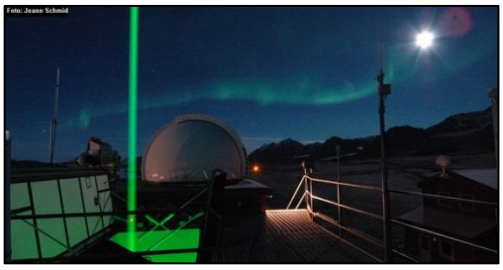
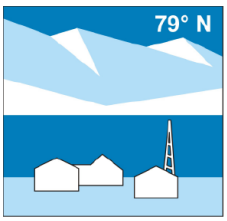



Photos from NPI, AWI and CNR

Report from the

Ny-Ålesund Atmosphere Flagship open work group meetings 3-7 October 2016

at Kjeller, Norway



Ny-Ålesund Atmosphere Flagship open work group meetings,

3-7 October 2016, Kjeller, Norway.

Schedule

Monday 3 Oct	WG1 & WG5
	Before lunch: WG1 & WG5
Tuesday 4 Oct	After lunch: Planning common field campaigns 2017
	Evening: WG meeting dinner
Wednesday 5 Oct	WG4
Thursday 6 Oct	WG2
Friday 7 Oct	Parallel session WG3 & WG6

The format of the meetings will differ due to the needs of the different working groups. The program is set up by the leader of each working group, and follows:

Ny Ålesund Atmosphere Flagship open workshop

Kjeller 3 – 7 October 2016

Program for WG1 and WG5 (3 – 4 October)

Monday 3 October

09:00 – 10:30

Welcome & Practical stuff

Young Jun Yoon (KOPRI)
"DMS-Aerosol-CCN: Interaction and climate feedbacks in Arctic atmosphere "

Paul Zieger (SU)
"Cloud and aerosol interactions in a warming Arctic - Upcoming experiments at Ny-Alesund and beyond"

Masataka Shiobara (NIPR)
"The Arctic Clouds, Aerosols and Radiation Experiment (Arctic-CARE) planned in Japan's ArCS (Arctic Challenge for Sustainability) program"

Elena Barbaro (University Ca' Foscari, Venice)
"Water soluble compounds in Arctic aerosol"

10:30 – 11:00 Coffee break

11:00 – 12:30

Andrea Spolaor (University Ca' Foscari, Venice)
"Determination of polar Black carbon and total aerosol concentration levels in non-free atmosphere: an innovative approach"

Hans-Christian Steen-Larsen (University of Copenhagen)
"Biases in the simulation of the Arctic atmospheric hydrological cycle elucidated using continuous water vapor isotope observations"

Kerstin Ebel (Köln University)
"Synergistic long-term observtions of vertically resolved cloud properties using a novel microwave radiometer/radar for Arctic clouds at AWIPEV"

Radovan Krejci (SU)
Interplay between aerosols, clouds, water vapour: Ny Ålesund perspective

12:30 – 13:30 Lunch

13:30 – 15:00 & 15:30 – 17:00

Hans-Christen Hansson (SU)
"Climate change pattern observed at Ny Ålesund: External and internal forcings"

Discussion on join data analysis and publications:
Below is a list of possible papers to start the discussion on join science and papers using data we mostly already have.
Please feel free to add additional ones.

1) *Aerosol Size Distribution analysis using simultaneous measurement series at Zeppelin and Gruvebadet. (Italian team)*
2) *Joint publication on the characteristics of CCN at the Zeppelin (KOPRI)*
3) *Joint publication on the contribution of DMS to the particle formation and growth in the Arctic Environment (KOPRI)*
4) *Combining in situ and remote sensed cloud microphysics with in situ observations of aerosols and cloud residuals at Zeppelin (SU)*
5) *Aerosol microphysics observed in-situ and with lidar: July 2015 haze event? (Christoph Ritter, AWI)*

Tuesday 4 October

09:00 – 10:30

Andreas Massling (Aarhus University)
"Continuous activities at the high Arctic Villum Research Station"

Join discussion:
What are the main scientific questions in aerosol and cloud research in the Arctic we want to address? Do we have all tools to do it? If not what is missing?

10:30 – 11:00 Coffee break

11:00 – 12:30

Continuation of morning discussion and planning of join papers & new observations of clouds and aerosols.

12:30 – 13:00 Lunch

WG2: Long-term observations and trends in temperature, precipitation, clouds and radiation		
09:00 – 09:15	Marion Maturilli (AWI)	Introduction, Meteorological stations across Svalbard
09:15 – 09:30	Sandro Dahlke (AWI)	Pan-Svalbard temperature differences in the context of Arctic Warming
09:30 – 09:50	Dagrun V. Schuler / Herdis M. Gjelten (met.no)	Long-term data series of temperature and precipitation in the Arctic
09:50 – 10:05	Marzena Osuch (Polish Academy of Science)	Changes in seasonality of air temperature and precipitation in western Spitsbergen
10:05 – 10:20	Marion Maturilli (AWI)	Looking upwards: Changes in the tropospheric column over Ny-Ålesund
10:20 – 10:30	ALL	Discussion
10:30 – 11:00	*COFFEE BREAK*	
11:00 – 11:15	Ewa Lupiskaya (Univ. of Silesia)	Changes in precipitation types in relation to changes in atmospheric circulation in Ny-Ålesund and Hornsund
11:15 – 11:30	Mareile Wolff (met.no)	Uncertainty of solid precipitation measurements [Results from WMO-SPICE]
11:30 – 11:45	Hans-Werner Jacobi (CNRS/Univ.Grenoble)	Summary WG4; long-term observations of snow height; BC on snow
11:45 – 12:00	Radovan Krejci (Univ. Stockholm)	Summary WG5; long-term aspects of atmospheric aerosols
12:00 – 12:15	Masataka Shiobara (NIPR)	Summary WG1; long-term aspects of cloud observations
12:15 – 12:30	ALL	Discussion
12:30 – 13:30	*LUNCH*	

13:30 – 13:45	Stephen Platt (NILU)	Long-term observations of trace gases at the Zeppelin mountain station
13:45 – 14:15	various contributors	Documentation of long-term observations of other parameters, e.g. - sea ice on Kongsfjord - glacier retreat - permafrost thawing - others
14:15 – 14:45	ALL	Discussion of main scientific questions to approach within WG2
14:15 – 15:15	*COFFEE BREAK*	
15:15 – 15:30	Marion Maturilli (AWI)	Data quality aspects: - Calibration Laboratory in Ny-Ålesund - International Data Networks
15:30– 16:30	ALL	Discussion / Planning of future joint activity

Focus of this WG2 meeting:

- documentation of available atmospheric long-term observations;
- merging trends of various climate parameters;
- defining concrete scientific questions as nuclei for joint analyses and publications.

Measurements that will become long-term observations in the future (e.g. data records currently shorter than ~10 years), and potential overarching scientific questions related to the other Flagship programs will likely be subject to a follow-up meeting.

WG3. Boundary Layer Research

The Boundary Layer (BL) is the part of the atmosphere in which exchange of heat, traces gases and moisture with the ground occurs. This lowest layer of the atmosphere is difficult to describe precisely in climate models. In Ny-Ålesund additionally the orography leads to a complex wind shear pattern and the different terrain types with their individual humidity and heat capacity lead to distinct micrometeorological phenomena. Generally, turbulent fluxes during stable conditions are small, hence in a long-term perspective, similar instrumentation, calibration and evaluation schemata are desired.

On the other hand different stations have already years of experience in BL research in Ny-Ålesund. New partners will follow soon.

For this reason WG-3 tries to bring together the research in this area with the aim to better coordinate activities. Joint future campaigns for process studies, the integration of new equipment into the existing infrastructure, a gap analysis, efforts for data comparability and joint publications shall be discussed. In order to obtain a representative data set on BL research for the Kongsfjord probably site specific micrometeorological considerations have to be addressed for each measurement complex. This discussion will hopefully guide a way how a comparison to modelling can be performed, links to the WG-s of snow and clouds and evolves our understanding of the representativeness of Ny-Ålesund.

WG4 Aerosols (black carbon) and snow, including snow albedo feedback

1. Data sets of long-term snow observations (Morning sessions 9:00 to 10:30 and 11:00 to 12:30)

Name	Affiliation	e-mail	Title
Grzegorz KARASINSKI & Bartek LUKS	Institute of Geophysics, Polish Academy of Sciences	gkaras@igf.edu.pl luks@igf.edu.pl	Snow research at Polish Polar Station Hornsund
Tomasz WAWRZYNIAK & Marzena OSUCH	Institute of Geophysics, Polish Academy of Sciences	twawrzyniak @igf.edu.pl marz@igf.edu.pl	Inter- and intra-annual changes of snow depth at Hornsund meteorological site
Jean-Charles GALLET	Norwegian Polar Institute	jc@npolar.no	Long-term snow and ice data on Brøggerhalvøya
Friedrich OBLEITNER	Innsbruck University, Austria	friedrich.obleitner @uibk.ac.at	Snow structure in the Kongsfjorden area and related processes (measurements and simulations)
Mareile WOLFF	Norwegian Meteorological Institute	mareilew@met.no	Snow height measurements in Ny-Alesund
Marion MATRUILLI	AWI Potsdam, Germany	Marion.Maturilli@ awi.de	Automatic snow height measurements in Ny-Alesund
Angelo VIOLA	ISAC-CNR, Italy	a.viola@isac.cnr.it	Snow measurements at the CCT
Julia BOIKE *(not present)*	AWI Potsdam, Germany	Julia.Boike@awi.de	Snow measurements at Bayelva
Heidi BACHE STRANDEN	NVE, Norway	hrb@nve.no	Measurements of snow water equivalent and experiences with a snow pillow in Ny-Ålesund
Alix REVERDY	LGGE, CNRS / University Grenoble Alpes	Alirev@gmail.com	Comparison of snow height and SWE measurements at Ny-Alesund

2. Role and the behavior of impurities in the snow (Afternoon session 13:30 to 15:00 and 15:30 to 17:00)

Name	Affiliation	e-mail	Title
Andrea SPOLAOR	Ca Foscari University of Venice, Italy	andrea.spolaor@unive.it	Monitoring the chemical composition of the annual snow in the Spitsbergen area
Elena BARBARO	Ca Foscari University of Venice, Italy	barbaro@unive.it	Evaluation the influences of solar radiation on elemental chemical composition in polar surface snow
Jean-Charles GALLET	Norwegian Polar Institute	jc@npolar.no	BC regarding the long term monitoring on Brøggerbreen and some data from Ice cores

Alia KHAN	National Snow and Ice Data Center, University of Colorado, US	alia.khan@colorado.edu	Spectral measurements of snow: searching for a spectral signature of black carbon in snow utilizing contaminated and non-contaminated sites of Svalbard, Norway
Andrea SPOLAOR	Ca Foscari University of Venice, Italy	andrea.spolaor@unive.it	Study the morphological and chemical evolution of the surface and subsurface Svalbard snow cover during the melting phase

Work Group 6: Variability in surface UV irradiance and ozone column

Ny-Ålesund Atmosphere Flagship open work group meetings, Kjeller, Norway,

7 October 2016

09:00 – 10:30 First session

Measurements of the surface solar UV irradiance and ozone column performed by NILU at Ny-Ålesund in the frame of the National ozone monitoring project (Tove Svendby, NILU).

Long-term variability in surface UV radiation over Hornsund for the period 1983-2015 derived from the reconstructed and observed time series (Piotr Sobolewski, Institute of Geophysics, Polish Academy of Science).

Effective albedo derivation from UV measurements (Hanno Müller, Institute of Meteorology and Climatology, University of Hannover)

Variability features of the ozone column and surface UV irradiance according to the observations performed by ISAC-CNR at Ny- Ålesund (Boyan Petkov, ISAC-CNR)

10:30 – 11:00 Coffee break, mineral water and fruit

11:00 – 12:30 Second session

Presentation of results yielded by preliminary analyses of the available data sets and discussion of ideas about future joint publications.

12:30 – 13:30 Lunch

13:30– 17:00 Third and Forth sessions

Discussion about applications of the expected results (validation of satellite measurements, model simulations, climate studies etc.) and eventual possibilities for further joint work in the frames of SSF or other project calls.

15:00 – 15:30 Coffee and cake

Combined report from the
Ny-Ålesund Atmosphere Flagship open work group meetings
3-7 October 2016 at Kjeller, Norway

The following work group meetings took place

WG1: Clouds, humidity, precipitation (lead: M. Shiobara, HC Hansson)
WG2: Long-term observations and trends in temperature, precipitation, clouds and radiation (lead: M. Maturilli)
WG3: Boundary layer meteorology (lead: C. Ritter, A. Viola)
WG4: Interaction of snow, atmosphere, and aerosols (lead: H.-W. Jacobi, J.-C. Gallet)
WG5: Atmospheric aerosol (lead: R. Krejci)
WG6: Variability in surface UV irradiance and ozone column (lead: B. Petkov)

Table of content

Summary of the WG1 & WG5: "Aerosols & Clouds, Humidity and Precipitation"

NySMAC – Atmospheric flagship workshop, Kjeller, Norway 3 – 7 October 2016

Participation list:

Young Jun Yoon, Paul Zieger, Angelo Viola, Mauro Mazzola, Mario Schiavon, Elena Barbaro, Andrea Spolaor, Sang-Jong Park, Nuncio Murukesh, Masataka Shiobara, Radovan Krejci, Friedrich Obleitner, Hans-Werner Jacobi, Stephan Kral, Tjarda Roberts, Ove Hermansen, Manuel Dallosto, Roland Neuber, Christoph Ritter, Hans-Christian Steen-Larsen, Kerstin Ebel, Hans-Christen Hansson, Anderas Massling.

Talks summary

Join session of WG on Clouds, Humidity and Precipitation and WG on aerosols started with set of presentations on current ongoing experimental activities and data analysis.

"DMS-Aerosol-CCN: Interaction and climate feedbacks in Arctic atmosphere " Young Jun Yoon (KOPRI).

Group from KOPRI presented results on long term observations of aerosol activation using Cloud Condensational Nuclei (CCN) counter showing strong annual cycle in number of aerosol particles available for cloud formation following annual cycle of aerosol size distribution. Observations of DMS show close link with new aerosol formation and aboundance of ultrafine particles.

"Cloud and aerosol interactions in a warming Arctic - Upcoming experiments at Ny-Alesund and beyond" Paul Zieger (SU)

Stockholm University group summarized the long term observations of aerosol microphysical properties and related data analysis. With new instrumentation the work has been extended with measurements of cloud residual particles and their microphysicla and optical properties.

"The Arctic Clouds, Aerosols and Radiation Experiment (Arctic-CARE) planned in Japan's ArCS (Arctic Challenge for Sustainability) program" Masataka Shiobara (NIPR)

Long term observations of cloud fraction show least cloud occurence during Arctic spring and thus rise additional argument for aerosol cloud studies also during other seasons. Intensive field campaign in March 2017 will focus on in-situ studies of low level clouds with special focus on mixed phase between liquid and ice phase.

"Water soluble compounds in Arctic aerosol" Elena Barbaro (University Ca' Foscari, Venice)
"Determination of polar Black carbon and total aerosol concentration levels in non-free atmosphere: an innovative approach" Andrea Spolaor (University Ca' Foscari, Venice)

Analysis of detail size segregated aerosol speciation based on samples from Gruvbadet presented concentration levels of Rare Earth Elements (REE), aminoacids and levoglucosan. Amino acids in PM10 fraction are very similar to marine aerosol. Strong correlation between Vanadium and Nickel indicates influence of oil combustion. Black carbon in snow studies from glaciers were compared to balloon borne measurements.

"Biases in the simulation of the Arctic atmospheric hydrological cycle elucidated using continuous water vapor isotope observations" Hans-Christian Steen-Larsen (University of Copenhagen)

Studies of water vapour isotope composition can help us understand the cloud activation and how water is redistributed through the troposphere.

"Synergistic long-term observtions of vertically resolved cloud properties using a novel microwave radiometer/radar for Arctic clouds at AWIPEV" Kerstin Ebel (Köln University)

Newly installed set of cloud radars and radiometers will provide broad set of remotely sensed properties of Arctic clouds, their microphysical properties, phase and spatial and temporal variability.

Interplay between aerosols, clouds, water vapour: Ny Ålesund perspective Radovan Krejci (SU)

There is a link between the aerosol number size distribution and meteorological parameters at Zeppelin, mostly with relative humidity as well as water vapour concentration. .During events of a high concentration of small particles (dominating nucleation and Aitken mode), the water vapour concentration at both Zeppelin and down by the fjord were of the same magnitude. The largest amount of small particles (around 30 nm) connected to relative humidity was found in spring for relative humidity less than 50% and in summer for relative humidity in the interval of 80 – 96%. A high aerosol number concentration is also coinciding with low RH, implying the importance of clouds and precipitation as a sink of the larger particles.

"Climate change pattern observed at Ny Ålesund: External and internal forcings" Hans-Christen Hansson (SU)

Simulations with an Earth system model with aerosol physics and chemistry show that the sulfate aerosol reductions in Europe since 1980 can potentially explain a significant fraction of Arctic warming. The Arctic receives an additional energy and warms by 0.5 _C on annual average in simulations with declining European sulfur emissions. Arctic warming is amplified mainly in fall and winter, but the warming is initiated in summer by an increase in incoming solar radiation as well as an enhanced poleward oceanic and atmospheric heat transport.

"Continuous activities at the high Arctic Villum Research Station" Andreas Massling (Aarhus University)
Overview of observations and plans at Danish high Arctic station "Station Nord – Villum"
Now when several years of observations are available from station Nord, join analysis with observations at Ny Ålesund should be one of the priorities of future data analysis.

<u>Discussion on join data analysis and publications:</u>

1) *Aerosol Size Distribution analysis using simultaneous measurement series at Zeppelin and Gruvebadet. (Italian team, SU)*
2) *Joint publication on the characteristics of CCN at the Zeppelin (KOPRI, SU)*
3) *Joint publication on the contribution of DMS to the particle formation and growth in the Arctic Environment (KOPRI, SU, Italian team)*
4) *Combining in situ and remote sensed cloud microphysics with in situ observations of aerosols and cloud residuals at Zeppelin (SU, KOPRI, NIPR, AWI)*
5) *Aerosol microphysics observed in-situ and with lidar: July 2015 haze event? (AWI, Polish team)*

WG2 on "Long-term observations and trends in temperature, precipitation, clouds and radiation" had their meeting on Thursday, 6 October 2016. Scheduled were several presentations on atmospheric long-term observations of temperature, moisture and precipitation, and their relation to the atmospheric circulation. These were complemented with contributions on long-term observations of other climate variables. After this overview of the changing climate in Ny-Ålesund, future joint activities were discussed.

Marion Maturilli presented an update on the metadata collection of the meteorological station stations across Svalbard. In a next step, the metadata collection will be handed over to Christina Pedersen with the intention to publish the information on the Atmosphere Flagship webpage.

Based on the meteorological long-term data of several stations across Svalbard, **Sandro Dahlke** highlighted the climatological differences between the stations in the eastern part of Svalbard with their more continental cold climate compared to the warmer western part of Svalbard with maritime influence. Comparing with other stations across the Arctic, he emphasized the particular location of Svalbard in the North Atlantic region of the Arctic.

Herdis M.Gjelten explained the reconstruction and homogenization of the Svalbard temperature data series, and showed that warming occurred already in the 1930s and 1950s. Though the recent warming is the strongest, the autumn season (SON) in the 1950s had temperatures almost as high as today's values. The recent temperature trend is strongest in winter, from 1979 to now amounting to 2.3 degree per decade. An analysis of 'warm' (>0°C) and 'cold' (<-10°C) days reveals a reduced variability. Furthermore, significant trends in annual precipitation sum were reported for all stations.

Instead of looking at monthly data, **Marzena Osuch** applied the MASH method (moving average over shifting horizon) to daily air temperature and precipitation from Hornsund, Longyearbyen and Ny-Ålesund. She explained that the coldest period has shifted from December-January to March-April due to the increasing temperature in winter. While the distribution of precipitation at Hornsund was homogeneous over the early years, she pointed out a maximum in precipitation occurring in autumn (Aug./Sep.) in recent years. She mentioned that within Arctic Cordex, the validation of regional model data is potentially extendable to other Svalbard data.

Continuing on atmospheric circulation patterns, **Nuncio Murukesh** highlighted that the second EOF of Dec-Jan-Feb sea level pressure anomalies for 1979-2015 was increasing (Skandinavian Blocking). He further showed an example of the Indian rain radar. It was suggested that these data could be used to check the precipitation-correction planned for the met.no data.

Ewa Lupiskaya talked about mixed, liquid and solid precipitation, stating that at Hornsund a decrease in solid precipitation frequency was found for MAM and JJA, and at the same time a decrease in solid precipitation amount was observed in MAM, JJA and DJF. Based on a circulation type classification, she linked these observations to air advection from the southern sector leading to an increase in liquid precipitation and decrease in solid precipitation.

The uncertainty of solid precipitation measurements was discussed by **Mareile Wolff** who had participated in the WMO-SPICE study. She explained that the secondary reference for these measurements was provided by an automative gauge with double fence. Several other instruments and set-ups (e.g. weighing gauges, present weather sensors, dysdrometers, different fencing arrangements) were tested revealing large differences up to 60% in solid precipitation amount. She

noted that the undercatch of solid precipitation is larger at high wind speeds, and that the uncertainty of precipitation measurements should be considered in trend analyses.

Hans-Werner Jacobi summarized the outcome of WG4 on Snow, reporting that it is planned to create a data set of long-term snow observations, including meta data etc. He pointed out the need for common averaging periods for automatic snow heights, asking for a recommendation based on potential WMO standards. Considering long term snow height data, he mentioned Hornsund (from 1982) and the Bayelva site at Ny-Ålesund (from 1998).

An overview of the WG5 on Aerosols was given by **Radek Krecji**, stating that BC was found to have a slightly decreasing trend. He mentioned that the annual cycle of aerosol number density had its minimum in October and maximum in spring, and that the aerosol number size distribution was changing with the accumulation mode mostly present in Arctic haze season, while in summer the aerosol particles are smaller (due to wash-out). He noted that a change towards a more maritime system may have an effect on aerosol since DMS is a precursor, and pointed out the importance of distinguishing between local production and transport.

Stephen Platt reported on long-term observations of trace gases on Zeppelin mountain, listing e.g. the observation of CO2 and tropospheric O3 since 1989, and the rather new observations of isotopic components to identify source regions. He brought up that a lot of trend reports are available in NILU reports, and the observational data at http://ebas.nilu.no/default.aspx. He gave an overview on local and regional methane sources, and described related activities with the OsloCTM3 global chemical transport model.

Concluding the documentation of long-term observations, several WG2 participants presented short information e.g. on cloud observations, glacier retreat, sea ice on Kongsfjord and permafrost thawing.

In the final discussion, the participants agreed on 2 activities that some WG2 members will jointly work on in the future:

(1) SNOW / PRECIPITATION [joint activity of WG2 and WG4]

- Goal: generating a common data set
- involved will be various groups in Ny-Ålesund and Hornsund, bringing in measurements of snow height, precipitation; compare with Microwave Rain Radar
- First step: decision on correction for precipitation data

(2) AEROSOLS / CLOUDS / WATER VAPOUR [joint activity of WG1, WG2 and WG5]

- decreasing sulphate / increasing water vapor
  - ➔ what does it mean for aerosol formation ?
  - ➔ what does that mean for clouds ?

  Including the following data and participants cloud cover and cloud base (NIPR), aerosols (Sweden, Italy, KOPRI), humidity & thermodynamic state, radiation (AWI), remote sensing (lidar, radar) (AWI, NIPR, Univ.Cologne), visual cloud observations (Hornsund)

Atmopheric Flagship program

3-7 /10/2016 Kieller

Summary of the WG3 (Boundary Layer)

Participants:

Angelo Viola, Mauro Mazzola, Mario Schiavon, Sang-Jong Park, Nuncio Murukesh, Masataka Shiobara, Radovan Krejci, Friedrich Obleitner, Hans-Werner Jacobi, Stephan Kral, Tjarda Roberts, Ove Hermansen, Manuel Dallosto, Roland Neuber, Christoph Ritter

In an open and vivid discussion it became clear that the boundary layer research is an important topic for the atmospheric flagship programme in Ny-Ålesund. Current work is focused on: understanding the stable boundary layer, understanding the micrometeorological processes in Kongsfjord area, improvement of profiling the atmospheric parameters in the atmospheric column. This improvement would lead to the possibility to use the data for comparison with results gathered by atmospheric numerical model at different time scale resolution. But modeling cannot avoid the important contribution to "climate budget" provided by the ocean current that is in charge to transfer the accumulated heat in the ocean from low to high latitudes and in the atmosphere.

This further new step is expected to be synergically developed to be integrated with the atmospheric measurements.

The measurements, as well as the processes in the boundary layer can be linked directly to other processes or phenomena observed in the Artcic atmosphere as snow, aerosol and clouds that have been discussed in detail in WG4 WG1 and WG5 respectively. Due to the particular orography of the Kingsbay, several important question are still unsolved, for example about the characterisitcs of the boundary layer as observed from Zeppelin station or from the village or even on the sea.

During the WG3 session brief talks were presented from the four groups which currently perform in Ny-Ålesund research in atmospheric boundary layer to describe instrumentation used, current researches and future perspective. The arguments are summarized below.

KOPRI performs measurements in the ABL in Ny-Ålesund to improve forecasts and cloud microphysics studies but they extend the interest also other regions of the Arctic.

NCAOR is interested in the hydrological cycle and uses boundary layer research to link their observations and modelling to understand precipitation in the Arctic on a large scale.

CNR is proceeding with the measurements at CCT to study the stability of ABL , and with the tethered ballon to provide aerosol profiles in and above the boundary layer. .

AWI is interested on fluxes over different terrain and on coupling between micrometeorological and synoptic processes.

Moreover 3 groups that are not present at the moment in Ny-Ålesund consider coming back in Svalbard to:

-perform ABL measurements especially over snow covered surfaces and glaciers (University of Innsbruck)

- use UAV to understand the stable boundary layer and the boundary layer over complex orography (University of Bergen among others))s

-use controlled flying balloons for meteorological measurements over and around Svalbard (CNRF).

A point in WG3 session concerning the possible joint campaigns and projects foreseen for next year was open for discussion and three ideas were proposed:

1- Improve the atmospheric profiles by using the available tethered balloons systems in a coordinated way to: a) calibrate / improve the retrieval of the remote sensing instruments b) get information along the vertical above theCCT height c) combine aerosol / cloud measurements in the boundary layer. The equipment and expertise for this is readily available.
2- Use the cable car regularly for measurements of physical and meteorology parameters and and aerosol / clouds along the slope of the zeppelin mountains. This is indeed very important to understand the influence of the slope of the mountain on the individual measurements. A modular box for different kind of observations directly connected to the cabin is desirable. Additionally also the masts of the cable car or the existing wiring for power and internet might possibly be used for the installation of a few meteorological sensors between the ground station and the Zeppelin station.
3- Assess a careful and uniform calibration of sensors and an intercomparison between different data processing procedures. In particular for what concern the turbulent fluxes that are small most of the year and hence a close comparison can only be done if the sensor calibration and the evaluation scheme are at least very similar.

Other activities related to boundary layer studies have also been presented and gaps concerning measurements have briefly been discussed.

In particular the growing expertise in using microwave radiometers will allow joint coordinated measurement programmes on the water vapour and temperature profiles to the test of new retrieval algorithms.

The new KOPRI wind lidar to be installed in the proximity of the CCT will be very useful, due to its scanning ability, to extend the wind profile above the CCTower. New Eddy Covariance measurements over ice / glaciers or a coastal site (e.g. Brandal) will be identified to better use the AWIs system currently installed at the old pier. This idea needs to be

discussed more in details between the groups interested. In any case AWI will go on with its installation on the old pier for the near future.

At the moment there are no joint publications of the Ny Alesund boundary layer group. A paper on meteorological measurements during the total solar eclipse 2015 from AWI and CNR is in preparation.

Apparently many groups will be in Ny Alesund by the last week of March 2017. This will allow the preparation of new boundary layer group meeting on site.

During the discussion it became clear that many stations are interested in understanding the Arctic climate in a more extended view. Hence it can be foreseen that even if the research in Ny-Ålesund will improve in the future, more stations at different sites will be urgently needed to decompose local and synoptic phenomena. Cooperation with Hornsund and measurements campaigns in the vicinity of Longyearbyen have been mentioned.

Working Group 4: Aerosols (black carbon) and snow, including snow albedo feedback
Summary report for the meeting on 5 October 2016 in Kjeller, Norway

The presentations and the discussions of the workshop touched upon two different, albeit connected topics: 1. Data sets of long-term snow observations and 2. Role and the behavior of impurities in the snow.
The only snow parameter in Ny-Alesund with observational time series longer than five years appears to be the snow height. Such observations started in the village of Ny-Alesund already in the 70s by the Norwegian Meteorological Service, before being interrupted for a longer period. At present, the re-established manual snow height measurements are accompanied by multiple automatic measurements at different locations in and around Ny-Alesund. Snow water equivalent (SWE) measurements are generally rare and are still subject to major uncertainties even employing established techniques like snow pillows. Standard rain and snow gauges strongly underestimate solid precipitation and available corrections for wind influences remain to be site and instrument specific. A second site with long-term observations of snow height, SWE, and precipitation is Hornsund. Here, measurements started in the early 80s and have been performed manually. At both sites, the measurements of basic snow parameters are accompanied by measurements of albedo and stratigraphic information, which are also episodically available on the surrounding glaciers. Most of the stratigraphic observations have so far been linked to research projects and allowed the characterization of the springtime snowpack, often during the period of maximum snow height. Similar stratigraphic observations during other seasons (e.g. fall, winter, and melting period) appear to be very limited or even non-existing. The same seems to apply also for the measurement of chemical profiles in the snowpack in and around Ny-Alesund. The longest time series of continuous stratigraphic information appears to be a 60-day long sampling period with daily stratigraphic and chemical profiles obtained by the University Venice. A list of physical and chemical observations is summarized in a table with snow metadata also available at the webpage of the Atmosphere Research Flagship responding to the recommendation #1 of the working group.

The discussions allowed developing a number of recommendations by the work group:

1. The majority of the snow data is currently only accessible via the direct contact with the data owners, but not via open data bases. At least a short list of snow metadata is needed to distribute information on snow data beyond the working group and the flagship.
   Recommendation: The work group should publish a list of snow metadata (physics, chemistry, stratigraphy) on the Flagship web page. The list will be developed and verified by the members of the working group. It should be updated regularly and at least during future workshops and meetings of the work group. It should be communicated within all flagship activities and beyond.
2. The issue of a snow data base for the available observations in Ny-Alesund and Hornsund has been evoked. Different groups are working on making their data accessible via different (local) data bases.
   Recommendation: While a common snow data base would be desirable, it appears beyond a reachable goal of the working group with the currently available technical and

human resources. Moreover, it appears that the integration of the collected chemical snow data (e.g. high number of species, concentrations as function of time and depth) into a snow data base requires specific attention.

3. Manual snow height measurements are observations performed at a fixed (daily) point in time, automatic measurements generate continuous observations with short averaging periods. It has been shown that using different averaging periods of automatic measurements (e.g. 0:00 to 24:00 or 12:00 to 12:00) can introduce differences of up to several centimeters in the snow heights.
   Recommendation: To make automatic and manual snow height measurements better comparable a common averaging period for the automatic snow height measurements should be defined. It should be checked if the WMO-SPICE project issued recommendations for the averaging period. This issue should be treated at the next work group meeting.

4. Long-term, but uncorrected observations of precipitation at Ny-Alesund are available. It is well known that the observed precipitation needs to be corrected mainly in the case of solid precipitation. The corrections depend on wind speed and temperature. Some published studies are based on corrected precipitation time series. New correction functions have recently been published as a result of the WMO-SPICE project, while older correction functions specific for Ny-Alesund were published in the 90s by the Norwegian Meteorological Service. New technologies like radar have been deployed in Ny-Alesund. Similar difficulties exist for the precipitation observations at Hornsund. Here, an approach using a combination of different sensors with hydrological modeling will be applied to reduce the uncertainty in the precipitation record.
   Recommendation: The working group supports a homogeneous correction of the observed precipitation in Ny-Alesund. This correction could combine old and new corrections of the observations. The corrections should further include results of new instruments and technologies for precipitations and SWE. The final objective should be a recommended correction for precipitation time series to be used for further studies. The members of the working group may also explore if Ny-Alesund can be developed into a precipitation reference site. If successful, the approach used for the Hornsund data could be explored for Ny-Alesund.

5. Snow modeling that may be used to complement gaps in observational time series needs reliable meteorological forcing data. Some published snow modeling studies are based on such forcing data. A forcing data set for Hornsund is currently under development.
   Recommendation: The working group supports the development of homogenized forcing data for snow modeling studies. Such homogenized data sets should be developed in collaboration with the other working groups of the Atmosphere Research Flagship. Moreover, such forcing data have already been generated for published studies. Future meetings of the working group should try to attract a larger participation of the modeling community working, especially those involved in snow modeling projects at different scales.

6. “Arctic” test data including snow properties would have a wide range of applications in snow modeling and calibration/validation activities. Such test data are under development for the Hornsund site.

Recommendation: The working group supports the development of homogenized open-access data sets to test and validate models (snow and others). Such homogenized data sets should not be limited to snow, but should also consider the entire atmosphere-snow system and include standard meteorological parameters, surface exchange fluxes or permafrost. The development of such data sets requires the cooperation with and involvement of the different working groups of the Atmosphere Research Flagship and beyond (e.g. Glaciology Research Flagship). The development of such data sets for Ny-Alesund can profit from the experience currently generated using the Hornsund data.

7. Chemical information is based on analysis performed in different laboratories using different methods on site (Hornsund, Barentsburg) or after shipment to home laboratories. An inter comparison of the methods and techniques is needed and is the objective of an ongoing project distributing snow samples to different laboratories and analyzing for BC, major ions, and isotopes. Results of this inter comparison are expected in summer 2017.
   Recommendation: The working group supports the snow inter comparison project and will review the results during its next meeting.

Snow metadata collected after the meeting of the working group 4, on 5 October 2016 in Kjeller, Norway

Location	Station	Parameter	Method	Frequency + Period	Data access	Contact
Physics						
Hornsund	Hornsund	Snow height	Manually	Daily, 1982 - today	Via Contact	Tomas Wawrzyniak, tomasz@igf.edu.pl
Hornsund	Hornsund	Precipitation	Manually	Daily, 1982 - today	Via Contact	Tomas Wawrzyniak, tomasz@igf.edu.pl
Hornsund	Hornsund	SWE	Manually	Daily, 1982 - today	Via Contact	Tomas Wawrzyniak, tomasz@igf.edu.pl
Hornsund	Fuklebekken	Snow height	Manually	Weekly, 2013 - today	Via Contact	Tomas Wawrzyniak, tomasz@igf.edu.pl
Hornsund	300 point measurements	Snow height	Manually	Annually, 2013 - today	Via Contact	Tomas Wawrzyniak, tomasz@igf.edu.pl
Hornsund	50 point measurements	SWE	Manually	Annually, 2013 - today	Via Contact	Tomas Wawrzyniak, tomasz@igf.edu.pl
Brøggerhalvøya	300 point measurements	Snow height	Manually	Annually, 2001 - today	Via Contact	Jean-Charles Gallet, jc@npolar.no
Brøggerhalvøya	300 point measurements	Grounded ice	Manually	Annually, 2001 - today	Via Contact	Jean-Charles Gallet, jc@npolar.no
Ny-Alesund	Village	Snow height	Manually	1974 – 1976; 2008 - today	eklima	Mareile Wolff, mareilew@met.no
Ny-Alesund	Met. field	Snow height	Automatic	1998 – 2006	Via Contact	Mareile Wolff, mareilew@met.no
Ny-Alesund	Met. field	Snow height	Automatic	2011 – today	Via Contact	Marion Maturilli, marion.maturilli@awi.de
Ny-Alesund	Eddy Station	Snow height	Automatic	2013 – today	Via Contact	Marion Maturilli, marion.maturilli@awi.de
Ny-Alesund	Bayelva	Snow height	Automatic	1998 – today	Via Contact; PANGEA	Julia Boike, Julia.boike@awi.de
Ny-Alesund	Bayelva	Photographs	Automatic	?	PANGEA	Julia Boike, Julia.boike@awi.de
Ny-Alesund	CCT	Snow height	Automatic	2009 – today	Via Contact	Angelo Viola, a.viola@isac.cnr.it
Ny-Alesund	CCT	Spectral reflectance	Automatic	Hourly, 2009 – today	Via Contact	Angelo Viola, a.viola@isac.cnr.it
Ny-Alesund	CCT	Photographs	Automatic	?	Via Contact	Angelo Viola, a.viola@isac.cnr.it

Ny-Alesund	Met. field	SWE	Automatic	Hourly, 2010 - today	Via Contact	Heidi Bache Stranden, hrb@nve.no
Ny-Alesund	Met. field	Spectral albedo	Automatic	Hourly, 2012 – today	Via Contact	Masataka Shiobara, shio@nipr.ac.jp
Woodfjorden	?? point measurements	Spectral albedo	Manually	2013	Via Contact	Alia Khan, alia.khan@colorado.edu
Longyearbyen	?? point measurements	Spectral albedo	Manually	2013, 2015, 2016	Via Contact	Alia Khan, alia.khan@colorado.edu
Ny-Alesund	?? point measurements	Spectral albedo	Manually	2016	Via Contact	Alia Khan, alia.khan@colorado.edu
Stratigraphy						
Brøggerhalvøya	?? point measurements	Stratigraphy	Manually	Annually, 2015 - today	Via Contact	Jean-Charles Gallet, jc@npolar.no
Kongsvegen	5 point measurements	Stratigraphy	Manually	Annually, 2010 - 2012	Via Contact	Friedrich Obleitner, friedrich.obleitner@uibk.ac.at
Midre Lovenbreen	1 point measurements	Stratigraphy	Manually	Annually, 2010 - 2012	Via Contact	Friedrich Obleitner, friedrich.obleitner@uibk.ac.at
Austre Broggerbreen	1 point measurements	Stratigraphy	Manually	Annually, 2010 - 2012	Via Contact	Friedrich Obleitner, friedrich.obleitner@uibk.ac.at
Ny-Alesund	Bird cliff	Stratigraphy	Manually	Annually, 2010 - 2012	Via Contact	Friedrich Obleitner, friedrich.obleitner@uibk.ac.at
Ny-Alesund	Bayelva	Stratigraphy	Manually	Bi-annually, 1998 – today	Via Contact	Julia Boike, Julia.boike@awi.de
Ny-Alesund	3 point measurements (glaciers)	Stratigraphy	Manually	Annually, 2011 - 2015	Via Contact	Andrea Spolaor, andrea.spolaor@unive.it
Ny-Alesund	5 point measurements (glaciers)	Stratigraphy	Manually	Annually, 2016 - today	Via Contact	Andrea Spolaor, andrea.spolaor@unive.it
Austre Broggerbreen	60 point measurements	Stratigraphy	Manually	2014	Via Contact	Andrea Spolaor, andrea.spolaor@unive.it
Kongsvegen	1 point measurements	Stratigraphy	Manually	2012	Via Contact	Hans-Werner Jacobi, Hans-Werner.Jacobi@univ-grenobble-alpes.fr
Austre Lovenbreen	1 point measurements	Stratigraphy	Manually	2012	Via Contact	Hans-Werner Jacobi, Hans-Werner.Jacobi@univ-grenobble-alpes.fr
Ny-Alesund	Gruvebadet, 5 point measurements	Stratigraphy	Manually	2014	Via Contact	Hans-Werner Jacobi, Hans-Werner.Jacobi@univ-grenobble-alpes.fr
Chemistry						

Ny-Alesund	Met. field	EC, 0 – 5 cm	Manually	April 2013	Via Contact	Masataka Shiobara, shio@nipr.ac.jp
Ny-Alesund	3 point measurements (glaciers)	Chemical profiles (metals, ions, organics)	Manually	Annually, 2011 - 2015	Via Contact	Andrea Spolaor, andrea.spolaor@unive.it
Ny-Alesund	5 point measurements (glaciers)	Chemical profiles (metals, ions, organics)	Manually	Annually, 2016 - today	Via Contact	Andrea Spolaor, andrea.spolaor@unive.it
Broggerbreen	?? point measurements	BC, 0 – 5 cm	Manually	Anually, 2007 - today	Via Contact	Jean-Charles Gallet, jc@npolar.no
Woodfjorden	?? point measurements	rBC, eBC	Manually	2013	Via Contact	Alia Khan, alia.khan@colorado.edu
Longyearbyen	?? point measurements	rBC, eBC	Manually	2013, 2015, 2016	Via Contact	Alia Khan, alia.khan@colorado.edu
Ny-Alesund	?? point measurements	rBC, eBC	Manually	2016	Via Contact	Alia Khan, alia.khan@colorado.edu
Austre Broggerbreen	60 point measurements	Chemical profiles (metals, ions, organics)	Manually	2014	Via Contact	Andrea Spolaor, andrea.spolaor@unive.it
Kongsvegen	1 point measurements	Chemical profiles (ions, rBC)	Manually	2012	Via Contact	Hans-Werner Jacobi, Hans-Werner.Jacobi@univ-grenobble-alpes.fr
Austre Lovenbreen	1 point measurements	Chemical profiles (ions, rBC)	Manually	2012	Via Contact	Hans-Werner Jacobi, Hans-Werner.Jacobi@univ-grenobble-alpes.fr
Ny-Alesund	Gruvebadet, 5 point measurements	Chemical profiles (ions, rBC)	Manually	2014	Via Contact	Hans-Werner Jacobi, Hans-Werner.Jacobi@univ-grenobble-alpes.fr

Work Group 6: Variability in surface UV irradiance and ozone column
Ny-Ålesund Atmosphere Flagship open work group meetings, Kjeller, Norway,
7 October 2016

Summary report

During the **first part** of the meeting the participants were informed about the measurement instrumentation and the results achieved by the research teams participating in the Flagship activities and working at NILU (Norway), IG-PAS (Poland) and ISAC-CNR (Italy). In addition, the research group of radiation and remote sensing at the Institute of Meteorology and Climatology of the Hannover University, Germany, presented by Hanno Müller showed interest in the WG6 meeting and in future collaboration. The following presentations were listened and discussed:

- Measurements of solar UV radiation and total ozone, performed by NILU in the frame of the National Monitoring Programme (Tove Svendby, NILU).
- Long-term variability in surface UV radiation over Hornsund for the period 1983-2015 derived from the reconstructed and observed time series (Piotr Sobolewski, Institute of Geophysics, Polish Academy of Science).
- Effective albedo derivation from UV measurements (Hanno Müller, Institute of Meteorology and Climatology, University of Hannover)
- Variability features of the ozone column and surface UV irradiance according to the observations performed by ISAC-CNR at Ny- Ålesund (Boyan Petkov, ISAC-CNR).

Bearing in mind the above presentations it was concluded that the presented technical devices and datasets can be considered a sufficient basis for a joint analysis of the variability in surface solar UV irradiance and ozone column over Svalbard. The available instruments allow us also to plan a future activity on this issue that could enlarge our knowledge about the Arctic atmosphere.

The **second part** of the meeting dealt with some preliminary results about variability of the ozone content over Ny-Ålesund achieved through analysis of ozonesound data. It was decided to work on common publications based on these results together with those obtained by the ground-based instruments, which were discussed in the first part.

The **third part** of the WG6 meeting was devoted to possible future field activities. As a main goal it was planed to organize an intercomaprison campaign aimed to assess the quality of the measurement techniques and to uniform the methodologies and data format in order to achieve a

homogeneous data set. In addition, the collaboration with the other WG in the frame of the Atmospheric Flagship activity was discussed. It is expected that such contacts will help us to have correct estimates of the cloud cover, aerosol loadings, albedo and profiles of the atmospheric thermodynamic parameters, and ozone, which are necessary for the model evaluations of the surface UV irradiance.

Some previous publications of the teams participating in WG6:

Janusz W. Krzyścin and Piotr S. Sobolewski, 2001. The surface UV-B irradiation in the Arctic: Observations at the Polish polar station, Hornsund (77°N, 15°E), 1996-1997. Journal of Atmospheric and Solar-Terrestrial Physics, 63, 321–329.

P.S. Sobolewski, J.W. Krzyścin, 2004-2005. UV measurements at the Polish Polar Station, Hornsund, calibration and data for the period 2005-2006, Publications of the Institute of Geophysics, Polish Academy of Sciences D-67 (382) Atmospheric Ozone. Solar Radiation.

Sobolewski P., J. W. Krzyścin, J. Jaroslawski, K. Stebel, 2008. Measurements of UV radiation on rotating vertical plane at the ALOMAR Observatory (69° N, 16° E), Norway, 2007. Atmospheric Chemistry and Physics, 8, 3033–3043,

Julian Gröbner, Gregor Hülsen, Sigrid Wuttke, Otto Schrems, Sara De Simone, Veronica Gallo, Claudio Rafanelli, Boyan Petkov, Vito Vitale, Kåre Edvardsen and Kerstin Stebel, 2010. Quality assurance of solar UV irradiance in the Arctic, Photochemical & Photobiological Sciences, 9, 384–391.

Boyan Petkov, Vito Vitale, Julian Gröbner, Gregor Hülsen, Sara De Simone, Veronica Gallo, Claudio Tomasi, Maurizio Busetto, Vigdis Lonar Barth, Christian Lanconelli, Mauro Mazzola, 2012. Short-term variations in surface UV-B irradiance and total ozone column at Ny-Ålesund during the QAARC campaign, Atmospheric Research, 108, 9–18.

Petkov B.H., V. Vitale, C. Tomasi, A. M. Siani, G. Seckmeyer, A. R. Webb, A. R. D. Smedley, G. R. Casale, R. Werner, C. Lanconelli, M. Mazzola, A. Lupi, M. Busetto, H. Diémoz, F. Goutail, U. Köhler, B. D. Mendeva, W. Josefsson, D. Moore, M. L. Bartolomé, J. R. M. González, O. Mišaga, A. Dahlback, Z. Tóth, S. Varghese, H. De Backer, R. Stübi, K. Vaníček, 2014. Response of the ozone column over Europe to the 2011 Arctic ozone depletion event according to ground-based observations and assessment of the consequent variations in surface UV irradiance. Atmospheric Environment, 85, 169–178.