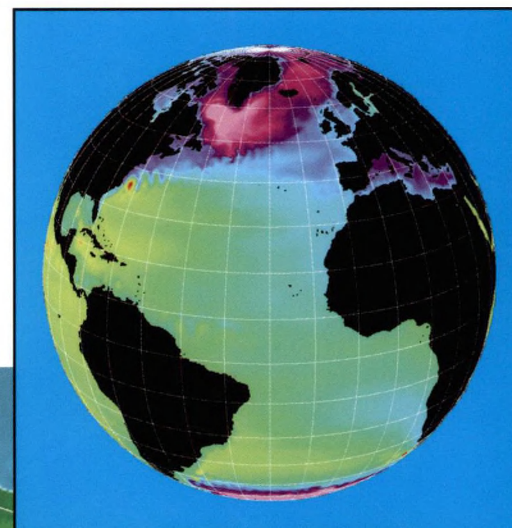
European Global Ocean Observing System

EuroGOOS Publication No. 14

January 2000

BOOS Plan

Baltic Operational Oceanographic System 1999 - 2003



Published by:

EuroGOOS Office, Room 014/12
Southampton Oceanography Centre
Empress Dock, Southampton
SO14 3ZH, UK
Tel: +44 (0)23 8059 6242 or 6262
Fax: +44 (0)23 8059 6399
E-mail: N.Flemming@soc.soton.ac.uk
WWW: http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/eurogoosindex.html

First published 2000

ISBN 0-904175-41-3

To be cited as:
Buch E and H Dahlin (eds) (2000) "The BOOS Plan: Baltic Operational Oceanographic System, 1999-2003". EuroGOOS Publication No. 14, Southampton Oceanography Centre, Southampton. ISBN 0-904175-41-3.

Cover picture

Large image: "A water perspective of Europe", courtesy of Swedish Meteorological and Hydrological Institute. The white lines show the watershed boundaries between the different catchment areas flowing into the regional seas of Europe.

Inset image: Height of the sea surface in the north Atlantic and Arctic simulated by the OCCAM global ocean model, courtesy of David Webb, James Rennell Division, Southampton Oceanography Centre.

BOOS Plan

Baltic Operational Oceanographic System 1999 - 2003

edited by Erik Buch and Hans Dahlin

EuroGOOS Personnel

Chairman	D Tromp	RIKZ, The Netherlands
Officers	E Buch	DMI, Denmark
	H Cattle	Met. Office, UK
	P Marchand	IFREMER, France
	S Vallerga	CNR, Italy
	C Tziavos (Chairman TPWG)	NCMR, Greece
	D Prandle (Chairman SAWG)	POL, UK
Honorary President	J D Woods	
Task Team Chairmen	O Johannessen	Arctic Task Team
	C Le Provost	Atlantic Task Team
	E Buch	Baltic Task Team
	N Pinardi	Mediterranean Task Team
	L Droppert	North West Shelf Task Team
Secretariat	N C Flemming (Director)	Southampton Oceanography Centre, UK
	J Fischer (Deputy Director)	University of Kiel, Germany
	S M Marine (Secretary)	Southampton Oceanography Centre, UK

Existing or forthcoming EuroGOOS Publications:

1.	Strategy for EuroGOOS 1996	ISBN 0-904175-22-7
2.	EuroGOOS Annual Report 1996	ISBN 0-904175-25-1
3.	The EuroGOOS Plan 1997	ISBN 0-904175-26-X
4.	The EuroGOOS Marine Technology Survey	ISBN 0-904175-29-4
5.	The EuroGOOS brochure, 1997	
6.	The Science Base of EuroGOOS	ISBN 0-90417530-8
7.	Proceedings of the Hague Conference, 1997, Elsevier	ISBN 0-444-82892-3
8.	The EuroGOOS Extended Plan	ISBN 0-904175-32-4
9.	EuroGOOS Atlantic Workshop report	ISBN 0-904175-33-2
10.	EuroGOOS Annual Report, 1997	ISBN 0-904175-34-0
11.	Mediterranean Forecasting System report	ISBN 0-904175-35-9
12.	Requirements Survey analysis	ISBN 0-904175-36-7
13.	The EuroGOOS Technology Plan Working Group Report	ISBN 0-904175-37-5
14.	The BOOS Plan: Baltic Operational Oceanographic System, 1999-2003	ISBN 0-904175-41-3

BOOS Members

- Bundesamt für Seeschiffahrt und Hydrographie (BSH), Germany
- Centre of Marine Research (CMR), Lithuania
- Danish Meteorological Institute (DMI), Denmark
- Danish Hydraulic Institute (DHI), Denmark
- Estonian Marine Institute (EMI), Estonia
- Finnish Institute of Marine Research (FIMR), Finland
- Finnish Environmental Agency (FEA), Finland
- Institute of Meteorology and Water Management (IMWM), Poland
- Institute of Oceanology (IO), Poland
- Institute fur Ostseeforschung Warnemunde(IOW), Germany
- Maritime Institute Gdansk (MIG), Poland
- Royal Danish Administration of Navigation and Hydrography (RDANH), Denmark
- Sea Fisheries Institute (SFI), Poland
- Swedish Meteorological and Hydrological Institute (SMHI), Sweden
- University of Gdansk (UG), Poland
- University of Latvia (UL), Latvia
- Warsaw University of Technology (WUT), Poland

For Members' addresses see Annexe 3

Contents

Executive Summary

An operational oceanographic service to the marine industry in the Baltic region will contribute to and improve the efficiency of marine operations, reduce the risk of accidents, optimise the monitoring of the marine environment, and climate, improve the assessment of fish stocks and improve the foundation of public marine management.

An operational oceanographic service supporting these activities shall primarily focus on observations, analysis and model predictions for water level, waves, currents, temperature, salinity, sea ice, oxygen, nutrients, algae, and chlorophyll.

Surrounded by nine countries - Germany, Poland Lithuania, Latvia, Estonia, Russia, Finland, Sweden and Denmark - the Baltic Sea is a very complex structure. The inhabitants of most of these countries live in the coastal area and have easy access to the sea. Historically their societies have been forged by the marine industries in fishing, shipping and ship building. In recent years also recreation for tourists from all Europe has become an increasingly important business. For natural reasons utilisation of the marine resources and the threat to the marine environment have always been easily noticeable.

Operational oceanography includes the routine collection, interpretation and presentation of data from the ocean and atmosphere to:

- Give a reliable description of the actual conditions of the sea including its living resources
- Provide prognoses for the future development of the conditions in the sea
- Establish a marine database from which time series and statistical analysis can be obtained for descriptions of trends and changes in the marine environment, including consequences for the living conditions in, on and around the sea

The Baltic Operational Oceanographic System - BOOS - constitutes a close co-operation between national governmental agencies in the countries surrounding the Baltic Sea responsible for collection of observations, model operations and production of forecasts, services and information for the marine industry, the public and other end users.

The goals of BOOS are to:

- Improve and further establish services to meet the requirements of environmental and maritime user groups
- Co-ordinate, improve and harmonise observation and information systems, where necessary
- Increase the quality of and harmonise user-oriented operational products
- Decrease the production costs of public products and services by sharing the workload
- Co-operate with HELCOM and other relevant bodies with the aim to avoid duplication of work and to maximise mutual assistance
- Identify new customers for operational oceanographic products
- Further develop the market for operational oceanographic products
- Develop BOOS pursuant to the GOOS Principles
- Provide high quality data and long time series required to advance the scientific understanding of the Baltic Sea
- Provide data and forecasts to protect the marine environment, conserve biodiversity, and monitor climate change and variability

BOOS is being built on existing systems and will develop mainly through commitments from the participating agencies. Already at present most of the components for an operational system are available within national or international programmes. The main tasks for BOOS will be to co-ordinate activities, develop coupling and interfaces between models, develop operational and technically compatible routines, optimise the scientific design of the sampling system in terms of observing strategy and quality control, improve components and harmonise products based on user requirements and economic assessments. These are complex technical matters requiring the application of new technology and science.

Operational system components exist today but mainly as separate and parallel systems duplicated between the nations. To meet present user requirements both geographical coverage of the products and regular products on different levels of data aggregation are lacking. Today most oceanographic products are produced in a classical academic way which means that they are mostly highly sophisticated, but not available when needed and seldom very user friendly.

The premier task for the 5 year period 1999 - 2003 therefore is to integrate the existing systems into a uniform entity in order to meet the users' demands for a high quality operational oceanographic service and to minimise the production costs. BOOS will be implemented by the accomplishment of in total nine projects:

- Optimising Existing Operational Observing Network
- Use of Remotely Sensed Data (Radar, Satellite)
- Operational Mesoscale Analysis System - PRODAS
- Optimisation of Existing Models and two-way Coupling of Models
- Ecological Modelling
- Harmful Algae Blooms - HABWARN
- Anthropogenic Load Model
- Current Assessment of the State of the Baltic Environment
- Info-BOOS

These projects focus on using and scientifically optimising the existing facilities and improving observations and modelling. This includes:

- Co-ordination of existing observation facilities supplemented with identification and establishment of additional observations sites needed to optimise models
- Establishment of an efficient system for free exchange of data within the participating institutions, including agreements on formats and data quality
- Improvement of the forecast capabilities by optimising and coupling existing atmospheric - ice and ocean models combined with an operational mesoscale analysis system and development and operationalisation of local and special product models
- Establishment of an information system that rapidly distributes the required products to the users

BOOS will additionally rely on technological developments achieved in a number of projects initiated by EuroGOOS such as the Ferry Box and anti-fouling projects, and BOOS will offer to test new developed instrumentation relevant to BOOS in co-operation with the developers.

1 Introduction

A significant part of world economic activity and a wide range of services, amenities and social benefits depend upon efficient management of human use of the sea (Hempel, 1995; Woods et al., 1996; Soares et al., 1998; Agenda 21, 1992). The Global Ocean Observing System (GOOS) was created in 1991 in response to the desire of many nations to improve forecasts of climate change, management of marine resources, to mitigate natural hazards and improve utilisation and environmental protection in the coastal zone (IOC, 1998). For many countries marine resources and services provide 3-5% of their Gross National Product - for a few much higher (OECD 1994; Pugh and Skinner, 1996; IFREMER, 1997).

Direct beneficiaries of the services produced by GOOS are the managers of coastal defences, ports and harbours, coastal civil engineering, fisheries and fish farming, shell fish farming, shipping and ship routing, the offshore oil and gas industry, cable and pipe-laying, recreation and tourism. Indirect beneficiaries, through improved forecasting of seasonal and multi-year climate variability based on ocean observations, include agriculture and food production, and the management of energy, fresh water and public health (Stel et al., 1997; Flemming, 1999; Weiher, 1999).

Predictions and information products will include the physical factors such as storms, currents, ice, waves as well as living resources, health of the oceanic ecosystem, coastal erosion and flooding. Implementation of the GOOS relies upon exploiting the existing level of scientific knowledge as rapidly as possible, while pursuing in parallel further research which will be needed for GOOS to reach its maximum efficiency and usefulness.

The GOOS Prospectus 1998 shows that GOOS is achievable on a reasonable time scale, and will start to produce products very quickly, that the products will continue to improve in scope, geographical coverage and value, and that this can be achieved by logical and progressive development from the present state of science and operational services. Economic analysis suggests that the costs and benefits of the GOOS are likely to be similar to those of the World Weather Watch, the successful system that underpins all weather forecasting.

The legal basis for proceeding with GOOS is defined by various international conventions and Action Plans, including the Convention on the law of the Sea; the Framework Convention on Climate Change; the Biodiversity Convention; Agenda 21 (agreed at the United Nations Conference on Environment and Development in Rio in 1992); Towards an Agenda 21 for the Baltic Sea Region (signed by the Heads of Governments of Baltic Sea States); the Global Plan for Protection of the Marine Environment from Land-Based Activities; the London Dumping Convention; the Agreement on Highly Migratory and Stradling Stocks, and others. The information provided by GOOS will be needed by governments to meet their obligations under these Conventions, and to comply with EU Directives on water quality, public health, and safety.

The Baltic Sea has been nominated "a demonstrations area" under EuroGOOS - the European component of GOOS.

In the present document the implementation plan for the period 1999 - 2003 of a Baltic Operational Oceanographic System (BOOS) is outlined. The plan is under continuous revision for which reason the present version reflects the state of the BOOS planning ultimo 1999.

2 Background

2.1 Ocean Dynamics

The Baltic Sea is an almost totally enclosed ocean area whose only connection to the open ocean is the narrow and shallow Danish Straits. The combination of a large drainage area imposing a massive fresh water input and shallow sill depths - maximum 18 m - makes the Baltic Sea the largest brackish water area in the world with salinities varying from almost zero in the innermost parts of the Baltic to 10-12 psu close to the sills.

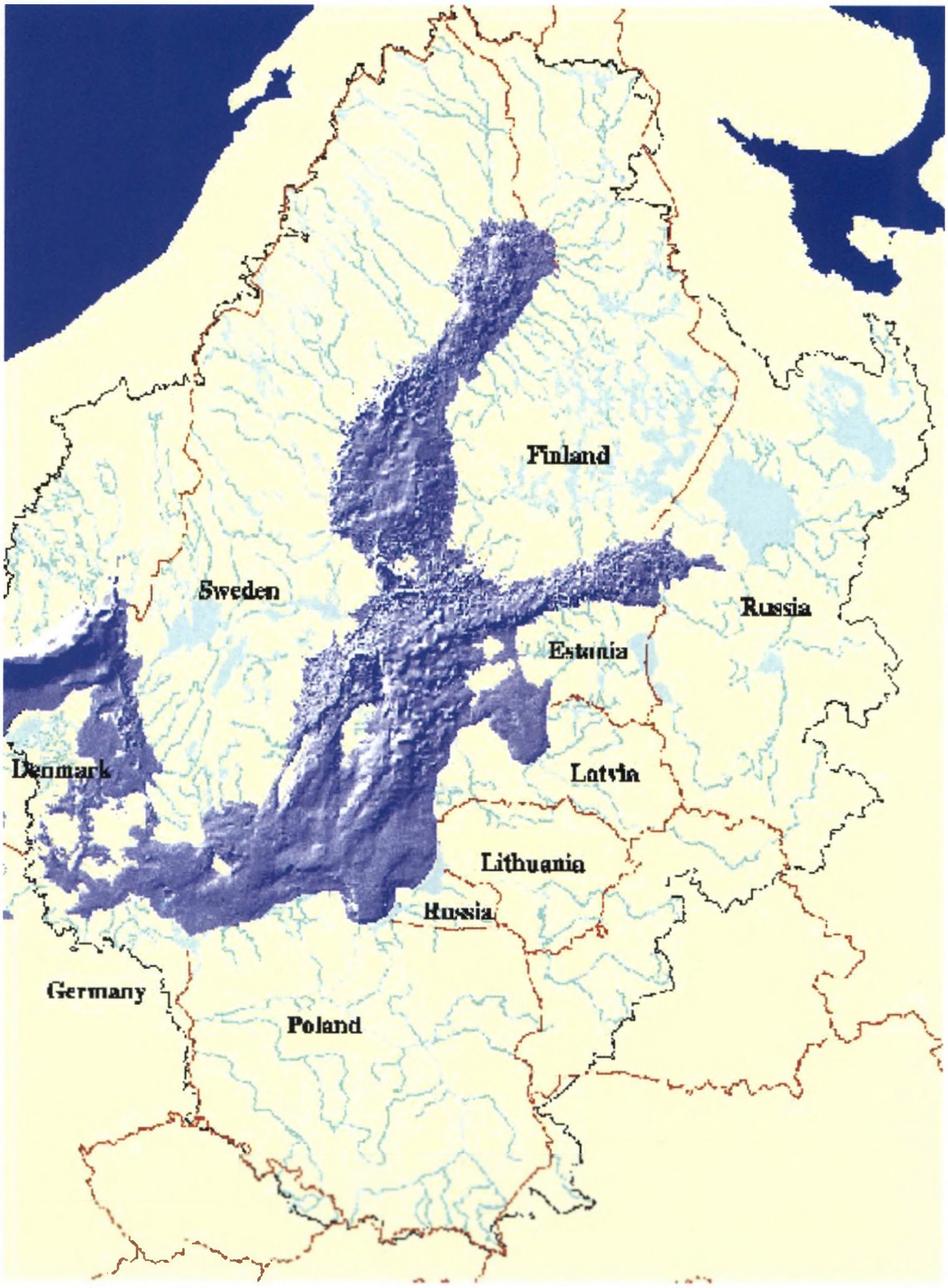


Figure 1. Baltic Sea area (Bottom topography, drainage basins, and political borders)

The shallow sill depths put strong limitations on the exchange of water between the Baltic Sea and the open ocean resulting in infrequent renewals of the Baltic Deep Water for which reason anoxic conditions often are experienced at great depth in the inner basins of the Baltic. For this reason there exists a very sensitive environmental balance in the Baltic Sea where even small changes may have a tremendous impact on the environment and thereby on the biota existing there - which very often are stressed to the verge of their capacity (Fonselius, 1995).

The large scale circulation in the Baltic depends on three factors: bottom conditions, water exchange with the North Sea and the supply of fresh water from land. Schematically, the circulation consists of a surface current with brackish water which flows out of the Baltic through Kattegat to the Skagerrak and the North Sea, and a current in deeper layers with more saline water going in the opposite direction. The fresh water largely comes from rivers in the drainage area of the Baltic, an area which is several times larger than the sea itself. Direct precipitation on the sea surface is almost entirely balanced during the year by evaporation (Brutsaert, 1982; Isemer, 1995).

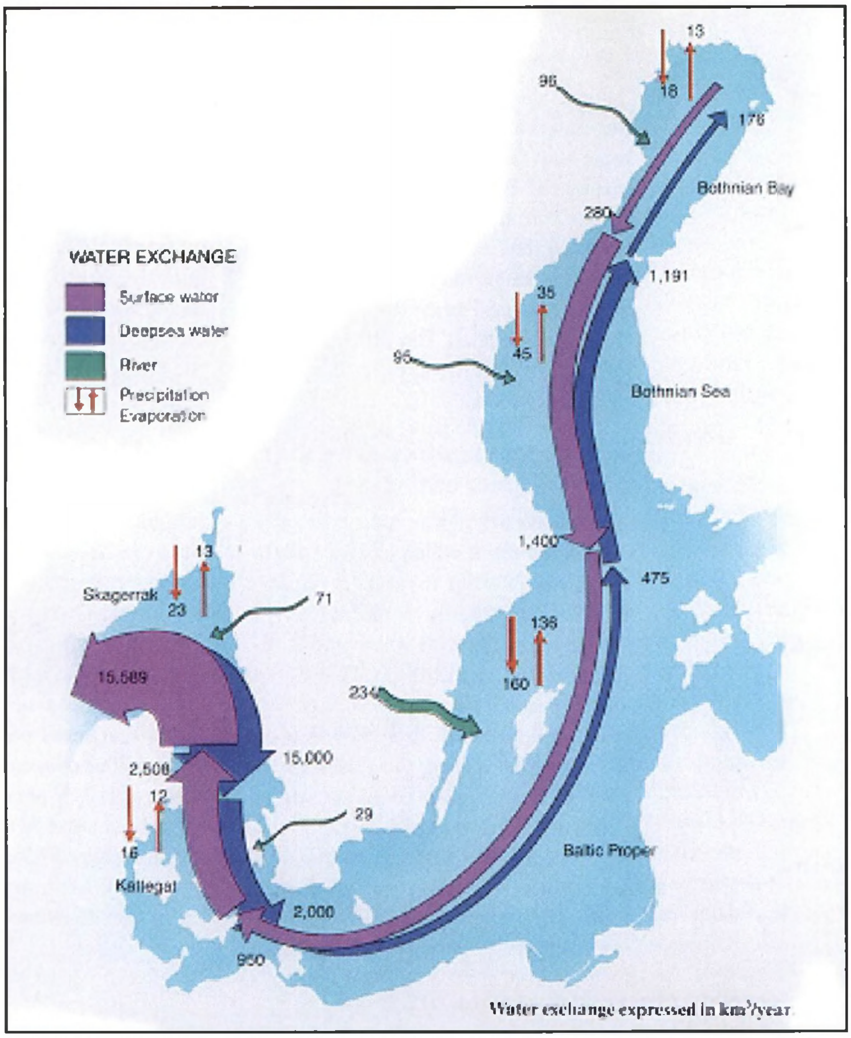


Figure 2. Water exchanges in the Baltic in km^3/year. Note that the river inputs are only shown for the Swedish coast. The Evaporation/Precipitation arrows refer to the sea areas within the Swedish sector of the Baltic. The exchanges through the Straits, and the Baltic water flows inwards and outwards, are shown for the whole Baltic (from National Atlas of Sweden).

The inflow of fresh water to the Baltic may be described as the engine which drives the large scale circulation. The inflow generally causes a higher water level in the Baltic than in Kattegat and Skagerrak. This difference in water level forces the brackish surface water out of the Baltic. On its way to the Skagerrak the brackish water becomes increasingly saline since the surface water mixes with the underlying water. In order to replace the water entrained into the surface current an undercurrent of more saline water is formed which runs through the Kattegat and further down into the deeps of the Baltic.

The Sound, the Belt Sea and Kattegat together make up the shallow sill area which restricts the exchange of water between the Baltic and the Skagerrak and it is here that most of the mixing takes place between Baltic water and the saltier water from Skagerrak.

Having passed the shallow sills the saltier, heavier Kattegat water spreads out into the Baltic close to the bottom along a number of channels and at the same time it becomes mixed with surrounding brackish water and increases in volume. Mainly as a result of mixing by the wind, the surface layer has an almost homogeneous salinity. A halocline separates this water from the more continuously stratified deep water. The halocline limits the turbulence and decreases the vertical mixing. Finally, the inflowing water is stratified at the level which corresponds to the density obtained by the bottom current as a result of being mixed with the surrounding water.

When meteorological factors are favourable, large inflows of salty Kattegat water take place which are able to displace the water masses present in the deepest basins (Fonselius, 1995). Between these events salinity slowly decreases in deeper areas as a result of vertical mixing. These stagnation periods have a strong influence on the oxygen and nutrient situation in the Baltic. The rate of turnover of water in the various basins can be estimated by calculating the flows between different sub-basins on the basis of volume and salt balance. The turnover time for the entire water volume of the Baltic is 25 - 35 years. Thus, pollutants entering the Baltic will remain in the system for a long time (Sjöberg, 1992). In the Kattegat and Skagerrak the turnover time amounts to a few months.

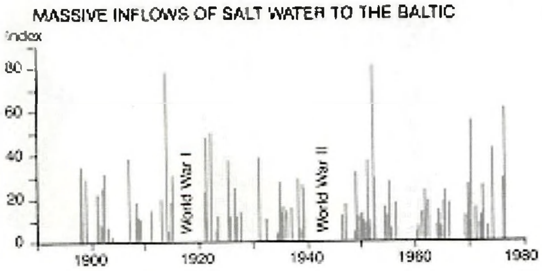


Figure 3. *The size of the inflows is characterised by an index based on the duration and mean salinity. High values represent large inflows (from National Atlas of Sweden)*

The temperature conditions in the surface layer show large annual and inter-annual variations. In summer surface temperatures reach values of 16 - 20°C, while during the winter, the surface water is cooled so much that ice may form. However, the extent of sea ice varies widely from year to year depending on mild or cold weather. The first ice starts to appear in the innermost bays of the Bothnian Bay during mid-November. During a normal winter, the entire Bothnian Sea, Sea of Åland, Gulf of Finland and the northernmost part of the Baltic are also covered with ice. During severe ice winters, also large parts of the Baltic, the Belt Sea, the Sound, Kattegat and even parts of Skagerrak are ice covered. The ice moves with the currents and the wind and becomes compacted mainly along the coast (Sjöberg, 1992; Seina and Palosuo, 1993, Lepparanta, 1998).

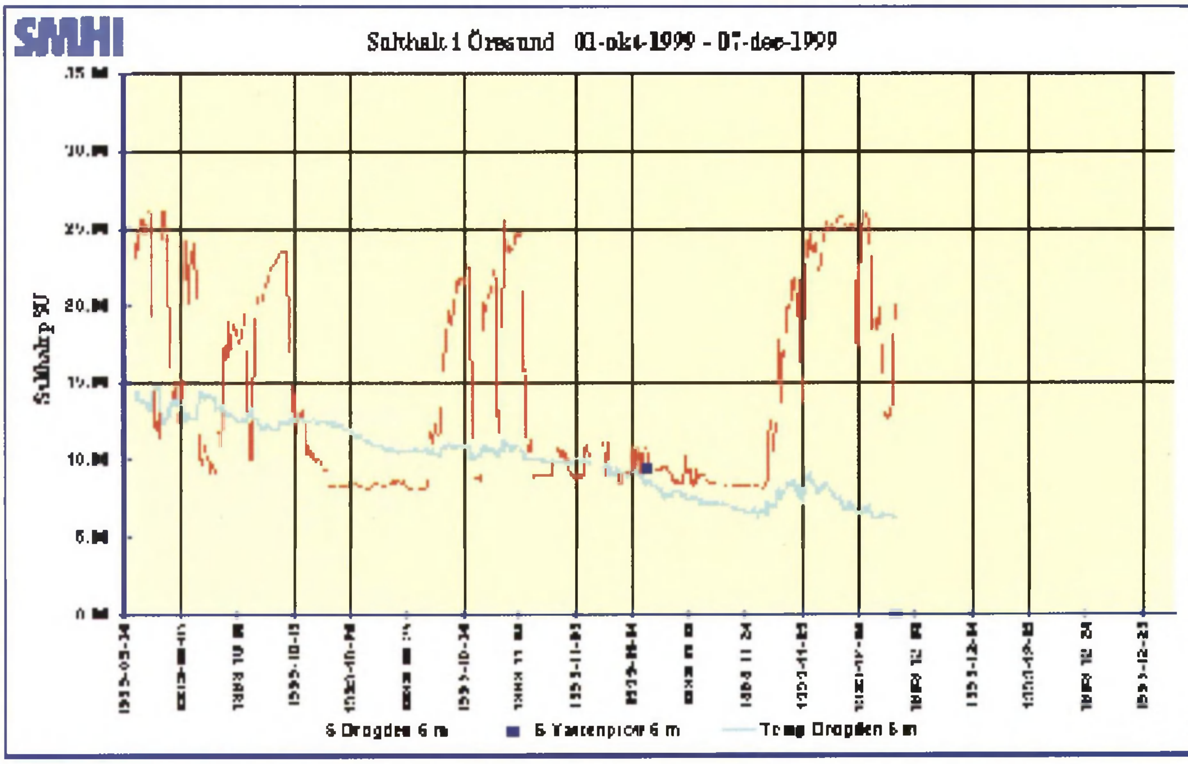


Figure 4. *Transport through the Öresund. Time series (1 October - 7 December 1999) of temperature and salinity at 6 m depth observed at the Drogden Lighthouse in the southern part of the Sound. Real-time updates are available on the SMHI homepage*

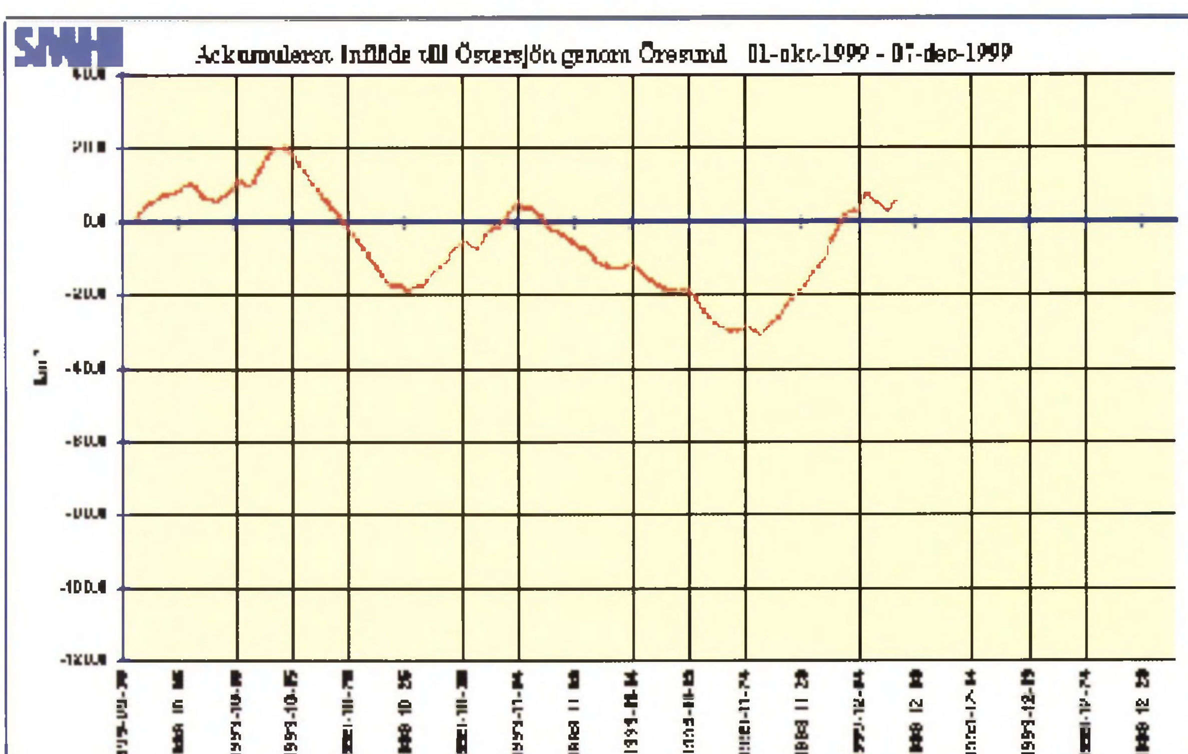


Figure 5. *Accumulated inflow of water to the Baltic Sea during the period 1 October - 7 December 1999. Real-time updates are available on the SMHI homepage (http://www.smhi.se/)*

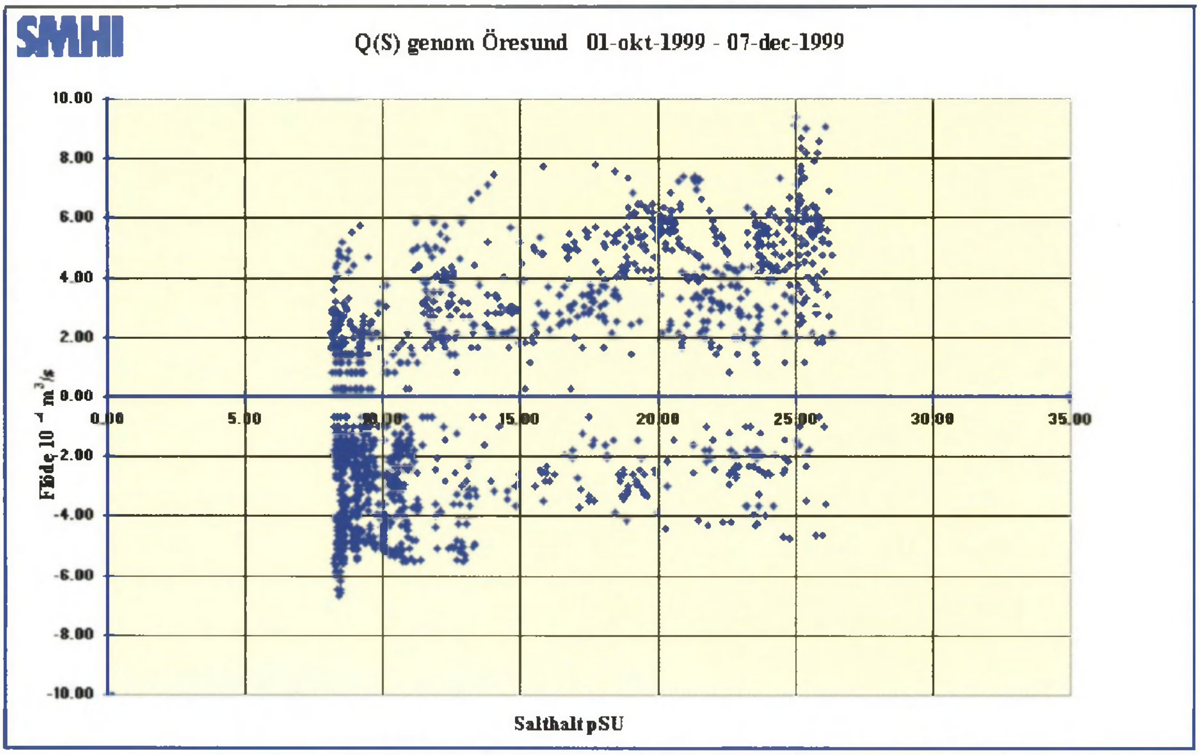


Figure 6. *Volume transport (10^4 m^3/s) versus salinity of water flowing in and out of the Baltic Sea during the period 1 October - 7 December 1999. Positive values of Q_s means inflow while negative values means outflow. Real-time updates are available on the SMHI homepage*

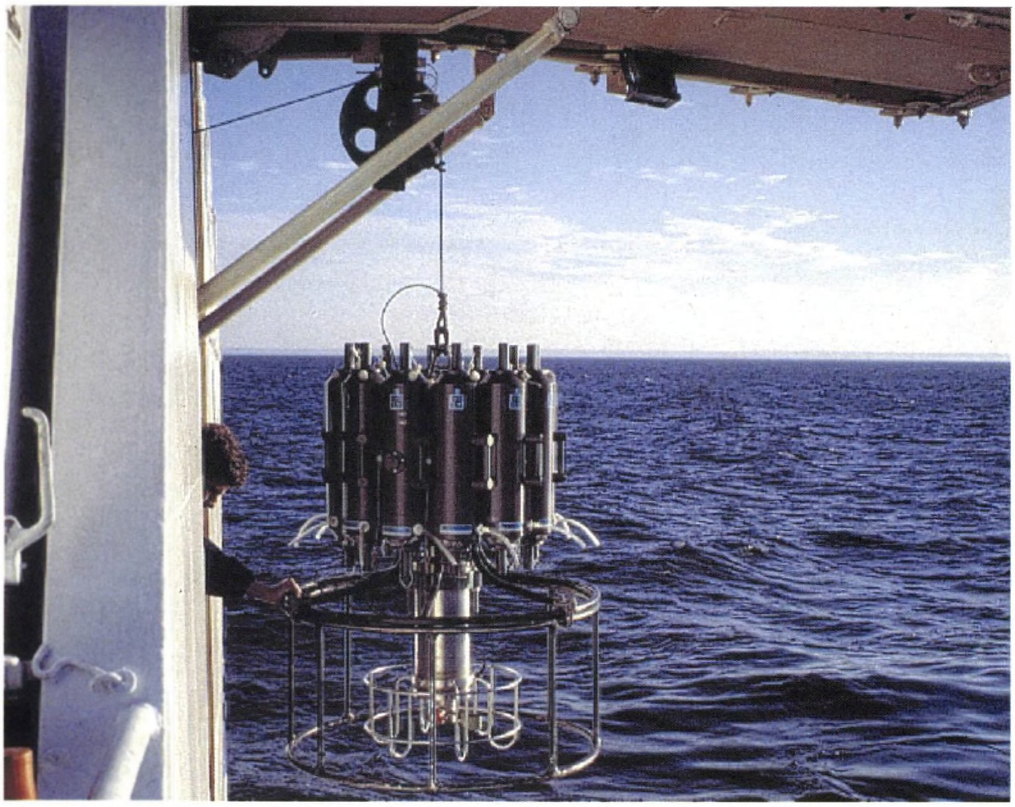


Figure 7. *Environmental monitoring off Poland, showing use of CTD and rosette of water sample bottles*

The Baltic Sea is almost tideless but frequent passages of atmospheric pressure systems cause changes in air pressure and wind forcing that generate water level fluctuations within the Baltic Sea of up to ± 1 m, extremes up to ± 2m. Additionally the passage of strong atmospheric pressure systems may cause water level differences between Kattegat and the western Baltic Sea of 0.8 to 1 m which results in very strong barotropic currents through the Danish Straits reaching maximum current velocities of 4-5 m/s (Fonselius, 1995; Sjöberg, 1992; Kowalewska-Kalkowska, 1998).

Figure 8. During strong winds the water along the coasts rises leading to flooding at exposed places (from National Atlas of Sweden).

Although the fetch in the Baltic is too short for the development of extreme waves, rough weather with high waves and strong wind is believed to have caused several severe accidents. Significant wave heights of 8 meters with individual waves above 10 meters have been measured during wintertime at some locations but interfering and topographically focused waves are believed to have caused the accidents.

Oxygen is necessary for all higher organisms in the sea. When there is a lack of oxygen, then hydrogen sulphide occurs, which is poisonous to all higher organisms and its occurrence results in sea bed mortality.

Oxygen enters the surface water through uptake from the atmosphere and through the photosynthesis of phytoplankton and other algae. During periods with low primary production or high oxygen consumption as a result of respiration and degradation of organic material such as dead algae, decaying faecal matter, etc. the supply from the atmosphere will be of greater importance. In deep water, where no light penetrates, photosynthesis cannot take place, for which reason oxygen is consumed by bacterial degradation of the organic material which "rains" down from the surface water. Consequently, oxygen concentrations in the deep water are lower than those in the surface layer. The factors decisive for oxygen conditions in deep waters are water turnover, vertical mixing and the amount of organic material supplied from surface water (HELCOM, 1996a). Many species find it difficult to survive and reproduce already when oxygen concentrations have dropped down to about 2 ml/l.

In Skagerrak and northern Kattegat there is more or less permanent halocline which prevents vertical mixing between surface and deep layers of water. However, this has only a marginal effect on oxygen concentrations owing to the intensive exchange of water with the North Sea and the large volume of water in relation to the organic material supplied. Nonetheless, the oxygen concentrations may locally decrease during summer and autumn in areas close to the coast where the organic load is generally larger and the water exchange poorer (Sjöberg, 1992). The oxygen conditions in the southern Kattegat and the Baltic proper may be compared with those prevailing in fjords i.e. poorer water exchange and smaller volume of deep water combined with a strong halocline and a heavy load cause oxygen deficiency in extensive areas. This mainly concerns deep areas of the Baltic to the east of Gotland. In these areas, the deep water below depths of 100-130m is rarely replaced and may remain stagnant for 10 years or more. In 1990, the deep water to the east of Gotland had not been oxygenised for 13 years which has resulted in extensive areas with dead bottom and hydrogen sulphide corresponding to 10-15% of the Baltic's area (which is 3-6% of the Baltic's volume) (Fonselius, 1995). Long periods of stagnation start with a strong turnover of water. On such occasions the bottom water is replaced by more saline, oxygen rich water from the Skagerrak and a strong halocline is established which prevents further water exchange for a long period.

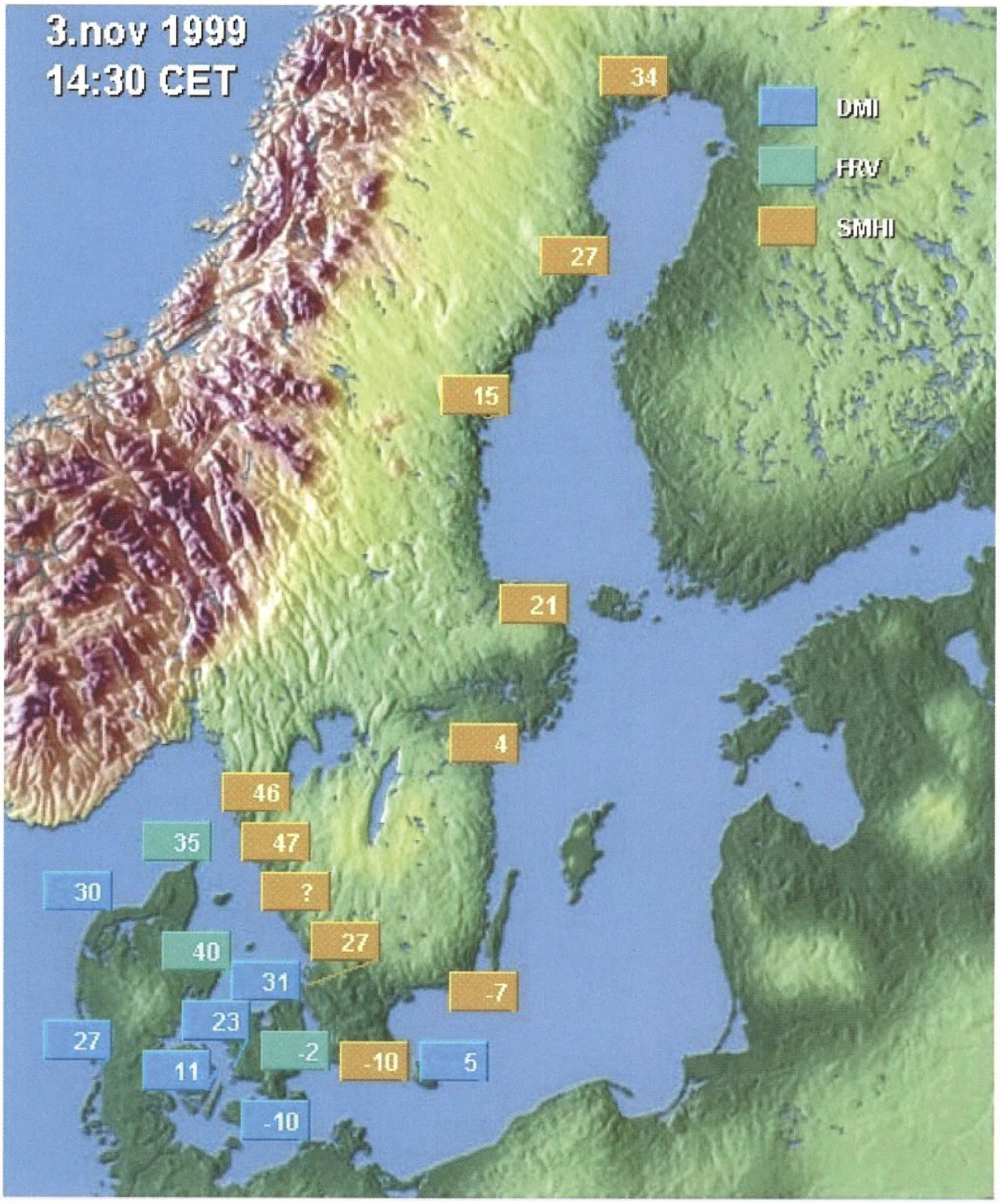


Figure 9. Real time presentation of water levels in the Baltic Sea on the BOOS homepage ***www.boos.org.*** *This homepage is updated every 30 minutes and data more than 1 hour old is not shown.*

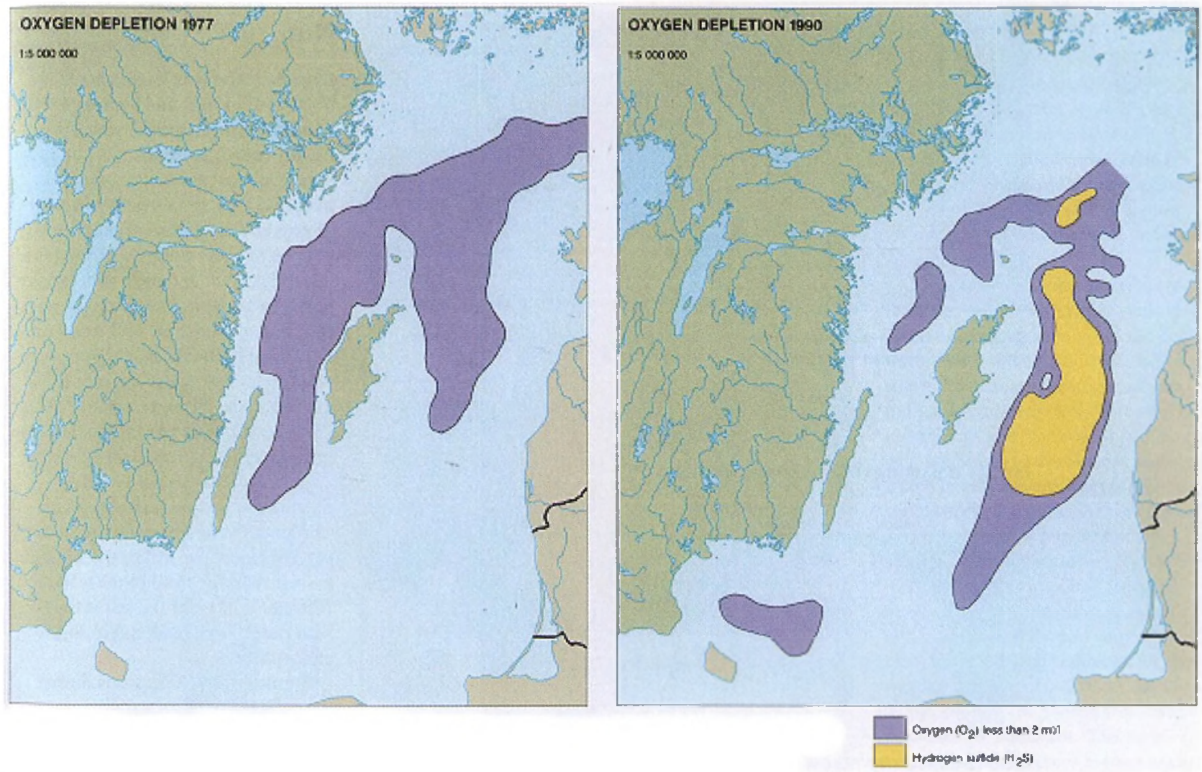


Figure 10a. Distribution areas of seabed oxygen deficiency in central parts of the Baltic, winter 1977 and winter 1990, (from National Atlas of Sweden).

Figure 10b. Oxygen depletion in Kattegat in 1990 (from National Atlas of Sweden)

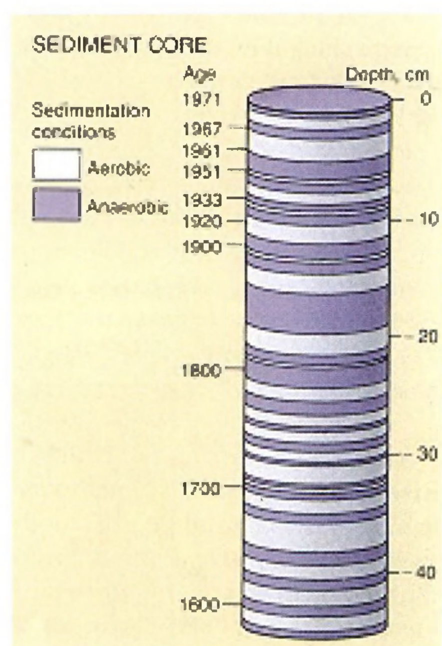


Figure 10c. Samples show that oxygen deficiencies occur regularly in the Baltic Sea (from National Atlas of Sweden).

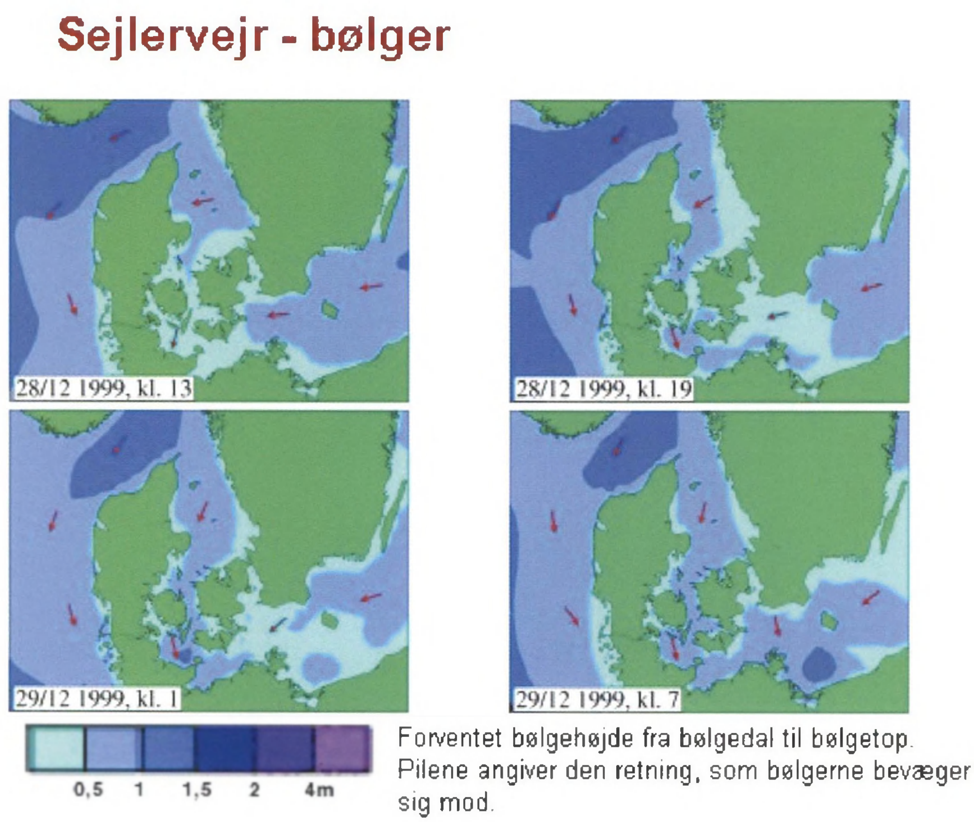


Figure 11. Wave forecasts for the Danish waters. Forecast for every 6 hours, one day ahead are available on the DMI homepage

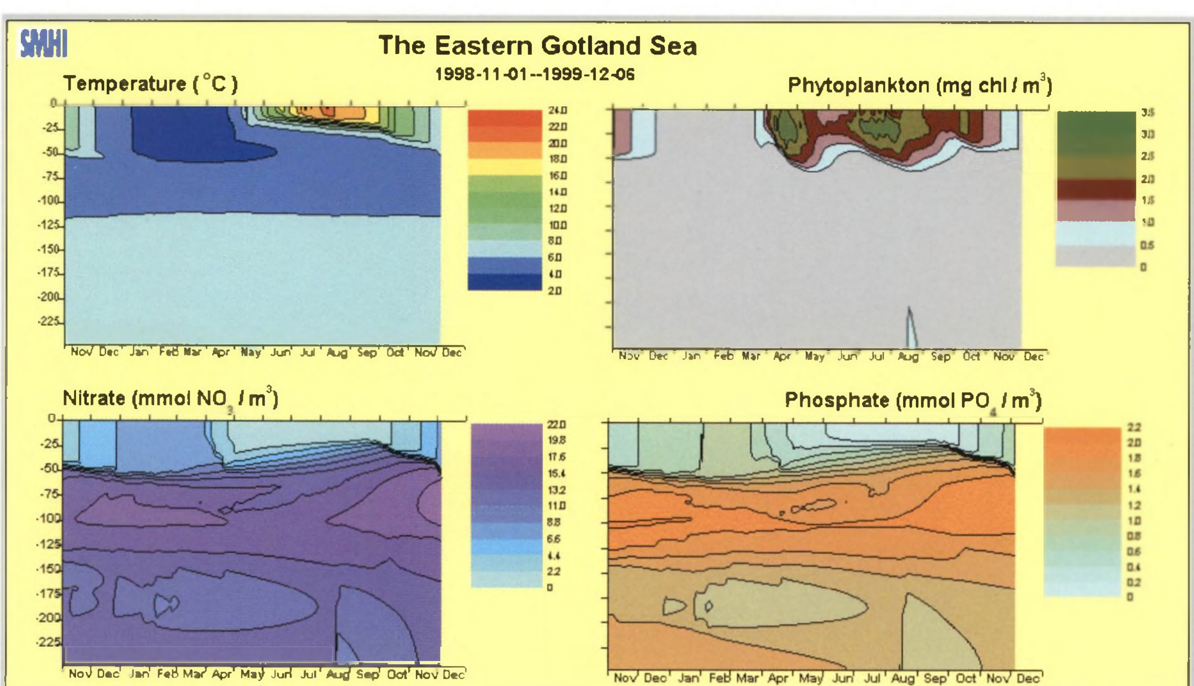


Figure 12. Time series based on model calculations showing the distribution of temperature, phytoplankton, nitrate and phosphate in the upper 100 metres of the Gotland Basin. Real-time updates are available on the SMHI homepage

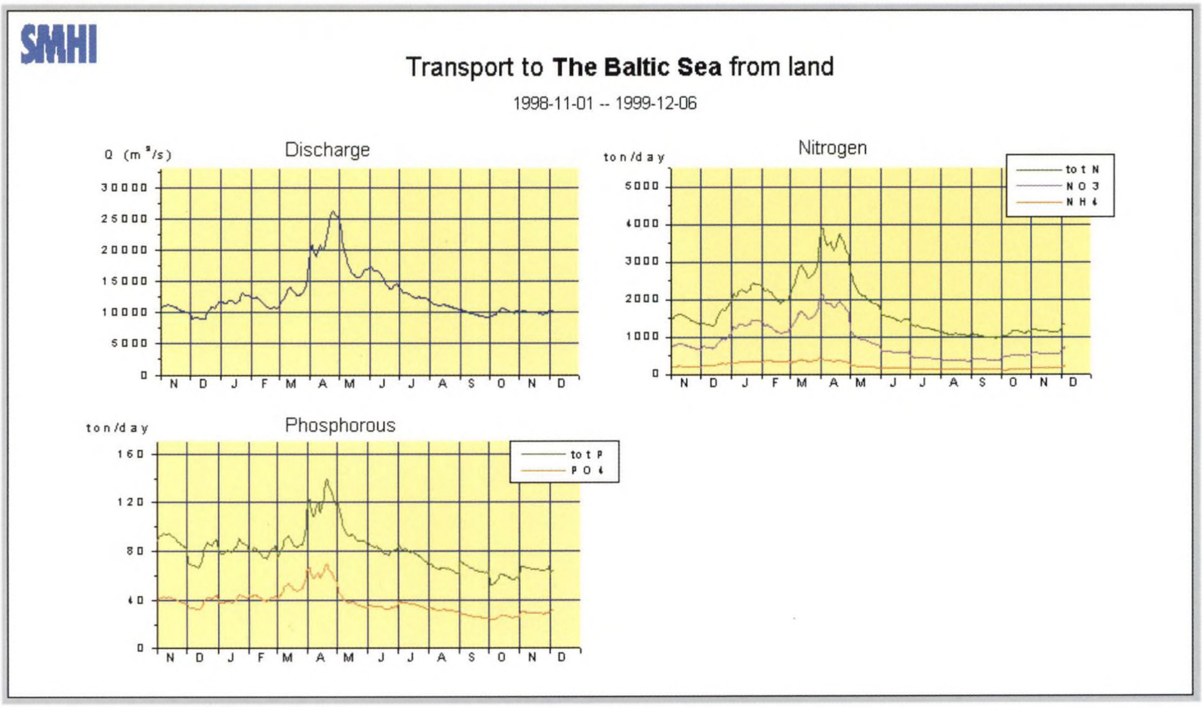


Figure 13. Model estimates of water and nutrient transports to the Baltic Sea from land. Real-time updates are available on the SMHI homepage

Figure 14. Polish research vessel "BALTICA".

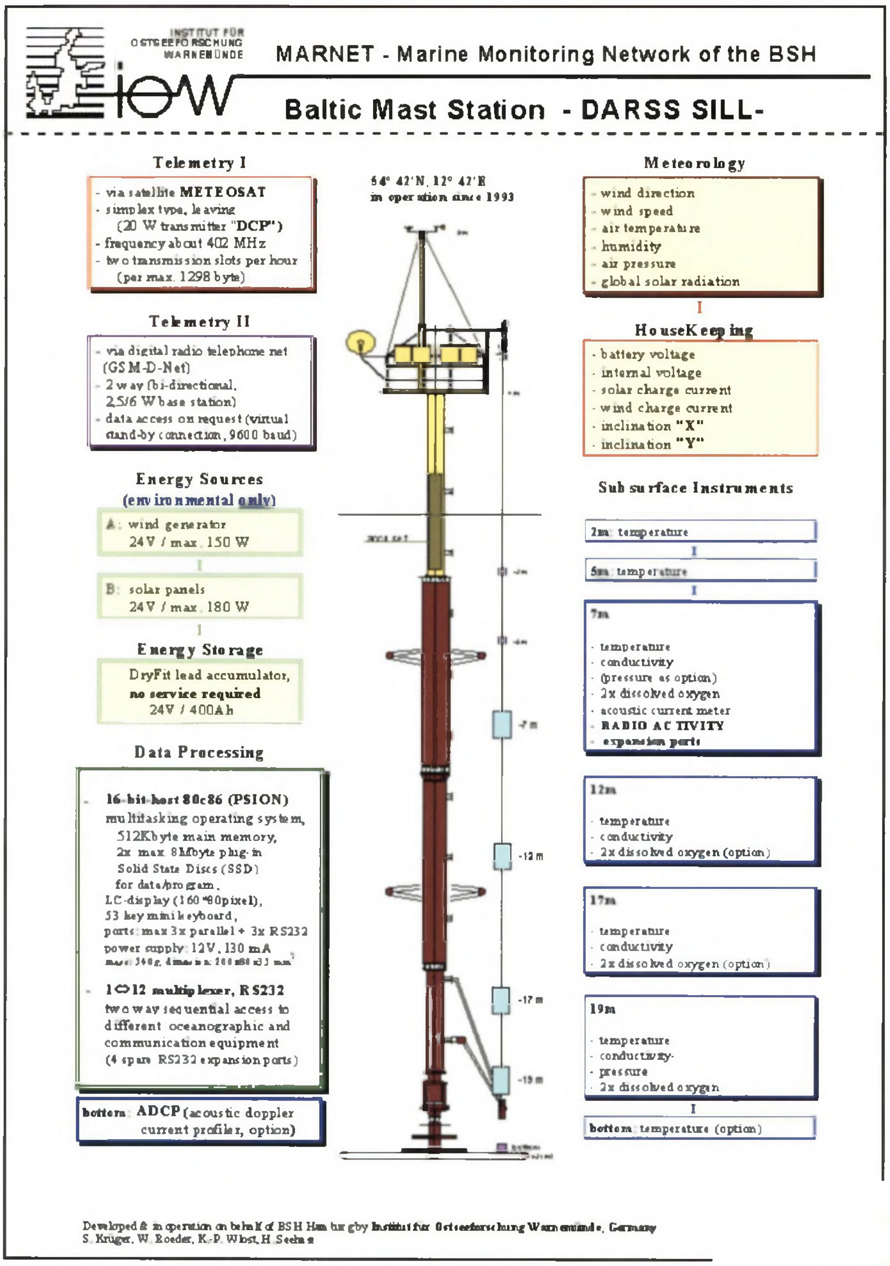


Figure 15. *Institute of Baltic Sea Research, Warnemünde operates fixed monitoring stations in the Baltic Sea. These stations will extend the German Fixed Monitoring Network with on-line satellite data transmission to the central data base on shore. These stations are important to the permanent observation of the water exchange between the Baltic Sea and the North Sea, as well as the exchange between different shallow basins and the central Baltic*

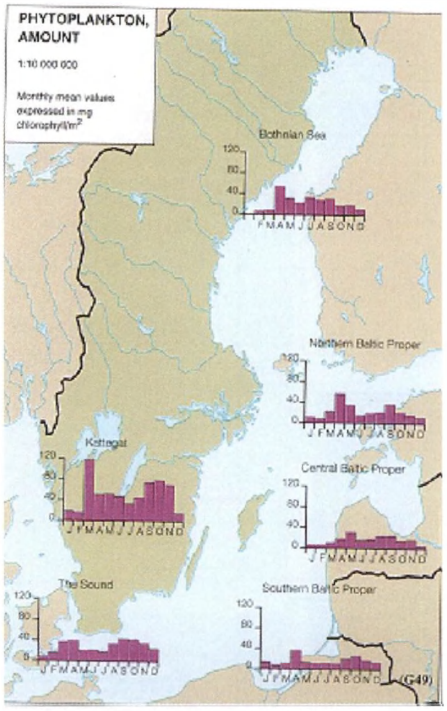


Figure 16. Phytoplankton amount (from National Atlas of Sweden)

Nutrients must be present for all new production of organic material; lack of nutrients will limit growth and may cause primary production to cease completely. The two most important and most widespread nutrients are phosphorus and nitrogen. Nitrogen occurs both in organically bound and inorganic compounds - nitrate, nitrite and ammonium; phosphorus is only found as organic compounds and phosphate.

The biological pump implies the role of marine organisms in the circulation of certain elements of the sea and by means of the interfaces between the sea and the atmosphere and between the sea and the sediments on the sea floor. The route taken by carbon through photosynthesis and biological circulation to carbon dioxide, water and different organic degradations products is remarkably effective. Some of this material is recirculated in the upper layers of the sea whereas another part is brought down to great depths to be either deposited on bottoms or slowly returned to the surface layers.

The science of the mutual relationships of organisms, including the relationship with ambient physical-chemical-geological environment is called ecology. Organisms depend upon each other, since some are producers capable of converting light energy or chemical energy into organic material, whereas others are consumers. These consumers obtain their nutrition by eating other organisms or degradation products of such organisms. The relationships between organisms are frequently complex and drawings can be made of them as models in food chains, in complicated food webs or in simpler ecosystem models. In these models, other factors may be included, e.g. energy sources, nutrients, water movements in form of up- or down-welling, migration of fish and different types of sea floors. The important role of bacteria and very small organisms in the energy turnover in the water mass and on the bottom has only been realised during the past one-two decades. Ecological modelling of the Baltic therefore involves intensive research activities to interlink and understand the special physical, chemical, biological and geological processes characterising the Baltic Sea.

Figure 17. Bongo net for collection of plankton samples

With a large drainage area inhabited by about 85 million people, a strong anthropogenic pressure is put on the Baltic Sea, since industry, agriculture and forestry generally are highly developed in most of the surrounding countries. There is therefore a continuous need to monitor, restrict and reduce discharges of pollutants (HELCOM, 1998a).

2.2 Marine Industry

In the Baltic the marine industries fishing, shipping and ship building have been a feature of the history and livelihood of the coastal areas for hundreds of years. For natural reasons, contact with the sea has been, and still is, concentrated in marine areas close to the coast. It is also in such areas that pressure on the utilisation of marine resources and the threat to the marine environment is most noticeable.

Marine resources are usually grouped according to different ways of utilising the sea. Resources which mainly come to mind are fish, the sea as a means of transportation, and seabed resources. The international Convention on the Law of the Sea gives a much more detailed account of ways of utilising the marine resources and lists them under the following main sectors:

- Food production
- Extraction of minerals
- Energy exploitation
- Transport
- Military use
- Use of water areas for effluents
- Outdoor recreation
- Marine historical preservation
- Marine nature conservancy
- Building activities
- Research and technical development

Interest in the sea and its resources has grown considerably following the introduction of the International Convention of the Law of the Sea in 1982. Future development in the marine sector may be expected to lead to increased utilisation of marine resources depending on how technology develops etc. In turn, this is linked to economic and social development in different parts of the region.

The marine industry has always been an integrated and well-established part of business community in the countries surrounding the Baltic Sea. Comments on the most important industries follow.

2.2.1 Transport

For centuries internal transport related to trade between the individual countries has been an important business in the Baltic and so has transport related to trade with the world outside the Baltic Sea. The internal maritime transport still plays an essential role in the exchange of goods and people between the Baltic countries. Over 500 million tons of marine cargo are transported in the Baltic annually.

All external transport has to pass through the narrow and shallow Danish straits. Recent statistics collected by the Danish Navy on the maritime traffic through the Danish straits show a slight increase in the traffic over the recent years (Fig. 18).

In the Gulf of Finland prognoses made by the Finnish Environmental Institute show that the maritime traffic will increase drastically in the coming years due to increased oil export from Russia (Fig. 19).

This trend places high demands on all systems that contribute to navigational safety in so much that:

- The fairway shall be well mapped
- The fairway shall be well marked with lighthouses and buoys
- A variety of radio navigation systems shall always be operational
- Well educated pilots shall be available

In addition to these traditional navigational aids, real-time data and forecasts of oceanographic parameters such as: water level, current velocity and direction, waves, sea ice, buoyancy and wind speed and direction are required by captains and pilots in order to secure a safe voyage of ship, cargo and crew.

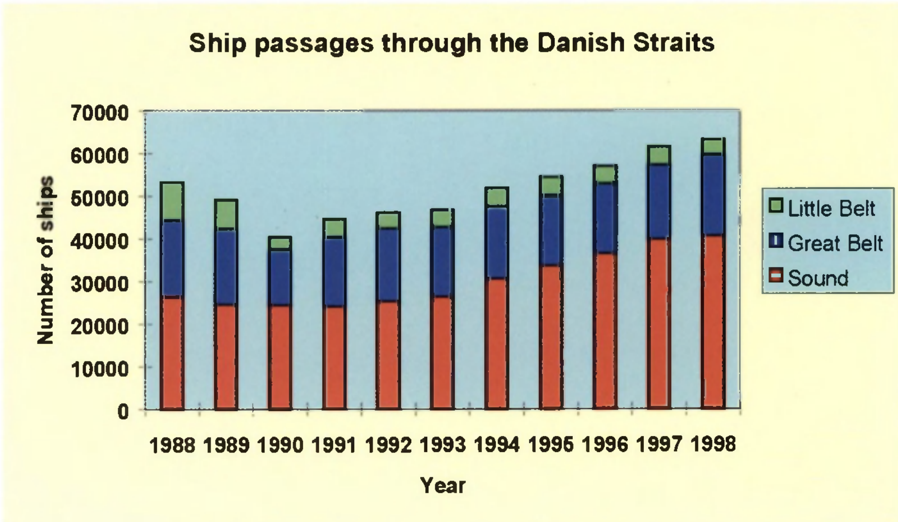


Figure 18. Statistics collected by the Danish Navy on ship passages through the Danish Straits

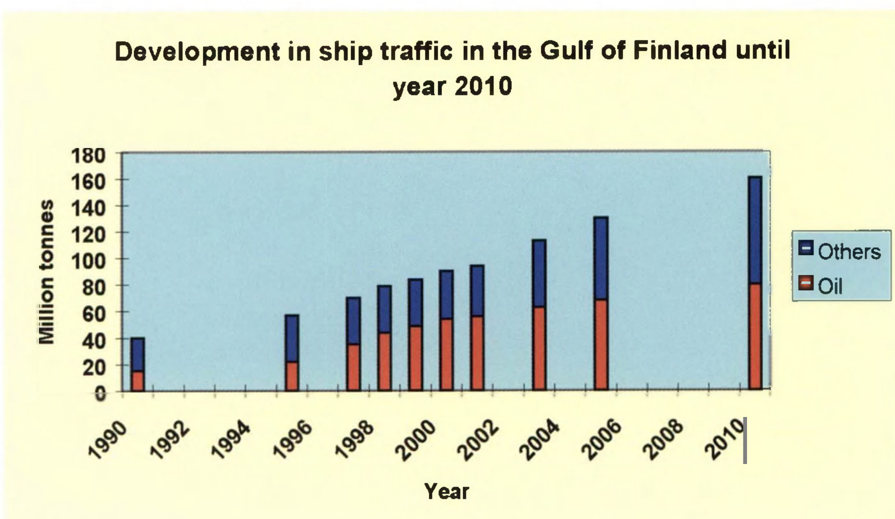


Figure 19. Prognosis on the development in ship traffic in the Gulf of Finland until year 2010. Prepared be the Finnish Environmental Institute.

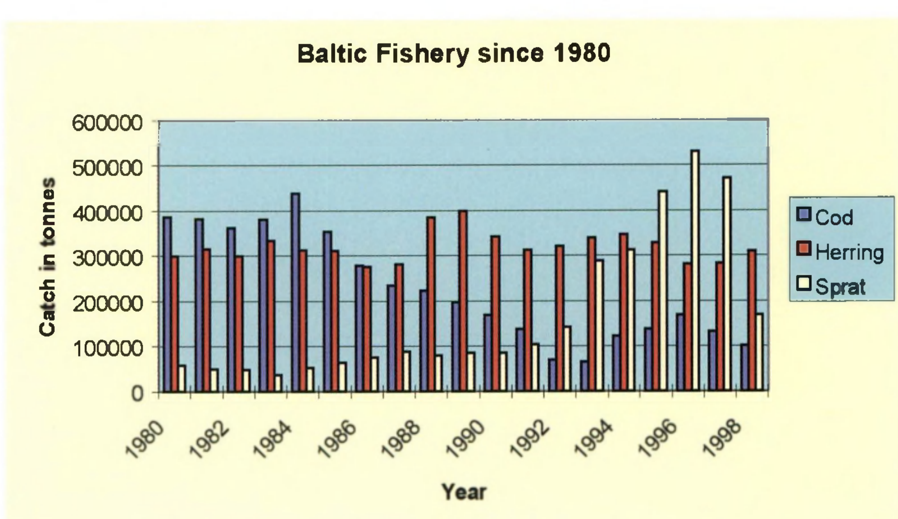


Figure 20. Catches of Cod, Herring and Sprat in the Baltic since 1980. (Source ICES)

2.2.2 Fisheries

Fishing has always been an important occupation in the Baltic area where important species are herring, cod, salmon, sprat and also some fresh water species such as pike, perch and pike-perch. The special physical environment found in the Baltic Sea with low salinities allowing both marine and fresh water species - although some existing close to the verge of their capacity - combined with frequent periods of anoxic conditions in the deep water means that the reproduction and survival of fish stocks are very sensitive to even small variations in the Baltic physical environment. The fishing industry - fishermen, processing industry, fishery managers etc. - therefore are very dependent on oceanographic information not only for safe and efficient daily operations but also for improvement of their long term planning and investments (Sjöberg, 1992).

2.2.3 Construction and engineering

A variety of construction work is going on in the Baltic region of which the construction of bridges across the Great Belt and the Sound have been the most important in recent years. Additionally a bridge across the Fehmarn Belt is in the planning stage. The building of these bridges means a reduction of the already very narrow opening between the Baltic and the open ocean which obviously will have an impact on the physical environment of the Baltic Sea. The planning of the bridges therefore involved a great oceanographic modelling effort in order to find a construction design that could minimise the effect on the Baltic environment. The presence of the bridges also put an extra constraint to the maritime traffic through the Danish Straits and thereby increases the risk for accidents. It is therefore important in due time to have a detailed knowledge of the meteorological and oceanographic conditions in the area of the bridge at the time of the passage.

Figure 21. Great Belt Bridge (source: Great Belt a/s)

2.2.4 Environmental protection and preservation

Topographically induced sensitivity and the high anthropogenic pressure have caused severe environmental changes in the Baltic Sea during the 20th century. Due to extensive research and monitoring awareness of these changes is good. The governments in the discharge area of the Baltic Sea have given the restoration of the Baltic environment high priority. The main responsibility to lead this work is put on the Helsinki Commission, HELCOM, but this work has also during the 90's been boosted by ministerial meetings and declarations. There is a political will to take measures to protect and restore the Baltic Sea but there is still a lack of knowledge about cost-effective measures. HELCOM and national environmental agencies are one group of main clients for an operational and regular production of information about state and trends of the Baltic Sea environment and its forcing factors. A developed BOOS will also give the pre-requisites for scenario modelling.

Real-time operational oceanographic forecasting is a required support for combating of accidental oil and chemical discharges into the sea. Both drift forecasts and impact assessments are produced to ensure optimum use of resources available.

For many decades industry, agriculture and forestry in the densely populated drainage area have put a strong environmental pressure on the Baltic Sea. The response has been international co-operation to set up measures to restrict and reduce discharges of pollutants as well as for an intensive monitoring effort. Modelling activities have been initiated to calculate transports of nutrients and other substances and to predict the drift of oil and chemicals which may be released into sea as a result of ship accidents. Monitoring of harmful algae blooms has been initiated using traditional sampling techniques, ships of opportunity and satellites (see homepage: http://www2.fimr.fi/algaline/).

2.2.5 Recreation

The shoreline of the Baltic has for generations attracted people from northern Europe for recreation purposes, an activity that has increased after the ending of the cold war. Leisure boating and wind surfing have especially increased during the recent 1 - 2 decades, which has resulted in higher frequencies of rescue operations and also fatal accidents (Wisniewski, 1993). More traditional recreational activities as fishing and bathing are also a cause of death for several people each year. The generally cold water restricts the search time to a few hours or less and calls for well focused search areas. Ocean forecasts and warnings are improving the safety connected to leisure activities in the Baltic Region.

2.2.6 The scientific community

Marine science activities have, as mentioned above, long traditions in the Baltic Sea, and large research projects are at present carried out focusing on climate, physical, chemical and biological oceanography, fishery, environment, geology etc. (e.g. Majewskiego and Lauera, 1994; BALTEX, 1995; BALTEX, 1997; and references therein). These projects do already relate highly to the existing network of observation sites and will depend on the BOOS activities in the future as BOOS will rely on the outcome of the scientific activities. Even if the mutual benefit is obvious the access to data is or is regarded as a major problem for researchers. The BOOS member agencies regard the scientific community as one of its most important partners and intend to create a system for easy access and a clear policy for rights to use data collected by the agencies.

2.2.7 Management and administration

The increased use of marine resources will also lead to requirements for a developed system in order to be able to handle different demands and to solve conflicts. A system of this kind must be based on knowledge of administrative boundaries, laws and regulations within different sectors, different interests and environmental conditions as well as on effective surveillance and utilisation of marine resources and environment. Overall physical planning should be developed into an instrument for a co-ordinated approach to the use and protection of marine resources.

Sustainable use of the ocean therefore requires political decisions and administrative measures. Increased competition between conflicting uses of the sea is also driving the need for better decision making tools. The decisions have to be based on the available knowledge of the state of and the processes in the sea. Bad decisions are today more frequent than necessary due to poor access to existing up to date knowledge. In the Baltic area the demand for better information for management is strong, e.g. the HELCOM Ministerial declaration 1998 (HELCOM, 1998b). Even if there is a long tradition of informing decision makers on all levels, the availability of high quality, aggregated and up to date information is still very much required.

BOOS will develop an operational chain from observations to end user products with a current implementation of results from research and based on user requirements.

Other marine industries are certainly of importance in the Baltic Sea area, but the above mentioned are the most important in relation to operational oceanography. It can, however, be mentioned that the interest in prospecting for oil and gas is strong in the Baltic and that suitable geological conditions for finding oil and gas fields exist. Aquaculture should also be mentioned among the new interests. Production of fish in cages and mussel farms have become a permanent activity in different places, mainly in the archipelagos.

A future resource utilisation which has now become of interest and which may be developed is offshore wind energy production.

Figure 22. Wind-power plant SVANTE (from National Atlas of Sweden)

2.3 Oceanographic activities and co-operation

Due to the importance of the Baltic Sea to the economic life of its bordering countries, marine research in the Baltic was initiated at a very early stage in the history of oceanography. Registration of water level and monitoring of the sea ice distribution were the first regular data collection activities that started already more than two centuries ago. In the middle of the previous century observations of temperature, salinity and current were initiated on Light Vessels. Regular research/monitoring cruises started a little more than one hundred years ago. These measuring programmes have generated some of the best oceanographic time series existing in the world.

In the present century and especially after World War II other monitoring programmes have started involving physical, chemical and biological oceanography, fisheries- and environmental assessment. Additionally numerous research projects with international co-operation have been carried out over the years, whereby a detailed knowledge of the complicated processes governing the Baltic Sea have been achieved. Figures on the following pages show the position of most of the stations presently operated regularly in the Baltic Sea. Some of these stations are today real time stations giving information on primarily water level but an increasing number of real time stations are established to measure parameters like temperature, salinity, currents and on a pre-operational level also oxygen, chlorophyll and nutrients. The establishment and the operation are up to now co-ordinated on a national or institutional level except for the HELCOM programme which is co-ordinated monitoring built on national commitments (see, for example, HELCOM, 1996a).

In recent years several modelling activities focusing on the Baltic Sea have been initiated, most of them with the aim to study specific processes in the area while a few have the goal to be operated in an operational mode to provide the marine industry with required prognoses of the behaviour of the Baltic Sea.

The Baltic Sea is a natural entity not only in a hydrological sense but also for multilateral co-operation. Every subject related to the sea is of common interest to the bordering countries and co-operation between the countries has existed on a more or less voluntary basis for the last millennium. Much of the Baltic marine co-operation has been co-ordinated by international bodies such as International Commission for Exploration of the Sea (ICES), the Baltic Marine Environment Protection Commission (HELCOM) and the International Baltic Sea Fisheries Commission (IBSFS), but much work has also been initiated through institutional or personal collaboration.

Since the formation of EuroGOOS its Baltic Sea Task Team has started to discuss, plan and co-ordinate activities related to operational oceanography in the Baltic Sea with the purpose of creating a Baltic Operational Oceanographic System - BOOS.

BOOS will be based on past investments in marine scientific research, marine technological systems including existing operational observing and forecasting services as well as on the established international infrastructure. Scientific and technological investments on a national and Baltic level has made BOOS possible and a number of services do already exist providing local data and forecasts for marine operations such as storm surge warning, wave forecasts, oil drift, toxic algae blooms, the extent of sea ice etc. In order to establish an integrated operational forecast system for the Baltic with its special physical, chemical, biological and geological characteristics, there is, however, a great demand for additional investments in scientific research and technological development focusing on the special demands for rapid data delivery, optimal model performance, data exchange, user friendly product dissemination etc. that is required by an operational service.

The economic and social needs for different types of forecast and data products in such an integrated operational service will be described in the next chapter.

Some of the extremely ambitious tasks that BOOS has to address are:

- Development of a mesoscale data analysis system
- Coupling of ocean and atmosphere models
- Coupling of regional and local models
- Development of ecological models taking into account the very special Baltic environment
- Optimising the existing observation network
- Introducing new observation technologies (remote sensing, radar) into an operational routine
- Develop and establish a harmful algae bloom warning system
- Establishing an efficient data exchange and product dissemination

Each of the tasks requires resources for further technological and scientific development including a pre-operational phase for development, checking and testing alternatives and refining the design and options for implementation.

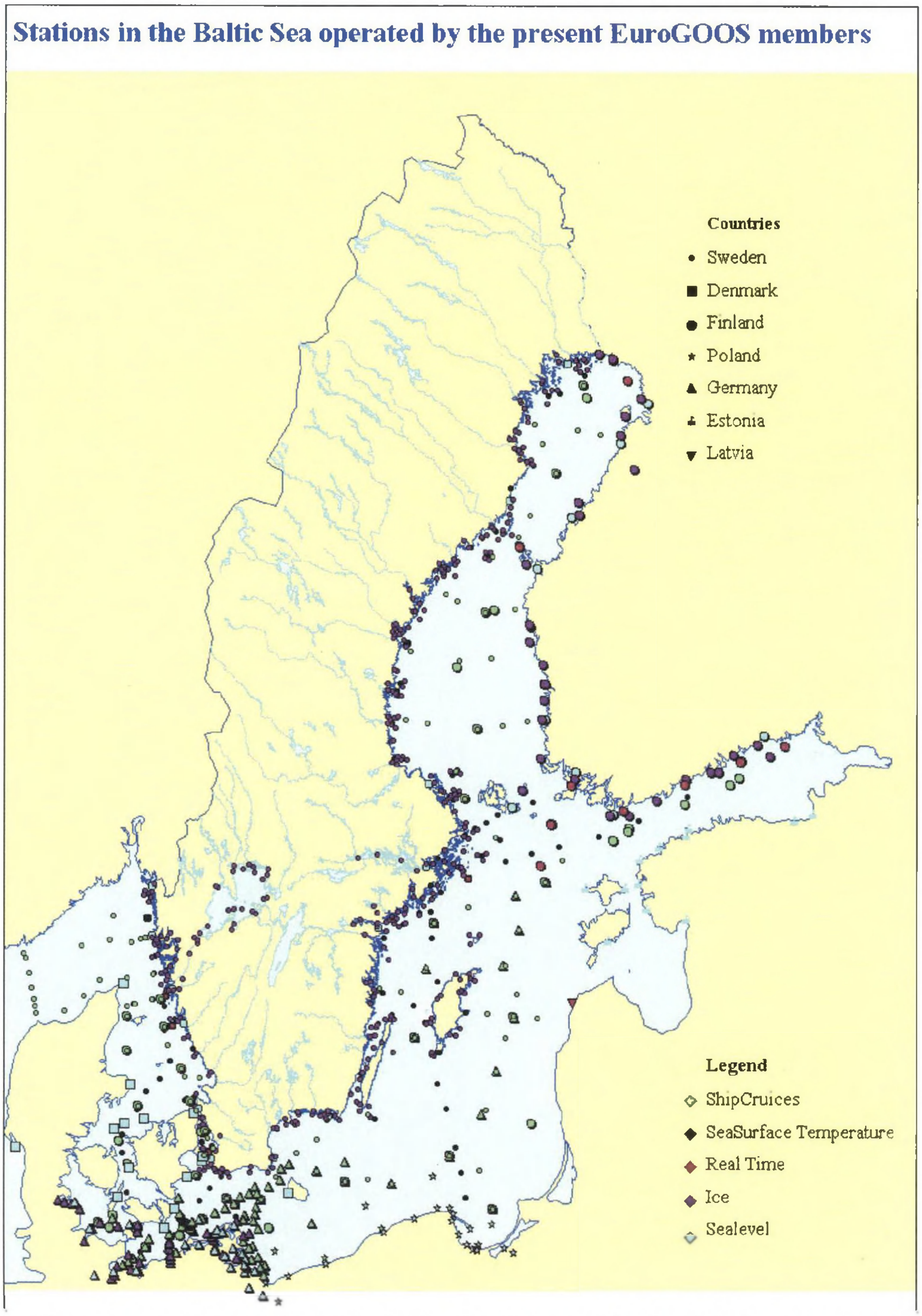


Figure 23. Oceanographic stations in the Baltic Sea operated by the BOOS partners

3 Baltic Operational Oceanographic System - BOOS

3.1 Introduction

BOOS constitutes a close co-operation between national governmental agencies in the countries surrounding the Baltic Sea responsible for collection of observations, model operations and production of forecasts, services and information for the industry, the public and other end users.

The existing ocean observing systems in the Baltic Sea have been developed and are operated to meet their own purpose, be it:

- Managing of fish stocks for sustainable exploitation
- Preserving healthy marine ecosystems
- Ensuring public health or
- Safe and efficient navigation

These purposes, which serve the broad public good, require long term observations and commitments as well as international co-operation which may be executed only through involvement from governments and governmental institutions.

The work of the International Council for the Exploration of the Sea (ICES), the Helsinki Commission for the Protection of the Environment of the Baltic Sea (HELCOM), the International Hydrographic Organisation (IHO), the International Maritime Organisation (IMO) and World Meteorological Organisation's (WMO) Baltic Sea Ice Meeting (the agenda of Marine Meteorological Commission) builds on intergovernmental agreements. The activities within these organisations are important for the establishment of an oceanographic operational observing system in the Baltic Sea.

Each of the observing systems, which is established or initiated by these organisations, serves its own needs and has its own data and information management system.

Therefore, the key issue for the establishment of an operational oceanographic observing system in the Baltic Sea is integration and further development of the existing observational systems and data sets. The objective is to maximise their utility for the specific purpose for which they have been originally designed and, by combinations of data sets with further stages of modelling and forecasting, to make them available for other relevant purposes and user groups. The combination of data types into a single system will permit higher resolution in models, more rapid delivery of products, and longer forecast horizons.

The existing observation systems should adapt and integrate new technologies to make observations more complete, more effective and more affordable, and the data infrastructure and management system should be complementary to existing systems and attuned to multiple sources of data and their multiple uses.

3.2 Goal and objectives of BOOS

The goals and objectives of BOOS are to:

- Improve and further establish services to meet the requirements of environmental and maritime user groups
- Co-ordinate, improve and harmonise observation and information systems
- Increase the quality of and harmonise user-oriented operational products
- Decrease the production costs of public products and services by sharing the workload
- Co-operate with HELCOM and other relevant bodies with the aim to avoid duplication of work and to maximise mutual assistance
- Identify new customers for operational oceanographic products
- Further develop the market for operational oceanographic products
- Develop BOOS pursuant to the GOOS Principles

- Provide high quality data and long time series required to advance the scientific understanding of the Baltic Sea
- Provide data and forecasts to protect the marine environment, conserve biodiversity, and monitor climate change and variability

3.3 Requirements

The most important marine industries in the Baltic area are described in Section 2.2 and the basic requirements of these and related industries are to a very high degree concentrated on information on the same few oceanographic parameters although the demands on resolution in time and space may be very different.

The most important marine related areas which require operational oceanography in the Baltic are:

- Shipping - all kinds
- Navigation in shallow areas and entrances to harbours
- Rescue operations, drift forecasting
- Military purposes
- Storm surge warnings
- Flood protection
- Coastal protection
- Transport calculations of water, substances and passive biological material, e.g. algae and fish eggs
- Bottom water renewal, oxygenation
- Environmental protection, impact assessment and management
- Ecosystem assessment
- Fisheries planning and management
- Recreation purposes
- Public warnings
- Research

An operational oceanographic service supporting these activities shall primarily focus on observations, analysis and model predictions of water level, waves, currents, temperature, salinity, sea ice, oxygen, nutrients, algae and chlorophyll.

A well functioning operational system will require:

- An up-to-date observation system that can provide data with a quality according to genuine international standards, combined with an international infrastructure for the capture, exchange and processing of oceanographic and hydrological (river discharge) data that is capable of supporting real-time or near real-time services
- A data analysis system that can provide description of the actual state of the sea and generate input data to operational models. Additionally the analysis system shall be able to create statistics and homogeneous time-series of gridded state-variables
- Access to meteorological forcing data and boundary conditions from North Sea and Atlantic models
- Operational forecasting models providing forecasts of conditions for the maximum forward look which is achievable by deterministic modelling and statistical forecast of expected conditions for longer periods
- A presentation and information system specifically targeted to deliver state and forecasts of the Baltic marine environment designed to meet exactly the requirements of the user at the site where the work is carried out

3.4 Existing components - the foundation for BOOS

BOOS is being built on existing systems and will develop mainly through commitments from the participating agencies. Already at present most of the components for an operational system are available within national or international programmes. The main tasks for BOOS will be to co-ordinate activities, develop operational routines, improve components and harmonise products based on user requirements. Each of these activities is itself composite, and highly technical.

Table 1. Existing operational components		
Observations (Only partly co-ordinated)	**Forecasts**	**Analyses**
• Meteorological synoptic • Meteorological climate • Sea level • Fixed stations, real time • Automatic buoys, real time • SST-ice network • Satellite remote sensing • Regular research vessel cruises • HELCOM monitoring • Ships of opportunity • Bottom fauna • Contaminants • Biological effect • Fish stock • Mussel watch • River discharge • Atmospheric deposition • Event • Local monitoring	• Weather Global forecasting High resolution limit area • Sea level • Wave • Sea ice • 1, 2 and 3 dimensional ocean • Local area ocean • Drift • Hydrological discharge • Atmospheric deposition Pre-operational models for ecology and water quality	• Mesoscale gridded analysis Meteorology • Sea surface temperature • Ice maps • Regional environmental • Periodic Baltic area environment • Assessment of commercial fish

Operational system components exist today but mainly as separate and between the nations parallel systems. To meet user requirements both geographical coverage of the products and regular products on different levels of data aggregation are lacking. Today many oceanographic products are produced in a classical academic way which means that they are mostly highly sophisticated but not available when needed and seldom very user friendly. There are exceptions, of course, but the BOOS Task Team has defined a long list of products which could be produced operationally, more cost-effective and user friendly.

3.5 Existing and planned real-time or near real-time products

At an early stage BOOS made an initial list of user requirements based on the experience of the participating agencies. This work is continuously up-dated.

Since operational data exchange of oceanographic data is only rudimentarily developed, BOOS will in the first stage focus on basic parameters for the real-time or near real-time products. Operational data exchange and dedicated analyses centres, DAC, will be established. In the first stage the following operational real-time or near real-time products are planned.

3.5.1 Water level

Interest in water level and its variations in the Baltic can be traced back many years. The practical importance of water level for shipping and the building of harbours was early recognised, but also in relation to coastal protection and storm surge warnings in exposed areas. In 1871 Denmark experienced one of its worst flooding catastrophes on the Baltic side when large areas of the islands of Falster and Lolland where flooded. This led to the building of dikes and an organised collection of water level observations. Similar experiences are reported from other Baltic countries. Therefore within the Baltic countries an intense network of tide gauges exists and several institutes produce forecasts especially for storm surge warnings and ship guidance in shallow pathways like the Danish straits. (Kozuchowski et al., 1993; 1995; Sztobryn and Krzymiñski, 1999; Sztobryn et al., 1997; Wisniewski, 1996).

In some countries real-time observations combined with short term forecasts are available on the internet. In the BOOS-system this service will be extended to cover the entire Baltic (see: www.boos.org).

3.5.2 Waves

Knowledge of wave heights and direction is important to almost all marine activities.

Only a few wave observation sites are in operation in the Baltic region at the moment and there is a great demand for the establishment of further observation points especially in shallow waters like the inner Danish waters. Satellite and radar observations will play a future role in monitoring the waves in the Baltic.

Wave forecast models are operated at a few institutions (Wisniewski, 1998; She and Nielsen, 1999; http://www.dmi.dk/vejr/index).

Within BOOS wave information will be exchanged between responsible agencies to support forecasts and warnings.

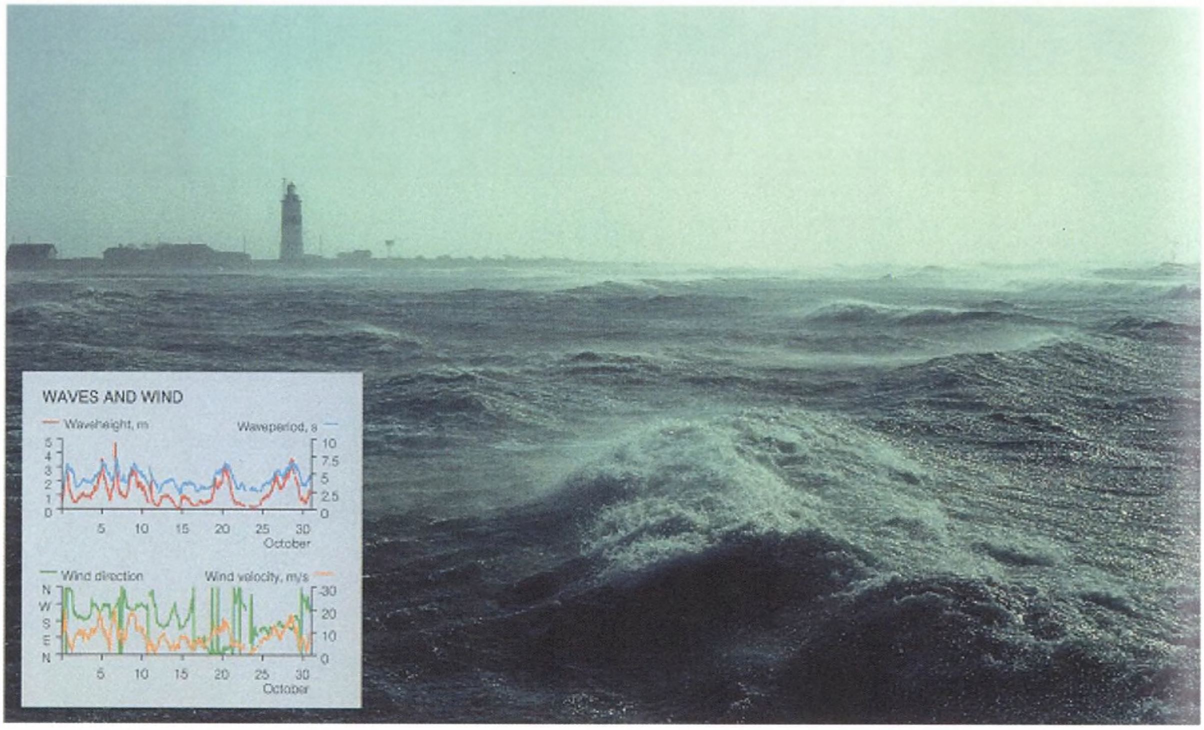


Figure 24. The diagram is compiled from observations of wave climate at Öland. The significant wave height is calculated from 10-minute observations and comprises the mean of the on-third of the waves during the period. Glommen lighthouse to the north of Falkenberg (from National Atlas of Sweden).

3.5.3 Sea Ice

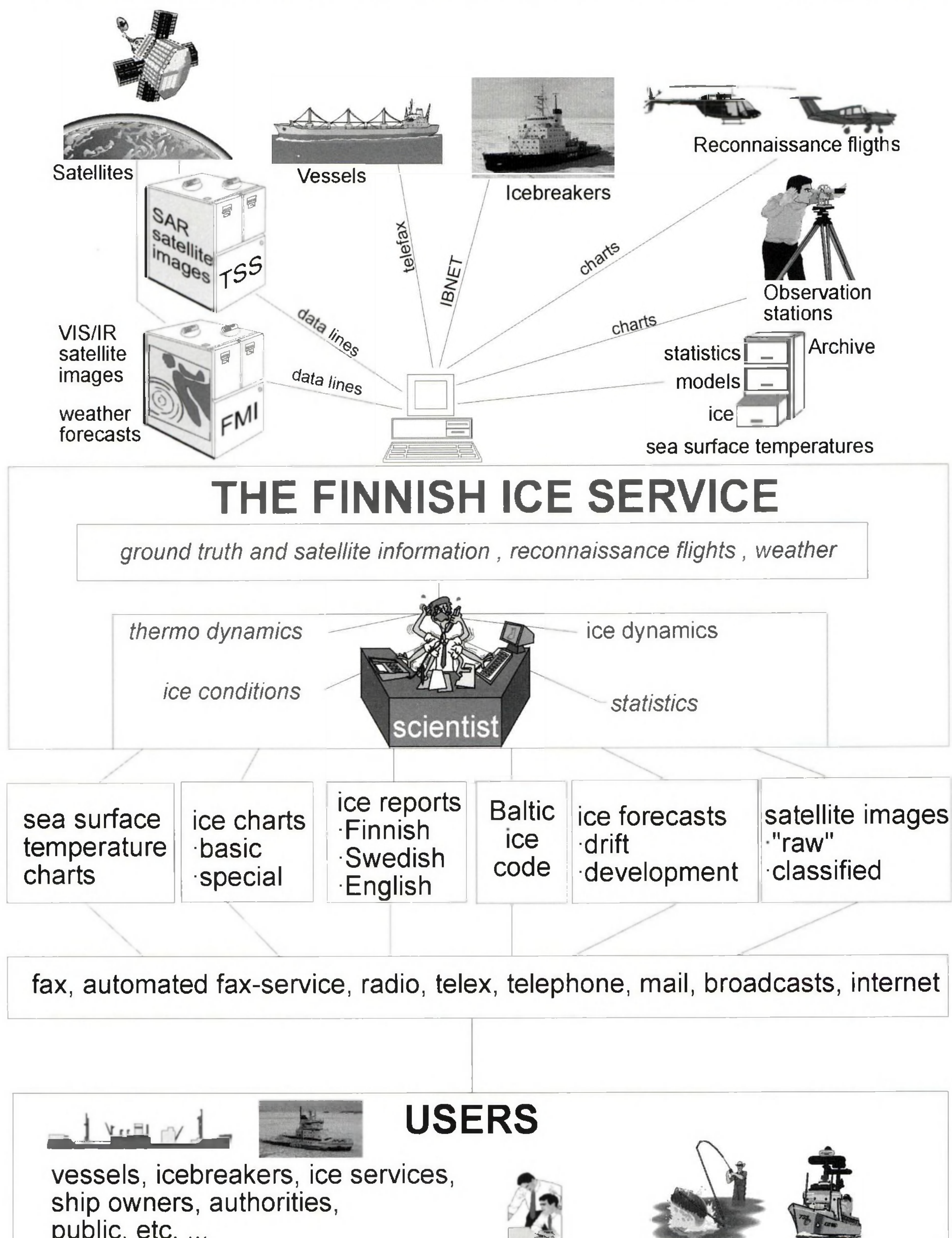
The presence of sea ice is of large practical and economical importance in the Baltic Sea. In the Baltic Sea some 90% of foreign trade is marine transported and over 500 million tons are transported annually - 40% during winter months. The Baltic Sea ice season lasts up to seven months and the maximum ice cover ranges from 50,000 to 420,000 km^2.

National ice services are responsible of the ice monitoring. Around the Baltic Sea there are operational services in Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. Sea ice data are collected, analysed and distributed by these services. The input data consists of (a) ground truth, such as data from observation stations, observations of vessels and icebreakers, etc., (b) visual and/or digital air-borne data collected by aeroplanes and icebreaker-based helicopters and (c) space-borne data of various satellites.

The services are issuing on daily or twice-a-week basis ice charts, ice reports in national languages and in English and in the Baltic Sea Ice Code. Some services are also able to produce ice forecasts and transfer satellite images and SAR basis classifications to the icebreakers and ships.

The national ice services have been co-operating successfully since the 1920s. During recent years there have been discussions for needs of a single Baltic Sea Ice Centre for data collection, analysis and information product distribution covering the needs of all Baltic Sea ice navigation.

THE OPERATION SCHEME OF THE FINNISH ICE SERVICE



3.5.4 Temperature and salinity

Observations of temperature and salinity are carried out in real-time at a number of fixed stations in the Baltic area. Additionally data are collected regularly from ships in connection with monitoring programmes and by ships of opportunity. Sea surface temperature data are also derived from satellite images. There is however a need to supplement the present observation scheme with real-time observations of sea surface temperature from both coastal and open sea and of the vertical distribution of temperature and salinity in the open Baltic at selected locations.

Several institutions have initiated 3d-model work that can produce forecasts on the temperature and salinity distribution. A few of these are today run in operational mode.

Twice weekly maps of the Baltic sea surface temperature are produced at some institutions based on remotely sensed data combined with available in situ measurements.

In particular for daily initialisation of meteorological and oceanographic forecast models a daily gridded sea surface temperature map will be produced by BOOS in the future.

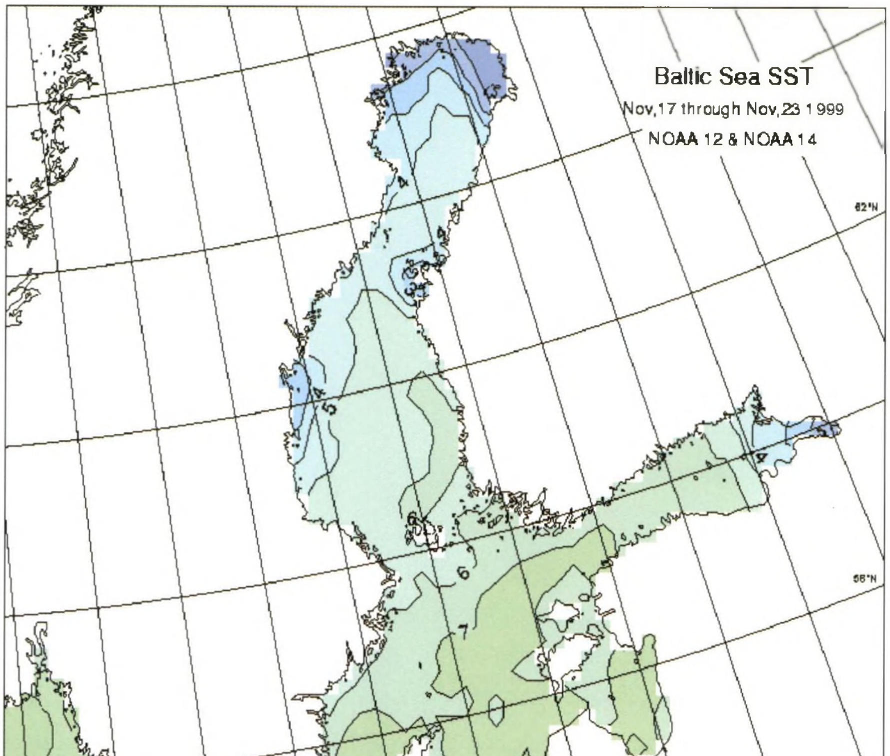


Figure 26. Map showing the surface temperatures of the Baltic Sea, the map is updated once a week. Available on the homepage of Bundesamt für Seeschiffahrt und Hydrographie (BSH)

3.5.5 Currents

Currents are measured in real-time at a few localities in the Baltic. There is a need for better observations in the open Baltic to monitor the transports between individual basins. Operational models exist at some agencies to produce forecasts of the vertical and horizontal current pattern. These are used operationally mainly for drift forecasting. Three dimensional models are being developed at several institutions.

Validation of the present operational forecasting systems has pointed out certain components which have to be developed to improve the quality of the forecasts.

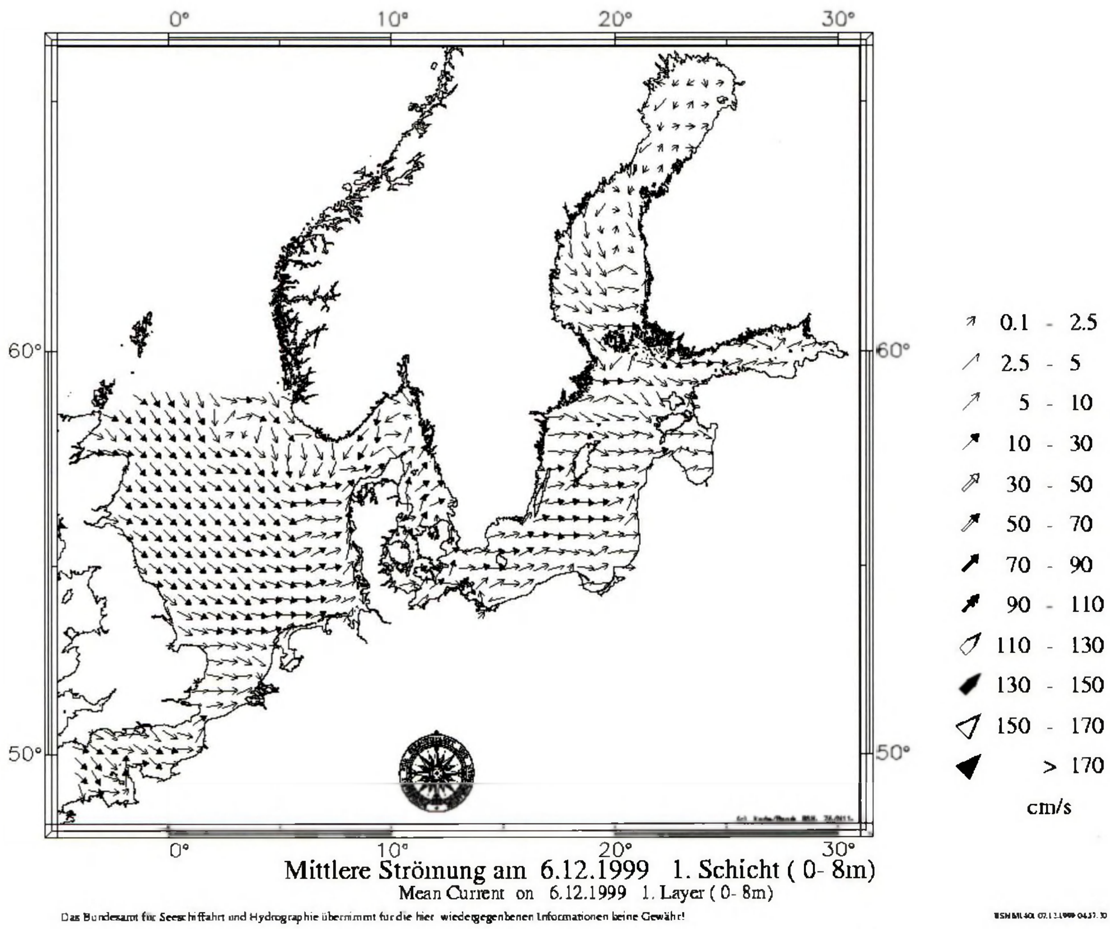


Figure 27. Forecast of the surface currents in the North Sea and the Baltic Sea - updated once a day. Available on the homepage of Bundesamt für Seeschiffarht und Hydrographie (BSH).

3.5.6 Algae

In most of the countries around the Baltic Sea, specific programmes are carried out to monitor and inform the authorities and the public of potentially harmful algae blooms. Frequent coastal sampling using ships and helicopters, ship-of-opportunity lines, satellite imagery and visual observations by e.g. coast guard pilots are used for this purpose. It is however the goal to improve the data sampling procedures and to provide an early-warning information system.

3.5.7 Hazardous substances

The presence of hazardous substances in the Baltic marine environment is recognised as the most severe (together with eutrophication) environmental problem of the Baltic Sea. "Hazardous substances" are defined as substances that are not only toxic but also persistent and liable to bio accumulation. The most well-recognised hazardous substances are organic chlorinated hydrocarbons, heavy metals and organo-metallic compounds.

Figure 28a. Divers studying the bottom fauna

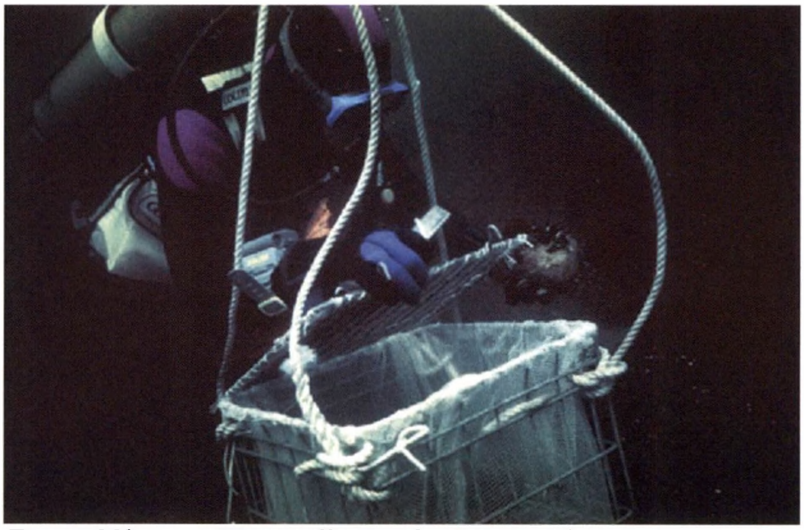


Figure 28b. Diver collecting bottom samples

Today, all components of the Baltic ecosystem; i.e. water, sediments and marine organisms are contaminated by hazardous substances. The entire food chain is contaminated, with the highest concentrations noted in top predators - those exclusively preying on fish, i.e. white-tailed eagles and seals. There are various negative biological effects caused by hazardous substances, primarily affecting reproduction and the immune system, as well as additional stress.

World wide research on hazardous substances is directed on two channels - estimation of contamination levels, and biological effects. In the Baltic Sea region, combined biological/ chemical as well as biological effects research is seldom undertaken.

There appears to be no obvious need for developing an operational oceanography program on hazardous substances, due to the delayed response in chronic effects on the food chain. However, relevant information on levels and trends should be included in an operational database, and information on actions to reduce discharges, as set in "HELCOM Objectives with Regard to Hazardous Substances" (HELCOM, 1996b).

Modelling is needed on two fronts: input and distribution, and bioaccumulation/decontamination processes. Because ecological modelling is a strong component of BOOS, BOOS scientists should consider modelling of these substances within the ecosystem modelling.

4 Implementation Plan

4.1 Introduction

To establish an operational oceanographic system for the Baltic Sea is a complex and resource demanding task, requiring additional investments in scientific research and technological development, focusing on the special demands for rapid data delivery, optimal model performance, data exchange, user friendly product dissemination etc. that is required by an operational service. Some of the components of a operational system do already exist -as outlined in the previous sections - but expenditure, effort and time are required to:

- Define an optimal observation network
- Upgrade some of the existing observation stations from delayed mode to real-time
- Installation of new sensors and equipment
- Introduce remotely sensed data into an operational setup
- Introduce common standards for data quality control and automate these
- Implement real-time data transmission links
- Establish a set-up for data analysis
- Optimise existing models
- Implement data assimilation
- Develop and implement coupling of ocean and atmospheric models
- Develop and implement ecological model
- Develop and implement an effective and user friendly information system

This constitutes a huge task involving scientific research, technological developments, committed international co-operation and strong co-ordination.

The premier task for the BOOS co-operation for the 5 year period 1999 - 2003 therefore is to start the integration and development of the existing systems into a uniform entity in order to meet the users demands for a high quality operational oceanographic service and to minimise the productions costs. BOOS will therefore within the coming 5 years focus on the implementation of the following nine projects:

- Optimum Design of a Sustained Ocean Observing Network Operational Oceanography - SOON
- Use of Remotely Sensed Data (Radar, Satellite) - RESEDA
- Development of a Prototype Ocean Data Analysis System - PRODAS
- Model Coupling and optimisation in BOOS - MOCOB
- Ecological Modelling - ECOMOD
- Harmful Algae Blooms - HABWARN
- Anthropogenic Load Model - ANTLOMO
- Current Assessment of the State of the Baltic Environment - PROBASS
- Info-BOOS

Detailed project descriptions will be worked out during late 1999 - early 2000.

These projects mainly focus on using and optimising the existing facilities within observations and modelling such as:

- Co-ordination and upgrading of existing observation facilities supplemented with identification and establishment of additional observations sites
- Establishment of an efficient system for free exchange of data within the participating institutions, including agreements on formats and data quality
- Improvements of the forecast capabilities by optimising and coupling existing atmospheric - ice and ocean models combined with a development and operationalisation of local- and special product models
- Establishment of an information system that easily distributes the required products to the users

These points are described in more detail in the following sections.

BOOS will additionally rely on technological developments achieved in a number of projects initiated by EuroGOOS such as the Ferry Box and anti-fouling projects, and BOOS will offer to test new developed instrumentation in co-operation with the developers.

4.2 Observations

Ocean data collection is very resource demanding due to instrumentation costs and in particular instrument maintenance (cleaning, calibrations etc.). An optimal observation system operated through international co-operation will therefore be the most cost effective way to collect the necessary observations. In the world ocean, not even one observing network is optimally designed. There are however, urgent needs to build up ocean observation systems optimally both from a scientific and economic point of view. Scientifically, an optimal observation system means a system which can provide the maximum amount of effective information (defined by the purpose of operational or climate oceanography) with a limited cost. The optimally designed system will ensure that the operational ocean model has the best ocean data for constructing initial fields and optimising model parameters, which are the two most essential factors to improve the current operational marine forecasts for the Baltic. Economically, an optimal observation system means that the system can provide a reasonable data set for operational and climate oceanography at minimum cost. This secures our budget for oceanography and provide a basis for ocean policy makers.

Optimal observation system design (OOSD) is a very challenging work, not only because we need to develop new scientific methods for the OOSD, but also because OOSD has first to be simplified and abstracted into some scientific questions, which can be involved in our existing/future knowledge, such as system evaluation theory, system control theory, information theory and modelling/statistical analysis methods.

An optimal ocean observation system design for operational oceanography in the Baltic will involve the following tasks:

- Development of new methods and indices to evaluate the existing observing system
- Development of new methodology and technology for the design of an optimal ocean observing network for climate study
- Development of new methodology and technology for the design of an optimal ocean observing network for operational oceanography
- Demonstration of a practical optimal observing network design for Baltic Sea operational oceanography

The BOOS members do already, as part of their national responsibilities, operate an intensive network of observation sites ranging from delayed mode and on-line real-time fixed stations to ship based monitoring programmes to remotely sensed data. The existing data collection network will form the basis for optimisation of the Baltic operational observation network. Additionally links to ongoing and planned research projects will be established with the purpose of exchanging data and final analysis products.

Another immediate task of BOOS is to validate the existing observation network with respect to:

- Upgrading observations from delayed mode to real-time mode
- Functionality, i.e. is the present instrumentation up to date and is the data quality according to agreed standards?
- Implementation of new technology (radars, new satellite sensors, Ferry Box instrumentation, anti-fouling etc.)
- Implementing observations of environmental and ecological parameters: oxygen, algae, nutrients etc.

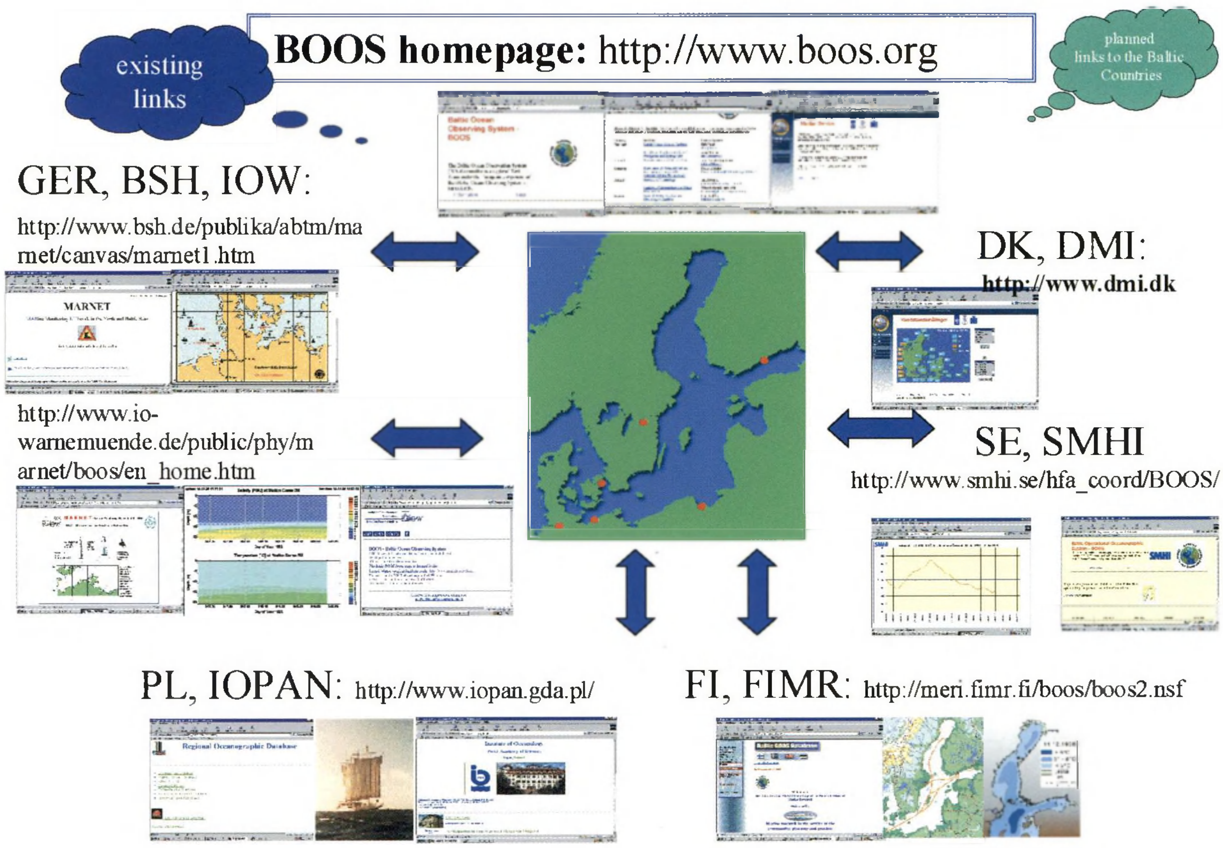


Figure 29. The BOOS homepage (www.boos.org) has links to institutions in the countries around the Baltic Sea, which provide operational oceanographic products on the internet

4.3 Data exchange

BOOS is able to take advantage of and build on a number of existing initiatives on managing data in the Baltic region to provide environmental information to a wide range of users. To meet the requirements of all its users BOOS will need to:

- Identify and make available all data and products to those organisations adding value
- Provide international communication networks and efficient standard formats and codes to make best use of them. Such networks and protocols must have bandwidth sufficient to allow straightforward timely interaction with data centres around the Baltic
- Implement advanced data quality control and validation systems. These systems shall ensure that the huge volumes of data required and collected are fit for purpose
- Secure archival methods that retain the value of historical data. This requires appropriate collection, maintenance and dissemination of documentation and meta-data
- Establish an integrated international data base. For users to locate and recover the information they require, the information should be described in and accessible from advanced data processing systems. These systems are developed and maintained at the individual institutions and they will be connected and operated in a co-ordinated manner, so that information stored at different sites are as accessible as if stored in a single location. These systems will provide a standard set of assessment methods that allow the BOOS partners to

investigate the availability of and retrieval of data and products

- Establish link to other data- and modelling centres for retrieval of boundary and forcing fields

The most urgent and vital part of the BOOS co-operation is the establishment of an efficient system for exchange of data between the participating institutions. The data exchange component can be divided into two problems:

- Clarification of legal matters in relation to exchange of data
- Establishment of technical solutions

The legal matters concerning the free exchange of data are an issue of importance not only to BOOS but to GOOS and EuroGOOS as well. Within EuroGOOS a Data Policy Panel has been established in order to clarify all the legal and financial principles relating to the exchange of data between the EuroGOOS members. The EuroGOOS Data Policy Panel has the task to prepare a draft on the EuroGOOS Data Policy for the EuroGOOS annual meeting in December 1999. The EuroGOOS Data Policy will to large degree follow the spirit in the agreements established within organisations like WMO and EUMETNET with regard to exchange and use of meteorological data (EuroGOOS, EG99.37).

BOOS will follow the EuroGOOS Data Policy.

To address the technical problems relating to data exchange BOOS established a Data Exchange WG in 1998. This working group has started the development and implementation of a FTP-box system for interagency exchange of measured data. The system has been established at a few BOOS member institutions and tested with good results. The operationalisation of this system does however await the adoption of the EuroGOOS Data Policy at the 2000 spring meeting of EuroGOOS.

A further development of the BOOS data exchange will take place under the Info-BOOS project and will there be integrated with the BOOS information system, see section (4.6).

4.4 Data analysis system

During the 1999- 2003 period BOOS will concentrate on the development and implementation of a prototype data analysis system for the Baltic Sea, which will focus on the physical conditions in the Baltic Sea. This means that it will sequentially demonstrate the temporal evolution of the surface quantities (sea surface temperature, sea-ice), as well as the 3-D distributions of salinity and temperature. As an environmental indicator also 3-D distributions of oxygen concentrations will be analysed. The prototype will be designed in a way that more water quality parameters can be incorporated into the system. It will also be able to serve as a test case for operational oceanography on the European level.

The demand for environmental information is escalating rapidly, requiring the design and development of increasingly exotic and comprehensive monitoring systems. Ocean data analysis is the diagnosis of the complete and consistent four-dimensional state of the sea from a vast, asynchronous, heterogeneous database. Development of a common Prototype Ocean Data Analysis System (PRODAS) will be one step in advance towards a co-ordinated Baltic Sea environmental assessment concept. Moreover, it will be a test case for deregulation of near real-time data exchange and international co-operation in operational oceanography.

Theoretically, for environmental analysis two aspects are of primary importance: the physical laws, and the spatial and temporal spectra of variance. The physical laws indicate how it might be possible to determine one variable from another, and the knowledge of spectra can be used to determine the acceptable spacing between observations. In practice we possess restricted knowledge about the physical laws that govern environmental change, and spectra indicate that the sampling should be much denser than we are be able to achieve in practice.

Even when based on the enormous database of Baltic Sea T/S profiles, a statistical approach based only on observations (Toompuu & Wulff, 1993) produces bulls-eyed structures that can not be associated with physical phenomena (Eigenheer & Dahlin, 1999).

These circumstances explain why, even for surface quantities, such as Baltic Sea SST and ice, present ocean data analysis systems are still based on subjective manual techniques rather than on objective algorithms. In Icemap (Ref. VTT), e.g. manually drawn isolines have to be manually gridded, or triangulated and interpolated, to achieve a digital map which turns out to be a both costly and insecure procedure.

PRODAS will opt for an objective method based on numerical models and data assimilation. Established forecast models perform well over several month periods, and sub-grid processes are parameterised. The spatial resolution of the model (and hence the analysis) and the relaxation time-scales can be assigned adequately according to the sampling density. For surface quantities priority will be given to development and putting into operation specific Baltic Sea blended in-situ and remote-sensing products.

4.5 Modelling

Operational oceanographic models are already a part of the operational service at a few institutes around the Baltic Sea and include models for 3-dimensional circulation, storm surge, wind waves, sea ice and dispersion of chemicals.

The operational models all run on a national basis except for the HIROMB model, a project formed within the HELCOM community and with the objective to develop and operate a common high resolution ocean model for the Baltic Sea. HIROMB is now fully parallelised and produces 48 hours forecast each day with as fine resolution as possible with today's computer capacity. Results are distributed via a WEB-page and all fields are downloadable from a ftp-server. The WEB-page also shows real-time validation of water level and SST based on real-time exchange of data.

To increase the theoretical, numerical and computer-dependent level of today's operational models, BOOS has identified at least two items to concentrate future research and development on:

4.5.1 Two-way coupling of atmospheric and oceanographic models

As both atmospheric and oceanographic models are run with increasingly finer resolution, the air-sea interaction gets more important; to include this more efficiently the models have to be coupled. This also includes the coupling of wave models with atmospheric models.

4.5.2 Interface to general local models

As a 3-dimensional eddy-resolving model of the Baltic Sea requires a resolution and computer capacity that cannot be met at all operational institutes, it is an advantage to only run a full Baltic Sea model at one or two places. However, even with an eddy-resolving Baltic Sea model, there is still a need for local models resolving archipelagos and other coastal areas with complicated topography. The configuration of the local models may be different from the Baltic Sea model, i.e. for one region a layer model may be more suited while another region is best modelled with a vertical sigma co-ordinate. The idea is to provide an operational interface to local models containing open boundary forcing of user-selected parameters and temporal resolution.

The work will be divided up into the following tasks:

- Develop a general coupling interface between atmospheric and ocean models (include current, wave and ice models)
- Develop a general interface between Baltic sea models and local (coastal area) operational models

- Make agreements on real-time data exchange for open boundaries in co-operation with the EuroGOOS North West Shelf Task Team
- Improve data assimilation, consider new aspects as a result of coupling

Additionally BOOS will initiate the development of ecological models with the purpose to run them in a pre-operational phase within the 5 year time frame.

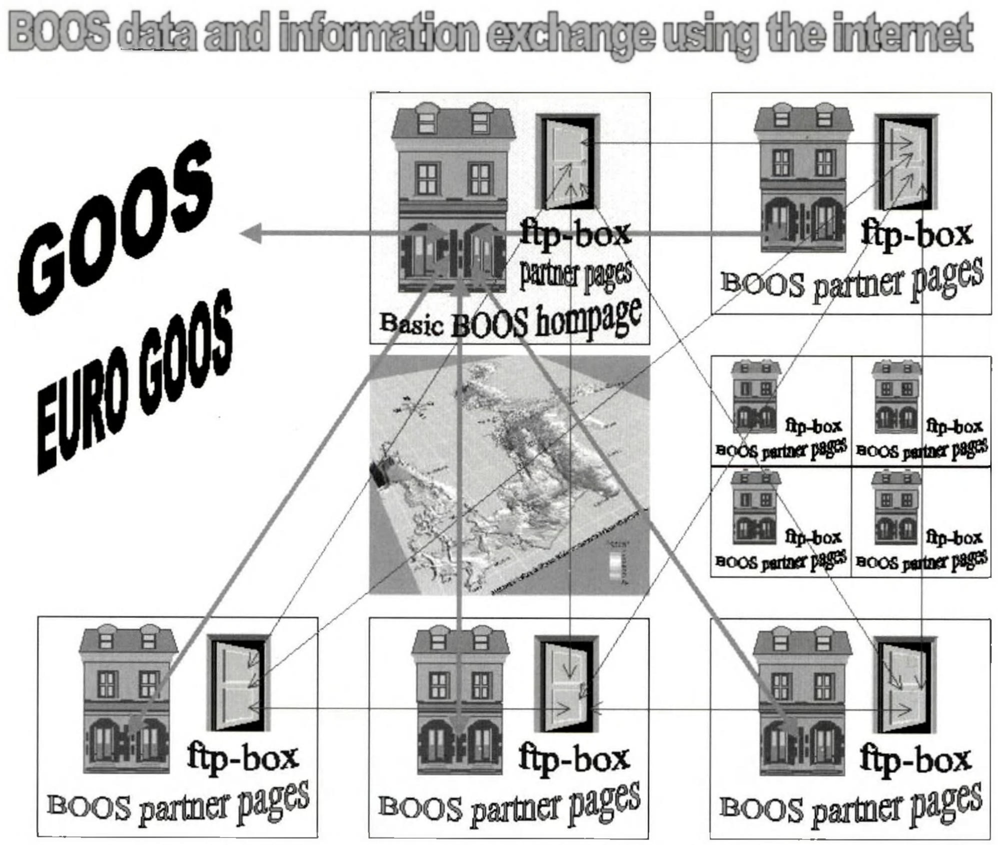


Figure 30. Members of the BOOS co-operation exchange data using a system of ftp-boxes. Each member institution puts the data, it wants to exchange with the other members, in its own ftp box, where it can be collected by the other partners. The system is protected by usernames and passwords

4.6 Presentation and distribution

It is obvious that no operational cross boundary system in any domain can be successful without efficient and robust information exchange and dissemination system. It is even more obvious that systems relying on data collected in different part of Baltic by different parties of co-operation cannot become really operational without such an information system. To support the BOOS objectives in the domain of information exchange and dissemination the InfoBOOS - BOOS Information System - is being developed.

The BOOS participants already produce a variety of operational oceanographic services of which storm surge warnings, drift forecasts, and state and forecast of sea ice distribution and concentration are the most advanced. These services are distributed to the users via established communication lines (phone, fax), internet, public media (papers, radio, TV). The BOOS homepage has links to a number of national products.

The InfoBOOS main tasks are to:

- Deliver a platform for operational interagency data exchange
- Deliver a platform for operational common product development including automatic production of value added oceanographic information
- Prepare platform for operational delivery of user-oriented products to the marine related society

All of the listed tasks are essential to allow BOOS achieving its objectives, especially:

- Improving services to the users
- Increasing quality of the products by better utilisation of existing data
- Providing more user-oriented products by means of more user-friendly product and data dissemination
- Decreasing production costs by sharing the workload

The proposed InfoBOOS structure is shown in Fig. 31 It is shown that InfoBOOS consists of two major parts: a user layer and a provider layer. Their tasks and content are described in the following paragraphs.

InfoBOOS user layer

The user layer is an interface between the users requesting specific oceanographic services and the agencies delivering requested products and being the BOOS members.

The user layer will be responsible for the following tasks within InfoBOOS:

- Seamless product delivery to the user in all forms potentially accepted by users
- Consistent presentation of distributed data and products
- Authentication of the user interested in access to specific products
- Authorisation of the user – granting access right to classified products
- Billing – accounting for the potential costs of delivered products (especially for commercial purposes)
- Automatic extraction of data and preparation of on-line products basing on the production schemes, knowledge about data locations, etc.

The above listed tasks are represented by layers in the user block. Most of them are obvious for those who are familiar with the information system build by the meteorological community (e.g. GTS system). Unfortunately the meteorological systems are open only to a limited number of agencies (only one representative from each country all over the world). The user interfaces are build up in different ways in different countries since GTS is only used for interagency data exchange. The InfoBOOS itself has to deliver generic tools for BOOS members, allowing distribution of the products to users with only a little customisation (e.g. nationalisation, customisation of oceanographic parameter map, etc.). Generally it is intended to prepare the generic tools for following user interface possibilities (shown in the figure as user interfaces):

- Fax/phone telecommunication services
- WWW homepages with different levels of information presentation (files, forms, graphs, maps and Internet applications)
- ftp interfaces
- Special data delivery system (e.g. S57 format data delivery for the hydrographic community)
- Remote information kiosks (e.g. in harbours with weather information, including waves and currents for yachtsmen)

The InfoBOOS will not be limited to those interface possibilities, but at least at the time of preparation of BOOS Implementation Plan we see them most important. The greatest urgency will be put on development of interactive Internet data delivery tools including interactive mapping and plotting tools.

The InfoBOOS user layer will provide a consistent approach to services and products from the user point of view, and will enable the combination of distributed products and data into a common 'look and feel' presentation system.

Scheme of the InfoBOOS – the BOOS's information system.

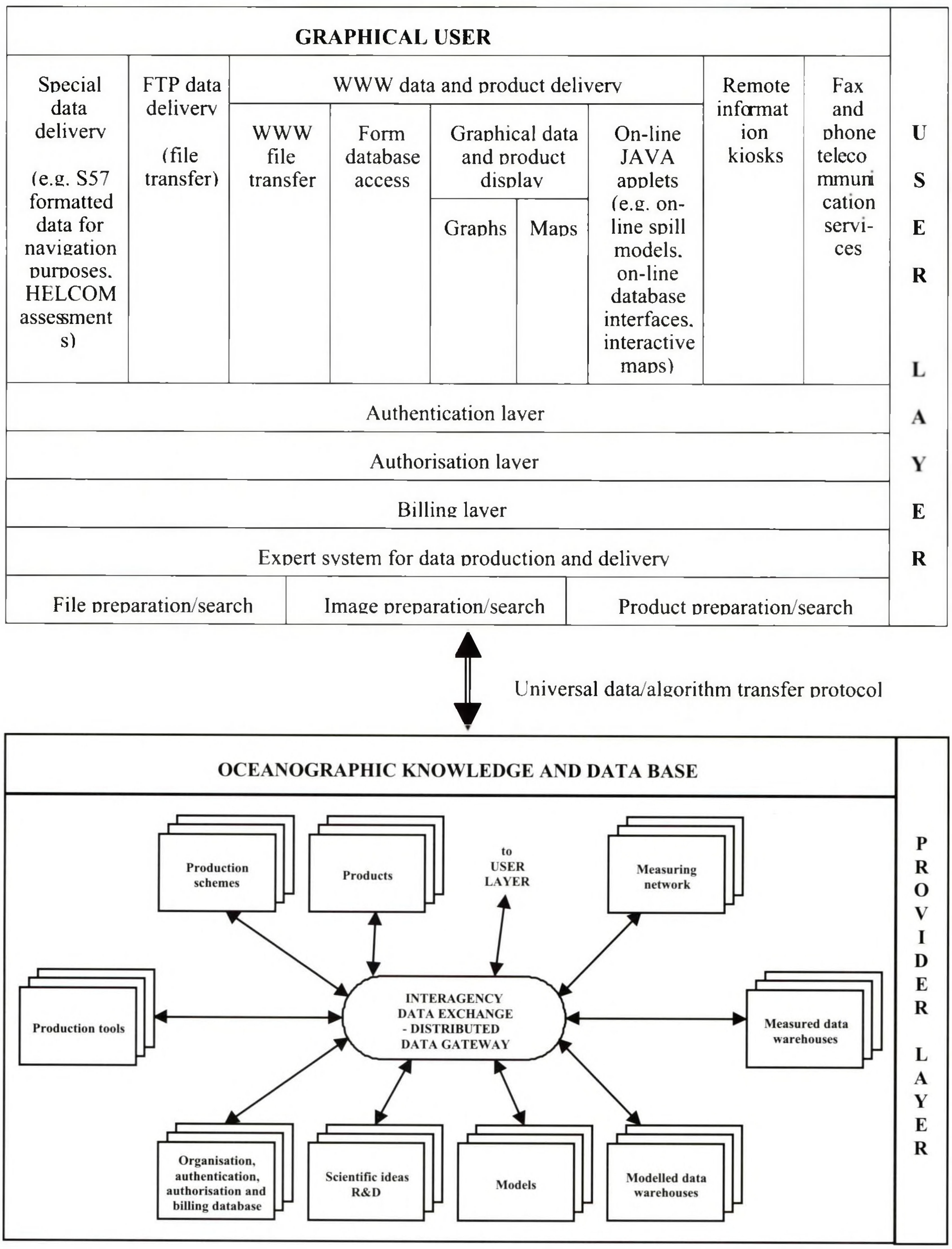


Figure 31

The InfoBOOS provider layer

The InfoBOOS provider layer is the living heart of the InfoBOOS system. The provider layer will consist of servers distributed between different agencies linked with tools for interagency data exchange and tools for translation of services and products to be readily accessed by the user (or user layer). Specifically the provider layer will consist of:

- Scientific ideas, research and development
- Oceanographic products
- Productions schemes
- Production tools
- Models – in different time-scales
- Modelled data warehouses
- Measuring network (both near real-time monitoring networks and non-operational data)
- Measured data warehouses
- Organisation, authentication, authorisation and billing database

Each of the above mentioned modules may be developed in parallel in different organisations with all rights to use existing and prototype data formats, internal databases and tools. The interagency data exchange will be realised through the data gateways (GW) which will be responsible for the harmonisation and translation of the data formats, etc. This means that the interfaces to already existing services and data formats will be organised.

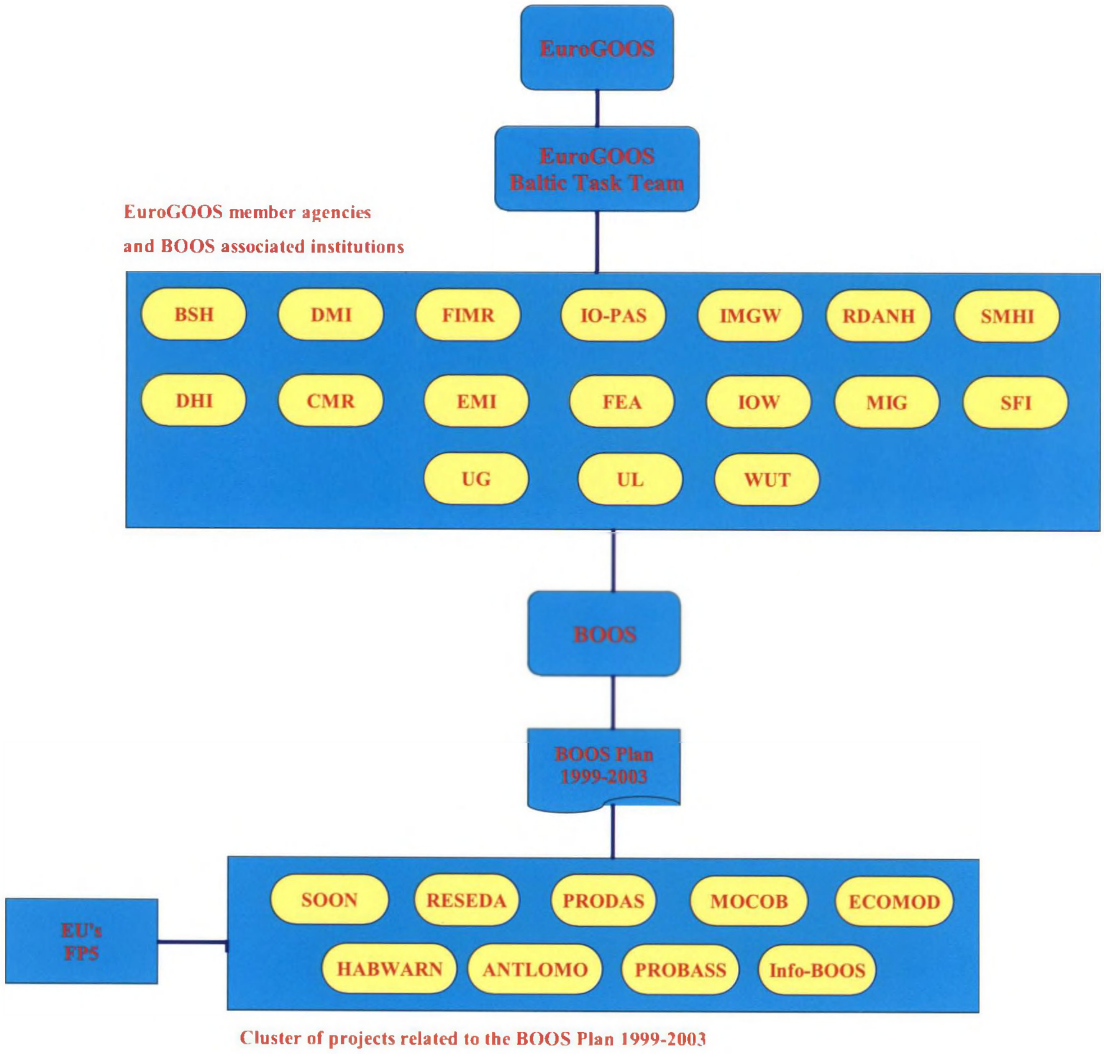
It is important to notice that BOOS has already started interagency data exchange based on the FTP-box approach and additionally there is a development of HIRNET communication program for operational oceanographic data exchange.

The above-mentioned modules will form a distributed Oceanographic Knowledge Base.

The provider layer will communicate with user layer through a universal data/algorithm transfer protocol, which is to be developed in order to facilitate both spatially and temporally distributed data and algorithms (production schemes).

5 Organisation

BOOS is initiated by the EuroGOOS Baltic Task Team, which is a formal body in the EuroGOOS co-operation. The highest authority of BOOS is a board of representatives from Baltic EuroGOOS members and BOOS associated institutions. The EuroGOOS Baltic Task Team and BOOS are both chaired by Dr. Erik Buch, Danish Meteorological Institute.

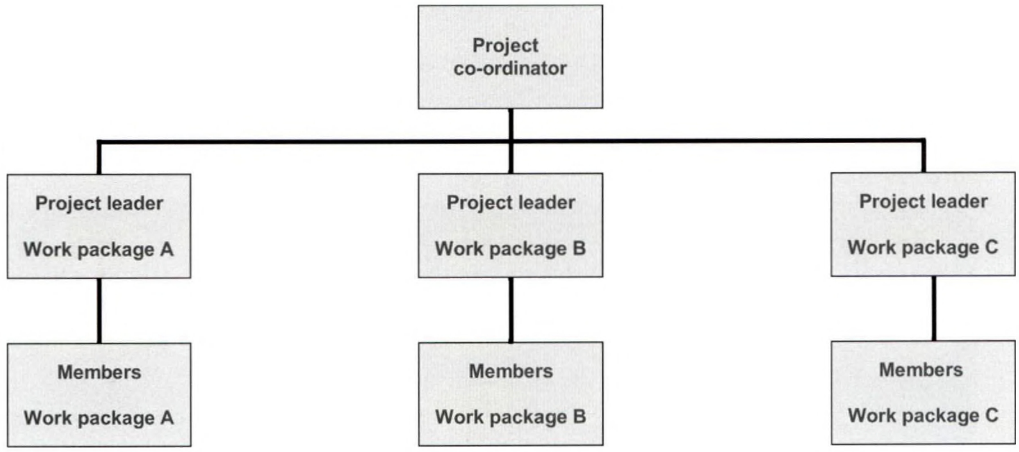


Project organisation

Within the BOOS programme nine projects are presently planned and for each project a project co-ordinator will be nominated, and who will be responsible to BOOS for the successful implementation of the project.

Each project will be divided in a number of work packages. The work packages will be carried out by experts from the BOOS member institutions and if necessary supplemented with experts from other organisations. Each work package is lead by a project leader.

The project co-ordinator and the project leaders form the project management.



Annexe 1

References

Agenda 21 1992. United Nations UNCED Document A/CONF.151/4 (Parts I and II)

BALTEX, 1995. Baltic Sea Experiment BALTEX - Initial Implementation Plan. International Baltex Secretariate Publication No. 1, 84pp.

BALTEX, 1997. The Main BALTEX Experiment 1999-2001 - BRIDGE. Strategic Plan. International Baltex Secretariate Publication No. 9, 78pp.

Brutsaert, W, 1982. Evaporation into Atmosphere. (Reidel, 1st ed.).

Eigenheer, A ,and H Dahlin, 1999. Quality assessment of the High Resolution Operational Model of the Baltic Sea. Journal of Marine Systems (submitted).

EuroGOOS, 1999. EuroGOOS Data Policy and Practices. EuroGOOS document EG99.37.

Flemming, N C, 1999. Dividends from investing in ocean observations: A European perspective. In: Proceedings of Oceanobs 99, October 1999, St Raphael, France.

Fonselius, S, 1995. Västerhavets og Östersöens Oceanografi. SMHI. 200pp.

HELCOM, 1996a. Third Periodic Assessment of the State of the Marine Environment of the Baltic Sea, 1989-93; Background document. Baltic Sea Environment, Proc. No. 64 B. 251pp.

HELCOM, 1996b. Recommendation 19/5 (30).

HELCOM, 1998a. The Third Baltic Sea Pollution Load Compilation. Baltic Sea Environment Proceedings. No 70.

HELCOM, 1998b. Report of HELCOM 19/98, 15/1, Annex 29.

Hempel, G (ed), 1996. The ocean and the poles: grand challenges for European co-operation. G. Fischer, Stuttgart; New York. ISBN 3-334-61023-3 (Jena), ISBN 1-56081-435-7 (New York). 381pp.

IFREMER, 1997. Données économiques maritimes françaises, Service d'Économie maritime. IFREMER, France. ISBN 2 905434 83 X. (Ed R Kalaydjian)

IOC 1998. The GOOS 1998 Prospectus. IOC, Paris 168pp.

Isemer, H J, 1995. Windspeed and Evaporation at the surface of the Baltic Sea. First Study Conference on BALTEX, Conference proceedings (ed. A.Omstedt). International Baltex Secretariate Publication No.3. 96 pp

Kowalewska-Kalkowska, H, 1998. Hydrologiczne i meteorologiczne uwarunkowania zmiennosci pol fizycznych wod w strefie brzegowej Zatoki Pomorskiej [Hydrological and meteorological determination of water physical fields in the coastal zone of the Pomeranian Bay], Problemy fizyczne ekologii wod naturalnych, Materialy, Konferencje, 36, Wyd. US, Szczecin, t.1, 217-226.

Kozuchowski K, A Stolarczuk and B Wisniewski, 1993. Many years changes of sea level in Swinoujscie (1811-1990), International Conference „Global Warming and Contemporary Climatic Changes in Poland", Wyd. US, Szczecin, s.31.

Kozuchowski K, A Stolarczuk and B Wisniewski, 1995. Klimatyczna zmiennosc poziomu morza w Swinoujsciu (1811-1990) [Climatic changeability of sea level in Swinoujscie], Contemporary Climatic Changes, Rozprawy i Studia. t.224 „Wspoczesne zmiany klimatyczne", Wyd. US, Szczecin.

Lepparanta, M (ed), 1998. Physics of ice-covered seas (2 vol.). Helsinki 1998.

Majewskiego, A and Z Lauera, 1994. Atlas Morza Baltyckiego. Instytut Meteorologii i Gospodarki Wodnej, Warszawa.

OECD, 1994. Megascience: The OECD Forum. Oceanography. Organisation for Economic Co-operation and Development, Paris, France. ISBN 92-64 14205-3.

Pugh, D P and L Skinner, 1996. An analysis of marine-related activities in the UK economy and supporting science and technology. IACMST Information Document No. 5. IACMST, Southampton, UK.

Seina, A and E Palosuo, 1993. The classification of the maximum annual extent of ice cover in the Baltic Sea 1720 - 1992. MERI no. 20, Helsinki str. 5-13.

She, J and J W Nielsen, 1999. Operational Wave Forecasts over Baltic and North Sea. DMI Scientific Report 99-7. 25 pp

Sjöberg, B (ed), 1992. Sea and Coast - National Atlas of Sweden. SMHI.

Soares, M, 1998. The Ocean our Future. Cambridge University Press, 248pp.

Stel, J H (ed), 1996. Proceedings of the First EuroGOOS Conference, 7-11 October 1996, The Hague, The Netherlands. Elsevier Oceanography Series, 62. ISBN 0 444 82892 3.

Sztobryn, M and W Krzymiñski, 1999. Extreme sea level events, sea-ice conditions, mean surface temperature and mean salinity changes during last 45 years - Gulf of Gdansk. Publicationes Instituti Geographici Universitatis Tartuensis, nr 84. Publications of Second Workshop on the Baltic Sea Ice Climate, Tartu, Estonia 1999, pp 26-36.

Sztobryn, M., M Kalas and A Staskiewicz, 1997. Changes of mean sea level and ice conditions in Gdynia as indicators of climate changes in the Gulf of Gdañsk. Sensitivity to Change: Black Sea, Baltic Sea and North Sea. Kluwer Academic Publishers. pp 1-9.

Toompuu, A and F Wulff, 1993. Spatial large-scale correlations for optimal interpolation of temperature, salinity and nutrient concentrations in the Gulf of Finland. Environmetrics 6: 55-72.

VTT. Icemap 2.8 user's manual. VTT/Laboratory for Information Processing.

Weiher, R F (ed), 1999. Improving El Niño Forecasting: The Potential Economic Benefits. US Department of Commerce, NOAA.

Wisniewski B, 1993. Warunki sztormowe i sytuacja nawigacyjna w czasie wypadku promu „Jan Heweliusz"[Storm conditions and navigation situation during the accident of ferry „Jan Heweliusz"], V Miedzynarodowa Konferencja „Inzynieria Ruchu Morskiego", Sekcja Nawigacji Morskiej Komitetu Geodezji PAN, Wyd. WSM, Szczecin, s.173-183.

Wisniewski B, 1996. Wezbrania sztormowe na polskim wybrzezu Baltyku [Storm surges at the Polish coast of the Baltic], Ogolnopolska Konferencja Naukowa „Wspolczesne problemy srodowiska wodnego", Wyd. Politechnika Szczecinska, s.219-230.

Wisniewski B, 1998. Falowanie wiatrowe [Wind waves], Rozprawy i Studia T.(CCCIV) 230, Wyd. Naukowe US, Szczecin, s.234.

Woods, J D, H Dahlin, L Droppert, M Glass, S Vallerga and N C Flemming, 1996. The Strategy for EuroGOOS. EuroGOOS Publications No. 1. Southampton Oceanography Centre. 132 pp. + Annexes. ISBN 0-904175-22-7.

Annexe 2
Excerpt from Baltic TT Report 1999

1. Achievements of the Baltic Sea Task Team - Baltic Ocean Observing System (BOOS)

a) Agencies active in BOOS

- Bundesamt fur Seeschiffahrt und Hydrographie (BSH), Germany
- Danish Hydraulic Institute, Denmark
- Danish Meteorological Institute (DMI), Denmark
- Estonian Marine Institute, Estonia
- Finnish Institute of Marine Research (FIMR), Finland
- Finnish Environmental Agency, Finland
- Institute of Meteorology and Water Management (IMWM), Poland
- Institute of Oceanology (IO), Poland
- Institute fur Ostseeforschung Warnemunde (IOW), Germany
- Maritime Institute, Poland
- Royal Danish Administration of Navigation and Hydrography (RDANH), Denmark
- Swedish Meteorological and Hydrological Institute (SMHI), Sweden

b) Workshops and meetings

- First workshop May 26-27, 1997
- Second workshop, March 11-12, 1998
- Third workshop, December 17-18 1998
- Fourth workshop, April 9, 1999
- Fifth workshop, May 19-20, 1999
- Sixth workshop, November 10, 1999

c) Publications and reports

- Minutes from workshops
- BOOS Plan - Baltic Operational Oceanographic System 1999 - 2003 (under preparation)

d) Funding from EU or other sources

- No specific external funding for EuroGOOS projects

e) New products, services, observing systems, or modelling and data distribution systems

Denmark

- Establishment of oceanographic stations for real-time collection of current, temperature and salinity
- Distribution of real-time observation on internet (*www.dmi.dk/vejr/vandstand/index.html*). Co-operation between RDANH, Danish Coastal Authority and DMI
- Wave prognoses model covering the North Sea-Baltic region operational at DMI from June 1, 1999. Results available on internet
- Oil drift model operational at DMI from 1 October 1999
- Modelling activities started up in a co-operation between Danish Hydraulic Institute (DHI) and DMI

Finland

- Establishment of an oceanographic station for real-time collection of meteorological parameters, wave height, current, water temperature and salinity
- Establishment of a new real-time tide gauge data transfer network to end users
- Distribution of real-time observations of wave height on internet
- Operational wave forecasts for shipping
- Establishment of a new ship-of-opportunity transect between Helsinki and Stockholm to record surface chlorophyll-a concentrations, temperature and salinity with spatial and temporal resolution of ca. 200 m and 2 days, respectively, as well as nutrient concentrations with lower resolution
- Establishment of a new information database for environmental information via internet (http://meri.fimr.fi)
- Finnish-Estonian co-operation on ship-of-opportunity measurements, data transfer and information dissemination has started

Germany

- Continuation of establishing the automatic oceanographic station network MARNET for real-time collection of current, temperature, salinity, oxygen, nutrient and meteorological data
- Continuation of the Baltic Sea Monitoring activities (as a contribution to HELCOM) - introduction of new methods e.g. a new ship-borne bio-optical measurement system
- Modelling activities started up based on MARNET data

Poland

- Preparations (design phase) for build up a VTS (Vessel Traffic System) system, including meteorological and hydrological real-time measurements and forecasts for the ports within the Gulf of Gdansk. IMWM has been appointed as the main supervisor
- Preparatory phase for establishing an oceanographic station on oil rig "BETA" -MI for a real-time observations and transmission
- Establishment of semi-permanent crossections for ADCP measurements (six time a year) - IMWM
- Implementation of the system HIRNET for HIROMB data distribution and exchange within Internet - MI
- Preparation for implementation of HIROMB forecast data distribution among Polish institutions (on going) - IMWM

Sweden

- New gridded climatology, salinity and temperature, for Skagerrak, Kattegat and the Baltic Sea for (re)initialisation of models
- Revision (ongoing) of observational network in order to better support data assimilation in operational models and validation of forecasts
- Introduction of high resolution operational forecasting system, HIROMB, for sea level and ice, and 3-D currents, salinity and temperature. (Operational 3 nm. and pre-operational 1 nm. resolution)
- Forecast products and forecasted data fields from HIROMB on internet server
- Introduction (ongoing) of remote access and operation of drift forecasting system
- Improved SST analyses including hind casting and assimilation in HIROMB forecast
- Improvement of physics and resolution of HIROMB

- Implementation of Danish-Swedish system of environmental monitoring buoys in the Kattegat - Belt area
- Upgrade of network for real time SST observations, fixed station and ships-of-opportunity
- Trials and introduction of undulating instruments and ferry boxes on a system of ferry and cargo lines. (Partly EU-financed)

2. Resources available to Member agencies in the Task Team region

a) Major institutes, research centres and forecasting services which are operational in the region

- Bundesamt fur Seeschifffahrt und Hydrographie (BSH), Germany
- Danish Hydraulic Institute, Denmark
- Danish Meteorological Institute (DMI), Denmark
- Estonian Marine Institute, Estonia
- Finnish Institute of Marine Research (FIMR), Finland
- Finnish Environmental Agency, Finland
- Institute of Meteorology and Water Management (IMWM), Poland
- Institute of Oceanology (IO), Poland
- Institute fur Ostseeforschung Warnemunde(IOW), Germany
- Maritime Institute, Poland
- Royal Danish Administration of Navigation and Hydrography (RDANH), Denmark
- Swedish Meteorological and Hydrological Institute (SMHI), Sweden

b) Research ships and large facilities such as satellite receiving stations, modelling centres, or large computer facilities available for research on marine operational models

Research ships:

Denmark	• 3
Finland	• 1
Germany	• 10
Poland	• 3
Sweden	• 2

Satellite receiving stations:

Denmark	• 1
Finland	• 1
Germany	• 3
Poland	• 1
Sweden	• 4

Modelling centres:

Denmark	• 2
Finland	• 3
Germany	• 3
Poland	• 4
Sweden	• 4

Large computer facilities:

Denmark	• 3
Finland	• 0
Germany	• 3
Poland	• 2
Sweden	• 3

c) Organisations and companies dedicated to marine instrumentation and technological development in this region

Denmark	• 5
Finland	• 2
Germany	• approx. 50
Poland	• 1
Sweden	• 1

3. Operational requirements, economic and social

The objectives for operational oceanographic services in the BOOS area are dominated by:

- navigational safety; warnings (icing, extreme waves, extreme sea level), sea ice, rescue operations (drift forecasts)
- Navigational economy; currents, sea level, waves, sea ice
- Flood warnings
- Research; daily cruise planning
- Algae blooms, risk and drift
- environmental monitoring and protection
- sea ice mapping and prediction
- storm surge
- coastal protection
- naval operations
- recreational activities
- exploitation of marine natural resources
- pre-investment studies for marine engineering companies (pipes, cables, etc.)

4. Future projects for implementation of operational services

a) Newly funded projects which will be running for the next years

- The BOOS group has started the implementation of a BOOS homepage with linkage to relevant product at national centres
- The BOOS group has established a working group with the task to develop an efficient system for exchange of real-time data
- Implementation of operational models for the BOOS area has started at a number institutions

b) Major priorities and problems, which need to be solved (technological or scientific), in order to implement the services required

- Define and establish a Baltic real-time observation network (coastal station, open ocean stations, ferries etc.). Includes effective solution on data communication
- Capacity building in Russia and Baltic countries in transition
- Data assimilation techniques in oceanographic models
- Early warning system for the ship traffic within the Baltic Sea
- Improved information for fish stock management, area/volume with favourable conditions for cod reproduction, drift of egg and larvae
- Biogeochemical models to support decision making on environmental measures, in particular nitrogen fixation and bottom processes

c) Proposals for new projects, which should be worked out and developed within the next year to obtain funding under Framework 5. Suggest topics, objectives, or new work being planned

- Info-BOOS
- Operational Mesoscale Analysis System
- Optimisation and Coupling of Existing Models
- Ecological Modelling
- Harmful Algae Blooms
- ENVIO-BOOS
- Use of Remotely Sensed Data (Radar, Satellite)
- Antropogenic Load Model
- Optimising Existing Operational Observing Network
- Current Assessment of the State of the Baltic Environment

d) Requirement for research and development, or new operational systems at the European level, which are needed to provide the infrastructure for your sea area of interest

- Firm agreements on data exchange policies and formats
- Wide data exchange and handling systems amongst Baltic Sea countries

Annexe 3

Addresses

- Bundesamt fur Seeschiffahrt und Hydrographie, Bernhard Nocht Strasse 78 P.O.Boks 301220, 20359 Hamburg, Germany
- Centre of Marine Research, Taikos pr.26, 5802 Klaipeda, Lithuania
- Danish Hydraulic Institute, Agern Alle 5, 2970 Hoersholm, Denmark
- Danish Meteorological Institute, Lyngbyvej 100, 2100 Copenhagen Ø, Denmark
- Estonian Marine Institute, Paldiski St. 1, 10137 Tallinn, Estonia
- Finnish Environmental Agency, P.O. Boks 140, 00251 Helsinki, Finland
- Finnish Institute of Marine Research, Lyypekinkuja 3A, P.O.Boks 33, 00931 Helsinki, Finland
- Institute fur Ostseeforschung Warnemunde, Seestrasse 15, 18119 Rostock, Germany
- Institute of Meteorology and Water Management, Waszyngtona 42, 81-342 Gdynia, Poland
- Institute of Oceanology, Powstancow Warzawy 55, 81-712 Sopot, Poland
- Maritime Institute, Dlugi Targ 41/42, 80-830 Gdansk, Poland
- Royal Danish Administration of Navigation and Hydrography, Overgaden o. Vandet 62B, 1023 Copenhagen K, Denmark
- Sea Fisheries Institute (SFI), ul. Kollataja 1, 81 - 332 Gdynia, Poland
- Swedish Meteorological and Hydrological Institute, 60176 Norrkoping, Sweden
- University of Gdansk, Al. Marszalka Pitsudskiego 46, 81-378 Gdynia, Poland
- University of Latvia (UL), 8 Zellu Str., Riga, LV1002, Latvia
- Warsaw University of Technology, Nowowiejska 20, 00-653 Warsaw, Poland

Annexe 4

Acronyms

ADCP	Acoustic Doppler Current Profiler
ANTLOMO	Anthropogenic Load Model
BALTEX	Baltic Sea Experiment
BOOS	Baltic Operational Oceanographic System
CNR	Consiglio Nazionale Delle Ricerche, Italy
CTD	Conductivity Temperature Depth
DAC	Dedicated Analyses Centres
ECOMOD	Ecological Modelling
ENVIO-BOOS	Environmental component of BOOS
EU	European Union
EUMETNET	European Meteorological Network
EuroGOOS	European Global Ocean Observing System
GOOS	Global Ocean Observing System
GTS	Global Telecommunication System
HABWARN	Harmful Algae Blooms
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission)
HIRNET	HIROMB Data Network
HIROMB	High Resolution Ocean Model for the Baltic Sea
IBSFS	International Baltic Sea Fisheries Commission
ICES	International Council for Exploration of the Sea
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer (Fr)
IHO	International Health Organisation
INFOBOOS	BOOS Information System
IOC	Intergovernmental Oceanographic Commission (Unesco)
MARNET	German automatic oceanographic station network
MOCOB	Model Coupling and optimisation in BOOS
NCMR	National Centre for Marine Research of Greece
OCCAM	Ocean Circulation and Climate Advanced Modelling
OECD	Organisation for Economic Co-operation and Development
OOSD	Optimal Observation System Design
POL	Proudman Ocenaographic Laboratory, UK
PROBASS	Current Assessment of the State of the Baltic Environment
PRODAS	Development of a Prototype Ocean Data Analysis System
RESEDA	Use of Remotely Sensed Data (Radar, Satellite)
RIKZ	Directoraat-Generaal Rijkswaterstaat, The Netherlands
SAR	Synthetic Aperture Radar
SAWG	Science Advisory Working Group of EuroGOOS
SOON	Sustained Ocean Observing Network Operational Oceanography
TPWG	Technology Plan Working Group of EuroGOOS
TT	Task Team
UNCED	United Nations Conference on Environment and Development
VTS	Vessel Traffic System
WG	Working Group
WMO	World Meteorological Organisation

Membership of EuroGOOS

CERFACS, France
Consiglio Nazionale Delle Ricerche (CNR), Italy
Danish Meteorological Institute, Denmark
ENEA, Italy
Environment Agency (EA) (formerly NRA), UK
Finnish Institute of Marine Research, Finland
IFREMER, France
Institute of Marine Research, Bergen, Norway
Institute of Marine Sciences, Turkey
Institute of Oceanology, Polish Academy of Sciences, Poland
Institution of Marine Biology of Crete, Greece
Instituto Español de Oceanografia (IEO), Spain
Koninklijk Nederlands Meteorolologisch Instituut (KNMI), Netherlands
Marine Institute, Ireland
Météo France
Meteorological Office, UK
MUMM, Department of Environment, Belgium
Nansen Environmental and Remote Sensing Center, Norway
National Centre for Marine Research of Greece
National Institute for Coastal and Marine Management (RIKZ), Rijkswaterstaat, Netherlands
Natural Environment Research Council (NERC), UK
Netherlands Geosciences Foundation (GOA), Netherlands
Norwegian Meteorological Institute (DNMI), Norway
Polish Institute of Meteorology and Water Management, Maritime Branch, Poland
Puertos del Estado, Clima Marítimo, Spain
Royal Danish Administration of Navigation and Hydrography, Denmark
Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), Russia
Swedish Meterorological and Hydrological institute, Sweden