

1st Baltic Earth Conference

Nida, Lithuania

13-17 June 2016



Baltic Earth

Conference Summary

This was the 1st large Conference of Baltic Earth. The conference largely followed the traditional pattern of BALTEX conferences. While in former times, islands were chosen as venues, we had relaxed this criterion a bit so that we considered small coastal resorts on peninsulas or even on the mainland; in any case outside of large cities. The format also followed largely the tradition: 4 ½ days, no parallel sessions; emphasis on a specific topic but encompassing the entire Baltic Earth scope.

At this conference we had a total of 141 participants with 134 abstracts from 15 countries, also from outside the Baltic Sea region. As a comparison: the first BALTEX conference in Visby 1995 had 146

participants with 104 abstracts. So we are on a similar level of participation but with a higher percentage of active contributions.

Nida had all that we needed for a Baltic Earth conference: a suitable venue with sufficient seating capacity, good accommodation and catering, friendly and helpful hosts, and a very charming atmosphere. In fact, Nida and the municipality of Neringa on the Curonian Spit, by far exceeded our expectations.

Opening ceremony

We were very happy that three distinguished personalities from Neringa and Klaipeda shared their time with us to give a brief welcome address. Firstly, the Mayor of Neringa City and Nida, **Darius Jasaitis**, welcomed us at this beautiful place, and reaffirmed us that we had chosen the perfect place for this conference, as the Curonian Spit has been both a product of nature and also human activities with an eventful history. We are grateful to **Eglė Baltranaite** for an excellent simultaneous translation from Lithuanian to English. **Lina Dikšaitė**, Vice-Director of Curonian Spit National Park, welcomed us on behalf of the Curonian Spit National Park, which is responsible for the conservation of one of the most impressive natural landscapes in Europe. Finally, **Saulius Gulbinskas**, Vice-Rector of the co-organizing Klaipeda University, also congratulated us for picking Nida for this conference, and also for picking the name “Baltic Earth” for this type of regional Earth system programme.

Opening Session

The opening session should set the stage for the conference with some overview presentations of a range of Baltic Earth relevant topics. An airline strike struck us in the first half of the conference week, resulting in three distinguished speakers not being able to come to the conference. The free slot in the morning of the first day was filled by Baltic Earth Science Steering Group chair **Markus Meier** (Baltic Sea Research Institute Warnemünde and Swedish Meteorological and Hydrological Institute) who seized the opportunity to give an in-depth introduction to Baltic Earth. Next, **Jan Harff** (Szczecin University, Poland, and Baltic Sea Research Institute Warnemünde, Germany) gave an overview over the geological history of the region during the Holocene, with a dedicated emphasis on human activities. A guest to our Baltic Earth community was **Donald Boesch** of the University of Maryland, USA, who gave a presentation on the Chesapeake Bay and the current efforts to rehabilitate the ecosystem under human pressure. Similarities but also differences between the Baltic Sea and the Chesapeake Bay as well as options to improve the environmental situation were discussed. Finally, **Martin Stendel** of the Danish Meteorological Institute, gave an overview over two centuries of extreme events over the Baltic and North Sea regions, based on the results of the two BACC reports (Assessment of Climate Change for the Baltic Sea basin, BACC Author Team 2008 and BACC II Author Team 2015) and the NOSCCA report on Climate change in the North Sea region, which is expected to be published later in 2016.

Topic and session summaries

The sessions are very briefly summarized below. Presentations may sometimes fit more than one session, but an allocation had to be made which may at times be not ideal, but it reflects the multidisciplinary nature of Baltic Earth to have interdisciplinary talks which are not easily pegged to a specific topic. During the two poster sessions, 80 posters were presented. The themes of the posters

cover the entire range of Baltic Earth topics, and lively discussions developed during these sessions. All oral and poster extended abstracts are available in the conference proceedings on the conference website: www.baltic.earth/nida2016.

Topic A Salinity dynamics

Salinity is a complex topic in the Baltic Sea and the recent major inflows have triggered a new interest in the interactions between salinity in the Baltic Sea and hydrographic and atmospheric processes. This is Baltic Earth Grand Challenge 1 to improve the understanding of salinity dynamics in the Baltic Sea.

Contributions to this session concentrated mostly on large volume changes (LVCs) and major Baltic Inflows (MBIs). **Michael Naumann** and co-workers gave an overview over the recent inflow events: in December 2014, after about 10 years with only weak saline inflows, a major Baltic inflow occurred. In November and December 2015 and in January-February 2016, weak and moderate inflows followed. The MBI in December 2014 initiated a huge measurements campaign to investigate in detail the streamer in water masses and to assess the impact on salinity and oxygen conditions in the deep basin of the Baltic Sea. All in all 22 expeditions with 7 research vessels were conducted since the end of 2014. One of the important results is that although the salinity in the deep eastern Gotland Basin has increased considerably by the recent sequence of inflows, the oxygen depletion rates increased by a factor of 1.5 during the last 2 decades, as reported by **Volker Mohrholz** and co-workers, and also observed by **Sergey Shchuka** and co-workers. Thus, improved oxygen conditions in the deep basins are faster depleted than after the MBIs in 1993 and 2003. In addition to measurement campaigns, model studies have been performed, trying to further elaborate and distinguish between conditions leading to large volume changes or major Baltic inflows (**Katharina Höfllich** and co-workers). The haline stratification in the Mecklenburg Bight plays a key role for the strength of the salt flux during larger inflows. Furthermore, LVCs/MBIs are related to special atmospheric circulation types and deep cyclones pathways, as stated by **Piia Post, Andreas Lehmann** and co-workers. **M.J. Lilover and co-workers** described the complex circulation patterns in the Gulf of Finland (estuarine vs. reverse estuarine circulation). Finally, the use of shallow-water Argo-floats for monitoring the recent inflow events was demonstrated by **Simo Siiriä** and co-workers.

Topic B Land-sea-atmosphere biogeochemical feedbacks

This topic is about nutrient and carbon sources, sinks and fluxes between the sea, the land and the atmosphere of the Baltic Sea region. It is related to the Baltic Earth Grand Challenge 2: Land-Sea biogeochemical feedbacks in the Baltic Sea region.

This session was opened by **Benjamin Smith** and co-workers who gave an overview over the climatic and socio-economic (i.e. land use) drivers and potential developments of future nutrient loads across the Baltic Sea catchment area. Results indicate that effects of both climate and land use on landscapes of the catchment area are important drivers of nutrient loads to the Baltic Sea and both need to be considered in developing policies and practice for science-based management of the Baltic Sea region. **Adolf Stips** and co-workers presented a Baltic Sea eutrophication assessment based on ecosystem model data, stating also that eutrophication in the Baltic Sea is mainly a coastal

problem. **Kari Eilola** and co-workers studied the role of the cyanobacteria life cycle on the biogeochemistry of the Baltic Sea, using SCOBI, a 3D high resolution coupled physical biogeochemical model. They report that including the cyanobacterial life cycle into the model improves the representation of the seasonal cycle and spatial distribution of cyanobacteria, also showing that increased nitrogen fixation during the past decades has to a certain degree counteracted N-load reductions. **Gregor Rehder** and co-workers reported on distributions and dynamics of methane and nitrous oxide in the central Baltic Sea following the 2014-2015 Major Baltic Inflow. They presented very interesting responses by the redox system of the Baltic Sea following the inflow.

The second part of the session was opened by an overview of the acid-base system of the Baltic Sea by **Karol Kulinski** and co-workers, showing that this sea area is particular, also due to the role of alkalinity. A method with a large potential to estimate air-sea flux of CO₂ by satellite measurements was presented by **Anna Rutgersson** and co-workers. The role of groundwater discharge into the Baltic Sea was studied by **Beata Szymczycha** and J Pempkowiak, showing that the total flux of groundwater to the Baltic Sea is quite small, but also that the flux of chemical substances via groundwater discharge can be locally significant. **Elina Miettunen** and co-workers presented a high-resolution 3D hydrodynamical model for the Finnish Archipelago; modelling here is particularly difficult due to the complex bathymetry; nevertheless, the model is able to produce the seasonal cycle in the surface temperature and can be used to simulate the transport of dissolved substances.

A special GEWEX contribution was given by **Monika Lakatos** on a new potential GEWEX Regional Hydroclimate Project in the Pannonian basin. The region is surrounded by mountain ranges and has only one outflow. As transition area between Mediterranean, Atlantic and continental climates this is an interesting region concerning water and energy studies and lies between the HyMEX and Baltic Earth domains. There are strong overlaps between the Pannex and Baltic Earth research questions, and a further collaboration between the two networks is envisaged.

Topic C Natural hazards and high impact events

Natural hazards and may pose serious threats as high impact events to coasts, ecosystems and human infrastructure, as storm surges at the coast, extreme wind events which are dangerous to forests, and urban flooding due to extreme precipitation. This is Baltic Earth Grand Challenge 3 to improve the understanding of natural hazards and extreme events in the Baltic Sea region.

Nadia Kudryavtseva and Soomere introduced a novel approach to estimate wave climate and storm severity from satellite altimetry. Using such data goes along with several technical challenges, which were discussed in detail. From the investigation of roughly 700.000 satellite altimetry measurements, no obvious trend in storminess can be deduced. Cyclic behavior in storminess is probably an artefact due to the shortness of the time series. **Jari Haapala** and co-workers discussed whether there will be extreme sea ice winters in the Baltic in future. Large scale atmospheric circulation anomalies are the main drivers of sea ice extremes. For the Baltic Sea, it is mainly the thickness of the ice that is decisive for an ice winter. That means that ridging must be taken into account. Ridging is mainly due to storms. An ice model has been run which includes prognostic variables for undeformed and deformed ice thickness. Both sea ice extent and thickness are projected to decrease considerably, and 10% of the winters are expected to be ice free. **Sergey Zhuravlev** and co-workers discuss changes in peak runoff of spring floods over the east of Gulf of Finland region. A decrease in the

south and an increase in the north are found, which the authors relate to the fact that there are more and longer thaw periods projected. As a consequence, the spatial correlation of peak runoff is decreasing. These findings are more or less independent from the chosen scenario. Finally, **Vladimir Ryabchenko** and coworkers discussed consequences for the marine environment related to the ongoing construction of the nuclear power station “Hanhikivi-1” in the Gulf of Bothnia. It turns out that the location for the power station is not chosen optimally, as extreme values of sea level, water temperature and significant wave height in the vicinity of “Hanhikivi-1” can be significant. Even without extreme events, the permanent release of heat into the marine environment from the operating power station is projected to lead to a strong increase in temperature and the disappearance of ice cover around 2 km vicinity of the power station, which allows for higher waves.

A recent find of historic weather data opened the opportunity for a detailed study of historic extreme wind events along the German and southern Baltic Sea coasts, as was presented by **Birger Tinz** and co-workers. They analyzed historic data sets of coastal signal stations with a comparably high spatial resolution which have been retrieved from newly discovered data archives (handwritten weather observations). Also **Ari Venäläinen** and co-workers studied extreme wind speeds. Their model aims at their spatial variations to support adaptation strategies for forest management. Finally, **Tanel Voormansik** and co-workers presented the prediction parameters for thunderstorms, hail and lightning using Doppler weather radars.

Topic D Sea level dynamics, coastal morphology and erosion

Sea level dynamics are complex in the Baltic Sea, and the southern coasts are vulnerable to global sea level rise. Coastal morphology and erosion is associated with sea level but also with wind and wave action. This topic is related to Baltic Earth Grand Challenge 4 to improve the understanding sea level dynamics in the Baltic Sea.

Sea level rise is one of the largest climate change driven hazards to low-lying coastal areas. Many simulated global scenarios reveal a statistically significant acceleration for the sea level. **Eduardo Zorita** and Birgit Hünicke demonstrated that the situation is different in the North Atlantic and in the Baltic Sea basin. While the Baltic Sea level is rising, and possibly continues to rise, both spatial and temporal patterns of acceleration (that is, a change in the speed at which sea level increases) are quite complicated. The largest accelerations are found in the eastern and northern Baltic Sea. **Jan Harff** with several co-authors discussed how sea level changes together with related drivers may affect sedimentary Baltic Sea coasts. The largest problems are expected to become evident at transgressive southern shores of the sea. Several local morphologic models already have predictive abilities and the qualitative structure of sediment transport along the southern and eastern Baltic Sea coasts has been established. However, little is known about the budget and magnitude of transport of sediments in the nearshore. There is also urgent need for higher-resolution projections of meteorological and hydrographic data. **Norman Dreier** and Peter Fröhle focused on the reaction of the longshore sediment transport at the German Baltic Sea to several scenarios of regional climate change. Both an increase in the wave heights and rotation in wind directions contribute to the possible changes. These changes may be even larger than the current magnitude of sediment transport by the end of the 21st century. This means a substantial increase in the pressure to the coastal and nearshore system and the necessity to plan countermeasures well ahead. **Katharina Klehmet** and Burkhardt Rockel asked whether individual extreme storm surge events can be related

to human induced climate change or they are just part of natural climate variability. On the one hand, the answer, to a first approximation, seems to be negative as the used model simulations do not reveal any shift in water level distribution. On the other hand, as neither of the models properly represents extreme water levels, the question about such an attribution is still relevant and timely.

The afternoon part of the session on sea level dynamics, coastal morphology and erosion primarily addressed changes in extreme sea levels and coastal impacts. Time scales of interest were from hours to centuries. Topics included analyses of changes in sea level extremes caused by changes in corresponding wind directions (**Tarmo Soomere** and co-workers), extreme value statistics of storm surges (**Evgeni Kulikov** and I Medvedev), synoptic and mesoscale sea level variability (**Igor Medvedev** and co-workers) or long-term dynamics of the Curonian Spit foredune (**Donatas Pupiensis** and co-workers). The concluding discussion primarily focused on future research directions as outlined in the Baltic Earth Science plan and potential activities of the corresponding working group.

Topic E Regional variability of water and energy exchanges

Coupled atmosphere-land-surface-ocean models still suffer from biases in simulated precipitation and evaporation, with negative consequences for the quality of weather prediction, re-analysis and climate projections. This is Baltic Earth Grand Challenge 5 to improve the understanding of regional variability of water and energy exchanges in the Baltic Sea region.

The oral session started with an overview of the GNSS4SWEC project by **Olivier Bock**, on behalf of Jonathan Jones and co-workers). The aim of GNSS4SWEC is to provide new GNSS-based tropospheric products for monitoring severe weather events and climate. Two presentations were given on the results of investigation of the energy balance components (including UV radiation, **Margit Aun** and co-workers) and turbulent fluxes (**Krzysztof Fortuniak** and co-workers). It was established that new modeling approaches are needed for supporting the measurements.

A number of presentations and posters were dedicated to the detection of current and projected spatial and temporal changes of water and energy cycle components, including precipitation, UV radiation, winter climatic conditions, life cycles characteristics of cyclones, sea water temperature, ice regime of the Baltic Sea and the Baltic Sea basin rivers, as well as river runoff and water level regime. For example, strong changes of air temperature and precipitation are expected over the territory of Belarus according to the talk of **Irina Partasenok** and Beate Geyer. **Stefan Hagemann** reported on the role of soil frost-induced soil moisture precipitation feedback. It was stated that soil frost-relevant processes are necessary for forthcoming climate change studies.

Topic F Regional climate system modelling

This topic is related to the Baltic Earth Working Group on Regional Climate System Models, whose objective is to improve coupled model systems of the atmosphere, the ocean, ice, land, biosphere and (not initially but at a later stage) human-induced processes .

Markus Quante and co-workers presented the NOSCCA project, a sister to BACC. The NOSCCA is organized like BACC, and provides a comprehensive overview over the current knowledge on climate

change in the North Sea area and its consequences. It will be published in late 2016 as Springer Open Access. **Ute Daewel** and Corinna Schrum reported on the relevance of higher trophic levels for modelling ecosystem dynamics in the Baltic Sea. They are working towards including fish and macrobenthos into the model. Climatic teleconnections between the Arctic region and the Baltic Sea region using NCEP-CFSR reanalysis were studied by **Erko Jakobson** and co-workers. They found that there are some correlations for temperature, specific humidity and precipitable water, but a teleconnection can be shown only to a certain extent. Aigars Valainis and co-workers (presented by **Uldis Bethers**) presented wave modelling activities in the Baltic proper and the Gulf of Riga to estimate future physical conditions at the Latvian coasts. Their model results indicate a slight increase of mean and storm waves, with a prevalence of westerly winds. Wave height increases in winter, but shows a significant decrease in October.

The latter half of the session included four presentations that covered the simulation of quite different drivers of the geochemical cycles in the Baltic region at several timescales. The drivers that were considered in these simulations were anthropogenic land-use changes at centennial time scales (**Anneli Poska** and co-workers), current ship emissions (**Jana Moldanova** and M. Quante, **Karin Haalund** and co-workers), and finally projections of the effect of greenhouse gas emissions on the regional climate (**Juris Sennikovs** and co-workers, presented by **Uldis Bethers**). All these drivers compete and interact in shaping the environment of the Baltic Sea region. For instance, land-use brought about expansion of agriculture change the reflectivity of the Earth surface modifying the regional climate response to increases in greenhouse gases or to changes in the Earth's orbit. At shorter timescales, measures adopted to counteract air pollution, like scrubbing the smokestacks and dumping those products into the sea may lead to an increase acidification of regional oceans.

Topic G Multiple and interrelated drivers of environmental changes

This is the new Baltic Earth Grand Challenge 6 to identify and understand the complex interrelations of multiple drivers of regional Earth system changes in the Baltic Sea region, including the human impact.

Rene Friedland and co-workers addressed how one can calculate Good Environmental Status and particularly the historical state by using data and models. This is not an easy task but the combination of models and data and further work are needed. **Marin Lodenius** discussed factors that affect metal and radionuclide pollution in the Baltic Sea. These factors as well as eutrophication and climate change are interrelated and often difficult to predict. Observations are the base for present understanding. **Insa Meinke** reported experience from the Northern German Climate Office and the stakeholder dialog illustrating a need for close and long term relation between the climate change community and different kind of stakeholders. **Hans von Storch** reviewed the idea of setting up climate services to serve as a platform for the knowledge exchange between climate science and stakeholders and recognition of the need for dialogue. The task is not to “teach” un-informed stakeholders some “truth”, but the task is to maintain an exchange of knowledge needs and options.

The session on Friday morning had to be re-arranged as the two designated speakers were unable to come due to the airline strike. This opened the opportunity for two promising young scientists to give

an oral presentation on what they had shown on their posters. The first presentation was given by BALTEX initiator **Ehrhard Raschke** (who had celebrated his 80th birthday the day before) who presented new results from GEWEX relating satellite information and models on the atmosphere water and energy cycles. The final presentation was given by PhD student **Jens Müller** and co-workers on alkalinity, acidification and the Baltic Sea carbon cycle, illustrating a close coupling to the whole drainage basin. The presentation was an excellent illustration for the need of Baltic Earth research where the carbon cycle integrates both land, sea and atmosphere processes in a complex and logical way.

Three outstanding scientists of BALTEX and Baltic Earth honoured and a special birthday boy...

During the conference dinner, Sirje Keevallik of Tallinn Technical University, Estonia, Anders Omstedt of University of Gothenburg, Sweden, and Hans von Storch, Helmholtz-Zentrum Geesthacht, Germany, were awarded a "Certificate of Excellence", in recognition of their outstanding achievements for the Baltic Earth and BALTEX science communities, on behalf of the Baltic Earth Science Steering Group and Baltic Earth and BALTEX scientific communities.



Sirje was among the first scientists in the early BALTEX days to bridge the gap between the post-soviet and western research communities in the eastern part of the Baltic Sea region in the 1990s. Together with Ehrhard Raschke, who celebrated his 80th Birthday at the conference, she was a crucial figure for the opening process and has been active in BALTEX and Baltic Earth ever since. She was co-chair of the BALTEX Science Steering Group until 2013. Anders had been an active member of the BALTEX Science Steering

Group from the very beginning, and soon became the driving factor for many BALTEX Phase I and II activities, including the BACC assessments. He was co-chair of the BALTEX Science Steering Group until 2013. During BALTEX Phase II, Hans initiated the BALTEX and Baltic Earth Assessments of Climate Change in the Baltic Sea basin (BACC), and thus made a considerable impact on the BALTEX and Baltic Earth research communities. He was co-chair of the BALTEX Science Steering Group until 2013. All three have with their experience and overview successfully contributed to the transformation of BALTEX to Baltic Earth, and have continued to be members of the Baltic Earth Science Steering Group.

We congratulate the three laureates and thank them for their long and successful support of the BALTEX and Baltic Earth communities! All the best for the future!

Acknowledgments

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