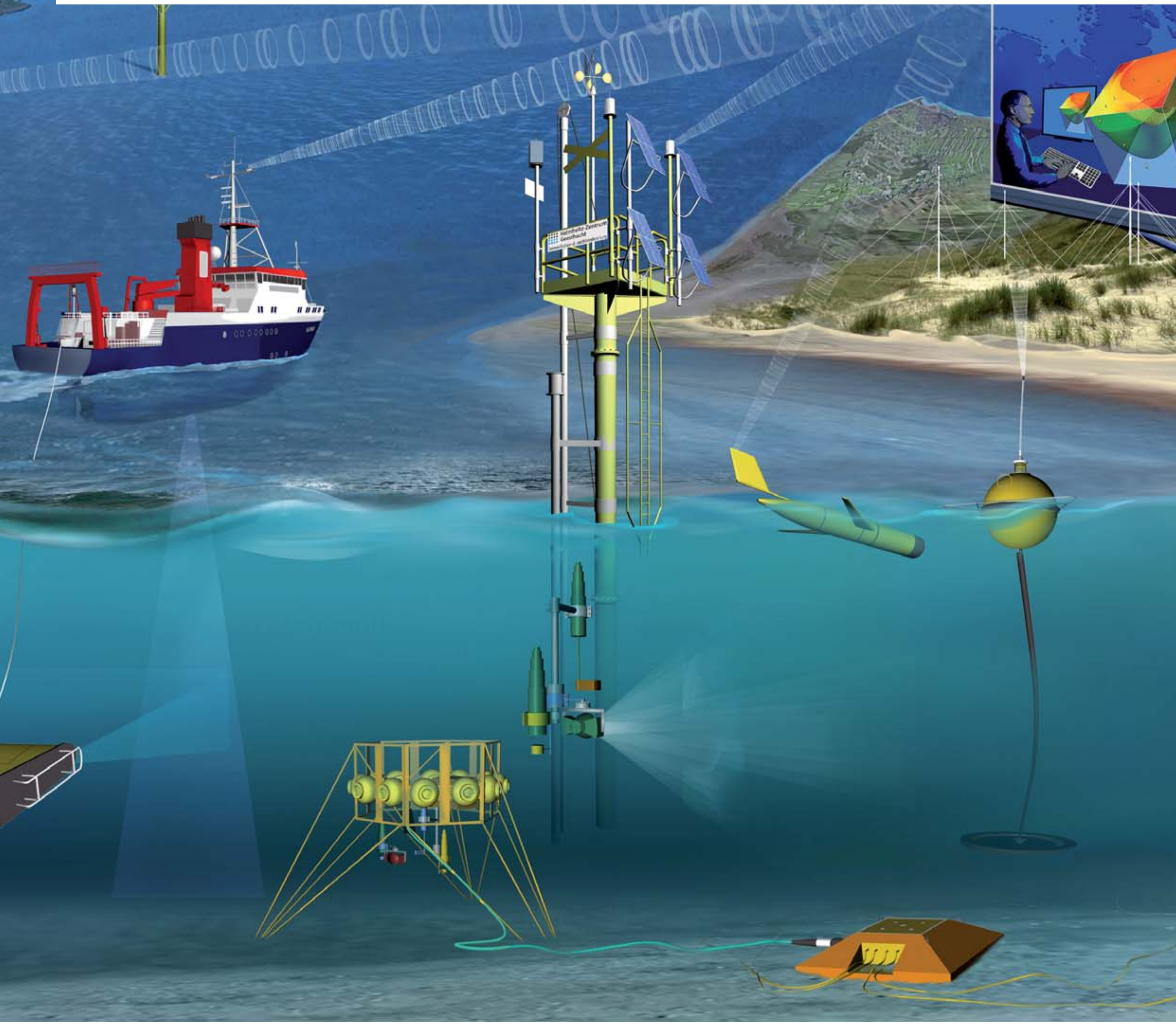
HELMHOLTZ-ZENTRUM GEESTHACHT

COSYNA
Progress Report 2013



COSYNA

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Content

Dear COSYNA friends:

2013 has brought lots of changes to COSYNA and many exciting new developments. Friedhelm Schroeder has passed on the helm to Holger Brix, the new COSYNA project manager since January 2014. It has been a smooth transition and Friedhelm is still on board helping, explaining and easing the change. Together with Burkard Baschek as head of the Institute for Operational Oceanography at HZG, we continue to have a strong team leading COSYNA into the future. We want to take this opportunity to express our heartfelt thanks to Friedhelm for all the hard work, ideas and creativity he has brought into COSYNA.

Before looking at the achievements of the past year, a brief glance into the future: Although initial funding for COSYNA is scheduled to end at the end of the 2014, all current partners and collaborators present at the Scientific Steering Committee meeting in late January 2014 expressed their interest and willingness to cooperate beyond 2014 to develop COSYNA even further, thus lying the foundation for additional data products, sensor and platform development as well as common scientific work and outreach activities.

In the past year, the transition of COSYNA from the early stages of development and deployment of instrumentation to an enhanced focus on products, science and interaction with the users has continued. One example for the exploration of users' needs and possible interaction were the successful workshops on "data streams" in January and on offshore wind farms in November.

The COSYNA Progress Report for 2013 gives an overview of the multiple facets of developments, improvements and scientific results from the participating groups. The Wadden Sea Exchange campaign in summer 2013, for instance, brought together teams from HZG, the Forschungs- and Technologiezentrum Büsum (FTZ) and the University of Oldenburg to investigate exchange processes between the German Bight and the Wadden Sea using multiple instruments and platforms. This successful field campaign serves as an impressive demonstration how the combination of COSYNA instrumentation and project partners yields high quality research.

In the area of remote sensing algorithm development for total suspended matter, chlorophyll a and gelbstoff concentrations from MERIS ocean colour observations for the Wadden Sea were tested, improved and adapted to MODIS. The potential of the hypOO measurement system for deployment on fixed platforms has been investigated at the Wadden Sea time series station Spiekeroog. HZG's HF radar systems were further validated and used for the refinement of ship-tracking algorithms. The pre-opearational integration of current data into modelling applications continued, while the model development activities shifted to the development and testing of regional coupled ocean-wave models for the German Bight.

FerryBoxes continued to deliver reliable data streams. The development and field-testing of high-precision pH and alkalinity sensors remained a research focus. Glider operations are now a standard procedure at HZG. For shipping safety reasons a virtual AIS (Automatic Identification System) was developed and the data from glider deployments were used to analyse suspended sediment.

The sensors at the ICBM pile in Spiekeroog now run in a fully operational and autonomous mode and deliver high quality data that undergo automatic quality controls. The second NLWKN pile (Bantsbalje) equipped with radar wave gauges came online in 2013.

Extensive testing of the operational mode was successfully completed at the underwater nodes in Helgoland and Spitsbergen under hard environmental conditions. The deployment procedures for the SedObs and NusObs lander systems were optimized and during several field campaigns exploring, for instance, tidal and seasonal variability of sediment fluxes, new scientific data could be gathered.

The breadth of approaches and measurement system made a consistent representation of data a challenging task that has been solved with the COSYNA data portal, which continues to be improved especially with regard to visualization and metadata representation.

COSYNA has laid the foundation for in-depth scientific analyses of the coastal system. We will continue to build on this foundation and are looking forward to having fruitful and interesting collaborations with all of our partners.

Dr. F. Schroeder C. Eschenbach

Field survey “Wadden Sea Exchange 2013” (WadEx2013)

R. Riethmüller

During summer 2013 (30 July to 12 August) a comprehensive ship campaign was carried out that comprised the inner German Exclusive Economic Zone (EEZ) tidal catchment area in the North and East Frisian Wadden Sea each. In total, three research vessels, one zodiac, and two gliders participated, whereby the COSYNA systems contributed the routine long-term observations (see Figure 1). The observational team comprised more than 20 scientists and engineers from the Helmholtz-Zentrum Geesthacht (HZG), the Forschungs- and Technologiezentrum Büsum (FTZ), and the University of Oldenburg.

Aims

In the last years new approaches were developed to understand the exchange and balance of particulate matter (SPM) between the German Bight and the Wadden Sea. Several good reasons suggest that the balance is mainly controlled by the import from the North Sea and that there exist significant regional differences that, e.g., affect the state of eutrophication across the Wadden Sea.

There are some fundamental scientific questions still to be resolved which require co-ordinated observational effort across the inner German Bight and several regions of the Wadden Sea:

- Why is the sediment budget in the Wadden Sea more or less balanced or only gradually changing given high alternating transports and significant variability of physical and biological parameters that obviously impact the matter transports?
- How is this approximate balance achieved under very different conditions at the East and the North Frisian coast?
- How is the nutrient consumption inside the Wadden Sea compensated by the import of particulate nutrients entering from the German Bight?
- What explains the regional differences in the eutrophication status?
- How big is the source area for material delivered to the Wadden Sea?

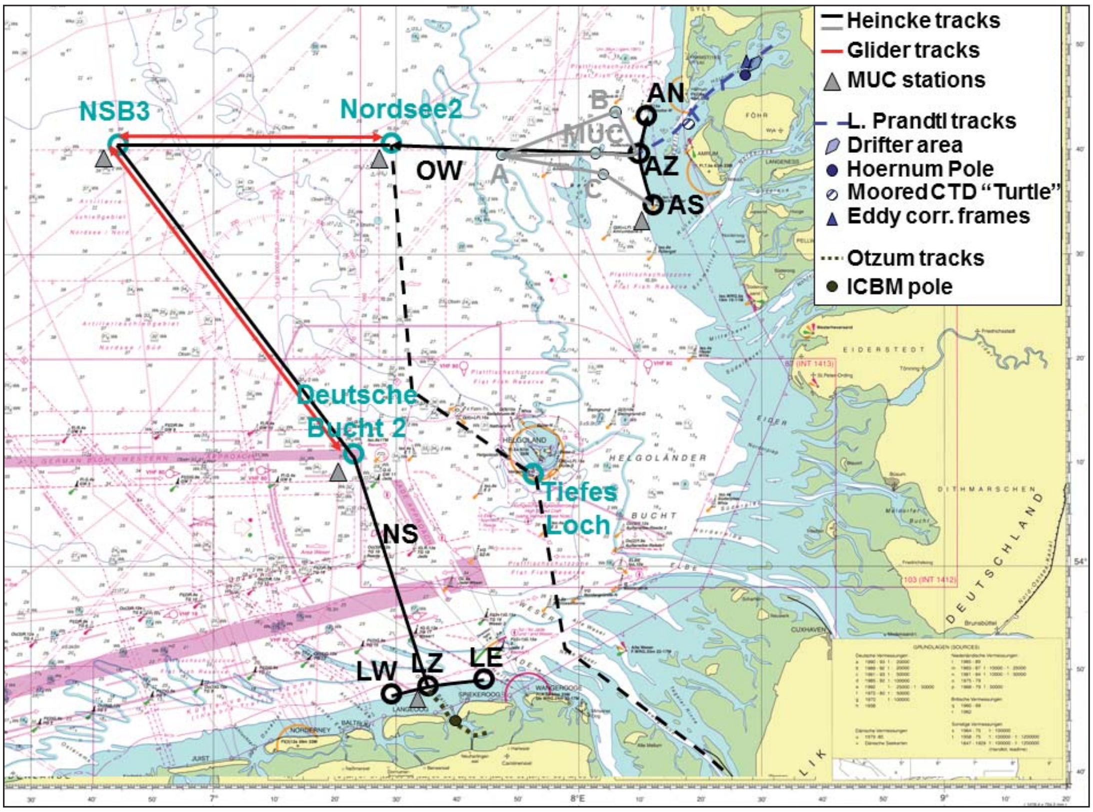


Figure 1: The measurement network during WadEx2013

Survey outline

The WadEx2013 strategy was

- to capture spatial, tidally resolved, in-situ features of cross-shore patterns of circulation, SPM concentrations and pelagic plus benthic bio-geochemical fluxes
- to conduct transects in front of the East Frisian and North Frisian coastline reaching from the inner parts of Wadden Sea tidal catchment areas into the German Bight

The differences in the cross-shore bathymetric and concentration gradients, general circulation patterns and admixtures of estuarine and North Sea waters should help to identify and quantify the main underlying processes that control the transport and exchange pathways within the inner German Bight.

The first half of the survey took place along an East-West transect from the MARNET buoy “NSB3” well into the Hoernum Deep, the second half along an North-South transect from “NSB3” into the Otzmuer Balje. Both transects were separately covered by two ships and the gliders (see Figure1). Observed parameters involved physical oceanography, biogeochemistry including alkalinity, primary production in the water column, benthic-pelagic fluxes of O_2, C, N, P, and Si. Under favourite weather conditions nearly all of the planned observations could be carried out.

First observational results

So far the processing and quality assurance of the data is underway and first scientific analyses are being carried out (see contribution by L. Merckelbach, this report). Figure 2 shows the overall conditions during WadEx2013 as observed with the scanfish towed by RV Heincke. They exhibit the typical summer stratification in the German Bight and their disappearance in the shallow near-coast part as well as the chlorophyll a maximum just below the pycnocline (Figure 3).

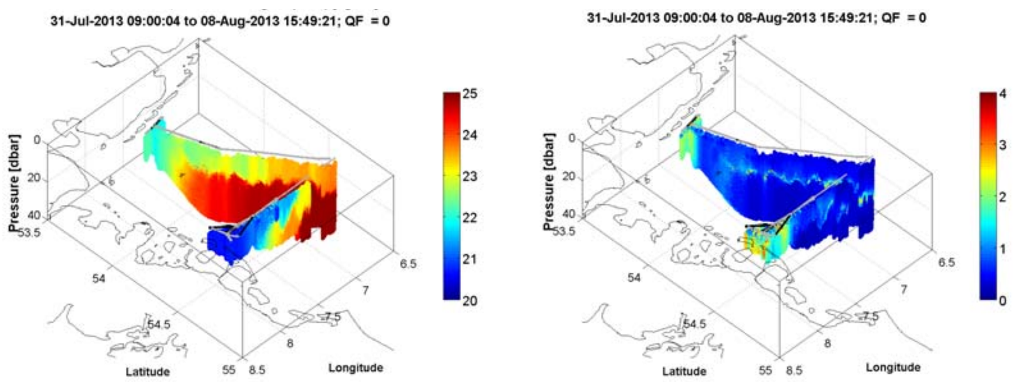


Figure 2: Density and chlorophyll a-fluorescence structure as recorded with the scanfish

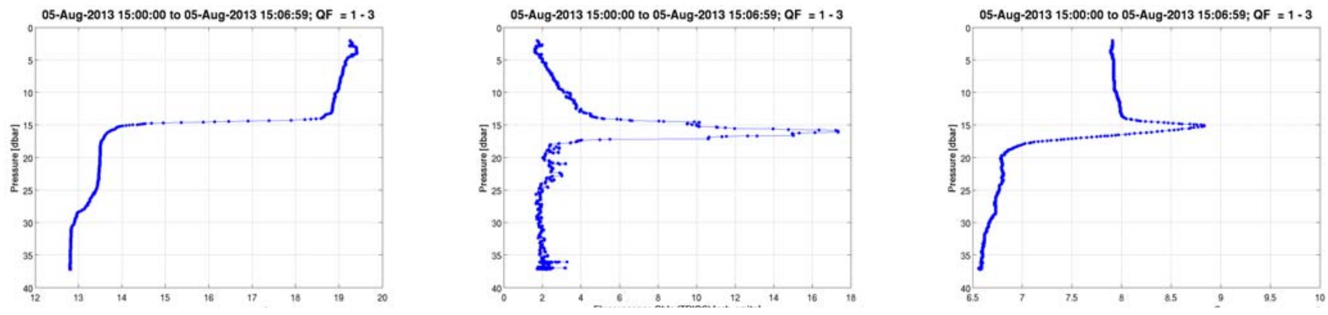


Figure 3: Vertical profiles of water temperature, fluorescence and oxygen taken at station NSB3

Estimation of suspended matter concentrations in the Wadden Sea by optical remote sensing

R. Riethmüller / G. Flöser / K. Heymann / F. Wallasch / W. Schönfeld / R. Doerffer

Aims for 2013

Wadden Sea poles

- Recording of high quality time series in the Hoernum Deep in the final year of pole operation
- Correction procedures for bio-fouling effects in the optical turbidity

Satellite optical remote sensing

- Test of improved algorithms to estimate total suspended matter, chlorophyll a and gelbstoff concentrations from MERIS ocean colour observations
- Adaptation of MERIS algorithms to MODIS

Technical/ Program Developments in 2013

Introduction

Our understanding of sediment, phytoplankton, nutrient and micro-pollutant transports in coastal waters is based on the observation of both the spatial and temporal patterns of suspended particulate matter. In COSYNA, temporal dynamics from subtidal to interannual scales is captured at fixed observation points, whereas satellite-borne spectrometers of ocean colour such as MERIS and MODIS reveal the spatial patterns and daily to interannual variability of water surface concentrations. Coastal waters exhibit high spatial and temporal variability in the type of water masses and the nature and concentrations of dissolved and suspended substances. Substantial progress has been made over the last decade in developing algorithms that efficiently separate the spectra detected from satellites into contributions from the atmosphere (Doerffer 2011), the water surface and substances within the water (IOPs, Inherent Optical Properties), namely humic acids (gelbstoff), phytoplankton chlorophyll a (chl a) and total suspended sediments (TSM) (Doerffer & Schiller 2007). In the COSYNA data portal, images of these three substances derived from MERIS observations were continuously provided until April 2012 when ENVISAT ceased to operate.

In this study, we extend the validation of the MERIS-algorithms to Wadden Sea waters. Additional challenges originate from the small-scale topographical features of the seabed, emerging tidal flats, TSM concentrations (TSMC) ranging well above 10 g m^{-3} and a larger fraction of lithogenic material present.

Methods

The study area was the Hoernum Deep, located in the North Frisian part of the Wadden Sea between the islands of Sylt, Amrum and Föhr. Since 2002, the Helmholtz-Zentrum Geesthacht (HZG) Institute of Coastal Research operates a pole observing system to measure time series of meteorological, oceanographic, optical and basic bio-geochemical parameters from March to November. Ten-minute time series of TSMC were computed from optical turbidity data that were transferred into TSMC by comparison with gravitational analysis of water samples (Flöser et al. 2011, Röttgers et al. 2012). Thus, a large set of in-situ validation data is available over a long time period that covers all tidal phases, different wind conditions and seasons from early spring to late autumn. The procedure was tested for the year 2008 because the pole system operated very well throughout the whole year.

For each MERIS overflight the pixel (edge length about 1 km) that contains the position of the observation pole is selected and the scattering length $b(440)$, as delivered by the ESA standard processor (Doerffer & Schiller 2007, Doerffer 2011), is calculated. The value is discarded if the pixel is flagged with an error mark (e.g. “cloud”). The scattering length is related to the pole TSMC observed within 10 minutes of MERIS overflight. One of the main problems in this procedure is the degradation of the optical pole data by bio-fouling. To minimize the impact of bio-fouling, the pole sensors are cleaned each one to two weeks, but the impact is still clearly detectable as an abrupt decrease in signal strength after cleaning (see Figure 1). Bio-fouling not only leads to an amplification of the backscatter signal, but also removes its typical dominant tidal periodicities. As a consequence, the impact of bio-fouling is not correctable, but a method to flag the periods of significant distortion was developed. It is based mainly on a comparison to acoustic backscatter signals recorded in parallel, which seem to be not influenced by bio-fouling. After passing all remote sensing and in-situ pole quality criteria, 60 validation pairs remain.

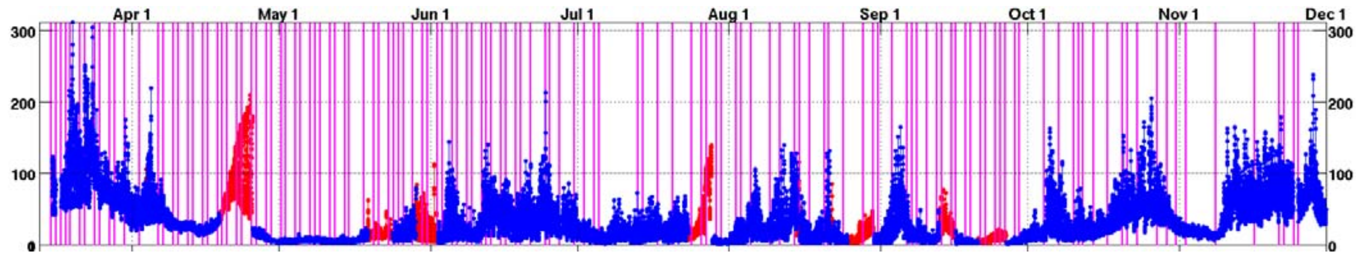


Figure 1: Pole TSMC [g m^{-3}] versus time for Hoernum Deep in 2008 (blue); red symbols indicate periods with detected bio-fouling distortion; pink lines denote the MERIS re-occurrence times where the pixel data at pole position passed all quality criteria.

Results (Highlights)

Figure 2 shows the pole TSMC data derived from optical turbidity versus *b(440)*, as derived from MERIS observations. Above some 5 g m^{-3}, the in-situ concentrations increasingly exceed the linear relationship as observed for the German Bight samples. The non-linear relationship is reasonably well (r^2 = 0.86) described by a power function of the form

$$TSMC = 1.329 * b(440)^{1.368} \quad (1)$$

Some outliers can be explained by relatively high temporal changes in in-situ concentrations. Removal of the six highest outliers does not change the regression curve or improve the correlation coefficient substantially.

Given the high spatial variability of TSMC and the MERIS grid size of approximately 1 km^2, the good correlation may appear somewhat surprising. The low TSMC was found mainly around slack water where all particles with high settling velocities settled away from the water surface. The remaining background of constantly suspended material may exhibit a comparably low variability. At the same time, one has to keep in mind that the pole data represent 10 min averages, which for average tidal currents of 0.5 m s^{-1} means an excursion length of 300 m, which is just a factor of 3 less than the MERIS grid edge length.

At the same time, for *b(440)* below 5 m^{-1}, the Wadden Sea data merge seamlessly with those from the German Bight (Doerffer & Schiller 2007) which fit well to the linear function TSMC=1.73* *b(440)* (see Figure 2) and were independently validated in the Skagerak (Sørensen et al. 2007). Thus, at least in the case of the Hoernum Deep, the transfer function (1) can be continuously applied for areas in the German Bight into the Wadden Sea area.

Applications

The motivation behind this study is the investigation of the transport pathways exchange patterns of particulate matter between the Wadden Sea and the German Bight that control the import of nutrients and fine sediments into the Wadden Sea. There are good reasons to hypothesize that the state of eutrophication within the Wadden Sea is due to regional differences in the morphology of tidal basins and the inner German Bight that control the net particulate matter exchange. Hence, in addition to time series data from Wadden Sea poles (HZG and ICBM/University of Oldenburg) and transect data from ship surveys, the spatial dynamics of TSMC data from satellite including the Wadden Sea will be extremely valuable. Further applications may be the transfer to other near coast areas with high TSMC or algorithms for the future generation of satellites (e.g. Sentinel).

Perspectives for 2014

- Extend the procedure for more years
- Extend the procedure to other observational poles in the German Wadden Sea: Jade Bay and behind Baltrum/ Langeoog
- A field survey in the Hoernum Deep to measure the optical properties of Wadden Sea water and their constituents.

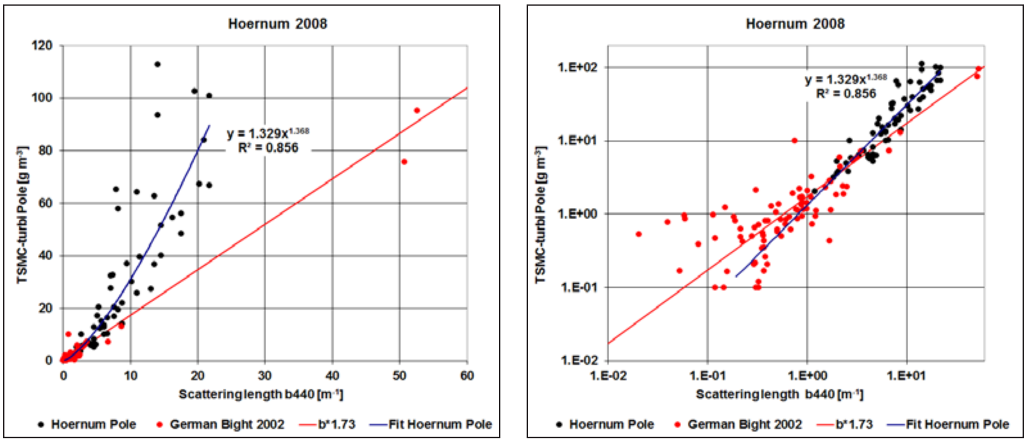


Figure 2: In-situ TSMC versus scattering length at 440 nm; left panel linear scale; right panel log-scale. For the Hoernum pole data, in-situ TSMC was computed from optical turbidity and b(440) from the ESA standard processor; for the German Bight 2002 data, in-situ TSMC was taken from water samples and b(440) from parallel in-situ measurements. The 2002 sample data were later corrected for residual material on the filter assuming a residual mass of 1 g m^{-3} on the filter (for details of the problem and procedure see Röttgers et al. 2012)

References

Doerffer R, Schiller H (2007): The MERIS Case 2 water algorithm, International Journal of Remote Sensing, 28:3-4, 517-535, DOI: 10.1080/01431160600821127

Doerffer R (2011): MERIS Algorithm Theoretical Basis Document 2.25. Alternative At-mospheric Correction Procedure for Case 2 Water Remote Sensing using MERIS. https://earth.esa.int/instruments/meris/atbd/abtd_2.25_v1.0.pdf. 25.05.2013

Flöser G, Wirth K, Riethmüller R (2011) : Wadden Sea Poles, COSYNA Progress Report 2011

Röttgers R, Flöser G, Heymann K, Krasemann H, Riethmüller R (2012): Improving measurements of suspended matter concentration. COSYNA Progress Report 2012

Sørensen K, Aas E, Høkedal, J (2007): Validation of MERIS water products and bio-optical relationships in the Skagerrak, International Journal of Remote Sensing, 28:3-4, 555-568, DOI: 10.1080/01431160600815566

Remote sensing

R. Röttgers / K. Heymann / M. Hieronymi / H. Krasemann / D. Müller / W. Schönfeld

Aims for 2013

- Field campaign for validation in Arctic waters
- Developing an NN-algorithm for MODIS and VIIRS data for the North Sea/Baltic Sea
- Preparation for Sentinel-3

Technical/ Program Developments in 2013

- An NN-algorithm for case 2 waters that uses MODIS and VIIRS data is developed. To continue after the failure of ENVISAT in 2012 and due to the late start of Sentinel-3 only in 2015, it was necessary to develop an algorithm for MODIS (and later VIIRS) data that produces chlorophyll, suspended matter concentrations, and gelbstoff absorption for coastal waters. This work was started in the framework of the MyOcean II project with a focus on the Baltic Sea. Later, the same algorithm will be trained for the North Sea. As the data structure of MODIS is fundamentally different from MERIS, the algorithm had to be constructed from the beginning and had to include an NN-based atmospheric correction.

Results (Highlights)

- The new MODIS case 2 water algorithm was trained with data from an optical model based on data from Baltic Sea waters and included variations of sea water temperature and salinity. First results (Figure 1) show an, expected, better performance than the standard processing for MODIS data, with spatially more homogeneous results, a higher number of non-flagged pixels and fewer artefacts. The absolute performance for chlorophyll, TSM and gelbstoff values has still to be validated with in-situ data before it can be applied routinely.

Problems

- Laptev Sea campaign failed due to a 10 days delay of the research vessel when coming to Tiksi.
- The different structure of MODIS and VIIRS data and the different sources for auxiliary atmospheric data had to be analysed and new program code had to be developed to read them, which delayed the processor development substantially.

Perspectives for 2014

- Finalising the case 2 water algorithm for MODIS and VIIRS data, to enable calculation of suspended matter and gelbstoff concentrations and to improve chlorophyll retrievals in coastal waters.

Publications

Örek H, Doerffer R, Röttgers R, Boersma M, Wiltshire KH (2013): Contribution to a bio-optical model for remote sensing of Lena River water. Biogeosciences, 10, 7081-7094. www.biogeosciences.net/10/7081/2013/ doi:10.5194/bg-10-7081-2013

Tan H, Doerffer R, Oishi T, Tanaka A (2013): A new approach to measure the volume scattering function. Optics Express, 21, 18697-18711, http://dx.doi.org/10.1364/OE.21.018697

Wollschläger J, Grunwald M, Röttgers R, Petersen W (2013): Flow-through PSICAM: A new approach for determining water constituents absorption continuously. Ocean Dynamics 63, 761-775

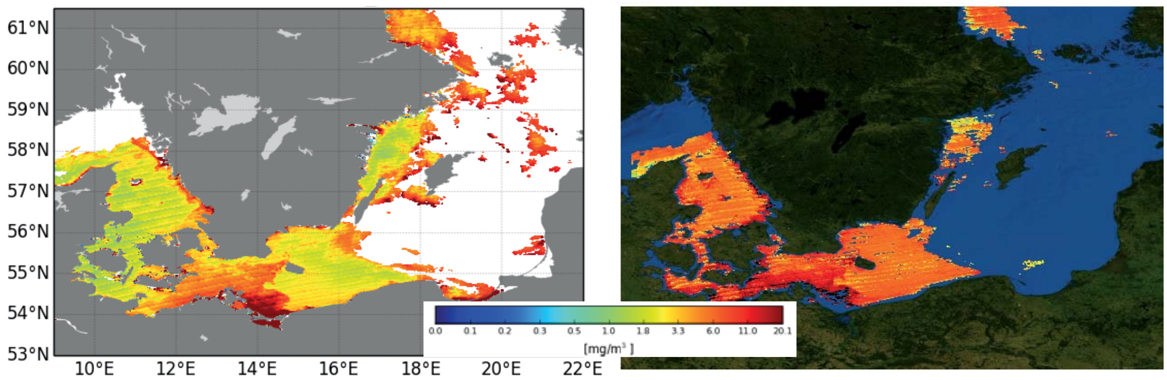


Figure 1: Comparison of the new Baltic Sea processor (left) with the standard MyOcean processor (right) for chlorophyll concentration.

hypOO

O. Zielinski / D. Voß / S. Garaba / A. Braun

Aims for 2013

Main research focus has been on shipborne ocean colour remote sensing in coastal areas, shelf seas and Arctic waters. Little work has yet been done to explore the potential of fixed platforms. The Wadden Sea time series station Spiekeroog (WSS) has been an operational hydrographic and marine environmental parameters observatory since autumn 2002 (Badewien et al. 2009). In the last few years instruments have been upgraded and there is need to provide insight into the available optical sensing technology. Objectives included (i) providing an extensive protocol on acquiring and processing of ocean colour remote sensing data, (ii) exploring correlations in ocean colour products (OCPs) and ocean biogeochemical parameters, (iii) assess the extent to which OCPs are useful in monitoring and managing the marine environment.

Technical/ Program Developments in 2012

At the station a 3 radiometer sensor setup at 24 m height above the basin is used. A RAMSES-ACC hyperspectral cosine irradiance meter for E_d (λ) downwelling solar irradiance and two RAMSES-ARC hyperspectral radiance meters L_{sfc} (θ_{sfc}, Φ_{Sun}, λ) for upwelling solar radiance and L_{sky} (θ_{sky}, Φ_{Sun}, λ) for sky leaving radiance are in use (TriOS GmbH, Germany). The schematic of the setup is shown in Figure 1. The sky facing radiance sensor is set at Θ_{sky} = 30° zenith angle and the sea surface facing radiance sensor is set at Θ_{sfc} = 30° nadir angle and the azimuthal angle relative to North is Φ_{North} = 159.5°. Φ_{Sun} is the relative azimuthal angle of the radiance meters to the sun. The radiometers collect irradiance and radiance continuously at 5-minute intervals. Wind speed is measured by a 14576 sensor cup anemometer and wind direction by 14566 sensor (Lambrecht, Germany).

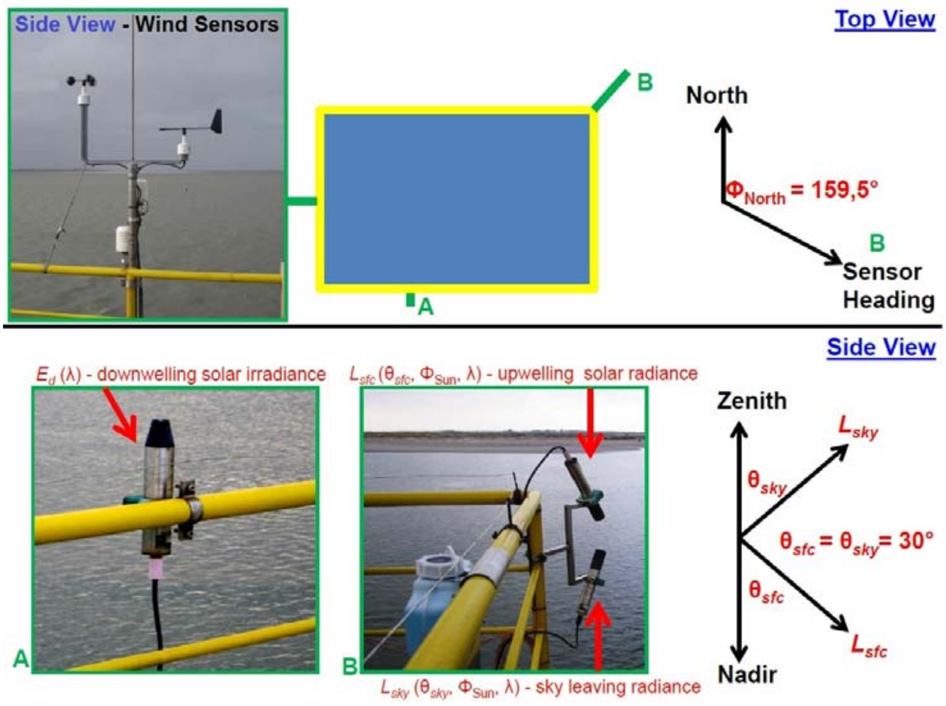


Figure 1: Top and side view of RAMSES radiometers as well as wind sensors setup on the Wadden Sea time series station Spiekeroog. The blue box gives a birds eye view of the measurement station, the green lines give the orientation of the devices.

Results (Highlights)

We have looked at how OCPs are related to turbidity (Garaba et al. 2014). The preliminary findings are summarized below.

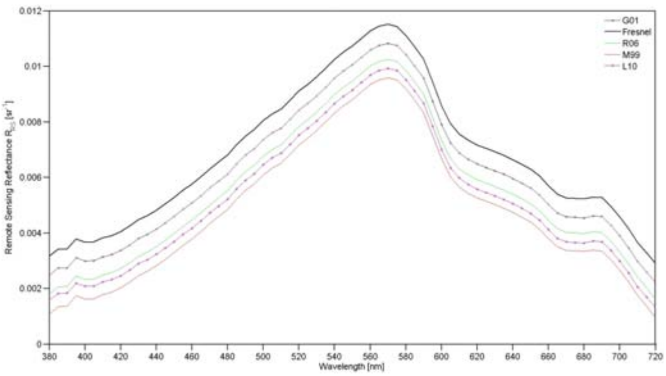


Figure 2: Example of R_{RS} after surface reflected glint correction observed on 18 August 2013 at 11:00. These correction approaches G01, R06, M99, and L10 are summarized in a recent protocol (Garaba and Zielinski 2013).

Problems

Ocean colour remote sensing at the observatory is affected by surface reflected glint and meteorological conditions. Observations during rainfall and or low light contain some information but little is known about them. We therefore use observations during daytime, i.e., no rainfall, no fog, after sunrise and before sunset. Bio-fouling impacts observations by submerged instruments (Figure 3b).

Perspectives for 2014

As little is known about the inherent and apparent optical properties of the WSS our goal is to carry out periodic measurements. These measurements will be complemented by the ocean colour remote sensing measurements that are already taken daily at 5 – 15 minute intervals. Inherent optical properties will also be used to solve radiative transfer problems in HydroLight modelling software as an essential procedure in performing optical closure tasks.

Beside the topic of the fixed station the already known radiometer set-up on RV Heincke is still in operation. Interested researchers can use the system on demand.

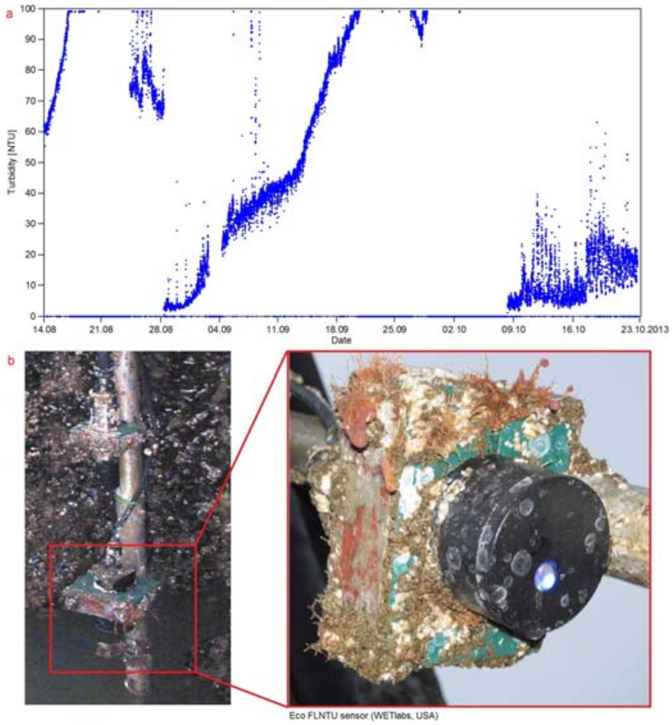


Figure 3: a) Time series of all raw in-situ turbidity data between August and October 2013. b) Bio-fouling on the Eco FLNTU sensor (WETlabs, USA). As material starts to accumulate on the sensor window turbidity measurements increase rapidly for example after 04.09.2013, turbidity values reach 100 NTU which is sensor limit. After cleaning for example 09.10.2013 to 23.10.2013 measurements are below 30 NTU. Note the date format DD.MM.YYYY.

Publications

Badewien T, Zimmer E, Bartholomä A, Reuter R (2009): Towards continuous long-term measurements of suspended particulate matter (SPM) in turbid coastal waters. Ocean Dynamics, 59, 227-238, doi:10.1007/s10236-009-0183-8

Garaba Sp, Zielinski O (2013): Methods in reducing surface reflected glint for shipborne above-water remote sensing. Journal of the European Optical Society - Rapid Publications, 8, 13058, doi:10.2971/jeos.2013.13058

Garaba Sp, Badewien Th, Braun A, Schulz A-C, Zielinski O (2014): Ocean color and turbidity observations at Wadden Sea time series station Spiekeroog. Geophysical Research Letters (submitted)

HF-radar monitoring in the German Bight

J. Horstmann[1] / J. Seemann[1] / M. Cysewski[1] / S. Maresca[2] / P. Braca[2] / T. Schlick[3] / K-W. Gurgel[3]

[1]Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Germany
[2]Center for Maritime Research and Experimentation, La Spezia, Italy
[3]Centre for Marine and Climate Research, University of Hamburg, Germany

Aims for 2013

- Continuous operation and maintenance of the three HF-radar systems deployed at the German North Sea coast
- Hard- and Software upgrades for all HF-radar stations
- Quasi operational real time measurements of current fields in the German Bight
- Validation of HF-radar surface currents with ship borne ADCP measurements
- Setup and testing of ship detection and tracking capabilities of multiple HF-radars
- Continuous collection of AIS information at the HF-radar sites

Technical / Program Developments in 2013

The HF-radar sites Sylt, Büsum and Wangerooge located at the German North Sea coast were operated through 2013 with only minor radar downtimes. Figure 1 depicts the overall availability of HF-radar data during all of 2013. The total number of days with radar data recorded at each station was 332.8 d at Sylt, 356.6 d at Wangerooge and 363.5 d at Büsum, respectively. The radar data were converted to surface current fields within our quasi operational processing chain, resulting in a current field observation every 20 min, which are made available via the COSYNA data portal in near real time (http://codm.hzg.de/codm/). A typical HF-radar retrieved surface current field from 5 Jan 2014 is depicted in Figure 2. The current vectors result from 20 minutes of radar data acquired at each of the three sites.

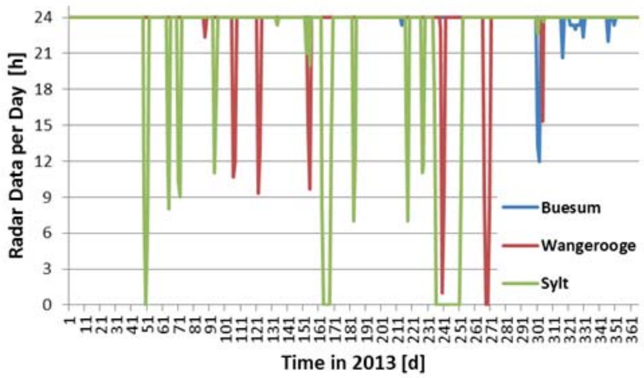


Figure 1: Data availability in 2013 from the HF-radar network observing the German Bight in the southern part of the North Sea.

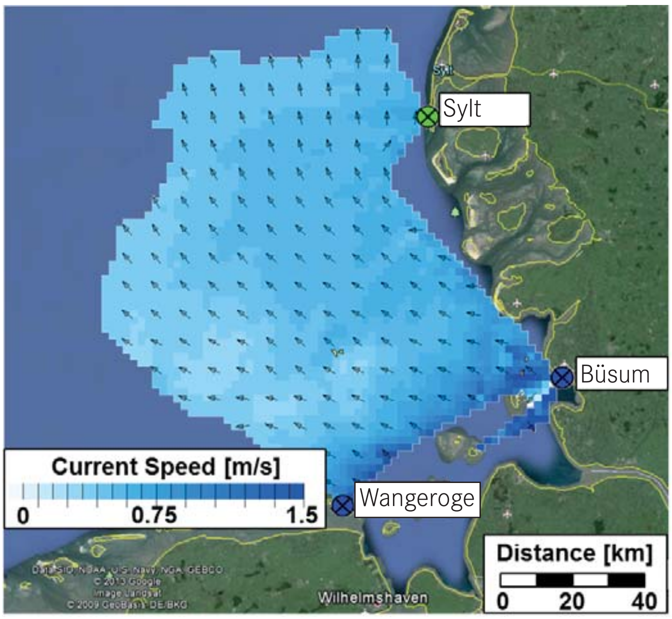


Figure 2: Surface current field in the German Bight resulting from 533 s of measurements acquired by each of the three HF-radar stations on 5 January 2014 at 04:19 UTC.

In late 2013 we started upgrading all HF-radar with new hardware, which was required to upgrade the systems with the latest software. Since April 2014, after runnig the systems in parallel mode for a time span of at least one month, all systems operate with the new hard- and software.

As part of HZG's co-operation with the University of Hamburg the HF-radar retrieved surface currents as well as significant wave heights have been compared to measurements obtained by a vessel mounted Acoustic Doppler Current Profiler (ADCP)

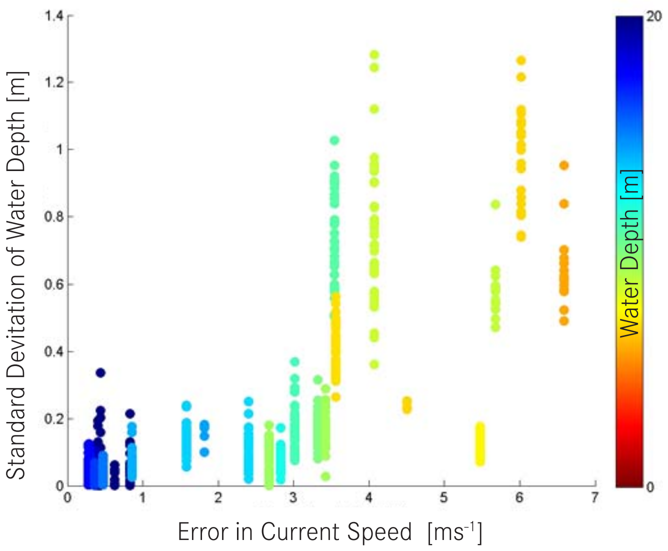


Figure 3: The error of HF-radar retrieved current speeds versus the standard deviation of the water depth within a HF-radar resolution cell is shown. The color coding refers to the mean water depth within the HF-radar resolution cell.

and directional wave rider buoys. We observed that generally the largest deviation between HF-radar and ADCP current values occurred for strong currents in the shallow water regions (<10 m). Further analyses showed that the standard deviation in surface currents increases not only with decreasing water depth, but in particular with increase of water depth variability within the resolution cell of the HF-radar (Figure 3). This is due to the fact that the variability of the water depth in shallow water leads to a strong variability of the surface currents and therefore in turn to a smearing of the measured Doppler peak resulting in a wrong estimate of the surface current.

Comparisons of HF-radar retrieved significant wave heights to measurement from a wave buoy showed a large scatter with a significant overestimation of HF retrieved wave heights. Observations of the HF retrieved significant wave heights over time showed a clear tidal signal with significant overestimations at high currents, which was not observed in the buoy measurements (Figure 4). In-depth analyses showed that a strong change of the surface currents within the integration time utilized for the retrieval (~20 min) leads to smearing of the integrated Doppler spectrum and therefore to significant errors in the wave height retrieval. A preliminary correction of the spectra alone already results in significant improvement of the retrieved significant wave heights (Figure 4). In 2014 a substantially improved retrieval scheme for HF-radar wave retrieval is expected to be ready, which will enable reprocessing of HF-radar data for significant wave heights.
Mid-2013 the Institute of Coastal Research at HZG and the Center for Maritime Research and Experimentation (CMRE) in La Spezia, Italy, have started to utilize the COSYNA HF-radar setup for ship detection, tracking and fusion purposes. The main idea of this task was to take advantage of the growing number of oceanographic HF-radars along the world's coasts and use them in addition to the oceanographic parameter retrieval for maritime surveillance applications. Furthermore, the application of HF-radars in oceanographic sensing and ship detection is a complementary problem as the presence of ships can limit the extraction of oceanographic parameters and in turn the presence of clutter (mainly due to the ocean) significantly affects the ship detection performance.
Since the HF-radar systems were set up for oceanographic parameters, their configurations are not ideal for ship detection, which leads to a degradation of the detection performance. In addition, the poor range and azimuth resolution of HF-radars, the significant false alarm rate due to both sea clutter and man-made/natural interference, as well as crowding of the HF-spectrum are all problems that have to be tackled.

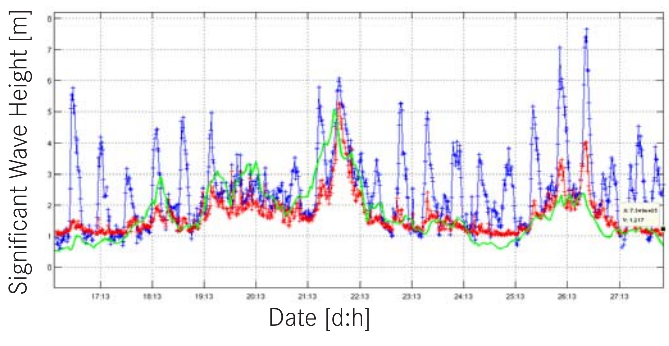


Figure 4: Significant wave height as retrieved from the HF-radar before (blue line) and after (red line) an a priori correction at the grid point of the wave rider buoy measurement (green line).

So far these problems have been addressed by applying state-of-the-art algorithms as well as combining data from multiple radar stations (Bruno et al. 2013, Maresca et al. 2013, 2014). The entire processing chain that has been setup for the German Bight system consists of the following parts:

- Ship detection, which is performed by using a 3D Ordered Statistics Constant False Alarm Rate algorithm (Dzvonkovskaya et al. 2009).
- Ship tracking that is based on the Joint Probabilistic Data Association rule (Bar-Shalom et al. 2011) in combination with an Unscented Kalman Filter (Julier & Uhlmann 2004).
- Data fusion strategy following the Track-to-Track Association and Fusion (T2T-A/F) paradigm (Bar-Shalom et al. 2011).

Results (Highlights)

In co-operation with the CMRE we set up the processing chain for ship tracking and have generated preliminary output covering several weeks of data acquired in the second half of 2013. Therefore, the ship detection is performed on site at each HF-radar station every 33 s and then forwarded to HZG. The tracking and fusion was performed as a post processing task and then incorporated into CMREs Fusion-as-a-Service (FaaS) tool, which allows fusion of different kind of available ship detection data. An example of resulting ship tracks after tracking and fusion of 30 minutes of HF-radar data collected on 1 August 2013 are depicted in Figure 5. Within the next steps the system will be setup to operate in near real time and in-depth validation of the ship detects and tracks in particular with respect to geophysical dependencies will be carried out.

Figure 5: Map of the German Bight showing ship tracks retrieved from the HF-radars (green tracks) and ship tracks recorded by the AIS receivers (grey track) after fusion of the data acquired at each of the radar sites on 1 August 2013 10:31 UTC. Ship tracks represent 30 minutes of data.

Problems

For validation of the HF-radar based ship detection and tracking reliable ground truth data are not available. For all validation purposes AIS data are utilized as ground truth. However AIS data have some significant drawbacks such as a limited coverage, which is also dependent on the weather conditions and the dependence on the active participation of the vessels. Although the latter is required by law for all ships traveling in international waters with a gross tonnage of over 300 we have observed several realistic HF-radar retrieved tracks that were not confirmed by AIS data although located well in the reception range of the AIS receivers. In addition the limited resolution of the HF-radar leads to problems in distinguishing ships traveling close to each other. This problem gets significant within high traffic areas such as the Elbe estuary.

Perspectives for 2014

For 2014 and beyond we plan to:

- Continuous operation and maintenance of the three HF-radar systems deployed at the German North Sea coast
- Quasi operational real time measurements of current fields in the German Bight
- Perform a surface drifter experiment in the German Bight for in-depth analyses of HF radar current retrieval
- Validate the improved HF-radar retrieved significant wave heights with buoy measurements as well as numerical model results
- Further improve the HF-radar ship detection and tracking and investigate the dependencies on geophysical parameters such as significant wave height
- Quasi operational setup and demonstration of HF-radar ship detection tracking

References cited

Bar-Shalom Y, Willett P, Tian X (2011): Tracking and Data Fusion: A Handbook of Algorithms. Storrs, CT: YBS Publishing

Dzvonkovskaya A, Gurgel K-W, Rohling H, Schlick T (2009): HF Radar WERA Application for Ship Detection and Tracking. European Journal of Navigation, 7 (3) 18-25

Julier SJ, Uhlmann JK (2004): Unscented filtering and nonlinear estimation. Proc. IEEE, 92 (3), 401–422

Kirubarajan T, Barshalom Y, Pattipati K, Kadar I (2000): Ground target tracking with variable structure IMM estimator. IEEE Trans. Aerosp. Electron. Syst., 36 (1), 26–46

Publications

Bruno L, Braca P, Horstmann J, Vespe M (2913): Experimental Evaluation of the Range-Doppler Coupling on HF Surface Wave Radar. IEEE Geosci. Remote Sens. Lett., 10 (4), 850–854

Maresca S, Braca P, Horstmann J (2013): Data fusion performance of HFSWR systems for ship traffic monitoring. In: Proc. of the 16th Intern. Conf. on Inform. Fusion (FUSION), Istanbul, 2013

Maresca S, Braca P, Horstmann J, Grasso R (2014): Maritime surveillance using multiple high-frequency surface-wave radars. IEEE Trans. Geosci. Remote Sens., 52 (8), 5056–5071

FerryBox

W. Petersen / M. Haller / J. Wollschläger

Aims for 2013

- Continuous operation of three underway FerryBox systems in the North Sea aboard cargo ships and ferries
- Continuous operation of the stationary FerryBoxes in Cuxhaven and on platform FINO3
- Field campaigns aboard research vessels with the FerryBox system
- Testing/optimisation of new sensor developments for unattended operation within FerryBox systems
- Contributions to the EU project JERICO
- Scientific evaluation of FerryBox data

Technical/ Program Developments in 2013

- Test and optimisation of pH/alkalinity sensor during a COSYNA campaign aboard RV Heincke.
- Evaluation of PSICAM data together with complementary biological data (genprobes, microscopy) from the campaigns (PhD thesis Jochen Wollschläger)
- Installation of a FerryBox aboard Hafnia Seaways, preparation of a FerryBox installation aboard Selandia Seaways

Results (Highlights)

Underway FerryBox systems

In 2013 the two underway FerryBox systems from HZG were operated during the entire year. The FerryBox aboard the vessel Hafnia Seaways was still operated on the route Rotterdam to Immingham with interruptions due to technical issues. The transect Immingham-Cuxhaven was not served by a FerryBox during all of 2013.

The vessel LysBris operated between Norway, Belgium and England. The operation of the basic system including oxygen and pH could be continued successfully with only a few gaps due to two-monthly maintenance carried out in Norway or the Netherlands. The FerryBox aboard the passenger ferry FunnyGirl was operated from Büsum or Cuxhaven to Helgoland throughout the year. The FerryBox routes in 2013 are shown in Figure 1.

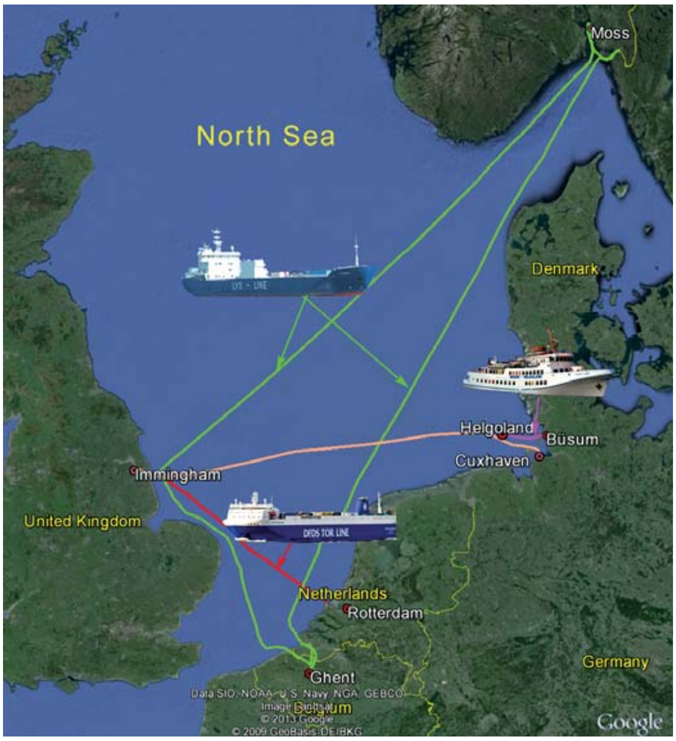


Figure 1: Operated routes (green LysBris, red: Hafnia Seaways, magenta: FunnyGirl) in the North Sea in 2013 (orange: transect Imm-Cux, not operated in 2013)

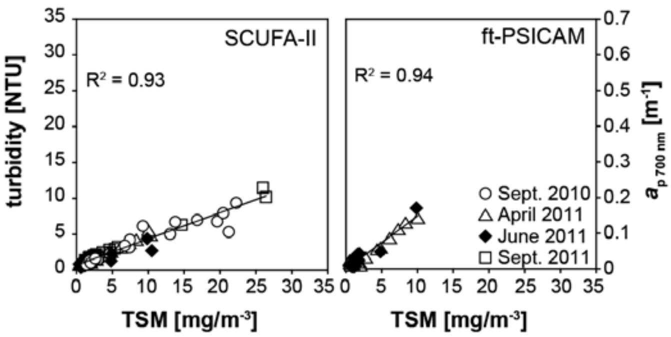


Figure 2: Determination of total suspended matter concentration by different methods on various cruises in 2010 and 2011, each against gravimetrically determined values. Left panel: light scattering-based (nephelometer) sensor, right panel: absorption based (flow-through PSICAM).

FerryBox systems on fixed platforms

In 2013 it was attempted to operate the stationary FerryBox systems in Cuxhaven at the mouth of the Elbe River and on FINO3 during the entire year. Again, the operation on the FINO3 station was interrupted several times either caused by power failures and subsequent problems with the FerryBox computer or by problems with the pump system that delivers seawater to the FerryBox.

Development and operation of new sensors: flow-through PSICAM

As already described in the 2012 progress report, continuously measured absorption coefficient data were obtained using a flow-through point source integrating cavity absorption meter (flow-through PSICAM) integrated in a FerryBox on several ship cruises in the years 2010 and 2011. These data were further evaluated with respect to high frequency determination of biologically relevant parameters. Despite providing a more stable proxy for chlorophyll-a, the measurements have been shown to be also useful for the determination of total suspended matter concentration in the water (Figure 2), which influences the light conditions and therefore phytoplankton productivity.

Furthermore, a comparison of chlorophyll-a concentrations calculated on the basis of traditional in-situ fluorescence data with concentrations based on absorption coefficient measurements showed certain differences caused by acclimatisation of the phytoplankton to high light intensities during the day quenching the fluorescence signal (Wollschläger et al. 2014a). Taking this result as an example, the different response of chlorophyll-a fluorescence and chlorophyll-a absorption to environmental factors offers the possibility to detect changes within the phytoplankton community by the simultaneous measurement of both parameters.

Investigation of phytoplankton community

Traditionally, routine observations of phytoplankton are carried out via microscopic analysis. Since this is tedious and time consuming it limits the number of samples to be analysed. Moreover, the focus of investigation lies mainly on the microphytoplankton, because smaller phytoplankton is easily overlooked and often insufficiently identifiable by microscopic means. Nevertheless, information about nano- and picophytoplankton are necessary for a thorough understanding of the whole community. Several methods have emerged in recent years for a better assessment of the small phytoplankton, like pigment analysis via HPLC, determination of size distribution by flow cytometry, or molecular biological approaches for acquiring taxonomical information.

Aim of a study carried out in 2013 was to evaluate a selection of these methods and their applicability in routine phytoplankton investigation, as well as to use them for investigation of the phytoplankton communities in the German Bight. Samples taken on several cruises in the years 2010 and 2011 were analysed using the above-mentioned methods in complement to cell counting by microscopy.

Focus of the molecular approach was the use of DNA/RNA-microarrays, so-called phylochips. They take advantage of molecular probes consisting of short nucleic acid sequences of the target taxon fixed on a solid surface, usually a glass slide (the microarray “chip”). When DNA or RNA extracted from a sample is applied on the chip, only the sequences, which are complementary to the respective molecular probes, hybridise with them and are bound to the chip. The position and intensity of the signal allow conclusions about the species occurring in the sample and their relative abundance.

The evaluation of this method was performed in co-operation with AWI. It turned out that the information provided by the DNA-based microarray is reliable mainly in terms of detecting the presence or absence of target taxa (Wollschläger et al. 2014b). Quantitatively, certain steps in sample preparation considerably biased the signal. In this respect, the results of a RNA-based microarray were more promising, since they showed a good correlation between signal intensity and, e.g., cell counts (see the contribution of K. Metfies in this report). Nevertheless, even the qualitative DNA-microarray contributed in combination with the other methods to a more comprehensive picture of the phytoplankton situation in the German Bight than microscopy alone (Wollschläger et al. in prep.). The microphytoplankton community showed seasonal succession with a well-known dominance of Dinoflagellates during the summer and in offshore regions (Figure 3).
No seasonal behaviour was observable for the nano- and picophytoplankton; instead, a change in the community was visible between 2010 and 2011.

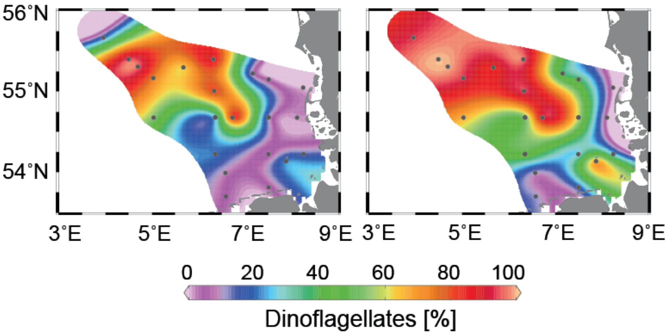


Figure 3: Contribution of Dinoflagellates to phytoplankton in the German Bight in July 2010. Left panel: based on cell counts, right panel: based on carbon biomass.

Comparison of FerryBox data with model data

The evaluation of model simulations using observational data contributes to the improvement of model performance and to the determination of possible gaps. FerryBox observations provide reliable data along the transect from England to Germany (Figure 1). The operational hydrographic model BSHcmod v4 as well as the Tidal Residual and Intertidal Mudflat model (TRIM) have been evaluated for water temperatures and salinity (shown in Figure 4 for BSHcmod v4). Besides the well-represented annual cycle, the small-scale temporal variations of water temperatures are present in both models; however, they are smaller than observed. Statistical measures indicate that both models could be improved in terms of reducing the offset of mean temperature levels, the correct representation of summer maximum temperatures and the level of deviation from the mean. The source of too low water temperatures in the western part of the transect in late summer for BSHcmod v4 has to be further analysed.

Comparisons of salinity, shown in Figure 4 (right panel) for FerryBox and BSHcmod v4, reveal high differences between observations and simulations and indicate systematic deviations that vary with location. Both models show certain limitations: TRIM and BSHcmod v4 lack correct salinity variability as well as range, i.e., too low (too high) simulated salinity in the German Bight (in the western part of the transect). Low salinity events in the southern North Sea are represented by BSHcmod v4 to some extent. In order to improve salinity values in the model it would be advisable to use validated daily fresh water input data for all main rivers entering the North Sea. More studies, also on vertical mixing, are needed to investigate salinity and temperature distribution as well. Also, the nesting of different grid sizes has to be evaluated further.

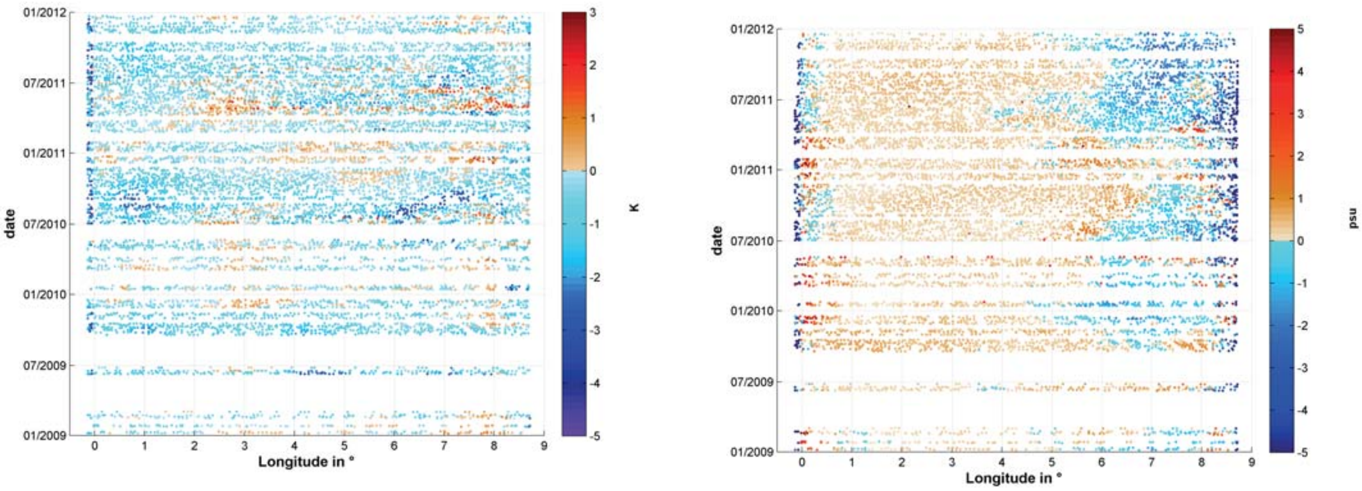


Figure 4: Differences of water temperatures (left panel) and salinity (right panel) for the transect from Immingham to Cuxhaven from 2009 to 2011 (BSHcmod v4 - FerryBox). The x-axes start at the East England coast and end in the German Bight. Positive values indicate model overestimation.

Problems

- The operation of the conventional nutrient analysers was only continued at station Cuxhaven due to too high maintenance efforts for the underway systems
- Even if the FerryBox works well on the station FINO3 the accessibility especially in wintertime is still a problem and leads to long downtimes
- The route Immingham – Cuxhaven was still not covered by a FerryBox due to several changes of the ships on this route

Perspectives for 2014

- One of the ships already prepared for the installation of a FerryBox will probably come back to the route Immingham to Cuxhaven
- On-going development and test of a new SIA based nutrient analyser (nitrate, nitrite and phosphate)
- Unattended operation of the newly developed high precise pH and alkalinity sensor for measuring the carbon cycle from the coast to the open sea
- Scientific evaluation of FerryBox data with regards to oxygen, nutrients and pCO_2 and entire carbon cycle
- The use of absorption spectra from the PSICAM for phytoplankton group identification

Publications

Haller M, Grunwald M, Petersen W, Kapitza H, Callies U, Dick S, Janssen F (2014): Data from FerryBoxes, fixed Stations and numerical models in the North Sea: A comparing evaluation. J. Marine Systems (submitted)

Petersen W (2014): FerryBox Systems: State-of-the-Art in Europe and Future Development. J. Marine Systems (accepted)

Wollschläger J, Grunwald M, Röttgers R, Petersen W (2013): Flow-through PSICAM: a new approach for determining water constituents absorption continuously. Ocean Dynamics 63(7): 761-775. doi: 10.1007/s10236-013-0629-x

Wollschläger J, Röttgers R, Petersen W, Wiltshire KH (2014 a): Performance of absorption coefficient measurements for the in situ determination of chlorophyll-a and total suspended matter. Journal of Experimental Marine Biology and Ecology 453(0): 138-147. doi: http://dx.doi.org/10.1016/j.jembe.2014.01.011

Wollschläger J, Nicolaus A, Wiltshire KH, Metfies K (2014 b): Assessment of North Sea phytoplankton via molecular sensing: a method evaluation. Journal of Plankton Research 36(3): 695-708. doi: 10.1093/plankt/fbu003

Gliders

L. Merckelbach / A. Werner / R. Kopetzky / B. Peters

Aims for 2013

- Implementing and testing a virtual AIS implementation
- Using glider data for suspended sediment analysis

Technical developments in 2013

Virtual AIS implementation

The Wasser-und-Schifffahrtsamt (WSA) and Wasser-und-Schifffahrtsverwaltung (WSV) have concerns regarding the adverse effects of the use of gliders on the safety of shipping. As reported previously, ideally gliders should be equipped with an AIS (Automatic Identification System) transponder, which makes gliders visible to most nearby ships, as at present day almost all seagoing ships are equipped with an AIS device. Equipping a glider with an AIS transponder is impractical. Therefore, it was suggested to develop a virtual AIS system whereby the actual glider position is broadcast by a land-based station on behalf of the glider. Discussions with WSA and WSV in 2012 have led to a design where an AIS message is broadcast based on:

- the actual GPS position when the glider is at the surface and via a satellite link connected to a server on shore;
- a predicted position when the glider is underwater.

The main difficulty is in predicting the position of the glider underwater due to the uncertainty in the actual water currents. A method was devised where the instantaneous current (magnitude and direction) is estimated from glider data only using a Kalman filter technique. The Kalman filter was able to estimate the position with a mean error of about 500 m for a subsurface time of 3 hours, see Figure 1. This was found acceptable by the authorities WSA and WSV.

The approach was implemented into a system that can generate predicted glider positions with three-minute intervals during a glider mission. This system comprises the following components: a module for communication with the glider server software, the Kalman filter for current estimation, a glider behaviour/dynamics model to predict the glider's behaviour, and a module that assembles positional information from either actual GPS data or predicted positions. The final step, i.e. to broadcast the positional information as an AIS message is privileged to WSV for legal reasons and planned to be implemented in 2014.

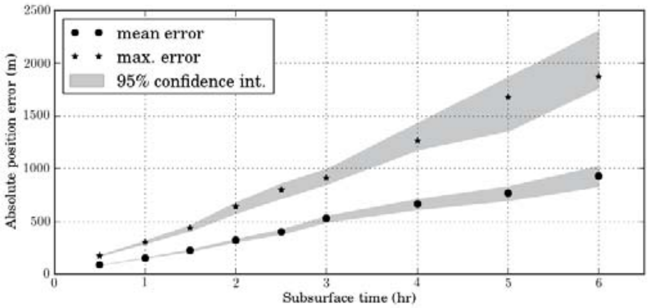


Figure 1: Performance of the Kalman filter/glider model, displaying the error between predicted and real position as function of the subsurface time.

Calibration frame

The gliders at HZG are equipped with optical (backscatter) sensors and CTDs. These sensors are fully integrated in the glider's system and hull, which makes a laboratory or field calibration cumbersome. To facilitate the glider sensor calibration a proto-type calibration frame has been developed, see Figure 2. This frame houses two gliders and a suite of other sensors including CTD, turbidity sensor, transmissometer and oxygen sensor. The frame therefore allows to make an in-situ comparison of sensors of different gliders and reference sensors that are more practical to calibrate. Turbidity and optical backscatter sensors can be calibrated against water samples using the three water samplers (shown in the left in-set of Figure 2).

Figure 2: Glider sensor calibration frame, developed at HZG

Results (Highlights)

A glider formation controlling algorithm

A glider equipped with an optical backscatter sensor, calibrated for suspended sediment concentration using the frame described above, is an ideal platform to study suspended sediment dynamics. Based on such observational data, as part of her thesis, MSc student M. Tropp formulated a vertical sediment concentration balance for a water column divided in discrete layers. In this approach the local rate of change of sediment concentration has been equated to the observed rate of change, from which fluxes between the layers (and bed) can be estimated. Comparing the estimated resuspension fluxes near the bed with the bed shear stress obtained from GETM model results, she found that the correlation is fair at best and concluded that a substantial difference between the observed and local rate of change of concentration can exist due to the presence of spatial (horizontal) concentration gradients as the glider (also) moves horizontally with respect to the ambient water.

In order to estimate the horizontal gradient from glider data, an experiment was planned where two gliders operate in each others proximity. To achieve this, an algorithm was developed that implements the leader-follower paradigm, that is, one glider, acting as leader is programmed conventionally following waypoints, whereas any number of followers are piloted automatically to maintain a prescribed distance from the leader. This algorithm reuses most of the components of the virtual AIS system described above, and is augmented with a component that determines the waypoint list and buoyancy drive of the follower glider so that this distance is maintained.

During a three-week experiment in August 2013 the algorithm was tested successfully on a configuration of one leader glider followed by a trailing second glider at a target distance of 5 km. Using a 2-layer model, separated by the thermocline, yielded resuspension fluxes that correlate well with the bottom shear stresses, see Figure 3.

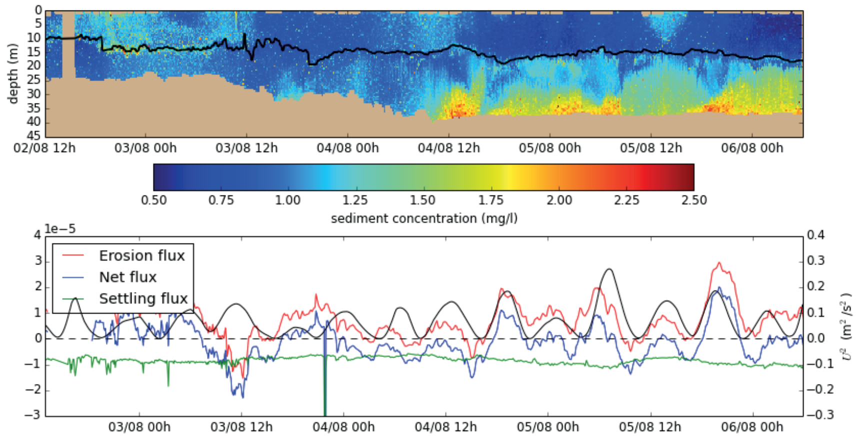


Figure 3: Observed sediment concentrations (top panel) and the corresponding calculated fluxes between water column and sea bed. From 4 August onwards, the erosion flux (red) correlates well with the depth-averaged current squared (black), i.e., a proxy for bottom shear stress.

Problems

Although the glider formation controlling algorithm appeared to be robust, the slow responsiveness of the leader-follower pattern due to the low glider speed in comparison with the magnitude of the tidal currents, it turned out that maintaining a precise distance is not a trivial task. This is in particular the case when the leader changes direction. For the flux calculations this is detrimental as gradients can be calculated reliably only when the two gliders are moving in-line. Although there is still scope to improve the algorithm, robust estimates for the horizontal gradient are obtained by using an additional follower glider.

Perspectives for 2014

The two HZG gliders will be fitted with microstructure sensors. Following test missions in May, the gliders will be used in a dedicated experiment near NordSeeBoje III (German Bight). In the same location, the gliders will also be flown in formation in order to calculate fluxes across the bed interface and pycnocline, whereas the microstructure data should shed light on the mixing processes directly. A bottom mounted ADCP will provide current profiles in order to have a more accurate estimate of bottom shear stresses and current shear across the pycnocline.

Long term observatory @ Pile Spiekeroog ICBM

T. Badewien

Aims for 2014

- The long-term observatory (LTO) “Pile Spiekeroog ICBM” has gathered environmental data for more than eleven years. These measurements will be continued and integrated into COSYNA.
- The technical renewal of the research platform is now almost completed. In 2014, the nutrient analyser on the platform will be modified to implement an improved approach for determining NO_x.

Technical / Program Developments in 2013

- All real-time data sets, except for current data, are available through the COSYNA data portal. The nomenclature of the parameters follows the suggestions made by the OceanSITES network within GOOS (www.oceansites.org). The reference depth is the long-term mean of the sea level (NN, Normal Null).
- New validation techniques for hydrographical data have been implemented and now run automatically.
- An ADCP was mounted at the bottom close to the platform using an anchor made of concrete. After a test period of 9 months, the anchor was not as firmly grounded in the sediment as expected. We therefore decided to mount the ADCP to a horizontal arm of 12 metres length. The arm will be deployed one metre above the bottom and will be fixed to the platform.
- Problems with the power supply of the nutrient analyser could finally be resolved.
- The autonomous operation of the new nutrient analyser initially failed due to soft- and hardware problems. These could be resolved after extensive error analyses.

Results (Highlights)

- The sensors on the platform run in a fully operational and autonomous mode. For example, high quality data are available for the storm surge caused by the storm front “Xaver” in December 2013.
- The quality of the data is assured through automatic validation routines and regular reference measurements with a profiling CTD.
- The data management and export to end-users is well established.

Problems

- The new nutrient analyser does not yet run in a fully operational mode.
- The ADCP has not been finally integrated into the new data management system. It was only recently installed. Therefore, current data are not yet available in real time.

Perspectives for 2014

The fully validated data sets will be published in an open access online database. They will then be available via a digital object identifier (doi).

Background and results from the pile HPA Elbe1

M. Berendt / N. Ohle / D. Schuster

Technical / Program Developments 2013

The proposed and realised implementation of the pile HPA Elbe1 (operated by HPA und HZG) in the mouth of the Elbe estuary between the fairway and the Wadden Sea is based on the idea to implement an observation station to measure morphodynamic exchange processes between the North Sea and the Elbe estuary and also between the deep fairway and the flat Wadden Sea area. The data can also be used to complement existing monitoring systems and programs.

The collected data contain the following basic COSYNA parameters belonging the so called category I (photo and schematic sketch of the pile HPA Elbe1 see Figure 1):

- Hydro- and morphological parameters:
  Currents, water pressure, water temperature, conductivity (and derived salinity),
  pH value, dissolved oxygen content, fluorescence, turbidity (incl. water samples)
- Meteorological parameters:
  Wind velocity, wind direction, barometrical pressure, air temperature, global solar radiation, precipitation rate, humidity

The location of the pile HPA Elbe1 (operated by HPA und HZG) is shown in Figure 2. As there is no external power supply at the off-shore location of the pile, measurements and analysis of nutrients cannot be done at that location. Therefore a ferry box was installed at the on-shore location Cuxhaven.

Due to the technical construction of the pile it was not possible to have it deployed during winter. Therefore the pile HPA Elbe1 was uninstalled during winter time and was only in operation in the summer time of the years 2012 and 2013 during the following time periods:

- 2012: March 15th until November 20th
- 2013: March 19th until October 30th

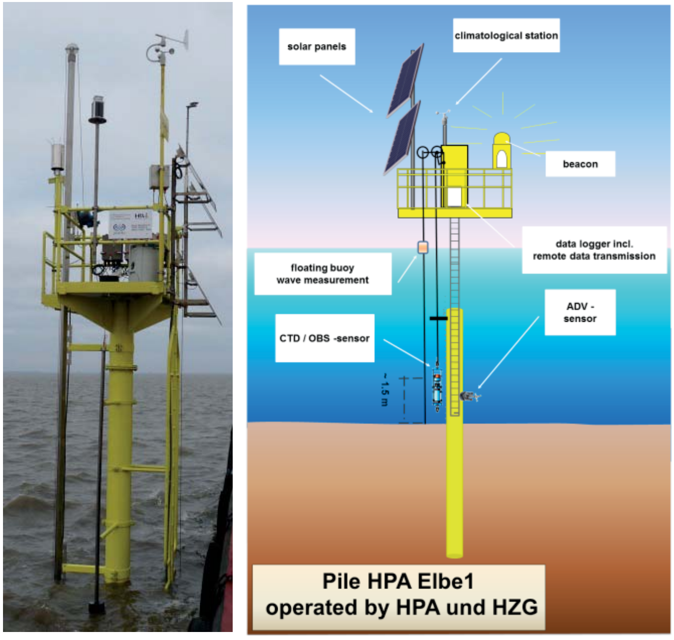


Figure 1: Photo and schematic sketch of the pile HPA Elbe1

Figure 2: Location of the pile HPA Elbe1 in the Elbe mouth

Results

Data delivery of the HPA Elbe1 pile was robust. Most of the data is categorized as data with the COSYNA quality status 2 (see Figure 3). On one hand, the turbidity and conductivity data are correlated with the wind direction and the wind velocity and therefore with the wave impact on the flat Wadden Sea areas, on the other hand with the fresh water discharge of the Elbe. Therefore the data gives a spectrum of the exchange processes within the Elbe mouth.

Problems

Due to a failure within the CTD/OBS- and the ADV-sensor, there were no hydro- and morphological data and measurements taken between September, 18th 2012, 06:20h and September, 25th 2012, 11:30h. The meteorological data are not affected from this gap.

Perspectives

Data of the pile HPA Elbe1 will be further analysed and will be used as calibration and validation data for hydro- and morphodynamic models. Presently, there are no plans to install and operate the pile in future.

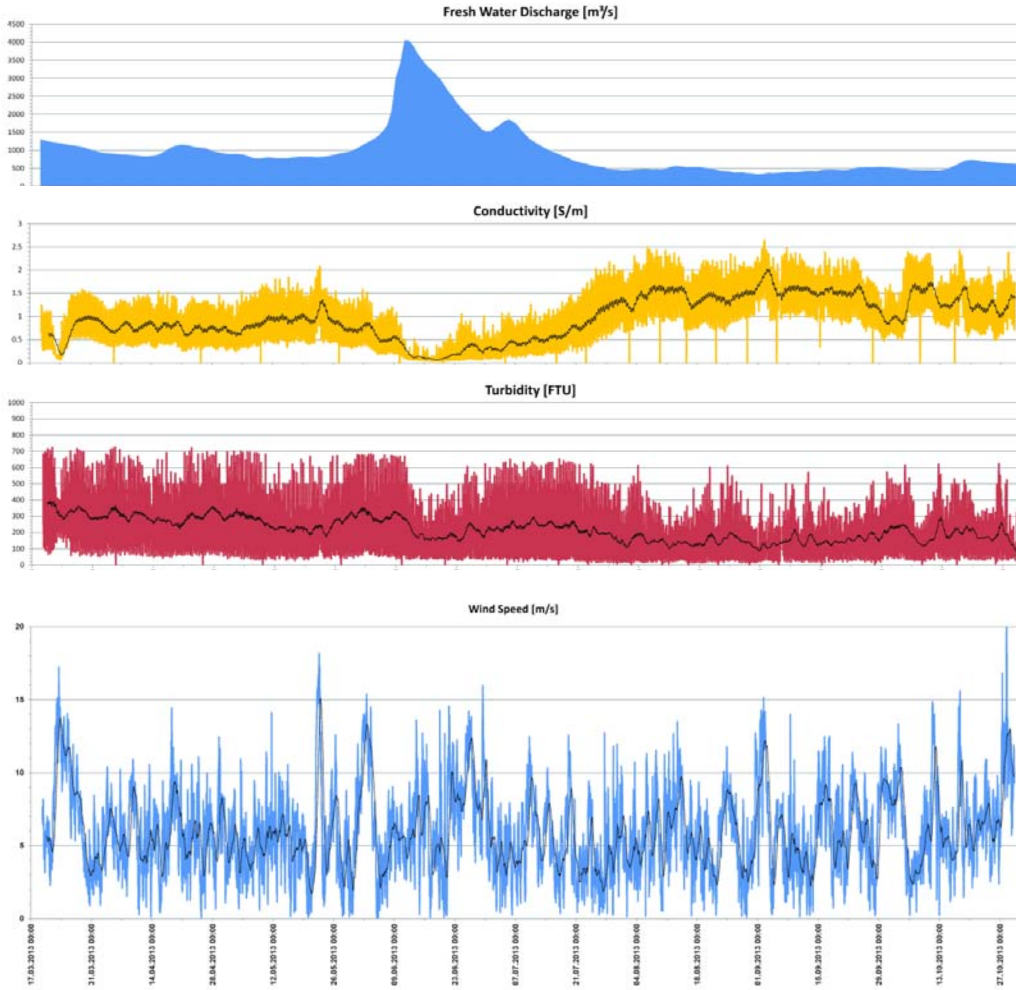


Figure 3: Data from the pile HPA Elbe1, from top to bottom: Fresh Water discharge, Conductivity, Turbidity, Wind Speed

Radar wave gauges in the East Frisian Wadden Sea

M. Witting / C. Berkenbrink / A. Wurpts

Technical / Program Developments in 2013

The proposed COSYNA-contribution of Coastal Research Station (CRS) consists of the implementation of two wave gauge radar sensors on existing piles in the Lower Saxony Wadden Sea. The first pile “Ostfriesisches Wattenmeer” (Pile_NLWKN_Steinplate) was equipped in spring 2012 and is delivering online data since 7th of June 2012. The second pile “Leyhörn” needed an additional pile in the Leybay area. Measuring wave climate at the position “Leyhörn” was impossible because of morphological changes. The position is dry during the time of mean water level and below. Therefore an additional pile was set up in the beginning of 2013. This pile “Bantsbalje” is online since 23th of July.

Pile “Bantsbalje”

The whole system of the pile is a prototype regarding the combination of the RADAC sensor, the autonomous power supply by solar panels and the transmission of the data over 2 WLAN radio links (Figure 1). One radio link connects the pile with the lock of Leysiel, where the data are controlled and sent further via the second radio link, which connects Leysiel lock with a bridge where a proper TCP/IP cable connection exists. The system of two sequential radio links was chosen because one single link would have been more expensive and the second radio link existed already.

Via ftp (Filezilla) these data are uploaded on a server on Norderney from where the ftp upload of the controlled and reprocessed data to the COSYNA server takes place every 60 minutes. Reprocessing and uploading is done by a MATLAB script. The following parameters are transmitted to the COSYNA server (http://tsdata.hzg.de/index.cgi?seite=plot_form) and can be found there in the category “Pile”, under the station name: “Pile_NLWKN_Bantsbalje”:

- Gauge - 10-minutes mean water level
- MeanPeriod - T_{m02} mean wave period by spectral moments m_0 and m_2
- Peak Frequenz - f_p frequency of spectral peak period
- WaveHeight - H_{m0} – spectral wave height (significant spectral height)

	Pile_NLWKN_ Steinplate	Pile_NLWKN_ Bantsbalje
Geo. N	53°41’13”	53° 33,985'
Geo. E	7°8’32”	7° 0,898'
Other data	wind (direction and speed)	-

Figure 1: Top: the pile “Bantsbalje" with sensor arm and solar panels at high water, bottom: RADAC sensor

Bantsbalje is a small channel which opens out into the Osterems. Long waves from the North Sea rarely reach the station Bantsbalje, frequently local generated wadden waves are observed.

Problems

Many technical problems occurred on the system since July 2013. Failures arise mainly due to the RADAC system itself and due to the autonomous power supply by solar panels.

- In April 2013 the RADAC system couldn't store the data on the integrated SSD. A new external SSD was mounted and worked well. Power consumption of the external SSD was higher than that of the internal which lead to the installation of an additional solar panel.
- In September 2013 voltage of the solar panels dropped inexplicably. As a consequence an additional battery was installed. In the winter the system operated only when the sun sufficiently loaded the batteries (Figure 3).
- In winter 2013/14 the external SSD was changed again to an internal SSD with less power demand and the batteries where changed.
- In January 2014 the whole system broke down due overvoltage probably due to a nearby lightning stroke. The whole system has to be repaired and the motherboard of the system is in a redesign process at RADAC Company, Netherlands due to this failure. The system Bantsbalje will be in operation again in summer 2014.

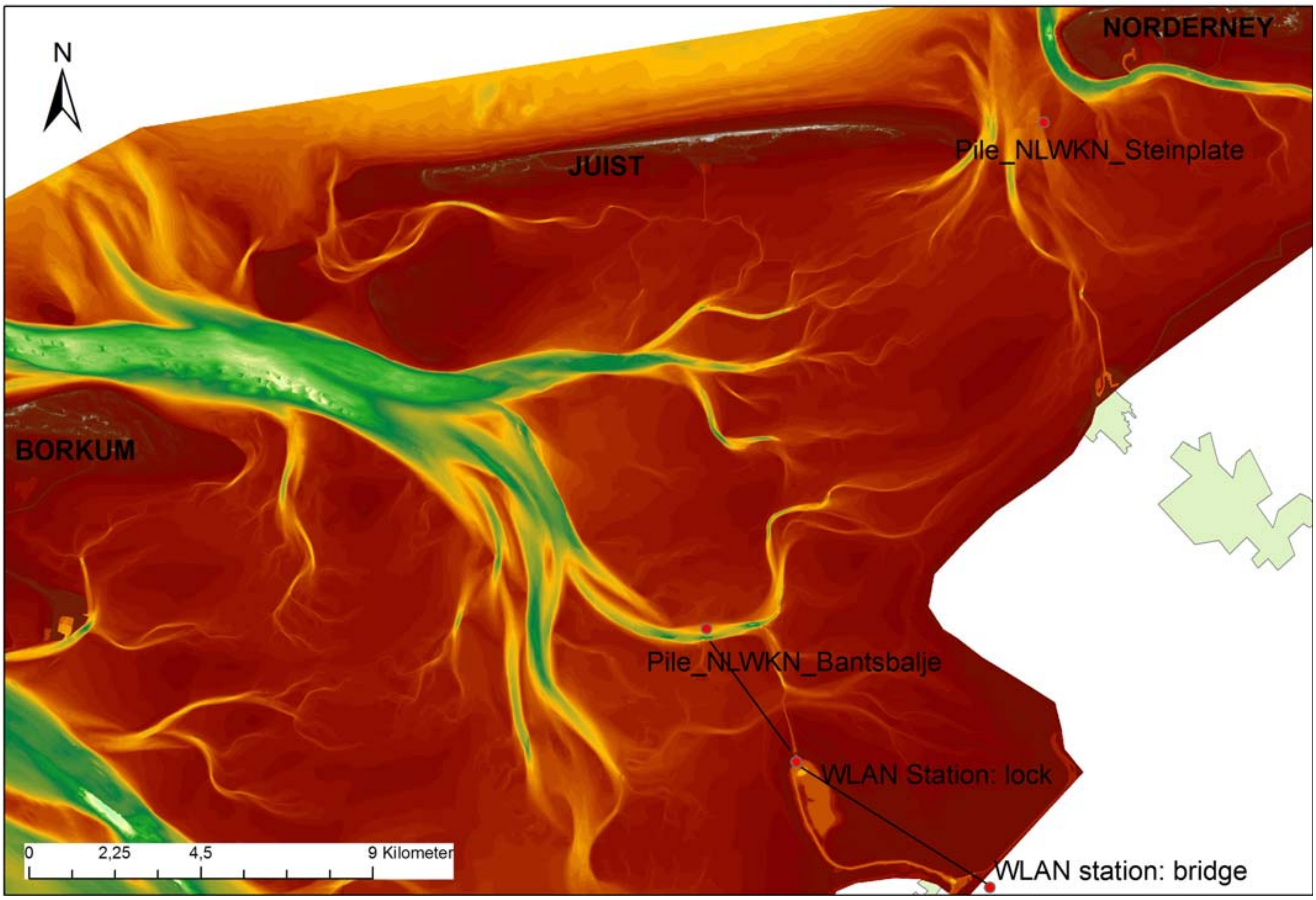


Figure 2: Locations of NLWKN-piles Steinplate and Bantsbalje

Results

Data delivery from the pile NLWKN_Bantsbalje is not very robust leading to large data gaps (Figure 3). The failures of the system are due to various technical problems. The quality of the data is ranked with 2 (probably good data).

Remarkably the intensity of the sea state e.g. wave height H_{m0} strongly correlates with the tidal water level (Figure 4). This is due to the fact that the pile is located in a sheltered channel surrounded by shallow intertidal flats.

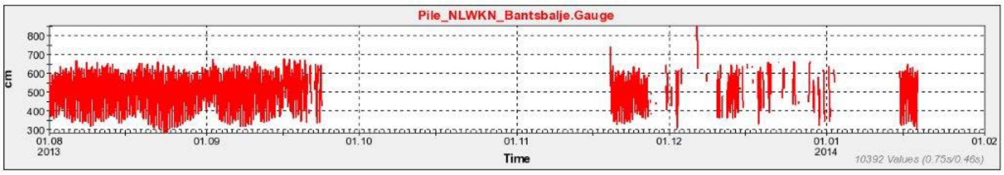


Figure 3: Water level data of the pile "Bantsbalje" with various data gaps.

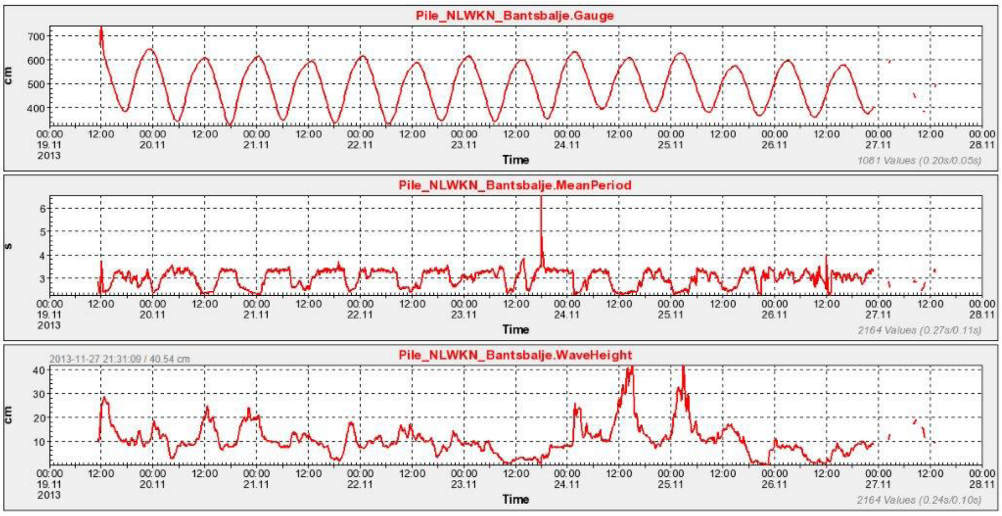


Figure 4: Raw Data of Pile NLWKN_Bantsbalje, top: water level, middle: mean period, bottom: H_{m0}.

Perspectives for 2014

- Resuming of the operation of Bantsbalje system
- Data validation/comparison at pile Bantsbalje with a different measurement system e.g. AWAC AST, Nortek, Norway

Validation of coastal wave models by COSYNA field data

G. Herrling / C. Winter / G. Flöser / R. Riethmüller

Coastal morphodynamic systems are driven by the combined action of waves and tides. Tidal inlets between barrier islands are prominent examples of highly active systems, subject to a continuous mutual interaction of the prevailing hydrodynamic forces, sediment transport and morphological evolution. A recent study has shown how storm events in contrast to tide-dominated fair-weather conditions determine the sedimentology and morphology at an exemplarily mixed-energy tidal inlet at the East Frisian barrier island system in the southern North Sea (Herrling & Winter 2013). In the latest study, the morphological responses to an exemplary high-energy storm event and to a 6-months period of representative fair-weather conditions were simulated by a process-based numerical model (Delft3D). The Wadden Sea poles of Helmholtz-Zentrum Geesthacht (HZG) provided useful near-coast validation data of wave parameters in the model domain. Hydrodynamic model results were validated by time series of water levels and wave parameters measured during the storm event 'Tilo' on Nov. 9th, 2007 at a COSYNA measuring pole located in the inner part of the tidal inlet Accumer Ee separating the islands of Baltrum and Langeoog. The pole was operated between 2000 and 2007 by the HZG Institute of Coastal Research and within the framework of the Coastal Observing System for Northern and Arctic Seas (COSYNA). The observation point was located at a hydrodynamic complex and morphologically dynamic location at the junction of the main tidal channel and a larger tributary. Observed wave parameters were calculated from water level elevations recorded at a frequency of 2 Hz taken from a floater guided along a rod with magnetic readout.

Four days of data are shown in Figure 1. Observed significant wave heights ranged between 0.2 and 1.1 meters at the measuring site sheltered in the back-barrier basin. Peak wave periods reached up to 4.2 seconds. During a short period at the peak of the storm, unexpectedly high surge exceeded the level of the mounted device leading to unreliable recordings. Phases and amplitudes of the observed water levels and wave parameters are fairly well reproduced taking into account the complexity of the wave-current interactions at the measuring site (Figure 1). In the future, well validated wave models may serve as tools for the interpolation of observational gaps in less complex coastal areas.

Publication

Herrling G, Winter C (2013): Morphological and sedimentological response of a mixed-energy barrier island tidal inlet to storm and fair-weather conditions. Earth Surf. Dynam. Discuss. 1, 745-782, doi:10.5194/esurfd-1-745-2013.

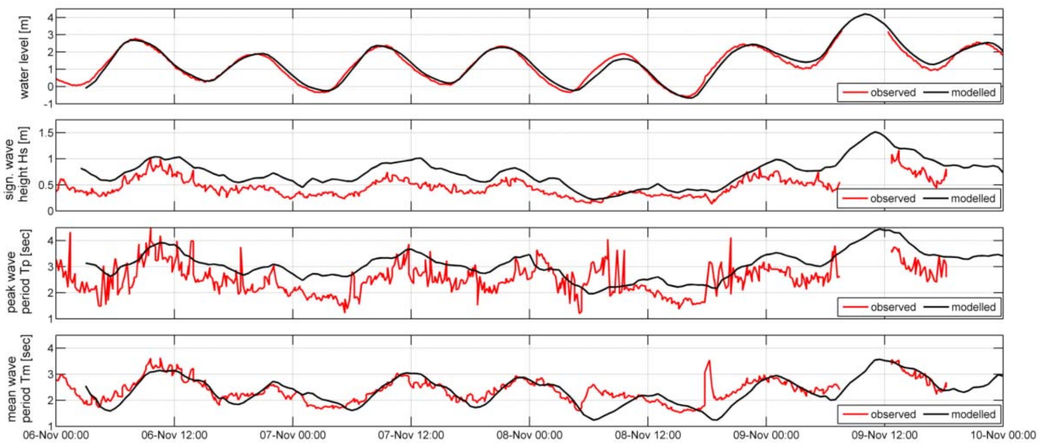


Figure 1: Observed and modelled water levels, significant wave heights (Hs), peak wave periods (Tp) and mean wave periods (Tm) at the back-barrier of Langeoog island during storm event "Tilo" in Nov. 2007; observations of the Coastal Observing System for Northern and Arctic Seas (COSYNA)

COSYNA underwater nodes

P. Fischer / B. Baschek / M. Grunwald, F. Schroeder / M. Boer / R. Loth / J. Klaus-Stöhner / T. Boehme et al.

Aims for 2013

After installing two different prototypes of the COSYNA underwater node system in 2012 in Helgoland (59,11°N / 8,52°O - full node system with 10 access points, Figure 1) and in Spitsbergen (78,9°N, 11.9°E - small node system with 4 access points), both systems were extensively tested under full operational mode in 2013.

The following milestones were planned for 2013:

- Testing the capacity and robustness of the underwater node system under the harsh environmental conditions of the North Sea and the Arctic.
- Testing the stability and applicability of the node systems in full operational mode with different sensor types and user groups.
- Extensive tests of the functionality and stability of the prototypes under real conditions including sensors with GBit data transfer rates.

Technical/ Program Developments in 2013

Year round operation of the two node systems off Helgoland and Spitsbergen with an extensive test procedure under operational conditions:

- Beginning in January 2013, the two node systems at Helgoland and Spitsbergen were tested for their capacity to host a CTD and an ADCP continuously year round and to provide reliable data to the COSYNA server system at HZG (Geesthacht) without human interference.
- In April 2013, an extensive test was done at Helgoland together with the COSYNA working group "Bodennahe Messysteme" (see C. Winter, this report). A sensor unit comprising multiple and complex sensors (Table 1, Figure 2) was attached to the node system to test if multiple and highly complex sensors could be operated reliably and fully remote controlled from Bremen (MARUM) via the internet. Sensors used in this test were:

Table 1: Sensors attached to the node system in April 2013 in close co-operation with the COSYNA working group "Bodennahe Messysteme".

Probe	Variables to measure	Company
Vector	Small scale turbulence, wave and flux measurements	NORTEK, Norway
CTD	Conductivity, temperature, pressure, turbidity, fluorescence.	Sea&Sun, Germany
FRRF (Fast Repetition Rate fluorometer)	High-speed chlorophyll-a fluorescence measurements.	Chelsea Technologies Group Ltd., UK
ADCP600	Current and turbulence over the water column.	NORTEK, Norway
ADCP1200	Current and turbulence over the water column.	NORTEK, Norway

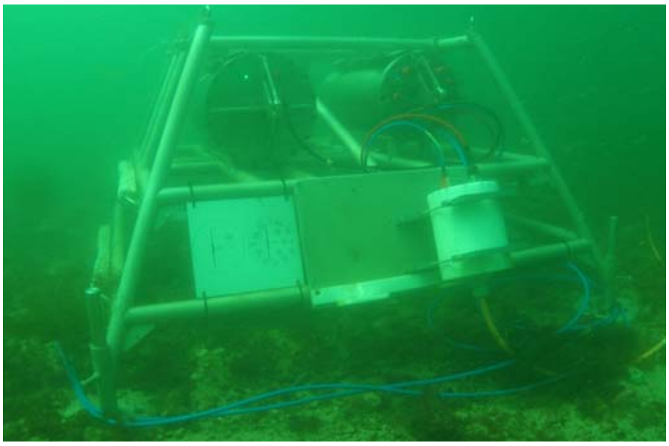


Figure 1: COSYNA underwater node off Helgoland in 10 m water depth.

Figure 2: Sensor unit with 5 complex sensors attached to the COSYNA underwater node system off Helgoland in April 2013 in co-operation with the COSYNA working group „Bodennahe Messysteme" (C. Winter)

In September 2013, the Arctic node system at Spitsbergen (Figure 3) was upgraded with a new remote controlled profiling winch (Figure 4) to make daily vertical CTD profiles from the bottom to the surface. Furthermore, the entire system was prepared for the first winter campaign. The sampling program included a stereo-optical sampling program of the fish and macro-crustacean community of a typical Arctic hard bottom community together with the continuous assessment of the main hydrographic variables via CTD and ADCP.

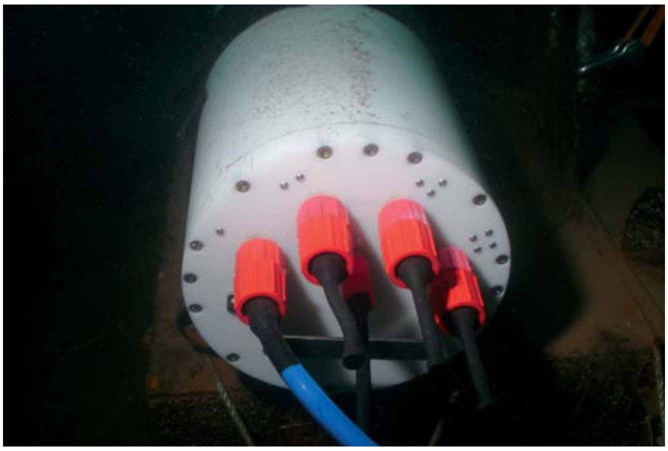


Figure 3: Arctic (small) COSYNA underwater node system with 4 under water wet-pluggable power and data access points.

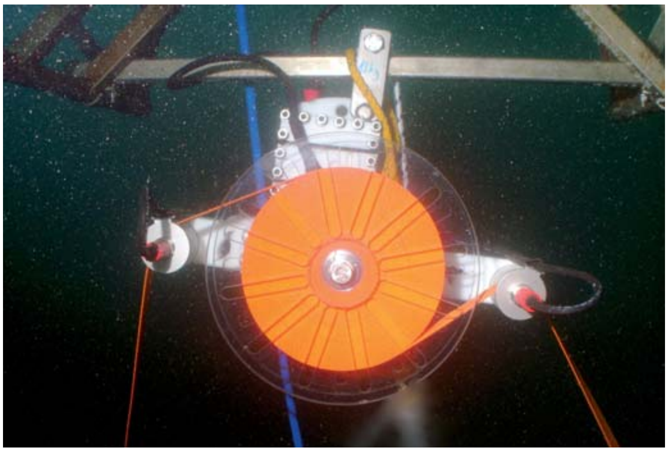


Figure 4: Newly developed COSYNA winch system for remote controlled profiling of the stereo-optical sensor unit „RemOs1" in Spitsbergen.

Results (Highlights)

For both sites (Helgoland and Spitsbergen) the basic concept of the COSYNA node system as an under-water pluggable power and data communication unit proved to be highly valuable and resilient. The Helgoland node system survived its first winter in 10 m water depth and two severe storms with wind speeds up to 195 km/h in December 2013. Even though the system had to withstand wave heights of up to 8 m in the area, and therefore was severely affected by extreme hydrodynamic forces, the system remained in full operational mode all the time and delivered data even under such extreme conditions when no more measurements would be possible using any other method. We therefore were able to measure current, turbulence and the main hydrographic variables in a shallow coastal area at wind speeds > 12bft in-situ. Such data have never been measured before in that area.

In Spitsbergen, the system allowed a fully remote controlled daily profiling of the attached CTD and the stereo-optical unit RemOs1 (Figure 5). This sampling schedule allowed for a continuous assessment of the mobile fauna in that area and provided a unique insight in the temporal succession of the macrozoobenthos and fish community (Figure 6).

Based on the available COSYNA installations at Helgoland and Spitsbergen, several request for co-operation have been submitted to the COSYNA working group "Unterwasserknoten" in 2013.

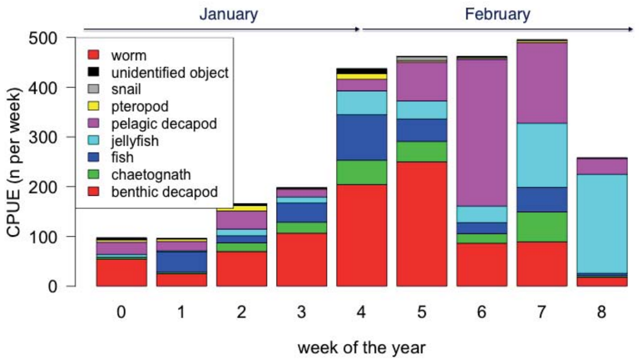


Figure 6: Temporal succession of the Arctic hard bottom and associated epi-benthic and pelagic community in Kongsfjorden Spitsbergen from 01. 01.2013 - 31.02.2013. Shown are the weekly CPUE's (total number of specimen per week) integrated over the entire water column.

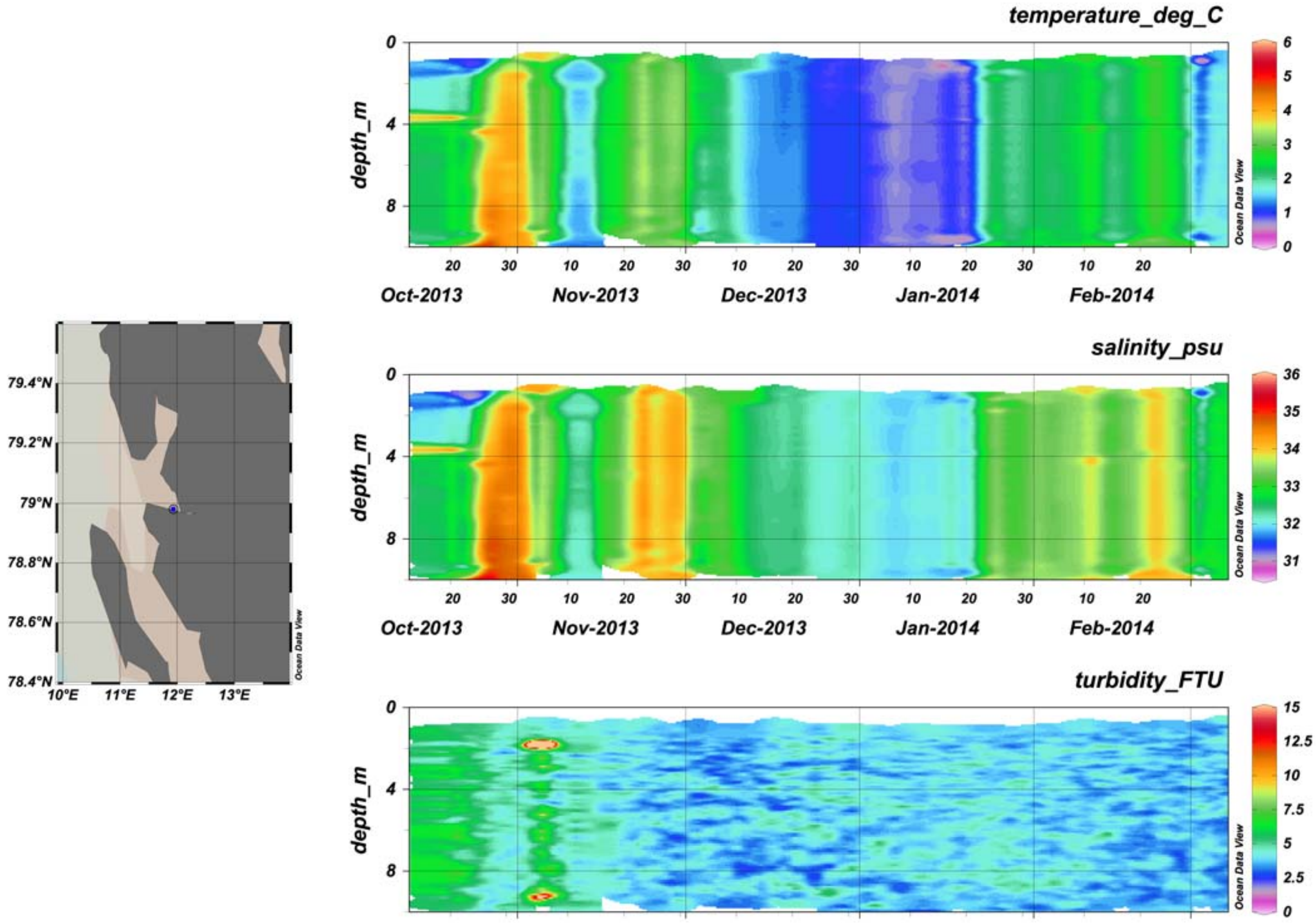


Figure 5: Vertical daily CTD profiles for temperature, salinity and turbidity from Spitsbergen (78,9°N, 11.9°E).

Problems

The main problems occurring during 2013 were related to the underwater pluggable connectors. Both systems (Helgoland and Spitsbergen) had multiple failures leading to a system shut down for days to weeks due to “burned” plugs (Figure 7). After several similar failures, the manufacturer of the plug system was contacted and invited to Germany for a thorough discussion of the problems and to find a solution. Based on the COSYNA experiences with the plug system, the manufacturer performed tests on their own and confirmed the problems. The manufacturer retracted all parts without additional charge and replaced them against a new product line and plug configuration. After the exchange of all plugs and connectors in the system, the system outlasted another six-month test period without any additional failures until spring 2014 and therefore can be assumed as stable.

Figure 7: "Burned" plug at the node system at Helgoland.

Perspectives for 2014

In 2014, the test period described above has ended successfully so that the node system can be classified as ready for operation. During the test phase, two minor issues have been detected with respect to the stability of the power system. It turned out that in case of a full cable damage (cable break, e.g., due to an anchor) of one sensor access port, the entire system may be battered in a way, that all ports would shut down. This issue was discussed in the working group and will be solved in 2014.

This power issue revealed another problem in the control system. In case of a plug or connector failure, it is not yet possible to detect the location of the failure. Additional power sensors at different locations will improve this so that a more precise damage report is possible in case of a system failure. This is especially important in case the node is installed in a remote area with difficult and possible temporally restricted access by divers.

Publications

Wehkamp M, Fischer P (2014): A practical guide to the use of consumer-level digital still cameras for precise stereogrammetric in situ assessments in aquatic environments. Underwater Technology (in press)

Fischer P, Wienke C, Assmus R, Schwanitz M, Walcher C, Brand M, Schroeder F, Boer M, Grunwald M, Loth R, Klaus-Stöhner J, Boehme T (2014): The AWIPEV underwater observatory for long-term monitoring of the shallow water ecosystem in Kongsfjorden. Talk – The Kongsfjorden Workshop – Hamn i Senja, Norway

Fischer P, Baschek B, Schroeder F, Schwanitz M, Walcher C, Boer M, Grunwald M, Loth R, Klaus-Stöhner J, Boehme T (2013): The new COSYNA Underwater Node System – a transregional and transinstitutional research approach in the North Sea and in the Artic. Invited Talk – ROBEX Symposium 2013 – Dresden

Fischer P, Baschek B, Schroeder F, Schwanitz M, Walcher C, Boer M, Grunwald M, Loth R, Klaus-Stöhner J, Boehme T (2013): The new COSYNA Underwater Node System – a transregional and transinstitutional research approach in the North Sea and in the Artic. Talk – Futoore 2013 – Hamburg

Wehkamp S, Fischer P (2013): The impact of coastal defence structures (tetrapods) on decapod crustaceans in the southern North Sea. Marine Environmental Research, 92 : 52–60, doi: 10.1016/j.marenvres.2013.08.011

Wehkamp S, Fischer P (2013): Impact of hard-bottom substrata on the small-scale distribution of fish and decapods in shallow subtidal temperate waters. Helgoland Marine Research, 67: 59-72

Fischer P, Baschek B, Schroeder F, Grunwald M, Boer M, Böhme T, Loth R, Klaus-Stöhner J, Wehkamp S, Walcher C, Brand M (2013): COSYNA underwater Node. Poster - Workshop on FerryBoxes, Helsinki

COSYNA near bed observation systems: The lander SedObs

C. Winter

Introduction

The autonomous sea floor lander COSYNA SedObs (Sediment Dynamics Observatory) is a four-legged platform for the measurement of physical processes at and above the sea floor. It provides a stable frame for the attachment of various self-recording sensors and instruments for observations in shallow water environments in rough sea conditions. The lander is deployed from research ships, is placed on the sea floor for autonomous measurements, and recovered after the mission by an acoustic release of a pop-up buoy (Figure 1). The main scientific foci of the measurements are physical processes at the sea floor, i.e., the interplay of hydrodynamics, sediment dynamics, and bed evolution. The standard instrumentation thus aims at a comprehensive image of relevant parameters such as waves, mean currents, turbulence, sediment characteristics and transport loads, as well as sea bed morphodynamics at highest possible temporal and spatial resolutions. The typical deployment times range from little over a tidal cycle to several days.
Typically, the SedObs lander measurements are accompanied by other sea-floor landers (e.g. COSYNA NusObs; see T. Oehler & M. Schlueter this report), moored instruments, and observations from stationary (anchored) or moving ships.

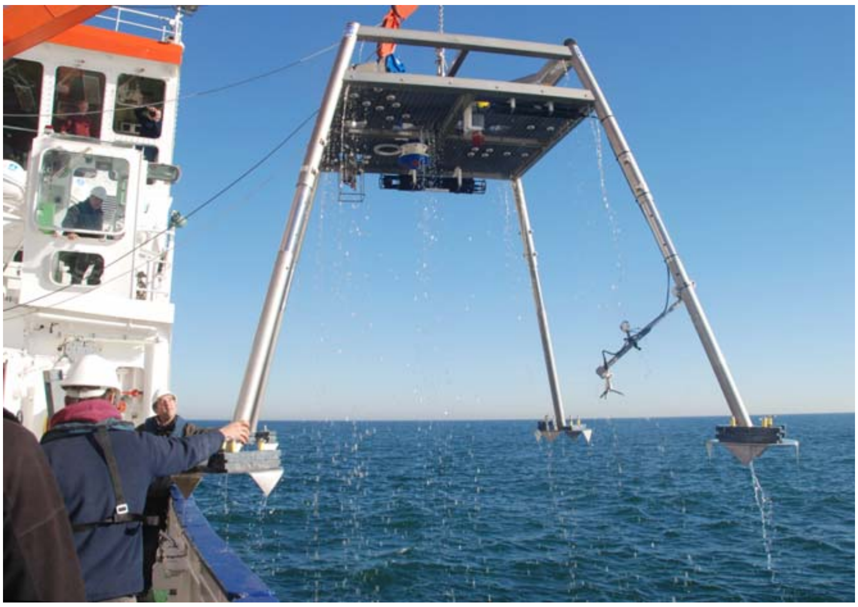


Figure 1: Recovery of lander SedObs during HE417 (Photo C.Winter)

Activities in 2013

The lander system has been used in the framework of different scientific projects. The widely acknowledged state-of-the-art research infrastructure provided by the Helmholtz-Zentrum Geesthacht (HZG) within the framework of COSYNA is used in different research projects funded by other institutions. SedObs operation is mainly embedded in the ongoing Bremen University MARUM research centre activities in the projects SD1 and CCP5. Since April 2013 the BMBF research project NOAH (Emeis et al.) provides means for a PhD project focusing on lander data and technical support for the lander operation.

In 2013 SedObs was used during four research cruises (Figure 2): We joined the second leg (March 14-22) of cruise H395 with RV Heincke to the German Bight (PI Proefrock, HZG). During this cruise the lander was used for one long (105 h) and one shorter deployment (31 h) near Helgoland, together with the sea floor lander NusObs. The lander was also used from the small research ship FK Senckenberg during two campaigns. The first was a short trip (May 6-8, PI Winter) to a position East of Helgoland for one single deployment; the second cruise (September 18- 26, PI Winter) to places in the Jade tidal channel, offshore Spiekeroog and in a bedform field East of Helgoland. The last cruise from October 28 to November 13 2013 was HE 412 (PI Winter) with four deployments near Helgoland, again together with the sea floor lander NusObs.

In co-operation with colleagues from the COSYNA Underwater Node Helgoland (lead P. Fischer, AWI) some SedObs instruments were deployed for longer time periods and extensive testing of system parameters was performed. The node infrastructure allowed direct online access to the deployed instruments. The period covered the phytoplankton spring bloom in the Southern North Sea at Helgoland Island.

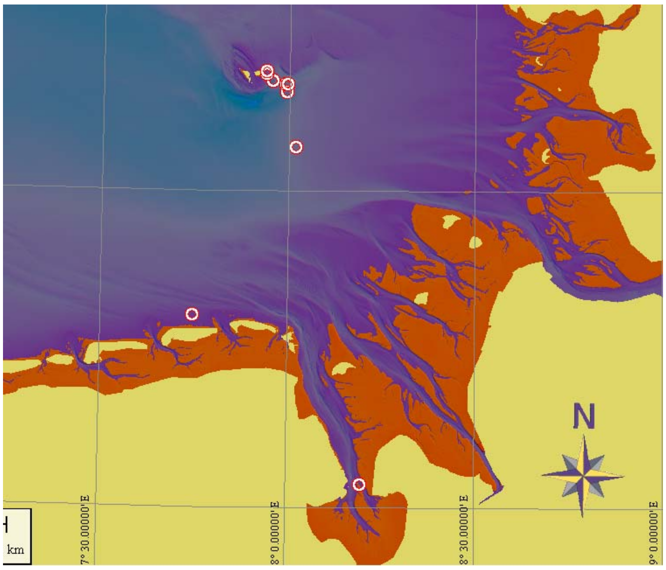


Figure 2: Deployments of lander SedObs in 2013. Note the clustering of positions in the East of Helgoland

Technical/ Program Developments in 2013

Usually, the lander is deployed by releasing it from a launching unit, after orientating it considering the flow direction and secure placement on the sea floor. A device for remote observation of these parameters (orientation, pitch, and roll) during launch has been developed in the recent past. The abrupt release of the lander from the launcher – the technique used before - had been driven by triggering a (costly and messy) explosive cartridge. Technical development has recently led to an alternative driven by an electric motor.

The lander system is equipped with self-contained autonomous instruments that run on individual power supply and record their data in instrument specific data storage. This has the advantage of easy installation and assemblage. However monetary and time expenses for the exchange of batteries and the download of data from the individual devices suggest research on other options. Thus, currently a central data acquisition and power supply is under development at MARUM.

Results (Highlights)

The simultaneous operation of different sensors for the near-bed observation of hydrodynamics, sediment transport and morphodynamics leads to a coherent description of local seabed characteristics. In this the approach is of great scientific potential as processes may be observed as detailed as under laboratory conditions, without the constraints that usually are associated with sediment flume experiments.

The results of different lander deployments - so far preliminary - reveal interesting interactions between processes, which are the basis of ongoing in-depth research in the framework of two main research directions. The first topic is the mutual adjustment of boundary layer flows and bedform development. The second topic is the occurrence of periodic stratification in the water column under tidal forcing and its effect on the water column and near-bed hydrodynamics.

The seabed in sandy environments is rarely flat. Bedforms of various sizes and geometric properties develop in response to the hydrodynamic forcing and sediment availability. On the other hand they constitute prominent bed roughness elements, thus influencing flow structure in the boundary layer. Despite considerable scientific effort invested into the subject several aspects of the two-phase flow problem of near bed sediment transport in the presence of bedforms remain to be understood. Sea floor landers allow the in-situ observation of sediment dynamics on the sea floor for a very high range of dynamic conditions. This not only covers the changing flow conditions within a tidal cycle but also the effects of waves and extreme currents during storms. Different domains of highly variable sedimentological and morphological characteristics have been measured so far. The ongoing research focuses on the time and length scales in which bedforms adapt to changing flow conditions. As an example, Figure 3 shows hydro-acoustic data of bedform adaptation. Obviously, the bedform shapes adjust to the tidal forcing. At certain tidal stages the bed is highly mobile and small turbulent structures develop behind the steep bedform lee side (t1 in Figure 3). These structures obviously are the main agent of sediment mobilisation, forming upward directed patches of sediment suspensions under these conditions (t3). Recent observations on the interaction of seabed structures and coherent flow structures also cover areas of consolidated muds, large dunes, limited sand supply dunes and biogenic habitats.

The combination of ship and lander based field data on the water column hydro- and sediment dynamics has shown interesting tidal characteristics for different domains in the shallow German Bight. At these locations, periodic stratification of the water column is observed. For parts of the tidal cycle water

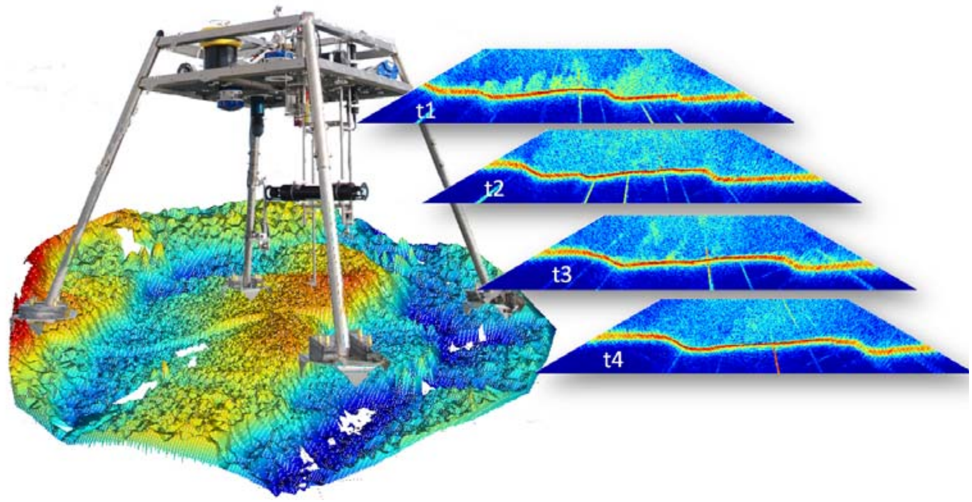


Figure 3: Small scale morphodynamics: Interaction of flow structures in the lower water column and the bed morphology at different tidal stages.

masses of different density separate into distinct layers. These layers could be shown to move independently, i.e., with a decoupled tidal ellipticity (tidal rotation direction and shape). This effect has been described so far only for regions of the outer Rhine and Liverpool Bay regions of freshwater influence (ROFI), and seems to apply to large parts of the German Bight. Research is on-going on the initiation of these periodic stratifications, and their effect on the water column and near-bed hydro- and sediment dynamics.

Problems

So far, most of the instruments and sensors which form the SedObs system operate as planned and without severe problems. As the lander operation is ship based and thus depending on suitable wave conditions during launching and especially during recovery, weather conditions remain the main problem: During all cruises of 2013 the deployments were influenced by sea conditions limiting the sea floor observations to domains in the lee of Helgoland Island. However, this area is a highly interesting domain, characterised by a high variability of morphological structures, sea floor sedimentology, and hydrodynamic characteristics.

The ME 3D Profiler instrument is used for the hydro-acoustic scanning of the domain below the lander. The data is of utmost relevance for the envisaged scientific focus on the mutual adjustment of turbulent motions and structures on the sea-bed. Unfortunately, the instrument so far is still unreliable and shows unpredictable functioning / malfunctioning cycles. However, after exchange of several components the unit did operate as planned during some deployments in 2013.

The standard ADCPs worked very well despite an interesting flaw, which appeared only sporadically, and was limited to specific ranges of single transducers. After some considerable testing and diagnostic inspection it was found that the instruments needed degaussing, i.e. eliminating a remnant magnetic field from the manufacturer.

Perspectives for 2014

In 2014 the lander system will be used in COSYNA / NOAH based ship cruises HE 417 (lead C. Winter) and in HE432 (lead M. Holtappels, MPI) for the characterisation of representative domains in the German Bight. Focus will be on a process-based understanding of the interaction of large scale hydrodynamic forcing, local hydrodynamics, and small-scale bed morphodynamics. In collaboration with project partners from HZG, MPI Bremen and other research institutions the focus will be put on the interaction between biogeochemical processes and bed morphodynamics.

Publications

Data from SedObs field data have been presented and discussed at several national workshops and meetings. Publications based on field data from SedObs deployments are envisaged as the scientific projects develop.

NusObs – In-situ measurements of benthic fluxes for spatial budgets and process oriented studies

T. Oehler / M. Schlüter

Aims for 2013

The benthic lander system NusObs (Nutrient and Suspension Observatory, designed by KUM, AWI, MARUM and HZG) has been available since March 2012 and was successfully used during cruises HE-383 and HE-386 of this year (Figure 1). Aims for 2013 were (1) to continue the field work, which was achieved by participation on cruises HE-395 and HE-412 in March and November, respectively, (2) the geochemical analysis of sediment as well as pore water samples derived by NusObs or Multicorer deployments and (3) the implementation of additional methods to NusObs. In addition, a GIS project (Geographic Information System) was built up for spatial analysis of benthic fluxes in the German Bight (Figure 2).

Figure 1: Deployment of the NusObs lander for quantification of benthic fluxes of nutrients, oxygen consumption and transport processes. The lander was deployed for more than 24 hours at the seafloor.

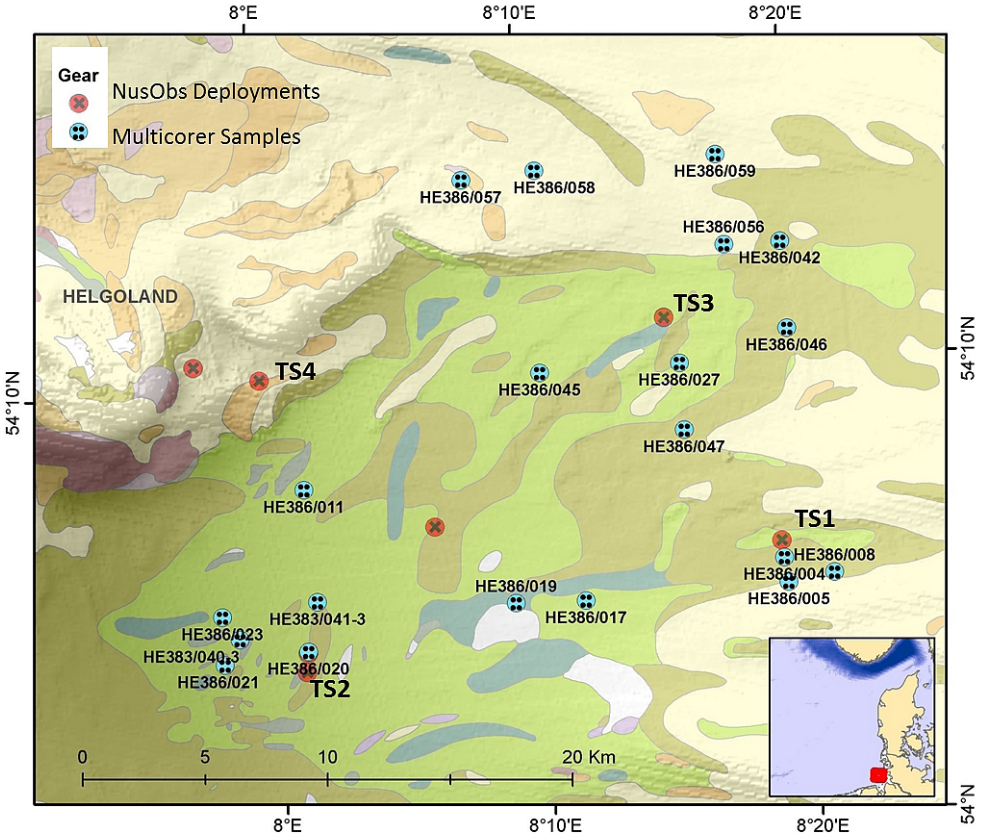


Figure 2: Sampling sites located southeast of Helgoland, summarising NusObs deployments as well as pore water studies and ex situ sediment incubations based on Multicorer samples. Time series sites (TS1 to TS4) were revisited during each cruise.

Technical / Program Developments in 2013

Based on the successful data acquisition in 2012 we further optimised the mode of deployment and recovery of the NusObs Lander. Furthermore, we applied and optimised the injection mode of the syringe sampler to add a bromide tracer into the chambers. This allows computation of transport processes along the sediment water interface. We also developed hard- and software for integration of additional sensors and sampling systems. This allows us to employ sensors like the SUNA nitrate sensor, current sensors, or pH sensors as well as systems for high-resolution sampling of bottom and pore waters.

Results (Highlights)

During cruises of RV Heincke the time series sites (Figure 1, TS1 to TS4) investigated in 2012 that cover different sediment types were revisited. An example for data derived during a NusObs deployment at a time series site is shown in Figure 3. The data obtained at the time series sites allows a comparison and quantification of seasonal variations of benthic fluxes. In co-operation with the Senckenberg Institute, we considered the impact of biologically mediated transport like bioturbation or bioirrigation on benthic fluxes and remineralisation processes. Considerable seasonal variations of benthic fluxes were observed. For example, benthic fluxes of a nutrient like silicic acid or the oxygen consumption - a proxy for the flux of organic matter reaching the seafloor - measured for a sandy mud site are almost twice as high in summer compared to the winter season.

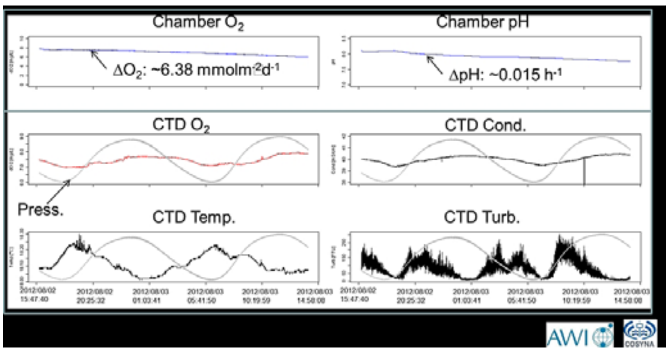


Figure 3: An example for data derived during a NusObs deployment. The change of O_2 concentration as well as pH in the benthic chamber are obvious. Furthermore, the pressure, O_2 concentration, conductivity, temperature, and turbidity in the bottom water are recorded.

Problems

With respect to our major aim in 2013, revisiting the time series sites for seasonal studies, no specific problems were observed during the lander deployments. Restrictions, like the deployment in water depths of less than 25 m (due to the limited length of the chain applied for recovery) or difficulties to sample sand sediments will be considered in 2014.

Perspectives for 2014

In the years 2012 and 2013, the focus of our contribution to COSYNA was to operate the NusObs Lander to derive data sets about benthic fluxes in the German Bight. For these purposes very few technical aspects had to be fixed or modified. Starting in 2013 and part of our perspective for 2014 are technical improvements and modifications. One topic is to measure fluxes from sandy sediments using the NusObs Lander. For this purpose, an additional chamber design will be added to the lander. Furthermore, additional sensors and actuators will be applied during the deployments to measure in-situ parameters like nitrate. Additionally, we intend to mount a profiling system to the lander to obtain in-situ pore water samples.

Publications

The data acquisition and analysis is part of a Ph. D. thesis. Manuscripts are in preparation and are supposed to be submitted in the first half year of 2014.

Deployment of MOKI on the underwater node Helgoland

H-J. Hirche / T. Hanken

Aims for 2013

Deployment of MOKI on the underwater node Helgoland

Technical developments in 2013

An alternative light head for dark-field illumination was planned and developed (Figure 1) and was built for deployment in 2014.

Results

MOKI was delivered to Helgoland in July 2013. It was deployed in August and was online in November.

Problems

In the beginning the data communication of MOKI did not work properly. Only the use of a much shorter cable resulted in a working connection. When LOKI was finally sampling, it was already grown over and covered by sediment, as was revealed after the recovery in March 2014.

Perspectives for 2014

Deployment of the newly developed dark-field light head.

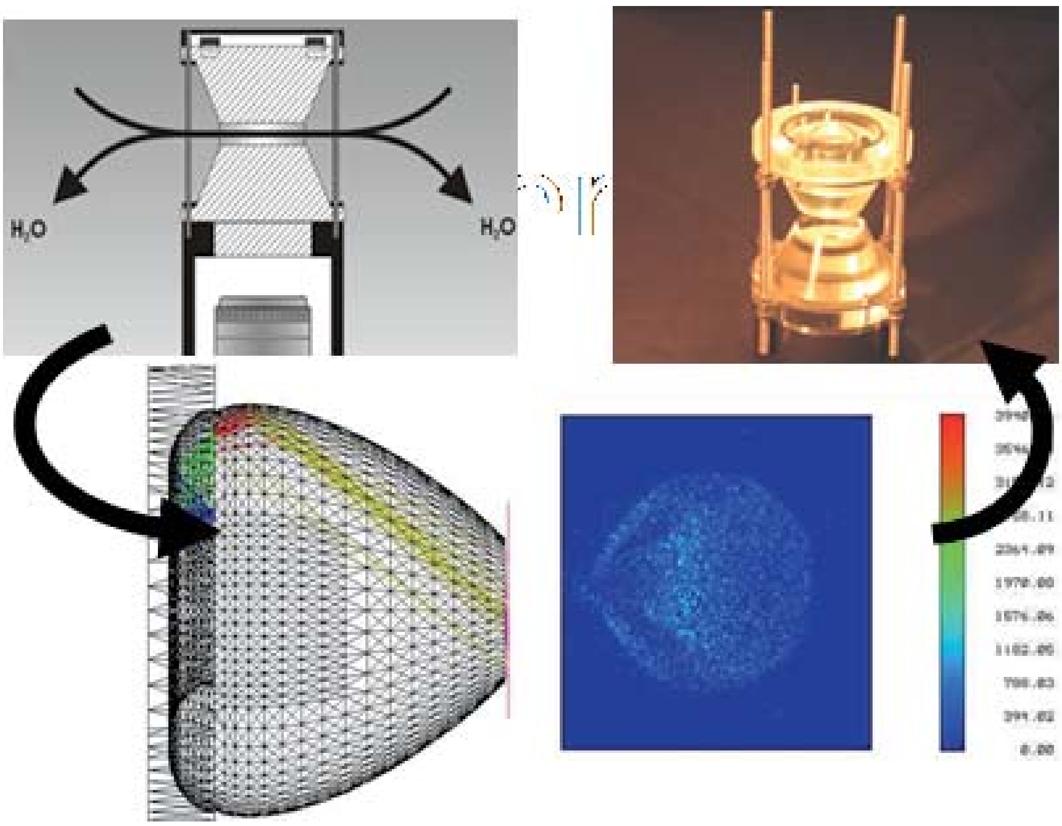


Figure 1: Concept and model of light path of the new dark-field light head

Automated nucleic acid biosensor system for observing phytoplankton - AUTOSENS

K. Metfies / F. Schroeder

Aims for 2013

We applied for funding the development of a nucleic acid biosensor system that allows carrying out analyses of phytoplankton with high resolution in time and space.

- Task 1: The integration of an optimised automated filtration module with the FerryBox in Cuxhaven was accomplished in 2012. For 2013 it was planned to test long term applicability and functionality of the device in the field by doing regular samplings with the device.
- Task 2: Another important task for 2013 was the connection of the automated filtration module with the biosensor to obtain a fully automated nucleic biosensor.
- Task 3: Finally, it was planned for 2013 to analyse field samples collected in the North Sea during COSYNA-Heincke cruises in 2010 and 2011 and samples taken on a regular basis with the automated filtration module in Cuxhaven using the semi-automated ALGADEC biosensor.

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.

Technical Implementation

Task 1:

The automated filtration unit was installed in combination with the FerryBox system in Cuxhaven in 2012. As planned, in 2013 the system was tested for its long-term applicability and functionality by collecting samples using the device on a regular basis April – December 2013. The samples were stored in the laboratory until further analysis.

Overall, the testing was successful. It was possible to operate the device via remote desktop and automatically collect samples. However, during a longer period of low temperatures (< 0°C) problems occurred with the positioning of the filters in the filter storage system, resulting in a disruption of the filtration process. These problems could be overcome by adjusting the system. Furthermore, some of the tubes had to be replaced because they were not suited to withstand the vacuum on a long-term basis. In December 2013 the COSYNA container in Cuxhaven was flooded. Subsequently, the computer of AUTOFIM was broken and had to be repaired.

Figure 1: Picture of the automated filtration module installed in combination with the FerryBox system in the COSYNA container in Cuxhaven.

Task 2:

In 2013 a concept for the connection of the filtration unit and the semi-automated biosensor was developed. The cells collected on the filter were supposed to be re-suspended in the hybridisation-mix via a treatment with ultrasound. Subsequent to the treatment the re-suspended sample was supposed to be transferred into the inlet of the biosensor by drawing the solution through the filter using a pump.

The feasibility of the concept was assessed by determining the optimal settings of the ultrasound echo-pulse instruments in terms of ultrasound strength. Defined cell numbers of the diatom *Pseudonitzschia sp.* were filtered and subjected to ultrasound treatments. Subsequently RNA was isolated from the cells. RNA concentrations were highest after a treatment with 100 % ultrasound power (Figure 3A). However, a visual assessment of the RNA integrity after ultrasound treatment revealed that the RNA was fragmented at an ultrasound power >60 % (Figure 3B). After the treatment with 60 % ultrasound power the RNA was still intact, while degradation was observed after the treatment with 80 % ultrasound power. The filtration of the solution after ultrasound treatment did not increase the degradation of the RNA, but the RNA concentration was decreased in comparison to the treatment without filtration.

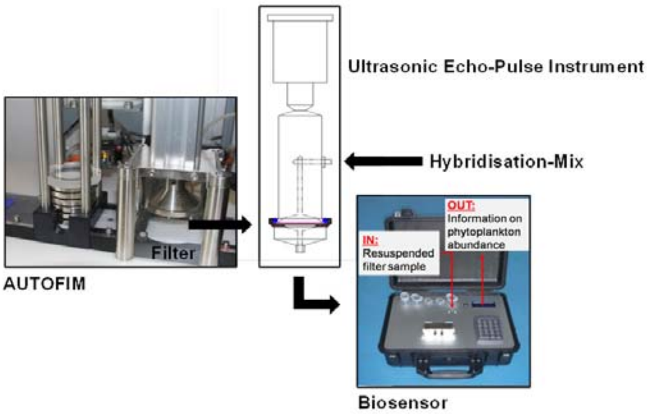


Figure 2: Concept for the connection of AUTOFIM and the biosensor.

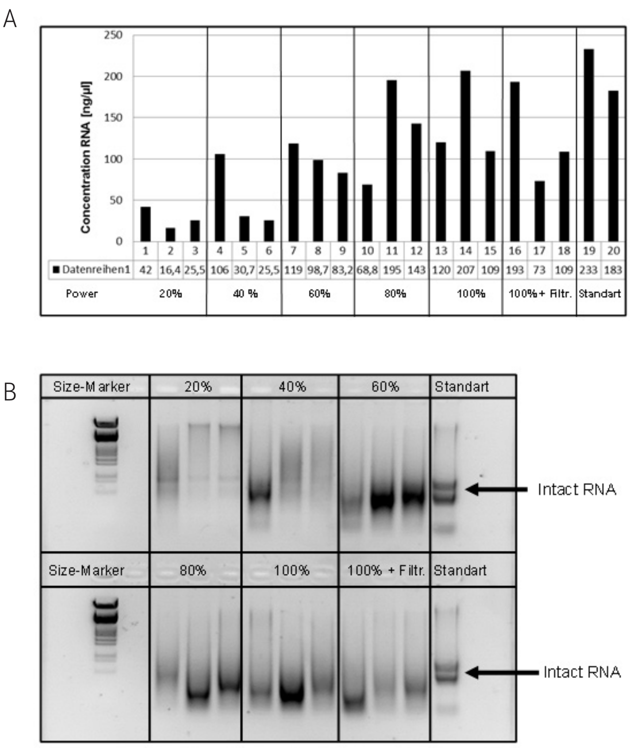


Figure 3: (A) RNA concentrations determined after ultra-sound treatment. (B) Visual test of the RNA integrity using an agarose-gel.

In summary it is feasible to re-suspend the cells via ultrasound and transfer the RNA by drawing the solution through the filter into the biosensor. However, the concentration of RNA after a treatment at 60 % ultrasound power is only 50 % of the concentration obtained by a standard isolation protocol for RNA.

Task 3:

Samples collected in the North Sea during COSYNA-Heincke cruises in 2010 and 2011 were analysed with focus on the abundance of *Pseudonitzschia sp.* using the semi-automated biosensor system. The data were validated with microscopic counts of the samples. The results obtained with this method evaluation are published in Wollschläger et al. 2014.

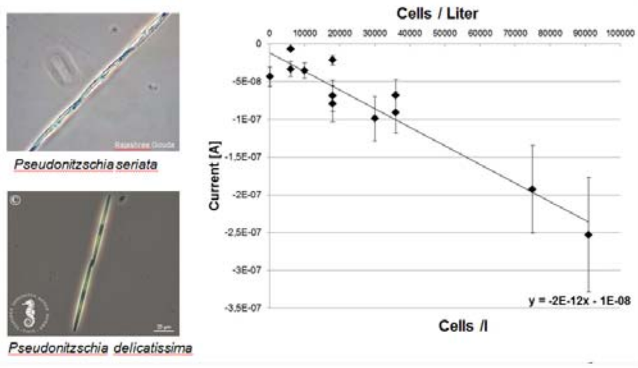


Figure 4: The diagram displays the results of a field trial focusing on the abundance of Pseudonitzschia sp. in samples collected in the North Sea.

Activities planned for 2014

The main task for 2014 will be the implementation of the concept for the connection of the automated filtration module with the biosensor to obtain a fully automated nucleic biosensor. Furthermore, it is planned to carry on with the development and optimisation of the molecular probe-sets and analyse field samples taken on a regular basis with the automated filtration module in Cuxhaven with the semi - automated ALGADEC biosensor.

Publications

Wollschläger J, Nicolaus A, Wiltshire KH, Metfies K (2014): Assessment of North Sea phytoplankton via molecular sensing: a method evaluation. Journal of Plankton Research 36(3): 695-708. doi: 10.1093/plankt/fbu003.

Integrative sampling approaches for the analysis of chemical contamination

D. Pröfrock / H. Helmholz / J. Petersen / A. Prange

Locations "Seebäderbrücke" Cuxhaven and underwater node "Margate" near Helgoland

Aims for 2013

The aim for 2013 was the testing of the re-designed infrastructure at Cuxhaven and Helgoland. The developed techniques should enable the long term, field-testing of different types of passive samplers. The first data sets generated in 2011 and 2012 should be further verified.

Technical/Program Developments in 2013

In 2013 the continuous operation of the sampling system could be maintained and an on-going third sampling series was started at the beginning of June.

The finished technical improvements now allow the deployment of passive samplers for inorganic contaminants such as Chemcatcher ® metal and Diffusive Gradients in Thin Films (DGT) devices beside polymeric sheet based samplers. In order to get a comprehensive image of the contamination level in different environmental compartments specific traps for the sampling of SPM have been continuously sampled over the whole year to measure particle bound contamination levels during the deployment period, while active samplers (*Mytilus* spec.) were continuously used to determine the bioavailable part of pollution as well as potential associated effects (see Figure 1). Different lab experiments using a specially designed flow thru exposure system have been performed to calibrate the different passive samplers. The aim was to extend the number of measureable elements, since most of the literature is currently restricted to the analysis of only a few elements (see Figure 2).

Results (Highlights)

Starting in June 2013 a periodical sampling (every 6-7 weeks) has been performed after the new deployment of mussels in the beginning of May. Since some additional cages have been deployed in the year before this results in an overlap of the two deployment periods, which provides some additional insight into the adaptation process of the newly deployed mussel population. Both locations were sampled simultaneously. Basic physiological data like condition index, gonadosomatic index and energy budgets gave hints on a different fitness of the Blue Mussels at these two stations (see Figure 3).

The sampling and handling of the mussels as well as the logistics were further improved. Parallel multi-element analysis of mussel tissue indicated elevated levels of relevant contaminants such as Pb, Cd in mussels sampled at Cuxhaven. They also showed a relatively fast response to the changing environmental conditions as observable especially directly after the transplantation. Additionally water samples from both locations were analysed to correlate the concentration levels with the measured body burdens.

In September and October a new type of DGT passive samplers for organic contaminants were tested at the station Cuxhaven as part of a JERICO TNA project collaboration together with the University of Lancaster.

Figure 1: Sampling station at Cuxhaven equipped with integrative (different types of passive and active) samplers, mussel samples

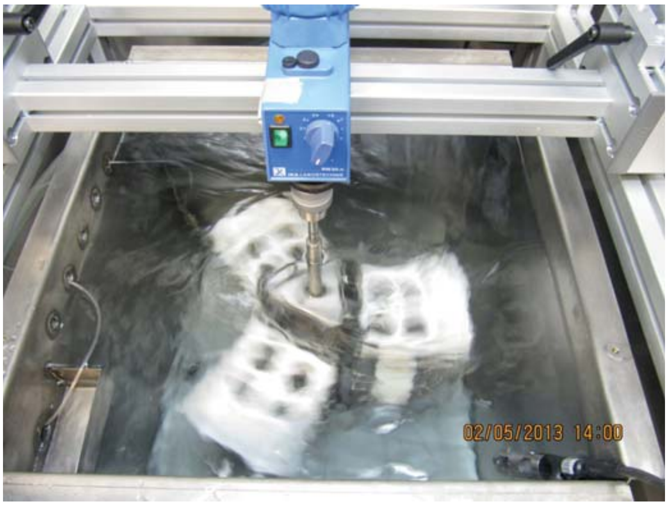


Figure 2: Flow Thru Tank system for the calibration of different passive sampling devices under lab conditions.

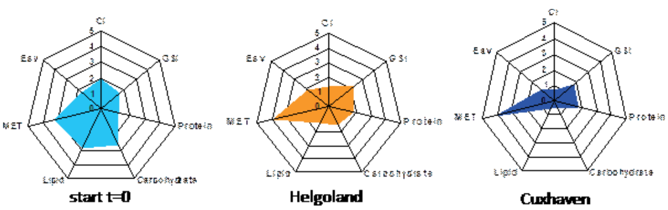


Figure 3: Z-transformed values for start (t = 0), reference station Helgoland and charged station Cuxhaven at t = 8 month. Associated biometric and bioanalytical measurements like Condition Index (CI), Gonadosomatic Index (GSI), Mitochondrial electron transfer (MET), basic nutrients (proteins, carbohydrates, lipids) accumulated to available energy (E_{av}) indicate the diminished physiological status of the transplanted mussels in the charged regions.

Problems

The most important challenge that arose during the year was again related to the development of a biofilm and the massive growth of hydrozoa and barnacles on all surfaces of the sampling equipment, which necessitates a regular cleaning procedure. In Cuxhaven the strong growth of mussels and barnacles on the surface of the station even results in a complete blockage of the elevator like deployment system, which lead to the breakage of the stainless steel winch cable, which is mandatory to lift up the system from the water column.

The whole station, in particular the underwater parts had to be cleaned by industry divers to remove all the biota from the surfaces and to make the lift system movable again. Especially at the Helgoland station a predatory impact of crustaceans reduces the number of available organism for the planned investigation at the end of the deployment period. The crustaceans also partly effected the deployment of DGT style passive samplers since a number of damaged samplers have been observed with missing receiving phases or small holes inside the membrane.

Perspectives for 2014

Minor improvements of the technical infrastructure will be necessary in order to further optimise the handling and to prevent the frequently observed bio-fouling. Laboratory experiments will be conducted to test the performance of the passive sampler and calibrate the diffusion based sampling processes. Additionally lab incubation experiments with mussel cultures will be conducted to investigate the impact of single contaminants on the expression of potential marker proteins in digestive glands as well as gill tissues. These results will help to further evaluate the conducted field experiments. It is planned to start a new deployment period at the beginning of April. The data set for chemical contamination will be accomplished by analysing further SPM and water samples.

Furthermore a high frequent sampling campaign is planned to compare time weighted average concentration data obtained via passive sampling with data from high frequent spot sampling at the station in Cuxhaven.

Publications

Petersen J, Pröfrock D, Broekaert JAC, Prange A: Passive sampling as a tool for time-integrated analysis of metal and metal species in marine waters using ICP-MS-MS. European Winter Conference on Plasma Spectrochemistry 2013, Krakow, Poland, 10-15 Februar 2013

Petersen J, Pröfrock D, Broekaert JAC, Prange A: Passive sampling as a tool for time-integrated analysis of metals in marine waters using ICP-MS-MS. 6th International Passive Sampling Workshop and Symposium, Bordeaux, France, 26-29 June 2013

Petersen J, Pröfrock D, Broekaert JAC, Prange A: Passive sampling as a tool for time-integrated analysis of metals in marine waters using ICP-MS-MS. DGT Conference 2013, Lancaster, UK, 09-11 July 2013

Helmholz H, Strižak Ž, Ruhnau C, Erk M, Lassen S, Prange A: Utilization of Proteomic Techniques for the Identification of Potential Contaminant-related Biomarker. Proteomic Forum 2013

Strižak Ž, Ivanković D, Pröfrock D, Helmholz H, Cindrić A-M, Erk M, Prange A (2014):
Characterization of the cytosolic distribution of priority pollutant metals and metalloids in the digestive gland cytosol of marine mussels: seasonal and spatial variability. Science of the Total Environment 470–471: 159–170

Numerical modelling and data assimilation

E. Stanev / J. Staneva / S. Grayek / J. Schulz-Stellenfleth / S. Grashorn / A. Behrens

Aims for 2013

In 2013 work was focused on development and testing of regional coupled ocean-wave models for the German Bight. The impact of coupled wave-currents models on analyses and short-term forecasts in German Bight has been studied.

Integrated ocean observing systems closely link in-situ and remote measurements with numerical models enabling the reconstruction and forecast of key state variables with full spatial coverage. The COSYNA modelling is further developed to produce reliable nowcasts and short-term forecasts of the circulation and physical properties in the German Bight. One of the expectations is that the model can provide consistent three-dimensional temperature and salinity fields to fill in the gaps in in-situ and satellite observations and eventually produce reliable physical components to be used in further biogeochemical applications. Analyses on the added value of assimilation of temperature and salinity data from different sources, e.g. OSTIA, FerryBox, etc. on the improving the ocean state have been performed.

The unstructured grid ocean model SELFE was set up and tested to check the possibility of a future enhancement of the hindcast and forecast capabilities of the COSYNA modelling system.

As the Bundesamt für Seeschifffahrt und Hydrographie (BSH) showed interest in the HF radar assimilation done at HZG one aim for 2013 was to apply the GALATON system to operational output from the BSH model. An important task was to check whether the approach is able to deal with the specific forecast errors contained in the operational output. For this purpose, the model error covariances so far used for the GETM model had to be adjusted to the new data.

Another goal was to take steps towards the integration of further observational data into the GALATON system. One important activity in this context was the combined analysis of HF radar data and tide gauge measurements. Another issue was the relation between surface currents and current profiles. This was for example investigated using ADCP data acquired at the FINO3 platform, which is covered by the Sylt HF radar station.

Technical/Program Developments in 2013

Wave-circulation coupling

Coupling between the wave model (WAM) and the hydrodynamical model (GETM) is being developed and applied for the German Bight region. The coupling improves the estimates of ocean state variables, especially in coastal areas like the Wadden Sea and estuaries. It takes into consideration both: the effect of currents on waves and the effects of waves on upper ocean dynamics, in particular on mixing and drift currents. In WAM the depth and /or current fields can be non-stationary, grid points can fall dry and refraction due to spatially varying currents and depths is accounted for in the quasi-stationary approach. GETM was modified to account for wave effects by introducing the depth dependent radiation stresses and Stokes drift. The terms were calculated from the integrated wave parameters according to Mellor (2008). The gradient of the radiation stresses serves as an additional explicit wave forcing term in the momentum equations for the horizontal velocity components. The transfer of momentum by waves becomes important for the mean water level setup and for the alongshore currents generated by waves in the surf zone.

NEMO model

During 2013 a model setup for the North Sea and Baltic Sea region based on the Nucleus for European Modelling of the Ocean (NEMO) framework was developed. Forcing at the open boundaries includes tidal sea surface elevation, tidal barotropic currents, and climatological temperature and salinity profiles. Tidal forcing includes 9 tidal components (M2, S2, N2, K2, K1, O1, P1, Q1, and M4) and their individual coefficients are derived from harmonic analyses provided by the OSU Tidal Inversion Software (OTIS). Temperature and salinity profiles originate from climatological data by Janssen et al. (1999) and were projected on the model grid using a simple 'next neighbour' approach. All datasets are temporally interpolated on the internal model time-step using the default modules provided in the NEMO framework.

Atmospheric forcing uses the 'CORE bulk formula' formulation plus analytical solar insulation, simulated sea surface temperature and cloud cover to provide estimates of short and long wave solar radiation. Cloud cover, wind speed components at 10 m as well as air temperature and specific humidity at 2 m are derived from European Centre for Medium-Range Weather Forecasts (ECMWF) analyses data.

SELFE hydrodynamic model

Additionally to GETM and NEMO a setup of the unstructured grid ocean model SELFE coupling the North and Baltic Sea has been developed and tested for a storm surge that happened in December 2013. SELFE can be utilised on parallel cluster environments.

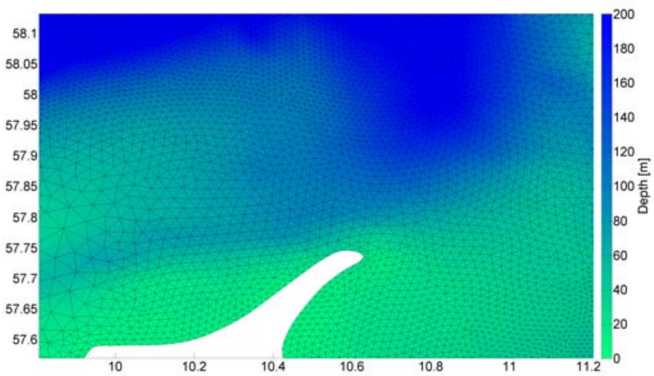


Figure 1: Example of the unstructured grid around the northern tip of Denmark

Assimilation of sea surface temperature and salinity data

Assimilation of data in the near-coastal zone is not well developed even for traditional observations (e.g., tidal gauge data). However, there is a huge amount of continuous ADCP, buoy and platform data with very high temporal resolution available for the European coastal region (e.g., MARNET stations) and FerryBox data in the German Bight, together with Operational Sea Surface Temperature and Sea Ice Analyses (OSTIA) data, which could provide valuable sources of data to be assimilated. Furthermore, there is a need of improving the performance of models in near-coastal zone to a level allowing efficient assimilation of newly available data.

The performance of the SST assimilation is analysed by comparing the RMS differences between the model simulated SST with that from OSTIA for February, 2011 (Figure 2). The RMSE values of the Free Run versus OSTIA demonstrate that in most of the offshore area of the German Bight the values of the RMSE are relatively low (lower than 0.5 deg.). This shows that the Free Run model is capable to simulate the surface temperature reasonably well. The improvement of the data assimilation run with respect to the free run is clearly demonstrated. The RMS errors are significantly reduced by the assimilation.

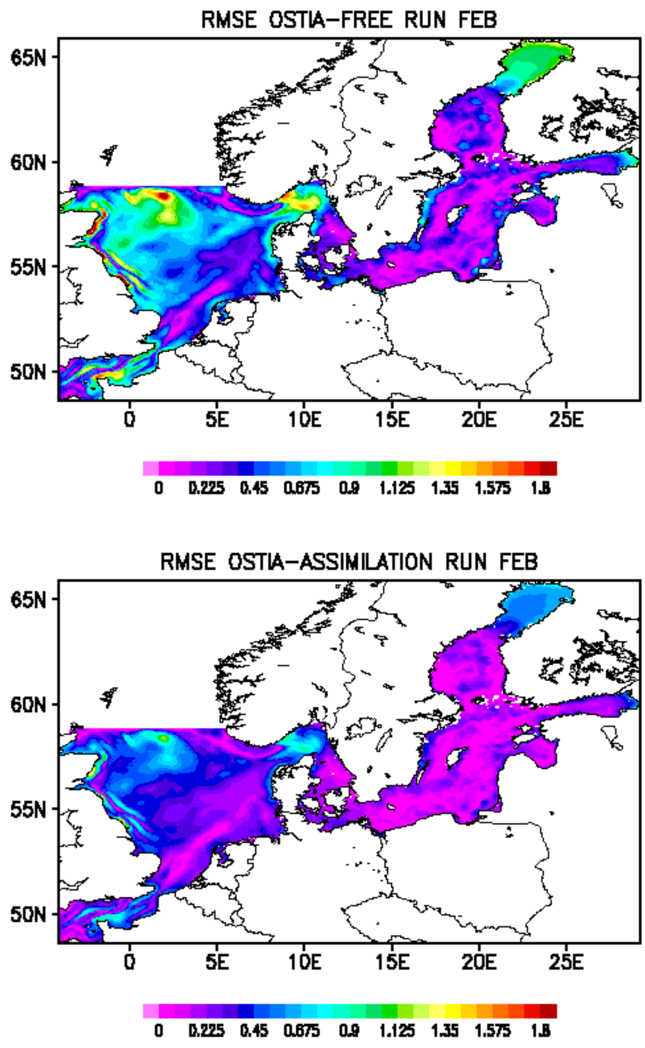


Figure 2: Model errors (RMS) in [°C] for February 2011 between the OSTIA and the free-run (top panel) and OSTIA SST and the assimilation-run (bottom panel)

Assimilation of HF radar

The GALATON system for the assimilation of HF radar data was applied to operational BSH model output (see Figure 3). Data from the coastal model with approximately 1 km resolution were used. Both the coverage and resolution are slightly different from the GETM setup so far used in the COSYNA system. Model error statistics were estimated based on an EOF analysis technique. In a first step a standard approach was used, where the model error correlation structure is assumed to be identical to the background statistics. In a second step a new method was implemented, in which observations are used to improve the estimation of the model error covariance matrix.

Furthermore, investigations concerning the combined use of HF radar and tide gauge measurements were performed. A method was implemented, which allows the analysis of different terms in the momentum equation (e.g., acceleration, pressure gradient, Coriolis force). Based on this investigation an approach was developed which has the potential to provide new information about bottom friction. This method is currently being tested and optimised. In addition this analysis can help in the integration of tide gauge data into the assimilation system.

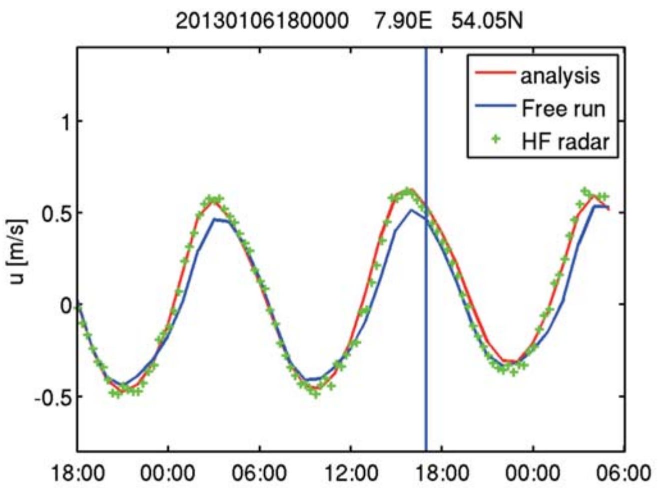


Figure 3: Example of a GALATON analysis based on HF radar measurements and data from the operational BSH model.

Investigations on atmospheric boundary layer rolls

Atmospheric boundary layer rolls and their impact on upper ocean circulation were investigated using a combination of two high-resolution data sources: (1) data from the Advanced Synthetic Aperture Radar (ASAR) onboard ENVISAT with a spatial sampling of approximately 500 m × 500 m and (2) continuous observations taken at the research platform FINO1 with 2 min temporal sampling at eight heights between 33 and 100 m (Müller et al. 2013). The parallel analysis of instantaneous image data in combination with the FINO1 time series enabled us to quantify both the spatial and temporal dynamics of mesoscale and submesoscale wind variations. The influence of these variations with different temporal and spatial scales on the hydrodynamics of the German Bight was addressed using outputs from a three-dimensional circulation model.

Results (Highlights)

Validation of the results of the coupled wave-circulation model with in-situ measurements show that the wave period measurements were reproduced much better, when the hydrodynamic forcing is applied. The agreement in significant wave height (Hs) and Tm2 period between the observations from buoy data and the WAM simulations is very good (Figure 4).

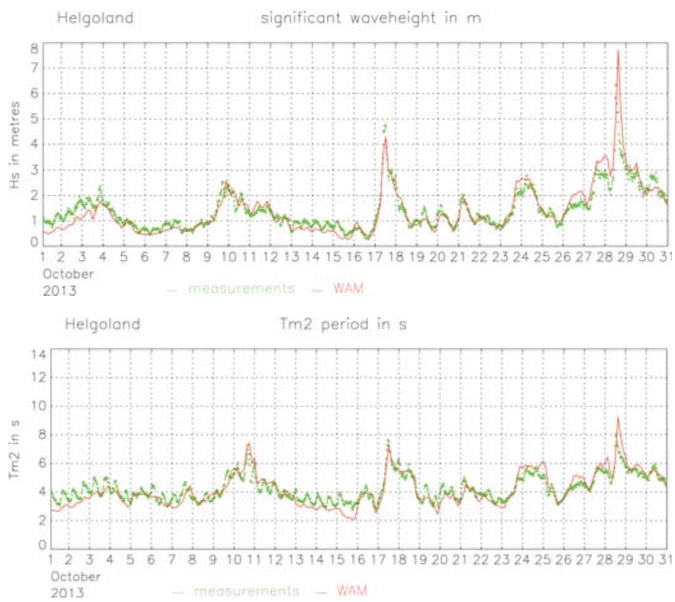


Figure 4: Time series of measured and computed wave parameters at the location Helgoland from the German Bight WAM simulations

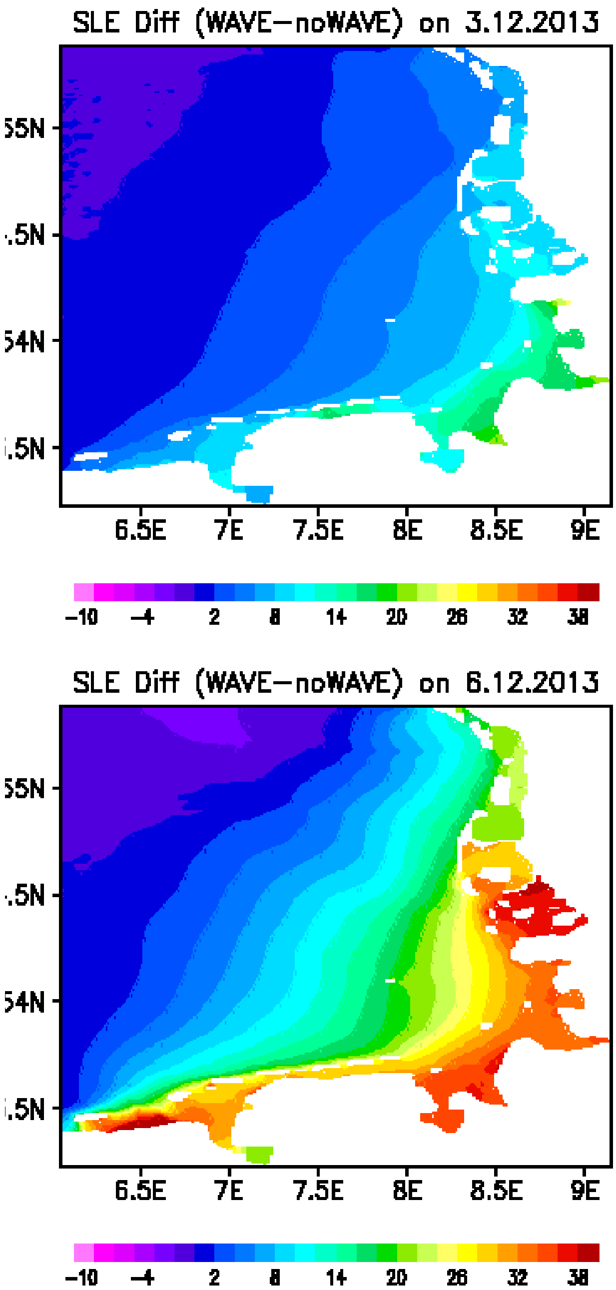


Figure 5: Sea surface elevation (SLE) difference between coupled wave-circulation model (WAM-GETM) and circulation model only (GETM) for the German Bight on 3 December 2013 (top) and during the storm Xaver on 6 December 2013 (bottom).

We demonstrate the role of coupling by analysing the impact of waves on extreme events (storm Xaver on 6 December 2013, see Figure 5). The radiation stress increases the average water levels, which is much pronounced in the coastal area. During normal conditions the differences of the sea level due to the coupling with wave model reaches maximum 10–15 cm in the Elbe area. However, during the storm Xaver, the differences of simulated sea level when considering waves are about 30–40 cm along the whole German coast. Therefore the uncertainties in most of the presently used models result from the nonlinear feedback between strong tidal currents and wind-waves, which can no longer be ignored in operational oceanography, in particular in the coastal zone where its role seems to be dominant.

During the reporting period we studied also the usefulness of and problems associated with the usage of OSTIA SST data, together with measurement data, e.g., from FerryBox along track sea surface temperature (SST) and salinity (SSS) data for assimilation (Figure 6). We analysed the feasibility of an assimilation of OSTIA SST and FerryBox SST and SSS data based on data from numerical models, and gave estimates of the corresponding errors. Outputs from four model runs of a German Bight model, assimilating OSTIA SST in combination with and without FerryBox SST and SSS have been assessed. It was demonstrated that the assimilation improves the ocean state not only for temperature but also for salinity.

The SELFE model setup is showing promising results not only in surface elevation (see Figure 7) for pile stations in the North and Baltic Sea but also for salinity and temperature distributions.

Comparisons of operational BSH model output with HF radar data showed good agreement with respect to tidal constituents, e.g., with regard to the tidal ellipses shape. For the total currents, i.e., including the wind-driven part, larger deviations could be found depending on time and location. These results showed that the agreement is good enough to be able to compute an analysis. At the same time the departure is big enough to justify the effort involved in the assimilation process.

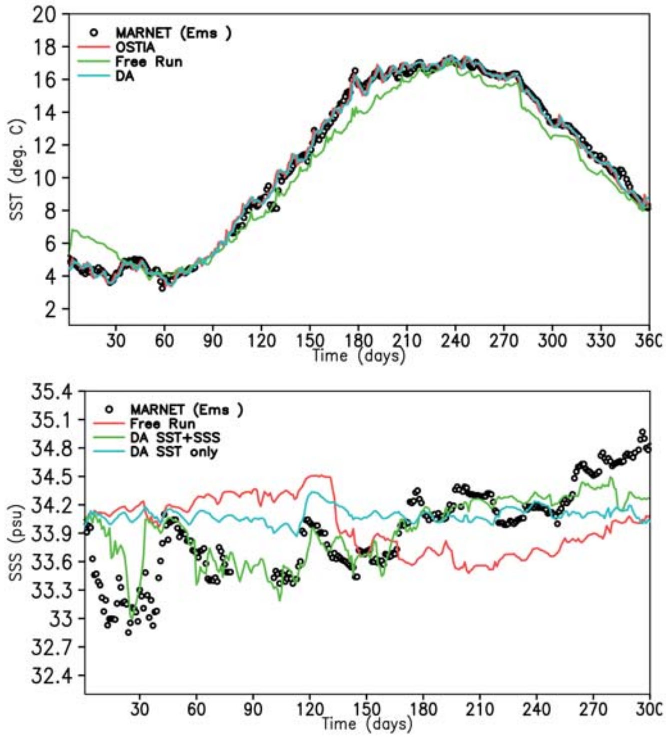


Figure 6: Validation of simulated SST and SSS from the German Bight model against independent MARNET observations for 2011

The new approach for the estimation of the model error covariance matrix leads to an improved forecast skill in the area covered by the HF radar. It seems possible to extend the forecast horizon from 6 hours to 12 hours. This is currently investigated in more detail.

Problems

There is still some work required to add monthly statistics in the wave and circulation model results. Technical problems during 2013 were connected with the change to a new cluster thus limited disk data space.

For the assimilation of HF radar there are still too few independent current measurements. Data from a drifter experiment could unfortunately not be used because of data link problems.

Unstructured grid models such as SELFE produce a bigger amount of results due to a higher resolution yielding in more grid points. Therefore one needs a considerable amount of computer storage capacity, which might become a problem. To achieve a reasonable ratio between real and simulation time supercomputing systems are a prerequisite. Today computing time on such systems is temporally restricted and expensive.

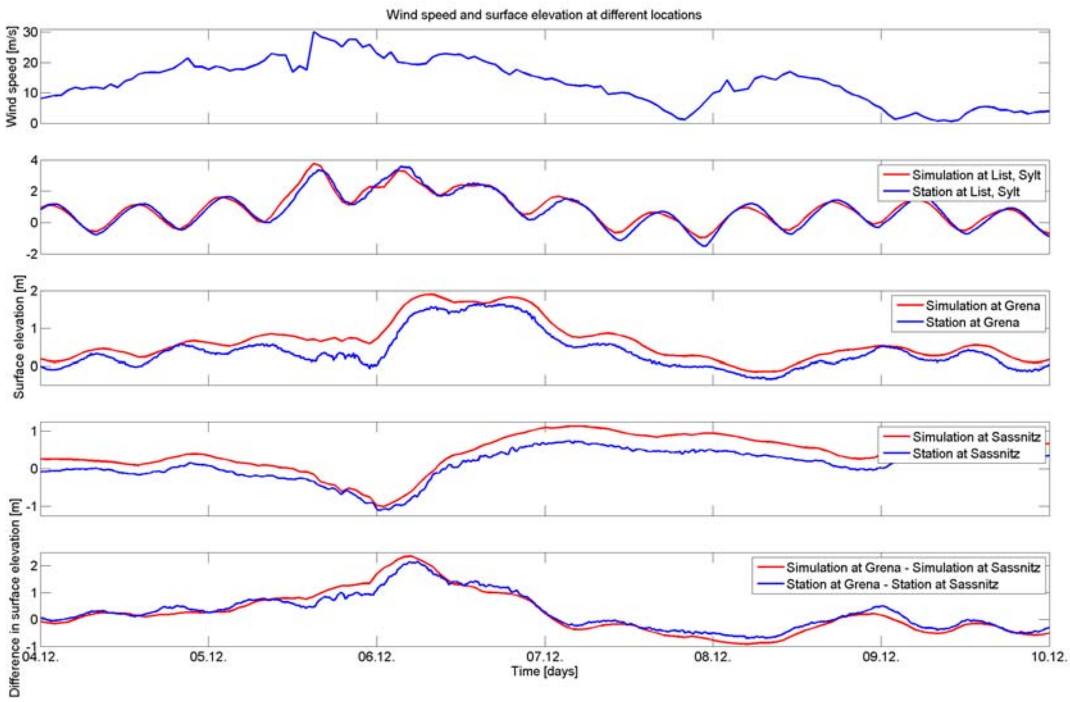


Figure 7: Validation of the SELFE model setup using some pile stations in the North and the Baltic Sea.

Perspectives for 2014

The two-way coupled wave-hydrodynamic model will be included into the COSYNA web site and data portal.

Validation of model simulations with observations including monthly statistics will be added.

The hydrodynamic model part of SELFE will be coupled to a surface wave model to enhance the modelling of current speeds in coastal areas.

Near real-time products based on assimilation of temperature and salinity data will be provided on the COSYNA site.

The promising work on the combined use of HF radar data and tide gauge measurements will be continued. This may lead to the integration of tide gauge measurements into the GALATON assimilation system.

The new approach for the model error statistics will be further optimised. The method will be tested with both BSH and GETM model data. A possible extension of the forecast horizon from currently 6 hours to 12 hours will be investigated.

Publications

Müller S, Stanev EV, Schulz-Stellenfleth J, Staneva J, Koch W (2013): Atmospheric boundary layer rolls: Quantification of their effect on the hydrodynamics in the German Bight. J. Geophys. Res., 118 (10), 5036-5053

Stanev EV, Ziemer F, Schulz-Stellenfleth J, Seemann J, Staneva J, Gurgel K (2014): Blending surface currents from HF radar observations and numerical modelling: Tidal hindcasts and forecasts. Submitted to J. Atmos. Ocean Techn., 2013

Data management & quality assurance

G. Breitbach

Aims for 2013

- Development of a visualisation tool for 3-D moving in-situ platforms like gliders.
- Development of a metadata structure which includes COSYNA web-service URLs in a metadata element named observedProperty

Technical/Program Developments in 2013

- A new version of the COSYNA data portal (http://codm.hzg.de/codm) was developed.
- A 3-D view of glider parameters has been developed.
- A Java applet for better visualisation of glider data has been integrated into the COSYNA data portal.
- Procedures to use MODIS as remote sensing tool for chlorophyll has been developed and integrated into the data portal.
- Pre-operational quality checks have been applied to many more parameters.
- The wave model has been integrated into the data portal.
- Data transmission from a CTD at the COSYNA underwater node Helgoland using SOS (Sensor Observation Service) has been established and is available in the data portal.

Results (Highlights)

The COSYNA data portal (Figure 1) now enables users to get access to the data with only 2 more clicks after selection of parameter, time and bounding box ("Select all datasets" and "Create map", "Create plots" or "Downloads" according to what is wanted).
A new icon for the visualisation of data has been added to the portal, which so far is used for glider data only. In all other cases the icon is grayed out (Figure 2).

Problems

The wave height results provided by the wave model are in meters whereas the wave rider buoys measure in cm. This is only a minor problem because the plot limits could be set independently.
Due to new security restriction of Java it might be problematic or even impossible to look at the new Java applet from Figure 2 in the future.

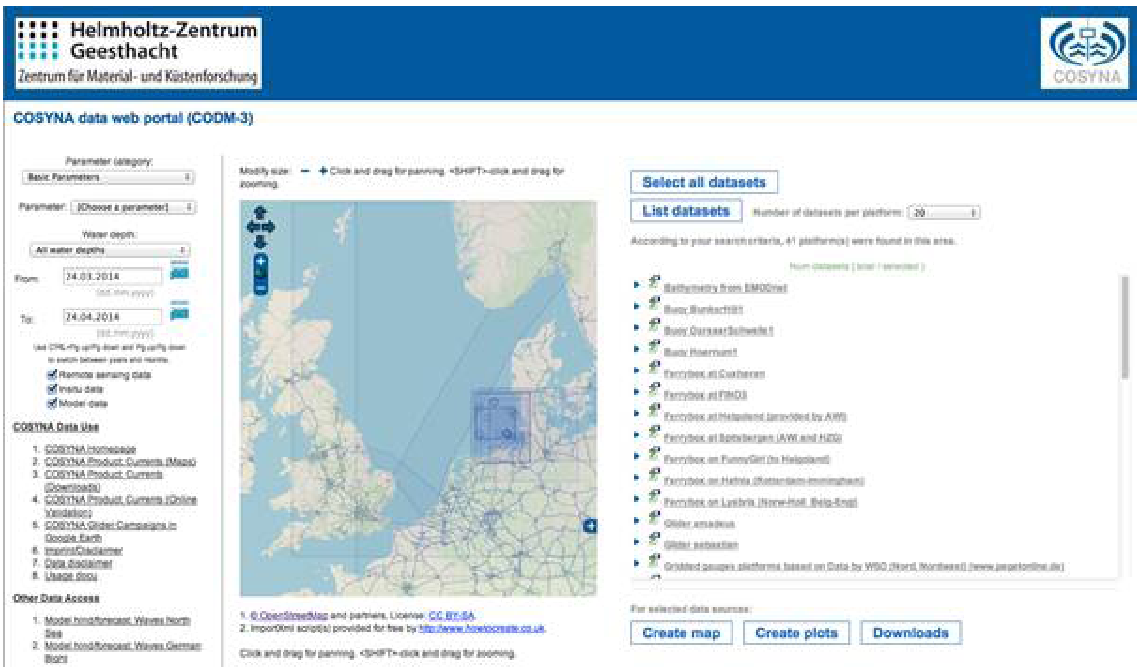


Figure 1: Initial view of the COSYNA data portal.

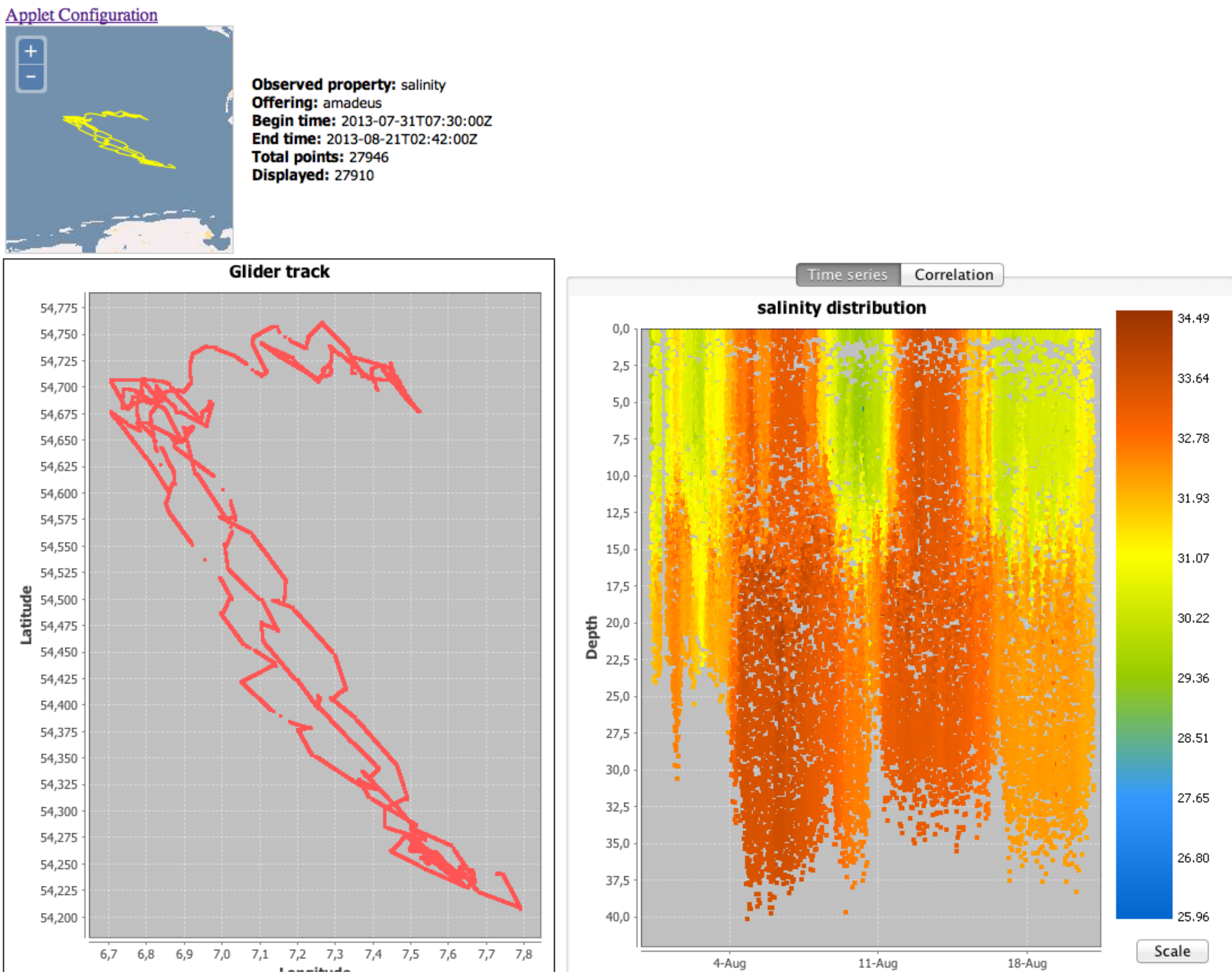


Figure 2: The new Java applet for glider data: In the data portal a parameter (salinity) is selected; clicking on the applet icon of one of the campaigns produces the graph. Using "Applet Configuration" other parameters from the same campaign can be added.

Perspectives for 2014

- Development of more Sensor Observation Services directly at sensors according to the OGC standard SWE (Sensor Web Enablement)
- Bug fixes for the portal

Publications

Breitbach G, Krasemann H (2013): A new Approach in Data Management for an Integrated Coastal Observation System. At: International Conference on Marine Data and Information Systems - Lucca (Italia), September 23-25, 2013 http://imdis2013.seadatanet.org/content/download/73324/952023/file/S2P11_IMDIS2013.pdf

Outreach & science-stakeholder interaction

C. Eschenbach

Aims for 2013

- As in previous years, the aim for 2013 was to reach out to the scientific community, potential users and the general public with new insights resulting from COSYNA activities.
- In particular, major efforts were undertaken to establish an interaction with potential COSYNA product users from the offshore energy sector.

The focus of this report is on activities conducted or initiated by the COSYNA project management. Other activities such as scientific publications, participation in conferences and trade exhibitions or further developments of the COSYNA data portal are reported in the respective sections.

Interaction with stakeholders from offshore-wind energy sector

Potential users of COSYNA products include state and local authorities, associations (e.g., nature conservation), science and industry. In 2013, we have put substantial effort into establishing and strengthening contacts and interactions with potential COSYNA users from the offshore wind energy industry. The aims in doing so were (1) to improve COSYNA products and their usability and (2) to pave the way for future co-operations with offshore wind energy companies. Major steps were interviews to prepare the long planned workshop, the realisation of the user workshop with approximately 100 participants, and the evaluation of the workshop outcomes and post-processing (wrap up). These efforts were undertaken jointly and in very fruitful co-operation with the Federal Maritime and Hydrographic Agency (BSH) and the German Weather Service (DWD).

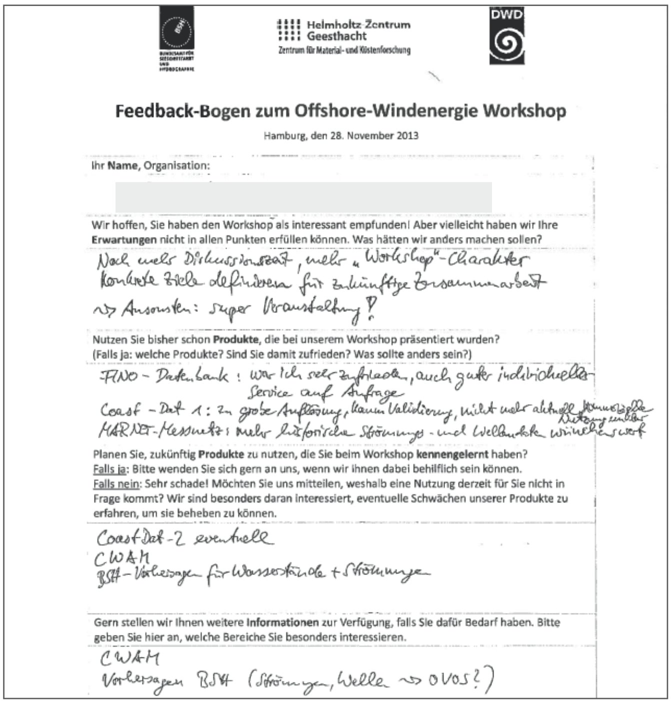
Interviews

Through personal contacts, literature and internet research we identified numerous people from the offshore wind energy industrial sector who might possibly take an interest in our activities and the planned user workshop. Interviews were conducted with Dt. Offshore Consult, Vattenfall, RWE Innogy GmbH, Linnhoff Offshore AG, HOCHTIEF Solutions AG, RS Diving Contractor, and Nordic Yards. Most of the interviews were conducted face-to-face and took about 1 hour (and more). In general, we found the interviewees open-minded and willing to talk about their use and requirements of data. Data use and requirements by the different companies span a wide range from raw to processed and evaluated data in various formats and provided through a variety of user interfaces. Forecasts for several hours were mentioned as being most welcome. Several interviewees expressed a considerable willingness for co-operation concerning oceanographic measurements in wind farms and data exchange.

Workshop

As we concluded from the interviews that safety (EHS) plays a pivotal role, this aspect became an integral part of the workshop. The workshop was entitled “Neue Produkte zur Unterstützung der Offshore-Windenergie. Mehr Sicherheit und Effizienz durch detaillierte Zustandserfassung und Vorhersagen“ and held on 28 November 2014, in Hamburg. The programme comprised the four sections introduction, risk assessment, state description, and forecasts, with each section covering presentation of (scientific) data products, related user statements and discussion. 92 participants from 33 different organisations attended (Figure 1). The feedback on the workshop was very positive, it was, however, suggested that the next events or meetings should allow more time for discussion, thus being “real” workshops (Figure 2).

Figure 1: The workshop was held jointly with BSH and DWD (top). 92 representatives of 33 organisations participated. (bottom)


Helmholtz Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

DWD

Feedback-Bogen zum Offshore-Windenergie Workshop

Hamburg, den 28. November 2013

Ihr **Name**, Organisation:

Wir hoffen, Sie haben den Workshop als interessant empfunden! Aber vielleicht haben wir Ihre **Erwartungen** nicht in allen Punkten erfüllen können. Was hätten wir anders machen sollen?

Noch mehr Diskussionszeit, mehr „Workshop“-Charakter
Konkrete Ziele definieren für zukünftige Zusammenarbeit
⇝ Ansonsten: super Veranstaltung!

Nutzen Sie bisher schon **Produkte**, die bei unserem Workshop präsentiert wurden?
(Falls ja: welche Produkte? Sind Sie damit zufrieden? Was sollte anders sein?)

FINO-Datenbank: war ich sehr zufrieden, auch guter individueller Service auf Anfrage
Coast-Dat 1: zu grobe Auflösung, kaum Validierung, nicht mehr aktuell
MARNET-Messnetz: mehr historische Strömungs- und Wellendaten wünschenswert

Planen Sie, zukünftig **Produkte** zu nutzen, die Sie beim Workshop **kennengelernt** haben?
Falls ja: Bitte wenden Sie sich gern an uns, wenn wir Ihnen dabei behilflich sein können.
Falls nein: Sehr schade! Möchten Sie uns mitteilen, weshalb eine Nutzung derzeit für Sie nicht in Frage kommt? Wir sind besonders daran interessiert, eventuelle Schwächen unserer Produkte zu erfahren, um sie beheben zu können.

CoastDat-2 eventuell
CWAM
BSH-Vorhersagen für Wasserstände + Strömungen

Gern stellen wir Ihnen weitere **Informationen** zur Verfügung, falls Sie dafür Bedarf haben. Bitte geben Sie hier an, welche Bereiche Sie besonders interessieren.

CWAM
Vorhersagen BSH (Strömungen, Welle ⇝ OVOS?)

Figure 2: First announcement (top). The feedback sheets revealed positive reactions (bottom).

In order to maintain the established contacts with the offshore wind energy sector, HZG, BSH and DWD agreed on future/next steps, such as further interviews with companies, combined presentation of the portfolio of the respective data products, and participation in the “Windforce 2014” exhibition in June 2014 in Bremen.

Inreach and outreach activities in 2013

Print products

As in the previous years, COSYNA published several print products and contributed for example to the BOOS Newsletter 3 (spring 2013). The Annual Progress Report 2012 elucidated research activities, selected results, and the approach to problems taken by the COSYNA workings groups and sub-projects. The report was completed in May 2013, widely read and appreciated by internal and external partners and stakeholders.

Events

COSYNA was presented at public events, such as the Coastal Conference „Einladung zum Dialog: Küstenforschung, Küstennutzung und Küstenschutz“, March 2013, in Hamburg, gathering experts from German Economy, Strategy and Nature Conservation as well as scientists. We participated in the “POLEKO” in Poznan, Poland, which is the biggest ecological fair in Poland and in Central and Eastern Europe, with representatives from industry, local government and non-governmental institutions associated with ecology. In order to discuss the new strategic orientation in the upcoming years, COSYNA organized two meetings of the Scientific Steering Committee (CSSC).

COSYNA Website

The up-dating and re-designing of the COSYNA homepage (www.cosyna.de) is an ongoing process that was continued in 2013. On average, the COSYNA website has been visited by more than 500 different visitors per month (without HZG visitors) and the number of visits increased to more than 1000 visits per month during 2013. In addition, the ongoing conceptual planning and discussions for the fundamental relaunch of the HZG website – including the COSYNA website – have taken their time.

COSYNA App

COSYNA supports an interactive app, which was developed and commissioned together with the Public Relations department at HZG in 2012. For a new version, the home screen (Figure 3) was considerably refurbished and descriptions of the COSYNA partners included. More COSYNA instruments are represented with description, photos, and (online real time) results. Additionally, an English version of the app is provided.

Figure 2: An interactive COSYNA app shows the various instruments, models und products, and explains the COSYNA approach (soon available for tablets in the Apple and Android stores).

Problems

Interaction with companies from the offshore wind energy sector has been starting very promising, however concrete tangible outcomes are still lacking.

Perspectives for 2014

Planned activities are participations in public, sectorial, and cross-sectorial events, for example, the 7th edition of the “European Maritime Day” and the international offshore wind energy exhibition “Windforce 2014”, both held in Bremen in May and June 2014, respectively.

As funding, but of course not COSYNA will be finished at the end of 2014, next steps are sketched: we will start planning for a final report und a public meeting with all COSYNA contributors in early 2015.

COSYNA

Coastal Observation System for Northern and Arctic Seas

Website: www.cosyna.de

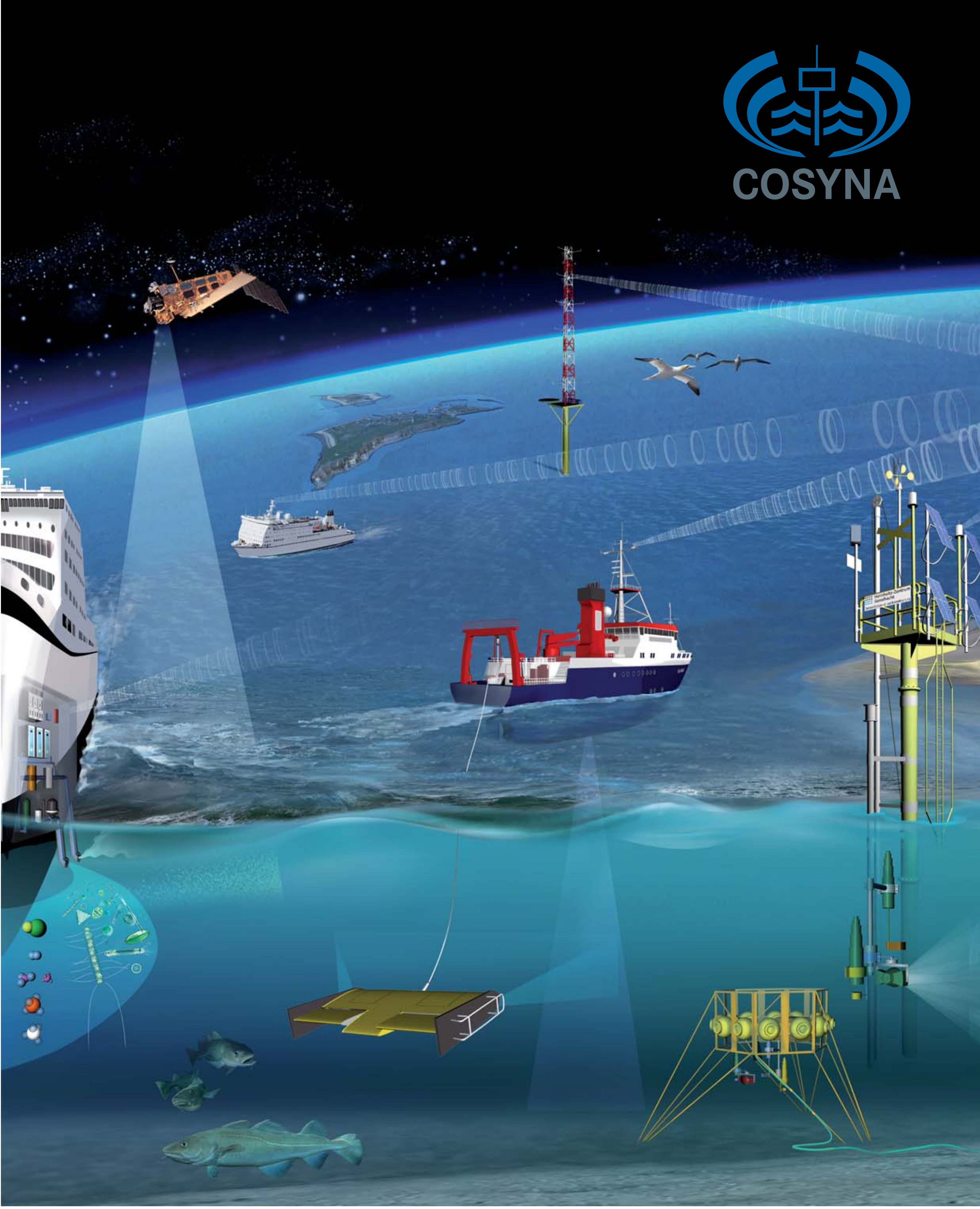
COSYNA data portal: http://codm.hzg.de/codm

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research
Institute of Coastal Research
Max-Planck-Straße 1
21502 Geesthacht

director:
Prof. Dr. Burkard Baschek
+49(0)4152 87-1534
burkard.baschek@hzg.de

contact:
holger.brix@hzg.de
christiane.eschenbach@hzg.de

June 2014



Helmholtz-Zentrum
Geesthacht

Centre for Materials and Coastal Research