Ocean Observations Panel for Climate

The more research carried out on our oceans, the more significant its role has proven in the broader climate system. Observing Earth's Ocean System is therefore a vital component of climate research, and the OOPC is working hard to direct this effectively, as its Chair **Dr Eric J Lindstrom** explains

Could you offer an overview of the Ocean Observations Panel for Climate and why it began?

OOPC began in the 1990s as a means to gather and document the requirements for sustained ocean observations. Requirements are the basis for building complex systems. They help to drive the decision making and keep organisation of activities on track. The general idea at the time was to build sustained global observations of the upper ocean around the most stringent requirements. Those observations needed for climate records would have the highest quality and consistency and would meet the needs of many other applications in the process. The idea was a good one and we are still working on it.

What impact does the ocean have on climate and why is it so essential to study this?

The ocean is sometimes referred to as the 'fly wheel' of the climate system. The capacity of the ocean to store heat is more than 1,000 times that of the atmosphere. This enormous heat capacity both stabilises the planet and serves as a long-term memory for the atmosphere. Now, in our greenhouse world, it is the ocean taking up the vast majority of the excess heat – ensuring that we will live with a warming world long into the post-carbon economy. The ocean and atmosphere also play nearly equal roles in transporting heat from the equator towards the poles to maintain the heat balance of the planet. We definitely need to keep our eye on the ocean to understand the trajectory of the climate.

As Chair of OOPC, what does your role involve? To what extent do you take part in the research you base your advice upon?

As Chair of OOPC – a volunteer position I should emphasise – I am a 'community organiser'. One tries to bring the best scientific advice on the ocean to the climate observing system; what to measure, how and how well to measure it, and justification for our advice. It's a scientific enterprise so our answers and advice are based on today's knowledge and technology. We learn from ongoing research, and as new technologies emerge, so we continue to revise and amend the observing system requirements. Since one of our primary objectives is to promote the collection of consistent long-term records of the environment, we must always balance and calibrate the impact that changes in the observing system (if implemented) might have on our analysis of the environment.

Leadership of OOPC requires knowledge of what is needed and what is feasible in terms of ocean observing. In that respect, I bring to the job a career as both a sea-going researcher, and now a programme manager for satellite-based ocean research. At NASA Headquarters, where I oversee selection and execution of nearly 150 physical oceanography research projects, I am exposed daily to the cutting-edge of ocean research. It's a broad view that helps channel good scientific advice to the Global Climate Observing System (GCOS).

Could you tell us more about your role as Physical Oceanography Program Scientist for NASA. What do you do in this capacity and how does this role affect the experience you bring to OOPC?

NASA's Earth Science Division funds research in Earth System science utilising its fleet of Earth Observing satellites. A primary task for me is to organise the selection of the work involving specialised ocean physics research. Much of this work might be characterised as trying to understand the ocean's role in climate. The second task is to provide NASA with the science guidance it needs to build and maintain the satellite fleet itself. So you could characterise my job as caring for the scientific community that both exploits NASA's ocean satellites and provides guidance to the agency.

What are some of the recommendations for a sustained global ocean observing system for climate have you made?

Without going into the technical details (of which there are many), I would say OOPC has had an enormous role in shaping the sustained observing system we have today – and more importantly in shaping the future of the system. For example, a key success of OOPC and ocean community has been the implementation of the system for observing global sea-level change. It has a number of dimensions: satellites to measure the shape of the sea surface; other satellites to measure the change in the mass of the ocean; tide gauges and calibration sites to anchor the satellite data to benchmarks and longer records; and an array of more than 3,000 profiling floats to measure upper ocean temperature and salinity changes that impact the volume of ocean water. This system, built over the last decade, is a key sub-system of the Global Climate Observing System (GCOS). It monitors sea-level rise (more than 3 mm/yr on global average) and allows us to estimate contributions from change in mass (eg. melting ice caps) and thermal expansion (eg. ocean warming). It's an amazing suite of technology with quite diverse international support and collaborations. It is responsive to the requirements elaborated in the GCOS plans by OOPC.

Could you give examples of the strategies OOPC are helping to develop for evaluation and evolution of the system and how these are improving it?

OOPC tries to keep a watchful eye on the entire ocean observing system as it pertains to climate monitoring. Periodic evaluation of elements of the system are undertaken to assess the need for adjustment of the driving requirements. Presently we are engaged in initial development of a suite of observing requirements for the deep ocean (>2 km depth). As of now, there is no specific set of observing requirements (agreed internationally) for the deep ocean. We hope that making such a set of requirements for GCOS will stimulate innovation and new investment in this area.

Independently, we are also trying to schedule a community review of the upper ocean thermal observing system. This system has been in place, in some form, for decades and primarily involves moorings, expendable

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bathythermographs (XBTs) deployed from volunteer observing ships, and profiles of temperature and salinity from more than 3,000 Argo floats (autonomous instruments that profile the upper 2km of the ocean every 10 days). Our goal in OOPC is to assess the 'fitness for purpose' of the system for monitoring upper ocean heat content. Such an assessment might lead to recommended adjustments in GCOS requirements (an adjustment based on current knowledge of the ocean) or implementation (an adjustment based on how the mix of observing technologies can best be tailored to fulfil climate observing requirements).

By what means is the OOPC supporting global ocean observing activities?

We 'support' ocean observing activities across the planet by providing an agreed set of standards and best practices for nations to contribute to climate monitoring. Over time, we have become more sensitive to the diverse set of requirements that drive ocean observing activities in general. However, for vast tracts of ocean, it is the climate imperative that leads to making regular, high-quality observations.

How is OOPC supported? Do you think that programmes like these receive enough support and attention from governments?

OOPC is a high-level coordinating structure. We don't observe the ocean – we simply set the targets for observing, which allow for unification of diverse national contributions around a common aim. Our primary support comes through the Intergovernmental Oceanographic Commission (IOC, see p22). We are perennially short of funds for such coordination work, but society does recognise the climate change issue and OOPC does its best to keep the best science advice available for the ocean observing system.

To what extent does the OOPC work with Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), and the World Climate Research Programme (WCRP)? How does it benefit their work?

OOPC is the ocean domain body for the GCOS, the open-ocean panel for the GOOS (see p32), and the ocean observing arm of the WCRP (see p9). By being tasked to work across all these dimensions, we try to deliver the best possible ocean observing system for a variety of purposes and customers. The logistics and cost of ocean observing are significant challenges, so we try to build one system that meets many needs.

In terms of success, what has the Panel research produced thus far? Have you had an impact on adapting policy?

Maybe the biggest impact of OOPC has been as a central point of discussion for observing the physical nature of the ocean. Climate observing requirements have helped us build quite a useful global system of observations. The existence of the observing system has led us to a greater understanding of sea level rise and the role of ocean in climate. The fact that people know we must adapt to a changing ocean (and land) as well as a changing atmosphere is partly because of GCOS.

What plans for the future of OOPC do you have?

Over the last year OOPC has been working with the larger ocean observing community to develop a 'Framework for Ocean Observing' that would broaden the concept of an OOPC to include panels for ocean biology and biogeochemistry. It is obvious to all that we need a broader set of observations sustained in the global ocean and that the principles upon which the present system in built can be applied more broadly. I look forward to building a global sustained suite of observations in the ocean that fully encompass the coupled physics, biology, and chemistry that make it the life-blood of our planet.

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