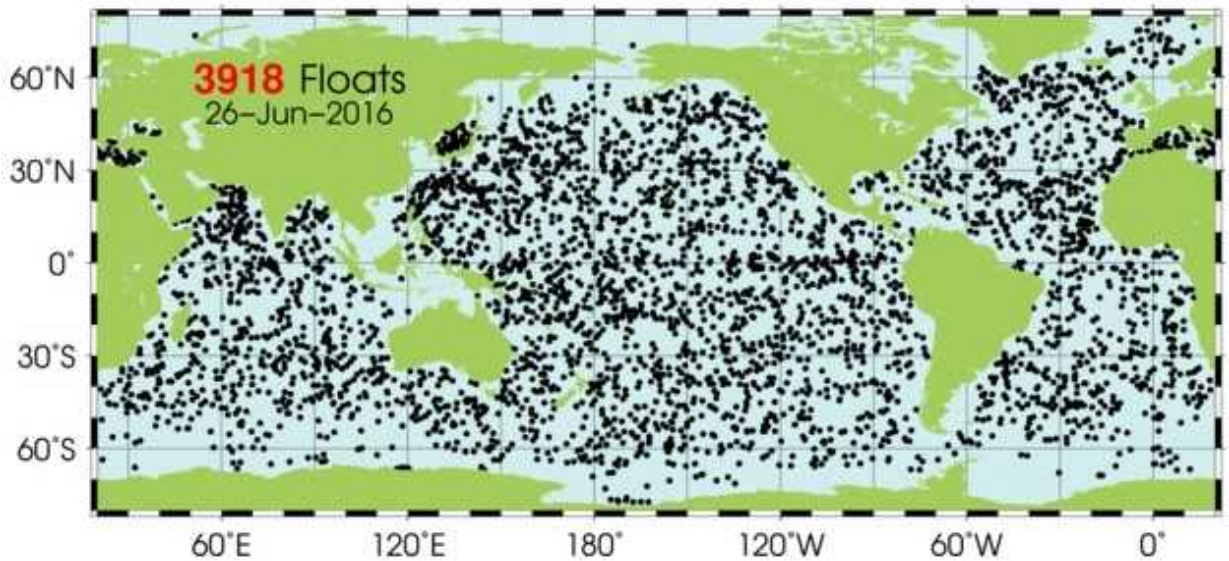
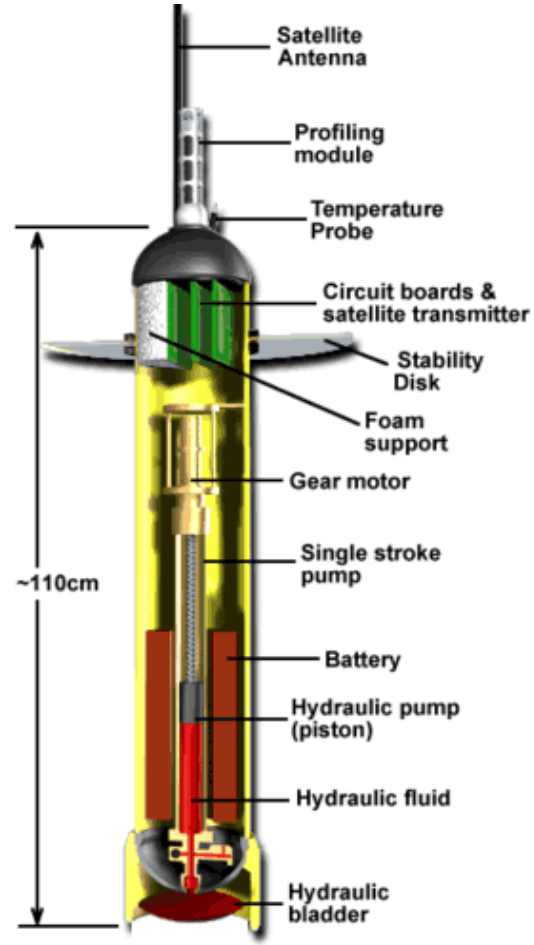
Technology for biology measurement and survey

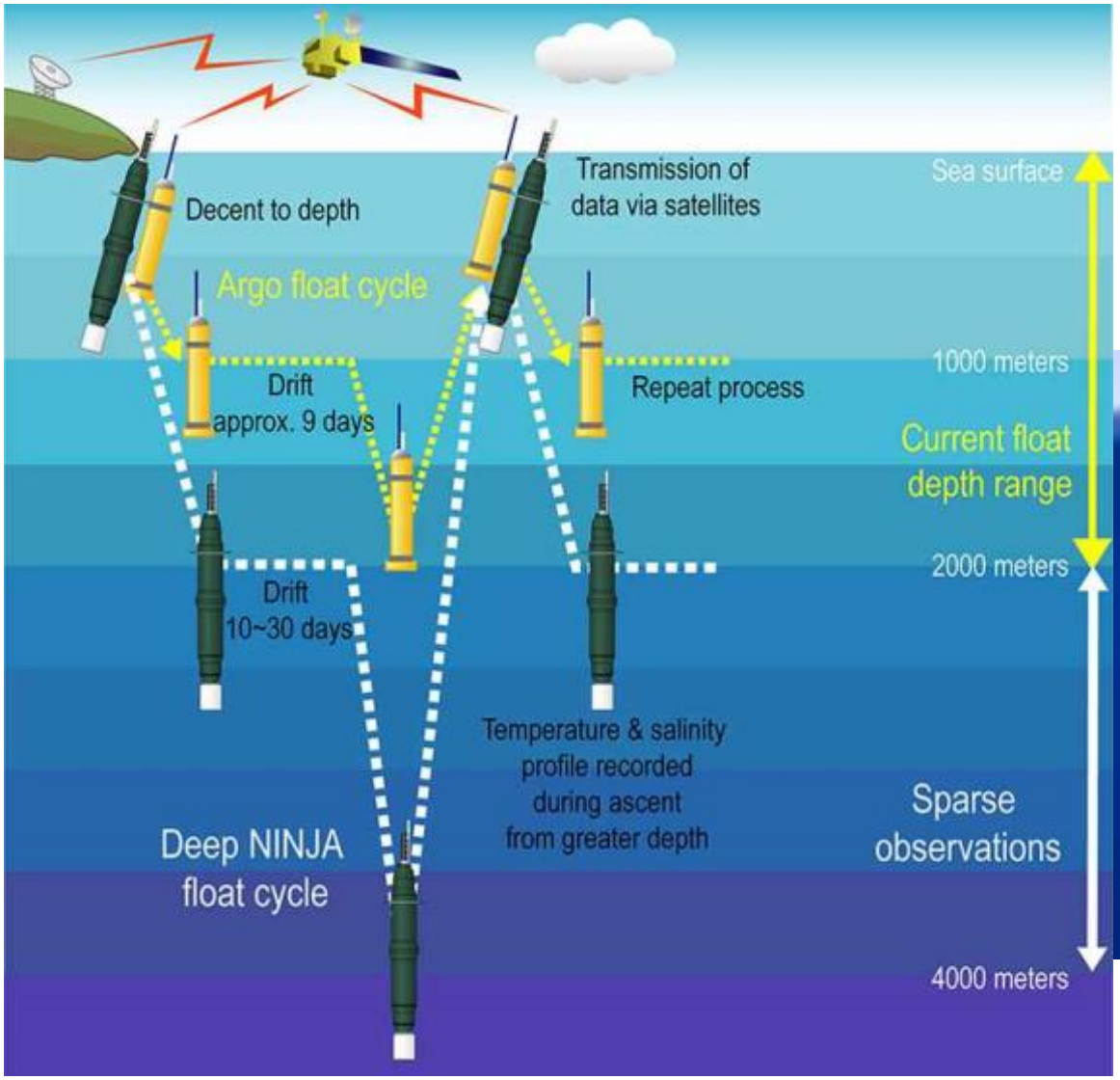
Author: Matt Mowlem
Date: 30/06/2016
Version: 1


DISCOVERY



http://www.argo.ucsd.edu/index.html




Transmission of
data via satellites
Sea surface
Decent to depth
Argo float cycle
1000 meters
Drift
approx. 9 days
Repeat process
Current float
depth range
2000 meters
Drift
10~30 days
Temperature & salinity
profile recorded
during ascent
from greater depth
Sparse
observations
Deep NINJA
float cycle
4000 meters

Contextual sensors

- CTD
- Oxygen
- Nutrients
- Carbonate system

Commercial in situ examples

SeapHOx

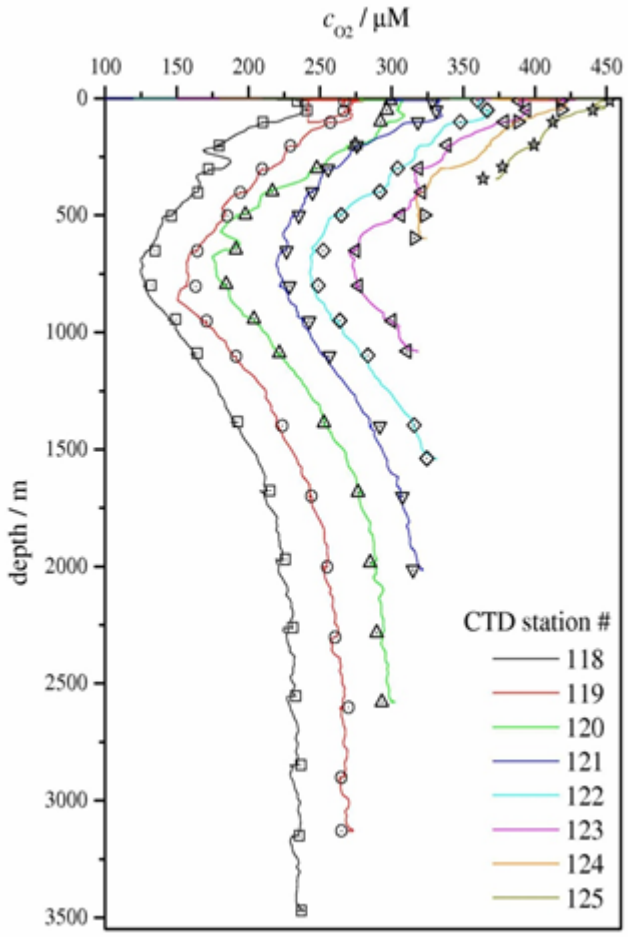
SBE52
CTD

SEAFET

SBE43F
DO
SUNA
(nitrate)

Aanderaa
4830

CT-DO Sensor


c_{O2} / µM
100
150
200
250
300
350
400
450
0
500
1000
1500
2000
2500
3000
3500
depth / m
CTD station #
118
119
120
121
122
123
124
125

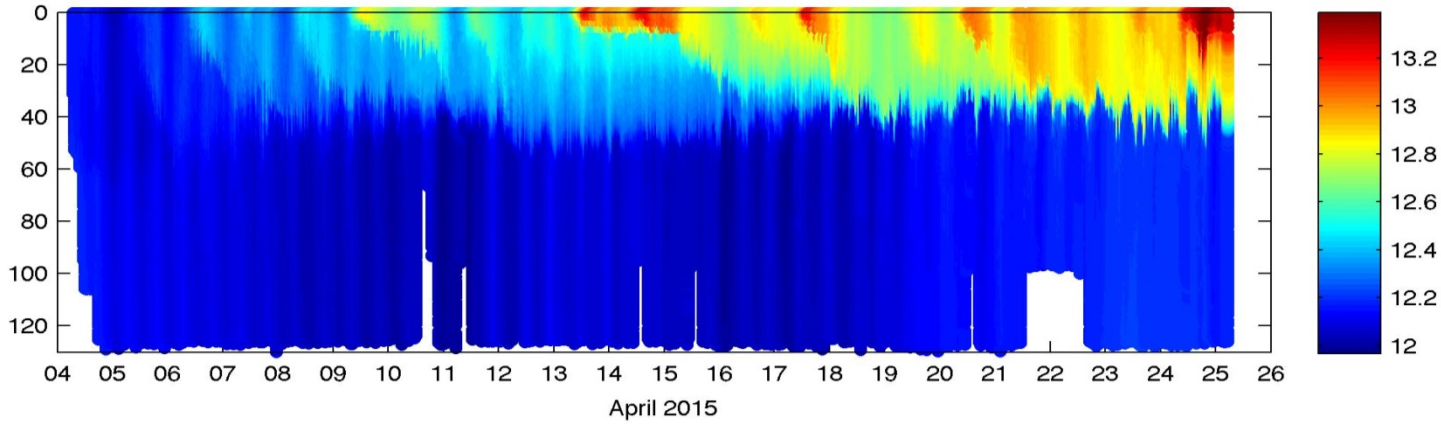

S

Nitrate deployment on gliders

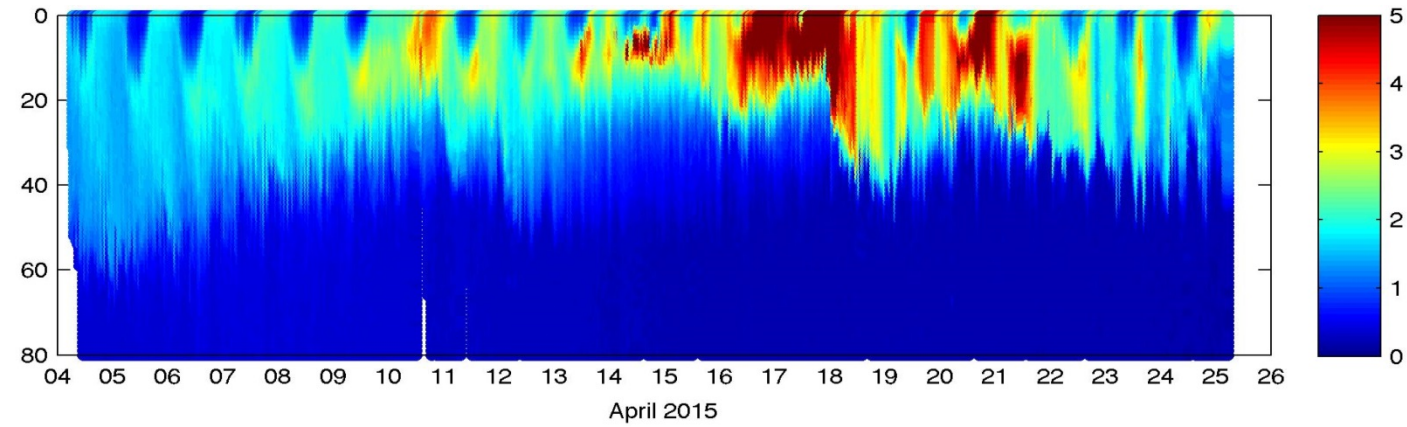
- Celtic Sea, April 2015

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

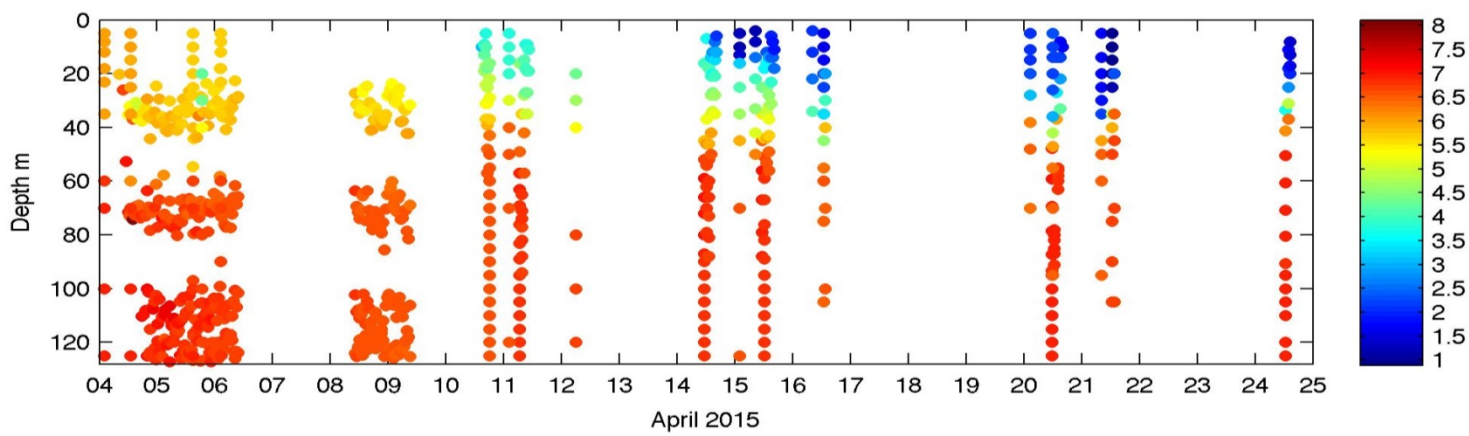
Temperature (°C)



Chlorophyll (mg/m^3)

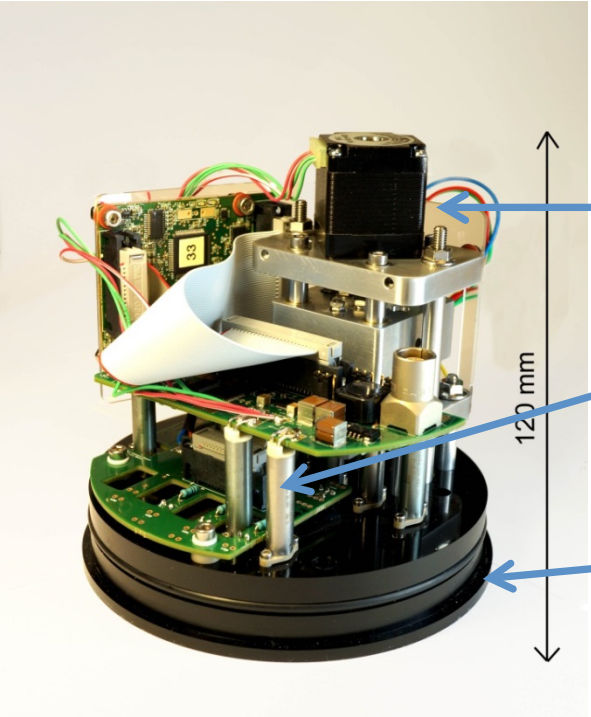


Nitrate (µM)



Lab on chip

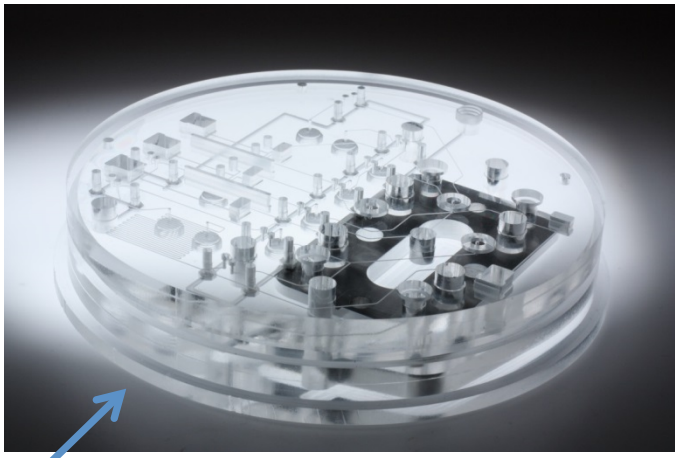
- Lab on chip: Nitrate, Nitrite, pH, Phosphate, Silicate, Iron, Manganese, Total Alkalinity, Ammonia, DOP, Dissolved Inorganic Carbon, DON, PCB, PAH,



Pump

Valves

Microfluidic Chip

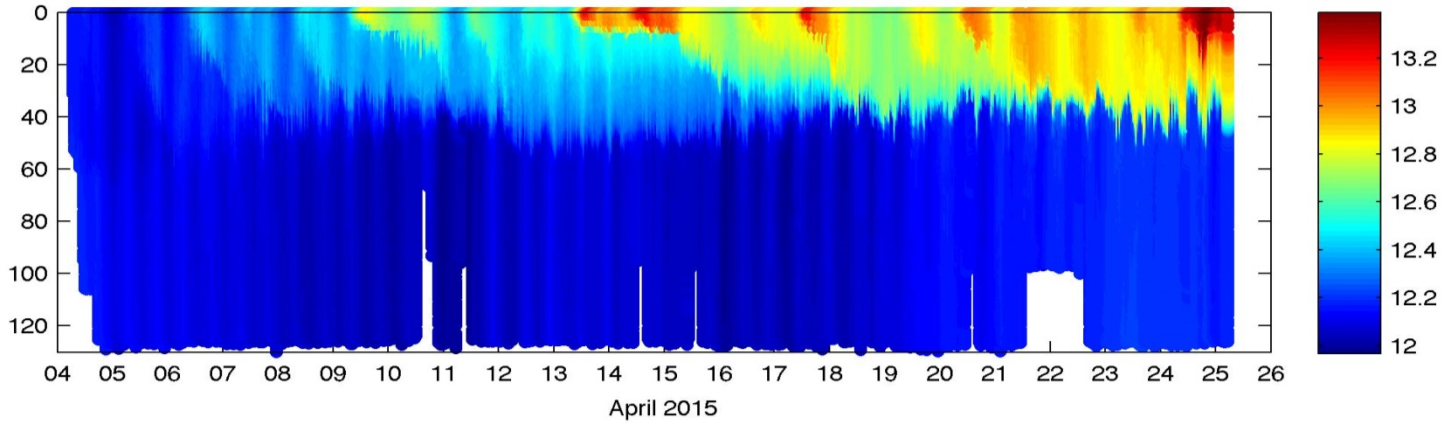


Nitrate deployment on gliders

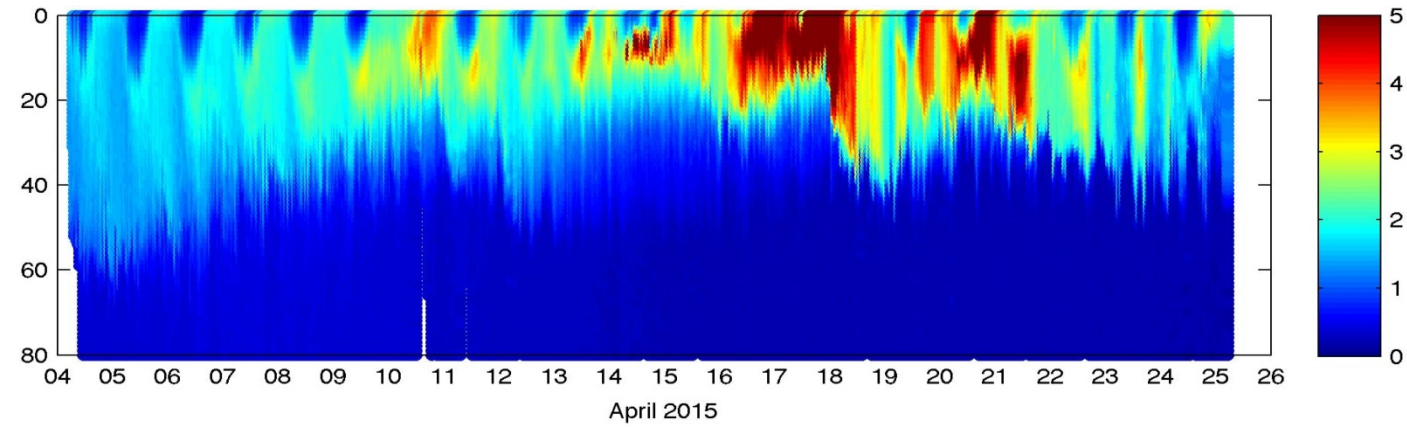
- Celtic Sea, April 2015

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

Temperature (°C)



Chlorophyll (mg/m^3)



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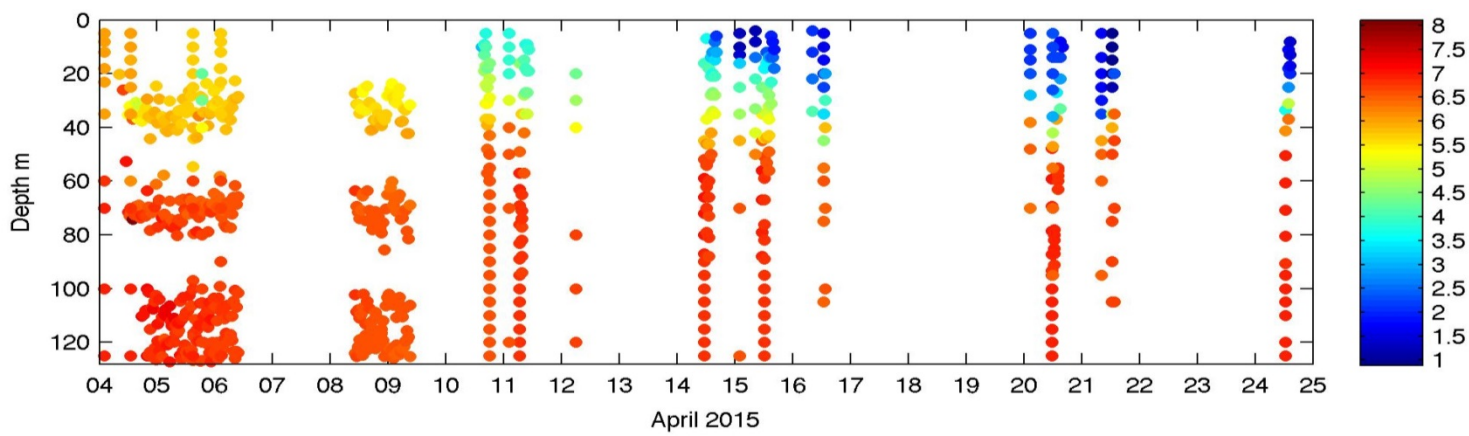
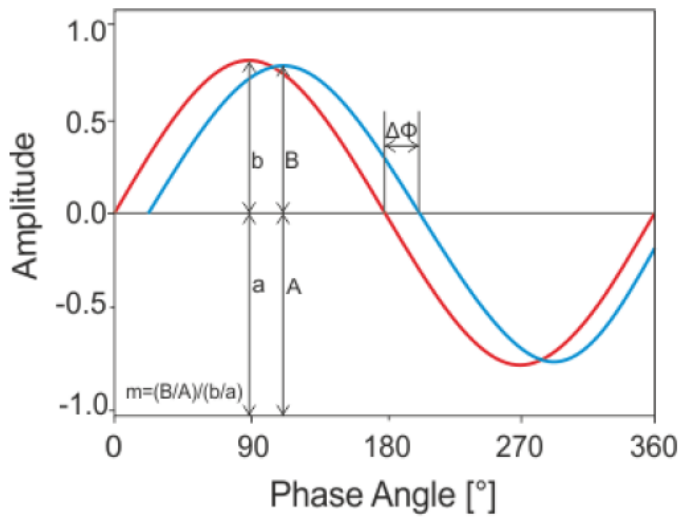


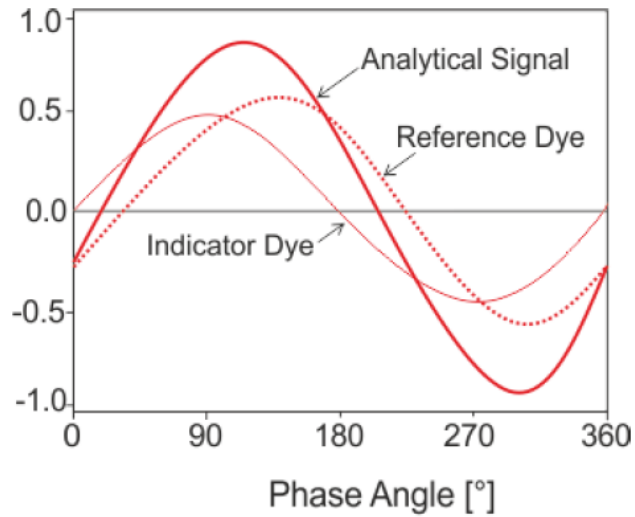
PI: Arne Körtzinger

New pCO_2 Optode

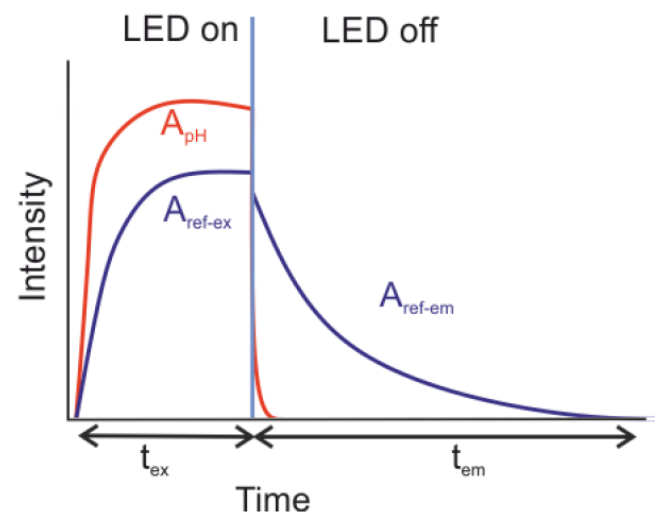
(WP6.1, jointly with KM CONTROS)

Clarke, J., Ph.D. Thesis, University of Southampton, 2015.

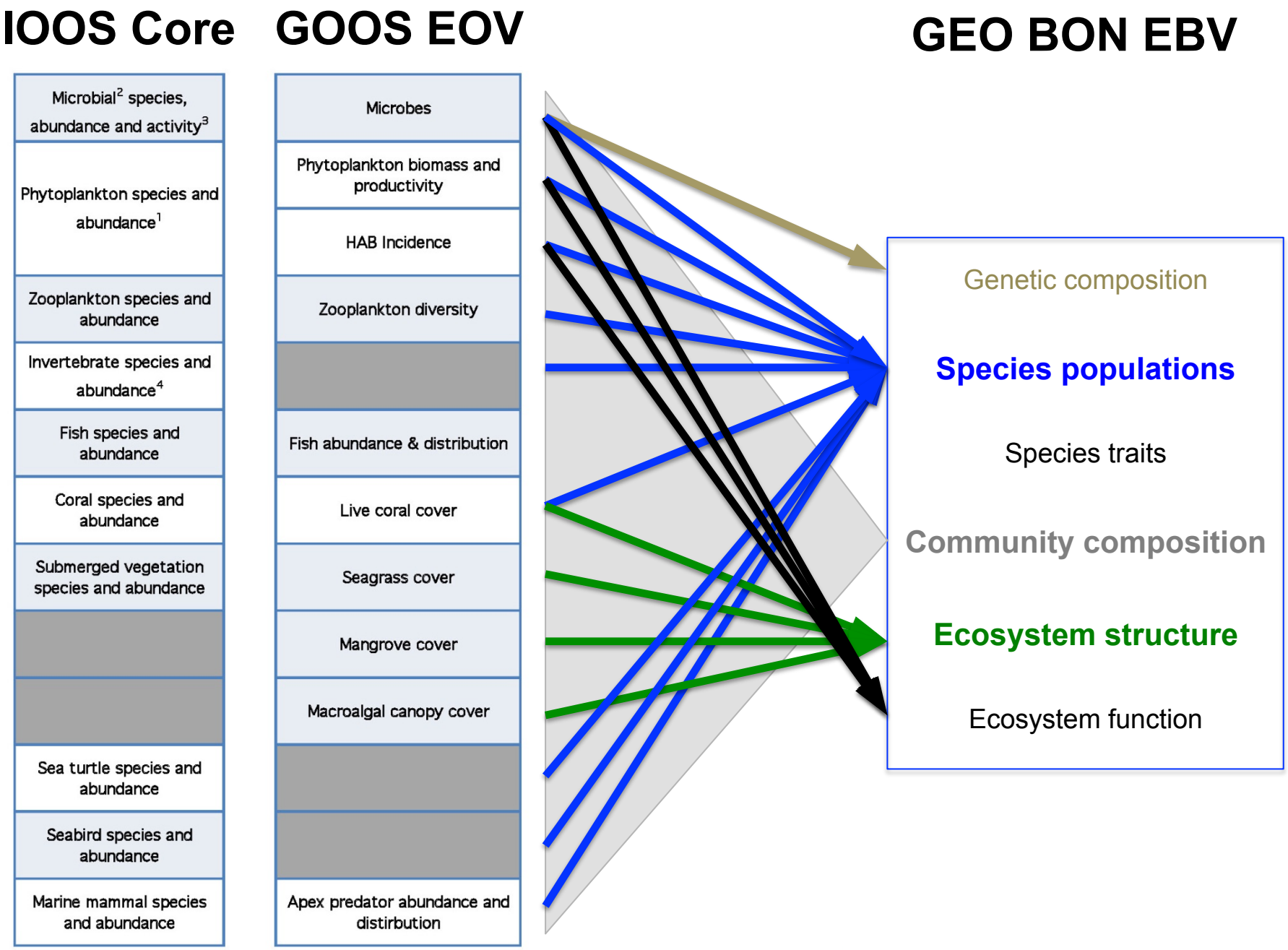




- Successful development of CONTROS O_2 optode
- pCO_2 optode based on dual luminophore referencing technique (DLR)
- Prototype of CONTROS pCO_2 optode available in 2nd half of 2016
- Intensive lab testing of different DLR variants (frequency-domain vs. time-domain DLR)



→ Ph.D. project by Tobias Hahn funded by H2020/AtlantOS:
Laboratory and field testing of novel O_2 and pCO_2 optodes and their application in chemical oceanography


IOOS Core
GOOS EOV
GEO BON EBV
Microbial[2] species, abundance and activity[3]
Phytoplankton species and abundance[1]
Zooplankton species and abundance
Invertebrate species and abundance[4]
Fish species and abundance
Coral species and abundance
Submerged vegetation species and abundance
Sea turtle species and abundance
Seabird species and abundance
Marine mammal species and abundance
Microbes
Phytoplankton biomass and productivity
HAB Incidence
Zooplankton diversity
Fish abundance & distribution
Live coral cover
Seagrass cover
Mangrove cover
Macroalgal canopy cover
Apex predator abundance and distirbution
Genetic composition
Species populations
Species traits
Community composition
Ecosystem structure
Ecosystem function

	Microbes/ Phyto	Zooplankton	Fish	Top Predators	Benthos
Optics/ Imaging					
Acoustics					
Genomics					
Platforms					
Data Vis					

Biology and Ecosystems EOV feasibility in 2030

Phytoplankton biomass and productivity	biomass: Fluorescence (qualitative only); multispectral fluorescence (qualitative); cytometry (semi quantitative), Nucliec acid amplification (semi quantitative), absorbance, underwater microscopy
	productivity: (in situ) incubation (D0, Radiotracer,Isotope), FRRF, NAA (semi quantitative), single cell analysis, Biogeochemical stoichiometry (O,P,N,carbonate…..)
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

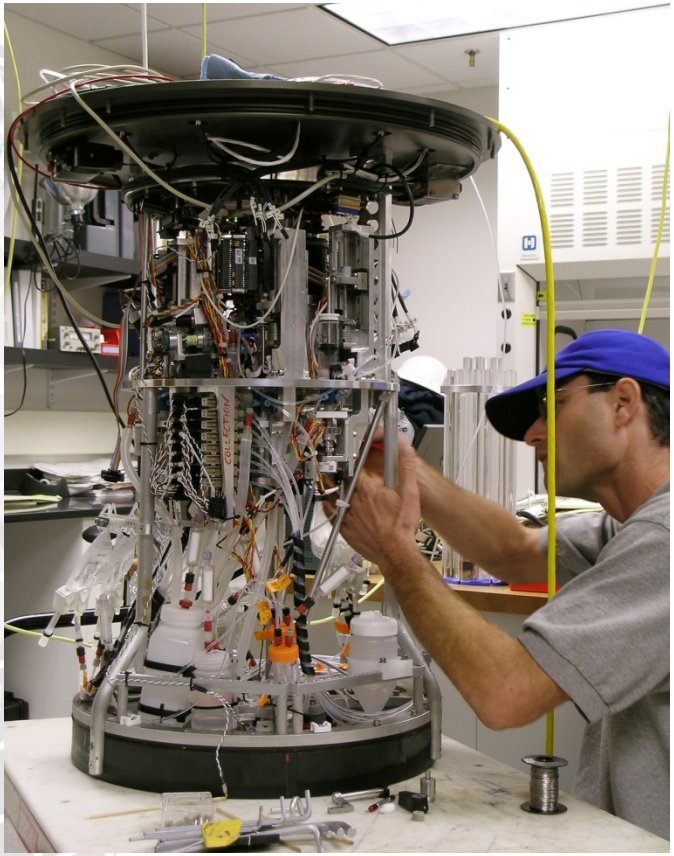
Biology and Ecosystems EOV feasibility in 2030

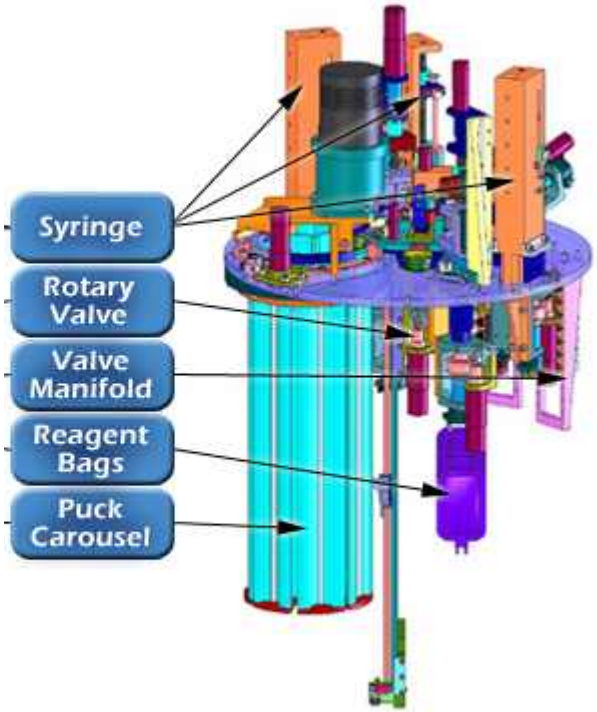
Apex predator abundance and distribution	Active acoustics, OTN / tagging / biotelemetry, passive acoustics, imaging, multifrequency active acoustics, NAA / eDNA
Live coral cover	hyperspectral imaging (above or in water, during day, best in the NIR), imaging, respirometry, carbonate parameters / stoichiometry 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

nekton diet	animal tag, faecal (NAA/analysis), eDNA, anatomy sample stable isotope analysis. Sediment traps Incorporation rate: e.g. Seal glide angle / behaviour from tagging
biological vital rates	respiration, growth feeding: Capture and incubation. Energy expenditure from tagging

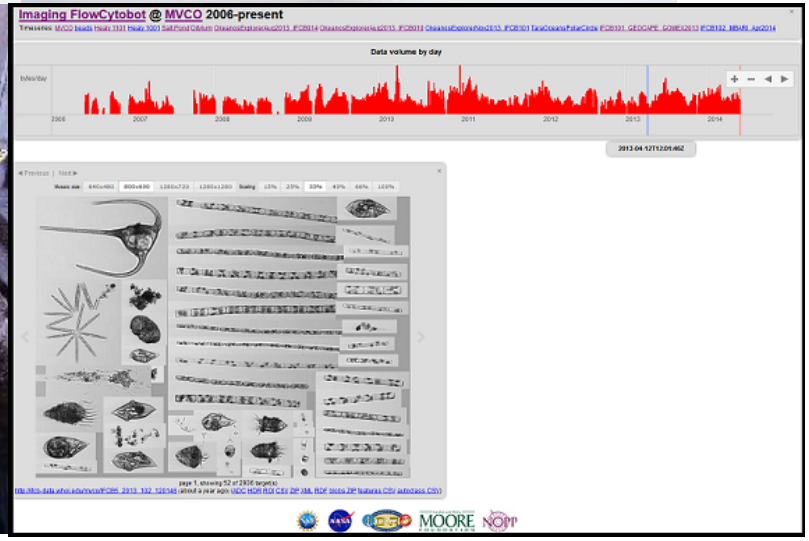
Genomic sampling, HAB, plankton, eDNA



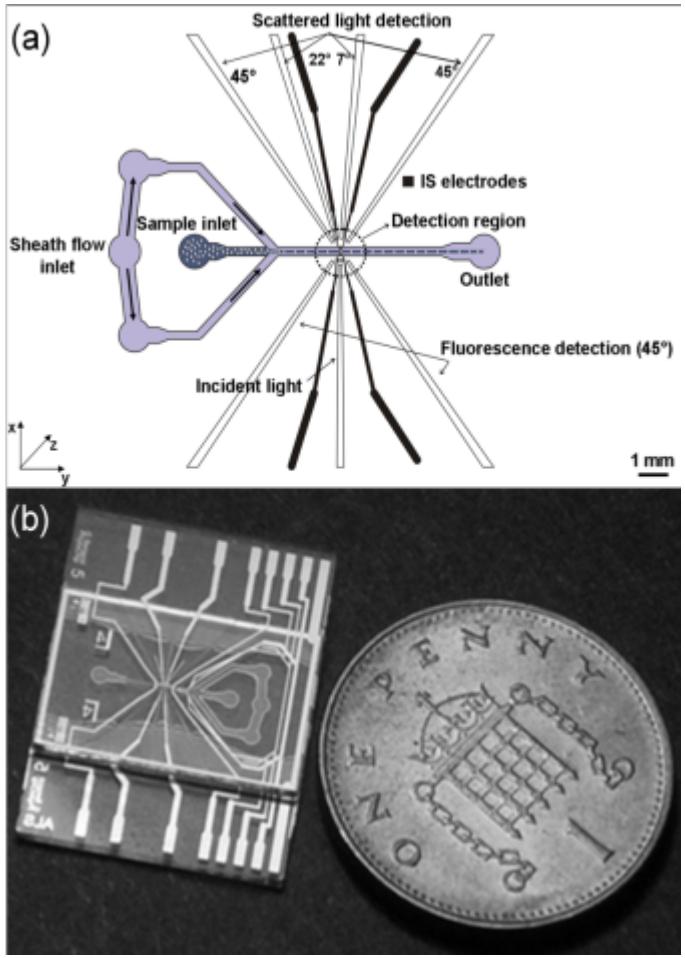


DTU working with DHI and MBARI to convert and evaluate existing ESP for eDNA

Cytometry: plankton HAB

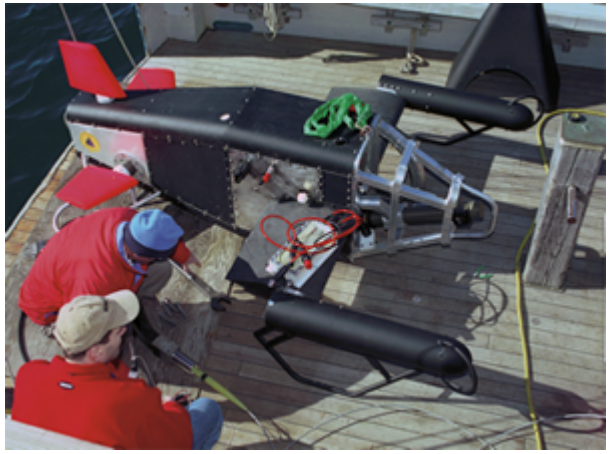


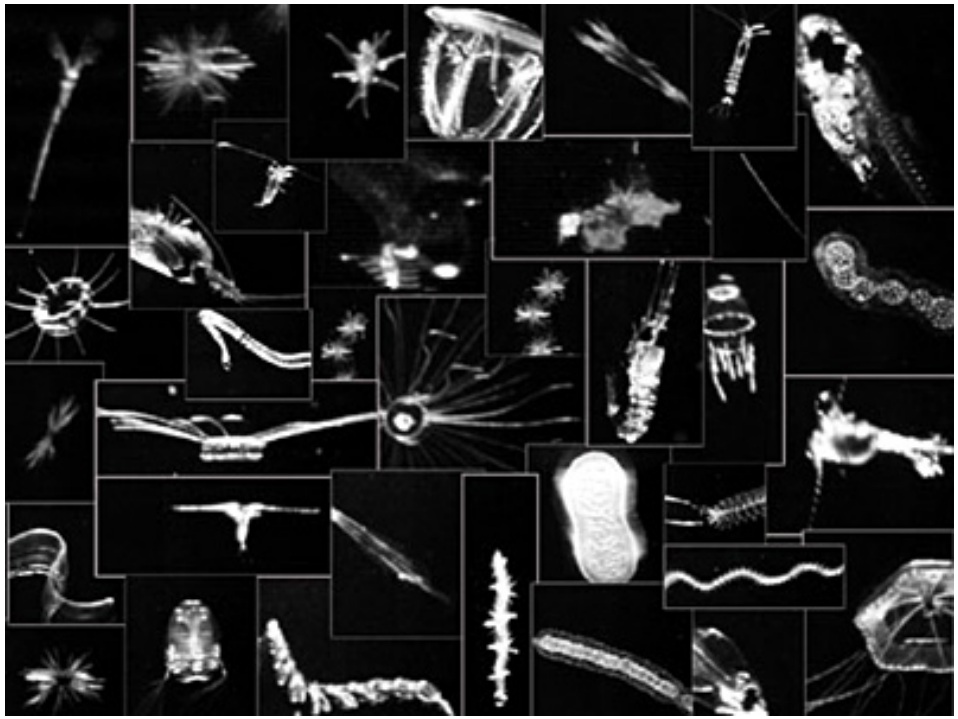
Cytometer



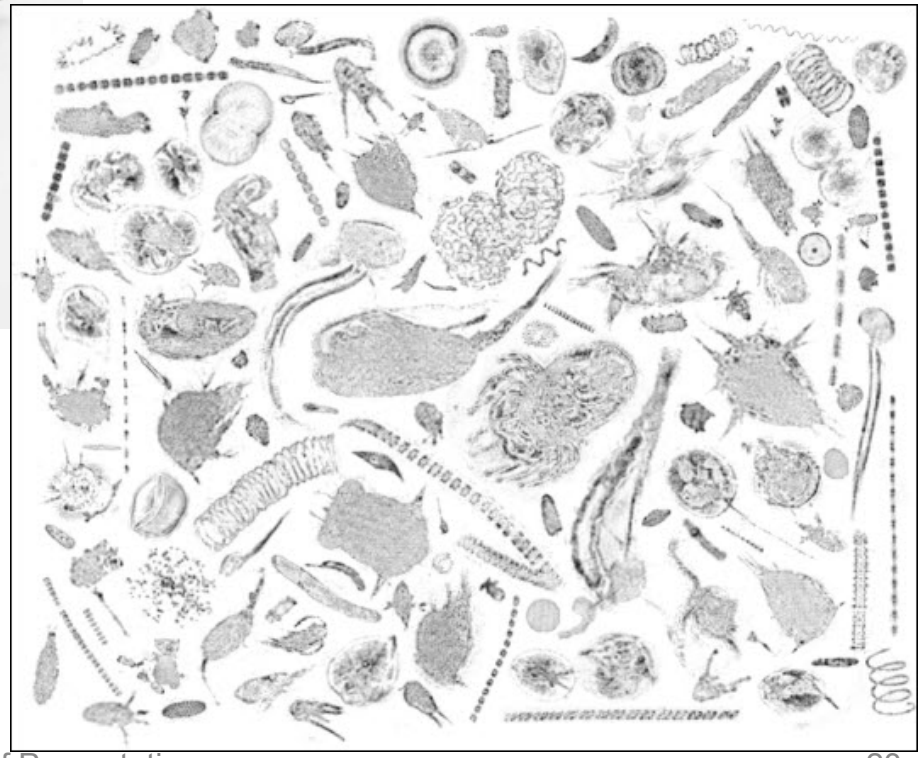
- Simultaneous measurement of electrical (impedance) and optical properties of individual cells
- In-lab prototype
- No air required for optics or operation (suitable for deep sea)
- Challenges include sample concentration, and optical detection limits (power in chip)

Zooplankton: VPR

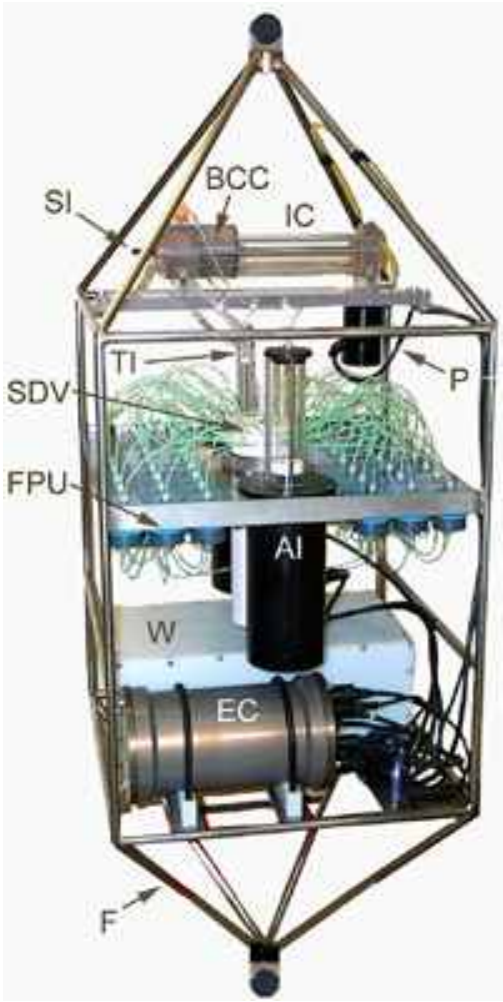




Particles/plankton: Holography



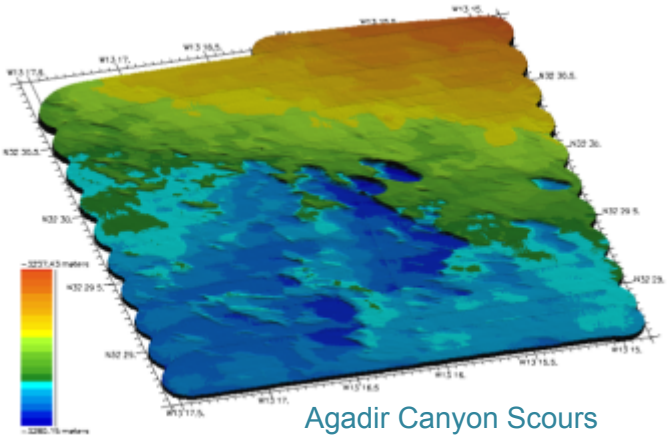
Phytoplankton productivity



Stoichiometry

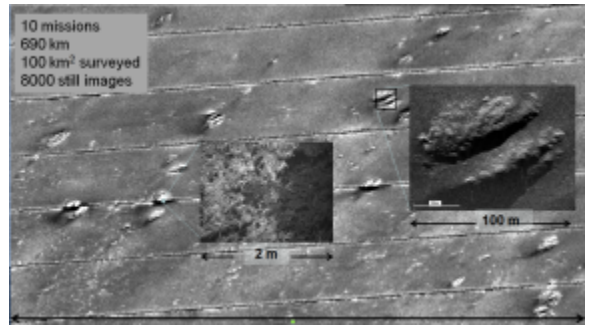
Acoustic and optical imaging

Bathymetric Surveys



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

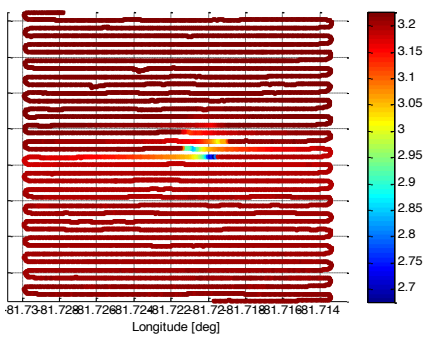
Sidescan Surveys



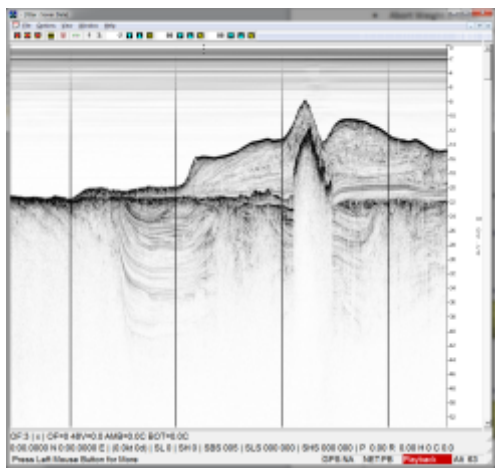
Darwin Mounds (Rockall)
Cruise JC060 [2011]
Altitude 15 – 50 m

Photographic Surveys

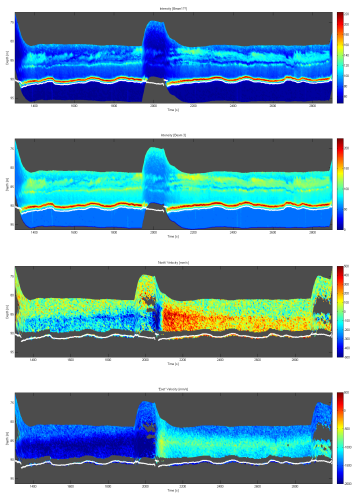
Celtic Sea
Cruise DY008 [2014]
Altitude 2.2m



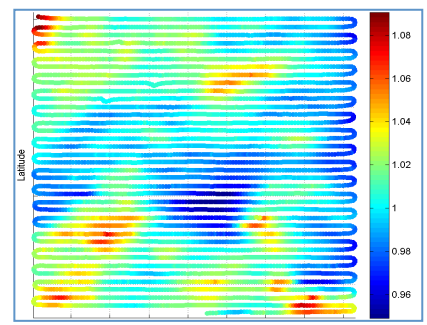
EH signal from JC44



Sub bottom profiler data
Pelagia 2013



ADCP data
Pelagia 2013



Magnetometer total field (normalised).

Autonomous imaging

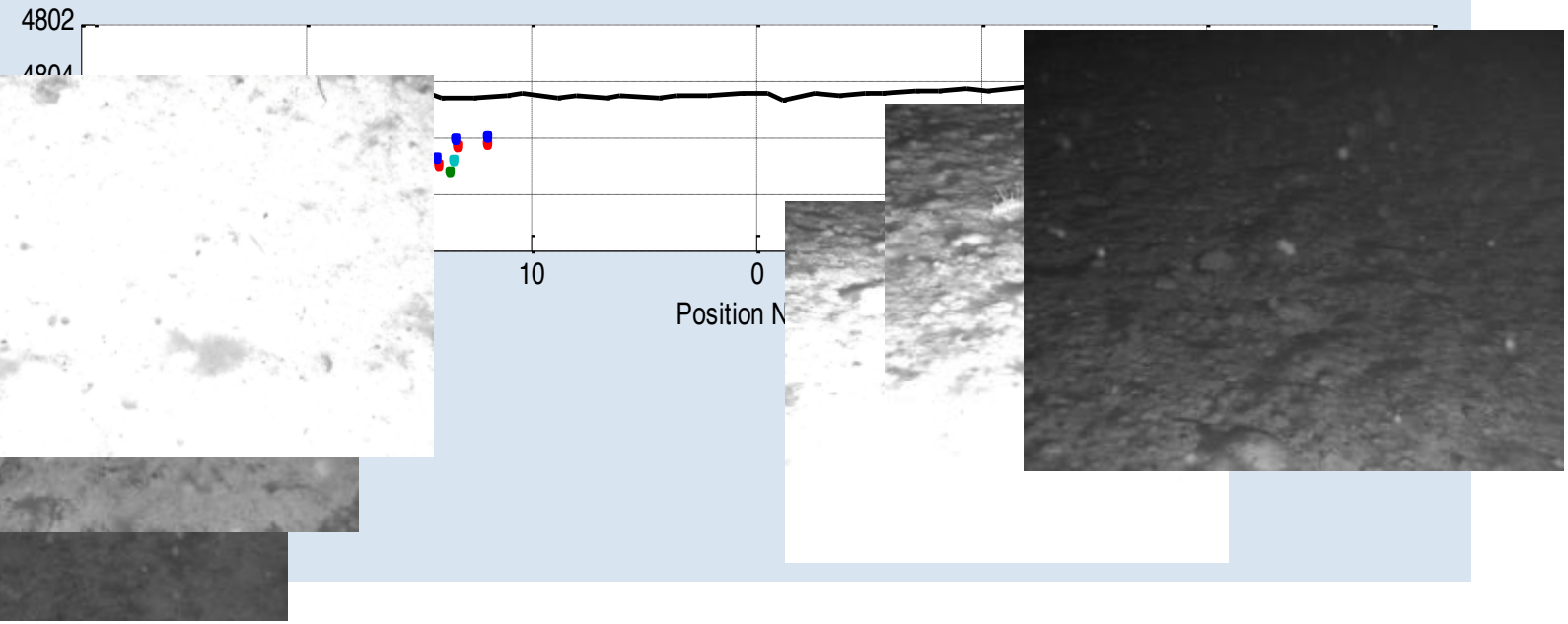
Photographic Surveys

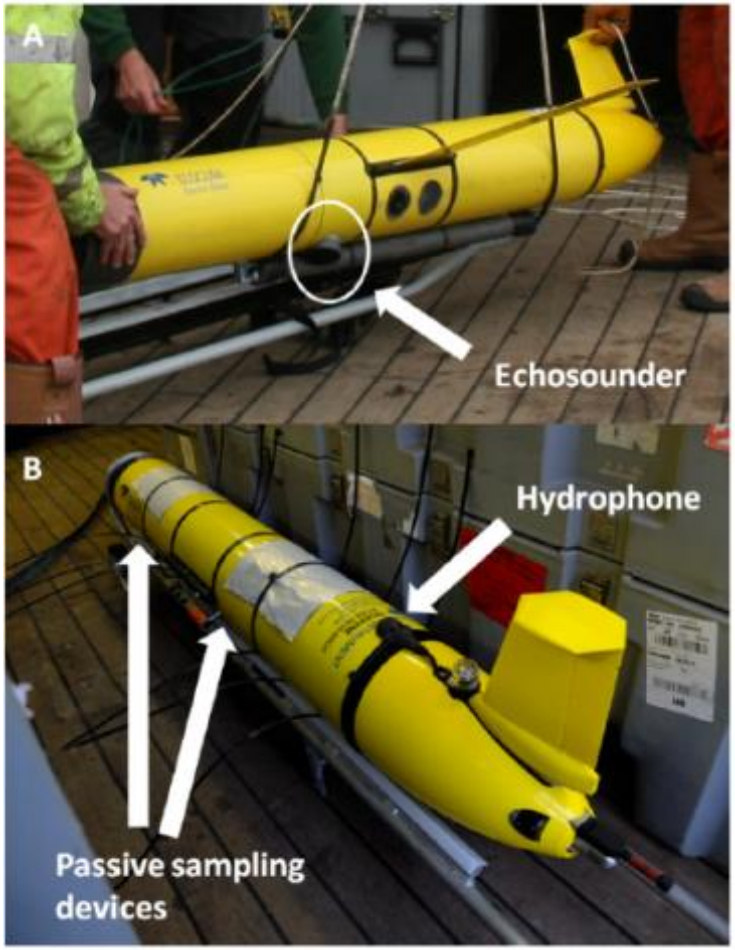
Celtic Sea Cruise DY008 [2014]

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





Contents lists available at ScienceDirect

Methods in Oceanography

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

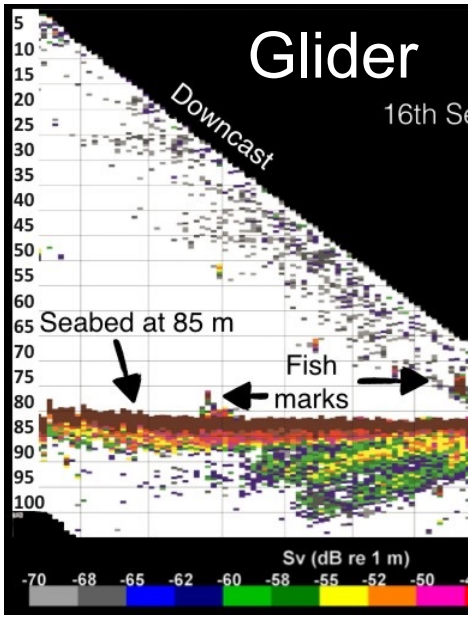
Full length article

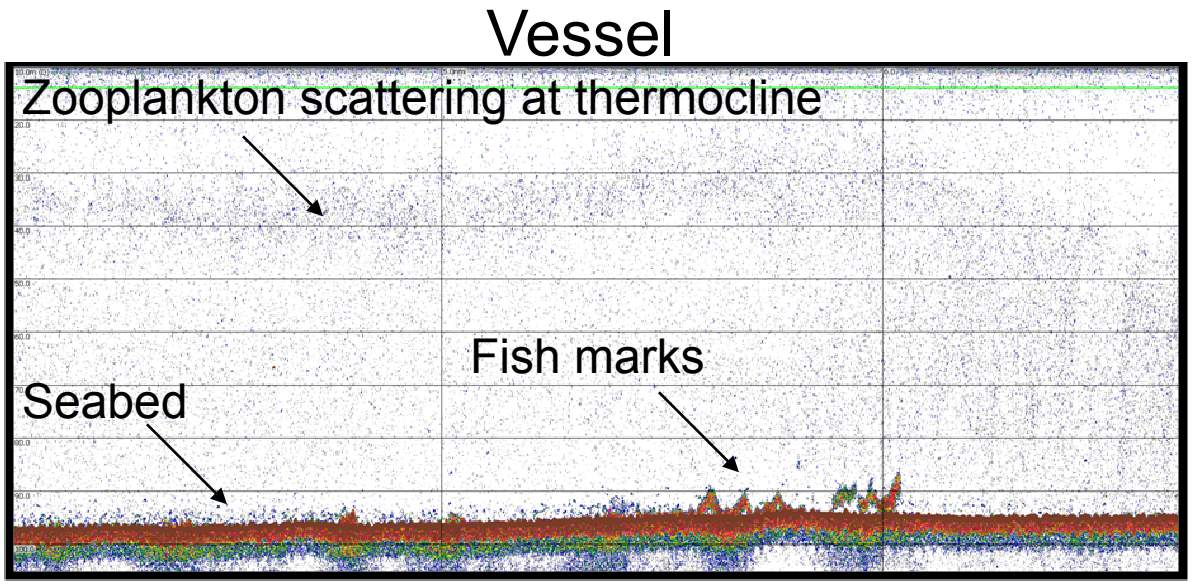
Assessing the potential of autonomous submarine gliders for ecosystem monitoring across multiple trophic levels (plankton to cetaceans) and pollutants in shallow shelf seas

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[a], Alice R. Jones[a,h]

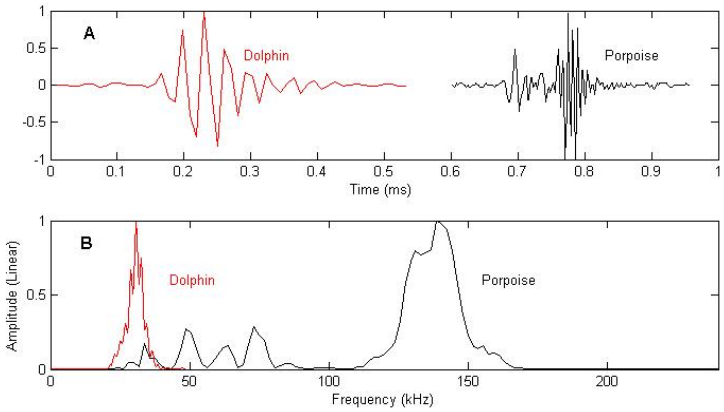
[a] National Oceanography Centre Southampton (NOCS), European Way, Southampton SO14 3ZH, UK
[b] Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK
[c] British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK
[d] Scottish Oceans 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, Gaustadalléen 21, NO-0349 Oslo, Norway
[f] Masaryk University, Research Centre for Toxic Compounds in the Environment (RECETOX), 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



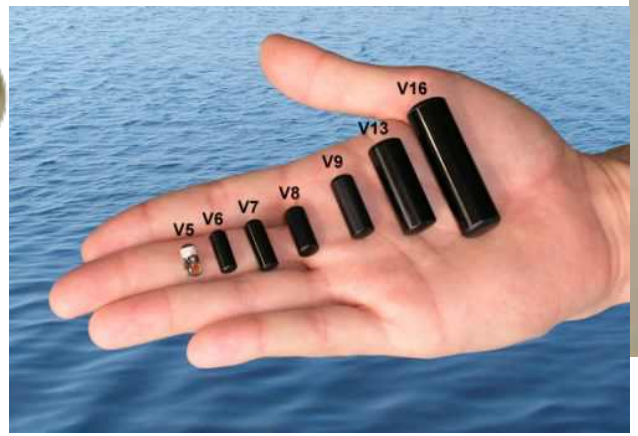


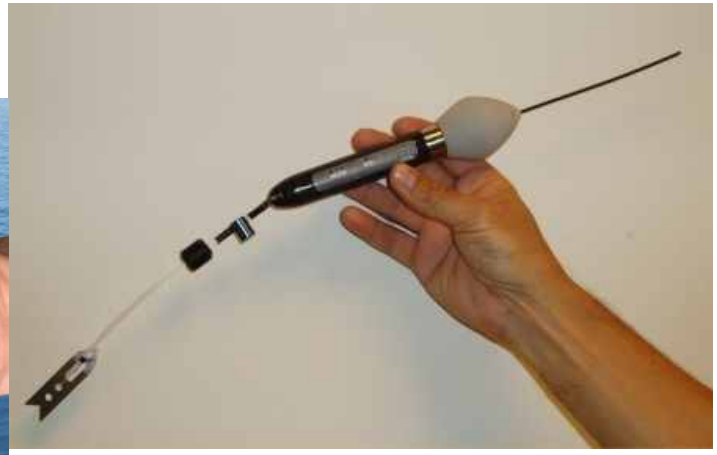
Examples of cetacean acoustic data collected using the glider-mounted PAM



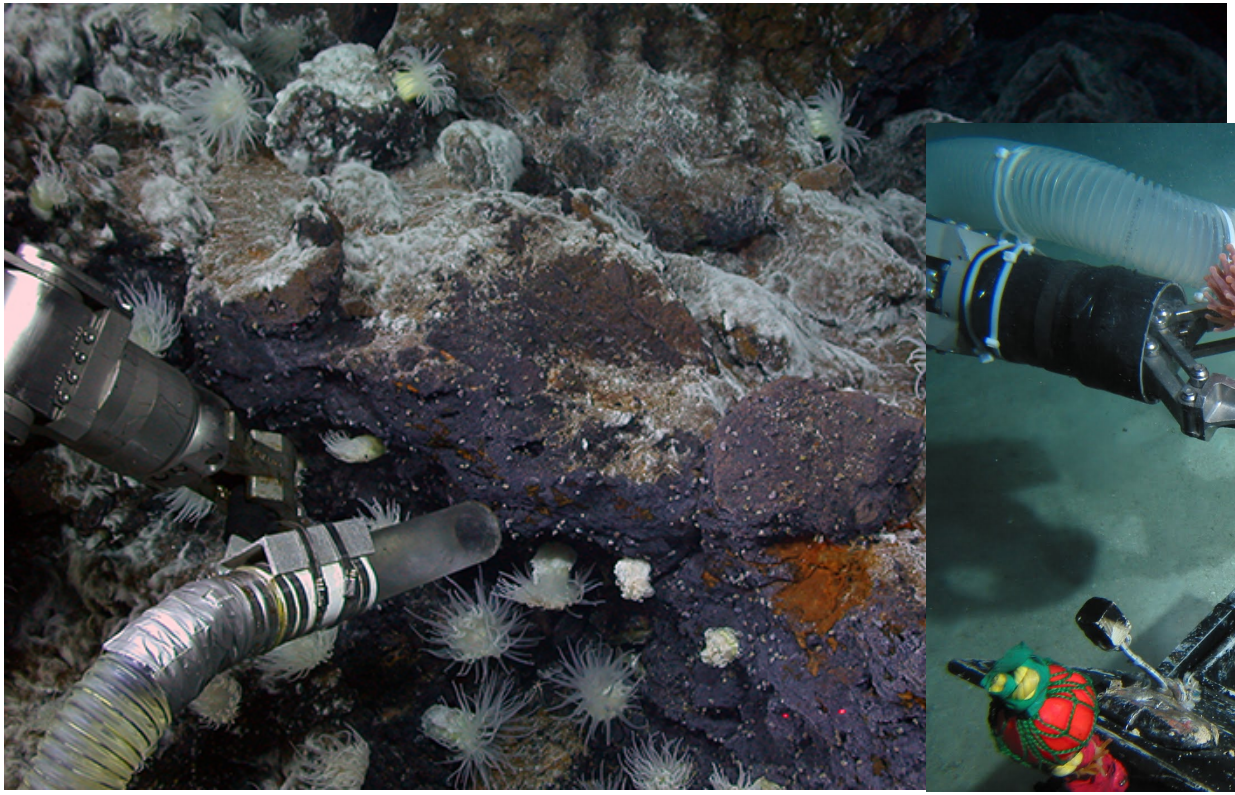
Waveforms (A) and power spectra (B) of detected dolphin and porpoise clicks using the modified d-tag

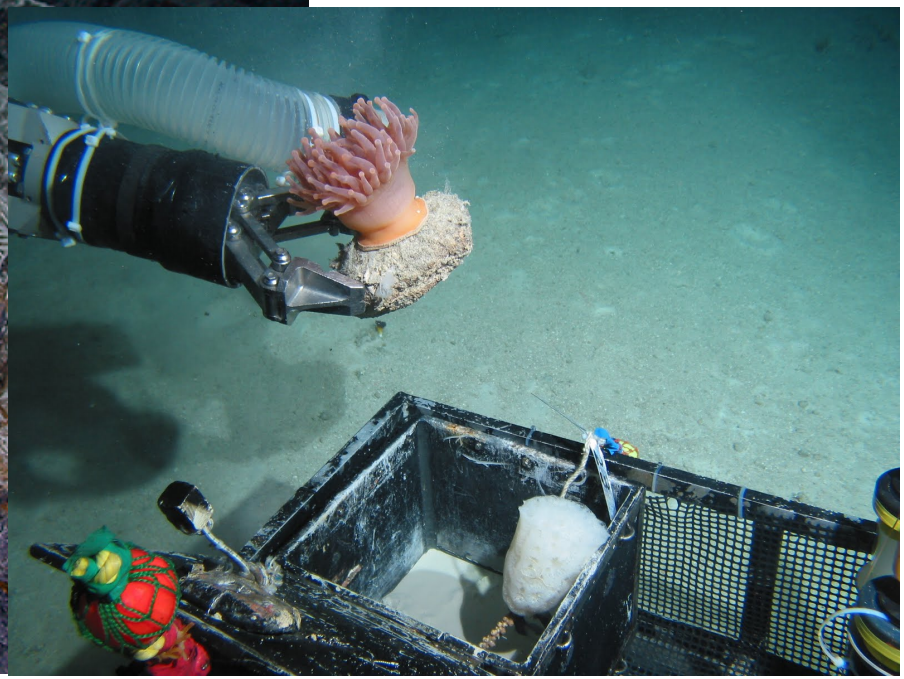
Tagging



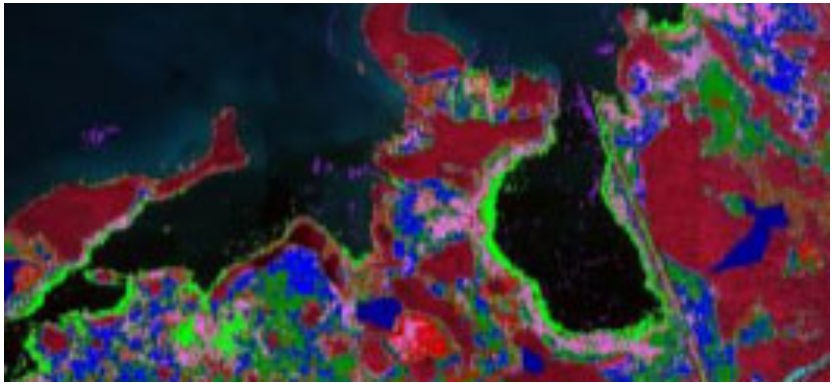


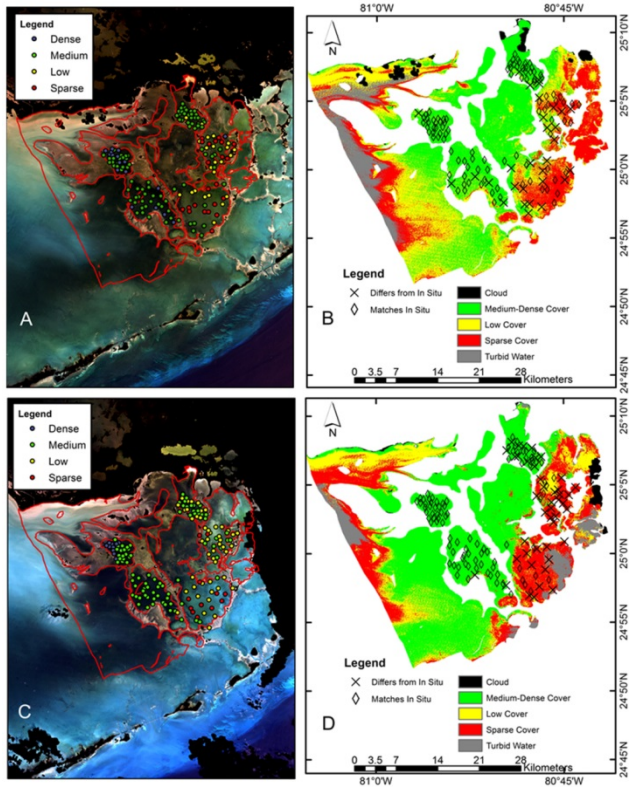
(Auto)sampling





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

AtlantOS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 63321.