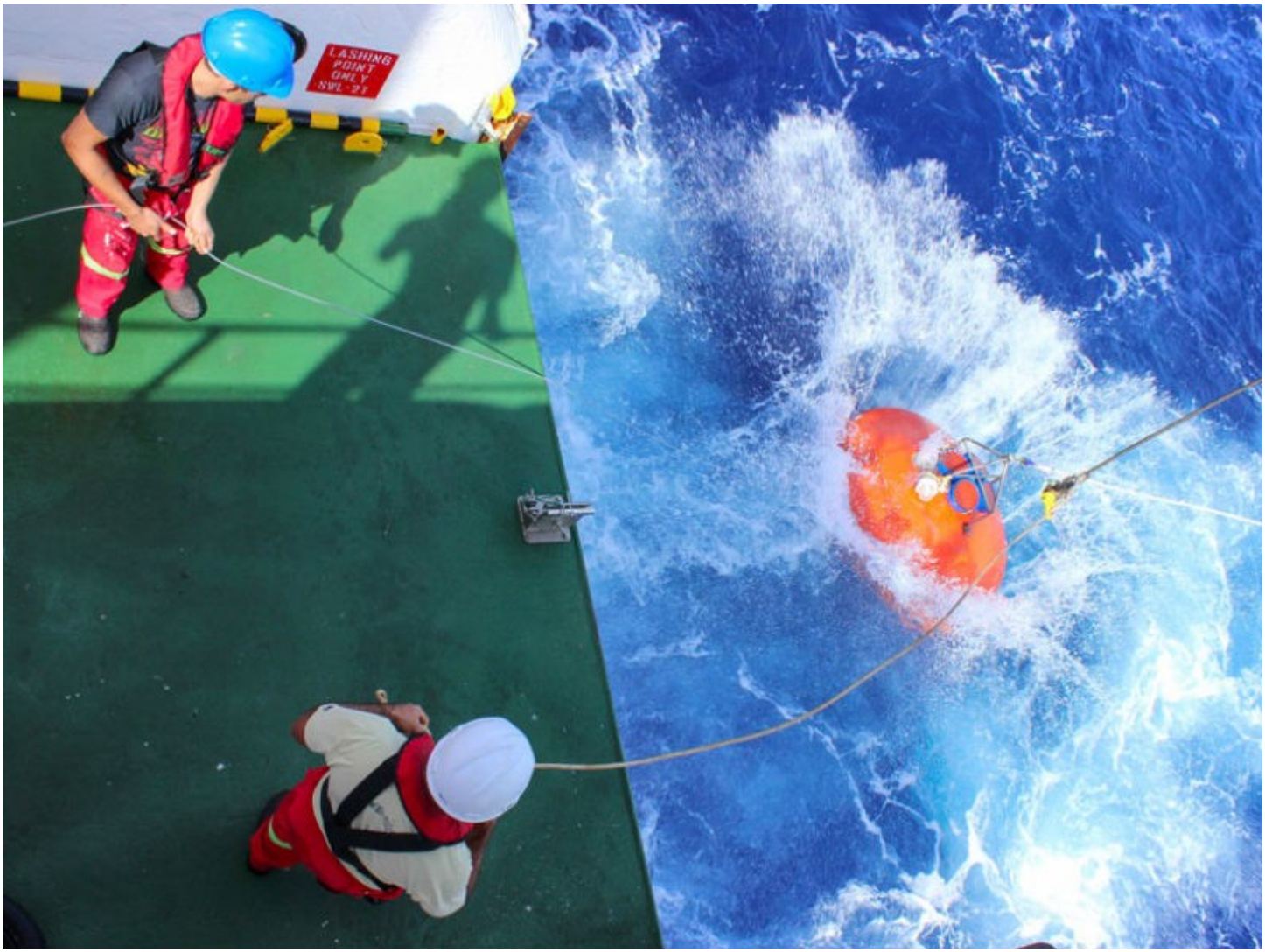
Planning a Sustainable Future for Earth's Oceans

Ocean experts are engaged in a long-term effort to envision, develop, and implement best practices for meeting today's needs while preserving ocean resources for future generations.



Technicians on board the R/V *Algoa* in 2015 deploy oceanographic instrumentation along the Agulhas System Climate Array to provide long-term observations of the Agulhas Current, a western boundary current of the southwest Indian Ocean. Credit: Jarred Voorneveld

By Jordan Van Stavel, Johannes Karstensen, Juliet Hermes, and Jay Pearlman 25 August 2020

Not long ago, I (J.V.S.) found myself, as an early-career scientist, saying yes to participating in a research cruise and collecting oceanographic data without having any prior experience in

oceanography. Fortunately, my supervisor at the time put me at ease when she pulled out a trusty handbook of best practices for seagoing data collection and told me I'd be fine if I followed them.

I have since participated in many more oceanographic cruises and trained numerous students using that handbook, so I understand just how essential easily accessible and reliable best practices are, and I value the efforts of the experts who compile them. In that regard, it is equally important to acknowledge and ensure that guides of best practices are updated and improved upon as technology advances over time.

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Humans and wildlife are threatened by many global challenges, not the least of which is the loss or contamination of resources from Earth's oceans. Sustainability requires finding ways to benefit from the resources that our oceans offer while ensuring that these resources are also available to future generations. The path toward sustainability is complicated, however, by the sheer number of interacting forces in the oceans and the unpredictable results of altering these forces.

A combination of senior experts and young professionals from the ocean science community met last December to consider the status of best practices and common methods in ocean research. They also developed a vision and plans that include means to evolve these practices, and they provided suggestions on how an Ocean Best Practices System (https://www.oceanbestpractices.org/) (OBPS) for the community can be improved.

This work is part of an ongoing effort by an OBPS international steering group to address issues related to ocean resource sustainability through a framework set by the United Nations' 17 Sustainable Development Goals (https://www.un.org/sustainabledevelopment/sustainable-development-goals/) (SDGs) [*United Nations* (https://doi.org/10.18356/55eb9109-en), 2019]. In addition to "life below water" (SDG 14), four SDGs are closely linked to the ocean: food security (SDG 2), human health (SDG 3), sustainable consumption and production (SDG 12), and climate change (SDG 13) [*Wackernagel et al.* (https://doi.org/10.3389/fenrg.2017.00018), 2017; *United Nations* (https://doi.org/10.18356/55eb9109-en), 2019].

Each SDG is linked to targets, which in turn are evaluated through suitable indicators. The details of the respective indicators are complex, but ultimately, we need two things to measure our progress toward these goals. The first is data that are interoperable (https://eos.org/editors-vox/enabling-findable-accessible-interoperable-and-reusable-data) and can be exchanged easily among various platforms. The second is knowledge of how much uncertainty is inherent in data from sensors operating on various ocean-observing platforms around the world.

A Need for Ocean Best Practices

To improve data interoperability, we need well-defined, well-documented, widely accepted, and reproducible ocean-observing practices (https://eos.org/meeting-reports/whats-the-best-way-to-responsibly-collect-ocean-data) [*Pearlman et al.* (https://doi.org/10.3389/fmars.2019.00277), 2019]—a set of ocean best practices. "Best practices" define the current state of knowledge for "a methodology that has repeatedly produced superior results relative to other methodologies with the same objective" [*Simpson et al.* (https://doi.org/10.25607/OBP-436), 2019, p. 8]. For example, methodologies that are well demonstrated for the given objective, documented and peer reviewed, and commonly used by more than one organization would rate highly. Of course, efforts to constantly revise and improve best practices are inherent in the term "best."

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Ocean best practices go beyond instrument handling or calibration, however, to cover the entire ocean-observing value chain, from observations to applications and societal impacts [*United Nations Educational, Scientific and Cultural Organization* (https://doi.org/10.5270/OceanObs09-FOO), 2012]. The success of the ocean-observing value chain inevitably plays a role in our ability to deliver the SDG target indicators and, ultimately, to achieve the related SDGs.

Operational and research-related oceanographic activities form the foundation of the ocean-observing value chain and require careful structuring to ensure their efficiency, coherence, and coverage. Community-agreed ocean best practices improve coordination between multi-institutional projects and provide consistency across the board in areas of research with similar sampling objectives. This coordination and consistency will improve our ability to acquire high-quality information to inform ocean forecasting over various time and space scales [*Pearlman et al.* (https://doi.org/10.3389/fmars.2019.00277), 2019].

Scientists and technicians working at the major global ocean-observing networks and platforms have agreed on the imminent need to update and sustain ocean best practices to ensure superior quality data collection. This agreement led to the inception of the United Nations Educational, Scientific and Cultural Organization/Intergovernmental Oceanographic Commission (UNESCO/IOC) Steering Group for the OBPS, which is hosted at the IOC Project Office for the International Oceanographic Data and Information Exchange (IODE) in Oostende, Belgium.

The OBPS comprises three main components: a persistent document repository (https://www.oceanbestpractices.org/repository/) with enhanced discovery and access capabilities [*Buttigieg et*

al. (https://doi.org/10.23919/OCEANS40490.2019.8962680), 2019], a peer-reviewed research topic (https://www.frontiersin.org/research-topics/7173/best-practices-in-ocean-observing) in the scientific journal *Frontiers in Marine Science*, and training approaches leveraging UNESCO's OceanTeacher Global Academy (https://www.iode.org/index.php?option=com_content&view=article&id=431&Itemid=100177) and social media [*Pearlman et al.* (https://doi.org/10.3389/fmars.2019.00277), 2019]. Through such technological solutions and community approaches, the OBPS enhances the management of methods and supports the development of ocean best practices.

One example of a widely reviewed and globally adopted compilation of ocean best practices, currently available from the OBPS repository, is the Global Ocean Ship-based Hydrographic Investigations Program Standard Operating Procedures for ship-based observations, which is a compilation of detailed instructions for high-quality collection and analysis techniques of several oceanographic and biogeochemical ocean parameters [*Hood et al.*, 2010 (https://repository.oceanbestpractices.org/handle/11329/373), 2019 (https://doi.org/10.25607/OBP-833)].

Making Best Practices a Reality

Creating and using best practices present a variety of challenging questions. A few of these include the following:

Are the best practices region specific or universally applicable?
Are they cost-effective?
Are they recognized and agreed upon by an international community of experts?
Have they been repeatedly used by the community?

To assist in creating best practices, the OBPS has provided a set of templates (https://repository.oceanbestpractices.org/) and is also introducing an endorsement process whereby specific methods or measures can be selected and nominated by an internationally recognized, established ocean-observing community and promoted as representing that community's current best practice. This endorsement system is currently implemented via the Observing Coordination Group and in dialogue with three Global Ocean Observing expert panels.

New users of a best practice might come across issues with the clarity of concepts or in some of the steps involved. The OBPS, therefore, encourages that best practice creators also upload training information or videos to support the best practice.

To address some of these challenges from an observing community perspective, the third in a series of Evolving and Sustaining Ocean Best Practices workshops was held last December at the IOC Project

Office for IODE.

Each session included a wide range of input from community members; in addition to general remarks, they provided technical and practical updates on institutional involvement, all of which contributes to the future of ocean best practices and the OBPS. To fully understand the requirements of the OBPS users in the observing community, workshop discussions covered outcomes and guidance from previous workshops and conferences, a community survey from July 2019 that consisted of 423 responses from 66 countries, and the SDGs [*Simpson et al.* (https://doi.org/10.25607/OBP-436), 2019].

Addressing the Issues

A vision for the next decade of the Ocean Best Practices System (OBPS) stresses "agreed and broadly adopted methods for every activity in ocean observing from research to operations to application." A few of the main concerns highlighted during the workshop were the limited awareness of existing practices across global ocean-observing networks and platforms; the lack of advanced techniques to make discovery easy; missing incentives to drive community building; the need for capacity development in ocean observing through sharing, training, and uptake of best practices; and the lack of a community-accepted process for accessing best practices [*Simpson et al.* (https://doi.org/10.25607/OBP-788), 2020].

Workshop participants accounted for all of these factors to produce a vision for the next decade of the OBPS. This vision of having "agreed and broadly adopted methods for every activity in ocean observing from research to operations to application" [*Pearlman et al.* (https://doi.org/10.3389/fmars.2019.00277), 2019] guides the technical and social aspects (https://eos.org/opinions/ocean-observations-for-everyone) of the community effort required to advance toward broad interoperability with the use of best practices [*Simpson et al.* (https://doi.org/10.25607/OBP-788), 2020].

Two polls provided participants with opportunities to offer input from these discussions. The first poll integrated the outcomes of workshop panel discussions and flagged four key attributes within the OBPS on which the vision should focus. Participants ranked these attributes to establish priorities for improving the OBPS:

the OBPS portal/interface
outreach and communication
capacity development
synthesis and development of standards

The Panel on Best Practice Vision for the Decade then reviewed recommendations to identify six

means to support the decadal vision, which were ranked during a second poll:

creating a document outlining principles of what makes a best practice, essentially a guide to the "best practices for best practices"
proposing to editors of peer-reviewed journals that their publications cite best practices when publishing papers, to focus on the initiative to make science more reproducible
creating a community forum for the OBPS to promote the discussion on methods
expanding outreach and communications activities
initiating a pilot project on synthesis of best practices
creating a broader initiative to promote capacity development and integrate the varied methodologies currently in use (e.g., online training courses, shipboard training on research cruises or visiting fellowships)

For this vision to manifest, the panel recommended that these priorities and directions be shared with the ocean-observing community to display how the operational OBPS is evolving to meet user needs [*Simpson et al.* (https://doi.org/10.25607/OBP-788), 2019].

The Way Ahead

Workshop participants settled upon a trio of strategic objectives as a way forward over the next decade. Proceedings from the workshop (https://repository.oceanbestpractices.org/handle/11329/1273) expand on the full recommendations for the direction of the OBPS, but briefly, the organization should do the following:

sustain its globally recognized and trusted system for the promotion, enhancement, visibility, and use of ocean best practices and standards
be responsive to community needs by curating this system for easy and effective development, use, and dissemination of ocean best practices and standards that are fit for purpose
catalyze the adoption and creation of ocean best practices and standards through various means such as community engagement and capacity development

The OBPS developers strongly encourage members of the ocean research community to become involved in this process as an advocate for the OBPS, by contributing best practices, or by contributing to emerging capacity development activities. The upcoming Evolving and Sustaining Ocean Best Practices IV (https://www.oceanbestpractices.org/events/evolving-and-sustaining-ocean-best-practices-iv/) workshop, which will be held virtually from 18 to 30 September, offers another opportunity for ocean practitioners to collaboratively address best practices as well as recommendations for the OBPS to meet community needs. Outcomes of the workshop will guide the next implementation phase of the

OBPS.

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Citation: Van Stavel, J., J. Karstensen, J. Hermes, and J. Pearlman (2020), Planning a sustainable future for Earth's oceans, *Eos, 101,* https://doi.org/10.1029/2020EO148206. Published on 25 August 2020.