Technology for biology measurement and survey

Author: Matt Mowlem
Date: 30/06/2016
Version: 1
Decent to depth

Argo float cycle

Transmission of data via satellites

Repeat process

Sea surface

Current float depth range

Drift approx. 9 days

Drift 10~30 days

1000 meters

Temperature & salinity profile recorded during ascent from greater depth

Sparse observations

2000 meters

4000 meters

Deep NINJA float cycle
Contextual sensors

• CTD
• Oxygen
• Nutrients
• Carbonate system
Commercial in situ examples

SeapHOx  SBE52  CTD  SEAFET  SBE43F  DO  SUNA (nitrate)  Aanderaa 4830
CT-DO Sensor

![Graph showing depth vs. $c_{ox}$ concentration for different CTD station numbers](image)

CTD station #
- 118
- 119
- 120
- 121
- 122
- 123
- 124
- 125
Nitrate deployment on gliders

• Celtic Sea, April 2015

Alex Vincent & Maeve Lohan, NOC / SOES (U. Soton)
Temperature (°C)

Chlorophyll (mg/m³)

Nitrate (µM)
Lab on chip

- Lab on chip: Nitrate, Nitrite, pH, Phosphate, Silicate, Iron, Manganese, Total Alkalinity, Ammonia, DOP, Dissolved Inorganic Carbon, DON, PCB, PAH,
Nitrate deployment on gliders

• Celtic Sea, April 2015

Alex Vincent & Maeve Lohan, NOC / SOES (U. Soton)
New pCO₂ Optode
(WP6.1, jointly with KM CONTROS)

- Successful development of CONTROS O₂ optode
- pCO₂ optode based on dual luminophore referencing technique (DLR)
- Prototype of CONTROS pCO₂ optode available in 2nd half of 2016
- Intensive lab testing of different DLR variants (frequency-domain vs. time-domain DLR)

→ Ph.D. project by Tobias Hahn funded by H2020/AtlantOS:
Laboratory and field testing of novel O₂ and pCO₂ optodes and their application in chemical oceanography
<table>
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<tr>
<th>IOOS Core</th>
<th>GOOS EOV</th>
<th>GEO BON EBV</th>
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<tr>
<td>Microbial species, abundance and activity&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Microbes</td>
<td>Genetic composition</td>
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<td>Phytoplankton species and abundance</td>
<td>Phytoplankton biomass and productivity</td>
<td>Species populations</td>
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<td>HAB Incidence</td>
<td>Species traits</td>
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<td>Invertebrate species and abundance&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Zooplankton diversity</td>
<td>Community composition</td>
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<td>Fish species and abundance</td>
<td>Fish abundance &amp; distribution</td>
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<td>Coral species and abundance</td>
<td>Live coral cover</td>
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<td>Submerged vegetation species and abundance</td>
<td>Seagrass cover</td>
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<td>Sea turtle species and abundance</td>
<td>Mangrove cover</td>
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<td>Seabird species and abundance</td>
<td>Macroalgal canopy cover</td>
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<tr>
<td>Marine mammal species and abundance</td>
<td>Apex predator abundance and distribution</td>
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<td>Microbes/ Phyto</td>
<td>Zooplankton</td>
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# Biology and Ecosystems EOV feasibility in 2030

| **Phytoplankton biomass and productivity** | biomass: Fluorescence (qualitative only); multispectral fluorescence (qualitative); cytometry (semi quantitative), Nucleic acid amplification (semi quantitative), absorbance, underwater microscopy |
| **Harmful Algal Bloom (HAB) incidence** | NAA, cytometry, toxin biosensor, hyperspectral obs. |
| **Zooplankton diversity** | multifrequency active acoustics, imaging, NAA / eDNA |
| **Fish abundance and distribution** | Active acoustics, OTN / tagging, biotelemetry, passive acoustics, imaging, multifrequency active acoustics, imaging, NAA / eDNA |
Biology and Ecosystems EOV feasibility in 2030

| Apex predator abundance and distribution | Active acoustics, OTN / tagging / biotelemetry, passive acoustics, imaging, multifrequency active acoustics, NAA / eDNA |
| Live coral cover                       | hyperspectral imaging (above or in water, during day, best in the NIR), imaging, respirometry, carbonate parameters / stoichiometry for larger scale |
| Sea grass cover                        | hyperspectral and imaging / thermal imaging, high tide low tide |
| Mangrove cover                         | imaging (remote sensed) |
| Macroalgual canopy cover               | in situ imaging and sonar altimetry / good bathym. Data |
Biology and Ecosystems EOV feasibility in 2030

<table>
<thead>
<tr>
<th>nekton diet</th>
<th>animal tag, faecal (NAA/analysis), eDNA, anatomy sample stable isotope analysis. Sediment traps Incorporation rate: e.g. Seal glide angle / behaviour from tagging</th>
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<tr>
<td>biological vital</td>
<td>respiration, growth feeding: Capture and incubation. Energy expenditure from tagging</td>
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<td>rates</td>
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Genomic sampling, HAB, plankton, eDNA

DTU working with DHI and MBARI to convert and evaluate existing ESP for eDNA
Cytometry: plankton HAB
Cytometer

- Simultaneous measurement of electrical (impedance) and optical properties of individual cells
- In-lab prototype
- No air required for optics or operation (suitable for deep sea)
- Challenges include sample concentration, and optical detection limits (power in chip)
Zooplankton: VPR
Particles/plankton: Holography
Phytoplankton productivity

Stoichiometry
Acoustic and optical imaging

Bathymetric Surveys

Agadir Canyon Scours
Cruise JC027 [2008]
Altitude 50 – 100m

Sidescan Surveys

Darwin Mounds (Rockall)
Cruise JC060 [2011]
Altitude 15 – 50 m

Photographic Surveys

Celtic Sea
Cruise DY008 [2014]
Altitude 2.2m

EH signal from JC44

Sub bottom profiler data
Pelagia 2013

ADCP data
Pelagia 2013

Magnetometer total field
(normalised)
Autonomous imaging

Photographic Surveys

Celtic Sea Cruise DY008 [2014]

60 km of camera survey
capturing ~37,000 images
Altitude of 2.2m
Photographic Surveys are not always easy

The problem with this work is that you have a very good chance of colliding with the seabed.
Assessing the potential of autonomous submarine gliders for ecosystem monitoring across multiple trophic levels (plankton to cetaceans) and pollutants in shallow shelf seas

Lavinia Suberg a,∗, Russell B. Wynn a, Jeroen van der Kooij b, Liam Fernand b, Sophie Fielding c, Damien Guihen c, Douglas Gillespie d, Mark Johnson d, Kalliopi C. Gkikopoulou d, Ian J. Allan e, Branislav Vrana f, Peter I. Miller g, David Smeed h, Alice R. Jones h

a National Oceanography Centre Southampton (NOC), European Way, Southampton SO14 3ZH, UK
b Centre for Environment, Fisheries and Aquaculture Science (CEFRAS), Peakefield Road, Lowestoft, Suffolk NR33 0HT, UK
c British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK
d Scottish Ocean Institute, East Sands, University of St Andrews, St Andrews, Fife, KY16 8LB, UK
e Norwegian Institute of Water Research, Oslo Centre Interdisciplinary Environmental & Social Research, Gastadalten 21, NO-0349 Oslo, Norway
f Masaryk University, Research Centre for Toxic Compounds in the Environment (RECTOX), Kamenice 753/5, 62500 Brno, Czech Republic
g Remote Sensing Group, Plymouth Marine Laboratory, Prospect Place, Plymouth PL1 3DH, UK
h The Environment Institute & School of Ocean and Earth Sciences, University of Adelaide, South Australia 5005, Australia
2D echosounder profiles comparing glider and vessel-based data

Examples of cetacean acoustic data collected using the glider-mounted PAM

Waveforms (A) and power spectra (B) of detected dolphin and porpoise clicks using the modified d-tag
Tagging
(Auto)sampling
Hyperspectral / remote imaging
AtlantOS objectives

• Recording and supporting emerging networks
• Technology roadmapping
• Development of (meta)genomic samplers
• EOV / EBDV feasibility assessment
• Best practice recording, coordination, development and dissemination
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 63321.