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Anders Omstedt

45 years of wandering - from processes to systems, through outer and inner seas

An interview by Hans von Storch and Marcus Reckermann
with a foreword by Jüri Elken

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Front cover: Anders Omstedt in 1998 (Photo by Ingvar Anehed)

About this interview

This interview was conducted based on personal discussions and e-mail conversations with Anders in 2019 - the most important one at the Waterfront Hotel by the Göta River in Göteborg. **There, we also recorded Anders' video statement, which is part of this interview and which is available at the Baltic Earth website (http://baltic.earth/interviews).** Anders was kind and agreeable as ever but very focused, and we shot the impressive statement, which is 10 min long, in one take.

This interview is part of a series of interviews that Hans von Storch, together with others, has conducted with outstanding scientists over the past decades, mostly in the field of climate research, meteorology and oceanography. (http://www.hvonstorch.de/klima/interview.htm)

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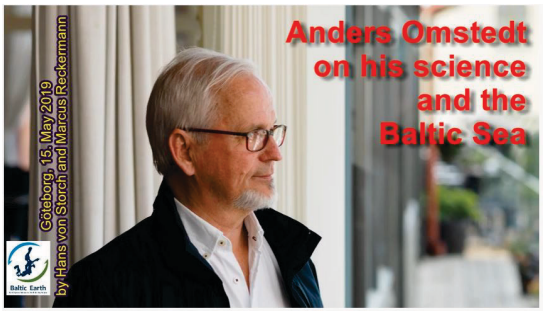
- von Storch, H. and M. Reckermann, 2020: Anders Omstedt: 45 years of wandering - from processes to systems, through outer and inner seas. An interview. International Baltic Earth Secretariat Publication No. 17, 2020. ISSN 2198-4247

Photos were provided by Anders Omstedt and Hans-Jörg Isemer.

Anders' video statement available at

http://baltic.earth/interviews



Some words from the International BALTEX and Baltic Earth Secretariat

Anders has been in the BALTEX and Baltic Earth boat since its launch, and he has always been on the bridge, sometimes as the captain, sometimes as the alert watchman to help set new course and avoid groundings. For new crewmembers, he has always had an understanding and motivating word and gave support wherever he could. We thank Anders for many years of cordial and fruitful collaboration!

Marcus Reckermann, Silke Köppen and Hans-Jörg Isemer

Preface

This is another account of an eminent and fine scientist on how our field and its community grew and matured in the past 40 and more years. As in the previous cases, we are not so much interested in institutional developments and related careers, but in how scientifically productive individuals perceive the course of science, knowledge, understanding and paradigms. Note that “perception” means subjective accounts, not claims of truth.

So far, all interviewed people have been “old white men” who do not feel the urge to convince others of their greatness, but who want to share their excitement about ideas, methods and concepts, without missionary dominance.

Anders Omstedt fits really well in this description - a “nice guy”, modest but determined, who has contributed to our understanding of the interplay of ocean, sea ice and atmosphere in the Baltic Sea region - and who contributed significantly to the formation of a most successful egalitarian scientific community, namely BALTEX and Baltic Earth. A community with many different languages and very different scientific socialization of their members. A community, which contributed to overcome the unfortunate separation of the scientific realms in the East and West, and which is now overcoming disciplinary borders.

Anders Omstedt, himself a physically trained oceanographer, has been a key player in the process of building the paradigm of the Baltic Sea region as one geographical system, harboring many exciting challenges concerning processes, mechanism, monitoring and impacts.

Ooh, did we forget to mention that Anders is a real Gentleman? - He is.

Hans von Storch and Marcus Reckermann, January 2020

Foreword

Some four decades ago, in the 1970s, when our good and respected friend Anders Omstedt started his career in oceanography, it was a very interesting and even revolutionary time for this discipline. New sensor-based high-resolution observation techniques, computer-based numerical modelling opportunities and satellite-based images of sea- and land surfaces called for innovative approaches in oceanographic research. Who else could have handled this better than the young generation of enthusiastic scientists like Anders, well educated in physics, mathematics and computer science? It is very interesting to read in this interview how Anders navigated the different aspects of top level ocean and climate science.

Policy-driven research questions were on the agenda already in the nearly ancient 1970s. In Sweden, an economically very hot topic was on the table, about a cold issue: increasing winter navigation needed much better information on ice dynamics. Anders got that job, and he was excellent. He understood quite soon that the sea surface could not be well handled without good process knowledge in the atmosphere and the underlying stratified water column. Following a number of professional research reports, Anders' first "classy" paper was published in Tellus in 1983, about autumn cooling in the Bay of Bothnia, using the complete contemporary research arsenal. The full hydrothermodynamical numerical model with vertical resolution included the new ƙ-ϵ model for turbulence (introduced by Rodi just in 1980). It was driven using advanced heat flux descriptions at the sea surface and was validated by observed thermal stratification time series, conducted on autonomous buoy stations by tape-recording thermistor chains. Awarded for these results, including his work on initial ice formation, Anders received his PhD in 1985 from Göteborg University, and subsequently broadened his ice dynamics studies, also pursuing a fruitful cooperation with Canadian scientists.

For the systems approach, the vertical resolution of sea dynamics is not sufficient – the sea consists of interconnected basins. Anders built the first realistic-as-possible basin-resolving model of the Baltic Sea, published in 1990. It can be easily integrated over very long periods, as long as forcing data are available. This was well in advance of the coming societal needs; remember that climate change was not a public issue in those times. As a branch of this PROBE approach, the ecosystem-oriented BALTSEM model is widely used by many scientists up to now. However, the Baltic Sea is not the only multi-basin sea. Anders has successfully implemented his modelling approach in the Mediterranean Sea, together with an Egyptian colleague.

Environmental and climatic applications of physical oceanography came to Anders' research agenda already in the end of 1990s. He is highly acknowledged for detailed studies of atmospheric and hydrological forcing. Working towards closed budget estimates of water and heat fluxes, he was able to extend the forcing data half a millennium backwards, covering different medieval climate periods. Together with his younger colleagues, Anders made very interesting historical reconstructions of Baltic Sea temperature, sea ice, salinity, river runoff and oxygen, which serve as a good basis for understanding the ongoing and future climatic and environmental changes.

Anders has always been looking for new scientific challenges. In the mid-2000s, he discussed that physical oceanography and related modelling skills could be applied to the chemistry-based carbon dioxide and acidification topics, anticipating that this concept could be interesting and fruitful. Anders decided to follow this path and initiated a cooperation between biochemical and carbon system modelling and modern observation techniques, including data collected by the FerryBox systems, i.e. sensors installed on regularly operated

ferries and cruise ships. The published papers demonstrate that the carbon cycle plays an essential role in the assessment of changes in eutrophication and hypoxia.

Anders likes writing very much. This usually means a good and creative silence in the working cabinet. However, Anders frequently needs to go out to provide inspiration and motivation for colleagues and the wider public. He is well known for his speeches, conference presentations and organization of cooperation. We highly acknowledge the fundamental role Anders played in the BALTEX cooperation, and as a permanent caretaker of its progress.

Jüri Elken, 23 January 2020

The Interview

The 1970s

When leaving school, you opted for environmental science. Why did you do so, and what was, in those days, "environmental science"? Which opportunities did the university have for you? Which challenges?

After military service, I started in a civil engineering programme in Linköping but was not happy with the pedagogic approach and with the many boring lectures. I therefore changed direction and went into university studies in mathematics at Stockholm University. It was such a liberation to have just a few lectures each week and have time to go deeper into mathematics.

At that time, I became aware that I could study oceanography at the University of Gothenburg, but before doing so, I studied physics for half a year at Stockholm University and then moved to Gothenburg. After the first year of oceanographic studies, I started to think about how to get a job; in Sweden, more meteorological students found jobs than oceanography students. I therefore went back to Stockholm University and studied meteorology. After a year, I found a job as meteorology assistant in a Swedish-Finnish winter navigation research programme at SMHI.

It was easy at the time to follow your own ideas without being pushed into education programmes, which for me was very inspiring. I was fascinated by the ocean and did not know much, but I was driven by the feeling that I would like to learn more, and I liked reading. In 1972, the UN conference on the environment was taking place in Stockholm, but I was not involved. Instead, the Vietnam War was escalating, and I became strongly engaged against it. At that time, SMHI had moved from Stockholm to Norrköping, and I moved to the countryside outside Norrköping, which gave me new perspectives. In late 1970, energy production using nuclear power plants became a political topic, and Sweden held a referendum on nuclear energy in 1980. Together with colleagues at SMHI, we organized several study courses on the negative environmental effects of nuclear power.

A main issue was winter navigation in the Baltic Sea, which was mostly related to sea ice forecasting. In those days, satellite data were not yet available for routine operations. How was that done, and which scientific challenges emerged?

The winter navigation programme in which I was involved included two parts. One was related to sea ice forecasting and the other part to sea to ice mapping. The programme started at the beginning of the 1970s, when it was realized that for industrial development in the northern Baltic Sea, it was necessary to have year-round shipping. Before that time, shipping in the Gulf of Bothnia was halted during the icy season. Ice mapping was done by persons reporting on ice conditions along the coasts and by airplane observations. Sea ice, analysed by maps, was irregular in time and space and poor in information regarding leads, thicknesses, ridges and changes. My scientific challenge was to go from ice map information to the modelling of sea ice dynamics and thermodynamics, in which many different physical processes occur.

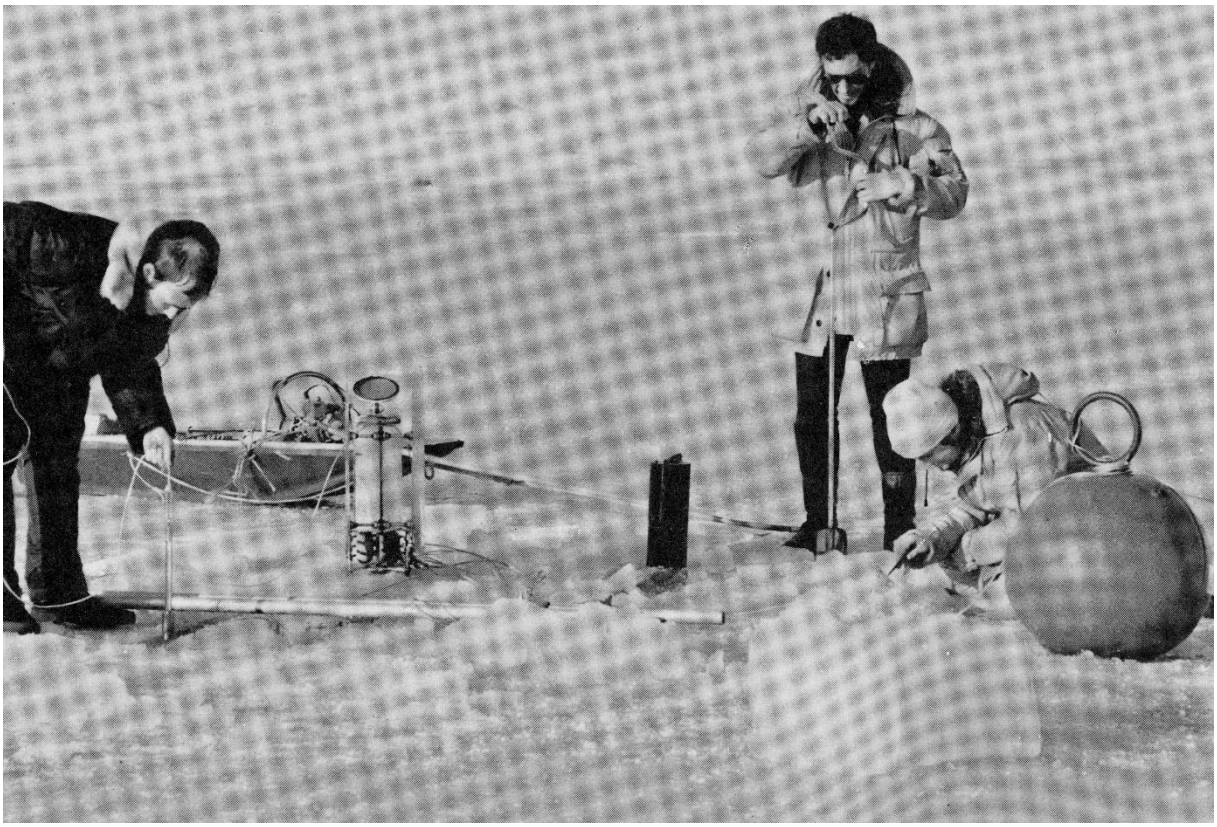


Fig 1. Field studies of Anders Omstedt (right), together with Jan-Erik Lundqvist (left) and Ingemar Udin (middle), both of whom are from SMHI.[1]

When did satellite products become available, first in an experimental way and later in an operational way? Which products were these? What was the effect when scientists obtained in this manner a synoptic view of the details of what was going in the Baltic Sea? Did it have an effect on your own work?

In 1974, our first sea ice experiment from the winter of 1973/1974 was reported to the Winter Navigation Board.[1] The field experiments were related both to ice dynamics and to ice mapping. The researchers at SMHI were Thomas Thompson, Ingemar Udin and Jan-Erik Lundqvist, all of whom had meteorological backgrounds. Later, Jörgen Sahlberg and Leif Nyberg, both with oceanographic backgrounds, became important co-workers. In the Finnish part of the programme, Erkki Palosuo and later Matti Leppäranta joined and contributed sea ice knowledge.

At the time, there was great interest in satellite information, and both NOAA 2 AVHRR data and ERTS-1 data were available. The NOAA satellite, measuring infrared emissions and estimating sea surface temperatures and ice, provided rather coarse daily information and only during cloud-free periods. The ERTS satellite included a multispectral scanning radiometer, providing high-resolution (70-100 metres) information. It penetrated through the clouds but was available only in limited areas over the Baltic Sea every 18th day. The ERTS data were on the right scale for identifying leads and illustrated many more ice features than the

[1] Omstedt, A., Thompson, T., and Udin, I. (1974). Havsisundersökningen i Bottenviken 1974. Forskningsrapport nr 8, Styrelsen för Vintersjöfartsforskning, Sjöfartsverket i Sverige och Sjöfartsstyrelsen i Finland

old ice maps. These data truly caught my and many scientists' curiosity. Later, satellite information led to a variety of products used in operational sea ice services but still with limitations due to the complex sea ice structure.

In this first phase of your work, the conceptual focus was to study processes, particularly the formation and breaking up of sea ice. The idea was that understanding the mechanics of the involved significant processes would allow for understanding and eventually predicting the system of sea ice dynamics. Could you elaborate on this concept?

Based on field observations during 1973/74 and the next field experiment, "Sea Ice -75", I received my Bachelor's degree in oceanography, related to the dynamics of sea ice, which was later published (Fig 2).[2] From observations, I calculated the force balance in sea ice and illustrated that, in the Baltic Sea, the dominant forces were wind, currents, Coriolis forces and internal friction. One of the weakest points in this study was estimating the mean sea ice thickness with its level and ridged ice, for which almost no data were available. The modelling of internal friction was tricky since it involved the break-up and ridging of sea ice processes. My inspiration here was the AIDJEX (Artic Ice Dynamic Experiment) programme, which launched a number of drifting buoys in the Arctic Ocean and improved the ideas about ice drift. AIDJEX was led by Norbert Untersteiner who was very inspiring as a scientist and organizer. Here, I also met Jim Overland, John Wettlaufer and many other world leading scientists.

My curiosity was now directed towards understanding the coupling among atmosphere, ice, water and land, leading to almost 20 years of active sea ice research, including my Ph.D. and a number of publications. The research was closely connected to international research, and my approach was to build numerical models, based on field observations. Here, I had great help from Urban Svensson, who developed a numerical equation solver called PROBE (Programme for Boundary Layers in the Environment), based on his experience working with Brian Spalding in the UK. This equation solver, using finite volume methods, gave me an effective instrument for addressing a large number of processes and coupled model systems. In the beginning of the 1990s, research together with Leif Nyberg and Jörgen Sahlberg could introduce a new forecasting system for sea ice thermodynamics and drift at SMHI. The dynamic part of the ice model had been developed in a Finnish-Chinese programme with Matti Leppäranta as lead scientist, and it was applied to the Bohai Sea and the Baltic Sea (the BOBA model) and was later applied in a coupled North Sea-Baltic Sea model by Corinna Schrum. In our BOBA model version, the ice-ocean coupling was assessed through PROBE and using a division of the Baltic Sea based on ice climatology regions.[3,4]

[2] Udin, I., and Omstedt, A. (1976). SEA ICE -75, Dynamical report. Forskningsrapport nr 16:8, Styrelsen för Vintersjöfartsforskning, Sjöfartsverket i Sverige och Sjöfartsstyrelsen i Finland

[3] Omstedt, and Nyberg, L. (1995). A coupled ice-ocean model supporting winter navigation in the Baltic Sea. Part 2: Thermodynamics and meteorological coupling. SMHI Reports, RO 21.

[4] Omstedt, A., Nyberg, L. and Leppäranta, M. (1994). A coupled ice-ocean model supporting winter navigation in the Baltic Sea. Part 1. Ice dynamics and water levels. SMHI Reports, RO 17, 17 pp.

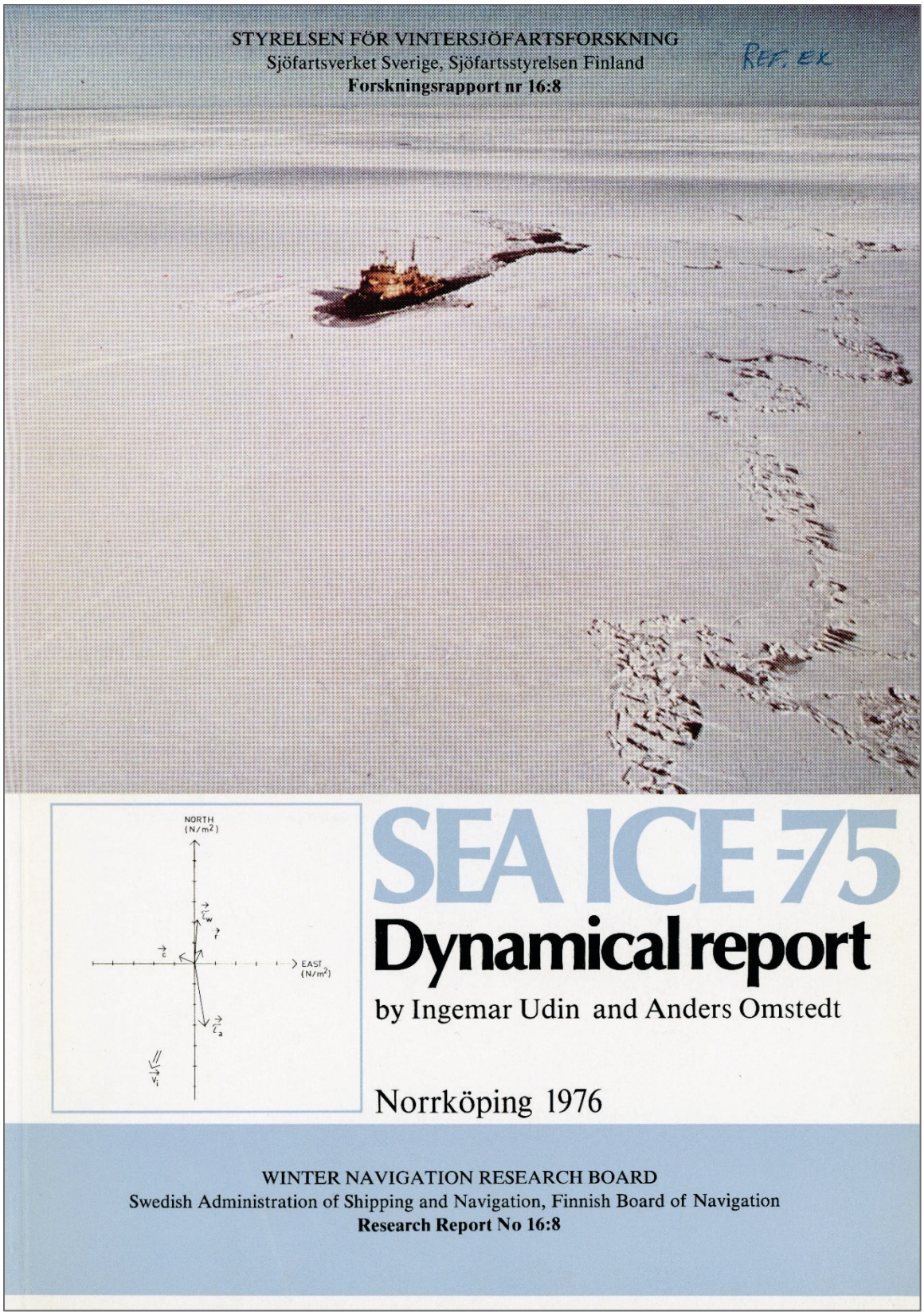


Fig 2. The force balance of drifting sea ice in the Bothnian Bay is investigated.[2]

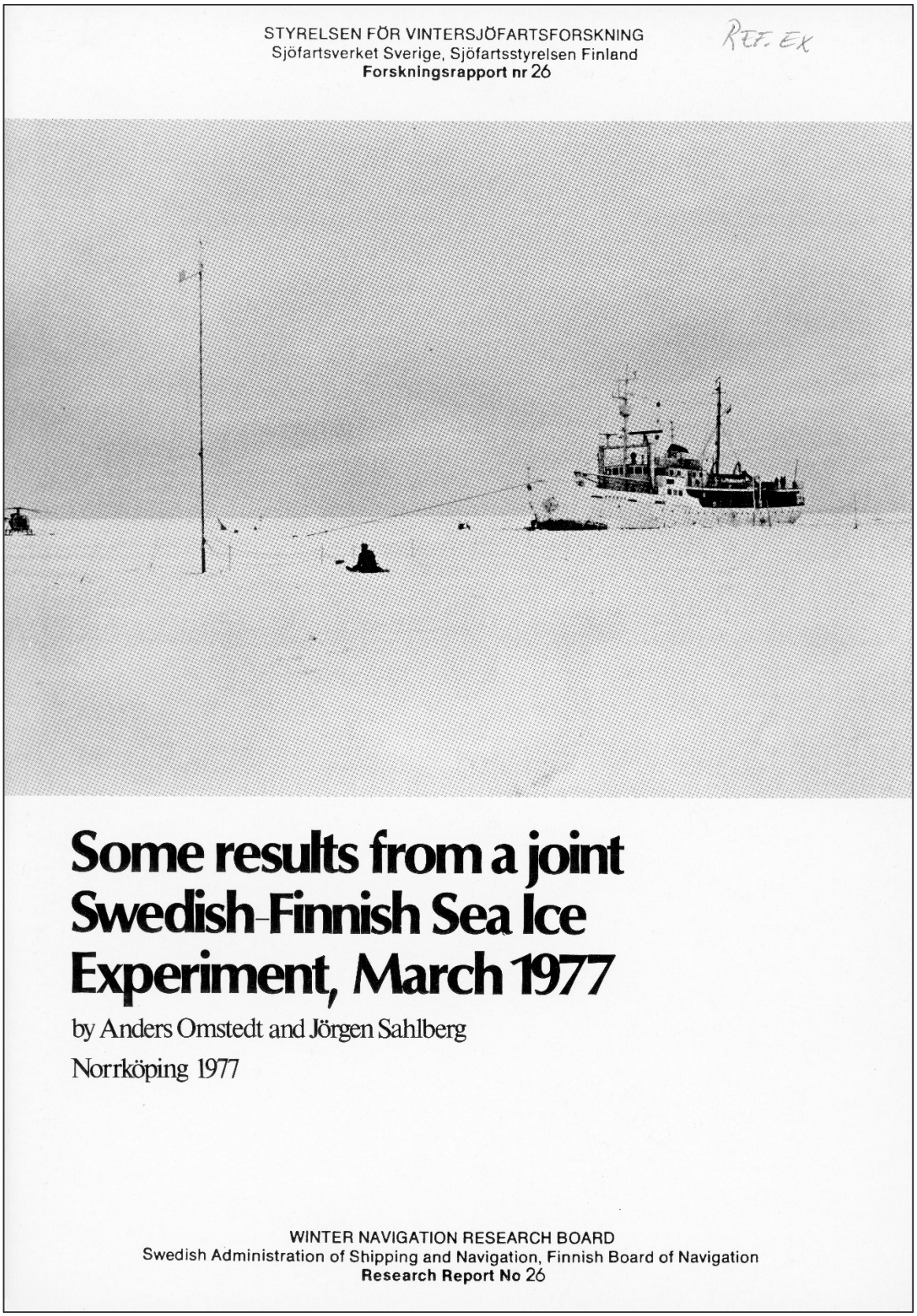


Fig 3. Drifting ice experiment with the Finnish research vessel *Aranda*.[5]

[5] Omstedt, A., and Sahlberg, J. (1978). Some results from a joint Swedish-Finnish sea ice experiment, March 1978. SMHI Reports, RMK 10, Norrköping, Sweden

If you look back, which experience in the 1970s was most important – not only for you scientifically but also for the scientific community?

Already in the winter of 1973/74, I was involved in making field observations on drifting sea ice. The results were published as reports in the Swedish and Finnish Winter Navigation Research Programme. Personally, I learned to organize and publish field experiments. The observations opened a number of new research questions. One of the most exciting personal experiences was that theoretical consideration could result in simulations not far from observations, which challenged my thinking, provide a new philosophical experience that theory can yield insights about nature but that there is much more to learn. From my Ph.D. tutor Professor Gösta Walin, I also learned to question my own and others' results.

The field data that we collected and published were new for the Baltic Sea and opened up collaboration in international research, including the Baltic Sea countries, USA, Canada, China and Japan. For the science and remote sensing communities, it was important to obtain new observations from coastal seas that were different from the Arctic Ocean with regard to ice-atmosphere-ocean properties. With a limited research budget, we were able to interact with a large international network working on polar and sub-polar seas.

How were international research and collaboration organized in the '70s? Is there a big difference compared to today? Was there much international collaboration and were there international opportunities for students back then?

The Baltic Sea ice community was well organized with regular meetings sharing operational and research results. One of the international research programmes that also became my school of science was the Arctic Ice Dynamics Joint Experiment (AIDJEX). They published regular AIDJEX bulletins with quite open-minded discussions about many aspects of ice in the Arctic Ocean. The programme was led by Norbert Untersteiner, Professor of Atmospheric Sciences in Seattle, who also formed the Arctic Buoy Programme.

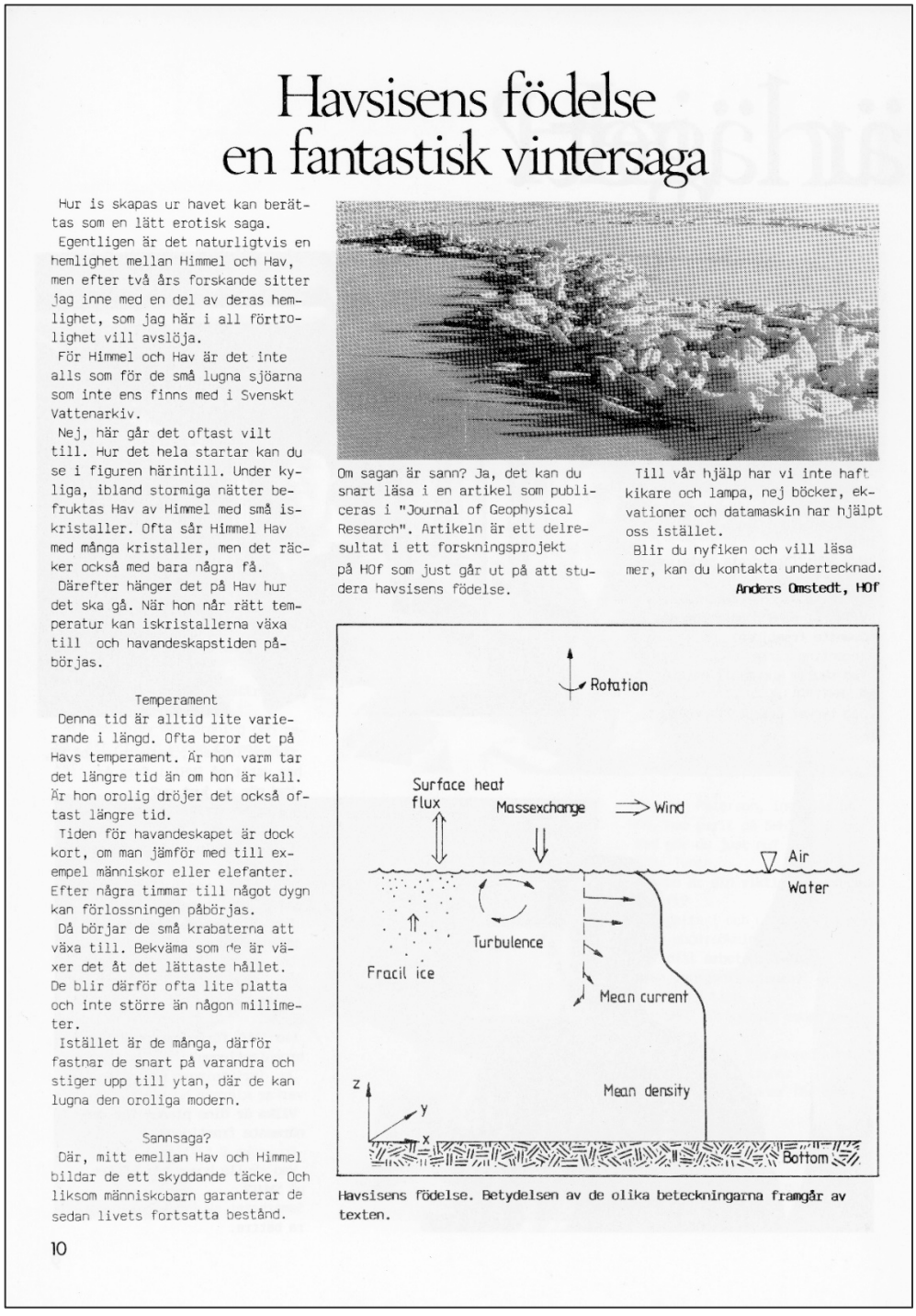
Untersteiner took initiatives in organizing summer schools, e.g., in 1981 in Maratea, Italy. I was able to participate in this summer school, where I met many scientists whose papers I had been reading -- a very stimulating experience. I was also able to give a presentation on modelling Frazil ice. Later, I was a member of the Working Group on Thermal Regimes of the Section on Ice Research and Engineering of the International Association for Hydraulic Research. The work was driven by Steven Daly at CRREL, resulting in a state-of-the-art report on Frazil ice, and I became the author of a chapter on numerical simulations of Frazil ice. [6]

My research was also closely connected to Finland. For me, the interesting research developments took place in the USA, Canada, Japan and Finland. It was not until the 1990s and the formation of the BALTEX programme that my research collaboration became more European oriented. A major difference between the 1970s and today is that the research was mainly financed by national money and the Swedish-Finnish winter navigation programme.

[6] Omstedt, A. (1994). Numerical simulation of frazil ice. In: Report on Frazil Ice, ed. S.F.Daly. CRREL Special Report 94-23.

The 1980s

Already in the 1980s, I was interested in the connection between science and the arts and wrote a popular article in the internal SMHI journal *Vind för Våg* about the birth of sea ice as a winter fairy tale (Fig 4).



Havsisens födelse
en fantastisk vintersaga

Hur is skapas ur havet kan berättas som en lätt erotisk saga.
Egentligen är det naturligtvis en hemlighet mellan Himmel och Hav, men efter två års forskande sitter jag inne med en del av deras hemlighet, som jag här i all förtrolighet vill avslöja.
För Himmel och Hav är det inte alls som för de små lugna sjöarna som inte ens finns med i Svenskt Vattenarkiv.
Nej, här går det oftast vilt till. Hur det hela startar kan du se i figuren härintill. Under kyliga, ibland stormiga nätter befruktas Hav av Himmel med små iskristaller. Ofta får Himmel Hav med många kristaller, men det räcker också med bara några få.
Därefter hänger det på Hav hur det ska gå. När hon når rätt temperatur kan iskristallerna växa till och havandeskapstiden påbörjas.

Temperament

Denna tid är alltid lite varierande i längd. Ofta beror det på Havs temperament. Är hon varm tar det längre tid än om hon är kall. Är hon orolig dröjer det också oftast längre tid.
Tiden för havandeskapet är dock kort, om man jämför med till exempel människor eller elefanter. Efter några timmar till något dygn kan förlossningen påbörjas.
Då börjar de små krabaterna att växa till. Bekväma som de är växer det åt det lättaste hållet. De blir därför ofta lite platta och inte större än någon millimeter.
Istället är de många, därför fastnar de snart på varandra och stiger upp till ytan, där de kan lugna den oroliga modern.

Sannsaga?

Där, mitt emellan Hav och Himmel bildar de ett skyddande täcke. Och liksom människobarn garanterar de sedan livets fortsatta bestånd.

Om sagan är sann? Ja, det kan du snart läsa i en artikel som publiceras i "Journal of Geophysical Research". Artikeln är ett delresultat i ett forskningsprojekt på HOf som just går ut på att studera havsisens födelse.

Till vår hjälp har vi inte haft kikare och lampa, nej böcker, ekvationer och datamaskin har hjälpt oss istället.
Blir du nyfiken och vill läsa mer, kan du kontakta undertecknad.

Anders Omstedt, HOf

Havsisens födelse. Betydelsen av de olika beteckningarna framgår av texten.

10

Fig 4. An early attempt to make science interesting for the non-experts[7]

[7] Omstedt, A. (1984). Havisens födelse. En fantastisk vintersaga. SMHI, Vind för Våg, Nr 1, p. 10

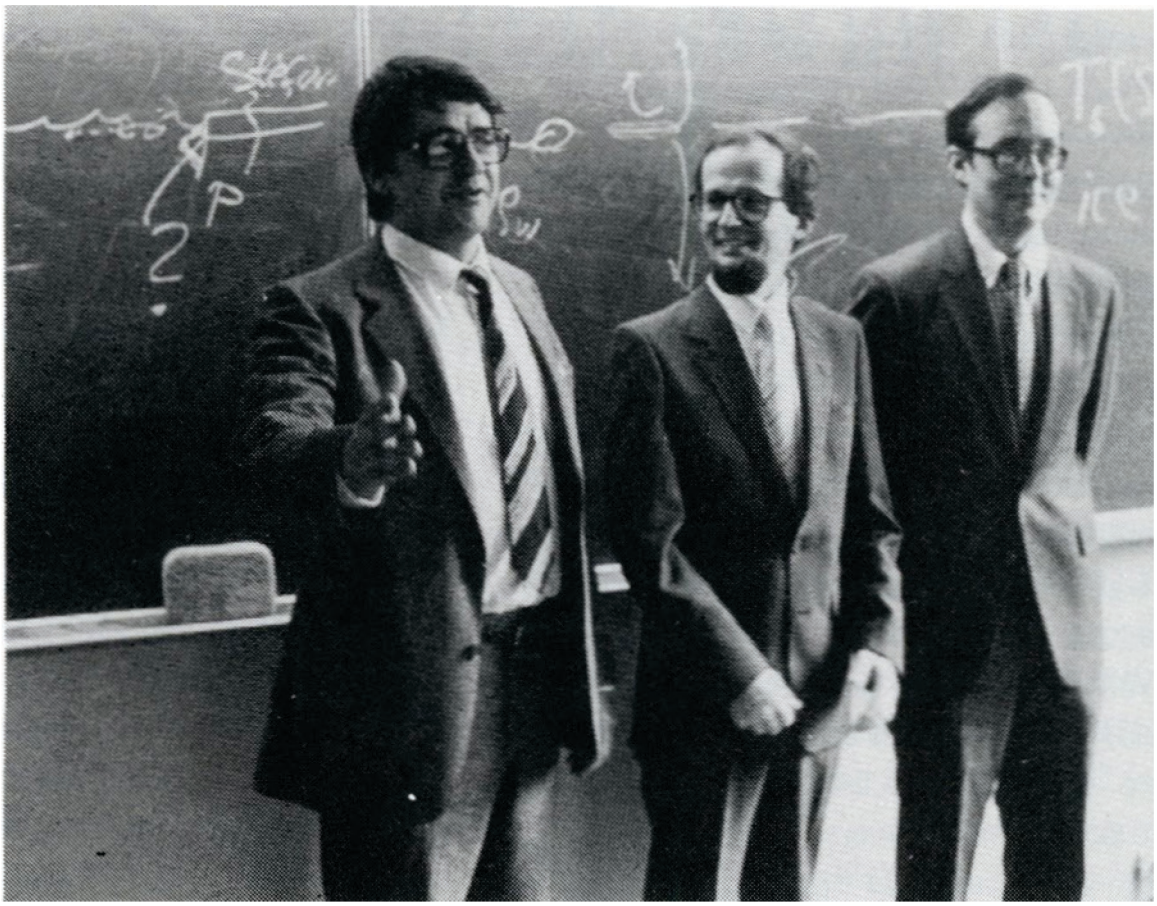


Fig 5. In 1985, Anders Omstedt (middle) defended his Ph.D. – with Seely Martin (right) from University of Washington in Seattle, USA, as opponent and Gösta Walin (left) as supervisor.

Fig 6. In 1988, Anders Omstedt visited Japan at the 9th International Symposium on Ice in Sapporo, together with colleagues from Luleå.

Fig 7. Bornö Marine Research Station played an important role and inspiration for Anders Omstedt during his oceanographic education and workshops.

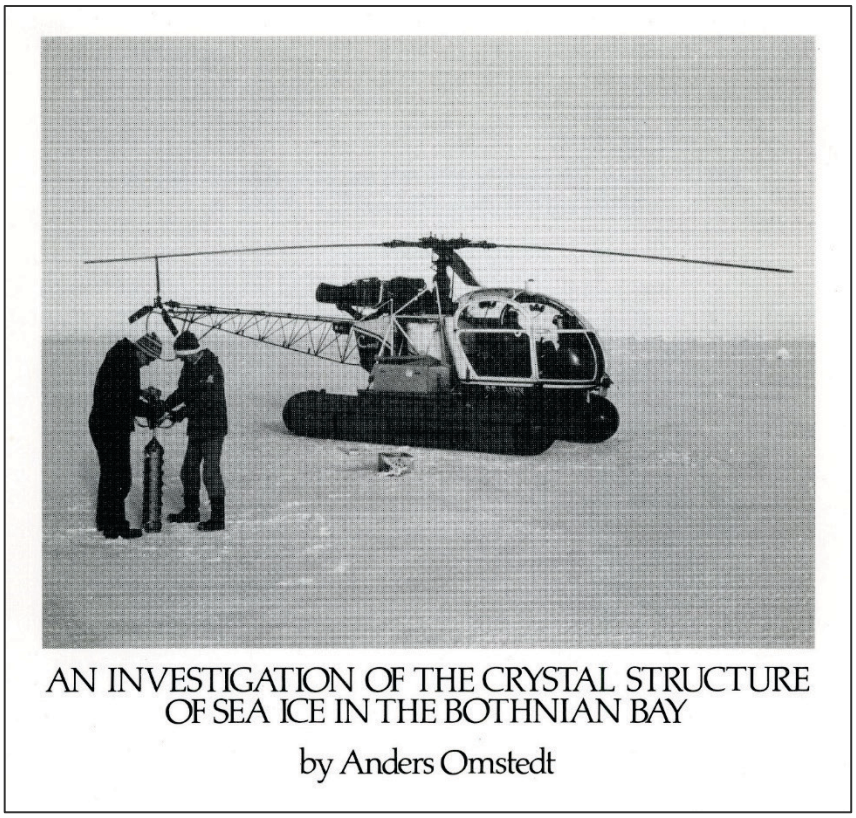


Fig 8. Ice core measurements together with Lars Åström from the University of Luleå.[8]

[8] Data available in Omstedt, A. (1985). An investigation of the crystal structure of sea ice in the Bothnian Bay. SMHI Reports, RHO 40, Norrköping, Sweden.

In the 1980s, the atmospheric and oceanic sciences in Sweden changed. The focus moved from process studies and predictions to environmental issues, particularly the issue of eutrophication. How did this change come along, and what did it mean for you?

The increasing concern about pollution of the Baltic Sea generated new efforts in integrating different scientific disciplines and generating common databases. The threats identified were the prevalence of anoxic deep basins, a decrease in the population of grey seals, and increased frequency of toxic plankton blooms, etc. In a programme financed by the Swedish Environmental Protection Agency, I, together with Nils Gustafsson and Lars Meuller at SMHI, contributed by collecting meteorological data for modelling the Baltic Sea and its drainage basin. This database became an important source of information for many Baltic Sea modelling efforts. Later, some of the results from the Swedish Environmental Protection Agency programme were published in a book by Fredrik Wulff, Lars Rahm and Per Larsson.[9]

In 1986, the Chernobyl accident occurred, generating several studies of how radioactive substances were spread in the atmosphere, on land, in lakes and in the Baltic Sea. The human dimension was later described in the book *Chernobyl Prayer* by Svetlana Aleksijevitj, illustrating how literature can describe the human dimensions in a deeper way than science.

The focus in the marine science was now moving into systems understandings, but I was not ready to go into environmental science since many physical processes were not well modelled. Instead, I followed basically two paths. The first went into processes such as turbulence, supercooling, Frazil ice dynamics, grease ice formation, sea ice growth and melting, sea ice drifts and ridging, while on the other path, I started to build system understanding by modelling lakes and coastal seas in a simplified manner, focusing on observations and the most important physical processes.

When we prepared for this interview, you mentioned that a key moment for understanding the hydrodynamics of the Baltic Sea was when the first satellite images became available, demonstrating that the Baltic Sea was actually filled with eddies and that the variability in the Baltic Sea was not mostly due to wave dynamics, as well as strong eddy activity. Did it represent a shift in paradigm, and what did this finding imply?

Most ocean models at that time had a very crude treatment of processes such as ice, strait flows and turbulence, and they were coarse in model resolution. In the 1970s, much concerned general ocean circulation, external and internal waves. When the first satellite images became available in the late 1970s, many eddies were also shown in the Baltic Sea. Ships' observations of these eddies (named Meddies in the Mediterranean and Beddies in the Baltic Sea) came later, and the science community was -- and still is -- uncertain about how to interpret and model their importance.

Through the equation solver PROBE, I gain access to a well-tested two-equation turbulent model and started to investigate temperature and salinity effects in a turbulent Ekman layer. The coupling with the atmosphere underwent a number of processes and needed to be parameterized, in an often very crude way. Later, I established good cooperation with the University of Uppsala, where turbulent studies over the Baltic Sea took place through the work of a group around Ulf Högström, Ann-Sofie Smedman and later Anna Rutgersson. Later, I

[9] Wulff, Rahm and Larsson, Eds. 2001. A system analysis of the Baltic Sea. Springer. Ecological studies 148. ISBN 3-540-67769-0 *Link*

studied other physical processes, such as supercooling, Frazil ice dynamics and particle size distribution, grease ice formation, ice drift and ridging, sea ice growth and melting.

In 1985, I defended my Ph.D., and in 1990, I was appointed Associate Professor (docent) at the University of Gothenburg.

Through cooperation with Urban Svensson, we were able to develop several advanced models, both for Frazil ice dynamics and for ice melting. For example, we developed a model that coupled a high Reynold number turbulence model to a low Reynold number model, and it was applied to the ice-ocean interface during melting.[10]

By applying different process-oriented models to lakes and coastal seas, I gained a deeper system understanding. The first results on this research were published by Tellus in 1983 [11], showing that salinity strongly influences water cooling by stabilizing stratification of the surface, as well as deeper layers. This work increased my interest in estuarine circulation, in which in- and out-flows of different water masses added processes, such as strait flow dynamics[12], interleaving, deep water mixing and selected withdrawal[12]. Here, the work by Anders Stigebrandt was very inspiring and offered a deeper understanding of salinity dynamics and strait flow dynamics. I then worked on coupled sub-basin models, and my first Baltic Sea model was published in 1990.[13] This model was later improved with regard to sea ice, deep water mixing, strait flows, and biogeochemistry, and it became my work horse for addressing a number of environmental and climate challenge problems.

How did this change of focus coincide with changes in public attention and the role of science in advising society?

The concern about pollution in the Baltic Sea increased the pressure to improve the communication between scientists and society. The universities received new economic support for marine resources and field activities. They were given the task of supporting the Swedish government, agencies and other interested actors in their efforts to improve the marine environment. They were also asked to provide regular up-to-date status descriptions and analyses of knowledge on the seas around Sweden. The task was to transform scientific knowledge into public knowledge, and a number of professional information persons were connected to the universities. I was involved in building up the Stockholm University Marine Centre and later as a scientific coordinator at the Swedish Institute for the Marine Environment. Many scientists, including myself, were trained to write popular descriptions of their own research.

During the 1980s, I started to search for a new way of thinking and communicating. Working with science was rewarding, but facts were not everything in this communication; instead, intuition and emotions were important as well. Why, for example, could you become

[10] Svensson, U., and Omstedt, A. (1990). A mathematical model of the ocean boundary layer under drifting melting ice. J. Physical Oceanography, Vol. 20, No. 2, 161 – 171 *link*

[11] Omstedt, A., Sahlberg, J., and Svensson, U. (1983). Measured and numerically simulated autumn cooling in the Bay of Bothnia. Tellus, 35 A, 231 – 240 *link*

[12] Strait flow dynamics involve a number of processes that control the exchange of water and properties between basins connected by straits or channels. Here, the non-linear aspects of the equation of motion become important, as well as friction, stratification and selected withdrawal, which analyse the upstream depths of the flowing layers.

[13] Omstedt, A. (1990). Modelling the Baltic Sea as thirteen sub-basins with vertical resolution. Tellus, 42 A, 286 – 301 *link*

emotionally touched by some scientific presentations, whereas other science presentations are perceived as icy and boring? Or what is the difference between communicating with scientists and with children? I started to think about what was missing in analytical thinking and how I could better express emotions and promote intuition. I slowly learned, by participating in a number of summer schools, that emotions, intuition and dreams were full of knowledge when connected to analytical thinking. The new language was the language of arts, which was well described in different dramas, poems and films. I now started to read literature in a new way, with inspiration from many persons with backgrounds in arts, psychology and teaching.

In 1988, I was married to Britt, who was working as a librarian. Later, we had three children: Herman, born in 1990; Mikael, born in 1991; and Ragnhild, born in 1995. They accompanied me on many meetings and trips around the Baltic Sea and to Canada.

Fig 9. During a Great Lakes conference in Canada, the Omstedt family was visited by colleagues from SMHI. Mikael sits on Anders' lap, and Herman sits on Britt's lap. Eleonor Marmefelt, Lennart Cederberg, Lars Rahm and Bertil Håkansson join the family around the table.

The 1990s

As a scientist trained in the physical tradition, the 1980s, with eutrophication as a dominant issue, must have been difficult, but it certainly helped you later in the 1990s to engage in biogeochemistry. We will come to this later – but first, the 1990s, with the massive political changes in the Baltic Sea region, saw the advent of BALTEX and the interest in the water and energy cycles. How did this change come about?

The collapse of the Soviet Union in 1991 changed the regional science efforts in a dramatic way. Suddenly, the whole Baltic Sea was open for oceanographic measurements, and there were different regional initiatives, such as the Swedish Riga project. Together with Ragnar Elmgren and Bengt Ow Jansson, we evaluated the Estonian marine and limnology research.[14] At the same time, Tarmo Kõuts, a highly skilled oceanographer from Estonia, was working with me on deep water properties in the Baltic Sea, financed by the Swedish Institute.[15] At that time, I was also involved in the Gulf of Bothnia in 1991.

In 1992, I became a visiting scientist at the Canada Centre for Inland Waters (CCIW), Burlington, Canada, and at Institute of Ocean Sciences (IOS), Sidney, Vancouver Island, Canada. The CCIW was a leading institute regarding circulation in the large lakes, with many similarities to the Baltic Sea. Here, I was working with Ray Murthy on deep water mixing in Lake Ontario. Ray Murthy was also the scientific coordinator for the Gulf of Bothnia in 1991. At IOS, they had a leading group related to the Arctic ice and ocean processes. I was working there with Ed Carmack and Rob Macdonald on ice ocean processes at the Mackenzie shelf/estuary.

The collapse of the Soviet Union also influenced Canada in different ways; for example, much of the research budget for Arctic Ocean research was cut. Coming back from Canada in 1993, the planning had started to build up a joint research programme within the GEWEX programme, which later was called BALTEX (the Baltic Sea Experiment). GEWEX (the Global Energy and Water Exchanges project) was and is still a part of the World Climate Research Programme (WCRP), and it has been heavily involved in observation and modelling programmes to understand the Earth´s water and energy cycles, which one can say is the heart of the climate system.

The BALTEX programme could benefit greatly from the collapse of the Soviet Union, leading to the possibility of gaining access to data all around the Baltic Sea and improving research cooperation. It was also an important initiative since it put meteorology, hydrology and oceanography together, with strong components of remote sensing and modelling. This was new for Baltic Sea research, which had been dominated by national initiatives and marine biology research.

[14] Elmgren, R., Jansson, B.-O., and Omstedt, A. (1992). Marine research and limnology. Evaluation of Estonian research in natural sciences. Report to the Estonian Science Fund Council by the Swedish Natural Science Research Council, Box 6711, S-113 87 Stockholm, Sweden, 99 – 124

[15] Kõuts, T., and Omstedt, A. (1993). Deep-water exchange in the Baltic Proper. Tellus, 45A, 311-324 *link*

Fig 10. The first official BALTEX Science Steering Group meeting at HZG (then still called GKSS) in Geesthacht, 16 to 17 May 1994, with the following participants from left to right: 1st row in front: Zdzislaw Kaczmarek, Ehrhard Raschke, Dalia Smelstoriute, and Lennart Bengtsson. 2nd row: Jerzy Dera, Anders Omstedt, Peeter Karing, and Valery Vouglinskiy. 3rd row: Wolfgang Krauß, Ivan Vent-Schmidt, and Eero Holopainen. 4th row: Jouko Launiainen, Nils Gustafsson, and E. Ruprecht, 5th row: Hans-Joerg Isemer, Jürgen Willebrand, Evgenij Zaharchenko, Ivan Skouratovich, Pekka Alenius, and N. Woetman-Nielsen.

What was the significance of studying the water and energy cycles in the Baltic Sea region? This study was embedded in a larger international effort, in GEWEX/WCRP.

For an improved understanding and modelling of the global climate system, the water and energy cycles needed to be better observed and modelled. The global models were coarse, and the GEWEX idea was to use the drainage basin concept to better balance the scale problem since the point source data and global model resolution were strongly imbalanced. The closing of the water and energy cycles using the Baltic Sea and its drainage basin allowed for a consistent way to investigate how these models were able to describe water and energy cycles.

When BALTEX started, my Baltic Sea model was ready to address these cycles. At the First BALTEX Study Conference in Visby in 1995, I presented how the water and heat cycles could be closed in the Baltic Sea catchment.[16] At that conference, I also presented a first study of the sensitivity of Baltic Sea ice to climate change.[17] The study conference at Visby was the start of many other BALTEX study conferences, held on different islands all around the Baltic Sea. New students were now able to be involved in this research, and SMHI asked me to chair a Ph.D. programme that connected SMHI to Uppsala University (Anna Rutgersson), Stockholm University (Ulrika Willén), the Royal Institute of Technology in Stockholm (Phil Graham), and the University of Gothenburg (Lars Axell). This mission was truly inspiring.

In 1998, I became visiting Professor of Oceanography at the University of Gothenburg and 2001 full Professor, financed by the Swedish Research Council, which gave me a new platform for research and teaching.

Fig 11. The Baltic Sea ice community organized regular workshops – here is a group photo of the Second Workshop on the Baltic Sea Ice Climate, Otepää, Estonia, 2-5 Sept. 1996.

An interesting development in the cooperation among meteorology, hydrology and oceanography was that long-term numerical simulations of the Baltic Sea became possible. Modelling on a decadal scale immediately illustrated that the understanding of several processes in the ocean models was missing, particularly in estuarine and strait flow dynamics. Decadal and centennial model runs therefore became my mode of learning how the Baltic Sea physical system worked, and they generated a number of articles during the coming decades by my Ph.D. students and me.

[16] Omstedt, A. and A., Rutgersson (2000). Closing the water and heat cycles of the Baltic Sea. Meteorol. Z., 9, 57-64 *link*

[17] Omstedt, A. and L., Nyberg (1996). Response of Baltic Sea ice to seasonal, interannual forcing and to climate change. Tellus, 48 A, No. 5, 644-662 *link*

What were the societal and political dimensions of the new BALTEX network?

The BALTEX programme, with scientists all around the Baltic Sea and with its well-organized secretariat, could systematically improve the regional understanding of different aspects related to climate change. It started by investigating processes, and in the first phase of BALTEX, large efforts were exerted into measuring and modelling different processes, such as net precipitation over the Baltic Sea and river runoff. Later, BALTEX also included biogeochemical processes and assessments of the knowledge about regional climate change (BACC). The BALTEX meetings generated friendships between colleagues and improved collaboration and research. The BALTEX programme therefore worked for integration between western and eastern, as well as between the northern and southern parts of the region, with respect to science and national institutes.

A significant achievement of yours in the 1990s was the "snow band" article, which you published in MWR (Monthly Weather Reviews), making use of the coupling of sea ice and the atmosphere. What was this article about, and how would you assess the significance of this paper in retrospect?

In the article, we investigated the coupling between a high-resolution weather forecasting model and a coupled ice-ocean model.[18] The study showed that the sea state variables used in the ice-ocean model influenced the weather forecast, both directly on the local scale due to the local impact of surface fluxes of latent and sensible heat and on regional and larger scales. The convective snow bands with cold air mass outbreaks during winter, which can produce large amounts of snow along the Swedish east coast, were well captured as an extreme example of the influence of the sea state on a regional scale. This work clearly demonstrated the need for high resolution coupled weather-ice-ocean forecasting models and provided an inspiration when designing climate models.

The 2000s

The beginning of the 2000s saw the transition from BALTEX Phase I to Phase II. You had been in the BALTEX boat since its launch in the early 1990s and became its chair in the 2000s. Why was this transition made, and what were the differences between Phase I and II?

After almost 10 years working on processes for understanding of the water and heat cycles and building improved numerical models, the research priorities were broadened to incorporate climate change including marine acidification and environmental problems. There were still large gaps in the understanding and modelling of the water and heat cycles, and this research continued during BALTEX Phase II but now in a broader context. The reason was increasing concern about global warming, as well as regional concern about the environmental conditions in the Baltic Sea, such as eutrophication. In general, we believed that the development of our network and improved models could be important contributions to the management of the Baltic Sea.

[18] Gustafsson, N., Nyberg, L. and A. Omstedt (1998). Coupling high-resolution atmosphere and ocean models for the Baltic Sea. Monthly Weather Review ,126, 2822-2846 *link*

BALTEX Phase I had emphasized the water and energy cycles and how the budgets could be closed. What was the scientific relevance of that, and was it achieved in BALTEX Phase I? What would you consider the greatest achievement of BALTEX Phase I?

The closure of the water and heat balance was an important aspect of BALTEX Phase I and other GEWEX programmes. It starts from the drainage basin concept that states that all water and heat entering into the drainage basin can be estimated at a river outlet, or in the case of the Baltic Sea, at its entrance area. This estimate then allows a robust test of climate models with their often-coarse horizontal resolution. Based on modelling, Anna Rutgersson and I published a paper on the closure (Omstedt and Rutgersson, 2000). The closure concept also opens up the need to model strait flow dynamics in the Baltic Sea entrance area and in other Baltic Sea straits. In narrow, stratified straits, with large variations in topography, the dynamics are non-linear, complex, and often not resolved in circulation models. The knowledge about the Northern Kvark Strait between the Bothnian Bay and the Bothnian Sea was poor, and my research group, together with oceanographers at the University of Gothenburg, therefore organized a field study. The results illustrated several important aspects to be considered in the modelling of the exchange between these two basins.[19]

For me, the greatest achievement during BALTEX Phase I was that long-term numerical simulations of the Baltic Sea became possible. Modelling on decadal scales illustrated that, in the ocean models, some components were insufficiently included, particularly in the seasonal variation of sea ice and the estuarine and strait flow dynamics. Decadal and centennial model runs therefore became my school of learning how the Baltic Sea physical system worked, and I generated a number of articles.

Several aspects of model sensitivity needed to be investigated by the Baltic Sea models: initial conditions, forcing conditions and modelling of past Baltic Sea conditions. Before approaching these questions, large databases had to be created for these studies. Here, BALTEX could benefit from a much broader international research community, working to creating a better understanding of past climate and environmental conditions. Several methods were used, and gridded meteorological databases were generated for centennial time scales and were opened to the science community.

My research group could benefit from the cooperation with the group around Deliang Chen at the University of Gothenburg, Sweden, including Youmin Chen, working on statistical downscaling, and the group around Jürgen Luterbacher, now at Justus-Liebig Universität Giessen, Germany, working on gridded databases. The work resulted in a number of important studies, illustrating, for example, that models could be initialized and spun up with arbitrary conditions and that long realistic runs could be integrated without knowing specific initial conditions.[20] Other examples are winter characteristics on centennial time scales[21] and sea

[19] Green M. J.A., Liljebladh B. and A. Omstedt (2006). Physical oceanography and water exchange in the Northern Kvark Strait. Continental Shelf Research 26, 721-732. DOI 10.1016/j.csr.2006.01.012 *link*

[20] Omstedt A. and D. Hansson (2006). The Baltic Sea ocean climate system memory and response to changes in the water and heat balance components. Continental Shelf Research 26, 236-251. DOI 10.1016/j.csr.2005.11.003 *link*

[21] Eriksson C., A. Omstedt, J.E. Overland, D.B. Percival, H.O. Mofjeld (2007). Characterizing the European sub-arctic winter climate since 1500 using ice, temperature and circulation time series. Journal of Climate 20, 5316-5334. DOI 10.1175/2007JCLI1461.1 *link*

ice modelling on centennial time scales[22]. Many interesting historical events, such as Karl XI´s march across the iced Belt Sea in 1658, could now be simulated by numerical models. The long-term runs were made possible through broad international cooperation, involving three Ph.D. students (Christian Nohr, Christin Eriksson and Daniel Hansson) and Deliang Chen and Youmin Chen.

Many of my modelling experiences were later published in a book offering guidance for the design of models of lakes and coastal seas[23]. For the first time, it was possible to publish all of the model programmes and driving forces needed to reproduce the results illustrated in the book. This process demonstrated an important change in the scientific practice, making models and data available to all.

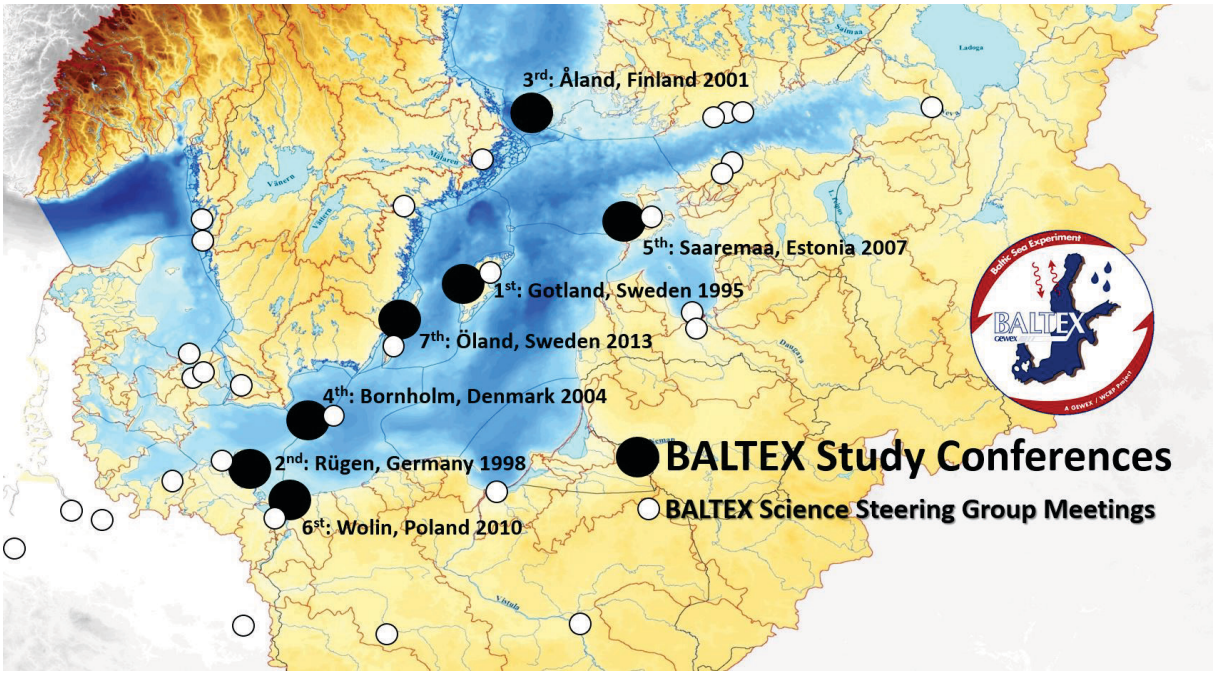


Fig 12. Locations of BALTEX Study Conferences and Science Steering Group meetings

[22] Hansson D. and A. Omstedt (2008). Modelling the Baltic Sea ocean climate on centennial time scale; temperature and sea ice. Climate Dynamics 30, 763-778. DOI 10.1007/s00382-007-0321-2 *link*

[23] Omstedt A. (2011). Guide to process based modelling of lakes and coastal seas. Springer-Praxis books in Geophysical Sciences, DOI 10.1007/978-3-642-17728-6. Springer-Verlag Berlin Heidelberg. *link* and Omstedt A. (2015). Guide to process based modelling of lakes and coastal seas. Second Edition. Springer-Praxis books in Geophysical Sciences, DOI 10.1007/978-3-319-17990-2. Springer-Verlag Berlin Heidelberg. *link*

Together with other BALTEX oceanographers, you wrote a review article on the achievements of BALTEX in Baltic Sea oceanography (Progress in Oceanography 128 (2014) 139–171). What would you consider the greatest BALTEX II achievements in oceanography, as well as in other fields?

We wrote two major reviews, first on BALTEX Phase I [24] and then on BALTEX Phase II [25]. They were reviews from an oceanographic point of view but also considered other fields of importance.

One of the great achievements was that, together with the International BALTEX Secretariat, we were able to form a new network of scientists and organizations around modelling the Baltic Sea, its drainage basin and its interaction with the atmosphere and the land. In Phases I and II, there were many improvements, e.g., that meteorological, hydrological, oceanographic and ice data were made openly available to the research community. Additionally, new types of data were generated from research vessel cruises with advanced measurements of mixing and flow patterns in the Baltic Sea, from FerryBoxes, from the Östergarnholms meteorological site, and from satellites and other instruments. At the same time, much effort was exerted on model development, with much success. Despite marked progress in Baltic Sea research over the last few decades, several gaps remain in our knowledge and understanding, such as:

- modelling of the hydrological cycle in atmospheric climate models due to large biases, with consequences for the Baltic Sea and land surface models;
- mixing processes in the Baltic Sea, with its often strong and complex salinity stratification, as well as deep water mixing;
- the carbon cycle in the Baltic Sea and its drainage basin; and
- modelling of sea ice properties, such as albedo, optical properties and ridging.

These limitations in knowledge (among other reasons) were the basis for forming the Baltic Earth programme that continued after BALTEX Phase II.

You already mentioned the BACC assessments. How did this idea come about, and what was your impulse to participate in this effort?

In an early stage of BALTEX Phase II, Hans von Storch suggested that we should initiate a regional climate assessment programme. I was in the BALTEX Science Group and strongly supported this new initiative as a new possibility to bring together a large network of scientists around the Baltic Sea, now also with climate change and historical/geological competencies. Hans von Storch later became a Doctor honouris causa at the University of Gothenburg and an inspiration to my ocean climate group.

[24] Omstedt A., Elken J. Lehmann A., and J. Piechura (2004). Knowledge of the Baltic Sea Physics gained during the BALTEX and related programmes. Progress in Oceanography 63, 1-28. DOI 10.1016/j.pocean.2004.09.001 *link*

[25] Omstedt A., Elken J., Lehmann A., Leppäranta M., Meier H.E.M., Myrberg K., Rutgersson A. (2014) Progress in physical oceanography of the Baltic Sea during the 2003–2014 period. Progress in Oceanography 128, 139-171. doi: http://dx.doi.org/10.1016/j.pocean.2014.08.010 *link*

In the 2000s and early 2010s, you became interested in the carbon cycle. How did this come about?

The carbon cycle is at the heart of anthropogenic climate change due to increased greenhouse gases. Modelling the carbon dioxide-oxygen dynamics also makes systematic studies of eutrophication and climate change possible. Here, we received good support from marine chemists such as Leif Anderson and David Turner, both from the University of Gothenburg. Additionally, Bernd Schneider and his group from Leibniz Institute for Baltic Sea Research at Warnemünde became an important inspiration for me and the BALTEX community, by making measurements of inorganic carbon and related parameters available. From these observations, it was possible to obtain new insights into primary production and biological mineralization, which are major parameters in ecosystem models. My group worked closely with Bernd Schneider, and later, he became a Guest Professor at the University of Gothenburg. Here, we could also benefit from our earlier experience on long modelling run studies from pre-industrial conditions through today. In the carbon work, three Ph.D. students (Karin Wesslander, Erik Gustafsson and Moa Edman) were involved, working closely with BALTEX Phase II. Our first article on modelling the carbon dioxide-oxygen dynamics was presented in 2009, [26] and we could use our earlier work on centennial time scales showing that, e.g., the total alkalinity could be realistically simulated. Later, several other aspects of carbon dioxide-oxygen dynamics were analysed and published.

In the 2000s, the research funding landscape fundamentally changed with the advent of BONUS. You coordinated and participated in the BONUS project yourself. What was the difference from the previous funding mechanisms?

Well, it was not so different from earlier EU programmes. Both the EU and BONUS have created a large number of research programmes with limited time periods, focusing on impacts on society. To build systematic knowledge, this approach is problematic since most scientists must leave the programmes often before mature knowledge is available and before the results are implemented into something useable for society. The funding landscape has therefore not changed. It is likely that a longer research time scale and better implementation plans could improve the research outcomes.

[26] Omstedt A., Gustafsson E. and K. Wesslander (2009). Modelling the uptake and release of carbon dioxide in the Baltic Sea surface water. Continental Shelf Research 29, 870-885. DOI: 10.1016/j.csr.2009.01.006. *link*

Fig 13. In 2001, Anders Omstedt became a full Professor at the University of Gothenburg. Later, in 2002, the formal nomination took place with colleagues, friends and family.

Fig 14. Zhanhai Zhang (left), before defending his Ph.D. on modelling ice dynamics of semi-enclosed seasonally ice-covered seas at Helsinki University in 2000. With his supervisor Matti Leppäranta (middle) and his opponent Anders Omstedt (right).

Fig 15. One of the unknown straits in the Baltic Sea, the Northern Kvark Strait, was investigated in 2003.[27]

[27] Green M. J.A., Liljebladh B. and A. Omstedt (2006). Physical oceanography and water exchange in the Northern Kvark Strait. Continental Shelf Research 26, 721-732. DOI 10.1016/j.csr.2006.01.012 *link*

Fig 16. BACC meeting in Helsinki in 2005.

Fig 17. Celebrating midsummer with Phil Graham and BACCquavavit.

Fig 18. Some of Anders Omstedt's Ph.D. students were involved in BALTEX phase II research. From left: Erik Gustafsson, Christin Eriksson, Karin Wesslander and Daniel Hansson.

Fig 19. In the BONUS programme, Anders Omstedt coordinated the programme Baltic-C, which addressed the Baltic Sea carbon cycle -- here with some of the participants during a meeting in 2009. From left: Björn Carlsson, Guy Schurgers, Karol Kuliński, Anna Rutgersson, Teresia Wällstedt, Matti Pertillä, Hildegard Kubsch, Maria Norman, Jacek Beldowski, Bernd Schneider, Janusz Pempkowiak, Annekatrin Loeffler, Magnus Mörth, Anna Maciejewska, Laura Joesuu, Aleksandra Szczepańska, and Anders Omstedt

The 2010s

In 2013, BALTEX II gave way to Baltic Earth. You had been the BALTEX II chair at the end of its period. Why did this transition occur, and how was it organized? What is different about Baltic Earth compared to BALTEX?

Yes, at the end of BALTEX II, I was co-chair together with Silja Keevallik and Hans von Storch. Baltic Earth continues the work of BALTEX Phases I and II by focusing on modelling, education and services, but now with a broader concept: earth system understanding. A difference is that Baltic Earth is addressing a number of grand challenges, following the general trend in science.

Baltic Earth has now existed for 6 years, so it is time for some recapitulation. What do you consider its achievements until now, and what are your recommendations for the future?

During its first years, it has successfully organized workshops and conferences similar to BALTEX, as well as an increasing number of summer schools -- very good activities. When the Baltic Earth Assessment Reports (BEAR), which will summarize the main achievements within the different Grand Challenges, are ready, it will be possible to evaluate the Baltic Earth initial phase.

For the future, I recommend that Baltic Earth better connect to the United Nations Sustainability Goals 2030 and particularly the United Nations Decade of Ocean Science for Sustainable Development (2021-2030). I also recommend that Baltic Earth build a systematic science-based information platform, with some of the most important time series updated. Today's young generation will need to respond to many alarming signals, and easily available facts about the changes in the Baltic Sea are needed.

I also recommend carrying on the BALTEX/Baltic Earth concept during the next decade and expanding the connection between science and the arts when illustrating important results and generating pedagogic stories that can be shared around the Baltic Sea.

Comparing the first decade of BALTEX and now Baltic Earth, it seems that the initial main scope of examining the regional water and energy cycle and hydrology/meteorology has somewhat lost its importance. Does this emphasis reflect a general shift in the research priorities, or are there other possible reasons?

Well, it has not lost importance. The water and heat cycles are the most important parts of climate models, with a strong need for improvements. By not addressing the closure problem, this important information is hidden. Using the closure concept, the quality of climate models can easily be evaluated, and there are still large uncertainties here. For earth system models, similar calculations should be performed for the nutrients and carbon cycles. Instead of regularly calculating the closure results, scientists have started to calculate differences between models, illustrating model uncertainties and calculating ensemble means. This approach is interesting but complex and does not focus on improving or evaluating the models. To support knowledge development, the closure results could also be presented on information platforms, regularly updated and discussed by experts.

You are now a "free-lance scientist" (i.e., you are retired). How do you now fill your days, and what are your scientific "hobbies"?

Well, as a scientist, you perhaps never stop thinking about difficult questions. By the end of this century, it is estimated that the human population will have grown to more than 10 billion people, and by 2050, almost 70% are expected to be living in urban areas and megacities, increasingly alienated from the marine environment with its pervasive plastic contamination. Early in my study of the oceans, I became interested in the thermodynamics of the water surface layer and in ice formation. The initial ice formation in the ocean in the form of Frazil ice was the topic of my Ph.D. research. At that time, I became increasingly aware that my studies of the "external sea" also fed into my studies of my "internal sea", and I was relieved to find that my emotional awareness was not frozen. Frazil ice is much more dynamic than solid ice and served as a metaphor for my emotional life – wild and fascinating.

Later, during my post-doctoral studies in Canada, I studied deep-water processes in Lake Ontario and the Baltic Sea, while becoming interested in my own and others' dreams. I became aware that I could think in different ways. Working with computer coding and answering children's questions on the same day gave me experience in how the left and right sides of my brain worked and complemented each other – although this was not discussed among natural scientists at that time. I was becoming interested in more philosophical questions about the mind, communication and how we process experience.

My oceanographic work became increasingly oriented towards understanding systems and modelling physical ocean processes fed into biochemical modelling of the carbon system. This work opened the possibility of addressing problems related to climate change and eutrophication and of modelling multiple stressors of the ocean. Such modelling, mostly using a bottom–up approach, became increasingly complex. The human effects on the climate were obvious. We modelled these effects by considering past and present climatic conditions and extending them into the future by prescribing different emission pathways. Anthropogenic pressures on the ocean, especially on its coastal seas, are strong in various ways, raising new questions about how to model human impacts.

What determines human behaviour and what pathway humanity will take in the future are questions that cannot be answered with certainty. It was obvious to me that science must improve its understanding of human behaviour and human perceptions of the ocean and coastal seas, so I wrote a book about how analytical thinking and intuition could be better and more productively connected (Omstedt, 2016[28]). Dreams can be used as a teaching tool in transforming emotions into stories of great value and psychological resonance, and these stories can be used in the task of integrating analytical thought and intuition. From long experience in dream groups, I realized that dream analysis provides an excellent background for studying how we think. In the book, I argue that the intuitive thinking that connects science and the arts should be better used by scientists.

After retirement, I expanded on this idea by investigating the connection between science and the arts, starting from marine science and our conscious and unconscious perceptions of the

[28] Omstedt, A. (2016). Connecting Analytical Thinking and Intuition: And the Nights Abound with Inspiration. Springer Briefs in Earth Sciences. ISBN: 978-3-319-27533-8 (Print) 978-3-319-27534-5 (Online). DOI 10.1007/978-3-319-27534-5. Springer International Publishing. *link*

ocean. The aim with this new book (Omstedt, 2020[29]) is to illustrate the central importance of the ocean and coastal seas for humans.

So writing is one of my "hobbies", addressing different aspects of the seas and life, but of course, I now have more time to remain a free-lance emeritus and retired man. Other activities include looking after our summer houses and building model boats.

What is your vision for the Baltic Sea and its coastal regions in the next century? What would you wish to see, and what do you expect to see?

A healthy Baltic Sea in harmony with the surrounding countries and with advanced science-based managements of all resources. Properly handled, the Baltic Sea has such potential, being a sea of inspiration, cooperation, and peace and a source of food.

If you look back on your career, how has the possibility to have research funded changed over the decades?

I guess we now have more money for research and with greater competition.

What would be your main advice to young researchers at the start of their careers?

Science is very rewarding and requires brave students who are willing to learn from others and follow their own interests. Therefore, my main advice is: be brave and follow your own interests and go for the joy of building new knowledge. In the early phase of your career, read the book by Sneider and Schneider (2016)-[30]

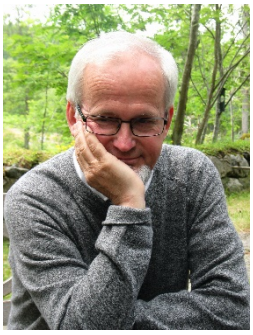
Fig 19. Ragnhild Omstedt and Hans-Jörg Isemer announce the prize for best poster during the Study Conference of BALTEX in Międzyzdroje, Island of Wolin, Poland, 14-18 June 2010.

[29] Omstedt, A. (2020). A Philosophic View of the Ocean and Humanity. Springer Nature. *link*
[30] Sneider, R., and J., Schneider (2016). The Joy of Science: Seven principles for scientist seeking happiness, harmony, and Success. Cambridge University Press. ISBN: 9781107145559. *link*

Fig 20. The King of Sweden, Carl XVI Gustaf, was welcomed to the 7th BALTEX Study Conference 2013 in Borgholm, Island of Öland, Sweden, by the General Director of SMHI, Lena Häll Eriksson. Photo: Karl Nilsson/SMHI.

Fig 21. Anders Omstedt (left) working together with Hans von Storch (right) on the BACC assessment.

Curriculum Vitae



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Research

How do the water bodies of the earth function and how will future changes influence them?

To answer these questions, we must develop our understanding of the water, energy, nutrient and carbon cycles, ecosystem changes and human behaviour. The coupling of water bodies with the atmosphere and surrounding land surfaces is also of major interest. Main research approaches are detection studies using and developing long-time series and attribution and scenario studies using and developing aquatic process-oriented models. Recent research focuses include the human role and the connection between science and the arts. The research plays an active role in the BALTEX and Baltic Earth programmes.

Professional Experiences

Positions

- Professor emeritus, Department of Marine Sciences, University of Gothenburg, 2016-10-
- Deputy Head of Department of Earth Sciences, University of Gothenburg, 2012-07-01 - 2015-06-30
- Coordinator at Swedish Institute for the Marine Environment, 2009-11-01 – 2013-12-31
- Member of the Faculty Board of Science at University of Gothenburg, 2009-07-01—2011-06-31
- Deputy Head of the Department of Earth Sciences, University of Gothenburg. 2006-07-01--2009-06-30, 2012-07-31-

- Chairman of the Research Strategic Group (PROF) at the Department of Earth Sciences, University of Gothenburg. 2006-07-01—2009-06-31, 2012-07-01-
- Member of the Advisory Group at the Department of Earth Sciences, University of Gothenburg. 2006-07-01 --2009-06-31, 2012-07-01-
- Chairman of the Appointment Committee at the Department of Earth Sciences, University of Gothenburg. 2003-09-16 -- 2006-06-30
- Head of the Ocean Climate Group at the University of Gothenburg, Department of Earth Sciences - Oceanography, 2001-10-01--
- Professor, University of Gothenburg, Earth Sciences Centre-Oceanography, 2001-10-01--
- Head of oceanographic research, SMHI, 2000-06--2001-09
- Visiting Professor in Oceanography, University of Gothenburg, 1998-2001
- Research Scientist, SMHI, 1992-12–2000-05
- Visiting Scientist, Institute of Ocean Sciences, Canada, 1992-07--11
- Visiting Scientist, Canada Centre of Inland Waters, 1992-01--06
- Associate Editor, Journal of Geophysical Research 1991--1994
- Head of oceanographic research, SMHI, 1986--1992
- Senior oceanographer, SMHI, 1982--1986
- Meteorologist, SMHI, 1975--1982
- Meteorological assistant, SMHI, 1973--1975

Degrees

- Associate Professor, University of Gothenburg, 1990.
- Ph.D., Göteborg University, Physical Oceanography, 1985-11-09. Thesis: On cooling and initial ice formation in the upper layers of the ocean.
- B.Sc., Stockholm University, Mathematics, Physics, Meteorology and Oceanography, 1974.

Key qualifications

Prof. Anders Omstedt has participated actively in several national and international scientific bodies, and he has played an active role in the BALTEX (Baltic Sea Experiment) and BONUS programmes and was active in the MUSCAD (MUlti proxy Studies of Climate Anno Domini) and EUROCEAN programmes. He has been involved in the build-up phase of the Stockholm Marine Centre as a member of the board during 1990-1991 and 1993-1998. He was responsible for coordinating the BALTEX research within SMHI (1995-2001). Since 1996, he has been a member of the BALTEX Science Steering Group, and between 1997 and 2002, he was chair of the Swedish IGBP (International Geosphere-Biosphere Programme) and WCRP (World Climate Research Programme) Subcommittee for BALTEX. In 2000-2006, he a member of the Swedish National Committee for the IGBP and WCRP. At SMHI, he was responsible for the BALTEX Ph.D. programme, which included four Ph.D. students working on the atmosphere, river-runoff and ocean modelling.

Anders Omstedt is, since 2001, Professor in the Department of Earth Sciences: Oceanography at the University of Gothenburg, as well as, since 2016, in the Department of Marine Sciences. Earlier he was the Head of Oceanographic Research at SMHI and Visiting Professor at the University of Gothenburg, having an extensive experience in ocean and lake modelling. During 2007-2009, he was Deputy Head of the Department of Earth Sciences at University of

Gothenburg, where he was involved in the reorganization of the department and responsible for research.

His main work has been oriented towards the ocean climate and the physics of ice-covered water bodies, particularly the Baltic Sea and the polar oceans. He has developed several numerical models for cold water bodies, such as rivers, lakes, estuaries, shelf seas and the polar oceans. His recent research work is oriented towards climate change and modelling of coupled physical-biogeochemical systems, including the carbon cycle.

Anders Omstedt has written approximately 250 articles, books and book chapters, more than 100 of which have been published in reviewed international journals and books. His professional experience involves being a project/scientific leader for many research programmes, a reviewer and guest editor, a chair and convener, an invited speaker, an adviser for Ph.D. theses, a member of examination committees, a tutor for M.Sc. and Ph. D. theses, and a member of international unions and working groups.

Awards and Honors

- Member and mentor in Expert Panel on the reaccreditation of the University Postgraduate (Doctoral) Programme Oceanology University of Zagreb, Faculty of Science, Croatia, April 2018.
- Member and mentor in Expert Panel on the reaccreditation of the University Postgraduate (Doctoral) Programme Applied Marine Sciences University of Split, Faculty of Science, Croatia, April 2018.
- Elected member of the Faculty Board of Science, University of Gothenburg, 2009-2012.
- Deputy Head of Department of Earth Sciences, University of Gothenburg, 2006-2009.
- Deputy Head of Department of Earth Sciences, University of Gothenburg, 2012-2015
- Member of BALTEX Science Steering Group and Co-Chair of BALTEX, 1995-2013
- Member of the Baltic Earth Science Steering Group, 2014-2017
- Member of the Baltic Earth Senior Advisory Board, 2018-
- Certificate of Excellence in recognition of outstanding achievements for the Baltic Earth and BALTEX science communities, June 2016

Project/scientific leader of major research programs

- Commercial shipping as a source of acidification in the Baltic Sea. Together with David Turner, Ida-Maja Hasselöv, Angela Wulff, Anna Rutgersson. FORMAS, 2013-2016.
- BONUS/Baltic-C program. Coordinator and principal investigator. 2009-2011.
- Modelling carbon dioxide in the Baltic Sea from pre-industrial times to the present and into the future (AD1500-2100). The Swedish Research Council, 2007- 2012
- EUR-OCEANs (European Network of Excellence for Ocean Ecosystems Analysis). Principal investigator. The Sixth Framework Programme for Research and Technological Development of the European Communities (FP6). 2005--2008
- Geosphere Dynamics; especially the Baltic Sea water and mass transport. Göteborg University and Swedish Natural Science Research Council. 2001-10-01--
- The climate sensitivity of sea ice. Research related to sea ice in the Baltic Sea and climate. Financed by the Swedish and Finnish Winter Navigation Research Board. 2000-2001.

- SMHI's part in: Salinity change in the Baltic Sea during the last 8500 years and during the coming 10 000 years. Financed by SKB, 1999-2000.
- SMHI's part in: Pilot study of Evaporation and Precipitation in the Baltic Sea (PEP in BALTEX): A field experiment of BALTEX, financed by EU-MAST III, 1997-2000.
- SMHI's part in: Baltic Air-Sea-Ice Study (BASIS): A field experiment of BALTEX, financed by EU-MAST III, 1997-2000.
- Coordinating the SMHI's part within the BALTEX research, 1995-2001
- SMHI's part in: Ice formation and the influence of ice-coverage on the circulation in the Baltic Sea, Part of the BASYS project financed by EU-MAST III, 1996-1999.
- The role of sea ice in the climate system. NFR, 1995/96-1998.
- Modeling of inflow and dense bottom water mixing in non-tidal seas and Great Lakes. NFR, 1993/94-94/95.
- The thermohaline circulation in the Gulf of Bothnia. Financed by the Swedish Environmental protection Agency, 1990/91-91/92.
- The oceanographic conditions in ice covered seas - three model studies. Financed by NFR, 1990/91-92/93.
- On the thermal and dynamic control of an ice cover in semi-enclosed seas. Financed by NFR, 1988/89.
- Model computations of bottom boundary currents related to the Baltic Sea. Financed by the Natural Sciences Research Council (NFR), 1987/88.
- Forecasting sea ice. Research related to operational forecasting of sea ice in the Baltic Sea. Financed by the Swedish and Finnish Winter Navigation Research Board. 1983-1996.

Reviewer and guest editor in the following journals/books

- Editor in Oxford Research Encyclopedias of Climate Change, 2016 -
- BACC II Author Team (2015). Second Assessment of Climate Change for the Baltic Sea basin. Springer Regional Climate Studies. ISSN 1862-0248 ISSN 1865-505X (electronic). ISBN 978-3-319-16005-4 ISBN 978-3-319-16006-1 (eBook). DOI 10.1007/978-3-319-16006-1. Springer Cham Heidelberg New York Dordrecht London.
- Editorial Board of OCEANOLOGIA, 2014 -
- Limnology and Oceanography
- BACC Author Team (2008) Assessment of climate change for the Baltic Sea basin.Series: Regional Climate Studies. ISBN: 978-3-540-72785-9. Springer-Verlag.
- BACC Group (2007) "BALTEX assessment of climate change for the Baltic Sea basin", Springer-Verlag
- Global and Planetary Change
- FORMAS Fokuserar 9: Österjön – hot och hopp. ISBN 91-540-5970-4. FORMAS, Stockholm, Sweden
- Boreal Environment Research
- Continental Shelf Research
- Cold Regions Science and Technology
- German Journal of Hydrology
- Geophysica (Editorial Board, 2001-)
- Journal of Geophysical Research
- Journal of Marine Systems
- Journal of Fluid Mechanics
- Journal of Physical Oceanography
- Journal of Sea Research (Guest editor)

- Meteorologische Zeitscrift
- Nordic Hydrology
- Oceanologica Acta
- Tellus
- The Netherlands Journal of Sea Research

Chairman, convener or invited speaker

- Member of the Conference Committee for 2nd Baltic Earth Conference. The Baltic Sea Region in Transition. Helsingør, Denmark, 11-15 June 2018.
- Over aching talk: "The development of climate science of the Baltic Sea region" during 2nd Baltic Earth Conference. The Baltic Sea Region in Transition. Helsingør, Denmark, 11-15 June 2018.
- Invited speaker: A Doctoral Students Conference: Challenges for Earth system sciences in the Baltic Sea region: From measurements to models. University of Tartu and Vilsandi Island, Estonia, 10-14 August 2015.
- Invited speaker: International advanced PhD course on Impact of climate change on the marine environment with special focus on the role of changing extremes. Askö Laboratory, Trosa, Sweden, 24-30 August 2015.
- Co-convener during EGU General Assembly 2015. Vienna Austria 12-17 April. Climate change assessments for the Baltic and North Sea regions: Observations, model projections and impacts. Convener: Marcus Reckermann. Co-Conveners: Corinna Schrum, Markus Quante, Anders Omstedt
- Co-chairmen of BACC II (BALTEX Assessment of Climate Change for the Baltic Basin)
- Invited Speaker University of Szczecin, Poland. "Baltic Sea past, present and future marine system". 15 March 2010.
- Invited speaker "Dissent is the Motor of Further Development". Scientific Symposium on the occasion of the 60th Birthday of Prof. Hans von Storch, October 16, 2009, Hamburg, Germany
- Invited speaker 7th Baltic Sea Science Congress 2009, August 17-21, 2009, Tallinn, Estonia.
- Invited speaker ICCMI 2008-Impact of Climate Change on the Maritime Industry, June 2-4, Malmö, Sweden.
- Chairman during Assessment of Climate Change for the Baltic Sea Basin-The BACC Project. International Conference. Göteborg, Sweden, 22-23 May 2006.
- Invited speaker during ESF/COST workshop on "Ocean climate around Europe" 20 -21 January 2005. Title: Monitoring programs needed for detection of ocean climate change.
- Chairman during the third MUSCAD (Multi-proxi Studies of Climate Anno Domini) Göteborg, 2004.
- Chairman and Invited speaker during The Fourth Study Conference on BALTEX, Gudhjem, Bornholm, 24-28 May 2004.
- Chairman of the Appointments Committee for Geosciences at Göteborg University, 2003-
- Invited speaker for the Tvärminne Zoological Station Celebrating its 100th anniversary. September 18-21, 2002. Title: Knowledge gained about the Baltic Sea from the BALTEX program.
- The program and organization Committee of the Fourth Workshop on the Baltic Sea Ice Climate, Norrköping, Sweden, 22-24 Mai, 2002.
- Co-convener 24th General Assembly of the EGS, the Hague, 19-23 April 1999.
- Chairman during The Second Study Conference on BALTEX, Rugen, Germany, May, 1998.
- European Geophysical Society, Vienna 1997.

- Chairman of the Second Workshop on the Baltic Sea Ice Climate, Otepää, Estonia, 2-5 Sept., 1996.
- The First Workshop on the Baltic Sea Ice Climate, Tvärminne, Finland, 1993
- European Geophysical Society, Copenhagen, 1990
- Conference of the Baltic Oceanographers, Norrköping, 1990
- International Association for Hydraulic Research, Helsinki, 1990
- Symposium on the Marine Environment, Linköping, 1986

Appointed faculty opponent or evaluator for following Ph. D., and licentiate thesis

- Jari Uusikivi, 2013. On optical and physical properties of sea ice in the Baltic Sea. Ph D thesis University of Helsinki, Finland.
- Marius Årthun, 2011. Water mass transformations and air-sea exchange in the Barents Sea. University of Bergen, Norway.
- Mats Granskog 2004. Investigations into the Physical and Chemical Properties of Baltic Sea Ice. Department of Geophysics, University of Helsinki. Ph. D thesis March 6, 2004.
- Bin Chen, 2002. On the modelling of sea ice thermodynamics and air-ice coupling in the Bohai Sea and the Baltic Sea. Department of Geophysics, University of Helsinki. Ph. D thesis May 8, 2002.
- Zhanhai Zhang, 2000. On modelling ice dynamics of semi-enclosed seasonally ice- covered seas. Department of Geophysics, University of Helsinki. Ph. D. thesis September 8, 2000.
- Lars Henrik Smedsrud, 2000. Frazil ice formation and incorporation of sediments into sea ice in the Kara Sea. Geophysical Institute, Bergen University. Ph. D. thesis.
- Madleine Carlsson, 1997. Sea level and salinity variations in the Baltic Sea. An oceanographic study using historical data. Department of Oceanography, Gothenburg University. Ph. D. thesis.
- Lars Hammar, 1994. Frazil ice evolution in open channels. Luleå University of Technology. Tech. Licentiate thesis.

Member of the following boards, working groups and societies

- Member of Baltic Earth Science Steering Group (BESSG. http://www.baltic-earth.eu/organisation/bessg.html), 2014-
- Member of Conference Committees for 1st Baltic Earth Conference: Multiple drivers for Earth system changes in the Baltic Sea region. Nida, Curonian Split, 13-17 June 2016.
- Member of the Conference Committee for the 9th Baltic Sea Congress, 26-30 August, 2013, Klaipeda, Lithuania.
- Member of the Conference Committee and organisation Committee for the 7th Study Conference on BALTEX, Borgholm, Island of Öland, Sweden, 10-14 June 2013.
- Member of the International Conference on Assessment of Climate Change for the Baltic Sea Basin, Tallinn, Estonia, 6-7 September, 2012.
- Member of Conference Committee for the 8th Baltic Sea Science Congress on August 22-26, 2011 in St.Petersburg, Russia.
- Member of Conference Committee for 6th Study Conference on BALTEX. Miedzyzdroje Island of Wolin, Poland, 14-18 June 2010.
- Member of the Advisory Committee of Forum Östersjön, 2009 -

- Member of the organization committee for the International Advanced PhD Course on: Climate impact on the Baltic Sea from science to policy. 27 July-5 August 2009, Nexö, Bornholm, Denmark.
- Member of Scientific Advisory Committee for the 6th Workshop on Baltic Sea Ice Climate, August 25-28, 2008. Lammi Biological Station, Finland.
- Member of Conference Committee for 5th Study Conference on BALTEX. Kuressaare, Saaremaa, Estonia, 4-8 June 2007.
- Member of the science steering committee for the Baltic Sea Science Congress, Rostock, Germany, March 19-13, 2007.
- Elector for forming the new board at the Swedish Research Council, 2006.
- Working group forming new board at the Faculty of Science at Göteborg University, 2005.
- The scientific committee of the fifth Workshop on the Baltic Sea Ice Climate, Hamburg, Germany, 2005.
- The scientific committee of the Baltic Sea Science Congress 2005 in Sopot, Poland.
- Co-chairperson for the Workshop: Climate variations in Sweden During the Past 2000 Years. SMHI, 2005.
- The organization committee for the Workshop: Climate variations in Sweden during the Past 2000 Years. Göteborg University, 2004.
- The organization committee for the Workshop: Climate variations in Sweden during the Past 2000 Years. Uppsala University, 2003.
- The organization committee for the Workshop: Climate variations in Sweden during the Past 2000 Years. Stockholm University, Nov 6-8, 2002.
- SWECLIM-MARE workshop on Processes of importance for the large-scale salinity distribution of a semi-enclosed sea such as the Baltic at Kristineberg, Sweden, 4-6 November 2002.
- The scientific program committee of the Fourth Study Conference on BALTEX, Bornholm, Denmark, 2004.
- The program and organization committee of the Fourth Workshop on the Baltic Sea Ice Climate, Norrköping, Sweden, 22-24 May, 2002.
- The organisation committee for Climate and Ozone: Programme Conference, Bergen, 27-29 November 2001.
- The scientific program committee of the Third Study Conference on BALTEX, Mariehamn, Åland, 2-6 July 2001.
- BALTEX Working Group of Energy and Water Cycles 1998-2005
- KLIMAProg (the Norwegian Climate Program) board 2001-2002.
- The Swedish national committee for the IGBP and WCRP, 2000-
- Advisory board for the Baltic Sea Science Congress 2001 and 2003.
- The BALTEX/BRIDGE Task Force, 1998-
- The scientific program committee of the Second Study Conference on BALTEX, Rugen, Germany, May 25-29, 1998.
- Chairmen of the Swedish IGBP-WCRP Subcommittee for BALTEX, 1997-
- The Scientific Steering Group of BALTEX, 1996 -
- The program and organization committee of the Second Workshop on the Baltic
- Sea Ice Climate, Otepää, Estonia, 2-5 Sept. 1996.
- The Swedish IGBP - WCRP Subcommittee for BALTEX, 1993 – 1997.
- The scientific and local organization committee of the First Study Conference on BALTEX, Visby, Sweden, Aug. 28- Sept. 1, 1995.
- The scientific and local organizing committees of an Ad¬vanced Study Institute School: "Physics of Ice-covered Seas, Savonlinna, Finland, 1994", 1992-1994.

- The International Association for Hydraulic Research, Committee on Ice Problems, 1992 – 1996.
- The evaluation commission of the Marine Research in Estonia, 1991 – 1992.
- The board of Stockholm Marine Research Center, 1990 - 1991, 1993 -1998.
- The International Association for the Physical Sciences of the Ocean (IAPSO) Commission on Sea Ice, 1987 – 1997.
- The International Association for Hydraulic Research, Working Group on the Thermal Regime of Water Bodies, 1986 – 1996.
- The Swedish Geophysical Society.
- The European Geophysical Society.
- The American Geophysical Union.
- The Swedish Marine Society.

Member of examining committee for the following Ph. D. thesis, associate professor and post-doctoral positions

- Hongxing He, Ph D planned to 2015, Göteborg, Sweden.
- Johanna Linders, PhD planned to 2015, Göteborg, Sweden.
- Peng Zhang, pH D 2015, Göteborg, Sweden.
- Jesper Björklund PhD 2014, Göteborg, Sweden.
- Selma Pacariz, PhD 2013, Göteborg, Sweden.
- Thinghai Ou, Ph D, Göteborg, Sweden.
- Cecilia Bennet, Ph D., Göteborg, Sweden, 2009.
- Lin Tang, Ph D., Göteborg, Sweden, 2009.
- Johan Burman, Ph. D., Göteborg, Sweden, 2006.
- Christine Aschberger, Ph. D., Göteborg, Sweden, 2004.
- Mikkel Sanders, Ph. D., Lund, Sweden, 2003.
- Cecilia Johansson, Ph. D., Göteborg, Sweden, 2003.
- Anna Sjöblom, Ph.D., Uppsala, Sweden, 2002.
- Karin Gustafsson, Ph. D., Göteborg, Sweden, 2002.
- Bengt Liljebladh, Ph. D., Göteborg, Sweden, 2000.
- Charlotta Pers, Ph. D., Linköping, Sweden, 2000.
- Evaluation of postdoctoral position in Oceanography, University of Gothenburg, Sweden, 2000.
- Bo Gustafsson, Ph. D., Göteborg, Sweden, 1997.
- Göran Björk, Ass. Prof., Göteborg, Sweden, 1997.
- Annika Andersson, Ph. D., Luleå, Sweden,1997.
- Johan Mattson, Ph. D., Göteborg, Sweden, 1996.
- Lars Rydberg, Ass. Prof, Göteborg, Sweden, 1996.
- Elias Valur Holm,, Ph. D., Stockholm, Sweden,1994.
- Johan Rodhe, Ph. D., Göteborg, Sweden, 1992.
- Bertil Håkansson , Ph. D., Göteborg, Sweden, 1990.

Tutor for the following thesis

- Johannes Johansson, Master of Science. Characterizing the surface accumulation of cyanobacteria in the Baltic Sea using remote sensing and in situ data during the period 2002-2014. Department of Earth Sciences, University of Gothenburg, 2015 B883.

- Moa Edman, PhD Thesis, Modelling the Dissolved Inorganic Carbon System in the Baltic Sea, Department of Earth Sciences, University of Gothenburg, 2013, https://gup.ub.gu.se/publication/184857
- Irene Wåhlström, PhD Thesis. Fluxes and transformation of Carbon in the Siberian Shelf Sea under changing Environment. University of Gothenburg, Department of Chemistry and Molecular Biology. 2012. Together with Leif Anderson (Main supervisor) and Göran Björk.
- Karin Wesslander, PhD Thesis. The Carbon Dioxide Systems in the Baltic Sea Surface Waters. University of Gothenburg, 2010. Doctoral thesis No. A 137.
- Victor Veiderpass, Master thesis in Oceanography. The Swedish oceanographic expedition 1877 lead by F.L. Ekman: Climate characterization of the Baltic Sea-Kattegat marine system, based on field observations, SST-series and model data. University of Gothenburg, 2011.
- Erik Gustafsson, PhD Thesis. The Baltic Sea Marine System: Human impact and natural variations. University of Gothenburg, 2010. Doctoral thesis No. A 133.
- Daniel Hansson, PhD Thesis. Ocean Climate Variability over Recent Centuries Explored by Modelling the Baltic Sea. University of Gothenburg, 2009. Doctoral thesis No. A 125.
- Jessica Ask. Master of Science. Monitoring strategies for climate change detection: Statistical assessment of marine data. University of Gothenburg, 2009.
- Christin Ericsson. PhD thesis. Characterizing and reconstructing 500 years of climate in the Baltic Sea Basin. University of Gothenburg, 2009
- Christian Nohr PhD thesis. Oceanographic studies of the Baltic Sea with emphasis on sea ice and mixing processes. University of Gothenburg, 2009 Together with Bo Gustafsson (Main supervisor) and Göran Björk.
- Emilia Lalander. Master of Sciences. Surface water circulation in the Panama Bight- Influence on the circulation around the Island Gorgona Thesis for Master of Sciences, Göteborg University, 2006.
- Leandra Caldarulo. Master of Sciences. Can the different coral reef distribution around Gorgona Island, Colombian Pacific be explained by differences in temperature? Thesis for Master of Sciences, Göteborg University, 2006.
- Johanna Nilsson. Master of Sciences. Does the deep-water temperature in the Gullmar Fjord reflect the Nordic climate? Thesis for Master of Sciences, Göteborg University, 2005.
- Martin Hansson. Monitoring and Prediction of Algal Blooms in the Baltic Sea- Using Satellite Data and a Fuzzy Logic Model for Cyanobacterial Blooms. Thesis for Master of Sciences, Göteborg University, 2004.
- Emma Pettersson. How well does HIROMB simulate temperature and salinity in the Kattegat? Thesis for Master of Sciences, Göteborg University, 2003.
- Karin Wesslander. Are the Nordic Seas Cooling? Thesis for Master of Sciences, Göteborg University, 2003.
- Martin Hansson, Can satellite SMMR and SSM/I data improve ice mapping over the Baltic Sea? A 10 weeks project at Department of Oceanography, Göteborg University.
- Lars Axell. Turbulent mixing in the ocean with application to Baltic Sea modeling. Ph. D. thesis in Oceanography, Göteborg University, 2001.
- Anna Rutgersson. Water and Heat Exchange Processes over the Baltic Sea. Ph. D. thesis in Meteorology, Uppsala University, 2000.
- Ola Nordblom. Numerical simulation of the atmospheric surface layer. Master's Thesis, Luleå University of Technology, 1997:351 CIV, 1997.

Teaching and examination

- Oceanographic models (Oceanografiska Modeller, OC6310) a 10 weeks course at Earth Sciences, University of Gothenburg, 2013.
- Geophysical Fluid Dynamics a 10 weeks course at Earth Sciences University of Gothenburg, 2012-2013
- Oceanographic models (Oceanografiska Modeller, OC6310) a 10 weeks course at Earth Sciences: Oceanography, University of Gothenburg, 2011.
- Co-organizer and lectures for Advanced PhD course: Climate impacts on the Baltic Sea- from science to policy, 27 July to 5 August, Bornholm, Denmark. 2009.
- Oceanographic models (Oceanografiska Modeller, OC6310) a 10 weeks course at Earth Sciences: Oceanography, University of Gothenburg, 2009.
- Responsible for organizing the PhD education within Earth System Science at the University of Gothenburg, 2008-
- Examination of Sofia Åström Master Thesis: Modelling the effects of horizontal density gradients on wind driven surface mixed layers. 2009.
- PhD Course in Process oriented numerical modelling of lakes, coastal seas and oceans a 10 weeks course at the Earth Sciences Centre: Oceanography, University of Gothenburg, 2008
- Geophysical Fluid Dynamics a 5 weeks course in Ocean Models II at the Earth Sciences Centre: Oceanography, University of Gothenburg, 2007
- Geophysical Fluid Dynamics a 5 weeks course in Ocean Models II at the Earth Sciences Centre: Oceanography, University of Gothenburg, 2006
- Geophysical Fluid Dynamics a 5 weeks course in Ocean Models II at the Earth Sciences Centre: Oceanography, University of Gothenburg, 2005.
- Ph. D. Course in ocean and lake modeling. Earth Sciences Centre, University of Gothenburg, 2004.
- Ph. D. Course in ocean and lake modeling. Earth Sciences Centre, University of Gothenburg, 2002.
- Examination of Ph.D. students in Physics of Sea Ice. Earth Sciences Centre, University of Gothenburg, 2000.
- Ph. D. Course in ocean and lake modeling. Earth Sciences Centre, University of Gothenburg, 1998.
- Invited teacher during a summer school in Maratea, Italy. Lecture topic: Forecasting Ice on Lakes, Estuaries and Shelf Seas. Organized by NATO Advanced Science Study Institute, 1998.
- Invited teacher during a summer school in Savonlinna, Finland. Lecture topic: Freezing Estuaries and Semi-Enclosed Basins. Organized by IAPSO (International Association for Physical sciences of the Ocean), 1994.
- Dynamic Oceanography, SMHI, Norrköping, Sweden, 1977-1979.
- Introduction courses in oceanography and sea ice at SMHI, Norrköping, Sweden, 1975-1986

Publications

Articles in reviewed scientific journals

- Jansson, P., Ferré, B., Silyakova, A., Dølven, K.O., Omstedt, A. (2019). "Replication Data for: A new numerical model for understanding free and dissolved gas progression towards the atmosphere in aquatic methane seepage systems", https://doi.org/10.18710/LS2KUX, DataverseNO, V1
- Jansson, P., Ferré, B., Silyakova, A., Dølven, K.O., Omstedt, A. (2019). A new numerical model for understanding free and dissolved gas progression towards the atmosphere in aquatic methane seepage systems. Limnology and Oceanography: Methods. Published by Wiley Periodicals, Inc. on behalf of Association for the Sciences of Limnology and Oceanography.17 pages. DOI: 10.1002/lom3.10307
- Meier HEM, Edman MK, Eilola KJ, Placke M, Neumann T, Andersson HC, Brunnabend S-E, Dieterich C, Frauen C, Friedland R, Gröger M, Gustafsson BG, Gustafsson E, Isaev A, Kniebusch M, Kuznetsov I, Müller-Karulis B, Omstedt A, Ryabchenko V, Saraiva S and Savchuk OP (2019). Scenario simulations of biogeochemical cycles in the Baltic Sea. Front. Mar. Sci. 6:46. DOI: 10.3389/fmars.2019.00046
- Meier HEM, Edman MK, Eilola KJ, Placke M, Neumann T, Andersson HC, Brunnabend S-E, Dieterich C, Frauen C, Friedland R, Gröger M, Gustafsson BG, Gustafsson E, Isaev A, Kniebusch M, Kuznetsov I, Müller-Karulis B, Omstedt A, Ryabchenko V, Saraiva S and Savchuk OP (2018). Assessment of Eutrophication Abatement Scenarios for the Baltic Sea by Multi-Model Ensemble Simulations. Front. Mar. Sci. 5:440.doi: 10.3389/fmars.2018.00440. Nov 2018, Vol. 5, article 440.
- Turner, D.R., Edman, M., Gallego-Urrea, J., A., Claremar, B., Hasselöv, I-M., Omstedt, A., Rutgersson, A., (2018). The potential future contribution of shipping to acidification of the Baltic Sea. Ambio 47: 368. https://doi.org/10.1007/s13280-017-0950-6
- Omstedt, A. (2017). The Development of Climate Science of the Baltic Sea Region. In Oxford Research Encyclopedia of Climate Science. Oxford University Press. doi:10.1093/acrefore/9780190228620.013.654.
- Ahlgren, J., Grimvall, A., Omstedt, A., Rolff, C., and J., Wikner (2017). Temperature, DOC level and basin interactions explain the declining oxygen concentrations in the Bothnian Sea. Journal of Marine Systems, 170, 22-30. http://www.sciencedirect.com/science/article/pii/S0924796316301877
- Shaltout, M., and A., Omstedt (2015). Sea-level change and projection for future flooding along the Egyptian Mediterranean coast. Oceanologia 57, 293-307, http://dx.doi.org/10.1016/j.oceano.2015.06.004
- Gustafsson, E., A. Omstedt, and B. G. Gustafsson (2015), The air-water CO2 exchange of a coastal sea— A sensitivity study on factors that influence the absorption and outgassing of CO2 in the Baltic Sea, J. Geophys. Res. Oceans, 120, doi:10.1002/2015JC010832.
- Omstedt, A, Edman, E, Claremar , B, and A. Rutgersson (2015). Modelling the contributions to marine acidification from deposited SOx, NOx, and NHx in the Baltic Sea: Past and present situations. Continental Shelf Research 111, 234-249, doi: 10.1016/j.csr.2015.08.024
- Shaltout, M., and A., Omstedt (2015). Modelling the water and heat balances of the Mediterranean Sea using a two-basin model and available meteorological, hydrological and ocean data. Oceanologia, 57, 116-131, http://dx.doi.org/10.1016/j.oceano.2014.11.001

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No. 12 Programme, Abstracts, Participants. MedCORDEX-Baltic Earth-COST Workshop "Regional Climate System Modelling for the European Sea Regions". Universitat de les Illes Baleares, Palma de Mallorca, Spain, 14 - 16 March 2018, International Baltic Earth Secretariat Publication No. 12, 96 pp, March 2018.

No. 13 Conference Proceedings. 2nd Baltic Earth Conference. The Baltic Sea in Transition. Helsingør, Denmark, 11 - 15 June 2018. International Baltic Earth Secretariat Publication No. 13, 216 pp, June 2018

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No. 15 Programme, Abstracts, Participants. Baltic Earth Workshop on Hydrology of the Baltic Sea Basin: Observations, Modelling, Forecasting. St. Petersburg, Russia, 8- 9 October 2019 International Baltic Earth Secretariat Publication No. 15, 48 pp, October 2019

No. 16 Programme, Abstracts, Participants. Baltic Earth Workshop on Climate projections and uncertainties in the northern Baltic Sea region. Helsinki, Finland, 19- 20 November 2019 International Baltic Earth Secretariat Publication No. 16, 38 pp, November 2019

No. 17 Anders Omstedt: 45 years of wandering - from processes to systems, through outer and inner seas. An interview by Hans von Storch and Marcus Reckermann. International Baltic Earth Secretariat Publication No. 17, 63 pp, February 2020

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New Omstedt generation (Mikael left and Herman right), studying Baltic Sea ice.

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