

Theme Session E

Operational Oceanography

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ICES CM 2006/E:01

Tackling the appropriate processes, temporal and spatial scales for fisheries Operational Oceanography

Benjamin Planque

Fish populations fluctuate in abundance, even in the absence of fishing, and the causes of these fluctuations have been searched for in the physical environment since the beginning of the 20th century. Typical development of individual fish includes egg, larvae, juvenile, and adult phases which sense the environment at very different spatial and temporal scales. Typically, eggs may act as passive drifters over a period of a few days to weeks, whilst adult fish undergo active migration over tens to hundreds of kilometres and live for years to decades. The physical processes involved are specific of each life stage. Here, it is argued that physical processes related to fish recruitment mostly occur at the meso-scale (10–100 km), which calls for the development of Operational Oceanography to hindcast and forecast typical mesoscale features such as fronts and eddies. The operational products also need to fit with current (and possible future) fisheries assessment and management practices, i.e. they need to take the form of easy-to-use indices, available on an annual or seasonal basis, and available for past periods of at least several decades.

Keywords: mesoscale, thermal fronts, river plumes, vortices, hindcasts, hydrography.

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ICES CM 2006/E:02

Applications of Operational Oceanography to fisheries management: the case of the anchovy in the Bay of Biscay

Laure Buffaz and B. Planque

Fish population size may fluctuate strongly from year to year, and these variations can be directly related to those of recruitment. From birth to the stage of recruit, individual development takes place in different spatial and temporal physical environments. Controlling physical processes are diverse and occur predominantly at the mesoscale (e.g. upwellings, fronts, river plumes, ...). The understanding and quantification of these structures may allow for early recruitment estimates for use by fisheries

management. Operational Oceanography products can be used to identify physical processes so that relevant information can be provided in a timely fashion for fisheries assessment and management. Here, an application of Operational Oceanography to fishery management is presented for the stock of anchovy (*Engraulis encrasicolus*) in the Bay of Biscay. Anchovy recruits may contribute up to 75% of the adult population, so that recruitment assessment is critical for stock size predictions. Previous studies have already established relationships between recruitment and hydroclimatic indices. However, physical-biological models are simplified representations of the real system and not all physical parameters are observed or modelled adequately, so these models have been limited in their forecasting capabilities. In the present work, we suggest an approach which can account for incomplete representation of the physical-biological system. The model, based on quantile regressions, does not predict the expected recruitment, but predicts the maximum recruitment which can be expected under observed physical conditions. The model is expected to be more robust than previous models which did not account for incomplete knowledge/representation of the environment-recruitment relationship. It can constitute a powerful tool for providing advanced warning when recruitment is expected to be low as a response to environmental conditions.

Keywords: anchovy, environmental indices, recruitment, quantile regression, Bay of Biscay.

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ICES CM 2006/E:03

On modelling of a HAB possible advection at North-west Iberia

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A three-dimensional hydrodynamic model is applied in the NW Iberian Peninsula Coast to study how a strong inshore northward advection of a toxic dinoflagellated bloom took place at the end of the upwelling season in 2005.

Toxic dinoflagellated blooms have happened before in different years (1986, 1990, 1995, and 1998) at the end of autumn. The advection of the population of toxic cells from outside was cited as a possible cause of these HABs in Galician Rías. This would explain why blooms have

been found in Portuguese waters several weeks before the Galician coast. In those papers, a thermal inshore poleward plume (different from the offshore poleward current visible from satellite images) is suggested as a possible cause of the northward advection. However, the hydrodynamic force is not clearly identified yet.

In this study, a three-dimensional model with realistic forcings is used during a typical autumn season. This is typically the period when the northward flux advecting HABS from Portuguese Coast to Galician Rias is established. The importance of the different factors involved (wind forcing, Iberia Poleward, buoyance plume,...) is studied.

Keywords: HABs, NW Iberia, hydrodynamic model, toxic dinoflagellated bloom.

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ICES CM 2006/E:04

Automated measuring system for monitoring of coastal waters: Synthesis of results of the EU-funded FerryBox project

Franciscus Colijn, Wilhelm Petersen, Henning Wehde, and Friedhelm Schroeder

Within the EU-funded project FerryBox during a three-year period 9 ferries in European waters were used to make on-line observations of standard oceanographic parameters (water temperature, salinity, turbidity, chlorophyll *a* fluorescence). On selected ferries additional observations were made with an ADCP, with nutrient sensors, pH, or oxygen sensors. A few trials were made with a flowcytometer and with a FRRF. Results of the measurements will be presented. Apart from the *in situ* observations data were combined with remote sensed data from the ENVISAT satellite, to obtain information about the scale of observed phenomena such as the extension of algal blooms. Several efforts were undertaken to use the operational data as input to ecosystem-oriented models as well as for water transport models.

The strength of the system is that detailed environmental information for coastal and offshore waters becomes available without the need of expensive ship time of research vessels. Therefore the FerryBox system has proven to be a cost-effective alternative for regular monitoring of water quality in coastal areas. However, also scientific applications were made to study the extension of eutrophication phenomena, upwelling, and long distance effects of river inflows. By using the ADCP estimates of sediment transports in a tidal inlet could be made. Examples of the different applications will be presented. FerryBox has been adopted as a pilot project for GOOS.

Keywords: Operational Oceanography, GOOS.

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ICES CM 2006/E:05 – Withdrawn

ICES CM 2006/E:06

Phosphorus regulation of the cyanobacteria development in the Baltic Sea

Monika Nausch and Günther Nausch

Diazotrophic cyanobacteria are an important component of the phytoplankton community in summer. For calculations and modelling of the nitrogen fixation rates, often the phosphate excess after the spring phytoplankton bloom in May was used because phosphate declines until summer when cyanobacteria appear often in high biomass. However, these observations are based mainly on data which were obtained from cruises in May and in July or August. In 2001, 2004, and 2005 phosphorus pool sizes were investigated in the eastern Gotland Basin in a higher temporal resolution to describe their changes in relation to the cyanobacterial development. The results showed that the phosphate excess in May is consumed already in the middle of June before the main period of the cyanobacterial development occurred and that the decrease of phosphate was not accompanied by an increase of particulate and dissolved organic phosphorus pools. Phosphate uptake by phytoplankton and export of particulate organic phosphorus had to be balanced. It was calculated that the phosphate excess was not sufficient to realise the phytoplankton growth in June. Additional phosphorus sources were necessary.

Vertical and lateral transport processes, remineralization, as well as the usage of dissolved organic substances can close the gap. The subsequent cyanobacterial development seemed to be based on phosphorus stored in the biomass produced in June. During further growth, cyanobacteria reduce their internal phosphorus pool which is reflected in C:P ratios. Finally, cyanobacteria form surface blooms and collapse due to phosphate limitation.

In recent years a new phenomenon was observed in the Baltic Sea. Despite extremely high concentrations of phosphate remained in the summer surface layer of the Bornholm Sea, no remarkable cyanobacterial biomass developed.

Possibly, there exists a limitation by other factors like iron or an inhibition by sulphate.

Keywords: Cyanobacteria development, phosphorus regulation, phosphorus pool sizes.

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ICES CM 2006/E:07

On creating sustained Operational Oceanography in Europe

Hans Dahlin, Director EuroGOOS

Operational Oceanography is defined in many different ways depending on the background of the person who makes it. One definition is to be able to deliver oceanographic data, products, and services when required by a user. This means a service which in many cases has to be available 24 hours every day, but it can also include services with a regularity of a year. Compared with operational meteorology, weather and climate service, Operational Oceanography still has a long way to go. Global and regional intergovernmental conventions, including the now old ICES convention, have required and stimulated development of Operational Oceanography. ICES "Service Hydrographique" is a good example.

A wide range of operational marine services has existed for decades, e.g. ice service, drift forecasts, and environmental trend monitoring, but the development of the Global Ocean Observing System, GOOS, has introduced a strategy for a more coherent implementation of Operational Oceanography from global to local scales.

In Europe, governmental agencies with national responsibilities for marine services and research established an association in 1994 to promote and co-ordinate the development of GOOS and European Operational Oceanography – EuroGOOS – which now has 33 member agencies. At present priority is given to pan-European co-ordination, GMES, GEOSS and the sustainability of observations, products, and services.

The justification for Operational Oceanography is user requirements. Before operational services are implemented an important task is to harmonise what oceanography can produce and what the users can really use. The ICES Planning Group on the North Sea Pilot Project, PGNP (NORSEPP) are now in their second year of testing the production of quarterly reports. This process needs to be continued for fisheries management and other user areas.

Keywords: GOOS, EuroGOOS, PGNP, GMES, GEOSS.

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Modelling cyanobacteria bloom variability in the Baltic Sea

Thomas Neumann, F. Janssen, and G. Schernewski

Common features of the Baltic Sea are heavy cyanobacteria blooms in summer. Although these blooms regularly occur the intensity of the blooms changes from year to year as well as within decadal time scales.

With the aid of a 3D ecosystem model of the Baltic Sea we have simulated cyanobacteria development under different conditions. We found out that anthropogenic changes in nutrient loads and the atmospheric forcing in the winter season influence the strength of cyanobacteria blooms. Both mechanisms regulate the available excess phosphate (with respect to the Redfield-ratio) and with it the precondition for cyanobacteria blooms.

Keywords: cyanobacteria, modelling, Baltic Sea.

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ICES CM 2006/E:09

An operational oceanographic service system for the Baltic Sea

Lennart Funkquist

As a result of a multilateral agreement between Baltic Sea governments, SMHI has undertaken the task to run a 3D operational ocean model (HIROMB) for the Baltic Sea including Skagerrak, Kattegat, and the Sounds. The model runs twice a day, each time producing a 48-hour forecast. The results are immediately accessible to national institutes via ftp and a WEB page. The HIROMB model has recently been updated to include data assimilation of SST, sea ice parameters, and salinity and temperature profiles using the method of optimal interpolation.

The ocean model system contains a fully coupled sea ice model and a biochemical module. Important for the ecosystem modelling is the forcing by daily river runoff including concentrations of nitrogen and phosphorus.

There are several important services that use the outcome of the model system. Most important is the SeaTrack-web, an internet application mainly developed for tracking oils spills. It can be run at almost all relevant agencies around the Baltic and has successfully been used for a number of severe oil spills and sea rescue actions. Other applications worth mentioning are modelling of the drift of plankton and fish larvae.

The biochemical model is used both in the operational service and in assessments of environmental impacts.

Keywords: Operational Oceanography, Baltic Sea.

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ICES CM 2006/E:10

Development of a European Marine Ecosystem Observatory (EMECO)

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There are a number of current initiatives to establish collaboration between European national and multi-national agencies to maximise benefits from operational monitoring programmes (e.g. EuroGOOS, ECOOP, and GMES). As pressure upon national resources mount and growing awareness of environmental problems with a transboundary nature continues, for example at a catchment level in the Water Framework Directive and for a prospective European marine directive, the need for (international) collaborative regional initiatives have begun to be realised. As the first step towards establishing a wider regional initiative a European Marine Ecosystem Observatory (EMECO) has been established within the North Sea.

To develop EMECO (www.cefas.co.uk/emeco <http://www.cefasdirect.co.uk/EMECO>) a bottom-up approach has been adopted based upon collaboration between agencies with statutory responsibilities for a range of environmental pressures from monitoring and assessment of nutrients and hazardous substances, wave monitoring to fish stock assessments. The monitoring programmes associated with such activities are by nature long term and these programmes form key components of EMECO. However, there are a range of other programmes with either a relevant North Sea component (EU Ferry Box programme, International CPR programme, Smart-Buoy programme) or are part of wider initiatives (e.g. satellite remote sensing) that will also contribute to the observatory. It will also embrace initiatives to protect and conserve renewable and sustainable resources such as Marine Protected Areas and closed area for fisheries such as the Dutch Cod Box. The observatory will provide an opportunity to integrate research with monitoring and assessment programmes and to undertake reviews at a regional level to identify gaps in information and develop strategies to address shortcomings.

Within the ecosystem approach, ICES is increasingly aware of the need to include ecosystem considerations in its fisheries assessment models in order to enhance their predictive properties. Moreover, ICES readiness to carry out integrated assessments could be greatly enhanced by the scientific framework embedded in EMECO.

This paper will describe the approach taken so far with EMECO, will explore the relationships and chances for collaboration with other initiatives (ECOOP GMES, EuroGOOS) and will examine how EMECO might contribute to ICES needs for environmental information in fisheries and ecosystem advice.

Keywords: ecosystem observatory, monitoring, Ferry Box, Smart-Buoy, remote sensing.

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ICES CM 2006/E:11

Estimation of ecosystem changes exemplified by fish community from the Irminger Sea as a result of active water warming in the North Atlantic in the last decade

Andrey P. Pedchenko and A. V. Dolgov

Regular monitoring of hydrographic conditions carried out by PINRO in the North Atlantic showed active warming of water in the upper 500-m layer of the Irminger Sea beginning in 1995. Based on the data from the trawl-acoustic surveys of 2003–2005 the composition and structure of the Irminger Sea pelagial ichthyocenosis are considered. As compared to the data collected in the 1980s significant changes caused by the increase in water temperature have been found. The broader distribution of many fish species northward and the migration of warm-water fish species to the Irminger Sea from more southern areas of the Atlantic have been noticed.

Keywords: distribution, hydrographic conditions, the Irminger Sea fish species, ichthyocenosis, pelagial.

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ICES CM 2006/E:12

Modelling the dynamics of harmful blooms of *Chattonella* sp. in the Skagerrak and the Kattegat

Kari Eilola, E. Almroth, L. J. Naustvoll, P. A. Andersen, and B. Karlson

The presentation shows observations, satellite images, and model results describing the growth and spreading of *Chattonella* sp. flagellates in the Skagerrak and the Kattegat. *Chattonella* sp. is a harmful alga that may cause fish kills through damage to the gills. Calm weather, stable water column stratification, and low turbulence may facilitate the onset of a *Chattonella* bloom. Results from the three-dimensional hydrodynamical model HI-ROMB (High Resolution Operational Model for the Baltic Sea) are used as forcing of a transport model that

computes vertical and horizontal transports of chemical and biological compounds. A modified version of the Swedish Coastal and Ocean Biogeochemical model (SCOBI) is used to describe the temporal evolution of the phytoplankton spring blooms in the year 2001 when *Chattonella* was abundant, and in 2002 when only small amounts of *Chattonella* were observed. A comparison with satellite images and cell counts indicates that the model captures the main transport patterns of phytoplankton in the surface layers of the offshore areas. The *Chattonella* bloom of the model starts in the quite shallow parts of the western Kattegat and in the stratified coastal areas of the northern Skagerrak. The coastal waters near the river Göta Älv of Sweden also indicate a tendency towards an increased occurrence of *Chattonella*. *Chattonella* is observed in the model during both years, but the occurrence of *Chattonella* is more significant in the year 2001 than in 2002.

Keywords: algal blooms, *Chattonella* sp., diatoms; HAB, marine ecology, modelling, North Sea, Skagerrak, Kattegat.

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ICES CM 2006/E:13

Moving towards operational ecosystem modelling for the prediction of HABs and the “ecosystem approach”

John R. Siddorn, Ricardo Torres, J. Icarus Allen, and Martin W. Holt

Routine operational running of physical models, for instance hydrodynamic or wave models is now relatively mature within European waters. More recently operational systems have been developed to couple these hydrodynamics with ecosystem models of a range of complexities.

This has been made possible by improvements in ecosystem modelling techniques and increased computing power, and is to some extent being driven by the desire for complete system knowledge (the “ecosystem approach”) to assess the health of our waters. Additionally, the forecast of Harmful Algal Bloom events is seen as a key benefit to running such models operationally and with a forecast capability.

This paper details the pre-operational trials of an ecosystem model of the North-West European Continental Shelf which couples a physical model developed by the Proudman Oceanographic Laboratory (POLCOMS) at 7-km resolution, and Plymouth Marine Laboratory’s European Regional Seas Ecosystem Model (ERSEM). ERSEM is a complex ecosystem model including both pelagic and benthic systems and has a number of size and functional group classes for phytoplankton, zooplankton,

and bacteria, as well as detailed nutrient chemistry. This model is nested into larger-scale models, which provide realistic physical lateral boundary conditions. A key step forward will be in the implementation of data assimilation into the model. The scheme presented here uses an Ensemble Kalman Filter to incorporate satellite-derived inherent optical properties into a version of the POLCOMS-ERSEM model, and shows potential to greatly improve model skill.

Output of the ecosystem model combining phytoplankton biomass with physical and biogeochemical parameters is used to produce maps of the risk of occurrence of harmful algae using a fuzzy-logic type approach.

The merits of this approach are assessed.

Keywords: ecosystem model, shelf seas, data assimilation, plankton, ERSEM, HAB.

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ICES CM 2006/E:14

Operational Oceanography of the North Sea/Skagerrak and Norwegian Sea by Ferrybox Systems: From one line to a coordinated network of Ferryboxes

Henning Wehde, Kai Sørensen, Friedhelm Schroeder, Wilhelm Petersen, and Harald Loeng

The FerryBox project, supported by the EC has documented that Ferryboxes are mature systems for monitoring water quality in coastal areas. A network of Ferryboxes has been established within the North Sea/Skagerrak and the Norwegian Sea. Four ferries are at the moment in operation in these areas and new lines are planned. The network and results from observations will be presented. The results are available in real time for the core sensors temperature, salinity, particles, and algal biomass measured as chlorophyll *a* fluorescence. The systems are also equipped with a water sampling system which can be triggered remotely. This makes the system very operational for e.g. monitoring of harmful algal blooms.

A new sensor and measurements of e.g. nutrients are considered based on the experience from the FerryBox project.

In addition advanced measurement of water leaving reflectance is measured and is used for real time validation of optical satellite data. The Ferrybox results are compared with remote sensing data, in order to have a better knowledge of the spatial development and combined with numerical models to improve significance. The data from the Ferrybox sensor and satellite data are presented in a common portal to have easy access to all data and additional information.

Keywords: Operational Oceanography, Ferrybox.

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ICES CM 2006/E:15

Integration of oceanographic information off the Oregon and Washington coasts into U.S. West Coast groundfish ecology and fisheries management

Maria Jose Juan Jorda and John A. Barth

With the long-term goal to improve science for ecosystem-based management of the U.S. West Coast groundfish fishery, this study had three objectives: (1) the assembling and merging of long-term oceanographic data sets for temperature, salinity, chlorophyll *a*, and current velocity off the Washington and Oregon coasts; (2) the generation of oceanographic data products consisting of climatological monthly means, standard deviations, and coefficients of variation at several depths; (3) a preliminary investigation of whether groundfish distributions and abundances are associated with any particular ocean habitat or individual oceanographic variables. The fish data were derived from a bottom trawl survey conducted by the National Marine Fisheries Service. Five summertime ocean habitats with distinct physical and biological characteristics were identified off the Washington and Oregon coasts: Offshore Habitat, Upwelling Habitat, Highly Variable Upwelling Habitat, River Plume Habitat, and Highly Variable Habitat. Overall, the analyses suggested that the species composition differs among the five ocean habitats. Some species were highly indicative of some habitats; however, the associations were weak due to the high degree of overlap of ocean habitats in terms of species composition. In contrast, groundfish species showed strong associations with individual oceanographic factors, primarily depth, surface chlorophyll *a*, and bottom salinity and temperature, indicating that groundfish distributions are mainly organized along bathymetric gradients. In addition, latitudinal variations in upwelling intensity, river discharge and productivity led to the identification of three hotspots where high chlorophyll *a* concentrations were associated with large abundances of specific groundfish species.

Keywords: groundfish, oceanographic data sets, oceanographic data products, ecosystem-based fisheries management, ocean habitats.

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ICES CM 2006/E:16

An ecosystem modelling approach to predicting cod recruitment

Einar Svendsen, Morten Skogen, Paul Budgell, Geir Huse, Jan Erik Stiansen, Bjørn Ådlandsvik, Frode Vikebø, Lars Asplin, and Svein Sundby

The NORWECOM ocean model system implemented with the ROMS ocean circulation model has been run for the north Atlantic over 25 years. Modelled time-series of volume fluxes, primary production and drift of cod larvae through their modelled ambient temperature have been analysed in conjunction with observational-based VPA estimated time-series of 3-year-old cod recruits in the Barents Sea. Individual time-series seem to explain less than 50% of the recruitment variability. However, a combination of simulated inflow of Atlantic water and primary production may account for 70% of the variability with a 3-year predictability. Different approaches demonstrate a small ensemble of predictions all indicating a significant drop in recruits from 2005 to 2006 of about $3\text{--}4 \times 10^8$ recruits, fortunately not down to a critically small level.

Keywords: ecosystem modelling, cod recruitment, prediction, NORWECOM, ROMS.

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ICES CM 2006/E:17

The TOPAZ monitoring and prediction system for the Atlantic and Arctic Oceans

L. Bertino, K. A. Lisæter, A. Samuelsen

Ocean data assimilation systems allow combining remote-sensing and *in situ* ocean observations with primitive equations in ocean general circulation models (OGCM). They thus provide initial conditions for short-term ocean current forecasts (ten days to one month) and boundary conditions to nested high-resolution models of coastal seas and can be operated in hindcast to reproduce past events over long periods. When marine living resources are under considerable pressure, ocean analysis and short-term forecasting systems (from 10 days to one month ahead) cannot be neglected. This paper presents the TOPAZ system, being the Arctic component of the MERSEA integrated system and one of the contributors to the GODAE international initiative. The system is based on the latest scientific developments in terms of ocean modelling with the Hybrid Coordinate Ocean Model (HYCOM) and data assimilation with the Ensemble Kalman Filter (EnKF). We present validation results of the system and applications of nested regional models and coupled physical-biogeochemical models.

Keywords: ocean forecasting, data assimilation, Arctic Ocean, coupled physical biogeochemical models, Ensemble Kalman Filter.

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ICES CM 2006/E:18

Mersea Marine Core Services: towards an integrated environmental monitoring system

Y. Desaubies and the Mersea consortium

The Mersea project is funded by the European Commission to develop ocean and marine applications for GMES (Global Monitoring for Environment and Security). The Mersea system is based on the assimilation of remote sensing (altimetry, sea surface temperature, sea ice, ocean colour) and *in situ* observations (Argo and XBT profiles) into high resolution ocean models. The system will contribute to the development of integrated core ocean services in Europe. Its design includes a global, as well as four regional components (Nordic, Baltic / North Sea, North East Atlantic, and Mediterranean seas) which provide ocean analyses and forecasts in real time through data assimilation. The essential climate variables are temperature, salinity, sea level, sea ice, and velocity fields, but research efforts are underway to include biogeochemical and ecosystem variables. The input data and forcing fields are provided by dedicated Centres. The whole system is linked through an Information Management System to guarantee easy access to users. The target delivery of the initial service is 2008, but a preliminary version of the system is in place. The Marine Core Service is delivering data, information, and products on the physical environment. Such information is necessary to produce indicators on the state of the oceans; it is also a contribution and a support to the agencies in charge of environmental monitoring and reporting. Integrated data products, including remote sensed and *in situ* data are also a useful contribution to ocean, climate, and fisheries research.

Keywords: Operational Oceanography, ocean monitoring, environmental reporting.

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ICES CM 2006/E:19

The Mediterranean Forecasting System: a GMES prototype regional core service and the environmental applications

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The main elements of the Mediterranean ocean Forecasting System (MFS) were implemented as part of several EU projects and national funding. The latest upgrades and the integration in the future GMES Marine Core service is being undertaken in the MERSEA Integrated Project.

MFS 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 system at basin scale and for sub-regional areas; c) a product dissemination/exploitation system. The latest updates of the system considers a model at 6.5 km horizontal resolution, daily 10-day forecasts, weekly analyses with assimilation of all available data, both from satellites (SST, SLA) and *in situ* (XBT, ARGO). Sub-regional forecasts up to 2 km resolution in several open ocean and shelf areas are produced as part of a network established in 2005 and called Mediterranean Operational Oceanography Network (MOON) for the further development of ocean forecast products in the basin. The forecast and analysis data are available in real time to both an internal and external community of users. The latter is composed of governmental and military agencies, environmental protection agencies, research institutes, and private companies.

All projects have developed and are implementing biogeochemical models coupled to the forecasting system for future predictions of algal blooms in different shelf areas. End-users applications involve oil spill forecasting, real time observing and a modelling system for commercial species fish management.

Keywords: Mediterranean Sea, Operational Oceanography, environmental applications.

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ICES CM 2006/E:20 – Poster

Towards confidence indexes for model forecast in coastal waters

J. Ozer, V. Pison, S. Scory, D. Van den Eynde, and B. Nechad

In this paper we describe how we progressively develop confidence indexes for the model forecast routinely made for Belgian Coastal Waters. An overview of the

suite of operational models is given first. It includes amongst others a second generation wave model and a three-dimensional baroclinic model. These models are implemented on different nested grids to finally get a relatively high horizontal resolution in our main area of interest, i.e. the Belgian Exclusive Economic Zone. Models are run twice a day using met forecast (wind, atmospheric pressure, air temperature, cloud coverage, etc.) coming from the Met Office. The data available in near real time are presented afterwards. These are coming from fixed stations (the Meetnet Vlaamse Banken), "ship of opportunity" (the oceanographic research ship Belgica) and remote sensing (MODIS aqua). The parameters that are evaluated are the wave height and direction, the water level and the sea surface temperature. As met forcing are time and space interpolated to fit with model characteristics, wind speed, wind direction and air temperature are also evaluated at some points in the area. The evaluation scheme is made of various statistical tests which are discussed in details. Particular attention is paid to identify, for each variable, the most appropriate time window and the most relevant statistic. Results obtained during a first test period are then presented and analysed.

Keywords: Operational Oceanography, forecast, confidence index.

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Development of real-time data exchange system between research vessels and shore-based analysts via Internet satellite

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Local area network and an Internet system have been installed in more than half of the research vessels (R/Vs) in Japan. However, communications between R/Vs and shore-based analysts are still limited because of low speed and high cost lines between them, although the Internet has already spread around the world. We have developed a data exchange system which operates in real time with inexpensive cost between R/Vs and shore-based laboratories. In this system, PC servers on R/Vs 1) produce TESAC/BATHY messages from CTD data and sends them to Japan Meteorological Agency, 2) archive CTD and cruise data to the database, and 3) synchronize the database with an on-land server. The database synchronization is controlled by http protocol and only the updated data are exchanged through high data compression by the IMMARSAT-B with HSD (High Speed Data Service, 64 kbps) communication. Both the on-R/V and on-land server are able to provide temperature, temperature gradient, temperature front maps at several depths, and research activities from the synchronized database through the web. The R/V communications have been successfully tested between two ships and shore-based analysts. At present, a broadband communication system

is being developed, taking advantage of an Internet satellite (ETS-VIII; Japan Aerospace Exploration Agency). This system will enable not only real-time data exchange between multi-R/Vs but also remote control of oceanographic instruments by shore-based analysts.

The real-time data exchange between multi-R/Vs will allow surveys to be more efficient and provide the data useful for ocean prediction models.

Keywords: real-time data exchange, Internet, satellite communication, research vessel.

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Operational Oceanography System in the Prestige crisis: problems, solutions and applications

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This paper presents the way of acting in a marine emergency by means of an *Operational Oceanography System*, together with its problems, solutions and applications. The emergency example here exposed is the catastrophe of the oil tanker *Prestige* that sank at 3,500 m depth, off the coast of Galicia (northwestern Spain) on 19 November 2002. The intermittent discharge of oil from the stricken tanker (approximately 65,000 tonnes of heavy fuel) as well as the wind and wave induced large-scale sea surface dispersion, causing a great tracking and recovery problem. As a result, an Operational Oceanography system was established in the Bay of Biscay. This system included monitoring, forecasting and data dissemination schemes, comprising analysis of *in situ* tracked buoys, and satellite and visual observations of the oil combined with numerical model predictions. The conventional oil recovery approaches adopted initially close to the wreck became a labour-intensive recovery operation which involved up to 180 fishing boats at sea and thousands of people on land over a 10-month period. A significant amount of the oil discharge, between 25,000 and 35,000 tonnes, reached the area of the Bay of Biscay and caused severe impacts on the coastlines of the northern Spain and western France in January, February, and March of 2003. The exhaustive analysis made after the *Prestige* crisis showed a great lack of human and material resources.

Keywords: Biscay, crisis, fuel, oceanography, oil, operational, Prestige, spill.

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Problems of hydrographic observations on standard sections in the North Atlantic and adjacent seas

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The observations of PINRO on standard sections in the North Atlantic and adjacent seas have been conducted for many decades and are unique in respect of duration and continuity. The data from these observations have been widely used to estimate changes of marine climate and their effect on fishing ecosystems of seas.

The information about the position of standard sections made by PINRO is presented; the patterns of composition, number, and time distribution of observations are given. The reduction in research volume in the recent one-and-a-half decades and the negative consequences of this to the development of applied tasks has been noticed. The proposals on the necessity to standardize sections and develop international cooperation in expedition monitoring of sea environment have been formulated.

Keywords: Barents Sea, ecosystem, hydrography, monitoring, North Atlantic, Norwegian Sea, standard sections.

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