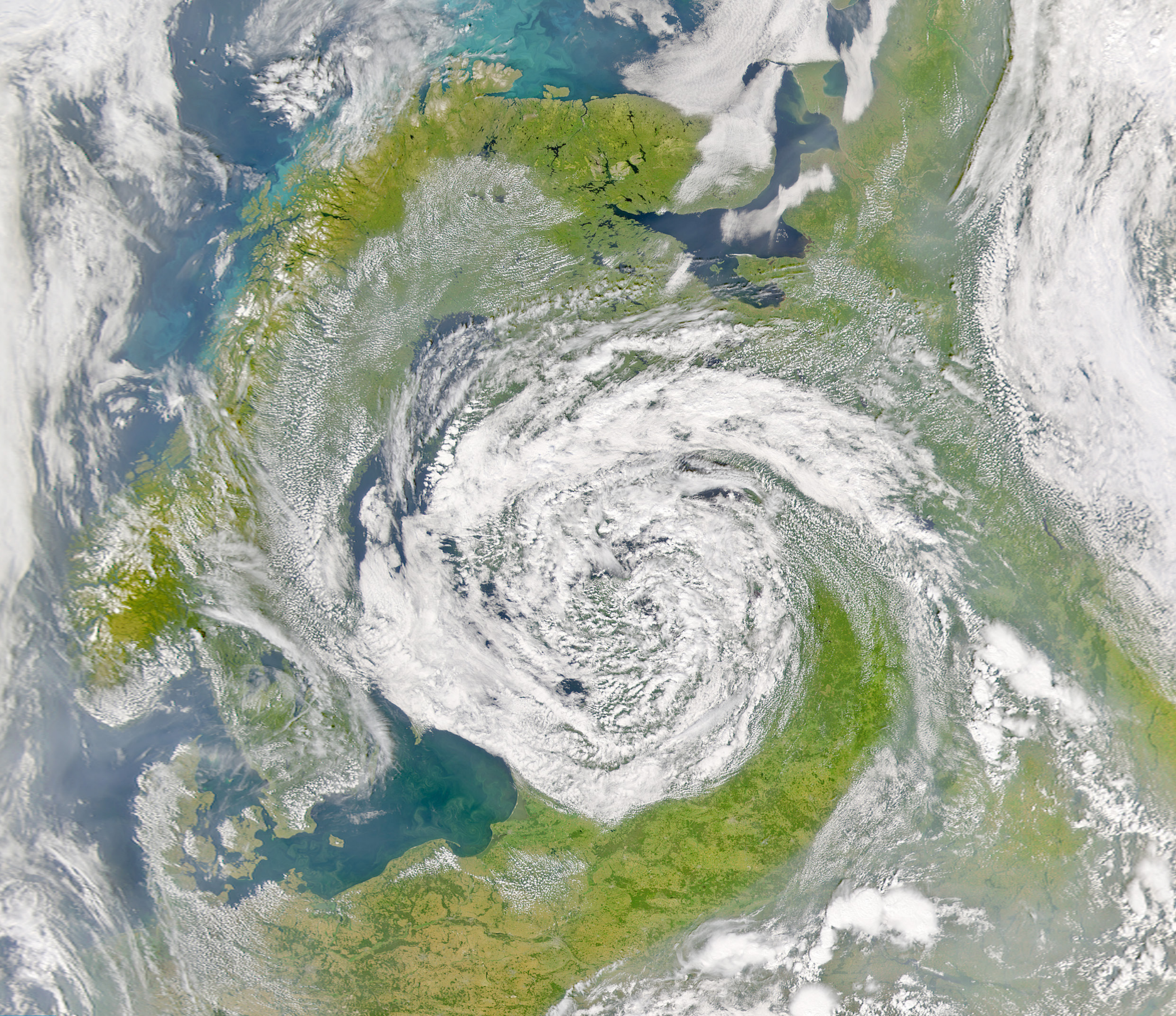

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Baltic Earth Workshop on

Natural hazards and extreme events in the Baltic Sea region

Finnish Meteorological Institute, Dynamicum
Helsinki, 30-31 January 2014

Programme, Abstracts, Participants

Baltic Earth
Earth System Science for the Baltic Sea Region

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Front page: A low-pressure system over the eastern Baltic Sea region, captured by the Sea-viewing Wide Field-of-View Sensor (SeaWiFS) on July 30, 2004. Image provided by the SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE.

Page 3: Copenhagen after the rain storm on 2 July 2011, Photo: Finn Majlergaard.

Page 4: Copenhagen after the rain storm on 15 August 2011, Photo: Martin Stendel.

Page 24: The Odra river on 22 July 1997 near Czelin, Poland (A. Kwapiszewski, from: Dubickiego A, Sloty H. and Zielinskiego J. (Eds.): Dorzecze Odry – Monografia Powodzi Lipiec 1997, Instytut Meteorlogii I Gospodarki Wodnej, Poland).

Baltic Earth Workshop on

Natural hazards and extreme events in the Baltic Sea region

Finnish Meteorological Institute, Dynamicum, Helsinki

30-31 January 2014

Co-Organized by

FINNISH METEOROLOGICAL INSTITUTE

UPPSALA UNIVERSITET

DMI

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Baltic Earth
Earth System Science for the Baltic Sea Region

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Anna Rutgersson, Uppsala University, Finland
Martin Stendel, Danish Meteorological Institute, Copenhagen, Denmark
Marcus Reckermann, Int. Baltic Earth Secretariat at Helmholtz-Zentrum Geesthacht, Germany

Introduction

Contemporary society is very sensitive to extreme geophysical events that have severe implications for human life, generate economic losses and influence ecosystems. Understanding the underlying causes of natural disasters (i.e. the nature of the extreme events and the links to ecosystem and society) increases the ability to predict the occurrence and severity and may save human lives as well as mitigate economic losses. Many natural hazards have hydro-meteorological origin (storms, waves, flooding, droughts) and can potentially be better understood. Natural hazards are often caused by several factors (storm surge in combination with precipitation and river runoff might cause extreme flooding). Closely linked to natural hazards are extreme events, for which presently the prediction capabilities are very limited. This is generally well recognized regarding infrastructure such as dam safety and urban flooding risks, but the range of ecosystem services at risk is more poorly defined, from vital societal functions such as drinking water supply to biodiversity.

Recent changes in climate factors for the Baltic Sea region are generally well described. The uncertainty is larger when analyzing changes in extreme conditions, as they are few. The shortage of data reduces the statistical significance in the analysis (see also the next “Assessment of climate change for the Baltic Sea basin”, BACC II). There are indications that the storm tracks in the northern hemisphere have shifted slightly northward during the last century as a consequence of global warming. In addition, there are indications of additional circulation changes in the northern hemisphere due to the significant reduction of Arctic ice cover (BACC II). This can potentially alter wind and precipitation patterns (the origin of many natural hazards). These relations are, however, not clearly understood and described and there is a need to further investigate this with a Baltic Sea perspective. The adaptation capability of many terrestrial ecosystems, marine species and society in general depends very much on the changes in the extreme events.

Suggested key research areas for the Baltic Sea region with an Earth system perspective are:

- Understanding changes in atmospheric circulation in the northern hemisphere (due to higher global mean temperatures and reduced sea ice in the Arctic Ocean) and the impact of circulation changes on climate extremes in the Baltic Sea region in the future.
- Response and contribution of marine processes to changes in extreme and climate variability (water level, waves, ice conditions, sea surface temperature).
- Monthly to seasonal prediction systems and probabilistic estimates of the extreme events.
- How has the achievement of environmental goals influenced changes in extreme conditions (droughts, floods and heat waves)?
- How vulnerable is drinking water security to hydro-meteorological extremes?

- What is the response of marine ecosystems to extreme events (coastal processes) using integrated studies (what drives what, when and how)?
- How will the carbon cycle of the Baltic Sea region respond to changes in extreme conditions (the amount, timing and quality of carbon delivered to the Baltic Sea, and the subsequent fate of that carbon)?

The Workshop

To initiate the work focusing on extreme events in the Baltic Sea region, we are organizing this Workshop in Helsinki, 30 - 31 January 2014. The aim of the Baltic Earth Workshop is to review our understanding of extreme events in past, present and future and to direct research needs.

Workshop goals are

- to establish linkages between groups focusing on observations, statistical analysis and predictions,
- to identify gaps in knowledge and weaknesses in our ability to observe, understand and statistically calculate extreme events, and
- to review modelling capabilities to estimate the occurrence of extreme events.

Projected outcomes are

- a review of the current state-of-the-art research, gaps and advances in observations, analysis, modeling and prediction (focusing on the scientific understanding),
- action items with identified partners on how to coordinate overlapping interests, close gaps in knowledge, and enhance networking between groups, and
- plans for further research in Baltic Earth.

The first day of the workshop (Thursday 30 January) is dedicated to oral and poster presentations, to present an overview over the current knowledge and research results.

The second day of the workshop (Friday 31 January) is dedicated to open discussions and group work. It is intended to form outbreak groups to discuss specific topics. Each group will summarize the main points raised during the topical discussions.

In the end we inted to form and foster a Baltic Earth community of scientists, networking in the field of natural hazards and extreme events in the Baltic Sea region.

The Organizers

FINNISH METEOROLOGICAL INSTITUTE

Baltic Earth

Baltic Earth Workshop on

Natural hazards and extreme events in the Baltic Sea region

Finnish Meteorological Institute, Dynamicum, Helsinki

30-31 January 2014

Programme

Day 1: Thursday 30 January 2014

09:00 **Welcome by the Host of the Workshop**
Jari Haapala, Finnish Meteorological Institute (FMI), Finland
Yrjö Viisanen, Research Director, FMI

09:15 **Introduction to Baltic Earth and the Workshop**
Anna Rutgersson, Uppsala University, Sweden

09:30 **Extremes in a changing climate change**
Jouni Räisänen

10:00 **Changes in extreme climates of the greater Baltic Sea region since 1851: Observations versus simulations**
Deliang Chen, Tinghai Ou and Alexander Walther

10:20 **From short range forecasts to climate change projections of extreme events in the Baltic Sea region**
Martin Stendel

10:40 **Do we need a coupled modelling system when modelling extreme events?**
Anna Rutgersson and Lichuan Wu

11:00 Coffee Break

11:30 **Extreme sea levels on the Finnish coast**
Kimmo Kahma

12:00 **Changes in severe storm and high sea-level events on the Estonian coast**
Jaak Jaagus

12:20 **Storm surge climate in the western Baltic Sea 1948-2012**
Hendrik Weidemann and Ralf Weisse, Helmholtz-Zentrum Geesthacht, Germany

12:40 **Storm surges in the easternmost Gulf of Finland during operation of the Flood Protection Barrier of St. Petersburg**
Vladimir Ryabchenko, P.Andreev, A.Averkiev, A.Dvornikov, K.Klevanny and V.Tsepelev

13:00 Lunch Break

14:00 **Does Arctic sea ice decline increase the occurrence of extreme weather conditions in mid-latitudes?**
Timo Vihma

14:30 **Shift of extreme spring streamflow on rivers in Belarus part of the Baltic Sea basin**
Irina Partasenok and Ryhor Chekan

14:50 **Probabilistic seamless extreme rainfall forecasting system for lead times 1-120 hours**
Jarmo Koistinen, Harri Hohti, Janne Kauhanen, Juha Kilpinen, Pertti Nurmi, Pekka Rossi, Miikka Jokelainen, Mari Heinonen, Tommi Fred and Dmitri Moisseev

15:10 **Hybrid Approach for the Assessment of Changes of Extreme Waves at the German Baltic Sea Coast on the Basis of Regional Climate Model Data**
Norman Dreier, C. Schlamkow, P. Fröhle and D.Salecker

15:30 **Thunderstorm climatology of Northern Europe in 2002-2013 based on the NORDLIS lightning location system**
Antti Mäkelä, Sven-Erik Enno and Jussi Haapalainen

15:50 Coffee Break

16:20 Day 2 Preview and Group Allocation

16:40 Poster Session Self Presentations (2 min, 2 slides each)

17:20 Poster Session including light Dinner (ca. 19:00)

20:00 End of Day 1

Day 2: Friday 31 January 2014

09:00 Introduction to Group Work

09:20 Group Work with individual Coffee Break

11:30 Group reports (10 +5 min each)

12:30 Final Discussion and Lookout

13:00 End of Workshop

Oral presentations

(in sequence of presentation)

Oral 01

Extremes in a changing climate change

Jouni Räisänen
Department of Physics, University of Helsinki, Finland

In a changing climate, various types of climatic extremes also change. Some generic issues related to this include the following:

1. One should not mix the changes in the magnitude (e.g., the 99th percentile of temperature at some location) and frequency of extremes (e.g. the frequency of cases in which the old 99th percentile is exceeded in a new climate). Often, seemingly small changes in the magnitude are associated with surprisingly large changes in the frequency.
2. While "extremes are more sensitive to changes in variability than the mean", a large change in mean climate is more important than a small change in variability. This situation is frequently encountered (e.g.) in model simulations of summertime temperature extremes.
3. For the same change in mean climate, the change in the frequency of extremes depends inversely on the magnitude of present-day variability. Thus, for example, a warming climate is expected to bring a larger relative increase in the frequency of very warm months than very warm individual days.
4. Attempts to predict extremes in future climate are fraught with several difficulties. Not only is the ability of models to capture the relevant physics a larger question mark for extremes than the mean climate, but the sampling noise also increases towards the tails of the distribution. Finally, biases in simulated present-day climate imply a need to combine the model simulations with information on the observed distribution when estimating the distribution of climate variables in the future. This post-processing can be done in several ways, and it also represents a significant source of uncertainty in projections of extremes.

Oral 02

Changes in extreme climates of the greater Baltic Sea region since 1851: Observations versus simulations

Deliang Chen[1]*, Tinghai Ou*[1,2] *and Alexander Walther*[1]
[1]*Regional Climate Group, Department of Earth Sciences, University of Gothenburg, Sweden*
[2]*Faculty of Earth Systems and Environmental Sciences, Chonnam National University, Korea*

This study focuses on past changes in long term extreme climates over the greater Baltic Sea region. Over the past decade, several European projects dealt with changes in extreme climatic conditions in Europe. One of these projects is EMULATE (European and North Atlantic daily to MULtidecadal climATE variability) that did a systematic mapping of the observed trends of 64 temperature and precipitation indices (most of them are indicators of extreme climates), based on daily instrumental records from European stations started before 1900. We use this knowledge as a starting point to look at the changes in the study region using gridded (0.5x0.5 degree latitude x longitude) daily temperature and precipitation observations during 1951-2005 (E-Obs V9.0), in comparison with the global climate model simulations (CMIP5, used by the IPCC AR5) during the same period. The aims of the study are 1) to present an overview of long term (150 and 100 years) trends of extreme climates of the study region revealed by the EMULATE indices, 2) to examine regional patterns of temporal changes of a few selected indices in the gridded observations and the global model simulations for the study region over the last decades.

Oral 03

From short range forecasts to climate change projections of extreme events in the Baltic Sea region

Martin Stendel, Danish Meteorological Institute, Copenhagen, Denmark

Natural hazards and extreme events, although rare, are a focus research area in Denmark and as such of relevance for the Baltic Sea region. An overview will be given discussing recent research at DMI on such events on diverse time scales, from very short range weather forecasting to climate change considerations relevant on time scale of decades. The presentation will cover incidents like the extreme precipitation event that flooded Copenhagen in July 2011, with a discussion of possibilities to improve very short range forecasts (“nowcasting”), the highly unusual flooding event in Roskilde Fjord following the storm “Bodil” in December 2013, as well as changes in extreme precipitation statistics over Denmark in the RCP 4.5 and 8.5 scenarios and recent research on possible connections between sea ice decline in the Barents and Kara Seas and cold winter spells in the Baltic Sea region.

Oral 04

Do we need a coupled modelling system when modelling extreme events?

Anna Rutgersson[1], Lichuan Wu[1], Markus Meier[2] and Christian Dietrich[2]
[1]Department of Earth Sciences, Uppsala University, Sweden
[2]Swedish Meteorological and Hydrological Institute, Norrköping, Sweden

In the extratropical regions most extreme hydrometeorological events are related to extreme extratropical cyclones. They are accompanied by strong winds, large amount of precipitation and often storm surges. Numerical models are useful tools for predicting storms but also for analysing forcing and frequency of cyclonic events. In numerical models, the development of severe storm systems is very sensitive to surface forcing.

A three-component 3D modelling system (atmosphere-waves-ocean) is developed covering the North Sea and the Baltic Sea. The model components are the regional atmosphere climate model RCA, the ocean model NEMO and the wave model WAM. The model components are coupled using the coupler OASIS with a two-way coupling mode. The purpose of the study is to analyse the importance of introducing improved description of surface waves and sea surface temperature on the strength and development of extreme extratropical cyclones. Storms having caused great damage during the last few years are investigated. Minimum pressure and maximum wind speed is increased when introducing surface waves, while the track is less influenced. Methodology of coupling is also of importance.

Oral 05

Extreme sea levels on the Finnish coast

Kimmi Kahma
Finnish Meteorological Institute, Helsinki, Finland

The Baltic Sea is a semi-enclosed basin where sea level variance is dominated by changes in the water balance, predominantly long term ones, whereas the short term variations are mainly controlled by the dynamics inside the basin. The global sea level rise as well as the postglacial land uplift are important on a time scale of centuries, while tides and long term changes in salinity and temperature play a small but not insignificant role.
Modern infrastructure, nuclear power plants in particular, have increased the need for reliable estimates and forecasts of extreme sea levels. At the same time, estimating and modelling the extremes of the sea level in the Baltic Sea has turned out to be a much more complicated problem than was assumed 50 years ago. Both the water balance and the short term variability have undergone changes that were unknown in the past, and meteo-tsunamies, which were nearly dormant for decades, have again appeared.
Here new modelling tools for tackling these problems will be presented.

Oral 06

Changes in severe storm and high sea-level events on the Estonian coast

Jaak Jaagus
Department of Geography, University of Tartu, Estonia

Variations and trends in storminess (number of storm days), and mean and maximum sea levels are analysed along the Estonian coast during the last century. Catalogues of windstorms were created for two stations located on the westernmost coast of Saaremaa Island. An increase in storminess was detected at the both stations, although inhomogeneities in the wind data make the trend estimates less reliable. Data of sea-level measurements were obtained from nine tide gauge stations from different coastal regions of Estonia. Mean sea level trends depend on the post-glacial isostatic land uplift, which is different at different parts of Estonia. Eliminating the influence of the uplift, the estimated sea level rise was 2.2–3.2 mm/yr during 1950–2011, which was higher than the global mean (1.7 mm/yr). The majority of increases in storminess and sea level have been observed during the cold half-year (November – March). An increase in annual maximum sea level has been much higher than in mean values, which indicates a strong increase in the flooding risk. Variables describing the intensity of zonal circulation (westerlies) are highly correlated with storminess and sea level on the Estonian coast during 1950–2011.

Oral 07

Storm surge climate in the western Baltic Sea 1948-2012

Hendrik Weidemann and Ralf Weisse
Helmholtz-Zentrum Geesthacht, Germany

Storm surge activity in the Baltic Sea is usually analyzed from tide-gauge data covering more or less extended periods. More comprehensive spatial or systematic analyses are mostly lacking. We use a high-resolution numerical tide-surge model driven by high-resolution reanalyzed atmospheric fields to reconstruct Baltic Sea sea levels from 1948 to 2012 on an hourly basis. We show that the model reasonably reproduces observed water levels and provide a systematic analysis of the storm surge climate during the past 65 years in the western Baltic Sea. We found that storm surge climate showed pronounced inter-annual and decadal fluctuations but could not detect substantial long-term trends over the period considered. Prefilling and seiches contributed substantially to some of the observed peak water levels in the past. For the German coast, we demonstrate that storm surges with and without contributions from prefilling occurred at about equal shares. When prefilling was present, lower wind speeds were generally needed to sustain comparable peak water levels. Seiches also contributed to some of the observed surges usually with a preferred phase shift. In about one third of the cases contributions from seiches at peak water level were found to be larger than about 10 cm.

Oral 08

Storm surges in the easternmost Gulf of Finland during operation of the Flood Protection Barrier of St. Petersburg

V.Ryabchenko[1], P. Andreev[2], A. Averkiev[3], A.Dvornikov[1], K. Klevanny[4] and V. Tsepelev[2]
[1]St.Petersburg Branch, P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences
[2]North West Administration on Hydrometeorology and Environmental Monitoring, St. Petersburg
[3]Russian State Hydrometeorological University, St.Petersburg
[4]Ltd"CARDINAL Soft", St.Petersburg

We present the results of calculations of storm surges in the easternmost Gulf of Finland allowing for the operation of the Flood Protection Barrier (FPB) of St. Petersburg. Storm surges were investigated using two model systems: CARDINAL and NEVAM.
According to runs with CARDINAL, in the case of passage of extreme cyclones over the Baltic Sea, the level rise in the Gulf of Finland west of the FPB at the closed FBP gates does not exceed 20-30cm. In Neva Bay in this case there is an accumulation of water by Neva runoff and a significant slope level can be created. The level rise in the delta of Neva can reach 1.5m and be dangerous.
The NEVAM was used for simulation of storm surges in November-December 2011, when closing of gates of the FBP was performed. Comparison of calculation results with water level measurements at stations «Kronstadt» and «Mining Institute» and the current velocity measurements at the bottom station near the lighthause «Tolbukhin» showed that the model adequately works in extreme conditions.

Oral 09

Does Arctic sea ice decline increase the occurrence of extreme weather conditions in mid-latitudes?

Timo Vihma
Finnish Meteorological Institute, Helsinki, Finland

The areal extent, concentration and thickness of sea ice in the Arctic have strongly decreased during the recent decades, but cold, snow-rich winters have been common over mid-latitude land areas since 2005. A review on the knowledge of the effects of sea ice decline on weather and climate is presented. Several studies based on observations, atmospheric reanalyses, and model experiments suggest that the sea ice decline, together with increased snow cover in Eurasia, favours circulation patterns resembling the negative phase of the North Atlantic Oscillation and Arctic Oscillation. The suggested large-scale pressure patterns include a high over Eurasia, which favours cold winters in Europe and northeastern Eurasia. Mid-latitude winter weather is, however, affected by several other factors, which generate a large inter-annual variability and often mask the effects of sea ice decline. In addition, the small sample of years with a large sea ice loss makes it difficult to distinguish the effects directly attributable to sea ice conditions. Several studies suggest that, with advancing global warming, cold winters in mid-latitude continents will no longer be common during the second half of the 21st century. Recent studies have also suggested causal links between the sea ice decline and mid-latitude summer precipitation.

Oral 10

Shift of extreme spring streamflow on rivers in the Belarus part of the Baltic Sea basin

Irina. S. Partasenok, Svetlana V. Povazhnaya and Grigoriy S. Chekan
Division of Hydrology, Republic Hydrometeorological Centre, Minsk, Belarus

The intra-annual distribution of precipitation is the most variable component of the water resources of Belarus. This distribution is controlled by extratropical cyclones from the Atlantic Ocean and Mediterranean that bring most of precipitation to the nation. That's why the aim of our study was to quantify major characteristics of these cyclones and to estimate effects of their passing through the Belorussian territory on regional water budget including floods and low water conditions.
We documented the long-term fluctuations of streamflow and occurrence of extreme phenomena on the rivers of Belarus during the post-World War II period. It was established that annual water resources of the nation vary from year to year without systematic tendencies. At the same time, analysis of intra-annual distribution of streamflow reveals significant changes since the 1970s: increase of winter and decrease of spring runoff. As a result, the frequency of extreme spring floods has decreased. These changes in water regime are associated with climatic anomalies caused by large-scale alterations in atmospheric circulation, specifically in trajectories of cyclones. As a manifestation of these circulation changes, we observe increase of the surface air temperatures, more frequent cold season thaws, redistribution of seasonal precipitation totals, and decrease of the fraction of frozen precipitation in the shoulder seasons.

Oral 11

A probabilistic seamless extreme rainfall forecasting system for lead times of 1-120 hours

Jarmo Koistinen[1], Harri Hohti[1], Janne Kauhanen[1], Juha Kilpinen[1], Pertti Nurmi[1], Pekka Rossi[1], Miikka Jokelainen[2], Mari Heinonen[2], Tommi Fred[2] and Dmitri Moisseev[3]
[1]Finnish Meteorological Institute, Helsinki, Finland
[2]Helsinki Regions Environmental Services Authority HSY, Helsinki, Finland
[3]University of Helsinki, Department of Physics, Helsinki, Finland

A real time 24/7 automatic alert system is in operational use at the Finnish Meteorological Institute (FMI). It consists of 51 ensemble forecasts of the exceedance probabilities of four rainfall accumulation categories (weak, moderate, heavy, very heavy) in the continuous lead time range of 1 hour to 5 days. Nowcasting up to six hours applies ensemble nowcasts of weather radar measurements. The extrapolation technique applies atmospheric motion vectors (AMV) originally developed for satellite data. Exceedance probabilities of rainfall accumulations are computed for the future 1 h and 3 h periods and they are updated every 15 minutes. For longer forecasts exceedance probabilities are calculated for future 3 and 12 h periods. From approximately 1 hour to 2 days Poor man's Ensemble Prediction System (PEPS) is used applying the high resolution short range Numerical Weather Prediction models HIRLAM and AROME. The longest forecasts apply EPS data from the European Centre for Medium Range Weather Forecasts (ECMWF). The seamless blending of the ensemble sets from the 3 various forecast sources is performed applying gridded mixing of accumulations with equal exceedance probabilities. An application is presented in which the rainfall accumulation scenarios are coupled with the optimization of the performance of the greater Helsinki wastewater treatment plant. Extension of the system to European coverage has been studied in two EU projects.

Oral 12

Hybrid approach for the assessment of changes of extreme waves at the German Baltic Sea coast on the basis of Regional Climate Model data

N. Dreier[1], P. Fröhle[1], D. Salecker[1], and C. Schlamkow[2],
[1]Hamburg University of Technology, Germany
[2]University of Rostock, Germany

One of the most important effects of climate change on the near-shore hydrodynamics are changes of the local sea state caused by changes of the local wind field over the sea. Possible changes of extreme wave events can reduce the effectiveness and safety of coastal and flood protection structures under storm conditions, hence have to be taken into account for the development of future adaptation measures of the constructions.
A combined statistical-numerical approach is used for the calculation of transient time series of significant wave heights for the time period 1960-2100 on the basis of wind conditions from runs of the regional climate model Cosmo-CLM. The time series are calculated for two realisations each of the SRES-emission scenarios A1B and B1. Finally the log-normal extreme value distribution is used to calculate extreme wave events with a return period of 200 years from time periods of 40 years.
The future changes of the extreme wave heights are different along the German Baltic Sea coast and are depending on the SRES-emission scenario and the projection period. Increases and decreases of the extreme wave heights are within a range from +14% down to -14% and no robust trend is found for the changes.

Oral 13

Thunderstorm climatology of Northern Europe in 2002-2013 based on the NORDLIS lightning location system

Antti Mäkelä[1], Sven-Erik Enno[2] and Jussi Haapalainen[1]
[1]Finnish Meteorological Institute, Finland
[2]University of Tartu, Estonia

A 12-year statistics (2002-2013) of the Nordic Lightning Information System (NORDLIS) are presented. NORDLIS is a joined lightning location network between Norway, Sweden, Finland, and Estonia, comprising in 2013 of 34 lightning location sensors. We show the regional and temporal distribution of lightning in Northern Europe during the study period. Our results indicate that the average annual ground flash density values are greatest in Southern Sweden, Baltic countries and Western Finland. The average number of thunderstorm days is largest in the Baltic countries and Southwestern Sweden. The largest observed daily number of ground flashes is 51,500, and the largest daily ground flash density is about 5 CG km^{-2}; this has occurred in southern Sweden in July 2003. The average daily number of ground flashes peaks in mid-July – early-August. Cold season (October – April) thunderstorms occur frequently over the North Sea west of Norway and in the west coast of Denmark. Our results also show that an intense thunderstorm may occur practically anywhere in Northern Europe except for certain maritime and mountain areas.

Poster presentations

(alphabetically, as presented)

Poster 01

Changes in Baltic Sea Surface Temperature extremes

Byoung Woong An and Jari Haapala
Finnish Meteorological Institute, Helsinki, Finland

The probability of extreme sea surface temperatures (SST) occurring in the future seems apparent in the Baltic Sea, therefore its prediction and inferences are essential. This study analyses changes of the SST in the Baltic Sea and calculates return periods using extreme value distributions. To illustrate the application of the extreme value theory, annual SST maxima and minima from the Baltic Sea regional climate model (Hordoir et al, 2013) were analysed. The changes were estimated from the control simulation of the 20th century (1971-2000) and were assessed for the projected periods 2011-2040, 2041-2070, and 2071-2099, forced by the IPCC SRES A2 emission scenario. Under that scenario, results indicate that the warm extremes (e.g. 10- and 30-year return values) will occur more frequently than those for the current condition, and there seems to be a gradual increase of warm extremes from the southern to the northern Baltic Sea, while cold extremes will almost disappear in the future.

Poster 02

Variability of western and south-western wind extremes over the Baltic Sea

Svenja Bierstedt, Eduardo Zorita and Birgit Hünicke
Helmholtz Zentrum Geesthacht, Germany

We analyze changes of wind extremes from west (W) and south-west (SW) in the Baltic Sea region during winter (DJF) based on regional reanalysis data (coastdat) over the period from 1948 to 2012. Extreme winds occur mostly and are strongest in the winter season. Although on average all wind directions are quite frequent over the Baltic Sea, extremes are very focused on W and SW directions. Trends in the frequencies of extremes from SW can be detected, namely an increasing trend from 1970 to 1990 and a decreasing trend since then. A correlation between the sum of W (SW) frequencies and corresponding intensities shows a significant value of 0.54 (0.25). For the other directions there is no such high correlation (<0.08). A similar correlation as it was described for wind directions is also visible in a similar but weaker trend for SW wind intensity. This means years with more (less) W/SW winds show higher (lower) wind velocities. After identifying eight circulation types, type 4 (type 2) can be related to W (SW) winds and it shows a similar temporal evolution as W (SW) wind frequencies. Type 4 is dominated by low pressure located east of Sweden and for type 2 it lies west of Norway.

Poster 04

Dangerous high water levels on the Zapadnaya Dvina River, Republic of Belarus

Chekan R. and Kvach A.
Republic Hydrometeorological Center, Minsk, Belarus

The most dangerous hydrological events for Belarus are the very high water levels on the rivers when water reaches across the river banks covering surrounding land areas (flood plain). The causes of these high water levels can be snow melt floods, perennial rains, and winter freshets. In this work we assess dangerous high levels on the example of the Zapadnaya Dvina River (Daugava) within the territory of Belarus.
The Zapadnaya Dvina River (Daugava) flows across the territory of Russia, Belarus and Latvia. Length of the River is 1020 km and its catchment area is 87.9 thousand km^2 (within Belarus 328 km and 33.1 thousand km^2, respectively).
First observations of water level on the Zapadnaya Dvina River were conducted in 1876 at Vitebsk and in 1878 at Suraz and Ullah. At present, 14 hydrological posts, 9 meteorological stations work in the River basin.
The extent of flood damage depends on many reasons. They include heights and durations of dangerous water levels, the areas of flooding, season of flooding time (spring, summer, or winter), and timely taken preventive measures.
Catastrophic flood on the Zapadnaya Dvina River during the period of instrumental observations was in 1931. Outstanding floods were documented in 1878, 1929, 1941, 1951, and 1956, and big floods were documented in 1958, 1962, 1994, 2004, and 2010.

Poster 05

Effects of air temperature and precipitation on the maximum level ice thickness in the Baltic Sea

Bin Cheng, Timo Vihma and Lixin Wei
Finnish Meteorological Institute, Helsinki, Finland

The sea ice is seasonally covered in the Baltic Sea. The ice season lasts from 4 months in the south to up to 7 months in the far north. The thermodynamic growth of sea ice in the Baltic Sea depends on the heat exchange at the ice-water interface, the radiative and turbulent heat fluxes at the ice/snow surface, as well as on precipitation. Applying a thermodynamic snow/ice model, we address the roles of air temperature and precipitation on the annual maximum level ice thickness in the Baltic Sea. The portion of sea ice growth results from severe cold outbreak and heavy snowfall are investigated. The results demonstrate that the relative importance of these forcing factors changes during the ice growth season. In early winter, the air temperature has a dominating role, and cold periods allow a fast ice growth. In late winter, however, the amount of snow fall becomes essential; if the snow pack on sea ice becomes thick, long periods of cold weather do not cause much more ice growth from ice bottom, but snow-ice or superimposed ice may still grow from snow-ice interface upward.

Poster 06

Evaluation of extreme water levels and their return periods near Tallinn using the ensemble approach

Maris Eelsalu, Priidik Lagemaa, Katri Pindsoo, Tarmo Soomere
Institute of Cybernetics at Tallinn University of Technology and Marine Systems Institute at Tallinn University of Technology, Estonia

A common problem in estimates of extreme water levels and their return periods is the large variation of the results depending on the particular method in use and set of underlying data. As long-term water level time series are rare and the properties of strong storms and associated surges may be changing, the solution is often sought using a combination of relatively short-term sets of recorded water level, numerical modelling and various statistical distributions of extreme values. We make an attempt to create an ensemble for such estimates and to evaluate the spreading of the results for a nearshore area representative for Tallinn Bay using several different methods for the assessment of extreme values. These methods are applied to (i) long-term measured local water level within different time intervals, (ii) a synthetic data set generated by merging measured water levels with a hindcast using the HIROMB model and (iii) water level time series calculated using the Rossby Centre Ocean Model (Swedish Hydrological and Meteorological Institute) for 1961–2005.

Poster 07

Precipitation accumulation analysis – Assimilation of radar-gauge measurements and validation of different methods

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Detailed estimates of accumulated precipitation is crucial in extreme precipitation events, unfortunately, these are the situations when meteorological information is most deficient. Typically, intensive convective storms are limited both in space and time, features that makes it difficult to estimate the precipitation accumulation. Weather radar suffer of attenuation in heavy rain situations and surface stations are usually too sparse. Assimilation methods, where radar and gauge observations are combined, are therefore not always able to resolve the precipitation accumulation properly in those precipitation situations.
In this study we focus on two flooding events in Finland; Karjaa, 26 July 2013 and Helsinki, 22 August 2011. Radar algorithms have been developed to compensate for attenuation caused by intervening precipitation in C-band weather radars, new methods use parameters available in dual-polarization radar and improved results are shown in this presentation. FMI's assimilation of radar and gauges, within LAPS RandB-method (Gregow et. al. 2013), is sensitive to the amount of available gauge stations and the scale of the rain showers, i.e. whether the precipitation is detected by the gauges or not. A new development includes lightning observations to handle this problem; the preliminary results look promising and will be presented.

Poster 09

Climate tolerance - sensible way to define weather extremes

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Before we understand what is extreme in weather, we should understand where are the thresholds for a regular regime. It is possible to model the anomalies against the mean annual cycle with a IMA(0,0,1) model, that breaks into stationary white noise and non-stationary random walk terms. Actually for local temperature anomalies the variance of the white noise comes much larger than that for the random walk generator. It is sensible to fix the regular regime of weather by means of the standard deviation of the stationary white noise component. The extreme events could be looked not for seasons, but against the climate tolerance. Afterwards is simple to calculate examples on the basis of long time-series, for instance for Stockholm air temperature series in the period 1756-2011.

Poster 12

Severe water events in the Odra River mouth area in the light of recent sea level rise

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In the Odra River mouth area (the southern Baltic Sea) flooding threat is posed by storm surges as well as snow-melt and rainfall events. The case study revealed that a extreme high water occurred when a few surges, one by one, took place at the Pomeranian Bay coasts. Such cases resulted in a persisting many days' storm surge in the lower Odra channels and in the Szczecin Lagoon (e.g. winter 2007, autumn 2009). Such events were usually registered under the condition of the increased water volume in the Baltic Sea. Extreme values of water level were also observed when storm surges limited the outflow of the Odra River during snow-melt or rainfall events (e.g. springs 2002, 2010). The long-term sea level rise at the southern Pomeranian Bay coast, which is 0,17 cm per year averaged in the period of 1953-2012, may increase duration of storm surges as well as its maximum values. Water level rise in the Odra River mouth area may increase flooding threat for low-lying coastal areas around the Szczecin Lagoon and areas adjacent the lower Odra channels.

Poster 14

Frequency of hazardous hydrometeorological phenomena in Belarus

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9 to 30 hazardous hydrometeorological phenomena are registered annually in the Republic of Belarus. Mostly these hazardous phenomena have a local character. However, phenomena such as rain, strong wind, heavy rain, heavy snow, extreme fire danger, in some years cover a large part of the territory of Belarus. The total share of weather-dependent sectors in the Republic of Belarus is 41.5 % of GDP output. Preliminary estimates made by the World Bank showed that the economy of Belarus nowadays loses an average of about 93 million dollars (in 2005 prices) due to damage from adverse and severe weather events and conditions.
Approximately 80% of all hazards are related to the warm season (freezing squalls, heavy rains, hail), for which an active convective activity typical. This affects phenomena connected with wind, like strong winds, squalls, tornadoes, heavy rain, long rain, rain, hail.
Over the past 20 years the quantity of hot days with maximum air temperature ≥ 25 ºC has increased. Negative impacts of hazardous hydrometeorological phenomena on various sectors of the economy and social sphere of life of the population as a whole leads to significant economic and social losses and requires constant consideration of hydrometeorological information.

Poster 15

Trends in long-term components and rapid variations in the water level: A case study for Tallinn Bay

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We make an attempt to separate the slowly varying component of water level of the Baltic Sea and to estimate separately trends in annual and decadal extremes of the background water level and in short-time surges on the example of water level time series simulated using the RCO model for 1961–2005. The background water level is associated either with 8-day running mean of the water level time series or, alternatively, with the envelope of instantaneous water level minima. While the de-correlation time of the simulated time series is ca 14 days, the residual short-term variations have de-correlation time less than 1 day and a relatively low level of autocorrelation but contain almost all of the variations created by single storms. The annual maxima of both storm-driven variations and background water level exhibit a rapidly increasing trend. The similar maxima for the envelope of instantaneous water level minima contain almost no trend. This feature suggests that the increase in the water level extremes in the eastern Baltic Sea largely follows the increase in variations created by single storms.

Poster 16

Assessment of extreme surge hydrographs for the south-western Baltic Coast using univariate and bivariate statistical models

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When designing flood protection structures it is common practice to define storm surge water levels with certain return periods that the structure must withstand to ensure the protection of lives and property. In German Coastal Engineering practice, typical probabilities of occurrence are in the range between p=0.02 and p=0.002 (return periods of 50 to 500 years, respectively).
For certain protection structures, such as dunes, not only the maximum water level during a storm surge is crucial but also the duration of the high water event, as the erosion of the dune can continue as long as water reaches the dune.
Therefore storm surge hydrographs, being the progression of water levels over the time, are needed to design these protection structures or to assess their reliability. In order to create storm surge hydrographs of a certain probability of occurrence water level time series at several locations along the German Baltic Sea coast were investigated.
Annual peak water levels and maximum fullness of storm surges are statistically classified, using univariate as well as bivariate models. To generate random storm surge hydrographs with a given probability of occurrence, in a first step a function is derived that is able to simulate different water level progressions. By varying the functions shape parameters as well as the time of the peak water level an arbitrary number of storm surge hydrograph shapes can be gained. All these hydrograph shapes are scaled in height and duration using random pairs of water levels and fullness with a given probability. These storm surge hydrographs may be used as design values or to assess the reliability of the protection structure.
Poster 17

Modelling of extreme weather events in Latvia in 2012 using WRF

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Weather Research and Forecast (WRF) model is a numerical weather prediction model that is widely used both in operational weather forecasting and in numerous research applications. The goal of this study is to explore WRF capabilities in modeling of extreme weather events over the territory of Latvia. Two events in 2012 were selected for analysis. In July 7 two extremely hot days (maximal temperature > 30 C) were followed by intensive precipitation over the Western part of Latvia. In 26 October the first snowstorm of the winter left 3500 households without electricity.
For calculations a nested domain setup was chosen with an outer domain of spatial resolution 15 km and inner domain covering the territory of the Baltic States with 3 km spatial resolution. For initial and boundary conditions the ERA-Interim dataset from European Centre for Medium-Range Weather Forecasts (ECMWF) was used. Comparison with observational data from the Latvian Environment, Geology and Meteorology Centre was carried out.

Poster 18

Direct radiative effect of wildfire smoke on severe thunderstorm events in the Baltic Sea Region

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The impact of wildfire smoke on a derecho event through direct radiative effect in the Baltic Sea Region on August 8, 2010, is investigated utilising the Hirlam Aladin Research for Mesoscale Operational NWP in Europe (HARMONIE) model. HARMONIE is able to successfully resolve dynamics of the derecho and simulations considering smoke aerosol influence can be compared to simulation without aerosol. There were remarkable smoke aerosol concentrations (maximum total aerosol optical depth more than 4 at 550 nm) accompanying the derecho event originating from the summer 2010 wildfires from Russia.
Reduction in the shortwave radiation flux at the surface resulting from aerosol influence simulated by the HARMONIE model is up to 200 W/m^2 in the area with the highest aerosol concentrations causing near surface cooling of up to 3 ºC. Differences in the simulated storm dynamics appear quite small in spite of noticeable aerosol direct radiative effect.

Poster 20

How does the city influence precipitation extremes?

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The increasing interest in urban climatology reflects the growing concern about of quality of life in cities in the perspective of ongoing warming. The urban heat island is present in every city, but much less is known about the infuence of the city on humidity and precipitation. The city can enhance convergence and convection, by the increased roughness. The instability generated by UHI over the city and downstream can support development of convective clouds. There are indications that the intensity of precipitation can increase with the growth of the city.
To analyse the impact of cities on precipitation course and the intensity of extreme events, a set of 30 automatic measurement posts with rain gauges recording precipitation totals with a time step of 5 minutes were established, at 12 places air temperature and humidity are measured as well. They are located evenly within the city of Łódź (25) and in its rural surroundings (5).
Case studies with analysis of evolution of convection in different parts of the city during the advection of air masses from different directions with attention to the front passages is planned with detailed analysis of differences in rainfall intensities between urban and rural posts.

Baltic Earth Workshop on

Natural hazards and extreme events in the Baltic Sea region

Finnish Meteorological Institute, Dynamicum, Helsinki

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