Developments in Operational Oceanography in Europe and Australia

[1]Roger Proctor and [2]Affliation:
[1]Proudman Oceanographic Laboratory , UK and
[2]IMOS/eMII, University of Tasmania, Australia

Abstract

Over the next 3 years exciting developments in Operational Oceanography are planned in both Europe and Australia.

In Europe, rapid increases in human uses of marine resources and the impact of climate change are making the European shelf and coastal seas more susceptible to natural hazards, more exposed to and threatened by pollution, and potentially less valuable to national economies. Conflicts between commerce, recreation, development, environmental protection, and the management of living resources are becoming increasingly contentious and politically charged. The need for the provision of quality observational data and model hindcast/forecast products has never been greater. Co-funded by the European Commission and the Member States projects are underway or planned which will deliver this information. The MERSEA project, a 4-year pre-operational project, finishing this year, has laid the groundwork by establishing global and regional modelling systems providing a forecast once a week. The ongoing ECOOP project continues the regional theme with the aim to raise the standard of three coastal observing and forecasting systems in each of five regional seas all utilising MERSEA products, and establishing Marine Information and Decision-making Systems of Systems. The 3-year *MyOcean* project, starting this year, will establish the Marine Core Service for Europe through five data Thematic Assembly Centres and one Global and six regional Model Forecasting Centres, providing reliable, routine information for use by all the European Community. Beyond 2012 the vision is that all EU marine data will be coordinated, banked and quality assured through the establishment of EMODNET, the European Marine Observations and Data Network to enable the Marine Core Service to be sustainable indefinitely.

In Australia, the Integrated Marine Observing System (IMOS) is an ambitious 5-year project funded by the Australian national and regional governments with matching support from universities and research centres to implement and establish a multi-platform real-time observing system covering the Australian EEZ and a large part of the Indian Ocean. A complementary forecasting programme, BlueLink/BlueLink2, is developing forecasting systems to provide global, regional and coastal sea products.

Although in many respects Europe and Australia are contrasting environments the challenges facing Operational Oceanography in both regions, of data integrity and the delivery of routine, reliable model and observational products, are similar.

1.Europe

The overall strategy for delivery of marine information in European Union (EU) seas and oceans is developed under the GMES (Global Monitoring for Environment and Security, www.gmes.info), an initiative for the implementation of information services dealing with environment and security. In the marine domain the delivery of this initiative began with the MERSEA (Marine Environment and Security for the European Area, www.mersea.eu.org) project whose strategic objective was to provide an integrated service of global and regional ocean monitoring and forecasting to intermediate users and policy makers. The backbone of such monitoring and forecasting systems relies on combined use of in-situ and satellite data, numerical ocean models and data assimilation. The regional nature is critical to the delivery of the MERSEA objective and through EuroGOOS, the GOOS Regional Alliance for Europe, a number of Regional Operational Oceanographic Systems / Networks (collectively known as ROOSs) have been set up to implement best practice and achieve effective day to day collaboration. Each ROOS has a Memorandum of Understanding between participating institutes and at present there are six: Arctic GOOS, Baltic (BOOS), North West Shelf (NOOS), Biscay / Iberian (IBI-ROOS), Mediterranean collaboration (MOON) and the Black Sea GOOS.

European coastal observatories have different strengths and weaknesses arising from their geographical situations, their requirements and funding constraints. A current EU project 'European Coastal sea Operational Observing and forecasting system' , (ECOOP, www.ecoop.eu), aims to build up a sustainable pan-European capacity in providing a timely, quality assured marine service (including data, information products, knowledge and scientific advice) in European coastal-shelf seas. ECOOP focuses on improving and harmonizing fifteen coastal observing and forecasting systems (Fig. 1) and integrating their data through a marine information system of systems. ECOOP is divided along the ROOS regional lines (excluding the Arctic) with 3 coastal systems taken from each region. The data integration is aimed at developing an end-to-end structure which can be more widely applied, as ECOOP develops only a subset of European coastal observatories. Europe has led the way in using instrumented ferries as platforms for measuring surface properties (http://www.ferrybox.org), whereas the application of HF radar for measuring surface currents still lags behind their use in the USA.

These past and ongoing projects pave the way for the GMES Marine Core Service (MCS) which has the objective to streamline European capacities for forecasting, monitoring and reporting on the ocean state, for both the global ocean and the regional European seas. MCS will address the requirements from national and European policies, international conventions, as well as European and international agencies, for data, information products and indicators on the environment at local to global scales. The Strategic Implementation Plan for MCS (Ryder, 2007) stresses the critical importance of the provision of global and regional products for use by downstream services and end users (Fig. 2). This vision is to be implemented over the next 3 years (2008-2011) through the project *MyOcean* which will develop a consistent and reliable MCS with a strong interactive feedback from the intermediate users who, ultimately, will be the predominant downstream service suppliers. *MyOcean* will "deliver regular and systematic reference information (processed data, elaborated products) on the state of the oceans and regional seas at the resolution required by intermediate users & downstream service providers, of known quality and accuracy, for the global and European regional seas." *MyOcean* will operate through 12 production units (building on existing real-time data processing and forecasting centres): five observation 'Thematic Assembly Centres' for sea level, sea surface temperature, sea ice and wind, ocean colour, and *in situ* measurements; which will provide information and deliver data to seven 'Monitoring and Forecasting Centres', one providing global coverage and six regional centres corresponding to the ROOSs. Each production unit will be conducting integration, operations and assessment as well as research and development. They will all be under operational commitments to deliver a service.

MCS is constructing the 'Meteorological office' for the Sea: to provide every day the best information and forecast of the physical state and lower level biogeochemical condition of the marine environment. It is the first system of this kind in the world.

Clearly this will require that Member States *in situ* monitoring networks support the quality assurance and the data collection required for a sustained MCS. This has been foreseen in the European Marine and Maritime Science, Research, Technology and Innovation Strategy where one of the essential actions is the establishment and resourcing of a European Marine Observation and Data Network (EMODNET). This would see "the establishment of permanent, sustained monitoring and observation structures and the underpinning data provision, curation, information management and dissemination needed to support good ocean governance, good science, a better understanding of ocean dynamics, improved resource utilisation and the protection of the marine environment". A case for having EMODNET was laid out in one of the background papers of the EC Maritime Green Paper Consultation Process (Anon, 2006). The paper proposed the main tasks of such a network could be:

(1) to facilitate the systematic and operational long-term collection of data necessary to understand biological, chemical and physical behaviour of seas and oceans
(2) to encourage the interoperability of data collected by different regions
(3) to ensure the quality of the data
(4) to process operationally the raw data into information that is usable by service providers and researchers
(5) to render the data easily accessible
(6) to provide a repository for data collected in EU-funded projects.

Thus, the EU has invested over €60m in these projects (with matched funding from the Member States) and over the next 3-5 years major changes in the delivery of European oceanographic products are planned to aid the implementation of downstream (i.e. local) services.

2. Australia

There are ongoing concerns about adequate marine research capability for Australia to service Australia's requirements and responsibilities, which are significant because Australia has the third largest marine jurisdiction of any nation on earth. At over 14 million km^2 Australia's Exclusive Economic Zone (EEZ) is nearly twice the surface area of the Australian continent, and its extent at high latitude and in Antarctic waters adds to the challenge.

Australia is a continent surrounded by major ocean currents on its eastern, western, northern and southern boundaries, best known of these being the East Australian Current and the Leeuwin Current (which directly affect the Australian climatic conditions and help sustain the marine ecosystems). There is evidence that these currents are changing on decadal time scales and have already impacted marine ecosystems, but the data is sparse and neither the currents nor ecosystems have been monitored in a systematic way. Research on marine climate impacts is an open book and the pages are nearly blank, because long term data has been missing.

The Integrated Marine Observing System (IMOS) is a A$92M project established with A$50M from the National Collaborative Research Infrastructure Strategy (NCRIS) and nearly equal co-investments from Universities and government agencies, including overseas partners. It is a nationally distributed set of equipment established and maintained at sea, providing streams of oceanographic data and information services that collectively will contribute to meeting the needs of marine research in both open oceans and coastal oceans around Australia. In particular, if sustained in the long term, it will permit identification and management of ***climate*** change in the marine environment, an area of research that is as yet almost a blank page. It also provides essential data to understand and model the role of the oceans in climate change, and data to initialize seasonal climate prediction models. It will provide an observational nexus to better understand and predict the fundamental connections between coastal biological processes and regional/oceanic phenomena that influence ***biodiversity***. While as an NCRIS project IMOS is intended to support research, the data streams are also useful for many societal, environmental and economic applications, such as biodiversity conservation and management of ***marine*** natural resources and their associated ecosystems, support and management of coastal and offshore industries, safety at sea, marine tourism and defence.

The IMOS strategic goal is to assemble and provide free, open and timely access to streams of data that support research on:

(1) The role of the oceans in the climate system, and

(2) The impact of major boundary currents on continental shelf environments, ecosystems and biodiversity.

The benefits of IMOS transmit to the terrestrial sectors (e.g. ***water*** management, agriculture), for example through providing a better underpinning science base from which to characterise and predict weather patterns that are connected to oceanic phenomena. The return from investing in ocean observations of the nature of IMOS was estimated through an economic analysis undertaken in 2006 by the Australian Academy of Technological Sciences and Engineering and the Western Australian Global Ocean Observing System Inc. (*Economics of Australia's sustained ocean observation system, benefits and rationale for public funding*). That study, based on only a limited set of benefiting industries concluded that the cost:benefit to the Australian economy of investing in oceans observations was better than 1:20.

The IMOS infrastructure also contributes to Australia's commitments to international programs of ocean observing and international conventions, such as the 1982 Law of the Sea Convention that established the Australian EEZ, the United Nations Framework Convention on Climate Change, the Global Ocean Observing System (http://www.ioc-goos.org/) and the intergovernmental coordinating activity Global Earth Observation System of Systems (http://www.earthobservations.org/).

IMOS is made up (Fig. 3) of nine national facilities that collect data, using different components of infrastructure and instruments, and two facilities that manage and provide access to data and enhanced data products, one for in situ data and a second for remotely sensed satellite data. The observing facilities include three for ***bluewater and climate observations*** (Argo Australia, Enhanced Measurements from Ships of Opportunity and Southern Ocean Time Series), three facilities for ***coastal currents and water properties*** (Moorings, Ocean Gliders and HF Radar) and three for ***coastal ecosystems*** (Acoustic Tagging and Tracking, Autonomous Underwater Vehicle and a biophysical sensor network on the Great Barrier Reef). The principal operators of the facilities are the major players in marine research in Australia. The value from this infrastructure investment lies in the coordinated deployment of a wide range of equipment aimed at deriving critical data sets that serve multiple applications (Fig. 4). Additional information on IMOS is available at http://www.imos.org.au.

Implementation of IMOS facilities began in the period July to October 2007. IMOS has attracted strong support from the States, including Queensland for the Great Barrier Reef and South Australia for the Great Australian Bight. It is too early to assess the accomplishments relative to the IMOS goals, but progress has been good. Setting up an observing system in the ocean is challenging because of the harsh environmental conditions, and the need to develop Australian capability in using some of the equipment. Never-the-less, the IMOS facilities are on track to achieve their planned goals, and some have already demonstrated a leading role in the international development of the Global Ocean Observing System.

3. Summary

There is a need to ***sustain the capability being implemented*** through these current investments, to maintain long-term monitoring and forecasting capability required to support marine research and applications. IMOS in its present form is directed toward a proof of concept and building capability whereas the European systems are more advanced. The focus on research attracts co-investment from research agencies; however, they usually are not in a position to make a commitment to long-term sustained observing. There is a mistaken belief that research agencies should develop techniques and, once proven, they can be implemented by so called operational agencies. But operational agencies cannot accept a new mission without new, sustained support and this has been recognized in Europe through funding of the *MyOcean* project and in Australia through the BlueLink/BlueLink II projects.

The process for development of marine and environmental infrastructure needs to address the need for sustained observing *from the outset*. Experience over the past 25 years has demonstrated that sustained environmental observations serve the purposes of both research and operational agencies. It is recognized that both types of agency can be the home for sustained observing infrastructure, and there need to be appropriate incentives to encourage this to happen. A long-term commitment to ocean observing can be made on the basis of a staged development, where completion of one stage and proof of concept springs the release of already committed resources for the next stage.

There is a need to develop and prove applications of IMOS data in ***societal and industrial applications*** as well as research. This has been recognized in Europe through a series of data management initiatives, the latest of which is SeaDataNet (www.seadatanet.org) and which paves the way for EMODNET. Although in Australia there has been some engagement, with the tourism sector for example, a marine observing system has not existed in the past, and most industries do not have experience in using sustained marine data products. There needs to be more incentive to attract investment and sharing of resources from industries.

The data-streams produced by IMOS have a wide range of applications in research and in societal, environmental and economic activity. No single application or small set of applications however will be so profitable that they could cover the cost of the whole system. Monitoring the marine environment has to be a public-good function, much like the weather service, a fundamental operational objective of *MyOcean*.

In Australia national coordination, and in Europe continent-wide coordination, is required to produce innovative products and services that will justify public expenditure by contributing to the sustainability of both regions EEZs. The European Union has established Global Monitoring for Environment and Security (GMES) for this purpose. A similar initiative in Australia—call it Australian Monitoring for Environment and Security (AMES)—could use the data from a number of ongoing related environmental observing activities, including the weather service, IMOS, hydrological monitoring, Tsunami warning system and other environmental monitoring to produce innovative products and services. The purpose of a body to coordinate Australian monitoring for environment and security would be to ensure the maximum national benefit from public investment by coordinating inter-dependent institutions to produce innovative services using satellites, new sensor technologies and in situ sensor networks.

So, as can be seen, despite the different geographical contexts and status of development, many of the problems which Europe and Australia face to establish and implement sustained oceanographic products are essentially the same.

4. References

Anon, (2006), European Marine Observation and Data Network (EMODN) Background Paper 4a of the Maritime Green Paper Consultation Process. SEC (2006) 689.

Ryder, P., (2007), Sustainable Marine Environmental Information Services to meet collective European needs. EuroGOOS publication 26, December 2007

Fig.1 Locations of ECOOP coastal observing and forecasting systems

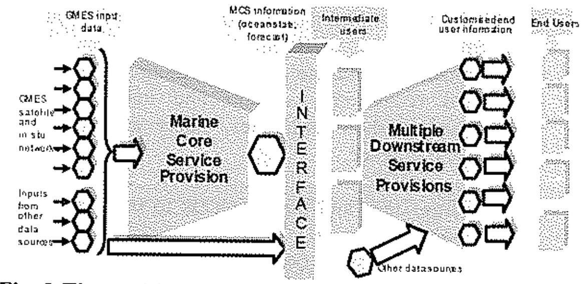

Fig. 2 The position of the MCS in the overall chain of service delivery (from Ryder 2007)

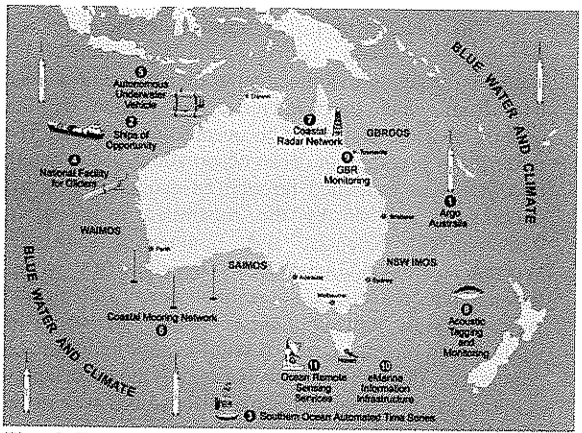

Fig. 3 The IMOS data facilities and their regional node implementation

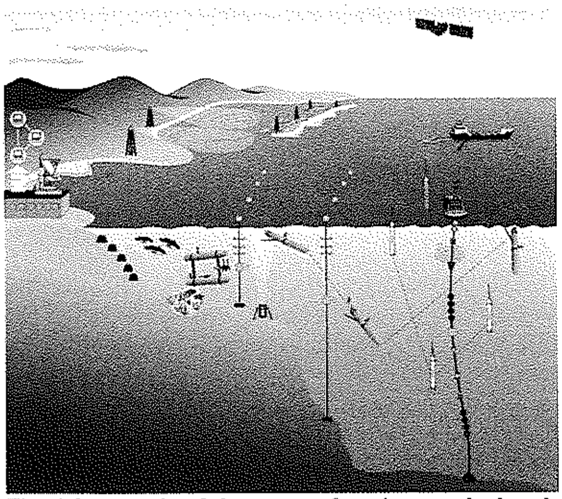

Fig. 4 Schematic of the range of equipment deployed in IMOS