GLOBAL OCEANS:
An Adaptable & Scalable Oceanographic Research Platform Model

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GLOBAL OCEANS: AN ADAPTABLE AND SCALABLE OCEANOGRAPHIC RESEARCH PLATFORM MODEL

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Abstract

The need for a full complement of oceanographic research assets and infrastructure to address critical environmental and societal issues relating to our oceans has been well-defined by a number of US Federal agencies. Global Oceans presents here a new model for optimizing the short-term charter of non-research vessels for scientific research to fill infrastructure gaps and augment existing resources.

The distinguishing qualities of this model are that it is both Adaptable to the science needs of each cruise and Scalable globally, including to remote and understudied geographic regions. It is demonstrated here that the Global Oceans model accomplishes these objectives in a way that is functionally and operationally on par with dedicated research vessels.

1. INTRODUCTION & BACKGROUND

The importance of sustaining a full complement of oceanographic research infrastructure assets that will enable the US to meet a range of critical scientific and societal objectives is emphasized in a recent report[i] published by the Committee on an Ocean Infrastructure Strategy for U.S. Ocean Research in 2030, of the National Research Council, which states:

"The ability to observe, understand, and predict changes to the environment, such as the climate system, ocean chemistry, ecosystems, and the water cycle, requires a comprehensive array of ocean infrastructure. Importantly, these problems demand capacity at both global scales and regional scales, to examine areas of high stress (e.g., coastal zone) or rapid change (e.g., Polar Regions). Environmental stewardship demands the full array of present capabilities in the ocean sciences and is a major impetus for needed improvements in both sensor and sampling capabilities to meet needs in 2030."

The report further emphasizes that "the most essential infrastructure component will continue to be the ability for scientists to go to sea aboard research vessels".

We suggest here that the overarching requirements embodied in the recommendations formulated by this Committee in order for the US to meet current and future challenges in this context are essentially twofold: 1) that ocean scientists must retain, and indeed expand, their capacity to conduct research at sea, both regionally within US waters and coastlines, and globally in open ocean, remote and Polar regions; and 2) that a critical component of that capability is a high quality and sufficiently available array of sampling, measuring and analytical instrumentation and tools that will capture the data needed to understand these environmental changes.

We will simplify these dual needs further by defining them by the following terms; oceanographic resources must be "Adaptable", i.e. correctly brought to bear for each scientific objective, and "Scalable", i.e. able to be effectively projected anywhere geographically that they are required. The greatest challenge, we suggest, is to achieve both of these ends simultaneously in the context of currently available resources and in a way that is cost-effective and non-capital intensive.

This paper outlines how Global Oceans, a US-based nonprofit 501c3 organization, is designed to support ocean science research along these two axes and why the integration of Global Oceans as a non-Federal partner with the IOOS will be of benefit.

2. TECHNICAL AND USER REQUIREMENTS

2.1 **Offshore Service Vessels as Adaptable Platforms**

In a fully robust research vessel program, meeting the need for data acquisition across the span of oceanographic disciplines; across the full vertical ocean depth profile; and within geographically remote and environmentally variable study regions, requires a wide range of ship configurations, equipment and on-board support.

For global operations in non-US and remote regions, additional complexity is added by requirements to coordinate operational and science teams; ensure control and security of science assets; and mitigate risks associated with unanticipated logistical factors. Given this operating environment, the strategy for achieving scalability with the Global Oceans platform model relies on the type of vessel we have chosen to utilize and a standardized process for its conversion into a temporary research platform.

Offshore Service Vessels, including Platform Supply Vessels (PSVs), Anchor Handling Vessels (AHTSs) and similar service vessel configurations, are viable platforms from the standpoint of deck space and configuration, adaptability for research work and seakeeping performance (Figure 1).

The reliable and sufficiently widespread availability of these vessels globally for short- or long-term engagement in proximity to the scientific study area facilitates execution along the "Scalable" dimension of our model. Figure 2 illustrates the global distribution by region of this vessel type indicating the wide scope of this vessel pool. Our research indicates that 10% - 20% of the global fleet is available at any given point for short-term charter, representing a perpetual selection pool of between 275-550 vessels worldwide.

Figure 1- Platform Supply Vessel

Logistical and configuration optimization (e.g. containerized laboratory placement, supplemental quarters, redundant power and other systems) of this standard platform can then be replicated across this large global vessel pool, resulting in improved cost control and rapid expedition deployment regardless of operating theater and the individual vessel chartered (Figure 3).

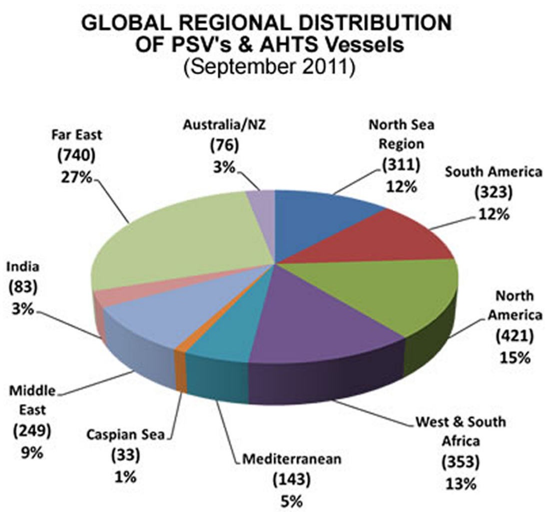

Figure 2 – Global Vessel Distribution[ii]

Once this model is offered to the operating community of IOOS agencies as a standalone resource, then user access and planning integration becomes a function of the scheduling process and user planning interface. The distributed nature of planning and resource use among Federal agencies is compatible with this approach and, in our view, would benefit from both a planning and cost-benefit standpoint by aggregating multiple, agency-specific needs and technical requirements across single cruise-specific platforms.

Figure 3: Configured Global Oceans Platform

2.2 **Mission-Adapted Containerized Laboratories**

The utilization of containerized laboratories that can be economically shipped by conventional carriers to any global port and securely attached and powered on deck is fundamental to the feasibility of the ship-conversion model proposed here. In order for these facilities to contribute to adaptability and scalability, certain conditions must be met: suitability for intended use; safety for use at sea; and their degree of availability. Let's examine these factors.

Global Oceans utilizes an existing fleet of containerized steel-shell units which meet the certification requirements of ABS and USCG for human habitation when placed on vessels at sea (Figure 4). Laboratories are engineered with appropriate power supply and distribution, clean power, lighting, waste management, water and gas supply, HVAC and emergency escape. Power and HVAC control systems are redundant. International certification from DNV, IMO, SOLAS and Lloyds on every unit ensures approval for worldwide use. Units are safety-rated by ABS for a double-stacked configuration on the high seas.

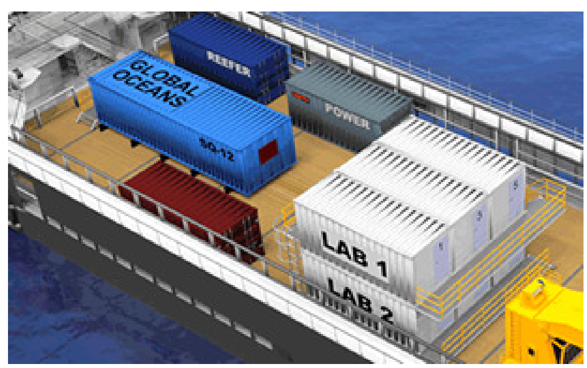

Figure 4 – Containerized Laboratories on Deck

Containerized laboratories also facilitate the segregation of functional use with independent environmental and contamination control (Figure 5). A biological wet lab can be equipped with aquaria and temperature control different from the HVAC requirements for chemical analysis with GC-Mass Spec and other instrumentation.

Clean labs with air filtration and entry protocols can be supplied for trace metals analysis. Dedicated computer and data feed workstations maintain their own humidity controls, external cable management and satellite uplink capabilities. Microbiology labs may require anaerobic biological hoods, cold storage to -80°F and ambient temperature control.

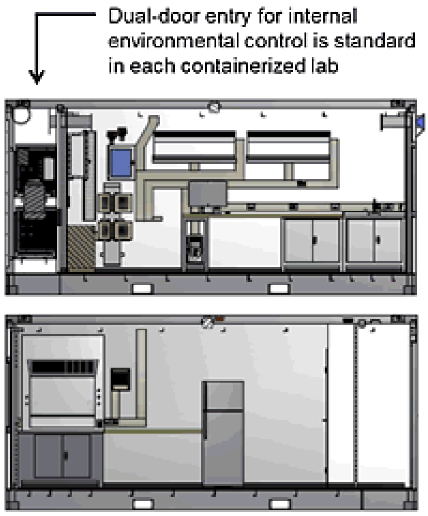

Figure 5 – Containerized Laboratories (Internal View)

Existing labs available for scheduling are drawn from a standing facilities fleet of several hundred units routinely utilized by the oil and gas industry on stationary drilling platforms and vessels, and maintained in eight global locations all no more than three weeks away from any departure port. These units are rented for the duration of each expedition then returned to the supplier's fleet pool.

Global Oceans has enabled additional adaptability for multidisciplinary use of these labs with a modular design concept which allows rapid re-configuration of workspace and infrastructure requirements as requested by each principal investigator. Unitized workstation "pods" with sinks, fume and biological hoods, reagent storage, recirculating holding tanks and instrument stations are being designed by Global Oceans for this purpose.

The resulting system is therefore both Adaptable and Scalable and contributes to the ability of the entire model to respond to the geographic limitations of current resources and to cost-effectively expand the research infrastructure footprint.

2.3 **Expanding Access to Instrumentation**

It is common for oceanographers to bring their own analytical instrumentation with them on research cruises for setup in the ship's laboratory. Global Oceans' strategy for supporting analytical research is first to make available appropriate and plentiful workspace for instrumentation in a temperature- and humidity-controlled environment. Second, it is to provide all of the necessary power, supplies, reagents, fluids, gases and waste management necessary for the operation of each PI's equipment. This support is built into our planning and inquiry process for laboratory configuration and instrument support.

However there is another trend becoming evident from our discussions with researchers and research operations managers: the desire for a broader array of analytical instrumentation to be made available and folded into the larger complement of choices for in-field research support. One knowledgeable source commented that "My own belief is that we're on the tail end of about 20 years of PI-specific instrumentation, and are now in a good position to define the next generation of standardized on-board equipment."[iii]

To meet the need for analytical instrumentation Global Oceans has partnered with leading suppliers to develop customized programs for short term use and return of instruments on Global Oceans expeditions, including GC/Mass Spec, LC/Mass Spec, ICP/Mass Spec, GC/IRD/Mass Spec, seawater-compatible TOC analysis and others. Partnerships have been established with GE, Perkin-Elmer and Agilent Technologies. Delivering calibrated state-of-the-art instrumentation and assay supplies to each expedition vessel, installed in custom configured containerized labs, will enable more research, more cost-effectively.

2.4 **ArcGIS Data Analytics Tools**

Esri, Inc. (Redlands, CA), a leading GIS software provider, is working with Global Oceans to provide each laboratory computer workstation on board expeditions with installed ArcGIS for Desktop Advanced software systems, providing a complete set of tools for basic mapping and advanced analysis, data creation and visualization on Windows desktop, or on Macs running a Windows emulator such as VMware Fusion, Parallels or Boot Camp. ArcGIS easily imports and exports Google Earth KML.

Data collected at sea can be moved from existing formats into an Arc Marine geodatabase utilizing ETL (Extract, Transform and Load) tools installed in each system – which satisfies the requirements of the NSF's Rolling-Deck-To-Repository (R2R) project for data archiving and public access.

In addition, ArcGIS Online provides a free cloud-based, collaborative content management system for maps, apps, data, and other forms of public access to geospatial information. Utilizing these ArcGIS tools, scientists can query their data, perform analysis and build maps during the expedition.

As a standardized resource that can be integrated across any infrastructure configuration this GIS data processing, formatting and archiving capability will contribute to the adaptability of Global Oceans platforms to multiple projects and science needs.

2.5 **GO-CEPT Expedition Planning Tool**

Global Oceans and the McClintock Lab at the University of California, Santa Barbara (UCSB) are developing a new GIS-enabled mapping and planning tool built on the Sea Sketch platform and Esri's ArcGIS software called the Global Oceans Collaborative Expedition Planning Tool (GO-CEPT).

GO-CEPT will allow participating science teams to collaborate in advance on designing an optimal multi-project cruise track that will support the needs of each project on an expedition. GO-CEPT integrates a forum-based online environment with interactive mapping tools and GIS map layers, together with analytics and reporting tools that model resource allocation and cost variance against changes to the expedition plan and cruise track.

2.6 **Boeing's "*Echo Ranger*" Autonomous Underwater Vehicle (AUV)**

Global Oceans and Boeing's Unmanned Underwater Systems Group in Huntington Beach, CA are in continuing discussions to develop a structured approach to offering the ocean science community the use of Boeing's AUVs coupled with the Global Oceans deployment platform for scientific research, beginning with Boeing's existing *Echo Ranger* AUV. The Global Oceans/*Echo Ranger* package will include technical and logistics support from Boeing, including on-site support.

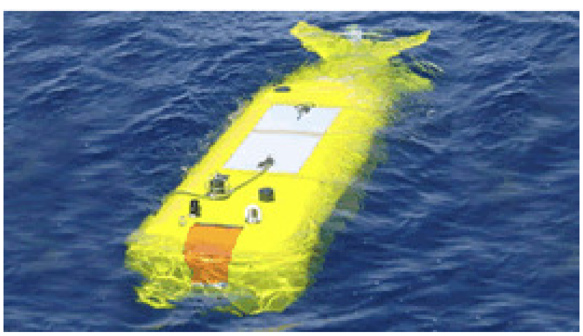

Figure 6 – Boeing AUV *Echo Ranger*

Echo Ranger's ability to be containerized and shipped globally to any expedition departure port, together with the large deck space and heavy-duty crane/lift capacity available on platform supply vessels provides a workable scenario for deploying *Echo Ranger* at sea.

Echo Ranger (Figure 6) is a large-diameter, 18.5' length AUV designed to execute multiple data acquisition tasks including water sampling, measurement of ambient physical parameters and acoustics mapping. PI-designed equipment can be added to interior ports or attached externally to facilitate a wider range of measurements. *Echo Rangers'* 10,000 foot depth rating and 80 mile horizontal range will provide an additional tool for short-term mission deployment and retrieval in coastal, Polar and open ocean regions from Global Oceans' platforms.

Global Oceans and Boeing believe that *Echo Ranger*, in addition to future new undersea research vessels manufactured by Boeing and made available through Global Oceans, will be a valuable addition to ocean science over the next several decades.

3. INTEGRATION WITHIN IOOS

The operational model for acquiring expedition-specific ship platforms for research is usefully enabled within the IOOS structure by the following:

- The ability by Global Oceans to provide a single user interface that will coordinate the shared use of platforms across IOOS member agencies
- The ability to provide supporting research assets, including working labs and equipment, which facilitate scientifically useful ship conversion
- A functional scope of resources that are able to measure and observe all 26 core IOOS variables that can be observed from a research vessel
- Global Oceans' capability for ensuring data standardization, formatting and archiving as required by DMAC and NSF's Rolling-Deck-to-Repository (R2R) protocols

The foregoing capabilities described in this paper are important components of the Global Oceans model and represent resources which fulfill the objective of delivering a system that is both Adaptable and Scalable, and therefore of adding value to the larger set of IOOS research infrastructure.

4. THE WAY FORWARD FOR THE NEXT DECADE

The model elucidated here is one that can be sustained and strengthened over time and is one which in our view can indeed be the way forward for the next ten years and beyond. We look forward to helping define agency-specific needs in the context of Global Oceans' capabilities and to formulating a plan for implementing an appropriate IOOS user interface for planning and project execution.

5. CONCLUSION

The Global Oceans model of expanding ocean research capability with an Adaptable and Scalable platform that does not require new capital investment for additional infrastructure, coupled with the cost-benefit advantage that comes with well-coordinated sharing of resources across agencies, will deliver significant value to the IOOS network of Federal agencies.

References

[i]"Critical Infrastructure for Ocean Research and Societal Needs in 2030" (National Academies Press, 2011)
[ii] Adapted from "Global Support Vessel Monthly: Offshore Research Report", October, 2011.
[iii] Rick Spinrad, VP of Research, Oregon State University, personal communication, February, 2012.

For additional information visit: www.global-oceans.org