Supporting EOVs and FAIRness with smarter sensors

Eric Delory

Oceanic Platform of the Canary Islands - PLOCAN
Outline

What does an in-situ observing system do and how?
How much does it cost?
How can sensors help on EOV coverage?
How can we better support FAIRness from sensors?
The role of Research Infrastructures
We cannot measure everything, nor do we need to

- Driven by requirements
- Rooted in reality
- Measurement must be feasible

Driven by requirements, negotiated with feasibility

**Essential Ocean Variables / Core Variables**
<table>
<thead>
<tr>
<th>PHYSICS</th>
<th>BIOGEOCHEMISTRY</th>
<th>BIOLOGY AND ECOSYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea state</td>
<td>Oxygen</td>
<td>Phytoplankton biomass and diversity</td>
</tr>
<tr>
<td>Ocean surface stress</td>
<td>Nutrients</td>
<td>Zooplankton biomass and diversity</td>
</tr>
<tr>
<td>Sea ice</td>
<td>Inorganic carbon</td>
<td>Fish abundance and distribution</td>
</tr>
<tr>
<td>Sea surface height</td>
<td>Transient tracers</td>
<td>Marine turtles, birds, mammals abundance and distribution</td>
</tr>
<tr>
<td>Sea surface temperature</td>
<td>Particulate matter</td>
<td>Hard coral cover and composition</td>
</tr>
<tr>
<td>Subsurface temperature</td>
<td>Nitrous oxide</td>
<td>Seagrass cover and composition</td>
</tr>
<tr>
<td>Surface currents</td>
<td>Stable carbon isotopes</td>
<td>Macroalgal canopy cover and composition</td>
</tr>
<tr>
<td>Subsurface currents</td>
<td>Dissolved organic carbon</td>
<td>Mangrove cover and composition</td>
</tr>
<tr>
<td>Sea surface salinity</td>
<td></td>
<td>Microbe biomass and diversity (*emerging)</td>
</tr>
<tr>
<td>Subsurface salinity</td>
<td></td>
<td>Invertebrate abundance and distribution (*emerging)</td>
</tr>
<tr>
<td>Ocean surface heat flux</td>
<td></td>
<td></td>
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<tr>
<td>CROSS-DISCIPLINARY</td>
<td></td>
<td></td>
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<tr>
<td>Ocean colour</td>
<td>Ocean Sound</td>
<td></td>
</tr>
</tbody>
</table>
PLOCAN Observatory
## PLOCAN Observatory

<table>
<thead>
<tr>
<th>Observatory Component</th>
<th>Start of Operations</th>
<th>Depth</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – Testbed &amp; coastal observatory</td>
<td>2013</td>
<td>30m to 600m</td>
<td>RV campaigns, seabed stations</td>
</tr>
<tr>
<td>3 – Extended Observatory</td>
<td>2013</td>
<td>Down to 1000m</td>
<td>RV Campaigns, Gliders</td>
</tr>
</tbody>
</table>
ESTOC Station

- Located 100 km North of Canary Islands in the Canary Current, the weak eastern boundary current of the subtropical North Atlantic gyre.

- 3600m water depth

- Exhibits open ocean, oligotrophic gyre characteristics

- Not directly influenced by the coastal upwelling

- Influenced by mineral deposition of atmospheric dust from nearby Sahara

- Close to BATS latitude
Data FAIRness status, good ... but best for M2M?

European marine data and data products brokers and assembly centers:
Copernicus CMEMS INSTAC
SEADATANET
EMODNET

European Marine RIs:
EMSO ERIC, EMBRC ERIC, EuroArgo ERIC
JERICO RI, GROOM

Common open tools for data retrieval:
THREDDS
ERRDAP
EMSO Canarias (ESTOC) open-ocean fixed station costs
Some paths for cost-effective EOV coverage and FAIRness

• Mix of mobile and fixed platforms
• Smaller lower-power, and multifunctional sensors
• Greater reliability
• Open-standards and Web Services for FAIRness
• Use the potential of artificial intelligence?
Multifunctional ecosystem sensors

- The potential of spectral optics (fluorometry, absorptiometry, ...)
- Multifunctionality and multiplatform integration capability (size, power, interoperability)
- Good response time and accuracy, low maintenance, high stability

But ...
- Still lack of commercial integration of truly efficient antifouling systems
- The problem of market adoption for smaller platforms, availability of hi-end components (UV LEDs)

Ifremer/ Delauney Antifouling system

TriOS (Germany) NeXOS O1-Vis and O2

TriOS MatroFlu-VIS

O1-Vis and O2
Ocean sound, a cross-disciplinary variable

Passive acoustics: hydrophones with embedded acoustic processing
NeXOS, TRL 7 (ocean noise)
Bioacoustics still at low TRL
Other applications:
Geophysics
Meterology

Needs:
artifacts automatic removal, intelligent scene analysis for power/storage optimisation

Test of NeXOS A1 on deep glider
Interoperability at a cost:
- metadata proficiency
- overhead
Friendly sensorML editor for SWE services
Scalable, multi-domain, open-source solutions for sensor web discovery (Findability)
Adapting commercial sensors and platform to SWE architecture

Sensor Web Architecture components
- Sensor Observation Service
- Sensor Web viewer
- Sm(i)le SensorML editor
Integration on vehicles and floats
Figure 19: Demo area, offshore Las Palmas (Spain), Atlantic Ocean.
Figure 11: Noise measurements in the 125Hz band for the transect going offshore. The x-axis is data point number. There is definitely a pattern emerging. Spikes on the second half right of the graph are attributed to glider mechanics involved in the control of buoyancy.
Sensor web technologies
Cross-domain & multiplatform sensor and data interoperability
Reaching out to RIs
EMSO EGIM Interoperable multi-sensor packages

- From shallow water to 6000m
- Candidate platform for coastal observatories in JERICO-S3
- Low-power antifouling technologies
- SWE capable
- Reliability: tested against hydrostatic pressure, Solar radiation, Thermal shock during immersion, Vibrations, Mechanical shock
- Validation underway at several sites
- Standalone and cabled
- 12 ports
Smarter sensors for coastal observations

• Innovative sensors and sampler for biogeochemistry, contaminants and biology
• Coastal EGIM with embedded AI
• Sensor Web services and easier sensor service registration for FAIRness

• Transnational access
  Call open since 2\textsuperscript{nd} of June

http://www.jerico-ri.eu/ta/
References


