The Future of Operational Oceanography

BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

The Future of Operational Oceanography 2013

Congress Centre Hamburg (CCH), Germany

8 - 10 October 2013

Book of Abstracts

Presentations, Posters, and List of Participants

Part A: Presentations

Observing systems

The new COSYNA Underwater Node System – a transregional and transinstitutional research approach in the North Sea and in the Artic

Philipp Fischer[1], Burkard Baschek[2], Friedhelm Schroeder[2], Michael Boer[3], Maik Grunwald[3], Reiner Loth[4], Jakob Klaus-Stöhner[4] and Tobias Boehme[3] et al.

[1] *Alfred-Wegener-Institut, Helmholtz Center for Polar- and Marine Research, Germany*
[2] *Helmholtz-Center Geesthacht, Germany*
[3] *4h-Jena, Germany*
[4] *Loth Engineering, Germany*

Coastal ecosystems are important interface zones between the terrestrial and the marine realm. Due to the continuously increasing anthropogenic pressure on most coastlines worldwide, a significant increase in the effort to monitor and assess changes in the coastal systems has been proposed. In the framework of COSYNA (Coastal Observation System of the Northern and Artic Seas), a cable connected underwater observatory for long term exposure even under extreme environmental conditions has been developed. Two prototypes of the COSYNA underwater node system have been installed in 2012 in the southern North Sea and in an Artic Fjord System (Kongsfjord Svalbard) and are operated since then continuously. These systems provide the logistic underwater platforms to operate standard sensors like ADCP and CTD as well as complex sensors like a continuous plankton recorder or a stereo-optical fish detection device with a data transmission rate up to 1 GHz year in both ecosystems.

The main scientific objective of the COSYNA underwater node technology is the continuous assessment and (near) real time analysis of environmental parameters in the COSYNA target environments the North Sea and the Arctic Sea. The continuous data stream of the main oceanographic, hydraulic and biological parameters sampled synchronously in the two ecosystems year round even under extreme conditions like severe storms in the North Sea or ice coverage in the Artic are used to monitor, analyse and to model ecosystem behaviour with respect to abiotic environmental dynamics and environmental shifts.

Application of continuous measurements on FerryBoxes to carbon fluxes in the North Sea

Michael Haller and Wilhelm Petersen

Institute of Coastal Research, Helmholtz Zentrum Geesthacht (HZG)

The monitoring of marine environments in coastal seas is still a challenge when continuous and reliable observations are needed. The use of ships of opportunity (SoO) as a platform for marine measurements is cost-effective and can provide continuous and reliable measurements of near-surface parameters. For many years, FerryBoxes have been installed on several SoOs in the North Sea and other coastal oceans. They are protected from damage by waves and biofouling can be easier handled. So they serve as a valuable tool for further research on coastal seas.

In context of acidification and eutrophication of the oceans as well as climate warming, research is needed for the evaluation of quantitative values regarding the cycles of oxygen and carbon. The gas exchange between ocean and atmosphere being part of the oxygen cycles is used for estimation of net primary production. These processes of gas exchange are strongly influenced by temperature, salinity and wind speed. Empirical functions are used for parameterisation of the gas transfer velocity and have been under discussion in recent years.

In this study we present data analyses of FerryBox transects in the North Sea covering a time period of one year. On-board the FerryBox systems, optodes provide continuous measurements of dissolved oxygen concentrations. Together with temperature and salinity observations as well as wind field information derived from ECMW model reanalyses and from DWD forecasts, the air-sea exchange of oxygen and carbon has been calculated for coastal zones. FerryBox systems on ships of opportunity provide continuous measurements over a longer timescale along transects in coastal oceans. Depending on the ship routes, the time interval at one point is about 1-2 days, so weekly data of oxygen anomalies are usable for the flux estimates. Details of the analyses procedure as well as results will be presented.

Towards reliable in-situ real-time oxygen measurements

Detlev Machoczek

German Federal Maritime and Hydrographic Agency (BSH)

The Federal Maritime and Hydrographic Agency (BSH) operates a measuring network with 6 automatic stations in the German Bight and 5 stations in the Western Baltic Sea. The objective of this network is the monitoring of the actual meteorological and hydrographical conditions in these areas and the collection of data for the composition of long time-series in terms of climate change.

A very important parameter describing the status of the sea is its oxygen content. Oxygen measurements deliver information about the biological status of the sea area as well as information about the water exchange. They help to evaluate the environmental conditions for marine life and indicate biological production or extinction. From the mid 1980s BSH started trials to measure the oxygen content of seawater continuously on its network stations. Clark-cell sensors measuring oxygen content electrochemically in a closed system were applied. These sensors needed extensive calibration and maintenance work before their installation at sea. Their long-term stability was limited to the reaction of the electrolytical liquid and they were susceptible to bio-fouling. Altogether the results of these measurements were not satisfying.

Therefore another sensor, the Züllig-sensor, an open system based on a galvanic measurement principle, was introduced. This system did not need a membrane and an electrolytical liquid. It used a whetstone for cleaning the electrode. Unfortunately the sensor showed deficits too. It was mechanically instable and consumed a lot of energy. Small changes in the surface geometry of the electrode created major changes in the oxygen values generated by the sensor.

With the introduction of sensors measuring the oxygen content by opto-chemical technology, BSH was able to produce reliable in situ real-time oxygen values for the first time. The sensor, based on a principle which is called dynamic luminescence quenching, has no moving parts, is easy to handle, does not need much energy and is able to produce stable measurements up to one year. Nevertheless it is, like the Clark-cell-sensor, susceptible to bio-fouling.

Check measurements are necessary to guarantee the correctness of the measurements of the optodes of the network stations. These measurements were carried out by taking water samples and determining in a profiling measuring system (CTD) the oxygen content by Winkler-titration. As this procedure needs laboratory equipment and a lot of extra time, these measurements can be carried out only infrequently. To get more check measurements, the type of optodes installed at the network stations cannot be used, as its response time (up to 30 s) is much too long.

As fast optode-sensors with a response time of less than 1 s have been developed, BSH has tested such a sensor in a CTD-System to find out if such a sensor can be used for check measurements too. First results show that the sensor is suitable for continuous profiling measurements as the response time is less than 1 s (90 % value) and as long as the heave down velocity is not too high. The sensor has a tendency to underestimate the existing saturation values. Deviations from the existing saturation values are highest at high oxygen saturation values and decrease when the oxygen values are diminishing. The sensor shows a slight nonlinearity in the increase of the deviation of the sensor with increasing time. A recalibration of the senor is only necessary after 4 months. After 25 years of testing different ways of measuring the oxygen content of seawater continuously, the optode-technology now guarantees reliable real-time measurements which can be checked easily by a CTD-system fitted out with a fast optode sensor, almost superseding the laborious Winkler-titration.

Measurements of Directional Sea State Spectra with an Array of Radar Level Sensors, a Wave Rider Buoy and an ADCP at the research platform FINO 1

Sebastian Rütten[1], Stephan Mai[1], Ulrich Barjenbruch[1], Christian Senet[2] and Jens G. Fischer[2]

[1] *German Federal Institute of Hydrology (BfG)*
[2] *German Federal Maritime and Hydrographic Agency (BSH)*

Radar level sensors have successfully been utilised to retrieve non-directional sea state data e.g. significant wave height, maximum wave height and non-directional sea state frequency spectra. The main advantages of radar level gauges compared to in situ instruments as sea state buoys or ADCPs are 1.) remote measurements without impact of harsh marine environmental conditions and 2.) an expected high accuracy because of an expected linear instrument's modulation transfer function.

In the past BfG has developed a single radar level sensor system to retrieve sea state parameters with reliable and validated results. Since 2012 BfG develops and tests an array of radar level sensors to retrieve the directional properties of sea state. The hardware consists of a set of four radar sensors. The sensors are arranged together to form a triangle with one additional sensor in the triangle's center.

BSH and BfG jointly started a test of the array of radar sensors at the research platform FINO 1 located about 45 km north of the East Frisian island of Borkum (German Bight). Besides of logistic support BSH provides measurements of a directional wave rider buoy and an ADCP for the accuracy test. Since April 2013 all measuring devices are operated simultaneously.

During the two month of simultaneous operation a good agreement of buoy data, ADCP and radar data is found. A quantification of the agreement, especially for the mean direction and the directional spreading of the sea state, will be given in the presentation. A comparison of directional spectra of the sea state will be given for selected time periods. Besides of directional features also non-directional sea-state parameters will be discussed.

Finally, the measurements of wave direction are analysed with respect to their alignment or misalignment with wind direction, which is a relevant aspect in the design of offshore wind farms.

Surface Current Measurements by Radar

Marius Cysewski, J. Seemann, F. Ziemer, G. Schymura and J. Horstmann

Helmholtz-Zentrum Geesthacht, Centre for Materials and Coastal Research, Germany

The department of Radarhydrography at the Centre for Materials and Coastal Research (HZG) operates and develops different radar systems to observe wind, waves and currents on the water surface on different range scales. The benefit of each system will be presented.

For the project COSYNA (Coastal Observing System for Northern and Arctic Seas) a network of over-the-horizon (HF) radars are set up in the German Bight. This system known as WERA (WEllen RAdar) is developed by the University of Hamburg and the company Helzel. To obtain on optimal coverage three WERA systems are running in pre-operational mode for COSYNA set up on the islands of Wangerooge , Sylt and close to the harbor of Buesum. The azimuthal and range resolutions are: 3 degrees and 1.5 km, respectively with a maximum range of 120 km. Ocean current maps are measured three times an hour and transmitted to a server at HZG, which calculates 2D current maps on a regular 2 km grid. Some measurements may be corrupted by a circular distortion pattern which is not removed by the Radio Frequency Interference (RFI) suppression algorithm of the WERA software. A quality check of the ocean current data is implemented to identify and flag these situations. This procedure checks the past temporal variability between measurements. Quality checked current maps acquired by HF-radar have been used successfully for some years in the data assimilation of 2D current model running at HZG. Results of the cross-validation between WERA currents, ship-based ADCP profiling as well 2D model (free run) will be presented.

The Doppler shift measured by X-band radar can be used for the mapping of sea surface currents. The method of horizontally surface scanning we called Radar Doppler Current Profiler (RDCP). Two synchronized radars, set up on a ship with constant view direction both and an intersection angle of 90deg, were applied to observe radial velocities of the surface scatterers with high resolution. Each of the radar devices transmits and receives 1000 pulses per second and forms during the A/D converting radar radial cells with a length of 7.5 m. The post-processing software computes and corrects the influence of ship movement (tracked by precise GPS navigation) and wind-range dependency for each radial cell. The full surface current vector is calculated by merging the two purged radial components into a geo-coded grid with the grid distance of 15 m. To validate the radar additional ADCP measurements with UP- and DOWN-looking transducers are acquired and first some results will be demonstrated. The Radar Doppler Current Profiler has been used to map local variability within the three dimensional current field like small eddies, convergences and divergences supporting studies of hydrodynamics and other processes. To study process and process interactions in the water smaller than 10m the development of a new Alpha-Radar (X-band) with the radial resolution approximately 1.2m, is launched and will upgrade the RDCP soon.

ARGO experiments and developments in the Baltic Sea

Petra Roiha[1], Simo Siiriä[1], Aleksi Nummelin[1], Eemeli Aro[2] and Tero Purokoski[1]

[1] *Finnish Meteorological Institute, Helsinki, Finland*
[2] *Aalto University, School of Electrical Engineering, Department of Automation and Systems Technology*

Finnish Meteorological Institute has been testing ARGO floats in the Baltic Sea as a mean for collecting data from the sea areas that are not easily reachable by research vessels or remote sensing. The observational data for Baltic Sea off-shore areas is very sparse and new observational methods are needed to fill the gaps in our knowledge and collect new data for different purposes, such as, operational activities, modelling and ocean science.

The ARGO floats have been used successfully in the deep oceans. However, applying the ARGO floats in Baltic Sea is not straight forward, as the conditions differ greatly: the water is brackish, some areas are heavily trafficked and the northern parts freeze during the winter. In addition, the mean depth is only 54 metres, which is only a fraction of depths where ARGO floats have commonly been used.

In 2011 FMI purchased two ARGO floats with pressure, salinity and temperature sensors, balanced for the brackish water and two-way Iridium satellite connections. The first one was used with normal diving algorithm, which checks the pressure hourly. The second float was modified by Aalto University so that the algorithm checks the pressure every 15 minutes. The first float was deployed in the Bothnian Sea in May 2012 and it measured over 200 profiles during its half year mission. The float with faster pressure detection was tested in May 2013 and deployed in the Bothnian Sea. In this presentation we present and analyse the results from these experiments and discuss further possibilities of this kind of measurement approaches.

Helmholtz-Alliance „Robotic Exploration of Extreme Environments – ROBEX“

Corinna Kanzog and Martina Wilde

Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Germany

The Helmholtz Alliance "Robotic exploration of extreme environments - ROBEX" combines two so far completely independent research areas: deep-sea and lunar research. In this unique project aerospace specialists and deep-sea researchers from 15 German research institutes jointly develop technologies for robotic systems to perform autonomous missions on the moon and in the deep sea. The aim of the alliance is to analyze existing research and technological approaches, to identify synergies, of which the exploration of both areas with its extreme conditions and requirements will benefit as well as to jointly develop new technologies. Both research fields have analogous requirements to a centralized and intelligent energy supply, communication networks and nodes, navigation as well as the balance of autonomy from remote control. Both research communities agreed on a common scenario, wherever possible combines important scientific needs in the two extreme environments, the moon and the deep sea. Two research themes were identified which are of similar interest to both communities:

1. Exploration of hot vents and cold seeps in deep sea over long time periods
2. New methodologies for seismic studies on earth and on the moon

In order to reach the scientific goals of the ROBEX alliance, a combination of stationary systems and mobile elements was identified as the best solution. Stationary docking stations serve as central units for energy supply and data transfer for mobile components such as autonomous vehicles. The mobile units are expected to perform scientific exploration at various sites in near or far distance from the main port. The concept of a modular setup was chosen as this approach includes stimuli for technological innovations from which both communities, lunar and deep-sea research, will profit.

By the end of the project, demonstration missions in both the deep sea and in lunar analog test areas should show that substantial progress could be made in both research areas by combining the complementary technical and scientific expertise in both communities.

In-situ radioactivity spectrometer and software developments for automated radionuclide characterization in the marine environment

C. Tsabaris[1], A. Prospathopoulos[1], D.L. Patiris[1], Th. Dakladas[2] and K. Sarantakos[1]

[1] *Hellenic Centre for Marine Research, Institute of Oceanography, Attica, Greece*
[2] *National Technical University of Athens, Faculty of Electrical Engineering, Athens, Greece*

In-situ radioactivity measurements in aquatic environment are scarce, since most of the relative systems are not optimized for wide applications. The in-situ approach has been applied so far by installing the underwater detection systems on large moored buoy networks (Tsabaris and Ballas, 2005, Appl. Radiat. Isot. 62, 83). Recently, an underwater in-situ gamma-ray spectrometer has been developed to operate autonomously and to provide quantitative results for long periods due to stability of its electronics (Tsabaris et al., 2008, Appl. Radiat. Isot. 66, 1419; Bagatelas et al., 2010, Environ. Monit. Assess., 165, 159). The spectrometer provides activity concentration in absolute units (Bq m^{-3}) for all gamma ray emitters in the energy range from threshold energy (50 keV) to 3000 keV. Furthermore, software is being developed for automated analysis of the acquired spectra using a wavelet-based smoothing technique (Tsabaris and Prospathopoulos, 2011, Appl. Radiat. Isot. 69, 1546). The spectrometer has been tested in the lab and deployed for seismicity studies in aquifers close to L'Aquila fault, submarine groundwater studies through radon monitoring as well as a radioecology monitoring study for detection of health hazards. Future upgrades and actions include installation of the system in deep platforms and floating stations for real-time measurements as well as applications for monitoring radioactive wastes and exploration of submerged mineral resources (Uranium exploration, hydrocarbon detection etc.).

Environmental monitoring using the OceanPack: A Robust, Flexible and Cost-Efficient "*Environmental Monitoring System*"

Saskia Heckmann and Stefan Marx

SubCtech GmbH, Germany

Permanent monitoring of water quality parameter is very important to understand environmental processes around the world. However, the possibilities to get permanent, high quality data are limited due to insufficient availability of robust, autonomous systems with high quality data. After many years of research there is still a need for more sophisticate technology to measure and to understand the interaction of, for example, greenhouse gases like CO_2 with the environment or Oil in water as condition monitoring.

The company SubCtech used their long lasting experience to develop the modular *OceanPack* System which is nowadays used by public authorities, science and industry.

The system approved especially while used in difficult conditions such as high sediment yield (up to 10,000 FTU), growing bio-fouling (e.g. the Wadden Sea), high waves (e.g. Racing Yacht *OceanoScientific*® Programme France) and extreme temperatures (+40, - 40℃) as they appear on the open ocean, at Antarctica or at moorings. With the self cleaning function, use of NMEA standard data protocol for easy integration into existing databases and easy data transfer (e.g. via Iridium) this system is especial suitable to work unattended, autonomous over a long time period.

After three years of application SubCtech is proud to present different data collected using the AUMS (Autonomous Underway Measurement System) *OceanPack* on different kind of ships. Form large research vessels e.g. RV Belgica (Belgium), RV Polarstern (Germany) and Ke-Xue (China) doing Sea-Air-Exchange measurements to middle size sailing ships e.g. La Louise (France), Aldebaran (Germany) and Bark Europa (Netherlands) performing water quality measurements in hardly sampled regions like around Greenland and Antarctic.

The gained experiences from these operational applications were used to improve theses innovative systems even more and be able to offer autonomous systems with self cleaning function, generating high quality data, while working unattended.

Marine Services, Management and Infrastructure

GMES-PURE: Shaping the marine GMES/COPERNICUS user requirements

Yota Antoniou[1], P. Gorringe[1], E. Kwiatkowska[2], H. Bonekamp[2], G. Dybkjær[3], K. Nittis[1] and P. Albert[2]

[1] *EuroGOOS AISBL, Brussels, Belgium,*
[2] *EUMETSAT, Darmstadt, Germany,*
[3] *DMI, Copenhagen, Denmark*

The Copernicus/GMES Marine Core Service (MCS) as currently implemented by MyOcean-2 will become operational in 2014. Recently, the European Commission (EC) has started the two-year project called GMES-PURE (Partnership for User Requirements Evaluation), to define and apply a structured process (see Figure 1) for the elaboration of the future MCS user requirements and their translation into service specifications, service data and technical requirements. While the focus for service data requirements is on space observations, high-level data requirements for in-situ observations will be captured and delivered as well. GMES-PURE constitutes a unique opportunity for MCS users to ensure that their current and emerging requirements are captured in time and to influence the future evolution of the MCS. The establishment and maintenance of long-term user driven operational services requirements and related coherent service specifications include a weighing of evolving user needs, scientific and technological capabilities, cost-effectiveness and affordability. This presentation will explain GMES-PURE approach and roadmap and how users can get and will be involved in the project.

EMODNet – Physical Parameters

Patrick Gorringe[1], Antonio Novellino[2], Giuseppe Manzella[3], Dick Schaap[4], Lelsy Richards[5] and Sylvie Pouliquen[6]

[1] EuroGOOS AISBL, Belgium; [2] ETT s.r.l., Italy; [3] ENEA, Italy; [4] MARIS, The Netherlands; [5] NERC BODC, UK; [6] Ifremer, France

European Marine Observation and Data Network (EMODnet) has been created to improve the usefulness to European users for scientific, regulatory and commercial purposes of observations and the resulting marine data collected and held by European public and private bodies, wherever that data has been collected from. European Commission, represented by the Directorate-General for Maritime Affairs and Fisheries (DG MARE), is running several service contracts for creating pilot components of the ur-EMODNET and it is assisted by a Marine Observation and Data Expert Group (MODEG) .

The EMODNet Physical Parameters Portal (http://www.emodnet-physics.eu/) is one of the EMODnet portals and it is aimed at providing access to archived and real time data catalog on the physical condition in Europe's seas and oceans. The overall objectives of the EMODNet Physics preparatory action is to provide access to archived and near real-time data on physical conditions in Europe's seas and oceans by means of a dedicated portal and to determine how well the data meet the needs of users from industry, public authorities and scientists. The objectives are achieved through:

- A portal that allows
    - Access to marine data from measurement stations and ferryboxes. Both near real-time and archived data of time series are to be made available.
    - Metadata for these data sets using EMODNet/INSPIRE standards
    - Metadata maps and overviews for whole seabasins showing the availability of data and monitoring intensity of that basin.
- Monitoring and reporting of the effectiveness of the portal in meeting the needs of users in terms of ease of use, quality of information and fitness for purpose of the product delivered.

EMODnet Physics aims to contribute to the broader initiative 'Marine Knowledge 2020', and in particular to the implementation of the European marine monitoring programme and marine services (GMES). It is based on a strong collaboration between EuroGOOS associates and its regional operational systems (ROOSs), MyOcean and SeaDataNet consortia. The portal also respects INSPIRE standards for discovery and access and it is operational 24 hours a day, 7 days a week, and provides information and tools to potential users (managers, policy makers, researchers, specialized users) in fact it:

- Gives access to thematic monitoring data that can be queried/selected
- Gives access to monitoring observations
- Provides data to GMES, researchers and specialised users

In two years of activity, by means of joint acivities with its pillars EuroGOOS, SeaDataNet and MyOcean, EMODnet Physical Parameters was able to connect about 400 fixed stations.

Towards an Ocean Services Model at Fisheries and Oceans Canada

Michael Ott

Fisheries and Oceans Canada

In order to satisfy government, industry, and public demand for faster access to more integrated, effective, and efficient ocean information, products, and services, the Government of Canada's Department of Fisheries and Oceans (DFO) is defining and developing an operational oceanography program. DFO laid the groundwork for a coordinated national approach to Ocean Services by examining its mandate and current activities in light of new technologies, opportunities, and commitments, including in the Arctic. At the same time, DFO continues to work with other Government Departments and international collaborators, including the GODAE OceanView Program, in developing ocean forecasting capability in Canada through coupled atmospheric and ocean forecast systems, ice modelling, and ice assimilation. However, a national strategy is needed to coordinate government efforts in building Canadian ocean service capacity with those of academia, including networks and centres of excellence such as ArcticNet and MEOPAR. Based on consultations with clients to understand the ocean services they require, DFO is completing an Ocean Services Framework to implement a national program for operational oceanography consistent with DFO's ecosystem-based management approach for fisheries and habitat management and its climate change adaptation program. Current work on the Canadian Ocean Services Framework will be described, along with an overview of present efforts to develop an Ocean Services system at DFO.

The MarCoast Network – Structure and Services

Kerstin Stelzer, Carsten Brockmann and Jasmin Geißler

Brockmann Consult GmbH, Germany

Water Quality products and services derived from satellite data, combined with in-situ or modelled data are included in the portfolio of the MarCoast Network of Water Quality Service Providers. The network comprises services from 14 service providers spread over Europe which cover almost completely the European seas and coastal zones. This cooperation and its technical offer have been developed as a GMES marine downstream service over the past 8 years, supported through the ESA GMES Service Element programme and the EU FP7 Aquamar project. The network is currently starting to be continued as a self-sustained association. The goal of the network is to ensure quality assured services to users, and to optimize costs through network internal services, R&D support and guidance by the user community. The network aims in a branding of the products and services in order to enlarge the quality, reliability and visibility of the services. Specifically, the mission of the network is to

- Provide a harmonised service portfolio at European level plus individual products and services by each service provider
- Ensure quality of the services by an harmonized validation process
- Ensure documented and proven quality of the services to its customers
- Facilitate the dialogue and exchange between researchers, service providers and users
- Optimise the costs for service operations
- Provide backup mechanism in case of temporary operational problems of single service providers
- Optimise cost/benefit for marketing, promotion and market expansion

There are different roles within the network: service providers from both, private companies and public organisation, are the main actors in the network, coordinated by a management board. R&D teams (within the SP as well as external teams) will provide support the development of new products and the validation process. Finally, users will be associated to the network and will guide the further development of the network, e.g. by recommending/requesting new products.

The services comprise near-real time provision of daily satellite services, validation services, user tailored maps and reports, time series extraction, combination of satellite data and in-situ data / model data as well as temporally and spatially aggregated products. The products are based on a common set of variables such as chlorophyll, suspended matter, CDOM, Turbidity and Sea Surface Temperature. Discussions with users lead to well-tailored products that fulfil the requirements of the users and support them in their duty for reporting, monitoring of the coastal waters and analysing the development of the past years. One example is the aggregation of seasonal statistics of chlorophyll concentration within WFD water bodies using the satellite products within the respective time frame. Comparisons with the statistics derived from in-situ data performed for different countries showed that this method could be one element for the WFD reporting and for future assessment within in the MSFD. The combination with in-situ data is an important corner stone that provides a more comprehensive picture of the environment than this is possible using only one of the methods. Specific products of individual service providers, i.e. not being among the standard products of the network, need to be compliant with the validation protocol and be approved by the Validation Bureau.

Observing the Oceans from Space

Dynamic oceanic front maps for improved metocean, and harmful algal bloom detection for aquaculture

Peter I. Miller and Andrey A. Kurekin

Remote Sensing Group, Plymouth Marine Laboratory, United Kingdom

We have developed novel Earth observation (EO) methods for visualising and inferring the spatio-temporal distribution of dynamic oceanic fronts, in order to provide additional information on physical oceanography pertinent to offshore industries. For instance, this analysis may reveal if there is more eddy activity at particular locations or times of year, or predictable seasonal changes in the width of the slope current. EO front maps from a 30-year time-series can be integrated with other metocean information, for instance current meters or ADCP that reveal physical processes at depth but are restricted to small regions and limited time span.

Examples will be shown for regions of industry interest, such as the Faroe-Shetland Channel and the Gulf of Mexico. Potential applications include site selection and design, real-time operations and spill management. It may also address conservation concerns by incorporating information on marine mammal and seabird usage of fronts into detailed site selection, for example for offshore renewable energy. This research is based on the *composite front map* approach, which is to combine the location, strength and persistence of all fronts observed over several days into a single map, improving interpretation of dynamic mesoscale structures (Miller, 2009). These techniques are robust and applicable to any geographic area, and are even able to detect major fronts when completely obscured by cloud cover.

Our second development is for discrimination of dense harmful algal blooms (HABs), which are typically detected by EO through analysis of chlorophyll-a as a proxy, though this cannot indicate the harmfulness of bloom or dominant species. An automated data-driven approach has been developed to identify HAB characteristics of ocean colour data, and to classify pixels into ‘harmful’, ‘non-harmful’ and ‘no bloom’ categories. This method has been thoroughly validated by the EC AquaMar project for two high biomass HAB species: *Karenia mikimotoi* off the English and Scottish coasts and *Phaeocystis globosa* in the southern North Sea. Accurate results were achieved using both MODIS and MERIS satellite data, correctly identifying 89% of *Phaeocystis* and 88% of *Karenia* blooms in these regions. This generic approach is now being considered for addition to existing HAB monitoring efforts for the Scottish aquaculture industry and in the southern North Sea.

Miller, P.I. (2009) Composite front maps for improved visibility of dynamic sea-surface features on cloudy SeaWiFS and AVHRR data. *Journal of Marine Systems*, 78(3), 327-336. doi:10.1016/j.jmarsys.2008.11.019

Ocean Colour Remote Sensing – current status und new developments

Carsten Brockmann

Brockmann Consult GmbH, Germany

The availability of optical remote sensing data of the global ocean since 1997, with the spaceborne radiometers SeaWiFS (NASA, 1997 – 2011), MERIS (ESA, 2002 – 2012) and MODIS (NASA, 2002 – current) has contributed significantly to an improved understanding of ocean biology, global carbon cycle and oceanographic processes. Methodological developments lead to algorithms which allow, in the case of MERIS onboard the ENVISAT satellite, the retrieval of the water leaving reflectance with an accuracy of better than 5% (relative percentage difference RPD) for so called Case 1 waters. The retrieval of the chlorophyll concentration in these waters is achieved with an accuracy of 12% (RPD). In optically complex waters (Case-2), such as the southern North Sea or the Baltic Sea, the atmospheric correction is coupled with the marine signal, and the accuracy is 1% - 12% RPD depending on spectral band. The quality of the retrieval of the single water constituents (chlorophyll, suspended matter, yellow substance) depends on overall composition ("masking effect"), the bio-optical model, and varies largely. The satellite sensors and the processing algorithms have matured over the last 15 years and permit now operational services (see presentations on MyOcean and MarCoast) as well as scientific investigations exploiting data time series. Two important ESA projects shall exemplify this: the CoastColour project is aiming at coastal areas. MERIS Full Resolution data (300m spatial resolution) are processed and validated for 27 coastal regions distributed globally to enable regional biological and oceanographic applications. The Ocean Colour Climate Change Initiative is providing a 15 years time series of marine reflectances and water constituents, based on merged data from the three sensors mentioned above in a harmonised way and with an per-pixel error characterisation.

The space segment of ocean colour instruments is currently being updated with the VIIRS instrument, an operational ocean colour sensor operated by NOAA. VIIRS was launched in fall 2011 and its data products are currently in beta status. In 2014 ESA will bring the first OLCI instrument into space (OLCI-A), which is the MERIS follow-on sensor but with improved spectral characteristics. The OLCI-B instrument will follow 18 months later and with the two instruments an unprecedented spatial coverage, at a resolution of 300m, will be achieved. European researchers and value-adding industry are currently preparing for the new possibilities as well as the challenges created by the vast amount of data from the new sensors.

An interesting option for the coastal zone, rivers and lakes will be available through ESA's Sentinel 2 satellite in 2014. This instrument is dedicated to land application with a spatial resolution of 20m. However, its spectral characteristics will also allow retrieval of water constituents. The error of the retrieval will be larger compared to ocean colour sensor.

Ocean colour data from geostationary satellites is a new and exciting option. The geostationary orbit means quasi-continuous observation of a part of the world's ocean. However, the geostationary orbit at 36000km height (compared to 700km for polar orbiting satellites like ENVISAT) poses large technological challenges. In 2010 Korea launched GOCI, the first geostationary ocean colour satellite. NASA is planning a geostationary instrument (GEO-CAPE) for the 2020 time frame, and also ESA is currently conducting studies, e.g. for an atmospheric correction for high latitude, so that data of the North Sea and Baltic Sea can be used.

Detection and Analysis of Fronts in the North Sea

Grit Kirches[1], Michael Paperin[1], Carsten Brockmann[1], Holger Klein[2] and Kerstin Stelzer[1]

[1] *Brockmann Consult GmbH, Germany*
[2] *German Federal Maritime and Hydrographic Agency (BSH)*

Fronts in the ocean are important oceanographic structures, because of their role as boundaries between water masses with different properties and their strong influence on the local dynamic, the dispersion and concentration of substances. Changes in water temperature and density, as well as changes in the wind pattern caused by climate change are likely to influence water mass distribution and hence will be visible in statistical quantities of frontal structures. In the North Sea and in particular in the German Bight two types of fronts are dominant: River Plume Fronts (RPF) between the freshwater entries of the rivers and the intrinsic North Sea water, as well as Tidal Mixing Fronts (TMF) between the seasonally stratified water close to coast and saltier and therefore heavier North Sea water. Other front-like structures are the boundaries between the North Sea water and the Baltic outflow from the Skagerrak, as well as between the inflow of Atlantic water from the North and from the English Channel. A large German national project, KLIWAS, has been initiated by the Federal Ministry of Transport, Building and Urban Development in order to assess the impact of climate change on river, coastal and ocean water ways. The work presented here is part of this initiative and is focussing on evaluating long time series of satellite observations to establish a front climatology of the North Sea, and to study derived statistical quantities with respect to potential climate change impact. The development of algorithms which automatically detect frontal positions and gradients from earth observation (EO) data is an important pre-condition for the processing of long EO data time series which are used to establish a climatology for North Sea fronts. The characteristics of fronts have been used to develop an algorithm for front detection comprising pre-processing steps and the identification of fronts itself.

The new algorithm - GRADHIST - builds upon the state-of-art established Cayula and Cornillion (1992) as well as the Canny (1986) front detection algorithm. The investigation of the specific properties of both algorithms has shown that their combination and some refinements of their subroutines were useful for the front detection in the North Sea. By adjusting this combined algorithm w.r.t. thresholds and scaling, it may be applied to different ocean colour and SST sensors such as MERIS and MODIS for Ocean colour AATSR, AVHHR and MODIS for SST. Applying to sea surface temperature and ocean colour parameters opens the possibility of detecting and investigating frontal positions and gradients and of deriving reliable reference data to assess the impacts of climate change on fronts. Therefore, ten-year time series of AATSR, MERIS, MODIS and a twenty year time series of AVHRR data have been processed by applying the algorithm for the North Sea. GRADHIST allows an automated processing of comprehensive EO data sets to produce a climatology for front positions and gradients in the North Sea and other shelf sea areas. They also enable the establishment of front maps as an operational downstream product which will help to monitor potential change due to climate change.

References:

Canny, 1986, A computational approach to edge detection, IEEE Transactions on Pattern Analysis and Machine Intelligence 8(6) , pp. 679–698

Cayula and Cornillon, 1992, Edge detection algorithm for SST images, Journal of Atmospheric and Oceanic Technology 9(1), pp. 67–80

Radar Retrieved Ocean Surface Winds: Validation and Applications

J. Horstmann[1,2], R. Carrasco[2], C. Wackerman[3] and R. Foster[4]

[1] *Helmholtz-Zentrum Geesthacht, Geesthacht, Germany*
[2] *Center for Maritime Research and Experimentation, La Spezia, Italy*
[3] *General Dynamics Advanced Information Systems, Ypsilanti, USA*
[4] *Applied Physics Laboratory, University of Washington, Seattle, USA*

Within this presentation we will introduce and validate methodologies to retrieve high resolution wind fields using space borne synthetic aperture radar (SAR) as well as ship-borne marine radar. The SAR covers a swath with of up to 500 km with a wind field resolution of 500 m and a typical revisit time of a couple of days. In contrast to the SAR the marine radar resolves only an area of 2 km x 2 km, however, with a wind field resolution of ~50 m on a continuous basis. For validation, SAR data were acquired under tropical cyclone conditions, which covered a range of wind speeds between 2 and 45 m/s. The resulting SAR wind fields were compared to co-located scatterometer winds from QuikSCAT as well as wind speed measurements acquired during reconnasance flights by the stepped frequency microwave radiometer (SFMR). Comparison resulted in a root mean square error of 17.6° for wind directions and 4.6 m/s for wind speeds, were the wind speed error increases with wind speed. The marine radar retrieved winds were collected during a three weeks experiment off the west coast of San Francisco from the RP Flip and covered wind speeds between 2 and 25 m/s. The resulting wind speeds were compared to *in situ* measurements recorded at the platform and resulted in in a root mean square error of 4.8° for wind directions and 0.5 m/s for wind speeds. Observations showed that the wind speed measurements reduced in quality with distance to the radar platform.

Last but not least we will present some applications of SAR and marine radar winds. One example will be showing the results of assimilating SAR wind fields into numerical models of tropical cyclones. The second example will show the possibilities of SAR winds with respect to wind energy mapping. The last example will show the observation possibilities of marine radar retrieved small-scale wind features in comparison to small scale numerical modeling.

Improving the storm surge forecast in Venice through a calibration of ECMWF wind obtained using scatterometer data

Marco Bajo, Georg Umgiesser, Debora Bellafiore, Stefano Zecchetto and Francesco De Biasio

Institute Of Marine Sciences - National Research Council (ISMAR-CNR), Italy

The European Space Agency is funding a project to use altimeter and scatterometer data to improve the storm surge forecast in Venice. This project, named eSurge-Venice, is connected with the ESA DUE Storm Surge project, eSurge, which is focused on other European and extra-European areas. In this context, several past storm surge events were identified and analysed. It is well known that ECMWF winds are underestimate in the Mediterranean Sea with respect to the satellite scatterometer ones, which represent the best wind data at present available to describe the wind fields in regional basins.

Scatterometer data were compared to ECMWF analysis wind fields producing relative bias maps for each of the selected storm surge event. These have been used to tune the ECMWF winds used as forcing for hindcast the storm surge events. Here two storm surge cases are analysed, one happened on October 31, 2004 and the second on November 26, 2010. Results show the corrected wind fields are more effective in the reproduction of the surge peak, but also in all the temporal window considered in the two cases.

Modelling and Forecasting Systems

Observation System Simulation Experiments for the German Bight with Emphasis on the Potential of Sensor Platforms within Wind Parks for Operational Ocean Forecasting

Sebastian Grayek, Johannes Schulz-Stellenfleth and Emil V. Stanev

Helmholtz-Zentrum Geesthacht, Geesthacht, Germany

This study provides an estimate of the enhancement of quality of operational forecasting the German Bight by combining presently operating platforms with sensors deployed within the newly planned wind parks. For evaluating the impact of observation networks on the forecasting skill of greater regions information about temporal/spatial availability and sensor specific accuracy of measurements alone are insufficient. More important are the comprehensive covariance patterns of the investigated region and respective observation error propagation during an extra- or interpolation of the observations. We, therefore, perform several Observation System Simulation Experiments (OSSE). This method measures the observation error propagation through a forecasting network by utilizing background statistics derived from covariance information of numerical model simulations. Its main weakness is that numerical models tend to overestimate the spatial correlation length and, therefore, by using the simulated background statistics from the model the OSSE tend to give a too optimistic estimate of the given observation network significance. However, the validation and calibration of the covariance information from the numerical model is difficult because this would necessitate a sufficient temporal/spatial coverage of covariance information from observations, which, in most cases, is not available. In this study the error covariance information estimated in areas, where observations are available is extrapolated to the full domain making assumptions about the smoothness and homogeneity of the error statistics.

Operational oceanography as an Information System for HAB forecasting

Marcos Cobas-García[1], Manuel Ruiz-Villarreal[1],; Luz García-García[1], Pablo Otero[1], Gonzalo González-Nuevo[2] and Jose Manuel Cabanas Jose[2]

[1] *Instituto Español de Ocenografía (IEO), Centro Oceanográfico de A Coruña, Spain.*
[2] *Instituto Español de Oceanografía (IEO), Spain.*

Over the past ten years, the Coastal Ocean Modelling Group of the Spanish Oceanography Institute has gained wide experience in the simulation of the circulation of the Iberian Atlantic shelf and slope using the Regional Ocean Model System (ROMS). In its present configuration, the ocean model is being run operationally with atmospheric data supplied by the regional weather service (MeteoGalicia), and a web site has been developed for the dissemination of the results of the model and model-derived products (http://www.indicedeafloramiento.ieo.es). This portal allows the visualization of values of temperature, salinity currents, chlorophyll concentrations in aquaculture areas and other derived products. In addition to this, results of the model are published in a THREDDS server (centolo.co.ieo.es:8080/thredds), and can be downloaded by the members of the oceanographic community. We will present in this contribution the products developed to characterize the oceanographic conditions during different periods of Harmful Algal Blooms (HABs), when the hydrodynamic model runs coupled with a biochemical model. The simulations have been performed in the framework of the ASIMUTH project (http://www.asimuth.eu), aimed at the development of forecasting capabilities to warn of impending HABs. These events are a recurrent phenomena in North-western Iberian coast throughout the whole year, with intense manifestation in particular periods, badly affecting the interests of an important share of the economy of the area, formed by aquaculture and recreational industries. We will illustrate how the simulations help us gain insight of the oceanographic conditions affecting the development of HABs, and how the biochemical model provides values of chlorophyll concentrations and nutrients, from which we can extract useful information towards the understanding of HABs dynamics and towards increasing our capacity of HAB forecasting.

An Operational Oceanography Experiment: Evaluation of Forecasting Strategies

Reiner Onken and Baptiste Mourre

Centre for Maritime Research and Experimentation (CMRE), Italy

In September 2012, the CMRE conducted an experiment in the northwestern Mediterranean Sea off the French Provence coast, the major elements of which were a ship-based oceanographic survey, the deployment of a fleet of underwater gliders and nowcast/forecast studies with the Regional Ocean Modeling System (ROMS). The objective was to provide in-situ data for assimilation in ROMS and to validate the ROMS forecasts against the observations using different forecasting strategies.

The observational data consist of 63 CTD (Conductivity-Temperature-Depth) casts, data from seven simultaneously operating Slocum gliders, trajectories of 19 surface drifters, time series data from seven moorings, and underway measurements with shipborne ADCP (Acoustic Doppler Current Profiler) and thermosalinograph. In addition, data from a contemporaneous French glider survey were available for validation.

ROMS was set up with 32 layers in the vertical and ~1.9 km horizontal resolution, it was one-way nested in the Mediterranean Forecast System (MFS, at 1/6º resolution), and the surface boundary conditions were provided by the COSMO atmospheric prediction model. Three different forecast strategies were pursued:

(1) ROMS initialization from MFS and without assimilation of observations,

(2) initialization from a quasi-synoptic data set of CTD casts, and

(3) initialization from MFS with sequential assimilation of glider data using an Ensemble Kalman Filter. The comparison of the forecast skills of the different strategies will be presented.

Status and new trends in operational wave forecasting in Germany

Arno Behrens

Helmholtz Zentrum, Institute for Materials and Coastal Research, Geesthacht, Germany

In 1981 the German Meteorological Service (Deutscher Wetterdienst, DWD) started beside the usual numerical weather prediction additionally an operational wave forecasting based at that time on the second generation wave model HYPA (Hybrid Parametric). In 1992 HYPA has been replaced by the third generation wave model WAM (WAve Model) and in the course of time since then a lot of extensions and improvements have been embedded into the operational wave forecast system of the DWD. The results of the daily wave forecasts are validated continuously with measurements recorded by wave buoys worldwide. The corresponding comparisons and statistical analysis of those confirm the good quality of the wave model results on all scales. Further measurements obtained by satellite borne radar altimeters are assimilated into the fields of a global wave model and are for this reason not available for validation purposes.

Wind waves generated in storm situations represent natural hazards and therefore the operational wave forecast system is an appropriate warning tool for offshore activities and coastal environment, especially on regional or local scales. A representative example shown here is the severe winter storm Britta that afflicted the North Sea during the night from 31 October to 1 November 2006.

Currently the wave forecast system of the DWD includes a global wave model GWAM and a regional wave model for Europe (EWAM). Both are running twice a day at 00 and 12 UTC for a global seven days and a regional three days forecast. The EWAM generates boundary information for two coastal models that are running pre-operational within the frameworks of DeMarine-2 (German Bight and western part of the Baltic Sea) and COSYNA[1] (North Sea, including a fine meshed nest for the German Bight). The aim in both projects is the development of a coupled system combining the waves with a hydrodynamic model. In DeMarine-2, the CWAM (Coastal WAM) will be coupled with the HIROMB-BOOS Model (HBM) and currently takes already into account water level changes and currents delivered by the HBM which itself uses in return the radiation stress as additional force calculated by WAM. First encouraging results of the CWAM are shown and will be discussed. In the framework of COSYNA, WAM has been coupled to the hydrodynamic model GETM (General Estuarine Ocean Model) using the approach described in Mellor (2008). Results are available for a certain time period and will be presented as well.

Another new trend in operational wave forecasting is the approach of ensemble prediction and therefore a corresponding test has been performed with the coastal wave model CWAM that has been driven by four different sets of boundary values and wind fields calculated by twenty different realisations of the atmospheric model COSMO-DE of the DWD. Results for a one month period will be discussed in detail. The aim of that investigation was to prove whether such an application would be a reasonable extension on a local scale for the future operational wave forecasting system at the DWD.

[1] COSYNA : Coastal Observing System for North Sea and Arctic Seas (Helmholtz-Zentrum Geesthacht)

Reference:

Mellor, George L., 2008: The Depth-Dependent Current and Wave Interaction Equations: A Revision. J. Phys. Oceanogr., 38, 2587–2596

Uncertainty estimation for operational forecast products – a multi-model-ensemble for the North Sea and the Baltic Sea

Inga Golbeck, Frank Janssen and Xin Li

German Federal Maritime and Hydrographic Agency (BSH)

Several independent operational ocean models provide forecasts of the ocean state (e.g. sea level, temperature, salinity and ice cover) in the North Sea and the Baltic Sea on a daily basis. These forecasts are the primary source of information for a variety of information and emergency response systems used e.g. to issue sea level warnings or carry out oil drift forecast. The forecasts are of course highly valuable as such, but often suffer from a lack of information on their uncertainty.

With the aim of augmenting the existing operational ocean forecasts in the North Sea and the Baltic Sea by a measure of uncertainty we have started to produce a multi-model-ensemble (MME) for sea surface temperature, sea surface salinity and water transports in the framework of the MyOcean-2 project. The plan is to extend the MME to other variables like e.g. sea level, ocean currents or ice cover based on the needs of the model providers and their customers.

We will present the methodology used to create the MME and first results for the ensemble mean and the related uncertainty.

Advantages of vertically adaptive coordinates in numerical models of stratified shelf seas

Ulf Gräwe, Peter Holtermann, Hans Burchard and Knut Klingbeil

Leibniz Institute for Baltic Sea Research, Warnemünde, Germany

Shelf seas such as the North Sea and the Baltic Sea are characterised by spatially and temporally varying stratification that is highly relevant for their physical dynamics and the evolution of their ecosystems. Stratification may vary from unstably stratified (e.g., due to convective surface cooling) to strong vertical stratification with density jumps of up to 10 kg/m^3 per m (e.g., in overflows into the Baltic Sea). Stratification has a direct impact on vertical turbulent transports (e.g., diapycnal fluxes of nutrients) and influences the entrainment rate of ambient water into dense bottom currents. This in turn determines the stratification of and oxygen supply to, e.g., the central Baltic Sea. Due to limitations of computational resources and since the locations of such density jumps cannot exactly be predicted a priori, a predefined layer distribution cannot sufficiently resolve the stratification evolving during time.

We use a coupled multi nested model of the North Sea/Baltic Sea system (resolution varying between 4 nm and 600 m) to study the performance of sigma-coordinates and vertically adaptive coordinates. This presentation will show how numerical mixing is substantially reduced and model results become significantly more realistic when vertically adaptive coordinates are applied. Specific focus will be on summer thermocline dynamics and inflow dynamics in the Baltic Sea.

Oceanographic downscaling with unstructured modelling: Towards ocean-wave-atmosphere coupling

Rodolfo Bolaños, Jacob Tornfeldt Sørensen, Ole Svenstrup Petersen, Morten Rugbjer and Henrik R. Jensen

DHI, Denmark

MyOcean products have been used for down scaling purposes in the North Sea (NS). The 3D-modelling of the NS was performed with the unstructured grid MIKE 3 model. MIKE 3 is based on the numerical solution of the 3D incompressible Reynolds averaged Navier-Stokes equations subject to the assumptions of Boussinesq and of hydrostatic pressure. Thus, the model consists of continuity, momentum, temperature, salinity and density equations and it is closed by a turbulent closure scheme. The free surface is taken into account using a sigma-coordinate transformation approach. Boundary conditions from MyOcean are combined with half-hourly tidal boundary condition. The atmospheric forcing employed was provided by the StormGeo model. Climatological river flow was used within the simulations. Observational data was available from 5 ADCP locations in water depth ranging between 110 m and 190 m from 10/09/2011 to 12/12/2011. The model was implemented in an irregular mesh containing 23285 nodes and 42911 elements with a combined sigma-z layers vertical distribution, using 13 sigma layers in the top 61 m and 20 z layers below that.

Large spatial and time variability were observed in the ADCP data produced by the combined tidal and baroclinic dynamics inducing the formation of mesoscale eddies in the domain. These were observed in the numerical model, reproducing some of the spatial variability observed between stations. Statistical validation showed bias lower that 0.05 m and good agreement in current direction was observed. The effect of wind, boundary with the Baltic Sea, spin up and model resolution were also assessed and will be further discussed.

A discussion on ocean-wave-atmosphere coupling considering the present ocean model implementation will also be presented.

New approaches for the assimilation of HF radar data in the German Bight

Johannes Schulz-Stellenfleth, Emil Stanev and Joanna Staneva

Helmholtz-Zentrum Geesthacht (HZG), Germany

Three HF radar stations located at the islands of Wangerooge and Sylt as well as on the mainland in Büsum are operated as part of COSYNA system. The radar system provides surface current measurements every 20 min and has a range of about 100 km.

One important component of COSYNA is an integrated approach, where measurements are merged with numerical model data to optimise state estimates. The present study will describe different approaches to combine HF radar surface current measurements with data from a three dimensional circulation model.

Some general statistics about numerical model errors will be presented. In particular a spectral analysis is applied to the difference of model data and HF radar observations, which allows to get insight into the correlation time of the model errors. Furthermore, the model/observation differences are decomposed into a vorticity free and a divergence free component, which is useful to characterise the model errors.

The spatio temporal interpolation (STOI) method developed at HZG is a statistical approach to correct data from a free model run using an analysis window of typically one tidal cycle. The scheme is based on an EOF analysis to estimate the model error background statistics and is capable of providing improved short term forecasts.

Statistics of the free model run, the HF radar data and the STOI analysis are shown for several months. Both the three dimensional primitive equation model GETM and the operational BSH model are used to provide free model run data. GETM setups with boundary forcing from the MYOCEAN North West Shelf model are used. Maps of innovation and residuals are presented. Furthermore forecast errors for different forecast horizons are discussed. Results are also compared to independent measurements taken at the FINO-1 and FINO-2 platforms. The impact of the analysis is, e.g., illustrated by drifter trajectory simulations.

Alternative approaches using traditional assimilation methods with model restart are discussed. The most critical issue in this case is the treatment of the boundary forcing and the meteo forcing. The problem is analysed for different types of numerical model errors. Also the use of nested model setups and model configurations with larger coverage and lower spatial resolution are discussed.

Furthermore first results obained by combined assimilation of HF radar data and tide gauge measurements are presented. A strategy to combine the assimilation of barotropic variables with the assimilation of baroclinic variables is discussed as well. The presentation will also include operational aspects of the HF radar assimilation. In particular quality control and computational requirements will be addressed.

Special Topics

„MeSMarT“ - Measurements of Shipping Emissions in the Marine Troposphere

Lisa Kattner[1,2], Barbara Mathieu-Üffing[1,2], Maksym Chirkov[1], John Burrows[1], Volker Matthias[3], Andreas Richter[1], Stefan Schmolke[2], Norbert Theobald[2], Sieglinde Weigelt-Krenz[2] and Folkard Wittrock[1]

[1] *University of Bremen, Institute of Environmental Physics (IUP), Bremen, Germany*
[2] *German Federal Maritime and Hydrographic Agency (BSH)*
[3] *Helmholtz Zentrum, Institute for Materials and Coastal Research, Geesthacht, Germany*

Over the last years discussions about ship emissions have increased and grown in importance due to the increase of commercial shipping as well as studies about their dangerous health effects. While industrial and traffic air pollution from ashore is decreasing because of technological improvements and stronger political regulations the impact of ship emissions becomes more and more relevant, especially in coastal areas and harbour cities. The establishment of a Sulfur Emission Controlled Area (SECA) for North Sea and Baltic Sea has been a first step to control and reduce sulfur dioxide (SO_2) emissions by consecutively regulating the sulfur content of fuels. To reduce nitrogen oxide (NO_x) emissions from shipping, the emission of newly built engines is limited according to the year the engine is built (Tier I – III regulations).

The project MeSMarT (Measurements of shipping emissions in the marine troposphere) has been established as a cooperation between the University of Bremen and the German Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency) to estimate the influence of ship emissions on the chemistry of the atmospheric boundary layer. It aims to monitor background concentration as well as elevated signals of gases and particles related to ship emissions with various methods to cover a wide range of relevant pollutants and their spatial and seasonal distribution. SO_2, NO_2, NO, CO_2 and O_3 are measured with in-situ techniques, SO_2 and NO_2 as well by remote sensing applying the MAXDOAS-technique. The data will also be compared with satellite measurements and passive sampling in order to find a method to observe the long-term effect of regulations like SECA. High volume filter samples will be taken and analyzed especially for sulfate, nitrate, organics and elemental composition to investigate possible sources, sinks, and conversion of ship emission derived compounds. Modeling of the chemical and physical processes on the basis of measured data will also be included in the MeSMarT project to improve the understanding of ship emission influence.

Measurements and sampling take place during ship campaigns conducted by the BSH in the North Sea and Baltic Sea and will be complemented with stationary measurements on a tower on the island Neuwerk which is close to the main shipping routes through the German Bight. Here we present first results of ship campaigns in late 2012 and 2013 as well as preliminary data from the measurements on the island Neuwerk.

Contributing to standard operating procedures in ocean sciences – The ISO Guide to the Expression of Uncertainty of Measurements (GUM)

Christoph Waldmann

University of Bremen, MARUM, Germany

With the advent of the Thermodynamic Equation of State (TEOS) a new concept on how to quantify the quality of data will find entry into ocean sciences. The Guide to the Expression of Uncertainty in Measurements is an ISO standard (ISO/IEC Guide 98-1:2009) that defines a standard procedure to define the uncertainty of a measurement carried out. Today in metrology the term “measurement error” has been replaced by the term “uncertainty” which is due to the fact that the result of the measurement is now seen as the best estimate with the method being used and that the true value is actually unknown. The consequence of this approach is that uncertainties can be calculated employing statistical methods whereas formerly certain assumptions have been made about so called systematic errors.

The motivation behind introducing TEOS was to make ocean measurements traceable to SI units. In particular salinity as one of the fundamental parameters were under scrutiny and as part of the European Metrology Research Program ENV05 OCEAN new methods have been developed to enable traceability. Currently there are concrete plans for a follow-up project that where density will move into the focus. In this framework GUM is a powerful tool to be able to compare alternative measurement approaches and also delivers quality estimates for past measuring campaigns.

In the planned presentation the state of the art of the mentioned activities will be presented to demonstrate the power of GUM. It is also meant to motivate other groups to consider GUM as the base to quantify the quality of the collected data based on the concept of uncertainty.

Operational data for the validation of ocean models: Chances and challenges

Nikesh Narayan

German Federal Maritime and Hydrographic Agency (BSH)

The changes of thermodynamics, sea level and circulation of the North Sea is studied using the hindcast simulations performed using HAMburg Shelf Ocean Model (HAMSOM). The operational data collected over the years in the North Sea proves to be very helpful in validating the model and identifying the weak areas in the model. Comparison of model results with MARNET data and BSH summer cruise data showed that the HAMSOM model performance is reasonably good with respect to the surface temperature, but the model was not very effective in capturing the variability of salinity. Tide gauge data provided by the PSMSL was also used to study the effectiveness of model in simulating the sea level change associated with the climate change scenario. The tide gauge data together with temperature data from Helgoland was used to identify thermosteric component of sea level trend with respect to changes in North Atlantic Oscillation (NAO). Operational data used in concordance with model results can be an effective tool in disentangling the complex teleconnections between various physical components of North Sea. However, there is a lack of in situ measurements especially current measurements which would be very effective in validating the model circulation. Current measurements along the coast at different depths could also help in monitoring the changes in seasonal coastal upwelling changes in North Sea and Baltic Sea. It would also help in studying the mass and energy exchanges between the North Sea with the North Atlantic which will be very important in a changing climate scenario. The continued monitoring of North Sea with operational data is very important to ensure the authenticity of the model results and to understand the changing North Sea.

The new KLIWAS North Sea Climatology for oceanic and atmospheric in-situ data

Manfred Bersch, Remon Sadikni, Viktor Gouretski, Annika Jahnke-Bornemann and Iris Hinrichs

Integrated Climate Data Center (ICDC) at the CliSAP Cluster of Excellence, University Hamburg (Center for Earth System Research and Sustainability, CEN), Germany.

The assessment of climate change impacts on the North Sea and the overlying atmosphere requires reliable reference data in order to identify change and impacts against a highly variable background with time scales from hours to multi-decadal. Therefore, in the frame work of the research programme “KLIWAS - Impacts of climate change on waterways and navigation - Searching for options of adaptation” of the German Federal Ministry of Transport, Building and Urban Development (BMVBS), a new climatology was developed in a close co-operation of the Federal Maritime and Hydrographic Agency (BSH), the German Meteorological Service (DWD) and the Integrated Climate Data Center (ICDC) of the University Hamburg.

All available oceanographic in-situ data for temperature and salinity have been carefully checked for quality before further processing, while the atmospheric data had already been quality controlled by the DWD. More than 13 million temperature and 12 million salinity (starting in 1890) as well as more than 19 million atmospheric data (air temperature, dew point and air pressure starting in 1950) have been processed. Monthly averages have been created on specified grids for the ocean and atmosphere. For the first time oceanographic and meteorological climatologies are provided on a coordinated grid. The climatological data set is supposed to be growing with time and new data can be implemented as they are collected. It is planned to add additional parameters in future.

The climatologies will be used to analyse the temporal and spatial variability in the North Sea area and deduce long-term trends. Additional the data sets will be needed for the validation of regional climate scenarios. The products are publicly available at the ICDC portal (http://icdc.zmaw.de/knsc.html).

Water level forecast for the operation of the mobile barriers in Venice

Georg Umgiesser, Marco Bajo and Christian Ferrarin

Institute Of Marine Sciences - National Research Council (ISMAR-CNR), Venezia, Italy

A storm surge forecast system, based on a finite element hydrodynamic model was set up at the Centre for sea level forecasting and flood warnings of the Venice Municipality (ICPSM). The model runs on a computational grid of the Mediterranean Sea and uses a 2-dimensional formulation of the shallow water equations. The storm surge forecast is enhanced through a routine based on an Artificial Neural Network (ANN) that strongly improves the forecast. The fifth day forecast is now better than the accuracy of the first day forecast of the original prediction.

Precise storm surge forecast is now getting even more important for the city of Venice due to the building of the mobile gates (MOSE). These gates will be raised during high water, interrupting the connection between the lagoon and the Adriatic Sea. The operation of the mobile gates will strongly depend on the forecast capabilities of the models that are running in Venice. The decision, if the gates have to be closed, will be based on the water level forecast. Therefore, a precise forecast would be needed in order to avoid false closures and missed closures. It would also be important to estimate the uncertainty of the event.

Various techniques how to improve the water level forecast in Venice are discussed, including ensemble forecast methods, assimilation techniques and integration of remote sensing data. For the last point the new ESA project eSurge-Venice is presented that tries to integrate scatterometer and altimeter data into the analysis period.

Part B: Poster

Observing systems

Optimum interpolation of surface and bottom hydrography in the North Sea

Ismael Núñez-Riboni and Anna Akimova

Johann Heinrich von Thünen-Institut; Institut für Seefischerei, Germany

The aim of this ongoing study is to use Gauss-Markov optimum interpolation (OI) to produce maps of surface and bottom hydrography in the North Sea at various time-scales (months, yearly quarters, years and monthly climatology). This type of maps is of particular interest for ecosystem and fisheries research as well as for model validation. We estimate empirical covariance functions and noise variance for temperature and salinity from ca. 90'000 hydrographic profiles collected between 1980 and 2012 in the North Sea. The data sources are the Integrated Climate Data Center of the cluster of excellence “Integrated Climate System Analysis and Prediction” of the University of Hamburg, the World Ocean Database and Coriolis. As a byproduct, we test the performance of two (to our knowledge new) improvements to the OI methodology with cross-validation: 1) Instead of the usual multiplication of longitudinal and meridional covariance functions, we will combine them with the ellipse's equation to yield a space covariance function with elliptical isolines. 2) We will apply a “correction” of interpolated data by matching their probability density functions with the one of the input anomalies.

FerryBox Systems: State-of-the-art and Incorporation in European Observation Networks

Wilhelm Petersen

Helmholtz-Zentrum Geesthacht, Institute of Coastal Research, Geesthacht, Germany

The development and use of FerryBox systems as a cost-effective instrument for continuous observations of the marine environment has been well established during the last years. After completion of the EU-funded FerryBox project in 2005 systems have evolved to maturity and are since widely used around the coasts of Europe. The FerryBox community initially formed from the partners of this project provides mutual exchange of experience (www.ferrybox.org). The presentation will give an overview about existing FerryBox network in Europe. Within the EU funded infrastructure project JERICO the technical harmonization as well as developing of a best practise guide for FerryBox systems will be a step further to high quality environmental data products. In the meantime most of European FerryBox physical data are collected centrally within the MyOcean project and data will be also available in the pilot portal for physical parameters in EMODnet.

The availability of newly developed sensors allows the extension of FerryBox measurements to more biological relevant parameters which are of interest for the requirements of the Marine Strategy Framework Directive (MSFD). The present state-of-the-art as well as the incorporation into European observing systems such as Alg@line in the Baltic Sea or the coastal observatory COSYNA in the North Sea will be presented. Different examples of application of FerryBox data such as the combination with remote sensed data show the usefulness of such measurements. The potential of FerryBox sea surface temperature (SST) and salinity (SSS) measurements for the improvement of model state estimates in the German Bight will be demonstrated.

The Lena Delta region of the Laptev Sea - a unique confluence for the study of changing Arctic dynamics

V. Fofonova[1,3], R. Doerffer[2], H. Orek[2], A.C. Kraberg[3], B. Heim[4], P. Overduin[4], S. Danilov[1], K.H. Wiltshire[1,3,4]

[1] *Alfred Wegener Institute Helmholtz Center for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Helmholtz-Zentrum Geesthacht, Germany,*
[3] *AWI-Helgoland,*
[4] *AWI-Potsdam.*

The shelf zone of the Laptev Sea and the Lena Delta in particular, has shown pronounced changes over the last 100 years. Despite growing interest into the region, the still insufficient amount of observational data as well as the lack of modeling efforts with fine resolution over the shelf leaves many challenging questions.

Certain observational evidence has, however, already accumulated, leading to valuable insights about dynamics in the current region. We collected the data about temperature and salinity profiles, dissolved oxygen and pH for the Lena Delta region of the Laptev Sea for different years. Additionally, the newly organized expedition to the Lena Delta allowed collecting the particulate carbon content and chemical composition in the main Lena freshwater channels. Based on these data, the dominant environmental factors driving the biological system were established.

Given the large territory, the direct measurement data have to be supplemented by a hydrodynamical and bio-optical analysis via remote sensing and modeling. The goal of our modeling approach is to simulate the shelf circulation dynamics under the action of varying atmospheric forcing, Lena runoff and tidal forcing, and their impact on ecosystem dynamics.

Comparison of optical proxies for the determination of chlorophyll-*a* and total suspended matter

Jochen Wollschläger, Maik Grunwald, Rüdiger Röttgers, Wilhelm Petersen

Helmholtz-Zentrum Geesthacht, Institute of Coastal Research, Geesthacht, 21502, Germany
Email: Jochen.Wollschlaeger@hzg.de

Chlorophyll-*a* concentration ([chl-*a*]) and concentration of total suspended matter ([TSM]) are important and routinely measured parameters in biological oceanography, since they provide information about the phytoplankton, which forms the basis of the marine food web. The first parameter is a commonly used indicator for phytoplankton biomass due to its role as pigment required for photosynthesis. TSM includes, besides phytoplankton, also detrital material and mineral particles. Therefore, it governs light intensity in the water and influences photosynthetic activity of the phytoplankton.

The measurement of optical proxy values like chl-*a* fluorescence and turbidity offers a fast and convenient way to obtain information about these parameters, and the appropriate methods can be often applied *in situ* and/or continuously. This provides the high spatial and temporal coverage necessary to resolve also fronts and trends in the distribution of [chl-*a*] and [TSM] (patchiness). However, fluorescence is closely related to phytoplankton physiology and therefore susceptible to changes in phytoplankton condition or species composition. Alternatively, water constituent absorption is considered as a more reliable proxy, since it refers to a physical property of the phytoplankton, and is therefore less influenced by physiology. However, this requires accurate and stable absorption measurements. Systems using integrating spheres like the point-source integrating cavity absorption meter (PSICAM) have shown to be valuable tools for this purpose. They allow the determination of water constituent absorption over the whole range of the visible spectrum without biases from light scattering on particles. Furthermore, the measurements are very sensitive due to a long optical path length.

In this study, the different optical proxies were compared with respect to their reliability in determining [chl-*a*] and [TSM]. The evaluation was based on both discrete stationary measurements and continuously measured transects, which were performed in the German Bight on several campaigns at different seasons. Absorption measurements were made taking advantage of a PSICAM as well as of a new, custom-made flow-through version of this device, the ft-PSICAM. Regarding [TSM], linear relationships of comparable quality were established to both turbidity and absorption. Regarding [chl-*a*], the linear relationship was stronger for absorption than for fluorescence. Additionally, it could also be demonstrated that the fluorescence signal is considerably influenced by the ambient photosynthetic active radiation

Multi-parameters observatories and their contribution to a better knowledge of the ocean

Emilie Dorgeville

Aanderaa (http://www.aanderaa.com/)

Aanderaa (Bergen, Norway) has been involved in the instrumentation of several ocean observatories, contributing in the collection of valuable datasets improving knowledge of the ocean environment. In this presentation, I would like to mention three different systems that have contributed in either monitoring of oxygen depletion or climate change and how they helped to improve observations techniques, technologies and knowledge of the ocean.

The EU-project Hypox (http://www.hypox.net/) aiming at monitoring oxygen depletion and the associated processes in aquatic systems implemented continuous observation systems monitoring oxygen and relevant parameters at high resolution. By its proven long term stability (years) and reliability, the Aanderaa oxygen optode sensor played a key role in the success of the project. An on-line observatory (http://mkononets.dyndns-home.com:8080/) was installed in April 2011 in the Koljoefjord, Sweden to assess and model the dynamics of a system of fjords. This cabled observatory provides a powerful tool for collecting large amount of data in real time or for postprocessing with more than 50 sensors installed measuring at multiple levels Horizontal and Vertical Currents, Conductivity/Salinity/Density, Temperature, Oxygen, pCO2, Wave/Tide, Turbidity, Chlorophyll A, pH, ORP, FDOM and Cyanobacteria. In addition, this observatory is used as a test and development facility for sensors and anti-fouling methods (including test of pCO2 sensor under development at Aanderaa).

Another observatory has been deployed at the Conch Reef in Florida (USA) by the University of North Carolina. The observatory is composed of a oxygen sensors' network combined with currents, water level, Conductivity/Salinity and Turbidity measurements. The goal is to investigate in details the respiration of the reef community in general and of giant sponges in particular. One mode of operation is to place one optode in the outflow of a giant sponge and the other in the ambient water. The difference in readings give possibilities to track the activity of the sponges with respect to changes in the environment e.g. tides, waves, currents, particle concentration, lunar cycles and seasons.

In addition, Aanderaa has supplied UNI Research (Bergen, Norway) with long term observatories (based on the Smartsub http://www.aanderaa.com/productsdetail.php?SmartSub-Observatory-44) deployed under the Antarctic Ice Shelf in order to monitor the impacts of enhanced melting of the shelves on the climate system. The systems are intended to collect data during several years requiring large amount of power, acoustic data transmission, multi-level data measurements including temperature, conductivity/salinity, pressure, oxygen and currents, etc. For more information; http://www.eu-thor.eu/.

The Gotland Deep Environmental Sampling Station in the Baltic Sea

Ralf D. Prien, Mareike Peterson, Detlef E. Schulz-Bull

Leibniz Institute for Baltic Sea Research, Germany

The Gotland Deep Environmental Sampling Station (GODESS) is a profiling mooring, i.e. a profiling body with the payload (the instruments making measurements) is ascending and descending through the water column at predefined times or intervals. During a deployment of the mooring (typically between 3 and 6 months) repeated profiles of the measured parameters are registered so that an insight of the changes and dynamics during this deployment period will be gained. A special interest for this station is the redoxcline in the Gotland Basin between the oxygenated surface layers and the anoxic deep layer. This redoxcline has its causes in the strong halocline between the fresher surface waters and the deeper North Sea water.

GODESS consists of a bottom weight, holding the station in place, the acoustic releaser with recovery line, the underwater winch and the profiling instrumentation platform.

The underwater winch is an Automatic Elevator System Type 3, built by Nichiyu Giken Kogyo Co. Ltd., Japan. At pre-programmed times or intervals a set length of the Kevlar line is paid out; since the profiling platform has a net buoyancy of about 9 kgf it ascends through the water column. When the set length is paid out the winch stops for a set time and starts reeling the line back in. The underwater winch was delivered with 350 m of line which limits the reach. In our application the winch is moored in a depth of about 180 m, held in place by the bottom weight pulling downwards and the net buoyancy of the winch system (about 36 kgf) pulling upwards. The battery capacity is designed for about 300 profiles of 160 m length each.

The profiling platform was designed at the IOW, the instrumentation of the platform consists of a Sea & Sun Technology CTD 90 M with sensors for CTD, turbidity, Chl a fluorescence, ORP, pH and a fast oxygen optode.

The poster will present the motivation for a profiling mooring in the Gotland Basin, the actual design, results from a deployment and future plans.

Marine Services, Management and Infrastructure

BlackSeaTrack Web as GMES operational downstream service for the Black Sea environmental safety

Alexander Kubryakov and Gennady Korotaev

Marine Hydrophysical Institute of National Academy of Sciences of Ukraine,
2 Kapitanskaya Str. 99011 Sevastopol, Ukraine

Over the last decade a substantial increase in sea-borne transportation of not only general goods and passengers, but also raw oil and refined petroleum products has taken place and is predicted to continue in the near future in the Black Sea. This increase in sea-borne transportation enhances the risk of serious accidents at sea that could have dramatic impacts on the fragile marine environment of the Black Sea. Remote sensing data show that the majority of oil spills occur along major shipping routes, suggesting that shipping, rather than land-based oil installations have been the principal cause of concern. A single large spill from ships, platforms or land-based oil installations could severely impact biota and the economies of all coastal countries and could produce significant damage of the Black Sea ecosystem and fishing. Also, due to the semi-enclosed character of the basin, an oil spill will definitely pollute the coastline of the basin incurring great losses to the recreation industry and potentially threatening human health. Fighting oil pollution in the Black Sea is a great challenge.

The risk of shipwrecks and resulting catastrophic oil spill necessitates the use of the modern technologies to effectively protect the marine environment. In turn, such technologies require high-quality products based on operational oceanography.

The development of Black Sea operational oceanography has made it possible to transfer cost-efficient technologies to the region as GMES operational downstream service for addressing oil pollution and for search and rescue in case of a shipwreck.

The BlackSeaTrack Web (BSTW) system for accidental oil spill forecasts in the Black Sea has been developed in the framework of the EU funded the MONINFO project led by the Black Sea Commission. The system is based on the Seatrack Web (STW) model developed by a consortium of Baltic Sea countries. It is adapted to the configuration of the Black Sea observation system and is implemented according to the regional contingency plans.

The BSTW system consists of three parts:

- forcing in the form of forecasted operational data of stratification, sea currents and wind fields, which is provided by the Black Sea MFC located at MHI in Sevastopol. The Black Sea MFC is the MyOcean regional marine forecasting center. It runs operationally and produces weather and ocean forecasts;
- an oil drift model jointly developed by the Swedish Meteorological and Hydrological Institute (SMHI) and the Royal Danish Administration of Navigation and Hydrography and which takes into account and adequately describes almost all physical and chemical processes affecting an oil spill;
- a graphical user interface developed by SMHI and based on open source GIS-server technology.

The BSTW system is available via the Internet, fully operational 24 hours a day and user friendly. It allows for immediate access to the latest forecasts that drives the system. In addition, it can also be used for various floating objects and backtracking.

Some examples of the use of BSTW to real events showed that this system is a useful operational tool for solving various problems of safety in the Black Sea.

R&D contributions of HZG to the European Copernicus Programme

I. Nöhren, E. V. Stanev, J. Schulz-Stellenfleth, K. Wahle, A. Behrens, S. Grayek

Helmholtz-Zentrum Geesthacht, Germany

In the frame of the European Copernicus Programme, formerly known as GMES (Global Monitoring for Environment and Security), Helmholtz-Zentrum Geesthacht (HZG) is involved in several R&D activities to enhance Copernicus applications in the marine area.

Ocean waves are the most important environmental parameter for many activities on the ocean and reliable forecasts are crucial for safeguarding life and property at sea and along the coast. The EU funded project MyWave aims at improving the marine Copernicus services by the introduction of ocean waves. The main objective is to substantially improve the ocean wave model products through the development of state of the art coupled atmosphere-wave-ocean model systems. The main task of HZG is to combine and document all new developments into a consistent model version of the numerical wave model WAM and to provide the required infrastructure for testing and program code distribution.

One goal of the EU project MyOcean is to provide Copernicus users with continuous access to the Copernicus service products, as well as the interfaces necessary to benefit from research and development activities. HZG is the leader of the R&D work package in which the common scientific and technological developments, which are considered as priorities, are undertaken. HZG is mostly involved in numerical modeling and data assimilation.

Based on the Copernicus services, many other value-added services can be tailored to more specific public or commercial needs. One of these downstream services has been investigated in the EU project FIELD_AC (Fluxes, Interactions and Environment at the Land-Ocean Boundary. Downscaling, Assimilation and Coupling). This project aims at providing an improved operational service for coastal areas and to generate added value for shelf and regional scale predictions from Copernicus Marine Core Services. HZG was involved in the investigation of current/wave interaction processes and high resolution modelling of hydrodynamic processes in near coastal areas.

With COSYNA a prototype of a downstream service is developed at HZG together with German partners from research and governmental institutions. It is an operational, integrated observational system that combines observations and numerical modeling to describe the environmental status of the North Sea and Arctic coastal waters. Tools are developed that give a quantitative estimate of observation systems significance, so called OSE: Observation System Experiments. COSYNA aims to provide knowledge tools that can help authorities and other stakeholders to manage routine tasks, emergency situations and evaluate trends.

On-line ice resistance survey for the ships supporting winter navigation in ice channels of the Baltic Sea

Tarmo Kõuts and Kaimo Vahter

Marine Systems Institute at Tallinn University of Technology, tarmo.kouts@msi.ttu.ee (Estonia)
Madis-Jaak Lilover, Marine Systems Institute at Tallinn University of Technology, madis-jaak.lilover@msi.ttu.ee
Kaimo Vahter, Marine Systems Institute at Tallinn University of Technology, kaimo.vahter@msi.ttu.ee

Winter navigation occurs mostly in ice channels, broken into fast or drift ice by icebreakers. Every ship proceeding in such ice channel experience certain resistance, which could vary quite considerably both in space and time. This study is aimed to describe the nature of ship resistance in ice channels in relation with forcing functions. In order to build up basic knowledge and understanding of ice resistance, *in situ* measurements directly in areas of winter navigation are essential. Measurement technology is based on understanding that in different ice conditions (smooth or ridged ice, ice compression, etc.) ice interaction with ship hull results with ship hull vibration of different intensity which then is registered and taken as measure of ship resistance in ice. Icebreaker of Estonain Maritime Administration EVA-316 was instrumented and vibrations of the ship hull is recorded in terms of 3D acceleration sensor which is tightly fixed to the ship hull. Accelerations in three dimensions x-y-z are measured in 4Hz regime, processed, maximums per minute found and recorded on SD memory card together with GPS position and time with one minute interval. In order to have on-line control over ship hull vibrations, acceleration data and ship position is transferred in real time into FTP server of the Marine Systems Institute, using GSM/GPRS protocol. Next after a preliminary analysis of data the ice resistance index is calculated. The comparison of acquired ship hull vibration data with satellite ice images showed that obtained data well distinguish open water and ice, also different severity of ice conditions could be estimated. An attempt to relate the ship hull vibration data and ice resistance index to relevant forcing parameters like wind speed and direction was successfully made. The analysis of 2012 March data of Gulf of Riga cruises of IB EVA-316 revealed that in case of similar wind speed and ice properties, the case with perpendicular wind direction in relation of ship course had 15% higher mean ship hull vibrations than the case of parallel to ship course wind direction. From last, we can conclude that wind direction and namely angle between wind direction and ship course, is an important factor determing the ship resistance in ice channel. Ship hull vibration data showed adequately also different ship manoeuvres in ice, what icebreaker performs during assistance of merchant vessels.

Recorded data of ship hull vibrations together with ship speed and course forms dataset which enables to assign a specific rank for the severity of ice conditions directly in locations of ship operations, where this information is most needed. In order to give forecast ability for that system, a fuzzy logic relational scheme was defined, applied and validated. Forecast of ship resistance in ice for fairway into Pärnu Port, Gulf of Riga, the Baltic Sea was designed and realised in pre-operational mode. The study concludes that the ship hull vibration measurements applied for detection of the ship resistance in ice channel is a useful tool for on-line monitoring the ice conditions along the fairways of winter navigation. Collected data can be used for validation of ice dynamics models and forecast of ice conditions, as well ice compression in particular. Shipborne measurements of ice resistance serve also goals of statistical analysis of winter navigation in certain sea area and help optimize this for the future.

Observing the Oceans from Space

Jellyfish prediction of occurrence from remote sensing data and a non-linear pattern recognition approach

A. Albajes[1], M. Haneda[1], L. Romero[1], A. Soria-Frisch[1], Q. Vanhellemont[2]

[1]*Starlab Barcelona S.L., Space Engineering Unit. Teodor Roviralta 45, 08022 Barcelona, Spain.*
[2] *Royal Belgian Institute of Natural Sciences (RBINS), Unit of the North Sea Mathematical Models (MUMM/UGMM/BMM). 100 Gulledelle, 1200 Brussels, Belgium.*

Impact of jellyfish in human activities has been increasingly reported worldwide in the last years. Segments such as tourism, water sports and leisure, fisheries and aquaculture are commonly damaged when facing blooms of gelatinous zooplankton. Hence the prediction of the appearance and disappearance of jellyfish in our coasts, which is not understood from its biological point of view, has been approached as a classification problem, a set of potential ecological cues was selected to test their usefulness for prediction. Remote sensing data was used to describe environmental conditions that could support the occurrence of jellyfish blooms, with the aim of capturing physical-biological interactions: forcing, coastal morphology, food availability, and water mass characteristics are some of the variables that seem to exert an effect on jellyfish accumulation on the shoreline, under specific spatial and temporal windows. A data-driven model based on computational intelligence techniques has been designed and implemented to predict jellyfish events on the beach area as a function of environmental conditions. Data from 2009 over the NW Mediterranean continental shelf have been used to train and test this prediction protocol. Standard level 2 products are used from MODIS (NASA OceanColor) and MERIS (ESA - FRS data). After application of the included level 2 flags and additional quality checks for turbid waters, the data products are reprojected to a standard grid, 1 Km and 250 m for MODIS and MERIS respectively. Adjacent overpasses are stitched together and if overlap occurs in the MODIS data, the best quality data is retained, based on viewing geometry. The procedure for designing the analysis system can be described as following. The aforementioned satellite data has been used as feature set for the performance evaluation. Ground truth has been extracted from visual observations by human agents on different beach sites along the Catalan area. After collecting the evaluation data set, a cross-fold validation is established for comparing the performance between different computational intelligence methodologies. The outperforming one in terms of its generalization capability has been selected for prediction recall. Different tests have been conducted in order to assess the prediction capability of the resulting system in operational conditions. This includes taking into account several types of features with different distances in both the spatial and temporal domains with respect to prediction time and site. The implementation and performance evaluation results are detailed in the present communication together with the feature extraction from satellite data. To the best of our knowledge the developed application constitutes the first implementation of an automate system for the prediction of jellyfish appearance founded on remote sensing technologies. Moreover the results can be used in order to throw new light on the ecological procedures underlying jellyfish appearance.

Optimizing phytoplankton time series analysis in the North Sea in support of trophic synchronization studies of sole larvae

Dimitry Van der Zande, Genevieve Lacroix and Kevin Ruddick

Royal Belgian Institute of Natural Sciences, DO Nature (ex-MUMM), Brussels, Belgium
dimitry.vanderzande@mumm.ac.be

Phytoplankton or algal blooms (AB) are generally defined as a rapid increase of the biomass of algae in an aquatic system. The naturally occurring spring algal blooms are an important source of organic food for the subsequent trophic levels in the marine food chain of the North Sea. The timing of the bloom may influence the secondary production (match-mismatch hypothesis) and the higher trophic levels and thus algal bloom information is useful for fish stock management. Satellite chlorophyll a (CHL) data are a suitable proxy for phytoplankton biomass and provide a unique means to monitor AB dynamics over a large area with a temporal and spatial resolution that is unmatched by traditional seaborne observations. However, the irregular availability of CHL observations both in space and time due to cloudiness, quality flagging, sensor malfunction, etc. has to be considered as it impacts the accuracy of the description of the algal blooms in terms of onset, duration and intensity. While most quality assessments of CHL products only consider the accuracy of individual satellite CHL observations, the impact of sampling irregularity on the quality of the time series for describing a phytoplankton bloom is often neglected.

The main objective of this study is to provide optimized satellite CHL time series for algal bloom dynamics studies and subsequently for trophic synchronization studies (e.g. match-mismatch indices). Standard satellite-based CHL products from MERIS were used to generate CHL time series for sole (Solea solea) larvae during their travel between spawning grounds and nurseries in the North Sea for the years 2003 to 2011. The multi-temporal quality of these CHL time series was assessed in order to improve the CHL time series when possible or omit low quality data for further processing. Results showed that in the Belgian nursery irregular sampling frequently lead to errors of up to 30% on the 90 percentile of CHL (CHL-P90) which is a descriptor of the intensity of the bloom. When possible, a temporal interpolation approach was used to improve the CHL time series reducing the relative errors of the CHL-P90 to 10%-15%. Subsequently, the dates corresponding to the onset, maximum and end of the phytoplankton spring bloom were determined and compared to the sole larval food requirements as modeled by SOLEMOD. SOLEMOD is an individual-based model (IBM) for sole larval dispersal resulting from the coupling between a 3D hydrodynamical model (COHERENS) and a Lagrangian particle tracking module. The IBM includes four stages of development (eggs, yolk-sac, first-feeding and metamorphosing larvae) and considers temperature-dependant stage durations and stage-dependant vertical migrations. Eggs are released in six main spawning grounds, during a 3 month-period (temperature dependent). After their pelagic phase, larvae settle in the nursery areas defined according to the sediment type. The Algal bloom dynamics (and interannual variability) for the sole nurseries will be presented accompanied with an example of the use of these data products in a match-mismatch assessment.

Detection and Analysis of Fronts in the North Sea

G. Kirches[1], M. Paperin[1], C. Brockmann[1], H. Klein[2] and K. Stelzer[1]

[1] *Brockmann Consult GmbH, Geesthacht, Germany*
[2] *German Federal Maritime and Hydrographic Agency (BSH)*
Contact: grit.kirches@brockmann-consult.de

Fronts in the ocean are important oceanographic structures, because of their role as boundaries between water masses with different properties and their strong influence on the local dynamic, the dispersion and concentration of substances. Changes in water temperature and density, as well as changes in the wind pattern caused by climate change are likely to influence water mass distribution and hence will be visible in statistical quantities of frontal structures. In the North Sea and in particular in the German Bight two types of fronts are dominant: River Plume Fronts (RPF) between the freshwater entries of the rivers and the intrinsic North Sea water, as well as Tidal Mixing Fronts (TMF) between the seasonally stratified water close to coast and saltier and therefore heavier North Sea water. Other front-like structures are the boundaries between the North Sea water and the Baltic outflow from the Skagerrak, as well as between the inflow of Atlantic water from the North and from the English Channel. A large German national project, KLIWAS, has been initiated by the Federal Ministry of Transport, Building and Urban Development in order to assess the impact of climate change on river, coastal and ocean water ways. The work presented here is part of this initiative and is focussing on evaluating long time series of satellite observations to establish a front climatology of the North Sea, and to study derived statistical quantities with respect to potential climate change impact. The development of algorithms which automatically detect frontal positions and gradients from earth observation (EO) data is an important pre-condition for the processing of long EO data time series which are used to establish a climatology for North Sea fronts. The characteristics of fronts have been used to develop an algorithm for front detection comprising pre-processing steps and the identification of fronts itself.

The new algorithm - GRADHIST - builds upon the state-of-art established Cayula and Cornillion (1992) as well as the Canny (1986) front detection algorithm. The investigation of the specific properties of both algorithms has shown that their combination and some refinements of their subroutines were useful for the front detection in the North Sea. By adjusting this combined algorithm w.r.t. thresholds and scaling, it may be applied to different ocean colour and SST sensors such as MERIS and MODIS for Ocean colour AATSR, AVHHR and MODIS for SST. Applying to sea surface temperature and ocean colour parameters opens the possibility of detecting and investigating frontal positions and gradients and of deriving reliable reference data to assess the impacts of climate change on fronts. Therefore, ten-year time series of AATSR, MERIS, MODIS and a twenty year time series of AVHRR data have been processed by applying the algorithm for the North Sea. GRADHIST allows an automated processing of comprehensive EO data sets to produce a climatology for front positions and gradients in the North Sea and other shelf sea areas. They also enable the establishment of front maps as an operational downstream product which will help to monitor potential change due to climate change.

References:

Canny, 1986, A computational approach to edge detection, IEEE Transactions on Pattern Analysis and Machine Intelligence 8(6) , pp. 679–698

Cayula and Cornillon, 1992, Edge detection algorithm for SST images, Journal of Atmospheric and Oceanic Technology 9(1), pp. 67–80

Water Quality Monitoring by Satellite

Stefan Riha, Birgit Gerasch, Harald Krawczyk

Photogrammetry and Image Analysis , Earth Observation Center
Deutsches Zentrum für Luft- und Raumfahrt, Rutherfordstr. 2, 12489 Berlin
[stefan.riha@dlr.de; birgit.gerasch@dlr.de; harald.krawczyk@dlr.de]

To establish and maintain certain water quality standards, effective control methods of water parameters are of high importance. Eutrophication and annual phytoplankton blooms play an important role in areas with a strong anthropogenic influence, such as the Baltic Sea. Annual mass growth of phytoplankton and the subsequent biomass, causes several problems for ma-rine life and the matter budget. Cyanobacteria is capable of fixing atmospheric nitrogen and thereby adds to the already dominant problem of eutrophication and threatens other marine organisms with its capability of producing toxins. These cyanotoxins can even affect human beings directly or indirectly through the food chain. Solid knowledge about the place and ex-tent of these blooms as well as interannual variability is very important for understanding and improving the ecological situation. In Situ measurements in wide aquatic areas are time-consuming and expensive, yet only give spatially and temporally limited information whereas satellite remote sensing offers monitoring of bio-optical parameters with a high spatial and temporal resolution. Over the past years, the Marine Remote Sensing Group at the German Aerospace Center has developed different methods for the derivation of water constituent parameters from spectral satellite sensor data. Besides todays standard parameters for chloro-phyll, suspended matter and gelbstoff, novel approaches for important parameters like water transparency and cyanobacteria specific pigments were taken. A new neural-network-based algorithm addressing the specific optical properties of cyanobacteria in the Baltic Sea was developed. The algorithms were developed for the MERIS sensor and will be adjustable to the OLCI instrument aboard the coming SENTINEL-3 mission. Besides the development of new methods, InSitu-measurements of important optical properties above and beneath the water surface are another expertise of the workgroup, based in Berlin-Adlershof. These measure-ments are needed for validation and improvement of existing algorithms as well as the devel-opment of new algorithms. The Poster will give an overview over the current algorithms and results.

Bivalve beds detection in intertidal flats on the German North Sea coast with synthetic aperture radar observations

Sabrina Melchionna and Martin Gade

Institute of Oceanography, University of Hamburg. Bundesstraße 53, D-20146 Hamburg, Germany.
Email: sabrina.melchionna@zmaw.de, martin.gade@uni-hamburg.de

Intertidal flats are coastal areas that fall dry once during each tidal cycle. Remote sensing techniques are ideally suited for the surveillance of these areas that are generally difficult to access. In this respect, Synthetic Aperture Radar (SAR) sensors, because of their all-weather capabilities and their independence on daylight, may be the first choice; however, radar imaging is rather complex, and the very processes responsible for the backscattering of microwaves by bare soils are still subject to research. In this contribution we will present that multi-polarized, multi-frequency, and multi-temporal SAR imagery can be used to detect bivalve beds in exposed intertidal flats.

In 2012 and 2013, within the German national project SAMOWatt (“SAR Monitoring of the Wadden Sea”), a considerable number of SAR images from TerraSAR-X (X-band, horizontally and vertically polarized) and Radarsat-2 (C-band, vertically polarized) of five test areas during low tide along the German North Sea coast were acquired. The test areas represent regions of typical sediment distributions on intertidal flats, and include vegetated areas and bivalve beds. In each test area we identified the approximate locations of bivalve beds by using field data from measurement campaigns carried on in 2006, 2012, and 2013. In order to understand which are the more advantageous bands, polarization channels, or combinations of them, that underline these structures in the intertidal flats, we focused our analysis on the Normalized Radar Cross Section (NRCS), on the polarization coefficient, function of the two polarization channels in X-band, and on the band coefficient, function of the two frequency bands in vertical polarization. Furthermore, we created layer stacks of 4m resolution of multi-temporal NRCS data, and evaluated their mean and standard deviation.

We observed that bivalve beds can be detected at all available bands and polarization channels due to their high NRCS values; however, edges of the tidal channels present similar values. In order to distinguish between bivalve beds and channel edge areas, we benefit of the different roughness characteristics they show in the multi-temporal approach, the former showing high mean NRCS and low NRCS standard deviation, the latter showing high mean NRCS and high NRCS standard deviation. Likewise, we observed a marked contrast between bivalve beds and their surroundings in the polarization coefficient, whose values smoothly fluctuate for bivalve beds and have a rough texture elsewhere. We also observed that the band coefficient values underline a characteristic spatial distribution of oysters, which grow in parallel banks.

Multi-polarized, multi-frequency, and multi-temporal analyses of high resolution SAR data provide, therefore, a valuable input for the detection of bivalve beds as much as for the routine monitoring of exposed intertidal flats on the German North Sea Coast, and the potential of the approach here presented for crude sediment classification is currently under investigation.

Storm Observations by Remote Sensing, Influences of organized Gusts on Ocean Waves and on Generation of Rogue Waves

A. L. Pleskachevsky[1], S. Lehner[1] and W. Rosenthal[2]

[1] German Aerospace Centre (DLR), Remote Sensing Technology Institute, 82234 Weßling, Germany, Email: Andrey.Pleskachevsky@dlr.de
[2] Gauss, 28199 Bremen, Germany

The impact of the gustiness on surface waves under storm conditions is investigated with focus on the appearance of wave groups with extreme high amplitude and wavelength. During many storms characterized by extremely high individual waves measured near the German coast especially in cold air outbreaks the moving atmospheric open cells are observed by optical and radar satellites. According to measurements the footprint of the cell produces a local increase in the wind field at sea surface, moving as a consistent system with a propagation speed near to swell wave traveling speed.

The optical and microwave satellite data are used to connect mesoscale atmospheric turbulences and the extreme waves measured. The parameters of open cells observed are used for numerical spectral wave simulations (North Sea with horizontal resolution of 2.5km). The wind field “storm-in-storm” including moving organized mesoscale eddies with increased wind speed was generated. To take into account the rapid moving gust structure the input wind field was updated each 5min. The test cases idealized with one, two, and four open individual cells and respectively with groups of open cells, with and without pre-existing sea state as well the real storm conditions are simulated.

The model results confirm that an individual moving open cell can cause the local significant wave height increase in order of meters within the cell area and especially in a narrow area of 1-2km at the footprint center of a cell (the cell’s diameter is 40-90km). In a case of a traveling individual open cell with $15 m \cdot s^{-1}$ over a sea surface with a pre-existing wind-sea of and swell, a local significant wave height increase of 3.5m is produced. A group of cells for a real storm condition produces a local increase of significant wave height of more than 6m during a short time window of 10-20min (cell passing). The sea surface simulation from modeled wave spectra points out the appearance of wave groups including extreme individual waves with a period of about 25s and a wavelength of more than 350m under the cell’s footprint. This corresponds well with measurement of a rogue wave group with length of about 400m and a period of near 25s. This has been registered at FiNO-1 research platform in the North Sea during Britta storm on November 1, 2006 at 04:00 UTC.

The results can explain the appearance of rogue waves in the German Bight and can be used for ship safety and coastal protection. Presently, the considered mesoscale gustiness cannot be incorporated in present operational wave forecasting systems, since it needs an update of the wind field at spatial and temporal scales, which is still not available for such applications. However, the scenario simulations for cell structures with appropriate travel speed, observed by optical and radar satellites can be done and applied for warning messages.

Sea State Variability, Wind Field and Coastal Interaction Processes Observed by High Resolution TerraSAR-X Satellite Radar Images.

Susanne Lehner, Andrey Pleskachevsky and Miguel Bruck

German Aerospace Center (DLR), Remote Sensing Technology Institute, 82234 Weßling, Germany
Susanne.Lehner@dlr.de Andrey.Pleskachevsky@dlr.de Miguel.Bruck@dlr.de

Methods to derive wind speed and the sea state by simple empirical models from SAR data are presented and applied for use in high resolution numerical modeling for coastal application. The new radar satellite TerraSAR-X (TS-X) images the sea surface with a high resolution up to 1m. So not only the wind information, integrated sea state parameters but also individual ocean waves with wavelengths down to 30m are detectable. Two-dimensional information of the ocean surface retrieved using TS-X data is validated for different oceanographic applications: derivation of fine resolved wind fields (XMOD algorithm) and integrated sea state parameters (XWAVE algorithm). Both algorithms are capable to take into account fine-scale effects in the coastal areas.

The wind and sea state information retrieved from SAR data are applied as an input for a wave numerical spectral model (wind forcing and boundary condition) running at fine spatial horizontal resolution of 100m. Results are compared to collocated buoy measurements. Studies are carried out for varying wind speed and comparison against wave height, simulated using original TS-X derived wind, show sensitivity of waves on local wind variation and thus the importance of local wind effects on wave behavior in coastal areas. Examples for the German Bight, North Sea are shown.

The TS-X satellite scenes render well developed ocean wave patterns of developed swell at the sea surface. Refraction of individual long swell waves at a water depth shallower than about 70m is caused by the influence of underwater topography in coastal areas is imaged on the radar scenes. A technique was developed for tracking of wave rays depending on the change of swell wavelength and direction. We estimate the wave energy flux along the wave tracks from deep water to the coastline based on SAR information: wave height and wave length are derived from TS-X data.

Modelling and Forecasting Systems

Assimilating NOAA's SST data and in situ T, S profiles into BSH operational circulation model for the North and Baltic Seas

Svetlana N. Losa[1], Sergey Danilov[1], Jens Schröter[1], Lars Nerger[1], Silvia Maßmann[2], and Frank Janssen[2]

[1] *Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany*
[2] *Federal Maritime and Hydrographic Agency, Hamburg, Germany.*

The operational circulation model of the German Federal Maritime and Hydrographic Agency (BSH) has been augmented by a data assimilation (DA) system in order to improve the hydrography forecast of the North and Baltic Seas. The DA system has been developed based on the Singular Evolution Interpolated Kalman (SEIK) filter algorithm (Pham et al., 1998) coded within the Parallel Data Assimilation Framework (Nerger et al., 2004, Nerger and Hiller, 2012). The quality of the forecast has been previously improved by assimilating sea surface temperature (SST) measurements obtained with the Advanced Very High Resolution Radiometer (AVHRR) aboard polar orbiting NOAA's satellites (Losa et al., 2012). We investigate possible further improvements using in situ observational temperature and salinity data: MARNET time series and CTD and Scanfish measurements. The study addresses the problem of the local SEIK analysis accounting for the data within a certain radius. The localisation radius is considered spatially variable and dependent on the system local dynamics. As such, we define the radius of the data influence based on the energy superposition of the baroclinic and barotropic flows.

References

D. T. Pham, J. Verron, L. Gourdeau. "Singular evolutive Kalman filters for data assimilation in oceanography," C. R. Acad. Sci. Paris, Earth and Planetary Sciences, vol. 26, pp. 255–260, 1998.

L. Nerger, W. Hiller, J. Schröter . "PDAF - The Parallel Data Assimilation Framework: Experiences with Kalman Filtering," In: Zwieflhofer, W., Mozdzynski, G. (Eds.), Use of high performance computing in meteorology: proceedings of the Eleventh ECMWF Workshop on the Use of High Performance Computing in Meteorology. Singapore: World Scientific, Reading, UK, pp. 63–83, 25 - 29 October 2004.

L. Nerger, W. Hiller. "Software for Ensemble-based Data Assimilation Systems — Implementation Strategies and Scalability," Computers and Geosciences, vol. 55, pp. 110-118, 2012.

S. N. Losa, S. Danilov, J. Schröter, L. Nerger, S. Maßmann, F. Janssen. Assimilating NOAA SST data into the BSH operational circulation model for the North and Baltic Seas: Inference about the data. Journal of Marine Systems, vol. 105–108, 152–162, 2012.

The OSERIT drift model and web interface: one year on

Valérie Dulière, Fabrice Ovidio, Jean-Pierre Vogt and Sébastien Legrand

Royal Belgian Institute for Natural Sciences, Management Unit of the North Sea Mathematical Models (RBINS-MUMM), Brussels, Belgium
E-mail: v.duliere@mumm.ac.be

OSERIT is an acronym for 'Oil Spill Evaluation and Response Integrated Tool', a drift model and web interface. It was recently developed by RBINS-MUMM for the partners of the Belgian Coastal Guard. Its goal is to provide relevant information to support the decision-making process of the best response strategy in case of oil spilled at sea. It can also provide forecast and backtrack 2D trajectories of objects drifting at the sea surface. OSERIT includes:

- a new generation 3D drift and fate model based on the Lagrangian particle tracking approach and state-of-the-art oil-related parameterizations
- a user-friendly web interface that allows to quickly launch model simulations 24/7 and to access and visualize model results (*i.e.* maps of drift trajectories, beaching risk, oil concentration and exposure time), and other physical parameters influencing the sea state (*i.e.* surface current, wind, significant wave height)

Since October 2012, OSERIT is operational and accessible to users. Here, we suggest a look back over the last year. We will present how this new tool has been received among the users community, how it has been used and for which results.

Drift prediction by models: What influences the uncertainties?

Valérie Dulière[1], Silvia Massmann[2] and Pierre Daniel[3]

[1]*Royal Belgian Institute for Natural Sciences, Operational Directorate Natural Environment (previously RBINS-MUMM), Brussels, Belgium.*
[2] *BSH, Hamburg, Germany.*
[3] *METEO-FRANCE, Direction de la Prévision, Division Marine et Océanographie, Toulouse, France.*
E-mail: v.duliere@mumm.ac.be

“Which oil spill model is the best? How accurate is your model?” Those questions are often raised during conversations about oil spill models. Many different oil spill models are used around the world, all with their own specificities (i.e. weather and sea conditions, model parameters, physico-chemical parameterizations, produced diagnostics, operational constraints). Unlike for atmospheric models and to some extend also for ocean models, the occasions to validate oil spill models are quite rare since drift experiments are costly and complex. It is therefore difficult for modellers to provide reliable information on their model performance.

On December 9th 2012, a wave buoy from CEFAS became detached and started to drift on the sea surface until it was recovered providing about 2 days recorded GPS positions. A number of model simulations have been performed using four different models (SeaTrackWeb, BSHdmod.L, MOTHY and OSERIT) to estimate the drift of the buoy. Based on this real test case, we discuss how currents, winds and waves affect the buoy estimated trajectories and how uncertainties in the weather and sea

RDFS-PT: A Nowcast-Forecast system for high resolution coastal applications

Azevedo, A., A. Oliveira, A.B. Fortunato, G. Jesus, J. Gomes, M.F. Rodrigues, J. Rogeiro

Hydraulics and Environment Department (DHA), National Laboratory for Civil Engineering (LNEC), Av do Brasil 101, 1700-066 Lisboa, Portugal

Natural and man-made disasters worldwide cause widespread destruction of property, human injuries and deaths. Even if disasters have unpredictable occurrences or consequences, many mitigation actions can be done to diminish the resulting damages or their severity. Preventive measures are currently under improvement and their effectiveness aims at decreasing the impact of the hazards. Thus, the protection of important environmental and social assets in river and coastal regions requires the early warning of potential hazards, such as floods, pollution events and tsunamis. Timely hazard forecasting is an essential part of risk management for vulnerable communities, providing the necessary information for population evacuation, pollution protection resources allocation and efficient emergency personnel management. Forecast systems combine our ability to measure and to simulate the behavior of water bodies, by integrating numerical models, monitoring networks and information technology systems, to provide real-time, short-term, predictions of the main physical and chemical parameters.

This work presents a nowcast-forecast information system, tailored for coastal applications. The information system is based on the custom deployment of a generic forecasting platform, modified for short to long wave predictions, and implemented in a modular way to accommodate future developments. It integrates a suite of high-resolution numerical models, for distinct purposes like circulation, waves, oil spills, morphodynamic and water quality.

The present study will focus mainly on the oil spill modeling system. A brief explanation of the numerical model and all the oil weathering processes is made. Acknowledging that one of the easiest and friendliest ways of reaching a broad spectrum of stakeholders, from the coastal managers to the avid recreational user, is to produce images and animations integrating the products of the running forecast models, taking advantage of the several visualization tool boxes, many of which support GIS (Geographic Information System) capacities. Therefore, the present work will also provide a brief description of the several derived products generated by the oil spill forecast system and their integration/presentation in a WebGIS platform.

The RDFS-PT, due to the use of non-structured simulation grids, is very well suited for cross-scale applications that can range from the ocean to coastal zones and estuaries. This feature provides the stakeholders and port authorities the capability to have all the information (in-time and with high-resolution) needed to support them in the combat of a real crises event.

Sensitivity of sub-regional ocean forecasts to different initialization techniques

Leopoldo Fazioli, Antonio Olita*, Alberto Ribotti, Roberto Sorgente

CNR-IAMC, Institute for Coastal Marine Environment, CNR, Italy, Oristano section
**antonio.olita@cnr.it*

In the present work we analyze the quality of the ocean forecasts produced in the Central Mediterranean area as function of different initialization techniques. The model producing the forecasts is a Princeton Ocean Model implementation for the Central Mediterranean, namely the Sicily Channel sub-Regional Model (SCRM). Model is forced at surface with 1 –hourly atmospheric forecasts and at open boundaries receives information from a coarser basin scale model. In the present study forecasts are initialized in three different ways , namely slave mode (S), partially-active (PA) and active (A) mode. While in S mode the initial condition is created by interpolation of scalar and vector fields from the coarse model (also providing boundaries), in partially-active and active modes the model has more time to develop its own dynamics. In PA mode the model performs a two-weeks hindcast to create initial conditions, during which it may partially develop its own dynamics. In A mode forecasts are initialized from a continuous analysis run assimilating Sea Level Anomalies through a 3D-variational software. Forecasts quality for the three modes is verified against remotely sensed SST. Both optimally interpolated SST as well “raw” synoptic SST were used. For each forecast “cycle” basic statistics and some non-dimensional skill have been calculated. Results provides interesting information on the best initialization procedures to be adopted in operational forecasting when using one-way nested models.

Seatrack Web means drift forecasting and backtracking

Thomas Hammarklint

SMHI / Swedish Meteorological and Hydrological Institute
Samhälle & Säkerhet Havsmiljö / Oceanography
SE - 42671 VÄSTRA FRÖLUNDA

The Seatrack Web system consists of three main parts: forcing in the form of forecasted flow and wind fields, an oil drift model and a graphical user interface. The oil drift model PADM has been jointly developed by the Swedish Meteorological and Hydrological Institute (SMHI) and the Danish Maritime Safety Administration (DAMSA).

Seatrack Web is the official HELCOM oil drift forecasting system. Included in the code is SINTEF oil weathering technology. Today, Seatrack Web is used by oil response authorities around the Baltic Sea as well as in commercial applications, for example oil terminals. Besides oil drift, Seatrack Web can forecast drift of algae and other floating objects.

The new web interface makes your set up for the chosen drift forecast simple and direct. Whether you want to make an algae drift forecast or a backtracking of an oil spill including AIS (Automated Information System for ships) in your search for possible pollutant, the choices in each step are intuitive. The result are presented in an advanced player.

Traditionally, oil spill have been detected by eye witnesses, but as remote

sensing and satellite technology has advanced, potential oil spills can be detected automatically by satellite. By using a new web service, Seatrack Web makes it possible to set up a system for automatic oil drift forecasts from satellite detected oil spill.

The main benefit of the Seatrack Web as part of an automatic system is the Short time from detection to a first guess forecast. This gives more time for expert consulting before decisions on what kind of action is needed.

Special Topics

Online determination of glyphosate and aminomethylphosphonic acid in water samples

B. Rathjen[1], S. Lassen[1], B. Niemeyer[1,2]

[1] *Institute of Coastal Research/Molecular Recognition and Separation, Helmholtz-Center Geesthacht, Max-Planck-Straße 1, D-21502 Geesthacht, Germany*
[2] *Institute of Thermodynamics, Helmut Schmidt University / University of the Federal Armed Forces Hamburg, Holstenhofweg 85, D-22043 Hamburg, Germany; bernd.niemeyer@hsu-hh.de, tel. +49 40 6541-3500*

Glyphosate is the active ingredient of one of the most prevalent herbicides used in both agricultural and non-agricultural areas all over the world. Due to the vast amounts of glyphosate applied, there are increased concerns about its impact on the environment.

Traditional monitoring of contaminants in marine and coastal environments involves sampling on board of survey vessels, sample storage and subsequent analysis in a fully equipped laboratory. A cost-effective alternative is the use of online measuring devices situated on board of ships like ferries for continuous observations which offer high spatial coverage and temporal resolution. By the use of online sampling and analysis systems sample storage and transportation are avoided. This research is part of COSYNA (Coastal Observation System for Northern and Arctic Seas), in which analytical systems for the description of the environmental status of the North Sea and of Arctic coastal waters are developed and characterized.

In the present work a sequential injection analysis system (SIA) is developed in order to evaluate the concentrations of glyphosate and its main metabolite AMPA in the aquatic environment. A well established HPLC method with postcolumn derivatization for the detection of these two compounds is converted into a compact and automatable SIA set-up (Figure 1).

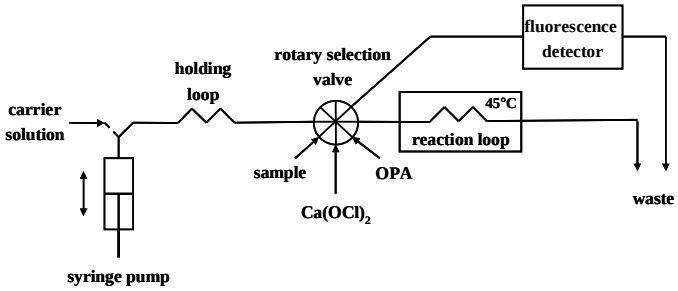

Figure 1: Scheme of the SIA system used for the detection of glyphosate and AMPA

Due to the low concentration of the analytes in the aquatic environment a preconcentration step is required. For this purpose the inclusion of solid phase extraction (SPE) into the process is intended. The SIA instrumentation as well as preliminary results will be presented.

Munitions in German Marine Waters

German Federal/Coastal States Panel for the North and Baltic Seas:
Expert Group on Underwater Munitions

Bund/Länder-Ausschuss Nord- und Ostsee (BLANO): Expertenkreis Munition im Meer
Head Office of the Federal/Coastal States Expert Group on Underwater Munitions:
Ministry of Energy transition, Agriculture, Environment and Rural Areas Schleswig-Holstein
c/o Herr Jens Sternheim (Chairman) or Herr Claus Böttcher (General Manager)
Mercatorstraße 3, 24106 Kiel, Germany, Phone: +49 (0)431 988-3450 or -3460, Fax: +49 (0)431 988-2833
E-mail: munition@meeresschutz.info

Wars, demilitarization activities, military and defense-related testing and practice have exposed many areas around the world to warfare materials, among them the North Sea and the Baltic Sea. It has been estimated that 1,600,000 t of conventional and chemical munitions are still present in German waters of the North and Baltic Seas, and that around 1,300,000 t of these are located in the North Sea alone. This legacy has numerous concrete and potential economic and environmental impacts and has often been termed as a problem concerning society as a whole.

In December 2011 the German federal government and the coastal states presented the jointly elaborated survey “Munitions in German Marine Waters - Stocktaking and Recommendations (Effective 2011)“ to the public. The objective of this pioneering work was to give a consolidated overview of all types of munitions present in German marine waters as derived from all information currently known, to assess the situation, and to provide recommendations on that basis.

The outcome report presented in December 2011 was designed as a living and growing document in order to form the basis of a systematic approach for dealing with this whole-society problem: The German Program on Underwater Munitions. Elaborating on its milestone report, the federal/coastal states Expert Group on Underwater Munitions published the first annual update report on developments and progress in January 2013. In addition to annual reporting, the expert group is tasked with accompanying the implementation of the recommendations given in the initial report.

Transparency and international cooperation were identified as major requirements for this systematic approach and therefore the up-to-date reports, information and supplementary materials have been made publicly accessible on a dedicated website: www.underwatermunitions.de www.munition-im-meer.de

Part C: List of Participants

A

	Carolin	Abromeit	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Ph.D.	Alberto Carlos	de Oliveira Antunes de Azevedo	National Laboratory for Civil Engineering
	Yota	Antoniou	EuroGOOS AISBL

B

	Soheil	Bahrebar	Iranian National Center for Oceanography
Dr.	Marco	Bajo	ISMAR-CNR
Prof. Dr.	Burkard	Baschek	Helmholtz-Zentrum Geesthacht (HZG)
Dr.	Arno	Behrens	Helmholtz-Zentrum Geesthacht (HZG)
	Jose M.	Beltran	Stockholm University
	Ina	Bendler	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Christian	Boddenberg	OceanWaveS GmbH
Dr.	Rodolfo	Bolanos	DHI
	Holger	Brix	University of California Los Angeles / HZG
Dr.	Carsten	Brockmann	Brockmann Consult GmbH
Dr.	Bernd	Brügge	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Thorger	Brüning	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Katharina	Bülow	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

C

Prof.	Sayedur R.	Chowdhury	Institute of Marine Sciences and Fisheries
	Marius	Cysewski	Helmholtz-Zentrum Geesthacht (HZG)

D

Dr.	Verena	Dauben	MBT GmbH
Dr.	Alexander	Davidov	MBT GmbH
	Claudia	Denker	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Stephan	Dick	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Mark	Dickey-Collas	ICES
	Emilie	Dorgeville	Xylem/Aanderaa
	Heike	Dreyer	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Valerie	Duliere	RBINS/DO nature

E

Dr.	Iris	Ehlert	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Sandra	Erdmann	German Marine Reserarch Consortium (KDM)

F

Prof. Dr.	Philipp	Fischer	Alfred-Wegener Institut für Polar und Meeresforschung (AWI)
Dr.	Götz	Flöser	Helmholtz-Zentrum Geesthacht (HZG)
	Vera	Fofonova	The Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI)
Dr.	André	Fortunato	National Civil Engineering Laboratory
	Alexander	Frohse	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

G

Dr.	Pramod P.	Gaike	P.V.P.College Patoda TQ-Patoda Dist - Beed (M.S) India
	Birgit	Gerasch	Deutsches Zentrum für Luft- und Raumfahrt (DLR)
	Tobias	Gies	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Inga	Golbeck	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dipl.-Ing.	Stefan	Grammann	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Annika	Grage	Niedersächsische Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN)
Dr.	Ulf	Gräwe	Leibniz Institute for Baltic Sea Research (IOW)
	Sebastian	Grayek	Helmholtz-Zentrum Geesthacht
Prof.Dr.	Joachim	Gröger	Thünen-Institut für Seefischerei
Dr.	Maik	Grunwald	-4H-JENA engineering GmbH
Dr.	Anna	von Gyldenfeldt	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

H

Dr.	Michael	Haller	Helmholz Zentrum Geesthacht (HZG)
	Thomas	Hammarklint	Swedish Meteorological and Hydrological Institute
	Saskia	Heckmann	SubCtech GmbH
Dr.	Hartmut	Heinrich	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Marion	Heinrich	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Fred	Hesser	Bundesanstalt für Wasserbau (BAW)
Dr.	Lars R.	Hole	Norwegian Meteorological Institute (met.no)
	Niels	Holt	FCOO, Defence Centre for Operational Oceanography
Dr.	Jochen	Horstmann	Helmholz Zentrum Geesthacht (HZG)
Dr.	Johanna	Ikävalko	Finnish Meteorological Institute

J

	Kai	Jancke	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Simon	Jandt	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Frank	Janssen	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Mathias	Jonas	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

K

	Michael	Kahsu Tesfazgi	Eritrea National Fisheries Corporation operates under Eritrea ministry of Marine resources
Dr.	Corinna	Kanzog	Alfred-Wegener Institute (AWI)
	Lisa	Kattner	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Susanne	Kehrhahn-Eyrich	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Christoph	Kirbach	CONTROS Systems & Solutions GmbH
Dr.	Grit	Kirches	Brockmann Consult GmbH
	Holger	Klein	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Meral I.	Köbrich	Universität Bremen
Dr.	Tarmo	Kõuts	Marine Systems Institute, Tallinn University of Technology
Dr.	Sören	Krägefsky	Alfred-Wegener-Institut
	Harald	Krawczyk	Deutsches Zentrum für Luft- und Raumfahrt
Prof.	Yannis N.	Krestenitis	Aristotle University of Thessaloniki
Dr.	Joachim	Krohn	Helmholtz-Zentrum Geesthacht (HZG)
Dipl.-Ing.	Siegfried	Krüger	Baltic Sea Research Institute (IOW)
Dr.	Alexander	Kubryakov	Marine Hydriphysical Institute of National Academy of Sciences of Ukraine

L

	Annick	Van Laere	Flämischen Hydrographie
	Ina	Lorkowski	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

M

	Detlev	Machoczek	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.-Ing.	Stephan	Mai	German Federal Institute of Hydrology (BfG)
	Cobas-Garcia	Marcos	Instituto Español de Oceanografía
	Michaela	Markovic	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Silvia	Maßmann	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Barbara	Mathieu-Üffing	BSH/University of Bremen
Dr.	Said	Mazaheri	National Institute for Oceanography
Dr.	Sabrina	Melchionna	Institute of Oceanographie, University Hamburg
	Inge	Menzenhauer-Schumacher	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dr.	Peter	Miller	Plymouth Marine Laboratory
	Seyed Hamzeh	Mirkhalili	
	Jens	Möller	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

N

	Nikesh	Narayan	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Prof.	Bernd	Niemeyer	Helmholtz-Zentrum Geesthacht (HZG)
	Ingeborg	Nöhren	Helmholtz-Zentrum Geesthacht (HZG)
PhD	Antonio	Novellino	ETT
Dr.	Ismael	Núñez-Riboni	Johann Heinrich von Thuenen Institut für Seefischerei

O

Dr.	Reiner	Onken	NATO-STO Centre for Maritime Research and Experimentation
	Michael	Ott	Fisheries and Oceans Canada

P

	Maike	Peters	
Dr.	Wilhelm	Petersen	Helmholtz-Zentrum Geesthacht (HZG)
	Mareike	Peterson	Institute for Baltic Sea Research (IOW)
Dr.	Ralf	Prien	Leibniz-Institute for Baltic Sea Research (IOW)
Dr.	Claudia	Propp	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

R

Dr.	Hans-Christian	Reimers	Landesamt für Landwirtschaft, Umwelt und ländliche Räume (LLUR)
Dr.	Jan H.	Reißmann	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Stefan	Riha	Deutsches Zentrum für Luft- und Raumfahrt (DLR)
Dr.	Rolf	Riethmüller	Helmholtz-Zentrum Geesthacht (HZG)

S

Dr.	Eberhard	Sauter	Alfred Wegener Institute (AWI)
Dr.	Nils H.	Schade	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Dipl.-Ing.	Martina	Schirmacher	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Wolfgang	Schönfeld	Helmholtz-Zentrum Geesthacht (HZG)
Dr.	Johannes	Schulz-Stellenfleth	Helmholtz-Zentrum Geesthacht (HZG)
	Soeren	Schwartze	Werum Software & Systems AG
PhD	Simo-Matti	Siiriä	Finnish Meteorological Institution
	Kai	Soetje	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Marek	Stawarz	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Carsten	Stein	Werum Software & Systems AG
	Kerstin	Stelzer	Brockmann Consult GmbH

T

Dr.	Susanne	Tamm	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Jan	Tegtmeier	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Ina	Tränkmann	OceanWaveS GmbH
Dr.	Christos	Tsabaris	Hellenic centre for Marine Research

U

Dr.	Sylvia	Ullmer	MarKdo GeoInfo
Dr.	Georg	Umgiesser	ISMAR-CNR

V

	Roswitha	Velten	Bundesamt für Seeschifffahrt und Hydrographie (BSH)

W

Dr.	Christoph	Waldmann	Universität Bremen/MARUM
	Ralf	Wasserthal	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Henning	Wehde	Institute of Marine Research, Bergen
	Bärbrl	Weidig	Bundesamt für Seeschifffahrt und Hydrographie (BSH)
	Martina	Wilde	Alfred Wegener Institut für Polarforschung
Dipl.-Ing.	Klaus-Peter	Wlost	Baltic Sea Research Institute (IOW)
Prof. Dr.	Jörg-Olaf	Wolff	ICBM, University of Oldenburg
	Jochen	Wollschläger	Helmholtz-Zentrum Geesthacht (HZG)

X

	Yu	XIN	IFBM, Hamburg University

Z

	Wolfgang	Zahn	FZ Juelich
Dr.	Dimitry	Van der Zande	MUMM
Dr.	Manfred	Zeiler	Bundesamt für Seeschifffahrt und Hydrographie (BSH)