



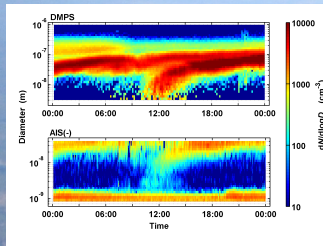
Comprehensive environmental observations and their integration into the Arctic-boreal environment.

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Finland



SMEAR II station
(boreal) 1995 -

Main message:

- 1) **Commitment to comprehensive and continuous environmental observations**
- 2) **Continuous method development (instrumentation, models)**
- 3) **Active and open collaboration across various boundaries**
- 4) **Willingness to tackle and solve grand challenges together**



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**

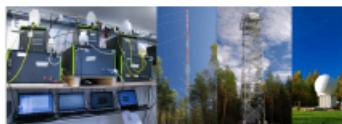
**with
comprehensive observation
network and data synthesis**

Integrative and comprehensive Understanding on Polar Environments (iCUPE): the concept and initial results

Tuukka Petäjä¹, Ella-Maria Duplissy¹, Ksenia Tabakova¹, Julia Schmale^{2,3}, Barbara Altstädter⁴, Gerard Ancellet⁵, Mikhail Arshinov⁶, Yrjö Balin⁶, Urs Baltensperger², Jens Bange⁷, Alison Beamish⁸, Boris Belan⁶, Antoine Berchet⁹, Rossana Bossi¹⁰, Warren R.L. Cairns¹¹, Ralf Ebinghaus¹², Imad El Haddad², Beatriz Ferreira-Araujo¹³, Anna Franck¹, Lin Huang¹⁴, Antti Hyvärinen¹⁵, Angelika Humbert^{16,17}, Athina-Cerise Kalogridis¹⁸, Pavel Konstantinov¹⁹, Astrid Lampert⁴, Matthew MacLeod²⁰, Olivier Magand²¹, Alexander Mahura¹, Louis Marelle^{5,21}, Vladimir Masloboev²², Dmitri Moiseev¹, Vaivos Moschos², Niklas Neckel¹⁶, Tatsuo Onishi⁵, Stefan Osterwalder²¹, Aino Ovaska¹, Pauli Paasonen¹, Mikhail Panchenko⁶, Fidel Pankratov²², Jakob B. Pernov¹⁰, Andreas Platis⁷, Olga Popovicheva²³, Jean-Christophe Raut⁵, Aurélie Riandet⁹, Torsten Sachs⁸, Rosamaria Salvatori²⁴, Roberto Salzano²⁵, Ludwig Schröder¹⁶, Martin Schön⁷, Vladimir Shevchenko²⁶, Henrik Skov¹⁰, Jeroen E. Sonke¹³, Andrea Spolaor¹¹, Vasileios Stathopoulos¹⁸, Mikko Strahlendorf¹⁵, Jennie L. Thomas²¹, Vito Vitale¹¹, Sterios Vratolis¹⁸, Carlo Barbante^{11,27}, Sabine Chabrillat⁸, Aurélien Dommergue²¹, Konstantinos Eleftheriadis¹⁸, Jyri Heilmä¹⁵, Kathy S. Law⁵, Andreas Massling¹⁰, Steffen M. Noe²⁸, Jean-Daniel Paris⁹, André Prévôt², Ilona Riipinen²⁰, Birgit Wehner²⁹, Zhiyong Xie¹² and Hanna K. Lappalainen^{1,15}

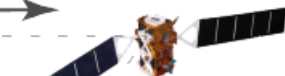
Atmospheric
Chemistry
and Physics
Discussions
Open Access
EGU

GROUND-BASED



4D TARGETED CHEMICAL & MICROPHYSICAL DETAIL
POINT-LOCATION
TIME SERIES

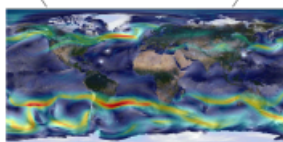
SATELLITES



FREQUENT, GLOBAL
SNAPSHOTS;
E.G. AEROSOL
AMOUNT & AEROSOL
TYPE MAPS, PLUME &
LAYER HEIGHTS

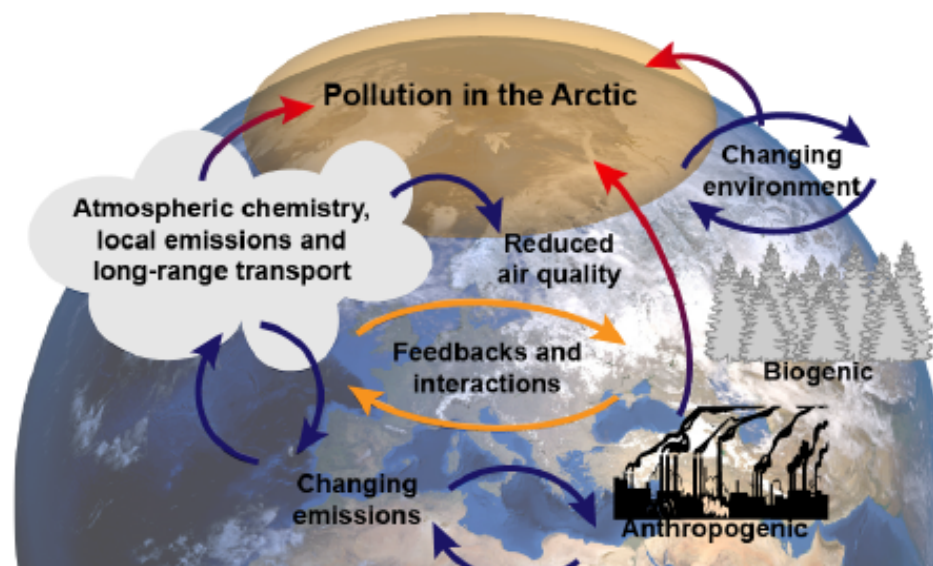
CURRENT STATE
INITIAL CONDITIONS
ASSIMILATION

MODELS



MODEL VALIDATION
PARAMETERIZATIONS
CLIMATE SENSITIVITY
UNDERLYING MECHANISMS

SPACE-TIME INTERPOLATION,



iCUPE

<https://www.atm.helsinki.fi/icupe/>

Integrative and Comprehensive Understanding on Polar Environments
ERA-PLANET Strand 4
The EU Framework Programme for Research and Innovation
Horizon 2020



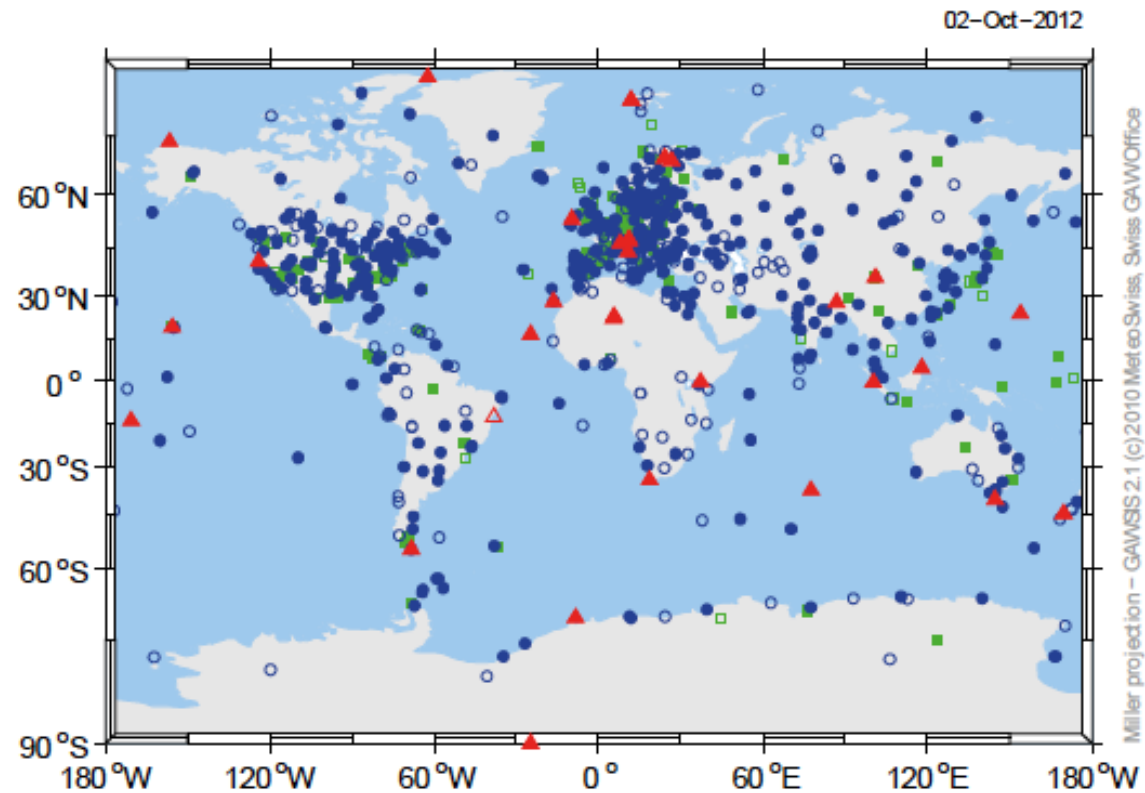


Aerosols, Clouds, and Trace gases Research Infrastructure - European ESFRI research infrastructure

- ACTRIS provides data and research, instrument, industry, and training services for the various user groups
- ACTRIS consists of observing stations, exploratory platforms, instrument calibration centres, data centre, and Head Office
- ACTRIS implementation is led by Finland and UHEL and FMI contributes to ACTRIS Head Office, Data Centre and have several ACTRIS national stations



The Global Atmospheric Watch (GAW) Network



▲ GAW Global Station ● GAW Regional Station ■ Contributing Station
Open symbols denote closed or inactive stations.



TROPOS

Pan Eurasian Experiment (PEEX) analysis of existing capacity → capacity building in education, training, instruments, new stations for regional representation



WG: T. Petäjä, I. Bashmakova, A. Borisova, P. Alekseychik, H.K. Lappalainen, A. Mahura, N. Altimir, S. Chalov, P. Kontantinov, N. Zaitseva + many active stations



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.

Nature Comment (2018), Nature 553, 21–23



Many developing countries, such as Mongolia, have rural economies, so projects that can provide farmers with up-to-date agricultural information are crucial.

Steps to the digital Silk Road

Sharing big data from satellite imagery and other Earth observations across Asia, the Middle East and east Africa is key to sustainability, urges Guo Huadong.

Nature Comment (2018), Nature 554, 25-27

Sharing big data from satellite imagery and other Earth observations

Global SMEAR and Digital Belt & Road - DBAR

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Atmospheric nucleation / clustering processes

I Small clusters and molecules

- No direct connection to NPF
- Very slow growth

II Critical size for clustering

- Sulphuric acid and amines
- Slowly growing (<1 nm/h)
- Determines $J_{1.5}$

III Growing clusters

- Low-volatile organics
- Rapidly growing (~ 2 nm/h)
- Nano-Köhler
- Determines J_3

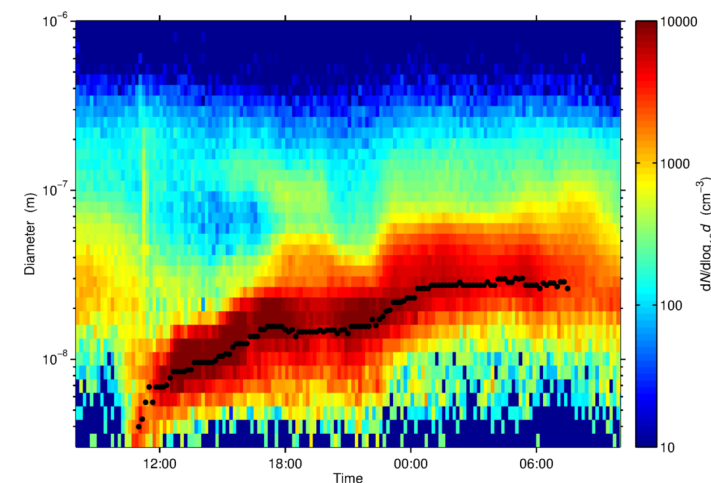
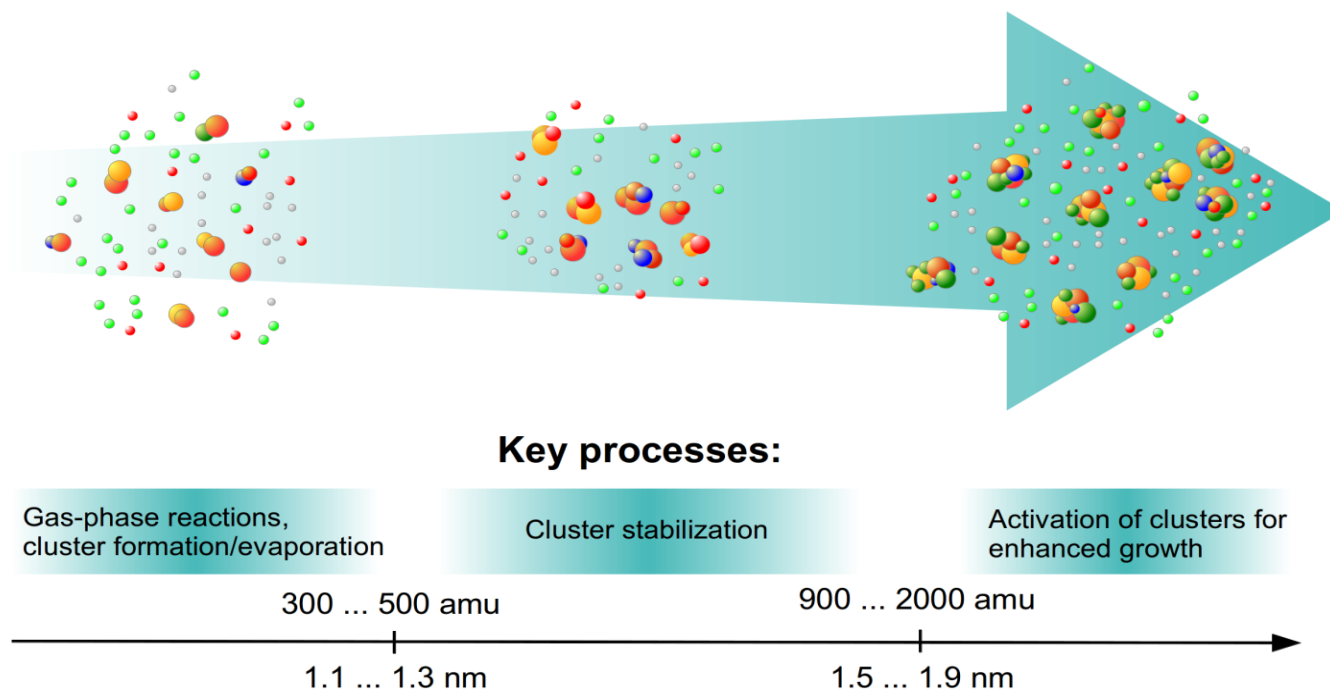
Connection to clouds and precipitation: see

BAECC

A FIELD CAMPAIGN TO ELUCIDATE
THE IMPACT OF BIOGENIC AEROSOLS
ON CLOUDS AND CLIMATE

Petäjä et al. (2016)

Bull. Am. Met. Soc.



BUCT / HAZE supersite: Lab construction and facilities



- May 2017, the lab was a chemistry lab for education;

Lab construction and facilities



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- Nov 2017, the lab was renovated

Lab construction and facilities



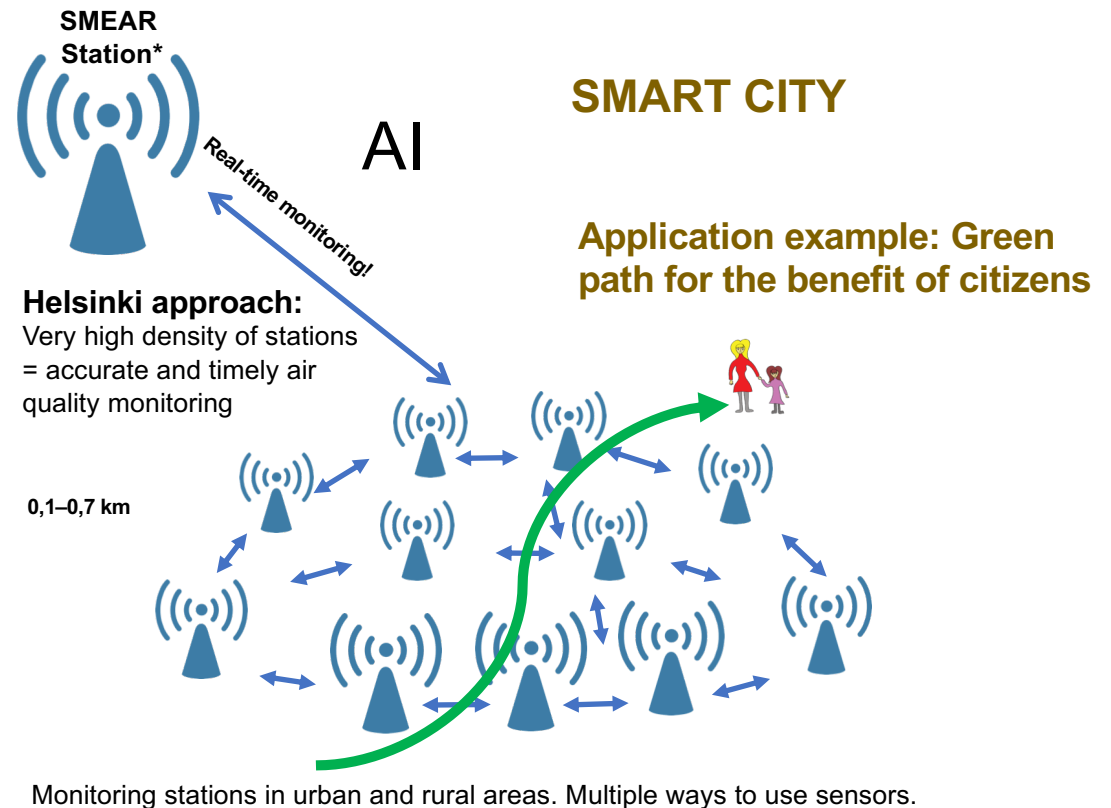
- May 2017, the lab was a chemistry lab for education;
- Nov 2017, the lab was renovated
- Feb 2018, the lab is well equipped with start-of-the-art instruments

HIGH DENSITY OF MEASUREMENT STATIONS & AUTOMATICALLY CALIBRATED SENSORS PROVIDING REAL-TIME MEASUREMENT DATA

- Low cost mini- & micro-sensors and base stations across the environment supported by 4G NB-IOT network leading to a viable 5G service
- Field calibration by highly accurate atmospheric science SMEAR Station

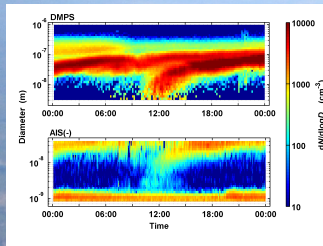
Enables multiple applications:

- City planning, health and wellbeing, wearable and fitness devices, vehicular technology, mobile apps, HD-maps
- High quality maps and calibration technique that takes into account correlations across environments.



SMEAR* = Station for Measuring Earth Surface-Atmosphere Relations (SMEAR)

<https://www.atm.helsinki.fi/SMEAR/>



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(boreal) 1995 -





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Vipuvoimaa
EU:lta
2014–2020



Euroopan unioni
Euroopan aluekehitysrahasto

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Prof. Tuukka Petäjä

- Full Professor of experimental atmospheric sciences
- Vice director of INAR institute
- Head of aerosol laboratory, Head of SMEAR research infrastructure
- Pan Eurasian Experiment (PEEX) Science director
- over 350 peer reviewed publications, 17 in Nature or Science
- H-factor 66, total number of citations over 18000
- Vaisala award for development of scientific instrumentation for nanoparticles and trace gases
- Thompson Reuters Highly cited scientist since 2014
- Academician, International Eurasian Academy of Sciences

