

## PAN-EURASIAN EXPERIMENT (PEEX) PROGRAM OVERVIEW -

### ACTIVITIES IN 2012-2015 AND FUTURE PROSPECTS

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## INTRODUCTION

Pan-Eurasian Experiment (PEEX) initiative (<https://www.atm.helsinki.fi/peex/>) is an international, multi disciplinary, multiscale bottom up initiative established in 2012. The main focus of the initiative is to solve interlinked global environmental challenges influencing societies in the Northern Eurasian region. The goal is to solve with comprehensive, continuous observations the scientific questions that are specifically important for the Arctic-boreal region in the coming years, in particular the global climate change and its consequences to nature and the Northern societies. PEEX aims to deliver novel ground based land-atmosphere data for constructing reliable early warning systems (floods, forest fires, droughts), for predicting extreme weather events and estimating the environmental contamination of industrial accidents

The initiative has grown fast and at the moment it is involving research communities from 20 different countries from Europe, Russian and China. Altogether 80 institutes have contributed to the PEEX Science Plan, which identifies the program at large, introduces the research agenda, the components of the future PEEX research infrastructure, the topics relevant for impact making and outreach activities. The program is coordinated by the University of Helsinki and the Finnish Meteorological Institute together with the Moscow

State University (MSU) and AEROCOSMOS from Russia and Institute of Remote Sensing and Digital Earth (RADI) and University of Nanjing from China.

### **PROGRAM APPROACH IN 2012-2015**

In 2012-2015 PEEEX has established a program organization, determined the program structure and aims and taken the first steps towards implementation. The Program headquarters is situated at the Kumpula Campus in Helsinki, Finland and is coordinated by the University of Helsinki, Div. Atmospheric Sciences of the Physics Department and the Finnish Meteorological Institute. The main offices in Russia are hosted by AEROCOSMOS and Moscow State University and in China by Institute of Remote Sensing and Digital Earth (RADI, CAS) and University of Nanjing. In addition to the above listed institutes The Program Scientific Steering Committee consists representatives of Institute of Atmospheric Optics, Tomsk (RAS, RU), Inst. of Geography (RU), Institute of Atmospheric Physics (CAS, CN), World Meteorological Organization and the iLEAPS program within Future Earth.

The program structure, concept and the research agenda including the key topics for the first five years are described in the PEEEX Science Plan ([http://www.atm.helsinki.fi/peex/images/PEEX\\_SP\\_\\_27052015.pdf](http://www.atm.helsinki.fi/peex/images/PEEX_SP__27052015.pdf); see also Lappalainen et al. 2016). In implementing the PEEEX research agenda we have opened the PEEEX Special issue in the Journal of Atmospheric Chemistry and Physics ([http://www.atmos-chem-phys-discuss.net/special\\_issue265.html](http://www.atmos-chem-phys-discuss.net/special_issue265.html)). The special issue serves as a primary platform collecting PEEEX relevant scientific results for the periodic PEEEX science assessment. The Assessment(s) will be distributed to different stakeholders and policy making processes such as the Arctic Council, IPCC, Future Earth and the European, Russian and Chinese ministries. In 2015-2016 we have published the first PEEEX papers determining the mission goals and concepts (Kulmala et al. 2015, Hari et al. 2016, Lappalainen et al. 2016) and presented first assessment of the competing effects of CO<sub>2</sub> and secondary organic aerosols in Eastern Siberia (Arneth et al. 2015) Furthermore, PEEEX has been actively promoted to the Russian science community and aspects of the PEEEX research infrastructure development in Russia have been introduced by Lappalainen et al. (2014), Kulmala et al. (2016) and Alekseychik et al. (2016). PEEEX has also been proposed to the central government of China as one of the key projects in the Silk Road Economic Zone initiative (Kujansuu et al. 2015).

For establishing a multidisciplinary research community PEEEX has organized series of joint workshops together with the Nordic Center of Excellence (NCoE) called “Cryosphere-atmosphere interactions in a changing Arctic climate” (CRAICC). The aim of the workshops has been deepen the research collaboration between PEEEX and CRAICC and to identify the most relevant research questions for a more specific topics compared to Science Plan such as “Arctic shipping and climate change”. The first bilateral research approach in the frame of PEEEX collaboration has been initiated between University of Helsinki and AEROCOSMOS. The Finnish Center of Excellence on in Atmospheric Science – “From Molecular and Biological processes to The Global Climate” funded by the Academy of Finland for the years 2014-2017 and “Development of methods for monitoring of the dynamics of natural and anthropogenic emissions of trace gases and aerosols in the atmosphere based on satellite data and modeling” funded by the Russian Ministry of Education for the years 2014-2016 provides the backbone to the joint research activities.

Education of the next generation of scientists as well as capacity building of the experts takes place at the workshops and international courses. PEEEX benchmarked courses are especially suitable for networking and collaboration and are typically intensive field or laboratory courses. Topics range from hands on data-analysis field courses on atmospheric processes and feedbacks and atmosphere-biosphere interactions in Hyytiälä, Finland; Integrated Carbon Observation System (ICOS); permafrost-biogeochemistry-climatology-ecology in Spasskaya, Russia; laboratory course on stable isotopes in Sapporo, Japan. The courses bring together experts of the PEEEX topics and facilitate horizontal learning among the participants and teachers. Courses organized by PEEEX contributing institutes are opened, when possible, to other the community. Some of the examples are

air pollution – from local to global in Nanjing, China; atmospheric optics, Moscow, Russia, paleolimnology of Northern Eurasia, Petrozavodsk, Russia; application of weather and cloud radars in Hyytiälä, Finland.

PEEX has also been introduced in several conferences or executive forums such as Valdai Club in Russia or “Beautiful China - Steps Towards 21st Century” symposium in China. Furthermore, PEEEX Special Sessions has been organized, for example, in the International Geographical Union (IGU) Conference – Moscow in August and European Aerosols Conference (EAC) - Milan in September. The 1<sup>st</sup> PEEEX Science Conference was held on 10-12 February 2015 in Helsinki, Finland. The conference gathered ca 150 participants from Europe, Russia and China including plenary speakers such as Director General Pavel Kabat, IIASA. PEEEX has also established a collaboration between the European, Russian, Chinese and global partners to maximize the impact of the becoming research highlights, scientific assessment and research infrastructure development in the climate policy relevant processes. The key partners and stakeholders here are IIASA, International Eurasian Academy of Sciences (IEAS); Digital Earth, Future Earth, Arctic Council (SAON), WMO and GEO - GEOSS.

The strategically important task of PEEEX is to fill the observational gap in atmospheric in-situ data in the Northern Eurasian region regions. In 2012-2015 PEEEX has made preparatory work with the Russian station networks so that the metadata approach is ready to be launched and would be the first step connecting the Russian RI to international research infrastructure frameworks. As a part of this task we have also published the “PEEX view tool” ([http://www.atm.helsinki.fi/aapon\\_demo\\_php/test15\\_demo.html](http://www.atm.helsinki.fi/aapon_demo_php/test15_demo.html)), which enables the comparison between the in situ data and the modelled data. The PEEEX-View is an online tool for visualizing and analyzing of simulation and observational data and a demo version has recently been released in the PEEEX website. In the future, the PEEEX-View is envisioned to combine multidisciplinary datasets of varying temporal and spatial scales.

One of the concrete tasks of the PEEEX is to establish a coordinated, coherent land based PEEEX observation network over the Northern Pan-Eurasian region. The concept of the hierarchical PEEEX in situ station network is based on the know-how from 20 year development of the SMEAR-II flagship station measurement theory and techniques (Hari et al. 2016). The backbone of the station network is built on the existing biosphere (ecological) and atmospheric observation networks in collaboration with European, Russian, Chinese and global partners. In practice this would mean the upgrading and expanding the current measurement capacity of the stations step by step with the new blocks of instruments (Kaukolehto et al. of this issue). The station upgrading and /or establishing new stations would need national investments of Russia and China.

## **FUTURE PROSPECTS**

PEEX continues expanding the stakeholder and contact networks in 2016. Having new contacts with the Northern American teams are one of the priority areas. For example joint workshops on Arctic measurements are to be organized in Helsinki. Furthermore, the PEEEX aims to strengthen the collaboration with the China Silk Road Economic Belt Initiative. PEEEX recognizes the unique opportunity to explore cooperation in the sustainable development of environments along the Silk Road Economic Belt and Road. PEEEX has the potential to establish a framework for solving environmental problems in the Belt and Road countries, and become a community of shared interests. PEEEX research outcome and observation activities and the new methodological concepts are providing new information not only for the climate policy making in the global scale but also for the regional scale; including mitigation and adaptation planning.

The PEEEX contribution to the Paris COP process is strongly linked with the establishment of the Global-SMEAR station network and the SMEAR-concept. The first ideas of Global SMEAR network has been introduced just recently at a Paris COP side-meeting in December 2015. The PEEEX in situ station network over Northern Eurasian is based on the SMEAR-II flagship station measurement theory and techniques (Hari et al. 2016, Kulmala et al. 2016). We are currently working on documenting the SMEAR-Concept, which includes hierarchical blocks of instruments setups for different surfaces (boreal forest, peatland, urban, Arctic

marine etc.) and technical descriptions of the data processing and storage system. Furthermore, we underline that the satellite observations are to be connected to the ground based observations of the PEEEX network.

In the first phase PEEEX is expanding gradually the existing SMEAR station network in Finland, Estonia and China and will be establishing the first stations based on SMEAR concept in Russia during 2016-2018. With the PEEEX network based on SMEAR concept we are able to make reliable estimation and identification of the real carbon (CO<sub>2</sub>) sources leading to enhanced atmospheric CO<sub>2</sub> emissions. We are also able to estimate the carbon sink, especially the role of boreal forest being able store the atmospheric CO<sub>2</sub>. For example, via the flux towers with a height larger than 100m high we are able to calculate the carbon sink-source balance over 1000 km<sup>2</sup> footprint area. After having a reliable quantitative estimations of the current sink-source dynamics over wide boreal forest regions the next step would be to make practical actions to determine that the CO<sub>2</sub> sink (storage) would be stronger than the CO<sub>2</sub> source (emissions) in the future.

Besides CO<sub>2</sub> dynamics also the dynamics related to the Short-Lived Climate Forces (SLCF), e.g. air pollutants like black carbon, ozone and aerosol particles are crucial for global climate. Using extensive, comprehensive, continuous observations we are able to understand how SLCF contributes over arctic-boreal regions and in China to regional and global climate. PEEEX research approach aims to span over scientific boundaries and start a more intensive interaction between natural sciences and socio-economics. Novel socio-economic pathways and recommendations for policy making are crucial to meet regional and global challenges. On the other hand if socio-economic investigations are interacting with exiting and improving natural scientific knowledge we can together find sustainable solutions to meet the requirements given by the COP21 agreement in Paris.

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