5th Study Conference on BALTEX

4 to 8 June 2007; Kuressaare, Saaremaa, Estonia

Summary

With more than 140 registered participants from 16 countries and 120 papers presented (of which 65 were oral presentations and 55 given as posters), the 5th Study Conference on BALTEX was successfully conducted in Kuressaare, Estonia. The full Conference program and proceedings as well as additional information are available at www.baltex-research.eu/conf2007/.

The entire spectrum of BALTEX phase II research including neighbouring areas and the involvement of stakeholders were covered. About 75 % of all papers were addressing the objectives which are new in the frame of phase II of BALTEX, an encouraging indicator for the present and future development of the programme.

The conference reflected the wider scope of BALTEX phase II with much stronger contributions in climate and environmental topics than during previous conferences and there were many opportunities to discuss how further work in this direction could be stimulated.

The strong focus on climate and climate modelling and impacts of climate change continues. It is clear that BALTEX makes excellent contributions to its mother programmes GEWEX/CEOP and WCRP, as was impressively outlined by related presentations given in the opening session of the Conference. It is also obvious that BALTEX is already moving beyond the scope of these programmes, particularly in areas where air and water quality issues are addressed. Outputs from climate models are being used for more detailed studies affecting a large cross section of sectors within society, leading to challenges in communication of scientific results. Climate change and related impacts are also prominent areas where the outreach of BALTEX has recently become increasingly effective through the close cooperation with the Helsinki Commission (HELCOM). HELCOM used the Conference to express its wish for a continuous cooperation with BALTEX to assess even better the impacts of climate change on the Baltic Sea ecosystem.

The political dimension and importance of in particular the climate-related aspects of the BALTEX program were clearly highlighted by three welcome addresses in the opening session of the Conference where both expectations and awareness related to environmental information needed for decision making at different levels (the European, national Estonian and local levels) were pointed out by representatives of the European Parliament and the national Estonian Ministry of the Environment, and the mayor of the hosting city Kuressaare.

The Conference participants enjoyed good contributions from several research programmes and networks such as LOICZ, EUR-OCEANS and ENSEMBLES and a strengthened interaction between BALTEX and these networks is one way forward

towards the broader objectives of BALTEX phase II. Cooperation and integration with such networks should be pursued but BALTEX needs to define its focus along the implementation plan and define interfaces/ linkages to other activities, which allow for organised cooperation without loosing the BALTEX identity.

Coupling and off-line modelling of biology and chemistry both on land, ocean, and atmosphere were presented. BALTEX researchers are increasingly involved in CO_2 science with both observational and modelling activities. Better tools and methods for dynamic analysis of ecosystem impacts to climate variability and change are emerging. The building blocks for regional earth system models are available and the first steps have been taken.

The Conference also demonstrated case studies on how research knowledge is further developed and processed for decision making: the ASTRA project and several regional and local studies addressed within the COASTMAN project showed the transfer of research knowledge to practical application in areas related to climate change and coastal zone management in regions of the Baltic Sea Basin.

The Conference was also used for group meetings and workshops, among them a regular two-days meeting of the BALTEX Working Group Radar and an evening workshop on present and future data management in BALTEX. Presentations given at the latter workshop spanned an introduction to the BALTEX data management web site, which acts as portal for all BALTEX data management issues (www.baltex-research.eu/data), an overview over BALTEX Phase II data management future directions, including a presentation of the relevant data portals UNIDART and CERA. Furthermore, the access to CEOP data was explained, and a comprehensive data portal to worldwide climate data, the Climate Explorer, was presented.

The organisation of the conference ran smoothly thanks to the professional preparations and on-site management by the BALTEX Secretariat and the local organisers. The perfect weather and the attractive local surroundings contributed to a good and relaxed spirit.

Session summaries

Session 1: Improving knowledge on water and energy cycles

BALTEX continues producing unique datasets for energy and water cycle research; examples include CEOP in-situ reference site data and precipitation and wind products based on an extended weather radar network BALTRAD in northern Europe. Studies using both *in-situ* and remotely sensed data show improvements in understanding and quantifying a variety of water and energy cycle relevant variables such as atmospheric precipitable water and water vapour, surface wind speed, solid precipitation and extreme marine snowfall. In studies of air humidity and rain, local observations have been better interpreted in terms of large-scale atmospheric circulation, and new techniques based on GPS show promise.

Regional Climate Models both standalone atmospheric and coupled atmosphere-ocean-sea ice-land surface models are further validated and used for generation of water cycle estimates for the Baltic Sea Basin. Several alternative estimates of the

water and energy budget in the BALTEX region are emerging, but more work is needed to gain consensus. More stringent tests of RCMs are being performed over varied regional climates trying to make the best use of available observations. BALTEX scientists have taken leadership in an intercontinental GEWEX regional climate model transferability study using CEOP data from various GEWEX Regional Hydrometeorology Projects.

Several process-oriented and regional BALTEX studies presented demonstrated the necessity of improved high resolution in regional model studies. The high resolution allowed a detailed description of cold air outbreaks over the Gulf of Finland and variations in the atmospheric boundary layer which are also important for oceanographic process studies such as upwelling and sea ice dynamics. The effect of swell on the air-sea momentum exchange was shown to have noticeable influence on the Baltic Sea only with low wind speed.

For the first time, pathways and ages of inflowing salt- and freshwater to the Baltic Sea have been determined by a 3-dimensional model study. In different inflow situations the pathways of higher saline water from the Bornholm Basin through the Stolpe Channel into the Gotland Basin can take different routes. The simulations of water ages of inflowing water from the Kattegat and freshwater from rivers requires at least 100 years simulations because residence times of inflowing waters range between 30 and 40 years, respectively.

Upwelling in the Baltic Sea was the subject of several studies, and improved understanding on spatial and temporal variations in the surface salinity and temperature has been obtained. A good overview of advances in physical oceanography of the Gulf of Finland has been given with progress being achieved for hydrography, meteorology, air sea interaction, water levels, wave dynamics and optics. Advance is made in measuring sea ice thickness by altimeter and airborne electromagnetic methods, as well as in modelling the dynamic redistribution of ice thickness. Effects of surface albedo on the cloud radiative forcing and sea ice thermodynamics have been better quantified.

Session 2: Climate change, variability and impact

With 45 submitted papers, this section enjoyed the highest resonance in the community in terms of number of papers submitted. The organisers therefore split the original session into three parts, which will be considered separately in the following.

Session 2a: Past climate variability and change

Important aspects of this session may be summarized by the following statements:

1. The Baltic Sea Basin has a number of long (up to centuries) and high-quality datasets available (such as for surface air temperature, rainfall, runoff, ice coverage in the sea, in lakes and rivers, snow cover) which allow concrete conclusions for detection of past climate change and variability in the region. Major findings of the recently concluded BACC project were confirmed, but also new evidence beyond the BACC conclusions were reported. There are however also shortcomings due to inhomogeneities caused *e.g.* by changing measurement techniques and data gaps, which hinder clear statements on past changes. Sea surface temperature is such a basic pa-

rameter, where a conclusive analysis for the last century seems to be handicapped by data in homogeneities, whereas the analysis of remotely-sensed SST for the recent three decades (here the Baltic Sea series is among the longest worldwide) clearly showed a significant increase, in strong correlation with the concurrent surface air temperature increase in the Baltic Sea Basin. Another measured parameter, where the directly measured quantity can hardly be used for climate change studies is near-surface wind speed, but various proxy data (derived *e.g.* from air pressure gradients) do not indicate significant wind speed changes during the recent century, but variations at decadal time scale.

2. More studies use regional models to i) help interpreting observations of past climate change and variability, and ii) extending studies to periods with no or very limited, mostly proxy-data coverage. First attempts to reconstruct variables such as runoff and surface air temperature beyond instrumental data records for the last millennium where reported, where the runoff re-construction had been the focus of different studies. A new aspect was the additional (to the atmosphere model) use of a hydrological model in offline mode. Noteworthy although mostly insignificant changes in runoff during the recent decades included an increase in the northern and a decrease in the eastern part of the Baltic Sea Basin. Sea temperature and maximum ice extent in the Baltic Sea were shown to be modelled reasonably realistically for the recent 500 years and the study indicated that conditions as observed in the 1990s may have occurred already earlier e.g. in the 1930s and 1730s.

3. Two papers summarized - theoretically and also in practical terms for the Baltic Sea Basin – the still rather scarce knowledge on attribution of regionally observed changes to anthropogenic forcing. While a proper attribution in the Baltic Sea basin is still hindered by the dominance of natural variability and by the similarity of the patterns of predicted changes due to anthropogenic forcing, observed changes in *seasonal mean precipitation* show a striking similarity to what could be expected as caused by anthropogenic forcing.

4. It is also obvious that there are now more studies underway where past climate variability is being linked to future climate change through the use of continuous regional transient simulations and some presentations already showed regional variability for periods spanning *e.g.* 1900 to 2100.

Session 2b: Climate projections

Advanced climate projections are a challenge in terms of science and also resources needed and only few international projects are making substantial progress in this fields. Among those is ENSEMBLES, an EU-FP6 co-sponsored integrated project, with one of its objectives reading *to develop an ensemble prediction system based on global and regional Earth System models, validated against observations and analyses, to produce for the first time, an objective probabilistic estimate of uncertainty in future climate at the seasonal, decadal and longer timescales.* As with other EU-co-sponsored projects a close interaction of ENSEMBLES and BALTEX was suggested where BALTEX could consider i) analyzing RCM performance in the Baltic Sea region; ii) applying ENSEMBLES data in climate variability and climate change studies; iii) contributing with coupled RCM simulations to ENSEMBLES; and iv) using ENSEMBLES results as forcing of impact models.

A total of six different projection studies were reported dealing mainly with parameters such as air temperature, precipitation and precipitation extremes, runoff, but also on drought periods and Baltic Sea surface waves. As a general consensus: while for mean and seasonal temperature some distinct features of future changes emerge, the effect in water cycle relevant variables such as runoff and precipitation is less clear for the next decades. For the end of this century, coherent signals are an intensification of the hydrological cycle particularly in winter but also in the annual mean. A weakening is projected for the summer season. A future increase in winter precipitation is in particular evident in the northern part of the basin. Taking recent extreme events as an indication for ongoing climate change may be misleading: The recent extreme dry summers 2002, 2003 and 2006 in regions in Finland triggered a study on whether evidence is available for more droughts of this type to come under climate change scenarios. Results indicate that existing data do not show any trend *e.g.* in number of dry days for the recent decades and projections for Finland differ between models used and have generally a low signal to noise ratio. However, southern and eastern regions in the Baltic Sea Basin are projected to suffer from longer dry periods in summer.

Session 2c: Impact of climate change

Impact of climate change is new on the BALTEX Phase II agenda, the more valuable are the number of high-quality papers given, most of which dealt with impacts on either the marine or terrestrial and freshwater ecosystems in the Baltic Sea Basin. The HELCOM Assessment of Climate Change in the Baltic Sea area based on the BALTEX/BACC assessment was reviewed and highlighted as a perfect example of co-operation and dialogue between the scientific community and environmental policy makers. HELCOM's interest is by definition focussed on the marine ecosystem and hopes for future co-operation to asssess even better the impacts of future climate change on the Baltic Sea ecosystem.

Research examples included changes in SST and related variability of cyanobacteria in the Baltic Sea, a new model system for assessing the impact of climate change on nutrient runoff from catchments exemplified for the Kokemäenjoki Basin in Finland, and the quantification of the impact of climate change on the Baltic Sea ecosystem using a coupled biogeochemical and circulation model with focus on nutrient and oxygen dynamics, thus indicating steps towards establishing and using ecosystem models or regional earth system models for the purposes of assessing climate change impacts on the Baltic Sea ecosystem.

As to land ecosystems, knowledge gaps and research priorities have been critically and comprehensively reviewed and discussed with respect to climate change and the following key questions for research have been proposed:

- How will the distribution and abundance of pests and pathogens respond to climate change?
- What are the likely trajectories and spatial patterns of land use change within the Baltic Sea region and what consequences will result for species distributions, carbon sequestration, runoff and land-sea nutrient fluxes?
- How will changes in hydrology, soil thermodynamics, biogeochemistry, microtopography and vegetation affect the contribution of extant peatland areas?
- What will be the consequences for the ecosystem taking into account feedback mechanisms with respect to water quality in lakes and land runoff?

Further impact studies included relations of climate change to annual river runoff, extreme rainfall in urban areas, and crop yield as an indicator for climate variability.

The session closed with a thought-provoking presentation on the tourism sector in the context of climate change. Tourists are both part of the problem, free riders who benefit from, for example, warmer summers, and victims who will experience damages due to climate change – such as increased danger of contracting diseases on holidays. Although the impacts and opportunities posed by climate change could be significant, the sector seems to have little interest in the issue at present.

Session 3: Coastal zone and water management

Adaptation to climate change impact on the water sector in the continental part of the Baltic Sea Basin was reviewed and examples from different regions were given. As there is still quite some uncertainty on the magnitude or even direction of future changes in precipitation and runoff, water authorities in countries like Poland have to consider measures such as flood barriers on the one hand, and increasing supply (or reducing demand) for water on the other hand. Several presentations showed how models generate information offered for or even already being used in practical applications for decision making. Two examples, among others, include hydrological models combined with high resolution climate scenario data from regional climate models generating useful information to governments deciding on measures for increased protection against flooding by large lakes under climate change in Sweden, or the high resolution operational model for the Baltic Sea providing marine core services related to extreme events for scientific and industrial communities being applied to the Gulfs of Riga and Finland.

BALTEX II is now providing a platform for integration of natural and socio-economic sciences in order to better understand and assess coastal zone functioning and services and predict ecosystem changes in the coast due to human activities and climate change. Vulnerability of the Baltic Sea coast was discussed in several COASTMAN project presentations, including sea level rise during storms, erosion, and high levels of nutrients and pollutants. Causes of cost vulnerabilities were presented in individual case studies such as Klaipeda Deepwater Port Development (Lithuania), a controversial harbour for oil production in Stockholm (Sweden), and human activities in the Haapsalu Bay area (Estonia). Other case studies were devoted to coastal regions in Lithuania, the Oder mouth and the Kadetrinne in the Baltic Sea.

Integration of research is needed for development of ecosystem based management and governance in the Baltic Sea region. This integration is also needed for the assessment of impacts of socio-economic changes in the major catchments of the Baltic Sea on the quality of coastal zone waters. Cooperation between BALTEX II and LOICZ II holds a promise to further develop tools needed by policy makers to respond to the ecosystem changes in the Baltic Sea region, as was particularly stressed also in an overview presentation on LOICZ II given in the opening session of the Conference. This cooperation would need to be defined, including the cooperation with projects like the COASTMAN project.

Session 4: Linking BALTEX science to air and water quality and impacts on ecosystems

The first part of this session represented a rather broad field of research. Nutrient inputs were discussed in several oral and poster contributions. Variability and trends in observed concentrations in rivers, lakes and the Baltic Sea as well as loadings from the atmosphere were discussed along with impacts on land and water ecosystems. The variability in concentrations and loads of nutrients is strongly influenced by anthropogenic inputs but also by climate variability on annual and shorter time scales. Changes in atmospheric circulation due to climate change can have significant effects on e.g. atmospheric deposition of nitrogen as demonstrated by multi decadal chemical transport modelling. Advances in chemical transport modelling of persistent organic pollutants over the Baltic were also presented.

An overview presentation on EUROCEANS activities in the Baltic Sea was given focusing on the dynamics of fish stocks as well as an overview of changes in the biology and physics of the North Atlantic and global oceans. The temperature increase in the Baltic Sea goes in parallel to what is observed in the North Atlantic. The increase in temperature may become a dominant factor influencing the Baltic Sea ecosystem as much as eutrophication in the future..

The second part of the session was dedicated to one topic, the "Carbon Cycle". Several recent studies have addressed the carbon cycle in the Baltic Sea. Strong links have been found between the carbon cycle and eutrophication and pollution problems. There is strong need for modeling the carbon budget of the Baltic Sea, but considerable uncertainties are associated with input and output terms. Advance has been made in modeling the CO_2 budget in the atmospheric boundary layer, including surface fluxes and exchange across the boundary layer top. Advance has been made in measuring and understanding the turbulent transfer of CO_2 over the sea surface. Important advances have also been reported in understanding the different processes in the Baltic Sea that influence the marine CO_2. Upscaling information from point measurements to aggregated fluxes is a current research topic. The exchange of CO_2 between the land biosphere and the atmosphere can be reasonably well modelled reproducing the observed diurnal cycles and synoptic-scale variability. However, it appeared obvious from the presentations given that the "atmospheric", the “land surface” and the "marine" communities are looking somewhat one-sided into their world. Joint BALTEX activities on this field of research will hopefully lead to a better understanding between these groups.

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