


Deepwater Horizon Oil Spill Principal Investigator One Year Update Workshop

Wave Glider – Monitoring the Gulf of Mexico

Graham Hine
Senior Vice President of Operations

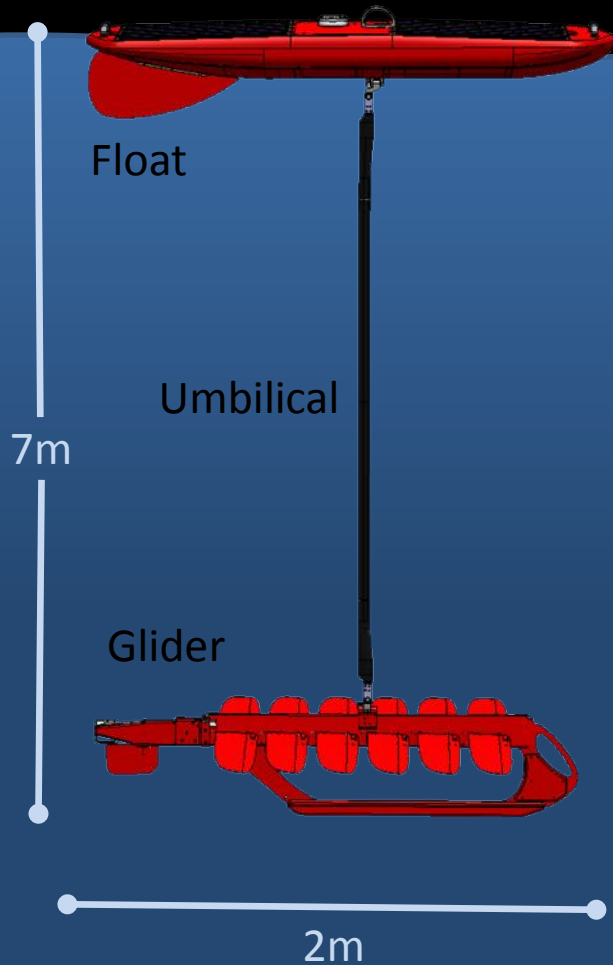
Liquid Robotics, Inc.

25 October, 2011

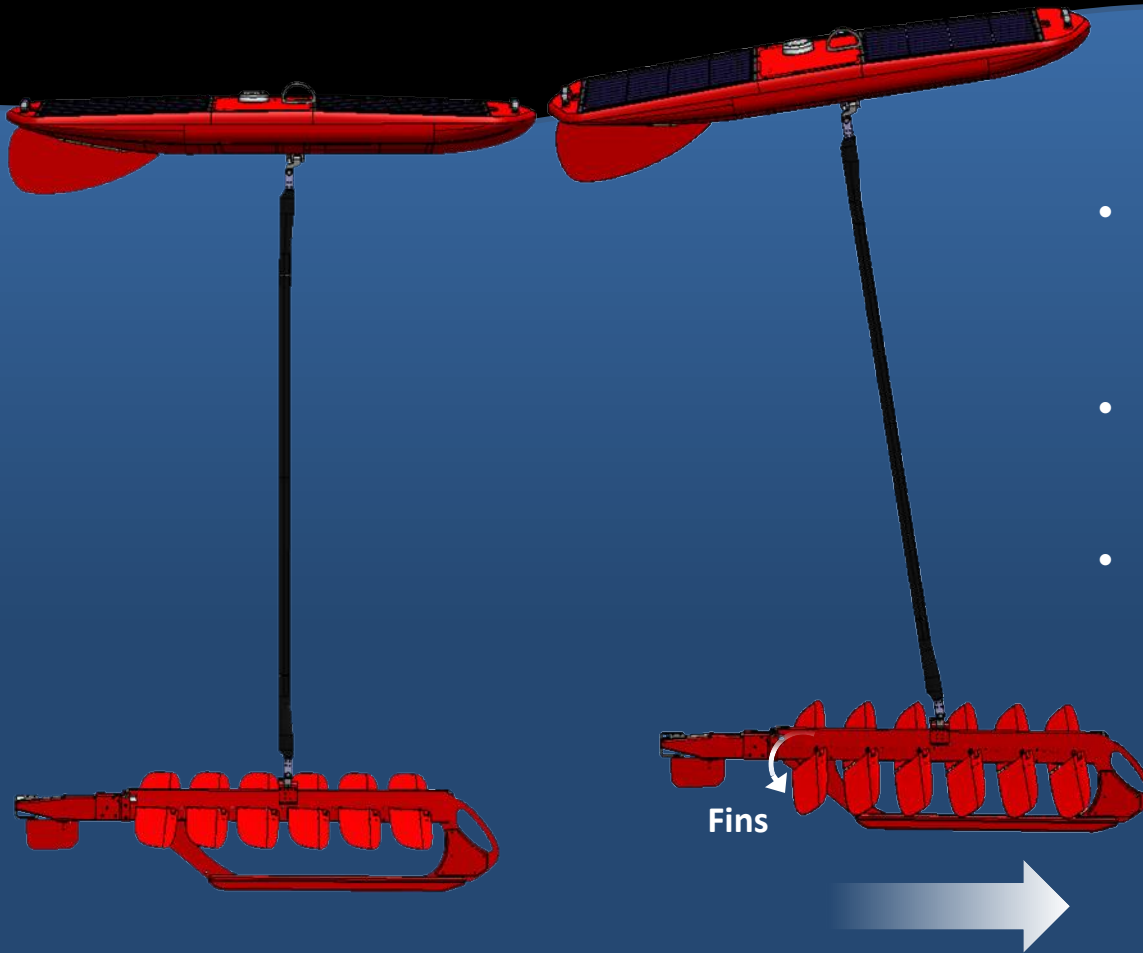
 Macondo Wellhead

Wave Gliders Launched under BP Direction

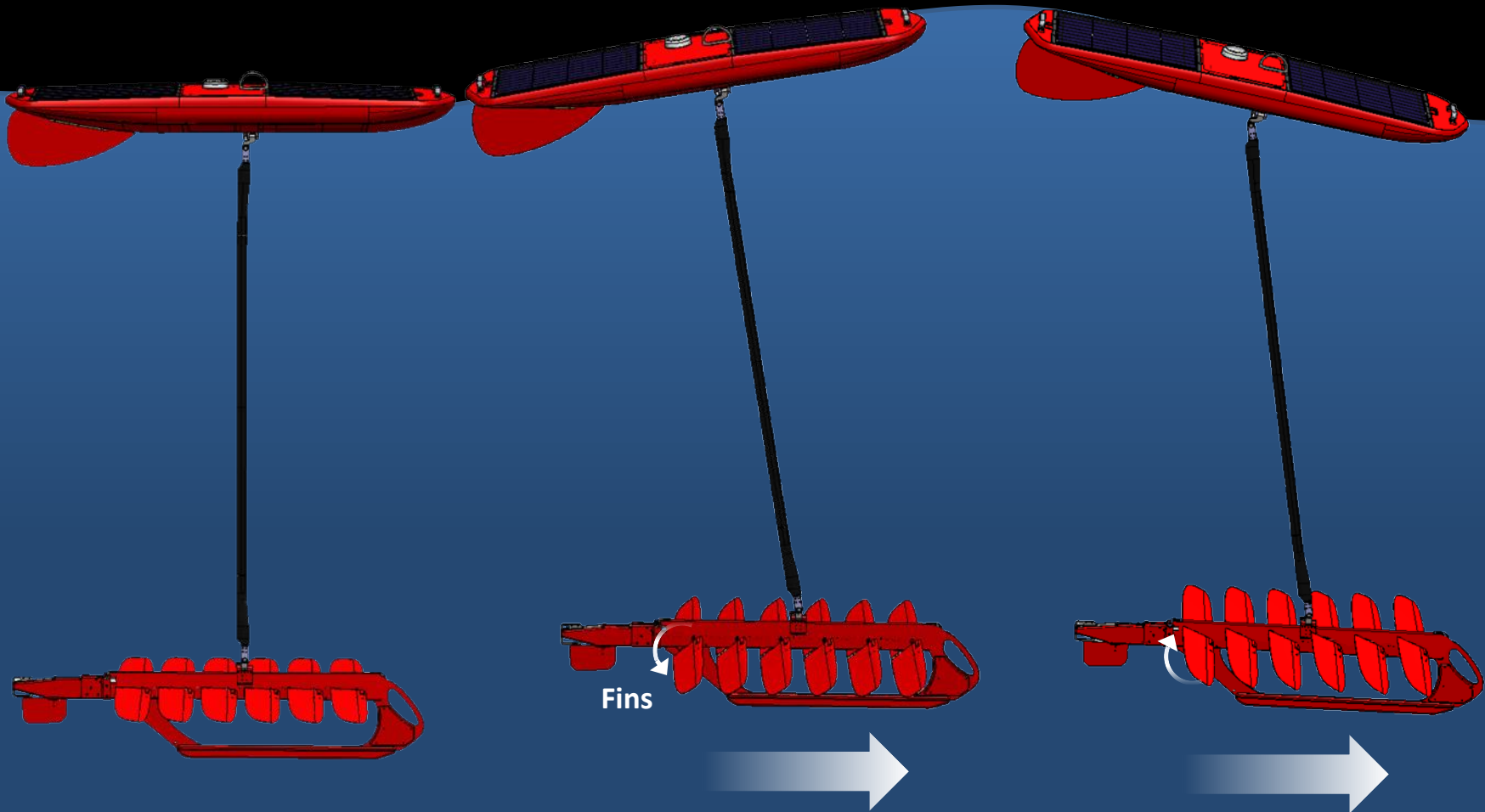




Separation between surface float and subsea glider harvests wave energy and transforms it into forward thrust



- A passing wave lifts the float and pulls the glider upward
- Passive fins on the glider are pushed downward
- As the glider moves up, the fins generate thrust to pull the vehicle forward



- Both upward and downward motions produce thrust
- A rudder at the tail of the glider steers the vehicle in any direction

2010 Gulf of Mexico Wave Glider Operations

Technology Capability Review

Activity: 10 Sept 2011 – 14 Nov 2011

Goals:

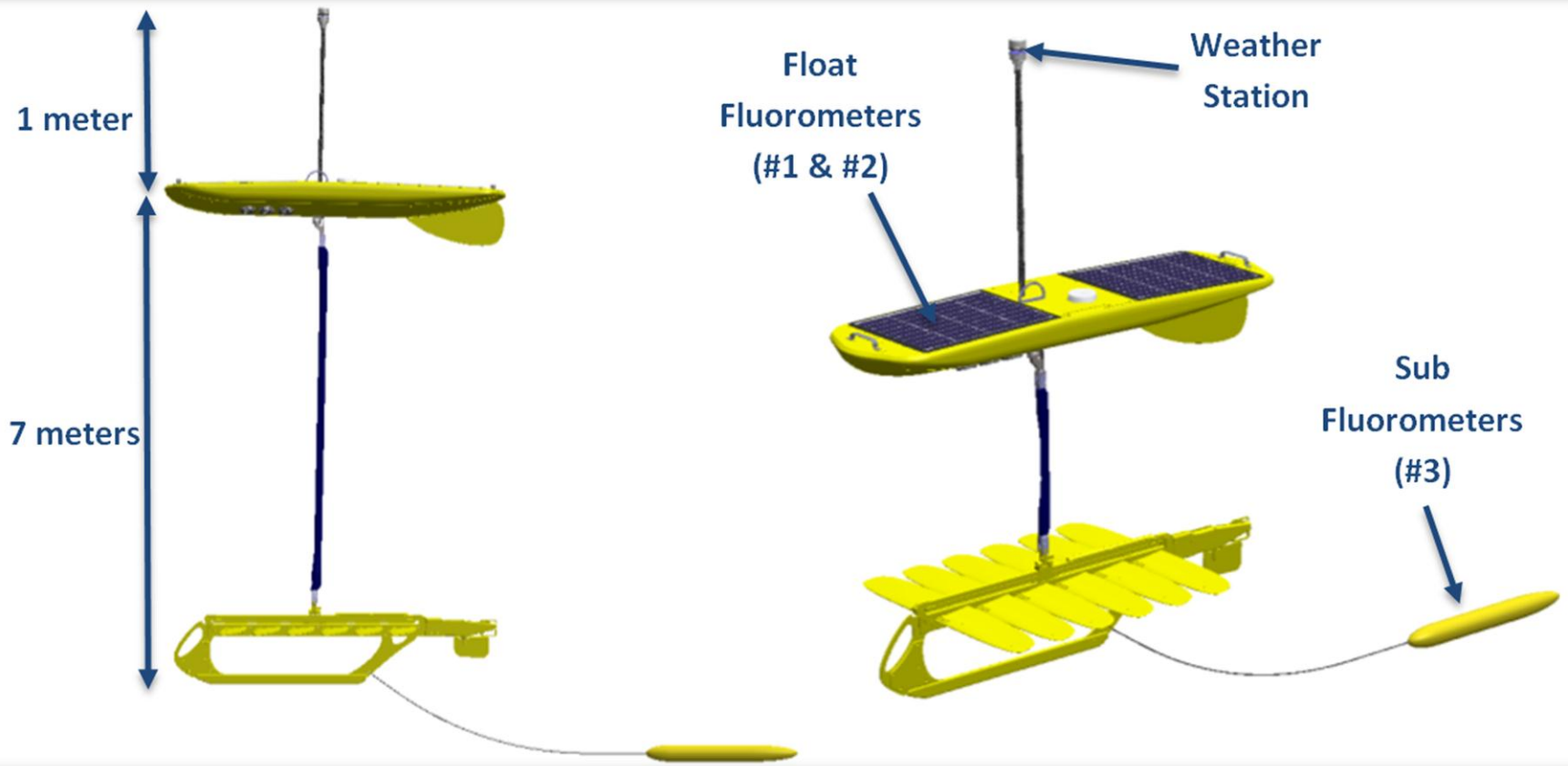
- Evaluate platform as a potential long-term monitor
- Test integrated Turner C3 fluorometer configuration as a hydrocarbon detector
- Additionally deliver MET data

Results:

- Mixed
- Platform and sensor anomalies occurred, but several weeks of good collections were obtained.

Macondo Well

2010 Wave Glider Layout



Sensor Configuration

Sensor	Measurement	Sensor Location	Sample Rate	Telemetry Rate
Weather Station	Air Temp	1 m	1 Hz	15 min
	Barometric Press	1 m	1 Hz	15 min
	Wind Speed & Dir	1 m	1 Hz	15 min
C3 Fluorometer 1	Refined Fuels	0 m	1 min	7min
	CDOM	0 m	1 min	7min
	Turbidity	0 m	1 min	7min
	Water Temp	0 m	1 min	7min
C3 Fluorometer 2	Refined Fuels	0 m	1 min	7min
	Crude Oil	0 m	1 min	7min
	Chlorophyll A	0 m	1 min	7min
	Water Temp	0 m	1 min	7min
C3 Fluorometer 3	Refined Fuels	7 m depth	1 min	7min
	CDOM	7 m depth	1 min	7min
	Turbidity	7 m depth	1 min	7min
	Water Temp	7 m depth	1 min	7min

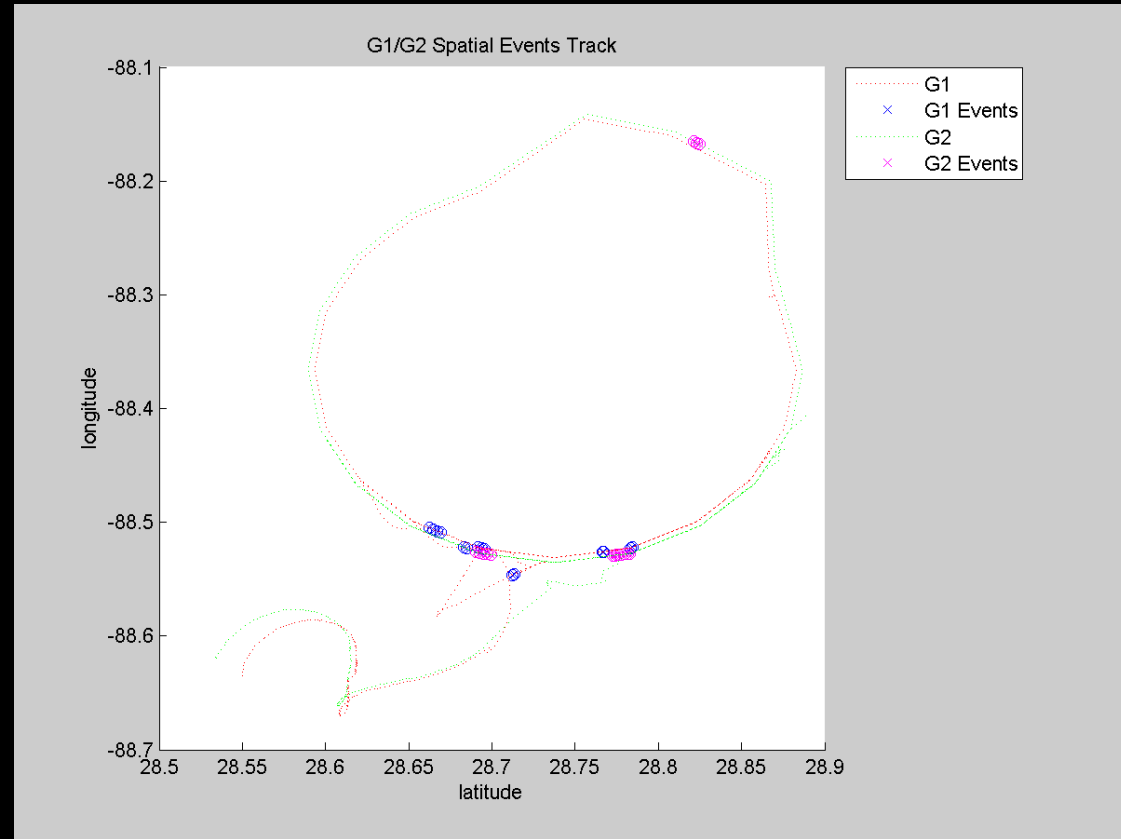


Hydrocarbon Event Detection

Analysis performed by
Fraser Dalglish, Ph.D.

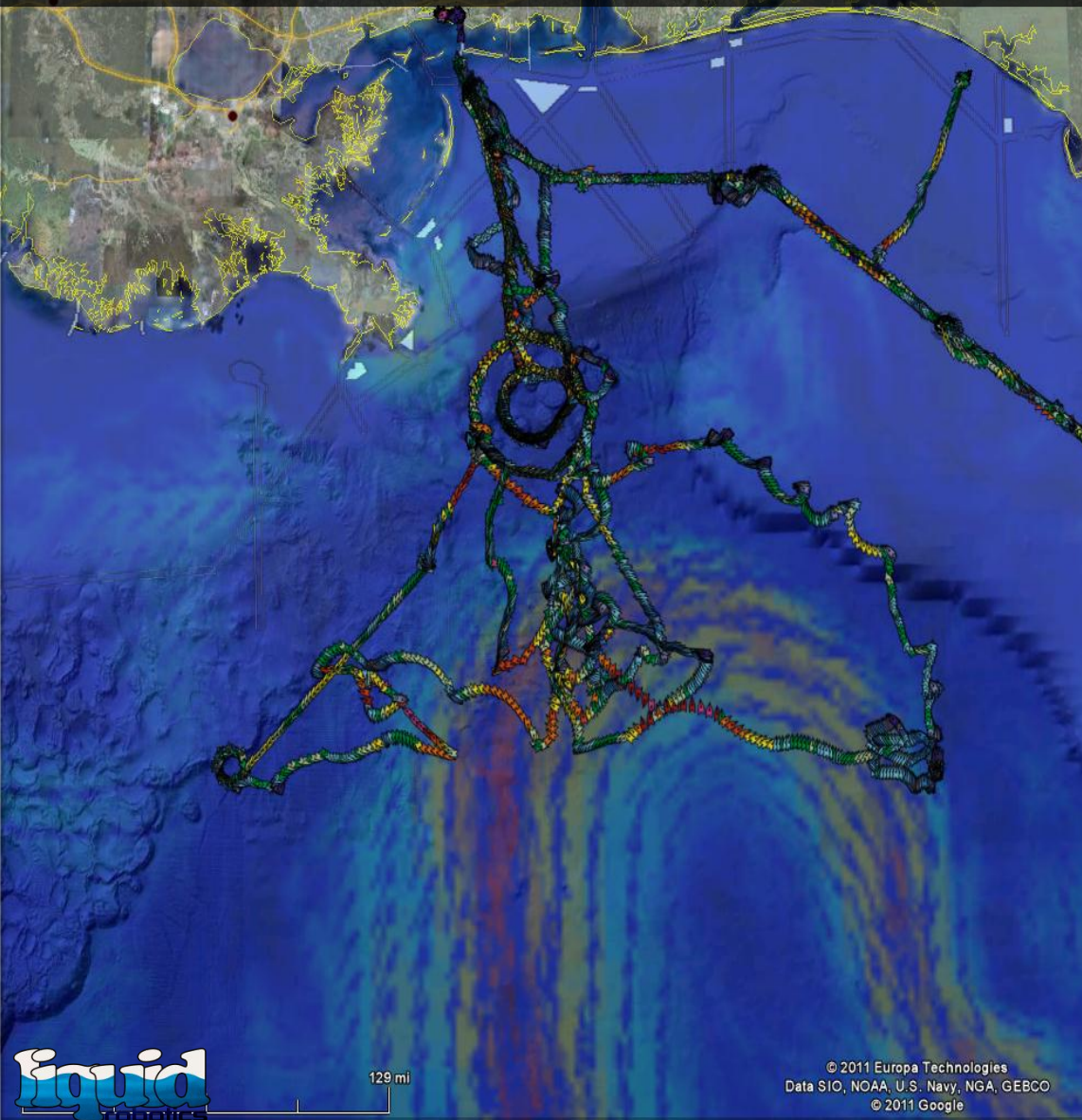
Event detection method attempts to eliminate sensor anomalies and use correlation between sensor channels to identify probable hydrocarbon events.

2011 – transitioned to a real-time analysis tool capable of notifying shore personnel. Algorithm developed by Fraser Dalglish and Bing Ouyang.



2011 Gulf of Mexico Wave Glider Operations

High-Resolution, Long Term Data



Additional missions and incremental improvements:

- ADCP Current Measurements
- Passive Acoustics
- Pre- and post-mission instrument calibration

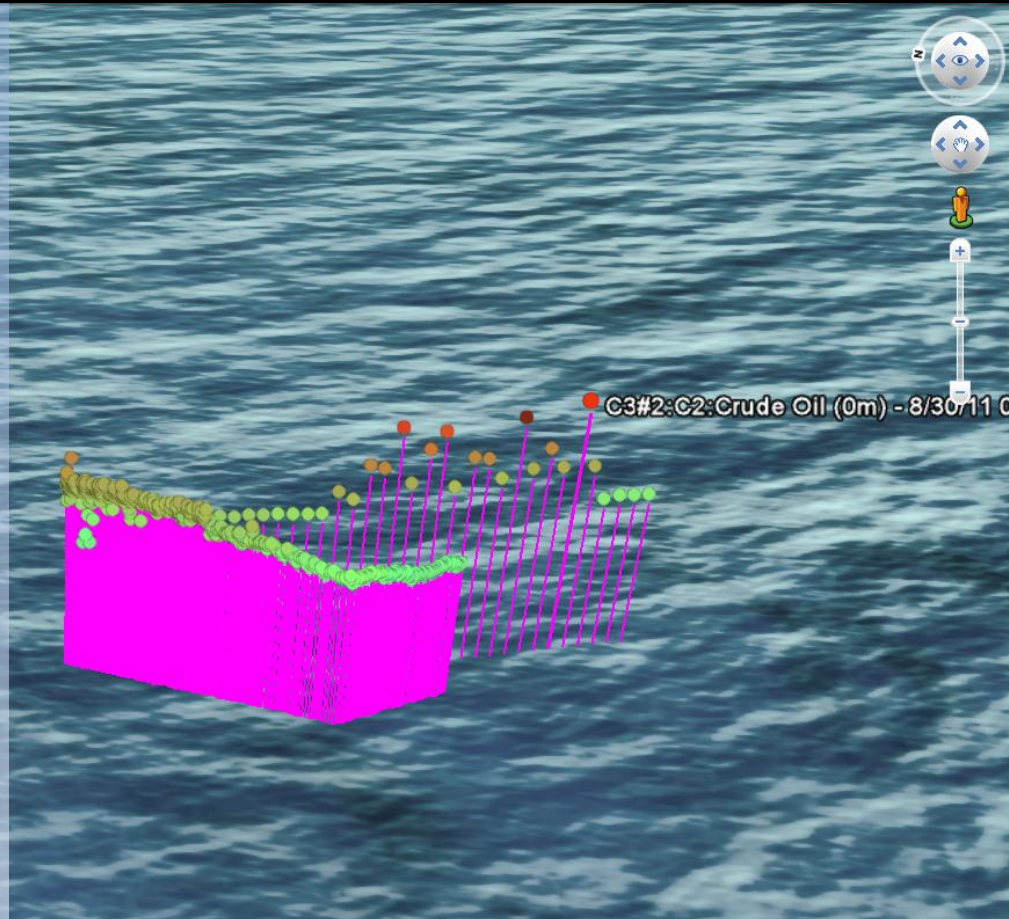
- Six 60-day sorties with 4 vehicles

8,669	Nautical Miles Traveled
2,109,649	Fluorometry Points
132,930	Weather Points
78,759	Ocean Current Points
2,570 GB	Acoustic Recording

Ongoing

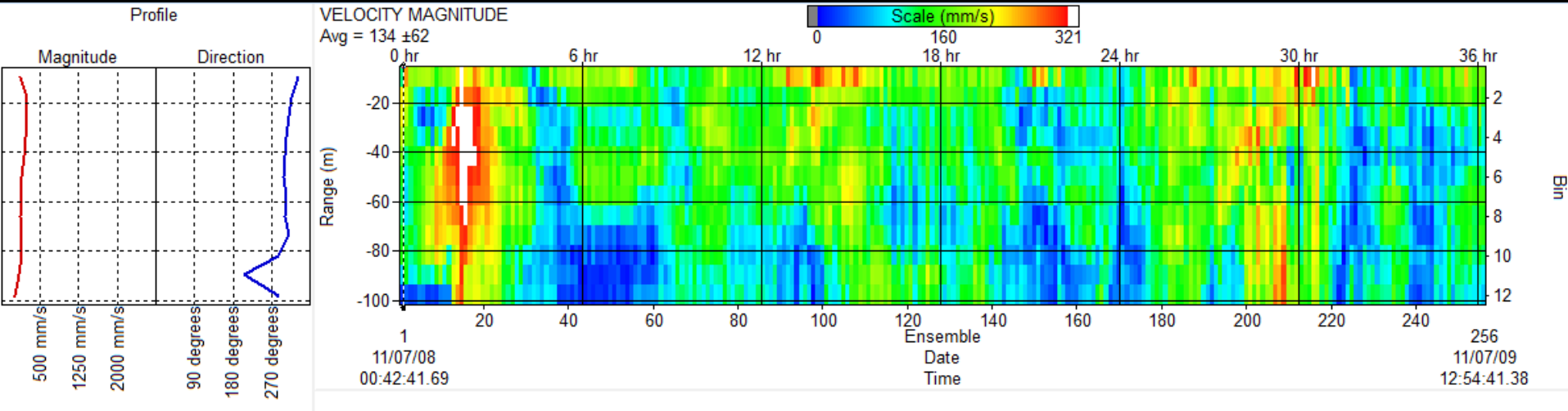
2011 Gulf of Mexico Surface Water Quality

- Primarily a fluorometry mission
- Float (0 meters):
 - Refined Oil (x 2), CDOM, Turbidity, Crude Oil, Chlorophyll-A
- Towfish (~12 meters)
 - Refined Oil, CDOM, Turbidity
- Automatic Event Detection
 - Fraser Dagleish, Bing Ouyang HBOI/FAU.

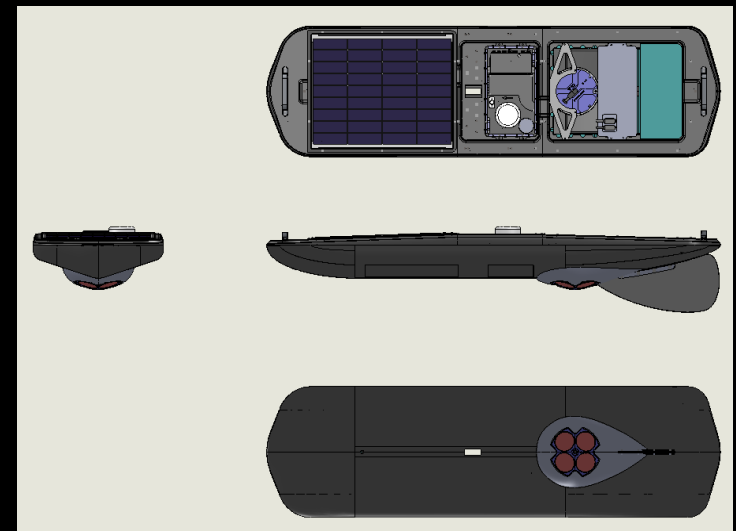


From: <Bing>
To: <List>
Date: Fri, 16 Sep 2011 14:27:16 -1000
Subject: LRI vehicle event notification
(lat: 28.126, lon: -89.129), vehicle: G5, sensor: c32 at: 16-Sep-2011 20:26:36
detail info: crude: current:90.64
chlor: current:22.84

Loop Current Edge Feature Measurement

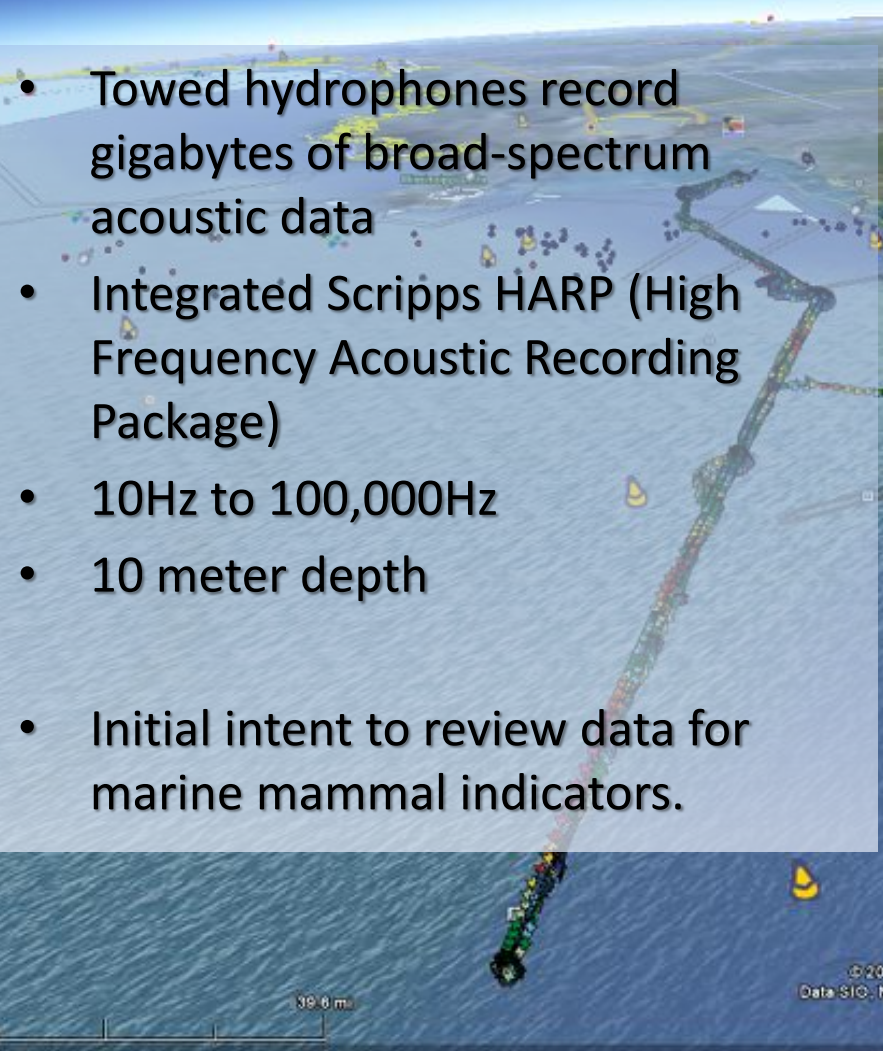
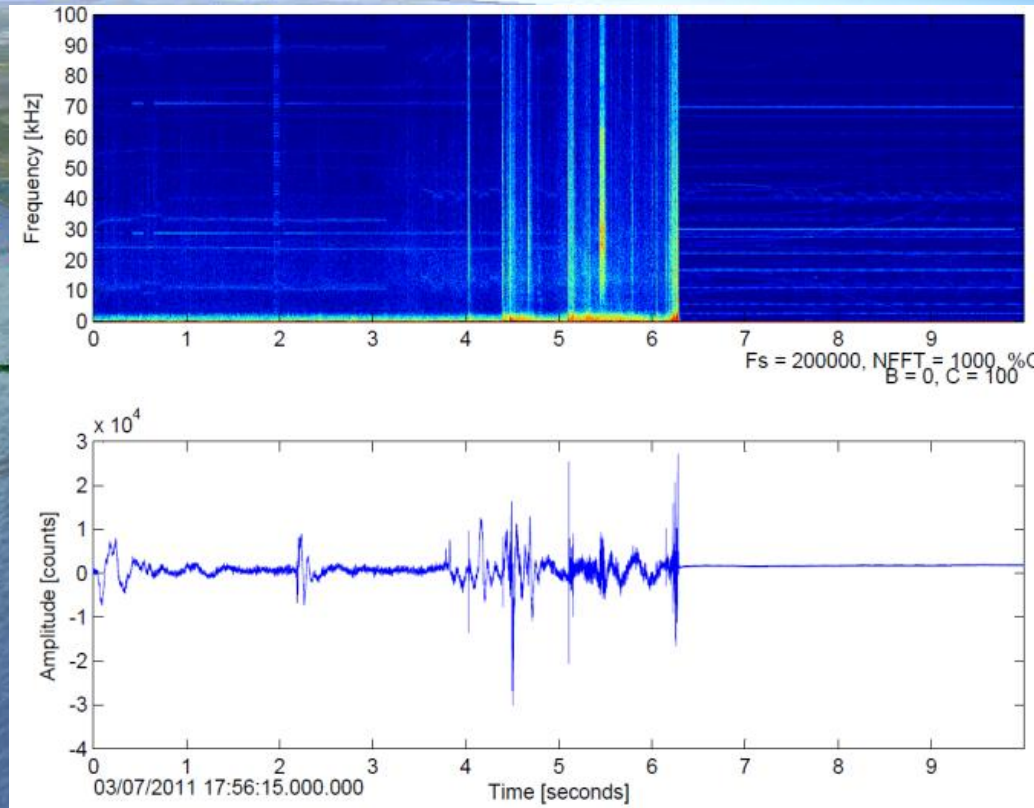


- Teledyne Benthos WHM300 ADCP
- Depths to ~100meters
- Careful piloting
 - Head into suspected current front until ~1.5 knot currents detected.
 - Back out with fixed heading 90 degrees to the current
 - Dive back in.



Passive Acoustics

- Towed hydrophones record gigabytes of broad-spectrum acoustic data
- Integrated Scripps HARP (High Frequency Acoustic Recording Package)
- 10Hz to 100,000Hz
- 10 meter depth
- Initial intent to review data for marine mammal indicators.



Postcard from a Wave Glider - Iridium

Down-looking images collected by Wave Glider.

Primarily an engineering tool, but potentially useful for selective sampling.



Gulf of Mexico, March 2011





Wave Glider™

Autonomous Ocean Vehicle

- *Persistent*
 - Year long missions without fuel or maintenance
- *Mobile*
 - Travel to op area, patrol, and return for maintenance.
 - Capture spatial and temporal dynamics.
- *In-Situ*
 - Direct measurements at ocean surface.



PACX GRAND CHALLENGE

Unprecedented Journey of marine robots across the Pacific

***4 Wave Gliders, 300 Days, 25,000 miles 2,250,000 discrete data pts.
Available in real time***

The Route, The Data

- ***Hawaii – Japan & Australia***
- ***Sensors:***
 - *Seabird BPCTD w/Dissolved Oxygen Sensor*
 - *Datawell MOSE-G Directional Wave Sensor*
 - *Airmar PB200 WeatherStation*
 - *Turner Designs C3 Submersible Fluorometer*
- ***Continuous Data Services open to Scientists Worldwide***



The Contest, The Reward

- ***Scientific challenge for ocean exploration & discovery***
- ***Judged by a distinguished science board***
- ***Award – 6 months of Wave Glider data services***
- ***Wave Glider configured & routed your way***
- ***Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, The Monterey Naval Post Graduate School***