



Minutes of the
13th Meeting
of the Baltic Earth
Science Steering Group

held at

**Baltic Sea Centre
Stockholm University
Stockholm, Sweden**

22 August 2019

Edited by
Marcus Reckermann

Participants at the 13th Baltic Earth Science Steering Group meeting

| Last name | First name | Affiliation | Function |
|-------------|------------|---|-----------------------------|
| Aigars | Juris | Latvian Institute of Aquatic Ecology, Riga, Latvia | BESSG member |
| Andrusaitis | Andris | BONUS EEIG, Helsinki, Finland | BESAB observer |
| Dailiniende | Inga | Klaipeda University, Lithuania | BESSG member |
| Elken | Jüri | TalTech, Tallinn, Estonia | BESAB Chair |
| Gröger | Matthias | Swedish Meteorological and Hydrological Institute, Norrköping, Sweden | BESSG member |
| Haldin | Jannica | HELCOM Secretariat, Helsinki, Finland | BESAB member |
| Köster | Fritz | DTU Aqua, Denmark | BESAB member (via Skype) |
| Kulinski | Karol | Institute of Oceanology PAN, Sopot, Poland | BESSG member |
| Lips | Urmass | TalTech, Tallinn, Estonia | BESSG member |
| Meier | Markus | Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany | BESSG Chair |
| Myrberg | Kai | Finnish Environment Institute SYKE, Helsinki, Finland | BESSG member |
| Omstedt | Anders | University of Gothenburg, Sweden | BESAB member |
| Post | Piia | University of Tartu, Estonia | BESSG member (via Skype) |
| Reckermann | Marcus | International Baltic Earth Secretariat at Helmholtz-Zentrum Geesthacht, Germany | IBES, BESSG member |
| Rehder | Gregor | Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany | BESSG member |
| Rutgersson | Anna | Uppsala University, Sweden | BESSG member (via Skype) |
| Soomere | Tarmo | TalTech, Tallinn, Estonia | BESSG member |
| von Storch | Hans | Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Germany | BESAB member |
| Stendel | Martin | Danish Meteorological Institute | BESSG member (via Skype) |
| Weisse | Ralf | Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Germany | BESSG member (via Skype) |



Summary of Decisions and Action Items

- Decision 1: Karol Kulinski was approved as new Baltic Earth Science Steering Group Vice-Chair.
- Decision 2: The 3rd Baltic Earth Conference will be held 1-5 June 2020, in Jastarnia, Hel peninsula, Poland.
- Decision 3: The BEAR reports, including BACC III, shall be published as a special issue in *Earth System Dynamics*, a Copernicus journal.
- Decision 4: Tentative submission time window for the BEAR reports with ESD is March 2020 until September 2020. The 14th BESSG and BEAR Author Meeting will be the final BEAR author meeting before the submission to ESD and release to external reviews.
- Decision 5: BESSG Meeting #14 and BEAR Author Meeting will take place at SMHI, Norrköping, Sweden, in late January/February 2020. This meeting is tentatively planned as back-to back meeting with the 3rd physical HELCOM EN-Clime-Baltic Earth meeting.
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- Action Item 1: **Marcus Reckermann** and **Markus Meier** to prepare BEAR principles, based on the BACC principles, which will be added to the journal description at ESD, to warrant a high and uniform format and quality of all BEAR reports.
- Action Item 2: **Sergey Zhuravlev** with **Marcus Reckermann** to prepare Baltic Earth Workshop on “Hydrology of the Baltic Sea Basin: Observations, Modelling, Forecasting”, St. Petersburg, Russia, 8-9 October 2019, in connection with the celebrations of the 100th year’s birthday of the Russian State Hydrologic Institute, St. Petersburg.
- Action Item 3: **Kai Myrberg** with **Marcus Reckermann** and **Markus Meier** to prepare the Baltic Earth Workshop on “Climate projections and uncertainties in the northern Baltic Sea region”, Finnish Environment Institute, Helsinki, Finland, 19- 20 November 2019
- Action Item 4: **Marcus Reckermann** and the Secretariat with **Karol Kulinski** and **Markus Meier**, to prepare the Second Announcement for the 3rd Baltic Earth Conference in Jastarnia, Hel Peninsula, Poland
- Action Item 5: **Marcus Reckermann** with **Markus Meier** and the HELCOM Secretariat (**Jannica Haldin**) to find a time slot for the 14th BESSG meeting in conjunction with the 2nd BEAR and 3rd EN Clime meeting

Introduction

The 13th Baltic Earth Science Steering Group Meeting was a short afternoon meeting, attached to the Baltic Sea Science Congress, 19-23 August 2019 in Stockholm, Sweden. The meeting was also the 1st BEAR Author Meeting. The Baltic Earth Senior Advisory Board was invited to this meeting. Main topic of the meeting was the discussion of first drafts and reports of the Baltic Earth Assessment Reports.

TOP 1: Organizational Issues

1.1 Approval of the agenda

The agenda was approved.

1.2 Approval of the previous 12th Baltic Earth SSG meeting minutes

The previous meeting minutes were approved.

1.3 Review of previous 12th Baltic Earth SSG meeting action items

The action items of the previous meeting were shortly recapitulated. All have been completed.

1.4 Membership issues:

BESSG memberships

Karol Kulinski, Research Department Head at the Institute of Oceanology PAN in Sopot, Poland, was approved as new Baltic Earth Science Steering Group vice chair. Karol follows Anna Rutgersson on this position who had announced her withdrawal from this task (**Decision 1**).

TOP 2: Presentation on the EN Clime process by Jannica Haldin

Jannica Haldin gave a brief overview presentation on EN Clime and its recent activities. The 3rd EN Clime meeting had been held on 19 August in Stockholm (minutes available [here...](#))

Specific notice was given on the preparations for the update of the Baltic Sea Action Plan, for which all HELCOM expert groups, including EN Clime, are asked to provide a synopsis and suggestions for new items and measures for the updated BSAP. Furthermore, a HELCOM Science Agenda will be developed, concomitantly with the new BSAP, and Baltic Earth and other regional stakeholders are invited to provide input. It was decided to use the Baltic Earth Science Plan as input for this.

It was further noted that the work on the specific topic teams (Sea level and extremes, Carbon and Nutrient Cycles, Water cycle, Energy Cycle) is ongoing and that for some specific fields, experts are still need to be nominated.

TOP 3: Baltic Earth Events and activities

The report secretariat report was distributed electronically before the meeting by Marcus Reckermann. Due to the limited time, this was not presented orally at the meeting. The report is given in Annex 1. There, the date and location of the 3rd Baltic Earth Conference is given: 1-5 June 2020 in Jastarnia on the Hel peninsula, Poland (**Decision 2**).

TOP 4: Baltic Earth Assessment Reports (BEAR) Author Meeting

Marcus Reckermann reported on the negotiations concerning a suitable journal to publish the BEAR reports. The reports, including BACC III, shall be published as a special issue in *Earth System Dynamics* (ESD), a Copernicus journal. They are Open Access and are flexible page limits; also they provide the production as a printed issue. However, there is a condition of the journal to open this to more

contributions than the ones invited directly by Baltic Earth. Concern was uttered that this may compromise quality and focus on the subject, and BEAR principles (which are adopted from the BACC principles) may be weakened and articles may not fit the idea of the BEAR assessments; however, the acceptance of external contributions depends on the requirements and conditions, which will be clearly defined (BEAR principles, **Action item 1**), so that contributions which fulfil the conditions will be accepted; those who do not, will be rejected. Under the conditions that all contributions fulfil the strict BEAR criteria, it was agreed to publish the BEAR reports with ESD (**Decision 3**).

The tentative submission time window for the BEAR reports with ESD was defined as **from 1 March 2020 until 30 September 2020**. Before that, a rigorous internal review shall take place. The 14th BESSG and BEAR Author Meeting will be the final BEAR author meeting before the submission to ESD and release to external reviews (**Decision 4**).

Present BEAR authors (Kai Myrberg, Gregor Rehder, Anna Rutgersson, Ralf Weisse, Marcus Reckermann, Matthias Gröger, Markus Meier, Urmars Lips) gave a short overview over the status of the work. Sergey Zhuravlov was unable to participate in the meeting. Short presentations by Anna Rutgersson, Ralf Weisse and Marcus Reckermann, and provisional drafts by Andreas LehmannL/Kai Myrberg and Markus Meier can be viewed on the password-protected part of the BEAR webpage (open to BEAR authors and BESSG/SAB members, password available with MR).

Three author teams had submitted first drafts: (Salinity dynamics, Natural hazards, Sea level dynamics, and Climate change and impacts). Issues discussed involved the following:

- Urmars Lips stated he intends to involve more experts in new observation systems concerning the atmosphere and hydrosphere (New climate observation systems); it was suggested to involve Franz Berger to this chapter;
- there may be overlapping issues in certain chapters, e.g. between Extreme events and Sea level dynamics, this needs to be coordinated;
- BEAR and EN Clime messages need to be consistent;
- the Multiple Drivers article may have the potential to be of greater (public) interest, however, this is a very diverse and wide field and the focus of the chapter needs to be elaborated. Matthias Gröger mentioned a tool used by the Swedish Agency to assess cumulative effects. Juris Aigars announced to send material on invasive species for the Multiple Drivers article;
- Markus Meier suggested separating the BACC II article into two papers due to the vast amount of material. In addition, it was suggested that a separate paper could be written on the socio-economic impacts of climate change in the Baltic Sea region if a coordinating author can be identified.

A further BEAR Author meeting (possibly via Skype) in winter is envisaged. In any case, a physical meeting before the submission to ESD is planned in late January/February 2020 at SMHI, in conjunction with the 14th BESSG meeting. This meeting is tentatively planned as back-to back meeting with the 3rd physical HELCOM EN-Clime-Baltic Earth meeting. The specific time will be communicated in due time (**Decision 5**).

TOP 5: Miscellaneous

5.1. Hans von Storch proposed a project for collaboration:

Suggestion for an analysis of the role of hydrodynamical noise (=unprovoked variability) in the Baltic Sea by Hans von Storch

- The presence of unprovoked variability (“noise”) in process-based hydrodynamical models of the atmosphere is long known: for global models since 1972, for regional models since 1995.
- A general concept for explaining this emergence of noise is provided by Hasselmann’s “Stochastic climate model” (1976)
- In the past, when coarse resolution ocean models were used, noise was observed in global ocean models as induced by atmospheric noise, but not by oceanic dynamics because of the overall too viscous (honey-like) dynamics. In recent years, however, systematic studies demonstrating the emergence and significance of internally generated variability have been published (see, e.g., Penduff et al., 2018)
- In regional, high-resolution models, this emergence of noise was first described, it seems, for the Baltic Sea by Büchmann and Söderkvist (2016), for the Mediterranean Sea by Waldman et al. (2017), and for the South China Sea by Tang et al. (2019a). The scale separation of externally forced variability and internally generated variability in the South China Sea was studied by Tang et al. (2019b) – variability on scales less than 100 km were mostly found to be unprovoked. These are spatial scales of relevance for ecosystems and for morphodynamics.

A search is suggested if such studies on the formation, the scales, and the impacts of hydrodynamic noise has been done for the Baltic Sea. Also, to what extent numerical experimentation with such model is taking into account the stochastic character of such experiment related to the presence of noise.

If no such activities are underway, a work group should be set up for doing such a study. This would require the availability of a high-resolution model (5km grid resolution?) of the hydrodynamics of the Baltic Sea, and a young scientist who would be willing (and paid for) to devote 1 year of his/her time for such an effort. The work plan would follow the work done and published by Tang SQ (2019a,b).

Interested colleagues should directly contact Hans (hvonstorch@web.de).

5.2 BESSG Meeting #14

The 14th Baltic Earth Science Steering Group meeting shall take place in combination with a BEAR Author meeting and the 3rd EN Clime meeting, at the SMHI in Norrköping, Sweden. Time window is late January/February 2020. The specific time will be communicated in due time.

Draft

Marcus Reckermann, 16 Oct 2019

Markus Meier, 17 Oct 2019

Report by the **International Baltic Earth Secretariat** for BESSG #13
22 August 2019, Baltic Earth Centre, Stockholm University

1. Action items of BESSG #12

All completed (see Annex 1)

2. BESSG issues

Resigned: **Corinna Schrum**, Helmholtz-Zentrum Geesthacht, Germany

Suggested as new BESSG co-chair: **Karol Kulinski**, Institute of Oceanology, Polish Academy of Science, Sopot, Poland. <https://www.iopan.pl/BGeochem/KK-cv.html>

3. Past Baltic Earth activities, since November 2018 (BESSG #12)

- *Baltic Earth Workshop on Multiple drivers for Earth system changes in the Baltic Sea region Tallinn University of Technology, Tallinn, Estonia, 26- 27 November 2018*

Many experts from the different research fields followed our invitation and found the time to come to Tallinn to speak at the workshop, more than 110 participants attended. Next to the 31 oral presentations, we had 32 posters, and a high number of young scientists from all over the Baltic Sea region. This, and the open and curious spirit at the workshop showed that the topic is of high interest to many scientists, and is also on the agenda of decision makers and needs to be taken up. The bottom line of the presentations and following discussions was that we do know quite a lot about the individual drivers, but much less about their interlinkages and their dependencies on climate change.

A concrete outcome of the workshop is the intention to write an assessment report on this topic, to be published in the Baltic Earth Assessment Report series (BEAR). Presenters at the workshop agreed to contribute as co-authors this assessment. The paper will give an overview over what we know and, more importantly, what we do not know, and how can we proceed in future research activities towards disentangling the interlinkages of the multiple drivers, wherever possible and useful to improve management options.

<https://baltic.earth/events/multipldrivers2018/afterm.html>

- *1st Baltic Earth Winter School, 22-29 March 2019, IOW Warnemünde, Germany*

10 students from the whole Baltic Sea region came to Warnemünde for this one week Baltic Earth Winter School, organized by IOW. It was more specific than the Baltic Earth Summer Schools, focusing on the analysis of climate variability from years to millennia as recorded from instrumental data, historical documents and proxy data such as tree ring data or sediment cores. Emphasis was given on the fundamentals of statistics, time series analysis, multivariate data analysis, uncertainty analysis in statistical methods and strategies of statistical analysis.

<https://baltic.earth/winterschool2019/>

A 2nd Baltic Earth Winter School in March 2020 is already in preparation.

<https://baltic.earth/winterschool2020/>

- *Baltic Earth Session "Climate and other drivers of change: Interlinkages, ramifications and impacts in coastal regions" at EGU General Assembly 2019, 7-12 April 2019, Vienna, Austria*

This Baltic Earth contribution to the EGU General Assembly 2019 was a PICO Session, on the afternoon of the last day of the conference. Still the more surprising was the numerous and vivid participation. The topics presented spanned the whole range of different drivers, and proved a good supplement to the Multiple Drivers workshop a few months earlier.

<https://meetingorganizer.copernicus.org/EGU2019/picos/33083>

- *Baltic Sea Science Congress, Stockholm, Sweden, 19-23 August 2019*

Many contributions (orals and posters) to this BSSC Conference are given by collaborators in the Baltic Earth network. We welcome if Baltic Earth was acknowledged, if applicable. A poster on BEAR will be presented on Thursday afternoon.

<https://www.su.se/ostersjocentrum/english/baltic-sea-science-congress-2019>

- *BEAR*

There is now a short BEAR web page, explaining the background.

<https://baltic.earth/bear/>

- *EN CLIME*

There is now also a short web page about the HELCOM-Baltic Earth network on climate change in the Baltic Sea region (EN CLIME).

https://baltic.earth/en_clime/

- *Baltic Earth input to BANOS and participation in BANOS stakeholder event at ICES Conference, 11 September 2019*

As a scientific stakeholder to BONUS, Baltic Earth, as other stakeholders of BONUS, was invited to participate in the process mediated by the governance and management action of the BANOS CSA to “develop a joint Baltic and North Sea strategic research and innovation agenda as well as engagement strategies and platforms that enable key stakeholders and end-users of knowledge and innovation of the planned programme to be part of the action from the very beginning.

The BANOS CSA will engage a writing team to draft a Strategic Research and Innovation Agenda (SRIA). Baltic Earth has submitted, together with an introductory cover letter, a summary of the Baltic Earth Science Plan 2017 as an overview over current Baltic Earth topics. Thank you for providing input for this and for suggestions for possible authors for the agenda.

Please find the Baltic Earth input for the BANOS CSA SRIA in Annex 2.

3. Upcoming Baltic Earth activities

- 5th Baltic Earth Summer School, Askö, Sweden, 26 August – 2 September 2019

As the previous summer schools, the 5th Baltic Earth Summer School will focus on past and future changes in climate of the Baltic Sea region. Students will be introduced into fundamental processes of the atmosphere, ocean, sea-ice and land surface with relevance for the climate system. 2 students will attend the course. The course is organized by Leibniz Institute for Baltic Sea Research Warnemünde, Rostock University and the Baltic Earth programme through the International Baltic Earth Secretariat at Helmholtz-Zentrum Geesthacht, and is hosted by Askö Laboratory of Stockholm University, Baltic Sea Centre. Anticipated lecturers include Markus Meier, Anna Rutgersson, Karol Kulinski, Christoph Humborg and Marcus Reckermann.

<https://baltic.earth/summerschool2019/>

- EMS Copenhagen, 9-13 September 2019

At the European Meteorological Society Annual Meeting 2019, GEWEX is organizing a session “UP2.7: European Regional Hydroclimate Projects helping understand water cycle processes and drivers”, which will bring together the three European Regional Hydroclimate Projects of the GEWEX Regional Hydroclimatology Panel: HyMex, PannEx and Baltic Earth. Anna Rutgersson, co-convening this session, will represent Baltic Earth, with input from the Steering Group. Steering Group members who are able to participate in the EMS 2019 in Copenhagen are invited to join the session and join Anna in representing Baltic Earth.

<https://meetingorganizer.copernicus.org/EMS2019/session/33677>

- Baltic Earth Advanced Training Course in Estonia, 15-20 September 2019

An advanced training school “Applications of remote sensing in the Baltic Sea region” will take place from 15 to 20 September 2019 in Võru Kubija Spa, Estonia. The school is organised by the University of Tartu together with the International Baltic Earth Secretariat at Helmholtz-Zentrum Geesthacht. 26 Students were selected from 40 applications, from around the Baltic Sea. The main goals of the Training School are to bring together young researchers in the field of Remote Sensing/Earth Observation from different countries surrounding the Baltic Sea. Early stage scientists will be provided hands-on training in a relaxed informal atmosphere, and the young scientists will be given new perspectives and inspirations for their own projects. Renowned keynote speakers will give insights into current hot topics in the area.

<https://baltic.earth/voru2019/>

- Baltic Earth Workshop on Hydrology of the Baltic Sea Basin: Observations, Modelling, Forecasting. St. Petersburg, Russia, 8-9 October 2019

The workshop will bring together scientists to overcome the barriers in hydrological studies, including monitoring, modelling and forecasting. Both water quantity and quality issues will be

discussed to develop a more integrated understanding of the interactions between the water, energy and matter cycles, as well as direct and indirect anthropogenic effects.

Objectives of the workshop are to review recent scientific contributions to assess past, current and future changes of the water cycle, to share the experience of hydrological and hydrochemical monitoring, using different tools and approaches, to review recent developments in hydrological modelling in the Baltic Sea basin and neighboring domains, and to discuss water quality issues and waste water treatment projects in the Baltic Sea basin. There is an open Call for Abstracts with deadline of 16 August (subject to deadline extension).

The workshop is co-organized by the State Hydrological Institute St. Petersburg, Russia, and the International Baltic Earth Secretariat at Helmholtz-Zentrum Geesthacht.

Website: <https://baltic.earth/hydrology2019/>

Flyer: https://baltic.earth/hydrology2019/material/Hydrology_StPb2019_Flyer.pdf

- Baltic Earth Workshop on Climate projections and uncertainties in the northern Baltic Sea region
Finnish Environment Institute, Helsinki, Finland, 19- 20 November 2019

The uncertainty of climate projections has been shown to be largest in the northern Baltic Sea and Gulf of Finland. This workshop intends to bring together experts to discuss this. Several aspects need to be taken into account: Adaptation is a major topic, and advice based on climatic projections is needed for various management issues. Also, effective mitigation is needed e.g. in terms of eutrophication etc. Concerning the carbon balance, it is necessary to evaluate the role of the northern Baltic Sea in the global carbon balance. Does the northern Baltic Sea act as strong source (cf. Arctic coastal areas)? Moreover, the northern Baltic Sea may act as a modelling laboratory for studying climate change mechanisms in northern latitudes.

Representatives of frequently used biogeochemical models for Baltic Sea ecosystems, such as ERGOM, SCOBI, BALTSEM, BFM, SPBEM, ECOSMO and PROBE-Baltic, will discuss the issues above. A Call for papers is open, abstract deadline is 11 October. A common paper to AMBIO as outcome of this workshop is envisaged.

Website: <https://baltic.earth/helsinki2019/>

Flyer: https://baltic.earth/helsinki2019/material/Helsinki2019_Flyer2.pdf

- BESSG #14, January-February 2020

The next full 2-day meeting of the Baltic Earth Science Steering Group is loosely planned for January-February 2020 (exact dates and venue tbd)

- Baltic Earth session at EGU 2020, 3-8 May 2020

There will be a Baltic Earth session at the EGU 2020, as in the previous years. The scope will be the same but the title and text will be slightly adapted to attract more contributions from other parts of the world. For the session description of the 2019 session, see <https://meetingorganizer.copernicus.org/EGU2019/picos/33083>

- 3rd Baltic Earth Conference, 1-5 June, Jastarnia, Poland

The 3rd Baltic Earth Conference will take place in Jastarnia, Poland, on the Hel peninsula, close to the Gdansk metropolitan area, 1-5 June 2020. The conference motto this year is “Earth system changes and Baltic Sea coasts” to reflect the importance of coastal issues in Poland, but all aspects of Baltic Earth research will be treated, as usual.

Website: <https://baltic.earth/hel2020/>

Flyer: <https://baltic.earth/hel2020/material/3BalticEarthConfPoland2020.pdf>

- 3rd ClimatEurope Festival, 16-17 June, Riga, Latvia

The International Baltic Earth Secretariat was approached by the organizers of the 3rd ClimatEurope Festival, which is a stakeholder conference related to the topics of the ClimatEurope project (<https://www.climateurope.eu/>). Scope of the project is to a. develop a Europe-wide framework for Earth-system modelling and climate service activities, b. coordinate and integrate on-going and future European climate modelling, climate observations and climate service infrastructure initiatives, c. establish multi-disciplinary expert groups to assess the state-of-the-art in Earth-system modelling and climate services in Europe, and identify existing gaps, new challenges and emerging needs, and d. enhance communication and dissemination activities with stakeholders.

After two Festivals in southwestern and south eastern Europe ([Valencia, Spain](#) and [Belgrade, Serbia](#)), the third conference is envisaged to take place in the Baltic Sea region, in Riga, Latvia.

We believe that a collaboration will be a good thing for Baltic Earth, as the ClimatEurope goals largely overlap with ours, in particular, the BEAR/BACC III and EN CLIME activities. In this respect, we would also like to invite HELCOM and BONUS/BANOS as relevant stakeholders to this Festival.

The IBES cooperates with ClimatEurope regarding the organization of the Festival and is also involved in the scientific planning and stakeholder involvement. It should be noted that the Festival is not primarily a scientific event but a stakeholder conference, but the scientific basis of climate change in the Baltic Sea region will be provided by Baltic Earth experts. BESSG members are encouraged to propose inputs and further potential stakeholders in the Baltic Sea region, like users of climate information. Local partner in Riga is the Latvian Weather Service ([meteo.lv](#)).

Annex 1: Action Items of BESSG #12

- Action Item 1: **To conveners** to Baltic Earth sessions at EGU 2019, to announce and advertise these sessions. **Completed**
- Action Item 2: **To all** to advertise and consider participation and represent Baltic Earth at the BSSC 2019 and show the Baltic Earth logo on slides/posters wherever appropriate **Completed**
- Action Item 3: **Markus Meier** and **Marcus Reckermann** to prepare the summer school: prepare website, content and agenda, announcement, fix application deadline, by February. **Completed**
- Action Item 4: **Piia Post** with support of **Marcus Reckermann/Secretariat**, to prepare the workshop on Remote Sensing **Completed**
- Action Item 5: **Marcus Reckermann** and **Markus Meier**, all to stimulate the Baltic Earth Young Scientists to organize a Baltic Earth Session at Youmares, with logistical assistance from the Secretariat **Completed**
- Action Item 6: **Sergey Zhuravlev, Valery Vuglinsky** with **Marcus Reckermann** and **Markus Meier** to prepare the Baltic Earth Workshop on “Hydrology of the Baltic Sea region” (tentative title) in St. Petersburg, in early October 2019. **Completed**
- Action Item 7: **Marcus Reckermann/Secretariat** with **Karol Kulinski** to assess possible venues and prices for the conferences; **to all** to find a topic/title/motto for the conference **Completed**
- Action item 8: **Markus Meier** and **Marcus Reckermann** to suggest a common structure for BEARs which is loose enough to accommodate all the different subjects but also provides a common comparable structure to warrant a level of consistency among the papers. **Completed**
- Action Item 9: BACC III lead author **Markus Meier** and **Jannica Haldin** (HELCOM) to identify and approach potential experts for membership in the EN climate. **Completed**
- Action Item 10: **To all BEAR Authors** to have a first draft of the BEARs ready by June 2019. **Extended to 15 July, completed.**
- Action Item 11: **Marcus Reckermann** and **Markus Meier** to investigate possible publication options for BEARs, negotiate with publishers and then decide on the best option. **Completed**

Annex 2: Baltic Earth Input for BANOS CSA SRIA

Cover letter and Baltic Earth Science Plan Summary and research needs



Baltic Earth

Earth System Science for the Baltic Sea Region

May 2019

Dear Ladies and Gentlemen,

as scientific stakeholder of BONUS, we would like to share the current Baltic Earth research priorities with you, on behalf of the Baltic Earth Science Steering group and the Baltic Earth research community. We hope and believe that the envisaged Strategic Research and Innovation Agenda (SRIA) for BANOS may profit from the Baltic Earth research perspective.

Baltic Earth, the international and interdisciplinary open Earth system research network for the Baltic Sea region, has been a scientific stakeholder in Earth system research in the Baltic Sea region since 2013, when it superseded BALTEX after 20 years. The *Grand Challenges* of Baltic Earth embrace important aspects of regional Earth system science in the Baltic Sea region (see attached Science Plan and Summary). Baltic Earth and its predecessor BALTEX have been involved in multiple BONUS projects in the past (ECOSUPPORT, Baltic-C, Amber, Sheba, BalticApp, INTEGRAL), resulting in many scientific publications and stakeholder involvements.

Baltic Earth is dedicated to basic research and as such may help to complement the new SRIA with some basic questions and aspects, which require attention to support more applied research goals. The identification of knowledge gaps and research needs for the coming years provides the scientific basis for management decisions and policy making to help find solutions for the challenges society faces now and in the future.

The attached “Baltic Earth Science Plan 2017” represents a comprehensive description of the Baltic Earth research topics. This is what the community of Baltic Earth scientists in the Baltic Sea region considers important to tackle in the near future.

Currently, Baltic Earth scientists are preparing several Baltic Earth assessment reports (BEAR) to provide a current and scientifically sound overview over the Grand Challenge topics and other important aspects related to regional Earth system science in the Baltic Sea region. The assessment reports will be available in 2021.

Attached, please find the Baltic Earth Science Plan 2017, and a short summary of the Grand Challenges, including some research needs as bullets, as identified by Baltic Earth.

Markus Meier

Baltic Earth Science Steering Group
Chair

Marcus Reckermann

International Baltic Earth Secretariat
Head



Baltic Earth

Earth System Science for the Baltic Sea Region

May 2019

Baltic Earth Science Plan Summary and Research needs

This is a joint document of the Baltic Earth Science Steering Group and is intended to provide input for the BANOS SRIA Writing Team. It represents the perspective of the basic Earth system research network Baltic Earth and formulates future research needs as perceived by the Baltic Earth community.

Baltic Earth Science Plan 2017

Climate change and other anthropogenic and natural changes in the atmosphere, on land and in the sea exert different pressures on the natural and human-shaped environment of the region. These pressures include regional warming, declining sea ice cover, sea level rise, deoxygenation, acidification, changing precipitation and runoff patterns, as well as changing frequencies of high impact events like storm surges, floods, drought and heat periods.

The characterization and analysis of these pressures, as well as a synthesis of the state of scientific knowledge about their causes and impacts, has been a core goal of the BALTEX and Baltic Earth climate change assessments (BACC I and II). It has been shown that the observed environmental changes are often caused by a mixture of interwoven factors, among them climate change and its associated impacts, eutrophication, pollution, fisheries, land cover use and others. Each of these factors has a scientific and a societal dimension, which are often interdependent, and which makes the identification of a single or even dominant responsible factor difficult. Baltic Earth strives to analyze these factors and processes in order to identify knowledge gaps and research needs for the coming years, to provide the scientific basis for management decisions and policymaking, and to help finding solutions for the challenges society faces now and in the future.

Baltic Earth Grand Challenges

The pillars of Baltic Earth activities are the Grand Challenges, which define research issues of fundamental importance for informing the science-based environmental management of the Baltic Sea region. These topics reflect current issues, which scientists feel have a strong relevance for society and the scope and vision of Baltic Earth. The Grand Challenges are strongly interlinked with each other, and knowledge gained in one field also affects the understanding in others.

Below, the current Grand Challenges as well as the overarching coupled modelling challenge are briefly described, with dedicated research needs for consideration in the BANOS SRIA.

1. Salinity dynamics

Spatial and temporal variations in Baltic Sea salinity are not only controlled by oceanographic processes, but are also driven by changes in the water and energy cycle. Salinity is an important factor controlling ecosystem functioning and biodiversity, in particular in the brackish Baltic Sea with its pronounced horizontal and vertical gradients. Climate change scenarios suggest an enhanced hydrological cycle in the northern Baltic Sea region, causing increased precipitation and runoff, leading to decreased salinity. However, due to large biases in projections of the regional water balance, in wind fields and the global sea level, it is still unclear whether the Baltic Sea will become less or more saline, also depending on the frequency and extent of major inflows in the future. Since the Baltic Sea ecosystem has adapted to the present salinity regime, even small changes in salinity may exert stress on marine fauna and flora with associated consequences on species distributions and biodiversity.

Research needs:

- Assessment of the regional freshwater input (precipitation minus evaporation plus runoff) on seasonal to inter-annual timescales
- Assessment of the development of saline stratification and its role for increasing hypoxia
- Atmospheric variability (wind), how is it influencing inflows and salinity distributions
- Salt-water inflows, what are they dependent on? Can we predict major inflows? What determines their frequency and extent?
- Exchange between the coastal areas and the open sea and between sub-basins, turbulent mixing processes
- Improvement of observational data inventory (cruises, moorings, buoys)
- Improved coupled atmosphere-ocean model systems

2. Land-Sea biogeochemical linkages

Eutrophication is a key environmental problem in the Baltic Sea. The riverine loads of nutrients are strongly influenced by agricultural land cover and practices and are sensitive to the effects of climate warming on soil mineralization processes and by the amount and seasonal distribution of runoff, in turn influenced by rainfall patterns. Baltic Sea waters are rich in carbon. Dissolved organic carbon (DOC) derived from decomposition and leaching of organic matter from peatlands, forests and lakes is a major carbon source for the Baltic Sea, particularly from the boreal catchments of the northern basins. Little is known about the fate of the DOC, its biogeochemical activity, or interactions with nutrient cycles and phytoplankton production. The potential decoupling of carbon uptake and inorganic nutrient availability is a major uncertainty in the causal link between eutrophication and hypoxia.

Research needs:

- Better quantification of nutrient and carbon retention in the sediments
- Basin-specific deviations of the general marine acidification trends by coastal processes
- Better incorporation of biogeochemical fluxes and transformations in the drainage networks into coupled regional biogeochemical models
- Assessments of submarine groundwater seepages
- Mechanisms and drivers dominating the dynamics of the forest-dominated northern vs. the agriculture-dominated southern basins
- Extension of databases with missing terrestrial loads data

- Development of land-ocean system models

3. *Natural hazards and extreme events*

Many natural hazards are of hydro-meteorological origin (storms, waves, flooding, droughts), and are often caused by a mixture of several factors. Average changes in the recent climate in the Baltic Sea region are relatively well described, but the uncertainty is much larger for extreme conditions. These extreme events pose a substantial threat to infrastructures or ecosystems albeit their relative rareness. The shortage of available data on these events reduces the statistical significance in the analysis and the capability to predict them.

Research needs:

- Improvement of monthly to seasonal prediction systems and probabilistic estimates of the extreme events
- Detailed investigations of extreme events, analysis of the process chain which triggers extreme events
- Specific attribution analyses of past extreme events to elucidate the possible role of anthropogenic forcing factors
- Analysis of the vulnerability of key societal functions to changed hydro-meteorological extremes

4. *Sea level and coastal dynamics*

Sea level dynamics in the semi-enclosed Baltic Sea are driven by meteorological, astronomical, hydrological and geological factors. The sea level varies at different time scales, ranging from hours to seasons, decades and millennia. The sea level records in the Baltic Sea sampled by tide gauges belong to the best and longest data in the world, and several high-resolution satellite products allow the analysis of absolute sea level changes. Still, there is incomplete knowledge on short-term sea level variations. In particular, the linkages between the sea levels of the Baltic and North Seas and the North Atlantic on the one hand, and the impact of large scale atmospheric circulation patterns, such as the North Atlantic Oscillation on the other hand, needs to be better investigated.

Research needs:

- Improving detection and attribution of anthropogenic signals in Baltic Sea sea-level rise and variability by quantification of multi-decadal trends in the wind regimes, salinity, glacial isostatic adjustment or sea-ice cover, together with changes in ocean dynamics in the North Atlantic
- Consistent analysis of available data sets to quantify the relative importance of the different factors contributing to Baltic Sea sea-level dynamics
- A systematic comparison of tide gauges and high-resolution satellite products
- Disentangling processes which lead to extreme sea level variability
- Development of a (meta-) database of Baltic Sea sea-level data and assessments of past, ongoing and future variability and change of the regional sea level

5. Regional variability of water and energy exchanges

Knowledge of the water and energy cycles in the Earth system is an inherent part of regional climate studies. However, the understanding of the processes and their incorporation into reliable models remains insufficient, which is evident by the poor performance of recent climate models in simulating the hydroclimate. In particular, precipitation and evaporation are among the parameters causing the largest problems for weather prediction, meteorological reanalysis and regional climate studies. Most coupled atmosphere - land-surface-ocean models do not have a closed water cycle and hydrological applications need bias correction when the output of regional climate models is used. Results of the various methods differ considerably, and for most methods, uncertainty estimates are not available. The assessment of hydrological studies for the different sub-basins of the Baltic Sea catchment area reveals that the approaches to calculate the water cycle over land differ and are not coordinated. Goal should be an assessment of past and current hydrological changes and to project future runoff and salinity changes in the Baltic Sea.

Research needs:

- Development of homogeneous hydrological datasets for the whole catchment area
- Measurement of hydrological and atmospheric exchange processes from the surface to the top of the atmosphere at different time scales for various spatial scales
- Analysis of the natural variability of energy and water components including the quantification of changes in extremes and the determination of probabilities of their occurrences (for the last century up to now)
- Combination of conventional measurements with new remote sensing products
- New model parameterizations considering e.g. an improved understanding of cloud-aerosol-feedback mechanisms, cloud processes and atmospheric boundary layer processes

6. Multiple drivers of regional Earth system changes

It has been shown that a mixture of interwoven factors, such as eutrophication, pollution, fisheries, hydrographic engineering, agricultural and forestry practices and land cover change, is responsible for the current environmental situation. Current observational datasets, system understanding and available modelling tools are mostly insufficient to ascribe key dimensions of change to a single or even dominant factor, or to construct credible scenarios of future changes. There is a need for increased cooperation among researchers with specialized knowledge of the different components of the coupled biophysical-societal system, with the goal to develop an understanding in the dynamics of the interrelated multiple drivers and their impacts on regional Earth system changes. This may in the future allow better-tailored strategies for environmental management.

Research needs:

- Assess and synthesize the current disciplinary knowledge, and investigate interconnections
- Develop datasets and identify data gaps
- Design model experiments with key components and their interactions

7. Coupled regional Earth system modelling

This is an overarching task, as all of the previously described scientific themes rely on different shades of coupled Earth system modelling. The current modelling capacity in the region includes atmospheric, oceanographic, cryospheric, hydrological, ecosystem and biogeochemical modelling,

terrestrial ecosystem, carbon cycle, agricultural and forest production modelling. Earth system models coupling the atmospheric, marine and terrestrial domains are hosted by national climate centres in several countries. Frontiers in regional Earth system modelling include the integration of linkages and feedbacks across domains such as the role of land-sea nutrient fluxes for marine ecosystem dynamics and sea surface-atmosphere greenhouse gas exchange.

Research needs:

- Model evaluation and model inter-comparison for the Baltic Sea and other coastal sea regions
- Identification of processes important for regional Earth system dynamics that are not well resolved or not well parameterized in state-of-the-art models
- Model development, optimization, coupling of model components and adaptation for high-performance parallel computing
- Designing and performing coordinated experiments for past, present and future climates
- Development of analysis and visualization tools for large data sets of multi-model ensemble simulations

Education and interdisciplinary summer schools

Finally, we would like to emphasize the need for a good education in the field of regional Earth system research in all its variations. The increasing interdisciplinary and inter-connections between the different disciplines before the background of climate change makes a better education of a future generation of scientists necessary, who will have a better disciplinary and interdisciplinary knowledge with associated modeling skills. Therefore, we strongly advocate the funding of disciplinary and interdisciplinary summer schools in the various fields of the regional Earth system science.