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Coastal Processes: Challenges for Monitoring and Prediction

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REA 07 - Abstracts

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Title

Evaluation of nearshore modeling for the Battlespace Preparation (BP07) trial period

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The Delft3D modeling system is evaluated for an area near Castiglione, Italy with current meter and wave data collected during the Battlespace Characterization (BP07) Trial conducted by the NATO Undersea Research Center April 18-27, 2007. In this study, high-resolution Coupled Ocean Atmosphere Mesoscale Prediction System winds force a nested Simulated Waves Nearshore (SWAN) for the area of interest with lateral boundary conditions provided by WaveWatch III. Delft3D simulations are performed for the exercise period utilizing directional wave spectra from SWAN and tides from Oregon State University. We investigate the model?s performance using standard bathymetric data provided by NURC (~30 m resolution) as well as an experimental product based on satellite-derived bathymetry estimates.

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Title

From 1D to 3D: can REA, targeted by remote sensing and in-situ monitoring, elucidate the energy transfers at the mesoscale?

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Title

Rapid environmental assessment of marine coastal areas for naval operations using sequential space filling designs

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Environmental information is important for successful planning and execution of naval operations. A thorough understanding of environmental variability greatly increases the likelihood of mission success. Present-day naval operations are increasingly focused on coastal-littoral waters rather than the open ocean. Historical data records may be sparse or inexistent in these areas. Survey methodologies to rapidly collect data in dangerous and contested shallow territorial seas are required. This work applies space filling designs to build sampling strategies that can provide accurate estimations of oceanographic fields with a modest navigation time. The design results from sequentially optimizing a cost metrics that combines the benefit of a potential sample location in filling up the holes in space and the cost of visiting that point and collecting a measurement. Optimization is done using a Simulated Annealing approach. The space filling approach has been employed to carry out a rapid environmental assessment of the Bay of Palma de Mallorca, Balearic Island (Spain). The considered region occupies an extension of 65.18 Km2, being the longest and widest measures 12.4 and 4 Km, respectively. The design parameters were a survey time limited to 5 hours, a navigation speed of 15 knots and a measuring time of 300 seconds. The designed survey was physically performed in 4 hours and 25 minutes using the R/V IMEDEA1 equipped with two thermosalinometers. Temperature and salinity were recorded at 2 meters deep at the prescribed sampling points. Krigging techniques were applied to process observations. The environmental spatial characterization shows the existence of a westward temperature gradient with a thin filament of warm waters intruding the centre area of the bay.

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Title

Sea state forecasting: extending and validating wave models for new applications

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Wave models have traditionally been developed for navigation safety purposes from the global ocean to the beach scale. Detailed knowledge of the wave field is also highly important for air-sea interactions (wind stress, aerosol production) and remote sensing (e.g. via biases of radar measurements). Numerical wave models have also been applied for a long time for forcing nearshore circulation models. Unfortunately wave models are still essentially validated in terms of significant wave height only and other parameters (bottom orbital velocities, radiation stresses, mean square surface slope ...) may be poorly estimated. The current state of the art on numerical wave modelling is reviewed here, and ongoing improvements aiming at validating wave models on a wider variety of parameters are discussed. In particular early results will be shown using a saturation-based dissipation function that opens the way for a reliable and physically sound estimation for the surface flux of turbulent kinetic energy, and the estimation of ambient noise generated by breaking waves. Numerical improvements of the WAVEWATCH III model will also be discussed. These aim at providing a seamless modeling framework capable of representing sea states efficiently from the global scale to the beach face, using a combination of different gridding approaches and various numerical schemes.

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Earth Observation techniques in support of REA - results from the EOREA project

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The European Space Agency (ESA) is committed to building the user base for Earth Observation (EO) through Programmes such as the Data User Element (DUE). The DUE Programme funds demonstration projects with a view to establishing new EO-based services and partnerships. We report on one such project, Earth Observation enhanced Rapid Environmental Assessment (EOREA). EOREA focuses on two service lines according to the expertise of the partners. Flyby Srl are a consultancy specializing in optical image analysis. They are deriving bathymetry and other parameters from high-resolution (spectral and spatial) imagery as stand-alone information and as input to Decision Support Systems. Satellite Observing Systems specialize in satellite wind and wave measurements and are making these available in near real-time alongside conventional forecasts. In addition a dataset of satellite-derived geostrophic currents is being demonstrated to and validated by the users. The project users are the Italian Hydrographic Office (IIM) and Nato Undersea Research Centre (NURC), who are both contributing expertise and making available data sets for validation. We give results from the service development and validation work, and discuss prospects for further development in light of a new funding opportunity in 2008.

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Assessment of oily wastes inputs into marine environment from costal petroleum refineries : case studies

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The present article includes some of studies which have been achieved during the last two decades in different regions of the Middle East on the assessment of the role of coastal petroleum refineries in adding oily wastes into their adjacent marine environment. These assessments conducted as necessary for either Regional State of the Marine Environment Report or for the preparation of National Integrated Coastal Zone Management Plans in parts of Mediterranean Sea (Egypt), Red Sea (Egypt and Saudi Arabia) and ROPME Sea Area (Oman). The article describes the followed methodology in each case study which in some cases the objective was limited to the estimation of oily wastes losses and inputs during various refining processes inside the refinery. In other cases, the objective of the assessment extended to link inputs, dispersal and effects of oily wastes in their receiving marine environments.

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Mapping the bathymetry of the Dee estuary using wave inversions of marine radar image sequences

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The bathymetry of a 4km radius area of the Dee Estuary in Liverpool Bay has been mapped using a wave inversion of marine radar data. The radar is mounted 30m above sea level on an island in the estuary and 10 minute sequences of radar images of the sea surface are recorded automatically each hour giving 360 degree coverage of the area. Three such records taken around one high tide during a moderate wave event have been processed to produce the map using a wave inversion that accounts for both frequency and amplitude dispersion. The results are compared to those of a LIDAR survey of the intertidal areas carried out within two days of the analysed radar records in 2006, and also to a combined LIDAR and Multibeam echosounder survey carried out in 2003.

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Network-enabled REA: architectures for near-real-time data collection and fusio

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This briefing will cover the application of communication and information processing techniques to support REA research, to enhance real-time experimental outcome in new ways. While the main focus is on the architectures used to enable collaborative work between NURC and its partners, the solutions presented are relevant in a wider context, and can be applied to address recognized capability gaps.
The discussion will cover three main areas where network-enabled capabilities can be successfully applied: a) network infrastructure, b) information infrastructure, c) context-based data management. This includes: - 2-way always-on satellite links to enable distributed processing, low-cost broadband services to offload existing links and to provide network capabilities to disadvantaged platforms, and advanced quality of service mechanisms to allow seamless Internet Protocol operations across heterogeneous media. - Information infrastructure, techniques used to collect, process, store and distribute data acquired during sea trials, including self-synchronization between web services. - Context-based data management to provide interoperability between heterogeneous information systems, including metadata and data reduction using genetic sequencing algorithms. The added value of the solutions proposed derives from the methodology of translating scientific requirements into working solutions, integrating commercial off the shelf systems within realistic environments. In this perspective we will use DART sea trials, conducted in 2006, as a test case to address requirements and solutions to fulfil scientific requirements for collaboration and information sharing with many external research partners, with guaranteed quality of service.

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Title

Effects of the physical and biogeochemical variabilities on the spatial heterogeneity of the zooplankton distribution in the Black Sea

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In order to understand the role of the physical process on spatial and temporal variability of the zooplankton biomass, we carried out data driven simulations using a 3-d coupled physical and biogeochemical model and data assimilation based upon observations in the Eastern Black Sea during October 2000. Instability of the rim current was identified as a major mechanism for continious supply of nutrients to the euphotic zone through the formation of eddies in the study area. The anticyclonic eddies between the Rim Current and the coast were entrapping the zooplankton as well as the other biogeochemical variables. Along the boundaries of the anticyclonic eddies, upwelling was occuring, which was bringing nutrients into the euphotic zone and leading to short term local blooms. These episodic blooms were supplying foods for the zooplankton.

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Data Driven simulations of synoptic physical and biogeochemical variabilities in the Southwestern Black Sea.

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Two quasisynoptic survey of the South-western Black Sea region with near mesoscale resolution were carried out during May - June 2001. The general plan was to obtain two quasisynoptic surveys of the region with near mesoscale resolution ~25 km and sub-mesoscale survey with finer resolution in areas of interest. The survey was divided into two legs, each of about 6 days. The initial quasisynoptic survey, Leg 1, was carried out during May 22-28, 2001. The second leg was carried out during June 12-18, 2001. The CTD probe equipped with Temperature, conductivity, Chlorophyll, transmission and PAR sensors were used at each station. Biological data collected during this experiment consist of Nutrients, Clorophyll-a, phytoplankton and zooplankton. Data driven simulations in the Black Sea based upon these observations and a coupled 3-d physical and biochemical models have been carried out. The dynamical model employed here is the Harvard Primitive Equation Model. The bio-chemical model coupled to physical model includes phyto-plankton ,zoo-plankton, detritus, nitrate, ammonium and Chlorophyll. The model initialized using physical, chemical and biological data collected during the first leg of the survey. Model forced with QuickSCAT Level 3 Daily wind fields. MODIS derived chorophyll-a and SST data were assimilated throughout the model simulations. The skill of the model was evaluated, before and after assimilating the data collected during second leg.

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Observations of the Western Adriatic Current as a summertime mixed-layer system

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During the Dynamics of the Adriatic in Real-Time experiments, the U.S. Naval Research Laboratory and NATO Undersea Research Centre together with international partners focused on monitoring, predicting, and understanding the complex dynamics of a coastal frontal zone and related eddies and filaments. To accomplish this, Shallow water Environmental Profiler in Trawl-resistant Real-time configuration moorings (SEPTRs) were deployed in arrays across the Western Adriatic Current (WAC) frontal zone in the central Adriatic Sea. SEPTR technology enabled near-real-time monitoring of waves and profiles of ocean velocity, temperature, salinity, and optics despite heavy fishing activity. In summertime, the WAC in this region takes the form of a mixed-layer current with sea-surface height sloping upward towards the coast and a matching deepening mixed-layer depth. Month-long time-series of temperature and salinity profiles reveal significant mesoscale variation of this pattern. Acoustic Doppler Current Profiler (ADCP) data show anti-cyclonic shear between an inshore and a central mooring (12 km distant) with offshore moorings having typical WAC downstream flow while the inshore mooring shows a return flow that forms a recirculation structure. A bora wind storm disrupts this pattern with observed strong deepening of the onshore mooring mixed-layer depth while all mixed-layer currents flow in the WAC direction, but the recirculation pattern reappears after the winds have calmed. Superimposed on the mesoscale currents and mixed-layer-depth changes are near-inertial oscillations that produce internal-wave variability at the thermocline. Vertical velocities of these internal waves can be large and are directly observed by the ADCPs with downwelling periods stronger than upwelling periods producing a net downward flux near the thermocline. These results demonstrate the utility of monitoring time-series of temperature, salinity, and velocities simultaneously across a coastal current. Both geostrophic and ageostrophic components contribute significantly to the dynamics, and accurate assessment requires monitoring of both advective and thermohaline structures.

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Title

Off-shore Wave Measurements in the Ligurian Sea

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Ocean time series have been always considered extremely useful and interesting for scientific purposes, for public safety, and for engineering applications. Coastal erosion analysis and prevention, integration of data for weather forecasting, analysis of offshore structures behaviour with respect to the sea heave, and complementary information to safely operate off shore navigation are only some of the applications related to the sea waves. In off-shore applications remote sensing techniques are commonly used since the difficulty of managing any device with extension in deep waters. On the contrary, several other methods, including wave buoys, pressure and acoustic water level sensors, upward-looking ADCPs, are usually employed to monitor and estimate ocean waves in shallow waters. The ODAS Italia 1 buoy, about 11 meters long out and about 37 meters long into the water, is moored at 36.5 nm south from Genoa, Italy on a 1370 m deep sea bottom by means of an elastic mooring thus allowing it to move around its anchoring position. The buoy was specifically designed as a stable measuring platform for air-sea interaction research. Even though the buoy was not conceived as a wave measuring platform, and cannot be considered as a classical wave meter buoy, it is also equipped by a wave measuring system composed by three low-cost precision acoustic altimeters installed, upward-looking, on a trellis under the sea surface at about 10 m The altimeters operate for 5 minutes each hour at a sampling frequency of 2 Hz. The collected time series are statistically processed onboard to estimate wave parameters (i.e., height and direction). A camera has been recently installed in order to acquire a single frame per hour during daylight thus providing sea-truth information related to the sea state. During the LASIE experiment (Ligurian Sea, 16-22 June 2007) a Waverider buoy was deployed by NURC close to the ODAS buoy thus allowing a field calibration and a direct comparison of the ODAS estimates.

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Title

Forecasting and hindcasting near-shore wave conditions using dynamical and statistical downscaling

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A new high-resolution nested forecast and hindcast wave model suite is presented. The model suite is doubly nested with a coarse (45km) and intermediate (10km) resolution and SWAN for the near-shore domain (500m resolution). The WAM setup has been modified to allow arbitrary orientation of the two model grids. The SWAN model grid can also be orientated freely with regard to the outer model. The model suite is used operationally and shows good agreement with observations. A new method for statistical downscaling of long (hindcast) time series is also presented. A simple nonparametric bootstrap technique is being used to relate near-shore conditions to the coarse, open-ocean data found in a 52-year coarse hindcast archive applicable to open ocean conditions. A simulation of slightly more than a year has been carried out using the full model suite described above. Local wave statistics as well as return values for significant wave height have been estimated for a semi-sheltered position on the western coast of Norway. The high-resolution (SWAN) model correlates well with buoy measurements. The downscaling techniques are quite rapid in the sense that the nesting is flexible and new high-resolution model domains can be added at will. Furthermore, statistics for local wave conditions can be estimated rapidly compared to the generation of a complete hindcast archive as we statistically scale down a hindcast simulation. We thus require a much shorter high-resolution model simulation (approximately one year) to relate conditions in-shore to those stored in the coarse, open-ocean hindcast archive.

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Title

Eddies and filaments of the Western Adriatic Current: analysis and prediction

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ntense mesoscale/sub-mesoscale eddy activity is evident in observations of the West Adriatic Current (WAC) system, flowing along the Italian coast. We report analyses of remote sensing and in situ data acquired for the ?Dynamics of the Adriatic in Real Time (DART)? project in 2006. The data are being used to investigate the following questions: Where do these features form? What drives their development? How rapidly do they evolve? Do they contribute significantly to across-shelf exchange? We employ a nested Adriatic Sea implementation of the NCOM numerical hydrodynamic model combined with observations from satellites (thermal IR and ocean color), current meter moorings, and ship hydrographic transects (thermo-salinographs, and vertical-profiling and undulating CTDs), to study the temporal and spatial evolution of these features and their associated forcings and response. Instabilities, which manifest as rapidly translating and evolving eddies and filaments in the model runs, are associated with changes in the prevailing winds. Moderate to strong NW winds compress the WAC coastward and suppress the instabilities, while relaxation to light winds or SE shifts expand the WAC and enhance the instabilities. Well organized multiple eddy features tend to appear, grow in unison, then dissipate along the coast north of Gargano Peninsula, while south of it (downstream, in the WAC), individual eddies appear to be topographically generated. The eddies and associated filaments translate, stretch and rotate in response to current advection and shear. The eddies evolve over time scales of a few days to a week, depending upon their size and forcing transients. The general character and evolution of the modeled features agree well with the observations. However, some details are sensitive to model conditions and may be inherently random at resolvable scales. Based on the size, intensity and evolution time scales of the features their potential contributions to coastal/deep ocean exchange are assessed and implications for coastal monitoring and prediction, and marine operations are considered.

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Title

What do we need to accurately model the upper layer ocean velocity: the example of a Bora event in the Adriatic Sea

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In order to perform successful search-and-rescue (S&R) operations, effective oil-spill predictions, and more generally Rapid Environmental Assessment (REA) tasks, an accurate modeling of the upper layer ocean velocity is a demanding requisite. The trajectories of drifting objects are indeed dependent on many near-surface processes, including pressure driven currents, drift currents induced by winds and wind-generated waves on the ocean surface. In the coastal ocean, observations often cannot resolve the complex spatial and temporal distribution of the oceanic variables, and numerical models must be utilized. These include models of the oceanic, atmospheric and sea state, supported by additional information from in situ measurements, coastal radars and remote sensing. The presentation deals with some of the relevant processes pertaining to accurate modeling of surface velocities, by setting up a test case where virtual floaters are released in an idealized shaped basin using the latest release of the Regional Ocean Model System (ROMS) hydrodynamic model. Among the others, the effect of vertical resolution in the circulation model, the effect of different vertical mixing parameterization and the parameterization of surface roughness value are discussed. In addition to this, an application of the 3-D hydrodynamic model ROMS in the Adriatic Sea during a short period of winter 2002 is presented and discussed, with respect to the displacement of actual satellite-tracked drifters released during the experiment. The latter numerical test was performed using the hydrological data collected during the ADRIA02-03 Joint Research Program field trials and meteorological forcing from the Limited Area Model Italy (LAMI) model.

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Double-Diffusive Layers in the Adriatic Sea

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During the NURC/NRL DART06A cruise in late March 2006, a microstructure profiler was deployed to perform turbulence measurements in the upper layers of the Southern Adriatic Sea. Measurements in the Po river plume along the Italian coast displayed classic double-diffusive layers and staircase structures resulting from the relatively colder and fresher Po river outflow water masses overlying warmer and more saline water masses from the Adriatic Sea. We report here the water mass and turbulence structure measurements of 91 casts made in the water columns containing double-diffusive layers.

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Turbulence in the upper layers of the Southern Adriatic Sea under various meteorological conditions during summer 2006

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As part of the DART06B observational campaign, carried out from RV Alliance of the NATO Undersea Research Center (NURC) in late August 2006, a microstructure profiler was deployed to make turbulence measurements in the upper layers of the Southern Adriatic Sea. Nearly 300 casts were made, resulting in the largest upper layer turbulence dataset available to-date in this semi-enclosed sea. A majority (163) of these were made near the location where a long term mooring (B90) was deployed in 90 m deep water column to measure water column properties, and meteorological and surface wave conditions. We were able to measure turbulence properties in the upper layers under a variety of atmospheric forcing conditions that included strong wind forcing, nighttime convection, mixed convection and wind forcing, weak wind forcing and strong insolation. The resulting dataset provides a kaleidoscope of turbulence properties and turbulent mixing above, below and in the strong pycnocline present at a depth of 15 to 25 m in the coastal waters of the Southern Adriatic Sea during late summer. The measured dissipation rates in the mixed layer are consistent with relevant similarity scaling by the observed friction velocity u* and the surface buoyancy flux Jb0. Below the mixed layer, in the strongly stratified pycnocline and in the interior of the water column below, mixing is episodic and internal wave field-driven. The relevant length scale is the Ozmidov length scale , which indicates the maximum size of the eddies (overturns) possible in a stably stratified fluid. By assuming that the Ozmidov scale LO is proportional to the estimate of the LT, the scale of the overturns suggested by Thorpe, LO=c0 LT, we can then write the dissipation rate below the mixed layer as Ck L**2 N**3, where the coefficient Ck = Co**2. Computation of this varying factor c0 and its variability in the set of measurements are carried out and discussed.

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Title

Sound-speed field tracking in a range-dependent shallow water environment by ensemble Kalman filtering

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In the framework of the European Seas Observatory Network (ESONET) a research objective is to couple physical oceanography and ocean acoustics into a data inversion and assimilation scheme for monitoring dynamic processes in shallow waters at multiple scales. In this paper the use of ensemble Kalman filtering scheme is investigated for tracking the time variations of a sound-speed field in a vertical section of a shallow water environment, taking into account the seafloor and sub-seafloor acoustic properties. The measurement setup consists of a broadband, multi-frequency sound source and a vertical receiving array spanning a significant part of the water column. In this preliminary study the state-space variables represent the main features of the sound-speed profiles in a low dimensional parameterization scheme, i.e., thickness of mix layer and thermocline vs. range. To test the algorithm full-field acoustic data are synthesized from multi-model super ensemble ocean predictions obtained in support of the BP07 MREA experiment southeast of Elba, Italy. Bottom geoacoustic properties obtained from previous geoacoustic inversion are input to the propagation model as a background dataset. Sea-surface temperature (SST) data from satellite and in-situ CTD observations provide a priori rough information about the range-dependent subsurface structure and an estimation of the sea-surface sound speed. The evolution of the entire sound-speed field is then sequentially estimated in an ensemble Kalman filtering scheme to handle correctly the non-linearity of the inverse problem.

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Internal waves in the Strait of Messina

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The internal waves in the south of the Strait of Messina (Italy) are studied using observational data and numerical simulations. The observational data consisted in SAR images, XBT/CTD measurements and thermistor string measurements from the COACH06 cruise. The numerical model used was the Lamb model, which solves the fully nonlinear, nonhydrostatic Boussinesq equations on a f plane. The model is two-dimensional, with spatial variation in the vertical and cross-bank directions only. Ten out of fourteen SAR images presented internal waves? events for the month of October 2006. From these images, we estimated some of the internal waves figures: a least square fit of the front positions of the southward propagating internal waves trains gives a propagation speed of 1.00 m/s and a bore release time of 2 hours after maximum northward tidal flow at Punta Pezzo. The frequency dispersion of the bore gives a "stretching coefficient" of the wavelength between the two first waves of 37m/km. An EOF decomposition of the CTD/XBT and thermistor string measurements then gave us the first three modes of the internal waves: the propagation occurs at 90m (first EOF maximum) for a temperature gradient oscillating from 85 to 115m (second EOF maxima). The numerical runs, initialized by the density profiles obtained from data, illustrated the model sensitivity to initial tidal speed (leading or not to internal waves generation). An interesting way for characterizing internal wave properties was made by applying a polynomial fit (least-square) to the projection of the second empirical orthogonal function on the first one for each simulation. The polynomial?s shape can tell whether there is an internal wave event occurrence and gives, if this is the case, some indications on the internal wave train characteristics.

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Title

A passive acoustic contribution to REA: geoacoustic inversion using ship noise

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As a contribution to REA, this communication proposes a new passive geoacoustic inversion method for shallow water environments (10 to 300 m). The method relies on the inversion of broadband noise and spectral lines produced by ships of opportunity when sounds are recorded during ships? tracks. It is offered covertness and simplifications of geoacoustic inversion schemes. Using ship movement allows simplifying the measurement tools, a single hydrophone is required when the ship?s position is monitored, if not only three are needed under the assumption of a constant speed, rectilinear ship?s trajectory. For broadband noise, the interference patterns generated by the ship movement and the propagation properties of the waveguide are exploited to extract the relative dispersion curves on a chosen bandwidth (difference of radial wave number versus frequency). For spectral lines, the propagation properties of the wave guide and ship movement are exploited via Doppler Effect to extract the absolute dispersion curves (radial wave number versus frequency). These curves are then inverted to estimate geoacoustic properties. The inversion scheme is tested both against realistic synthetic data and a set of real data from three shallow water trials (15 meter depth for trial off the Southern coast of Barcelona, Spain, 135 meter depth for trial in the bay of Biscay, France and 300 meter depth for trial in the Deep Laurentian Channel, Canada) . The results showed to be accurate and robust. The proposed technique, which is suitable to a small number of hydrophones and quite easy to implement, offers interesting perspectives for passive geoacoustic inversion.

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A passive acoustic contribution to REA: geoacoustic inversion using marine mammals vocalizes

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As a contribution to REA, this communication proposes a new passive geoacoustic inversion method for shallow water environments (100m to 300 m deep). The method relies on the inversion of very low frequency, broadband calls produced by marine mammals (more precisely Mysticetes such as Blue, Fin and Right Whales). It is offered covertness and simplifications of geoacoustic inversion schemes under the assumption that calls are present. The method is dedicated to a sparse array of hydrophones located on the boundaries of an about 100 km2 shallow waters area. Due to the small number of hydrophones, classical Matched Field Processing is not efficient and new processing is proposed using broadband emission (frequency from 10 Hz to 200 Hz), modal propagation and time-frequency tools. The unknowns of the problem are the whale position, the emitted signal and finally the channel properties (sounds speed profile and bottom geoacoustic properties). For each hydrophone?s record, a time-frequency analyse is carried on to estimate the time of arrival of any propagative mode?s energy versus frequency. Then from these times of arrival measurements, a sequential process is proposed to: - firstly, estimate the source position without knowing the emitted signal and the channel properties, - secondly, estimate the emitted signal without knowing the channel properties, - thirdly, from the source position, the emitted signal and the time of arrival of energy at each hydrophone, dispersion curves of the channel (group speed versus mode index and frequency) are estimated and inversed to produce the channel properties. The inversion scheme is tested against a set of real data from two shallow water trials (Right Whale 10Hz to 200Hz Gun Shot calls in the 120 meters deep bay of Fundy , Canada and Blue Whale 80Hz to 20Hz D calls in the 300 meters deep Laurentian channel, Canada) . Comparison with a priori knowledge bout the channel proved that the inversion results are promising. The proposed technique, which is suitable to a small number of hydrophones and quite easy to implement, offers interesting perspectives for passive geoacoustic inversion.

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ALTICORE - a consortium serving European Seas with Coastal Altimetry

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The ALTICORE project (value-added ALTImetry for COastal REgions) began in December 2006 and runs for two years thanks to funding provided by the European INTAS scheme (www.intas.be). The main objective of the project is to bridge the current altimetry gap over coastal areas, by improving the quality and availability of coastal altimetry data in some European Seas (Mediterranean, Black, Caspian, White and Barents). ALTICORE is a follow-on from the regional ALBICOCCA (ALtimeter-Based Investigations in COrsica, Capraia and Contiguous Areas) initiative. The ALBICOCCA project partners are further strengthened by leading teams from Russia and Azerbaijan. An important aspect of ALTICORE is that it should provide more effective ways of data exchange, in a reliable way, through the development of data management infrastructures that ensure long-term continuity and interoperability, in view of a rapidly growing usage of coastal altimetry. We will summarize the anticipated project stages, namely: 1) improvement of the most widely distributed, 1 Hz, data by analyzing the corrective terms and providing the best solutions, including those derived from appropriate local modelling; 2) development of a set of algorithms to automate quality control and gap-filling functions for the coastal regions; 3) development of testing strategies to ensure thorough validation of the data. We will also outline the design and implementation of a Grid-compliant system for efficient access to distributed archives of improved coastal altimeter data; this consists of regional data centres, each having primary responsibility for regional archives, local corrections and quality control, and operating a set of web-services allowing access to the full functionality of data extraction and integration. We will conclude by discussing a follow-on project; this will investigate further improvements to the processing, including the use of higher frequency (10 or 20 Hz) data. The whole project aims to promote the 15 years of largely unexploited global altimetry over the coastal areas to the rank of an operational record

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Recent advances and forthcoming initiatives in coastal altimetry

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Fifteen years of global altimetry data over the coastal ocean lie, largely unexploited, in the data archives, simply because intrinsic difficulties in the corrections and issues of land contamination in the footprint have so far resulted in systematic flagging and rejection of these data. Recently, a number of studies have dealt with the problem of analyzing these nearshore data, and some initiatives have been launched for an extensive reprocessing of the coastal altimetric records in order to recover all the available information. In this presentation we summarize what has been done so far, and introduce the forthcoming activities in this area. We will start from recalling some studies during the second half of the 1990s which were amongst the first to identify the need for custom processing, better (local) tidal modelling, careful screening of the data, improvement of the wet tropospheric correction and retracking. We will then review how those ideas were implemented around the turn of the century, for instance how customized tidal modelling was used by Vignudelli et al. (2000) in a study over the Corsica Channel in combination with current meter and tide gauge data. Results were encouraging, showing that with simple improvements in the processing, the signal recovered at seasonal time scales was in good agreement with the in situ measurements and allowed to infer useful oceanographic conclusions. We will then describe in detail the French-Italian ALBICOCCA initiative for coastal altimetry and finally we will briefly illustrate a number of initiatives that build on the activities described above and aim at moving coastal altimetry to operational status. These include the INTAS ALTICORE project.

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Title

Diapycnal fluxes in shelf waters with estuarine influence due to internal inertial waves

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We have used oceanographic measures that were taken as a part of MREA04 experiment (Maritime Rapid Environmental Assessment 2004) by the NATO Underwater Research Centre (NURC) on the southwest coast of the Iberian Peninsula, from 27 March to 18 April 2004. Using ADCP (Acoustic Doppler Current Profiler) measures at two locations on the Setubal Bay shelf, we have observed internal waves at several times during the experiment period. A rotary spectral analysis was used to study the characteristics of these waves finding that the dominant interval frequency was the diurnal band that corresponds to the inertial frequency at this latitude. With CTD (Conductive Temperature Depth) and ADCP data we have calculated vertical distributions of Brunt-Väisälä frequency, vertical shear and gradient Richardson number. Using a parameterization of diapycnal diffusivity depending of gradient Richardson number, we have estimated diapycnal fluxes associated to presence of internal inertial waves. When these disappear, the diapycnal fluxes decrease indicating that these waves play a key role on diapycnal mixing processes. The study zone is influenced with waters from Sado Estuary. The estuarine plume is clear at the first meters when the signal of inertial waves has disappeared. On the other hand, when the inertial waves are acting, the stratification decreases and the estuarine waters mix with the oceanic waters with high intensity.

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The Magistrato Alle Acque real-time monitoring network

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The Magistrato alle Acque, the Venice Water Authority, is taking a series of measures to counteract the degradation of the lagoon, including the dredging of the contaminated sediments, clean-up of contaminated sites inside the lagoon, pollution prevention from the industrial discharges, wetlands reconstruction. In order to control the status of the ecosystem and to verify both the short and long term effects of the initiatives taken to counteract the degradation of the lagoon environment, the Magistrato alle Acque has set up a real-time system to monitor the quality of the water of the Venice lagoon. The monitoring system is composed by 10 stations placed in different part of the lagoon, in order to cover the most significant areas of the lagoon: a) the area surrounding the city of Venice, b) the part of the lagoon directly influenced by the industrial area of Porto Marghera, c) the area of the southern lagoon close to the city of Chioggia, an important economical center for fishing activities, d) various areas close to the outlet of the main rivers which flow into the lagoon and e) reference unperturbed areas.

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Error modeling and sampling guidance using the ensemble transform and ensemble transform kalman filter during the BP07 Trial

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Ensemble based stochastic methods can be used to track multi-scale ocean prediction errors and guide sampling strategies towards forecast optimization. However, the perturbed ensemble should be large in order to adequate resolve state variables covariances and should include all significant sources of error and uncertainty. For meso-scale applications and limiting the sources of uncertainty, due to boundary and initial conditions constraints, a smaller number of ensemble members may still be capable to correctly distinguish error states within the domain if there are no local strong instabilities, as we could expect in areas like the South Ligurian Sea where the BP07 trial took place. This work presents preliminary tests using the Ensemble Transform (Bishop and Toth, 99) to span a small (20 members) calibrated ensemble of possible predictions of state variables, based on atmospheric forcing uncertainty, using a space-time deformation technique. The Ensemble Transform Kalman Filter was used to estimate the observation patterns at a specific time that would produce the highest minimization of ensemble spread of selected state variables (i.e. minimizing model predicted error) for a specific target area and target times, following a procedure similar to the one described in Mamjumdar, et.al., 99. The first goal was to make sure the model-ship-data loop could be established within usable timeframes for operational applications. The second goal was to infer the quality of this simplified methodology in tracking and reducing model errors. This presentation will address both goals but will focus only on the work done up to the delivery of observation guidance and will not tackle assimilation procedures or the impact of assimilated data. For this reason, time standard deviations of state variables was used as a proxy of the unbiased model errors to test ensemble calibration, and model-data comparisons of non-assimilated observations were then used to check the overall limitations of the procedure. Results show the Ensemble Transform has the potential to successfully predict the dynamical evolution of model errors and clearly distinguish states of high ensemble spread and higher error from states of smaller ensemble spread and smaller errors.

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Radar remote sensing of sea states and ocean surface currents using SAR and land-based systems

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Recent developments in marine Synthetic Aperture Radar processing allows the unambiguous estimation of the directional wave spectrum (Collard et al. IEEE JOE 2005) and surface currents (Chapron et al. JGR 2005) from complex SAR images. Validation and applications to the coastal ocean are described. The use of such wave and current products in synergy with other land-based radars (Xband marine radar and HF radar) is also discussed based on on-going measurements in France using a Helzel WERA 12 MHz radar and repeated ENVISAT ASAR acquisitions. HF-derived currents provide very accurate current measurements with a relatively coarse (about 1-4 km) spatial resolution, while HF-derived sea state parameters generally require special filtering to provide useful information. On the contrary SAR imagery provides stable sea state measurements with realistic spatial gradients, while surface currents based on Doppler centroid estimates are difficult to interpret in terms of current in the presence of wind or sea state gradients, requiring a sophisticated joint analysis of the Doppler and radar cross section signals.

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Coastal radars for surface current monitoring: Venice and Istrian coast examples

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Shore-based coastal radars have been used since 2001 in the Northern Adriatic Sea area with the aim of studying the evolution of sea surface currents over a variety of temporal and spatial scales, providing a detailed comprehension of the coastal circulation in the immediate vicinity of the Venice Lagoon. Surface patterns of the low-frequency current in a 20X30 km region in front of the Venice Lagoon were analysed, and surface circulation was related to prevalent wind regimes in the area. Four different categories of wind forcing were defined: calm weather conditions (wind speed equal to or lower than 3 ms-1), bora (NE wind) and sirocco (SE wind). A final category contained all other wind directions. Mean flow, vorticity and kinetic energy spatial distributions were compared for different wind forcing conditions. A 5 km wide coastal area was characterized by a flow field with maximum vorticity, while currents outside this narrow coastal strip were found to be part of the Adriatic basin-wide cyclonic circulation. Two recurrent counter-rotating vortices having about 4-5 km radius, associated with the tidal jets at the inlets, were evidenced in the residual flow in front of the lagoon. Vortices were destroyed under strong bora wind forcing, since bora wind induced a strong southward coastal jet detached from the coast by about 5 km homogenizing the flow and eliminating the dipole. Since August 2007 radars have been located along the Istrian peninsula, with the aim of providing a near-real time current mapping tool. Two more stations will be added along the Italian coastline, and measurements will continue until June 2008, providing thus a unique insight of the sub-mesoscale circulation for the area. Some preliminary results on submesoscale features revealed by the measurements along the Istrian coast will be presented.

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Small scale characterization of air-sea boundary effects using solar-powered autnomous undersea vehicles

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Weather, wave and ocean forecasts have a profound impact on naval operations around the world. The U.S. Navy is interested in technologies that lead to improved observation, modeling, and predictions of both small and large scale processes in the air/ocean/shore environments. A Solar-powered Autonomous Undersea Vehicle (SAUV) was developed under ONR funding to address the need for a persistent, mobile and autonomous environmental monitoring platform. The SAUV is capable of operating on the surface or submerged, providing researchers with a tool that may be used to collect high resolution in-situ data over long periods of time (weeks to months) over large areas. By integrating multiple and varied sensors onto the SAUV vehicle and developing the appropriate survey strategies, new methods for studying ocean processes are possible. Better methods for obtaining meteorological measurements, particularly high resolution spatial and temporal data over larger areas of the ocean, are needed to characterize the complex air-sea boundary layer. To answer the question ?How good are current atmospheric models in terms of air-sea interaction?? NURC is comparing existing models with satellite and in-situ observations. Typically fixed instruments (buoys) are used to collect in-situ data. The SAUV, instrumented with a METOC package, can improve the spatial and temporal resolution of in-situ data to help answer important questions about the validity of current models. A fundamental objective of the proposed work is to improve the characterization of the air-sea boundary layer. This would include the development of novel data collection techniques and survey protocols using the SAUV. Furthermore, it requires the development of methods to couple this in-situ data with real-time satellite imagery in order to evaluate models and improve parameterizations that more accurately characterize the air-sea environment.

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SAR observations of oceanic internal solitary waves in the Mozambique Channel.

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We report on a series of Synthetic Aperture Radar (SAR) observations of the Mozambique Channel, revealing for the first time large scale signatures of oceanic internal solitary waves along the Mozambique shelf. On-shelf, off-shelf and along-shelf propagation of the waves is found between 22.5 to 26° S. In the near-shore region, some of the on-shelf propagating wave trains are identified as internal waveforms of elevation, thus revealing information on the stratification (i.e. that the pycnocline is deeper than half the total water depth). Between 20 to 22.5° S (the Sofala Shelf) the internal waves mainly propagate off-shelf. The Sofala continental slope is predominantly supercritical relative to the semidiurnal tide, and has large barotropic tides. Here, we investigate a possible generation mechanism for these off-shelf propagating waves. Using an average stratification for the region and ray-tracing techniques, ?local? generation of the internal solitary waves by an internal tidal beam scattering at the pycnocline is investigated. It is shown that the internal wave spatial structure revealed by the SAR observations is consistent with the local generation hypothesis, after reflections from the sea floor of internal tidal beams generated at the shelf break, in a similar manner to that already reported for the Bay of Biscay. Even larger-scale internal solitary-like waves have been observed further off-shelf, toward the centre of the Mozambique Channel, some 400 km from the Mozambican shelf break. Manders et al. (2004) showed that repeated reflection of internal tidal beams in the Mozambique Channel is a possibility. It is suggested that these internal waves could be generated by similar beam scattering at the pycnocline after multiple reflections of internal tidal beams from the bottom and the surface.

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Wave Model Observations and Predictions

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A wave prediction system covering the Adriatic Sea and the Gulf of Manfredonia using SWAN (Simulating Waves Nearshore) model was demonstrated during the ?Dynamics of the Adriatic in Real-Time 2006? (DART06) experiment spanning two periods in 2006. Daily forecasts of significant wave height, mean wave period, and mean peak period were provided daily to DART06 participants. The regional wave model was run from October 2005 to November 2006 using winds from forecasts provided by the ALADIN meteorological model run in Croatia. Comparisons to in situ wave measurements made specifically for this experiment and to altimeter measurements showed that SWAN performed fairly well with a generally a small negative bias. The forcing winds were also evaluated and showed reasonable performance. Certain events such as the Bora and Sirocco are discussed as it pertains to the wave model performance.

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Error assessment and mitigation for through-the-sensor bathymetry data from the AQS-20A

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Since 2002, the Naval Research Laboratory has developed Through-the-Sensor (TTS) capabilities to extract environmental data from tactical systems with no impact to mission. This capability is especially important to naval activities that operate in shallow water, demand the best environmental picture, and must obtain this information on-scene (denied areas or data perishability issues). This paper discusses our efforts with the AQS-20A towed mine hunting system to obtain TTS multibeam bathymetry data, identify sources of error, mitigate them where possible, and assess total uncertainty. One source of error is the depth sensor, which needs a correction factor for depth offset as determined by comparing the derived data with high-resolution data obtained from a dedicated multibeam system. The ocean induces some of this error when there is prevailing current flow across the wing or when the wave action is strong enough to create noise in the pressure sensor data. With present techniques that do not correct for oceanic influences, the extracted bathymetry data has an uncertainty of 0.3 meters. Here, we examine how the uncertainty may be reduced by mitigation of pressure sensor errors.

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Numerical lagrangian simulations of particles trajectories using operational and relocatable ocean models

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The prediction model of pollutants dispersion is, usually, based on coupling the lagrangian with eulerian circulation models. The eulerian model provides velocity fields used to drive the lagrangian particle dispersion model. The particle diffusion strongly depends on the Eulerian velocity fields and the ocean forecast accuracy is important to predict correctly the spreading of pollutants in the sea. Two different lagrangian simulations approaches are presented: the first has been carried out in the Adriatic Sea and makes use of the Eulerian fields provided by an existing Regional Operational Ocean Model (Adriatic Regional Model AREG); in the second application a relocatable ocean model has been implemented to increase the accuracy of the existing operational Mediterranean Forecasting System in the Ligurian Sea. In the Adriatic Sea two different operational products have been used to drive the Lagrangian model: the AREG-5k (5km horizontal resolution) and the AREG-2k (2km horizontal resolution). The comparisons between simulated trajectories and drifters launched during DART (Dynamics of the Adriatic in Real Time) show good improvement when higher resolution is used (2km). The relocatable model used in the Ligurian Sea application is based on the Harvard Ocean Prediction System (HOPS); it has been nested in MFS (Mediterranean Forecasting System) circulation model which daily releases 10 days forecast of temperature, salinity and velocity field. The choice of a telescoping approach is justified by the 6.5km grid spacing characterizing the MFS model, resolution that could represent a limit for the lagrangian model to forecast pollutant spreading. HOPS Model has been implemented with 3 km horizontal resolution and 23 vertical sigma layers. Initial and lateral boundary conditions are obtained from MFS. The atmospheric forcings are interactively computed using the European Centre for Medium Range Weather Forecast (ECMWF) operational products.

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Client-server interoperable geospatial information system to support Operational Oceanography applications

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Supporting operational oceanography means managing data from various organizations in a wide range of proprietary formats. Common approach is to download the needed data set and then convert them into a single commonly accepted format (usually with a loss of information). This clearly becomes inconvenient and cumbersome as soon as the amount of data to manage grows. Moreover, very often it is required to employ several toolkits to allow scientists and developers to perform complex operations. It is common to encounter situations where data produced by one toolkit are required as input by another. Connecting software developed by different vendors is a demanding task that is not always possible without adopting well accepted standards. The solution is represented by the creation of a client-server architecture based on well-accepted protocols and interfaces which will guarantee interoperability both at toolkit level as well as at service level. We define interoperability as the capability to communicate, execute programs or transfer data among different functional units in a manner which requires the user to have little or no knowledge of the unique characteristics of those units. The outcome is the seamless exchange of information and procedures between different organizations employing public, well-known standard protocols and interface1 connections. It finally worthwhile to introduce the two leading organizations which are issuing standards in the geospatial community: ISO Technical Committee 211 (TC 211) and Open Geospatial Consortium Inc (OGC).

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In-Situ Measurements of Air-Sea Interaction Processes during LASIE on board RV PLANET

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In the marine boundary layer, air-sea interaction processes have an impact on the exchange of momentum, heat and water vapor. In June 2007 an experiment was carried out in the Ligurian Sea within the framework of the NURC project LASIE (Ligurian Air-Sea Interaction Experiment), to study the impact of atmospheric processes on sea surface parameters and vice versa. The main scientific goal of LASIE was to contribute to the evaluation and development of parameterizations of oceanic and atmospheric boundary layers and their interactions. To achieve this goal a detailed characterization of the mean and turbulent structure of the ocean and atmosphere boundary layers in the Ligurian Sea was conducted. The experiment took place with three ships in the area between La Spezia and the CNR ODAS Italia 1 buoy (LAT 43° 47.36' N, LON 09° 9.80' E). Small scale turbulence studies of the upper ocean layer were carried out by RV URANIA and RV LEONARDO. RV PLANET had the task to characterize the meteorological and hydrographic situation in an area of 15 x 15 nm around the ODAS buoy and the coastal area off Riomaggiore. In-situ measurements included four deployed moorings with two thermistor chains, one deployed in the shallow coastal area and a second in deeper water about 11 nm northeast of the ODAS-buoy. Additionally a wave rider buoy and ADCPs were moored for the monitoring of coastal currents and of wave heights. In the ODAS buoy area the hydrographic conditions were measured by a CTD-probe and a towed CTD-chain. The chain was equipped with 81 sensor fins which were operated in depths between about 5 m and 250 m. Meteorological investigations were carried out by radiosoundings with a repetition rate of 3 hours. In order to study the variability of temperature and relative humidity in more detail at defined heights a tethersonde system was used up to wind velocities of 8 m/s. These studies were completed by ceilometer measurements and a series of meteorological sensors which were mounted on board RV PLANET at different height levels: sonic anemometers, cup anemometer, temperature and humidity sensors, pyranometers, pyrgeometers, rain and visibility sensors.

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Title

Optical absorption of chromophoric dissolved organic matter in the estuary of the Po river (Northern Adriatic, Italy)

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Dissolved organic carbon, nutrients, chlorophyll a , chromophoric organic matter were measured in order to evaluate the variations and the origin of chromophoric dissolved organic matter during the spring bloom from February to May-June 2003 and 2004 along a transect extending from the Po river offshore.

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Title

Dynamics of the Near-Surface Layers

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A simplified 3D oceanic model was derived (Giordani et al., 2005a,b) by prescribing continuously analysis-derived geostrophic currents into the momentum equation in substitution of the horizontal pressure gradient. The time sequence of geostrophic currents is used as a low-resolution and low-frequency interpolator which acts as a guide in the model. Consequently the simulated small-scales (< Rossby radius) are dynamically coherent with the geostrophic guide. This assimilation technique degenerates the primitive equation system but gives numerous advantages which are: i) to avoid the shocks and the radiation of spurious numerical gravity waves induced by the usual sequential assimilation data systems, ii) to perform realistic mesoscale and submesoscale simulations on annual scale and iii) nested onto an operational large scale model, this model can be used to perform computationally cheap real-time forecasts with higher resolutions in regional domains (downscaling) for operations and research. Adaptation of this new assimilation technique to specific problems of the equatorial band are in progress. Some results will be presented in the frameworks of the POMME (North-East Atlantic Ocean, 2001) and the AMMA-EGEE (Guinea Gulf, 2006) experiments for the middle and the equatorial-tropical latitudes respectively. The dynamic of the near surface layer in response to the wind forcing was studied with a generalized Q-vector omega-equation (Giordani et al., 2006). This approach allow to unravel the physical sources of vertical velocity. Particularly, this diagnostic tool applied to a filamentary mixed-layer structure simulated during the POMME experiment has shown that the associated vertical velocity was created by trapping the surface wind-stress energy into this structure.

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Battlespace on Demand: Operationalizing Naval Oceanography

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Title

The generic evolution of BMT marine information systems and the advancement of environmental decision-support concepts

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Since its formation in 1985 as the UK privatisation of the National Maritime Institute and the British Ship Research Association; British Maritime Technology Ltd now renamed, BMT Group Ltd, has been at the forefront in pioneering PC based systems to address marine community decision-support needs. Application areas include; ship berthing and manoeuvring, search and rescue, oil and chemical spills, pollutant ecotoxicology, drilling muds and cuttings and production waters and noise propagation. In areas such as search and rescue and oil spills, BMT systems have been adopted by many national agencies and oil and gas major operators across Europe and internationally. From the onset, the design concept has consisted of three basic components namely; a fast-time simulation of the tide-current-wind environment for target area, a set of environmental phenomenology model representations of the relevant causal processes chain e.g., oil and gas physical dispersion, toxic geochemical transfers into ecosystem departments, and software integration of results to create specific end user dynamic information for risk management and decision-making. An underlying feature of all systems is a need to create a suitable geospatial description of the marine environment to enable realistic fast-time forecasting of hydrodynamic currents needed to drive the environment phenomenology models. The requirement for stand-alone operation in remote locations means that such systems which are heavily data populated can be viewed as prototypes of what is now commonly termed rapid environment assessment REA systems. Understanding the evolution and innovative design methodology of BMT marine information systems offers helpful guidance to development of marine REA?s. This paper is presented in the form of a review tracing the evolution of BMT marine information systems from early pioneering versions adopting innovative tidal current atlas computations framed within a Microsoft Windows environment through to current systems under development that are web service enabled and can ingest remote operational forecasts and observational data within an OGC compliant operational environment. Our approach to assimilating satellite Earth observations and in-situ measurements to improve system modelling performance and control will be also presented.

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Title

The evolution of the SEPTR platform from ADRIA02 to DART06: technical issues and solutions.

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During DART06 cruise four SEPTR platforms have been successfully deployed in the Adriatic Sea, acquiring and delivering in real-time CTD, light attenuation and current profiles together with wave measurements. The SEPTR platforms used during this experiment are the final step of a project started in 1999. A prototype was first produced at NURC and successfully deployed in ADRIA02-03 cruises. Due to the fact that the original prototype has been developed reusing much of the BARNY technology and keeping the same geometry, severe volume limitation prevented further improvements. A cooperative agreement between NRL and NURC was signed in July 2003 for the development and construction of five enhanced SEPTR platforms with larger geometry. This presentation will focus on the technical aspect of the evolution from the first BARNY-like prototype to the SEPTR platform employed during the DART06 experiment, showing engineering solution adopted and future enhancements.

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Empirical algorithms for bathymetry estimation in littoral areas by fusing multi-spectral satellite data and depth samples collected by AUVs

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Two types of local empirical algorithms for estimating shallow-water bathymetry from data acquired by multi-spectral high resolution satellite sensors are retrieved and their performance compared against measurements collected during hydrographic surveys over the area of interest of the BP07 NURC test trial. The inversion algorithms directly relate spectral radiances at the sensor surface with the sea depth. A multi-linear (ML) algorithm and a radial basis function neural network (RBF-NN) algorithm are considered for comparison. They are trained for fusing radiances from contemporary acquisitions of Ikonos and QuickBird data. The training procedure uses depth samples collected by an autonomous underwater vehicle (AUV) to estimate the coefficient of the ML regression and the RBF-NN parameters. Comparison with depth samples (not used in the training procedure) from acoustic hydrographic surveys shows good correlation with the retrieved depths with the RBF-NN algorithm outperforming the ML regression in terms of mean square error, which is of the order of 0.5 meter. The methodology can be used in a very controlled environment (clear sky and smooth sea surface, for instance) and does not include any physical

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Statistical prediction of particle motion and planning of Lagrangian sampling for the DART experiment using historical drifter data

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Historical drifter data in the Adriatic Sea are analyzed, investigating particle evolution as function of initial conditions. Maps of drifter concentrations at various times are built and interpreted as maps of the probability to find a particle at a given time in the neighborhood of a certain point. Results in the region around the Gargano Cape, are used to suggest Lagrangian sampling strategies for the DART experiment

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REA equipment for seabed characterization using ambient noise

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It is possible to extract the seabed's reflection coefficient and sub-bottom layer structure from ambient noise and its directionality. To date, experimental work at NURC has been based on a drifting vertical array, but other platforms such as gliders are also possible. Favourable comparisons have been made with seismic boomer profiles to sediment depths of 25m, or so. A prototype autonomous, light weight, low power system with an on-board processor has been built at NURC and designed to gather seabed reflection properties at a remote site. This data is suitable for insertion directly in range prediction tools. The on-board processing reduces the data rate so that REA satellite link technology can bring the data directly to the grey ship or laboratory. Future air-droppable systems will be based on experience with the prototype.

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Relative dispersion from a high-resolution coastal model of the Adriatic Sea

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Synthetic drifter trajectories obtained from a Naval Coastal Ocean Model realistic simulation of the Adriatic circulation are used to study the statistics of particle pair dispersion. The main objectives are to explore the relative dispersion using D^2(t) and the Finite Scale Lyapunov Exponent (FSLE). The effect of uncertainties in unresolved/missing processes is represented by applying spatial and temporal filtering to the flow field. It is found that the boundary currents dominate the relative dispersion at spatial scales greater than 20 km, following a D^2(t)~t^2.2 law (and \delta^{-0.8} for the FSLE), corresponding to a ballistic regime characteristic of horizontal shear dispersion. This law is consistent with in-situ observations and robust to low-pass filtering as long as the coherence of the boundary currents is maintained. Small-scales are found to be far more sensitive to temporal and spatial filtering.

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Geoacoustic inversion in the north-eastern Caribbean using a hydrographic survey vessel as a sound source of opportunity

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During the spring of 2006, hydrographic survey vessel HNLMS Snellius ran an extensive multibeam and side scan survey of the Saba bank, a large submerged atoll located in the north-eastern Caribbean. The survey provided an excellent opportunity for a number of small-scale geoacoustic inversion experiments in a shallow water environment which attracts many divers for its unique tropical ecosystem and rich marine wildlife. The feasibility of a rapid deployment of ocean-acoustic sensors and equipment was demonstrated for the purpose of an environmental assessment of the area southwest of the small volcanic island of Saba. The environmental impact was kept to a minimum by exploiting the hydrographic ship as a sound source of opportunity that was moving along the survey lines and passing near a light, sparse vertical array deployed from a rubber boat on anchor. Several low-frequent narrowband tones were identified for the inversion process that provided an accurate account of the experimental geometry in terms of moving source and receiving array positions, and detailed geoacoustic properties of the sea floor and sub-seafloor.

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Title

Mission planning tools and optimized deployment of autonomous underwater vehicles for tactical characterization of coastal areas

Michael Incze NUWC

USA Autonomous Underwater Vehicles (AUV) most often have evolved with specific mission focus areas determined by the defense sponsor or commercial customer. These focus areas have driven platform design and capabilities, as well as the Mission Planners delivered with these vehicles. While these Mission Planners have a broad spectrum of sophistication in the interfaces, none provide guidance to the operator in designing a track plan best suited to the mission. For some mission areas, the path design is relatively straight-forward. If 100% sensor coverage of an area is required, as is often the case for mine-clearance or industrial reconnaissance, the area of responsibility determines the boundaries, and an estimate of sensor sweep width determines the track spacing. There are other mission areas, however, where the area boundaries are too large, and the dynamic parameters too variable, to allow full sensor coverage in a synoptic sense. In these cases, compromises in survey extent and resolution demand track optimization that is driven by vehicle number, speed and endurance trade-offs, the spatial and temporal variability of the measured parameters, and environmental factors that physically influence AUV performance. Rapid Environmental Assessment, the essence of planning for all tactical missions, is one critical area where survey optimization is essential, and the selection of optimal waypoints, depths, and geometries to best characterize the changing physical environment with limited platforms and time becomes a critical challenge. Researchers at the Naval Undersea Warfare Division, Newport are using commercially available AUVs from OceanServer Technologies, Inc. with YSI oceanographic sensors to conduct environmental surveys in shallow waters and apply a minimum tension model approach to develop 3-D characterizations with Dynamic Graphics, Inc. software. The software allows for an evaluation of the evolving fidelity, comparing the incoming data log files from the AUVs with the developing detail of the 3-D oceanographic characterization, and allowing for confidence estimates that represent cost:return for continued survey effort. On-board adjustments to track spacing resolution, as an example, can result from this evaluation to optimize the survey effort and still meet the tactical requirements for detail. This presentation provides a description of the methodologies and early results in the investigation of this approach.

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A buoy network system for acoustic monitoring and communications

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Operational Model for Prediction Circulation and Transport of Oil Spills in the Black Sea

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A new 5-min operational model for the prediction of circulation and transport of oil spill in the Black Sea is presented. The hydrodynamic module is developed on the basis of the DieCAST high-resolution low-dissipative ocean model adapted to the Black Sea. The oil spill transport module is built on the basis of the random walk approach, which allows predicting motion of individual particles, the assembly of which represents accidental oil spills.

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Monitoring and prediction in the dynamically and topographically complex South Florida Coastal Seas System

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The South Florida Coastal Seas System is characterized by complex topography and strong interactions with large scale flows. The 3.5km resolution South Florida Hybrid Coordinate Ocean Model (SoFLA-HYCOM) and the 900m resolution Florida Keys Hybrid Coordinate Ocean Model (FKEYSHYCOM) encompass both the coastal regions (the broad Southwest Florida shelf, the narrow Atlantic Keys shelf, the shallow Florida Bay and Biscayne Bay) and adjacent deep regions (the Straits of Florida), including Marine Protected Areas (the Florida Keys Marine Sanctuary and the Dry Tortugas Ecological Reserve). The presence of the strong Loop Current/Florida Current system and associated eddies connects the local and basin-wide dynamics. A multi-nested approach has been developed to ensure resolution of coastal scale processes and proper interaction with the large scale flows. Issues associated with environmental prediction challenges are evaluated, such as different strategies of nesting to HYCOM GODAE products and the impact of resolution adopted by the atmospheric forcing and the model grid size. Comparisons to data provided by the observational monitoring network include time series from moored ADCP currents and from Florida Current transport at 27oN (NOAA cable data). The model simulations depict the dominance of wind-driven and buoyancy-driven flows (which are controlled by river inputs) on the inner- and mid- SW Florida shelf, while a wind-driven current opposing the mean Florida Current flow is evident on the Atlantic Keys shelf. Loop Current variability influences the outer- SW Florida shelf currents. Eddy passages along the Loop Current/Florida Current front depict strong interactions with coastal flows and improvements in the timing of these passages are observed when nesting to a data assimilative Gulf of Mexico HYCOM model. The mean Florida Current transport is captured in most model simulations; however, the best agreement to observed fluctuations is seen when nesting to a full North Atlantic basin HYCOM model. High resolution around Florida Bay and the Florida Keys is essential to capture changes in shallow hypersalinity conditions due to intrusions of regional riverine waters. The modeling activities and the observational network are part of the South Florida pre-operational monitoring and prediction system.

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Data driven oceanographic and sonar performance forecasting during BP-07

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In April-May 2007 the Blue Planet or Battlespace Preparation 2007 (BP07) experiment coordinated by NURC as part of MREA07 took place southwest of Elba. Operational oceanographic and sonar performance forecasts were provided for this experiment. In situ measurements of temperature and salinity were collected by CTD sensors aboard HNLMS Snellius and NRV Leonardo. These observations were complemented by the temperature and sound velocity measurements routinely collected by the Moving Vessel Profiler (MVP) aboard HNLMS Snellius. The MVP provides a rapid and convenient way of collecting data while sailing. Ocean forecasts were generated on board of the Snellius with back up support from MIT, using the Harvard Ocean Prediction System (HOPS). Based on the HOPS forecasts, sonar performance forecasts made with the ALMOST model were provided in near realtime. The resulting fields were advertised on the web servers of the experiment. In this paper details and results of both the oceanographic and acoustic modelling components are presented and the contribution of the Moving Vessel Profiler to the assimilation data is evaluated.

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West water dispersion from Infulene Vale in Maputo Bay

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Glider-based surveys of the Kuroshio Current and Philippine Archipelago - operational lessons and early results

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The MERCATOR North Atlantic Ocean and Mediterranean Sea forecasting system: provider of boundary or initial conditions for coastal modeling

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We focus on the 1/15th degree North Atlantic and Mediterranean Sea high resolution analysis and forecasting system operated at Mercator-Ocean in real-time. The ocean model is based on the general circulation model OPA-8.1 developed at LOCEAN (Paris) and is designed to simulate the oceans with a very high horizontal resolution (5 to 7 km). The assimilation system is based on the Reduced-Order Optimal Interpolation algorithm and uses 1D vertical multivariate EOFs to extract statistically-coherent information from the observations. The multivariate system assimilates jointly altimeter data, SST and in situ observations (temperature and salinity profiles). After an overall description of the current multivariate system, we compare its performances to the previous monovariate one. In particular, we show the positive impact of the assimilation of temperature and salinity vertical profiles on water masses representation. We then present the results of a "hindcastforecast" exercise to assess the forecasting skills of the Loop Current and Loop Current Eddy frontal position in the Gulf of Mexico. We finally draw perspectives for the next-generation high resolution system which is under construction.

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Title

Swell forecast with a super-ensemble

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Nowadays, many swell models providing operational forecasts are available. Unfortunately, their results may considerably diverge and choosing one single model among them is a rather difficult and subjective task. A recently developped approach consists in merging different model forecasts into one single multi-model forecast; this technique is called the super ensemble (SE). It is based on previous model runs and data records and so belongs to the data assimilation techniques family. This method, first proofed in meteorology, has also already been tested with success in oceanography, e.g. for determining acoustic properties or surface drift. During the DART06 campaigns, the SWAN ARPA, SWAN NRL, WAM ATHENS and WAM ISMAR swell models were run simultaneously and measurements, such as the significant wave height or the mean wave period, were recorded at different locations of the Adriatic Sea, providing a wonderful dataset to test the SE technique. A preliminary approach, based on linear combination of the model outputs, is presented and the performance of the SE to hindcast and forecast a situation is evaluated through statistical error measurements.

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Ocean Predictions for REA: Modelers, Data and Modeling Systems

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Comparison of NCOM and ADCP currents during DART

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Numerical simulations of the Adriatic Sea were conducted with the Navy Coastal Ocean Model (NCOM) during the Dynamics of the Adriatic in Real Time (DART) Experiments conducted between Oct 2005 and Sep 2006. NCOM was run on a high-resolution, 1-km grid. Model forcing included tides, surface fluxes from the ALADIN atmospheric model, relaxation to a daily satellite SST analysis, monthly climate river and runoff discharges with realtime (daily) discharge only for the Po, and open boundary conditions south of Otranto from a global model. Currents predicted by NCOM were compared with currents from 12 ADCP moorings located along a line between the Gargano Peninsula and Split, Croatia. Tidal analysis of the NCOM and ADCP currents showed generally good agreement. The largest disagreements were near the surface, perhaps due to internal tides. Tidal currents at the moorings were generally small and contributed less than about 10% to the total variance of the ADCP currents at 10-m depth and less than 20%near the bottom. Further comparisons were conducted using de-tided currents. Correlations between the NCOM and ADCP de-tided currents were highest in the West Adriatic Current (WAC), which flows southeast along the Italian coast, where the path of the current is somewhat constrained. Lowest correlations were in the interior, likely due to non-deterministic variability. Comparison of current variance also showed best agreement near the Italian and Croatian coasts. In the interior, the NCOM-ADCP mean current variance compared fairly well for Nov-Jan, but for Feb-Aug the NCOM mean variance decreased significantly relative to the ADCPs and the discrepancy increased with depth. Spectral analyses indicate that most of the difference in variance is at frequencies below 0.3 cycles/day.

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Title

Bayesian acoustic prediction derived from oceanographic forecast and acoustic inversion

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The prediction of the transmission loss evolution on a day to week frame, in a given oceanic area, is an important issue in sonar performance prediction. It relies primarily on acoustic propagation models, which convert water column and geometric/geoacoustic parameters to 'instantaneous' acoustic field estimates. The main limitations of acoustic propagation models are, in general, the accuracy of the numerical solution and the limitations imposed by the approximate description of the propagation environment. The later are, by far, the most important drawback when acoustic inversion is concerned, where the inverted environment that best matches the measured acoustic data, is often shifted from the true environment. This shifted environment is sometimes referred to as the "equivalent environment". This inversion problem has its counter part in forward acoustic prediction, where the best acoustic match may not be obtained for the best environmental prediction (considering water column, bottom and bathymetry data all together), as generally advocated in standard transmission loss prediction systems. The claim in the present work is that, by converting the oceanographic prediction and the bottom parameters to 'acoustically equivalent' counterparts, the acoustic prediction can be obtained in an optimal way, adapted to the environmental model at hand. Here, acoustic prediction is formulated as a Bayesian estimation problem, in which, the data are oceanographic forecasts, a set of known bottom parameters, a set of acoustic data, and a set of water column data. The predictive posterior density of the future acoustic signal is written as a function of elementary density functions relating past oceanographic forecasts, real water column measures, bottom archival data and 'acoustically equivalent' environmental parameters. The latter are obtained by acoustic inversion with past data. The concept is tested on simulated data based on water column measures and forecasts for the MREA'03 sea trial.

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Method comparison for extreme wave analysis on the Italian coasts

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The occurrence and severity of extremes might become relevant as their mean frequency increases monotonically over a period like it happens during the few last decades. Actually, climate is defined by the type, frequency and intensity of weather events. Average values of specific weather parameters over fixed time intervals provide information about the mean status of the atmosphere, the soil and the sea during those intervals. Anthropogenic climate change has the potential to alter the prevalence and the impact of extremes such as heat waves, storms, floods and droughts. This study focuses on the relevance that the extreme weather events have in modifying past evolutions and future scenarios of the Italian coasts and seas. Precisely, this work makes use of widely recommended methods for the statistical analysis of extreme waves. The current level of understanding in this field, allows to: select wave datasets of independent and identically-distributed (idd) data; identify the best fit to the data distribution; evaluate, from the distribution, the extreme waves values and return periods (Tn). Waves are treated as parameters being characterized by the value of two properties: their incoming direction and their significant height. A diagnose of the employed dataset allows to determine the mean and cumulative persistence of waves above a fixed threshold in vulnerable points near the Italian coastline. Important information about the relevance of potentially occurring extreme events is provided by the characterization of the future sea states by computing the mean and cumulative persistence of the extreme waves over threshold at the wished return periods Tn. Two methods are principally used for this study, one uses the idd data as the result of a selection of largest r-annual events (normally r ≈ 5), the other obtains the idd data by keeping only the peaks-over-threshold. The two methods are based on different choices and both apply to a 42-years length time-series (part of the ERA40 reanalysis from 1957 to 2002) of wave data. The first method optimizes the level of data independence within the selected dataset, but dramatically reduces the number of elements

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Title

Daurade: an AUV for REA

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The French hydrographic and oceanographic office (SHOM) and the Atlantic underwater studies group (GESMA) are developing an AUV for REA applications. The vehicle should be accepted by the end of the year 2007, and a program of 3 years of studies will follow, to improve the strategies of survey and develop a prototype of a data fusion capability. Carrying numerous sensors, it will implement new algorithms for survey optimisation. The aim of this paper is to present this new vehicle and to give an insight on its future capabilities for REA applications.

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Fresh evidence on internal tides in the Adriatic Sea

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Croatia Oceanographic data collected in the framework of the ITHACA project have been examined in order to detect and interpret different physical processes in the area. One of the main objectives was to gain more information on internal tides at the Adriatic shelf break. The work comprised thermistor measurements carried out on the islands of Bisevo, Susac and Lastovo at 10 equidistant depths, between 4 and 40 m, on submarine cliffs opened to the southeast. These measurements were complemented and verified by using thermistor chain data collected in the framework of the DART project (DART06 cruises). Preliminary analysis revealed significant diurnal temperature oscillations at Lastovo. The strongest variations were driven by the sea/land breezes (middle of July 2006). However, at the end of June 2006 the diurnal wind forcing was not significant, whereas barotropic currents at a nearby ADCP station as well as sea levels at Split and Dubrovnik contained pronounced diurnal signal. The wind and tidal influence on temperature variability were separated by applying multiple cross wavelet spectral analysis with hourly wind and sea level (or barotropic current) data treated as inputs and isotherm heights at Lastovo considered as an output. The analysis confirmed that significant correlation between the tides and the thermocline oscillations existed at the end of June 2006.

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VHF coastal radar observations during LASIE 2007 in the Gulf of La Spezia: preliminary results

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LSEET, Toulon, FRANCE A dual-station very high-frequency Wellen Radar (WERA), transmitting at 45MHz was deployed along the Gulf of La Spezia coast during June 2007, as part of the LASIE program. Two radar sites were installed along the coast 7-km apart: one in La Rocchetta military site, and one on the roof of the ENEACNR center in Lerici. They are operated at 45 MHz in both beam-forming and direction-finding modes. A 15-day continuous time series of radial and vector surface current fields was acquired starting on 13 June ending 28 June 2007. Over a 30-min sampling interval, WERA mapped coastal ocean current over a 15km-square footprint with a 250m horizontal resolution. Highly variable complex surface circulation was observed that include inertial and wind-driven currents. To illustrate this circulation, progressive vector diagrams, frequency analysis, EOFs and Lagrangian transport analysis are shown and discussed.

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Sea level rise monitoring along the coast of Bangladesh

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One of the most recent concerns of global warming to the coastal areas and small islands of Bangladesh will be rise in sea level due to melting of polar ice sheets mountain caps and glaciers and thermal expansion of ocean waters. The potential consequences are inundation of low lying lands, acceleration of coastal erosion, increasing the risk of flood disaster, problems relating to drainage and irrigation system, increase of salt water intrusion into ground water, rivers, bays and agricultural lands. It can also damage port facilities, coastal structures, bird sanctuaries, etc. Hence, it would become important for any nation bordering the sea to understand the sea level processes and monitor its variations. A good knowledge of the variations of the mean sea level is required for development of long term data collection and suitable models to predict various scenarios of sea level and its impact. These models would serve as tools to support the policy and decision makers and those involved in the sustainable management of the coastal resources. A pre-requisite to carry out any analysis is the availability of reliable and long term data on tides and fine contour topographic maps of the coast. Recognising the importance of building of such a data base Bangladesh Govt. has taken a project for the coastal belt and the Bay of Bengal for collecting tidal data by the latest model acoustic and pressure electronic tide gauges. About 10 nos. acoustic tide gauges has been installed by Bangladesh Inland Water Transport Authority (BIWTA) and data collection and processing work is going on and the project is being implemented since 2005.

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Optical properties in the Gargano-Manfredonia Gulf region

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In-situ measurements of inherent and apparent optical properties during the two DART cruises 19-20, March and 26-27, August 2006, in addition to laboratory measurements of total suspended matter and chlorophyll concentrations were analysed. Optical properties vary in space and time in the research area due to horizontal and vertical water mass displacement, currents, seasonal changes etc. Irradiance and radiance measurements with PRR800 allowed determination of attenuation downward/upward coefficients for 14 wavelengths. From AC9 measurements absorption and total attenuation coefficients were calculated for 9 wavelengths. Coefficients were compared across the wavelengths and through vertical distribution at the stations for the two periods of measurements. The investigated waters are characterized by a sharp water color gradient from coastal to the open sea, covering a full range of optical properties. Optical water types determined through qualitative spectrum characterisation and PAR attenuation measurements vary across the spectrum of optical water types. Range of attenuation coefficients in the area dominate over seasonal differences between the two seasons. High attenuation coefficients indicate that suspended sediments significantly influence optical properties of the region, in addition to high concentrations of dissolved colored substances. Linear relation is observed between absorption and total ectinction coefficients in most of the cases, and correspondence exist between suspended matter concentrations and total extinction coefficients. Relationship is explored between optical properties and chlorophyll concentrations.

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Estimating lagrangian residual circulation (LRC) in the Iroise Sea

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The Iroise Sea is located at the western end of Brittany (France), along the route of low-pressure atmospheric systems. The area is shallow (mean depth of 110m) and exhibits strong tidal currents (up to 8 knots in springtime). In summer, tidal fronts are generated in transition zones between the coastal area where strong tidal currents efficiently mix the whole water column, and the offshore ocean, where tidal mixing does not reach the surface, which induces stratification. Frontal regions are subject to intense biological activity. Due to the intense maritime traffic and the permanent threat of pollution, it is essential to monitor the LRC in the Iroise Sea and to evaluate the relative contribution of the different physical processes at play (tides, atmospheric forcing, density gradients). We evaluate Lagrangian residual currents using two methods. First, we investigate Longuet-Higgins (1969) approximation. This method provides a rough estimate of the LRC based on instantaneous velocities and velocity gradients and shows how much the Lagrangian drift can affect fluid transport. Results are obtained in a framework consistent with classical Longuet-Higgins studies: a 2D velocity field computed by an ocean model that ignores wind forcing and accounts only for the M2 tidal component. Second, we compute the full trajectories of fictive particles using ARIANE, a diagnostic Lagrangian tool (Blanke, 1997) and infer the LRC from these trajectories. The analysis is performed for both an ocean model output (3D regional ocean model MARS, forced by high-resolution meteorological data from the regional atmospheric model WRF) and high-frequency radar current measurements (SURLITOP experiment carried out by ACTIMAR, 2005). In the latter case, Open-boundary Modal Analysis (Lekien 2004) was used to overcome the spatio-temporal variations of the radars range and coverage, by interpolating, extrapolating and filtering the measurements. Estimated Lagrangian residual curents are compared against Lagrangian drifter tracks from a September 2005 field experiment in the Iroise Sea.

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Interannual variability of the Egyptian shelf zone circulation

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We started to explore the interannual variability of the Egyptian shelf zone circulation connected to atmospheric forcing by means of numerical simulation of the general circulation using a high resolution model approximately 1.5 km horizontal resolution with 25 vertical layers and water flux boundary condition. In order to reproduce the interannual variability, the model has been forced with 6hr frequency atmospheric data obtained from (ECMWF) analysis, and daily average frequency lateral boundary conditions from a Mediterranean Sea general circulation model (OGCM). The simulation carried out using the last version of Princeton Ocean Model (POM). We have concentrated on the period from 15th of September 2006 till 15th of October 2006. We hope in the future to use this domain for operational oceanography. The Egyptian Shelf Slope Current (ESSC) was demonstrated in the models on 7-10-2006. The ESSC flows eastward along the extended shelf at the east of Egypt. Egyptian Shelf model (EGYSHM) suggests three new small mesoscale features; two anticyclonic eddies, and a cyclonic eddy.

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Alternating upwelling/downwelling in the Adriatic Sea

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An experiment was carried out in the Adriatic shelf-break area, from February to September 2006, in order to investigate internal tides and background against which they develop. It resulted in an unexpected finding: subsurface temperature oscillations, characterized by the 24, 12 and 8 h periods, were exceptionally strong at one of the thermistor stations and the corresponding baroclinic current variability was largest at a nearby ADCP station. In order to distinguish between the tidal and wind forcing of the diurnal variability, wavelet spectral analysis was performed on the meteorological and oceanographic time series. It showed that the sea/land breezes were responsible for the periodic interchange of pronounced upwelling and downwelling in mid-July 2006. The event was analyzed in some detail and was interpreted using results of analytical and numerical modeling.

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Extracting bottom information from towed-array reverberation data

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Long-range reverberation data were gathered on towed arrays during the NATO Rapid Response exercises (1996-1998) and the Boundary Characterization experiments (2000-2004) in both the Mediterranean and Atlantic oceans. Our REA approach included measurements, data processing, quick-look analyses, and model-data comparisons. Polar plots of the beam time series data, overlaid on bathymetry, were a valuable survey tool. Reverberation highlights usually correlated with bottom bathymetry and known features. Other scattering features, not on the charts, could often be identified by detailed follow-on surveys. A manual inversion procedure was used at sea to extract bottom loss and scattering strength from measured reverberation beam time series. More detailed inversions were conducted post-trial. Towed array beam patterns are included in the modelling, so polar plots of model-data differences can be used to provide crude scattering maps of the area. . [Work supported in part by the US Office of Naval Research and NATO SACLANTCEN/NURC].

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The application of REA to underwater warfare: the Defence R&D Canada approach

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The environmental information required for deployed forces operations and planning in littoral environments frequently depends on historical databases that may be incomplete or inaccurate. For example, acoustic transmission loss predictions made using historical sound speed and bottom loss databases may lead to large errors in estimated sonar detection ranges. To enable rapid environmental assessment (REA), measurement tools have been developed to improve the sampling of water column and seabed properties from a moving vessel. Metrics for the sensitivity of sound propagation to these properties have been developed to determine the relative importance of different environmental parameters, to quantify the impact of incomplete or degraded environmental information, and to specify the appropriate spatial and temporal scales for sampling. A GIS-enabled database has been developed to manage environmental data and provide it to clients, including an acoustic propagation prediction server for High Level Architecture synthetic environments. The integration of these aspects of the REA program was demonstrated during the shallow water 2006 (SW06) sea-trial off the coast of New Jersey. Transmission loss predictions made using REA data provided a significantly better fit to measured values than those using historical databases.

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Model-based directed drifter launches in the Adriatic Sea: Results from the DART Experiment

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A high-resolution numerical model of the Adriatic Sea is used to predict Lagrangian coherent structure boundaries, quantified by finite-size Lyapunov exponents (FSLE), for flow features in the region of the Gargano Peninsula during the course of the Dynamics of the Adriatic in Real Time (DART) observational program. Model predictions of such high-dispersion regions located on available ship-tracks were used to direct the launching of pairs of surface drifters on three days during March 2006, with the goal to maximize coverage of the sampling area. Overall, the combined use of FSLEs with ealistic coastal circulation models appears to be a promising avenue to aid real-time-directed drifter launches in observational programs.

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The MOMA project: meteorology and oceanography pilot network for Turkish coastal seas

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With plans to be continued after its first two-year first phase, the MOMA project is designed to establish a network of observations, and daily running meteorological and oceanographic forecasts covering the immediate region and the Seas surrounding Turkey. Two strategically and climatically important coastal regions with immediate needs for monitoring have been selected for the first phase pilot activities: These are thee (i) Turkish Straits System and (ii) Cilician Basin regions. Both regions have developing industry, high coastal population, heavy shipping including oil transport, and wide continental shelf areas and straits and delicate marine ecosystems which are sensitive to climate change. The coastal measurements include sea-level, currents, sea-water temperature and salinity, meteorological variables, nutrients and chlorophyll, air-land-sea eddy momentum, heat, water and CO2 fluxes. Coastal scale daily weather forecasting includes regional weaather elements, aerosol dust transport and meteorolgical data assimilation. Coastal ocean models investigate the dynamics of Bosphorus and Dardanelles straits and the Sea of Marmara. Daily forecasts driven by surface fluxes are made for currents and hydrography of waters adjoining the Mediterranean coast of Turkey, focusing in turn for the Cilician Basin, the Gulf of Iskenderun and Mersin Bay.

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Orographic effects on meteorological fields over the Adriatic from different models

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Two meteorological models at different resolutions are used for the investigation of the influence of orography on meteorological fields above the Adriatic. The analysis is performed on the fields from the regional LAMI model, given at 7 km horizontal resolution every 3 hours, and the global ECMWF model, at 0.5 deg every 6 hours, which cover the DART period (Oct/2005 - Sep/2006). The ECMWF orography can be considered as a smoothed version of the LAMI orography. Hence the differences between LAMI and ECMWF fields should enable the effects of orography to be more clearly seen. The analysis is focused on three typical weather situations over the Adriatic, namely the bora, sirocco and ethesian winds. The mean differences for each weather situation are examined over the entire period to find persistent features. Subsequently, the analysis is performed on particular episodes which are chosen as either being characteristic of each of the weather situations or are concurrent with DART IOPs.

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A realtime Ocean Prediction System

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One of the NRL contributions to the Mrea_07 exercise was to provide, in realtime, ocean forecast. The NRL prediction system is based on the relocatable version of the NCOM model, developed by C. Rowley at NRL. The main characteristic is its capability of being rapidly configured (usually less than 6hr from request) everywhere in the world. Therefore, goal is not to provide the most accurate representation for a specific area, but rather to provide good representations everywhere with the available data (i.e., in spite of the lack of observations). For the Mrea_07, the prediction system was configured on 3 nesting domain ranging approximately 4, 2, and 0.6 km. Two separate inner nests were configured for the Elba and LaSpezia areas, respectively. For this application, no data were assimilated in realtime. We will briefly discuss the main issues associated with realtime operations. Ocean forecast is usually the last ring of a long string of products developed at several different centers: a delay in acquiring one of the input data, the classic computer breakdowns (just to mention a few issues) may create a domino effect and ultimately a late deliver of the forecast. We will present and discuss the quality and accuracy of the Mrea_07 simulations. We have deliber

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Nearshore Characterization from Unmanned Aerial Vehicles (UAV)

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Abstract:

The nearshore is a highly dynamic area where hydrodynamic and morphodynamic processes may change on a wide range of spatial and temporal scales. Information regarding these variations of the littoral environment including the estimation of waves, currents and bathymetry is critical for a large range of military and civilian applications. Standard in situ bathymetric surveying techniques, such as ship-board echo-sounding or amphibious vehicle surveying can be used to perform REA of the nearshore but these techniques may not be possible in denied environments and do not allow the collection of data during periods of large waves or strong currents. For these reasons, remote sensing of the shore is highly desirable. Satellites are an attractive potential solution but for the surf-zone they typically have problems related to limited resolution, a complete lack of temporal sampling on dynamical time scales and access limitations due to both orbital constraints and resource contention. Recent research efforts at the NATO Undersea Research Centre have focused on remote sensing acquisitions using a non-stationary platform: the AeroVironment Raven UAV (Unmanned Aerial Vehicle).The goal of the project was to acquire medium duration video imagery of a beach and surf-zone, geo-rectify, merge and time-average the images in order to create time-averaged surf zone imagery, then use the resulting time exposures to study the configuration and evolution of nearshore sand bars. Two separate field exercises were performed and over 18 hours of imagery were collected.During these exercises, extensive testing was performed to characterize the UAV geometry, meta-data reliability and video camera properties. Testing included lens calibrations, ground calibrations in a controlled environment to precisely determine the geometry of camera mounting relative to the airframe, static attitude sensor calibrations and in-flight acquisition of imagery of a dense ?target farm? of ground reference points to perform dynamic calibration of attitude sensors. Once total package accuracy was assessed and errors minimized, image georectification, mosaicing and time-averaging were performed.

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Title

Optical properties and water clarity, a comparison between in-situ measurements and satellite derived products in the Adriatic sea.

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Abstract:

Battlespace preparation for modern Naval Operations in coastal areas includes open and covert methods for remote and in situ environmental conditions assessment. Local measurements, carried by autonomous vehicles, buoys, land stations and ships, are usually more expensive and difficult to execute, especially in denied or out-of-area locations, and do not usually allow to collect wide area synoptic snapshots. However, they provide accurate ground-truth used to validate and calibrate numerical models, tactical decision aids (TDA?s) and prediction systems. Remote sensing tools (airborne and satellite based) complement these local observations by providing wide area synoptic coverage of near surface features, or water column integrated properties, and provide a safe and easy to access methodology to infer environmental characteristics of the battlespace. In this regard, it is essential to combine local and remote sensing observations to create complete and accurate physical fields snapshots, allowing an expert extrapolation of the satellite and aircraft imagery and a sound local dynamics characterization. The objective of this poster is to present the performance's evaluation of an algorithm in estimating biophysical products from remote sensing acquisitions. The methodology is based on a simple inverse model for retrieving the absorption, backscattering, and beam attenuation coefficients within the surface ocean layer from the water leaving radiance. For this purpose, SeaWiFS and MODIS products are compared to optical instrument measurements (AC-9 and transmissometer) taken during cruises. On the basis of the results presented, we will assert that the algorithm has good performance in clear water, while in most turbid water the beam attenuation coefficient values are underestimated as compared to the in situ measurement, and, consequently, these values overestimate the diver visibility. Further investigations (e.g. using the data collected during DART06 cruises) could be essential to understand the real kind of these errors, that can be attributable to poor atmospheric corrections, sensor calibration and/or parameter estimations, and to improve the algorithms.

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Bathymetry estimation from high-resolution satellite images

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Remote spectral imaging of the littoral zone can provide valuable information for Rapid Environmental Assessment (REA). Our long-term goal is the development of spectral analysis tools that fully exploit the information content in optical imagery data, particularly it applies to remote sensing of ocean color and the extraction of bathymetry, water quality and bottom type information. With the advent of high spatial resolution imaging sensors, such as QUICKBIRD and IKONOS, there is the potential to retrieve additional information; applications include identifying and characterizing underwater objects and materials and mapping water depth. The small pixel size of these sensors (< 3 m) is a key factor to obtain accurate batimetric computations to retrieve information in shallow water, particular at depth of less than 10 m, which is a critical area of interest for amphibious operations. The fundamental principle behind using optical remote sensing image to map bathymetry is that different wavelengths of light will penetrate water to a varying degree. When light passes through water column it becomes attenuated by interaction with the water and the in situ constituents. Red light attenuates rapidly in water and does not penetrate further than about 5 meters in clear water. By contrast, blue light penetrates much further and in clear water the seabed (bottom type) can reflect enough light to be detected by a satellite sensor even when the depth of water approaches 30 meters. When the water type and the bottom reflectance are uniform over the study area, bathymetric mapping is relatively straightforward, one variable problem and requires a minimum of field data. The problem becomes much more complex when the water type and the bottom type vary over the scene; in this case, bathymetric mapping is thus an inherently multivariate problem requiring at least several spectral bands. This poster presents a NURC's approach on bathymetry estimation and shows the results retrieved during two NURC's experimentations (Steadfast Jaguar06 and BP07).

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Surface currents and wind effects in the area of LASIE Experiment.

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Long time series of surface currents and wind stress are analyzed to estimate how local wind can modify the upper layer circulation. Current metres data were collected by an upward-looking ADCP RD&I Sentinel 300 kHz deployed in the open Ligurian Sea (43°47.77’ N; 9°02.85’ E) near the meteo-oceanographic buoy ODAS ITALIA1, wind speed and direction were measured each hour from the buoy at 13.5 m above the sea surface. The ADCP sampled the upper 50 m of water column with 8 m vertical resolution and 1h time interval from 13 September 2003 to 25 May 2004. Currents were mainly barotropic and directed NW, according to the general circulation of the area, with a mean velocity of about 18 cm/s and hourly mean peaks up to 80 cm/s. In some cases the upper layer (0-8 m) currents displayed relevant differences from the layers below, in particular for the presence of a strong southward component. EOF (empirical orthogonal function) decomposition allows to better identify the effects of surface forcings, separating large scale circulation from the local variability. The first mode, which on the average accounts for about 70% of the signal, well describes the barotropic motion; the second mode accounts for about of 20% of the variability but in some can reach more than 50%. Second mode currents are important only in the first layer, having a mean intensity of about 10 cm/s which strongly reduces with depth. The effects of the local wind were estimated by means of a 1-D numerical model integrating the Ekman equations in the vertical plane. A constant wind stress of 0.2 N/m2, representing the mean observed value, can drift a mean current in the upper 10 m of about 12 cm/sec; for a wind stress of 0.35 N/m2, corresponding to a wind speed of 14 m/s, the velocity increases up to 28 cm/s, thus able to strongly modify the mean geostrophic components.

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Title

Real time assessment of a developing eddy dipole in the Iceland Basin

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During July and August 2007, whilst undertaking a multidisciplinary process study and mooring maintenance cruise near 60° N, 20° W in the Iceland Basin, satellite images showed the propagation and development of an eddy dipole eastwards into the region of our mooring array. Short, targeted, surveys were made of the developing dipole structure, alternating between the use of the CTD frame and the towed SeaSoar undulating recorder as vehicles for in-situ instruments. Near real-time satellite data in conjunction with VM-ADCP data to over 500 m were used to determine the movement of the eddy centres and the central jet as the system developed. By Targeting vertical net hauls and water collection for on-deck incubations the biogeochemical impact of this mesoscale structure could be assessed. The cyclonic and anticyclonic components expressed potential vorticity anomalies at significantly different depths, and the anti-cyclonic component appeared to be winter mode water with a remnant signal of deep winter mixing to over 800 m. The anticyclonic eddy had a cold surface signature as isopycnals were uplifted above the weakly stratified eddy core. The cyclonic eddy had a warm surface signature as though increased stability in the upper water column had led to greater summer heating. There were significant differences in phytoplankton and zooplankton communities, but quantitatively much of this data is still to be worked up. The curious three dimensional structure of this dipole made forecast modelling difficult but some model snapshots will be presented for comparison and contrast.

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Drifter dispersion experiments in the Ligurian Sea: preliminary results

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As part of MREA07 and LASIE07, surface drifters were deployed in the Ligurian Sea to study the dispersion due to surface currents and to provide ground truth for VHF radar measurements in the Gulf of La Spezia. All drifters were of the CODE design with a vertical extension of about 1 m near the surface. The units operated in the open sea were equipped Argos transmitters for localization and data telemetry and GPS receivers for finer positioning. Those deployed in the Gulf of La Spezia were fitted with cellular phone modems (GSM-GPRS) for data telemetry and GPS receivers for positioning. One unit was also equipped with acoustic velocimeters to measure the water-following capabilities of the CODE design. The drifters were deployed in clusters with size varying between 125 and 500 m. Three clusters of 5 units were released in the vicinity of the ODAS buoy in the open Ligurian Sea on 14 May, 17 and 22 June 2007. The first cluster moved coherently to the west and southwest before dispersing (after about 10 days) into drifters heading to the north and northeast and one unit proceeding to the southeast. In contrast, the two releases in June resulted in clusters that remained together for more than a month and moved northward before joining the slope current along the Ligurian and French coasts. Dispersion was only evident when some drifters escaped from the fast slope current and recirculated cyclonically in the Ligurian Sea, or when the cluster eventually reached the Gulf of Lions, moved offshore and progressed to the south and southeast in the open sea. In total, five drifter experiments were conducted in the Gulf of La Spezia between 18 and 26 June 2007. Clusters of 3 to 6 drifters were operated for periods ranging between 4 and 65 hours. All drifters were recovered or ended up on the coast, on sea walls, etc. The drifter equipped with the acoustic velocimeters revealed that the drifters followed the surface currents with ~2 cm/s accuracy. The drifter tracks show that the circulation in the Gulf of La Spezia can be quite complex and time-varying. Drifters can move away from each other after a few hours resulting in significant dispersion, or they can stay together for days.

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Title

Simulation of LASIE Weather Situations with the Relocatable Local Model of BGIO

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During the LASIE experiment 14.6. - 28.6.2007 a hierarchy of atmospheric models ran at the Bundeswehr Geo-Information Office (BGIO) on a IBM p655 supercomputer. Within the global model (GME) of Deutscher Wetterdienst (DWD) with 40 km horizontal grid resolution, a relocatable 7 km (RLM) and 3 km (RLMK) version of the non-hydrostatic Local Model (LM) were nested with one way interaction. RLMK graphics were transmitted in real time to the LASIE web server. Two characteristic early summer weather situations are described in this study: anticyclonic 14./15.6.2007 and cyclonic 26./27.6.2007. Local thermal effects like land and sea breezes controlled the anticyclonic case, which are simulated by RLMK very well. Atmospheric dynamics in interaction with surface effects dominated during the cyclonic case. Lee waves and flow channelling between Mediterranean isles and near coast lines are forecasted with RLMK realistically. In addition to the discussion of the model simulations a brief description is given to the concept and realization of an objective method for meteorological model forecast quality assessment, which has been developed at BGIO on the basis of ECMWF ERA-40 data. The aim of this project is (i) to quantitatively assess the actual forecast quality using an objective method for all military missions worldwide based on the ERA-40 data set. The measure will be available for every operational RLM area during a short range forecast period up to 36 h. To achieve a clear cause-effect relationship it must be related to general synoptic structures. Further, (ii) the derived information is intended to be used to identify characteristic model forecast deficiencies with respect to geographic location and synoptic situation, and to retrieve climatologies for each operational area under military consideration.

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Improved near-shore ocean predictions from trawl-safe bottom mounted platforms and super-ensembles techniques

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Multi-model Super-Ensemble (SE) aiming at combining optimally different models have been shown to improve significantly atmospheric weather predictions. In the coastal ocean, prediction skills are still low due to high dynamics, the presence of small-scales processes, the lack of real-time data and limited reliability of operational models which prevented the proper application of the SE method so far. Here, we report improved prediction skills and reduced uncertainty in coastal area through a unique combination of the SEPTR - a trawl-safe bottom mounted platform transmitting near real-time data, and state-of-the-art super-ensemble techniques from a series of eight operational models ran during an experiment in the Adriatic Sea.

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Assessment of deterministic and stochastic multi-model ocean predictions and uncertainties on acoustic propagation in shallow waters

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It is well known that high environmental variability may significantly impact acoustic operations in shallow waters. In the framework of the BP07 sea trial South-East of Elba, Italy, several operational models were used to assess the uncertainty of ocean and acoustic predictions. They were further used to optimize MVP and CTD sampling strategies in the area and incorporated in super-ensemble predictions which aim at combining optimally individual forecasts. These different products were then compared and suggest that multi-model super-ensemble strategies provide more reliable predictions and further reduce the uncertainty on the environment. A sensitivity study of environmental predictions on low frequency (300 to 1800 Hz) acoustic signals was conducted. The analysis is performed within the perspective of geoacoustic inversion and conclusions are drawn about the limitations of oceanographic variability and uncertainty upon geoacoustic inversion methodologies.

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Title

Standards based mission planning for ocean sampling

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The U.S. Naval Research Laboratory at Stennis Space Center, Mississippi is developing a common mission planning and monitoring system that incorporates the impact of the environment on mission performance. The state of the art is independent software systems that marginally incorporate environmental conditions in mission planning. Consideration of the environment is paramount for underwater vehicles and a flexible, common, standards-based software system is needed. Results are presented for an assessment of mission planning system developments in the U.S. Navy for underwater vehicles. This study found multiple independent efforts with custom software packages that are based on different languages and toolsets and that comply with few if any existing standards. For the organization purchasing these systems, this situation results in high life-cycle costs that are typically associated with custom software. Findings are presented from a study that revealed movements towards standardization in command and control for autonomous vehicles. The results of an examination of the theoretical basics of mission planning are presented with the conclusion that mission planning and monitoring is an exercise in geo-spatial/temporal decision making. The consequence of this realization is that supporting software should be built upon a Geographic Information System (GIS) as opposed to the addition of ad-hoc GIS capabilities to vehicle specific command & control systems. Examples of GIS capabilities common across the spectrum of mission planning are given in addition to an introduction of the Commercial Joint Mapping Toolkit (CJMTK). This paper also clarifies the objectives of mission planning and monitoring systems which are fundamentally to facilitate rapid decision making and not necessarily to view environmental data or to provide high fidelity vehicle simulations. Examples are provided of mission planning system functional capabilities highlighting the extent to which software aids in the decision making. One approach that is discussed is Traffic Light Analysis (TLA), which promises to simplify the process of making decisions on 4DxN (4 dimensional, N data types) information. Finally, a proposed High Level Architecture for a common Mission Planning/Monitoring system is presented.

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Title

Development of a 2-d coupled wave current model on unstructured meshes

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In this paper we present a coupled wave current model which solves the Shallow Water and Wave Action equation on an unstructured grid. The use of unstructured meshes renders the scheme more efficient than models using structured meshes to resolve the model domain, the bathymetry and the involved gradient fields of currents, water levels and wave action. The coupled model has been successfully applied to various environments like e.g. the lagoon of Venice. Several verification cases for the current, the wave and the coupled model will be shown where the efficiency and robustness of the implemented algorithms is demonstrated. The hydrodynamic model is based on the Shallow Water equation with the hydrostatic approximation which is characterized by a semi-implicit algorithm for the temporal integration and a finite element approach for the horizontal spatial integration (Umgiesser, 1997). The model is called SHYFEM (Shallow water HYdrodynamic Finite Elements Model) which is a two-dimensional vertically integrated finite element model which solves the shallow water equations developed at the ISMAR-CNR of Venice and successfully applied to several coastal environments [Ferrarin and Umgiesser, 2005; Umgiesser,1997; Umgiesser and Bergamasco, 1995; Scroccaro et al., 2004]. SHYFEM is fully coupled via with the 3rd generation spectral wave model WWM [Wind Wave Model; Hsu et al, 2005], which solves the WAE Wave Action Equation on unstructured spatial grids. The WWM adopts state of the science source term formulation for the generation, nonlinear interaction and decay of wave energy. The fractional step method [Yanenko, 1971] is used to split the wave action balance equation into spatial, frequency and directional space. These three parts are integrated successively which makes it possible to apply efficient numerical algorithms to solve the equations in the certain dimension. The Wave model has been verified in different environments against in-situ measurements [Hsu et al, 2005, 2006; Roland et al. 2005, 2006].

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Title

Rea in a complex Arctic environment

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In order to overcome a lack of real-time data, and to test the process of data gathering, processing and distribution, a Cat.2 REA was conducted ahead of the exercise Cold Response 07 in Northern Norway. No OGMC was tuned for the exercise area, making tactical evaluation of the oceanographic conditions very difficult. During the REA, 170 CTD casts were performed over a 6 day period. The data collected was distributed as a Tactical Information CD to the exercise participants. The entire process, from data gathering to distribution was completed within a time frame of 11 days.

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Mesoscale variability and transports in the Gulf of Lions (NW Mediterranean) by the variational analysis of Lagrangian data and 3D numerical model outputs

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We analyse the trajectories of 20 satellite-tracked drifters (holey-sock drogue at 50 m depth) released in the Northern Current (NC) in two periods of different stratification conditions: June and December 2005. From low-pass filtered at the cut-off period of 36h, the 3h-interpolated position data reveal the well-known mean patterns of the along-slope circulation and show up a mesoscale signal with a time scale around 2 days. The reconstruction of currents at 50 m depth is drawn for the Gulf of Lions along-slope circulation by the use of the variational method developed by Taillandier et al. (Ocean Modelling, 2006) applied to these Lagrangian data in combination with NW Mediterranean model (MARS3D) outputs. The trajectories in the core of the NC provide corrections on the intensity and width of the model NC. The trajectories which sample the mesoscale activity (showing pathways trapped over the shelf) are used to reorganise the model eddy activity by refining the location and shape of NC meanders. Improved model fields are used to simulate trajectories and to make diagnostics on the shelf slope transports linked to NC instabilities.

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Title

Mesoscale dynamics of the Balearic front integrating glider, ship and satellite data

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Two independent surveys were carried out in order to characterize the Balearic front (Northern Mallorca island). The first survey was performed by the coastal glider 'Maya' between 7 and 13 July 2007, covering a total distance (go and return) of about 90 nm along the Envisat track 773. The autonomous platform collected 148 CTD profiles from 10 m to 180 m depth in one week (~21 profiles per day). Every 6 hours, the glider goes up to the surface and sends the measured data by satellite transmission. Real-time processing of data allowed us to identify the position of the Balearic front and design in advance the CTD/XBT sampling for the ship survey that was conducted between 9 and 12 July on board R/V García del Cid. Due to bad meteorological conditions, the ship sampling period along the same satellite track was reduced to less of one day. We collected 8 CTD profiles reaching 600 m depth and 14 XBTs were launched between CTD stations. Preliminary analysis shows coherent results from both data sets (ship and glider). Using a reference level of 180 m depth, we have found maximum geostrophic velocities of 45-50 cm/s flowing northeastwards along the North Mallorca coast. There are not significant differences when dynamic height is computed using a reference level of 180 or 600 m depth (ship data), which ensure the results obtained from glider data. Moreover, the comparison of geostrophic velocity from CTDs (ship and glider) and interpolated dynamic topography from merged altimetry fields along the Envisat track shows a coherent pattern, although the magnitude from altimetry data is lower due to the filtering applied in the interpolated fields. The width of the Balearic front along the satellite track is about 35-40 km and it is clearly detected in salinity (not in temperature) with lower values (37.4 PSU) near coast that likely are related to the input of Atlantic Water through the Mallorca channel.

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Vertical structure of the marine boundary layer during the LASIE experiment.

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During the LASIE experiment (Ligurian Sea, 16-22 June 2007) the height of the marine atmospheric boundary layer has been derived using two different measuring systems. Onboard of N/O URANIACNR, radiosondes were released every 3 hours while a ceilometer was continuously measuring. Here, we present preliminary results of the comparison between these two different systems under meteorological condition characterized by flat sea, low wind, high humidity and strong cloud cover variability. Results are also compared to results from previous experiments in the area.

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Title

Towards Rapid Environmental Assessment and Coastal Forecasting in the Northern Adriatic

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A coastal ocean forecast in the Northern Adriatic is necessary to protect the coastal environment and to respond to operational assessment requests and emergencies on a rapid way. The concept of Rapid Environmental Assessment (REA) is based on observations that can provide an accurate description of the present status of the coastal ocean and consequently environmental prediction within a short time. An integrated observing and prediction system is required to both initialize a numerical model and assimilate data from a monitoring network. This work in particular aims to establish a REA system in the Northern Adriatic based on three coastal monitoring networks and the large scale operational forecasting system of the Adriatic Basin investigating different modeling issues. The Princeton Ocean Model has been implemented in the Northern Adriatic and nested in the Adriatic Regional (AREG) model. Two different modeling systems were tested considering the old AREG model and the new one having different resolutions to downscale the initial and the boundary conditions. Model validation has been performed with Satellite Sea Surface Temperature (SST) observations and coastal CTDs. Quantitative comparisons have been done between model results and observations using space and time mean estimates of bias, root mean square error and pattern correlation coefficient. A multi-scaling optimal interpolation technique has been applied to meld coastal data and large scale fields in the model initialization. The spin up time, necessary to develop the new scales circulation features, has been investigated to be able to define the minimum time required with the maximum accuracy in model results. This has been possible through energetic evaluation and comparison with coastal observation too. The simulation period considered is August and September 2003 during which the summer stratification breaks down and the water column get well mixed. This event is very interesting to test model performances in a very critical area characterized by a shallow and wide continental shelf and a substantial river freshwater inflow.

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Title

Marine coastal monitoring in the Gulf of Manfredonia (Southern Adriatic Sea)

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Coastal environments are complex systems characterized by various processes with variable space and time scales; a continuous and high frequency monitoring of marine environment needs to assess the present marine ecosystem and to estimate and manage in real time perturbations due to anthropogenic pressure or natural events. This work has been carried out in the framework of the PITAGEM project (CLUSTER 10 programme, development of Southern Italy marine research structures), where an integrated marine coastal monitoring network has been set up in the Gulf of Manfredonia (Southern Adriatic Sea), a complex area under potential pollution deriving from industrial, agricultural, harbour and urban activities. The network consisted of real time oceanographic (water temperature, salinity, dissolved oxygen, chlorophyll a and turbidity) and atmospheric (air temperature and pressure, solar radiation, wind speed and direction) observations, performed by a multiparametric coastal platform, and periodic oceanographic (water temperature, salinity, dissolved oxygen, chlorophyll a, turbidity and pH profiles and surface and bottom nutrient, chlorophyll a and suspended solid concentrations) observations, carried out by a coastal vessel. Data, acquired from May 2002 to April 2005, was stored in a data bank, after a data quality control check procedure. Periodic instrument maintenance and recalibration activities have been performed to obtain reliable data. By the oceanographic platform it was possible to collect consistent and continuous water temperature, air pressure and wind direction data from August 2004 to April 2005, and air temperature, solar radiation and wind speed from December 2004 to April 2005. Monitoring cruises were carried out six times from May 2002 to November 2004. Preliminary data show that seasonal water column set up depends on annual air temperature trend, while short-term variations depend on other factors such as local atmospheric perturbations. Furthermore, three different zones were individuated in the Gulf: a coastal area, affected by river inputs, an offshore area, influenced by the Western North Adriatic current and a central area, characterized by intermediate and mixing processes.

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Title

Local Geoacoustic Inversion on a single hydrophone

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Geoacoustic inversion is one of the key components of acoustic REA techniques in shallow waters. We propose in this paper an extension of Holland&Osler's inversion approach using the repetitivity of LFM signals and absolute amplitude levels of received echos. The method is tested on the CALIMERO data set collected in the Med sea in 2004.The method is robust and needs weak assumption on the medium. The results are consistent with in situ measurments.

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Title

Variational analysis of drifter positions and model outputs for the reconstruction of surface currents in the Central Adriatic during fall 2002

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In this talk we present an application of a variational method for the reconstruction of the velocity field in a coastal flow in the central Adriatic Sea, using in-situ data from surface drifters and outputs from the ROMS circulation model. The variational approach, previously developed and tested for mesoscale open ocean flows, has been improved and adapted to account for inhomogeneities on boundary current dynamics over complex bathymetry and coastline, and for weak Lagrangian persistency in coastal flows. The velocity reconstruction is performed using nine drifter trajectories over 45 days, and a hierarchy of indirect tests is introduced to evaluate the results as the real ocean state is not known. For internal consistency and impact of the analysis, three diagnostics characterizing the particle prediction and transport, in terms of residence times in various zones and export rates from the boundary current toward the interior, show that the reconstruction is quite effective. A qualitative comparison with sea color data from the MODIS satellite images show that the reconstruction significantly improves the description of the boundary current with respect to the ROMS model first guess, capturing its main features and its exchanges with the interior when sampled by the drifters.

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Title

A mesoscale eddy tracked along the Libyo-Egyptian coast (Eastern Mediterranean Sea): reconstruction and characterization from surface drifters and altimetry

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We present an application of a variational method to characterize a mesoscale eddy along the Lybio-Egyptian coast, using in-situ data from surface drifters and satellite altimetry. The variational approach, previously developed and tested for mesoscale open ocean flows, has been used to provide a reconstruction of the surface flow at high resolution combining synoptic information from sea surface height with Lagrangian data. A quantitative assessment of such analysis is performed with independent information given by Sea Surface Temperature imagery. Transport barriers computed by Lyapunov Exponents in the reconstructed flow should be collocated to any advected tracer fronts: therefore we look where the transport barriers are tangent to SST fronts and where there are not. The eddy has been tracked during a four month period. The evolution of its surface structure (core location, extension, pathway) can be described efficiently using dynamical properties of the reconstructed flow. This characterization allows to investigate the participation of this mesoscale eddy in the general circulation of Atlantic Waters over the Eastern Mediterranean.

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Ligurian air-sea interaction experiment

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The main scientific goal of the Ligurian Air-Sea Interaction Experiment (LASIE), which took place in the Ligurian Sea from 14 June to 5 July 2007, is to contribute to the evaluation and development of parameterizations of the oceanic and atmospheric boundary layers and their interactions. To achieve this goal during LASIE a detailed characterization of the mean and turbulent structure of the ocean and atmosphere boundary layers in the Ligurian Sea was carried out. In this presentation, some preliminary results will be discussed.

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Submerged Remote Sensing (SRS) Technique

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Currently, there are efforts to use autonomous underwater vehicles, gliders and moorings to extending spatial and temporal measurement capabilities in oceanographic research. These platforms operate at either fixed depths, programmed to change depths, sea saw, undulated or profile through the water column. Sensor data collected is usually internally recorded and then transmitted via satellite-based communications when at the surface or dump via a cable when retrieved by a vessel. A variety of optical instruments have been deployed on these observing platforms with most of them measuring inherent optical properties (IOPs) because day/night illumination differences do not affect these measurements, they can be directly related to in situ properties and are not sensitive to vehicle orientation. Fluorescence sensors also have provided valuable information related to the biological and dissolved components in the ocean. Disadvantages of IOP and fluorescence measurements are that they measure a small volume and in order to obtain vertical distributions the platform must profile or undulate. The ability to estimate integrated optical properties from the surface to the depth of a platform would be highly advantageous, especially for moorings and AUVs. The Submerged Remote Sensing (SRS) technique takes downwelling irradiance at two wavelengths at a known depth, and given time, date, position and the extra-terrestrial solar spectral irradiance, computes the total water and atmospheric attenuation above the sensor. Using irradiance profiles from the North Atlantic, the integrated diffuse attenuation (490 nm) was predicted for depths from 20 to 120 m. Mean K(490) ranged from 0.028 to 0.400 m**-1 with the average ratio between the SRS to measured K(490) being 0.986, with a standard deviation of 0.073 (or a mean difference of SRS minus measured of 0.001 m**-1 + 0.0048 m**-1, n = 221). The SRS technique was only published as an SIO Technical Memo 87-18 (1987) and is not easily available. We plan in the future to explore the robust nature of SRS algorithm using a much larger optical database to include coastal areas.

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Super-ensemble prediction of surface drift

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Predicting the surface drift of floating particles is required for various applications, such as search-and-rescue activities, mine tracking, pollutant spreading, biology (e.g. larvae spreading) etc. However, it remains a very challenging problem. Indeed, the prediction of surface drift by using surface currents has a chaotic nature. In particular, it is extremely sensitive to the details of the advective Eulerian velocity field, as even small changes in the current estimates can lead to drastically different trajectories. But these small variations of the velocity field are inevitable because, despite large progress made in ocean models during the last decades, they remain tributary of various sources of error (unresolved scales and turbulent closure, internal model parameters, initial conditions, atmospheric forcing fields, bathymetry, coastline etc.). Finally, on top of these difficulties, the drift trajectory also depends on different forcings not represented in ocean models: the wind and wave fields. Therefore, traditionally, surface drift estimates have been obtained from surface currents provided by ocean models, or from the rule of thumb applied to the wind field provided by atmospheric models, with a possible contribution from the Stokes drift provided by wave models. In order to tackle some of the difficulties mentioned, we used the integrated hyper-ensemble approach, aiming at combining optimally ocean (ROMS, NCOM), atmospheric (different implementations of the Aladin model), and wave (different implementations of the SWAN model) contributions to the surface drift. We successively tried out different techniques: the simple ensemble mean, the ensemble's best member, and the unbiased linear estimator. Furthermore, we also implemented methods allowing a time-evolution of the model's weights: the Kalman filter and the particle filter, the latter being useful when the model weights do not form a Gaussian distribution. These various deterministic and statistical methods, applied in the framework of DART06 and MREA07, are assessed and compared, and show some promising avenues for improved surface drift predictions.

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Lagrangian data assimilation in the Gulf of Mexico

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The intent of this study is to test the Lagrangian data assimilation method developed by Ide et al. (2002) in a more realistic setting. For that purpose, we have implemented a 3 layer reduced gravity model of the Gulf of Mexico (GOM). This modeling set up has been shown to be one of the simplest representation of the GOM that simulates the nonlinear process of eddy shedding. Our proof of concept methodology is based on assimilating synthetic drifters that were initially placed within the eddy. The assimilation method is based on the use of ensembles to sample the prior error covariances. We have shown that as little as 2 carefully placed drifters are needed to recover the eddy. The remarkable efficiency of the methodology is investigated by looking at volumes of influence that we defined as the region that will be influenced by the observed drifter location after assimilation. These volumes of influence can define a metric for the efficiency of assimilating different types of observation. We will also present some preliminary results of the comparison of Eulerian and Lagrangian regions of influence.

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West Adriatic coastal water summertime excursion into the East Adriatic

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A pool of less saline surface waters has been observed in late June 2006 at the northern edge of the South Adriatic Pit. Three possible sources have been assumed: (1) Albanian rivers, (2) middle Adriatic rivers, or (3) West Adriatic Current (WAC). Through the examination of ADCP data collected within DART and ITHACA projects, and of satellite images, source (3) appears to be the likely culprit. Such an extended excursion is especially surprising as rather low winds and stable conditions prevailed in mid/late June. However, quite strong Etesian winds occurred in first 12 days in June, with a maximum close to the western shore. Therefore, it is suspected that these winds enhanced the WAC and inclined sea level along the western shore, resulting in a transversal eddy-like circulation when the winds later relaxed. These WAC eddies grew and reached middle east-Adriatic waters for about two weeks and were successfully simulated by the Navy Coastal Ocean Model. Finally, we quantify the role of various bathymetrical features on the WAC transversal dynamics through idealized modelling studies.

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Measuring waves in the surf/swash zone using video/image processing methods

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The aim of this contribution is to present and discuss some original techniques for acquiring high-frequency sea-surface and wave run-up elevation measurements, using video-image processing techniques. Towards that purpose, two experiments were set up in different beaches of Lesbos Island (NE Aegean Sea, Greece), combining oceanographic measuring instruments with commercial video cameras. The general principle of the method is simple: videos of the processes are obtained from fixed cameras and after scaling and lens distortion aspects are taken into account, the image frames are exported. In the following step, image processing techniques are applied to identify bodies on each frame that can result to the final measurement. For the sea surface elevation measurements, 10 cm diameter red poles have been installed at various depths, and their free (dry) sections, as well as the upper and lower limits, are identified, allowing for the tracing of the sea surface. Wave run up motion can be tracked through the detection of the foam on the leading edge of the swash. The final data have been successfully compared with manually obtained measurements from the videos, as well as with pressure sensor series. Among the benefits of the method compared to the use of sensors is that it is low-cost, direct (measuring directly the desired quantity), and in the case of swash motion measurements, non intrusive, allowing continuous (both in time and 2D space) measurements.

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Title

Operational data management in MHI NASU

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Significant volumes of oceanographic data both archive and operational are stored in the Data Bank of Marine Hydrophysical Institute of National Academy of Science of Ukraine (MHI NASU). Data sources of MHI NASU Databank are cruise observations, oceanographic platform (experimental branch of MHI), Black sea drifting buoys, satellite data, marine observations network. The list of real (quasi-real) time values contains meteorological parameters (wind, waves, pressure fields) obtained via GTS and FTP-servers, hydrophysical parameters (temperature, salinity, currents) measured by drifters, sea level data from MedGLOSS station located in Experimental branch of MHI NASU in Katsiveli. We have developed the first version of operational data management software realizing the following functions: - data receiving, its conversation to our data formats, operational quality control and loading to the MHI NASU database. -visualization of data; -providing data selection (together with archive data if it is necessary) via desktop and web interfaces. Sea level and drifter data will be also accessible soon on the web-site of the Marine Environmental and Information Systems Department of MHI NASU.