SEVENTH FRAMEWORK PROGRAMME

Area 6.4.1.2. Cross-cutting research activities relevant to GEO

ENV.2008.4.1.2.1. Monitoring and observing oxygen depletion throughout the different Earth system components

Final Report, month 36

Period covered: 1.Apr. 2009 to 31.Mar.2012

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Project acronym: *HYPOX*

Project full title: *In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies*

Grant agreement no.: *226213*

Date of preparation: *03 Aug 2012*

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PART A: TEXT PARTS

4.1 Final publishable summary report

4.1.1 Executive Summary

HYPOX carried out pioneering work to build capacities for state of the art oxygen monitoring. The adopted monitoring strategies take relevant temporal and spatial scales of oxygen depletion into account that are inadequately addressed by previous oxygen observation approaches. To achieve this HYPOX deployed stand-alone or cabled observatories that are able to perform long-term continuous measurements of oxygen and associated parameters. At several sites, profiling observatories as well as drifting or towed instruments were used to investigate spatial patterns of hypoxia. The sites were carefully selected to cover a large range of contrasting 'hypoxia characteristics' with respect to hydrographical setting, man made pressures, and vulnerability to climate change. Supported by modeling studies that were carried out as part of HYPOX, this facilitates the extrapolation of the knowledge obtained – both with respect to hypoxia characteristics and appropriate monitoring strategies – to a large variety of ecosystems. In order to comprehensively address hypoxia, ecosystem responses (with a strong focus on hypoxia impact on biogeochemical processes and element cycling) have been included as well as the investigation of past hypoxic conditions based on faunal patterns and organic and inorganic proxies from the sediment record. Adopted monitoring strategies and technologies were carefully selected according to identified gaps in knowledge and existing information on the characteristics of the respective target sites. Based on generalized findings achieved by careful analysis of the data from observatories and field campaigns as well as application of data assimilation and modeling techniques, hypoxia ecosystems were classified and recommendations for future oxygen monitoring defined.

Supporting GEO tasks within the running GEO Workplan (2009-12) has been one of the major goals of the project. The results obtained in HYPOX are highly relevant to GEOSS objectives from ecosystem, water management, and climate points of view. Four HYPOX services, each representing a metadata or data delivery service capable to comply with a GEOSS accepted standard, have been registered at the GEOSS registry. Substantial progress was made concerning the interoperability of observation systems for oxygen depletion in different systems. A standardized and GEOSS compliant data flow from the observatories to the end users was established. The achievements of the HYPOX project substantially improved capacities for oxygen monitoring as well as for the prediction of oxygen depletion and evaluation of existing and future impacts on ecosystems. An increased demand for ocean observation and in particular for oxygen observations in the next decades is foreseen in the context of the Marine Strategy Framework Directive and in response to the expected increase in the exploration of marine Resources. HYPOX knowledge provides essential pieces to a conclusive observing strategy to ensure sustainability of the envisaged activities through baseline studies as well as by the observation of changes. This represents a major potential impact generated by the project that will extend into the future.

Observations and measurements obtained by the observatories and during the targeted field campaigns represent one of the most important project results. The data are archived in the long term data repository and publishing network PANGAEA (http://www.pangaea.de) and accessible through the HYPOX data portal (http://dataportals.pangaea.de/hypox). The portal additionally contains information on the sites and descriptions of the observatories. The data sets are also listed in table 4.2.A2 in this report. Peer reviewed publications as well as dissemination activities (e.g., scientific conferences, workshops, TV-, and radio shows, newspapers) represent other important outcomes of the project and are listed in tables 4.2.A1 and A2 of this report. Several reports have been produced to distribute the knowledge obtained in HYPOX. The reports as well as scientific presentations held at the project meetings are available at the information section of

the project web site (http://www.hypox.net/front_content.php?idcat=399). The information section further includes more general and intelligible information on HYPOX and on hypoxia in the form of brochures, policy briefs, posters, and presentations. Some of the project outreach material is also included in section 4.1.6. Images and video clips providing further information on project activities and target sites are found in the media section of the project web site (http://www.hypox.net/front_content.php?idcat=528).

4.1.2 Summary description of project context and objectives

The occurrence of hypoxic (low oxygen) conditions is increasing in water bodies worldwide. This is mainly a consequence of anthropogenic nutrient input ('eutrophication') and global warming. Eutrophication mainly involves fertilizer runoff from agriculture and input of domestic and industrial waste waters and stimulates excessive growth of microalgae (algal blooms) just like crop growing in fertilized farmlands. The biomass produced in excess sinks to the seafloor where it is being utilized by animals and micro-organisms. The oxygen that is consumed by these organisms reduces the oxygen content of bottom waters. If bottom water oxygen declines significantly, ecosystems undergo successive deterioration. If the oxygen drops to very low levels, mass mortality of higher organisms sets in (e.g., Fish kills). Eventually, ecosystems turn into permanently oxygen free (anoxic) 'dead zones' where micro-organisms replace all higher life. The collapse of animal communities leads to a dramatic decline in ecosystem functions and services such as biodiversity, fisheries, and tourism. Once the oxygen is depleted a vicious cycle sets in that adds to ecosystem decline and impedes recovery. Nutrients, locked in the sediments in the presence of oxygen are returned to the water column where they stimulate further algal growth. The combination of microbial and chemical processes at oxygen poor conditions further results in the release of toxic substances and greenhouse gases from the seafloor. Global warming is expected to add to oxygen depletion: warming of water will lead to degassing of oxygen, and an enhanced microbial activity. Together with changes in wind and precipitation patterns, higher temperatures will potentially increase stratification at many sites and reduce vertical oxygen transport to deeper waters. The situation is not expected to improve: Global warming is predicted to decrease oceanic oxygen concentrations by several percent over the next century and ever-growing human populations are likely to increase nutrient runoff and the formation of 'dead zones'.

Irrespective of the substantial threats of hypoxia for aquatic ecosystems, oxygen monitoring is still limited to relatively few sites that are typically visited monthly or even at longer time intervals. To get alarmed before ecosystems lose functions that may take several decades to restore, oxygen monitoring capacities have to be improved. The response of individual organisms and ecosystems as a whole depends on frequency, duration, spatial extent and severity of hypoxia events. Hence, state of the art monitoring efforts need to consider the appropriate temporal and spatial scales in order to address the complexity of hypoxia related effects and to be able to assess the status of an ecosystem. In order to maximize the gained knowledge, HYPOX monitoring of oxygen and related parameters were carried out in a variety of aquatic systems that differ in oxygen status or sensitivity towards change. HYPOX target sites in coastal and open seas include the North Atlantic - Arctic Ocean transition, three contrasting sites in the Black Sea, the world's largest anoxic basin (Bosporus outlet area, Romanian Shelf, Crimean Shelf) as well as Baltic Sea sites (Gotland Basin, shallow western Baltic). Selected land-locked water bodies include Swiss lakes as freshwater systems, the Swedish Koljoe fjord and the Scottish marine Loch Etive as humid fjord systems as well as several lagoons and embayments in the subtropical Greek Ionian Sea.

Continuous measurements of oxygen and associated parameters and dedicated field campaigns represent the core part of the HYPOX project. The field work focused on the physical and biological processes that contribute to oxygen depletion and on the effects of oxygen conditions on animal communities and biogeochemical processes. Compared to standard oxygen monitoring that simply follows temporal changes in oxygen concentrations this approach allows to assess the causes of hypoxia formation as well as the consequences for ecosystems. Investigations of actual oxygen conditions are accompanied by studies of past hypoxia to improve our understanding of long term trends of hypoxia and the effect of changing climate on oxygen conditions. These studies include analyses of existing long term data series, indicator species, benthic communities, and organic and inorganic proxies for past oxygen conditions that are preserved in the sediment record. These combined investigations allow a holistic perspective on hypoxia causes and

consequences and demonstrate how an integrated observation of oxygen depletion may look. In order to extend the gained knowledge in space (i.e., generalization of the findings) as well as in time (i.e., extrapolation of current observations into the future) hypoxia modeling represented another intrinsic part of the project. The obtained generalizations and forecasting capabilities facilitate an examination of the effects of future climate and eutrophication scenarios on oxygen availability and ecosystem functioning. If ecosystems are deteriorating, modeling capabilities will also provide means to decide on adequate countermeasures to be taken. Combining observations and predictions of oxygen availability with existing knowledge about the effects of hypoxia on animal communities and ecosystems improves our understanding of the potential loss of ecosystem functions and services as a consequence of global warming and eutrophication.
One central HYPOX objective was to contribute to the actions towards the implementation of a Global Earth Observation System of Systems (GEOSS) that are coordinated by the Group on Earth Observations (GEO) and laid out in the GEO Workplan (2009-2012). HYPOX adopted GEOSS principles of data sharing and standardization and registered services at the GEOSS registry. By filling gaps in oxygen depletion measurement capabilities and in standardization and sharing of data relevant to understanding present and future impacts of oxygen depletion, HYPOX added to the societal benefits addressed by GEOSS. Project partners took part in selected task groups and actively contributed to GEO activities (plenaries, summits, work group meetings, workshops, GEO Workplan preparation). Workshops carried out at project meetings and conferences served to increase awareness for GEOSS within and outside of the consortium.
Seven work packages (WPs) and a coordination and outreach work package closely collaborate to achieve the objectives and disseminate the obtained data and knowledge concerning in situ monitoring, field work, data sharing, data assimilation, modeling, and the assessment of future hypoxia formation and its impacts on ecosystems. An overview of the work package structure including the interconnections is provided in the supplementary material (part 4.1.6 of this report). The observational work in (1) coastal and open seas and (2) land-locked water bodies is carried out in WP6 and 7, respectively. WP6 and 7 are closely connected to WP1 that is set up to decide on the appropriate observatory technologies and monitoring strategies for the different sites and to collect the knowledge obtained on these issues upon observatory implementation and operation. WP4 adds the historic perspective to oxygen observations looking into long term monitoring data sets, recent and fossil animal communities, and the sedimentary record. WP5 takes care of the collection and archiving of existing data from the different target sites as well as of the huge amount of data obtained in HYPOX in compliance with common standards in ocean observation. WP2 directly uses the data to improve and validate models of hypoxia formation and the effect of oxygen depletion on biogeochemical processes in order to generalize findings and build forecasting capabilities. The knowledge obtained from measuring and modeling efforts is collected and synthesized by WP3. Finally, WP8 takes care of dissemination and outreach activities as well as project coordination. In the following the main tasks of the different WPs are highlighted.
WP1 (‘Improving and integrating in situ observation capacities of oxygen depletion’) provided the platform to discuss and optimize design and operation of in situ observatories at the selected project sites in coastal and open seas, and land-locked water bodies. Additionally, WP1 defined the parameters that, together with oxygen, are required to allow for an unambiguous interpretation of the acquired data. To facilitate data archiving and data sharing, WP1 was – in close collaboration with WP5 – responsible for standardization of metadata and products for data sharing. Another important WP1 task was the collection of information on the characteristics of the respective observatory sites, the site specific scientific requirements, and the instrumentation to be used. WP1 also focused on the definition of recommendations for observatory operation, for a harmonization of metadata descriptions, and for feasible ways to assure and control data quality. Towards the end of the project, WP1 developed recommendations and strategies for future monitoring activities in hypoxic sites according to the data collected in the HYPOX project. Furthermore the design and architecture of an interoperable data system and appropriate

quality assurance procedures were defined based on the information collected from the different partners and sites.
WP2 ('Modeling and prediction of short and long term factors affecting oxygen depletion in different systems') improved the prediction of oxygen depletion in aquatic ecosystems by developing and using numerical tools to assimilate oxygen sensor data, by integrating the various observations made at different spatial and temporal scales. A further important task was the provision of feedback to observational scientists regarding optimal sampling and observation strategies. The performance of physical and biogeochemical models was tested against the observations from the different HYPOX target sites. Then the models were used to assess the sensitivity of oxygen depletion to variations of physical and biogeochemical parameters on different temporal and spatial scales. This represented a first step to test different scenarios of climate change, eutrophication, natural variability for different open and land-locked systems and their effects on oxygen depletion. Furthermore, WP2 was set up to advance our understanding of the relative importance of oxygen supply and oxygen use in governing oxygen depletion, providing essential knowledge to distinguish natural variability from manageable, anthropogenic effects. Based on the findings obtained in HYPOX, WP2 finally synthesized the knowledge on the factors governing hypoxia formation and on the prediction of hypoxia in the different systems as obtained from the modeling and data assimilation approaches applied.
WP3 ('Existing and future impacts of hypoxia on ecosystems') was dedicated to the evaluation of existing and potential future impacts of hypoxia and anoxia on aquatic ecosystems. An important task of WP3 was to gain understanding of the physical processes behind the formation of hypoxia at the different target sits in parallel to the study of biological processes, nutrient cycling, and dissolved oxygen dynamics. This combined effort was crucial for a proper identification of drivers of oxygen deficiency. Based on the knowledge of the drivers, WP3 focused on the impact of hypoxia on ecosystems including spatial as well as temporal aspects to understanding the temporal evolution of hypoxia effects and for the classification of ecosystems with respect to drivers, pressures, impacts, and responses. By analyzing existing knowledge and integrating new findings from the field observatories and by numerical modeling, an interdisciplinary understanding of the drivers of oxygen depletion, pathways of ecosystem decline due to hypoxia, pathways of recovery, and impacts of hypoxia on ecosystem goods and services was developed. In the context of WP3, ecosystem function describes also changes in the biogeochemical environment and redox changes due to changes in oxygen availability. WP3 represented the knowledge platform to provide a synthetic, interdisciplinary understanding to support the prediction of oxygen depletion using modeling (via WP2), and to derive important strategies and tools for decision making related to nutrient and water management scenarios. WP3 also provides feedback to WPs 1, 6, and 7 to adjust monitoring to the specific requirements of the respective ecosystem.
WP4 ('Indicators of past hypoxia dynamics: improving long term records by abiotic and biotic proxies') used different proxies for past events of oxygen depletion or anoxia in aquatic ecosystems in order to understand past oxygen concentration changes and to explore their applicability for investigations of recent hypoxic conditions. WP4 contributed to an understanding of the history of aquatic ecosystems with regard to variation in oxygen depletion. This was crucial in order to develop and compare scenarios of global change and their effects on oxygen depletion and the ecosystem. Proxies applied include the benthic community composition as well as inorganic and organic constituents in the sediment record. Methods used in WP4 include high resolution seismic profiling as well as sediment core analysis using a range of inorganic and organic substances that provide information on past conditions. To determine how oxygen availability changes benthic community structure and ecosystems in general, biodiversity (macrobenthic, meiobenthic, microbial) was investigated in sediment samples from different water depths.
WP5 ('Knowledge base on oxygen depletion: Data sharing, standardization and interoperability according to GEOSS') was dedicated to enable a regular and reliable flow of data from the

observatories and other data acquired within HYPOX or available from other sources to the data archive and the data portal. In cooperation with WP 1, 6, & 7 comprehensive descriptions of the data going back to the individual sensor, data quality descriptors, and instrument standards on calibration and methodology were provided. All that information was collected and added as metadata to the individual sensor data. WP5 data management task encompassed the complete observation data life cycle, from data capture, processing, quality assessment and quality control, archiving and dissemination, compilation and publication of regular and reliable data products. WP5 also assured that HYPOX data management and corresponding infrastructures are compliant with ISO / OGC standards and with the principles of GEOSS to facilitate access by potential users.

WP6 and WP7 (WP6: 'Assessing in situ oxygen depletion in shelf and open seas'; WP7: 'Assessing in situ oxygen depletion in land-locked water bodies') carried out investigations in (1) open and coastal seas and (2) land-locked water bodies, respectively. In situ observatories / monitoring platforms were set up and targeted field campaigns were performed at the different target sites. For WP6 this included sites in the Black Sea (Bosporus outlet are, several sites at the Northwestern shelf off Romania and the Crimean shelf), the Baltic Sea (Gotland Basin, Eckernfoerde Bay), and the HAUSGARTEN area in the Fram Strait at the North-Atlantic / Arctic transition. Target sites in WP7 included Swedish and Scottish fjords (Koljoe Fjord, Loch Etive), Ionian Sea lagoons and embayments (Amvrakikos Gulf, Aetoliko Lagoon, Katakolo Bay) and Swiss Lakes (Lake Zurich, Lake Zug, Lake Lugano, and Lake Rotsee). High temporal resolution continous and – as far as possible – long term monitoring observations and results of targeted field campaigns were used for assessing characteristics, drivers, and consequences of oxygen depletion. As a first step the work in WP6 and 7 also included the collection of existing relevant oceanographic data of the target sites as well as knowledge on ecosystem, water management, and climate. As far as possible this knowledge was delivered or linked to the HYPOX data base and used to characterize the present status as well as history of the respective open sea areas. This information served to decide on appropriate monitoring strategies and contributed to the identification of gaps in current observation capabilities for the respective areas. In WP6, relevant physical (salinity, temperature, currents and freshwater input) and biogeochemical (oxygen, nutrients, turbidity) parameters were measured in the most severe hypoxic / anoxic open European seas (i.e., Baltic Sea, Black Sea) and in the Arctic where previous work indicates rapid decrease in bottom water oxygen concentrations due to alteration of transport processes related to global change. WP7 sites were selected to cover a broad range of settings with respect to anthropogenic impact, hydrographic conditions (e.g. frequency and mechanism of bottom water renewal / overturning events) and sensitivity towards climate change. In collaboration with WP1 and WP5, WP6 and 7 were also responsible for continuous assessment and quality control of collected data. Feedback from other WPs for refinement of technology (WP1), identification of key parameters (WP3), and temporal scales for assessing oxygen depletion in the respective systems was used to adjust observation strategies. Data bases for the respective observatories were established and quality control routines defined together with WP5.

WP8 ('Coordination, dissemination and outreach') was dedicated to the management of the project, the dissemination of the project findings, and outreach towards the scientific community, the GEO community, as well as towards potential end users of the data acquired in HYPOX. Management issues included internal communication and integration of all partners as well as monitoring of the overall progress towards project objectives. WP8 supported and guided the project partners with respect to scientific and administrative obligations including deliverables as well as reporting on scientific progress and finances towards the EC. Outreach tasks in WP8 included networking with other scientific bodies and initiatives including members of the GEO community and potential end users of the knowledge produced in HYPOX. WP8 efforts to improve the visibility of HYPOX included the production and distribution of outreach material (project web site, brochures, films...). Furthermore WP8 was responsible for the organization of

annual meetings and workshops. In cooperation with WP5, WP8 was responsible for the maintenance and continuous improvement of the project web site.

4.1.3 Description of main S & T results / foregrounds

4.1.3.1 OVERVIEW

HYPOX carried out pioneering work to build capacities for state of the art oxygen monitoring. The adopted monitoring strategies take relevant temporal and spatial scales of oxygen depletion into account that are inadequately addressed by previous oxygen observation approaches. The results obtained in HYPOX largely improve our understanding of the fate of oxygen in aquatic systems. To achieve this HYPOX deployed stand-alone or cabled observatories that are able to perform long-term continuous measurements of oxygen and associated parameters. At several sites, profiling observatories as well as drifting or towed instruments were used to investigate spatial patterns of hypoxia. The sites were carefully selected to cover a large range of contrasting 'hypoxia characteristics'. Supported by modeling studies that were carried out as part of HYPOX, this facilitates the extrapolation of the knowledge obtained – both with respect to hypoxia characteristics and appropriate monitoring strategies – to a large variety of ecosystems. In order to comprehensively address hypoxia, ecosystem responses (with a strong focus on hypoxia impact on biogeochemical processes and element cycling) have been included as well as the investigation of past hypoxic conditions based on faunal patterns and organic and inorganic proxies from the sediment record. Adopted monitoring strategies and technologies were carefully selected according to identified gaps in knowledge and existing information on the characteristics of the respective target sites. Based on generalized findings achieved by careful analysis of the data from observatories and field campaigns as well as application of data assimilation and modeling techniques, hypoxia ecosystems were classified and recommendations for future oxygen monitoring defined. The results obtained in HYPOX are highly relevant to GEOSS objectives from ecosystem, water management, and climate points of view. The achievements of the HYPOX project substantially improved capacities for oxygen monitoring as well as for the prediction of oxygen depletion and evaluation of existing and future impacts on ecosystems.

Observations and measurements obtained by the observatories and during the targeted field campaigns represent one of the most important project results. The data are archived in the long term data repository and publishing network PANGAEA (http://www.pangaea.de) and accessible through the HYPOX data portal (http://dataportals.pangaea.de/hypox). The portal additionally contains information on the sites and descriptions of the observatories. The data sets are also listed in table 4.2.A2 in this report. Peer reviewed publications as well as dissemination activities (e.g., scientific conferences, workshops, TV-, and radio shows, newspapers) represent other important outcomes of the project and are listed in tables 4.2.A1 and A2 of this report. Several reports have been produced to distribute the knowledge obtained in HYPOX. The reports as well as scientific presentations held at the project meetings are available at the information section of the project web site (http://www.hypox.net/front_content.php?idcat=399). The information section further includes more general and intelligible information on HYPOX and on hypoxia in the form of brochures, policy briefs, posters, and presentations. Some of the project outreach material is also included in section 4.1.6. Images and video clips providing further information on project activities and target sites are found in the media section of the project web site (http://www.hypox.net/front_content.php?idcat=528).

4.1.3.2 IMPROVING AND INTEGRATION OF OXYGEN OBSERVATION CAPACITIES

As a first step to discuss and optimize design and operation of in situ observatories information available from the HYPOX target sites were collected by the different partners. This included available data sets that were put together and linked to the HYPOX data portal were possible. Separate reports were prepared summarizing the available information for open and coastal sea sites and land locked water bodies: Report D6.2 'Report on linking of existing data bases with relevance to oxygen depletion to HYPOX data base' (http://metaworks.pangaea.de/download.php?fileid=149) and D7.2 'Compilation report on

existing information and data bases relevant for the project' (http://metaworks.pangaea.de/download.php?fileid=357). This information as well as additional information compiled by the different partners from the literature and knowledge existing at the respective institutions was summarized in report D1.2 'Report on scientific requirements and technical specification of a multiparameter and long-term oxygen depletion observation system' (http://metaworks.pangaea.de/download.php?fileid=144). The report contains all main pieces of information related to the selected sites where HYPOX monitoring activities were carried out and provides information on the different monitoring systems. For the Crimean shelf (Black Sea) scientific and technical requirements to investigate oscillations of the pycnocline (the layer of the water column with strongest density gradients that separate the upper oxic layer from anoxic waters below) were identified. Several specific sites in the region were selected as HYPOX target sites (Dnepr Canyon, Tarkhankut region, Omega Bay, inner and outer Sevastopol Bay). For the Northwestern Black Sea shelf the bottom water oxygenation and its temporal variability after thirty years of reduced nutrient input as well as its influence on nutrient release from the seafloor was identified as the main gap in knowledge. For the Bosporus outlet area the oxygen injection into the deep water column by the inflow of saline waters from the Marmara Sea was selected as the main focus. Plans included investigations of the areal distribution and intensity of the inflow as well as the fate of the oxygen and the impact on biogeochemical processes of the water column. For all Black Sea sites investigations of benthic assemblages including meio- and macrofauna and in some cases microorganisms were included. The naturally existing across shelf oxygen gradients provide ideal condition to study the impact of bottom water oxygenation and its fluctuations on the composition of benthic communities. For the Baltic Sea it was decided to focus HYPOX activities on the Gotland Basin. Planned investigations again focused on the pycnocline and included the water column as well as the seafloor and the processes occurring there. In the case of the Fram Strait the primary focus was on long term oxygen monitoring in the bottom water to indentify gradual changes that may occur in response to climate change at this particularly vulnerable area. For the land-locked water bodies a large portion of the gaps in knowledge related to frequency, intensity, and mechanisms on bottom water oxygenation in silled and stratified water bodies with restricted exchange. This concerned the target sites Koljoe Fjord (Sweden), Loch Etive (Scotland) and some sites in Greece adjacent to the Ionian Sea. In addition, the potential role of gas seepage from the seafloor as a geogenic driver of oxygen depletion was identified as a scientific task for the Greek lagoons and embayments. Somewhat connected to the work carried out in the pycnocline of the Black and Baltic Sea the focus for the investigations of the Swiss lakes was put on the layer of the strongest gradient in density and oxygen with special emphasis on the lowest concentrations and smallest spatial scales that can be addressed with the technology currently available.

Already at an early stage of the project, roles and responsibilities of HYPOX stakeholders covering the complete work flow from the data production of scientists to long term data archiving and publication were defined and compiled as Report D1.1 'Report on recommendations for the operation of the individual observatory systems and how the data should be made available' (http://metaworks.pangaea.de/download.php?fileid=351). These issues were also promoted during a data management / data sharing session at the first annual meeting (http://metaworks.pangaea.de/download.php?fileid=279). Technical specifications on how a distributed HYPOX data system shall be designed and how metadata should be provided were established. Furthermore, appropriate data format and protocol standards were identified (e.g., OGC CSW, SOS, O&M) as well as the steps necessary to contribute data to the HYPOX data portal and to the relevant GEOSS portals.

Special emphasis was on the selection of appropriate methods to address the scientific questions. As HYPOX was no technology-driven project this mainly involved the selection of appropriate measuring platforms and sensors from what was available at the market or already developed by the different partner institutions. However, in some cases existing technologies and instruments had to be modified, improved, combined, or developed from scratch to meet the scientific

requirements. One example is the Multifiber Optode MuFO that was constructed to monitor high frequency oscillations of oxygen concentrations in Crimean shelf bottom waters as they may result from internal waves. MuFO allows to simultaneously measure oxygen concentrations at 100 points in the lowermost meters of the water column (Fischer and Koop-Jacobsen, submitted). In order to resolve oxygen oscillations at the level of the pycnocline in space as well as in time a profiling observatory was set up. This cutting edge technology uses an underwater winch to autonomously record consecutive profiles of oxygen and associated parameters. The in-situ Profiling Analyzer (PIA) was constructed to resolve trace levels of oxygen in the water column of the Swiss lakes. The instrument combines state of the art optical sensors for low oxygen concentrations (trace optodes) with microscale Clark electrodes that were operated by custom-built electronics to improve the performance in the lower concentration range. A lot of effort was also put into the improvement, validation and modification of the so-called eddy correlation technique (Berg et al. 2003). This non-invasive method to quantify benthic oxygen fluxes is ideal for the assessment of the role of benthic oxygen demand for hypoxia development. Within HYPOX workshops were carried out and intensive field testing as well as experimental and modeling studies (e.g., Holtappels et al., in prep.) were performed to better understand strengths and limitations of the method. New developments included programming of the software package 'ECDiagnostics' for the analysis of eddy correlation measurements (open access freeware that will be released soon) as well as the modification of the method for the determination of sulfide fluxes. Other technical and methodological developments focused on the optimization of existing sensor technologies. A novel procedure for the calibration of optical oxygen sensors (optodes) was established in cooperation with the manufacturer (AADI, Bergen, Norway) and disseminated to scientists and representatives of companies in the field of sensor production at workshops and conferences as well as via publications (e.g., http://www.earthzine.org/2010/05/26/oxygen-monitoring-in-aquatic-ecosystems-eu-project-hypox/; http://meetingorganizer.copernicus.org/EGU2012/EGU2012-9242-1.pdf). Further investigations focused on the long term stability of oxygen optodes and included careful analysis of long term recordings as well as thorough testing under laboratory conditions (Lo Bue et al 2011; http://archimer.ifremer.fr/doc/00045/15584/14489.pdf). To allow for reliable long term monitoring in highly productive coastal environments the effect of biofouling on sensor readings was investigated as well as the feasibility of different antifouling strategies under in situ conditions.
At a later stage of the project, knowledge obtained from observation activities at the different was summarized and used to identify recommendations for future monitoring attempts. The information was compiled into report D1.3 'Report on first data quality checks and recommendations for future observation system' (http://metaworks.pangaea.de/download.php?fileid=362). In addition to descriptions of the monitoring activities based on examples from the different sites and monitoring recommendations the report also addresses issues of data quality control.

4.1.3.3 ASSESSING OXYGEN DEPLETION IN SHELF AND OPEN SEAS AND LAND LOCKED WATER BODIES

Within HYPOX investigations were carried out in open and coastal seas and land-locked water bodies. In situ observatories were set up and targeted field campaigns were performed at the different target sites. High temporal resolution continuous and – as far as possible – long term monitoring observations and results of targeted field campaigns were used for assessing characteristics, drivers, and consequences of oxygen depletion. Target sites in open and costal seas included the most severe hypoxic / anoxic open European seas (i.e., Baltic Sea, Black Sea) as well as the Arctic where previous work indicated rapid decrease in bottom water oxygen concentrations possibly due to alteration of transport processes related to global change. The target sites in land-locked water bodies covered a broad range of settings with respect to anthropogenic impact, hydrographic conditions (e.g. frequency and mechanism of bottom water

renewal / overturning events) and sensitivity towards climate change. Sites were geographically separated from each other and ranged from lagoons and embayments in the Ionian Sea (Aetoliko Lagoon, Amvrakikos Gulf, Katakolo Bay) to fjords in northern Europe (e.g., Koljoe Fjord).
In the beginning of the project existing knowledge on hypoxia occurrence was selected for the respective target sites in order to facilitate planning of field campaigns and observatory deployments. This included review and compilation of all historical and present data sets and literature relevant to the project. Where possible, legacy data were provided to the HYPOX data portal. The information represented a starting point of the observational work and was summarized in separate reports focusing on open and coastal seas (D6.2 'Report on linking of existing data bases with relevance to oxygen depletion to HYPOX data base'; http://metaworks.pangaea.de/download.php?fileid=149), and land locked water bodies (D7.2 'Compilation report on existing information and data bases relevant for the project'; http://metaworks.pangaea.de/download.php?fileid=357). A third report includes information on the legacy data that have been provided to the portal: D 5.1 'HYPOX data management plan and policy and catalogue of relevant legacy data sets' (http://metaworks.pangaea.de/download.php?fileid=148).
Based on the collected information gaps in knowledge were identified as a basis for the selection of appropriate locations and planning of surveys and observatory deployments. To overcome inadequacies of current observation capabilities, a strong focus was on the identification of parameters to be monitored as well as the selection and set up of appropriate sensors and monitoring platforms. Information about the respective observatories and monitoring strategies that were selected for the different sites were collected into the report D1.2 'Report on scientific requirements and technical specification of a multiparameter and long-term oxygen depletion observation system' (http://metaworks.pangaea.de/download.php?fileid=144). Deployments of observatories in the following implementation phase were highly successful and have been realized at all proposed target sites. The observation instruments and approaches included cabled and stand-alone static and profiling oceanographic moorings, benthic observatories, and drifting profilers, as well as ship based instruments that were deployed from ships for areal surveys or vertical profiling at high resolution. Numerous other sampling and measuring methods and technologies were used during the accompanying field campaigns that were carried out to comprehensively address characteristics, drivers as well as the consequences of hypoxia at the respective sites. Thanks to the dedication of project members and allocation of additional funding sources from other projects and partner institutes funds, initial plans could be substantially extended in several respects. Eckernfoerde Bay was included as an additional site in the western Baltic. The Gotland basin observatory that was projected as a standard static oceanographic mooring could be upgraded and turned into a profiling observatory that was capable to monitor the temporal evolution of water column oxygenation throughout the oxic-anoxic transition zone. The stand-alone observatory in the Koljoe Fjord was additionally provided with a cable to the shore providing power supply for continuous operation and broadband communication for near real time data access. The original plans included only one observatory of this kind to be installed in the Scottish fjord Loch Etive. In addition a sea ice observatory in the Arctic was installed towards the end of the project that included sensors to investigate oxygen concentrations in the ice itself as well as in the upper water column.
The description on observatories and achievements is provided by report D6.1 'Installation and operation of in situ observatories for monitoring oxygen depletion and associated parameters in shelf and open seas (Black Sea, Baltic Sea, Fram Strait) and collection of data into the HYPOX web portal' (http://metaworks.pangaea.de/download.php?fileid=355) and D7.1 'Set-up and implementation of in situ observatories for monitoring oxygen depletion and associated parameters in land-locked water bodies (Swiss Lakes, Koljoe Fjord, Loch Etive, Ionian Sea lagoon) and data collection into the HYPOX web portal' (http://metaworks.pangaea.de/download.php?fileid=356). A lot of the findings from the different sites have been presented at international conferences (table 4.2.A2 and 'conferences, meetings

and workshops' table in section 4.1.6) and already resulted in a number of peer reviewed publications (table 4.2.A1 and 'publications published and in press' table in section 4.1.6). Table 'submitted and planned publications' in section 4.1.6 lists some of the publications that will be published in the future based on the work carried out. Some more scientific results have been compiled in the form of reports in the end of the project, again separately for open and coastal sea sites and land locked water bodies: D6.3 'Report (if possible in the form of publications) on critical parameters for prediction of oxygen depletion in coastal and open sea systems' (http://metaworks.pangaea.de/download.php?fileid=398) and D7.3 'Report (where possible as publications) and assessment of the key physical and biogeochemical processes affecting oxygen depletion in the respective aquatic systems'; (will be available soon at http://www.hypox.net/front_content.php?idcat=399&idlang=19, section 'documents').
Data generated by the observatories and by means of accompanying field campaigns were added to the HYPOX web portal / PANGAEA data repository at minimum delay (http://dataportals.pangaea.de/hypox/). Provision of data to the repository took place either semi-automatically or as discrete submissions uploaded by the responsible scientists. At the end of the project the vast majority of the data from the different sites are uploaded and online data continue to stream in. Following GEOSS data sharing policy data are generally open access. For data sets that are currently protected by a moratorium to provide project partners with the time necessary to finalize validation and preparation of scientific publications unrestricted data download will be granted at the latest three years after submission of the data to the archive. However, all data sets are already listed in the portal and metadata as well as contact information of the PI is provided. The data sets contribute directly to the project target to build a knowledge base on oxygen depletion based on GEOSS data sharing, standardization and interoperability principles.
HYPOX monitoring activities were highly successful and a lot of the efforts will hopefully be continued in future projects or on national funds (see section 'Involvement of HYPOX partners in future hypoxia monitoring and continuation of monitoring efforts started in HYPOX')
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4.1.3.3.1 Black Sea

HYPOX observation efforts focused on three target areas in the Black Sea. Conditions at the Bosporus outlet area and the Crimean shelf area are characterized by the natural oxygen gradient of the Black sea ranging from oxic conditions within surface waters to anoxic conditions below the permanent oxycline at approximately 150m water depth. The sites served as 'hypoxia model systems' to investigate potential spatio-temporal dynamics of oxygen depletion and the impact of these conditions on different compartments of ecosystems including faunal patterns and biogeochemical processes. The northwestern shelf off Romania represented the third target site. Situated above the permanent oxycline the Romanian shelf still suffered substantially from oxygen depletion and used to harbor vast 'dead zones' in the second half of the 20th century. Only after eutrophication (nutrient input from anthropogenic sources) started to be substantially reduced in the1990s conditions improved. Consequently, HYPOX investigations at the northwestern shelf focused on the recovery of a previously hypoxic ecosystem.

4.1.3.3.1.1 Bosporus area

Observational work in the Bosporus outlet area was carried out during two field campaigns in 2009 (R/V ARAR) and 2010 (R/V MARIA S. MERIAN, leg MSM15/1). Water column work focused on the oxygenation of the anoxic water columns by intrusions of warm, saline, and oxygen-rich water from the Marmara Sea that enter the Black Sea through the Bosporus. Additionally sediment investigations were carried out along depth transects spanning from oxygenated to anoxic conditions to study (1) the influence of bottom water oxygenation on benthic meio- and macrofauna communities and (2) indications of past oxygen / redox conditions of the Black Sea based that are preserved in the sedimentary record.

Extensive CTD surveys were carried out to locate the Marmara sea water plume. In 2009, strong oxygen and temperature signatures of the Bosporus plume were found at the mouth of the Bosporus and at stations further to the East. Investigations revealed, however, that oxygen intrusions by Bosporus waters change over time. During the 2010 cruise no oxygen intrusions could be detected below the permanent oxycline and only at one station an aged plume could be identified based on a weak temperature anomaly. CTD survey data have been submitted to the portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
In order to investigate the influence of oxygen on biogeochemical processes in the water column (especially the nitrogen and manganese cycle), standard and free-falling pump-CTDs were used for high resolution sampling of the deep water column, especially at the depths of the oxygen intrusions. The water samples were analyzed for nutrients and redox-sensitive species including ammonium, nitrate, nitrite, sulfide, phosphate, silicate and manganese. At specific depths, water was sampled to perform experiments with labeled substrates. 15N-labeled ammonium and nitrate were used to detect potential rates of nitrification, denitrification, and anammox. The study indicated a huge impact of oxygen intrusions on biogeochemical conversions in the water column. To quantify the significance of these processes for the nitrogen cycle of the Black Sea as a whole and to understand the factors governing the inflow of Marmara Sea water into the Black sea investigations with modeling tools have been started. These will continue after the end of the project.
In order to investigate intrusions of Marmara Sea water on larger temporal scales a oxygen sensor equipped ARGO type profiling float 'PROVOR-DO' was deployed in the area. In contrast to standard ARGO floats the float was programmed to sink to the seafloor after profiling to avoid drifting of the float with the currents during the resting time between profiles in order to maximize the presence within the target area. Unfortunately the float stopped operation already after a couple of profiles. The data obtained, however, provided valuable information on the behavior of the float and was directly used to improve the design. Specifically the communication was upgraded from Argos to Iridium telemetry to reduce the time needed for data transmission and hence the drift during surfacing of the float. An improved float was already constructed within the lifetime of the project and is expected to be launched soon. Data from the first float are available at http://www.coriolis.eu.org/Data-Services-Products/View-Download/Access-to-Argo-floats-by-WMO-number (float reference 5902291).
Sediments were sampled in the Bosporus outlet area along a depth (and, hence, oxygen) gradient to investigate the influence of bottom water oxygen concentrations on benthic assemblages (meio- and macrofauna). The results have important implications for the assessment of hypoxia impacts on benthic communities for areas that are that are threatened with oxygen depletion. Strong changes in faunal communities with changing oxygen availability were observed and indicator species for hypoxic conditions were successfully identified. As far as they are analyzed, fauna data have been uploaded to the data portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6. The work already resulted in several scientific publications (see table 4.2.A1 and the 'publications published and in press' table in section 4.1.6 as well as the report D6.3 at http://metaworks.pangaea.de/download.php?fileid=398). An overview about the fauna work in the Bosporus outlet area is also found in presentations held at the project meetings (http://metaworks.pangaea.de/download.php?fileid=321 and http://metaworks.pangaea.de/download.php?fileid=401).

4.1.3.3.1.2 Crimean Shelf area

The observational work focused on two areas at the western Crimean shelf (Dnepr Canyon Paleo-Delta). Investigations were carried out during cruise leg MSM 15/1 of R/V MARIA S. MERIAN. To get a first overview of the position of the oxycline CTD surveys were carried out. Data have been uploaded to the portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6. Oxygen conditions in the bottom waters and visual inspection of the benthic habitats was done by spatial surveys with the towed observatory MEDUSA and the

manned submersible JAGO. Track data as well as oxygen and additional data and videos recorded by MEDUSA are available at the data portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
To investigate temporal dynamics in bottom water oxygen concentrations an array of three moorings were deployed for the duration of the cruise in two areas at different depths around the position of the oxycline. Parameters measured included oxygen, temperature, salinity, and water currents. Some details of the observatory setup and deployment and an example plot are found at http://dataportals.pangaea.de/hypox/index.php?ptype=map&detail&id=112. Indeed, bottom water oxygen showed large fluctuations on time scales of hours to days indicating that hypoxia is not a static phenomenon. Hence benthic communities – potentially also in other areas – have to cope with a much higher variability than previously imagined. Data from the moorings are uploaded to the portal. Direct links are found in table 'data generated in HYPOX' in section 4.1.6. Oxygen profiles recorded in the lower meters of the water column at high temporal resolution with the MuFO system showed that fluctuations in bottom water oxygen concentrations even involved lower time scales down to the range of minutes. Detailed investigations of bottom water properties and benthic oxygen demand with short term benthic observatories (BBL-profiler, Eddy Correlation System, micro profiler, benthic chambers) showed that the observed strong temporal variations in oxygen concentration were strongly coupled to physical displacement of the oxycline while the effect of biological processes (benthic oxygen uptake) was minor. To further investigate the oceanographic drivers of the observed oscillations modeling studies are started that will continue after the project ended.
Extensive investigations were carried out to study the influence of oxygen availability on biogeochemical cycling of elements at the Crimean shelf. Main focus of the investigations was on rates and pathways of organic matter mineralization. Studies included in situ investigations with short term benthic observatories (micro profiler, benthic chambers) as well as incubation experiments and geochemical investigations on retrieved sediment cores. Rates of oxygen uptake and total mineralization rates proved to be low. Only a minor fraction of the oxygen is used for the oxidation of reduced substances that are produced during anaerobic carbon degradation in the sediment. Iron and manganese driven early diagenetic processes are restricted to the oxic part of the shelf while significant sulfate reduction is only found in the sediments underlying anoxic waters. Interestingly, sediments subject to hypoxic conditions and strong temporal changes in bottom water oxygen concentrations showed reduced rates of biogeochemical processes, although organic carbon, carbon and nitrogen isotopic composition, as well as C/N ratios were present in similar amounts in all stations. In situ microprofiles of oxygen and geochemical parameters of retrieved cores were uploaded to the portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
Visual inspections carried out during the MEDUSA and JAGO surveys and close up photography of the seafloor by a high resolution still camera attached to the benthic crawler C MOVE already indicated that benthic live was hardly able to colonize hypoxic zones and zones of strong oscillations in bottom water oxygenation. This was confirmed by sediment samples taken along depth gradients at the Crimean shelf. Rich benthic macrofauna live was restricted to the shallowest depth (100m) where oxygen is presumed to be always available. Further down the shelf where oxygen is found only in limited amounts or only at certain periods in time diversity, abundance, and biomass of macrofauna organisms strongly decreased. In contrast, meiofauna organisms were found at all depths where oxygen was at least occasionally available. Also at low oxygen conditions meiofauna sometimes appeared in large numbers and show complex patterns of species richness and abundances across the oxic and hypoxic shelf. Careful studies of life organisms in freshly retrieved samples indicated that some meiofauna organisms were able to thrive even at anoxic depths. The physiological principle allowing for life without oxygen as well as the question if the organisms are able to complete their life cycle in anoxic habitats are yet to be investigated. Macro and meiofauna data have been uploaded to the portal. Direct links are found in table 'data generated in HYPOX' in section 4.1.6. Microorganisms appeared at all

depths in relatively uniform numbers. Studies of microbial diversity clearly indicated a strong effect on bottom water oxygenation and its dynamics on benthic bacterial community structure. This work will strongly increase our understanding of hypoxia effects at the microbial scale. Microbial abundances were uploaded to the data portal (Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.). At circular organic matter rich spots of unknown origin that were abundant at the hypoxic parts of the shelf, mats of filamentous sulfide oxidizing bacteria of the genus *Beggiatoa* were found. To our knowledge this is the first record of the occurrence of mat-forming sulfide reducers in this area.
In order to extend investigations of Black Sea water column properties two ARGO type oxygen sensor equipped floating profilers ('NEMO floats') were deployed in the western Black Sea. Within the lifetime of the project they recorded as many as 260 oxygen profiles - equivalent to 8% of all deep Black Sea oxygen profiles collected since measurements started in 1923. They show important oceanographic features of the Black sea with high significance for the oxygenation of the water column and the seafloor (e.g., effect of the shelf topography on diapycnal mixing, cold intermediate water formation in winter). Data analysis requires extensive application of modeling tools and is currently underway. Some first results are found in report D2.5 'Report on assimilation of HYPOX observatory oxygen data and model results on factors governing oxygen dynamics in the Black Sea'
(http://metaworks.pangaea.de/download.php?fileid=353)
Further project work was carried out at several other Crimean shelf sites (inner and outer Sevastopol Bay, Omega Bay, Tarkhankut area). Work at these sites did not involve in situ oxygen monitoring. Instead water column and sediments were characterized based on retrieved samples by means of traditional techniques and voltammetry. Again, investigations included extensive studies of benthic fauna. The data are uploaded to the portal (direct links are found in table 'data generated in HYPOX' in section 4.1.6).

4.1.3.3.1.3 Northwestern shelf off Romania
Several surveys investigating oxygen distribution, water column characteristics, and benthic fauna assemblages were carried out along established depth transects off the coast of Romania. Oxygen distribution and fauna surveys (macro and meiobenthos) were carried out. In agreement with studies carried out in earlier years oxygen was found to generally decrease with depths. Oceanographic data from the surveys were uploaded to the portal (direct links are found in table 'data generated in HYPOX' in section 4.1.6).
Studies of fauna showed a similar pattern as found on the Crimean shelf with biodiversity, abundances, and biomass strongly decreasing with depth. This pattern is indicative of the loss in benthic ecosystem function and services to be expected when systems turn hypoxic. However, compared to conditions in the second half of the last century the ecosystem of the northwestern Black Sea shelf clearly recovered as the former dead zones are largely recolonized. On the other hand, fast growing, opportunistic and sometimes invasive species still occupy ecological niches where long-lived and slow-growing species were found beforehand. Characteristic habitats like mussel beds and fields of the red algae *Phyllophora* still did hardly reestablish.
The observatory was installed in the sheltered 'Portita area' at 28m water depth to monitor the seasonal evolution of bottom water oxygenation on the shelf. The observatory consisted of a static mooring with sensors for oxygen, oceanographic parameters, and currents installed close to the seafloor and an additional oxygen sensor attached further up in the bottom water layer. The obtained data provided the first long-term (3-month) in-situ time-series of oxygen and additional parameters at the seafloor of the north-western shelf. The time series data were uploaded to the data portal (Direct links are found in table 'data generated in HYPOX', section 4.1.6.). The observatory data are complemented by benthic nutrient fluxes measurements performed in core incubations and by in situ chamber deployments in May and Sep.. Based on the data it was possible to identify biological and hydrophysical controls on oxygen. In spring at low biological activity and before the evolution of the seasonal thermocline (temperature driven density

gradient) bottom water oxygen remained constant. In early summer oxygen decreased probably due to restricted bottom water ventilation as a consequence of thermal stratification. Later in July a sudden drop coincided with increased turbidity indicative of settling organic matter from a sinking senescent phytoplankton bloom. In combination with reduced oxygen solubility and restricted vertical transport bottom water oxygen levels reach hypoxic levels. A few weeks before minimum oxygen concentrations were met at the Portita site a significant fish kill was recorded by project members in a nearby area. The observatory data as well as the fish kill event in Jul. 2010 clearly demonstrate that even after three decades of reduced nutrient input oxygen conditions at the Romanian shelf still didn't recover completely and may still drop to critical levels in warm summers. When bottom water oxygen concentrations are low, reduced forms of nutrient effluxes (ammonium, phosphate) from the sediment internally fuel productivity, even decades after the peak of eutrophication relaxed.

4.1.3.3.2 Baltic Sea

HYPOX investigations in the Baltic Sea were originally restricted to the eastern Gotland basin where they covered both studies of the water column and the bottom water and seafloor. As in the Black Sea the deep basins of the Baltic Sea are characterized by oxygenated surface waters that are separated by a strong density gradient form the underlying, dense, and anoxic deep waters. Investigations in the Gotland basin again made use the natural 'hypoxia laboratory' created by these conditions. Following a project expedition to the Gotland Basin that partially failed due to bad weather conditions, Eckernfoerde Bay in the western Baltic was included as additional project site. This was possible through a close collaboration with the long term monitoring site 'Boknis Eck' where regular ship based observations are regularly carried out since decades. The addition of this site broadened the focus of the project considerably and provided strong support to modeling activities.

4.1.3.3.2.1 Eastern Gotland basin

The Gotland basin water column was investigated by means of the stand-alone profiling mooring GODESS (GOtland Deep Environmental Sampling Station; http://www.io-warnemuende.de/GODESS.html). The GODESS observatory consists of a profiling body that contains a multiparameter CTD and a fast optical oxygen sensor that is connected to an underwater winch sitting in the deep anoxic water column. At predefined times the winch is released and the profiling body ascends through the upper part of the water column while recording oxygen, salinity, temperature and additional oceanographic parameters. Three successful deployments were carried out at different seasons within the lifetime of the project. The data have been uploaded to the portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6. Further information as well as an example plot is found in the HYPOX web portal at
http://dataportals.pangaea.de/hypox/index.php?ptype=map&detail&id=121.
Although the deep Baltic Sea is one of the most stable stratified water bodies on earth it turned out that conditions at the transition between the oxic and anoxic water part of the water column strongly fluctuate on a time scale of hours to days. The position of the oxic-anoxic interface oscillates most likely due to a combination of vertical movements of the pycnocline (the layer of the steepest gradient in density) and due to water masses with different pycnocline properties passing along the location of the mooring. Fluctuations were most prominent in the stormy season where even injections of oxygen into the anoxic water column below the pycnocline were observed. The observed temporal dynamics in oxygen and, hence, in redox conditions have significant implications for biogeochemical processes and element fluxes between the lower and the upper compartment of the water column (i.e., diapycnal transport). The latter is of high significance for the Baltic Sea ecosystem as nutrients (esp. phosphate) released from the anoxic sediments can be provided to the sunlit top water layer if they cross the pycnocline. In the top

layer the nutrients fuel productivity of microalgae including harmful cyanobacteria that are observed to bloom in summer at increasing frequency.
Benthic observatories were deployed in the Gotland Basin in different seasons to investigate areal distribution and temporal dynamics of bottom water oxygenation. Special focus was on the depth where the dynamic oxycline described above hits the seafloor. Bottom water hypoxia monitoring was accompanied by short term incubations of additional instruments to investigate the impact of different oxygen conditions on benthic processes and fluxes. These instruments included benthic chambers, micro profilers, an eddy correlation device and planar optodes for snapshots of vertical oxygen distributions in the sediments. The focus of these studies was on organic matter mineralization and fluxes of nutrients (nitrogen species and phosphate) across the sediment-water interface. Furthermore investigations included water column and sediment sampling for chemical and geochemical analyses and mapping of habitats across the oxygen and depth gradient by means of a towed camera system. Data available at the data portal include water chemistry, sediment geochemical data, as well as interfacial fluxes of oxygen and DIC. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
Several month long time series of bottom water oxygen concentrations were successfully recorded at the position of the oxycline. In agreement with GODESS observations, measurements depict oxygen fluctuations in the hypoxic zone with periodicities in the range of hours to weeks. Fluctuations were strongest in the stormy season when bottom water oxygenation oscillated between deep hypoxia and concentrations close to air saturation. Correlation with wind data showed that strongest injections of oxygen into bottom waters coincided with strong southwesterly winds. Such major bottom water oxygenation events will strongly affect the redox-sensitive N and P cycling and associated nutrient release from the underlying sediments.
Nutrient release showed strong correlations with the bottom water oxygenation and the prevailing pathway of organic matter mineralization. Ammonium efflux from the sediment peaked under anoxic conditions where also strong fluxes of sulfide were measured. Habitat mapping revealed the pronounced occurrence of microbial mats around the oxycline. Their presence has distinct implications for the benthic nitrogen cycle as these organisms are able to store high amounts of nitrate that is turned into ammonium upon the oxidation of sulfide. Indeed, a strong release of ammonium was found to be associated with the occurrence of microbial mats. This contributes to enhanced primary production potentially leading to eutrophication and promoting fast oxygen depletion. More information on the studies carried out at the Gotland basin seafloor are found in presentations held at the HYPOX project meetings (http://metaworks.pangaea.de/download.php?fileid=331; ...fileid=373; ... fileid=374)

4.1.3.3.2.2 Eckernfoerde Bay / western Baltic
The focus of the investigations at the long term monitoring site Boknis Eck in Eckernfoerde Bay was on nutrient recycling under a regime of seasonal hypoxia. The site was visited monthly over a period of one year and water column characteristics were studied by standard CTD casts. Investigations were mostly based on geochemical analyses of sediment cores as well as core incubations and involved a strong modeling component. Geochemical data obtained from the sediment cores are uploaded to the portal (direct links in table 'data generated in HYPOX' in section 4.1.6.). Data on oxygen and many other parameters are available through the Boknis Eck monitoring time series
(http://www.loicz.org/projects/documents/010412/index_0010412.html.en)
High nutrient concentrations in the western Baltic lead to an intense productivity in surface waters. Microalgae that sink out of the sunlit top layer settle on the seafloor where they are mineralized. Nutrients, especially ammonium are released from the algal biomass upon microbial degradation and efficiently pumped back to the water column by sediment dwelling worms keeping rates of nutrient recycling high. At warm and stagnant summer conditions severe hypoxia was found to develop in the bottom water. Consequently, seafloor worm populations

were wiped out. Nutrient effluxes from the seafloor stay high also without the worms' pumping activity. Measurements, experiments and numerical simulations revealed that methane produced by microorganisms under hypoxic conditions seeped from the seafloor and carried nutrient-rich pore water to the water column in summer. Nutrient recycling even got more efficient under these conditions as in addition to ammonium also phosphates escaped from the anoxic sediments. Seasonal hypoxia thus acts in support of even more hypoxia by fertilizing algal growth that further reduces bottom water oxygen upon decay. As a side effect hypoxia also adds to global warming if methane – a strong greenhouse gas – escapes to the atmosphere. It can be expected that similar feedback loops exist also in other areas that similarly suffer from summer hypoxia.

4.1.3.3.3 HAUSGARTEN / Fram Strait

In order to understand the impact of large-scale environmental changes on the Arctic marine ecosystem, the deep-sea observatory HAUSGARTEN in Fram Strait west of Svalbard was established. Multidisciplinary research activities at HAUSGARTEN cover almost all compartments of the marine ecosystem from the pelagic zone to the benthic realm. Repeated water and sediment sampling and the deployment of moorings and free-falling systems have taken place since the observatory was established in summer 1999. Previous investigations indicated a decrease in bottom water oxygen concentrations that may be due to alteration of transport processes related to global change. Within HYPOX observational work was continued and long term oxygen measurements were extended. More information on the benthic observatory that was equipped with additional oxygen sensors and deployed in HYPOX is found at http://dataportals.pangaea.de/hypox/index.php?ptype=map&detail&id=13. Oxygen data from the HAUSGARTEN observatory including long term time series recorded before and during HYPOX (> 2000 days of recording in total) and discrete bottom water oxygen values determined in samples were uploaded to the data portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.

The data obtained by the replicate sensors were used to investigate the long term stability and reliability of optode readings. The findings were included into a publication (Lo Bue et al. 2011). Based on the current knowledge it has to be concluded that despite the good performance of the optodes in short-term and shallow-water applications, this sensor type is probably not entirely suited for long-term measurements in deep, polar waters, and in low-current environments in general. The attempt to continuously study the temporal development of dissolved oxygen concentrations in the deep Arctic Ocean remains to be a big challenge, and apparently needs new, improved sensors.

The monitoring of bottom water oxygenation was complemented with microprofiler measurements of sediment oxygenation. Transecting microprofilers were used to investigate benthic oxygen distribution / aerobic mineralization on a microscale. A long term micro profiler device with long-lived optical microsensors was deployed in summer 2011. Data from the instrument that will be retrieved in summer 2012 will show for the first time seasonal changes and the effect of ice cover on sediment oxygen distributions and uptake rates. Finally, sediment sampling for geochemical analyses has been carried out in HYPOX.

Connected to HYPOX objectives and partly based on knowledge obtained within the project an autonomous monitoring system was built in cooperation with OPTIMARE (Bremerhaven, Germany) and successfully deployed during in the Arctic in 2011. The system monitors chemical, oceanographic and optical parameters in and under the Arctic sea ice (oxygen, temperature, salinity, photosynthetically active radiation and chlorophyll fluorescence) and allows to extend investigations of oxygen levels and climate change effects to the Arctic. The system consists of a surface unit standing on the ice and three sensor modules, one located within the ice and two below the ice at different water depths. In addition, a temperature string with 24 thermistors is connected to the surface unit to measure temperature profiles within the ice and in the upper water column. Data are sent via Iridium satellite network in near real time.

4.1.3.3.4 Loch Etive

Investigations in the fjord-like Loch Etive in Scotland, UK started with surveys on properties of the seafloor (including investigations of benthic fauna and biogeochemical conditions) and the water column in the two contrasting basins (upper and lower Loch Etive). These provided baseline data and served to identify suitable observatory locations.

Subsequently, two permanent in situ observatories, one cabled online observatory in the upper hypoxic basin and one autonomous mooring in the lower well mixed basin in Loch Etive, have been deployed in autumn 2009. The new and innovative Loch Etive Cabled Observatory (LECO) has been designed and constructed for long term monitoring of oxygen concentrations and other physical parameters (salinity, temperature, current speed and direction) at two different depths at high temporal resolution. A base station to which the observatory is connected was established on the shores of upper Loch Etive. The cable and base station enables real-time data transfer (via broadband) and continuous power supply for the instruments which in turn provide the possibility for long term monitoring of oxygen, salinity, temperature and currents at high temporal resolution (every 10min). Additional information on the observatory is found at http://dataportals.pangaea.de/hypox/index.php?ptype=map&detail&id=21. From the beginning on the collected data are stored on a local database at SAMS and displayed in real-time on a dedicated webpage since spring 2010. Since summer 2011 the data stream has been hooked via SOS server to the data repository PANGAEA and the HYPOX data portal. The observatory generated high quality data until it was struck by lightning in winter 2011. Repair is underway and a redeployment of the observatory is planned for the near future. Data of the LECO observatory were automatically uploaded to the data portal and will continue to be archived after redeployment. Direct links to the data are found in table ‘data generated in HYPOX’ in section 4.1.6. Plotting functionalities to display the most recent data are implemented in the portal and will be automatically updated once data start again streaming in (http://dataportals.pangaea.de/hypox/sosclient/chart.php?id=21&client=lochetive_seaguard&cy=1).

Continuous recordings proved highly suitable to monitor rare and episodic events of bottom water oxygenation by dense and saline waters overflowing the shallow Bonawe Sill. These events are easily overlooked with classical monitoring approaches. The combination of observatories in the upper and lower basin allowed an in depth analysis of the bottom water renewal events as the potential to overcome the sill is a combination of conditions at both sides of the sill. It turned out that these events require very specific oceanographic and meteorological conditions including spring tides, cold temperatures, easterly winds, and weak freshwater input. Besides the long term monitoring capacity, the data collected by the observatory provide important input for the SAMS modeling work in Loch Etive. Online data access further allowed to continuously compare model results with the data streaming in which substantially increased the efficiency of modeling studies. Last not least real time data provided the opportunity for targeted sampling campaigns when changing conditions were recorded by the observatory and can serve as the basis for future early warning services in cases where conditions in the deep Loch Etive get unfavorable for benthic life.

4.1.3.3.5 Koljoe Fjord

Two field campaigns represented the first steps towards monitoring of the Koljoe Fjord / the Orust-Tjörn fjord system in Sweden. Based on knowledge obtained during these campaigns a design for a stand alone moored observatory was developed. The mooring consisted of a string of sensors and a current meter and monitors salinity, temperature, and oxygen at four different depths in the water column as well as bottom water current speeds and sea level variations. A first short term test deployment was carried out in autumn 2009. Subsequently a long-term deployment took place in Havstens Fjord in the same ford system. In extension of original plans the stand-alone observatory was turned into a cabled observatory with online data access and

deployed in Koljoe Fjord in Apr. 2011. Additional information on the Koljoe fjord observatory is found at http://dataportals.pangaea.de/hypox/index.php?ptype=map&detail&id=22. Since the deployments the observatory has continuously provided real-time data. Using the same technology as in case of Loch Etive data sets are automatically transferred to the data repository PANGAEA and the HYPOX data portal. The measurements are available in near real time and the latest data that are streaming in are displayed with an online plotting tool at the HYPOX data portal as well as through a web display run by Gothenburg University (http://dataportals.pangaea.de/hypox/sosclient/chart.php?id=22&client=koljoefjord_seaguard; http://dataportals.pangaea.de/hypox/sosclient/chart.php?id=22&client=koljoefjord_rdcp; http://mkononets.dyndns-home.com:8080). In order to include also conditions in the surface waters an additional mooring was deployed in the Koljoe Fjord in September 2011 that measures oxygen, salinity and temperature at 3m water depth. Data sets available at the portal include measurements from the stand-alone observatory deployments as well as data from the cabled observatory that are periodically added as they stream in. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
As in Loch Etive, deep water renewal events were found to happen rarely and episodically. Again, meteorological and oceanographic conditions have to act together to allow for deep water overcoming the sills. Hydrographic conditions in the Orust-Tjörn fjord system that opens to the Baltic Sea on both ends are rather complex. Depending on water levels at the entrances circulation through the fjord system can happen clockwise or counterclockwise. Deep water renewal may both increase or decrease oxygen concentrations in the deep Koljoe Fjord depending on the origin of the water and deep water conditions in the neighboring fjords. Online access to the data proved favorable for quality control and modeling activities performed in parallel. In order to understand the functioning of the system, effects of vertical mixing, water exchange, tides, and wind forcing on the oxygen distribution and variability in the fjord were assessed with modeling tools. Quality control of the obtained data has been undertaken through comparisons with reference data collected by the Swedish Meteorological and Hydrological Institute on a monthly basis.
Accompanying field campaigns were carried out in Koljoe Fjord to investigate drivers of hypoxia and to assess the impact of oxygen conditions on biogeochemical processes. Sediment-water exchange rates of oxygen, dissolved inorganic carbon and nutrients in the Koljoe Fjord were measured by means of in situ in chambers and benthic landers. The results are used to constrain the role of sediments in oxygen depletion in the Koljoe Fjord. Data from the accompanying field campaigns were uploaded to the portal (direct links in table 'data generated in HYPOX' in section 4.1.6.).

4.1.3.3.6 Ionian Sea lagoons and embayments
Investigations were carried out in two semienclosed systems (Amvrakikos Gulf and Aetoliko Lagoon) and an open embayment (Katakolo Bay). The main objective of the work was to investigate characteristics and temporal evolution of hypoxia occurrence and the role of the respective drivers of oxygen depletion (geographic and oceanographic conditions, anthropogenic forcing, and gas seepage). The majority of observations were carried out during repeated field campaigns with small local vessels. Methods used included CTD casts, coring for geochemical analyses, acoustic surveys as well as ROVs and the towed multiparameter observatory MEDUSA. Measurements of temperature, salinity, oxygen, pH, currents, ORP, turbidity, dissolved methane and sulfide were carried out at all three sites. Gas, water, and sediment samples were collected by divers for gas analysis (methane isotopic analysis in Amvrakikos Gulf, methane and sulfide isotopic analysis in Aetoliko Lagoon). In addition, visual inspection of the sea-floor was carried out and seismic data were recorded in order to identify structures (pockmarks) indicative of gas seepage
MEDUSA surveys were carried out in order to monitor variations of oxygen in correspondence with methane and sulfide seepage. To investigate the role of gas seepage as a driver of oxygen

depletion in more detail, the benthic observatory GMM (Gas Monitoring Module) was deployed for four months in Katakolo Bay.
Data from the different field campaigns including survey data obtained with the towed observatory MEDUSA as well as time series recorded with the benthic observatory GMM were uploaded to the data portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
Amvrakikos Gulf was found to be seasonal anoxic. The main drivers of hypoxia / anoxia in Amvrakikos Gulf were confirmed to be oceanographic and anthropogenic (fertilizer runoff, sewage, fish farming). Surveys with the towed observatory MEDUSA in three different sectors of Amvrakikos Gulf did not show significant gas seepage, apart from a pockmark site. Here an enhanced depletion of oxygen was observed but only in close vicinity to the seabed and inside the pockmark itself. In the permanently anoxic Aetoliko Lagoon the vertical distribution of the oxygen in the water column was found to be controlled by density stratification of the water column. The surface layer is well oxygenated throughout the year while in deeper waters oxygen content was found to continuously decrease reaching anoxia at depth. The depth of the oxycline was found to change with season. Stratification in Aetoliko Lagoon is mainly controlled by salinity due to the relatively strong fresh-water input, and the limited connection to the adjacent Messolonghi Lagoon. Hypoxia and anoxia potentially increase microbial production of sulfide and methane in the sediments indicating that gas in Aetoliko Lagoon is rather a product of hypoxia, not a driver.
In Katakolo Bay gas seepage was found to be much more vigorous and of clearly thermogenic origin. Hundreds of bubble plumes were detected over a wide area during MEDUSA surveys and lowered oxygen concentrations were observed around the plumes. Modeling activities are underway to explain the observed oxygen and methane distribution.
The design of the benthic observatory GMM that was deployed in Katakolo Bay detects dissolved gases (oxygen, methane, sulfide) with commercially available sensors and additionally records key physicochemical factors (temperature, pressure, conductivity). The GMM observatory successfully performed a long term (22 Sep. to 31 Dec. 2010) monitoring of oxygen in a methane seepage site. Periods where oxygen decreases down to hypoxic levels often correlated with times of increased methane concentrations. GMM data showed a complex interrelationship between oceanographic parameters (currents, temperature, methane and oxygen) and meteorological factors (wind intensity and direction). Data interpretation was facilitated by the chosen time series approach as the different processes contributing to the observed variations (seepage, currents, meteorological conditions) all operate on different time scales from minutes to days. The hypoxia episodes appeared to be due to a combination of enhanced degassing from the seabed and very low regimes of currents and wind (low circulation).

4.1.3.3.7 Swiss lakes

The water columns of Swiss lakes were investigated to study the effect of oxygen on water column biogeochemistry of freshwater systems at the smallest possible scales. Oxic-anoxic interfaces are known to represent biogeochemical hotspots of element cycling in aquatic systems characterized by intense redox-cycling. These investigations called for novel technologies as sensors to trace oxygen down to nanomolar concentrations at high resolution and with fast response times were missing. Such sensors are required for the localization and description of the oxic-anoxic interface at the lower end of the hypoxic zone. The recently introduced amperometric STOX-sensor (Revsbech 2009) provides the necessary lower detection limit but proved too slow for the planned profiling applications in the lake water columns.
Electrochemical and optical oxygen microsensors were successfully used for profiling measurements. This was possible by performing in situ calibrations and by the introduction of custom-built amplification-stages for the amperometric sensors. This innovation resulted in a detection limit below 5nmol / L and a resolution of 0.06 nmol for the amperometric sensor. The

sensors were combined with a high resolution online-controlled water sampler to form the profiling observatory PIA (In situ Profiling Analyzer). A photograph of the PIA device as well as additional information is found at http://dataportals.pangaea.de/hypox/index.php?ptype=map&detail&id=24.
PIA was successfully deployed from small research platforms in Lake Rotsee, Lake Zug, and Lake Lugano. Online data analysis and presentation during profiling allowed controlled sampling of the hypoxic zone down to the nanomolar concentration-range. Water samples were analyzed for dissolved nitrogen species, phosphate, manganese, iron, and methane. Data obtained with PIA in Lake Zug and Lake Rotsee were uploaded to the portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
High-resolution profiles revealed that even the sharp oxyclines in strongly stratified lakes show hypoxic tails on the meter scale with oxygen concentrations still in the nanomolar range. This knowledge is crucial for water column sampling as well as for an understanding of the interconnection of the different redox processes and their relation to oxygen. In Lake Rotsee, analyses of nutrient, metal and methane concentration profiles clearly showed that redox-cycling of nitrogen-species directly below the oxycline was thus spatially separated by the long hypoxic tails from the true oxic-anoxic interface where redox-cycling of methane, manganese and iron species occurred. The depth of the oxic-anoxic interface as well as the spatial distribution of submicromolar oxygen concentrations varied significantly between casts and were closely followed by the respective redox-reactions. This seems to indicate a spatially heterogeneous distribution of submicromolar oxygen-concentrations and an enhanced spatial redox-variability in this biogeochemically active zone.

4.1.3.4 IMPROVING LONG TERM HYPOXIA RECORDS BY ABIOTIC AND BIOTIC PROXIES

Different proxies for past events of oxygen depletion or anoxia in aquatic ecosystems were applied in order to understand past oxygen concentration changes and to explore their applicability for investigations of recent hypoxic conditions. This included organic and inorganic proxies, benthic community structure, and hypoxia indicator species. Studies were focused on Black Sea shelf areas (Bosporus outlet area, Crimean shelf, Sevastopol area, Romanian shelf), Ionian Sea lagoons (Amvrakikos Gulf), Swiss Lakes (Lake Zurich, Lake Rotsee), and Eckernfoerde Bay (western Baltic Sea). In extension of the initial plans additional studies in the northern Baltic (Bottenwiek area) as well as in Lake Alat (Bavaria, Germany) were carried out by the associated HYPOX partner MfN (Museum for Natural History, Berlin, Germany). The main objectives were to reconstruct the recent and past changes in the redox conditions using geochemical proxies and to obtain knowledge on structures of the benthic communities and species that indicate hypoxia in the various basins. Understanding the history of aquatic ecosystems with regard to variation in oxygen depletion is crucial in order to develop and compare scenarios of global change and their effects on oxygen depletion and the ecosystem.
At the beginning of the project available knowledge about long-term and short-term effects of changes in the oxygen regime on biota and communities was compiled for the different target sites. The review of available data indicated the insufficiency of the existing knowledge for an adequate interpretation of observed changes in benthic communities in response to hypoxia. The data on biological characteristics in the Black Sea, Baltic Sea, Swiss lakes and Ionian Sea lagoons were selected to characterize past oxygen regime at the respective target sites. The collected data included information about spatial and temporal variations in oxygen depletion and response of biota to these changes on the levels of individuals, populations, and communities. Available data on macro- and meiobenthic communities at the oxic-anoxic transition of the Crimean shelf and the Bosporus area were reviewed with special focus on the influence of bottom water oxygen on abundances and diversity of the respective groups. For the Romanian shelf existing data on past hypoxia occurrence and eutrophication and its influence on benthic communities were collected. Reports for the Baltic Sea indicated mats of sulfide

oxidizing bacteria as obvious indicators of past oxygen conditions. Based on legacy data on sediment geochemistry a strong influence of near-bottom oxygen conditions on the cycling of Nitrogen compounds and redox-sensitive metals can be expected. Existing long term monitoring data from Swiss lakes suggest that thermal stratification and increased algal blooms are the main cause of the hypoxia in the Swiss lakes. Existing knowledge on sedimentation rates, and visual inspections of the sediment characteristics indicate that deep water anoxia in Amvrakikos Gulf evolved in the last 20-30years. The results of the collection of available data has been compiled into report D4.2 'Report on available knowledge about past oxygen regimes and benthic indicators species at selected target sites' (http://metaworks.pangaea.de/download.php?fileid=147).
Several cruises were conducted at an early stage of the project to carry out sediment coring as well as geological and geophysical surveys. Target sites of these investigations were the Bosporus outlet area and the Romanian shelf in the Black Sea as well as Ionian Sea Lagoons and Swiss lakes. The main objective of the work was to reconstruct the basin evolution and past changes in the redox conditions in the various basins. In the Bosporus area geophysical subbottom profiling and sediment sampling was carried out and sediments were collected for geochemical measurements as well as analyses of benthic fauna. At the Romanian shelf analysis of sediment characteristics was performed along a depth gradient with a special focus on signs of past benthic communities and signs of recent biological and geochemical processes (e.g., iron precipitation, sediment layering). Cores were taken in Swiss lakes for later biomarker analysis. In the Greek lagoons sediments were sampled for the analysis of foraminifera indicative for past oxygen conditions. Report D 4.3 'Report on coring, marine geological and geophysical surveys' (http://metaworks.pangaea.de/download.php?fileid=354) compiles information on the investigations carried to identify past oxygen conditions, to characterize the ecosystems and to collect samples for later analyses.
Over the time course of the project, analyses of the samples and data obtained at the different sites during several field campaigns were carried out. In the Bosporus outlet area of the Black Sea, geochemical analyses of cores were done in order to study the hypoxia history and the effects of Mediterranean water in the ventilation of the area. Methods used included XRF core scanning and TOC/TIC analysis. Benthic community and indicator species studies were carried out and compared to information on oxygen distribution obtained in parallel. In Lake Rotsee lipid biomarkers were studied. In Lake Zurich trace metal distributions were carried out as well as an analysis of existing long term monitoring data of oxygen and associated parameters. Lipid biomarker studies were also carried out in Amvrakikos Gulf and complemented by investigations of Foraminifera assemblages. Pore water geochemistry was analyzed for phosphorus-iron dynamics in Eckernfoerde Bay (western Baltic Sea). Nitrogen and carbon isotopes and purple sulfur bacteria were studied in samples from the northern Baltic Sea (Bottenwiek) and Lake Alat, respectively. Finally, benthic population structure and hypoxia indicator species were studied in the Black Sea shelf areas (Istanbul Strait outlet area, Crimean shelf and Sevastopol area, and the Romanian shelf). The findings obtained with the different methodologies at the different sites are compiled in report D4.1 'Report on assessment of changes in oxygen availability using organic and inorganic proxies, benthic communities structure, and hypoxia indicator species' (http://metaworks.pangaea.de/download.php?fileid=364). Several publications and manuscripts showing more about the work carried out by the project partners in relation to past oxygen changes is found in report D4.4 'Publications on past variation of oxygen depletion and relation to paleo-environmental changes' (http://metaworks.pangaea.de/download.php?fileid=396). A lot of the findings from the different sites have been presented at international conferences (table 4.2.A2 and conferences, meetings and workshops table in section 4.1.6) and already resulted in some peer reviewed publications (table 4.2.A1 and 'publications published and in press' table in section 4.1.6). Table 'submitted and planned publications' in section 4.1.6 lists some of the publications that will be published in the future based on work carried out. A summary of the main achievements is provided below.

4.1.3.4.1 Inorganic geochemical studies in the Bosporus outlet area

The Bosporus is the only connection of the Black Sea to the world's ocean. The area is characterized by the Mediterranean inflow that is responsible for the ventilation and sluggish deep circulation of the anoxic Black Sea basin. The Mediterranean water enters the Bosporus outlet area through the submarine extension of the Bosporus channel, and then spreads as a uniform 2-3 m thick saline sheet over the shelf. At depths of 50-75 m, it mixes with the Cold Intermediate Water and sinks along the continental slope forming a series of lateral intrusions to depths of 500 m. The Bosporus outlet area is also characterized by a fan-delta complex on the mid and outer shelf areas. Shallow sill depth of the Istanbul Strait together with the oxygen consumption by organic matter mineralization is responsible for the establishment of a permanent oxic-anoxic boundary (chemocline) in the area. The oxic-anoxic boundary is presently at 100-150 m depth, but may have varied in the past as result of the changes in the amounts of the Mediterranean water, of riverine water input and global sea level.
Geophysical subbottom profiling and sediment coring was performed during two cruises along transects ranging from water depths of 75 to 300m. The cores were analyzed for physical properties, elemental analysis, and for total organic carbon (TOC) and inorganic carbon (TIC) and dated by 14C analysis. The core data were uploaded to the data portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.
The Holocene basin evolution was investigated based on high resolution seismic profiling and the obtained cores and showed evidence for two unconformities. The inorganic geochemical studies indicate that the anoxia development started after the latest connection with the Mediterranean. Redox changes and anoxia history in the area have been unraveled using manganese and the iron-carbon-sulfur system. Oxic-anoxic boundaries and changes in the bottom water conditions in the slope area are detectable by manganese, sulfur and iron anomalies in the cores, which show the rise of the redox boundary to water depths between 120 and 150 m around 6800 years before present. As a result of this work, the change in the direction (eastward shift) at 5300 years before present and ventilation effects of the Mediterranean inflow can be observed. In the eastern part of the outlet area down to water depths of at least 300m, ventilation effect of Mediterranean water is indicated by high manganese concentrations that last until today. These manganese anomalies are not associated to contents of iron and sulfide. A recent shoaling of the oxic-anoxic boundary about 250-300 years ago is indicated by manganese anomalies associated with iron and sulfur anomalies in a core collected from western side of the study area where no ventilation effect by Mediterranean water is observed today.

4.1.3.4.2 Inorganic Geochemical Studies Lake Rotsee and Lake Zurich

Lake Rotsee is a small 16m deep, prealpine, monomictic (i.e., water column is completely mixing once per year) and eutrophic lake. The lake has a stable stratified water column and is anoxic at depth throughout most of the year. Eutrophication by untreated sewage impacts the lake since 150 years and led to an elevated productivity. The large mesotrophic Lake Zurich has a maximal depth of 136 meters. Long-term monitoring data (1936 to present) including oxygen concentrations exist for Lake Zurich. The lake is highly sensitive to changes in climate, namely temperature changes. The discrete annually deposited layers (varves) in the sediments were used to obtain an age model.
Cores were taken in both lakes. Inorganic markers, i.e. trace metals, were analyzed in the sediment cores of Lake Zurich. Iron and manganese distributions showed a seasonal pattern in Lake Zurich. Our results suggest that a peak of iron in the winter half year was due to higher terrigenous supply, whereas manganese was sensitive to bottom water oxygenation. The ratio of manganese to iron was correlated with bottom water oxygen concentrations and indicated that manganese traces oxygenation of the bottom water during spring when the lake mixes completely. Data from geochemical analyses were uploaded to the data portal (links are found in table 'data generated in HYPOX' in section 4.1.6).

4.1.3.4.3 Long term monitoring data series for Lake Zurich
A several decade long oxygen monitoring program of Swiss authorities in Lake Zurich allowed HYPOX scientists to investigate the impact of climate variability on oxygen conditions. Throughout the 1970ies and 1980ies the 135 m deep water column overturned nearly every winter ventilating the lake down to the bottom. Since then, increasing water temperatures led to a stronger stratification of the lake and winter cooling failed to completely mix lake waters and fully replenish bottom water oxygen sometimes for periods of several years. This resulted in an overall decrease in oxygen availability in the deep lake in the last twenty years that clearly reflects climate forcing. Oxygen loss through biological oxygen demand can be ruled out as phosphorous loading of the lake steadily declined throughout the period due to improved wastewater treatment and banning of phosphates in detergents. Long term monitoring clearly confirmed the potential of global warming to turn ecosystems hypoxic.

4.1.3.4.4 Pore water Phosphorus-Iron Dynamics in Boknis Eck / Eckernfoerde Bay
From mid Mar. until mid Sep., vertical mixing is restricted by density stratification of the water column, which leads to pronounced periods of hypoxia during late summer due to microbial respiration of organic material in the deep layer and sediment. In autumn the stratification breaks up and bottom water oxygen concentrations rise again. The dominant fauna in the sediments in winter / spring are polychaetes that exist in high abundances and irrigate the pore waters. Filamentous sulfide oxidizing bacteria are present below the sediment surface at the redox interface at the top of the sulfide layer and appear at the sediment surface at low oxygen conditions in summer. Between Feb. 2010 and Jan. 2011 sampling of sediment cores was carried out monthly.
Geochemical analysis of the sediments showed that ferrous iron and phosphate concentrations rapidly increased following the onset of anoxia. This is most likely due to reductive dissolution of iron oxide minerals and the release of iron-adsorbed phosphate. Ferrous iron and phosphate fluxes across the sediment water interface increased by a factor 10 from Sep. to Oct., remained fairly high in Nov. and then returned to background levels in Dec. when fully oxic conditions are restored in the bottom water. The results demonstrate the dynamicity of the sediments over the short autumn anoxic period and the potential importance of the benthos in supplying nutrients to the water column for the following spring. Ongoing work will address whether the phosphate and ferrous iron fluxes out of the sediments are determined directly by the onset of anoxia or indirectly by the ceasing bio-irrigation due to animal mortality. Geochemical data from Eckernfoerde Bay cores were uploaded to the data portal (links in table ‘data generated in HYPOX’ in section 4.1.6.).

4.1.3.4.5 Studies of inorganic and organic proxies in Baltic Sea, Black Sea and Lake Alat
Sediment cores were studied for the impact of eutrophication in the northern most Baltic Sea (Bottenwiek). The results indicate that during the past hundred years the area of the Bottenwiek was eutrophied only to a small extent. However, sedimentary nitrogen and carbon isotopes show clear trends towards higher values in more recent sediments (the last 2 decades) indicating the increasing bioproductivity and more nutrients in that area. This potentially has strong implications for future oxygen conditions in the area. The physicochemical stratification and stability of the meromictic (permanently stratified) and anoxic Lake Alat was studied with respect to the influence of the dense population of purple sulfur bacteria on the nitrogen cycle. Water samples and surface sediments obtained from short cores are used for the analysis with a sub-decadal resolution. Ages are obtained by the lead 210 dating method. The analyses are ongoing.

4.1.3.4.6 Natural radionuclides and Cesium studies in Amvrakikos Gulf (Greece)

Amvrakikos Gulf is a semi-enclosed embayment with an area of 405 square kilometers. It is connected to the open sea through a narrow and shallow channel. The gulf receives relatively large freshwater inputs by two rivers. As a result, Amvrakikos Gulf is stratified with a surface layer and a bottom layer that are separated by a strong pycnocline (steep density gradient). Amvrakikos Gulf is the only Mediterranean Sea fjord and shows an outflow of brackish water at the surface and an inflow of saline water in the near-bed region. While the surface layer is well oxygenated, oxygen concentrations decline sharply below the pycnocline and reach anoxic conditions in the bottom layer. Natural radionuclides (238U, 232Th, 226Ra, 40K), man-made cesium 137 distributions and total concentrations of iron and manganese were investigated in the sediment cores. Enhanced uranium activity levels and disequilibrium between 238U and 232Th were observed and are attributed to riverine inputs of phosphate fertilizer that hold radioactive materials. Uranium input by input of weathering products of the phosphate rocks via surface and ground waters seemed of lesser importance. Highest concentrations of cesium 137 were found in the deeper sediment layers and suggest high sedimentation rates for the Amvrakikos Gulf. Preliminary sedimentation rate estimates based on lead 210 are in the range of 0.3 to 0.6 cm per year. Higher resolution Cesium data and the final lead 210 data will provide the age model that allows for more detailed reconstructions of past oxygen conditions at the seafloor based on foraminifera analyses. Existing data on sediment radionuclides and metals as well as foraminifera were uploaded to the data portal. Direct links to the data are found in table ‘data generated in HYPOX’ in section 4.1.6.

4.1.3.4.7 Noble Gases in the Black Sea

Sediment samples for analyses of noble gas distributions were collected at different water depths at the Crimean shelf and the northwestern shelf off Romania as well as in the Bosporus outlet area. Investigations aim to reconstruct hypoxia through determination of atmospheric noble gases (He, Ne, Ar, Kr and Xe) in the pore waters from three different locations. The core sites in the Bosporus area and at the Crimean shelf were chosen to represent oxic, hypoxic and anoxic zones. The noble gas content in the Bosporus area samples may provide insight into oxygen as well as salinity conditions before and after the Mediterranean-Bosporus connection. It is anticipated that through the diversity of the three sites, the noble gas measurements could provide very interesting insight into past variations in oxygen and salinity along the Black Sea shelf. In order to evaluate the potential of noble gases as a record of oxygen abundance, analyses will focus on periods in the sediment record where the Black Sea evolved from a rather oxic, limnic basin into a brackish, hypoxic, anoxic and euxinic (no oxygen, free sulfide) state. Furthermore, noble gases may be used as a tracer for past methane production in the sediments. Analysis of the collected sediment samples is ongoing and results should become available in the coming months.

4.1.3.4.8 Biomarkers studies in Lake Rotsee and Lake Zurich, Amvrakikos Gulf, and the Northwestern Black Sea shelf off Romania

The high-resolution Lake Rotsee biomarker study revealed a complete eutrophication history of the last 150 years. We observed times of higher primary productivity especially around 1920 and in the 1960s that can be explained by high nutrient input from the catchment through agriculture and untreated sewage. Periods of higher productivity resulted in enhanced stratification, as indicated by higher Tetrahymanol concentrations beginning in the 1920s. The coincidence of high TOC values with higher concentrations of C16:1ω7 fatty acid indicates higher biomass of iron-, manganese and sulfate-reducing bacteria and times of more intense or longer hypoxia in the lake. High concentrations of delta 13C non-depleted glycerol dialkyl glycerol tetraether concentrations indicated periods with high methanogen biomass in the sediment and increased emissions of methane into the water column. The onset of higher methane production is characterized by higher concentrations of strongly delta 13C depleted 17beta-21beta-bishomohopanoic acid and diploptene indicating radiation of aerobic methane oxidizing bacteria.

Later, anaerobic methanotrophic Archaea increased in abundance, which was traced by higher sn2- and sn3-hydroxyarchaeol concentrations in the sediment. The Chromatiaceae derived pigment okenone and the pigment isorenierantene which is derived from Chlorobiaceae, could be detected in Lake Rotsee and suggested that anoxic conditions reached into the photic zone in the past.
For the Amvrakikos Gulf two biomarkers (isorenieratene and chlorobactene) were found, indicating at least seasonal photic zone anoxia. Biomarkers and benthic fauna were analysed in a combined study in order to reconstruct eutrophication and hypoxia in this embayment, with high similarities to developments of hypoxia in the Black Sea. Data on geochemical properties of Amvrakikos gulf sediments were uploaded to the data portal (links in table 'data generated in HYPOX' in section 4.1.6.)

4.1.3.4.9 Benthic community structure and hypoxia indicator species at the Crimean shelf and the Bosporus outlet area
An extensive study of the benthic community structure and hypoxia indicator species was carried in the Crimean shelf and Bosporus outlet area of the Black Sea. Oceanographic and benthic environmental conditions were studied during two cruises (R/V ARAR and R/V MARIA S. MERIAN) in Nov. 2009 and Apr. / May 2010. In the coastal zone of Crimea, sampling was carried out every 45 days throughout the year. The analyses involved oxygen concentrations in the water column and oxygen and sulfide in sediment pore waters. Sediment sampling for the biological studies were carried out using multi-corer, push-corer and box corers.

4.1.3.4.9.1 Crimean shelf
Studies were carried out in five areas (1) Tarkhankut, (2) Omega Bay, (3) inner Sevastopol Bay, (4) outer Sevastopol Bay, and (5) Dnepr Canyon (Paleo-Delta). The studies focused on the changes in taxonomic structure, quantity and biomass of modern meiobenthos in response to seasonal hypoxia in the environment. Oxygen and sulfide in the pore waters was determined by voltammetry in retrieved cores. Pore water and bottom water chemical data and fauna data are available at the data portal. Direct links to the data are found in table 'data generated in HYPOX' in section 4.1.6.

4.1.3.4.9.2 Tarkhankut seeps
The cape Tarkhankut at the westernmost part of the Crimean peninsula is characterized by shallow methane seeps. Sulfides in pore waters as well as bacterial mats are typical features of the benthic habitat. The only time of sulfide absence in the bottom sediments was during winter storms, when bacterial mats vanish completely. As soon as sediments are undisturbed for several weeks bacterial mats are again formed. At the end of the summer sulfide concentrations in the pore waters of up to 3 millimol / L were observed. The meiobenthos density in the sediment layer varies widely depending on redox conditions. At a sulfide free reference site, abundance and diversity of meiofauna was highest in the upper sediment and decreased with depth. In sulfidic sediments on the other hand meiofauna abundance was highest in the lower sediment layers where the hydrogen sulfide concentration reaches its maximum. Alive specimens of the harpacticoid copepod (*Darcythompsonia fairlensis*) were found in the anoxic and sulfidic sediments in high abundances. At the reference site, in normoxia, more species of harpacticoid copepods were observed but *D. fairlensis* was missing. The studies demonstrate that some benthic metazoans are able to thrive into sulfidic environments. Populations of *D. fairlensis* may be used as indicators of hypoxic conditions.

4.1.3.4.9.3 Sevastopol Bay
Bottom waters in the inner Sevastopol Bay regularly experience hypoxic conditions as a result of anthropogenic / industrial pollution and restricted water exchange. Sediments in the inner part of the bay are rich in organics and always anoxic / sulfidic. Sulfides are released from the sediments

during hypoxic events. The outer part of the Sevastopol Bay is rather pristine and was chosen as reference site. Hypoxic events have never been reported for the outer bay waters.
Omega Bay is located at the shoreline of Sevastopol, but no industrial objects are located around the bay. Anthropogenic pressure is thus restricted to municipal waste waters. The water exchange is restricted by a narrow outlet. Hypoxic conditions in the bottom waters typically evolve in summer and sulfide is present in the pore waters in high concentrations.
Total macrobenthos abundance was found to decrease when sulfide reached the upper sediment layers but the sensitivity towards sulfide was different in different taxonomic groups. Several groups, including gastropods, certain crustaceans, and nematodes, even showed the opposite tendency with highest abundances where sulfide appeared closest to the sediment surface. This is especially true for many nematode species that seem to prefer hypoxic habitats.
Fifteen species of harpacticoid copepods were recorded in the inner part of Sevastopol Bay with *Haloschizophera pontarchis* dominating the community at strong hypoxic conditions. In Omega Bay species composition of harpacticoid copepods changed in response to oxygen availability. While *Darcythompsonia fairliensis* dominated in hypoxic conditions individuals of the genus *Scotopssyllus* dominated under normoxic conditions when *D. fairliensis* was absent. *H. pontarchis* and *D. fairlensis* may thus serve as indicator species of hypoxic conditions in bottom sediments of the Crimean shelf coastal zone.

4.1.3.4.9.4 Dnepr Canyon Paleo-Delta / western Crimean shelf
Sediment samples were collected along two depth transects at the western Crimean shelf. Total benthos abundances were highest at the shallowest station at approx. 100m water depth and generally declined with depth. Nematodes dominated the benthic communities at all depths in terms of abundances. Depending on water depth, harpacticoid copepods, foraminifers, or bivalves represented the second most abundant groups. Again, the polychaete *Vigtorniella zaikai* showed maximum abundances in the oxygen-sulfide transition zone. This suggests, that this species may be useful as indicator for hypoxia in water column and bottom sediments at all regions of the Black Sea.

4.1.3.4.9.5 Bosporus outlet area
The response of the benthic fauna to oxygen depletion in the Bosporus Strait outlet area was studied along a transect ranging from 100 to 300m water depth. Benthic fauna analyses suggest that the oxic / anoxic transition zone supports a rich protozoan and metazoan community. ‘Live’ organisms were investigated based on Rose-Bengal staining and by means of direct observations using microscopy on board the research vessel. Living specimen of several groups (gromiids, allogromiids, hydrozoans, nematodes, polychaetes) were found under hypoxic as well as anoxic / sulfidic conditions in water depths region of 150 to 300m. These results suggest a successful adaptation of some groups of benthic organisms to hypoxic / anoxic and even sulfidic environments. Main groups of macrobenthos in the sediments of the Bosporus outlet area were crustaceans, annelids, bivalves and echinoderms. Annelids, gastropods and the polychaete *Vigtorniella zaikai* were found down to water depths of 250m. *V. zaikai* showed highest abundances at the oxygen / hydrogen sulfide transition at about 160 m water depth and may serve as indicator species for these conditions. Meiobenthos assemblages were dominated by nematodes and harpacticoid crustaceans. Abundances generally decreased with water depth but occurred in greater depths as compared to macrobenthic organisms (i.e., 300m). Fauna data from the Bosporus outlet area were uploaded to the data portal. Direct links to the data are found in table ‘data generated in HYPOX’ in section 4.1.6.

4.1.3.4.10 Benthic community studies at the Romanian Shelf
The Romanian shelf in the NW Black Sea is characterized by the Danube inflow that has a strong influence in terms of salinity, organic load and sediment grain-size. The dominant biocoenoses in the coastal zone are *Mya arenaria*, *Lentidium mediterraneum*, *Melinna palmata*,

and *Modiolula phaseolina* communities. There have been mass mortalities of some marine organisms such as fish, mollusks, crustaceans and other animals in the Romanian littoral zone during summer months due to hypoxia.
Four cruises were performed with the R/V MARE NIGRUM within HYPOX and covered all the Romanian continental shelf at water depths ranging from 10 to 200m. Sf. Gheorghe transect, a south-eastward oriented transect in front of the Danube Delta, as well as a sheltered area ('Portita') were chosen to monitor the oxygen regime and the benthic fauna. Supplementary research was conducted at Constanta and Mangalia transects for a comparison of the northern and the southern ecosystems. Bottom water and water column chemical properties were uploaded to the data portal (links to the data are found in table 'data generated in HYPOX' in section 4.1.6).
In Sf. Gheorghe and Portita, in front of the Danube Delta benthic macrofauna communities were dominated by worms, mollusks, and crustaceans. The most abundant populations were found in the biocoenoses of hard bottom mussels and muddy-shelly bottom mussels in the deeper areas of Sf. Gheorghe and Mangalia transects. In the Sf. Gheorghe area two species of polychaeta - *Melinna palmata* and the invasive species *Dipolydora quadrilobata*, appeared in particularly high numbers. *Melinna palmata* dominated assemblages represent a new sub-coenosis that is found in areas that were before typically occupied by *Mytilus* communities. The high abundances of *Melinna palmata* indicate that the state of the benthic ecosystem in the area is still fragile. The Macrofauna communities still differ substantially from the situation in the 1960s at the beginning of the highly eutrophic period. While in the 1960s the main benthic communities extended over large areas some of them have now been reduced and fragmented while others while others were completely replaced by invasive species occupying their habitats. In 2010 mass mortalities of some marine organisms such as fish, mollusks, crustaceans and jellyfishes were recorded in shallow waters of the Romanian Black Sea. Mortalities were generally the result of oxygen depletion induced by high temperatures, unusually high fresh water input and calm weather. At the end of Jul. 2010 the lowest oxygen concentration of the last 12 years was recorded in the area.
Several polychaete species were identified as possible indicator species for eutrophication (nutrient rich conditions) and organic pollution. High abundances of *Heteromastus filiformis* indicate natural or human induced disturbances. *Nephtys hombergii* is tolerant to organic pollution and the low oxygen concentration. *Melinna palmata* is a very common species throughout the whole Black Sea basin and indicates natural or anthropogenic disturbances if it appears in high abundance and forms high biomasses. *Prionospio cirrifera* is resistant to pollution with organic substances or petroleum products and is abundant in areas with moderate pollution and increased eutrophication.
Meiobenthos communities
The Black Sea meiobenthic communities are poorly studied. Nematodes at the Romanian shelf were intensely studied in HYPOX. The highest diversity was found on the profile Sf. Gheorghe in the stations at around 100m water depth. A dominant nematodes community tolerant to eutrophication conditions, organic loading and hypoxic conditions is spread throughout the investigated area, from the shallow waters to the deepest bottoms at the limit of the metazoan life. In 2011 the dominant species were *Sabatieria abysalis*, *S. pulchra*, *Desmodora pontica*, *Halanonchus bullatus*, *Axonolaimus ponticus* and *Theristus oxycercus*. The nematode diversity increases with depth, which may suggest that the nematodes in the Black Sea, under unfavourable conditions, may have an adaptive strategy in response to physiological stress factors like hypoxia. Their occurrence deep in the anoxic part of the sediments suggest that the nematodes may develop different metabolic ways, possibly including chemosynthetic mechanisms to produce energy and obtain food. Nematode communities were well represented when oxygen concentrations were particularly low in some parts of the shelf in 2010.

4.1.3.4.10 Benthic Foraminifera studies in Amvrakikos Gulf (Ionian Sea)

Benthic Foraminifera analyses were carried out in sediment cores from the Amvrakikos Gulf. Preliminary results show that benthic Foraminifera assemblages exhibit changes in relation to the decline of oxygen availability at the bottom of the gulf. The onset of low oxygen availability is marked in the core sediments by a lithological change. At this transition layer, benthic Foraminifera diversity started to decrease. Shallow infauna species dominated together with agglutinated foraminifera. The abundance of epifauna species showed a gradual decrease. When the sea floor is characterized by the minimum oxygen values, the benthic diversity is the lowest and deep infauna species become dominant. The oxygen increase at the sea floor is characterized by an increase in benthic diversity with epifauna and shallow infauna species replacing the microfauna. Many of the benthic species obtained at the onset of the low-oxygen interval were observed also at this stage. Foraminifera data were uploaded to the portal (links in table 'data generated in HYPOX' in section 4.1.6.)

4.1.3.5 MODELING AND PREDICTION OF FACTORS AFFECTING OXYGEN DEPLETION

Modeling activities in HYPOX were aimed at: (1) improving our understanding of the hydrologic and biogeochemical processes leading to hypoxia formation, (2) building the model capacity to better predict the future risk of oxygen depletion in aquatic ecosystems, and (3) to be able distinguish natural controls from manageable, anthropogenic effects causing hypoxia. This was done by developing and applying numerical tools to simulate the oxygen dynamics at the HYPOX field sites. A particular point of attention was to assimilate high-resolution oxygen sensor data and integrate various observational data made at different spatial scales and temporal resolutions. Based on model simulation results, feedback was provided to observational scientists regarding optimal sampling and observation strategies.

Two modeling workshops were held during the HYPOX project. The first workshop took place during the kick off meeting and was used to plan and harmonize modeling activities by the different partners. At the same time, this workshop established connections between modelers and observational scientists at the different institutions. The second workshop was carried out during the first annual meeting and consisted of a training workshop on physical-biogeochemical modeling of oxygen depletion. Tutorial lectures were given by HYPOX principal investigators and invited experts.

The modeling work performed in HYPOX was principally focused on the the different HYPOX target sites. Typically, the work was carried out by modeling groups located at the same institutions as the scientists running the HYPOX observatories. This made sure that field observations and model simulations were harmonized. From a model perspective, key efforts in HYPOX related to (1) circulation and biogeochemistry in the Black Sea basin (2) Baltic Sea sediment biogeochemistry (3) water exchange and mixing in fjord systems, and (4) generic modeling tools to advance understanding of reactive transport of oxygen in estuarine and coastal areas. Modeling achievements were strengthened by additional investigations of the affiliated project partners, namely the Norwegian Institute for Water Research (NIVA) and the Interfacultary Center for Marine Research at Liège University (MARE-ULg).

Model-based research in HYPOX was presented at international conferences (table 4.2.A2 and conferences, meetings and workshops table in section 4.1.6) and already resulted in some peer reviewed publications (table 4.2.A1 and 'publications published and in press' table in section 4.1.6). Table 'submitted and planned publications' in section 4.1.6 lists some publications that will be published in the future based on the work carried out. All project reports on HYPOX modeling work were prepared towards the end of the project and thus provide a good synthesis of the work carried out. Report D2.1 'Report on the relative importance of physical processes, sediment biogeochemistry, macrobenthos, and human-impact on hypoxia development in aquatic systems varying in tidal energy, topography and human impact' (will be available soon at http://www.hypox.net/front_content.php?idcat=399&idlang=19, section 'documents') uses a benthic-pelagic ecosystem model to investigate how climate change will increase the risk of

hypoxia in coastal seas. Report D2.3 ‘Report on vertical mixing in hypoxic basins and its dependence on atmospheric and marine boundary conditions’ (http://metaworks.pangaea.de/download.php?fileid=390) focuses on the modeling of fjord systems with reference to fjords at the Swedish coast. Report D2.4 ‘Report on oxygen dynamics in silled basins and its dependence on atmospheric, marine, and terrestrial boundary conditions, including land-use and nutrient loading’ (http://metaworks.pangaea.de/download.php?fileid=391) reports on fjord exchange taking Loch Etive as an example. Report D2.5 ‘Report on assimilation of HYPOX observatory oxygen data and model results on factors governing oxygen dynamics in the Black Sea’ (http://metaworks.pangaea.de/download.php?fileid=353) compares observations of the profiling floats obtained in the Black Sea basin in HYPOX to modeling results and investigates the future potential of oxygen sensor equipped floats for data assimilation approaches. The below text describes some of the modeling work carried out in HYPOX and highlights some of the results.

4.1.3.5.1 Black Sea hydrophysical and biogeochemical modeling

The suboxic zone in the Black Sea (a layer between oxic surface and anoxic deeper water) is highly variable and depends on climate variability as well as anthropogenic eutrophication. However, it is still uncertain which factor is the more important one governing the low oxygen concentrations. So far numerical models have not been explored in detail to assess the biogeochemical system response to anthropogenic and climate forcing. A coupled 1D hydrophysical-biogeochemical model (GOTM plus ROLM) was set up to study the major elements in the redox transition layer in the Black Sea. The model was able to adequately reproduce the observed data. Furthermore the analysis of the difference between interannual and perpetual-year runs clearly showed a pronounced impact of the North Atlantic Oscillation (NAO) on the oxygen dynamics of the Black Sea. In a second step the Nucleous of European Modeling (NEMO) physical model was coupled to the ROLM model to investigate the performance in simulating the main physical and biogeochemical features in the Black Sea. Finally, the Black Sea simulation work was extended by coupling ROLM with the 3D hydrophysical model GETM. This promising approach will be followed up also after the end of the project. Modeling tools were also used to analyze data from two ARGO type profiling floats that were released in the Black Sea as part of HYPOX. These data shed new light on spatial and temporal dynamics of hypoxia in the Black Sea (e.g., the seasonal variability of the subsurface oxygen maximum, cold water mass formation and diapycnal mixing) and were also used to estimate minimum requirements for future float based studies of Black Sea oxygen conditions. Other Black sea modeling efforts concerned the investigation of the hydrophysical processes that lead to the temporal dynamics in water column and bottom water oxygenation observed in the Bosporus outlet area as well as at the Crimean Shelf (see above). Modeling studies are ongoing and will serve to better understand Marmara Sea water injections in the Bosporus outlet area and short and medium term oscillations of the oxycline at the Crimean Shelf and in the open Black Sea. The associated HYPOX partner MARE-ULg has performed numerical model simulations of the Black Sea biogeochemistry using a 3D coupled hydrodynamical - biogeochemical model describing the food web from bacteria to gelatinous carnivores and explicitly representing processes in the anoxic layer down to the bottom. The relative importance of the different processes implied in the oxygen budget of the Black Sea, as well as their seasonal / interannual variability has been assessed.

4.1.3.5.2 Fjord exchange modeling

4.1.3.5.2.1 Loch Etive

A physical fjord circulation/mixing model for the HYPOX target site at Loch Etive was constructed and optimized based on the POLCOMS (structured grid) model. In an early phase of the work, legacy data and data obtained by a standard stand-alone mooring in Airds Bay as well from annually repeated CTD surveys were used for model testing and validation. In the

following, real time data from the Loch Etive Cabled Observatory (LECO) were additionally used. The model proved feasible to describe how short and long term variations in external forcing (tidal forcing, wind, heat flux and rivers runoff) affect the hydrodynamic structure and thermo-haline fields in the Loch Etive fjord. To improve horizontal resolution and better capture deep water renewal events a higher resolution model (FVCOM) was setup for hydrostatic simulations of the main physical properties of Loch Etive. FVCOM was able to handle complex geometries and topographies and was found to be highly suitable for fjord system studies. Sensitivity model runs were performed based on climatological data from 1999-2001 with realistic atmospheric forcing and tidal data from nearest gauging station (Oban). Validation of FVCOM modeling results based on real-time data sets obtained from the Loch Etive Cabled observatory (LECO) revealed excellent agreement for physical parameters: T, S and tidal oscillations. In collaboration with University of Edinburgh a localized version of FVCOM was run at the National Supercomputer Centre HECToR with improved horizontal resolution. This led to a successfully description of stratification very close to the observed data, especially in the vicinity of the narrow straits with shallow sills. Amendment of the modeling environment with oxygen as a variable and with algebraic expressions for water column and benthic oxygen demand are underway and will be continued in the future.

4.1.3.5.2.2 Koljoe Fjord

A coupled physical-biogeochemical-ecological basin model was set up for the Orust-Tjörn system, which includes three sub-basins Havstens Fjord, By Fjord as well as the HYPOX target site Koljoe Fjord. The physical circulation and mixing model has been originally developed by Anders Stigebrandt and applied to several other fjords earlier with good results. The biogeochemical part, originally developed to study eutrophication of Norwegian fjords, has been updated to include all processes needed for hypoxia simulations in the fjord system. Topographic, meteorological and hydrological forcing data has been collected for the fjord system. The boundary conditions to the open Skagerrak turned out to be crucial and it was found that at least a weekly resolution was needed. Historically there are only monthly observations, so weekly measurements were initiated in HYPOX to obtain the state at the Skagerrak border and the internal states of the fjord basins. Using forcing datasets with different temporal resolution (from monthly to daily forcing obtained from the HYPOX mooring in the Havstens Fjord), the modeling of physical variables characteristic for vertical mixing and stratification such as temperature and salinity, has been tested carefully and proved to give very reliable results with high correlation to observations. Oxygen modeling was successfully added and preliminary model outputs showed good agreement with measurements. A phosphorus submodel is under development and will shortly be implemented. An additional model has been derived that predicts minimum oxygen concentrations in the deep water of fjords and assesses the importance of different physical and biogeochemical parameters for hypoxia. In conclusion the model simulations revealed that the coastal monitoring program at the Swedish west coast are not sampling frequently enough to target hypoxia and deep water exchange events in the fjord and that wind patterns along the coast are very important for in- and outflows over the sills.

4.1.3.5.3 Baltic Sea reactive biogeochemical modeling

Models were developed to investigate benthic cycling of redox sensitive elements in environments subject to hypoxia. The overall goal was to investigate how the pathways of organic matter degradation and biogeochemical fluxes across the sediment-water interface respond to changing oxygen concentrations. Most of the work focused on the seasonally-hypoxic HYPOX target site in the southwestern Baltic, the Boknis Eck site in Eckernfoerde Bay. The observational data were obtained from monthly sampling and additional laboratory experiments were used to constrain the model. The data set included geochemical pore water profiles, sediment- water fluxes (dinitrogen, ammonium, nitrate, nitrite) and bioirrigation data from core incubations. A sensitivity analysis was performed on how the sedimentary nitrogen cycling

changes as a function of bottom water oxygen levels. The model results show excellent agreement with observations and provide a general mechanistic framework for interpreting the existing knowledge of nitrogen turnover processes and fluxes in continental margin sediments, as well as for predicting the types of environment where these reactions are expected to occur (Dale et al. 2011).

4.1.3.5.4 Site independent / generalized modeling studies
The mathematical equations for the transport-reaction modeling of 1D, 2D and 3D oxygen fields in sediments as a consequence of bio-irrigation were systematically investigated using the open source software R (Meysman et al. 2010). All modeling tools developed prior and during HYPOX available to consortium members and others (via open access R site; http://cran.r-project.org/). A combined experimental and modeling study of surface-subsurface flow in sand ripples was carried out together with modelers from the University of Austin in Texas, USA. The study has strong implications for fluxes of oxygen and other solutes in permeable sediments exposed to hypoxia (Janssen et al., in press).
A model investigation was carried out to assess the relative importance of climate forcing versus nutrient loadings on the development of hypoxia in temperate coastal systems (contribution to report D2.1; (will be available soon at http://www.hypox.net/front_content.php?idcat=399&idlang=19, section 'documents'). The role of the different drivers on the evolution of hypoxia was investigated using a 1D coupled physical-biological model (a pelagic 1D turbulence k-epsilon model, a pelagic ecosystem model, and a benthic diagenetic model). The model is calibrated for the Oyster Grounds (North Sea) but the model approach is generic, allowing to assess both the impact of changing climate forcing and nutrient loadings on hypoxia in stratified coastal ecosystems.

4.1.3.5.5 Use of simulations and statistical tools to advance Eddy Correlation measurements
The relatively novel Eddy Correlation (Eddy Covariance) method to quantify benthic fluxes of oxygen and potentially also other solutes (e.g., sulfide) has a strong potential to assess the role of sediment oxygen demand for hypoxia development in bottom waters. However, data analysis and interpretation is still under debate. HYPOX partners took part and were involved in the organization of several workshops on the Eddy Correlation method. The software package ECDiagnostics was developed in HYPOX for the processing of oxygen Eddy Correlation data. The software is written in the open source framework R and produces diagnostic documents providing flux calculations, statistics and quality indicators. The R software has been distributed for beta-testing among HYPOX partners and a publication is in progress. In parallel a 2-D k-epsilon model of the benthic boundary layer was developed within the COMSOL Multiphysics software environment to describe the influence of non steady state conditions in the bottom water (i.e., current velocities and solute concentrations) on bottom water fluxes determined by means of Eddy Correlation measurements. The study revealed that Eddy Covariance measurements of oxygen fluxes can be heavily biased by these transient conditions. Based on the obtained results it is possible to estimate the error that is potentially introduced.

4.1.3.6 EXISTING AND FUTURE IMPACTS OF HYPOXIA ON ECOSYSTEMS
Based on the findings from the observational work, investigations of past hypoxia and modeling efforts that are described above the existing and potential future impacts of hypoxia on aquatic ecosystems were evaluated. To meet this objective an understanding of the physical processes behind the formation of hypoxia at the different target sites had to be gained in parallel to the study of biological processes, nutrient cycling, and oxygen dynamics. This combined effort was crucial for a proper identification of drivers of oxygen deficiency. Based on the knowledge of the drivers, the impact of hypoxia on ecosystems was assessed including spatial as well as temporal aspects. This was a crucial step in order to understand the temporal evolution of hypoxia effects and to be able to classify ecosystems with respect to drivers, pressures, impacts, and responses.

Combining existing knowledge and with new findings from investigations at the different sites and numerical studies, an interdisciplinary understanding of the drivers of oxygen depletion, pathways of ecosystem decline and recovery, and impacts of hypoxia on ecosystem goods and services was developed. In this context ecosystem function describes also changes with respect to biogeochemical conditions and redox changes due to changes in oxygen availability. The obtained knowledge on hypoxia drivers and consequences represented an important prerequisite in order to adjust monitoring strategies to the specific requirements of the respective ecosystem – within HYPOX as well as for future monitoring attempts.
A first step towards these objectives was the compilation of existing information on hypoxia characteristics and the impact on ecosystems at the different target sites. The collected information was summarized in report D3.3 'Compilation of existing data on effects of hypoxia on ecosystems at target sites' (http://metaworks.pangaea.de/download.php?fileid=146). At a later state of the project, a similar overview was produced, this time including information obtained during the project. Again, a report was produced (D3.4 'Report on ecosystem function decline due to hypoxia and recovery'; http://metaworks.pangaea.de/download.php?fileid=395).

Starting already at the kick off meeting several workshops on impacts of hypoxia on ecosystems were carried out. A main objective of these workshops was the development of conceptual models listing the most important driving forces, pressures, impacts, and ecosystem responses as well as their interdependencies for the respective target sites. Graphical representations of these conceptual models are part of report D3.1 'Report on drivers / mechanisms of hypoxia / anoxia and their spatial and temporal occurrence' (will be available soon at http://www.hypox.net/front_content.php?idcat=399&idlang=19, section 'documents').
During a final 4 day workshop, partners from most HYPOX institutions drafted an overview manuscript synthesizing the most important knowledge obtained in the project that will be submitted for publication in Biogeosciences soon after the end of the project (Friedrich et al., in prep.). An overview of the content of that manuscript was already presented at two international conferences (http://meetingorganizer.copernicus.org/EGU2012/EGU2012-9136.pdf; http://www.pices.int/publications/presentations/2012-Climate-Change/Yeosu-2012-presentations.aspx, session 8). Another important product is a report on hypoxia impacts on ecosystems with a strong focus on biogeochemistry and large scale element cycling (D3.2 'Report on future impacts of hypoxia on ecosystems and their goods and services'; available soon at http://www.hypox.net/front_content.php?idcat=399&idlang=19, section 'documents').

4.1.3.7 KNOWLEDGE BASE ON OXYGEN DEPLETION: DATA SHARING, STANDARDIZATION AND INTEROPERABILITY

In order to turn the monitoring results and the other data obtained in HYPOX into useful and accessible information large efforts were undertaken to enable a regular and reliable flow of data to the data archive and the data portal. This included HYPOX data as well as available data from other sources. For the monitoring results, special emphasis was on comprehensive descriptions of the data going back to the individual sensor and the provision of data quality descriptors and instrument standards on calibration and methodology. All that information was collected and added as metadata to the individual sensor data. HYPOX data management tasks encompassed the complete observation data life cycle, including data capture, processing, quality assessment and quality control, archiving and dissemination, compilation and publication of regular and reliable data products. Furthermore a functional sensor registry and interoperable data collection architecture was designed and it was assured that HYPOX data management and corresponding infrastructures were compliant with ISO / OGC standards and with the principles of the Global Earth Observation System of Systems (GEOSS). Conformity with agreed standards and connection to interdisciplinary earth observation initiatives was identified as an important requirement to facilitate access by potential users. To support GEOSS, HYPOX collected a large amount of hypoxia-related data, linked different HYPOX observatories to GEOSS, and

pioneered in the testing and definition of common standards and protocols for oxygen observation and sensor calibration. Once GEOSS is fully operational the collected information and description of available services will be made available to the public through the 'GEOSS common infrastructure' – a set of services and archives that helps to search for data and results of past and ongoing earth observations.
Before observational work started existing data from HYPOX target sites was compiled by the different partners (see above). The incoming legacy data were used as a first case study to establish the data flow from partners to the data archive and the data portal and to implement data management practices and policies. To facilitate data upload of legacy data an online collaboration tool (panMetaWorks; http://metaworks.pangaea.de/) was adopted for HYPOX for online submission of data sets. A report on these issues including an inventory of the collected legacy data was prepared already in the first year of the project and presented to the project partners at the first annual meeting (D5.1 'HYPOX data management plan and policy and catalogue of relevant legacy data sets'; http://metaworks.pangaea.de/download.php?fileid=148)
Semi-automatized data retrieval from the two cabled observatories (Loch Etive and Koljoe Fjord) to the Pangaea data archive and the HYPOX data portal was established. This included the development of Software components (Sensor Observation Service (SOS) and SOS clients) that implement standards of the Open Geospatial Consortium (OGC) in compliance with GEOSS. The SOS is a web service that offers standardized interfaces to collect information about instruments and to retrieve data produced by those instruments. The data is being offered using the OGC observations and measurement (O&M) protocol. The first SOS client regularly connects to the SOS and request data from it. The client than automatically conducts all work necessary to produce the files required for data import into the data archive PANGAEA. A second SOS client is used to request near-real time data from the SOS and graphically display it on the HYPOX portal page. The cabled observatories were set up to be queried with OGC/SWE compatible SOS standard interfaces which enable these observatories to provide standardized real-time access to their data. All components implement OGC SWE ('Sensor Web Enablement') standards and provide a significant contribution to GEOSS. The observatory systems in Loch Etive and Koljoe Fjord served as platforms to test new data access concepts based on OGC SWE. This standard is highly suited for ocean observation applications as it is able to handle the complexity and diversity of ocean data collection systems. This standard is also recommended by GEOSS but has only been implemented in a few cases within ocean sciences so far. HYPOX is providing crucial feedback to allow for a widespread introduction of this class of standards into ocean observation systems. Sensor Observation Services from both cabled observatories were registered at the GEOSS services registry.
More than 250 data sets that have been collected by the different observatories and during HYPOX field campaigns have been curated, archived, and made available through the HYPOX data portal (http://dataportals.pangaea.de/hypox/). An overview of the uploaded data sets is found in table 4.2.A2 as well as in the table 'data generated in HYPOX' in section 4.1.6. The data portal was created already in the first year of the project and has been continuously refined and enriched with information on target sites and the monitoring activities carried out. Extended functionalities were implemented and include plotting functionalities as well as the possibility to display near real-time data from the two cabled observatories (e.g., http://dataportals.pangaea.de/hypox/sosclient/chart.php?id=22&client=koljoefjord_seaguard).
The data portal further includes a GeoRSS feed that is basically a GML (Geographical Markup Language) enriched news feed, which shows the latest HYPOX datasets and their coordinates. This GeoRSS feed was successfully added as a service to the Compust GEOSS portal (http://geossregistries.info/geosspub/service_details_ns.jsp?serviceId=urn:geoss:csr:service:urn:uuid:5e3ce24e-4434-4781-bd8e-be7a22dfa652).
A workshop on the HYPOX data portal and on HYPOX contributions to GEOSS) was held at the final project meeting. Presentations and discussions held during this workshop were compiled as a report (D5.3 'Status report of the HYPOX data inventory, and on HYPOX data

management procedures as contribution to the GEO work plan activities (GEO 2007) including concepts, schemes, and established workflows within observatories and archives'; http://metaworks.pangaea.de/download.php?fileid=397).
The efforts towards the implementation of standardized and interoperable data handling and data provision represent a major contribution to promote GEOSS and to strengthen Europe's visibility in the GEO community. In addition, HYPOX contributed to GEOSS by many other means. These activities are described in the following part (Potential impact of the project).

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4.1.4 Potential impact and main dissemination activities and exploitation results

4.1.4.1 POTENTIAL IMPACT AND WIDER SOCIETAL IMPLICATIONS

One of the major findings during the lifetime of HYPOX was that the general public as well as decision makers have been highly interested in the findings of the HYPOX project. In particular residents who learned about monitoring activities in close by waters were very positive about the established facilities and even offered their support to ensure continuous operation. There is a natural curiosity to learn about the environmental issues and to ensure the conservation of the ecosystem. Within HYPOX public outreach activities have been playing a significant role and as the focus of research is immediately recognized as of high importance for judging the environmental conditions HYPOX has been successful in producing an impact with wider societal implications.

With the foreseeable growth in offshore activities in the next decades there will be a strong demand in carrying out baseline studies and in monitoring of any changes of the affected freshwater and marine environments. Currently a strong interest in exploring natural resources in the Arctic has developed and some countries and non- governmental organizations are concerned about letting these activities evolve without proper environmental monitoring. Projects like HYPOX are able to provide essential pieces to a conclusive observing strategy to ensure sustainability of the envisaged activities. Within HYPOX a number of observing strategies have been explored and therefore an expertise has been built up that can be used for any oxygen observing system either in closed waters or the open sea. Through the continuation of observatory sites as for instance Loch Etive and Koljoe Fjord Points of Contact for consultation will endure well beyond the lifetime of the project.

Strongest societal relevance and impact was immanent to the project through contribution to earth observation and to the societal benefit areas of the Global Earth Observation System of Systems (GEOSS). The impacts achieved are in line with the main targets of FP7 activity 6.4 ('Earth observation and assessment tools for sustainable development'), and, more specifically in Activity 6.4.1.2 'Cross-cutting research activities relevant to GEO'. HYPOX supported GEOSS through contributing to individual GEOSS tasks and help in further fostering the GEOSS Common Infrastructure. Therefore the vision for GEOSS was fully embraced by HYPOX in particular to support the establishment of an infrastructure for a comprehensive and sustained Earth observations and information system.

HYPOX activities have been aligned to address some of the strategic targets of GEOSS i.e. to assist in the provision of timely, quality long-term global information as a basis for sound decision making. This will enhance the delivery of benefits to society in the following initial areas [GEOSS Strategic Targets Document 12 (Rev1), as accepted at GEO-VI, Nov 2009]:

- Understanding environmental factors affecting human health and well-being
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change
- Improving the management and protection of terrestrial, coastal, and marine ecosystems
- Understanding, monitoring, and conserving biodiversity

Data acquisition, processing, and dissemination in HYPOX were following the principles and recommendations of the GEOSS initiative. The applicability of proposed common standards for data formats and handling has been excessively tested and fed back to GEOSS and best practices in the field of oxygen observation (e.g., with respect to sensor calibration) have been developed and proposed to the ocean observation community. HYPOX also strongly engaged in initiatives to promote visibility and acceptance for GEOSS. On the long run, HYPOX impact will be strongly related to future GEOSS achievements. Through the continuation of the work started within HYPOX in other project like for instance the proposed project COOPEUS (lead by MARUM at Uni-HB and currently under negotiation with the EC) and similar national and European initiatives where HYPOX partners are strongly involved in an enduring impact on future observing programs can be foreseen.

HYPOX strongly improved capacities for monitoring and predicting oxygen depletion by carrying out oxygen observations at sites which are threatened by oxygen stress and / or global change, but were so far lacking adequate monitoring capacities. HYPOX efforts resulted in knowledge for the prediction of future conditions of water bodies. This is essential in order to propose measures for the prevention of further oxygen depletion at sites were drivers are identified as manageable. Reliability of the predictions was improved by investigating the role of the sediments and benthic fauna in addition to water column monitoring. HYPOX helped to constrain uncertainties on the influence of climate change and eutrophication on the oxygen content of a wide range of aqueous environments. Hypoxia monitoring - until now largely neglected in the observing and monitoring programs - was implemented and promoted as an essential element in ocean observation. Improved monitoring strategies have been developed and applied to target ecosystems. The appropriate technologies and sensors have been selected and efforts were made to assess and improve their performance and reliability (e.g., by development of calibration procedures and addressing issues of biofouling). Depending on hypoxia characteristics, a large variety of different platforms were used and quality control measures as well as a reliable and standardized flow of data were established. Observations were transformed into scientific results and knowledge with strong support from numerical modeling and data assimilation efforts that represented a key component of the project. The impact obtained by HYPOX will exceed the lifetime of the project as the obtained knowledge will provide a strong and valuable input for future oxygen observation attempts.
In situ oxygen monitoring was carried out at all proposed target sites in Europe's open and coastal seas, in land locked marine systems (including fjords, lochs, lagoons) as well as freshwater systems (lakes). Additional observations were obtained from the open Black Sea Basin as well as from Eckernfoerde Bay in the shallow western Baltic. HYPOX addressed interactions with all earth system components and as well as their contributions to oxygen depletion in water bodies. Quantification of oxygen uptake and consumption rates in HYPOX links the aquatic realm with the connected solid and gaseous earth system components. Investigations carried out in land locked water bodies directly connected to the impact of terrestrial processes on hypoxia at these sites. Legacy data from all sites including long term data series were evaluated to identify the key parameters driving oxygen depletion in the different ecosystem and to decide on appropriate monitoring strategies. Data obtained from observatories and dedicated field campaigns during the project were used to assess drivers of oxygen depletion as well as consequences for the ecosystems. A key component of this analysis was the employment of modeling tools that were developed and tested and that took the role of biogeochemical processes as well as atmospheric and terrestrial components acting on the ecosystems into account. Furthermore the models added predictive capacities to the investigations that allowed to test hypotheses on the impact of global change and pollution on oxygen depletion. This interdisciplinary approach strongly improved current observation capabilities for the target ecosystems and will provide a large impetus and provide invaluable know-how for future oxygen monitoring in European waters.
By quantifying the oxygen content in aqueous environments and its temporal changes, HYPOX directly contributed to the prediction of the resulting impact on marine ecosystems, biodiversity and hypoxia-related biogeochemical processes. HYPOX observations provide quantitative inputs for predicting the external forcing processes today and in future. This knowledge as well as the modeling expertise gained in HYPOX will continue to serve as a basis for correct oxygen depletion forecasts. This in turn contributes to the planning of appropriately tailored adaptation measures to climatic change. HYPOX activities, especially investigations at previously eutrophied systems at the northwestern shelf and in Swiss lakes, provide valuable information concerning the extent to which a reduction of anthropogenic nutrient input leads to an alleviation of the oxygen depletion problem. This knowledge is strongly needed for cost benefit analyses in order to optimize mitigation measures. By investigating hypoxia in aqueous environments in conjunction with hypoxia impacts on animal communities and biogeochemical processes

HYPOX helped to predict the future impacts on marine ecosystems, including biodiversity and related biogeochemical feedbacks. The work carried out in HYPOX represents a milestone towards a knowledge base on oxygen depletion that provides European policy and decision makers with the necessary information to optimally guide the overall strategies for sustainable development and the successful planning and negotiation of internationally binding treaties. Substantial progress was made concerning the interoperability of observation systems for oxygen depletion in different systems. A standardized data flow to a permanent data repository and the web-based HYPOX data portal was established and open access is provided to all metadata and numerous data sets already now and will include all HYPOX data sets at the latest three years after upload. This includes the semi-automatized handling of the observation from the cabled observatories as well as a standardized web-based upload procedure to collect data and metadata from the large variety of moored and ship based observatories as well as the data collected during targeted field campaigns carried out in HYPOX. Managing and merging the huge range of observations of different origin was successfully carried out by the World data center WDC-Mare in conjunction with the data repository and data publishing network PANGAEA which also services a wide range of other interdisciplinary EU projects. The solid data base and knowledge platform created by HYPOX contributes information needed to evaluate the status of hypoxia at the target ecosystems and its potential future impact on the ecosystems. The HYPOX web site not only supplies the measured data through its data portal but also includes the full suite of knowledge and higher level information on hypoxia causes and consequences gained during the project (e.g., reports and presentations). Dedicated dissemination activities and strong links with GEOSS assure the visibility of HYPOX in the field of earth system observation and raise the chance that future hypoxia monitoring will add to the obtained knowledge base. This will further increase its value for decision making processes that are needed in order to keep ecosystems in healthy conditions, to allow for their recovery, and to avert catastrophic events like fish mass mortalities.

4.1.4.2 EXPLOITATION OF THE RESULTS

4.1.4.2.1 Improvements of hypoxia monitoring capacities accomplished within HYPOX and benefit for future monitoring efforts

The projected increase in oxygen depletion will increase the demand for state of the art oxygen monitoring in the future. Oxygen conditions represent a key parameter for the assessment of the environmental status of ecosystems. More observations of oxygen and other environmental parameters in coastal and continental shelf areas will be soon needed in the scope of the European Marine Strategy Framework Directive. This will enlarge the impact of HYPOX results and the need for the knowledge on appropriate monitoring strategies obtained in HYPOX. HYPOX represents a pilot mission towards the implementation of a hypoxia observation network in European waters. A significant part of the HYPOX monitoring capacities will be sustained also after the lifetime of the project. Examples are the cabled observatories deployed in Koljoe Fjord and Loch Etive which will continue operation and data provision to the archive and the data portal (in case of the Loch Etive Cabled Observatory LECO that suffered from a lightning stroke a redeployment will take place after repair). Likewise, deployments of the profiling mooring GODESS (Gotland Deep Environmental Sampling Station in the Baltic Sea) will most likely continue in the future. Apart from the different HYPOX products / reports that are all made available through the HYPOX web page, maintained monitoring activities will assure that Points of Contact for consultation will endure well beyond the lifetime of the project. The main contribution to future hypoxia monitoring, however, is represented by the knowledge obtained on appropriate monitoring strategies for different ecosystems. This includes the identified scientific requirements and knowledge gaps as well as technological aspects that have to be addressed in the future in order to successfully describe hypoxia causes, characteristics, and consequences at a given site. HYPOX investigations clearly showed that standard monitoring approaches (infrequent water column sampling at fixed stations) are inadequate to tackle the

crucial aspects of hypoxia in a comprehensive way. Aspects missed by standard approaches include resolving of (1) temporal and (2) spatial scales of hypoxia, (3) addressing specific hypoxia thresholds of different ecosystem components (e.g., benthic fauna vs. microbial conversion pathways), (4) addressing hypoxia drivers, and (5) addressing hypoxia consequences:
Prerequisite of appropriate monitoring is the availability of adequate technologies and technological expertise. In HYPOX, substantial progress was achieved concerning the development of new technologies and the adaptation of existing technologies to specific monitoring requirements. Examples are found in sections 4.1.3.2 'Improving and integration of oxygen observation capacities' and 4.1.3.3 'Assessing oxygen depletion in shelf and open seas and land locked water bodies'.
In addition to knowledge obtained concerning monitoring strategies and technologies HYPOX also demonstrated the benefit of combining observations and simulations. This contributed to a better understanding of the processes underlying hypoxia development, to distinguishing natural variability from manageable, anthropogenic effects, to the generalization of findings and gaining of predictive capacities, and to the optimization observational strategies. Another substantial improvement of monitoring capacities achieved in HYPOX concerns the implementation of a regular and reliable flow of data from observatories to the data archive and the data portal. Furthermore, HYPOX ensured compliance with the Global Earth Observation System of Systems (GEOSS) and common ocean observation standards and established links to GEOSS. Operational data flows as well as connection to global earth observation initiatives will be a crucial step for any future monitoring activities and will again invoke a demand for knowledge obtained in HYPOX.

4.1.4.2.2 Use of HYPOX results and knowledge by HYPOX partners
The primary use of the results obtained in HYPOX will be to add to the scientific output of the respective partners in the form of peer reviewed publications and contributions to international conferences. Already within the lifetime of HYPOX numerous talks and publications were provided to the scientific community and many more will follow soon (table 4.2.A1 and 4.2.A2, as well as tables 'publications published and in press' and 'submitted and planned publications' in section 4.1.6). By mentioning of the funding sources in the presentations and publications this likewise advertises the engagement of the European Union in the field of ocean observation. Publications and contributions to conferences will improve the scientific profile of the project partners and improve prospects of success for future project applications.
The huge amount of data collected in HYPOX calls for a continuation of analysis efforts which will also result in further cooperation, project applications, publications, and will continuously add to the visibility of HYPOX in the scientific community. Some examples:
1) The time-series data obtained at the northwestern Black Sea shelf off Romania will be assimilated into the Black Sea model that is run by ISMAR-CNR. Modeling of the oxygen dynamics on the shelf floor is envisaged with Eawag, Department of Surface Waters.
(2) Based on oxygen observations obtained in the Bosporus outlet area and at the Crimean shelf further modeling work will be carried out at HZG / GKSS. Main objectives will be a better understanding of the hydrophysical mechanisms of the observed oxygen oscillations and the contribution of biogeochemical processes in Bosporus plume waters to the Black Sea nitrogen cycle.
(3) The data collected in Eckernfoerde Bay are used at IFM-GEOMAR to predict the effect of seasonal hypoxia on benthic nutrient fluxes. This will help interpret water column data (e.g., oxygen and nutrients) measured at 'Boknis Eck' in Eckernfoerde Bay but also in other areas.
(4) Sediments, collected in the Gotland Basin will be used by IFM-GEOMAR to investigate the redox-sensitive cycling of Uranium and Molybdenum as a proxy of paleo oxygen variability.
(5) Knowledge on fjord exchange processes obtained by SAMS will be expanded to the entire western Scottish coast. Modeling of local hydrodynamics at the entrance of Loch Etive was already used for the design of the monitoring component in the international sea-bed carbon

dioxide release project. In addition to physical processes the model will also be used to investigate biological and environmental issues (e.g., prediction of harmful algal blooms and dispersal of fish parasites).
(6) Hypoxia expertise at NIOO-KNAW / NIOZ is applied to North Sea ecosystems that were not covered by HYPOX. This takes place in a recently started project on coastal hypoxia in the North Sea area (funded by the Darwin Center for Biogeociences / Dutch Science foundation).

4.1.4.2.3 Potential use and users of the data and knowledge results outside the HYPOX consortium

Oxygen represents a key variable for many ecosystems. Oxygen availability governs the suitability of a given ecosystem as habitat for any higher live from the tiniest work to the largest fish. As an example, effects on benthic fauna have been demonstrated by investigations carried out along oxygen gradients at the HYPOX target sites in the Black Sea. Likewise, the presence or absence of oxygen has a vast influence on pathways and rates of biogeochemical processes with prominent implications for large scale element cycling including the possible release of nutrients, toxic substances, and greenhouse gases to the environment. Effects on sediment and water column biogeochemistry have been clearly shown by HYPOX investigations at several sites (e.g., Bosporus and Swiss Lakes water column, Gotland Basin, Eckernfoerde Bay and Crimean Shelf sediments). On the other hand, oxygen conditions and oxygen uptake integrate a large variety of biological as well as physical processes and may used as a general indicator for status and trends of aquatic systems. Data on oxygen depletion in European waters are thus highly significant for a large variety of applications including the assessment of Ecosystem status in connection to the European Marine Strategy Framework Directive. Possible applications that could benefit from HYPOX results and future monitoring that is based on HYPOX knowledge (1) assessment of ecosystem status (identification of baseline, observation of trends, comparison with past conditions), (2) identification of relevant sites and proper strategies and technologies for hypoxia monitoring (3) identification of risks for ecosystems (e.g., deteoriation, development of dead zones, loss of biodiversity or fishery yield, biogeochemical processes releasing toxic substances, e.g., sulfide), (4) identification of the need for mitigation and restoration measures (5) identification of appropriate mitigation and restoration measures and evaluation of their effectiveness, (6) assessment of the vulnerability of ecosystems to anthropogenic activities (e.g., nutrient release (eutrophication), exploratory activities) and climate change.
Over the time course of the project a list of possible users has been compiled, including projects and initiatives dealing with environmental issues, stakeholders, governmental bodies, and non-governmental agencies. The list is included in part 4.1.6 of the report. Some specific benefits and users of HYPOX data and knowledge are listed below as examples of the broad applicability.
(1) Data obtained at the deep-sea observatory HAUSGARTEN will feed into decision-making processes of the Arctic Monitoring and Assessment Programme (AMAP), the Arctic Ocean Sciences Board (AOSB), the International Arctic Science Committee (IASC), the European Polar Board (EPB) and other, related international organizations.
(2) Time series of oxygen and associated oceanographic parameters recorded at the North-western shelf will help to identify hypoxia drivers (currents, temperature, oxygen utilization during decomposition of organic matter, stratification, climate variability) and to assess the ecosystem's recovery from past eutrophication, the potential for recolonization of former 'dead zones', the state of the habitat for bottom-dwelling fish, and the impact of hydrocarbon exploitation on the northwestern shelf.
(3) Observational data obtained in HYPOX have already been incorporated in a GIS data base for the Bay of Sevastopol and other costal areas of Crimea. The results have already been delivered to the local community, used and endorsed by local stakeholders (http://wiki.iczm.org.ua/en/index.php/Dissemination). The received biological data have been used in other EU projects (CoCoNet, PERSEUS), National programs of the Ukrainian National Academy of Sciences and other scientists outside the HYPOX consortium (e.g., Marine Biology

and Ecology Department at the Fisheries Faculty at Sinop University, Turkey, Shirshov Institute of Oceanology (RAS), Moscow, Russia).
(4) Results obtained in Eckernfoerde Bay at station Boknis Eck provide important insights into the contribution of sediments to bottom water hypoxia (directly and via feed back loops). Boknis Eck should be considered as a natural laboratory for studying hypoxia and the potential impact on benthic biota and foodwebs. This type of information would be invaluable for marine authorities, ecosystem modelers and NGOs.
(5) Data from the profiling mooring will complement IOW's long term monitoring program data. In the future the data are expected to be incorporated into the HELCOM database to which all IOW monitoring data are contributing. This will fosters the use of the data by researchers interested in the Gotland Basin region.
(6) The identified combination of natural and man made conditions that results in inflow events and deep water renewal of Loch Etive provides the means to regulate oxygen conditions at depth to some extent. Specifically, short term reduction of freshwater inflow through the River Awe hydro-electric system would be needed in times of spring tides and favorable winds. This would be possible by joint efforts of local authorities and energy suppliers (Scottish and Southern Energy) based on on-line monitoring data flow from equipment deployed in the deep-basin and at the entrance of Loch Etive, similar to one deployed within the HYPOX project.
(7) The BOX project in By Fjord in the Koljoe Fjord / Orust-Tjörn fjord system shows that active oxygenation of the deepwater in anoxic fjords decreases the leakage of phosphorus from the sediments. If these efforts are continued and extended into other fjords the expertise gained in HYPOX would be valuable to identify appropriate strategies for monitoring of the efficiency of the oxygenation measures.
(8) The Koljoe Fjord observatory leaders have been approached by a state organization to find out about the possibility to monitor the impact of dumping of excavated sediment into the fjord. In this case a continuous, online access to relevant parameters is of great importance to have control over the dumping process and the parameters that characterize the status of the fjord water.

4.1.4.2.4 Interactions with companies

Close contacts were established to professional suppliers of instruments and services in the field of oxygen and ocean observation throughout the lifetime of the project. The strong interest in ocean observation efforts in European waters of the companies working in this field is obvious from the letter of recommendation that was provided in the preparatory phase by the Norwegian company Aaderaa Data Instruments (AADI) and the commitments specified therein. Another clear indication of the relevance of the project work to companies was the positive response of companies to the invitation for an oxygen sensing workshop held at the second annual meeting in Horw, Switzerland. Representatives of several international companies from Germany, Switzerland, Denmark, Norway, and Japan participated in the workshop and several others sent posters and printed information material. Companies did profit from close contacts to HYPOX scientists not only through the revenue of products supplied to the project members but also with respect to knowledge transfer and the identification of innovation potential and future markets in the field of ocean observation. Some specific examples of fruitful interactions of HYPOX with SMEs are described below.
(1) Anderaa Data Instruments (AADI, Bergen, Norway) used the Koljoe Fjord observatory as test bed for the recently developed sensor strings as well as for the novel optical carbon dioxide sensor. AADI further actively took part in the development of the closed vessel calibration procedure within HYPOX. A similar system was already installed at AADI and will serve for the calibration of optical sensors for oxygen and carbon dioxide.
(2) Develogic (Hamburg, Germany) was involved in the setup of HYPOX cabled observatories. Thanks to this involvement Develogic is now able to deliver electronic components to provide

real-time data access to observatory data based on cellphone services. An important argument for customers is the fact that the system is field proven.
(3) Institute for Marine Resources GmbH (IMARE Bremerhaven, Germany) was subcontracted by AWI to design a mooring for long-term observation of oxygen in shallow waters based on off the shelf underwater equipment and to provide quality control of the time series data obtained at the northwestern Black Sea shelf. The obtained technical solution proved successful and could potentially be established and marketed as low-cost standard solution for oxygen monitoring, e.g., in mussel farms.
(4) NKE electronics (Hennebont, France) will benefit from the knowledge obtained within HYPOX on float operation in 'seafloor resting mode'. This will help NKE to keep its position in the world market of Argo floats.
(5) Antifouling experiments on oxygen optodes by means of automated chlorination continued at Ifremer within HYPOX. These technologies have a substantial marketing potential. Strong sensor biofouling observed in HYPOX cabled observatories demonstrated the need for antifouling measures for successful oxygen monitoring in coastal areas. Discussions were started about a transfer of technologies between Ifremer and AADI.
(6) Tecnomare-ENI has been collaborating with INGV for many years to develop systems for long term monitoring of near seafloor processes. An example of such instruments is the Gas Monitoring Module (GMM) that was deployed in HYPOX to monitor oxygen and methane variations in Katakolo Bay. A similar platform could serve as a standard instrument for the monitoring of many different kinds of seafloor phenomena. Similar cooperations were established in HYPOX with the sensor manufactures FRANATECH (Lueneburg, Germany) and CONTROS (Kiel Germany) that provided methane sensors for investigations in HYPOX.

4.1.4.2.5 Involvement of HYPOX partners in future hypoxia monitoring and continuation of monitoring efforts started in HYPOX
As mentioned above, several of the oxygen monitoring activities started in HYPOX (cabled observatories in Koljoe Fjord and Loch Etive, profiling observatory in the Gotland Basin) will be followed up also in the future. In addition, continuous oxygen measurements at the HAUSGARTEN observatory will be continued for an indefinite period on national as well as international funding (if available). Initiatives integrating physical oceanographic work across Fram Strait and the LTER (Long-Term Ecological Research) site HAUSGARTEN in a larger, preferably cabled, submarine infrastructure are currently under evaluation by the HGF (Helmholtz Association of German Research Centres) and the German BMBF (Federal Ministry of Education and Research). Monthly water column monitoring in Eckernfoerde Bay by the Boknis Eck Time Series project is established and will be ongoing. As a follow up of biogeochemical investigations carried out in HYPOX the addition of a benthic monitoring program is currently under discussion. INGV and UGOT will continue joint efforts to investigate the significance of gas seepage as geogenic driver of oxygen depletion at the Ionian sea target sites.
Several of the HYPOX partners (e.g., AWI, Ifremer, IOW, INGV) were already strongly engaged in ocean observation activities before the start of the project. These institutions strengthened their profile with respect to hypoxia monitoring and will of course continue activities in this field.
The core expertise of most of the consortium was primarily centered around basic research in marine and freshwater environments. The experience obtained within HYPOX therefore opens an additional field of research for many of the groups involved. Several partners are planning to make use of these new opportunities. As a basis for future activities in this field all observatory leaders compiled funds needed for observations of oxygen and associated parameters as they were carried out at the different target sites. The figures are summarized in a table in section 4.1.6 and include the costs for the purchasing / constructing the observatories as well as funds

needed for five years of sustained observations. Below some specific examples of planned future ocean observation activities are provided.
(1) IFM GEOMAR and several other HYPOX partners seek to continue their research in the Baltic Sea within the EU BONUS program. Consortia are currently formed and more detailed planning is underway. Within the recently approved ROBOX project (HGF, National funding) the Baltic Sea will serve as a test site for sensors and platforms for the long-term in situ measurements of gases by in situ mass-spectrometry. Monitoring of bottom water oxygen dynamics is central to these activities. A cruise with R/V ALKOR to the Gotland Basin will be carried out in 2013 as a follow up of HYPOX to continue investigations of nutrient fluxes in response to bottom water oxygenation in the hypoxic transition zone.
(2) IBSS is aiming to extend the focus of its investigations of black sea fauna to ecosystem monitoring with special focus on the response of the benthic communities to anthropogenic pressures and climate change. Oxygen monitoring is identified as an essential component in local programs for investigation and protection of coastal environments and will be carried out by MHI in Sevastopol – a cooperation that proved extremely fruitful already in HYPOX studies at the Crimean shelf.
(3) ITU EMCOL and INGV are involved in EMSO and ESONET activities to establish a permanent cabled observatory for earthquake and environmental monitoring in the Sea of Marmara. Recently, ITU-EMCOL has submitted a proposal (MARDEP) to the Turkish authorities to apply for two fixed point observatories to monitor Mediterranean Sea water intrusions and the oxycline at the HYPOX target site in the Bosporus outlet area.
(4) UGOT will apply for funding to sustain the cabled observatory in Koljoe Fjord for a elongated period of time. Participation in HYPOX also facilitated the participation in upcoming proposals to the EU in the field of ocean observation and sensor development.
GeoEcoMar will purchase an oxygen- and possibly chlorophyll sensor equipped ARGO type float in the framework of the FP7 PERSEUS project to be used for Black Sea monitoring. Furthermore, the implementation of an early warning system for marine geohazards is planned which will include 5 buoys that will be equipped with oxygen sensors.

4.1.4.3 MAIN DISSEMINATION ACTIVITIES

A major component of the work carried out in HYPOX was dedicated to the transfer of the knowledge to audiences within and outside the scientific community. In agreement with the strong implications of hypoxia and hypoxia research for ecosystem goods and services and, hence, for society, activities were not restricted to dissemination of scientific results. Additionally, endeavors have been made to increase the awareness for the issue of oxygen depletion in aquatic systems also outside the scientific community. The main activities concerning the dissemination of the obtained results and the increase of awareness for hypoxia included (1) scientific publication and contributions to conferences and workshops, (2) contacts to media and other dissemination activities including the preparation of outreach products, (3) provision and maintenance of the project web site, and (4) networking with projects, initiatives, and knowledge platforms. An overview about these activities is given below.

4.1.4.3.1 Publications, conferences, and workshops

Numerous hypoxia-related studies were already published by project partners during the project lifetime, most of them in peer-reviewed journals (see table 4.2.A1 and the ‘publications published and in press’ table in section 4.1.6). A lot more publications are expected for the future (table ‘submitted and planned publications’ in section 4.1.6 lists some of them. A central project publication that is expected to foster the visibility of HYPOX in the scientific community is the planned project overview article to be published in Biogeosciences. The article will provide an overview of the HYPOX findings with respect to hypoxia characteristics at the different target sites, appropriate monitoring strategies as well as impacts and consequences of hypoxia for ecosystems (see above). HYPOX was well represented in international conferences and

workshops. Contributions included presentations and posters as well as invited talks and organization and chairing of topical sessions. An overview about the contributions of all partners is found in table 4.2.A2 as well as in table 'conferences, meetings, and workshops' in section 4.1.6. Several workshops that were open to non-project members were organized during the annual meetings. This included the modeling workshop and the Data portal / GEOSS workshop described above as well as an oxygen sensing workshop that took place during the second annual meeting. The sensing workshop focused on oxygen sensor technology and applications and brought scientists in contact with invited representatives from leading manufacturers of oxygen sensing devices. Most of the presentations held during that workshop as well as posters from manufacturers that couldn't join the workshop are found at http://www.hypox.net/front_content.php?idcat=399 in section 'Annual meeting 2011: Oxygen Sensor Workshop'.

4.1.4.3.2 Media contact and public outreach activities

HYPOX engaged in a lot of public outreach activities (see table table 4.2.A2 and table 'media contact and public outreach activities' in section 4.1.6). Categories of activities included informative meetings with policy makers, stakeholders, and civil society, public lectures for the interested public as well as school children, press releases, weblogs, podcasts, publication of popular science articles, interviews in newspapers, radio and TV programs including talk shows, science programs as well as TV shows for children. A lot of the outreach activities were centered around general information on hypoxia with a special focus on project activities (annual meetings, upcoming cruises, observatory deployments). A good example for the information of the public about project activities and their relevance for society are the efforts undertaken to inform the County Board, the regional community and school children about the services provided by the Koljoe Fjord cabled observatory.

In order to make policy makers, stakeholders, and the general public aware of the threats of hypoxia and the need for improved oxygen monitoring a project brochure as well as four two-page policy briefs ('Hypoxia briefs') were produced. The brochure provides information on the general issue of hypoxia and its link to global change and eutrophication, as well as on project focus and scientific approaches, and the members of the HYPOX consortium. The brochure is available online since spring 2010 (http://www.hypox.net/upload/infomaterial/brochure_hypox100114_Online.pdf). The policy briefs merge general information on different aspects of hypoxia with findings from the HYPOX project. The 'Hypoxia Briefs' are available online since Jul. 2012 and distributed through the project web page (section 'Policy briefs' at http://www.hypox.net/front_content.php?idcat=399). 150 hardcopies of the brochure as well as of the four 'Hypoxia Briefs' were distributed to partners, related projects, potential end users, and GEO task representatives. Brochure mailing took place in early summer 2010 while the policy briefs were sent around at the end of the project.

In early summer 2010 the Coordination Team launched an information article on HYPOX in "International Innovation", an annual produced by Research Media (www.research-europe.com). In addition to recipients specified by the HYPOX coordination team (partners, related projects, potential end users, and GEO task representatives), Research Media distributed the magazine to numerous people in science, industry, governmental as well as non-governmental institutions. An online version of the article is also available through the HYPOX web page (www.hypox.net/upload/infomaterial/hypox_international_innovation.pdf)

The HYPOX web site (www.hypox.net) was launched right away at the start of the project and updated and improved throughout the project. Project relevant images and films, news and project information and products (outreach material as well as deliverables / reports) were added to the media, news and information section, respectively. The media section is based on implemented Web 2.0 Services Picasa and YouTube. The HYPOX Picasa web album contains several hundred photographs from HYPOX activities. Video footage available in the media

section includes videos showing deployment of HYPOX observatories as well as other oceanographic instruments. Furthermore it includes underwater footage obtained with the manned submersible JAGO in the Black Sea during the HYPOX cruise with R/V MARIA S. MERIAN as well as short interviews with the HYPOX observatory leaders that introduce to the different target sites. The data portal described above is directly linked to the HYPOX web site and includes not only the links to the data sets but also description of sites (including links to the observatory leader's site introductions mentioned above), descriptions and images of observatories, as well as example plots of monitoring data and modeling results.

4.1.4.3.3 Linkages with projects and initiatives

Apart from scientific publications and contributions to conferences and workshops, networking with other projects and initiatives was carried out as more direct means to inform about HYPOX and to strengthen awareness for hypoxia and oxygen monitoring in the scientific community and connected domains. The main contacts established are mentioned below.

Contact to the ARGO float community was made by presenting an optode calibration procedure developed in HYPOX at the ARGO-oxygen meeting. Strong links to ESONET-EMSO-VISO and other projects and initiatives aiming to improve hypoxia monitoring in European waters were maintained and several project representatives joined the 2011 general assembly of the ESONET NoE. HYPOX partners further contributed to meetings of additional ocean observation and biodiversity initiatives, including Lifewatch, LTER, and ASPERA. Overview talks on HYPOX observatory activities were held at the final meeting of the FP7 project EuroSITES. Additional contacts made by HYPOX representatives included several other institutions and projects, e.g., the 'SCOR working group 128 on hypoxia', the 'Benguela Current Commission', the 'Ocean Obs' initiative, the 'Collaborative Research Centre on subsurface dissolved oxygen in the tropical ocean (SFB 754)'. HYPOX further interfaced with the EU project CLAMER (www.clamer.eu) and contributed to several CLAMER public outreach activities. A text on ocean deoxygenation and coastal hypoxia was provided as a contribution for the CLAMER synthesis report. Further linkages were built with other projects and initiatives to disseminate scientific as well as technological aspects of HYPOX. These included affiliations and contributions to EURO-ARGO (www.euro-argo.eu), the CORDIS Technology Marketplace (http://cordis.europa.eu/marketplace), LOICZ (http://www.loicz.org), Marine TT (www.marinett.eu), innovation seeds (www.innovationseeds.eu), WaterDISS (www.waterdiss.eu) and the Science for Environment Policy News Alert Service (http://ec.europa.eu/environment/integration/research/newsalert/index_en.htm).

Striking evidence for a successful project networking was the recruitment of four additional partner institutions towards the end of the first year of the project: (1) Laboratoire des Sciences du Climat et de l'Environnment at the Commissariat à l'Energie Atomique et aux Energies Alternatives, France, (2) Museum of Natural History / Leibniz Institute for Research on Evolution and Biodiversity at the Humboldt University Berlin, Germany, (3) MARE Interfacultary Research Centre, University of Liege, Belgium, and (4) Norwegian Institute for Water Research, Norway. Scientists from the affiliated partner institutions contributed to project meetings and scientific discussions but also to HYPOX studies and hence to the scientific output of the project.

4.1.4.3.4 Promotion of GEOSS and strengthening of Europe's visibility in the GEO community

Supporting GEO tasks within the running GEO Workplan (2009-12) has been one of the major goals of the HYPOX projects. As described in the DoW of HYPOX a number of GEOSS partners took over responsibilities in selected task groups. One major initiative was related to the GEO task ST-09-02 that deals with the integration of universities and research institutions into GEOSS (Promoting Awareness and Benefits of GEO). As part of this activitiy GEOSS workshops on ocean observation have been organized back to back to the IEEE OCEANS conference (Mai 2009).

The visibility of the HYPOX project in the GEO community was fostered by contributions to and participation in GEO meetings (see table table 4.2.A2 and 'conferences, meetings and workshops' table in section 4.1.6). The publication of an article on HYPOX in the GEO related online journal Earthzine (www.earthzine.org/2010/05/26/oxygen-monitoring-in-aquatic-ecosystems-eu-project-hypox/) added to the visibility of HYPOX in the GEO community.
Two GEO workshops have been organized with colleagues in the US to bring different stakeholders in the field together and come up with recommendations on next steps towards establishing GEOSS in ocean science (GEOSS Workshop XXVII 'Understanding the Integrated Ocean Observation System, including Sub-surface Sensors'), and XXXVIII 'Evolution of Oceans Observing Systems – Building an Infrastructure for Science'. One of the outcomes has been that agreement on the establishment of a GEO Community of Practice to allow for a better international coordination of existing and to be established observing infrastructures.
Four HYPOX services, each representing a metadata or data delivery service capable to comply with a GEOSS accepted standard, have meanwhile been registered at the GEOSS registry. These standardized services are linked to the HYPOX component.
HYPOX was engaged to introduce new ideas into the formulation of the new GEO Worksplan 2012-15. A new task (SB-01) emphasizing the role of ocean observations was phrased where an active participation of HYPOX partners is documented. A major component of this work will be helping to define best practices and standard processing methods to harmonize the data quality.
A close connection was established to EGIDA a project that is setup to coordinate earth and environmental projects to promote GEOSS (www.egida-project.eu). At the GEOSS workshop during the final HYPOX meeting a close collaboration between HYPOX and EGIDA was established. The brokering approach promoted by EGIDA appears to be the right concept to improve detectability and accessibility of ocean observation data. Agreement has been reached between project partners and representatives of EGIDA to support the demonstration of the EGIDA approach by making HYPOX core observational data available to the EGIDA services.

4.1.4.4 SOCIO ECONOMIC IMPACT

For the case of HYPOX, socio-economic impact is here defined as the benefits and costs that impact welfare and economic growth among the population in the regions where new observation infrastructures are established. The benefits and costs that should be taken into account in a socio-economic analysis are those that are generated directly by the project and relate to the objectives of stakeholders that relate to the project. In case of oxygen observations in HYPOX and in general, stakeholders include research institutions, state operated monitoring agencies like hydrographic offices, fishery organizations, tourism industry and companies involved in offshore operations. A good example relating to benefits and costs is connected to the HYPOX observatory in Koljoe Fjord. The observatory leaders have been approached by a state organization to assess the possible feasibility for the monitoring of the impact of dumping excavated sediment into the fjord. In this case a continuous, online access to oxygen and other relevant parameters would be of great importance to have control over the dumping process and the parameters that characterize the status of the fjord water. This example shows that HYPOX benefits can be directly related to the preservation of the environmental status of the monitored regions by providing the necessary information needed to adjust dumping operations in order to minimize the environmental impact. With respect to costs in that particular example access to online data from an observatory would probably save the customer investments of the order of several hundred thousands Euro for accompanying observations. In many cases, however, quantifications of benefits of observing infrastructures are not that straightforward but may still be highly significant to society. One example would be the increased production of hydrogensulfide in coastal waters under hypoxic conditions. This may lead to a smell nuisance with strong implications for recreational value and potentially harmful consequences to human health. Consequently an impact on tourism and also on the welfare of residents living close by can be expected but is not easily turned into benefits in terms of costs that were saved.

Socio-economic impact can also be measured by quantifying the increase of contractual research revenues based on HYPOX work and findings. This includes European, national, or research projects negotiated with private companies. Within HYPOX several companies were involved in developing and supplying adequate instruments and devices (see above), potentially improving their competitiveness on the marine technology market.

Five areas of socio-economic benefit to which the project significantly contributed are listed below. In brackets some links to other parts of the final report are provided where the HYPOX contributions to the respective areas are addressed in some detail. However, it exceeds the scope of this report to present a comprehensive quantitative analysis. Instead the main categories for assessing the socio-economic impact have been addressed in a more qualitative manner.

KNOWLEDGE. Example benefits: Publication of data sets through the publication network Pangaea, publications of scientific results in scientific journals (see tables 4.2.A1, 4.2.A2, and tables 'data generated in HYPOX', 'publications published and in press' and 'submitted and planned publications' in section 4.1.6'), value of the access granted to external researchers through the adopted open access data policy (see section 'Potential use and users of the data and knowledge results outside the HYPOX consortium')

DEVELOPMENT. Example Benefits: Technological output represented by the identified monitoring technologies and practices including novel approaches to handle the obtained data sets as well as calibration procedures developed and transferred to the ocean observation community (see section 'Improvements of hypoxia monitoring capacities accomplished within HYPOX and benefit for future monitoring efforts')

EDUCATION AND TRAINING. Example benefits: Graduates (masters and PhD level) trained in the observation infrastructure, and students using the infrastructure (see table 'HYPOX students' in section 4.1.6)

EMPLOYMENT. Example benefits: newly created jobs (researchers and non-research staff at project partner institutions, potentially employees in manufacturers in the field of ocean observation; see table 'HYPOX staff' in section 4.1.6 and section 'Interactions with companies')

KNOWLEDGE TRANSFER AND COLLABORATIONS. Example benefits: Collaborative projects building on HYPOX achievements and involving HYPOX partners, competitive national and international funding (see section 'Involvement of HYPOX partners in future hypoxia monitoring and continuation of monitoring efforts started in HYPOX')

4.1.5 Address of project public website and relevant contact details

www.hypox.net
All relevant contact details are provided on the project web site

4.1.6 Supplementary material promoting the work of the project

4.1.6.1 Project factsheet

EUROPEAN COMMISSION
European Research Area

EARTH OBSERVATION

HYPOX

AT A GLANCE

Title: In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies

Instrument: Area 6.4.1.2.,ENV.2008.4.1.2.1,FP7

Total Cost: 4.665.281 €
EC Contribution: 3.499.711 €

Duration: 36 months
Start Date: 01/04/2009

Consortium: 16 partners from 11 countries

Project Coordination: Antje BOETIUS and Felix JANSSEN, MPI, Bremen, DE
Christoph WALDMANN, Marum, Bremen, DE

Project Web Site: www.hypox.net

Key Words: Oxygen depletion, climate change, in situ water cycle monitoring, GEOSS, aquatic ecosystems, marine, freshwater, global ocean observation, eutrophication, biodiversity

THE CHALLENGE

All higher aquatic life depends on oxygen. It is, thus, an alarming finding that hypoxic (low oxygen) conditions in aquatic ecosystems increase in number, duration and extent due to global warming and eutrophication. Global warming will lead to degassing of oxygen, increased stratification, reduced deep-water circulation and changes in wind patterns affecting transport and mixing. Observed and projected increases in hypoxia (e.g., exponential growth of "dead zones") are accompanied by enhanced emission of greenhouse gases, losses in biodiversity, ecosystem functions and services such as fisheries, aquaculture and tourism. These drastic threats call for strong efforts to investigate and monitor present and past hypoxia in order to understand causes and consequences, and to be able to predict future hypoxia and its impact on ecosystem functions and services.

PROJECT OBJECTIVES

A better understanding of global changes in oxygen depletion requires a global observation system continuously monitoring oxygen and associated parameters at high resolution, including the assessment of physical mixing and of the role of the seafloor in controlling the sensitivity of aquatic systems to and recovery from hypoxia. Within HYPOX, oxygen depletion and associated processes will be monitored in a broad range of aquatic systems that differ in oxygen status or sensitivity towards change: oxygen-rich open ocean with high sensitivity to global warming (Arctic), semi-enclosed basins with permanent anoxia (Black Sea, Baltic Sea) and seasonally or locally anoxic land-locked systems (fjords, lagoons, lakes). The obtained

Earth observation

monitoring results will be combined with information on past hypoxia and state-of-the-art numerical modelling to predict future hypoxia and its effect on aquatic ecosystems. HYPOX will further generate the necessary know-how to decide on appropriate oxygen monitoring efforts in the future.

METHODOLOGY

In situ observatories will be set up by installation of new systems and by implementing reliable sensors to existing platforms. These observatories will monitor oxygen and associated parameters (e.g., hydrodynamics, temperature, salinity, other gases) at high frequency. In addition, state-of-the art autonomous and towed equipment will be used for in situ studies and sampling of sediments and the water column during repeated surveys. Biological processes in the water column and the sediment will be studied in order to understand their role in hypoxia development and the changes in biodiversity and function when aquatic systems shift towards oxygen depletion. HYPOX will further include compilation and analysis of existing monitoring data and investigations of past hypoxia in the sedimentary record using fossils, biomarkers, and geochemical proxies. Modelling tools that couple physical and biogeochemical processes will be developed and used to predict oxygen availability in aquatic systems that are subject to global warming and eutrophication.

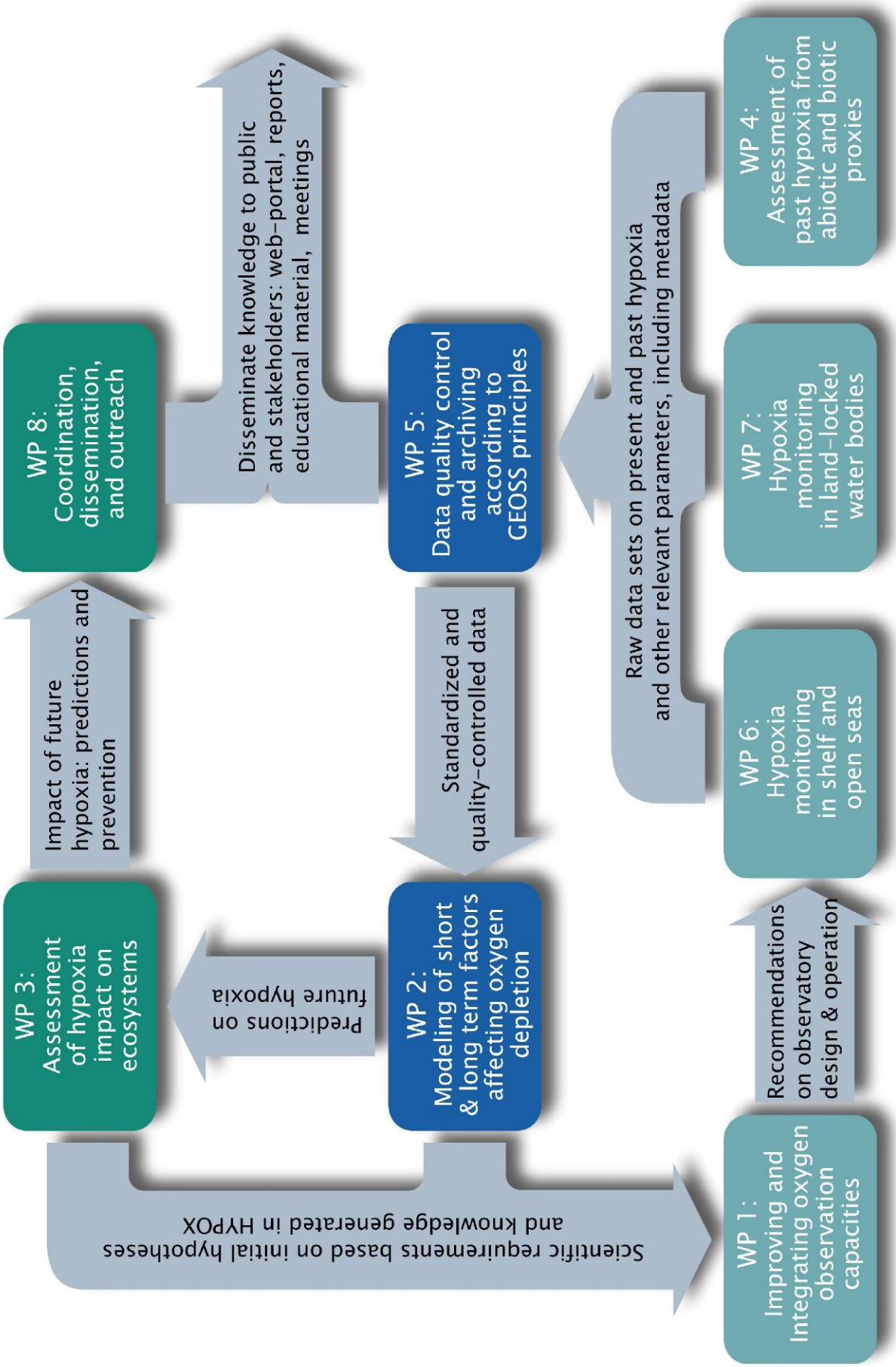
All project data will be kept in compliance to the standards of the Global Earth Observation System of Systems (GEOSS) and made available through a web portal run by the state-of-the-art world data centre WDC MARE (www.wdc-mare.org).

EXPECTED RESULTS

HYPOX will build capacities to monitor oxygen in aquatic systems which is an underrepresented parameter in observing and monitoring programmes. HYPOX will develop a research platform for understanding past, present and future impacts of natural variation, global change and land use on oxygen depletion and ecosystem functions and services. Scientific data will be passed on to students of aquatic and environmental sciences, citizens, and stakeholders. Obtained knowledge will be disseminated to local, regional and global organisations concerned with water and ecosystem health and management with the ultimate goal to develop tools for decision making. HYPOX will connect to the Regional Alliances of GOOS (the oceanographic component of GEOSS) and the Scientific Committee in Oceanographic Research (SCOR) working group on hypoxia. The project will contribute to the GEOSS cross cutting activities *Architecture* and *Data management* as well as to the GEOSS societal benefit areas *Water*, *Climate*, *Ecosystem* and *Biodiversity*.

PROJECT PARTNERS	
Max Planck Institute for Marine Microbiology (MPI), DE	Istanbul Technical University, Eastern Mediterranean Centre for Oceanography and Limnology (ITU-EMCOL), (Turkey) TR
Alfred Wegener Institute for Polar and Marine Research (AWI), DE	Center for Marine Environmental Sciences at Bremen University (Marum), DE
Swiss Federal Institute of Aquatic Science and Technology (Eawag), (Switzerland) CH	Scottish Association for Marine Science, GB
A.O.Kovalevsky Institute of Biology of the Southern Seas (IBSS), (Ukraine) UA	University of Gothenburg, SE
Leibniz Institute of Marine Sciences at the University of Kiel (IFM-GEOMAR), DE	University of Patras, GR
French Research Institute for Exploitation of the Sea (Ifremer), FR	Institute for Coastal Research (GKSS), DE
National Institute of Geophysics and Volcanology (INGV), IT	The National Institute of Marine Geology and Geo-ecology of Romania (GeoEcoMar), (Romania) RO
Leibniz Institute for Baltic Sea Research, (IOW), DE	Centre for Estuarine and Marine Ecology (NIOO-KNAW), NL

4.1.6.2 Work package structure



4.1.6.3.1 Publications published and in press

Partners involved	Authors	Year	Title	Language	Journal / Book	Publisher, city, country	Volume & publication date	pages	URL of abstract (full text if open access)	HYPOX funds acknow-ledged	open access provided (Yes / No)	peer reviewed (Yes / No)
PUBLICATIONS PUBLISHED AND 'IN PRESS'												
1 (MPG-MPIMM) 10 (Uni-HB)	Boetius, A. Janssen, F. Waldmann, C.	2010	Oxygen monitoring in aquatic ecosystems – EU-Project HYPOX	english	Earthzine (Ecosystems, Oceans, Water) Online publication	IEEE Committee on Earth Observations	26.05.10	N/A	www.earthzine.org/2010/05/26/oxygen-monitoring-in-aquatic-ecosystems-eu-project-hypox/	yes	yes	yes
1 (MPIMM)	Holtappels, M. Kuypers, M.M.M. Schlüter, M. Brüchert, V.	2011	Measurement and interpretation of solute concentration gradients in the benthic boundary layer	english	Limnology and Oceanography Methods	Association for the Sciences of Limnology and Oceanography, Waco, TX, USA	9 Jan. 2011	1-13	http://www.smf.su.se/beam/news/publications/2011/Holtappels/	no	no	yes
1 (MPIMM)	Holtappels, M. Lorke, A.	2011	Estimating turbulent diffusion in a benthic boundary layer	english	Limnology and Oceanography Methods	Association for the Sciences of Limnology and Oceanography, Waco, TX, USA	9 Jan. 2011	29-41	http://www.aslo.org/lomethods/free/2011/0029.html	no	no	yes
1 (MPG-MPIMM)	Janssen, F. Cardenas, M.B. Sawyer, A.H. Dammrich, T. Krietsch,J. de Beer, D.	in press	A comparative experimental and multiphysics computational fluid dynamics study of coupled surface-subsurface flow in bedforms	english	Water Resources Research	American Geophysical Union, Washington, DC, USA	N/A	N/A	http://www.agu.org/journals/pip/wr/2012WR011982-pip.pdf	yes	no	yes
3 (Eawag)	Rempfer, J. Livingstone, D. M. Blodau, C. Forster, R. Niederhauser, P. Kipfer, R.	2010	The effect of the exceptionally mild European winter of 2006/2007 on temperature and oxygen profiles in lakes in Switzerland: a foretaste of the future?	english	Limnology and Oceanography	Association for the Sciences of Limnology and Oceanography, Waco, TX, USA	55(5) Sep. 2010	2170-2180	http://www.aslo.org/lo/toc/vol_55/issue_5/2170.html	yes	no	yes
4 (IBSS)	Orekhova, N.A. Konovalov, S.K.	2009	Oxygen and sulfide in the bottom sediments of the Sevastopol Bay.	russian	Ecological safety of coastal and shelf areas and utilization of shelf resources	Ecosi-Gidrofisika, Sevastopol, Ukraine	18 2009	48-56		no	no	yes
4 (IBSS)	Orekhova, N.A. Konovalov S.K.	2009	Voltammetric studies of the bottom sediments of the Sevastopol Bay	russian	MHI Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	18 2009	52-66		no	no	yes
4 (IBSS)	Bondarev I.P	2009	Submarine Landscape of the North Black Sea continental shelf-slope transitional zone.	english	Extended abstr. Fifth Plenary Meeting of Project IGCP 521-INQUA 0501, 2009 Aug. 22-31	Deu Publishing House, Izmir, Turkey	Aug. 2009	34-35		yes	no	yes
4 (IBSS)	Zaika, V.E. Sergeeva, N.G. Gulin, M.B.	2009	The population structure of polychaeta Vigtorniella zaikai (Kisseleva, 1992) in the Black sea and the characteristics of a community in which it is the dominating species	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	8(4) Dec. 2009	59-66	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Gulin, M.B., Timofeev, V.A. Bondarenko, L.	2010	Zoobenthos in microbiotopes of methane seeps of the Crimean shelf zone	russian	Systems for environmental monitoring	Ecosi-Gidrofisika, Sevastopol, Ukraine	14 2010	225-229		yes	no	yes
4 (IBSS)	Orekhova, N.A.	2010	Hypoxia and anoxia in the coastal sediments of Crimean.	russian	Theoretical and applied edition "Geography and tourism", Eds. Ya.B.Oleinik et al.	Alterpress, Kiev, Ukraine	4 2010	146-152		yes	yes	yes

Publications published and in press (continued)

4 (IBSS)	Kolesnikova, E.A.	2010	On finding Archesola typhlops (Sars, 1920), the harpacticoid new for the Black Sea, at depths greater than 100m.	english	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	9(1) Mar. 2010	52	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Sergeeva, N.G. Zaika, V.E. Bondarev, I.P.	2010	The lowest zoobenthos border in the Black Sea Near-Bosporus region.	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	10(1) Mar. 2010	65-72	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Konovalov, S.K. Romanov, A.S. Moiseenko, O.G. Vnukov, Yu. L. Chumakova, N.I. Ovsyany, E.I.	2010	The Sevastopol Bay oceanographic atlas	russian	The Sevastopol Bay oceanographic atlas	Ecosi-Gidrofisika, Sevastopol, Ukraine	May 2010	320pp		no	yes	yes
4 (IBSS)	Gulin, M.B. Stokozov, N.A.	2010	Variability of oxic/anoxic conditions over the fields of methane seeps at the NW Black Sea shelf slope	english	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	9(2) Jun. 2010	51-57	http://repository.ibss.org.ua/dspace/handle/99011/7	no	yes	yes
4 (IBSS)	Zaika, V.E. Bonadarev, I. P.	2010	The bottom hypoxia on the shelf and anoxia of the Black Sea deep water benthic zone.	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	9(2) Jun. 2010	58-61	http://repository.ibss.org.ua/dspace/handle/99011/7	no	yes	yes
4 (IBSS)	Mazlumyan, S.A	2010	The conceptual model for assessing the value of the near- shore ecosystem.	english	Proc. Int. Conf. INQUA 501 - IGCP 521	Rhodes, Greece	Sep. 2010	130-132		yes	yes	yes
4 (IBSS)	Orekhova, N.A. Sergeeva, N.G. Gulin, M.B. Konovalov, S.K.	2010	Events of hypoxia and anoxia in the Crimean coastal waters	english	Proc. Int. Conf. INQUA 501 - IGCP 521	Rhodes, Greece	Sep. 2010	153-154		yes	yes	yes
4 (IBSS)	Sergeeva, N. G. Mazlumyan, S.A. Konovalov, S.K.	2010	Benthic fauna independent of oxygen depletion in environment (Outer and Inner Parts of the Sevastopol Bay)	english	Proc. Int. Conf. INQUA 501 - IGCP 521	Rhodes, Greece	Sep. 2010	187-189		yes	yes	yes
4 (IBSS)	Zaika, V.E	2010	On the approaches to evaluation of the macrofauna near the Black Sea aerobic benthal lower boundary.	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	9(3) Sep. 2010	29-39	http://repository.ibss.org.ua/dspace/handle/99011/7	no	yes	yes
4 (IBSS)	Zaika, V.E	2010	Distribution of the macrobenthos in phaseolina silt zone of the Black sea.	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	9(3) Sep. 2010	35-42	http://repository.ibss.org.ua/dspace/handle/99011/7	no	yes	yes
4 (IBSS)	Sergeeva, N. G. Lichtschlag, A Mazlumyan, S.	2011	Protozoa and Metazoa Living under Hypoxia /Anoxia Conditions in the Black Sea: Discovery of Actively Moving Animals in situ.	english	Proc.3rd Bi-annual Black Sea Scientific Conference and UP-GRADE BS-SCENE Project joint Conference	Odessa, Ukraine	2011	188-189		yes	yes	yes
4 (IBSS)	Svishchev, S.V. Konovalov, S.K. Kondratiev, S.I.	2011	Patterns of seasonal changes in content and distribution of oxygen in the waters of the Sevastopol bay.	russian	Marine Hydrophysical Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	4 2011	64-78		yes	yes	yes
4 (IBSS)	Kolesnikova, E.A. Sergeeva, N.G.	2011	A new record of Darcythompsonia failensis (Copepoda, Harpacticoida) in the Black sea.	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	10(1) Mar. 2011	72	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Kosheleva, T.N.	2011	Deep-water nematodes (Desmoscolecida, Nematoda) of the Paleo Dnieper (Black Sea): diversity and abundance	russian	Abstr. VII Inter. Conf. on Ecological Problems of aquatic Ecosystems. "Pontus Euxinus-2011" (Sevastopol, Ukraine)	Ecosi-Gidrofisika, Sevastopol, Ukraine	May 2011	148-149	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes

Publications published and in press (continued)

4 (IBSS)	Orekhova, N.A. Kotel'yanets, E.A.	2011	Oxygen deficit in coastal sediments of the Black Sea with various anthropogenic pressures.	russian	Abstr. VII Inter. Conf. on Ecological Problems of aquatic Ecosystems. "Pontus Euxinus-2011" (Sevastopol, Ukraine)	Ecosi-Gidrofisika, Sevastopol, Ukraine	May 2011	184-185	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Orekhova, N.A. Kotel'yanets, E.A.	2011	Monitoring of the bays of Sevastopol coast.	russian	Proc. X th sci. conf. Lomonosov's disputes Eds. Ivanov V.A. et al.	Branch of MSU, Sevastopol, Ukraine	May 2011	18		yes	no	yes
4 (IBSS)	Svishchev, S.V.	2011	Qualitative assessment of oxygen exchange between the Sevastopol bay waters and the atmosphere	russian	Abstr. VII Inter. Conf. on Ecological Problems of aquatic Ecosystems. "Pontus Euxinus-2011" (Sevastopol, Ukraine)	Ecosi-Gidrofisika, Sevastopol, Ukraine	May 2011	215	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Svishchev, S.V.	2011	Assessment of the intensity of gas exchange of oxygen between the atmosphere and the waters of the Sevastopol bay	russian	Proc. X th sci. conf. Lomonosov's disputes Eds. Ivanov V.A. et al.	Branch of MSU, Sevastopol, Ukraine	May 2011	22		yes	no	yes
4 (IBSS)	Kolesnikova, E.A. Sergeeva, N.G.	2011	A new Record of the species Sarsameira parva (Boeck, 1872) and Tachidiella minuta G. O. Sars, 1909 (Copepoda, Harpacticoida) from the Black Sea.	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	10(2) Jun. 2011	26	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Zaika, V.E. Gulin, M.B.	2011	The maximal depths of fish inhabitation in the Black Sea and features of their trophic strategy nearby of oxic/anoxic interface.	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	10(2) Jun. 2011	39-47	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Zaika, E. Ivanova, K. Sergeeva, N.	2011	Seasonal changes of meiobenthos of the Sevastopol Bays with analysis of influence of bottom hypoxia	russian	Marine Ecology Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	Special issue (2) Jun. 2011	29-36	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Bondarev, I.P.	2011	Mollusc ecology as an evidence of gradual Black Sea level rise in Holocene	english	Proc. Int. Conf. INQUA 501 Seventh Plenary Meeting, Odessa, Ukraine	Astroprimt, Odessa, Ukraine	Aug. 2011	63-65	http://www.avalon-institute.org/IGCP	yes	yes	yes
4 (IBSS)	Sergeeva, N. G. Konovalov, S.K. Kolesnikova, E. Chekalov, V.	2011	Response of meiobenthos communities to hypoxia in the Black Sea coastal zone (Tarkhankut, Crimea)	english	Proc. Int. Conf. INQUA 501 Seventh Plenary Meeting, Odessa, Ukraine	Astroprimt, Odessa, Ukraine	Aug. 2011	151-154	http://www.avalon-institute.org/IGCP	yes	no	yes
4 (IBSS)	Konovalov, S. Vladymyrov, V. Dolotov, V. Sergeeva, A. Goryachkin, Yu. Vnukov, Yu. Moiseenko, O. Alyemov, S. Orekhova, N. Zharova, L.	2011	Coastal Management Tools and Databases for the Sevastopol Bay (Crimea).	english	Proceedings of the Tenth International Conference on the Mediterranean Coastal Environment Ed. E. Özhan	Rhodes, Greece	Sep. 2011	145-156		no	yes	yes

Publications published and in press (continued)

4 (IBSS)	Orekhova N.A. Konovalov S.K.	2011	Oxygen – the key indicator of the environmental state	russian	Proc. IV Intern.l sci. conf. "Physical methods in ecology, biology and medicine"	LNU Ivana Franka, L'viv, Ukraine	Sep. 2011	68-69		yes	no	yes
4 (IBSS)	Zaika, V.E. Konovalov, S.K. Sergeeva, N.G.	2011	The local and seasonal hypoxia occurrences at the bottom of the Sevastopol bays and their influence	russian	Marine Ecological Journal	Ecosi-Gidrofisika, Sevastopol, Ukraine	10(3) Sep. 2011	15-25	http://repository.ibss.org.ua/dspace/handle/99011/7	yes	yes	yes
4 (IBSS)	Sergeeva, N. G. Gooday, A. J. Mazlumyan, S.A. Kolesnikova E.A. Lichtschlag A. Kosheleva T.N. Anikeeva O. V.	2011	Meiobenthos of the oxic/anoxic interface in the south-western region of the Black Sea: abundance and taxonomic composition	english	Anoxia: Paleontological Strategies and Evidence for Eukaryote Survival Eds. Altebach A.V., Bernhard J.H., Seckbach J.	Springer	Oct. 2011	369-401		yes	no	yes
4 (IBSS)	Konovalov, S.K. Eremeev, V.N.	in press	Regional features, stability and evolution of the biogeochemical structure of the Black Sea waters.	russian	Stability and evolution of the Black sea oceanographic properties Eds. Eremeev V.N., Konovalov S.K.	Ecosi-Gidrofisika, Sevastopol, Ukraine	in press	N/A		yes	yes	yes
4 (IBSS)	Konovalov, S.K. Eremeev, V.N.	in press	Monitoring of the Black sea Biogeochemical properties: major features and changes	english	Earth Systems Change Over Eastern Temperate Europe	National Academy of Science of Ukraine, Kiew, Ukraine	in press	N/A		no	yes	yes
4 (IBSS)	Sergeeva, N.G. Mazlumyan, S.A. Çağatay, M. N. Lichtschlag, A.	in press	Hypoxic meiobenthic communities of the Istanbul Strait's (Bosporus) outlet area of the Black Sea	english	Turkish Journal of Fisheries and Aquatic Sciences	Central Fish. Res. Inst. (CFRI), Trabzon-Turkey and Japan Intern.Cooper.Agency (JICA)	in press	N/A		yes	no	yes
5 (GEOMAR)	Dale, A. W. Sommer, S. Bohlen, L. Treude, T. Bertics, V. J. Bange, H. W. Pfannkuche, O. Schorp, T. Mattsdotter, M. Wallmann, K.	2011	Rates and regulation of nitrogen cycling in seasonally hypoxic sediments during winter (Boknis Eck, SW Baltic Sea): sensitivity to environmental variables.	english	Estuarine, Coastal and Shelf Science	Elsevier, Amsterdam, The Netherlands	95 2011	14-28	http://dx.doi.org/10.1016/j.ecss.2011.05.016	yes	no	yes
7 (INGV) 6 (IFREMER) 2 (AWI)	Lo Bue, N. Vangreisheim, A. Khripounoff, A. Soltwedel, T.	2011	Anomalies of oxygen measurements performed with Aanderaa optodes	english	Journal of Operational Oceanography	The Institute of Marine Engineering, Science and Technology London, United Kingdom	4(2) 2011	29-39	http://archimer.ifremer.fr/doc/00045/15584/14489.pdf	no	no	yes
11 (SAMS)	Shapiro, G. I. Aleynik, D. L. Mee, L. D.	2010	Long term trends in the sea surface temperature of the Black Sea	english	Ocean Science	Copernicus Gesellschaft mbH, Göttingen, Germany	6 7.05.10	491-501	www.ocean-sci.net/6/491/2010/	yes	yes	yes
11 (SAMS)	Inoue, T. Glud, R.N. Stahl, H. Hume, A.	2011	Comparison of three different methods for assessing in situ friction velocity: A case study from Loch Etive, Scotland	english	Limnology & Oceanography Fluid & Environment	Association for the Sciences of Limnology and Oceanography, Waco, TX, USA	9 13.05.11	275-287	http://www.aslo.org/lomethods/free/2011/0275.pdf	yes	yes	yes
11 (SAMS)	Shapiro, G. I. Wobus, F. Aleynik, D. L.	2011	Seasonal and inter-annual temperature variability in the bottom waters over the Black Sea shelf	english	Ocean Science	Copernicus Gesellschaft mbH, Göttingen, Germany	7 22.09.11	585-596	www.ocean-sci.net/7/585/2011/	yes	yes	yes

Publications published and in press (continued)

11 (SAMS)	Stahl, H. Glud R.N. Davison W. Warnken K.W. Sochaczewski L. Zhang H.	2012	A new combined sensor for simultaneous high resolution imaging of 2-D oxygen and trace metal dynamics in irrigated sediments.	english	Limnology & Oceanography Methods	Association for the Sciences of Limnology and Oceanography, Waco, TX, USA	In press	N/A		yes	yes	yes
12 (UGOT)	Almroth, E. Tengberg, A. Pakhomova, S.V. Andersson, H. Hall, P.	2009	Effects of resuspension on benthic fluxes of oxygen, nutrients, dissolved inorganic carbon, iron and manganese in the Gulf of Finland, Baltic Sea	english	Continental Shelf Research	Elsevier, Amsterdam, The Netherlands	29 Mar. 2009	807-818		no	yes	yes
12 (UGOT)	Almroth-Rosell, E. Eilola, K. Hordoir, R. Meier, M. Hall, P.	2011	Transport of fresh and resuspended particulate organic material in the Baltic Sea - a model study	english	Journal of Marine Systems	Elsevier, Amsterdam, Holland	87 Feb. 2011	1-12		no	yes	yes
12 (UGOT)	Wesslander, K. Hall, P. Hjalmarsson, S. Lefevre, D. Omstedt, A. Rutgersson, A. Sahlée, E. Tengberg, A.	2011	Observed carbon dioxide and oxygen dynamics in a Baltic Sea coastal region	english	Journal of Marine Systems	Elsevier, Amsterdam, Holland	86 Mar. 2011	1-9		no	yes	yes
12 (UGOT)	Ruhl, H. André, M. Beranzoli, L. Çagatay, N. Colaço, A. Cannat, M. Dañobeitia, J. Favali, P. Géli, L. Gillooly, M. Greinert, J. Hall, P. Huber, R. Karstensen, J. Lampitt, R. Larkin, K. Lykousis, V. Mienert, J. Miranda, M. Person, R. Priede, I. Puillat, I. Thomsen, L. Waldmann, C.	2011	Societal need for improved understanding of climate change, anthropogenic impacts, and geohazard warning drive development of ocean observatories in European Seas	english	Progress in Oceanography	Elsevier, Amsterdam, The Netherlands	91 Apr. 2011	1-33		no	yes	yes
12 (UGOT)	Viktorsson, L., Almroth Rosell, E., Tengberg, A., Vankevich, R. Neelov, I. Isaev, A. Kravtsov, V., Hall, P.	2012	Benthic phosphorus dynamics in the Gulf of Finland, Baltic Sea	english	Aquatic Geochemistry	Elsevier, Amsterdam, The Netherlands	in press available online since Jan. 2012	N/A		yes	yes	yes
12 (UGOT)	Ekeroth, N. Lindström, M. Blomqvist, S. Hall, P.	2012	Recolonisation by macrobenthos mobilises organic phosphorus from reoxidised Baltic Sea sediments	english	Aquatic Geochemistry	Elsevier, Amsterdam, The Netherlands	in press available online	N/A		yes	yes	yes

Publications published and in press (continued)

13 (UPAT)	Ferentinos, G. Papatheodorou, G. Geraga, M. Iatrou, M. Fakiris, E. Christodoulou, D. Koutsikopoulos,C. Dimitriou, E.	2010	Fjord water circulation patterns and dysoxia/anoxia related processes in a Mediterranean embayment, Amvrakikos Gulf, Greece.	english	Estuarine, Coastal and Shelf Sciences	Elsevier, Amsterdam, Netherlands	88 10.08.10	473-481	http://www.sciencedirect.com/science/article/pii/S0272771410001939	yes	no	yes
14 (HZG / GKSS)	He, Y. Stanev, E. Yakushev, E. Staneva, J.	2011	Numerical modelling of biogeochemical regime response to decadal atmospheric variability during 1960-2000 in the Black Sea	english	Chemical Structure of Pelagic Redox Interfaces: Observation and Modeling, The Handbook of Environmental Chemistry Ed. E. Yakushev	Springer, Heidelberg, Germany	2011	1-19		yes	no	yes
14 (HZG / GKSS)	He, Y. Stanev, E. Yakushev, E. Staneva, J.	2012	Black Sea biogeochemistry: response to decadal atmospheric vatiability during 1960-2000 inferred from numerical modelling	english	Marine Environmental Research	Elsevier, Amsterdam, Netherlands	77 2012	90-102		yes	yes	yes
15 (GeoEcoMar)	Duliu, O. Cristache, C. Oaie, Gh. Culicov, O. Frontasyeva, M. Toma, M.	2009	ENAA studies of pollution in anoxic Black Sea sediments	english	Marine Pollution Bulletin	Elsevier, Amsterdam, Netherlands	58 2009	827-831		yes	yes	yes
15 (GeoEcoMar)	Begun, T. Teaca, A. Gomoiu, M.-T.	2010	Ecological state of macrobenthic populations within Modiolus phaseolinus biocoenosis from Romanian Black Sea Continental Shelf	english	Geo-Eco-Marina	GeoEcoMar, Romania	16 2010	5-18	http://www.geoecomar.ro/website/publicatii-revista-geo-eco-marina.html	yes	yes	yes
15 (GeoEcoMar)	Vasiliu, D. Gomoiu, M.-T. Boicenco, L. Lazar, L. Timofte, F.	2010	Chlorophyll a distribution in the Romanian Black Sea inner shelf waters in 2009	english	Geo-Eco-Marina	GeoEcoMar, Romania	16 2010	19-28	http://www.geoecomar.ro/website/publicatii-revista-geo-eco-marina.html	no	yes	yes
16 (NIOO KNAW) / 17 (NIOZ)	Middelburg, J. J. Levin, L.A.	2009	Coastal hypoxia and sediment biogeochemistry	english	Biogeosciences	Copernicus Gesellschaft mbH, Göttingen, Germany	6 28.07.09	1273-1293	http://www.biogeosciences.net/6/1273/2009/bg-6-1273-2009.html	yes	yes	yes
16 (NIOO KNAW) / 17 (NIOZ)	Cox, T. J. S. Maris, T. Soetaert, K. Conley, D. J. Van Damme, S. Meire, P. Middelburg, J. J. Vos, M. Struyf, E.	2009	A macro-tidal freshwater ecosystem recovering from hypereutrophication: the Schelde case study.	english	Biogeosciences	Copernicus Gesellschaft mbH, Göttingen, Germany	6 10.12.09	2935-2948	http://www.biogeosciences.net/6/2935/2009/bg-6-2935-2009.html	yes	yes	yes
16 (NIOO KNAW) / 17 (NIOZ)	Meysman, F.J.R. Galaktionov, O. Glud, R.N. Middelburg, J. J.	2010	Oxygen penetration around burrows and roots in aquatic sediments	english	Journal of Marine Research	Yale University, New haven, USA	68 01.01.10	309-336	http://jmr.publisher.ingentaconnect.com/content/jmr/jmr/2010/00000068/00000002/art00006	yes	no	yes

Publications published and in press (continued)

16 (NIOO KNAW) / 17 (NIOZ)	Zhang, J. Gilbert, D. Gooday, A. J. Levin, L. Naqvi, S. W. A. Middelburg, J. J. Scranton, M. Ekau, W. Pena, A. Dewitte, B. Oguz, T. Monteiro, P. M. S. Urban, E. Rabalais, N. N. Ittekkot, V. Kemp, W. M. Ulloa, O. Elmgren, R. Escobar-Briones E. Van der Plas A. K.	2010	Natural and human-induced hypoxia and consequences for coastal areas: synthesis and future development	english	Biogeosciences	Copernicus Gesellschaft mbH, Göttingen, Germany	7 10.05.10	1443-1467	http://www.biogeosciences.net/7/1443/2010/bg-7-1443-2010.html	yes	yes	yes
16 (NIOO KNAW) / 17 (NIOZ)	Cox, T.J.S. Soetaert, K. Vanderborght, J.-P. Kromkamp, J. Meire, P.	2010	Modeling photosynthesis-irradiance curves: effects of temperature, dissolved silica depletion and changing community assemblage on community photosynthesis	english	Limnology and Oceanography: Methods	Association for the Sciences of Limnology and Oceanography, Waco, TX, USA	8 01.08.10	424-440	http://www.aslo.org/lomethods/free/2010/0424.html	no	yes	yes
16 (NIOO KNAW) / 17 (NIOZ)	Van Frausum, J. Middelburg, J. J. Soetaert, K. Meysman, F. J. R.	2010	Different proxies for the reactivity of aquatic sediments towards oxygen: A model assessment	english	Ecological modelling	Elsevier, Amsterdam, Netherlands	221 24.08.10	2054-2067	http://www.sciencedirect.com/science/article/pii/S0304380010002668	no	no	yes
16 (NIOO KNAW) / 17 (NIOZ)	Danovaro, R. Corinaldesi, C. Dell'Anno, A. Fuhrman, J.A. Middelburg, J.J. Noble, R.T. Suttle, C.A.	2010	Marine viruses and global climate change	english	FEMS Microbiology Reviews	Wiley, New York, USA	35(6) 04.01.2011	993-1034	http://onlinelibrary.wiley.com/doi/10.1111/j.1574-6976.2010.00258.x/abstract	no	no	yes
MARE-ULg	Vandenbulcke, L. Capet, A. Beckers, J. M. Gregoire, M.	2010	Onboard implementation of the GHER model for the Black Sea, with SST and CTD data assimilation.	english	Journal of Operational Oceanography	The Institute of Marine Engineering, Science & Technology, London, United Kingdom	3(2) 2010	47-54	http://www.imarest.org/Publications/TechnicalProceedings/JOO.aspx?PageContentMode=1#113	no	no	yes
MARE-ULG	Gregoire, M. Soetaert, K.	2010	Carbon, Nitrogen, Oxygen and Sulfide budgets in the Black Sea: a biogeochemical model of the whole water column coupling the oxic and anoxic part.	english	Ecological Modelling	Elsevier, Amsterdam, The Netherlands	221 06.07.10	2287-2301	http://www.sciencedirect.com/science/article/pii/S0304380010002760	no	no	yes
NIVA	Pakhomova, S.V. Rozanov, A.G. Yakushev, E.V.	2009	Dissolved and Particulate Forms of Iron and Manganese in the Redox Zone of the Black Sea	english	Oceanology	Springer, Heidelberg, Germany	49 (6) 2009	773–787		no	no	yes

Publications published and in press (continued)

NIVA	Yakushev, E. Pakhomova, S. Sørenson, K. Jens, S.	2009	Importance of the different manganese species in the formation of water column redox zones: Observations and modelling	english	Marine Chemistry	Elsevier, Amsterdam, The Netherlands	117 2009	59-70		no	no	yes
NIVA	Dellwig, O. Leipe, T. März, C. Glockzin, M. Pollehne, F. Schnetger, B. Yakushev, E.V. Böttcher, M.E. Brumsack, H-J.	2010	A new particulate Mn-Fe-P-shuttle at the redoxcline of anoxic basins	english	Geochimica et Cosmochimica Acta	Elsevier, Amsterdam, The Netherlands	74 2010	7100-7115		no	no	yes
NIVA	Yakushev, E.V. Debolskaya, E.I. Kuznetsov, I.S. Staalstrøm, A.	2011	Modelling of the meromictic Fjord Hunnbunn (Norway) with an Oxygen Depletion model (OxyDep)	english	Chemical Structure of Pelagic Redox Interfaces: Observation and Modeling, The Handbook of Environmental Chemistry Ed. E. Yakushev	Springer, Heidelberg, Germany	2011	1-17		yes	no	yes
NIVA	Yakushev, E. V. Kuznetsov, I. S. Podymov, O. I. Burchard, H. Neumann, T. Pollehne, F.	2011	Modeling of influence of oxygenated inflows on biogeochemical structure of the Gotland Sea, central Baltic Sea: changes in distribution of manganese	english	Computers and Geosciences	Elsevier, Amsterdam, The Netherlands	37 2011	398-409		no	no	yes
4 (IBSS)	Orekhova, N.A. Kotel'yanets, E.A.	2010	Variations in hydrochemical and hydroecological properties of the Sevastopol Bay sediments.	russian	Young scientists to geographic studies: Collection of scientific papers	Obriy, Kiev, Ukraine	6 Nov. 2010	80-84		yes	no	no
5 (GEOMAR)	Bange, H. W. Dale, A.W. Hansen, H. P. Karstensen, J. Malien, F. Petereit, C. Laß, K. Friedrichs, G.	2011	Boknis Eck Time Series Station: Measurements from 1957 to 2010.	english	LOICZ Inprint	LOICZ project office, Geesthacht, Germany	2011 v1 2011	16-22		no	yes	no
13 (UPAT) 7 (INGV)	Papatheodorou, G., Christodoulou, D. Etiope, G. Geraga, M. Ferentinos, G. Kordella, S.	in press	Seabed fluid flows in Ionian Sea and Western Greece: indicators of petroleum and natural gas reservoirs	english	Aegean and South Eastern Mediterranean Sea	Sideris Publications, Athens, Greece	in press	N/A		yes	no	no
NIVA	Staalstrøm, A. Bjerkeng, B. Yakushev, E. Christie, H.	2009	Water exchange and water quality in Hunnbunn – Evaluation of dredging in the Thalbergsund with regard to improved water quality	norwegian	NIVA Rapport	NIVA, Oslo, Norway	5874 2009	51	http://rapp.niva.no/symfoni/RappArkiv7.nsf/URL/71ABB8C8F899F20DC12576A1003F5446/$FILE/5874-2009.pdf	no	yes	no

4.1.6.3.2 Publications submitted and planned

Partners involved	Authors	Expected year of publication	Title	Language	Journal / Book	Publisher, city, country	HYPOX funds acknow-ledged	open access provided (yes / no)	peer reviewed (yes / no)
SUBMITTED PUBLICATIONS									
1 (MPIMM)	Fischer, J.P. Koop-Jakobsen, K.	2012	The Multi Fiber Optode (MuFO): A novel system for simultaneous analysis of multiple fiber optic oxygen sensors	english	Sensors & Actuators B, Chemical	Elsevier, Amsterdam, The Netherlands	yes	no	yes
3 (Eawag)	North, R.P. Livingstone, D.M.	2012	Comparison of linear and cubic spline methods of interpolating lake profiles	english	Limnology and Oceanography: Methods	Limnology and Oceanography Methods	yes	no	yes
3 (Eawag)	Naeher, S. Schubert, C.J.	2012	Impact of recent lake eutrophication on microbial community changes as revealed by high resolution lipid biomarkers in Rotsee (Switzerland)	english	Organic Geochemistry	Elsevier, Amsterdam, The Netherlands	yes	no	yes
4 (IBSS)	Kolesnikova E.A. Mazlumyan S.A. Sergeeva N.G.	2012 / 2013	First studies on Harpacticoida fauna of oxic/anoxic interface at Bosporus area of the Black Sea. Density distribution along depth gradient and biodiversity	english	Turkish Journal of Fisheries and Aquatic Sciences	Central Fisheries Res. Inst., Trabzon, Turkey	no info	no info	yes
4 (IBSS)	Sergeeva N.G. Mazlumyan S.A. et al.	2012 / 2013	Protozoa and Metazoa under hypoxia/anoxia conditions of the Istanbul Strait's (Bosporus) outlet area of the Black Sea.	english	Turkish Journal of Fisheries and Aquatic Sciences	Central Fisheries Res. Inst., Trabzon, Turkey	no info	no info	yes
4 (IBSS)	Kolesnikova E.A. Zaika V.E. Sergeeva N.G.	2013	Harpacticoida in coastal and deep-water zones under the hypoxic conditions (Black Sea).	english	Book: Copepods: Physical Characteristics, Habitat and Feeding Behavior.	Nova Science Publishers, USA	no info	no info	no info
4 (IBSS)	Sergeeva N.G. Kosheleva T.N.	2012 / 2013	Free-living Nematoda in coastal zone under the hypoxic conditions (Sevastopol region, Black Sea).	russian	Marine Ecological Journal	Ecosi-Gidrophica, Sevastopol, Ukraine	no info	yes	yes
4 (IBSS)	Sergeeva N.G. Kosheleva T.N. et al.	2013	Free-living Nematodes of oxic / anoxic interface at northwest part of the Black Sea.	english	Marine Ecology	Wiley, New York, USA	no info	no	yes
5 (GEOMAR)	Dale, A. W. Bertics, V. J. Treude, T. Sommer, S. Wallmann, K.	2012	Modeling benthic–pelagic nutrient exchange processes and porewater distributions in a seasonally–hypoxic sediment: evidence for massive phosphate release by Beggiatoa?	english	Biogeosciences	Copernicus Gesellschaft mbH, Göttingen, Germany	yes	yes	yes
5 (GEOMAR)	Bertics, V. J. Löscher, C. R. Salonen, I. Dale, A. W. Schmitz, R. A. Treude, T.	2012	Occurrence of benthic microbial nitrogen fixation, coupled to sulfate reduction, and denitrification in the seasonally hypoxic Eckernförde Bay, Baltic Sea	english	Biogeosciences	Copernicus Gesellschaft mbH, Göttingen, Germany	will be in the finalized version	yes	yes
11 (SAMS)	Hsieh Y. Geibert W. Van-Beek P. Stahl H. Aleynik D.L. Henderson G.M.	2012	Using the radium quartet (228Ra, 226Ra, 224Ra and 223Ra) to estimate water mixing and radium inputs in Loch Etive, Scotland.	english	Marine Chemistry	Elsevier, Amsterdam, The Netherlands	yes	no	yes

Publications submitted and planned (continued)

13 (UPAT)	Papaefthymiou, H. Papatheodorou, G. Athanassopoulos, D. Geraga, M. Iatrou, M. Christodoulou, D. Fakiris, E.	2011	Physical and chemical associations of natural radionuclides and 137Cs in the sediments of a Mediterranean fjord-like embayment, Amvrakikos Gulf (Ionian Sea), Greece	english	Journal of Environmental Radioactivity	Elsevier, Amsterdam, The Netherlands	yes	no	yes
12 (UGOT)	Dalsgaard, T. De Brabandere, L. Hall, P.	2012	Denitrification in the central Baltic Sea	english	Geochimica Cosmochimica Acta	Elsevier, Amsterdam, The Netherlands	yes	no	yes
13 (UPAT) 7 (INGV)	Etiope, G. Christodoulou, D. Kordella, S. Marinaro G. Papatheodorou, G.	2012	Offshore and onshore seepage of thermogenic gas at Katakolo Bay (Western Greece)	english	Chemical Geology	Elsevier, Amsterdam, The Netherlands	yes	no	yes
14 (HZG / GKSS)	He, Y. Stanev, E. Staneva, J.	2012	Variability of Suboxic Zone as seen in continuous observations and 3D Numerical Simulations in the Black Sea	english	Ecological Modelling	Elsevier, Amsterdam, Netherlands	yes	no	yes
15 (GeoEcoMar)	Vasiliu D. Boicenco L. Gomoiu M-T. Lazar L. Mihailov M-E.	2012	Temporal variation of surface chlorophyll a in the Romanian near shore waters	english	Mediterranean Marine Sciences	Hellenic Centre for Marine Research, Greece	yes	no	yes
15 (GeoEcoMar)	Lazar L. Vasiliu D. Boicenco L. Timofte F.	2013	Eutrophication of the Romanian Black Sea waterswithin 2008-2010	english	Journal of Environmental Protection and Ecology	Balkan Envrionmental Association, Sindos, Thessaloniki, Greece	no	no	yes

Publications submitted and planned (continued)

IN PREP AND PLANNED PUBLICATIONS									
All partners	Friedrich, J. Janssen, F. Aleynik, D. Boltacheva, N. Dale, A. Etiope, G. Erdem, Z. Geraga, M. Gomoiu, M-T. Hall P. Hanson, D. Holtappel M. Kirf, M. Kononets, M. Konovalov, S. Lichtschlag, A. Livingston, D. Marinaro, G. Mazlumyan, S. Näher, S. North, R. Papatheodoru, G. Pfannkuche, O. Prien, R. Rehder, G. Schubert, C. Soltwedel, Th. Sommer, St. Stahl, H. Teaca, A. Tengberg, A. Waldmann, Ch.	2012	Investigating hypoxia: diverse approaches to addressing a complex phenomenon	english	to be submitted to Biogeosciences	Copernicus Gesellschaft mbH, Göttingen, Germany	yes	yes	yes
1 (MPIMM)	Lichtschlag A. Janssen, F. Holtappels, M. Wenzhöfer, F. Boetius, A.	2013	Benthic oxygen consumption under variable oxygen conditions at the Crimean shelf	english	Not decided yet	N/A	yes	N/A	yes
1 (MPIMM)	Lichtschlag A. et al.	2013	Oxygen effect on early diagenesis at the Crimean shelf	english	Not decided yet	N/A	yes	N/A	yes
1 (MPIMM)	Holtappels, M. Lichtschlag, A. Janssen,F. Fischer, J. et al.	2013	Bottom water oxygen dynamics at the Crimean shelf, Black Sea	english	Not decided yet	N/A	yes	N/A	yes
1 (MPIMM)	Holtappels, M. Lichtschlag, A. Füssel, J. Lavik G. Struck, U. Kuypers, M.	2013	Oxygen intrusions in Bosporus waters	english	Not decided yet	N/A	yes	N/A	yes

1 (MPIMM)	Holtappels M. Khalili, A. Donis, D. Wenzhöfer, F. Glud, R. Kuypers, M.	2013	Effects of non steady state oxygen concentrations on benthic exchange rates as assessed by eddy covariance measurements	english	Not decided yet	N/A	yes	N/A	yes
1 (MPIMM)	Gerdhard, G. et al.	2013	Oxygen intrusions in Bosporus waters	english	Not decided yet	N/A	yes	N/A	yes
1 (MPIMM) 6 (Ifremer) 7 (INGV) 12 (UGOT)	Janssen, F. Fischer, J. P. Holtappels, M. Kononets, M. Lichtschlag, A. Lo Bue, N. Marinaro, G. Salvetat, F. Tengberg, A. Wenzhöfer, F. Boetius, A.	2013	A simple calibration procedure to improve oxygen optode data qualitydeveloped and tested within the EU FP7 project HYPOX	english	Not decided yet	N/A	yes	N/A	yes
3 (EAWAG)	North, R.P. Livingstone D.M. Hari, R.E. Niederhauser, P. Köster, O.	2013	The physical impact of the late 1980s climate regime shift on Swiss lakes and rivers	english	Not decided yet	N/A	yes	N/A	yes
3 (EAWAG)	North, R.P. Livingstone D.M.	2013	Annual prediction of hypolimnetic oxygen depletion in lakes	english	Not decided yet	N/A	yes	N/A	yes
3 (EAWAG)	North, R.P. North, R.L. Livingstone D.M.	2013	Long term changes in hypoxia in the Lake of Zurich and their impact on internal nutrient loading	english	Not decided yet	N/A	yes	N/A	yes
3 (EAWAG)	Naeher, S. Schaeffer, P. Adam, P. Schubert, C.J.	2013	Maleimides in recent sediments – New insights into chlorophyll degradation and palaeoenvironmental reconstructions	english	Not decided yet	N/A	yes	N/A	yes
3 (EAWAG)	Naeher, S. Gilli, A. Hamann, Y. North, R. Schubert, C.J.	2013	Seasonally resolved redox dynamics of manganese and quantitative bottom water oxygen reconstructions using Mn/Fe ratios in Lake Zurich, Switzerland	english	Not decided yet	N/A	yes	N/A	yes
3 (EAWAG)	Naeher, S. Geraga, M. Schubert, C.J. Papatheodorou, G. Ferentinos, G. Kaberi, H.	2013	Anthropogenic environmental changes in a semi-enclosed embayment – Insights from benthic foraminifera and lipid biomarkers in Amvrakikos Gulf, Greece	english	Not decided yet	N/A	yes	N/A	yes
9 (ITU)	Erdem, Z. Çağatay, M.N.	2012	Sedimentary records of Mediterranean inflow and evolution of anoxia in Istanbul Strait's outlet area of Black Sea.	english	Quaternary Science Rewiews	Elsevier, Amsterdam, The Netherlands	yes	yes	yes
9 (ITU)	Çağatay, M.N. Erdem, Z. Ülgen U.B. Damcı, D. Acar, D.	2012	Holocene history of Mediterranean water inflow and channel-network complex in the İstanbul Strait outlet area of the Black Sea	english	Geology	The Geological Society of America, Boulder, CO, USA	yes	yes	yes

Publications submitted and planned (continued)

12 (UGOT) 5 (IFM-GEOMAR)	Nilsson Kononets Viktorsson Hall et al.	2012	Recycling and removal of organic carbon in sediments of the central Baltic Sea	english	Not decided yet	N/A	yes	N/A	yes
12 (UGOT) 5 (IFM-GEOMAR)	Viktorsson Kononets Ekeroth Hall et al.	2012	Benthic phosphorus dynamics in the eastern Gotland Basin	english	Not decided yet	N/A	yes	N/A	yes
12 (UGOT)	Hall Dalsgaard de Brabandere Kononets	2012	Denitrification in sediments of the eastern Gotland basin	english	Not decided yet	N/A	yes	N/A	yes
12 (UGOT) 5 (IFM-GEOMAR)	Hall Sommer Kononets et al.	2012 / 2013	Benthic nitrogen cycling and burial in the central Baltic Sea	english	Not decided yet	N/A	yes	N/A	yes
12 (UGOT) 5 (IFM-GEOMAR)	Hall Sommer Kononets et al.	2012 / 2013	Recycling of biogenic silica in sediments of the central Baltic Sea	english	Not decided yet	N/A	yes	N/A	yes
15 (GeoEcoMar)	Lazar L. Gomoiu M-T. Vasiliu D.	2013	Long term regularities and disturbances of Oxygen regime in the NW Black Sea coastal waters	english	Not decided yet	N/A	yes	N/A	no
MARE-ULG 1 (MPG-MPIMM)	Capet A. Holtappels, M. Lichtschlag, A. Gregoire M et al.	2013	Benthic-pelagic coupling in the Black Sea: combining model results with in-situ data	english	Not yet decided	N/A	yes	N/A	yes

4.1.6.4 Fieldwork and observatory deployments

CONDUCTED FIELDWORK AND OBSERVATORY DEPLOYMENTS							
General info			**Cruise / observation Dates**	**Measurements**			
Region / site	**Vessel / cruise leg**	**Type of investigation / leading scientist / institution**	**Start / End / station time or observation period**	**Parameters**	**Coverage**	**Samples**	**Gear**
Black Sea / Romanian shelf	R/V MARE NIGRUM	Research Cruise / in situ observations & sampling program / Dan Secrieru / GeoEcoMar	19.05.09 - 28.05.09 / 10 days	oxygen, salinity, temperature, pH, beam transmission / attenuation, turbidity, nutrients, phytoplankton, zooplankton, geochemistry, sedimentology, meiofauna, macrofauna, bathymetry	discrete sites, vertical profiles & point measurements	water samples, sediment samples	CTD, Multicorer, Van Veen, Seaguard, multibeam, Nansen zooplankton net,
Ionian Sea, Greece / Amvrakikos gulf	R/V IRENE	Research cruise / George Papatheodorou/ UPAT	Jun. & Aug. 2009 / 10 days and 17.07.10 - 25.07.10 / 9 days	temperature, salinity, oxygen, pH, ORP, methane, sulfide, currents, seismic profiles, sonographs	discrete sites, vertical profiles, point measurements	sediment samples	Aandera RCM9-MKII, YSI 600 XL, IN-SITU TROLL 9500, METS sensor, Sea & Sun Technology, ATM, ADCP (only 2010), Mini corer, gravity corer, Minirover MKII ROV, 3.5kHz profiling system EG&G side scan sonar
Black Sea / Sevastopol Bays	small ships	Research cruise / Sergey Konovalov, Vitaly Timofeev & Maksim Gulin / MHI & IBSS	20.07.09, 02.09.09, 07.09.09, 09.10.09, 01.12.09, 28.01.10, 19.03.10, 18.05.10, 08.07.10 / 1 day each	oxygen, salinity, temperature, nutrients, meiofauna	vertical profiles, (water and sediments) discrete sites, point measurements,	water samples, sediment samples, meiobenthos samples	sample tube, diver, Model DLK-60, Portable Meter, Hach HQ40d, Standard ionomer PH150M
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Research cruise / Per Hall / UGOT	Aug. 2009 / 2 days	CTD profiling, water column sampling	discrete sites, vertical profiles, discrete time points	water samples	CTD
Black Sea / Tarkhankut (Crimea)	shore based work	Research field trip / Maksim Gulin, Sergey Konovalov, Vitaly Timofeev / IBSS & MHI	2.8.09, Sep. 2009, 25.11.09 / 1 day each 10.03.10 - 11.03.10 / 2 days 19.08.10 - 20.08.10 / 2 days 25.08.10 / 1 day	oxygen, salinity, temperature, nutrients, meiofauna	vertical profiles, (water and sediments) discrete sites, point measurements	sediment samples, meiobenthos samples	sample tube, diver, Model DLK-60, Portable Meter, Hach HQ40d, Standard ionomer PH150M
Baltic Sea / Gotland Basin	R/V ALKOR	Research cruise / Olaf Pfannkuche / IFM-GEOMAR	18.09.09 - 06.10.09 / 19 days	benthic fluxes, sediment and pore water biogeochemistry, sediment accumulation rates, CTD profiling, water column sampling	discrete sites, vertical profiles & point measurements	water samples, sediment samples	Benthic landers, CTD, Multiple corer
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Research cruise / Per Hall / UGOT	Nov. 2009 / 2 days	CTD profiling, water column sampling	discrete sites, vertical profiles, discrete time points	water samples	CTD
Black Sea / Bosporus area	R/V ARAR	Research cruise / Namik Çagatay / ITU-EMCOL in collaboration with IBSS/ Sofia Mazlumyan	09.11.09 - 21.11.09 / 9 days	oxygen, salinity, temperature, nutrients, oxygen uptake, N-cycling, geochemistry, sedimentology, meiofauna, macrofauna	discrete sites, vertical profiles & point measurements	water samples, sediment samples	CTD, pump-CTD, Multiple corer, gravity corer, Box corer
Scottish Sea / Loch Etive	R/V CALANUS R/V SOEL MARA	Deployment of Loch Etive Observatory/ Henrik Stahl/ SAMS	27.11.09 - 28.11.09 / 2 days	oxygen, salinity, temperature, pressure, currents	discrete sites, vertical profiles (CTD), time series (Observatory)	water column measurements	CTD,Observatory
Baltic Sea / Eckernfoerde Bay	R/V LITTORINA	Research cruise / diverse leading scientists / IFM-GEOMAR	monthly samnlping from Jan. 2010 to Dec. 2010	porewater chemistry and fluxes	vertical profiles, (water and sediments) discrete sites, point measurements	water samples, sediment samples	CTD, Mini Multiple Corer

Fieldwork and observatory deployments (continued)

Ionian Sea, Greece / Katakolo bay	R/V IRENE	Research cruise / George Papatheodorou/ UPAT	01.03.10 - 06.03.10 / 6 days	temperature, salinity, oxygen, pH, ORP, methane, currents, seismic profiles, sonographs	discrete sites, vertical profiles, point measurements	sediment samples	Aandera RCM9-MKII, YSI 600 XL, IN-SITU TROLL 9500, METS sensor, Sea & Sun Technology, ATM, 3.5kHz profiling system EG&G side scan sonar
Black Sea / Bosporus and Crimean shelf area	R/V MARIA S. MERIAN / MSM 15/1	Research cruise & observatory deployment / Antje Boetius / MPG-MPIMM in collaboration with Eawag, IBSS, Ifremer, ITU-EMCOL, INGV	12.04.10 - 08.05.10 / 24 days	oxygen, salinity, temperature, nutrients, oxygen uptake, N-cycling meiofauna, macrofauna, sedimentology, geochemistry	Discrete sites, vertical profiles, point measurements, transects, time series, drifting	Water samples, sediment samples	CTD, pump-CTD, benthic lander systems, oceanographic moorings, towed observation systems, floats, manned submersible benthic crawlers, Multiple corer, box corer, gravity corer
Baltic Sea / Gotland Basin	R/V PROFESSOR ALBRECHT PENCK	observatory deployment	09.05.10 - 10.05.10 / 1 day	oxygen, salinity, temperature, pressure, redox potential, turbidity, fluorescence	vertical profiles, time series	no samples	GODESS profiling mooring
Black Sea / Romanian shelf	R/V MARE NIGRUM	Research cruise & observatory deployment / Dan Secrieru / GeoEcoMar	14.05.10 – 26.05.10 / 12 days	oxygen, salinity, temperature, pH, beam transmission/ attenuation, turbidity, water column nutrients, phytoplankton, zooplankton, geochemistry, sedimentology, meiofauna, macrofauna, bathymetry, observatory deployment, benthic oxygen and nutrient fluxes (sediment core incubations)	discrete sites, vertical profiles & point measurements	water samples, sediment samples	CTD, Multiple corer, Van Veen, multibeam, Nansen zooplankton net, SEAGUARD RCM 9
Baltic Sea / Gotland Basin	R/V ALKOR	Research cruise / Olaf Pfannkuche / IFM-GEOMAR	29.05.10 - 21.06.10 / 20 days	benthic fluxes, sediment and pore water biogeochemistry, CTD profiling, water column sampling	discrete sites, vertical profiles & point measurements	water samples, sediment samples	Benthic landers, CTD, Multiple corer
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Research cruise / Per Hall / UGOT	Jun. 2010 / 2 days	Benthic fluxes, sediment and pore water biogeochemistry, sediment accumulation rates, CTD profiling, water column sampling	discrete sites, vertical profiles, discrete time points	water samples, sediment samples	Benthic landers, CTD, Multiple Corer
Black Sea / Crimea area	R/V PROFESSOR VODYANITSKYI / Leg 64	Research cruise / Yury Tokarev / IBSS	30.06.10 – 6.07.10 / 7 days	oxygen, salinity, hydrogen sulfide, temperature, nutrients, meiofauna, macrofauna	vertical profiles, discrete sites, point measurements, transects	sediment samples	CTD, bottom-grab, gravity corer
Fram Strait / HAUSGARTEN	R/V POLARSTERN	Research cruise / ARK XXV/2	30.06.10 - 29.07.10 / 30 days	oxygen, salinity, temperature, oxygen uptake, sedimentology, bacteria, meiofauna, macrofauna	discrete sites, vertical profiles & point measurements	water samples, sediment samples	CTD, moorings, Multiple corer, Box corer, Benthic Lander
Ionian Sea, Greece / Aetoliko lagoon	small vessel OCEANIS II	Research cruise / George Papatheodorou/ UPAT	02.07.10 - 06.07.10 / 5 days	temperature, salinity, oxygen, pH, ORP, methane, sulfide, currents, seismic profiles, sonographs	discrete sites, vertical profiles, point measurements	sediment samples, water samples	YSI 600 XL, IN-SITU TROLL 9500, METS sensor, Sea & Sun Technology, ATM, Mini corer, water sampler, ELAC Hydrostar, 3.5kHz profiling system EG&G side scan sonar
Baltic Sea / Gotland Basin	R/V ALKOR R/V MARIA S. MERIAN	observatory deployment	03.07.10 - 05.08.10 / 34 days	oxygen, salinity, temperature, pressure, redox potential, turbidity, fluorescence	vertical profiles, time series	no samples	GODESS profiling mooring

Fieldwork and observatory deployments (continued)

Black Sea / Romanian shelf	R/V MARE NIGRUM	Research cruise / Dan Secrieru / GeoEcoMar	starting 22.07.10 / 2 days for HYPOX	oxygen, salinity, temperature, pH, beam transmission / attenuation, turbidity, nutrients, phytoplankton, zooplankton, geochemistry, sedimentology, meiofauna, macrofauna	discrete sites, vertical profiles & point measurements	water samples, sediment samples	CTD, Multiple corer, Van Veen, Nansen zooplankton net
Swiss lakes / Lake Zug	small research platform SALM I	Research cruise / Mathias Kirf / Eawag	28.07.10 / 1 day	Oxygen finestructure and N-compounds across oxic / anoxic boundary in water column	vertical profiles, discrete sites, discretet time points	water samples	customized CTD ("Profiling Analyzer"; "PIA") for high-resolution profiling of oxygen
Baltic Sea / all major basins NE of Rostock	R/V MARIA S. MERIAN / MSM 16/1a	Research Cruise / Gregor Rehder / IOW	30.7.10 - 22. 8.10 / 24 days	oxgen, methane, CTD, core properties	discrete sites, vertical profiles, point measurements	sediment cores, CTD-stations, hydrocasts	CTD, pump CTD, gracity corer, Rumohr corer, Frahm corer
Baltic Sea / Gotland Basin	R/V SKAGERAK	Research cruise / Per Hall / UGOT	16.08.10 - 01.09.10 / 17 days	benthic fluxes, sediment and pore water biogeochemistry, sed acc rates, CTD profiling, water column sampling	discrete sites, vertical profiles & point measurements	water samples, sediment samples	Benthic landers, CTD, Multiple corer
Black Sea / Romanian shelf	R/V MARE NIGRUM	Research cruise & observatory recouvery / Marian T. Gomoiu & Jana Friedrich / GeoEcoMar & AWI	05.09.10 - 10.09.10 / 6 days	oxygen, salinity, temperature, pH, beam transmission / attenuation, turbidity, water column nutrients, phytoplankton, zooplankton, geochemistry, sedimentology, meiofauna, macrofauna observatory recovery, in-situ benthic oxygen and nutrient fluxes (benthic flux chamber lander), benthic oxygen and nutrient fluxes (sediment core incubation)	discrete sites, vertical profiles & point measurements, time series	water samples, sediment samples	CTD, Multiple corer, Van Veen, Nansen zooplankton net, SEAGUARD RCM 9, benthic flux chamber lander
Swiss lakes / Lake Rotsee	small research platform SALM I	Research cruise / Mathias Kirf / Eawag	14.09.10 / 1 day	Oxygen finestructure and N-compounds across oxic / anoxic boundary in water column	vertical profiles, discrete sites, discretet time points	water samples	customized CTD ("Profiling Analyzer"; "PIA") for high-resolution profiling of oxygen
Ionian Sea, Greece / Amvrakikos gulf and Katakolo bay	R/V BARBADONIS	Research cruise / Giuseppe Etiope / INGV	14.09.10 - 23.09.10 / 10 days GMM observation period 22.09.10 - 31.12.10. GMM recovery 17.01.11.	oxygen, methane, temperature, salinity, turbidity and video images by MEDUSA, Deployment GMM	Transects and long-term monitoring at seabottom	water and sediment samples	MEDUSA, GMM
Swedish fjords / Koljoe Fjord	R/V ALICE	Weekly measurements/ Bengt Liljebladh and Daniel Hansson, UGOT	20.09.10 - 16.11.10 / 58 days	Salinity, temperature, oxygen, phytoplankton, nutrients	Discrete sites at standard depths (according to coastal monitoring program)	Water samples	CTD
Swedish fjords / Himmerfjärden	Small ships of the field station on the island Askö	Deployment of moorings for 24-48 hours / MPG-MPIMM & University of Landau-Koblenz (Departement of Environmental Physics)	24.09.10 - 11.10.10 / 18 days	oxygen, salinity, temperature, current	discrete sites, vertical profiles, discrete time points, time series	flux measurements, hydrographic casts	Seabird MicroCat, Nortec ADV, RDI ADCP, Aanderaa Optodes, Zebra-tech Optodes, RBR thermistors and CTD
Scottish Sea Lochs / Loch Etive	R/V CALANUS R/V SOEL MARA	Recovery of Loch Etive Observatory/ Henrik Stahl/ SAMS	27.09.10 - 28.09.10 / 2 days	oxygen, salinity, temperature, pressure, currents	discrete sites, vertical profiles (CTD), time series (Observatory)	Water column measurements	CTD,Observatory
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Research cruise / Per Hall / UGOT	Oct. 2010 / 2 days	Benthic fluxes, sediment biogeochemistry, CTD profiling, water column sampling	discrete sites, vertical profiles, discrete time points	water samples, sediment samples	Benthic landers, CTD, Multiple Corer
Ionian Sea, Greece / Amvrakikos Gulf	R/V AGIOS SOSTIS	Research cruise / George Papatheodorou/ UPAT	09.10.10 - 10.10.10 / 2 days 14.03.11 - 17.03.11 / 4 days 24.05.11 - 27.05.11 / 8 days	temperature, salinity, oxygen, pH, ORP, methane, sulfide, nutrients, currents (ADCP), geochemistry, sedimentology, micropalaeontology	discrete sites, vertical profiles, point measurements	water samples, sediment samples	YSI 600 XL, IN-SITU TROLL 9500, METS sensor Franatec, H2S ATM - Sea & Sun Technology, ADCP Teledyne, mini corer

Fieldwork and observatory deployments (continued)

Ionian Sea, Greece / Aetoliko lagoon	small vessel OCEANIS II	Research cruise / George Papatheodorou/ UPAT	02.11.10 - 03.11.10 / 2 days 15.02.11 - 16.02.11 / 2 days 29.04.11 - 30.04.11 / 6 days	temperature, salinity, oxygen, pH, ORP, methane, sulfide, nutrients	discrete sites, vertical profiles, point measurements	water samples	YSI 600 XL, IN-SITU TROLL 9500, METS sensor Franatec, H2S ATM - Sea & Sun Technology.
Baltic Sea / Gotland Basin	R/V HEINCKE R/V ALKOR	observatory deployment	16.11.10 - 11.01.11 / 56 days	oxygen, temperature, salinity, oxydation/reduction potential, pH, turbidity, fluorescence	vertical profiles, time series	no samples	GODESS profiling mooring
Swiss lakes / Lake Zurich	small research platform SALM I	Coring for Fe, Mn analysis / Eawag	17.11.10 / 1day	oxygen measurements	discrete sites, vertical profiles, discrete time points	Sediment cores	CTD, sediment corer
Scottish Sea Lochs / Loch Etive	R/V CALANUS R/V SOEL MARA	Deployment of Loch Etive Observatory / Henrik Stahl / SAMS	15.01.11 - 16.01.11 / 2 days	oxygen, salinity, temperature, pressure, currents	discrete sites, vertical profiles (CTD), time series (Observatory)	Water column measurements	CTD, Observatory
Tropical NE Atlantic off Mauretania / HYPOX related OMZ site	R/V MARIA S. MERIAN / MSM 17/4	Deployment of BBL-Profiler	12.03.11 - 21.04.11 / 40 days	oxygen, salinity, temperature, current (ADV)	discrete sites, vertical profiles, time series	4 to 48 hour long measurements of the vertical gradients of oxygen, salinity, temperature and current velocity	Seabird MicroCat, Nortec ADV, Aanderaa Optodes
Black Sea / Romanian shelf	R/V MARE NIGRUM	Research Cruise / in situ observations & sampling program / Dan Secrieru / GeoEcoMar	01.04.11 - 04.04.11 / 3 days	oxygen, salinity, temperature, pH, beam transmission / attenuation, turbidity, nutrients, phytoplankton, zooplankton, geochemistry, sedimentology, meiofauna, macrofauna, bathymetry	discrete sites, vertical profiles & point measurements	water samples, sediment samples	CTD, Multicorer, Van Veen, Seaguard, multibeam, Nansen zooplankton net
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Observatory deployment, System test, Software test / UGOT & UNI-HB	18.04.11 - 19.04.11 / 2 days	oxygen, conductivity, pressure, temperature, doppler current sensor parameters	vertical profiles, time series	no samples	Seaguard, RDCP, optodes, pCO2 sensor, S and T sensors
Scottish Sea Lochs / Loch Etive	R/V CALANUS R/V SOEL MARA	Recovery of Loch Etive Observatory/ Henrik Stahl/ SAMS	05.05.11 - 06.05.11 / 2 days	oxygen, salinity, temperature, pressure, currents	discrete sites, vertical profiles (CTD), time series (Observatory)	Water column measurements	CTD,Observatory
Baltic Sea, Gotland Basin	R/V ALKOR 355	Research Cruise	29.05.11 - 21.06.11 / 24 days	Oxygen, N-species(dinitrogen, nitrite, nitrate, ammonium), sulfide sulfate, phosphate, silicate, total alkalinity, pore water geochemistry, temperature, salinity, seafloor imaging	discrete sites, in situ fluxes in benthic chambers, micro-profiles, water column profiles, vertical pore water profiles	water samples, sediment samples, photo and video footage	CTD, Lander, transecting micro-profiler, eddy correlation, multiple corer
Swedish fjords	R/V ALICE	Research cruise / Bengt Liljebladh and Per Hall / UGOT	30.05.11 - 31.05.11 / 2 days	Oxygen gradient together with physical measurements	Continuous measurements of O2, sal., temp. at two depths; current and turbulence measurements at bottom with ADV	Water samples	ADV, optodes, S and T sensors, RCM9
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Research cruise / Per Hall / UGOT	Jun. 2011 / 2 days	Benthic fluxes, sediment biogeochemistry, CTD profiling, water column sampling	discrete sites, vertical profiles, discrete time points	water samples, sediment samples	Benthic landers, CTD, Multiple Corer
North Sea / Sylt	shore based work	Sampling for microbiological and biogeochemical experiments / Gerdhard Jessen / MPG-MPIMM	08.06.11 / 1 day	oxygen measurements, microbial ecology, biogeochemistry	Sylt long term ecological field site	Sediment cores, seawater	Sediment corer
Fram Strait / HAUSGARTEN	R/V POLARSTERN / ARK XXVI-2	Research cruise / Michael Klages / AWI & MPG-MPIMM	13.07.11 - 03.08.11 / 22 days	oxygen, salinity, temperature, oxygen uptake, sedimentology, bacteria, meiofauna	discrete sites, vertical profiles & point measurements	water samples, sediment samples	CTD, moorings, multiple corer, ROV, Benthic Lander
Scottish Sea / Loch Etive	R/V Calanus R/V Soel Mara	Redeployment of observatory	15.08.11-16.08.11 / 2 days	oxygen, salinity, temperature, pressure, currents	discrete sites, vertical profiles (CTD), time series (Observatory)	water column measurements	CTD,Observatory
Baltic Sea / Gotland Basin	R/V ELISABETH MANN BORGESE	deployment of GODESS profiling mooring (failed)	19.8.11 / 1 day	oxygen, salinity, temperature, pressure, redox potential, turbidity, fluorescence	discrete sites, discrete time points, vertical profiles (one CTD profile)	no samples	ship CTD, GODESS CTD

Fieldwork and observatory deployments (continued)

Baltic Sea / Hel, Gdansk Bay	shore based work	Field campaign / Frank Wenzhöfer / MPG-MPIMM	23.8.11 / 10 days	oxygen, currents, benthic fluxes of oxygen, nutrients, and sulfide, groundwater seepage rates, sediment topographies	discrete sites, discrete time points and time series	Water samples	recording current meter, benthic chambers, Eddy Correlation System, sediment surface scanner
Swedish fjords / Himmerfjärden	Small ships of the field station on the island Askö	Research cruise / MPG-MPIMM & Stockholm University	10.11.11 - 21.11.11	oxygen, salinity, temperature, currents (ADV), nutrients	discrete sites, time series, vertical profiles	short term moorings: 24-48 hour time series of vertical profiles, flux measurements	Seabird MicroCat, Nortec ADV, Aanderaa Optodes, CTD
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Research cruise & observatory service / Per Hall / UGOT	05.12.11 - 09.12.11 / 5 days	Benthic fluxes, sediment and pore water biogeochemistry, sediment accumulation rates, CTD profiling, water column sampling, oxygen gradients & currents in BW	discrete sites, vertical profiles (water and sediment), discrete time points	water samples, sediment samples	Benthic landers, CTD, Multiple corer
Scottish Sea / Loch Etive	R/V Calanus R/V Soel Mara	Recovery of observatory	12.01.12 - 13.01.12 / 2 days	oxygen, salinity, temperature, pressure, currents	discrete sites, vertical profiles (CTD), time series (Observatory)	water column measurements	CTD,Observatory
Ionian Sea, Greece / Aetoliko lagoon	small vessel OCEANIS II	Research cruise / George Papatheodorou/ UPAT	13.01.12 - 16.01.12 / 4 days	sonographs	2-D seabottom coverage	no samples	EG&G side scan sonar
Swedish fjords /	R/V ALICE	Research cruise / Bengt Liljebladh Per Hall / UGOT	06.03.12 - 08.03.12 / 3 days	Water column profiles of nutrients, benthic nutrient and DIC fluxes, CTD profiling, 2-D oxygen imaging across sediment-water interface in situ	discrete sites, vertical profiles (water and sediment), discrete time points	water samples, sediment samples	Benthic landers, Planar optode, CTD, Rosette sampler
Swedish fjords / Koljoe Fjord	R/V SKAGERAK	Research cruise / Per Hall / UGOT	16.04.12 - 21.04.12 / 6 days	Benthic fluxes, sediment and pore water biogeochemistry, 2-D oxygen imaging across sediment-water interface in situ, CTD profiling, water column sampling, oxygen gradients & currents in BW	discrete sites, vertical profiles (water and sediment), discrete time points	water samples, sediment samples	Benthic landers, Planar optode, CTD, Rosette sampler

4.1.6.5 Data generated in HYPOX

DATA GENERATED IN HYPOX					
General info & contact		**Time period covered**	**Type of data and archive information**		
Region / site / data origin	**Responsible scientist / institution / email**	**Start / End / duration**	**Parameters / Gear**	**Coverage**	**Data archive name / URL**
Partner 1 (MPG-MPIMM)					
Black Sea / western part / R/V METEOR	Gaute Lavik / MPIMM / glavik@mpi-bremen.de	15.05.07	oxygen, salinity, temperature, pressure, turbidity, chlorophyll-fluorescence / CTD	discrete sites, vertical profiles, transect	PANGAEA Archive / http://doi.pangaea.de/10.1594/PANGAEA.733529
Black Sea / Bosporus area / R/V ARAR	Moritz Holtappels / MPG-MPIMM / mholtapp@mpi-bremen.de	11.11.09 - 19.11. 09	oxygen, salinity, temperature, nutrients / CTD	vertical profiles	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.733533
Black Sea / Bosporus area & Crimean Shelf / R/V M.S.MERIAN	Antje Boetius / MPG-MPIMM / aboetius@mpi-bremen.de	12.04.10 - 08.05.10	cruise track / research vessel	transects	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.738639
Black Sea / Bosporus area & Crimean Shelf / R/V M.S.MERIAN	Anna Lichtschlag / MPG-MPIMM / alichtsc@mpi-bremen.de	12.04.10 - 08.05.10	pore water and solid phase geochemistry, sulfate reduction rates, procaryotes abundance / Multicorer sediment cores	discrete sites, vertical profiles in the sediment	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22sediment+core%22+and+lichtschlag+and+msm15%2F1 (53 data sets)
Black Sea / Bosporus area & Crimean Shelf / R/V M.S.MERIAN	Anna Lichtschlag / MPG-MPIMM / alichtsc@mpi-bremen.de	12.04.10 - 08.05.10	high resolution oxygen microsensor profiles / in situ micro profiler	discrete sites, vertical profiles, discrete time points	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22in+situ+oxygen+microprofile*%22+and+wenzh%F6fer+and+msm15%2F1 (15 data sets)
Black Sea / Bosporus area & Crimean Shelf / R/V M.S.MERIAN	Moritz Holtappels / MPG-MPIMM / mholtapp@mpi-bremen.de	12.04.10 - 08.05.10	oxygen, salinity, temperature, pressure, turbidity, chlorophyll-fluorescence / CTD	discrete sites, vertical profiles, discrete time points	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.762412
Black Sea / Bosporus area & Crimean Shelf / R/V M.S.MERIAN	Antje Boetius / MPG-MPIMM / aboetius@mpi-bremen.de	17.04.2010	navigation track / TV guided multiple corer	transect	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.740086
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Antje Boetius / MPG-MPIMM / aboetius@mpi-bremen.de	17.04.10 - 06.05.10	swath sonar bathymetry / multibeam echosounder	transects	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.738638
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Antje Boetius / MPG-MPIMM / aboetius@mpi-bremen.de	20.04.10 - 22.04.10	survey Position data / towed system MEDUSA	transects	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.740092
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Antje Boetius Jan Fischer Anna Lichtschlag / MPG-MPIMM / aboetius@mpi-bremen.de jfischer@mpi-bremen.de alichtsc@mpi-bremen.de	20.04.10 - 24.04.10	oxygen temperature / Clark electrode, optode, Pt100 / MEDUSA towed system	transects	PANGAEA Archive (2010) / http://www.pangaea.de/search?q=%22physical+oceanography%22+and+merian+and+boetius (4 data sets)
Black Sea / Crimean Shelf / R/V M.S.MERIAN R/V M.S.MERIAN	Antje Boetius / MPG-MPIMM / aboetius@mpi-bremen.de	20.04.10 - 04.05.10	sediment echo sounding profile / Parasound	transect	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.738640
Black Sea / Bosporus area & Crimean Shelf / Short term moorings	Moritz Holtappels / MPG-MPIMM / mholtapp@mpi-bremen.de	22.04.10 - 07.05.10 / 15 days	temperature, salinity, oxygen, current moored CTDs	discrete sites, discrete depths, time series	PANGAEA Archive / http://www.pangaea.de/search?q=%22Physical+oceanography+at+time+series+station%22+and+holtappels (15 data sets)
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Antje Boetius / MPG-MPIMM / aboetius@mpi-bremen.de	25.04.10 - 06.05.10	survey position data / manned submersible JAGO	transects	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.740088
Black Sea / Crimean Shelf / R/V M.S. Merian	Jan Fischer / MPG-MPIMM / jfischer@mpi-bremen.de	25.04.10 - 06.05.10	time series: bottom water oxygen profiles / MultiFiberOptode (MuFO)	discrete sites, vertical profiles, discrete time points	will be uploaded to Pangaea after completion of sample and data analysis
Partner 2 (AWI)					
Fram Strait / Haus-garten / R/V POLARSTERN, ATALANTE, MARIA S. MERIAN	Thomas Soltwedel Ingo Schewe / AWI / tsoltwedel@awi-bremerhaven.de ischewe@awi-bremerhaven.de	2000 - 2009	oxygen / Winkler samples from sediment-overlying waters	discrete sites, discrete time points	PANGAEA Archive (2010) / http://www.pangaea.de/search?q=hypox+%22dissolved+oxygen%22+and+sauter+or+soltwedel+not+%22oxygen+optode%22+not+amvrakikos (12 data sets)
Fram Strait / Haus-garten / Long term benthic observatory	Thomas Soltwedel Ingo Schewe / AWI / tsoltwedel@awi-bremerhaven.de ischewe@awi-bremerhaven.de	14.07.04 - 14.07.12 / > 2000 days	oxygen, temperature / optode on long term benthic observatory	discrete sites, time series	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=citation%3AOptode+citation%3A%22physical+oceanography%22+citation%3Ahausgarten (7 data sets)
Black Sea/ Romanian shelf/ Northwestern Shelf Observatory	Jana Friedrich / AWI / Jana.Friedrich@awi-bremerhaven.de	22.05.10 - 29.08.10 / 100 days	oxygen, temperature salinity, turbidity, current speed and direction / recording current meter SEAGUARD RCM9	Discrete site, time series	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.746272

Data generated in HYPOX (continued)

Partner 3 (Eawag)					
Swiss lakes / Lake Rot / SALM I	Sebastian Naeher / Eawag / sebastian.naeher @eawag.ch	2009, 2010 / covers approx. 150 years of lake history	TOC, TIC, N concentrations, C/N ratios, d13C, d15N, chlorin index and chlorin concentrations data, diatoms, porosity, accumulation rates, trace metals	discrete sites, vertical profiles in the sediment	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+and +%22lake+rot%22+and+naeher (7 data sets)
Swiss lakes / Lake Zurich / ArETHuse	Sebastian Naeher / Eawag / sebastian.naeher @eawag.ch	2009, 2010 / covers approx. 110 years of lake history	TOC, TIC, N concentrations, C/N ratios, d13C, d15N, chlorin index and chlorin concentrations	discrete sites, vertical profiles in the sediment	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+and +%22lake+zurich%22+and+naeher (7 data sets)
Ionian Sea, Greece / Amvrakikos Gulf /	Sebastian Naeher / Eawag / sebastian.naeher @eawag.ch	2010 / covers approx. 50 years of gulf history	TOC, TIC, N concentrations, C/N ratios, d13C, d15N, chlorin index and chlorin concentrations	discrete sites, vertical profiles in the sediment	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+and +amvrakikos+and+naeher (4 data sets)
Swiss lakes / Lake Zug / SALM I	Mathias Kirf / Eawag / mathias.kirf@eawag.ch	28.07.10	oxygen finestructure and N-compounds across oxic / anoxic boundary in water column / customized CTD ("Profiling Analyzer"; "PIA") for high-resolution profiling of oxygen	discrete sites, vertical profiles, discrete time points	PANGAEA Archive (2011 & 2012) / http://www.pangaea.de/search?q=hypox+and +%22lake+zug%22+and+kirf (8 data sets)
Swiss lakes / Lake Rot / SALM I	Mathias Kirf / Eawag / mathias.kirf@eawag.ch	14.09.10	oxygen finestructure and N-compounds across oxic / anoxic boundary in water column / customized CTD ("Profiling Analyzer"; "PIA") for high-resolution profiling of oxygen	discrete sites, vertical profiles, discrete time points	PANGAEA Archive (2011 & 2012) / http://www.pangaea.de/search?q=hypox+and +%22lake+rot%22+and+kirf (5 data sets)
Partner 4 (IBSS)					
Black Sea / Crimean Shelf - Sevastopol Bay inner part & outer part, Omega Bay, Tarkhankut / M/B T.I. VYAZEMSKIY & shore-based research	Sergey Konovalov / MHI / sergey_konovalov @yahoo.com Nelli Sergeeva / IBSS / nserg05@mail.ru	07.2009 & 09.2009 & 10.2009 & 12.2009 & 12.2009	Sediment pore water chemistry / Voltammetry & geological corer	discrete sites, vertical sediment profiles, discrete time points	PANGAEA Archive (2010) / http://doi.pangaea.de/10.1594/PANGAEA.753516
Black Sea / Crimean Shelf - Sevastopol Bay outer road - inner part - Omega Bay / M/B T.I. VYAZEMSKIY	Nelli Sergeeva Kateryna Ivanova / IBSS / nserg05@mail.ru	21.07.09 - 08.07.10	Meiofauna / sediment cores taken by SCUBA divers	discrete sites, discrete time points	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.767385
Black Sea / Crimean Shelf - Tarkhankut / shore-based research	Sergey Konovalov / MHI / sergey_konovalov @yahoo.com Nelli Sergeeva Maxim Gulin / IBSS / nserg05@mail.ru m_gulin@mail.ru	05.09.09	bottom water hydrochemistry, oxygen, BOD / Niskin Bottles, in situ oxymeter-thermometer HQ40d and Hach Sension-5 conductivitiy probe, wet chemical methods	discrete sites, discrete time points	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.769697
Black Sea / Bosporus area / R/V ARAR	Nelli Sergeeva Sofia Mazlumyan / IBSS / nserg05@mail.ru mazlmeister@gmail.com	11.11.09 - 19.11. 09	Meiofauna / Multiple Corer samples	discrete sites, transect, discrete time points	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.762131
Black Sea / Crimean Shelf - Sevastopol Bay outer part - inner part, Omega Bay / M/B T.I. VYAZEMSKIY	Sergey Konovalov / MHI / sergey_konovalov @yahoo.com Nelli Sergeeva / IBSS / nserg05@mail.ru	01.2010 & 03.2010 & 05.2010	Sediment pore water chemistry / Voltammetry & geological corer	discrete sites, vertical sediment profiles, discrete time points	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.767384
Black Sea / Crimean Shelf - Sevastopol Bay outer road - inner part - Omega Bay/ M/B T.I. VYAZEMSKIY	Sergey Konovalov / MHI / sergey_konovalov@yahoo.com Nelli Sergeeva / IBSS / nserg05@mail.ru	28.01.10 - 18.05.10	Bottom water chemistry / Niskin bottle	discrete time points, transect	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.769698
Black Sea / Bosporus area / R/V M.S.MERIAN	Nelli Sergeeva Sofia Mazlumyan / IBSS / nserg05@mail.ru mazlmeister@gmail.com	12.04.10 - 18.04.10	Meiofauna / Multiple Corer samples	discrete sites, transect, discrete time points	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.777375
Black Sea / Bosporus area / R/V M.S.MERIAN	Natalya Boltacheva / IBSS / nboltacheva@mail.ru	12.04.10 - 18.04.10	Macrofauna / Box Corer samples	discrete sites, transect, discrete time points	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.777378
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Natalya Boltacheva / IBSS / nboltacheva@mail.ru	21.04.10 - 06.05.10	Macrofauna / Box Corer samples	discrete sites, transect, discrete time points	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.777377
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Nelli Sergeeva / IBSS / nserg05@mail.ru	25.04.10 - 06.05.10	Meiofauna / Multiple Corer samples	discrete sites, transect, discrete time points	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+sergeeva +meiobenthos+crimea (2 data sets)

Data generated in HYPOX (continued)

Partner 5 (IFM-GEOMAR)					
Baltic Sea / Gotland Basin / R/V ALKOR	O. Pfannkuche / GEOMAR / opfannkuche @ifm-geomar.de	18.09.09 - 05.10.09	Geochemical pore water data / Multiple Corer sediment cores	discrete sites, discrete time points, depth transect, vertical sediment profiles	PANGAEA Archive (2011) / http://www.pangaea.de/search?q=hypox+pfannkuche+%22AL346%22+not+%22water+bottle%22 (11 data sets)
Baltic Sea / Gotland Basin / R/V ALKOR	O. Pfannkuche / GEOMAR / opfannkuche @ifm-geomar.de	20.09.09 - 21.09.09	oxygen, hydrochemistry / CTD / Rosette	discrete sites, discrete time points, vertical profiles	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.771968
Baltic Sea / Boknis Eck (Eckernförde Bay) / R/V ALKOR, POLARFUCHS, LITTORINA	A. Dale / GEOMAR / adale@geomar.de	18.02.10 - 17.02.11 (14 cruises)	Geochemical pore water and particulate data / Multiple Corer sediment cores	discrete site, discrete time points, vertical sediment profiles	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+dale+%22boknis%20eck%22 (2 data sets)
Baltic Sea / Gotland Basin / R/V ALKOR	O. Pfannkuche / GEOMAR / opfannkuche @ifm-geomar.de	29.05.10 - 21.06.10	Geochemical pore water data / Multiple Corer sediment cores	discrete sites, discrete time points, depth transect, vertical sediment profiles	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+pfannkuche+%22AL355%22+not+%22water+bottle%22 (27 data sets)
Partner 6 (Ifremer)					
Black Sea / Bosporus area / R/V M.S.MERIAN	Jean Francois Rolin / Ifremer / Jean.Francois.Rolin @ifremer.fr	16.04.10 - 03.06.10 / 49 days	oxygen, salinity, temperature / PROVOR-DO float	drifting, time series, vertical profiles	Coriolis data base / http://www.coriolis.eu.org/Data-Services-Products/View-Download/Access-to-Argo-floats-by-WMO-number (float reference 5902291)
Partner 7 (INGV)					
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Giuditta Marinaro / INGV / giuditta.marinaro@ingv.it	20.04.10 - 24.04.10	oxygen, methane, temperature, salinity, turbidity and video images / MEDUSA towed system	transects	PANGAEA Archive (2010) / http://www.pangaea.de/search?q=hypox+%22lo%20bue%22+merian (5 data sets)
Ionian Sea, Greece / Amvrakikos Gulf, Aetoliko lagoon / Local vessels	Giuseppe Etiope / INGV / giuseppe.etiope@ingv.it	14.09.10 - 23.09.10	oxygen, methane, temperature, salinity, turbidity and video images / MEDUSA towed system	transects	PANGAEA Archive (2011) / http://www.pangaea.de/search?q=hypox+and+etiope+and+amvrakikos+and+medusa+not+katakolo (9 data sets)
Ionian Sea, Greece / Katakolo Bay / Local vessels	Giuseppe Etiope / INGV / giuseppe.etiope@ingv.it	14.09.10 - 23.09.10	oxygen, methane, temperature, salinity, turbidity and video images / MEDUSA towed system	transects	PANGAEA Archive (2011) / http://www.pangaea.de/search?q=hypox+and+etiope+and+medusa+and+katakolo+not+gmm (9 data sets)
Ionian Sea, Greece / Amvrakikos Gulf, Aetoliko lagoon, Katakolo Bay / Local vessels	Giuseppe Etiope / INGV / giuseppe.etiope@ingv.it	14.09.10 - 23.09.10	Methane & sulfide isotopes / direct underwater sampling by scuba divers, gas chromatorgraphy, mass spectrometry	discrete sites at seabottom	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.780270
Ionian Sea, Greece / Amvrakikos and Aetoliko lagoons, Katakolo Bay / Local vessels	Giuseppe Etiope / INGV / giuseppe.etiope@ingv.it	22.09.10 - 31.12.10	oxygen, methane, temperature, salinity turbidity currents / GMM benthic observatory	time series, discrete sites at seabottom	PANGAEA Archive (2011) / http://doi.pangaea.de/10.1594/PANGAEA.762950
Partner 8 (IOW)					
Baltic Sea / Mecklenburg Bight, Arkona Basin, Bornholm Basin, Southern Gotland Basin / R/V POSEIDON	Rudolf Endler / IOW / rudolf.endler @io-warnemuende.de	29.11.09 - 17.12.09	geological data	discrete sites, vertical sediment profiles, discrete time points	will be uploaded to Pangaea after completion of sample and data analysis
Baltic Sea / Gotland Basin / GODESS	Ralf Prien / IOW / ralf.prien @io-warnemuende.de	09.05.10 - 10.05.10 / 1 day	oxygen, salinity, temperature, pressure, redox potential, turbidity, fluorescence / GODESS profiling mooring	discrete site, time series of vertical profiles	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.777607
Baltic Sea / Gotland Basin / GODESS	Ralf Prien / IOW / ralf.prien @io-warnemuende.de	03.07.10 - 05.08.10 / 34 days	oxygen, salinity, temperature, pressure, redox potential, turbidity, fluorescence / GODESS profiling mooring	discrete site, time series of vertical profiles	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.777608
Baltic Sea / Arkona Basin, Bornholm Basin, Gotland Basin, Bothnian Bay, Bothnian Sea / R/V M.S.MERIAN	Gregor Rehder / IOW / gregor.rehder @io-warnemuende.de	31.07.10 - 22.08.10	oxygen, salinity, temperature, depth, methane / CTD	Discrete site, time series of vertical profiles	PANGAEA Archive (2012) http://doi.pangaea.de/10.1594/PANGAEA.780460
Baltic Sea / Arkona Basin, Bornholm Basin, Gotland Basin, Bothnian Bay, Bothnian Sea / R/V M.S.MERIAN	Gregor Rehder / IOW / gregor.rehder@io-warnemuende.de	31.07.10 - 22.08.10	geological data	discrete sites, vertical sediment profiles, discrete time points	will be uploaded to Pangaea after completion of sample and data analysis
Baltic Sea / Gotland Basin / GODESS	Ralf Prien / IOW / ralf.prien @io-warnemuende.de	16.11.10 - 11.01.11 / 56 days	oxygen, salinity, temperature, pressure, redox potential, turbidity, fluorescence / GODESS profiling mooring	discrete site, time series of vertical profiles	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.777609
Baltic Sea / Mecklenburg Bight, Arkona Basin, Bornholm Basin, Southern Gotland Basin / R/V POSEIDON	Rudolf Endler / IOW / rudolf.endler @io-warnemuende.de	29.11.09 - 17.12.09	oxygen, salinity, temperature, depth, methane / CTD	discrete sites, vertical profiles, discrete time points	will be uploaded to Pangaea after completion of sample and data analysis
Partner 9 (ITU-EMCOL)					
Black Sea / Bosporus area / R/V ARAR	M. Namık Çağatay Zeynep Erdem / ITU-EMCOL / cagatay@itu.edu.tr Erdemz@itu.edu.tr	11.11.09 - 19.11.09	major and minor elements / Interface Gravity Corer, mini Multiple Corer, Long Gravity Corer & XRF Corescanner	discrete sites, transects, vertical sediment profiles, discrete time points	PANGAEA Archive (2010) / http://www.pangaea.de/search?q=hypox+arar_2009+geochemistry (24 data sets)

Data generated in HYPOX (continued)

Black Sea / Bosporus area / R/V ARAR	M. Namık Çağatay Zeynep Erdem / ITU-EMCOL / cagatay@itu.edu.tr Erdemz@itu.edu.tr	11.11.09 - 19.11. 09	total organic carbon and total inorganic carbon / Interface Gravity Corer, mini Multiple Corer, Long Gravity Corer & Schimadzu TOC Analyzer	discrete sites, transects vertical sediment profiles, discrete time points	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=TOC+and +hypox+and+ARAR_2009 (7 data sets)
Black Sea / Bosporus area / R/V M.S.MERIAN	M. Namık Çağatay Zeynep Erdem / ITU-EMCOL / cagatay@itu.edu.tr Erdemz@itu.edu.tr	12.04.10 - 19.04.10	major and minor elements / Interface Gravity Corer, Long Gravity Corer & XRF Corescanner	discrete sites, transects vertical sediment profiles, discrete time points	PANGAEA Archive (2010) / http://www.pangaea.de/search?q=hypox +MSM15%2F1+geochemistry (17 data sets)
Black Sea / Bosporus area / R/V M.S.MERIAN	M. Namık Çağatay Zeynep Erdem / ITU-EMCOL / cagatay@itu.edu.tr Erdemz@itu.edu.tr	12.04.10 - 19.04.10	total organic carbon and total inorganic carbon / Interface Gravity Corer, Long Gravity Corer & Schimadzu TOC Analyzer	discrete sites, transects vertical sediment profiles, discrete time points	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=TOC+and +hypox+and+MSM15%2F1 (6 data sets)
Partner 11 (SAMS)					
Scottish Sea Lochs / lower Loch Etive (Airds bay) / R/V CALANUS	Henrik Stahl / SAMS / henrik.stahl@sams.ac.uk	2009 - 2011	physical oceanography, oxygen / CTD	discrete sites, vertical profiles	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22station +loch+etive%22+and+%22airdsbay%22+not +%22time+series%22 (3 data sets)
Scottish Sea Lochs / upper Loch Etive / R/V CALANUS	Henrik Stahl / SAMS / henrik.stahl@sams.ac.uk	2009 - 2012	physical oceanography, oxygen / CTD	discrete sites, vertical profiles	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22Loch +Etive%2C+Hypox+site%22+OR+%22Upper +Loch+Etive%2C+re5%22 (10 data sets)
Scottish Sea Lochs / lower Loch Etive Airds bay stand alone observatory	Henrik Stahl / SAMS / henrik.stahl@sams.ac.uk	01.09.09 - 30.05.10 / 271 days	physical oceanography, oxygen / mooring (CTD)	discrete sites, discrete depths (22m), time series	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.779865
Scottish Sea Lochs / upper Loch Etive / Loch Etive Cabled Observatory	Henrik Stahl / SAMS / henrik.stahl@sams.ac.uk	08.12.09 - 04.12.11 / 726 days	physical oceanography, oxygen, currents / Loch Etive cabled observatory (RDCP 600)	discrete sites, discrete depths (124m), time series	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22upper +loch+etive%22+and+%22124+m%22+and +%22time+series%22 (3 data sets)
Scottish Sea Lochs / upper Loch Etive / Loch Etive Cabled Observatory	Henrik Stahl / SAMS / henrik.stahl@sams.ac.uk	04.02.10 - 04.12.11 / 488 days	physical oceanography, oxygen, currents / Loch Etive cabled observatory (Seaguard)	discrete sites, discrete depths (14m), time series	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22upper +loch+etive%22+and+%2214+m%22+and +%22time+series%22 (3 data sets)
Scottish Sea Lochs / upper Loch Etive / Loch Etive Cabled Observatory	Henrik Stahl / SAMS / henrik.stahl@sams.ac.uk	24.01.11 - 04.12.11 / 314 days	physical oceanography, oxygen, currents / Loch Etive cabled observatory (Seaguard)	discrete sites, discrete depths (14m), time series	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22Loch+Etive +cabled+observatory+SeaGuard+data%22 (8 data sets)
Scottish Sea Lochs / upper Loch Etive / Loch Etive Cabled Observatory	Henrik Stahl / SAMS / henrik.stahl@sams.ac.uk	24.01.11 - 04.12.11 / 314 days	physical oceanography, oxygen, currents / Loch Etive cabled observatory (RDCP 600)	discrete sites, discrete depths (124m), time series	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22Loch+Etive +cabled+observatory+rdcp%22 (9 data sets)
Partner 12 (UGOT)					
Swedish Fjords / Koljoe Fjord / diverse local vessels	Per Hall / UGOT / perhall@chem.gu.se Phillip Axe / SMHI / Phillip.Axe@SMHI.se	1930 -2010	oxygen, salinity, temperature, nutrients / CTD	discrete sites, vertical profiles, discrete time points	PANGAEA Archive (2010) / http://dataportals.pangaea.de/hypox/index.php? ptype=data&formtype=simple&q_=smhi (276 data sets)
Swedish Fjords / Koljoe Fjord / R/V SKAGERAK	Per Hall Madeleine Nilsson Mikhail Kononets / UGOT / perhall@chem.gu.se madnil@chem.gu.se m.kononets@chem.gu.se	06.2009, 08.2009, 10.2009, 04.2010, 06.2010, 10.2010, 06.2011	oxygen, salinity, temperature, pressure / CTD	discrete sites, vertical profiles, discrete time points	will be uploaded to Pangaea after completion of sample and data analysis
Baltic Sea / Gotland Basin / R/V ALKOR, SKAGERAK	Per Hall Madeleine Nilsson Mikhail Kononets / UGOT / perhall@chem.gu.se madnil@chem.gu.se m.kononets@chem.gu.se	08.09.09 - 06.10.09 06.2010 08.2010	benthic fluxes of oxygen and DIC / benthic chamber lander	discrete sites, discrete time points	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.779611
Swedish Fjords / Havstens Fjord / Autonomous moored observatory	Per Hall Mikhail Kononets Anders Tengberg / UGOT / perhall@chem.gu.se m.kononets@chem.gu.se anderste@chem.gu.se	Nov. 2009 - Apr. 2011	oxygen, salinity, temperature, currents	Continuous measurements at several depths.	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox +%22havstens+fjord%22 (5 data sets)
Swedish Fjords / Koljoe Fjord / R/V SKAGERAK	Per Hall Madeleine Nilsson Mikhail Kononets / UGOT / perhall@chem.gu.se madnil@chem.gu.se m.kononets@chem.gu.se	06.2010 10.2010 & 06.2011	benthic fluxes of oxygen and DIC / benthic chamber lander	discrete sites, discrete time points	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.779604
Swedish Fjords / Koljoe Fjord / Cabled observatory	Per Hall Mikhail Kononets Anders Tengberg / UGOT / perhall@chem.gu.se m.kononets@chem.gu.se anderste@chem.gu.se Christoph Waldmann Andree Behnken / MARUM / waldmann@marum.de abehnken@marum.de	since 12.07.2011	oxygen, pCO2, salinity, temperature, currents / cabled observatory, on-line real time data and archived data, Seaguard	discrete site, time series, several discrete depths	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+and +%22Koljoefjord+cabled+observatory+seaguard%22 (9 data sets)

Data generated in HYPOX (continued)

Swedish Fjords / Koljoe Fjord / Cabled observatory	Per Hall Mikhail Kononets Anders Tengberg / UGOT / perhall@chem.gu.se m.kononets@chem.gu.se anderste@chem.gu.se Christoph Waldmann Andree Behnken / MARUM / waldmann@marum.de abehnken@marum.de	since 12.07.2011	oxygen, pCO2, salinity, temperature, currents / cabled observatory, on-line real time data and archived data, RDCP	discrete site, time series, several discrete depths	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=hypox+and+%22Koljoefjord+cabled+observatory+RDCP%22 (6 data sets)
Partner 13 (UPAT)					
Ionian Sea, Greece / Amvrakikos Gulf / R/V Eirini NP464	George Papatheodorou / UPAT / gpapathe@upatras.gr	Jul. 2008	Natural radionuclides,137-Cs activity concentrations, Fe, Mn / sediment cores	discrete sites, vertical sediment profiles, discrete time points	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.780288
Ionian Sea, Greece / Amvrakikos Gulf / R/V Eirini NP464	George Papatheodorou / UPAT / gpapathe@upatras.gr	Aug. 2009, Jul. 2010, Mar. 2011, May 2011	oxygen, salinity, temperature, pressure, pH, ORP / CTD	discrete sites, vertical profiles	PANGAEA Archive (2010, 2012) / http://www.pangaea.de/search?q=%22Physical+oceanography%22+and+UPAT+and+%22Amvrakikos+gulf+%22+not+gmm (4 data sets)
Ionian Sea, Greece / Aetoliko lagoon / Oceanis II	George Papatheodorou / UPAT / gpapathe@upatras.gr	Jun./Jul. 2010, Nov. 2010, Feb. 2011, Apr. 2011	oxygen, salinity, temperature, pressure, pH, ORP / CTD	discrete sites, vertical profiles	PANGAEA Archive (2012) / http://www.pangaea.de/search?q=%22Physical+oceanography%22+UPAT+and+%22Aetoliko+lagoon%22+not+gmm (4 data sets)
Ionian Sea, Greece / Amvrakikos Gulf / R/V Eirini NP464	George Papatheodorou / UPAT / gpapathe@upatras.gr	Jul. 2010, Mar. 2011	Currents / ADCP	transect, discrete time points, vertical profiles	PANGAEA Archive (2010, 2012) / http://www.pangaea.de/search?q=%22Current+velocity%22+and+UPAT+and+%22Amvrakikos+gulf%22 (7 data sets)
Ionian Sea, Greece / Aetoliko lagoon / Oceanis II	George Papatheodorou / UPAT / gpapathe@upatras.gr	Jul. 2010	bathymetry / SBES echosounder	discrete sites, vertical profiles, bathymetric points	PANGAEA Archive (2012) / http://doi.pangaea.de/10.1594/PANGAEA.777087
Ionian Sea, Greece / Amvrakikos Gulf / R/V Eirini NP 464	Maria Geraga/ UPAT/ mgeraga@upatras.gr	14.03.11	benthic foraminifera / Kajak sediment core sampler	discrete sites, vertical sediment profiles	PANGAEA Archive (2012) http://www.pangaea.de/search?q=geraga+and+papatheodorou+and+foraminifera+ (2 data sets)
Partner 14 (HZG / GKSS)					
Black Sea / Crimean Shelf / R/V M.S.MERIAN	Emil Stanev / HZG (GKSS) / emil.stanev@hzg.de & Antje Boetius Felix Janssen / MPG-MPIMM / aboetius@mpi-bremen.de fjanssen@mpi-bremen.de	Since 07.05.10 / one profile per float every 5 days	oxygen, salinity, temperature / NEMO float #144 & #145	drifting, time series, vertical profiles	PANGAEA Archive (2010) / http://dataportals.pangaea.de/hypox/index.php?ptype=data&formtype=simple&q_=%22nemo%20float%22 (2 data sets)
Partner 15 (GeoEcoMar)					
Black Sea / Romanian shelf / R/V MARE NIGRUM	Dan Secrieru / GeoEcoMar / d.secrieru@yahoo.com	May 2009	oxygen, conductivity, salinity, pH, RedOx potential, temperature, sulfide, phosphate, silicate, nitrite, nitrate / Multiple Corer overlying water samples	discrete sites, discrete time points	PANGAEA Archive (2009) / http://doi.pangaea.de/10.1594/PANGAEA.730111
Black Sea / Romanian shelf / R/V MARE NIGRUM	Dan Secrieru / GeoEcoMar / d.secrieru@yahoo.com	May 2009, May 2010, Jul. 2010, Sep. 2010, Apr. 2011	oxygen, pressure, depth, temperature, sigma-theta, salinity, conductivity, Chla fluorescence, beam attenuation, beam transmission, turbidity, pH / CTD	discrete sites, vertical profiles, discrete time points	PANGAEA Archive (2010, 2011) / http://www.pangaea.de/search?q=%22Physical+oceanography%22+and+%22oxygen+data%22+and+%22Mare+nigrum%22 (5 data sets)
Associated Partner: Norsk Institutt for Vannforskning (NIVA)					
Black Sea/ Northeastern coast/ R/V ASHAMBA	Evgeniy Yakushev / NIVA / eya@niva.no	09.06.11 / 5 hours	pressure, depth, temperature, sigma-theta, salinity, conductivity, oxygen, pH, Alkalinity, phosphate, polyphosphate, total phosphorus, silicate, nitrate, nitrite, ammonia, urea, total nitrogen, hydrogen sulfide, TOC, Mn(II), Mn(III), Mn(IV), Fe(II), Fe(III), Hg dissolved, Hg total / pump system	discrete site, vertical profile, discrete time points	NIVA and Southern Branch of Shirshov Institute of Oceanology RAS
Associated Partner: Laboratoire des Sciences du Climat et de l'Environnement (UMR CEA-CNRS-UVSQ)					
Mediterranean Sea/ Rhone Delta /	Christophe Rabouille / LSCE / christophe.rabouille@lsce.ipsl.fr	2008	Sediment and porewater data	discrete sites	SISMER/ Ifremer data archive / http://www.ifremer.fr/sismerData/jsp/visualisationMetadata2.jsp?strPortail=ifremer&langue=FR&pageOrigine=CAM&cle1=FI352008450120
Mediterranean Sea/ Rhone Delta /	Jean Jaques Naudin / LOB / Christophe Rabouille / LSCE / christophe.rabouille@lsce.ipsl.fr	2009	oxygen, primary production / CTD	discrete sites, transects	SISMER/ Ifremer data archive / http://www.ifremer.fr/sismerData/jsp/visualisationMetadata2.jsp?strPortail=ifremer&langue=FR&pageOrigine=CAM&cle1=FI352009450090

4.1.6.6 Conferences, meetings and workshops

CONFERENCES, MEETINGS, AND WORKSHOPS						
Partners involved	**People attending**	**Period**	**Title of Conference / Meeting Workshop (Venue)**	**Contribution**	**Type of audience**	**countries addressed**
All partners	Representatives from all partner institutions	15.04.09 -17.04.09	HYPOX kick off meeting (Bremen, Germany)	Talks	Scientific Community	Europe
All partners	Representatives from all partner institutions	22.03.10 - 26.3.10	HYPOX first Annual Meeting (Istanbul, Turkey)	Talks	Scientific Community	Europe
All partners	Representatives from all partner institutions	03.05.11 - 05.05.11	HYPOX second Annual Meeting (Horw / Lucerne, Switzerland)	Talks	Scientific Community Industry	Europe
All partners	Representatives from all partner institutions	11.03.12 - 14.03.12	HYPOX third Annual Meeting (Rome, Italy)	Talks	Scientific Community	Europe
(1) MPG-MPIMM (2) AWI (3) Eawag (4) IBSS (5) IFM-GEOMAR (8) IOW (15) GeoEcoMar	Dale, A. Friedrich, J. Gomoiu, M.-T. Janssen, F. Lichtschlag, A. Livingstone, D. Mazlumyan, S. Naeher, S. North, R. Prien, R. Rehder, G. Schubert, C. Sergeeva, N. Soltwedel, T. Sommer, S.	20.02.12 - 24.02.12	WP3 HYPOX synthesis paper writing workshop (Scuol, Switzerland)	Talks, discussions, manuscript parts	Scientific community	Europe
1 (MPG-MPIMM)	Wenzhöfer, F. Lichtschlag, A. Holtappels, M. Janssen, F.	11.05.09 - 14.05.09	OCEANS ´09 IEEE / Balancing technology with future needs (Bremen, Germany)	Attendance	Scientific Community Industry	International
1 (MPG-MPIMM)	Janssen, F.	04.06.09 - 05.06.09	Data management in ESONET NoE (Bremen, Germany)	Attendance	Scientific Community	Europe
1 (MPG-MPIMM)	Boetius, A.	31.03.10 - 02.04.10	Monaco Blue Ocean Initiative (Monaco)	Workshop participant	Scientific Community	Europe
1 (MPG-MPIMM)	Janssen, F.	20.05.10 - 21.05.10	Ukranian-German Workshop on cooperation in Marine Sciences/ (Sevastopol, Ukraine)	Talk, Poster	Scientific Community Policy makers Media	Ukraine Germany
1 (MPG-MPIMM)	Boetius, A.	22.05.10 - 26.05.10	ASM General Meeting (San Diego, CA, USA)	Plenary Talk	Scientific Community	International
1 (MPG-MPIMM)	Boetius, A.	24.06.10	Brussels Meeting on Ocean sciences (German and EU representatives) (Brussels, Belgium)	Presentation	Scientific Community Policy makers	Europe
1 (MPG-MPIMM)	Boetius, A.	30.08.10	Society for Ecology (GfÖ) Annual Meeting (Göttingen, Germany)	Plenary Talk	Scientific Community	Germany
1 (MPG-MPIMM)	Boetius, A.	30.10.10	Geological Association Germany, Annual Meeting (Darmstadt, Germany)	Plenary Talk	Scientific Community	Germany
1 (MPG-MPIMM)	Boetius, A.	14.12.10 - 17.12.10	ESONET General Assembly 2010 (Marseille, France)	Poster and report on HYPOX	Scientific Community	Europe
1 (MPG-MPIMM)	Boetius, A.	13.02.11 - 14.02.11	Monaco Blue Ocean Initiative (Monaco)	Session convener	Scientific Community Policy makers Media	Europe
1 (MPG-MPIMM)	Fischer, J. Holtappels, M. Janssen, F. Lichtschlag, A. Wenzhöfer, F.	13.02.11 - 18.02.11	Aquatic Sciences Meeting 2011 / Limnology and Oceanography in a Changing World (San Juan, Puerto Rico, USA)	Talks, session convener	Scientific Community	International
1 (MPG-MPIMM)	Boetius, A.	21.02.11 - 25.02.11	ASM Workshop Dallas "Microbiology of Climate Change" (Dallas, TX, USA)	Workshop participant	Scientific Community	International
1 (MPG-MPIMM)	Boetius, A.	17.03.11 - 18.03.11	Max Planck Symposium on Extreme Environments (Bremen, Germany)	Plenary Talk	Scientific Community	International
1 (MPG-MPIMM)	Janssen, F.	22.03.11 - 24.03.11	EuroSites (Enhancing Europe's capability for in-situ ocean observation) / final project meeting (Heraklion, Crete, Greece)	Invited talk	Scientific Community Policy makers	Europe
1 (MPG-MPIMM)	Boetius, A.	23.03.11 - 25.03.11	LTER annual workshop	Presentation	Scientific Community	Germany
1 (MPG-MPIMM)	Boetius, A.	02.04.11 - 05.04.11	VAAM (Karlsruhe, Germany)	Plenary Talk	Scientific Community	Germany
1 (MPG-MPIMM)	Boetius, A. Holtappels, M. Janssen, F. Lichtschlag, A. Wenzhöfer, F.	03.04.11 - 08.04.11	European Geosciences Union, General Assembly 2011 (Vienna, Austria)	Talk + Poster session convener	Scientific Community	International
1 (MPG-MPIMM)	Boetius, A.	05.04.11 - 06.04.11	EGU, Deep Sea Frontiers Symposium (Vienna, Austria)	Presentation	Scientific Community	International
1 (MPG-MPIMM)	Janssen, F.	04.05.11 - 05.05.11	Oxygen sensing technology workshop with manufacturer's representatives during the HYPOX second Annual Meeting (Horw / Lucerne, Switzerland)	Talks, workshop organization	Scientific Community Industry	International
1 (MPG-MPIMM)	Boetius, A.	21.05.11 - 25.05.11	ASM General Meeting (New Orleans, LA, USA)	Session Convenor	Scientific Community	International
1 (MPG-MPIMM)	Janssen, F.	25.05.11 - 27.05.11	Argo-oxygen meeting (Ifremer, Brest, France)	Talk, discussions	Scientific Community	International
1 (MPG-MPIMM)	Fischer, J.	30.05.11 - 01.06.11	Wasser 2011, Jahrestagung der Wasserchemischen Gesellschaft der GdCH (Norderney, Germany)	Talk	Scientific Community	Germany

Conferences, meetings and workshops (continued)

1 (MPG-MPIMM)	Boetius, A.	27.06.11 - 30.06.11	FEMS General Meeting (Geneva, Switzerland)	Session Convenor	Scientific Community	International
1 (MPG-MPIMM)	Jessen, G.	14.08.11 - 19.08.11	Goldschmidt Conference (Prague, Czech Republic)	Poster	Scientific Community	International
1 (MPG-MPIMM)	Janssen, F.	14.09.11 - 15.09.11	CLAMER conference "Living with a warming ocean: European Research and Public Perception of Climate Change Impacts on the Marine Environment" (Brussels, Belgium)	Invited Attendance, workshop participant	Scientific Community Policy makers Media	Europe
1 (MPG-MPIMM)	Lichtschlag, A.	24.10.11 - 26.10.11	EUR-OCEANS Conference - Ocean deoxygenation and implications for marine biogeochemical cycles and ecosystems (Toulouse, France)	Poster	Scientific Community	Europe
1 (MPG-MPIMM)	Janssen, F.	15.11.11 - 17.11.11	GEO-VIII Plenary and Exhibition (Istanbul, Turkey)	Attendance, taking care of HYPOX booth	Scientific Community Industry Policy makers Media	International
1 (MPG-MPIMM)	Boetius, A.	21.02.12	OceanSites Steering Committee meeting; Discussion of equipping time series with oxygen optodes (including deep water observatories), and of providing a central web side for data (San Diego, USA)	Attendance	Scientific Community	international
1 (MPG-MPIMM)	Boetius, A.	21.03.12	TEEB Conference (The Economics of Ecosystems and Biodiversity) (Leipzig, Germany)	Invited talk	Scientific Community Policy makers	international
1 (MPG-MPIMM)	Boetius, A.	26.03.12	Annual Meeting LTER Network (Long Term Ecological Research Sites); report of Time series studies in the ocean, Discussion of questionnaires towards Marine Ecosystem assessment (also deep ocean) (Frankfurt, Germany)	Talks	Scientific Community	Germany
1 (MPG-MPIMM)	Boetius, A. Janssen, F. Lichtschlag, A. Jessen, G. Donis, D.	23.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	Talk, Poster, session convener	Scientific Community	International
1 (MPG-MPIMM)	Boetius, A.	25.04.12	EGU, Deep Sea Frontiers meeting (Vienna, Austria)	Presentation	Scientific Community	Europe
1 (MPG-MPIMM)	Janssen, F.	14.05.12 - 20.5.12	ICES/PICES Symposium 'Effects of Climate Change on the World's Oceans' (Yeosu, South Korea)	Invited talk	Scientific Community	International
1 (MPG-MPIMM)	Janssen, F.	24.05.12 - 25.05.12	ASPERA workshop on Deep Ocean Cabled Observatories, presentation on future monitoring activies at the HYPOX target site HAUSGARTEN (Amsterdam, The Netherlands)	Invited talk	Scientific Community	International
2 (AWI)	Friedrich, J.	21.10.10 - 22.10.10	GEOECOMAR INTERNATIONAL SYMPOSIUM 2010 (Bucharest, Romania)	talk	Scientific community	International
2 (AWI)	Soltwedel, T.	13.02.11 - 18.02.11	EuroSites (Enhancing Europe's capability for in-situ ocean observation) / final project meeting (Heraklion, Crete, Greece)	Invited talk	Scientific community	Europe
2 (AWI)	Friedrich, J.	03.04.11 - 08.04.11	European Geosciences Union, General Assembly 2011 (Vienna, Austria)	Talk + Poster, session convener	Scientific Community	International
2 (AWI)	Friedrich, J.	22.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	talk + session convener	Scientific community	International
2 (AWI)	Friedrich, J.	03.06.12 - 07.06.12	ESCA 2012 (Venice, Italy)	talk	Scientific community	International
3 (Eawag)	Livingstone, D. M.	15.08.10 - 20.08.10	31st Congress of the International Society of Limnology (SIL) (Cape Town, South Africa)	Poster	Scientific Community	International
3 (Eawag)	Naeher, S.	07.02.11 - 11.02.11	"Molecular Organic Biogeochemistry" – Nebroc/Ecolmas course at the Royal Netherlands Institute for Sea Research (Texel, The Netherlands)	Workshop participant	Scientific Community	Europe
3 (Eawag)	Naeher, S. Kirf, M. Schubert, C. North, R.	03.04.11 - 08.04.11	European Geosciences Union, General Assembly 2011 (Vienna, Austria)	Posters	Scientific Community	International
3 (Eawag)	Livingstone, D. M. North, R. P.	30.05.11 - 03.06.11	54th International Conference on Great Lakes Research (IAGLR 2011) (Duluth, MN, USA)	Talks, session convener	Scientific Community	International
3 (Eawag)	Livingstone, D. M.	27.06.11 - 01.07.11	7th Symposium of European Freshwater Sciences (SEFS7) (Girona, Spain)	Invited plenary talk	Scientific Community	International
3 (Eawag)	Naeher, S.	18.09.11 - 23.09.11	International Meeting on Organic Geochemistry 2011 (IMOG) (Interlaken, Switzerland)	Poster	Scientific Community	International
3 (Eawag)	Naeher, S.	22.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	Posters	Scientific Community	International
4 (IBSS)	Sergeeva, N. Gulin, S. Bondarev, I.	22.08.09 - 31.08.09	IGCP 521-INQUA 0501 Fifth Plenary Meeting and Field Trip (Istanbul, Izmir, and Çanakkale, Turkey)	Talk	Scientific Community	International
4 (IBSS)	Kosheleva, T. Sergeeva, N. G.	21.09.09 - 24.09.09	VI International Conference on Ecological Problems of aquatic Ecosystems. "Ponticus Euxinus-2009" (Sevastopol, Ukraine)	Talk	Scientific Community	International
4 (IBSS)	Sergeeva, N.G. Kolesnikova, E.A. Mazlumyan, S.A.	19.05.10 - 22.05.10	Intern. theoretical and practical Conf. Biodiversity and Sustainable Development (Simpheropol, Ukraine)	Talk	Scientific Community	International
4 (IBSS)	Sergeeva, N.G.	20.05.10 - 21.05.10	Ukranian-German Workshop on cooperation in Marine Sciences (Sevastopol, Ukraine)	Talk	Scientific Community	Ukraine Germany
4 (IBSS)	Konovalov, S.K.	06.09.10 - 11.09.10	Operation and evolution of the Black and Azov Sea ecosystem under global climate change. (Katsiveli, Ukraine)	Talk	Scientific Community	International
4 (IBSS)	Orekhova, N.A.	06.09.10 - 11.09.10	Hypoxia in the bottom sediments of the Crimean coast (Katsiveli, Ukraine)	Poster	Scientific Community	International
4 (IBSS)	Orekhova N.A.	06.09.10 - 10.09.10	Ocean Teacher Academy Training Course: Introduction to Marine Data Management for Young Scientists (Oostende, Belgium)	Attendance	Scientific Community	International
4 (IBSS)	Gulin, M. Timofeev, V. Bondarenko, L.	13.09.10 - 17.09.10	International scientific and technical workshop "Systems for environmental monitoring" (Sevastopol, Ukraine)	Talk	Scientific Community	International

Conferences, meetings and workshops (continued)

4 (IBSS)	Sergeeva, N.G. Mazlumyan, S.A. Orekhova, N.A. Gulin, M.B. Konovalov, S.K.	27.09.10 - 05.10.10	Events of hypoxia and anoxia in the Crimean coastal waters INQUA 501-IGCP 521 (Rhodes, Greece)	Talk, Posters	Scientific Community	International
4 (IBSS)	Kosheleva, T.N. Orekhova, N.A. Kotel'yanets, E.A. Svishchev, S.V.	24.05.11 - 27.05.11	VII Inter. Conf. on Ecological Problems of aquatic Ecosystems. "Ponticus Euxinus-2011" (Sevastopol, Ukraine)	Talks	Scientific Community	International
4 (IBSS)	Sergeeva, N.G. Konovalov, S.K. Kolesnikova, E. Chekalov, V. Bondarev I.P.	21.08.11 - 28.08.11	INQUA 501 Seventh Plenary Meeting (Odessa, Ukraine)	Talk	Scientific Community	International
4 (IBSS)	Orekhova, N.A. Konovalov, S.K.	06.09.11 - 10.09.11	IV Intern.l sci. conf. "Physical methods in ecology, biology and medicine" (L'viv, Ukraine)	Talk	Scientific Community	International
5 (IFM-GEOMAR)	Schorp, T.	28.09.09 - 02.10.09	Workshosp: Biogeochemical modeling in aquatic environments: using R as a simulation environment (NIOO KNAW, Yerseke, The Netherlands)	Attendance	Scientific Community	Europe
5 (IFM-GEOMAR)	Dale, A. Mattsdotter, M.	19.01.10 - 21.01.10	BONUS Annual Conference 2010 (Vilnius, Lithuania)	Attendance	Scientific Community Civil Society	Europe
5 (IFM-GEOMAR)	Dale, A.	25.03.10	Workshop: Modeling hypoxia and related processes in aquatic environments (Istanbul Technical University, Istanbul, Turkey)	Organization and talk	Scientific community	Europe
5 (IFM-GEOMAR)	Dale, A.	13.10.10 - 15.10.10	Uncertainties of Scenario Simulations (SMHI, Norrköping, Sweden)	Talk and poster	Scientific community	Europe International
5 (IFM-GEOMAR)	Sommer, S. Bertics, V.	13.02.11 - 18.02.11	Aquatic Sciences Meeting 2011 / Limnology and Oceanography in a Changing World (San Juan, Puerto Rico, USA)	Talks	Scientific Community	International
5 (IFM-GEOMAR)	Sommer, S. Noffke, A.	22.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	Poster	Scientific community	International
6 (Ifremer)	Lericolais G.	03.04.11 - 08.04.11	European Geosciences Union, General Assembly 2011 (Vienna, Austria)	Talk	Scientific Community	International
7 (INGV)	Etiope, G.	19.06.09 - 26.06.09	Goldschmidt conference (Davos, Switzerland)	Attendance	Scientific Community	International
7 (INGV)	Lo Bue N. Delauney,L. Khripounoff, A Vangreisheim, A. Gayet,L. N. Le Douaron,L. Hovdenes, J. Tengberg, A.	22.09.11 - 23.09.11	Martech 2011 (Cádiz, Spain)	Talk	Scientific Community	International
7 (INGV)	Etiope, G.	29.11.11 - 02.12.11	11th International Conference on Gas Geochemistry (La Jolla, San Diego, CA, USA)	Talk and poster	Scientific Community	International
8 (IOW)	Prien, R.	17.08.09 - 21.08.09	7th Baltic Sea Science Congress (Tallinn, Estonia)	Poster	Scientific Community	Europe
8 (IOW)	Rehder , G.	13.12.10 - 17.12.10	AGU Fall meeting (San Francisco, CA, USA)	Talk, posters	Scientific Community	International
8 (IOW)	Prien, R.	21.04.11	Technologies for Coastal Observations Workshop, Venice Water Authority (Venice, Italy)	Talk	Scientific Community Industry	International
8 (IOW)	Prien, R. Schulz-Bull, D.	06.06.11 - 09.06.11	Oceans 2011 IEEE/OES (Santander, Spain)	Talk	Scientific Community Industry Civil Society	International
8 (IOW)	Rehder, G. Prien, R.D. Schulz-Bull, D.E.	22.08.12 - 26.08.12	8th Baltic Sea Science Conference (St. Petersburg, Russia)	Talks, posters	Scientific Community	Europe
9 (ITU-EMCOL)	Çağatay, M. N.	06.10.09 - 10.10.09	2. International Symposium on the Geology of Black Sea Regions. Geology and Geophysics session (Ankara, Turkey)	Session convener and chairman	Scientific Community	International
9 (ITU-EMCOL)	Erdem, Z.	03.04.11 - 08.04.11	European Geosciences Union, General Assembly 2011 (Vienna, Austria)	Talk	Scientific Community	International
9 (ITU-EMCOL)	Çağatay, M.N. Erdem, Z.	25.04.11 - 29.04.11	64th Geological Congress of Turkey 2011, Session 4: Marine, Lacustrine and Coastal Geology (Ankara, Turkey)	Session convener, chairman, Talk	Scientific Community	International
9 (ITU-EMCOL)	Çağatay, M.N. Erdem, Z.	15.11.11 - 17.11.11	GEO-VIII Plenary and Exhibition (Istanbul, Turkey)	Talk, Attendance	Scientific Community Civil Society Policy makers Media	International
9 (ITU-EMCOL)	Çağatay, M.N. Erdem, Z.	21.08.11 - 28.08.11	INQUA 501 Seventh Plenary Meeting (Odessa, Ukraine)	Session convener, chairman, Talk	Scientific Community	International
9 (ITU-EMCOL)	Erdem, Z.	22.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	Talk	Scientific Community	International
10 (Uni-HB)	Waldmann, C.	11.05.09 - 14.05.09	OCEANS ´09 IEEE / Balancing technology with future needs (Bremen, Germany)	Conference chair	Scientific Community Industry Civil Society Policy makers Media	International
10 (Uni-HB)	Waldmann, C.	27.07.09 - 28.07.09	Kick off meeting of GEO task ST-09-02 (Rome, Italy)	Attendance	Scientific Community Industry Policy makers	International
10 (Uni-HB)	Huber, R.	09.11.09 - 10.11.09	LifeWatch WP3 Data Providers Platform - second Zandvoort workshop (Zandvoort, The Netherlands)	Attendance	Scientific Community	Europe
10 (Uni-HB)	Waldmann, C.	19.09.10	GEOSS Workshop XXXVIII – Evolution of Ocean Observing Systems, building on infrastructure for science (Seattle, WA, USA)	Organization and talk	Scientific Community Industry Policy makers	International

Conferences, meetings and workshops (continued)

10 (Uni-HB)	Waldmann, C.	03.11.10 - 04.11.10	GEO-VII Plenary Session (Beijing, China)	Presentation	Scientific Community Industry Policy makers Media	International
10 (Uni-HB)	Waldmann, C.	09.05.11 - 11.05.11	Joint GEO/EGIDA Workshop of the EGIDA Stakeholder Network and Advisory Board "Connecting GEOSS and its Stakeholders in Science and Technology" (Bonn, Germany)	Workshop participant	Scientific Community	Europe International
10 (Uni-HB)	Huber, R.	23.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	Talk	Scientific Community	International
11 (SAMS)	Jackson, K.	31.03.09 - 02.04.09	Ocean Business 2009 (Southampton, UK)	Attendance	Scientific Community Industry	Europe
11 (SAMS)	Stahl, H.	01.06.09 - 03.06.09	Annual Science Meeting (Liverpool, UK)	Talk	Scientific community	Europe
11 (SAMS)	Aleynik, D.	02.05.10 - 07.05.10	European Geosciences Union, General Assembly 2010 (Vienna, Austria)	Attendance	Scientific Community	International
11 (SAMS)	Stahl, H.	06.06.10 - 08.06.10	Invited seminar at AADI workshop on ocean observatories (Bergen, Norway)	Talk	Scientific Community Industry	Europe
11 (SAMS)	Glud, R. N.	13.02.11 - 18.02.11	Aquatic Sciences Meeting 2011 / Limnology and Oceanography in a Changing World (San Juan, Puerto Rico, USA)	Talks, session convener	Scientific Community	International
12 (UGOT)	Hall, P. Viktorsson, L. Kononets, M. Ekeroth, N. Cuellar, E. de Brabandere, L.	18.09.09 - 06.10.09	HYPOX Baltic data workshops on-board Alkor during cruise (Gotland Basin, Baltic Sea)	Talks, discussions	Scientific Community	Europe
12 (UGOT)	Hall, P.	09.12.09	Seminar on the Gotland Basin and the Koljoe Fjord at Southern Denmark University (Odense, Denmark)	Invited talk	Scientific Community	Europe
12 (UGOT)	Hall, P.	21.02.10 - 26.02.10	Ocean Sciences Meeting (Portland, OR, USA)	Invited talk	Scientific Community Policy makers	International
12 (UGOT)	Hall, P.	03.03.10	Seminar series at MBARI (Moss Landing, CA, USA)	Invited talk	Scientific Community	International
12 (UGOT)	Hall, P. Viktorsson, L. Kononets, M. Ekeroth, N. Dalsgaard, T. Tengberg, A. Nilsson, M. Atamanchuk, D.	16.08.10 - 01.09.10	HYPOX Baltic data workshops on-board Skagerak during cruise (Gotland Basin, Baltic Sea)	Talks, discussions	Scientific Community	Europe
12 (UGOT)	Hall, P. Waldman, C. Kononets, M. Huber, R. Tengberg, A.	14.12.10 - 17.12.10	ESONET General Assembly 2010 (Marseille, France)	Talk	Scientific Community Policy makers	Europe
12 (UGOT)	Hall, P.	07.02.11	Lecture on marine infrastructure at UGOT (Gothenburg, Sweden)	Invited talk	Scientific Community	Sweden
12 (UGOT)	Tengberg, A. Kononets, M. Atamanchuk, D. Stigebrandt, A.	22.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	Talks + posters	Scientific Community Policy makers	International
12 (UGOT) & 10 (Uni-HB)	Hall, P. Waldmann, C.	21.05.12 - 22.05.12	European Maritime Days (Gothenburg, Sweden)	Workshop organization and Talk	Scientific Community Civil Society Policy makers Industry	Europe
12 (UGOT)	Tengberg, A.	08.07.12 - 12.07.12	ASLO Summer Meeting (Japan)	Talk	Scientific Community Policy makers Industry	International
13 (UPAT)	Papatheodorou, G. Ferentinos, G.	13.09.09	One day meeting organised by the Amvrakikos Fishermen's Association (Centre of Environmental Education of Arachthos, Amvrakikos Gulf, Greece)	Talks, discussions	Civil Society Policy makers	Greece
13 (UPAT)	Papaefthymiou, H. Athanassopoulos, D. Papatheodorou, G. Iatrou, M. Geraga, M. Christodoulou, D. Fakiris, E.	18.04.10 - 23.04.10	16th Radiochemical Conference, Marianske (Lazne, Czech Republic)	Poster	Scientific Community	International
13 (UPAT)	Papatheodorou, G. Ferentinos, G.	13.05.11 - 15.05.11	"Amvrakikos Gulf: Is viable development possible?" Conference dedicated to the Amvrakikos Gulf. Organised by the Panepirotischer Confederation of Greece (Amphilochia and Vonitsa, Epirus, Greece)	Talks, discussions	Scientific Community Civil Society Policy makers	Greece
13 (UPAT) & 7 (INGV)	Etiope G. Papatheodorou G. Marinaro G. Christodoulou D. Lo Bue N. Kordella S. Geraga M. Ferentinos G. Iatrou M. Fakiris E. Prevenios M.	30.05.11 - 31.05.11	Deep Sea and Sub Seafloor Frontier Workshop. (University of Tromsø, Norway)	Invited talk	Scientific Community	Europe
13 (UPAT)	H. Papaefthymiou G. Papatheodorou D. Athanassopoulos T. Karagiannidi N. Vlachos M. Geraga D. Christodoulou A. Koutsodendris	18.09.11 - 23.09.11	3rd International Nuclear Chemistry Congress (Palermo, Sicily, Italy)	Talk	Scientific Community	International

Conferences, meetings and workshops (continued)

13 (UPAT) & 7 (INGV)	Papatheodorou G Christodoulou D. Kordella S. Etiope G. Marinaro G. Lo Bue N. Geraga M. Ferentinos G.	29.11.11 - 02.12.11	11th International Conference on Gas Geochemistry (La Jolla, San Diego, CA, USA)	Talk and poster	Scientific Community	International
13 (UPAT) & 7 (INGV)	Papatheodorou G. Etiope G. Kordella S. Christodoulou D. Marinaro G. Lo Bue N. Geraga M. Ferentinos G.	07.05.12 - 11.05.12	10th National Symposium on Oceanography and Fisheries (Athens, Greece)	Talks and poster	Scientific Community	Greece
14 (HZG / GKSS)	He, Y.	14.06.10 - 18.06.10	Estuarine Ecology (Summer School) (Yerseke, The Netherlands)	Attendance	Scientific Community	Europe
14 (HZG / GKSS)	He, Y.	03.04.11 - 08.04.11	European Geosciences Union, General Assembly 2011 (Vienna, Austria)	Poster	Scientific Community	International
14 (HZG / GKSS)	Emil, S. He, Y.	22.04.12 - 27.04.12	European Geosciences Union, General Assembly 2012 (Vienna, Austria)	Talk and Poster	Scientific Community	International
15 (GeoEcoMar)	Melinte, M. Oaie, G.	07.05.09 - 08.05.09	2nd yearly scientific meeting of GeoEcoMar (Romania)	Talk	Scientific Community	International
15 (GeoEcoMar)	Gomoiu, M.-T.	17.08.09 - 21.08.09	SEFS6 - The 6th Symposium for European Freshwater Sciences "Challenges and opportunities for freshwater sciences in a changing climate" (Sinaia, Romania)	Attendance and Poster presentation	Scientific Community	International
15 (GeoEcoMar)	Teaca, A. Begun, T. Opreanu, P. Gomoiu, M.-T. Briceag, A. Oaie, G. Stoica M.	22.08.09 - 31.08.09	IGCP 521-INQUA 0501 Fifth Plenary Meeting and Field Trip (Istanbul, Izmir, and Çanakkale, Turkey)	Attendance and Poster presentation	Scientific Community	International
15 (GeoEcoMar)	Gomoiu, M.-T.	08.10.09 - 11.10.09	2nd International Conference on Aquatic Biodiversity (Sibiu, Romania)	Plenary Talk	Scientific Community	International
15 (GeoEcoMar)	Gomoiu, M.-T.	22.10.09 - 24.10.09	Romanian National Conference of Ecology: "Ecology and Evolution: Origins, Development and Perspectives" (Galati, Romania)	Plenary Talk	Scientific Community	International
15 (GeoEcoMar)	Gomoiu, M.-T.	30.10.09 - 31.10.09	International Black Sea Action Day & 1st Marine Environment Workshop and Activities (Samsun, Turkey)	Attendance for receiving the Black Sea Medal Award 2009	Scientific Community Civil Society	Europe
15 (GeoEcoMar)	Gomoiu, M.-T.	19.11.09 - 24.11.09	European Geosciences Union, General Assembly 2009 (Vienna, Austria)	Poster	Scientific Community	International
15 (GeoEcoMar)	Begun, T. Teaca, A. Gomoiu, M.-T. Muresan M. Surugiu V.	10.05.10 - 14.05.10	38th CIESM Congress (Venice, Italy)	Posters	Scientific Community	International
15 (GeoEcoMar)	Gomoiu, M-T. Secrieru, D. Balan, S.	03.04.11 - 08.04.11	European Geosciences Union, General Assembly 2011 (Vienna, Austria)	Attendance, posters	Scientific Community	International
15 (GeoEcoMar)	Gomoiu, M.-T. Teaca, A. Begun, T. Vasiliu, D. Lazar, L.	01.10.11 - 10.10.11	3 rd International Symposium on the Geology of the Black Sea Region (Bucharest, Romania)	Talk, posters	Scientific Community	international
15 (GeoEcoMar)	Gomoiu, M.-T. Muresan, M.	04.10.11 - 07.10.11	Aquatic Biodiversity International Conference (Sibiu, Romania)	Talk	Scientific Community	International
15 (GeoEcoMar)	Vasiliu, D.	01.11.11 - 05.11.11	3rd Black Sea Biannual Scientific Conference BS-OUTLOOK (Odessa, Ukraine)	Posters	Scientific Community	International
15 (GeoEcoMar)	Gomoiu, M-T Secrieru, D. Teaca, A. Begun, T. Opreanu, P. Muresan, M. Vasiliu, D. Lazar, L.	22.04.12 - 27.04.12	European GeoSciences Union, General Assembly 2012 (Vienna, Austria)	Attendance, posters	Scientific Community	International
16 (NIOO KNAW) / 17 (NIOZ)	Cox, T.J.S	18.09.09	Necov Summersymposium (Delft, The Netherlands)	Invited Talk	Scientific Community	Belgium The Netherlands
16 (NIOO KNAW) / 17 (NIOZ)	Meysman, F.	02.05.10 - 07.05.10	European Geosciences Union, General Assembly 2010 (Vienna, Austria)	Invited Talk	Scientific Community	International
16 (NIOO KNAW) / 17 (NIOZ)	Meysman, F.	13.02.11 - 18.02.11	Aquatic Sciences Meeting 2011 / Limnology and Oceanography in a Changing World (San Juan, Puerto Rico, USA)	Talk	Scientific Community	International
MARE-ULg	Gregoire, M.	02.05.10 - 07.05.10	European Geosciences Union, General Assembly 2010 (Vienna, Austria)	Session Convener, talk	Scientific Community	International
NIVA	Yakushev E.V.	02.05.10 - 07.05.10	European Geosciences Union, General Assembly 2010 (Vienna, Austria)	Talk, posters	Scientific Community Civil Society Policy makers Media	International
NIVA	Yakushev E.V.	15.08.11 - 19.08.11	Goldschmidt 2011 Conference (Prague, Czech Republik)	Talk, posters	Scientific Community Industry Civil Society Policy makers Media	International

4.1.6.7 Media contact and public outreach activities

MEDIA CONTACT/PUBLIC OUTREACH ACTIVITIES						
Partners involved	**People involved**	**Date of publication / broadcasting**	**Content / subject**	**Dissemination means: e.g., web page url, title of newspaper, broadcast company, program**	**Type of audience**	**countries addressed**
1 (MPG-MPIMM)	Boetius, A.	17.02.09	Methane consumption in the sea	Interview German radio station "NDR"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	07.04.09	Biological oceanography and the challenge of climate change	German news magazine "Focus"; www.focus.de/ wissen/campus/ meeresforschung- unbekannte- unterwasserwelt_ aid_387022.html	Civil Society Policy makers	Germany
1 (MPG-MPIMM)	Janssen, F. Schlösser, M. Borgwardt, S.	08.06.09	Project start and kick off meeting	Press release through institutes homepage; www.mpi-bremen.de	Scientific Community Civil Society Media	Europe
1 (MPG-MPIMM)		28.08.09	First press release through HYPOX news section. Several contributions followed over the time course of the project	http://hypoxnews.blogspot.de/	Scientific Community Civil Society Policy makers Media	International
1 (MPG-MPIMM)	Boetius, A.	20.09.09	Marine Science in times of climate change	Radio talkshow of the German radio station "HR3"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A. Bienhold, C. Schoettner, S. Ufkes, J. Ramette, A.	Oct.2009	Microbial ecology and diversity and climate change	German popular science magazine "BioSpektrum"; www.biospektrum.de/blatt/d_bs_pdf&_id=1013672	Scientific Community Civil Society	Germany Austria Switzerland
1 (MPG-MPIMM)		14.01.10	Hypox Brochure ('EU-project HYPOX: oxygen monitoring in aquatic ecosystems A short introduction to project tasks and partners')	online (http://www.hypox.net/upload/infomat erial/brochure_hypox100114_Online. pdf) and mass mailing to potential users	Scientific Community Civil Society Policy makers Media	International
1 (MPG-MPIMM)	Boetius, A.	10.02.10	Adaptiation of marine microorganisms to extreme habitats, global change, and man-made pollution	Lecture in lecture series "Exkurs" of the German Research Foundation, broadcasted by German online radio station "Deutschlandradio Wissen"; http://wissen.dradio.de/index.88.de.ht ml?dram:article_id=788&sid=&rando m=f6bff9	Scientific Community Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	09.03.2010	Life under low oxygen	Interview German radio station "SWR 3"	Civil Society	Germany
1 (MPG-MPIMM)	Janssen, F. Boetius, A. et al.	12.04.10 - 08.05.10	HYPOX field campaign to the Black Sea	Scientific weblog produced during leg MSM15/1 of R/V MARIA S. MERIAN; www.mpi-bremen.de/Weblog1_MSM_15-1.html	Scientific Community Civil Society Media	Europe
1 (MPG-MPIMM)		01.05.10	HYPOX - In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies	Article in International Innovation (http://www.hypox.net/upload/infomat erial/hypox_international_innovation. pdf and hardcopies sent around by the Publisher)	Industry Civil Society Policy makers	Europe
1 (MPG-MPIMM)	Boetius, A.	18.05.10	Microbial degradation of oil spill and the threat of hypoxia	Interview in Swiss newspaper "Zuericher Tagesanzeiger"; www.tagesanzeiger.ch/wissen/natur/ Bakterien-sollen-das-Erdoel- fressen/story/24850078	Civil Society	Switzerland
1 (MPG-MPIMM)	Boetius, A.	25.05.10	Oil spill and the effect on bottom water oxygen and benthic communities	Interview in Swiss online publication focusing on sustainability; www.nachhaltigkeit.org/2010052548 23/natur- landwirtschaft/interviews/die-tiefsee- muss-geschuetzt-werden	Civil Society	Switzerland, Germany, Austria
1 (MPG-MPIMM)	Boetius, A.	25.05.10	Gulf of Mexico oil spill - effect on bottom water oxygen and benthic communities	Article in Swiss newspaper "Neue Zuericher Zeitung"; www.nzz.ch/nachrichten/hintergrund/ wissenschaft/die_oelpest_als_bedroh ung_fuer_marine_tiere_1.5999784.ht ml	Civil Society	Switzerland
1 (MPG-MPIMM)	Boetius, A .	02.06.10	Interview about potential threats of hypoxia caused by gas and oil leakage from submarine exploration	German newspaper "Weserkurier"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	16.06.10	Threats from gas and oil spill including hypoxia (North Sea leak)	Interview in German newspaper 'Die Zeit'	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	18.06.10	oil spill, oxygen depletion through oil degrading bacteria	Talkshow in TV-program "Buten und binnen", German TV station Radio Bremen; www.radiobremen.de/mediathek/inde x.html?id=030779	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	20.06.10	interviews to potential threats of hypoxia caused by gas and oil leakage from submarine exploration	German newspaper "Süddeutsche Zeitung"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	21.06.10	interviews to potential threats of hypoxia caused by gas and oil leakage from submarine exploration	German newspaper "Frankfurter Rundschau"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	22.06.10	interviews to potential threats of hypoxia caused by gas and oil leakage from submarine exploration	German newspaper "Tagesspiegel"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	22.06.10	interviews to potential threats of hypoxia caused by gas and oil leakage from submarine exploration	broadcast German TV Station "RB buten and binnen"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	22.06.10	interviews to potential threats of hypoxia caused by gas and oil leakage from submarine exploration	German news broker "Reuters"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	26.07.10	threats from gas and oil spill including hypoxia (North Sea leak)	German TV station ("ARD")	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	02.08.10	biodiversity found in different (e.g., oxygen rich and oxygen poor) habitats	Interview in German Popular Science online magazine Spektrumdirekt; www.spektrumdirekt.de/artikel/10411 70&_z=859070	Scientific Community Civil Society	Germany, Austria, Switzerland
1 (MPG-MPIMM)	Boetius, A.	11.08.10	Oil degrading bacteria and oxygen depletion	TV report series "Quarks & Co", German TV station WDR	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	20.09.10	anthropogenic impacts on ocean diversity and other ecosystem services	Swiss newspaper "Basler Zeitung"	Civil Society	Switzerland

Media contact and public outreach activities (continued)

1 (MPG-MPIMM)	Lichtschlag, A. Schlösser, M. Heisterkamp, I. Kamp, A. Sevilgen, D. Ruff, E. v. d. Heijden, K. Stief, P. Wetzel,S. Nemecky S.	02.10.10 - 03.10.10	Climate change	Information booth, National Holiday in Bremen	Civil Society Policy makers Media	Germany
1 (MPG-MPIMM)	Boetius, A.	23.10.10	Marine Oceanography, including video footage recorded during HYPOX Black Sea cruise MSM15&1 of R/V MARIA S. MERIAN	Childrens TV show "Tigerentenclub" focusing on the environment, German TV station "SWR"; www.kindernetz.de/tigerentenclub/tv/sendung/-/id=6392/nid=6392/did=187218/1ivve y2/index.html	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	17.11.10	Podcast / CD on life in the ocean and its threats	Publisher "headroom"	Civil Society	Europe
1 (MPG-MPIMM)	Boetius, A.	29.11.10	Presentation to Industry ("Volkswagen") on future challenges in ocean sciences	Invited Presentation	Industry Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	22.12.10	SWR Television Broadcast "Planet Science" on threats to the Ocean	TV Program	Scientific Community Civil Society Policy makers	Germany
1 (MPG-MPIMM)	Boetius, A.	05.01.11	National Geographics Interview	newspaper	Civil Society	International
1 (MPG-MPIMM)	Boetius, A.	31.01.11	Museum of Bremen	Public presentation on Threats to the Ocean	Civil Society Media	Germany
1 (MPG-MPIMM)	Boetius, A .	19.04.11	interviews to potential threats of hypoxia caused by gas and oil leakage from submarine exploration	broadcast German radio Station "Bayrischer Rundfunk"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	20.04.11	TV Interview ZDF	TV	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	20.04.11	NDR interview on consequences of oil spills for hypoxia	broadcast German radio Station "NDR"	Civil Society	Germany
1 (MPG-MPIMM) 3 (Eawag)	Janssen, F. Schloesser, M. Boetius, A. Schubert, C.	28.04.11	Information on HYPOX on the occasion of the second annual meeting in Switzerland	Press release through MPG-MPI and Eawag homepage: www.mpi-bremen.de/HYPOX-Projekttreffen_in_Luzern.html www.eawag.ch/medien/bulletin/20110429/index Dissemination through science media information service "Informationsdienst Wissenschaft" www.idw.info/de/news420392 Online publications based on the press release: Myscience (www.myscience.ch/wire/neue_daten_zur_zunehmenden_sauerstoff_verknappung_in_europaeischen_gewaessern-2011-eawag) Innovations-Report (www.innovations-report.de/html/berichte/veranstaltungen/neuigkeiten_sauerstoff_verknappung_europaeischen_174439.html) Juraforum (http://www.juraforum.de/wissenschaft/neuigkeiten-zur-sauerstoff-verknappung-in-europaeischen-gewaessern-357019)	Scientific Community Civil Society Media	Europe
1 (MPG-MPIMM)	Boetius, A.	09.06.11	SWR II Impulse Interview	broadcast German radio station "SWR II"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	06.08.11	Interview on the protection of marine environments	Newspaper Journal "Handelsblatt"	Civil Society Policy makers	Germany
1 (MPG-MPIMM)	Boetius, A.	16.08.11	Portrait for the opening of the exhibition of the BUND "Dive in - diversity of our seas"	exhibition BUND	Scientific Community Civil Society Policy makers	Germany
1 (MPG-MPIMM)	Janssen, F.	19.09.11	Hypoxia in aquatic systems	Interview with German newspaper 'Focus' (25.08.2011)	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	26.11.11	ocean research, threats to marine environments	TV station "Bremen 4"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	23.11.11	ocean research, threats to marine environments	German TV station "SWR TV^"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	16.01.12	Interview on marine research, and threats for the future ocean	Broadcast German radio station "Bayrischer Rundfunk"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	18.01.12	Interview on female researchers in extreme environments	Broadcast German radio station "NDR"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	25.02.12	SWR interview on Marine research	Broadcast and podcast of German Radio station "SWR"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A .	22.03.12	Towards Horizon>> 2020 - Key observations from the scientific viewpoint	Presentation for the Members of the German Parliament, Berlin, Germany	Policy makers	Germany
1 (MPG-MPIMM)	Boetius, A.	28.03.12	deep sea threats, gas leakage	Broadcast German radio station "MDR"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	29.03.12	North Sea hypoxia, gas leakage	Broadcast German radio station "Bavarian radio"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	03.04.12	North Sea hypoxia, gas leakage	"Nano TV", German TV station "ZDF"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	03.04.12	North Sea hypoxia, gas leakage	Broadcast German radio station "Rundfunk Berlin Brandenburg"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	17.05.12	diversity of ocean life	"TV total", TV show at German TV station "Pro 7"	Civil Society	Germany
1 (MPG-MPIMM)	Boetius, A.	08.06.12	day of the ocean	Broadcast German radio station "Bavarian radio"	Civil Society	Germany
1 (MPG-MPIMM)		06.07.12	four HYPOX Policy Briefs ('HYPOXIA BRIEFS') on fundamentals of hypoxia characteristics, causes, and consequences as well as hypoxia monitoring	http://www.hypox.net/upload/infomaterial/hypox0120706_policybriefs_on01.pdf; _policybriefs_on02.pdf; _policybriefs_on03.pdf; _policybriefs_on04.pdf and mailing to potential users	Scientific Community Civil Society Policy makers Media	International
4 (IBSS)	Gulin, M.B.	03.09.10	HYPOX expedition MSM15/1 with R/V MARIA S. Merian in Apr. / May 2010	Interview in Sevastopol news paper "Truzhenik morya"	Civil Society	Ukraine
4 (IBSS)	E. Kolesnikova	12.06.11	Interview celebrated World Ocean Day was focused on climate changes and the problems of hypoxia expand at the Black Sea habitats. IBSS participation in HYPOX project was noted	Regional Sevastopol TV	Civil Society	Ukraine
4(IBSS)	Kolesnikova E.A.	31.10.11	Information about the environmental problems of the Black Sea in the International Day of the Black Sea. It was noted that on the project "Hypox" IBSS scientists have studied the benthos in hypox conditions in the Black Sea in shallow and deep-water. New interesting results have been recieved, confirming the existence of specific organisms of different taxonomic groups in conditions hypoxia and close to anoxia.	Lecture was held for the youth of the city, pupils and students at City Library.	Scientific Community Civil Society	Ukraine & Russia

Media contact and public outreach activities (continued)

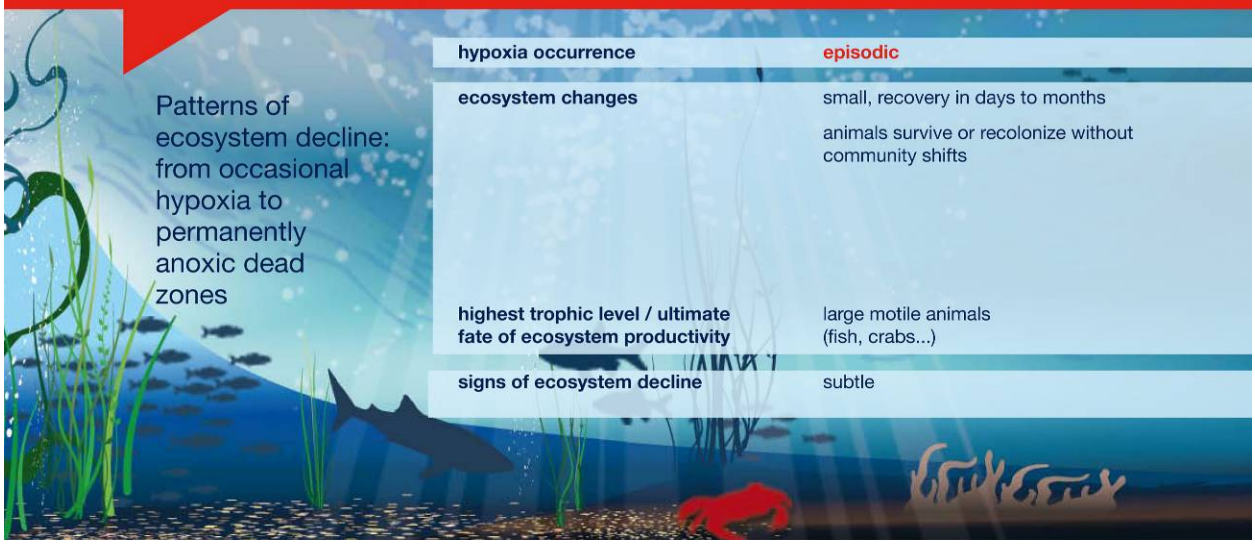
5 (IFM-GEOMAR)	Pfannkuche, O.	16.09.09	Start of expedition to eastern Gotland Basin with R/V Alkor	Press release through institute homepage; www.ifm-geomar.de	Scientific Community Civil society media	Germany
7 (INGV) 13 (UPAT)	INGV and UPAT teams	22.09.10	GMM deployment in Katakolo area	Articles in local newspapers ("Patris" and "Proti") (in greek) www.patrisnews.gr, www.protinews.gr	Civil Society Policy makers Media	Greece
8 (IOW)	Prien, R.	Nov. 2010	Article in "Leibniz-Nordost" 11/2010, pp 8-9: "Im Fahrstuhl durch die Gotlandsee"	Journal of the Leibniz-Gemeinschaft, http://www.wgl.de/?nid=prv&nidap=&print=0	Scientific Community Civil Society Policy makers Media	Germany
9 (ITU-EMCOL) 1 (MPG-MPIMM) 4 (IBSS)	Çağatay, N. Ulgen, U. Erdem, Z. Holtappels, M. Lichtschlag,A. Mazlumyan,S. Bondarev, I.	23.11.09	Information on the HYPOX Bosporus Cruise in Nov. 2009 with R/V "Arar"	Half page article in the Turkish Newspaper "Milliyet" www.milliyet.com.tr	Civil Society	Turkey
9 (ITU-EMCOL)	Erdem, Z., Çağatay, M.N.	08.06.11	Sedimentary Record of Mediterranean Inflow Effect on Redox Conditions of Istanbul Strait Outlet Area of Black Sea (English)	Library of Higher Education Council (www.yok.gov.tr); Library of Istanbul Technical University (library.itu.edu.tr)	Scientific Community	Turkey
9 (ITU-EMCOL)	Erdem,Z., Ulgen, U.	04.04.12	Communication Meeting of EC Funded Climate Change Research Projects: Hypox project presentation (in Turkish). Organized by UNDP in Ankara	Webpage of United Nations Development Programme http://www.undp.org.tr/Gozlem3.aspx?WebSayfaNo=3842 http://www.undp.org.tr/energenvirdocs/SNC_04.04.2012_5-Zeynep_Erdem.pdf	Scientific Community Industry Policy makers	Turkey
10 (Uni-HB) & 12 (UGOT)	C. Waldmann, P. Hall	20.04.11	Announcement of oxygen observatory deployment in Koljoefjord, Sweden	web page Uni-HB, UGOT	Scientific Community Industry Civil Society Policy makers Media	International
12 (UGOT)	Hall, P. Tengberg, A. Kononets, M.	Nov. 2010 - Apr. 2011	Information about installation of real-time on-line data observatory in the Koljoe Fjord to the County Board of western Sweden and the community of Orust.	Frequent telephone and email contacts.	Civil Society	Sweden
12 (UGOT)	Hall, P. Tengberg, A. Kononets, M.	18.04.11 - 19.04.11	Information to school class from southern Sweden about importance of continuous observation of the sea	Part of school class present on-board ship during installation of observatory	Civil Society	Sweden
12 (UGOT)	Hall, P. et al.	29.02.12	Information about Koljoe Fjord Observatory at Departmental Day	Audience: Dept. of Chemistry and Molecular Biology, UGOT	Scientific Community	Sweden
13 (UPAT)	Papatheodorou, G. Ferentinos, G. Koutsikopoulos, C.	Oct. 2009	Amvrakikos S.O.S Artapress, vol. 45, p.6-8. (greek)	Freepress magazine www.artapress.gr	Civil Society Policy makers Media	Greece
13 (UPAT)	Laboratory of Marine Geology and Physical Oceanography, UPAT	31.01.10	Amvrakikos Gulf – "Dead" Sea	Real News (national distributed weekly newspaper – section Real Planet) www.realnews.gr	Civil Society	Greece
13 (UPAT)	Papatheodorou, G.	04.02.10	Hypoxia in Amvrakikos Gulf, brief presentation of HYPOX.	Comment-discussion on daily informative TV program ("It happens now": "Simvainei tora") of Greek National Channel (NET)	Civil Society Policy makers Media	Greece
13 (UPAT)	Laboratory of Marine Geology and Physical Oceanography, UPAT	24.11.10	"Amvrakikos is dying"	KATHIMERINI (National distributed daily newspaper) http://news.kathimerini.gr/4dcgi/_w_articles_ell_3_24/11/2010_423582	Civil Society Policy makers Media	Greece
13 (UPAT)	Laboratory of Marine Geology and Physical Oceanography, UPAT	09.05.11	Amvrakikos is turning to "dead sea"	TA NEA (National distributed daily newspaper) http://www.tanea.gr/default.asp?pid=2&ct=1&artid=4630041	Civil Society Policy makers Media	Greece
13 (UPAT)	Papatheodorou, G.	10.05.11	Amvrakikos Gulf	Comment-interview on daily informative TV program "Morning briefing" of Greek National Channel (NET)	Civil Society Policy makers Media	Greece
13 (UPAT)	Laboratory of Marine Geology and Physical Oceanography, UPAT	10.05.11	Amvrakikos and Aetoliko, HYPOX activities	Comment-interview on daily informative TV program "Morning briefing" of Greek National Channel (NET)	Civil Society Policy makers Media	Greece
13 (UPAT)	Laboratory of Marine Geology and Physical Oceanography, UPAT	19.06.11	Amvrakikos and Aetoliko, "dead seas"	REAL NEWS (National distributed daily newspaper) Two-pages article in the section REAL PLANET www.realnews.gr	Civil Society Policy makers Media	Greece
13 (UPAT)	Laboratory of Marine Geology and Physical Oceanography, UPAT	01.01.12	SOS from Greek seas	http://www.prasinomple.gr/pics/pics1/file/tefxos34_1_12.pdf	Civil Society Policy makers	Greece
15 (GeoEcoMar)	Oaie, G.	03.11.09	Oxic/anoxic limit in the Black Sea	Romania Cultural Broadcasting	Civil society media	Romania
15 (GeoEcoMar)	Gomoiu, M.-T.	22.09.10	Hypoxia and hypoxic events at the Romanian Coast	Romania Cultural Broadcasting – "ProNatura"	Media Civil Society	Romania
16 (NIOO KNAW) / 17 (NIOZ)	Cox, T., Middelburg, J.	15.12.09	Selected results from publication "A macro-tidal freshwater ecosystem recovering from hypereutrophication: the Schelde case study"	Press release distributed by e-mail and published on internet: www.ua.ac.be/main.as.px?c=*NEWS&n=71502&ct=67682&e=218227 Media examples based on the above press release: On-line media: deredactie.be, demorgen.be, knack.be Printed media: Metro, Het Laatste Nieuws Blogosphere: http://users.telenet.be/denbrabo/artikels/milieu.htm	Scientific Community Civil Society Policy makers Media	Belgium, The Netherlands

4.1.6.8 HYPOX Project brochure

Aquatic systems short of breath: how come and why should we care?

Most aquatic life depends on oxygen. It is, thus, an alarming finding that the occurrence of hypoxic (low oxygen) conditions is increasing worldwide. This is mainly a consequence of anthropogenic eutrophication (nutrient input) and climate change. In eutrophied waters the excess algal biomass produced is typically not passed on along the food chain. Instead it sinks to the seafloor where it is utilized by micro-organisms consuming oxygen. If bottom water oxygen drops significantly, faunal communities and chemical conditions start to change. Ecosystems undergo successive deterioration, eventually turning into permanently anoxic environments where micro-organisms replace all higher life (see figure below). This collapse of animal communities leads to a dramatic decline in ecosystem functions and services such as biodiversity, fisheries, aquaculture and tourism. Since the 1960ies, the records of such "dead zones" doubled every ten years.

Hypoxic (low oxygen) conditions are increasing due to eutrophication and climate change. To better understand dynamics and drivers of oxygen depletion, the EU-funded project HYPOX is starting to build a global observation system for continuous oxygen monitoring. HYPOX further includes experimental and modeling studies on hypoxia drivers and consequences for ecosystems, to gain predictive and decision-making capabilities from the obtained monitoring data. All activities will be embedded into the framework of the Global Earth Observation System of Systems (GEOSS) which aims at integrating all earth related observations into a single source of data.



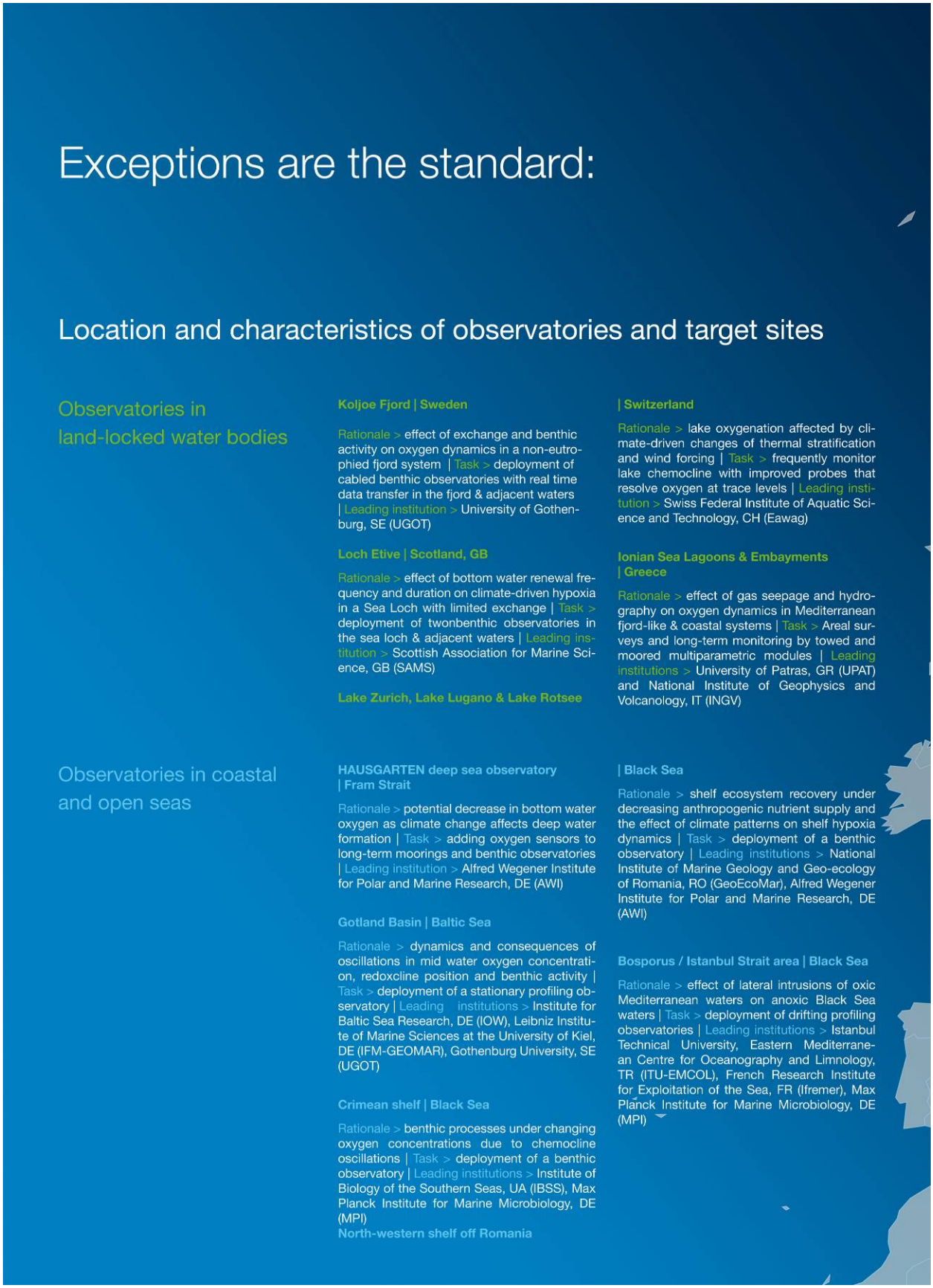
Climate change will add to oxygen depletion in several ways: warming of water will lead to degassing of oxygen, and an enhanced microbial oxygen demand. Together with changes in wind and precipitation patterns, higher temperatures will potentially increase stratification and reduce vertical oxygen transport to deeper waters and to the seafloor. Early stages of hypoxia are typically missed until obvious signs (e.g., fish mass mortality) show that dramatic changes did already occur.

To be alarmed before ecosystems lose functions that may take several decades to restore, oxygen monitoring capacities have to be improved. Within the project HYPOX monitoring of oxygen and related parameters is carried out at several different sites to improve our understanding of hypoxia formation and potential effects of anthropogenic activities and climate change on future oxygen levels.

As ecosystem responses depend on frequency, duration, spatial extent and severity of hypoxia events, continuous monitoring of oxygen concentrations is needed. In order to understand the reasons of hypoxia formation and to be able to predict potential effects of anthropogenic activities and global warming on future oxygen levels, monitoring of oxygen and related parameters have to be carried out in a variety of aquatic systems that differ in oxygen status and sensitivity towards change. Experimental and modeling studies of hypoxia drivers as well as consequences of oxygen depletion for ecosystems are needed to gain predictive and decision-making capabilities from the monitoring data obtained.

Successive stages of ecosystem decline upon exposure to increasing levels of hypoxia.
Note that strong shifts may go unnoticed if oxygen is not properly monitored and early hypoxia events are missed.

periodic	seasonal	persistent
moderate, recovery in months to years	severe, recovery takes years	severe, recovery needs decades
shift towards smaller animals, reduction in biodiversity	partial recolonization between hypoxic periods, severe biodiversity loss	no higher life left, endemic species extinct
restricted sediment reworking reduces denitrification and adds to eutrophication	additional eutrophication by phosphate released from reduced sediments	accumulation of reduced compounds in sediments impedes recovery. methane release adds to global warming and formation of new hypoxia events
large and small sessile animals (e.g., worms)	small animals and microbes	microbes and organic matter burial
nothing obvious („black spots“)	fish catches may start to decline	collapsing fish catches and mass mortality

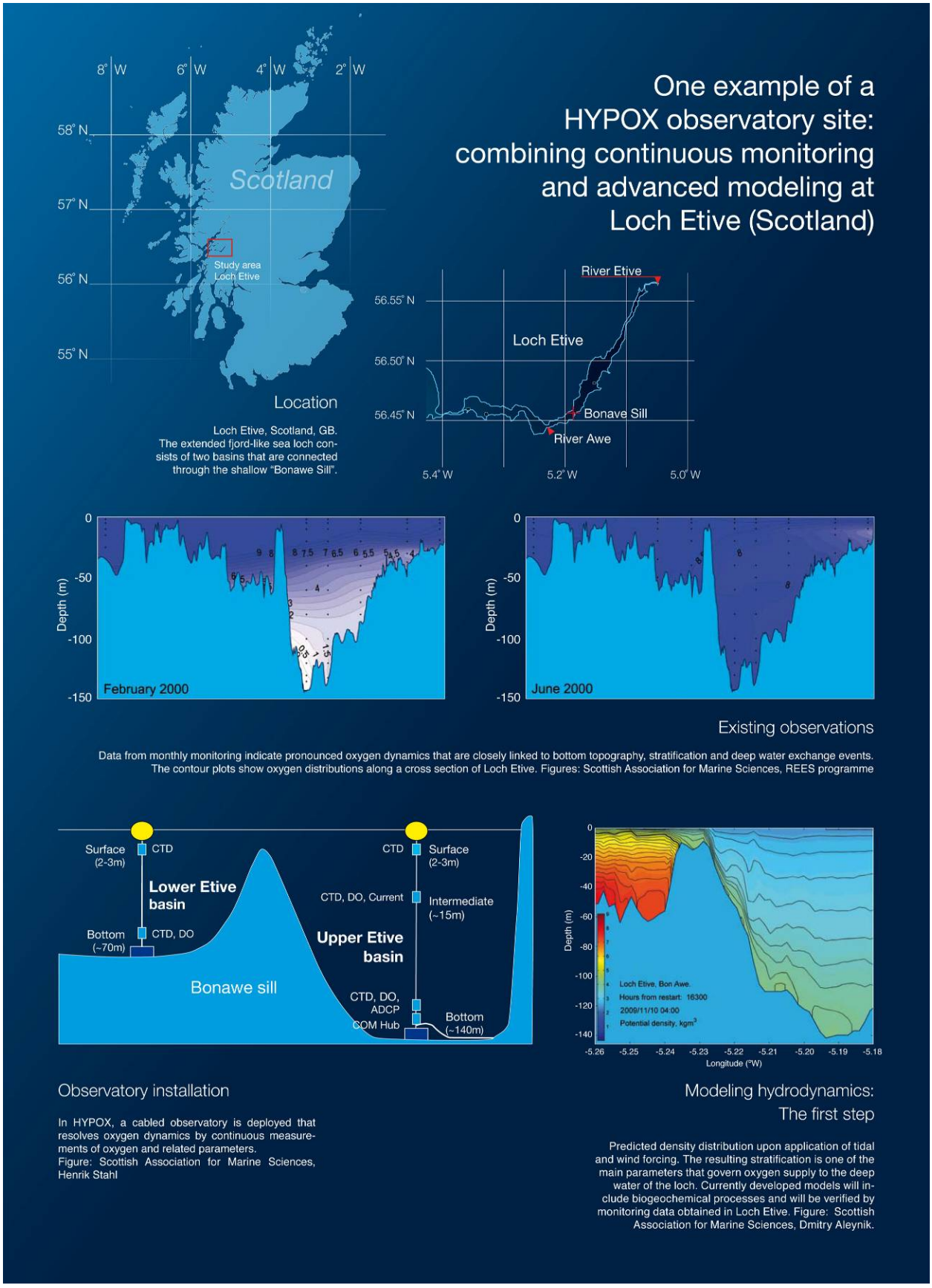

Exceptions are the standard:
Location and characteristics of observatories and target sites
Observatories in land-locked water bodies
Koljoe Fjord | Sweden
Rationale > effect of exchange and benthic activity on oxygen dynamics in a non-eutrophied fjord system | Task > deployment of cabled benthic observatories with real time data transfer in the fjord & adjacent waters | Leading institution > University of Gothenburg, SE (UGOT)
Loch Etive | Scotland, GB
Rationale > effect of bottom water renewal frequency and duration on climate-driven hypoxia in a Sea Loch with limited exchange | Task > deployment of twonbenthic observatories in the sea loch & adjacent waters | Leading institution > Scottish Association for Marine Science, GB (SAMS)
Lake Zurich, Lake Lugano & Lake Rotsee
| Switzerland
Rationale > lake oxygenation affected by climate-driven changes of thermal stratification and wind forcing | Task > frequently monitor lake chemocline with improved probes that resolve oxygen at trace levels | Leading institution > Swiss Federal Institute of Aquatic Science and Technology, CH (Eawag)
Ionian Sea Lagoons & Embayments | Greece
Rationale > effect of gas seepage and hydrography on oxygen dynamics in Mediterranean fjord-like & coastal systems | Task > Areal surveys and long-term monitoring by towed and moored multiparametric modules | Leading institutions > University of Patras, GR (UPAT) and National Institute of Geophysics and Volcanology, IT (INGV)
Observatories in coastal and open seas
HAUSGARTEN deep sea observatory | Fram Strait
Rationale > potential decrease in bottom water oxygen as climate change affects deep water formation | Task > adding oxygen sensors to long-term moorings and benthic observatories | Leading institution > Alfred Wegener Institute for Polar and Marine Research, DE (AWI)
Gotland Basin | Baltic Sea
Rationale > dynamics and consequences of oscillations in mid water oxygen concentration, redoxcline position and benthic activity | Task > deployment of a stationary profiling observatory | Leading institutions > Institute for Baltic Sea Research, DE (IOW), Leibniz Institute of Marine Sciences at the University of Kiel, DE (IFM-GEOMAR), Gothenburg University, SE (UGOT)
Crimean shelf | Black Sea
Rationale > benthic processes under changing oxygen concentrations due to chemocline oscillations | Task > deployment of a benthic observatory | Leading institutions > Institute of Biology of the Southern Seas, UA (IBSS), Max Planck Institute for Marine Microbiology, DE (MPI)
North-western shelf off Romania
| Black Sea
Rationale > shelf ecosystem recovery under decreasing anthropogenic nutrient supply and the effect of climate patterns on shelf hypoxia dynamics | Task > deployment of a benthic observatory | Leading institutions > National Institute of Marine Geology and Geo-ecology of Romania, RO (GeoEcoMar), Alfred Wegener Institute for Polar and Marine Research, DE (AWI)
Bosporus / Istanbul Strait area | Black Sea
Rationale > effect of lateral intrusions of oxic Mediterranean waters on anoxic Black Sea waters | Task > deployment of drifting profiling observatories | Leading institutions > Istanbul Technical University, Eastern Mediterranean Centre for Oceanography and Limnology, TR (ITU-EMCOL), French Research Institute for Exploitation of the Sea, FR (Ifremer), Max Planck Institute for Marine Microbiology, DE (MPI)


HAUSGARTEN
deep sea observatory | Fram Strait
Koljoe Fjord
| Sweden
Gotland Basin
| Baltic Sea
Loch Etive
| Scotland, GB
Lake Zurich, Lake Lugano &
Lake Rotsee | Switzerland
Crimean shelf
| Black Sea
North-western shelf off
Romania | Black Sea
Bosporus / Istanbul Strait area
| Black Sea
Ionian Sea Lagoons &
Embayments | Greece
Oxygen availability at a given site depends on the balance between oxygen supply (mainly physical transport and mixing) and removal (mainly biological oxidation of organic matter) which both vary on different time scales. The response of an ecosystem to hypoxia is determined by even more factors (e.g., adaptation of organisms to hypoxia, availability of nearby fauna for re-colonization, sediment inventory of oxidized and reduced components). To cope with this complexity, monitoring efforts in HYPOX encompass sites that differ both in oxygen availability and sensitivity towards change: Open ocean, oxic areas with high sensitivity to global warming (Arctic Ocean) are included as well as semi-enclosed basins where oxygen is naturally depleted (Black Sea, Baltic Sea), and partly eutrophied landlocked systems that experience hypoxia seasonally or locally (fjords, lagoons, lakes).

The HYPOX approach: from local observations to general predictions

Continuous measurements of oxygen and associated parameters are an important first step to examine the status of the system that is monitored. In order to extend the gained knowledge, however, modeling efforts need to be made. Modeling is the key tool to turn observations into generalizations that can be applied also to other ecosystems and predictions that extend the current observations into the future. These generalizations and forecasting capabilities are essential to examine the effects of future climate and eutrophication scenarios for oxygen availability and ecosystem functioning. If ecosystems are deteriorating, modeling capabilities will also provide means to decide on adequate countermeasures to be taken. Being aware of these issues, the HYPOX strategy complements oxygen monitoring with modeling efforts. To fully comprehend oxygen dynamics, HYPOX modeling aims to combine physical transport and biogeochemical processes in both the sediment and the water column. The measurements produced by the observatories and during targeted field campaigns will be used to verify the models and, via data assimilation, to improve their predictive capabilities. Model exploration will be used to extract early warning indicators and tipping points in system behavior. Combining observations and predictions of oxygen availability with existing knowledge about the effects of hypoxia on animal communities and ecosystems will improve our understanding of the potential loss of ecosystem functions and services as a consequence of climate change and eutrophication.

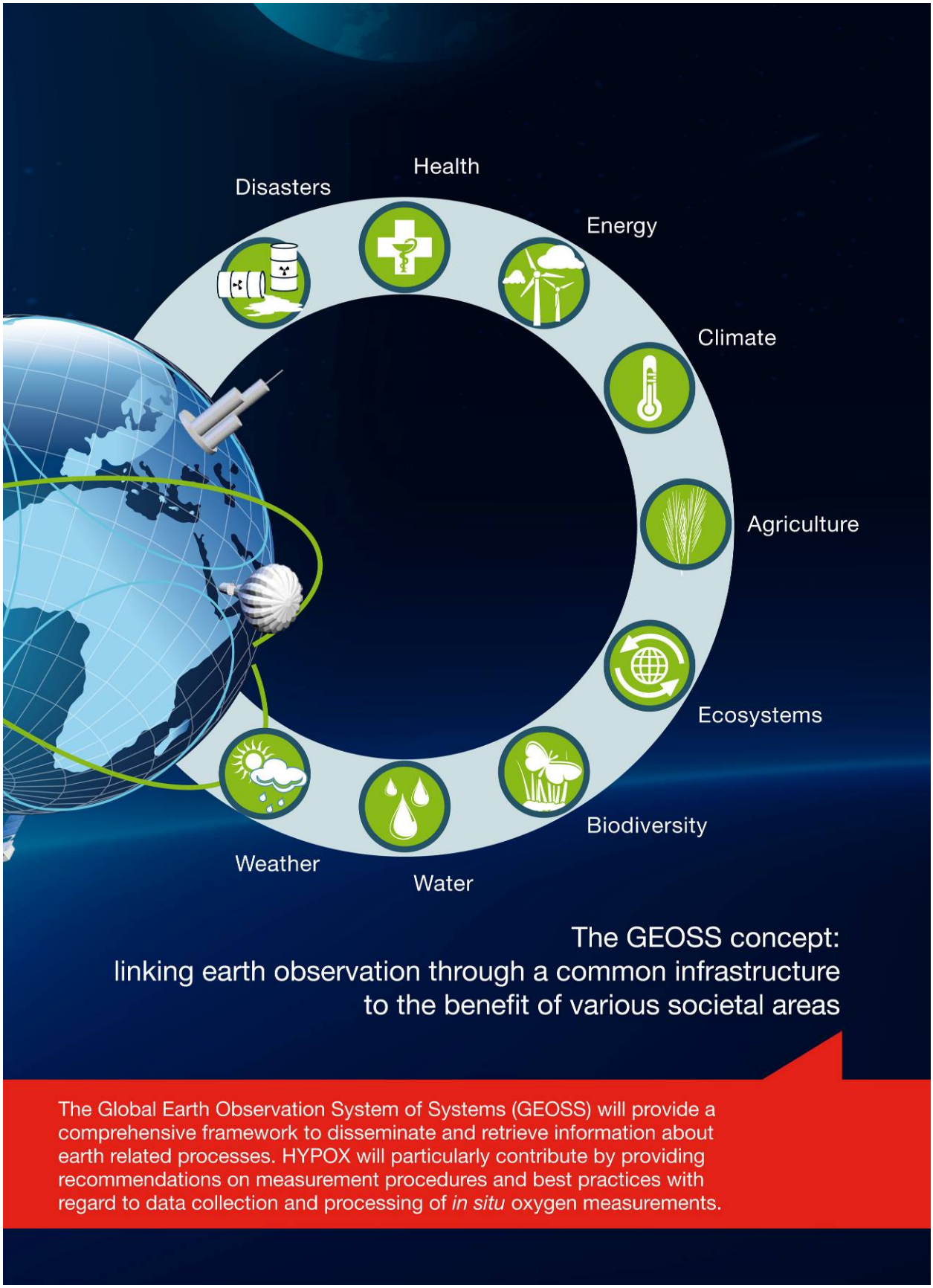
Simulations of hypoxia dynamics and consequences are an intrinsic part of the HYPOX work plan. Combining physical and biogeochemical modeling of both the water column and the sediments will provide means to extrapolate findings to similar ecosystems and to predict future hypoxia. These capabilities are needed to understand the effect of climate change and eutrophication on ecosystem functions and services and to decide on countermeasures that may be taken.


One example of a HYPOX observatory site: combining continuous monitoring and advanced modeling at Loch Etive (Scotland)
8° W
6° W
4° W
2° W
58° N
57° N
56° N
55° N
Scotland
Study area Loch Etive
Location
Loch Etive, Scotland, GB. The extended fjord-like sea loch consists of two basins that are connected through the shallow "Bonawe Sill".
River Etive
56.55° N
56.50° N
56.45° N
Loch Etive
Bonave Sill
River Awe
5.4° W
5.2° W
5.0° W
Depth (m)
0
-50
-100
-150
February 2000
June 2000
Existing observations
Data from monthly monitoring indicate pronounced oxygen dynamics that are closely linked to bottom topography, stratification and deep water exchange events. The contour plots show oxygen distributions along a cross section of Loch Etive. Figures: Scottish Association for Marine Sciences, REES programme
Surface (2-3m)
CTD
Lower Etive basin
Bottom (~70m)
CTD, DO
Bonawe sill
Upper Etive basin
CTD, DO, Current
Intermediate (~15m)
CTD, DO, ADCP
COM Hub
Bottom (~140m)
Observatory installation
In HYPOX, a cabled observatory is deployed that resolves oxygen dynamics by continuous measurements of oxygen and related parameters. Figure: Scottish Association for Marine Sciences, Henrik Stahl
Depth (m)
Loch Etive, Bon Awe.
Hours from restart: 16300
2009/11/10 04:00
Potential density, kgm^3
Longitude (°W)
Modeling hydrodynamics: The first step
Predicted density distribution upon application of tidal and wind forcing. The resulting stratification is one of the main parameters that govern oxygen supply to the deep water of the loch. Currently developed models will include biogeochemical processes and will be verified by monitoring data obtained in Loch Etive. Figure: Scottish Association for Marine Sciences, Dmitry Aleynik.

Standardization, integration, dissemination: compliance with the Global Earth Observation initiative

HYPOX is aiming at forming a community of practices in the field of oxygen observations in Europe and to link these activities with similar programs in North America and other countries engaged in this field. On a short time scale it is planned to establish permanent observatory stations and to link different observatories through free exchange of data in an accepted standard format. The dissemination of the collected information and description of available services and products will be made available through the GEOSS common infrastructure – basically a set of archives that helps to search for data and results of past and ongoing measuring campaigns. An important contribution to GEOSS will be to test and define common standards and protocols for oxygen observations. The technical implementation of the infrastructure will be carried out in close cooperation with the industry to identify cost efficient and commercially viable technical solutions.

From the perspective of a scientific user GEOSS will offer new opportunities to evaluate and interpret measurement results. For example, meteorological forcing will have an immediate impact on oxygen depleted waters in particular for shallow depths. The reliable availability of meteorological and standard ocean data is important for improved forecasts of oxygen conditions. Within HYPOX different modeling approaches will be used to demonstrate the forecasting capabilities.
The HYPOX project will help to develop a vision on how GEOSS help scientists to improve their knowledge on processes having a direct impact on the society and economy, in particular in regions close to the sea.


Disasters
Health
Energy
Climate
Agriculture
Ecosystems
Biodiversity
Water
Weather
The GEOSS concept:
linking earth observation through a common infrastructure
to the benefit of various societal areas
The Global Earth Observation System of Systems (GEOSS) will provide a comprehensive framework to disseminate and retrieve information about earth related processes. HYPOX will particularly contribute by providing recommendations on measurement procedures and best practices with regard to data collection and processing of *in situ* oxygen measurements.

Photos courtesy of
(upper left to lower right)

1. Giuditta Marinaro, INGV
2. Olaf Pfannkuche, IFM-GEOMAR
3. Henrik Stahl, SAMS
4. Jana Friedrich, AWI
5. Marian-Trajan Gomoiu, GeoEcoMar
6. Thomas Soltwedel, AWI
7. Olaf Pfannkuche, IFM-GEOMAR
8. George Papatheodorou, UPAT
9. George Papatheodorou, UPAT
10. Per Hall, UGOT
11. Guiseppe Etiope, INGV
12. Gilles Lericolais, Ifremer
13. Onay Yilmaz, milliyet, turkey
14. Carsten Schubert, Eawag
15. Christoph Waldmann, Marum
16. Onay Yilmaz, milliyet, turkey
17. Antje Boetius, MPI

In order to cover all aspects of hypoxia's causes and consequences a multidisciplinary approach is essential. The HYPOX project is built on a consortium of experts from 16 partner institutions located in 11 countries in and around Europe. Fields of expertise include disciplines as diverse as physical and biological oceanography, geology, anorganic and organic geochemistry, biogeochemistry, biodiversity, microbial and general ecology, taxonomy, instrumentation development, and numerical modeling.

Prof. Antje Boetius | Dr. Jana Friedrich | Prof. Namik Çagatay | Dr. Carsten Schubert | Prof. Marian-Trajan Gomoiu | Prof. Emil Stanev | Prof. Nelli Sergeeva | Dr. Olaf Pfannkuche

Getting to know the crowd

MPI, Bremen, Germany
Max Planck Institute for Marine Microbiology
Prof. Antje Boetius, aboetius@mpi-bremen.de
„The immense spreading of hypoxia in the last decades is one of the most alarming findings for environmental scientists."
Expertise: Microbial communities & habitats
Leader of workpackage "Coordination, dissemination and outreach"

AWI, Bremerhaven, Germany
Alfred Wegener Institute for Polar and Marine Research
Dr. Jana Friedrich, jana.friedrich@awi.de
„HYPOX is a great opportunity for me to continue my long term research on the human impact on the Black Sea ecosystem."
Expertise: Aquatic biogeochemistry & natural radionuclides.
Leader of workpackage "Impacts of hypoxia on ecosystems"

Eawag, Dübendorf, Switzerland
Swiss Federal Institute of Aquatic Science and Technology
Dr. Carsten Schubert, carsten.schubert@eawag.ch
„After realizing that oxygen concentrations in the atmosphere are declining, the participation in HYPOX is a must for our institute."
Expertise: Biomarker studies

GeoEcoMar, Constanţa, Romania
The National Institute of Marine Geology and Geo-ecology of Romania
Prof. Marian-Trajan Gomoiu, mtg@cier.ro
„We need to understand the recovery of the northwestern Black Sea ecosystem upon the decrease in environmental stress over the past 15 years."
Expertise: Aquatic ecology & environment protection

GKSS, Geesthacht, Germany - Institute for Coastal Research
Prof. Emil Stanev, emil.stanev@gkss.de
„HYPOX brings together expertise in measuring and modeling."
Expertise: Modeling of oceanography, biogeochemistry & sediment dynamics
Co-leader of workpackage "Modeling and prediction of short and long term factors affecting oxygen depletion"

IBSS, Sevastopol, Ukraine
A.O.Kovalevsky Institute of Biology of the Southern Seas
Prof. Nelli Sergeeva, nserg05@mail.ru
„How can higher life occur when oxygen concentrations are very low?"
Expertise: Meiobenthos diversity and ecology
Co-leader of workpackage "Indicators of past hypoxia dynamics "

IFM-GEOMAR, Kiel, Germany
Leibniz Institute of Marine Sciences at the University of Kiel
Dr. Olaf Pfannkuche, opfannkuche@ifm-geomar.de
„Environmental change and its consequences should be a prime target of European Research."
Expertise: *In situ* experiments & marine N-cycle

Ifremer, Plouzane, France
French Research Institute for Exploitation of the Sea
Dr. Gilles Lericolais, Gilles.lericolais@ifremer.fr
„We are eager to launch monitoring equipment at the Bosporus outlet - one of the areas in focus of the ESONET Network of Excellence."
Expertise: Marine geology & geophysics
Leader of workpackage "Assessing *in situ* oxygen depletion in shelf and open seas"

Dr. Gilles Lericolais | Dr. Giuditta Marinaro | Prof. Gregor Rehder | Dr. Christoph Waldmann | Prof. Jack Middelburg | Henrik Stahl | Prof. Per Hall | Prof. George Papatheodorou

INGV, Rome, Italy - National Institute of Geophysics and Volcanology
Dr. Giuditta Marinaro, giuditta.marinaro@ingv.it
„HYPOX will improve our understanding of variations in oxygen depletion: a great opportunity to improve environmental health!"
Expertise: Scientific payload of seafloor observatories & data management
Leader of workpackage "Improving and integrating *in situ* observation capacities of oxygen depletion"

IOW, Rostock, Germany - Institute for Baltic Sea Research
Prof. Gregor Rehder, gregor.rehder@io-warnemuende.de
"HYPOX provides us with a platform to exchange and develop ideas amongst the leading scientists working in this field in Europe."
Expertise: Marine chemistry & geochemistry

ITU-EMCOL, Istanbul, Turkey - Istanbul Technical University
Eastern Mediterranean Centre for Oceanography and Limnology
Prof. Namik Çagatay, cagatay@itu.edu.tr
„Understanding major oxygen level changes in the Black Sea history will help to predict future hypoxia in the Black Sea and elsewhere."
Expertise: Geochemistry
Co-leader of workpackage "Indicators of past hypoxia dynamics"

Marum, Bremen, Germany
Center for Marine Environmental Sciences at Bremen University
Dr. Christoph Waldmann, waldmann@marum.de
"HYPOX will foster standardization and the use of common infrastructures in ocean monitoring."
Expertise: Oceanographic technology & GEOSS
Co-leader of workpackage "Data sharing, standardization and interoperability according to GEOSS"

NIOO-KNAW, Yerseke, The Netherlands
Centre for Estuarine and Marine Ecology
Prof. Jack Middelburg, j.middelburg@geo.uu.nl
„Dissolved oxygen levels are declining in many aquatic ecosystems and we have to understand the ecological, biogeochemical and Earth System consequences."
Expertise: Benthic ecology and biogeochemistry
Co-leader of workpackage "Modeling and prediction of short and long term factors affecting oxygen depletion"

SAMS, Oban, Great Britain - Scottish Association for Marine Science
Henrik Stahl, henrik.stahl@sams.ac.uk
"We need to monitor hypoxia. It is a global problem already – and might become even worse due to climate change."
Expertise: *In situ* measurements
Leader of workpackage "Assessing *in situ* oxygen depletion in landlocked water bodies"

UGOT, Gothenburg, Sweden - University of Gothenburg
Prof. Per Hall, perhall@chem.gu.se
"We need to get a better balanced view of oxygen depletion in coastal and fjord systems - a view that considers natural causes and does not overemphasize anthropogenic impacts."
Expertise: Benthic biogeochemistry & sediment-water interactions

UPAT, Patras, Greece - University of Patras
Prof. George Papatheodorou, gpapathe@upatras.gr
"HYPOX will improve our understanding of hypoxia in Amvrakikos Gulf and other unique Ionian Sea ecosystems that are of fundamental economic importance for the local societies."
Expertise: Submarine mass transport & gas charged sediments


www.hypox.net
data portal
2
The HYPOX consortium consists of 16 partners form 11 nations in and around Europe. The project will run for three years (2009-2012).
HYPOX partner institutions are:
- Max Planck Institute for Marine Microbiology, Bremen, Germany (MPI)
- Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany (AWI)
- Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland (Eawag)
- The National Institute of Marine Geology and Geo-ecology of Romania, Constanta, Romania (GeoEcoMar)
- Institute for Coastal Research, Geesthacht, Germany (GKSS)
- A.O.Kovalevsky Institute of Biology of the Southern Seas, Sevastopol, Ukraine (IBSS)
- Leibniz Institute of Marine Sciences at the University of Kiel, Kiel, Germany (IFM-GEOMAR)
- French Research Institute for Exploitation of the Sea, Plouzane, France (Ifremer)
- National Institute of Geophysics and Volcanology, Rome, Italy (INGV)
- Institute for Baltic Sea Research, Rostock, Germany (IOW)
- Istanbul Technical University, Eastern Mediterranean Centre for Oceanography and Limnology, (ITU-EMCOL)
- Center for Marine Environmental Sciences at Bremen University, Bremen, Germany (Marum)
- Centre for Estuarine and Marine Ecology, Yerseke, The Netherlands (NIOO-KNAW)
- Scottish Association for Marine Science, Oban, Great Britain (SAMS)
- University of Gothenburg, Gothenburg, Sweden (UGOT)
- University of Patras, Patras, Greece (UPAT)
AWI
EMCOL
eawag
GeoEcoMar
GKSS
IBSS
IFM-GEOMAR
Ifremer
INGV
IOW
marum
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Text: Felix Janssen & Christoph Waldmann, Marum with support from Jack Middelburg, NIOO-KNAW
Layout & illustration: Sabine Lüdeling, www.medieningenieure.de
For further information on the HYPOX project, please contact:
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4.1.6.9.1 HYPOX Policy brief 1

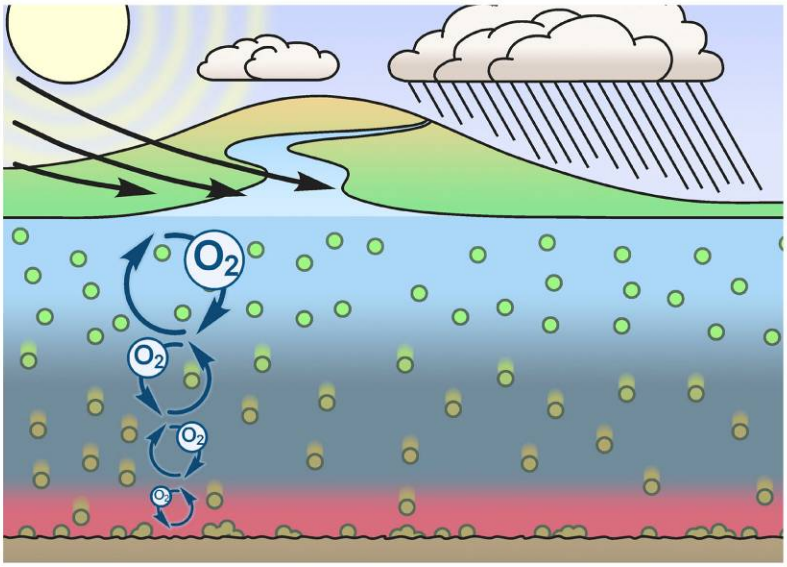
HYPOXIA BRIEF 1: Hypoxia fundamentals

Plentiful in air but scarce in waters: oxygen depletion in aquatic systems

Oxygen is generated as a byproduct of photosynthesis and therefore directly connected to the productivity of photosynthesizing organisms. The cycle is closed if all photosynthesized matter is consumed and respired by animals and microorganisms. However, if nutrients or organic material are supplied in excess, oxygen demand can increase locally. Aquatic ecosystems can turn hypoxic (low in oxygen) as oxygen transport in waters is much slower as compared to the atmosphere. In order to understand causes and consequences of oxygen depletion the EU project HYPOX specifically focuses on areas that are prone to hypoxia.

Oxygen deserves attention: too little oxygen even more

Oxygen is on the decline in aquatic ecosystems worldwide and is expected to decrease further, mainly due to anthropogenic pressures. Oxygen depletion ('hypoxia') has substantial consequences for life, its biodiversity and hence ecosystem goods and services. The EU project 'HYPOX' (www.hypox.net) developed novel oxygen monitoring strategies to identify ecosystems at risk and to support decisions on effective countermeasures. This series of 'Hypoxia Briefs' provide information on hypoxia causes and consequences and findings from three years of intense hypoxia research in European waters.



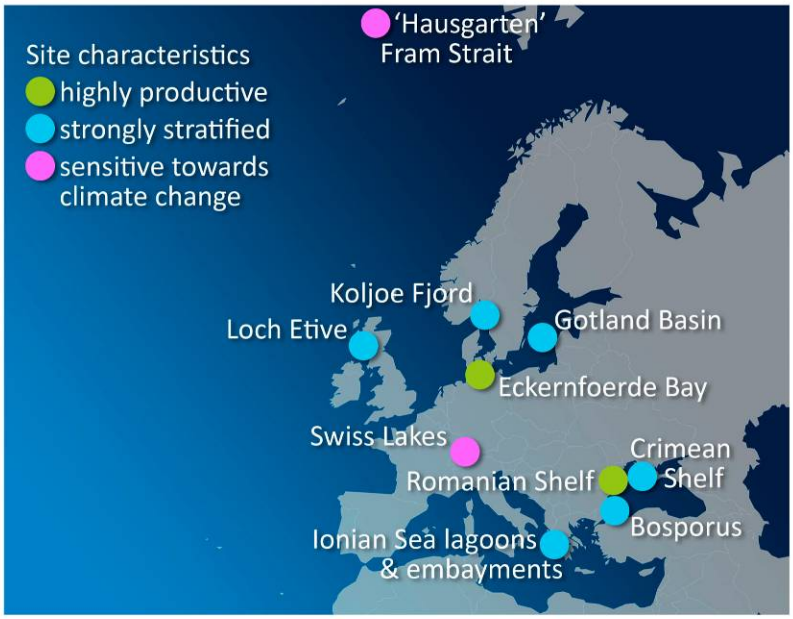
Oxygen needed for the decay of algae biomass at depth is mixed down by water movements created by winds and tides. Mixing intensity and oxygen availability diminish with depth, especially when solar radiation and freshwater input creates stratification. If high oxygen demand coincides with low supply by mixing, hypoxic conditions (pinkish zone) may occur (figure: Felix Janssen).

Oxygen always suffices – it's just not equally distributed

On Earth, the oxygen production by photosynthesizing organisms is almost equivalent to the oxygen respired by animals (including humans), microorganisms, and fungi. In aquatic systems, however, areas depleted in oxygen are rather common. This is because water bodies are characterized by low oxygen solubility, slow transport, and the restriction of oxygen production to the sunlit surface waters.

Grazing thousands of meters below the meadow

New production of oxygen in aquatic systems is restricted to the surface layer where sunlight allows for photosynthesis. In addition oxygen in surface waters is replenished from the atmosphere. Algal biomass produced by photosynthesis eventually sinks out of this layer and feeds organisms living in deeper waters or at the seafloor. But the maximum oxygen content of water is 20 to 40 times smaller as compared to air. In addition, transport of oxygen to depth is slow as mixing rates are several orders of magnitude lower than in the atmosphere. Oxygen availability in the interior of aquatic systems is hence a fragile balance between production, transport, and consumption of oxygen and organic matter.



Overview of the HYPOX target sites categorized according to main oxygen depletion characteristics. 'Sensitive towards climate change' signifies sites where oxygen availability at depth may reduce due to climate change impacts on deep circulation. (Figure: Sabine Luedeling, www.medieningenieure.de)

Triggers for hypoxic conditions

The project HYPOX focused on coastal systems and lakes where hypoxia is particularly common. Here, nutrient input from land can support high growth rates of microalgae. If this matter sinks to the seafloor a high oxygen demand is created. Bottom water hypoxia often occurs in summer, when high water temperatures and weak winds decrease oxygen solubility and mixing. In many cases density gradients additionally promote hypoxia development by reducing the downward mixing of oxygen. Warming of surface layers and freshwater input results in stratification and largely impedes oxygen transport to more dense waters below. In the deep Baltic as well as in fjords studied in HYPOX, oxygen at depth is replenished only during rare deep-water renewal events. Thorough investigations are needed to understand the complex processes that drive oxygen dynamics at the different sites. This knowledge is needed to predict future oxygen conditions and the impact of anthropogenic pressures and to decide on appropriate mitigation measures to prevent hypoxia.

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Information on hypoxia in the Gulf of Mexico: www.gulfhypoxia.net; http://serc.carleton.edu/microbelife/topics/deadzone/index.html; http://water.epa.gov/type/watersheds/named/msbasin/hypoxia101.cfm

Hypoxia science and status in the northwest Pacific by the PISCO program (including links to videos & images): www.piscoweb.org/research/science-by-discipline/coastal-oceanography/hypoxia

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4.1.6.9.2 HYPOX Policy brief 2

HYPOXIA BRIEF 2: Consequences of hypoxia

Ecosystems short of breath: hypoxia consequences for aquatic life

Hypoxia (oxygen depletion) impacts all life from the tiniest microorganism to the largest fish. Once 'dead zones' develop lacking higher life, recovery may take years or even decades – with strong implications for ecosystem goods and services. Hypoxia-related changes in microbial and chemical processes invoke the release of toxic substances and greenhouse gases that may add to ecosystem deterioration and global warming. Hypoxia effects are specific to ecosystems and thorough investigations are needed to identify the processes involved.

Oxygen deserves attention: too little oxygen even more

Oxygen is on the decline in aquatic ecosystems worldwide and is expected to decrease further, mainly due to anthropogenic pressures. Oxygen depletion ('hypoxia') has substantial consequences for life, its biodiversity and hence ecosystem goods and services. The EU project 'HYPOX' (www.hypox.net) developed novel oxygen monitoring strategies to identify ecosystems at risk and to support decisions on effective countermeasures. This series of 'Hypoxia Briefs' provide information on hypoxia causes and consequences and findings from three years of intense hypoxia research in European waters.

Fish kill at the northwestern Black Sea shelf during summer hypoxia in 2010. Photograph courtesy of Adrian Teaca.

Alarming oxygen levels

Hypoxia occurrence in seas and inland waters increases due to climate change and other human-induced pressures. When oxygen levels drop, animals relocate, show reduction in growth and reproduction, or die. The response depends on species and hypoxia severity and spatial extent. The paleontological record reveals an extreme example: in a warm period 250 million years ago oxygen levels dropped drastically and more than 90% of the marine species got extinct. Fish kills are the most obvious signs for 'dead zones'. Hypoxia also acts on microbial and chemical processes at the seafloor resulting in the release of toxic substances, nutrients and greenhouse gases. In coastal areas excess nutrients add to plankton growth and subsequent hypoxia. In 'oxygen minimum zones' microbial processes may turn nitrogen compounds into climate-relevant gases. To fully address the consequences of hypoxia, it is important to observe much more than just oxygen concentrations.

hypoxia occurrence	episodic	periodic	seasonal	persistent
ecosystem changes	small, recovery in days to months	moderate, recovery in months to years	severe, recovery takes years	severe, recovery needs decades
	animals survive or recolonize without community shifts	shift towards smaller animals, reduction in biodiversity	partial recolonization between hypoxic periods, severe biodiversity loss	no higher life left, endemic species extinct
		restricted sediment reworking reduces denitrification and adds to eutrophication	additional eutrophication by phosphate released from reduced sediments	accumulation of reduced compounds in sediments impedes recovery. methane release adds to global warming and formation of new hypoxia events
highest trophic level ultimate fate of eco system productivity	large motile animals (fish, crabs...)	large and small sessile animals (e.g., worms)	small animals and microbes	microbes and organic matter burial
signs of ecosystem decline	subtle	nothing obvious („black spots")	fish catches may start to decline	collapsing fish catches and mass mortality

Patterns of ecosystem decline: from occasional hypoxia to permanently anoxic dead zones

The long way back: slow recovery of benthic communities

Once a flourishing ecosystem with rich fishing grounds, the broad northwestern Black Sea shelf turned into the world's largest 'dead zone' after 1960, when vast inputs of nutrients and wastewaters resulted in area-wide oxygen depletion. Conditions only improved when fertilizer and industrial wastewater efflux dropped in the 1990s after the political changes in the riparian states. Investigations of the project HYPOX reveal that the ecosystem is still not restored. Opportunistic and sometimes invasive species still occupy ecological niches of long-lived and slow-growing organisms. Characteristic habitats like mussel beds did hardly reestablish. A major challenge for future monitoring is to identify declining oxygen levels at an early stage to allow for countermeasures before essential ecosystem functions are lost.

Filter feeder communities at the northwestern Black Sea shelf. In many areas the semitransparent fast growing ascidians still dominate over slow growing mussels that died off due to hypoxia. Photograph courtesy of Tim Stevens.

Oxygen rules seafloor processes

High nutrient levels in western Baltic waters sustain an intense production of microalgae. When the algal biomass is degraded at the seafloor, bottom water oxygen is consumed and nutrients are recycled back the water column – further enhancing productivity and the risk of bottom water hypoxia. At the long term monitoring site 'BOKNIS ECK' hypoxic conditions develop in summer and wipe out the bottom fauna. Next, the strong greenhouse gas methane is produced in the oxygen deficient sediments. Methane seeps from the seafloor, carrying high amounts of nutrients back to the water column and potentially adding to global warming. Summer hypoxia thus creates conditions favorable for even stronger oxygen depletion. Further efforts are needed to investigate if such feedback loops also exist in other areas that similarly suffer from summer hypoxia.

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Hypoxia research in the Northern Adriatic by the University of Vienna: www.marine-hypoxia.com

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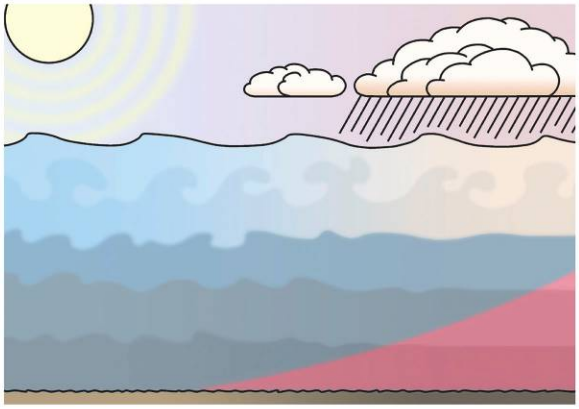
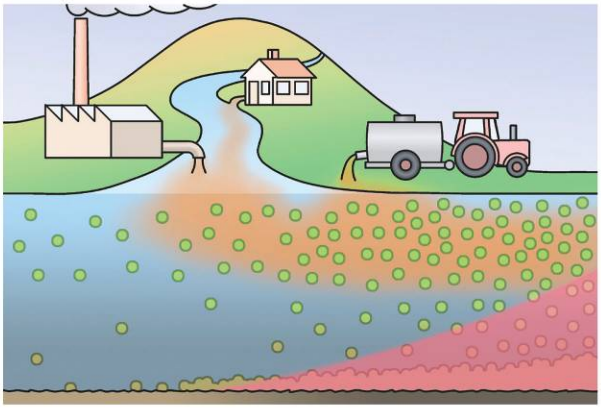
4.1.6.9.3 HYPOX Policy brief 3

HYPOXIA BRIEF 3: Anthropogenic drivers of hypoxia

Declining oxygen in water bodies of an overcrowded and warming world

Climate change and nutrient runoff from agriculture and wastewaters lead to decreasing oxygen levels in water bodies worldwide. This is due to a combination of physical, chemical, and biological processes including complex interactions between organisms and self-enhancing feedback loops. Hypoxia (oxygen depletion) has vast consequences for aquatic ecosystems. Long-term oxygen monitoring efforts are needed to assess trends in hypoxia development, and to identify the drivers and mechanisms involved. This information is indispensible for decisions on appropriate countermeasures.





Warming and increased precipitation associated with climate change intensify stratification and restrict mixing. Reduced downward mixing of oxygen may lead to hypoxia (pinkish area) in many aquatic ecosystems.

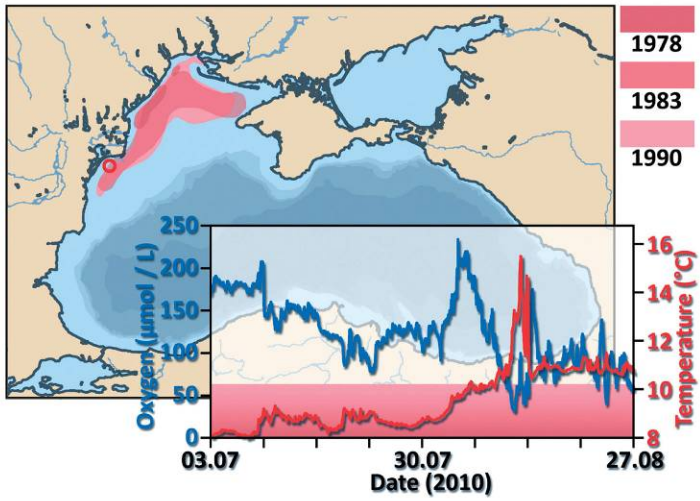
Fertilizer and wastewater runoff enhances primary production in surface layers and organic matter export to deeper layers. This creates oxygen demand and potentially hypoxic conditions at depth (figures: Felix Janssen).

Oxygen deserves attention: too little oxygen even more

Oxygen is on the decline in aquatic ecosystems worldwide and is expected to decrease further, mainly due to anthropogenic pressures. Oxygen depletion ('hypoxia') has substantial consequences for life, its biodiversity and hence ecosystem goods and services. The EU project 'HYPOX' (www.hypox.net) developed novel oxygen monitoring strategies to identify ecosystems at risk and to support decisions on effective countermeasures. This series of 'Hypoxia Briefs' provide information on hypoxia causes and consequences and findings from three years of intense hypoxia research in European waters.

Less supply and stronger demand: anthropogenic pressures causing deoxygenation of aquatic systems

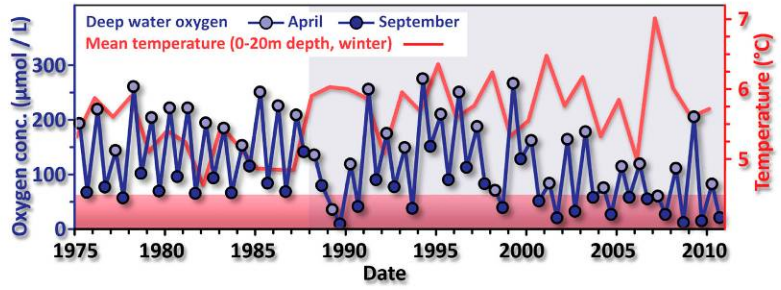
Climate change results in warming of surface waters and reduces their capacity to take up atmospheric oxygen. Warming – and in many places increased precipitation – intensifies stratification and reduces oxygen transport to deeper waters. In coastal and inland waters, eutrophication (nutrient input from waste waters and agriculture) adds to the problem. Growth of microalgae is stimulated just like crop growing in fertilized farmlands. Eventually the excess algal biomass sinks through the water column creating a strong oxygen demand at the seafloor. Once oxygen gets depleted animals die off and a vicious cycle sets in. Nutrients, locked in the sediments in the presence of oxygen are returned to the water column where they stimulate further algal growth. Methane and nitrous oxide, greenhouse gases produced by microorganisms at low oxygen conditions, further promote climate change. The situation is not expected to improve: Global warming is predicted to decrease oceanic oxygen concentrations by several percent over the next century and ever-growing human populations are likely to increase nutrient runoff and the formation of 'dead zones'.



Expansion of hypoxic areas (pinkish) on the Black Sea northwestern shelf in the 1970s to 1990s (map after Zaitsev, Yu, Mamaev V. (1997) Marine Biological Diversity in the Black Sea. UN Publications, New York). The graph shows oxygen and temperature in the bottom water at the 'Portita' site (red circle in map). Summer hypoxia (pinkish zone in the plot) may still occur although conditions largely improved since the 1990s (Jana Friedrich, unpublished data).

After 20 years of reduced nutrient input: Summer hypoxia at the Romanian Black sea shelf

The north western Black Sea shelf provides a unique example for the mitigation of coastal hypoxia through reduced nutrient input. Since the 1990s, when economies of former Black sea Soviet countries collapsed and nutrient inputs decreased substantially, oxygen concentrations in shelf waters generally recovered. However, continuous bottom water oxygen recordings carried out for the first time within the project HYPOX revealed that hypoxia still occurs at warm summer temperatures and unfavorable hydrographic conditions. At the same time a strong release of nutrients from the seafloor was found, showing memory effects that counteract recovery. Monitoring efforts are indispensable to follow improvements and to assess remaining risks for deterioration.



Abrupt warming of the upper layer of Lake Zurich in the late 1980s restricted lake winter overturning and oxygen replenishment from 1988 to present (blue gray area). As a result, hypoxic conditions (pinkish area) regularly occurred at the end of summer at the bottom of the lake, particularly after 1999. Data courtesy of Wasserversorgung Zürich.

Climate variability driving oxygen depletion in deep Lake Zurich (Switzerland)

The City of Zurich's long term monitoring program allowed HYPOX scientists to investigate the impact of climate variability on deep-water oxygen conditions in Lake Zurich. Throughout the 1970s and 1980s the water column overturned most winters, ventilating lake Zurich down to the bottom. An abrupt increase in air and water temperatures in the end of the 1980s strengthened the lake's stratification and reduced the frequency of overturning. Consequently, deep water hypoxia was commonly observed in the last twenty years, confirming that global warming can turn ecosystems hypoxic. Nutrient availability in Lake Zurich cannot explain the observed patters as it decreased since the 1970s. Long-term observations are needed to separate climate and nutrient driven hypoxia also for other systems and to identify appropriate mitigation strategies.

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Further reading

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4.1.6.9.4 HYPOX Policy brief 4

HYPOXIA BRIEF 4: Hypoxia monitoring strategies

An ocean of possibilities: how to select the right oxygen monitoring strategy

The classical oxygen monitoring approach with monthly to quarterly site visits is inappropriate to capture ecosystem status and trends. Instead, duration, frequency and spatial extent of hypoxia (low oxygen conditions) as well as hypoxia thresholds of key organisms and processes need to be considered. The project HYPOX addressed the relevant temporal and spatial scales by evaluating a variety of monitoring approaches targeted to contrasting ecosystems. In order to strengthen the contribution of oxygen monitoring to earth observation, HYPOX engaged in the Global Earth Observation System of Systems (GEOSS).

Oxygen deserves attention: too little oxygen even more

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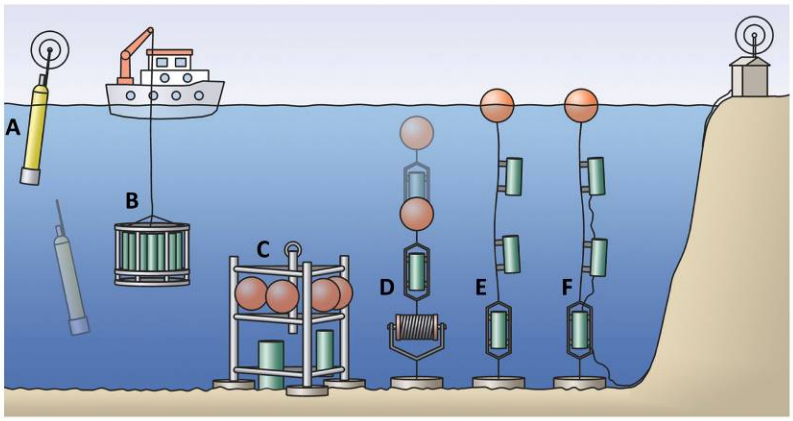

Schematics of the different oxygen observatory types used in HYPOX. (A) Argo float type drifting observatory, (B) ship-based towed or profiling instruments, (C) benthic observatories, (D) profiling moorings, (E) and (F) Stand-alone and cabled moorings (figure: Felix Janssen).

What to consider in hypoxia monitoring or: how low is 'low in oxygen'?

To understand life in low oxygen environments it helps to climb up high. On Mount Everest we only get 30% of the oxygen we're used to and conditions become detrimental for most of us. This threshold we share with many fish and crustaceans that start to die off at oxygen levels below 30% air saturation. Many bivalves or bottom dwelling worms, however, live happily at much lower concentrations. At oxygen levels as low as a few percent all higher aquatic life ceases. Remaining traces of oxygen still matter for microbial processes – with huge implications for large scale element cycling. Also temporal and spatial scales of oxygen depletion need to be considered as the ability to tolerate enduring and recurrent hypoxia or to escape into neighboring areas differs a lot between species. Long term monitoring is needed to assess ecosystem trends and to separate natural variability from effects of anthropogenic pressures and climate change. Hypoxia monitoring hence needs specific observatory instrumentation, and strategies have to be tailored to the ecosystems and processes in question.

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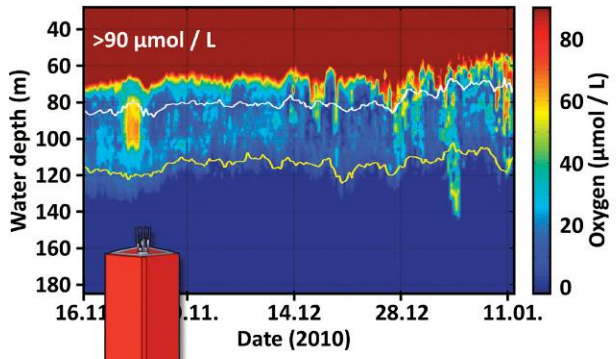
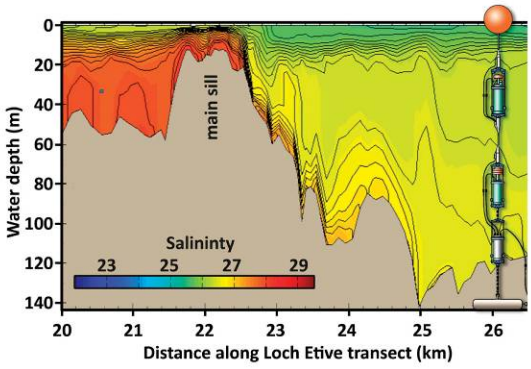


Time series of oxygen profiles in the Gotland Basin chemocline and a sketch of the profiling mooring used for data acquisition (not to scale). The yellow and white line indicate typical chemocline densities (sigma 8.5 and 9.5). Data and sketch courtesy of Ralf Prien.



Modeled salinity distribution in the Scottish fjord Loch Etive during saltwater inflow events (graph courtesy of Dmitry Aleynik). The sketch shows the cabled observatory that monitors oxygen and inflow events (not to scale). The data are used to validate the model (mooring sketch courtesy of Henrik Stahl and AADI, Bergen, NO).

Advanced hypoxia monitoring in HYPOX

Oxygen monitoring in HYPOX mostly focused on continuous measurements with stand-alone or cabled observatories. The observed temporal variability was unexpected and is intriguing for ecosystem modeling. Strong oxygen dynamics were found in the Baltic Sea water column, one of earth's most stratified systems. In bottom waters of the Black Sea hypoxic conditions sometimes developed in a matter of hours exposing seafloor communities to severe oxygen stress. Continuous monitoring also captured rare episodic events. Cabled observatories in Swedish and Scottish fjords recorded occasions of inflow and mixing that replenished oxygen at depth. Measurements were fed into simulations to better understand fjord exchange processes. The spatial scales addressed in HYPOX ranged from meter size fine structures of hypoxic lake waters to the basin scale oxygen distribution in the Black Sea. Two profiling floats recorded as many as 260 oxygen profiles - equivalent to 8% of all deep Black Sea oxygen profiles collected since measurements started in 1923.

Turning monitoring data into information

Once data are collected they need to be made available and discoverable. To this end it is essential to comply with common standards and practices with respect to the measured parameters and to the data flow from the observatories to the data archives and, finally, to the users. In combination with modeling activities a substantial contribution can be made to the definition of the 'Good Environmental Status' within the Marine Strategic Framework Directive. In order to merge oxygen observations with other complementary earth observation data, links to large scale initiatives as OceanSites, GOOS, and GEOSS need to be established. In support of GEOSS, HYPOX provided hypoxia-related data, linked HYPOX observatories to GEOSS, and pioneered in the testing and definition of common standards and protocols for oxygen observation.

Further reading

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Data portal EU-FP7 Project HYPOX: http://dataportals.pangaea.de/hypox/

International and European Argo float initiatives and data: http://www.argo.net, http://www.euro-argo.eu, http://www.coriolis.eu.org

Chesapeake Bay Environmental Observatory: http://cbeo.communitymodeling.org/index.php

Global Earth Observation System of Systems (GEOSS): http://www.earthobservations.org/geoss.shtml

Joint deepwater observatory initiative: http://www.oceansites.org

UNESCO / IOC Global Ocean Observing System http://www.ioc-goos.org

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4.1.6.10.1 HYPOX staff table

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Dr.	Felix	Janssen	male	Research associate	01.04.09 - 31.03.12
Dr.	Moritz	Holtappels	male	PostDoc	01.04.09 - 31.03.12
Dr.	Jan	Fischer	male	PostDoc	01.05.09 - 31.10.09
Dr.	Anna	Lichtschlag	female	PostDoc	01.08.09 - 31.03.12
Partner 2 (AWI)					
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Dr.	Jana	Friedrich	female	Senior Scientist	01.04.09 - 31.03.12
Dipl.-Ing.	Burkhard	Sablotny	male	Engineer	01.04.09 - 31.03.12
Partner 3 (Eawag)					
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Dr.	Rolf	Kipfer	male	Senior Scientist	01.04.09 - 31.03.12
Dr.	David	Livingstone	male	Senior Scientist	01.04.09 - 31.03.12
Partner 4 (IBSS)					
Prof.	Nelli G.	Sergeeva	female	Head of Department	01.04.09 - 31.03.12
Prof.	Victor E.	Zaika	male	Principal Scientist	01.04.09 - 31.03.12
Dr.	Maksim B.	Gulin	male	Senior sci., PhD	01.04.09 - 15.12.10
Dr.	Elena A.	Kolesnikova	female	Leading sci., PhD	01.08.09 - 31.03.12
Prof.	Sergey K.	Konovalov	male	Head of Department at MHI	01.04.09 - 30.09.11
Dr.	Sofia A.	Mazlumyan	female	Senior sci., PhD	01.04.09 - 31.03.12
Dr.	Igor P.	Bondarev	male	Senior sci., PhD	01.10.09 - 31.03.11
Dr.	S.A.	Romanov	male	Senior sci., PhD, MHI	01.04.09 - 31.07.11
	Oksana V.	Anikyeyeva	female	Junior sci.	01.09.09 - 31.03.12
	Vitalyi A.	Timofeev	male	Junior sci.	01.07.09 - 29.02.12
	Valery P.	Chekalov	male	Junior sci.	01.09.10 - 25.09.10
	L.V.	Bondarenko	female	Junior sci.	01.02.10 - 31.03.12
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	Irina N.	Anninskaya	female	Technician	01.09.09 - 31.03.12
	N.S.	Orekhova	female	Research Scientist, MHI	01.04.09 - 31.07.11
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	Tetiana N.	Kosheleva	female	Research Scientist	01.09.09 - 31.03.12
	E.A.	Ivanova	female	Research Scientist	01.06.11 - 31.03.12
Partner 5 (IFM-GEOMAR)					
Dr.	Andy	Dale	male	Research Scientist	01.04.09 - 31.03.12
Dr.	Olaf	Pfannkuche	male	Principal Scientist	01.04.09 - 31.03.12
Dr.	Stefan	Sommer	male	Senior Scientist	01.04.09 - 31.03.12
Prof.	Klaus	Wallmann	male	Head of department	01.04.09 - 31.03.12
	Sonja	Kriwanek	female	Technician	01.04.09 - 31.03.12
	Maike	Dibbern	female	Technician	01.04.09 - 31.03.12
	Bernhard	Bannert	male	Technician	01.04.09 - 31.03.12
	Asmus	Petersen	male	Technician	01.04.09 - 31.03.12
	Wolfgang	Queisser	male	Technician	01.04.09 - 31.03.12
	Mathias	Türk	male	Engineer	01.04.09 - 31.03.12
	Hans	Cordt	male	Technician	01.07.10 - 31.03.12
	Anna	Noffke	female	Scientist	01.01.12 - 31.03.12
Partner 6 (Ifremer)					
Prof.	Gilles	Lericolais	male	Researcher	01.04.09 - 31.03.12
Dr.	Jean-François	Rolin	male	Research engineer	01.04.09 - 31.03.12
Ing.	Serge	Le Reste	male	Research engineer	01.04.09 - 31.03.12
Ing.	Laurent	Delauney	male	Research engineer	01.04.09 - 31.03.12
Ing.	Florence	Salvetat	female	Research engineer	01.04.09 - 31.03.12
Partner 7 (INGV)					
Dr.	Dr. Giuseppe	Etiope	male	Senior Researcher	01.04.09 - 31.03.12
	Giuditta	Marinaro	female	Technologist	01.04.09 - 31.03.12
	Nadia	Lobue	female	Researcher	01.04.09 - 31.01.11
	Paolo	Favali	male	Research Director	01.04.09 - 31.03.12
	Roberto	Tardini	male	Technician	01.04.09 - 31.03.12

HYPOX staff table (continued)

Partner 8 (IOW)					
Prof.	Gregor	Rehder	male	Principal Scientist	01.04.09 - 31.03.12
Dr.	Ralf	Prien	male	Researcher	01.04.09 - 31.03.12
Dr.	Siegfried	Krueger	male	Engineer	01.04.09 - 31.03.12
Prof.	Detlef	Schulz-Bull	male	Researcher	01.04.09 - 31.03.12
	Heiko	Witt	male	Engineer	01.04.10 - 01.07.11
	Michael	Glockzin	male	Engineer	01.07.11 - 31.03.12
Partner 9 (ITU-EMCOL)					
Prof.	M.Namık	Çağatay	male	Principal Scientist	01.04.09 - 31.03.12
Prof.	Temel	Oğuz	male	Professor at METU-IMS	01.04.09 - 31.03.12
Dr.	Ümmühan	Sancar	female	Researcher	01.04.09 - 31.03.12
	Dursun	Acar	male	Engineer	01.04.09 - 31.07.10
Partner 10 (Uni-HB)					
Dr.	Christoph	Waldmann	male	Senior Scientist	01.04.09 - 31.03.12
Dr.	Robert	Huber	male	Senior Scientist	01.04.09 - 31.03.12
	Uwe	Schindler	male	Graduate	01.09.09 - 31.07.11
	Andree	Behnken	male	Graduate	01.03.10 - 30.06.11
Partner 11 (SAMS)					
Prof.	Ronnie	Glud	male	Professor	01.04.09 - 31.03.12
Dr.	Henrik	Stahl	male	Lecturer	01.04.09 - 31.03.12
Dr.	Mark	Inall	male	Senior Lecturer	01.04.09 - 31.03.12
Dr.	Dmitry	Aleynik	male	HYPOX Post Doc	01.04.09 - 31.03.12
Dr.	Keith	Jackson	male	Senior Lecturer	01.04.09 - 31.03.12
Partner 12 (UGOT)					
Prof.	Per	Hall	male	Professor	01.04.09 - 31.03.12
Prof.	Anders	Stigebrandt	male	Professor emeritus	01.04.09 - 31.03.12
Assoc. Prof.	Anders	Tengberg	male	1st research engineer	01.04.09 - 31.03.12
Dr.	Daniel	Hansson	male	Postdoc	01.10.09 - 31.03.12
Dr.	Bengt	Liljebladh	male	Research engineer	01.04.09 - 31.03.12
Partner 13 (UPAT)					
Prof.	George	Papatheodorou	male	Professor	01.04.09 - 31.03.12
Prof.	George	Ferentinos	male	Professor	01.04.09 - 31.03.12
Dr.	Maria	Geraga	female	Lecturer	01.04.09 - 31.03.12
	Stavroula	Kordella	female	PhD student	01.04.09 - 31.03.12
Dr.	Dimitris	Christodoulou	male	Research scientist	01.04.09 - 31.03.12
	Margarita	Iatrou	female	PhD student	01.04.09 - 31.03.12
Dr	Elias	Fakiris	male	Research scientist	01.04.09 - 31.03.12
	Michalis	Prevenios	male	PhD student	01.04.09 - 31.03.12
Partner 14 (HZG / GKSS)					
Prof.	Emil	Stanev	male	Professor	01.04.09 - 31.03.12
Partner 15 (GeoEcoMar)					
Prof.	Marian-Traian	Gomoiu	male	Professor	01.04.09 - 31.03.12
	Dan	Secrieru	male	Senior scientist	01.04.09 - 31.03.12
Dr.	Gheorghe	Oaie	male	Senior scientist	01.04.09 - 31.03.12
Dr.	Adrian	Teaca	male	Senior scientist	01.04.09 - 31.03.12
Dr.	Tatiana	Begun	female	Senior scientist	01.04.09 - 31.03.12
Dr.	Priscila	Opreanu	female	Senior scientist	01.04.09 - 31.03.12
	Mihaela	Muresan	female	Research scientist	01.04.09 - 31.03.12
	Sorin	Balan	male	Senior scientist	01.04.09 - 31.03.12
Dr.	Caraus	Ioan	male	Senior scientist	01.04.09 - 31.03.12
	Cristina	Voicaru	female	Technician	01.04.09 - 31.03.12
Partner 16 (NIOO KNAW) / Partner 17 (NIOZ+A104)					
Prof.	Jack	Middelburg	male	Professor	01.04.09 - 31.03.12
Dr.	Filip	Meysman	male	Senior scientist	01.04.09 - 31.03.12
Dr.	Tom	Cox	male	Postdoc	01.04.09 - 31.03.12
Associated Partner: Norsk Institutt for Vannforskning (NIVA)					
Dr.	Evgeny	Yakushev	male	Reseacher, Dr.Sc.	01.10.10 - 31.03.12
	Andre	Staalstrøm	male	Researcher	01.10.10 - 31.03.12
Associated Partner: Museum of Natural History at the Humboldt University Berlin (MfN)					
Dr.	Ulrich	Struck	male	Scientist	01.10.10 - 31.03.12
	Ewgenija	Kuhl	female	Laboratory Technician	01.10.10 - 31.03.12
Associated Partner: Laboratoire des Sciences du Climat et de l'Environnement (UMR CEA-CNRS-UVSQ)					
Dr.	Christophe	Rabouille	male	Group leader	01.10.10 - 31.03.12
	Bruother	Bombled	male	Technician	01.10.10 - 31.03.12
Dr.	Nadine	Tisnerat-Laborde	female	Senior scientist	01.10.10 - 31.03.12
Associated Partner: Interfacultary Center for Marine Research at Liège University (MARE-ULg)					
Dr.	Marilaure	Gregoire	female	Senior scientist	01.10.10 - 31.03.12
	Arthur	Capet	male	PhD student	01.10.10 - 31.03.12

4.1.6.10.2 HYPOX students table

HYPOX students						
First name	Surname	Gender	Aspired degree	Supervisor	Topic	Start and end date of work in HYPOX
Partner 1 (MPG-MPIMM)						
Gerdhard	Jessen	male	PhD	A. Boetius, A. Ramette	The influence of oxygen levels on microbial community diversity and composition	01.04.10 - 31.03.12
Partner 2 (AWI)						
No students involved						
Partner 3 (Eawag)						
Sebastian	Naeher	male	PhD	C.J. Schubert, R. Kipfer	Paleooxygen indicators (biomarkers, noble gases) in Lake Zurich, Lake Rotsee	01.08.09 - 31.03.12
Ryan	North	male	PhD	D. M. Livingstone R. Kipfer	Oxygen time series analysis in Swiss lakes	01.09.09 - 31.03.12
Mathias	Kirf	male	PhD	C.J. Schubert	Trace level oxygen measurements in lake water columns	01.09.09 - 31.03.12
Partner 4 (IBSS)						
Tetiana	Kosheleva	female	PhD	N.G. Sergeeva	The structure of deep-water free-living Nematodes communities at boundary of interaction the oxic-anoxic water masses (Black Sea)	01.09.09 - 31.03.12
Natalia	Orekhova	female	PhD	S.K. Konovalov	Voltammetry of the sea bottom sediments.	01.04.09 - 31.07.11
Sergey	Svishev	male	PhD	S.K. Konovalov	The oxygen budget of the Sevastopol Bay.	01.04.09 - 31.03.12
Partner 5 (IFM-GEOMAR)						
Tanja	Schorp	female	PhD	A. Dale, K. Wallmann	Benthic modeling	01.08.09 - 30.01.11
My	Mattsdotter	female	PhD	S. Sommer, O. Pfannkuche	Benthic boundary layer biogeochemistry focus nitrogen cycle	01.07.09 - 30.04.10
Kerstin	Kretschmer	female	Student assistent	S. Sommer, O. Pfannkuche	Benthic boundary layer biogeochemistry focus nitrogen cycle	01.02.12 - 31.03.12
Partner 6 (Ifremer)						
No students involved						
Partner 7 (INGV)						
Ludovica	Sartini	female	PhD	G. Etiope	Evaluation and quality checks of submarine environmental sensors	01.04.09 - 31.12.10
Partner 8 (IOW)						
David	Meyer	male	PhD	D. Schulz-Bull R. Prien	Oxydation/reduction processes at the Gotland Deep redoxcline	15.03.10 - 31.03.12
Partner 9 (ITU-EMCOL)						
Zeynep	Erdem	female	MSc	M.N. Çağatay	Sedimentary record of anoxia in the Black Sea	01.04.09 - 31.03.12
Umut Barış	Ulgen	male	PhD	M.N. Çağatay	Environmental changes in the Iznik Lake	01.04.09 - 31.03.12
Emre	Damcı	male	PhD	M.N. Çağatay	Environmental changes in the Lake Van	01.11.09 - 31.03.12
Partner 10 (Uni-HB)						
No students involved						

HYPOX students table (continued)

Partner 11 (SAMS)						
No students involved						
Partner 12 (UGOT)						
Madeleine	Nilsson	female	PhD	P. Hall, A. Stigebrandt	Benthic carbon cycling in oxic-hypoxic-anoxic marine systems	01.04.09 - 31.03.12
Mikhail	Kononets	male	PhD	P. Hall, A. Tengberg	Benthic oxygen dynamics in oxic-hypoxic marine systems	01.04.09 - 31.03.12
Lena	Viktorsson	female	PhD	A. Stigebrandt, P. Hall	Benthic phosphorus cycling in oxic-hypoxic-anoxic marine systems	01.04.09 - 31.03.12
Dariia	Atamanchuk	female	PhD	P. Hall, A. Tengberg	pCO2 sensing in oxic-hypoxic-anoxic marine systems	01.11.09 - 31.03.12
Partner 13 (UPAT)						
Dimitris	Christodoulou	male	PhD	G. Papatheodorou	Study of seabed fluid flows (SFF) using geophysical, geochemical and sedimentological techniques	01.04.09 - 31.03.12
Margarita	Iatrou	female	PhD	G. Papatheodorou	Anthropogenic Turbidity Current Deposits (Bauxite red mud slurry) in a seismically active graben, (Gulf Of Corinth)	01.04.09 - 31.03.12
Elias	Fakiris	male	PhD	G. Papatheodorou	Development of a seafloor classification system (Case studies from Ionian and Aegean Seas)	01.04.09 - 31.03.12
Stavroula	Kordela	female	PhD	G. Papatheodorou	Physical and chemical parameters of water column and sediments	01.04.09 - 31.03.12
Michalis	Prevenios	male	MSc	G. Papatheodorou	Processing of geophysical data	01.04.09 - 31.03.12
Partner 14 (HZG / GKSS)						
Yunchang	He	male	PhD	E. Stanev	Modeling of Black Sea oceanography and biogeochemistry	04.06.09 - 31.03.12
Partner 15 (GeoEcoMar)						
Ana Bianca	Cocioarta	female	MSc	M.-T. Gomoiu	invertebrate populations from the sedimentary bottoms of the Romanian Black Sea Coast	01.05.09 - 30.06.10
Luminita	Lazar	female	PhD	M.-T. Gomoiu	Chemical oceanography	01.05.09 - 15.12.11
Dan	Vasiliu	male	PhD	M.-T. Gomoiu	spatial-temporal distribution of chlorophyll a in the Romanian inner shelf waters as an indicator of phytoplankton community response to variability of environmental conditions	01.05.09 - 10.11.11
Florin	Timofte	male	PhD	M.-T. Gomoiu	Ecological state of zooplankton populations from the Romanian Black Sea waters	01.05.09 - 14.12.11

HYPOX students table (continued)

Cristina	Tabarcea	female	Phd	M.-T. Gomoiu	Microdistribution of Zooplanktonic populations on the Romanian Black Sea shelf.	01.05.10 - 31.03.12
Partner 16 (NIOO KNAW)						
Lorenz	Meire	male	MSc	F. Meysman	Modeling of the relative importance of physical processes, sediment biogeochemistry, and human impacts on hypoxia development in coastal systems.	01.10.10 - 30.06.11
Associated Partner: Norsk Institutt for Vannforskning (NIVA)						
No students involved						
Associated Partner: Museum of Natural History at the Humboldt University Berlin (MfN)						
No students involved						
Associated Partner: Laboratoire des Sciences du Climat et de l'Environnement (UMR CEA-CNRS-UVSQ)						
Flora	Toussaint	female	PhD	C. Rabouille N. Tisnerat	Recycling of organic matter and oxygen consumption in sediments from river deltas	01.10.10 - 31.03.12
Lise	Petitjean	female	MSc	C. Rabouille	Organic matter recycling in the Congo deep-sea fan and its relation to oxygen	01.04.11 - 31.07.11
Associated Partner: Interfacultary Center for Marine Research at Liège University (MARE-ULg)						
Arthur	Capet	male	PhD	M. Grégoire	Multidecadal Modelling of the Black Sea hydrodynamics and biogeochemistry	01.10.10 - 31.03.12
Pascal	Joassin	male	PhD	M. Gregoire	Long term analysis of biogeochemical data in the Black Sea using an interpolation tool (DIVA)	01.10.10 - 31.03.12

4.1.6.11 List of potential users of data and knowledge obtained in HYPOX

POTENTIAL USERS OF HYPOX KNOWLEDGE			
Geographic area / target site	**Institution**	**Topic**	**URL**
Multi-area			
Regional - global	UNEP	United Nations Environment Programme	GEO Data Portal	http://geodata.grid.unep.ch/
Regional - global	IPCC	Intergovernmental Panel on Climate Change	Greenhouse gas data base	http://www.ipcc-nggip.iges.or.jp/COP8/EFDB_Guidance_20021026.pdf
Global	Argo	International consortium	Data from profilers	http://www.argo.net/
European - national	MIC	The Monitoring and Information Centre	Civil Protection	http://ec.europa.eu/environment/civil/prote/mic.htm
European - national	EUCC	The Coastal & Marine Union	Scientific association	http://www.eucc.net
European - national	WWF	WWF European Policy Office, European Marine Programme	Environment Protection	http://www.panda.org/
European - national	ESF	Marine board- European Science foundation	Climate Change and Marine Ecosystem Research	http://www.clamer.eu/
European - national	Ifremer/ERIC	EuroARGO (ERIC consortium under constitution)	Profiling floats	www.euro-argo.eu
Arctic			
Arctic	AMAP	Arctic Monitoring and Assessment Programme	Arctic Pollution	http://amap.no/
Arctic	AOSB	Arctic Ocean Sciences Board	River discharge, Polynya, etc.	http://www.aosb.org/
Arctic	IASC	International Arctic Science Committee	Arctic Portal	http://www.arcticportal.org/iasc/
Polar	EPB	European Polar Board	IPY Portal	http://www.euroipy.org/
Black Sea			
Black Sea	BSEC	Black Sea Economic Cooperation	Black Sea Economic Cooperation	http://www.bsec-organization.org/
Black Sea	ICBSS	International Centre for Black Sea Studies	Black Sea Monitoring	http://www.icbss.org/
Black Sea	DCPO	WWF-World Wide Fund for Nature, WWF Danube-Carpathian Programme Office	Environment Protection	www.panda.org/dcpo/

List of potential users of data and knowledge obtained in HYPOX (continued)

Black Sea	CEVRE	Ministry of Environment and Forestry	Black Sea Environment	http://www.cevreorman.gov.tr/
Black Sea	NAFA	Ministry of Agriculture: Department of Fisheries	Black Sea Fishery and Aquaculture	http://www.nafa-bg.org/
Black Sea	BSEP	Black Sea Environmental Programme	Black Sea Environmental	
Black Sea	SHOD	Department of Navigation, Hydrography and Ocenaography of Turkish Navy	Navigation, Hydrography and Ocenaography	http://www.shodb.gov.tr/
Black Sea	IMS-METU	Marine Sciences Institute of the Middle East Technical University	Marine Resources Management	http://www.ims.metu.edu.tr/
Black Sea	MMEDIU	Ministry of Environment and Sustainable Development (Ministerul Mediului şi Dezvoltării Durabile)	Black Sea monitoring, Environment Protection	http://www.mmediu.ro/home/
Black Sea	ANPM	National Agency for Environment Protection (Agenția Națională pentru Protecția Mediului - A.N.P.M.)	Environment Protection	http://www.insse.ro/cms/files/evenimente/Tulcea/engleza/details.htm
Black Sea	ROWATER	"Romanian Waters" National Administration (Administrația Națională "Apele Române")	National Water Administration	http://www.rowater.ro/
Black Sea	A.N.P.A.	National Agency for Fishing and Aquaculture (Agenția Națională pentru Pescuit şi Acvacultură)	Black Sea Fishery	http://www.anpa.ro/
Black Sea	./.	Maritime Hydrographic Directorate (Direcția Hidrografică Maritimă)	Black Sea Hydrography	./.
Black Sea	MADR	Ministry of Agriculture and Rural Development (Ministerul Agriculturii şi Dezvoltării Rurale)	National Rural Administration	http://www.maap.ro/
Black Sea	ICPBS	International Commission for the Protection of the Black Sea	Black Sea Pollution Protection	http://www.blacksea-commission.org/
Black Sea	NASU	National Academy of Science of Ukraine	./.	http://www.nas.gov.ua/
Black Sea	IBSS	Institute of Biology of the Southern Seas, National Academy of Sciences of the Ukraine	Biological Oceanography	http://www.ibss.org.ua/
Black Sea	OC	Oceanological Centre, National Academy of Sciences of the Ukraine	Oceanography	./.
Black Sea	ITU EMCOL	Istanbul Technical University-Eastern Mediterranean Centre for Oceanography and Limnology	Black Sea (Paleo)oceanography	http://www.emcol.itu.edu.tr/
Black Sea	TÜBITAK	The Scientific and Technological Research Council of Turkey, Marmara Research Centre	Science Foundation	http://www.tubitak.gov.tr/
Black Sea	IU-IMSM	Institute of Marine Sciences and Management of Istanbul University	Environment Monitoring	http://www.istanbul.edu.tr/enstituler/denizbilimleri/turkce/turkish.htm
Black Sea	./.	Faculty of Fisheries of Istanbul University	Black Sea Fishery	http://www.istanbul.edu.tr/english/aquatic.php
Black Sea	./.	Faculty of Fisheries of Ege University	Black Sea Fishery	http://egefish.ege.edu.tr/
Black Sea	./.	Black Sea Coastal Centre (part of The Coastal & Marine Union)	Scientific association	ccblacksea@gmail.com
		Sinop University Fisheries Faculty Marine Biology and Ecology Department, Sinop TURKEY	Black Sea Environment Monitoring and Biology	http://www.sinop.edu.tr/

Black Sea	MHI	Marine Hydrological Institute, National Academy of Sciences of the Ukraine	Black Sea Hydrography, Environment Monitoring	http://www.mhi.iuf.net/
Black Sea		Black Sea GOOS Memorandum of Understanding	Black Sea operational oceanography	http://www.ims.metu.edu.tr/black_sea_goos/MoUdoc.htm
Baltic Sea				
Baltic Sea	IOW	Baltic Sea Research Institute Warnemuende	./.	http://www.io-warnemuende.de/
Baltic Sea	GEOMAR	GEOMAR Helmholtzzentrum für Ozeanforschung		http://geomar.de
Baltic Sea	HELCOM	Helsinki Commision		http://helcom.fi
Baltic Sea / North Sea	BSH	Bundesamt für Seeschifffahrt und Hydrographie	Maritime Services	http://www.bsh.de/
Baltic Sea	GEOMAR	Boknis Eck Time Series project (BETS)	Monitoring	http://www.ifm-geomar.de/index.php?id=bokniseck
Swiss lakes				
Swiss lakes	AWEL	Amt für Abfall, Wasser, Energie und Luft	Waste, Water, Energy, Air	http://www.awel.zh.ch/
Swiss lakes	WVZ	Wasserversorgung der Stadt Zürich	Water Supply	http://www.stadt-zuerich.ch/internet/wvz/
Swiss lakes	FOEN	Federal Office for the Environment, Hydrology Division Hydrological Analyses Section	Hydrology	http://www.bafu.admin.ch/org/organisation/00196/00223/index.html?lang=en
Swiss lakes	FOEN	Federal Office for the Environment, Hydrology Division Hydrological Forecasts Section	Hydrology	http://www.bafu.admin.ch/org/organisation/00196/00202/index.html?lang=en
Swiss lakes	GCOS	Global Climate Observing System Switzerland, Swiss GCOS Office	Environmental Monitoring	http://www.meteoschweiz.admin.ch/web/de/klima/klimabeobachtungen/gcos.html
Loch Etive and Scottish seas				
Loch Etive and sea around Scotland	SEPA	Scottish Environmental Protection Agency	Environment Protection	http://www.sepa.org.uk/
Loch Etive and sea around Scotland	SNH	Scottish Natural Heritage	Wildlife and Scenery	http://www.snh.org.uk/
Loch Etive and sea around Scotland	./.	The Crown Estate	Property Management	http://www.thecrownestate.co.uk/
Loch Etive and sea around Scotland	JNCC	Joint Nature Conservation Committee	Nature Conservation	http://www.jncc.gov.uk/
Loch Etive and sea around Scotland	SARF	Scottish Aquaculture Research Forum	Support of Research into Aquaculture	http://www.sarf.org.uk/

List of potential users of data and knowledge obtained in HYPOX (continued)

Loch Etive and sea around Scotland	SSPO	Scottish Salmon Producers Organisation	Salmon Farming	http://www.scottishsalmon.co.uk/
Loch Etive and sea around Scotland	DEFRA	Dept. for Environment, Food and Rural Affairs	Policy and regulations on the environment, food and rural affairs	http://www.defra.gov.uk/
Loch Etive and sea around Scotland	SCF	Scottish Coastal Forum (Scottish Government)	Coastal Management	http://www.scotland.gov.uk/Topics/Environment/Scottish-Coastal-Forum
Loch Etive and sea around Scotland	SAGES	Scottish Alliance for Geoscience, Environment and Society	Collaborative Research Initiative	http://www.geos.ed.ac.uk/
Loch Etive and sea around Scotland	./.	Argyll and Bute Council	Regional governmental body	www.argyll-bute.gov.uk/
Koljoe Fjord system				
Koljö Fjord	Swedish EPA	Swedish Environmental Protection Agency	National nature protection	http://www.naturvardsverket.se
Koljö Fjord	SMHI	Swedish Meteorological and Hydrological Institute	Management of information on weather, water and climate	http://www.smhi.se/
Koljö Fjord	BVVF	Bohuslans Vattenvardsförbund	Regional water monitoring	http://www.bvvf.se/
Koljö Fjord	HMI	Swedish National Marine Environmental Institute	Marine Information, Marine Monotoring	http://www.havsmiljoinstitutet.se/
Greek lagoons and embayments				
Amvrakikos Gulf	ETANAM	ETANAM S.A. (Development Agency For South Epirus - Amvrakikos)	Programme Management	http://www.etanam.gr/
Aetoliko Lagoon	ACEA	ACEA S.A. (Aquaculture Center of Acheloos S.A.)	Aquaculture Center	http://www.gsrt.gr/default.asp?V_ITEM_ID=639
Aetoliko Lagoon	./.	Municipality of Messolongi - Aetoliko	./.	http://www.dhmoi.gr/content.php?id=569&design=1&lang=english&type=showmunicipality&show=city
Katalolo bay	./.	Katakolo Port Authority Fund	./.	http://www.pytheas-travel.gr/yachting/marina.greece.htm
Aetoliko Lagoon and Katakolo bay	./.	Prefecture of Western Greece	./.	http://www.westerngreece.gr

4.1.6.12 Observatory costs as basis for future monitoring activities

Observatory costs table																				
Observatory info and approximate costs to carry out hypoxia monitoring for a duration of 5 years / for the lifetime of disposable observatories / for one survey																				
observatory information																				
general information					parameters measured, measuring depths, and temporal resolution															
					Oxygen		S / cond.		T		Sulfide		Methane		pCO2		pH		ORP	
site	leading institution	observatory name (if existent)	observatory type	data transmission	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **
Fram Strait, station 'HAUSGARTEN'	AWI		benthic observatory	on site storage	1	30min	/	/	1	30min	/	/	/	/	/	/	/	/	/	/
Loch Etive	SAMS	LECO	fixed mooring	cabled transmission	2	10min	2	10min	2	10min	/	/	/	/	/	/	/	/	/	/
Airds Bay	SAMS		fixed mooring	on site storage	23	20min	23	20 min	23	20 min	/	/	/	/	/	/	/	/	/	/
Koljoe Fjord	UGOT	Koljoe	fixed mooring	cabled transmission	5	30min	7	30 min	7	30 min	/	/	/	/	2	30 min	/	/	/	/
Havstens Fjord	UGOT		fixed mooring	on site storage	4	30min	5	30 min	5	30 min	/	/	/	/	/	/	/	/	/	/
Baltic Sea water column	IOW	GODESS	profiling mooring	on site storage	cont.	4-12h	cont.	4-12h	cont.	4-12h	/	/	/	/	/	/	cont.	4-12h	cont.	4-12h
Baltic Sea bottom water	GEOMAR		benthic observatory	on site storage	1	5min	1	5 min	1	5 min	/	/	/	/	/	/	/	/	/	/
Romanian Shelf	AWI		fixed mooring	on site storage	2	10min	1	10 min	2	10	/	/	/	/	/	/	/	/	/	/
Crimean Shelf	MPI		3 fixed mooring arrays	on site storage	3	10min	9	10min	9	10min	/	/	/	/	/	/	/	/	/	/
Bosporus	Ifremer		drifting profiling observatory	satellite transmission	cont.	2d	cont.	2d	cont.	2d	/	/	/	/	/	/	/	/	/	/
Black Sea Basin	HZG & MPI		drifting profiling observatory	satellite transmission	116	5d	116	5d	116	5d	/	/	/	/	/	/	/	/	/	/
Amvrakikos Gulf	INGV & UPAT	MEDUSA	towed observatory	cabled transmission	cont.	1s	cont.	1s	cont.	1s	cont.	1s	cont. (2)	1s	/	/	/	/	/	/
Amvrakikos Gulf	UPAT		casts	cabled transmission	cont.	1s	cont.	1s	cont.	1s	cont.	1s	cont. (2)	1s	/	/	/	/	/	/
Aetoliko Lagoon	INGV & UPAT	MEDUSA	towed observatory	cabled transmission	cont.	1s	cont.	1s	cont.	1s	cont.	1s	cont. (2)	1s	/	/	/	/	/	/
Aetoliko Lagoon	UPAT		casts	cabled transmission	cont.	1s	cont.	1s	cont.	1s	cont.	1s	cont. (2)	1s	/	/	/	/	/	/
Katakolo Bay	INGV & UPAT	GMM	benthic observatory	on site storage	1	5s	1	1min	1	1min	1	5s	1 (2)	5s	/	/	/	/	/	/

* the numbers refer to the numbers of measuring depths (not the water depth) where the respective parameter is measured. 'cont.' indicates continuous vertical profiles or free positioning in towed observatories.
If replicate sensors were used at the same depth please give in brackets the total number of sensors. example: 3 (5) (at 3 depths 5 sensors are installed in total)

Observatory costs table (continued)

Observatory info and approximate costs to carry out hypoxia monitoring for a duration of 5 years / for the lifetime of disposable observatories / for one survey

observatory information (continued)												costs and efforts									
general info		parameters measured, measuring depths, and temporal resolution															shiptime				
		Fluorescence		Turbidity		Currents		presssure / depth		videos					internal engineer / technician efforts				maintenance / data down-load		
site	leading institution	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	depths *	temporal resolution **	basis of cost & effort estimate	equipment costs (EUR)	external engineering / technician costs (EUR)	effort (person months)	gross salary (EUR per person month)	outgoing & incoming harbour	effort for deployment or survey (days)	no. of visits needed in 5 years	effort per visit (days)	effort for retrieval or survey (days)
Fram Strait, station 'HAUSGARTEN'	AWI	/	/	/	/	1	30min	1	30min	/	/	5 years	60,000	0	1	4,000	Bremerhaven	1	5	1	1
Loch Etive	SAMS	/	/	/	/	2	10min	1	10min	/	/	5 years	N/A	N/A	N/A	N/A	Dunstaffnage	1	10	1	1
Airds Bay	SAMS	/	/	/	/	/	/	23	20 min	/	/	5 years	N/A	N/A	N/A	N/A	Dunstaffnage	1	0	1	1
Koljoe Fjord	UGOT	/	/	/	/	42	30 min	2	30 min	/	/	5 years	100,000	0	4	5,000	Gothenburg	1	10	1	1
Havstens Fjord	UGOT	/	/	/	/	1	30 min	1	30 min	/	/	5 years	50,000	0	1	5,000	Gothenburg	1	0	1	1
Baltic Sea water column	IOW	cont.	4-12h	cont.	4-12h	/	/	cont.	4-12h	/	/	5 years	300,000	10,000	3	4,000	Rostock, Klaipeda	1 to 3	20	1 to 3	1 to 3
Baltic Sea bottom water	GEOMAR	/	/	1	5 min	1	5 min	1	5 min	/	/	5 years	250,000	0	2	4,000	Kiel	21	0	0	1
Romanian Shelf	AWI	/	/	1	10 min	1	10 min	1	10 min	/	/	5 years	95,000	10,000	2	4,000	Constanta	2	10	2	2
Crimean Shelf	MPI	/	/	3	10min	/	/	3	10min	/	/	5 years	182,500	0	1	4,000	Sevastopol	1	3	1	1
Bosporus	Ifremer	/	/	/	/	/	/	cont.	2 days	/	/	3 years	18,500	0	1	5,500	Istanbul	0,25	0	0	0
Black Sea Basin	HZG & MPI	/	/	/	/	/	/	116	5d	/	/	3 years	17,500	0	0	0	Sevastopol	1	0	0	0
Amvrakikos Gulf	INGV & UPAT	/	/	cont.	1s		/	cont.	1s	cont.	cont.	per survey	100,000	0	2	4,000	Amvrakikos	2		2	2
Amvrakikos Gulf	UPAT	/	/	cont.	1s	/	/	cont.	1s	cont.	cont.	5 years	40,000	4,000	4	4,000	Amvrakikos	0	20	5	0
Aetoliko Lagoon	INGV & UPAT	/	/	cont.	1s	/	/	cont.	1s	cont.	cont.	per survey	100,000	8,000	2	4,000	Aetoliko	2		2	2
Aetoliko Lagoon	UPAT	/	/	cont.	1s	/	/	cont.	1s	cont.	cont.	5 years	40,000	4,000	2	4,000	Aetoliko	0	20	3	0
Katakolo Bay	INGV & UPAT	/	/	1	5s	1	0.5s	1	1min	/	/	5 years	150,000	10,000	2	4,000	Katakolo	1	10	2	2

* the numbers refer to the numbers of measuring depths (not the water depth) where the respective parameter is measured. 'cont.' indicates continuous vertical profiles or free positioning in towed observatories.
If replicate sensors were used at the same depth please give in brackets the total number of sensors. example: 3 (5) (at 3 depths 5 sensors are installed in total)

4.1.6.13 Glossary / abbreviations

AADI Aanderaa Data Instruments, Bergen, Norway

Abiotic non-living chemical and physical factors and processes in the environment

ACExR-LESV coupled physical and biological model for fjord-like ecosystems

ADCP Acoustic Doppler Current Profiler (acoustic instrument to determine current velocities and directions in different layers of the water column, similar to RDCP)

ADV Acoustic Doppler Velocimeter (acoustic current meter for point measurements)

Advection mass transport by water movement

AGU American Geophysical Union, organization of geophysicists

Air saturation, saturation partial pressure of dissolved oxygen in the water in equilibrium with the atmosphere

AJAX Programming language for advanced web applications (Asynchronous JavaScript and XML)

AMS Accelerator Mass Spectrometer

Anaerobic microorganisms microorganisms that grow or grow exclusively in the absence of oxygen

Anoxia, anoxic regions of water bodies or sediments that are completely depleted in oxygen

Antifouling measures to prevent the accumulation of attached organisms on surfaces, e.g., of sensors or other devices

AODC acridine orange direct count (of microorganisms)

ARGO floats disposable drifting profiling observatories with satellite data transmission

ASOF-N EU-funded program: Arctic-subarctic ocean flux array for european climate: north

ASSEM EU-funded program: Array of Sensors For Long Term Seabed Monitoring of Geohazards

ASSEMBLAGE EU-funded program: ASSEssMent of the BLAck Sea sedimentary system since the last Glacial Extreme

Assimilation, data-assimilation combining observations of a system with modeling results to gain information about the current and future state of the system

AUV untethered underwater robot for water column work

AWI Project partner: Alfred-Wegener-Institut fuer Polar- und Meeresforschung, Bremerhaven, Germany

BBL Benthic Boundary Layer

BENGAL EU-funded program: BENthic biology and Geochemistry of a north-eastern Atlantic abyssal Locality

Benthic boundary layer lowermost portion of the water column that is directly affected by the presence of the sediment water interface

Benthic chamber, chamber device to quantify uptake and release of solutes by aquatic sediments

Benthic community Assemblage of species that inhabit the bottom of marine and freshwater environments

Benthic located at the bottom of aquatic environments

Benthos The habitat at the bottom of aquatic environments –including the physical environment as well as the organisms present

BIGO BIoGeochemical Observatory of partner IFM-GEOMAR

BIGSET BMBF-funded project: Biogeochemical Fluxes of Matter and Energy in the Deep Sea

Biodiversity, diversity variation of organisms within a given ecosystem: often used as a measure of the health of biological systems

Biofouling, fouling accumulation of attached organisms on surfaces, e.g., of sensors or other devices

Biomarker, organic marker persistent remains of organisms (e.g, skeleton material, fatty acids) that can be used to infer the environmental conditions (e.g., oxygen and nutrient availability) at the time the organisms was present

Biota organisms

Biotic relating to, produced by, or caused by living organisms

Bioturbation mixing of sediments by animals

BLASON EU-funded program: Black Sea Over the Neoeuxinian

BMBF German Federal Ministry of Education and Research

BOD biological oxygen demand

BONUS EU program on Baltic Sea research

BOX project "Baltic Deepwater Oxygenation"

BP before present

Brackish water with salt content between freshwater and seawater

C Carbon, conductivity

C/N Carbon to Nitrogen ratio, used to characterize organic material

C.CANDI model Calcite, Carbon And Nutrient Diagenesis model

CA Consortium agreement, contract between project partners

Carbo-Ocean EU-funded program: Marine carbon sources and sinks assessment

Chamber, benthic chamber device to quantify uptake and release of solutes by aquatic sediments

Chemocline layer in a water column whith strong gradients in water chemistry (e.g., transition from oxygenated to sulfidic waters), typically co-occurring with density gradients

CIESM The Mediterranean Science Commission

CLAMER EU FP7 on climate change effects on Marine Ecosystems

CLIME EU-funded program: Climate and Lake IMpacts in Europe

C-MOVE benthic crawler of partner Uni-HB

CMS Content Management System

COBO EU-funded program: Coastal Ocean Benthic Observatory

Cold seep, cold vent an area of the ocean floor where seepage of fluid that is rich in reduced compounds occurs

Cold vent, cold seep an area of the ocean floor where seepage of fluid that is rich in reduced compounds occurs

Columnar disturbances inhomogeneities in the sediment layering indicative of gas or liquids ascending from deeper sediment regions

COMARGE Continental Margin Ecosystems on a Worldwide Scale

COMET BMBF-funded project: Controls on Methane Fluxes and their Climatic Relevance in Marine Gas Hydrate-bearing Environments

Community structure composition of species (possibly including their interactions) in a given environment

Contros german Company spezialized in oil and gas sensors

CoP Community of Practice

COOPEUS EU FP7 / US project dealing with common data policies and standards relevant to global research infrastructures (lead by MARUM at Uni-HB)

CORALFISH EU-funded program: Interactions between Fisheries and the management of deep-sea corals

Coriolis/Argo French ARGO-related initiative

CORDIS EU Community Research and Development Information Service

COMSOL commercial multiphysics modeling software package

COSA EU-funded program: Coastal sands as biocatalytical filters

Crawler tethered underwater vehicle that moves on the seafloor on wheels or treads

CRIMEA EU-funded program: Contribution of high-intensity gas seeps in the Black Sea to methane emission to the atmosphere

CS-W see „OGC CS-W"

CT coordination team

CTD instrument including sensors for Conductivity, Temperature and Depth of seawater

D project deliverable, depth

DAMOCLES EU-funded program: Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies

Data-assimilation, assimilation combining observations of a system with modeling results to gain information about the current and future state of the system

dBScale company specialized in technology and services for environmental monitoring

DC The Dublin Core Metadata Initiative

Dead-zone low-oxygen areas typically occuring near inhabited coastlines where marine life is endangered or vanished

DFG German Research Foundation

DG Directorate General at the EC

Diapycnal mixing across (normal to) surfaces of constant density in the water column (isopycnal), mixing that overcomes stratification

DIC dissolved inorganic carbon

DIF Directory Interchange Format

DIVERSITAS International programme on biodiversity science

Diversity, Biodiversity variation of organisms within a given ecosystem: often used as a measure of the health of biological systems

DNRA dissimilatory nitrate reduction to ammonium

DO dissolved oxygen

DOI Digital Object Identifier: persistent identifier for scientific data

DOM dissolved organic matter

DOS Deep-Sea Observation System of partner IFM-GEOMAR

DoW Description of work

DPSIR assessment framework of the causal chain "Driver Pressure State Impact Response"

Eawag Project partner: Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz, Katanienbaum, Switzerland

EC European Commission

ECASA EU-funded program: Ecosystem Approach to Sustainable Aquaculture

ECMWF European Centre for Medium-Range Weather Forecasts

ECODIS EU-funded project: Dynamic Sensing of Chemical Pollution Disasters and Predictive Modelling of Their Spread and Ecological Impact

ECOOP EU-funded program: European COastal-shelf sea OPerational observing and forecasting system

EGU European Geosciences Union, organization of scientists associated with geosciences, planetary and space sciences

ELME EU-FP6 program "European Lifestyles and Marine Ecosystems"

EMCOL, ITU-EMCOL Project partner: Eastern Mediterranean Centre for Oceanography and Limnology at the Technical University of Istanbul, Istanbul, Turkey

EMERGE EU-funded program: European Mountain lake Ecosystems: Regionalisation, diaGnostics and socio-economic Evaluation

EMSO EU-funded program: European Multidisciplinary Seas Observation

EPOCA EU-funded program: European Project on OCean Acidification

EPOS II European "Polarstern" Study

EROS EU-funded program: European Rivers and Oceans System 2000

ESFRI European Strategy Forum on Research Infrastructures

ESONET EU sixth framework network of excellence **(**European Seas Observatory NETwork)

ESONIM EU-funded program: European Seafloor Observatories Implementation Model

Estuarine of an estuary or relating to an estuary

ETHAGEFO, UPAT Project partner: The Marine Geology and Physical Oceanography Laboratory at Patras University, Patras, Greece

EU European Union

EU-INTAS The importance of sediments for the water quality of the Gulf of Finland

Eulerian profiler anchored profiling instrument that records autonomously parameters (e.g., temperature, oxygen concentration)

Euro Argo European ocean observing float program, European component of ARGO

EUROCEANS EU-funded program: European Network of Excellence for Ocean Ecosystems Analysis

Euro-limpacs EU-funded program: Integrated project to evaluate impacts of global change on European freshwater ecosystems

EuroSITES EU-funded program: European Ocean Observatory Network

Eutrophication loading of aquatic systems with high amounts of nutrients (e.g., Nitrogen and Phosphorus) and organic matter

existDB open source database management system entirely built on XML technology

FerryBox EU-funded program on sensors for ships of opportunity

Float sensor-equipped buoy with radio data transmission facilitiy that drifts while montioring the environment

Flux amount of a compound (e.g., dissolved oxygen, sulfide, nitrate) that passes an area (e.g., a squaremeter of seafloor) per unit time

Fouling, biofouling accumulation of attached organisms on surfaces, e.g., of sensors or other devices

FP Framework Programme for Europan Union funding

FRANATECH German sensor manufacturer, Lueneburg, Germany

Free-falling device, lander instrument that is deployed from a ship, sinks to the seafloor, and re-surfaces after a release of weights

FVCOM The Unstructured Grid Finite Volume Coastal Ocean Model

GCOS Global Climate Observing System of Switzerland

GEF-UNDP Global Environment Facility / United Nations Development Programme

GEO Group on Earth Observations

GeoEcoMar Project partner: National Institute of Marine Geology and Geoecology Constantza, Romania

GEOMAR Project partner: Helmholtz Centre for Ocean Research Kiel, Kiel, Germany

GEONETCast GEO-initiative on satellite-based data dissemination system

GeoRSS a GML (Geographical Markup Language) enriched RSS news feed

GEOSS Global Earth Observation System of Systems

GEOSTAR EU-funded program: GEophysical and Oceanographic STation for Abyssal Research

GETM General Estuarine Ocean Model

GIGAS EU-funded program: GEOSS, INSPIRE and GMES an Action in Support

GIS geographic information system to captures, stores, analyzes, and present data linked to location

GKSS previous name of Project partner 14, now: „HZG"

glider AUVs that use positive or negative buoyancy for lateral movement to reduce energy costs for cruising

GMES EU-initiative on Global Monitoring for Environment and Security

GML Geography Markup Language is the XML grammar defined by the OGC to express geographical features.

GMM Gas Monitoring Module, benthic observatory of partner INGV

GODESS GOtland Deep Environmental Sampling Station, IOW Baltic observatory

GOOS Global Ocean Observing System, oceanographic component of GEOSS

GOTM General Ocean Turbulence Model

GPF Grant Agreement Preparation Form

GSM Global System for Mobile communications, the most popular standard for mobile phones in the world

HAUSGARTEN deep-sea long-term observatory located in Fram Strait that was established by AWI in 1999

HECToR UK National Supercomputing Service

HELCOM The Helsinki Commission / Baltic Marine Environment Protection Commission

HERMES EU-funded program: Hotspot Ecosystems Research on the Margins of European Seas

HERMIONE EU-funded program: Hotspot Ecosystem Research and Man's Impact on European Seas

HGF Hermann von Helmholtz Association of German Research Centres

Hydrosphere the combined mass of water found on, under, and over the surface of the earth

HYPER Research Project: HYPoxia mitigation for Baltic Sea Ecosystem Restoration

Hypolimnion the dense bottom layer of water in a thermally-stratified lake

HYPOX project acronym, *In situ* monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies

Hypoxia, hypoxic oxygen in the water reduced to a point that is dangereous to aquatic organisms living in the system.

HZG new acronym of Project partner 14: **„**Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research**"**

IAEA International Atomic Energy Agency

IBSS Project partner: A.O. Kovalevskiy Institute of Biology of Southern Seas, Department of Benthos Ecology, Sewastopol, Ukraine

IC Implementation committee, consists of leaders of work packages 1& 4-7 and the task leaders of the observatory sites

ICES International Council for the Exploration of the Sea

ICSU International Council for Science

IEEE Institute of Electrical and Electronics Engineers, non-profit organization for the advancement of technology

IFM-GEOMAR Project partner: Leibniz Institut fuer Meereswissenschaften an der Universitaet Kiel, Kiel, Germany

Ifremer Project partner: “Institut Français de Recherche pour l’Exploitattion de la Mer, Issy-les-Moulineaux, France

IGCO EU-funded program: Integrated Global Carbon Observation

IGCP International Geoscience Programme

IMARE german company specialized in sensors and instruments for marine sciences and technology for monitoring the environment and exploit marine ressources, Bremerhaven, Germany

INCO-Copernicus EU-Initiative to support the scientific and technological potential of Central & Eastern Europe

INGV Project partner: Istituto Nazionale de Geofisica e Vulcanologia, Rome, Italy

INQUA International Union for Quaternary Research

IN-SITU TROLL multiparameter probe instruments manufactured by In-Situ Inc., Ft. Collins, CO, U.S.A

INSPIRE EU directive to establish an nfrastructure for Spatial Information in the European Community

Internal wave large waves forming at density gradients within water bodies

IODP, ODP Integrated Ocean Drilling Program, Ocean Drilling Program

IOW Project partner: Institut fuer Ostseeforschung Warnemuende an der Universitaet Rostock, Rostock/Warnemuende, Germany

IPCC Intergovernmental Panel on Climate Change

IPR Intellectual Property Rights

IPT Isotope Pairing Technique, stable isotope approach to study nitrogen transformation in water or sediments

IPY International Polar Year

ISBS Istanbul Strait (Bosphorus) outlet area of the Black Sea

ISI ISI Web of Knowledge: online academic database provided by Thomson Scientific

ISO 19139 XML is a component of the series of ISO 191xx standards for Geospatial metadata that defines how to use XML to describe geographical information and associated services

ISO/OGC standards Data Integration and Interoperability Standards for Geo-information

ISO19115 standard of the International Organization for Standardization on Geographic Information Metadata

Isotopic signatures, stable isotope analyses a ratio of stable or unstable isotopes of particular elements found in an investigated material can be used to gain information about the processes and environmental conditions prevailing upon the formation of the material

IT Information Technology / data handling and processing

ITU-EMCOL, EMCOL Project partner: Technical University of Istanbul / Eastern Mediterranean Centre for Oceanography and Limnology

JAGO manned submersible run by project partner IFM-GEOMAR

JCOMM Joint Technical Commission for Oceanography and Marine Meteorology

KEYCOP EU-funded program: Key coastal processes in the mesotrophic Skagerrak and the oligotrophic Aegean

KM3NeT european initiative for a neutrino telescope at the bottom of the Mediterranean Sea

KNAW, NIOO-KNAW Project partner: Koninklijke Nederlandse Akademie van Wetenschappen, Center of Estuarine and Marine Ecology, Yerseke, The Netherlands

Lacustrine of a lake or relating to a lake

Laminated sediments, varve deposits sediments with repetitive structures reflecting a periodical / annual deposition cycle (e.g., alternately finer and coarser silt or clay, reflecting seasonal sedimentation)

Lander, free-falling device instrument that is deployed from a ship, sinks to the seafloor, and re-surfaces after a release of weights

LECO Loch Etive Cabled Observatory of partner SAMS

limnic relating to freshwater environments like lakes and rivers.

LOICZ (Land-Ocean Interactions in the Coastal Zone) project of the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP).

LOTUS BMBF-funded project: Long-term Observatory for the Study of Control Mechanisms for the Formation and Destabilization of Gas Hydrates

LSCE associated Project partner, Laboratoire des Sciences du Climat et de l'Environnement at the Commissariat à l'Energie Atomique et aux Energies alternatives

LTER Long-Term Ecological Research Network run by the US National Science Foundation

M project milestone / project month

Macroalgae large (visible, multicellular) algae

Macrobenthos large (visible) organisms at the bottom of aquatic ecosystems

MARBEF EU-funded program: Marine Biodiversity and Ecosystem Functioning

MARE Marine Research on Eutrophication

MARE ULg associated Project partner, University of Liege - MARE Interfacultary Research Centre, Liège, Belgium

Marine TT a EU FP7 support Action to improve access to EU marine research

MARNET Marine Environmental Monitoring Network in the North Sea and Baltic Sea which presently comprises ten automated measuring stations operated by the German Federal Maritime and Hydrographic Agency

MARUM, Uni-HB Project partner: Universitaet Bremen / Center for Marine Environmental Sciences, Bremen, Germany

MEDATLAS a collection of data on the Mediterranean and Black Sea

MEDUSA towed observatory of partner INGV

MEMS Microelectromechanical systems

Metadata data about data - additional information about a measured value (e.g., a sensor reading) time, location, sensor type, calibration...)

METAFUNCTIONS EU-funded project: Mapping Environmental Clues to Decipher the Function of Genes

METROL EU-funded program: Methane Flux in Ocean Margin Sediments

METS methane sensors

METU-IMS Middle East Technical University - Institute of Marine Sciences, Erdemli-Mersin, Turkey

MfN associated Project partner, Museum for Natural History, Berlin, Germany / Leibniz Institute for Research on Evolution and Biodiversity at the Humboldt University Berlin, Germany

MGT Management of the consortium

Microbial oxidation oxidation of organic matter or other compounds that is catalyzed by micoorganisms

MIMS Membrane Inlet Mass Spectrometry

Mineralization, remineralization decomposition of organic matter by organisms and release of the constituents: carbon(dioxide), nutrients (mainly nitrogen and phosphorus species)

MOLAR EU-funded program: Measuring and Modelling the Dynamic Response of Remote Mountain Lake Ecosystems to Environmental Change: A Programme of MOuntain LAke Research

Mooring a collection of devices, connected to a wire and temporarily achored on the sea floor

MPG, MPI Project coordinator: Max Planck Society for the Advancement of Science / Max Planck Institute for Marine Microbiology, Bremen, Germany

MPG-MPIMM Project partner, Max Planck Society for the Advancement of Science / Max Planck Institute for Marine Microbiology

MPI, MPG Project coordinator: Max Planck Society for the Advancement of Science / Max Planck Institute for Marine Microbiology, Bremen, Germany

MS mile stone

MSCL Multi-Sensor Core Logger

MSM German Research Vessel "MARIA S. MERIAN"

MuFO Multi Fiber Optode

MW Mediterranean Water

N Nitrogen

NAO North Atlantic Oscillation - important driver of climate fluctuations around the North Atlantic

NEMO Nucleus of European Modeling model of the Ocean

NEMO Float Argo float like floating profiling observatories

NEON US National Ecological Observatory Network

NERC Natural Environment Research Council

NIOO-KNAW, KNAW Project partner: Center of Estuarine and Marine Ecology at the Koninklijke Nederlandse Akademie van Wetenschappen, Yerseke, The Netherlands

NIOZ Project partner (adjoined after merger of NIOO KNAW with NIOZ), Koninklijk Nederlands Instituut voor Zeeonderzoek

NIVA associated Project partner Norsk Institutt for Vannforskning, Oslo, Norway

NIVA Project partner, Norwegian Institute for Water Research, Oslo, Norway

NKE instrumentation French company working in the field of marine Electronics, Hennebont, France

NMMP National Marine Monitoring Programme of Scotland

Node, subsea observatory node persistent subsea junction box to provide energy and data transfer for scientific instruments

Non-steady-state model numerical model that predicts transitions of the modeled phenomenon over time (e.g., solute dirstributions, currents) not the steady-state case

Nutrients compounds needed for organism growth, typically referring to phosphorus and nitrogen species needed by algae

O class of project outcome: other

O&M Observations and Measurements Encoding Standard

OAI-PMH Open Archives Initiative Protocol for Metadata Harvesting in an archive

OARRE EU-funded program: Oceanographic Applications to Eutrophication in Regions of Restricted Exchange

Observatory sensor-equipped device to montior aquatic environments

OceanSites worldwide system of long-term, deepwater observatories

ODIN Oceanographic Database research with Interactive Navigation

ODP, IODP Ocean Drilling Program, Integrated Ocean Drilling Program

OECD Organisation for Economic Co-operation and Development

OFOS Ocean Floor Observation System of partner IFM-GEOMAR

OGC CS-W Catalog Service for the Web defines common interfaces to discover, browse, and query metadata about data, services, and other potential resources.

OGC Open Geospatial Consortium, international organization defining standards for geospatial content and services, GIS data processing and data sharing.

OGC SOS see SOS

OGC SWE see WE

OGC-CSW Open Geospatial Consortium-Catalogue Services for the Web

Oligotroph poor in nutrients (e.g., Nitrogen and Phosphorus) and organic matter

OMEX EU-funded program: Ocean Margin Exchange

OMZ „Oxygen Minimum Zone" oxygen deficient open mid water body

Opportunists, opportunistic species organisms that are able to cope with a large variety of environmental conditions

OPTIMARE Company dealing with Marine Sensor Technologies, Bremerhaven, Germany

Optode optical sensor, in aquatic sciences mainly used for oxygen measurements

Organic marker, biomarker persistent remains of organisms (e.g, skeleton material, fatty acids) that can be used to infer the environmental conditions (e.g., oxygen and nutrient availability) at the time the organisms was present

ORION-GEOSTAR EU-funded program: Ocean Research by Integrated Observation Networks

ORP oxidation reduction potential (also: redox potential)

ORSED Environmental assessement of the Olt River reservoirs: focus on suspended matter and sediments

OSPAR OSPAR commission on protection and conservation of the North-East Atlantic and its Resources

Oxidation of reduced substances (chemical or biological) typically the (often microbially mediated and oxygen consuming) conversion of substances from the reduced to the oxidized form (e.g., sulfide to sulfate, ammonium to nitrate)

Oxycline layer in a water column whith strong gradients in dissolved oxygen concentrations, typically co-occurring with density gradients

Oxygen minimum zone low-oxygen zone at intermediate depths in the ocean (typically 200-1000m)

P Phosphorus

PANGAEA Publishing Network for Geoscientific & Environmental Data hosted at AWI and Uni-HB / MARUM

Pelagic community Assemblage of species that inhabit the water body of marine and freshwater environments

Pelagic-benthic models, coupled pelagic-benthic models numerical models that comprise processes both in water column and sediments

Pelagos The habitat of the water body of aquatic environments – including the physical environment as well as the organisms present

PERSEUS EU FP7 demonstration project on the protection of European Seas

PHARE EU-funded program: Hydrothermal Populations, their Associations and Relations with the Environment

Photic zone upper zone of aquatic systems where light levels allow for growth of algae

PI principal investigator, leading scientist

PIA Profiling observatory (In situ Profiling Analyzer) of Project Partner Eawag

Pockmarks depressions in the bed of the sea or of lakes that result from the release of gas or liquid

POLCOMS Proudman Oceanographic Laboratory Coastal Ocean Modeling System

PP class of project outcome dissemination level: Restricted to other programme participants

PROVOR Argo-type profiling oceanographic float of partner Ifremer – suffix "DO" indicates that an oxygen sensor was added

Proxies a measured variable (e.g., organic remains of organisms, trace metals) used to infer the historical conditions in a given environment (e.g., oxygen concentrations at the time of sedimentation of the sediment layer in question

psu Practical Salinity Units, conductivity-based salinity measure (numbers are close to the traditional grams per liter scale)

PU class of project outcome dissemination level: public

Pycnocline layer in a water body with a strong vertical salt (and density)

QA quality assessment

QC quality control

QM quality management

R class of project outcome: report

R/V Research Vessel

R open source mathematical software package

Ramsar The Ramsar Convention: International framework for the conservation of wetlands

RDCP recording doppler current profiler (acoustic instrument to determine current velocities and directions in different layers of the water column, similar to ADCP)

REC Software by Project partner NIOO KNAW to analyze Eddy Covariance / Eddy Correlation flux measurements

Redoxcline layer in a water column whith strong gradients in redox potential, often co-occurring with strong gradients in oxygen, sulfide, and density

REFLECT EU-funded program: Response of European Freshwater Lakes to Environmental and ClimaTic change

Remineralization, mineralization decomposition of organic matter by organisms and release of the constituents: carbon(dioxide), nutrients (mainly nitrogen and phosphorus species)

RER 2/003 EU-funded program: Marine Environmental Assessment of the Black Sea Region

Resilience the degree to which an ecosystem's composition, structure, and function can recover from disturbance

Respiration (of organic matter), respiratory processes decomposition of organic matter by organisms and release of the constituents: carbon(dioxide), nutrients (mainly nitrogen and phosphorus species)

RIDGE, RIDGE Unit geo-marine division at INGV

Riverine of a river or relating to a river

ROBOX HGF funded technology centered project

ROLM RedOx Layer Model

ROV remotely operated (underwater) vehicle

RSS, RSS feed Really Simple Syndication is a family of web feed formats used to publish frequently updated news

RTD Research and technological development

S Salinity

S & T Science and Technology

Saline high in salt content, typically higher then oceanic waters (e.g., Mediterranean, Red Sea)

SAMS Project partner, The Scottish Association for Marine Science

Sapropel organic matter rich, dark-coloured sediments that are thought to develop during episodes of reduced oxygen availability in bottom waters

Saturation, air saturation partial pressure of dissolved oxygen in the water in equilibrium with the atmosphere

SC Steering committee, consist of all work package leaders

SCOR, SCOR WG Scientific Committee in Oceanographic Research

SDI Spatial Data Infrastructures

SDU University of Southern Denmark

SeaGuard Recording Current Meter brand (Aaanderaa Data Instruments, Bergen, Norway), typically equipped with additional sensors (CTD, oxygen)

Seepage, gas seepage release of gas in the form of bubbles from the bottom of aquatic systems

SensorML: Sensor Markup Language, OGC standard for describing sensors and measurement processes

SESAME EU-funded program: Southern European Seas: Assessing and Modeling Ecosystem changes

SFB Special Priority Program of the DFG (Sonderforschungsbereich)

SIS-Germany german company specialized in marine sensors and instrument recouvery beacons

SME Small and medium scale enterprise

SMHI Swedish Meteorological and Hydrological Institute

SOS Sensor Observation Service, OGC standard provides an interface for managing deployed sensors and retrieving sensor / observation data

SPEAR EU-funded program: Sustainable options for People, catchment and Aquatic Resources

Stable isotope analyses, isotopic signatures a ratio of stable or unstable isotopes of particular elements found in an investigated material can be used to gain information about the processes and environmental conditions prevailing upon the formation of the material

Stagnation absence of flow and mixing in a water body

STOX special electrochemical oxygen sensor for the detection of traces of oxygen

Stox-Sensor special electrochemical oxygen sensor for the detection of traces of oxygen

Stratification stable vertical structure of water bodies due to a increase of density (due to salt and/or temperature gradients) with depth

Suboxic no longer oxic, not yet sulfidic; the region in water bodies or sediments where concentrations of oxygen and sulfide are both extremely low

Subsea observatory node, node persistent subsea junction box to provide energy and data transfer for scientific instruments

Sulfidic free sulfide present in the water (typically in anoxic regions of sediments and waters)

SWE standards to make all types of sensors, transducers and sensor data repositories discoverable, accessible and useable via the Web

Synoptical variability variability on scales between meso- and macroscale (typically some hundred to thousand km)

T Temperature

TECFLUX BMBF-funded project: TECtonically-induced material FLUXes

Tecnomare-ENI italian company specialized in design and engineering for the offshore industry and marine sciences

Thermocline layer at the transition of warmer surface and cooler deep waters with a strong vertical temperature gradient, typically at depth of 100 to 1000 m

TIC total inorganic carbon

TOC total organic carbon

Transport-reaction model numerical model that predicts distributions of substances from the combined simulation of physical transport and reactions (chemical or biologically mediated)

TU-Black Sea NATO-funded program: Ecosystem Modeling as a Management Tool for the Black Sea

U Uranium

UGOT Project partner: Goeteborgs Universitet, Gothenburg, Sweden

UNEP United Nations Environment Programme

Uni-HB, MARUM Project partner: Universitaet Bremen / Center for Marine Environmental Sciences, Bremen, Germany

Unisense danish company specialized in microsensors

UPAT Project partner, University of Patras, Greece

UPAT, ETHAGEFO Project partner: University of Patras, The Marine Geology and Physical Oceanography Laboratory, Patras, Greece

Varve deposits, laminated sediments sediments with repetitive structures reflecting a periodical / annual deposition cycle (e.g., alternately finer and coarser silt or clay, reflecting seasonal sedimentation)

VEINS EU-funded program: Variability of Exchange In the Northern Seas

Venting, gas venting release of gas in the form of bubbles from the bottom of aquatic systems

VISO ESONET and EMSO related ocean observation initiative (Virtual Institute of Scientific Users of Deep-Sea Observatories)

WDC-MARE World Data Center for Marine Environmental Sciences, a long term data archive certified by the International Council for Science and maintained by AWI and Uni-HB / MARUM

WOMP EU-funded program: Pathways of organic matter and its implication for biodiversity and sustainable uses in the White Sea

WP work package

XML Extensible Markup Language, rules for machine readable encoding of documents

XRF Core Scanner Core scanner using X-ray Fluorescence to analyze split sediment cores for major and minor elements

XRF X-ray fluorescence

Y.S.I. YSI Incorporated, Yellow Springs, OH, U.S.A. (producer of water quality monitoring equipment)

Zoobenthos animals at the bottom of aquatic ecosystems