BALTEX

Baltic Sea Experiment

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

Minutes of

Fourth Meeting of the BALTEX Science Steering Group

at
Institute of Oceanology PAS
in Sopot, Poland
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Participants at the 4th Meeting
of the BALTEX Science Steering Group

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Summary

The BALTEX SSG suggested closer co-operation and co-ordination between BALTEX and NOPEX, in particular as far as the field campaign activities of both programs are concerned. The SSG recommended mutual participation of BALTEX and NOPEX representatives at BALTEX SSG and NOPEX Executive Committee meetings.

PIDCAP-related activities and research made good progress. Achievements include enhanced and new data sets (e.g. precipitation measurements from different sources, and water vapour estimates from GPS). Modelling intercomparison studies with PIDCAP as the target period are being conducted at different institutions and Meteorological and Hydrological Services.

The PIDCAP study period includes the months of August to November 1995.

Data collection and preparation for BALTEX at national Meteorological Services made considerable progress. Improvements are desirable in particular in Denmark and Russia.

A BALTEX funding proposal to the INTAS program at EU level was approved supporting data preparation activities in Belarus and Russia. In total, three BALTEX proposals are now being funded at the EU level.

A BALTEX home page was implemented on the Internet.

The status of the BALTEX Oceanographic Data Centre was approved.

A BALTEX data user identification procedure was approved, which is in operation at present for the BALTEX Meteorological Data Centre.

The status of the BALTEX Hydrological Data Centre will be specified at a special workshop to be conducted in 1996. This workshop will also have to detail future BALTEX hydrological modelling plans.

Planning and implementation of the four major BALTEX field campaigns made considerable progress. Details of the experiment plans were reviewed and approved by SSG.

A BALTEX plan for future radar research was drafted by a special expert group and will be finalised in 1996.

The BALTEX Main Experiment is scheduled for the period October 1999 to March 2001. A Task Force was implemented to prepare plans for this experiment and to write a draft plan for discussion at the next BALTEX SSG meeting.

The next SSG meeting is scheduled to be held at the Latvian Hydro-meteorological Service in Riga on 14 to 16 April 1997.

Summary of Major Action Items

1. Professor Eberhard Ruprecht is asked to represent BALTEX on future NOPEX Executive Committee meetings and to report back to the BALTEX SSG immediately, if necessary, or at SSG's forthcoming meeting.

2. SSG asked in particular the SSG Chairman and the Danish and Russian BALTEX representatives in the SSG to undertake any suitable action to change the present attitude of the national Meteorological Services in Denmark and Russia towards a more open data exchange policy in the frame of BALTEX.

3. The Finnish Institute of Marine Research (FIMR) is requested to initiate any necessary action to build up the BALTEX Oceanographic Data Centre (BODC) along the lines of the status paper draft and the recommendations of the SSG.

4. The SSG asked Professor Zdzislaw Kaczmarek to organise a BALTEX hydrology workshop in autumn 1996 with the major objectives to detail the future BALTEX hydrological modelling strategy and the related data sampling strategy for the BALTEX Hydrological Data Centre (BHDC).

5. The BALTEX Secretariat is asked to publish short descriptions of the actual BALTEX field campaign plans in both the BALTEX Newsletter and at the BALTEX home page on the Internet.

6. The Chairman asked the SSG members to submit suggestions for potential members of the BALTEX Task Force to him as soon as possible.

7. The SSG requested the Task Force to prepare plans for the BALTEX Main Experiment and write a draft plan to be discussed at the next SSG meeting.

8. The BALTEX Secretariat is asked to undertake necessary action for the preparation of the second BALTEX Scientific Conference to be held in spring 1998 on the island of Rügen or at another suitable location at the German Baltic Sea coast.

Introduction

On invitation by Professor Jerzy Dera the fourth meeting of the BALTEX Science Steering Group (SSG) was held at the Institute of Oceanology (Member of the Polish Academy of Sciences, PAS) at Sopot, Poland. The meeting opened on Monday June 3, at 2 p.m. and closed at 11 a.m. on Wednesday June 5, 1996. The agenda of this meeting is given as Appendix 1 to these minutes. Section numbers of the minutes relate to topic numbers of the agenda. The participants at this meeting are listed in Appendix 2.

1 Opening

Professor Jerzy Dera opened the meeting and cordially welcomed the meeting participants in Sopot. He expressed his satisfaction that the BALTEX SSG followed his invitation and met in Poland for the first time. He reminded the audience of the long Polish tradition in specifically oceanographic and hydro-meteorological research with strong emphasis on the Baltic Sea and parts of its catchment region. He reminded the audience that the Polish territory extends over nearly 20 % of the Baltic Sea catchment region and, hence, Polish institutions and research groups have a natural strong interest in contributing to the BALTEX program. Professor Dera announced a scientific poster presentation at the Institute of Oceanology PAS (IO-PAS) in parallel to the BALTEX SSG meeting. The posters highlighted results of recent oceanographic and air-sea interaction studies performed at IO-PAS and other institutions (see Appendix 3 for a list of posters).

Professor Dera gave a brief overview on the planned time agenda (Appendix 1). He mentioned in particular a scientific BALTEX Symposium on Ocean Modelling and Oceanographic Research which was scheduled for the entire afternoon of the first meeting day.

Professor Dera wished the participants a stimulating and successful meeting and a pleasant stay at IO-PAS and in Sopot.

2 BALTEX Symposium on Ocean Modelling and Oceanographic Research

During the afternoon of June 3, a BALTEX Symposium on Ocean Modelling and Oceanographic Research was held as part of the BALTEX SSG meeting. This symposium was organised by the BALTEX Secretariat in close co-ordination with members of the BALTEX SSG and the hosting Institute of Oceanology. The symposium was chaired by Professor Wolfgang Krauß of Institut for Marine Sciences Kiel (IfMK). In addition to the SSG meeting participants numerous scientists from IO-PAS and other institutions attended.

Five invited speakers gave a state-of-the-art overview on various aspects of ocean modelling and oceanographic research with particular relation to the Baltic Sea and to the BALTEX scientific plans and aims. An introductory paper by Professor Dera reviewed recent oceanographic research at the Sopot Institute of Oceanology and at other Polish research institutions. Details of Polish investigations summarised by Professor Dera in his paper were presented as posters at IO-PAS throughout the entire BALTEX SSG meeting and gave a stimulating scientific environment for both the meeting participants and the poster authors.

The topics of the other papers included coupling of a Baltic Sea model to an sea-ice model, results of data assimilation experiments with a Baltic Sea model, and aspects of the coupling of a Baltic Sea model to an atmospheric circulation model. Research projects in these fields are on-going at different research institutions including IfMK, DMI, SMHI, FIMR and Helsinki University. Most of these projects are part of the BALTEX program. See Appendix 4 for the symposium's agenda and Appendix 5 for abstracts of the presented papers.

The symposium closed at 6.15 p.m. The participants met again at 7 p.m. in the garden of IO-PAS for a relaxing grill-party with delicious Polish specialities. On that occasion the mayor of Sopot welcomed the participants and expressed his wishes for a successful meeting.

3 Report of the BALTEX SSG Chairman

The meeting of the SSG was re-opened next morning at 9 p.m. by Professor Lennart Bengtsson, the Chairman of the BALTEX SSG. He reported on a few recent scientific results and achievements with particular relevance for BALTEX.

First model runs with a version of the BALTEX REMO at MPIfM Hamburg were conducted for parts of BALTEX-PIDCAP period August to October 1995. 3 to 5 days integrations were performed as test runs being performed with different physical parameterisation packages (DM/EM versus ECHAM4 physics) and different boundary conditions (6-hourly analysis versus 1-hourly model output both from the boundary hemispheric model). The model runs produced detailed precipitation fields for the entire BALTEX region to be compared with rain observations which are currently collected and processed by the BALTEX Meteorological Data Centre.

The Chairman further reported on improvements in parameterisation of lateral discharge at the global scale which recently were obtained at MPIfM Hamburg. Results of a newly developed HD (Hydrological Discharge) model showed better agreements with runoff measurements in large river catchments of the globe compared to earlier ECHAM3-T42 results. Improvements are mainly based on either a proper separation of flow processes or a more realistic model topography. A major still existing deficit is a time delay of the snow melt in the global ECHAM model leading to runoff biases particularly in arctic catchments.

The chairman reported - as a third highlight - on progress in obtaining atmospheric water vapour estimates using the existing GPS (Global Positioning System) station network in Scandinavia. This network of fixed GPS receiving stations is in operation for monitoring of the post-glacial land-rise. For the latter application atmospheric humidity is a contaminating noise, but using inverse techniques independent estimates of vertically integrated tropospheric water vapour aloft each receiving station may be estimated with a time resolution of some 20 minutes. Time series at about 30 stations in Scandinavia are presently prepared at Onsala, Sweden for August to October 1995 (PIDCAP) as part of the BALTEX research network NEWBALTIC which received funding through the EU. The Chairman pointed out the future potential of these data for use in e.g. data assimilation and model validation.

The Chairman continued summarising critical issues for the overall successful development of BALTEX. He pointed out the problem of collecting observational data from national Meteorological and Hydrological Services in as much as 10 different countries in the BALTEX region. He stressed the need for an easy and open-as-possible data exchange among data holding agencies and data users. Some aspects of the present status of the data collection in particular from national Meteorological and Hydrological Services are not in an optimal stage. Data exchange is partly either too slow and tends to be too restricted due to financial requests by some national Meteorological and Hydrological Services which are unrealistic to be fulfilled by data users or - more general - a research program like BALTEX.

The Chairman expressed his general satisfaction with respect to the implementation of the BALTEX modelling strategy and model development. Improvements are necessary for the hydrology modelling part. The Chairman pointed out that river catchments may be viewed as large integrative rain gauges to be used as complementary measuring tools to point rain measurements. However, in order to relate runoff data to precipitation physically-based hydrological models need urgently be developed or adjusted for coupled runs with atmospheric circulation models applied to the entire Baltic Sea catchment region. The need for a detailed hydrology modelling strategy is closely linked to the need of a suitable hydrology data sampling strategy in the entire BALTEX region, with particular emphasis on river runoff data.

The Chairman stressed the importance of continued efforts in planing of the four major BALTEX field campaigns.

Finally, he suggested a central BALTEX Intensive Observational Period with the conduction of coupled model runs and all operational and enhanced observational networks and tools being in operation. This period to be implemented for about two years around the year 2000 will constitute the core of BALTEX. Planning for the improvements of observational and modelling tools as outlined in the BALTEX Initial Implementation Plan should aim at being accomplished at the beginning of this period at latest. Preliminary preparation of this central experiment within BALTEX should start during the present SSG meeting.

4 SSG Membership and BALTEX-NOPEX Relations

4.1 SSG Membership

The Chairman introduced new members of the BALTEX SSG.

Dr. Jerzy Pruchnicki of the central office of the Polish Institute of Meteorology and Water Management (IMWM) in Warsaw will represent the Polish Meteorological and Hydrological Service.

Dr. Mikko Alestalo is the director of the Research Division at the Finnish Meteorological Institute in Helsinki and will represent the Finnish Meteorological Service.

Both new members attended the present meeting. The SSG welcomed the new members and expressed its satisfaction that the national Meteorological Services of both Poland and Finland are now represented in the BALTEX SSG.

The Chairman announced the wish of **Professor Anders Stigebrandt** of Göteborg University to resign from his SSG membership. Professor Stigebrandt who was unable to attend the present meeting due to illness indicated in a letter to the Chairman that he would be willing to continue his engagement in BALTEX. In particular he will continue to co-ordinate the preparation of the BALTEX oceanographic field campaign (BALTEX Network G) and to prepare funding application for this campaign. The SSG thanked Professor Stigebrandt for his continuous efforts in the planning and guiding of BALTEX.

Following a suggestion of Professor Stigebrandt the Chairman proposed to ask **Professor Anders Omstedt** of SMHI in Norrköping, Sweden, to become a member of the BALTEX SSG. Professor Omstedt is presently member of the BALTEX Working Group on Process Studies and he had been member of the BALTEX Initial Implementation Plan drafting group in 1994 and 1995.

The SSG agreed with this suggestion and asked the Chairman and the Secretariat to invite Professor Omstedt to become a new BALTEX SSG member.

The list of BALTEX SSG members, as of June 1996, is given in Appendix 21.

4.2 BALTEX-NOPEX Relations

The Chairman welcomed Professor Sven Halldin of Uppsala University, Sweden and Professor Sven-Erik Gryning of Risö National Laboratory, Denmark, as visiting representatives of the NOPEX (Northern Hemisphere Climate Land Surface Processes Experiment). Both are members of the NOPEX Executive Committee. NOPEX is a major land-surface experiment in the frame of IGBP/BAHC with a experimental site near Uppsala, Sweden. During recent NOPEX conferences and BALTEX Working Group meetings the need for a closer co-operation between BALTEX and NOPEX was noted. In order to improve co-operation continuous future participation of NOPEX-representatives at BALTEX SSG meetings, and BALTEX-representatives at NOPEX Executive Committee meetings were suggested by BALTEX and NOPEX scientists. The participation of Professors Halldin and Gryning at the present BALTEX SSG meeting is a fist step along this line and was arranged by the Chairman and Professor Halldin.

Professor Halldin gave a presentation on the present status of NOPEX which is summarised in the following.

4.2.1 NOPEX Objectives

NOPEX is specifically aiming at investigating fluxes of energy, momentum, water, and CO_2 - and the associated dynamics - between the soil, the vegetation and the atmosphere, between lakes and the atmosphere as well as within the soil and the atmosphere on scales ranging from centimetres to tens of kilometres. The objectives of NOPEX include

- To provide improved parameterisation schemes of exchange of water, energy and carbon between the land surface and the atmosphere in hydrological and meteorological models from the meso-scale to larger scales.

- To study the use of satellite and airborne remotely-sensed data for evaluation of surface fluxes and states by supplying hard data on the ground truth.
- To quantify the size of terms in the surface energy balance as well as in the water and carbon balances from different types of land cover, during both daily and annual cycles.
- To explore methods for aggregation and disaggregation of parameters between three spatial scales, patch scale, intermediate scale and regional scale. Patches may be for example topographical elements, land-use classes, infiltration areas, exfiltration areas, and others.
- To foster a new community of land-surface experimentalists capable of carrying out experiments in places with bad infrastructure and harsh climate.

4.2.2 NOPEX Measurement Strategy

The main NOPEX study region near Uppsala, Sweden, represents the southern part of the boreal zone and is entirely located inside the BALTEX region (sidelengths approximately 50 by 100 km), however distant (some 50 km) to the Baltic Sea coast to avoid influences of land-sea circulations. Two Concentrated Field Efforts (CFEs) of approximately one month duration each were conducted in this region during the summer of both years 1994 and 1995, respectively. A second NOPEX measurement site is being built up at Sodankylä located in the subarctic northern Finland, in particular for future winter time studies. A third NOPEX CFE (WINTEX) is presently planned for the winter 1997/98 with a pilot study to be conducted already March and April 1997. Professor Halldin noted that one funding application on the EU level was approved to support the preparation of WINTEX.

NOPEX measurements are split up into

- Concentrated Field Efforts (CFE),
- Continuous Climate Monitoring (CCM).

The CFEs include both local-scale and regional-scale studies. Local-scale activities and observations at specific sites (forest, agricultural, lake, mire) consist of a large variety of meteorological, micro-meteorological, bio-geophysical and hydrological measurements, including e.g. radiative, turbulent and CO_2 fluxes, vegetation and soil temperature, as well as runoff and ground water levels. Both airborne and surface measurements of fluxes are conducted. Regional-scale observations are aiming at i) the exploration of the spatial variability of e.g. fluxes across the NOPEX region, and ii) the improvement of flux-aggregation methods from local to regional scale.

CCM may be roughly divided into soil-vegetation-atmosphere monitoring, long-term catchment studies, and regional climate survey. A particular important parameter is precipitation which will be measured with various devices including radar, drop size and fall speed instruments, and gauge networks with enhanced network density.

4.2.3 NOPEX Analysis and Modelling

The NOPEX measurement activities are related to modelling activities with the objectives
- to support the analysis of local measurements,
- to develop generalised land-surface-atmosphere schemes,

- to support the analysis of remotely sensed data,
- to develop suitable regionalisation methods,
- to improve regional-scale hydrological modelling,
- to improve parametrisations in meso-scale atmospheric models, and to validate these models,
- to conduct parameter sensitivity studies,
- to test aggregation approaches.

4.2.4 NOPEX Data Policy

Professor Halldin outlined the general NOPEX data exchange policy. Access to NOPEX data sets is restricted during a 18 months period after data establishment or measurement. Afterwards it will be available for unlimited use to registered NOPEX data users. A general free access is presently foreseen not before the year 2000. The immediate use of NOPEX observational data within BALTEX modelling groups will therefore need further discussion.

4.2.5 Conclusions

The SSG thanked Professor Halldin for his overview and discussed future relations between BALTEX and NOPEX. SSG considered it valuable to co-ordinate future BALTEX and NOPEX activities, in particular the measurement parts of both programs. Combination of BALTEX (at Lindenberg and Östergarnsholm) and NOPEX (near Uppsala and Sodankylä) sites constitutes a representative location ensemble for the major hydro-meteorological climate conditions in the BALTEX region. Co-ordination in this respect would save measurement resources and is also expected to increase the likelihood of receiving funds on both national and the EU level.

The SSG suggested closer relations between BALTEX and NOPEX. The SSG agreed with the idea of mutual participation at SSG and Executive Committee meetings. **Professor Lars Gottschalk** of Oslo University, Norway, member of the NOPEX Executive Committee, will attend future BALTEX SSG meetings as the NOPEX representative.

Action : Professor Eberhard Ruprecht, the chairman of the BALTEX Working Group on Process Studies will represent BALTEX on future NOPEX Executive Committee meetings.

5 Report of the BALTEX Secretariat

The report of the BALTEX Secretariat was given by Dr. Hans-Jörg Isemer and focused on the following issues:

- PIDCAP Progress
- BALTEX Data Collection and Exchange
- Funding Applications
- BALTEX home page on the Internet.

5.1 PIDCAP Progress

A preliminary overview on the weather development and selected precipitation records during the PIDCAP (Pilot Study for Intensive Data Collection and Analysis of Precipitation) period, August to October 1995, was given. The few precipitation stations from different parts of the BALTEX region considered for this overview already indicate high variability of precipitation in time and space. Both regional-scale precipitation associated with frontal systems and local convective rainfall connected to showers and thunderstorms occurred frequently. Strong precipitation of several tenths of mm per day was observed at different stations in all months of the PIDCAP period. The entire PIDCAP period may be divided into 9 sub-periods, according to the specific precipitation patterns and events. The occurrence of two violent storm cyclones in November 1995, the latter causing adverse snowstorm conditions in southern Sweden and heavy precipitation elsewhere, suggests the additional inclusion of this particular month into the study period of PIDCAP.

The SSG followed this suggestion and defined the month of November 1995 as the fourth PIDCAP month. The PIDCAP period now includes August to November 1995. The SSG requested in particular to include November 1995 into the PIDCAP enhanced-data-collection activities.

A revised PIDCAP project description prepared by the BALTEX Secretariat was presented to the SSG and accepted (Annex 5).

Some preliminary results of PIDCAP projects were compiled in a first PIDCAP progress report (Annex 6). Major findings were introduced to the SSG and are summarised briefly as follows:

Daily precipitation sums from more than 3500 stations in the BALTEX region were collected at various national sources of 10 different countries and will be made available in homogeneous formats by the BALTEX Meteorological Data Centre (BMDC). The collection of precipitation observations from this dense network into one data archive is a particular BALTEX achievement. This data archive represents almost all available rain measurements from operational networks in the region. The number of stations is about 10 more than the regular SYNOP observations available on GTS.

Preliminary comparisons of rain measurements on ferry ships in the Baltic Sea (which were started as a specific BALTEX project) and model forecasts from the German Europa Model (EM) of DWD showed encouraging results.

Preparation of gridded precipitation data fields for the entire BALTEX region or parts of it is ongoing. These projects which include various data sources including model forecasts, radar and *in situ* measurements will benefit from the enhanced gauge station data set mentioned above.

GPS (Global Positioning System) derived vertically integrated tropospheric water vapour is being prepared for some 30 stations in Sweden and Finland as part of a BALTEX project. This new data source offers promising potential for data analysis, data assimilation and model validation purposes.

Improvement for analysing precipitation fields is expected from a combination of passive microwave (SSM/I) and infrared (Meteosat) satellite data.

Modelling studies with the BALTEX REMO (Regional Model) at both MPIfM and GKSS, and with HIRLAM at DMI and SMHI are focusing on the diagnosis of water and energy budgets, and validation of the water and energy cycles for the entire BALTEX region. Data from the PIDCAP period are also used for a model intercomparison project as part of the BALTEX-NEWBALTIC network. Sensitivity experiments with the BALTEX-REMO have been started at MPIfM with (i) different model resolution, (ii) different physical parameterization packages, and (iii) different boundary conditions tested.

The first PIDCAP workshop is being organised by the BALTEX Secretariat in close co-operation with SMHI, and will be held 10-12 June 1996 at SMHI, Norrköping, Sweden. See Appendix 8 for the time agenda of this workshop.

The SSG expressed satisfaction with the progress of PIDCAP-related studies and activities. The SSG encouraged the individual groups to draw conclusions on the experience made with PIDCAP-related research for input in the planning of the central BALTEX Main Experiment planned for 1999 onwards.

5.2 Data Collection Issues

Dr. Isemer briefly summarised the status and achievements of the BALTEX Data Centres. See Appendix 9 for an overview.

He stressed in particular the urgent need for a more detailed definition of the future data sampling strategy for both the BALTEX Oceanographic Data Centre (BODC) and the BALTEX Hydrological Data Centre (BHDC).

The BALTEX Meteorological Data Centre (BMDC) signed agreements with various national Meteorological and Hydrological Services which regulate the data transfer for BALTEX between data suppliers, BMDC, and data users. Each data user will have to sign a license agreement thus approving the rules being set up in the agreements between data suppliers and BMDC. A procedure for identifying BALTEX data users is required in order to guarantee legal and property rights of the data suppliers.

Details and SSG decisions on this subject are given below in Section 6.

A BALTEX Data Workshop with participation of the national Meteorological and Hydrological Services of the eastern BALTEX countries had recently been organised by the BALTEX Secretariat in Wroclaw, Poland. Major recommendations made at this workshop include

- to accomplish the exchange of all SYNOP data which are available at national Meteorological Services on the GTS system in real-time, this requires activities in particular in Belarus and Russia;
- to use GTS also for the exchange of non real-time data.

The latter point however needs approval and additional installation efforts at national Meteorological Services and GTS nodes.

Dr. Isemer noted problems in the field of meteorological data collection and exchange in particular in Denmark and Russia. DMI (Danish Meteorological Institute) confined so far only data contributions to BMDC (e.g. precipitation data) for the PIDCAP period. Further delivery of data for other BALTEX periods both in the past and for 1996 onwards was made dependent by DMI on suitable financial support.

The situation in Russia is additionally complicated because the meteorological data from the Russian BALTEX region are held at 5 different regional hydro-meteorological centres. Attempts of both the BALTEX Secretariat and Professor Valeri Vuglinski of SHI (Russian State Hydrological Institute St. Petersburg) to start a continuous and comprehensive data collection and exchange at these centres for BALTEX were only partly successful. Problems are of both financial and organisational nature.

Professor Vuglinski explained the present situation at the Russian ROSHYDROMET. The regional centres in Russia mentioned above have taken over responsibilities for data preparation and exchange issues. Compared to earlier (5 years ago or more) there is a certain lack of central co-ordination which makes it necessary to negotiate with all regional centres individually on a case-by-case strategy. This includes in particular discussions on financial support requested by the regional centres for any additional data preparation activities as for BALTEX. These financial requests were at least sometimes unrealistically high.

Dr. Pruchnicki mentioned WMO resolution No. 40 (Cg-XII, „Guidelines on international exchange of meteorological and related data including guidelines on commercial activities“) which might be instrumental to convince national Meteorological Services for a more open data exchange policy, in particular with research programs like BALTEX. Dr. Pruchnicki suggested to draw the attention of the Secretary General of WMO to the data problem in some countries if the situation will not change in spite of ongoing efforts of SSG members.

SSG thanked all national Meteorological and Hydrological Services for their BALTEX-related data activities and asked for continuous future efforts in this respect. SSG again stressed the mutual benefit for BALTEX and the national Meteorological and Hydrological Services. The improvement of modelling and data assimilation tools as planned in BALTEX may be hindered by a restrictive data policy of the national Meteorological and Hydrological Services.

Action: SSG asked in particular the SSG Chairman and the Danish and Russian BALTEX representatives in the SSG to undertake any suitable action to change the present attitude of the national Meteorological Services in Denmark and Russia towards a more open data exchange policy.

5.3 Funding Applications

Dr. Isemer reported on efforts of the BALTEX Secretariat to co-ordinated and submit two funding applications on the EU level the topic of which are the support of data collection activities for BALTEX at national Meteorological and Hydrological Services.

One proposal was submitted to INTAS-RFBR and includes contributions from Germany, Sweden, Belarus and Russia. The focus is on supporting activities in Belarus and Russia. This proposal was accepted for support by INTAS-RFBR. Dr. Isemer expressed his expectation for an improvement of the BALTEX data preparation status in both countries.

The second application was submitted to the ECOS/OUVERTURE program and includes contributions from Germany, Denmark, Sweden, Finland, Estonia, Latvia, Lithuania and Poland. Unfortunately, this funding application will not be supported (Information received during September 1996).

SSG thanked Dr. Isemer for his efforts to support data collection and preparation for BALTEX.

5.4 BALTEX Home Page on the Internet

A BALTEX home page is available now on the Internet. It can be reached at

http://w3.gkss.de/baltex/baltex_home.html

The BALTEX home page is maintained and updated by the BALTEX Secretariat. Any BALTEX-related information which may be available at other locations on the Internet should be linked to the BALTEX home page. Dr. Isemer suggested that individual BALTEX groups should prepare short descriptions of their work and results which may be part of the individual institution's home page. The BALTEX Secretariat would then just set a link to these pages providing thus for an overview on ongoing BALTEX activities. SSG supported this request and asked all BALTEX groups for support along this line.

6 Data Management and Availability

6.1 BALTEX Oceanographic Data Centre (BODC)

Dr. Pekka Alenius of Finnish Institute of Marine Research (FIMR) presented a draft of the status paper for the BALTEX Oceanographic Data Centre (BODC). This paper was drafted in close co-operation with the BALTEX Secretariat and with contributions of other oceanographers presently active in the BALTEX program. See Appendix 10 for the BODC status paper draft.

Dr. Alenius pointed out that a comprehensive oceanographic data archive including e.g. hydrographic data, sea level and current measurements is difficult to establish because of the non-routine data sampling in oceanography (compared e.g. to meteorology with routine networks being operational for weather forecast purposes). Many oceanographic data are sampled during oceanographic and biological research cruises. They are processed and stored at various national institutions, and it is most often even difficult to receive meta information on these data. Hence, a BALTEX ODC with physical storage of all oceanographic data seems unlikely to be established in due time.

Professor Wolfgang Krauß supported this view and gave examples for problems in obtaining oceanographic data from various institutions. He proposed in particular the ICES and HELCOM archives and centres which preferably could be used or contacted.

Professor Krauß and other SSG members stressed however the importance of a physical storage of all available sea level data from coastal stations of the Baltic Sea, in agreement with the BODC status paper draft. There are some 50 stations with available data, only part of which are presently in use within the Baltic Sea modelling activities in BALTEX.

After a lively discussion on the future role of the BODC the SSG approved the following recommendations:

- BODC will act mainly as a meta data centre with the objective to collect information on existing oceanographic data, and their availability. ICES and HELCOM archives should be used as extensively as possible. Meta data must include information on sea ice data (e.g. concentrations, thickness, drift information) and their availability.
- A BODC home page on the Internet with a link to the BALTEX home page should be established containing the BODC meta information as an easy and quick information tool.
- BODC is requested to build up a BALTEX sea level data archive from all accessible coastal sea level stations in the Baltic Sea. Sea level data with time resolutions of at least 3 hours and higher should be stored physically at BODC for exchange with BALTEX data users.
- The BODC draft status paper is accepted in general. An updated version modified according to the SSG recommendations should be prepared by FIMR as soon as possible and will have to be presented at the next SSG meeting for final approval. FIMR is requested to initiate any necessary action to build up the BODC along the lines of the status paper draft and the recommendations of the SSG.
- A BALTEX data user identification procedure like the one established for the BMDC (BALTEX Meteorological Data Centre, see below) will be necessary also for the exchange of sea level and other oceanographic data. User identification should be on the department level at least.

Action: FIMR is requested to initiate any necessary action to build up the BODC along the lines of the status paper draft and the recommendations of the SSG. BODC is requested to build up a BALTEX sea level data archive from all accessible coastal sea level stations in the Baltic Sea. Sea level data with time resolutions of at least 3 hours and higher should be stored physically at BODC for exchange with BALTEX data users.

6.2 BALTEX Meteorological Data Centre (BMDC)

Professor Eberhard Müller reviewed the status of the BALTEX Meteorological Data Centre (BMDC) being in operation at DWD Offenbach in Germany. The BMDC status paper as approved by the BALTEX SSG at its 3rd meeting in Visby is given in Appendix 11.

The division into real and meta data storage is now clearly defined for BMDC. Data collection activities both real and meta have started.

Due to legal and property rights of the data suppliers (i.e. national Meteorological and Hydrological Services) data exchange regulations had to be formulated and laid down in formal agreements to be signed by both data suppliers and BMDC. An exemplary agreement is given in Appendix 12. Before passing data to users, BMDC will have to request the users' confirmation of these data exchange regulations by receiving signatures on specific data license agreements.

Only registered BALTEX data users may receive data from BMDC. After discussion, SSG agreed on a data user identification procedure as detailed in Appendix 13. In summary, a data user may receive data from BMDC providing

- the user's complete identification form has been communicated by one BALTEX SSG member and has been registered at both the BALTEX Secretariat and at the BALTEX Data Centre,
- the user's data request has been detailed to the BALTEX Data Centre,
- a BALTEX Data License Agreement has been signed by both the data user and the BALTEX Data Centre.

SSG asked the BALTEX Secretariat to co-ordinate and streamline the data user identification procedure.

Professor Müller indicated that the future data output from BMDC will be in generally accepted formats such as GRIB and BUFR. Data delivery is planned through the Internet using a key code word for registered data users only.

The SSG recommended that data delivery to users should be free of any additional costs except possibly charges for real copy costs. Data suppliers who contributed to the establishment of the BMDC archive should not be charged at all if they need data from BMDC.

6.3 BALTEX Hydrological Data Centre (BHDC)

Professor Sten Bergström started with a brief overview on Swedish BALTEX activities which are summarised in Appendix 14. Of particular importance was the recent approval of funding for a Swedish Climate Modelling Centre from Swedish sources. Professor Bergström pointed out that part of the future activities of this modelling centre will be closely related to BALTEX.

Professor Bergström reviewed the status of the BALTEX Hydrological Data Centre (BHDC) which is formally installed at SMHI. A data set of monthly river runoff data from stations at river mouths at the Baltic Sea coast was collected at SMHI and has already been used (see Appendix 14 of the 3rd SSG meeting minutes). A strategy for building up daily river runoff data set is needed. Professor Bergström stressed his view that this archive should be closely related to actual users needs.

The SSG noted the need for a BALTEX hydrology data sampling strategy. A draft paper on „BALTEX Hydrological Data Management Strategy" by Professor Zdzislaw Kaczmarek (see Appendix 22) was introduced to the SSG and discussed. The data sampling strategy will have to be closely linked to the BALTEX hydrology modelling strategy which needs to be clarified in more detail. SSG suggested to hold a BALTEX hydrology workshop as soon as possible with the objectives to detail the BALTEX hydrology modelling plan and the related hydrology data sampling strategy. Professor Kaczmarek agreed to organise such a workshop in autumn 1996. As in particular river runoff data requirements may differ for hydrologists, meteorologists and oceanographers SSG suggested to invite representatives from all 3 disciplines for participation at the workshop.

In agreement with other SSG members Professor Kaczmarek pointed out that daily river runoff data will have to be archived with high regional coverage for at least a few sub-catchments of the BALTEX region which then will be taken as test catchments for modelling purposes. He suggested Vistula and/or Odra, Daugava, Neva and Torneälv in this context, in close agreement with earlier suggestions in the BALTEX Initial Implementation Plan. He further mentioned the need for collecting daily river runoff data for a period of several years in the past (of order 5 to 10 years at least, to be determined for different catchments) especially for model calibration and validation purposes. This sampling period should also include the special periods already under investigation in other BALTEX projects (1986/87, 1992/93, PIDCAP Aug to Nov 1995, see the BALTEX Initial Implementation Plan for details).

It was noted by SSG members that this strategy will also have implications for the other BALTEX Data Centres, in particular the BMDC as far as precipitation and other meteorological data required in the context of hydrological modelling are concerned.

Action: The SSG asked Professor Kaczmarek to organise a BALTEX hydrology workshop in autumn 1996 with the major objectives to detail the future BALTEX hydrological modelling strategy and the related data sampling strategy for the BHDC.

7 BALTEX Working Group Reports

7.1 Working Group Process Studies (WGP)

The chairman of the BALTEX Working Group Process Studies (WGP), Professor Eberhard Ruprecht summarised the conclusions of the 5th meeting of WGP which was held 7 May, 1996, at The Hague, The Netherlands. See the approved minutes of this meeting in Appendix 15. The main focus of this meeting was a review of the planning stage for the BALTEX field campaigns. Details on BALTEX field campaigns are given below in section 9.

SSG took the view that possibilities should be offered for other groups to participate at or contribute to BALTEX field experiments.

SSG suggested to publish short descriptions of the actual field campaign plans in both the BALTEX Newsletter and at the BALTEX home page on the Internet.

Action: SSG asked the BALTEX Secretariat to undertake action for publication of field campaign plans including offers for additional participation in the BALTEX Newsletter and the BALTEX home page.

7.2 Working Group Numerical Experimentation (WGN)

Dr. Nils Gustafsson gave the report on WGN for Professor Jürgen Willebrand who could not attend this meeting.

WGN had no meeting since the preceding 3rd SSG meeting at Visby. Dr. Gustafsson pointed out that much of the work and decisions in the field of numerical modelling is now being done through the BALTEX-NEWBALTIC project. There is considerable overlap in the membership of WGN and participants at NEWBALTIC. A particular achievement is the completion of the re-analysis project at SMHI for the period 15 December 1986 to 15 February 1987 (BALTEX cold winter target period). Preliminary results will be presented at the NEWBALTIC progress meeting June 1996 at SMHI in Norrköping, Sweden. The data from this re-analysis project are available for other users and will have to be requested directly at SMHI.

SSG acknowledged this progress and suggested to publish a quick note on this achievement including preliminary results on the Internet to be linked to the BALTEX home page.

Dr. Gustafsson announced a workshop on ocean data assimilation scheduled to take place in Sweden in May 1997. Upon application by Professor Willebrand and Dr. Gustafsson financial support for this workshop is approved by the MAST III program of EU. Although not a specific BALTEX workshop it is nevertheless closely related to BALTEX objectives. Dr. Gustafsson mentioned the project at IfMK (see the talk of Dr. Markus Meier at the Ocean Modelling Symposium, Appendix 5) and at other institutions.

8 BALTEX Radar Expert Meeting

Professor Ehrhard Raschke reviewed the work of a BALTEX radar expert workshop which was held at GKSS Research Centre, 20 and 21 May, 1996. This meeting had been organised as a response to a BALTEX SSG request formulated at its 3rd meeting in Visby. The meeting was organised by Professor Raschke supported by the BALTEX Secretariat which took part in the meeting.

The BALTEX radar expert group drafted a future action plan related to BALTEX radar research. A few copies of this draft were available at the SSG meeting.

The group pointed out that radar has been proven to considerably enhance the information on precipitation at the surface, in particular over areas with sparse or completely missing precipitation measurements. The group reviewed the present radar coverage in the BALTEX region as well as the current use of radar products in both operational and research applications.

In reviewing the group's draft report Professor Raschke stressed that a complete radar coverage of the Baltic Sea is of high importance for BALTEX. The radar workshop identified large gaps within the existing network, especially along the eastern portion of the Baltic Sea, and recommended to close these gaps with at least two additional radar stations in Poland (in the Gdansk region) and in the Baltic States (preferably near Riga), respectively. The presently available satellite data cannot close these gaps since precipitation estimates based upon such data are insufficiently accurate to meet the BALTEX requirements.

The radar group report further recommended to combine all radars into a BALTRAD (BALTEX Radar) network over much of the BALTEX region with the objective of delivering homogeneous radar products for the entire area to the BALTEX research community. Suggestions for the organisation and infrastructure of BALTRAD which should be built on experience with the existing NORDRAD network were given to archive these BALTRAD products for research purposes in BALTEX.

A number of BALTEX radar research projects were suggested whose goals are to produce optimum rainfall fields from radar. The need was stressed to develop methods of data assimilation of the BALTRAD products in order to incorporate the radar information into numerical weather prediction models.

Professor Raschke pointed out that the present draft needs improvement and final approval by the radar group. Respective tasks were distributed to group members. It is foreseen to finalise the BALTEX radar report in September 1996. The group suggested to apply for funding of BALTEX-related radar research from EU, probably at the next call of the Environment and Climate Program, in January 1997.

The BALTEX SSG stressed that any experience which is available from the Scandinavian NORDRAD network should be taken properly into account for the establishment of a future BALTRAD network and product. In particular integrated techniques should be developed based on e.g. model forecast, radar and gauge data in order to produce optimum 'true' precipitation fields. Members of the SSG pointed out that at present it is still difficult to get real precipitation estimates from e.g. NORDRAD radar. Reflectivity composites need continuous adjustments.

The BALTEX SSG thanked Professor Raschke for his activities and recommended to submit funding applications in order to build up a BALTRAD product for BALTEX as suggested by the BALTEX radar expert group.

9 BALTEX Networks

Particular emphasis was given to a review of and discussion on BALTEX Networks D, E, F and G which constitute the four BALTEX field experiments. Networks A, B and C contain major BALTEX modelling and data analysis projects (see section 9.2 of the BALTEX Initial Implementation Plan for details).

9.1 Network A : NEWBALTIC

Funding for Network A has approved through the EU Environment and Climate Program (ENVCLI) for the project NEWBALTIC. NEWBALTIC is co-ordinated by the SSG Chairman, Professor Lennart Bengtsson. The Chairman reviewed the NEWBALTIC general and specific objectives (see Appendix 16). He reported on good progress within NEWBALTIC. NEWBALTIC had its kick-off meeting at MPIfM Hamburg in December 1995. Contributions to NEWBALTIC come from institutions in Austria, Great Britain, Denmark, Sweden, Finland

and Germany. First results of NEWBALTIC will be summarized at the second NEWBALTIC meeting scheduled for June 12 to 13 at SMHI in Norrköping, Sweden.

9.2 Network B : High-resolution Process Studies with the Emphasis on Hydrological Modelling

The co-ordinator of Network B, Dr. Jens-Christian Refsgaard of DHI could not attend this SSG meeting. The Chairman summarised earlier communication with Dr. Refsgaard.

Unfortunately, the funding proposal BALTEX-HYACINT for Network B which was submitted to ENVCLI did not receive support by EU. See Appendix 17 for the BALTEX-HYACINT proposal summary. Hence, BALTEX projects proposed in Network B are therefor laying behind schedule. Dr. Refsgaard had additionally pointed out that at present no funding for BALTEX has been approved from Danish national sources. This is likely to have some impact on possibilities of future engagements of Dr. Refsgaard and, in general, Danish scientists. The only major funded Danish BALTEX contribution is DMI's modelling project with HIRLAM which is part of NEWBALTIC.
Dr. Refsgaard suggested to re-shape his first unsuccessful application, including the following changes:

- focus on coupling of a distributed physically-based hydrological model (MIKE-SHE) and a non-hydrostatic atmospheric model, data assimilation of soil moisture data, improvements in up-and down-scaling,
- a smaller group,
- partly new partners with stronger emphasis to atmospheric sciences,
- smaller overall budget.

SSG thanked Dr. Refsgaard for his continuous engangement in Network B. SSG agreed with Dr. Refsgaard's plans. SSG strongly suggested to re-submit the funding proposal for Network B in line with Dr. Refsgaard's suggestions.

Professor Eberhard Müller pointed out possibilities for a closer future co-operation of DWD with Dr. Refsgaard's group at DHI. SSG recommended a DWD contribution to Network B. A cut-down in the overall budget seems to be necessary, with a possible reduction in the overall number of contributors.

SSG encouraged Dr. Refsgaard to go for another attempt at the EU level and expressed its deep confidence in his work.

9.3 Network C : Baltic Sea and Sea-Ice Modelling

Professor Wolfgang Krauß is the co-ordinator of the BALTEX Network C which receives funding through the EU-MAST III program. The full title of the funded project is „Ice Formation and the Influence of Ice-Coverage on the Circulation in the Baltic Sea“. See Appendix 18 for a summary of objectives. Contributions for the project come from institutions in Sweden, Finland and Germany. The research work in Network C begun already although, due to some re-organisations within the MAST-III program, the funding was delayed by several months. The talk of Dr. Andreas Lehmann of IfMK at the Ocean Modelling Symposium (see Appendix 5) refers in part to this BALTEX project.

Professor Krauß informed the SSG about a further funding application which was submitted to the German Research Foundation (DFG). The objective of this new poject includes the coupling of a Baltic Sea model to an atmospheric circulation model (the BALTEX REMO version at MPIfM Hamburg). This project consists of contributions from various groups at IfM Kiel and MPIfM Hamburg and is co-ordinated by Professor Krauß and Professor Lemke of IfMK.

SSG considered this as a further important step to achieve the main goals of BALTEX. SSG thanked Professor Krauß and his group for his BALTEX-related activities.

9.4 Network D : ASCAP, the Air-Sea Interaction, Cloud and Precipitation Experiment over the Baltic Sea

Professor Ann-Sofi Smedman of Uppsala University is the co-ordinator of this network which constitutes one out of four BALTEX field experiments. She reviewed objectives and measurement plans for ASCAP.

ASCAP is a comprehensive plan for an air/sea interaction field campaign in the Baltic Sea. The central aim of ASCAP will be to improve model parameterisation schemes through a better understanding of the physical mechanism involved and to validate algorithms applied to remote sensing data. The specific scientific objectives of ASCAP include

- measurements of air-sea interaction processes (e.g. wind stress and evaporation) and sea state and wave spectra over the Baltic Sea,
- in-situ measurements (ground based and aircraft soundings) and observation of clouds and water vapour,
- in-situ measurements of precipitation by advanced methods on ships,
- parameterisation of air-sea interaction processes in regional models over the Baltic sea area,
- validation of algorithms to estimate cloud parameters and water vapour content from satellite data,
- validation of algorithms to estimate precipitation from radar data (NORDRAD) and satellite data,
- use of optimised parameterisations and algorithms to improve regional models,
- validation of numerical models against long term measurements over the Baltic sea area.

Professor Smedman pointed out that some of the measurements will run on a more or less continuous basis and may be seen as the monitoring component of ASCAP. These include

- air-sea interaction measurements on the small island Östergarnsholm situated some 4 kilometres east of Gotland,
- radar measurements operated by SMHI and satellite measurements,
- precipitation measurements from ferries between Lübeck and Helsinki.

These measurements have already begun in 1995 and are expected to be continued at least until 1997. The rationale for having these extended measurements is the inherent variability of the climatic system of the Baltic Sea area. The continuous measurements will thus enable picking up also rare but important weather events.

There is national Swedish funding approved for this component of ASCAP.

The main impetus will be on two Concentrated Field Efforts (CFEs), one in early summer (15 May - 15 June 1997), when the surface of the Baltic Sea is likely to be much colder than surrounding land areas, and one autumn campaign (4 weeks during September and October 1996), when the sea surface temperature is expected to be warmer than the air advected out over it. Both CFEs will each last for approximately a month. The campaigns will be concentrated geographically to the area east of Gotland.

The field station at Östergarnsholm has the character of a focal point of the air-sea exchange activities. The site has been chosen in close contact with international expertise on surface waves, so as to represent undisturbed off-shore Baltic Sea conditions for winds from a wide sector, ranging from Northeast to South. Here the sea fetch is of the order 100 - 200 kilometers and includes the Gotland Basin. With winds from other directions, effects of limited fetch on wave characteristics and hence on air-sea exchange processes will be studied in a systematic way. The field station consists of an instrumented 30 meter tower placed on a very low cliff at the extreme south end of the small, low island Östergarnsholm and of a directional wave rider buoy deployed about a kilometre south of the island. Turbulent fluctuations of wind and temperature will be recorded at four levels on the tower and humidity fluctuations at one level. In addition, slow response ('profile') measurements of wind, temperature and humidity will be recorded at several levels as well as radiation and other relevant meteorological data.

Further continuous measurement activities during ASCAP include e.g. Doppler radar (VAD) profiles of horizontal wind speed, horizontal wind direction, horizontal divergence and vertical air speed. A Micro Rain Radar (MRR) will be installed at Östergarnsholm and will provide rain-rates and drop spectra at a site where conventional gauges suffer because of wind exposure and sea spray. This MRR will be installed on RV *ALKOR* during the CFEs.

Measurements during CFEs can be divided into two categories: (i) measurements that will operate on a continuous basis during the four weeks of each CFE, and (ii) measurements that will be carried out as a series of experiments of limited duration, with special emphasis on periods with satellite overpass.

Category i) includes measurements with a Differential Absorption Lidar (DLAL) operated side by side with a UHF RADAR/RASS. These instruments will be deployed on Gotland, at the shore of a peninsula just 4 kilometres west of the Östergarnsholm station. This combined measuring system will provide not only profiles of the mean quantities of wind, water vapour mixing ratio and temperature, but in addition - by combined high resolution measurements - also profiles of turbulence parameters as dissipation rate, turbulent flux of water vapour and momentum. Turbulent flux measurements and measurements of the vertically integrated atmospheric water vapour content on a continuous basis during the CFE-s will also be provided on board of the research vessel RV *Alkor*, which will be cruising east of Östergarnsholm. Additionally, a more detailed dataset (compared to the continuous measurements) from weather radars and satellites will be compiled during CFEs. Fractional cloud cover and cloud base height will be provided by a laser ceilometer operated at Östergarnsholm. Vertically integrated cloud liquid content will be monitored by a 3-channel microwave radiometer operated on RV *Alkor.*

Category (ii) includes airborne flux measurements with a C- 130 aircraft, which can fly as low as 17 m above the surface of the sea. The C-130 will provide a wide range of thermodynamic and kinematic parameters, microphysical data as well as radiation measurements. Part of the flights will be co-ordinated with satellite overpasses (e.g. the DMSP, NOAA-K and ERS-2). An optical system onboard the C-130 will be used to measure precipitation. From RV *Alkor* radiosondes will be launched to measure the vertical profiles of temperature and humidity during the times of the satellite overpasses. Also, measurements with e.g. a microwave radiometer and a ceilometer will be co-ordinated with relevant satellite overpasses. RV *ALKOR* will also carry different rain measurement devices. Other measurements include tethered balloon soundings, frequent high resolution radio soundings and pilot balloon trackings operated from Östergarnsholm. Also, constant level balloons will be used, to trace wind trajectories from Östergarnsholm.

Institutions contributing to ASCAP include at present Uppsala University and SMHI, Sweden, Institute for Marine Science Kiel and MPIfM Hamburg, Germany, Risö National Laboratory, Denmark and the Meteorological Office, England.

Professor Smedman mentioned that results from a pilot CFE in ASCAP during spring 1996 yielded interesting flux mesurement results under very stable conditions. Both sensible and latent heat fluxes are negative (directed into the Baltic Sea) during these periods in May to July with values in the range of 1 to 10 W/m^2. Stable conditions occur frequently in spring and early summer over parts of the Baltic Sea.

Unfortunately, the first funding application for ASCAP submitted to EU in late 1995 failed to receive support although it was rated A in the evaluation process. Professor Smedman indicated that she and the ASCAP group is prepared to go for another attempt in January 1997. The major changes in the new application based on the evaluation result were summarised as follows:

- turbulence flux measurements and wave models to be included,
- usage of experimental results in atmospheric models strengthened, inclusion of a applications in a GCM prepared,
- streamlining of the project management.

The SSG thanked Professor Smedman for her engagement and strongly supported her initiative to re-submit the ASCAP funding proposal.

9.5 Network E : Cloud / Precipitation / Air - Land Surface Field Experiment

The co-ordinator of Network E, Professor Gerd Tetzlaff, reviewed the present planning stage for the BALTEX Cloud / Precipitation / Air - Land Surface Field Experiment.

Professor Tetzlaff pointed out that measurements in field experiments showed that the vertical turbulent energy fluxes at the surface usually fall short of the radiation fluxes to be redistributed by these turbulent fluxes. Magnitudes of 100 to 200 W/m^2 of this bias are rather common in clear sky, noon conditions. Field measurements (e.g. FIFE, TARTEX and others) showed a systematic relation between the inhomogeneity of the land surfaces and the observed deficit. However, no systematic investigation was performed allowing to relate the deficit to any physical property of measured parameters. The parametrisations applied in models contain these systematic deficits in the turbulent fluxes at the surface of inhomogeneous terrain and thus model results based on these parametrisations are likely to contain the effects of this bias.

Professor Tetzlaff considered a comprehensive key question to address the problem of the accuracy of the experimental methods of these turbulent fluxes as part of the land surface experiment within BALTEX. The BALTEX land surface experiment will basically contain two components:

- a long-term, multi-year monitoring campaign, and
- one or more Concentrated Field Efforts (CFEs).

The measurement site will be around the observatory Lindenberg (located south-east of Berlin) of the German Weather Service (DWD). The Lindenberg region represents a landscape typical for large parts of the Baltic catchment south of the Baltic Sea, showing wide lowlands extending from Germany to the east including parts of Poland, Belarus, Russia, and of the Baltic States. This landscape is typically rather flat, slightly hilly in parts with lakes and rivers being quite common. The hydrological conditions are under thorough investigation to find catchment areas with well-known hydrological conditions.

The long-term monitoring component of the BALTEX land surface experiment will be closely connected to the DWD measuring program LITFASS which is planned for the years 1996 until at least 2000. The scientific objectives of LITFASS include the determination and modelling of the fluxes of momentum, heat, water and other substances, representative for the horizontal scale of order of 10 km (which is the grid length of the operational NWP model DM presently in use at DWD) over heterogeneous land surfaces. The primary focus is on the investigation of sub-grid scale heterogeneity in the characteristics of the land surface, in the forcing conditions and the resulting fluxes. The measuring site as planned covers an area of about 20 by 20 kilometres. The full equipment will be deployed finally by 1998. The routine measurements then comprise area-covering data on the basic parameters such as air temperature, humidity, wind, radiation, soil temperature, soil moisture, runoff in several places, rain gauges, and data such as the leaf area index. In addition more detailed measurements will be taken at a tall tower of 100m height including vertical profiles and fluxes measured by covariance techniques as well as profiling work into the atmosphere up to several 100m height with remote sensing methods. The infrastructure of the measuring site is designed to host guest equipment. A detailed description of the LITFASS plan and the Lindenberg measurement site is available at Lindenberg observatory.

The CFE will extend over a shorter period of approximately four weeks. The surface energy budget is one of the main parameters under concern. The observational strategy foresees the implementation of several fully equipped energy budget stations. Aircraft measurements will be performed to provide area-covering information of the fluxes. It is also planned to use devices allowing to integrate over areas applying horizontally integrating methods such as acoustic systems or optic systems such as scintillometers. The quantification of the water budget requires measurements of the soil moisture, the aerial distribution of the precipitation, and the runoff. An optimal experimental period would be in the summer with large energy fluxes, good opportunities to find locally formed convective clouds, simple soil moisture conditions with little or no horizontal water flows in the relevant soil layers, and rather slow changes of the plant activities.

A first pilot field experiment is planned for the summer months of 1997. A major CFE is scheduled for the summer 1998.

The major CFE will include an heterogeneity experiment as discussed above with the objectives

- to map the heterogeneity based on an heuristic-empirical approach,
- to model the fluxes and estimate representative area averages,
- to measure the fluxes in the field in different flow regimes (trajectories),
- to measure area averages (acoustic and scintillometric),
- to measure cloud related parameters,
- to perform aircraft measurements (flights levels below 50m above the ground).

Professor Tetzlaff pointed out that there is no funding available at present for Network E. A funding application for a pilot modelling study for Network E failed to receive support. A funding application is at present being prepared to be submitted on the EU level, most likely to the ENVCLI program, at the beginning of 1997.

SSG expressed satisfaction with the development of Network E. SSG encouraged the co-ordinator to include both experimental groups and modelling studies into the planning for this BALTEX field experiment.

9.6 Network F : BASIS, the Baltic Air-Sea-Ice Study

Professor Jouko Launiainen is co-ordinating Network F. He summarised the planning stage for the BALTEX-BASIS experiment. He started pointing out that numerical modelling of the dynamics and thermodynamics of sea-ice needs verification and optimisation by observations. A detailed and multi-disciplinary observational data set of various physical processes in the wintertime atmosphere, ice and the sea is still lacking, in particular for the Baltic Sea. BASIS aims at an improved understanding and modelling of the energy and water cycles during winter conditions by conducting a winter field experiment in the marginal ice zone (MIZ) of the Baltic Sea. The overall objective of BASIS is to create and analyse an experimental data set for optimisation and verification of coupled atmosphere-ice-ocean models. Modelling studies will be associated with the BASIS field experiments, providing for a close link between observational strategy and modelling requirements in BALTEX.

Professor Launiainen summarised the specific objectives of BASIS which include the

- Investigation of water budget and momentum and thermal interaction at the air-ice, air-sea and sea-ice boundaries,
- Investigation of the atmospheric boundary layer (ABL), especially close to the sea-ice margin,
- Investigation of the ocean boundary layer (OBL),

- Validation of coupled atmosphere-ice-ocean models.

The Concentrated Field Effort (CFE) of BASIS is planned to be carried out during February and March 1998 in the Gulf of Bothnia. The location of the experimental area is preliminary planned between Umea and Vaasa, however, will have to be exactly determined later in accordance with the actual ice situation. The intensive period will last for three weeks and the experiment covers pre- and post-intensive period monitoring of weather and ice conditions. The central working platform is the Finnish ice breaking RV *Aranda* around which measuring grids for hydrographic, ice, and meteorological studies will be located, and airborne measurements will be made. Contribution from another research vessel is planned, and automatic stations, helicopters and aircraft, and snow scooters will be used. Experiments are concentrated in the region of the marginal ice zone (MIZ). The scale of the various experiments varies from micro-scale to meso-scale, i.e. the spatial and time scale range from 100 m to 100 km and from hours to days, respectively.

The aerological method will be used to calculate flux divergence of heat and moisture on the scale of the entire MIZ experimental region. Additional radiosonde stations with specific launching programs will be installed for BASIS at some coastal locations and onboard of participating RVs. Subgrid-scale fluxes will be determined from measurements of an aircraft (FALCON of DFLR Oberpfaffenhofen Germany) and two helicopters (HELIPOD system of University Hannover and FIMR Helsinki). The FALCON will operate in a box of approximately 200 km * 200 km side-length while helicopter missions will be concentrated in an area of 50 km radius around RV *Aranda*. Tower measurements on the ice and close to the shore line will give local near-surface flux measurements. A combination of meteorological and turbulence data from aircraft, HELIPOD and surface measurements has not been gained previously and is expected to yield good estimates of e.g. the area-averaged vertical flux divergence.

Professor Launiainen continued to state that an important goal of BASIS is to quantify the role of the surface properties in the air-ice-sea exchange of momentum, heat, and moisture. Information on ice concentration, ice roughness and ice kinematics will be obtained using SAR imagery from Radarsat and ERS-2, covering the experimental area at the ice edge zone. NOAA-AVHRR imagery will be used when cloud coverage is low. Ice drift is intended to be measured with several GPS equipped buoys, ARGOS buoys and radiosondes for location tracking deployed on ice. The vertical temperature profile in the sea water will be measured with thermistor chains connected to ARGOS buoys. Detailed ground measurements of ice surface roughness, ice salinity and temperature, and ice and snow thickness will be carried out directly on the sea-ice.

Hydrographic sections crossing the experimental region will be performed by the research vessels and ship- and helicopter-based CTD profiles will be measured during the CFE. Thermistor chains and current meters will be deployed beneath the sea-ice. At least one ADCP will be operated at the central base station from RV *Aranda*. The OBL turbulence structure will be measured by acoustic devices and small fast-responding propellers using eddy-flux and energy dissipation techniques.

At present BASIS will be carried out in co-operation of five institutes in Finland, Sweden, and Germany including the Finnish Institute of Marine Research (FIMR), Hannover University, Hamburg University, Swedish Meteorological and Hydrological Institute (SMHI), and Uppsala University. BASIS has co-operation and co-ordination with the Northern Hemisphere Climate Land Surface Processes Experiment (NOPEX), which will organise a winter field experiment in northern Finland. A funding proposal for BASIS is currently prepared to be submitted to EU-MAST III during October 1996. Professor Launiainen stated that even without EU funding a basic part of BASIS will be carried out with financial support from national sources.

SSG congratulated Professor Launiainen for the excellent progress in the planning of BASIS. SSG noted with satisfaction that the sea-ice in the Baltic Sea is well covered in the implementation of BALTEX. This refers to both modelling aspects (Network C) and experimental activities (Network F).

9.7 Network G: BAVAMEX, the Baltic Sea Vertical Mixing and Advection Experiment

The co-ordinator of Network G, Professor Anders Stigebrandt, could not attend this SSG meeting. The planning of BAVAMEX was shortly summarised by Professor Eberhard Ruprecht, the chairman of WPG. Further information from the written experiment plan have been added later to this report.

Professor Ruprecht pointed out that BAVAMEX will concentrate on the vertical mixing and advection in the major basins of the Baltic Sea. Other important processes like the inflow of new deepwater and outflow of Baltic proper surface water through the Belts and Öresund, and mixing and advection of new deepwater as it flows through the system of dense bottom pools and bottom currents in the south-western Baltic proper will not be investigated because they are either the focus of other ongoing experiments or are difficult to measure because of their ephemeral character.

It is intended to estimate the distribution of kinetic and potential energy in an experimental box extending from the shoreline to the maximum depth of a deep basin. The experiment should cover scales ranging in space from the size of the experimental box and in time from the length of the experiment down to the space and time scales of molecular dissipation and diapycnal mixing. BAVAMEX foresees the conduction of a summer experiment with a seasonal, essentially thermal stratification in the surface layers, and a winter experiment when the water is homogeneous down to the halocline at about 60 m depth. Each of the experiments should last for about 2 weeks.

The experimental box will be about 30 by 30 nautical miles with one border at the east coast of Gotland. Here the bottom slope is typical of the Baltic Proper and the experimental box includes parts of one of the major deep Baltic Sea basins. A further benefit of this location is that the meteorological measurements obtained during field phases of ASCAP at Östergarnsholm will be available. Four ships are expected to participate. Two of these will do continuous CTD (Conductivity-Temperature-Depth) and ADCP (Acoustic Doppler Current Profiler) measurements along transects perpendicular to the coast (about 30 nautical miles in length). Vessel-mounted ADCP and a vertically undulating vehicle carrying the CTD will be used. The distance between transects will be about 4 nautical miles. Each ship will cover four transects a day. 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.

At the start of an experiment moorings with current meters and CT (Conductivity-Temperature)-sensors will be deployed along the borders of the experimental box. These measurements will be used to compute fluxes of energy across the open boundaries of the box. Moorings with similar equipment will also be deployed inside the experimental area for studies of the frequency domain.

The BAVAMEX data sets will also be quite useful for testing circulation models with respect to, e.g. meso-scale dynamics. Circulation models are instrumental for the interpretation of motions on larger spatial scales in the experiment. There are several suitable models available, particularly the 3-dimensional circulation model at IFM Kiel, or at other research institutions (e.g. SMHI, FIMR and IOW) presently participating in BALTEX.

Professor Ruprecht noted that a funding application for BAVAMEX is currently prepared which is co-ordinated by Professor Stigebrandt with contributions from groups at Göteborg University, SMHI, FIMR and IOW. This application will be submitted to EU-MAST III in October 1996.

SSG thanked Professor Stigebrandt for his efforts in preparing for BAVAMEX. As for the other three field experiments SSG approved the experiment objectives and the planning for the implementation of BAVAMEX.

10 BALTEX and GEWEX

Professor Ehrhard Raschke shortly summarised that BALTEX is very well accepted in GEWEX and GHP. He stressed the importance for BALTEX to present preliminary results at future GEWEX SSG and GHP meetings. Of particular importance is the plan to use the GEWEX Continental Scale Experiment (CSE) regions (MAGS, GCIP, LBA, GAME and BALTEX) as test beds for satellite remote sensing applications. He mentioned the TRMM validation plans in the Amazon (LBA) catchment. The precise role of BALTEX in these plans will have to be explored in more detail.

11 Main BALTEX Experiment

The Chairman confirmed his view that BALTEX is now well developed. Several sub-projects started already or are in an advanced planning stage. Preliminary results from e.g. the PIDCAP projects and from the modelling Networks A and C are encouraging. The Chairman pointed out that BALTEX needs now to prepare for a main experiment for the entire Baltic Sea catchment region. As a starting point for discussion the Chairman presented a working paper draft „A Field Experiment for the Baltic Sea“ (Appendix 19). The Chairman reviewed his paper in detail. He pointed out the particular importance of getting more insight in the fluxes which provide for interactions between the individual components of the atmosphere/land surface/ocean/sea-ice system of the BALTEX region. A key parameter constitutes the net flow through the Danish Straits being determined by the river flow into the Baltic Sea and the budget of precipitation minus evaporation at the Baltic Sea surface. The Chairman reviewed present deficits in the observing system, data assimilation and modelling tools for the BALTEX region.

A lively discussion on a number of details on both observational and modelling aspects of such an experiment followed among the SSG members and meeting participants. It was concluded that such a comprehensive observational and modelling experiment for the entire BALTEX region will need a major planning effort of probably 2 to 3 years duration. SSG decided to establish a BALTEX Task Force Group with the general term to plan for the main BALTEX experiment and intensive observational period. The Task Force should consist of 6 to 8 scientists with expertise in all important observational and modelling aspects of such an experiment.

SSG followed the suggestion of the Chairman and approved the following general time plan. The main experiment will last from October 1999 to March 2001 thus covering two winter seasons. A pilot spin-up period of six months duration will precede the main experiment including April to September 1999. The BALTEX Task Force should present the first draft of the Experiment plan at the next SSG meeting in April 1997.

The terms of reference of the Task Force were discussed by SSG and approved. They include

- to prepare an overall plan for the Main BALTEX Experiment,
- to identify deficiencies in the present observing systems in the BALTEX region and propose improvements,
- to identify deficiencies in the present data assimilation and modelling systems and propose improvements,
- to suggest appropriate actions towards finding realistic technical, administrative and financial solutions,
- to undertake necessary co-ordination and consultation with the other GEWEX Continental Scale Experiments and relevant WCRP activities,
- to propose a suitable way of combining specific BALTEX field experiments and the Main Baltic Sea Experiment, and thereby to seek close co-ordination with other projects, such as NOPEX, LITFASS, and others,
- to finalise the report prior to the next BALTEX SSG meeting in April 1997.

SSG noted that the terms of reference might be adjusted by the Task Force, if necessary.

The membership of the Task Force will be determined until the end of July 1996. The Chairman asked the SSG members to submit suggestions for potential members of the Task Force to him as soon as possible. Membership of the Task Force should depend on expertise mainly but, having in mind the comprehensive task, also on the confirmation of the candidate's institution of the necessary logistical and financial support to fulfil the planning task.

Action: The Chairman asked the SSG members to submit suggestions for potential members of the Task Force to him as soon as possible.

The BALTEX Task Force membership was agreed upon in July 1996. See Appendix 20 for the present membership.

Action : The SSG requested the Task Force to prepare plans for the BALTEX Main Experiment and write a draft plan to be discussed at the next SSG meeting.

12 Further Items

The BALTEX SSG decided to have the second Scientific BALTEX Conference in late spring (May or June) of the year 1998. The conference site should be on the island of Rügen, Germany, or in its immediate vicinity. The first announcement of the Conference should be published at the beginning of the year 1997. Exact date and conference location will have to be determined in 1996.

Action: The BALTEX Secretariat is requested to plan for the second Scientific BALTEX Conference and undertake continuous action for a timely planning of the Conference.

13 Next SSG Meeting

The next SSG meeting is scheduled to take place in Riga, Latvia. The Latvian Hydrometeorological Agency offered to host this meeting and act as the local organiser. The meeting is scheduled for 14 to 16 April 1997.

14 Closing

The Chairman closed the meeting on 5 June at 11 a.m. He thanked the organiser, Professor Dera and his team at the Institute of Oceanology for the excellent preparation, organisation and support of the meeting. He expressed his gratitude to all meeting participants for their contributions.

List of Acronyms and Abbreviations

ABL	Atmospheric Boundary Layer
ADCP	Acoustic Doppler Current Profiler
ARGOS	DCP System on Polar-Orbiting Satellites
ASCAP	Air/Sea Interaction, Cloud and Precipitation Experiment
AVHRR	Advanced Very High Resolution Radiometer
BACAR	BALTEX Catchment Area
BAHC	Biospheric Aspects of the Hydrological Cycle, IGBP subprogram
BALTEX	Baltic Sea Experiment
BALTRAD	BALTEX Radar Network
BAMAR	BALTEX Model Area
BASIS	Baltic Air-Sea-Ice Study
BAVAMEX	Baltic Sea Vertical Mixing and Advection Experiment
BHDC	BALTEX Hydrological Data Centre
BMDC	BALTEX Meteorological Data Centre
BODC	BALTEX Oceanographic Data Centre
BSSG	BALTEX Science Steering Group
BUFR	Binary Universal Form for Data Representation
CCM	Continuous Climate Monitoring
CFE	Concentrated Field Effort
CSE	Continental Scale Experiment
CT	Conductivity - Temperature
CTD	Conductivity - Temperature - Depth
DCP	Data Collection Platform
DFG	Deutsche Forschungsgemeinschaft
DFLR	Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Oberpfaffenhofen / Germany
DLAL	Differential Absorption Lidar
DHI	Danish Hydraulic Institute, Hørsholm / Denmark
DM	Deutschland Modell
DMI	Danish Meteorological Institute, Copenhagen / Denmark
DMSP	Defence Meteorological Satellite Programme
DWD	Deutscher Wetterdienst, Offenbach / Germany
EC	European Commission
ECHAM	European Climate Model - Hamburg Version
ECOS / OUVERTURE	Programme of EC for Co-operation between the regions and cities of the EU and their counterparts in Central and Eastern Europe and the Mediterranean
EM	Europa Modell
ENVCLI	Environment and Climate Programme
ERS	European Remote Sensing Satellite (ESA Programme)
ESA	European Space Agency, Darmstadt / Germany
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FIFE	First ISLSCP Field Experiment
FIMR	Finnish Institute of Marine Research, Helsinki / Finland
GAME	GEWEX Asian Monsoon Experiment

GCIP	GEWEX Continental-scale International Project
GCM	General Circulation Model
GEWEX	Global Energy and Water Cycle Experiment
GFDL	Geophysical Fluid Dynamics Laboratory, Princeton / USA
GHP	GEWEX Hydrometeorological Panel
GKSS	GKSS Research Centre, Geesthacht / Germany
GPS	Global Positioning System
GRIB	Grid in Binary Format
GTS	Global Telecommunication System
HD	Hydrological Discharge
HELCOM	Helsinki Commission
HELIPOD	Measurement platform towed to a helicopter
HIRLAM	High Resolution Limited Area Model
HYACINT	Hydrological-Atmospheric Integrated Modelling at Subgrid Scale
ICES	International Council for the Exploration of the Seas
IfMK	Institut für Meereskunde, Kiel / Germany
IGBP	International Geosphere Biosphere Programme
IMWM	Institute for Meteorology and Water Management, Polish national Meteorological and Hydrological Service
INTAS	International Association for the Promotion of Cooperation with scientists from the Independent States of the Former Soviet Union
IO	Institute of Oceanology, Sopot / Poland
IOW	Institut für Ostseeforschung, Rostock-Warnemünde / Germany
ISLSCP	International Satellite Land Surface Climatology Project
LBA	LAMBADA-BATTERISTA Experiment for Amazonia
LITFASS	Lindenberg Inhomogeneous Terrain Fluxes between Atmosphere and Surface - a long-term Study 1995 - 2000
MAGS	Mackenzie River GEWEX Study
MAST	Marine Action in Science and Technology
METEOSAT	European Meteorological Satellite Series of EUMETSAT
MIKE-SHE	Distributed physically-based hydrological model
MIZ	Marginal Ice Zone
MPIfM	Max Planck Institut für Meteorologie, Hamburg / Germany
MRR	Micro Rain Radar
NEWBALTIC	Numerical Studies of the Energy and Water Cycle of the Baltic Region
NOAA	National Oceanic and Atmospheric Administration
NOPEX	Northern Hemisphere Climate Land-Surface Processes Experiment
NORDRAD	Nordic Weather Radar Network
NWP	Numerical Weather Prediction
OBL	Ocean Boundary Layer
ODC	Oceanographic Data Centre
PAS	Polish Academy of Sciences
PIDCAP	Pilot Study for Intensive Data Collection and Analysis of Precipitation
POM	Princeton Ocean Model
RASS	Radio-Acoustic Sounding System
REMO	Regional Model
ROSHYDROMET	Russian Meteorological and Hydrological Service
RV	Research Vessel
SAR	Synthetic Aperture Radar

SHI	State Hydrological Institute, St.Petersburg / Russia
SMHI	Swedish Meteorological and Hydrological Institute, Norrköping / Sweden
SSG	Science Steering Group
SSM/I	Special Sensor Microwave/Imager
SST	Sea Surface Temperature
SYNOP	Synoptical Surface Observation
TARTEX	Tartu-Experiment
TRMM	Tropical Rainfall Measuring Mission
UHF	Ultra High Frequency
VAD	Velocity-Azimuth Display
WG	Working Group
WGN	Working Group on Numerical Experimentation
WGP	Working Group on Process Studies
WINTEX	Winter Experiment in NOPEX
WMO	World Meteorological Organisation

Appendix 1

4th BALTEX SSG Meeting

Institute of Oceanology PAS
Sopot, Poland
3 - 5 June 1996

Agenda

Monday, 3 June 1996

2.00 pm

1 Opening, Welcome (J. Dera)

2 Ocean modelling symposium (see separate agenda)

7.00 pm Grill Party

Tuesday, 4 June 1996

9.00 am

3 Report of the BALTEX SSG Chairman (L. Bengtsson)

4 New SSG members,
NOPEX representatives, BALTEX - NOPEX relations

5 Report of the BALTEX Secretariat (H.-J. Isemer)
PIDCAP progress
Data collection issues
Funding applications submitted

6 Data Management and Availability
6.1 Report of the BALTEX Oceanographic Data Center (P. Alenius)
Status Paper Draft to be discussed
6.2 Report of the BALTEX Meteorological Data Center (E. Müller)
Status Paper to be discussed
6.3 Report of the BALTEX Hydrological Data Center (S. Bergström)
Data sampling strategy for hydrological data to be discussed
(Contribution by Z. Kaczmarek)

Tuesday, 4 June 1996 (continued)

12.30 pm Lunch

2.00 pm

7 Reports of BALTEX Working Group Chairmen
- 4.1 WG Process Studies (E. Ruprecht)
- 4.2 WG Numerical Experimentation (N. Gustafsson)
  Hydrological modelling strategy to be discussed

8 Report on a BALTEX radar expert meeting (E. Raschke)
Radar research concept for BALTEX to be discussed

9 Report of BALTEX Network co-ordinators
Progress, future EU applications and funding
(L.Bengtsson, J.C.Refsgaard, W.Krauß, A.S. Smedmann, G.Tetzlaff)
Planning of Field Experiments
(A.S.Smedmann, G.Tetzlaff, J.Launiainen, A.Stigebrandt)

10 GEWEX plans, Implementation of BALTEX in GEWEX (E. Raschke)

11 Planning of the main BALTEX Field Experiment

7.00 pm Dinner

Wednesday, 5 June 1996

9.00 am

11 Planning of the main BALTEX Field Experiment (continued)

12 Further Items

13 Next SSG Meeting

1.00 pm

14 Closing

Appendix 2

Participants at 4^rd BALTEX SSG meeting
June 3- 5, 1996
Sopot / Poland

Pekka Alenius	FIMR	Helsinki / Finland
Mikko Alestalo	FMI	Helsinki / Finland
Lennart Bengtsson	MPI	Hamburg / Germany
Sten Bergström	SMHI	Norrköping / Sweden
Karsten Bolding	DMI	Copenhagen / Denmark
Grigory Chekan	CH	Minsk / Belarus
Jerzy Dera	IOPAS	Sopot / Poland
Sven-Erik Gryning	Risø Lab.	Roskilde / Denmark
Nils Gustafsson	SMHI	Norrköping / Sweden
Sven Halldin	Uppsala University	Uppsala / Sweden
Hans-Jörg Isemer	GKSS	Geesthacht / Germany
Zdzislaw Kaczmarek	Institute of Geophysics	Warsaw / Poland
Wolfgang Krauß	IfM	Kiel / Germany
Jouko Launiainen	FIMR	Helsinki / Finland
Eberhard Müller	DWD	Offenbach / Germany
Jerzy Pruchnicki	IMWM	Warszawa / Poland
Ehrhard Raschke	GKSS	Geesthacht / Germany
Eberhard Ruprecht	IfM	Kiel / Germany
Ann-Sofi Smedman	Uppsala University	Uppsala / Sweden
Hilding Sundqvist	Stockholm University	Stockholm / Sweden
Gerd Tetzlaff	Leipzig University	Leipzig / Germany
Valery S. Vuglinsky	SHI	St. Petersburg / Russia
Zenon Wozniak	IMWM	Wroclaw / Poland

Appendix 3

Posters

No of Poster	Authors and title
1.	B. Wozniak, A. Rozwadowska, S. Kaczmarek, S. Wozniak: Institute of Oceanology, Polish Academy of Sciences (IO-PAS) - Seasonal variability of the solar radiation flux and its utilization in the South Baltic.
2.	S. Wozniak: Institute of Oceanology, Polish Academy of Sciences (IO-PAS) - Mathematical spectral model of solar irradiance transmittance through sea surface - its applications and examples for Baltic Sea.
3.	T. Petelski, M. Chomka: Institute of Oceanology, Polish Academy of Sciences (IO-PAS) - The sea spray emission contributing to the air-sea exchange in the coastal zone.
4.	J. Piskozub, T. Petelski, M. Chomka, V. Drozdowska: Institute of Oceanology, Polish Academy of Sciences (IO-PAS) - Water Aerosol Study in the Coastal Zone with Lidar System, PMS Counter and Impactors.
5.	A. Jankowski, D. Skalka: Institute of Oceanology, Polish Academy of Sciences (IO-PAS) - Water circulation variability in the Baltic (3D numerical model).
6.	A. Wroblewski: Institute of Oceanology, Polish Academy of Sciences (IO-PAS) - The Baltic mean sea levels and water volumes.
7.	M. Robakiewicz, F. Jasinska: Institute of Oceanology, Polish Academy of Sciences (IHydr.-PAS) - Vistula Estuary - Measurements and Modelling.
8.	B. Paplinska: Institute of Oceanology, Polish Academy of Sciences (IHydr.-PAS) - Sea waves in the Gdansk Bay - measurements and modelling of directional wave spectra.
9.	Z. Kaczmarek: Institute of Oceanology, Polish Academy of Sciences (IGeo.-PAS) - Water ballance model (Poland).
10.	H.T. Mitosek: Institute of Oceanology, Polish Academy of Sciences (IGeo.-PAS) - Reflection of climate variability within the monthly mean time series of temperature and discharge in die Baltic Sea drainage area: a statistical approach.

Appendix 4

BALTEX - Symposium

on Ocean Modelling and Oceanographic Research

as part of the 4th BALTEX Science Steering Group meeting

Monday June 3, 1996, 2 pm

Institute of Oceanology, Sopot, Poland

2.00 pm	**J. Dera**, Institute of Oceanology Sopot : "Selected results of the Polish research related to the BALTEX programme "
2.45 pm	**K. Bolding**, Danish Meteorological Institute, Copenhagen : "Towards a Coastal Ocean Prediction System for the Danish Domestic Waters "
3.30 pm	**A. Lehmann**, Institut für Meereskunde, Kiel : "Coupled Ice-Ocean Modelling of the Baltic Sea"
4.15 pm	Break
4.45 pm	**M. Meier**, Institut für Meereskunde, Kiel : "Data Assimilation into an Ocean Model of the Baltic Sea"
5.30 pm	**N. Gustafsson**, Swedish Meteorological and Hydrological Institute, Norrköping : "HIRLAM and Aspects of Coupling to an Ocean Model"
6.15 pm	Closing

Appendix 5

Towards a Coastal Ocean Prediction (COP) System for the Danish Domestic Waters

Karsten Bolding
Danish Meteorological Institute
Copenhagen, Denmark

Abstract

The Danish coastal waters include the shallow North Sea waters along the west coast of Jutland, the estuarine transition region or straits that separates the North Sea form the Baltic Sea, as well as the western Baltic. It is therefore essential that any coastal ocean prediction system can account for the extreme physical environment encountered in these waters, which ranges from the saline, tidal North Sea to the brackish, non-tidal Baltic.

Meteorological forcing

A very important aspect of any coastal ocean prediction system is access to high quality meteorological forcing. At DMI a version of the HIRLAM (HIgh Resolution Limited Area Model) is run on an operational basis providing meteorological forcing every three hours.

2-dimensional modelling (storm surge warning):

Historically, storm surge warning system has been based on purely deterministic 2D hydrodynamic models, solving the depth integrated shallow water equations. Observations of the sealevel has only been used for verification purposes and not taken an active role in the storm surge prediction. At DMI a pilot project was initiated following the work carried out at KNMI on using a time invariant Kalman filter for assimilating observed sealevels from a number of tide gauge stations into the hydrodynamical model. A system has been established for evaluating such a system. The initial investigations shows the for real storm surge events the system with the Kalman filter in some cases performs better and in some cases worth than the original system. The reason is that the model used with the Kalman filter is simplified compared to the hydrodynamic model from the original system (linear versus non-linear). In cases where the quality of the meteorological forcing is high the original system performs the best. On the other hand, when the quality of the meteorological forcing is not optimal the Kalman filter system performs better because of the additional information supplied by the tide gauge data.

3-dimensional modelling:

Three dimensional ocean modelling at DMI has concentrated on implementing the Princeton Ocean Model (POM) by Blumberg and Mellor for the North Sea - Baltic Sea area. Notably the advection scheme has been investigated in detail and different candidates have been tested. A good advection scheme is particular important in the Skagerrak - Kattegat area because of the very steep and sharp gradients in salinity and temperature. The central scheme in the original POM code has shown difficulties when applied to situation resembling to those observed by over- and under-shooting salinity and temperature.

Other areas have been implementing an testing different open boundary formulations and the so-called pressure-gradient error associated with the sigma coordinates used in POM.

The Future:

The future plans includes the development of a dedicated coastal ocean prediction system for the North Sea - Baltic Sea area. In this system the ocean model is on one of many pieces making up the entire system. For instance a system infrastructure has to be established including dissemination of model results observations (sea level, satellite, etc.) to relevant end users.

With respect to model development we will focus on using observations more actively in describing the state of the ocean, this will be achieved by exploring different methods of data assimilation. The most advanced data assimilation methods is still only on the development stage and implementation of these methods in real time ocean prediction systems might not be possible in a number of years.

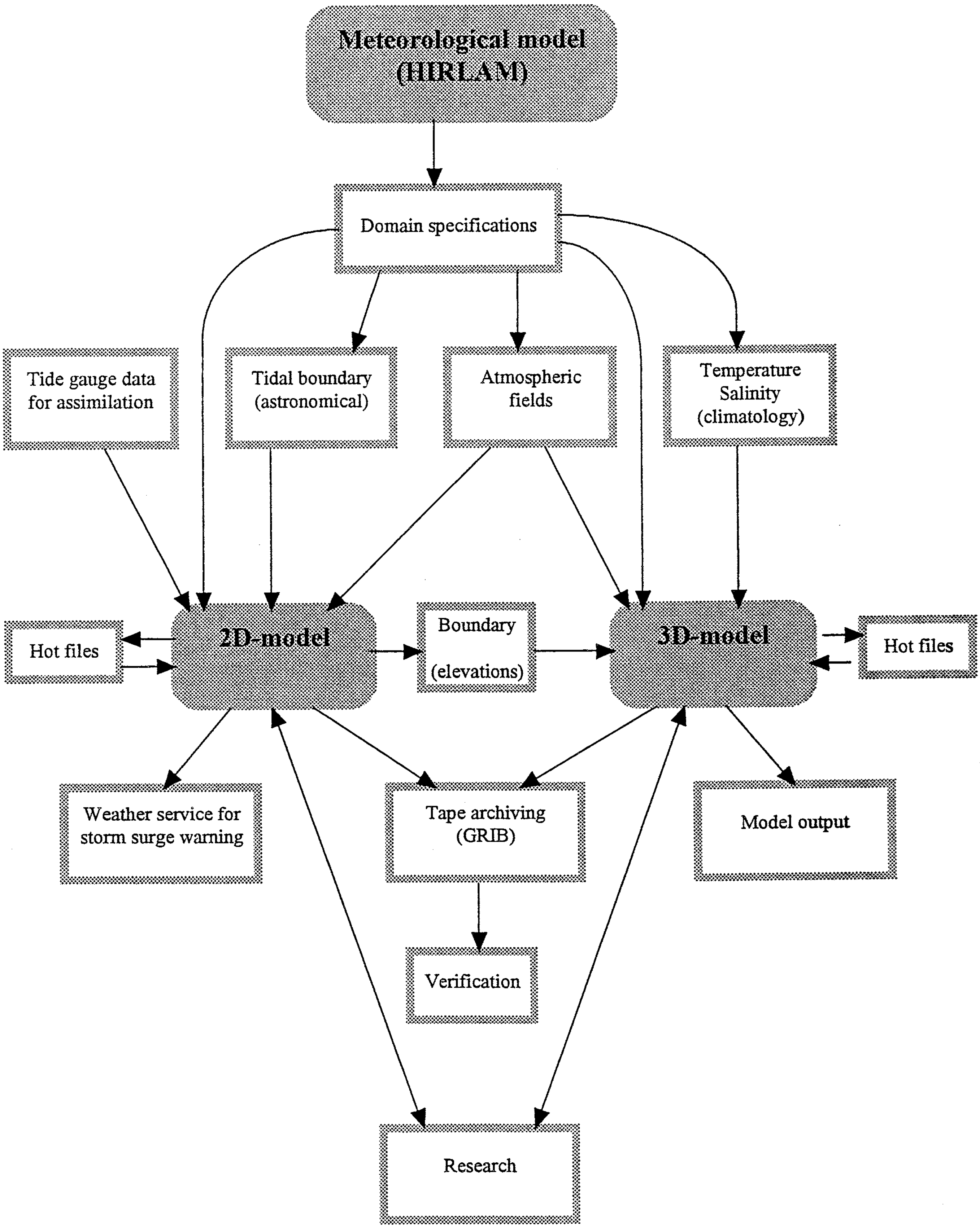

Figure: Meteorological model (HIRLAM)

COUPLED ICE-OCEAN MODELLING OF THE BALTIC SEA

Andreas Lehmann
Institut für Meereskunde, Kiel, Germany

Atmosphere, land, ice and ocean represent a strong coupled physical system. To understand the physics of this complex system, the utilization of coupled numerical models is necessary. Because the physical interaction of the components of the coupled system is rather complex and not fully understood, the first step to solve the problem is the development of numerical models which describe the physics of the different components in a reasonable way, the next step is the coupling of, at least, two components. The final aim will be a full atmosphere-ice-ocean system with hydrology included. In recent years rather sophisticated models of atmosphere, ice, ocean and hydrology have been developed. The setup or development of coupled models for the area of the Baltic Sea has just begun and is one main aim of BALTEX.

In principle, the coupling processes are well known (Figure 1), but in practice a unique description of the parameterizations of these processes is lacking. Uncertainties in the description of the exchange processes may lead to an unphysical drift of the coupled system. A similar effect is notable from unresolved physical processes in the models of the different components, and as a special problem, the almost unknown initial conditions of the ocean. To keep the coupled system on track, a so-called flux correction can be specified which means the solution of the coupled system is partially relaxed to observations. Sea surface temperature observations may be used for flux corrections. By means of satellite infrared radiometers, the two-dimensional surface temperature distribution of the Baltic Sea can easily be measured. To force the ocean to realistic sea surface temperatures, the upper level of the ocean model is relaxed to the observations. For the atmosphere, in turn, infrared SST's may serve as a lower boundary condition.

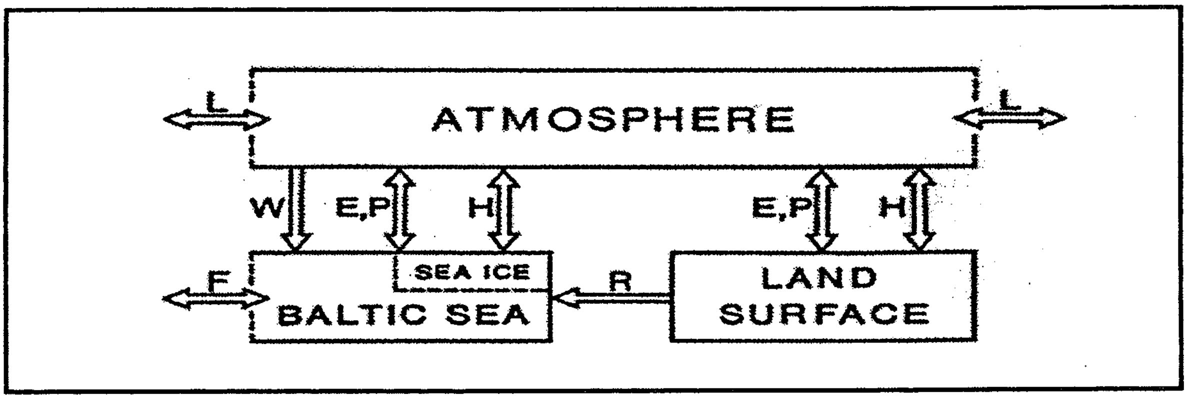

Figure 1 Principal coupling mechanisms between atmosphere, land surface and Baltic Sea. Arrows denote direction of influence.

E, P Evaporation and Precipitation over land and sea
F Inflow and outflow through the Danish Straits
H Heat and energy flux at the air-sea and air-land interfaces, including radiation
L Lateral exchange with the atmosphere outside the BALTEX region
R River runoff
W Wind stress at the sea surface

The Institute of Marine Research in Kiel has get up a coupled atmosphere ice ocean model in which ice and ocean are represented by a full coupled numerical model, and the atmosphere provides the forcing, thus, it is one-way coupled to the ice-ocean system. The ocean model is based on the free surface Bryan-Cox-Semtner model (Killworth et al., 1991) which is a special version of the Cox numerical general ocean circulation model (Bryan, 1969; Semtner, 1974; Cox, 1984). The horizontal resolution is 5 km, with 28 vertical levels specified. The ice model is a two-level dynamic-thermodynamic ice model which is based on the Hamburg sea ice model (Hibler, 1979; Stössel and Owens, 1992). Forcing is provided by the Europa Model (EM, Majewski, 1991) which supplies heat, salt and momentum fluxes to the coupled system. River runoff is taken from Bergström and Carlsson (1994). The main problem in setting up the coupled system is to find appropriate parameterizations for the corresponding fluxes responsible for driving the system, namely, momentum flux, latent and sensible heat fluxes, precipitation, evaporation and radiation fluxes. In case of an ice free ocean these fluxes act directly on the ocean surface, in case of ice, the fluxes act on the ice surface and the ocean receives a modified forcing depending on ice dynamics, ice thickness and concentration and an additional snow cover.

Besides the parameterization problem, there are uncertainties in the atmospheric forcing data. Statistical investigations of EM surface winds show an underestimation of high wind speeds over the Baltic Sea which causes misfits in oceanic surface elevations and corresponding errors in the water mass exchange between North and Baltic Sea through the Danish Straits. Additionally, vertical turbulent mixing processes are also effected. Similar uncertainties exist for other atmospheric parameters, e.g. the actual distribution of precipitation over the Baltic Sea is more or less unknown. Thus, E-P can only roughly be estimated. Uncertainties in the specified forcing will lead to errors in the corresponding fluxes, and hence, the estimation of the heat, salt and water budget of the Baltic Sea.

In summary, sophisticated ice and ocean models are available and may be used for coupled ice-ocean calculations. Problems are partly due to parameterizations of the exchange fluxes and uncertainties in the atmospheric forcing as well as in the turbulent mixing within the ocean.

For the future the coupled ice ocean system will be used to determine the water, heat and salt budget of the Baltic sea for the BALTEX years 1992/1993. The forcing will be provided from the EM and from the high resolution atmospheric model REMO. In parallel, improvements concerning the Baltic Sea ice model (EU-project, BASYS) and turbulent mixing in the ocean model will be undertaken.

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DATA ASSIMILATION INTO AN OCEAN MODEL OF THE BALTIC SEA

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One of the main purposes of BALTEX is the modelling of the water budget of the Baltic catchment area, which surrounds the Baltic Sea. The water budget of the Baltic Sea is governed by the huge impact of the river runoff and the limitation of the water exchange with the North Sea due to the shallow and narrow Danish Straits. The calculation of the net outflow from the Baltic Sea through the Danish Straits is an important component of the water budget for the whole BALTEX region. As baroclinic effects modify the transports, the salt budget of the Baltic Sea has to be included into the considerations. To achieve improved water and salt budgets, accurate modelling and monitoring of the highly variable in- and outflow through the narrow Danish Straits are required over long time periods. September 1992 until September 1993 was chosen as a first test year, including the latest major inflow of highly saline water into the Baltic in January 1993. This period allows to study moderate and strong exchange conditions between the North Sea and the Baltic Sea.

In this context we use a three-dimensional baroclinic model, i.e., a special version of the so-called GFDL model with a free surface (Killworth et al., 1991). To resolve topography in the Danish Straits, a high resolution of one nautical mile in horizontal and 3 m in vertical direction is used. Due to the computational burden we have to restrict the model domain to Kattegat, Belt Sea, Arkona and Bornholm Basin. Time and space dependent active open boundary conditions for temperature and salinity are implemented (Stevens, 1990). Surface elevations on the open boundaries are prescribed from tide gauge data or, in an improved model version, from results of a coarse grid barotropic model of the whole Baltic Sea, including river runoff.

The results of this barotropic model are improved by using the adjoint method (Le Dimet and Talagrand, 1986) to assimilate sea level and wind data. Tide gauges located around the Baltic Sea provide hourly surface elevation data for the test year. As most of the sea level differences between model and observations are due to errors in the surface wind fields, the assimilation procedure is used to fit control variables which improve space dependent model winds on time scales from 1 day up to 15 months. Synoptic wind observations from ships are included into the calculation of the cost function because assimilation of sea level data alone does not uniquely determine the wind fields. The model sea levels at almost all tide gauge locations are improved. It has been shown by comparison with independent wind observations that the optimized wind fields are improved also. The optimized meteorological forcing and surface elevations on the open boundaries are used forcing the regional model. We thereby employ the hypothesis of „barotropic decoupling".

With this regional model the inflow of saline water over Drogden and Darss Sill in January 1993 is simulated. The subsequent sinking down to the bottom of Arkona Basin and its flow through Bornholm Gatt to Bornholm Basin in February, where it sank down to the bottom, thereby lifting up old bottom water which partly left Bornholm Basin through Stolpe Channel, is in good correspondence with observed data. The spreading of saline water after the inflow has been analysed in detail, and mass and salt budgets have been calculated for the BALTEX test year 1992/93 validated against data (Meier and Krauss, 1996). These budgets are very sensitive to changes in the meteorological forcing and to changes in the open boundary conditions.

In future, the assimilation procedure will be extended to temperature profile data from ship cruises casted during 1992/93.

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HIRLAM and Aspects of Coupling to Ocean Models

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Swedish Meteorological and Hydrological Institute
Norrköping, Sweden

The coupling between high resolution weather forecasting models and ocean models is investigated. It is demonstrated by several case studies that improvements of short range weather forecasting in the area of the Baltic Sea can only be achieved through accurate descriptions of the lower boundary conditions over sea in the form of sea state variables such as sea surface temperatures and sea ice coverage. The examples are taken from summer situations without sea ice as well as from winter situations with extreme sea ice conditions. It is shown that the sea state variables used in the model influence the weather forecast both directly on the local scale due to the local impact of vertical 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 due to secondary circulations systems caused by the land-ice-sea differences.

It is furthermore demonstrated that the sea state conditions may change considerably within short range forecasting periods up to 48 hours. This implies the necessary application of ocean models, two-ways coupled to the weather forecasting model. The coupling of a simplified ocean model to the operational SMHI weather forecasting model HIRLAM is described. The coupled ocean model includes one component for the formation, advection and melting of sea ice and another component for the sea surface temperature in 31 Baltic Sea regions, including the modelling of the sea surface energy balance and a vertically resolved parameterization of turbulent transports. The coupled model system is applied operationally at the SMHI. No data assimilation is applied in the ocean component - manual modifications to the sea state variables are introduced a few times every winter season.

The application of this simplified 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. A successful application of a simple assimilation of sea surface temperatures is presented. 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" term to the ocean model equations over a time period of several hours. It turns out that this „nudging" is successful in avoiding the drift away from realistic sea state conditions. The described ocean data assimilation scheme has been applied successfully in a re-run of the BALTEX mesoscale re-analysis for the cold winter 1986/87. The quality of this re-analysis was assessed through the successful simulation of the convective snowbands in January 1987.

Future options for the coupling of simplified as well as more complex ocean models to the weather forecasting model are discussed, finally. It is concluded that many things can be learned from the application of the coupling to a simplified model as a first step, while the coupling in a second step must be extended to a more complete ocean model, that is able to describe advection processes such as coastal upwelling.

Appendix 6

BALTEX

Pilot Study
for Intensive Data Collection and Analysis
of Precipitation

PIDCAP

August to November 1995

Project Description

Revised Version
April 30, 1996

Contents

Summary

The Initial Implementation Plan for BALTEX, the Baltic Sea Experiment, foresees Intensive Observation Periods in order to provide basic data sets for the analysis and diagnosis of synoptic-scale systems and extreme events in the BALTEX region. The first of such an Intensive Observation Period is PIDCAP, the BALTEX *Pilot Study for Intensive Data Collection and Analysis of Precipitation.* The objectives of PIDCAP include 1) the collection, analysis and intercomparison of measured and estimated precipitation from different data sources in order to identify and establish reliable standards for model validation, and 2) the validation of the output of different regional models against such precipitation data sets. The observational period of PIDCAP is scheduled for August to November 1995, the area of interest is the entire catchment region of the Baltic Sea. Precipitation data sets to be compared will include standard data (gauge land stations) and non-standard data (research vessel, specially equipped ships of opportunity, from SSM/I and radar stations). Modelling groups at MPIfM, GKSS, DMI and SMHI will perform model runs with different regional models for the same period. At present, 16 different research projects from five countries are included in PIDCAP.

1 Introduction

A number of challenging tasks for BALTEX, as outlined in the Scientific Plan for BALTEX, can adequately be solved only in close co-operation between scientists and groups from different research directions or disciplines. Measurement and modelling of precipitation will be a key issue in order to meet the objectives of BALTEX. For validation of model results reliable ground truth data must be established. This includes estimates of their uncertainties. Ground truth data will have to be compared against each other in order to identify their specific potential with respect to model validation.

At a national BALTEX workshop in Germany the need for intense co-operation between different national groups within the German BALTEX contribution and with BALTEX groups in other countries has been recognized. As a consequence plans for co-operation and interaction between groups have been outlined during this workshop. An ad-hoc working group on problems of precipitation measurements pointed out the urgent need for an organized initiative to collect rain data from different sources for comparison and validation purposes.

The implementation of this initiative was planned in form of an Intensive Observation Period. The workshop suggested to organize a

BALTEX Pilot Study for Intensive Data Collection and Analysis of Precipitation (PIDCAP).

2 Objectives of PIDCAP

The objectives of this pilot study are

- to collect and analyse measured and estimated precipitation from different data sources,
- to compare different precipitation data sets against each other in order to identify and establish reliable standards for model validation,
- to validate the output of BALTEX Regional Models against such precipitation data sets,
- to develop, test and establish necessary data management and analysis procedures (especially the co-operation between different research groups and the BALTEX Meteorological Data Center) for future comprehensive studies in the framework of BALTEX.

The key data collection and modelling period for PIDCAP had originally been confined to three months, August to October 1995. One reason for this choice was that August to October include the period of the year with highest mean monthly precipitation on average for the entire BALTEX region. Furtheron, the intention was to concentrate in this first BALTEX observational period on rain only and exclude snowfall, or more general, winter conditions in the region. Two extreme storm events occurred during November 1995 in the BALTEX region which have been considered useful to be included in later model and diagnostic studies in the frame of BALTEX. Hence, the months of **August to November 1995** are defined as the PIDCAP observational period.

The area of interest for PIDCAP is the entire catchment region of the Baltic Sea. It will include both land surfaces and the Baltic Sea area.

3 Implementation of PIDCAP

The BALTEX Science Steering Group, on its second meeting in Helsinki, January 25-27, 1995, considered PIDCAP as an important contribution to BALTEX and recommended international participation. The Initial Implementation Plan for BALTEX identifies two types of field experiments in order to investigate physical processes related to the energy- and water cycle of the BALTEX region: 1) field experimental campaigns studying small- and meso-scale processes, and 2) Intensive Observational Periods, the principle objectives of which are to provide basic data sets for the analysis and diagnosis of synoptic scale systems and extreme events in the BALTEX region.

PIDCAP will be mainly an Intensive Observational Period. Additionally, a field campaign is scheduled for September 1 - 9, 1995, when the research vessel ALKOR of IfM Kiel will operate in the Baltic Proper east of the island of Gotland. Part of the contributions to PIDCAP described in section 4 are closely related to this ALKOR cruise.

For estimating rainfall and in order to validate rainfall predictions from models BALTEX will rely on a combination of different techniques with different characteristics concerning e.g. estimation technique, and resolution in time and space. The major objective of PIDCAP is to compare such rainfall estimates from different sources for at least part of the BALTEX area, and to identify their particular strengths and weaknesses. In a second step measured and estimated amounts of rainfall will be compared to model outputs. Time resolution of rain estimates will be at least one day. If possible, time resolution should be increased to 12 or 6 hours.

PIDCAP is meant to be a pilot experiment for later comprehensive BALTEX research phases. In this sense PIDCAP will serve as a test for procedures to combine data sets from different measurement and modelling sources. These procedures need to be developed towards a near-operational state. Hence, participation of the BALTEX Meteorological Data Center is an important step in order to test and, if necessary, to improve or develop data exchange strategies for BALTEX.

PIDCAP will rely on methods already available at different BALTEX participants or other groups. It will be run in „addition of expertise" mode: Each group is expected to determine rain in the BALTEX area by its own techniques for a given area and a given period of time. During the experiment there will be no central experiment co-ordination and no central logistics. Necessary contacts between individual groups have to be organized primarily by the participating groups. In order to prepare feasible data exchange during or after the study another co-ordinating meeting with participation of all groups will be performed before the start of PIDCAP. This meeting will be organized by the International BALTEX Secretariat in co-operation with the Institute of Marine Sciences in Kiel (IfM). However, in general, it is recommended that participating groups develop their own co-ordination of activities and procedures in PIDCAP. Both, IfM Kiel (L. Hasse) and the International BALTEX Secretariat will prepare and survey PIDCAP in a more loose manner, but activities have primarily to originate from the participating groups.

There will be no extra or central funding for PIDCAP. Participants will need to rely on their own sources and funding to support their participation in PIDCAP.

4 Contributions to PIDCAP

Two coordination meetings for PIDCAP took place on October 10, 1994 at IfM Kiel, and on August 29, 1995 in Visby, Sweden. The participating groups defined their research interest for PIDCAP. Data sampling strategies were coordinated. An announcement for PIDCAP was formulated and distributed asking for further participation of other groups.

To date, research groups in Sweden, Finland, Denmark, Austria, Great Britain and Germany have indicated their interest to participate in PIDCAP. Two projects from SMHI dealing with HIRLAM precipitation forecasts and meso-scale precipitation analysis including radar data from the NORDRAD network, a modelling project at DMI and a precipitation analysis project at Vienna University confirmed contribution to PIDCAP.

Two BALTEX data workshop were held in Minsk, Belarus, at the beginning of November 1994, and in St. Petersburg, Russia, in June 1995. During these workshops representatives of six countries which already co-operate within BALTEX (Belarus, Estonia, Latvia, Lithuania, Poland and Russia) indicated their intention to participate in PIDCAP. The intention is to provide a comprehensive data set of daily rainfall amounts measured at all existing conventional rain stations in those regions of the above-mentioned countries which are part of the BALTEX area. This will include, in particular, those stations which do not transmit their data into international accessible data centers, and hence, will not be available on a routine basis.

A first PIDCAP workshop is scheduled to take place on June 10 - 11, 1996 at SMHI, Norrköping, Sweden. First results and future research based on PIDCAP data will be discussed on this workshop.

In the following the participating research groups of PIDCAP and their research interests are shortly described. At present 16 projects are included in PIDCAP:

- I Rain estimates from ship gauges - Ferry-boats
- II Rain estimates from ship gauges - Research vessel
- III Estimation of the Atmospheric Water Vapor Content from Ground-Based GPS Observations
- IV Airborne validation of cloud and precipitation parameters
- V Application of Microwave Remote Sensing for the Study of Precipitation Systems over the Baltic Sea
- VI Derivation of rain rates from satellite data using a combination of visible, infrared, and microwave data
- VII Weather Radar Data for PIDCAP
- VIII Swedish Weather Radar Data for PIDCAP
- IX Rain measurements at land stations, daily values
- X Validation of model results of precipitation - REMO at GKSS
- XI Validation of model results of precipitation - REMO at MPIfM
- XII Validation of model results of precipitation - HIRLAM at DMI
- XIII HIRLAM precipitation forecasts for PIDCAP
- XIV Gridded meso-scale precipitation data for six hour periods during PIDCAP
- XV Monthly gridded precipitation data
- XVI Objective analysis of surface precipitation

They are described with more detail at the following pages.

I Rain estimates from ship gauges - Ferry-boats

1. Principal Investigators L. Hasse

2. Institute Institut für Meereskunde, Kiel

3. Participants K. Niekamp and M. Großklaus

4. Scientific Objective

Determine rain at the Baltic Sea

5. Methodology and Approach

We have deployed recording rain gages at ferries of the route Lübeck / Helsinki. This provides rain amounts for the main body of the Baltic Sea. The data can be used to establish a rain climatology of the Baltic Sea and to calibrate other techniques of rain estimation.

6. Measurement or Data Collection Plan

Data are collected at ships that run continuously between Lübeck and Helsinki and are about 40 hours out of 48 hours at sea. Special ship rain gages are used that are suitable to measure rain at moving ship. Rain amounts are determined every 8 minutes and are recorded together with the position for later analysis. We intend to equip two additional ships with ship rain gages in 1995. The data are collected along the mayor shipping route in the long direction of the Baltic Sea.

7. Analysis Technique

The data collection at running ship can be seen as a sampling for a given location along the ship route. For the determination of rain climatology, the rain amounts are corrected according to the time fraction of ship in area to total time. This provides a rain climatology along the back bone of the Baltic Sea. The simplest analysis techniques is to compare data at sea with data from shore stations, and draw isolines according to distance from shore (traditional analysis techniques). A better extrapolation from the line to the area is via numerical weather forecast models (NWF model). Such model provide fields of rain forecast for the area. Calibration against ship rain measurement of forecasted rain would lead to an improved determination of rain for the Baltic Sea.

8. Data Requirements, Co-operation

Rain measurements from shore stations and rain estimates from NWF models.

9. Time Plan
Two ships at present take observations continuously.

10. Additional Remarks

We would try to help to equip additional ships with ship rain gages, preferably such that do meteorological routine observations already. We intend to co-operate with other groups who need verification data from the sea.

II Rain estimates from ship gauges - Research vessel

1. Principal Investigators L. Hasse

2. Institute Institut für Meereskunde, Kiel

3. Participants K. Niekamp

4. Scientific Objective

Shipborne rain measurements for validation of rain estimates at sea from remote sensing methods and numerical weather forecast models.

5. Methodology and Approach

Rain will be measured at R.V. ALKOR by a mechanical ship rain gage and an optical disdrometer. The instrumentation is designed to allow measurements at a moving ship. Measurements are to be taken at a position where radar measurements are available and conditions are favourable for microwave satellite remote sensing of rain.

6. Measurement or Data Collection Plan

R.V. ALKOR will operate east of Gotland the first 10 days of September 1995 and collect rain data. Standard sampling interval is 8 minutes for rain amount and drop spectra. Data can be combined to hourly averages.

7. Analysis Technique

Data are available as short term (8 minute) and hourly rain amounts for a given position or cruise leg. The ship rain gage collects rain at a horizontal and a vertical rain collecting surface. Total rain amount is calculated as a function of local relative wind speed from the two items of information. The ship rain gage has been calibrated with reference to disdrometer measurements.

8. Data Requirements, Co-operation

Fields of frontal and convective rain for the position / cruise leg of R.V. ALKOR from any kind of rain estimation.

9. Time Plan

R.V. ALKOR will be available at the site east of Gotland from about 1 through 9 September 1995. Measurements will be made on route from Kiel to Gotland and return starting 25 August, ending 11 September 1995.

10. Additional Remarks

We will also try to measure air sea momentum transfer by the so-called eddy dissipation technique.

III Estimation of the Atmospheric Water Vapor Content from Ground-Based GPS Observations

1. Principal Investigators G. Elgered, J.M. Johansson, T.R. Carlsson

2. Institute Onsala Space Observatory, Chalmers University of Technology, Onsala, Sweden

3. Participants G. Elgered, J.M. Johansson, T.R. Carlsson

4. Scientific Objective

Provide time series of the atmospheric water vapour content above some 25 GPS sites in Sweden and Finland during the August-October 1995 time period.

5. Methodology and Approach

The total propagation delay due to the neutral atmosphere is estimated simultaneously with the geodetic quantities while analyzing GPS data. A correction based on the ground pressure at the site is subtracted from the total propagation delay to obtain a quantity related to the water vapor content. An uncertainty of 1 mbar in the ground pressure corresponds to 0.4 kg/m^2 in the water vapor content. The water vapour content will also be derived from radiosonde data obtained at four Swedish sites. These will be used to validate the GPS results. Since the time resolution of these data is typically 12 hours we will also carry out a comparison using a microwave radiometer at the Onsala site operating at the frequencies 21.0 and 31.4 GHz, which gives both the water vapor and the cloud liquid content for more than 90% of the time. It provides the inferred water vapor content with a time resolution much better than a minute.

6. Measurement or Data Collection Plan

The Swedish and Finnish GPS networks are operating continuously and data from the PIDCAP period have been available since late 1995. Data from a ground based microwave radiometer have been acquired at the Onsala Space Observatory and radiosonde data from Swedish sites will also be used.

7. Analysis Technique

The software package GIPSY developed by Jet Propulsion Laboratory is used for the geodetic analysis of the GPS data. Special software needed to estimate the water vapour content and to compare these results with those from the other techniques have been developed 'in house'.

8. Data Requirements, Co-operation

Estimates of the orbits of the GPS satellites have been obtained from the International GPS Service for Geodynamics (IGS). The local pressure at each GPS site will be estimated by the Swedish Meteorological and Hydrological Institute (SMHI). SMHI will also deliver the radiosonde data.

9. Time Plan

The GPS data from the PIDCAP period have been analyzed and quality checked. Estimation of water vapour content time series is ongoing (April 1996) and is planned to be complete in August 1996. Data from the microwave radiometer is being processed and will be completed before the summer. Radiosonde data have not yet been delivered. Comparisons between the data sets will continue through the rest of 1996 and into 1997. Time series (quality checked) of the water vapour content will, however, be made available to the community at the end of 1996.

IV Airborne validation of cloud and precipitation parameters

1. **Principal Investigators** D. Offiler

2. **Institute** United Kingdom Meteorological Office

3. **Participants** D. Jones, S. English

4. Scientific Objective

Validation of RT models describing (precipitating) clouds for development of passive microwave precipitation and liquid water path (LWP) algorithms (e.g. for AMSU, SSM/I, SSM/T1+2, MIMR)

5. Methodology and Approach

a) To use C-130 thermodynamic and microphysical data and NORDRAD data to populate an RT model for comparison with SSM/I and airborne microwave radiometer radiances at 23.8, 50.3, 89 and 157 GHz.

b) To use C-130 *in situ* data to validate SSM/I LWP algorithms and to test performance of these algorithms in precipitating systems. These algorithms will also be validated against LWP derived from C-130 microwave radiometers.

6. Measurement or Data Collection Plan

C-130 flights will be coordinated with R/V Alkor, DMSP overpasses and NORDRAD radar network. The C-130 has a long endurance and may operate at all heights up to approximately 10 km. Comprehensive measurements of standard thermodynamic parameters, cloud microphysics and narrow- and broad-band infra-red radiation are made as well as passive microwave observations at a range of frequencies.

7. Analysis Technique

LWP retrieval algorithms have already been developed by UKMO and expertise exists in combining radar and aircraft data for radiative transfer modelling at microwave frequencies.

8. Data Requirements, Co-operation

a) All DMSP passive microwave radiances
b) Ship/ferry raingauges
c) NORDRAD rainfall fields
d) 3D reflectivity fields from Rostock radar
e) "Alkor" radiometer TBs and derived water vapor burdens/LWPs

9. Time Plan

There may a few months delay in producing "definitive" calibrated microwave TBs from the aircraft radiometers. *In situ* thermodynamic and microphysical values could be made available on a shorter time scale.

V Application of Microwave Remote Sensing for the Study of Precipitation Systems over the Baltic Sea

1. Principal Investigators E. Ruprecht and C. Simmer

2. Institute Institut für Meereskunde, Kiel/Meteorologisches Institut, Bonn

3. Participants C. Füg, H. Gäng, D. Ackermann

4. Scientific Objective

Investigation of the microwave radiation of rain clouds for validation of microwave radiative transfer models and algorithms to estimate rainfall over the sea.

5. Methodology and Approach

During a 2 weeks period August/September 1995 an experiment on the research vessel "Alkor" is planned in the center of the Baltic Proper.
Measurements are planned on board with the following instrumentation:
- radiosondes launched from the ship to describe the thermodynamic state of the atmospheric column above
- microwave radiometer, to measure the downwelling microwave radiances
- ceilometer, to determine the height of the cloud base
- instrumentation to measure sea surface temperature and meteorological data at ship level: temperature, humidity, wind, radiation.

The data are used as input for:
- the radiation model to simulate the upwards and downwards directed microwave radiances
- the mesoscale cloud model GESIMA to simulate the (vertical) distribution of cloud water and ice content and of precipitation water. The 3-dimensional distribution of rainwater within the precipitation system will be analyzed with help of RADAR observations.

6. Measurement or Data Collection Plan

a) radiosonde observations (T,RH,v) several times per day: at the times of satellite overpasses (SSM/I) and depending on certain weather situations (precipitation systems).
b) microwave data from the ship-borne radiometer: continuously
c) synoptical observations: every hour (including SST)
d) cloud base height: continuously.

7. Analysis Technique

8. Data Requirements, Co-operation

In addition to the observations carried out on board the following data are required for the period of the experiment:
a) SSM/I data of all overpasses
b) Satellite data in the VIS and IR spectral range from NOAA-satellite (AVHRR), METEOSAT
c) Precipitation data from gauge on "Alkor"
d) RADAR data (NORDRAD, DWD)
   - 3-dimensional for the experimental site
   - horizontal distribution of derived precipitation over the Baltic Sea
e) numerical results of REMO.

9. Time Plan

a) The experiment is planned for the time period of August 23 to September 6, 1995. The data will be processed in the following two months.
b) Satellite data
   - VIS, IR data are normally available within one month after observation
   - SSM/I data are available 2 - 3 month after observation.

VI Derivation of rain rates from satellite data using a combination of visible, infrared, and microwave data

1. Principal Investigators J. Fischer

2. Institute Freie Universität Berlin

3. Participants R. Bennartz, A. Thoss

4. Scientific Objective

Although several global retrieval algorithms for cloud and rain parameters based on microwave data over ocean exist, the application of these algorithms to the BALTEX region is rather problematic. Two major reasons for that are: First, global algorithms may not represent special climatic regions very well. Second, the Baltic Sea is mainly comprised of coastal waters. Taking into account the low resolution of spaceborne passive microwave radiometers, algorithms developed for open ocean conditions will fail. In order to tackle these problems we will derive synergic algorithms using a combination of infrared and visible data, which has a high resolution, and microwave data. Employing these algorithms, datasets of cloud liquid water content, instantaneous rain rates, and other parameters will be made available.

5. Methodology and Approach

In the microwave region a broad range of physically realistic atmospheric conditions will be simulated using an existing matrix operator model. Additionally, statistical information derived from NOAA/AVHRR and METEOSAT data will be included in the retrieval algorithms.

6. Measurement or Data Collection Plan

Data from NOAA/AVHRR, METEOSAT and DMSP/SSM/I is needed. Further, radio-soundings for the BALTEX region are needed as input for radiative transfer simulations.

7. Analysis Technique

The simulated and statistical datasets will be inverted using gradient methods.

8. Data Requirements, Co-operation

NOAA/AVHRR and METEOSAT data are operationally archived at the FU Berlin. Microwave datasets (SSM/I) for the PIDCAP study period from August to October 1995 have to be purchased from Remote Sensing Systems, Santa Rosa, California. The total expenses for that will be about 800 US$/month = 2400 $ total. In order to validate the retrieval algorithms, especially for rain rates, it will be necessary to get rain radar measurements.

9. Time Plan

Preliminary studies will be done until May 1995. First results of the retrieval algorithms will be available at October 1995.

10. Additional Remarks

Additional financial support is needed, to purchase the SSM/I data for the PIDCAP study period (see. 8.).

VII Weather Radar Data for PIDCAP

1. Principal Investigators J. Riedl (DWD, MOHp)

2. Institute German Weather Service (DWD)
Meteorological Observatory Hohenpeissenberg (MOHp)

3. Participants I. Doelling

4. Scientific Objective

Provision of radar reflectivity data and area precipitation data.

5. Methodology and Approach

a) Filter technique investigations (Doppler, statistical) and optimization of the signal processor parameters
b) Topical Z/R-relation derived from Distrometer data
c) Calculation of area precipitation (100 km range) and adjustment by surface rain gauge data (see additional remarks)
d) Extraction of three-dimensional radar reflectivity data from the Rostock radar (see additional remarks)
d) Estimation of the precipitation coverage of the southern Baltic Sea by compositing NORDRAD, Danish and German radar data.

6. Measurement or Data Collection Plan

1. November 94 - July 95
   a) Preparation radar Rostock (performance, clutter effects, storage capacity)
   b) Preliminary evaluation Distrometer/Ombrometer data Rostock (and Fehmarn)
   c) Preparation of access to NORDRAD and Danish radar data and to wind data.
2. August 95 - December 95
   a) Operational radar data collection including Distrometer/Ombrometer data (DWD)
   b) Data collection NORDRAD and wind data for selected periods
   c) Calculation of adjusted area precipitation data.

7. Analysis Technique

8. Data Requirements, Co-operation

a) NORDRAD data
b) Ship rain gauge data (L. Hasse, Kiel)
c) Surface rain gauge data (DWD)
d) Wind data (DWD-network, masts and buoys in the Baltic Sea).

9. Time Plan

November 94 - July 95 (6.1) and August 95 - December 95 (6.2).

10. Additional Remarks

a) To 5c): Adjusted data of daily accumulated area precipitation will be calculated for up to 10 selected days of the period.
b) To 5d): The extraction will be performed for the predetermined satellite passages.

VIII Swedish Weather Radar Data for PIDCAP

1. Principal Investigators T. Andersson

2. Institute Swedish Meteorological & Hydrological Institute
Research & Development

3. Participants T. Andersson, D. Michelson

4. Scientific Objective

a) To improve our ability to use radar for analysing precipitation.
- To improve our knowledge of the characteristics and behaviour of precipitation.
- To improve our knowledge of the characteristics and behaviour of clutter types.
- To improve current methodology for identification and removal of artifacts in radar data caused by clutter.

b) To improve our ability to use radar for analysing winds.
- To develop a methodology for utilizing clear air echoes when analysing winds (during warm seasons).

5. Methodology and Approach

- Image analysis methods on 2-D PseudoCAPPI imagery.
- Improved methods for analysis and processing of 3-D polar data.
- Improved analysis of vertical reflectivity profiles.

6. Measurement or Data Collection Plan

a) NORDRAD composite imagery:
- archive all individual reflectivity and wind images
- generate and archive all composite images
- generate and archive corrected composite images (see point 7).

b) Precipitation from satellites
- archive ZNP volume scans from Gotland, coincident with DMSP SSM/I image acquisitions.

c) UKMO C-130 campaign: week 36 (see project IV in this report)
- archive reflectivity and wind colume scans from the Gotland, Karlskrona and Norrköping radars.

7. Analysis Technique

8. Data Requirements, Co-operation

Knowledge of DMSP SSM/I data aquisition times. (C. Simmer, Kiel, see project V)

9. Time Plan

Data collection: August - October 1995.
Data analysis: Autumn - Winter 1995-96.

IX Rain measurements at land stations, daily values

1. Principal Investigators A. Lehmann

2. Institute Deutscher Wetterdienst (DWD) Offenbach
Meteorological Data Centre for BALTEX at DWD

3. Participants R. Luckner

4. Scientific Objective

The Meteorological Data Centre for BALTEX will be the service centre for all national and international participants in BALTEX research activities as regards meta-information on data, data collection and data exchange.

PIDCAP should be the first testing phase to develop, test and establish necessary management and analysis procedures.

5. Methodology and Approach

MDC obtained information about precipitation data in the BALTEX countries by an questionnaire, which was distributed to all meteorological and hydrological services, participating in BALTEX. The information about delayed data is expected to be not yet complete for some countries. The MDC will contact international participants in order to supply the information.

6. Measurement or Data Collection Plan

The BALTEX MDC partly works as a METADATA Centre.
The following types of data are planned to be stored physically at DWD (relating to PIDCAP):

- all data of the German meteorological network
- all data of the PIDCAP area (type SYNOP and TEMP), transmitted in real time via GTS.

The MDC will endeavor to obtain additional delayed precipitation data, measured and stored in the countries participating in PIDCAP.

7. Analysis Technique

8. Data Requirements, Co-operation

The success of taking available additional non-real-time data from abroad will depend on the co-operation of PIDCAP nations.

9. Time Plan

Real-time data will be available as quick-look data with only a very short delay.
Non-real-time data of German precipitation network will be available about 2 months after the end of a measuring period.

X Validation of model results of precipitation

1. Principal Investigators B. Rockel

2. Institute GKSS Forschungszentrum Geesthacht

3. Participants U. Karstens, R. Nolte-Holube

4. Scientific Objective

Validation of the BALTEX Version of the Regional Model (REMO), in particular the validation of the parameterization for rain fall. Computations will be carried out using the physical parameterization routines developed by the German Weather Service (DWD). The results will be compared to measured precipitation rates and the results of the study proposed by the Max-Planck-Institute for Meteorology in Hamburg (MPI), (see proposal XI) .

5. Methodology and Approach

REMO is based on the "Europa-/Deutschland-Modell (EM/DM)" weather forecast models of the DWD. The user can choose between two implemented physics: the original EM/DM and the ECHAM4 physics.

6. Measurement or Data Collection Plan

Spatial resolution of precipitation data calculated by REMO is 18 x 18 km^2. Temporal resolution is approximately 5 min; however, a minimum of 1 h for model output is preferred. The output format is either HDF or WMO GRIB1. 30h forecasts will be performed using the hours 6 to 30 for precipitation interpretation.

7. Analysis Technique

8. Data Requirements, Co-operation

Analysis data (six hourly EM initial analysis) of the DWD are required for the selected period. These data are used to run the REMO in low resolution (55 x 55 km^2, l-REMO) that calculated the boundary values for REMO in high resolution (18 x 18 km^2, h-REMO). We are interested in all data relevant for the atmospheric energy budget and water cycle, especially rainfall data.

9. Time Plan

Per workday normally we can run one l-REMO/h-REMO combined 30h forecast on the Cray C916 at the German Climate Computing Centre in Hamburg. Therefore, we will need about three months to get all results for the selected period (Aug. - Oct. 1995). If we could get the analysis data by day from the German Weather Service during that period, the results can be obtained latest end of November 95.

10. Additional Remarks

X I Validation of model results of precipitation

1. Principal Investigators M. Claussen

2. Institute Max-Planck-Institut für Meteorologie, Hamburg

3. Participants D. Jacob

4. Scientific Objective

Validation of the Regional Model (REMO) with respect to parameterization of processes relevant for rain fall. The parameterization routines implicit in the Hamburg climate model ECHAM4 will be tested and compared with the performance of the routines implicit in the Europa-/Deutschland-Modell (EM/DM) weather forecast models of the German weather service (DWD) (see proposal X).

5. Methodology and Approach

REMO is based on the EM/DM weather forecast models of the DWD. REMO includes prognostic equations of temperature, humidity, and liquid water instead of total heat and total water content as used in EM/DM. Two packages of parameterization routines can be chosen: from EM/DM and from ECHAM4.

6. Measurement or Data Collection Plan

Spatial resolution of precipitation data calculated by REMO is 18 x 18 km^2 . Temporal resolution is approximately 2 - 3 min; however, only 1h-mean values are stored as model output. The output is GRIB 1.

7. Analysis Technique

8. Data Requirements, Co-operation

Analysis data (six hourly EM initial analysis) of the DWD are required for the selected period. These data are used as boundary values for REMO. We are interested in all meteorological data (mean sea level pressure, wind, temperature, cloudiness, and, particularly, precipitation) that can be used for comparison with REMO results. Co-operation is planned with DWD and GKSS (see proposal X).

9. Time Plan

Under favorable circumstances, it takes approximately one month to simulate one month. Depending on the availability of the EM initial data, the simulations can be finished by December.

XII Validation of model results of precipitation - HIRLAM at DMI

1. Principal Investigators B. Sass

2. Institute Danish Meteorological Institute (DMI), Copenhagen

3. Participants DMI staff

4. Scientific Objective

Validation of the atmospheric water cycle in the HIRLAM forecasting system during the PIDCAP period.

5. Methodology and Approach

The most recent version of the HIRLAM analysis and forecast model will be used. The model domain is chosen to agree with that used at SMHI. In addition, this applies to the horizontal and vertical model resolution. The data assimilation and forecasts with the HIRLAM forecasting system will be carried out in delayed mode at DMI in contrast to the procedure applied at SMHI. This method has the advantage that conventional meteorological data that may not be available due to real time cut-off limitations can be utilized in the analyses.

6. Measurement or Data Collection Plan

The atmospheric analysis frequency is 6 hours. For validation of the parameterized precipitation it is relevant to consider forecasted precipitation up to a forecast range of at least 24 hours. Such forecasts will be done daily, with precipitation data stored every 3 hours for the BALTEX region. For selected periods the frequency may be increased to one hour.

7. Analysis Technique

8. Data Requirements, Co-operation

The experience gained from the real time data assimilation and analysis with the HIRLAM system at SMHI will be utilized at DMI. The processing in delayed mode (see the time plan) also enables the utilization of various precipitation data made available to the modelling groups for validation.

9. Time Plan

The data assimilation system including extensive diagnostics related to the water cycle is set up during spring 1996. The results of the precipitation validation utilizing other data obtained during PIDCAP should become available one year later.

XIII HIRLAM precipitation forecasts for PIDCAP

1. Principal Investigators K.-G. Karlsson

2. Institute Swedish Meteorological and Hydrological Institute (SMHI), Norrköping, Sweden

3. Participants K.-I. Ivarsson, K.-G. Karlsson, N. Gustafsson

4. Scientific Objective

Validation of precipitation forecasts from the mesoscale version of the HIRLAM model.

5. Methodology and Approach

HIRLAM is the basic regional weather prediction model used at all the Nordic meteorological institutes. A special version is used at SMHI which includes a prognostic scheme for cloud water (the Sundqvist scheme), an improved radiation scheme and a new physiographic database with a better description of roughness and surface characteristics (topography, forest and vegetation types, land and sea fractions in each gridpoint etc.). In this study, a fine-resolution version of HIRLAM will be used having a horizontal resolution of 20 km and including 24 vertical layers.

6. Measurement or Data Collection Plan

The mesoscale HIRLAM version will be run operationally in parallel with the standard version of HIRLAM at the time for the PIDCAP experiment. Precipitation forecasts will be stored and collected for the area of interest. At least two forecast runs will be performed each day (00 UTC and 12 UTC) producing accumulated precipitation in three hour intervals. A higher time resolution (one hour) may alternatively be used.

7. Analysis Technique

Not applicable.

8. Data Requirements, Co-operation

No special requirements.

9. Time Plan

The mesoscale HIRLAM is introduced operationally 15 February 1995. Preparations for the collection of HIRLAM forecasts for the area of interest will be done before August 1995. Results will be compiled in its final form by the end of 1995.

10. Additional Remarks

Special case studies could be introduced for studying particularly interesting weather situations to test parametrization and model formulations.

XIV Gridded mesoscale precipitation data for six hour periods during PIDCAP

1. Principal Investigators L. Haggmark

2. Institute Swedish Meteorological and Hydrological Institute (SMHI), Norrköping, Sweden

3. Participants D. Michelson

4. Scientific Objective

Our objective is to create a database containing gridded analyzed precipitation information for every six hour period, during the BALTEX PIDCAP. The used grid resolution will be 0.1 degree.

5. Methodology and Approach

The analysis is based on optimal interpolation, where consideration is taken to the various data sources specific qualities, such as accuracy and sensor internal pixel correlation.

Analysis will be accomplished by integrating data from NORDRAD, observations from the synoptical and climate station networks, and forecasts from HIRLAM.

6. Measurement or Data Collection Plan

All NORDRAD, synoptical and HIRLAM data generated during the PIDCAP will be saved and used in the analysis.

7. Analysis Technique

Preprocessing of weather radar data before creating NORDRAD composites includes applying automated routines for removal of clutter and anomalous propagation echoes. See point 5 for analysis method.

8. Data Requirements, Co-operation

9. Time Plan

Analysis during the first half of 1996.

10. Additional Remarks

XV Monthly gridded precipitation data

1. Principal Investigators B. Rudolf

2. Institute Global Precipitation Climatology Centre
DWD Offenbach/Main

3. Participants B. Rudolf

4. Scientific Objective

Monthly gridded area-mean precipitation from different sources, separately, intercompared as well as merged:

- rain-gauge measurements
- IR geosynchr. satellite observations
- DMSP-SSM/I polarorb. satellite observations
- NWP model results
- climatic long-term means.

5. Methodology and Approach

Objective analysis of rain-gauge data by spatial distance/directional interpolation (method SPHEREMAP after Willmott et al.). Satellite based estimates provided by the GPCP Satellite Centres operated by NOAA and NASA (methods: GPI for IR, emission after Wilheit et al. and scattering after Ferraro et al. for SSM/I). Model based accumulated from daily ECMWF results. Grid size 0.5 degree latitude by longitude.

6. Measurement or Data Collection Plan

GTS data (SYNOP and CLIMAT reports) will be prepared to be used in the analysis with delay of about one month after observation. Additional raingauge data from national sources will be prepared with delay of about one month after delivery. The delay of delivery is unknown. Satellite based estimates will be available with a delay of about six months after observation. Model results will be prepared with delay of about one month after forecast.

7. Analysis Technique

See under 5.

8. Data Requirements, Co-operation

Monthly precipitation data from co-operating countries have to be acquired and (partly) digitized by the help of BALTEX secretariat:

600 stations	Germany	100 stations	Latvia
200 stations	Poland	400 stations	Finland
60 stations	Estonia	600 stations	Sweden
100 stations	Lithuania	50 stations	Denmark
2000 stations	Russia (baltic sea rivers catchment areas)		

9. Time Plan

Gridded single-source estimates will be available one month after data delivery (see 6.). Results of intercomparison studies are expected to be obtained by mid of 1996.

XVI Objective analysis of surface precipitation

1. Principal Investigators M. Hantel, F. Rubel

2. Institute Institute for Meteorology and Geophysics
University of Vienna - Institute for Medical Physics,
Vienna / Austria

3. Participants M. Hantel, F. Rubel

4. Scientific Objective

Grid point representation of the precipitation field over the BALTEX region based on rain gauge and radar data.

5. Methodology and Approach

The surface precipitation from SYNOP data was analysed. High resolution surface observations and radar data will be added. This guarantees optimum use of the radar information (high space/time coverage) and the surface information (high local accuracy).

6. Measurement or Data Collection Plan

Three sources of routinely observed data will be combined for the present project:
(1) Regular SYNOP data;
(2) Radar data (European sources);
(3) Additional data from the BALTEX Data Centre.

7. Analysis Technique

The technique described in 5. can be run in a coarse mode and in a fine mode. The present coarse mode over Europe has a space/time resolution of 55 km/12 hours, dictated by the SYNOP network. Preliminary runs over Austria in the fine mode (Rubel, 1994) resolve down to 12.5 km and 1 hour in time. The fine mode requires additional climate data; it shall be further elaborated for the PIDCAP period.

8. Data Requirements, Cooperation

The technique described will be applied for selected cases and periods. The more BALTEX data become accessible, the finer the structures we can resolve. This requires cooperation with the other PIDCAP groups.

9. Time Plan

- Since end of 1995; coarse mode completed.
- 1996: Runs of selected cases in fine mode.
- Coarse mode precipitation fields of the PIDCAP period will be published soon in a PIDCAP precipitation atlas.

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6 List of Abbreviations

AMSU	Advanced Microwave Sounding Unit
AVHRR	Advanced Very High Resolution Radiometer
BALTEX	Baltic Sea Experiment
DMI	Danish Meteorological Institute, Copenhagen
DMSP	Defense Meteorological Satellite Programme
DWD	Deutscher Wetterdienst, Offenbach
ECHAM	European Climate Model - Hamburg version
ECMWF	European Center for Medium Range Weather Forecast, Reading
EM / DM	Europa Model / Deutschland Model
GESIMA	Geesthachter Simulations Model der Atmosphäre
GKSS	GKSS Research Center Geesthacht
GOES	Geostationary Operational Environmental Satellite
GPCP	Global Precipitation Climatology Project
GPI	GOES Precipitation Index
GPS	Global Positioning System
GRIB	Grid in Binary Format
GTS	Global Telecommunication System
HDF	Hierarchical Data Format
HIRLAM	High Resolution Limited Area Model
IfM	Institut für Meereskunde, Kiel
IR	Infrared
LWP	Liquid Water Path
MDC	Meteorological Data Centre
METEOSAT	European meteorological satellite series of EUMETSAT
MIMR	Multi-frequency Imaging Microwave Radiometer
MOHp	Meteorological Observatory Hohenpeissenberg
MPIfM	Max Planck Institut für Meteorologie, Hamburg
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NORDRAD	Nordic Weather Radar Network
NWF	Numerical Weather Forecast
NWP	Numerical Weather Prediction
PIDCAP	Pilot Study for Intensive Data Collection and Analysis of Precipitation
RT	Radiative Transfer
REMO	Regional Model
SMHI	Swedish Meteorological and Hydrological Institute, Norrköping
SPHEREMAP	Interpolation method
SSM/I	Special Sensor Microwave/Imager
SST	Sea Surface Temperature
TB	Brightness Temperature
UKMO	United Kingdom Meteorological Office
VIS	Visible
WMO	World Meteorological Organization

Appendix 7

PIDCAP

Progress Report

30 May 1996

Upon request of the BALTEX Science Steering Group individual BALTEX research groups submitted short reports on the progress of PIDCAP-related research. This document contains reports which arrived at the BALTEX Secretariat as of 30 May 1996.

Hans-Jörg Isemer
BALTEX Secretariat
GKSS Research Centre

Number of precipitation land stations during PIDCAP

(Status as of 30 May 1996)

Country	Number
Belarus	60
Denmark	620
Estonia	60
Finland	450 2)
Germany	299
Latvia	87
Lithuania	72
Poland	1144 2)
Russia	160 1)
Sweden	762
Total	**3714**

1) Data availability not confirmed
2) Exact number to be determined

Through initiative of both the BALTEX Secretariat and the BALTEX meteorological data centre (BMDC) daily precipitation depths from more than 3500 land stations in the BALTEX area (see table) are currently being collected into the data archive of BMDC. Meteorological surface observations at synoptic stations as well as data on soil moisture, soil temperature and radiation are also being collected from all available stations in the BALTEX area.

Hans-Jörg Isemer
BALTEX Secretariat
GKSS Research Centre

PIDCAP PROGRESS REPORT

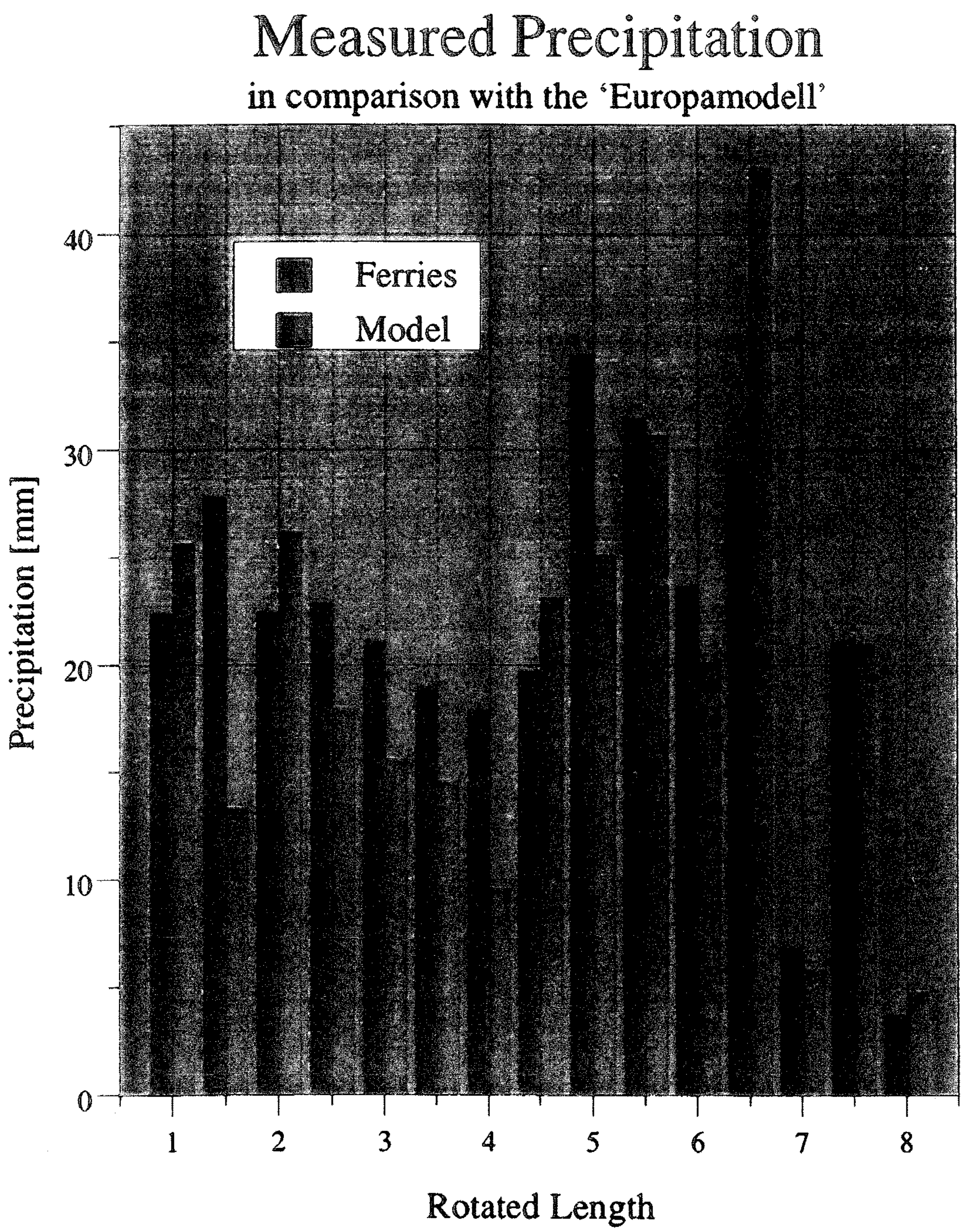
In Situ Measurements of Precipitation on Ferries

Prof. Dr. Lutz Hasse, Institut für Meereskunde, Kiel, Germany

In order to improve knowledge about precipitation on the Baltic Sea, in situ measurements of precipitation are being performed. These data are suitable to determine precipitation climatologies along the ship's tracks through the central Baltic. Extrapolation to areal means is possible with aid of other products, e.g. from remote sensing or numerical modelling. For these products the data can be used as sea truth.

Since May, 1995 there are five ship rain gauges working in the Baltic Sea area. Four of these are installed at large ferry ships, while the fifth one is implemented at the automatic weather station of the IOW (Institut für Ostseeforschung, Warnemuende) north of the island Darss. The data delivered by the ship rain gauges are supplemented by disdrometer measurements performed on RV ALKOR. This disdrometer measures the dropsize distributions of rainfall and therefore can be used to classify rainfall events to check the parametrizations of convective and stratiform rain used in numerical models.

Intercomparisons have been performed between the gauge measurements and the 24 hours forecast of precipitation from the 'Europamodell' of the DWD (Deutscher Wetterdienst). For this purpose each rainfall measurement of the ferries was assigned to a model grid square and forecast period. Then both the measured precipitation and the corresponding model output were summed up as function of the model longitudes ignoring measurements within the Luübeck- and Helsinki grid squares. Figure 1 shows the result of this intercomparison based on
PIDCAP-Data (Aug. 13th - Oct. 31st, 1996). Despite of this coarse method a good correlation between the displayed parameters is evident. The precipitation measured by the gauges and taken from the 'Europamodell' total 297 and 324 mm, respectively. This intercomparison has also been performed for each month separately. It showed best correlation in August and smaller correlation in October. Further analyses using later datasets will reveal whether this is an indication for seasonal variations in quality of model output. For the time being we perform similar intercomparisons between the gauge data and the 'REMO' model operated at the MPIfM (Max-Planck-Institut fuer Meteorologie, Hamburg). Data produced by this model are of special interest, first because this model is run in the climatological mode and second because these data are available in a much higher temporal resolution than data of the 'Europamodell'. Results of this studies will be presented at the PIDCAP meeting in Norrköping.


Measured Precipitation
in comparison with the 'Europamodell'
Ferries
Model
Precipitation [mm]
0
10
20
30
40
1
2
3
4
5
6
7
8
Rotated Length

Precipitation and Convection during PIDCAP[1]

M. Hantel[2], F. Rubel[2], F. Hamelbeck[3] and M. Ehrendorfer[3]

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1) OVERVIEW The IMG is undertaking an effort to supply analysed fields of surface precipitation for the PIDCAP period (Aug. - Oct. 1995) as background verification for the other groups. Further, for an improved understanding of the precipitation mechanism we are analysing the 3D-structure of convective activity in the free atmosphere over the BALTEX area.

2) ACHIEVEMENTS Using SYNOP rain gauge data IMG has analysed twice daily precipitation fields over the BALTEX region for the complete PIDCAP period (Rubel, 1996). Fig. 1 shows the structure characteristics of observed precipitation over Europe. This demonstrates the basis for using routine data for the present analysis (resolution 55 km × 12 hours)

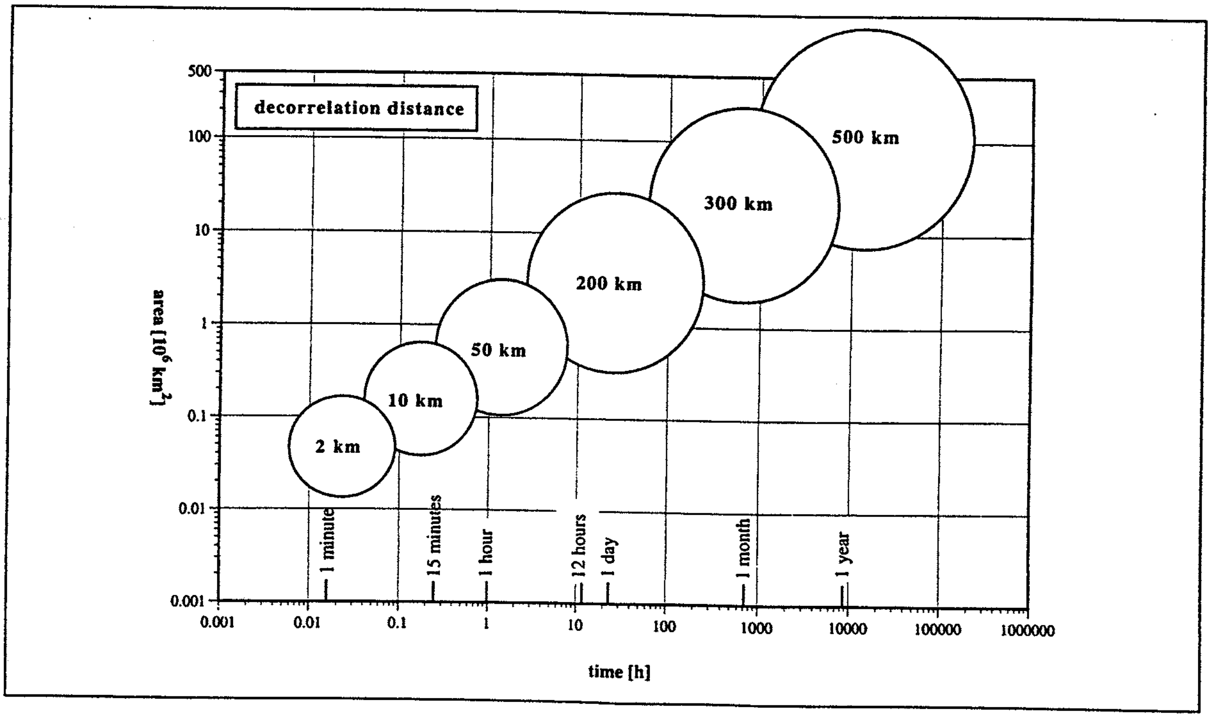

Fig. 1 Scale dependence of correlation function used for statistical analysis of precipitation, represented here by decorrelation distance for increasing spatial and temporal resolution.

and suggests, as next step, to employ higher resolving observations from the advanced BALTEX network (18 km × 1 hour) for an improved analysis.

Further, with the Vienna diagnostic model DIAMOD (Dorninger et al., 1995) we are determining the sub-gridscale correlation between moist enthalpy $c_p\vartheta$ ($\vartheta \equiv T + Lq/c_p$ is equivalent

[1]Progress Report for BALTEX Science Steering Group, May 1996
[2]Principal Investigators, Contribution of IMG to PIDCAP
[3]IMG, Vienna

temperature) and vertical velocity ω (Fig. 2). This flux $c(p)$ quantifies the strength of convection in the free atmosphere and is referred to as *total convective heat flux*. The differential equation that governs $c(p)$ is driven by the diagnosed gridscale budget of moist enthalpy. From

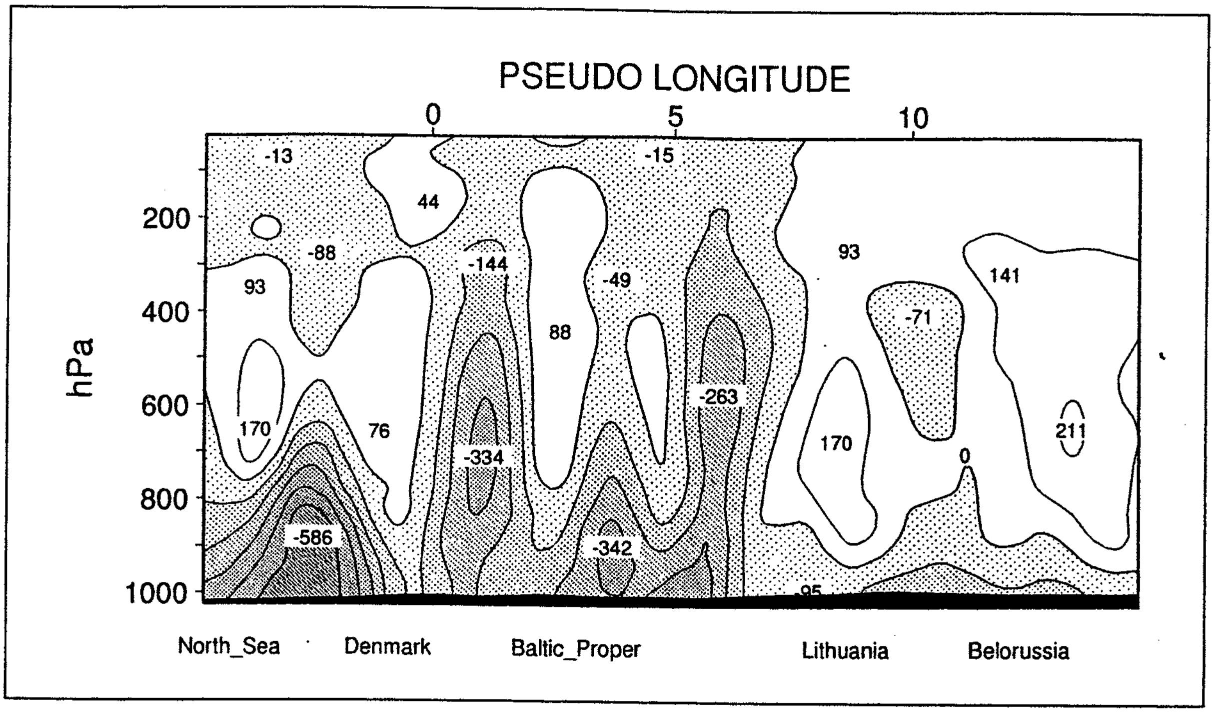

Fig. 2 East-west vertical section (pseudolatitude 2°S in rotated coordinate system) from North Sea to continental Europe of total convective heat flux defined as $c(p) \equiv g^{-1} c_p \overline{\vartheta' \omega'}$, averaged over area (100 km)^2 and over 12 hours, centered 29 Sept. 1995, 12 h. Upward flux negative (shaded), distance of isolines 100 W/m^2.

Fig. 2 one can distinguish 3 cells with sizeable convective strength (-586, -334, -342 W/m^2). Note that convection is largely confined here to the maritime sector while over Denmark and the continent it breaks down. This case was characterized by a stationary low over the Baltic.

3) OUTLOOK Further work along the lines sketched is in progress. We are trying to concentrate efforts upon (i) selecting meteorologically interesting cases on basis of PIDCAP- and BALTEX-specific data (including Radar); and (ii) enhancing both time and space resolution for the diagnostics of $c(p)$.

Acknowledgments This research was partly supported by the *EC Environment and Climate Research Programme - Climatology and Natural Hazards* (Contract No. ENV4-CT95-0072). Cooperation with, and data supply by, ECMWF (Reading) and ZAMG (Vienna) is acknowledged.

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Estimation of the Atmospheric Water Vapour Content from Ground-Based GPS Observations

G.Elgered, J.M. Johansson and T.R. Carlsson
Onsala Space Observatory
Chalmers University of Technology

With the start of the NEWBALTIC project in January 1996 it has been our task to provide time series of the water-vapour content above Swedish and Finnish continuously operating GPS sites. Approximately there were five Finnish and twenty Swedish stations operating during the main part of PIDCAP. These networks, primarily used for geodetic and geodynamic purposes, produce simultaneously with the site coordinates also an excess propagation path caused by the atmospheric constituents. From these data it is possible to infer the atmospheric water-vapour content.

The first step is to subtract the effect caused by the dry air. This can be done accurately by using the ground pressure at the GPS antenna. Since no meteorological sensors are yet available at the GPS sites pressure corrections were provided by the Swedish Meteorological and Hydrological Institute (SMHI) using a three dimensional interpolation method. Because the propagation of an error in the ground pressure is 0.4 kg/m^2/mbar we have verified that the interpolated pressure values agree at level much better than 1 mbar compared to the measured ground pressure at the Onsala site.

By applying the pressure correction we obtain the propagation delay caused by the atmospheric water vapour, often called the wet delay. The second step of the algorithm is to estimate the water vapour content from this quantity. Through a simple model using a "conversion factor" we estimate the water-vapour content from the wet delay. We have in earlier studies showed, using radiosonde data from Swedish sites, that one would introduce an extra algorithm error of approximately 2.4 % (rms) of the water vapour content if a constant, but optimized, conversion factor was to be used over the entire area of Sweden. If, however, the model includes the ground temperature this rms error can be reduced to about 1 %. Further reduction of the error with one or two tenths of a percent may be expected if one optimizes the model for a specific site. Such a model would, however, not be significantly more useful since radiosonde data would then be needed for each GPS site. In any case an algorithm error of 1 % is quite acceptable today when the accuracy of the GPS estimates of the wet delay are approximately of the order of 5 %. A paper dealing with the algorithm errors is in preparation.

The accuracy of estimated water-vapour contents from GPS data has been studied through comparisons with nearby radiosonde data for the sites of Sundsvall and Onsala for the month of August. Typical rms differences are 2 kg/m^2. We note, however, that the distances between the GPS and the radiosonde sites are some 40 km. In addition the wet delay inferred from microwave radiometer data acquired at the Onsala site have been compared to the estimated wet delay using the GPS data. The typical rms differences in the corresponding water-vapour content are in this case slightly smaller, namely 1.5 kg/m^2. This may be expected since these two instruments are located at the same site. Perhaps also the microwave radiometer provides slightly more accurate estimates than do the radiosonde data.

In any case it will be interesting to find out how much these numbers may vary as the results from the less humid months of September and October become available.

The following table shows the status of the data processing and evaluation:

	August	September	October
GPS data available (Swedish, Finnish, + other sites)	Yes	Yes	Yes
GPS data processed (geodetic analysis)	Yes	Yes	Yes
Water-vapour content derived (pressure corrections applied)	Yes	Ongoing	No
Radiosonde (RS) data available	Yes		No
RS data processed	Yes		No
Onsala radiometer data processed	Yes	Yes	Ongoing
Quality checks and comparison	Ongoing	No	No
Final results available over ftp	No	No	No

If we do not run into any unforeseen problems it is planned to have at least the August and September data analyzed in order to allow comparisons between the three different methods to be presented at the meeting in Norrkoping, June 10 -12, 1996.

In summary, it seems safe to state that so far the project has been running smoothly. The GPS data seem to have few gaps and the accuracy is as good as we could have reason to expect. This means an rms difference of 5 - 10 % of the water-vapour content when comparing the results to those from microwave radiometer data. It should be noted that it is an advantage to be able to work with GPS data that are old (not closer to real time than a month) since this means that we can use the most complete geodetic solutions including the very best determined GPS orbits which otherwise may introduce an extra uncertainty in the estimated wet delays.

Figure 1 : Locations of GPS stations which have delivered data during PIDCAP.

Figure 2 : Vertically integrated water vapour content at 4 sites in southern Sweden during 4 to 6 August 1995.

Figure 3 : Integrated water vapour (IWV) at Onsala, Sweden from GPS compared to ground-based microwave radiometry data (WVR) for August 1995.

Fig. 1

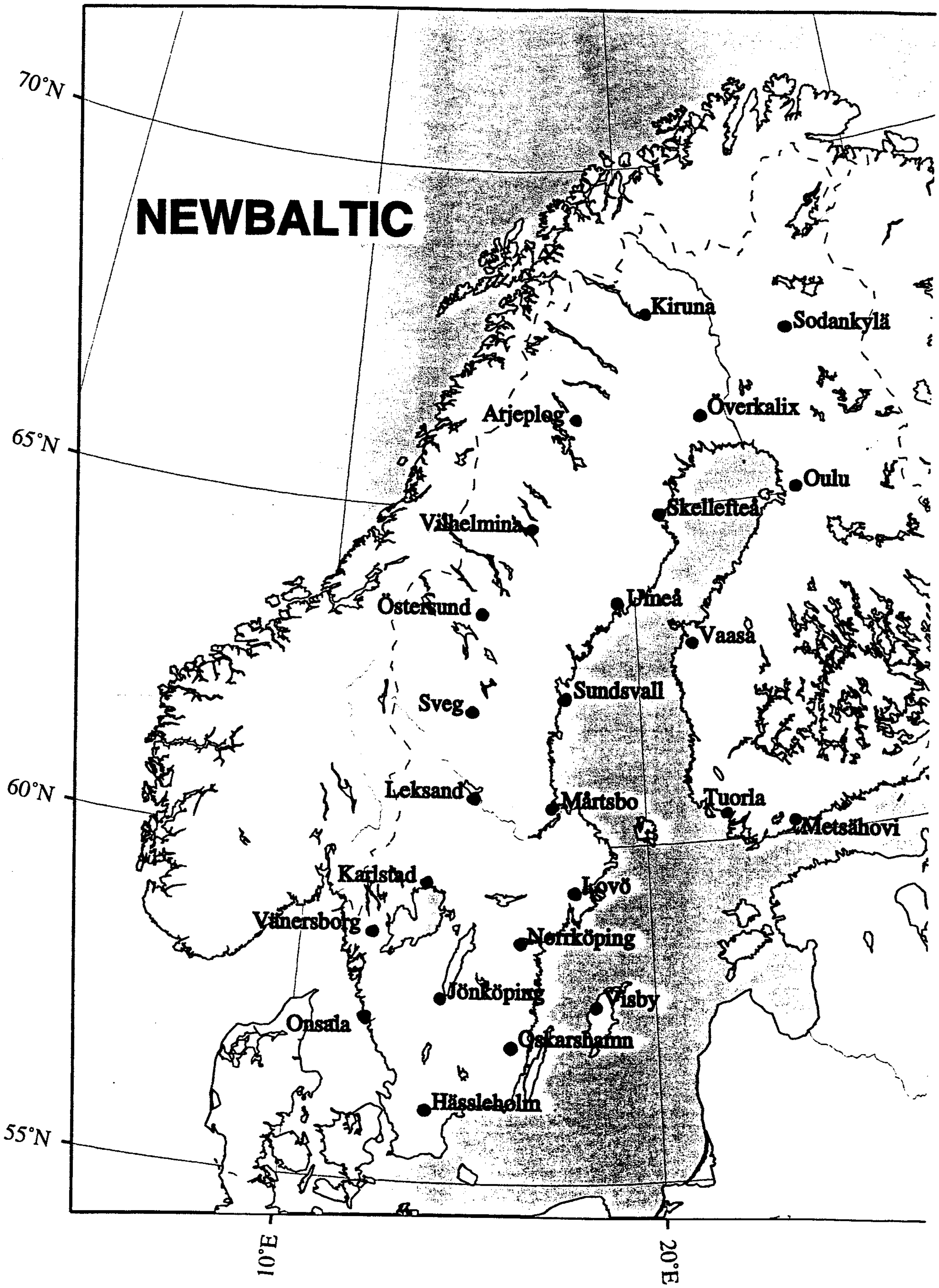

NEWBALTIC
70°N
65°N
60°N
55°N
10°E
20°E
Kiruna
Sodankylä
Överkalix
Arjeplog
Oulu
Skellefteå
Vilhelmina
Umeå
Östersund
Vaasa
Sundsvall
Sveg
Leksand
Mårtsbo
Tuorla
Metsähovi
Karlstad
Lovö
Vänersborg
Norrköping
Jönköping
Visby
Onsala
Oskarshamn
Hässleholm

Fig. 2

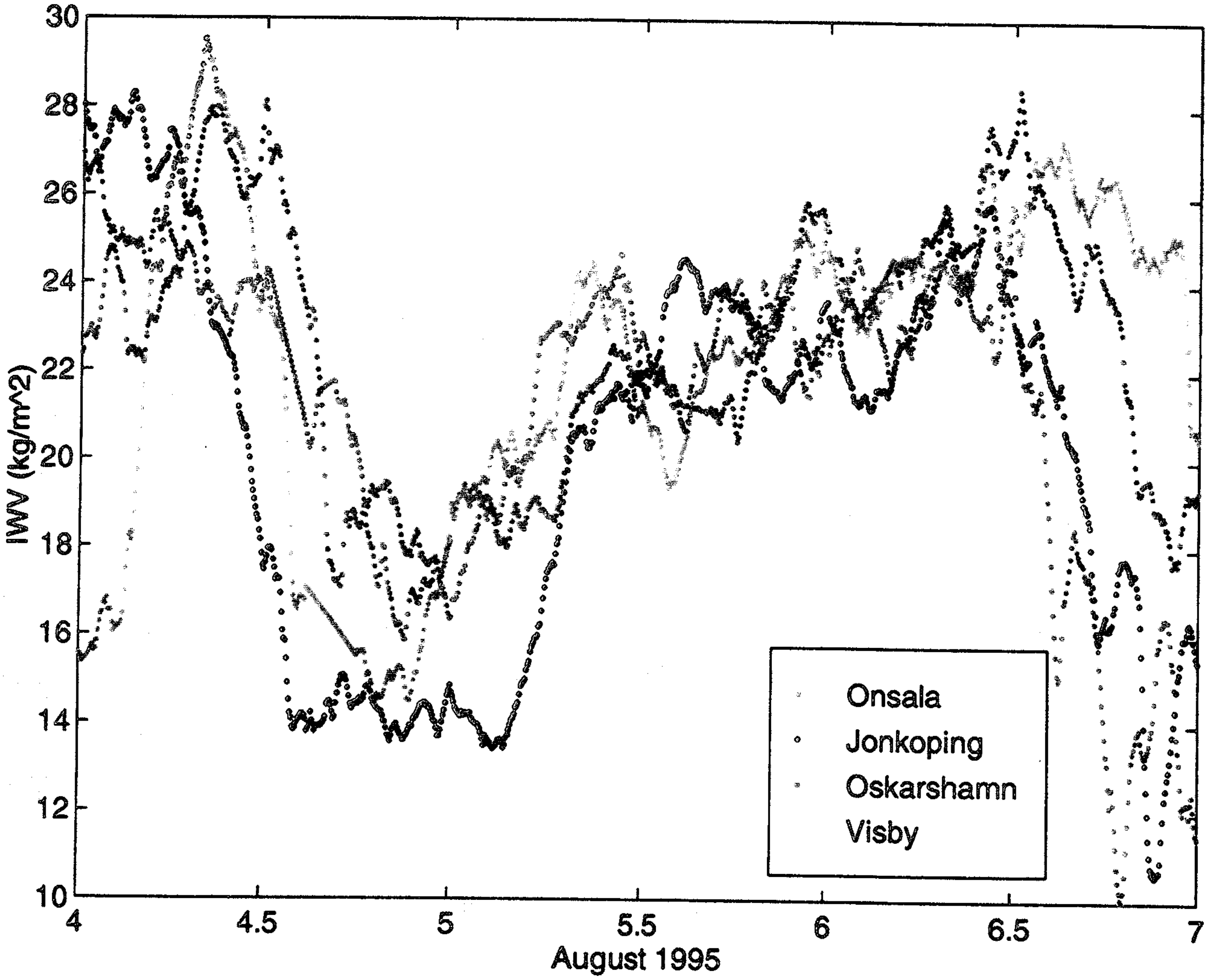
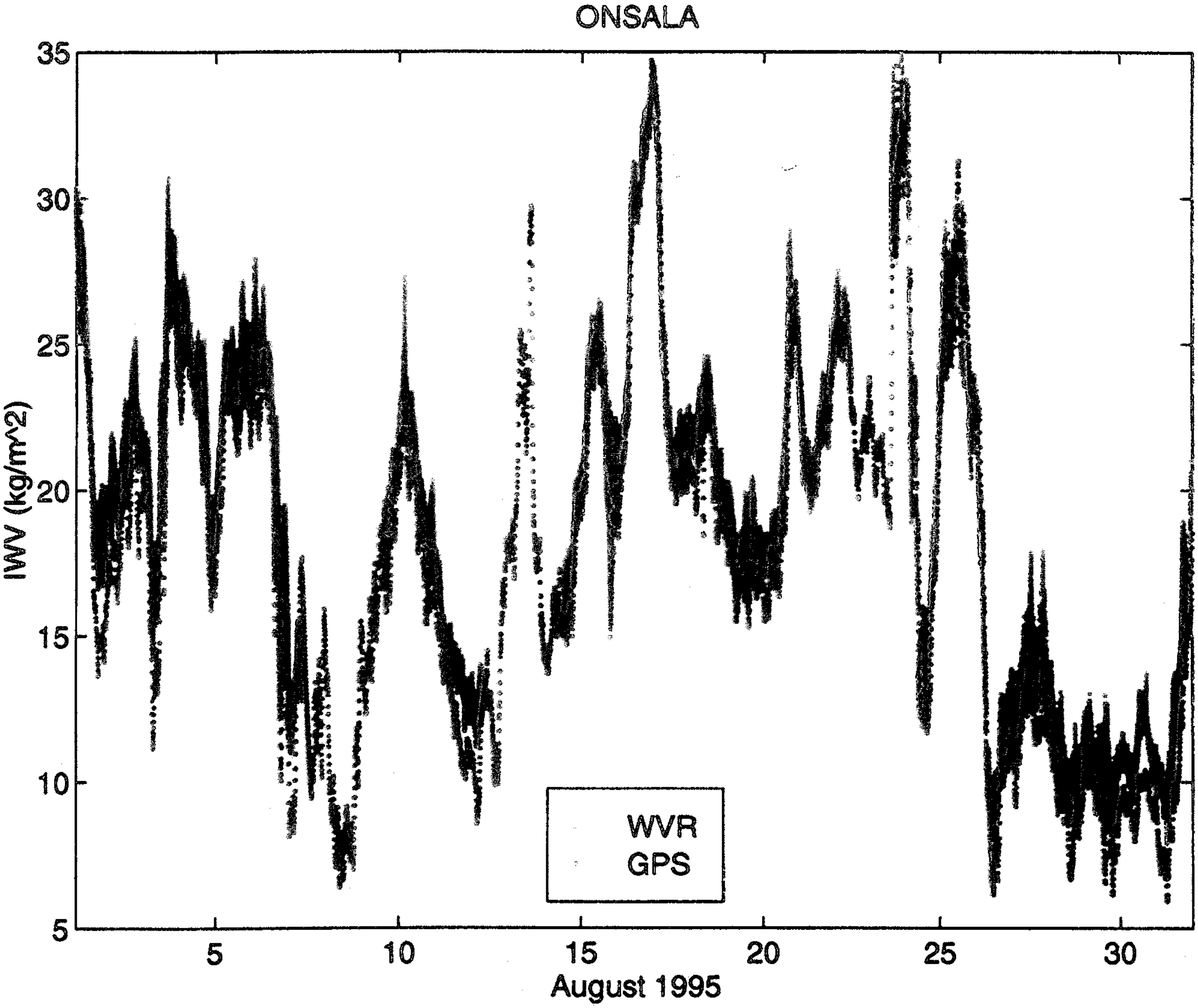

30
28
26
24
22
20
18
16
14
12
10
IWV (kg/m^2)
4
4.5
5
5.5
6
6.5
7
August 1995
Onsala
Jonkoping
Oskarshamn
Visby

Fig. 3


ONSALA
35
30
25
20
15
10
5
IWV (kg/m^2)
5
10
15
20
25
30
August 1995
WVR
GPS

Weather radar data for PIDCAP from Rostock radar: Description of measurement strategy and first evaluations

Igor Doelling, Johann Riedl

1. Description of radar measurement strategy

During PIDCAP (whole period August-Oktober 1995) all local German Weather Service radar standard data and standard products from the Rostock radar were archived on DAT-tapes; the composites of Germany were archived at Offenbach. Also archived were all raw data which includes for each volume element (1km x 1°) the values {uz, cz, v, w} in polar coordinates (in the intensity mode without v und w), where: uz - uncorrected radar reflectivity factor, cz - corrected (with Doppler filter or statistical filter) radar reflectivity factor , v - Doppler velocity, w - spectral width. The scan strategy and the resolution of archived raw data are given in Tab. 1 and Fig. 1.

Scan	Resolution in time	Resolution in space
Precipitation	5 min	1km x 1°, elevation angle χ=0,7°=const., range 128km
Volume scan	15 min, duration of a scan appr. 7 min up to 9 min	1km x 1° for 18 elevation angles χ (Doppler mode: range 125km; intensity mode: range 250km)

Tab. 1. Resolution in time and space of archived radar raw data.

2. First evaluations

2.1. Standard radar data: An overview over radar measurements at Rostock during PIDCAP

For the PIDCAP period an overview over precipitation events in the nearly 100km radius around the Rostock radar was given (Doelling, I., K. Brueckner, J. Riedl and J. Seltmann: Uebersicht über die Rostocker Radarmessungen waehrend PIDCAP 1995). For this overview we used the radar products PC (Germany composit) , PY (rain amount over 24 hours in the 100km radius of the Rostock radar) and data from ground precipitation measurements of thirteen facilities in the 110km radius of the Rostock radar. The radar data show that the ground clutter from coastal lines and clutter echoes from ships and ferry boots over sea are more problematic than it seems before the start of measurements. The investigation of the clutter echoes and the rejection of these echoes will be nontrivial.

2.2. Radar raw data: Estimation of precipitation tops over sea and land areas

For several different precipitation events we derived from raw data the precipitation echo tops between the 15km- and 40km- range of the Rostock radar for two sectors over sea and over land (Fig. 2). The raw data were used because the vertical resolution of the standard radar products is not sufficient for deriving differences in precipitation tops over sea and over land (resolution of standard data is one kilometer, whereas the resolution of raw data is generally much more better). Special precipitation events were selected (in the standard product overview): one stratiform case, three convective cases. For the investigations new radar products derived from raw data were created: MAPRHI, MSPRHI. The MAPRHI is shown and described in Fig. 3. The MSPRHI (Multiple Section Pseudo RHI) are overlayed sections from East to West, overlayed from 100km south of the radar to 100km north of the radar (in 1km-steps). The investigated cases show principally the possibility to use radar raw data to estimate differences between precipitation tops over sea and over land. Nevertheless, the small number of investigated cases is not enough to give an extensive information about generally trends of precipitation tops (especially showers) over different sea or land areas. Furthermore, the investigation need a thoroughly error estimate which is not trivial (and is not given yet).

3. Distrometer data

During PIDACP one-minute distrometer data from a Joss-Waldvogel distrometer at Rostock were archived.

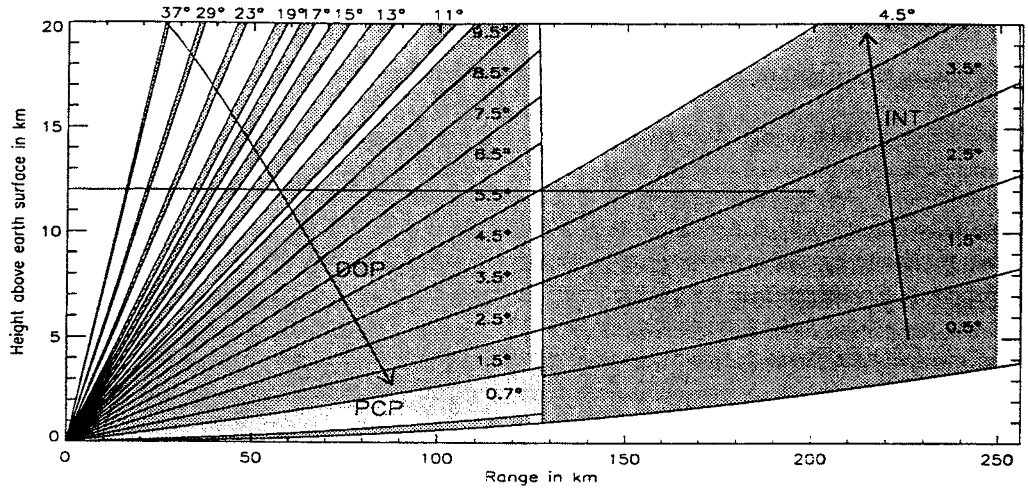


Fig. 1. German Weather Service radar scan strategy (see also Tab. 1). DOP, INT - Doppler and intensity modes of the volume scan, PCP - precipitation scan.

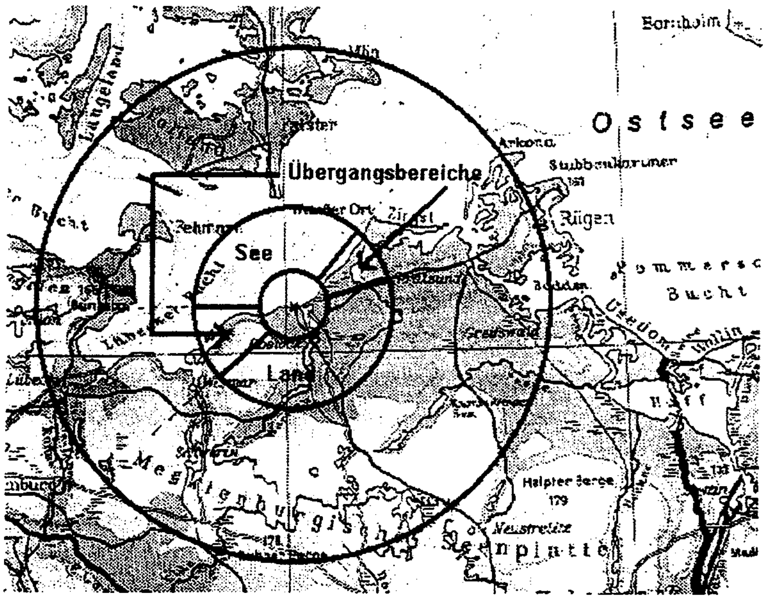


Fig. 2. Closer area (100km) to the Rostock radar. The 15km-, 40km- and 100km- radii, also the different areas where the precipitation tops were evaluated (sea, land, transition zones), are given in the figure. The different areas were selected outgoing from several criterions: no ground clutter, especially no areas too close to the radar (several km) and no clutter from coastal lines; distance to the radar „not too close" because there are rather data at the higher elevation angles, and „not too far" to use the better height resolution of raw data (see Fig. 1).

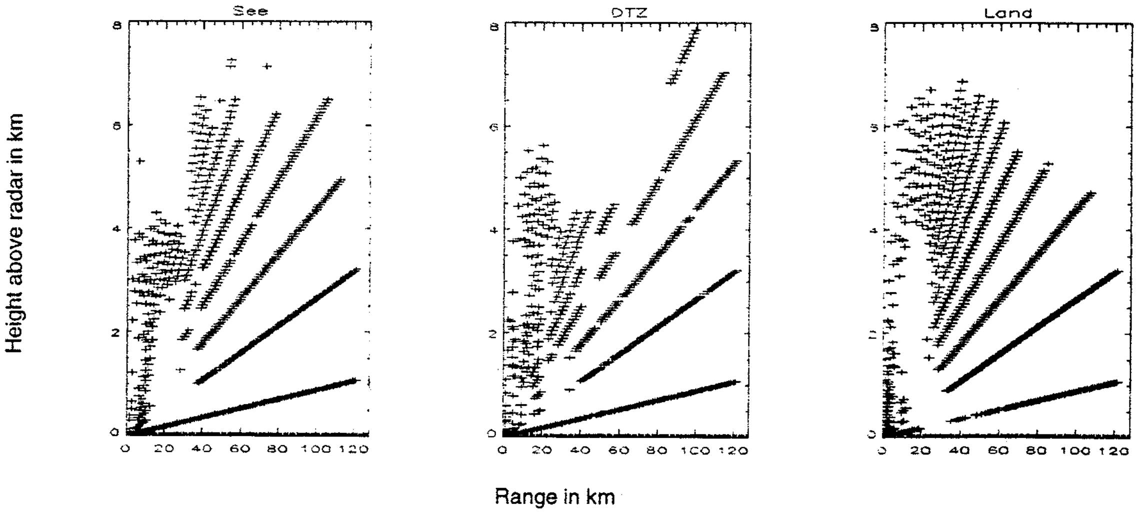


Fig. 3. MAPRHI - Multiple Azimuth Pseudo RHI (echotop): The MAPRHI were derived from a volume scan (Tab. 1, Fig. 1). RHI - Range Height Indicator (fixed terminology in radar meteorology), Pseudo - not from a vertical scan as the RHI but from volume scan raw data, MA - the PseudoRHI of a defined sector (e.g. sea) were overlayed, echotop - only the filling (5dBZ threshold) of a volume element is shown to see the echotops in the sector. The investigation of precipitation events was done visually (to eliminate echoes e.g. of aircraft) for each fifteen-minute MAPRHI of the event.

Swedish Weather Radar Data in BALTEX

Progress report for PIDCAP

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Objectives

SMHI R & D's objectives in PIDCAP are both logistical and scientific. The logistical objective is to evaluate if/how radar data can be collected and archived for the PIDCAP period so as to prepare accordingly for larger scale data collection responsibilities.

The scientific objectives are:

1. To improve our ability to use radar for analysing precipitation.
- To improve our knowledge of the characteristics and behaviour of precipitation.
- To improve our knowledge of the characteristics and behaviour of clutter types.
- To improve current methodology for identification and removal of artifacts in radar data caused by clutter.

2. To improve our ability to use radar for analysing winds.
- To develop a methodology for utilizing clear air echoes when analysing winds (during warm seasons).

Data Collection

Radar data has been collected for the initially defined PIDCAP period (August-October, 1995). Individual events during November, 1995 were also collected. The data is catagorized as follows:

1. NORDRAD composite imagery (from Swedish radars):
- individual reflectivity and wind images, saved and archived.
- composite images can be generated from individual images.

2. Polar volumes from the Gotland radar:
- Non-Doppler polar volume scans from Gotland, coincident with DMSP SSM/I image acquisitions, saved and archived.

3. UKMO C-130 campaign: week 36, 1995:
- hardware failure with the Gotland radar prevented data acquisition.

Methodology Update

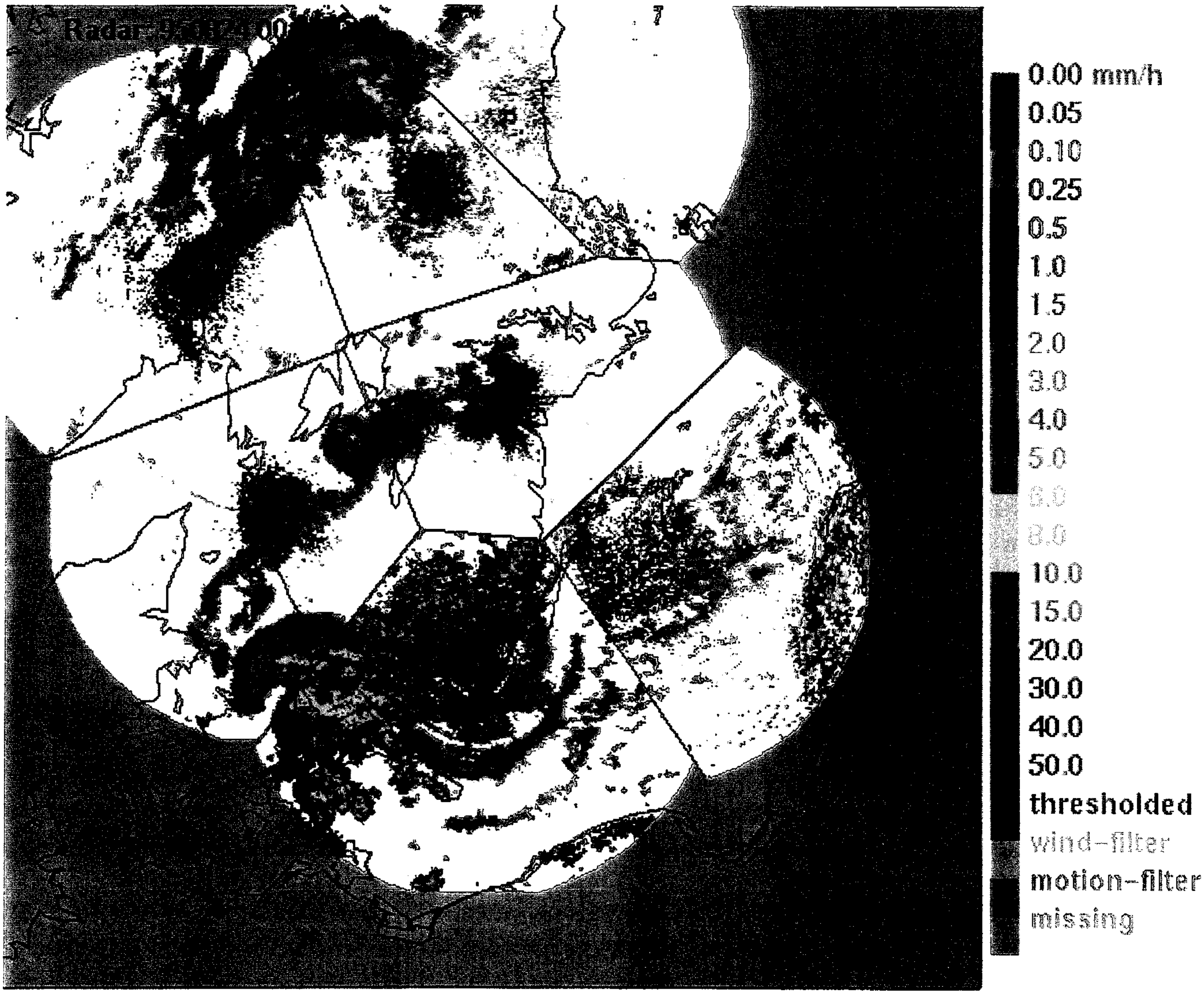
Image analysis methods on 2-D PseudoCAPPI imagery.

Analysis of such a high level product has well-known disadvantages when attempting to identify and remove artifacts caused by clutter types. Lower level products, such as polar volumes, are much preferred and are the prioritized product for these research tasks. We have, however, implemented a provisional method, using 2-D PseudoCAPPI imagery for each individual Swedish radar, which tests whether the non-Doppler reflectivity image contains anomalous propagation echoes. If this is the case for a given image, it is not used when generating a NORDRAD composite. The same geographical area can be covered using the overlap from other (clutter-free) radar nodes. The result is used in quantitative applications such as the Mesoscale Analysis project (L. Haggmark).

Improved methods for analysis and processing of 3-D polar data.

The tools available for remote sensing R & D at SMHI are currently being upgraded. Once in place, this research task will be initiated. The approach is to analyse the vertical structure of reflectivity along with those factors influencing the potential for anomalous propagation and how this affects resulting polar data acquisition.

Figure caption (see next page).
Example of a 500 m PseudoCAPPI composite from Swedish radars for the PIDCAP area. The time of acquisition is 1995-08-24 at 00:00 UTC. A mesoscale cyclone is moving in from the south west. Very strong land clutter is seen from south-eastern Sweden, the Polish coast,and the Baltic coast. Sea clutter is seen as concentric echo rings in the Baltic proper.


0.00 mm/h
0.05
0.10
0.25
0.5
1.0
1.5
2.0
3.0
4.0
5.0
6.0
8.0
10.0
15.0
20.0
30.0
40.0
50.0
thresholded
wind-filter
motion-filter
missing

Identification of Precipitation from Combined Passive Microwave and Infrared Measurements in the Baltic Region.

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e-mail: bennartz@zedat.fu-berlin.de
Germany

Introduction

Passive microwave sensors, like the Special Sensor Microwave/Imager (SSM/I), have been used to remotely sense instantaneous rain rates over land and water surfaces. Due to the different spectral signatures of land and sea surfaces, most microwave algorithms are dedicated to either land or sea surfaces. These algorithms generally exclude coastal regions with inhomogenous surfaces. Since the spatial resolution of passive microwave sensors is in the order of 30 km, large areas around the coastlines have to be discarded from the investigations. With regard to the footprint size of the SSM/I at 19 GHz (3dB-size: 69 × 43 km), only about 10% of the sea surface can be regarded as open water for example for the Baltic Sea. The main issue of this study is to introduce a new precipitation identification algorithm that allows for precipitation screening even in coastal regions, where conventional algorithms fail. This algorithm is developed using data measured from the SSM/I in May and June 1993 in the Baltic region. The resulting identification algorithm will be adapted to the PIDCAP period, if SSM/I data is available.

Methodology

The algorithm is based on a combination of SSM/I data and infrared data obtained from the geostationary Meteosat system. The approach consists of two steps. First, a simple approach to correct coastal SSM/I data for the land contamination within each footprint is developed. The quality of the correction is found to be dependent on the ratio between the SSM/I navigation error and the size of the frequency dependent SSM/I footprint. At low frequencies the correction method leads to physically interpretable data, while at 85 GHz the signal is impaired by the navigation errors.

Second, a precipitation identification algorithm is introduced. The identification algorithm is based on a neural network of the Kohonen type. This unsupervised learning algorithm is robust against noisy data and can be used to describe even complicated, multi-dimensional data distributions with small sets of representative points. The network is trained using the corrected coastal data and fractional cloud coverage at different infrared brightness temperature levels derived from Meteosat The physical information content of the network's results is extracted using the results of a radiative transfer model.

Three different sources of information are combined in this work; in addition to the Meteosat and SSM/I data, a high resolution land/sea mask is used to retrieve the land coverage within each SSM/I footprint. The investigation is geographically limited to the Baltic Sea and the North Sea and, for validation purposes, the Algorithm Intercomparison Project 2 (AIP-2) region. The AIP-2 took place between February and April 1991 in the southern part of Great Britain and France. For this period precipitation radar data as well as SSM/I and Meteosat data were available.

Results

A sensitivity analysis (Figure 1) of the algorithm at different radar precipitation rates shows, that the algorithm produces reliable results for open sea conditions and, if a correction of brightness temperatures for coastal effects is applied, for coastal regions as well.

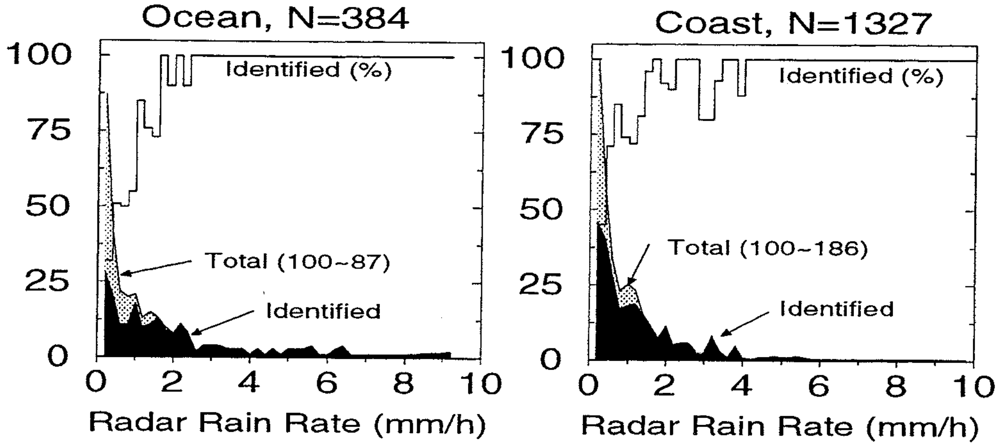

Figure 1: Sensitivity of the precipitation identification algorithm to radar derived footprint averaged rain rates. The line gives the relative sensitivity in per cent, while the grey-shaded and black areas give the total number of pixels and the number of correctly identified pixels. These areas are normalised to a peak value of 100 (the corresponding actual value is given in brackets).

However, for precipitation rates below 1 mm/h, the accuracy of the precipitation identification decreases rapidly with decreasing precipitation rate. This result partially reflects the theoretical limitations of the remote sensing of precipitation using satellite data. Despite the disadvantageous observation geometry of the Meteosat system at high latitudes, a comparison with conventional algorithms showed the superiority of the combined SSM/I and Meteosat precipitation identification algorithm. In total 88.2% of the rain events during AIP-2 were correctly identified. Based on the Kohonen approach and the precipitation identification method new rain retrieval algorithms will be developed. If SSM/I data is available, the results of the identification algorithms and first guess retrievals will be ready within two months.

PIDCAP PROGRESS REPORT

Application of Microwave Remote Sensing for the Study of Precipitation Systems over the Baltic Sea

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Institut für Meereskunde, Kiel, Germany
and C. Simmer
Bonn University, Germany

Measurements

During 3 weeks of the PIDCAP period of BALTEX the current properties of the atmosphere were measured on board of the RV "ALKOR" from the IFM. Measurements took place with

1) Upward looking radiometer, measuring brightness temperatures (TB's) in the microwave range at 3 frequencies: f1=21.3 Ghz, f2=23.8 Ghz, f3=31.7 Ghz,

2) Radiosonde soundings, performed 1-4 times per day, measuring atmospheric temperature and humidity profiles,

3) Taking synoptic data, like amount of cloudiness, air pressure, sea surface temperature and others,

4) Laser Ceilometer, detecting the hight of cloud base.

Modelling of microwave brightness temperatures

The directly measured microwave TB's were compared with modelled ones. These modelled TB's were calculated by constructing atmospheres, exactly following the data of the radiosonde ascents and then applying a microwave radiativ transfer model, that was developed at the IFM by C. Simmer in recent years (Programcode "MWMOD"). The center of this model is the line by line parametrization of oxygen absorption lines, water vapour absorption lines and water vapour continuum absorption.

Two widely used formulations were tested:

1) "MPM89" code following Liebe,1989
2) "MPM93" code following Liebe,1993

Development and applying semistatistical algorithms for total precipitable water (TPW) and liquid water path (LWP)

A global set of radiosonde soundings (N=11000) was the base for a set of microwave TB's at the radiometer frequencies, calculated with "MWMOD" by use of line parametrization model "MPM89" or "MPM93". This set was transformed in terms of empirical orthogonal vectors, achieved with a EOF analysis. With this ensembles of EOF transformed TB's a system of lookup tables could be built up. Multilinear interpolation leads to the corresponding TPW or LWP value for every EOF transformed TB vector.

Results

1) Comparison of TB's

Fig. 1a, 1b compares the measured TB's against the modelled ones by displaying the difference TBmeas - TBmod over the TPW from the radiosonde ascents. Only those soundings are taken, where no substantial amount of low or middle level clouds were present. It is seen, that in the case of the use of "MPM89" the average difference between measured and modelled TB's is 0.1 K for 21.3 GHz, -1.0 K for 23.8 GHz and +1.2 K for 31.7 Ghz. It seems, that for higher water vapour contents the differences are decreasing, assuming more negative values for the two frequencies near the 22.235 GHz water vapour absorption line. Calculating radiation transfer with "MPM93" shows the same behavior, but the averaged differences are more negative than with "MPM89".

So in whole the older line parametrization leads to a slightly better agreement between modelled and measured TB's. The difference in bias between the 21.3 GHz and 23.8 GHz comparison at both parametrizations may be due to a little frequency shift of the radiometer channels.

2) Comparison of algorithms

The application of the lookup table algorithms for TPW on the TB's, measured during the radiosonde soundings, is shown in Fig. 2. Only cases without rain events were selected. Additionally the results of an common algorithm, that was supplied by the radiometer factory ("CCIR" algorithm) are shown. A strong bias of 3.7 kg/m^2 appears with the "CCIR" algorithm. The lookup table gives only a small bias against the radiosonde derived TPW value. The algorithm developed with "MPM89" points out the smallest bias. This correlates with the previous shown result concerning the comparison of measured and modelled TB's. Again the difference TPW(algorithm) - TPW(radiosonde) seems to decrease with higher TPW values in the atmosphere.

The use of the lookup table for LWP on time series of TB's shows a small positive bias for cloudfree situations, while the two "CCIR" algorithms give negative values in this cases (Fig. 3). For higher amounts of LWP the "CCIR" algorithm with fixed coefficients leads to higher LWP, due to the fact, that this algorithm assumes a fixed value of cloud droplet temperature. Namely at high LWP values this fixed effective cloud temperature may be too high, and therefor the microwave emission is assumed too low, corresponding to the decreasing emission coefficient of water with rising temperature. The other "CCIR" algorithm requires the effective cloud temperature explicitly. In this case the droplet temperature was calculated by use of the ceilometer data together with a first estimate of LWP.

In summary the deviation from 0 g/m2 of retrieved LWP without clouds is less when applying the lookup table. If rain occurs all algorithms are failing. The lookup table leads to irregular values, because no rain events were put into the EOF analysis during their development. Validation at LWP > 0 is not possible, because no independent measurements of the cloudwater amount took place. So the "MWMOD" seems to be able to produce algorithms better then existing formulations if the method of creating EOF transformed lookup tables is choosen. The absorption line parametrization "MPM89" gives slightly better results in comparison with the new formulation "MPM93".

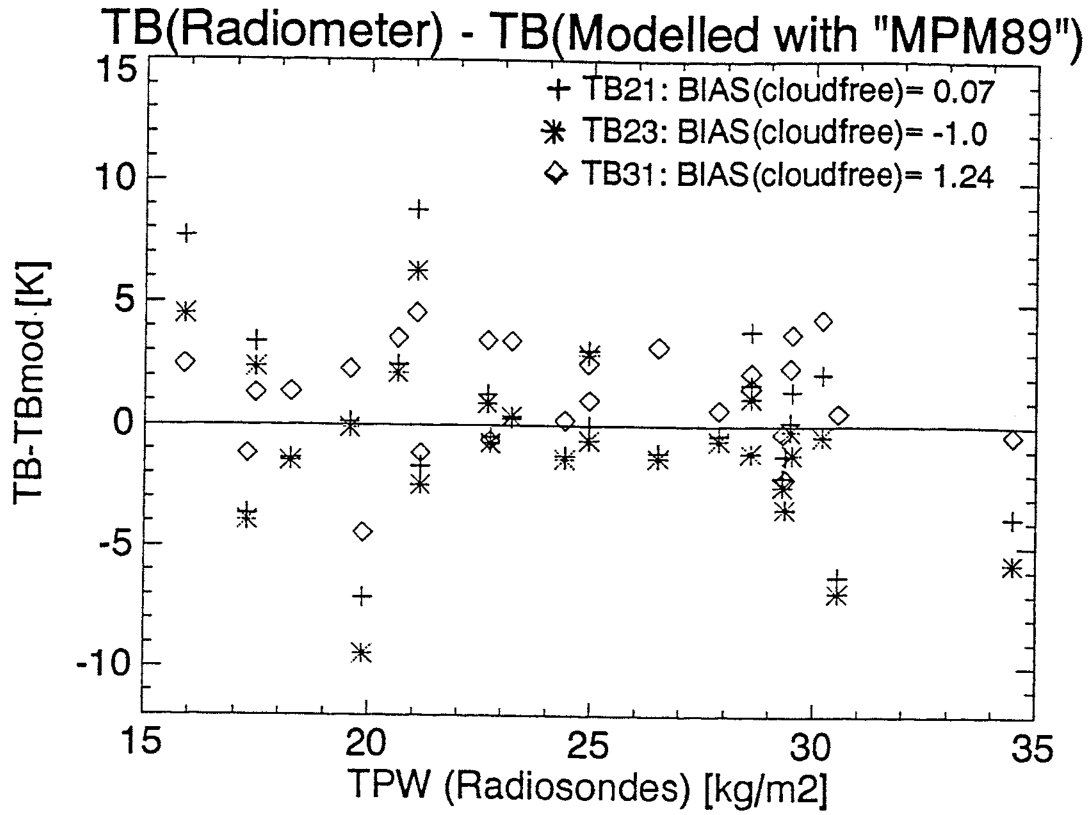
TB(Radiometer) - TB(Modelled with "MPM89")
+ TB21: BIAS(cloudfree)= 0.07
✱ TB23: BIAS(cloudfree)= -1.0
◇ TB31: BIAS(cloudfree)= 1.24
TB-TBmod [K]
15
10
5
0
-5
-10
15
20
25
30
35
TPW (Radiosondes) [kg/m2]

Fig. 1a

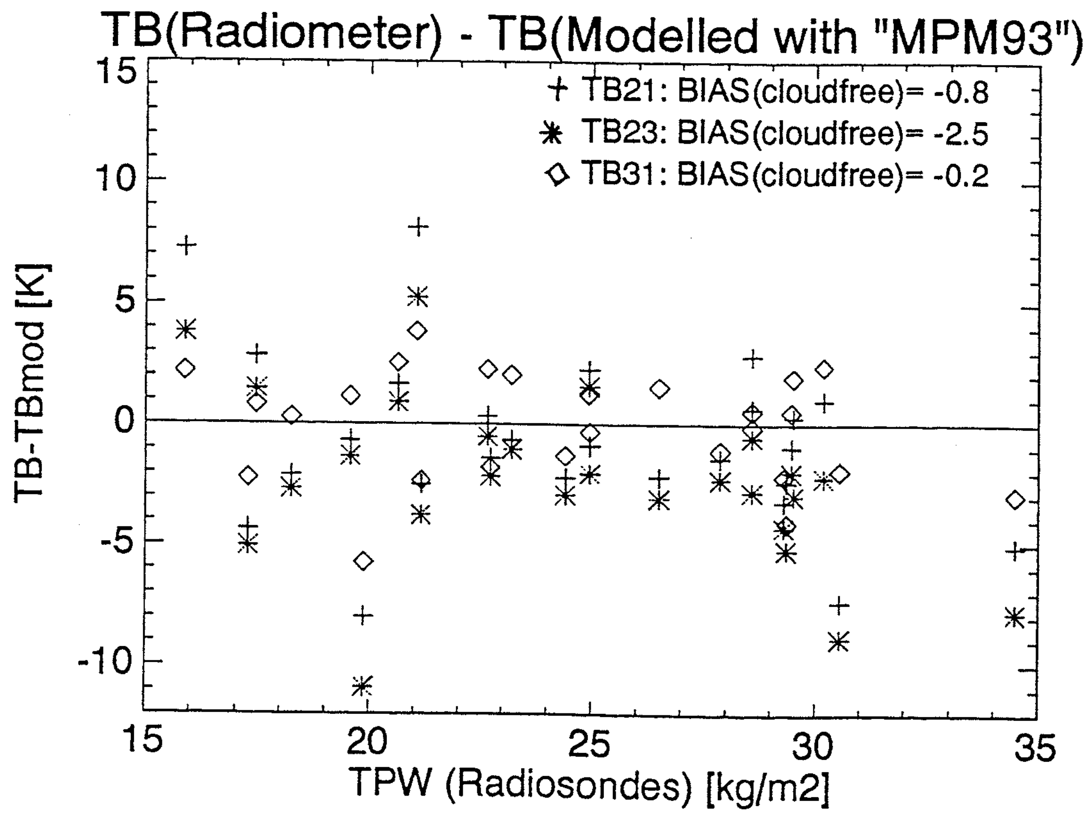
TB(Radiometer) - TB(Modelled with "MPM93")
+ TB21: BIAS(cloudfree)= -0.8
✱ TB23: BIAS(cloudfree)= -2.5
◇ TB31: BIAS(cloudfree)= -0.2
TB-TBmod [K]
15
10
5
0
-5
-10
15
20
25
30
35
TPW (Radiosondes) [kg/m2]

Fig. 1b

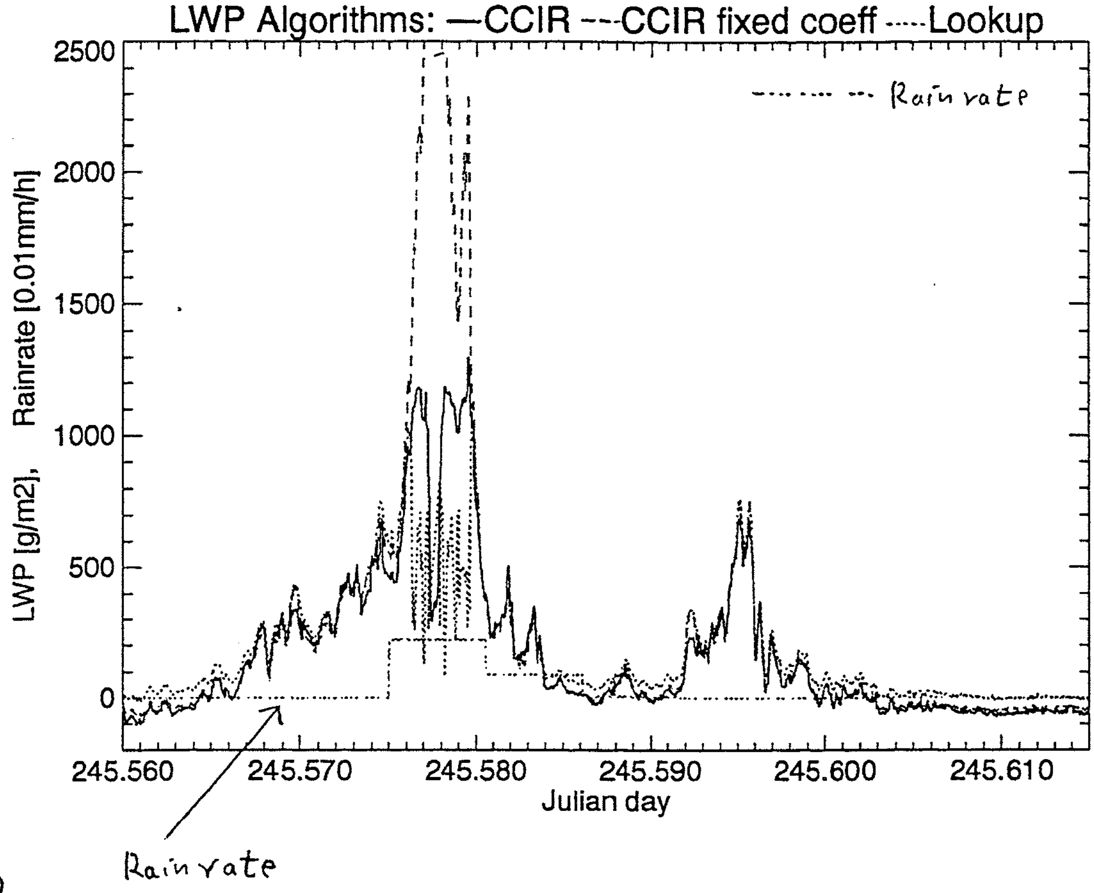
LWP Algorithms: —CCIR ---CCIR fixed coeff ·····Lookup
LWP [g/m2], Rainrate [0.01mm/h]
2500
2000
1500
1000
500
0
245.560
245.570
245.580
245.590
245.600
245.610
Julian day
Rainrate
Rainrate

Fig. 3

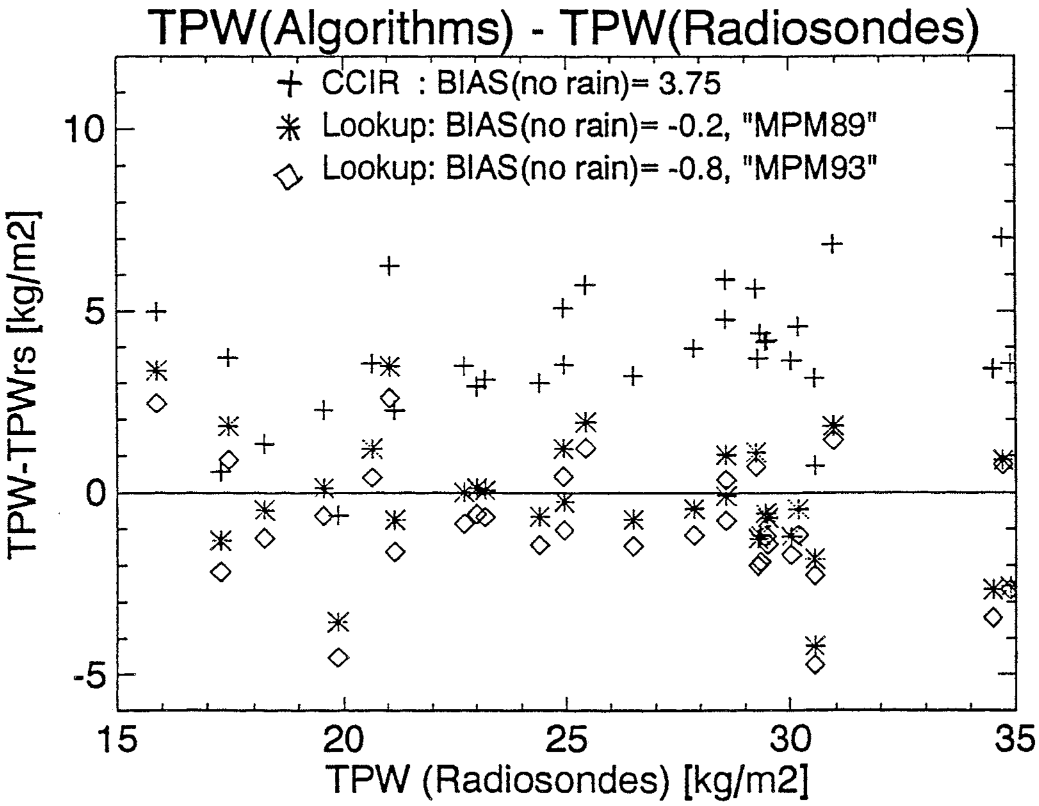
TPW(Algorithms) - TPW(Radiosondes)
+ CCIR : BIAS(no rain)= 3.75
✳ Lookup: BIAS(no rain)= -0.2, "MPM89"
◇ Lookup: BIAS(no rain)= -0.8, "MPM93"
TPW-TPWrs [kg/m2]
10
5
0
-5
15
20
25
30
35
TPW (Radiosondes) [kg/m2]

Fig. 2

The diagnosis of water and energy budgets in an atmospheric limited area model

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Summary

A tool has been developed for diagnosing the various terms in the moisture and energy budget of the Baltex region (the catchment area). The diagnostic tool which is outlined below is currently being tested in the HIRLAM model at DMI. It is to be applied for budget computations and model validation in the PIDCAP period making use of various measurements related to the water and energy transports.

The total moisture budget is given by (1). The volume of integration is bounded by the orography, the top of the atmosphere and the vertical walls along the lateral boundary.

$$\frac{dW_{tot}}{dt} = \frac{1}{A} \bullet \int_V \frac{\partial}{\partial t}[\rho (q+q_l)]\, dv =$$

$$\frac{1}{A} \cdot \left[\int_V (-\nabla \bullet \rho \vec{V}(q+q_l))\, dv\right] - \frac{1}{A}\left[\int_A (W'_p - W'_e)\, da\right] \qquad (1)$$

In (1) A is the total horizontal integration area , v is the integration volume and ρ is air density. q is the specific humidity, q_l is the specific cloud water amount. $\vec{V}$ is the 3-dimensional wind vector, W_p' and W_e' are precipitation and evaporation intensities per unit area, respectively.

Also the budget of the total energy consisting of internal energy J , potential energy, ϕ and kinetic energy K is made for a limited area. The change of the total energy E per unit horizontal area is governed by (1)

$$\frac{dE}{dt} = \frac{1}{A} \times \int_V \frac{\partial}{\partial t}[(J+\phi+K)\rho]\, dV =$$

$$\frac{1}{A} \times \left[-\int_V \nabla \bullet ((c_p T + \phi + K)\rho \vec{v})\, dV + \int_V (\rho Q + \vec{v} \cdot \vec{\tau})\, dV\right] \qquad (2)$$

J is the specific internal energy, $\phi = gz + \phi_0$ is the specific potential energy which is the sum of the geopotential energy gz relative to the orography and the geopotential of the orography relative to the mean sea level. c_pT is the specific enthalpy. The above equation may be derived from the equations of internal, potential and kinetic energy changes based on the first law of thermodynamics, the equation of state for an ideal gas and the equation of continuity (see for example Wiin-Nielsen, 1973). Q is the specific diabatic heating due to all processes including frictional heating , and $\vec{v} \bullet \vec{\tau}$ is the loss of atmospheric kinetic energy due to surface friction. The last two terms on the right hand side of eq. 2 may therefore be combined into one term which equals the atmospheric non-frictional diabatic heating.

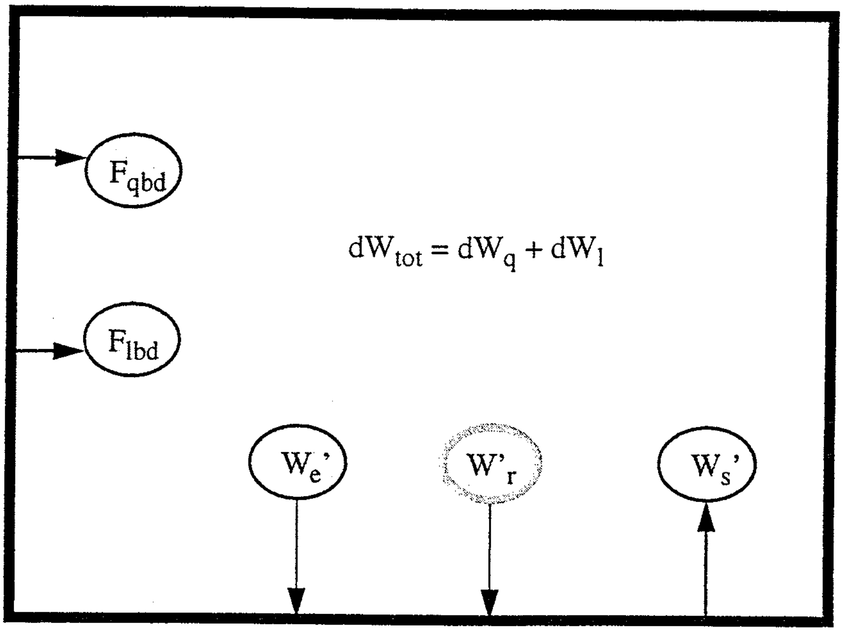
The changes of the humidity and energy components in (1) and (2) occur as a result of fluxes across the lateral boundaries as well as internal circulations and physical processes. A transformation of the model variables in rotated spherical coordinates enables that a diagnosis can be done on the complex Baltex catchment area defined in geographical coordinates. The budget equation can be integrated in time. e g. the involved fluxes can be averaged in time. Also the vertical structure of the changes can be diagnosed. Horizontal model fields have been introduced for the radiative infrared and solar fluxes at the 'top' and at the 'bottom' of the atmosphere. Also 'instantaneous' precipitation intensity fields for rain and snow have been introduced. For limited areas like the Baltex area the diagnosis has shown that the flux divergence of energy and moisture through the lateral boundaries and the vertical transports inside the domaine can be very significant and may dominate over the net forcing due to physics. This feature is consistent with observational studies from other parts of the globe , e.g. from the ATEX experiment. descibed by Augstein et al.(1973)

References:

Augstein. E. , Riehl. H., Ostapoff, F. and Wagner. V. 1973:
Mass and energy transports in an Undisturbed Atlantic Trade-Wind Flow. - *Mon. Wea. Rev., 101, No.2. 101 -111.*

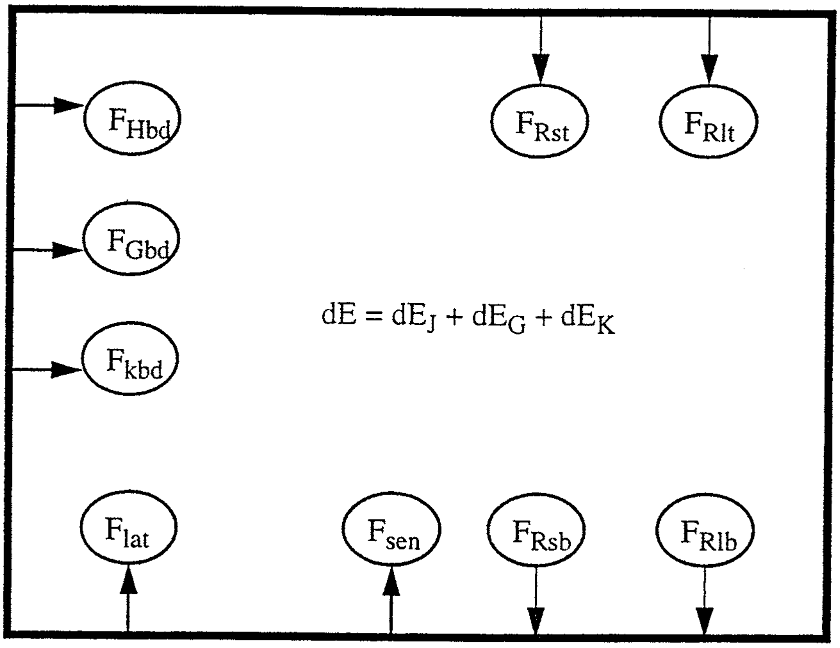
Wiin-Nielsen, A.. 1973:
Compendium of Meteorology, Vol.1. Part 1. *WMO publication no. 364*

MOISTURE BUDGET.



F_{qbd} : humidity flux divergence through horizontal and vertical transports.
F_{lbd}: cloud water flux divergence through horizontal and vertical transports
W_e' : evaporation/dew flux
W_r' : rain flux
W_s' : snow flux

ENERGY BUDGET



F_{Hbd} : Enthalpy flux divergence from horizontal and vertical transports.
F_{Gbd}: Geopotential flux divergence from horizontal and vertical transports
F_{Kbd}: Kinetic energy flux divergence from horizontal and vertical transports
F_{lat} : Energy released from precipitation
F_{sen} : Sensible heat transfer to atmosphere
F_{Rst} : Net solar flux density at the top of the atmosphere.
F_{Rlt} : Net infrared flux density at the top of the atmosphere
F_{Rsb} : Net solar flux density at the bottom of the atmosphere
F_{Rlb} : Net infrared flux density at the bottom of the atmosphere

Validation of Model Results of Precipitation

B. Rockel, U. Karstens, R. Nolte-Holube

GKSS Forschungszentrum

The model to be validated in this sub-project is the GKSS version 1.1 of the Regional Model (REMO). This is essentially the same as the Europamodell of the German Weather Service (DWD) with the following differences: Prognostic equations for water vapour, cloud water, cloud ice, and temperature are used instead of total heat and total water content.

Computations are made on a 1/6°x1/6° horizontal grid and 20 vertical levels. The time step of the model is 2 minutes. The forecast output is stored hourly. For the PIDCAP period 30h forecasts will be performed. The results for precipitation from 6-30h are used for comparison with measurements. Initialisation is taken from the DWD analyses and the hourly boundary conditions are provided by forecast of the Europamodell.

As a first target period within PIDCAP we choose the 27-31 August. During that period in the high baroclinic region at the southern and south-eastern flank of the extended European mid-tropospheric trough a cyclone developed during 28-29 August over northern Italy. It quickly moved north- and north-eastward across Poland and deepened rapidly. It developed into a violent Baltic Sea storm with enhanced precipitation in the central and south-eastern BALTEX region.

At present we have obtained measurements of synoptic stations from Sweden, Poland, Estonia, and Lithuania for comparison against model produced precipitation. Figure 1 shows as an example the results for the 29 August, measurements and model results are shown in the left and right picture, respectively. In Sweden there are only two small regions with precipitation. The first one show light orographic rain in the westerly mountains. The other one is the south-east coast lying under the influence of the low over the Baltic Sea. These regions are well represented by the model results. The precipitation band over Poland, Lithuania, and Estonia can also be recognised in the model results. As a first conclusion we can say that the regions of precipitation are well represented in the model results. However, the precipitation rate seems to be larger in the model than in the observations, which is contrary to the comparisons we made for June 1993. More detailed explanations will be possible when more rain measurements are available.

To illustrate the necessity for daily model restart when comparing with measured data on a daily time scale, a 54-78h forecast starting at 28 August 00 UTC is compared with a 6-30h forecast starting at 30 August 00 UTC in figure 2. The rain bands in the 3 day forecast are displaced and show an overall with lower precipitation rate. Especially the rainband over Poland dissolved in the 3 day forecast drastically. The reason for this not yet clear and is one point for future research.

At present we have started a series of 30h forecast runs for the whole PIDCAP period.

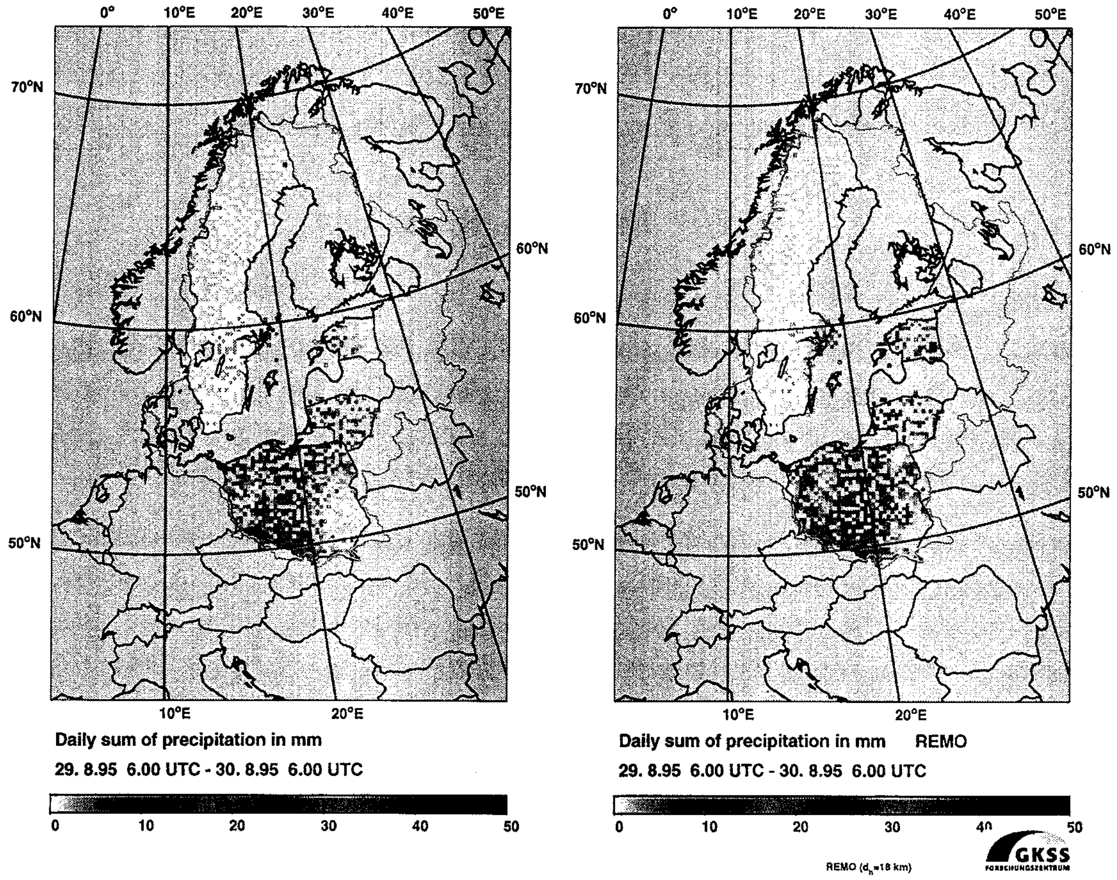

0°
10°E
20°E
30°E
40°E
50°E
70°N
60°N
50°N
10°E
20°E
Daily sum of precipitation in mm
29. 8.95 6.00 UTC - 30. 8.95 6.00 UTC
0
10
20
30
40
50
Daily sum of precipitation in mm REMO
29. 8.95 6.00 UTC - 30. 8.95 6.00 UTC
REMO (d$_h$=18 km)
GKSS
FORSCHUNGSZENTRUM

Fig.1

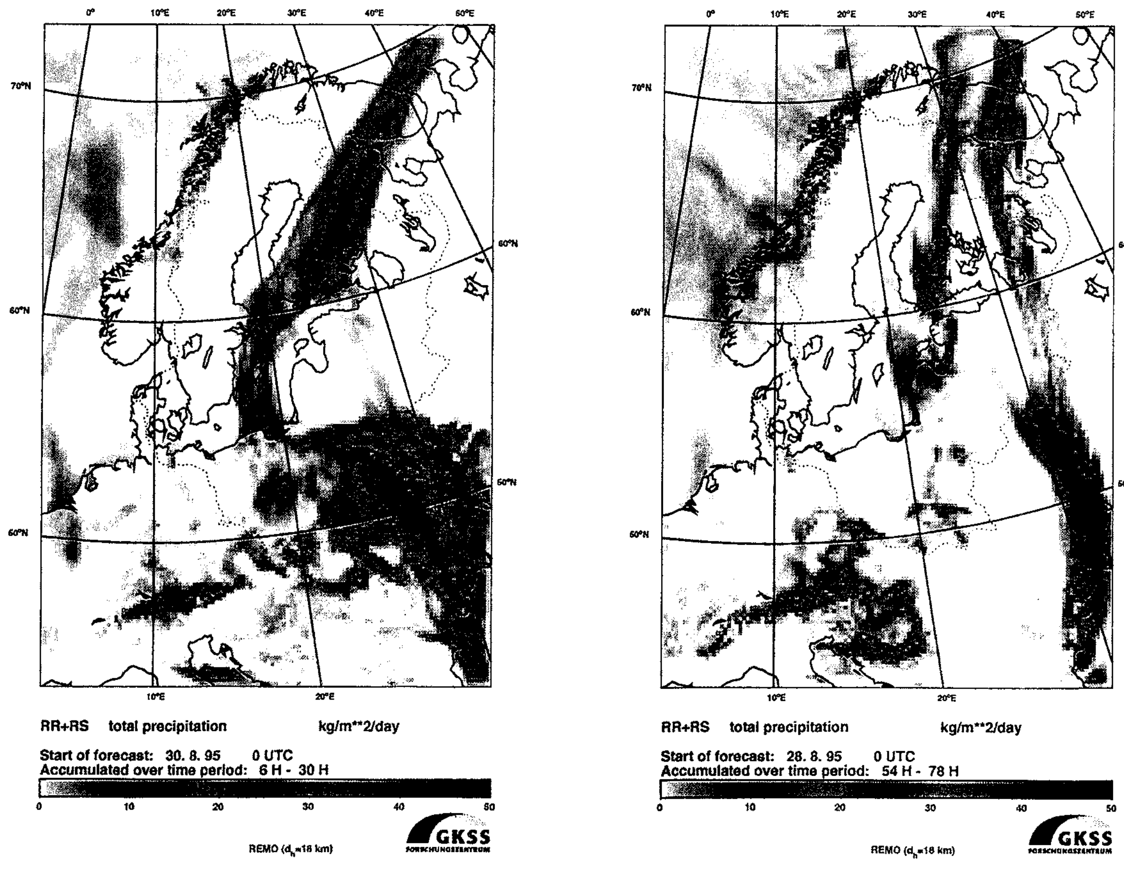

RR+RS total precipitation kg/m**2/day
Start of forecast: 30. 8. 95 0 UTC
Accumulated over time period: 6 H - 30 H
0
10
20
30
40
50
REMO (d$_h$=18 km)
GKSS
FORSCHUNGSZENTRUM
RR+RS total precipitation kg/m**2/day
Start of forecast: 28. 8. 95 0 UTC
Accumulated over time period: 54 H - 78 H

Fig.2

REMO AT MPI AND DKRZ

Progress-Report

Daniela Jacob, Ralf Podzun

The implementation of the ECHAM4 physics packages in REMO has been finished. Therefore REMO is now available with two different parameterization packages for the physical processes of the atmosphere.

A number of sensitivity experiments are under work or planned to identify differences in both model versions. Two time periods are used, first the whole PIDCAP episode (3 months) and second a 6 day period (27.8.95 to 31.8.95).

For the second period an intense model intercomparison is planned, where mainly HIRLAM, UKMO and REMO results will be compared. A strategy of the intercomparison has been carried out.

Following this concept some model runs have been done with REMO on the 0.5 and the 0.167 degree resolution for the short period with both physical schemes (DWD physics and ECHAM4 physics).

Comparing the results of the two simulations on 0.5 degree resolution driven by analyses at the lateral boundaries on a 6 hour time interval indicate that the different physics packages lead to different spatial distributions of the meteorological variables.

Using the DWD physics (52) the cyclonic development shows stronger gradients and more intense precipitation over the area of interest than using the ECHAM4 physics (51).

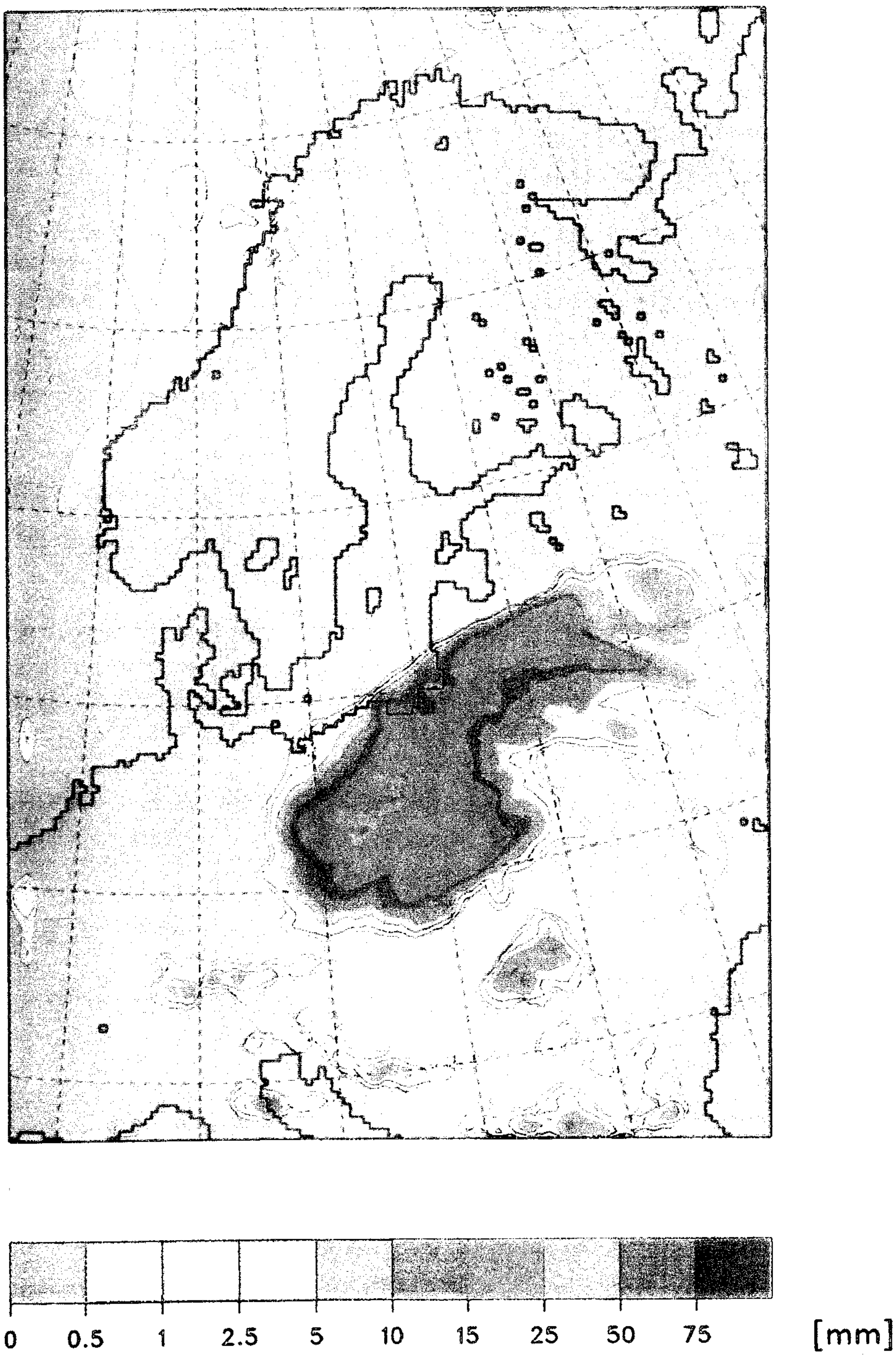
Comparing the results of a 0.167 degree resolution run with DWD physics driven by analyses (53) with the results of the corresponding run (59) driven by (52) shows that the spatial distribution and the time development of the precipitation in (59) are closer to observations than in (53).

This is also true for the results of the equivalent two simulations with the ECHAM4 physics. To get a better understanding of this feature a more detailed investigation will be done in the near future. Looking at all simulations it seems that REMO with the ECHAM4 physics contains more diffusion than REMO with DWD physics, which can only be due to the different treatment of the vertical diffusion.

Further evaluation will be carried out using the observations taken during the PIDCAP episode.

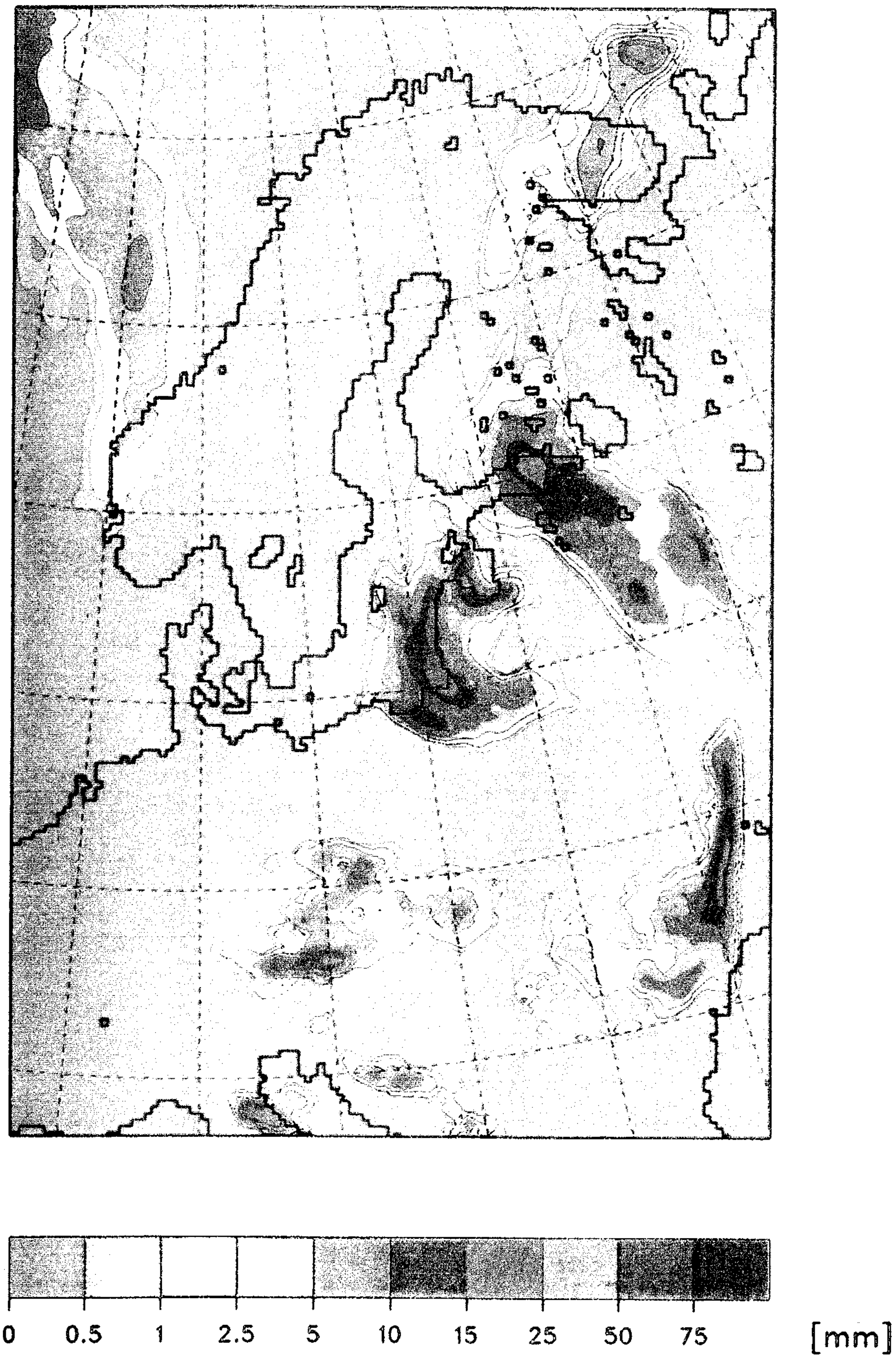
by analyses

Total Precipitation (053) 31089506 - 31089518



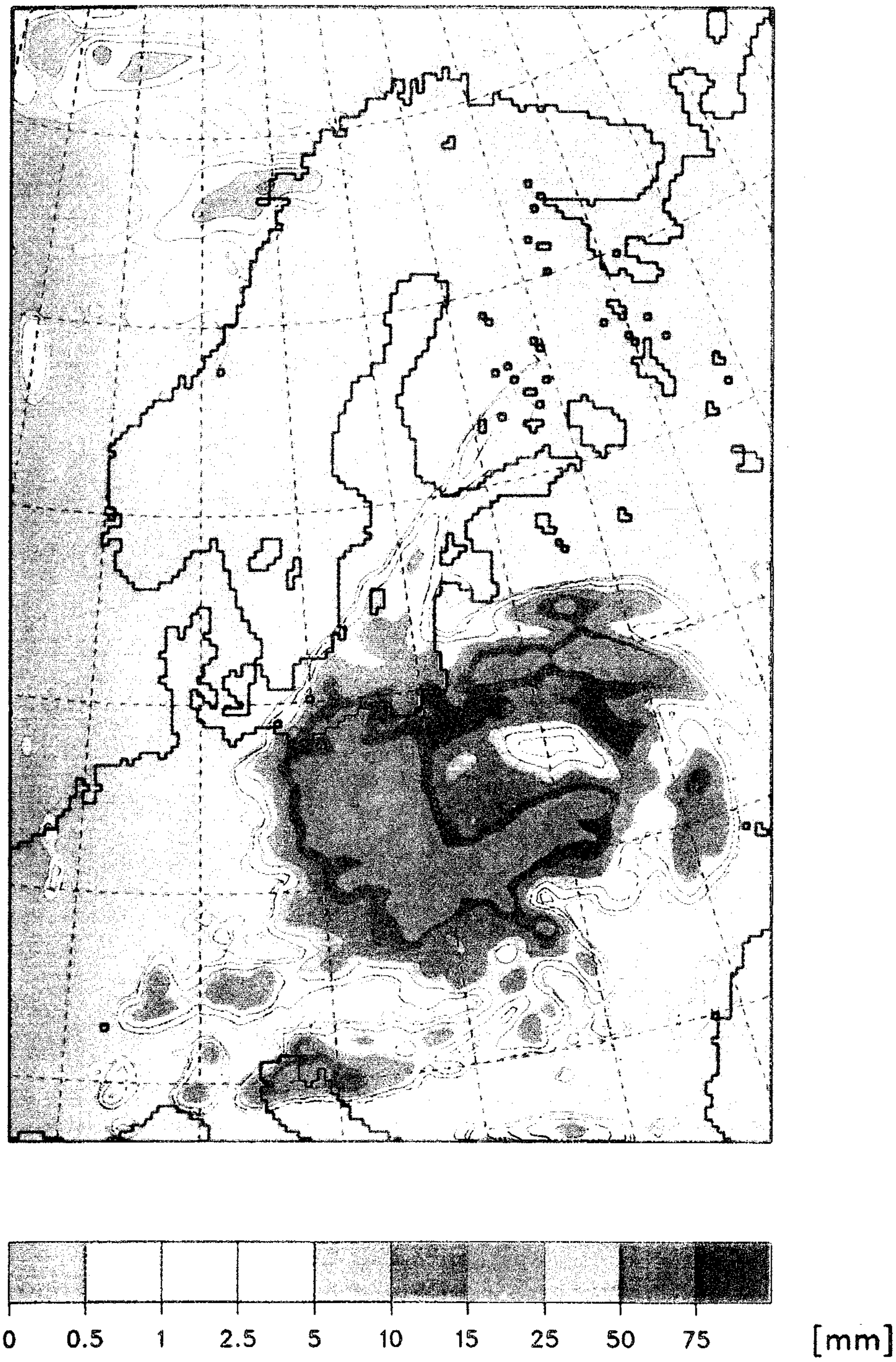
54 (52)

Total Precipitation (059) 31089506 - 31089518

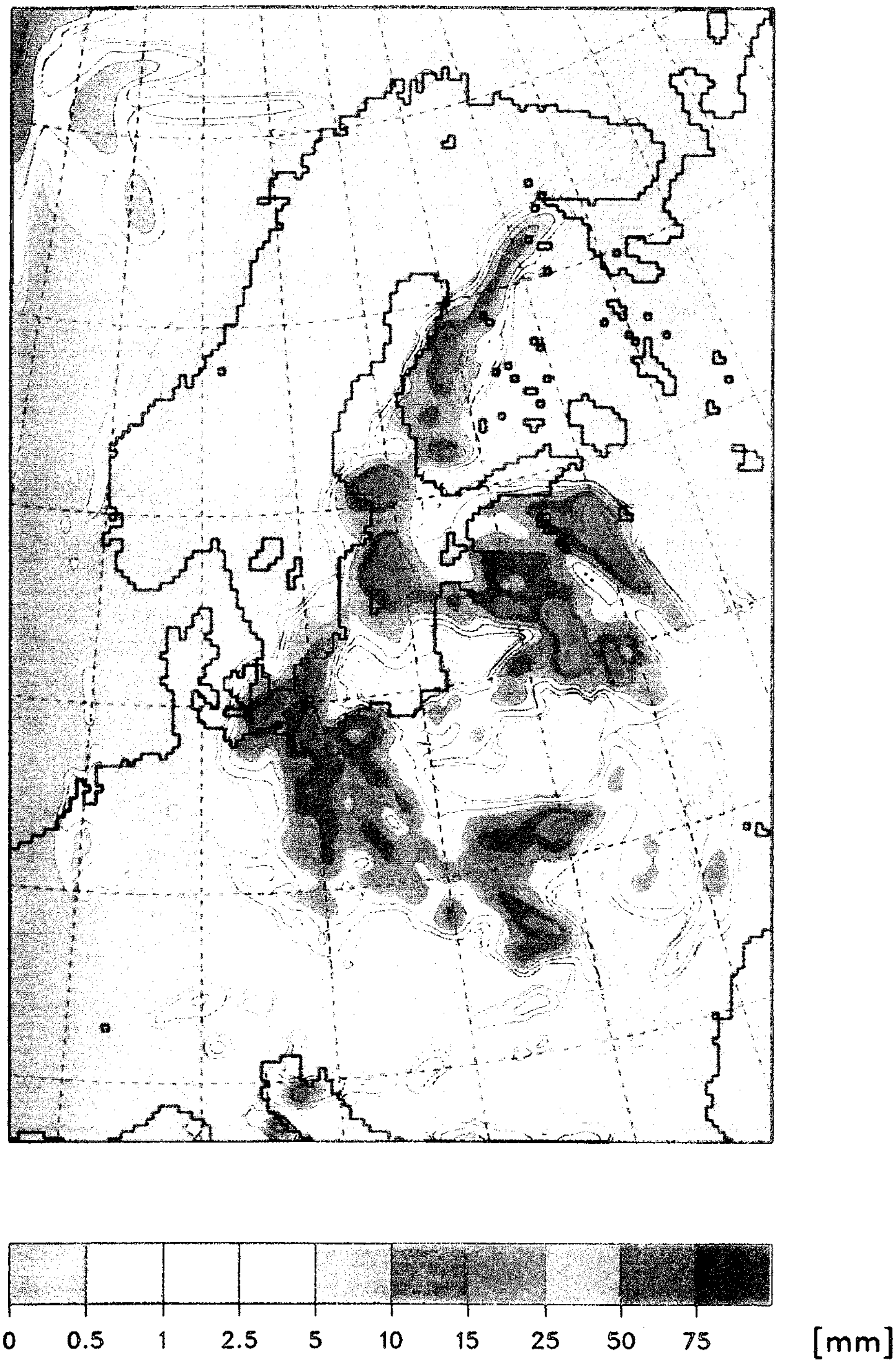


by analyses

Total Precipitation (056) 31089506 - 31089518



Total Precipitation (057) 31089506 - 31089518



Appendix 8

First PIDCAP Workshop
June 10-11, 1996
SMHI, Norrköping, Sweden

Agenda

Monday, June 10, 1996

2.00 pm:	Opening, Welcome (**S. Bergström, SMHI**) Introductory Remarks (**H.-J. Isemer, GKSS**)
2.15 pm:	**H.-J. Isemer, GKSS, Geesthacht, Germany:** Weather patterns and selected precipitation records during PIDCAP
in	the BALTEX region - A preliminary overview.
2.35 pm:	**A. Lehmann, DWD, Offenbach, Germany:** Status report on the BALTEX Meteorological Data Centre and availability of PIDCAP data.
2.55 pm:	**L. Hasse, IfM, Kiel, Germany:** Rain measurements on ships during PIDCAP.
3.15 pm:	**F. Rubel, Vienna University, Austria:** Structure functions for precipitation.
3.35 pm:	**D. Michelson, SMHI, Norrköping, Sweden:** SMHI's remotely sensed PIDCAP data: Clouds and precipitation.
3.55 pm:	Break
4.30 pm:	**L. Haggmark, SMHI Norrköping, Sweden:** Precipitation analysis for the PIDCAP period - a case study.
4.50 pm:	**J. Riedl and I. Dölling, Met.Obs. Hohenpeissenberg, Germany:** Data from Rostock weather radar during PIDCAP and first evaluations.
5.10 pm:	**G. Elgered, Onsala Space Observatory, Onsala, Sweden:** Status report on GPS data during PIDCAP.

5.30 pm: **R. Bennartz, Berlin University, Germany:**
Retrieval of instantanious rain rates in the southern Baltic Sea from a combination of microwave, visible and infrared satellite data - first results.

5.50 pm: **H. Gäng, IfM, Kiel, Germany:**
Radiometric observations of cloud and atmosphere from RV ALKOR during PIDCAP.

6.10 pm: **C. Simmer, Bonn University, Germany:**
3D radiometric effects of rain clouds simulated with data of the Gotland radar.

6.30 pm: Closing of first session

<u>Tuesday, June 11, 1996</u>

9.00 am: **F. Hamelbeck, Vienna University, Austria:**
DIAMOD - a tool for diagnosing convection.

9.20 am: **B. Rockel, GKSS, Geesthacht, Germany:**
Results of REMO short range forecasts for 27-31 August 1995 with GKSS/DWD physics.

9.40 am : **D. Jacob, MPIfM, Hamburg, Germany:**
Intercomparison of two physical parameterization packages in REMO
using
PIDCAP data for verification.

10.00 am: **X. Yang and B. Sass, DMI, Copenhagen, Denmark:**
Preliminary results of data assimilations for a sub-period of PIDCAP using the HIRLAM forecasting system.

10.20 am: Break

10.45 am : Discussion, Future Plans, Further Items

12.00 am : Closing of the workshop

Lunch

<u>Note</u> This agenda will be adjusted if further contributions are submitted. The present time planning foresees 15 minutes time at maximum for each speaker and leaves at least 5 minutes for discussions. The latter might be extended if appropriate.
HJ Isemer, BALTEX Secretariat, GKSS Research Centre, Geesthacht, Germany.
20 May, 1996

<u>Appendix 9</u>

BALTEX Data Exchange
-Status of the Data Centres-
as of June 1996

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

P = Planning Stage

A = Approved by SSG, Data Center and Data Suppliers

S = Started

Hans-Jörg Isemer, Sopot, Poland, SSG meeting, June 1996

Appendix 10

BALTEX Oceanographic Data Center: BALTEX ODC

Status Paper Draft, submitted to BALTEX SSG, June 1996

1 Object and division of the task

The Finnish Institute of Marine Research (FIMR) has offered to act as the Oceanographic Data Center for the BALTEX international research project. The FIMR has experience on serving as a data center for an international organization. We served several years as the first data center for the HELCOM in 1980's. The BALTEX-ODC will act as a service center for all BALTEX participants in oceanographic data questions.

The BALTEX oceanographic data can either be stored physically at BALTEX-ODC or the ODC can act as a meta data center. In case of meta data center, only information on the contact addresses of the data originators and information on the data available from the originators is provided.

Preliminary opinion of BALTEX oceanographers has been that meta data information for most of the data is sufficient. Lots of oceanographic data are also stored in other international data centers like ICES and HELCOM data bases. Department of Geophysics in University of Helsinki has collected a Baltic Sea Climate Data Bank. The possibilities are somewhat limited to the personnel available. Some decisions of the BALTEX-SSG and BALTEX oceanographic community are needed on the level of services desired.

2 Data types

The oceanographic data can be categorized as several types. These could be the following:

1. data for model initializations (e.g. SST, salinity, sea level)
2. data for model verification and validation (e.g. SST, salinity, sea level, currents)
3. meteorological data (e.g. wind, air pressure, humidity)
4. ship data from cruises (e.g. position, time, temperature, salinity, ADCP current measurements, CTD data)
5. buoy data (e.g. temperature, salinity, currents, meteorological data)
6. sea ice data (e.g. area of ice, ice thickness)

3 Time periods of data

BALTEX key periods are 1986-1987, 1992-1993 and 1995. Other important periods are the BALTEX oceanographic experiments, BASIS and BAVAMEX, 1997 and 1998. As complete data sets as possible from the key years are most probably needed. The Baltic Sea Climate Data Bank is an example of such an effort. Cooperation with that data bank is suggested, because the data originators are also BALTEX participants.

Long term time series are needed for model verifications and validations. Specially widely used data type has been sea level data. Data sets from selected sea level stations around the Baltic Sea from the last 10-20 years could be well motivated.

4 Meta data information

Meta data contains the contact addresses and persons of data originators as well as information on their data holdings and availability of data. Such a list can include the oceanographic institutions around the Baltic Sea and the international oceanographic organizations where data is available on certain conditions. Meta data can be put available in Internet. The FIMR has a WWW server where a home page for BALTEX ODC can be constructed. That home page can then be linked to the BALTEX secretariat home page.

5 Physical data storage

Although the opinion among oceanographers has been that meta data could be sufficient for most purposes, some important widely used data sets could be collected physically into the BALTEX ODC, like sea level data. Data sets from the oceanographic experiments, where many different institutions take part, might also be motivated to be collected in a consistent way physically together. The FIMR has facilities to produce e.g. CD-ROM's on limited amounts.
Need for physically accessible data base or files via FTP should be negotiated. An FTP site is easily build up, but an internationally accessible online data base needs many more efforts. If the BALTEX ODC should collect data physically, the originators should be responsible for basic quality control of the data before submission to the ODC.

6 Activities so far

The BALTEX ODC has been quite inactive so far. There has been only one major request from a scientist. The ODC has served as a meta data center for that request. No data files for BALTEX have yet been stored in BALTEX ODC.

7 Proposed actions

1. The FIMR will serve as a oceanographic meta data center for the BALTEX. A BALTEX ODC home page in WWW will be formed.
2. The oceanographic data center will be linked to Baltic Sea Ice Climate Data.
3. The FIMR will store physically BALTEX oceanographic experiments data and sea level time series.

Appendix 11

The METEOROLOGICAL DATA CENTRE for BALTEX (BALTEX - MDC)

Angela Lehmann
Deutscher Wetterdienst - BALTEX - MDC -
D-63004 Offenbach a.M., Germany

1. OBJECT AND NATURE OF TASK

The hydrological cycle and the exchange of energy between the atmosphere and the surface of the earth control and regulate the climate in a fundamental manner. In order to reduce the uncertainties in our under-standing of the processes and the balances in the hydrological and energy cycles a cage experiment was installed in the region of the Baltic Sea and its catchment area - BALTEX.

BALTEX will explore, model and quantify the various processes determining the space and time variability of the energy and water cycle of the Baltic Sea and its catchment area. BALTEX will undertake specific assessments of the total flux divergence of heat, water and momentum for this region and determine its coupling to the large-scale atmospheric circulation and to the water exchange through the Danish Straits. The scientific objectives will be addressed by a combined observational and modelling approach where the Baltic Sea, the land surfaces of its catchment area and the atmosphere will be considered as one system.

BALTEX is a regional contribution to the Global Energy and Water Cycle Experiment (GEWEX). All countries around the Baltic Sea take part in BALTEX.

A meteorological data centre has been set up at the Deutscher Wetterdienst (DWD) for the BALTEX international research project (which is expected to run until about the year 2002). The BALTEX-MDC acts as service centre for all national and international institutions participating in the research project.

The BALTEX-MDC coordinates resp. realizes the collection and exchange of project-related data and information relevant to the data (metadata) from the BALTEX area. The realization of a data assimilation scheme and the compilation of water and energy balances in the BALTEX-MDC is planned as from 1997.

The BALTEX-MDC uses the infrastructure and the routine services of the DWD.

2. DATA MANAGEMENT

At present only a small part of data observed in the BALTEX region is transmitted to international data centres and hence is available for the research program. One of the aims of the BALTEX-MDC is to make available all BALTEX-relevant data to the user.

The BALTEX-MDC works partly as a real and partly as a virtual data centre. It collects and stores selected observation data from the BALTEX area and information on supplementary observation data of the participating countries and provides these to the institutions participating in the BALTEX research project upon request.

2.1 DEFINITIONS OF THE BALTEX AREA

- BACAR

The BALTEX area is defined in a limited sense as the catchment area of the Baltic Sea (BAltic Catchment ARea - BACAR). Its boundaries are depicted in fig.1.

- BAMAR

A BAltex Model ARea (BAMAR) has been defined for special tasks (modeling). The position and extent of BAMAR can be seen in fig. 2. The definition of BAMAR is tied to the data assimilation which is planned to use the BALTEX model BM (a special version of the operational weather prediction model "Europa-Modell") of the DWD.

2.2 DEFINITION OF THE TIME PERIODS FOR DATA COLLECTION

All BALTEX-MDC activities concerning data collection, storage, and release refer to the project period including selected test periods of 1986/87 and 1992/93 in accordance with the BALTEX Initial Implementation Plan. Projected periods are:

- Period 1: 1986, Dec.- 1987, Feb.
- Period 2: 1992, Dec.- 1993, Feb.
- Period 3: 1993, May - 1993, June
- Period 4: 1995, Aug.- 1995, Nov. (PIDCAP period)
- Period 5: continuously from about summer of 1996

The year 2002 is taken tentatively as the end of the project period and the end of data collection.

2.3 REAL DATA ARCHIVE

Real data management and an international data archive are planned for the BALTEX area in the BALTEX-MDC for selected data types from conventional routine observations, which are considered to be indispensable for a large number of research collectives and tasks. In addition, all data archives available at the DWD on a routine basis can be used for the BALTEX project.

2.3.1 REAL-TIME-DATA (rt-data)

rt-data are required especially for the data assimilation in using models. All reports of the following types for BAMAR routinely distributed via GTS are stored at the DWD on a routine basis:

SYNOP(FM12),SHIP(FM13),METAR(FM15),SPECI(FM16),BUOY(FM18),PILOT(FM32), PILOT SHIP(FM33),TEMP(FM35),TEMP SHIP(FM36),CODAR(FM41),AMDAR(FM42), CLIMAT(FM71),CLIMAT SHIP(FM72),SATEM(FM86),SATOB(FM88).

The data are stored synoptically.

Special BALTEX data storage: Observation data of the following types additionally provided by the countries:

- SYNOP, SHIP, PILOT, PILOT SHIP, TEMP, TEMP SHIP.

The transmission of the current rt-data should be realized via GTS. Appropriate transfer media have to be specified for the transmission of synoptic data of the past periods.

2.3.2 NON-REAL-TIME-DATA (nrt-data)

nrt-data are required mainly for verification purposes, case studies, and for climatological statements. The following data types are projekted to be stored for BACAR in real mode:

- precipitation data (6h-, 12h-, 24h-totals) from all categories of stations
- soil temperature and soil moisture at all available depths from all types of stations
- snow depth from all types of stations
- radiation data (24h-sums) from all types of stations

  at least: global solar radiation
  desirable: direct solar
  diffuse solar
  longwave downward
  longwave upward
  reflected solar.

All data will be stored in time series arrangements.

2.3.3 MODEL DATA FROM THE DATA ASSIMILATION

see 4.

2.3.4 DATA OF ENERGY AND WATER BALANCE

see 4.

2.3.5 EXTERNAL PARAMETERS

For modelling purposes the following fields of external parameters will be available for BAMAR (grid point values with a resolution of 1/6 degree):

- elevation
- parameters describing type of soil
- parameters describing vegetation.

Elevation data with a resolution of 30 sec x 30 sec (approximately 1 km x 1 km) are available for a large part of BAMAR (UKMO data set).

2.4 VIRTUAL DATA ARCHIVE

With respect to the limited capacity of the BALTEX-MDC it is impossible to build up real data archives for all the variety of meteorological observations. Therefore, a virtual data storage is planned for the following data types of BACAR:

- data from measurement campaigns / BALTEX field experiments
- non-conventional observations as
  - radar data
  - satellite data
- observation data from the climatological network (usually 3 times/ day), as far as not stored really (see 2.3.2)
- precipitation and radiation data with high temporal resolution (<=1h)
- special measurements at observatories.

That means: in the BALTEX-MDC, information on the aforementioned data will be available at their proper storage address. The data themselves will remain with their producers.

As the diversity of these data is very large, the metainformation is limited to basic information as, e.g.:

- identification number and/or name of station
- site of measurements (inclusive height above mean sea level)
- spatial resolution
- period of measurement
- definition of data
- measuring principles / instruments
- availability / usability of data
- owner of dataset / contact person (for requests by BALTEX users).

3. DATA POLICY

i) The principles for the use of data are laid down in formal obligations

- between the DWD and the providing country
- between the user of the data and the DWD/BALTEX-MDC

(see appendix).

ii) Data delivery by the BALTEX-MDC is strictly limited to groups or scientists which are officially registered as participants in BALTEX.

iii) The delivery of data by the providing country will be free of charge.

iv) The distribution costs at the BALTEX-MDC will be covered by the user (as far as they are not data suppliers).

v) The collected data will be kept at BALTEX-MDC for some years after completion of the whole project and made available upon request. Toward the end of the project the SSG will decide on the future storage of the data.

4. DATA ASSIMILATION

A data assimilation scheme is planned to be developed for the BALTEX model (BM). The BM is based on the EM/DM system (Europa-Modell/ Deutschland-Modell) of the DWD with a resolution of 1/6 degree and 25 levels. The assimilation system is of the intermittent type consisting of a "Optimum Interpolation" analysis, a nonlinear normal mode initialisation, and a 6-hour forecast serving as a first guess for the next analysis. Once defined, it will be left unchanged for the whole research period. It will be run in a delayed mode 4 times/day for BAMAR and will produce a complete, homogeneous, and consistent data set of meteorological variables. Water and energy balances will be conducted for BACAR as well as for BAMAR.

Model results as well as energy and water balances will be archived.

5. OUTPUT OF THE BALTEX-MDC

The BALTEX-MDC will place the following data sets at the users disposal on request:

i) Synoptic data sets for BAMAR or parts of it for specified dates / periods of time in a synoptical arrangement

ii) Aerological data TEMP and PILOT for BAMAR or parts of it for specified dates / periods of time in a synoptical arrangement

iii) Precipitation, snow depth, soil temperature and moisture, and radiation data for BACAR as time series with respect to the station

iv) Grid point data of assimilation procedures four times/day for BAMAR with a horizontal resolution of 1/6 degree and on 25 levels.

v) Monthly sums of energy and water balances for BACAR and BAMAR.

The supply of data is planned on media or via data line.

The BALTEX-MDC will inform on the status of data collection in the Internet.

[1] Baltic Sea Experiment BALTEX Initial Implementation Plan, Internat. BALTEX Secr., Publ. No. 2, March 1995

Appendix 12

AGREEMENT

Between

the Deutscher Wetterdienst (DWD) as the operator of the Meteorological Data Centre for BALTEX, represented by the president of the DWD,

and

the ...., **the Supplier**, represented by the ....,

the following Agreement has been reached:

1. Background

1.1 BALTEX, the Baltic Sea Experiment, will explore, model and quantify the various processes determining the space and time variability of the energy and water cycle of the Baltic sea and its catchment area. Organizations and institutions from 10 countries are participating and co-operating in the BALTEX Research Programme. It is planned to extend BALTEX over a ten-year period.

1.2 Data support from the national meteorological, hydrological and oceanographical services is of the greatest importance for a successful outcome of the BALTEX Research Programme. This Agreement has the dual purpose of safeguarding the access to data for scientists participating in BALTEX as well as protecting the commercial rights and intellectual property rights of the data suppliers.

1.3 For the purpose of the BALTEX International Research Project the Meteorological Data Centre, hereinafter referred to as **MDC**, has been set up. The MDC coordinates the collection and exchange of project-related data and information relevant to the data (metadata) from the BALTEX area. The MDC uses the infrastructure and the routine services of the DWD.

2. Scope

2.1 Subject to the terms and conditions herein, the Supplier shall, deliver data and/or documentation to the MDC free of information charge and delivery costs. The MDC is allowed to distribute the delivered data and/or documentation in accordance with this Agreement to any party which is officially registered as participant in BALTEX, hereinafter referred to as **the User**.

2.2 This Agreement permits the distribution of data and/or documentation to Users only for the sole purpose of scientific utilization within the scope of BALTEX. The data and/or documentation cannot be used, either by DWD or Users, for commercial exploitation, business use, re-sale or re-distribution.

2.3 The Users shall have the right to obtain data and/or documentation from MDC free of charge. The distribution cost shall be covered by the User.

2.4 The MDC may not, either against remuneration or not, grant use of the data and/or documentation by way of ownership or licence, to any third party without the written consent of the Supplier.

3. Specification of data

3.1 The data in general comprise meteorological and hydrometeorological data as well as metadata. The specification of data together with the schedule for delivery is appended to this Agreement as Appendix A.

3.2 The data shall be delivered to the MDC in the format that is commonly used by the Supplier. If necessary, the access software shall also be delivered accordingly.

4. Licence Agreement

4.1 The MDC guarantees to have a Licence Agreement signed by the User before transfer of the aforementioned data and/or documentation is conducted. The Licence Agreement shall have the same form as the one appended to this Agreement, Appendix B.

5. Intellectual Property Rights

5.1 The intellectual property rights to the data deposited in accordance with this Agreement shall be retained by the Supplier.

5.2 The Supplier reserves the right to require acknowledgements and, where appropriate, co-authorship to any scientific publication arising out of the use of the aforementioned data and/or documentation supplied by the Supplier.

5.3 The Supplier shall have joint intellectual property rights, together with the User to the results of the research which has been performed with data and/or documentation licenced from the MDC in accordance with this Agreement. The Supplier and the User shall have the right to use said results in its Governmental Services.

6. Remedies

6.1 The MDC shall safeguard the interest of the Supplier with regards to data and/or documentation supplied in accordance with this Agreement.

6.2 The MDC shall, on its own initiative or on demand by the Supplier, exclude any User or group of Users from further data supply in connection with BALTEX if non-fulfilment of the Licence Agreement is proven. In combination herewith the MDC shall obtain a formal confirmation from the data User or group of Users in question that all data supplied by the Supplier within the scope of BALTEX has been destroyed or erased.

7. Feed-back

7.1 The MDC shall annually, not later than by the end of March each year, issue a report containing a list of data and/or documentation which has been distributed the year before and all Users which have received data.

7.2 The MDC shall inform the Supplier if any Licence Agreement that affects the data of the Supplier has been terminated.

8. Validity of this Agreement

8.1 This Agreement enters into force when signed by both parties and shall be valid up to and including December 31, 1998. Unless cancelled by either party in writing giving three month notice, the Agreement shall be prolonged for a further period of one year. Such a prolongation shall be possible also for the following years.

8.2 The Supplier may terminate this Agreement with immediate effect if MDC is in breach of any condition herein and fails to rectify such breach of contract within thirty days after written notice from the Supplier.

8.3 Cancellation or termination of this Agreement, in accordance with this section, shall not affect the Users right to use data and/or documentation within the scope of BALTEX.

8.4 If this Agreement is terminated in accordance with this Section 8, MDC shall, not later than thirty days after termination, give the Supplier a formal confirmation that all data supplied by the Supplier within the scope of BALTEX has been destroyed or erased.

8.5 It is the understanding of both signing Parties that, whether this Agreement is in force or not, the Supplier shall retain all its rights to the data and to its subsequent use by MDC or data Users at all times, if not otherwise agreed in writing.

This Agreement has been drawn up in two identical originals, of which the Parties have taken one each.

........, ...	Offenbach, ...
Date	Date
For the	For the Deutscher Wetterdienst
....	....
	U. Gärtner
	The president

LICENCE AGREEMENT

Between

the Meteorological Data Centre for BALTEX at the Deutscher Wetterdienst, hereinafter referred to as **MDC**,

and the ...., hereinafter referred to as **the Licensee**,

the following Agreement has been reached:

Preamble

This Agreement has as its purpose the release of data, meteorological, hydrometeorological, physiogeographical and metadata with documentation within the bounds of the BALTEX Research Programme.

1. Licence

1.1 Subject to the terms and conditions herein, the MDC grants to the Licensee a non-exclusive licence to data and/or documentation for scientific purposes within the BALTEX Research Programme. The specification of data is appended to this Licence Agreement as Appendix I. The data have been supplied to the MDC by individual participants in BALTEX, **the Suppliers**. The Suppliers are institutions in the countries of the BALTEX Research Community.[1)]

1.2 The Licensee shall have the right to obtain the licence to data and/or documentation from MDC free or charge. The distribution cost will be covered by the Licensee.

1.3 The Licence does only permit the use of data and/or documentation for the sole purpose of scientific utilization within the scope of the BALTEX Research Programme. The data and/or documentation may not be used for commercial exploitation, business use, re-sale or re-distribution.

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1) **Countries of the BALTEX Research Community are:**
Belarus, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden

2. Proprietary Rights

2.1 The intellectual property rights to the data licenced in accordance with this Licence Agreement shall be retained by the Suppliers.

2.2 The Suppliers reserve the right to require acknowledgements and, where appropriate, co-authorship to any scientific publication arising out of the use of the aforementioned data and/or documentation supplied by the Suppliers. However, the Licensee himself will give proper reference to Suppliers contributing to his data supply.

2.3 The Suppliers shall have joint intellectual property rights, together with the Licensee to the results of the research which has been performed with data and/or documention licenced from the MDC in accordance with this Agreement. The Suppliers and the Licensee shall have the right to use said results in its Governmental Services.

2.4 The Licensee may not, either against remuneration or not, grant the use to the data and/or documentation mentioned in this Agreement by way of ownership or licence, to any third party without the written consent of the Suppliers.

3. Feed-back

3.1 The Licensee shall send 1 copy of his study results gained from the Suppliers data to each country (i.e. to a national institution) which contributed to the Licensees data supply. The delivery will be unrequested and free of charge.

4. Warranties

4.1 The MDC warrants that it is authorized by the Suppliers to grant licences as stipulated in this Agreement.

4.2 The MDC accepts no liability for errors or gaps in the data or in the enclosed documentation. Also no guarantee is given for usability on the Licensees technical equipment.

5. Validity of this Agreement

5.1 This Licence Agreement enters into force when signed by both parties and shall be valid until the specific research efforts, for which the data has been supplied, has been completed. Should the BALTEX Research Programme be terminated before the completion of the specific research effort, an early termination of this Licence Agreement shall be possible. Its date is subjected to the decision of the BALTEX Science Steering Group.

5.2 The MDC may terminate this Licence Agreement with immediate effect if the Licensee is in breach of any condition herein and fails to rectify such breach of contract within thirty days after written notice from MDC.

5.3 If this Licence Agreement is terminated in accordance with this section the Licensee shall, not later than thirty day after termination, give MDC a formal confirmation that all data supplied by MDC within the scope of BALTEX has been destroyed or erased.

This Licence Agreement has been drawn up in two identical originals, of which the Parties have taken one each.

Date:	Date: ....
For the Meteorological Data Centre for BALTEX at the Deutscher Wetterdienst	For the Licensee

Appendix 13

Hans-Jörg Isemer
International BALTEX Secretariat

Identification of BALTEX Data Users

Various institutions and agencies in numerous countries hold different types of data which are required for research purposes in BALTEX. For example, part of the observational data are collected operationally by national hydro-meteorological services and agencies of at least 10 different countries in the Baltic Sea catchment area. All these institutions with potentially important data for BALTEX will be named **data suppliers** in the following.

The BALTEX Science Steering Group (SSG) has appointed three **BALTEX Data Centres** for meteorology, hydrology and oceanography with the main objective to concentrate specific types of data or information (metadata) at these Centres, and thus to facilitate the data exchange between the different data suppliers on the one side and individual scientists or research groups within BALTEX on the other side. The latter will be referred to as **data users** in the following. General guidelines for the data exchange policy within BALTEX were outlined in the BALTEX Initial Implementation Plan.

Most of the data and information which are transmitted by the data suppliers and stored at the BALTEX Data Centres are subject to property rights or other legalities and, hence, to certain access restrictions. These data will be shortly referred to as **BALTEX Data** here. Rules and procedures for the exchange of BALTEX Data between BALTEX Data Centres and data users are determined through formal agreements between data suppliers and the BALTEX Data Centres. These rules will have to be confirmed and accepted by data users, who wish to have access to BALTEX Data. This confirmation will be through a BALTEX Data License Agreement to be signed by both the data user and the BALTEX Data Centre before BALTEX Data will be made available by the Data Centres.

An important restriction is that BALTEX data will be passed only to registered **BALTEX Data Users**. Identification of BALTEX Data Users will be done by members of the BALTEX SSG only, as has recently been decided on the 4th meeting of the BALTEX SSG (June 1996, Sopot, Poland). A list of authorised BALTEX Data Users will be stored at the BALTEX Secretariat and at the BALTEX Data Centres. Registration as a BALTEX Data User is performed upon request of the user and is subject to the following procedure.

Identification of BALTEX Data Users must be on the department level and has to include the name of the Principle Investigator, his complete address, the participants at his BALTEX project who will work directly with the data, and a short description of the BALTEX project the data are needed for. To facilitate communication it is urgently recommended to follow the key-words on the attached BALTEX Data User Identification form. The project description should be short, the entire completed form must not be longer than one page. The user's request has to be communicated by at least one member of the BALTEX SSG preferably from the same country as the potential data user.

In the course of the project any change of the research group membership has to be notified to the BALTEX Secretariat.

Copies of the BALTEX Data User Identification Form may directly be copied from the BALTEX Home Page on the Internet at

http://w3.gkss.de/baltex/baltex_home.html

The BALTEX Secretariat and the BALTEX Data Centres will provide forms upon request.

Summary

A BALTEX Data User may receive BALTEX Data from a BALTEX Data Centre providing

- the User's complete identification form has been communicated by one BALTEX SSG member and has been registered at both the BALTEX Secretariat and at the BALTEX Data Centre,
- the User's data request has been detailed to the BALTEX Data Centre,
- a BALTEX Data License Agreement has been signed by both the Data User and the BALTEX Data Centre.

Key-words for BALTEX Data User Identification

1. Title of Project :
2. Principle Investigator :
3. Institute :
   Department :
   Mail address :
   Phone :
   Fax :
   E-mail :
4. Participants :
5. Scientific Objective :
6. Methodology and Approach :
7. Additional Remarks :
8. Communicated by BALTEX Science Steering Group member
   Name :
   Date : Signature :
9. Registered at BALTEX Secretariat
   Date : Signature:

Appendix 14

SMHI
1996-05-21
S. Bergström

Swedish BALTEX activities

Report to the BALTEX SSG meeting in Sopot June 3-5, 1996

The Swedish research within, or related to, BALTEX is mainly carried out within some international research projects such as PIDCAP, NEWBALTIC, CIRDEX, BALTMEX, DYNOCS, BASYS and a project on ice formation and the influence of ice-coverage on the circulation in the Baltic Sea. Important is also the extensive land/atmosphere exchange studies carried out within the international NOPEX project with a study area close to Uppsala.

The Department of Meteorology of Uppsala University is responsible for the Östergarnsholm air/sea interaction project with the objective to improve parameterizations at different scales. This project is centred to a research site on the Island of Östergarnsholm, 4 km east of the island of Gotland.

Four Ph D students, financed by SMHI, are now active in various aspects of meteorological, hydrological and oceanographic modelling in cooperation with University departments in Stockholm, Uppsala and Göteborg.

A Swedish research programme on regional climate modelling has received positive response by the Swedish foundation for strategic environmental research (MISTRA). This means that the Swedish Climate Modelling Programme will be established in cooperation between five university departments in Stockholm, Uppsala and Göteborg and SMHI in Norrköping. A modelling centre, the Rossby Centre, will be located at SMHI as the hub of the programme. The funding amounts to a total of 33 MSEK until the end of the century, with a possible additional four years extension. The planning phase has just started.

Appendix 15

Minutes
of the 5th Meeting of the
BALTEX Working Group on Process Studies

Date: Tuesday, May 7, 1996, 19.00

Location: The Hague, Frans-Halzsaal in the Congress Centre

Participants:

M. Claussen, S. Halldin, H. U. Lass, A. Omstedt, J. C. Refsgaard, E. Ruprecht, H.-J. Isemer, A.-S. Smedman, G. Tetzlaff, several guests.

Agenda

1. Welcome and report by the chairman
2. H.-J. Isemer: Report from the BALTEX Secretariat, Status of PIDCAP
3. A. Omstedt: Status of the ice experiment (BASIS)
4. A.-S. Smedman: Ongoing activities around Oestergarnsholm and plans for an experiment at the Baltic Sea

5a. G. Tetzlaff: Activities around Lindenberg and future plans for a land experiment

5b. S. Halldin: Plans for the NOPEX experiment WINTEX and a possible co-operation with a BALTEX land experiment

6. H. U. Lass: Status of the oceanic experiment
7. Discussion about a main BALTEX experiment
8. Further items to be discussed

TOP 1:

The chairman welcomed the WG members and guests. Unfortunately the two invited NOPEX scientists Drs. A von de Griend and L. Gottschalk were not able to attend the meeting. The chairman described the three goals for this meeting.

1. Receive information about the field experiments and discuss further plans,
2. Discuss the suggestion by the chairman of the BALTEX SSG, L. Bengtsson, about a main BALTEX experiment,
3. discuss the possibility of more close co-operation between BALTEX and NOPEX.

TOP 2:

H.-J. Isemer reported from the BALTEX Secretariat that the data exchange with the Baltic states is a main concern of the Secretariat, these states need and asked for financial support to make their data available for BALTEX. Other data problems are with the data centres, the exchange of meteorological data is most advanced, oceanographic data start to flow and fill the centre, hydrological data are still very sparse.

PIDCAP is running well, after the end of the observing period (October/November 1995), the period of evaluation is under way, progress will be seen mid June in Norrkoeping at the first PIDCAP Workshop.

TOP 3:

Since the co-ordinator of the Atmosphere-Ice-Ocean Experiment, J. Launiainen, could not attend the meeting, A. Omstedt gave the report. After a plan was proposed by the three scientists J. Launiainen, P. Lemke, A. Omstedt, the co-ordinator invited interested groups for a participation on BASIS. Eight groups from Finland, Germany and Sweden showed their interest and responded with a proposal to the co-ordinator. These papers are the basis for a proposal to the EU, due in October 1996. BASIS is planned for a period in February/March 1998 at the southern edge of the ice in the Bothnian Bay. Measurements and observation will be carried out at the ice, water and land with buoys, ships and air planes. The main goal is to investigate the fluxes of sensible and latent heat and of momentum at the different surfaces and their variations.

TOP 4:

The measurements performed by the University of Uppsala at the islet of Oestergarnsholm will continue at least for one year more. Mrs. Smedman was successful to interest other groups in participation at different periods during this year. Thus, two or three times during this year field experiments will be carried out with several groups with the goal to investigate the atmospheric boundary-layer over the Baltic Sea.

TOP 5a:

G. Tetzlaff reported that the German Weather Service (DWD) is now running its observational programme at the experimental site near Lindenberg. The goal of these activities is a continuous validation of the small-scale DWD models. The DWD offers the participation for other experimental groups and is prepared to be the host of one of the BALTEX land experiments. Mr. Tetzlaff proposed a general experimental plan the goal of which is investigation of the energy budget of the boundary layer. The measurements should be carried out on instrumented towers, small masts, helicopters and air planes.

TOP 5b:

S. Halldin presented his opinion about a co-operation between BALTEX and NOPEX. He stated that the goals of BALTEX and NOPEX are very similar and a closer co-operation will be for the benefit of both. That is also true for the funding situation. The WG members fully agreed with these statements and hoped for a better co-operation in the future.

S. Halldin then reported about the NOPEX activities for a winter experiment in North Finland. A proposal is sent to the EU for a pre-experiment and it will probably be funded. Since the time schedule of this winter experiment and of BASIS is about the same, it was discussed whether it may be possible to run both experiments at the same time. Besides of scientific reasons to do this, the air plans could be used more effectively. Further discussion between the organisation groups is needed.

TOP 6:

The co-ordinator for the ocean experiment, A. Stigebrandt, could not attend the meeting. Thus H.-U. Lass reported about the activities and plans of the group, which have been established during the BALTEX Conference in Visby. An experiment is proposed east of Gotland in an area 30 x 30 nm. A pilot study in August 1997, a winter experiment between December 1997 and March 1998, and a summer experiment during June to August 1998 are planned all with at least 4 ships. The scientific goal is the investigation of the mixing processes above and below the halocline and related transfer of energy in the Gotland basin.

General remarks to TOP 3-6:

Definitive plans for all four experiments are now existent. Two are connected to ongoing experiments (at Oestergarnsholm and Lindenberg). Such a combination is advantageous because the situations encountered during the short period (in general four weeks) of the special experiment can be classified to regularly apparent or seldom etc.

The WG agreed that the co-ordinators should write a description of their experiment, together with a call for further participation. These two papers for each experiment should be published in the BALTEX News Letters and should appear in the BALTEX home page.

TOP 7:

The WG welcomed the ideas of a main BALTEX experiment of the chairman of the SSG, L. Bengtsson. The WG members discussed two possible aims:

- to provide observation for an analysis of the hydrological (and energy) cycle over the whole BALTEX area, or
- to investigate large-scale processes in the BALTEX area, e.g. fronts.

For both goals it is necessary to include as much different synoptic situations as possible. Thus, an observation period of at least one year, better 15 to 18 months, which include two winters, is needed.

The WG agreed, that the observation network (in particular the radiosonde network) has to be extended for this purpose. For the decision, where new observation sites have to be set up, an analysis of the results of the numerical models (HIRLAM, REMO) must be carried out. The WG agreed that we should ask the WG for Numerical Experimentation to outline the main experiment based on results of the numerical models. The main experiment should comprise intensive observation periods, a transect of field experiments may be taken into consideration, including the continuous atmospheric measurements at Oestergarnsholm and Lindenberg and the water exchange observations at Darss Sill and through the Danish Straits.

TOP 8:

No definitive decision was made about the next WG meeting;

Helsinki was proposed for the next meeting site, unless travel money will become available through German sources, then the next meeting will take place in Kiel (or maybe in Lindenberg). About the time we shall wait for the SSG meeting in Sopot.

The meeting was closed at 21.45.

Eberhard Ruprecht

Chairman of the WG on Process Studies

Appendix 16

BALTEX - Network A

NEWBALTIC: Numerical Studies of the Energy and Water Cycle of the Baltic Region

Co-ordinator: Prof. Lennart Bentsson

Proposal Summary

To reduce the uncertainties in our understanding of the hydrological and energy cycle of one of the most problematic regions in Europe, the Baltic Sea and its catchment area, this project will explore, model, and quantify the various processes which determine the space and time variability of the energy and water cycle in the Baltic region.

This proposal is part of Baltic Sea Experiment (BALTEX) as its overall goal is to provide the large-scale water and energy budget over the Baltic region from

- regional-scale atmospheric reanalysis and satellite data,
- meteorological data assimilation,
- diagnostics from several regional-scale atmospheric models,
- hydrological models and observations.

Moreover it is intended

- to develop new data assimilation techniques for coupled models,
- to assess the climate of the Baltic region as well as the long-term hydrological balance,
- to assess the role of snow cover in the energy and water budget of the Baltic region,
- to assess new parameterization schemes of land surface subgrid-scale variations.

The novel scientific contribution is the assessment of the water balance of the Baltic Sea and its catchment area by combining large-scale hydrological and atmospheric models.

The improvement of our understanding of the Baltic energy and water cycle will be beneficial for short range weather prediction, medium and long term climate prediction, climate impact studies, observational techniques and networks designs, water resources assessment and management, as well as environmental aspects.

Specific Objectives

1) To apply atmospheric data assimilation techniques in order to create data sets for the study of the water and energy budgets in the Baltic Sea area for a number of specified data periods of particular interest.

2) To study the atmospheric branches of the water and energy cycles over the Baltic region for selected data periods using regional-scale models and analysis systems.

3) To validate diagnostics based on regional-scale atmospheric assimilation systems by comparing the results from several systems with each other and with independent observations.

4) To assess analysed and predicted fields of atmospheric humidity, cloud water content, longwave outgoing and shortwave absorbed radiation of the atmosphere/earth system with independent data retrieved from satellite observations.

5) To provide checks on the consistency of the BALTEX data and to assess and improve the model's physical realism and predictive accuracy for weather forecasting and climate simulation in the region of N.W. Europe.

6) To develop and validate new mesoscale atmospheric data assimilation techniques, including data assimilation for simplified models describing ice and water surface conditions of lakes and seas in the Baltic Sea area as well as data assimilation for soil moisture and soil temperature.

7) To investigate the effect of a denser network of humidity observations provided by satellite data on the atmospheric humidity analysis.

8) To estimate the water balance of the catchment areas of the Baltic region using hydrological models and thereby to provide a validation of the hydrological component of atmospheric models.

9) To estimate the present-day climatological energy and water budget over the Baltic region in order to assess the representativeness of budgets estimated for selected periods. Emphasis is given to the coupling of a hydrological model and an (atmospheric) climate model.

10) To investigate the role of snow accumulation, change of state, and ablation in the Baltic energy and water cycle.

11) To assess the parameterization of so-called subgrid-scale variations of surface conditions, i.e. of inhomogeneities of the land surface which cannot be resolved by a weather forecast or climate model. Special emphasis is given to the subgrid-scale variations of the land-water distribution, sea-ice concentration, and snow cover, as well as the representation of subgrid-scale flow phenomena, e.g. land-sea breeze systems.

Appendix 17

BALTEX - Network B

BALTEX-HYACINT: BALTEX-Hydrological-Atmospheric Integrated Modelling at Subgrid Scale

Co-ordinator: Dr. Jens-Christian Refsgaard

Proposal Summary

This project proposal constitutes an important element in the overall research plan for BALTEX. a key European contribution to GEWEX. The overall aim of BALTEX-HYACINT is to develop a full coupling between a high resolution atmospheric model and an integrated hydrological model comprising the key elements of existing hydrological models as well as improved SVAT and snow modules and procedures for data assimilation of remote sensing data and for scaling. An important element of the integrated model will be its ability to be operated at different spatial scales with different discretizations. More specifically, the project objectives are:

- To test, intercompare and further develop process submodels for land surface - atmosphere interaction at heterogeneous vegetation covered (HETSVAT) and snow covered land surfaces.
- To develop and test a methodology for integrating remote sensing data and distributed physically-based hydrological models through data assimilation techniques.
- To develop and test a methodology for upscaling of process descriptions and parameters in hydrological models. The methodology should be able to account for the effects of horizontal land surface heterogeneities and include procedures for incorporation of subgrid variability in process descriptions and parameter estimations.
- To develop an integrated hydrological model and a full coupling with an atmospheric model and to validate the coupled hydrological-atmospheric model on the NOPEX data set.

The modelling work will be based on existing tools which will be further developed, namely the MIKE SHE distributed physically-based hydrological model, the HBV (plus experience from the similar EGMO and WATBAL) semi-distributed conceptual hydrological models and the HIRLAM atmospheric model. The modelling work will be carried out for small scale catchments focussing on the NOPEX area near Uppsala and on meso scale catchments in Germany and Sweden.

Appendix 18

BALTEX - Network C

Ice formation and the influence of ice-coverage on the circulation in the Baltic Sea

Co-ordinator: Prof. Wolfgang Krauß

Objectives

Within BALTEX (Baltic Sea Experiment), a regional subprogramme of GEWEX (Global Energy and Water Cycle Experiment), exchange processes for energy and water between the atmosphere and the Baltic Sea are of central importance (BALTEX, 1992, 1994). They are closely related to the large-scale circulation system of the Baltic. The project aims at an improved simulation and understanding of this circulation on synoptic and seasonal time scales. These processes are influenced by the ice coverage during the winter season. Ice occurs annually in the Baltic. On the average the annual maximum sea ice extent is 50 % and the length of the ice season is 6 months in the northern parts (SMHI and FIMR, 1982). Ice plays a major role at the air-sea interface and largely modifies the momentum transfer and the exchange of heat and materia between the atmosphere and the sea. Wind-induced currents and associated sea level variations may drastically change, if parts of the Baltic are ice-covered (Lisitzin, 1957; Omstedt and Nyberg, 1991). Under maximum ice extent the sea level differences between Kattegat and Baltic, which are largely controlling major inflows of saline water into the Baltic, will be different from those in mild winters. Freezing and melting of ice also have notable effects on the stratification of the Baltic Sea water masses. Furthermore, the water exchange through the Danish Straits may become directly reduced due to ice ridging in the straits. In the coastal zone, land fast ice will reduce the coastal circulation. A typical feature in the Baltic Sea dynamics, inertial oscillations, also may become damped during the ice covered season due to the additional friction provided by the ice bottom on the water (Leppäranta and Omstedt, 1990).

Coupled ice-ocean models will contribute to a better knowledge of the inflow of saline, oxygen-rich water into the Baltic, which is vital for life in the deep basins. Realistic models are also a prerequisite for progress in modelling biological and chemical systems in the Baltic. Also the climate in the bordering countries is strongly influenced by the ice-coverage of the Baltic. Additionally, ice is a factor of concern in the economic life in the region and coupled ice-ocean models can contribute to the development of better forecast models for safer and more economic winter navigation.

The strategy of the present proposal is to couple 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. The necessity of such a project is explicitly stated in the BALTEX Implementation Plan as Project C on page 61 (BALTEX, 1994).

It involves the following specific objectives:

(i) The implementation of an ice model into the free surface GFDL General Circulation Model

(ii) Process studies, both by field experiments and process oriented models, and comparison with the coupled model in order to improve its parameterization

(iii) Determination of the sensitivity of the ice distribution on model parameters, especially on the thickness redistribution and the constitutive law of the ice

(iv) A systematic assessment of the model's ability to reproduce currents and stratification in the basins of the Baltic, ice formation, coverage, drift, and melting.

The model output - temperature, salinity, currents, sea level and ice coverage - will be made available to other groups, opening the possibility to compare the results to observations or using them as input data for biological and chemical models or as boundary values for regional models.

Appendix 19

A Field Experiment for the Baltic Sea

Lennart Bengtsson

1. Introduction

The BALTEX project is now well established and recognized as a key experiment within GEWEX. The specific characteristics of the BALTEX area with a sizable inland sea in its centre make it extra scientifically attractive. Of the different GEWEX subprograms BALTEX is also a genuine international undertaking and the potential deliverables are of great importance for the region. The political recognition of the importance of the Baltic region as stressed in the recent meeting in Visby by the political leaders of the area, has added extra impetus. There is good reasons to believe that environmental research in the Baltic Sea and surrounding land areas will be considered as a high priority research field by the actual countries as well as by EU.

The research infrastructure for BALTEX is successively being put into place. It is proceeding well but research financing and the exchange of data is not developing as quickly as I had hoped. BALTEX is strongly dependent on the support from the meteorological, hydrological and oceanographic agencies in particular with respect to the free access to observational data. In the long term the meteorological services and other agencies, including their commercial activities will benefit strongly from the BALTEX programme and I am therefore sure that the minor difficulties we have had so far will soon disappear.

All efforts both nationally and internationally must now be undertaken to obtain the financial support for the research programme. Projects which has not been supported so far must be critically reviewed and if necessary reformulated.

The weather and climate in the Baltic Sea area is characterized by a considerable variability over time periods extending up to several decades. Present model experiments suggest that these variations are partly chaotic and partly related to sea surface temperature anomalies preferably in the tropical oceans. A field experiment with a duration of a year or two cannot catch the low frequency variability. This aspect can only be handled by creating a long term data base from available data sets and from an improved future monitoring and operational program. A field experiment will by practical necessity be restricted to a year or two and we must therefore concentrate the field experiment on such studies which are of a more general nature. However, we must also keep the long term aspects in mind.

2. A Baltic Sea field experiment

As indicated in the science plan for BALTEX a major field experiment encompassing the whole area is anticipated. Such an experiment will not only include enhanced observations on synoptic and subsynoptic scales, but also enhancement of data-assimilation and modelling.

What are the most critical areas ?

What do we need to know more accurately for a determination of the energy and water balance of the area ?

Finally underpinning the GEWEX program is to develop systems for observation, data-assimilation and modelling which is applicable to other areas of the globe where detailed observations of the type we have in the Baltic area do not exist. An important objective for BALTEX is therefore to test new concepts in modelling and data-assimilation which can be used say in the North Atlantic or over parts of the Arctic. Let me try to give a few example below.

2.1 Upper air in situ data

A determination of the atmospheric water cycle is strongly dependent of good in situ observations and thereby not only from water vapour but probably even more so from vertical profiles of wind and temperature. This is due to dynamical adjustment processes which means that the combined use of models and assimilated winds and temperatures remarkably well can reconstitute the field of water vapour but not the other way around! A consistent use of water vapour information is therefore very difficult to explore in the data-assimilation and major efforts must be explored to improve this. Presently, water vapour, precipitation, clouds etc. are essentially only used to validate models, not to improve the initial state of the atmosphere.

Pending suitably observing system studies in the area a sensible approach would be to aim for an optimized semi-homogenous network of standardized upper air observations. As a minimum the network outlined on fig 4.2 of the initial implementation plan must be assured. Possible enhancements would be sounding capabilities (wind, temperature and water vapour) at least for the lower and middle troposphere for Bornholm, Visby (to be continued), Saaremaa and Öland.

The integrated water vapour from the GPS stations in Sweden are extremely promising. All efforts should be done to extend these measurements to cover the whole Baltic area. Urgent efforts are required to integrate these observations in the data-assimilation systems.

2.2 Surface data

This will have to be carefully analysed but as a minimum we should incorporate all the national networks at highest time and space resolution.

2.3 Remote sensing

Satellite and radar data will essentially be used for validation and process studies. How can we integrate this information into models? This needs to be clarified.

2.4 Measurements for the validation of calculated water and energy fluxes

This will be one of the most important parts of the program. High quality in situ measurements of radiation (solar (total and diffusive) and terrestrial), evaporation and precipitation to be integrated by available satellite measurements (estimates).

2.5 Hydrological data

We need to know run off with a higher time resolution but ideally still representing the water balance for largest possible areas. What is possible to achieve?

2.6 Estimating net run off through the Danish Straits

This will possible require a smart combination of measurement and detailed modelling. How well could it be done?. What additional observations do we need? What time resolutions versus accuracies?

2.7 Marine observations in the Baltic Sea

What needs to be measured and what can be inferred from modelling and available measurements?

2.8 Sea ice measurements

What do we additionally need? Are the ice-modeller satisfied what they presently have?

3. Combination of high resolution field experiments (for process studies) and the main experiment

It will be necessary to clarify the relation between the large scale experiment and the small scale studies (see fig 3 in the implementation plan). Presumably the best solution is to arrange the minor studies to fall within the time period of the major experiment.

4. Length and timing of experiment

It is suggested that we should aim for an experiment of some 18 months duration including two winters. It should be preceded by a 6 months spin up period. Assuming that the BALTEX SSG can take a decision early 1997 it seems reasonable that the experiment could take place October 1999 - April 2001.

5. Proposal

BALTEX SSG is proposed to establish a special task force to develop a concrete plan for the Baltic Sea field experiment. The plan shall be finalised by Jan./Feb. 1997. The task force shall be supported by the BALTEX Secretariat in its work.

Appendix 20

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(as of October 1996)

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Appendix 22

BALTEX HYDROLOGICAL DATA MANAGEMENT STRATEGY

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INTRODUCTION

Data collection and data assimilation activities constitute key elements of the overall BALTEX strategy. In the Baltic Sea region a relatively dense network of hydrological stations exists. Nevertheless, problems may arise in collecting, processing and disseminating data necessary to meet BALTEX objectives. This draft document is aimed to form a basis for decisions to be taken at the Fourth Session of the BALTEX Science Steering Group in connection with the expected role of national hydrologic services and the BALTEX Hydrologic Data Centre (BALTEX-HDC) in providing these data.

Hydrological data are measured, processed and disseminated by national hydrological services, and/or another water agencies, in order to provide information for planning, designing and operating water projects, as well as for providing security against water related hazards, like floods and droughts. Global issues, such as climate change or global environmental threats, are usually of secondary importance in establishing national water resources information policies. It should be noted that in some countries hydrological data are gathered in a decentralised way, what may complicate unification of measurement techniques, quality control procedures and data management in general.

NATIONAL SERVICES AND INTERNATIONAL PROGRAMMES

Several international programmes require hydrological data. This imposes new tasks on national hydrological services. Unfortunately, data specifications for programmes mentioned below, are poorly co-ordinated. Because in most countries funds available for operating hydrological services are very limited, this may create difficulties in meeting international data demands. In addition, a pressure for commercialisation of hydrological services may cause difficulties in exchanging data. Some of international research programmes requiring hydrologic data are discussed below.

(A) One of the main objectives of the Global Energy and Water Cycle Experiment is "To determine the hydrological cycle and energy fluxes by means of global measurements of observable atmospheric and surface properties." (Scientific Plan for GEWEX, 1990). Most of the GEWEX hydrological activities are organised on a regional level. The GEWEX plan calls for "...a major data collection effort to complement the existing river discharge data assembled by the UNESCO Hydrology Programme and the WCRP Global Run-off Data Project".

(B) The Hydrology and Water Resources Programme (HWRP) of WMO deals with collection, transmission, processing, storage, retrieval and publication of basic hydrologic data (WMO Technical Regulations, 1988). HWRP is linked with other WMO programs. Up to now two databases were established in framework of the HWRP: the Hydrological Information Referral Service (INFOHYDRO), and the Global Runoff Data Centre (GRDC) in Koblenz.

(C) The International Hydrological Programme (IHP) of UNESCO was launched in 1974. Some of IHP projects require collection of large hydrological data sets. One such example is the Flow Regimes for International Experimental and Network Data (FRIEND) project. The FRIEND database contains daily discharge data from a number of catchments which should be relatively free from anthropogenic influences.

(D) The Biospheric Aspects of the Hydrological Cycle (BAHC) Project was established within the International Geosphere - Biosphere Programme (IGBP) of ICSU. BAHC has developed a framework (BAHC, 1993) for interdisciplinary research activities to address the question: "How does vegetation interact with physical processes of the hydrological cycle?". Observations from space are expected to support data obtained from land-surface experiments.

(E) The aim of Global Climate Observing System (GCOS) is to co-ordinate and to facilitate critical observational tasks needed to address such issues as:

(a) Detect and quantify seasonal, inter-annual, and multi-year climate change;
(b) Document natural climate variability and extreme climate events;
(c) Model, understand and predict climate variability and change;
(d) Assess the potential impact of climate on ecosystems and socio-economics;
(e) Develop strategies to diminish potentially-harmful effects and amplify beneficial ones;
(f) Provide services and applications to climate-sensitive sectors;
(g) Support sustainable development.

Some of the above priorities exhibit the need for better understanding of hydrological processes. The following hydrological data are required by the GCOS Plan:
(a) precipitation,
(b) snow cover and snow water equivalent data,
(c) surface runoff characteristics,
(d) potential and actual evaporation and evapotranspiration,
(e) soil moisture and groundwater storage.
In many cases the density of measurement network, and the procedures used for data processing do not meet the expectations of climatic and biospheric modelling communities. There is e.g. a limited possibility to get systematically measured data on evapotranspiration and soil moisture, in most cases available only at selected experimental sites.

HYDROLOGICAL DATA IN BALTEX

Hydrologic data are needed for:

(a) Documenting long-term variability and/or change in hydrological systems and their impacts on water resources;
(b) Providing hydrological input to atmospheric and oceanographic models;
(c) Enhancing the role of hydrology in studying land/soil degradation, natural ecosystems, biodiversity loss, etc.

The science of hydrology and water management depend on progress in atmospheric sciences, and on meteorological data providing input to catchment models. The national hydrological services will contribute to various international programmes only if they will see the possibility to benefit from them. Such benefits may include:

(a) Better parameterisation of hydrologic models;
(b) Use of climatological data in water resources assessment;
(c) Improvements in hydrological forecasting and warnings, particularly against large scale water-borne disasters;
(d) Climate impact assessment.

Condicio sine qua non for efficient co-operation is a joint planning of monitoring activities, with an equal participation in this process of representatives of various geophysical disciplines.

The following general recommendations may be formulated in connection with the role of national hydrological services in the Baltic Sea Experiment:
(a) To the possible extent the results of hydrological and meteorological measurements should be processed and disseminated in a way enabling their use for benefits of both scientific disciplines; (b) Hydrological community should participate in planning and implementation of BALTEX, in order to ensure its usefulness for the science of hydrology.

DATA SAMPLING STRATEGY

The following in situ data are relevant for BALTEX and should be stored at the **Hydrological Data Centre (BALTEX-HDC):**

Discharge data:
(a) long term monthly naturalised time series for analysing seasonal and inter annual runoff variability;
(b) daily discharge data for the project period (1996 - 2005);
(c) instantaneous or event-based data for analysis of extremes.

The above data should be stored by BALTEX-HDC:

for gauges at the mouth of first-order river catchments in Baltic region;
for second-order rivers of catchment area $> 10{,}000\ km^2$;
for 10 to 20 experimental river basins with minimal anthropogenic impacts (benchmark, pristine).

Lake levels: data collected for a set of large lakes with negligible/accountable anthropogenic impacts. The required temporal resolution: monthly to annual.

Water temperature and ice phenomena in lakes and rivers: Time series of water temperature, and dates of freeze-up and ice cover break-up may serve as an indicator of climate change. For each typical GCM grid a representative group of water bodies (one river, one shallow lake, and one deep lake) should be selected.

Snow cover: Time series of the extent, duration and water equivalent of snow cover may be needed for hydrologic modelling.

The BALTEX-HDC should collect necessary information on river catchments boundaries, location and characteristics of gauges sites, methods of measurements, irrigation and other water use as well as other information important for the assessment of the stored hydrologic data.

METADATA ARCHIVES AND OTHER PROBLEMS

A number of hydrologic variables of importance for studying energy and water fluxes in the region (as e.g. evapotranspiration, groundwater table in pristine aquifers, and lake stratification patterns) will be measured in a research context of specific BALTEX field experiments. Such data should be stored by respective research institutions, which should inform the BALTEX-HDC on:

- type, location and period of experiment,
- list of measured elements,
- measuring methods,
- spatial and temporal resolution,
- data availability and contact person.

It is assumed that some of the catchment characteristics (topography, soil types and vegetation) needed for hydrologic modelling and experiments will be stored at BALTEX-MDC.

DATA POLICY

The BALTEX-HDC will provide guidelines for the data supply. To the extent possible these guidelines should be based on documents of the Global Runoff Data Centre in Koblenz. National hydrological services (water agencies) are responsible for the quality of data.

Data stored at BALTEX-HDC should be available for all research groups involved in the BALTEX programme. The principles on the dissemination and use of data should be laid down in formal obligations of the BALTEX-HDC to the data suppliers, and of data users to the BALTEX-HDC - in a way similar to principles agreed in relation to meteorological data.

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