The National Oceanography Centre-OSRL autonomy project and reflections on the 2017 Oil on Water Exercise

ANDREW GATES AND SARAH HALL

Outline

- Collaborative NERC innovation fellowship

  National Oceanography Centre and Oil Spill Response Limited

- Roles for Marine Autonomous Systems (MAS) in oil spill response and monitoring

- MAS in action in oil spill response

  Reflections on the oil on water exercise

- Potential benefits

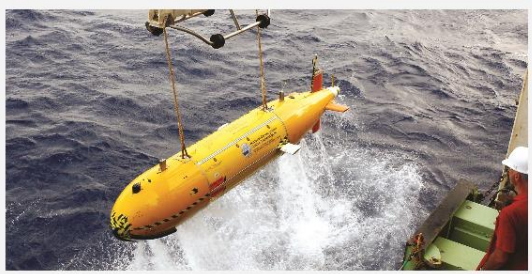
- Lessons learned

Oil Spill Response

OSRL & National Oceanography Centre (NOC) Autonomy Project

NERC Innovation Partnership

Evaluate how autonomous surveillance systems (platforms and sensors) fit into emergency oil spill response and day to day assurance monitoring



Oil Spill Response

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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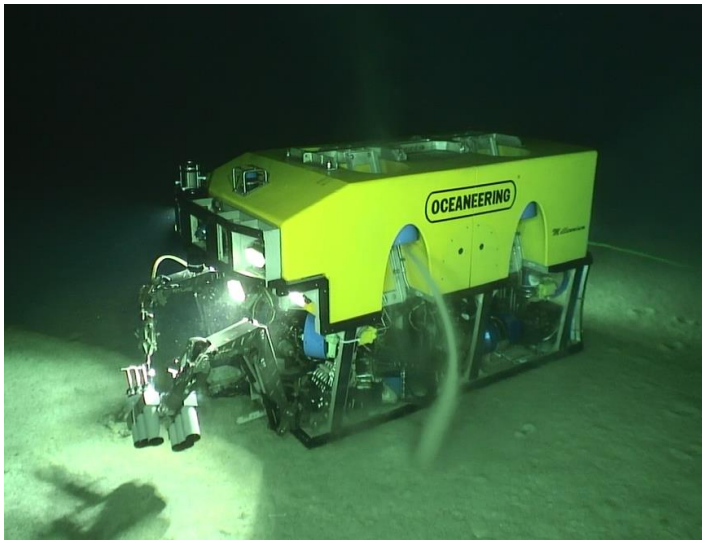
Key outputs

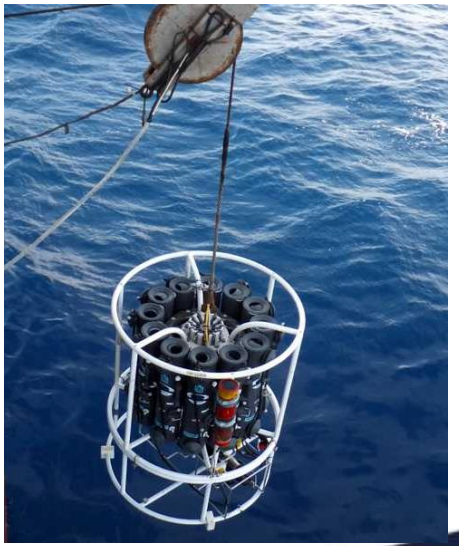
Final report summarising operational application of MAS to improve the effectiveness and efficiency of response to oil spill incidents - ‘bridging Research to Response’

Peer reviewed research “Roles for marine autonomous systems in oil spill response and monitoring”

Presentations/ technical sessions:
NERC Environmental Expo
Visualisation centre, OSRL Oil on Water exercise
Marine Measurement Forum
OSRL Core group
ITAC
NOC’s MARS Show Case
Interspill


JAMES COOK

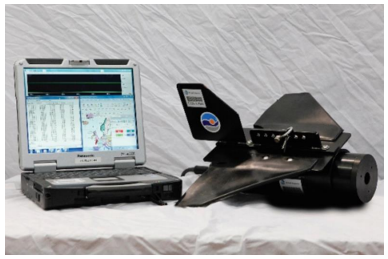

OCEANEERING



In-water surveillance

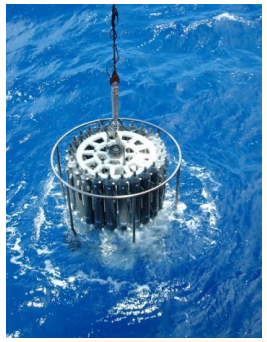
In situ fluorescence (SMART Protocols)

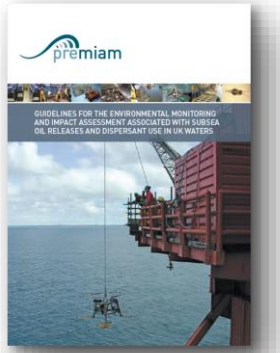
- Demonstrate dispersant effectiveness



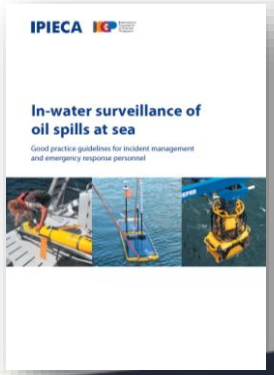
Water column sampling

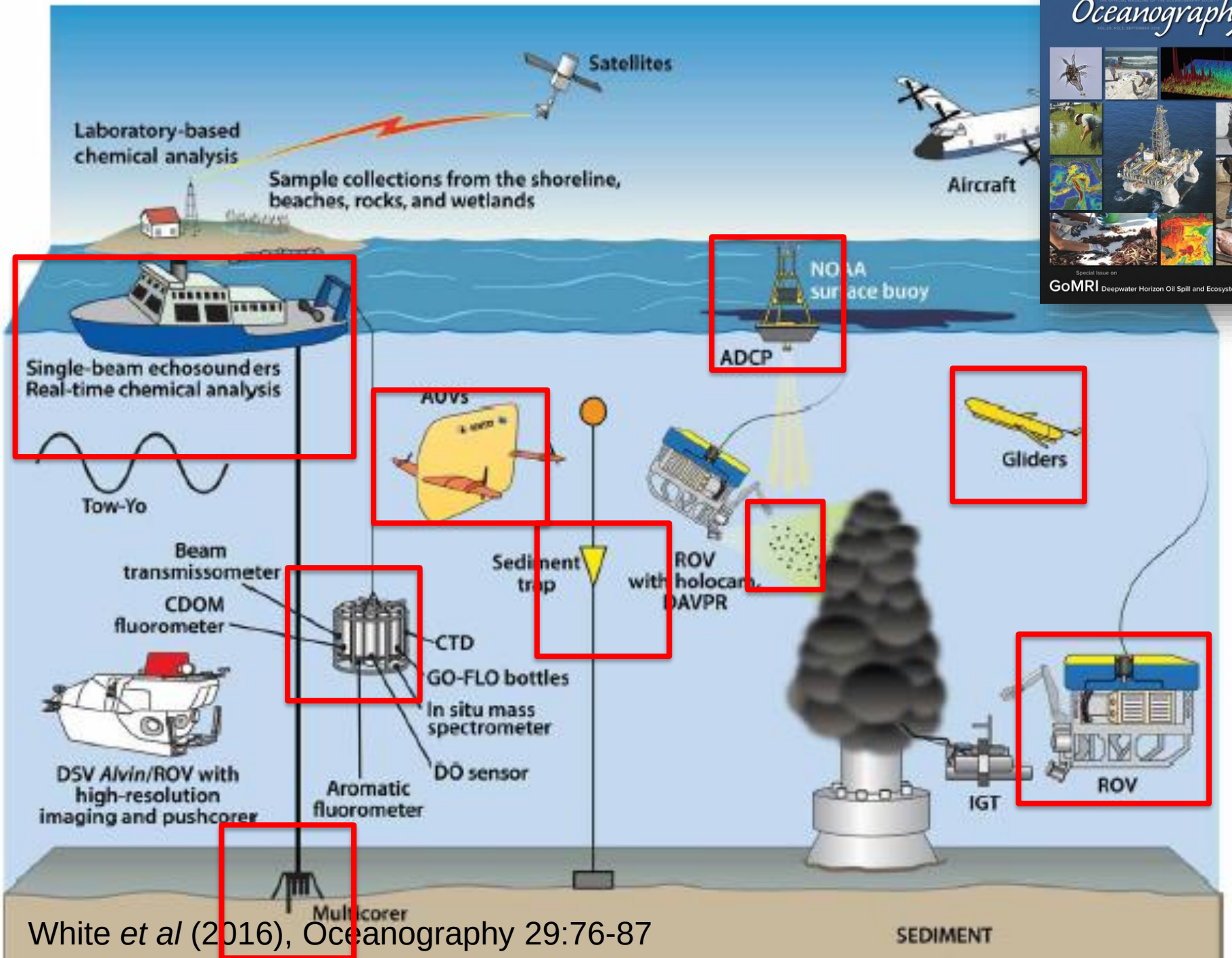
- Post spill monitoring
- Atypical dispersant application





New IPIECA and IOGP good practice





White *et al* (2016), Oceanography 29:76-87

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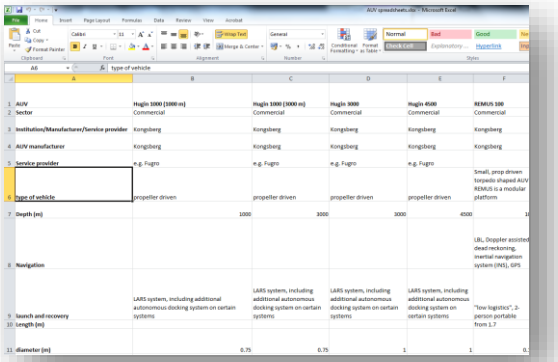
Commercially available systems



	A	B	C	D	E	F
1	AUV	Hugin 1000 (1000 m)	Hugin 1000 (3000 m)	Hugin 3000	Hugin 4500	REMUS 100
2	Sector	Commercial	Commercial	Commercial	Commercial	Commercial
3	Institution/Manufacturer/Service provider	Kongsberg	Kongsberg	Kongsberg	Kongsberg	Kongsberg
4	AUV manufacturer	Kongsberg	Kongsberg	Kongsberg	Kongsberg	Kongsberg
5	Service provider	e.g. Fugro	e.g. Fugro	e.g. Fugro	e.g. Fugro	
6	Type of vehicle	propeller driven	propeller driven	propeller driven	propeller driven	Small, prop driven torpedo shaped AUV. REMUS is a modular platform
7	Depth (m)	1000	3000	3000	4500	
8	Navigation					LBL, Doppler assisted dead reckoning, inertial navigation system (INS), GPS
9	launch and recovery	LARS system, including additional autonomous docking system on certain systems	LARS system, including additional autonomous docking system on certain systems	LARS system, including additional autonomous docking system on certain systems	LARS system, including additional autonomous docking system on certain systems	"low logistics", 2-person portable from 1.7
10	Length (m)					
11	diameter (m)	0.75	0.75	1	1	0.

Industry

Exploration and mapping: Multibeam bathymetry, Sidescan sonar, Sub-bottom profile, Ground truth aerial observations, Geohazards

Baseline survey for Environmental Impact Assessment: Water column, Seabed photography, Vulnerable Marine Ecosystems (VME)

Pipeline routes

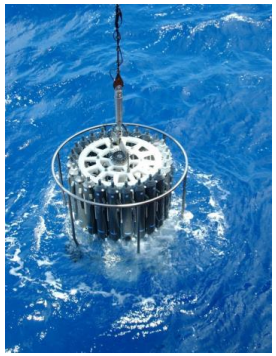
Asset integrity inspection (e.g. pipeline survey), Oil detection

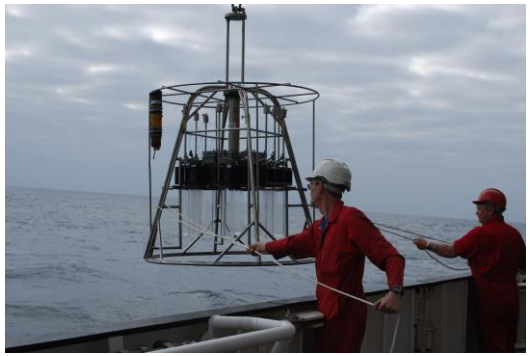
Applications for oil spill response/monitoring

Parameter	Why?	Method	Autonomous Alternative
Water column oil	Track oil/dispersed oil	CTD/rosette packages to measure extent and variation in oil	MAS deployed fluorescence sensors or UW Mass Spec.
Water column oxygen	Microbial oxidation	*In situ* sensing with O2 sensor on CTD	O2 sensor on autonomous vehicle
Oil droplet size distribution	Effectiveness of dispersant	CTD deployed LISST	AUV deployed LISST
Currents	Implement current model using real time data	ADCP	ADCP from MAS

Challenges?

Parameter	Requirement	Method	Autonomous Alternative?
Water column	Water column sampling	CTD/rosette packages to take water samples	AUV water sampling device?
Sediments	Chemical, physical & biological	Standard sampling protocols	AUV photography?

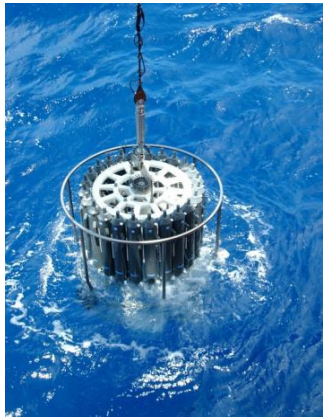




Oil spills

Tracking Hydrocarbon Plume Transport and Biodegradation at Deepwater Horizon

Richard Camilli,[1]* Christopher M. Reddy,[2] Dana R. Yoerger,[1] Benjamin A. S. Van Mooy,[2] Michael V. Jakuba,[3] James C. Kinsey,[1] Cameron P. McIntyre,[2] Sean P. Sylva,[2] James V. Maloney[4]



CTD Rosette sampling to identify area of plume

AUV *Sentry* to map plume from Macondo

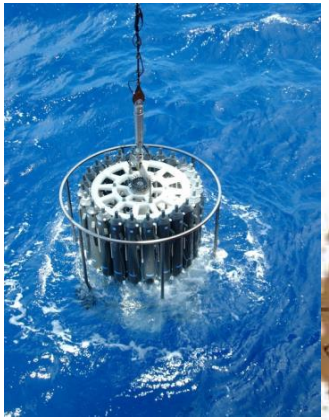
In situ mass spectrometer on both platforms

3 AUV surveys

Image: WHOI

Camilli et al., (2010) *Science* 330, 201-204

Camilli et al., (2010) *Science* 330, 201-204



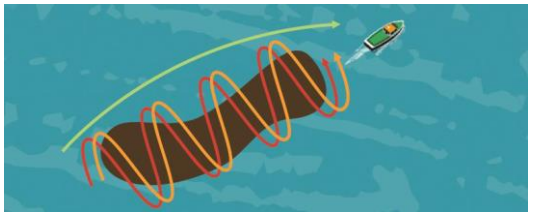
Oil spill application

SPECIAL
MONITORING of
APPLIED
RESPONSE
TECHNOLOGIES

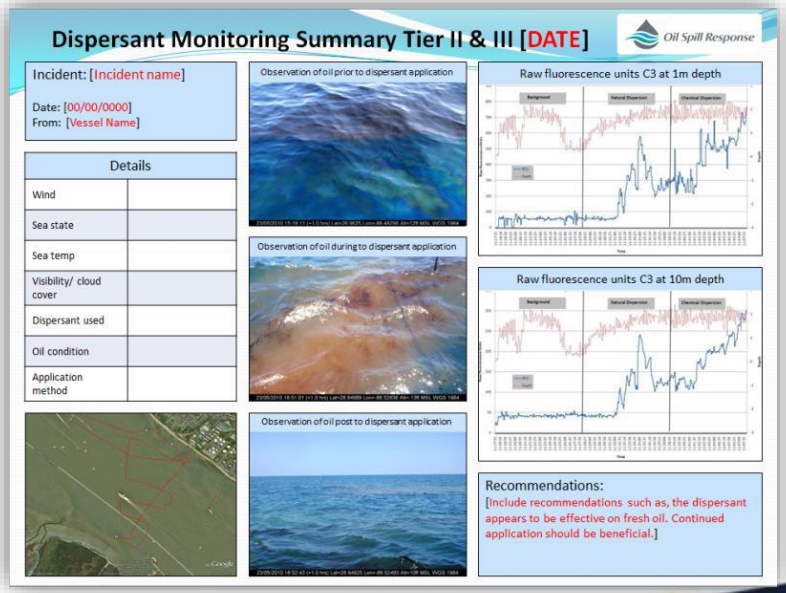
Developed by:

U.S. Coast Guard
National Oceanic and Atmospheric Administration
U.S. Environmental Protection Agency
Centers for Disease Control and Prevention
Minerals Management Service

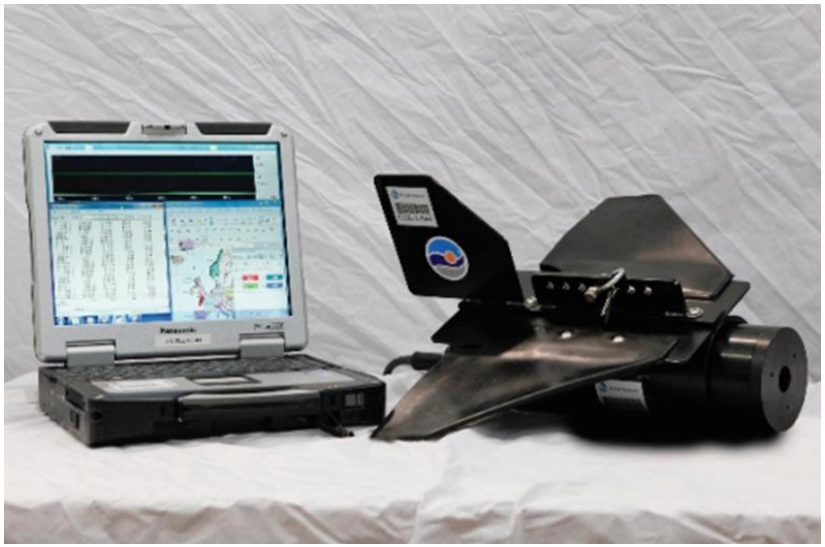
Smoke rising from the *New Carissa*, February 1999. Photo by USCG



Fluorescence readings
Background
Natural dispersion
Chemical dispersion



Next generation SMART monitoring?



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Oil Spill Response

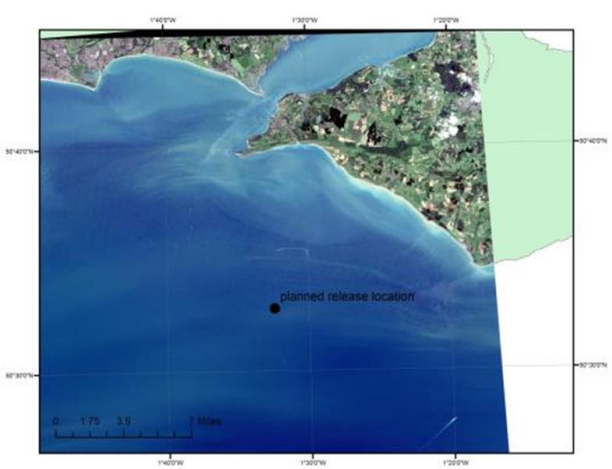
Oil on water exercise 2017

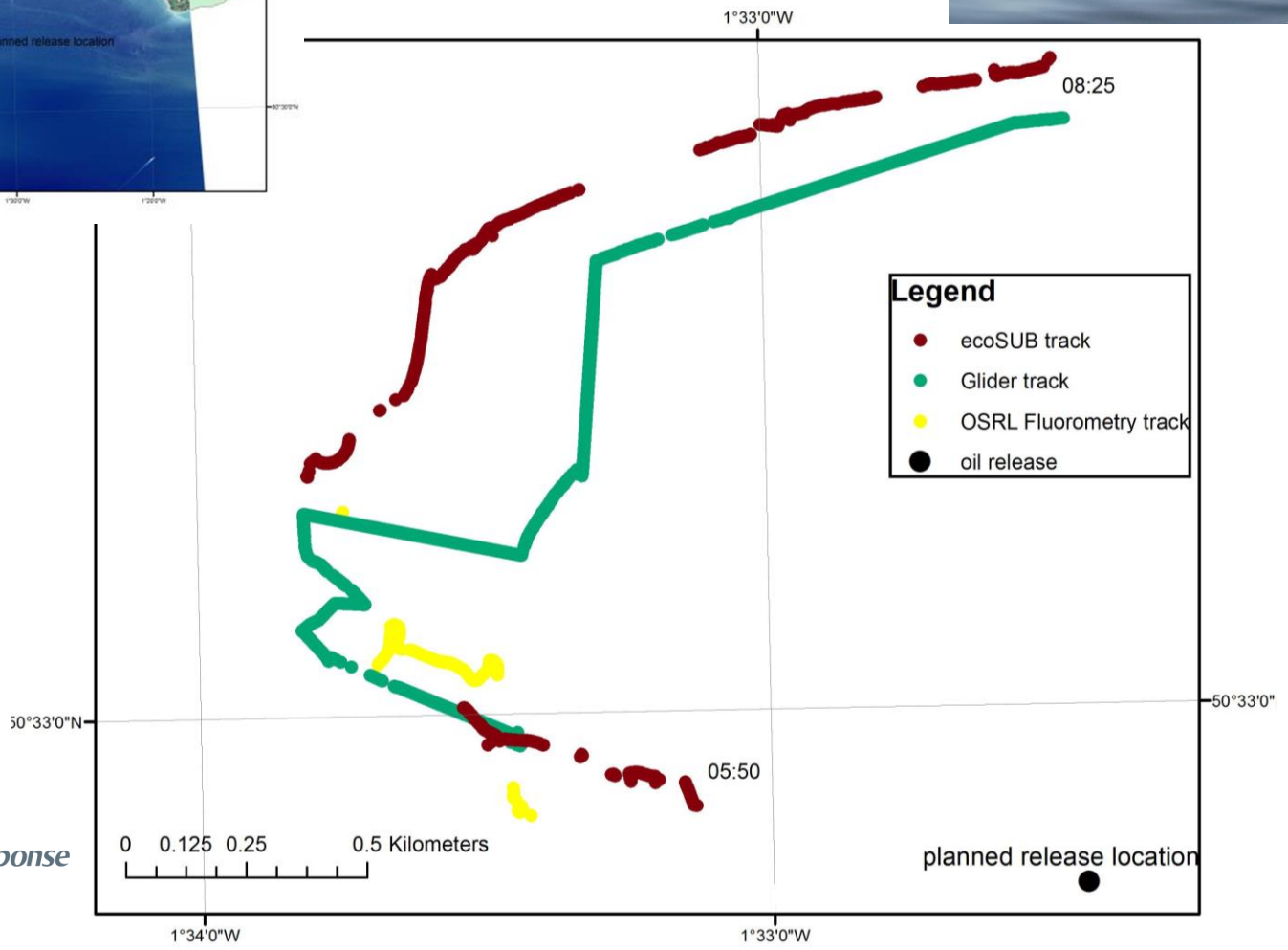
•Testing the effectiveness of surface dispersant using fluorescence sensors in AUVs

• In comparison to traditional fluorometry equipment used by OSRL on spills

• 2 x companies, 2 x AUVs

- EcoSUB
- Slocum G2 Glider





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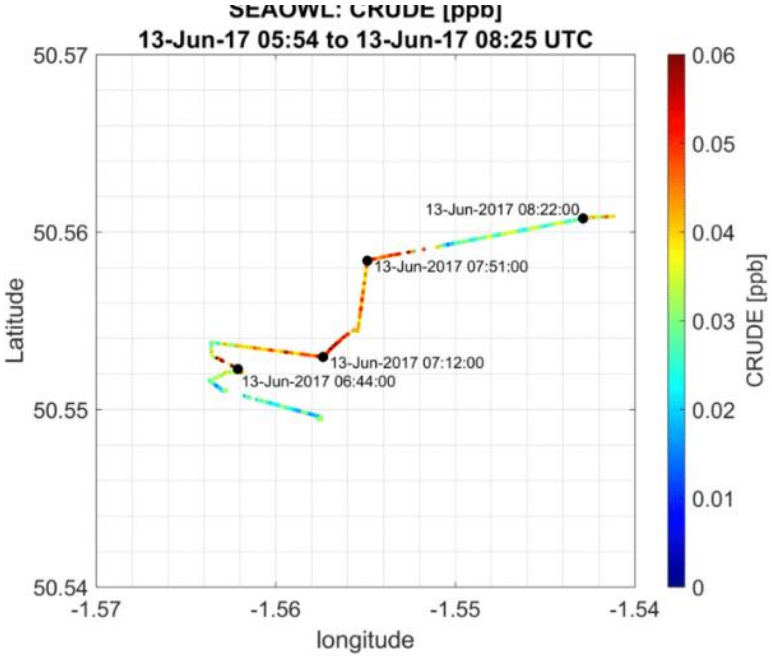
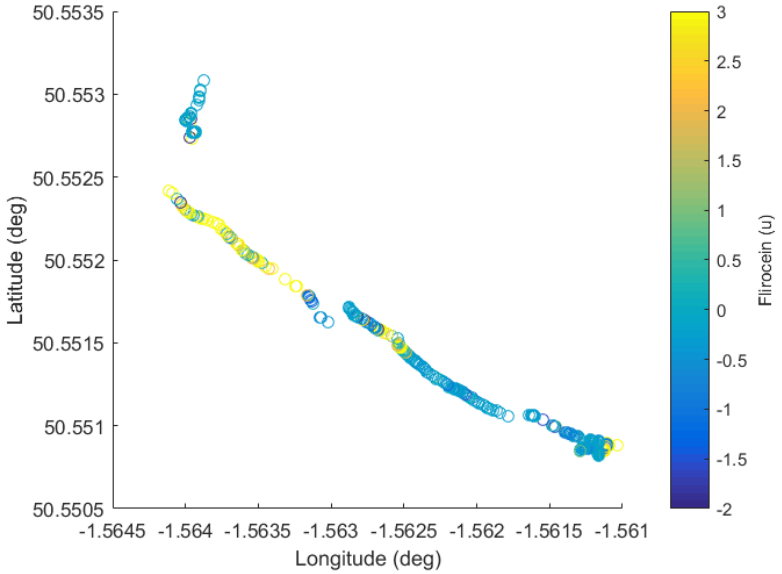
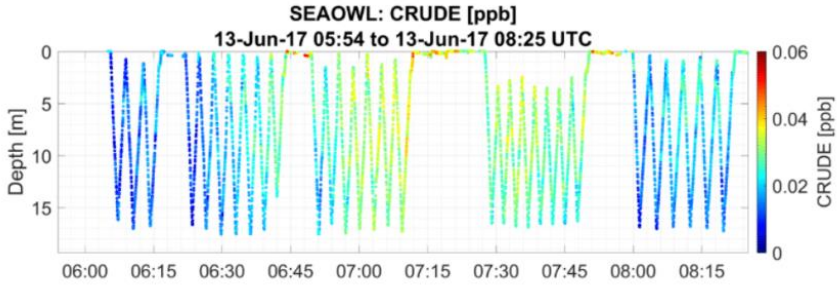
Initial Results

BlueOcean MONITORING

ecoSUB robotics







Oil On Water 2017

MAS can detect oil in the water column in an operational environment

Data can be displayed in near real time in visualisation centre (EOC/COP)

Operational learnings

- Planning
- Safety
- Launch and recovery
- Service provision
- Response personnel working with MAS

Applications

What are the benefits?

Situational awareness:	Improved spatial coverage Near real-time data collection Continual monitoring during response Data collection in otherwise inaccessible areas
Reduced costs:	Reduced requirement for large ships? Improved efficiency
Rapid mobilisation:	Deployment from shore/smaller vessel?
Safety:	Removing personnel from hazardous area Monitoring during dispersant spraying
Validation:	Modelling Aerial observations

Use of appropriate technologies

Building confidence in the technology

Capability of vehicles:	Levels of autonomy Challenging environments
Risk assessment:	Mission success rate De-confliction (underwater and surface)
Real-time data:	Requirements from responders/regulators? Interpretation Visualisation
Availability of systems:	Service provision

How can MAS improve/supplement current response methods?

Oil companies on board?: Exercises/Demonstrators


DISCOVERY
TOBI
AUTOSUB3
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AutoCat