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Baltic Earth
Earth System Science for the Baltic Sea Region

Newsletter

Contents

Baltic Earth – Earth System Science for the Baltic Sea region

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After 20 years of intensive scientific and outreach activities, the Baltic Sea Experiment (BALTEX , 1993-2013), one of the original continental-scale experiments of the Global Energy and Water Cycle Experiment (GEWEX) within the World Climate Research Program (WCRP), recently came to its scheduled end. As BALTEX was among scientists regarded as a very successful research programme, the science steering group agreed to launch a successor programme with the new name “Baltic Earth”, with a revised focus on Earth system science. The programme is led by a renewed and younger steering group to continue the interdisciplinary and international collaboration in the Baltic Sea region. Although Baltic Earth will face new challenges, it inherits the BALTEX network (people and institutions), infrastructure (secretariat, study conferences, workshops, and publications) and scientific legacy, symbolized by a somewhat modified logo (compare the logos on both covers of this issue). Like BALTEX, the new programme aims to be embedded into international, global-scale programmes like GEWEX/WCRP and Future Earth.

The vision of Baltic Earth is to achieve an improved Earth system understanding of the Baltic Sea region. This means that the research disciplines of BALTEX will continue to be relevant, but with a more holistic view that encompasses processes in the atmosphere, land, and sea as well as in the anthroposphere. Specific „Grand Challenges“ are being formulated that will represent major interdisciplinary research questions to be tackled by the new programme in the coming years. Thematic assessments of particular research topics will be compiled by expert groups which shall help to identify gaps in our current knowledge and to initiate research projects. An example of such a thematic assessment with a benefit for society is the BALTEX Assessment of Climate Change for the Baltic Sea Basin (BACC). It summarizes the currently available knowledge on past, present and future climates in the Baltic Sea region, following the approach of the Intergovernmental Panel on Climate Change, but with a much more pronounced regional focus. At present, the second assessment is in its final phase and is expected to be published in spring 2014. One important activity of Baltic Earth will be to continue this series of assessments.

A science plan is being developed by the acting Interim Science Steering Group (ISSG) and will be available in summer 2014. It will be presented at the 3rd Lund Workshop on Regional Climate Modelling. Today, the ISSG consists of 22 scientists (7 females and 15 males), representing 10 Baltic Sea countries, various disciplines and key institutes of the region. The ISSG is chaired by Markus Meier (Swedish Meteorological and Hydrological Institute, Sweden) and Anna Rutgersson (Uppsala University, Sweden). After the implementation phase of Baltic Earth, a permanent Science Steering Group (SSG) will be appointed in June 2014.

Markus Meier, Marcus Reckermann and Anna Rutgersson (from left) unveil the new Baltic Earth logo at the 7th Study Conference on BALTEX.

The science plan will be updated regularly and will respond to a continuously on-going definition of core research questions that are identified as key scientific issues or Grand Challenges. These will be identified at upcoming workshops and conferences and by assessing existing knowledge in specific research fields by dedicated working groups. Research foci are planned for periods of about 3-4 years. Baltic Earth will communicate with stakeholders and national and international research funding agencies to promote funding relevant to the Grand Challenges.

Currently, a Senior Advisory Board (SAB) is being installed, consisting of members with extensive international experience in a specific scientific field of Baltic Earth and research management. The tasks of the SAB will be to provide advice to the SSG in terms of strategy and overall directions; to provide insight and contacts to relevant stakeholders, international boards and funding organizations; and to assist in acquiring financial support for specific Baltic Earth activities which require additional funding.

The provisional Baltic Earth Grand Challenges are summarized below:

1. Salinity dynamics in the Baltic Sea. This is a particularly relevant topic for the Baltic Sea, due to its unique oceanography. Salinity dynamics are directly related to the water cycle of the entire catchment area, and its understanding is a prerequisite for the understanding of ecosystem dynamics. Available projections suggest a decrease of up to 2-3 salinity units by the end of the century. The working group will investigate regional precipitation patterns (runoff), atmospheric variability (wind), saline water inflows, and the exchange between the sub-basins and turbulent mixing processes in more detail. The outcome will be a review article including also recommendations to improve coupled atmosphere-ocean models to be used for new regional climate projections (see also the article on page 3).
2. Land-sea biogeochemical feedbacks in the Baltic Sea region. The processes occurring within the drainage area greatly influence the functioning of the Baltic Sea ecosystem. This topic addresses the interaction between the land and the sea including also multiple stressors like eutrophication, acidification, overfishing and climate change. Numerous experimental data and sophisticated model tools are available, but there is a lack of process understanding and representative process parameterizations. On 13 November 2013, a first strategic international Baltic Earth Workshop on "Challenges for biogeochemistry research in the Baltic Sea Region" was held in Sopot, Poland.
3. Natural hazards and extreme events in the Baltic Sea region. Natural hazards have very complex origins, and presently the understanding as well as the capability to predict extreme events is limited. This is generally well recognized regarding infrastructure related to dam safety and urban flooding risks. However, the range of ecosystem services at risk, including biodiversity and vital societal functions such as drinking water supply, is poorly defined. Many natural hazards have hydro-meteorological origins (storms, waves, flooding, droughts) and can potentially be better described and predicted. Man-made structures can alter the impacts of extreme events like floods, e.g. through river regulation, land reclamation, dams, soil sealing, and sewage systems in urban areas, and all of these factors need to be taken into account when estimating potential impacts. A first strategic international Baltic Earth Workshop on "Natural hazards and extreme events in the Baltic Sea region" is planned for 30-31 January 2014 in Helsinki, Finland (see also the article on page 5).
4. Understanding sea level dynamics in the Baltic Sea. The global mean sea level shows large variations at regional scales, which are reflected in the heterogeneous pattern of sea-level trends in the Baltic Sea over the past 30 years. The large uncertainties in projected future global sea level rise are thus magnified when considering regional scenarios for sea level change. The complex bathymetry of the Baltic Sea and the influence of the North Sea and the Baltic Sea catchment area present challenges for sea level projections that are distinct from the global scale. The working group will utilize available long-term records of tide gauge and satellite data to assess multi-decadal variability and centennial trends. Further, global sea level scenario simulations will be regionalized for the Baltic Sea and North Sea regions. A Baltic Earth Workshop on satellite data for sea level research in the Baltic Sea is under planning.
5. Understanding regional variability of water and energy exchange in the Baltic Sea region. This topic contributes to the WCRP Grand Challenges and GEWEX Science Questions, and continues some former BALTEX research areas that still remain open. Some of those topics include efforts for an improved understanding of cloud-aerosol-feedback mechanisms, cloud processes, and atmospheric boundary layer processes for improved modeling capabilities; the diagnosis of natural variability of energy and water components including changes in extremes; the observation of atmospheric processes and characterization of uncertainties using conventional meteorological and hydrological observations; and surface and satellite based remote sensing techniques.

Within these Grand Challenges, anthropogenic changes and impacts will be treated together with the natural drivers. In addition to the scientific challenges, outreach and education are expected to be strong components of Baltic Earth. Dedicated working groups on outreach and communication as well as on education have been created. Their tentative aims are (1) to provide an arena for scientific discussion to communicate findings within the Baltic Earth research community as well as with other research

communities and society (see also the article on page 7), and (2) to communicate the importance of the Grand Challenges to funding agencies and to promote funding of relevant research. Major educational activities will be the organization of summer schools in the Baltic Sea region on specific Baltic Earth topics.

Additional working groups which are inherited from BALTEX, focus (1) on the added value of regional climate system models for the Baltic Sea catchment area and (2) on the assessment of existing scenario simulations for the Baltic Sea, investigating the combined impact of changing climate and changing nutrient loads from land and from the atmosphere. The differences in available projections assuming, for instance, the implementation of the Baltic Sea Action Plan (BSAP) for nutrient load reductions, will be explained to stakeholders like the Helsinki Commission (HELCOM). Both working groups will produce a scientific review article as outcome. For all working groups interested new members are very welcome.

www.baltic-earth.eu
www.gewex.org
www.icsu.org/future-earth
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Salinity dynamics of the Baltic Sea

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Within the new program Baltic Earth, key scientific issues or Grand Challenges (GC) for future research have been identified. One of the GC for Baltic Earth is ‚Salinity dynamics of the Baltic Sea''. The detailed understanding of the salinity dynamics is mandatory for a better knowledge of the ecosystem of the Baltic Sea. Furthermore, salinity is the key parameter for understanding the energy and water cycle of the Baltic area. Still, the present knowledge of the salinity dynamics is very limited. Thus, climate variability of atmospheric forcing, including regional precipitation patterns and runoff, water exchange with the North Sea (Major Baltic Inflows), sub-basins circulation and water exchange and vertical turbulent mixing will be of core interest. The present knowledge of the salinity dynamics are summarized in detail in Leppäranta and Myrberg (2009) and in the BACC Author Team (2008), here we will only give a very condensed view on the aims of the working group on ‚Salinity dynamics of the Baltic Sea''.

The salt budget

The salt budget of the Baltic Sea is determined by a balance between saline inflow from the Kattegat and brackish water outflow from the Baltic through the Danish Straits. River runoff and precipitation cause dilution, while evaporation acts in the opposite direction. Ice formation and melting act as evaporation and precipitation, respectively, but have no influence on an annual timescale. Generally, during dry periods the mean salinity of the Baltic Sea increases, while during wet periods it decreases. These long-term changes are superimposed by the atmospheric-driven water exchange between North Sea and Baltic Sea. The salinity and the stratification in the deep basins are linked to the occurrence of Major Baltic Inflows (MBIs; Matthäus, 2006) of higher saline water of North Sea origin, which occur sporadically and transport higher saline and oxygenated water to the deep layers. These major inflows are often followed by stagnation periods with no strong saline inflows, during which the permanent halocline weakens and even disappears in some basins. Extended areas of oxygen deficiency develop in the areas where the salinity stratification remains.

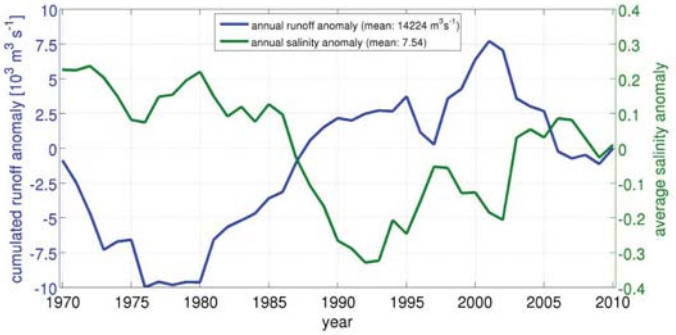

Figure 1. Accumulated anomaly of river runoff to the Baltic Sea (blue line) based on runoff data extracted from Kronsell and Andersson (2012), and volume averaged annual salinity of the Baltic Sea (green line) based on BSIOM.

Decadal variations

Salinity variations on decadal timescales are governed by the water balance. They have been small though significant over the last 100 years (Leppäranta and Myrberg, 2009). About half of the decadal variability of the average salinity of the Baltic Sea is related to the accumulated freshwater inflow (Meier and Kauker, 2003). Figure 1 displays the accumulated annual runoff anomaly and the anomaly of the averaged salinity of the Baltic Sea for the period 1970-2010. Salinity has been calculated from the Kiel Baltic Sea model BSIOM (Lehmann and Hinrichsen, 2000), and runoff data have been extracted from Kronsell and Andersson (2012). From 1970 to 1980, runoff was mainly below the average and thus the mean salinity was above the long-term mean. With the beginning of the 1980s, runoff anomalies were again mostly positive until 2002. Until 2010, runoff decreased and reached about the average value. The mean salinity of the Baltic Sea closely follows variations in accumulated total river runoff.