Ny-Ålesund Atmosphere Flagship Program: Collaboration and new directions in atmospheric research in Svalbard and the wider Arctic

The project is a combined project (workshops and network)

Submitted by Norwegian Polar Institute

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Besides the core project group for this proposal, the Science steering committee and the working group leaders of the Atmospheric flagship program will contribute actively to the project

Excellence

Atmospheric research in Ny-Ålesund and in Svalbard taking part in the Atmosphere Flagship (http://nysmac.npolar.no/research/flagships/atmosphere.html) activities has increased in diversity and magnitude during the recent years. The Flagship program has proven to be unique and efficient channel to bring together international atmospheric research community active at Svalbard. Currently there is more than 150 scientists, young researchers and graduate students active within Atmospheric flagship. During recent years it also expanded beyond Ny-Ålesund and includes institutes and scientists working at Hornsund, Longyarbyen and Barentsburg. Thanks to the support from SSF we could also develop close connections with atmospheric research team from Aarhus University active at Villum Station in North of Greenland. Active atmospheric research at Ny-Ålesund centered on long-term studies of atmospheric compositions and meteorology attracted number of research teams, e.g. from Finland (University of Helsinki), Switzerland (PSI, ETH Zurich), USA (University of Alaska) complementing the existing program. The atmospheric flagship represents a unique platform for coordination of the research and scientific exchange in terms of join data analysis, publications, identification of gaps, and related joint planning of future research and activities to minimize the environmental footprint.

Summary of major achievements of the Atmospheric flagship in recent years:

- Establishment and active work in eight working groups: **WG1:** Clouds, humidity and precipitation, **WG2:** Atmospheric long-term observations and trends, **WG3:** Boundary layer meteorology, **WG4:** Snow-atmosphere-aerosols interactions, **WG5:** Atmospheric aerosols, **WG6:** Surface UV irradiance and ozone column, **WG7:** Atmospheric composition, **WG8:** Middle and upper atmosphere
- Development of metrology calibration laboratory at Ny-Ålesund
- Establishment of an open Atmospheric-Snow research platform at Gruvebadet
- Integration of observations and data analysis from Gruvebadet, Zeppelin Observatory, The Climate Change Tower, AWIPEV Observatory, including in-situ and remote sensing.
- Week long Atmospheric Flagship workshop at AWI Potsdam, Germany (2018)
- Atmospheric flagship meeting, metrology and Black carbon workshops side events during SSC 2019 in Oslo
- Support to number of short individual visits between partner institutions
- Coordination of observational activities and field logistics related to MOSAiC project 2019-2020

During last two years there is also a number of join publications related to Atmospheric flagship activities:

- Role of biogenic organics in chemical composition of Arctic aerosol [*Choi et al.*, 2019]
- Black carbon and ionic species deposition to snow [*Jacobi et al.*, 2019]
- Aerosol properties observed at Svalbard and northern Greenland [*Dall'Osto et al.*, 2019]
- Annual variability of ice nucleating aerosol particles [*Wex et al.*, 2019]
- Cloud classification using remote sensing and radiosoundings [*Vassel et al.*, 2019]
- Aerosol-cloud interactions based on in-situ observations at Zeppelin Observatory [*Koike et al.*, 2019]
- Long-term observations of cloud condensation nuclei [*Jung et al.*, 2018]
- Optical and radiative properties of black carbon [*Zanatta et al.*, 2018]
- Radiative impact of biomass burning [*Lisok et al.*, 2018]

Achievements of the Atmospheric flagship program demonstrate that the collaboration in atmospheric research is increasingly successful. It significantly contributes towards fulfillment of the SSF strategic objectives and will play an important role in further SIOS development in coming years.

Flagship consortium and partners roles in the project

The Atmosphere Flagship Program has a chair, a co-chair and a scientific committee consisting of representatives from institutes active in atmosphere research in Svalbard. Currently the chair is Radovan Krejci from Stockholm University, and co-chair is Stephen Hudson from Norwegian Polar Institute. The scientific committee is asked for input and advice on the flagship activities. In addition, each of the eight WGs have a WG leader, which is responsible for the arrangements and discussions during the thematic WG meetings/workshops. The flagship maintains an email-list, and information on all flagship activities are distributed to this list and are open for all. The flagship encourages a bottom up-approach on the work, and welcomes all initiatives that supports collaboration and/or sharing of data and expertise.

National and/or international collaboration

The Atmospheric flagship program is a join international effort involving following core institutions active at Ny-Ålesund, Hornsund and Barentsburg stations:
Norwegian Polar Institute (NPI), Norwegian Institute for Air Research (NILU), Alfred Wegener Institute (AWI, Germany), Stockholm University (Sweden), National Research Council (CNR, Italy), National Institute of Polar Research (NIPR, Japan), Korean Polar Research Institute (KOPRI, Korea), Polish Academy of Sciences, Arctic and Antarctic Research Institute (AARI, Russia), Institute of Atmospheric Physics – Chinese Academy of Sciences, National Centre for Antarctic and Ocean Research (NCAOR, India).
In addition there are number of other partners mainly from universities active in Atmospheric flagship program, e.g., University of Florence and University Perugia (Italy), University of Tokyo (Japan), University of Grenoble (France), Saint Petersburg University (Russia), The University Centre at Svalbard - UNIS, The Arctic University of Norway – UiT, University of Life Sciences (Norway), University of Cologne (Germany), University of Bremen (Germany), University of Silesia (Poland), University of Southern Bohemia (Czech Republic)

Objectives

The Atmosphere Research Flagship Program will continue to bring scientists studying the atmosphere in Ny-Ålesund together to develop existing and establish new collaborations and joint research actions to tackle the challenge of climate change in the Arctic. The major unifying research themes for future development of the Atmospheric Flagship within the proposed project will be:

- Using the comprehensive set of observations and analytical tools to better understand processes controlling Arctic atmosphere properties, boundary layer meteorology, anthropogenic and natural influence on atmospheric composition and climate
- Joint analysis of long-term trends in numerous atmospheric parameters towards better understanding the magnitude and rate of changing environmental conditions in the Svalbard region

During past years the Atmospheric flagship activities were naturally driven to a large degree by individual working groups. The WGs are now well established and to further support integration and new ideas across the WGs we want to expand the focus from individual WGs to selected targeted scientific questions and goals in addition to major unifying themes presented above. The specific objectives of this proposal are the following:

1) Atmospheric observations and join data analysis from the MOSAiC IOP 2019-2020
2) Artic winter atmospheric composition, aerosol and cloud properties
3) Emerging new pollutants in the Arctic
4) Quantification and uncertainties in precipitation observations
5) New observing platforms
6) Further development of metrology laboratory and standardization of meteorological observations
7) UV observations and network
8) Work towards establishment of snow, precipitation and aerosol sample archive for future studies
9) Open atmospheric flagship bi-annual workshop in 2021.

Atmospheric observations and join data analysis from the MOSAiC IOP 2019-2020

The MOSAiC expedition (https://www.mosaic-expedition.org/) is the largest international scientific project to study the Arctic environment. Comprehensive set of observations will be carried out year round onboard and on the sea ice close to Polarstern icebreaker. The atmospheric component is an important part of the project. Long-term observation at Svalbard and namely in Ny-Ålesund complement the MOSAiC observational program and provide unique long-term perspective. Atmospheric observational program in Ny-Ålesund has been increased and intensified for 2019-2020 to fill the known gaps. As a result, there will be available unique comprehensive data set on atmospheric composition, aerosols, clouds and meteorology. Our plan is to carry out joint analysis within the Atmospheric Flagship and on a later stage together with the MOSAiC team.

Key collaborators: AWI (M. Maturilli, C. Ritter), NPI (S. Hudson), MET-NO (D. S. Vikhamar, K. Isaksen), SU (R. Krejci, P. Tunved, Paul Zieger,Claudia Mohr), CNR (V. Vitale, M. Mazzola, B. Petkov), NCAOR (Satheesan), U. Tokyo (M. Koike), NIPR (Y. Tobo, Y. Kondo, J. Inoue), Kitami Institute of Technology (K. Sato), Chiba U. (T. Takano), Kyushu U. (H. Okamoto), Kochi University of Technology (T. Hashino), IGF PAS (M. Lewandowski), KOPRI (S. J. Park, B.-M. Kim, Young Jun Yoon), Uni Cologne (K. Ebel)

Artic winter atmospheric composition, aerosol and cloud properties

Although research activities in the past mainly focused on Arctic Haze phenomenon and on conditions during Arctic spring – autumn period, during recent years it has been recognized that warming of the Arctic climate is most pronounced during winter. We want to focus on data analysis of wintertime observations of aerosols, clouds, meteorology and long-wave radiation to better understand the aerosol-cloud-radiation interactions in winter and develop a process understanding of main driving mechanisms of accelerated winter warming in Svalbard region.

Key collaborators: AWI (M. Maturilli, C. Ritter, A. Schultz), NPI (S. Hudson), MET-NO (D. S. Vikhamar, K. Isaksen), SU (R. Krejci, P. Tunved, Paul Zieger,Claudia Mohr), CNR (V. Vitale, M. Mazzola, B. Petkov), NCAOR (Satheesan), U. Tokyo (M. Koike, N. Moteki), NIPR (Y. Tobo, Y. Kondo, J. Inoue) , Kitami Institute of Technology (K. Sato), MRI (N. Oshima, K. Adachi), Nagoya U. (S. Ohata, Matsui. H.), Chiba U. (T. Takano), Kyushu U. (H. Okamoto), Kochi University of Technology (T. Hashino), IGF PAS (M. Lewandowski), KOPRI (S. J. Park, B.-M. Kim, Young Jun Yoon), Uni Cologne (K. Ebel)

Emerging new pollutants in the Arctic

There is an increasing need to quantify and understand the behavior of persistent organic pollutants (POPs) and new emerging pollutants in the Arctic environment. AMAP Assessment report from 2016 “Chemicals of Emerging Arctic Concern (CEAC)” has identified a number of organic pollutants important for the Arctic environment, e.g.: per and polyfluoroalkyl substances (PFAS), brominated and chlorinated flame retardants (B/CFR), Short chain chlorinated paraffins (SCCPs), Siloxanes, polychlorinated naphtalenes (PCN), Peentachlorophenol (PCP), Polycyclic Aromatic Hydrocarbons (PAH), polychlorinated biphenyls (PCB), micro- and nanoplastics. The initial work on this subject will focus on better understanding of temporal variability, trends and source apportionment.

Key collaborators: NMBU (R. Kallenbron), HZG (Z. Xie) NILU (O. Hermanssen)

Quantification and uncertainties in precipitation observations

Quantification of precipitation is one of the key parameters to understand process of atmospheric deposition of water, nutrients and air pollutants. It is exceptionally demanding task at high latitudes where large fraction of precipitation is in a form of snow. This will be addressed by following actions: There is number of precipitation measurements in Ny-Ålesund and results from different instruments and methodology will be compared to assess the variability. Based on the available data correction adjustment parameters for losses and sampling efficiency will be derived.

Key collaborators: UGA/CNRS (H.-W. Jacobi), EC Lyon (C. Larose), NP (J.-C. Gallet, C.A. Pedersen), CNR (V. Vitale, R. Salvatori, A. Spolaor), Uni. Florence (R. Udisti), AARI (B. Ivanov), Saint-Petersburg Uni. (P. Sviashchennikov), NIPR (K. Goto-Azuma, Y. Kondo, T. Aoki), U. Tokyo (M. Koike), IGF PAS (B. Luks), MetNo (M.A. Wolff), NCAOR (N. Murukesh), NILU.

New observing platforms

Together with the proposed new Norwegian Airborne Research Facility ForskAIR we will explore new possibilities in a field of airborne in-situ and remote observations relevant to science within Atmospheric Flagship. Airborne observations complement ground based measurements with information about spatial variability, mainly in vertical scale. It is also excellent tool for validation of various remote sensing techniques including lidars and radars. The deliverable will be identification of the most suitable platform and key parameters, which can be observed from ForskAIR platforms and are relevant for atmospheric research.

Key collaborators; SU (R. Krejci, P. Zieger), AWI (M. Zanatta), CNR (V. Vitale), ForskAIR (I.M. Larsen, M Gausa)

Further development of metrology laboratory and standardization of meteorological observations

Here we plan to promote and use the existing metrology laboratory at Vaskerilabet at Ny Ålesund. Currently it is equipped with tools for calibration of temperature and atmospheric pressure sensors. So far the metrology laboratory was used mainly to calibrate sensors at Climate tower operated by CNR. Within this project we plan intercalibration of air temperature sensors across the whole Ny Ålesund Research Station. We also plan to exploit possibility to develop also precipitation gauge calibration toolkit.

Key collaborators; INRIM (A. Merlone, G. Coppa), CNR (A.Viola), Justervesenet (Å.F. Olsen, R.A. Bergerud)

UV observations and network

Svalbard provides a great opportunity for studying the short- and median-term variations in the ozone column since the polar day allows obtaining continuous time series within a period of several months. The main goal of the planned collaboration is to study the relationship between the UV variations and the changes in the ozone column and the meteorological factors. The time-series from Ny-Ålesund, Barentsburg and Hornsund, in operation for more than 20 years, provide datasets that allow statistically significant analysis of the UV and ozone behavior. In addition, a new station with similar observations was established in Longyearbyen. Following the UV observations intercomparison in 2018 we plan to continue in harmonization of the UV measurements and in join data analysis.

Key collaborators: CNR (B. Petkov), NILU (T. Svendbly, G. Hansen), AWI (M. Maturilli), IGF PAS (P. Sobolewski), USB (J. Elster), MU (K. Láska), MGO (A. Solomatnikova), NP, AARI

Establishment of snow, precipitation and aerosol sample archive for future studies

Scientific and instrumental development together with changes in air pollution sources and emissions brings the need and interest in characterization of new pollutants and compounds in the environment. One of the limiting factors is that it seldom is available samples for retrospective analysis to assess the pollutants concentration in past. Currently there is an archive sampling program at Zeppelin Observatory using simple passive sampling method. We would like to do feasibility and methodological study to see if it possible to extend the sample archive with routine samples of atmospheric aerosol, precipitation and snow together with the Environment Specimen Bank (https://miljoprovebanken.no).

Key collaborators: NILU (O. Hermansen, K. Tørnkvist), NPI (S. Hudson), SU (Radovan Krejci), CNR (V. Vitale), NMBU (R. Kallenbron)

Atmospheric flagship bi-annual workshop in 2021.

The past atmospheric flagship workshops in 2014, 2016 and 2018 established a key scientific forum where the atmospheric research community meet every two years. The workshops have been a week-long event

providing enough space for plenary talks and discussion, sub-meetings within the different workgroups or on specific topics or project objectives. This arrangement offers possibilities for the individual scientists to pop in and out of the themes of interest. Within this project we plan to organize an open Atmospheric Flagship workshop in spring 2021 at KOPRI, The Republic of Korea. So far all workshops have been arranged in Europe and we believe that the meeting in The Republic of Korea will strengthen collaboration and involvement of scientists from Asia. The workshop will be organized back-to-back to The Polar Symposium organized by KOPRI. Objectives of this project will also be main themes for the workshop. Special focus will be directed to join data analysis and publication of the results from the MOSAiC IOP 2019-2020.
Key collaborators: SU (R. Krejci), NPI (S. Hudson, C.A. Pedersen), KOPRI (Y.J. Yoon), Atmospheric flagship Science Committee

Impact

Added value of the network project or workshop

The proposal is a continuation of a decade long effort to coordinate atmospheric research at Svalbard and a direct continuation of several SSG Ny-Ålesund flagship programmes projects during last years. The added value of the project, which will be very difficult to achieve otherwise, is summarized in the following items:
1) Integration of and further developing and strengthening the atmospheric research flagship program.
2) On broadening the thematic coverage including new emerging fields on atmospheric science relevant to the Svalbard region.
3) Exploiting synergy with MOSAiC project and results obtained during IOP 2019-2020
4) Development of long-term sustainable aerosol sampling for sample archive.
5) Coordinate and support scientific exchange through short-term visits, small groups thematic meetings and one large Atmospheric Flagship bi-annual workshop.

Relevance and benefit to society

The Arctic is experiencing rapid environmental change, faster and more pronounced than elsewhere on the globe. Climate and related changes in atmospheric properties and composition are in the core of the problem. Without understanding atmosphere, the most dynamic and variable “sphere” in the Arctic system, and processes driving the change, we will not be able to properly assess the impact and future evolution. This is also of key importance for local inhabitants, plans to Arctic exploration, sea shipping, etc.

Environmental impact

We plan to have three small and one large workshop. The selection of meeting locations will be done to minimize the air travel and number of travel days. Where feasible, all preparations and communication will be carried out through travel-free means, e.g. Skype, Zoom. On a more long-term perspective, increased coordination, collaboration and better communication within atmospheric research community in the Arctic decreases the environmental footprint in the Arctic itself. The observations can be planned more efficient and through data exchange we can avoid unnecessary replications of measurements.

Implementation

The frame of implementation is provided through milestones and work plan section of project form.

Resources, expertise, distribution of roles and cooperation

The Atmospheric Flagship is the core forum, collaboration and meeting platform for atmospheric research in Svalbard. It brings together leading groups and researchers active in this field. The Atmospheric flagship has a formal structure with a chair and co-chair and eight working groups depending on scientific interests. This proposal and its objectives are a direct outcome of the process addressing cross-WG research questions and needs. To keep the Atmospheric flagship as a living community and to develop it further is strongly dependent on the applied for SSG funds.