# Ny-Ålesund Atmosphere Flagship Program:
# Further development and strengthening of the collaboration

**The proposal is prepared by a sub-group of the Atmosphere Flagship on behalf of the flagship**

The Ny-Ålesund Atmosphere Flagship is one of the four Ny-Ålesund flagship programs. The main goal of the Atmosphere Flagship is to coordinate the atmosphere research and related activities conducted by several institutes from more than ten countries in Ny-Ålesund. This proposal aims on further developing and strengthening the atmosphere flagship program, and on broadening the thematic coverage to exploit scientific potential well beyond the level achievable by individual groups or institutes. To be able to keep up the good pace, the Flagship is dependent on the SSG funds to continue to arrange annual meeting places for the scientists.

## Relevance to the call

Current 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. Besides more and more comprehensive long-term observational effort, there have been numerous short terms intensive field experiments with additional ones planned in future. The majority of activities are complementary. Thus, 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 has increasing potential. This proposal aims at achieving scientific progress and research integration beyond the possibilities of the individual institutes. It will be achieved through collaboration and coordination of the atmosphere research with Ny-Ålesund being in its center. In addition to the groups active in Ny Ålesund, scientists and institutes working in Longyearbyen, Barentsburg, Pyramiden and Hornsund have been an important and integrated part of the flagship. Researchers from these communities have participated in the workshops and contributed to research activities. This collaboration will be further explored to better understand the atmosphere over Svalbard region on a broader scale. The Atmospheric Flagship will pay attention to support new initiatives and invite additional collaborators active in atmospheric research at Svalbard. e.g. middle and upper atmosphere research, activities associated with UNIS and the newly established Czech Arctic station in Longyearbyen. As before, the atmosphere flagship program is open to all scientists interested in or working on atmosphere science questions in Ny-Ålesund, on Svalbard, and beyond.

In following section, also summarizing the Atmospheric flagship achievements, it is demonstrated that this concept has shown to be increasingly successful. It can significantly contribute towards fulfillment of the SSF strategic objectives and play an important role in future efforts, e.g. SIOS in its upcoming operational phase.

## Achievements and contributions of the Atmospheric Flagship Program during the last years

This application is building on previous Atmosphere Flagship activities and it is following recommendations and agreements achieved at the Potsdam workshop in October 2014 (SSG grant 236782/E10), the Atmosphere Symposium during the Ny-Ålesund week in Tromsø in September 2015 (grant 246733/E10). Further development of the program was achieved thanks to the two years SSG grant (257652/E10) during 2016 and 2017. In autumn 2016, more than fifty scientists convened in Kjeller for a week-long workshop to identify relevant topics and plan data analysis. The progress and results have been then reviewed at (i) a on-site workshop organized at Ny Ålesund in spring 2017 and (ii) at the workshop held during Svalbard Science Conference in Oslo in November 2017. The main scientific achievements during the past two years can be summarized:

- Establishment of metrology calibration laboratory at Ny Ålesund
- Integration of micrometeorological and flux observations
- Analysis of long-term tropospheric humidity using radiosondes (Maturilli, 2016)
- Synergy of activities with intensive field experiments (e.g. ACLOUD 2017, new aerosol particle formation campaign in summer 2017)
- Join analysis of biomass burning plume episode in June 2015 (Markowicz , 2017; Moroni, 2016)
- Join work on aerosol and cloud properties from Zeppelin Obs. and Gruvebadet (Dall'Osto, 2017)
- Characterization of interannual and seasonal variations of lead potential source areas (Bazzano, 2016).
- Aerosol vertical distribution (e.g. Ferrero et al 2016)

- Pan-Arctic aerosol size distribution analysis (Freud et al, 2017)
- Joint with Glaciology flagship work focused on black carbon along glaciers (Spolaor et al, 2017)
- Development of a joined snow sampling protocol and establishment of a common snow sampling site close to the Gruvebadet installations. Initiation of joined winter-over snow sampling and analysis.
- The imitative UV-ICARE (supported by SSG) to establish a network along Svalbard in relation to surface UV measurements and ozone.
- A summary of the surface UV and ozone column observations (Hansen, 2017). Variability features associated with ozone column and surface UV irradiance observed over Svalbard from 2008 to 2014.

## Plans for further developments of the Atmospheric Flagship Program during the project period (including an implementation plan)

The Atmosphere Research Flagship Program will continue to bring scientists studying the atmosphere in Ny-Ålesund together to establish and develop collaboration 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 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
- Join analysis of long-term trends in numerous atmospheric parameters towards better understanding the magnitude and rate of changing environmental conditions in the Svalbard region.

As previously, the work in the Atmospheric Flagship program is structured into thematic work 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

Two additional work groups have been under development for some time, and within the proposed project we plan to activate them:

**WG7:** Atmospheric composition,
**WG8:** Middle and upper atmosphere

It is obvious from the thematic focus of the working groups that they have many close links and intersections. They are not to be seen as rigid entities, and depending on how the collaboration and scientific work evolve, some groups may be merged together as well as new ones will be established. The possibilities to establish new working groups based on scientific needs, as a bottom-up approach, is open.

To facilitate and encourage the cooperation within the Atmospheric Flagship we plan to organize the following events:

- Work groups meeting in autumn 2018 and 2019

The focus will be on progress with join publications and on plans for future collaborations. The event in 2018 will also provide a forum to plan additional activities towards the MOSAiC freeze in of Polarstern project scheduled for 2019-2020. The 2018 fall WG meeting will take place in Potsdam, Germany (in-kind meeting venue kindly offered by AWI). The 2019 event will be a continuation of the work in progress and planning of the next steps to keep the Atmospheric Flagship active and growing in terms of scientific output and collaboration. The location is not jet determined. Both WGs meetings will be after the same model used in the past (Kjeller, 2016), which has proven to be very effective: a full week devoted to sub-meetings within the different workgroups, and with the possibilities for the individual scientists to pop in and out of the themes of interest.

- On site workshops in Ny-Ålesund in spring 2018 and 2019.

The main scope will be to synchronize and discuss field activities and campaigns, and exchange information about on-going experimental work performed by various institutes through on-site excursions. This on-site one-day workshop has been arranged the two previous years already. The timing has been selected as a day when as many atmosphere scientists are present in Ny-Ålesund already, and no-one have been travelling to Ny-Ålesund only for this day meeting. This event take advantage of the ongoing activities to create more synergies without increasing the environmental footprint.

- Fund for guest travel

The flagship would like to continue the possibility to offer travel funds to individual scientists to visit each other to intensify common work on data analysis and joint publications.

- Contribute to the SIOS State of Environmental Science in Svalbard (SESS) report

The flagship will contribute to the first pilot SIOS SESS report. This activity is already funded by SIOS.

The main anticipated and quantifiable output of this proposal is:

- Establishment of two new work groups (atmospheric composition, middle and upper atmosphere)
- WG meetings in 2018, 2019 to plan and carry out join data analysis and identifying join publications
- Planning joint field work to minimize the environmental footprint.
- On-site meetings in Ny-Ålesund to increase knowledge on each others work and monitoring
- Jointly published articles
- Delivering metadata on ongoing atmosphere measurements to relevant systems like SIOS, RIS etc.

**Promoter of open data and metadata sharing**

There is a strong request from the atmosphere community to collect and make metadata on ongoing long-term observations available to promote the free and open sharing of data, to increase collaboration which again decrease the environmental footprint of the activities. The Atmosphere Flagship has been a pioneer in collecting available information on on-going atmosphere monitoring, and have since more than five years maintained a list of these (available on the Flagships webpage under Documents). The flagship urge to work together with SIOS and/or SSF/RIS to get this information into the appropriate metadatabase system, and we believe the next two year period will show a breakthrough in this respect.

## Anticipated work and activities for the work groups (WG).

**WG1: Clouds, humidity and precipitation**

Collaborators: SU (H.-C. Hansson, R. Krejci, P. Zieger), AWI (C. Ritter), KOPRI (S. J. Park, B.-M. Kim), CNR (M. Busetto, M. Mazzola), Univ. Perugia (D. Cappelletti), NCAOR (Satheesan), NPI (S. Hudson), NIPR (M. Shiobara), LaMP (O. Jourdan), U. Tokyo (M. Koike), IGF PAS, Uni. Cologne, Uni. Frankfurt, Uni. Bremen, Saint-Petersburg Uni. (P. Sviashchennikov)

This WG focuses on following scientific questions related to Arctic clouds: (i) What are the main driving forces for cloud formation? (ii) What are seasonal trends in cloud properties, their distribution and precipitation? (iii) Link in-situ observations with remote sensing tools. (iiii) How does the local orography affect cloud formation and type? Detailed existing observations of clouds and aerosols from Ny-Ålesund and Zeppelin Observatory together with an expanding network of meteorological observations around Ny-Ålesund will be used to investigate key processes controlling cloud formation and properties and their spatial and temporal variability. Newly established observations of vertical wind and LES modelling will be used to understand local orographic effects on cloud formation. Radiosounding profiles together with remotely sensed water vapor distribution and cloud properties form the basis for analysis of cloud vertical distribution analysis. Observations from tethered balloons with cloud observation payloads will provide a basis to study variability and heterogeneity of low-level clouds using in-situ data.

**WG2: Atmospheric long-term observations and trends**

Collaborators: AWI (M. Maturilli), NP (S. Hudson), AARI (B. Ivanov), Saint-Petersburg Uni. (P. Sviashchennikov), MET-NO (D. S. Vikhamar, K. Isaksen), SU (H.-C. Hansson, P. Tunved), CNR (M. Mazzola, B. Petkov), NCAOR (Satheesan), NIPR (M. Shiobara), Chiba U. (T. Takano), Tohoku U. (K. Yamada), Kyushu U. (H. Okamoto, K. Sato, T. Hashino), IGF PAS (M. Lewandowski).

Many parameters observed in Ny-Ålesund and in Svalbard region has now reached temporal coverage on a climatic scale (~30 years or more). The scope of this WG is to analyze these observations on a temporal context of long-term changes in Arctic climate. The overarching theme is to understand how the environment character is changing from polar to marine. Related activities will be (i) the analysis of atmospheric long-term measurements in terms of the warming Arctic, (ii) the combination of observations from a wider Svalbard region, Relevant oceanographic records as sea surface temperature, salinity and sea ice properties will be also be included. This WG will link other WGs on a basis of trend analysis. The WG will invite also modeling groups to the scheduled workshops who may contribute to the interpretation of the observed trends (e.g. on topics such as transport to the Arctic, radiative transfer, and the hydrological cycle) and in turn provide robust data for model validation. Last, this WG will be essential in contributing to the metadata collection, and to provide comprehensive info on the accessibility of the long term data sets.

**WG3: Boundary layer meteorology**
Collaborators: AWI (C. Ritter), CNR (A. Viola), KOPRI (S. J. Park, T.-.J Choi), NCAOR (Satheesan), IGF PAN (G. Karasiński, M. Bloch), Chinese Academy of Sciences (L. Zhou).
This WG focuses on understanding the processes driving the local boundary layer properties, with the aim to improve the understanding of (i) the stable boundary layer, (ii) influence and occurrence of micrometeorological phenomena, (iii) influence of surface types and properties on the boundary layer structure, (iv) coupling between local and synoptic processes. This effort will reduce the gap between observed and modelled boundary layer properties and shed a light on orographically influenced effects. Other WGs, especially WG1, WG5 and WG8 will strongly benefit from it. In Hornsund, corresponding systematic lidar sounding of the atmosphere is performed which will allow comparative analysis.

**WG4: Snow-atmosphere-aerosols interactions**
Collaborators: UGA/CNRS (H.-W. Jacobi), EC Lyon (C. Larose), NP (J.-C. Gallet, C.A. Pedersen), SU (J. Ström), 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), MRI (T. Aoki), U. Tokyo (M. Koike), Uni. of Silesia (E. Łupikasza), IGF PAS (B. Luks and colleagues), MetNo (M.A. Wolff), NCAOR (N. Murukesh), NILU.
This WG will focus on the atmosphere-snow interaction and the role of snow in recent regional and local environmental changes. Main themes are: (i) observations and trends of physical, chemical, and biological properties of solid precipitation and snow, (ii) deposition to snow, (iii) amount and vertical distribution of biological and chemical species with special attention to black carbon in the snow. Several atmospheric and snow physical parameters are already recorded by different groups at different locations around Ny-Ålesund, Barentsburg, Svea, Pyramiden, and Hornsund. This WG will closely cooperate with the Glaciology Flagship, and other SSG/SIOS funded initiatives, to integrate fully the interactions between snow and atmosphere.

**WG5: Atmospheric aerosols**
Collaborators: SU (R. Krejci, H.-C. Hansson, P. Zieger, P. Tunved), CNR (A. Lupi), U. Florence (R. Traversi, S. Becagli), Univ. Perugia (D. Cappelletti, B. Moroni), KOPRI (Y. J. Yoon, K.-T. Park), NCAOR(Satheesan), AWI (C. Ritter), NIPR (M. Shiobara, Y. Tobo, Y. Kondo), U. Tokyo (M. Koike), IGF PAS (M.Bloch).
Aerosol research is one of the most active themes of atmospheric research in Svalbard. By joining unique set of measurements, the focus will be to study complete atmospheric aerosol life cycle from formation followed by aging and transformation to cloud condensation nuclei and their interaction and removal by clouds and precipitation. Long-term data sets of aerosol chemical, optical and microphysical properties will help to understand the aerosol temporal and spatial distribution, pollution pathways and varying influence of natural and anthropogenic sources. Special attention will be on (i) new particle formation, (ii) aerosol cloud interactions, (iii) changes in aerosol sources linked to decreasing sea ice cover. This WG is closely connected to WG1 and will benefit from links to WG3 and to work related to understand the representativeness of Ny-Ålesund in WG2. Established collaboration with activities in Hornsund will be further explored.

**WG6: UV irradiance and ozone column**
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
Study of the variations in the ozone column and surface solar UV irradiance observed in Svalbard is the theme for this WG. 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 recently established in Longyearbyen. An important point in this WG will be the intercomparison campaign planned to take place in the spring of 2018 in the frame of "UV Intercomparison and Integration in a High Arctic Environment (UV-ICARE)" project (RiS 10871).

**WG7: Atmospheric composition**
Collaborators: NILU (O. Hermansen, P. B. Nizzetto), Helmholz-ZG (Z. Xie), NIPR (S. Muryama, J. Inoue, K. Adachi), KOPRI (Y. J. Joon), UiT (A. Dekhtyareva), SU (H.-C. Hansson, R. Krejci, P. Tunved)

Atmospheric composition and air pollution monitoring (Greenhouse gas (GHG) measurements, inorganic compounds including sulphuric and nitrous compounds, heavy metals and persistent organic pollutants) is the core theme of this new WG. The number of groups and sites where the atmospheric composition is studied increases steadily in Svalbard, and there is a strong potential in combining measurements from a wide range of studies. Only in Ny-Ålesund, are GHG measurements observed at four sites, POPs at two, with a additional newly established site in Longyearbyern. Thanks to the national air monitoring program lead by NILU there are continuous time series of air pollutants, some of them starting as early as in 1974. The main goals of this WG are: (i) compare already present observations and techniques, (ii) understand the long-term trends with respect to changing transport patterns and source characteristics changes.

**WG8: Middle and Upper atmosphere**
Collaborators: CNRS-IPAG (J. Lilensten), NMA (Y.L. Andalsvik), NIPR (H. Miyaoka), KOPRI (G. Jee, J.-H. Kim, C. Lee).
Svalbard is located inside of the auroral oval, a region called the "cusp", experiencing permanent income of electrons of solar origin, called the "polar rain". Combining the upper atmosphere research in Longyearbyen with similar activities in Ny-Alesund offers additional capabilities for the study of the upper atmosphere for two main reasons: (i) Ny-Ålesund is less light polluted than Longyearbyen, and (ii) the presence of permanent wintering staff allows for more refined experiments. With several newly installed instruments, there is a good ground for further development of middle and upper atmosphere research in Ny-Ålesund. This new WG will collaborate closely with WG1, WG5 since the cloud coverage is of prime importance for optical observations, and the polarization observations provide very sensitive mean to detect the presence of aerosols. It will also collaborate with WG2 on the impact of the solar activity on the climate.

## 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 on Svalbard. Currently the chair is Radovan Krejci from Stockholm University, and the flagship are in the process of selecting a new co-chair. The scientific committee is asked for input and advice on the flagship activities. In addition, each of the eight WGs have a WG leader (listed and underlined above), 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 encourage a bottom up-approach on the work, and welcomes all initiatives that supports collaboration and/or sharing of data and expertise.

## **Budget** (direct costs)

Total work group meetings 2018 and 2019: 2 x 187.5 kNOK= 375 kNOK
- Coffee, lunch and dinner: 50 pax x 200 NOK x 5 days + 50 pax x 750NOK =87.5 kNOK
- Limited travel funds for those requesting it: 10 pax x 10kNOK=100 kNOK

Travel for guest visits: 10 pax x 10 kNOK = 100 kNOK
Administration (5%): 24 kNOK
**Total direct costs applied for in this application: 499 kNOK**

**Modest estimate in-kind contribution: 802 kNOK**
- Venue costs WG meetings (2018, 2019): 50 pax x 300 NOK x 5 days x 2= 150 kNOK
- Worktime (CAP, RK): 2 pax x 0.5 month x 84 kNOK/month = 84 kNOK
- Worktime (WG leaders): 8 pax x 0.25 month x 84 kNOK/month = 168 kNOK
- Travel to meetings (science committee): 10 pax x 20 kNOK x 2= 400 kNOK

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