Relating Best Practices to Standardization in Ocean Science

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Abstract— **Over the past decade, the Ocean Best Practices System, hosted and maintained by the International Oceanographic Data and Information Exchange of UNESCO's Intergovernmental Oceanographic Commission, has grown to become a trusted and stable repository for all types of ocean Best Practices documentation. Given the nature of the information it contains, the repository embodies a unique resource base for supporting initiatives aimed at strengthening standardization in Ocean Science. Based on this consideration, the Ocean Best Practices System is forming a new task team to explore and evaluate the potential role that the comprehensive Best Practice information it secures could play in identifying and prioritizing processes for furthering this objective. Particular care is being taken to keep the work open and transparent through constant community engagement and by linking with international bodies/organizations dealing with measurement.**

Keywords – Best Practices, Standards, interoperability, trust

I. Introduction

A standard is a published document that establishes specifications and procedures designed to maximize the reliability of a material, product, method, and/or provided service. The use of standards helps to verify the credibility of products, technologies and services and establish that the relevant requirements of interconnectivity and interoperability are sufficiently assured. Standards fuel innovation and the development and implementation of new technologies.

Unlike a standard in the general "standardization" sense, a "measurement" standard is a realization of the definition of a quantity with a stated value and associated measurement uncertainty that is used as a reference; it can be a measuring system, a material measure, or a certified reference material. An international measurement standard is a measurement standard recognized by signatories to an international agreement that is intended to serve worldwide and can be used as the basis for assigning values to other measurement standards for the kind of quantity concerned.

On the other hand, a Best Practice (BP), broadly speaking, is a methodology that has repeatedly produced superior results relative to other methodologies with the same objective. To be fully elevated to a BP, a promising method will have been adopted and employed by multiple organizations [1]. BPs arise from a strongly perceived and shared need, and must be community-vetted to be truly effective. The implementation of standards may, and usually does, involve BP in some form or other whereas a BP may or may not incorporate a measurement standard, depending on context, conditions, and requirements.

In the field of Ocean Science, the Ocean Best Practices System (OBPS) has established itself as the leading platform for managing BPs at the global level with a trusted and stable repository carrying all types of relevant documentation. Seeing that a BP represents the distilled wisdom of a community on the best way of doing something, the content of the OBPS repository would therefore seem to be the logical place to start to develop standards in Ocean Science. Acknowledging this potential, the OBPS has decided to form a new task team to explore the feasibility of a similar undertaking. The main goal of this task team will be to evaluate the role that the comprehensive BP information secured in the OBPS could play in identifying and prioritizing processes for furthering standardization in Ocean Science.

The systematic adoption of BPs and "measurement" standards in ocean observations will be an important step towards consistently assuring the kind of high-quality data that is needed for scientific research and operational monitoring in many topical areas like climate change studies, retrospective modelling/weather forecasts and the design and operation of marine structures. Reference [2] has discussed this issue in the light of the regulations and standards of the maritime sector, following similar work done in the aviation industry for weather stations.

II. Overview of the Ocean Best Practices System

The OBPS is an UNESCO/IOC project (Fig. 1), sponsored by Global Ocean Observing System (GOOS) and the International Oceanographic Data and Information Exchange (IODE) of the Intergovernmental Oceanographic Commission of UNESCO (UNESCO-IOC). The repository is hosted by IODE. The OBPS is implementing a strategy that aims to

overcome the fragmentation endemic to Ocean Science where exchange is limited to single communities often, without much cross-community communication even in the case of similar disciplines. With a trusted and stable repository for all types of BP related documentation at its heart, the OBPS provides publication, discovery, and access to relevant and tested methods, from observation to application, as well as a foundation for capacity development and training in the use and creation of BPs for the Ocean Science community. Built to allow natural expansion, the efficient, targeted recovery of documented methodologies is assured through innovative, community-tuned search functionality that incorporates granular indexing via text-mining and ontology-based semantic search tools. The system is built upon open-source software and its capabilities have applicability for supporting diverse science disciplines.

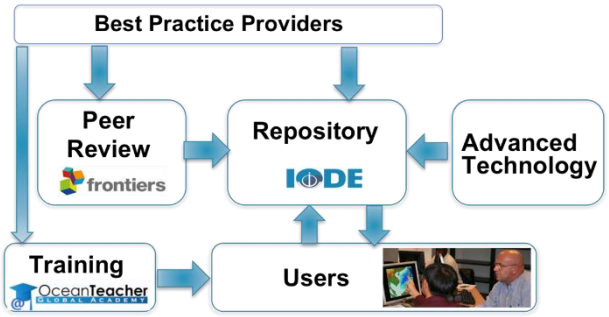

Fig. 1. Overview of the Ocean Best Practices System (OBPS).

III. Towards Standardization in Ocean Science

A. The Technology Landscape

As with all Science, Ocean Science too relies on observations to fuel its advancement, both in building and reinforcing underlying theory as well in supporting real-world applications to respond to society's needs. There are two basic categories of technology used in ocean monitoring: (1) the platform from which an observation is made such as a research vessel, a fixed observatory or station, or an unmanned automated vehicle; and (2) the actual instrument or methodology used to obtain the observation, usually in the form of a measurement, such as those provided by a Conductivity-Temperature-Depth (CTD) probe or a chemical analysis of a water sample. More and more, there is a tendency to move away from traditional operator-based approaches to completely autonomous solutions with minimal human intervention.

B. The Emerging Trend in Ocean Data Quality

Evidence-based policies help people make well-informed decisions about policies, programs, and projects by putting the best available evidence from research at the heart of policy development and implementation [3]. How can we get the best evidence in ocean research? Obviously, from systematic and long-term routine measurements of ocean variables, and possibly the rapid transmission of measurement results to permit timely interpretation and dissemination. Data coming from measurements underpin everything we know about the oceans, how they work, and how they interact with other Earth systems. Data of unknown or questionable quality undermines knowledge, weakens evidence, and ultimately lead to poor outcomes. Reliable ocean observations require sustained quality assurance (QA) effort. QA practices are essential because they help to certify the quality of generated data and provide supporting information and procedures to attest their credibility and value from diverse relevant perspectives: accuracy, resolution, sensor calibrations and checks, dates and times, deployment and maintenance intervals, process records, QC routines, etc. [4].

At a high-level, data quality is now beginning to be construed as 'fitness for purpose', i.e., is a data set good enough for what one wants to use it for? This shift in emphasis to "fitness for purpose" has a number of implications:

- the quality of data can no longer be viewed merely in terms of the characteristics of a measurement result (accuracy, precision, etc.);
- defining the needed quality of data will vary depending on how it will be used;
- the number of "data quality dimensions" that must be selected to assess the quality of data should be sufficient to describe its usability with respect to requirements.

In this new vision for ocean data (Fig. 2), standards will be essential as they establish trust in outcomes and permit technology and people to work seamlessly to meet expectations. Standards, furthermore, can provide a common language to measure and evaluate performance, make interoperability possible, and assure users and stakeholders that they are getting value for money - all valuable benefits viewed from the perspective of today's distributed marine "observatories" and global ocean observing networks. Finally, experience from other sectors have shown that the use of standards can drive invention and improvement leading to advancements in research and technological innovation.

Fig. 2. Core dimensions of a Data Quality framework underscoring "fitness for purpose" [5]

C. Some pertinent conceptual distinctions

– *Best Practices*

A Best Practice (BP) shall be intended as an ocean observing methodology that has repeatedly produced superior results relative to other methodologies with the same objective, and is already widely adopted and employed.

– *Measurement Standards*

A measurement standard will refer to a realization of the definition of an ocean observable with a stated value and associated measurement uncertainty that can be used as a reference; it could be a measuring system, a tangible measure, or a certified reference material traceable to the international system of measurement embodied by the Bureau International des Poids et Mesures (BIPM) and National Metrological Institutes (NMIs).

– *Technical Standards*

A technical standard will be a published document established by consensus within the ocean observing community and approved by a recognized standards body that sets down specifications and procedures designed to maximize the reliability of ocean observations and enhance the quality of any services or products derived from them.

A technical standard is to be construed as a strong recommendation, and adhesion may not necessarily be a requisite for a specific application.

– *Technical Regulations*

A technical regulation will be a document which will lay down the characteristics expected of technologies or methodologies - including provisions dealing with terminology, symbols, units, and marking or labelling requirements where called for - when they are being employed for observing the Ocean. Unlike a technical standard, compliance is to be considered mandatory for a technical regulation.

D. The OBPS as an Enabler of Standardization in Ocean Observing

In addition to its traditional role in research, Ocean Observing is increasingly being recognized as a fundamental pillar of Climate Science and an essential activity in the battle for the sustainable stewardship and development of the marine environment. Ocean observing actions are undertaken for various reasons and employ a variety of platforms from which equipment or sensors are deployed to measure variables of interest.

The technologies and methodologies employed in Ocean Observing are improving rapidly and constantly. Understanding the implications of using these technologies and methodologies and ensuring that any transitions or integrations involving them go smoothly and can be properly managed remains a crucial challenge that can only be addressed through standardization. But standards specific to Ocean Observing are still lacking to a great extent. The few standards that are encountered largely tend to be those implicitly ingrained in the technologies themselves or are ones that relate to general management.

Standards are not the same as BPs though, like BPs, their development is a consensus-based process. A standard has been described as "a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context" [6]. Ideally, it will be formulated on the basis of collective knowledge coming from science, technology and experience relevant to the subject of the standardization effort, with a view towards promoting the highest achievable level of benefit to the community or communities that will be affected. BPs and standards differ in at least five important ways:

- BPs lack the formal endorsement by acknowledged authority required of standards;
- BPs are more limited in scope compared to standards, often dealing with a very specific aspect (or, at best, a circumscribed set of aspects) of some particular activity (or the results thereof);
- Standards have a broader impact than BPs in terms of the number of communities they have the potential to influence (enhancing crosscutting);
- Standards tend to be more comprehensive, meaning that they usually include "added value" elements, like safety, environmental and climate change considerations, for example, that are overlooked when redacting BPs.
- Standards can incorporate provisions for their review, revision, suspension and discontinuation.

Despite the differences, BPs do resemble standards in that they both describe how best to do something. This underlying similarity makes them ideal building blocks for framing standards.

The OBPS is a global, sustained system comprising technological solutions and community approaches to enhance management of methods as well as support the development of Ocean Best Practices. It has no power to initiate standardization of any kind or issue standards on its own. But, because of its singular role as the global repository for Ocean Best Practices, the OBPS has within its power the means to help identify gaps in the continuum of needed standards and to help further processes of standardization in Ocean Observing. This can include support for the development of innovative physical (material) reference standards for areas of study in the field where these are known to be needed (Fig. 3).

At the moment, given the nature of the material contained in the OBPS archive, the following main areas have been identified as those most promising for exploring possibilities for creating standards:

a) Expositions of methodologies of measurement for specific ocean variables, with an emphasis on Essential Ocean Variables (EOVs) and Essential Climate Variables (ECVs);

b) Expositions of procedures for testing performances of specific devices, apparatuses or systems associated with Ocean Observing,

comprising operating characteristics and safety requirements;

c) Recommendations reflecting current state-of-the-art in the application of design and engineering principles to Ocean Observing technology;

d) Defining indicators which can reflect the maturity of operational implementation of best practices and standards

e) Lists of terms, definitions, or symbols, applicable to Ocean Observing.

The actions coming under a, b, d and e will deal predominantly with measurement and marine observations. Accordingly, to cover the purely metrology aspect, the European Metrology Network (EMN) for Climate and Ocean Observation will be approached and asked to participate in the newly forming OBPS task team on standards. This is a network of EURAMET, the European association of National Metrology Institutes (NMIs), and hence a link to the international system of measurement embodied by the Bureau International des Poids et Mesures (BIPM). Similarly, to cover the marine observations side, every effort will be made to include task team representatives from relevant programmes of the World Meteorological Organization (WMO) and other intergovernmental marine science organizations like the International Council for the Exploration of the Sea (ICES) and UNESCO-IOC as well as single universities and marine research institutes. The actions b and especially c will require expertise on standardization that will be tapped by linking with recognized standardization bodies like the International Organization for Standardization (ISO) and the Institute of Electrical and Electronics Engineers (IEEE).

The emerging OBPS task team will be focusing on the key aspects of transition from BPs to standards through addressing items a through e above. The evolution is not simply one way. Once a standard is created, best practices may be defined for consistent implementation of the standard. In this way, best practices and standards are strongly inter-related through a methodology life cycle. The logic underlying this cycle will be considered by the task team as needs for approaches to further interoperability, trust and the reduction of uncertainties are an essential part of an effective global ocean observing system

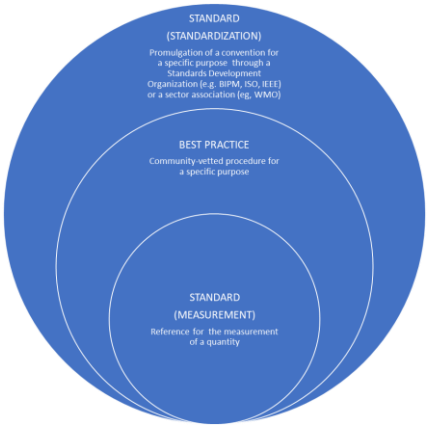

Fig. 3. The interplay of Best Practices and Standards.

IV. Conclusions

Over the past decade, the Ocean Best Practices System, hosted and maintained by the International Oceanographic Data and Information Exchange (IODE) of UNESCO's Intergovernmental Oceanographic Commission (IOC - UNESCO), has grown to become a trusted and stable repository for all types of ocean Best Practices documentation. Given the nature of the information it contains, the repository embodies a unique resource base for supporting initiatives aimed at strengthening standardization in Ocean Science. Based on this consideration, the Ocean Best Practices System is forming a new task team to explore and evaluate the potential role that the comprehensive Best Practice information it secures could play in identifying and prioritizing processes for furthering this objective. Particular care is being taken to keep the work open and transparent through constant community engagement and by linking with international bodies/organizations dealing with measurement (e.g., EURAMET, BIPM), standards (e.g., IEEE, ISO) and marine observations (e.g., WMO, ICES, UNESCO-IOC)

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