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Evolving and Sustaining Ocean Best Practices Workshop III

02-03 December 2019

International Oceanographic Data and Information Exchange (IODE)
of the Intergovernmental Oceanographic Commission of UNESCO
Project Office for IODE, Pakhuis 61, Wandelaarkaai 7, 8400 Oostende, Belgium

Proceedings

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Any opinions, findings, and conclusions or recommendations expressed in these proceedings are those of the contributors only.

Editor Note: Images of Workshop presenters are displayed with their permission.

1. Executive Summary

The oceans play a key role in global issues such as climate change, food security, and human health. Given their vast dimensions and internal complexity, efficient monitoring and predicting of the planet's oceans must be a collaborative effort of both regional and global scale. The first and foremost requirement for such collaborative ocean observing is the need to follow well-defined and reproducible methods across activities: from strategies for structuring observing systems, sensor deployment and usage, and the generation of data and information products, to ethical and governance aspects when executing ocean observing. In this document, "ocean observing" are all activities of the value chain from preparing and conducting observations to impacts on society through applications of information. To meet the urgent, planet-wide challenges we face, methods across all aspects of ocean observing should be broadly adopted by the ocean community and, where appropriate, should evolve into "ocean best practices" or standards.

The OBPS provides an opportunity space for the centralized and coordinated improvement of ocean observing methods. While many groups have created best practices, they are scattered across the Web or buried in local repositories and many have yet to be digitized. To reduce this fragmentation, there is now an open access, permanent, digital repository of best practices documentation (oceanbestpractices.org) that is part of the Ocean Best Practices System (OBPS). In addition to the repository, the OBPS includes a peer reviewed journal research topic, a forum for community discussion and a training activity for creating and using best practices. Together, these components serve to realize a core objective of the OBPS, which is to enable the ocean community to create superior methods for every activity in ocean observing from research to operations to applications that are agreed upon and broadly adopted across communities.

The Ocean Best Practices Workshop has now become an annual event with Workshop I, Paris 2017 and Workshop II, Paris 2018. The 2019 Workshop III in Oostende encouraged maximum audience participation and was structured with hour-long panels followed by discussion. This format was effective in stimulating ideas and discussions to lay out a future vision of ocean best practices and how OBPS will contribute to improving ocean observing in the decade to come.

Breakout Sessions were also a major part of the agenda, to provide opportunities for participants to share insights and importantly to make recommendations to the Panel on Vision for the Next Decade and ultimately the OBPS Steering Group.

Table of Contents

2. Introduction and Objectives

The **Ocean Best Practices Workshop III (OBP Workshop III**) was held at the **International Oceanographic Data and Information Exchange (IODE**) of the Intergovernmental Oceanographic Commission of UNESCO, Project Office for IODE, Oostende, Belgium, 02-03 December 2019.

It was organized with support from IODE, GOOS and IEEE Oceanic Engineering Society with the objective of better understanding the future needs of the ocean observing community. Specifically, also to provide recommendations to the IOC Ocean Best Practices System Steering Group for its inaugural meeting that followed the workshop. The workshop outcomes were defined as: (1) an articulated strategic direction for ocean best practices; (2) recommendations for best practice synthesis and 3) recommendations for further Ocean Best Practices System development/implementation, embedding outcomes from community input.

Over the 2 days, 50 international ocean experts from International agencies, Programmes, Projects and Organizations participated in presentations and panel discussions. Presentations were provided by most speakers and, where offered, are live linked in the proceedings below.

3. Workshop Agenda

02 Dec	Sessions	Lead/Panel	Scoping
09:00	Introduction and Ocean Best Practices System (OBPS) Overview	**Jay Pearlman** (IEEE)	Introduce the past OBPS requirements and the OBPS implementation; introduce Survey recommendations; Consider external topics/environment (e.g. SDG)
09:30	Panel on Community inputs for Best Practices (BP)	**Laurent Delauney** (IFREMER) *(Moderator)* Mark Bushnell (IOOS) Johannes Karstensen (GEOMAR) Gwenaelle Moncoiffe (BODC) Katherina Schoo (IOC-SDG)	How do we determine if there are gaps in observing methods? What are the priority areas for expanding BP implementation? How should the OBP Project team work with others in the community? Which external drivers should be prioritized (e.g. SDG) Above discussion may include items such as OceanObs follow-on, the next decade, inputs from survey and BP Workshop II.
10.30	Break		

10:45	Panel on Key Advances in Ocean Observing and in related Technologies	**Paul Gaughan** (MI) *(Moderator)* Kristin Beem (OSU) TBD David Murphy (Sea-Bird) Elisabeth Rémy (Mercator) Hugh Roarty (Rutgers)	What are likely key advances in ocean observing and associated technologies? What is the role/evolution of best practices and the OBPS in supporting these advances?
11:45	Panel on Synthesizing BPs (with similar objectives)	**Joaquin Tintore** (SOCIB) *(Moderator)* Emma Heslop (GOOS) Neil Holdsworth (ICES) Anya Waite (Dal - OFI)	Should there be a synthesis of BPs with similar objectives? If so, how and when is it best to create such a synthesis? What are the processes to do this and what is the OBPS role?
12:45	Lunch		
13:45	Panel on Standards and best practices	**Siri Jodha Khalsa,** (CIRES/NSIDC) *(Moderator).* Champika Gallage (WMO) Tom O'Reilly (MBARI) Marie-Françoise Voidrot (OGC) Ian Walsh (Sea-Bird) Lingling Yuan (NCOSM)	Why and under what conditions do we need standards and best practices? How do we transition between the two? How do we improve the processes for creating and transitioning between BP and standards?
14:45	Introduction to **Breakouts**	**Pauline Simpson (IODE)**	
15:00	**Breakouts** including afternoon break Standards and BP Next Decade/key advances BP Synthesis	*Moderators* **Christoph Waldmann** (MARUM) **Hugh Roarty** (Rutgers) **Eric Achterberg** (GEOMAR)	Breakout sessions continue the above panel discussions to formulate recommendations for future BP activities and priorities in support of the ocean observing communities
17:00	Adjourn		
18:30	Side discussions	Standards Capacity Development	Informal meetings at Hotel Bero
19:30	Dinner (No Host)		Zeezotje Restaurant https://www.zeezotje.com/index.php/nl/

03 Dec	Sessions	Lead/Panel	Scoping
08:45	Panel on Capacity Building and Training	**Maciej Telszewski** (IOCCP) *(Moderator)* Claudia Delgado (IODE) Ana Lara-Lopez (IMOS) Rachel Przselawski (GA) Sophie Seeyave (POGO) Jordan Van Stavel (SAEON)	Wider collaboration for OBPS training content and broader community engagement; address the approach for best practices training centers; creating and providing on-line courses and virtual training.
10.30	Break		
11:00	Breakout reports	**Johannes Karstensen** (GEOMAR) *(Moderator)*	
11:30	Open discussion	**Johannes Karstensen** (GEOMAR) *(Moderator)*	
12:30	Lunch		
13:15	Panel on Best Practices Vision for the Decade	**Anya Waite** (Dal-OFI) *(Moderator)* Juliet Hermes (SAEON) Neil Holdsworth (ICES) Bob Houtman (NSF) Elisabeth Remy (Mercator)	Based on inputs from the community and the workshop commentaries, this panel addresses the gaps and priorities for BP and OBPS development. This will be

		Anne Cathrin Wolfl (GEOMAR)	part of a recommendation to the IOC SG-OBPS
14:45	Break		
15:15	Concluding Remarks	**Jay Pearlman** (IEEE) **Emma Heslop** (GOOS) **Pauline Simpson** (IODE)	
16.00	Close of workshop		

4. Participants

Figure 1: Ocean Best Practices Workshop III, Oostende, Dec 2019 participants

Eric ACHTERBERG	GEOMAR, Germany
Ward APPLETANS	IOC- IODE, Belgium
Kristin BEEM	OSU, USA
Sergey BELOV	Russian Research Institute Hydrometeorological Information - World Data Center, Russian Federation
Mark BUSHNELL	U.S. IOOS, USA
Pier Luigi BUTTIGIEG (by Skype)	AWI, Germany
Luca CENTURIONI	SIO, USA
Laurent DELAUNEY	IFREMER, France
Claudia DELGADO	IOC- IODE, Belgium
Vicente FERNANDEZ	European Commission
Champika GALLAGE	WMO, Switzerland
Paul GAUGHAN	Marine Institute, Ireland
Juliet HERMES	SAEON, South Africa
Emma HESLOP	IOC- GOOS France
Neil HOLDSWORTH	ICES, Copenhagen
Bob HOUTMAN	NSF, USA
Reyna JENKYNS	ONC, Canada

Johannes KARSTENSEN	GEOMAR, Germany
Siri Jodha KHALSA	NSIDC/CIRES/Col.U. USA
Arno LAMBERT	IOC- IODE Belgium
Ana LARA-LOPEZ	Univ. of Tasmania
Ana Carolina MAZZUCO	Univ. Federal do Espírito Santo, Brazil
Gwenaelle MONCOIFFE	BODC, UK
Frank MULLER-KARGER (by Skype)	Univ. of South Florida, USA
Cristian MUÑOZ MAS	SOCIB, Spain
David MURPHY	Sea-Bird Scientific, USA
Tom O'REILLY	MBARI, USA
Francoise PEARLMAN	IEEE, France
Jay PEARLMAN	IEEE, France
Roberto PETROCCIA	CMRE, Italy
Rachel PRZESLAWSKI	Geoscience Australia
Greg REED	IOC- IODE, Belgium
Elizabeth REMY	Mercator Ocean, France
Hugh ROARTY	Rutgers Univ, USA
Nicholas RODEN	Univ. of Bergen, Norway
Maria RUIZ PARRADO	SOCIB, Spain
Katherina SCHOO	IOC - Ocean Science, France
Sophie SEEYAVE	POGO, UK
Pauline SIMPSON	IOC- IODE, Belgium
Stephane TAROT	IFREMER, France
Maciej TELSZEWSKI	IOCCP, Poland
Joaquin TINTORE	SOCIB, Spain
Jordan VAN STAVEL	SAEON, South Africa
Marie-Francoise VOIDROT	OGC, UK
Anya WAITE	Dalhousie Univ, Ocean Frontier Institute (OFI), Canada
Christoph WALDMANN	Univ. of Bremen, Germany
Ian WALSH	Sea-Bird Scientific, USA
Ai WANG	NCOSM, China
Nancy WILLIAMS	Univ. of South Florida, USA
Anne-Cathrin WÖLFL	GEOMAR, Germany
Lingling YUAN	NCOSM, China

Day 1: Monday 02 December 2019

5. Introduction and Ocean Best Practices System (OBPS) Overview - Jay Pearlman (IEEE)

Jay Pearlman welcomed participants and invited them to introduce themselves to surrounding participants. He explained the logistics of the meeting, highlighting that the format of the workshop had been designed to permit maximum participant discussion and recommendations. He noted that the desired outcome of the Workshop was guidance for the next 3-5 years activities on ocean best practices and offered an overview of the OBPS background.

Jay introduced a Best Practice as "*a methodology that has repeatedly produced superior results relative to other methodologies with the same objective"*. Best practices can come in many forms such as standard operating procedures, manuals, guides, cookbooks etc. However, they all have a common goal of improving the quality and consistency of processes, measurements, data and applications through agreed practices. He stressed the foundational nature of best practices in ocean observing, as they range across the whole value chain, from sensing and capturing data, to the development of information and knowledge, and populating decision-systems in support of a wealth of users. In order to understand the needs and requirements from the OBPS users in the observing community, the OBPS Steering Group looked at the outcomes from a number of activities including: 2018 BP Workshop II; OceanObs'19 community white paper (Pearlman et al (2019); OceanObs'19 Breakout sessions; IEEE/MTS OCEANS'19 Best Practices Panel in Seattle; the Community Survey held in July 2019 (423 responses from 66 countries) and the Sustainable Development Goals (SDGs). Selected findings are summarized below.

Guidance from 2018 BP workshop II:

BP creation and uptake

- support BP creation and uptake; increase OBPS visibility; build capacity development; enhance DOIs, metadata expansion and version control; refine advanced search, use of links, dashboard discovery options and endorsement (e.g. recommended best practices)

Governance and sustainability

- transition to IODE project under IOC; links to major activities such as JCOMMOPS, GEO Blue Planet and others; metrics and milestones

OceanObs'19 breakout recommendations:

Four recommendations for BP processes include

- the OBPS is a sustainable scalable system for best practices, is important for ocean observing and should be capable of evolving with new technologies
- establish capability for community-based review for best practices
- there is a need for a convergence of BPs with similar objectives
- Support the ocean and applications communities in creating and applying BP including training.

IEEE/MTS Oceans 2019 Seattle - panel:

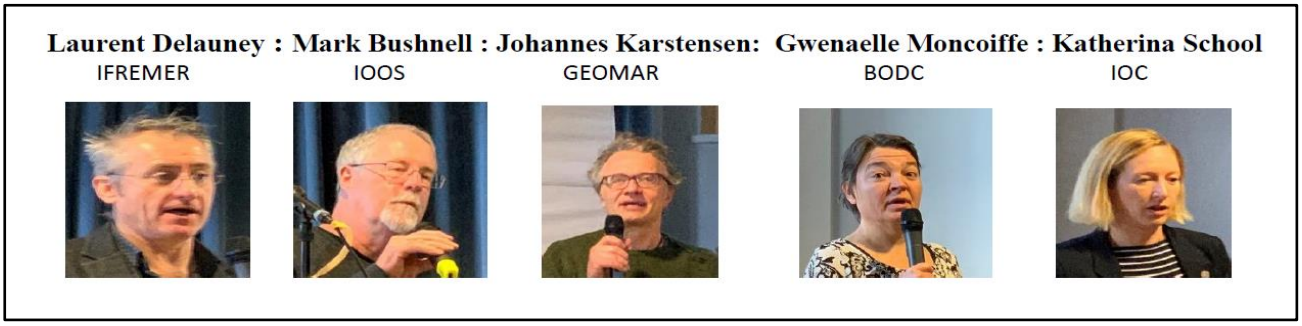
Transparency is essential in the dynamics of BP creation; BP are necessary due to expansion of observations and turnover of marine technicians; if two similar BP exist, then we need to have insights on which to use; and, more life cycle co-design is necessary (across the value chain).

Example from the survey of community - inputs for priorities during the next 3 to 5 years:

Expanding OBPS capabilities is the highest priority; Increasing community engagement; Including more applications; and extending linkages between BP and standards.

Best practices bring many benefits such as quality and consistency of observations, interoperability of data, efficiency (don't reinvent the wheel), and transparency. However, best practices are scattered and can be hard to find; they can be lost when a project ends, promising methods may not be shared, and work to create a best practice is often not acknowledged. Best practices are not only for observation but for the whole ocean value chain. Jay concluded by addressing the OBPS working group vision – "a future where there are agreed and broadly adopted methods across ocean research, operations and applications" - and mission "to provide coordinated and sustained global access to methods and best practices across ocean sciences to foster collaboration and innovation". The OBPS is now operational, supporting the entire ocean community in sharing methods and developing best practices following the FAIR Principles.

6. Panel on Community inputs for Best Practices (BP)



Laurent Delauney (IFREMER) (Moderator)

The panel was moderated by **Laurent Delauney** from IFREMER who introduced the four other panelists. As coordinator of the new JERICO S3 Project for coastal oceans in Europe, Laurent confirmed that best practices would be a prominent deliverable and theme throughout the four-year JERICO S3 project. Laurent gave a short presentation to set the stage. He considered the workshop objectives, the OBPS and the primary system elements addressed in the OceanObs'19 Community White Paper (Pearlman, et al, 2019). As a reminder, the workshop objectives include an articulated strategic direction for ocean best practices and recommendations for further OBPS development/implementation. The Community White Paper (CWP) addresses four primary topics: strategies for structuring observing systems; sensor deployment and usage; generation of data and information products; and ethical and governance aspects. These are complemented by a number of community specific items. "Ocean observing" can be summarized by a chain of processes executed for a single scientific project that aims to formulate or refine a hypothesis, or by an environmental agency delivering operational products. This can lead to best practices or standards. However, there are challenges due to the variability in requirements which tend to inhibit collaboration between communities along the value chain. Documentation of best practices may also differ across sectors (e,g., research institutions and private sector organizations). Laurent recognized the following items which may help: best practices template and associated keywords; peer review; unique identifier; maturity level (comparable to Technology Readiness Level, TRL); publication of ocean best practices (methods) and related documents in a recognized journal. Metrics can provide information on the impact of BPs, and coverage of dedicated methods in quality control, machine to machine communication, and automation, enabling development of co-creation with the system developers.

He tasked the panel to answer the following questions:

- How do we determine if there are **gaps** in observing methods**?**
- What are the **priority areas for expanding BP** implementation**?**
- How should the **OBPS team work** with others in the community**?**
- Which **external drivers** should be prioritized (e.g. SDG)**?**

- How can the OBPS team **motivate the community** to feed the OBPS system?

Laurent added one more question - *How can we motivate the community to feed the system in a structured way*? He noted that the community is wide and varied, including projects, environmental agencies, strategists, scientists and technologists dedicated to sensors, data, products. This should lead to rich inputs! Laurent invited all panelists to introduce themselves and then reflect on the panel topic.

Mark Bushnell (U.S. IOOS)
Mark has over forty years of experience in blue water and coastal oceanography. During this time, he has been engaged in a variety of tropical and subtropical oceanographic and climate change studies, working with emerging technologies and developing novel sensors and systems. He joined NOAA's National Ocean Service, where he initiated and managed the ocean systems test and evaluation programme, transitioning new technologies to an operational capability. Mark's presentation addressed each of the agenda panel questions and offered insights into how community inputs can be used to further the OBPS. He noted that the OBPS Steering Group must rely upon others to identify gaps in observing methods, listing several entities such as subject matter experts, operators and users as examples. He highlighted the need to leverage community efforts. He closed by listing several situations which might give rise to the development of new practices, such as those related to systems failures and resource reductions.

Gwenaelle Moncoiffe (BODC)
Gwen leads the vocabulary management group (VMG) at BODC. The team is responsible for maintaining, growing and further improving the NERC Vocab Server (NVS) and manages content of externally- and internally-governed vocabularies among many other responsibilities. Gwen thinks of OBPS as a tool for communities, supporting registration, cataloguing, and discovery of BPs including OBP life cycle management.

Katherina Schoo (IOC)
Katherina works on Sustainable Development Goal (SDG) 14, target 14.3 and its Indicator 14.3.1, which are focused on ocean acidification. The objective is to develop standards, collect data, engage experts in acidification, data, etc. She explained that SDG Goals and Targets were set by Member States with the adoption of the 2030 Agenda for Sustainable Development (https://sustainabledevelopment.un.org/post2015/transformingourworld). The UN General Assembly tasked the UN Statistical Commission with developing a monitoring framework and the Inter-Agency and Expert Group on the SDG Indicators (IAEG-SDG), which comprises 30 Member States and other members, was established to develop the indicator framework. IAEG-SDG agreed on a framework of 244 indicators and designated UN agencies as custodians of the various indicators, adopted by the UN General Assembly in 2017. It was confirmed that OBPS is tagging appropriate OBPS records with SDG metadata.

Johannes Karstensen (GEOMAR)
Johannes is an observational physical oceanographer. He works on aspects of improving global ocean observing as a member of scientific expert advisory groups such as the Ocean Observations Panel for Physics and Climate (OOPC), as a co-chair of the OceanSITES global time series observing network, and as a member of other international ocean observing groups (executive group member of OceanGLIDER, and alternate German delegate for ICES-SCICOM).

Panel Discussion including Comments

How do we determine if there are gaps in observing systems?

Mark Bushnell – We involve everybody in the value chain through workshops, conference papers and one-on-one discussions.
Gwenaelle Moncoiffe – We should continue to develop the User Interface (UI) so that it can support cross-community analysis of OBP including the following: user-friendly browsing and listing, allowing people to comment, evaluate and tag BP, display endorsement by communities, and use carefully selected controlled vocabularies as tags (need to help user quickly decide whether the BP document is worth exploring further or not).
If focusing on EOV-related OBP, one needs to establish a matrix of EOV vs BP [Editor note: already in hand] taking into account main stages in the data life cycle (data collection, near real time or delayed mode processing, QA/QC, documentation, metadata capture, publication, archive/exchange format, discovery, re-use including aggregation/integration into products, etc.), and environmental/regional variations. In addition, establish an OBP review process by engaging the relevant communities and existing WGs/IG/International networks and programmes [Editor note: Endorsement/review process to be implemented mid-2020].
Laurent Delauney – The TRL of each EOV and maturity of BP behind it are two different things, EOV readiness level has analysis behind it, and needs to be updated for BP maturity.
Johannes Karstensen – Observing methods follow from observing requirements, thus allowing for gaps identification. Requirements need to be scoped out. For example, requirements setting for acidification from coast to open ocean is very diverse (different observing methods to apply, and one needs different experts to assess this). Requirements are the key element to link..

Priority areas for expanding BP implementation?

Mark Bushnell – Pointed to NOAA's Readiness Level metric as an example of a tool that might be used when establishing priority areas for expanding BP implementation where one may consider a certain level of maturity before a process becomes a BP. He identified NOAA TRL 4-7 as those levels where BPs are becoming mature and should be nurtured.
Gwenaelle Moncoiffe – In situ sensor data, including BP associated with discrete measurements, can be connected to one or several EOVs/SDGs, and used by many networks. Focus on mature data types, the most stable / least disputed / best understood sets of BPs across their entire lifecycle (for example salinity/temperature/O2 + chl-a fluorescence). Use these as examples for other sensor data types to follow linking OBP to data (and referencing OBP in publications).
Emma Heslop – Use JCOMM vocabulary for data lifecycle and also link to BGC Eco Panel (pre-deployment to post mission process). It is complex to find BPs associated with each step. Another point is that we need a controlled vocabulary for GOOS endorsement processes. The level of maturity of BPs has not been yet addressed.
Gwenaelle Moncoiffe – BPs may get published before being mature, so we need an extra layer for reviewing.

How should the OBP Project team work with others in the community?

Mark Bushnell – Working across communities, the OBPS team combines their efforts, leveraging our existing capabilities.
Gwenaelle Moncoiffe – We should connect with teams and individuals involved in developing BPs, creating an open BP forum [Editor note: Oceanbestpractices forum is under development] with interactive user-friendly tools that would help attract contributors to the OBPS and promote the resource. In addition, we need to connect with non-oceanographic initiatives e.g. Research Data Alliance and CODATA: IG/TG/WG on interoperability, earth sciences, FAIR enablement, linking publications to datasets (scholix.org).
Laurent Delauney – For JERICO-S3, we involved OBPS in the project and this is a very powerful way to connect OBPS to communities and the EU Commission is willing to fund these activities

Tom O'Reilly – It is a good idea to have question-answer forums for the community which relate to BPs. Consider use of Stack Overflow for community communications
Mark Bushnell – There is a forum now available, so we are already working in this direction
Gwenaelle Moncoiffe - GitHub is used a lot in semantics and open discussions are conducted there as they are in Stack Overflow. This could be a good example.
Joaquin Tintore – Gaps in observing methods depend on drivers (science, technology, society). For each driver, we need to address the scales, for example different scales in ocean state and variability. For each scale, the requirements are different. A method needs to be established quickly. A framework needs to be adopted and then converged.
Maciej Telszewski – The SDG process is critical, but it will not help OBPS. First, most countries do not have capacity to measure. Second, SDG methodologies and endorsement needs to be very basic. One website instead of 2 for OBPS would be best [Editor note: in process]. Also, we should highlight what is the DOI status of each BP. One BP may be good for one requirement but not for another, and so we cannot have only one BP for one thing. We need to have a discovery option for the user to filter for the accuracy requirements.
Gwenaelle Moncoiffe – A best practice for one community or a given application might not work for another – community endorsement must be shown for given applications; Explore how to make the best of existing tools / platforms like GitHub; consider the link between best practices and standards – community BPs are needed to help conform to standards – e.g. SWE marine profile; Multi-lingual browsing options should be considered at some point in the future (greater uptake worldwide, especially in coastal areas) – even if the BP themselves are in English. She quoted data.org as a search interface example.

How to motivate the community to feed the system?

Katherina Schoo – SDG14 (10 targets with different ways to collect data). (Methods, data and metadata templates, data portal, training). Align with global, enforce implementation, increase capacity and relate to other processes.
Workflow integrated into OBPS? We are heavily involved in submitting all documents in OBPS. We have living documents with links to OBPS
Also establish one-stop-shop for ocean surface temperature, but note that acidification needs up to four variables. Minimum quality standards and number of variables are not yet agreed by our community.
Siri Jodha Khalsa – Only four variables?
Emma Heslop – GOOS is working on the endorsement process but it is not trivial to establish correct methodology. SDG BP endorsement process would help people find documents within the repository, that would be easy to do. You would be the first ones!!
Katherina Schoo – Agree.
Johannes Karstensen – Where do you engage the community?
Katherina Schoo – IOC is a custodian agency. There is an organization called GOA-ON with 690 members globally. Data is collected all around and is available in the portal. You may be able to call members to agree who does what in each country. Data in GOA-ON repository needs to come from NODCs and has different layers. Need as much community input from nations and then IODE to support the process.

7. Panel on Key Advances in Ocean Observing and in related Technologies -

Paul Gaughan (MI), (Moderator)

Paul Gaughan from the Marine Institute Ireland introduced the panel and reminded them of the questions to address:

- What are the likely key advances in ocean observing and associated technologies?
- What is the role/evolution of best practices and the OBPS in supporting these advances?

Kristin Beem (OSU)
Kristin outlined her work as a shipboard technician and responded to Q.1 by reporting that NSF had funded three Regional Class Research Vessels and that OSU will take delivery of the first one in 2021. The vessels will come with Real-Time Data Presence or Coriolix[1] and shoreside support model including chart functions, QC and metadata. Operators would be going from 10 to more than 40 resident sensors, which she acknowledged was challenging for technicians to support. But this she felt was where best practices/methodologies would provide buy-in and visibility to OBPS for operators as well as scientists. OBPS could offer evaluation of sensor technologies and also training for new technicians. It was important to get operators into the best practice/methodologies conversation and to encourage review, collection and use of best practices.

Elisabeth Remy (Mercator Ocean)
Elizabeth stressed that close collaboration between the ocean monitoring and forecasting centers (MFC) and the data providers is crucial. She then outlined the CMEMS (Mercator Ocean) and confirmed that MFCs from CMEMS and Ocean Predict are already involved with the observing community/agencies and beginning to be recognized as part of the full value chain from the observations to users. She highlighted the benefits from best practices for the observation community and listed some candidates for OBPS urging that we should continue to review and collect best practices and finished with displaying an inter-comparison between observation and forecast for long term re-analysis in salinity.

Hugh Roarty (Rutgers)
Hugh reviewed Rutgers contributions to MARACOOS, particularly best practices for HF Radar. He identified that their 2008 BP was in OBPS and questioned how to keep QA/QC/BP documents updated.

David Murphy (Sea-Bird)
David provided an industry perspective and confirmed the rapid expansion of platforms and sensors. He thought OBPS could help smaller operators (3-5 sensors) adopt BPs (orient OBPS linking platform-sensor parameters), as well as helping to manage quickly expanding data volumes e.g., Argo BGC and gliders.

Questions and Comments

Maciej Telszewski – What is the aim of OBPS – will it cope with massive input of BP from the atmospheric and weather community which is a much larger community?

[1] https://www.unols.org/document/2019-rvtec-meeting-appendix-xxvii-coriolix-cruise-observations-real-time-interface-open

Marie-Francoise Voidrot – There are different types of BP including BP for the experts; each time you encounter a new community, you go to a new level, addressing different types of BP.
Johannes Karstensen – Felt skeptical about going between scientific publications and BPs. We need to convert a journal article which includes a relevant BP into a separate BP document which makes the BP more accessible.
Luca Centurioni – A BP needs to be supported by scientific reviewed publications. We need something on top to identify a journal article as a best practice since it is only a science publication without this identification. We also need a review process that identifies the journal article as a BP? A science publication may be state of the art when published but not necessarily a BP.
Hugh Roarty – Works on HF radar, combining measurements between several systems. He asked how do you keep practices up to date; what is the life cycle of a BP?
David Murphy – Availability of BPs will have a positive impact as the technology for autonomous vehicles matures.
Christoph Waldmann – Questioned the distinction between standards and BPs, noting the emerging ISO standards for ocean technology. For example, the ISO 22013 new standard ("Marine environment sensor performance - specification, testing and reporting - General requirements") can be more important than an equivalent BP. [Editor note: In a follow-up discussion, Christoph explained that he wanted to point out the distinction between standards and best practices. ISO standards have a legally binding character while BPs may not have strict formal rules. Therefore, ISO standards, in a condensed form, are intended to ensure a fair competition between companies and other organizations developing and distributing sensors, platforms and other tools for the scientific community. Best Practices, on the other hand, are better suited where scientific organizations intend to harmonize their methodological concepts.] Christoph also asked what role do standards have in industrial firms?
David Murphy – Responded that standards also provide traceability back to national standards across all manufacturers.
Tom O'Reilly – Noted the key technology development of Iridium II with much greater bandwidth, leading to greater data volume.
Roberto Petroccia – Best practices may be specific to the usage; thus, we must define or redefine which kind of best practice we are talking about. There are clear needs for BPs on how you prepare the vehicle, quality of the data collected, and link to usage.
Ana Lara-Lopez – It is very hard to support those communities developing technology for ocean observing, particularly coastal processes and biodiversity. It is hard to support people to develop technology.
Reyna Jenkins – We need to understand granularity in processing. There is a need for instrument specific BPs – for example, Ocean Networks Canada (ONC) has descriptions for 'How you handle different company sensors because these can be different.
Christoph Waldmann – Look at the SeaBird website for best practice examples.
David Murphy – Suggested the use of templates (tell us what you want); the motivation is to give customers what they want.
Maciej Telszewski – It is great that information about best practices/methods is on manufacturers website. When users come to use particular instruments in a particular environment, that information will not be on the website – it comes from experience of using instruments.
Anya Waite - Noted the discrepancies across the span of capabilities and requirements, especially as seen in MBON.

8. Panel on Synthesizing BPs (with similar objectives)

Joaquin Tintore (SOCIB), (Moderator)

Joaquin Tintore introduced the panel and noted the workshop requirement for the panel to develop strategy and clarify specific recommendations. He gave a definite yes to the need for synthesis of best practices and then encouraged further development of best practices to standards whose differences he defined as bottom-up vs top-down. He felt this was an expectation of international funding agencies as well as individual organizations. Joaquin highlighted that OO'19 was a major step forward where everyone was mentioning BPs. He recommended OBPS build more BP critical mass. 1000 BPs in the repository is not sufficient to represent all communities.

Emma Heslop (GOOS)

This is Emma's third BP workshop and whilst the conversation and questions have developed they come back to the central question of how to manage the evolution of BPs.

Emma thinks communities are naturally moving towards synthesis and convergence already and noted Juliet Hermes/JCOMM is working towards documentation of systems in OBPS in order to identify gaps with respect to BPs for EOVs, etc. OBPS is collecting these BPs, but another message coming from the community is now to encourage convergence. She then queried at what point does a converged BP become a standard? She acknowledged that no methodology exists at present but it is related to convergence.

Emma considered whether BP creators need to provide additional metadata so that OBPS can increase search parameters; she mentioned that BPs on OSSEs (for modelling and observation communities) and on stakeholder use is needed. Perhaps annually the community can identify specific areas and funding could be sought to fill the gap/s.

Neil Holdsworth (ICES)

Neil challenged that all our sources of best practices are diverging from the published document. This is because in the time taken to develop and publish BP documentation, the community has moved on. The process is happening much quicker outside traditional publishing practices and is not yet under control. He outlined how ICES works with management, policy makers and industry etc to come up with a standard when there is sufficient maturity. He gave the example of ICES working with echo sounder manufacturers to create a standard. He made a key point of optimizing when to talk with manufacturers about implementing a best practice or standard. Alternatively, he gave the example of underwater noise where lots of different industries are sources of noise, eg. oil and gas, seismics, military, etc., and there are lots of standards but they are not working together yet.

Neil wished that OBPS would turn into an accreditation effort. [Editor note: BP Endorsement Process to be implemented mid 2020].

Anya Waite (Dal-OFI)

Anya called synthesis, a balanced reflection which is not the same as prioritization and posed the question - when should synthesis be done? She highlighted active controversies (e.g., working with communities; Nitrogen-fixation; genetics) which need excellent brokers – trusted communicators who consult across

different sides of controversies. She called for co-design with indigenous communities with whom OFI is working on developing BPs. She finished with the case study from the new SCOR Working Group 154 which addressed best practice through its '*Recommendation on plankton measurements to the GO-SHIP program (and OCEANSites)*' DOI: http://dx.doi.org/10.25607/OBP-718

The panel agreed that synthesis should occur whenever possible but questioned whether we have a process for synthesis or even what it means exactly?

Questions and Comments

Anya Waite – We should follow where BPs are already coalescing; the OBPS role is brokering that conversation. Convergence does not mean a single BP but a collection of consistent methods that can be recognized and recommended. Important to engage in regional initiatives.
Neil Holdsworth – Synthesis is about working together. If so, when is it best to do it and what are the mechanisms to move collaboration forward. Funding is often at the regional level, so seek funding at that level. The process is to build communities (not just researchers) and end up with a dialogue with stakeholders.
Emma Heslop – Suggested prioritizing what the observing community needs from best practices. It is likely to be a collection of BPs because not all have the same technology.
Anya Waite – Do you start with calls from the community - do a survey? [Editor note: a survey on best practices was completed July – September 2019 as mentioned in the introduction by Pearlman at this workshop. Results will be published in 2020.]
Siri Jodha – What does convergence mean?
Emma Heslop – It means converging towards a minimum number of BPs.
Neil Holdsworth – OBPS answers the question 'I have this data or system - what is the BP for me'? – This suggests the creation of a decision matrix tool.
Maciej Telszewski – The metadata sheet already contains the foundation for the matrix by providing info with lots of detail.
Jay Pearlman – How do you bring very disparate people together?
Neil Holdsworth – Most things we develop are for management; work backwards.
Anya Waite – We can bring communities together, in part, by using training and capacity building.
Reyna Jenkins – There is also value in having a place for showcasing new efforts.
Pauline Simpson – A common "language" such as we use in BP processing supporting vocabularies and natural language queries can be an element.
Johannes Karstensen –There are alternatives in community building, for example, using more traditional synthesis vs groups working online in non-traditional manner. The latter is not well suited to traditional publication processes.
Neil Holdsworth – The on-line interaction can be done in parallel with the machine learning community for example.
Joaquin Tintore – What is needed is a critical mass of people working together. There is also a redefinition of scientific excellence that should be addressed (publishing a paper is not enough).

9. Panel on Standards and Best Practices

Siri Jodha Khalsa (NSIDC/CIRES/Col.U.), (Moderator)

Siri Jodha Khalsa introduced the Panel and gave a presentation to provide some quick comments on Best Practices vs Standards, highlighting the similarities and differences. He then identified Best Practice, De Facto, De Jure, and Code as differing types of standards and provided a step-through the standards development process.

Champika Gallage (WMO)

Champika described three named types of WMO documentation: regulatory (Technical Regulations and Manuals, using "shall" or "should"), Guides, and other Technical Documents (guidelines and IOM reports), which are non-regulatory. She reviewed the process by which a Commission for Instruments and Methods of Observation (CIMO) guide is developed and updated. They are now published in sections to enable easy updating: I) guidance on the most effective practices for measurements and observations to achieve a standard quality; II) practical advice on techniques which are well established and in regular use, from the simplest to the most complex and sophisticated; and III) authoritative reference for all matters related to instrumentation and methods of observation in the context of WIGOS. She indicated a possibility to add a new section on ocean observing in III (or a new volume) and asked for feedback from participants.

Tom O'Reilly (MBARI)

Tom provided an overview of lessons learned when developing the Open Geospatial Consortium (OGC) PUCK standard and outlined the "necessary but not sufficient" considerations for standards adoption: it needs to work for stakeholders; manufacturers need the skill to build it; and there must be sufficient demand to use it. OGC PUCK is a protocol that allows observing systems to retrieve the payload information - data, code and metadata from the device itself via a controller.

MBARI and OGC worked together to evaluate the protocol and complete the standard and in 2011 PUCK was formally adopted as a standard by OGC. However, the resulting managing agent OOI was underfunded and dropped the requirement to use PUCK in RFPs beginning in 2014. PUCK use was no longer mandated. Since 2014, there have been only a few implementations of the protocol, e.g., some European projects such as NEXOS (https://www.nexosproject.eu/). Tom acknowledged that perhaps focusing on oceanographic sensors was too narrow.

Christoph Waldman –PUCK is liked by his community and he encouraged Tom to keep trying because there is no other solution around and so it has to be done manually.

Siri Jodha Khalsa - Queried whether, in the OGC review cycle of sensor web enablement, whether PUCK would be re-evaluated.

Laurent Delauney - Many of the participants in the NeXOS Project are now partners over the next 4 years in JERICO S3 (http://www.jerico-ri.eu/) which includes technological development of integration of Biosensors, etc. - so he thought there might be renewed interest in OGC PUCK.

Marie-Francoise Voidrot (OGC)

Marie-Francoise provided background on the Open Geospatial Consortium (OGC) - which is an international industry consortium of more than 520 companies, government agencies and universities

participating in a consensus process to develop publicly available interface standards with a focus on interoperability. She stepped through OGC Web Mapping Services, which helps many plotting operations and discussed the WMO/INSPIRE/OGC Memorandum of Understanding (MOU).

Lingling Yuan (NCOSM)
Lingling described the National Center of Ocean Standards and Metrology (NCOSM) which is in charge of the management of national marine standards and metrology in China. It is affiliated to the Ministry of Natural Resources. With approval from WMO and IOC, NCOSM acts as the Regional Marine Instrument Center for the Asia-Pacific (RMIC/AP) since 2011. They have established 34 marine measurement guidelines in the last 20 years. and she described the calibration facilities for many ocean sensors. Lingling confirmed NCOSM is actively utilizing and depositing into OBPS and offered to be on a panel to review best practices.

Ian Walsh (Sea-Bird)
Ian is Director of Science at Sea-Bird Scientific. He discussed and acknowledged the broad interpretation of standards and that there are a variety of standards already in place. He felt we are really early on in the process and are not there yet to derive standards from best practices. He suggested that a role for OBPS would be to guide the community to produce best practices in a structured way and gave the example of QARTOD manuals. He suggested the multiple best practices for a similar objective should be filtered to just a few and then reviewed for possible transition to a standard. He then moved to querying about FAIR within our own data systems.

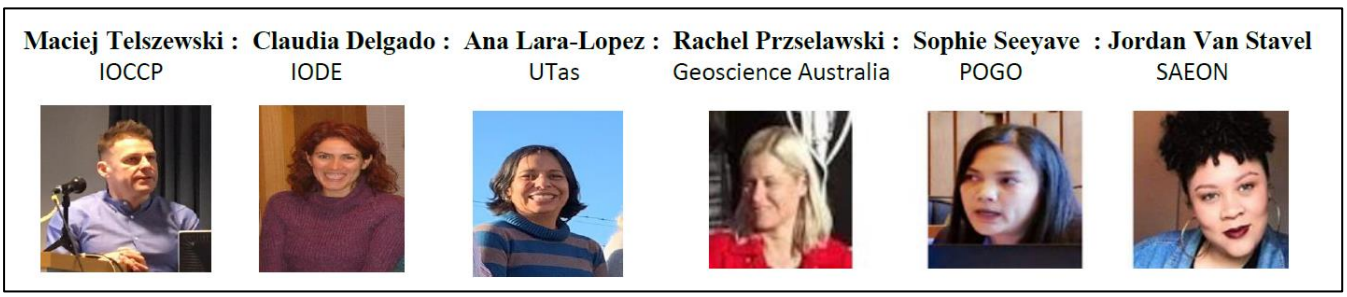
Questions and Comments

Siri Jodha Khalsa suggested that the Panel either focused on data and how to make it easy to access OR what process to transition from best practices to standards. No decision was made.

Gwenaelle Moncoiffe – Metadata and using authorized vocabularies is important to understand when we are talking about the same thing.
Ian Walsh – This is relevant to having consistent naming structure for datasets, i.e., labelling the datasets. If you expand this approach to multiple instruments, then it may become problematic. Ultimately, we need uniform labelling through the whole chain of data processing.
Gwenaelle Moncoiffe – Are you suggesting to combine the sensor name with the processing methodology?
Ian Walsh – Yes.

Day 2: Tuesday 03 Dec 2019

10. Panel on Capacity Building and Training



Maciej Telszewski (IOCCP), (Moderator)

Maciej Telszewski welcomed all Panel members who introduced themselves and before his presentation suggested that a future workshop meeting should take place where capacity building is needed (not in Europe or North America, i.e., not in the Northern Hemisphere). He suggested that an outcome of this session would be for the OBPS SG Work Package on Capacity Development to consider developing a product (paper, best practice, training module) which would describe various types of capacity development activities (with their pros and cons) in relation to various types of best practices in OBPS. Maciej described types, attributes and logistics of capacity development training courses including slides on the success of his latest Biogeochemical Sensors training course. He confirmed IOCCP was now working with OTGA to upload courses to their Moodle platform.

Claudia Delgado (IODE)
Claudia is IODE Training Coordinator & Project Manager of the IODE Ocean Global Teacher Academy (OTGA). She stressed in her presentation the difference between capacity development, where there are already some existing skills; with capacity building where there are none. She showed as an example "how to teach software without computers!" and she used this as a starter for discussing the role of Information and Communications Technology (ICT) as a tool to enhance capacity in all fields of knowledge, including a reference to the UNESCO-Qingdao Declaration (2018). The pros and cons of e-learning were discussed and specifically when e-learning is a good option, including, for best practices, the growing body of knowledge in already existing best practices and how to deliver the relevant training using online platforms. Reference was made to IOC Capacity Development (CD) Strategy 2015-2021 (https://unesdoc.unesco.org/ark:/48223/pf0000244047) and how OceanTeacher Global Academy, with its e-Learning Platform as well as its network of Regional Training Centres, contributes to the implementation of the IOC CD Strategy. The importance of following a good quality system and international standards and certification in training was discussed and she highlighted that the UNESCO/IOC Project Office for IODE is ISO 29990:2101 certified as a Learning Services Provider.

Ana Lara-Lopez (UTas)
Ana outlined many of the 'ocean' online training courses available in Australia. From her MOOCs, (Massive Open Online Course) to YouTube to full online courses (often leading to certification) to webinars. She highlighted that MOOCS can be expensive to produce; YouTube clips are short; online courses can be weeks in duration and webinars can be interactive. Ana outlined the pros and cons of online courses. They can reach a wider audience and so have the potential for greater impact and outreach. They offer flexible learning and are adapted to different learning requirements. The cons are that completion rates can be disappointing and getting feedback is a problem. She warned production, communication and marketing costs are not insubstantial.

Rachel Przeslawski (Geoscience Australia)
Rachel focused on capacity building with indigenous communities or developing countries and described two types of best practices: engaged (organized and planned two-way interaction) vs. abridged (opportunistic suitable for low budget countries). She encouraged more CD best practices to be uploaded to OBPS and suggested this would not detract from the OBPS science framework.

Jordan Van Stavel (SAEON)
Jordan outlined three types of research cruise training opportunities: 1) Dedicated student research training from such as SEAmester (South Africa programme), 2) Opportunistic such as that offered by the Schmidt Ocean Institute & Univ Washington, and 3) Land-based + cruise training fellowships (POGO Ocean Training Partnership) such as Atlantic Meridional Transect (AMT) and GEOTRACES North Atlantic FRidge cruises She listed factors to consider when applying for each.

Sophie Seeyave (POGO)

Sophie highlighted the POGO capacity development partnerships with GEO Blue Planet, Nippon Foundation, SCOR, and IOC/IODE/GOOS. She explained that POGO efforts involve training, networking, and equipment technology which include shipboard training, regional training, visiting fellowships and the POGO Centre of Excellence. She discussed the differences between professorships vs. visiting fellowships, listing the pros and cons. Lastly, she offered examples of successes: global impact; broad participation **(**almost 1,000 young scientists from over 90 countries have been trained); lasting impact **(**many alumni are now in senior management and teaching positions where they can influence capacity development in their countries); capacity development beyond training **(**research institutes in developing countries are joining the POGO network and participating in projects to develop low-cost instrumentation for coastal monitoring). There remain challenges: impact evaluation (time consuming and interpretation is problematic); the need to find a balance between providing training and ensuring that resources are in place for the training to be useful; many programmes are doing similar work yet are unaware of each other (they could be more effective working together).

Led by Rachel Przeslawski, we then participated in an exercise to build a word cloud going to menti.com and entering terms for 'what capacity development means to you'.

Figure 2: Word Cloud for capacity development

The exercise showed both expected responses (such as training) and some less typical comments (such as future proofing and deep). We recognize that words like capacity development and interoperability are defined in the eyes of the beholder's environment and perspectives and thus there is an underlying challenge in optimizing capacity development. The inputs are valuable as the Capacity Development WP of the OBPS-SG moves forward with its plans for the next 5-10 years.

Maciej then outlined recommendations from the Panel:

CAPACITY DEVELOPMENT PANEL - Key Draft Recommendations

- Develop a product (e.g., peer-reviewed paper, best practice, web page, training module), which would describe various types of capacity development activities (with their pros and cons) in relation to various types of best practices in OBPS and beyond.
  Similar to BP endorsement process, such product would not aim at providing a solution to every case but would provide guidance on the most suitable capacity development modality according to the need, EOV/platform that forms the subject of the capacity development, area of the ocean

observing value chain being targeted, career stage and geographical location of target audience, available budget, etc.

While developing this product, the compilation of all the different capacity development modes highlighted should be complemented by modes previously not considered: hackathons, problem-based learning, student projects, collaborative research projects, infrastructure investments/donations, mentoring programmes, training for policy makers (and school teachers?), formal academic programmes such as university degrees, and others to be determined. A recent survey by the EU project AANCHoR provides quite a complete list of capacity development types, which could be useful: https://www.surveymonkey.de/r/2D936XL.

The most suitable mode depends on the participant's current knowledge and available resources

- The SG-OBPS should be at a forefront of socializing the existing automated capacities across all ages (starting very early), interest groups and stakeholders (benefiters of "ocean services"). Programmes like "adopt a glider", "follow a float" and others should be communicated in order for the society to become fully engaged with the ocean-related aspects of our lives in the light of a shift from field surveys-based oceanography to automated data acquisition. It was noted, however, that there is still a place for ship-based observations and therefore shipboard training, and will be for the foreseeable future, given that we are still building new ships and the international research cruise fleet is still growing.
- There are already many best practices related to capacity development, including indigenous engagement. SG-OBPS should make a directed effort to increase the visibility of this type of resources and make sure they are included in OBPS.
- The SG-OBPS needs to ensure linkages with existing capacity development groups (e.g., colleagues behind the OceanObs19 breakout (Arbic et. al.), EU AANChOR project and several short-term funded projects)
- Important to note that the perspective at the workshop was skewed towards those from developed countries so the challenge is for all of us to recognize what we might be used to and what works for us will vary in developing countries (importance of "abridged" versions of best practices).
- Next SG-OBPS meeting/workshop should be hosted outside of Europe and ideally outside of the Northern Hemisphere. Ideally, it would be combined with a dedicated capacity development activity.
- OBPS should develop a communication tool, probably embedded in the website, for a relatively high-level technical discussions amongst the technical staff mostly dealing with issues described in best practice documents. This could help to facilitate more in-person interactions such as exchange programmes, international conferences and/or training programmes specifically for marine technicians. *We lack such a forum at a global scale*.[Editor Note: Oceanbestpractices forum under development]
- Include an OBPS introductory session/tutorial into capacity development activities and allow the users to provide feedback on the repository and other aspects of the OBPS.
- There is a strong need to develop (map out) and keep updated a compilation of planned capacity development activities (recognizing that this would require significant resources, not only to set up but to ensure the long-term sustainability and usefulness of such a system (i.e., a dedicated person to maintain/refine the system, keep it updated and populated).
- We need to consider the whole value chain in capacity development.
- We know that there will be a shift from field surveys to automated data acquisition. Capacity development can and should be adapted to include problem-based learning onshore (e.g., developing automated image recognition algorithms), with blended learning is ideal.

Questions and Comments

Discussion followed, with additional CD opportunities listed as hackathons, telepresence & dive-logging.

Juliet Hermes – In thinking about global and regional scale CD, wondered how to take a best practice and modify it to meet reduced needs,
Rachel Preszlawski – Thought that her abridged approach might apply. Question of low-cost instruments (for example a $100 CTD) for use in citizen science and developing countries.
*Joaquin Tintor*e – In addition to low cost "reduced" capacity development, he noted the strong need for highly technical knowledge exchange.
Maciej Telszewski – Noted that OBPS feedback may play a supporting role in both areas.
Kristin Beem – Highlighted the UNOLS RV Tech annual meetings, and InMarTech every two years as vehicles for expanding the reach of OBPS.
Jay Pearlman – Made the point that autonomous vehicles are the future and he wondered how we are preparing for it.
Rachel Preszlawski – There is also the point that most efforts are coastal and they may lack resources for autonomous vehicles.
A vigorous discussion led by *Joaquin Tintore* followed, regarding interaction & training of the newest technologies (cabled observatories, glider tracking) available online.
Ian Walsh – Stated that ships are not going away and nothing beats teacher / student standing next to each other on deck.
Sophie Seeyave – Mentioned that POGO & IODE created OceanSummer Schools, which provided a listing of training, which has gone stagnant.
Claudia Delgado – Noted the creation of the *marinetraining.eu* portal.
Siri Jodha Khalsa – Wondered if we need training for the use of OBPS, and might that become a part of capacity building.
Maciej Telszewski – Confirmed the OBPS training is indeed introduced in the ocean carbon coordination project training.

11. Breakout Reports - Johannes Karstensen (GEOMAR), (Moderator)

On the first day, three breakout sessions convened to address the topics and discussions of the first three panels: standards and best practices, the next decade/key advances, and best practices synthesis. The goal was to have smaller groups probe these different areas and then report back to the plenary on their thoughts and recommendations. The breakout reports were then followed by an open discussion to allow all of the participants to engage in each subject.

Breakout Session Report - 1: Standards and Best Practices

Christoph Waldmann led the Breakout Group discussion which agreed the following:

- Collecting these best practices in a central repository, the IODE Ocean Best Practices System (OBPS), is of high value for the ocean observing communities and science community as a whole.
- Not all Best Practices have to be transferred to standards. It depends on the value/benefit for the community.
- Mission critical observations, for instance Tsunami forecasting systems, need standards.
- Metadata of data is very important for data users. WMO has developed the Observing System Capability Analysis and Review (OSCAR) tool which targets all users interested in the status and the planning of global observing systems as well as data users looking for instrument specifications at platform level.

The breakout group listed 5 questions and 3 recommendations:

Questions:

- Where do we go with standards, clear goals to be defined?
- Can standards inhibit technological innovation or will standards promote innovation?
- How do we highlight the best practices that shall be converted to standards?
- What is a good time to define standards and what is the value of maintenance and how to interact with WMO?
- Should a rating system be established? This has to be a moderated process avoiding conflicting views.

Recommendations

- It should be considered to develop a more elaborate structure for the OBPS portal that make the access to the required information more intuitive.
- Pilot projects shall be initiated to assist this process where a certain number of different use cases shall be elaborated and act as template for other domains. This will include capacity building aspects. Champions could be the cases of the carbon measuring community, ARGO, GO-SHIP, and HF RADAR. The promotion of communities like the glider community would benefit from this effort.
- It should be considered to connect OBPS to GitHUb, or at least make use of the GitHub platform.

Breakout Session Report - 2 : Next decade and key advances

Hugh Roarty led the Breakout Group discussion and summarized their findings :

Hugh Roarty led the Breakout Group discussion and summarized their findings :

Finding #1: Interface Development

- 2/16 participants had used the site for a “real purpose”

- 3/16 participants have uploaded a BP to the site
- "It is a connector; we are not judging"
- Need to structure the repository, there is an opportunity to provide synthesis, who will support $
- Customize the interface
- Search vs Browse
- Early 2020 release of next version of interface

Finding #2: **Follow the Data**

- FAIR data principles created in 2016
- Template
- Example
- Guidelines
- Principles
- Checklist
- Five page document on creating best practice

Finding #3: Communication/marketing

- How to cope with fast changing landscape for BP
- Approach editors to prominent oceanography journals to introduce the idea of recommending BP be referenced in the manuscript
- Represents a policy change to journals
- Challenges open access, copyright

Maciej Telsweski – suggested a stronger approach like a position paper for approaching various journals to recommend BPs must be cited.

Breakout Session Report - 3: BP Synthesis

Eric Achterberg (Moderator);
Neil Holdsworth (Rapporteur)

Q1. Should there be a synthesis of best practices with a similar objective?

Yes, but with caveats:

- where the BP is **mature**(ish) enough;
- where there is **willingness** in the community;
- where it **makes sense** to bring them closer together, i.e., local biological systems may not see much benefit
- A **mechanism** needs to exist or be possible to conceive

Q2. Synthesis, - how, what, process?

Tools and Guidance are needed

- Guidance based on a case study for **matrix route** to best practices
  - Criteria for matrix needs to be formed by each stakeholder community,
  - Be inclusive
  - A guided matrix to help narrow the options

  Two stage approach:
  - A broad matrix based on high level criteria: resources, technical aspects, geography
  - Then work with community of practice to refine these criteria within their area of the value chain context, but to the same broad headings

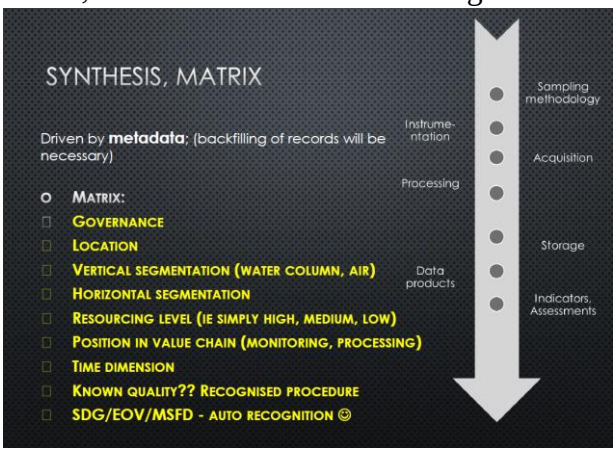
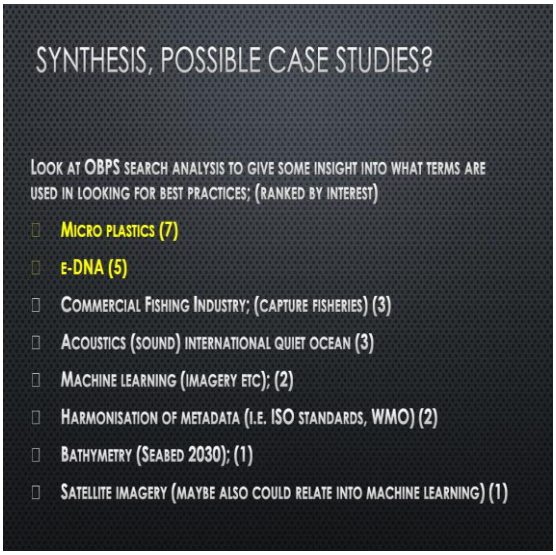


Figure 3: Synthesis matrix

Suggested case studies were presented and a SliDo survey revealed:

Top 4 results:

Harmonization of metadata	53%
Underwater noise	39%
Microplastics	37%
e-DNA	34%



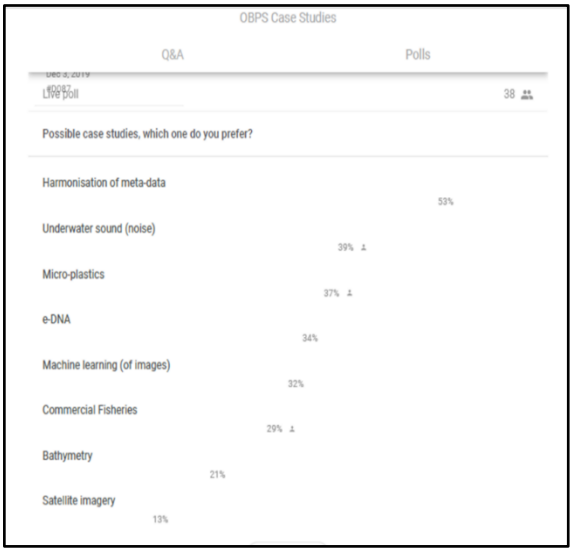


Figure 4: Case studies for a synthesis pilot

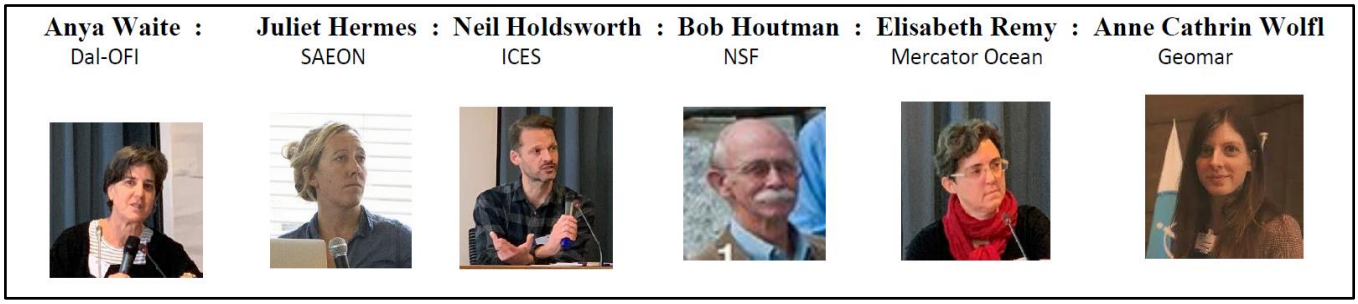
Q3. Synthesis - future considerations

OBPS methodologies - accreditation in the future
- springboard from matrix to a fluid way that allows a 'peer review' in a structured and open way that is inclusive

Questions and Comments

Johannes Karstensen – Can anyone identify a bottleneck to moving forward?
Joaquin Tintore – Felt the challenge was a social one, of many communities approaching OBPS from differing positions – thus the community response was disorganized.
Jay Pearlman – Asked for keywords that could identify the OBPS and ocean observing steps forward – we heard interoperable, known capability, trusted, and societal value.

12. Panel on Best Practice Vision for the Decade



Anya Waite (Dal-OFI), (Moderator)

Anya Waite moderated the discussion focused on directions for the next decade. She started it by suggesting a number of characteristics that may set the goals for the next five to ten years. She also guided the participants through two polls which engaged everyone. The effort here was to integrate the outcomes of the panel discussions and breakout sessions earlier in the workshop and also reflect on recommendations from prior surveys and conferences/workshops.

The characteristics of a decadal vision were broad and reflect the technical and social aspects of bringing together the community and working toward broad interoperability through the use of best practices and other means. The "strawman" characteristics were:

- Interoperability of data & knowledge & semantics
- Fully FAIR and known Data
- Excellent Data Management Plans
- 100% clear Provenance where data comes from and where it is being used
- Excellent Communication
- Trust in data, scientists and the general public.
- Value to Society

For interoperability, both data and knowledge interoperability (at all levels) needs to be part of the discussion. Additional facets of interoperability include legal interoperability, syntactic/semantic interoperability, etc. Does interoperability mean for the community or for the OBPS? It is both. We have an opportunity as this group to engage the different communities and challenge these communities about the availability of interoperable data within and across communities to support outcomes reaching across the value chain. These use data as a model of the vision, but the characteristics are applicable to the best

practices that cover the value chain from sensing to applications to societal impact. The panel identified that to play an effective role in furthering this vision, there are certain key attributes of the OBPS.

1. Portal / Interface
2. Synthesis and Standards and Accreditation
3. Outreach & Communication
4. Capacity Development & Retention

Using a Menti Poll (https://www.mentimeter.com, introduced to the participants by Juliet Hermes), the participants were asked to rate priorities of the four key characteristics. The results are provided in Figure 5. Rankings were on a scale from zero to ten, with ten being the highest prioritization. Each participant voted to rate the priority for major recommendations from the workshop discussions.

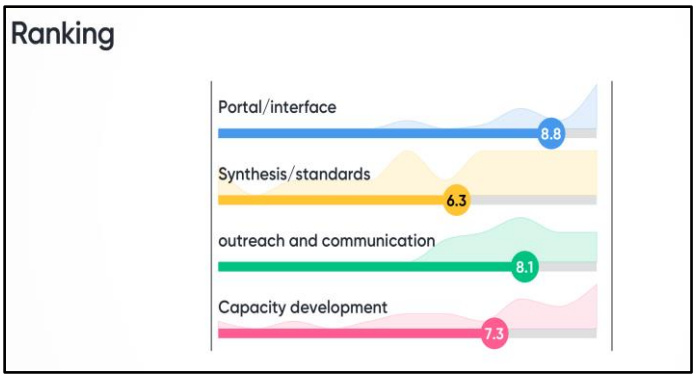


Figure 5: Ranking key attributes of OBPS

The lighter distributed colors show the voting patterns for each of the four subjects. The participants identified the portal/interface as the highest priority with outreach/communications second. The message is that participants believe that the OBPS must continue its move from passive accumulation of BPs towards engagement and collaboration. Upgrades to the interface are already under way. Outreach and communication – including developing a communication plan - needs strengthening beyond the activities that have been done some far. It is interesting to reflect that the convergence across similar best practices and the creation of standards was the lowest in the ranking of the four. Standards have not been readily accepted by observers due to the top down nature of standards creation. For the data and information practitioners, both *de jure* and *de facto* standards such as OGC WMS or NetCDF formats have found growing acceptance.

Bob Houtman – Thought we were missing a pilot project for standards development.

Anya Waite – Agreed that a pilot project for standards development was discussed and should have been included. Much constructive discussion followed on this and also on capacity development and training. There was a recommendation to the OBPS Steering Group to create subgroups within their work packages for specific actions in these two areas.

Juliet Hermes – Asked about the interoperability of data and knowledge and semantics – across organizations, networks and societal elements (citizen science). There are many dimensions to this question. Are we talking about the OBPS or attributes within the community? The system has to have the technical capability to address interoperability and semantics, but we also have to engage the different communities and challenge them as to where they are in terms of having interoperable data so that the entire community will take responsibility.

Pier Luigi Buttigeig (remote) – Offered that we are using semantics to link best practices to other best practices to create an ecosystem of practices that are interoperable. This should be extended to linking BPs to data sets themselves using the same semantic interoperability approach. If one of the pilot projects we identify and select is good data management practices, this could include the full spectrum of linkages as a demonstration (as a synthesis case).

Bob Houtman – Commented the real value of that would be that we can target communities to engage

more actively with best practices. He suggested that we host workshops of leaders of communities (to be identified) that are focused on exploring the value of best practices and the value of moving to a standard. This should also include capacity development and retention. Engage them to see if they are ready to move to another level.

Anya Waite summarized that the four categories in the ranking survey shown in Figure 5 above could be foci for next steps. This has a foundation of outreach and capacity.

Questions and Comments

Francoise Pearlman – Said that there is a communication and outreach plan being developed which will reflect the workshop recommendations.
Rachel Przeslewski – Raised the question of whether we should target the general public and would this be the right use of OBPS resources?
Elisabeth Remy – Noted that scientists need to engage the public but it is not clear if the public would use best practices. We should focus on those who will be users. This could be an expansion of communities such as modeling and other elements of science expertise. This should be more clearly identified, perhaps as tabs on the web site.
Pier Luigi Buttiegeig (remote) – Suggested one of the tabs – called "public" - could support citizen scientists, journalists, teachers, etc. Identify citizen science leads and others to engage with the Steering Group, expanding the base over the years. For example, look at best practices of journalists in their work and see if they can be included in the repository when they are addressing the oceans.
Frank Muller Karger (remote) - Said that there are practices from the European Marine Sustainability Framework and the Sustainable Development Goals that are not globally visible across communities.
Anya Waite – Suggested that OBPS engage an outreach professional for community engagement and provide recommendations for an effective communications plan.

The panel then reviewed recommendations for the OBPS with the following being identified:

- Develop a more elaborate structure for the OBPS portal that makes the access to the required information more intuitive.
- Initiate pilot projects to assist this process where a certain number of different use cases shall be elaborated to act as templates for other domains.
- Include more capacity building aspects in the programme. Selections could include communities such as the carbon measuring community, ARGO, GO-SHIP, and HF RADAR and gliders, who would be acting as champions.
- Consider connecting OBPS to GitHub, or at least make use of the GitHub platform.

The first three of these are related to users and community development. These complement the discussion earlier in this section. The use of GitHub for technology evolution is already underway and consistent with the current implementation actions. The use of web platforms for community engagement and information exchange is under development. To consolidate the recommendations, the panel then asked the participants to take another poll. This one was to get inputs on the priority of the recommendations. The results are shown in Figure 6 with a range of one to five, with five being the highest priority. Each person had one vote for each priority level. The light shading shows the distribution of the votes for each recommendation.

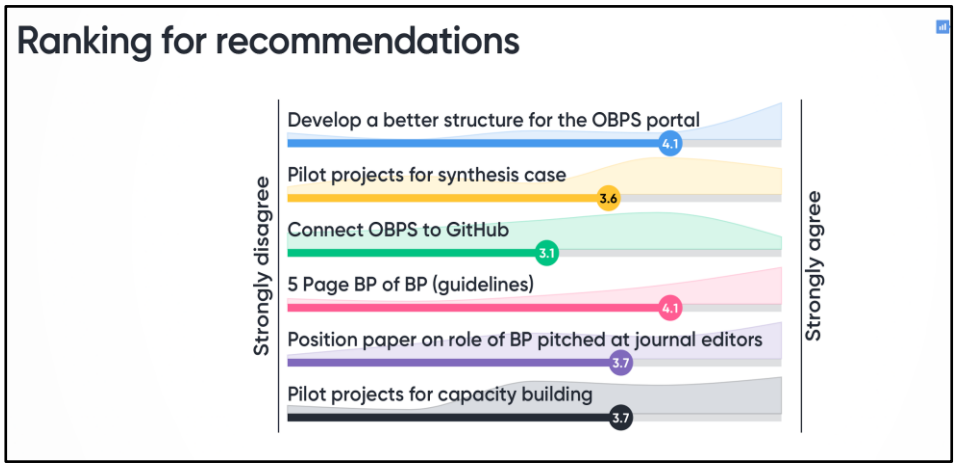


Figure 6: Vote Ranking for Recommendations

As the discussion continued, some elaboration of the above was identified. For example, it was proposed that there should be two groups of pilot projects, one for synthesis or convergence of similar best practices and a second for training and capacity development. These would make it easier for contributors and users of BPs to understand the nuances of working with the OBPS and BPs more generally.

In addition, the development of a five-page paper on what constitutes a best practice and how it can be efficiently contributed to the OBPS should be a priority. These are discussed below.

The two highest recommendations both relate to ease of use of the OBPS. At the next level are the pilot projects as well as working with the journals to have submission include both data and best practices used in the published research. The panel and participants offered rationale for the rankings and the comments were quite diverse. There were, of course, nuances in the interpretation. For example, it was suggested that some of the improved portal structure (which needs further definition) would reflect the ability to do and better understand synthesis which the pilot projects would illuminate. The recommendation for a better structure would help communicate the vision and next steps for the OBPS in addition to improving discovery and access. Thus, the implementation in 2020 of a forum for community interactions (as was mentioned earlier in the workshop) is an essential part of the updated structure to actively encourage community dialogue. The pilots for synthesis can then illustrate the impacts of the expanded structure. Details of comments and recommendations are provided in the sections below. These recommendations as well as others from prior BP workshops and community meetings support the OBPS vision and need to be shared with the ocean observing community to display the nature of OBPS as operational and evolving to meet user needs.

Recommendations of the panel on Best Practice Vision for the Decade

1. **Five page paper describing creating a BP for BPs** – Should we have templates or guidelines? The 'five pager' should be a set of principles as to what makes a BP. It should not be too prescriptive. For machine to machine readability however, there would need to be some mandatory formatting guidelines included. So, it should be something that helps give an overview of why we do best practices, what is a good process by which you distill information and knowledge to get to a BP and what the BP should include. This should be done at a (moderately) high level.

We have talked about the OBPS as a library of BPs. It is a broader repository where you can submit a guideline or SOP and the system can then, through community engagement, help nurture that into a BP. We need to make clear what a BP is and what is the intention of the document. Ultimately, the five pager needs to give some kind of guidance as to how to write a BP and make sure with these guidelines that everything we need is included. We could then use this to build a training course on creating a BP.

We are submitting an OBPS article to Wikipedia. The Wikipedia page on best practices has examples of disciplines where BP are used. We could add a section on BP of ocean observing.

In the general literature there are a number of books which talk about 10 easy steps to doing something, we could use this kind of example….'10 easy steps to building a BP'.

2. **Position paper to Journal Editors** – This would propose that journals require BP to be cited explicitly when publishing papers. Some of the participants felt that this is an important idea, but was not practical in the way it was phrased. This sort of idea already falls within open access to data efforts. We should rather focus on the existing initiative of how to make science reproducible.

Making BP citation a requirement might be too strong, as we don't have full convergence on each BP. It is possible that some people won't agree with the BPs that have been published and will instead cite their own practice in a paper. If people submit their protocol to the OBPS, it is easier to reference this in the journal to cut down on length. We are looking at ensuring people cite the methods they used in the paper (not necessarily the BP). Looking at other research activities, it would be good for funding agencies to also request that grant proposals highlight what methods they are going to use in their project. If it is stated in a proposal that BPs will be documented, then there should be followup by the funding agency that this occurs.

A contribution of the OBPS is that all submissions get a DOI and are citable. This allows manuals and SOPs to be cited through the DOI. This is something we would want to communicate in the letter to publishers. For the implementation with publishers, start with *Frontiers in Marine Science* as they are the journal for our "Best Practices in Ocean Observing" research topic. The Frontiers Board was receptive to the idea in terms of moving it to the Ocean Observations Section (with concurrence with the Section Editor). The editor of the IEEE journal agreed that citing methods should be included into the paper.

The panel felt that if there is a (slight) modification in methodology, authors would be expected to submit a new paper quoting the new methodology including the changes that have been made. This recommendation should be included in the position paper.

3. **Connect OBPS to GitHub** – Here the recommendation is to provide a forum for discussion on methods. We should not just connect to GitHub, as there are other platforms that can be used to log comments about one or more particular BP. There is an OBPS GitHub Repository for the code with an issue tracker and code-focused questions. There is the OBPS forum for community dialogue which is under development. The latter will be operational in 2020. There is a feedback mechanism on the OBPS interface and website; we have an active Twitter account. A feedback/review process for individual BP records within the repository is also being built.

4. **Outreach and communication -** The July 2019 Survey on ocean best practices showed that 20-30% of the respondents know about the OBPS. Of these 80-90% would recommend its use. This is a clear indicator that more outreach is required. For this extended outreach, illustrating the OBPS transparency and building trust are priorities. A significant Steering Group Work Package is addressing this important activity and one of the first actions will be to develop a communication strategy/plan particularly strengthening some of the activities that have been done some far and the suggestion of engaging a professional is well noted. This is part of adopting a culture of documenting and using best practices. In addition, users have asked about how to deal with the large number of practices and which to select for their own use.

For outreach, we need to refine our views on which communities will access BPs, e.g. the modelling community has recognized the need to document methods. We are now moving into phase 2 of the OBPS development. A first step would be to make citizen science more easily accessible through a public outreach tab (teachers, citizen scientists etc) on the website. For the nearer term – 1-year plan, the OBPS

Steering Group will use their User Communities Work Package to reach out more to science communities who are under-represented (e.g., modellers) and to under-represented regions. In addition, a target audience should be IOC level and the various programmes involved in GEO or IOC. There are also interesting outcomes from the European Marine Sustainability Framework that should be addressed. A mid-term goal could be to engage the public. This could be focused on teaching the general public about the importance of best practices.

5. **Pilot Project on Synthesis -** In the Breakout session on synthesis, there was a discussion on possible pilot case studies to address synthesis. These included: Microplastics, e-DNA; Acoustics (sound); Capture fisheries.; Machine learning and Harmonization of metadata.
The Figure 6 poll on p.30 did not address all of the potential issues. For example, given the constructive discussion on standards during the breakouts, it is not clear where pilot projects for standards actually fit in. This needs to be addressed further. Suggestions for selection of use cases for standards included acidification, HF Radar, Go-SHIP and Argo.

We are in the process of using semantics to link BP to other BPs (similar to linked data). There is another step which is linking BPs to related data sets using the same technology. This of course relies on BP creators making these links either in the text or metadata. So if a pilot project involves using good data management then we can enhance them by linking them to the BP. This could go into one of the synthesis cases.

The real value of this would be that we would have an even better opportunity to target some of these communities and engage them by saying there are this many BP in our system related to your community and the various activities that you do. Then perhaps a workshop of leaders of that particular community that is focused on engaging them in terms of 'there are this many BP' and explore the potential for the value of moving towards a standard or capacity building. Engaging them to help them decide if they are ready to move to another level.

6. **Capacity Development Pilot Project -** There are a lot of varied methodologies that are being used for capacity development. In terms of a repository of training opportunities the panel acknowledged that it would take significant work. IODE, meanwhile, has submitted a proposal for a broader initiative and this may determine the way forward. This needs person time, i.e., funding to keep it active. A training Home page should be organized by institution and organization showing which subject or topic is prioritized. Get more scientists and scholars to know this and contribute. There are many different categories that capacity development falls into and it would be beneficial to have a listing of those categories that then translate to different user groups and target audiences. One could then link BP for those user groups. So, at least as a minimum, to say that we think we have captured in the capacity development realm the various categories and user groups and BP and this would allow us to go into the system and collate the BP for various user groups and categories. This would make it easier for the user to actually capitalize on all of the information that is already available.
Anya Lara-Lopez – Asked the participants to define the difference between capacity building and capacity development.
Pier Luigi Buttigeig (remote) – Noted that at the Rio meeting for the Decade, the way the words were used were as follows: *when you build capacity one assumes there is no existing capacity; when you do capacity development, one assumes you are expanding and building upon existing capacity.* Development is broader. There is also a need to consider capacity retention because often capacity is built from funded projects and then the funding ends and the contributions need to be retained in the home countries. [Editor note: the phrase - *Capacity exchange* is now gaining use]
Bob Houtman – There are a lot of methodologies that can be used for expanding capacity development. The question we should address is which of these should we capitalize on in the near term and which are for future years.

Sophie Seeyave and the panel offered thoughts on the one-year and five-year directions for capacity development.

One Year

- Map criteria to audiences and come up with a matrix for audiences to select which type of training is required.
- Think about adding training and awareness about the OBPS to existing training programmes (e.g., to the NF POGO Centre of Excellence).
- Look for and encourage submission of capacity development methodologies to OBPS.
- Identify organizations that are already engaged - e.g., developing training videos based on early career or science training cruises that we are already planning to fund and getting the points of contact. For a small additional investment these could be captured.
- Think about how this could be more standardized for the 5-year time frame.
- Start with a pilot effort to demonstrate the value and then go to POGO, for example, to get advocacy.
- Increasing interactions and collaborations between organizations that are already doing this kind of thing. Look for synergies and an ability to capitalize on the individual investments to combine and have a greater impact.

Five Year

- Map different types of capacity development against different criteria, age of career stage, country or region, funding, platform, EOVs.
- Provide a matrix for people to choose the right method.

Juliet Hermes – Suggested the GOOS Regional Alliances as a focus for both best practices and knowledge sharing.
Sophie Seeyave – Pointed out the need for resources, which may become available at IODE through major project funding.

13. Recommendations from this Workshop

(see also Appendix 4: Recommendations for OBPS from other sources)

Recommendation (note some of these are already under development for implementation in 2020)	**Workshop Source**
● Create and maintain an open best practice forum for the community. ● Expand User Interface to support cross-community analyses of BPs. ● Expand the use of controlled vocabularies including for the endorsement process. ● Develop process for endorsement and review of BPs by expert groups. ● Use funded projects as a way to connect OBPS to communities. ● In the future, consider multi-lingual browsing.	**Panel on Community inputs for Best Practices**
● Include BP in training for new technicians and operators to encourage review, collection and use of BP. ● Establish links between BP and scientific journal articles; authors of journal articles should identify if an article is a BP ● Define and document a representative life cycle of a BP. ● Need instrument specific BP.	**Panel on Key Advances in Ocean Observing and in related Technologies**

• Customize the interface for ease of use. • Balance need for Search and Browse. • Approach editors of prominent oceanography journals to introduce the idea of recommending that BP be referenced in the manuscript.	**Breakout : Next decade and Key Advances**

• Panel recommends moving forward with convergence; convergence does not lead to a single BP but a collection of consistent methods that can be recognized and recommended.
• Encourage transitioning of best practices to standards
• Engage in regional initiatives, where funding can be sought
• Increase the number of BP in repository - community should provide guidance on where the gaps are.
• Provide a decision-making matrix to facilitate selection of BPs
• Facilitate community building through:
  ◦ bringing communities together using training and capacity building
  ◦ having a critical mass of people working together.
  ◦ including co-design with diverse participants such as Indigenous community.
	Panel on Synthesizing BPs (with similar objectives)

• Synthesis should happen when the BP is mature(ish) enough; willingness in the community; it makes sense to bring them closer together; A mechanism needs to exist or be possible to conceive. • Synthesis/convergence - build a criteria matrix that includes, for example, resources needed, technical aspects and geography (see Figure YY above), which needs to be formed by each stakeholder community. • Matrix would provide a springboard to endorsement and peer review in a structured open way. • Recommend pilot study in one of four areas: Harmonization of metadata, Underwater noise (Acoustics), Microplastics, or e-DNA • Identify keywords that identify OBPS attributes for future directions: interoperability, known capability, trusted, societal value	**Breakout : BP Synthesis**
• Create BP in a structured way, e.g., QARTOD Manuals. • Multiple best practices for a similar objective should be filtered to just a few and then reviewed for possible transition to a standard.	**Panel on Standards and Best Practices**
• Not all Best Practices have to be transferred to standards. It depends on the value/benefit for the community but mission critical observations, for instance Tsunami forecasting systems, need standards • It should be considered to develop a more elaborate structure for the OBPS portal that makes the access to the required information more intuitive. • Pilot projects shall be initiated to assist this process where a certain number of different use cases shall be elaborated and act as template for other domains. This will include capacity building aspects. Champions could be the cases of the carbon measuring community, ARGO, GO-SHIP, and HF RADAR. The promotion of communities like the glider community would benefit from this effort. • It should be considered to connect OBPS to GitHUb, or at least make use of the GitHub platform.	**Breakout : Standards and Best Practices**
• Consider the whole value chain in capacity development. • Create a forum for technical discussions related to best practices. • Map criteria to audiences and come up with a matrix for audiences to select which type of training is required.	**Panel on Capacity Building and Training**

• Develop a product that describes various types of capacity development activities (with their pros and cons) providing guidance on the most suitable capacity development methodologies in relation to various types of best practices in OBPS and beyond. • Invite best practices for programmes like "adopt a glider", "follow a float" and others for the society to become fully engaged • Add linkages, training and awareness about the OBPS to existing training programmes (e.g., to the NF POGO Centre of Excellence). • Examine new modes of training including hackathons, problem-based learning, student projects, etc • Look for and encourage submission of capacity development methodologies to OBPS. . • Start with a pilot effort to demonstrate the value and then go to POGO, for example, to get advocacy. • Increase interactions and collaborations with organizations that are already capacity development. Look for synergies and an ability to capitalize on the individual investments to combine and have a greater impact. **Five Year** • Map different types of capacity development against different criteria, age of career stage, country or region, funding, platform, EOVs. • Provide a matrix for people to choose the right method.	
• Write a five page best practice document describing how to create a BP. • Circulate a Position paper to Journal Editors requesting the mandatory inclusion of BP citations. • Connect OBPS to GitHub [already]. • Create a Communication Strategy and citizen science outreach. • Accomplish a Synthesis Pilot Project. • Accomplish a Capacity Development Pilot Project.	**Panel on Best Practice Vision for the Decade**

14. Concluding Remarks

Jay Pearlman, Emma Heslop and Pauline Simpson



The workshop was closed with concluding brief comments given by Jay Pearlman (IEEE), Emma Heslop (GOOS), and Pauline Simpson, (IODE) Project Manager IOC Ocean Best Practices System.

Jay discussed survey results. He reiterated the need for expanded outreach. Many people are seeing the OBPS for the first time. While the registry of methods is important, there should be support on a broader scale with the creation of fora for dialogues on methods and use including contributions from experts in academia, industry and policy. We need to address the propagation of trust and adoption as a priority. This is a cultural evolution in some aspects of the ocean observing and applications community. Capacity development can be quite complex when addressing observing and use on a global level and accommodation of different knowledge levels and funding access. This is a priority and Jay invited engagement by the workshop participants and others in contributing to capacity development. He noted the OBPS newsletter and encouraged all to consider contributing to it.

Emma mentioned the recommendations of this workshop regarding the repository interface and query structure. She noted the evolving community utilizing OBPS and the need for identifying and tracking preferred practices. Such information needs to be reflected in the portal. In addition, the evolution of our thoughts on moving best practices toward formalized standards was raised and should be more actively pursued. She expressed the importance of thought leadership and a broader advocacy. One area raised at the workshop is to approach journals with the idea of BP citations and their participation in the visibility of supporting synthesis of BPs. Are there other areas that would support the OBPS three to five year vision and could include a few bold initiatives. These should include key items in operationalizing ocean best practices in practical implementations.

Pauline focused on the repository, saying this workshop had provided a highly engaged focus group addressing the repository. It was obvious from workshop comments that OBPS needs to provide more training tools for users to understand the OBPS search interface and strategies and that will be a 2020 deliverable. OBPS will be seeking beta testers in 2020 after the next upgrade of the system is launched. Areas that will be updated are a more intuitive user interface with improved prioritization of search results and the expansion of vocabularies for improved retrieval.

In conclusion, Jay pointed to the support of the OBPS across the value chain from sensors to end users. He recognized that all elements of the value chain are not uniformly engaged, and this will be taken up in planning the next steps for the OBPS.

He thanked IEEE, NSF, IOC, IODE, GOOS for their sponsorship of the meeting.

The workshop adjourned at 15:45 CET

15. Appendices

Appendix 1 – Acronyms

BP	Best Practices
CIRES	Cooperative Institute for Research in Environmental Sciences (NOAA & Univ Colorado)
DOI	Digital Object Identifier
EBV	Essential Biological Variables
ECV	Essential Climate Variables
eDNA	Environmental Deoxyribonucleic Acid
EMOS	European Marine Observing System
EOVs	Essential Ocean Variables
FAIR	Findable; Accessible; Interoperable; Re-usable [data principles]
GEOMAR	GEOMAR Helmholtz Centre for Ocean Research
GEOS	Global Earth Observation System
GOOS	Global Ocean Observing System
GO-SHIP	Global Ocean Ship-based Hydrographic Investigations
GRA	GOOS Regional Alliances
ICES	International Council for the Exploration of the Sea

IEEE	Institute of Electrical and Electronics Engineers
IMOS	Integrated Marine Observing System (Australia)
IOC	Intergovernmental Oceanographic Commission of UNESCO
IOCCP	International Ocean Carbon Coordination Project
IODE	International Oceanographic Data and Information Exchange of IOC
IOOS	U.S. Integrated Ocean Observing System
ISO	International Standards Organization
JCOMM	Joint Committee on Oceanography and Marine Meteorology
JCOMM OCG	JCOMM Observations Communications Group
JERICO	Joint European Research Infrastructure Network for Coastal Observatories
MBON	Marine Biodiversity Observation Network
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Centre
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
OBPS	Ocean Best Practices System
OCEANOBS	Ocean Observation 19 [conference]
ODIP	Ocean Data Interoperability Platform
OGC	Open Geospatial Consortium
POGO	Partnership for Observation of the Global Ocean
QARTOD	lity Assurance / Quality Control of Real Time Oceanographic Data
RCN	Ocean Observation Research Coordination Network
SAEON	South African Environmental Observation Network
SCOR	Scientific Committee on Oceanic Research
SG-OBPS	Steering Group of the Ocean Best Practices System
SOCIB	Sistema d'observació i predicció costaner de les Illes Balears
SOP	Standard Operating Procedures
TRL	Technology Readiness Level
UNESCO	United Nations Educational, Scientific and Cultural Organization
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization

Appendix 2: List of Figures

Appendix 3: References

Pearlman, Jay; Bushnell, Mark; Coppola, Laurent; Karstensen, Johannes; Buttigieg, Pier Luigi; Pearlman, Francoise; Simpson, Pauline; Barbier, Michele; Muller-Karger ,Frank E. et al (2019) Evolving and Sustaining Ocean Best Practices and Standards for the Next Decade. *Frontiers in Marine Science*, 6:277, 19pp. DOI: https://doi.org/10.3389/fmars.2019.00277

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Appendix 4: Recommendations for OBPS from other sources

• BP creation and uptake
  ○ Support BP creation and uptake
  ○ Increase OBPS visibility
  ○ Build capacity development
  ○ Enhance DOIs, metadata expansion and version control
  ○ Refine advanced search, use of links, dashboard
  ○ Discovery options and endorsement (e.g.recommended best practices)
• Governance and sustainability
  ○ Transition to IODE project under IOC
  ○ Links to major activities such as JCOMMOPS, GEO Blue Planet and others
  ○ Metrics and milestones
	Guidance from 2018 BP workshop II

• The OBPS is a sustainable scalable system for best practices, is important for ocean observing and should be capable of evolving with new technologies establish capability for community-based review for best practices • There is a need for a convergence of BPs with similar objectives • Support the ocean and applications communities in creating and applying BP including training.	**OceanObs'19 breakout recommendations**

• Transparency is essential in the dynamics of BP creation • BP are necessary due to expansion of observations and turnover of marine technicians • If two similar BP exist, then we need to have insights on which to use • More life cycle co-design is necessary (across the value chain).	**IEEE/MTS Oceans 2019 Seattle - panel**
• Expanding OBPS capabilities is the highest priority • Increasing community engagement • Including more applications • Extending linkages between BP and standards.	**Example from the survey of community - inputs for priorities during the next 3 to 5 years**

[end]