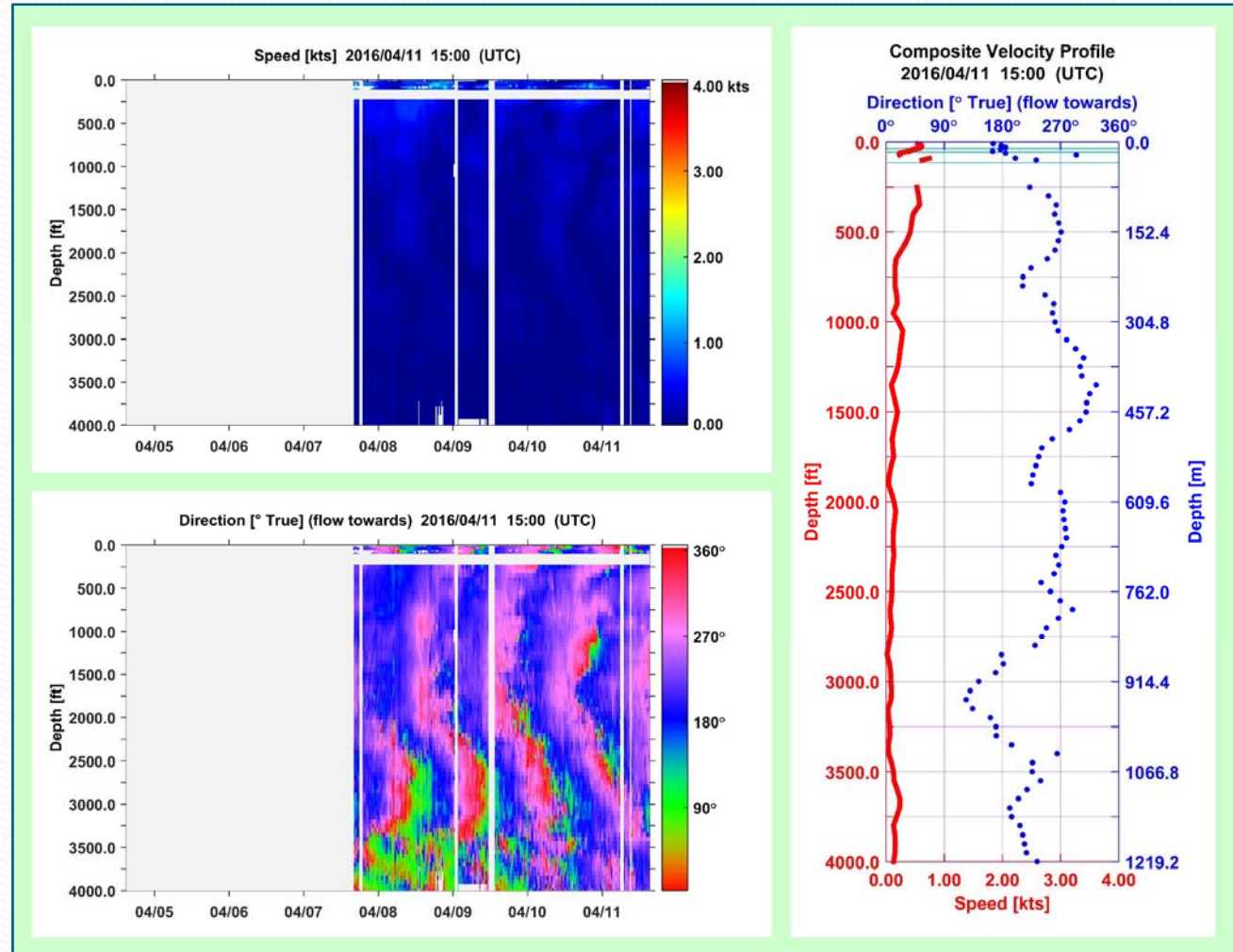
57 2850 ft 868.7 m

58 2900 ft 883.9 m

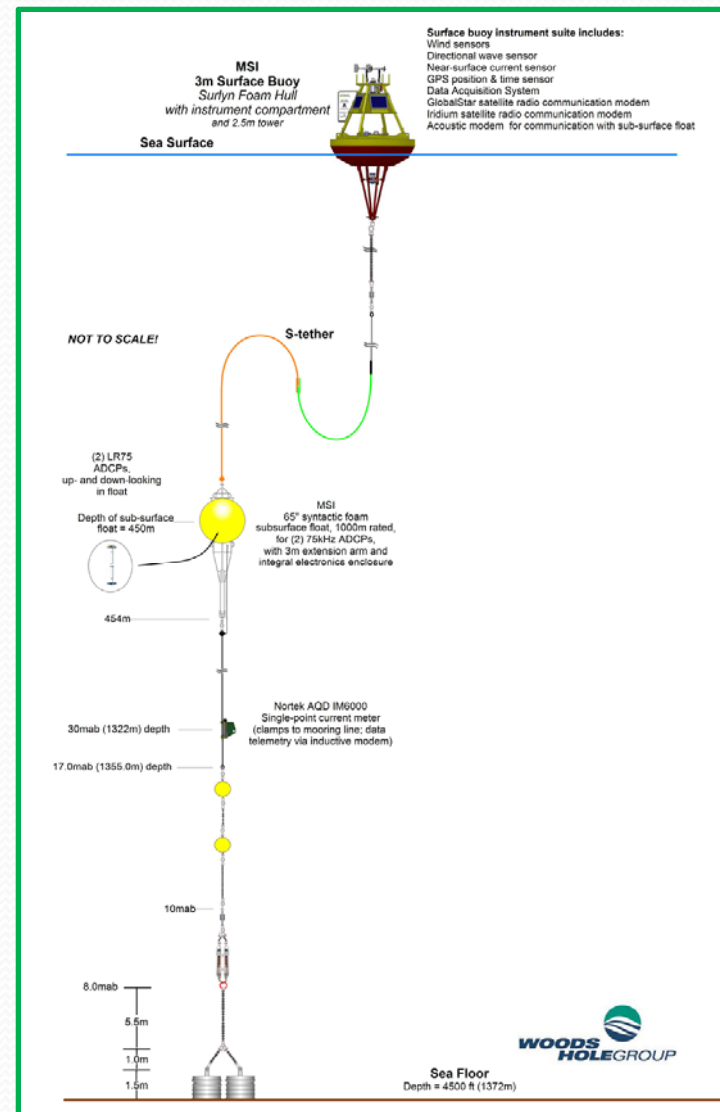
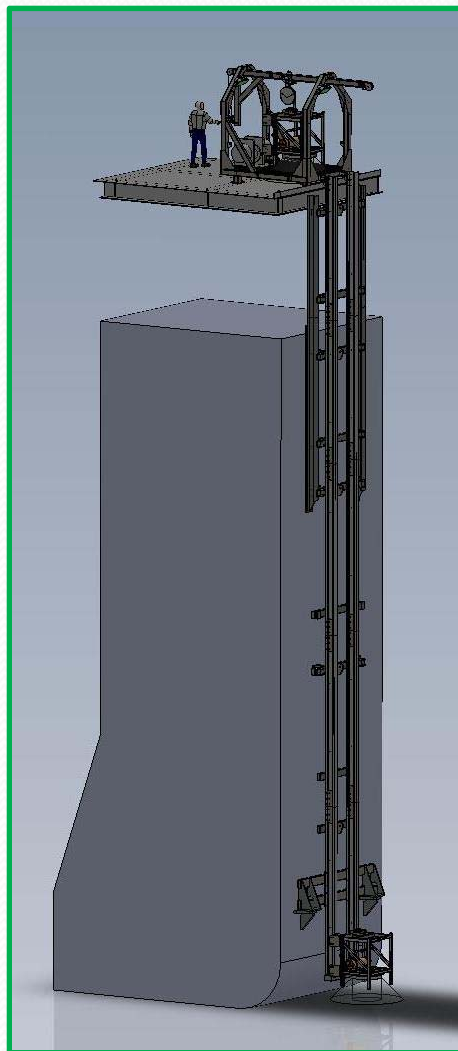
59 2950 ft 899.2 m

60 3000 ft 914.4 m

knots



Variations on a theme



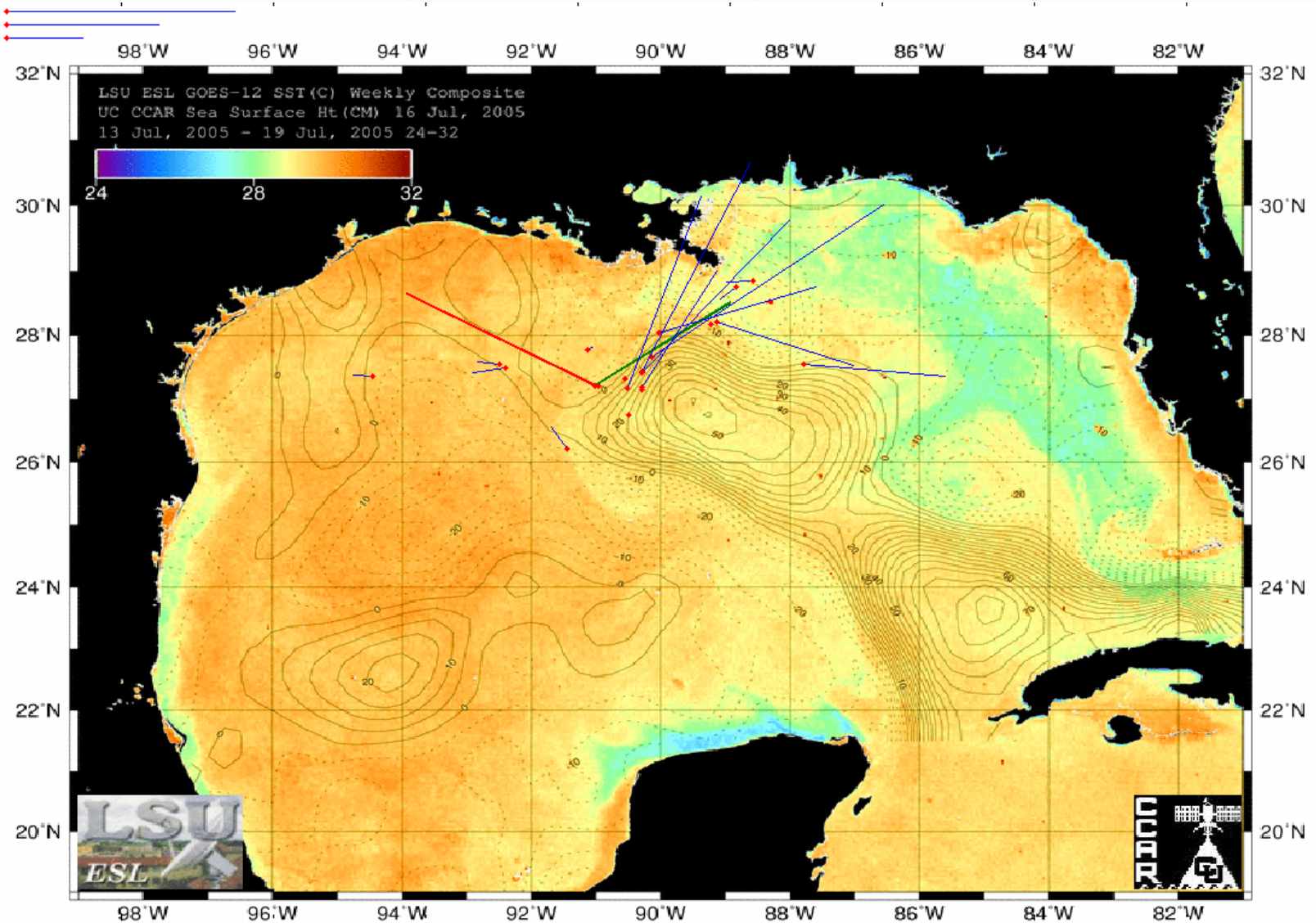
Data Delivery in Near-Real-Time

- Secure network or satellite connection
 - FTP to NDBC and WHG
 - Remote access
- Local distribution (CCTV or Website)
 - Graphics and text
 - Data export
 - Invaluable during operations
 - They don't want it and they cannot live without it
- Position and heading from navigation system or integrated GPS and compass

Success?

- In 2010, DeepStar commissioned a study of the first 5 years of the program
- We developed software tools, developed a database, and worked on the project for about a year
- We discovered that a substantial portion of the NTL database was compromised by metadata errors:
 - Incorrect latitude and longitude
 - Incorrect ADCP beam orientation
 - Instruments left in the water during rig moves
 - And more . . .

Incorrect ADCP Beam Orientation



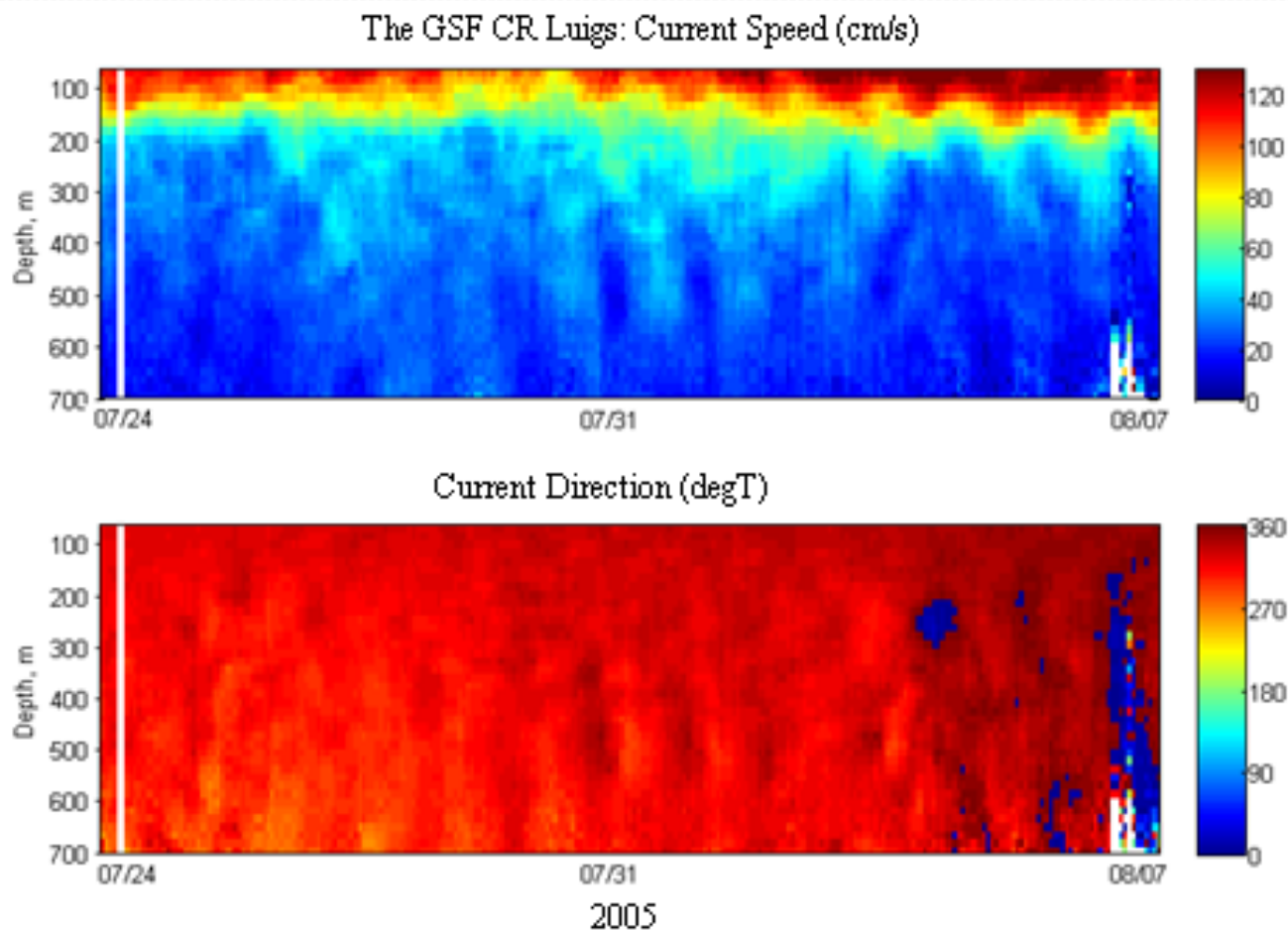
Despite these problems . . .

- 151 site-years of good data in the first 5 years of the program (2006 to 2010)
- Reason to believe there are in-excess of 300 site-years of good data now (2017)
- The data are publically available from NDBC
 - <http://www.ndbc.noaa.gov>
- The data contribute to our understanding of how the GoM works and can be used to support
 - Safer operations and more robust vessel designs
 - Research, shipping, fishing, extraction, recreation
 - Search and rescue
 - Spill and severe weather response

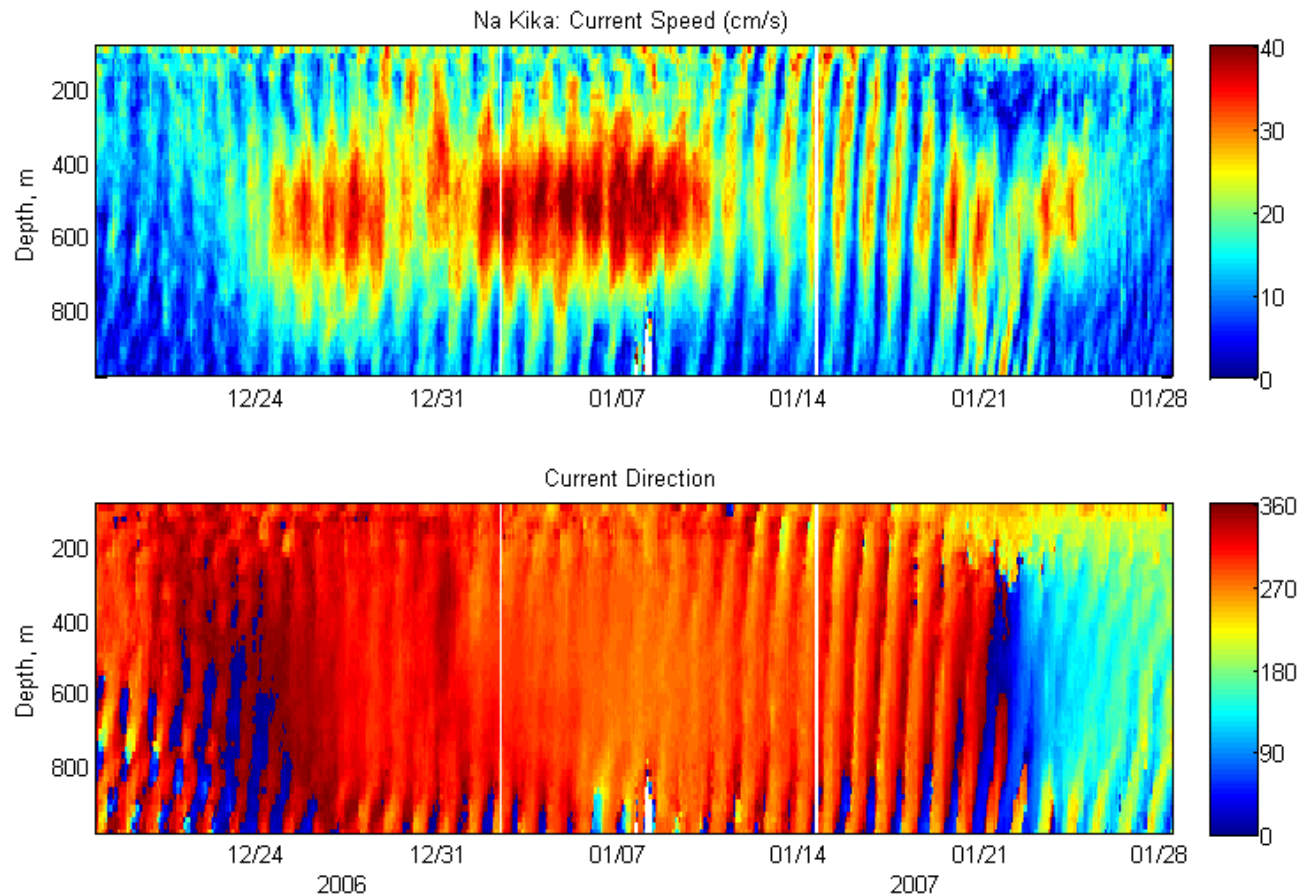
And . . .

- We found 560 energetic features in the flow that were not expected
 - Strong near-surface currents with high velocity shears in subsurface layers (100m – 200m) – 290 events
 - Mid-water “jets” with no surface signature – 88 events
 - Strong inertial oscillations at mid depths (~500m) – 60 events
 - Strong inertial oscillations near the surface – 28 events
 - “Slab” (vertically homogeneous) flows in wide layers (100s of meters vertically) – 60 events

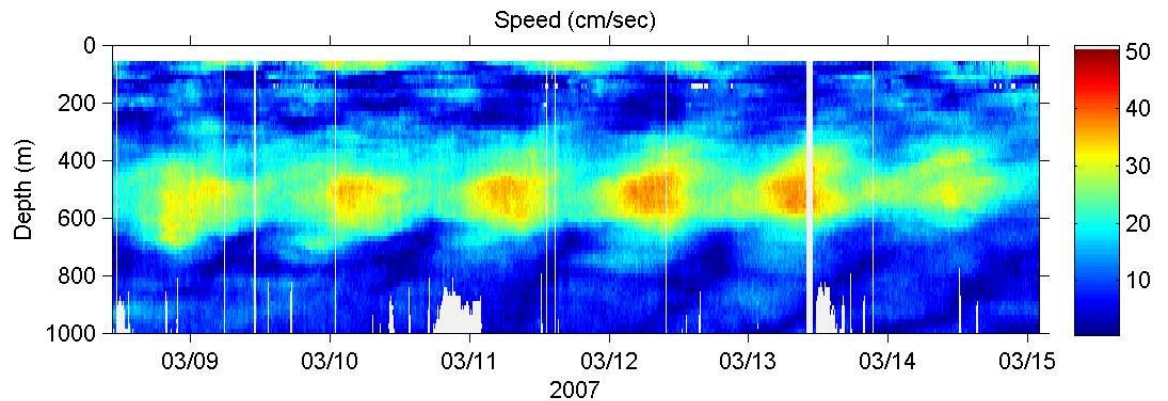
Strong near-surface currents with high velocity shear



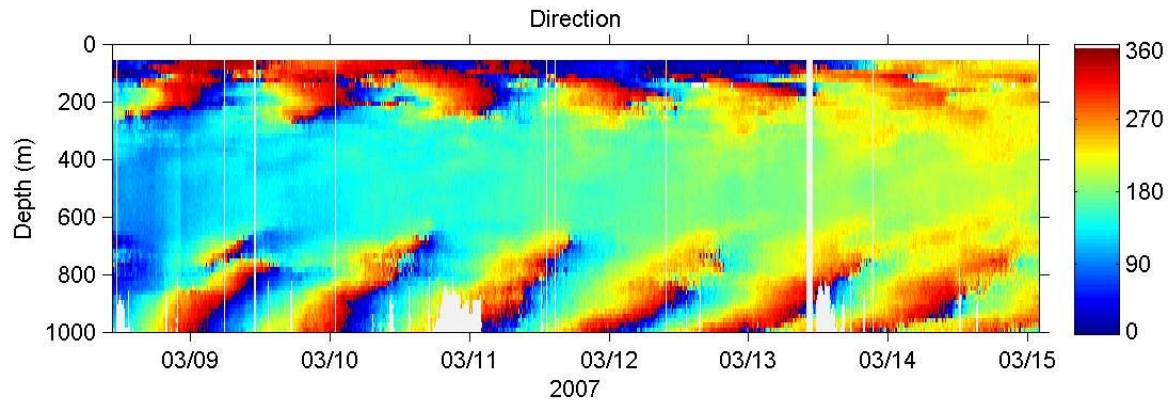
Mid-water jets with no surface signature



Strong inertial oscillations at mid-depths



From Jim Thompson-2828-8865-070102-070328-42862-00





There's no substitute for making a measurement . . .

The most exciting phrase
in science:

“That's funny . . .”

Questions?

