

MyOcean, building up the European “Marine Core Service”

by Pierre Bahurel

WITH A POTENTIAL MARKET COVERING 70% OF THE SURFACE OF THE GLOBE, AND BEING CONNECTED TO FIRST-PRIORITY ISSUES – CLIMATE, PROTECTION OF LIVING RESOURCES, THE FIGHT AGAINST ENVIRONMENTAL THREATS, etc. – OCEAN FORECASTING DEALS WITH A LARGE SPECTRUM OF APPLICATIONS AND USERS: RESEARCH AND OPERATIONAL, CIVIL AND MILITARY, GLOBAL AND LOCAL, REAL-TIME AND DELAYED MODE, etc. THE FIELD IS WIDE. BUT THERE IS ONLY ONE OCEAN. USERS, AS WELL AS SERVICE PROVIDERS SERVING THEM, WERE MISSING THE RELIABLE INFORMATION ON THE OCEAN STATE.

In the first half of 2007, Mercator Océan and its European partners have translated expectations from the European Union and its Member States into practical proposals and a 3-year action plan for a European “Marine Core Service” in order to provide precisely this missing information: this is the objective of the *MyOcean* project.



One easily understands the interest of reliable ocean forecasts for services dedicated to the exploitation and protection of ocean resources, such as fish (credit: European Community).

One can easily understand the many benefits of reliable ocean forecasts for services dedicated to the management and protection of ocean resources, such as fish farming, merchant shipping, safety and security at sea, environmental protection, harbour management, coastal areas monitoring, oil and mining extraction, defence (submarine discretion), or tourism. These services are progressively integrating the new kind of information brought by the operational ocean forecasting services. Moreover, the availability of accurate ocean analyses directly contributes to the development of seasonal and climate forecasts by supplying initial conditions to coupled ocean / atmosphere models. This underlines the important links between operational ocean forecasting and scientific activity on climate modelling, and also application sectors such as agricultural production, energy, economic planning, transport, etc.

The interest can be directly economic or can involve, even more directly, the safety and prosperity of the populations (as for example in the prevention of the El Niño events and the associated disasters). A

market analysis quickly demonstrates the added value of a generalist “middle-man” service, consisting of the elaboration, supply and circulation of ocean analyses and forecasts – the “core information” – and for the benefit of the downstream sector – the “customised” information. For many years, the real challenge in oceanography has been dealing with the development of a real ocean forecasting offer able to meet users’ demands. The MyOcean marine Core Service is the output of a long term investment, made with a patient but deep involvement of world-class institutions.

The result of a long effort to progressively strengthen ocean forecasting maturity at international, European and national levels

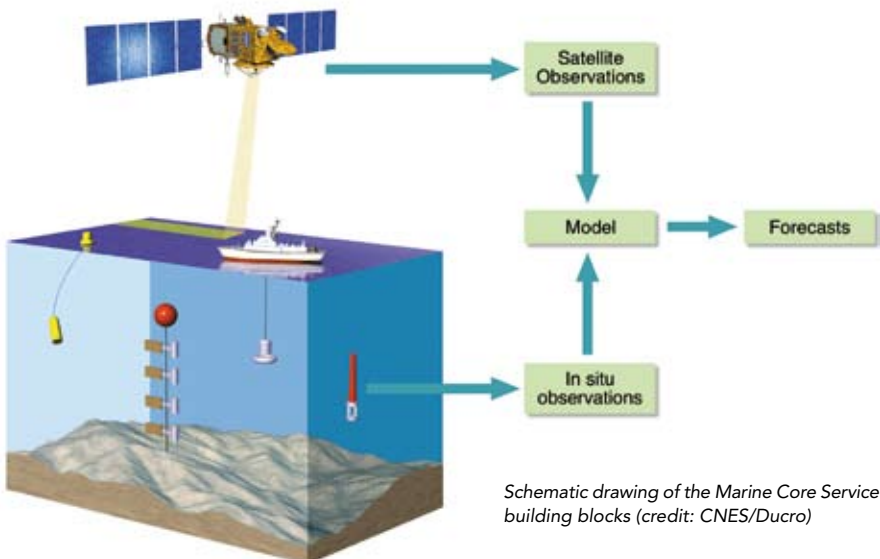
This is what was written ten years ago: *in acknowledgement that there was a need for better ocean observations and ocean forecasts and with the scientific and technical opportunity that readily available satellite data had delivered, the time had come to initiate the Global Ocean Data Assimilation Experiment (GODAE) that would lead the way in establishing global operational oceanography. A coordinated international effort is required to achieve this and GODAE constitutes the framework for this endeavour. The vision was: A global system*

of observations, communications, modeling and assimilation that will deliver regular, comprehensive information on the state of the oceans, in a way that will promote and engender wide utility and availability of this resource for maximum benefit to the community. Ten years ago, some leading scientists and managers had already identified that ocean forecasting was at hand, and that time had come to initiate international projects such as GODAE. They were right.

Today, ocean monitoring and forecasting has become a reality.

Ocean forecasts are provided on a regular basis by a dozen of operational oceanography centres in the world; forecasts are built through routine assimilation of real-time space observation and *in situ* data into numerical models. Some of them describe the global ocean as a whole, others are regional; Europe has this double capacity. Thanks to international experiments, European-funded projects and national initiatives, ocean forecasting has clearly demonstrated its feasibility.

The time has come to consider the consolidation of this capacity and its pre-operational validation, and prepare the transition to an operational phase.



Schematic drawing of the Marine Core Service building blocks (credit: CNES/Ducro)



The Prestige tanker disaster: monitoring the health of the ocean is an international responsibility (credit: French Customs)

The United States, Japan, Australia, Canada, and now China, are deeply engaged with their European partners in the development and consolidation of an operational ocean monitoring and forecasting capacity. Space oceanography programmes, as well as *in situ* ones, are gathering a wider range of countries in this global Earth Observation challenge for the ocean; this large cooperative effort is actively coordinated at an international level. On the service side, marine and meteorology operational teams gathered by the World Meteorological Organisation and Intergovernmental Oceanographic Commission recognise the

maturity of operational oceanography and its capacity to foster the development of marine services.

The international community is deeply engaged into operational oceanography, and Europe is indeed playing a leading role. On a scientific and technical basis, its ocean forecasting capacity is undoubtedly a world-leading one. Now, within the European GMES programme, the definition of a "Marine Core Service" has provided the expected roadmap for an entire community to engage in a clear and collective transition to a service organisation.

The Marine Strategy Directive (2005/0211(COD)) emphasises the following objectives:

"(13) As a first step in that preparation, Member States across a Marine Region should undertake analyses of the characteristics of their marine waters, identifying the predominant pressures and impacts on those waters, their economic and social use and the cost of degradation of the marine environment.

(14) On the basis of such analyses, Member States should then determine for the European waters a set of characteristics for good environmental status. For those purposes, it is appropriate to make provision for generic qualitative descriptors, detailed criteria and standards to be developed in the near future by the Commission with the involvement of all interested parties.

(15) The next step towards achieving good environmental status should be the establishment of environmental targets and monitoring programmes for ongoing assessment, enabling the state of the waters concerned to be evaluated on a regular basis."

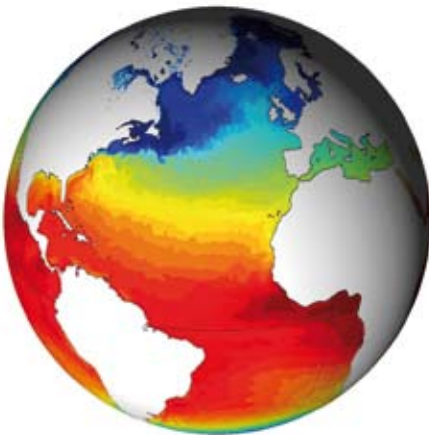
The GMES Marine Core Service, through the European Marine Monitoring and Assessment (EMMA) working group, jointly managed by the European Community and European Environmental Agency, should contribute to these reporting objectives.

The European Marine Core Service capacity is progressively writing its long-term roadmap.

The *Towards a future Maritime Policy for the Union* Green Paper emphasises the fact that [...] the *Global Monitoring for Environment and Security (GMES)* initiative will implement a number of public information services in support of European policies, derived from *in situ* and space observations. Marine services have been identified as a first priority. GMES should thus constitute a major component of the European Marine Observation and Data Network that the Green Paper proposes to set up. It is clear that the GMES Marine Core Service will represent a major building block of this Network.

MyOcean, the first implementation of the European Marine Core Service

Over the past 10 years, Europe has been playing a leading role in operational oceanography and has actively contributed to the emergence of a pre-operational ocean monitoring and forecasting capacity. With the GMES initiative and its Marine Core Service, the European community is moving on to the next phase, with a schedule fully in line with national, European and international expectations and the maturity of operational oceanography.



Example of Global Sea Surface Temperature map produced by the GMES Marine Core Service (credit: Mercator Océan)

Over the past 10 years, Europe has been playing a leading role in operational oceanography

The Marine Core Service (MCS) has been identified as achievable and important for a rapid implementation, and selected as such by the European Commission in its priorities. It is indeed one of the GMES so-called *Fast Track Services*. It will, in the marine sector, transition GMES to the provision of integrated and coordinated pan-European core operational oceanographic products and services. The objective of the Marine Core Service is to deliver a range of fully validated core operational oceanographic products and services which can be used by intermediate service providers to meet information needs of the European Union, Member States, European industry and European Citizens. The Marine Core Service will build on already existing and well coordinated pan-European research and operational oceanography capabilities to deliver the service infrastructure described in the so-called GMES Marine Core Services Implementation Plan. Through its participation in earlier EU-funded and national projects, the European operational oceanographic community stands ready and motivated to deliver the requirements of the Implementation Plan. The community has already federated itself across Europe to achieve this objective.

The specifications of the Marine Core Service have been described by an expert group – the Marine Core Service Implementation Group – formed by the European Commission. Chaired by Peter Ryder this implementation group published the Marine Core Service Strategic Implementation Plan.

MyOcean is the first implementation project of this Marine Core Service. Set up as EU-funded project under the Seventh Research Framework Programme (FP7), *MyOcean* is coordinated by Mercator Océan and gathers around 60 partners from 27 countries. All EU maritime countries are represented. The project has been proposed to the European Commission (FP7 Space

programme) in order to move from existing initiatives in operational oceanography into a pan-European “marine core service”. The project should start in late 2008, with a three-year duration. The strength of this collective response of European key players in oceanography is a demonstration of maturity of the European oceanography community. The existence of a European marine core service having been identified in the top three priorities of the EU GMES initiative for a European “Global Monitoring for Environment and Security” capacity, the MyOcean project is a direct answer to this political priority.

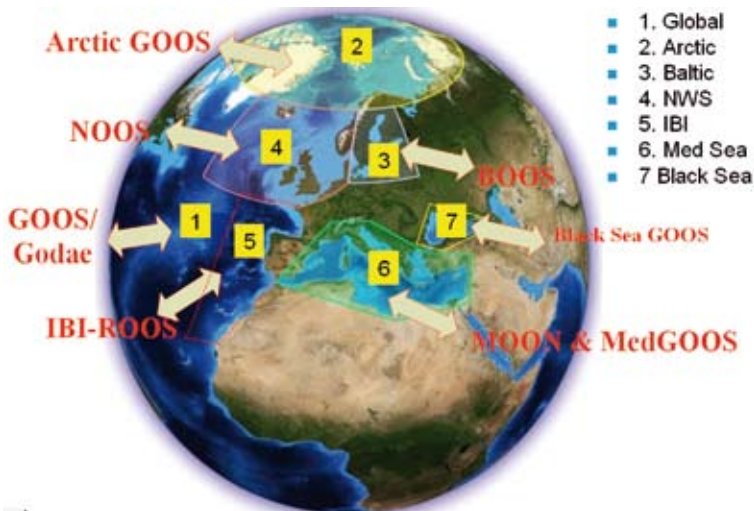
MyOcean at a glance

With the GMES programme and its Marine Core Service, the European Union is consolidating past efforts in pre-operational ocean monitoring and forecasting capacities in Europe through precursors run under the previous Research Framework Programmes (FP6) like MERSEA and BOSS4GMES or as projects funded by the European Space Agency (ESA) as GMES Service Elements (GSE) like MARCOAST and POLARVIEW.

The MyOcean consortium, as proposed to the European Commission, intends to deliver a portfolio of pan-European Marine

Core Service products and services through a robust and optimised ocean monitoring and forecasting core infrastructure. The validation process, planned through a 3-year experience, enables organisation of the user-driven service up to its pre-operational phase, with proposals addressing the long-term roadmap. MyOcean provides core information on the ocean in all areas of benefit for several categories of key users: the EU agencies such as the European Environment Agency (EEA); the European Maritime Safety Agency (EMSA); the Member States service providers (Met offices, coastguards, etc.); the intergovernmental bodies and their members (the OSPAR Commission, the Helsinki Commission (HELCOM), etc.).

The Global ocean and the European seas are monitored with an eddy-resolving capacity, based on assimilation of space and *in situ* data into 3D models, representing the physical state, the ice and the ecosystems of the ocean, over the past (25 years), in real-time and in the future (1-2 weeks). The high-quality products rely on the aggregation of European modelling tools; the scientific methods are produced through a strong cross-fertilisation between the operational and research communities.



The MyOcean Regional Areas (credit: CLS)

Value created for users

A new pan-European ocean core information

MyOcean will be focusing on consolidating and enhancing the services of ocean forecasting, both in quantity (full coverage of key areas) and quality (accuracy of key variables).

Estimation of the state of both the global ocean and regional seas: yesterday, today, tomorrow. The systems currently in place have been scientifically validated, focusing essentially on the “now cast” performances. In the *MyOcean* project, the R&D effort will enable major progress along the temporal dimension: with (i) improved short-term predictions (forecasts) based on the best possible atmospheric forcing functions, and (ii) qualified re-analyses of the past variability on seasonal to decadal time scales. The description of the ocean during the past 20-50 years will offer a very useful reference state of the ocean.

Enhancing the services of ocean forecasting, both in quantity and quality

Consolidation of very high resolution systems. The transition from eddy-permitting ($\sim 1/4^\circ$) to eddy-resolving ($\sim 1/12^\circ$) resolutions at basin and global scales will be ready for production in the early part of *MyOcean*. For coastal applications, downscaling to eddy resolving scales ($\sim 1/60^\circ$) smoothly nested into basin-scale configurations will be achieved gradually during the project.

Extension to marine ecosystems and biogeochemical components. The maturity already achieved by *MyOcean* partners in global and regional ocean circulation will be extended to other aspects of the marine environment. Major challenges for the next oceanographic revolution are to accurately estimate and forecast the distribution of marine bio-resources, and to provide real-time monitoring of global or basin-scale air-sea carbon exchanges. Specific R&D efforts will

be deployed in *MyOcean* to improve ecosystem process parameterisations, physical/biological interactions, forcing functions and integrated modelling systems with data assimilation capabilities. More robust approaches will be developed to extract key information from operational products to constrain the biological models, as well as efficient methods to assimilate satellite ocean colour data into predictive models.

Towards new or improved data sets and products. The quality of *MyOcean* products and services critically depends on the availability of state-of-the art *in situ* and remote sensing input data sets. Major improvements in data assimilation systems are expected thanks to the systematic use of new or improved data sets (e.g. Argo T and S profiles, velocities from drifters and floats, ocean colour, high resolution altimetry, GRACE and GOCE, SMOS, CRYOSAT, new SST sensors, and SAR for sea ice). *MyOcean* will address high level processing issues (validation, inter-calibration, error characterisation, new products) that are mandatory for an effective use of data in assimilation systems and/or for services.

A new pan-European ocean forecasting organisation and service

Towards a pan-European integrated capacity and infrastructure

MyOcean is commissioned to transition from pre-operational, non-homogeneous components of the existing European capacity to a fully operational and coordinated Marine Core Service, based on a network of committed operators. Most components of *MyOcean* already exist at national level, or as an output of previous European projects. *MyOcean* will push the evolution towards a coordinated network, avoiding unnecessary duplication that will generate large economies of scale, identifying critical components that need to be duplicated to increase robustness of the whole.

This will be developed along several transverse axes:

- **from global to regions** - making a coordinated and interlinked network

- of Thematic Assembly Centres and Monitoring and Forecasting Centres that will cover the entire globe with enhanced capacities for the European waters,
- from research to operations - fostering the development of innovation that will ensure the scientific quality of the products and services,
- covering the full range of marine disciplines - from observations to modelling, from monitoring to assimilation and forecasting, from short term forecast to long term re-analysis, from physics to ecosystems, from large global scales to very high frequency local signals,
- from local practices to coordinated expertise and standards - using community tools such as NEMO Ocean Global Circulation Model advanced ocean data assimilation methodologies and product quality verification methodologies (GODAE Metrics).

A system organisation based on regional and thematic skills... but offering a single pan-European service interface to users.

Observations, model-based data and added-value products are generated – and

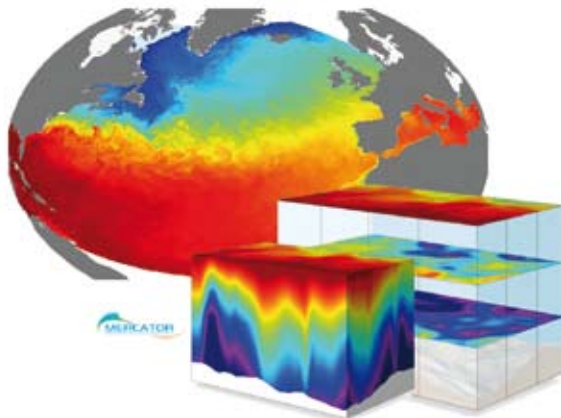
enhanced by dedicated expertise – by the following production units:

- five Thematic Assembly Centres, each of them dealing with a specific set of observation data: Sea Level, Ocean colour, Sea Surface Temperature, Sea Ice & wind, *In Situ* data
- seven leading Monitoring and Forecasting Centres to serve the Global ocean, the Arctic area, the Baltic Sea, the Atlantic North-West shelves area, the Atlantic Iberian-Biscay-Ireland area, the Mediterranean Sea and the Black Sea.

All these production components will be managed to serve a single service desk, a single interface, for all users.

Engagement of the user community.

The major expected progress will be the engagement of users of downstream services, and long term uptake of *MyOcean* products and services. The scientific excellence, which is a key driver of *MyOcean*, will ensure that the products and services are as close as possible to the leading edge of current knowledge. The resulting quality of the outputs will maximise the usefulness of *MyOcean* products and services for a wide



Example of three-dimensional ocean state information produced by the GMES Marine Core Service (credit: Mercator Océan)

range of applications. The development of standard products and services, and, a common framework for dissemination of information will also ease this adoption. In addition, essential ancillary information, such as estimates of the quality of the products and services (error bars), meta-data, alternative backup solutions, value added products (ocean indicators) will be developed, further increasing the potential adoption by downstream operational users.

The MyOcean project and the development of the Marine Core Service are visible signals of the maturity of European operational oceanography. The three forthcoming years will enable the harmonisation of the existing systems and the consolidation and/or development of the downstream value added services relying on this new capacity that Europe has decided to support. The entire organisation of the project is designed to ensure the service definition (products definition, service priorities) will be fully driven by the users engaged in the process.

Three overarching motivations for a MyOcean service and a European-wide engagement

There is one single ocean.

The Earth is an ocean planet. It's a unique environment. We cannot explain the climate over Europe without understanding the ocean. We find Mediterranean waters far west into the deep Atlantic. Ice in the Arctic governs the global ocean climate. A huge proportion of the world population lives close to the sea. Maritime transit

routes join the Black Sea to the Baltic via the Mediterranean, the Atlantic, the Arctic and the Global Ocean.

We cannot explain the climate over Europe without understanding the ocean

We need to know what's happening.

Satellites fly around the globe. Thousands of floats profile the deep ocean. Models assimilate this information. Scientists forecast the currents and temperatures of the oceans anywhere on the globe two weeks in advance. They could analyse variations in the heat content that governs extreme weather events, compute the sea level trend over the past 10 years with an accuracy of 1 mm, or even assess the state of the ecosystem this year. Whether we are European citizens, decision-makers in environmental policies, or chief operators in marine services, we need Global Monitoring for Environment and Security, the sooner the better.

We can play a role. Wherever we are.

Exploitation of the ocean is a reality and a gift for humanity. Its sustainability has to be organised. Its health has to be monitored. It's an international responsibility. The European voice is important. Satellites, *in situ* networks, ocean monitoring and forecasting capacities are core components of a collective responsibility, born from individual awareness. The ocean must be monitored, must be explained and must be sustained.



A Graduate of the prestigious *Ecole Polytechnique* (France), **Pierre BAHUREL** was among the founders of *Mercator Océan*, the French Ocean Forecasting Centre, in Toulouse and is currently its Managing Director. He is also the Coordinator of *MyOcean*, the European GMES Marine Core Service project. Pierre Bahurel's main activities have to do with operational oceanography: at national, European and international levels (ocean forecasting, and space oceanography). He is a member of the Global Ocean Data Assimilation Experiment (GODAE) and is also involved in several EC and ESA projects related to operational oceanography (such as MERSEA). He is actively involved today in the development of a pan-European capacity for global and regional ocean forecasting.