Norsk institutt for luftforskning
Norwegian Institute for Air Research

Air Quality in Ny-Ålesund

Monitoring of Local Air Quality 2018

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NILU report 21/2019

NILU report 21/2019	ISBN: 978-82-425-2990-9 ISSN: 2464-3327	CLASSIFICATION: A – Unclassified (open report)
DATE 24.09.2019	SIGNATURE OF RESPONSIBLE PERSON Ole-Anders Braathen, Viseadministrerende direktør	NUMBER OF PAGES 32
TITLE Air Quality in Ny-Ålesund Monitoring of Local Air Quality 2018		PROJECT LEADER Ove Hermansen NILU PROJECT NO. 114076
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ABSTRACT

The concentrations of the measured components are generally low and below national limit values for the protection of human health and critical levels for the protection of vegetation.

Wind from northern sectors gave the highest average concentrations of nitrogen oxides and sulphur dioxide, which indicates the power station and the harbour as possible sources. The measurement results for CO_2 show an annual variation with higher concentrations in the winter and lower in summer. Measured concentrations of CO were most likely caused by local snowmobile traffic.

NORWEGIAN TITLE

Luftkvalitet i Ny-Ålesund. Målinger av lokal luftkvalitet 2018.

KEYWORDS

Air quality	Long-range transport of air pollutants	Polar regions

ABSTRACT (in Norwegian)

De målte konsentrasjonene var generelt lave for alle komponenter og under nasjonale grenseverdier for beskyttelse av menneskets helse og økosystemet.

Vind fra nordlige sektorer ga de høyeste gjennomsnittskonsentrasjonene av nitrogenoksider og svoveldioksid, noe som peker på kraftstasjonen og havnen som mulige kilder. Måleresultatene for CO_2 viser en årlig variasjon, med høyere konsentrasjoner om vinteren og lavere om sommeren. Kilder for de målte konsentrasjonene av CO var mest sannsynlig lokal snøskutertrafikk.

PUBLICATION TYPE: Digital document (pdf)	COVER PICTURE: Source: NILU

Preface

The expressed mission of Ny-Ålesund is to serve as an international station for scientific research and monitoring. The activities are dependent on the near pristine environment and unique qualities of the Ny-Ålesund area, in particular research related to long range transported pollution, climate change and polar ecology.

Thus, it is essential to preserve the near pristine environment of the area and to keep local human environmental impacts at the lowest possible level so as not to jeopardise scientific research and monitoring. Ny-Ålesund is expected to be a prime example of the sustainable operation and development of a research station in the Polar Regions.

Comprehensive infrastructure and logistics are required to enable the extensive research activities in and around Ny-Ålesund. This cannot be done without any impact on the environment.

The project "Monitoring of Local Air Quality in Ny-Ålesund" ran from July 2008 until 2010. The main purpose of the project was to monitor a number of air pollutants to assess the impact of the activities in Ny-Ålesund on the environment and to detect possible influences on measurements in Ny-Ålesund and the nearby Zeppelin air-monitoring observatory.

Funding from the Svalbard Environmental Protection Fund made it possible to start up the project again, with the same type of measurements in the same location, in 2014 and continuing through 2015, to gather data for looking into changes since the previous project.

In 2016, NILU financed the continuation of the measurement program.

From 2017, contribution from Kings Bay AS has made it possible to establish the measurement activities on a more permanent basis, in connection with the project «Limits of Acceptable Change».

The contribution from Kings Bay AS includes providing the facilities needed for the instrumentation. Operation of instruments and samplers were carried out by staff from the Norwegian Polar Institute at the Sverdrup station as part of the agreement between NPI and NILU. NILU was responsible for the monitoring program and contributed with the instrumentation and data quality control. The air samples were analysed at the chemical laboratory at NILU. The measurements of black carbon are done by Department of Environmental Science and Analytical Chemistry (ACES), Atmospheric Science Unit, Stockholm University.

In November 2018, the measurement station was moved from Nordpolhotellet to Transformatorbua, both locations near the centre of Ny-Ålesund.

This report summarises the monitoring activities in 2018 and presents the measurements and the results from the first comparisons with earlier measurements.

The measurement results will be freely available for scientists and others for use in further studies in the region.

Contents

Summary

NILU - Norwegian Institute for Air Research are monitoring air quality and meteorology at a measurement station in Ny-Ålesund, Spitsbergen. The main purpose of the project is to assess the impact of the activities in Ny-Ålesund and to detect possible influences on measurements in Ny-Ålesund and the nearby Zeppelin observatory.

In November 2018, the measurement station Nordpolhotellet was terminated, and measurements at the new station, Transformatorbua, were started. The location of the new station is about 30 m north of the old.

The concentrations of the measured components are generally low and below national limit values for the protection of human health and critical levels for the protection of vegetation.

The highest average concentrations of nitrogen oxides and sulphur dioxide were measured with wind from northern sectors, which indicates the power station and the harbour as possible sources.

The instrument measuring CO_2 and CO broke down mid-May 2018. For the period up to this, the maximum hourly concentration of CO_2 was measured in early May. The measurements of CO gave higher concentrations in the spring, most likely caused by snowmobile traffic close to the station.

Total deposition of sulphur and nitrogen at Ny-Ålesund is estimated (Aas et al., 2019) to be lower than on the Norwegian mainland, but may have an impact on biology in this pristine arctic environment.

Air Quality in Ny-Ålesund
Monitoring of Local Air Quality 2018

1 Background

NILU have been measuring air quality and meteorological parameters at the measurement station Nordpolhotellet in Ny-Ålesund since June 2014 (Transformatorbua since November 2018). A corresponding measurement program was carried out at the same location in 2008-2010 (Hermansen et al., 2011). The purpose then and now is to investigate air pollution from local sources such as car traffic, the power station, boat traffic etc. Measurement results can be used to look at possible environmental impact from all activities in the area and to investigate any influence on scientific measurement activities in Ny-Ålesund and its surroundings. The measurement results from 2014-2015 and 2016-2017 are described in previous reports (Johnsrud et al., 2016), (Johnsrud et al., 2018).

The measurement results will be freely available for scientists and others for use in further studies in the region. This report gives an overview of the measurement program and a brief statistical summary of the results.

2 Measurement program

The measurement program is summarized in Table 1. The instruments used in the measurement program at Transformatorbua are shown in Figure 1.

Table 1: Measurement program at Nordpolhotellet/Transformatorbua in Ny-Ålesund.

Compound	Description	Sampler	Time resolution
$NO/NO_2/NO_x$	Nitrous oxides	Continuous monitor, API	1 hour
SO_2	Sulphur dioxide	Continuous monitor, API	1 hour
Picarro	Carbon monoxide, carbon dioxide	Continuous monitor, Picarro	1 hour
Main inorganic compounds	Gaseous and particle bound inorganic compounds; HNO_3/NO_3^-, NH_4^+/NH_3, SO_2, SO_4^{2-}, Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCl	Filter sampler, EK	1 week
Particles and soot	BC	PSAP	1 hour
Meteorology	Temperature, wind direction, wind speed, relative humidity, barometric pressure, precipitation intensity	Automatic weather station, Vaisala	1 hour

Figure 1: Interior of the measurement station Transformatorbua with instruments and other necessary equipment. (Photo: Ove Hermansen, NILU).

3 Measurement station

In late November 2018, the measurement station was moved from Nordpolhotellet to a new location about 30 m north, Transformatorbua. Both locations are close to the center of Ny-Ålesund, slightly downwind, to provide representative measurements of the air quality in Ny-Ålesund. The measurement station Transformatorbua is shown in Figure 2, and the location of the measurement stations is shown in Figure 3. Data from the Zeppelin observatory for advanced scientific measurements south of Ny-Ålesund, are also included in some figures.

Figure 2: Measurement station Transformatorbua in Ny-Ålesund. The measurement station is the small red building to the left, by the flagpole. (Photo: Ove Hermansen, NILU).

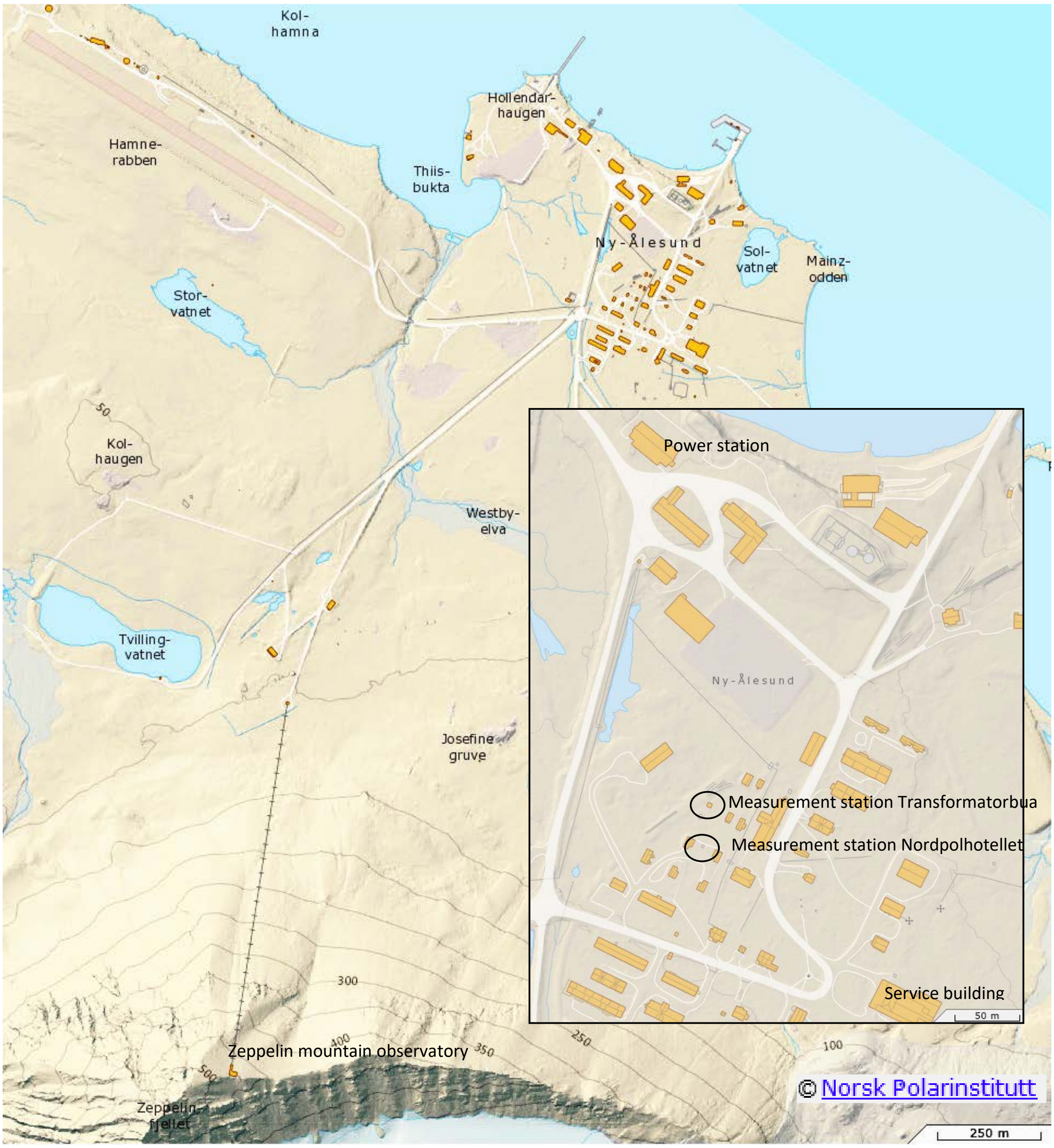


Figure 3: Location of the measurement stations Nordpolhotellet, Transformatorbua and the Zeppelin mountain observatory in Ny-Ålesund.

4 Results

4.1 Data capture

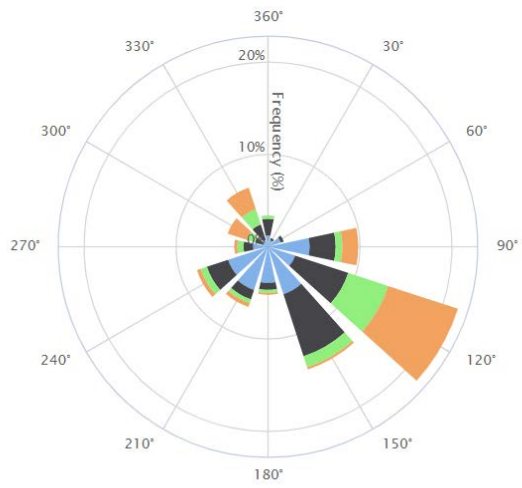
For the calendar year 2018, the data capture for most measurements were good, apart from the period of missing data when moving from Nordpolhotellet to Transformatorbua, as described in Table 2. For the CO- and CO_2-measurements there are no data after 14 May due to instrument failure.

Table 2: Periods of missing data (24 or more consecutive hours) from Ny-Ålesund 2018.

Compound/sampler	Periods missing data	Reason
$NO/NO_2/NO_x$, monitor	14.11. 08:00-20.11. 18:00	Instrument moved from Nordpolhotellet to Transformatorbua
SO_2, monitor	14.11. 08:00-20.11. 18:00	Instrument moved from Nordpolhotellet to Transformatorbua
CO, CO_2, Picarro	14.05.2018 05:00-1.1.2019	Instrument failure
Main inorganic compounds, filter sampler	12.11.-20.11.	Instrument moved from Nordpolhotellet to Transformatorbua
Particles and soot		
Meteorology: Temperature, relative humidity, barometric pressure, precipitation intensity	14.11. 12:00-20.11. 11:00	Instruments moved from Nordpolhotellet to Transformatorbua
Meteorology: Wind speed, wind direction	14.11. 12:00-20.11. 11:00	Instruments moved from Nordpolhotellet to Transformatorbua

4.2 Meteorology

Frequency of wind from 12 30-degrees sectors (wind roses) from Nordpolhotellet/Transformatorbua in Ny-Ålesund, and from Zeppelin mountain, are presented in Figure 4. At Nordpolhotellet/Transformatorbua the prevailing wind direction is from east-southeast and the highest wind speeds are also registered from this sector. At Zeppelin mountain the prevailing wind direction is more from south and south-easterly directions than in Ny-Ålesund.



a) b)

Figure 4: Wind roses from the measurement stations at Nordpolhotellet/Transformatorbua (a) and Zeppelin mountain (b) from January to December 2018.

Monthly average, maximum and minimum temperature from Nordpolhotellet/ Transformatorbua are presented in Figure 5. The figure also shows monthly average temperatures at the Zeppelin-mountain as well as the monthly normal temperatures 1961-1990 from Ny-Ålesund given by DNMI.

The temperatures at Zeppelin-mountain and Nordpolhotellet show similar variation during the period, with the monthly average temperatures at the mountain some degrees colder than down in Ny-Ålesund. For the entire period, the monthly average temperatures at Nordpolhotellet/Transformatorbua in Ny-Ålesund were higher than the normal temperatures given by DNMI. January and February had the largest deviations, both showing 10˚C higher monthly average temperature than the normal.

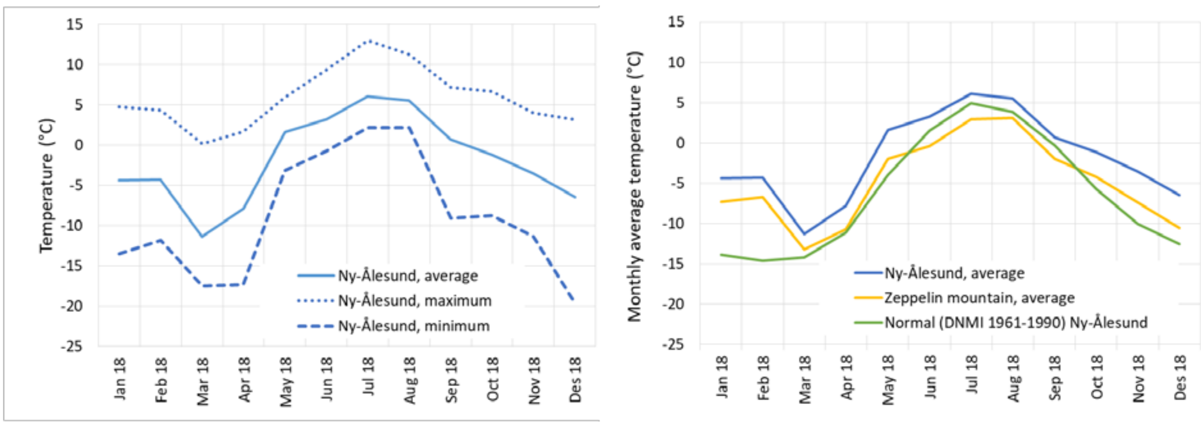


Figure 5: Monthly temperature statistics from Ny-Ålesund and Zeppelin mountain from January to December 2018.

4.3 Nitrogen oxides

Hourly concentrations of nitrogen oxides and nitrogen dioxide are shown as time series plots in Appendix A. Measurements of nitrogen dioxide are summarized in Table 3.

Table 3: Summary of hourly measurements of NO_2 in Ny-Ålesund January to December 2018.

Year	Month	Data coverage (%)	Average (µg/m³)	Maximum (µg/m³)	Time for maximum
2018	January	99	0.7	14.7	11.01.2018 23:00
	February	100	1.2	27.7	28.02.2018 10:00
	March	99	1.8	40.2	02.03.2018 12:00
	April	100	0.6	20.3	21.04.2018 05:00
	May	100	0.6	17.3	31.05.2018 23:00
	June	99	2.6	56.5	22.06.2018 12:00
	July	99	2.6	68.5	15.07.2018 10:00
	August	99	1.4	57.1	21.08.2018 18:00
	September	100	1.2	24.6	29.09.2018 17:00
	October	100	1.6	40.2	01.10.2018 07:00
	November*	78	1.6	39.4	24.11.2018 10:00
	December	99	4.3	92.8	09.12.2018 16:00

* Station moved from Nordpolhotellet to Transformatorbua

The NO_2-concentrations are generally very low compared to measurements in cities and agglomerations. The highest monthly average was 4.3 µg/m^3 at the new station location Transformatorbua in December 2018. This is clearly higher than the highest monthly averages measured at the former station Nordpolhotellet. It is too early to say if the higher concentrations were due to higher concentrations in Ny-Ålesund this month, or if the new station location is better suited for capturing the impact of the local emissions.

There are some episodes where the concentrations are elevated compared to the average concentrations at the station. The highest hourly average, 92.8 µg/m^3, was registered on 9 December 2018 from 15.00 to 16.00 (at the new station location). Observations from this episode are shown in Figure 6 with simultaneous SO_2-and wind direction-measurements. The figure shows that the maximum concentration occurred with wind from north.

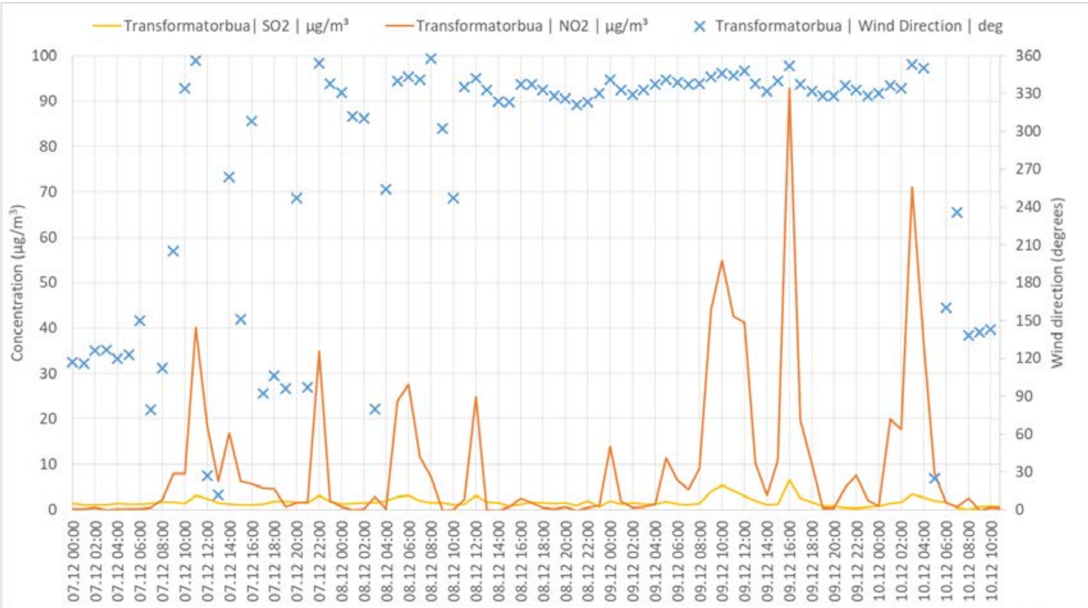


Figure 6: Hourly average concentrations of NO_2 and SO_2 and hourly registrations of wind direction at Transformatorbua, Ny-Ålesund on 7-10 December 2018.

Observed concentrations of NO_2 and SO_2 with simultaneous wind direction observations, presented in Figure 7, illustrates another episode of elevated concentrations. Even in this example, the highest concentrations occur with wind from northern directions, suggesting the harbour and the power station as possible sources. The figure also gives an estimate of harbour activity, which indicates that movements and presence of ships in the harbour may contribute to the measured concentrations during this period.

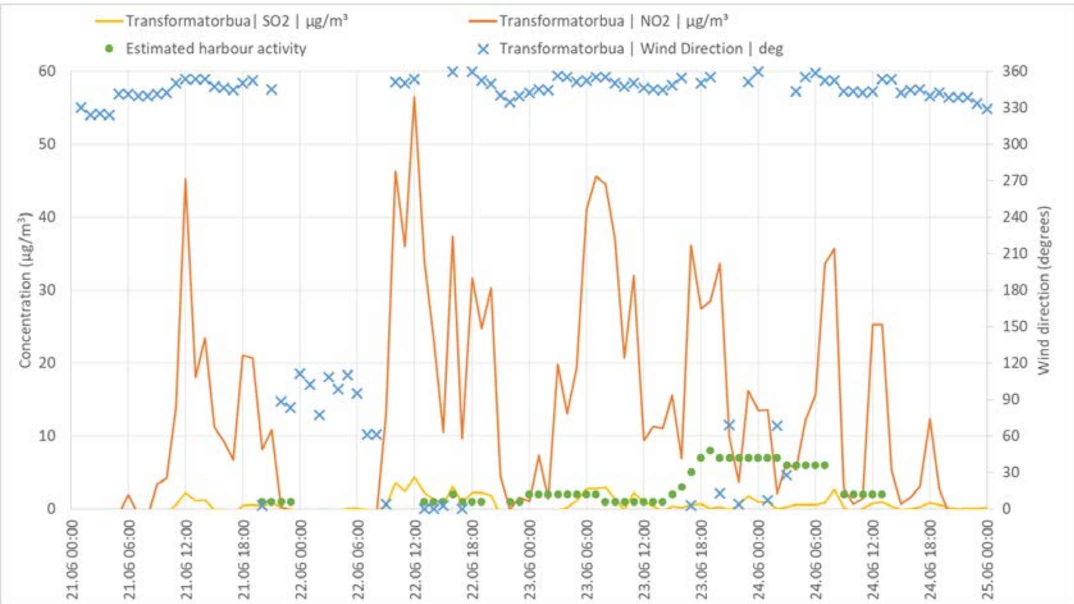


Figure 7: Hourly average concentrations of NO_2 and SO_2 and hourly registrations of wind direction at Nordpolhotellet, Ny-Ålesund on 21-24 June 2018. Harbour activity, represented by an estimated count of ships present, is based on the ship call log from Ny-Ålesund harbour.

Average concentrations of NO_x and NO_2 from 12 wind direction sectors at Nordpolhotellet for the period January to November are shown in Figure 8 and Figure 9 respectively. The figures illustrates that the highest average concentrations at Nordpolhotellet occurs with wind from north.

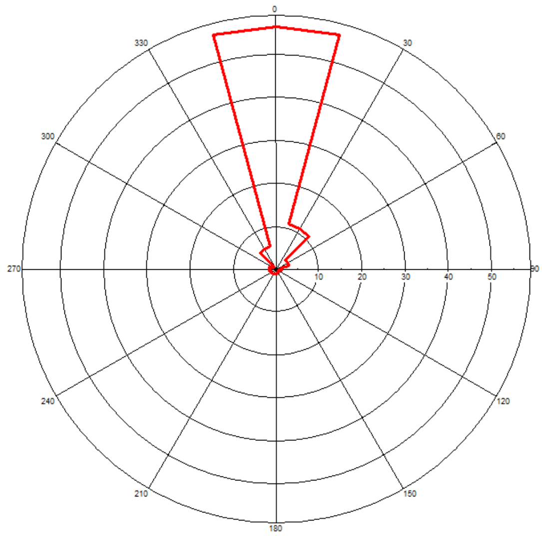


Figure 8: Average concentrations of NO_x ($\mu g/m^3$) with wind from 12 30-degrees sectors at Nordpolhotellet, January to November 2018.

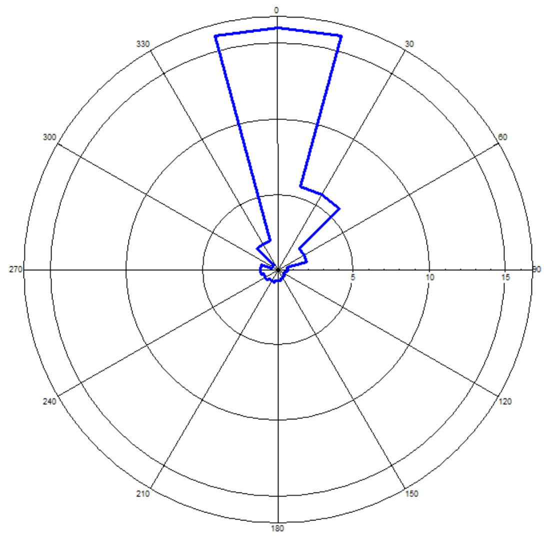


Figure 9: Average concentration of NO_2 ($\mu g/m^3$) with wind from 12 30-degrees sectors at Nordpolhotellet, January to November 2018

Average concentrations of NO_2 and NO_x from 12 wind direction sectors at Transformatorbua for the period November to December 2018 are shown in Figure 10. The figure shows elevated average concentrations with wind from west-northwest. Even though these figures indicates a shift to a slightly more westerly direction for the elevated concentrations, compared to Nordpolhotellet, the period with data from the new station location is very short. During this period there was also more human activity in Ny-Ålesund than usual for the time of year. The present data is therefore not necessarily representative for the general situation at the new station location.

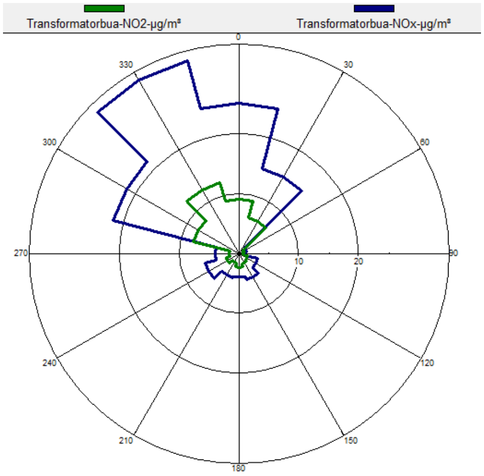


Figure 10: Average concentrations of NO_2 and NO_x (µg/m^3) with wind from 12 30-degrees sectors at Transformatorbua, November to December 2018.

4.4 Sulphur-dioxide (SO_2)

At Nordpolhotellet, SO_2 is measured with two different methods, a filter sampler giving weekly averages, and a continuous monitor giving hourly averages. The concentrations are generally low, and the filter sampling method is more accurate than the continuous monitor at such low concentrations. The disadvantage of the filter sampling method compared to the continuous monitor is the time resolution. The method gives no information on when episodes of higher concentrations occur within the weekly sampling period.

Most of the time the values are close to, or below, the detection limit of the continuous monitor, and the uncertainty of the method is high at this low concentration level. The method is however good at capturing episodes of higher concentrations which is why the instrumentation is included in the program. The higher time resolution of results, as given by the continuous monitor, is especially important when studying impact from sources that are active for short periods of time and/or close to the measurement station.

Hourly concentrations of sulphur dioxide are shown as time series plots in Appendix A. Measurements of sulphur dioxide are summarized in Table 4.

Table 4: Summary of measurements of SO_2 at Nordpolhotellet January to November and Transformatorbua November to December 2018. When monthly data coverage is below 75% no statistics are calculated.

Year	Month	Data coverage (%) (monitor)	Maximum (µg/m^3) (monitor)	Time for maximum (monitor)	Average (µg/m^3) from filter sampler
2018	January	97	1.3	27.01.2018 23:00	0.06
	February	97	10.0	05.02.2018 05:00	0.07
	March	98	4.5	17.03.2018 20:00	0.08
	April	99	1.3	05.04.2018 11:00	0.07
	May	100	1.6	25.05.2018 16:00	0.14
	June	98	4.4	22.06.2018 12:00	0.05
	July	99	7.0	15.07.2018 10:00	0.02
	August	99	3.7	21.08.2018 18:00	0.02
	September	100	3.1	24.09.2018 08:00 24.09.2018 09:00 24.09.2018 13:00 26.09.2018 15:00	0.01
	October	100	2.3	01.10.2018 07:00	0.02
	November*	76	0.9	24.11.2018 03:00 27.11.2018 08:00	0.06**
	December	99	8.8	31.12.2018 22:00	0.13

* Station moved from Nordpolhotellet to Transformatorbua. ** Data coverage 73%.

The highest monthly average SO_2-concentrations based on the filter sampling results were found from mid-winter to spring with the maximum measured in May 2018 to 0.14 µg/m^3. The filter sampling results showed nearly as high monthly average in December 2018 with 0.13 µg/m^3.

The highest hourly SO_2-concentration was measured in the early morning of the 5th of February 2018 with 10.0 µg/m^3 at 04-05 hours. At this time there was at gentle breeze from north-northeast. At the time, there were no registered harbour activity or ship traffic. We can also see slightly elevated SO_2-concentrations in the weekly filter sample covering these hours. We also see elevated hourly SO_2-concentrations around midnight at new year's eve, with 8.8 µg/m^3 at 21-22 hours. At this time there was a moderate breeze from north-northwest and a temperature of -14,7 °C. Fireworks may be a possible explanation for this, as we see the concentrations increase past midnight.

Average concentrations of SO_2 from 12 wind direction sectors at Nordpolhotellet from January to November and at Transformatorbua from November to December, based on data from the continuous monitor, are shown in Figure 11. At both stations the highest average concentrations are measured with wind from north. Like observed for NO_2, the concentrations of SO_2 measured at Transformatorbua are higher than the concentrations measured at Nordpolhotellet, but the time period is too short to draw any conclusions based on these values.

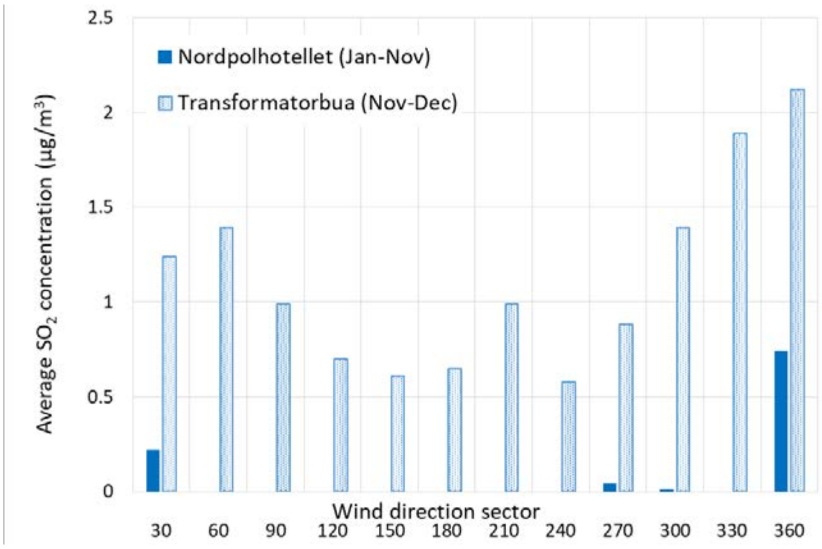


Figure 11: Average concentration of SO_2 (µg/m^3) with wind from 12 30-degrees sectors at Nordpolhotellet from January to November 2018, and from Transformatorbua from November to December 2018.

4.5 Carbon-monoxide (CO) and carbon-dioxide (CO_2)

Hourly concentrations of carbon-monoxide and carbon-dioxide measured with the Picarro instrument at Nordpolhotellet are shown as time series plots in Appendix A, along with simultaneous measurements with the same method at Zeppelin mountain.

Unfortunately, the instrument in Ny-Ålesund broke down in May, and there are no valid values after 14. May. Previous measurement results for CO_2 show an annual variation with higher concentrations during the winter and lower in late summer. The measurements from January to May 2018 show high values at the same level as the measurements for the same period the previous years, with the maximum hourly concentration measured to 420 ppm on 5. May 2018.

The CO-measurements at Nordpolhotellet the previous years show the highest concentrations and more variation in the hourly results in the spring. Data from January to May 2018 indicates a similar pattern. The highest hourly concentration was measured to 321 ppb at noon on 4. March. Hourly data from March 2018 are shown in Figure 12. The higher concentrations are measured during daytime and are most likely caused by human activity with snowmobiles in the vicinity of the measurement station. The CO-measurements from Zeppelin mountain in March 2018 are shown in Figure 13. The measurements at the observatory does not show the same variation, with episodes of elevated concentrations, as the measurements in Ny-Ålesund.

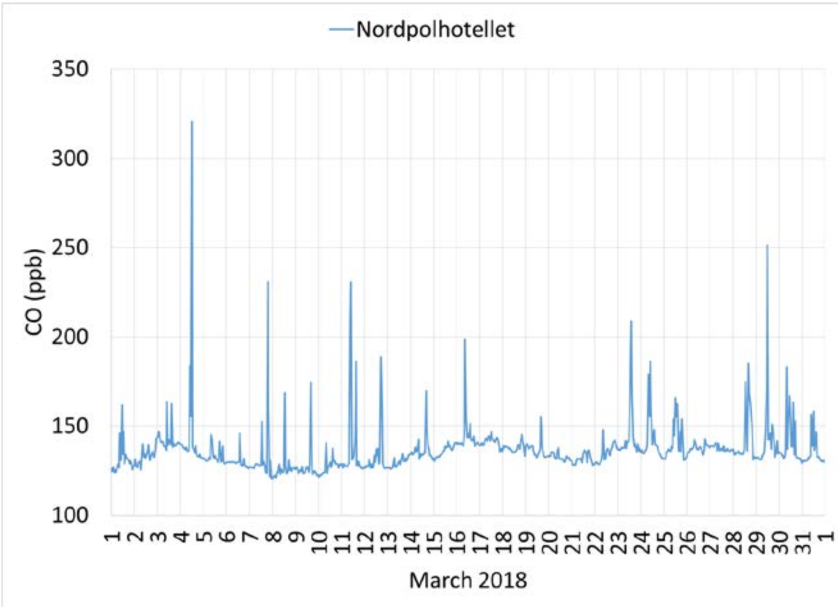


Figure 12: Hourly average concentrations of CO (ppb) from Nordpolhotellet, Ny-Ålesund in March 2018.

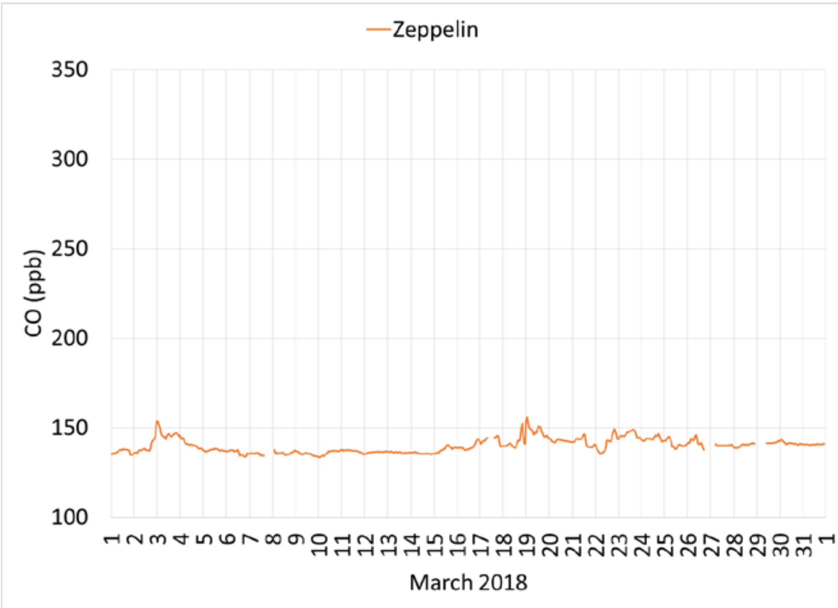


Figure 13: Hourly average concentrations of CO (ppb) from Zeppelin mountain in March 2018.

4.6 Soot, black carbon

Measurements of the light absorbing aerosol were carried out at Nordpolhotellet at Ny-Ålesund using custom-built Particle Soot Absorption Photometer (PSAP) [Bond et al., 1999]. Results are recalculated to black carbon equivalent (BCe) using specific absorption of 10 g/m^2. Measurement period is from January 2017 to December 2018. Data coverage is ~ 90%.

Monthly mean concentrations vary between 0.02 $\mu g/m^3$ and 0.1 $\mu g/m^3$ BCe with lowest values during summer period and highest in winter and early spring. General trend follows the typical Arctic cycle with strongest influence of long-range transport in early spring and cleanest air during late summer. In extreme occasions the hourly BCe values can reach above 1 $\mu g/m^3$.

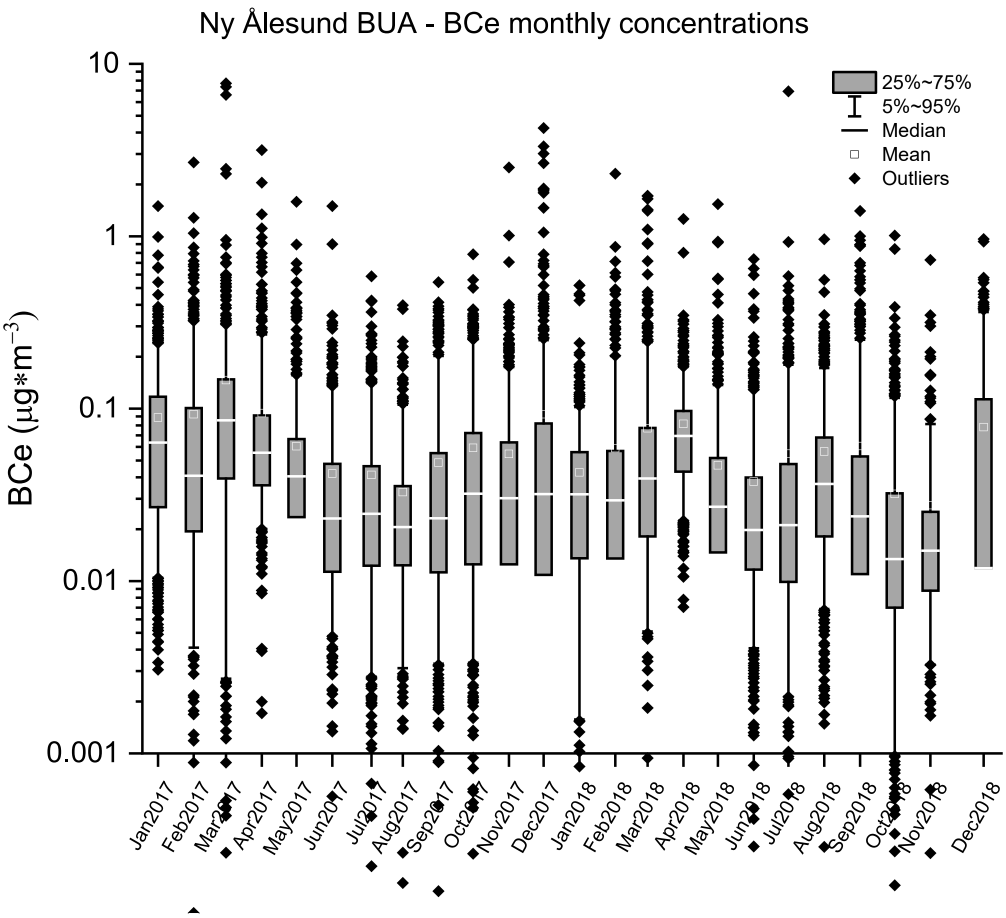


Figure 14: Monthly equivalent black carbon (BCe) concentration descriptive statistics in the Ny-Ålesund village (Nordpolhotellet) based on hourly data for period January 2017 – December 2018.

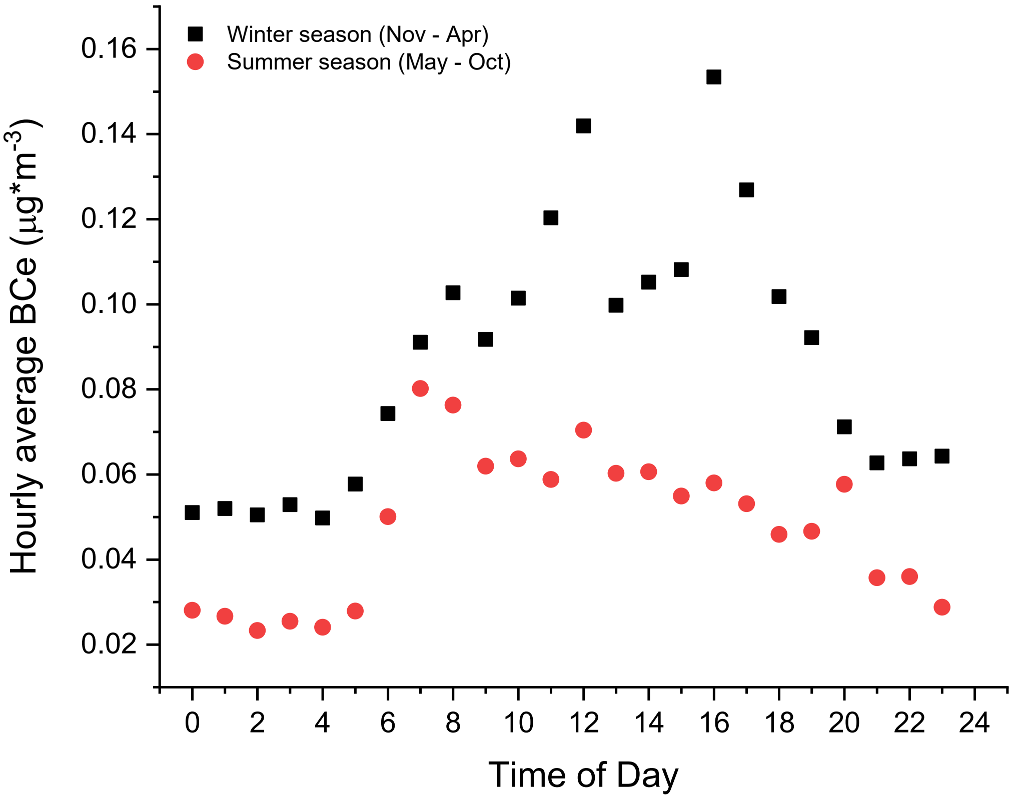


Figure 15: Diurnal cycle of the BCe concentration in Ny-Ålesund based on hourly data from 2017 and 2018.

Comparison of diurnal cycle of black carbon during winter season (November – April) and summer season (May – October) shows clearly the influence of local sources on black carbon concentrations in Ny-Ålesund village with sharp rise from nocturnal background values in the morning hours and elevated BCe levels until evening. During summer time elevated BCe concentrations gently decrease towards late evening. In contrast, during winter time there is a clear "lunch" and "dinner" maxima most likely linked to local traffic. Wintertime BCe concentrations are in average twice of those observed in summer.

4.7 Filter sampling of inorganic compounds

Main inorganic compounds in air are measured with a filter sampler on a weekly basis. A summary of the results are given in Table 5.

Table 5: Monthly and annual averages of main components in air measured in Ny-Ålesund in 2018. The measurements were done at Nordpolhotellet from January to 12. November and at Transformatorbua from 20. November to 31. December. Concentrations are given in µg/m³.

Year	Month	SO_2	SO_4-S	Sum NO_3-N	Sum NH_4-N	Mg	Ca	K	Cl	Na
2018	January	0.06	0.16	0.02	0.04	0.10	0.09	0.03	0.91	0.60
	February	0.07	0.14	0.02	0.04	0.12	0.05	0.04	1.56	0.93
	March	0.08	0.09	0.02	0.06	0.03	0.02	0.01	0.29	0.20
	April	0.07	0.25	0.03	0.09	0.04	0.03	0.02	0.38	0.32
	May	0.14	0.10	0.02	0.08	0.07	0.03	0.03	0.89	0.56
	June	0.05	0.11	0.02	0.08	0.09	0.11	0.03	0.80	0.40
	July	0.02	0.08	0.02	0.10	0.05	0.04	0.02	0.53	0.34
	August	0.02	0.11	0.02	0.13	0.07	0.07	0.03	0.75	0.47
	September	0.01	0.09	0.01	0.07	0.07	0.06	0.02	0.78	0.47
	October	0.02	0.07	0.01	0.03	0.08	0.09	0.03	0.80	0.61
	November*	0.06	0.12	0.01	0.03	0.09	0.07	0.03	1.16	0.67
	December	0.13	0.12	0.02	0.03	0.09	0.04	0.03	1.07	0.65
2018	Year	0.06	0.12	0.02	0.07	0.07	0.06	0.03	0.81	0.51

*Low data coverage (73%) due to moving of measurement station.

The SO_2-concentrations are discussed further in chapter 4.4. The highest monthly average sulphate-concentration was measured in April 2018. January and February also had slightly elevated monthly average sulphate-concentrations. Like for sulphate, the highest monthly average nitrate concentration was measured in April. The ammonium concentrations shows an annual variation with higher values in the spring and summer months, with the maximum monthly average in August.

The highest monthly concentrations of the sea-salt components magnesium, sodium and chloride, as well as potassium, were found in February 2018, while the highest monthly calcium concentration was found in June.

5 Comparison with data from Zeppelin observatory

Main inorganic compounds in air is also measured at the nearby observatory on Zeppelin mountain. One of the main purposes of the project is to detect possible influences of the activities in Ny-Ålesund on measurements at Zeppelin observatory. With the low concentration levels measured, at both sites, more extensive data analysis will be needed in order to conclude on this.

Annual averages of main components in air measured at Zeppelin observatory and down in Ny-Ålesund in 2018 are presented in Figure 16.

At both locations the measured concentrations are very low and close to the detection limit of the method. The station in Ny-Ålesund is closer to the sea and the concentrations of the sea-salt components are higher at this location.

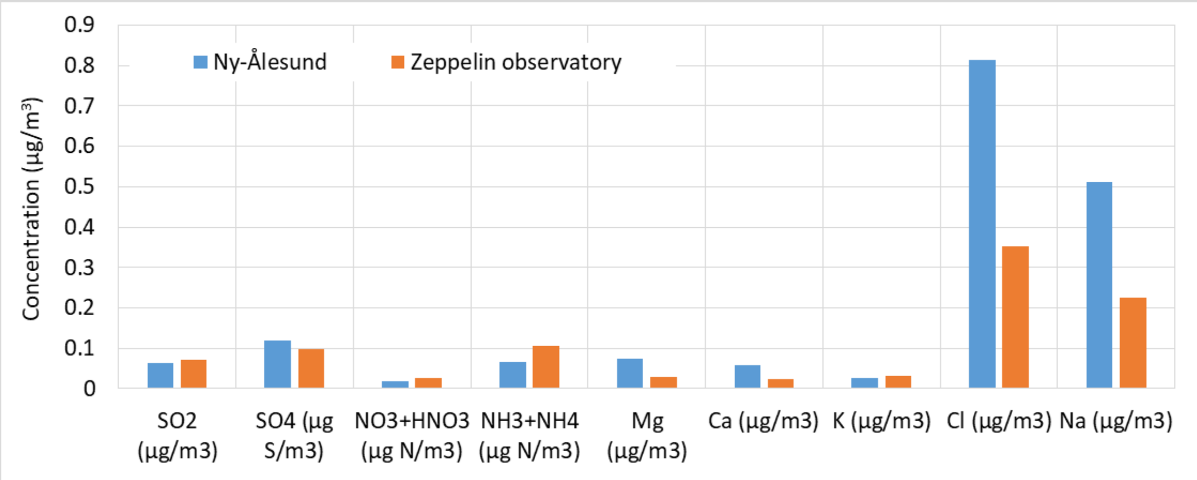


Figure 16: Annual average concentrations of main components in air measured at Ny-Ålesund and Zeppelin observatory in 2018.

6 Comparison with previous years

Monthly maximum SO_2-concentrations from 2008 to 2010 and 2014 to 2018 are presented in Figure 17, and monthly average SO_2-concentrations from the same years are presented in Figure 18. The highest hourly concentrations occur in the period September 2014 to January 2015, which coincides with the volcanic eruption at Holuhraun, Iceland. Apart from this period, the highest hourly concentrations seems to be in winter, with the maximum in February 2017. We also see elevated hourly concentrations during the summer period, but these are lower than in winter. For all previous years with measurements, except for the period when the measurements were influenced by the volcanic eruptions, the months January to April had the highest monthly average concentrations of SO_2.

The results from 2018 show a different annual distribution as the highest monthly average was registered in May, and even June had slightly elevated average concentration compared to previous years. Like previous years the concentrations during the months January to April 2018 were higher than in the summer months, but compared to previous years, the winter months' concentrations were low.

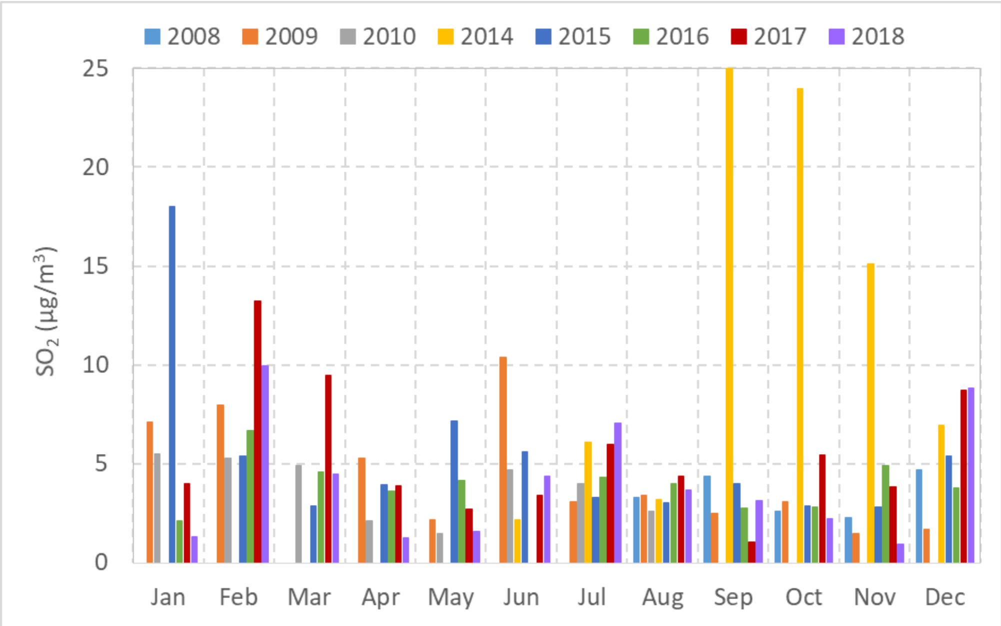


Figure 17: Monthly maximum hourly SO_2-concentrations from Nordpolhotellet for 2008-2010 and 2014-2018. Data from continuous monitor.

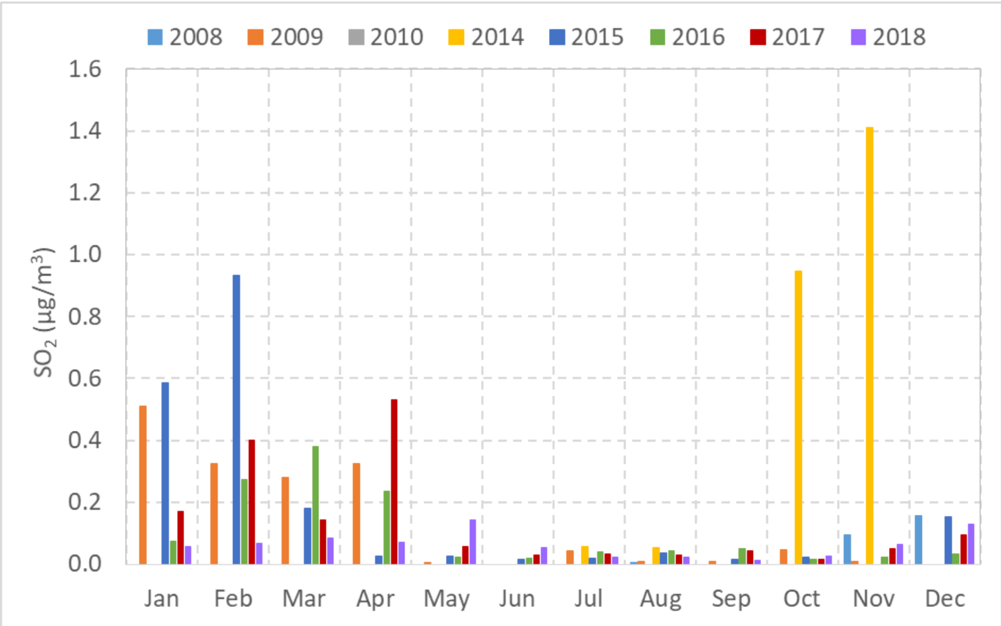


Figure 18: Monthly average SO_2-concentrations at Nordpolhotellet 2008-2010 and 2014-2018. Data from filter sampler.

Monthly maximum NO_2-concentrations from 2008-2010 and 2014-2018 are presented in Figure 19 and monthly average NO_2-concentrations from the same period are presented in Figure 20.

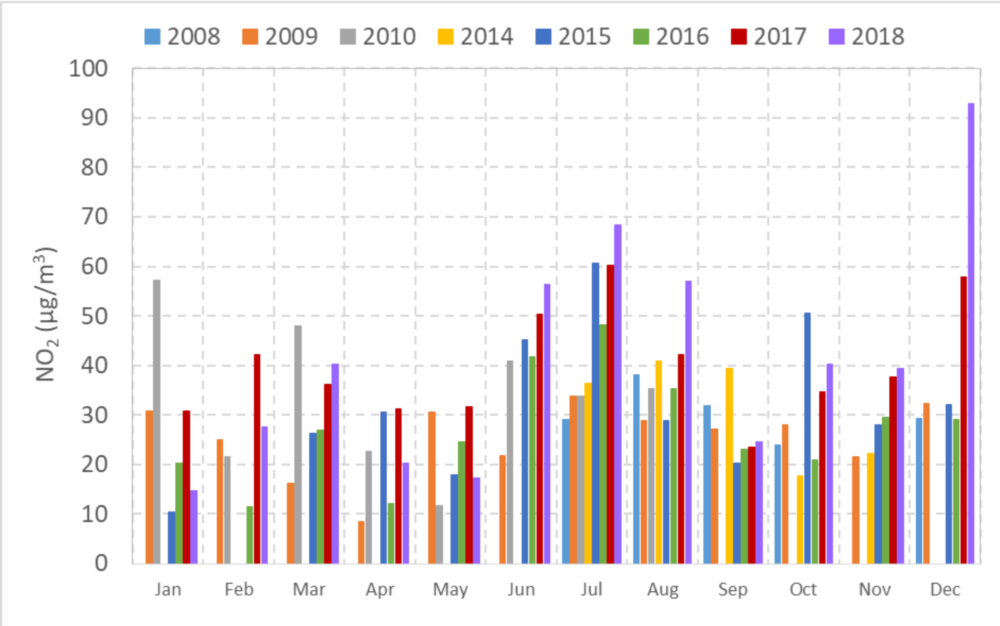


Figure 19: Monthly maximum hourly NO_2-concentrations at Nordpolhotellet for 2008-2010 and 2014-2018. Data from continuous monitor

The highest hourly concentration was measured in December 2018, but also June, July and August 2018 had high maximum hourly values.

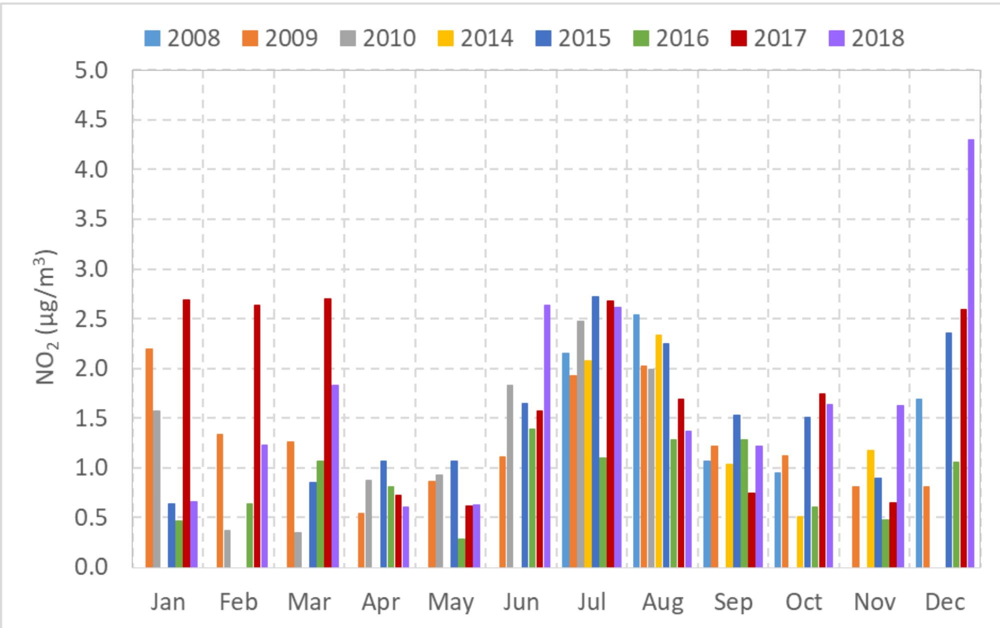


Figure 20: Monthly average NO_2-concentrations at Nordpolhotellet for 2008-2010 and 2014-2018. Data from continuous monitor

The monthly average NO_2 concentrations show an annual variation with higher averages in the summer months June to August, and the winter months December and January. For 2017, the average concentrations are in general somewhat higher than the previous years and show a different pattern, with elevated monthly average concentrations also in February and March. This may be explained by a change in the wind-pattern. As shown in Figure 21, during the months January to March in 2017 the frequency of wind from north and north-northwest were higher than during the same months the previous years, and even for 2018. Still the monthly average NO_2 concentration in March 2018 is elevated compared to previous years. The most significant feature in the 2018 results was however the elevated monthly average in December. As the measurements in December are done at the new location, the data series is too short to draw any conclusions yet whether these measurements are fully comparable with data from the old station location.

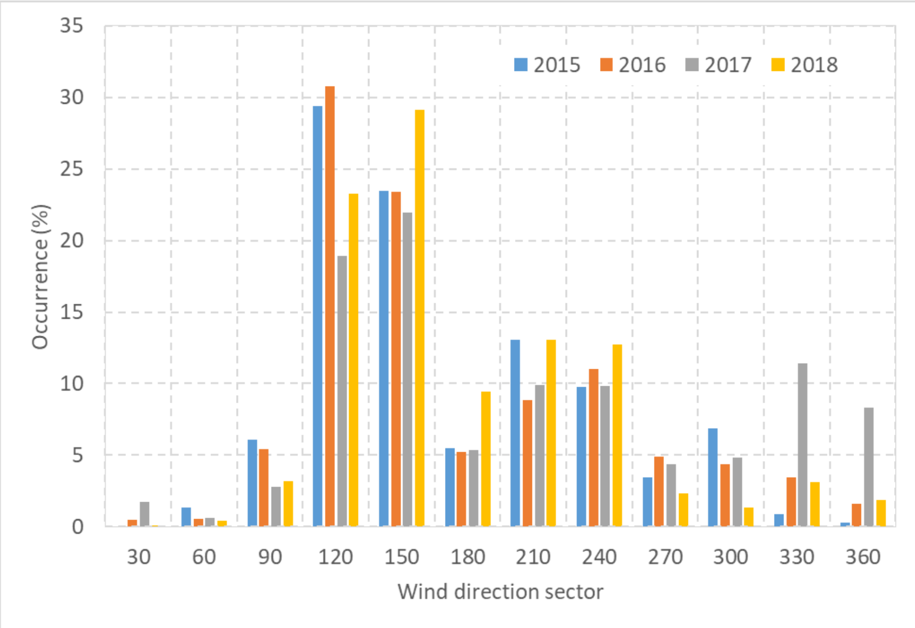


Figure 21: Frequency (% of the time) of wind from 12 30-degrees wind direction sectors at Nordpolhotellet for the period January to March for the years 2015 to 2018.

7 Deposition

Aas et.al. (2019) present annually estimates of the total dry deposition and the measured wet deposition of sulphur and nitrogen compounds at Norwegian background stations, as shown in Figure 22. The values given for Ny-Ålesund consist of estimated values for dry deposition, based on the concentrations measured at the Zeppelin observatory, and wet deposition measured at the Sverdrup station in Ny-Ålesund. The figures illustrate the decrease in deposition load moving from Birkenesobservatoriet in southern Norway to Svalbard in the far north.

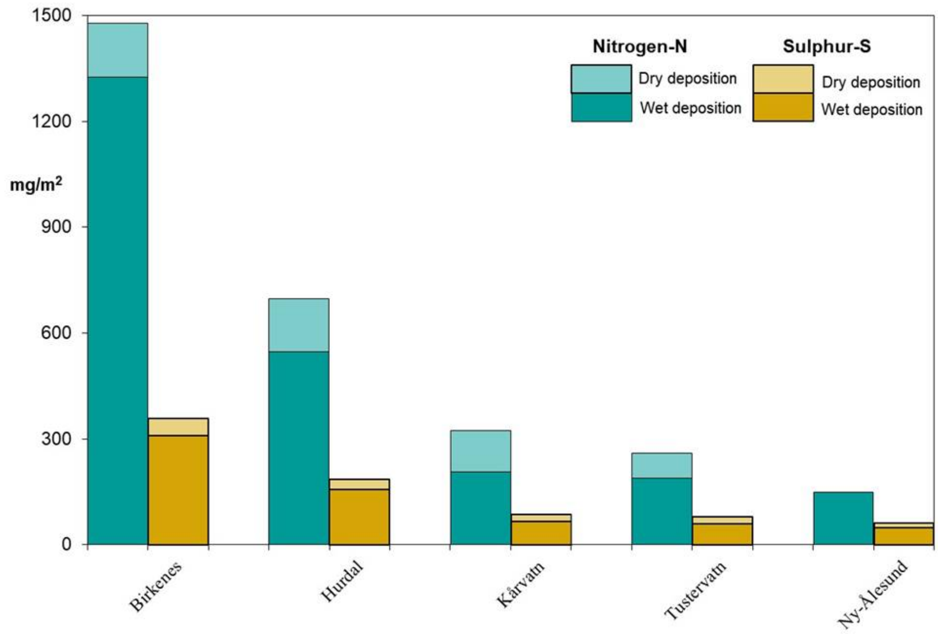


Figure 22: Total deposition (wet+ dry) of sulphur-S (SO_2, SO_4^{2-}) and nitrogen-N (NO_2, NH_4^+, NH_3, NO_3^-, HNO_3) at Norwegian background stations 2018 (Aas et al., 2019, Figure 3.5)

8 References

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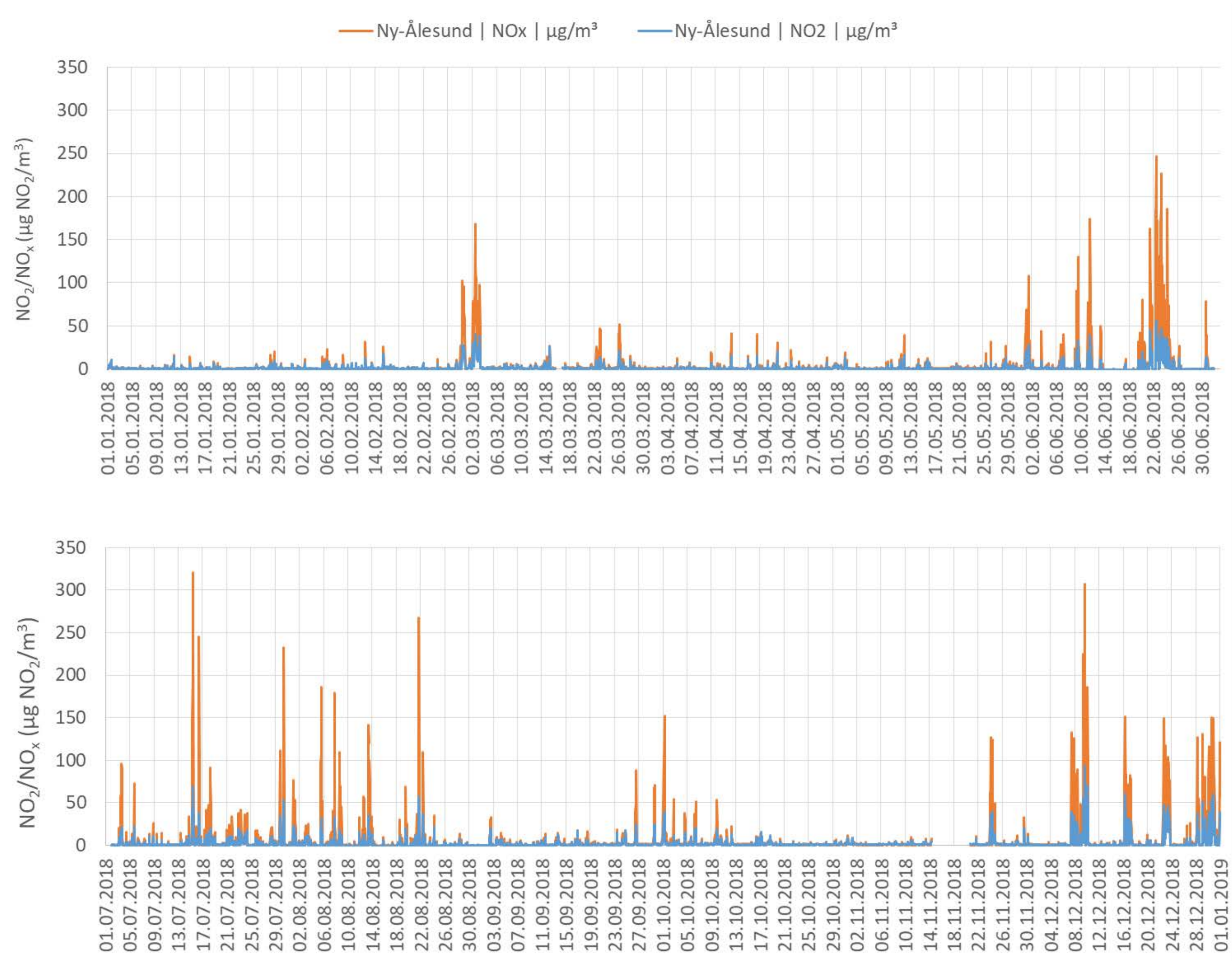
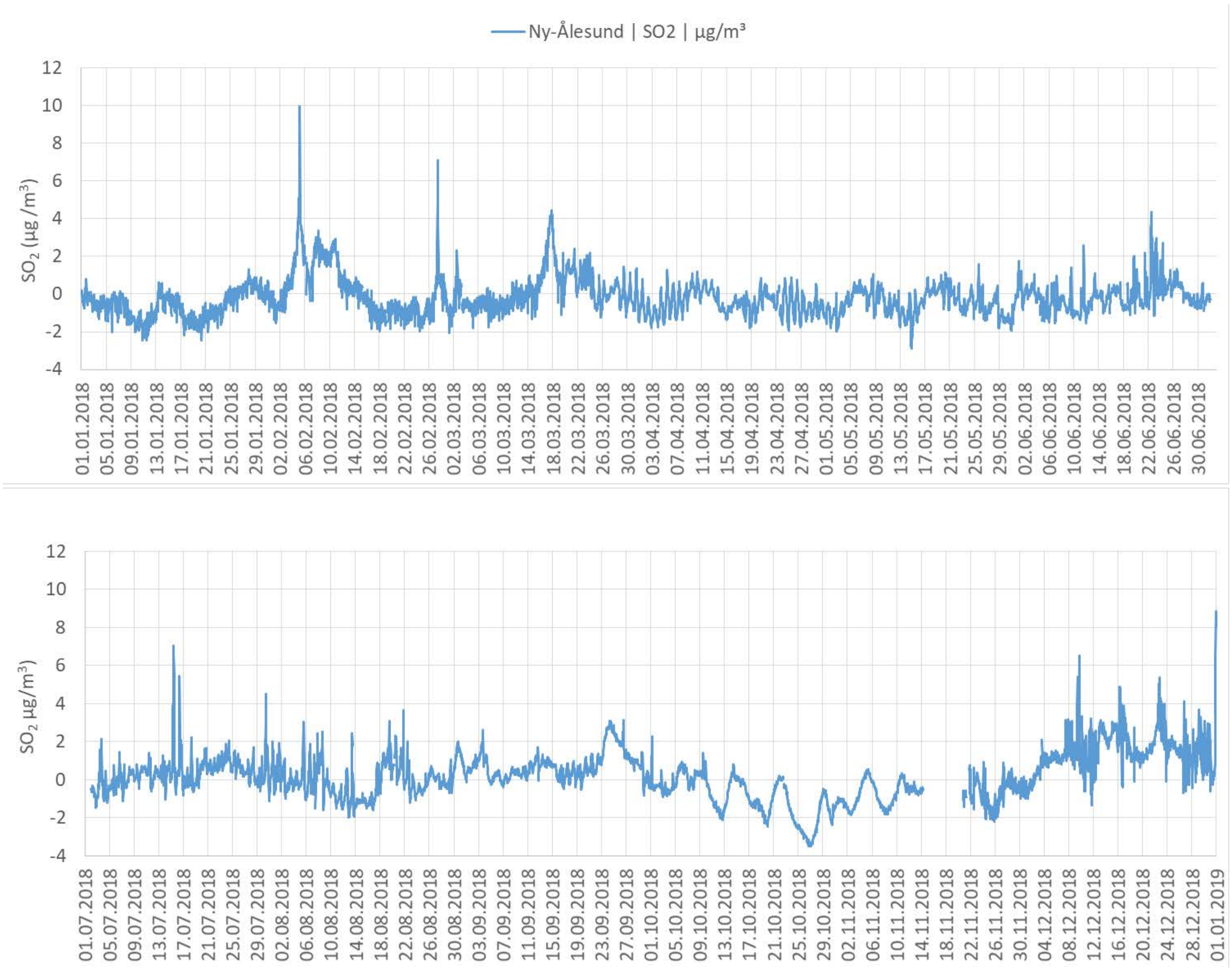
Appendix A

Measurement data

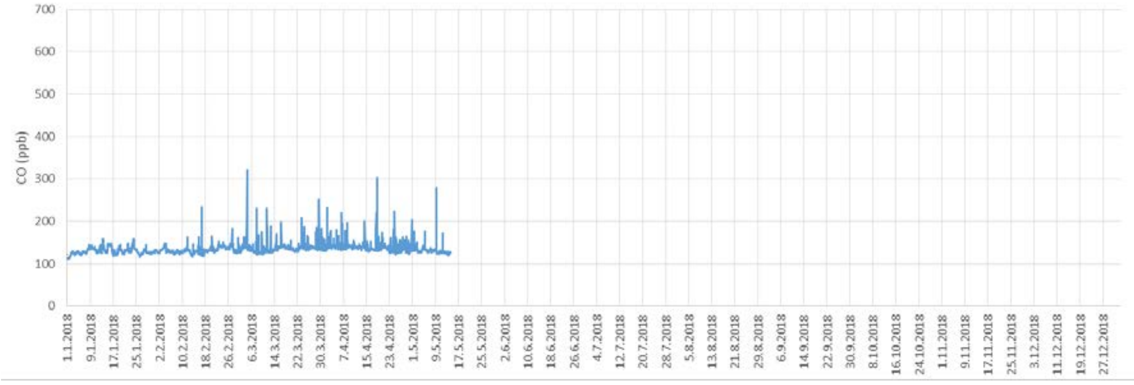
Hourly measurement data for NO_x and NO_2 at Nordpolhotellet, Ny-Ålesund 1.1.2018-14.11.2018 and Transformatorbua, Ny-Ålesund 20.11.2018-31.12.2018. NO_x as µg NO_2/m^3.



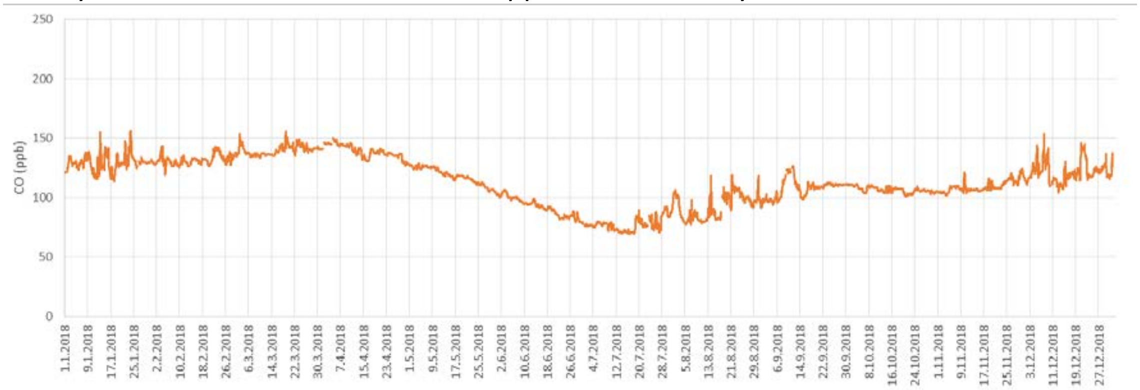
Hourly measurement data for SO_2 at Nordpolhotellet, Ny-Ålesund 1.1.2018-14.11.2018 and Transformatorbua, Ny-Ålesund 20.11.2018-31.12.2018.



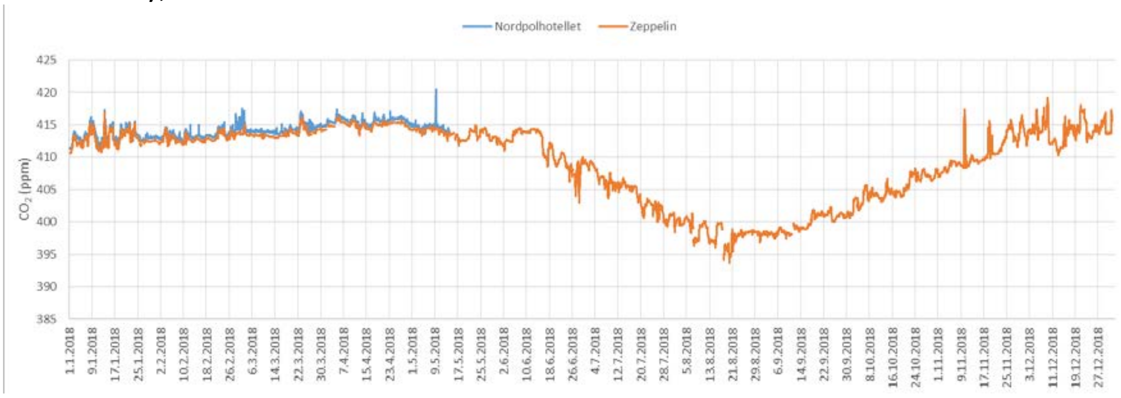
Hourly measurement data for CO at Nordpolhotellet, Ny-Ålesund, 1.1.-31.12.2018.



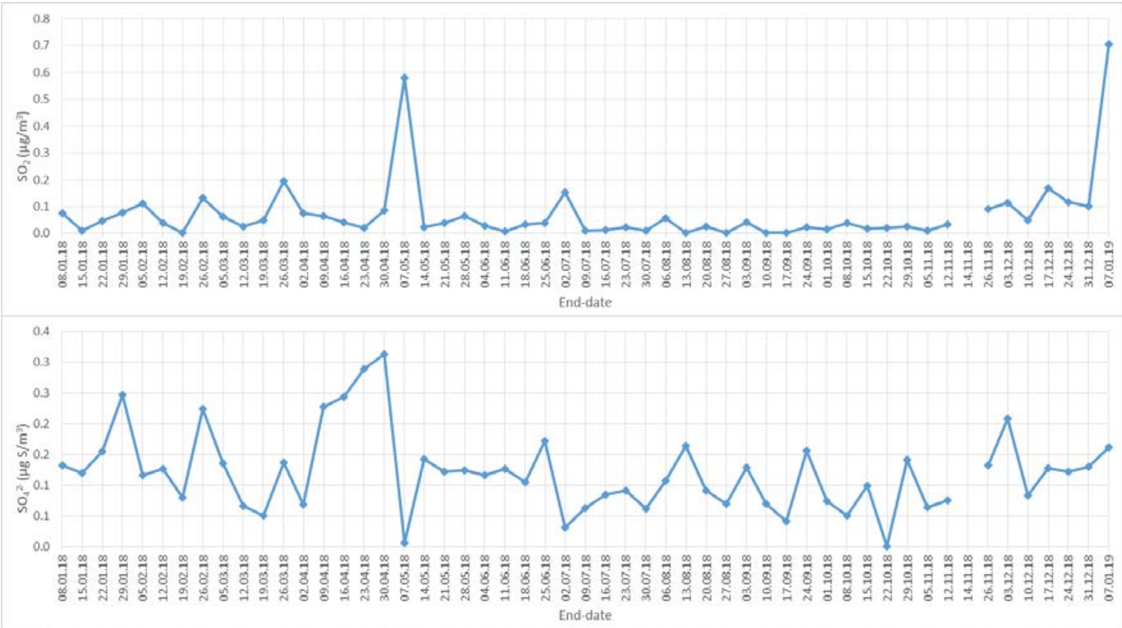
Hourly measurement data for CO at Zeppelin observatory, 1.1.-31.12.2018.

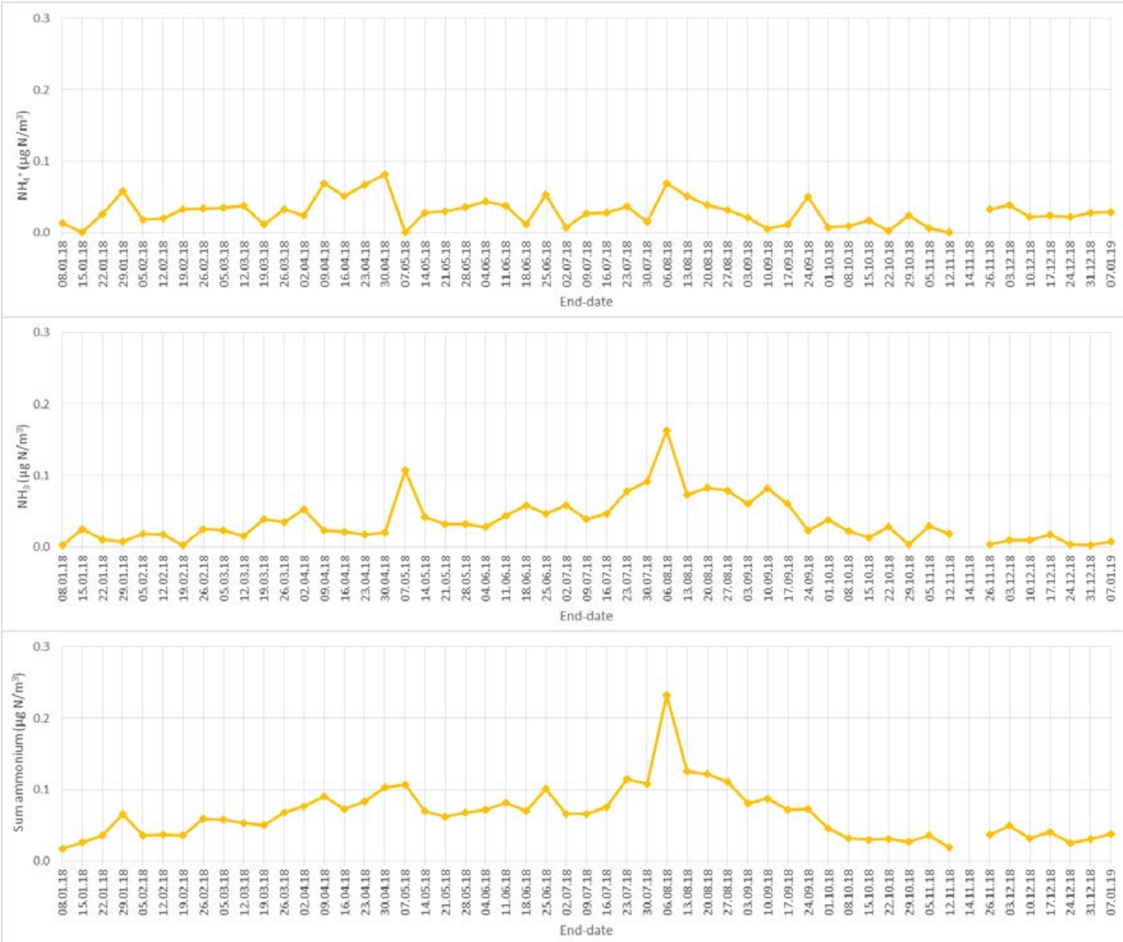


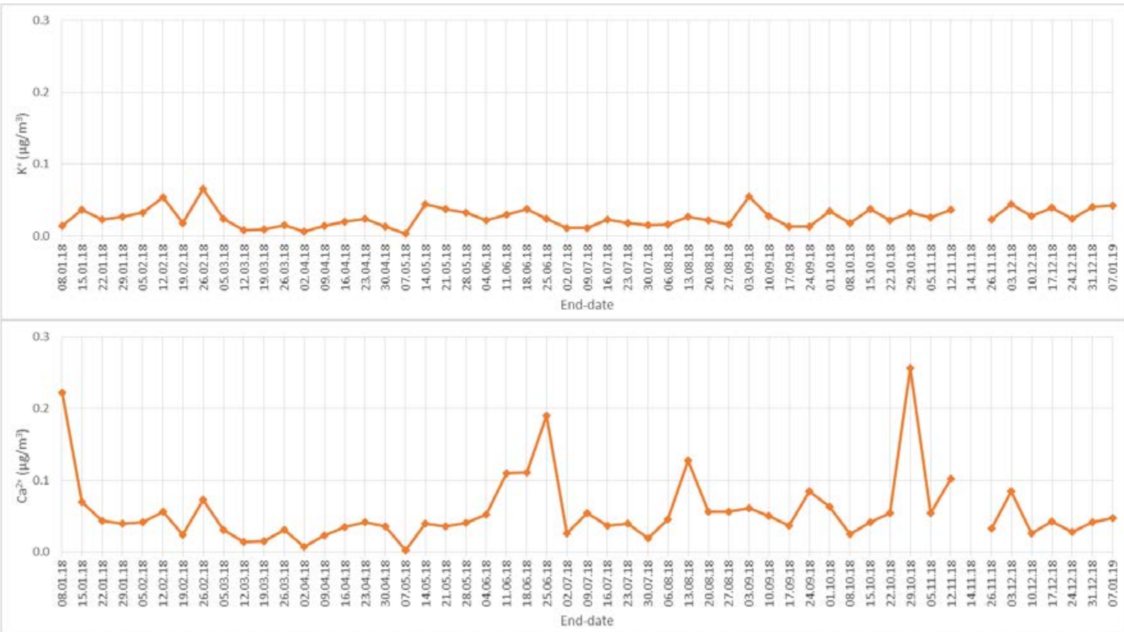
Hourly measurement data for CO_2 at Nordpolhotellet, Ny-Ålesund and at Zeppelin observatory, 1.1.-31.12.2018.

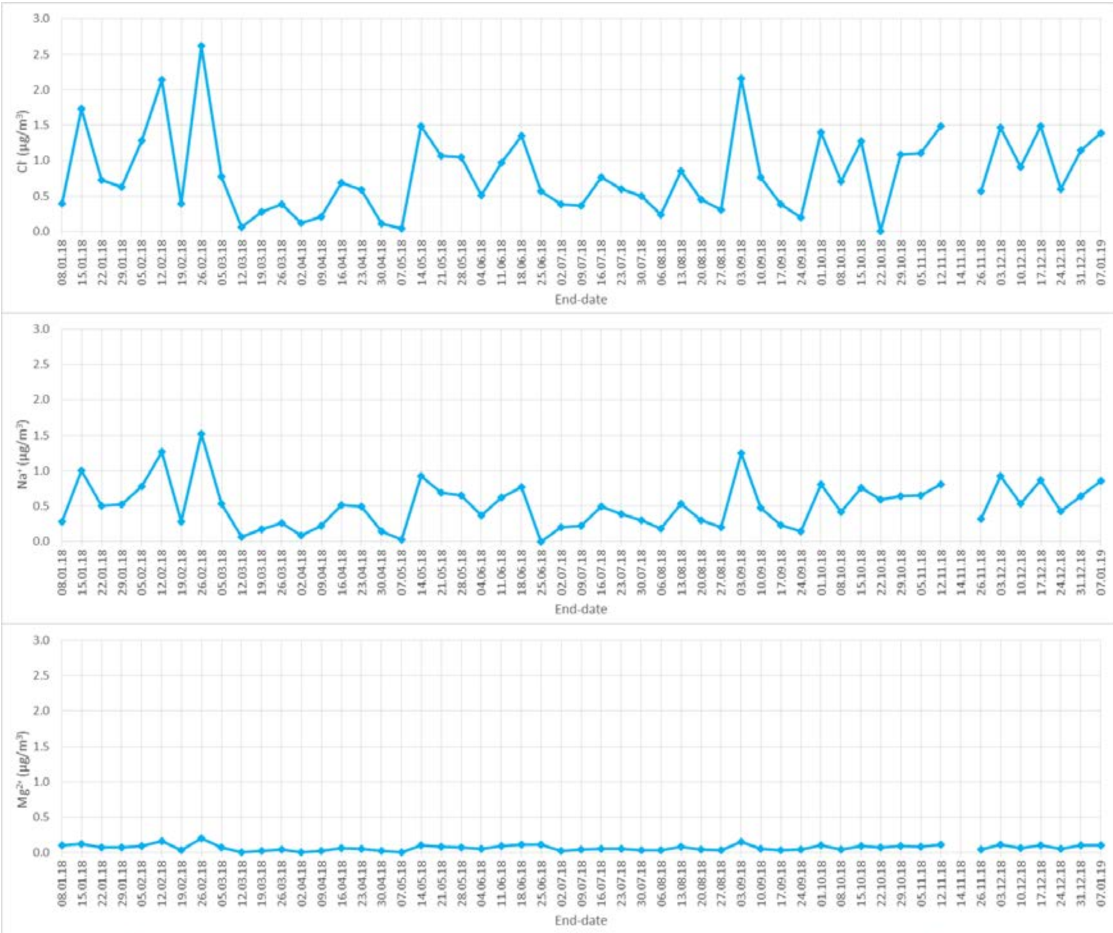


Analysis results of weekly filter sampling at Nordpolhotellet, Ny-Ålesund 1.1.-31.12.2018. 1.1.-12.11. at Nordpolhotellet, 20.11.-31.12. at Transformatorbua.




NH_4^+ (µg N/m³)
NH_3 (µg N/m³)
Sum ammonium (µg N/m³)
End-date
End-date
End-date


K^+ (µg/m³)
Ca^{2+} (µg/m³)
End-date
End-date


Cl⁻ (µg/m³)
Na⁺ (µg/m³)
Mg²⁺ (µg/m³)
End-date

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ISBN: 978-82-425-2990-9
ISSN: 2464-3327

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