SMART OCEAN/SMART INDUSTRIES: SCALING UP OF OCEAN DATA COLLECTION BY INDUSTRY

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Abstract

The World Ocean Council has launched the "Smart Ocean/Smart Industries" program - a global, multi-sectoral portal for coordinating ocean industry efforts to collect oceanic and atmospheric data. Smart Ocean/Smart Industries is a major new initiative and opportunity for industry leadership in contributing to the long term understanding, health and management of the ocean. The program will provide the structure and process for facilitating scientific community collaboration with industry in collecting data that: a) contributes to describing the status, trends and variability of ocean and atmosphere conditions and b) improves the understanding, modeling and forecasting of ocean ecosystems, resources, weather, climate variability and climate change. The program will ensure that voluntary observation efforts by shipping, oil/gas, fisheries, offshore renewable energy and other ocean industries is coordinated, efficient, cost effective and is integrated into national and international observation programs. The unique multi-sectoral basis of the program creates significant opportunities for synergies and economies of scale, e.g. in sensor development.

Key words: observing, operational oceanography, organization, international coordination, industry

1. VOLUNTARY OCEAN AND ATMOSPHERE OBSERVATIONS

The need for improved understanding of the physical, biogeochemical and ecosystem properties of the ocean, marine meteorology and ocean-atmosphere interactions has never been greater. The drivers for this include the need to: better understand and model the ocean's role in climate change; document how the marine environment is responding to climate change, e.g. increased storm frequency and intensity, ocean acidification; address the impacts on marine ecosystems, biodiversity and resources of the increased use of marine space and resources by a growing number and kind of commercial activities; ensure ocean ecosystems maintain their optimal capacity to sequester "blue carbon".

Shipping and other ocean industries (e.g. offshore oil/gas, fisheries, aquaculture, offshore renewable energy) are exposed to increased risk and uncertainty from changes in ocean conditions and climate and the inability to accurately model and predict these changes. The lack of data for much of the ocean, especially in the high seas and the atmosphere above the open ocean, contributes to this risk, especially as the effects of climate change becomes more evident.

Data gathered from observing the state and composition of the oceans and atmosphere supports safe and sustainable use of marine space and resources in numerous ways. Maritime transport accounts for about 90% of global commerce. Shipping is critically sensitive to marine weather and climate. Improved data, modeling and predictability supports safe and economic sea transport for sustainable development. Natural disasters take an increasingly large human and economic toll. Impacts on coastal areas from tropical cyclones, storm waves and storm surges can be better understood with improved data that lead to better forecasts and warnings. Marine and metrological data from ocean areas are needed to support both seasonal to inter-annual studies and decadal plus climate studies that support a better understanding of global climate change.

Some of the specific benefits of ocean and atmosphere observations include: improvements to predicting the weather at sea, helping predict and avoid the consequences of severe weather conditions and monitoring the state of the oceans using delayed-mode data in weekly and monthly analyses. In the area of climate change, observations support detecting long-term climate variability, building long-term records to monitor changes in the climate, and providing input to global computer models of the future state of the atmosphere. Improved data support ocean industry planning and operations in determining the most economic shipping routes, preparing forecasts and warnings for offshore industries and to help route ships and providing climatological data for the design of ships and structures at sea.

In-situ observations from ships and autonomous marine platforms have been the primary way to observe and monitor most oceanographic and atmospheric parameters. The data required pertain to the atmosphere above the sea (temperature, dew point, cloud, weather, visibility, pressure) and the surface of the sea

(temperature, waves, currents, ice). Marine observations also supplement and assist in calibrating satellite-derived observations. Observations from vessels and ocean platforms often cannot be supplied by any other means and provide a cost effective data collection.

Data is lacking due to the limits to ocean science programs and their resources available to collect information at the scale, frequency and intensity required to significantly improve ocean understanding. There are only a limited number of oceanographic vessels, which are expensive to operate and can only ensure partial coverage of the 70% of the earth that is ocean. Observations from scientific vessels have been augmented in recent years by an array of moored, mobile and temporary data gathering instruments. Oceanic and atmospheric data feed into an increasingly well-organized network of national and international ocean/atmosphere science programs. However, the extent of the unknowns, growing ocean use and impacts, and changes to global climate far outweigh the ability of current observations to adequately understand, predict and protect the future of the ocean.

2. VESSEL BASED OBSERVATION PROGRAMS

There are a number of programs that develop and support voluntary observations from vessels and platforms. At the global level, many of these are coordinated by the Ship Observations Team (SOT) of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM). National agencies and institutions implement and operate the JCOMM programs at the national level. JCOMM serves is the reporting and coordinating mechanism for the operational marine activities of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission of UNESCO (IOC).

The Ship-of-Opportunity Program (SOOP) collects a range of predominantly oceanographic data, most notably Upper Ocean Thermal (UOT) data, but also atmospheric and ocean carbon, ocean fluorescence and pigments, sub-surface temperature and salinity data. The UOT data are collected in the top 1000m of the oceans by expendable bathythermographs (XBTs). The probes are deployed at regular intervals along repeat XBT SOOP sampling lines from ships participating in the VOS Scheme, as well as other merchant, research and Navy ships. The UOT data collected by the SOOP support a range of operational and research applications, including: ENSO prediction; tropical ocean variability and prediction; global and regional heat storage; ocean transport and circulation; mid-high latitude variability; ocean state estimation and model evaluation; and climate change.

The Voluntary Observing Ship (VOS) program coordinates weather reports from all oceans and coastal areas. Data collected includes: atmospheric pressure, air temperature and humidity, sea surface temperature, wind speed and direction, visibility, cloud type, height and amount, and sea and swell conditions. Weather observations, including message preparation and transmission, take 10 - 15 minutes to complete. Observations are usually made every 6 hours, sent free of charge from ship to shore and distributed globally for use by all national meteorological services.

The VOS Climate Project (VOSClim) program seeks to provide a high-quality subset of marine meteorological data, supplemented by metadata, in real-time and also in delayed mode to support global climate research, modeling, and benchmarking. In particular VOSClim will be used to input directly into air-sea flux computations, as part of coupled atmosphere-ocean climate models, provide ground truth for calibrating satellite observations and provide a high quality reference data set for possible re-calibration of observations from the entire VOS Fleet.

The Automated Shipboard Aerological Program (ASAP) started in the mid-1980s to provide vertical profiles of temperature, humidity, wind speed and wind direction from the vast data-sparse ocean areas. The ASAP uses radiosondes tethered to gas-filled balloons to sample the atmosphere from the surface to a height of about 30km. It operates mostly on ships participating in the VOS Scheme, but also on some research and Navy vessels. The principal reporting areas are the North Atlantic Ocean and Mediterranean Sea.

It is important to ensure effective and efficient cooperation and synergies with other observation programs. These include the Ferry Box program (ocean data collected by ferries in Europe), the SeaKeepers program (ocean data collected by megayachts), the Argo program, the efforts of the OceanScope working group of the Scientific Committee on Ocean Research (SCOR) and others. There have also been several projects by individual shipping lines and oil companies to collect data from vessels in partnership with specific government or scientific institutions, e.g. the Oleander Project.

Ocean observation efforts have increased significantly over the past decade. Drifting buoys that observe meteorology and surface oceanography and profiling float networks have reached their target number of platforms (1250 and 3000 respectively). Ongoing deployments are required to maintain the networks as platforms fail or beach, and improve the spatial density of the platforms. Globally about 60 ships are enabling

24,000 XBT profiles to be undertaken annually. However, frequently-repeated XBTs are at only about 18 transects per year. High-density XBTs only account for a few transects per year, with agency ship rider onboard to do sampling. There are about 120 vessels sampling subsurface temperature and salinity and over 20 in the ASAP for sampling upper air profiles. Nonetheless, the overall growth of the ocean observation efforts have not reached the levels agreed upon for comprehensive coverage and data input.

Expanding the scope and scale of ocean and atmosphere observations is essential to improved understanding, modeling and predicting of the ocean and climate. This will in turn reduce risks to ocean industries posed by changing conditions. Government and scientific institutions and budgets will not be expanding in the near term to fill this need. The presence of growing numbers of commercial ships and platforms in the marine environment present a unique opportunity to cost effectively scale up data collection and a compelling case for ocean industries to expand their involvement in ocean observations.

3. IOOS AND INDUSTRY DATA COLLECTION

Ocean industries are active in much of the global ocean with fixed and mobile assets that create an enormous potential to respond to the need for more ocean observations. There are currently more than 80,000 merchant vessels (cargo, tanker, bulker, cruise) and 8,000 offshore oil and gas rigs, as well as ferries, fishing vessels, a growing number of offshore wind and wave energy platforms, one million kilometers of submarine cable and upcoming seabed mining and carbon sequestration operations.

The opportunity to use commercial vessels and platforms to collect ocean, weather and climate data has been developed in a limited manner to date. These important efforts to use ships and platforms of opportunity have generated valuable data. They have also accumulated critical experience in understanding what it takes to engage companies in ocean observations, develop the working relationships between commercial and scientific entities, install and maintain instruments, train seafarers, and, ultimately, collect and report data. Vessel and platform operators have been receptive to having ocean and atmosphere observing instrumentation on board. They see this as providing a service that provides feedback for their own benefit and only require that the equipment makes no, or minimal, demands on costs, insurance, time, people or operations.

Unfortunately, there are limitations to these programs. There have been significant difficulties in creating sustained, long term observations, e.g. due to companies being bought and sold, ships getting reassigned to different routes, lack of understanding and support at senior management levels for participation in voluntary observation programs, etc. Where there have been specific, one-off data collection partnerships between companies and scientific institutions, these often miss the opportunity to ensure the information can contribute to globally standardized data systems and analysis. On a broader scale, the programs to date have mainly focused only on merchant ships, and on oil platforms to a limited extent, but have not included other kinds of observation platforms, such as fishing vessels, offshore wind farms, aquaculture facilities, etc.

The scientists involved in international ocean observation programs recently concluded that limited progress has been made towards designing an integrated and global ocean observing system that would meet the needs of physical oceanographers, bio-geochemists and climate scientists and the policy makers charged with responding to the challenges of global change; the needs of biologists and ecologists and the natural resource and biodiversity managers charged with responding to degradation of habitats and ecosystem services; and the needs of maritime industries.

There is tremendous potential for ocean industry leadership in advancing the regular, sustained collection of standardized oceanographic and atmospheric data for input to scientific programs. However, effective use of industry ships and platforms requires a coordinated, cost-effective approach.

4. THE WAY FORWARD FOR THE NEXT TEN YEARS

4.1. Creating a Program to Scale Up the use of Industry Vessels and Platforms

A structure and process is needed to facilitate and foster, facilitate and coordinate industry efforts to expand the kinds and numbers of ships and platforms that are collecting data - and coordinate that industry interaction with the scientific community.

With the advent of the World Ocean Council (WOC) - the international, cross-sectoral industry leadership alliance on ocean sustainability - there is now an organization that is uniquely positioned to catalyze the role of business in addressing a range of priority ocean needs and opportunities. One of these priorities is developing a system to coordinate expanding and improving data collection by ocean industries.

The "Smart Ocean/Smart Industries" program has been launched following discussions with key national and international ocean and atmosphere observing programs, all of whom have shown strong interest in the program. Leadership companies from a range of ocean industries have encouraged the WOC to develop this portal for scaling up data collection from vessels and platforms and coordinating with the scientific community. The WOC brought together industry, science and government representatives in an initial workshop in December 2011 to design the program. The WOC and key stakeholders are developing the roadmap and workplan for moving forward with the program.

A large-scale integrated multi-industry effort to advance the role of ships and platforms in collecting data must employ standardized procedures, technologies and instrumentation. Collaboration will facilitate the development of sensors and instrumentation appropriate for harsh marine conditions and rigors of routine operation on commercial vessels and platforms, and also ensure easy installation, removal and servicing. Overall, the Smart Ocean/Smart Industries program can create synergies and economies of scale in developing the technology, operational practices and institutional arrangements, both within key sectors, such as shipping and offshore oil and gas, and across the wider range of ocean industries.

Within the framework of broad scale needs and opportunities for improved data collection by industry and, it will be very important to develop a phased approach. This will enable leadership companies to focus on specific, implementable activities that deliver short term outputs, e.g. demonstrating the ability to form the partnership for one ship to install and operate with instrumentation collecting and reporting basic oceanographic data and then scaling this up to more kinds of data and/or more vessels.

It is critical to learn from and build on the existing ships of opportunity programs and to work with and through existing national and international organizations that collect, transmit, store and analyze oceanographic and atmospheric information. In particular, WOC will coordinate with the relevant programs at the WMO, the IOC, especially the Global Ocean Observing System (GOOS). The JCOMM Ship Observations Team (SOT) provides an encompassing international science coordination structure for the vessels of opportunity programs.

3.2. The Smart Ocean/Smart Industry Value for Industry, Science, Governments and the Ocean

The business value of the program include: improved information for ocean condition observations, nowcasts, forecasts and hindcasts; improved predictability of, and reduced risk from, extreme events that impact ships and platforms; improved weather information and resulting savings from ship routing, fuel efficiencies, etc.; reputational benefits from contributing to ocean positive efforts to document and monitor the marine environment; opportunities for educational and promotional outreach to stakeholders and the public; increased leverage and opportunities to shape ocean science and policy; participation in the development of emerging new observational technologies; increased data on the physical and biological environment in which commercial activities are taking place; standardized data on environmental conditions and impacts, e.g. air and water emissions; data-driven input to corporate policies and practices; an increased and improved science basis for interaction with stakeholders on marine environmental issues.

The program's benefits to science and governments include: the ability to collect oceanic and atmospheric data on a significantly expanded spatial and temporal scale; the collection of data over longer time series and/or along repeated routes; the observation of ocean and atmosphere conditions in ways and places impossible to get by other means; the opportunity to fills major gaps in data and understanding; a highly cost effective means of data collection; increasing the global scope, scale and perspective of ocean data and understanding; improving and expanding the partnership and common ground between science, government and industry.

A comprehensive system of oceanic and atmospheric observations and monitoring will also provide input to international conventions and treaties, including: United Nations Convention on the Law of the Sea (UNCLOS); United Nations Framework Convention on Climate Change (UNFCCC); Convention on Biological Diversity (CBD); International Maritime Organization (IMO) Marine Pollution treaties (MARPOL).

There are numerous considerations to be addressed in developing such a program, including:

Networking, Integration and Institutional Relationships

- Frameworks for collaboration between industry and the marine research community
- Frameworks for collaboration among companies and between industry sectors
- Integration with existing ocean observing programs
- Standardization of policies and procedures

Scientific Program Requirements

- Scientific needs for ocean observation parameters
- Preferred or need locations for observations

- Priority marine routes for sustained ocean observation
- Development and implementation of observational programs
- Distribution of program resources to ships to meet the agreed sampling strategy in the most efficient way
- Maintaining appropriate inventories, monitoring reports and analyses, and information exchange facilities

Platforms
- Industries and kinds of activities/facilities appropriate for observation programs
- Vessel and platform types suitable for sustained observation efforts

Technology and Instrumentation
- Technologies that can enhance vessel or platform capability for ocean observations
- Priority instrument needs to meet future requirements
- Coordinating implementation of specialized shipboard instrumentation and observing practices
- Exchange of technical information on equipment and expendables, development, functionality, reliability and accuracy

Communications Procedures, Hardware and Software
- Information and advisory links with the scientific and government communities
- Managing communications, data transfer, distribution, handling, and archiving
- On-board data transfer and archiving to central vessel/platform facility
- Ship-to-shore communications and real time transmission of data for post-processing and distribution
- Shore-to-ship communications for supervision of shipboard data systems, system performance analyses and corrective action as required
- Hardware reliability and software robustness to provide unattended operation over periods of months to years
- Ensuring transmission of low resolution data in real time from participating ships; ensuring that delayed more high resolution data are checked and distributed in a timely manner to data processing centres
- EEZ access and data issues, including data ownership, release and sharing

Spatial Access
- EEZ access and data issues, including data ownership, release and sharing

5. CONCLUSIONS

The Smart Ocean/Smart Industries program is being developed as a bold new initiative that will link the commitment of leadership ocean companies to improving ocean science and health with the scientific community that collects oceanic and atmospheric data for better understanding the ocean and climate.

The program's vision is for leadership companies from a range of ocean industries to collaborate with the scientific community in the systematic, regular, sustained and integrated collection and reporting of standardized oceanographic and atmospheric data for input to scientific programs that improve the safety and sustainability of commercial activities at sea and contribute to maintaining and improving ocean health.

The goal of the program is to establish a platform/portal that facilitates and coordinates efficient, cost effective scientific community collaboration with shipping and other ocean industries in the collecting of oceanic and atmospheric data.