BALTEX

Baltic Sea Experiment

World Climate Research Programme / Global Energy and Water Cycle Experiment
WCRP GEWEX

Minutes of

6th Meeting of the BALTEX Science Steering Group

at
Danish Meteorological Institute
in Copenhagen, Denmark
2 - 4 March 1998

edited by
Hans-Jörg Isemer

International BALTEX Secretariat
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Summary of Major Action Items

1. The SSG chairman, Professor L. Bengtsson, will contact Dr. Pattermann at the EU in Brussels in order to discuss possibilities of umbrella funding actions for *BRIDGE* on the EU level.

2. Professor E. Raschke was asked to pursue the preparation and conduction of a BALTEX climate workshop along the lines discussed at this SSG meeting.

3. The BALTEX Secretariat is asked to keep connections to CEOP planning groups.

4. Dr. P. Alenius and Dr. A. Lehmann together with the BALTEX Secretariat (Dr. H.-J. Isemer) were asked to undertake necessary actions for the establishment of a sea ice and sea level data archive at BODC.

5. The BALTEX Secretariat was asked to establish a BALTEX publication library and a BALTEX project library with a suitably reduced keyword list.

6. Professors L. Gottschalk, D. Rosbjerg and S. Bergström were asked to prepare an action plan for the hydrological model intercomparison project in BALTEX, to be discussed at the next SSG meeting. Emphasis should be on identification of a responsible scientist or group with the required logistical and manpower support available.

7. Professor P. Mälkki will contact oceanographic research institutions around the Baltic Sea in order to discuss *BRIDGE* implementation possibilities (in particular co-ordinate research vessel cruises).

8. Professor P. Mälkki together with Professors W. Krauß, J. Dera and A. Omstedt were asked to outline the *BRIDGE* benefits for the oceanographic research community.

9. Dr. H.-J. Isemer was asked to review the present measurement activities related to the bridge building activities in both the Great Belt and the Öresund.

10. Members of the *BRIDGE* Task Force (Drs. M. Alestalo, S. Bergstöm, W. Wergen, A. Lehmann) and the BALTEX Secretariat (Dr. H.-J. Isemer) were requested to draft both a strawman of a *BRIDGE* implementation plan and a *memorandum of understanding* to be discussed by the SSG at the next SSG meeting during the BALTEX conference on Rügen. A meeting of this drafting group is tentatively planned for the 1st week in May 1998.

11.The BALTEX Secretariat was asked to write letters to both Professor Launiainen and Dr. Beyrich on behalf of the chairman of the SSG suggesting the new BALTEX panel memberships.

Introduction

The 6th meeting of the BALTEX Science Steering Group (SSG) was hosted by the Danish Meteorological Institute in Copenhagen, Denmark. The meeting opened on Monday, 2 March, at 2 p.m. and closed at 4 p.m. on Wednesday, 4 March 1998. A scientific symposium on „Regional-scale and climate atmospheric modelling of the BALTEX region“ was held as part of the SSG meeting during the afternoon hours of 2 March. The agenda of the meeting including the symposium's speakers list is given in Appendix 1 of these minutes. See Appendix 2 for a list of this meeting's participants.

1 Opening

Dr. Lars Prahm, Director General of the Danish Meteorological Institute (DMI), opened the SSG meeting and expressed his cordial welcome to the meeting participants. He stressed that the Baltic Sea has been for a long time among the central topics of research at DMI and in Denmark in general. The Baltic Sea constitutes a link between the Nordic Countries in several aspects. In particular the environmental issues both of the Baltic Sea itself and the surrounding areas have become a central topic of concern. Dr. Prahm continued to point out that a better knowledge of the Baltic Sea system is required in order to take steps for substantial improvement of the ecological and environmental situation in the area. This is a strong motivation for DMI to take part in research programs like BALTEX. Dr. Prahm mentioned in this context that DMI is actively taking part in the international HIRLAM project thus contributing to the development of improved weather and climate prediction systems. He acknowledged the impressive progress BALTEX has made during recent years. In closing his welcome address Dr. Prahm pointed out the importance of this meeting for the further preparation of the ambitious *BRIDGE* project and he wished the meeting all success for reaching the goals expected.

In his response the Chairman of the BALTEX SSG, Professor Lennart Bengtsson, thanked Dr. Prahm and his team at DMI for hosting the SSG meeting in Copenhagen. Professor Bengtsson shortly summarised the status of BALTEX as an acknowledged sub-program of the World Climate Research Program (WCRP) in the frame of GEWEX, the Global Energy and Water Cycle Experiment. The improved understanding and modelling of the water cycle in the climate system is one of the big tasks of today's research. Professor Bengtsson noted that this research area has been recognised by the European Union (EU) and is foreseen to be an issue of the funding policy in the future fifth EU framework. Being a part of GEWEX BALTEX is working closely together with meteorological and hydrological Services and will deliver useful products for use at Services. As examples, Professor Bengtsson mentioned improved coupled models for various operational duties as well as newly developed observational tools and methods such as GPS (Global Positioning System) data. Professor Bengtsson finished by acknowledging DMI's valuable contributions to BALTEX; he expressed his and SSG's hope for a continuous future contribution of DMI to BALTEX in general and *BRIDGE* in particular.

2 Symposium

Following earlier practice the SSG meeting continued with a scientific symposium, which was dedicated to regional-scale and climate atmospheric modelling of the BALTEX region. See Appendix 1 for the agenda of this symposium and Appendix 3 for abstracts of some of the presentations given at the symposium.

The chairman of the symposium, Mr. Leif Laursen, closed the symposium at 6.30 p.m. Both meeting participants and speakers at the symposium were invited by DMI to a relaxing and delicious evening dinner in a nearby restaurant.

3 Report of the BALTEX SSG Chairman

Professor Bengtsson briefly reviewed the general status of the BALTEX program. He expressed his satisfaction that BALTEX continues to cause scientific interest also in other than those countries being presently active in the BALTEX program. In particular recent steps in the development of coupled models have caused attraction. He also mentioned a comprehensive model intercomparison and validation project which has started now in the frame of the BALTEX-NEWBALTIC program. The latter uses data from the PIDCAP period August to November 1995.

Professor Bengtsson expressed his satisfaction that scientists and research groups from other than the 10 BALTEX countries are now actively contributing to BALTEX. Examples include institutions from the United Kingdom, The Netherlands, United States and Canada. In the latter case connections with MAGS (Mackenzie River GEWEX Study), another Continental Scale Experiment (CSE) of GEWEX, have recently been built up and joint modelling work has started.

The Chairman mentioned various occasions at international conferences and meetings where his presentation of the BALTEX program was very well accepted and has caused new contacts for future contributions to BALTEX.

The Chairman stressed that the most urgent task now is to take steps for the implementation of the Main BALTEX Experiment (*BRIDGE*). The Strategic Plan for *BRIDGE* which was published in October 1997 has been very well taken in the scientific community. Professor Bengtsson stressed that the important duty of the present meeting is an extended discussion on the implementation of *BRIDGE* including funding issues. He pointed out his opinion that the upcoming 5th EU framework program offers possibilities for receiving substantial funding support for *BRIDGE* because the water cycle, water management, and water quality issues are all expected to be among the topics of the 5th framework program. The EU sees both the Baltic and the Mediterranean Seas as the two key water bodies in Europe where research funding will be allocated to.

Action: The SSG chairman, Professor Lennart Bengtsson, will contact Dr. Pattermann at the EU in Brussels in order to discuss possibilities of umbrella funding actions for *BRIDGE* on the EU level.

Professor Ehrhard Raschke pointed out a lack of climatological studies in BALTEX. He suggested increased activities in both reviewing existing literature on the climate in the BALTEX region and conducting climate research based on new data. In this context two new global reanalysis data sets (from NCEP/NCAR and ECMWF) were suggested to be used for climatological studies of both the BALTEX and European regions. The SSG recommended to conduct a BALTEX climate workshop with the objective to summarise presently available evidence on the climate state and its variability of the Baltic Sea catchment region. Particular emphasis should be given to all relevant parameters determining water and energy cycles in the climate system of the Baltic Sea catchment region.

Action: Professor Ehrhard Raschke was asked to pursue the preparation and conduction of a BALTEX climate workshop along the lines discussed at this SSG meeting.

4 Report on GEWEX

Professor Ehrhard Raschke started his report on GEWEX by summarising the present structure of the GEWEX program (see Appendix 4 for a related diagram). He in particular mentioned the GEWEX Hydrology Panel (GHP) which is reviewing progress and interaction of the five CSEs in GEWEX (MAGS, GCIP, LBA, GAME, and BALTEX) in an annual term. Professor Raschke reminded the SSG that a strong co-operation and interaction among the CSEs is strongly endorsed by the GHP as part of the overall global GEWEX strategy. He encouraged BALTEX groups and scientists to take initiative in contacting research groups from other CSEs.

Scientific highlights of actual and planned GEWEX-related research were shortly outlined by Professor Raschke including the promising NASDA-TRMM satellite mission, recent progress in ECMWF seasonal forecasts and the future ESA satellite program.

GEWEX is currently setting up plans for a Central Enhanced Observing Period (CEOP) with expected contributions from all GEWEX projects. Preliminary plans for CEOP foresee the individual CSE catchments to act as test beds for global satellite data products, in particular for the new generation of satellites to be launched in the coming years. Intensive observational and modelling programs within the CSE catchments are suggested to produce ground truth for the various sensors on already operating as well as future satellites. Present preliminary time plans foresee the main phase of CEOP to start in the year 2001 with 2000 being a pilot or test phase. Professor Raschke noted that a one years overlap with *BRIDGE* would be sufficient to test the suitability of both *in situ* data and satellite products for several purposes. An option for *BRIDGE* could be that individual programs may be prolonged to cover also further periods of CEOP.

The SSG took notice of the GHP planning activities for the GEWEX-CEOP. With respect to the BALTEX *BRIDGE* preparations SSG endorsed collaboration with CEOP planning groups. Further *BRIDGE* planning should try to harmonise as much as possible with respective CEOP preparations.

Action: The BALTEX Secretariat is asked to keep connections to CEOP planning groups.

Professor Raschke finished his report by encouraging stronger collaboration between BALTEX and the other CSEs. The SSG followed Professor Raschke and endorsed initiatives to set up co-operation with other CSEs. Both the MAGS and GCIP programs were in particular mentioned in this context because of partially similar climate conditions and problems involved.

5 Report of the BALTEX Secretariat

Dr. Hans-Jörg Isemer, head of the BALTEX Secretariat at GKSS Research Centre in Geesthacht, Germany, gave the report of the Secretariat. Major issues are summarised in the following.

5.1 Funding of the Secretariat

Dr. Isemer explained the present staff member situation at the BALTEX Secretariat. All staff members except one (W. Jansen) are working on non-permanent positions with different funding available from both the German Research Ministry (BMBF) and GKSS Research Centre, but with different funding periods confirmed. The latter were summarised by Dr. Isemer in the following table:

The International BALTEX Secretariat at GKSS Research Centre Geesthacht, Germany

Staff and funding

Name	Funding source	Confirmed until	Outlook
W. Jansen secretary	GKSS, permanent	March 1999 (retirement)	?
R. Brandt project scientist	BMBF	December 1998	?
Dr. C. Ruhe project scientist	GKSS, post-doc	August 1998	August 1999
Dr. H.-J. Isemer project scientist	BMBF	March 1999	?

The SSG again acknowledged the engagement of GKSS in its support of the Secretariat. The SSG further took the opportunity to appreciate the German contributions by both BMBF and GKSS to maintain the Secretariat. SSG expressed its strong hope that further funding will assure the Secretariat's continuous work for BALTEX at the same level.

Professor Raschke strongly repeated earlier offers to scientists to take sabbaticals at the Secretariat for work on BALTEX-related issues. The SSG appreciated this offer and recommended to send scientists for temporary visits to the BALTEX Secretariat in Geesthacht. The latter will seek to provide particular support for such visits.

5.2 Second Study Conference on BALTEX

Dr. Isemer reported that preparations for the upcoming 2nd Study Conference on BALTEX are running remarkably smoothly. Major actions since April 1997 and the future time plan are given in Appendix 5.

Corner-stone developments and facts were summarised as follows: The Conference will be held 25 to 29 May 1998 at Hotel Aquamaris, Juliusruh, Island of Rügen, Germany. The Conference program has been established. It adequately covers the entire BALTEX research spectrum. In total 148 presentations will be given, including 12 invited papers, 60 oral contributed papers, 75 contributed posters and one invited evening lecture. Authors from as much as 23 countries will contribute to the Conference. Dr. Isemer pointed out that a considerable part of the papers submitted to the BALTEX Conference are originating from either cross-institutional or international co-operation indicating a high level of collaborations on both national and international levels in the frame of the BALTEX program. For the opening ceremony attractive speakers both from the science and political arenas including funding agencies have confirmed their attendance. Significant financial sponsoring could be made available for the support of the Conference. The following co-sponsors have so far confirmed support:

- European Union (EU) through the Environment and Climate Programme (DG XII),
- German Research Foundation (DFG),
- German Federal Research Ministry (BMBF),
- GKSS Research Centre Geesthacht GmbH,
- „Verein der Freunde und Förderer des GKSS-Forschungszentrums Geesthacht E.V.“,
- „Deutsche Fährgesellschaft Ostsee mbH“,
- „Deutsche Seereederei Touristik Rostock“.

The SSG expressed its satisfaction on the preparation status for the Conference and thanked both the Program Committee and the BALTEX Secretariat for their efforts. The SSG further appreciated in particular the funding support from the above-mentioned organisations.

5.3 BALTEX Data Exchange Issues and Policy

Progress made at the BALTEX Data Centres was briefly summarised by Dr. Isemer (see Appendix 6). A request of the Global Runoff Data Centre (GRDC) concerning unrestricted data delivery to GRDC was brought to the attention of the SSG.

5.3.1 BALTEX Hydrological Data Centre (BHDC)

The implementation of the BHDC at Swedish Meteorological and Hydrological Institute (SMHI) in Norrköping, Sweden, has made substantial progress since the preceding SSG meeting. See Appendix 7 for a detailed report. The sampling strategy and the data exchange rules are now both accepted and both data collection and delivery has started. The main focus is now on daily runoff data and 3- to 6-hourly meteorological data from selected stations covering the whole Baltic Sea catchment in a representative manner for purposes of model calibration and validation. The period for this data set includes 1980 to present. In particular the digitisation of pre-1990 data will require substantial efforts at many of the east-European hydrological Services.

5.3.2 BALTEX Meteorological Data Centre (BMDC)

The BMDC operated by the German Weather Service (DWD) in Offenbach, Germany, has reached a quasi-operational status in the BALTEX framework where both data collection and data delivery have an 'ongoing' status. Several data requests (the number of which has increased in the recent time) from BALTEX data users have been treated. The BALTEX data exchange rules have been found useful for an effective exchange of data. Data collection at BMDC is focusing on limited target periods during 1986 to 1995 and a continuous collection from 1996 onwards. Dr. Isemer pointed out that the east-European meteorological Services continue to request continuous financial support for their data preparation and delivery activities to BMDC. This support is at present obtained from both DWD and BMBF. No financial support is required for Germany and the Scandinavian countries. Dr. Isemer noted that, according to BMDC, DMI has delivered additional non-GTS data only for the PIDCAP period August to October 1995 while these data are still missing for the other target periods.

5.3.3 BALTEX Oceanographic Data Centre (BODC)

Dr. Isemer continued to note that the BODC at the Finnish Institute of Marine Research (FIMR) in Helsinki, Finland, has further the status of a meta data centre. The SSG discussed possible future requirements of oceanographic data and related tasks of BODC. It was suggested by several SSG members to establish a real BODC data archive of sea ice information and sea level measured at coastal stations around the Baltic Sea. In particular the sea level data should cover the period 1980 until present. Details on both the sea ice information required and the sea level stations to be used should be worked out by BODC together with BALTEX oceanographers.

The SSG recommended that an archive of sea ice and sea level data to be established at BODC.

Action: Dr. Pekka Alenius (BODC) and Dr. Andreas Lehmann (IfM Kiel, Germany) together with the BALTEX Secretariat (Dr. Hans-Jörg Isemer) were asked to undertake necessary actions for the establishment of a sea ice and sea level data archive at BODC.

5.3.4 Global Runoff Data Centre (GRDC) and General Data Exchange Policy

The GRDC is operated by the 'Bundesanstalt für Gewässerkunde' (BfG) in Koblenz, Germany and has been installed as part of the GEWEX program. Dr. Isemer reported on a letter he received from the head of GRDC, Dr. Wolfgang Grabs, where Dr. Grabs requested an unrestricted delivery and use of BALTEX runoff data for the purposes of GEWEX. Dr. Grabs had pointed out that he expects the GRDC data base for the Baltic Sea region to be substantially improved by inclusion of the BALTEX data collected at BHDC. The presently available GRDC runoff data from the Baltic Sea catchment basin are given in Appendix 8.

The SSG discussed the request in detail. It was noted that the present BALTEX data exchange policy has been established as a compromise with the view to make data necessary for BALTEX research purposes available on the one hand and to guarantee the rights and requirements of the various national Services as the primary data suppliers on the other hand. Only the restriction to deliver data exclusively to *registered BALTEX Data Users* has made data exchange possible at all in the frame of BALTEX. SSG members supported in general the idea of a free and unrestricted exchange of BALTEX data. However, several SSG members, representing in particular national Services, noted that GRDC distributes the *original station data* which makes an unrestricted delivery of runoff data to GRDC (and, hence, the global GEWEX community) problematic. It was also noted that delivery of precipitation data to the Global Precipitation Data Centre (GPCP, operated by DWD) is less restricted because GPCP is distributing *precipitation products* (e.g. monthly maps constructed from various sources) and not the original station records. SSG members repeatedly pointed out in this context that no internationally accepted document on hydrological data exchange (such as the WMO Resolution 40 for meteorological data) exists at present. Therefore national Services expect data users to take all pre-cautions that data do not drift into the commercial area in an uncontrolled manner. The SSG emphasised that BALTEX has exactly done this by setting up the BALTEX data exchange policy and related rules and agreements.

The SSG finally stated that, at present, a totally unrestricted delivery of BALTEX data to GRDC and GEWEX is likely to endanger the data delivery of Services to BHDC and, hence, is not recommended. The SSG suggested that BHDC may support GRDC by providing meta information on existing stations and records. Delivery of data itself should be subject to individual negotiations between GRDC and national Services.

5.4 BALTEX Publication and Project Libraries

A BALTEX publication library and a BALTEX project library are planned to be established in electronic form as part of the BALTEX home page on the Internet. The SSG approved the structure of both libraries as established by Dr. Isemer. The SSG also suggested to reduce the keyword lists for both libraries.

Action: The BALTEX Secretariat was asked to establish a BALTEX publication library and a BALTEX project library with a suitably reduced keyword list.

5.5 Hydrological Model Intercomparison Project

The implementation of a BALTEX hydrological model intercomparison project is delayed. Experience from other international intercomparison projects shows that they require considerable support in terms of both logistics and manpower. It has been found difficult to identify a leading project scientist who is sufficiently supported in this respect by his or her home institution. The SSG discussed possible options for such a project to some detail. The following strategy was suggested by the SSG:

- to conduct a small-scale, process-oriented model intercomparison and improvement activity based on NOPEX data,
- to concentrate on the Odra and Torne/Kalix catchments for application and intercomparison activities for regional-scale river basins.

Action: Professors Lars Gottschalk, Dan Rosbjerg and Sten Bergström were asked to prepare an action plan for the hydrological model intercomparison project in BALTEX, to be discussed at the next SSG meeting.. Emphasis should be on identification of a responsible scientist or group with the required logistical and manpower support available.

6 Report of BALTEX Working Groups

6.1 Working Group Numerical Experimentation (WGNE)

The chairman of WGNE, Professor Jürgen Willebrand, summarised the progress in the development of atmospheric, oceanographic and hydrological models related to BALTEX research. He referred to the 3rd meeting of WGNE held in Helsinki, 9 to 10 June 1997. The corner-stone developments are shortly summarised here as follows:

- The development and application of atmospheric models are in good shape. A recently started comprehensive model intercomparison project as part of the BALTEX-

NEWBALTIC program is expected to further contribute significantly to the improvement of the participating models.

- Efforts to couple a regional-scale atmospheric model to a 3-d circulation model of the Baltic Sea are even ahead of schedule.
- An intercomparison project for oceanographic models has been suggested by WGNE and announced to the scientific community. It will be targeted to the PIDCAP period August to November 1995.
- Data assimilation in oceanographic models is not fully implemented compared to BALTEX plans and needs further efforts.
- A full hydrological model for the entire Baltic basin has been set up and preliminary results are available. Links between hydrological models and climate models are established on the macro-scale.

For details see the minutes of the 3rd WGNE meeting attached as Appendix 9.

6.2 Working Group Process Studies (WGP)

Professor Anders Omstedt gave a review on the field experiments being presently conducted in the frame of BALTEX. See Appendix 10 for a map of campaign locations and years. Professor Omstedt pointed out that all four BALTEX experiments have now field campaigns either already conducted or planned. Dates of conducted and planned field campaigns were summarised as follows:

PEP in BALTEX

Continuous measurements:	1 May 1998 until 31 October 1999,
First Concentrated Field Effort (CFE1):	12 October to 12 November 1998.

BASIS

CFE:	16 February to 6 March 1998

DIAMIX

First pilot CFE:	June 1997
Second pilot CFE:	June 1998
First main CFE:	January 1999

Second main CFE:	September 1999 or September 2000.

LITFASS (DWD)

Continuous measurements:	1995 to 2001
Next CFE:	May/June 1998

The funding sources for the individual field experiments are different. Both PEP and BASIS receive international support as acknowledged EU-projects. DIAMIX is mainly a Swedish national project with contributions from a few non-Swedish groups (in particular from Germany and Poland). Funding support for DIAMIX is almost entirely originating from the contributing institutes' budgets. LITFASS is a project of the German Weather Service (DWD) and the main support is provided by DWD. Individual field measurements during specific campaigns are contributed by several institutions in Germany and other European countries and are financed by these institutions. Earlier funding applications to the EU for both DIAMIX and parts of LITFASS have not been successful.

6.3 Working Group Radar (WGR)

Dr. Mikko Alestalo reported on the recently conducted 2nd meeting of WGR, held 23-24 February, 1998 at DMI, Copenhagen. WGR's efforts are already strongly directed towards the planning for *BRIDGE*. The 2nd WGR meeting was in particular successful in determining the logistical requirements and plans for the implementation of a continuous production and delivery of weather radar products during the entire *BRIDGE* period. Steps towards connecting all existent Doppler weather radars located in the Baltic Sea basin into a BALTRAD network are underway. The establishment of a specific Radar Data Centre for *BRIDGE* has intensively been discussed. SMHI has been suggested to operate this data centre. For a detailed description see the 2nd WGR meeting minutes attached as Appendix 11.

The SSG acknowledged the progress being obtained by WGR. The SSG also encouraged WGR to put increased emphasis on elaborating improved methods for the use of radar data, in particular for data assimilation purposes. Professor Sten Bergström pointed out that SMHI has in general a positive attitude concerning the operation of a BALTEX Radar Data Centre. A final decision in this context will however require further discussions on logistical and financial aspects, both internally at SMHI and among the Services operating radars in the BALTEX area. It is too early to expect firm commitments from SMHI on this issue at the time being.

7 Report on BALTEX Networks

7.1 Full-scale Studies of the Energy and Water Cycle

Much of the work done in the frame of this network has been conducted through the EU-funded project NEWBALTIC. Professor Bengtsson was happy to announce that NEWBALTIC II has now been accepted for funding by the EU. NEWBALTIC II will start 1 April 1998 and will run for 2 years. Professor Bengtsson noted that the Dutch Weather Service KNMI is now also participating.

NEWBALTIC II will be the continuation of NEWBALTIC with specific emphasis on a recently started atmospheric model intercomparison project. High resolution re-analyses based on different NWP models have been produced. Detailed atmospheric model intercomparison have been undertaken for the period 1 August to 31 October 1995 with the following models being investigated:

1. HIRLAM-DMI

Re-analysis including data assimilation; 6h forecast intervals; the results of this run have been used as initial and boundary values for the other model runs, except REMO-DWD.

2. HIRLAM-SMHI

No data assimilation; run in climate mode.

3. REMO-GKSS

No data assimilation; run in forecast mode (30h intervals).

4. REMO-MPI (ECHAM4 physics)

No data assimilation; run in climate mode.

5. REMO- MPI (EM/DM physics)

No data assimilation; run in climate mode.

6. REMO-DWD

Re-analysis including data assimilation; 6h forecast intervals.

7. UKMO

No data assimilation; run in climate mode.

This model intercomparison is a major BALTEX initiative being conducted primarily by six Weather Services and institutes. All model runs have been driven by one analysis product, based on the HIRLAM-DMI re-analysis. Having performed the model integration for the PIDCAP period each of the participating institutes are now responsible for analysing the models' performance for one key parameter as follows:

German Weather Service (DWD):	Cloud cover
Danish Met. Service (DMI):	Precipitation
UK Met.Office (UKMO):	Surface sensible heat flux
GKSS:	Evaporation
University of Helsinki:	Short- and longwave radiation at ground
Swedish Met.Service (SMHI):	Total runoff, 2m airtemperature

Thus far, the intercomparison concentrates on daily values of basin-wide averages separated into land surface and Baltic Sea areas. Comparison with observed data is included as far as they are available. First results are available and the interpretation phase of this undertaking is ongoing.

7.2 Coupled Modelling of the Baltic Sea

In his review Professor Wolfgang Krauß, the chairman of this network, followed closely the network plan and description as given in section 9 of the BALTEX Initial Implementation Plan. He pointed out that all planned projects of this network have been started and are well in schedule. Good, or in some projects even exceptional progress has been made. An example for the latter is the successful coupling of the atmospheric regional model REMO to the 3-d Baltic Sea circulation model BSMO at Institute for Marine Research Kiel (IfMK). This has been achieved in a relatively short time period of less than 2 years. He referred to the contribution by Renate Hagedorn given at the scientific symposium (see Appendix 3). Other examples of successful projects in this network include

- the modelling of the transports through the Danish Straits using a chain of 3 oceanographic models including data assimilation,
- the use of the adjoint of a 3-d circulation model to improve the atmospheric forcing (i.e. wind speed) used for modelling the internal dynamics of the Baltic Sea,
- the coupling of a sea ice model of the Hibbler type to a 3-d circulation model of the Baltic Sea, a model run for the relatively mild winter 1992/93 has been successfully conducted, a run for the severe winter 1986/87 is currently been performed.

In order to gain insight in the long-term variability of the Baltic Sea a 10 to 20 years run with a version of the coupled sea ice-BSMO model is being planned.

Professor Krauß finally mentioned that most of the projects are not (or only partially) being funded by the participating institute's own budgets but receive external funds from national or EU sources. Thus the continuation of this network depends almost entirely on further external funding.

Keywords of this report are again summarised in Appendix 12.

7.3 PEP in BALTEX

PEP (Pilot Study of Evaporation and Precipitation in BALTEX) is designed as a pilot experiment to *BRIDGE*, with the specific scope to study precipitation and evaporation over the sea. Professor Ann Sofi Smedman is co-ordinating this experiment and informed the SSG on the implementation status of PEP. She pointed out that PEP is an international project funded by the EU.

Professor Smedman started outlining some basic motivations for the conduct of PEP. She pointed out that for determination of precipitation at sea *BRIDGE* needs to rely in particular on radar measurements. To test, improve and validate radar estimates of precipitation against in situ measurements, a pilot study prior to *BRIDGE* was considered necessary. At the same time PEP will provide data sets for the improvement of numerical models over the sea. The measurements in PEP will be concentrated along a transect from the northern coast of Germany to south-western Finland. For an 18-months period starting 1 May 1998 PEP will provide a comprehensive set of actual evaporation data measured with the eddy correlation technique at four well-exposed sites (Zingst, Germany; island of Christiansö, Denmark; island of Östergarnsholm, Sweden; and Kopparnäs, Finland) as well as precipitation, measured with micro rain-radars. An interesting contribution to PEP are rain measurements being continuously performed aboard of ferry ships running regularly from Germany to Finland along the transect mentioned above. Experimental data sets will be used within PEP for validation of evaporation routines in several models. As a preliminary example result from the activities in PEP Professor Smedman reported on findings that the HIRLAM model (being used as an operational NWP tool in several European Services) tends to overestimate turbulent fluxes at the Baltic Sea surface and improvements to this model are now being developed and tested. The precipitation data will also be used for calibration of weather radars.

A concentrated field effort with participation of research vessels will be conducted during 12 October to 12 November 1998. At Östergarnsholm a monitoring site for turbulent fluxes is being operated continuously since 1995.

7.4 BASIS

Professor Pentti Mälkki gave the report for Professor Jouko Launiainen, the co-ordinator of BASIS, who at the time being was participating at the first concentrated field effort (CFE1) of BASIS. Professor Mälkki noted that the present winter is so far a mild one with ice conditions being slightly below normal. He reported that the field experiments could be started in the planned region on both sides of the ice edge which was located between the Bothnian Bay and Bothnian Sea near Umea at the end of February.

Professor Mälkki continued by reviewing the BASIS aims which focus on an improved understanding and modelling of energy and water cycles during winter conditions by conducting a winter field experiment in the ice edge zone of the Baltic Sea in winter 1998. The study is carried out as a co-operation of five institutes from Finland, Sweden and Germany. BASIS is the first field experiment in the Baltic Sea covering the various branches of physical oceanography, sea ice research, marine meteorology and remote sensing. BASIS will collect data particularly of the

- exchange of heat, water and momentum between the air, ice and sea,
- structure of atmospheric and oceanic boundary layers and their interaction and exchange processes,
- ice motion and the atmospheric and oceanic driving forces, and
- interaction between thermodynamic and dynamic processes in the air, sea and ice.

Research vessels, research aircrafts and helicopters, meteorological balloon stations and a good set of automatic weather stations, turbulence equipment, and drifting buoys are being used. Analysis of the data sets is expected to result in improved remote sensing algorithms and, in particular, better parameterisations of air-ice-ocean interaction processes for development, validation, and optimisation of the coupled atmosphere-ice-ocean models. Professor Mälkki finished his summary by emphasising that BASIS is a project funded by the EU. The duration of the project as planned at present is 1997-2000.

7.5 LITFASS

Dr. Nicole Mölders briefed the SSG on recent developments related to the LITFASS (Lindenberg Inhomogeneous Terrain - Fluxes between Atmosphere and Surface - a Long-term Study) experiment. The general scientific objective of LITFASS is to determine and to model and parameterise the fluxes of momentum, heat, water and other substances, representative for the horizontal scale of the order of 10 km over heterogeneous land surfaces. Sub-grid scale heterogeneity in the characteristics of the land surface, in the forcing conditions as well as in the resulting fluxes will be taken into account. The LITFASS project is divided into three different sub-projects:

- development of a non-hydrostatic model with a grid-size of 100 m,
- experimental investigations within a 20 km x 20 km area around the Lindenberg Observatory,
- data management.

LITFASS is planned and conducted by DWD. The planning foresees LITFASS to be executed in stages from 1995 up to the year 2001. The investigation area for LITFASS is located around the Lindenberg Observatory of DWD south-east of Berlin. The LITFASS area is fixed around the central point of one grid-box of the Deutschland-Modell (DM), which is the high-resolution (15 km x 15 km) operational NWP model of DWD.

The monitoring network includes all parameters to validate micro-α-scale, non-hydrostatic atmospheric models. Examples include high resolution precipitation with a sample time down to 1 minute, global radiation, ground water, runoff, soil moisture, leaf-area-index and stomatal resistance. Five LITFASS-Energy-Balance-Stations will be installed over agricultural fields, in a forest and on a lake. All relevant parameters will be measured or observed at these stations so that the turbulent fluxes can be calculated with SVAT and boundary-layer models.

Research institutes in Germany and other countries are presently planning contributions to LITFASS. A field measuring campaign for BALTEX will be conducted during May/June 1998, using facilities of LITFASS. See Appendix 13 for a keyword summary on LITFASS 1998.

Dr. Mölders regret to report that, unfortunately, the EU did not fund the BALINEX subproject of LITFASS which addressed in particular the surface heterogeneity problem. The heterogeneity of the surface and its effect on the atmosphere was planned to be addressed by using acoustic tomography, measurements from motor gliders, forest RADAR, tethered balloons flying on constant levels, and surface observations. It was intended to use these data for evaluation of three typical parameterisation schemes of the surface heterogeneity. Currently attempts are underway to receive funding for parts of this proposal from other sources.

In spite of this drawback pilot field campaigns for LITFASS have been conducted at Lindenberg and also other locations in Germany. In 1997, the LINEX II experiment took successfully place at Lindenberg. Moreover, in 1997, a pre-experiment on acoustic tomography was performed at Melpitz, a site near Leipzig.

This year a further experiment will be carried out at Lindenberg, LINEX III. Particular attractive contributions planned include a cloud radar (funded by GKSS) and acoustic tomography (applied by the Leipzig Institute for Meteorology, LIM).

7.6 DIAMIX

Professor Anders Omstedt shortly summarised objectives and developments of DIAMIX (DIApycnal MIXing experiment).

DIAMIX is a planned oceanographic field experiment to evaluate the dynamics of wind-forced diapycnal mixing in the stratified ocean. It will concentrate on measurements of vertical mixing and advection in the Gotland Basin. It is intended to estimate the distribution of kinetic and potential energy in an experimental box extending from the shoreline of the island Gotland to the maximum depth of the eastern Gotland Basin.

Two pilot surveys have been conducted during June 1997 and 1998, respectively. It is foreseen to conduct a main summer experiment with an expected seasonal, essentially thermal stratification in the surface layers during 4 to 17 September 2000, and a winter experiment when the water is homogeneous down to the halocline at about 60 m depth during 18 to 31 January 1999.

The measurements will comprise moorings with current meters and CT-sensors and continuous ADCP and CTD recordings. Four ships are expected to participate. Two of these will do continuous CTD and ADCP measurements along transects perpendicular to the coast. Vessel-mounted ADCP and a vertically undulating vehicle carrying the CTD are planned to be used. The other ships will take CTD profiles and profiles of turbulent dissipation from the sea surface to the sea bed in many verticals each day. The meteorological measurements during PEP at Östergarnsholm and elsewhere will provide high-quality meteorological data and independent estimates of the air-sea exchange of heat, water and momentum.

The DIAMIX data sets will be useful for testing ocean circulation models with respect to e.g. meso-scale dynamics.

Professor Omstedt drew attention to the fact that DIAMIX is mainly a Swedish national project with contributions from a few non-Swedish groups (in particular from Germany and Poland). Funding support for DIAMIX is almost entirely originating from the contributing institutes' budgets.

8 Report on NOPEX

Professor Lars Gottschalk discussed major NOPEX progress. He noted the WINTEX experiment which, as a part of NOPEX, aims at exploring land-surface-atmosphere interactions in a winter-time boreal landscape through a Concentrated Field Effort (CFE) conducted at Sodankylä. The Sodankylä Meteorological Observatory, located in a sub-arctic forest area in northern Finland (67°29' N; 26°39' E), is one of the two main meteorological observatories of FMI. Professor Gottschalk mentioned that the continuous climate monitoring (CCM) activities in NOPEX gain more and more importance. CCM activities are already ongoing at the first major experimental NOPEX site near Uppsala in Sweden but will now also be strengthened at Sodankylä. See Appendix 10 for NOPEX field experiment sites.

A new 3-years project inside NOPEX concentrates on calibration and validation of a new generation of hydrological models. Data from a small-scale catchment located near to the water divide at the Norwegian/Swedish boarder, which is well equipped with both hydrological and meteorological measurement facilities, will be intensively used for this purpose.

Preliminary model results from both CFE1 and CFE2 near Uppsala were presented and discussed briefly by Professor Gottschalk. He pointed out that the modelling component in NOPEX is now getting increasingly stronger with contributions from several groups in Scandinavia and other European countries.

With respect to BALTEX-NOPEX co-operations he suggested to compare process formulations in various hydrological models (and the land surface components of atmospheric models) used in BALTEX based on validations against data taken during NOPEX field campaigns. This should be one part of the planned BALTEX hydrological model intercomparison project (see also item 5.5).

Professor Gottschalk re-called that the main objective of WINTEX is to prepare the best possible planning for a full-scale winter-time CFE (CFE4 in NOPEX) around the year 2000. The timing of CFE4 will be co-ordinated within an IGBP-BAHC and a WCRP-GEWEX context, especially with respect to the timing of the Main BALTEX Experiment *BRIDGE*. The NOPEX planning foresees CCM activities at the two measurement sites near Uppsala and at Sodankylä which will at least partly cover the *BRIDGE* phase. At least one CFE at Sodankylä will most probably be conducted during the *BRIDGE* phase.

The NOPEX data exchange policy has been re-considered at the recent NOPEX Executive Committee (EC) meeting in December 1997. Data from CFE1 and CFE2 will soon become openly available for the scientific community. The EC also considered it useful to make data from other CFEs and CCM activities more rapidly available to scientists outside the NOPEX community.

9 National Reports on Contributions to BALTEX and *BRIDGE*

National reports from 9 BALTEX countries initiated the *BRIDGE* preparatory discussion. Only major and most important contributions are shortly summarised in section 9. Section 10 notes major decisions and action items concerning the future preparations for *BRIDGE*.

9.1 Denmark

Leif Laursen noted that there is no national BALTEX funding confirmed at present in Denmark. This is the major reason for the small number of institutions and groups which actively contribute to BALTEX. He pointed out that the academic circles in Denmark need to be both better informed and more attracted for the BALTEX research program. The major DMI contribution to BALTEX is focused on improvements of the NWP model HIRLAM. An international HIRLAM consortium chaired at present by Leif Laursen has the main objective to develop and improve atmospheric models including data assimilation. Application of HIRLAM to BALTEX problems is considered a useful completion with mutual benefits for both programs.

9.2 Sweden

Professor Anders Omstedt reported on Swedish activities related to BALTEX. A summary of his report is given in Appendix 14. The main contributions to BALTEX in Sweden originate from Universities at Uppsala, Gothenburg, Stockholm and Chalmers, and from SMHI. There is a wide range of contributions covering almost all scientific areas in BALTEX. EU projects are an important source of funding but there is also considerable support from institutes and national funding agencies.

The SSG appreciated the numerous and valuable contributions to BALTEX from the Swedish scientific community as an excellent example of national engagement in an international research project.

9.3 Finland

Several institutes in Finland are actively participating in BALTEX in various research areas. Dr. Mikko Alestalo mentioned in particular the following institutions and contributions:

FMI	Improvement of HIRLAM Co-ordination of BALTRAD Participation in PEP
Helsinki University	Sea ice modelling Contribution to atmospheric modelling
Environmental Institute	Runoff and Precipitation Data Hydrologic modelling

As in Denmark a major outreach of BALTEX for the atmospheric part is expected through the development and improvement of the HIRLAM NWP model in close co-operation with the Services and the international HIRLAM consortium.

Professor Pentti Mälkki continued the report for Finland by summarising the contributions of the Finnish Institute of Marine Research (FIMR):

FIMR	Sea ice modelling Co-ordination of BASIS Participation at DIAMIX Host of the BODC

Professor Mälkki noted that there is further scientific potential in Finland for fruitful contributions to BALTEX. He in particular mentioned the Finnish Technical University, Helsinki, which has long tradition and high-level experience in particular in hydrological modelling. There are also several groups working on snow modelling.

Both speakers emphasised the usefulness of a *BRIDGE* document summarising the *BRIDGE* activities and participants. Such a document would be very useful to support applications for funding at Finnish national agencies.

9.4 Russia

Professor Valery Vouglinski summarised the Russian BALTEX contributions which are so far almost entirely confined to the Russian State Hydrological Institute (RSHI). The preparation and delivery of observational data and the use of the hydrological model HYDROGRAPH for the Neva catchment constitute the two major contributions to BALTEX. Professor Vouglinski pointed out that all Russian contributions to BALTEX require external international funding.

9.5 Estonia

Dr. Sirje Keevallik reported that the Estonian Meteorological and Hydrological Institute (EMHI) will most probably install a Doppler weather radar on the Estonian territory. She pointed out that this new radar would fill an identified gap in the radar coverage of the eastern Baltic Sea. Several small projects are conducted at different Estonian institutes and at EMHI which are related to BALTEX. Dr. Keevallik mentioned also the preparation and delivery of observational data to the BALTEX Data Centres conducted at EMHI. Most of the BALTEX activities in Estonia require external funds which mostly come from international sources.

Dr. Keevallik finally reported on experience in Estonia that national funding agencies most often request official international documents or contracts which state the benefits of BALTEX in general and the need for Estonian participation in particular. In essence, it appears that, in order to receive funding, scientific reasoning tends to be less important than to submit legal international documents.

9.6 Latvia

In his report on Latvia, Mr. Andris Leitass took up the latter problem of getting financial support which appears similar in Latvia. In a very open discussion he outlined the sometimes extremely difficult financial situation in Latvia, which is similar to a certain degree in the other

Baltic States and other countries in eastern Europe. Weather Services and research institutes are almost at the very end of priority lists of national funding agencies. Confirming the above noted statements from Estonia he pointed out that a lack of proper argumentation is an important reason for the almost zero funding situation He considered legal international BALTEX contracts stating both the necessity for e.g. Latvia to contribute to the research program and clearly understandable benefits for the society as highly important while scientific argumentation is less important. Political argumentation in general seems to be more promising than scientific reasoning.

Mr. Leitass announced a re-organisation of the national meteorological and hydrological measurement network which is likely to reduce the presently operating number of stations. However, this will most probably lead to positive developments as well. An example is the possible increase of RS ascents from 12-hourly to 6-hourly intervals at Riga.

9.7 Belarus

Dr. Gregory Chekan noted the national hydrometeorological Service as the only institution in Belarus with significant continuous contributions to BALTEX. The latter focus on observational data preparation and delivery as well as hydrological modelling. He stressed the importance of external international funding for all Belorussian contributions to BALTEX.

At this point the SSG discussed in detail the difficult funding situation in some of the east-European countries. The SSG emphasised that BALTEX is an accepted European research contribution to GEWEX, the latter being a global program which has been defined and set up, and is being continuously reviewed and supported by the World Climate Research Program (WCRP). Therefore, BALTEX has the support of WCRP and, hence, of the World Meteorological Organisation (WMO). The SSG stressed that support for BALTEX means essentially support for the goals and objectives of WMO. Having in mind that all BALTEX countries are WMO Members the SSG strongly suggested to clearly explain the mentioned BALTEX - GEWEX - WCRP - WMO relations when applying for national financial support for BALTEX.

9.8 Poland

Professor Zdzislaw Kaczmarek noted that the World Bank has recently agreed to finance the improvement of the Polish national meteorological and hydrological observing network. He mentioned in this context that only accepted national projects may receive digitised data from the national networks for free. While runoff and synoptical data are in general available in digitised form, most of the precipitation data taken at non-synoptic stations are available only on paper in year books or other documents. Professor Kaczmarek also noted that there is no formalised national BALTEX program established in Poland but contributions to BALTEX originate from research projects at individual institutes. A Polish BALTEX Task Force has been implemented with meteorological, hydrological and oceanological sections.

Professor Jerzy Dera explained in detail the BALTEX activities of the national oceanological section. Contributions are mainly originating from the Institute of Oceanology (IOPAS) in Sopot and the Hydroengineering Institute (IHPAS) in Gdansk, both members of the Polish Academy of Sciences. See Appendix 15 for a more detailed report.

9.9 Germany

The German contributions to BALTEX are originating from several agencies and institutions covering almost the entire spectrum of research activities in BALTEX. Professor Ehrhard Raschke mentioned in particular the German Weather Service (DWD), the Max-Planck-Institute for Meteorology (MPIfM), the Institute for Marine Sciences Kiel (IfMK), GKSS Research Centre, BfG in Koblenz, Institute for Baltic Sea Research Warnemünde (IOW), Ludwig Consulting Engineers, as well as Universities in Leipzig, Hannover, Dresden, Bayreuth and Bonn. Financial support for these activities are based on both national and international sources. The former originates from the individual institutes' own budgets or is to a large extent based on support given by the German Research Ministry (BMBF) while the latter is mainly contributed by the EU.

Professor Bengtsson noted that a National Committee for Climate Change Research has recently been established in Germany which will act as an advisory board to BMBF in particular for its funding and support policy. The Baltic Sea as well as energy and water cycles in the climate system are explicitly mentioned in recently established documents of the Committee, which Professor Bengtsson led to expect a longer-term perspective for receiving support for BALTEX and in particular *BRIDGE* - related research.

Dr. Bruno Rudolf finally gave a detailed outline of the BALTEX activities at DWD. See Appendix 16 for details.

10 Discussion on the Implementation of *BRIDGE*

A comprehensive and constructive discussion on the implementation strategy for *BRIDGE* led to decisions and recommended actions concerning preparations for *BRIDGE* which are summarised as follows:

10.1 New Time Plan

BRIDGE will be conducted in the period from **October 1999 to December 2001**. Modelling and observational activities during *BRIDGE* will be divided into

1) **a continuous base-line observational program** (comparable to the PIDCAP level) during the entire 27 months period, and

2) **specific enhanced observational programs** confined to limited periods of a few months duration. The latter will include the following periods:
    - January/February 2000
    - August/September 2000
    - April/May 2001.

10.2 Support activities

Independent, delayed-mode four-dimensional data assimilations performed by at least two operational Weather Services (DWD and one HIRLAM-associated centre) including BALTEX-related, „user-friendly“ data storage and distribution are planned as part of the base-line program. Possibilities for additional parallel continuous model runs (regional-scale atmospheric models, climate models in both coupled and uncoupled modes) at different centres are currently being investigated. For the base-line observational part special efforts are planned to collect relevant data from the entire BALTEX region as exemplified during the PIDCAP period.

The enhanced specific time-limited actions are planned to include e.g.

- high-resolution, non-hydrostatic atmospheric model runs for the entire BALTEX region, or specific sub-basins,
- coupled model runs which are too time-consuming for continuous applications during the base-line period,

- specific field campaigns to provide for high-quality observational data, which are needed in process-oriented studies,
- special efforts to enhance observational densities for the entire BALTEX region (e.g. to increase the density of rawinsonde observations).

10.3 Specific Oceanographic Observational Actions

Co-ordinated observational hydrographic field campaigns with participation of several research vessels from many institutions around the Baltic Sea were suggested as regular observational actions („International Baltic Year“) during the *BRIDGE* base-line period in order to document the annual cycle of relevant parameters in the Baltic Sea. The benefits of *BRIDGE* for the oceanographic community needs to be better spelled out. In- and outflow measurements at the Danish Straits are key parameters for closing the Baltic Sea budgets. It was noted that several permanent stations in the Straits are required.

Action: Professor Mälkki will contact oceanographic research institutions around the Baltic Sea in order to discuss *BRIDGE* implementation possibilities (in particular co-ordinate research vessel cruises).

Action: Professor Mälkki together with Professors Krauß, Dera and Omstedt were asked to outline the *BRIDGE* benefits for the oceanographic research community.

Action: Dr. Isemer was asked to review the present measurement activities related to the bridge building activities in both the Great Belt and the Öresund.

10.4 Implementation Steps

A *BRIDGE* implementation plan is urgently required now. It should be finalised before the end of the year 1998. A document will have to be established including commitments of institutions on their participation at *BRIDGE*. Such a document may be laid down either as part of the implementation plan or as a separate *memorandum of understanding*. It has been requested from national funding agencies to be submitted before or together with future funding applications for *BRIDGE*. A *BRIDGE* implementation meeting shall be conducted in the second half of the year 1998 or in early 1999 with participation of Services and other institutions which will play important roles in the implementation and conduction of *BRIDGE*.

<u>Action:</u> Members of the *BRIDGE* Task Force (Drs. M. Alestalo, S. Bergstöm, W. Wergen, A. Lehmann) and the BALTEX Secretariat (Dr. H.-J. Isemer) were requested to draft both a strawman of a *BRIDGE* implementation plan and a *memorandum of understanding* to be discussed by the SSG at the next SSG meeting during the BALTEX conference on Rügen. A meeting of this drafting group is tentatively planned for the 1st week in May 1998.

Different ways of inviting additional contributions to *BRIDGE* in particular from other than the present BALTEX countries were discussed. The following suggestions by Professors E. Raschke and S. Bergström were in particular endorsed by the SSG:

- to use the existing GHP/CSE structures developed in the frame of GEWEX,
- to talk individually to specific scientists, group leaders, and institution directors.

As part of the process to convince national funding agencies for allocating resources to the planned *BRIDGE* activities SSG again stressed that BALTEX is an approved WCRP program and thus has the blessing of the international community through WMO, UNEP and ICSU.

11 Status and Membership of BALTEX Panels

11.1 SSG

Professor Pentti Mälkki expressed his wish to resign from his SSG membership. The chairman, Professor Bengtsson, expressed his deep regret and reviewed Professor Mälkki's merits for the build-up and implementation of BALTEX as an European research program. In the name of the SSG and the whole BALTEX community he thanked Professor Mälkki for his continuous interest and support for BALTEX.

Upon suggestion of Professor Mälkki the SSG appointed **Professor Jouko Launiainen** of FIMR, Helsinki, Finland as a new member of the BALTEX SSG.

11.2 Working Group Process Studies

Dr. Frank Beyrich of the Lindenberg Observatory, Germany was appointed as a new member of the BALTEX Working Group Process Studies.

Action: The BALTEX Secretariat was asked to write letters to both Professor Launiainen and Dr. Beyrich on behalf of the chairman of the SSG suggesting the new BALTEX panel memberships.

11.3 BALTEX Task Force

The SSG prolonged the terms of the BALTEX Task Force and requested the group to put continuous efforts in the preparation of *BRIDGE* following the advice of the SSG.

12 Further items

No further items were discussed.

13 Next SSG Meetings

The SSG concluded to convene for its 7th meeting on 26 May 1998 at the 2nd Study Conference on BALTEX on the island of Rügen. This meeting will be short and is planned to exclusively review progress in the preparations for *BRIDGE.*

Professor Hilding Sundqvist offered to host the 8th SSG meeting at Stockholm University, Stockholm, Sweden, during the first calendar week of December 1998. The SSG suggested to start the next SSG meeting again with a scientific symposium which should focus on meteorological aspects related to BALTEX.

14 Closing of the Meeting

The Chairman closed the SSG meeting at 4 p.m. on Wednesday, 4 March 1998. He thanked all participants for engaged and constructive discussions. The participants of the meeting appreciated the excellent conduction of both the symposium and the SSG meeting at DMI and expressed their thanks to Dr. Lars Prahm and his team.

15 List of Acronyms and Abbreviations

ADCP	Acoustic Doppler Current Profiler
BAHC	Biospheric Aspects of the Hydrological Cycle, IGBP subprogram
BALINEX	BALTEX Land Surface Experiment at Lindenberg
BALTEX	Baltic Sea Experiment
BALTRAD	BALTEX Radar Network
BASIS	Baltic Air-Sea-Ice Study
BASYS	Baltic Sea and Sea-Ice Modelling
BfG	Bundesanstalt für Gewässerkunde, Koblenz, Germany
BHDC	BALTEX Hydrological Data Centre
BMBF	Bundesministerium für Forschung und Technologie, Bonn, Germany
BMDC	BALTEX Meteorological Data Centre
BODC	BALTEX Oceanographic Data Centre
BRIDGE	The Main BALTEX Experiment, planned for 1999-2001
BSMO	Baltic Sea circulation model
CCM	Continuous Climate Monitoring
CEOP	Central Enhanced Observing Period
CFE	Concentrated Field Effort
CSE	Continental Scale Experiment
CT	Conductivity - Temperature
CTD	Conductivity - Temperature - Depth
DFG	Deutsche Forschungsgemeinschaft, Germany
DIAMIX	Diapycnal Mixing in the stratified ocean; Field experiment in BALTEX
DM	Deutschlandmodell, operational NWP model of DWD
DMI	Danish Meteorological Institute, Copenhagen, Denmark
DWD	Deutscher Wetterdienst, Offenbach / Germany
EC	Executive Committee
ECHAM	European Climate Model - Hamburg version
ECMWF	European Centre for Medium Range Weather Forecast, Reading / UK
EGS	European Geophysical Society
EM	Europamodell, operational NWP model of DWD
EMHI	Estonian Meteorological and Hydrological Institute, Tallinn / Estonia
ESA	European Space Agency, Darmstadt / Germany
EU	European Union
FIMR	Finnish Institute of Marine Research, Helsinki / Finland
FMI	Finnish Meteorological Institute, Helsinki / Finland
GAME	GEWEX Asian Monsoon Experiment
GCIP	GEWEX Continental Scale International Project
GEWEX	Global Energy and Water Cycle Experiment
GHP	GEWEX Hydrology Panel
GKSS	GKSS Research Centre, Geesthacht / Germany
GPCP	Global Precipitation Data Centre
GRDC	Global Runoff Data Centre

Acronyms and Abbreviations (continued)

GTS	Global Telecommunication System
HBV	Swedish Conceptual Hydrological Model for Runoff Simulation
HIRLAM	High Resolution Limited Area Model
HTM	Horizontal Transport Model
ICSU	International Council of Scientific Unions
IfMK	Institut für Meereskunde Kiel, Germany
IHPAS	Institute of Marine Sciences, University of Szczecin, Szczecin, Poland
IMGW	Institute for Meteorology and Water Management, Polish Hydromet Service
INTAS	International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union
IOPAS	Institute for Oceanology, Polish Academy of Sciences, Sopot, Poland
IOW	Institute for Baltic Sea Research Warnemünde, Warnemünde, Germany
KNMI	Royal Netherlands Meteorological Institute, De Bilt / The Netherlands
LBA	LAMBADA-BATTERISTA Experiment for Amazonia
IGBP	International Geosphere Biosphere Program
LHMA	Latvian Hydrometeorological Agency, Riga, Latvia
LIM	Leipzig Institute for Meteorology
LINEX	Lindenberg Experiment
LITFASS	Lindenberg Inhomogeneous Terrain Fluxes between Atmosphere and Surface - a DWD long-term Study 1995 - 2000
MAGS	Mackenzie River GEWEX Study
MAST	Marine Action in Science and Technology
MPI	Max-Planck Institute
MPIfM	Max-Planck-Institute for Meteorology, Hamburg, Germany
NASDA	National Space Development Agency of Japan
NCAR	National Centre for Atmospheric Research
NCEP	National Centres for Environmental Prediction
NEWBALTIC	EU project for BALTEX: Full-scale studies on the energy and water cycle of the Baltic Sea catchment region
NOPEX	Nordic Pilot Experiment
NWAHMS	North-West Administration of the Russian Federal Service for Hydrometeorology and Environmental Monitoring, St.Petersburg, Russia
NWP	Numerical Weather Prediction
PEP	Pilot Study of Evaporation and Precipitation in BALTEX
PIDCAP	Pilot Study for Intensive Data Collection and Analysis of Precipitation
PILPS	Project for Intercomparison of Land Surface Parameterization Schemes
REMO	Regional Model
RS	Rawinsonde
RSHI	Russian State Hydrological Institute, St. Petersburg, Russia
SEWAB	Surface Energy and Water Balance Model
SMHI	Swedish Meteorological and Hydrological Institute, Norrköping/Sweden
SSG	Science Steering Group

Acronyms and Abbreviations (continued)

SVAT	Surface-Vegetation-Atmosphere-Transfer
TRMM	Tropical Rainfall Measuring Mission
UKMO	United Kingdom Met Office
UNEP	United Environmental Programme
UV	Ultraviolett
WCRP	World Climate Research Program
WGNE	BALTEX Working Group on Numerical Experimentation
WGP	BALTEX Working Group on Process Studies
WGR	BALTEX Working Group on Radar
WINTEX	Winter Experiment in NOPEX
WMO	World Meteorological Organization

Appendix 1

6th BALTEX SSG Meeting

at Danish Meteorological Institute (DMI)
Copenhagen, Denmark
2 - 4 March 1998

Agenda

Monday, 2 March 1998

14.00 1 **Opening, Welcome**
L. Prahm, Director of DMI
L. Bengtsson, Chairman of SSG

14.15 2 **Symposium**
Regional-scale and climate atmospheric modelling of the BALTEX region.
(see separate agenda)
18.25 **Closing of the symposium**

Tuesday, 3 March 1998

9.00 - 12.30 3 **Opening of the SSG meeting**
Report of the BALTEX SSG chairman
L. Bengtsson

4 **Report on GEWEX**
- GEWEX SSG meeting February 1998
- Coordinated GEWEX GHP Intensive Field Observing Period (CIOP)

E. Raschke

5 **Report of the BALTEX Secretariat**
This report will include short summaries on the progress at BALTEX Data Centres.
H.-J. Isemer

6 **Report of BALTEX Working Group chairmen**
A. Omstedt: WG Process Studies
J. Willebrand: WG Numerical Experimentation
M. Alestalo: WG Radar

Tuesday, 3 March 1998 (continued)

7 **Report of BALTEX Network co-ordinators**
L. Bengtsson, W. Krauß, A. Omstedt (for J. Launiainen),
A.S. Smedman, G. Tetzlaff, A. Omstedt (for A. Stigebrandt)

8 **Report on NOPEX**
L. Gottschalk

12.30 LUNCH

14.00 - 18.00

9 **National reports on contributions to BALTEX and *BRIDGE***
Denmark: L. Laursen
Sweden: A. Omstedt, S. Bergström
Finland: M. Alestalo, P. Maelkki
Russia: V. Vouglinsky
Estonia: P. Karing
Latvia: A. Leitass
Lithuania: P. Korkutis
Belarus: G. Chekan
Poland: Z. Kaczmarek
Germany: B. Rudolf, E. Raschke, W. Krauß
Other countries: L. Bengtsson

10 **Discussion on the implementation of *BRIDGE***

19.00 **DINNER (Invitation by DMI)**

Wednesday, 4 March 1998

9.00 - 12.30 10 **Discussion on the implementation of *BRIDGE* (continued)**

12.30 LUNCH

14.00 - 15.00 10 **Discussion on the implementation of *BRIDGE* (continued)**

15.00 - 16.00 11 **Status and membership of BALTEX panels**
(SSG, WGs, Task Force)

12 **Further items**

13 **Next SSG meeting**

16.00 14 **Closing of the meeting**

Explanatory Agenda

The central topic to be discussed at the upcoming 6th BALTEX SSG meeting will be the realisation of *BRIDGE*, the main observational and modelling period in BALTEX. Reports and items on the SSG meeting agenda should therefore concentrate on *BRIDGE* and *BRIDGE*-related matters. The SSG will be briefed on the planning for a co-ordinated GHP (GEWEX Hydrological Panel) Intensive Field Observing Period (CIOP), item 4. Under item 8 the possible co-ordination between NOPEX/WINTEX and *BRIDGE* will be discussed based on the actual time planning for the NOPEX field experiments near Uppsala and at Sodankyla. Possible relation and interactions with *BRIDGE* will be discussed.

The national reports (item 9) are thought to give an overview on commitments from institutions or groups and lacking contributions according to the recommendations of the *BRIDGE* plan.

The national reports as well as the reports of the working group chairmen and network coordinators (items 6 and 7) are additionally expected to review achievements compared to the objectives and aims as laid down in the BALTEX Initial Implementation Plan. Please, use table 9 (page 61) and the project contents of the BALTEX networks (pages 62 and 63) in the Initial Implementation Plan as kind of a check-up table and note in particular those projects which have so far not been implemented.

As indicated by the chairman of the BALTEX SSG, Professor Lennart Bengtsson, in his letter dated 6 January 1998 the SSG will have to prepare for an implementation meeting for *BRIDGE* to be held in the nearest future with expected participation of Weather Services, research institutes and universities in the 10 BALTEX countries and beyond. The SSG members are expected to play an active role in the preparation of this meeting and *BRIDGE* in general.

Hans-Jörg Isemer
International BALTEX Secretariat
on behalf of the SSG chairman, Professor Lennart Bengtsson
10 February 1998

6th BALTEX Science Steering Group Meeting
at Danish Meteorological Institute (DMI)
Copenhagen, Denmark
2 to 4 March 1998

Symposium on:

Regional-scale and climate atmospheric modelling of the BALTEX region

Monday, 2 March 1998

14.00	**Lars Prahm, Director General of DMI Copenhagen, Denmark** *Opening and welcome*
Chair:	*Anne Mette K. Jørgensen, DMI Copenhagen, Denmark*
14.15	**Lennart Bengtsson, MPIfM Hamburg, Germany** *Atmospheric modelling for the support of BALTEX.*
14.40	**Bent H. Sass and Xiaohua Yang, DMI Copenhagen, Denmark** *Developments at DMI related to data-assimilation in the NEWBALTIC project.*
15.05	**Mikko Alestalo, FMI Helsinki, Finland** *Regional-scale atmospheric modelling and data assimilation at FMI.*
15.30	**Nils Gustafsson, SMHI Norrköping, Sweden** *Regional-scale modelling, data assimilation and coupling to land surface models, lake models and sea models at SMHI (HIRLAM).*
15.55	**Werner Wergen, DWD Offenbach, Germany** *Regional-scale atmospheric modelling, data assimilation and coupling to land surface models at DWD.*
16.20	**BREAK**
Chair:	*Leif Laursen, DMI Copenhagen, Denmark*
16.45	**Renate Hagedorn, IfM Kiel, Germany** *Coupling of REMO to the Kiel Baltic Sea model.*
17.10	**Burkhardt Rockel, GKSS Geesthacht, Germany** *Atmospheric modelling of the energy and water cycle versus observations and remote sensing at GKSS.*
17.35	**Lech Lobocki, ICM University Warsaw, Poland** *Meso-scale modelling and data assimilation at ICM, Warsaw University.*
18.00	**Anders Omstedt, SMHI Norrköping, Sweden** *Closing the energy and water cycles of the Baltic Sea.*
18.25	**Closing**

Appendix 2

Participants at 6th the BALTEX SSG meeting DMI

2 - 4 March 1998

Mikko Alestalo	FMI, Helsinki, Finland
Lennart Bengtsson	MPIfM, Hamburg, Germany
Sten Bergström	SMHI, Norrköping, Sweden
Grigory Chekan (for Ivan M. Skuratovich)	Hydrometeorology Service of Belarus
Jerzy Dera	IOPAS, Sopot, Poland
Lars Gottschalk	University of Oslo, Norway
Hans-Jörg Isemer	GKSS Geesthacht, Germany
Zdzislaw Kaczmarek	Institute of Geophysics, Warsaw, Poland
Sirje Keevallik (for Peeter Karing)	EMHI, Tallinn, Estonia
Wolfgang Krauß	IfM, University Kiel, Germany
Leif Laursen	DMI, Copenhagen, Denmark
Andris Leitass	HMA, Riga, Latvia
Pentti Mälkki	FIMR, Helsinki, Finland
Nicole Mölders (for Gerd Tetzlaff)	LIM Institut für Meteorologie, Leipzig, Germany
Anders Omstedt	SMHI, Norrköping, Sweden
Ehrhard Raschke	GKSS Geesthacht, Germany
Dan Rosbjerg	ISVA - Technical University of Denmark, Denmark
Bruno Rudolf (for Angela Lehmann)	DWD, Offenbach, Germany
Ann-Sofi Smedman	MIUU, Uppsala, Sweden
Hilding Sundqvist	Met. Institute Stockholm University, Sweden
Valery S. Vuglinsky	Russian State Hydrological Institute
Jürgen Willebrand	IfM, University Kiel, Germany

Appendix 3

Regional-scale modelling, data assimilation and coupling to land surface, lake and sea models at SMHI

Nils Gustafsson and Anders Omstedt
Swedish Meteorological and Hydrological Institute
Norrköping, Sweden

1. Introduction

The High Resolution Limited Area Model (HIRLAM) forecasting system is the basic tool for atmospheric modelling activities at the SMHI. HIRLAM is used operationally for weather foreecasting. Research and development with regard to the HIRLAM system is coordinated within the framework of the international HIRLAM 4 Project. SMHI contributes to the development of variational data assimilation techniques, land surface parameterization schemes and vertical diffusion schemes within HIRLAM 4. The HIRLAM model is also used as the basis for a regional climate model by the SWECLIM Rossby Centre at SMHI. In addidition, HIRLAM is utilized within several EU-funded research projects as well as for some SMHI-funded PhD-projects.

The BALTEX Project is given high priority by the SMHI. Spatially and temporally consistent atmospheric data sets are needed for the study of energy and water budgets within the BALTEX project. These data sets are created by the application of data assimilation techniques together with high resolution atmospheric models. When such data assimilation is applied to historical data sets, we usually refer to this as atmospheric re-analysis. The SMHI contributes to the BALTEX project with such mesoscale atmospheric re-analysis. The main tool for the SMHI re-analysis is the HIRLAM data assimilation and forecasting system. SMHI also contributes to validation of atmospheric models, to development and tuning of physical parameterization schemes and to the development of coupled lake and Baltic Sea models within BALTEX.

2. A coupled lake model

Initially, a simple model for lake temperatures and lake ice thicknesses was developed (Ljungemyr et al., 1996). The model was verified independently, and it was also used for the re-analysis for the winter 1986/87. The initial lake model was a slab model based upon energy conservation and it treated the lakes as well-mixed boxes with depths represented by the mean depths. The model is forced by near surface fluxes calculated from total cloudiness, air temperature, air humidity and low level winds. A data base, describing 92,000 Swedish lakes, provides the model with lake mean depths, areal sizes and locations. When the model is used for parameterization of lake effects in the atmospheric model, all the smaller lakes and the fractions of larger lakes within each horizontal grid square of the atmospheric model are parameterized by four model lakes, representing the lake size and mean lake depth distributions. A sensitivity test showed great interannual variations of the ice-covered season, which implies that lake models should be used instead of climate data. The results from an experiment with two-way coupling of the lake model to the atmospheric model were verified by comparing forecasted weather parameters with routine meteorological observations. These results showed that the impact of lake effects could reach several $^\circ C$ in air temperatures close to the surface.

The simple slab lake model has recently been improved by the introduction of a vertically resolved model for the deeper lakes, including also a parameterization of vertical turbulent transports within the lakes and horizontal variations in the ice cover. The improved lake model system, including the vertically resolved model for deeper lakes, has been extended to include all lakes within the HIRLAM model integration area. This generalized lake model system was applied for the BALTEX mesoscale re-analysis of the winter 1992/93.

3. Coupling between the ocean model system BOBA/PROBE and HIRLAM

The coupling between a high resolution weather forecasting model and an ocean model has been investigated (Gustafsson et al., 1998). It was demonstrated by several case studies that improvements of short range weather forecasting in the area of the Baltic Sea require an accurate description of the lower boundary condition over sea. The examples were taken from summer situations without sea ice as well as from winter situations with extreme sea ice conditions. It was furthermore demonstrated that the sea state conditions may change considerably within forecasting periods up to 48 hours. This implies the necessary application of ocean models, two-way coupled to the weather forecasting model.

An advanced 2.5 dimensional ice-ocean model BOBA/PROBE has been coupled to the HIRLAM forecasting system. The ice-ocean model includes two- dimensional, horizontally resolved, ice and storm surge models and a one-dimensional, vertically resolved, ocean model applied to 31 Baltic Sea regions. The two-way coupling between HIRLAM and BOBA-PROBE, see Figure 1, was used for the re-analysis of 1986/87 and 1992/93. The ocean model system is forced by forecasts of surface pressure, 10 meter winds, 2 meter temperature, 2 meter humidity and total cloudiness from HIRLAM. SST observations from the Baltic Sea are assimilated in the ocean model system. The ocean model system provides forecasts of sea-surface temperatures and sea ice concentration to be used as the HIRLAM initial lower boundary condition.

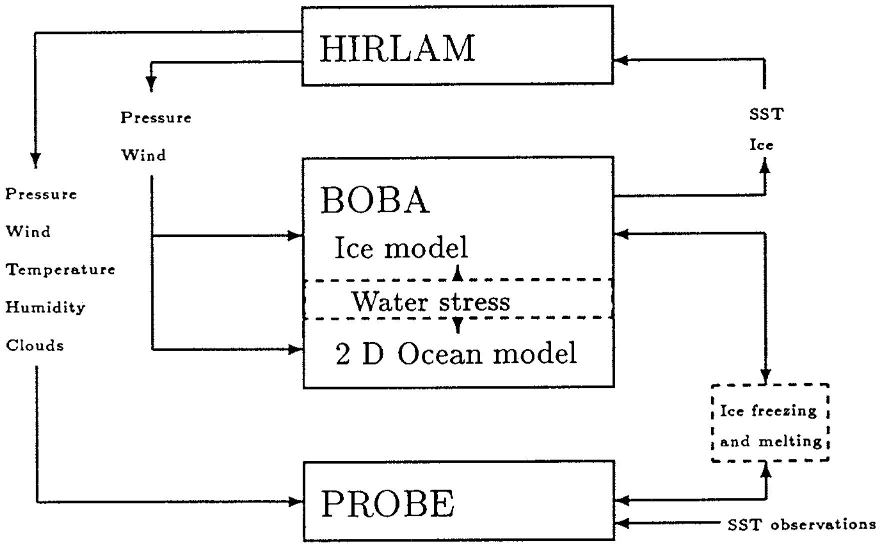

Figure 1: Coupling between HIRLAM and BOBA/PROBE for BALTEX re-analysis.

The application of the coupled model system to the mesoscale re-analysis for BALTEX showed that it is necessary to apply data assimilation for the sea state variables in order to avoid drift of the coupled model system towards less realistic model states. A succesful application of a simple assimilation of sea surface temperatures was introduced. The observed sea surface temperatures are first subject to a horizontal filter in order to restrict the influence to a larger horizontal scale of the model sea state. Then the differences between these filtered observed and the model sea surface temperatures are used to construct a modified sensible heat flux that is applied as a form of a "nudging" (or flux correction) term to the ocean model equations over a time period of several hours. It turns out that this "nudging" is sucessful in avoiding the drift away from realistic sea state conditions. The application of the SST data assimilation in BOBA/PROBE is illustrated in Figure 2.

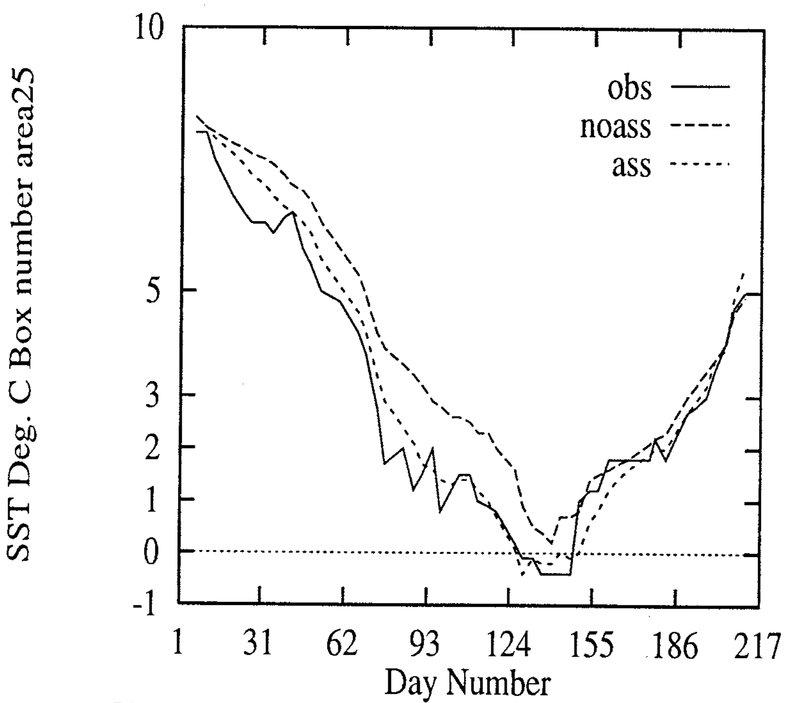

Figure 2: Time development of sea-surface temperature in the Baltic Proper during the period November 1986 - May 1987. Observations (full line), ocean model without data assimilation (dashed line) and with SST data assimilation (dotted line).

Mesoscale atmospheric re-analysis for the winters 1986/87 and 1992/93

Mesoscale atmospheric re-analysis has been carried out for the periods 15 December 1986 - 15 February 1987 and 1 December 1992 - 31 January 1993. For both periods, the HIRLAM data assimilation was first applied at a grid resolution of 55 Km and with 16 vertical levels. These coarse resolution analyses were then used as lateral boundary conditions for data assimilation and forecast runs with a grid resolution of 22 km and with 24 vertical levels. Input observations were radiosonde, radio wind, land surface, ship and aircraft observations.

Results from the re-analysis will be presented and the impact of the coupled models will be demonstrated and discussed.

References

Gustafsson, N., Nyberg, L. and Omstedt, A., 1998: Coupling of a High Resolution Atmospheric Model and an Ocean Model for the Baltic Sea. *Mon. Wea. Rev.*, in press.

Ljungemyr, P., Gustafsson, N. and Omstedt, A., 1996: Parameterization of lake thermodynamics in a high-resolution weather forecasting model. *Tellus*, **48A**, 608-621.

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REGIONAL-SCALE ATMOSPHERIC MODELLING, DATA ASSIMILATION AND COUPLING TO LAND SURFACE PROCESSES AT DWD

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Regional scale atmospheric modelling: the motivation

The main motivation for limited area regional scale atmospheric modelling is the desire to focus the available computer resources on one's own area of interest or responsibility. This also allows the exploitation of data sources which are only locally available. These include observations designated for national usage and high resolution information on the underlying surface which often are not available in the same detail on a contintental or even global scale. Regional scale models furthermore allow to put emphasis on the prediction of local weather parameters, such as precipitation, screen level temperature, visibility, gusts and thunderstorms. By running a limited area model, many national weather services have aquired the necessary flexibililty to satisfy their costumers needs with respect to the product range and timing. Furthermore, limited area models have for many countries been the first step towards Numerical Weather prediction (NWP) and thus played an important role in acquiring and extending know-how.

Regional scale atmospheric modelling: the problems

Mathematically, the system of equations in NWP is of the hyperbolic type. This means, that the solution in the limited area is uniquely defined by the predictive variables on the inflow boundary together with the initial condition. Because of mathematical problems, in most practical applications boundary values are prescribed on all boundaries and the problem is thus ill-posed. Furthermore, even with moderate advection speeds, the solution in the interior domain is largely determined by the information entering from the inflow boundary after one day into the forecast. This problem becomes even more aggrevated when considering propagating Rossby- and gravity waves. One of the biggest concerns is the severe lack of information about the initial state. Since the regional scale models have higher resolution, the problem is more severe here than in the driving global models.

Regional scale atmospheric modelling: the experience

While the above objection about the ill-posedness of the problem is theoretically correct, experience has not demonstrated that it is a major practical issue. However, great care is required when interpolating from the coarser driving model to the finer resolution regional model. The dominating influence from the inflow boundary is of course largest under high windspeed conditions. The quality of the forecast in the interior domain in these cases is heavily dependent on the accuracy of the boundary values. Using the most up-to-date available boundary information has turned out to be crucial. Under low advection velocities, regional scale models posess internal predictability depending in the quality of the intial conditions for the limited area.

The lack of high resolution observations to reduce the initial underdetermancy is crucial, although not as dramatic as the ratio of typically 1 % of available observations over initial values to be specified might indicate. Three arguments can be brought forward, which help to reduce the problem:
Data assimilation: When used for NWP, most limited area models rely on fourdimensional data assimilation for defining the initial state. The basic idea is to combine observations from the present and earlier times through dynamical and statistical constraints. Typically, a forecast model is used to advance the information from previous observations forward in time. By this process, information from well observed areas can be transported to data void areas thus providing a likely estimate of the atmospheric state even in areas where no measurements are made. However, this estimate is sensitive to errors in the previous observations, to errors in their interpretation and usage and to errors in the forecast model used to bring the information forward in time.
Scale interaction: As the forecast models describe nonlinear processes, there is a transfer of information between the various scales represented in the model. A typical example would be the generation of a front or a squall-line from initially undisturbed conditions. Experience has shown, that models are able to properly simulate that process. Therefore, even if the intial state lacks the fine scale details, forecasts can nonetheless be realistic.

Forcing from lower boundary: An important process helping to generate fine scale details is the forcing from the lower boundary of the atmosphere. A typical example would be the chanelling of the flow by the earth's orography. In mountain areas, regional scale models can properly describe the deflection of the flow and the associated weather phaenomena. The finer the horizontal resolution of the model, the more realistic the representation of the lower boundary.

Although regional scale modelling aims at providing detailed weather forecasts, there has generally been some lack of success in this area. For instance, daily maximum temperature and precipitation forecasts are not yet as accurate as desired. One of the reasons is the insufficient attention the processes in the soil have received. Soil moisture is an important quantity, whose mis-specification can result in the wrong partitioning of the incoming solar radiation into sensible and latent heat fluxes. This has consequences for the daily evolution of temperature and moisture in the boundary layer and in convective situations also for precipitation. Progress can be made by extracting the implicit information on soil moisture contained in the observed screen level temperatures and moistures by a variational approach.

Regional scale atmospheric modelling: the prospects

Even if all the above arguments apply, there is still the chance that the intial state would need fine scale detail for the forecast to be successful in its early stages. For these cases, additional data sources need to be exploited. A prime candidate are remote sensing techniques, such as radars and satellites. For instance, radars provide kowledge about the disitribution in time and space of cloud droplets. Unfortunately, this information is not easily usable in data assimilation systems. They require an 'inverse modelling' approach, in which the predictive variables of the model, e.g. wind temperature and moisture are changed in such a way that the cloud droplets generated by the model agree with the droplets as seen by the radar.

With computer capacities increasing through the advent of parallel architectures, there will be further increases in resolution for the driving models and for the embedded limited area models. There are already plans for global models to be run at a resolution of 25 km and for regional models at 2 km. Still finer resolution meets with the scale dependance of predictability so that the emphasis of regional modelling will possibly shift towards the adaptation mode focusing on the response of the flow to very fine scale orographic forcing.

Coupling of REMO to the Kiel Baltic Sea model

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Abstract

One main objective of the BALTEX program is to provide validated, coupled modelling tools for explaining and predicting the energy and water processes in the BALTEX catchment area. The coupling of the atmospheric regional model REMO to the Kiel Baltic Sea model is one contribution towards achieving this objective. With this coupled model system a first simulation was performed for the PIDCAP period (August to October 1995), during that an intensive cyclonic development was observed which led to an extreme cooling of the oceanic mixed layer. The modelled SSTs of the coupled system agree well with satellite observed data. Compared to DWD-SSTs of an uncoupled simulation main differences in SSTs occur in the Bornholm and Gotland Basin. They influence mainly corresponding heat fluxes and at a lower level the dynamics of the atmospheric model. The coupled simulation had no drift to an unrealistic state. Therefore the coupled model system can be used for a consistent calculation of components of the energy and water cycle.

1. Introduction

The importance of interactions between atmosphere and ocean on the global scale is shown by many coupled model studies. It is also known that on the regional scale the atmosphere influences the ocean. Simulations with the Kiel Baltic Sea model show that the process of massive influx of saltwater from the North Sea into the Baltic Sea can only be modelled with correct atmospheric forcing. In contrast to that, we know little about the fact how the Baltic Sea influences the atmosphere. To explore interactions between atmosphere and ocean on the regional scale the regional atmospheric model (REMO) from Max-Planck-Institute for Meteorology in Hamburg has been coupled to the Kiel Baltic Sea model (BSMO). Thus, we want to contribute to the quantification of the energy and water cycle of the Baltic Sea and its catchment area.

2. Models

The 3-dimensional atmospheric model REMO is based on the operational forecast model of the German Weather Service (DWD). It is used in the so-called climate mode, i.e. during the whole integration only the lateral boundary fields were updated every 6 hours (Jacob et al., 1997). The horizontal resolution is 1/6° on the rotated longitude/latitude grid. This is equivalent to approximately 18×18 km^2. The vertical distribution of the 20 model levels is the same as in the Europa-Modell from DWD. The Kiel Baltic Sea Model is a 3-dimensional eddy-resolving baroclinic model with a horizontal resolution of approximately 5×5 km^2 and a discretization of 28 levels in the vertical (Lehmann, 1995). Until now, these two models have been run separately and both were forced with DWD analyses or forecasts, respectively.

3. Results

To investigate the effects of the coupling, different simulations were performed for the PIDCAP-Period (Pilot Study for Intensive Data Collection and Analysis of Precipitation) from August to October 1995. Firstly, an uncoupled run of REMO was carried out, where SSTs were prescribed by DWD-SSTs. Secondly, a coupled run was performed, where SSTs were calculated by the Baltic Sea model and the forcing for BSMO was provided by directly in REMO calculated heat fluxes and wind stresses. The comparison of these two simulations shows remarkable differences in the results, which are depicted in Fig. 1 as averages over the Eastern Gotland Basin. Especially during the period of rapid cooling of the oceanic mixed layer (08/26/95 - 09/02/95) great differences occur.

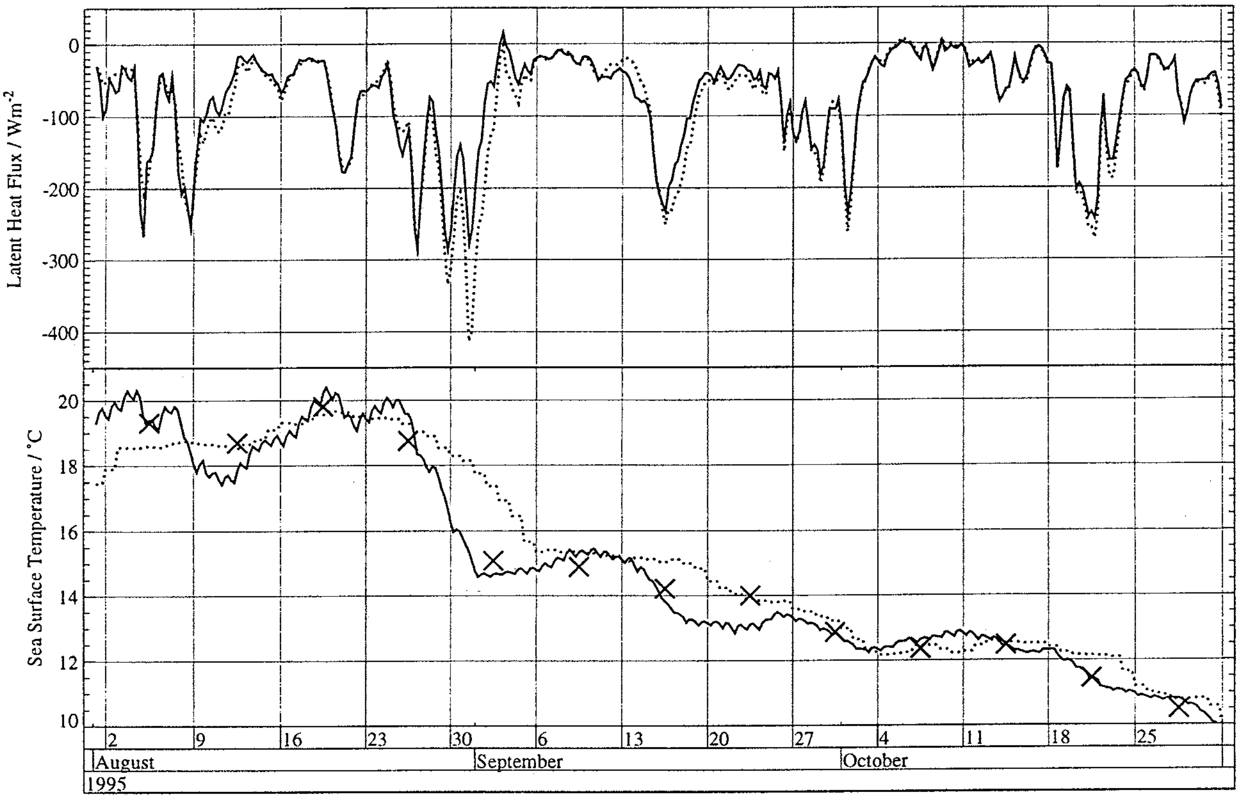

Fig. 1: *Sea Surface Temperatures (lower panel) and latent heat fluxes (upper panel) averaged over the Eastern Gotland Basin. Solid line: results of the coupled run, dotted line: results of the uncoupled run, crosses: SST from infrared satellite observations.*

This cooling is evident in the satellite observations (crosses) as well as in the modelled SSTs of the coupled run, whereas the SSTs of the DWD analyses more slowly decline. The considerable differences between DWD-SSTs and BSMO-SSTs cause also remarkable differences in latent heat fluxes which reach up to 50%. At other times there are only small differences in SSTs and correspondingly negligible differences in latent heat fluxes.

The comparison of the horizontal distribution of analyzed and modelled SST fields (Fig. 2) reveals that the DWD-SSTs generally show higher values than the BSMO-SSTs and additionally are of a character with no detailed patterns. In contrast to that, in the modelled SSTs the wind driven upwelling areas at the west coast of Gotland and also at the coast of Lithuania are well rendered. The comparison of SSTs with observations (here not pre-

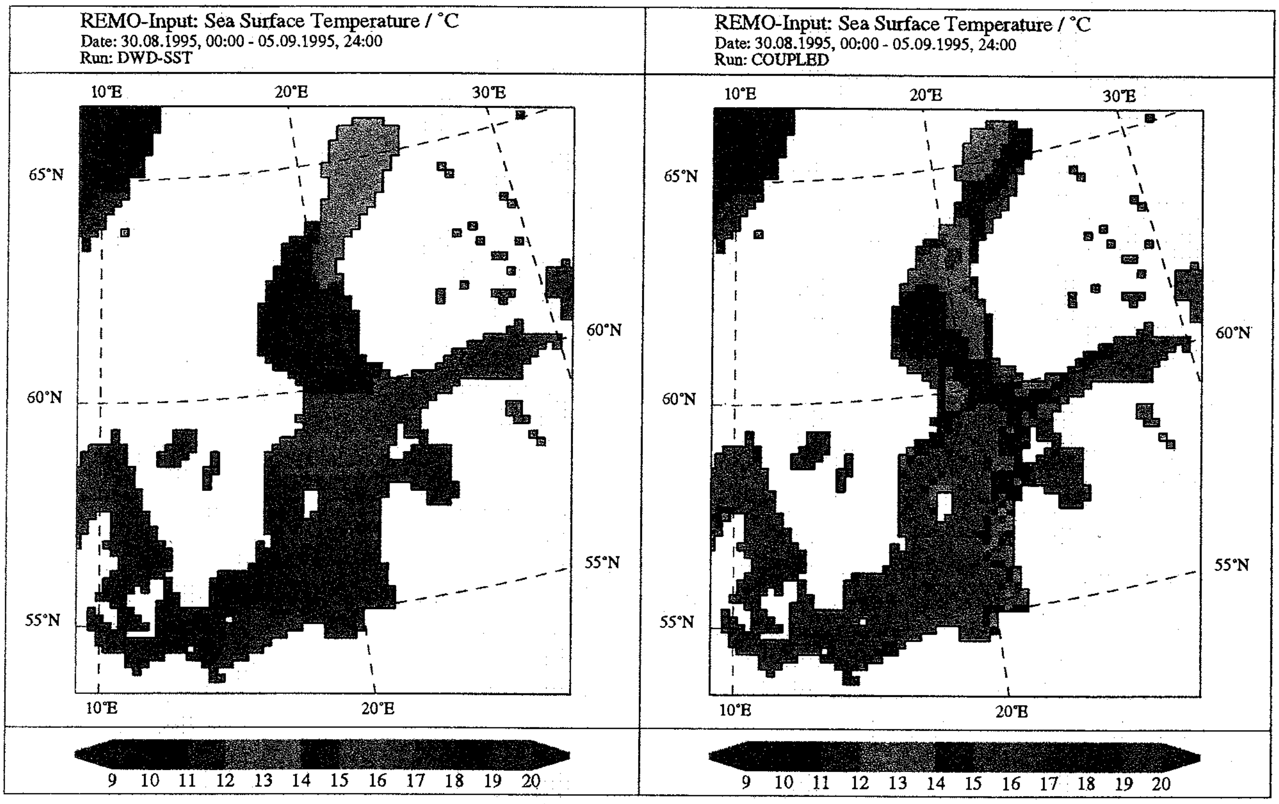

Fig. 2: *Mean Sea Surface Temperatures for 30.08.1995, 00:00 - 05.09.1995, 24:00; left: DWD analyses, right: results of the Baltic Sea model.*

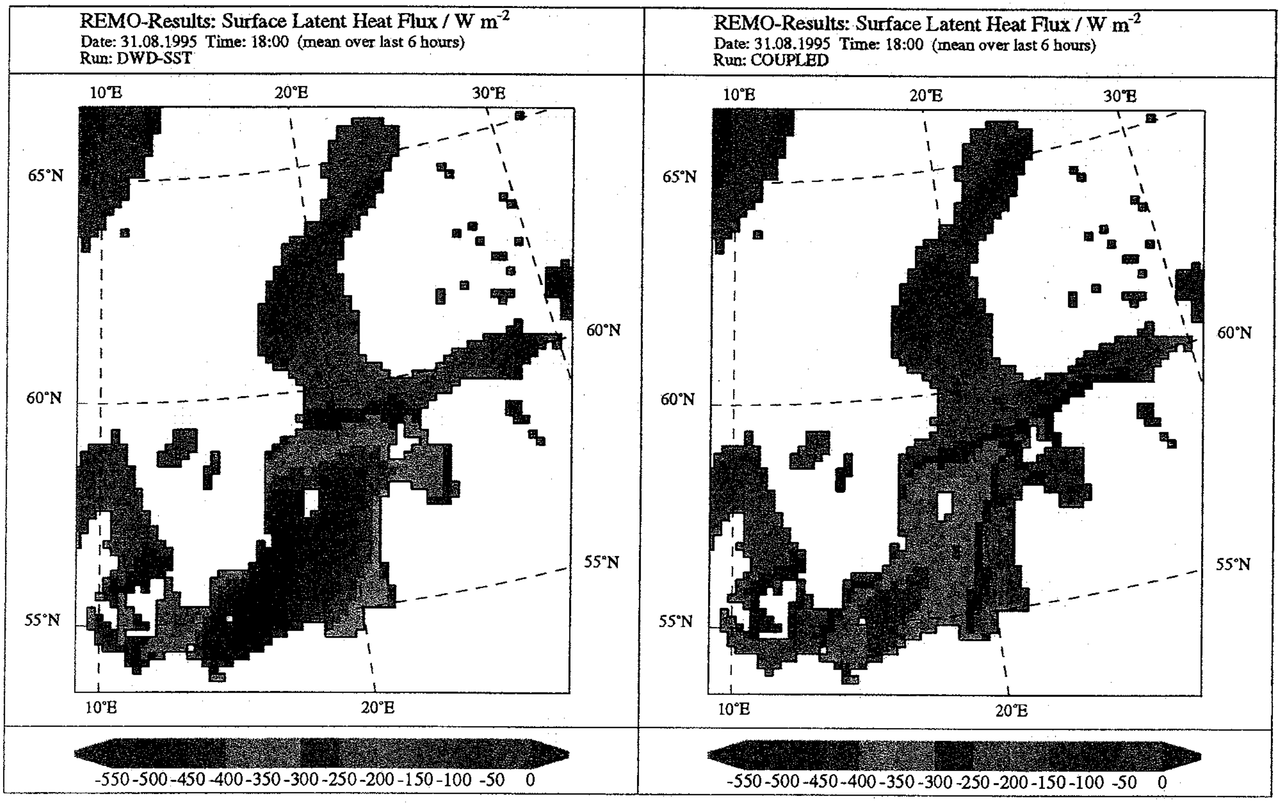

Fig. 3: *Latent heat fluxes from 31.08.1995, 18:00 (mean over last 6 hours); left: results of the uncoupled run, right: results of the coupled run.*

sented) show that the BSMO-SSTs are at least as good as the DWD-SSTs and in some cases even better. To demonstrate the effects of the coupling, in Fig. 3 latent heat fluxes of uncoupled and coupled simulations are shown. At the depicted date most differences appear in the Gotland and Bornholm Basin. In the upwelling regions the values differ up to 400 Wm^{-2} as a result of the cold SSTs in the Baltic Sea Model. The greatest differences in monthly mean values for the whole Baltic Sea occur in September, when in the coupled simulation latent heat flux is reduced by 10% and sensible heat flux by 15%. As a result of these changed heat fluxes also precipitation is diminished by 10%.
For the evaluation of the coupling effects on the dynamic variables of the atmosphere we have to distinguish between two situations. At the end of August, when fast moving cyclones were the dominant factor, there were rather no differences in the pressure field, although at this time greatest differences in heat fluxes occurred. This indicates that in strong advective situations the effects of the coupling are of subordinate importance. In contrast to that, more stationary conditions prevailed on September 13th, which led to the fact that the coupling effects were not superimposed by advective influences. This enabled the dynamic variables of the atmosphere to respond to the different heat fluxes. The basic structure of the pressure field (Fig. 4) is of course not effected, but on the regional scale obvious differences appear. The high pressure system in the northern part of the model area is more extended as well as shifted towards south-east in the coupled run. According to that, also the wind field over the Baltic Sea is different in both simulations.

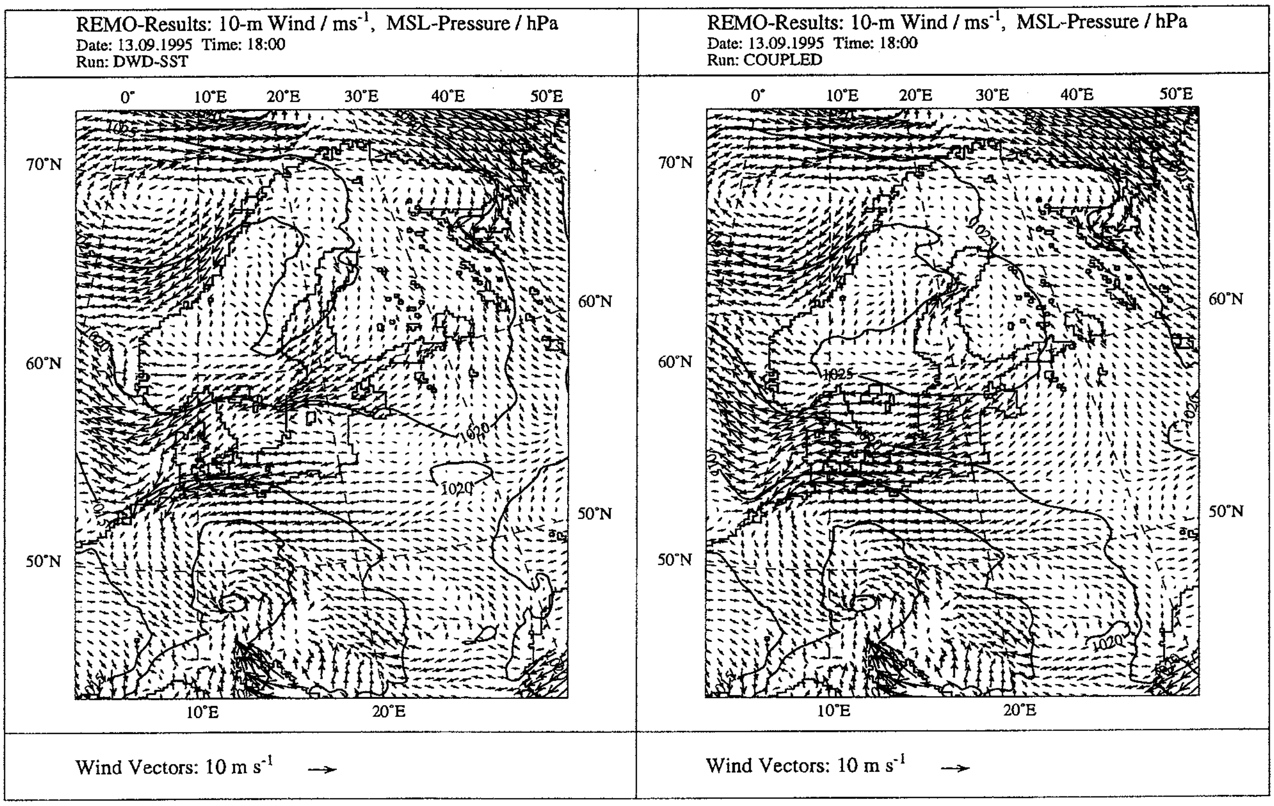

Fig. 4: *Mean sea level pressure and 10m wind field from 13.09.1995, 18:00; left: results of the uncoupled run, right: results of the coupled run.*

4. Conclusions

The simulation of the PIDCAP period with the uncoupled and coupled model shows that the fully coupled model system has been successfully installed. The modelled SSTs agreed well with observed SSTs and no flux correction was necessary. Therefore the coupled model provides a numerical tool that gives us the possibility to calculate the components of the energy and water cycle in a consistent way. The comparison of the uncoupled and coupled simulations reveals great differences in heat fluxes and – depending on the atmospheric conditions – slight differences in dynamic variables. The results indicate that the effects of the coupling can be superimposed by advective influences and that in such situations the coupling are of subordinary importance for the dynamic structure of the atmosphere.

Furthermore, longer simulations are necessary, because on the one hand we have to investigate whether in other seasons a drift occurs. On the other hand we have to explore the interactions between atmosphere and ocean under different atmospheric conditions, because we expect that under winter conditions the effects of the coupling are still more pronounced.

References:

Jacob, D., Podzun, R., 1997: Sensitivity Studies with the Regional Climate Model REMO. METEOROL. ATMOS. PHYS., **63**, 119 - 129

Lehmann, A., 1995: A three-dimensional baroclinic eddy-resolving model of the Baltic Sea. TELLUS, **47A**, 1013 - 1031

A18

Atmospheric modelling of the energy and water cycle versus observations and remote sensing at GKSS

B. Rockel GKSS Research Centre

Introduction

One major goal of BALTEX is to quantify the components of the energy and water cycle over the Baltic Sea catchment area. This can be achieved by analysing measured and model generated data over the BALTEX area for representative time periods. Our contribution to this goal is the use of remote sensing, ground based measurements and model generated data. A list of measurement types and measured parameters are listed in table 1. Up to now at GKSS we validated REMO against ISCCP, ScaRaB, GPS, RADAR, synop. stations, and precipitation stations. The differences between REMO and NOAA/AVHRR and SSM/I was studied at the Technical University of Dresden and the Institut für Meereskunde in Kiel, respectively. Radiation stations and ship data has not yet been considered. In the following only examples for work done at GKSS are given.

Remote Sensing	
ISCCP	Cloud Cover, Liquid Water Path, Cloud Top Temperature, ...
ScaRaB	Radiative Flux Densities
NOAA/AVHRR	Radiative Flux Densities
SSM/I	Water Vapour Path
GPS	Water Vapour Path
RADAR	Precipitation
Surface Observations	
Synop. Stations	2m Temp., 2m Dewpoint Temp., 10m Wind, Precip., CC, ...
Precipitation Stations	Precipitation
Radiation Stations	Radiative Flux Densities
Ship Data	Precipitation, Evaporation

Model Data

Model data are produced by the regional atmospheric model REMO on a spatial resolution of approximately 18km. The temporal resolution used for this study is one hour. REMO is run in a forecast mode with a prediction time of 30h. The output covers all components of the energy and water cycle. However, in this study we concentrated on those parameters also available in remote sensing data and ground based observations. These parameters are cloud cover, liquid water path, water vapour path, radiative flux densities, precipitation, 2m temperature and dew point temperature, and 10 m wind. The availability of the data also sets restrictions to the time periods used. These time periods are June 1993, March 1994, and August - October 1995.

Remote Sensing and Surface Observations

1. ISCCP

The aim of the International Cloud Climatology Project (ISCCP) is a global cloud climatology with a time resolution of one month and 250km horizontal resolution. Data from both geostationary and polar orbiting satellites form the basis of several stages of processing. The intermediate data product ISCCP-DX, derived for individual instantaneous satellite fields of views (FOV) ranging from 4 to 7 km in size at nadir with a horizontal sampling rate of 25 to 30 km and a time resolution of 3 hours, can be used here. Until now, the product is available for a few months only. One of these is June 1993. Among the DX variables, there is the cloud flag CLOUD. CLOUD is a binary variable and takes the values 1 or 0 if the ISCCP cloud detection mechanism considers a cloud or not, respectively. The CLOUD values are converted to the model grid by taking the average within a grid box. Because of the horizontal resolution, not in every REMO grid box a CLOUD value is given. Also, the satellite coverage of the BALTEX area is far from perfect. Especially at 2100 and 2400 UTC, almost only METEOSAT data is available up to about 60^0 N. A third reason for data gaps is that the ISCCP has to use a detection mechanism based on radiative transfer model analysis. This detection mechanism is sometimes unable to decide between cloudy or clear sky, i.e. along coastal lines, and gives an undefined value. Fig. 1 shows a time series of cloud cover from REMO and ISCCP data for June 1993. Most of the time the mean difference is <= 10%. The largest differences occur in those cases were the modelled frontal systems move at a significant different speed than observed.

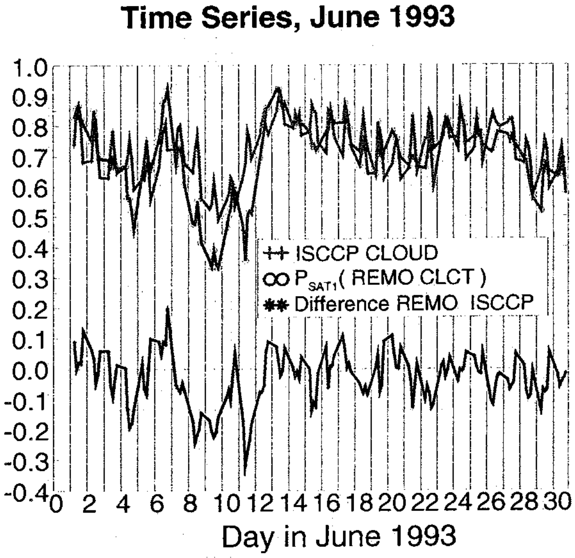

Fig.1 Comparison of REMO and ISCCP derived cloud cover over the REMO model area for BALTEX.

2. ScaRaB

As part of this study, we use data from the well-calibrated Scanner for Radiation Budget (ScaRaB) experiment to compare regional satellite estimates of the top of the atmosphere (TOA) earth radiation budget (ERB) over the BALTEX area against that calculated by REMO. Since the variability in the regional TOA ERB is mostly determined by the interaction of clouds with radiation, such a comparison gives inside into how reliably a regional model can describe the development of clouds, a major component of the energy as well as the water cycle in the atmosphere.

The ScaRaB experiment, a French-Russian-German co-operation, is a successor of the American Earth Radiation Budget Experiment (ERBE) and is designed to measure the short-wave and long-wave components of the ERB within a high accuracy on scales of about 250x250km^2. To fulfil our goal, these data are used to derive regional ERB products on a scale of about 18x18km^2. The data of the ScaRaB instrument are limited to the lifetime of the mission, March 1994 to February 1996, and during its lifetime to the roughly two overpasses per day. In order to derive a complete diurnal cycle and also to extend the investigations to times at which no ScaRaB data are available, a synergy with data from operational satellites as NOAA-AVHRR and METEOSAT has to be done.

A comparison of ScaRaB data with REMO results shows that REMO gives higher cloud top temperatures for the highest clouds, but lower cloud top temperatures for the other high clouds (Fig.2).

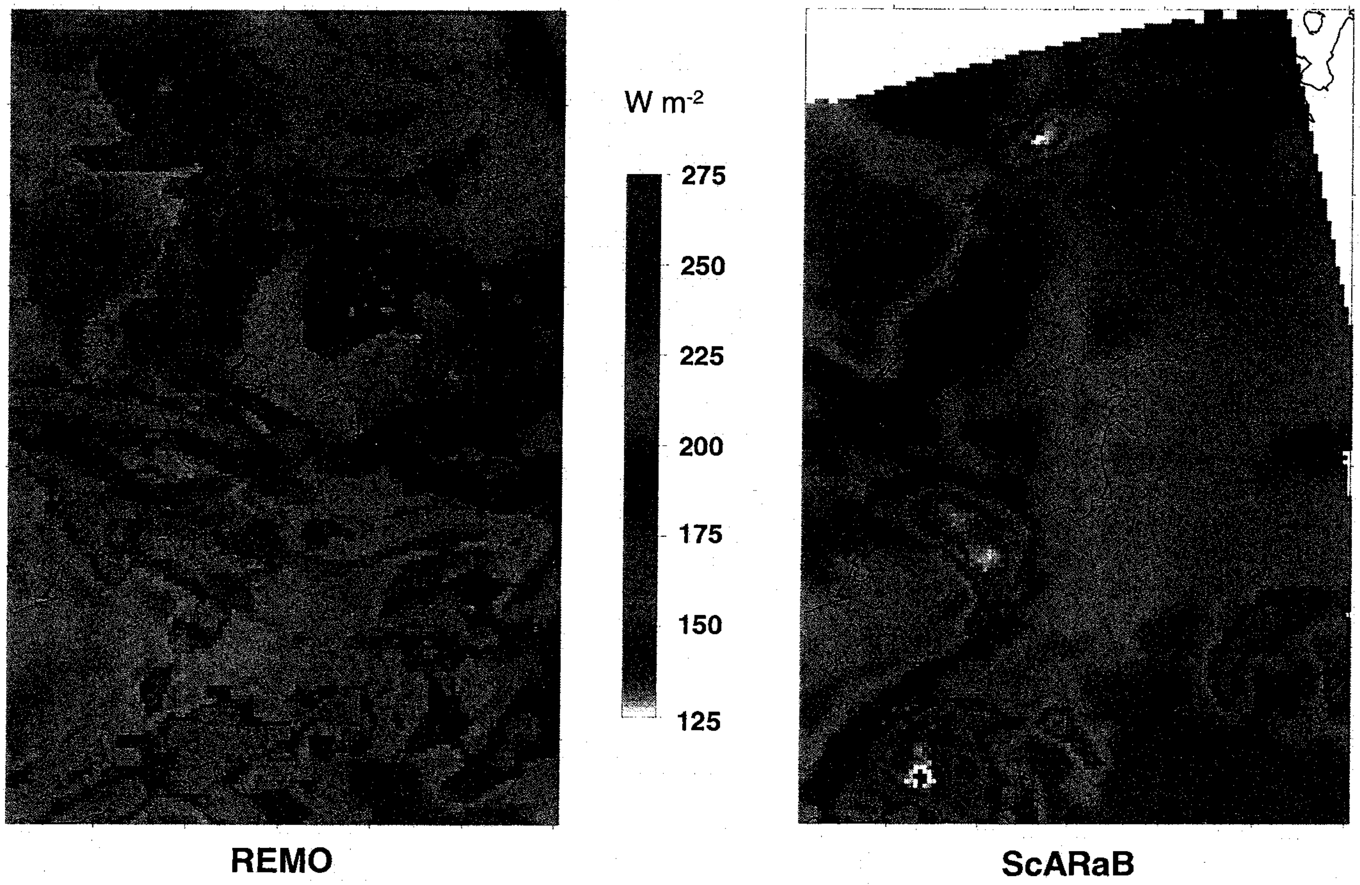
Outgoing Longwave Radiation at TOA from 01 March 1994 8:38 UTC

Fig. 2 Comparison of REMO and ScaRaB derived outgoing longwave at the top of the atmosphere.

4. GPS

The above mentioned remote sensing data have the advantage of a good spatial data coverage, but for specific times. The Global Positioning System (GPS) derived data has the vice versa characteristics: a high temporal resolution, but at specific geographical locations. The temporal resolution of the atmospheric water vapour path length is 5 minutes for each of the available data sets of the 25 GPS station in the BALTEX area. The target period in this study is the PIDCAP period August - October 1995.
The results of the GPS derived water vapour are compared with REMO forecasts and analyses data for the Europamodell (German Weather Service), T213 (ECMWF), and HIRLAM (Danish Meteorological Institute). Fig. 3 shows scatter plots of vertically integrated water vapour content from the different analyses and from REMO driven by this analyses versus GPS derived values. It can be seen that REMO enhances the water vapour content given by the analyses data.

5. RADAR and Synoptic Stations

Precipitation predicted by REMO and precipitation measured at synoptic stations and derived from RADAR measurements were studied for the PIDCAP period (August to October 1995). The precipitation pattern in REMO and measured data are generally in good agreement, but the amount of precipitation predicted by REMO is higher than measured.
The 2m temperatures are about 1 degree higher than measured, wheras the 2m dew point temperature is about 1 degree to low. This indicates that REMO is too wam and too dry near the ground. However, this are only mean values over all synoptical stations. The spatial distribution has to be studied in more detail in the future.

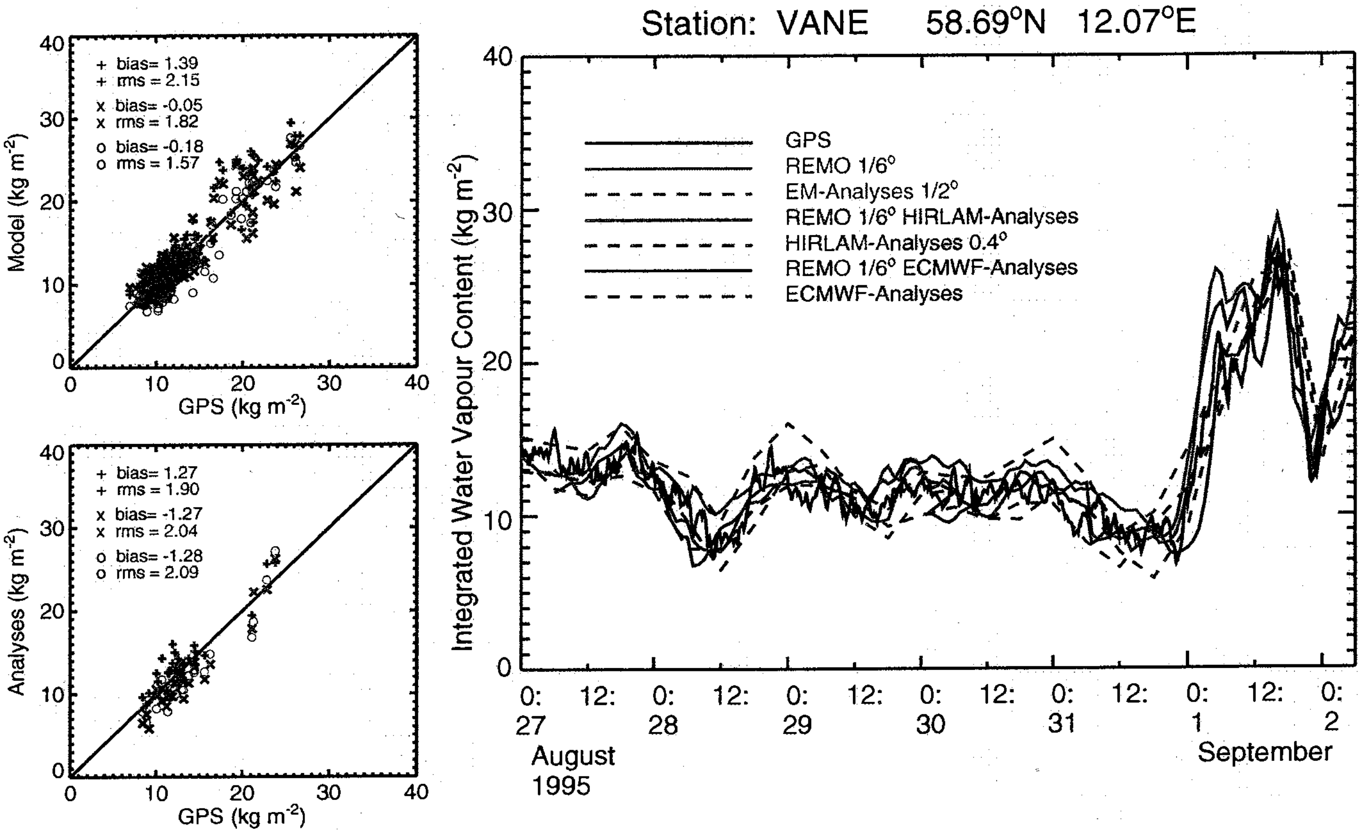

Fig.3 Comparison of REMO and GPS derived time series of vertically integrated water vapour content.

Meso-scale modelling and data assimilation at ICM, Warsaw University

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Introduction

This paper describes the numerical mesoscale weather prediction system, centered around the UK MetOffice 'Unified Model', implemented and used at the Interdisciplinary Centre for Mathematical and Computer Modelling (ICM) of Warsaw University, Poland. The system evolved from a small reasearch project initiated in 1994 to its present semi-operational stage reached in spring 1997. Currently, the system is running on a daily basis, providing short-term (48 to 72 hr) mesoscale forecast.

Numerical weather prediction was abandonded by the Polish weather service in the beginning of 80's in favour of interpreting the forecast products delivered by foreign weather centers. Lack of computer resources together with commonly known economic problems and with lack of general public interest hampered initiatives in this field for more than a decade. In 1994, the situation begun to improve, at least partially, when the first supercomputer machine in Poland (CRAY Y-MP/EL98) started its operation at the ICM. A research project was then initiated by a small (2 researchers) group of the Institute of Meteorology and Water Management (IMWM) employees. An initial experiment with the model (Jakubiak, 1996), consisting of a trial hindcast of a winter situation with strong winds occurence followed by a frontal system passage, demonstrated the strength of the system. Despite technical difficulties and limitations such as poor telecommunication means and computer power shortages, thanks to the involvement of the MetOffice and the ICM staff it was finally possible to conduct a three-month test run starting in the fall of 1996. This run demonstrated the ability of the ICM to maintain continuosly operation of the model.

The computer resources of ICM increased substantially in 1996 and 1997, when two subsequent supercomputers, a Cray Y-MP4E and a Cray T3E, were installed; the telecommunication links also improved gradually. In May 1997, under a new agreement between the UKMO and the ICM, the ICM started a daily operation of the model. The results - almost immediately - turned out extremely useful during the summer flood of 1997: the model produced highly alarming values of precipitation amounts during both the first and the second flooding period, so the forecasters had a chance to see the model forecast usefulness during the first period, and to use it to predict the second flood wave soon after that. This way, the model results likely contributed to the reduction of losses during the second flooding wave, as the alarmed communities managed to take effective defensive actions.

A brief description of the Unified Model

The Unified Model of the UK MetOffice is a primitive equation, semi-hydrostatic, grid model designed for multi-scale applications ranging from global climate simulations to mesoscale short-term weather prediction. The main prognostic fields are: horizontal velocity components, liquid water potential temperature and total water content. Prognostic equations are written in spherical coordinate system; for regional and mesoscale applications, the trasformation includes a rotation of the coordinate frame so that the equator of the system runs through the center of the model domain, thus minimizing local scaling/distortion errors. The equations of motion include some higher-order terms such as Coriolis terms in the vertical velocity equation and centripetal accelerations due to Earth rotation. A generalized pressure-type vertical coordinate $\eta(p, p_s)$ may be used; the present choice is the formulation of Simmons and Strüfing (1981) which remedies the pressure gradient error noncancellation problem in the stratosphere to a certain degree, as discussed in Simmons and Burridge (1981).

For a detailed description of the equation set, the reader is referred to White and Bromley (1988).

The numerical solution is obtained by a finite difference method, using the split-explicit scheme on the semi-stagerred Arakawa „B" grid (see e.g. Mesinger and Arakawa, 1976), with the Heun advection time-step.. The scheme was chosen to combine demands of computational efficiency and of conservation properties (conservation of angular momentum, global mass-weighted mean of all advected quantities) required for long-term climate integrations.

The model physics include parameterizations of turbulent and radiative transfer, convection, soil hydrology and surface heat balance. Alternative parameterizations are available.

The turbulent exchange is treated with either a local first-order, Richardson-number based closure, or with a non-local scheme for mixing of heat and moisture. Surface-layer exchange is treated with similarity-derived bulk coefficients, with consideration of different surface types (ground, ice, water) and of free convection conditions.

The 6-band longwave radiation scheme is based on Slingo and Wilderspin (1986), and the 4-band shortwave parameterization on the extended Slingo scheme (1985, 1989). Ozone, carbon dioxide, water vapour, convective cloud presence and cloud water content influence the radiation in the model.

Grid-scale condensation processes are described using the conservative cloud water/ice characteristics; the use of statistical fractional cloudiness parameterizations of Sommeria and Deardorff (1977) and Mellor (1977) permits condensation to occur before grid-scale supersaturation is reached. The large-scale precipitation formation is modelled with the autoconversion equation, which describes the autoconversion rate as a function of the cloud water mixing ratio; accretion and coalescence due to precipitation falling into a grid box from above are simulated by including appropriate terms in autoconversion equation. Further mechanisms included are the growth by deposition, evaporation and melting with corresponding environmental cooling.

The subgrid-scale cumulus and cumulonimbus convection parameterization follows the mass flux scheme of Gregory and Rowntree (1990). This is a bulk-type formulation with a simple closure, based on detection of initial convection layer with potential convective instability. The model accounts for entrainment of the surrounding air, cloud downdraughts, environmental changes due to mixing at the cloud top and compensating subsidence in cloud environment. The precipitation forms when certain thresholds for cloud liquid/ice content or cloud depth are exceeded. The model is applied to convective plumes acting within a grid box.

Land surface subsystem includes a 4-layer soil model for calculation of the ground heat flux, soil hydrology unit (soil moisture content changing in response to evapotranspiration, canopy throughfall, snowmelt, and surface and subsurface runoff), a vegetational canopy layer water storage that can intercept rainfall. Snow cover is handled by tracking the snow amount changing in response to sublimation/deposition, snowfall and melting. Aerodynamic roughness takes values dependent on surface type (land/sea/ice/snow), for water surface it also depends on wind speed. The albedo is specified differently for diffuse and direct light for various surface types and is dependent on numerous factors such as climatological vegetation, land use, soil type, solar zenith angle, presence and depth of the snow cover, etc.

The quality control system employs concepts of Bayesian probability theory (Lorenc and Hammon, 1988; Ingleby and Lorenc, 1993). A background check, based on calculation of conditional probability of gross error given the background value is applied after some initial data checks and is followed by a buddy-check based on probability criteria.

The data assimilation is accomplished by the analysis correction method of Lorenc, Bell and Macpherson (1991). The analysis focuses on retaining model modes with periods longer than that of the repeated data insertion; physical constraints such as geostrophy or non-divergence are introduced through balance relationships. This way, spin-up problems are reduced even without employing further dynamic initialization techniques.

Implementation at the ICM

The system made initially available by UKMO was the ‘portable’ configuration of the version 3.2; replaced by the newer 4.0 version utilized by the current semi-operational run. The portable version does not include all system components; most notably, it lacks the quality control module. To fill this data processing gap, we employ observation data files pre-processed by UKMO rather than raw data input. Lateral boundary condition files, taken from the regional setup of the Unified model, are also provided by UKMO. Occasionally, we resort to interpolation of the available forecasts from global models to provide timely execution in cases of delay of delivery or malfunction of the normal channel. Recently, the UKMO found it possible to extend the time range of forecasted boundary conditions from 48 to 72 hrs., which opens another possibility of securing the operation by using ‘old’ boundary conditions from a previous regional model cycle. Experimental runs with a global configuration of the Unified model were also tried, and are seen as a viable alternative to importing boundary conditions in the future.

To provide initial conditions of desired quality on the model grid, the assimilation system is run continuosly (in 3-hr increments) at the ICM rather than using interpolation from the regional configuration running at UKMO. At present, only certain classes of observations are used, mostly the surface and sounding data as well as aircraft observations and 120-km SATEM data from NESDIS.

The area chosen for the present semi-operational run encompasses Poland and its surroundings as well as the whole Baltic Sea (Fig. 1); the grid size is 144×96 with 0.15 degree resolution (about 17 kilometers). Earlier experiments were conducted on a 92×92 grid. There are 30 layers in the model, 13 of which falling within the boundary layer extent. Within present limitations, we are able to produce a single 48-hr forecast cycle per day at the nominal 00Z.

The model output, totaling around 100 MB per day is archived (currently in UKMO formats) on a robotized tape archive within the ICM, and is made available (in digital form) to a few research groups for scientific purposes. Selected parts of the current model output (streamlines, temperature, clouds and precipitation) are presented to general public in a graphic form by means of an Internet server. Visualization is performed using the popular Vis-5D software of the University of Wisconsin; more recently, efforts have been made to develop a broader set of graphic analysis tools by utilizing a commercial scientific package AVS/Express of Uniras.

Efforts have been initiated to develop a forecast quality monitoring subsystem. At the time of writing, these are in its initial phase.

Future plans and development directions

Present extent of model operation practically exhausted limited capabilities of the ICM, which is essentially an academic scientific centre. Intensive efforts are taken to both extend the computational potential in Warsaw (a 10 GFlop-class machine is expected soon), and to create basis for the growth of the research and development team which would provide intelectual resource necessary for future routine operations. Plans for further activity include both the operational enhancements of the current system and the developments in other related fields such as nested mesoscale models covering smaller areas, air pollution models and short-term models of the Baltic Sea.

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Closing the energy and water cycles of the Baltic Sea

by

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Introduction

Does the Baltic Sea gain or lose fresh water from the atmosphere? Does the Baltic Sea gain or lose energy from the atmosphere? How much water and energy leave the Baltic Sea through the entrance area? Can we close the energy and water balance of the Baltic Sea only by using measurements? These are questions that are essential for the BALTEX programme and require energy and water cycle studies. As the energy and water balances are closely linked they can not be studied in isolation, but require consistent methods, where both models and measurements are used. In the modelling, ocean models are important and necessary tools, which is illustrated by using the PROBE-Baltic model (Omstedt and Nyberg, 1996). The energy and water cycles were calculated and analysed using this model and observations from meteorological stations, water levels from the Kattegat and river runoff. The time period considered was from November 1980 to November 1995, thus a 15 year period.

The direct coupling between the energy and water cycles are through the turbulent latent heat flux, which cools the sea surface and removes fresh water from the Baltic Sea through evaporation, but several other energy and water fluxes need also to be considered. The water balance (Figure 1a) is controlled by:

1. The in- and out-flow between the Baltic Sea and the Kattegat.
2. The river runoff.
3. The meteorological runoff (precipitation minus evaporation).

The volume changes due to land uplift and expected climate change is much smaller, see Table 1 for the estimated order of magnitudes. On a long-term mean the water flows balance, but on shorter time scales this is not true.

In the calculations we have used the PROBE-Baltic model and considered the reduction of evaporation due to sea ice (Omstedt et al., 1997). The in- and out-flows were also calculated and the river runoff data were taken from observed monthly means (Bergström and Carlsson, 1994). The water balance for the Baltic Sea was evaluated by comparing measured and calculated mean salinities in the Baltic proper (Figure 2). The results illustrate the importance of considering the meteorological runoff to the Baltic Sea (Omstedt and Axell,1998).

The energy balance of the Baltic Sea water body (Figure 1b) is mainly controlled by:

1. The net heat flow from the open water surface to the atmosphere(equal to the sum of the sensible heat, the latent heat, and the net long wave radiation).
2. The sun radiation to the open water surface.
3. The heat flow between water and ice.
4. The sun radiation through the ice.
5. The heat flow associated with the in- and out-flows through the Baltic Sea entrance area.

The heat flows (taken as yearly means) due to river runoff, precipitation and snow are all small and could be neglected, see Table 2. As a long-term mean the sum of the energy fluxes balance, but on a shorter time scale this is not the case.

Closing equations

In energy and water cycle studies we are often dealing with small differences between large numbers. To correctly model these small, but important, differences it is important to apply all ways of checking the results. The idea of closing the energy and water balances is therefore of great importance as it allow us to get some additional information that could evaluate and improve our modelling efforts. As the atmosphere does not have any natural lateral boundaries, regional closing can only be done by considering net outflows from drainage basins or straits. In the case of the Baltic Sea and its drainage basin, the closing section is in the entrance area. The reason is that if we know the fresh water input to the Baltic Sea, this volume flow as a long-term mean needs to pass the entrance area. Only think about the problem we had to face if we should try to close the water balance in the middle of a drainage basin or in the central part of the Baltic Sea!

The closing equation for the water volume reads:

$$A_s \frac{dz_s}{dt} = Q_{in} - Q_{out} + (P - E)A_s + Q_r + Q_{rise} + Q_{cc} \qquad \{1\}$$

where A_s is the surface area of the Baltic Sea, z_s the water level of the Baltic Sea, Q_{in} and Q_{out} the in- and out- flows through the Baltic entrance area, P an E the precipitation and evaporation rates, Q_r the river runoff, Q_{rise} the volume flow associated with land uplift and Q_{cc} volume flow associated with expected climate change.

In the closing equation for the energy we consider the energy balance of the water body and the equation reads:

$$\frac{dH}{dt} = (F_{in} - F_{out} - G)A_s \qquad \{2\}$$

where $H = \int\int \rho \cdot c_p \cdot T \cdot dz \cdot dA$ is the total heat content of the Baltic Sea, F_{in} and F_{out} the heat fluxes associated with in- and out- flows and G the total energy gain to the atmosphere (note that the fluxes are positive when going from the water to the atmosphere). G reads:

$$G = (1 - A_i)(F_{net} + F_s^o) + A_i(F_w + F_s^i) + F_i + F_r \qquad \{3\}$$

$$F_{net} = F_h + F_e + F_l + F_{prec} + F_{snow} \qquad \{4\}$$

where A_i is the ice concentration, F_h the sensible heat flux, F_e the latent heat flux, F_l the net long wave radiation, F_{prec} and F_{snow} the heat fluxes associated with precipitation in the form of rain and snow respectively, F_s^o the sun radiation to the open water surface, F_w^i is the water flux to the ice covered regions, F_s^i sun radiation through the ice, F_i the heat sink associated with ice advection out from the Baltic Sea, F_r heat flow associated with river runoff, The estimated heat fluxes are given in Table 2. It should be noticed that we consider the energy balance of the Baltic Sea water body and not the atmosphere, as this will make the closing possible.

Results

For the closing of the energy and water balances we apply the Baltic Sea model by Omstedt and Nyberg(1996) and calculate the different flows given in the equations above. The results for the water balance is given in Table 3. From the table we can noticed that the meteorological runoff is positive. An error of about 2000 (m^3s^{-1}) in the fresh water input changes the salinity of the Baltic Sea about 1 permille (Omstedt and Axell, 1998) and must therefore be regarded as a large error in the water balance. It should be noticed that when estimating the atmospheric fresh water input to the Baltic Sea the whole region need to be considered. Figure 3, illustrates the regional distribution of precipitation minus evaporation rates. From the calculations one can notice that the precipitation and evaporation rates come close in the Baltic proper, but show a larger positive sign for the great gulfs (the Gulf of Riga, the Gulf of Finland and the Gulf of Bothnia).

The present water balance calculations are also compared with some other estimates. Jacob et al.(1997) presented three runs using models for the atmosphere. In the first run (run 1), the global climate model ECHAM4 was applied using climatological sea surface temperatures and calculations from a 7 year run. The second run (run 2), used the same model but with observed sea surface temperatures and calculations from 10 years. The third run (run 3), used the regional climate model HIRHAM and a 9-years simulation on a 50 km grid. In the latter calculation, sea surface temperatures from a coupled ocean-atmosphere model were used. For comparison the water balance from the HELCOM (1986) study is also added in Table 3. Before comparing we should note that different periods and models have been used, but all studies deal with the long-term properties of the water balance. From an oceanographic point of view it is easy to state that the meteorological water balance calculations by Jacob et al.(1997) show serious errors.

The corresponding estimates on the long-term mean energy fluxes are shown in Table 4. At a first look it is suprising that the different energy fluxes come so close to each other. Studing the total energy gain to the atmosphere (G) the results, however, show large differences. The energy balance of Henning(1988) is in a bad shape as already was pointed out by Stigebrandt(1995). The long-term gain was estimated by Henning(1988) to 16 (Wm^{-2}), which should correspond to an unrealistically import of heat through the entrance area of the Baltic Sea. As a long-term mean the total energy gain to the atmosphere G, must balance the difference between F_{out} and F_{in} . From a simple energy estimation the temperature difference between the in- and out- flowing water volumes read:

$$\Delta T = \frac{GA_s}{Q\rho c_p} \qquad \{5\}$$

where A_s is the surface area of the Baltic Sea, which is 3.7 10^{11} (m). Now using the estimated values of the total energy gain in Table 4 and a volume flow rate of 50 000 (m^3s^{-1}), the study by Henning(1988) predicts a temperature difference between the long-term in- and out-flows of 28 (^oC), bringing warmer water into the Baltic Sea. The underlying assumption is that the heat is exported and imported by the barotropic exchange in the entrance area and not by the baroclinic exchange. If we assume that the heat is mainly transported by the baroclinic exchange the temperature difference given below should increase with a factor of 3, becoming even more unrealistic. The corresponding values for the runs from Jacob et al.(1997) is -9 and + 9(^oC) and in the case of present study about -2(^oC). The estimates from Henning (1988) is clearly an overestimation, which is also true in the run 2 and 3 by Jacob et al.(1997). The reason is that on a long-term average the Baltic Sea is not importing such a large amounts of heat. This could be illustrated by looking on the deep water temperatures in the Baltic Sea and it was already shown by Wallerius(1932) that the energy in the in flowing water to the Baltic Sea is small. Wallerius (1932) stated: "*the contribution from sea water to the Baltic Sea heat content is thus almost negligible - a fact that is not unimportant to state, as the opposite information also is given in the scientific press* "

In Figure 4 an example is given from a standard oceanographic station east of Gotland, the Gotland Deep (BY 15). The figure illustrates that even during a major inflow event with saltier water entering into the Baltic Sea, the deep water temperatures show only small variations. From all available temperature and salinity measurements at BY15 for the period 1980 to 1995 and model calculations, Figure 5, we can again notice that the temperatures in the deeper layers in the Baltic Sea show only small variations indicating that the heat flow into the Baltic Sea is small. The calculations were taken from the PROBE-Baltic model with the total energy gain equal to -1 (Wm^{-2}).

In the run 1 by Jacob et al. (1997) and in the present calculations, the sign is changed indicating a net out flow of heat from the Baltic Sea. The prediction in run 1 seems to be an overestimation and whether the Baltic Sea exports heat or not needs to be studied more, but the total energy gain to the Baltic Sea should probably become almost zero. This condition could then be used as an important constraint to the energy budget.

Conclusions

We have illustrated the need of using an ocean model in the energy and water cycles studies of the Baltic Sea and its drainage basin. The water and energy balances need to be solved togheter and the Baltic Sea entrance area should be used as the closing section for the budgets. The conclusions from the paper are summarised as follows.

(1) The long-term water balance needs to be in accordance with the salinity in the Baltic Sea and the meteorological fresh water inflow is positive and in the order of 10^3 (m^3s^{-1}).

(2) The long-term energy balance of the Baltic Sea is almost in local balance with the atmosphere. The surface energy balance of the Baltic Sea water body should thus become close to zero.

(3) In energy and water cycle studies for the BALTEX programme, the response of the salinity and the heat content of the Baltic Sea are important parameters to study when evaluating and improving the models.

In future work within BALTEX and particularly during the BRIDGE experiment we need to explore the possibilities of using the closure constraints on both the water and the energy cycles. We also need to investigate the water and energy transports through the Baltic Sea entrance area by performing accurate measurements of volume exhange, salinity and temperature. The planning of such measurements should be of major importance in the preparation of the BRIDGE experiment.

Acknowledgements

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Table 1. Estimated yearly mean volume flows for the Baltic Sea (order of magnitude).

Q_{in} (m^3s^{-1})	Q_{out} (m^3s^{-1})	Q_{out}-Q_{in} (m^3s^{-1})	(P-E)A_S (m^3s^{-1})	Q_r (m^3s^{-1})	Q_i (m^3s^{-1})	Q_{rise} (m^3s^{-1})	Q_{cc} (m^3s^{-1})
10^5	10^5	10^4	10^3	10^4	10^2	10^1	10^1

Table 2. Estimated yearly mean energy fluxes for the Baltic Sea (order of magnitude).

F_{net} (Wm^{-2})	F_w^o (Wm^{-2})	F_s^o (Wm^{-2})	F_w^1 (Wm^{-2})	F_s^1 (Wm^{-2})	F_{prec} (Wm^{-2})	F_{snow} (Wm^{-2})	F_i (Wm^{-2})	F_r (Wm^{-2})	F_{in}-F_{out} (Wm^{-2})
10^2	10^2	10^2	10^0	10^1	10^0	10^0	10^{-1}	10^0	0

Table 3. A comparison between some estimates on the long time mean water balance of the Baltic Sea.

AUTHOR	Q_{in} (m^3s^{-1})	Q_{out} (m^3s^{-1})	Q_{out}-Q_{in} (m^3s^{-1})	Q_r (m^3s^{-1})	A_s(P-E) (m^3s^{-1})	Storage (m^3s^{-1})
Present paper	40 423	57 721	17 298	15 141	1 868	-289
Jacob's et al.-97, run 1			19 089	15 316	3 773	0
Jacob's et al.-97, run 2			19 216	15 760	3 456	0
Jacob's et al.-97, run 3			30 029	22 768	7 261	0
HELCOM, -86, Table 11g			14 938	13 829	1 259	149

Table 4. A comparison between some estimates on the long time mean energy balance of the Baltic Sea.

AUTHOR	F_h (Wm^{-2})	F_e (Wm^{-2})	F_l (Wm^{-2})	F_s^o (Wm^{-2})	F_w^1 (Wm^{-2})	F_s^1 (Wm^{-2})	G (Wm^{-2})
Present paper	7	35	43	-90	3	-0	-1
Jacob's et al.-97, run 1	7	32	44	-88			-5
Jacob's et al.-97, run 2	11	36	44	-86			5
Jacob's et al.-97, run 3	13	37	38	-83			5
Henning, -88	18	39		$-41^{1)}$			16

1) Net radiation

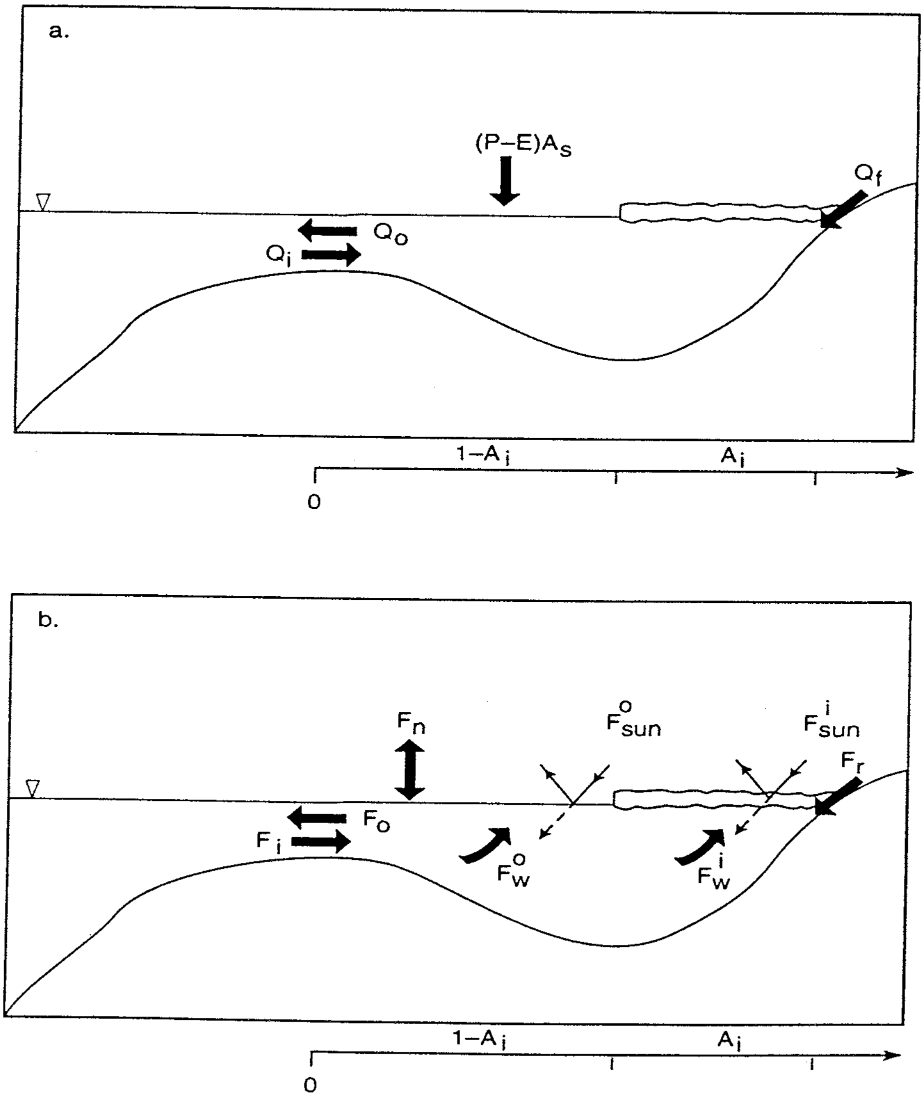


Figure 1. The main components in the water(a) and energy(b) cycles of the Baltic Sea.

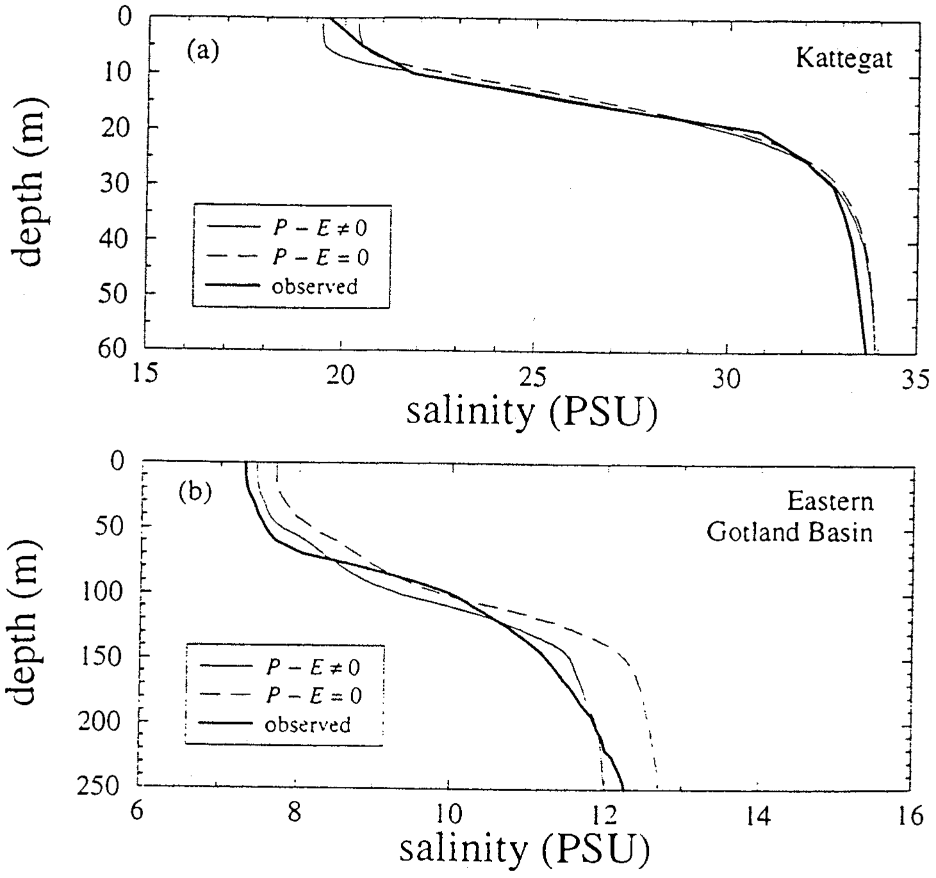


Figure 2. Median salinities from the Kattegat(a) and the Eastern Gotland Basin(b) from 15-year calculations (1980-1995), with and without meteorological runoff (precipitation minus evaporation rates, P-E). From Omstedt and Axell (1998).

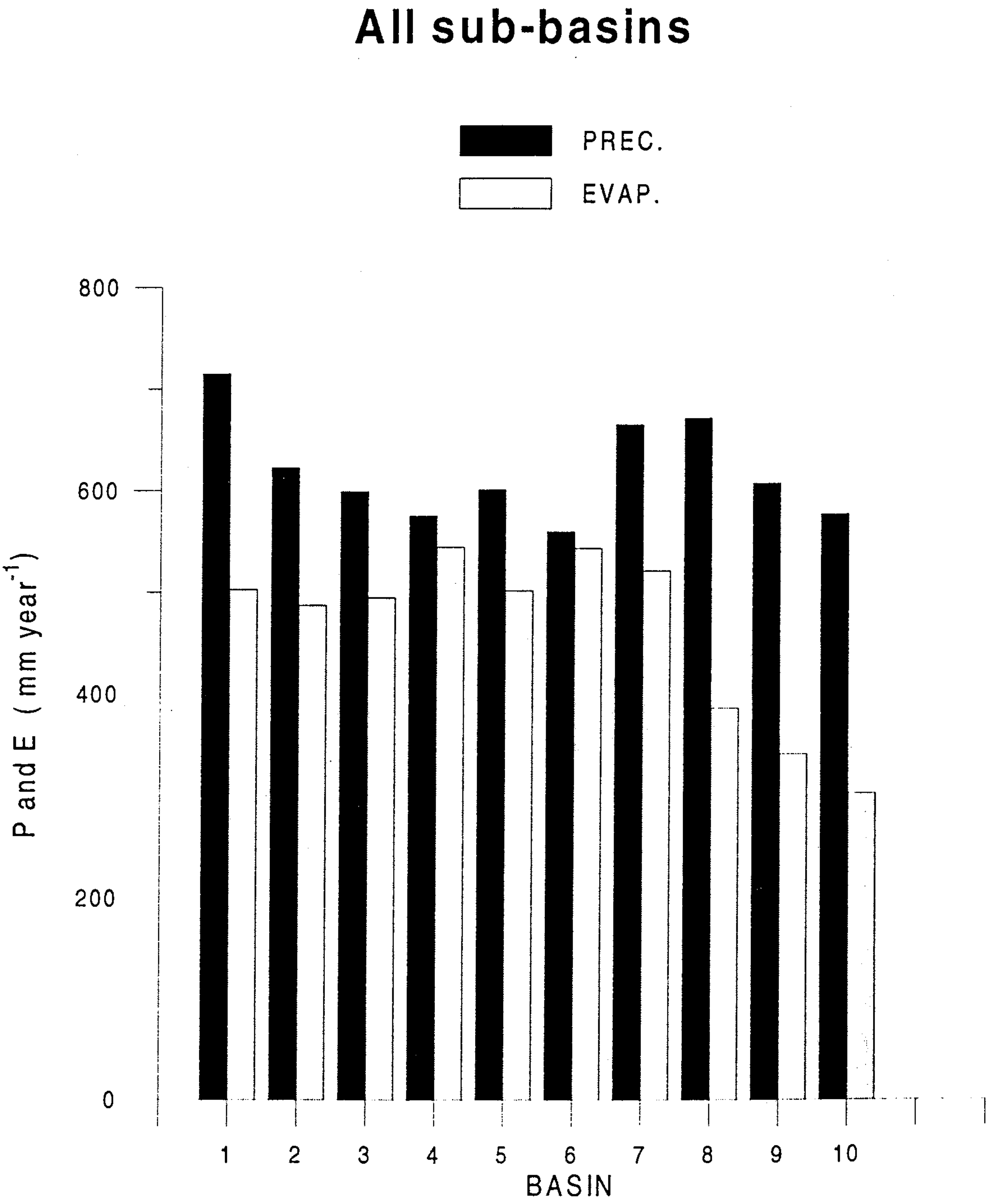


Figure 3. The long-term means of precipitation and evapporation rates for different sub-basins of the Baltic Sea. The sub-basins are given in Omstedt et al., (1997).

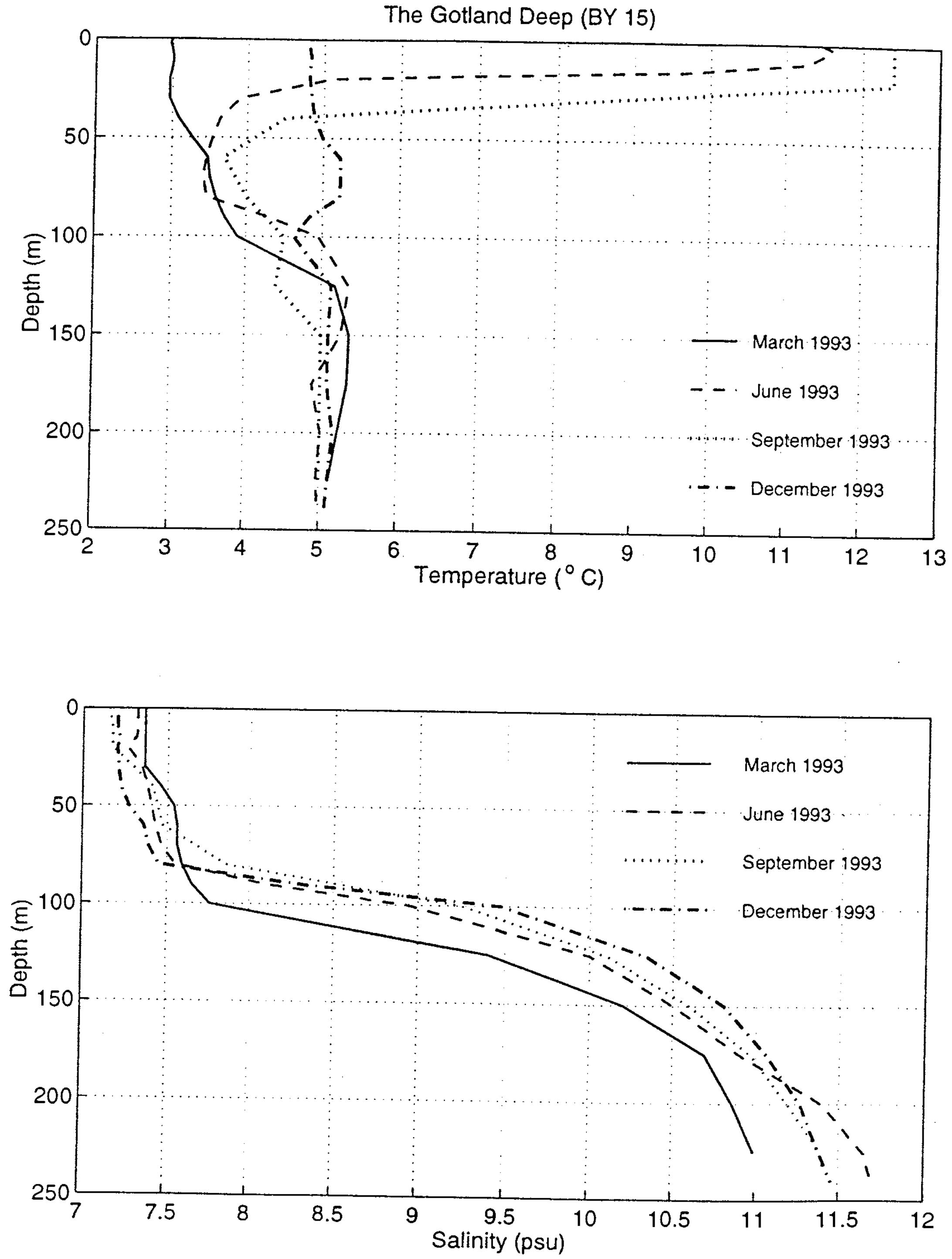


Figure 4. Salinity and temperature change in the Gotland Deep (BY15) during the major inflow 1992/93.

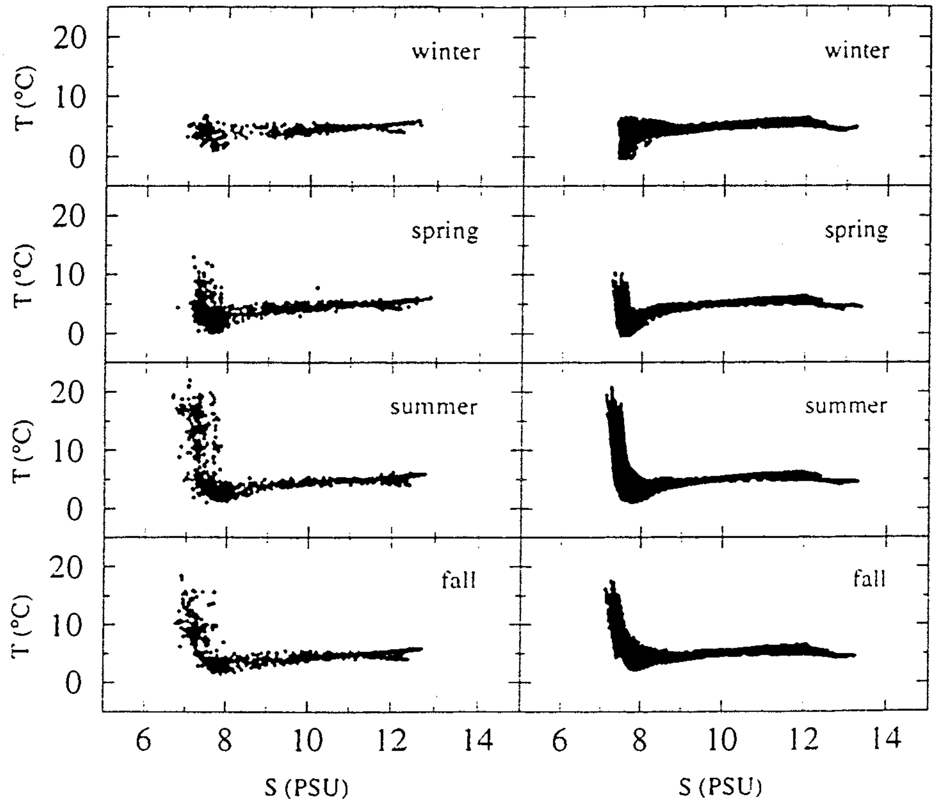
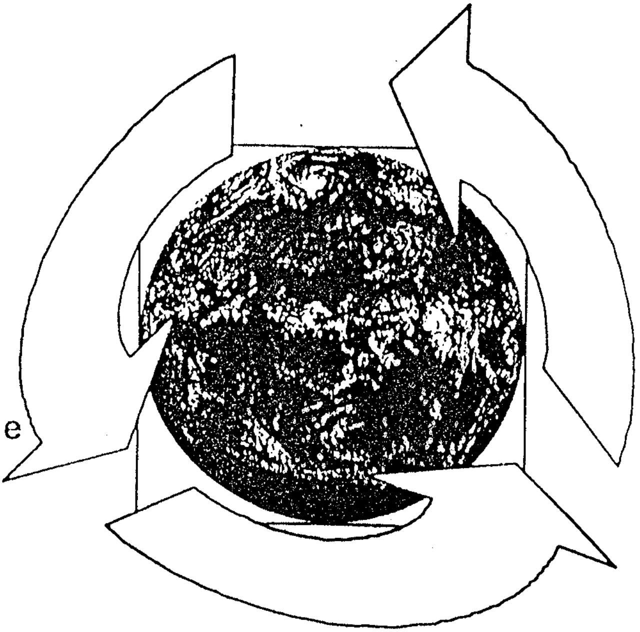


Figure 5. Seasonal T-S diagrams based upon observations (left panels) and calculations (right panels) from the Eastern Gotland Basin. The observations are from BY15. From Omstedt and Axell (1998).

Figure 1. Hydrometeorology Panel as part of the GEWEX Program.



Hydrometeorology Panel

- ○ GEWEX Continental-Scale International Project (GCIP)
- ○ Baltic Sea Experiment (BALTEX)
- ○ GEWEX Asian Monsoon Experiment (GAME)
- ○ Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA)
- ○ MacKenzie GEWEX Study (MAGS)
- ○ International Satellite Land-Surface Climatology Project (ISLSCP)
- ○ Global Runoff Data Center (GRDC)

Modelling/Prediction Panel/WGNE (Cloud & LSP)

- ○ GEWEX Cloud System Study (GCSS)
- ○ Project for IC of Land-Surface Parameterizations (PILPS)

Radiation Panel/WGRF

- ○ International Satellite Cloud Climatology Project (ISCCP)
- ○ Surface Radiation Budget Project (SRB)
- ○ Baseline Surface Radiation Network (BSRN)
- ○ GEWEX Water Vapor Project (GVaP)
- ○ Global Precipitation Climatology Project (GPCP)
- ○ Cloud Radar Study
- ○ Aerosol Pilot Dataset

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Appendix 5

Second Study Conference on BALTEX

Hotel Aquamaris, Juliusruh,
Island of Rügen, Germany
25 - 29 May 1998

Actions since April 1997 and future time plan:

1st Announcement:	*May 1997*
2nd Announcement, Call for Papers:	*November 1997*
Sponsoring and support:	*continuous, almost finished*
Opening ceremony:	*continuous, almost finished*
Invited speakers:	*continuous, almost finished*
Deadline for abstracts:	*31 January 1998*
Conference programme:	*February 1998, draft finished*
Notification to authors:	*28 February 1998, done*

Registration with payment and accommodation reservation:	*15 March 1998*
Registration and payment for social event (boat trip):	*15 March 1998*
Deadline for financial support application:	*15 March 1998*
Notification to participants:	*31 March 1998*
Opening of the conference:	*25 May 1998*

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Appendix 6

BALTEX Data Exchange
- Status of the BALTEX Data Centres -
(as of 26 February 1998)

Progress made since the 5th SSG meeting is encircled.

	BMDC (DWD)	BHDC (SMHI)	BODC (FIMR)
Sampling Strategy	A	A	a
Status Paper	a	a	a
Rules, Agreements	a - A - I	a - A - I	-
Data Collection, real	O	S - O	P
Data Collection meta	O	S - O	S
Data Delivery	S - O	S	P

P	Planning Stage
a	Approved by SSG and Data Centre
A	Approved by SSG, Data Centre and Data Suppliers
I	Implemented
S	Started
O	Ongoing

Hans-Jörg Isemer, International BALTEX Secretariat, 26 February 1998

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Appendix 7

THE BALTEX HYDROLOGICAL DATA CENTRE

(BALTEX - HDC)

Ola Pettersson
Swedish Meteorological and Hydrological Institute - BALTEX - HDC
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1. OBJECT AND DIVISION OF TASK

SMHI in Norrköping, Sweden, hosts the BALTEX Data Centre for hydrology with the main objective to concentrate specific types of hydrological data and information about this data. BALTEX HDC has the special duty to make runoff data accessible from runoff stations in the BALTEX region.

SMHI has earlier collected runoff data from all countries around the Baltic Sea. This has resulted in an operational data base that consists of monthly runoff data from gauge stations and calculated monthly runoff for 122 coast-segments. The time period for the monthly runoff data base is: 1950 - 93 (-95 for Sweden, Finland and Lithuania). A first BALTEX Hydrology Workshop was held in Warsaw, September 9-11, 1996, in order to specify the further demands of hydrological data from the BALTEX community. As a result of this workshop the Hydrological Data Sampling Strategy for BALTEX was approved by BALTEX SSG on 16 April 1997.

The most important data to be collected and prepared by the BHDC for dissemination to the BALTEX community are **daily runoff data** from operational runoff networks in the BALTEX area. Reliable runoff data from dense networks in four specific catchments shall be collected. These special study basins are: Torneälv, Neva, Daugava, and Odra. The total area of the special study basins is about 710 000 km². A minimum requirement is an average of one runoff station per 4000 km² leading to a minimum requirement 150 runoff stations for all the four mentioned study basins. For the other catchments in the BALTEX region a reduced data coverage (data from a basic network of about 100 runoff stations) was considered sufficient. The daily runoff data are required for both tuning and validation of hydrological models, which requires a minimum of 5 to 10 years of runoff data. It was suggested that daily runoff data should be collected from the time period 1980 and onwards. For climatological studies a few very long runoff records (longer than a century) preferably based on daily data shall be collected by the BHDC.

The following additional data will be collected and archived by BHDC depending on their availability: snow equivalent of water, soil moisture, information on ground water, lake level, lake and river temperature, ice observations.

Meteorological observations required as input for different hydrological models shall be collected by BHDC.

To accomplish these tasks the BALTEX HDC will use the infrastructure and routine services of the SMHI.

2. DATA MANAGEMENT

The data collected by the BHDC is supplied mainly by different national institutes in the countries participating in BALTEX. The structure of the daily runoff data base is identical to the one that SMHI currently use for the Swedish national runoff network. In that way BHDC can benefit from any progress being made to the current data base structure at SMHI. Meta data and other hydrological data will be stored in a different databases designed solely for these purposes. Information on the contents of the BALTEX HDC will be made available through internet/WWW at the following adress:

http://www.smhi.se/sgn0102/bhdc/index.htm.

Data will be provided to BALTEX Data Users upon request.

2.1 TIME PERIODS OF DATA

The daily runoff data are required for both tuning and validating of models. This requires a minimum of 5 to 10 years of runoff data depending on the type of model. The Warsaw hydrology workshop suggested to include runoff data for the period 1980 onwards in the archives of BHDC. In particular the Vistula catchment experienced a number of dry years in the 1980s, hence, extension to the periods 1970 onwards might be necessary to avoid tuning biases. This extension should however be exceptional.

Other hydrological data will be collected depending on their availability and specific requirements from the BALTEX modelling community. Most of these data are not measured routinely but are only available from specific experiments. The data will be collected from within the same time span as the runoff data.

3. DATA POLICY

The regulations for the use of data are set through agreements between the

- SMHI - BALTEX HDC and the providing institute
- User of the data and the SMHI - BALTEX HDC

Data delivery by the BALTEX HDC is strictly limited to groups of scientists which are officially registered as BALTEX Data Users
The delivery of data from the supplying institute will be free of charge
The distribution costs at the BALTEX HDC will be covered by the user

4. STATE OF BHDC DAILY RUNOFF DATA BASE

(as of February 1998)

4.1 PRESENT DATA

The following data are stored in a SQL based relational database management system. The structure of this database is the same as SMHI currently use for the Swedish national runoff network. In that way BHDC can benefit from any progress being made to the current database structure at SMHI.

4.1.1 RUNOFF DATA

4.1.1.1 Special study basins

- **Torne**, complete data set from 1980 to 1996, with all available runoff stations, ice observations, river temperature, and selected Swedish meteorological stations.
- **Neva**, Russian runoff data from November 1986 to March 1987, September 1992 to August 1993 and October 1995 to March 1996. Three runoff stations cover the period January 1981 to December 1988. Runoff data from Finland from 1980 - 1996.
- **Daugava**, Belorussian runoff data from November 1986 to April 1987, January 1992 to December 1993 and October 1995 to May 1996. Latvian runoff data January 1986 to December 1987, January 1992 to December 1993 and all months in 1995. From two Latvian stations data have been collected from January 1980 to December. Russian runoff data from November 1986 to March 1987, September 1992 to August 1993 and October 1995 to March 1996.
- **Odra**, data from November 1990 to October1995 from 25 runoff stations.

4.1.1.2 Basic network

- **Finland**, a selection of 73 Finnish runoff stations. Daily runoff data from 1980 - 1996 has been delivered and stored. No agreement necessary.
- **Russia**, a selection of necessary runoff stations for hydrological modelling will be made by Dr. Vinogradov, RSHI. No agreement signed. Three runoff stations cover the period January 1981 to December 1988.
- **Estonia**, a selection of 8 runoff stations has been decided for the period 1980 and onwards. Supplier agreement has been signed. Delivery of data from the period 1980 - 1996 started in December 1997 and will be finished in April 1998. Data from 1997 and later will be delivered on demand from BHDC.
- **Latvia**, a selection of 11 runoff stations has been decided for the period 1980 and onwards. Supplier agreement has been signed. Delivery of data from the period 1980 - 1996 started in December 1997 and will be finished in April 1998. Data from 1997 and later will be delivered on demand from BHDC. The first delivery from two runoff stations has been stored from January 1980 to December 1996. GKSS(BALTEX Secretariat) has a bilateral project with Latvia for the establishment of a 15 years runoff/met data set for the Daugava part in Latvia with the option of delivering the data also to BALTEX data centres. This is a project being recently initiated with financial support from the German Research ministry (BMBF).

- **Lithuania**, a selection of 10 runoff stations has been decided for the period 1980 and onwards. Supplier agreement has been signed. Delivery of data from the period 1980 - 1996 started in December 1997 and will be finished in April 1998. Data from 1997 and later will be delivered on demand from BHDC.
- **Belarus**, a selection of 15 runoff stations has been decided for the period 1980 and onwards. No agreement signed with BHDC. GKSS(BALTEX Secretariat) has a bilateral project with Minsk for the establishment of a 15 years runoff/met data set for the Daugava part in Belarus with the option of delivering the data also to BALTEX data centres. This is a project being recently initiated with financial support from the German Research ministry (BMBF).
- **Poland**, runoff data from 25 stations in the Odra region. No data from the Vistula region. No agreement signed. Runoff data from Odra are stored from 25 stations, the time periods are from November 1990 to October 1995, with the exception of 29 February 1992 and 30 April 1992. GKSS(BALTEX Secretariat) has a bilateral project with IMWM Wroclaw and will receive runoff and met data for the period 1989 to 1996 in the next months. These data will be open for use in BALTEX.
- **Germany**, information on runoff stations and data will be delivered as soon as possible.
- **Denmark**, discussion with NERI, The National Environmental Research Institute/Danmarks Miljøundersøgelser. No agreement signed.
- **Sweden**, a selection of 66 Swedish runoff stations. Daily runoff data from 1980 - 1996 has been delivered and stored. No agreement necessary.

4.1.1.3 Other Runoff data

- **Russia**, daily runoff from 190 stations from November 1986 to March 1987, September 1992 to August 1993 and October 1995 to March 1996. Two hydrologic years (October 1995 -August 1997) of data from all available runoff stations will be collected in the frame of INTAS 95-872.
- **Estonia**, daily runoff from 46 stations, the time periods are from January 1986 to December 1987 and January 1992 to December 1993.
- **Latvia**, daily runoff from 64 stations, the time periods are January 1986 to December 1987, January 1992 to December 1993 and all months in 1995.
- **Lithuania**, daily runoff from 77 stations, the time periods are from January 1992 to December 1993 October 1995 to May 1996.
- **Belarus,** daily runoff from 48 stations, the time periods are from November 1986 to April 1987, January 1992 to December 1993 and October 1995 to May 1996. Two hydrologic years (October 1995 -August 1997) of data from all available runoff stations will be collected in the frame of INTAS 95-872.

4.1.2 OTHER HYDROLOGICAL DATA

Ice observations and river temperature from Torneälv special study basin. No other hydrological data has so far been collected.

4.1.3 METEOROLOGICAL DATA

Meteorological observations required as input for different hydrological models shall be collected by BHDC. These data must cover the time period 1980 and onwards. In particular for the four special study basins the following data may have to be included:

- meteorological observations made at all accessible synoptic stations
- precipitation measurements from all accessible non-synoptic stations
- accessible measurements from climate stations
- radiation measurements at ground from all accessible stations

In order to meet the requirements of different hydrological models the following meteorological parameters shall at least be included in the data base: precipitation, 2 m air-temperature, 2 m humidity, air-pressure, 10 m windspeed, radiation // cloud cover // sunshine duration.

To accomplish the task to collect all meteorological data described by BALTEX SSG a large effort must be undertaken by BHDC. In order to meet the demands made by the hydrological modellers the following strategy is instead suggested by SMHI.

BHDC will collect and distribute the following (3h) meteorological parameters starting from 1 January 1980:

- precipitation
- 2m air temperature
- 2m humidity
- air-pressure
- geostrophic wind
- cloud cover

The time period for the whole data set may be extended to cover the period 1970-1979. The data will be distributed on a grid (1°×1°) covering the whole BALTEX area. It should be noted that the proposed data set will be adequate to model the whole of the Baltic basin.

In addition to this gridded data set BHDC will also collect and distribute a denser set of meteorological data for the modelling of the Torne älv basin.

4.2 PLANS FOR THE FUTURE

A more active dialog must be established with Denmark, Poland and Germany.

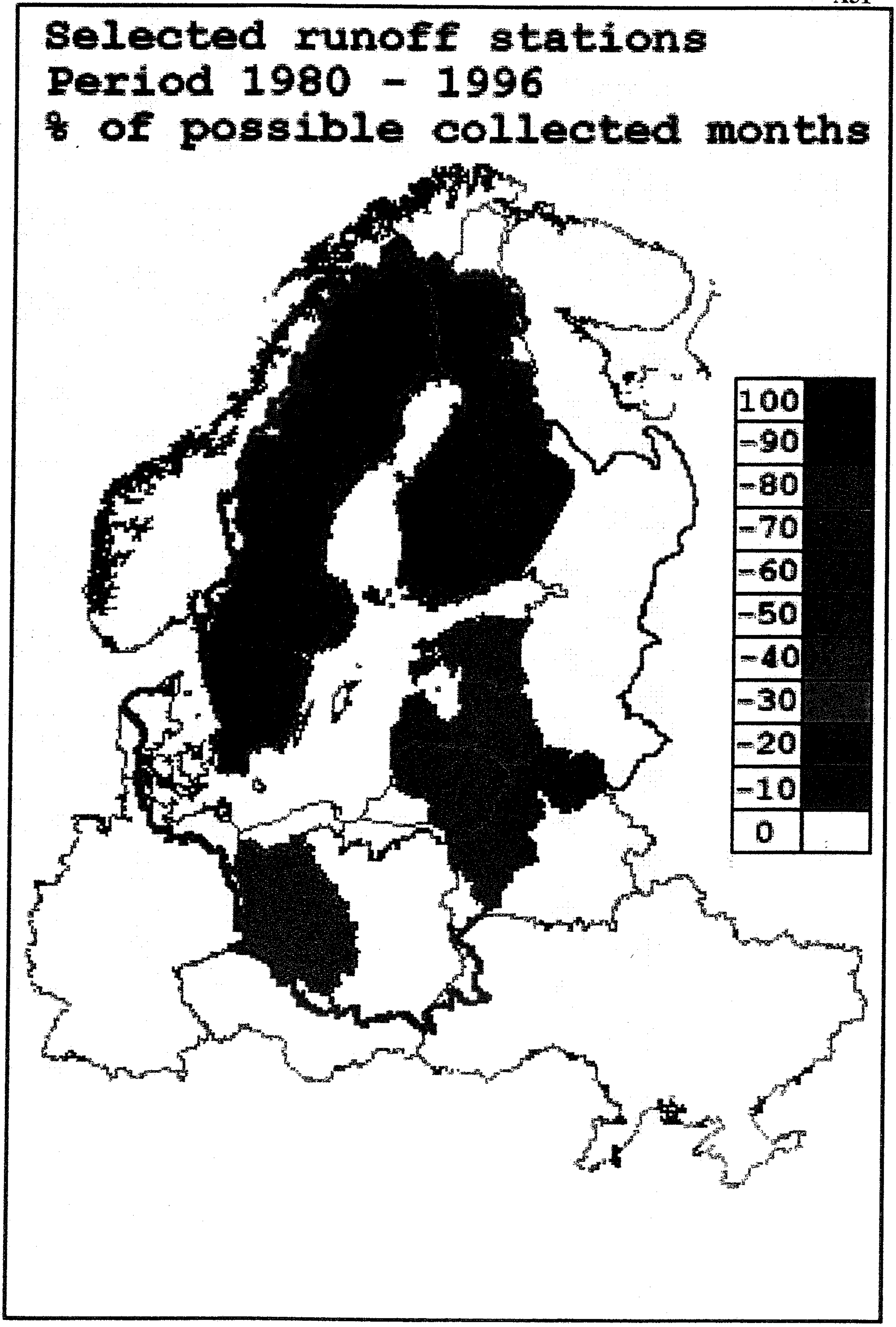
5. DATA DELIVERED:

From monthly runoff data base to:

Department of Systems Ecology, University of Stockholm, Sweden
Department of Water and Environment Studies, University of Linköping, Sweden
Umeå Marine Sciences, University of Umeå, Sweden
National Board of Waters and Environment, Finland
Institut für Meereskunde an der Universität Kiel, Germany
Max Planck Institute for Meteorology, Germany
Institut für Ostseeforschung Warnemünde, Germany
Danish Institute for Fisheries Research

From daily runoff data base to:

Gulf of Riga Project, Research and Development, SMHI, Sweden



Selected runoff stations
Period 1980 - 1996
% of possible collected months

GLOBAL RUNOFF DATA CENTRE (GRDC)
Stations at the Baltic Sea

Appendix 8

Rivers common to Norway-Sweden (WMO Subregion 29)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6229100	Nedre Bullaren	Vassbotten	58.88 N	11.54 E	621	1 .1978	12.1992	D	0
6229100	Nedre Bullaren	Vassbotten	58.88 N	11.54 E	621	1.1981	12.1992	M	0
6229500	Vaenern-Goeta	Vaenersborg	58.38 N	12.32 E	46830	1 .1985	12.1992	D	0
6229500	Vaenern-Goeta	Vaenersborg	58.38 N	12.32 E	46830	1.1807	12.1992	M	0

Rivers common to Sweden-Finland (WMO Subregion 32)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6232100	Torneaelv	Nedre Abiskojokk	68.34 N	18.82 E	3294	1 .1978	12.1992	D	4
6232100	Torneaelv	Nedre Abiskojokk	68.34 N	18.82 E	3294	9.1984	12.1992	M	7

Sweden (WMO Subregion 33)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6233100	Viskan	Asbro	57.25 N	12.32 E	2160	1 .1978	12.1993	D	0
6233100	Viskan	Asbro	57.25 N	12.32 E	2160	1.1927	12.1993	M	0
6233150	Fyllean	Simlangen	56.72 N	13.12 E	262	1 .1978	12.1993	D	0
6233150	Fyllean	Simlangen	56.72 N	13.12 E	262	1.1981	12.1993	M	0
6233200	Oesterdalaelven	Groetsjoen	61.81 N	12.44 E	559	1 .1978	12.1992	D	0
6233200	Oesterdalaelven	Groetsjoen	61.81 N	12.44 E	559	1.1981	12.1992	M	0
6233300	Velenan	Velen 2	58.72 N	14.32 E	45.000	1 .1978	12.1993	D	0
6233300	Velenan	Velen 2	58.72 N	14.32 E	45.000	1.1981	12.1993	M	1
6233350	Alsteran	Getebro	57.01 N	16.17 E	1345	1 .1978	12.1993	D	0
6233350	Alsteran	Getebro	57.01 N	16.17 E	1345	1.1981	12.1993	M	0
6233400	Ammeran	Fyras	63.52 N	15.39 E	2412	1 .1978	12.1993	D	0
6233400	Ammeran	Fyras	63.52 N	15.39 E	2412	1.1981	12.1993	M	0
6233450	Faxaelven	Ankarvattnet	64.87 N	14.24 E	430	1 .1978	12.1992	D	0
6233450	Faxaelven	Ankarvattnet	64.87 N	14.24 E	430	1.1981	12.1992	M	0
6233500	Jovattenan	Nedre Jovattnet	65.74 N	15.05 E	358	1 .1978	12.1992	D	0
6233500	Jovattenan	Nedre Jovattnet	65.74 N	15.05 E	358	1.1982	12.1992	M	0
6233550	Kassjoean	Storsillret	62.66 N	16.29 E	165	1 .1978	12.1992	D	0
6233550	Kassjoean	Storsillret	62.66 N	16.29 E	165	1.1981	12.1992	M	0
6233600	Vattholmaan	Vattholma 2	60.02 N	17.73 E	284	1 .1978	12.1993	D	0
6233600	Vattholmaan	Vattholma 2	60.02 N	17.73 E	284	1.1981	12.1993	M	0
6233650	Angerman	Solleftea	63.17 N	17.27 E	30640	1 .1985	12.1992	D	0
6233650	Angerman	Solleftea	63.17 N	17.27 E	30640	1.1965	12.1992	M	0
6233680	Vindelaelven	Sorsele	65.53 N	17.52 E	6110	1 .1989	12.1992	D	0
6233680	Vindelaelven	Sorsele	65.53 N	17.52 E	6110	1.1920	12.1992	M	0
6233750	Lule	Boden Waterworks	65.83 N	21.62 E	24490	1 .1973	12.1992	D	0
6233750	Lule	Boden Waterworks	65.83 N	21.62 E	24490	1.1965	12.1992	M	0
6233780	Raneaelv	Niemisel			3768	1 .1989	12.1992	D	0
6233780	Raneaelv	Niemisel			3768	1.1924	12.1992	M	0
6233800	Lapptraesket	Ytterholmen	66.16 N	21.78 E	1004	1 .1978	12.1992	D	0
6233800	Lapptraesket	Ytterholmen	66.16 N	21.78 E	1004	1.1984	12.1992	M	0

Denmark (WMO Subregion 34)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6934050	Arup	Arup	56.89 N	8.49 E	105	5.1936	5.1970	M	2
6934100	Skjern	Alergard	55.95 N	8.72 E	1040	6.1924	12.1979	M	10
6934150	Skive	Hagebro	56.41 N	9.01 E	522	1.1966	5.1970	M	11
6934200	Gudena	Astedbro	55.90 N	9.62 E	187	1.1976	12.1979	M	0
6934250	Gudena	Tvilumbro	56.24 N	9.67 E	1290	1.1918	5.1970	M	1
6934300	Uggerby	Asted Bro	57.45 N	10.13 E	151	6.1917	5.1970	M	1
6934310	Lindholm	Elkaer Bro	57.16 N	9.92 E	106	6.1918	5.1970	M	1
6934350	Ribe	Staunager	55.32 N	8.88 E	680	6.1933	5.1970	M	2
6934400	Arhus	Skiby	56.14 N	10.04 E	120	6.1919	5.1970	M	1
6934450	Giber	Fulden	56.08 N	10.23 E	46.000	9.1960	5.1970	M	11
6934500	Tryggevaelde	Lille Linde	55.33 N	12.22 E	131	6.1917	12.1979	M	9
6934530	Amose	Bromolle	55.61 N	11.39 E	288	10.1920	5.1970	M	3
6934570	Ringsted	Lille Svenstrup	55.47 N	11.76 E	195	10.1949	5.1970	M	6
6934571	Susa	Hollose Molle	55.30 N	11.68 E	753	6.1934	5.1970	M	2
6934700	Odense	Ejby Molle	55.40 N	10.42 E	526	6.1931	5.1970	M	2
6934800	Brede	Bredebro	55.06 N	8.83 E	292	10.1921	5.1970	M	2
6934850	Grona	Vindtvedkanalen	54.93 N	8.95 E	603	6.1959	5.1970	M	8

Baltic Sea Coast - West - (WMO Subregion 41)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6341500	Tollense	Klempenow			1403	11.1977	10.1984	D	0
6341500	Tollense	Klempenow			1403	11.1977	10.1984	M	12
6441107	Rega	Trzebiatow	54.07 N	15.27 E	2627	1 .1978	12.1988	D	0
6441107	Rega	Trzebiatow	54.07 N	15.27 E	2627	11.1945	10.1990	M	2

Finland - Gulf of Bothnia (WMO Subregion 54)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6854100	Kokemjenjoki	Kalsinkosi	61.35 N	22.12 E	26025	1 .1931	12.1992	D	0
6854100	Kokemjenjoki	Kalsinkosi	61.35 N	22.12 E	26025	1.1931	12.1992	M	0
6854200	Lapnanjoki	Alahaermae	63.37 N	22.70 E	3955	1 .1931	12.1992	D	0
6854200	Lapnanjoki	Alahaermae	63.37 N	22.70 E	3955	1.1931	12.1992	M	0
6854300	Lestijoki	Lake Lestijarvi Outlet	63.92 N	24.70 E	380	1 .1921	12.1992	D	0
6854300	Lestijoki	Lake Lestijarvi Outlet	63.92 N	24.70 E	380	1.1921	12.1992	M	0
6854400	Kiiminginjoki	Haukipudas	65.20 N	25.40 E	3845	11.1911	12.1992	D	20
6854400	Kiiminginjoki	Haukipudas	65.20 N	25.40 E	3845	11.1911	12.1992	M	20
6854500	Oulujoki	near The mouth	65.02 N	25.52 E	22900	1 .1950	12.1992	D	0
6854500	Oulujoki	near The mouth	65.02 N	25.52 E	22900	1.1950	12.1992	M	0
6854590	Oulujoki	Lake Lenfad Outlet	64.20 N	29.58 E	2065	1 .1911	12.1992	D	0
6854590	Oulujoki	Lake Lenfad Outlet	64.20 N	29.58 E	2065	1.1911	12.1992	M	0
6854600	Siurnanjoki	near The mouth	65.32 N	25.43 E	14315	1 .1911	12.1992	D	0
6854600	Siurnanjoki	near The mouth	65.32 N	25.43 E	14315	1.1911	12.1992	M	0
6854700	Kenijoki	near The mouth	65.78 N	24.55 E	50900	1 .1949	12.1992	D	0
6854700	Kenijoki	near The mouth	65.78 N	24.55 E	50900	1.1949	12.1992	M	0
6854800	Kalajoki	near The mouth	64.20 N	27.03 E	3005	1 .1911	12.1992	D	0
6854800	Kalajoki	near The mouth	64.20 N	27.03 E	3005	1.1911	12.1992	M	0
6854900	Kyronjoki	near The mouth	63.13 N	21.85 E	4805	1 .1911	12.1992	D	0
6854900	Kyronjoki	near The mouth	63.13 N	21.85 E	4805	1.1911	12.1992	M	0

Finland - Gulf of Finland (WMO Subregion 55)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6855100	Vantaanjoki	near The mouth	60.23 N	24.98 E	1680	1 .1937	12.1992	D	0
6855100	Vantaanjoki	near The mouth	60.23 N	24.98 E	1680	1.1937	12.1992	M	0
6855200	Kymijoki	Anjala	60.70 N	26.82 E	36305	4 .1938	12.1992	D	0
6855200	Kymijoki	Anjala	60.70 N	26.82 E	36305	4.1938	12.1992	M	0
6855270	Nilakka	near Vesanto	63.02 N	26.67 E	2157	1 .1896	12.1992	D	0
6855270	Nilakka	near Vesanto	63.02 N	26.67 E	2157	1.1896	12.1992	M	0
6855280	Kivijarvi	above Lake Keitele	63.05 N	25.53 E	2186	1 .1910	12.1992	D	0
6855280	Kivijarvi	above Lake Keitele	63.05 N	25.53 E	2186	1.1910	12.1992	M	0
6855300	Porvoonjoki	near The mouth	60.47 N	25.62 E	1135	2 .1963	12.1992	D	0
6855300	Porvoonjoki	near The mouth	60.47 N	25.62 E	1135	2.1963	12.1992	M	0
6855400	Vuoksi	Tainionkoski	61.22 N	28.78 E	61061	1 .1847	12.1992	D	0
6855400	Vuoksi	Tainionkoski	61.22 N	28.78 E	61061	1.1847	12.1992	M	0

Odra (WMO Subregion 57)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6357010	Odra	Hohensaaten-Finow	53.23 N	14.14 E	109564	11.1990	12.1996	D	0
6357010	Odra	Hohensaaten-Finow	53.23 N	14.14 E	109564	11.1990	12.1996	M	11
6357500	Odra	Eisenhuettenstadt			52033	11.1940	10.1996	D	0
6357500	Odra	Eisenhuettenstadt			52033	11.1940	12.1995	M	2
6457010	Odra	Gozdowice	52.77 N	14.32 E	109729	11.1900	12.1994	M	0
6457100	Odra	Slubice			53382	1.1951	12.1990	M	0
6457200	Notec	Nowe Drezdenko			15970	1.1951	10.1990	M	0
6457700	Odra	Polecko	52.06 N	14.85 E	47293	1.1946	12.1987	M	0
6457707	Bobr	Zagan	51.62 N	15.31 E	4254	1 .1978	12.1988	D	0
6457707	Bobr	Zagan	51.62 N	15.31 E	4254	1.1951	10.1990	M	0
6457800	Warta	Gorzow	52.73 N	15.23 E	52404	11.1900	12.1994	M	0
6457956	Prosna	Boguslaw	51.90 N	17.95 E	4303	1 .1978	12.1988	D	0
6457956	Prosna	Boguslaw	51.90 N	17.95 E	4303	1.1951	10.1990	M	0
6457982	Drawa	Drawsko Pomorskie	53.50 N	15.80 E	602	1 .1978	12.1988	D	0
6457982	Drawa	Drawsko Pomorskie	53.50 N	15.80 E	602	1.1978	12.1988	M	0

Wisla (WMO Subregion 58)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6458010	Wisla	Tczew	54.10 N	18.82 E	194376	11.1900	10.1994	M	1
6458203	Skawa	Wadowice	49.81 N	19.50 E	836	1 .1978	12.1988	D	0
6458203	Skawa	Wadowice	49.81 N	19.50 E	836	1.1951	10.1990	M	0
6458406	Dunajec	Nowy Sacz	49.62 N	20.68 E	4341	1 .1978	12.1988	D	0
6458406	Dunajec	Nowy Sacz	49.62 N	20.68 E	4341	11.1945	10.1990	M	2
6458450	Wisla	Szczucin	50.30 N	21.08 E	23901	1.1921	12.1990	M	0
6458500	Wisla	Warszawa	52.25 N	21.03 E	84857	1.1921	10.1990	M	11
6458550	Bug	Wyszkow	52.58 N	21.45 E	39119	11.1920	10.1987	M	1
6458600	San	Radomysl	50.68 N	21.93 E	16703	11.1920	10.1987	M	1
6458713	Wieprz	Krasnystaw	50.98 N	23.17 E	3003	1 .1978	12.1988	D	0
6458713	Wieprz	Krasnystaw	50.98 N	23.17 E	3003	1.1951	10.1990	M	0
6458753	Pilica	Przedborz	51.08 N	19.75 E	2535	1 .1978	12.1988	D	0
6458753	Pilica	Przedborz	51.08 N	19.75 E	2535	1.1951	10.1990	M	0
6458805	Narew	Suraz	52.90 N	22.95 E	3376	1 .1978	12.1988	D	0
6458805	Narew	Suraz	52.90 N	22.95 E	3376	1.1951	10.1990	M	0
6458810	Narew	Ostroleka			21862	1.1951	10.1994	M	0
6458863	Pisa	Ptaki	53.39 N	21.79 E	3561	1 .1978	12.1988	D	0
6458863	Pisa	Ptaki	53.39 N	21.79 E	3561	1.1951	10.1990	M	0
6458924	Liwiec	Lochow	52.50 N	21.67 E	2462	1 .1978	12.1988	D	0
6458924	Liwiec	Lochow	52.50 N	21.67 E	2462	1.1951	10.1990	M	0
6958100	Zapadny Bug	Kamenka Bugskaya	50.03 N	24.38 E	2260	1 .1978	12.1987	D	0
6958100	Zapadny Bug	Kamenka Bugskaya	50.03 N	24.38 E	2260	1.1978	12.1987	M	0

GLOBAL RUNOFF DATA CENTRE (GRDC)
Stations at the Baltic Sea

Estonia; North-West Russia (WMO Subregion 72)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6972010	Lejvajygi	Paiuba	59.38 N	24.97 E	84.300	1 .1978	12.1987	D	0
6972010	Lejvajygi	Paiuba	59.38 N	24.97 E	84.300	1.1978	12.1987	M	0
6972050	Piarnu	Orekula	58.47 N	24.77 E	5180	1 .1978	12.1987	D	0
6972050	Piarnu	Orekula	58.47 N	24.77 E	5180	1.1965	12.1984	M	0
6972100	Nuhcha	Nuhcha	63.92 N	36.22 E	1350	1 .1978	12.1988	D	0
6972100	Nuhcha	Nuhcha	63.92 N	36.22 E	1350	1.1978	12.1988	M	0
6972150	Maloshuika	Maloshuika	63.75 N	37.40 E	481	1 .1978	12.1988	D	0
6972150	Maloshuika	Maloshuika	63.75 N	37.40 E	481	1.1978	12.1988	M	0
6972200	Suur-Emaiygi	Tartu	58.38 N	26.75 E	7850	1 .1978	12.1987	D	0
6972200	Suur-Emaiygi	Tartu	58.38 N	26.75 E	7850	1.1978	12.1987	M	0
6972250	Pliussa	Brod	56.58 N	28.58 E	5090	1 .1978	12.1987	D	0
6972250	Pliussa	Brod	56.58 N	28.58 E	5090	1.1978	12.1987	M	0
6972300	Sorot	Osinkino	57.06 N	29.35 E	3170	1 .1978	12.1987	D	0
6972300	Sorot	Osinkino	57.06 N	29.35 E	3170	1.1978	12.1987	M	0
6972350	Narva	Narva (Hep)	59.35 N	28.25 E	56000	1 .1955	12.1991	D	1
6972350	Narva	Narva (Hep)	59.35 N	28.25 E	56000	1.1955	12.1991	M	0
6972400	Luga	Tolmatchevo	58.78 N	30.00 E	5990	1 .1978	12.1987	D	0
6972400	Luga	Tolmatchevo	58.78 N	30.00 E	5990	1.1978	12.1987	M	0
6972430	Neva	Novosaratovka	59.80 N	30.72 E	281000	1 .1980	12.1988	D	0
6972430	Neva	Novosaratovka	59.80 N	30.72 E	281000	1.1859	12.1984	M	1
6972450	Perekhoda	Podsosonie	57.80 N	30.86 E	138	1 .1978	12.1987	D	1
6972450	Perekhoda	Podsosonie	57.80 N	30.86 E	138	1.1978	12.1987	M	0
6972500	Dymka	Domachevo	59.57 N	33.84 E	112	1 .1978	12.1980	D	0
6972500	Dymka	Domachevo	59.57 N	33.84 E	112	1.1978	12.1980	M	0
6972600	Olonka	Olonets	60.93 N	33.06 E	2120	1 .1978	12.1987	D	0
6972600	Olonka	Olonets	60.93 N	33.06 E	2120	1.1965	12.1984	M	0

Western Dvina - Rivers between Western Dvina and Neman (WMO Subregion 73)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6973010	Venta	Kuldiga	57.03 N	21.86 E	8320	1 .1978	12.1987	D	0
6973010	Venta	Kuldiga	57.03 N	21.86 E	8320	1.1978	12.1987	M	0
6973200	Maza Yugla	Starini	56.96 N	24.50 E	492	1 .1978	12.1987	D	0
6973200	Maza Yugla	Starini	56.96 N	24.50 E	492	1.1978	12.1987	M	0
6973300	Western Dvina (Da	Daugavpils	55.88 N	26.68 E	64500	1.1965	12.1984	M	0
6973500	Polota	Yankovo I	55.50 N	29.20 E	618	1 .1978	12.1987	D	0
6973500	Polota	Yankovo I	55.50 N	29.20 E	618	1.1978	12.1987	M	0
6973700	Obsha	Beliy	55.83 N	33.03 E	1590	1 .1978	12.1987	D	0
6973700	Obsha	Beliy	55.83 N	33.03 E	1590	1.1978	12.1987	M	0
6973900	Myadelka	Pusaki			462	1 .1978	7 .1987	D	0
6973900	Myadelka	Pusaki			462	1.1978	7.1987	M	4

Neman (WMO Subregion 74)

GRDC-No.	River	Station	Latitude	Longitude	Area (km²)	data from	data to	Daily/Monthly Data	Miss. Val. in %
6974010	Vilnya	Santakaj			164	1 .1978	12.1986	D	0
6974010	Vilnya	Santakaj			164	1.1978	12.1986	M	0
6974020	Vejvirzhas	Mikuzhyaj			258	1 .1978	12.1986	D	0
6974020	Vejvirzhas	Mikuzhyaj			258	1.1978	12.1986	M	0
6974100	Minia	Kartiana	55.96 N	21.36 E	1230	1 .1978	12.1986	D	0
6974100	Minia	Kartiana	55.96 N	21.36 E	1230	1.1978	12.1986	M	0
6974150	Neman	Smalininkai	55.02 N	22.52 E	81200	1.1812	12.1993	M	1
6974200	Shyashupe	Kalvariya	54.33 N	23.16 E	444	1 .1978	12.1986	D	0
6974200	Shyashupe	Kalvariya	54.33 N	23.16 E	444	1.1978	12.1986	M	0
6974550	Molchad	Molchad	53.63 N	25.71 E	211	1 .1978	12.1987	D	0
6974550	Molchad	Molchad	53.63 N	25.71 E	211	1.1978	12.1987	M	0
6974600	Neman	Stolbtsy	53.46 N	26.80 E	3070	1 .1978	12.1980	D	0
6974600	Neman	Stolbtsy	53.46 N	26.80 E	3070	1.1978	12.1980	M	0

Appendix 9

BALTEX: Working Group on Numerical Experimentation

Minutes of the 3rd meeting in Helsinki
9 - 10 June 1997

Agenda

1. Introduction
2. Status of hydrological modeling
3. Status of ocean modeling
4. Data availability
5. Review of coupled ocean-atmosphere projects
6. Ocean data assimilation
7. Status of BALTEX modeling projects
8. Other matters
9. Closure

1. Introduction

The 3rd meeting of the BALTEX Working Group on Numerical Experimentation (WGNE) took place from Monday, June 9 to Tuesday, June 10, 1997. J. Willebrand, the chairman of the Working Group, welcomed the participants of the meeting. A list of the participants is given in Appendix A.

J. Willebrand gave an overview of the previous activities of the group, and reviewed the purpose of the WGNE: The group should review, follow and coordinate the development of atmospheric, oceanographic and hydrological models. The group should also initiate and review the development of coupled models as well as data assimilation systems, and identify gaps in observational data necsessary for model validation.

In general, modeling activities appear to be in a good shape and progress, except three-dimensional model simulations of the thermo-haline circulation and long-term variability of the Baltic Sea have not been started yet. However, first results from a 15 year integration with the process model PROBE-Baltic (Omstedt and Nyberg, 1996) has been recently presented. With respect to data assimilation, at the moment there is no ocean general circulation model available which assimilates the full range of hydrographic observations. During the 2nd group meeting, September 1995 in Visby, Sweden, ocean data assimilation has been identified as a topic needing specific attention. A proposal to have a workshop on this issue has been forwarded to the EU, but unfortunately was not funded.

There was a general discussion on the future of the working group. Because the BALTEX modeling community is small, it seems that there is less coordination needed compared with other international programms. However, the group confirmed the need for a continuation of the working group.

2. Status of hydrological modeling

S. Bergström reported on the status and progress on hydrological modeling. Until now the following modeling activities have been carried out within the BALTEX programme by SMHI (Swedish Meteorological and Hydrological Institute) and MPI (Max-Planck Institute for Meteorology, Hamburg). Hydrological modeling is also being carried out by GKSS in Geesthacht:

a) Full hydrological model for the Baltic drainage basin

Within the NEWBALTIC project links between hydrological models and climate models are established on the macro-scale. The conceptual HBV-96 hydrological model is applied to the entire Baltic basin and its subbasins as a first step in this process. This application is rather straightforward. Only the scale is different and the database is much more complicated than in traditional applications. Thanks to the Swedish research programme "Large-scale Environmental Effects and Ecological Processes in the Baltic Sea", both meteorological and hydrological data are available for model calibration. The meteorological database originates from the network of synoptic stations covering the area, which was interpolated into grid-squares of 1 by 1 degree. The hydrological database consists of monthly flow from all major rivers in the area and interpolated data in the 15% of land area not covered by measurements (Bergström and Carlsson, 1994).

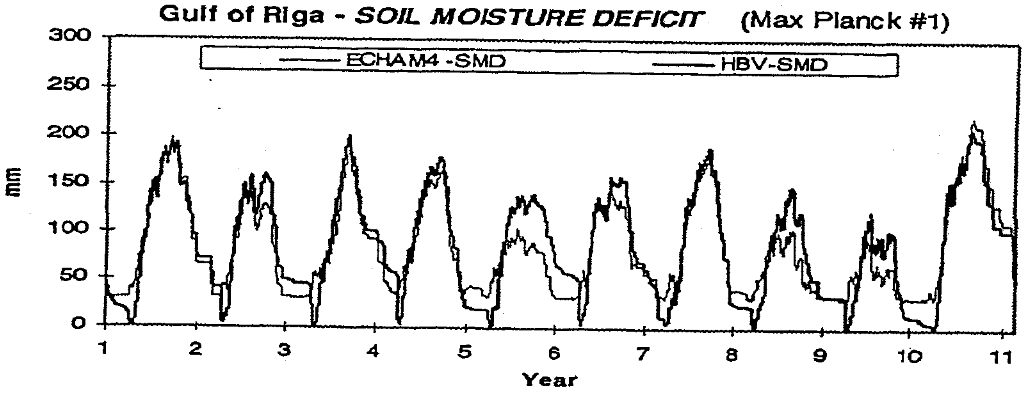


Figure 1: *Simulated daily river flow and observed monthly data for the drainage basin of the Gulf of Riga (from Bergström et al., 1997).*

The macro scale model consists of 25 subbasins and includes a hypsometric distribution, classification into forests and open land, and explicitly accounts for the effects of larger lakes on river runoff by a routing procedure. Fig. 1 shows the simulation for the Gulf of Riga catchment with this model.

The model application has revealed problems, which mainly seem to be related to the homogeneity of the databases used. Most significant are long term homogeneity problems, showing up as increasing bias between model output and observations in some catchments. It is quite obvious that long term homogeneity has to be addressed in future BALTEX work. The routines for data collection and correction have to be considered as well as possible human impact on runoff records.

b) Intercomparison of atmospheric models and hydrological models

One objective of the development of a macro-scale hydrological model for the Baltic basin is intercomparisons between process descriptions in hydrological models and climate models and validation of the latter against runoff. So far preliminary intercomparisons have been made between the ECHAM-4 model and HBV-96 in some of the basins. Fig. 2 shows a comparison between the soil moisture accounting routines of the two models as driven by precipitation and temperature data for 11 fictitious years from ECHAM-4 for the Gulf of Riga drainage basin. This means that the precipitation and air temperatures used as input are identical.

The results show similarities as concerns modeled soil moisture dynamics, but there seems to be a difference during wet years. Comparisons between the modeled snow conditions and runoff simulations of the models reveal deviations which are still subject to analysis.

Figure 2: *Comparison between the dynamics of the soil moisture accounting of the ECHAM-4 model and HBV-96 for the Gulf of Riga catchment. The HBV model is driven by precipitation and air temperature data from ECHAM-4 in this case (from Bergström et al., 1997).*

c) Future model intercomparisons according to the BRIDGE plan

Due to different requirements of different models the intercomparison within the BALTEX Main Experiment (BRIDGE) will be split into two phases:

- Intercomparison and validation of hydrological models
- Intercomparison and validation of the representation of individual processes of the surface energy and water balance and soil water dynamics of atmospheric and hydrological models.

The intercomparison of hydrological models (Phase 1) will cover, at least, ten years of daily data and will be carried out in the special test basins identified. The intercomparison and validation of SVAT models and hydrological models will start at the beginning of the main experiment and will focus both on large scale data and data that are available from the field experiments (NOPEX and Lindenberg).

The discussion of the working group confirmed the need for a hydrological model intercomparison. It was recommended that hydrologists and meteorologists who work in hydrology should start an initiative for model and process intercomparison. Within NEWBALTIC which is preceeding the Main Baltic Sea Experiment, a group consisting of N. Gustafsson, W. Wergen and S. Bergström was asked to evaluate the possibility for developing a standard hydrological model for use in atmopsheric models.

3. Status of ocean modeling

W. Fennel reported on the status and progress in ocean modeling of the Baltic Sea. The ocean modeling in the oceanographic community of the Baltic Sea is mainly based on the GFDL-type ocean model (Geophysical Fluid Dynamics Laboratory; Cox-Bryan) with free surface (Killworth) and the modular descendants MOM 1 & 2 (Modular Ocean Model). Models are run in Kiel, Warnemünde and Tallinn. There are several versions which extend over the whole Baltic including parts of the North Sea, as well as some regional models. The horizontal resolution typically varies from 1 to 3 nm. The Hamburg Shelf Model developed by Backhaus is also applied to the Baltic Sea. A modified version was developed further at the BSH (Bundesamt für Seeschiffahrt und Hydrographie) and is run in an operational mode by the BSH and the SMHI. The DHI (Danish Hydraulic Institute) has developed a family of models which are used in several projects for which no further information is availble. In the DMI a Baltic Sea model based on the POM (Princeton Ocean Model) has been implemented. A joint Finnish-Estonian model (FINEST) mainly focussed on the area of the Gulf of Finland was recently developed. In Norway a Baltic Sea model based on MICOM (Miami Isopycnic Coordinate Ocean Model) was set up which, however, seems to be used only as a test case with no further development.

Ocean modeling of the Baltic Sea appears to be somewhat uncoordinated. The models differ in various technical aspects, such as grid-types (e.g. B- and C-grid), the vertical discretization (z-coordinates, sigma-coordinates and isopycnal layers), and the horizontal coordinates, e.g. UTM (Universal Transversal Mercator Projection) and spherical coordinates. Comparision of the different models could be helpful to explore the specific potential of the different versions. This would require a test-bed which could be used by the different groups. Moreover, the initial fields and the meteorological forcing must be provided in order to avoid a mixture of effects due to different atmospheric forcing and of the ocean model properties. The framework of BALTEX could be helpful to provide coherent forcing data of high quality.

After a longer discussion, as a first step towards a model intercomparison it was proposed to encourage the BALTEX modeling community to simulate a three months episode (August-October 1995) with their own models. A. Lehmann agreed to send around a proposal with a call for contributions at the BALTEX conference in 1998. The outcome of this exercise could then serve as a basis for further steps towards an organized ocean model comparison.

The first announcement of this modeling exercise which was made public short after the meeting is given in Appendix B.

4. Data availability

W. Wergen reported on data management for BALTEX, as far as relevant for modeling projects. For the management of the meteorological, hydrological, and oceanographic data, three data centers have been established:

- Meteorological data center at DWD, Offenbach, Germany
- Hydrological data center at SMHI, Norrköping, Sweden
- Oceanographic data center at FIMR, Helsinki, Finland

In order to obtain access to the data stored at these centers, a scientist first needs to be identified as 'BALTEX Data User' by a member of the 'Science Steering Group (SSG)'. Applications should be submitted on a special form available from the BALTEX secretariat or under URL http://w3.gkss.de/baltex/usform.html.
Once a user is registered, he can request data from the relevant data center. After having signed a 'Data License Agreement', confirming the rules and conditions for data use, the data will be provided on suitable media or by direct line. Only the nominal costs for the media and postage will be charged.

BALTEX Meteorological Data Center (BMDC):

The BMDC is collecting data for the following periods:

- Dec. 1986 - Feb. 1987
- Dec. 1992 - Feb. 1993
- May 1993 - June 1993

- Aug. 1995 - Nov. 1995
- July 1996 - Dec. 2002

The archives contain the synoptic, real-time observations as distributed on the GTS as well as delayed mode, (climtological) data, stored as time series. The latter have undergone extra quality control at the BMDC. Observations will be provided as ASCII data. The BMDC will also store and make available gridpoint data as generated by participating NWP-centers. These fields will be provided in GRIB-form. In addition to the real archive, a virtual archive will be maintained with pointers to additional meteorological data being stored at other institutions.

An up-to-date status report of the BMDC can be found in the world wide web under: http://w3.gkss.de/baltex/statdwd.html

BALTEX Hydrological Data Center (BHDC):

The BHDC is formally installed at SMHI. The data base consists of:

- Monthly runoff from gauge stations, m^3/s
- Calculated monthly runoff for coast-segments, m^3/s

The number of segments around the Baltic Sea is 122, and the time period extends from 1950 to 1993 (-1995 for Sweden, Finland and Lithuania).

The working group acknowledged the work of the BMDC and BHDC. The BODC appears to be in a less satisfactory state. The need for an oceanographic meta data center and a center for sea level data was stressed by the working group. The group strongly recommended that steps have to be taken to improve the situation at the BODC.

5. Review of coupled ocean-atmosphere projects

N. Gustafsson reported on coupled atmosphere-ocean modeling at the SMHI. A high resolution weather forcasting model has been coupled to an advanced 2.5-dimensional ice-ocean model. The ice-ocean model includes two-dimensional, horizontally resolved, ice and storm surge models and a one-dimensional, vertically resolved, ocean model applied to 31 Baltic Sea regions. The coupled model system is applied operationally at the SMHI. No data assimilation is applied in the operational ocean component; manual modifications to the sea state variables are introduced a few times every winter season.

From case studies it could be demonstrated that improvements of short range weather forecasting in the area of the Baltic Sea require an accurate description of the lower boundary condition over sea. Sea state variables used in the model influence 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 during winters with cold air mass outbreaks over the open water surfaces of the Baltic Sea are extreme examples of the influence of sea state variables on a regional scale.

Furthermore, sea state conditions may change considerably within forecasting periods up to 48 hours which implies the the necessary application of ocean models, two-way coupled to the weather forecasting model.

The application of the operational coupled model system to the mesoscale re-analysis for BALTEX shows that it is necessary to apply data assimilation for the sea state variables in order to avoid drift of the coupled model system towards less realistic model states. With a simple assimilation of sea surface temperature observations (nudging) the drift away from realistic sea state conditions could be avoided.

The coupled atmosphere-ocean model system is only a first step in the development of a future coupled model. Further development steps will include:

- Improved coupling between the atmospheric and ocean model components by introduction of consistent flux calculations to be applied in both model components and calculation of albedo and roughness length from available information on sea ice structure.
- Improvement of the spatial resolution of the ocean model PROBE by refinement of the thermodynamic regions.
- Input of sea surface temperature observations, and possibly also sea ice concentration observations, derived from satellite image data by an image processing system.

The present coupled model system certainly is associated with specific as well as general limitations. The horizontal resolution is limited by the thermodynamic regions of the PROBE model. A refinement of these regions is one possibility but the long term objective should be to introduce a 3-dimensional, horizontally resolved, ocean model to be coupled to the mesoscale atmospheric model.

A. Lehmann reported on the state of coupled ocean-atmosphere modeling at IfM-Kiel and MPI Hamburg. In a joint effort, the Kiel Baltic Sea model will be coupled to the REMO of the MPI Hamburg. This work is done by R. Hagedorn (IfM-Kiel), D. Jacob (MPI Hamburg) and A. Lehmann (IfM-Kiel).

The 3-dimensional atmospheric model REMO is based on the operational forecast model of the German Weather Service (DWD). It is used in the so-called climate mode with the physical parameterizations which are implemented in the Europa-Model (Jacob et al., 1997). The horizontal resolution is 1/6° on the rotated longitude/latitude grid. This is equivalent to approximately 18×18 km^2. The Kiel Baltic Sea Model is a 3-dimensional eddy-resolving baroclinic model with a horizontal resolution of approximately 5×5 km^2 (Lehmann, 1995). Until now, these two models have been run seperately and both were forced with DWD analyses or forecasts, respectively.

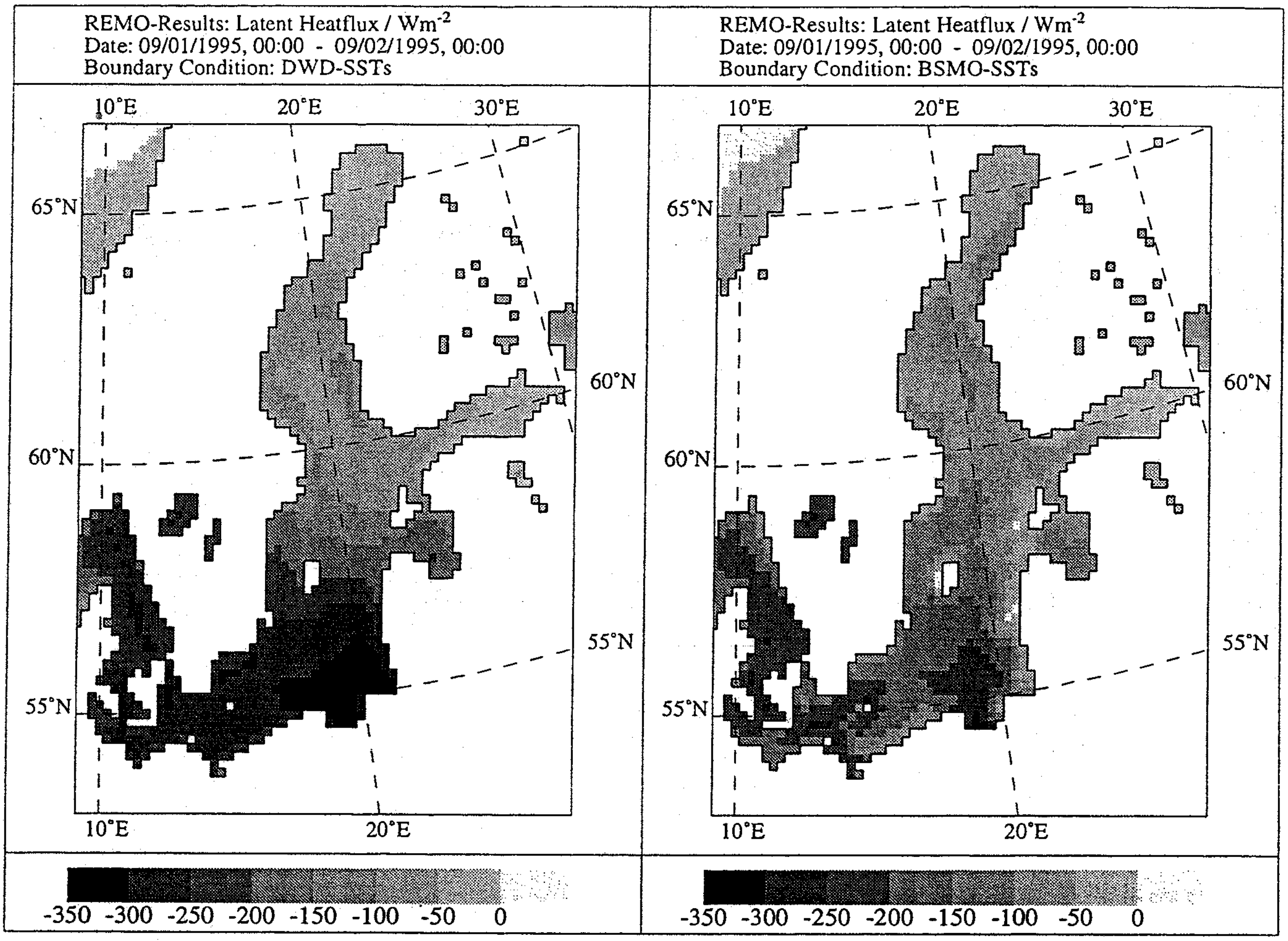


Figure 3: *Mean latent heatflux, 09/01/1995, 00:00 - 09/02/1995, 00:00; left: SSTs from DWD analyses as boundary condition, right: SSTs from BSMO as boundary condition.*

The first steps towards the coupling were sensitivity studies with different forcings for both models. Firstly, a run of REMO with DWD analyses as boundary conditions was performed. The results of this run were used as forcing for the Kiel Baltic Sea Model. SSTs, as a result of this run, were used as surface boundary condition for a new run of REMO.

The simulations were performed for the PIDCAP-Period (Pilot Study for Intensive Data Collection and Analysis of Precipitation) from August to October 1995. Differences up to 6° Celsius in single grid boxes appeared while comparing satellite observed SSTs with DWD-SSTs used in REMO so far.

The different SST's used as surface boundary condition for the atmospheric model induced different 2 m air-temperatures, thus sensibel and latent heat fluxes between ocean and atmosphere were also effected. Values of latent heat flux differed up to 200, Wm^{-2} and even changed their sign as a result of cold SST's in the Baltic Sea Model (Fig. ??)

The mean value of August, averaged over the whole Baltic Sea, differed by nearly 30 Wm^{-2}. This in turn reduced the mean evaporation of August by approximately 20 mm

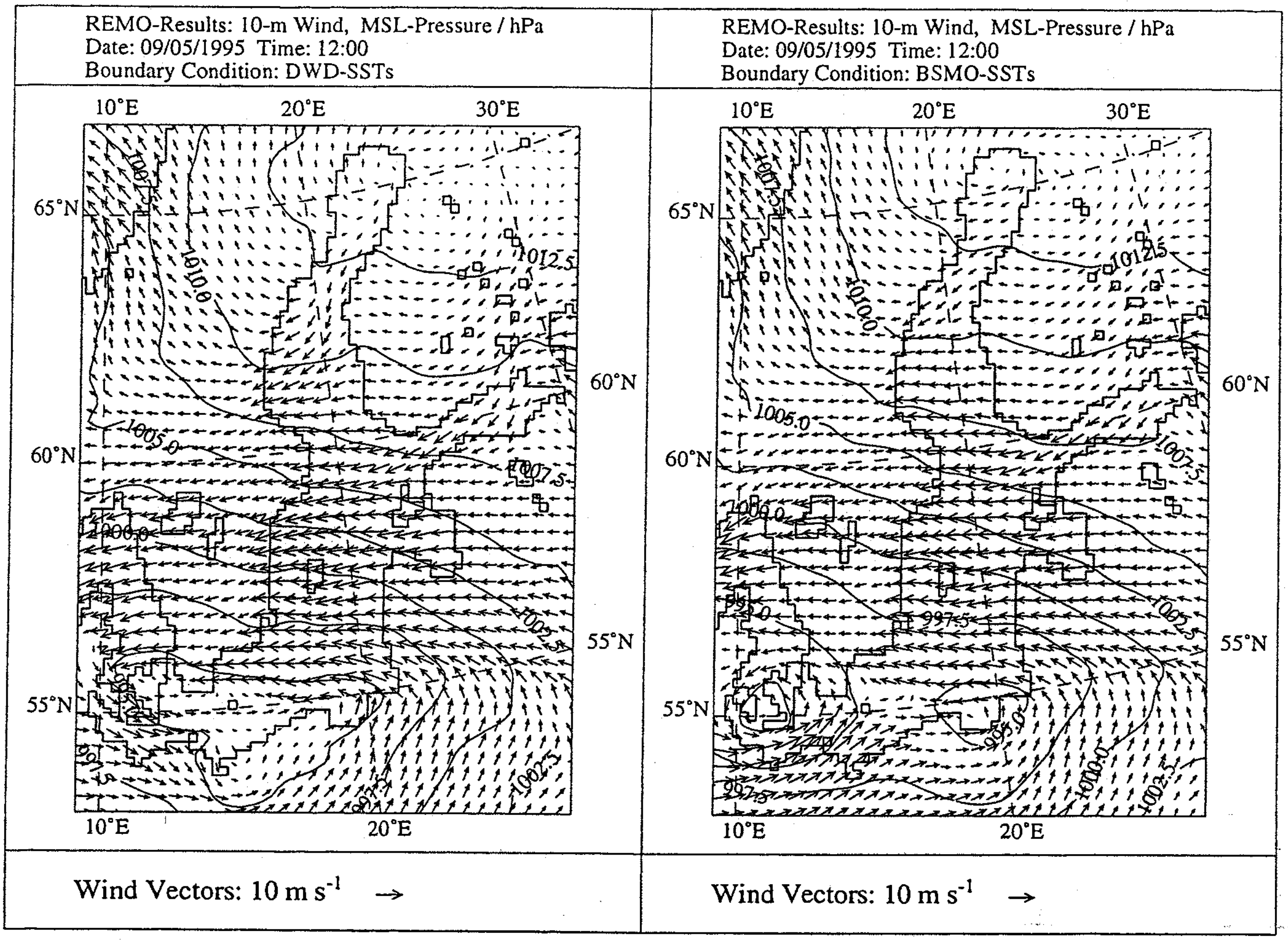


Figure 4: *Mean sea level pressure field and 10-m wind field for 09/05/1995, 12:00; left: SSTs from DWD analyses as boundary condition, right: SSTs from BSMO as boundary condition.*

which had a further effect of a reduced precipitation, especially over this regions.

An example for the impact of the different SSTs on the dynamic of the atmospheric model is given in Fig. 4, which shows the mean sea level pressure and wind fields on September 5th, 1995.

As expected, the basic structure of the pressure field is hardly effected by different SSTs used as surface boundary condition. However, small differences in the surface pressure field induce remarkable deviations in the 10 m wind, even in areas where SST differences are small. The sensitivity studies show that the atmospheric response to the different surface boundary conditions are not negligible. The changes in heat fluxes are very high, whereas the pressure field is less influenced by different SSTs.

Since the last group meeting there has been much progress in developing coupled atmosphere-ocean models. From the first model studies it appears that there is a non negligible interaction between atmosphere and the Baltic Sea. With the application of coupled atmosphere-ocean systems, the quality of re-analysis could be improved. The group concluded that the coupled atmopshere-ocean modeling seems to be well on the way, so that at the moment no further initiatives of the WGNE are necessary.

6. Ocean data assimilation

A. Lehmann reported on oceanographic data assimilation at IfM-Kiel. To improve the results of a regional model of the Baltic Sea (Meier, 1996), surface elevations from a coarse grid barotropic model of the Baltic Sea were prescribed at open boundaries and optimized wind forcing was used. The results of the barotropic model, including river runoff, were improved by using the adjoint method to assimilate sea level and wind data into the model. Tide gauges located around the Baltic Sea provided hourly surface elevations for the years 1992/93. As most of the sea level differences between model results and observations were due to errors in the surface wind fields of the atmospheric model, the assimilation procedure was used to optimize space dependent model wind fields on time scales from one day up to 15 months. Synoptic wind observations from merchant ships were included into the calculation of the cost function because assimilation of sea level data alone does not uniquely determine the wind fields. Indeed, an improvement of optimized wind fields could be shown by comparing them with independent wind observations.

In order to optimize surface heat fluxes between atmosphere and ocean, the assimilation of temperature data requires an adequate parameterization of the mixed layer processes. For the assimilation of temperature data the regional model (horizontal resolution ~ 2 nm) with the corresponding adjoint model which was setup corresponding to the method described in Schiller and Willebrand (1995) has been tested in twin-experiments.

After some discussion the group concluded that for the atmospheric part, data assimilation is well on the way, but for the development of oceanographic data assimilation methods ~~and the assimilation of historical data to estimate transports~~ through the Danish Straits new initatives would be needed. This is also true for the hydrological data assimilation.

7. Status of BALTEX modeling projects

a)Mesoscale re-analysis

D. Jacob gave some informations on REMO modeling activities. REMO runs for the years 1992-1993 with $1/2^0$ and $1/6^0$ resolution will be available to the end of September, 1997. D. Jacob stated that DMI (Danish Meteorological Institute) has already done a re-analysis of the PIDCAP period which may be useful driving ocean models.

W. Wergen will check if the DWD will perform a re-analysis of the PIDCAP period.

b) Development of a sea ice model for the Baltic Sea

The EU-MAST III project BASYS (Baltic Sea System Study) has started in August, 1996. The overall objectives of BASYS are:

- To further the understanding of the susceptibility of the Baltic Sea to external forcing

- To improve the qunatification of past and present fluxes

Besides the determination of the physical fluxes through the Baltic Sea, the position of matter in the sediments and the biogeochemical cycle are of scientific interest. The BASYS Subproject 6 "Baltic Sea Ice" is connected to BALTEX. The strategy of BASYS/SP6 is to coupled and systematically improve an eddy resolving general circulation model of the Baltic with an ice model and compare its results with observations from field cruises and satellite data. It involved the following objectives:

- The implementation of an ice model in the free surface GFDL general circulation model
- Preocess studies, both by field experiments and process orientated models, and comparison with the coupled model in order to improve its parameterization
- Determination of the sensitivity of the ice distribution on model parameters, especially on the thickness redistribution and the constitutive law of ice
- A systematic assessment of the models ability to reproduce currents and stratification in the basins of the Baltic, ice formation, coverage, drift and melting

With the coupled ice-ocean model the winters 1991/92 and 1992/93 were simulated with the forcing prescribed from the Europa-Model. The ice formation was in reasonable agreement with the ice evolution documentated by ice charts. However, simulated ice thicknesses were too strong and the melting of ice was too weak. Fig. 5 displays SST and ice thickness for 28 January 1995 and 25 May 1995. In January the evolution of the sea surface temperature and the ice thickness is in reasonable agreement with observations, but at the end of May there should be no ice at all. Main reasons for the overestimation of ice thicknesses and underestimation of ice melting rates were due to uncertainties in the atmospheric forcing. The forcing data of the Europa Model were not consistent with the ice evolution during the beginning of the year 1993. Thus, the atmospheric surface parameters were biased to artifical ice conditions at the sea surface. Consequently, by using this forcing to drive the coupled ice-ocean model, the ice evolution could not be correctly simulated.

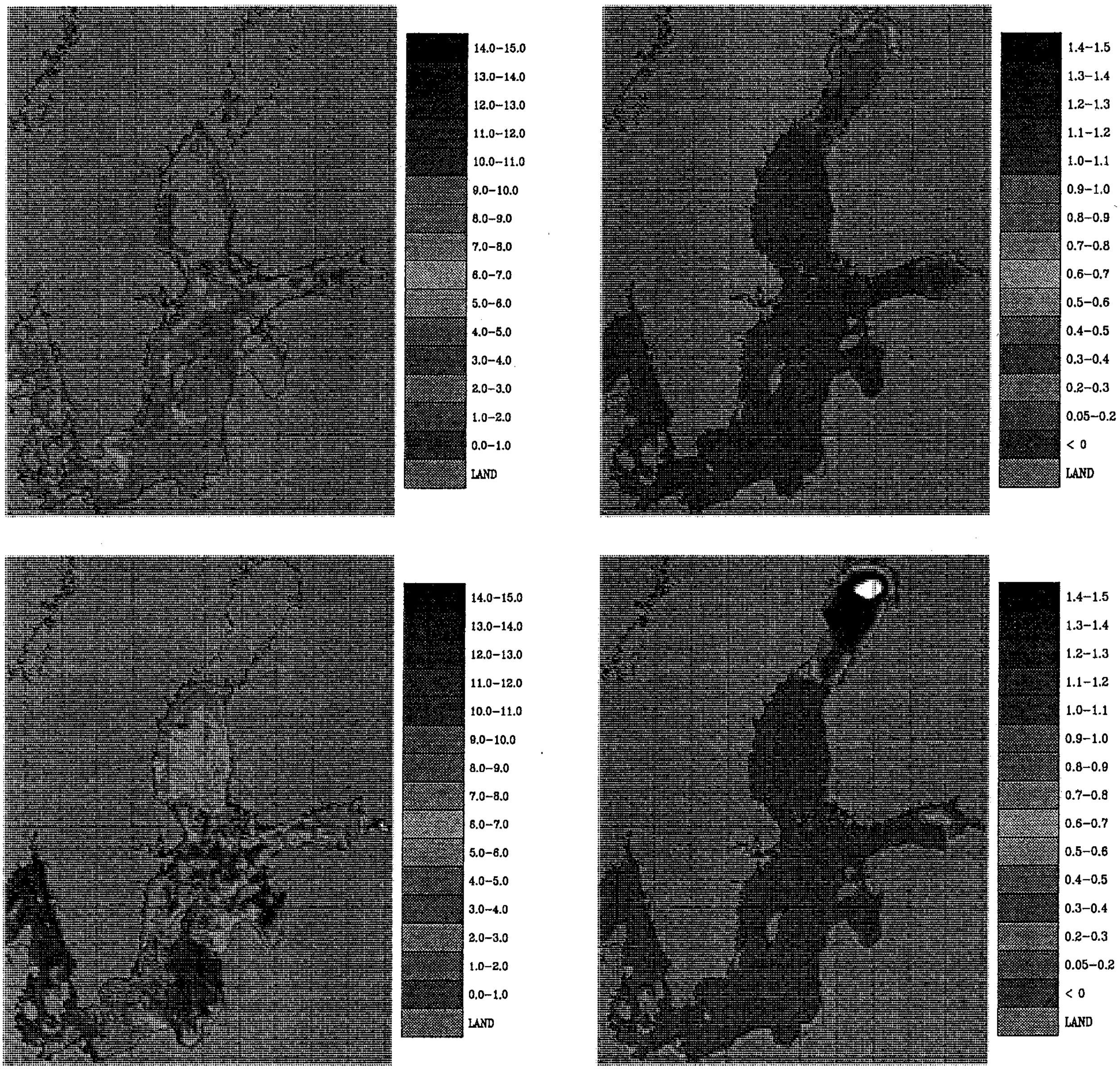


Figure 5: *Coupled ice-ocean simulation of SST (upper left) and ice thickness (upper right) for 28 January 1993; SST (lower left) and ice thickness (lower right) for 25 May 1993.*

8. Other matters

The participants felt that there is only little information on the ocean modeling work the BSH (Bundesamt für Seeschiffahrt und Hydrographie) is doing. W. Fennel was asked to contact the BSH and to inquire informations on its modeling activities.

Probably most of the participants will be at the 2nd Study Conference on BALTEX in May, 1998, next meeting activities will be discussed there.

The group thanked C. Fortelius for hosting the meeting at the Univerity of Helsinki.

9. Closure

The meeting was adjourned at 12:00 h.

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Appendix A

List of participants

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Appendix B

Second Study Conference on BALTEX
Session on Numerical Modelling
Subsession on Oceanographic Modelling of the PIDCAP Period
First Announcement

Dear Colleagues:

The International Second Study Conference on BALTEX will be held at Juliusruh on the Island of Ruegen, Germany 25-29 May 1998. The conference will review research results in meteorology, hydrology and oceanography, as related to water and energy cycles of the entire water catchment region of the Baltic Sea. There will be 6 main sessions on

- data collection and climatological studies
- process studies and field experiments
- remote sensing applications
- numerical modeling
- data assimilation and coupled modeling
- results from other GEWEX Continental Scale Experiments.

Within the session on Numerical Modelling a subsession on Oceanographic Modelling the PIDCAP Period is planned.

In recent years, different oceanographic models of the Baltic Sea and North Sea has been developed at a number of institutions. While objective and numerical realization of the models may be diverse, most models are based on primitive equations, and are able to simulate circulation and stratification in response to atmospheric forcing.

During a recent meeting of the BALTEX Working Group on Numerical Experimentation, the need to obtain an overview on performance and capabilities of existing Baltic Sea Models was stressed. While a systematic model intercomparison is a task requiring substantial time and resources, it was agreed that the simulation of a specific hydrographic situation or period by different oceanographic models would be already rather useful. The PIDCAP period (August-October 1995) was chosen to be of particular interest. During PIDCAP strong changes in the hydrographic parameters of the surface layers of the Bornholm and eastern Gotland Basin occurred in response to the atmospheric forcing. Therefore, these areas are of particular interest for analysis and comparison.

We like to encourage all institutions/individuals working on Baltic Sea modeling to take part in this modeling exercise, and to consider the simulation of the PIDCAP period and the presentation of the results during the conference as an important task to further the scientific discussion on performance and capabilities of todays oceanographic models. Forcing fields as well as initial condition will be supplied on request by the Institut fuer Meereskunde, Kiel.

If you are interested in participating in this modeling exercise and for further informations, please send me a short note via e-mail not later than 30 AUG 1997. Please inform also your colleagues in your institution working on Baltic Sea modeling.

Best regards

Andreas Lehmann (alehmann@ifm.uni-kiel.de)

Time table

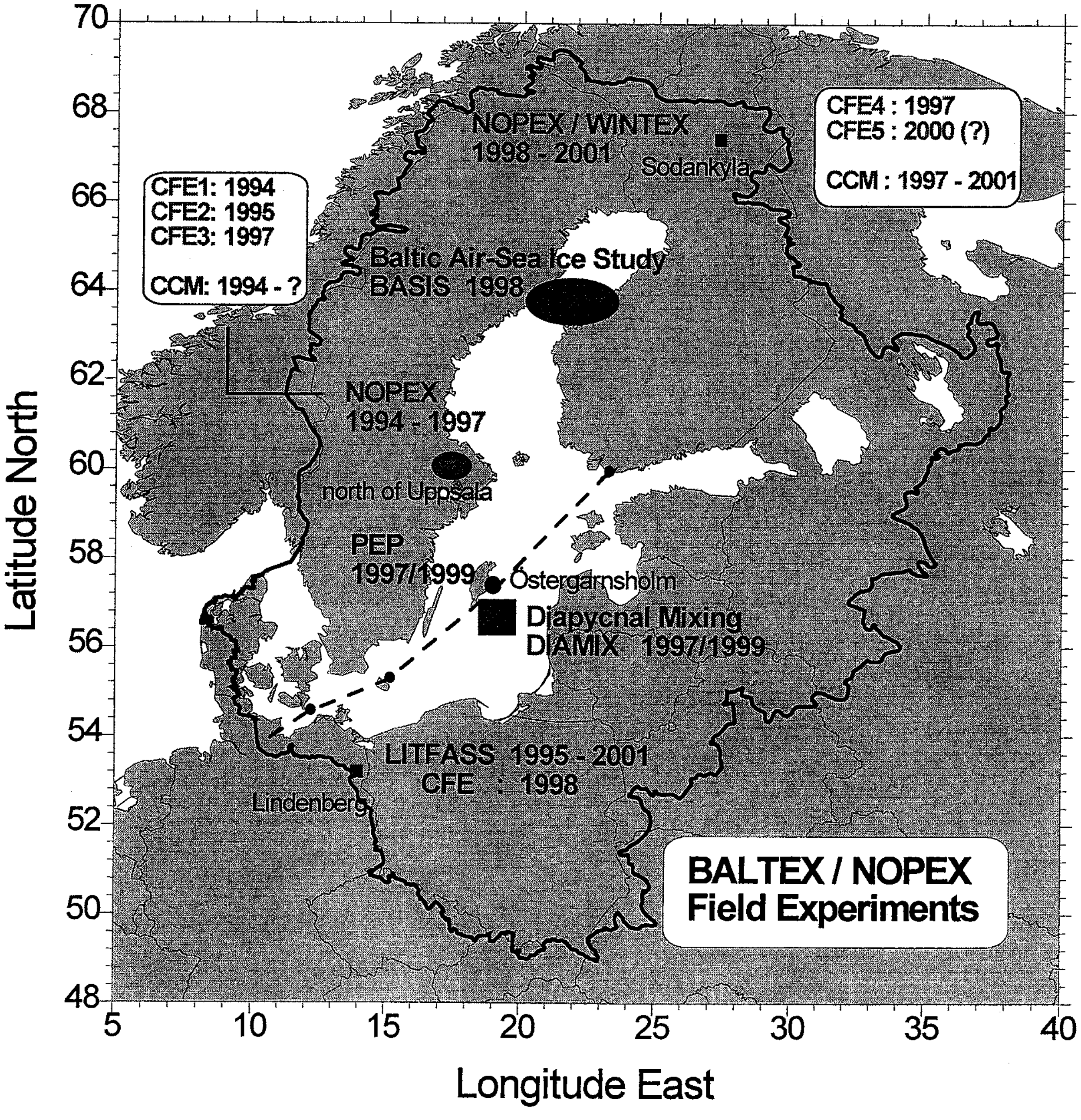
July 1997: First announcement

Late summer 1997: Second announcement and call for papers

December 1997: Deadline for submitting papers

Appendix 10

BALTEX and NOPEX
Field Experiments



FELDEXP4.DOC, 1 November 1998, Hans-Jörg Isemer, International BALTEX Secretariat

Appendix 11

Minutes of the 2nd meeting of the BALTEX Working Group on Radar

Danish Meteorological Institute
23-24 February, 1998

The meeting concentrated on aspects relating to the BALTEX Radar Data Centre.

1. **Welcome**: The participants were welcomed by the Chairman, Jarmo Koistinen (FMI). Participating were: the Chairman, Søren Overgaard (DMI), Daniel Michelson (SMHI) and Jan Svensson (SMHI).

2. **Apologies**: Johann Riedl (DWD), Hans-Jörg Isemer (International BALTEX Secretariat), Chris Collier (U. Salford), Zdzislaw Dziewit (Institute of Meteorology and Water Management), and Tage Andersson (SMHI) were unable to attend.

3. The agenda was adopted.

4. **BRDC**: Daniel Michelson presented SMHI's concept for establishing and operating the BRDC. This task has not yet been officially accepted by SMHI; nevertheless, preparations have been made which would make such an undertaking possible. The BRDC would be run as a voluntary research and development activity and not as an official operational service. Details are found in the points below. The WGR anticipates a decision being made, at the forthcoming SSG meeting, on whether SMHI would accept this responsibility.

   The hardware targeted for use by the BRDC has already been purchased.

BRIDGE Radar Data:

BALTRAD products. The following products were agreed upon:

- 500 m Pseudo-CAPPI images, 2×2 km, 15 min, 8-bit resolution, well-defined projection, from each contributing radar, sent to the BRDC from suppliers.
- dBZ composites, 2×2 km, every 15 minutes, 8-bit resolution, well-defined projection, generated at the BRDC from the Pseudo-CAPPIs. Generated at the BRDC.
- 3-hourly accumulated precipitation fields (mm) from 15-minute dBZ composites. The Mesoscale Analysis system (MESAN) presently used at SMHI would be targeted for generating this product. Generated at the BRDC.
- VAD/VVP soundings (height (masl), speed (m/s), direction (degrees), "quality") every 15 minutes, from as many radars as possible. Sent to the BRDC from suppliers. Raw radial wind velocity volumes will not be available at the BRDC.

Programs: The Radar Analysis and Visualization Environment (RAVE), developed at SMHI, would be used at the BRDC. It could also be of potential use by other members of the WGR during the course of BRIDGE.

File format: Daniel will draft a generic BALTRAD file format and forward it to the WGR for review. By "generic" it is implied that such a file format would be self-explaining and consist of an ASCII header followed by data compressed using a freely available compression algorithm. Already available data formats like NORDRAD, BUFR and even simple formats like GIF (with a static header) will also be considered. Each member should arrive at an optimal solution in its transmission/receival with the BRDC.

Data Transmission: A survey was made of the members' communications facilities. Daniel will investigate the option of establishing a file system at the ECMWF and report back to the group. Existing lines will be used as much as possible. Where new facilities are needed, these will be evaluated on an individual basis between SMHI and the other member. Such new facilities should be established free of charge with possible development costs. SMHI will cover its own costs and the other members will cover theirs.

Schedule: Each participating member should establish working communications to/from the BRDC by October 1, 1998. Starting January 1, 1999, the BRDC will start "pre-BRIDGE" operations with the ambition to commence secure operations by April 1, 1999. The BRDC will operate continuously until March 31, 2001.

Availability: Data should be transmitted between the BRDC and the participating members in near-real time (< 24 hours). Data availability will not be guaranteed; yet, the BRDC and each contributing member should implement data flow monitoring procedures which will insure continuous data and product flow. BALTRAD products will be available to BRIDGE users after an agreed-upon delay in order to insure that the commercial value of the products has been eliminated. Details will be worked out during the course of the WGR's continued preparations for BRIDGE.

Archiving and retrieval: The four BALTRAD products listed above will be archived at the BRDC on Digital Linear Tapes (DLT). The latter three products will be available to the BALTEX community. Retrieved products will be available for viewing (with a long delay) at a BRDC website which could be password protected. The product data files themselves could be available on DAT and possibly CD-ROM.

Data costs: BALTRAD products will be available free of charge for the purposes of non-commercial research and development activities according to the BALTEX data exchange policy. Data supplied to the BRDC must be done so free of charge in order for them to be included in the BRDC's activities. The WGR anticipates that the BALTEX Secretariat will establish data exchange agreements with institutes participating in BRIDGE and that such agreements will eliminate the need for the BRDC to have its own licensing agreements with participiting institutes.

6. Optimal Precipitation Products:

Radar Calibration: Significant calibration activities are already taking place within the NORDRAD collaboration, between FMI and SMHI. FMI and DWD have already discussed implementing FMI's calibrating methods on the Rostock radar. DMI is building a 5.5 GHz tracking radiometer for the sun which could be valuable for relative calibration of a network of radars. The radiometer is targeted for installation during the summer of 1998 and could thus be used during BRIDGE. The WGR will pursue the issue of calibration to maximize the homogeneity of the BALTRAD network prior to the start of BRIDGE.

Clutter cancellation: Both SMHI and DMI are presently developing methods for identifying and treating anomalous propagation echoes from both land and sea. FMI's radars have Doppler capability out to full range and are confident with their present treatment of anaprop from land; sea clutter poses an occasional problem. Algorithms could be introduced to the data delivered to the BRDC before and/or during BRIDGE. Software packages for treating anaprop and clutter could be made available to WGR members free of charge as part of the transfer of knowledge and technology in BALTEX. Our ability to deal with anaprop and clutter has improved to the point where we should be able to implement methods confidently.

Vertical reflectivity profile correction: FMI is developing methods which will use a time-integrated vertical reflectivity profile, taken from their IRIS software, which they will use to correct effects like those from the bright band. These activities will be implemented and verified during 1998. SMHI has commenced similar activities, except that they are using radar data together with HIRLAM data to improve the diagnosis of various radar artifacts. These methods show great potential in deriving quantitatively useful radar information at far ranges from radars. We hope to implement some of these algorithms in deriving BALTRAD products. There was also some discussion on the relevance of the attenuation correction used and not used in various radars.

Hydrometeor phase and type analysis: FMI has commenced analysis of 2m height temperature and relative humidity data and a statistical model which gives the probability of hydrometeor phase. SMHI will be integrating a routine, for identifying the hydrometeor phase and type, in their combination of radar with HIRLAM data; there is, however, no firm timetable for these activities. FMI can eventually provide a table containing hydrometeor water content as a function of temperature and relative humidity at the height of 2 m. Based on this table the BRDC will use agreed-upon Z-R coefficients *A* and *b* for different hydrometeor water contents when reflectivities are transformed into accumulated precipitation amounts. We hope to implement such algorithms in generating BALTRAD products, yet there are currently numerous uncertainties which must be dealt with before this can be done confidently.

Integration of radar and gauge data: The WGR has no plans on developing or implementing methods which adjust radar data to rain gauges; the gauges simply cannot be regarded as the "truth". The MESAN approach, where different observation systems are integrated into "best-estimate" products, taking into acount each system's characteristics and errors, is preferred and is targeted for use in generating a BALTRAD product (see above). It is unknown whether anyone will be conducting flow distortion error corrections to gauge observations; this would be especially valuable for snow measurements.

Other independent data and corrections: Chris Collier may be receiving a new PhD student who would work with analysis of satellite and radar data within the framework of the WGR. Apart from these activities, the members of the WGR do not plan on conducting reseach in this area.

7. **Developments in the radar network**: DMI is planning on installing a new Doppler radar at Holbæk, Sealand. The Kastrup radar would then be moved to central Bornholm and possibly become Dopplerized. This would be done by the year 2000. DNMI is planning on installing a new Doppler radar at Mandal by the summer of 1999. They have plans on purchasing additional radars but these may not be realised during the BRIDGE time span. The Estonian Meteorological and Hydrological Institute (EMHI) has budgeted two new radars; activities are being carried out in close cooperation with FMI. The siting of these two radars are tentatively SW and SE Estonia, which would be optimal in terms of the relation to the present NORDRAD network.

8. **WGR membership**: Søren Overgaards WGR membership is currently being considered internally at DMI. A member from Norway would also be a welcome addition. Jarmo will approach DNMI. Dr. Vladimir Zhukov, from the Research Centre for Remote Sensing of the Russian Federal Service for Hydrometeorology and Environmental Monitoring, has been nominated as a Russian member of the WGR. FMI will approach the EMHI with regard to WGR membership.

9. **Forthcoming relevant meetings and timescales**: Most of the WGR will be present and taking part in the COST-75 Final Seminar at Locarno, Switzerland, 23-27 March, 1998. The WGR Chairman will try to arrange a time and a place for a short WGR meeting at this event. Jarmo will be travelling to Poland (IMWM) in March and can discuss WGR matters then.

This document will be presented at the forthcoming meeting of the BALTEX SSG, 3-4 February, 1998 at DMI, by Mikko Alestalo (FMI).

Jarmo will be presenting the state of the art of weather radar, with regard to its use in BALTEX, at the forthcoming conference at Rügen. The WGR should try to hold a short meeting at this event as well.

The WGR should definitely hold a longer meeting sometime during the autmn of 1998, tentatively during November and hosted by SMHI.

10. **Any other business**:
Hans-Jörg Isemer at the International BALTEX Secretariat requested that we try to put our activities in relation to those stated in the Initial Implementation Plan:

One of the prime scientific objectives of BALTEX is to gain a better understanding of precipitation in the BALTEX region, to model and verify precipitation, and to conduct budget studies. The Baltic Sea is especially emphasized in this respect. The activities of the WGR and those conducted at the BRDC aim at making significant contributions in this area. Some of the activities are covered within the project "PEP in BALTEX". Others are being pursued through internal activities at WGR-member institutes.

REPORT

Appendix 12

1.2 Oceanographic Data Assimilation

a) Restart including observed data, only occasionally available
b) Nudging to SST (weekly maps or climatology)
c) Adjoint method

1.4 Transport through the Danish Straits

a) Kiel Model: transports much improved by the adjoint method due to a better wind field and better sea levels
b) Other (simplified) models exist without assimilation (Gustafsson, Mattson, Schrum etc.)

2.2 Baltic Sea Response to Atmospheric and Hydrological Forcing
and
2.4 Thermohaline Circulation and Long-term Variability of the Baltic Sea

a) Kiel Model:
---- Inflow well reproduced
---- Main problems: mixed layer depth
thickness of thermocline
mixing in the interior beneath the thermocline
---- Long-term runs (10 - 20 years) are planned, model behaviour unknown
b) Other (box-like) models exist (Omsted and Nyberg, Gustafsson etc.)
c) 3D material coordinate model at SMHI under development (Funkquist)

2.3 Development of a Sea Ice Model for the Baltic Sea Model

a) Kiel model is coupled with a Hibler-type ice model (Hamburg Sea Ice Model)
Run for (mild) winter 1992/3 is completed, run for severe ice winter 1986/87 has been started

Improvements expected from:
b) SMHI : Parameterization of turbulent processes in open water and under ice
Heat flux package
c) University Helsinki: Ice dynamics, rheology, thermodynamics

2.9 Coupled Atmosphere/Ocean/Land Surface Model

a) Kiel Model coupled with REMO, PIDCAP-period modeled
b) Other approaches: HIRLAM coupled with 2.5D ice-ocean model (sea ice model with barotropic advection plus 1D vertical model for 31 Baltic subregions; Gustafsson et al.)

Summery

a) All projects well on schedule; good progress

b) Future financial support open, without support end of most projects in Kiel

Appendix 13

LITFASS-Experiment 1998

Scientific Goals

(a) Collection of a **complex** meteorological / hydrological **dataset for initialization, forcing and validation of** high-resolution, non-hydrostatic **meso-γ scale** meteorological **models**

(b) Measurement of **soil parameters, radiation** components and **turbulent fluxes** over **different types of land surface** (meadow, agricultural fields, forest, lake) and collection of data for the validation of SVAT models

(c) Measurements of **turbulent fluxes** which are **representative for different horizontal scales** using point mea-suring devices and spatially integrating measurement systems

(d) Identification and assessment of processes and small-scale surface structures determining the energy and water cycles and the **formation of clouds and precipitation over non-homogeneous terrain**

(e) Development and testing of **data assimilation** methods for **remote sensing** data and hydrological parameters (sensor synergy study)

LITFASS-Experiment 1998

MOL Operational Monitoring Program

Basic Measurements

- synoptic weather station
- BSRN station (radiation measurements)
- aerological station (four full radiosoundings per day)

Remote Sensing

- Tropospheric wind profiler (482 MHz) with RASS
- Boundary layer wind profiler (1290 MHz) with RASS
- Ceilometer

Boundary Layer Research Field Site

- Radiation budget
- Soil temperature, soil moisture, soil heat flux
- Profile Mast (12 m) for wind, temperature, humidity
- Meteorological Tower (99 m) with wind, temperature, humidity measurements at 8 levels
- Sodar-RASS system

LITFASS-Experiment 1998

Special LITFASS Measurement Program

- will be tested during the experiment and
- will be operational in 1999/2000,
  i.e. over the BALTEX-BRIDGE period

- five micrometeorological logger stations (basic meteorological, radiation and soil measurements) over different types of land use
- 15 registrating rain gauges
- 10 water gauges above ground
- special monitoring program of soil and plant parameters for a number of test fields

LITFASS-Experiment 1998

Additional Measurements during the Experiment

Vertical Soundings

- Tethersonde system (6 sondes up to 1000 m)
- water vapour DIAL
- Raman lidar for temperature / moisture profiling
- Microwave-Radiometry
- Sun-/Star-Photometry
- 95-GHz Cloud Radar
- Cloud-Video

Flux Measurements

- Eddy-Correlation measurements at the 5 micrometeorological field sites
- Scintillometer measurements over different path lengths (200 m .. 5 km)
- HELIPOD sonde
- Research aircraft

LITFASS-Experiment 1998

Participants

- German Weather Service (DWD)
- GKSS Geesthacht
- KNMI De Bilt (The Netherlands)
- Wageningen Agricultural University (The Netherlands)
- MPI for Meteorology Hamburg
- University of Hannover
- University of Kiel
- University of Bayreuth
- University of Dresden
- DLR Oberpfaffenhofen
- Central Aerological Observatory (Russia)

1998-02-23

Appendix 14

Swedish national report on contributions to BALTEX and *BRIDGE*: Report from 1997 activities.

By Anders Omstedt(Chairman of the Swedish working group on BALTEX)

During the last year the main Swedish activities within BALTEX have been related to several EU-funded projects as NEW Baltic 1 (Sten Bergström), BASYS-SP6 (Anders Omstedt), PeP in BALTEX (Ann-Sofie Smedman), BALTEX-BASIS (Bertil Håkansson) and also DIAMIX (Anders Stigebrandt) which has been funded through national money.

The main working places for BALTEX related work in Sweden are: SMHI in Norrköping, Meteorological Institute at Uppsala University and Oceanographic department at Gothenburg University. But also work on humidity measurements using GPS data are developed through work at Chalmers in Gothenburg.

During November 13, 1997 a seminar on Swedish BALTEX activities was held at the Royal Swedish Academy of Sciences. At the seminar several presentation were given and the chairman of BALTEX, Lennart Bengtsson, informed about *BRIDGE.*

The Swedish Regional Climate Modelling Program (SWECLIM) has started with new staff involved both as Ph.D students at different university departments and as researchers at the Rossby Centre in Norrköping.

The measuring site at Östergarnsholm (Ann-Sofie Smedman) has continued and DIAMIX (Anders Stigebrant) have performed a first pilot experiment east of Gotland.

The discussion about *BRIDGE* has continued and SMHI is positive to the experiment but has not yet made any commitments. Four Ph D. students have actively been involved in BALTEX research at SMHI, two of these are now working as researchers at the Rossby Centre.

The activity within the BALTEX Hydrology Data Centre at SMHI is presented in a separate report.

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Appendix 15

REPORT
Activity of the BALTEX Polish Task Group Oceanological Section in 1997

Polish researches which were a part of the BALTEX Programme were carried out in six themes.

1. A complex spectral model (developed before) of solar radiation influx and its utilization for various processes in the Baltic was applied to characterize seasonal and spatial variabilites in the main elements of the solar radiation balance for the southern Baltic.
   Meteorological observations made onboard of Voluntary Observing Ships for the period of 1980 to 1992 and a semi-empirical parametrisation of the solar radiation influx to the Baltic were used to estimate monthly and annual mean irradiance at the Baltic Proper surface and their seasonal and interannual variability.
   A theoretical model (developed before) of the downward irradiance reflection by transmission through the wind-ruffled sea surface was extended by adding reflection and transmission of the upward irradiance. Basic dependences between the properties of the sea surface and the hydrological and meteorological factors were analysed.
   The variabilities of the aerosol optical thickness spectral of the Baltic atmosphere and aerosol size spectral distributions over the Baltic was analysed by means of the Empirical Orthogonal Functions method.
2. Researches of the mass fluxes parametrization (including water mass) from the sea to the atmosphere have been continued. A field experiment TABEX-97 of measuring dropplet emission from the sea was carried out on the Lithuania shore.
3. Diagnostic modelling of seasonal current variability in the Baltic was completed for steady flows in the period April - November.
   Further researches have been continued for adaptation Princeton Ocean Model for analysis and diagnosis of the Baltic environment state and adjacent sea regions.
4. Seasonal influence of the mean level of the North Sea basin on water volume changes in the Baltic was analysed stochastically with weighting of correlated atmospheric forcing.
   A study of a long term variablity of mean annual water volumes of the Baltic was completed. Description of basic statistical characteristics, periodic structure, connection with North Sea levels and application of parametric stochastic processes were included.
5. Wave measurements and verification of the wave forecast model WAM together with studies of directionality of non-standard wave spectra were carried out as part of studies to improve methodology of forecasting wave fields.
6. Interaction of Baltic environment and the Vistula River have been studied continously. Description of hydrodynamic condition in the Gulf of Gdańsk and numerical 3D modelling of this region during experiment POLRODEX'96 were carried out together with analysis of application of the HIROMB model forecast.

The presented themes were worked out in the Institute of Oceanology, Polish Academy of Sciences and in the Institute of Hydroengineering, Polish Academy of Sciences. Results of the researches were printed in 19 publications and presented at 9 conferences. Next 6 papers are in print and 6 papers are submitted as Institute Reports. Twelve lectures partly elaborated in 1997 are submitted to conferences in 1998.

Sopot 25 February, 1998

A92

Appendix 16

DWD

DWD's BALTEX-related activities in 1997

1. Provision of data for the German BALTEX area

- data from the conventional measuring networks,
- radar products,
- model products

2. Delayed mode data assimilation (NEWBALTIC)

- set-up and run of a delayed mode data assimilation system
- reanalysis for the PIDCAP period (August to October 1995 +)
- development of a soil moisture assimilation scheme (GKSS/DWD)

3. Meteorological Observatory Lindenberg

- two LITFASS field experiments (surface-atmosphere exchange over grass and over forrest)

4. Operation of the Meteorological Data Centre BMDC

- completion of the data collection, data processing
- reformatting and quality control of data
- development of data visualisation software
- fulfil of users' requests
- creation of a BMDC Homepage providing information on datasets **http://www.dwd.de/research/baltex/e_baltex.html**

5. Participation in project meetings and working groups

- BALTEX SSG
- BALTEX Radar WG
- INTAS 95-872 (data from Belarus and NW Russia)
- NEWBALTIC Workshops
- Preparation of the BRIDGE Strategic Plan

Data Assimilation in NEWBALTIC: Activities in 1997

BALTEX Model (BM) characteristics:

- hydrostatic model based on EM/DM code of DWD
- horizontal resolution: 1/6 degree (121 x 181 grid points)
- vertical resolution: 30 levels

BM analysis:

• atmospheric analysis for Φ, (u, v), p-s, rh	00, 06, 12, 18 UTC
• SST analysis	00 UTC
• snow analysis	00, 06, 12, 18 UTC
• analysis of T-2m and rh-2m	00, 03, 06, ... , 21 UTC

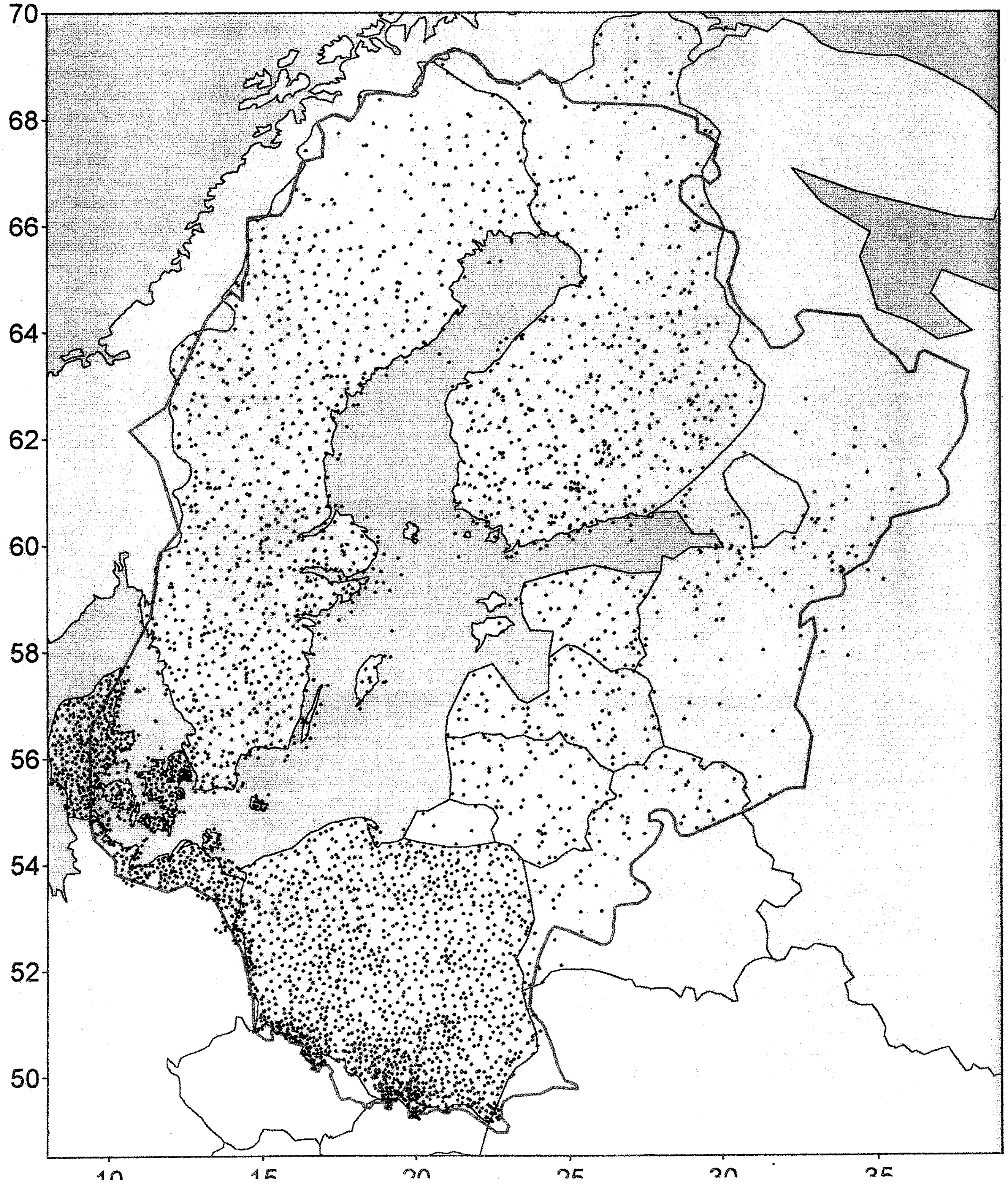
Observations:

• conventional data	SYNOP and BALTEX-SYNOP
	SHIP, BUOY
	TEMP, PILOT
	AIREP, ASDAR
	additional SST data from SMHI for PIDCAP
• satellite data	SATOB, SATEM

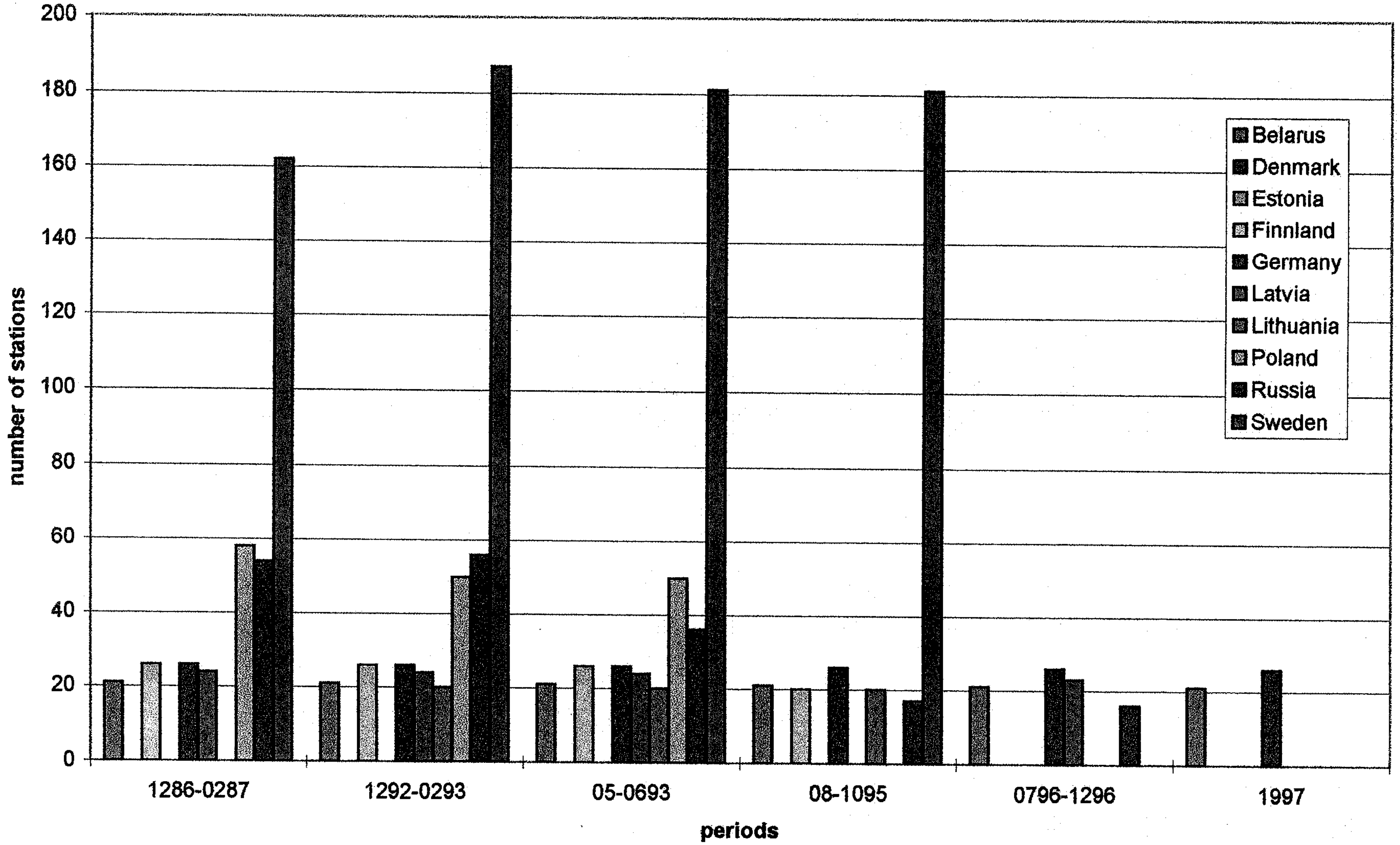
Reanalysis for PIDCAP period (08/1995 - 10/1995):

- production of high resolution analyses
- evaluation of energy and water budgets
- comparison of time series of precipitation of BM, EM, and analysed observations
- model intercomparison (REMO, HIRLAM, Unified Model, DWD models)
- validation of vertically integrated water vapour (IWV)
- sensitivity studies concerning the soil moisture assimilation
- investigation of model humidity using detailed diagnostic output

Precipitation stations of BACAR area for the PIDCAP period

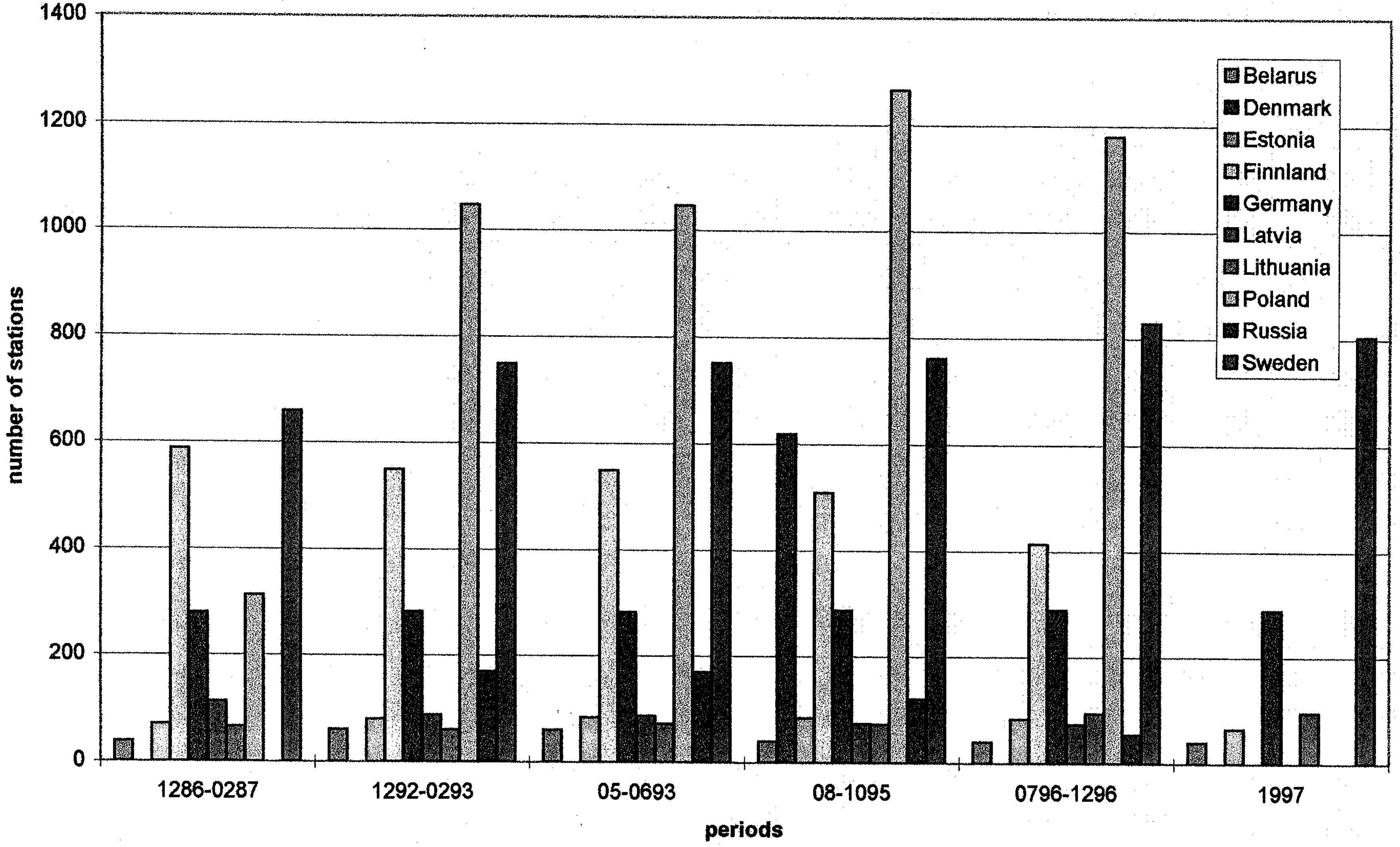


Non-real-time synop data



BMDC Feb. 1998

Non-real-time precipitation data



BMDC Feb. 1998

DWD

The DWD will continue to contribute to BALTEX with regard to BRIDGE by:

1. Provision of the necessary data as far as possible incl.

- data from the conventional measuring networks
- radio sonde data (partly 6-hourly soundings)
- radar products
- satellite products
- model products

2. Operation of a delayed mode data assimilation

- production of high-resolution analyses
- use of additional non-operational observations available from BMDC
- storage of quality information from data assimilation

3. Accommodation of a field experiment at MO Lindenberg

- linked to the LITFASS-project of DWD
- based on experience from the LITFASS-98 experiment

4. Operation of the Meteorological Data Centre BMDC

- continuous data collection from July 1996 onwards
- collection of additional data for the BRIDGE period
- doing some additional quality control on non real-time data
- (?) compilation of a complete climate dataset (definition?)

5. Participation in working groups.

! External support will be needed to fulfil the tasks
listed in points 2 and 4 to the extent required !!!

International BALTEX Secretariat Publication Series

No. 1 : Minutes of First Meeting of the BALTEX Science Steering Group
at GKSS Research Center in Geesthacht, Germany, May 16-17, 1994.
August 1994.

No. 2 : Baltic Sea Experiment BALTEX - Initial Implementation Plan.
March 1995, 84 pages.

No. 3 : First Study Conference on BALTEX, Visby, Sweden,
August 28 - September 1, 1995. Conference Proceedings.
Editor: A. Omstedt, SMHI Norrköping, Sweden. August 1995, 190 pages.

No. 4 : Minutes of Second Meeting of the BALTEX Science Steering Group
at Finnish Institute of Marine Research in Helsinki, Finland, January 25-27, 1995.
October 1995.

No. 5 : Minutes of Third Meeting of the BALTEX Science Steering Group
at Strand Hotel in Visby, Sweden, September 2, 1995.
March 1996.

No. 6 : BALTEX Radar Research - A Plan for Future Action.
October 1996, 46 pages.

No. 7 : Minutes of Fourth Meeting of the BALTEX Science Steering Group
at Institute of Oceanology PAS in Sopot, Poland, June 3-5, 1996.
February 1997.

No. 8 : *Hydrological, Oceanic and Atmospheric Experience from BALTEX.*
Extended Abstracts of the XXII EGS Assembly, Vienna, Austria, April 21-25, 1997.
Editors: M. Alestalo and H.-J. Isemer.
August 1997, 172 pages.

No. 9 : The Main BALTEX Experiment 1999-2001 - ***BRIDGE***. Strategic Plan.
October 1997, 78 pages.

No. 10: Minutes of Fifth Meeting of the BALTEX Science Steering Group
at Latvian Hydrometeorological Agency in Riga, Latvia, April 14-16, 1997.
January 1998.

No. 11: Second Study Conference on BALTEX, Juliusruh, Island of Rügen, Germany,
25-29 May 1998. Conference Proceedings. Editors: E. Raschke and H.-J. Isemer.
May 1998, 251 pages.

International BALTEX Secretariat Publication Series (continued)

No. 12: Minutes of 7th Meeting of the BALTEX Science Steering Group
at Hotel Aquamaris in Juliusruh, Island of Rügen, Germany, 26 May 1998.
November 1998.

No. 13: Minutes of 6th Meeting of the BALTEX Science Steering Group at
Danish Meteorological Institute in Copenhagen, Denmark, 2 to 4 March 1998.
January 1999.

Copies are available upon request at the International BALTEX Secretariat.