



MERSEA Integrated Project

Marine EnviRonment and Security for the European Area

Executive Summary

Call identifier :
FP6-2002-space-1-GMES

Thematic priorities :
Ocean and marine applications

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MERSEA IP – Participating Agencies

Contractors name	Short name	Country
Institut Français de Recherche pour l'Exploitation de la MER	IFREMER	France
Department of Fisheries and Oceans	DFO	Canada
Department Fisheries and Marine Research	FDMR	Cyprus
Danish Meteorological Institute	DMI	Denmark
Hamburg Institut fuer Meereskunde	IFM/UH	Germany
Joint Research Centre EU /	JRC	E.U.
BOOST Technologies	BOOST	France
Collecte Localisation Satellites	C.L.S.	France
Centre National de la Recherche Scientifique	CNRS	France
Instituto Canario de Ciencias Marinas	ICCM	Spain
MERCATOR OCEAN	MERCATOR	France
Alfred-Wegener-Institut für Polar- und Meeresforschung	AWI	Germany
Leibniz-Institut fuer Meereswissenschaften	IfM/Kiel	Germany
Hellenic Centre for Marine Research	HCMR	Greece
Agency for New Technology, Energy and the Environment	ENEA	Italy
Instituto Nazionale di Geofisica e Vulcanologia	INGV	Italy
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale	OGS	Italy
Marine Informatie Service BV	MARIS	NL
Utrecht University	UU	NL
Norwegian Meteorological Institute	met no	Norway
Nansen Environmental and Remote Sensing Center	NERSC	Norway
Consejo Superior de Investigaciones Cientificas	CSIC	Spain
Instituto Espanol de Oceanografia	IEO	Spain
METU Institute of Marine Sciences, Middle East Technical University	IMS	Turkey
European Center for Medium range Weather Forecasting International	ECMWF	Int.
Ocean Numerics Ltd	ON	UK
Plymouth Marine Laboratory	PML	UK
Southampton Oceanography Centre	NERC-SOC	UK
The Met Office	UK Met Office	UK
Instituto di Scienze dell'Atmosfera e del Clima	CNR-ISAC	Italy
CNR - Istituto di Studi Sui Sistemi Intelligenti per l'Automazione	CNR-ISSIA	Italy
Météo France	MF	France
Proudman Oceanographic Laboratory	POL	UK
University of Southampton	USOU	UK
Alcatel Space	ASP	France
University of Reading	UREADES	UK
Techworks Marine Limited	Techworks	Ireland
University of Bremen	GeoB	Germany
Consorzio Nazionale Interuniversitario per le Scienze del Mar	CoNISMA	Italy
University of Helsinki	U-HEL	Finland



OVERARCHING OBJECTIVE OF MERSEA - IP

Strategic objective

The strategic objective of MERSEA is to provide an integrated service of global and regional ocean monitoring and forecasting to intermediate users and policy makers in support of safe and efficient offshore activities, environmental management, security, and sustainable use of marine resources. The system to be developed will be the Ocean and Marine services element of GMES.

Project summary

MERSEA aims to develop a European system for operational monitoring and forecasting on global and regional scales of the ocean physics, biogeochemistry and ecosystems. The prediction time scales of interest extend from days to months. This integrated system will be the Ocean component of the future GMES system.

At the core of the system is the collection, validation and assimilation of remote sensed and in situ data into ocean circulation models that allow for the self consistent merging of the data types, interpolation in time and space for uniform coverage, nowcasting (i.e. data synthesis in real-time), forecasting, and hind-casting, and delivery of information products.

The project will develop marine applications addressing the needs of both intermediate and end-users, whether institutional or from the private sector, with the objective to :

- Improve the safety and efficiency of maritime transport and naval operations ;
- Enable the sustainable exploitation and management of ocean resources (offshore oil and gas industry, fisheries) ;
- More efficiently mitigate the effects of environmental hazards and pollution crisis (oil spills, harmful algal blooms) ;
- Improve contribution to ocean climate variability studies and seasonal climate prediction and its effects on coastal populations ;
- Improve national security and reduce public health risks,
- Advance marine research with the aim to better understand the global climate, the ocean and its ecosystems.

The project will lead to a single high-resolution global ocean forecasting system shared by European partners together with a co-ordinated network of regional systems for European waters which will provide the platform required for coastal forecasting systems. During the project the main pre-operational systems will be transitioned towards operational status and three of the centres will converge on a single ocean model framework suitable for both the deep ocean and shelf-seas.

The development of such a system requires an unprecedented level of collaboration and coordination of multidisciplinary research, development and operational activities. The project will federate the resources and expertise of diverse institutes, agencies, and companies in the public and private sector, in the fields of satellite data processing, in situ ocean observing systems, data management, ocean and ecosystem modelling, ocean, marine and weather forecasting, and fisheries.



ENHANCEMENT OF THE STATE OF THE ART

Ocean Observing Systems

GMES requires high quality and reliable information from fully validated global data sets, both remote sensed and in situ remotely sensed data from satellites deliver near real-time, long-term, synoptic, high resolution, global estimates of key parameters (e.g. sea surface topography, sea surface temperature, ocean colour, sea ice, winds). However, since they can sense only surface parameters, they must be complemented by in situ data, which are much more sparsely and irregularly distributed in time and space. The in situ data are indispensable for calibration of the satellite data, validation of the models, assimilation into the models and improving the assimilation of the satellite data.

One of the objectives of MERSEA is to develop further the European capacity in global ocean remote sensing data processing and distribution. A remote sensing workpackage will ensure the availability in real time of state-of-the-art remotely sensed global products optimised for supporting operational oceanography. Near real time and delayed mode products will be delivered over the period 2004 -2008. In parallel, processing systems will be improved through R&D activities and consolidated to become fully operational by 2008.

The **in situ observing system** has been revolutionised in the past few years by the ARGO program which is seeding the global ocean with thousands of autonomous profiling floats reporting temperature and salinity to 2000 m depth on a real-time basis. These data are essential for the modelling and assimilation within MERSEA. Thus, it is proposed to extend and contribute to the ARGO array to provide MERSEA with global, real-time upper ocean salinity and temperature information.

There are no observing systems providing routinely biogeochemical data, which are desperately needed by the modelling and forecasting system planned under MERSEA. This gap will be filled by the MERSEA activity of operating and demonstrating real-time multidisciplinary moorings in representative ocean regions ("provinces"). A profound need exists for the collection of multi-disciplinary in-situ data, since satellites cannot provide the required information (chlorophyll estimates are possible but only in the near-surface layer and need constant validation, while e.g. oxygen and nutrients cannot at present be observed from space), and no observing system exists for such type of information. Gliders and floats with multidisciplinary sensors are promising innovative tools to fill this gap, and MERSEA will demonstrate their value in operational systems.

Forcing fields (wind action, surface heat and moisture fluxes) obtained from numerical weather forecasting are essential to determine and forecast the ocean response. But as they are presently provided, they present several draw-backs : the parameterisations are simplified and not optimised for oceanic applications ; and available satellite data (scatterometer) are not used to their full resolution. MERSEA intends to improve the forcing fields and to provide operational products in support of the monitoring system.

Modelling and assimilation

The state of the art for the optimum combination of such diverse data sets is through assimilation into numerical models, which take explicitly into account the physics and dynamics which control the temporal evolution of the ocean¹. Systems such as FOAM, MERCATOR, MFS and DIADEM/TOPAZ for instance, have continuously demonstrated over several years the ability to monitor and forecast global ocean and European seas through routine assimilation of near-real-time satellite and in situ observations into 3D

¹ This is of course exactly the approach of numerical weather prediction systems for the atmosphere



ocean models. As participants in the international Global Ocean Data Assimilation Experiment (GODAE), the partners strive to ensure that these systems and their developments are at the most advanced level, and that they contribute to demonstrating the feasibility and the value of *operational oceanography*.

These monitoring systems must now be further upgraded, consolidated, more fully validated to ensure their reliability and transitioned to a state of readiness for fully operational monitoring during GMES. These tasks are part of the workplan for MERSEA.

While global models are necessary to provide the extensive coverage expected from GMES, higher resolution coverage is required for **regional** and **local** applications. On the regional level, operational models are run by national agencies (usually Meteorological Offices) to provide analyses and forecasts of sea state, storm surges, and sea-ice or icebergs, to forecast the drift of oil spills and to assist in search and rescue operations. Some of these systems are well developed and co-ordinated (in the North and Baltic Seas, for instance), but systems for other areas are either operating in a research mode –with uncertainty for recurrent funding and continuing operations- or are non-existent.

The key scientific and technical improvements to the regional models that will be achieved within MERSEA include the use of appropriate boundary data (*nesting*) from larger area models (e.g. the global model) ; increases in model resolution ; assimilation of available local data sets and high resolution remotely sensed data ; improvements in the modelling of the region of the shelf break and assessment of improvements in predictive skill; and ecosystem modelling. Finally, some of the pre-operational systems will transition towards pre-operational daily forecasts.

Marine applications

Some of the most significant marine services, in terms of safety at sea and risk prevention, are provided by NWP² centres in the form of wind, wave, storm surges, and sea-ice forecasts. These centres also provide assistance and support in case of accidents and disasters (search and rescue, oil spill forecasts). The quality and skill of these analyses and forecasts (particularly of freak waves and sea-ice) could be improved by the use of high resolution information on ocean currents and temperatures, which are presently not taken into proper account. MERSEA proposes to contribute to the development of enhanced marine services through the provision of high resolution currents in support of marine safety.

MERSEA will also develop products for final users such as the offshore oil and gas industry, fisheries fleets, forecasting of sea ice and iceberg drifts, improved current prediction for search and rescue operations, and improved sea state (surface wave) forecasts notably by better incorporation of wave-current interaction modelling.

Studies of **seasonal forecasting** are also proposed in this project, because of the very high stakes involved. NWP centres, produce such forecasts operationally, using rather low resolution ocean. It is known now that significant skill can be achieved in seasonal prediction in the tropics (particularly precipitation), if high resolution sea surface temperature fields are used to initialise the forecasts. MERSEA proposes to investigate and develop the methods required to incorporate high resolution ocean products into these forecasts, and to evaluate the improvement in predictive skill.

² Numerical Weather Prediction



SPECIFIC OBJECTIVES

In view of the state of the art, as briefly reviewed above, MERSEA has identified the following key specific objectives :

- Develop the systems needed, and use them, to provide real-time, high quality, validated, merged products from satellite data for surface height, surface temperature, ocean colour, sea-ice and surface velocity.
- Implement and assess the value of moorings and gliders for bio-geochemical data. Initiate routine provision of real-time data from specific research vessels. Make cost-effective contributions to the in situ system for the Mediterranean and the global Argo system. Collect in situ data and make them available in real-time through a unique server.
- Implement and test a high resolution global ocean model ; develop a deep ocean model for use in shelf seas and evaluate its performance on NW European shelf; evaluate methods for nesting of models ; develop and assess biogeochemical models ; assess the impact of several types of observations on the assimilation systems.
- Progressively implement a co-ordinated ocean and sea-ice monitoring and forecasting system for the global ocean and European seas, assimilating in situ and satellite data and providing high resolution forecasts on a daily or weekly basis for physical and bio-geochemical variables.
- Make systematic assessments of the performance of the analyses and forecasts of the physical and bio-geochemical variables.
- Assess the value of boundary data for regional forecasts and for two ocean coastal observatories; implement data assimilation methodologies for regional seas and test their impact.
- Develop an information management system that will deliver both real-time and delayed mode information to users, allowing them to exploit multiple data sets from many different sources with user-friendly internet-based interfaces. Provide full documentation and meta-data.
- Develop and demonstrate applications in support of the safety of marine operations including improved wave-forecasting, and forecasts for ship routing, the offshore oil and gas industry, oil spill drift and search and rescue.
- Implement research results and perform specific experiments to improve nowcasting (analysis) and forecasting for ecosystems, seasonal weather forecasting.
- Help to organize appropriate teams and agencies to establish the proper framework for the ocean component of GMES by 2008.

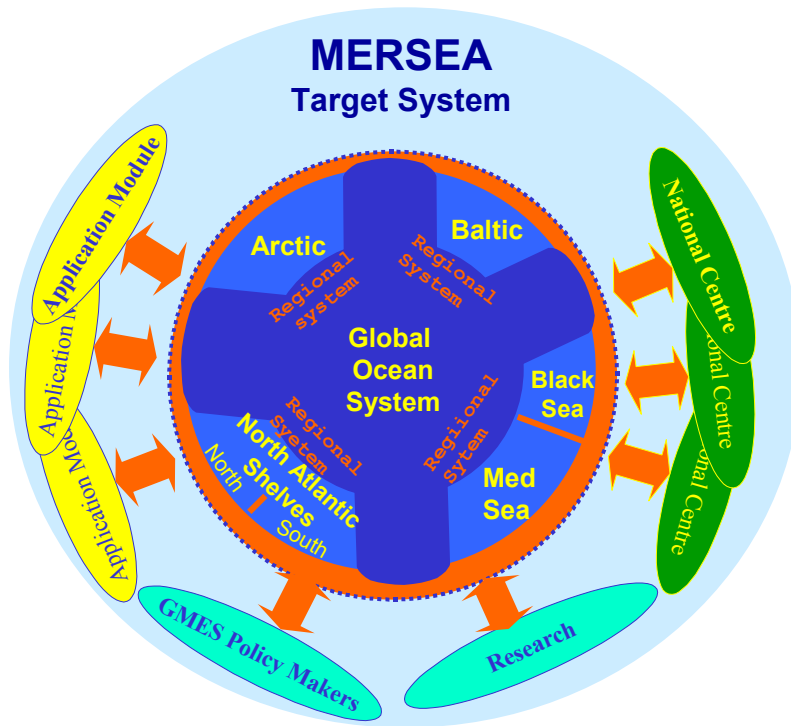


Figure 1 : Schematic of a European Ocean Monitoring and Forecasting System. All the sub-systems received, process, and assimilate data from remote and in situ sensors; they exchange information to elaborate and distribute products to intermediate users (Application modules), national centres and agencies (coastal monitoring, meteorological services), service companies, research laboratories, policy makers and the general public.

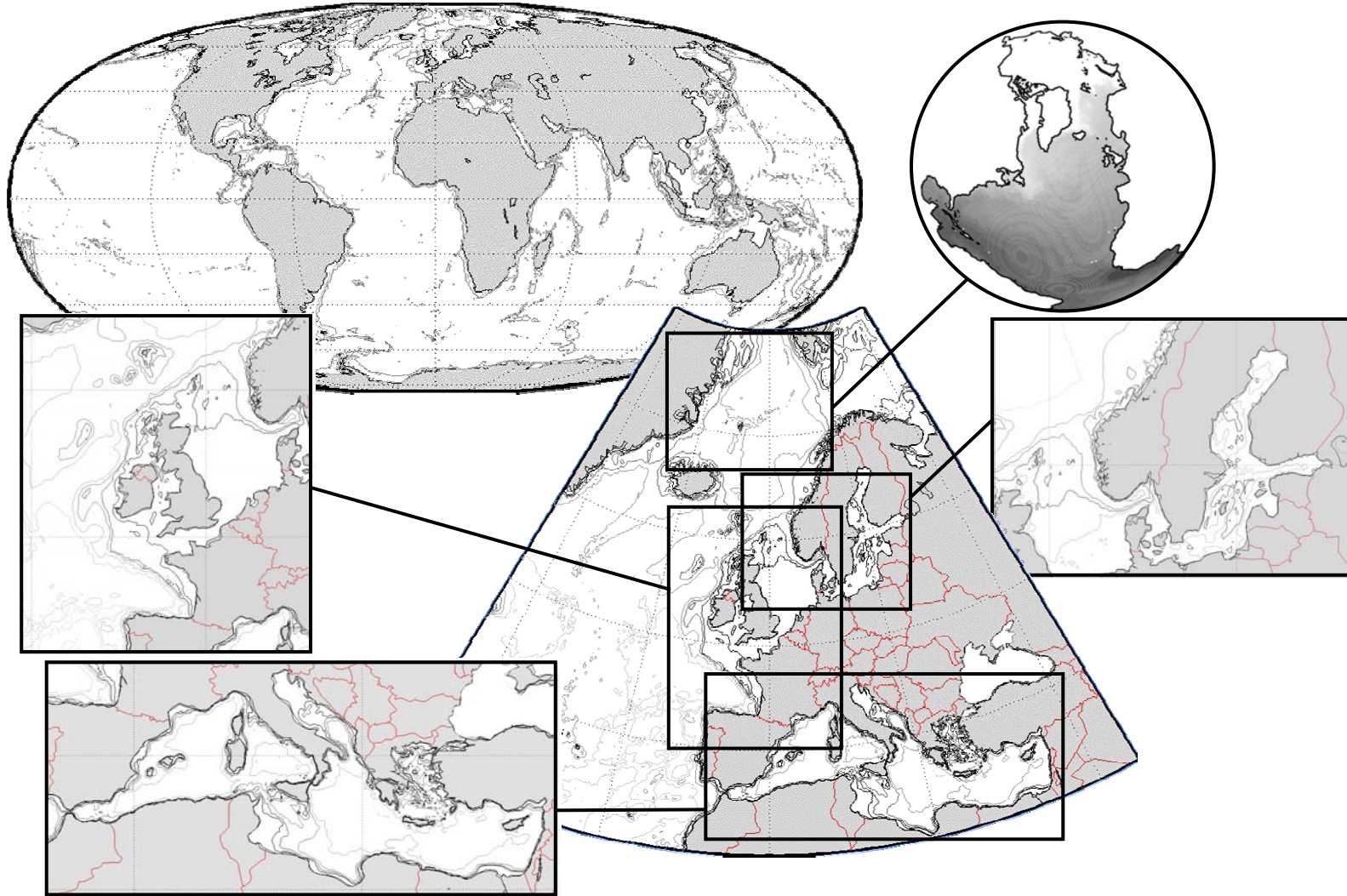


Figure 2 : Illustration of the geographical coverage of the MERSEA system, ranging from global to regional sub-systems. Exact boundaries are indicative only.