Modifications to BALTEX Objectives:
Open discussion initiated by the Science Steering Group

General Introduction

At its 22nd meeting held 24 and 25 January 2008 at the Swedish Meteorological and Hydrological Institute (SMHI) in Norrköping, Sweden, the BALTEX Science Steering Group (BSSG) initiated a review of the present objectives defined for Phase II of BALTEX as detailed in the implementation document for 2003 to 2012 (BALTEX, 2006). A discussion on potentially necessary changes or amendments to BALTEX Phase II objectives, potential activities and milestones was opened, also motivated by the fact that new BSSG members have recently suggested several adjustments to the BALTEX Phase II science and implementation plans. Emphasis was on the rational and feasibility of research to be conducted in the next 4 to 5 years ahead of us in BALTEX Phase II.

Participants at BSSG #22 in front of the SMHI building

The plenary discussion centred on the identity of BALTEX, where a range of opinions were voiced related to the extent of how far BALTEX should deviate from the original objectives as defined in strong alignment with those of the Global Energy and Water Cycle Experiment (GEWEX). While some BSSG members stressed the necessity for BALTEX to comply as closely as possible with the basic GEWEX objectives, others supported a more flexible opening of the programme to other areas with particular regional relevance. In the latter context, Objectives 2 and also 4 of BALTEX Phase II were considered potential candidates to successfully merge the traditional BALTEX science with new challenges in climate, hydrological and environmental research in a broader context. It was argued that the relevant regional questions and problems apparently call for a cross-cutting rather than monothematic approach. A re-definition of some research goals was considered to be potentially necessary. For this purpose, three ad-hoc breakout groups were established to initiate a revision of Objectives 1, 3 and 4 research goals, potential activities and milestones, respectively. Objective 2 was excluded from this exercise because the majority of the group felt that no obvious need for modifications at this time.

The following sections review the main discussion points and suggestions from the recent BSSG meeting. The BSSG took no decisions so far but intends to do so at the next BSSG meeting in Helsinki in January 2009.

Objective 1: Better Understanding of the Energy and Water Cycles over the Baltic Sea Basin

Breakout Group A (Timo Vihma, Franz Berger, Ole Bøssing Christensen, Jüri Elken, Andreas Lehmann and Jan Piechura)

General

In practice, Objective 1 is a follow-up of the BALTEX Phase I. Five potential activities (PA) were planned to reach this objective.

Potential Activities

PA 1.4.1 *Regional analysis and re-analysis for different variables for specific purposes* was redefined as *Regional analyses and re-analyses with a high resolution and time span.*

For better understanding of energy and water cycles, BALTEX needs (a) analyses or re-analyses of the past conditions and (b) regional climate model results for the past, to be validated against re-analyses, and for the future. For the atmosphere, there are promising re-analysis projects going on or to be started in the near future. These include (i) the ERA-Interim re-analysis (1989-2008) by the ECMWF, (ii) further development of MESAN mesoscale analysis system in the SMHI, and (iii) the Arctic System Reanalysis, a U.S. IPY initiative including the atmosphere-sea ice-land surface system in the whole Baltic Sea catchment area with a 10 km horizontal resolution. In the ENSAMBLES project, climate models with 25 km resolution, forced by ERA-40 (1958-2002), have been run for the Baltic Sea catchment. In the field of operational modelling, analyses with 2-3 km resolution are available for at least parts of the Baltic Sea catchment area, providing improved data sets to study, among others, the coastal air-sea interaction. Accordingly, there are good perspectives for improved analyses and re-analyses of the atmosphere and the Earth surface, but for the Baltic Sea there is no homogeneous long-term gridded data set available.

PA 1.4.2 *Further development of models and model improvement* was redefined as *Evaluation and further development of models and model improvement*.

This is a continuous activity with several relevant challenges still remaining. These are related, among others, to in- and outflows and dense bottom currents, sea ice diversity, precipitation, effects of land-surface heterogeneity, as well as generation of ground-water and runoff. Considering model evaluation, new ground-based remote sensing methods to measure vertical profiles of atmospheric variables with high temporal and spatial resolution offer new methods and approaches for validation. There is potential for collaboration between BALTEX and EUMETSAT.

PA 1.4.3 *Closing the Energy and Water Budgets on a high level of confidence* was redefined as PA 1.4.4 *Quantification of the energy and water budgets on a high level of confidence*.

The main challenges are not only in closing of the budgets, but also in the quantification and reliability of them. Uncertainties remain in estimates of precipitation minus evaporation over

the Baltic Sea. Improved resolution of models and application of data on changes in the sea salinity for model validation is supposed to yield gradual improvement in the modelled water budgets. So far only few studies have analyzed the energy balance.

PA 1.4.4 *Improvement of quantititive precipitation forecasts* was redefined as PA 1.4.3,

as it should logically be before the PA on the energy and water budgets. National Meteorological Services in the BALTEX countries have a lot of activities in the field of combined application of radar data, mesoscale analysis techniques, and mesoscale modeling. Hence, we can expect improved products for water management. The SSG agreed that links between PA 1.4.3, the BALTEX Working Group on Radar, and the BALTEX Phase II Objective 3 should be more elaborated.

PA 1.4.5 *Evaluation of models and data sets for their use in climate impact analysis and environmental issues*

was considered unnecessary, as its planned content is essentially included in PAs 1 and 2.

Objective 3: Improved Tools for Water Management
Breakout Group B (Phil Graham Dan Rosbjerg, Valery Vuglinsky, Ryhor Chekan, Piotr Kowalczak, Hans-Jörg Isemer)

General

Management of river basins (such as *e.g.* reservoir dimensions, flood protection measures and the like) are taken largely at local, regional or national levels. Thus, BALTEX may be faced with a scale mismatch between the research dimension so far mainly addressed in BALTEX (this being basically of continental dimension) and the needs of decision makers (this being of river basin scale, local to regional). Numerous regional and national projects dedicated to particular river catchments, sub-catchments, lagoons and the like are on going, however, few of them relate their work to BALTEX. It needs to be critically assessed which potential benefits and input BALTEX may offer (and is indeed offering) to decision makers, or more generally, to projects targeted to local or regional issues in the field of water management.

Goals

While goal 3.2.1 *Development and Validation of Coupled Hydrological-Atmospheric Models* seems well defined and on track, it was noted that no initiatives related to 3.2.2 *BALTEX Selected River Basins* have been initiated so far. It was suggested to concentrate future activities jointly with goal 3.2.4 *Improvement of Flood forecasting.* The latter area has been the subject of several both concluded and ongoing EU-funded research projects, where an inventory on results targeted for river basins in the BALTEX region should be undertaken in the frame of BALTEX. A BALTEX workshop is proposed to be held in Poland in early 2009 with focus on the river Oder basin. This could lead to new efforts on basin-scale hydrological modelling aiming at improved flood forecasting methods and systems. As to 3.2.3 *Studies of Climate Change Impacts on Water Resources Availability and Extreme Events,* an apparent weakness is that little effort is visible related to extreme events.

Potential Activities

3.4.1 *High Resolution Hydrological Modelling*

This will be carried out in Denmark within a newly established research project, HYACINTS (Hydrological Modelling for Assessing Climate Change Impacts at different Scales). The project will focus particularly on groundwater applications within Denmark. Special efforts on the impact of lakes are conducted in Russia. Sweden has ongoing activity, which also includes impact of large lakes, among others. For instance, a new hydrological model is currently being developed at SMHI to better address applications to nutrient transport and climate change impacts.

3.4.2 *Improvement of Parameter Estimates for Distributed Hydrological Modelling*

Research on improving parameter estimation techniques is currently being done in connection with activity 3.4.1. In contrast to the present implementation plan, ungauged or poorly gauged basins are not specifically addressed in BALTEX.

3.4.3 *Coupling Hydrological Models to Regional Climate Models*

For the whole BALTEX region this has been done both in Sweden and in Germany. Local studies will be carried out in Denmark under the HYACINTS Project mentioned in 3.4.1. Aside from numerous national projects, Swedish hydrologists also participate in the EU ENSEMBLES Project, where their research focuses on coupling RCM ensembles climate simulations to hydrological modelling.

3.4.4 *Analysis of the Consequences of Climate Change for Hydrology and Water Resources Management*

The consequences in relation to aquifers will be investigated in Denmark through the HYACINTS Project mentioned under 3.4.1. Projects in Russia will look specifically at lakes, and general assessments for the whole Baltic area are carried out in Sweden and Germany. Sweden, Finland, Norway, Latvia and Lithuania have been working at national level on impacts to hydropower through a common Nordic project, CES (Climate and Energy Systems) funded by Nordic Energy Research. CES aims to identify the overall impacts of projected climate change on the energy sector. The hydropower studies within CES also include dam safety considerations under climate change.

A particular problem within BALTEX is the disconnection between hydropower-related climate studies and the BALTEX programme, see the general comment above. In part to address this, communication with the CES Project on potential cooperation activities has been initiated. A concrete suggestion is to use the next BALTEX Conference as a forum for sharing results across research projects. A specific session devoted to CES research would offer such an opportunity. This need not be restricted to hydropower and could include other aspects of energy impacts being addressed in CES, such as windpower and bioenergy.

3.4.5 *Hydrological Modelling with Radar-derived Precipitation Applications*

An upcoming meeting in St. Petersburg will put focus on this potential activity and most likely give rise to some new activities. Inclusion of radar-based product will also be considered in the coming efforts to improve flood forecasting methods.

New suggested Potential Activities

The group suggested elaborating three additional potential activities under objective 3 of BALTEX Phase II, with draft titles suggested as follows:

- *Dam safety* should be considered together with the impact studies on the future hydropower potential;
- *River ice* is a major problem in Russia and maybe elsewhere in the BALTEX region that needs more focus;
- *Coastal zone management* might be closer linked to the water resources management activities.

Objective 4, Breakout Group C (Bernd Schneider, Sven-Erik Gryning, Joakim Langner, Anders Omstedt, Marcus Reckermann)

General

This objective has been introduced in BALTEX Phase II as an entirely new component to BALTEX research, recognizing the need to integrate biogeochemical processes to arrive at a true Earth System approach. The objective title was now re-phrased from “Gradual Extension to Air and Water Quality Studies” to “Biogeochemical cycles and transport processes within the regional Earth system under anthropogenic influence” to better focus on the challenges of this objective. Emphasis was put on biogeochemical process understanding and modelling in a changing world under anthropogenic pressure.

Biogeochemistry is defined as the integrative study of interactions between the living and the non-living environment which govern the fluxes and reservoirs of the Earth´s elements such as carbon, nitrogen, phosphorus, silicate, sulphur, oxygen, calcium, iron, etc. The expertise of BALTEX in describing the water and energy cycle and the development of coupled regional climate models embracing the atmosphere, the Baltic Sea with sea ice, and the land surface with rivers and lakes, calls for an application in biogeochemical matter flux estimations under anthropogenic pressure. An extension to organism-based ecological research and modelling (“ecosystem modelling”) seems not feasible within the scope of BALTEX.

While biogeochemical research in the Baltic Sea area has a long tradition, and many research groups exist, BALTEX has the unique approach to integrate the Baltic Sea and the hydrological cycle in the atmosphere and on land. In other words, the holistic description of the Baltic Sea basin is a BALTEX domain. Also there is strong expertise in (coupled) regional climate modelling.

The research goals and potential activities were re-defined to account for the above considerations. The aspects of understanding biogeochemical processes, quantifying the fluxes, and the integration into coupled regional climate models are explicitly addressed. New aspects are a stronger integration of terrestrial processes (in the existing version of the

implementation plan the focus is on processes in the Baltic Sea) and the stronger reference to climate change.

Goals

The research goals were re-defined as follows:

1 Improving the understanding of biogeochemical processes in the sea and on land

Biogeochemical processes in aquatic and terrestrial environments are in principle similar, but act on different time scales, and also differ in heterogeneity. For a sound quantification of fluxes between land and sea, a good understanding of the different processes on land and in the sea is necessary. Emphasis should be put here on the biogeochemistry of carbon, nitrogen, phosphorus and oxygen.

The carbon cycle in the Baltic Sea and in the adjacent terrestrial environment requires special attention. Most aquatic biogeochemical models consider only the organic carbon and ignore the interaction with the marine CO_2 system. BALTEX will promote research involving the CO_2 system in order to balance the CO_2 gas exchange between the Baltic Sea and the atmosphere, to introduce additional variables for the validation of biogeochemical models, and to simulate potential changes of the Baltic Sea CO_2 system using different scenarios for climate changes and anthropogenic nutrient loads, and to estimate the implications for the ecosystem functioning and for the role of the Baltic Sea as a source/sink for atmospheric CO_2.

2 Quantification of biogeochemical fluxes between sea, land and atmosphere

A precondition for the description and quantification of reservoirs, transports and transformation processes is the availability of data for anthropogenic sources (on land, but also ship borne) and fluxes of the biogeochemically important elements C, N, P, O and other elements of interest between the atmosphere, the land surface and the Baltic Sea. Specifically, air-sea and air-land fluxes (*e.g.* through precipitation, deposition, sequestration), land-sea fluxes (*e.g.* origins and fate of elements in different catchments, transport through rivers, estuarine processes), and fluxes within the sea (*e.g.* advection, mixing, biogeochemical turnover rates) need to be quantified using best available methods at best possible spatial and temporal resolution, for which measuring campaigns should be promoted.

3 Integration of biogeochemical components into coupled regional climate models

Coupling biogeochemical models with regional climate models is a major challenge for the coming years. Existing biogeochemical models should be gradually integrated and coupled with hydrological and atmospheric models, to comprehensively simulate the dispersion processes of biogeochemically relevant elements now and under changing climate conditions. With respect to atmospheric transport and deposition, the overall research needs should focus on the adaptation of the most advanced atmospheric chemistry and transport models suited for the simulation of transport, transformations and deposition of air constituents and aerosols on adequate spatial and temporal scales.

Concrete research questions (among others yet to be defined) in connection to the revised BALTEX Phase II Objective are:

- What is the fate of biogeochemcally relevant elements in the Baltic Sea basin as the hydrological cycle is altered due to climate change?
- How is the atmospheric deposition of elements on sea and land affected by climate change?
- Will climate change lead to an increase or a decrease in eutrophication of the Baltic Sea? What are the regional differences? What are the differences between the elements (N, P, Si)?
- How will the carbon cycle on sea and land be affected by climate change?