Using an Autonomous Underwater Vehicle to Map and Sample a Subsurface Oil Plume in the 2010 Gulf of Mexico Oil Spill

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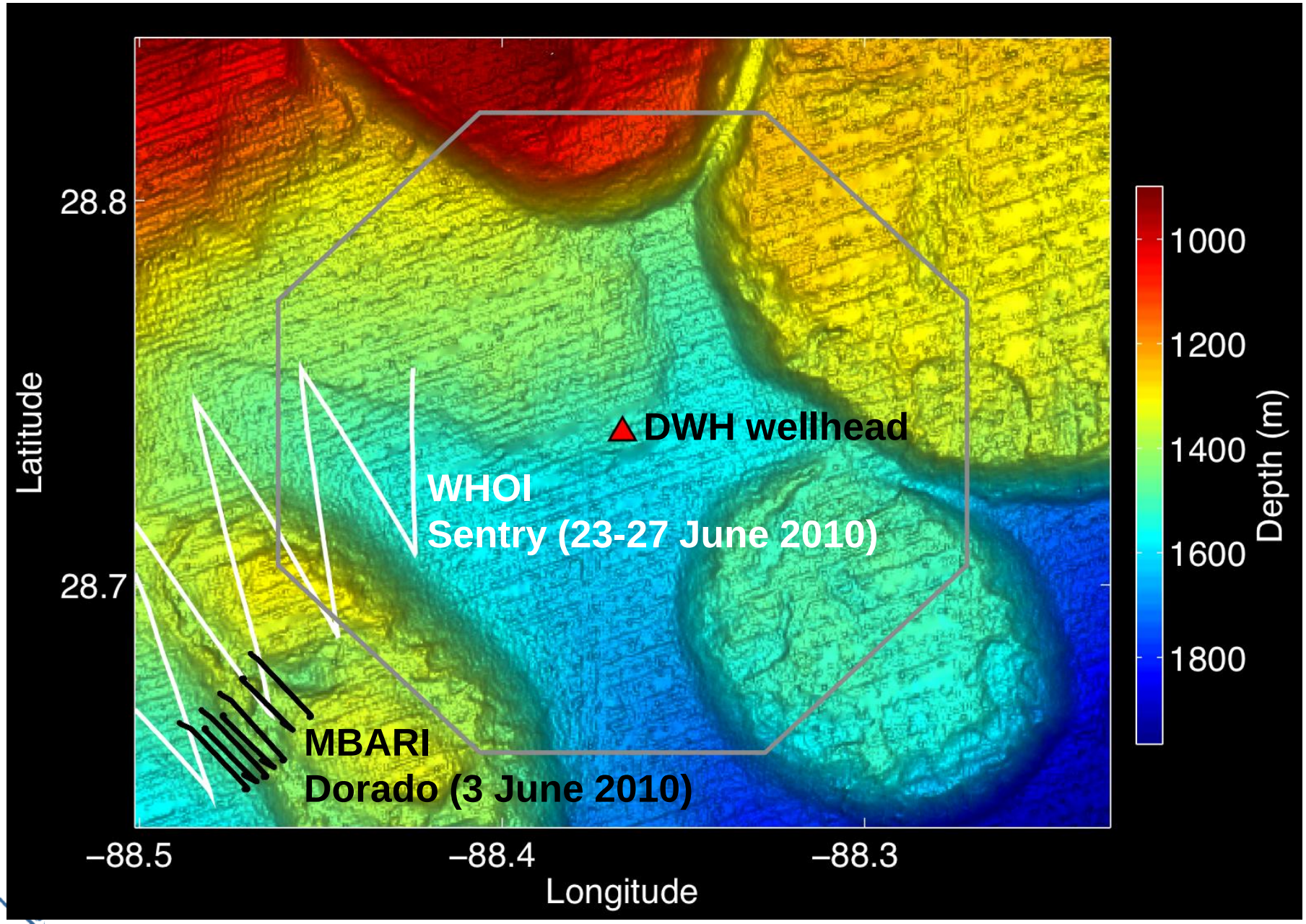
April 2011

Outline

- Introduction of MBARI Dorado AUV with 10 water samplers (gulpers) .
- Dorado AUV's deployment at 13 km to the southwest of the Deepwater Horizon wellhead for making high-resolution surveys and acquiring water samples in a suspected subsurface oil plume.
- A peak-detection algorithm for the AUV's gulpers to capture water samples with peak hydrocarbon signals in the subsurface oil plume.
- Summary

MBARI Dorado AUV Deployed on NOAA Ship Gordon Gunter Cruise GU-10-02



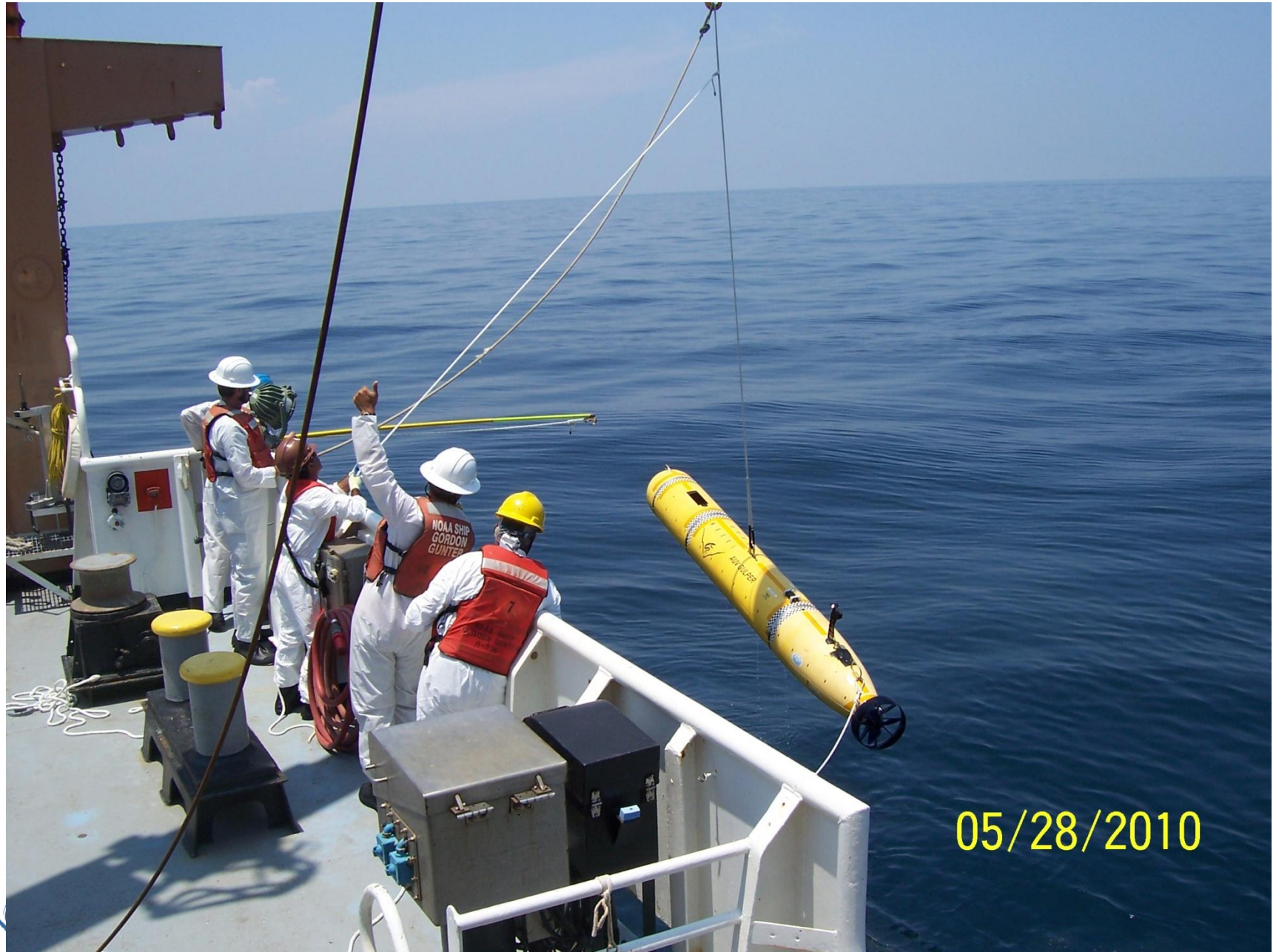
MBARI's Dorado AUV with 10 Gulpers

Dorado AUV's Sensors at the Gulf of Mexico

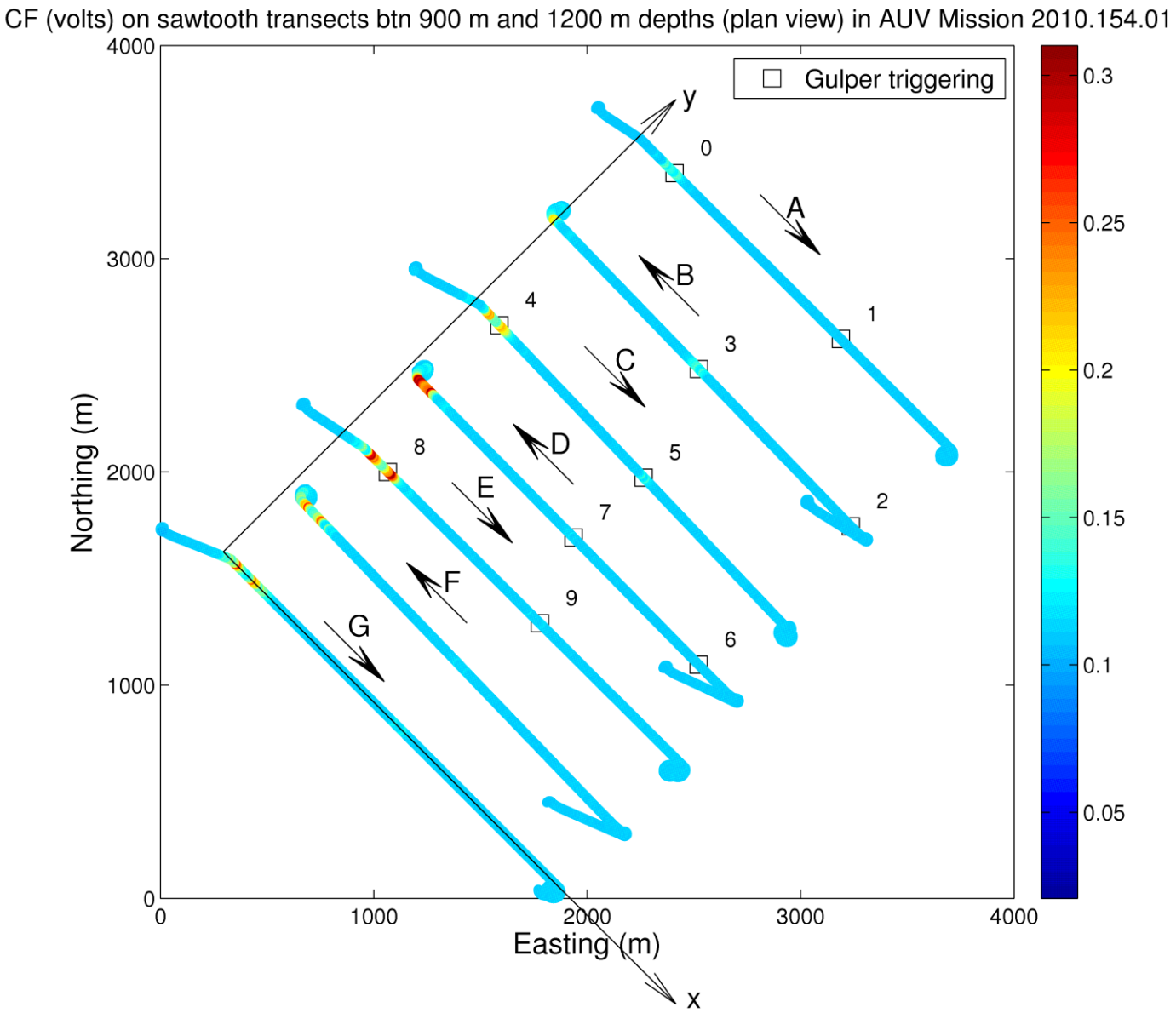
Table 1. Variables measured with sensors on the MBARI AUV

Variables	Sensors
Temperature, Salinity	Dual Sea-Bird Electronics SBE3 temperature and SBE4 conductivity sensors, using SBE25 conductivity, temperature, depth (CTD) board sets
Pressure	Paroscientific Digiquartz 8CB4000-I High Pressure Intelligent Depth Sensor, 0-4000 m range
Density	Derived from temperature, salinity and pressure using the MATLAB seawater analysis toolbox from CSIRO
Dissolved oxygen concentration	Sea-Bird SBE43 oxygen sensor
Colored Dissolved Organic Matter (CDOM) fluorescence	WETLabs ECO-FL CDOM fluorometer 370 nm excitation; 460 nm emission
Optical backscattering at 420 nm	HOBI Labs HydroScat-2
Optical backscattering at 700 nm	HOBI Labs HydroScat-2
Chlorophyll fluorescence at 700 nm (420 nm excitation)	HOBI Labs HydroScat-2

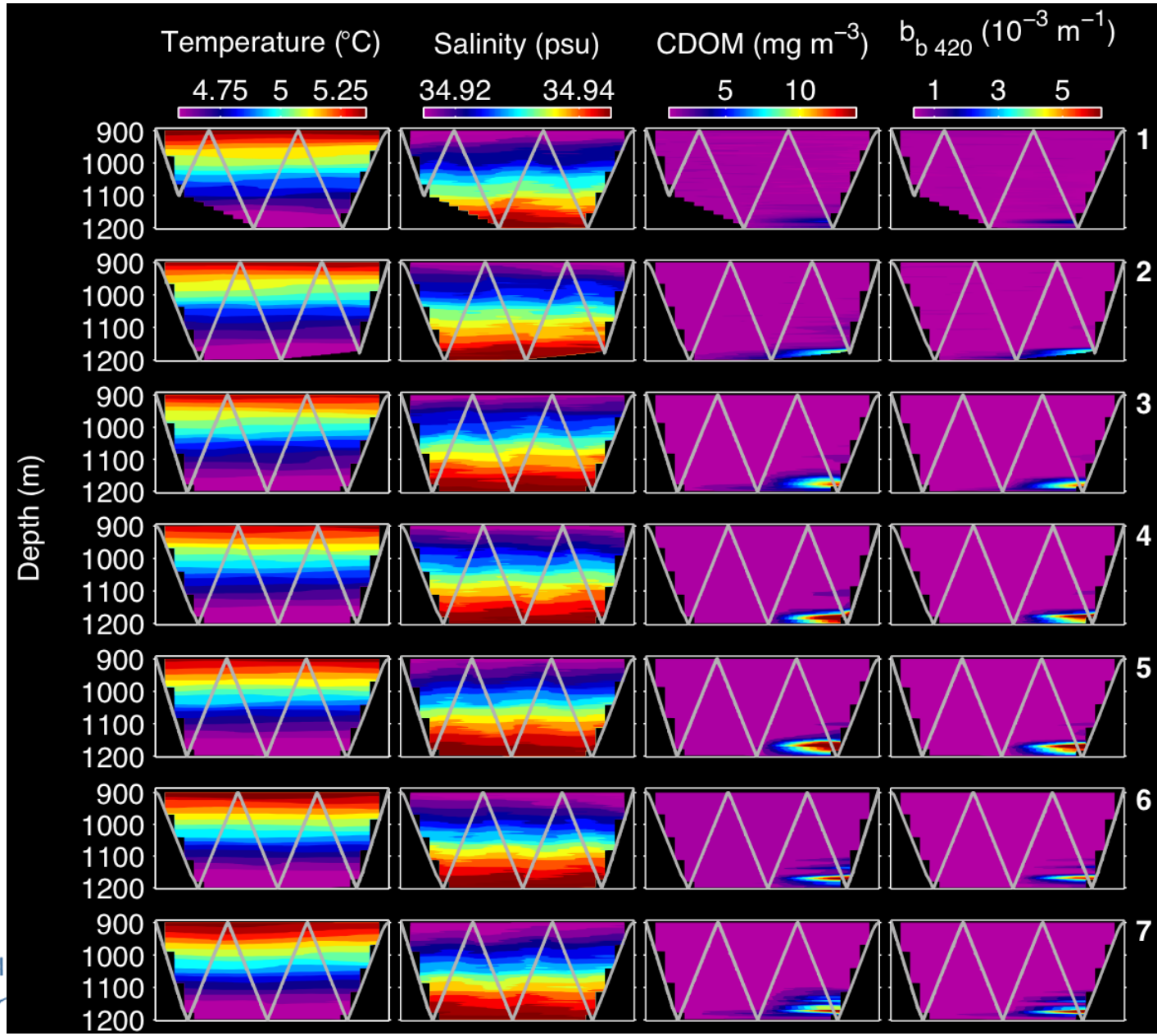
Dorado AUV Launch/Recovery on Ship Gordon Gunter



Dorado AUV Survey Tracks



Subsurface Oil Plume Measured by the AUV



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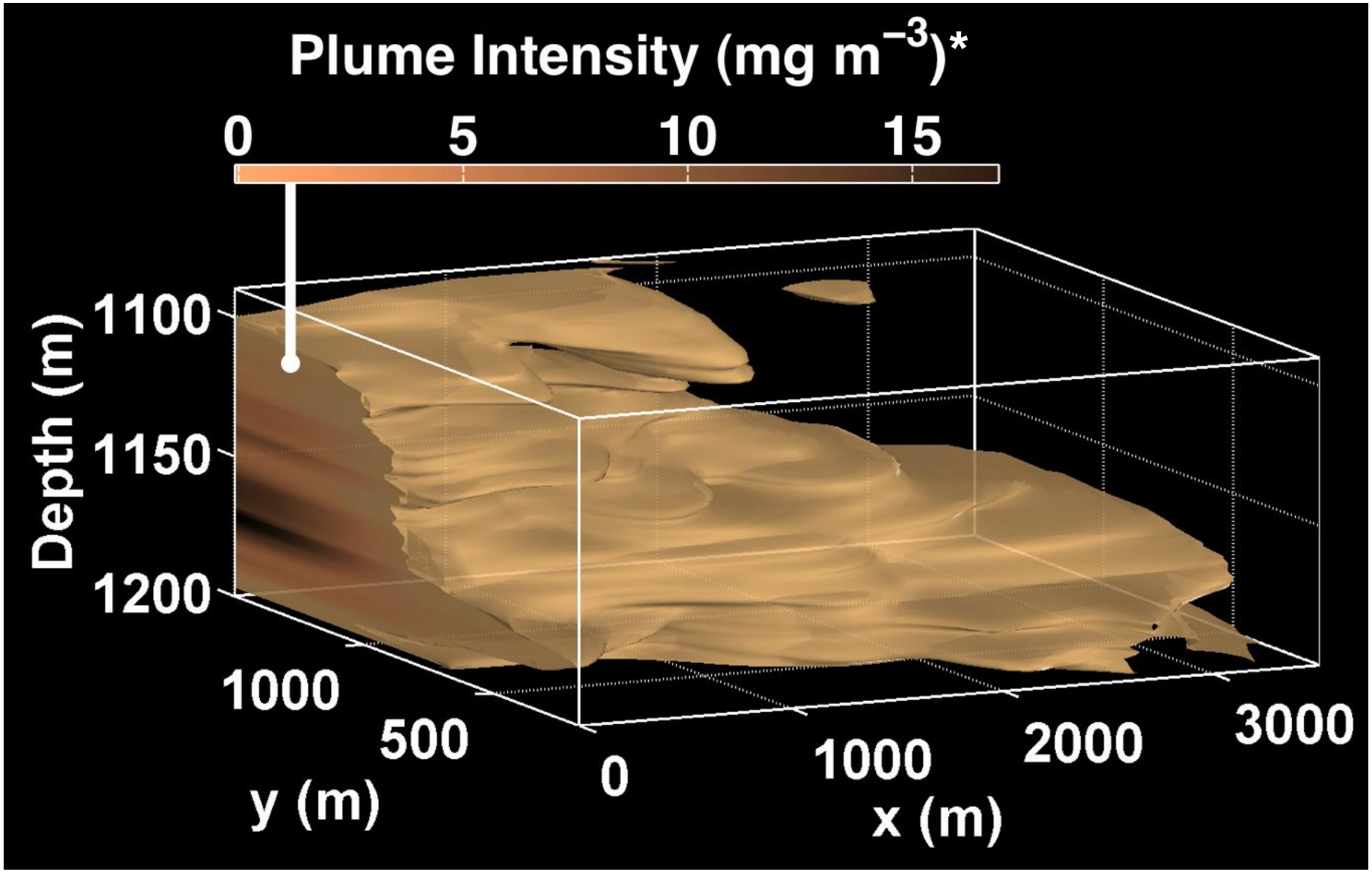
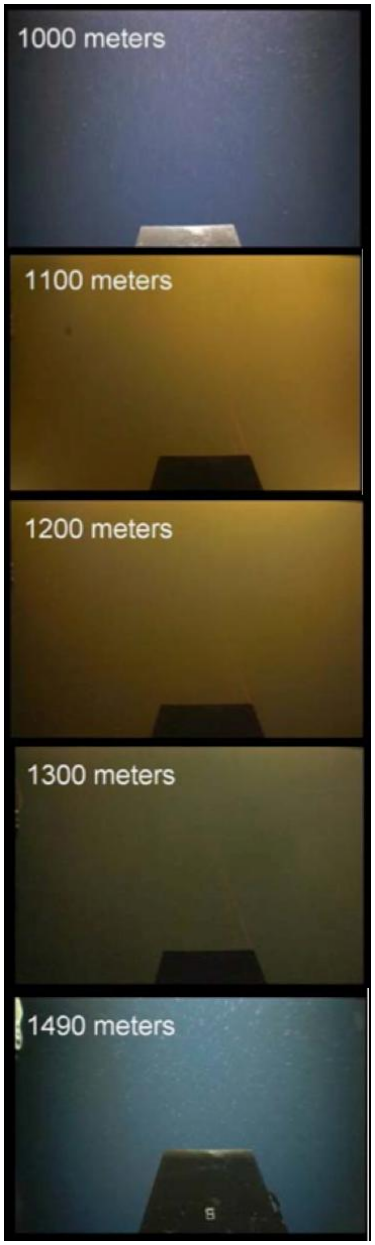
Subsurface Oil Plume Structure

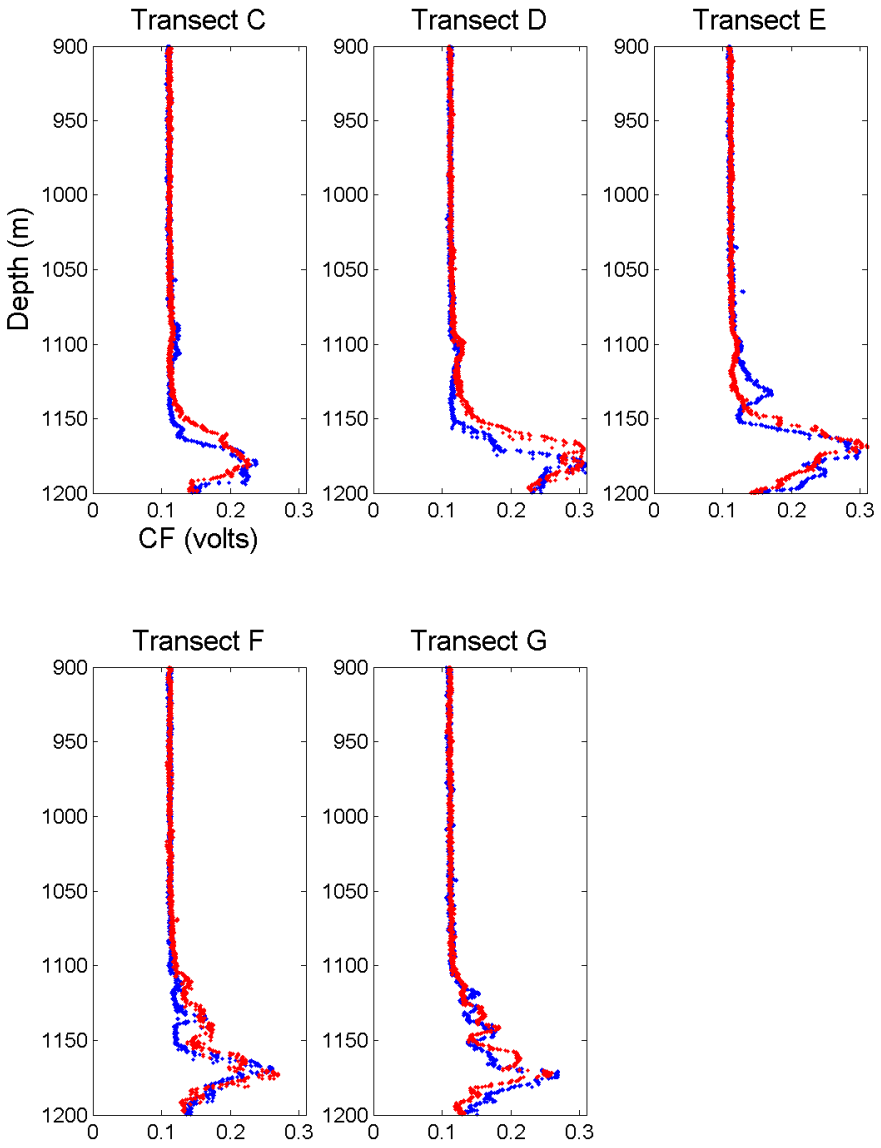


*** Above background, based on fluorometric CDOM data**

Subsurface Oil Plume Structure

1 June 2010
ROV images < 0.5 km
SW of wellhead
Camilli et al. (2010)





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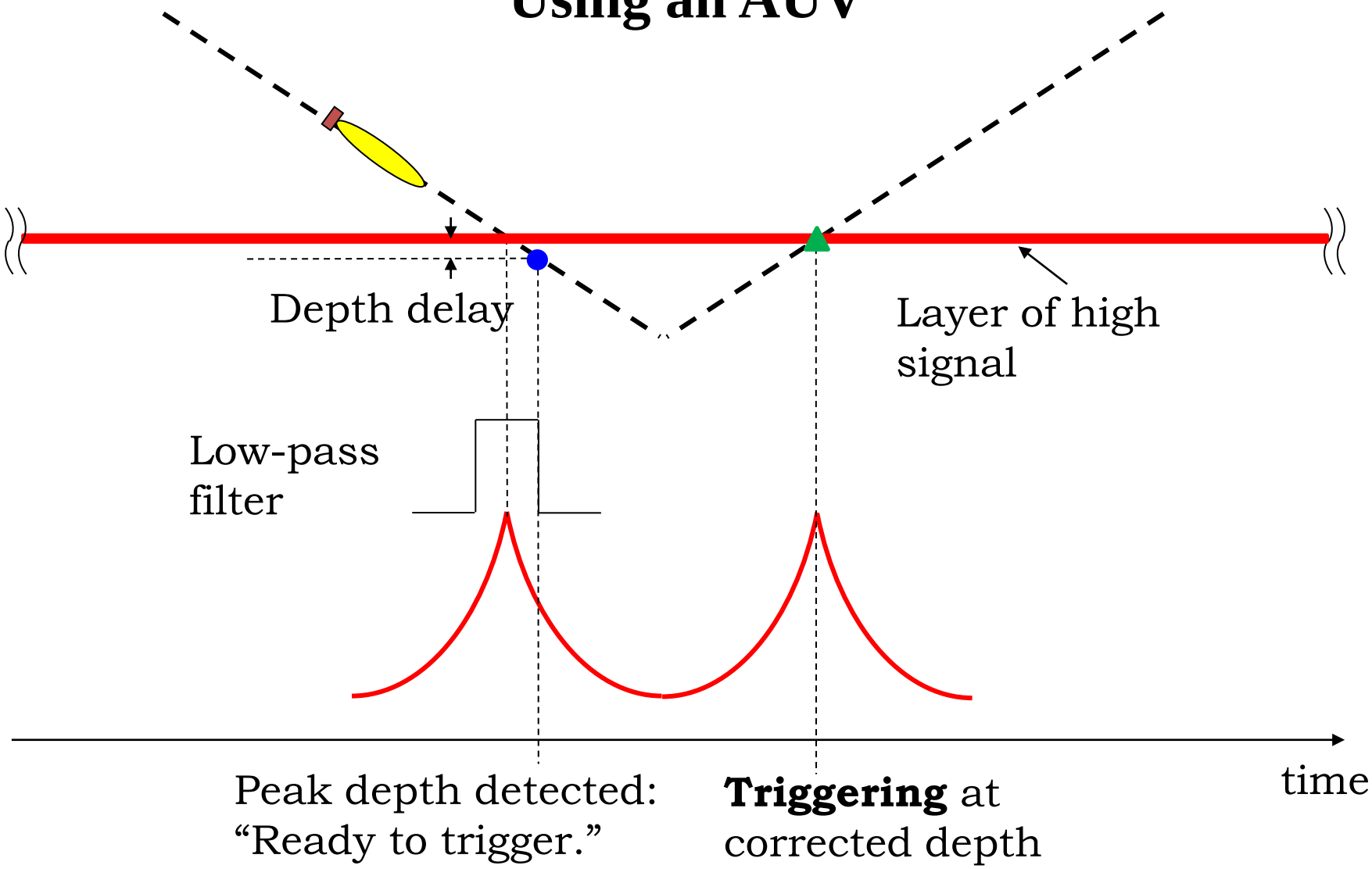
Subsurface Oil Plumes Found in Other GoM Cruises and Studied in Laboratory Experiments

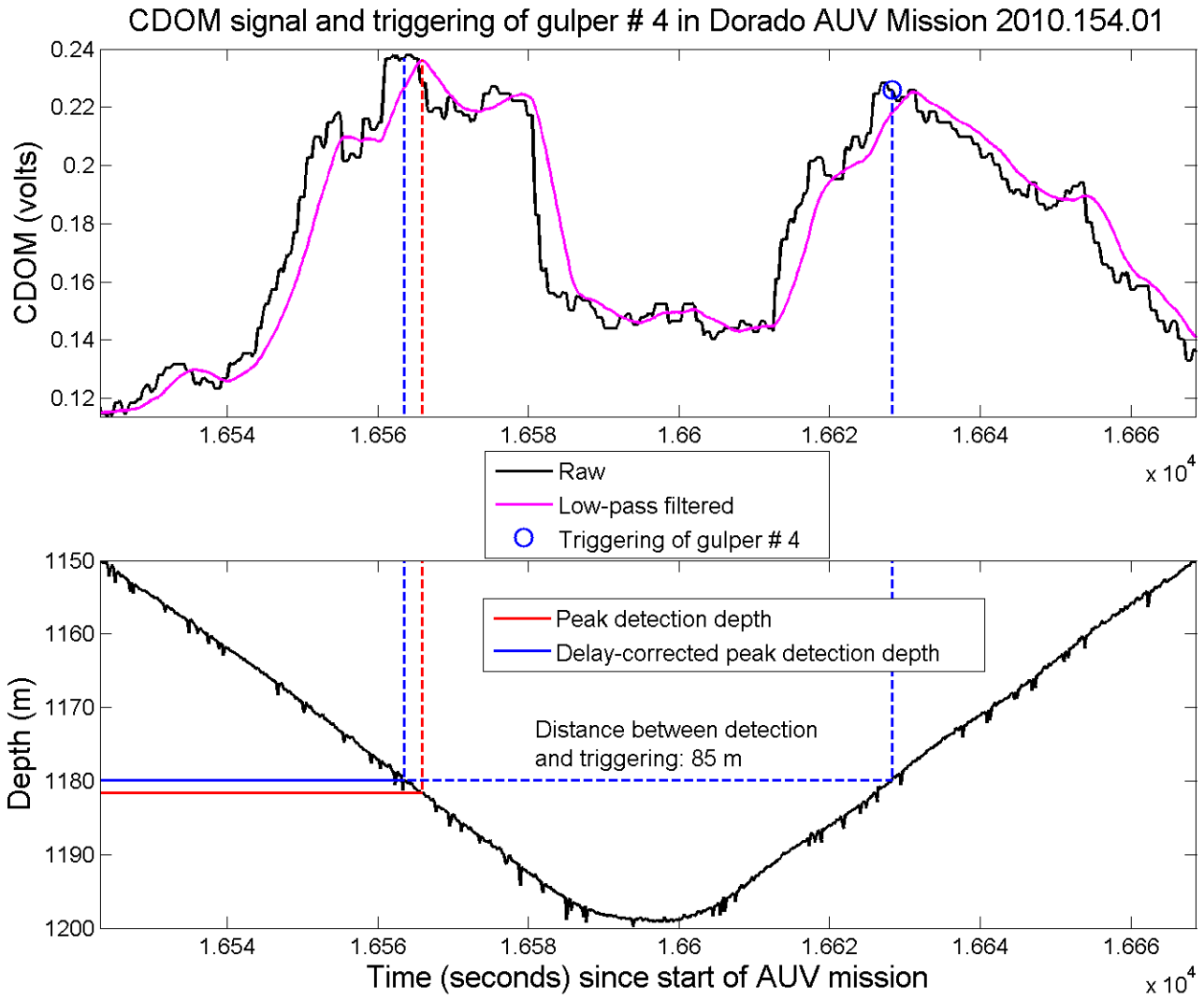
- Subsurface hydrocarbon plumes below 1000 m depth to the southwest of the Deepwater Horizon wellhead were also identified in (Camilli et al., 2010), (Diercks et al., 2010), (Hollander et al., 2010), (Parsons et al., 2010).

- Laboratory experiments have shown that a horizontal mixture of dispersed oil droplets and water forms at the "plume trapping height" where the buoyancy flux and the ambient stratification reach a balance (White et al., 2010, Socolofsky et al., 2010).

An Algorithm for Capturing Peak-Signal Water Samples Using an AUV

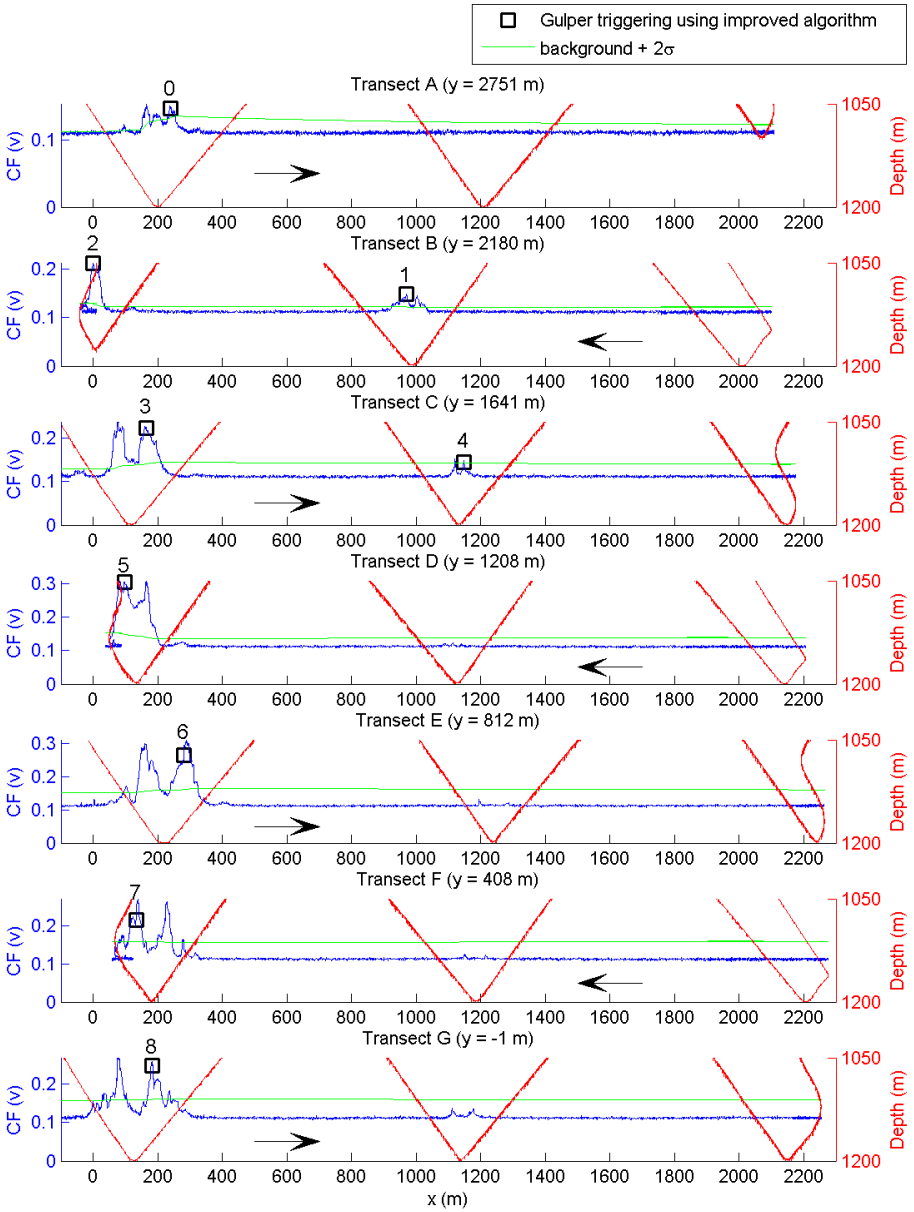


Capturing Peak-Signal Water Samples Using an AUV



Y. Zhang, R. S. McEwen, J. P. Ryan, J. G. Bellingham, H. Thomas, C. H. Thompson, and E. Rienecker "A Peak-Capture Algorithm Used on an Autonomous Underwater Vehicle in the Gulf of Mexico Oil Spill Response Scientific Survey," *Journal of Field Robotics*, revision under review.

Capturing Peak-Signal Water Samples Using an AUV



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Summary

- On 3 June 2010, at 13 km to the southwest of the Deepwater Horizon wellhead, we deployed the MBARI Dorado AUV to make high-resolution surveys and acquire water samples in a suspected subsurface oil plume.

- At the survey site, we developed a peak-capture algorithm for the Dorado AUV's 10 gulpers to capture water samples at CDOM fluorescence peaks in a horizontally oriented oil layer.

- Synoptic mapping + targeted sampling by an AUV provides for an effective approach for studying subsurface hydrocarbon plumes.

Acknowledgments

MBARI: The David and Lucile Packard Foundation
Chris Scholin, Steve Etchemendy, Marine Operations

NOAA: NOAA Sea Grant under grant CFDA 11.473/RCOOS S673 ,
NOAA Ship Gordon Gunter crew, Russell Brown, Charles Thompson,
Shailer Cummings, Glenn Zapfe, Zdenka Willis, Samuel Walker

WHOI: Robert Nelson