# PLENARY SESSION

## Theme 1

## THE STATE OF THE OCEAN – CURRENT CHALLENGES AND FUTURE PROSPECTS

**Tuesday 6 November 2007**
**09.00-10.30**
**Chameleon Suite**
**Corinthia Palace Hotel, Attard, Malta**

This conference theme focuses on critical issues such as climate change, threat to marine biodiversity and food security, marine disasters and coastal vulnerability, with special reference to their implications for Women and Youth. It also attempts to develop new approaches and methodologies for the participation of women and youth in the management of ocean space and sustainable ocean governance.

Chair: Hon. Vincent Galea, Minister for Competitiveness & Communications
Rapporteur: Mike Butler

# Speech by Hon. Vincent Galea

*Minister for Competitiveness and Communications, Malta*

Distinguished Guests, Ladies & Gentlemen, Good Morning.

It is a pleasure for me to be here addressing this conference.

We deliberate today on a most crucial topic: the present state of the oceans. Apart from the scientific aspects which *Pacem in Maribus* in general, and this session in particular addresses, we have to examine the impact on humankind, of such developments as climate change and its relationship to the ocean and to its resources. Let us not forget that 40 years ago, it was Malta which advanced the initiative at the United Nations, whereby ocean resources beyond national jurisdiction were declared part of humankind's patrimony.

In the same spirit of international solidarity, Malta also took the initiative at the UN whereby climate change was declared a common concern of us all. In so doing, Malta was being faithful to its vocation to safeguard not just the Mediterranean sea, which has bestowed and enriched its history, but also the conservation of the oceans around the world.

We now need to move forward suggesting that the technology necessary to give access to the riches of the ocean should be part of the common heritage. This concept was dear to Elisabeth Mann Borgese, who was the great mover behind that principle which Arvid Pardo famously enunciated at the UN one day forty years ago. That literally changed international law, endowing it with a deep sense of social equity that the previous idea of the freedom of the high seas was completely lacking.

The state of the ocean today does not just call for conservation, although that is a high ideal to which we all subscribe. Rather, we should emphasise that we want an ocean whose resources are guarded and developed in a sustainable manner. The sustainable development of the ocean is a responsibility we owe not just to ourselves but to those who come after us in the flow of history. Hence, rather than wanting to, as it were, to encase the sea so that it remains untouched, what this conference is propounding is an integrated management of its resources for the common good through that supranational authority, the Seabed Authority. In our view, this authority has yet to establish its credentials as a global entity, really active in the sustainable development of the ocean and its resources. Besides marine life and seabed minerals, this authority should encompass the riches below the seabed, as well as those economic sectors, such as tourism and shipping, which depend directly on the ocean for their sustenance and growth.

During this session, you will hear of the effects of climate change on polar regions. Dramatic as those consequences are, let us also bear in mind that we all, especially in the Mediterranean, already see and suffer what global warming brings about, affecting our daily lives and our sustenance. Energy from the ocean, properly harvested and exploited, and including the use of tidal and wave power, can help us seek more and more renewable resources. But let us not make the mistake of thinking that ocean resources, especially fisheries, are there for all time. On the contrary, let us admit that time is running out for us unless today we apply those measures which science and technology have strongly recommended that we adopt.

Malta, a maritime and insular nation in geography, but anything but insular in its perception of state responsibility, is willing and determined to play a continuing role in the campaign for a sustainable ocean.

Last month, to our satisfaction, we witnessed the launching of the Communication on Maritime Policy by Commission President Manuel Barroso and Commissioner Joe Borg. This Communication on Maritime Policy is a solid foundation for the establishment of integrated Maritime Policy that will usher a new era in decision-making, not just to safeguard our interest in the shipping, fishing and the tourism sector but at the same time to safeguard the marine and coastal environment, promote safety and security, as well as ensuring economic and physical well-being of communities living in coastal areas and islands.

# Assessing the Polar Oceans

David Carlson

*Director, IPY, International Programme Office*

**Abstract**
Coordinated international research programmes during the International Polar Year 2007 - 2008 should result in the most thorough assessment of the polar oceans ever conducted. Using ships, satellites, buoys, drifters, remotely operated and autonomous vehicles, deep-diving mammals, and regional and global models, IPY researchers will assemble an integrated assessment of polar ocean-atmosphere-ice systems, including polar marine ecosystems, and of the linkages of polar ocean systems to global ocean systems. IPY researchers will give particular attention to deep water formation processes in both hemispheres, to the role of southern ocean ecosystems in global carbon cycling, to physical and biological implications of changing sea ice, and to marine ecosystems endangered by exploitation, contamination and climate change. New information and new observing technologies from IPY will represent important components of future polar ocean observing systems.

# The Importance of the Professional in Meeting the Challenges and Future Prospects for the Oceans

Graham Hockley

*Director Policy and Professional Affairs –*
*Institute of Marine Engineering Science and Technology - IMarEST*

**Abstract**

The Oceans are surely Humankind's new frontier. Although human knowledge is ever expanding we know relatively little about what resources the oceans may contain, what opportunities they may offer to provide energy, new drugs, sources of food and create wealth generally. As in all frontier situations, throughout history, there is a temptation to get rich quick without considering the long term impact of ones actions. This paper will consider the role of the professional in the frontier environment, who or what that professional stands for and how they can and should ensure that developments are truly beneficial and sustainable.

**Key Words:** Oceans, Professional, marine, knowledge, ethics, sustainable

## Introduction

This paper will develop themes and personal observations that should provoke thought on the importance of the professional in overcoming the challenges facing the world's oceans. To do this it will review some current and predicted developments, the advantages that they should produce and perhaps more critically the challenges they will throw up. In particular it will then try and highlight the professional's role in ensuring that those challenges are met efficiently, economically, ethically and perhaps, above all, sustainably.

## Professional

As a starting point what or who is a professional needs to be defined. According to the Collins Thesaurus a professional is:

**Adept, Competent, Efficient, Experienced, Expert, Qualified, Skilled, Trained**

Using these words as key descriptors of a professional, the paper will look at three specific areas of development in science, engineering and technology. This is also appropriate as science, engineering and technology are part of the same continuum. Science explores and analyses the physical world to develop ideas and concepts that engineering then develops into practical useable items, which are technologies which in turn are used by humankind to provide goods and services, in short the basis of trade.

## Technology - Trade

Looking at these three in the reverse order and taking trade first. It will probably not come as a surprise, but roughly 90% of the world's trade is carried by sea at some stage or other on its journey from production to market. Maritime trade follows well established routes that are determined by geography, economics and to a degree history. The story the routes tell is not new and reflects the movement of raw materials to areas of production and from there to areas of consumption. However, not all the routes are established and new ones will continue to be developed into the future, for example the increasing flow of Natural Gas from Russia around North Cape. Significantly another new route is represented by the massive flow of manufactured goods from Asia and the Far East to Europe and America.

- Current figures show manufactured goods have now overtaken mining and agricultural products as the most significant proportion of world trade. This not un-naturally links in with the inexorable rise in world GDP over the last 50 years, and the exponential rise in world trade.
- Agricultural commodities are the only other category which shows a slight fall in movement by sea. However, this does not mean that world trade in agricultural goods is falling. It merely shows that many perishable goods are now carried by air.

Whether this rise in world trade will continue is undoubtedly a matter for debate and one that even experts may disagree upon. However, caveated by saying that current developments in the US economy may change things, it is generally predicted that growth will continue for a while leading to ever increasing trade, the vast majority of it using the world's sea lanes. Nonetheless, it may be worth considering that if shipyards fulfill their current order books for tankers, then their total carrying capacity may soon exceed that of current world oil production.

Consideration of the world's shipbuilding programme leads to the second area for discussion engineering, and in particular potential developments in ship design.

**Engineering – Ship Design**

Ship design and the associated power plants have changed out of all recognition since the demise of sail, which really began just over 250 years ago. Looking backwards, briefly, there is the move from paddlewheels to propellers; from reciprocating steam engines to steam turbines, diesels and gas turbines. The past is interesting, not least because it informs the future, but it is not our purpose of this paper to look back but to consider today and look forward. Thinking about today's developments there are:

- Massive bulk carriers, whether oil, gas or minerals.
- Vast container ships – perhaps the classic here is the Emma Maersk which last year was said to have delivered Christmas from China to the UK.
- High speed ferries with strange hull forms.
- Cruise liners carrying many thousands of passengers.
- There are common themes here: Size and Speed, although applied in different ways in each sector each is driven by business imperatives of that sector.

It is difficult to determine which way the industry will go in the future. There might be a return to some form of sail assistance to reduce fuel usage or perhaps there will be a move to ultra fast cargo ships to cut voyage time and reduce the number of vessels needed on any particular route. However, the infrastructure required by such vessels is extensive and will certainly need international agreement as well as considerable investment from multinational companies. Perhaps even more concerning would be the production of the proposed Mile Long floating city, a vessel housing around 40,000 people. If it were built there is even wild conjecture that the new Airbus 380 would be able to land on its upper deck. This project's supporters say it maybe seen as soon as 2095, a concept with potential for considerable impact on the sea area in its immediate vicinity. More realistically we may well see vessels such as the modular sea base within the next 10 to 20 years. A highly flexible facility constructed by bringing huge barges together in any configuration that may be required to build a port, airport or even a small town.

**Science - Climate**

A mile long city vessel may be huge, but it is nothing compared with the science issue of the moment - climate change; a subject of immense interest and concern to most.

It is obviously too big an issue to cover to any sensible degree in a short key note paper. However, we will look at just a few of the issues that will give the world pause for thought and cause professionals to exercise their true professionalism in dealing with them. The following are selected from a recent overview given by Dr. Jim Baker, former NOAA Administrator.

It is widely acknowledged that cooling the planet to counteract the effects of greenhouse gases could probably greatly ease the situation and reduce the effects of dangerous climate change. These are some types of geo-engineering that have been suggested:

- Artificial floating islands that would not only increase the area available for plants to grow and absorb Carbon Dioxide ($CO_2$) but would also provide habitats for food sources.

- Wave powered pumping systems which make the sea surface cooler by bringing up cold water from the depths have also been proposed. If this is managed so that sea surface temperature remains at around present levels this is fine. However, what about the impact in the deep ocean?

- Another possible amelioration mechanism would be to form artificial clouds in key areas of the world, thereby reducing the sun's heating impact. This is good providing it does not entrap heat under the cloud cover, thereby increasing surface temperature negative feedback effects further.

However, as we all know cooling the planet is only one way to reduce the impact of global warming. Another key method would be to halt or reduce the amount of $CO_2$ in the atmosphere. Two methods for consideration are:

- Firstly the enrichment of the ocean's surface with iron. In essence iron filings are cast onto the surface and the now nutrient enriched waters provide an ideal environment for increased phytoplankton production, essentially producing "Bloom" conditions. These phytoplankton absorb the $CO_2$ from the water and fix it within themselves as organic carbon. In time they die, sink to the ocean floor and eventually become part of future hydrocarbon deposits. However, this is not the whole story as, of course, the phytoplankton are a source of food to other organisms and carbon is released back into the system when the predators respire. This is just one of a number of possible untested side effects. Let alone whether the process will be viable on the scale required or will even be allowed under global legislation.

- Secondly, carbon storage facilitated by depositing $CO_2$ lakes in the deep ocean, greater than 3000m, where it would remain for a considerable period of time.

In short these processes offer possible solutions, but there are a large number of issues that should be understood and assessed in a professional manner before any of them are implemented on a large scale. A failure to do this might have significant unintended consequences and cause damage to the environment as great as that which the technique was trying to avert.

**The Professional**

Having given a very quick review of just some of the current and developing technologies that will affect the world's oceans, it is worth recapping the title of this paper:

**The Importance of the Professional in Meeting the Challenges and Future Prospects for the Oceans**

While also remembering those words associated to the professional:

**Adept, Competent, Efficient, Experienced, Expert, Qualified, Skilled, Trained**

The concept of a professional is not new and probably first emerged in the medical and legal professions hundreds of years ago. In essence then as now a professional should ignore his or her personal preferences to support what they understand to be accurate, factual and truthful. Over the years this has expanded to include a sound knowledge of their profession and the developments within it, in effect all those things covered by these adjectives. In other words they may be relied upon by others to be all those things, but why? Well it is covered by another long standing concept, INTEGRITY. This may perhaps be summed up by this extract from a professional code of conduct:

To safeguard the public interest in matters of safety, health and the environment. They shall exercise their professional skill and judgment to the best of their ability, and discharge their professional responsibilities with integrity.

With this in mind it is appropriate to recap on the issues raised above:

- The growth in world trade – essential for humankind's future prosperity and development, but currently happening at such a rate that individuals and systems are under extreme pressure and may not react as expected unless professionally reviewed.

- The recent collision of a vessel with a gas platform in the North Sea is perhaps one extreme example of a lack of professionalism. It was in part caused by the stress the ship's master was under. This highlights the fact that it is sometimes the professional's role to say, "No, I cannot do what you ask".

- There are exciting concepts in the development of ship design with great potential for good and benefit. It is the professionals role to ensure that this good and benefit is not lost because aspects of the new design have unforeseen consequences on the wider environment. For example at what range will a high speed crafts wash impact on the shore, seabed and indeed marine life.

- Finally and most importantly, the impact of climate change must be addressed. It is a new problem with the potential for impacts on humankind that we cannot yet conceive. Similarly, there must be potential for solutions that we cannot yet conceive and it is here that the professionals truly come into their own: Conceiving, Assessing, Designing, Developing, Operating, Reviewing, Learning and Improving on the technologies, so that viable solutions may be found that have as little negative impact as possible on our oceans and planet, even when to propound these solutions may not be the easiest or most appealing option.

In conclusion, if humankind is to meet the challenges and future prospects for the oceans in a way that is sustainable, viable and ethical. Then the solutions that will have been developed and put forward will have been conceived and taken forward by people who are professional in their approach and attitude whether they think of themselves as professionals or not.

# Climate variability events and marine forecasting activities in the Mediterranean Sea: the operational oceanography approach

Nadia Pinardi

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**Abstract**
The Mediterranean Sea long-term ocean variability has been studied intensively in the past twenty years and results illustrate the correlation between atmospheric forcing variability and ocean response at seasonal, interannual and interdecadal time scales. Major climate variability events have occurred in the eighties and nineties driven by long-term interannual variability of atmospheric forcing connected to the North Atlantic Oscillation-NAO index during winter and to regional climate regimes, such as Etesian wind variability. In addition, teleconnections of the Mediterranean climate variability with Indian Monsoon and NAO variability have been studied. Water mass decadal variability has been detected in the observations and the model simulations. Moreover, shorter-term ocean variability, connected with the timescales from the seasonal to the mesoscales, has been thoroughly investigated.

This has produced the implementation of a Mediterranean ocean Forecasting System-MFS to forecast the ocean variability in the Mediterranean Sea from the global scale to the shelf areas, from the hydrodynamic components to the biochemical variability at the weekly to monthly time scales. The MFS has started operational activities in January 2000. Presently it produces daily analyses and daily 10-day forecasts of currents and temperature and salinity fields for the entire Mediterranean at approximately 6 km resolution.

The main elements of the MFS - simultaneously operating in near real time observational data network, general circulation model and data assimilation scheme - were implemented as part of the Mediterranean Operational Oceanography Network financed by several EU funded projects, a collaborative effort joining together 26 scientific and operational Institutions around the Mediterranean. Several end-user products were already produced for the sustainable planning of marine resource exploitation and for the management of emergencies at sea, but it is in the future years that the benefit of a science-based approach to operational oceanography will be felt for the entire Mediterranean community.

## Introduction

Operational oceanography has started in the nineties to realise a world wide system of monitoring and forecasting of the marine environment from the open sea to the coastal areas in order to give the continuous assessment and predictions of the tri-dimensional marine state and its associated biochemical components, from pollutants to ecosystem components. In the Mediterranean several European Projects and countries national projects have started to develop the Mediterranean Forecasting System (MFS) in the late nineties.

Mediterranean Sea environmental problems that are of concern for MFS are:

- changes in the basin hydrological cycle in underground waters and in precipitation events;
- fate and dispersal of oil and contaminants in the open sea;
- fate and dispersal of land derived nutrients and contaminants;
- fishery activities and aquaculture;
- algal blooms and adverse effects in coastal areas (anoxia, turbidity, etc.);
- coastal erosion;
- ecosystem changes, invasive species and long term adverse marine trends.

All these problems require a scientific basis of understanding, monitoring and modelling of the marine environment from the basin scale to the coastal areas. MFS is implementing and demonstrating the marine integrated information system, from monitoring to forecasting, that will give this scientific information to environmental policy makers.

The MFS started operational activities in January 2000. Presently it produces daily analyses and weekly 10-day forecasts of currents and temperature and salinity fields for the entire Mediterranean at approximately 6km resolution. The products are available at http://gnoo.bo.ingv.it/mfs.

### The Mediterranean Forecasting System at a glance

The Mediterranean Forecasting System is based upon the demonstration of the real time functioning of an integrated system composed of: a) the Near Real Time Observing system; b) a numerical forecasting systems at basin scale and at sub-regional scales; c) a product dissemination/exploitation system. Forecasts are produced once a day at the basin scale for 10 days and at the sub-regional scale for 5-7 days.

The observing system is working in real time and all data (satellite and in situ) are assimilated into the MFS model. The forecast and analysis data are available in real time to different users. The MFS hydrodynamics has been coupled recently with an ecosystem forecasting model (see http://poseidon.ogs.trieste.it/cgi-bin/opaopech/mersea) which forecasts primary producers biomass and nutrients in the open ocean areas of the basin.

MFS represents the Mediterranean component of the future European Seas forecasting system that is now under development within the European GMES initiative (Global Monitoring for Environment and Security, http://www.gmes.info ).

### The Mediterranean Operational Oceanography Network

MFS evolved from 2005 in a network of Institutions around the Mediterranean Sea that are sustaining the operational systems started with European funded projects. The Mediterranean Operational Oceanography Network (MOON, see http://www.moon-oceanforecasting.eu ) now assembles various basin scale models and sub-regional models, the observing system and the downstream applications from the forecast products.
This network is an international initiative within the EuroGOOS Regional Alliance and it coordinates its activities with the other Regional Alliances present in the region, such as MedGOOS (http://www.medgoos.net). This allows to cover all aspects of the growing field of operational oceanography from real time observations and forecasts to capacity building activities.

### The large scale observing and data management system

The observing system components of MOON are: 1) the satellite data; 2) the Ship Of Opportunity Program (SOOP) vertical profiling system; 3) the Mediterranean Moored Multidisciplinary Array (M3A) observing platforms and 4) the autonomous drifting and profiling systems.

Real Time remotely sensed data collection and analysis is the backbone of nowcasting/forecasting in the ocean. For the Mediterranean Sea, real time Sea Surface Temperature (SST, Figure 1) and Sea Level Anomalies (SLA) are produced daily and assimilated in the forecasting ocean model.

The SOOP for the Mediterranean Sea has been organised for vertical temperature profiles from XBT sensors. The along track nominal resolution is 12 nm and XBT are used down to 900 meters.

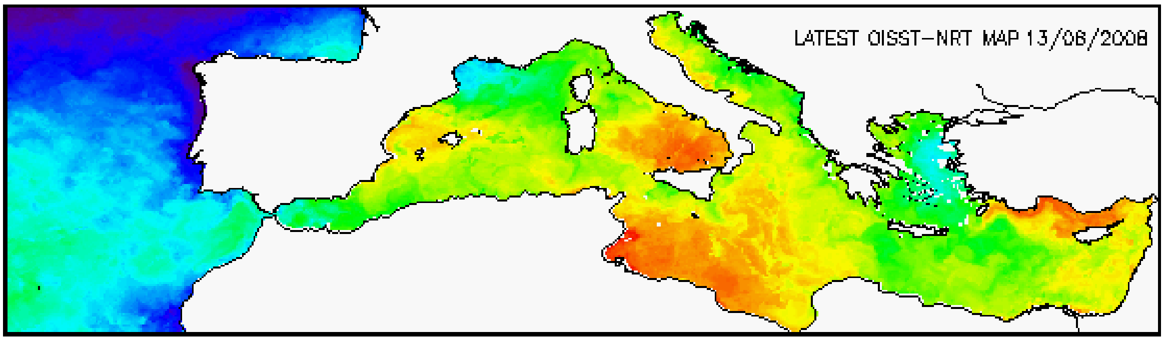


Fig. 1: Sea Surface Temperature data from a composite of satellite data for the August 13, 2008. The data are produced by the GOS - CNR group at the following web site: http://gos.ifa.rm.cnr.it/

The Mediterranean Moored Multisensor Array (M3A) design fulfils the requirements of MFS in situ multidisciplinary observations. The system is used to monitor the high temporal variability of the air-sea physics, the upper thermocline variability in temperature and salinity, the euphotic zone biogeochemistry for the open ocean regions. The monitored state variables are: air temperature and dew point temperature, surface pressure, surface winds, precipitation, solar radiation for the surface, temperature and conductivity, oxygen, fluorescence, turbidity, and nitrates at selected depths. Three monitoring stations are now operational in the Mediterranean Sea, one in the Ligurian Sea, one in the Adriatic and the last one in the Aegean Sea.

The autonomous drifting and profiling network for the Mediterranean Sea consists of a high space-time resolution network of autonomous subsurface profiling floats. A total of 20 to 25 profiling floats were released between 2004 and 2006 with a parking depth of 350 meters, profiling down to 700 and 2000 meters every five and twenty five days respectively. Another profiling system in use in the Mediterranean Sea is the Glider array that in 2005-2006 collected data for the first time in the Ionian Sea from the surface down to 200 meters. Nowadays new gliders are at work in different regions of the Mediterranean Sea and the data are available in real time.

The overall MOON sampling scheme for the 2004-2006 period is shown in Fig. 2.

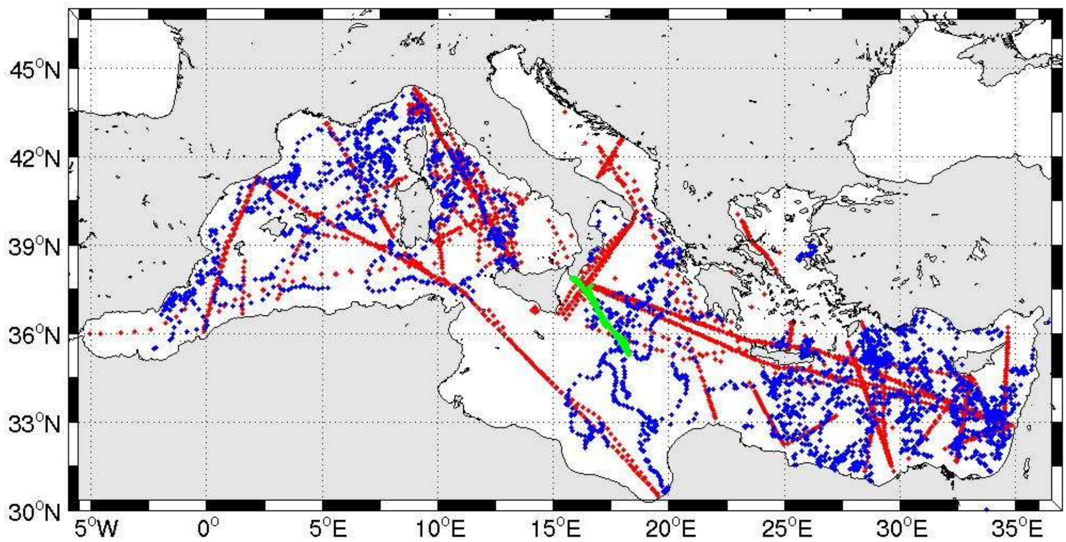


Fig. 2: The overall sampling by drifting buoys (ARGO), SOOP XBTs and gliders from the period 2004-2006.
Connected to the multisensor sampling scheme, MOON has organised a data management system at the regional level that will consider both real time data dissemination and delayed mode quality control and archiving. This is necessary since regional data are at higher resolution than required for the global ocean and will require adapted quality control procedures.

**The modelling and forecasting system**

Ocean current forecasts are possible only if accurate initial and boundary conditions are known with sufficient accuracy and a numerical model is used to predict the future evolution of the flow field. In order to fulfil these requirements, an assimilation system and a numerical model have to be developed, coupled to the observing system data collection in real time. In MOON the basin scale MFS model assimilates all data available in real time with a multivariate data assimilation scheme.

Other two basin scale models are available but at lower resolution. Aiming at a better description of the dynamics and processes in the different areas of the Mediterranean Sea, MOON includes models resolving different domains and scales, ranging from several to few km. Nested in MFS basin scale model, nine high-resolution sub-regional and shelf models were implemented and are now offering products at an operational level. Recently the MFS has been coupled offline with a biogeochemical model that is now forecasting once a week the Chlorophyll and the nutrients in the open ocean areas of the overall basin. In Table 1 we list the available forecasting models, some characteristics of the codes and the resolution.

Table 1: MOON regional, sub-regional and shelf operational models description.

| Model Name | Institute | Country | Model | Resolution | Region |
|---|---|---|---|---|---|
| MFS | INGV | Italy | OPA | 1/16° | Basin |
| OPA-BFM | Istituto Nazionale di Oceanografia e Geofisica Sperimentale | Italy | Biogeochemical Flux Model | 1/8° | Basin |
| --- | MERCATOR | France | OPA | 1/15° | Basin |
| POSEIDON | HCMR | Greece | POM | | Aegean Sea |
| ESEOMED | Puertos | Spain | DieCAST | 1/20° | Western Mediterranean |
| PREVIMER | IFREMER | France | MARS3D | 3 km | North-western Mediterranean |
| SCRM | IAMC-CNR | Italy | POM | 1/32° | Sicily Strait |
| AFS | INGV | Italy | POM | 1/45° | Adriatic Sea |
| ALERMO | University of Athens | Greece | POM | 1/30° | Aegean-Levantine |
| ROSARIO-II | IOI-Malta Operational Center | Malta | POM | 1/64° | Malta Shelf |
| CYCOFOS | Oceanogr. Center Univ. of Cyprus | Cyprus | POM | 1/60° | North-eastern Levantine |
| KLEVANT | Institute of Marine Sciences, Middle East Technical University | Turkey | POM | 1.35 km | Cilician basin |
| SELIPS | Institute of Oceanography and Limnology Research, Ltd | Israel | POM | 0.01°-0.012° | South-eastern Levantine |

Ocean forecasts require atmospheric forecasts to derive wind stresses and heat fluxes that force the ocean models. Most of the basin scale models use the European Center for Medium Range Weather Forecasts (ECMWF) deterministic ten days forecasts and analyses for the hindcasts. The sub-regional and shelf models use more resolved atmospheric forecasts such as the SKIRON forecast at high resolution for the whole Mediterranean Sea (http://forecast.uoa.gr) and/or the Aladin forecasts from MeteoFrance.

The products of all the forecasting systems are: regularly mapped fields of hydrodynamic state variables such as sea level, tri-dimensional currents, temperature and salinity, heat fluxes, water fluxes and wind stresses. Waves are also part of the operational systems but they are still uncoupled to hydrodynamics. In addition, derived products such as transport through Straits, mean values of state variables over specific areas are offered in a case by case specific end user need.

Validation and assessment of the quality of all the forecasting systems is an on-going activity by all the operational models. The quality control protocols involve the comparison with independent data and intercomparison between different model outputs.
Ensemble forecasting techniques are being developed that will ensure proper consideration of model and forcing errors.

**MOON end-user applications**

MOON makes available the forecast with a Web visualization system that can be accessed from a single entrance point, i.e., the MOON service Web portal (http://moon-oceanforecasting.eu). This service helps to find the available products in forms of maps of currents and other state variables. An example of the visualization service for the MFS basin scale model is given in Fig. 3.

The products from all the existing forecasting and observing systems are exchanged between the MOON Members and several applications have, and will be, developed with multiple environmental products inputs.

The end-user applications that exploit the nowcasting/forecasting products are mainly concerned with:

- oil spill and contaminant prediction models;
- floating objects models for search and rescue;
- ship routing and safety of maritime transport;
- integrated coastal management tools related to impacts of climate change;
- ecosystem and environmental oriented indicators from operational oceanography products;
- relocatable models for fast emergency intervention at sea;
- stock assessment and management in the open sea;

The oil spill modelling efforts have been the first to start in the MFS and then MOON community applications. Several oil and contaminant spill models have been coupled in the past years to the environmental data produced by the MOON forecasting systems. One of them, so-called MEDSLIK oil spill model is operationally integrated into MFS and several sub-regional forecasting systems. An important application of this oil spill real time forecasting system has been the assistance given to UNEP/MAP REMPEC Office for the management of the Lebanon accident in July 2006. The MEDSLIK integrated in CYCOFOS and MFS gave reliable forecasts of the oil spill dispersal along the Lebanon and Syrian coasts.

All the listed applications have been experimented in the past three years at different space and time scales. MOON should facilitate the development of all these applications making evident the importance of operational oceanography for the sustainable development of open ocean and coastal areas.

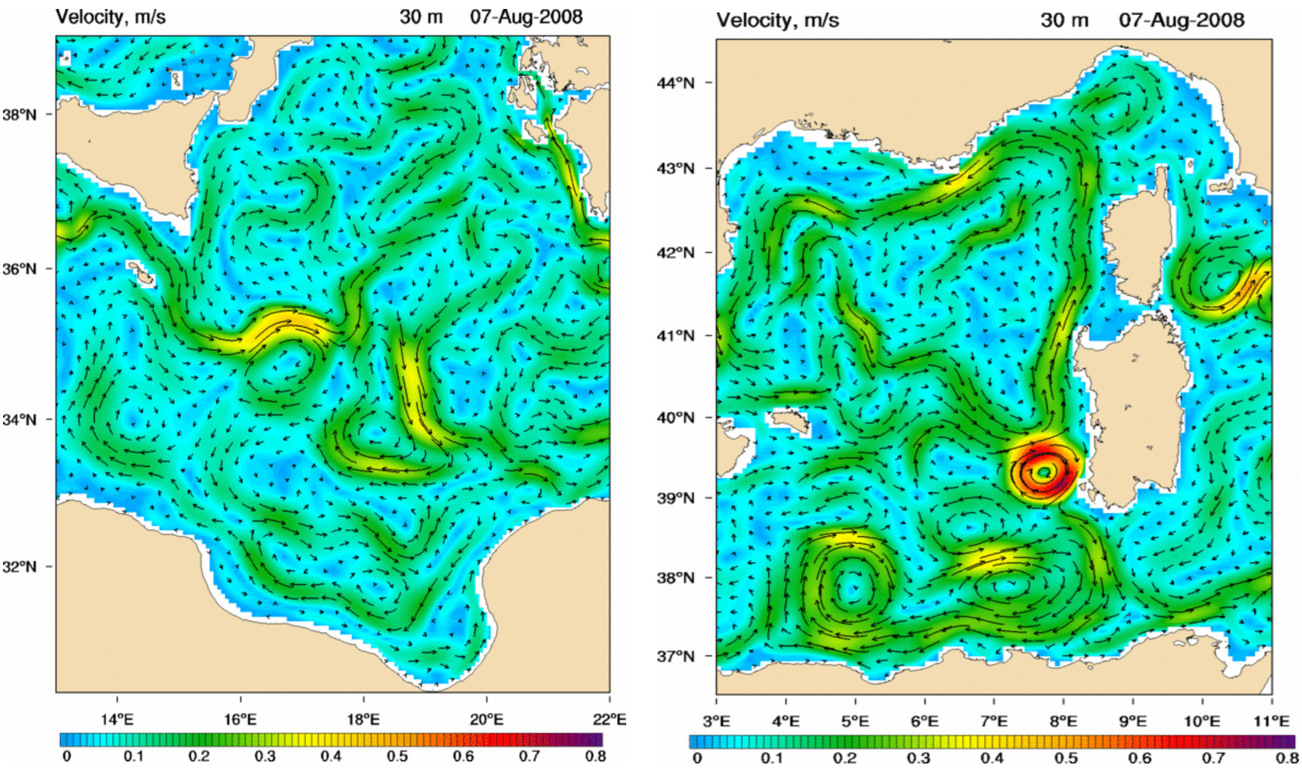


Fig. 3, 4: Basin scale ocean currents from the MFS Web portal at http://gnoo.bo.ingv.it/mfs.
Left panel: Ionian Sea currents; Right panel Western Central Mediterranean currents for August 7, 2008. The current directions are shown by arrows and the amplitude with colour in $ms^{-1}$.

**Conclusions**

A short term forecasting system for the Mediterranean basin scale and the coastal areas has been developed that provides continuous monitoring of the flow field evolution and its changes. Such a system is the backbone for ecosystem and pollution dispersal predictions that already provide forecasts of coastal algal biomass variability, oil spill fate and dispersal and indicators of ecosystem health and change.

This system also provides the meaning to improve our understanding of the Mediterranean Sea variability and climate change impacts, making available data of unprecedented time and space continuity.