

Project	AtlantOS – 633211
Deliverable number	6.4
Deliverable title	Metrology best practice manuals
Description	The outputs of workshops: genomic observatories (Ribocon and AWI), nutrients and oxygen sensor observations (Ifremer), carbonate chemistry sensors measurements (IO PAN) and trace elements measurements (UOP) will be turned into best practice manuals for free on-line dissemination.
Work Package number	6
Work Package title	Cross-cutting issues and emerging networks
Lead beneficiary	GEOMAR
Lead authors	GEOMAR: Eric Achterberg AWI: Pier L. Buttigieg, Felix Janssen Ribocon: Jörg Peplies IFREMER: Chantal Compere
Contributors	
Submission data	17/08/2018 (delayed due to vacation time)
Due date	31/07/2018
Comments	Two out of five workshops (UOP, AWI/RIBOCON) have been held, and outputs delivered. Two other workshops (IFREMER) with outputs will be held in autumn 2018, and one workshop with output in early 2019 (IOPAN).



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 633211.

Stakeholder engagement relating to this task*

WHO are your most important stakeholders?	<input type="checkbox"/> v Private company If yes, is it an SME <input type="checkbox"/> v or a large company <input type="checkbox"/> ? <input type="checkbox"/> v National governmental body <input type="checkbox"/> v International organization <input type="checkbox"/> NGO <input type="checkbox"/> v others Please give the name(s) of the stakeholder(s): TriOS, Anderaa, NKE, various scientists from multiple countries
WHERE is/are the company(ies) or organization(s) from?	<input type="checkbox"/> v Your own country <input type="checkbox"/> v Another country in the EU <input type="checkbox"/> v Another country outside the EU Please name the country(ies): ...Germany, France, Norway
Is this deliverable a success story? If yes, why? If not, why?	<input type="checkbox"/> Yes, because successful workshops have been held, with strong engagement of stakeholders and important outputs that will form the basis for ocean observing practices and best practice approaches. <input type="checkbox"/> No, because
Will this deliverable be used? If yes, who will use it? If not, why will it not be used?	<input type="checkbox"/> Yes, the outputs of the deliverable will be used by companies, observing organisations and individual researchers. The training aspect, and the outputs of the meeting, will have of important positive consequences for the observing communities as a new generation of observers is trained and also the outputs lay the foundation to much improved Best Practice guidelines in the community. <input type="checkbox"/> No, because

NOTE: This information is being collected for the following purposes:

1. To make a list of all companies/organizations with which AtlantOS partners have had contact. This is important to demonstrate the extent of industry and public-sector collaboration in the obs community. Please note that we will only publish one aggregated list of companies and not mention specific partnerships.
2. To better report success stories from the AtlantOS community on how observing delivers concrete value to society.

*For ideas about relations with stakeholders you are invited to consult [D10.5](#) Best Practices in Stakeholder Engagement, Data Dissemination and Exploitation.

D6.4 Metrology best practice manuals: The outputs of workshops: genomic observatories (Ribocon and AWI), nutrients and oxygen sensor observations (Ifremer), carbonate chemistry sensors measurements (IOPAN) and trace elements measurements (UOP) will be turned into best practice manuals for free on-line dissemination. PM40

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IFREMER: Chantal Compere

The metrology workshop on uncertainty in measurements of trace elements was held in Plymouth (UK), in the period July 18-20 2016. The meeting was organised by the University of Plymouth. There were 25 – 30 participants, and the meeting consisted of a mix between theoretical considerations and practical applications of uncertainty issues of analytical measurements of trace elements. A publication on best practices in uncertainty assessments for trace metal measurements in seawater was produced and submitted to *Frontiers in Marine Science*, Topic on Ocean Best Practice. The manuscript is currently under review, with minor revisions.

In cooperation with Agriculture and Agri-Food Canada, a three-day genomic workshop was organized by AWI and Ribocon at the Max Planck Institute for Marine Microbiology, Bremen, Germany, in the period 21-23 February 2018. The workshop was on enhancing interoperability and coordination of long-term observing systems capable of observing biodiversity using metagenomic and metatranscriptomic (i.e. “omic”) techniques. Participants represented notable initiatives which are applying rapidly advancing DNA and RNA sequencing technologies to deliver unprecedented insights into the composition, structure, and functioning of ecological communities. The workshop networked major international activities in the field in order to promote the harmonisation and mainstreaming of omic approaches in biodiversity observing activities across marine, terrestrial, and freshwater systems. The workshop’s primary outcome was the initialisation of a “Global Omics Observatory Network” (GLOMICON), to better coordinate multiregional, long-term, and omically enhanced observation activities. Workshop minutes are currently finalized for upload to the workshop’s page at the AtlantOS website¹. An online collaborative forum and mailing list have been established to synchronise follow-up activity. The participants aim to establish regular sharing of data, methods, calibration standards, and visioning in order to secure the foundation of a sustainable observatory network. In this new community, drafts of best practices are being compiled (expected to be shared across the network in November) and will be submitted to the UNESCO/IOC-IODE Ocean Best Practices archive once they have been approved by the network (estimated: February 2019).

A workshop on ocean observations of oxygen, pH and CO₂ is scheduled for October 10-12, 2018 in Brest (France). The workshop will be organised by IFREMER, with a contribution by IOPAN. In addition, a workshop on nutrient and fluorescence observations is scheduled for December 4-6, 2018 in Brest (France). The meeting will be organised by IFREMER.

The workshop planned by IFREMER within the framework of the AtlantOS project WP 6.2 “Common metrology and Best Practices” have been postponed towards the second half of 2018 and are held in the form of joint elements to other European consortia. Under the auspices of the European Commission, Jerico NEXT, EMSO ERIC, ENVRIPLUS and AtlantOS, are participating to the international effort to

¹ <https://www.atlantos-h2020.eu/events/workshop-on-enhancing-omics-observation/>

harmonize the practices in Environmental Monitoring and to push up the interoperability technologies for sharing ocean instruments.

1. On the occasion of the Sea Tech Week 2018 in Brest (France) (www.seatechweek.eu), EMSO ERIC, JERICO-RI, ENVRIPLUS and AtlantOS are jointly running a 3-day workshop for technical and scientific staff, aiming to increase the level of marine observation practices for oxygen and carbonate chemistry variables (Program in Annex 1). The objectives will be to promote Best Practices and to develop synergies around these widely used categories of data, between EMSO, Jerico NEXT, ENVRIPLUS and AtlantOS communities, and between users of seafloor and water column data. A position paper on “Dissolved oxygen measurements: scientific needs, sensors accuracy and synthesis of Best Practices recommendations” for a better use of oxygen sensors in order to improve the quality of the oxygen data for scientific exploitations is planned (Deliverable 1) at the end of the workshop. The final version will be provided at the end of January 2019 for free on-line dissemination.
2. The ATLANTOS project and the JERICO-RI consortium are jointly organizing a workshop in December in Brest, with the aim of increasing the level of interoperability for nutrient and chlorophyll-fluorescence observations (Program in Annex 2). A position paper on sustaining ocean Best Practices (sharing experience on nutrient measurements in the lab and in situ) from feedback on the use of the various sensors nutrients in situ available on the market or developed by research institutes is planned (Deliverable 2) at the end of the workshop. The final version will be provided at the end of February 2019 for free on-line dissemination.

A workshop will be organised on carbonate chemistry sensors by IOPAN, in June 2019. Atlantos will contribute to this workshop, which will be in addition to our planned workshops.

Workshop on enhancing interoperability & coordination of long-term omics observations

Locations

Maps below the agenda

Hotel: 7 things (<https://www.7things-hotel.de/en/home.html>; 53.10609, 8.84819)

Getting to the hotel: Tram 6 from the airport or the main train station (to the University (UNIVERSITÄT). Alight at UNIVERSITÄT-SÜD. The tram lines will turn off to your right, continue walking straight down Universitätsallee for ca. 220 m. The hotel will be to your right. Buy tickets from automatic machines at the airport stop (outside), the station (inside), or in the tram itself. Unless you intend to make multiple trips, you would select a single adult ticket for the “Bremen 100” zone (EUR 2.80).

Meeting locations:

- 21-22nd: Max Planck Institute for Marine Microbiology | Celsiusstraße 1 | 28359 Bremen
- 23rd: The BITZ | Fahrenheitstraße 1 | 28359 Bremen

Talk formats:

All talks are 15 minutes long with no individual Q&A; a panel at the end of each session will be used to address questions collectively. Remote speakers will be allocated 5 minutes of Q&A after their talk if they are unable to participate in the panel discussion.

In their talks speakers are asked to:

1. Dedicate ~5 minutes to brief the audience on the mission of their project(s)
2. Dedicate ~5 minutes to describe the role of omics in their projects, noting gaps and challenges
3. Dedicate ~5 minutes to visioning how and where their efforts would contribute to a global omics observatory network

Day 1 – Plenary talks

Time	Event	Lead(s)	Location
08:30-09:00	Meeting registration	Sandra Nowack	In front of Lecture hall 4012
09:00-09:10	Welcome and motivation on behalf of AtlantOS and Agriculture and Agri-Food Canada	Jörg Peplies & James Macklin	4012
09:10-09:20	Workshop outline and logistics	Jörg Peplies & Felix Janssen	
09:20-09:30	Aligning efforts to realise a global omics observatory network	Pier Luigi Buttigieg	

Session 1 (Chair: Felix Janssen)			
09:30-09:45	The Genomic Observatories Network	Chris Meyer	4012
09:45-10:00	The EcoBiomics initiative	James Macklin	
10:00-10:15	CPR: An example of a coordinated, functional monitoring network	Willie Wilson	
10:15-10:45	Panel discussion	Session speakers	
10:45-11:00	Coffee break (in front of lecture hall 4012)		
Session 2 (Chair: Pier Luigi Buttigieg)			
11:00-11:15	Scaling up: high throughput genomic approaches for biodiversity analysis	Mehrdad Hajibabaei	4012
11:15-11:30	Tracking biological communities using omics: an example from Monterey Bay combining different sequencing-based approaches	Kathleen Pitz	
11:30-11:45	DNAqua-Net: coordinating aquatic DNA monitoring activities	Florian Leese	
11:45-12:00	MBON: a GEO BON framework for coordination and stakeholder interfaces	Frank Muller-Karger	
12:00-12:30	Panel discussion	Session speakers	
12:30 -13:30	Lunch (MPI cafeteria, central Foyer, ground level)		
Session 3 (Chair: James Macklin)			
13:30-13:45	Tara Oceans’ ecosystems biology approach to address microbial contributions to macro-ecological processes	Chris Bowler	4012
13:45-14:00	The Ocean Sampling Day: a global, epipelagic, omics snapshot	Antonio Fernandez-Guerra	
14:00-14:15	Global characterization of microbial taxonomic and functional diversity in the Earth Microbiome Project	Luke Thompson (remote)	
14:15-14:30	The role of the GSC and MIxS in global omics observation	Pelin Yilmaz	
14:30-14:45	Trade-offs in selecting 'omics sampling methods	Stéphane Pesant	
14:45-15:15	Panel discussion	Session speakers	
15:15-15:45	Coffee break (in front of lecture hall 4012)		

Session 4 (Chair: Jörg Peplies)			
15:45-16:00	In situ technologies for marine omics	Julie Robidart	4012
16:00-16:15	Integrating omics into multidisciplinary, long-term Arctic marine monitoring: The FRAM microbial observatory	Katja Metfies	
16:15-16:30	NEON: Operating a continental-scale observatory network	Christine Laney (remote)	
16:30-16:45	NOAA 'omics research and efforts to transition into management applications and operational observations	Kelly Goodwin (remote)	
16:45-17:30	Discussion and Day 2 planning	Session speakers, Pier Luigi Buttigieg, Felix Janssen	
No-host dinner			

Breakout sessions

Logistics: The breakout sessions are structured in two consecutive series, each of which includes three discussion slots. During the each series, topic leads remain in the room assigned to 'their' topic while participants cycle between rooms. Every participant (except the leads) will thus discuss each topic in a series.

Lead(s) should ensure each group has a rapporteur documenting the discussion (and participants should be prepared to serve as rapporteur during at least one session).

Discussion themes below have been synthesised from registration feedback.

Meta-topics to consider as discussion points in each session:

- Coping with rapid technological change: comparability across time
- (Meta)data, documentation, and standards for network-wide archiving, tracking, and exchange
- Planning-to-publication best practice development and alignment
- Gap analysis

Day 2 – Breakout session

Block	Time	Event	Lead(s)	Location
	09:00-09:15	Pre-breakout orientation	Jörg Peplies, Felix Janssen	MPI Cafeteria
A	09:15-10:00	Topic 1: What do we need to realise an extended, operational, and sustained omics observatory network in the next decade?	Chris Meyer	Conference room 2100
	09:15-10:00	Topic 2: Global questions and reporting frameworks	Rob Young	Small seminar room 4020
	09:15-10:00	Topic 3: Data analysis – intercomparison in the face of methodological variance	Antonio Fernandez-Guerra	Meeting room 1346 (Aquarium)
B	10:15-11:00	Topic 1: What do we need to realise an extended, operational, and sustained omics observatory network in the next decade?	Chris Meyer	Conference room 2100
	10:15-11:00	Topic 2: Global questions and reporting frameworks	Rob Young	Small seminar room 4020
	10:15-11:00	Topic 3: Data analysis – intercomparison in the face of methodological variance	Antonio Fernandez-Guerra	Meeting room 1346 (Aquarium)
	11:00-11:30	Coffee break (MPI Cafeteria)		
C	11:30-12:15	Topic 1: What do we need to realise an extended, operational, and sustained omics observatory network in the next decade?	Chris Meyer	Conference room 2100
	11:30-12:15	Topic 2: Global questions and reporting frameworks	Rob Young	Small seminar room 4020
	11:30-12:15	Topic 3: Data analysis – intercomparison in the face of methodological variance	Antonio Fernandez-Guerra	Meeting room 1346 (Aquarium)
	12:15-12:30	Leads consolidate notes in allocated meeting rooms (rapporteurs and interested participants can assist)		
	12:30-13:30	Lunch (MPI Cafeteria)		
D	13:30-14:15	Topic 4: Harmonised advancement of in situ measurements and sampling	Julie Robidart	Conference room 2100

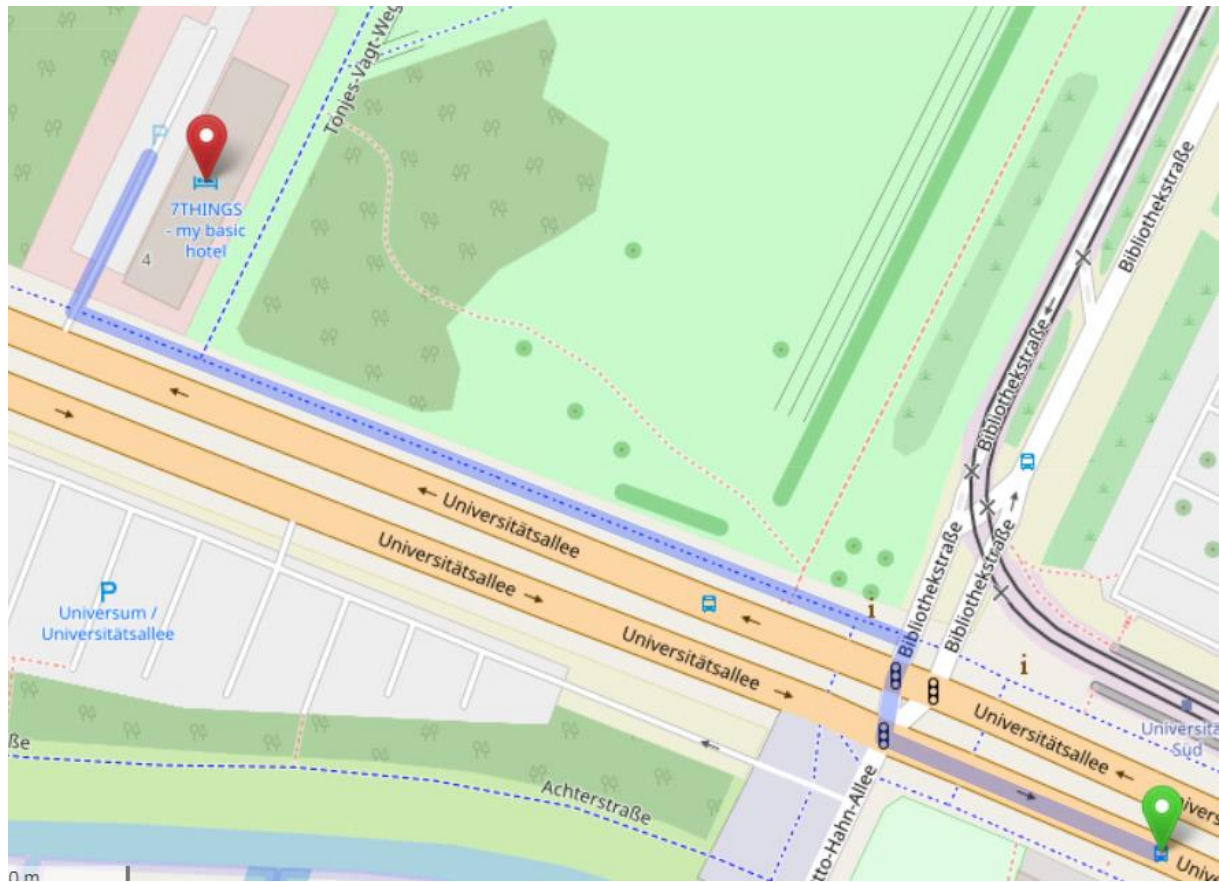
	13:30-14:15	Topic 5: Harmonising bench methodologies, intercalibration, and method sharing	Kathleen Pitz & Christian Wolf	Small seminar room 4020
	13:30-14:15	Topic 6: Sample exchange for cross-validation, interoperable inventorying, and archiving	Stéphane Pesant	Meeting room 1346 (Aquarium)
E	14:30-15:15	Topic 4: Harmonised advancement of in situ measurements and sampling	Julie Robidart	Conference room 2100
	14:30-15:15	Topic 5: Harmonising bench methodologies, intercalibration, and method sharing	Kathleen Pitz & Christian Wolf	Small seminar room 4020
	14:30-15:15	Topic 6: Sample exchange for cross-validation, interoperable inventorying, and archiving	Stéphane Pesant	Meeting room 1346 (Aquarium)
	15:15-15:45	Coffee break (MPI Cafeteria)		
F	15:45 -16:30	Topic 4: Harmonised advancement of in situ measurements and sampling	Julie Robidart	Conference room 2100
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	15:45 -16:30	Topic 6: Sample exchange for cross-validation, interoperable inventorying, and archiving	Stéphane Pesant	Meeting room 1346 (Aquarium)
	16:30-16:45	Leads consolidate notes in allocated meeting rooms (rapporteurs and interested participants can assist)		
	17:00-17:30	Reconvene for housekeeping announcements		Lecture hall 4012
	19:30	Meeting dinner		Ständige Vertretung, Böttcherstrasse 3-5 28195 Bremen

Day 3 – Wrap up

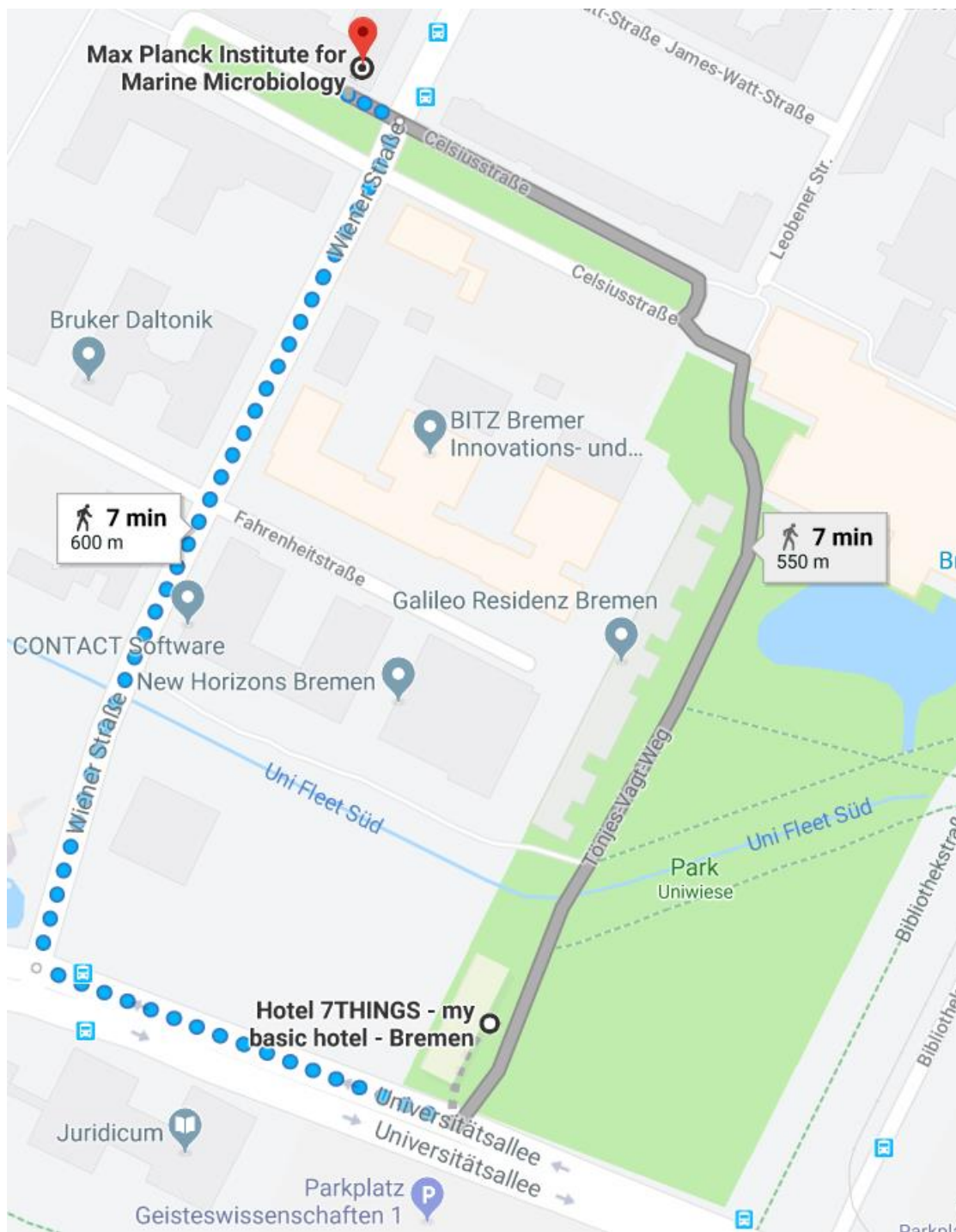
Time	Event	Lead(s)	Location
09:00-09:45	Debrief on breakout group series 1 (Topics 1-3): 10 min summaries + 5 min Q&A	Breakout Leads	BITZ
09:45-10:30	Debrief on breakout group series 2 (Topics 4-6): 10min summaries + 5 min Q&A	Breakout Leads	
10:30-11:00	Coffee break (BITZ)		
11:00-12:20	Communicating the path ahead, defining outputs, creation of follow-up task teams, planning next meeting(s) Any participants departing during this block will have the option to present their thoughts first.	All	BITZ
12:20-12:30	Workshop close	James Macklin, Pier Luigi Buttigieg	BITZ
12:30	Lunch (MPI Cafeteria)		

Maps

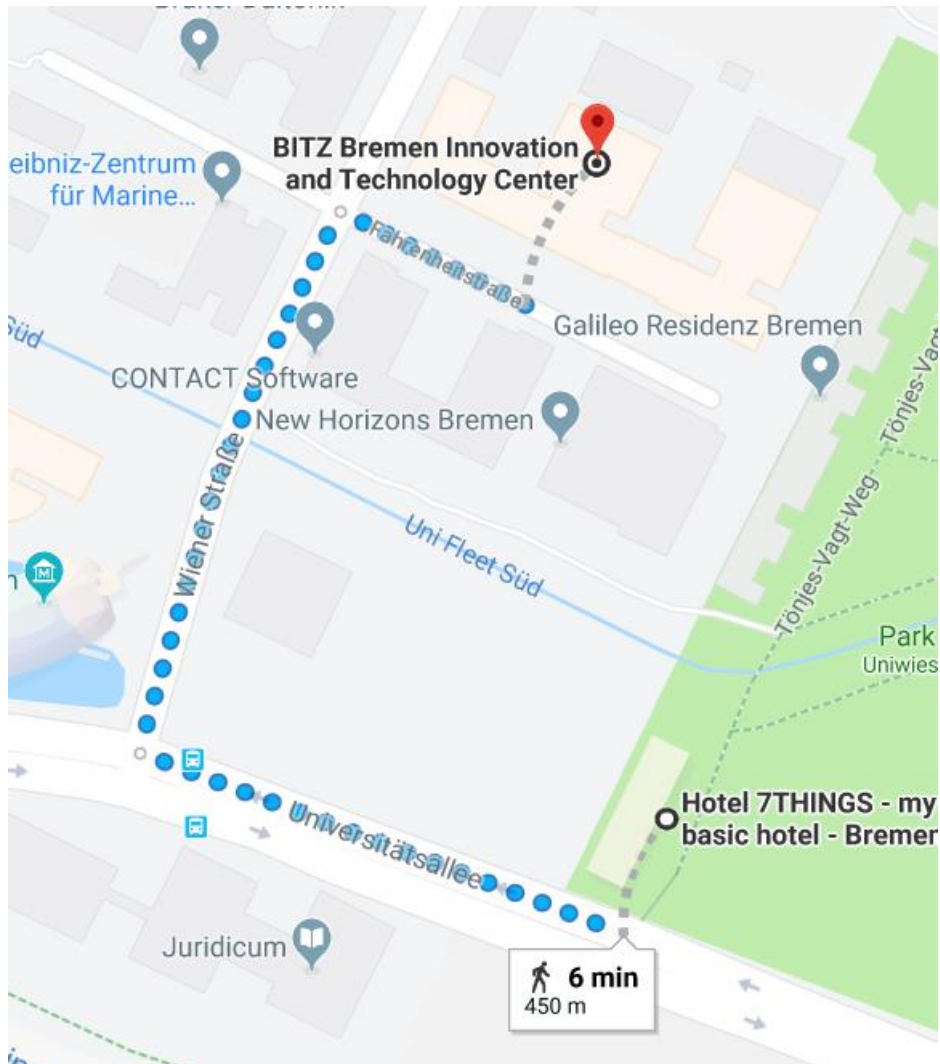
Tram 6 stop “Universität-Süd” to the 7-things Hotel



7-things Hotel to the MPI (21-22nd)



7-things Hotel to the BITZ (23rd)



Developing a Collaborative Network for Long-term, 'omic Observation

Plenary Minutes and Breakout Summaries

Authors:

- Pier Luigi Buttigieg (AWI)
- Felix Janssen (AWI)
- Jörg Peplies (Ribocon)

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Introduction

These are brief minutes of a workshop, organized by members of the AtlantOS project and Agriculture and Agri-Foods Canada, which aimed to seed a Global Omics Observatory Network (GLOMICON). Omics technologies have shown great promise in biodiversity assessments, research, and monitoring and are continually becoming more cost effective and deployable. However, there is much to be done in order to mainstream omics data in global reporting frameworks and assessments. This is made particularly challenging by the rapid advancement of this relatively young field. Participants discussed current projects and infrastructures which can be federated under GLOMICON, and – in a series of breakout sessions – discussed what the early actions of such a network should be. With GLOMICON in place, there is a greater chance for the global omics community to produce harmonised data, information, and knowledge on the state of the Earth’s biosphere. This, in turn, can augment more mature frameworks with unprecedented insights into ecological dynamics. Following the meeting, working groups and communication platforms have been established and momentum is being built to sustain this emerging network.

Note that much of the meeting was recorded and content may be made available on request to the organisers.

2018-02-21 | Plenary

Introductory presentations

1. Welcome and motivation on behalf of AtlantOS and Agriculture and Agri-Food Canada (Jörg Peplies & James Macklin)
 - 1.1. The organisers introduced themselves and the meeting’s mission to create a sustained network and community of practice for long-term omics-based observation across ecosystems.
 - 1.1.1. AtlantOS’ objectives to deliver a framework for Atlantic observing system was outlined, and the relevant WPs (2,3,6), metrology deliverable (best practices) was

connected to the theme of the workshop. Ribocon's role and the general case for SME involvement outlined.

- 1.1.2. The motivation of Agriculture and Agri-Food Canada motivation to co-fund the workshop was outlined, noting the growing role of omics in its operations. The degree of standardisation and consistency required by a federal monitoring agency emphasised, along with its value to long-term observation. Further, the needs of stable omics best practices and a community to develop these in was emphasised.
2. Meeting logistics and information provided to participants.
3. The case for a Global Omics Observatory Network (Pier Luigi Buttigieg). A presentation was delivered which outlined the case to align the participants' efforts and to realise a global omics observatory network.
 - 3.1. The presentation emphasised the role of the meeting's participants as key voices in the community, able to help realise a consolidated future for omics observation at a global scale.
 - 3.2. Central themes and needs were put forward as points of subsequent discussion:
 - 3.2.1. The need for a registry of long-term omics sites: it is still difficult to list who is observing ecosystems with omics technologies with long-term infrastructure
 - 3.2.2. Echoing the central AtlantOS mission the need to federate and align existing initiatives, networks, and standards organisation into an integrated solution
 - 3.2.3. Distributed, yet harmonised, information resources connected by modern linked data technologies along the FAIR principles
 - 3.2.4. The need to accommodate variation in approaches while simultaneously generating consistent information products
 - 3.2.5. The need for a coordination layer via a community of practice and genomic standards bodies
 - 3.2.6. Open channels between individual observatories and data aggregators/integrators to ensure smooth dataflow and the formulation of relevant genomic indicators to stakeholders outside the omics community
 - 3.2.7. The value of contributing to global strategies and calls as a unified front. OceanObs19 as an example.
 - 3.2.8. The need to include discussions on readiness and preparedness levels for our technologies and information products – bringing omics products out of the pure research silo so they can be used in applied solutions

Plenary session 1 (Chair: Pier Luigi Buttigieg)

The Genomic Observatories Network (Chris Meyer, Neil Davies)

4. The Genomic Observatories Network (GON) is aligned with the principles of standardised and integrated omics observing and could be a model for the present effort.
 - 4.1. The GON's Mission: to create a global network of sites using DNA-based observation
 - 4.2. The GON was nucleated by the Moorea BIOCODE project, applying omics to map an entire island ecosystem (<https://www.mooreabiocode.org>)
 - 4.2.1. There was an central need to keep data collection and analysis highly standardised among all participants , and methods and technologies to accomplish this were deployed (e.g. <http://biocode.berkeley.edu/>) .

- 4.2.2. The effort developed strong connection to Genomic Standards Consortium (GSC) and similar bodies to ensure that it was reusing existing standards and extending them in a coordinated way
- 4.3. The operation of the GON and some of its challenges were presented
 - 4.3.1. Time and resources required to handle sequencing and contextual data and coordinate field sampling are still high
 - 4.3.2. Standards-compliant solutions to offer the GON central storage and validation of metadata were developed to ease operations. The Genomic Observatories Meta-Database (GeOMe; <https://www.geome-db.org/>) was presented as an example.
- 5. Perspectives and future development
 - 5.1. The mission / vision of the GON will remain constant: Advance science, compliant with global standards
 - 5.2. Link GeOMe with other metadata archives
 - 5.3. Pursue future workshops to promote core aims and train regional groups to create more nodes in the GON
 - 5.4. Continue to implement and co-develop standards and interface with large genomics-based projects (e.g. OSD, Global ARMS Program)
 - 5.5. Archive samples: relevance in a fast moving field
 - 5.5.1. Questions surround whether specimen and environmental samples are needed or whether the archiving of DNA extracts is sufficient to save resources
 - 5.6. Develop biodiversity models incorporating genomic data
- 6. The central challenges facing the GON was stated as the need for funds and an institutional home, as solid leadership/ownership is needed to lead coordinated actions.

The EcoBiomics initiative (James Macklin)

- 7. This governmental initiative is a component of the Canadian biomonitoring apparatus and includes themes such as:
 - 7.1. Standardization and repeatability, from the field sampling, wet-lab sample processing, microfluidics, and bioinformatics routines
 - 7.1.1. Data standardisation is centralised in a local integrated sequence database which is CDV, Darwin Core and MIxS compliant easing output to aggregators
 - 7.1.2. The standardisation allows rapid plotting and report generation, along with 'push button' tools for policy makers
 - 7.1.3. Multi-ecosystem and -taxon focus: soil, aquatic, invertebrates
 - 7.1.3.1. Study sites include oil sand extraction sites, eutrophied soils, eutrophied lakes, freshwater systems
 - 7.1.4. Practices to establish new observatories in locations of high value and/or concern
 - 7.1.5. Science with end-user focus
- 8. Motivations for monitoring are society-focused and include environmental impacts, food production and safety, soil health, and water quality
 - 8.1. The relevance of community consensus and best practices to report on impact with omics technologies was stressed: are we consistent in raising alarms?
- 9. Acknowledgement that symposia co-hosted by AWI at the Biodiversity Information Standards (TDWG) meetings nucleated the present workshop

Continuous Plankton Recorder (CPR): An example of a coordinated, functional monitoring network (Willie Wilson)

10. A brief history of the CPR surveys was provided, summarising the foundations of its ~90 year time series
 - 10.1. The key to its success is homogenous and highly conserved sample collection, traditionally based on microscopic analysis
 - 10.2. Modernisation of the survey happens very carefully, but genomics is being added to extend the CPR's coverage
 - 10.2.1. DNA extraction on material captured in the CPRs 270µm silk filters has been added to existing analytical pipelines – this does not interrupt the core time series
 - 10.2.2. Methods to extract DNA from existing formalin-fixed samples can retroactively build an omics-based time series dataset. Tests performed thus far show promise.
 - 10.2.3. Possibilities to bolt on more instruments (e.g., molecular sampler with different fixatives, optical plankton imaging)
 - 10.3. The CPR utilises a number of existing platforms and also avails of ships of opportunity, to extend its spatial and temporal coverage
 - 10.3.1. 12000 Nautical miles per month, 550000 samples (preserved in formalin at room temperature)
 - 10.3.2. Target areas (NAtlantic, NPacific, Southern Ocean), gaps in tropics and subtropics)
 - 10.4. The CPR's tradition was the birthplace of microplastic studies, and recent foci echo other societal concerns (e.g., pathogens, plankton – pathogen interactions)
 - 10.5. A central philosophy has been the layering of new and emerging practices onto the core methods, instead of replacing anything in order to maintain the series.
 - 10.6. It was stressed that a connection of GLOMICON to POGO should be established.

Panel discussion (Session speakers)

11. A key theme: how can we sustain funding for the network's efforts? Suggestions and points raised included:
 - 11.1. Ensure that the data products from each of the project's WPs is ingested by large aggregators / data users (e.g., GEOSS, GBIF, OBIS) and meets their requirements to convince stakeholders of the value and readiness of the work. Stakeholders (e.g., governmental agencies) have to be included to get to know their needs / specific questions.
 - 11.2. Connecting to governments is not a guarantee to sustainability. Benefit for end users / economies needs to be flagged – the knowledge generated must help address specific issues via case studies (e.g. Agriculture and Agri-Food Canada's focus on oil sands)
 - 11.3. The CPR network survived for 90 years as a large proportion of time is focused on raising funds from international, independent sources for robustness. There were funding problems along the way (esp. early 1990s). Helpful elements:
 - 11.3.1. Attempt to engage countries
 - 11.3.2. Keep costs low to promote feasibility
 - 11.3.3. Identify strong societal drivers connected to the work: The CPR was initiated largely to support fisheries, now themes such as natural capital and microplastics are to the fore.

- 11.3.4. Contribute to large-scale reports and establish connections to other initiatives to promote the use of your network
- 11.3.5. Maintain solid time-series data to win the long game. Eventually, a well-planned series will become a gold standard and cannot be ignored.
 - 11.3.5.1. However: Omics technologies are very diverse. Agreement on an operational technology is needed so that the series is not invalidated by sudden adoption of new technology.
- 11.4. Along with an institutional home, a sustained network should provide services and not only generate costs
 - 11.4.1. subscription models for such services not yet widely established but have been thought about
- 12. The issues of integrating biodiversity information on a large scale is a very large one, we can provide some stability in the omics field, but network-wide commitments to a solid time-series (which may not be the most cutting edge) would require funding.

Session 2 (Chair: Felix Janssen)

Scaling up: high throughput genomic approaches for biodiversity analysis (Mehrdad Hajibabaei)

- 13. On a meta-level, key points included:
 - 13.1. While place-based observation is needed, but we do need other sampling scales and strategies to cover biodiversity – Observatories should not only be static
 - 13.2. To be effective for broader concerns, observation systems must synchronise activity on ecological categories such as invasive species, pests, pathogens, endangered species, food crops and species, and ecological bioindicators
- 14. The work programme presented focuses on technologies and concepts, targets the biodiversity spectrum from genomes to ecosystems, and centres on three case studies.
 - 14.1. Costa Rica bioinventory project
 - 14.1.1. Based on the work of taxonomists, a “Facebook of species”
 - 14.1.2. All content on the web and available to other researchers,
 - 14.1.3. Basset et al showed there is an immense amount of effort needed to catalogue a group of insects in a plot : 24,354 person days
 - 14.1.4. Similar taxonomic, expert-driven methods are still used to e.g. test water quality, but the degree of effort is not sustainable in the long-term
 - 14.2. The Canadian CABIN (equivalent to the EPA river and stream projects) was noted.
 - 14.2.1. With the sequencing of >85% of CABIN, there is a good trove of data to feed a Biomonitoring 2.0 system.
 - 14.3. Due to lack of resources and the sheer amount of effort they require, these projects haven’t really fulfilled their aims.
 - 14.4. Stressed that omics doesn’t need to be exhaustive: one doesn’t need whole genomes – one can target specific genes as needed to reduce costs and effort. The type and amount of sequencing should be tailored to the biological questions : maximize information output.
 - 14.5. Voucher specimens provide a provenance record of omic markers that populate databases, their importance should not be overlooked in building the science around the omic data

- 14.6. Sequencing workflows: bulk analysis will likely be the order of the day. Multiple areas along these pipelines need standardization, but community consensus (outside of single projects) hard to build.
 - 14.6.1. For example, while opinions are strong, there is no one primer set to rule them all, thus multiple studies with different methods are required to reduce false negatives and confirm the ecological signals seen
- 14.7. In the bioinformatics domain, the time has come to move more firmly into methods that draw from gold standard databases – reference databases have an immense value in normalising global systems.
- 14.8. Despite all technological progress, it is vital to recognise that sampling design and coverage is the cornerstone of observation and should be an early priority
- 14.9. Other and emerging projects featuring omics:
 - 14.9.1. New projects with WWF – established a citizen scientist program
 - 14.9.2. Reaching out to industry: the oil industry invested in this and their R&D hub is using omics technology
 - 14.9.3. A biosecurity workshop with national stakeholders has also been done.

Tracking biological communities using omics: an example from Monterey Bay combining different sequencing-based approaches (Kathleen Pitz)

15. MBARI's MBON project was introduced and its efforts to combine existing biodiversity information with omics data flows emphasised. The CANON project was also noted, with its ability to capture sudden events with robotic platforms
 - 15.1. MBARI's platforms, including advanced technology for adaptive sampling (e.g. front detection coupled to sampling triggers) and ESP technology to filter and observe in situ were noted.
 - 15.2. Motivating questions require solid spatial and temporal series to address, e.g how are invasive species spreading?
16. In such scenarios and in aid of long-term feasibility, methods that are both affordable and easily repeatable are needed to monitor biodiversity
17. Two examples of MBARI projects were described as successful applications of long-term and biospatially guided omic monitoring:
 - 17.1. At an aquatic eDNA monitoring site, four different genomic, taxonomic markers were examined through time and robust seasonal signals were detected over the 2013-2016, with some notable deviation.
 - 17.2. A spatial study examined whether omics can corroborate biogeographic breaks when examining zooplankton samples. Higher diversity was detected in the southern sector of the analysis while northern communities showed variation between biogeographic regions
18. MBARI's historical samples were noted
 - 18.1. These samples were collected and processed with different methods, including sampling and filtering methods
 - 18.2. Collection blanks are also collected: This is a feature that an observatory network should discuss carefully: what kinds of negative and positive controls should be collected by all in the community? How do we handle sequences detected in negative controls?

19. The bioinformatics workflows applied were noted, along with open questions for standardised analysis:
 - 19.1. All diagnostic, log files, and metadata is always deposited in the standardised way
 - 19.2. The BIOM format, suitable for sparse data matrices, is used to package metadata and OTU tables.
 - 19.3. Taxonomic annotation is a target for improvement. There is a need for cross-validation with other partners and
 - 19.4. Would like to make the data searchable by sequence similarity too, so other sequences can be found. BLASTable DBs?
 - 19.5. Open questions: Where are the reasonable cutoffs? What is the sequence behind taxonomic annotations?
 - 19.6. It is vital that unannotated / unprocessed sequences are made available for others to use alternative methods
20. All omic work (current focus on barcodes) must be linked to the outputs of traditional sampling to maximise benefit

DNAqua-Net: coordinating aquatic DNA monitoring activities (Florian Leese)

21. The mission of DNAqua-Net: develop roadmap to incorporate omics in standard ecological assessments. In part, this responds to an EU mandate to bring ecosystems into a good state by 2027 (formerly set for 2015)
22. The project is a COST action to link initiatives to enable breakthroughs in scientific developments. It currently networks >400 members.
23. Workshops on developing molecular indices and taxonomic indices have been hosted
24. Many of the tasks assigned to the projects working groups align to the questions put forth by K Pitz (above, points 15-20)
25. Omics and Bioassessment:
 - 25.1. The talk noted that there's a degree of dislike of omics techniques in the Environmental Assessment space, as they upset decades-old monitoring frameworks that are carefully intercalibrated.
 - 25.2. Simultaneously, however, there's a recognition that there's a need to add omics techniques due to the insight they can provide (e.g. increased taxonomic resolution).
 - 25.3. The corollary: To work in this space, omics must be linked to EnvAssessment metrics and incorporated into indices for bioassessment
 - 25.4. Thus DNAqua-NET is trying to show that omics can be added, and aligned to existing assessments
26. Some issues and barriers were noted
 - 26.1. There is a persistent issues with normalizing DNA read counts across organismal sizes and categories
 - 26.2. The psychological barrier to adopt emerging approaches in environmental assessment is strong – we need to communicate the advantages very clearly, and make the economic case: why is this more useful than traditional, cheaper methods?
 - 26.3. The links from WGs in DNAqua-NET to each stage of the harmonisation process were shown.
27. DNAqua-NET can contribute to GLOMICON via:

- 27.1. A large collection of experts
- 27.2. A framework of standardized protocols and information sharing routines
- 27.3. Potential sustainability and regulatory interfaces: An application for a permanent working group through CEN on eDNA and DNA-based topics is in process.
 - 27.3.1. Working through CEN, omics standards can be propagated through all EU countries
 - 27.3.2. This route offers a platform to lobby for the addition of genetic assessments to mainstream activities,
- 27.4. A community which can help develop performance based standards
- 27.5. Funds for meetings workshops are available
- 27.6. A new journal on the topics of the Action has been established

MBON: a GEO BON framework for coordination and stakeholder interfaces (Frank Muller-Karger)

- 28. The Marine Biodiversity Observation Network (MBON), a marine-themed component of GEO BON, is a framework for coordination and stakeholder interactions, rebooting the CoM. MBON:
 - 28.1. offers a device to establish an international community of practice, attempting to link the trying to link the IOC and GEO to what users need
 - 28.2. contributed to the development of Essential Ocean Variables (EOVs) , following the success of the Essential Climate Variables (ECVs)
 - 28.2.1. EOVs were defined through an elaborate process. EOVs for physics and chemistry are well-established, but biological and ecological (Bio-Eco) variables are still conceptual and need development within the existing physicochemical infrastructure
 - 28.2.2. There is a drive to unify the EOVs with the Essential Biodiversity variables (EBVs), and intersection that would be of note for marine omics
 - 28.3. link historical data in OBIS and update its content with new data types
 - 28.4. create best practices for data and metadata
 - 28.5. aims to ultimately create dynamic biogeographic seascapes formed by integrating biodiversity data, omics data, satellite data, etc
 - 28.6. through the Global Ocean Observing System (GOOS) regional alliances, provide a route to integrate new technologies into globally operational systems.
- 29. A use case in the South Florida Keys was described, a sister project to K Pitz's example at MBARI and a test bed for omics technologies
- 30. The need to link omics efforts to societal concerns was underscored – timeseries and other sampling campaigns must be focused in regions where governments want data and insight. The worth of omics can then be demonstrated in this arena.
- 31. Issues with best practices in omics are of concern, for example:
 - 31.1. Linking OTUs and sequences to organisms present in the environment is done in many ways, we need a basic set of techniques that we can use as a baseline (even if imperfect) around the world
 - 31.2. There is a need to understand what eDNA actually means – shedding rates, degradation rates, etc must be considered
 - 31.3. Despite progress, costs for omics-based observation with reasonable replication are still too high, esp. for developing nations

32. Successes with eDNA were noted and more noted as forthcoming, particularly in connection with microbial dynamics as a component of biodiversity and harmful algal blooms
33. The need to produce data products which can be ingested by bodies monitoring progress towards the Sustainable Development Goals was underscored.

Panel discussion

34. Central topic: the path to standards
 - 34.1. The lack of a strong link between official standards committees like CEN and the science standards committees (GSC, TDWG) was noted. If we don't create such a link, there's a strong chance their efforts will decouple and the mainstreaming process will take longer or use methods not in sync with the majority of practitioners
 - 34.2. Standards bodies such as NIST rest on a business model where standards creators have to pay for their standards to be ratified. Strange for science, but commonplace in industry.
 - 34.3. It was noted that standards are not closed or locked in CEN. Even if we don't have SOPs now, we could produce guidelines on what not to do.
 - 34.4. Formulating guidelines and best practices through an omics network are the way we can begin to work into standards – targeting the baseline methods that are called for above would be helpful
 - 34.4.1. The urgent need for a baseline methodology was underscored again
 - 34.5. It was noted that standards hosted by official bodies typically get re-evaluated every 5 years and they are open to comment. This provides a route to update them even in the quickly developing field of omics
 - 34.6. It was stated that standards bodies exist because industry needs regulation and certification to boost confidence in products. While we may not need to go that far, we do have to accept a responsibility to assure the users that our “products” are adhering to standards that work
 - 34.7. It was noted that we need use cases to interface with standards bodies. Agencies like FBI and RCMP want to use omics data in their investigations, and are asking for standards.
 - 34.7.1. It was stressed that use-case data sets should be at the fore of this discussion:
Ideally, we would baseline off of a data set that has a time series focusing on one marker gene running for 10 years at one site, using the same methods in the field and lab.
 - 34.8. It was stated that we need a minimal best practice document out there so it can be used, commented on, and revised at pace. Pilot studies are taking too long and by the time they conclude, the technology in this field has already changed.
 - 34.9. Standards work should have access to a set of samples that are well-characterised and preserved, but also a raw read archive for bioinformatics work and standards
 - 34.9.1. It was noted that several programmes do exist which store or are considering the storage of samples, but each has different methods.
35. Key issue raised: trust in eDNA methods and reporting
 - 35.1. It was noted that work with eDNA is still in its infancy: we're still not sure what it's telling us, still very much a research topic. Its binding properties, degradation rates, etc are not characterized. Neanderthal eDNA has been recovered from cave dirt, raising doubt in eDNA records

- 35.2. Workshops on the topic were noted, particularly those run by US and CA agencies (inc. EPA, DoD, USGS) where similar concerns were raised.
- 35.3. Some stated that they are reasonably confident in early alpha diversity data, but would be very reluctant to work with relative proportions of counts
36. Trust in omics data and data provenance:
 - 36.1. The issue of lack of trust in data due to unclear provenance or a lack of methodological and quality control documentation was raised.
 - 36.2. Would GLOMICON be a means to put forth documentation and QC requirements?
 - 36.3. It was noted that MBARI packages sampling, wet-lab, and bioinformatics metadata in its data products, which could serve as a model for a broader network
 - 36.4. GLOMICON could sketch out more extensions to the standards space to account for the various theatres of investigation.
 - 36.5. The possibility of developing links between databases such as ENA/GenBank and OBIS was raised. It was noted that until the community pushes this, such interoperability is unlikely to materialise.
 - 36.6. It was noted that following submission to Genbank, data does go through some QC. However, raw reads are still sometimes difficult to discover and access.
 - 36.6.1. The discontinuation of CAMERA was noted as a setback, while systems like MG-RAST were noted as successors filling this need.
 - 36.6.2. It was also noted that the ENA system does allow archiving of extended information in the EBI metagenomics portal.
 - 36.7. Given the above (points 36.1-36.6), it was suggested that GLOMICON could produce periodic reports/reviews on readiness levels for omics technologies and information solutions (differentiating eDNA, methods, primers, etc) which could serve as a basis for consensus building
 - 36.8. It was further noted that the Genomic Standards Consortium (GSC) has been operational for 10 years and has developed standards that are used by the INSDC.
 - 36.8.1. The bottleneck is the extension of the standards is laborious. Encouraging usage is likely to be a top down mandate.
 - 36.9. It was noted that similar issues arose around the handling of museum specimens
 - 36.9.1. Access to specimens was difficult as managers and curators both lacked time/interest in handling requests; it will take going to the funders to ensure that facilitating truly functional access is part of each project/programme's core tasks
 - 36.10. It was noted that the GSC did discuss such issues with funders, databases, and similar bodies, which went as far as issuing recommendations rather than requirements. Discussions with MG-RAST offered an interesting avenue for progress: compute jobs which lacked good description were deprioritised on their servers
 - 36.11. EBI metagenomics portal getting together with MG RAST to develop common standards for omics communities – they may offer standards for the community
37. Interface theme: national processes
 - 37.1. It was suggested that interfacing with a body like GEO and/or UNESCO/IOC would provide an avenue to national discussions on biodiversity monitoring with new technologies. In the marine setting, more attention will be placed at this level as the decade of ocean observation for sustainable development is starting soon, now is the time to get ideas in the process.

- 37.2. It was suggested that we consolidate first, most likely via the GSC before approaching these bodies, MBON can offer another point of interface

Tara Oceans' ecosystems biology approach to address microbial contributions to macro-ecological processes (Chris Bowler)

38. The Tara project aims at providing a global assessment on plankton ecosystems across size classes (zooplankton to viruses). It is well documented through several publications and companion websites
- 38.1. Sequencing targets: metagenomes and transcriptomes, barcodings
 - 38.2. Sampling protocols standardized to be able to compare globally, metadata / reporting standards required for all stations
 - 38.3. Rich collection of contextual measurements, parallel investigations with imaging system (in situ cameras) and classical microscopy
 - 38.4. Global data sets allow the development and application of insight (e.g., interactome to generate hypotheses)
 - 38.5. All data are open access
39. The early phase insights are furnished by novel techniques (e.g. single cell genomes, eukaryote gene catalogue) and have extended scientific knowledge (e.g., radiolarian abundances, gene expression in a natural community)
40. Limitations included:
- 40.1. Patchy sample coverage
 - 40.2. Eukaryote genetic diversity too large to be addressed with current methods
 - 40.3. Mapping of DNA and imaging results has proven difficult
 - 40.4. Capacities to deal with sampling and data were often stretched
41. Despite limitations, the project has provided a set of approaches that can be adapted into long-term observing strategies, merging omics with multiple other forms of observation

The Ocean Sampling Day: a global, epipelagic, omics snapshot (Antonio Fernandez-Guerra)

42. The OSD approach was to take a global snapshot of microbial diversity using synchronised sampling by many groups during the summer solstice of 2014
- 42.1. This addressed basic microbial ecology questions (who, what, how)
 - 42.2. Components of OSD (global, orchestrated, contextual data...)
43. The OSD procedure, being community-centric, required registration, acquisition of legal permissions for biosampling, aligned and standardised sampling procedures, as well as standardised archiving of all samples and data.
44. OSD generated both recommendations and mandatory requirements and provided a handbook to all participants to promote consistency
45. Limitations were identified:
- 45.1. Spatial bias of sampling to northern hemisphere and coastal sites; however, this complements the Tara samples quite well

- 45.2. Unavoidable analytical differences created issues with comparison, due to issues including low sequencing depth, different sequencing instruments (HiSeq vs. MiSeq) different bioinformatics workflows. Reanalysis necessary.
- 46. Scientific results included
 - 46.1. Results clearly showing that the coastal microbiome differs strongly from that of the open ocean.
 - 46.2. Functional redundancy of the microbial communities is high; but taxonomy varies: important implications for biomonitoring

Global characterization of microbial taxonomic and functional diversity in the Earth Microbiome Project (Luke Thompson, remote)

- 47. The EMP sought to create a multi-ecosystem representation of microbial diversity to understand global distributions of biomass, taxa, functions, and ecological roles. The EMP does not have an intentional temporal component, but has pioneered
 - 47.1. The study was motivated by the meta-analyses in past studies
 - 47.2. Central idea: crowd-source new samples, taken by colleagues all around the world and provide the sequencing and analyses as a service
 - 47.3. The impressive number of samples, environments, and other features of the collection were presented
 - 47.4. As with Tara and OSD, standardised techniques enabled EMP (sampling, metadata collection, etc)
- 48. Scientific outputs were many, but the following were highlighted:
 - 48.1. Clustering of samples based on the environmental origin, including organismal environments
 - 48.2. New bioinformatics approaches (deblur) were used to overcome limitations and errors common in OTUs generation
 - 48.3. Results included detection of global spatial patterns, nestedness, and new insights from microdiversity
- 49. The importance of standardized metadata and controlled vocabularies was stressed, as was work to improve existing vocabularies and ontologies to track microbial sampling
- 50. The EMP's experience base, data management, and tooling can all be potential components of an omics ecosystem observatory workflow

The role of the GSC and MIxS in global omics observation (Pelin Yilmaz)

- 51. The GSC began as a grassroots initiative to bring standardisation to genomic information through checklists such as MIxS.
 - 51.1. As DNA/RNA sequence data is increasing exponentially, the need to increase adoption more pressing
 - 51.2. Standardised information on contextual data needed to use the full sequence data potential.
 - 51.3. GSC-compliant metadata are supported by INSDC databases, and stored as key-value pairs in structured comment blocks

52. The GSC's approach to building standards was noted: It identifies the geographic, environmental, and procedural information required to contextualise omics data and determine whether different data sets are comparable
 - 52.1. A core set of fields is mandatory
 - 52.2. A set of extensions to the core are available for different environments or omics techniques, allowing domain-focused standardisation
 - 52.3. New extensions can be added by the community
 - 52.4. An example of metadata collected was shown
53. It was noted that, at this stage, there is no means to control and enforce compliance, only encourage it
54. Checklists for new omic approaches are being developed.
55. Access to MIxS checklists, available as spreadsheets, is possible via the GSC website
56. An RDF representation is being developed, and documentation is available in the GSC GitHub repository
57. The potential to develop and share checklists and packages developed by the GLOMICON community was noted

Trade-offs in selecting 'omics sampling methods (Stéphane Pesant)

58. The EMOSE intercomparison experiment was introduced: its objectives centred on systematically comparing methods used by large omics initiatives and developing best practice recommendations
59. Such exercises, performed periodically, would be vital to maintain alignment in an omics observatory network
60. All protocols were tested on the same water (Mediterranean) and the trade-offs of each method discussed
61. The methods used by major sequence-driven initiatives were also compared
62. Methods were applied to large volumes of water, in addition to the typical sampling volumes
63. Data and metadata generation were carefully managed
64. A hackathon was held to develop and modify bioinformatics tools to best contend with the data generated by EMOSE

Panel discussion

65. Questions were raised about the future of the EMP, particularly its sustainability
 - 65.1. Plans exist to continue gathering more samples for amplicon and shotgun sequencing, as well as further bioinformatics analyses
 - 65.2. Sustainability is an open question
66. The usefulness of repeated comparison experiments like EMOSE was underscored
 - 66.1. It was noted that such comparisons should be extended to cover all methodological differences between network nodes, and also compare omics outcomes to those of classical methods.
 - 66.2. It was put forth that even if substantial knowledge is generated, putting this into universal recommendation is still likely to be a challenge; however, it was agreed that such approaches would help all learn about the limitations and strengths of the methods utilised in the network.

- 66.3. It was noted that programmes like the CPR will not implement recommendations until a proper comparison is done.
- 67. The value of performing DNA/RNA extraction and sequencing at one was discussed. General agreement about the value to standardisation, but questions about feasibility for a global network open
- 68. SP: intercomparisons needed.
- 69. It was noted that new activities to build reference libraries (incl. those for larger organisms) were in progress, which would serve as an asset to the network, even in their early phases
- 70. The funding from the Moore Foundation to build more eukaryote references (e.g. the UniEuk project) was noted
 - 70.1. Single cell genomics help to build libraries, but full species characterisations are still missing.
- 71. The need for standard materials to test different workflows on was stated
 - 71.1. A few examples of standard material generation in the omics domain, such as the NIST 'Genome in a Bottle' were given
 - 71.2. If, in addition to in vitro standards, natural material standards were available, we would be able to test differential extraction and similar upstream methods.
- 72. It was noted that intercalibrations are hard to organize – and, due to resource usage, cannot grow even bigger by including every new method in the field. Agreeing on a core set of methods, that may not be cutting edge, is perhaps more feasible.
- 73. The risks of varying PCR inhibitors present in extracts from different sources and the technical variation introduced during amplification was noted
- 74. The value of corroborating, parallel methods was noted. The divergence of omics “abundances” and those determined by imaging showed that barcode sequences have multiple complications. For example, read counts from Diatoms and Dinoflagellates are very different. Verification with non-omics techniques (e.g., with images) is still needed.

Session 4 (Chair: Jörg Peplies)

In situ technologies for marine omics (Julie Robidart)

- 75. An overview of recent developments in situ samplers, sensors, sequencers was provided
- 76. It was noted that nucleic acid extraction is a major bottleneck to these systems
 - 76.1. There are promising technologies (microfluidic extractions) being explored, but more field testing needs to be done
- 77. The need for SOPs for DNA and RNA procedures for extraction was identified
- 78. It was noted that the BioArgo programme has genomics in its vision, which should be on the network's radar
- 79. A published overview of existing eDNA/RNA sensors & samplers was referenced; the publication outlines the strengths and weakness of various platforms: the choice of platform is a question of prioritising needs (replication, deployment time, etc)
- 80. An Introduction to the Marine Autonomous Plankton Sampler was provided
 - 80.1. The sampler uses sterivex technology
 - 80.2. Patenting is underway

- 80.3. A test deployment as bench-type version attached to towed pump (towfish) has been performed; hourly sampling over 10 days, comparison to flash-frozen samples, sequencing data will soon become available.
- 80.4. It was noted that an autonomous deployment is planned in the Western Channel to capture the spring bloom
- 81. An evaluation of different nucleic acid fixatives is needed to provide guidance for autonomous platforms
- 82. Focused omics for key organisms:
 - 82.1. A lab on a chip solution for pathogen detection was noted
 - 82.2. An ESP with micro-arrays focus on nitrogen fixers was also described
- 83. It was emphasised that omics data must be coupled with parallel observations of environmental parameters to be of value
- 84. It was noted that in situ sensors typically need dedicated technician(s) and scientist(s) for deployment, depending on their TRL. This is an important consideration when budgeting and planning logistics
- 85. A discussion followed where the following were noted:
 - 85.1. Deep sea capabilities are present with modifications such as pressure housing and sample de-pressurizing components
 - 85.2. In situ sequencing is still difficult, sample preparation is the main challenge
 - 85.3. When marketed, the cost of ESP v3 should be around 200k per unit, but no official prices are available
 - 85.4. Regarding nucleic acid preservation, it was claimed that DNA can be preserved practically indefinitely and RNA for 90 days, unclear whether information content is the same
 - 85.5. Possible links to AWI's work on preservatives and extractions in AtlantOS noted

NEON: Operating a continental-scale observatory network (Christine Laney, remote)

- 86. Minutes are terse, as this presentation is available as a recorded video (on request)
- 87. NEON was introduced – a major US NSF initiative which is itself an observatory network funded for the long-term (~30 years)
- 88. A video introduction to NEON was shown
 - 88.1. All US sites are monitored with consistent technology
 - 88.2. The scope includes terrestrial and freshwater deployments, with automatic sensors, manual sampling, and remote sensing at all sites.
- 89. A detailed introduction of NEON approach was provided, outlining its formidable range of technology and data handling
- 90. A discussion followed the recorded presentation:
 - 90.1. NEON was noted as an example of a project/programme that should have a strong role in shaping standards.
 - 90.2. It was noted that GSC MlxS package extensions have been earmarked as useful and extensions are under development / being refined.
 - 90.3. It was noted that alignment of NEON's large mandate with several existing networks is laborious. Integration of networks (NGRAS, BOLT) would be useful, and linkages should be strengthened whenever possible
 - 90.4. It was noted that a team of 40 professional software developers are involved in developing the informatics backend to ensure production-grade technology
 - 90.5. NEON method selection process:

- 90.5.1. Working groups were convened and assembled workflow designs and selected sequencing methodologies
- 90.5.2. Technical working groups are still active and providing feedback on the methods chosen
- 90.6. Sample archiving strategies:
 - 90.6.1. NEON is currently establishing its own operational archiving solutions around a single bioarchive for all samples. At the present time, it distributes samples to local archives
- 90.7. Coping with novel technology:
 - 90.7.1. Technical working groups will be established to provide advice.
 - 90.7.2. A temporal overlap between the operation of current and new methods is desired to allow some form of comparison/calibration
- 90.8. On funding: NEON is operated under a major research facilities grant of NSF, planning started in 2004, same funding as other observatories, 30 year funding allocated for the operational phase.

NOAA 'omics research and efforts to transition into management applications and operational observations (Kelly Goodwin, remote)

- 91. As above, this was a recorded presentation and is available on demand, minutes are terse.
- 92. NOAA's motivations to use omics applications were outlined and several papers from the presenter are available on the issue. As noted in other talks, the ability to assess water quality and pathogen loads are featured.
- 93. The sequencing work done as part of The California Cooperative Oceanic Fisheries Investigations (CalCofi; <http://www.calcofi.org/>), a project tied to the impacts of fishery collapse was described
- 94. NOAA uses the ESP in an operational manner
 - 94.1. An AUV version has been tested, with the capacity to responsively sample based on the detection of thresholds in environmental parameters
- 95. Challenges: data richness, missing quantity
- 96. As the speaker could not be present for Q&A, comments were gathered:
 - 96.1. It was asserted that ground truthing is still sorely needed eDNA (see above)
 - 96.2. Open question: Can less well-funded partners participate in ESP biomonitoring? This is important if this monitoring is to be truly global
 - 96.3. Questions posed about the availability of raw data: are there embargo periods?
 - 96.4. Questions posed about the vision for the future of automated sampling. How will this transform to operational monitoring?

2018-02-22 | Breakout sessions

Breakout 1: Pathway to implementation

Summary

97. There was unanimous agreement from participants that some organizational structure/group was a necessary feature moving 'omics approaches forward in the coming decade of biodiversity observation systems. The group also agreed that it should be open to possible scaling up of different 'omics capacities to encompass the range of biological molecules, not just sequence data. There was also general agreement to build upon efforts from previous Genomics Observatories, leveraging language where possible in the more expansive inclusion of non-sequence molecular data. Success will depend on champions, and motivated, dedicated leadership. It was emphasized that as a global community, we would all benefit from knowing what each other are doing and how we are organizing efforts. It is important that we proactively organize our efforts and demonstrate that we are a mature research community. Further, it was noted that we must recognize rapid change, but simultaneously recommend standards and a review policy for evaluating and incorporating new technologies into operational systems. Whenever possible, OOs should look to augment existing efforts, leveraging existing infrastructure and activities. At a minimum, early work should enable us to share structured data freely between observatories, including all protocols and settings that could cause differences in outcomes.

Proposed actions

- 97.1. Generate a census / registry of existing omics observatories or long-term time series
 - 97.1.1. A prescribed set of attributes (type of data, frequency, targeted communities, methods, costs, purpose, available SOPs, etc.) to be determined by a subcommittee of OO members should be associated with each observatory
- 97.2. Adopt metadata standards and explore their broadening beyond MixS to encompass partner activities
 - 97.2.1. Augmentation of metadata standards normally proceed through user group workshops
 - 97.2.2. Alternative to flat file checklists proposed using permalinks
 - 97.2.3. Interface through metadatabases such as GeOMe and link to INSDC resources such as with ENA. Momentum and critical user mass is needed here.
- 97.3. Further efforts to link to existing frameworks and projects to help formalise our network's functioning and elect chairs/co-chairs to drive forward priorities
 - 97.3.1. During the meeting, an initial link was made to GEO BON and a one-page description of our activities drafted. We proposed a GEO BON omics-focused Task Force be assembled via GLOMICON.
 - 97.3.2. Inquiries to reporting mechanisms linked to the UN SDG process were proposed.
 - 97.3.3. Link to the WPs of the ASSEMBLE+ Genomic Observatory project (meeting in Crete)
- 97.4. Explore opportunities to assign and fund a dedicated person (program manager) to keep the GLOMICON momentum going
- 97.5. Consider submitting a SCOR working group proposal for the marine members of the network, to allow meetings and trainings
- 97.6. Provide guidance, certification, and a clearing house for standard operational procedures (SOP), protocols, workflows, etc. to be shared among community members to

- demonstrate coordination for broad comparative value in derived datasets – would benefit grants and proposal
- 97.7. Identify hurdles to current data aggregation efforts to prevent future problems
- 97.8. Provide menu of participation models for potential nodes, including minimal requirements and estimated costs
 - 97.8.1. Note that current research funding is project focused, rather than observatory focused – we must find how to channel projects into a wider framework

Breakout 2: Global questions and reporting frameworks

Summary

- 98. The questions and issues that GLOMICON is uniquely poised to address were discussed in this breakout. It was acknowledged that the cross-domain capacity in this group was quite unique: all other groups and bodies (incl. funding schemes) are rather domain specific. This poses challenges, but also allows opportunities to tackle interdisciplinary problems. It was very clear that omics cannot exist in isolation if global questions are to be addressed: tight integration with other long-term data series is needed, including other biological data series to corroborate signals. Many possible topics of interest were identified during the breakout (detailed minutes available on request), but consensus was found around topics such as:
 - 98.1. Omic insights into the impacts of climate change on ocean and terrestrial health
 - 98.1.1. Multi-regional and multi-ecosystem responses in biotic assemblages to global change in both taxonomic and functional dimensions
 - 98.1.2. Dynamics of global biogeography, particularly of microbial taxa
 - 98.1.3. Changes in baseline ecology and composition
 - 98.1.4. Identification of early-warning and indicator genes associated with negative ecosystem states, invasive species, and hazards
 - 98.2. Environmental Impact Assessments including omics surveys of ballast water, invasive species, early warning signs for ecosystem change, biodiversity reduction, and the progress of restoration ecology practices.
 - 98.3. Methodological questions regarding the formulation of best practices of current and emerging omic technologies such as:
 - 98.3.1. What are the optimal spatio-temporal sampling regimes to adopt for any given research target? Observatories as test-beds.
 - 98.3.2. How can we consolidate signals following differing bioinformatic workflows? Construction of ensemble methods and identification of what works for detection along with what is cutting-edge at the time.
 - 98.3.3. How do omics-derived taxonomic signals compare to traditional data series? Do historical signals integrate with omics outcomes?
 - 98.3.4. How can we formulate and use calibration materials such as mock communities and standard environmental samples for global systems?
 - 98.3.5. How can we formulate, deploy, and tune omics-based indicators in the long-term?

- 98.3.6. How can we interface with existing indicators such as the, EOVs, EBVs, Living Planet Index (LPI) and the Ocean Health Index (OHI)?
- 98.4. Operational services could also be provided by nodes in the network, such as
 - 98.4.1. Ballast water certification (as performed by a NIOZ spin-off)

Proposed actions and discussion points

- 99. Foremost, we should extend and build networks to better understand global needs and formulate testable hypotheses aligned to the questions outlined above.
 - 99.1. This involves the engagement of future stakeholders including industries such as oil and gas and deep-sea mining
 - 99.2. The process of identifying potential gaps to address global themes can be folded in to this action.
- 100. Once primary research targets are identified, the physicochemical data needed to contextualise the omics data needed should also be identified and standards adapted accordingly
- 101. We should submit EOV specification sheets using omics to GOOS and EBV material into GEO BON to link to these frameworks and align early
- 102. The scale of the research themes is planetary, thus the network should frame its activities along the SGDs or NASA proposals
- 103. Sites for observatories should be identified and recommended based on how well they can contribute to the global mission, this ties in to the questions of spatiotemporal observation patterns
- 104. Existing networks – most without omics components -handle many themes we have identified above (e.g., Land-ocean carbon flow). Some of these date back to the late 80 and 90s (LOIS Land-Ocean interaction studies) and should be engaged.
 - 104.1. It was noted that several UK efforts aim to follow drainage and monitor rivers, but lack omic approaches so far (proposed for addition).
 - 104.2. The LTER network was noted as well as their aim to address process driven questions in this field. Some omics adoption is already active here.
 - 104.2.1. Across-Atlantic LTER activities (Pom Island and Martha's Vineyard) the last is new, both include omics. It was noted that engagement with LTER omics-enabled sites is important to get them involved in our activity. We can learn much from their network, including their strengths in metadata provision.
- 105. All of the above activity requires agreed data exchange formats, even though this may need quite a bit of discussion. Generating a set of best practices is feasible and required; an exhaustive list of what is going on in the field is also absent. It was noted in this break out registry of should include minimum criteria to qualify as a omics-enabled observatory

Breakout 3: Data analysis – intercomparison in the face of methodological variance

Summary

106. This group noted the central importance of generating datasets from reference material for benchmarking analytical procedures. It was noted that resources are required to compile, quality control, document, and, to a lesser degree, sustain such a collection of benchmarking data sets.
- 106.1. These data sets will be key in comparing current and emerging technologies to test and understand the impacts of updates of a network's methodological base (cf. 90.7)
107. It was noted that some reference data sets do exist, but often in their own formats. GLOMICON's role here would be to connecting to the relevant communities (e.g., Tara, OSD) and allow smoother access and normalisation. This would be a model for future large efforts to adopt at an early phase.
108. It was noted that this network should reach out to existing activities (e.g., "mockrobiota" and "Genome in a Bottle") to transfer best practices
109. It was noted that some degree of top-down enforcement (or more likely, positively endorsing) is required to boost implementation of best practices by the community. For example:
- 109.1. Requirement to implement best practices to be part of the network.
- 109.2. Eventually, if GLOMICON succeeds in getting close to operationalising omics activities, funders can be approached to require compliance

Proposed actions and discussion points

110. It was noted that a key action would be to federate and boost interoperability of public databases which hold omics data (taxonomic and functional) with those that contain environmental data and taxonomic data from traditional methods. They are present, but true interoperation is not present.
- 110.1. Discovering relevant data is still difficult, federated and standards-compliant markup along the FAIR principles is needed
- 110.2. It was noted that OBIS' data formats and API standards offer a point of linkage to such efforts. It is likely that would it make easy for OBIS to link (also important for GBIF). Experience from CoML showed a reasonable approach, using the WORMS approved taxa list as a standard.
111. It was suggested that GLOMICON could follow GBIF's lead to create operational links to traditional taxonomic archives
- 111.1. This would function around the assignment of DOIs to data sets, similar to the UNITE activities for Fungi. The UNITE system allow metadata to be attached to sequences. How do we proceed outside Fungi to handle the community accepted DOIs? Perhaps the BOLT system offers some models.
112. General support for inviting NCBI (and other INSDC) representatives to provide advice from the sequence DBs side
113. Regarding data as a guiding principle of network organisation, it was suggested that we should enquire how GEO BON groups operate: it seems to be guided more by scale (ecosystem, populations etc) not the evidence/data type (omics, methods).

Breakout 4: Harmonised advancement of in situ measurements and sampling

Summary

- 114. It was noted that there is a very diverse array of platforms and devices in place, even surveying this is demanding.
 - 114.1. A white paper on platforms and SOPs.
 - 114.2. A SCOR WG or similar funding mechanism would be required to scope this adequately.
- 115. Encourage pilot studies (need further discussion). Requirements for instruments should be guided by
- 116. Long term decision making. Use existing infrastructures. Lessons learned by NEON.

Proposed actions

- 117. Agree on and contribute to a single access point for SOPs
- 118. Create an index to facilitate knowledge transfer regarding affordable technologies to promote global adoption of similar technology.
- 119. Similar to 118, create a database or index for new technologies, allowing users who are in a position to field test technology to contribute to advancing TRLs quickly
- 120. As a general recommendation, we should not be reluctant to be prescriptive about technology requirements

Breakout 5: Harmonising bench methodologies, intercalibration, and method sharing

Summary

- 121. It was agreed that the key to addressing this topic is the exchange of standard samples, mock communities, and data sets to understand at which level observatory data can be integrated (e.g. for meta-analyses) and how much error or variance is introduced as each stage along the workflows.
 - 121.1. Following this logic, the desirability of creating a study to understand which steps create variation was noted. It was not clear how intensive this study would be, and some parts may still left as black boxes if resources are too limiting.
- 122. It was noted that the level of standardisation needed will depend on the needs of the stakeholders involved, including academia, industry, and policy elements. It will also be tied to the legal consequences (cf. 34.7).
- 123. The minimal requirement for reporting methods should be full documentation, allowing exact reproduction of results

Proposed actions and discussion

- 124. As with other method-focused breakouts, it was agreed that a single place to collect methods is required.
 - 124.1. The metadata around such methods should be standardised and the standards that hold them extended to meet current needs.

125. It was agreed that a contact list for groups interested in contributing to lab comparisons should be established.
126. Once calibration guidelines are established: In the GLOMICON registry, label observatories that are calibrated (i.e. have participated in calibration activity) and distinguish them from those that are yet to be calibrated as an incentive.
- 126.1. It was noted that such activities are likely to be ecosystem and material-specific (e.g. soils, water, sediment, tissue), however, some overlap is also expected, especially with similar materials.
- 126.2. For feasibility, it was suggested that such activities work on DNA extracts (rather than raw samples). AWI and MBARI proposed making the first step.
127. It was noted that the ASSEMBLE+ community has networking grants for transnational access to culture collection via CCAP: They might be willing to provide mock communities. Contact should be established.
128. It was noted that AtlantOS activities may tie in with those of MBON and LTER . Collectively, they could ask for additional money to perform EU-US work, but regionality is still an issue.
129. It was noted that Jed Furhman's group have sent mock communities to collaborators on request. These are not yet deposited in culture collection. GLOMICON should engage such groups.
130. It was noted that the Tara, OSD, and EMP approaches all minimise variability. Their principles should be transferred to a large-scale network too.
131. It was accepted that methods have to be different for different materials to get the best results (different materials, different organisms) – however, this also introduces technical variability. A fine balance must be struck and standards should be disaggregated between sample types.
132. It was proposed that short-term integration may be more feasible at the data/information level: metrics can be weighted or otherwise adjusted to account for known variation and compiled into aggregate indicators, similar to the OHI or LPI. This would reduce the need for low-level agreement, but requires calibration to determine appropriate integration operations.

Breakout 6: Sample provision for cross-validation, interoperable inventorying, and archiving

Summary

133. The need to archive samples from long-term observatories was universally recognised a priority for omics observing. It serves as a buffer against technological change by allowing periodic, retroactive sequencing with new technology and as legacy
134. It was stressed that even if there are no pressing questions at the time of sampling, samples in any spatiotemporal pocket can later become necessary for both global and local questions, as well as legal or policy issues.
135. It was agreed that distributed archiving is preferred over centralised solutions to preserve robustness in the system and allow partners to transfer samples if one archive were to shut down (the CPR has encountered this before).
136. As with other tasks, connecting existing resources is essential for stocktaking prior to building new solutions. Networks like the GGBN were noted.

137. It was agreed that there must be a registration and inventorying system for all archived samples, where metadata is entered and quality checks performed. The systems used by GDBN were noted as an example.
138. Access to archived samples must be regulated to preserve enough material for decadal retro-analyses. A review committee was recommended for access applications.
139. It was stressed that a concept for sample preservation should be associated with in situ sequencing technologies, which are quickly becoming a reality,

Proposed actions and discussion

140. It was suggested the network consider business models to support archives in the long-term, including either pay-for-access or pay-for-archiving models.
141. It was noted that participants were not able to access GGBN data: it is possible it focused on intra-network availability. This is something to avoid from an early phase in GLOMICON.
- 141.1. It was noted that links to GGBN should be pursued, but links harvesting data from GGBN should also be secured
142. It was noted that the museum community (perhaps via TDWG) should be engaged. Previous success with the Smithsonian for OSD was highlighted.
143. Several participants will attend the upcoming GGBN meeting in Vienna, where they can enquire about the status and scope
144. It was noted that the legal side of sample archiving should not be overlooked (Nagoya etc) as experience from MicroB3 has shown.
- 144.1. While it has to be addressed it shouldn't be a major problem as there is a foundation (e.g., building on OSD). It was noted that a good legal framework will ease place-based activity.
145. It was noted that best practices for sample archiving and access are needed for distributed archives to qualify against.

Communicating the path ahead, defining outputs, creation of follow-up task teams, planning next meeting(s)

146. It was agreed that successive meetings should be more focused on the deliverables identified during this meeting: A stepwise approach is more likely to yield tangible results while there is no direct funding for GLOMICON. The following early steps were suggested:
- 146.1. Collect, organise, and expose information on observatories as a registry
- 146.2. Collect reference data sets and attempt to render them interoperable
- 146.3. Collect SOPs and methods from nodes.
- 146.3.1. It was noted that several institutions and projects (e.g. AWI, EMP) are in the process of digitising their protocols, ready for sharing.
- 146.3.2. Volunteers were identified to carry this forward
- 146.3.3. It was noted that protocols may need expert revision before becoming "certified". Until then, they can be exposed as 'emerging / not tested'.
- 146.3.4. Protocols.io was put forth as a ready means to expose SOPs (as is done by the EMP)

- 146.4. Begin sample exchanges for cross-comparison of results generated by different labs and methods stacks.
 - 146.4.1. AWI and MBARI to explore implementation
- 146.5. Canadian partners agreed to coordinate sample exchanges and intercomparisons for soil samples
- 146.6. It was noted links should be made to similar initiatives in omic intercomparison based in Barcelona
- 147. It was agreed that an online collaborative space will be set up to collect interest and report on progress.
 - 147.1. A Google Drive and Group with folders for each task will be established by the AWI partner.
- 148. It was noted that the registry of observatories (referenced and called for above repeatedly) that already have omic component should be connected to MixS metadata through GSC.
 - 148.1. This will establish a coalition and build momentum
 - 148.2. It will also provide a network to gather information on the status of the data to analyse gaps and needs to integrate.
 - 148.3. The Genomic Observatory representative will take the lead on this and also attempt to find a place for this information to reside. It was agreed that this should not be too strongly bound to one institution's servers, but in a collaborative space. BON may support or provide the infrastructure.
- 149. It was noted that some partners have capacity to provide sequencing capacities for others in the next year or two
- 150. It was noted that we should learn from and connect to groups pursuing human microbiome work – there are likely to be observatories in the human ecosystem too
- 151. It was noted that this network (particularly the marine components) should pursue SCOR WG proposal. Focused on marine but bridging between land and oceans is welcome.
 - 151.1. Typically 5 pages.
 - 151.2. Meeting money for 5 years is provided.
 - 151.3. Could add to funding available funds in Genome Canada, GeoBON.
 - 151.4. It was noted that an application right away (April) would be pre-mature. A lead must be identified and assemble a diverse team.
- 152. It was agreed that the AWI partner compile and submit a GEOBON task team proposal (invited by GEO BON during the meeting) in the next 2 weeks.
- 153. It was agreed that data exchange, analysis, and product generation would benefit through better links to GBIF & OBIS
 - 153.1. A request to the OBIS partner was lodged, asking for a statement on what kind of data they would like to ingest
- 154. It was agreed that channels should be established to update and revise existing standards relevant to omics (MixS, TDWG standards). AWI, MPI, and AAFC partners will lead.
- 155. The consolidation of GLOMICON's identity was identified as a necessary step
 - 155.1. Establishing a GEO BON task force would help this process. A GEO BON meeting in China (July) offers a chance to discuss this
- 156. It was affirmed that communication with the relevant WPs in ASSEMBLE+ is necessary to synchronise activities, check for overlap, and pursue potential integration.
- 157. Access and benefit sharing
- 158. PhD student on Nagoya protocol in FOGs group.

159. Follow up meeting:

159.1. Potentially funding by James, Merdad, (Florian ?)

159.2. Follow up Hackathon meeting early fall.

160. Preparatory work for upcoming funding calls was underscored as a means to poise the network for funded growth in the next funding round:

160.1. It was noted that networking for next EU Framework programme has to start now along with white paper preparation and advertising in Brussels

160.2. Canadian and US funders are also preparing calls, and regional participants will enquire.

AtlantOS is an EU funded project (<https://www.atlantos-h2020.eu/>) that aims to optimise and enhance integrated Atlantic Ocean Observing Systems. One specific objective within AtlantOS work package 6.2 is to develop common metrology techniques and best practice (including standards) for measurement of priority Essential Ocean Variables (EOVs), ensuring dataset accuracy, precision and reliable intercomparisons between different technologies, laboratories, sampling locations and times. As part of this objective a workshop focussing on trace element measurements will be hosted by Plymouth University, UK and run from Monday 18th July to Wednesday 20th July. The workshop will have four components and will include a mixture of lectures/tutorials, worked examples and practical exercises (including the opportunity to discuss your own oceanographic data sets). It will cover:

1. The oceanographic context and biogeochemical cycling of trace elements.
See e.g. *"Marine biogeochemistry of iron"*, S.J. Ussher, E.P. Achterberg and P.J. Worsfold, *Environmental Chemistry*, 1, 67-80 (2004) doi: 10.1071/EN04053; GEOTRACES (<http://www.geotraces.org/>).
2. An introduction to statistics, traceability, uncertainty and terminology in metrology.
See e.g. *"Metrology in Chemistry in a nutshell"*, I. Leito, (<http://www.ut.ee/ams/metrology-in-chemistry-in-a-nutshell/>).
3. The modelling or "bottom up" approach to uncertainty estimation.
See e.g. *"Uncertainty contributions to the measurement of dissolved Co, Fe, Pb and V in seawater using flow injection with solid phase preconcentration and detection by collision/reaction cell-quadrupole ICP-MS"*. R. Clough, H. Sela, A. Milne, M.C. Lohan, S. Tokalioglu, P.J. Worsfold, *Talanta*, 133, 162-169 (2015), doi: 10.1016/j.talanta.2014.08.045. *"Combined uncertainty estimation for the determination of the dissolved iron amount content in seawater using flow injection with chemiluminescence detection"*. G.H. Floor, R. Clough, M.C. Lohan, S.J. Ussher, P.J. Worsfold, C. R. Quètel, *Limnology and Oceanography: Methods*, 13, 673-686 (2015), doi: 10.1002/lom3.10057.
4. The empirical or "top down" approach to uncertainty estimation.
See e.g. *Nordtest Technical Report NT TR 537, Edition 3.1* (2012) (http://www.nordtest.info/index.php/technical-reports/item/handbook-for-calculation-of-measurement-uncertainty-in-environmental-laboratories-nt-tr-537-edition-3.html?category_id=2).

The course will be delivered by Prof Paul Worsfold (PW), Dr Rob Clough (RC) and Dr Simon Ussher (SU) from Plymouth University, UK, Prof Maeve Lohan (ML) from University of Southampton, UK and Prof Ivo Leito (IL) from the University of Tartu, Estonia.

The workshop is free to attend (i.e. no registration fee) but places are limited. The workshop will take place in a lecture room (Smeaton Building, Room 102a) and computer suite (in Smeaton Building Computer Suite, Room 100) with a desktop computer for each participant. You may however wish to bring your own laptop and log on through eduroam (optional). A campus map is available at http://www6.plymouth.ac.uk/files/extranet/docs/EXAMS/3D_campus_map.pdf. All coffees, lunches and teas will be provided. Participants will have to arrange their own accommodation, breakfasts and evening meals. There is a range of accommodation available in Plymouth at that time of year. There is no funding available to support travel and subsistence costs.

If you wish to apply to register for the workshop please email Prof Paul Worsfold at pworsfold@plymouth.ac.uk and include "uncertainty workshop" in the header. If possible, include a brief statement on what oceanographic datasets you are / will be working with. See below for the workshop programme.

Workshop timetable

Monday 18th July (Smeaton Building, Teaching Room 102a)

- 09.00 – 10.30** Introductions by presenters and delegates and course overview
- 10.30 – 11.00** Coffee break
- 11.00 – 12.00** Trace element biogeochemistry (SU/PW)
- 12.00 – 13.00** GEOTRACES intercalibration and preparation of reference materials (ML/PW)
- 13.00 – 14.00** Lunch
- 14.00 – 15.00** Introduction to method validation and metrology (RC/IL)
- 15.00 – 15.30** Tea
- 15.30 – 17.30** Worked examples/exercises (in Smeaton Building Computer Suite, Room 100)
- 17.30 – 18.00** Summary, question and answer session
- 19.00 –** Informal arrangements for dinner

Tuesday 18th July (Smeaton Building, Room 102a)

- 09.00 – 10.30** Modelling approach (also called “theoretical”, “predictive”, “bottom-up”; IL/RC)
- 10.30 – 11.00** Coffee break
- 11.00 – 12.30** Worked examples/exercises (in Smeaton Building Computer Suite, Room 100)
- 12.30 – 13.30** Lunch
- 13.30 – 15.00** Exercises continued, summary, question and answer session
- 15.00 – 15.30** Tea
- 15.30 – 17.00** Empirical approach (also called “experimental”, “retrospective”, “top-down”; IL/RC)
- 17.00 – 18.00** Worked examples/exercises (in Smeaton Building Computer Suite, Room 100)
- 19.00 -** Workshop dinner (venue TBA)

Wednesday 20th July (in Smeaton Building Computer Suite, Room 100)

- 09.00 – 10.30** Exercises continued, summary, question and answer session
- 10.30 – 11.00** Coffee break
- 11.00 – 12.30** Open discussion, close of meeting and lunch

Task 6.2 Common metrology and Best Practices

Nutrients and oxygen sensor observations

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The workshop planned within the framework of the AtlantOS project WP 6.2 “Common metrology and Best Practices” was postponed at the end of 2018 in the form of joint elements to other European consortia.

Under the auspices of the European Commission, Jerico NEXT, EMSO ERIC, ENVRIPLUS and AtlantOS, are participating to the international effort to harmonize the practices in Environmental Monitoring and to push up the interoperability technologies for sharing ocean instruments.

1. On the occasion of the Sea Tech Week 2018 in Brest (France) (www.seatechweek.eu), EMSO ERIC, JERICO-RI, ENVRIPLUS and AtlantOS are jointly proposing a 3-day workshop for technical and scientific staff, aiming to increase the level of marine observation practices (Program in Annex 1).

The objectives will be to promote Best Practices and to develop synergies around these widely used categories of data, between EMSO, Jerico NEXT, ENVRIPLUS and AtlantOS communities, and between users of seafloor and water column data.

A position paper on “Dissolved oxygen measurements: scientific needs, sensors accuracy and synthesis of Best Practices recommendations” for a better use of oxygen sensors in order to improve the quality of the oxygen data for scientific exploitations is planned (Deliverable 1) at the end of the workshop. The final version will be provided at the end of January 2019 for free on-line dissemination.

2. The ATLANTOS project and the JERICO-RI consortium are jointly organizing a workshop in December in Brest, with the aim of increasing the level of interoperability for nutrient and chlorophyll-fluorescence observations (Program in Annex 2).

A position paper on sustaining ocean Best Practices (sharing experience on nutrient measurements in the lab and *in situ*) from feedback on the use of the various sensors nutrients *in situ* available on the market or developed by research institutes is planned (Deliverable 2) at the end of the workshop. The final version will be provided at the end of February 2019 for free on-line dissemination.

Gantt chart of deliverables

	2018			2019	
	October	November	December	January	February
Workshop on Interoperability Technologies and Best Practices in Environmental Monitoring	Brest 10-12 October				
White Paper final version				<u>Deliverable 1:</u> Dissolved oxygen measurements: scientific needs, sensors accuracy and synthesis of Best Practices recommendations	
Workshop on Interoperability of Technologies and Best Practice : Application to <i>in situ</i> nutrients and phytoplankton fluorescence measurements			Brest, 3-7 December		
White Paper final version					<u>Deliverable 2:</u> Position paper to express the expectations and a roadmap for future on nutrients measurements



EU Coastal and Open Sea Observatories

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Workshop on Interoperability Technologies and Best Practices in Environmental Monitoring

Brest, 10-12 October 2018

(Registration deadline: 5th September)

Long-term *in situ* marine observation, be it coastal or open sea, seafloor or water-column, is achieved by a variety of devices and systems operated by a number of teams meeting different demands in multiple contexts. In spite of this diversity, operators and users are facing a set of common constraints and have obvious benefits in sharing practices and means. Under the auspices of the European Commission, JERICO-RI, EMSO ERIC and AtlantOS, are participating to the international effort to harmonize the practices of this domain and to push up the interoperability technologies for sharing ocean instruments:

- The Joint European Research Infrastructure Network For Coastal Observatories (JERICO-RI, www.jerico-ri.eu) is a solid and transparent European network dedicated to provide operational services for the timely, continuous and sustainable delivery of high quality environmental data and information products related to marine environment in European coastal seas.
- The European Multidisciplinary Seafloor and water-column Observatory European Research Infrastructure Consortium (EMSO ERIC, www.emso-eu.org) is a distributed Research Infrastructure of marine observatories addressing natural hazards, climate change and marine ecosystems in the service of science researchers, marine technology engineers, policy makers, and the public.
- AtlantOS (Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems, www.atlantos-h2020.eu) is a Blue Growth research and innovation project that proposes the integration of ocean observing activities across all disciplines for the Atlantic, considering European as well as non-European partners.

On the occasion of the Sea Tech Week 2018 in Brest (France) (www.seatechweek.eu), EMSO ERIC JERICO-RI and AtlantOS are jointly proposing a 3-day workshop for technical and scientific staff, aiming to increase the level of marine observation practices.



Building on the results of previous similar interoperability workshops¹, the event will focus on:

- Sensor Web Enablement implementation.
- Cabled coastal observatories operations
- Metrology of dissolved oxygen, pCO₂ and pH in marine environment
- Dissolved oxygen and temperature: seafloor and water column data, from sensor to users.

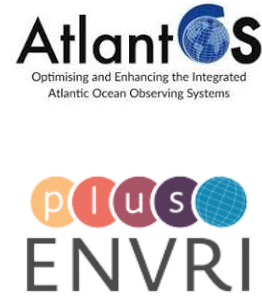
Organisers: **Ifremer:** Jérôme Blandin, Ingrid Puillat, Laurent Delauney, Virginie Thierry, Chantal Compère; **HCMR:** George Petihakis, Manolis Ntoumas; **OGS:** Rajesh Nair; **HZG:** Wilhelm Petersen; **GeoMar:** Eric Achterberg; **CNRS:** Mathilde Cannat, Déborah Chavrit, **UPC:** Joaquin del Rio

¹ - WS on Interoperability Technologies for sharing ocean instruments and real-time data, AtlantOS - EMSO ERIC, OI London March 2018.

- WS on Best practices, EMSO ERIC, Rome, October 2017.

- WS on Cable Observatories, JERICO-NEXT, Barcelona 2016.

- WS on Harmonizing New Network Sensors, JERICO NEXT, Paris December 2016.



Agenda/content:

Wednesday 10th october 08:30-09:00 (Chamber of Commerce and Industry, Brest)

Welcome of participants

Wednesday 10th october 09:00-12:00 (Chamber of Commerce and Industry, Brest) - Sensor Web Enablement implementation - Chair: Eric Delory (PLOCAN) (TBC) and Jay Pearlman (IEEE France).

1) Introduction - Objectives of the session – 10'

2) Debriefing on “Interoperability technologies for sharing ocean instruments and real-time data”, AtlantOS - EMSO ERIC Workshop at OI-2018 London (15th march 2018) – 30'

3) Industrial experiences of SWE implementation (effort, difficulties, results) – 90'

- SWE implementation of the MiniFluo instrument on the ALSEALMAR glider – Laurent Beguery (TBC) – 15'
- SWE implementation of the TriOS MatrixFluo instrument (EU NeXOS project) - TriOS representative (TBC) – 15'.
- SWE implementation of acoustic sensors on the NKE Provov Float – Yves Degre (TBC) – 15'.
- SWE implementation tools – 52 North (TBC) – 15'.
- SWE implementation on observatories: EGIM – Bertrand Moreau (TBC) – 15'.
- SWE implementation on observatories: OBSEA – Joaquin del Rio (TBC) – 15'.

4) Discussion

- How to implement interoperability technology for on the shelves instruments (O₂, CO₂ Optode, pH sensors, etc.) and platforms (Gliders, Floats, USV, etc.)?
- How long will be the race to achieve the full chain to produce traceable measurements in databases, from sensor construction to measurement production at sea?
- How efficient is the actual situation when the components are fully interoperable?
- What is the European situation versus the other continents?
- Is the research community ready for such interoperability practices?
- R&D needed for smart sensors?

**Wednesday 10th october 14:00-18:00 (Chamber of Commerce and Industry, Brest) -
Cabled coastal observatories operations – Chair: Joaquin del Rio (UPC)**

1) Introduction - Objectives of the session – 10'

From the operational experience of each presented observatory, this session aims to propose solutions likely to enhance operations on most cabled coastal observatories.

2) Debriefing on “JERICO-NEXT Cabled Observatories” Workshop, UPC Vilanova i la Geltrú, Barcelona 2016 – 30'

3) Six case studies: 90'

- OBSEA: Joaquin del Rio Fernandez, Marc Nogueras, Universitat Politècnica de Catalunya
- SmartBay: Alan Berry, Marine Institute
- EMSO Nice/Molène: Nadine Lantéri, Xavier Bompais, Ifremer
- Utö: Lauri Laakso, Finnish Meteorological Institute
- LoVe : tba
- UNH/UNS: tba

4) Discussion: 60'

- What is most critical in running a coastal cabled observatory?
- What are the operational issues that need most urgent improvement?
- How to decrease access costs while maximizing availability of coastal cabled observatories?

**Thursday 11th october 09:00-12:00 (Chamber of Commerce and Industry, Brest) –
Metrology of dissolved oxygen, pCO₂ and pH in marine environment – Chair: Laurent Delauney (Ifremer)**

1) Introduction - Objectives of the session – 10'

2) Debriefing on “JERICO-NEXT Harmonizing New Network Sensors” Workshop, Paris December 2016 – 30'

3) Oxygen metrology: present situation for the marine community – 20' (F.Salvetat)

4) CO₂ metrology, present situation for the marine community – Arne Körtzinger or Björn Fiedler (TBC) - 20'

5) pH metrology, present situation for the marine community - Socratis Louciades, NOCS – or Mario Esposito, GEOMAR (TBC) – 20'

6) Discussion

- Interoperability and metrology, what does it mean?
- Metrology tools, laboratory or/and on board equipment and protocols?
- Metrology for carbon fluxes and acidification, are absolute *in situ* measurements achievable?
- Metrology for carbon fluxes and acidification, is traceability a dream?
- R&D needed for sensors?

Thursday 11th october 14:00-17:00 (Ifremer Brittany Center) – Metrology facilities and dissolved oxygen sensor calibration. Chair: Florence Salvetat (Ifremer)

- Presentation of the Ifremer calibration facilities all along a demonstration of a O2 reference calibration experiment at the Ifremer metrology laboratory.
- Demonstration of the EMSO O2 calibration bench under development.
- Traceability management, explanation and discussion.
- Round table on possibilities and performance of the EMSO O2 calibration bench and associated best practices that could be proposed.

2 groups. Maximum: 8 Persons each group.

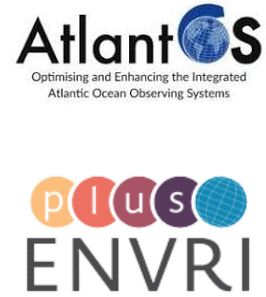
Friday 12th october 09:00-17:00 (Ifremer Brittany Center) – Dissolved oxygen : seafloor and water column data, from sensor to users. Chairs : M. Cannat (CNRS-IPGP), Virginie Thierry (Ifremer)

This two half-day session will bring together producers and users of dissolved oxygen from seafloor and water column sensors, in deep sea and coastal environments. The objectives will be to promote Best Practices regarding the acquisition, qualification, distribution of dissolved oxygen data and to develop synergies around these two widely used categories of data, between EMSO, JERICO-RI and AtlantOS communities, and between users of seafloor and water column data. After a brief update on the scientific objectives specific to each community, the session will focus on the practical aspects of time series data production in each context, from sensors characteristics, acquisition parameters, quality control and calibration procedures, to data processing and interpretation.

- 1) Introduction - Objectives of the session – 10'
- 2) Presentation of the scientific issues and corresponding needs (spatial coverage, accuracy, data availability, etc..) associated with dissolved oxygen data for each community
 - a) Seafloor data - Pierre-Marie Sarradin (20')
 - b) Water column data - Laurent Coppola (20')
- 3) Data acquisition, state of the art of sensor knowledge, implementation and recommendations



- a) Oxygen optodes - Henry Bittig (20')
 - b) Moorings : known issues, recommendations for implementation and qualification - Dominique Lefèvre (20')
 - c) Autonomous platforms (Argo and gliders) : known issues, recommendations for implementation and qualification - Henry Bittig (20')
 - d) O2 data acquired from SBE43 sensor during an hydrographic casts: known issues, recommendations for implementation and qualification - Laurent Coppola (20')
 - e) The case of very low oxygen concentration area - Aurélien Paulmier (tbc) (20').
 - f) Presentation of the White Paper on Best Practices prepared for OceanObs19 par Jay Pearlman (tbc) (20')
- 4) Data management: Dissolved oxygen data in the Coriolis Data Base - V. Racapé (20')
 - 5) Practical session on best practices regarding data analysis (1h)
 - 6) Final discussion and synthesis of best practice recommendations (45'')



Registration:

The organising committee will select applications according to the relevance of the applicants experience to the conference and according to the availability of seats and rooms.

Pre-registrations are open on the following link: [Registration_Form](#).

The deadline for pre-registration is on the wednesday 05th of september 2018.

The final approved participant list will be established for the 10th of september 2018.

Main sponsors: EMSO ERIC – JERICO-NEXT – AtlantOS - ENVRIplus

VENUE

**On 10th and 11th morning at the Chamber of Commerce
and Industry in Brest**



**1 Place du 19eme Régiment d'Infanterie
29200 Brest
In the city center near train station**

From the airport: the best is to take a taxi or take airport shuttle service :

<https://www.brest.aeroport.bzh/transports-en-commun>

Taxi Brestois: +33 298 801 801

In the city center - Take public transport services

<http://www.bibus.fr/>





1625 Route de Sainte-Anne, 29280 Plouzané

From the airport: the best is to take a taxi - Taxi Brestois: +33 298 801 801

From the City Center:



Walk to Place de la Liberté



You have to go to Liberté Tramway station - Take line A: Direction Porte de Plouzané, stop at Fort Montbary or Porte de Plouzané.



You now have to take the bus number 13 at Fort Montbary or Porte de Plouzané, direction Plouzané Mairie (attached map) and stop at Piccard. Cross the street, walk down to the roundabout and find Ifremer gate on the right hand side.

Schedules:

<http://www.bibus.fr/imprimez-fiches-horaires.aspx>

Plans

Tram ligne A:

http://www.bibus.fr/wpFichiers/1/1/Ressources/file/Plans%20r%C3%A9seau%202017_2018/BIBUS%20

[TOTEM%20TRAM%202016-VF.pdf](#)

Bibus ligne 13:

http://www.bibus.fr/wpFichiers/1/1/Ressources/file/Plans%20r%C3%A9seau%202017_2018/BIBUS-Ligne%2013-2016.pdf

List of hotels in the city center

Name of the hotels	Address	Phone number	Website
Oceania Centre	82 rue de Siam	02.98.80.66.66	http://www.oceaniahotels.com/oceania-brest-centre.php
L'Amirauté	41 rue de Branda	02.98.80.84.00	https://www.oceaniahotels.com/h/hotel-l-amiraute-brest/presentation
Les voyageurs	2 rue Yves Collet	02.29.61.09.09	https://www.accorhotels.com/fr/hotel-A4A5-hotel-mercure-brest-centre-les-voyageurs/index.shtml
Bellevue	53 rue Victor Hugo	02.98.80.51.78	http://www.hotelbellevue.fr/
Kyriad	157 rue Jean Jaurès	02.98.43.58.58	http://www.kyriad-brest-centre.fr/fr
La Gare	2 Bd Gambetta	02.9844.47.01	http://www.hotelgare.com/
Hôtel le continental	41 rue Emile Zola	02.98.80.50.40	https://www.oceaniahotels.com/h/hotel-le-continental-brest/presentation
Abalis	7 av Clémenceau	02.98.44.21.86	http://www.abalys.com/
Hôtel de la rade	6 rue de Siam	02.98.44.47.76	http://www.hoteldelarade.com/
Hôtel St Louis	6 rue Algesiras	02.98.44.23.91	http://brest-hotel.com/
Agenda	10 Frégate la Belle Poule	02.98.33.96.00	http://agenda-hotel.fr/



Hôtel Vauban	17 av Clémenceau	02.98.46.06.88	http://www.hotelvauban.fr/
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From Coastal to Open Sea observations

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Workshop on Interoperability of Technologies and Best Practices:

Application to in situ nutrients and phytoplankton fluorescence measurements

Brest, 3-7 December, 2018

Phytoplankton are the main primary producers in the marine food web, and they fuel the higher trophic levels with carbon and nutrients. Thus, reliable phytoplankton and nutrient data are prerequisites for a trustworthy assessment of the trophic state of marine systems, and relative evaluations of “good ecological status”. Due to their fundamental role, significant effort has gone into developing techniques and methodologies aimed at assessing phytoplankton distribution, biomass, composition and productivity. However, nowadays, even if developments and researches are still expected to progress further ahead, it has become obvious we are facing diversity in the techniques and methodologies to quantify the nutrient concentrations and the phytoplanktonic biomass. With growing use of in situ sensors, quality control and calibrations in accordance to reference lab methods are essential.

Aware of these needs, the marine community has already progressed in the first steps towards harmonization of technologies and operating practices relating to similar measurements, partly thanks to several workshops and projects.

In this context, the ATLANTOS project and the JERICO-RI consortium are jointly organizing this workshop, with the aim of increasing the level of interoperability for nutrient and chlorophyll-fluorescence observations. The workshop builds on the results of previous interoperability workshops.

It is organized in 2 parts, the first one dealing with nutrient sensors, (reference lab methods and *in situ* sensors), and the second one with chlorophyll fluorescence. The event will focus on:

- Sharing experience on nutrient measurements in the lab and *in situ*, Best Practices measurements (Part 1)
- Automated chlorophyll fluorescence observations: needs of reference for metrology purposes, harmonized archiving and flow of the data towards EU channels (Part 2)

Expected outcomes

Part 1: Best practices for nutrients measurement

- Review of Best Practices in terms of reference measurements (in lab) and in terms of *in situ* measurements with nutrient sensors
- Position paper on sustaining ocean Best Practices from feedback on the use of the various *in situ* nutrients sensors available on the market or developed by industry and research institutes;

Part 2: Best practices for chlorophyll fluorescence observations

A white paper including:

- Fluorometer characteristics and their primary calibration: what are the primary optical properties the different sensors are detecting, how the sensors should be calibrated, how comparable data is obtained with sensors having different optical designs? Status, needs and gaps
- Steps in quality control of the *in situ* measurements: synthesis of the gaps and needs in QC, field validation and metrology, with special focus on the need of reference materials
- Harmonization of the optical biological data flow: the state of the art of the optical biological data flow through the European channels (EMODNET BIO, EurOBIS, SeaDATAcloud): Practices and how to, gaps and needs, strategy on short, medium and long term.

Total number of targeted attendees in plenary parts

- **Participants : maximum 40/ maximum 20 to each part**
- **Academic researchers, engineers and SMEs**

Organisation

This workshop is jointly organised by:

- The Joint European Research Infrastructure Network for Coastal Observatories (JERICO-RI, www.jerico-ri.eu) is a solid and transparent European system of systems dedicated to provide operational services for the timely, continuous and sustainable delivery of high quality environmental data and information products related to marine environment in European coastal seas.
- ATLANTOS (Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems, <https://www.atlantos-h2020.eu/>) is a research and innovation project that proposes the integration of ocean observing activities across all disciplines for the Atlantic, considering European as well as non-European partners.

Organisers: Ingrid Puillat, Laurent Delauney, Anne Daniel, Agathe Laes-Huon, Chantal Compere, **Ifremer**; Rajesh Nair, **OGS**; Wilhelm Petersen, **HZG**.

Scientific Committee for the nutrient Session (part 1) organised by ATLANTOS: Naomi Greenwood, **CEFAS**, Eric Achterberg, **GEOMAR**, **Atlantos Partners**.

Scientific Committee for the phytoplankton session (part 2) organised by JERICO-NEXT: Jukka Seppälä, **SYKE**; Felipe Artigas, **CNRS-LOG** or Alain Lefebvre (Ifremer), Klaus Simon, **VLIZ**, Naomi Greenwood, **CEFAS** to be confirmed

Program and agenda

Part 1: Nutrient measurements: how to implement lab good practices to the in situ sensors utilisation?

Objective: The aim of this workshop is to review the best practices applied to the nutriment measurements in the laboratory so as to determine what applies to the in situ instrumentation. This workshop suggests learning on quality procedures implemented for the lab reference methods to extract elements essential to the qualification of the *in situ* nutrient data sets. The goal is to propose a method which can be easily used and adopted by several organizations.

Tuesday 4th December

Morning session (9:00 13:30): Presentation of CFA reference method and best practices implemented for the nutrient measurements in the lab

Chair person Eric Achterberg (Geomar) and Agathe Laes-Huon (Ifremer)

- 1) Welcome, introduction, objectives, logistics 5 minutes
- 2) Chemical principles and performances of the nutrient CFA reference method (Ifremer and others?) Methodological limitations : sample storage, contaminations, salt effect (Ifremer + K. Bakker NIOZ, 15 mins
- 3) Use of SCOR-JAMSTEC CRMs to properly guarantee comparability of data from different laboratories and revision of the GO-SHIP nutrients manual (Malcolm Woodward PML) 15 mins

Coffee Break 30 mins

- 4) European intercomparison exercises by Quasimeme (Quasimeme representative M. Knockaert or K. Parmentier, to be confirmed) 15 minutes
- 5) Protocol for the method performance assessment and the uncertainty determination in the laboratory ; experience feedback on the normative aspects and accreditation (Anne Daniel , Dominique Munaron) 15 mins
- 6) Requirements for reporting of nutrient meta data (Atlantis partners) *In situ* monitoring of nutrients concentrations in rivers and lakes : european performance assessment standardization (AQUAREF, N. Guigues or B. Lepot) 15 mins

Afternoon session (14:30-17:30): Reference lab methods “practices”

Measurements of nutrients in labs (Ifremer) 2 groups, Maximum : 8-10 persons each group. Preparation of calibration solutions, use of CRMs, control charts, determination of blank values, etc..

Wednesday 5th December

Morning session (9:00-13:00): *In situ* nutrient measurements “protocols presentation”.

Chairperson Rajesh Nair (OGS), Naomi Greenwood (CEFAS)

- 1) *In situ* measurements of nutrients (Agathe Laes_Huon Ifremer) 10 mins
- 2) Flash presentations of nutrient sensors commercially available or developed for research projects: (measurement principle, figures of merits, interferences size, power supply, deployment feedback) 7 mins per speakers

P. Claquin, Caen University Fr, Wiz sensor (SME Systea);

D. Munaron, LER Ifremer Fr, Chemini sensor (Ifremer),

A. Beaton, M. Mowlen NOCS, UK Lab-on-a-Chip sensor (NOCS), to be confirmed,

H. Claustre, LOV Fr SUNA sensor (SME, Satlantic),

C. Barus Legos Fr, ANESIS sensor

Coffee Break 30 minutes

Topic review:

- 3) Pre and Deployment experience: types of environment, mode, length of deployment, sampling frequency, self-calibration life, maintenance, biofouling, reagent storage, other...(Facilitators P Worsfold, C Barus) – 40 mins
- 4) Post-deployment phases: data transmission (real time...), signal treatment, interoperability, post maintenance, quality control (all sensors users) Facilitator F. D’ortenzio, 40 mins
- 5) How to select the right sensor and for which application? TRL, technical barriers to advancement or modification, multiple plug and play sensors, next generation of sensors (Facilitator Paul Worsfold UOP to be confirmed) - 40 mins

Afternoon session (14:00-17:30): *In situ* nutrient measurements “Practices”

Chairperson Anne Daniel , Agathe Laes-Huon

Use of several nutrient sensors (Chemini, WIZ, SUNA, NOCS Lab on Chip (to be confirmed), ANESIS, ...) : pre-deployment deployment of sensors and post-deployment – 2 groups 8-10 persons each group only workshop participants

Thursday 6th December

Morning and afternoon (9:00-16:00): *In situ* nutrient measurements, discussion.

Chairperson : Atlantis Jerico Next leader work package + other partners

Taking into account input of sessions of Tuesday and Wednesday, Preparation of a draft white paper to express the expectations and a roadmap for future

Part 2 – Chlorophyll fluorescence observations

Wednesday afternoon

Session 1: Instrument characteristics and their primary calibration (2h)

Objective: Provide a description of the different technologies and sensors and which optical properties they are detecting. Discuss how the sensor primary calibration should be conducted, to obtain as comparable data as possible, when using different technologies. Discuss the pros-and cons of the different calibration protocols. Preparation of a draft white paper

PI: Laurent, Daniella or Florence...preparation of the synthesis and presentation

+ presentations of the instrument characteristics by providers (short)

- 1) Introduction to JericoNEXT and Atlantis – 10'
- 2) Introduction to session- Objectives – 10'
- 3) State of the art: Synthesis presentation (PI)- 20'
- 4) Presentation of some sensors characteristics (3 private companies?) 3x15'
- 5) Discussions 30'

Session 2: Steps in quality control of the in situ representativeness of the measurements (2h)

PI: Jukka Seppälä, SYKE

Objective: Provide an outline for QC actions for in situ measurements. Discuss which types of reference materials may be used in in situ QC. Discuss why the reference materials are needed in field quality control. What are the specific needs of each technology? How the QC of sensors will help in field validation of data. Discuss on expectation versus possibilities.

- 1) Introduction - Objectives of the session – 10'
- 2) State of the art: Synthesis presentation (PI)- 20'
- 3) Discussion and preparation of a white paper: expectation versus possibilities, the provider position (1h30)

Thursday Morning

Session 3: Harmonisation of the optical biological data flow

PI: To be confirmed

Objective: Taking into account input of sessions 1 and 2, how to improve the harmonization of the optic biological data and metadata flow? **Needs of the users: expectation from the modeling community and from the satellite one.** Preparation of a draft white paper to express the expectations and a roadmap for future

- 1) Introduction - Objectives of the session – 5'
- 2) Optic biological data flow: status of the harmonization and gaps : Synthesis presentation (PI)- 20'
- 3) Needs from the scientists: 20'
- 4) Discussion to write a white paper: Technical possibilities, pitfall and way forward (VLIZ , MIO et al.): 1h30'

Thursday afternoon...until 4pm

PIs: To be confirmed

Session 4: Writing the white paper, by gathering input from sessions 1-3. 4 pages max each section, in parallel or in serial sessions