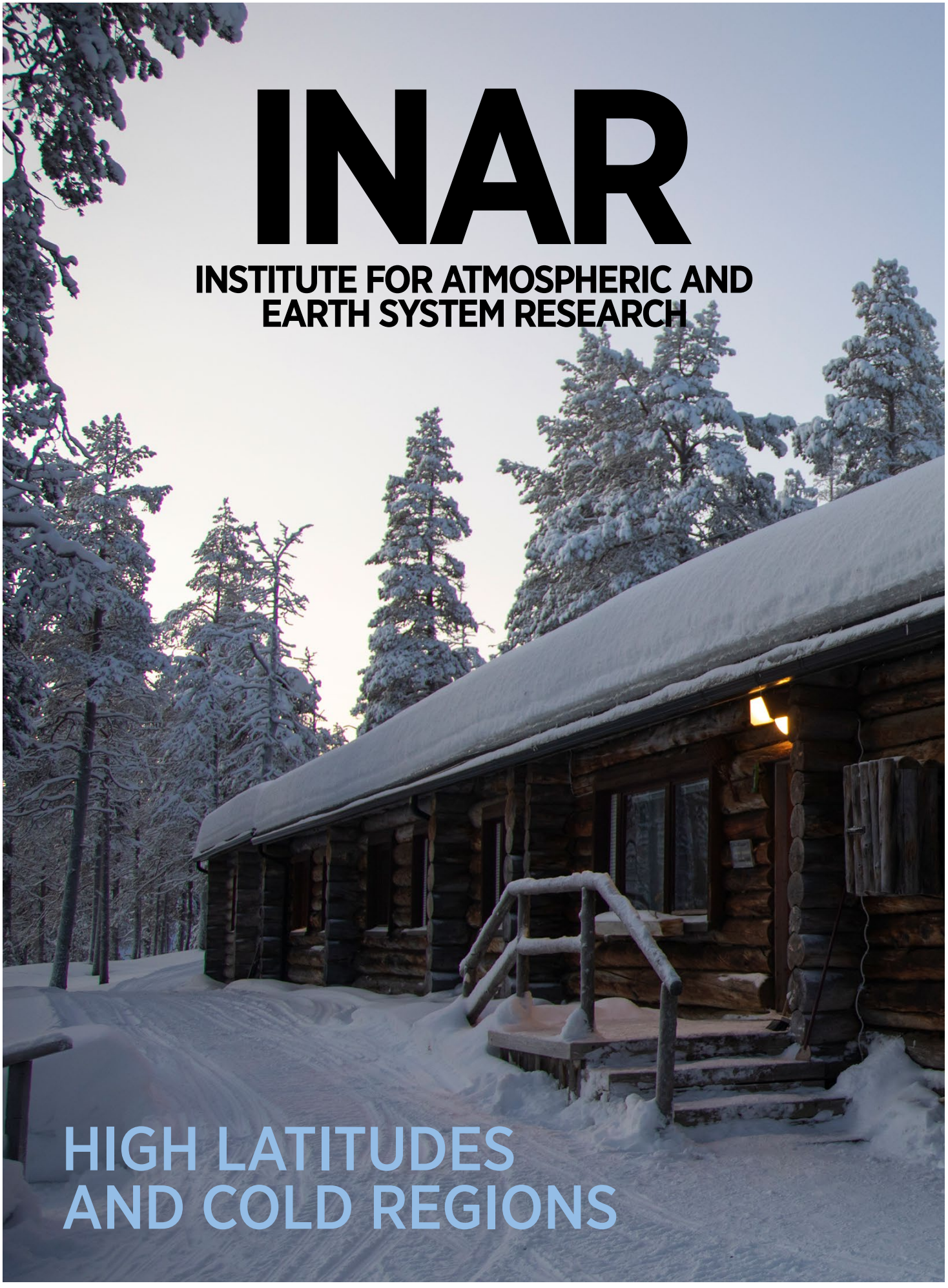

INAR

INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

HIGH LATITUDES AND COLD REGIONS

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

INAR'S PRESENCE IN THE POLES AND COLD REGIONS

We are facing 'Global Environmental Challenges' that include hazardous air quality, food and fresh water scarcity, ocean acidification, and loss of biodiversity. These Challenges are a peril to human well-being and the security of future generations.

The Cold regions of Earth are particularly experiencing an enhanced response to a changing climate, such as thawing and melting of ice, which in turn changes surface albedo, endangers fresh water sources and ground stability, and enhances natural greenhouse gas emissions.

The rise in temperature in the Arctic are opening new possibilities for increased human activities in the region. As a result, we can expect increasing urbanization, and an impact to the air quality. Global trade activities in the region will multiply if the northern sea route opens for shipping between the Atlantic and Asia's Far East. There is prospect of extracting major natural resources such as oil, natural gas and minerals in the North, which would introduce further natural and social consequences.

However, these environmental challenges do not stand isolated in our world; they are interlinked throughout the Earth System in what we term the Global Grand Challenges. In order to fully understand these challenges, we need to integrate and expand current Earth observations efforts using multidisciplinary science and international collaboration.

With this aim, the Institute for Atmosphere and Earth System Research (INAR, University of Helsink) has been actively building a research and research infrastructure network at national, Nordic, European and global scales. INAR international research efforts include short-term campaigns to establishing longterm research infrastructures in every continent, including Arctic and Antarctica (see Polar Research).

INAR coordinates and provides data for European environmental RIs monitoring the ecosystem, such as ICOS (Integrated Carbon Observing System; monitoring greenhouse gases), ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure), and AnaEE (environment monitoring) as well as other international collaborations working in the Polar regions (e.g INTAROS, GEOSS) (see INAR in Collaborations).

INAR is working to enhance our Earth System understanding with excellent science, and to serve for policy-making and innovations.

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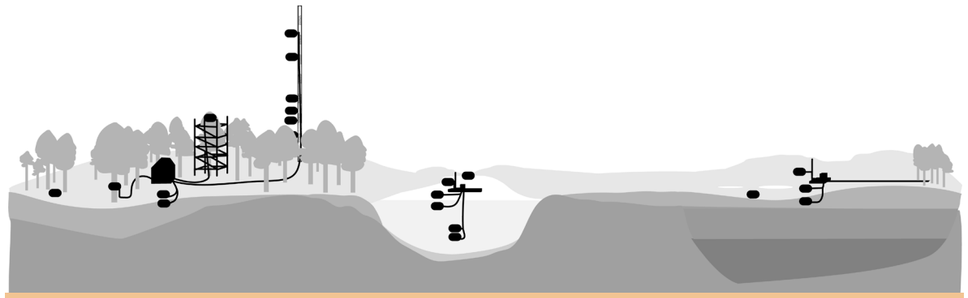
Editor and Layout: Stephany Mazon

SMEAR STATIONS



Why the Northen Regions:
The arctic boreal region, especially the arctic coastal lines and Siberia, is crucial for understading global climate. Permafrost thawing and Arctic sea ice changes will have multiple environmental (greenhouse gas emissions, air quality), economic (energy production, extraction of minerals, traffic and shipping activities, infrastructures) and societal (urbanization, cultural changes) consequences. This area will undergo substantial changes during next 40 years.

Värrio SMEAR I
SMEAR-I Värriö station is the main station of INAR's Arctic research. SMEAR I offers versatile atmospheric ecosystem measurement data for research use (open data https://avaa.tdata.fi/web/smart).

The **SMEAR ("Stations Measuring Earth Surfaces and Atmosphere Relations")** station concept is based on a comprehensive, integrated measurement system in operation 24/7, tracking long-term continuous environmental and key ecosystem parameters. The concept was developed at the flagship observatory "SMEAR II" station in Finland (61°51' N, 24°17' E) with the world's longest and most comprehensive measurement series of atmospheric aerosols and energy flows since 1995.

GlobalSMEAR initiative takes the SMEAR station concept and upscales it worldwide. Ground data from GlobalSMEAR can combine with remote sensing data, laboratory experiments, computer models assimilated together with machine learning tools to enable us to understand and to quantify land – atmosphere – ocean feedbacks under the changing climate, to solve the air quality at a regional and global scales and to use the data for early warning systems. *GlobalSmear website.*

There are currently 7 locations hosting a SMEAR-based stations: Northern boreal-Arctic regions: SMEAR national network (SMEAR I-Värriö, SMEAR II-Hyytiälä, SMEAR III-Kumpula and SMEAR IV-Kuopio); Hemi-boreal region: SMEAR-Estonia, and Megacities: Nanjing and Beijing (China).

INAR ARCTIC INITIATIVES

Pan-Eurasian Experiment PEEX

Arctic-Boreal HUB

AASCO Arena for the Gap Analysis of the Arctic Science Co-Operation

The Pan-Eurasian Experiment (PEEX) is an extensive research collaboration network involving Russian Arctic research institutes and stations. In connection with the broader Earth-atmosphere interaction research. The program will also develop a network of Arctic and Boreal monitoring stations based on the SMEAR concept. The PEEX network includes Arctic cooperation with China, e.g. Through the GEOSS Cold Regions & High Mountains activity. *Website: www.atm.helsinki.fi/peex/*

U-Arctic Thematic Network, The Arctic-Boreal Hub, led by INAR is an extension of the PEEX cooperation network, which covers Arctic universities and activities through the U-Arctic community and provides a Forum for the presentation of research. *UArctic website.*

"Arena for the Gap Analysis of Existing Arctic Science Co-Operations" (AASCO) 2020-2021.
AASCO take places as a high-level, high-visibility international Arctic forum working towards an integrated understanding of the Earth system in the Arctic, in particular its feedback system relating the atmosphere, ocean and land components. AASCO is working to bridge the scientific research communities working on the Arctic. AASCO is funded by the Prince Albert Foundation. *AASCO website.*

INAR POLAR RESEARCH

INAR is actuvily involvd in international measurement campaigns and expedition. In addition, INAR exports its own aerosol measuring devices to various Arctic research sites, contributng to building up the Polar research infrastructures .

Svalbard

Ny-Ålesund (2017 - present), 78°55”30’N 11°55”20’E

Solving secondary aerosol (particle) formation pathways and effect of future sea ice loss, sea ice as source of aerosol-relevant chemistry.
Read: Beck, L. et al., Geophysical Research Letters, 48, e2020GL091334

Greenland

Villum Research Station (2015, 2019 - present), 81°43”00’N 17°47”57’W.

The Villum Research Station (VRS) in Northernmost Greenland is located in Station Nord. Instrumentation allows for the investigation of atmospheric particle physics and chemistry with influences from the Arctic ocean.
Read: Sippilä, M., et al., Nature 537, 532–534 (2016)

MOSAiC Expedition

Multidisciplinary drifting Observatory for the Study of Arctic Climate (2019-2020)

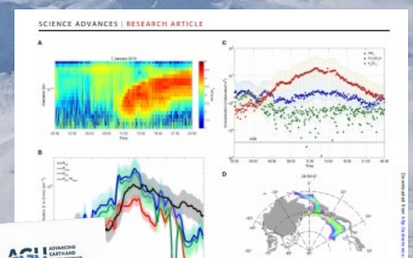
Coined the “largest Arctic expedition in History”, MOSAiC is a 1-year long research cruise expedition. Instrumentation is carried onboard the research cruise as well as adjacent to the ship in a mobile, temporary installation on top of the floe. In total, over 500 researchers from 20 countries are involved onboard and more behind the scenes for a project aimed at better understanding climate change in the Arctic. Website: mosaic-expedition.org/

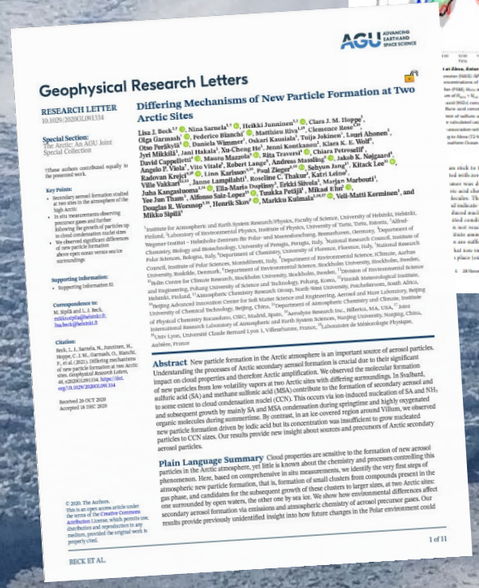
Nepal Himalayas (Third Pole)

Himalayas (Nov-Dec 2014), 27°57’ N, 86°48’ E
Collaboration of INAR with PSI and Italian CNR, with the aim to understand the mechanism behind new particle formation at 5000 m.
Read: Bianchi, F., et al., Nat. Geosci. 14, 4–9 (2021)

Antarctica

Aboa (2014 - 2015; 2021-2022), 73°02”32’S 13°24”26’W
Marambio (2018, 2022-2023), 64°14”27.65’S 56°37”36.31’W
Neumayer III (2018 - 2019), 70°38”42’S 8°15”51’W
Focuses on sources of cloud condensation nuclei (CCN) and cloud formation, as well as ice nucleation and ice nucleating bacteria, among other.
Read: Jokinen et al., Sci. Adv. 4: eaat974, (2008)
Järvinen et al. Atmos. Chem. Phys., 13, 7473–7487 (2013)





INAR PROJECTS

iCUPE (Integrative and Comprehensive Understanding on Polar Environments)
(2017 - 2020)
iCUPE is a project under the ERA-PLANET (European network for observing our changing planet).

Delivered iCUPE Datase
iCUPE provides open datasets to wider communities of research, stakeholders, decision-makers, and ends-users. These include ground-based measurements for particle number, black carbon and ozone concentration; occurrence, transport and exchange fluxes of emerging organic contaminants in snow, ice, and water of the Arctic regions; vertical and horizontal variability of the atmospheric boundary layer aerosol using unmanned aerial systems.
In total, +20 datasets are delivered (acess here: https://www.atm.helsinki.fi/icupe/index.php/datasets/list-of-datasets-as-deliverables).

On-going:

ATM-GTP (2017 - 2022)
Atmospheric Gas-to-Particle conversion
To understand the first steps of atmospheric aerosol particle formation and growth, the critical atmospheric processes relevant to global climate and air quality, and the COBACC (Continental Biosphere-Aerosol-Cloud-Climate) feedback loop that is important in Arctic and boreal regions.

GASPARCON (2017 - 2022)
Molecular steps of gas-to-particle conversion: From oxidation to precursors, clusters and secondary aerosol particles.
To resolve the atmospheric oxidation processes that convert volatile trace gases to particle precursor vapours, clusters and new aerosol particles by developing new methods and instrumentation techiniques.

AcroBEAR (2020 - 2023)
Arctic Community Resilience to Boreal Environmental change: Assessing Risks from fire and disease
Aims to asses the impact and spread of fire-sourced particulate and ozone air pollution as well as natural-focal disease (NFD) occurrence across three high latitude regions (Alaska, Eastern Siberia, Sweden) and the pan-Arctic regio; to develop an understanding of their impact. severity and capacity for resilience among local communities.

CHAPAS (2020 – 2024)
CHAsing Pre-industrial AeroSol
CHAPAs is studying aerosols in pristine environments like the Arctic and Siberia as a proxy to help scientists quantify the ways in which new aerosol particles form and grow, pointing to pre-industrial aerosol nucleation mechanisms that could enhance the accuracy of climate models.

ACFA (2021 – 2024)
Antarctic Climate Forcing Aerosol
Aims to understand climate-forcing properties of Antarctic aerosols, atmospheric processing and long-range transport of aerosols, as well as the interaction of aerosols with radiation and clouds. It compares 3 sites: high altitude Concordia, in land Aboa, and sea level Marambio sites.

Molecular understanding on the aerosol formation in the high Arctic (2020-2024)
The aim is to merge and utilize data collected from Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition and two complementary stationary sites in the Arctic, at Ny Ålesund, Svalbard and at Villum, Greenland.

Outreach:

Hack-the-Arctic
Arctic hackathon (March 2021)
Hack the Arctic was a 48-hr online hackathon open to public participiation to use Arctic environmental data to design a service or project for society, policy-making or research. The eventwass co-organised by INAR, ICOS Head Office, and the ENVRI Community.

HACK THE ARCTIC

INTERNATIONAL COOPERATION IN COLD REGIONS

INTAROS aims to develop an efficient integrated Arctic Observation System by extending, improving and unifying existing and evolving systems in the different regions of the Arctic.

The INTAROS Data Catalogue contains data collected/compiled by partners in different regions of the Arctic. Dataset themes include marine ecosystems, ocean, sea ice, atmosphere, terrestrial, glaciology, natural hazarads and community-based monitoring.

Website: www.intaros.eu/
INTARAOS Data Catalogue: https://catalog-intaros.nersc.no/

GEOSS: Global Earth Observation System of Systems (GEOSS) gathers forces from international institutions, organizations and industry. The aim is to facilitate the open access of Earth observation data and pro-cessing systems. It is an initiative of the GEO (Group on Earth Observations) multi-national community.
The GEOSS Portal is an online open platform for data and analytical software packages.

Website: www.earthobservations.org
GEOSS Portal: www.geoportal.org/

SIOS is a regional observing system for long-term measurements in and around Svalbard addressing Earth System Science questions. SIOS integrates the existing distributed observational infrastructure and generates added value for all partners beyond what their individual capacities can provide. INAR is a full member of SIOS.

Website: https://sios-svalbard.org/
SIOS Knowledge Centre: https://sios-svalbard.org/Services

SAON: the Sustaining Arctic Observing Networks (SAON) is an initiative of the Arctic Council and the International Arctic Science Committee.

Its goals (ref: SAON Strategy 2018-2028) are to:

1. "Create a roadmap to a well-integrated Arctic Observing System;
2. Promote free and ethically open access to all Arctic observational data;
3. Ensure sustainability of Arctic observing."

Website: www.arcticobserving.org/

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