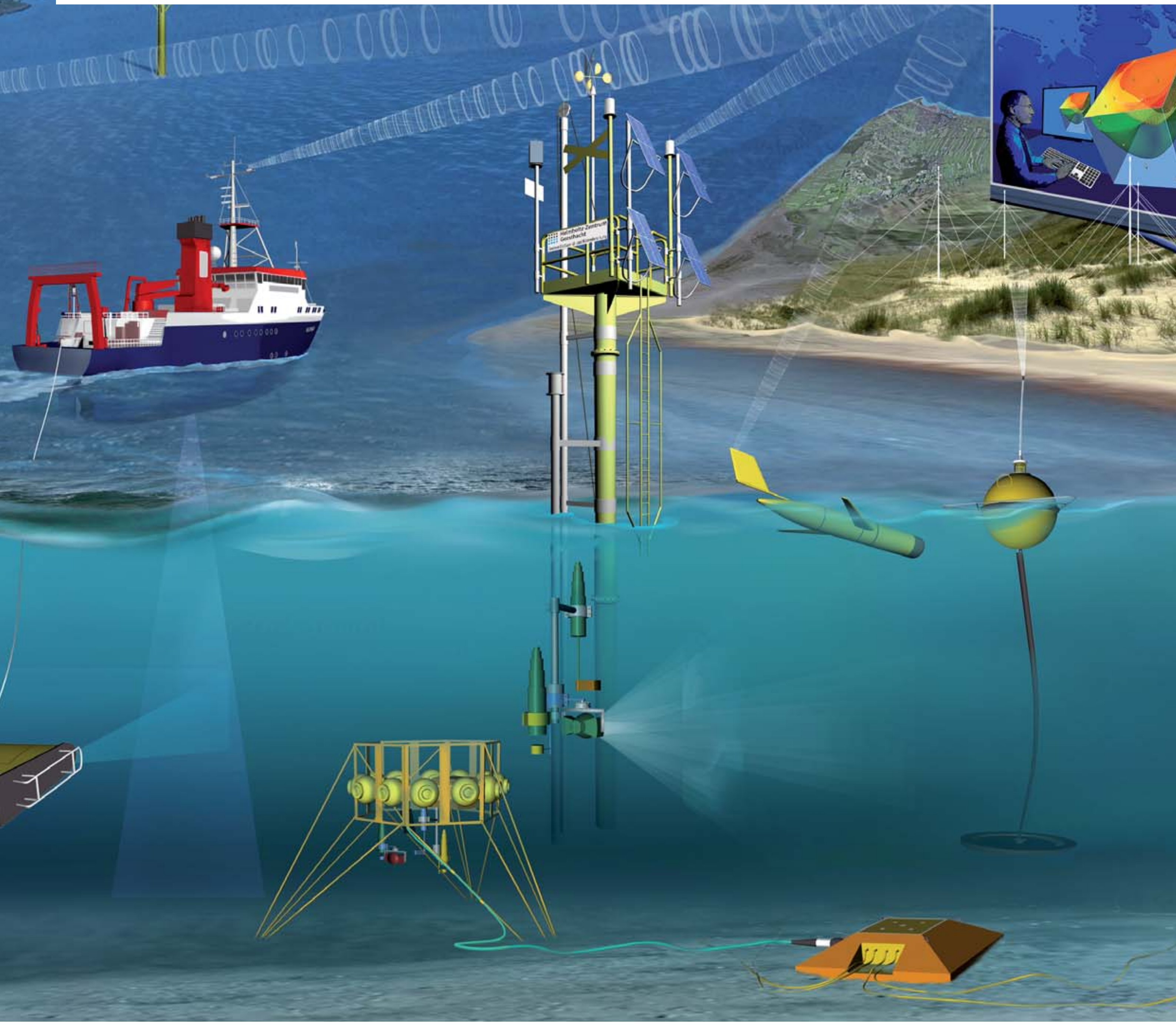
HELMHOLTZ-ZENTRUM GEESTHACHT

COSYNA
Progress Report 2010



COSYNA

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Content

Liebe Kolleginnen und Kollegen,

nun ist das erste Jahr der COSYNA-Aktivitäten vorüber und es ist Zeit, einmal Bilanz über die vergangenen Monate zu ziehen. Insgesamt waren wir recht erfolgreich und haben die für 2010 gesteckten Ziele erreicht.

Die routinemäßige Messung von COSYNA-Daten an den Pfählen und auf den FerryBox-Routen erfolgte ohne größere Probleme. Satellitendaten von MERIS wurden ebenfalls weiterhin routinemäßig in das COSYNA-Datenportal eingepflegt.

Verschiedene neue COSYNA-Stationen wurden aufgebaut (FerryBox Cuxhaven) bzw. stehen kurz vor der Fertigstellung (FerryBox FINO-3). Ein neues Sensorsystem (Scanfish) wurde erprobt und wird inzwischen routinemäßig auf Heincke-Fahrten eingesetzt. Als weiteres innovatives Trägersystem wurde ein Glider angeschafft und in ersten Einsätzen erprobt. Für das HF-Radarsystem wurde eine weitere Station auf Wangerooge in Betrieb genommen, so dass nun die gesamte Deutsche Bucht abgedeckt wird und routinemäßig Oberflächenströmungen alle 20 Minuten erhoben werden. Diese Beobachtungen werden nun in das 3D-Zirkulationsmodell GETM assimiliert und damit die Güte der Aussagen verbessert; Prognosen für 2 Tage sind inzwischen möglich. Damit haben wir das erste prä-operationelle COSYNA-Produkt erstellt: Routinemäßig sind nun zu jeder Stunde Strömungsfelder der Deutschen Bucht über das COASTLAB-Portal verfügbar. Insgesamt wurde dieses Portal ausgebaut und stellt nun die zentrale Datenanlaufstelle von COSYNA dar.

Sowohl die Datenassimilationsschemata als auch die hydrodynamische und Ökosystem-Modellierung wurden in wesentlichen Punkten verbessert.

Eine wesentliche Aufgabe im Jahr 2010 war die Festlegung von gemeinsamen Qualitätsstandards. Hierzu fanden mehrere Arbeitskreissitzungen statt, in denen ein abgestimmtes QS-Schema verabschiedet wurde, das eine Untermenge aus SeaDataNet ist.

Weiterhin wurde eine ganze Reihe von neuen Instrumenten bestellt (SedOBS, NuSOBS, hypOO usw.) und es wurde begonnen, neue Instrumente gemeinsam mit Firmen zu entwickeln bzw. fertig zustellen (MOKI, Nukleinsäuresensor). Bezüglich des Unterwasserknotens wurde ein Lastenheft erstellt und mit ersten Arbeiten zur Vorerprobung begonnen. Sammeleinrichtungen für Spurenstoffe (aktive & passive Sampler) wurden konzipiert und in die HZG-Fertigung gegeben. In diesem Vorwort sollen nicht alle Aktivitäten aufgezählt werden; schauen Sie bitte dazu in den Bericht. Ich glaube, dass wir auf einem guten Weg sind und dass es uns im Laufe des Jahres auch gelungen ist, die Zusammenarbeit zwischen den doch sehr heterogenen Gruppen zu intensivieren. Dazu haben Sie alle durch Diskussionen und Beiträge in den einzelnen Arbeitskreisen beigetragen. Nicht zuletzt wurde dies auch wesentlich vom COSYNA-Management durch den Aufbau und die Pflege eines Sharepoint-Servers unterstützt. Ein Ergebnis dieser gemeinschaftlichen Arbeit ist auch die COSYNA-Broschüre, die nun dieses Zusammenwirken nach außen darstellt. COSYNA wurde zudem durch eine Reihe von Vorträgen bekannt gemacht. Aber auch der Aufbau des CoastLab-Raums und die neue Website (März 2011) haben zur Außendarstellung beigetragen.

Lassen Sie mich an dieser Stelle allen danken, die zum Gelingen von COSYNA beigetragen haben. Ich wünsche uns für 2011 eine ebenso gute Zusammenarbeit und viel Erfolg!

Geesthacht, den 18.4.2011

First COSYNA Product / E. Stanev

Aims for 2010

The merging of numerical model and observations with data assimilation techniques is one of the key objectives in COSYNA. The aim for 2010 in this context was to develop a first version of a pre-operational product based on HF radar data. HF radar systems are able to provide information on ocean surface currents with high temporal and spatial resolution and can thus be used to improve state estimates obtained by numerical circulation models. First radar measurements acquired by the Wangerooge station have become available at the end of 2009. In 2010 additional measurements were provided by the station Büsum and later on by the third station at the island of Sylt. The focus in 2010 was on the implementation of the basic software infrastructure including data handling and pre-processing procedures and robust assimilation methods required for the continuous provision of integrated products.

Program Developments in 2010

The provision of a first version of an HF radar based pre-operational product achieved in 2010 required both substantial technical work and the development of dedicated assimilation procedures appropriate for the specific requirements in the German Bight. The following issues required most attention:

- The first necessary step was the implementation of basic data handling and pre-processing routines, e.g., reading and writing in netcdf format or interpolation of radar and model data to common spatial and temporal grids.
- The second step in the development of an integrated product was a joint statistical analysis of HF radar surface current measurements and co-located numerical model outputs. This was, e.g, done by comparison of tidal ellipses parameters associated with the dominating M2 tidal signal like major and minor axis, ellipticity or inclination.
- As part of the statistical analysis a neuronal network was applied to investigate spatial and temporal correlation scales. As an interesting by-product this investigation led to an efficient procedure for a 6 hourly forecast of surface currents based on the radar measurements alone.
- In the third phase an assimilation procedure was implemented which combines numerical model results and radar measurements using estimates for both forecast and observation errors. The integrated product consists of a re-analysis of the previous 12 hours, which is provided on a 1 km grid with 1 hour temporal sampling.

In the first development phase software was written in the high level programming language OCTAVE. For the pre-operational system the coding was done in FORTRAN90 in order to be compatible with systems run at operational services like, e.g., BSH.

Results (Highlights)

Regarding the pre-operational provision of integrated products the main results achieved in 2010 are:

- provision of 12 hourly re-analysis of surface currents in the German Bight based on a combination of numerical model results and HF radar data (COSYNA product 1)
- provision of a 6 hourly forecast of surface currents based on HF radar data alone

The product data are integrated into the COSYNA web portal and can thus be visualised as well as downloaded in netcdf format.

Figure 1 shows an example of a surface current field measured by the HF radar (left) together with the respective estimate obtained by combination of the observation with numerical model (right) for Jul 25, 2010, 9:00 UTC.

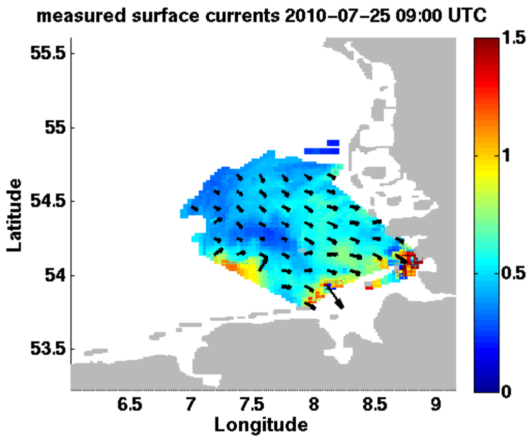
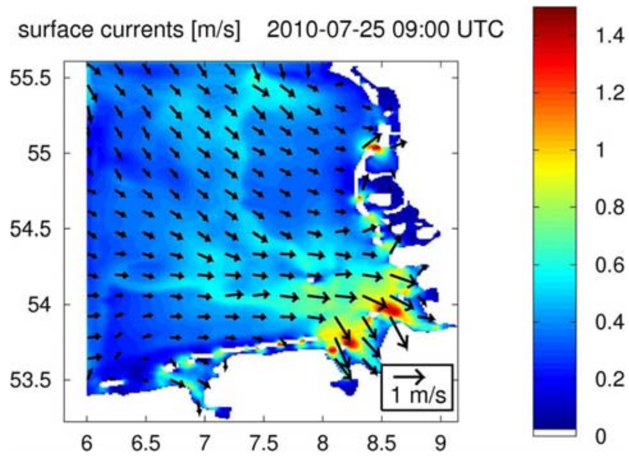


Fig. 1: a) Surface currents measured by the HF radar on Jul 25, 2010, 9:00 UTC.



b) Surface current field for the German Bight computed for the same time by a combination of the HF radar data with numerical model.

Problems

One of the key problems is the shortage of suitable in situ data urgently required for the validation of the integrated products. In particular, Acoustic Doppler Current Profiler (ADCP) data are essential for this purpose. These data are needed to

- fine tune the numerical model
- have a solid basis for the error models for the numerical model an the observations
- clarify some uncertainties about the thickness of the surface layer sensed by the radar
- provide reliable error estimates for the integrated product

First ADCP measurements have recently become available from the FINO-1 and FINO-3 station, but these are at the very edge of the area covered by the radar (FINO-3) or not covered at all (FINO-1). Furthermore the FINO ADCP data have large data gaps and are at the moment hardly suitable for a thorough statistical analysis.

Perspectives for 2011

In 2011 the work on the HF radar assimilation procedures will continue. In this context the focus will be on validation studies and the optimisation of an 12 hour forecast assimilation system. In parallel it is planned to develop a first version of an integrated product based on the assimilation of FerryBox data.

Publications

Schulz-Stellenfleth J., Wahle K., Staneva J., Seemann J., Cyseswki M., Gurgel K.W., Schlick T., Ziemer F. & Stanev E. (2010) Nutzung eines HF-Radarsystems zur Beobachtung und Vorhersage von Strömungen in der Deutschen Bucht im Rahmen von COSYNA, DGM, 10/3, pp 3-8.

Schulz-Stellenfleth, J. & Stanev E. (2009) Statistical assessment of ocean observing networks - A study of water level measurements in the German Bight, Ocean Modelling, Vol 33, pp 270-282.

Wahle K. & Stanev E. (2011) Consistency and Complementarity of Different Coastal Ocean Observations. A Neural Network-based Analysis for the German Bight, submitted to GRL.

Barth A., Alvera-Azcarate A., Gurgel K.-W., Staneva J., Port A., Beckers J.-M., Stanev E.V. (2010) Ensemble perturbation smoother for optimizing tidal boundary conditions by assimilation of High-Frequency radar surface currents - application to the German Bight, Ocean Science, 6, pp 161-178.

FerryBox / W. Petersen

Aims for 2010

- Continuous operation of three FerryBox systems aboard cargo ship and ferries respectively in the North Sea.
- Campaigns aboard research vessels with the FerryBox system
- Building up a stationary FerryBox in Cuxhaven (mouth of the Elbe River)
- Testing/optimization of new sensors for unattended operation within FerryBox systems
- Planning and developing of a stationary FerryBox on the research platform FINO-3 in the North Sea
- Data quality assurance of FerryBox data
- Scientific applications of FerryBox data

Technical Developments in 2010

- At different campaigns aboard RV Heincke new sensors for pCO_2 (company Contros, Germany), pH (PhD thesis S. Aßmann) as well as nutrients (SIA, HZG development C. Frank) have been successfully tested and optimized.
- The stationary FerryBox system in Cuxhaven has been installed and is operational since September 2010. Averaged (10min) and automatically quality checked data are transferred to the HZG database in realtime.
- The design and technical requirements for a FerryBox on the research platform FINO-3 have been defined and a complete system has been ordered. Installation will be in spring 2011.
- High precision pH sensor (PhD S. Aßmann) has been successfully tested on several campaigns aboard research vessels (FS Heincke, FS Polarstern).

Results (Highlights)

The routes operated within COSYNA in 2010 are shown in Fig. 1:

Fig. 1: Operated routes in the North Sea in 2010

Campaigns aboard research vessels

In 2010 the FerryBox system has been operated four times in the German Bight aboard the research vessel FS Heincke including continuous nutrient measurements. Fig. 2 shows as an example dates of temperature, salinity and pCO_2:

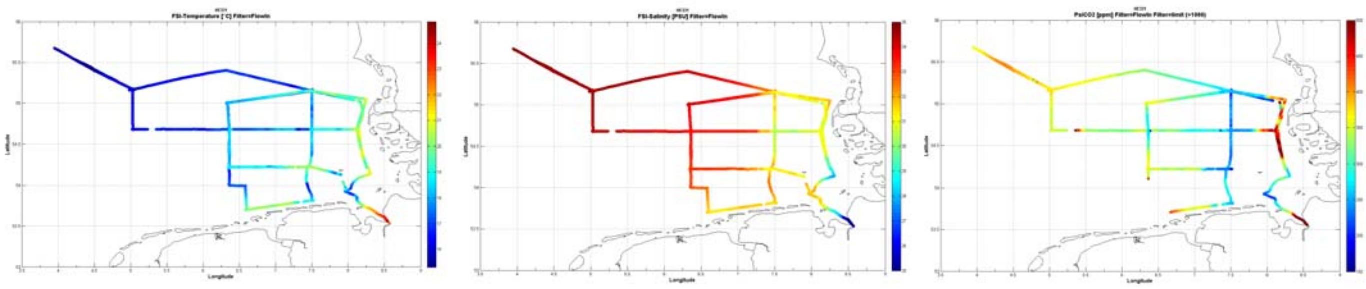


Fig. 2: Water temperature, salinity and pCO_2 measured by the FerryBox during a campaign aboard RV Heincke in ther German Bight in July 2010.

A FerryBox has been operated aboard the RV Pelagia during the BSH campaign monitoring the entire North Sea in August 2010 (Fig. 3)

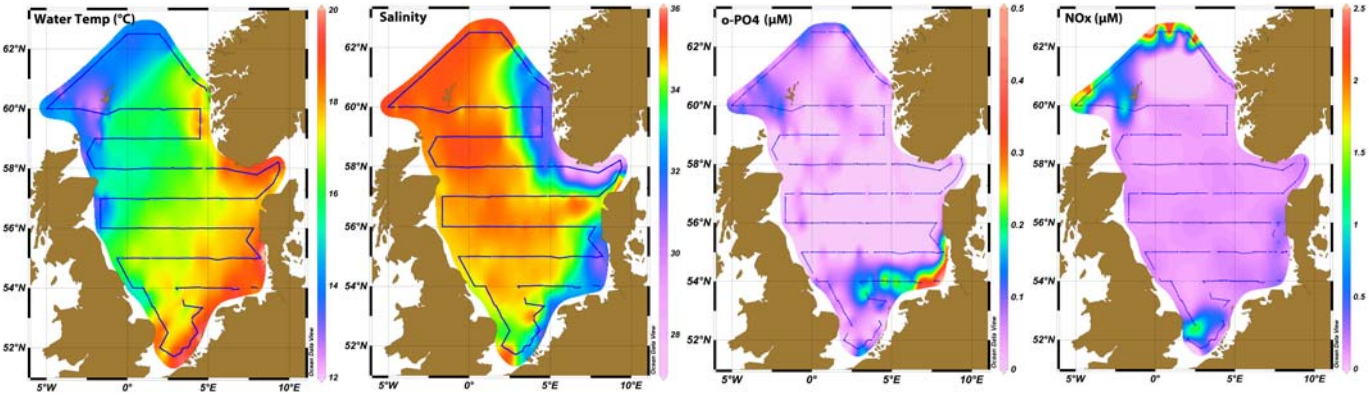


Fig. 3: Contour plots (water temperature, salinity, o-phosphate, nitrate+nitrite) from FerryBox data aboard RV Pelagia August 2010

Stationary FerryBox

Exemplary data from the stationary FerryBox system in Cuxhaven are shown in Fig. 4:

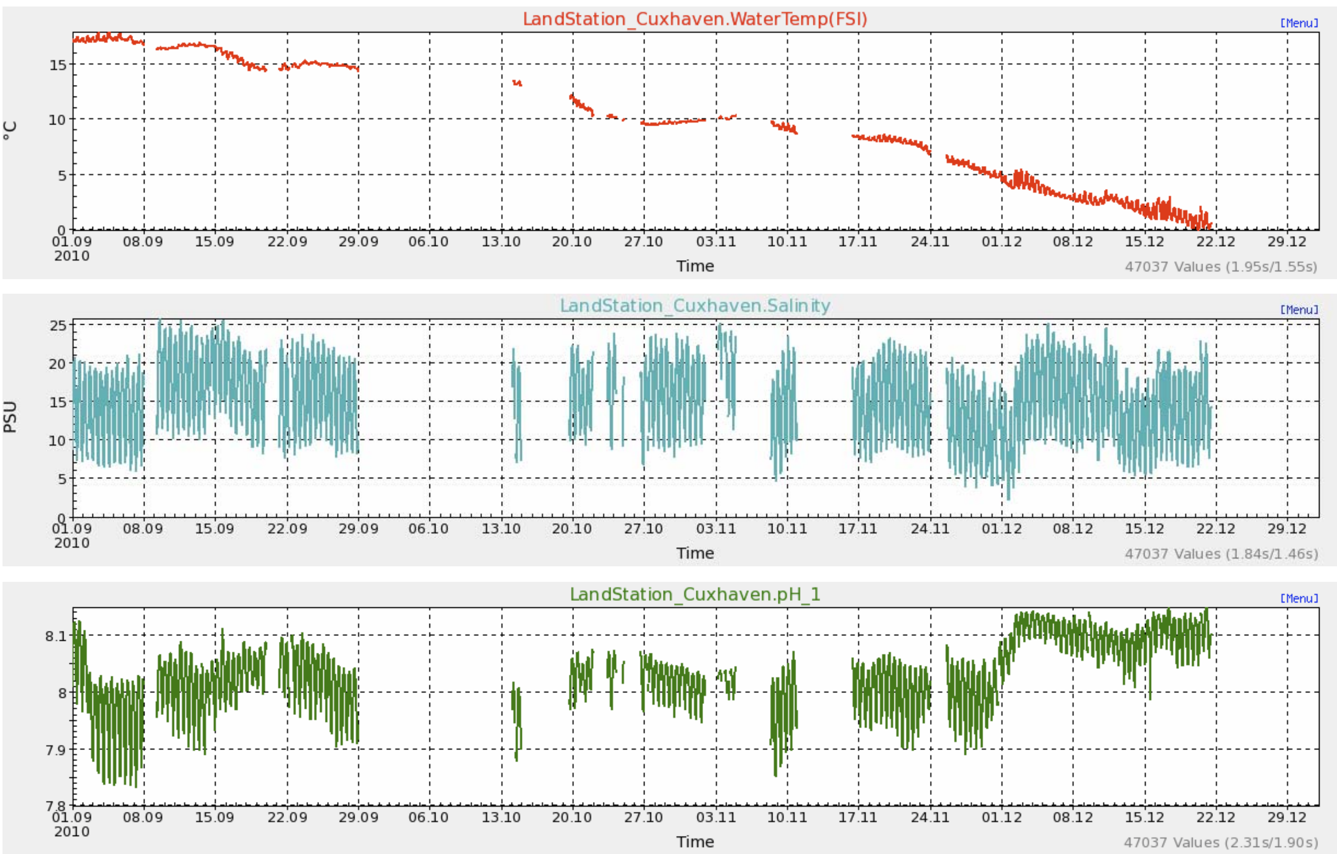


Fig. 4: Stationary FerryBox Cuxhaven: Time series of water temperature, salinity and pH from September to December 2010

Test and optimization of new sensors

In 2010 new types of sensors have been extensively tested during the ship campaign. Exemplary the comparison of two pCO_2 sensors (ProOceanus and Contros) and the correlation with the pH data are depicted in Fig. 5:

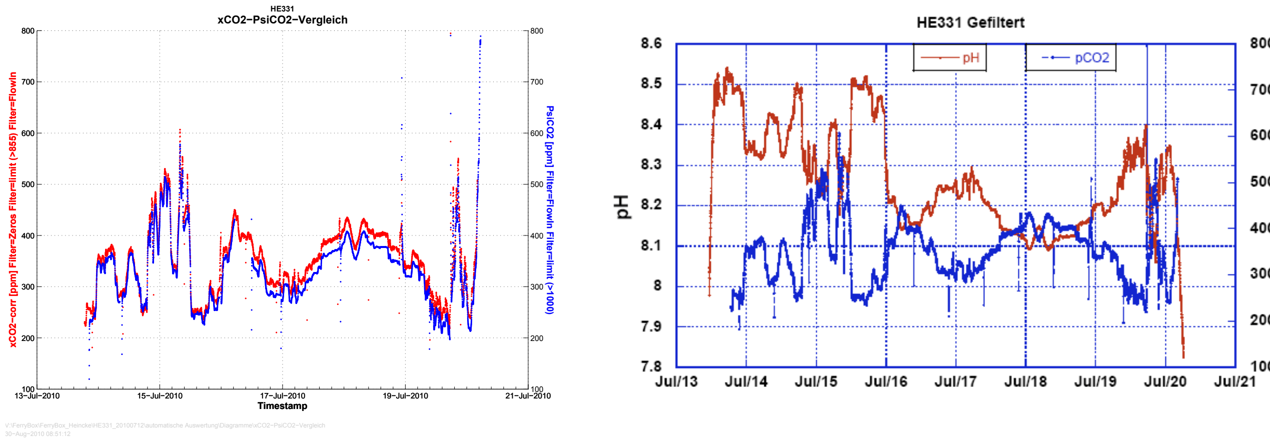


Fig. 5: Comparison of pCO_2 data measured by two different sensors and comparison of pCO_2 data with pH data (RV Heincke, July 2010)

Scientific applications

In 2008 a freshwater intrusion along the transect of the Cuxhaven – Immingham has been observed (Fig. 6). By investigation of a drift model (PELETS-2D) it could be shown that this water masses were probably transported from the Rhine River estuary (Fig. 7) in the days before (Petersen et. al. 2010).

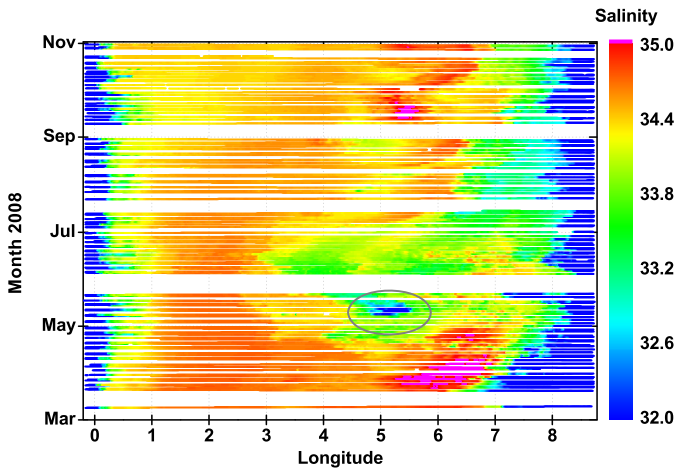


Fig. 6: Pooled salinity data along the Immingham to Cuxhaven transect in 2008. The grey circle indicates the time period in detail looked at

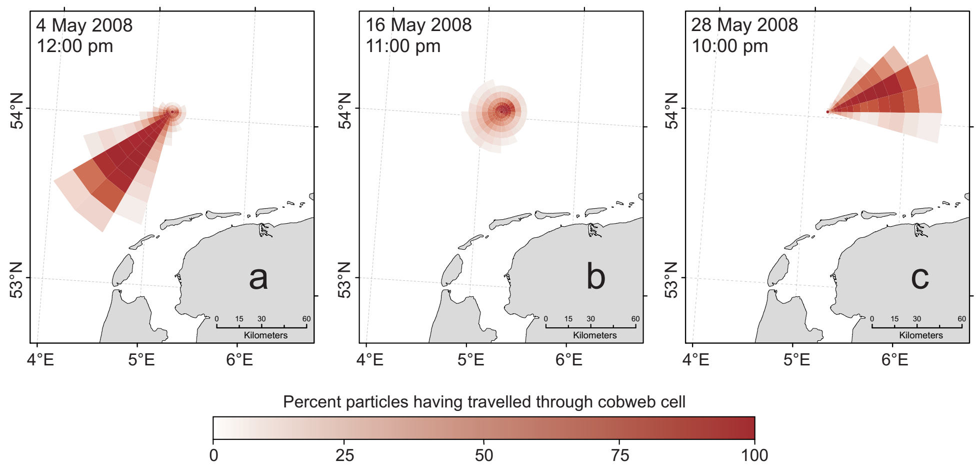


Fig. 7: Cumulative Travel History (CTH pattern) from three different Lagrangian particle transport simulations with PELETS-2D on 4th May (a), 16th May (b) and 28th May (c) (trajectories integrated over a 12 day period backward in time).

Problems

- Several technical problems with the FerryBox aboard TorDania lead to a reduced data set on this route in the first half of 2010.
- Changing of ship routes and/or ships is still an issue using voluntary ships as a platform. After recovering from the worldwide economic crisis in 2009 the vessel TorDania operated more or less continuously on the route Cuxhaven-Immingham. The vessel LysBris changed the route in 2010 again. Since April this vessel was on a new route going from Norway (Moss, Halden) - Germany (Hamburg) - England (Chatham) – Spain (Bilbao) – England (Immingham) – Norway on a fortnightly basis. This route covers a very large area now. However, in case of technical problems data are lost over a longer time because the system can only be maintained in Hamburg. Furthermore with a frequency of only every 14 days short term processes such as algal bloom cannot be detected with the necessary time resolution.
- Measuring nutrient is still a big issue. Aboard the vessel TorDania and LysBris automatic nutrient analysers from the company Systea (Italy) are operated. However these devices are still not robust enough for unattended long-term operations. Due to several measures the systems reached a higher stability but are still problematic. Thus, reliable nutrient data are still very patchy.
- The very limited personal capacity is still a big problem operating all FerryBox systems with the necessary care. Thus for instance quality control is often lagging behind due to personnel bottlenecks. As well as scientific evaluations and applications of the large amount of FerryBox data could be improved by employing additional PhD students and/or PostDocs.

Perspectives for 2011

- Continuation of regular FerryBox measurements aboard the three vessels
- Installation, test and continuous operation usage of the FerryBox on FINO-3
- Improvement of automated quality assessments
- Test and installation of new sensors/parameters (pCO_2, PSIcam, high precision pH and alkalinity sensor)

Publications

Frank C., Schroeder F. Petersen W. (2010) FerryBox: Using Automated Water Measurement Systems to Monitor Water Quality: Perspectives for the Yangtze River and Three Gorges Dam. Journal of Earth Science, 21, 861–869.

Petersen W., Schroeder F. & Bockelmann F.-D. (2010) FerryBox – Application of Continuous Water Quality Observations along Transects in the North Sea, submitted to Ocean Dynamics.

Aiken C., Petersen W., Schroeder F., Gehrung M. & Ramirez von Holle P. (2010) Ship-of-Opportunity Monitoring of the Chilean fjords using the pocket FerryBox, submitted to Journal of Atmospheric and Oceanic Technology.

Wadden Sea Poles / G. Flöser/R. Onken

Aims for 2010

Three poles were planned to operate in 2010: poles JADE1 and JADE2 in the Jade estuary, and pole HOERNUM1 in the Hörnum tidal basin. While the JADE poles were intended to remain in service during the winter 2009/2010, HOERNUM1 was dismantled in December 2009 and re-erected in April 2010. Unscheduled, the instrumentation of JADE1 had to be removed in January 2010 because of icing, but it was reinstalled in March when the ice was gone. By contrast, JADE2 was severely damaged by the ice drift and was demolished in January, leaving only one pole station in the Jade Bay.

Technical Developments in 2010

The biologically relevant sensors for O_2 saturation, pH and fluorescence were installed in all three pole stations (Hörnum [in March], Jade1 and Jade2 [in May]) in spring 2008. The O_2 sensor worked properly from the beginning, with no problems except biofouling. With the fluorescence sensors there were some problems with high variability in sensor sensitivity and the automatic switching of the sensitivity range. It turned out that the optical setup in otherwise identical sensors was not the same. We had the optics replaced by identical ones in all sensors, and set the sensitivity range to minimum so that all sensors now are able to detect values corresponding to 200 µg/L chlorophyll. The sensitivity of the sensors varies – although identical if calibrated with chlorophyll in acetone in the lab – in seawater still by a factor of ~2, so that each sensor should be calibrated before and after use with seawater samples.

The pH sensors do not work properly on board the pole stations. The values vary between 7 and 12, sometimes within a very short time range. A particular problem seems to come from the maintenance actions, because after cleaning the sensor needs two days to reach a constant signal level. The first guess was that the high impedance at the sensor's output is the problem, therefore we separated all direct contacts between sensor and pole station. The signal behaviour did not improve, however. The assumption now is that the sensor is influenced by electric fields in the immediate surrounding of the pole station, which, if it is true, would not be easy to solve. In spring 2011 we intend to make dedicated field measurements in order to find the origin of the problem. There are, however, the pH values taken during maintenance actions by hand-held instruments which can be used for scientific purposes.

At the end of the year, we can look back on 2.5 years of O_2 values, about 2 years with fluorescence values, but no pH data.

Results (Highlights)

Although not all the biological parameters were available as highly resolved time series, important ecosystem phenomena can be observed (Figure 1 and 2). The spring bloom is visible as maximum in fluorescence, oxygen and also in pH albeit with poorer temporal resolution. The tidal oscillation is very clear and in summer much stronger than in winter; even a spring-neap tide pattern can be discovered.

This hints to a spatial gradient which is transported along the pole with the tidal currents. Averaged over the year, we also find that the oxygen saturation as well as the pH is higher in Hörnum than in the Jade Bay, a phenomenon which may be due to the higher suspended matter content in the Jade Bay. Higher SPM concentration leads to lower light intensity in the entire water column and thus to lower primary production and/or higher organic matter degradation, both leading to lower oxygen concentration. All these hypotheses remain to be confirmed.

Perspectives for 2011

In 2011, a field campaign shall help to solve the problems with the pH sensor.

During winter, a storing CTD will be installed at the seafloor instead of the pole station. The experience of the last two cold winters shows that it is too risky to keep the poles running over winter. The O_2 data are valuable for a long-term frequency analysis.

Publications

Flöser G., Burchard H. & Riethmüller R. (2011) Observational evidence for estuarine circulation in the German Wadden Sea, Continental Shelf Research, submitted.

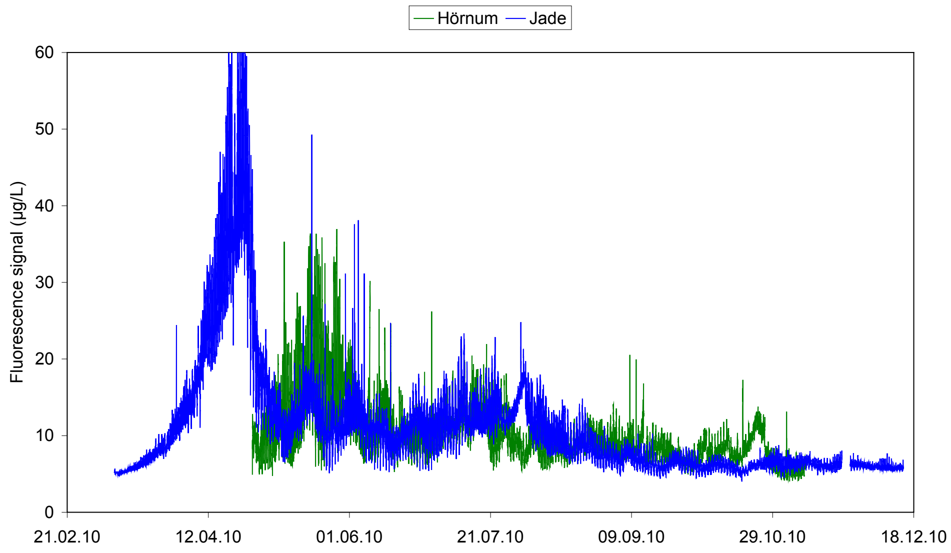


Fig. 1: Fluorescence time series for both Jade and Hörnum pole stations in 2010. The spring bloom in mid-April is very well visible, and the stronger tidal oscillations in summer with respect to winter.

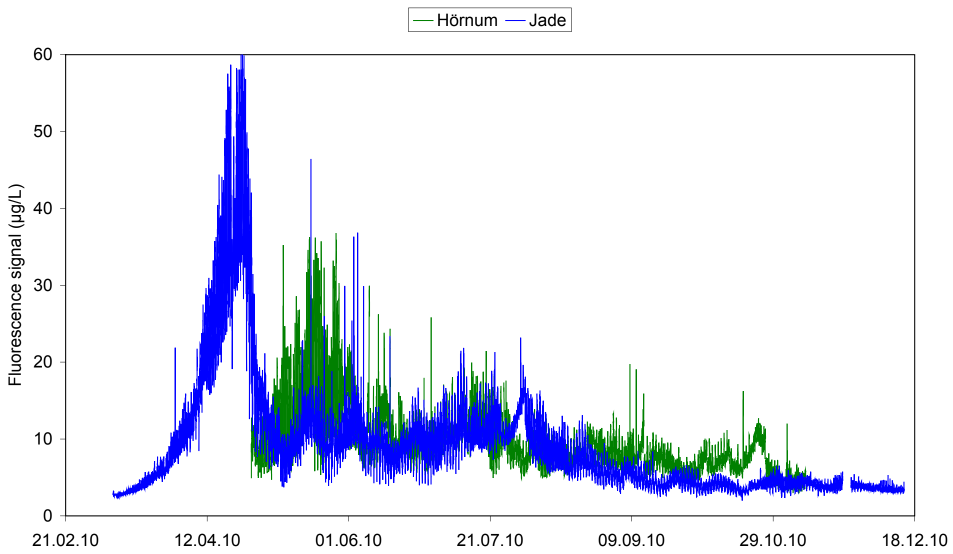


Fig. 2: Time series of oxygen saturation and pH values (not from the pole sensors, but from handheld instruments during maintenance). The spring bloom (cf. Figure 1) also has effects on both pH and O_2, and in O_2 the higher oscillation amplitude in summer can clearly be seen. It is also evident that the pH in the Hörnum basin is always higher than in the Jade Bay.

HF Radar / F. Ziemer

Aims for 2010

- Mounting respectively adapting the three coastal HF-Radar stations: Wangerooge, Büsum and Sylt.
- Tests of the functionality of the HF techniques.
- Setup of the network for the pre-operational real time monitoring.
- Setup of the data processing to produce 2D current vector maps.
- First quality checks.
- Preparation of the geophysical validation.

Technical Developments in 2010

- Installation of the real time monitoring network by integrating the OUTPUT of 3 HF radar field stations Wangerooge, Büsum and Sylt.
- Installation of the software that produces netCDFs of the surface current field within the German bight every 20 minutes.
- Set up of workflows for ADCP validation data

Results (Highlights)

- August 2010: Installation of the HF-network and the network-node at HZG for the continuous real time observation of the surface current field within the German Bight acquired by HF-radar.
- Successful integration of post-processing software for validation data (ADCP).

Problems

- The cut through of the transmitter antenna cable at Wangerooge caused a shut down of the full HF system, because this station was defined as Master within the vector calculation network.
- High humidity inside the station “Büsum” led to a shut down of the station. The repair measures lasted about 2 weeks.

Perspectives for 2011

- Start of the geophysical validation by collocating in-situ measurements of the surface current field and HF observations.
- Set up of workflows for HF- and microwave radar data

Publications

Book chapter

Flampouris S., Seemann J., Senet C. & Ziemer F. (2011) Storm impact on the coastal geomorphology and current field by wave field image sequences. In: Advances of Hydrological Remote Sensing for Monitoring Global Changes. Editors: Ni-Bin Chang and Yang Hong, John Wiley & Sons. In reviewing process.

Peer reviewed paper

Flampouris S., Seemann J., Senet C. & Ziemer F. (2011) The influence of the inverted sea wave theories on the derivation of coastal bathymetry. IEEE - Geoscience and Remote Sensing Letters, vol. 8, p. 5, 2011.

Conferences

S. Flampouris, J. Seemann & F. Ziemer; Radar observations of wave field in littoral zone, IGARSS, Hawai, 25-30 July 2010.

S. Flampouris, J. Seemann & F. Ziemer; Observation of littoral hydrodynamics by ground based Dopplerized X-band Radar;, Ocean Sciences Meeting, Portland 2010.

S. Flampouris, J. Seemann & F. Ziemer, 8216; Determination of the storm impact on the coastal bathymetry based on radar image sequences’ Pan Ocean Remote Sensing Conference - PORSEC 2010, Keelung, Taiwan, 18-23 October 2010.

K.W. Gurgel, T. Schlick, J. Seemann, F. Ziemer & G. Vulgaris (2011): HF Radar Observations in the German Bight: Measurements and Quality Control, Proceedings; CMTE 2011 Monterey USA.

Remote Sensing / R. Doerffer, H. Krasemann, R. Röttgers

Aims for 2010

- Improvement of atmospheric correction of MERIS over coastal water
- Sampling of in situ data for improvements of bio-optical model
- Measurements of scattering phase functions with new scatterometer
- Continuous flow PSICAM (point source integrated cuvette absorption meter)

Technical Developments in 2010

A new instrument to measure the scattering phase function of particulate matter in water has been developed (PhD work by H. Tan).

A new sun photometer was put into operation at Büsum and integrated into the international Aerosol Robotic Network (AERONET). It measures also the polarised components of solar and sky radiance.

The prototype of the continuous flow PSCICAM (point source integrated cuvette absorption meter) was successfully tested. The operational version for integration into the FerryBox is under development. It will be used to monitor different functional types of phytoplankton by their absorption spectra.

The prototype of the capillary absorption meter for measuring coloured dissolved organic matter (CDOM) has been developed and tested. The operational version will be integrated into the FerryBox.

Results (Highlights)

- Water radiance model finished
- Neural Network based algorithms for atmospheric correction and retrieval of coastal water properties were designed for OLCI on SENTINEL-3 and accepted by ESA.
- Hyperspectral absorption spectra of different phytoplankton species as the basis for ENMAP algorithms
- New compilation of inherent optical properties (IOPs) of North Sea water from different seasons, which is now based on 9 cruises

Supporting externally funded projects:

- ESA Water radiance project
- ESA Coastcolour project
- ESA Climate Change Initiative Ocean Colour ECV
- ESA SENTINEL-3 algorithm development
- EU Primary Production Project PROTOOL
- DLR Raumfahrtagentur ENMAP Development
- WIMO, Verbundprojekt Wissenschaftliche Monitioring Konzepte für die Deutsche Bucht, funded by the government of Niedersachsen

Problems

An angular dependent problem in the atmospheric correction for MERIS was detected, a work around was developed and integrated in BEAM, further tests are needed.

Some problems evolved in the transmission of data from the spectrometer system, which is installed on the platform FINO-3. It is nearly solved. Furthermore a diagnosis system is required for remote control of the data quality.

Perspectives for 2011

- Advanced algorithms, which include temperature and salinity effects of pure water concerning absorption, scattering and refractive index
- Adaptation and validation of MERIS regional algorithms for coastal waters on a global scale incl. Arctic regions.
- Measurements of bio-optical variables in Lena River mouth for COSYNA Arctic

Publications

Burjack I. (2010) Analyse der Schwebstoffverteilung in der Deutschen Bucht mit dem Satelliteninstrument SEVIRI. Bachelorarbeit im Fachbereich Geoinformatik / Geophysik an der TU Bergakademie Freiberg.

Müller D. (2010) Geostatistische Analyse der Chlorophyllverteilung in der Nordsee basierend auf MERIS-Satellitendaten. Dissertation Fachbereich Geowissenschaften der Universität Hamburg.

Glider / R. Onken, L. Merckelbach, R. Kopetzky, A. Werner, B. Peters

Aims for 2010

The first shallow-water SLOCUM glider (named Amadeus) was acquired from Teledyne Webb Research in 2009. During fall of that year, the necessary infrastructure (glider laboratory with ballast tank, crane, internet access) was set up. First tests and longer missions were planned for the upcoming year.

Technical Developments in 2010

Due to the extraordinary long winter, the first outdoor test took place in June 2010 on a test range of the German Navy in the Eckernförde Bight (Baltic Sea). However, the test failed from the outset because of the malfunction of the ballast pump. The pump was shipped for repair to Teledyne Webb and thereafter in September the glider passed the inital tests. In order to verify the communication with the glider and its behaviour in extremely shallow water, another test was performed in October, again in the Baltic Sea. It turned out that the glider can be operated in water depths not shallower than about 10 m. The first long-term mission was planned for November/December, but this had to be cancelled because of the early onset of winter and was rescheduled for 2011. A second SLOCUM glider Sebastian was acquired in December. Furthermore, a so-called dockserver was set up, which the glider can connect to via a satellite link. Via this server, data can be downloaded from the glider whilst in mission and new commands can be sent to the glider.

Results (Highlights)

In February 2011, Amadeus performed its first long-term mission of about 15 days in the German Bight. It was launched on February 9 about 4 miles north of Helgoland, heading northwest according to schedule (see Fig. 1). After one week, Amadeus commenced its return trip to the launch position, where it was recovered successfully on February 24.

Data collected during this mission are shown in Figure 2. The upper panel shows salinity, computed from the CTD's conductivity, temperature and pressure for a two-day period around 12 February. Due to strong mixing as a result from currents and windforcing and lack of a thermocline (as it was winter), most of the time the water column is well-mixed. Around 12 February, however, the glider crossed a front. The top panel shows the detailed recordings of the horizontal and vertical gradients in salinity at the location of the front. The bottom panel shows the concentrations of chlorophyll-A for the whole mission period. Because of the winter season, the concentrations are low. During the course of the mission, some variability in chlorophyll is observed. Further analysis should distinguish between geographical and temporal effects.

Fig. 1: The track of glider Amadeus on its first successful mission.

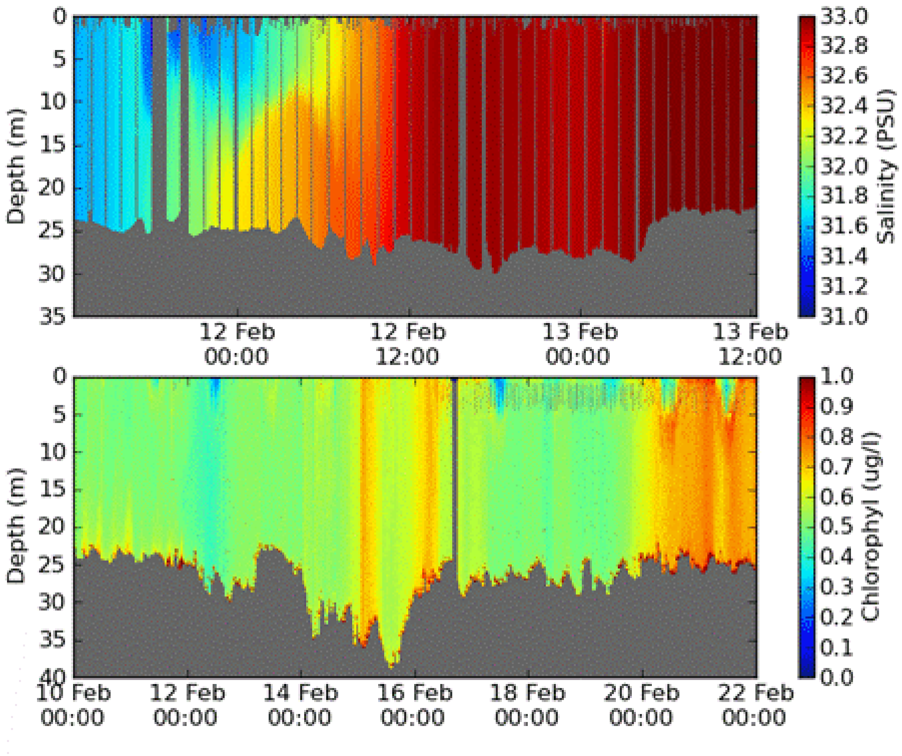


Fig. 2: Measured salinity (top panel) and chlorophyll-a (bottom panel).

Problems

The only problem that caused a serious set-back was that the buoyancy pump of the glider had not been functioning properly since the delivery. Unfortunately, this had gone unnoticed during the preparation and caused the first test mission in June to fail. Although the pump was repaired under warranty and with priority, long delays caused by administrative issues with customs meant that the glider was ready for testing not before October 2010.

Perspectives for 2011

After a successful long-term mission in Ferbruary 2011, the second glider Sebastian will be subjected to initial tests in the Baltic Sea by the end of March. A second long-term mission is planned for April. The plan is that the two gliders will be deployed from the Heincke cruise that takes place in the beginning of April. A transect between the measurement stations Nordsee Boje III and Deutsche Bucht are foreseen. The recovery will most likely be done near Helgoland. Based on the evaluation of the results, in terms of both scientific data and operational aspects, plans will be made for follow-up mission. These missions will still have the character of a pilot project, i.e. operational use of gliders is not foreseen in 2011. These pilot missions should identify how well gliders cope with the tidal currents, which kind of hardware/firmware problems occur on the glider platform and how to handle them automatically, and how to set up the sample strategy, for example.

SCANFISH / R. Riethmüller, H. Rinck, H. Thomas, R. Kopetzky, J. Su, K. Wirtz

Aims for 2010

- Routine operation during the four RV Heincke Surveys in the German Bight
- Adaptation of the system onboard RV Ludwig Prandtl
- Test and implementation of the “Sampling-Calibration-Profiler” SCP
- Processing of ScanFish data (no QC) during the surveys to generate space-time patterns of observations as a first step for near real-time processing
- GUI-based software for delayed processing and QC by the technical staff
- Development of intercalibration schemes with other COSYNA platforms
- Use of the data for model and data assimilation scheme testing and validation
- Preliminary analysis of the 2009-data for building hypotheses on the phytoplankton growth and decomposition

Technical Developments in 2010

- Successful operation during the four German Bight surveys with RV Heincke. Collection time covered more than 95% of the survey period
- Implementiation and test of Scanfish and SCP onboard Ludwig Prandtl were implemented almost successful; adding vertical observations to FerryBox data onboard the ferry Funny Girl on transects between Büsum and Helgoland
- Improvement of mechanical stability of the system at towing speeds up to 10 knots

Results (Highlights)

Water masses: Taken the surveys from 2009 (Mai, July, Sep) and 2010 (Mar, May, July) together, one observes the well-known increase of fresh water influence towards the coasts. In spring and autumn, nearly no stratification was observed. Observations in T/S diagrams were confined within triangles (Fig. 1). Following Becker et al. (1983), linear mixing of three water bodies (Estuarine-EST, North Sea surface-NSS and North Sea bottom-NSB) was applied. Fig. 2 shows an example for a highly stratified situation from July 2010. In the North-Western edge of the surveyed area, even three layers of water bodies with different admixtures of NSS/NSB waters were observed. The change in water temperature here was nearly 10 oC within one meter. Interestingly, NSB water is mixed over the whole water column at the deep hole south of Helgoland, a feature also observed at other situations of pronounced stratification.

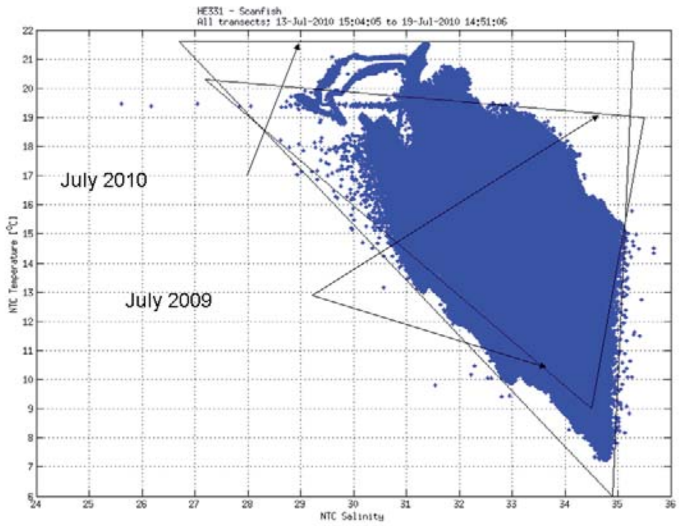


Fig. 1: T/S diagram Scanfish July 2010

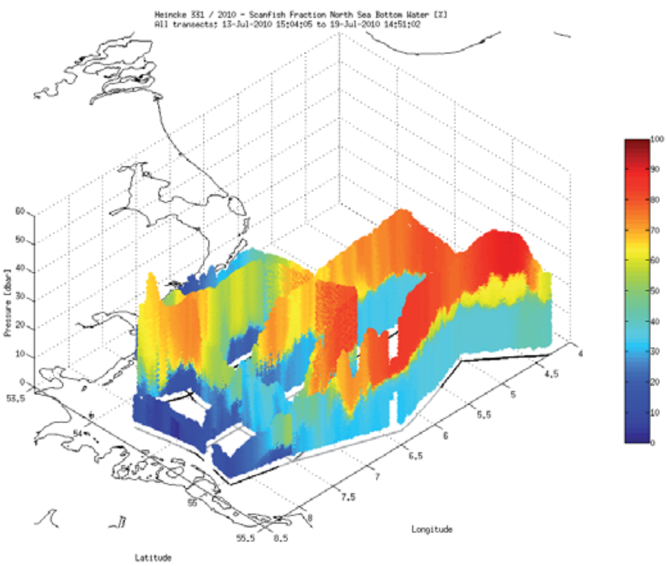


Fig. 2: Fraction of NSB Water in the German Bight, July 2010

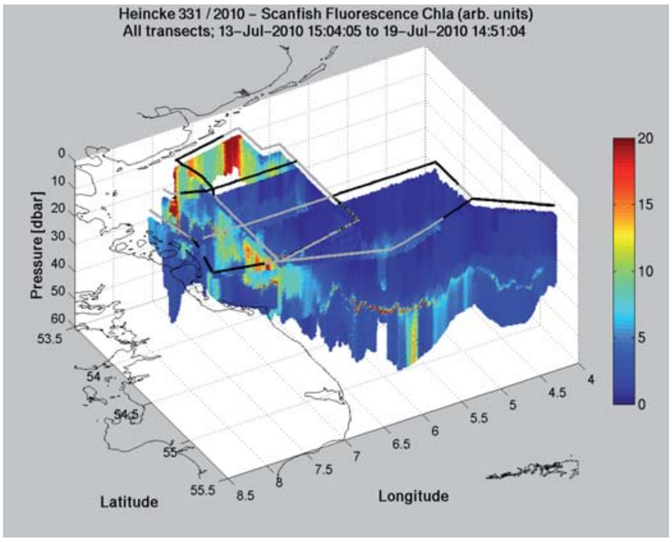


Fig. 3: Fluorescence Chl-a in the German Bight, July 2010

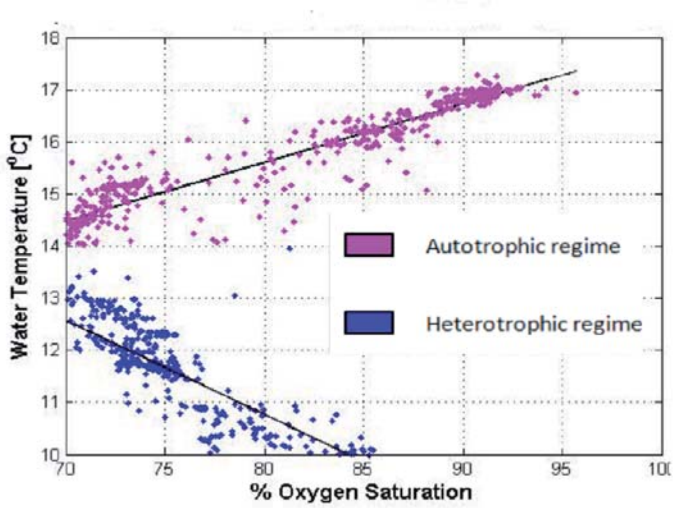


Fig. 4: Water temperatures vs. oxygen saturation for water depth >35 m, July 2009

Fluorescence of Chl-a was often not observed at the surface but in deeper layers. In July 2010 it was confined to a narrow 1m thick band along the lower thermocline (s. Fig. 3), an optimal position to do still photosynthesis and at the same time having access to higher nutrient waters, as indicated by 1-dim model calculations (K. Wirtz, personal communication). By investigating oxygen saturation and fluorescence regimes autotrophic and heterotrophic regimes could be identified in the July 2009 survey (s. Fig. 4) below 35 m water depth (Charpentier, 2010). The heterotrophic regime was confined to the NSB waters that on the other hand had much higher concentrations of chlorophyll than the overlaying NSS waters. These patterns indicate the existence of NSB water specific processes and will be further explored by analysing other surveys.

Problems

- Wire guidance and interaction of motor & brake on both the winches
- Time lag response of sensors especially at thermoclines
- Routine 24 hour operation requires a lot of personnel (3 per campaign)

Perspectives for 2011

- Integration of Scanfish data and metadata into coastlab dataportal
- Generation of QC data sets for selected campaigns
- Intercalibration procedures with FerryBox and Profiler systems established Real-time processing with pre-operational filters
- Routine use of profiler to collect samples with improved power supply (single wire) for the sampling devices on the profiler

References

Becker G. A., Fiúsa A. F.G., James I.D. (1983) Water Mass Analysis in the German Bight during MARSEN, Phase I. J. Geop. Res., No. 14, Vol. 88, 9865-9870.

Charpentier S. (2010) Statistical Analysis of Scanfish Data in the German Bight, Personal Laboratory Project ENSTA 2011 (Internal Report).

Active and Passive Samplers for Pollutants / A. Prange, D. Pröfrock, J. Gandraß

Location Cuxhaven

Aims for 2010

The aim for 2010 was to plan and setup the sampling infrastructure. This would allow us to test the system already during the winter month regarding its mechanical stability during storm events or ice drift and how it is affected by fouling.

Technical Developments in 2010

The main technical developments in 2010 were focused on planning and realizing a sampling platform at the "Seebäderbrücke" in Cuxhaven, which allows an easy deployment and sampling of the active and passive samplers. The platform has been realized close to the Cuxhaven FerryBox, which provides important data such as temperature, salinity or current. The idea of a sampling system has been developed in close cooperation with the HZG Technikum, which allows the parallel deployment of active and passive samplers.

Problems

Problems occurred in particular during the planning and realization of the sampling system due to time delay.

Perspectives for 2011

The HZG workshop scheduled the finishing of the sampling infrastructure for the end of March. It is planned to install the sampling devices during April/May at Cuxhaven and to deploy the first active and passive samplers. Until the end of 2011 the infrastructure should be tested under real world conditions to allow redesigning if necessary. A first set of samples will be generated.

Fig. 1: Working platform and sampling device for the Cuxhaven location

Location Helgoland

Aims for 2010

The aim for 2010 was to plan and setup the sampling infrastructure, which will be installed on one tetrapod located within the TN 10 field of "MarGate". This would allow us to test the system already during the winter month regarding its mechanical stability during storm events and how it is affected by fouling.

Technical Developments in 2010

The main technical developments in 2010 were focused on planning and realizing an underwater sampling platform, which could be installed on the head of a Tetrapod within the TN 10 field of "MarGate". The aim was to develop a system, whose main parts are interchangeable with the sampling device of the station at Cuxhaven.
Divers will perform the deployment and sampling at the Helgoland station. The idea of the sampling system has been developed in close cooperation with the HZG Technikum allowing a parallel deployment of active and passive samplers. The preparation of the Tetrapod (hole drilling, installation of the anchor points) has been already realized in collaboration with the AWI diving group (P. Fischer).

Problems

Problems occurred in particular during the planning and realization of the sampling system due to time delay.

Perspectives for 2011

The HZG workshop scheduled the finishing of the sampling infrastructure for the end of March. It is planned to install the sampling devices during April/May at Helgoland and to deploy the first active and passive samplers. Until the end of 2011 the infrastructure should be tested under real world conditions to allow redesign if necessary. A first set of samples will be generated.

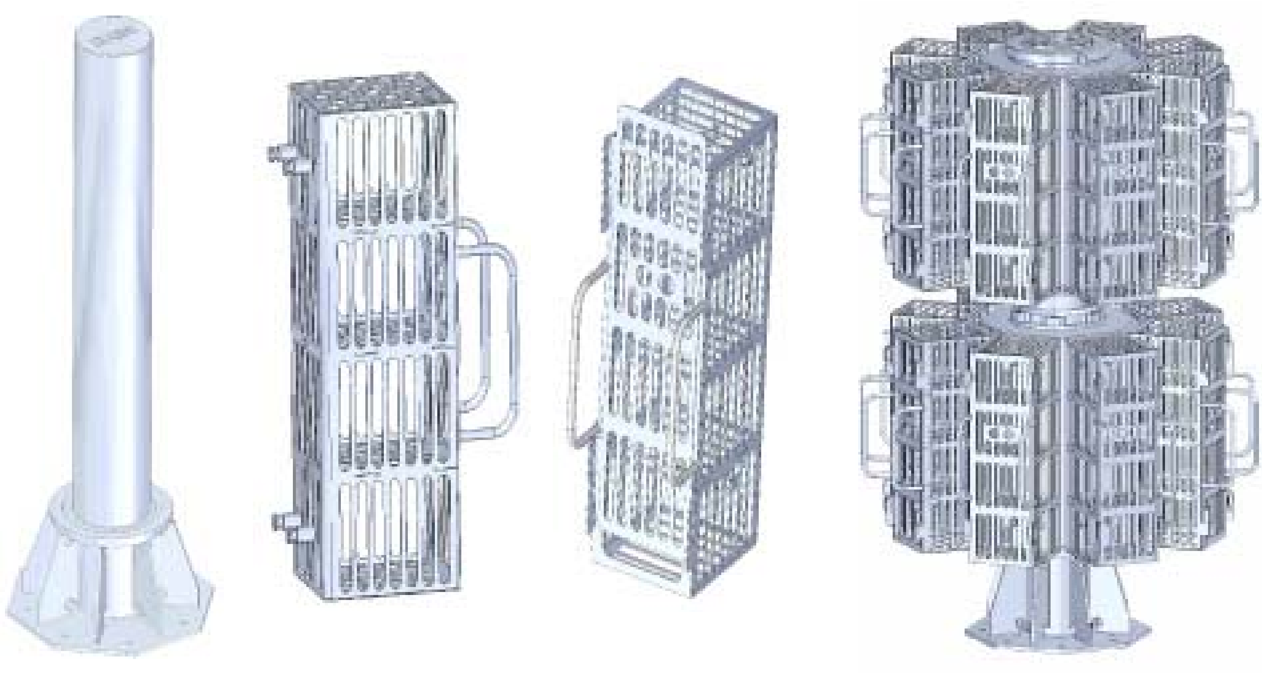


Fig. 2: Properties of the sampling device for the Helgoland "MarGate" position

SedOBS / C. Winter

Measurement Strategy within COSYNA

The working group "Near bed measuring systems" of COSYNA is a cooperation of MARUM Uni Bremen, FTZ-Westküste Uni Kiel, Bundesanstalt für Wasserbau, AWI-Sylt, Senckenberg Institut Wilhelmshaven, IfBM Uni HH, AWI-Bremerhaven, and IMARE Bremerhaven.

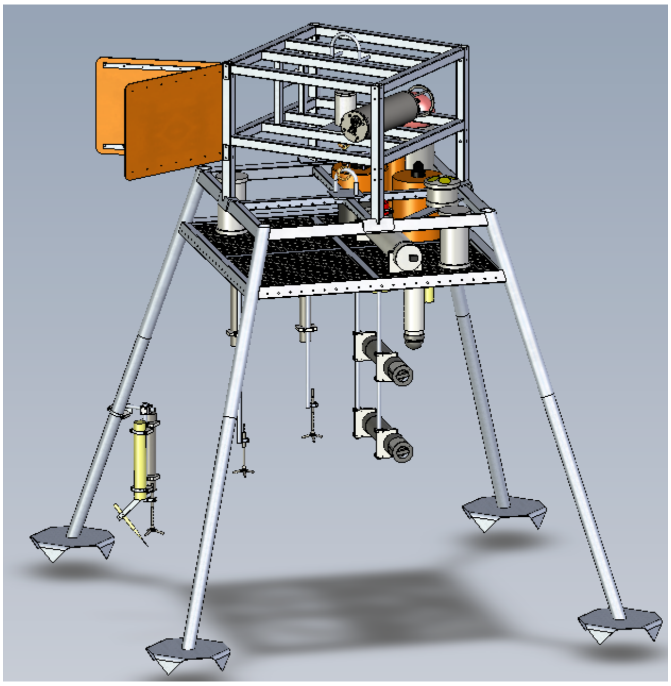
Within the project COSYNA the working group addresses the topic near bed processes with a focus on the spatial variability of bed roughness and its effect on the local hydrodynamics, sediment dynamics and various biogeochemical processes. These processes constitute important parameters in the understanding and numerical modelling of shallow water systems. In the first phase of COSYNA two reference lander systems are designed and set-up: NuSOBS, the nutrient observation system and SedOBS, the sediment dynamics observatory.

The SedOBS Lander aims at a high resolution and synoptic measurement of the COSYNA standard parameters and additional physical properties. A variety of sensors for the detection of biogeochemical parameters (temperature, salinity, oxygen, pH), water turbulence, current velocity, sedimentology, and morphology in combination with acoustic measurements of the underwater sound have been evaluated and combined in a lander system with a dedicated deployment and recovery strategy.

Ordering of instruments

The SedOBS system is built up by a launcher and lander, and several autonomous sensors. At this stage the following items have been ordered:

1. KUM Lander
2. KUM Launcher
3. TRDI ADCP Model WHM600; Current profiles, Waves over lander
4. TRDI ADCP Model WHMZ1200; Current profiles below lander
5. Nortek Vector Velocimeter; Turbulence near the bed
6. LISST 100X; Particle size dynamics
7. Sea- and Sun CTD; COSYNA base parameters pressure, temperature, conductivity, chlorophyll, pH, turbidity, oxygen
8. UNISENSE Eddy Correlation; Oxygen dynamics, primary production
9. MarineElectronics 3D Profiler; Micro-bathymetry and bed roughness
10. IMAGENEX Scanning Sonar 881A; Morphology of the environment
11. Noise Logger; Autonomous UDAQ system



NuSOBS / J. Friedrich, O. Zielinski

Aims for 2010

Nutrient and Suspension Observatory team: Kay Emeis, ZMAW (Mc Lane Samplers), Michael Schlüter & Jana Friedrich, AWI (Lander frame, flux chambers, CTD), Oliver Zielinski, IMARE (Nitrate and DOM dynamics)

In 2010, the NuSOBS team, in collaboration with potential manufacturers, aimed for designing the observatory and for providing respective offers of instrumentation to HZG for commissioning. It had been planned to start manufacturing the lander frame and the commissioning of instruments in 2010.

Measurement Strategy within COSYNA

The goal is the development and testing of an autonomous seafloor-based observatory for time-series measurements of

a) dynamics of suspended particulate and dissolved organic matter
b) dynamics of nutrients and oxygen in the near-seafloor water column
c) sediment-water fluxes of nutrients and oxygen consumption
d) nutrient dynamics within the sediment

The NuSOBS observatory will eventually allow to quantify benthic nutrient budgets and to estimate the role of the benthic-pelagic coupling at selected locations within the German Bight.

The observatory/benthic lander system will provide the following COSYNA parameters:
Category 1 - water temperature, salinity, currents, turbidity, oxygen in the bottom water
Category 2 - biogeochemical parameters like pH, nutrients, alkalinity in the bottom water and TOC, DOC, TIN, TON, sediment-water fluxes of oxygen and nutrients, porewater profiles of oxygen and nutrients, and suspended particulate matter in the bottom water

Ordering of instruments

Following discussions in the NuSOBS team, HZG-COSYNA representatives and the KUM Company, we agreed to operate in separate frames

a) the McLane Phytoplankton Sampler and McLane Remote Access Filtrate Sampler for suspended particulate and dissolved organic matter
b) the two benthic flux chambers for measurement of benthic nutrient and oxygen fluxes.

The size and weight of the Mc Lane Samplers are too large to be operated alongside the benthic flux chambers in the same frame. Therefore, two separate frames will be manufactured.

The in-situ measurement system for nitrate and dissolved organic substances will be operated on the SedOBS lander as it requires undisturbed hydrographic conditions. This would not be the case on the chamber lander. It's flexible design will allow for attachment to different future lander systems.

In the start version, the NuSOBS lander will consist of two benthic flux chambers equipped with optode and pH sensors in each of the chambers, syringe sampling units and lander electronics. The data from within the chambers will be recorded by a Sea&Sun CTD 115 unit. Outside the chambers, the CTD will record temperature, salinity, turbidity, chlorophyll and oxygen. A current meter will record vertical and lateral currents.

Lander frame

The specification of the lander frame and the benthic flux chambers to be manufactured by KUM GmbH has been sent to HZG in December 2010. The issue of a sensor for sediment penetration depth of the flux chambers is still unresolved. The development of such a sensor should be part of the instrument development task of KUM.

CTD/oxygen sensors

Sea & Sun has sent an offer for a CTD 115M including 3 optodes and 2 pH sensors.

Current meter

HZG has rejected the wish for a Recording Current Meter by Aanderaa that includes ADCP and CTD parameters. No further discussions took place regarding ADCP.

Nitrate and (C)DOM flow through system

System was designed. All relevant sensors are specified. The data acquisition of the central optical nitrate sensor is still under discussion. Fluorescence sensor (Turner C3) is available.

To date, we do not have information which of the NuSOBS components have been already commissioned by HZG.

hypOO / O. Zielinski

Aims for 2010

Development, testing and data analysis of a pre-operational hyperspectral optical observatory (hypOO), consisting of an automated hyperspectral remote sensing reflectance sensor system mounted on stationary and mobile platforms. Main objective for 2010 was the evaluation of a stationary design at the HZG Jade-1 pole and data gathered from a temporary installation on RV Heincke. Additionally it was intended to prepare a permanent installation on board RV Heincke.

Technical Developments in 2010

- The hypOO sensor system was successfully operated at HZG pole JADE-1.
- Provisions for the permanent hypOO installation on RV Heincke were made (internal effort of AWI).
- The dataset from the temporal hypOO installation on board RV Heincke cruise HE302 was used to develop an automated data processing and quality control scheme.
- Required hardware were selected and purchased (IMARE and HZG).

Results (Highlights)

"Quality control of automated hyperspectral remote sensing measurements from a seaborne platform" based on the HE302 dataset evaluation was submitted for publication. A new automated detection of sunglint corrupted spectra was proposed. See Figures 1-4 for illustration and first results.

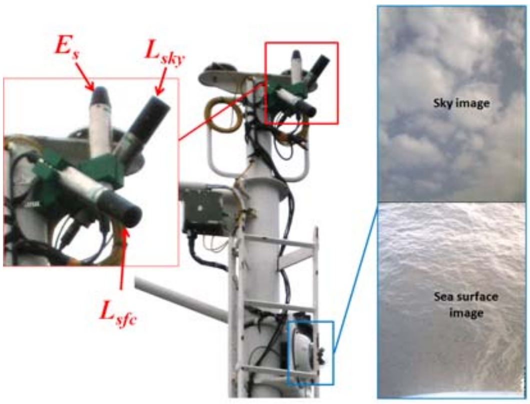


Fig. 1: hypOO sensor system on board RV Heincke HE302.

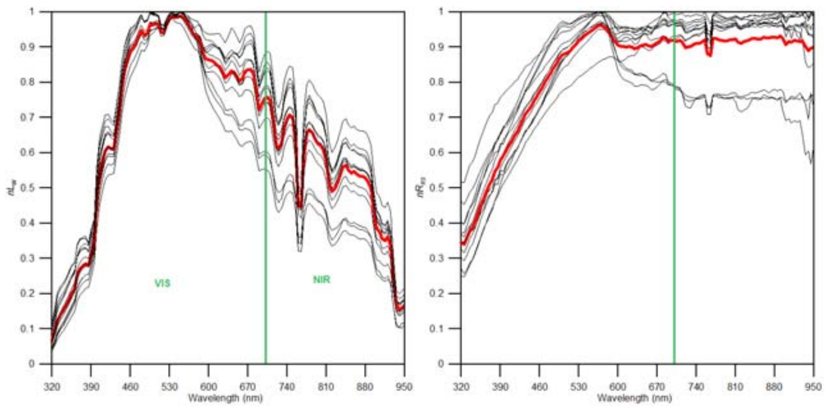


Fig. 2: Examples of sunglint effected spectra, left normalized Lu, right normalized RRS.

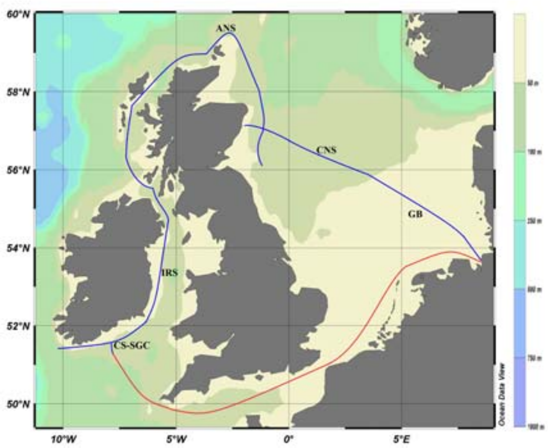


Fig. 3: Cruise track of RV Heincke cruise HE302.

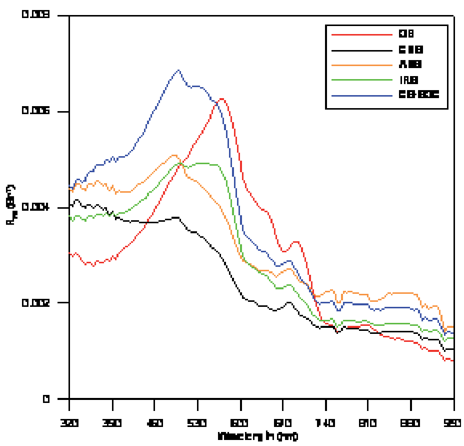


Fig. 4: Typical reflectance spectra from different regions along the cruise.

The installation at the JADE-1 pole of HZG in the Jade Bay proved the successful integration in a low energy environment. Data were available via the HZG data server and processed at IMARE according to the procedures established from HE302 evaluation mentioned above. From an exemplary dataset of more than 15000 radiometer samples (Nov/Dec 2009 and March-May 2010), a subset of 4346 reflectance spectra was successfully quality checked and used in subsequence for a calculation of the corresponding Forel-Ule color index as an indicator of changes in water constituents. Further analysis of SPM, CDOM and chlorophyll content is currently going on. See Figures 5 and 6.

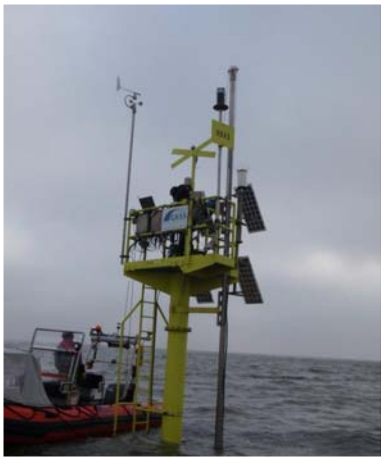


Fig. 5: Jade1 pole of HZG with hypOO system.

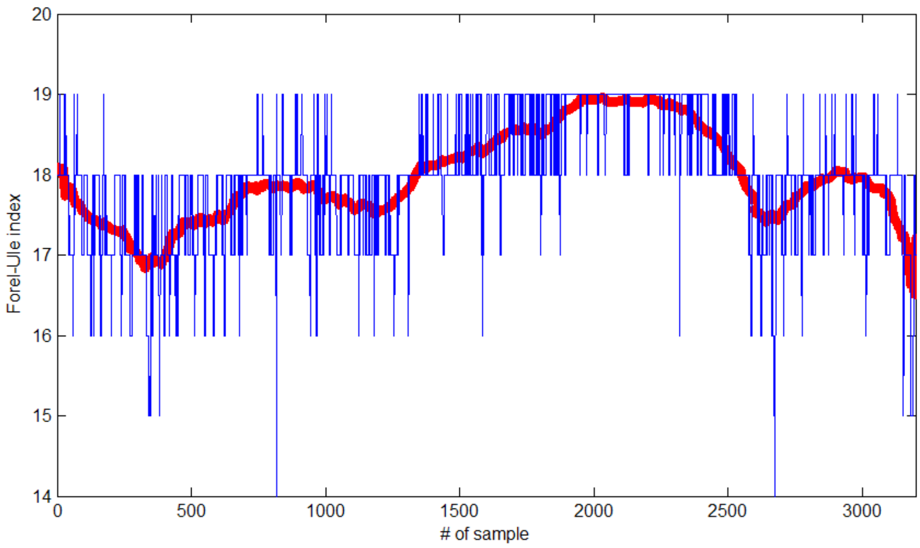


Fig. 6: Exemplary dataset of Forel-Ule index (blue) variation from 19.03. - 09.05.2010. Smoothed in red.

Underwater Node / P. Fischer

Aims for 2010

The aim for 2010 was to establish the technical framework for the development of a COSYNA UW-nodes. Four major milestones were planned for 2010:

1. Definition of the technical requirements of a North Sea / Polar UW-Node.
2. The compilation of a functional specification paper for a COSYNA UW-node as baseline for an external design-study.
3. Definition of necessary pre-experiments for „dry"-testing of the UW-communication and energy supply strategy.
4. Initiation of „on land" installation for the planned first UW-node off „Helgoland".

Measurement Strategy within COSYNA

The milestones were all approached and partly fulfilled. The main goal of 2010 was to develop a resilient technical specification and implementation strategy of an UW-node with a focus on the full compatibility to all other COSYNA systems.

- Milestone 1) Since the end of 2010, a resilient technical concept is available for the planned COSYNA UW-node which has been discussed by external US-organisation (MARS, VENUS, Neptune).
- Milestone 2) A thoroughly discussed functional specification paper for the COSYNA UW-node has been compiled in 2010 and is waiting for commissioning.
- Milestone 3) Dry-, and wet-tests have been performed to test the concept of the COSYNA UW-node. The tests have proven that all sensors available so far within COSYNA (e.g. CTD, ADCP, Stereo-Camera, div. single parameter logger) can be fully operated by the users or HZG even from far-distance connections via the Internet (Fig.1).
- Milestone 4) All necessary „on land" installations have been assigned to companies and will be completed in spring 2011.

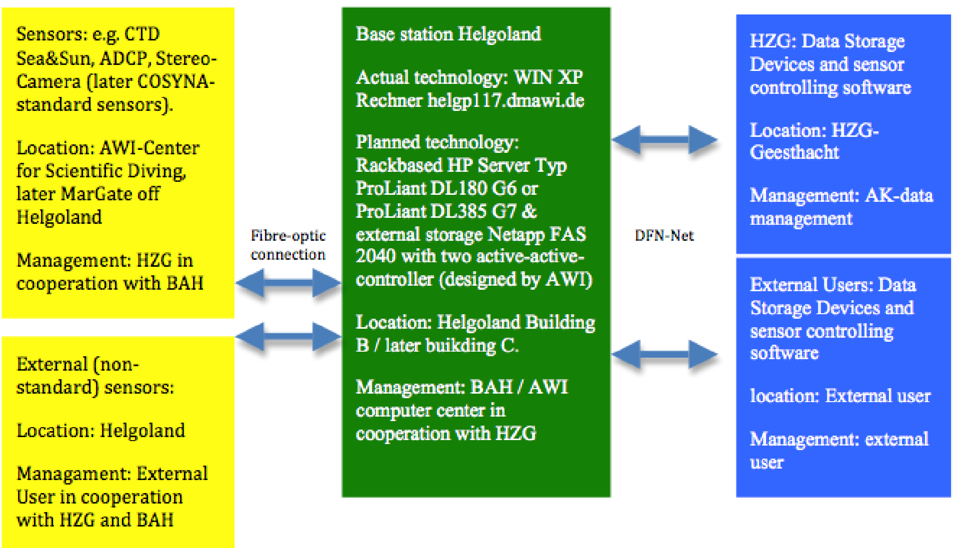
Technical Concept

The following specification form the baseline of the UW-node (fully described in the functional specification paper, see above):

- Maximum distance to the nearest land-station 10 km
- Maximum operation depth 100 m
- 4 high-speed UW-connectors (1 GBit) and ten 100 Mbit / 100 Watt) connectors
- Standard communication protocols of the node are TCP/IP with adapter technology for RS232, RS424, RS485, CAN-Bus, USB and Video
- Possible later integration of international communication protocols like PUK (integration of metadata in the communication protocol)

Ordering of instruments

- Installation of the necessary „on land" installation (fibre-optical and energy cables) for the later UW-node off „Helgoland"
- Commissioning of the functional specification paper to an external company
- CTD (Sea&Sun)
- WorkHorse Sentinel ADCP



MOKI / H.-J. Hirche, J. Schulz

Aims for 2010

MOKI is based on a prototype (LOKI) for towed application developed during the last 6 years. In order to update the technical components and adapt the system to a moored deployment, the development has been planned in 2 steps for 2010 and 2011. Main goals for 2010 were

- Conceptualization of the complete system
- Search and purchase of system components
- Construction of optical system (GigE-digital camera (1.3 - 4 MPix), macro lens, illumination system)
- Construction of measuring head (laboratory version)
- Development of embedded PC-System, implementation of hard- and software
- Construction of test system (camera, optics, illumination, measuring head, embedded-PC)
- Tests of imaging and frame capturing
- Documentation

Measurement Strategy within COSYNA

The final aim is to continuously monitor mesozooplankton abundance in the COSYNA testfield Helgoland UW-Node.

Technical Concept

MOKI is a moored zooplankton sensor, consisting of a camera system with measuring head and illumination, an underwater control unit, and a deck unit.
The camera system has a 1.4 or 4 megapixel GigE (bw) camera, imaging at 15 fps.
The measuring head has an integrated illumination system consisting of LEDs flashing at frequencies <100 µs.
The control unit houses an embedded PC with software for image segmentation and storage, extraction of AOI (Area-of-Interest), and connectors for external sensors (CTD, fluorescence, etc.).
The deck unit includes software (the "LOKI-Browser") for visualization, annotation of organisms to a taxonomic tree, interactive size measurements, statistical analysis in R, etc..
Images are immediately combined with external sensor data using SQL based software.

Ordering of instruments

The development and ordering of MOKI is planned in 2 steps. In 2010 the first step was completed, resulting in order 1. It is planned to complete step 2 in late 2011.

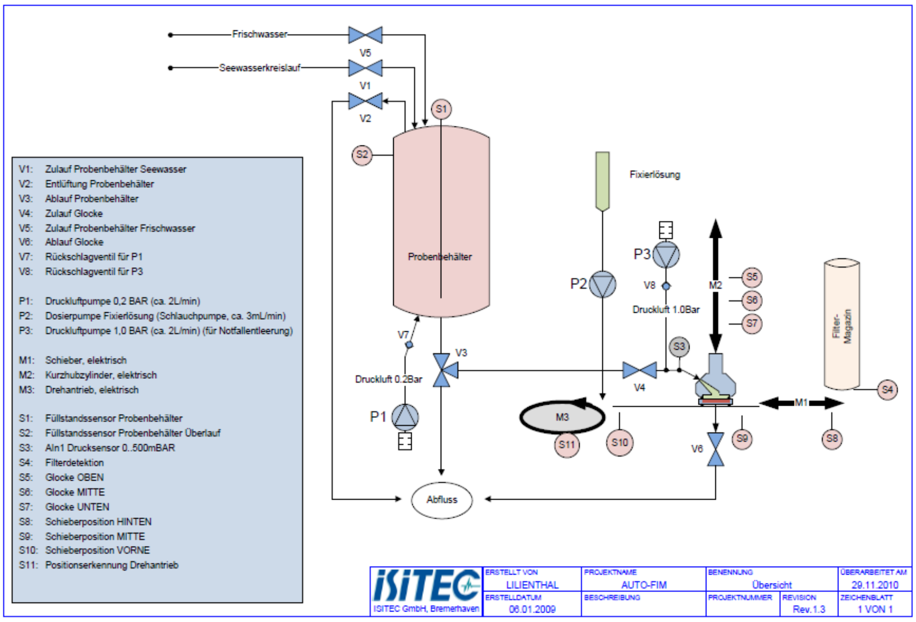
Nucleic Acid Biosensor – AUTOSENS / K. Metfies, F. Schröder

Aims for 2010

We applied for a nucleic acid biosensor system, that allows to carry out analyses of phytoplankton with high resolution in time and space.

For 2010, it was planned to develop an automated filtration module for the nucleic acid biosensor system that can be used for routine sampling, storage of phytoplankton, and subsequent analysis with the biosensor system.

Technical Concept



Measurement Strategy within COSYNA

In combination with the FerryBox system the nucleic acid biosensor system is supposed to generate regular information on the occurrence of phytoplankton key species in the North Sea.

Ordering of instruments

Construction and production of the automated filtration module was ordered from iSiTEC GmbH in Bremerhaven. A first test of the filtration unit is planned for spring 2011 in the North Sea.

Pre-operational wave and circulation model system / E. Stanev

Aims for 2010

At present coastal prediction system deployed in the area of the German Bight integrates near real-time measurements with numerical models in a pre-operational mode and provides continuously state estimates and forecasts of coastal ocean state. The forecasting suite includes nested 3-D wave and hydrodynamic models running in a data-assimilation mode, which are forced with an up-to-date meteorological forecast data. Development of a pre-operational wave and circulation model system for the North Sea and the German Bight was one of the major aims for 2010.

Program Developments in 2010

- Within the framework of COSYNA a wave model system provides 24 hour wave forecasts twice a day and makes the results available in the web under http://www.coastlab.org.
- The nested grid circulation model system for the North Sea-Baltic Sea and the German Bight developed in the frame of COSYNA in 2010 provides real time simulations together with a 3-day forecast. The pre-operation circulation model results for the North Sea and the German Bight are available under http://www.coastlab.org.
- Model-Data validations

Results (Highlights)

Pre-operational wave model system for North Sea and German Bight

The model chain includes a pre-operational wave model for the North Sea, running on a model grid with a spatial resolution of about 5 km (Figure 1) and a finer nest for the German Bight (Figure 2) with grid spacing of about 1 km. The appropriate tool used for this application is the third generation wave model WAM that is running successfully at numerous institutes worldwide. The driving wind fields and the required boundary information at the open boundaries of the North Sea wave model are allocated by the German Weather Service (DWD: Deutscher Wetterdienst).

The North Sea wave model provides boundary information for the model of the German Bight. Both wave models run in shallow water mode and calculate the two dimensional energy density spectrum at every of the active model grid points in the frequency-/direction space. An example for a comparison of the COSYNA wave model results with measurements recorded at the buoy of the BSH (Bundesamt für Seeschifffahrt und Hydrographie) 'German Bight' is shown in figure 3. The time series of measured and computed wave heights includes the results of the DWD models as well.

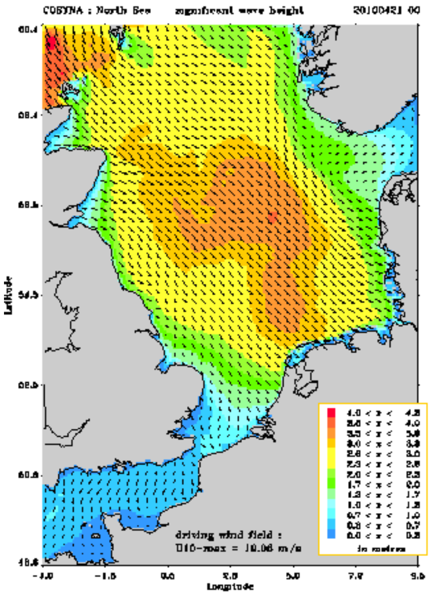


Fig. 1: Distribution of the significant wave height and the corresponding wind field in the North Sea (21 April 2010, 00 UTC)

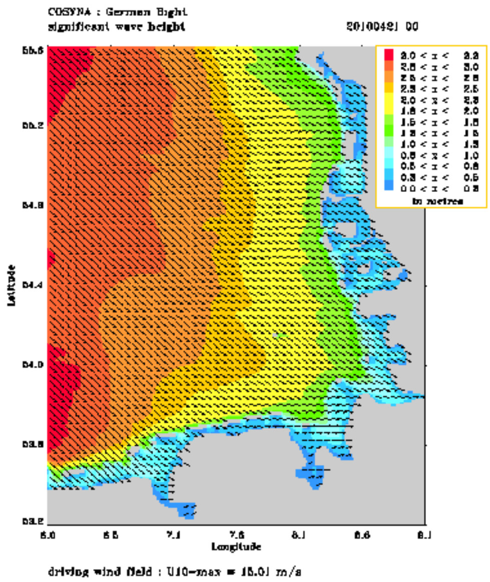


Fig. 2 : Distribution of the significant wave height and the driving wind field in the German Bight (21 April 2010, 00 UTC)

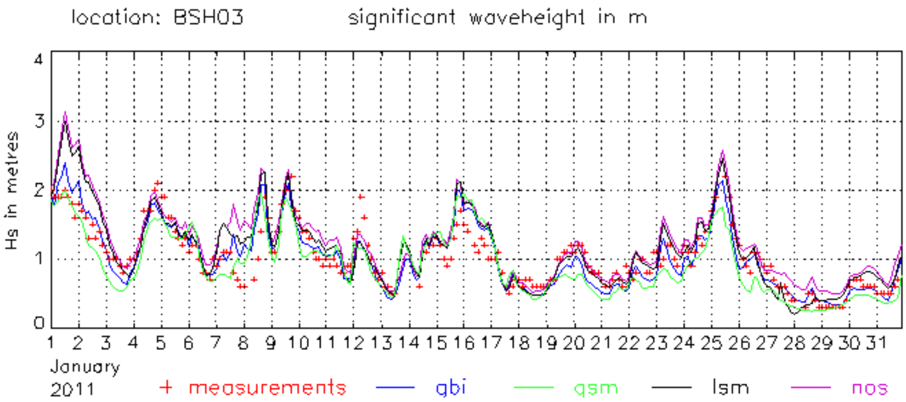
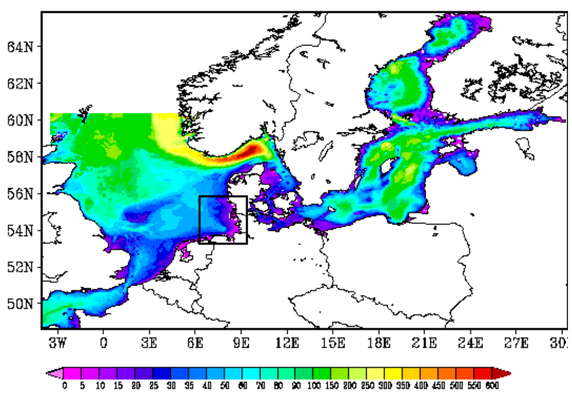


Fig. 3 : Time series of measured and computed significant wave height at the BSH buoy 'German Bight' for January 2011 (gbi : COSYNA German Bight model, nos: COSYNA North Sea model, lsm : DWD regional model, gsm : DWD global model.

Pre-operational circulation model system

A nested-grid General Estuarine Transport Model (GETM) is set-up to predict the circulation and physical properties of the German Bight. The nested-grid model (Fig. 4) consists of three model configurations: A coarse-resolution North Sea-Baltic Sea (~ 3 nm) outer model, a fine-resolution (~ 1 nm) inner model covering the German Bight and two finer resolution (~ 200 m) models for the Wadden Sea region - one for the East-Frisian Wadden Sea, and the second for the Sylt-Römö Bight. The model system is forced by: 1) the atmospheric fluxes estimated from bulk aerodynamic parameterizations using DWD atmospheric forecasts, 2) river run-off and 3) time varying lateral boundary conditions of sea surface elevations as well as temperature and salinity. The latter is estimated from the outer model simulations.

The nested grid inner models enable enhancement of meso-scale features. Furthermore, new parameterizations of the effect of surface waves on the turbulence characteristics developed in the reporting period is an important pre-requisite for coupling between waves and circulation models.



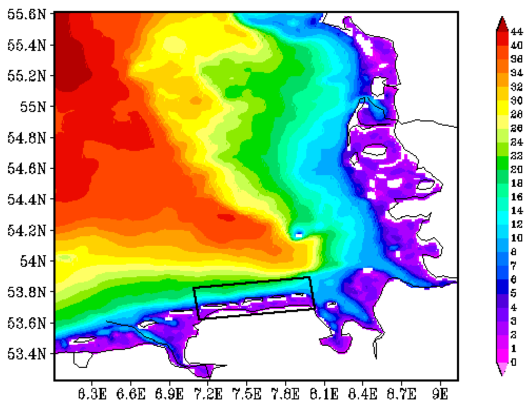


Fig. 4: Nested modelling system for the German Bight

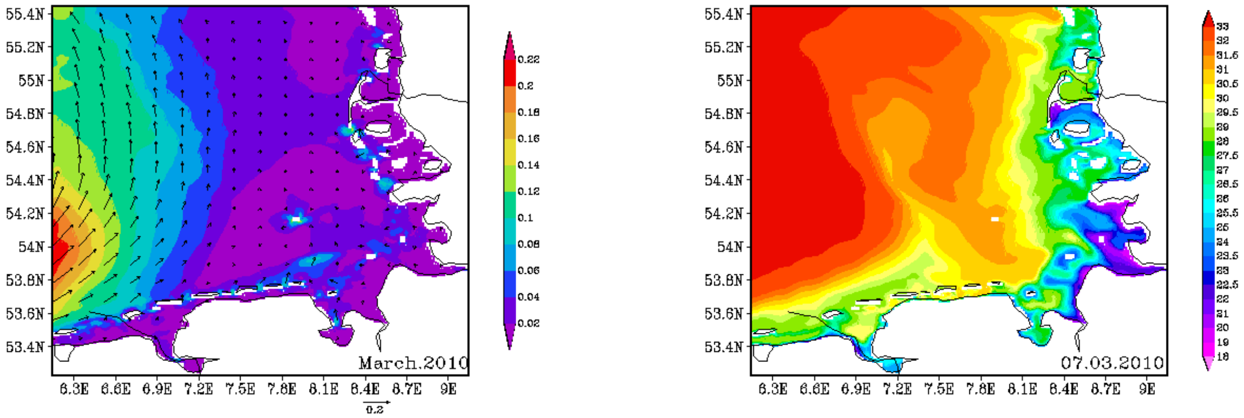


Fig. 5: Time average of the vertically integrated circulation (left) and a snapshot of sea surface salinity (right) in the German Bight for the pre-operational period

Problems

One of the major technical problems is related to the available disk space at HGZ to store the pre-operational model simulations.

Perspectives for 2011

In 2011 we will develop the first version of the COSYNA Product #2: Pre-operational hindcasts of surface temperature and salinity in the German Bight. Additionally we will concentrate on more detailed validation of the pre-operational model results against the COSYNA data.

Publications

Grayek S., Staneva J., Schulz-Stellenfleth J., Petersen W. & Stanev E. (2011) Use of FerryBox surface temperature and salinity measurements to improve model based estimates for the German Bight. J. of Marine Systems, in press.

Stanev E., Schulz-Stellenfleth J., Staneva J. & Grayek S.: Coastal Observing and Forecasting System for the German Bight. Hydrophysical state and error estimates, Ocean Sci., submitted.

Pleskachevsky A., Dobrynin M., Babanin A. V., Gunther H. & Stanev E. (2011) Turbulent mixing due to surface waves indicated by remote sensing of suspended particulate matter and its implementation into coupled modeling of waves, turbulence and circulation, J. Phys. Oceanogr., doi: 10.1175/2010JPO4328.1.

Ecosystem Models /

K. Wirtz, M. Schartau, J. Su (left Dec 2010) and R. Hofmeister (since Nov 2010)

Aims for 2010

Our research group planned to

- finalize, document and test our novel trait-based ecosystem model (Model for Adaptive Ecosystems in Coastal Seas, MAECS) in 0D and simple box set-ups
- develop an integrated, curvilinear MAECS 3D setup for the German Bight, based on the General Estuarine Transport Model (GETM), a benthic biogeochemistry module and high resolution, reasonable physical and chemical boundary conditions (atmosphere, rivers,...)
- assess parameter sensitivities in the biogeochemical module (as preparation for later data assimilation)
- run stable MAECS simulations for the German Bight (2003-2005)
- characterize trends, patterns and variability inherent to COSYNA data (MERIS, SCANFISH, FerryBox, Helgoland Roads time-series)
- compare, in a qualitative way, model results and COSYNA data

Program Developments in 2010

The development of new equations describing bulk dynamics and adaptation in marine-coastal ecosystems was completed. First papers document the ability of the equations to reproduce changes in key properties of major functional groups of the ecosystem. These key traits comprise cellular stoichiometries (Wirtz and Pahlow, 2010, Smith et al. 2011), or the body size of planktonic prey or consumers (Wirtz, 2011, see also subm. papers) Fig.1 shows an ecological application to the mean size and biomass of phytoplankton at Helgoland. The Marine Adaptive Ecosystem model for Coastal Seas (MAECS) is conceptually new with respect to a fully mechanistic and effective representation of complexity and diversity underlying ecological dynamics. In its biogeochemistry (BGC) module, MAECS also contains part of the BGC model and parameterizations developed by Schartau et al. (2007).
MAECS was outlined to contribute to an integrated (modular) coastal model system. A curvilinear physical model (GETM) was devised for the German Bight, using a grid with higher resolution of the coastal margins together with Wadden Sea areas and covering all relevant river mouths (incl. Rhine). At the end of 2010, KOE initiated an integrative approach by first considering output of the COSMO- regional climate model (CCLM, one-way offline coupling, provided by B. Geyer and B. Rockel) and of the atmospheric chemistry model CMAQ (provided by A. Aulinger and V. Matthias). Our pelagic model MAECS is furthermore bidirectionally coupled to a benthic BGC module (OMEXDIA, Soetaert et al., 1996). Model runs are currently well maintained on a parallel computing cluster (HPCSUN at IfK) by R. Hofmeister, who repeatedly conducted simulations for the years 2003-2005. These runs provide preliminary results that need to be further analysed in order to debug the model.
KOE initiated a setup for parameter sensitivity studies, which are essential to specify constraints that are needed for pre-operational model runs. We used a modified module (by M. Kreus) of our code focusing on BGC aspects in a 1D setup and permuted model parameter values in order to compute a full Hessian matrix (second derivatives of model fluxes to parameter variations). The inversion of the Hessian then provides uncertainty measures for model parameters, which should be used as prior estimates in pre-operational data assimilation (see Fig. 3).
Together with R. Riethmüller, KOE performed statistical analysis of the vertically resolved SCANFISH data, revealing essential new insights into the spatio-temporal distribution of major physical and biological state variables. These findings already guide ongoing model refinements with respect to vertical mixing and resuspension, and lateral transport. Supported by KOI, KOR and KOF, we conducted various integral analyses using continuous observations from MERIS, FerryBox, and Langeoog or Helgoland Roads time-series. We could show that in combination, these data reveal consistent trends and patterns (in this case for phytoplankton spring and autumn blooms) that could not be detected using a single data source alone.

References

Schartau M., Engel A., Schroter J., Thoms S., Volker C. & Wolf-Gladrow, D. (2007) Modelling carbon overconsumption and the formation of extracellular particulate organic carbon. Biogeosciences, 4, 433–454.

Soetaert K., Herman P.M.J. & Middelburg J.J. (1996) A model of early diagenetic processes from the shelf to abyssal depths. Geochimica et Cosmochimica Acta 60, 1019–1040.

Results (Highlights)

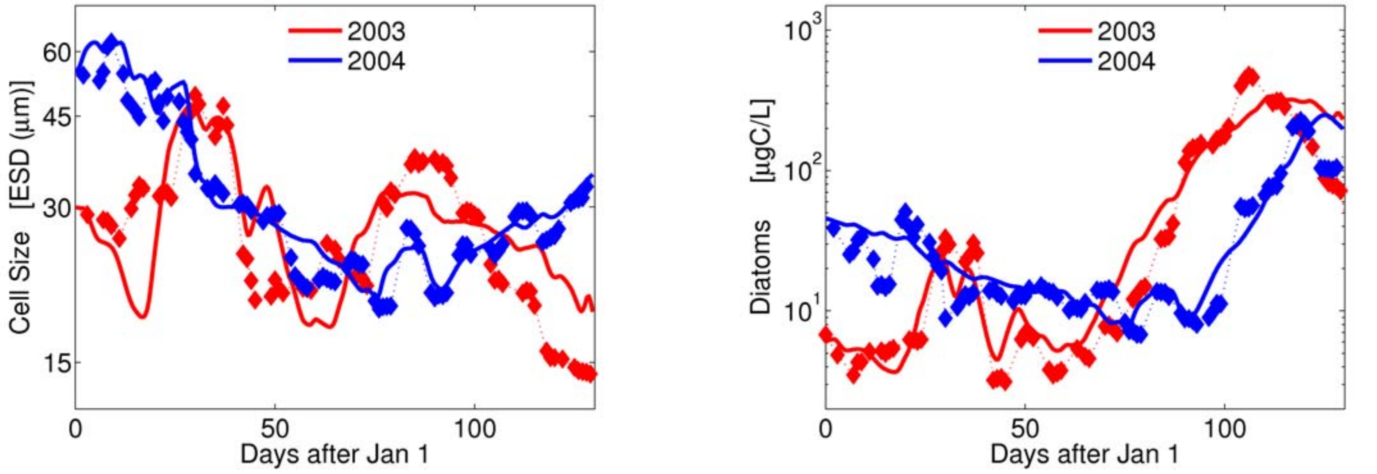


Fig. 1: Spring dynamics in phytoplankton concentration (right) and algal mean cell size (given in equivalent spherical diameter, ESD; left) for two consecutive years. Data from the AWI station Helgoland Roads (diamonds) are compared to results of our new model which resolves size as an adaptive trait. Trait variations (here shown on the scale of years and weeks) are found to be essential to accurately simulate the concentration dynamics.

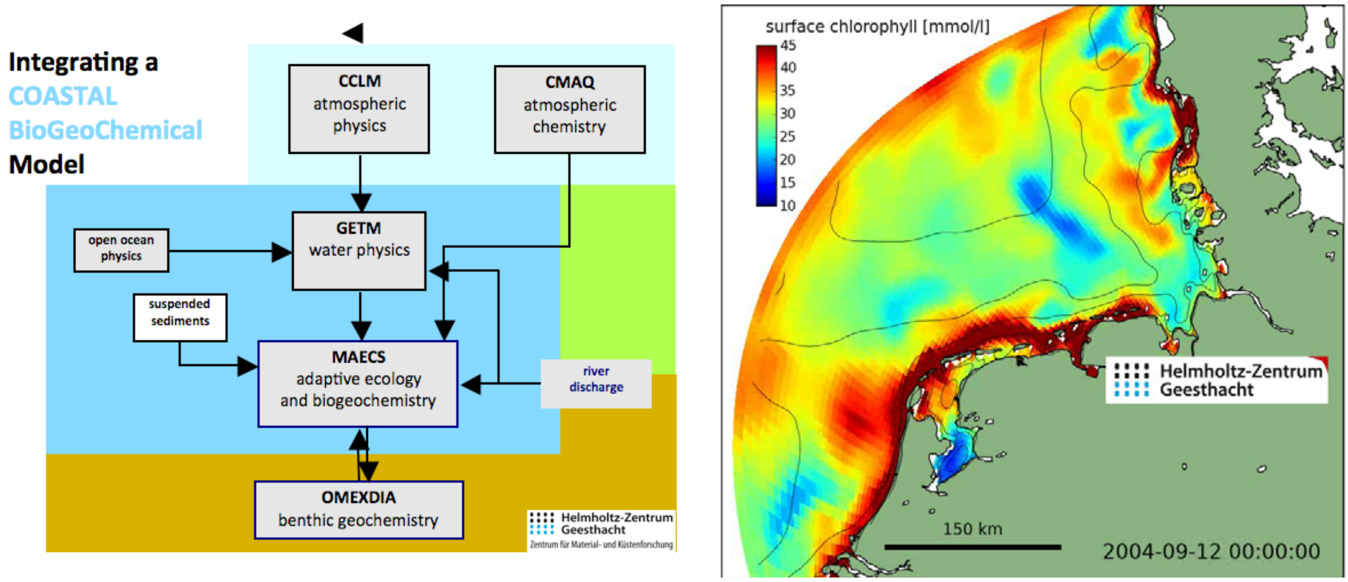


Fig. 2: Left: Online and offline coupling of an integrated system, including the new pelagic ecosystem model MAECS. Right: Snapshot of a simulation run showing chlorophyll concentration (for a autumn day in 2004) over the entire Wadden Sea and German Bight.

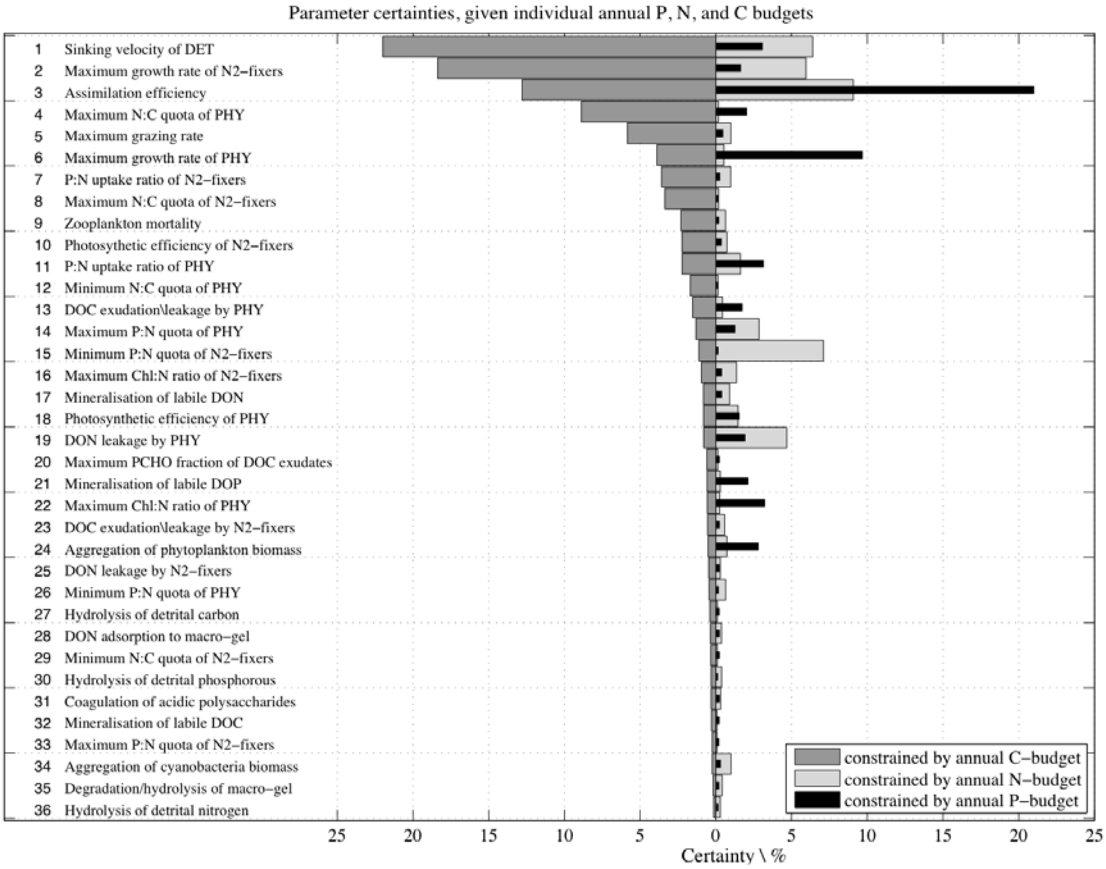


Fig. 3: Parameter uncertainty analysis (Hessian matrix inversion) for a modified 1D version of the BGC module.

Problems

Technical and numerical problems appeared during the coupling of MAECS to the benthic module OMEXDIA. The GETM structure did not account for possible two-way coupling between a biological model in the water column and a benthic environment. Hence, a new coupling scheme and numerical integration methods for resolving strong fluctuations in benthic-pelagic fluxes had to be developed (starting with a 1D setup near Helgoland). Primary concerns were the resolution of processes in the benthic part because their characteristic time scales are different to the processes resolved by the pelagic modules (dealing with stiff differential equations). First parallel model runs with GETM also revealed problems in the communication between sub-domains and a slowing down of numerical efficiency which have to be corrected. The consideration of biogeochemical fluxes at the open ocean boundary yet remains unclear. The model system lacks an operational representation of major components such as suspended particulate matter (SPM) or benthic ecology. Many aspects like vertical transport (resuspension – deposition), lateral effects of tidal front dynamics, or the interaction between carbon-, nitrogen-, and phosphorous-cycles needs accurate analysis and model-data comparisons which are currently beyond the manpower capacity of KOE.

Data provided by colleagues within COSYNA often require further processing, scientific documentation and statistical assessment before they can be used for model validation. This task takes a considerable fraction of KOE time.

Perspectives for 2011

The coupled model system (with MAECS as central element) will be refined in order to run for longer periods (e.g. 2000-2006). By the end of 2011, KOE plans first estimates of combined annual nitrogen and carbon fluxes in the German Bight. These budget calculations will include benthic fluxes, atmospheric nitrogen deposition, as well as riverine nutrient loads. To solve many of the technical limitations described above, and to work towards a community model system, we will adopt and further develop an existing open source coupling tool (FABM) which is based on a contract work for IfK/KOE. This way we aim to bundle model development activities (e.g. related to SPM or benthic BGC models) of partner institutions or such as IOW, NIOZ, or the CLISAP cluster.

The framework for MAECS sensitivity studies will be ported to a site near Helgoland and to two-dimensional transects, where uncertainty analyses will specifically address benthic-pelagic coupling and ecological variables. Initial estimates (for primary production, or related nitrogen and carbon fluxes) will pinpoint to special information needs to the observational COSYNA groups. The parameter uncertainty analysis will also be beneficial for the data assimilation group when refining their filters for state estimation.

Publications (2010)

only papers relevant to COSYNA data analysis or ecosystem model development

1) published/accepted:

Wirtz K.W. & Pahlow M. (2010) Dynamic CHL and nitrogen-carbon regulation in algae optimizes instantaneous growth rate. Marine Ecology Progress Series 402, 81-96.

Holstein J. & Wirtz K.W. (2010) On the origin of highly active biogeochemistry in deeper coastal sediments – Inverse model studies. Biogeosciences, 7, 3741-3753.

Brandt G. & Wirtz K.W. (2010) Interannual variability of alongshore spring bloom dynamics in a coastal sea caused by the differential influence of hydrodynamics and light climate. Biogeosciences 7, 371-386.

Maerz J., Verney R., Wirtz K.W. & Feudel U. (2010) Modeling flocculation processes: intercomparison of a size class-based model and a distribution-based model. Continental Shelf Research (in press).

Wirtz K.W. (2011) Metabolic scaling in phytoplankton due to intracellular light and CO_2 decline. Journal of Plankton Research (in press).

ENSTA-Report: Charpentier, S. (2010) Statistical analysis of SCANFISH data for the German Bight.

2) submitted:

Su J., Tian T., Krasemann H., Schartau M. & Wirtz K.W. (2010) Resuspension influences spring and autumn phytoplankton blooms in a shallow coastal sea - relating satellite data to event scale processes, submitted to Journal of Geophysical Research – Biogeosciences.

Smith S.L., Pahlow M., Merico A. & Wirtz K.W. (2010) Optimality as a Unifying Concept for Planktonic Organisms and Their Ecology (invited review for Limnology & Oceanography).

Tirok K, Bauer B., Wirtz K. & Gaedke U. (2010) Community dynamics driven by feedbacks between functionally diverse trophic levels (submitted).

Tian T., Su J., Wiltshire K., Flöser G. & Wirtz K.W. (2010) Physical control of winter-spring algal community structure in the German Bight and its effect on bloom timing. Continential Shelf Research (under revision).

Wirtz K.W. (2010) Maximum ingestion rate scales with predator–prey size ratio (under revision).

3) in preparation:

Kreus M. & Schartau M. (2011) Sensitivities of biogeochemical flux estimates to variations of model parameters at Baltic Sea monitoring site BY15 Gotland Deep. (in prep for Continental Shelf Research).

Wirtz K.W. & Sommer U. (2011) Physiologically regulated sinking controls decline and succession of spring phytoplankton (in prep. for Marine Biology).

Wirtz K.W. (2011) Intermittency in food particle processing rules grazing kinetics (in prep. for MEPS).

Wirtz K.W. (2011) Mechanistic and evolutionary derivation of size-depending grazing rates (in prep. for Journal of Plankton Research).

Tian T. & Wirtz K.W. (2011) Sensitivity of coastal diatom spring bloom dynamics to meteorological and hydrographic anomalies (in prep.).

Wirtz K.W. & Schroeder F. (2011) The integrated coastal observation and model system COSYNA (accepted for the SCACR proceedings; will be prepared as a regular paper).

Data Management & Quality Assurance / G. Breitbach, J. Gandraß

Aims for 2010

Major aims for Data Management (DM) and Quality Assurance (QA) were:

1. Establishment of joint Working Groups and Work Flows for DM&QA
2. Creation of an integrated data view for different COSYNA data sources (COSYNA Data Portal)
3. Development and setup of key elements of a QA Framework

Program Developments in 2010

A HZG-internal and a joint working group of the COSYNA consortium have been established to work on and reach consensus on DM and QA issues. COSYNA Sharepoint is used as communication platform and to manage documents.

Data Management

To attain the aim a few prerequisites were needed.

1. A metadata system to store the metadata.
2. An additional database for data from surveys, i.e. research vessel surveys.
3. Disk space to store gridded data from remote sensing and models.

As metadata base system NOKIS was selected, a metadata system developed for the coastal agencies in Germany. Two data formats exist in COSYNA, the netCDF format for gridded data and an Oracle database format for time series data. Metadata for platforms and long-term time series were created with the help of the NOKIS editor whereas metadata for single events like FerryBox transects, satellite scenes or HF radar measurements were created by program code based on a static metadata template with dynamic information from this single event taken into account as well. Rules were installed for writing netCDF metadata into files which are read by procedures to create dynamic metadata in NOKIS. These are applied to all FerryBoxes, standard sensors on the Ludwig Prandtl, MERIS netCDF files, HF radar netCDF files and to the HF radar data assimilation into the GETM model.

Quality Assurance

Key elements for a COSYNA Quality Assurance Framework were developed. Where possible, (inter)national guidelines e.g. from SeaDataNet were followed to enable interoperability. Key elements are descriptors for data quality and processing levels (e.g. uniform Quality Flag and Data Level schemes) and a unified outline for documentation of data generation and processing, the latter to ensure trackability and quality control of data (sets). The setup of an Inventory of Platforms – Sensors – Parameters incl. associated metadata serves for documentation and concurrently provides core metadata for the COSYNA data portal.

Results (Highlights)

The COSYNA data portal could be used to search for different parameters in a selectable time interval and location. The portal offers a chart plot and/or a map plot for the requested data if applicably. Always possible is the download of the data and the display of meta-data for platforms and data. Different data sources for one parameter could be visualized as chart plot or map together as shown in fig. 1.

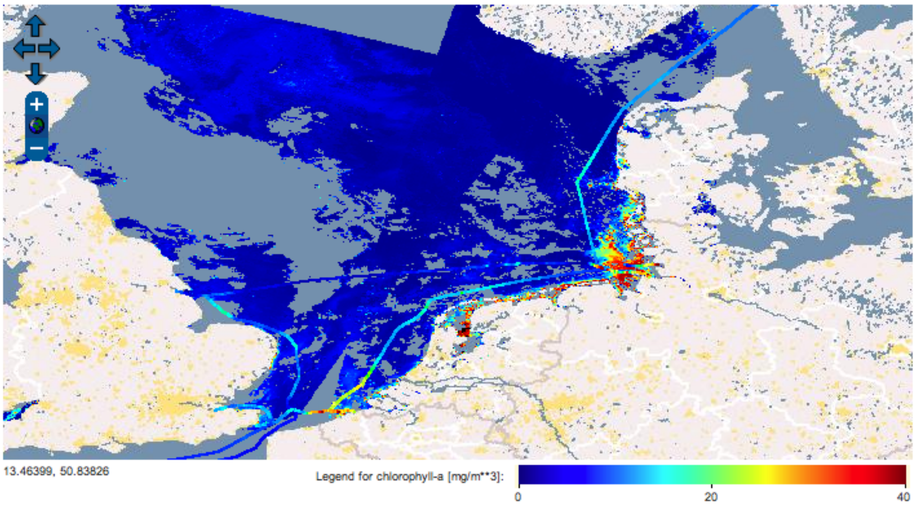


Fig. 1: Chlorophyll from MERIS and FerryBoxes in an integrated view.

Perspectives for 2011

Data Management

1. The integration of additional measurement platforms like Glider and Scanfish into the database and portal.
2. It should be possible to use the depth as search criterion.
3. The visualization of time dependant maps and the combination of gridded data with in-situ data from fixed stations will get added to the portal.

Quality Assurance

1. Development/improvement of Near-Realtime Quality Control including the establishment of regional climatologies and intercomparison of differing workflows/algorithms with test data sets
2 Intercomparison of measurement techniques and evaluation of measurement uncertainties

Publications

Breitbach G., Krasemann H. & Onken R. (2010) Data Management in COSYNA. In: International Conference on Marine Data and Information Systems, IMDIS 2010. Paris (F), 29.-31.03.2010.

Community Tools / C. Eschenbach, F. Schroeder

Aims for 2010

As the scientific work in COSYNA is carried out together by several partners with numerous staff members, communication and collaboration via paper- and web-based tools are a prerequisite for the sustained success of COSYNA. As the first essential devices for managing activities and communication in COSYNA the following issues have been identified: (1) a COSYNA brochure, (2) a COSYNA SharePoint communication server and (3) a COSYNA website. These community tools were planned, designed and set up in 2010.

Developments and Highlights in 2010

(1) COSYNA brochure

The brochure gives an overview of the aims and activities of COSYNA. First an introduction into the research areas - the North Sea and Arctic Coasts - is given, followed by the description of the motivation and the integrated approach of COSYNA. One of the first pre-operational products (prognosis of current fields) is characterized. Observing systems, such as poles for stationary in situ observations, FerryBoxes, surveys with research vessels (incl. Scanfish) and Ocean Colour from Satellite Remote Sensing are briefly described and depicted with typical results. New technologies to be developed and deployed in COSYNA (SedOBS, NuSOBS, MOKI, Underwater Node, Nucleic Acid Biosensor) are described. The brochure provides insights into the characteristics as well as exemplary outcomes of hydrodynamic and ecosystem models covering different processes and spatial scales. The concluding section deals with data management and the COSYNA data portal as user interface for data retrieval and presentation. An illustration showing an overview of the research area, the North Sea, and the observing systems was contributed by an internationally well-known designer. As many COSYNA members were involved in the discussions of the composition and the single articles the team efforts took some time but considerably improved the brochure and the COSYNA team spirit.

(2) COSYNA SharePoint

The COSYNA SharePoint is a website that provides a central storage and collaboration space for documents, information, and ideas (external access: https://webcoop.hzg.de, HZG-internal access: http://webcoop/sites/COSYNA/default.aspx, HZG members use their usual network account and external COSYNA members got specific user names and passwords).

The SharePoint site helps all the COSYNA members to share information and work together - it is a tool for collaboration. All COSYNA members can contribute their own content within the given structure. In particular, the COSYNA SharePoint site

- stores general COSYNA documents,
- provides all COSYNA members with protocols of meetings and information on upcoming events,
- shares information within and among the work groups,
- coordinates calendars and schedules.

The structure shown in figure 1 was identified to be suitable for the demands of the COSYNA community. The tabs in the upper navigation bar offer access to the literature database and the advanced search tool (in all documents). Access to "COSYNA Management" and "HZG-Internal" is restricted to the respective members.

Records of recent and upcoming events, tasks, and activities can be found in the central part of the homepage (Announcements, To Do List, Calendar).

The items shown left are shortcuts to specific document folders and collaboration tools. The folder "COSYNA Documents" is the place where all documents are stored. It is divided into subfolders according to the documents provided (official documents, work documents, presentations, etc.).

A major feature of the "COSYNA Activities" is "COSYNA Meetings" which is the entry page to the work spaces of all the COSYNA meetings (AK-Meetings, CSSC, ...). They provide space for the agendas, documents, presentations, and protocols of the meetings.

On the right panel of the COSYNA Sharepoint Homepage one can find COSYNA links and links to other observatories.

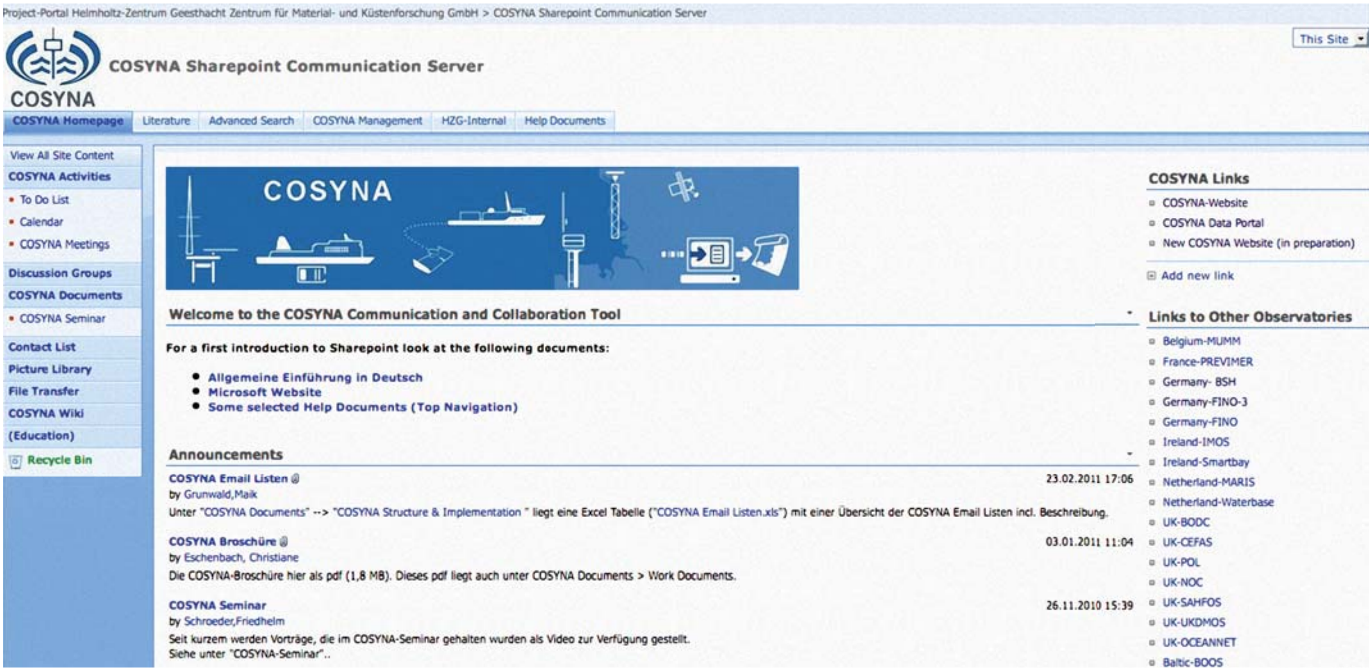


Fig. 1: Snapshot of the COSYNA SharePoint Homepage

(3) New COSYNA Website

The design of the new COSYNA website started with the collection of material and a first design of the site navigation structure.

Problems

As COSYNA is designed for long-term research of several collaborating partners community tools play a crucial role. However, as always with web-based software tools it takes some time and perseverance to establish such tools and encourage participation of all members.

Perspectives for 2011

The COSYNA Sharepoint website was set up and is ready for use. In 2011 it will need further refinement and adjustment to the changing and (hopefully) growing demands of the COSYNA community.

Detailed planning and the main work for the new COSYNA website will be carried out until April 2011.

New paper-based communication tools for special purposes, like flyers for user work shops, are planned.

CoastLab Room / M. Grunwald

Aims for 2010

- Provide a platform for displaying different datasets and additional presentations for discussing and presentation purposes
- Establishing a set of displays connected to arbitrary types of computers (PC, Sun, Apple) to present data with independence of their origin: databases, CoastLab portal, FerryBoxes, PowerPoint presentations, ...
- Computers and displays should be separated by each other due to noise level and generation of heat.

Technical Developments in 2010

- 9 displays (in a 3 by 3 rack) of 42" each and the required equipment for signal transmission from the server room (computers) to the CoastLab room (displays) were delivered and installed in December 2009 and January 2010.
- Different types of display combinations are available: 9xsingle, "big picture" (all 9 displays are combined to one), or 4 displays are combined and 5 single ones remain.
- In January a Sun Server with 16 ThinClients, 3 PCs and an Apple MacMini were installed.
- In June a new control software has been installed to simplify the use.

Results (Highlights)

- In February first visitors were introduced into COSYNA by showing data and a presentation. From this time a lot of visitor groups (students, administration agents, school classes) and HZG internal activities used this facility.
- This arrangement provides the unique opportunity to simultaneously examine different data sets with a group of people in a high resolution (full HD) and an appropriate size.

Problems

- Switching from "big picture" to single mode last too long and sometimes the switchover has a malfunction by remaining content from the former setup on single displays.

Perspectives for 2011

- Problems mentioned above will be solved by successive updates of software starting in April.
- Standard set-ups will be defined for different groups of interest.
- The standard set-ups should be called and displayed by a single click which starts a defined preset for the corresponding group of viewers.

COSYNA

Coastal Observation System for Northern and Arctic Seas

Website: www.cosyna.de

COSYNA data portal: www.coastlab.org

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