Finding solutions to environmental challenges relevant to Arctic-boreal regions

Hanna K. Lappalainen, University of Helsinki, Finland
Tuukka Petäjä, University of Helsinki, Finland
Veli-Matti Kerminen, University of Helsinki, Finland
Timo Vihma, Finnish Meteorological Institute, Finland
Alexander Baklanov, World Meteorological Organization, Switzerland
Nikolay Kasimov, Moscow State University, Russia
Valery Bondur, AEROCOMOS, Moscow, Russia
Vladimir Melnikov, Tyumen State University, Russia
Sergej Zilitinkevich, Finnish Meteorological Institute, Finland
Markku Kulmala, Department of Physics, University of Helsinki, Finland

Abstract (300 word limit)

Statement of the Problem: We need to perform a holistic research approach and establish coordinated comprehensive measurements in order to solve still open scientific questions that are specifically important for the Arctic-boreal region in the coming years. In particular the open science questions in the context of global climate change and its consequences to nature and to the Northern societies are related to net effects of various feedback mechanisms connecting the biosphere, atmosphere and human activities. Such feedbacks stem from higher temperature and increased concentration of greenhouse gases (GHG) in the future that lead to further permafrost thawing, land cover changes, increased dissolved organic carbon content in freshwaters, acidification of the Arctic Ocean, increased photosynthetic activity, elevated GHG uptake by terrestrial ecosystems and increased Biogenic Volatile Organic Compound (BVOC) emissions leading to aerosol and cloud formation affecting the radiation budget. These feedbacks either hinder or speed up the climate change. **Findings:** The latest review of the current in situ observations over the Northern Eurasian region demonstrates the urgent need for the comprehensive, coordinated in situ observation system detecting the Earth surface and atmosphere processes. Also the marine observations from the ocean, sea ice, and atmosphere are needed to obtain a better understanding on the state and change of the marine Arctic climate system. The processes to be studied include, sea ice thermodynamics and dynamics; ocean heat and freshwater budgets; ocean circulation, waves, and tides; ocean chemistry and ecosystems; atmospheric heat and moisture budgets; synoptic-scale cyclones and Polar lows; troposphere-stratosphere coupling; atmospheric boundary-layer processes; as well as aerosols and clouds. Furthermore, we need to identify new methods on how to connect the cryosphere-atmosphere changes to the economy-energy-environment analysis (e.g. forest management) and the feedbacks between them, to determine and re-evaluates the processes that facilitate the maximum benefits from the novel research outcomes to be utilized in e.g. carbon dioxide emission market analysis, health risk assessment and management, climate change mitigation and adaptation **Conclusion & Significance**: New concepts, methods including analysis of big data and coordinated research activity are needed to find solutions to these challenges. It is also important to establish education program and create processes where research outcomes are effectively used for the policy making and for the benefit of the Northern societies.

Image

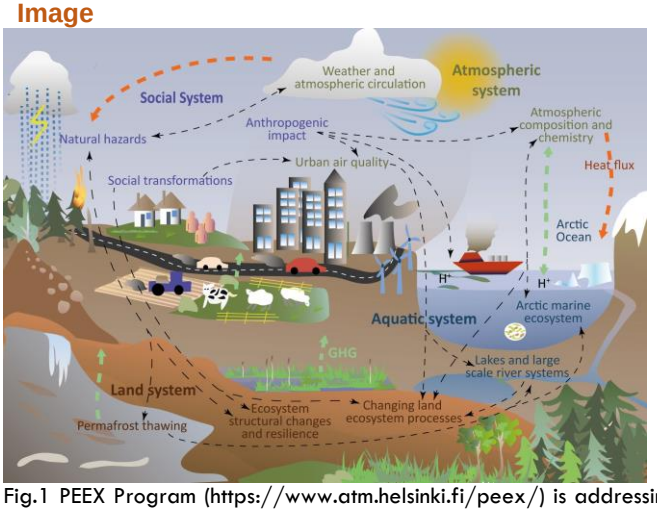

Fig.1 PEEX Program (https://www.atm.helsinki.fi/peex/) is addressing the role of holistic system understanding and the quantification of the feedback loops in order to find solutions to global challenges.

Recent Publications (minimum 5)

1. Lappalainen H.K et al. (2016). Pan-Eurasian Experiment (PEEX): System understanding of the Arctic-boreal regions for constructing scenarios and assessments of the future development of the Northern Pan-Eurasian environments and societies, Atmos. Chem. Phys., 16, 14421-14461, doi:10.5194/acp-16-14421-2016.
2. Kulmala M et al. (2016) Pan-Eurasian Experiment (PEEX) Program: Grant Challenges in the Arctic-boreal context, J. Geography Environment Sustainability, 2, 5-18.
3. Alekseychik P et al. (2016) Ground-based station network in Arctic and Subarctic Eurasia: an overview, J. Geography Environment Sustainability, 02(09), 75-88.
4. Kulmala M et al, (2015) Introduction: The Pan-Eurasian Experiment (PEEX) – multi-disciplinary, multi-scale and multi-component research and capacity building initiative, Atmos. Chem. Phys., 15, 13085-13096, doi:10.5194/acp-15-13085-2015.
5. Hari P et al. (2016). Conceptual design of a measurement network of the global change, Atmos. Chem. Phys., 16, 1017-1028, doi:10.5194/acp-16-1017-2016, 2016.

Biography

Hanna K. Lappalainen, PhD, Pan-Eurasian Experiment (PEEX) Program Secretary General, works currently at, at the University of Helsinki, Finland. Starting from 2013 she has been concentrating on the development of the PEEX Program. PEEX is a multi scale and multi disciplinary program aimed at finding science based solutions for the global environmental challenges, such as climate change, at the Northern high latitudes and in China. She has worked with the conceptual design of the program structure and the identification of the program's research agenda. She is the lead editor of the PEEX Science Plan and has promoted PEEX in several international forums such as U-Arctic, GEOSS and the Arctic Council SAON. She is interested in developing the PEEX in situ observation network in the Northern Eurasian region.

Email:
hanna.k.lappalainen@helsinki.fi

Notes/Comments: