ABSTRACTS of PRESENTATIONS

Pan-Eurasian Experiment (PEEX) from the System Understanding of the Arctic-boreal regions for scenarios and assessments of the Northern Pan-Eurasian environments

Hanna K. Lappalainen[1,2], T. Petäjä[1], T. Kurten[3], V.-M. Kerminen[1], Y. Viisanen[2], V. Kotlyakov[4], N. Kasimov[5], V. Bondur[6], G. Matvienko[7], A.Baklanov[8,11], HD. Guo[9] , M. Kulmala[1], S. Zilitinkevich[1,2,10]

[1] *Department of Physics, University of Helsinki, Finland*
[2] *Finnish Meteorological Institute, Helsinki, Finland*
[3] *Department of Chemistry, University of Helsinki, Finland*
[4] *The Institute of Geography RAS, Russia*
[5] *Moscow State University, Russia*
[6] *AEROCOSMOS, Russia*
[7] *Institute of Atmospheric Optics SB RAS, Russia*
[8] *World Meteorological Organization, Switzerland*
[9] *Institute of Remote Sensing and Digital Earth, CAS, China*
[10] *Department of Radiophysics, Nizhny Novgorod State University, Russia*
[11] *Danish Meteorological Institute, Copenhagen, Denmark (on leave)*

Contact e-mail: *hanna.k.lappalainen@helsinki.fi*

The Pan-Eurasian Experiment (PEEX) Program (https://www.atm.helsinki.fi/peex) is a new multidisciplinary, multiscale research – research infrastructure – education and policy making initiative. PEEX research agenda focused on understanding biosphere-ocean-cryosphere-climate-society interactions and feedbacks of the Arctic - boreal regions in the North Eurasia geographical domain (*Arneth et al., 2010; Carslaw et al. 2010; Kulmala et al. 2014*). In frame of the PEEX geographical domain China is seen as a crucial area both in source and impact point of view. The research agenda covers different spatial and temporal scales, and encompasses diverse geographical regions including both natural and urban environments. The four major large-scale systems studied by PEEX are the land, atmosphere and aquatic systems, and anthropogenic activities. Each of the main systems is addressing three key topics and related large-scale research questions. In addition to the four major systems, the PEEX research agenda addresses the feedbacks and interactions between the systems and the major biogeochemical cycles (water, carbon, nitrogen, phosphorus, sulfur) (*Lappalainen et al. 2014, 2015*).

The PEEX research results are used for producing different types of scenarios and assessments on the impacts of climate change and air quality changes on human population, society, energy resources and capital flows. PEEX will also provide information for mitigation and adaptation strategies for the changing Arctic environments and societies, and will also carry out risk analysis of both human activities and natural hazards (floods, forest fires, droughts, air pollution).

Arneth A. et al. (2010) Terrestrial biogeochemical feedbacks in the climate system. Nature Geosci., 3, 525–532.

Carslaw, K. S. et al.. (2010) A review of natural aerosol interactions and feedbacks within the Earth system. Atmos. Chem. Phys., 10, 1701–1737.

Kulmala et al. (2014) CO2-induced terrestrial feedback mechanism: From carbon sink to aerosol source and back.Boreal Env. Res., 19, suppl. B, 122–131.

Lappalainen et al. (2014): Pan-Eurasian Experiment (PEEX)- a research initiative meeting the grand challenges of the changing environment of the northern Pan-Eurasian arctic-boreal areas. J. Geography, Environment, Sustainability No 2(7) pp. 14-48.

Lappalainen H.K, Kulmala M. & Zilitinkevich S. (eds) (2015). Pan-Eurasian Experiment (PEEX) Science Plan. http://www.atm.helsinki.fi/peex/images/PEEX_SciencePlan_PROOFversion.pdf

WMO Global Atmosphere Watch (GAW) and World Weather Research Programme (WWRP) research for the Arctic

Alexander Baklanov [1]

[1] *World Meteorological Organization (WMO), Geneva, Switzerland*

Contact e-mail: *abaklanov@wmo.int*

The World Meteorological Organization (WMO) is the UN system's authoritative voice on the state and behavior of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources.

The Global Atmosphere Watch (GAW) programme of WMO (SSC chair G. Carmichael, AER chief O. Tarasova) is a partnership involving the Members of WMO, contributing networks and collaborating organizations and bodies which provides reliable scientific data and information on the chemical composition of the atmosphere, its natural and anthropogenic change, and helps to improve the understanding of interactions between the atmosphere, the oceans and the biosphere. GAW focal areas are aerosols, greenhouse gases, selected reactive gases, ozone, UV radiation and atmospheric deposition.

More than 100 countries have registered more than 800 stations with the GAW Station

Information System (GAWSIS). Various GAW expert groups and central facilities exist including:
- 7 Scientific Advisory Groups (SAGs) to organize and co-ordinate GAW activities by parameter, and the Expert Teams on World Data Centres (ET-WDC) and Near-Real-Time Chemical Data Transfer (ET-NRT CDT).
- 4 Quality Assurance/Science Activity Centres (QA/SACs) perform network-wide data quality and science-related functions.
- 35 Central Calibration Laboratories (CCLs) and World and Regional Calibration Centres (WCCs, RCCs) maintain calibration standards and provide instrument calibrations and training to the stations.
- 6 World Data Centres archive the observational data and metadata, which are integrated by GAWSIS.

The World Weather Research Programme (WWRP, SSC chair S. Jones, WWRD chief P. Ruti) advances society's resilience to high impact-weather through research focused on improving the accuracy, lead time and utilization of weather prediction. It engages with users and stakeholders to define research priorities and facilitate transition to applications. WWRP aims at Seamless Prediction of the Earth System from minutes to months using coupled systems – thus applying expertise in weather science to promote convergence between weather, climate and environmental communities.

The WWRP Polar Prediction Project (PPP, chair T. Jung) will promote cooperative international research in order to enable the development of improved weather and environmental prediction services for the Polar Regions on timescales from hours to seasonal. The PPP (http://polarprediction.net) is organizing the Year of Polar Prediction (YOPP), which will cover an extended period of coordinated intensive observational and modeling activities in order to improve polar prediction capabilities on a wide range of time scales in both Polar Regions.

The presentation includes suggestions for collaboration of the GAW and WWRP programmes with the CRAICC-PEEX initiatives and joint strategy for integrated environmental modelling relate to atmosphere – aquatic - anthropogenic activities (e.g. shipping) in the Arctic.

Satellite microwave observations and investigations of extreme events in the Arctic

Elizaveta Zabolotskikh [1], Vladimir Kudryavtsev [1], Pavel Golubkin [1], Olga Aniskina [1], Bertrand Chapron [1,2]

[1] Satellite Oceanography Laboratory, Russian State Hydrometeorological University (RSHU), St. Petersburg, Russia
[2] French Research Institute for Exploitation of the Sea, IREMER, Brest, France

Contact e-mail: *liza@rshu.ru*

Some recent results obtained at Satellite Oceanography Laboratory in the area of the Polar Lows (PLs) detection using satellite microwave data, and wind waves generation by PLs are summarized. Polar lows are short-living intense mesoscale atmospheric low pressure weather systems, developing poleward of the main baroclinic zone and associated with high surface wind speeds. Investigations of PLs are complicated by their small sizes and short life span. Satellite measurements are the only source of the data providing PLs observations on regular basis for practical and fundamental applications. A new approach for detection and tracking polar lows was developed based on the atmospheric columnar water vapor field analysis. These fields are retrieved from satellite passive microwave measurements. The vortex structures are detected in these fields, sea surface wind speeds are checked and polar lows are identified. Some results of modelling and forecast of PLs using regional WRF model with assimilation of atmospheric water vapor content retrieved from passive microwave data are also discussed. A simplified practical model for estimation of wind waves field generated by PLs is suggested. The model accounts for the effect of wind waves trapping by fast moving PLs. This effect results in unexpected and abnormal enhancement of wind waves that represent the danger for shipping.

Record low sea ice concentration in the central Arctic during the summer of 2010

Jinping Zhao [1]

[1] Ocean University of China

Contact e-mail: *jpzhao@ouc.edu.cn*

The Arctic sea ice extent has shown a declining trend over the past 30 years. Ice coverage reached historic minima in 2007 and again in 2012. This trend has recently been assessed to be unique over at least the last 1450 year period. In this talk, the

main key issues related to the sea ice retreat are addressed, including ice concentration, ice drifting patterns, melt ponds, heat absorption, etc.

The keynote of this talk is to introduce a special phenomenon. In the summer of 2010, a very low sea ice concentration appeared at high Arctic latitudes, even lower than that of surrounding pack ice at lower latitudes. This striking low ice concentration in the central Arctic named here as a record low ice concentration (RLIC) is unique in our analysis period of 2003-2011, and has not been previously reported in the literature. The RLIC was not the result of ice melt because sea ice was still quite thick based on in situ ice thickness measurement. Instead divergent ice drift appeared to be responsible for the RLIC. A high correlation between sea ice concentration and wind stress curl suggests that the sea ice drift during the summer of 2010 responded strongly to the regional wind forcing. The drift trajectories of ice buoys exhibited a transpolar drift in the Atlantic sector and an eastward drift in the Pacific sector, which appeared to benefit the RLIC in 2010. Under these conditions more solar energy can penetrate into the open water, increasing melt through increased heat flux to the ocean. We speculate that this divergence of sea ice could occur more often in the coming decades and that its impact on hemispheric SIC and associated climatic significance warrants further research.

Satellite monitoring of Arctic sea ice

Leif Toudal Pedersen [1]

[1] *Danish Meteorological Institute (DMI), Copenhagen, Denmark*

Contact e-mail: *ltp@dmi.dk*

Recent developments in operational and climate monitoring of Arctic sea ice will be presented. The European Copernicus Marine Environmental Monitoring System and the Sentinel series of satellites will provide a much more reliable source of data on short-term and long-term developments of Arctic sea ice. In addition a number of ESA/NASA/JAXA satellite missions today provide very useful data on sea ice extent, thickness, drift and snow cover. Results from JAXA, ESA, EUMETSAT and EU projects on sea ice monitoring will be presented.

Contribution of Arctic shipping to the atmospheric concentrations and deposition of pollutants in the Arctic

Jesper Heile Christensen, M. Winther, M. S. Plejdrup

Department of Environmental Science, Aarhus University, Frederiksborgvej 399, 4000 Roskilde, Denmark

Contact e-mail: *jc@envs.au.dk*

Emissions from ships inside Arctic are an important source of the Arctic pollution as e.g. SO2, NOx and Black Carbon (BC). This talk presents a detailed BC, NOx and SO2 emission inventory for ships in the Arctic for the year 2012 based on satellite AIS data, ship engine power functions and technology stratified emission factors. Emission projections are presented for the years 2020, 2030 and 2050 combined with emission from polar diversion routes as given by Corbett et al. (2010). Furthermore the Danish Eulerian Hemispheric Model (Christensen, 1997; Brandt et al., 2012), which is 3-d Chemical Transport Model covering the Northern hemisphere, was used to study the transport of BC, SO2 and O3 and estimate BC deposition results in order to examine the current and future contribution from Arctic ship traffic to atmospheric concentrations and deposition of pollutants in the Arctic.

Organizations shaping Arctic future: studying organizational decisions to produce applied prediction

Aleksei Shcherbinin[1,2], Sirkku Juhola[1], Risto Makkonen[2], Pauli Paasonen[2]

[1] *University of Helsinki, Department of Environmental Sciences, Finland*
[1] *University of Helsinki, Department of Physics, Atmospheric Division, Finland*

Contact e-mail: *aleksei.shcherbinin@helsinki.fi*

Predicting the future development paths in the context of climate change is a challenging and a crucial task. This is particularly so in the Arctic region, given its relative pristineness and high sensitivity to anthropogenic impacts. Rising temperatures and melting sea ice in the Arctic contribute to the likelihood of increased marine traffic, exploration and extraction of new sources

of hydrocarbons, minerals, fishing grounds, hydropower, and even use of fresh water for resource extraction. In light of these substantial changes and risks accompanying them, the topic of forecasting future anthropogenic activities in the region appears to be timely and even critical. However, future scenarios of socio-economic development are complex and highly uncertain exercises, especially when dealing with macro level drivers. Here, we present a more localized approach that can be used for identification of key anthropogenic activities in the Arctic region, and potentially for future marine navigation projections. Specifically, we propose to study major organizations already operating in the Arctic and forecast future changes based on their decisions and long-term development projects in the area of interest, further estimating relative environmental and socio-economic impacts of these projects. As an illustration of this approach we present a study focused on Gazprom long-term project of complex infrastructure and gas production development and transportation centres on the Yamal peninsula by the year 2030. In order to assess these developments, we gathered available information about this project; estimated emissions associated with gas production for the new infrastructure using GAINS model and simulated impacts of these emissions to the local climate using ECHAM platform.

The connection between Southern ocean winds, meridional overturning and Indo-Pacific compensation

Markus Jochum

University of Copenhagen, Denmark

Contact e-mail: ***mjochum@nbi.ku.dk***

The Several 500 year-long integrations of the Community Earth System Model are used to understand to what extent Southern Ocean (SO) winds control the strength of the Atlantic Meridional Overturning Circulation (AMOC). In contrast to previous studies we find no control whatsoever. The AMOC strength is the same in all simulations; SO winds, however, do control where North Atlantic Deep Water upwells: via the diabatic pathway in the Indo-Pacific basin for weak winds, and via the adiabatic pathway through the SO Ekman divergence for strong winds. Our analysis suggest that previous idealized studies have neglected the importance of the Indo-Pacific basin, thereby overemphasizing the importance of the adiabatic SO path for AMOC dynamics.

Ice service for ship traffic and oil exploration in ice covered areas

Nicolai Kliem

Ocean and Ice Operations, Danish Meteorological Institute, Copenhagen, Denmark

Contact e-mail: ***nk@dmi.dk***

The Greenland Ice Service at the Danish Meteorological Institute has produced information of the ice conditions around Greenland for more than 55 year. The main users are the ship traffic around Greenland which is crucial for the supply of cargo to the country. With the climate changes and in particular the reduced distribution and thickness of sea ice, there is an increased marine activity giving rise to an increased demand for ice information. Today the main products are ice charts for the waters around Greenland together with written messages for the fjord system of southern Greenland. While the offshore ice charts more or less look the same today as 50 years ago the monitoring techniques has developed from helicopter and aerial observations to entirely be based on satellites data. Inshore though, ice services are still depending on helicopter reconnaissance. With the increasing number of satellites with higher resolution and with the developments of high resolution sea ice models, the next "jump" in development of the ice service is to begin. The users ask for forecasts, more frequent updates, and higher resolutions. In my presentation I will provide a brief overview of the ice services today, and I will link the demands from the users to the necessary and planned developments.

How do we estimate the climate impact on the Arctic due to long range transported particles from shipping emissions?

Adam Kristensson

Department of Physics, Lund University, P. O. Box 118, SE-221 00, Lund, Sweden

Contact e-mail: ***adam.kristensson@nuclear.lu.se***

In order to estimate the climate impacts of aerosol particles in the Arctic it is necessary to model their size-resolved concentration in the Arctic domain together with their chemical properties. One way to do this is to use existing databases on ship emissions, and use it in a regional or global model to estimate the transformation, transport and distribution of aerosol particles in the Arctic. This large-scale model needs correct emission databases, detailed aerosol dynamics process modeling as support, and measurement data to validate the long range transport of aerosol particles. Fresh atmospheric particle ship emission databases can be built from existing coastal field campaigns outside the Arctic, near major ship lanes. Data to validate the dispersion model for long range transported aerosol particles can be collected from existing and future coastal sites measurements, which are some distance away from the shipping lanes. The transformation on different ageing time scales can be simulated in detail with an aerosol dynamics box model. We present how these measurements and how the box modeling can be performed to estimate the chemical composition and size distribution of particles in the Arctic, which steam from shipping emissions.

Earth System simulations of Arctic region in CRAICC

Risto Makkonen

Department of Physics, University of Helsinki, Finland

Contact e-mail: ***risto.makkonen@helsinki.fi***

The previous work in CRAICC has led to substantial developments of Earth System Models (ESM), e.g. the Norwegian Earth System Model (NorESM). As part of the final synthesis of CRAICC, global Earth System simulations are performed with a specific model version NorESM1-CRAICC. Several additional ESM modules have been implemented in the project, including interactive emission modules for biogenic volatile organic compounds and DMS, atmospheric aerosol nucleation and organic aerosol formation. The synthesis simulations focus both on anthropogenic forcing over the Arctic and potential high-latitude Earth System feedbacks. CRAICC will provide harmonized NorESM experiments to assess the relative roles of the specific feedbacks on climate, and reflect the climate effects to anthropogenic climate change. Although the climate feedbacks require global simulations, CRAICC will specifically focus the impacts and changes in the Arctic region.

Ocean and sea ice modelling for Arctic shipping

Mads H. Ribergaard, Till A.S. Rasmussen, Kristine S. Madsen

Danish Meteorological Institute, Research and Development Department, Denmark

Contact e-mail: ***mhri@dmi.dk***

As shipping and offshore activities increases in the Arctic region, the importance of forecasting ocean and sea ice parameters follows. DMI runs HYCOM coupled with CICE as an operational system covering the Arctic and North Atlantic, forced by the ECMWF atmospheric model. The resolution of the model system is around 10 km and it includes assimilation of sea ice concentration and ocean surface temperatures. This system runs twice a day and produces forecast for 6 days. In addition to the forecast, a 10 year hindcast (2004 – 2013) has been simulated. DMI is responsible for the operational oil spill modeling around Greenland. As a consequence of this an oil spill simulation system is ready in case of emergency. This talk will present the operational setup, validation results from the hindcast simulation and examples of the oil spill simulations.

Sea ice research supporting safe and efficient shipping in the Arctic

Jari Haapala

Marine Research Unit, Finnish Meteorological Institute, Helsinki, Finland

Contact e-mail: ***Jari.Haapala@fmi.fi***

Sea ice cover has always been an advantage or obstacle for a mankind. During the last decades, sea ice characteristics of the Arctic Ocean,

including thickness, extent, drift and composition, have changed considerably. The largest changes and inter-annual variability have been observed in the summer period. The changes have already reflected on widespread interest of utilization of huge natural resources, using Northern Sea Route for a shorter navigation route between Europe and Asia and tourism in the Arctic. In this talk, I will discuss about ongoing research activities in the FMI which supports safe and efficient shipping the Arctic. A particular focus will be on new methods to monitor sea ice conditions by coastal and satellite radars as well as modelling capabilities of high resolution short term forecasting.

Arctic shipping activities and possible consequences for the regional climate

Andreas Massling [1], Jesper Christensen[1], Merete Bilde[2], Marianne Glasius[2], Rossana Bossi[1], Jacob Klenø Nøjgaard [1], Henrik Skov [1], Lise Lotte Sørensen [3]

[1] *Department of Environmental Science, Aarhus University, Roskilde, Denmark*
[2] *Department of Chemistry, Aarhus University, Denmark*
[3] *Arctic Research Centre, Aarhus University, Denmark*

Contact e-mail: *anma@envs.au.dk*

Climate change is associated with anthropogenic emissions of long-lived greenhouse gases and short-lived climate forcers such as atmospheric particles. The particles can be transported via long-range transport from other parts of the world to the Arctic. Black carbon aerosol is known to have a significant impact on the surface albedo when deposited on snow- and ice-covered surfaces and sulfate aerosol is known to have high potential to contribute to the formation of clouds and fog and thus impact on climate. Arctic shipping is expected to become more intense because the waters have become increasingly ice-free during the summer months in the previous decades. The ships then may transit either the Northern Sea Route over the Russian Arctic from Europe or the Northwest Passage through the Canadian Arctic from the Atlantic and emit large amounts of particulate matter with significant impact on the regional climate in the Arctic.

The new Villum Research Station (VRS) at Station Nord (Northeast Greenland) was established in 2014 to monitor important climate parameters and give the possibility to detect future changes in atmospheric pollution caused the ship emissions. This presentation also gives an overview of facilities at the new station and corresponding on-going activities.

Enviro-HIRLAM black carbon modelling for Northern Europe and Arctic

Alexander Kurganskiy[1], R.B. Nuterman [1,4], A.G. Mahura [5], A.A. Baklanov [5,6], B.H. Sass [5], E. Kaas [1]

[1] *Niels Bohr Institute, University of Copenhagen (NBI, UC), Juliane Maries Vej 30, DK-2100, Copenhagen, Denmark.*
[2] *Russian State Hydrometeorological University, Russia.*
[3] *Institute of Northern Environmental Problems, Kola Science Center, Apatity, Murmansk reg., Russia*
[4] *Tomsk State University (TSU), Tomsk, Russia.*
[5] *Danish Meteorological Institute, Copenhagen, Denmark.*
[6] *World Meteorological Organization, Switzerland.*

Contact e-mail: *alexkurg@nbi.ku.dk*

A modeling of black carbon (BC) temporal and spatial evolution in the atmosphere has very high interest in recent years. BC is considered as the second main climate stressor next to CO2. Being a product of incomplete combustion of fossil fuels, biofuels and biomass, BC absorbs heat in the atmosphere that leads to atmospheric warming and positive climate forcing. Moreover, BC particles deposited on snow surface decrease surface albedo and consequently cause melting that is considered as important process for Northern Europe and Arctic from climate point of view. In this study, the Enviro-HIRLAM (Environment - High Resolution Limited Area Model) online-coupled meteorology-chemistry model was employed to simulate BC atmospheric transport, dispersion and deposition over the Northern Hemisphere with focus on Northern Europe and Arctic. In order to predict BC transport the following major BC emission datasets have been linked to the model: ECLIPSE – anthropogenic emissions, IS4FIRES and GFAS – wildfires emissions, AU_RCP and SILAM – ship emissions. Model runs have been performed for 29 July – 13 August, 2010 and 19 – 27 January, 2010 episodes, which were characterized by unfavorable weather conditions and high air pollution concentrations. The simulated BC concentrations as well as BC deposition fluxes have been analyzed and compared with ground based observation data.