Marine Autonomous Systems:
new developments and applications in marine mapping and monitoring

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National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Dr Russell B Wynn

MAREMAP
Marine Environmental Mapping Programme

Marine mapping and monitoring: a perfect storm…….

Policy change

Increasing

Statutory obligations (marine monitoring)

Anthropogenic change

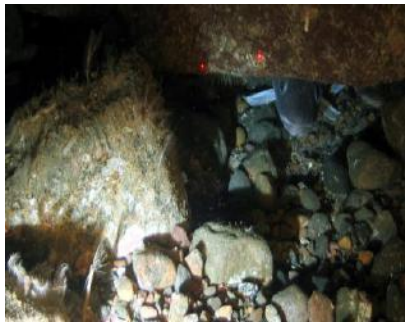
Increasing

Human activities

Environmental change

Increasing

Data resolution (spatial + temporal)



Economic change

Increasing

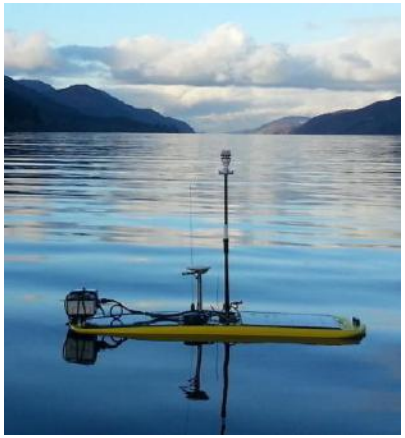
Monitoring costs (vessel fuel oil)

£75M

£86M

Rise of the Machines……

Marine Autonomous and Robotic Systems at NOC (MARS)



1) Autonomous Underwater Vehicles (AUVs)

- *Autosub3 (1600 m WD)*
- *Autosub6000 (6000 m WD)*
- *Autosub LR (6000 m WD)*

2) Submarine Gliders

- *4 x Slocum 200 m*
- *4 x Slocum 1000 m*
- *4 x Seaglider 1000 m*

3) Unmanned Surface Vehicles

- *1 x Liquid Robotics Waveglider*

4) Remotely Operated Vehicles

- *ROV Isis*
- *HyBIS*

- 16 vehicles, increasing to 40 by end of 2014/15
- £10M capital investment in 2013-15

Autosub Long Range – a new AUV with ultra long range and endurance

6000 km, 6 months, 6000 m, 600 kg AUV

Across ocean basins, long persistence, seasonal hibernation

First planned science missions during NERC FASTNEt Research Programme in 2014

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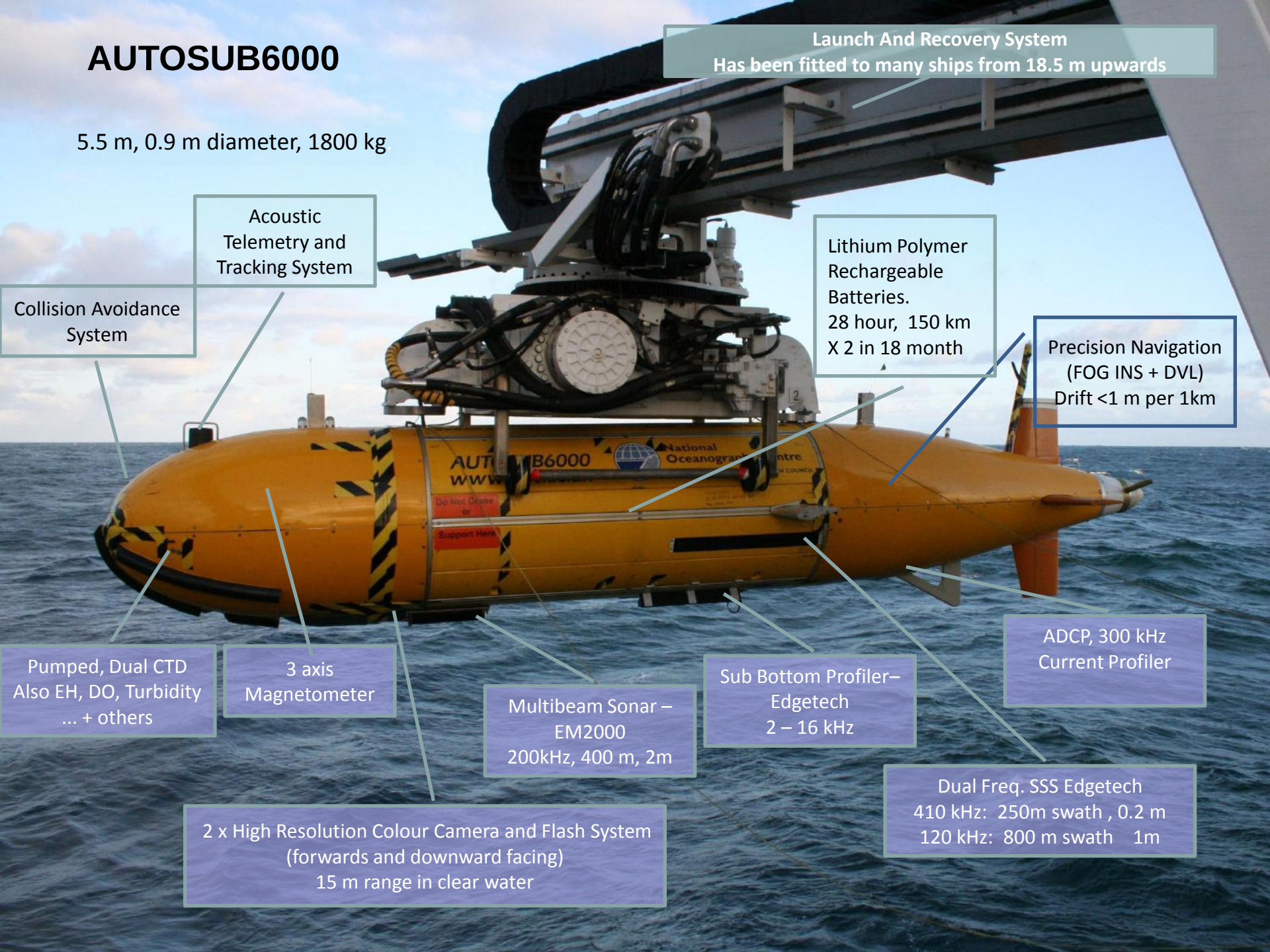
AUTOSUB6000



High-resolution photomosaics of the deep seafloor at 5000 m WD

- Autosub6000
- >100,000 individual seafloor images
- Largest continuous deep-sea photo
- Automated image recognition required!

Marine Imaging Workshop

7-10 April 2014
National Oceanography Centre
Southampton, UK

Themes

- Image collection
- Strategies and practicalities
- Processing of images
- Including correction for colour, size, and camera position
- Still image/video annotation
- Annotation strategies for large data sets
- Including automation and crowd sourcing
- Data management

Important Dates

2 December 2013	Registration and abstract submission open
15 January 2014	Abstract submission deadline
7 February 2014	Abstract acceptances announced
14 February 2014	Registration and photo competition entry deadline
7-10 April 2014	Workshop

For more information or to register go to marine-imaging-

Innovative under-ice and deep-sea vent studies with Autosub AUV

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UK scientists to probe Pine Island Glacier

By Jonathan Amos
Science correspondent, BBC News

Jonathan Amos explains how snow tractors, robot subs and seals with sensors will help study the glacier

UK scientists are about to set out for Antarctica to investigate the mighty Pine Island Glacier.

The PIG drains about 10% of all the ice sliding off the west of the continent, and has seen a marked thinning and a surge in velocity in recent decades.

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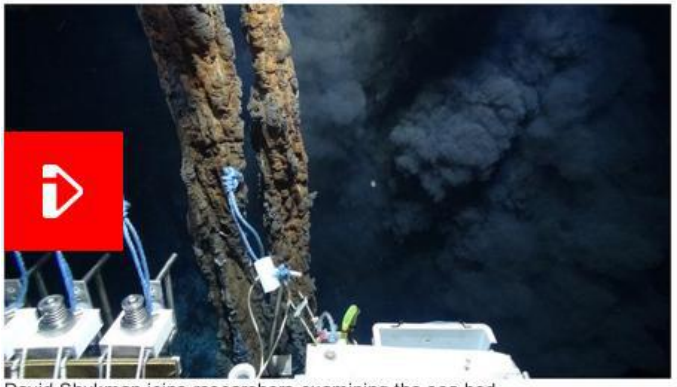
Deepest undersea vents discovered by UK team

By David Shukman
Science editor, BBC News



David Shukman joins researchers examining the sea bed

UK scientists exploring the ocean floor in the Caribbean have discovered an "astounding" set of hydrothermal vents, the deepest anywhere in the world.

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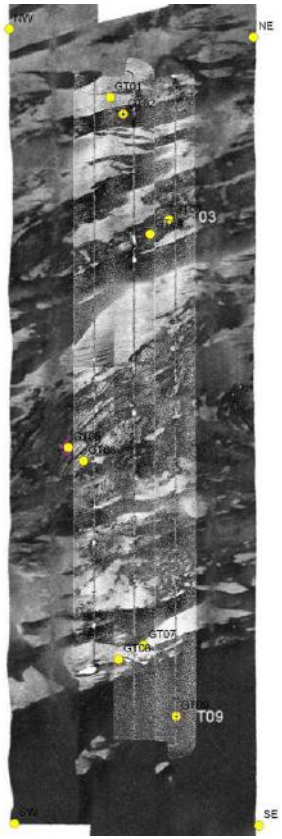
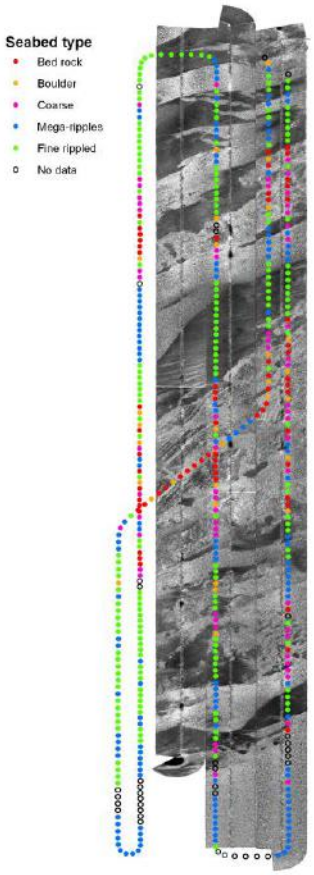
"We will foster UK and international partnerships so that business, government, civil society and scientists can work together to address the challenges of managing the marine environment "

Shallow-water AUV surveys of the Haig Fras rMCZ off southwest UK at 100 m WD





• High-resolution AUV multibeam bathymetry and sidescan sonar data **compared well** with equivalent vessel-based data from the same area (obtained by Cefas as part of the MCZ evidence programme)

• Autosub6000 also collected valuable water column data and a total of **15,000 full-colour seafloor photos**

• The integrated dataset illustrates the potential of AUVs for producing **ground-truthed habitat maps**

• The site will be revisited in late summer 2014 to assess **natural change** and AUV repeat survey methods

Submarine gliders for acoustic monitoring

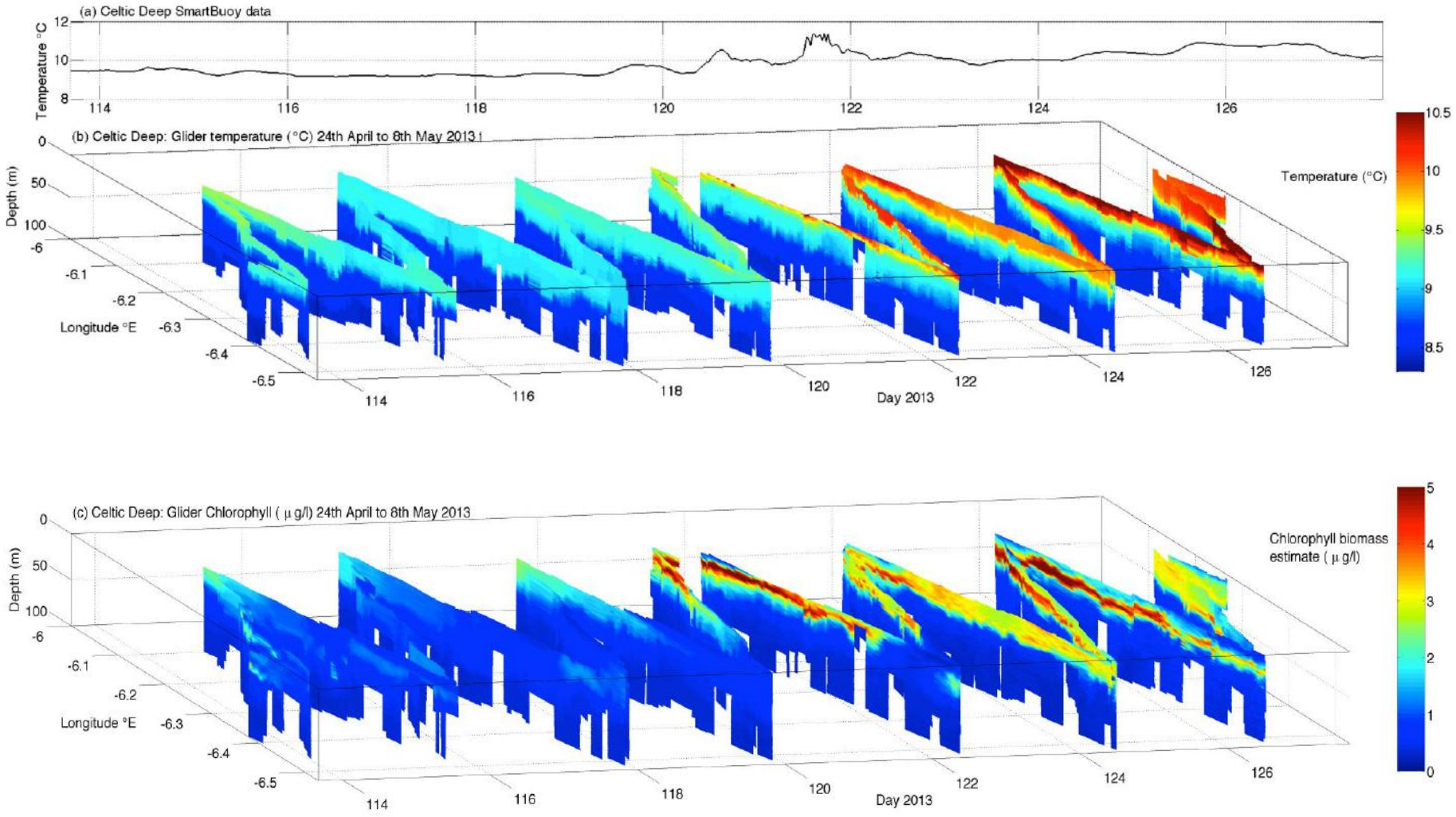
2 x shallow-water Slocum gliders running in tandem
One month deployment off SW UK in Sept-Oct 2013
Monitoring of multiple abiotic and biotic parameters

CTD and fluorometer (abiotic data and phytoplankton)
120 kHz echo-sounder (zooplankton and pelagic fish)
D-TAG Passive Acoustic Monitor (small cetaceans)
Hydrocarbon sensor

Damien Guihen
British Antarctic Survey

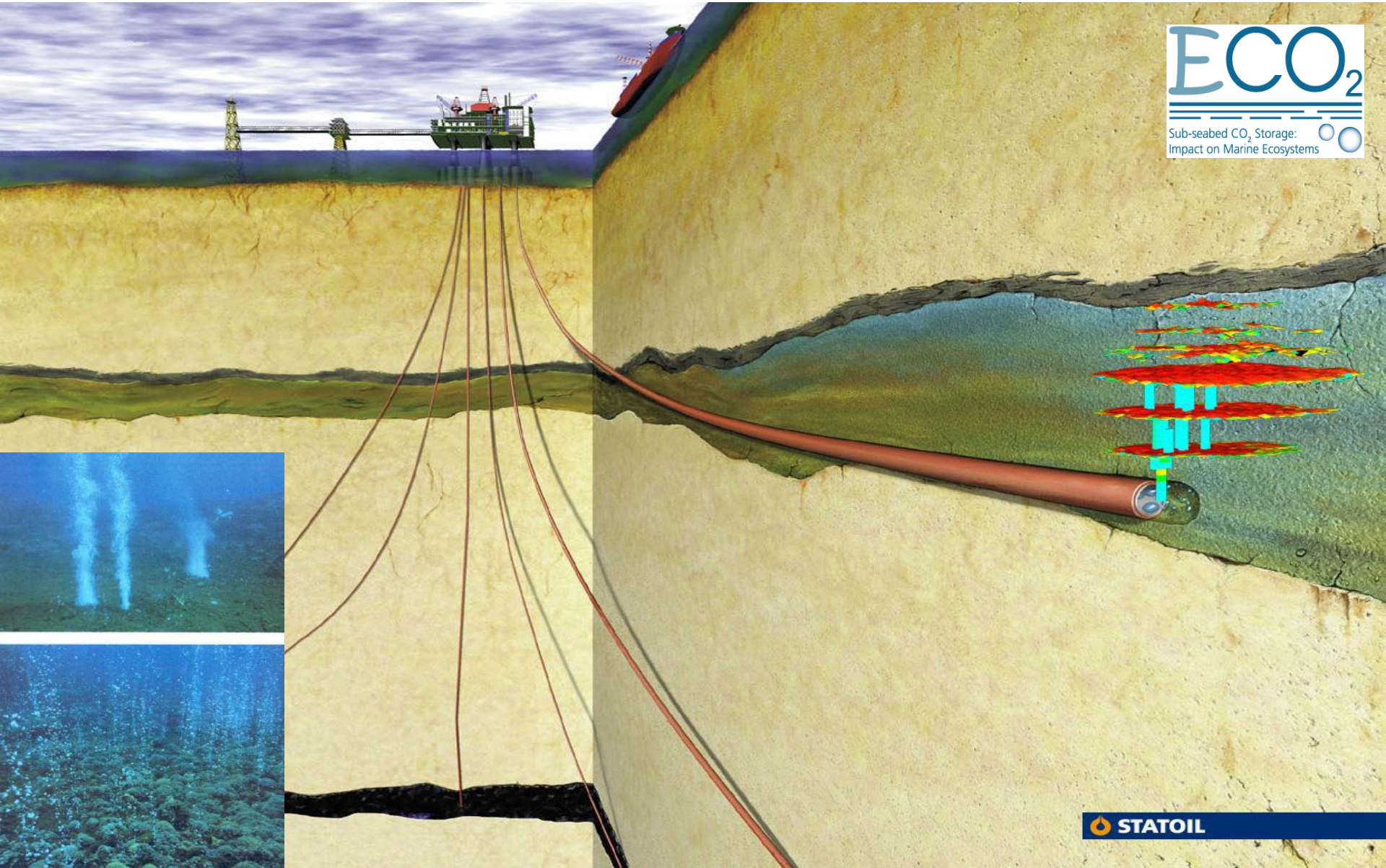
Shallow-water glider surveys over the Celtic Deep

• Deployment of a NERC **shallow-water Slocum glider** over the Celtic Deep in spring 2013, to monitor onset of density stratification and the phytoplankton response (6 repeat transects in 15 days, measuring T, S, O_2, Chl, CDOM and Optical Backscatter)



Sub-seabed CO_2 storage - monitoring leakage and ecosystem impacts

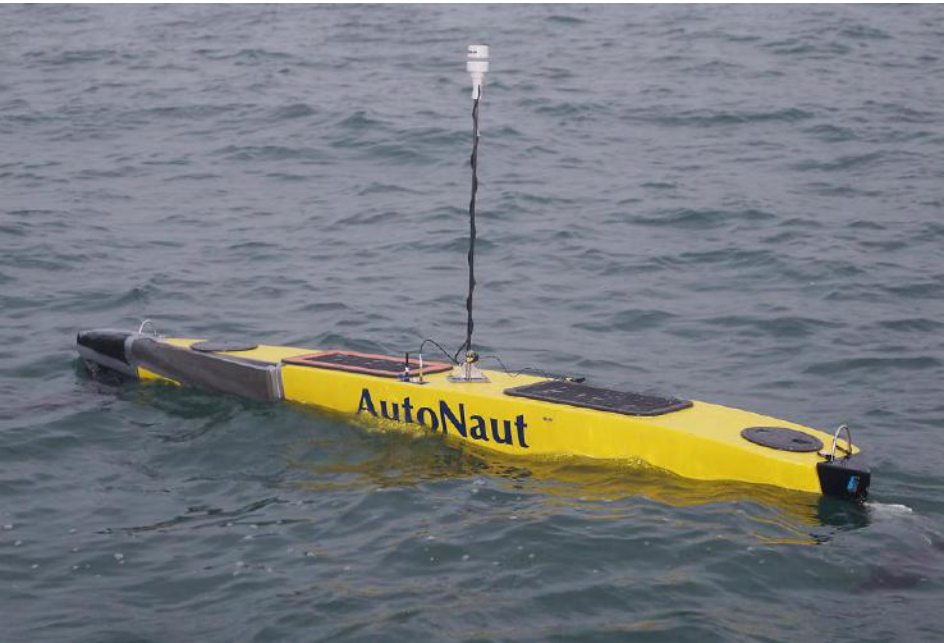
Autosub6000 with Eh, Ph and CO_2 sensor – deployed over Sleipner CCS site in northern North Sea



Long Endurance Marine Unmanned Surface Vehicles (LEMUSV)

- Small Business Research Initiative (SBRI); focus on UK SMEs
- Funded by TSB, NERC and DSTL, managed by NOC
- Two companies (MOST and ASV) selected to build and test prototypes
- Ideal platforms for upper water column, metocean and acoustic data collection
- Further trials and proof-of-concept studies being undertaken throughout 2014

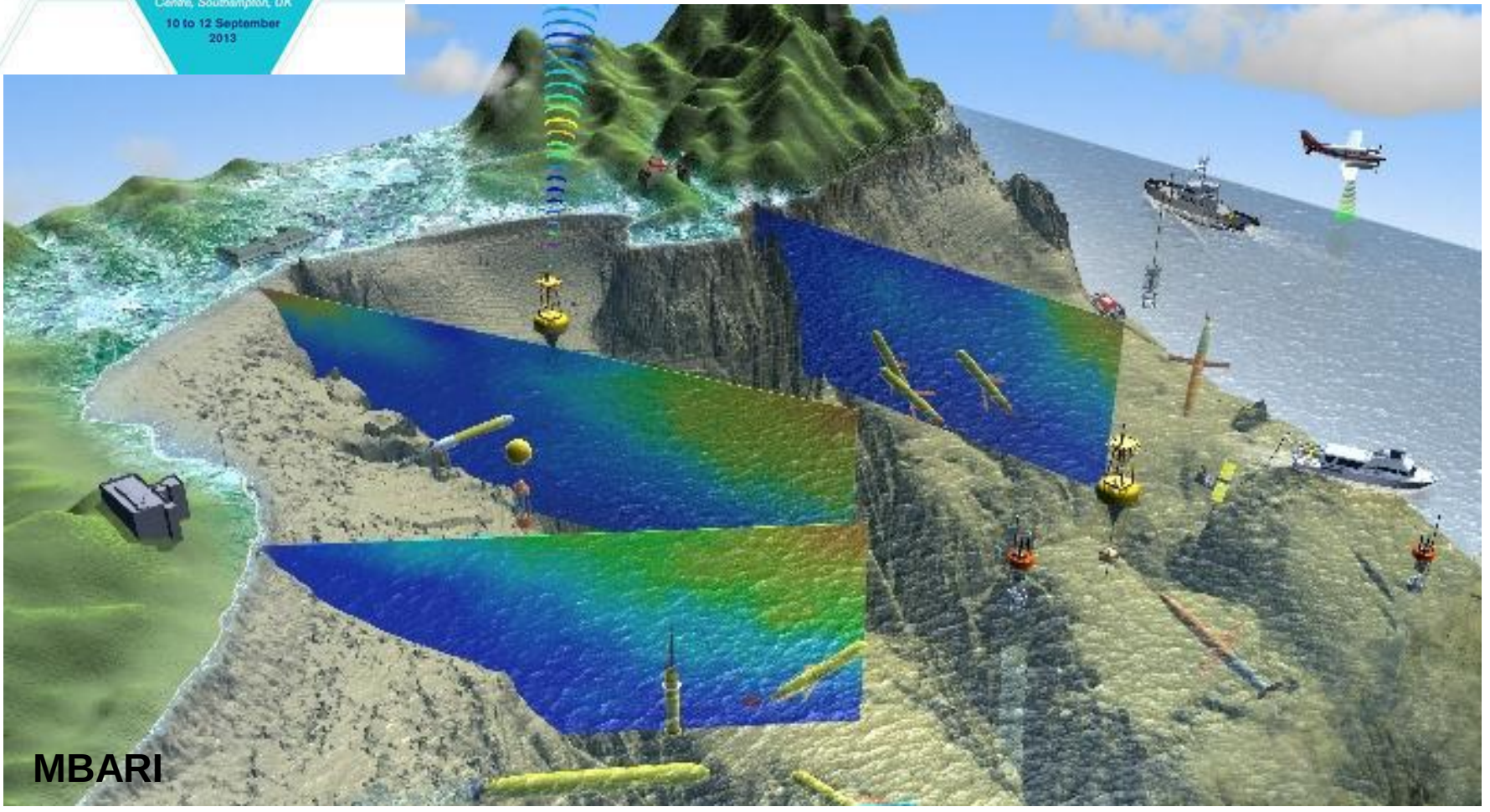
MOST 'AutoNaut'



ASV 'C-Enduro'

Working towards an integrated marine mapping and observing network in UK waters

- Sharing resources and expertise; “doing more for less”
- Tackling legal, technological and operational issues
- Co-funding proof-of-concept studies with partners



UK Marine Environmental Mapping Programme (MAREMAP)

In 10 years the aspiration for MARS is to be able to 1) deploy MAS in any part of the world's ocean, at any depth, 2) use MAS to map and monitor a comprehensive range of marine parameters of importance to science, policy and industry, at the full range of spatial and temporal scales required, and 3) rapidly deploy MAS in response to any marine event requiring urgent monitoring

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