

ARCTIC DATASETS IN THE INAR'S INTERNATIONAL COLLABORATION

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INTRODUCTION

The INAR is leading the Pan-Eurasian EXperiment (PEEX; www.atm.helsinki.fi/peex) initiative as an international, multi-disciplinary, multi-scale programme focused on solving interlinked global challenges influencing societies in the regions of the Northern Eurasia, including selected Arctic regions. The PEEEX Research Infrastructure's (RI) building blocks are linked to in-situ observations, remote sensing/ satellite monitoring, data systems and modelling activities. The RI has 3 components: observation component, data component and modelling component. According to the PEEEX Science Plan (PEEX, 2015) the RI main aims are: (i) to establish and sustain long-term, continuous and comprehensive ground-based, air/seaborne research infrastructures linked with remote-sensing data; (ii) to develop new datasets with continuous, comprehensive data flows; and (iii) to implement validated and harmonized data products for models of different spatio-temporal scales and –processes in focus. Observations networks will produce large volume of raw data to be pre/processed and analysed as well as delivered in a form of datasets (or products) to the research and stakeholders/end-users communities. Several steps taken are discussed here, and include an overview (as PEEEX-e-Catalogue) of measurement capacity of existing stations, linkages to Integrated Arctic Observation System (INTAROS) and Integrative and Comprehensive Understanding on Polar Environments (iCUPE).

METHODS AND RESULTS

In-Situ Atmospheric-Ecosystem Collaborating Stations

Although more than 200 stations are presented in the PEEEX regions of interest, but so far only about 60+ Russian stations have metadata information available (peexdata.atm.helsinki.fi - under request). The station metadata enables to categorize stations in a systematic manner and to connect them to international observation networks, such as the World Meteorological Organization - Global Atmosphere Watch Programme (WMO-GAWP), China Ecosystem Research Network (CERN), and perform standardization of data formats. As part of the INAR activities with Russian partners, an electronic catalogue was published (PEEX, 2019; as a living document; last updated in June 2019) to be updated with new information on stations and new stations joining the PEEEX network). The e-catalogue (www.atm.helsinki.fi/peex/index.php/peex-russia-in-situ-stations-e-catalogue) introduces information on measurements and contacts of the Russian stations in the collaboration network. The catalogue aim is to

promote research collaboration and stations as partners of the collaboration network and to give wider visibility to the stations activities.

Integrated Arctic Observation System

From 200+ stations (in total) 11 Russian stations in the Arctic region were selected for the Integrated Arctic Observation System (INTAROS; intaros.nersec.no) Atmospheric, Terrestrial and Cryospheric parts/themes. The updated metadata were obtained for these measurement stations located within the Russian Arctic territories. Metadata include basic information, physico-geographical and infrastructure description of the sites and details on atmosphere and ecosystem (soils–forest–lakes–urban–peatland–tundra) measurements. For the atmospheric part, the measurements for meteorological parameters such as the air temperature, relative humidity, wind speed and direction, precipitation; and for the terrestrial and cryospheric parts, the measurements for temperature profiles of the soil/ peat layers, and soil/ peat temperature profile down to the bed rock (bore hole) can be provided. Measurements at these sites represent more local conditions of immediate surrounding environment and datasets (as time-series) are available under request.

To demonstrate ("show case") capabilities of observational s capabilities, the detailed analysis results for selected Russian station (Marre-Sale) was performed. These include inter-annual, month-to-month and diurnal cycle variabilities of meteorological and ecosystem parameters, which are underlying climatic and environmental changes observed in the Arctic regions of Russia. Moreover, trends of selected meteorological parameters were also analysed for about 100 meteorological stations located in the northern and Arctic latitudes.

In total, about 50 datasets (including those from UHEL/INAR: links to SMEAR-I station meteorology-pollution-ecosystem data and PEEEX-e-catalogue metadata for in-situ atmospheric-ecosystem collaborating stations of Russia) are presented now in the INTAROS web-based catalogue (catalog-intaros.nersec.no/dataset) by organizations contributed, related research themes/ topics, data formats, and types of licenses (majority under the Creative Common Attribution). Themes includes atmosphere, ocean, sea ice, marine ecosystem, terrestrial, glaciology, natural hazards, and community-based monitoring. As for SMEAR-I (Station for Measuring Atmosphere-Ecosystem Relations) station, being a part of the INAR activities, it was set up in 1991. Programme includes meteorological (wind speed and direction, air temperature and relative humidity), radiation (global, reflected, net), chemistry/aerosols (CO₂, SO₂, O₃, NO_x, etc.); ecosystem, photosynthesis, irradiance related measurements (detailed information on measured parameters including instruments - www.atm.helsinki.fi/SMEAR/index.php/smea-1/measurements).

Integrative and Comprehensive Understanding on Polar Environments

The datasets (in total about 20) as products for researchers, decision- and policy makers, stakeholders and end-users communities will be produced as part of the Integrative and Comprehensive Understanding on Polar Environments (iCUPE; www.atm.helsinki.fi/icupe/index.php) activities. All these datasets are expected to be publicly available for different applications. Focusing on the Arctic region territories, the planned datasets will include novel data on anthropogenic contaminants in snow and ice cores and organic contaminants in the air-snow-water; concentrations of different chemical species and aerosols as well as their characteristics including vertical profiles; various atmosphere-hydrosphere-cryosphere-etc. related parameters in the Arctic based on ground-airborne-satellite-etc. platforms; near-real time parameters of the Arctic Research Infrastructures; others. Some datasets will focus on selected areas in northern latitudes, others - on geographical locations (measurement sites). A list of expected datasets is presented at <https://www.atm.helsinki.fi/icupe/index.php/datasets/list-of-datasets-as-deliverables>.

These planned datasets are promoted to larger science and public communities through so-called dataset "teasers" (www.atm.helsinki.fi/icupe/index.php/submitted-datasets). For Arctic regions, these include "promotional" materials on fractional snow cover area in selected sites of Svalbard islands; proxies for mixing layer height, condensation sink and gross primary production; dataset for ground-validation of precipitation measurements in high-latitudes; atmospheric mercury speciation and isotope observations; time series of lake size changes; concentration of organic contaminants, mercury and other heavy metals in annual snow and shallow core records; source apportionment of organic aerosols including source regions; occurrence, transport and exchange fluxes of emerging organic contaminants; small-scale vertical

and horizontal variability of the atmospheric boundary layer aerosol using unmanned aerial systems; absorption coefficient/ equivalent black carbon standardized dataset for long term impacts; continuous vertical observation of aerosol and cloud properties; and others. These also include those from the iCUPE Russian collaborators for the Russian Arctic: atmospheric mercury measurements at Amderma station; elemental and organic carbon over the north-western coast of the Kandalaksha Bay of the White Sea; micro-climatic features and Urban Heat Island intensity in cities of Arctic region; and others.

Since Dec 2018, so far, datasets on emerging organic contaminants in air/snow/water, anthropogenic contaminants in snow/ice cores, near-real time aerosol absorption measurements from selected regions/ locations of the Arctic were delivered (www.atm.helsinki.fi/icupe/index.php/datasets/delivered-datasets), and more are expected during 2019-2020. Majority of archived datasets (as products) are directly linked (and downloadable) at website, and corresponding Read-Me files are available with detailed description and metadata information included. Following data management plan, UHEL will maintain these datasets accessibility, and the raw data to be hosted and maintained by the datasets providers.

Selected datasets are also to be tested and integrated into several platforms. One of these is linked to COPERNICUS services. COPERNICUS is the largest data provider. To facilitate and standardize access to Copernicus data, there are 5 cloud-based online platforms known as the Data and Information Access Services (DIAS). These will provide mass storage and handling of data as well as centralized access to data, processing tools, and relevant information. The DIAS platforms (CREODIAS - creodias.eu; SOBLOO - sobloo.eu; MundiWebServices - mundiwebservices.com; ONDA - www.onda-dias.eu/cms; and WEKEO - www.wekeo.eu) allow users to explore, process, and download Copernicus data and information as well as have ability to process and combine with data from other sources. It is also possible to develop and host new applications in the cloud. Other tested platforms for pre/post-processing/analysis data include the Virtual Laboratory, VLab (vlab.geodab.org) Google Earth Engine (earthengine.google.com), Polar Thematic Exploitation Platform, Polar-TEP (portal.polartep.io), EUROGEOSS Geo Discovery and Access Broker (www.eurogeoss-broker.eu). Moreover, datasets can be also interlinked with the INTAROS web-catalogue (catalog-intaros.nersc.no/dataset).

CONCLUDING REMARKS

All types of observations (in-situ, satellite, etc.) are of critical importance for understanding processes and changes occurred in different environments including atmosphere, hydrosphere, biosphere, etc. All produced datasets are of practical importance and applicability for various models verification, and in particular those of the PEEEX-Modelling-Platform (www.atm.helsinki.fi/peex/index.php/modelling-tools-demonstration). Moreover, the PEEEX, INTAROS and iCUPE datasets and catalogues will be demonstrated and promoted during upcoming research training events such as intensive courses and young scientist summer schools (Apr and Aug 2020, in St.Petersburg and Moscow, Russia) on multi-scale processes modelling, observations and assessments for environmental applications.

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REFERENCES

- PEEX (2015): Pan-Eurasian Experiment, PEEEX Science Plan. Eds. H.K. Lappalainen, M. Kulmala, S. Zilitinkevich. ISBN 978-951-51-0587-5, ISBN 978-951-51-0588-2 (on-line), 307p, www.atm.helsinki.fi/peex/images/PEEX_SP_27052015.pdf
- PEEX (2019): PEEEX In-Situ Atmospheric-Ecosystem Collaborating Stations – Russian Federation ; e-Catalogue, version of June 2019; https://www.atm.helsinki.fi/peex/images/PEEX_catalogue_June_2019_Optimized_Locked.pdf
- Mahura A., T. Petäjä, H.K. Lappalainen, G. Oblogov, A. Vasiliev, A. Borisova, I. Bashmakova, N. Altimir, S. Chalov, P. Konstantinov, J. Bäck, L. Järvi, A. Ojala, J. Pumpanen, S.M. Noe, E-M. Duplissy, F. Pankratov, V. Shevchenko, M. Varentsov, A. Baklanov, I. Ezau, S. Zilitinkevich, and M. Kulmala (2019): Linking PEEEX with Russian Arctic observations and datasets. Abstracts Book of the Arctic Year of Polar Prediction (YOPP) Science Workshop (14-16 Jan 2019, Helsinki, Finland), pp. 50-51
- Mahura A., H.K. Lappalainen, G. Oblogov, A. Vasiliev, A. Borisova, I. Bashmakova, N. Altimir, S. Chalov, P. Konstantinov, J. Bäck, T. Petäjä, S. Zilitinkevich, and M. Kulmala (2019): Russian Arctic in the PEEEX Observational System. Geophysical Research Abstracts, Vol. 21, EGU2019-10987
- Mahura A., R. Makkonen, P. Poutanen, H.K. Lappalainen, T. Petäjä, M. Boy, M. Kulmala, S. Zilitinkevich (2019): TRAnsferable Knowledge and Technologies: Measuring Ecosystem-Atmosphere Relations and Multi-Scale Modelling for Assessment and Management of Environmental Impact. Geophysical Research Abstracts, Vol. 21, EGU2019-12584