BALTEX Newsletter

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BALTEX Phase II Science Framework and Implementation Strategy

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The numerous scientific achievements of BALTEX Phase I called for application in other areas where knowledge on and modelling capabilities of the energy and water cycles in the climate system are fundamental. A Science Plan for BALTEX Phase II covering the years 2003 to 2012 has therefore been published in early 2004 which suggests to enlarge the scientific scope of the programme and strives to contribute to establishing not only physical but also environmental policy- and stakeholder-relevant information. An important aspect is a more holistic approach towards observing, understanding and modelling major environmental and socio-economic aspects relevant for the entire Baltic Sea basin. Parts of BALTEX Phase II research activities will thus contribute to the build-up of a high resolution integrated modelling capability for Northern Europe, embedded in an Earth System Model.

Based on the Science Plan, a *Science Framework and Implementation Strategy Document for BALTEX Phase II* is currently being established. The structure of this document follows the six major objectives as defined in the Science Plan for BALTEX Phase II:

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- Better understanding of the energy and water cycles over the Baltic sea basin.
- Analysis of climate variability and change since 1800, and provision of regional climate projections over the Baltic Sea basin for the 21st century.
- Provision of tools for water management, with emphasis on more accurate forecasts of extreme events and long-term changes.
- Gradual extension of BALTEX methodologies to air and water quality studies.
- Strengthened interaction with decision-makers, with emphasis on global change impact assessments.
- Education and outreach at the international level.

Objectives 1 to 4 are basically addressing science issues, while objective 5 and 6 are related to strategic and political issues which will have to be pursued as cross-cutting activities in the context of all four science objectives. The Science Plan explains the scientific objectives in terms of several related major goals. The *Research Framework and Implementation Strategy Document* suggests how to achieve these goals and describes potential activities as more concrete implementation measures. It also specifies additional data needs and highlights the desired involvement of stakeholders.

In September 2004, a dedicated Research Framework and Implementation Strategy (RFIS) Writing Team, chaired by the leading author, met the first time at Risø National Laboratory, Denmark. During this very creative and successful meeting the outline and main parts of the RFIS were established. The first draft was presented for discussion to the BALTEX Science Steering Group (BSSG) at its 17th meeting in Poznan, Poland, in November 2004. The BSSG principally approved the draft, suggested several improvements, and the RFIS Writing Team was given the mandate to finalize the document. In April 2005, the RFIS final draft has been sent out for external review. Comments and suggestions of external referees will be considered during June and July, hence, we expect the final *Science Framework and Implementation Strategy* for BALTEX Phase II to be available at the end of the 2005 summer season.

Members of the Writing Team at the Risø Workshop, September 2004 (left to right): Sven-Erik Gryning, Andreas Lehmann, Sigrid Meyer, Anders Omstedt, Liselotte Sörensen, Ann-Sofi Smedman, Clemens Simmer, L. Phil Graham, Jörgen Nilsson, Markku Rummukainen, Berit Arheimer, Hans von Storch, Dan Rosbjerg.

Baltic Sea Research within BALTEX Phase II: Some Thoughts

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I just come back from the EUR-OCEANS kick-off meeting in Paris when I read the e-mail from Hans-Jörg Isemer asking for contributions to the BALTEX Newsletter. EUR-OCEANS is a new Network of Excellence within the FP6 (Sixth Framework Programme for Research and Technological Development of the European Communities) with the aim to develop models for assessing and forecasting the impact of climate and anthropogenic forcing on food-web dynamics of pelagic ecosystems in the open ocean. The Baltic Sea is one of the 7 marine systems within this network. We were able to put the Baltic Sea into the work much due to the efforts by David Turner (Göteborg University) and Fritz Köster (Danish Institute for Fisheries Research). BONUS is another new initiative within FP6 aiming to organize the funding agencies around the Baltic Sea. We are also soon going into the FP7 programme with probably increased funding and new research possibilities. BALTEX is well recognised in EUR-OCEANS, BONUS and also HELCOM. Our new Science Framework and Implementation Strategy as well as our initiative to start an assessment on climate change (BACC, see article by Hans von Storch) are very timely.

BALTEX is now expanding into other disciplines and we therefore need to communicate maybe in a more popular form sending out the message that our research is strongly needed. Below the first of three articles related to Baltic Sea research are presented. They have recently been published in the Swedish journal *Havsutsikt* a journal from the Swedish Marine Research Centres (Umeå, Stockholm and Göteborg Marine Research Centres). I have translated them into English and expanded them slightly. Good reading!

The Baltic – A Wondrous Enigma

Understanding the climate and its impact on the Baltic Sea is not easy. Understanding the current state of affairs is hard enough. Understanding what happened in the distant past is even harder because we have no pre-1700 measurement values. Most difficult of all is to understand what is going to happen in the future. We still know far too little about what is going on with the factors that govern the climate and how the Baltic Sea works. Future research is facing several challenges. This is the first of three articles about the Baltic Sea climate, yesterday and tomorrow.

The Baltic is considered one of the most thoroughly studied seas in the world, one for which there are long series of measurement data. That may very well be true, but does it mean we know enough about our large inland sea? Hardly. In fact, we lack fundamental understanding of several important processes in the Baltic Sea. Generally speaking, oceanographic measurement values are also very difficult to interpret. Data is collected by research vessels at different times and different places. The measurements vary sharply in quality from one time to the next, from one place to the next. Let's take a closer look at the curve over the mean salinity of the Baltic (Figure 1) and its variation during the 20th century. Calculating mean salinity is no easy task. Available data are unevenly distributed in time and space. No measurements were taken during the two world wars, so the reconstructed curve is based on estimates and we have no idea how precise those estimates are. We need more in-depth studies here.

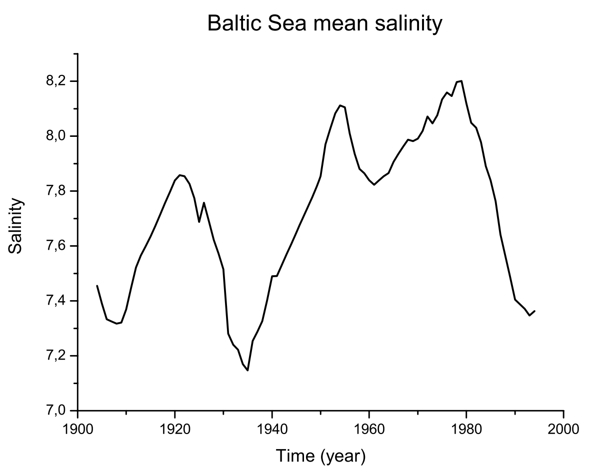

Figure 1. *Estimated mean salinity of the Baltic Sea and its variations during the 20th century. Mean salinity is calculated as a mean over the entire Baltic Sea and at all depths. Redrawn from Winsor et al. (2001, 2003).*

An Important Curve

It is worth pointing out that an uncertain curve is better than none at all, and mean salinity data give us valuable knowledge about the Baltic Sea. If nothing else, the diagram shows that everyone who interpreted the declining salinity of the 1980s and 1990s as a surfire sign of global and regional climate change was jumping to conclusions. The curve has dropped sharply before. The difference in mean salinity on a time-scale of 30 years is small. To determine whether the Baltic Sea climate is intact, more brackish, or more marine, we need high-quality measurement information covering a period of more than 30 years. The mean salinity curve is currently used in various climate and water balance studies. It has made possible an initial estimate on how well we can calculate freshwater inflow into the Baltic. But estimating the uncertainty in the curve will be an important and difficult future research task.

NAO and the Baltic Sea

It has become popular among Baltic researchers to relate their measurement data to something called NAO. A strong connection between NAO and the Baltic Sea climate is shown quite frequently. NAO determines, for instance, whether the winter in parts of Europe will be mild or severe. NAO, or North Atlantic Oscillation, is given as a measurement of differences in air pressure that describes air flow over the North Atlantic Ocean. But it is a blunt measurement and clearly overestimated as an instrument for describing the large-scale atmospheric circulation – how and where the winds blow. And the causes of variations in NAO are still unclear. What we do know is that atmospheric circulation over the North Atlantic has a powerful impact on the Baltic Sea climate. But we do not know what causes changes in these air flows. Another central field of research is expanding here.

Ocean Climate Group at Göteborg University
see *http:// www.oceanclimate.se*

Stable Mean Temperature

Has global warming affected the Baltic Sea? And if so, how? Some people say that the climate has deviated from the natural variation in the past 30 years. A recent study carried out within our research group (Omstedt and Nohr, 2004) recounts how various meteorological factors varied in the air above the Baltic Sea during this period. Air temperature and wind have increased; cloudiness and relative humidity have declined. Nevertheless, analysis of the sea's heat balance shows that the Baltic Sea has not been appreciably affected – the trends cancel each other out. Locally, we can track trends in different parts of the Baltic Sea and at various depths, but the net effect does not yield a trend. The mean water temperature of the Baltic Sea is stable despite regional warming. The reason was explained by the heat balance that indicated no trend in the Baltic Sea net heat loss.

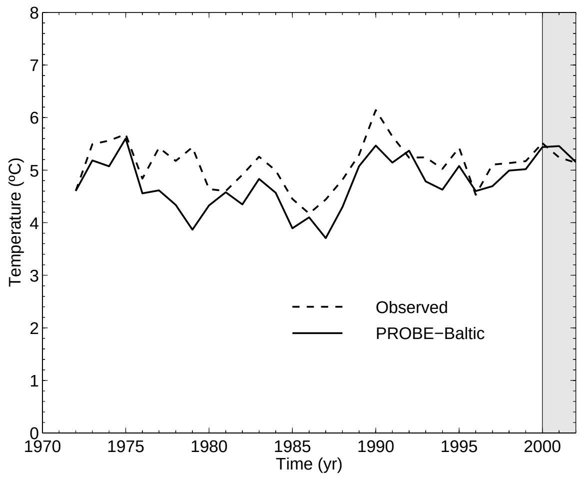

Figure 2. *Observed (dashed line) and modelled (fully drawn line) annual variation of Baltic Sea mean water temperature. The BALTEX/BRIDGE period is marked in grey. From Omstedt and Nohr (2004).*

A Wondrous Enigma

An inventory of what we know and do not know about how the Baltic Sea functions under current climate conditions was recently performed within the framework of the BALTEX program (Omstedt et al., 2004). The review indicates a strong need for research.

The research world has gained access to new databases in the last 10 years. The building of the new databases is an extraordinarily meaningful contribution to research, but they are unfortunately imperfect. Necessary documentation and information about data quality are often lacking. We still cannot go to the database and get answers to elementary questions about weather and wind. How much does it rain and how much does the wind blow on the Baltic? Or can trends be analyzed based on gridded data sets? Several key processes in the sea are also poorly understood. How does energy from the wind go into the sea and cause mixing? How are the deep waters of the Baltic renewed? What is the role of the Straits? How is river water spread in the Baltic Sea? How much ice is there in the Baltic Sea? Exciting tasks await new doctoral students and researchers. Almost everything about the sea as a climate system remains to be discovered. And the Baltic Sea remains a wondrous enigma.

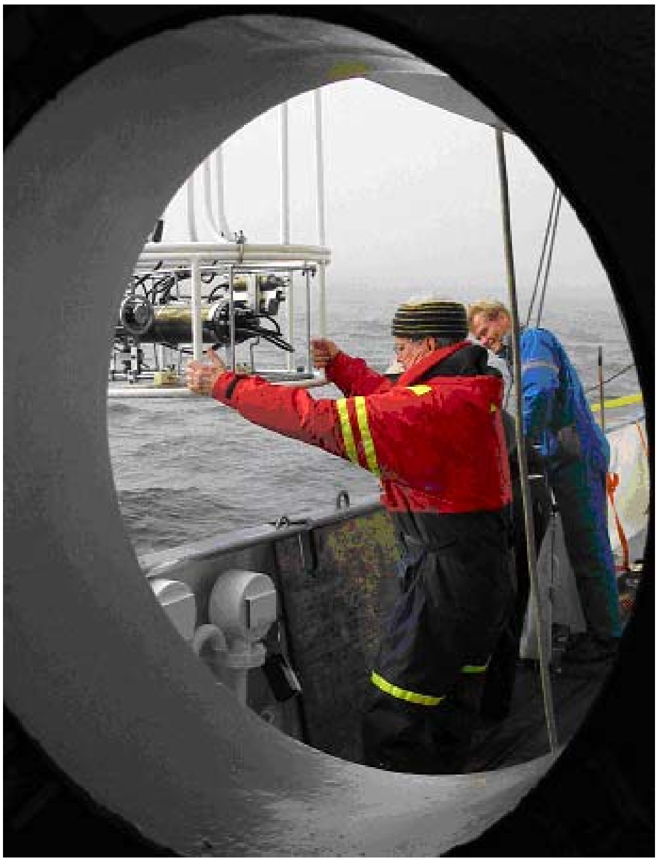

Figure 3. *The Northern Kvark Strait is one of the unknown straits of the Baltic Sea that connects Bothnian Bay and Bothnian Sea. Our group at Göteborg University is performing field measurements to find out the water exchange mechanisms. On the photo the author and Dr Bengt Liljebladh perform salinity and temperature measurements from R/V Skagerrak.*

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BACC – BALTEX Assessment of Climate Change for the Baltic Sea Basin

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Background

A new objective of BALTEX Phase II is *the analysis of climate variability and change since 1800, and provision of regional climate projections over the Baltic Sea basin for the 21st century*, see page 1. In September 2004, a group of climate and environmental researchers, including myself, initiated to conduct a *BALTEX Assessment of Climate Change for the Baltic Sea Basin* with the ultimate goal to review existent literature on the subject and publish an assessment book by 2006. The BALTEX Science Steering Group (BSSG), at its 17th meeting held November 2004 in Poznan, Poland, endorsed the BACC initiative and, at the same time, suggested close cooperation with a parallel initiative proposed by the Helsinki Commission (HELCOM), to the extent possible and agreeable for the involved individuals and institutions. At a dedicated meeting of representatives of BALTEX, BACC and HELCOM, held January 2005 in Copenhagen, Denmark, the two initiatives mentioned above were suggested to be merged into a joint BALTEX-HELCOM Climate Assessment Project, with the following three organisations or groups being involved: 1) HELCOM, 2) BALTEX, as a major European science programme, and 3) the BACC group. The overall project coordination is with the International BALTEX Secretariat. The plan foresees HELCOM to use the material on climate change assessment, which is currently being compiled by the BACC group, for dedicated HELCOM Thematic Assessment Reports, to be published in 2007, or later.

The BACC Goal

The purpose of the BACC assessment is to provide the scientific community with an assessment of ongoing climate change in the Baltic Sea Basin. An important element is the comparison with the historical past (until about 1800) to provide a framework for the severity and unusualness of the change. Also changes in relevant environmental systems, due to climate change, shall be assessed – such as hydrological change, ecosystems, and ocean waves. BACC will also provide a review on our current knowledge on projected future climate change. The overall format is similar to the IPCC (Intergovernmental Panel on Climate Change) process, with author groups for the individual chapters, an overall policymaker-summary, and an external review process, organized by the BALTEX SSG. The final form of the assessment is planned to be published as a book with the following structure:

1. Introduction and Policy Advise
2. Past and Current Climate Change, Detection and Attribution
3. Projections of Future Climate Change
4. Climate-related Change in Terrestrial and Freshwater Ecosystems
5. Climate-related Change in Marine Ecosystems

Special emphasis will be given to literature in languages other than English, because this body of knowledge is all too often not entering the IPCC and other assessments.

Participants at the 1st BACC Workshop enjoy the sunshine on the balcony of the HELCOM Secretariat in Helsinki, Finland, 20 May 2005.

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DEKLIM Final Symposium

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Within the German Climate Research Program DEKLIM funded by the Federal Ministry of Education and Research (BMBF), "Regional Process Studies in the Baltic Area" was one of four major research areas. DEKLIM has been set up in 1999 and funding started in February 2001. DEKLIM will continue until the beginning of 2007. However, BALTEX-relevant projects came already to an end in the beginning of 2005. At the DEKLIM-Final Symposium, held 10 to 12 May 2005 in Leipzig, Germany, eight BALTEX projects in DEKLIM with more than 30 institutions being involved presented their results.

Regional process studies in the Baltic Sea Basin cover a wide range of topics, from climate reconstruction of the environmental conditions during the last 1000 years to the development and application of a fully coupled regional climate model of high complexity. Several groups analyse the influence of the Baltic Sea itself, compare observational techniques to measure precipitation or investigate the influence of surface heterogeneities on evaporation to better describe and understand the water and energy cycle in the Baltic Sea region. Additionally, a new complex scheme to describe physical processes in frozen soils and its snow covers has been developed as well as a new technique to derive land surface parameters from satellites. Finally, the interaction between carbon and nitrogen fluxes and the water and energy budget of the terrestrial biosphere in the Baltic Sea basin have been investigated.

BALTIMOS and **IBSEN** have been identified as central projects within DEKLIM’s “Regional Process Studies in the Baltic Area”. Taking the principle results of both projects together first steps to a regional Earth System Model of the Baltic Area have been made.

BALTIMOS (Development and validation of a coupled model system in the Baltic region): The coupled regional model system BALTIMOS has successfully been established and validated. Simulations show that this model system is able to realistically describe extreme salt water inflow events as well as other features in the ocean and atmosphere. This system has been built for regional climate studies under today’s and future climate conditions. It can be used to investigate possible changes in water availability, droughts, floods and even more type of extremes. It can now be extended to cover not only the physical cycles but also bio-geochemical cycles in the Baltic Sea, e.g. to investigate algal bloom and water quality issues. The cooperation between numerous experimental and modelling groups was excellent and led to major improvements of BALTIMOS.

DEKLIM projects at
http://www.deklim.de

IBSEN (Integrated Baltic Sea Environmental Study - Analysis and simulation of the hydrological and ecological variability in the last 1000 years): The central goal of IBSEN was to contribute to the climate reconstruction in the Baltic Sea environment. A model hierarchy comprising regional climate models to high resolution circulation and ecosystem models has been used to investigate causes of natural variability in the Baltic Sea environment which is important for sustainable use. The Medieval Warm Period, the Late Maunder Minimum and the present climate could successfully be reproduced. Central results for the reconstruction of the hydrological and ecological variability for the two strongest climate signals during the last 1000 years are the reconstruction of present and historical surface and bottom temperatures from pelagic algae and benthic foraminifers, and the good agreement of monitored temperature, salinity, nutrients and phytoplankton distributions with a high resolution circulation and ecosystem model of the Baltic Sea.

See the following pages for more BALTIMOS and IBSEN result. In a forthcoming issue results of other DEKLIM projects will be presented.

BALTIMOS: Analysis of the Water Cycle of the BALTEX Region using an Integrated Atmosphere-Hydrology-Ocean Model

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Introduction

A major task of the Baltic Sea Experiment (BALTEX) is to simulate the whole water and energy cycle of the Baltic Sea basin to identify important processes, which are relevant to the energy and water cycle. In this project "Development and Validation of a Integrated Model System in the Baltic Region" (BALTIMOS), which is funded by the German government through the DEKLIM programme (see previous page), a fully integrated model system for the Baltic Sea basin, called BALTIMOS, has been developed. This is done by linking the existing model components REMO for the atmosphere (Jacob 2001), BSIOM for the ocean and sea ice (Lehmann 1995), and LARSIM for the hydrology (Richter et al. 2003, Bremicker 2000). In addition, a comprehensive validation of the integrated model for the Baltic Sea and its catchments area will be performed using data from a period of about two decades. Validation is a necessary condition to achieve reliable estimates of the water and energy budgets for the Baltic Sea basin for present climate conditions.

Model Design

The model area of the atmospheric model covers a region between 0 to 30 degree East and 45 to 75 degree North with a horizontal grid mesh size of 1/6 degree. The water balance model LARSIM is a meso-scale model to simulate the water balance of large river basins continuously. Not only does it incorporate the runoff generation in areas and the translation and retention in river channels, but also the processes of interception, evapotranspiration and water storage in the soils and aquifers as well as artificial influences (e.g. storage basins, diversions). A block diagram of the integrated model is shown in Figure 1. See the BALTEX Newsletter #6 for a map of the hydrological model area with catchments and river routing scheme used.

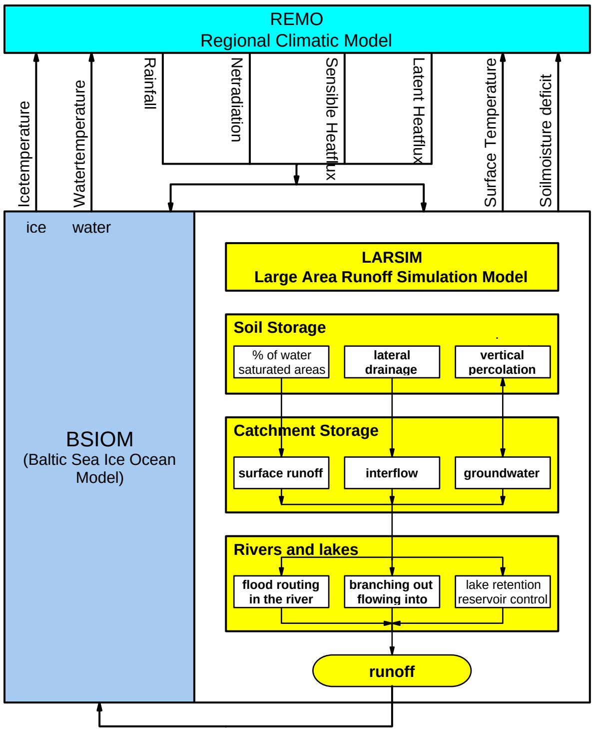

Figure 1: *Block diagram of the integrated atmospheric-hydrological-ocean model.*

Results and Outlook

A comprehensive validation of the coupled model for the Baltic Sea and its catchment area has been performed using data from a period of about two decades. Validation is a necessary requirement in order to achieve reliable estimates of the water and energy budgets for the Baltic Sea area, not only for present climate conditions but also for investigations of future climate changes.

The validation is done in three steps. In the first step the validation is carried out with measured meteorological data input for a period from 1996 to 2000. There is a good agreement between the measured and simulated runoff (not shown). In the second step the validation is performed for REMO and LARSIM. Figure 2 displays the measured and calculated sums of runoff using REMO meteorological input data. There is a little underestimation of the yearly total runoff before 1993, caused by an overestimation of evapotranspiration. In the third step the coupled model REMO-BSIOM-LARSIM system is validated. Figure 3 shows the result for total monthly runoff to the BALTEX region for a period from 1999 to 2001 to There is an overestimation of the calculated runoff during winter and an underestimation during summer. The effect of using the coupled model to calculate runoff seems rather small, but the coupled model system is able to simulate the water cycle of the BALTEX area under climate conditions independently of boundary conditions from the ocean (*i. e.* sea surface temperature etc.).

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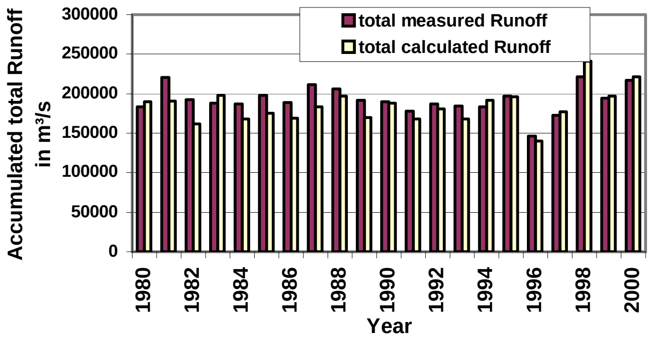

Figure 2. *Validation of the coupled REMO-LARSIM model system: Accumulated annual total calculated and measured runoff to the Baltic Sea during 1980 to 2000.*

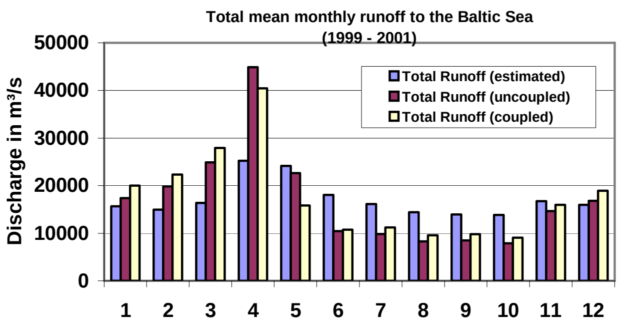

Figure 3. *Validation of the fully coupled REMO-BSIOM-LARSIM model system: Annual cycle of total calculated and measured runoff to the Baltic Sea during 1999 to 2001.*

IBSEN: A Millennium Study of Regional Climate Variability in the Baltic Sea

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The German Climate Research Program DEKLIM, funded by the Federal Ministry of Education and Research (BMBF), consists of more than 100 projects which are organised in 37 joint projects. These joint projects are clustered in four research areas: 1. Paleoclimate, 2. Climate variability and predictability, 3. Regional processes in the Baltic Sea, and 4. Climate impact research. The motivation for these four research areas are: investigations of the climate in the past (*paleoclimate*) are a key for an improved understanding of long-term processes in the climate system of the earth and is essential for the separation of natural and anthropogenic climate change. The understanding of the *variability* of the present climate is a necessary prerequisite for the *prediction* of future climate change. An important aspect is the continuous development of regional climate models especially for the Baltic Sea. Within DEKLIM, IBSEN is one project with considers a retrospective look at the past. The interactions of climate change and natural systems as well as the human society are subject of interest. Goal is the development of scientific criteria for concrete actions of adaptation to climate change or the development of avoidance and mitigation strategies.

A Retrospective Look at the Past

During the last three years, the Baltic Sea Research Institute Warnemünde has coordinated the joint project "Integrated Baltic Sea Environmental Study" (IBSEN) in cooperation with the GKSS Research Centre Geesthacht and the Alfred Wegener Institute for Polar- and Marine Research Bremerhaven. The goal of IBSEN was the analyses and simulation of the hydrological and ecological variability in the Baltic Sea during the last 1000 years with a special focus on the two strongest signals during the last 100 years: the Medieval Warm Period (MWP) (1150-1190 A.D.) and the Little Ice Age (LIA) at the sun spot Late Maunder Minimum (LMM) (1670-1710 AD). These periods have been compared to the last 40 years of the 20th

century which cover the 1960s cold period and the 1990s warm period.

The applied methods are time slice experiments for the three periods forced by a 1000 years climate simulation using a complex model hierarchy. A global climate model simulates the whole period of 1000-2000 A.D. From this run the periods of present climate, LIA and MWP are used as initial and boundary conditions for a regional climate model of Europe (Zorita et al., 2004). The results of this model are used to force a high resolution circulation model of the Baltic Sea in which an ecosystem model is embedded. The results of the present climate simulation have been compared with physical, chemical and biological observations from the HELCOM monitoring programme and with observations from surface sediments. The results of the MWP and LIA simulations have been compared with proxies from sediment records.

IBSEN Website at
http://www.io-warnemuende.de/projects/ibsenweb/en_index.html

1000 Years in 60 Centimeters

Very often, it is not easy to identify the direct response of climate variability in biological systems due to the influence of biological interaction (predator-prey dynamics), anthropogenic influences such as eutrophication or pollution, or the influence of fisheries which can mask climate signals. Therefore, it is a fundamental question to what extent biological variability in regional closed areas like the Baltic Sea can be addressed to climate variability. Very helpful in this case was the gain of a sediment core from the Gotland Basin (central Baltic Sea) in which the last 1000 years are concentrated in 60 cm (Figure 1). In this core the climate of the last millennium can be identified. In the lower part the black laminated layer represents the MWP. During this period a high productivity occurred. The high bottom salinity and the strong stratification in combination longer lasting stagnation result in an anoxic water body and in laminated sediments. The high productivity during MWP has also been shown in a multiproxy analysis of an other sediment core from the Gotland Sea (Dippner and Voss, 2004). The same laminated structure can be observed on the top of the core which represents the present climate. Also during the present climate, high productivity in combination with a high bottom salinity and strong stratification result after a stagnation period in an anoxic water body and in laminated sediments. A major part of the high productivity can be addressed to diazotrophic cyanobacteria. The mediator how interannunal variability in cyanobacteria can be addressed to climate variability has been discussed in Janssen et al. (2004). In between, a light grey unstructured layer can be seen which represents the LIA. In this period the production was low. The low salinity is the reason for a well mixed water body with oxygen at the bottom. This result is life at the bottom (e.g. benthic foraminifera) and an unstratified sediment due to bioturbation.

Figure 1 shows in addition on the right hand side the vertical distribution of salinity and oxygen in the Gotland Sea as simulated with the model hierarchy for the three periods. During the MWP the salinity decreases with a permanent anoxia at the bottom. The LIA is characterized by low salinity with an increase of a well mixed water body and oxygen at the bottom. In contrast, in the present climate the salinity shows a weak decrease and an increase in anoxia. The direct comparison of climatic events from the pre-industrial periods with the present climate will provide an improved understanding of the system Baltic Sea.

Acknowledgement: IBSEN has been funded by the German Federal Ministry of Education and Research (BMBF) in the framework of the German Climate Research Programme DEKLIM.

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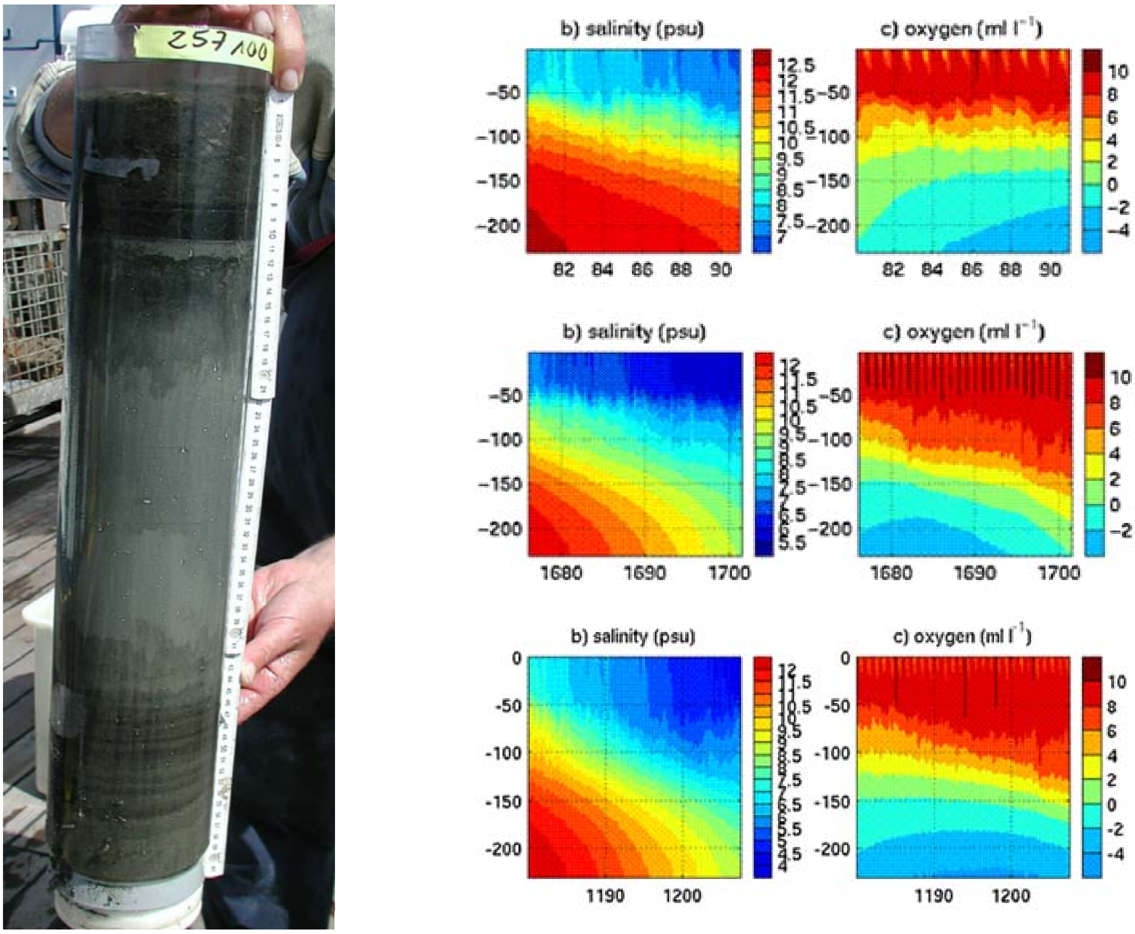

Figure 1 (IBSEN). *Left: Core 257100 from the Gotland Basin (central Baltic Sea) taken in June 2003. This sediment core covers the last 1000 years in 60 cm. Three layer are visible: A black laminated layer on the bottom representing the MWP, a grey and homogeneous layer in the middle representing the LIA and a laminated black layer on top representing the present climate. Right: Vertical distribution of salinity and oxygen in the Gotland Sea as simulated with the model hierarchy for the three above periods.*

Snow Cover Changes Over Northern Eurasia during the Last Century: INTAS Project SCCONE in its Final Stage

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The general objective of the SCCONE project (funded 2002 – 2005) has been to assess the temporal and spatial variability of snow cover over Northern Eurasia, its climatic causes and hydrological consequences during the 20th century.

The research has been accomplished through the extraction and comparison of surface data, which have been at the disposal of all the participating eight teams. Valuable has been the significant enlargement of the data for the FSU (former Soviet Union) territory to be made accessible to the scientific community at the end of the project. The comparison of the satellite and ground data has allowed to receive preliminary results about features of the albedo of the snow cover. Estimates of the spatially averaged snow cover variations, basic statistics and trends have been established. An example is shown in Figure1.

The deliverables of the SCCONE project are:

A) Publications in international and Russian scientific journals, and presentations in international conferences.

B) Web-site about the main scientific results (in preparation and will be opened at the end of the project in June 2005)

C) Data (CD-Rom incl. the necessary metadata) about:
(i) Daily snow depth (~ 1936-2000)
Russia & Kazakhstan ~ 225 stations
Nordic countries ~ 15 stations
(ii) Monthly data (~ 1936-2000)
Russia - 225 stations
Nordic countries ~ 100 stations (see NORDKLIM website at www.smhi.se/hfa_coord/nordklim/)
(iii) Snow survey ~ 1200 stations (1966-2000)
(iv) Circulation and runoff data

The continuation of the snow studies are being elaborated for a new INTAS application. They would include, among other things, (1) further improvements to the present SCCONE data set including updates of the data and its gridding for cartography and statistical analysis of snow variability, for the use in studies of albedo by means of satellite and ground data, for the climate model experiments, and for investigation of snow in mountainous areas; (2) aspects of future snow-climate changes (through scenarios); (3) further cooperation with satellite communities.

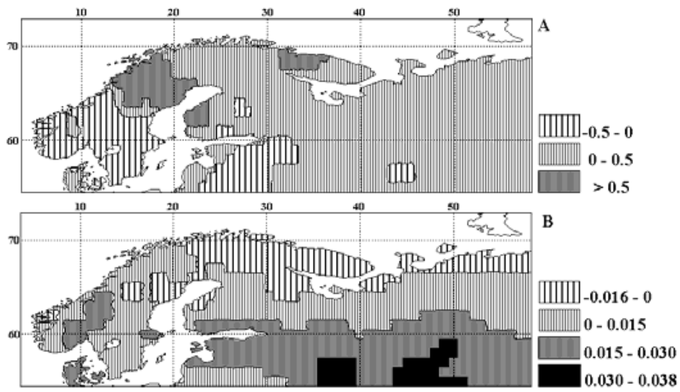

Figure 1. *Top: Trend of duration of the annual snow cover period (Units: days/year) in Northern Eurasia for the period 1936 to 2000.*
Bottom: Trend of mean winter season surface air temperature (C/year) for the same region and period as above.

BACC – BALTEX Assessment of Climate Change for the Baltic Sea Basin

Continued from Page 5

Status

At the first BACC workshop held May 2005 in Helsinki, Finland, more than 30 authors discussed the very comprehensive draft material established so far. The huge amount of compiled information requires mainly shortening, as well as some restructuring and additions. The challenging next milestone is to have a revised version ready for external review by early October 2005. A second BACC workshop is planned for December 2005 to be held in Warsaw, Poland. It is my pleasure to note that the *Springer* Publishing Company has confirmed interest to publish the planned book.

More Details on BACC at
http:// www.gkss.de/BACC

The size of the *BACC group* has rapidly grown – and continues to do so. At present, it consists of more than 80 contributing authors from 10 countries and a BACC Science Steering Committee (SSC), which I have the pleasure to chair. I like to highly appreciate all contributions made so far in support of BACC, and thank in particular the appointed responsible chapter lead authors Raino Heino, Heikki Tuomenvirta, L. Phil Graham, Ben Smith, Bodo von Bodungen, Joachim W. Dippner, and Ilppo Vuorinen for their enthusiasm and support.

Finally, I appreciate the enthusiasm of the BALTEX SSG Chair, Hartmut Graßl, who, in closing the BACC Copenhagen meeting, stressed that BALTEX as a major European science programme and a "family member" of the World Climate Research Programme (WCRP) will gain reputation by supporting and officially cooperating with a major intergovernmental organisation such as HELCOM. At the same meeting, the HELCOM Secretary Juha-Markku Leppänen welcomed the planned cooperation as an outstanding example for HELCOM to conclude a joint project proposal with an European science programme in support of an official HELCOM Thematic Assessment Report. For the entire *BACC group*, I wish to thank HELCOM and BALTEX for past and future support to BACC.

Temporal and Spatial Variability of Surface Fluxes over Sea Ice in the Northern Baltic Sea - A Model Data Comparison

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1. Introduction

At the fourth Study Conference on BALTEX coupled atmosphere-land-ocean and coupled sea ice-ocean models have been presented. Generally, these models show that most of the characteristics of the Baltic Sea and the overlying atmosphere can be described realistically. Thus, the models can be used for budget calculations and climate change studies. However, the representation of the physical exchange processes between for example ocean and atmosphere still suffers from inadequately resolved processes. Thus, comparing estimations of the energy and water budget from different models reveal large differences. How can the reliability of the models be increased and how can uncertainties be reduced?

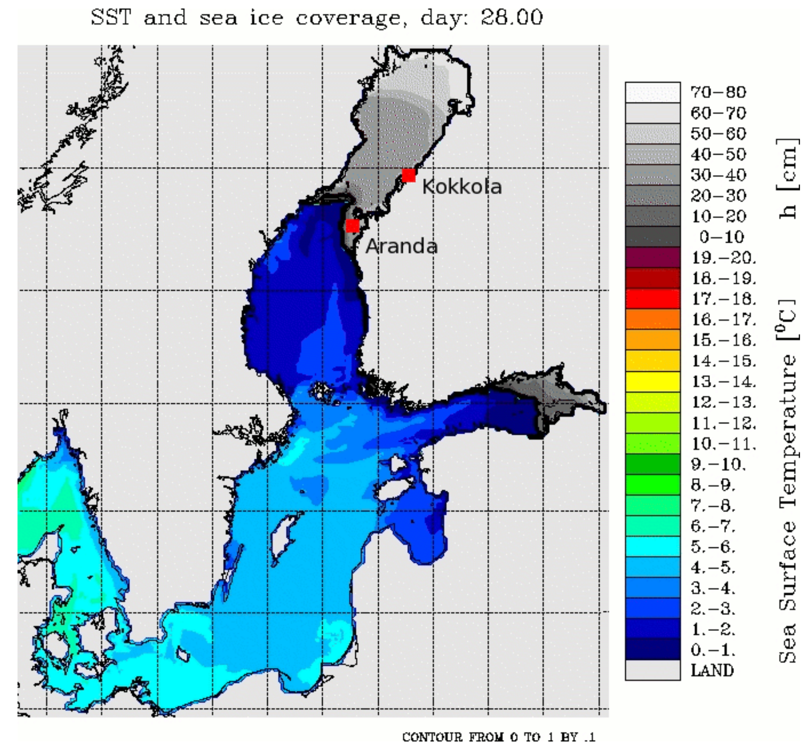

Figure 1. *Simulated SST and sea ice extent for 28 February 1998 with positions of the ice stations Kokkola and Aranda.*

For a better understanding of the energy and water cycle in the Baltic area, a more detailed validation of the model components and a more extensive use of already available observations and satellite measurements are required. The detailed evaluation must include besides the standard parameters also the fluxes, thus a detailed analysis of coupling mechanisms and forcing functions.

We believe that the atmosphere-ocean or land-atmosphere fluxes are the key for the different behavior of the models. Often the uncoupled versions of sophisticated models (e.g. atmosphere only, sea ice-ocean only) perform even better than in a coupled mode. This hints clearly to the important role of the fluxes. In an atmosphere model the ocean surface temperatures and sea ice extent are prescribed. Thus, the atmospheric model is controlled by the ocean parameters. In a sea ice-ocean model surface fluxes between atmosphere and ocean drive the ocean model.

Comprehensive data sets suitable to validate coupled model systems are sparse. However, within the BALTIMOS project eight field campaigns over the open and ice-covered water of the Baltic Sea during the period 1998-2001 (Brümmer et al., 2003) have been conducted. The observations mainly focussed on:

- the atmospheric boundary layer structure and processes and the air-sea-ice interaction over areas with inhomogeneous sea ice cover,
- the atmospheric boundary layer structure over open water under different synoptic conditions such as cold- and warm-air advection and frontal passages.

Thus, these data sets which have been systematically conducted during all four seasons and over open water and sea ice of the Baltic Sea are ideally suited for validation of coupled model systems. In Brümmer et al. (2003) potential users are explicitly encouraged to use this data set.

We used this data set to carefully evaluate our three-dimensional coupled sea ice-ocean model BSIOM (Lehmann & Hinrichsen, 2000, 2002) which is forced by observed atmospheric and river runoff data (SMHI's meteorological and runoff data base). Bulk formulas used to calculate the fluxes between atmosphere and ocean are given in Hagedorn et al. (2000). Here we focus only on the BASIS 1998 winter experiment. A comparison of observations from the other field experiments with model data will be discussed elsewhere.

2. BASIS (Baltic Air Sea Ice Study) 1998

During the Baltic Air-Sea-Ice Study (BASIS) field experiment, lasting from 16 February to 6 March 1998, turbulent heat, moisture and momentum fluxes as well as radiation fluxes were measured over ice and water in the northern Baltic Sea (Brümmer et al. 2002). The locations of the ice stations Kokkola and Aranda which were about 80 km apart from each other are shown in Figure 1. Kokkola ice station was placed on land-fast ice at a distance of 100 m from the shore of a peninsula. The nearest distance to the open sea was about 130 km. The second ice station was installed close to the Finnish research ice breaker Aranda on land-fast ice about 4 km south of the isle of Vallgrund and at a distance of about 30 km from the ice edge. The temporal interval of the measurements at the two sides was 10 minutes, whereas calculated values are given on 6 hourly interval.

During BASIS 1998, sea ice conditions with respect to sea ice extent only slightly varied. Thus, the sea ice extent of 28 February 1998 can be taken as representative for the sea ice situation of this period (Figure 1). The modeled sea ice extent nicely compares with observations (compare with Figure 1 in Brümmer et al., 2002).

2.1. Evolution of Meteorological Quantities

During BASIS 1998, the meteorological conditions in the experimental area were characterized by a rapid sequence of high and low pressure systems and passing atmospheric fronts. Figure 2 shows the time series of the basic meteorological quantities pressure p, temperature T, water vapor mixing ratio m, wind speed U and wind direction *Wind Dir.* at Kokkola and RV Aranda. Steady weather conditions lasted not longer than one day.

On the rear of lows, passing close to or directly over the experimental area, air temperatures decreased rapidly below 0°C (17, 19, 24 February). These three cold episodes lasted only one to two days and ended respectively with approaching warm fronts. Water vapor mixing ratio shows the same structure as temperature. Wind speeds were highly variable with maximum wind velocities up to 20 m/s. Rapid changes in wind directions were related to moving fronts. Extracted atmospheric (SMHI forcing) data at position Kokkola compare well with the corresponding measurements. However, wind velocities agree better with Aranda measurements due to the different measurement heights (Kokkola 2 m, Aranda 10 m).

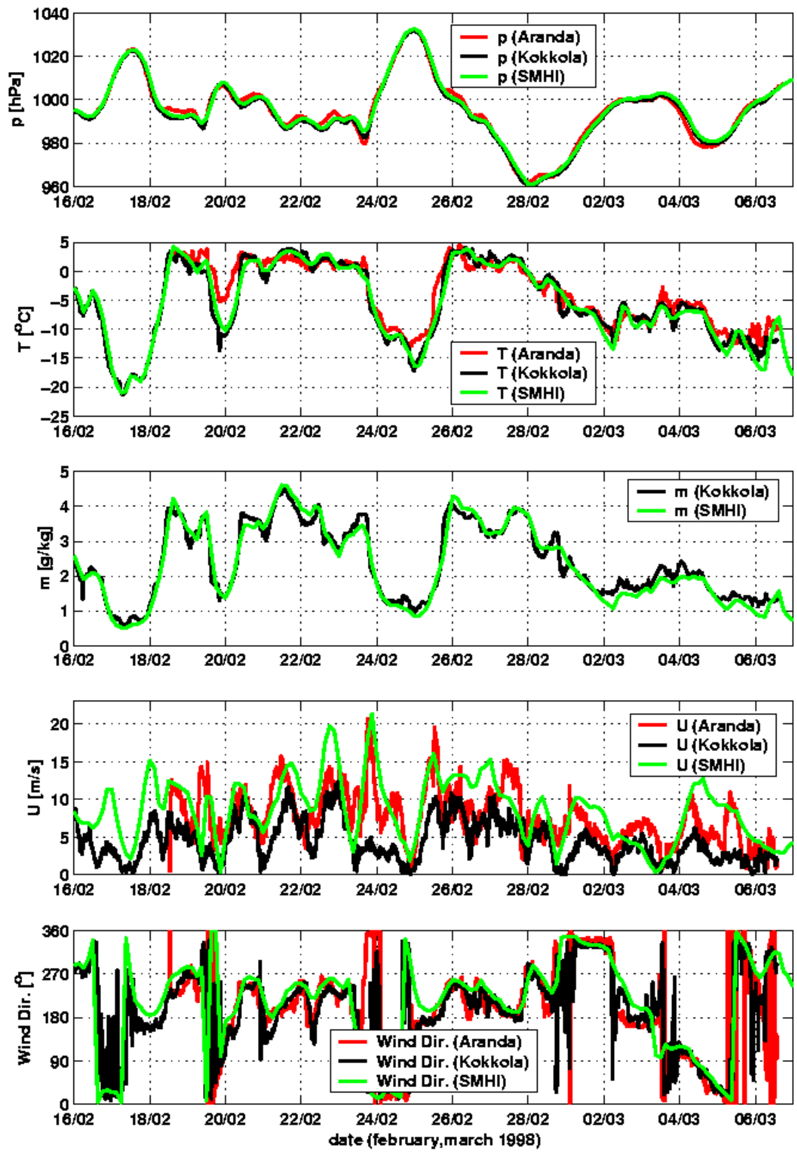

Figure 2. *Time series of the basic meteorological quantities pressure p, temperature T, water vapor mixing ratio m, wind speed U and wind direction Wind Dir. at Kokkola and RV Aranda in comparison with observed atmospheric data (SMHI's meteorological data base) at Kokkola.*

2.2. Radiation Fluxes

The temporal evolution of surface fluxes measured at Kokkola and Aranda are presented in Figure 3. Although these two stations were only 80 km apart, there are clear differences visible which might be due to differences in cloud cover. Differences in cloud cover might also cause deviations between calculated (BSIOM) and measured values. The albedo of the ice/snow surface varied between warm and cold episodes with some time delay. Periods of high albedo during freezing periods (white ice surface) and low albedo during melting periods when the ice surface is widely gray instead of white can be discriminated. Tendencies of modeled albedos compare well with observations. The downwelling long-wave radiation flux *Lw(o)* is closely related to the varying cloud conditions. During warm periods with low-level clouds (e.g., about 325 Wm^{-2} on 21 February) and during cold air periods with clear sky (e.g., about 175 Wm^{-2} on 25 February) *Lw(o)* shows extreme values. It is impressive how well calculated (BSIOM) long-wave radiation fluxes compare to observation. Compared to *Lw(o)*, the variability of the upwelling long-wave radiation flux *Lw(u)* is smaller, but the extreme values also occurred during the above mentioned two extreme weather conditions.

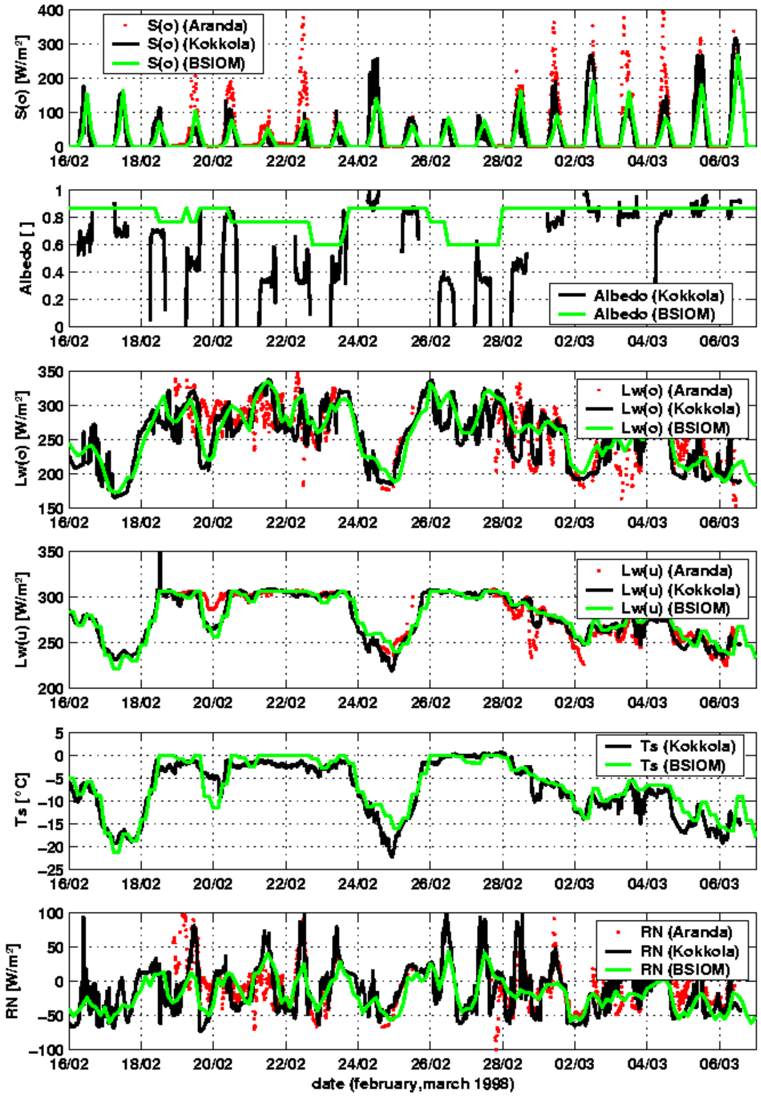

Figure 3. *Time series of radiation parameters downwelling short-wave radiation S(o), albedo, downwelling long-wave radiation Lw(o), upwelling long-wave radiation Lw(u), surface temperature Ts and net radiation RN at Kokkola and RV Aranda in comparison with model data at Kokkola.*

The surface temperature *Ts* shows approximately the same structure as the air temperature (Figure 2). Surprisingly, calculated sea ice surface temperatures compare extremely well with observations. The net radiation flux, *RN=S(o)-S(u)+Lw(o)-Lw(u)*, varies with the daily cycle and clouds. Day values were positive (e.g. 22 February at Kokkola) and night values were predominately negative (e.g. 25, 27 February at Kokkola). The comparison of net radiation fluxes reveals the largest deviations, because little differences in short-wave radiation and downwelling long-wave radiation lead to larger discrepancies, although the overall structure is covered extremely well.

2.3. Turbulent Fluxes

Turbulent fluxes of heat and momentum are presented in Figure 4. Sensible heat fluxes reflect the advection of warm and cold air masses due to moving lows and passing fronts. The sensible heat flux *H* varies approximately between -100 Wm^{-2} and 100 Wm^{-2}. Negative values are a result of melting weather conditions (e.g. 20/21, 22 and 25/26 February) with high wind speeds, and positive values occur when the air temperature rapidly drops below 0°C on the rear of passing lows. The latent heat flux *E* was not measured, thus only the calculated latent heat is displayed. The momentum flux τ reflects the wind speed variations caused by the synoptic variability. Extreme values occurred on 24 February during cold front passage. Surprisingly, the measured τ values are much higher compared to calculated data although the wind speeds on 24 February were in relatively close agreement (wind measurements at Kokkola did not show a maximum at all, Figure 2).

The air-surface temperature difference *Ts-T* reflects the direction of the sensible heat flux. Although the overall structure of measured and calculated differences agree quite well there are larger differences up to 10°C. These differences are mainly due to deviations of calculated sea ice surface temperatures from the observations.

3. Conclusions

Our comparison shows that measurements such as the BASIS 1998 data are extremely useful for validation of coupled model systems. The synoptic variability of atmospheric parameters and fluxes was extremely well represented in the coupled sea ice-ocean model. Here we were only able to give an impression of the potential of this comprehensive data set from eight field campaigns covering all four seasons. An extended analysis and comparison of the total data set with our coupled sea ice-ocean model including also available satellite data will be performed. For our knowledge, it is the first time that a sophisticated coupled sea ice-ocean model is validated by measured atmospheric parameters and fluxes. However, the time series are relatively short and the representativeness of the measurements for a larger area needs to be assessed. For a better quantification of the energy and water cycle of the Baltic area a detailed evaluation of sophisticated models must include, besides the standard parameters also the fluxes which include a detailed analysis of coupling mechanisms and forcing functions. Thus, flux measurements at the air-sea-ice and air-sea interface are needed to improve the understanding of the information exchange between ocean and atmosphere and to improve coupled model systems. With such a detailed validation the reliability of coupled model systems will increase and uncertainties will be reduced.

4. Acknowledgement

We are grateful to Burghard Brümmer and Amelie Kirchgäßner who provided the BASIS data for the winter field experiment 1998.

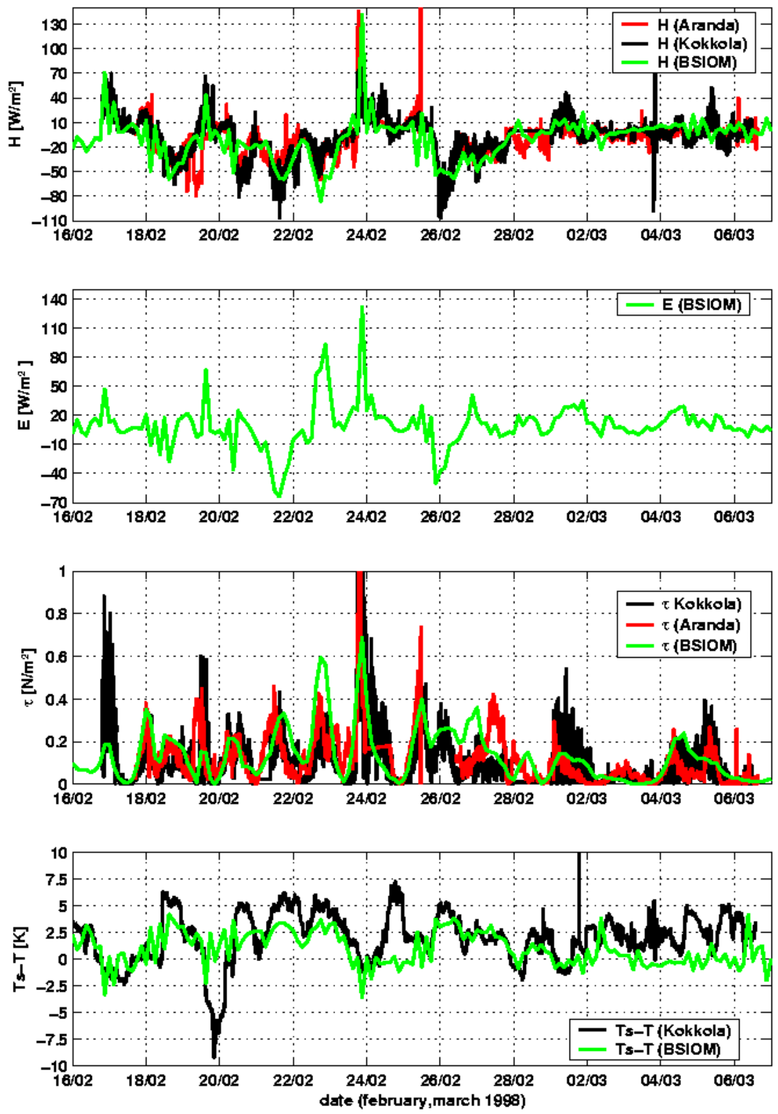

Figure 4. *Time series of sensible heat flux H, latent heat flux E, momentum flux τ and surface-air temperature difference Ts-T at Kokkola and RV Aranda in comparison with model data at Kokkola.*

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BALTEX is the European continental-scale experiment within the Global Energy and Water Cycle Experiment (GEWEX). It constitutes a research programme focussing on water and energy cycles in the climate system of the entire Baltic Sea basin with contributions of more than 10 countries. GEWEX has been launched by the World Meteorological Organisation (WMO), the International Council for Science (ICSU) and UNESCO's Intergovernmental Oceanographic Commission (IOC), as part of the World Climate Research Programme (WCRP). The scientific planning of BALTEX is under the guidance of the BALTEX Science Steering Group, chaired by Professor Hartmut Graßl, Max-Planck-Institute for Meteorology, Hamburg, Germany. The BALTEX *Newsletter* is edited and printed at the International BALTEX Secretariat with financial support through the GKSS Research Centre Geesthacht, Germany. It is the hope, that the BALTEX *Newsletter* is accepted as a means of reporting on plans, meetings and work in progress, which are relevant to the goals of BALTEX, as outlined in the Scientific and Initial Implementation Plans for BALTEX.

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