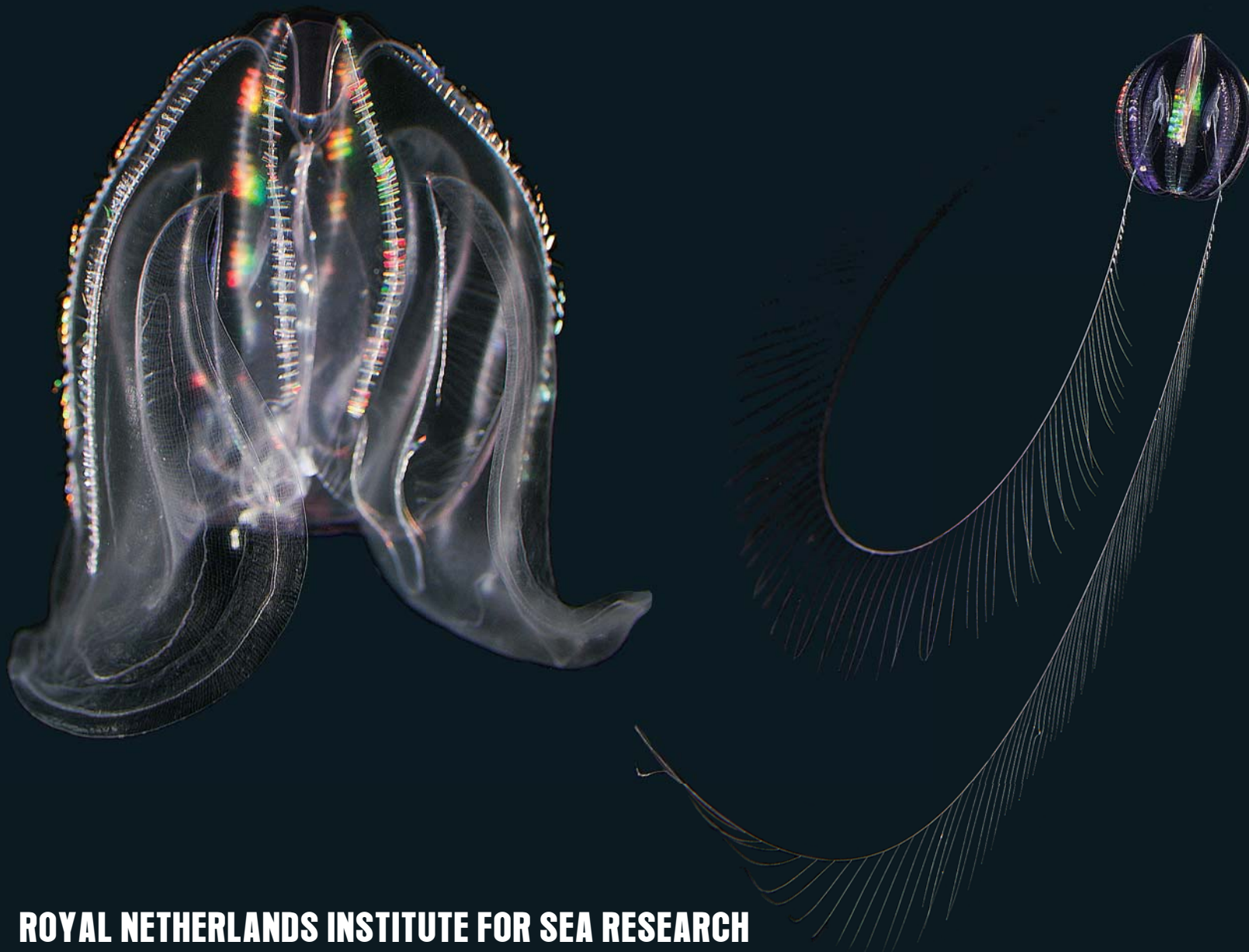


ANNUAL REPORT 2012



ROYAL NETHERLANDS INSTITUTE FOR SEA RESEARCH

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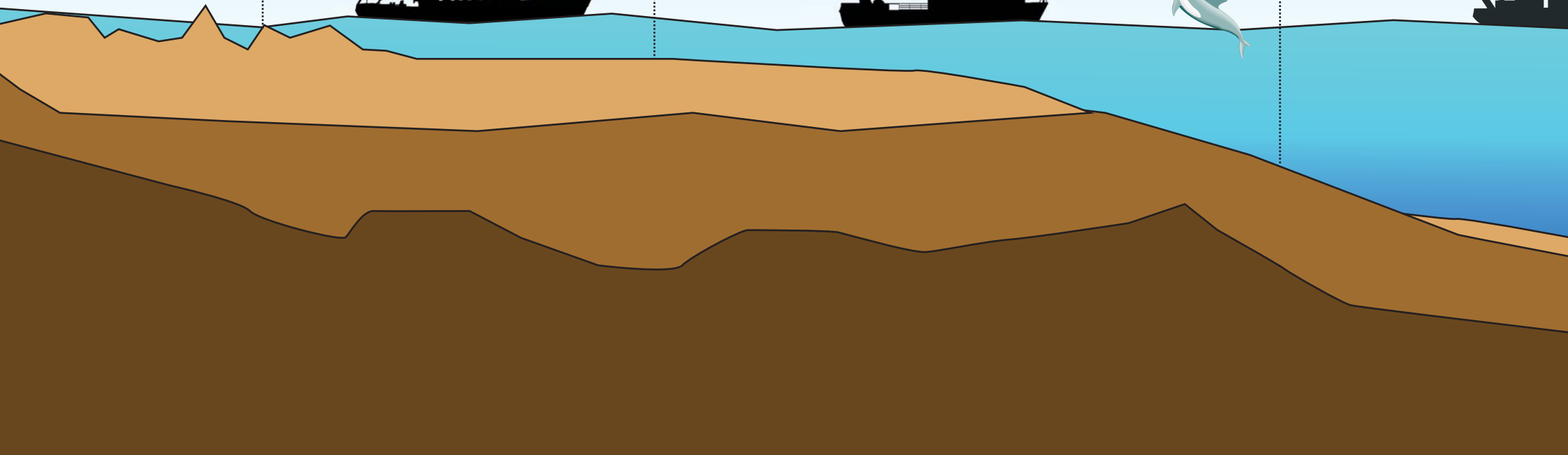
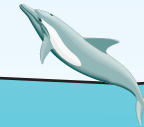


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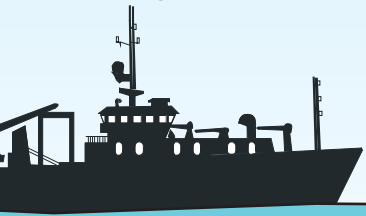


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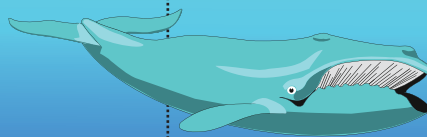


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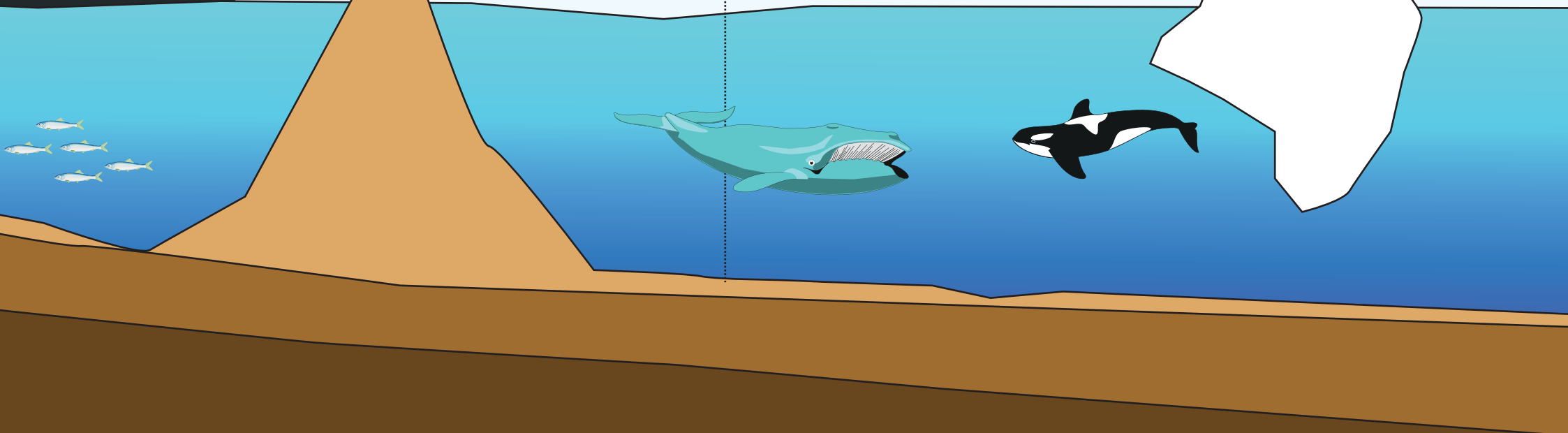
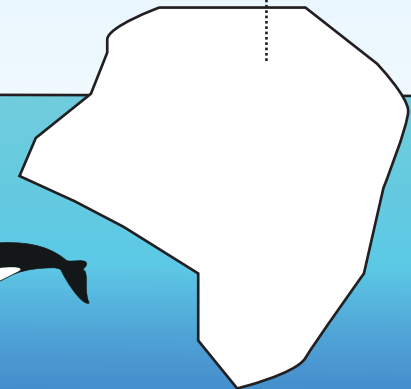
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Introduction



January 1, 2012 represented a milestone in the ~140 years history of the institute, when the former Centre of Estuarine and Marine Ecology (CEME) in Yerseke merged with the Royal Netherlands Institute for Sea Research NIOZ, located on the Island of Texel. The combined institute falls under the umbrella of The Netherlands Organisation for Scientific Research (NWO) constitutes the largest concentration of marine scientists in The Netherlands. The merger was formalized on April 4 by His Royal Highness the Prince of Orange in the presence of representatives of the Royal Netherlands Academy of Arts and Sciences (KNAW), NWO, policy-makers, cooperating universities and institutions and maritime industry. The merger significantly strengthened the role of Royal NIOZ as the national Netherlands oceanographic institute, also in an international perspective.

Gaining fundamental insights in complex and dynamic marine ecosystems and environments is of vital importance for modern society and at the heart of the mission of Royal NIOZ. Our activities, our mission, our multidisciplinary research, including frontier applied studies, and our modern facilities, including ships, are dedicated to this task.

Furthermore, NIOZ supports academic marine research with knowledge and infrastructure in the Netherlands and abroad.

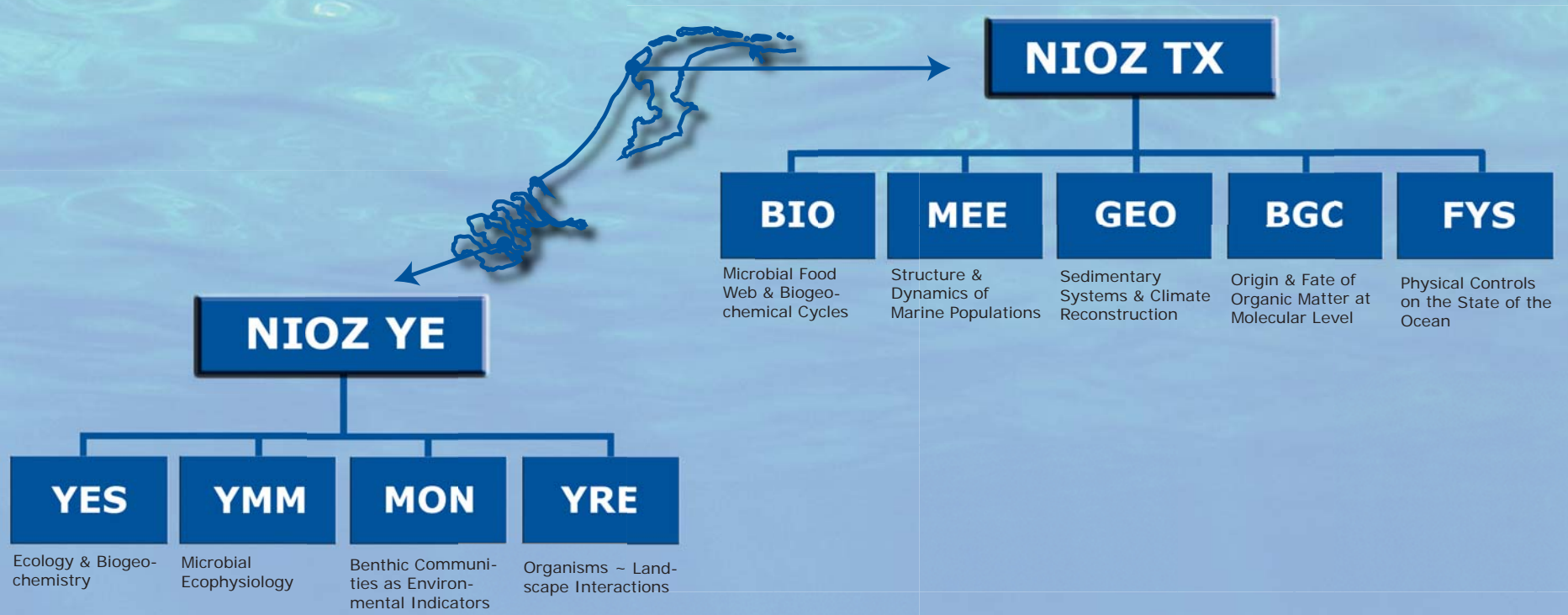
Research at Royal NIOZ focuses on marine environments globally, from estuaries and deltaic settings, from polar regions via temperate zones to tropical coral reefs, and into the depths of the oceans. This annual report presents the 2012 highlights of our activities and results along an in- to offshore context, and is backed up by the vital statistics in the

final pages. More information is available on-line via www.nioz.nl/annual-report-2012

The year 2012 was a year of excellent productivity, growth and change, another very successful and dynamic year for our institute.

Henk Brinkhuis, General Director
Herman Ridderinkhof, Deputy Director





About NIOZ

The Royal Netherlands Institute for Sea Research, NIOZ, is the oceanographic institute of the Netherlands. The mission of NIOZ is to extend and communicate scientific knowledge on seas and oceans for a better understanding and a sustainable use of our planet, to manage the national facilities for sea research, and to support research and education in the Netherlands and abroad.

In 1876, the institute was established as the Zoological Station in Den Helder. It evolved into a multidisciplinary oceanographic institute while addressing marine physics, chemistry and geology from the late 1950's onward. The institute was renamed as 'The Netherlands Institute for Sea Research', and since 1970 it resides at the Frisian island of Texel. On January 1, 2012, NIOZ merged

with the Centre for Estuarine Marine Ecology (NIOO-CEME) in Yerseke. NIOZ now has two locations, one on Texel at the border between the North Sea and the Wadden Sea, and one in Yerseke, situated in the Dutch Delta area.

NIOZ Research is organized in five scientific departments at Texel and four research groups in Yerseke as illustrated in the figure. NIOZ Research is supported by Marine Research Facilities (MRF) and Ship Management & Logistics (SML), managing our fleet of five research vessels and sea going equipment, by Marine Technology (MTec) for constructing and servicing equipment as well as for technical support during cruises, and by the Data Management Group (DMG), responsible for the archiving and accessibility of research data.

A recent development concerns NIOZ Science Harbour, where fundamental science meets green initiatives for the exploitation of the seas. Companies are invited to develop and test new ideas and concepts in an inspiring setting with direct access to scientific expertise and excellent research facilities.

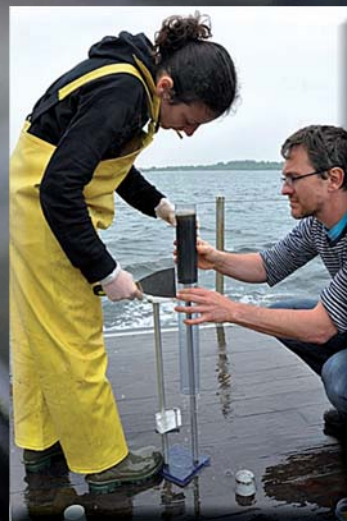
For more information check our website at: www.nioz.nl

DELTA

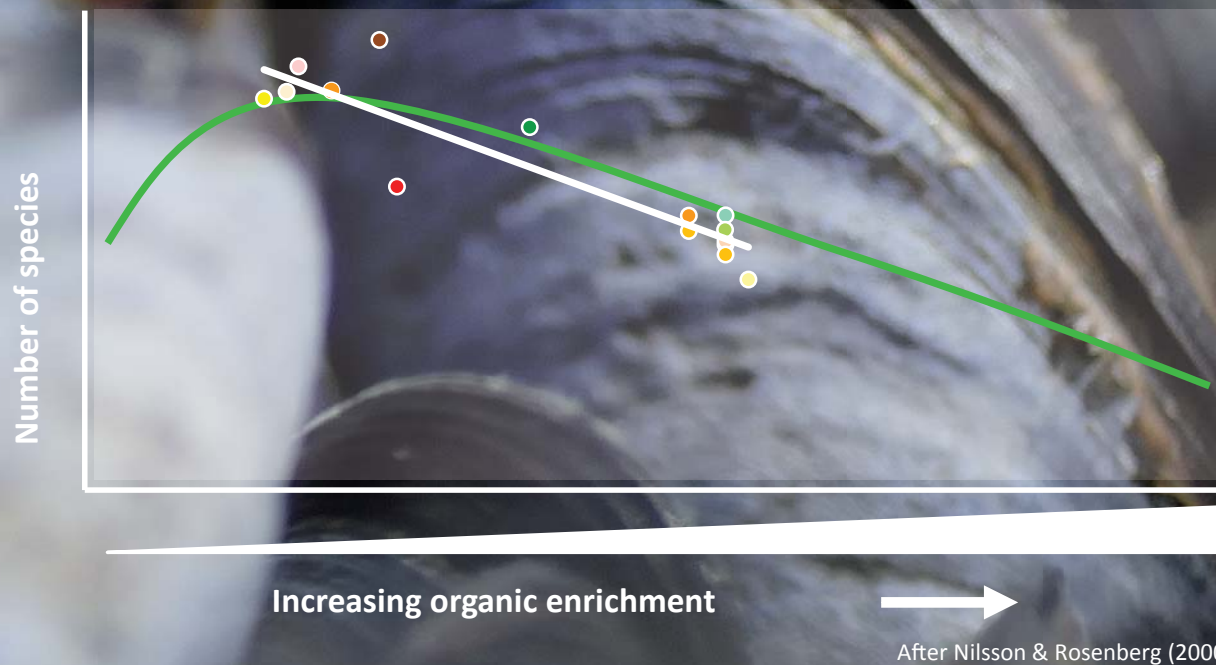
Lake Grevelingen: a model ecosystem in our backyard

Increasing water temperatures and stagnant bottom waters promote oxygen free zones in coastal areas. Lake Grevelingen represents a model system to study the effects on the chemistry of water and sediments.

Lake Grevelingen is a former Meuse-Rhine estuary that turned into Europe's largest non-tidal brackish water lake upon the completion of the Brouwersdam in 1972. Its water quality may deteriorate dramatically during warm summers, when a high oxygen demand and limited mixing of water due to the exclusion of tides result in severe oxygen depletion. Such hypoxic conditions may be detrimental to water tourism and the mariculture of mussels and oysters in Lake Grevelingen, but at the same time it provides an excellent opportunity to study its biogeochemical consequences. In 2012, an intensive field campaign was conducted in collaboration with various national and international partners. The water column and sediment of a single anoxic basin were sampled on a monthly basis with RV Luctor. Experiments and analyses covered a wide range of biogeochemical topics, including benthic metabolism, nitrogen cycling, microbial long distance electron transport, and the thread-forming bacterium *Beggiatoa*.



Enhanced food supply reduces benthic biodiversity



Benthic biodiversity patterns from Greece to Norway show species richness to decrease with higher food supply. The cause for this relationship remains elusive.

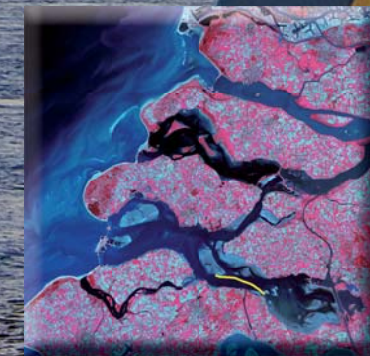
Through the Marine Biodiversity and Ecosystem Functioning (MARBEF)-network, a total of 15 data sets on seafloor biodiversity were made available for statistical analyses. The data covered habitats from Greek to Norwegian waters, encompassing a wide range in food supply to the seafloor. Species richness, the number of benthic species per unit area, was found to be highest in the Irish Sea and the Sea of Crete and showed a minimum in the Dutch Delta. Relating species richness to environmental conditions showed a convincing negative trend with the rate of food supply. This observation accords well with the declining trend of the general hump-shaped relationship between diversity and productivity (see figure). The upward cline presumably reflects food limitation on species richness, but such low rates of food supply are apparently lacking for the habitats investigated here. The immediate cause for the observed declining trend, however, is hard to identify, as an increase in food supply may occur along with other changes in environmental conditions that affect species richness.

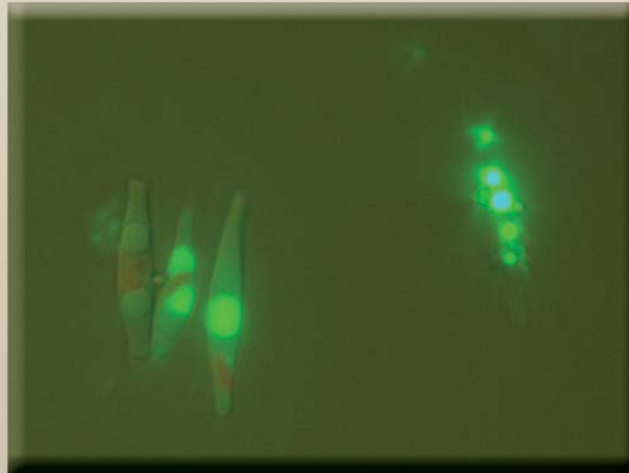
DELTA

Novel tool reveals highly variable chlorophyll contents in estuaries

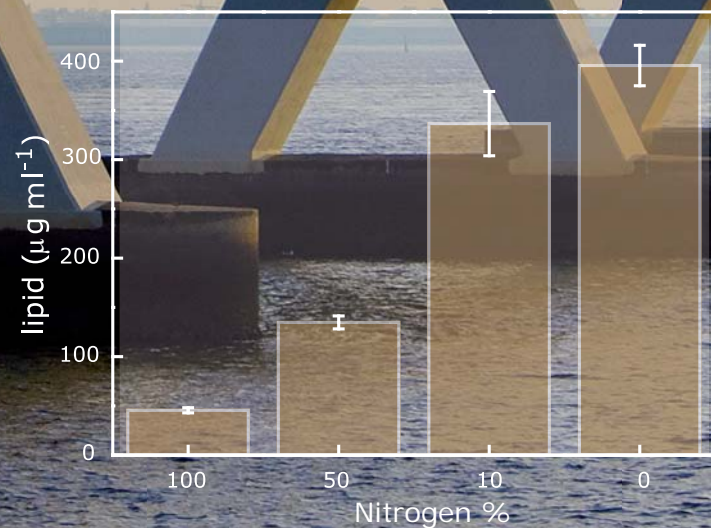
Phytoplankton provide food for the higher trophic levels in marine systems. Novel monitoring tools are developed to understand their distribution in dynamic estuaries.

Estuaries are vital coastal ecosystems of great economic and ecological value, where microscopic algae represent an important food source for the higher trophic levels. In order to understand their distribution we developed (PROTOOL, EU) measuring tools to be applied on ships of opportunity, like ferries. For example, the 'reflectance module' is designed to capture the light reflected by the water column which allows us to quantify phytoplankton abundance. This resembles the technique that is applied in remote sensing by satellites, but now at the ship's level. The Google Earth image shows green bars for the chlorophyll estimates along a transect (yellow line), as obtained from this module for a cruise on the Oosterschelde. The light green bars show the locations of the fixed stations according to standard sampling strategies. Note that continuous monitoring reveals substantial spatial variability in phytoplankton biomass, which may go unnoticed by conventional techniques.





Microscopic algae as future source for biodiesel?



The marine diatom *Phaeodactylum tricorneratum* accumulates unusually large amounts of lipids. Pilot studies should demonstrate economic feasibility to use microalgae for biodiesel production.

Microalgae not only have a higher yield per surface area than macroscopic plants, but many of them can grow in environments that are unsuitable for crops. Moreover, mass cultivation of marine microalgae does not depend on the supply of freshwater, which often limits the production of fresh water algae and crops. We have isolated the marine diatom *Phaeodactylum tricorneratum* and demonstrated that it accumulates unusually large amounts of lipids which even increased while growing the algae under nitrogen limitation (see illustration). This, along with the ability to convert waste products of biodiesel production into lipids as well, renders *Phaeodactylum tricorneratum* an excellent source for biodiesel production. A high biomass and lipid content are the prerequisites to make the harvesting economically feasible. Within the framework of the EU demonstration project InteSusAI, this diatom will eventually be cultivated in bioreactors of up to 10 hectares.

INTERTIDAL

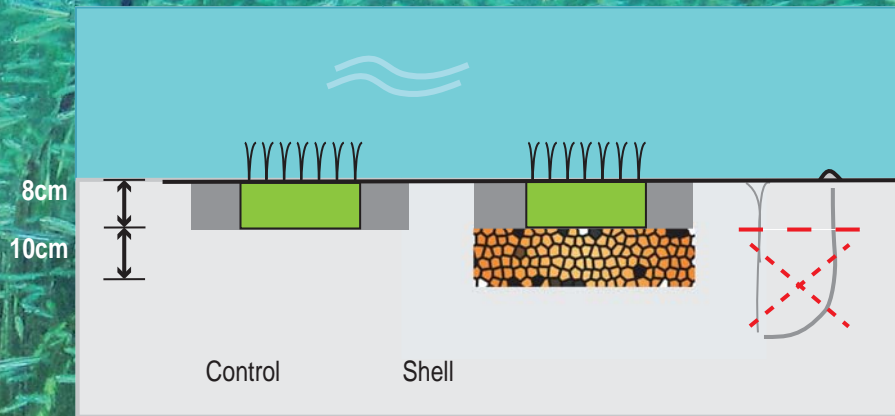
Seagrasses survive toxic sediments thanks to co-occurring clams with symbiotic bacteria






Seagrasses are among the few vascular plants able to root and grow in sulfidic marine sediments. A tripartite cooperation with clams that host symbiotic bacteria allows them to grow in these toxic sediments.

Intertidal sediments receive large quantities of organic debris which is largely decomposed by bacteria producing the highly toxic hydrogen sulfide. Some vascular plants growing in sulfidic sediments release oxygen from the atmosphere via the roots into the sediment in order to detoxify the sulfide by oxidation. However, seagrass has developed a unique tripartite life form to alleviate the lethal sulfide stress. Small clams living in the rooted zones of seagrass host symbiotic bacteria on their gills that are capable of sulfide oxidation for growth. The bacteria are harvested by the clams as a food source whereas the seagrass benefits from the reduction in sulfide stress. It has been demonstrated that seagrass plants grow faster in habitats with such clams than without. If we are to preserve and restore seagrass beds, we clearly need to examine how they cooperate with other organisms as well as studying the plants themselves.



Eliminating biomechanical warfare contributes to restoration success



-  Ambient
-  Reworked
-  Shell layer
-  Seagrass sod
-  Seagrass sod

 Exclusion affected sediment in a schematic lugworm burrow



©Marjolijn Christensen

Humans are ecosystem engineers *par excellence*, but the success of their efforts to preserve or restore specific habitats may depend on species interactions.

Ecosystem engineers are species that modify their physical habitat and thereby improve their fitness. Such modifications may prohibit the establishment of other species, a phenomenon known as 'biomechanical warfare'. In a restoration project of the seagrass *Zostera noltii* in the Oosterschelde, we excluded negative interactions between lugworms and seagrass by applying a 10 cm thick shell layer in the sediment, and planting the seagrass on top of this. The layer effectively excluded adult lugworms and significantly reduced the relief caused by the worms. At a sheltered site we observed a significant improvement in seagrass growth, whereas at an exposed site, physical disturbance due to waves was a dominant effect wiping out the consequences of ecological interactions. Shielding restoration species from biomechanical antagonists can contribute to restoration success by helping the planted species to overcome a minimal density threshold above which it can further maintain itself.

INTERTIDAL

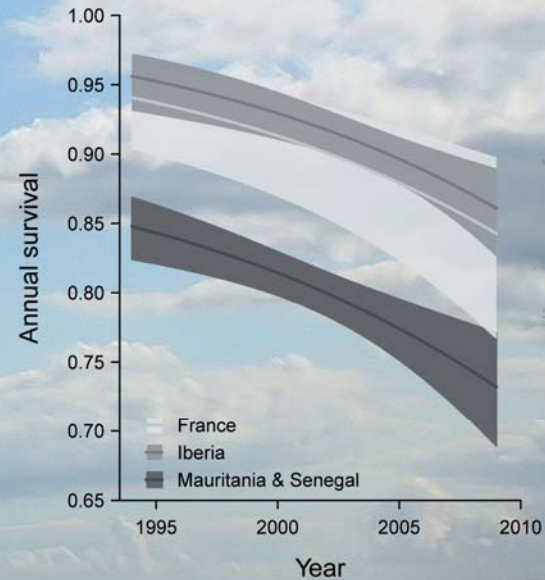
Red knot personalities affect mudflat exploitation on a large scale



Red knots exhibit various personalities which are expressed in their feeding strategies during periods of food shortage.

Animals differ from each other: some are bolder, more aggressive, or more explorative than others. Red knots are shorebirds that depend on the mudflats of the Wadden Sea where they live off buried clams. In an experimental setting, their individual behaviour was studied by quantifying the way they explored five artificial food patches. Some individuals remained at one patch, while others readily explored all patches. Given these results, we re-analysed red knot occurrence in the Dutch Wadden Sea in years of food shortage due to cockle dredging. It is now recognized that 'non-explorative' knots need to deal with food shortages locally, whereas 'explorative' knots, in search of better forage, go to mudflats in, for instance, England and Germany. This versatility presumably increases the resilience of red knot populations in the Dutch Wadden Sea.

Spoonbills habitually migrate further south than is good for them



Do spoonbills choose the best places to spend the winter? An analysis of their survival and winter site choice suggests they do not.

Spoonbills that breed in the Netherlands winter along the Atlantic coast between France in the north and Senegal in the south. Year-round observations of more than 2000 adult spoonbills that were ringed as nestlings from 1988 to 2010 revealed that birds that spend the winter in Europe have a higher survival rate than birds that fly to their 'traditional' wintering grounds in West Africa. Despite this, a significant number of spoonbills keep making the journey each autumn all the way to Africa. Spoonbills thereby demonstrate that habitual behaviour can be a major limitation when it comes to making the necessary adaptations to a changing climate or habitat.

COASTAL

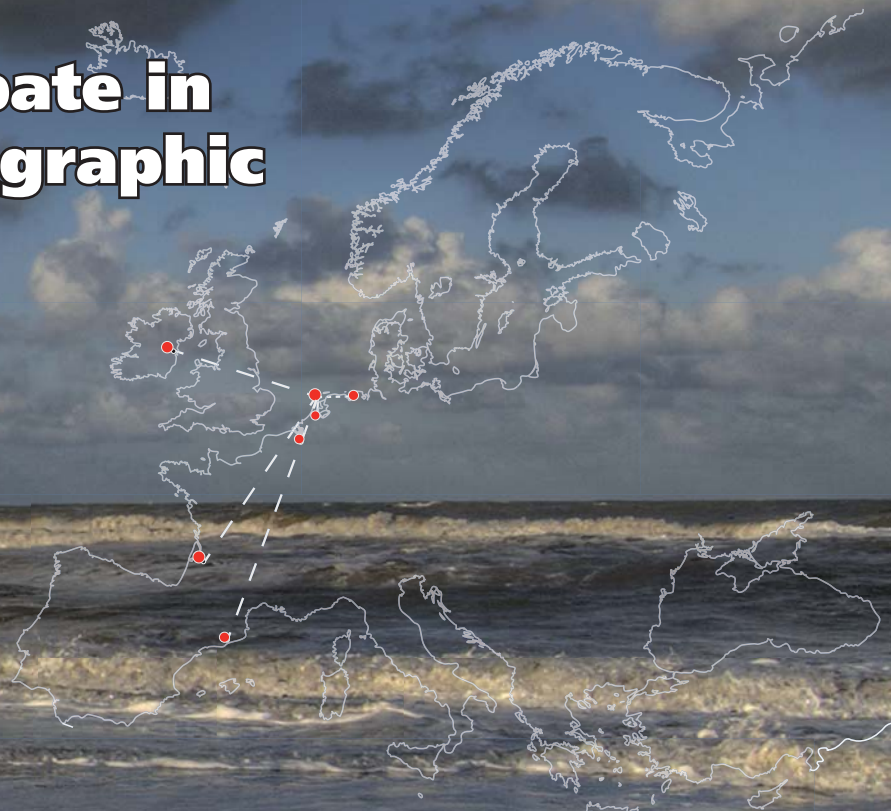
Internal waves near Texel-beach

A summer bather entering a calm sea from the beach may sense alternating warm and cold water. Surprisingly, these variations seem to be caused by internal waves.

On a calm summer day, an array of high precision sensors has measured fast changes in water temperature of up to 1°C near a Texel beach. The measurements show that sensed variations are in fact internal waves, supported in part by vertically stable stratification in temperature, hence in density. Such motions are common in the deep ocean, but generally not in shallow seas where mixing is expected strong enough to homogenize. The internal beach waves have amplitudes ten times larger than those of the small surface wind waves. Their mixing rates are larger than for internal waves found in open ocean but smaller than wave breaking above deep sloping topography. Results not only improved our knowledge on the redistribution of material in seas and ocean, we also learned that humans can sense differences of 1°C in waters of 18°C .



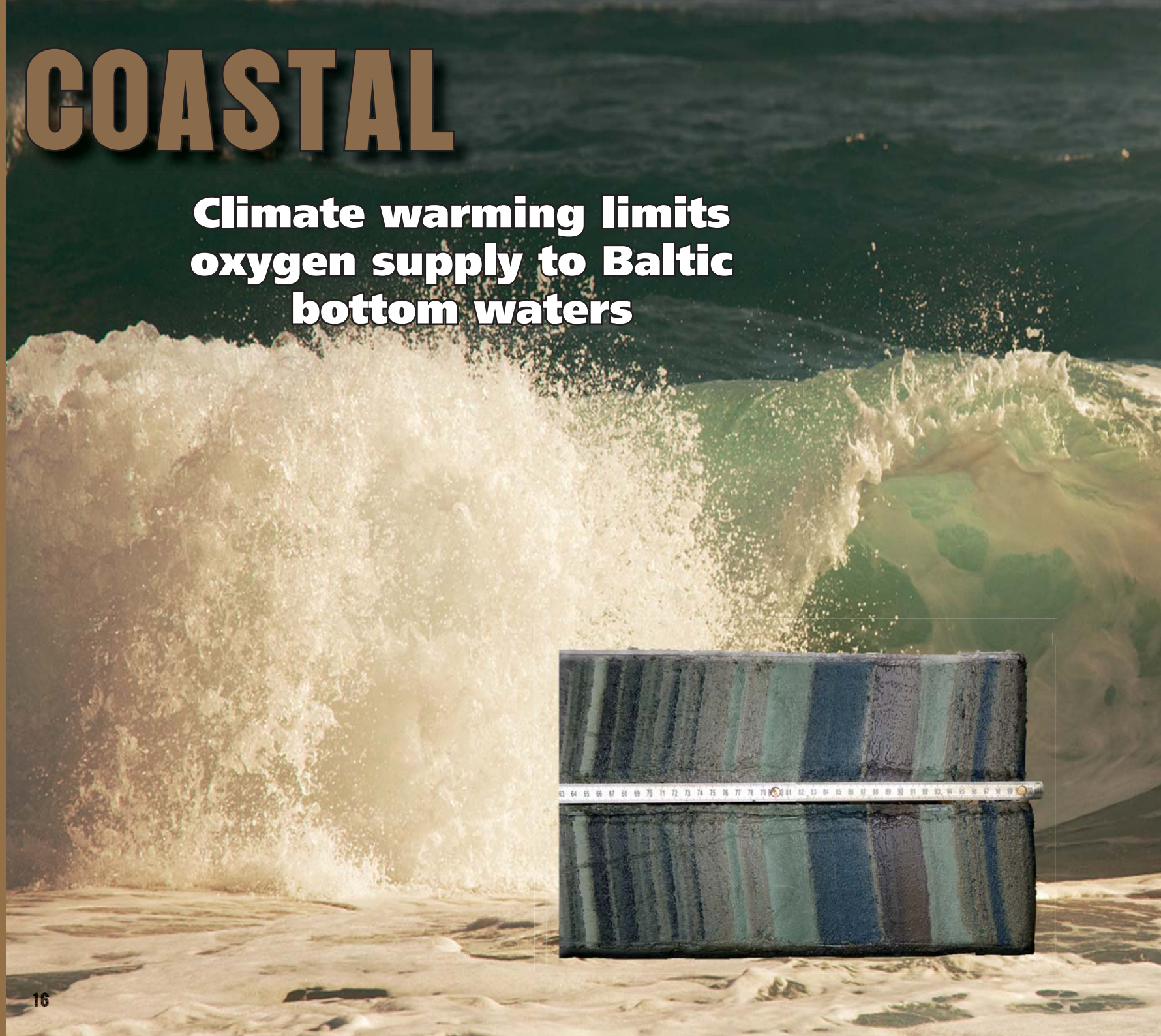
Citizens participate in collecting oceanographic data



The colour of natural waters provides invaluable information on their composition. CiTCLOPS aims at developing low-cost solutions to collect coastal and oceanic data. Currently, colour determinations for quality assessment of natural waters are largely based on spectral measurements at sea and from space. A simpler approach involves the almost forgotten Forel-Ule colour comparator scale. It has been applied since the 19th century and provides a methodological connection to historical ocean colour data series which are used as a baseline for recent climate change. The CiTCLOPS consortium will design an extended, rugged, and low-cost scale to be used by the general public. A second development concerns the design and construction of low-cost water quality sensors and methods to establish water clarity and natural fluorescence. Applications (App's) for smartphones will be developed to monitor these water quality parameters. This EC-funded project (3 years) to establish a Citizens' Observatory for Coast and Ocean Optical Monitoring, is carried out by a consortium from academia, technology centres, industry and end-user organisations based in five EU countries.

COASTAL

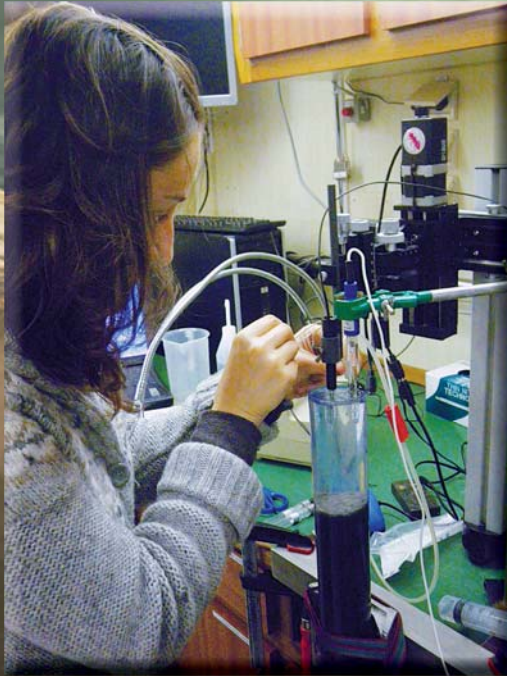
Climate warming limits oxygen supply to Baltic bottom waters



The surface water temperature of the Baltic has increased by 2°C since the Little Ice Age. The spreading of oxygen free bottom waters in the Baltic may be a scenario of future climate warming.

Climate change has a strong impact on ecosystem health, particularly in marginal seas such as the Baltic, for example causing the spreading of oxygen-free areas, the so-called dead zones. An integrated study of the sedimentary record (past 1,000 years) by NIOZ, German and Scandinavian scientists provided new insights into the functioning of the Baltic Sea ecosystem under natural and human-influenced climatic changes. Between the Little Ice Age (AD 1550-1850) and the Modern Warm Period the surface water temperatures, reconstructed using TEX₈₆ as a molecular 'palaeo-thermometer', increased by ~2°C. Simultaneously, the anoxic areas in the Baltic Sea began to expand significantly as evident from the accumulation of laminated sediments. These results provide evidence that changes in surface temperature strongly influence deep water oxygenation, and highlight the risk of a continued spreading of anoxic areas during climate warming in the future.

Marine sediments operate as natural batteries



The nano-wiring of sediments by chains of bacteria may speed up chemical reactions and provides new views on the biogeochemical functioning of bacterial communities and sediments.

In 2010, laboratory experiments by Danish researchers revealed that filamentous bacteria are capable of transferring electrons over centimeter-scale distances in marine sediments. By generating electrical currents, these intriguing bacteria make marine sediments operate as a natural battery. In 2012, we have demonstrated that this remarkable phenomenon not only occurs in the lab, but also in natural sediments. In Dutch coastal waters, we have discovered various habitats where long-distance electron transport occurs, such as subtidal sediments, salt marshes and seasonally hypoxic basins. Our results show that the process strongly impacts the sedimentary oxygen uptake and sulphur cycling at these sites, showing that long-distance electron transport could have profound implications for the mineral cycling and ecosystem functioning of the seafloor. On the applied side, this process may potentially lead to novel bio-electrical applications, such as improved electricity generation in microbial fuel cells, or even to new conductor materials applied in bio-electronics.

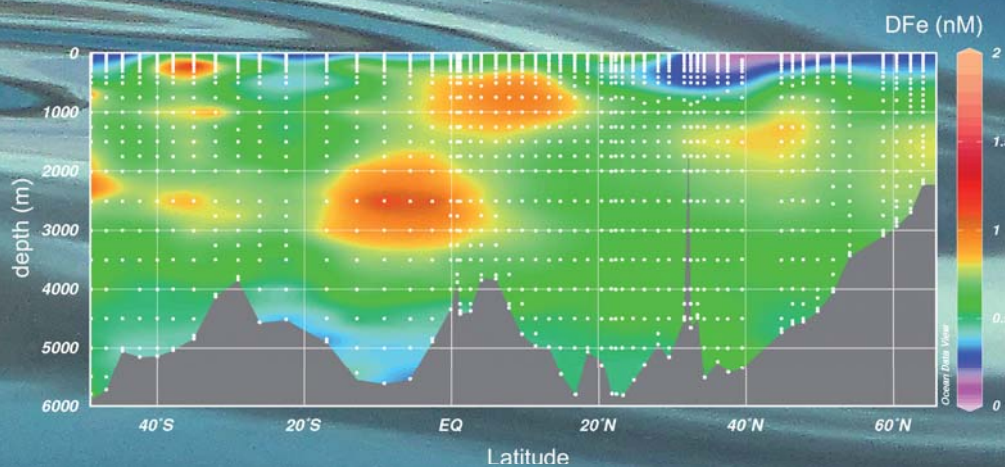
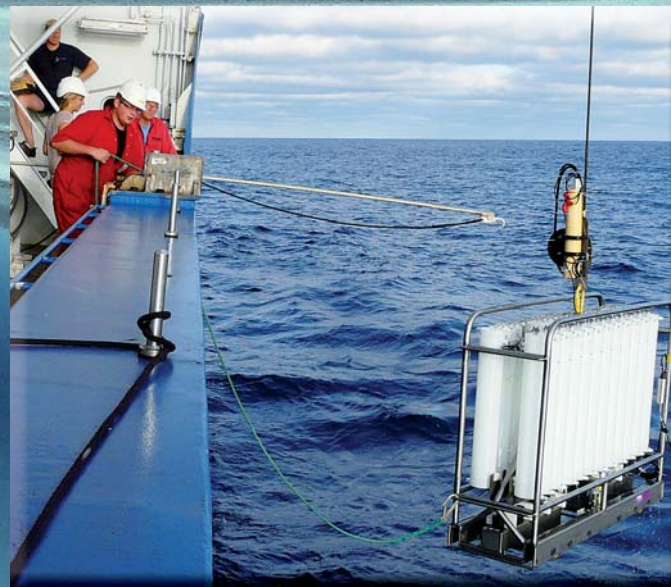
OPEN OCEAN

Pelagia supports international Red Sea project

NIOZ' flag ship RV Pelagia with crew and technicians supported a research project between Germany and Saudi Arabia on the geology and biology of the Red Sea. In April and May RV Pelagia sailed to the Red Sea for a 63-days charter within the framework of the "Jeddah Transect Project", a scientific collaboration between GEOMAR (Kiel, Germany) and the King Abdulaziz University (Jeddah, Saudi Arabia). Four projects participated in two multidisciplinary cruise legs. The first leg concentrated on the geology, microbiology and geophysics of the central Red Sea Rift zone, whereas the second leg focused mainly on biology. Aided by GEOMAR's submarine JAGO, special attention was given to food web structures, corals and macro algae. Between the cruise legs in Jeddah harbour, a two-day VIP event was organized on board RV Pelagia, attended by GEOMAR director P. Herzig and the president of the Helmholtz Association J. Mlynek. On that occasion, many locals visited the ship and the Pelagia crew was in turn invited to the gala dinner that celebrated the end of the project.



On a voyage of discovery: unravelling the role of trace metals in the biological cycle



A 17,500 km long sampling transect in the West Atlantic reveals a wealth of information on the bio-availability of trace nutrients and their sources.

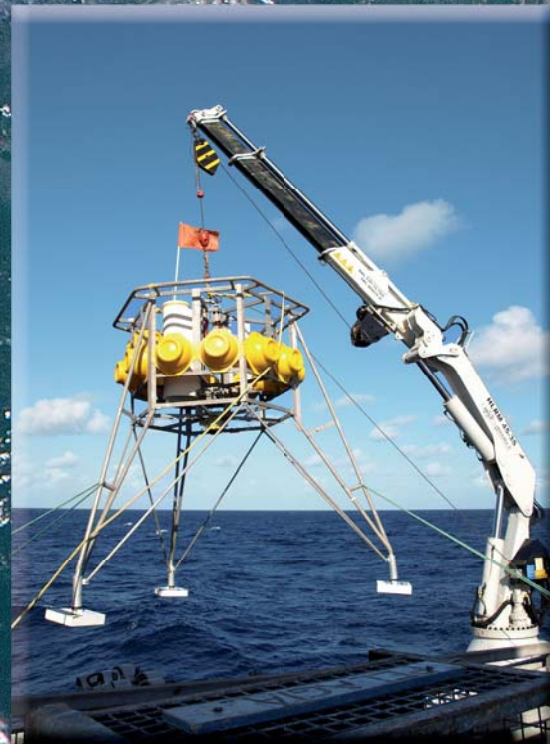
Each organism needs six trace elements for growth: iron, zinc, manganese, cobalt, nickel and copper. In the open oceans these trace metals occur in extremely low abundances. Plankton ecosystems in large parts of the oceans likely are limited by the availability of one of these bio-essential trace nutrients. The NIOZ is at the forefront of the international GEOTRACES program to discover and map for the first time the large scale distribution of these trace metals. Engineers of NIOZ designed a revolutionary new titanium sampling system with 24 samplers of ultraclean PVDF plastic. The longest-ever (17500 km) full-depth (4-6 km) open ocean vertical section was sampled in the West Atlantic Ocean from Iceland to the Falklands. The resulting database is unprecedented with more than 1300 data values for each of many trace metal elements. Iron has multiple sources like dust from the Sahara, hydrothermal vents, mineralization in oxygen minimum zones, and the Amazon River. Zinc shows close covariance with major nutrient silicon.

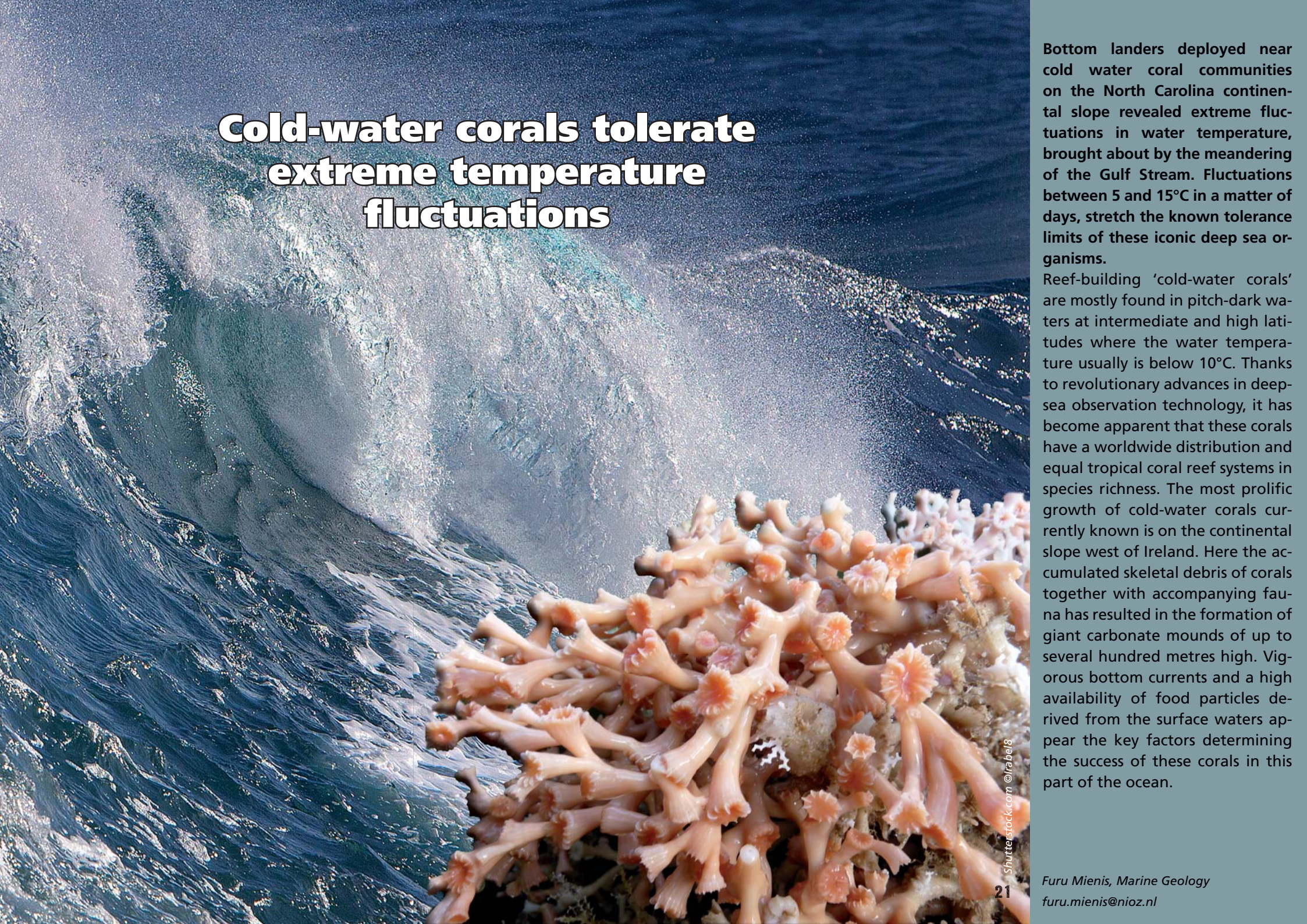
OPEN OCEAN

Internal tides drive up-slope sediment transport

Oscillating currents in Whittard Canyon were demonstrated to result in net up-slope transport of suspended particulate matter. This observation urges for a more diversified view on sediment transport in submarine canyons.

Submarine canyons are commonly viewed as conduits for merely down-slope transport of particles from the shelf to the deep sea. This view is challenged by observations made with bottom landers in Whittard Canyon, a large branching submarine canyon system incised in the shelf edge and slope of the northern Bay of Biscay. In its upper reaches, oscillating tidal currents with peak velocities in excess of 50 cm s^{-1} transport suspended particulate matter alternately up- and down-slope, with a conspicuous up-slope tendency. The up-slope transport is counteracted, however, by intermittent down-slope mass transport as sediment gravity flows, the submarine equivalent of avalanches. These gravity flows periodically fuel deep-sea benthic ecosystems with relatively fresh food. The study of Whittard Canyon was carried out in the framework of the European integrated HERMIONE project (2009-2012), in which 50 research institutes participated.





Cold-water corals tolerate extreme temperature fluctuations

Bottom landers deployed near cold water coral communities on the North Carolina continental slope revealed extreme fluctuations in water temperature, brought about by the meandering of the Gulf Stream. Fluctuations between 5 and 15°C in a matter of days, stretch the known tolerance limits of these iconic deep sea organisms.

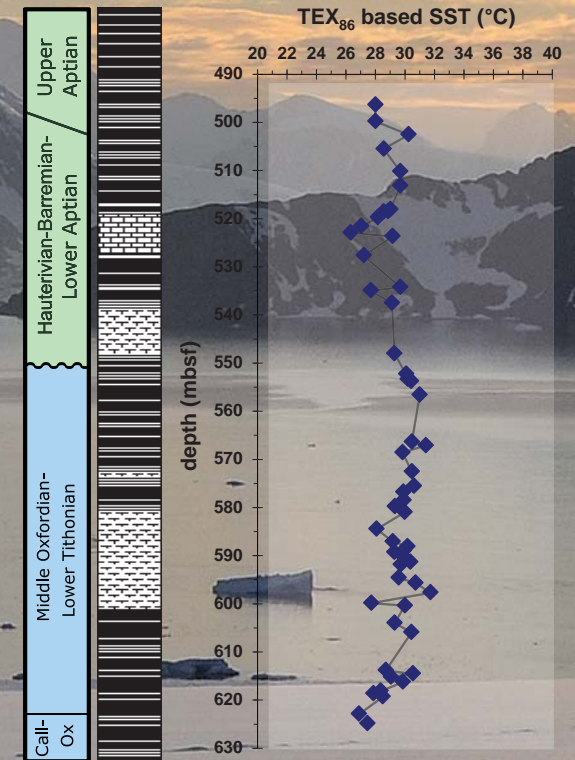
Reef-building 'cold-water corals' are mostly found in pitch-dark waters at intermediate and high latitudes where the water temperature usually is below 10°C. Thanks to revolutionary advances in deep-sea observation technology, it has become apparent that these corals have a worldwide distribution and equal tropical coral reef systems in species richness. The most prolific growth of cold-water corals currently known is on the continental slope west of Ireland. Here the accumulated skeletal debris of corals together with accompanying fauna has resulted in the formation of giant carbonate mounds of up to several hundred metres high. Vigorous bottom currents and a high availability of food particles derived from the surface waters appear the key factors determining the success of these corals in this part of the ocean.

POLAR

Subtropical conditions for Antarctic coast and Southern Ocean in ancient greenhouse world

Over the past 150 million years, the Earth has frequently experienced a much warmer climate than today. New techniques developed at NIOZ enable an accurate reconstruction of paleoclimate temperatures.

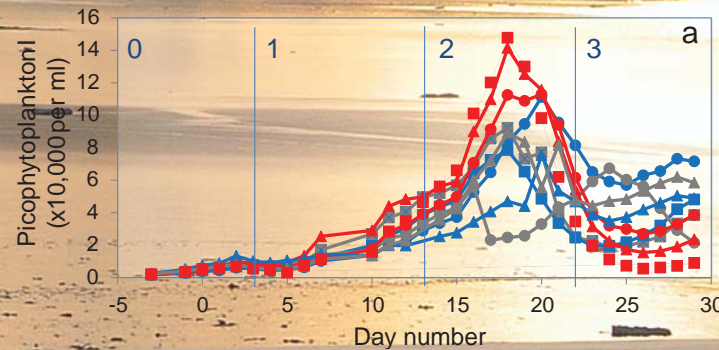
The technique used to reconstruct ancient temperatures is based on the chemical structure of fossil bacterial membrane lipids and is therefore called 'molecular palaeothermometry'. It has been applied to a 1000 m long ocean sediment core from East Antarctica to reconstruct Antarctic temperatures during the Eocene (ca. 55 – 48 million years ago), a warm period with atmospheric carbon dioxide levels four to five times higher than at present. Molecular palaeothermometry revealed summer temperatures of over 25°C and extremely mild winters. This scenario is well in line with the pollen and spore analyses by researchers from the Universities of Utrecht and Frankfurt, which suggest that the prevailing climate supported growth of subtropical forests along the Antarctic coastline. Similarly it was demonstrated, in collaboration with researchers from the University of Oxford, that the Southern Ocean experienced subtropical temperatures around 140 million years ago.



Tiny algae dominate the phytoplankton community at high CO₂ levels

Acidification of the Arctic Ocean promotes a shift towards smaller microalgae. This change may reduce the efficiency of the biological pump.

Approximately half of the CO₂ released by the burning of fossil fuel is absorbed by the oceans. The resulting acidification of the ocean may strongly impact the community composition of microalgae which form the basis of the ocean food web. The Arctic Ocean is particularly sensitive to acidification due to the high solubility of CO₂ and low carbonate saturation state of its cold surface waters. In Kongsfjorden (Spitsbergen), we studied the consequences of ocean acidification on the natural Arctic community of algae and microorganisms. Large enclosures were manipulated by imposing a range of CO₂ pressures and the community composition was monitored for a period of one month. Particularly, the growth of algae smaller than three micrometer in diameter was stimulated at higher CO₂ levels. These small algae are intensively grazed and appeared prone to viral lysis, which dramatically affect the structure and functioning of the Arctic food web, and reduces the biological draw-down of atmospheric CO₂ into deeper waters.

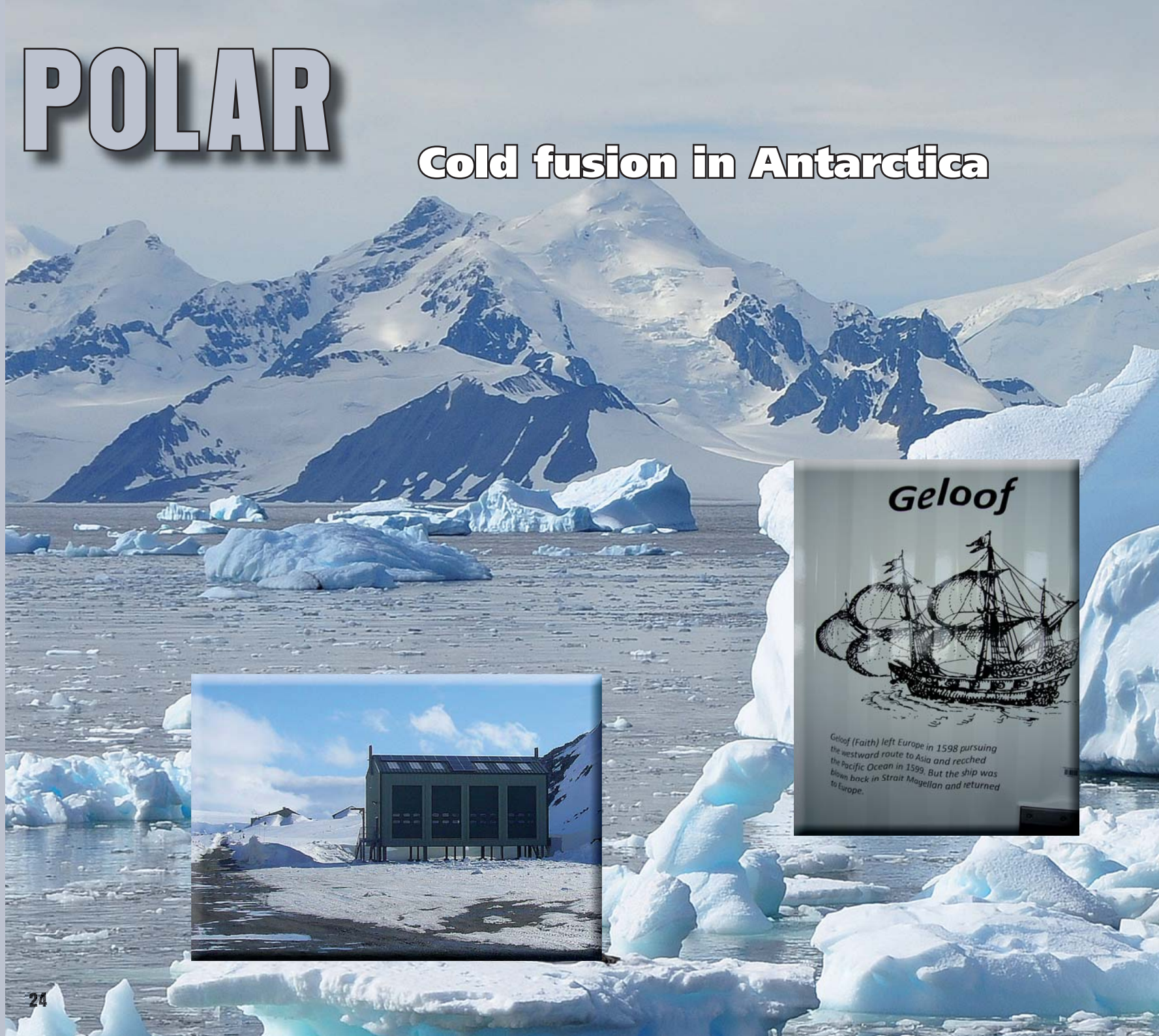


POLAR

Cold fusion in Antarctica

The Netherlands Organization for Scientific Research (NWO) launched a joint research program with the British Antarctic Survey. Two out of five projects are supervised by NIOZ scientists.

West Antarctica is rapidly warming. Glaciers melt faster causing extra sea-level rise, a concern for The Netherlands. Some once permanent ice fields at sea have disappeared and there is less annual winter sea ice. The frozen paradise still is a habitat for microscopic algae in the sea, krill, penguins, whales and for top predators like the leopard seal and orca. Yet, warming seawater, less ice, more meltwater, affect the algae that are the base of the foodweb. NWO has launched a joint program with the British Antarctic Survey (BAS). Joint enthusiasm of BAS, NWO and NIOZ was pivotal for the initiative and for the design, realization and names of the new Dirk Gerritsz Laboratory and its four mobile laboratories Annunciation, Faith (Geloof), Hope (Hoop), and Love (Liefde). Two of the five projects are by NIOZ scientists. Johann Bown, Patrick Laan and Hein de Baar measure dissolved iron in the sea, because iron is essential for growth of the algae. Tristan Biggs and Corina Brussaard study the foodweb interactions between the algae, viruses and microzooplankton.



Geloof (Faith) left Europe in 1598 pursuing the westward route to Asia and reached the Pacific Ocean in 1599. But the ship was blown back in Strait Magellan and returned to Europe.

Without a trace.....



The mobile Dirck Gerritsz Laboratory has been set up at Rothera station to accommodate Dutch polar research. Dedicated gear has been developed by NIOZ workshops to complement the Antarctic research facilities.

Two Antarctic research projects by NIOZ focus on the nutrition and growth of microorganisms, requiring ultraclean procedures for sampling this pristine habitat. NIOZ' workshops have constructed equipment to support these studies. For collecting water samples down to a maximum depth of 650 m, a battery powered winch was designed to be operated from a Zodiac. It is made of titanium and furnished with a Kevlar cable. The actual sampling is done with a scaled-down version of the ultraclean NIOZ PRISTINE watersampler. This five liter sampler can be clamped to the cable and closed with a messenger weight running down the cable. This combination of proven techniques with a newly developed hydraulically actuated valve resulted in a highly reliable sampling device even under polar conditions. The choice of materials warrants ultra-clean procedures with a minimal risk of contaminating water samples for trace metal analyses.

© Corinna Brussaard / NIOZ TX

Interview



Gert-Jan Reichart

Climate Research Using the Past

The past may help to gain insight into climate changes in the present. This is one of the primary aims of biogeology. Dr Gert-Jan Reichart, head of the department of Marine Geology since September 2012, believes that NIOZ can make a significant contribution to climate research. 'We have the expertise and good facilities. Our workshops can build all sorts of equipment and we have our own fleet of research vessels. This is the power of NIOZ, top-notch'.

Single-celled organisms building calcareous skeletons, similar to mussels and oysters, abound in the oceans; these might well hold the key to understanding climate change. Their calcareous skeletons have been preserved in the sediment on the sea floor ever since these organisms existed. Analysis of their remains, retrieved from sediment layers, may provide clues about the history of our climate. 'The calcareous skeleton is formed by

calcium, oxygen and carbon. Their stable isotope composition varies depending on the circumstances under which the skeletons were formed. By measuring the stable isotopes we may find answers to questions such as what was the climate like when the organisms lived and what was the salinity of the sea water? Combining all data on past climate conditions may help to explain what is presently happening to our climate.'

'Crucial knowledge', says Reichart. 'The current rise in global temperature is worrying, but it may turn out a lot worse than we think now. The rise is likely to be slowed down by the gradual melting of the ice caps. But we don't know how long this is going to continue. We know a lot, but not everything.'

Starting off as a welder, Reichart switched to working as a scientist for Utrecht University and the Alfred Wegener Institute in Germany. At NIOZ,

he is involved in attracting new, and supervising extant staff. 'I've more time to do research now. At university, one is also involved in teaching. I like doing the chemical analyses myself, and I want to see all data for interpretation. I am really on the ball, which I have to be, I think.'

Risks and Benefits of Saharan Dust



Jan-Berend Stuut

Seven hundred to nine hundred million tons of Saharan dust is blown into and across the Atlantic Ocean annually. This may cause damage to, for example, corals or cause respiratory problems among the Caribbean population. Moreover, the outbreak of foot-and-mouth disease in the UK in 2001 may well have been caused by germs, carried by dust over thousands of kilometres.

The wind-blown dust, however, may also have positive effects. Nutrients in Saharan dust may stimulate the growth of algae, which takes CO_2 from the atmosphere and produces oxygen. The sinking of dead algae out of the upper ocean removes the CO_2 from the atmosphere for a prolonged period of time. 'That's the hypothesis at any rate', says Jan-Berend Stuut, who was awarded a 2-million-euro grant by the EU last year to study this phenomenon.

The idea for this project, which is partially funded by NWO (Netherlands Organisation for

Scientific Research), was conceived during the re-enactment of the Beagle journey in 2010. On board, Stuut engaged in a discussion with a geo-engineer who proposed reducing the greenhouse effect by adding large amounts of iron dust to the sea. The reality, however, is more complex. 'After the eruption of an Icelandic volcano in 2010 along with the volcanic ash a large amount of iron was deposited in the sea. The boost of algae growth, however, was short-lived because of a nitrate shortage. It's like in agriculture, where farmers alternately apply lime and fertilizers to prevent mineral shortages. Together, these create fertile soil. I imagine that this works in about the same way in the ocean.'

Stuut's research project started in October 2012 and will continue for five years. Devices for collecting desert dust from the atmosphere and from the seawater have been moored to the seabed in the Atlantic Ocean on five sites between



Africa and the Caribbean. Data from these devices in combination with satellite images will be used to record variability in dust transport and settling throughout the year.

In addition to the project leader, a technician, two PhD students and a postdoc, each contributing their own expertise, are involved in this project. As a geologist, Stuut is also interested in the history of the desert dust: '10,000 years ago, the Sahara was a savannah with trees. But during the last ice age 20,000 years ago, the area was even more barren than it is today, and lots of desert dust ended up in the ocean. The layers of sediment that accumulated on the ocean floor in the course of history thus represent a kind of climate archive. In sediment cores retrieved from the seabed, we can try to interpret these layers. This is interesting because we may very well know when the ice ages occurred but we still know very little about the climate of Africa at the time'.

Interview



Peter Herman

Regional Projects and International Relevance

The merger of NIOZ on Texel and the Centre for Estuarine and Marine Ecology (CEME) in Yerseke on 1 January 2012 consolidated the position of the two most important Dutch institutes in the field of coastal and sea research. Well over a year after the actual merger, the participants are satisfied. Prof. Peter Herman, director of the Yerseke division says: 'Of course adapting to an existing organization and to its procedures and customs can be difficult at times, but overall it was OK. Collaboration with Texel has many positive aspects'.

One of the first projects where scientists from Texel and Yerseke are working together involves research into the consequences of oxygen depletion on benthic life in the former Grevelingen estuary in Zeeland. Since NIOZ and Yerseke have merged, physicists and the lander group from Texel are also involved. Using their measuring de-

vices, we can achieve more than we could on our own.

The availability of devices that are developed in the Texel workshop is a great advantage of the merger, says Herman. 'We used to buy the standard equipment; now we have something unique. And we've something to offer as well. Equipment that we use for measuring mudflat formation in Zeeland can also be used for research into subsidence in the Wadden Sea'.

Despite all the positive experiences, Herman also has his worries, especially about the future of fundamental research. 'We have to seize every opportunity to survive. We have to join forces to secure our position within the *Topsectoren*. And it's increasingly important that we join in with regional projects. We've taken up the role of scientific advisors on the deepening of the

river Schelde, and we're also involved in projects in the Grevelingen estuary and Oosterschelde. At the same time, we must guard the international relevance of our work, to ensure our participation in European projects. We don't want to be seen as some small, regional institute either, or even worse, as a kind of consultancy'. Laughing, he adds, 'we're too expensive for that'.

All this affects Herman's own activities; apart from being a division manager, he is also a professor and the head of the department of Spatial Ecology. 'I'm more often on the go and I have to attend meetings more frequently. It's at the expense of other tasks, but that's the way it is. However, I do want to stay involved in scientific research. That's my basic motivation and I don't want to become estranged from it.'

Cold-Water Corals: Unique and Vulnerable

Dick van Oevelen

At depths of 300 to 800 metres below the ocean surface, reefs can be found that have been formed by cold-water corals. To the best of knowledge, the highest coral reef densities are found off the coasts of Ireland and Norway, but reefs have also been observed in the Bay of Biscay, the Mediterranean Sea and along the west coast of Africa. As sunlight does not penetrate to depths where these corals live, they cannot produce food themselves. Awareness of their vulnerability has led to measures directed at their conservation, says Dick van Oevelen from the department of Ecosystem Studies at NIOZ.

Van Oevelen talks passionately about his research that involves collaboration with scientists from various disciplines. As an ecologist, he shares his interest in the secrets of the cold-water corals with geologists. 'These organisms are very special. They feed on dead algae that sink to the

seabed, using tentacles to gather their food. Another interesting aspect of the coral reefs is that they abound with other life forms. It is the corals that mainly build the reef, but they are part of a diverse community of soft corals, sponges and worms, each with their specific role in maintaining the reef. Some worms, for example, produce parchment-like tubes, which are subsequently enveloped by a calcareous layer produced by the corals. This form of collaboration contributes to the strength of the reef.'

Some carbonate mounds formed by cold-water corals are as old as 2.5 million years. Underwater robots and other modern - and expensive - equipment enabled scientists during the last two decades to study the reefs in more detail. We have learnt a lot over the past years, but many questions still remain unanswered. It is not clear yet, for example, how many cold-water reefs exist

worldwide. 'We don't know how many reefs have disappeared either, but probably a lot. Trawling by fishermen has about the same effect on reefs as clearcutting has on a forest: everything is taken down. A dead reef can recover but that may take decades due to the very slow growth of the corals in the cold environment where they live. Much of the reef in the Bay of Biscay has probably disappeared. What is left, is found in areas inaccessible to trawlers. That is telling in itself.'

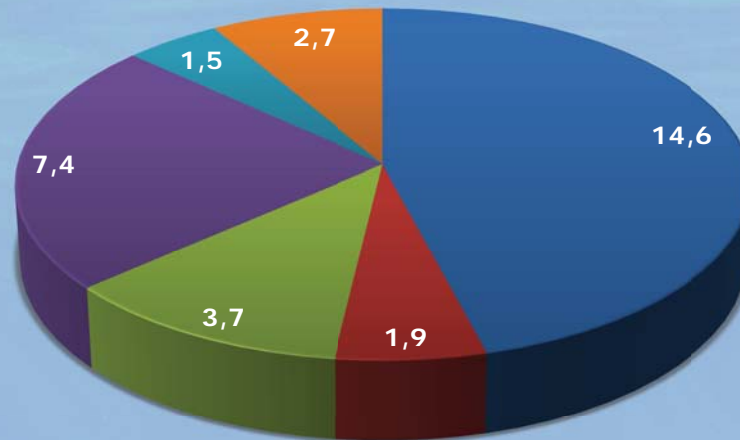
However, there is still some hope. 'Trawling is no longer allowed in areas with reefs. Restrictions have also been imposed on the oil industries. Companies are obliged to do research before they can start working in a particular area. In this way, cold-water corals may force us to revise our views on the deep sea.'



Facts & Figures

Budget

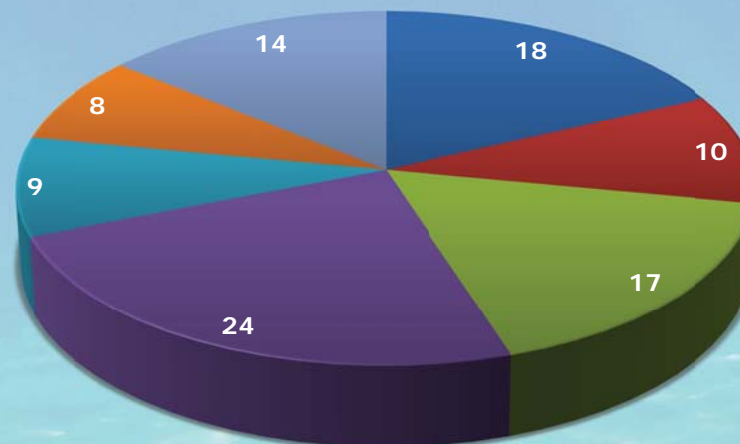
The overall budget for 2012 amounted to 31.8 M€. NWO contributed by 14.6 M€ as structural funding and by 1.9 M€ as a one-off subsidy. Additional funding, totaling 11.1 M€, was received through national (3.7 M€) and international (7.4 M€) project acquisitions. Chartering RV Pelagia to third parties yielded a net revenue of 1.5 M€. Miscellaneous and *ad hoc* funding, mostly related to the merger with NIOO-CEME, amounted to 2.7 M€. A detailed budget overview is presented on-line at www.nioz.nl/annual-report-2012



- Structural funding NWO
- One-off contribution 2012
- Project acquisition NWO
- Project acquisition otherwise
- Charters
- Miscellaneous

Personnel

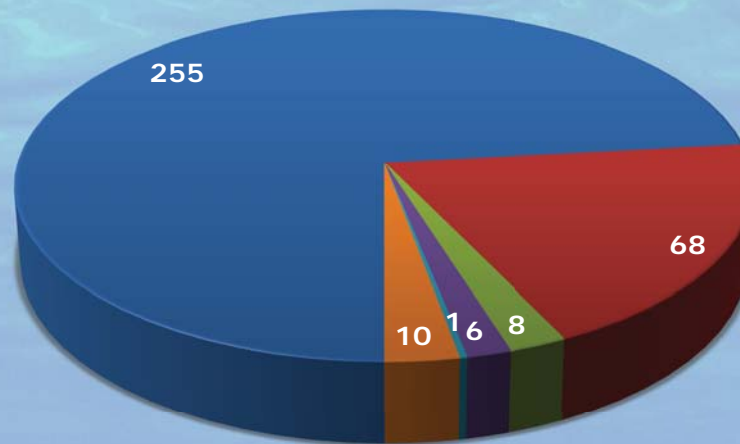
Per 31 December, NIOZ employed 353 staff, equivalent to 318.5 fte's. The international profile of NIOZ is underscored by the substantial number of employees from outside the Netherlands: 89 from over 20 different nationalities. The relative distribution over various staff categories (see the pie diagram) has been fairly constant over the past years. Administration, Ship Crews and Technical staff accounted for approximately 30% of the population, while scientific staff, including tenured scientists, PhDs, postdocs tenured and non-tenured laboratory technicians, accounted for roughly 70%. For more information (in Dutch) see www.nioz.nl/annual-report-2012



- PhD
- Postdoc
- Tenured scientists
- Scientific support
- Technical staff
- Ship crews
- Services & Administration

Output & Outreach

NIOZ scientists have authored 255 peer reviewed publications, ten of which in journals with an impact factor over ten. Eight PhD's successfully defended their thesis and received their doctorate; three at the University of Groningen, one at VU University Amsterdam, and four at Utrecht University. Moreover, a complete book, six contributing book chapters as well as 68 non-refereed publications and ten NIOZ reports have been written. More than 280 orals and 120 posters have been presented at symposia or workshops and the weekly NIOZ colloquium series covered close to 40 lectures. Over 50 public outreach activities such as public lectures, radio/television or newspaper interviews were organised by individual scientists. For a detailed overview of NIOZ output and outreach, see www.nioz.nl/annual-report-2012



- Peer reviewed publications
- Non-refereed publications
- Dissertations
- Book chapters
- Monographs
- NIOZ reports

Marine Research Facilities (MRF)

The NIOZ research vessel Pelagia sailed for 223 operational days in ten cruises, three of which as charter cruises with third parties, and seven within the National Programme for Sea Research (ZKO: Zee- en Kustonderzoek), EU/ESF or NIOZ programmes. RV Luctor sailed for 147 days in five research projects, mainly on the river Schelde, Oosterschelde and Grevelingen. RV Navicula sailed for 170 days in ten research projects, five student courses, and a charter cruise along the North Sea coast for IMARES. More information on NIOZ' research vessels and cruises can be found at www.nioz.nl/cruises



RV Pelagia



RV Luctor



RV Navicula

NIOZ Royal Netherlands Institute for Sea Research, situated on Texel and in Yerseke, is an institute of the Netherlands Organisation for Scientific Research (NWO).

www.nioz.nl

NIOZ Texel
Visiting address:
Landsdiep 4
1797 SZ 't Horntje, Texel

Postal address:
P.O. Box 59
1790 AB Den Burg, Texel
The Netherlands
Telephone: +31(0)222 - 369300
Fax: +31(0)222 - 319674

NIOZ Yerseke
Visiting address:
Korringaweg 7
4401 NT Yerseke

Postal address:
P.O. Box 140
4400 AC Yerseke
The Netherlands
Telephone: +31(0)113 - 577417
Fax: +31(0)113 - 573616

The annual report can be ordered free of charge, by preference on an exchange base, from the library of NIOZ Royal Netherlands Institute for Sea Research. It is also available at the NIOZ website www.nioz.nl/annual-report-2012

This Annual Report was produced under the responsibility of the directors
Henk Brinkhuis & Herman Ridderinkhof

Realization:
Marianne Baas, Judith van Bleijswijk,
Eric Epping, Pieterella Luttkhuizen,
Henko de Stigter, Marcel Wernand

Lay-out:
Nelleke Barten-Krijgsman

Interviews:
'Joop Rommets - journalist en tekstschrijver'

Printed by:
Zeeman Reclamegroep, Den Helder

ISSN: 0165-9162

Cover photo:
Lodewijk van Walraven



The mission of NIOZ is to gain and communicate scientific knowledge on seas and oceans for a better understanding and sustainable use of our planet, to manage the national facilities for sea research and to support research and education in the Netherlands and in Europe.