Oceanography

deYoung, Oceanography 2013, 1:1
http://dx.doi.org/10.4172/ocn.1000e103

Editorial

Open Access

Oceanography Grows Up: What to do Now?

Brad deYoung*

Department of Physics and Physical Oceanography, Memorial University, St. John's, Newfoundland, Canada

Oceanography as a discipline has a very short history, only a little more than a century. But much has happened in a short time. We have gone from not knowing what the bottom of the ocean looks like, and sampling with mechanical instruments and rope, to simultaneous sampling throughout the global ocean and flying autonomous gliders that communicate *via* satellite. Our growth in understanding has also expanded from ignorance as to what causes ocean currents to an ability to model much of the physical and ecological dynamics of the oceans. So as a discipline we have grown up. Perhaps as a grownup discipline it is time to change our approach to studying the ocean. With our knowledge and enormous technological capability to work in the oceans, maybe we should reconsider what we need to learn and what we can offer to society.

Oceanography in the service of improved sustainable resource management has been one of the drivers of our discipline, dating back to the development of ICES in the late 19th century. While we have made enormous advances, we have not been terribly effective in improving ocean management either in the short or the long term. Decision making at the annual time-scale is so driven by societal needs that scientific input has little effect. But for long-term planning we might expect that our understanding of fisheries oceanography should be useful in improving management regimes for fisheries. Even with our somewhat uncertain understanding of the whole picture, we might hope that our models and ecosystem knowledge would lead to better strategic management.

We are now good at observing the ocean and the body of our knowledge is substantial, but there remain substantial gaps. Nonetheless, while we have a good understanding of the mean circulation of the ocean, and can quite easily calculate geostrophic flows such flows do not dominate everywhere and our understanding of non-linear process remains limited. Our approach to the representation of mixing in ocean models, typically through rather simplified parameterizations, demonstrates the limited understanding that we have about this process. The connections between the open ocean and the continental shelf take place over a region where water and physical properties of the ocean change very significantly very quickly and over short distances. We have very few good measurements in such frontal zones and have learned to accept that our models poorly represent the exchange dynamics at the shelf-break. Yet we recognize that we need such understanding to properly represent the exchange that is crucial to fully understanding how the open ocean influences water properties on the shelf.

In addressing this challenge, my starting point is to wonder why we should care to make our discipline 'useful'. No doubt some would say that we do not really need to be useful, that enhancing knowledge of our ocean environment is enough justification and that increased knowledge will eventually lead to societal benefits, whether they be direct or indirect. But even such utility sceptics have to apply for funding and funding agencies, governments and the wider public are all seeking greater benefit from research funding in general and from environmental research in particular. We must consider how oceanography can be more useful, how we might enhance the relevance of our discipline and the interest in it and what paths we might take to provide greater benefit from the scientific research that we do.

There are many different possible users of enhanced ocean understanding. For example, we could start by considering the many activities that take place on the ocean-fishing, shipping, mining, oil drilling and others. Some of these groups, e.g. in particular the offshore oil companies, directly support ocean research and the development and application of ocean technology. If we include coastal users, then the number of direct users of the ocean is much larger since it includes nearly half of humanity who live close to the ocean and who use the coastal ocean for recreation, sewage disposal, their business and living. At the wider societal scale everyone is influenced by the ocean since the ocean's role in the climate system creates indirect links to everyone and influences us in significant ways, through changing weather patterns, such as hurricanes in the Gulf of Mexico, climate change and declining Arctic sea-ice. Even those who live far from the ocean, e.g. in central Asia, experience the touch of the ocean, even if such influence is intermittent and invisible to them.

Extreme environmental events have had an enormous impact in many places around the world: hurricanes in the USA, tsunamis in the Indian Ocean and oil spills such as the Deepwater Horizon incident. These few examples demonstrate the wide range in character and geography of environmental catastrophes that have a link to the ocean. The links to ocean science can be about remediation once the incident has happened (e.g. Oil spills) or about prediction, or early warning, to reduce the loss of human life (hurricanes and tsunamis). There are many different possible approaches to the study of such environmental problems - from enhancing basic understanding to enabling improved prediction to developing new technology for improved observation and monitoring. The benefits from improved warning and better coastal developmental planning are clearly substantial both socially and economically.

A growing area of study and concern is that of climate change and climate variability (the natural part). In recent years, we have begun to see how important decadal variability is in the ocean and the degree to which greenhouse gases have influenced the climate system. While we can measure the heat and CO_2 that have been taken up by the ocean, we still do not have a clear picture as to how the large scale ocean circulation has been influenced, how changes in Arctic sea-ice might influence global scale ocean dynamics and many other aspects of the oceanic response to anthropogenic disruption. Ocean acidification is another part of the greenhouse gas story. It is now clear how much the ocean will acidify over the coming century, with very little likelihood of mitigation given the growing rate of CO_2 production, but the impact

***Corresponding author:** Brad deYoung, Department of Physics and Physical Oceanography, Memorial University, St. John's, Newfoundland, Canada, E-mail: bdeyoung@mun.ca

Received February 07, 2013; **Accepted** February 08, 2013; **Published** February 11, 2013

Citation: deYoung B (2013) Oceanography Grows Up: What to do Now? Oceanography 1: e103. doi:10.4172/ocn.1000e103

on ocean marine life and marine biogeochemistry remains uncertain in spite of the unprecedented rate of change.

There have been many significant improvements in ocean science over the past several decades. Many of the textbooks from which we teach lag far behind our real understanding. Books still cover the ocean as if it were mostly a linear, quasi-static system with limited interconnectivity. Our ability to observe and to model the ocean has changed enormously. A teenager in the Ukraine can now make discoveries about fish in the Pacific while sitting in his room at home. The Argo float program demonstrates that we really can make global scale measurements if we work together. We really are now limited only by our imagination. While money remains a practical limitation, the scale of what we can achieve is more limited by our thinking and the way in which we tackle a problem. If we work together, globally and across disciplines, focussing on challenges that integrate societal and scientific interest then global scale challenges can be addressed. Such approaches are still in their infancy. We are still learning how now to harness this capacity and how to work together collectively to define the issues and how best to tackle problems.

Drivers for funding of marine research have evolved. Funding for the US Office of Naval Research supported much of the instrumentation developed in the post-war period. While the technology and techniques developed would spread around the world, the interests of the US Navy and their support through the ONR were crucial in supporting the development of much of the basic technology (from CTDs to current meters) that we now see as standard. During this period, there was strong support for basic research but only rarely did such basic research; funding provide enough support to enable significant technological development. Today, the situation is more varied. Changes in technology have now allowed instrumentation development with much smaller budgets and by smaller groups, e.g. the development of sensor technology. As well as funding agencies, pushing for economic benefit, often look towards technological developing even in quite small programs.

Not everything is getting better. While our technological capacity has increased, it has not been uniformly true that the infrastructure available for marine science has been expanding. Ship resources have at various times become limited as the real costs have risen and national funding agencies have had to restrict the number of days at sea. It has been said that with the development of remote sensing our need for sea-time has reduced. For particular applications or in some areas, such may well be the case, but in general remote sensing is often tied to other direct studies or ground-truthing that can lead to an increased demand for ship time.

With our increased technological ability to sample the ocean, at fine spatial scales, under many different conditions, on a regular basis throughout the year, we are now in the interesting and challenging position of having to make choices. There was a day when new sampling would guarantee new results. In its first century, oceanographers were like excited kids taking each new toy out into the ocean and coming back with new and important results. Moreover, such discoveries often led to real shifts in our perspective on the ocean. Such an approach to new surprises is not so common today. There is still much to learn but sudden paradigm shifts in our perspective are becoming less frequent and typically require more careful planning and a more cooperative approach.

However, other than changing the rate of development, the number of paradigms that we break through, what else has begun to change for oceanographers? Perhaps the way in which we approach the study of the ocean needs to change. We have both much greater knowledge and capability and must consider how best to use our observational capacity to create the key new understanding that we lack. It is not simply about how to frame the question but how best to make use of our national and international ability to observe and model the ocean.

While our data collection for the ocean remains incomplete, there is little doubt that the rate of data collection is increasing annually. We have many operational data collection systems that now collect data continuously: the global Argo program, the many cabled observatories, coastal radar systems, fishing vessels, oil rigs, at aquaculture sites and in many other locations. Unfortunately, it can be very difficult to locate and access many of these data. Only a small portion enters public databases. Even worse, we are not even aware of the existence of any of it. Therefore, we do now even know to go looking for it. Beyond such operational data, there are the data that reside on computers scattered around the world collected by dedicated research teams, data that does not reside in an open data center. In addition, of course data here can mean much more than observations of the ocean. Data can also mean results from numerical models, of which there are many thousands. Sharing model results are something that we do rather poorly and intermittently. There are of course many different models, of many different types, and sharing them would require careful consideration of issues associated with model structure and representation but the idea that we could bring together the observations and model results in some global sense, while clearly a dream, is also a possibility.

Strikingly we now live in an era in which we can access vast amounts of data from our smart phones, from nearly any corner of the globe. Even a few short decades ago who would have thought such a development possible. There have been some efforts to integrate our global ocean data with such developments, e.g. Google Ocean, but these efforts are far from complete and have yet to become a central part of our ocean study. Why YouTube is so easy yet sharing oceanographic data so hard? We need to develop new approaches to sharing data with the key first step being a commitment to fully sharing all the data that we do have. We must demonstrate at the same time the value of such data to the wider community beyond the scientific one. If we can demonstrate the value of such wide data sharing and develop the tools to enable creative exploration of the data then perhaps there would be a much wider group of interested users of our data and research who would push for even more data collection and study.

For decades, we have argued that oceanography can directly produce results that will benefit society with the development of improved scientific understanding that would lead to enhanced sustainability of ocean resources, direct economic benefit through such development and the protection of life and property. Such work has not been without its successes but we can do much more given our present understanding and capacity. Have we really been getting the most from our research and has there been enough focus on the gaps between our programs and activities? By bringing our research, our data and our model results together and working towards a wider shared vision, we could stimulate greater interest in the ocean, in oceanography as a discipline and produce many more direct and indirect benefits from our study of the ocean.

Citation: deYoung B (2013) Oceanography Grows Up: What to do Now? Oceanography 1: e103. doi:10.4172/ocn.1000e103