

Marine Autonomous Systems in Support of Marine Observations (MASSMO)



National
Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Dr Russell B Wynn (MARS Chief Scientist)



Rise of the Machines.....



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Top Google hits for 'Robot', 'Drone' and 'Robot Drone'

"Say hello to ROOMBOTS"



"FAA fine against drone photographer dismissed"



"How robot drones revolutionized the face of warfare"



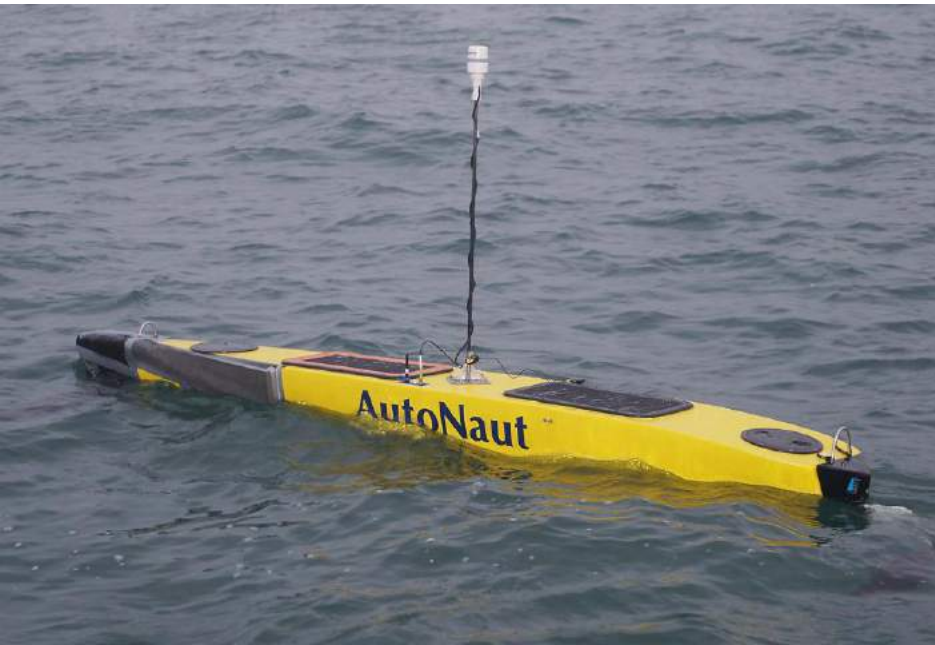
NERC Marine Autonomous Systems and Robotic Systems (MARS)



Marine Autonomous Systems in Support of Marine Observations (MASSMO)

- Trial new USVs developed as part of SBRI (co-funded by NERC/NOC and DSTL)
- Share resources and expertise regarding MAS fleet operations in UK waters
- Collect acoustic, metocean and biological data with a range of MAS sensors
- Clean, quiet, portable, low-cost technology (compared to survey vessels)

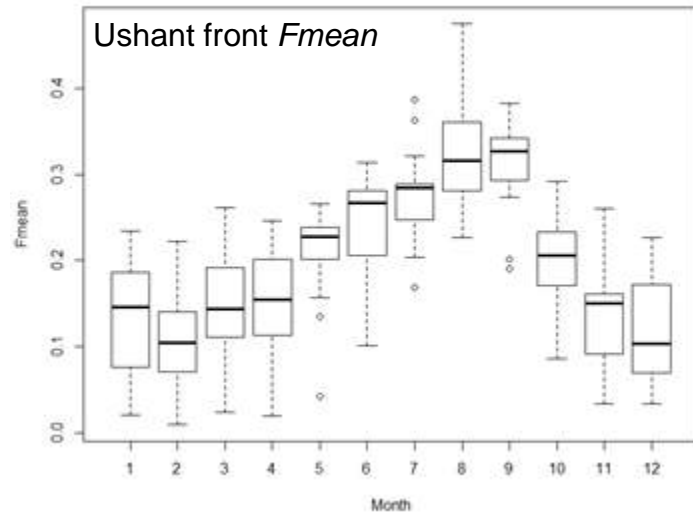
MOST AV 'AutoNaut'



ASV 'C-Enduro'

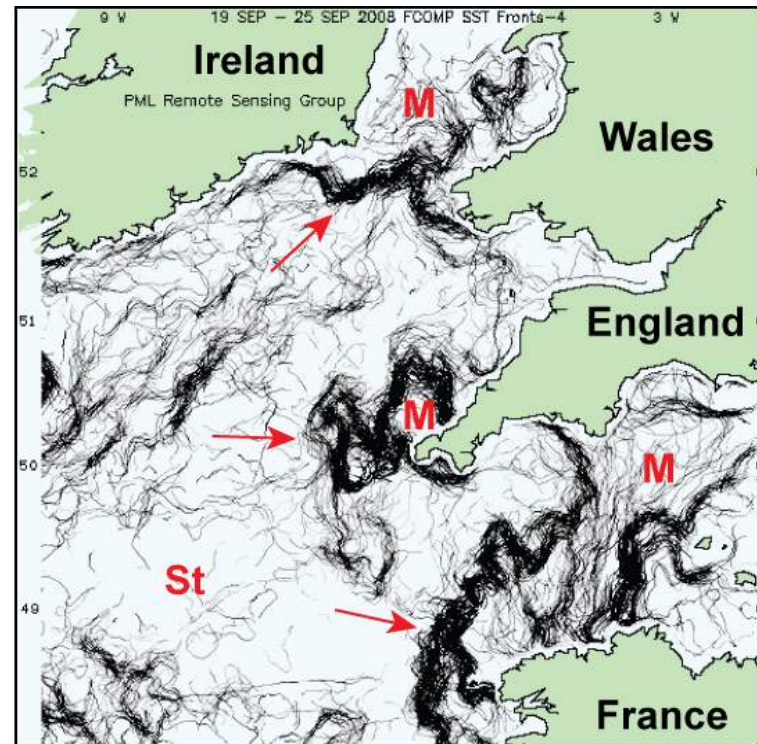
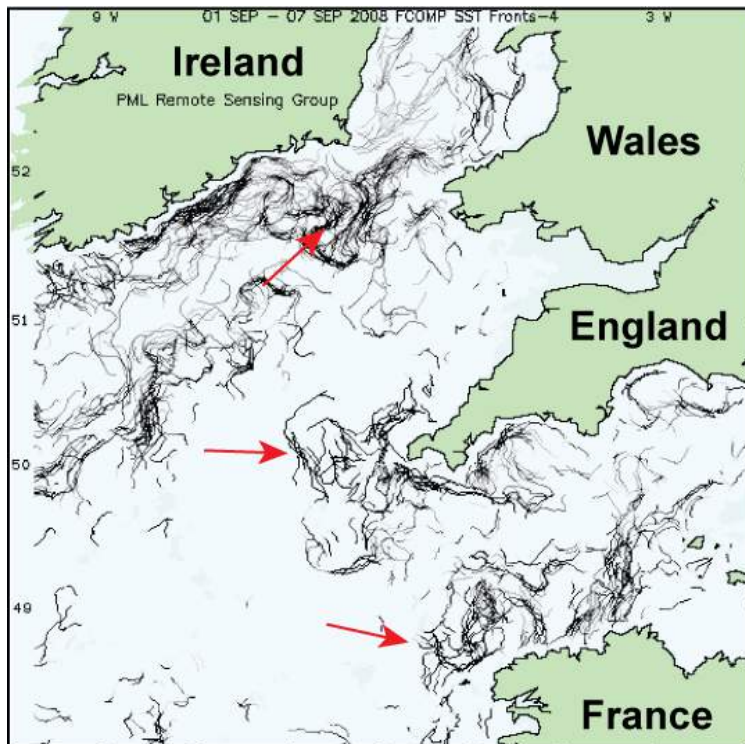


Targeting tidal-mixing fronts off southwest UK with submarine gliders



Fronts act as both barriers
and convergence zones

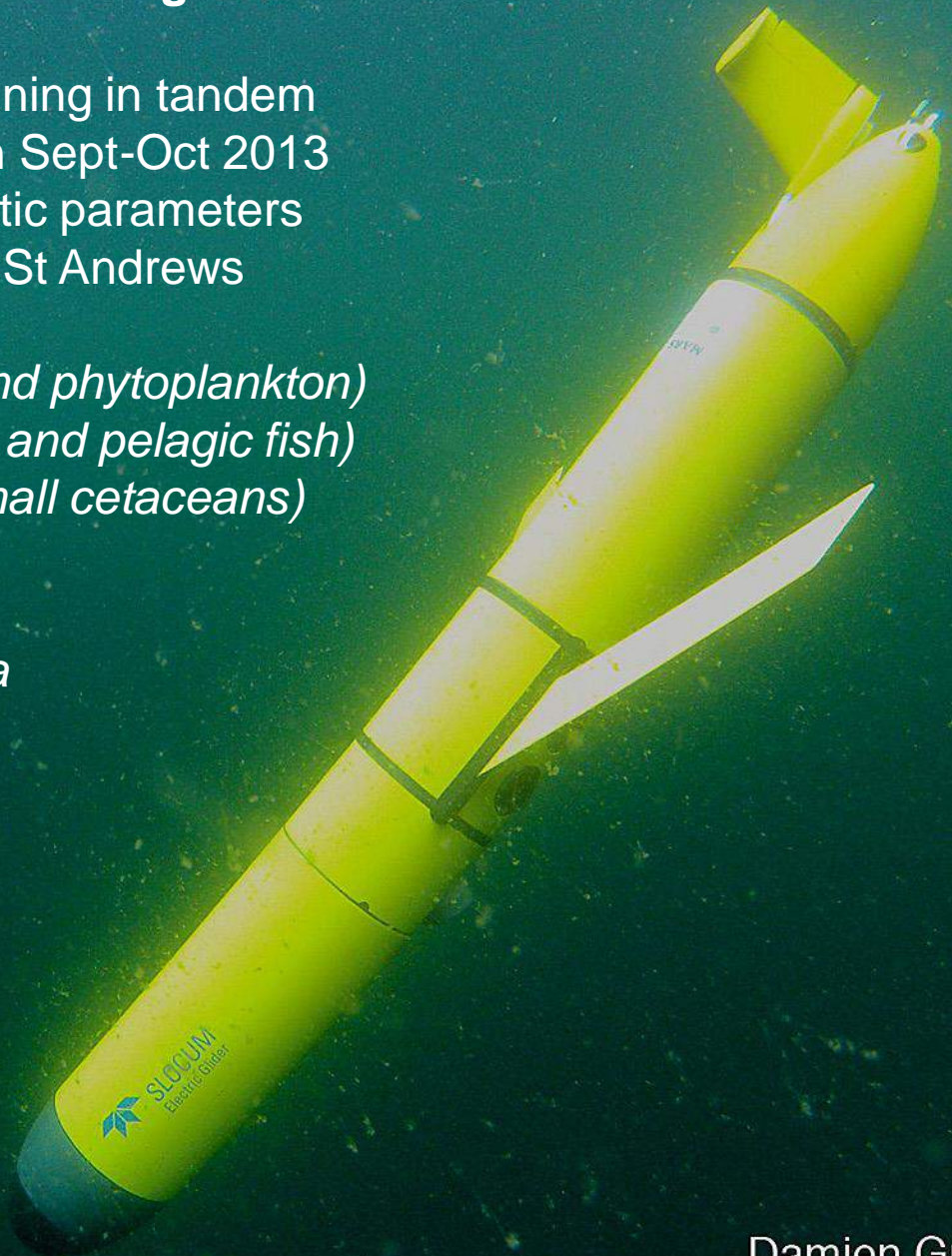
PML Plymouth Marine Laboratory



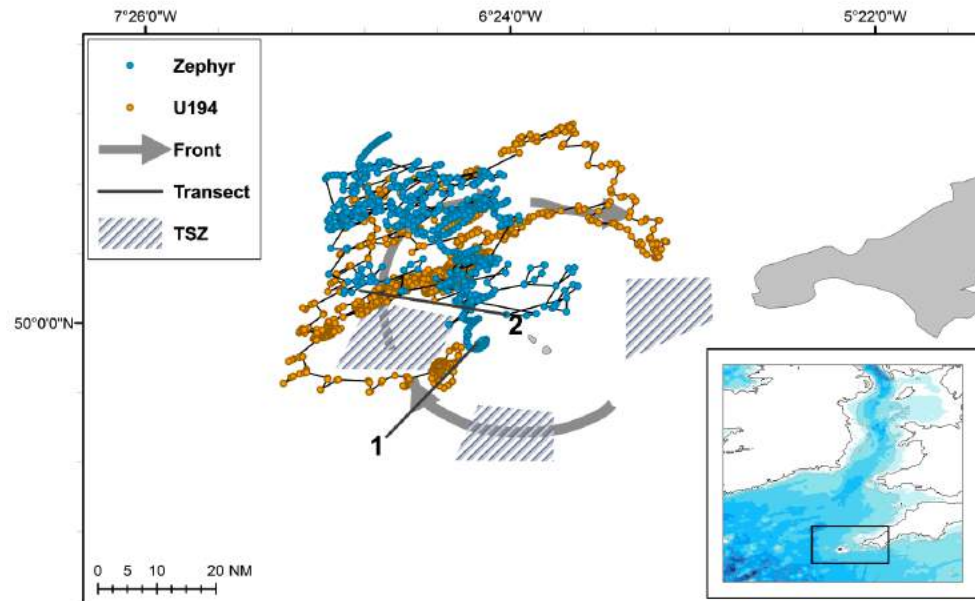
Submarine gliders for acoustic monitoring

2 x shallow-water Slocum gliders running in tandem
One month deployment off SW UK in Sept-Oct 2013
Monitoring of multiple abiotic and biotic parameters
NOC + BAS, PML, Cefas, NIVA, Uni St Andrews

CTD and fluorometer (abiotic data and phytoplankton)
120 kHz echo-sounder (zooplankton and pelagic fish)
D-TAG Passive Acoustic Monitor (small cetaceans)
Hydrocarbon sensor
MetOcean data
RV Cefas Endeavour calibration data
Satellite-based front mapping



Shallow-water submarine glider trials off southwest UK in autumn 2013

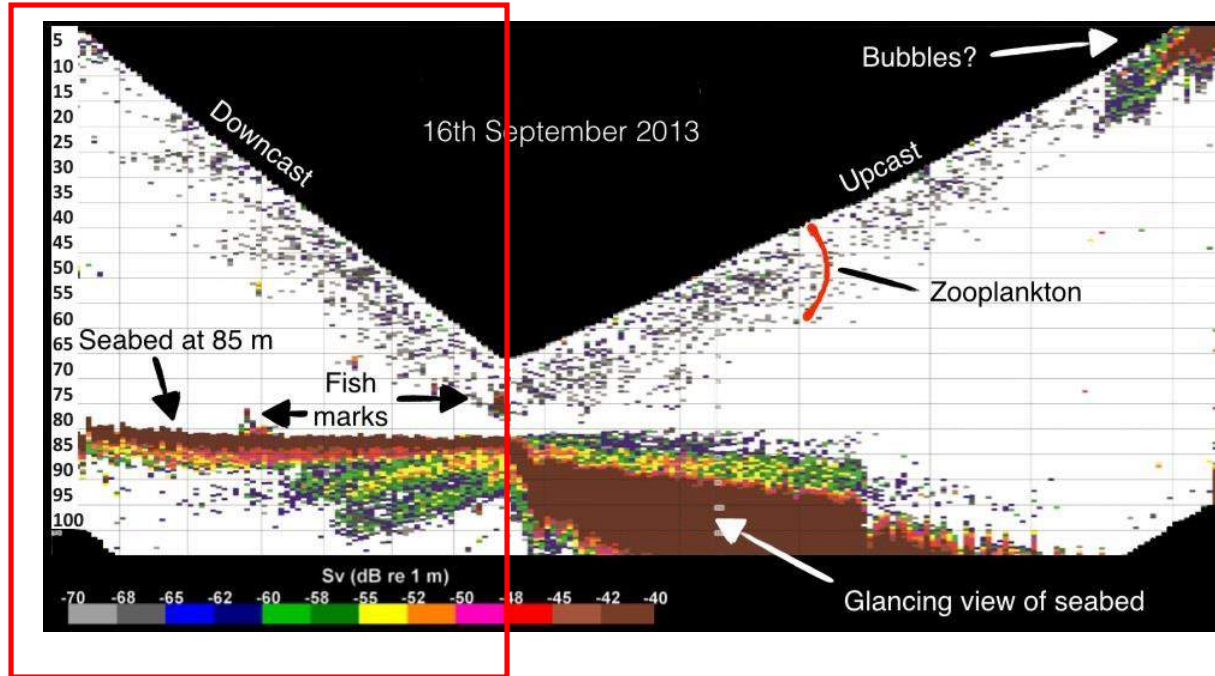


Deployment week	1	2	3	4	5	6	7	8	9
DEPLOYMENT									
<i>Zephyr</i>									
<i>U194</i>		Repairs							
SENSORS									
<i>Zephyr CTD + fluorometer</i>									
<i>U194 CTD + fluorometer</i>		Repairs							
<i>Zephyr DTAG</i>		Memory full			No recordings, broken cable				
<i>U194 echo-sounder</i>		Repairs			No recordings, software problem				

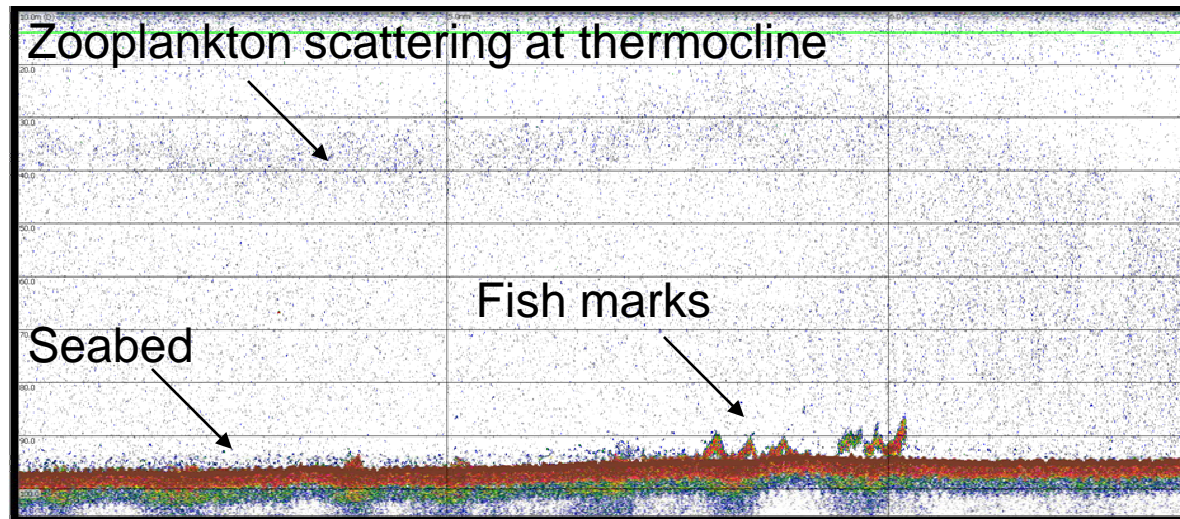
- 40 days in water
- 2700 dives up to 100 m WD
- 1100-1300 km covered
- Tidal flows up to 0.75 m/s

2D echosounder profiles comparing glider and vessel-based data

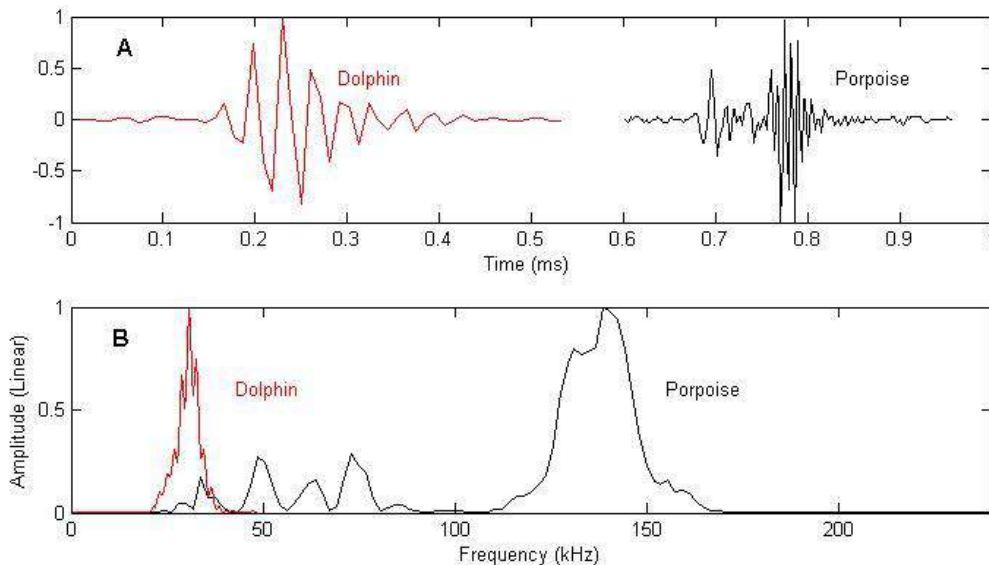
Glider



Vessel

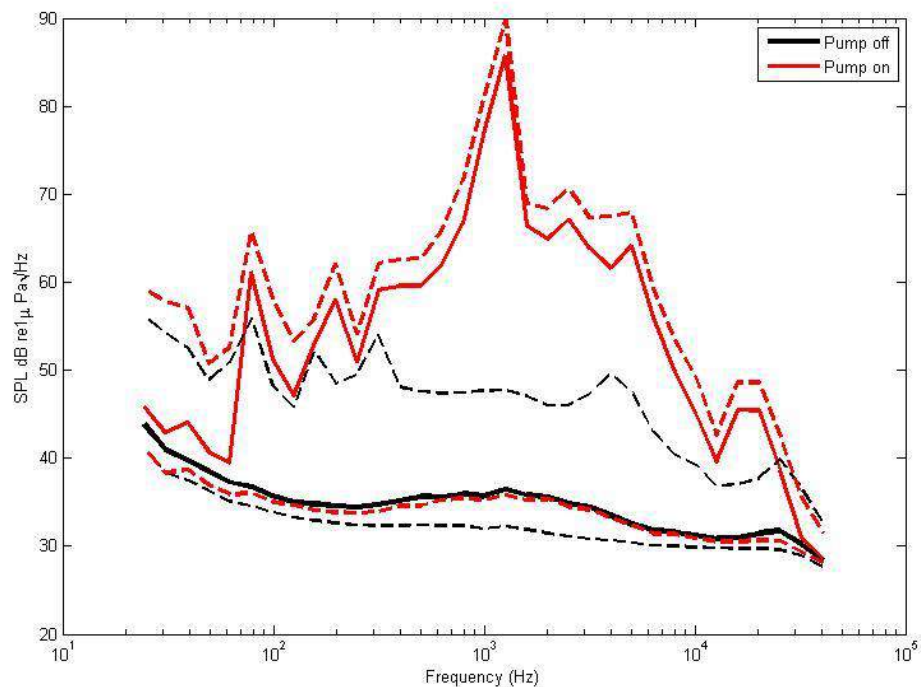


Examples of cetacean acoustic data collected with the d-tag PAM



Waveforms (A) and power spectra (B) of detected dolphin and porpoise clicks using the modified d-tag

Spectrum-level noise measurements showing the effect of the glider buoyancy pump





Contents lists available at ScienceDirect

Methods in Oceanography

journal homepage: www.elsevier.com/locate/mio

Full length article

Assessing the potential of autonomous submarine gliders for ecosystem monitoring across multiple trophic levels (plankton to cetaceans) and pollutants in shallow shelf seas

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ABSTRACT

A combination of scientific, economic, technological and policy drivers is behind a recent upsurge in the use of marine autonomous systems (and accompanying miniaturized sensors) for environmental mapping and monitoring. Increased spatial-temporal resolution and coverage of data, at reduced cost, is particularly vital for effective spatial management of highly dynamic and heterogeneous shelf environments. This proof-of-concept study involves

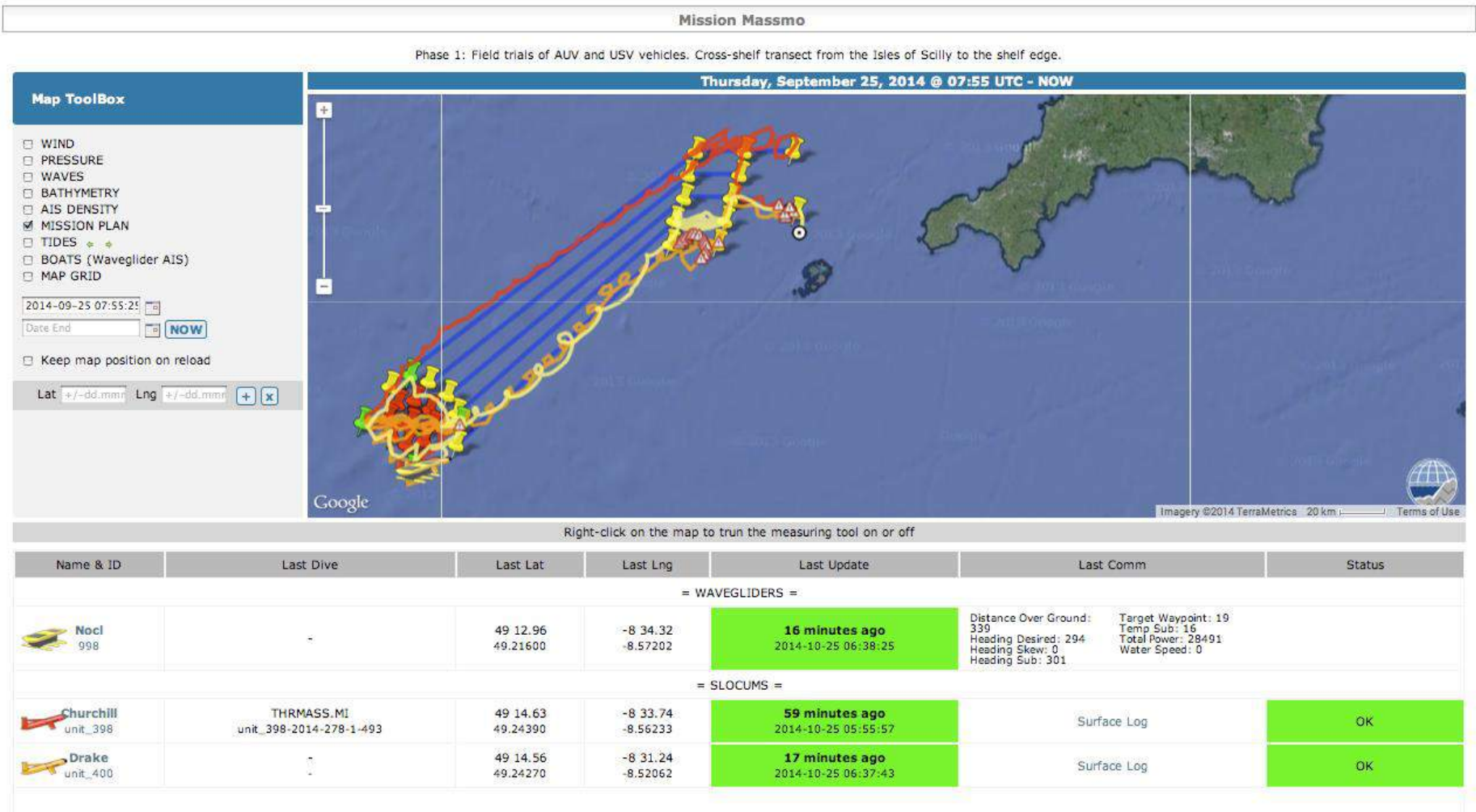
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<http://dx.doi.org/10.1016/j.mio.2014.06.002>

2211-1220/© 2014 Published by Elsevier B.V.

P1 - USVs and submarine gliders targeting oceanic fronts off southwest UK



- 5 USVs + 2 submarine gliders, supported by Scilly IFCA RIB / RV Cefas Endeavour
- Satellite data from PML, metocean data from UK Met Office and Cefas Smartbuoy
- 5 vehicles traveled up to 400 km in a 12-day period reaching >150 km from land
- Winds >70 mph and waves >7 m high affected vehicles, oceanography and biology!
- Valuable test of platforms and operations (piloting, C&C, data management etc)

Operations Room - The Hub of the Project

The Operations Room is located at the heart of the National Oceanography Centre in Southampton and is the central hub for the *Exploring Ocean Fronts* project.

The room is filled with maps, charts and tracking information, including meteorological data provided by the Royal Navy and oceanographic data supplied by Plymouth Marine Laboratory. There is also a large screen showing the track and progress of the vehicles at sea.

Two NOC pilots are on constant watch in the Southampton Ops Room, controlling the movements of all but one of the vehicles at sea. Some of the piloting is also being supported by partners at other sites, including the National Oceanography Centre in Liverpool which owns one of the wave gliders.

At regular intervals a bell rings, signalling that a glider has reached the surface of the ocean and is sending and transmitting data, and able to receive new directions from the pilots.



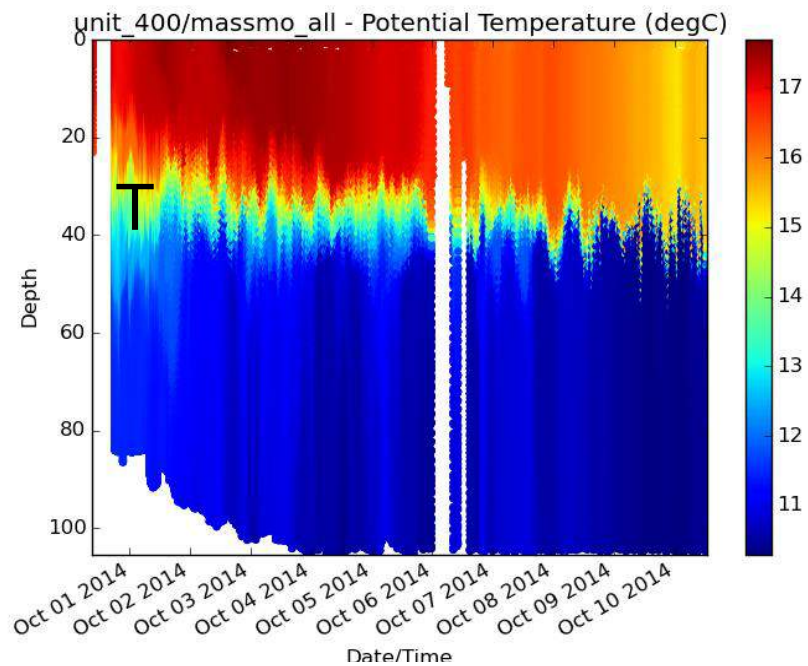
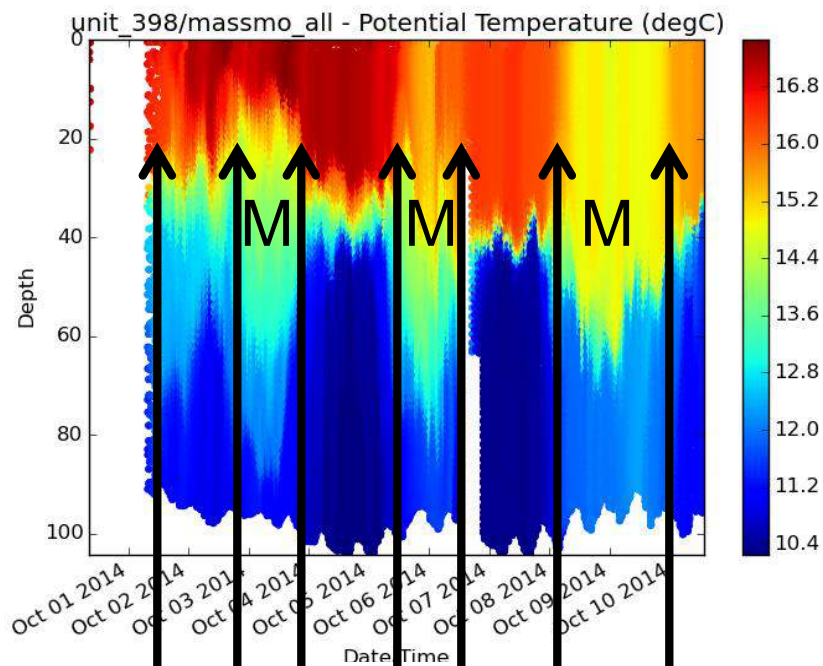
Maps, charts and tracking information.



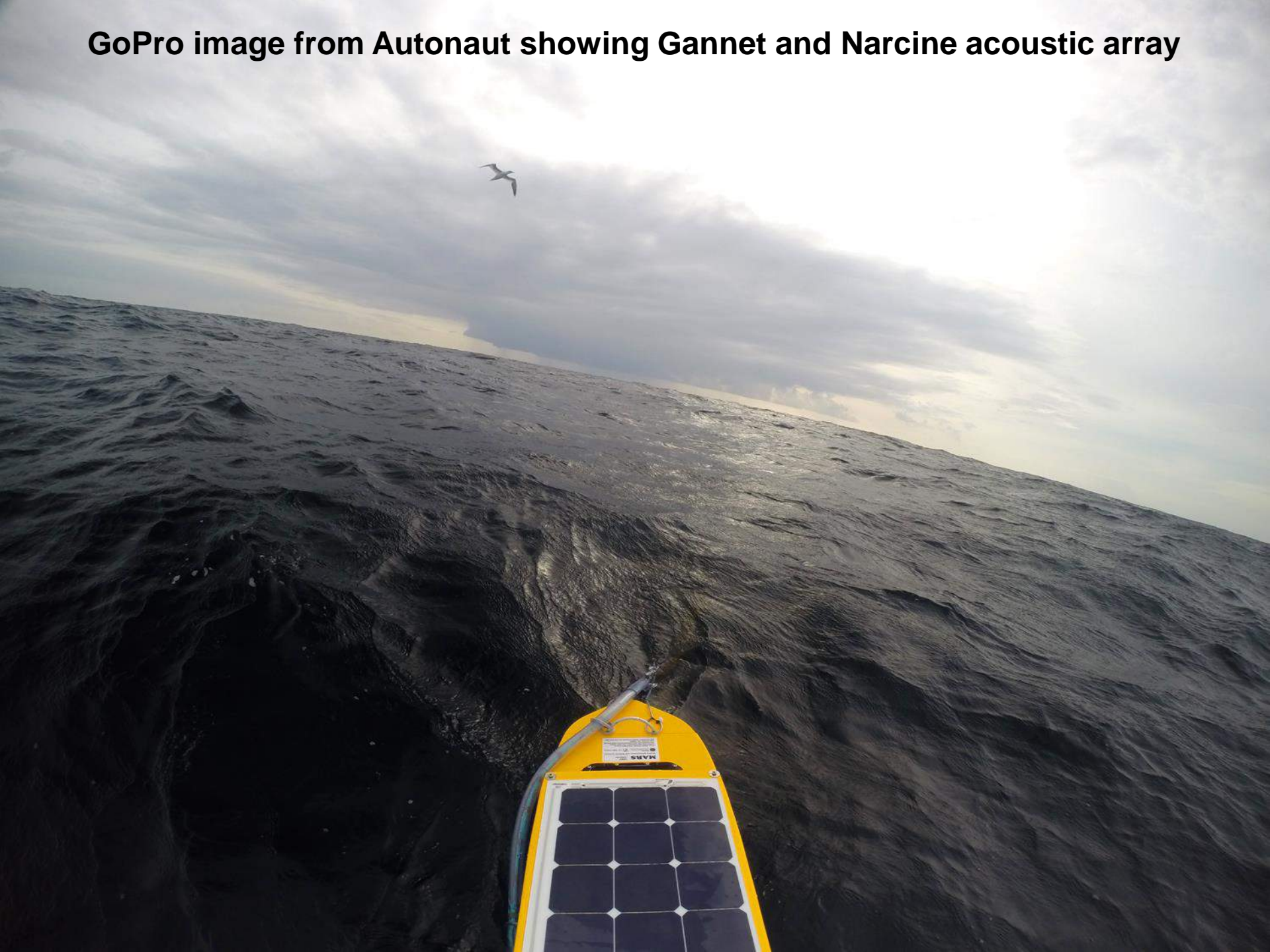
Large screen showing the track and progress of the vehicles at sea



Two NOC pilots are on constant watch in the Southampton Ops Room



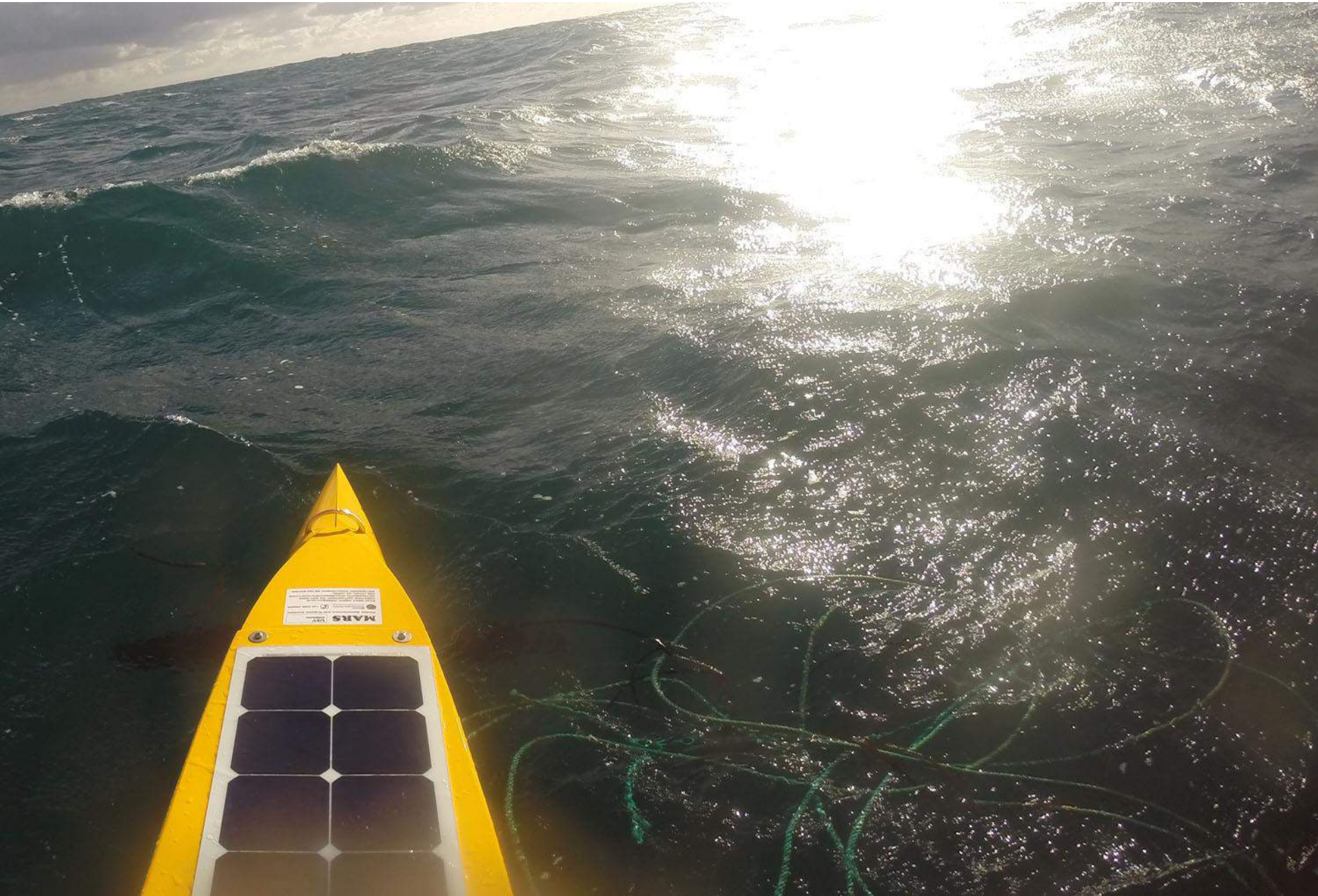
GoPro image from Autonaut showing Gannet and Narcine acoustic array



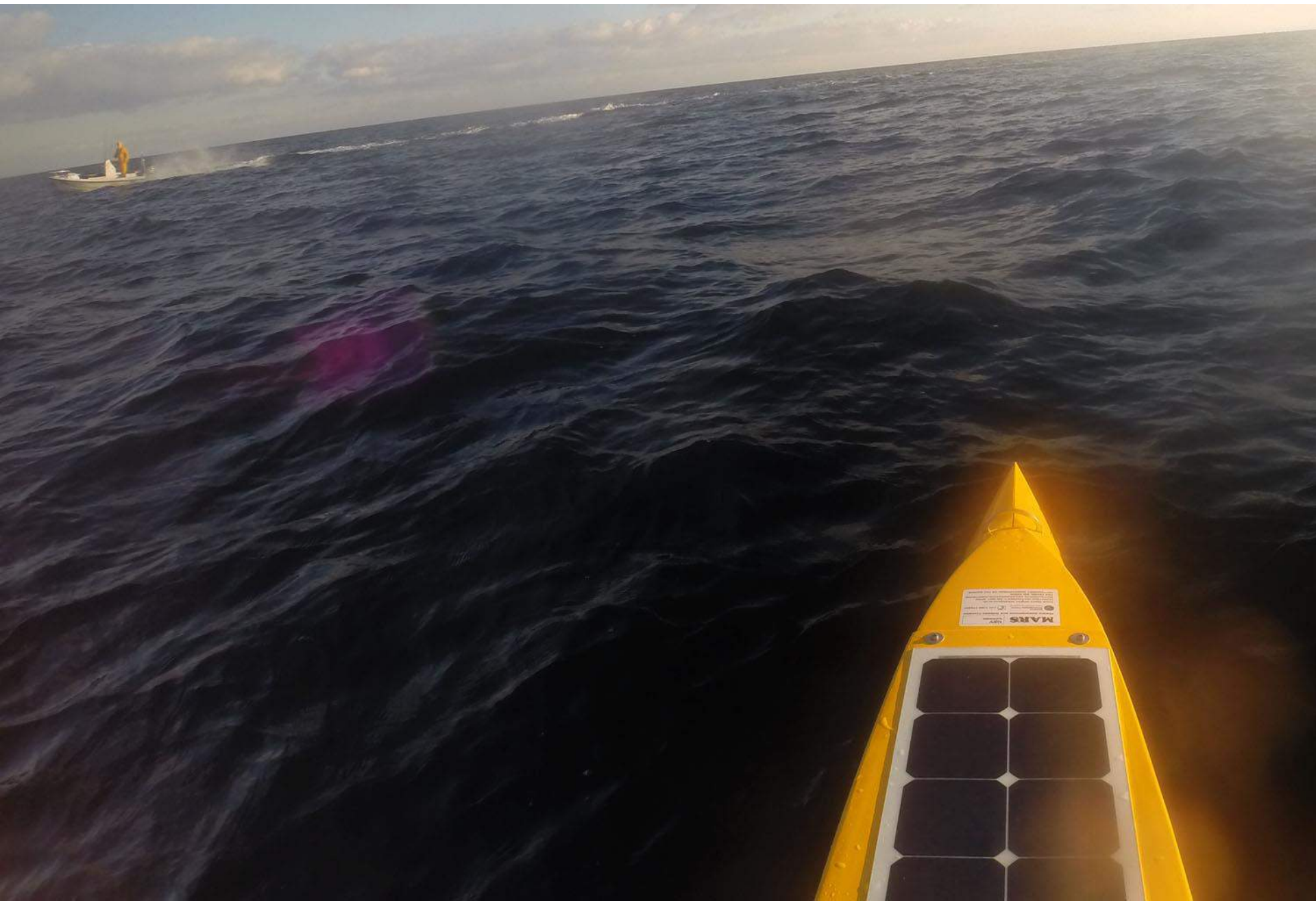
GoPro image from Autonaut showing floating weed mat



GoPro image from Autonaut showing floating rope and other debris



GoPro image from Autonaut showing small fishing boat



GoPro image from Autonaut showing Royal Navy vessel



GoPro videograb from Waveglider SV3 showing Harbour Porpoise



MASSMO Phase 2

Fish tracking using Unmanned Surface Vehicles (USVs) and seabed receivers

- MBA has expertise in fish movement analyses and acoustic tagging techniques
- Plymouth area has several new management zones (e.g. MCZs)
- USVs are now capable of carrying equipment for acoustic fish tracking



USVs fitted with acoustic receivers

85 rays and flatfish tagged and released



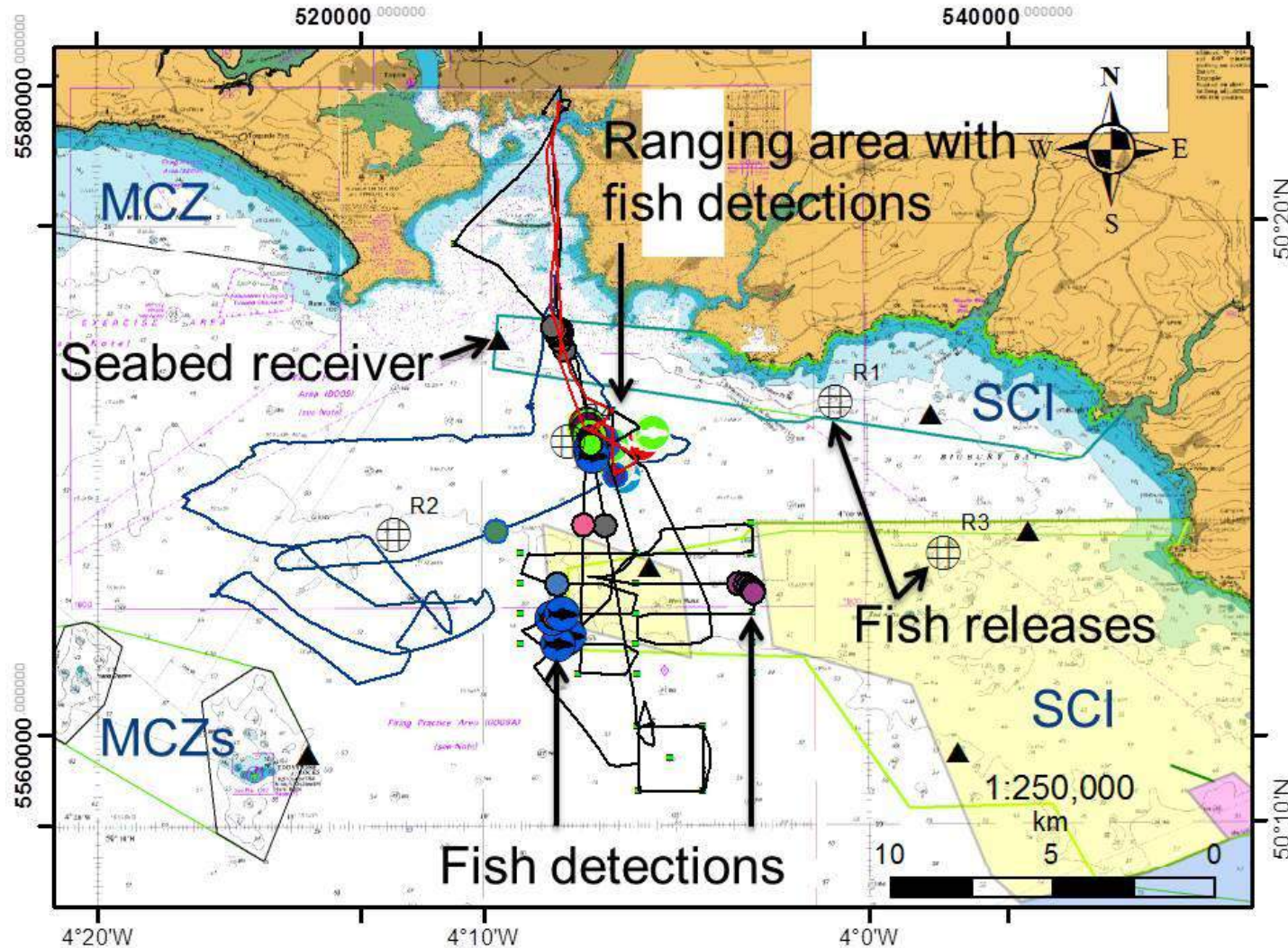
Est. 1884
Incorporated by
Royal Charter 2013



Seabed receivers deployed

MASSMO Phase 2

Fish tracking using Unmanned Surface Vehicles (USVs) and seabed receivers



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Royal Charter 2013

SV3

AutoNaut

C-Enduro

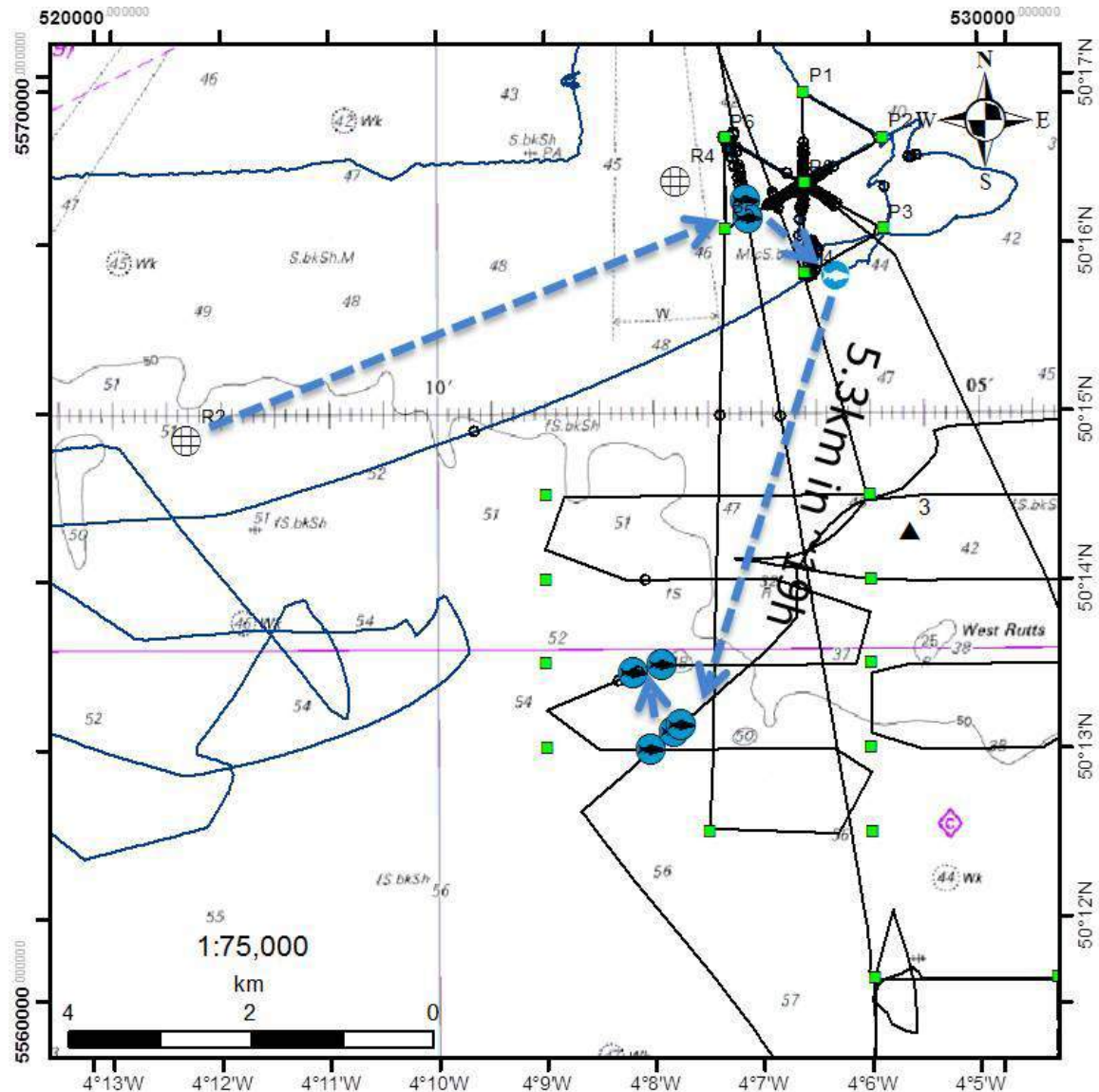
- Autonaut logged 60 detections from 7 fish; SV3 logged 50 detections from 15 fish
- 3 plaice moved up to 6.5 km in ~48 hours

MASSMO Phase 2

Fish tracking using Unmanned Surface Vehicles (USVs) and seabed receivers

4 plaice detected by both Autonaut and SV3, e.g. PLE1466

- Released at R2 on 14/10
- Detected by SV3 at 1500 hrs on 04/11
- Detected by Autonaut at 1822 hrs same day (~1.1km)
- 5 further detections by SV3 on 05/11; moved 5.3km in 19h (~280m h⁻¹), then 0.9km in 1h



Est. 1884
Incorporated by
Royal Charter 2013

MASSMO media coverage



2 October 2014 Last updated at 18:01

Big robot fleet takes to UK waters



By David Shukman
Science editor, BBC News



The BBC's David Shukman: "We are now entering a new era of almost constant observation of the oceans"

A fleet of marine robots is being launched in the largest deployment of its kind in British waters.

Unmanned boats and submarines will travel 500km (300 miles) across an area off the southwestern tip of the UK.

The aim is to test new technologies and to map marine life in a key fishing ground.

In total, seven autonomous machines are being released in a trial heralded as a new era of robotic research at sea.

Two of the craft are innovative British devices that are designed to operate for months using renewable sources of power including wind and wave energy.

The project, led by the **National Oceanography Centre**, involves more than a dozen research centres and specialist companies.

Chief scientist Dr Russell Wynn told BBC News: "This is the first time we've deployed this range of vehicles carrying all these instruments."

Drones of the deep

Marine robots come in a variety of strange shapes and sizes, and no fewer than four different types

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New underwater robots set to revolutionise marine science



National Oceanography Centre launches ambitious new project

CHRIS GREEN Tuesday 07 October 2014



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A fleet of seven aquatic robots has been launched into the ocean off the south west of England, ushering in a new era of marine research carried out by unmanned vehicles.

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Project management software

100% Web: schedule, track, report. 250 000+

The project, led by marine researchers at the National Oceanography Centre (NOC) in Southampton, is the most ambitious of its kind in Europe. The selection of crafts will travel 300 miles



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Marine Autonomous Systems in Support of Marine Observations (MASSMO)

Capital investment



[dstl]

SBRI Government challenges. Ideas from business. Innovative solutions.

NERC
SCIENCE OF THE ENVIRONMENT

Eight Great Technologies

David Willetts

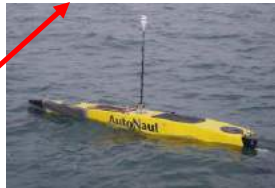
Policy Exchange



Supporting business



MOST
(Autonomous Vessels)



ASV unmanned marine systems



RS AQUA

LIQUID ROBOTICS

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Everywhere you look

Joint operations



National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Cefas

Isles of Scilly
IFCA
Inshore Fisheries and Conservation Authority



Public engagement



BBC

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Research projects

UNIVERSITY OF
EXETER

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Data management

BODC British Oceanographic Data Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

End users

Department for Environment Food & Rural Affairs

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ROYAL NAVY

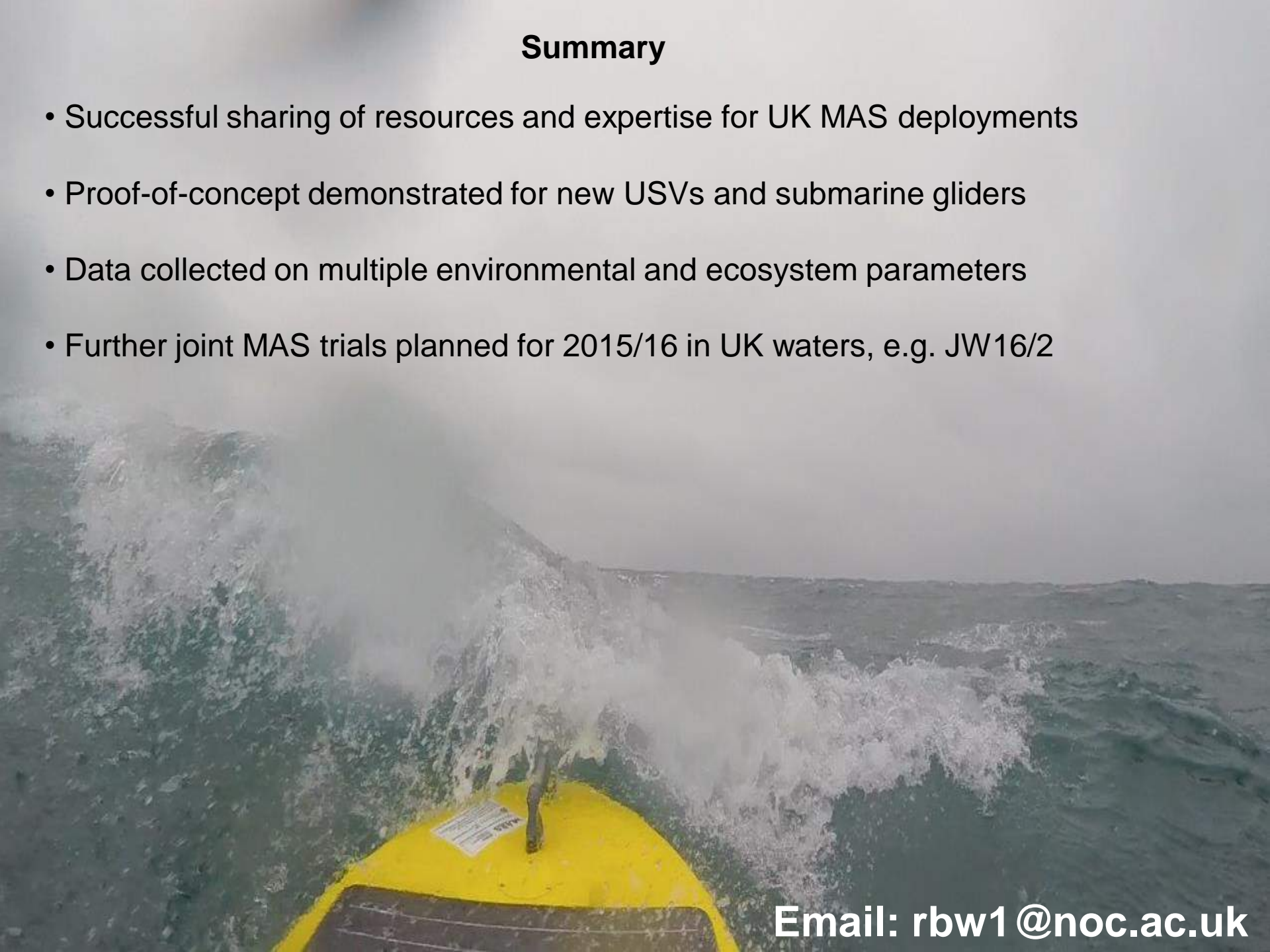
SHELF SEA BIOGEOCHEMISTRY
www.uk-ssb.org

Operational products

PML Plymouth Marine Laboratory

Summary

- Successful sharing of resources and expertise for UK MAS deployments
- Proof-of-concept demonstrated for new USVs and submarine gliders
- Data collected on multiple environmental and ecosystem parameters
- Further joint MAS trials planned for 2015/16 in UK waters, e.g. JW16/2



Email: rbw1@noc.ac.uk

The Seabird Group (UK and Ireland)



supporting research and conservation

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The Seabird Group's mission

The Seabird Group, a registered charity, was founded in 1966 to promote and help coordinate the study and conservation of seabirds. It maintains close links with other national and international ornithological bodies. Members receive, and can contribute to, regular newsletters, and the colour journal *Seabird*, published annually. The Group organises regular international conferences and provides small grants towards research and survey projects. It was part of the SEABIRD 2000 partnership, a major initiative to census all the seabirds breeding in Britain and Ireland between 1998 and 2002. The Group actively encourages its members to get involved in surveys of seabirds and other research work.



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