PAN-EURASIAN EXPERIMENT (PEEX) PROGRAM OVERVIEW

For contact: Dr. Hanna K. Lappalainen
hanna.k.lappalainen@helsinki.fi

PEEX / GlobalSMEAR Secretary General
Institute for Atmospheric and Earth Sytem Research (INAR)
University of Helsinki, FINLAND

09:10-09:20 – PEEX Programme overview, Hanna Lappalainen / Alexander Mahura

Session II-A (09:20-10:30): Welcome new Partners

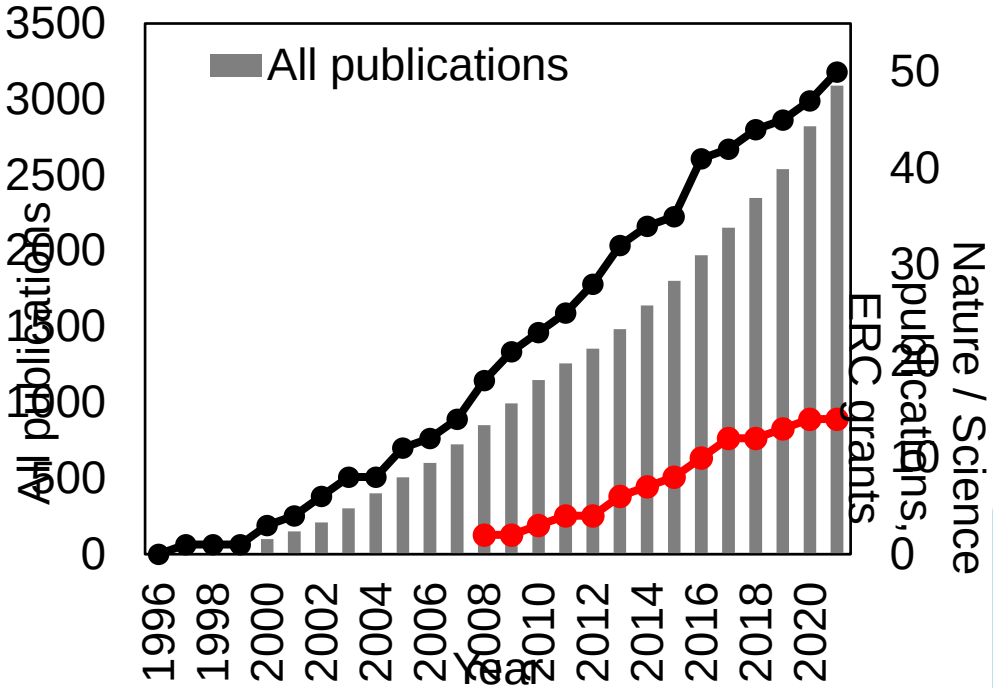
22 April 2025

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Academician
Markku Kulmala
Director of INAR Institute,
University of Helsinki, FI
Citation over 40000
H-index >100
ISI No. 1 Citation in Geoscience (2011-2018)

INAR - WORLD CLASS RESEARCH in numbers

Number of published peer reviwied papers & European Research Council (ERC) funding



	1990	2018	2026	2035
ISI Highly cited	0	8	15	25
Disciplines covered	2	4+9	19	30
Professors educated	1	40	70	120

Ten University of Helsinki researchers rank in top 1% for citations in their respective fields

The Highly Cited Researchers 2024 list highlights scholars whose publications have received the most citations from other researchers over the past decade.

Atmospheric sciences

Markku Kulmala

Tuukka Petäjä

Douglas Worsnop ↗ (primary affiliation: Aerodyne Research)

19.11.2024 University of Helsinki News

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Institute for Atmospheric and Earth System Research

Global grand challenges

Climate change

Volcanoes

Energy

Biodiversity loss

Epidemic diseases

Chemicalisation

Earthquakes

Air quality

Fresh water

Ocean acidification

Deforestation

Food supplies

Demography / Population / Urbanization

AIM:

TO TACKLE AND SOLVE GLOBAL GRAND CHALLENGES

with comprehensive observation network and data synthesis

KEY QUESTION : Why understanding of Atmosphere – Earth Surface – Biosphere is important for Climate Change ?

- New feedback mechanism / interactions / processes
- More time to act: Mitigate & Adapt

Tools for understanding of Atmosphere – Earth Surface – Biosphere interaction, feedbacks

- **Pan-Eurasian Experiment (PEEX) Program:** for understanding the Atmosphere – Earth Surface – Biosphere in the Arctic – boreal context / Northern Eurasia / Silk Road Region (**2012** ->) **www.atm.helsinki.fi/peex**

- **GlobalSMEAR:** (Stations Measuring Earth Surface Atmosphere Relations) Initiative for Global Earth Observatory for filling the observational gap of the atmospheric – ecosystem in situ data (**2015 -** >) **www.atm.helsinki.fi/globalsmear**

- **Climate University** free online courses for universities and everyone who wants to make the sustainability transition in the society real (**2018 -** >) **climateuniversity.fi**

PEEX Program HQ / GlobalSMEAR Initiative at UH

Prof. **Tuukka Petäjä**,
Vice-Director INAR,
University of Helsinki, FI

Academician
Markku Kulmala
Director of INAR Institute,
University of Helsinki, FI

Dr. **Hanna Lappalainen**
PEEX /GlobalSMEAR
Secretary general
INAR
University of Helsinki, FI

Dr. **Alexander Mahura**
PEEX-Modelling-Platform
INAR
University of Helsinki, FI

Administrative matters Mrs. **Alla Borisova**

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

In Evaluation:
Proposal COST Action PEEX-EU-NEN-ReN "*Pan-Eurasian EXperiment – Europe – Near Europe Neighbourhood countries Earth System Research Network*"

17 countries; 31 partners incl. 9 from Ukraine; 4 yr; 600 Keu

Coordinated by Univ Helsinki

Based on Science Plans of
PEEX (https://www.atm.helsinki.fi/peex)
ACCC (https://www.acccflagship.fi)

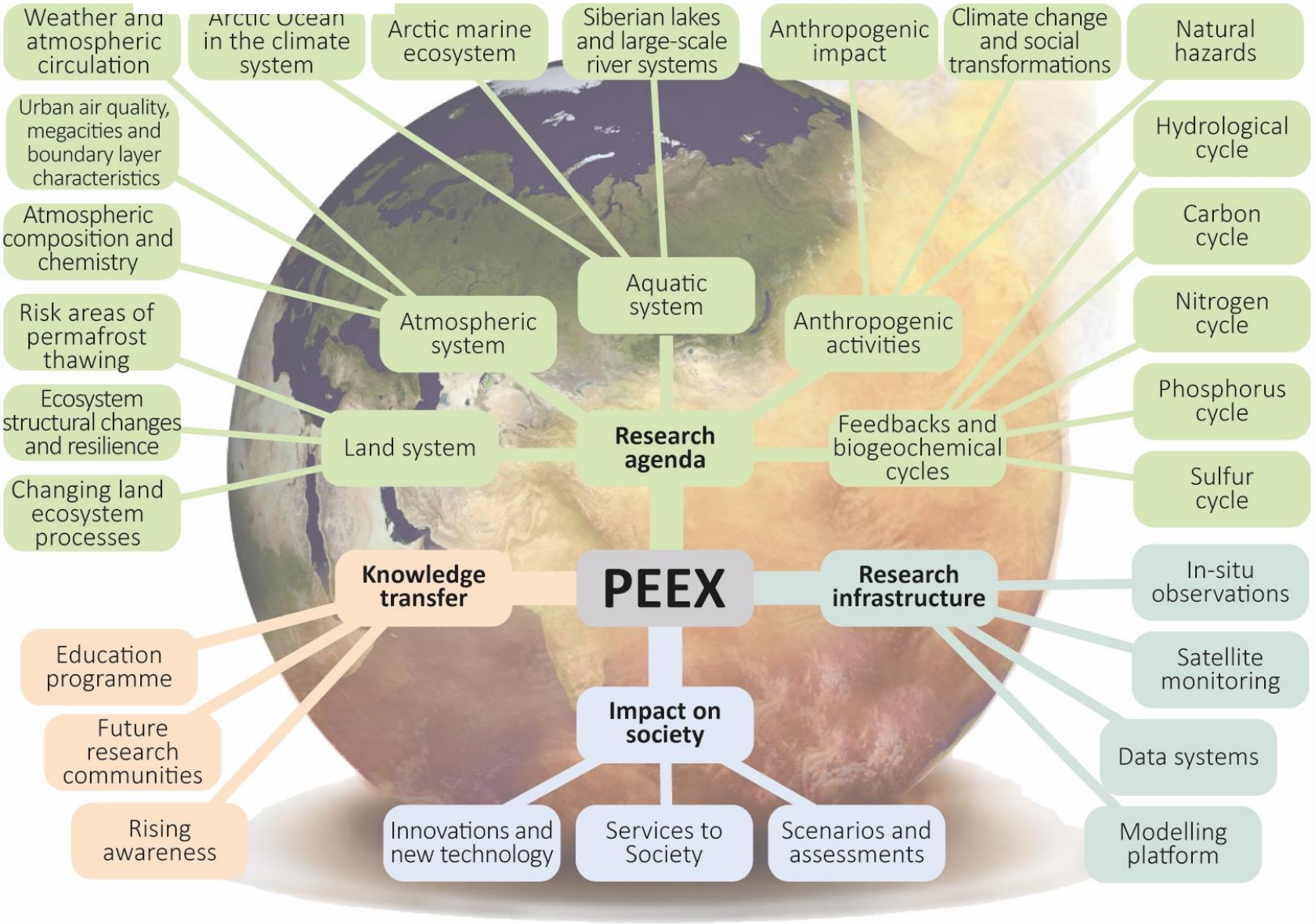
https://www.atm.helsinki.fi/peex/images/PEEX_Science_Plan.pdf

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Institute for Atmospheric and Earth System Research

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

PEEX PROGRAM STRUCTURE



PEEX PROGRAM WEBSITE

https://www.atm.helsinki.fi/peex

aterials Contact us

Latest news

5th International Forum on Big Data for Sustainable Development Goals (FBAS 2025)

The 5th International Forum on Big Data for Sustainable Development Goals (FBAS 2025), scheduled to take place in Beijing from September 6 to 8, 2025. The event is hosted by the Chinese Academy of [Read more]

2nd International Conference on "Climate Service – Science and Education"

The 2nd International Conference on "Climate Service – Science and Education" is planned for 16–18 April 2025 at the Odesa I.I. Mechnikov National University (ONU; Odesa, Ukraine) in a hybrid format. The Conference aims [Read more]

PEEX Seminar at the 4th ACCC Impact Week

The PEEX seminar (hybrid – online/ onsite) will take place on 22 April 2025 during the 4th Atmosphere and Climate Competence Center (ACCC) Impact Week (22-25 April 2025 at the Sofia Cultural Center in [Read more]

meteorology – atmospheric composition on multi-scales for the Pan-Eurasian EXperiment (PEEX) domain for weather, air quality and climate applications" [Read more]

ClimEd Training N6: Mastering Technologies of Massive Open Online Courses Development for General Public

The ClimEd 6th Training on "Mastering Technologies of Massive Open Online Courses Development for General Public" took place in a hybrid mode during 10-14 February 2025. The ClimEd project trainings are focused on training [Read more]

PEEX Modelling Platform research and development through CSC HPC research projects

The IT Center for Science (CSC, Finland, https://www.csc.fi) provides opportunities for initiating and expanding collaboration between Finnish and international universities/ organizations in research and educational projects employing CSC's

PEEX Newsletters

https://www.atm.helsinki.fi/peex/index.php/portfolio-items/peex-newsletter-blog/

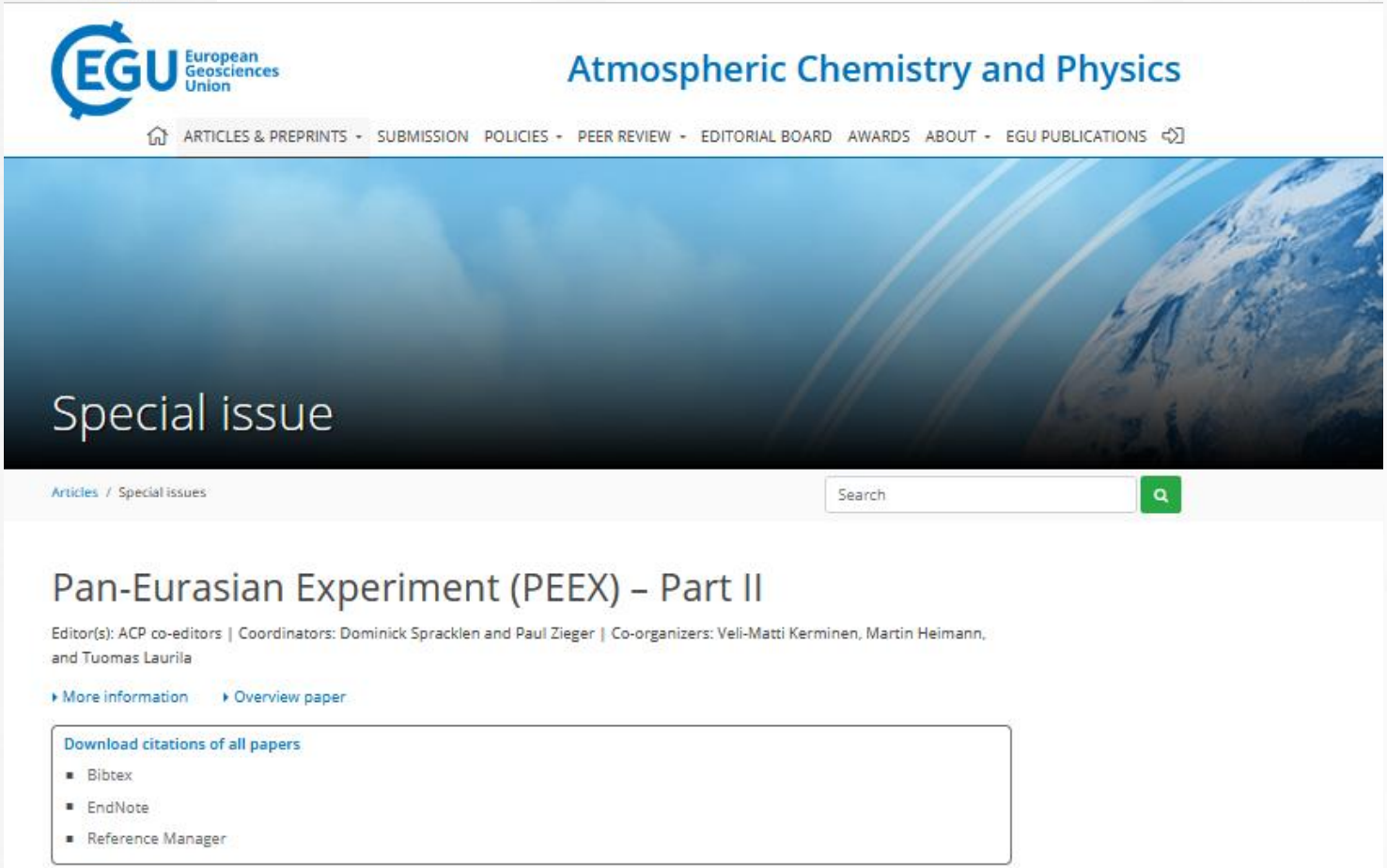
- 4 issues per year
- a forum to advertise your work, activities, etc.
- For contact: Editor Alla Borisova alla.borisova@helsinki.fi
- Want to receive our newsletter? Please, click on subscribe
- ***https://helsinki.us11.list-manage.com/subscribe?u=9193f2d7d1d2cd44df10dd7d5&id=34b12ce65d***

NEW PARTNERS
SIGNED PEEX MoU in 2024

University / Research Organization	Country	Date
IMMSP - Institute of Mathematical Machines and Systems Problems, NAS	Ukraine	(signed 13 Mar 2024
YU - Yarmouk University	Jordan	(signed 13 Mar 2024)
KAU - Kyiv Academic University	Ukraine	(signied 26 Mar 2024)
UoB - University of Belgrad, Faculty of Agriculture	Serbia	(signed 5 Apr 2024)
UHMS - Ukrainian Meteorological and Hydrological Society	Ukraine	(signed 11 Apr 2024)
EULS - Estonian University of Life Sciences, Institute of Forestry and Engineering	Estonia	(signed 10 May 2024)
OPNU - Odesa Polytechnic National University	Ukraine	(signed 18 Jun 2024)
ONU – Mechnikov Odessa National University	Ukraine	(signed 18 Jun 2024)
FDU - Fudan University	China	(signed 19 Aug 2024)
DUT - Dalian University of Technology,	China	(signed 19 Aug 2024)
KazNU - Al-Faradi Kazakh National University	Kazakhstan	(signed 19 Aug 2024)
AUI - Agricultural University of Iceland	Iceland	(signed 11 Oct 2024)
ITU - Istanbul Technical University,	Turkey	(signed 4 Dec 2024)

Signing MoUs with other interested Partners is in progress

PEEX RESEARCH



Part II: https://acp.copernicus.org/articles/special_issue1103.html

Part I: https://acp.copernicus.org/articles/special_issue395.html

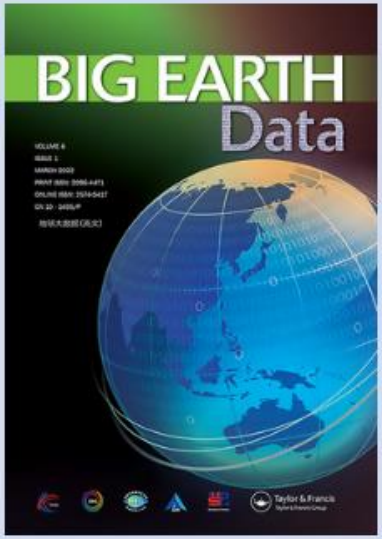
INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

PEEX RESEARCH

Submit a Manuscript to the Journal
Big Earth Data

For a Special Issue on
High-quality environmental information and analysis for the Arctic boreal region and High Mountain Asia

Manuscript deadline
28 February 2023



Special Issue Editor(s)

Hanna Lappalainen, *University of Helsinki, Finland*
hanna.k.lappalainen@helsinki.fi

Yubao Qiu, *International Research Center of Big Data for Sustainable Development Goals (CBAS), China*
qiuyb@cbas.ac.cn

Any-Maija Sundsröm, *Finnish Meteorological Institute, Finland*
anu-maija.sundstrom@fmi.fi

Lanhai Li, *Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences*
lilh@ms.xjb.ac.cn

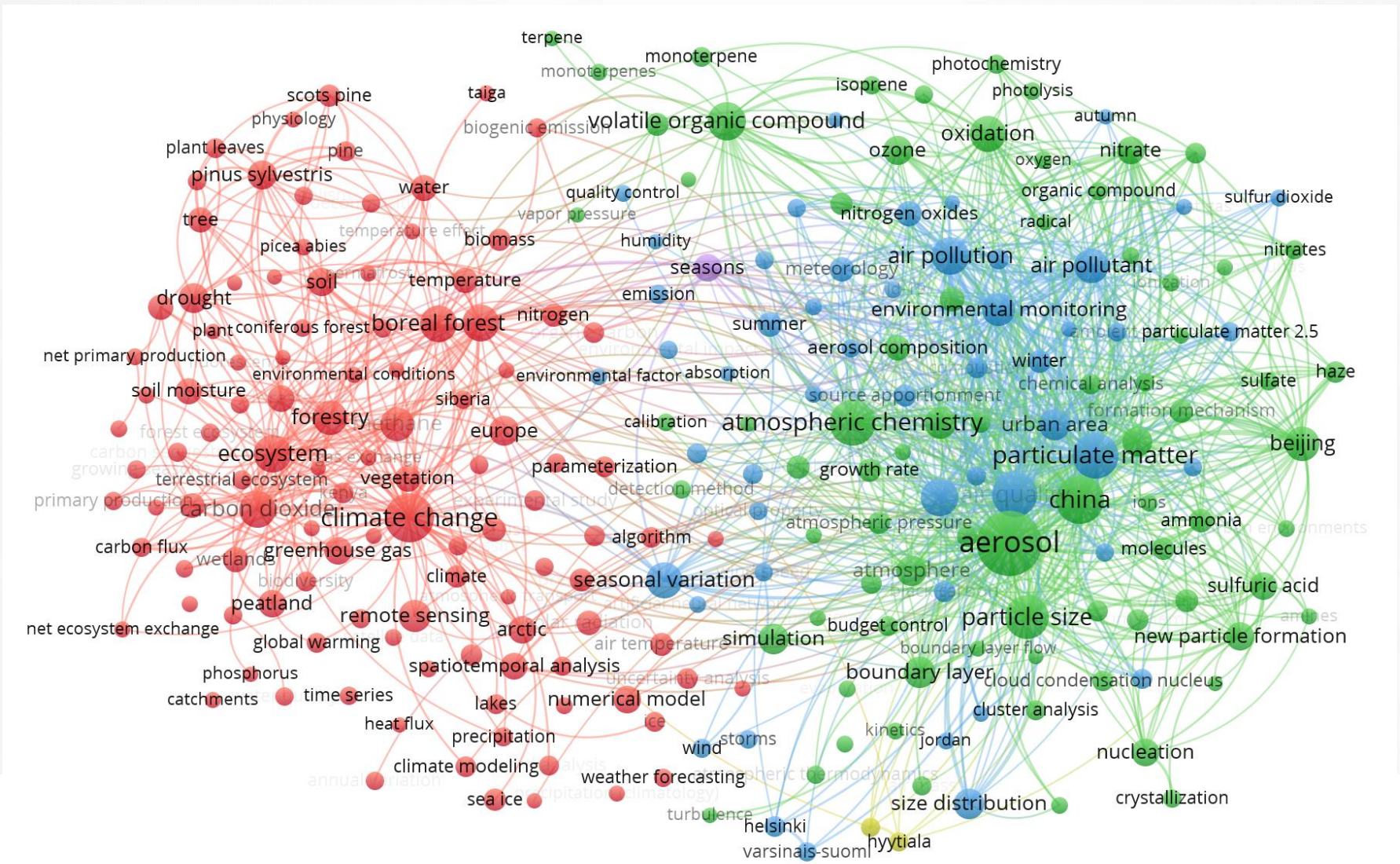
Veli-Matti Kerminen, *University of Helsinki, Finland*
veli-matti.kerminen@helsinki.fi

Xiao Cheng, *Sun Yat-sen University, China*
chengxiao9@mail.sysu.edu.cn

SUBMIT AN ARTICLE | VISIT JOURNAL | ARTICLES

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

PEEX RESEARCH

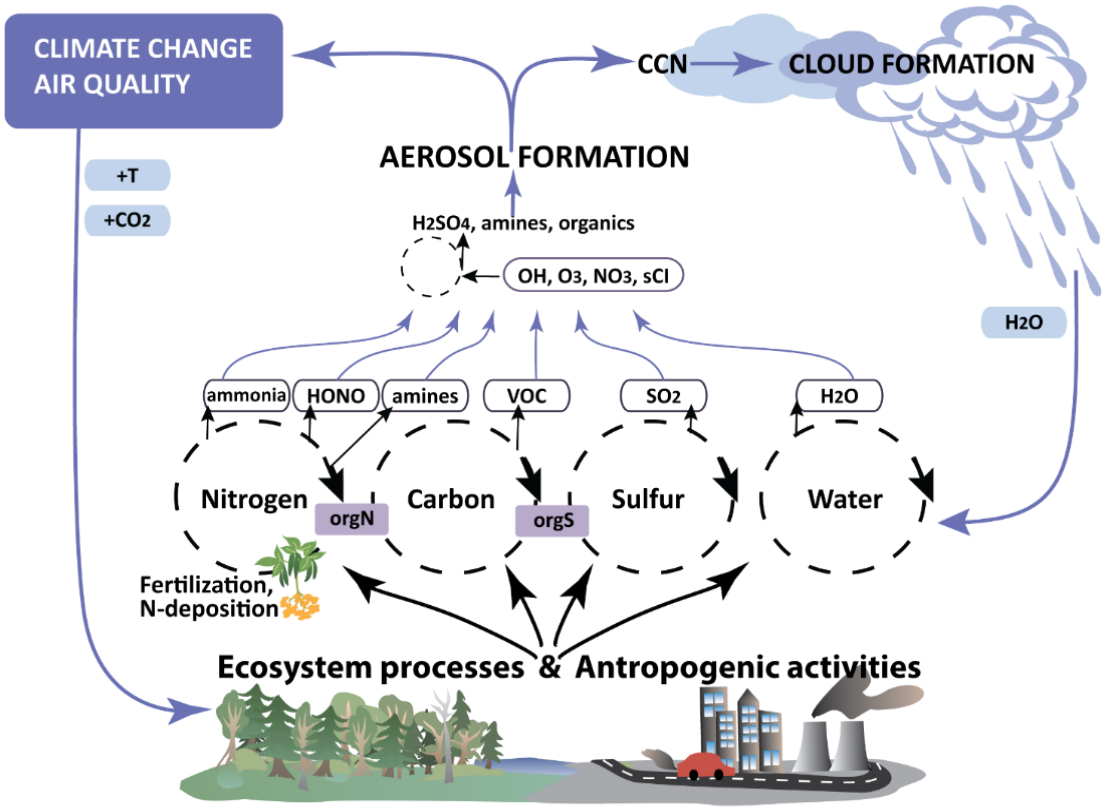


INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

PEEX: TOWARDS SYSTEM UNDERSTANDING OF THE ARCTIC-BOREAL REGIONS

Research approach from process studies towards understanding & quantification of feedbacks

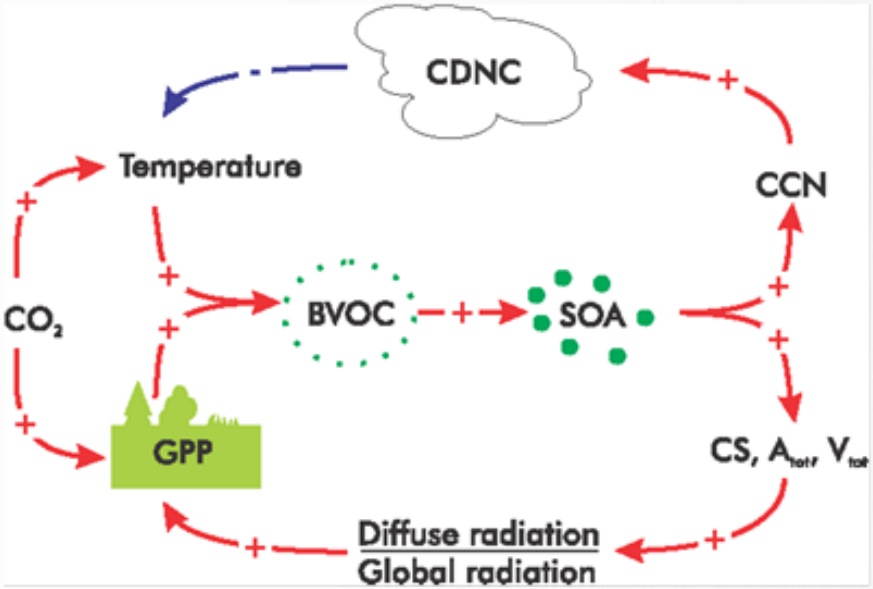
- system specific topics are basically related to **process understanding**
- individual process understanding enables to **quantification of biogeochemical cycles**
- via biogeochemical cycles the energy and matter flows linked to a wider system context enabling us to **analyze the feedback phenomena**
- feedbacks are essential components towards **(climate) system understanding**



INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

FEEDBACK LOOP RELEVANT TO ARCTIC-BOREAL REGIONS: **COBACC** (**CO**ntinental **B**iosphere-**A**erosol-**C**loud-**C**limate)

- two major overlapping feedback loops. The focal points of these two loops are ambient temperature and plant gross primary production (GPP).
- The loops are closely tied with aerosol-cloud interactions and with the atmospheric carbon sink, and both tend to act toward suppressing global warming



BVOC=biogenic volatile organic compounds
SOA=secondary organic aerosol
CS=the condensation sink
A_{tot}=total aerosol surface area
V_{tot}=total aerosol volume
CCN=cloud condensation nuclei
CDNC=cloud droplet number concentration
GPP=Gross Primary Productivity

Kulmala et al. 2014, Paasonen et al. 2013, PEEX Science Plan

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

PEEX RESEARCH OVERVIEW 2015-2020

Atmos. Chem. Phys., 22, 4413–4469, 2022
https://doi.org/10.5194/acp-22-4413-2022

Atmospheric Chemistry and Physics
EGU

Overview: Recent advances in the understanding of the northern Eurasian environments and of the urban air quality in China – a Pan-Eurasian Experiment (PEEX) programme perspective

Hanna K. Lappalainen[1,36], Tuukka Petäjä[1], Timo Vihma[2], Jouni Räisänen[1], Alexander Baklanov[3], Sergey Chalov[4], Igor Esau[5,44], Ekaterina Ezhova[1], Matti Leppäranta[1], Dmitry Pozdnyakov[6,23], Jukka Pumpanen[7], Meinrat O. Andreae[8,41,42], Mikhail Arshinov[9], Eija Asmi[2], Jianhui Bai[10], Igor Bashmachnikov[6], Boris Belan[9], Federico Bianchi[1], Boris Biskaborn[11], Michael Boy[1], Jaana Bäck[12], Bin Cheng[2], Natalia Chubarova[4], Jonathan Duplissy[1,43], Egor Dyukarev[13], Konstantinos Eleftheriadis[14], Martin Forsius[15], Martin Heimann[16], Sirkku Juhola[19], Vladimir Konovalov[17], Igor Konovalov[18], Pavel Konstantinov[4,32], Kajar Köster[12], Elena Lapshina[20], Anna Lintunen[1,12], Alexander Mahura[1], Risto Makkonen[2], Svetlana Malkhazova[4], Ivan Mammarella[1], Stefano Mammola[21,22], Stephany Buenrostro Mazon[1], Outi Meinander[2], Eugene Mikhailov[23,24], Victoria Miles[2], Stanislav Myslenkov[4], Dmitry Orlov[4], Jean-Daniel Paris[25], Roberta Pirazzini[2], Olga Popovicheva[26], Jouni Pulliainen[2], Kimmo Rautiainen[2], Torsten Sachs[27], Vladimir Shevchenko[28], Andrey Skorokhod[29], Andreas Stohl[30], Elli Suhonen[1], Erik S. Thomson[31], Marina Tsidilina[32], Veli-Pekka Tynkkynen[33], Petteri Uotila[1], Aki Virkkula[2], Nadezhda Voropay[34], Tobias Wolf[35], Sayaka Yasunaka[33], Jiahua Zhang[36], Yubao Qiu[36], Aijun Ding[37], Huadong Guo[38], Valery Bondur[39], Nikolay Kasimov[4], Sergej Zilitinkevich[1,2,45,†], Veli-Matti Kerminen[1], and Markku Kulmala[1,39,40]

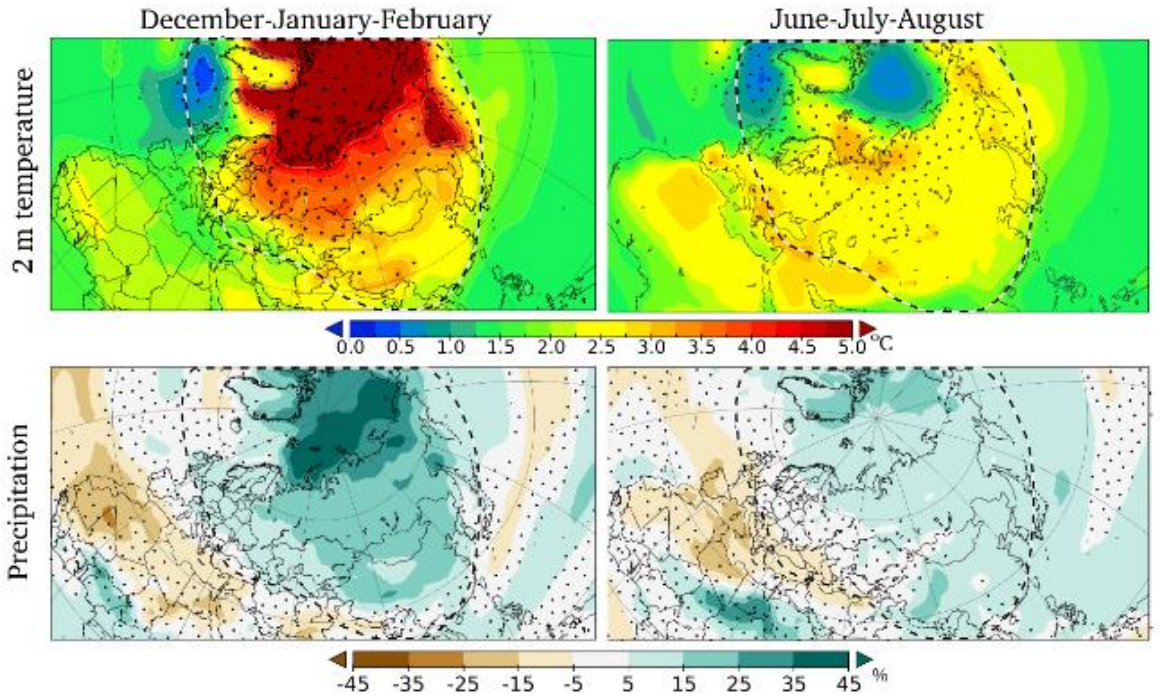
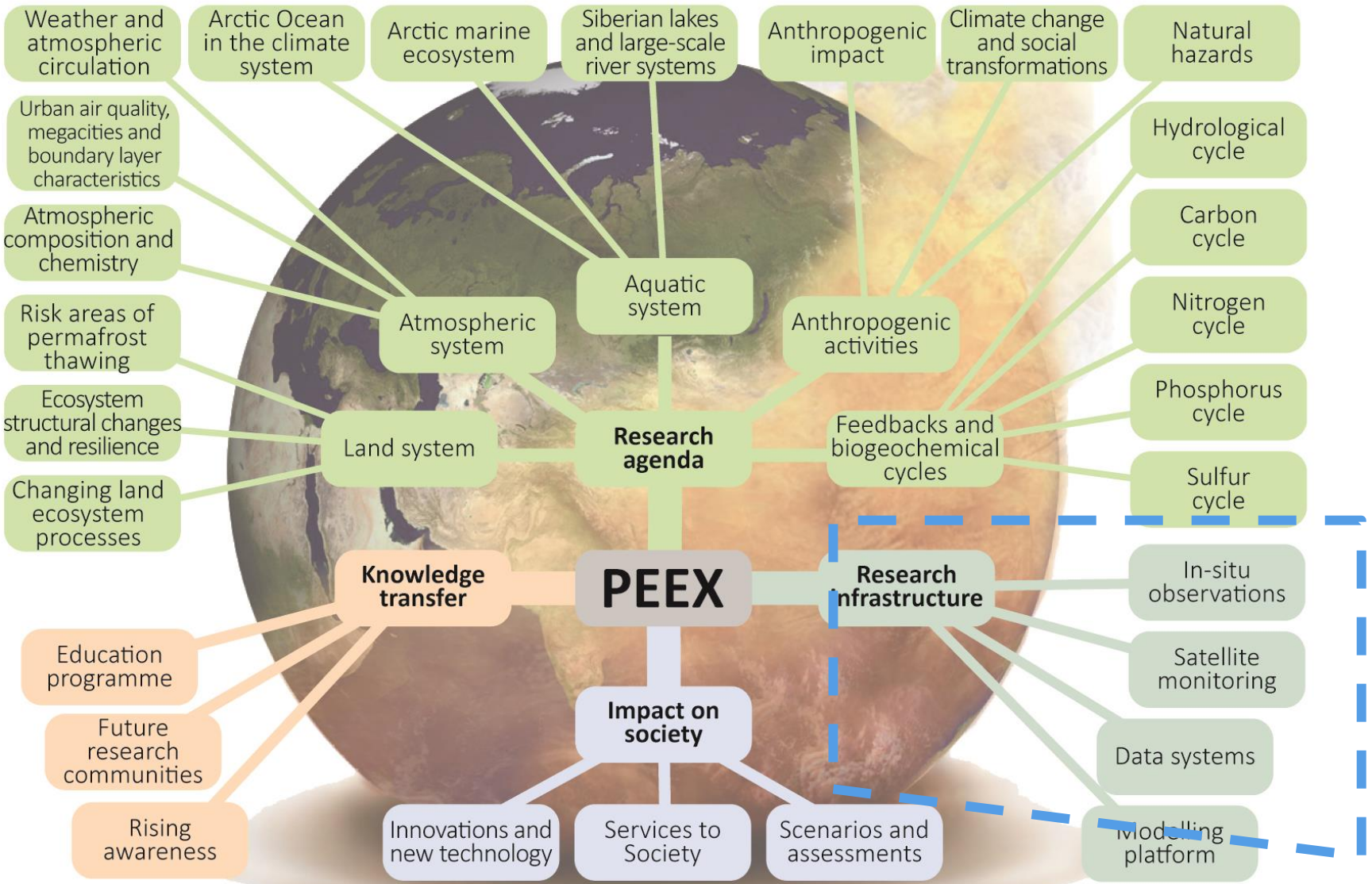


Figure 9. Changes in 2 m temperature (°C, upper panels) and precipitation (%, lower panels) during the 21st century. Present-day climatology is averaged over the years 1981–2010 and end-of-century climatology over 2070–2099. Winter (left) and summer (right) are shown separately. Dotted areas indicate high variability in the model ensemble (for temperature: standard deviation of 21st century change exceeds 1 °C; for precipitation: standard deviation of 21st century change exceeds 100 % or present-day precipitation). The model results are from IPCC AR5, based on 42 individual models in CMIP5 experiments under the RCP4.5 scenario.

Prof. Risto Makkonen, FMI team

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

RESEARCH INFRASTRUCTURE



INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Pan-Eurasian Experiment
PEEX

SMEAR
GLOBAL CHALLENGES NEED GLOBAL MEASURES

Vision: Global observation network

THERE IS A NEED FOR ADVANCED IN SITU STATIONS IN

M. Kulmala: Nature Comment, Nature 553, 21–23 4 Jan 2018)

The answer is a global Earth observatory — 1,000 or more well-equipped ground stations around the world that track environments and key ecosystems fully and continuously

- Researchers could find new mechanisms and feedback loops in this coherent data set
- Policymakers could test policies and their impacts
- Companies could develop environmental services

An enclosure for measuring gas exchange between plants and the atmosphere at a station in Finland.

Build a global Earth observatory

Markku Kulmala calls for continuous, comprehensive monitoring of interactions between the planet's surface and atmosphere.

SMEAR II-station in Hyytiälä, FINLAND

GlobalSMEAR Flagship station

Boreal forest country side

Flagship station SMEARII

N 61° 50.845', E 24° 17.686', altitude 180 m a.s.l.

The SMEAR II (Station for Measuring Ecosystem – Atmosphere Relations) in Hyytiälä, Finland, represents the most advanced station of the SMEAR concept. SMEAR II station is carrying out measurements 24/7 on 1200 parameters on different ecosystems: boreal forest, wetland and lakes.

SMEAR II is contributing to several global Earth Observation systems and networks such as WMO GAW, GEO-GEOSS, FluxNet, AERONET and SolRad-Net, and to the European Research Infrastructures such as ICOS, ACTRIS, AnaEE and eLTER.

Instrument cottage

Instruments on mast and towwers to measure at different heights

Eddy Covariance systems

Aerosols

Shoot-level flux chamber

Lake raft housing instruments

FOREST

LAKE

PEATLAND

Biosphere Pedosphere Hydrosphere Atmosphere

* WMO GAW World Meteorological Organization - The Global Atmosphere Watch , The intergovernmental Group on Earth Observations (GEO) - a Global Earth Observation System of Systems (GEOSS), ICOS (Integrated Carbon Observation System), ACTRIS (Aerosols, Clouds, and Trace gases Research Infrastructure), AnaEE (Infrastructure for Analysis and Experimentation on Ecosystems), eLTER (Integrated European Long-term Ecosystem)

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

STATIONS MEASURING EARTH SURFACE-ATMOSPHERE RELATIONS (SMEAR)

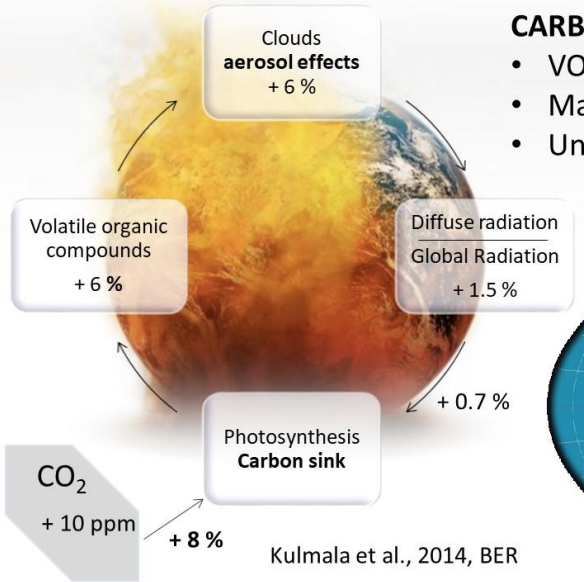
Research infrastructure - proof of concept for meeting the UN SDGs

BIG EARTH DATA
2021, VOL. 5, NO. 3, 277-305
https://doi.org/10.1080/20964471.2021.1936943

Atmospheric and ecosystem big data providing key contributions in reaching United Nations' Sustainable Development Goals

Markku Kulmala [a,b,c,d,e,f], Anna Lintunen [a,g], Ilona Ylivinkka [a], Janne Mukkala [a], Rosa Rantanen [a], Joni Kujansuu [a,b,c,f], Tuukka Petäjä [a,b,c,e], and Hanna K. Lappalainen [a,e,h]

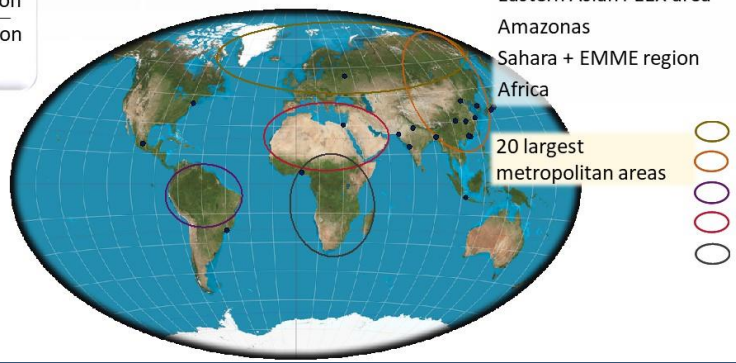
THE POTENTIAL OF SMEAR CONCEPT: GLOBAL COMPREHENSIVE FEEDBACK ANALYSIS



Kulmala et al., 2014, BER

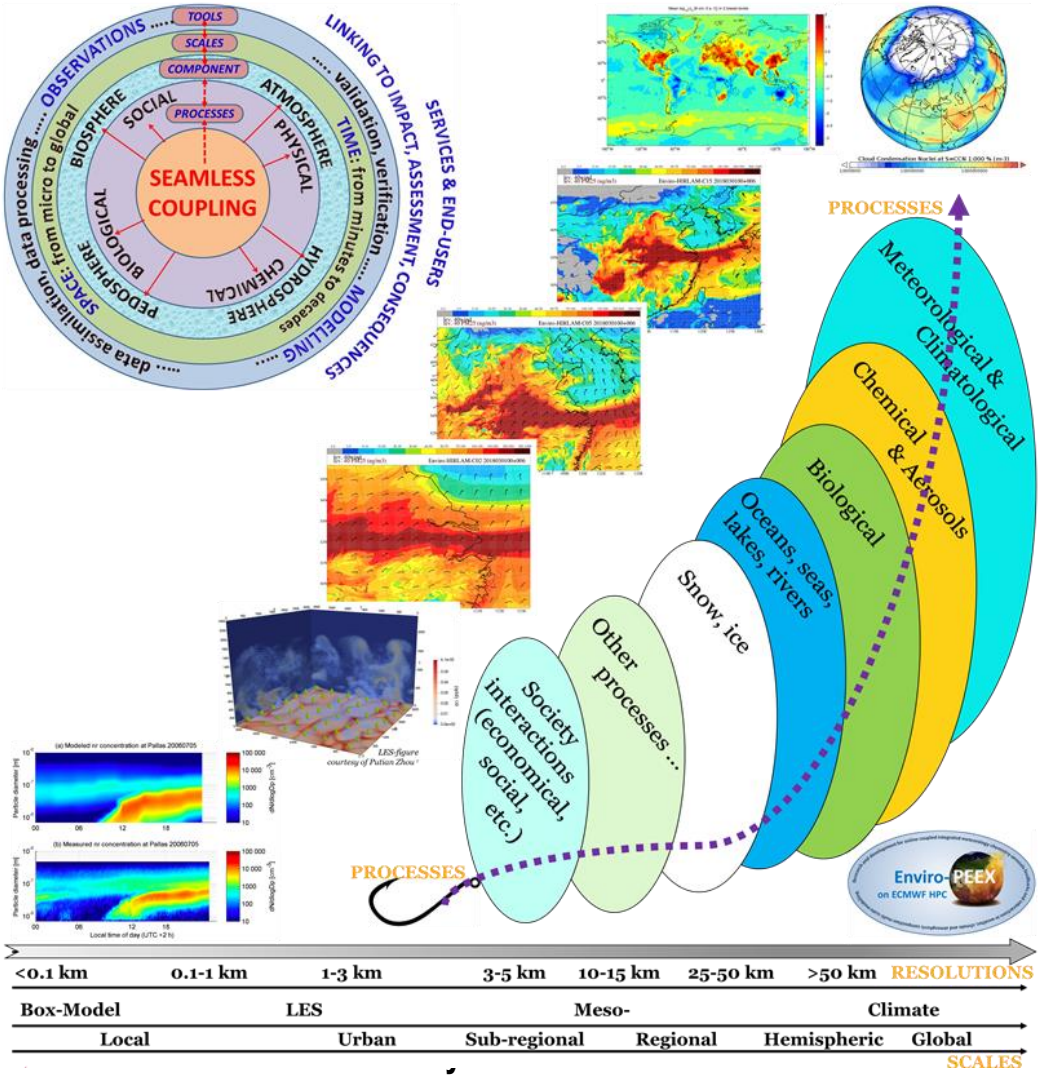
CARBON SINK PLUS

- VOCs, Aerosols, clouds, precipitation
- Max 1.8 x carbon sink (Hyytiälä / SMEAR II results)
- Uncertainties
  => observations / models



Pan-Eurasian Experiment
PEEX

Enviro-PEEX on ECMWF & CSC projects



"PEEX-MP research and development for seamless/online integrated meteorology-chemistry-aerosols feedbacks & interactions in weather, climate & atmospheric composition multi-scale modelling"

(2018 ..... 2027)

https://www.atm.helsinki.fi/peex/index.php/enviro-peex_next/

https://www.atm.helsinki.fi/peex/index.php/enviro-peex_plus/

https://www.atm.helsinki.fi/peex/index.php/peex-mp-europa3/

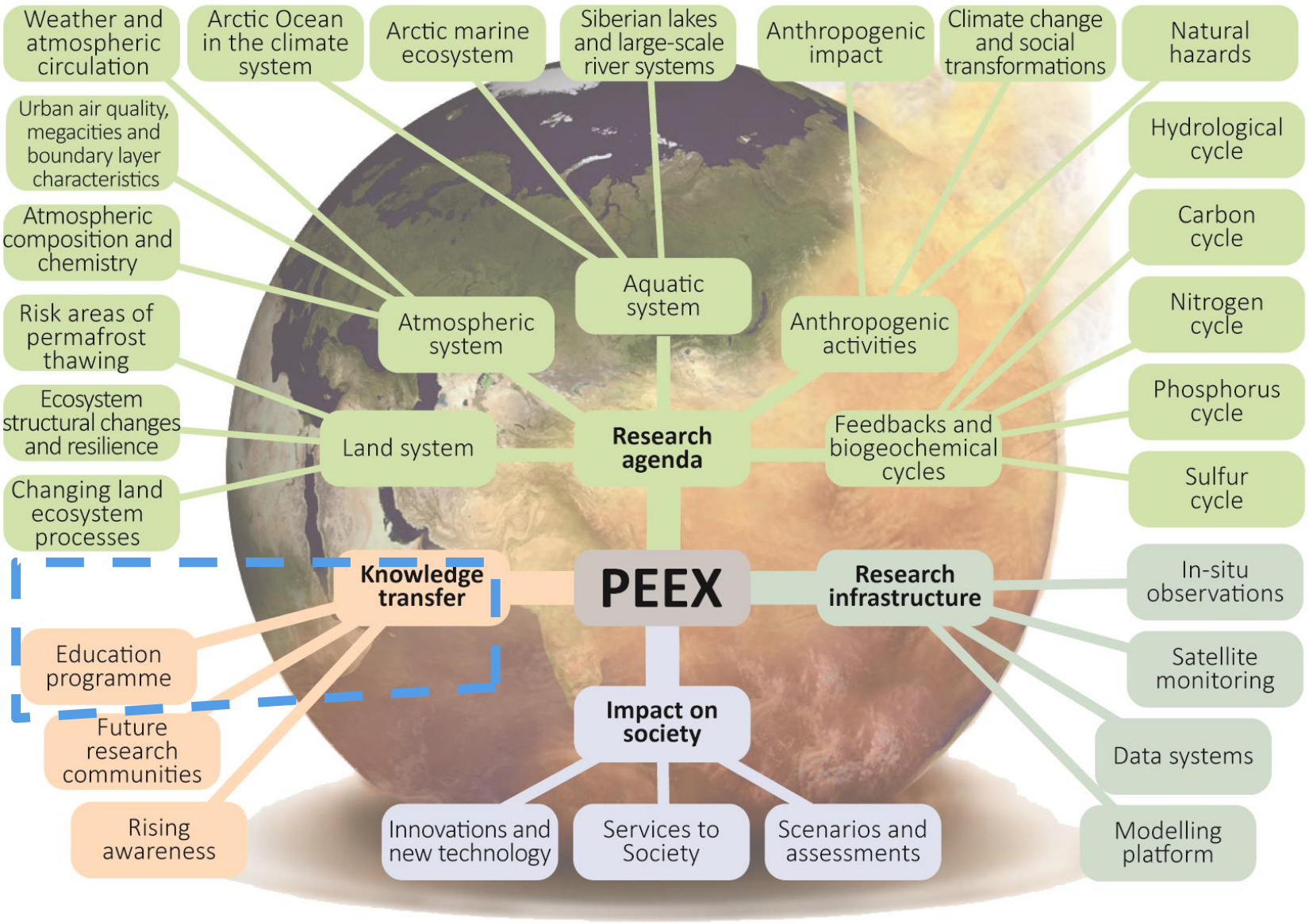
https://www.atm.helsinki.fi/peex/index.php/mp-at-csc

Objectives:

- to analyze importance of meteorology-chemistry-aerosols interactions & feedbacks;
- to provide a way for development of efficient techniques for online coupling of NWP and ACT via process-oriented parameterizations and feedback algorithms.

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

EDUCATION



INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Pan-Eurasian Experiment
PEEX

EDUCATION

EU Erasmus+ Programme
Virtual Exchanges projects in 2023-2027

- to engage students with climate competences and green agenda together with interdisciplinary, green and soft skills
- to educate 500 students in 1 Virtual Exchange (VE) Week (2x5 VE Weeks in total)
- to educate altogether 5000 students as Climate Messengers in 3 years period
- These projects are coordinated by INAR, University of Helsinki

- For contact: Dr. Hanna K. Lappalainen (hanna.k.lappalainen@helsinki.fi)

EDUCATION

EU Erasmus+ Programme
Virtual Exchanges projects in 2023-2027

Call open for VE Week May 2025

https://www.atm.helsinki.fi/cluvex/wp-content/uploads/2025/03/announcement_Spring-2025_2nd_VEWeek-for-students-1.pdf

ANNOUNCEMENT: VIRTUAL EXCHANGE WEEK (VE Week) FOR STUDENTS

CLUVEX VIRTUAL EXCHANGE (1 ECTS)

12—16 May 2025

Climate University for Virtual Exchanges (CLUVEX) is an international multidisciplinary online course. CLUVEX introduces and discusses the latest scientific knowledge on climate change from **multidisciplinary perspectives**: natural sciences, social sciences and the arts.

The virtual exchange (VE) is a great opportunity to experiment interacting in **an international environment - especially if you have considered applying for a traditional student exchange**. Participating in the VE Week does not require an advanced knowledge base in natural sciences. More important is to be interested in climate change-related issues and workshopping in an international team. **The VE Week is open to students of all fields coming from Europe and Neighbourhood East countries.**

During the virtual exchange, you will work in small international groups of like-minded students (up to 10 students + 1 moderator). A central part of the exchange is a *Climate Horizon* exercise, framed by interdisciplinary and intercultural discussions on climate change. You will work online on the exercise individually and in your groups. CLUVEX welcomes students from learning institutions in the **Europe and Neighbourhood East countries.**

WHEN: 12—16 May 2025,
from 14:00 to 17:00 (EET, Helsinki time)
PLACE: Online in Zoom
COMPLETION METHOD: online participation on each day (3h per day) and a final report.
AWARD: 1 ECTS credit issued by the University of Helsinki & Climate Messenger Certificate issued by the CLUVEX project.

Register here:
https://elomake.helsinki.fi/lomakkeet/133870/lomake.html

REGISTRATION DEADLINE: 1 May 2025
VE WEEK: course code ATM398 at the University of Helsinki
WHO CAN APPLY: BSc, MSc, PhD, PostDoc students
MAX CAPACITY: up to 500 students

LANGUAGE: English
COST: no fee
MORE INFORMATION:
https://www.atm.helsinki.fi/cluvex

CONTACT INFORMATION:

University of Helsinki, Finland:
alexander.mahura(at)helsinki.fi
julia.karhumaa(at)helsinki.fi
University of Copenhagen, Denmark:
maher.sahyoun(at)nbi.ku.dk
Odessa National University, Ukraine (UA):
valeriya.ovcharuk(at)gmail.com
Taras Shevchenko National University of Kyiv, UA:
olga.s.meteo(at)gmail.com
Yerevan State University, Armenia:
a.aproyan(at)ysu.am

Co-funded by the European Union

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Institute for Atmospheric and Earth System Research

EDUCATION

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Pan-Eurasian Experiment
PEEX

Courses

2-5 ECTS each
35 ECTS in total
CC-BY-SA

www.climateuniversity.fi

CLIMATE UNIVERSITY


CLIMATE.NOW


SUSTAINABLE.NOW


CIRCULAR.NOW


LEADERSHIP FOR SUSTAINABLE CHANGE


SYSTEMSCHANGE.NOW


STATISTICAL TOOLS


CLIMATECOMMS.NOW

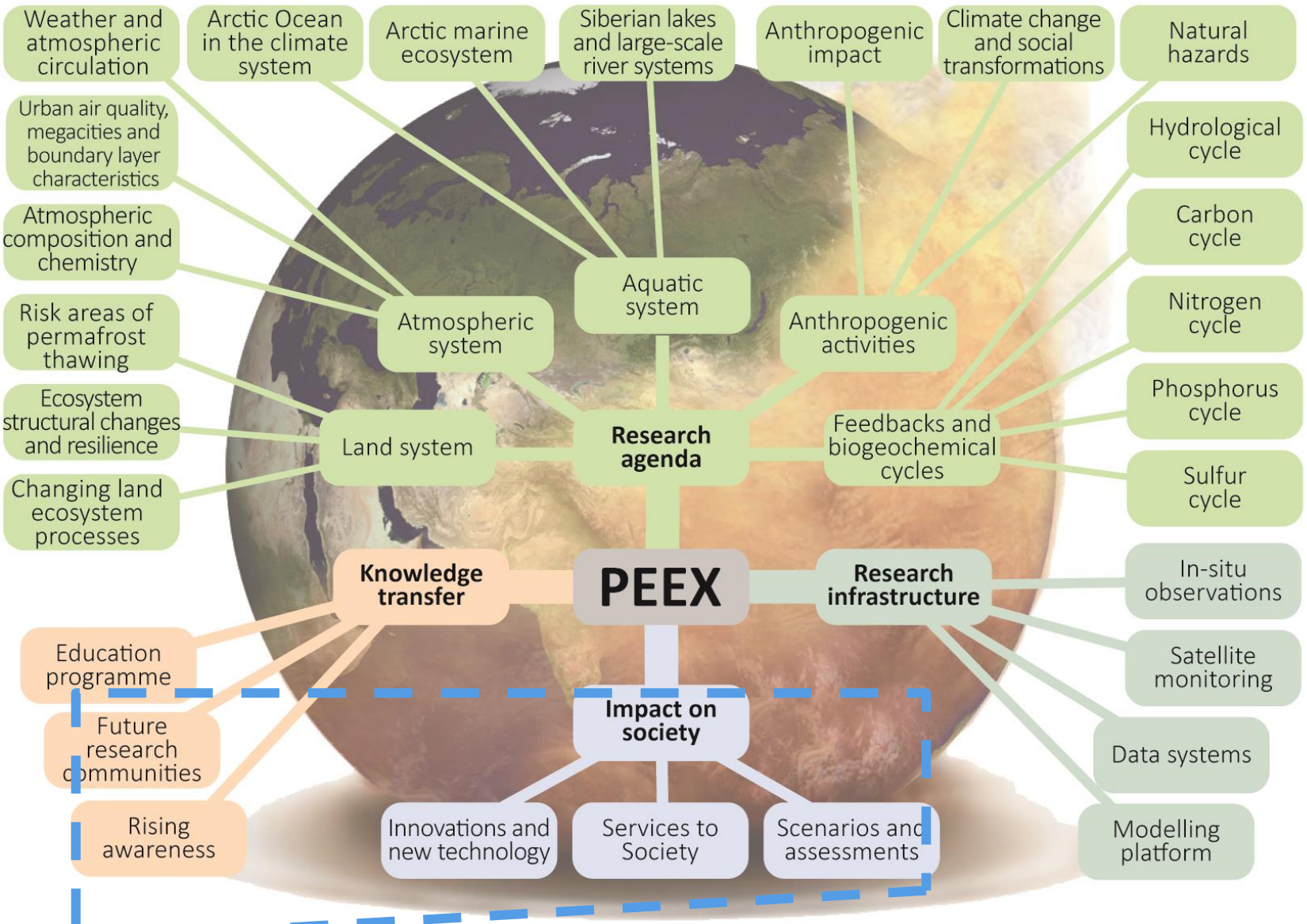

SOLUTIONS.NOW


LUKIOLAISEN ILMASTO.NYT

For contact: Dr. Laura Riuttanen (laura.riuttanen@helsinki.fi)

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

SOCIETY IMPACT



PEEX SCIENCE DIPLOMACY /IMPACT ON SOCIETY

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Gap analysis of the existing Arctic Science Co-Operations (AASCO)

HSH Prince Albert II of Monaco visited Värriö Research Station (SMEAR I) on 6 June 2023

In figure in front, from left; Olivier Wenden, Hanna Lappalainen, Mikko Sipilä, HSH Prince Albert, Erkki Parkkinen, Bernard Fautrier together with station staff, Riikka Karppinen and Jaana Bäck.

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

SAON
SUSTAINING ARCTIC OBSERVING NETWORKS

WORLD METEOROLOGICAL ORGANIZATION

UArctic
Thematic Networks

unitar
United Nations Institute for Training and Research

SIOS
SVALBARD INTEGRATED ARCTIC EARTH OBSERVING SYSTEM

CBAS

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

PEEX SCIENCE DIPLOMACY /IMPACT ON SOCIETY

The Arena for the Gap Analysis of Existing Arctic Science Co-Operations (AASCO)

White Paper

Summary of the AASCO event on February 4-5, 2025 in Monaco

https://www.atm.helsinki.fi/peex/wp-content/uploads/2025/03/AASCO_White_Paper_published260325.pdf

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

THANK YOU